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Sands of LIFE National Vegetation Classification (NVC) Survey

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JBA Consulting

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Crynodeb Gweithredol

Mae'r adroddiad hwn yn cyflwyno trosolwg o waith arolwg i fapio llystyfiant deg system twyni tywod Cymreig gan ddefnyddio'r Dosbarthiad Llystyfiant Cenedlaethol fel rhan o'r prosiect Twyni Byw (Sands of LIFE). Mae'r deg safle wedi eu lleoli mewn pedwar Ardal Cadwraeth Arbennig (ACA) sydd wedi eu dynodi ar gyfer cynefinoedd dywod wedi'i chwythu. Y safleoedd yw ACA Abermenai i Dwyni Aberffraw, ACA Harlech a Dyffryn, ACA Twyni Bae Caerfyrddin ac ACA Cynffig.

Arolygwyd y deg safle rhwng Mai ac Awst 2019 gan dîm o fotanegwyr profiadol. Mapiwyd cynefinoedd trwy aseinio clystyrau homogenaidd o llystyfiant i'r gymuned ac is-gymuned agosaf yn y Dosbarthiad Llystyfiant Cenedlaethol. Cofnodwyd cwadratau cynrychioliadol a nodiadau targed i ategu'r nodiadau a creuwyd yn y maes. Dadansoddwyd data i asesu'r mapio maes, yn enwedig ar gyfer standiau cymhleth, ond ar y cyfan mae'r dosbarthiad a ddefnyddir yn deillio o'r asesiadau a gwneud yn y maes. Osgowyd mapio llystyfiant trosiannol lle bo hynny'n bosibl, ond cofnodwyd brithwaith llystyfiant gydag asesiad o gyfran pob math o llystyfiant a gyfrannodd.

Mapiwyd cyfanswm o 3,995 hectar o llystyfiant ar draws y deg safle. Cofnodwyd 306 o fathau o gynefinoedd, wedi'u haseinio'n uniongyrchol yn bennaf i gymuned ac is-gymuned gydnabyddedig y Dosbarthiad Llystyfiant Cenedlaethol (DLC). Trefnwyd y cynefinoedd mewn cyfres patrwm naturiol, o gymunedau megis llinynlin, twyn embryo, twyni symudol, twyni sefydlog i gynefinoedd olynol hwyr gan gynnwys coetir prysgwydd. Roedd ardaloedd gwlypach yn cefnogi ystod o gynefin ffen a thwyni llac.

Roedd cyfuniad a dilyniant y cymunedau llystyfiant ar bob safle yn amrywio. Effeithiwyd gan ffactorau megis dibynnu ar y gyfradd cronni neu'r erydiad, sefydlogrwydd prif grib y twyni, maint ardal pori, symudedd tywod a dadwaddoli'r glaswellt sefydlog, aflonyddwch lleol a sut oedd y safle wedi ei rheoli.

Y math mwyaf cyffredin o llystyfiant a gofnodwyd yn yr arolwg oedd **Glaswelltir Twyni Sefydlog SD8 Festuca rubra-Galium verum**, llystyfiant nodweddiadol twyni calchaid sefydlog. Mae pob un o'r tair is-gymuned sychach o'r math hwn o llystyfiant yn gyffredin. Cofnodwyd symiau mawr o **Gymuned Twyni Lled-sefydlog SD7 Ammophila arenaria-Festuca rubra** a **Glaswelltir Twyni SD9 Ammophila arenaria-Arrhenatherum elatius** hefyd.

Cofnodwyd ystod o fathau o llystyfiant mewn twyni llac, gyda **Chymuned Lac Twyni SD16 Salix repens-Holcus lanatus** y fwyaf cyffredin. Cofnodwyd ardaloedd mawr o **Gymuned Twyni Llac SD15 Salix repens-Calliargon cuspidatum** a **SD17 Potentilla anserina-Carex nigra**.

Roedd prysgwydd a choetir yn bresennol ar y twyni, gyda'r math mwyaf cyffredin wedi'i gofnodi fel **Coetir W1 Salix cinerea-Galium palustre**. Roedd **Brysgwydd W22 Prunus spinosa-Rubus fruticosus** a **Phrysgwydd W25 Pteridium aquilinum-Rubus fruticosus** yn gyffredin mewn ardaloedd sychach.

Roedd rhai o'r mathau o llystyfiant sy'n cynnal rhywogaethau nodedig yn cynnwys llystyfiant twyni llac olynol y gellir ei gyfeirio at gymuned **Twyni Llac Sagina nodosa-**

Bryum pseudotriquetrum a Chymuned Twyni Llac SD14 Salix repens-Campylium stellatum, yn ogystal â chymuned flynyddol Twyni SD19 Phleum arenarium-Arenaria serpyllifolia.

Cofnodwyd ystod o llystyfiant trosiannol rhwng llystyfiant twyni tywod a morfa heli, tir amaethyddol a glaswelltiroedd arfordirol. Mae trawsnewidiadau i forfa heli yn nodwedd benodol o'r safleoedd a arolygwyd yn y prosiect.

Mae effaith ymyriadau cadwraeth dros yr hanner canrif ddiwethaf wedi cael effaith nodedig ar llystyfiant y twyni tywod. Mae dyfeisiadau sydd wedi'u hanelu i raddau helaeth at gael gwared â llystyfiant coediog a chreu amodau tywod agored, symudol wedi arwain yn aml at llystyfiant sy'n anodd gwahaniaethu oddi wrth yr ardaloedd na chawsant eu newid. Er hyn mae'r ymyriadau diweddar yn gadael rhywfaint o wasgnod ar y llystyfiant.

Mae'r arolwg yn uwchleuo yr amrywiaeth naturiol o llystyfiant twyni tywod sy'n bresennol yn nhwyni tywod mawr Cymru. Mae pwysigrwydd y llystyfiant a'r gwaith cadwraeth natur i'w chynnal yn hynod o bwysig.

Executive Summary

This report presents an overview of survey work to map the vegetation of ten Welsh sand dune systems using the National Vegetation Classification as part of the Sands of LIFE project. The ten sites are located in four Special Areas of Conservation designated for habitats of blown sand; the sites are Abermenai to Aberffraw Dunes SAC, Morfa Harlech and Morfa Dyffryn SAC, Carmarthen Bay Dunes SAC and Kenfig SAC. This overview report summarises detailed site accounts published as separate reports and is accompanied by GIS data and photographs available from NRW.

The sites were surveyed between May and August 2019 by a team of experienced botanists. Habitats were mapped by assigning homogenous stands of vegetation to the closest matching community and sub-community of the National Vegetation Classification. Representative quadrats and target notes were recorded to support the field identification. Some analysis of data was used to assess the field mapping, particularly for difficult stands, but overall the classification used is derived from the field-based assessment. The mapping of transitional vegetation was avoided where possible, but vegetation mosaics were recorded with an assessment of the proportion of each contributing vegetation type included.

A total of 3,995 ha of vegetation was mapped across the ten sites. This vegetation was assigned to 306 habitat types, mostly directly assigned to a recognised NVC community and sub-community. The habitats were arranged in a natural pattern, with a series of communities from strandline, embryo dune, through mobile dunes, fixed dunes to late successional habitats including scrub and woodland. Wetter areas supported a range of dune slack and fen habitats. The combination and sequence of vegetation communities at each site varied depending on the rates of accretion or erosion at the beach transition, the stability of the main dune ridge, the extent of grazing, the mobility of sand and decalcification of fixed swards, local disturbance and site management.

The most common vegetation type recorded in the survey was **SD8 *Festuca rubra-Galium verum* fixed dune grassland**, the typical vegetation of fixed calcareous dunes. All three of the drier sub-communities of this vegetation type are common. Large quantities of **SD7 *Ammophila arenaria-Festuca rubra* semi-fixed dune community** and **SD9 *Ammophila arenaria-Arrhenatherum elatius* dune grassland** were also recorded.

A range of vegetation types were recorded in dune slacks, with **SD16 *Salix repens-Holcus lanatus* dune-slack community** being the most common, but large areas of **SD15 *Salix repens-Calliargon cuspidatum* dune-slack community** and **SD17 *Potentilla anserina-Carex nigra* dune-slack community** also recorded.

Scrub and woodland were present on the dunes, with the most common type recorded being **W1 *Salix cinerea-Galium palustre* woodland**, both where *Salix cinerea* has invaded slacks and also around areas of freshwater wetland on the dune systems. Stands of **W22 *Prunus spinosa-Rubus fruticosus* scrub** and **W25 *Pteridium aquilinum-Rubus fruticosus* underscrub** were common in drier places.

Some of the vegetation types supporting notable species included the early-successional dune slack vegetation referable to the NVC type **SD13 *Sagina nodosa-Bryum pseudotriquetrum* dune-slack community** and **SD14 *Salix repens-Campylium stellatum* dune-slack community** as well as the dune annual community **SD19 *Phleum arenarium-Arenaria serpyllifolia* dune annual community**.

A range of transitional zones between sand dune vegetation and saltmarsh, agricultural land and coastal grasslands were recorded. Transitions to saltmarsh are a particular feature of the sites surveyed here.

The impact of conservation interventions over the last half a century have had a notable impact on the vegetation of the sand dunes. Interventions largely aimed at removing woody vegetation and creating open, mobile sand conditions have often resulted in vegetation which is difficult to distinguish from nearby good quality sand dune habitat, although recent interventions inevitably leave some imprint on the vegetation assemblage.

The survey highlights the diversity and extent of the natural vegetation of sand dunes present on the large dune systems of Wales. Their nature conservation importance in terms of the unique, natural, coherent patterns of vegetation are clearly demonstrated.

Introduction

Sands of LIFE

Sands of LIFE is a major conservation project to rejuvenate 2400 hectares of sand dunes across Wales. The project aims to recreate movement in the dunes and revitalise habitats which are home to some of our rarest wildlife. Sands of LIFE will reprofile dunes and create bare areas to allow sand to move again, lower the surface of dried-out dune slacks to recreate pools and wet habitats, promote sustainable grazing by livestock and rabbits and remove scrub and invasive non-native species.

The project covers 10 sites across four Special Areas of Conservation (SAC). These are: Tywyn Aberffraw; Newborough Warren; Morfa Dinlle; Morfa Harlech; Morfa Dyffryn; Laugharne-Pendine Burrows; Pembrey Coast; Whiteford Burrows; Kenfig and Merthyr Mawr.

Sands of LIFE NVC Survey 2019

JBA undertook a full National Vegetation Classification survey of all of the project sites, except Merthyr Mawr, under contract to NRW through the Sands of LIFE project. The survey took place during the spring and summer of 2019 with a team of experienced botanists. The surveys provided an update on the previous whole-site NVC surveys completed as part of the JNCC's Sand Dune Survey of Great Britain carried out in the late 1980s and early 1990s (Sand Dune Survey of Great Britain)

This report summarises the findings but full details of the NVC survey are included in a separate report for each site. Detailed GIS layers with NVC polygons, target notes, quadrat locations and photograph locations are held by NRW and available on request from the library. The details of the site-specific reports are:

1. Heathcote SJ, Finch R, Lamacraft D, Orange A, Ruffino L, Sheehan K, Stewart B, Toop C, 2022. Sands of LIFE National Vegetation Classification (NVC) survey – Site report for Tywyn Aberffraw. NRW Sands of LIFE Report No: 540 , 97pp, Natural Resources Wales, Bangor.
2. Heathcote SJ, Finch R, Lamacraft D, Ruffino L, Stewart B, Toop C, 2022. Sands of LIFE National Vegetation Classification (NVC) survey – Site report for Newborough Warren. NRW Sands of LIFE Report No:541 , 91pp, Natural Resources Wales, Bangor.
3. Heathcote SJ, Lamacraft D, Gillis M, 2020. Sands of LIFE National Vegetation Classification (NVC) survey – Site report for Morfa Dinlle. NRW Sands of LIFE Report No: 542, 52pp, Natural Resources Wales, Bangor.
4. Heathcote SJ, Finch R, Orange A, Ruffino L, Lamacraft D, 2020. Sands of LIFE National Vegetation Classification (NVC) survey – Site report for Morfa Dyffryn. NRW Sands of LIFE Report No: 543, 89pp, Natural Resources Wales, Bangor.
5. Heathcote SJ, Finch R, Orange A, Ruffino L, Lamacraft D, 2021. Sands of LIFE National Vegetation Classification (NVC) survey – Site report for Morfa Harlech. NRW Sands of LIFE Report No: 544, 81pp, Natural Resources Wales, Bangor.

6. Heathcote SJ, Finch R, Ruffino L, Sheehan K, Stewart B, 2020. Sands of LIFE National Vegetation Classification (NVC) survey – Site report for Pembrey Coast. NRW Sands of LIFE Report No:545, 72pp, Natural Resources Wales, Bangor.
7. Heathcote SJ, Finch R, Lamacraft D, Ruffino L, Stewart B. 2020. Sands of LIFE National Vegetation Classification (NVC) survey – Site report for Laugharne-Pendine Burrows. NRW Sands of LIFE Report No: 546, 97pp, Natural Resources Wales, Bangor.
8. Heathcote S J, Finch R, Lamacraft D, Ruffino L, Sheehan K A, Stewart B, (2021). Sands of LIFE National Vegetation Classification (NVC) survey – Site report for Whiteford Burrows. NRW Sands of LIFE Report No: 547, 62pp, Natural Resources Wales, Bangor.
9. Heathcote SJ, Finch R, Lamacraft D, Orange A, Ruffino L, Sheehan K, Stewart B, Thomas L, 2021. Sands of LIFE National Vegetation Classification (NVC) survey – Site report for Kenfig. NRW Sands of LIFE Report No: 548, 97pp, Natural Resources Wales, Bangor.

One Sands of LIFE project site, Merthyr Mawr, was surveyed separately as part of the Dunes 2 Dunes project and the survey details are included in a separate report (Pickard *et al.* 2019). However, for completeness details of this survey are included here in this summary report.

Sand Dune Survey of Great Britain

These ten sites in the Sands of LIFE Project were previously surveyed using the NVC in the late 1980s and early 1990s as part of the Sand Dune Survey of Great Britain (SDSGB). The results for Wales were summarised in Dargie (1995) and individual site reports were prepared. The relevant site reports for the SoLIFE project are:

1. Ashall J, Duckworth J, Holder C, Smart S. 1992a. Sand dune survey of Great Britain. Site report no. 123. Aberffraw, Ynys Mon. Peterborough: Joint Nature Conservation Committee.
2. Ashall J, Duckworth J, Holder C, Smart S. 1992b. Sand dune survey of Great Britain. Site report no. 122. Newborough Warren and Forest, Ynys Mon. Peterborough: Joint Nature Conservation Committee.
3. Ashall J, Duckworth J, Holder C, Smart S. 1991a. Sand dune survey of Great Britain. Site report no. 115. Morfa Dyffryn, Meirionnydd. Peterborough: Joint Nature Conservation Committee.
4. Ashall J, Duckworth J, Holder C, Smart S. 1991b. Sand dune survey of Great Britain. Site report no. 116. Morfa Harlech, Meirionnydd. Peterborough: Joint Nature Conservation Committee.
5. Dargie T. 1989a. National sand dune vegetation survey. Site report no. 51. Whiteford Burrows. Peterborough: Nature Conservancy Council.
6. Dargie T. 1989b. National sand dune vegetation survey. Site report no. 52. Pembrey Coast. Peterborough: Nature Conservancy Council.
7. Duckworth J, Holder C, Smart S. 1991. Sand dune survey of Great Britain. Site report no. 121. Morfa Dinlle, Arfon. Peterborough: Joint Nature Conservation Committee.
8. Jones PS. 1989. National sand dune vegetation survey. Site report no. 43. Merthyr Mawr. Peterborough: Nature Conservancy Council.

9. Jones PS, Etherington JR. 1988. Mid Glamorgan vegetation survey. Kenfig Pool and dunes. Peterborough: Nature Conservancy Council.

The maps and other spatial data produced as part of these surveys were digitised by NRW in the early 2000s, and versions of these are included in the site-specific reports. Similar surveys were completed in Scotland from 1995 onwards. The surveys in Scotland led to the recognition and description of sand dune communities not adequately captured in the original NVC. These are summarised in Mountford (2011) and are used in this survey.

Sand Dune SACs in Wales

The Sands of LIFE project focusses on sites where sand dune habitats are amongst the Qualifying Interest (QI) features for a Special Area of Conservation. The location of the four SACs involved are show in Figure 1. One of these sites, Pembrey Coast, consists of two separate areas, Pembrey Burrows in the south and Tywyn Gwendraeth (MOD Pembrey) in the north, which are separated by Pembrey Country Park and Pembrey Forest.



Figure 1: Location of project SACs and their constituent dune systems

National Vegetation Classification

The National Vegetation Classification (NVC) is a phytosociological scheme developed to provide a comprehensive system to classify vegetation throughout Wales, Scotland and England. The final scheme was published in the five British Plant Communities volumes (Rodwell 1991a; 1991b; 1992; 1995; 2000). The system has been in widespread use since it was developed in the late 1980s. The Sand Dune Survey of Great Britain used this classification system on the Welsh dunes in the late 1980s and early 1990s (Dargie 1995). Since the publication of the original volumes much has been written to develop the classification further, including the Users' Handbook (Rodwell 2006) and a review of proposed additions (Mountford 2011) and, of particular relevance here, this includes a summary of the additional NVC community types identified in the Scottish part of the Sand Dune Survey of Great Britain (Dargie 1993).

The NVC is not designed as a hierarchical scheme, unlike much European phytosociology. However, the vegetation communities were split into groups based on the broad habitat type, with open vegetation being used as a catch-all for a diverse group of vegetation types at the end. The group codes are shown in the table below.

Table 1: NVC categories

NVC Prefix	Category	No. comms	Notes for Sand Dune survey
A	Aquatic	24	Sometimes found in coastal waterbodies but generally not mapped in this survey
CG	Calcicolous grassland	14	Rare on sand dunes, such as where climbing dunes are found on limestone bedrock
H	Heaths	22	Includes a specific community for dune heath and some other heathland types that may occur on dunes
M	Mire	38	Includes some of the mires that develop in dune slacks
MC	Maritime cliff	12	Coastal grassland influenced by salt, most commonly on coastal cliffs, and includes some vegetation occasionally found on strand lines and shingle
MG	Mesotrophic grassland	13	Often found on damper or more enriched soils on sand dunes
OV	Open vegetation	42	Includes communities of disturbed ground and tall herb vegetation that are sometimes found on dunes
S	Swamp and tall-herb fen	28	Uncommon in sand dunes but includes communities found in some deeper slacks as well as ponds and lakes on or around dunes
SD	Sand dune	19	The main vegetation of sand dunes
SM	Saltmarsh	28	Intertidal vegetation often found around the edges of sand dunes and occasionally overlapping with them
U	Calcifugous grassland	21	A range of calcifuge grasslands, often found in the uplands, and occasionally present on dunes
W	Woodland	25	Woodland and scrub communities including many found on sand dunes

NVC codes and naming conventions

The NVC volumes introduced a specific way of naming each community, a convention which is followed throughout this report. The community is assigned a letter with a sequential number, following which are listed one to three prominent species from the community, then a word or two describing the vegetation type for example **SD8 *Festuca rubra-Galium verum* fixed dune grassland** or **W1 *Salix cinerea-Galium palustre* woodland**

Where these communities include sub-communities, these are described in the NVC volumes by a number (typically two) of their characteristic species, or rarely another defining features (e.g. typical sub-community, or species-poor sub-community). Examples for SD8, which includes five sub-communities, are:

Typical sub-community, *Luzula campestris* sub-community, *Tortula ruralis* ssp. *ruraliformis* sub-community, *Bellis perennis-Ranunculus acris* sub-community, and *Prunella vulgaris* sub-community.

When using shorthand codes these communities are assigned a letter based on the order in which they are described in the volumes (a, b, c...). The same applies where these sub-communities are split further, referred to as 'variants' in the NVC volumes. These are similarly named using prominent species, and assigned a roman numeral for the purposes of mapping (i, ii, iii...). The full name of a community (given at least at the first mention in each report would then look something like this: **SD8c *Festuca rubra-Galium verum* fixed dune grassland, *Tortula ruralis* ssp. *ruraliformis* sub-community**. This may then be referred to in the text as simply **SD8c**.

Frequency, abundance and constant species

Frequency and abundance are the two main variables used to interpret the vegetation data in the NVC volumes, and they are fundamental to the presentation of data in the published volumes. The floristic tables in the NVC combine all data assigned to that community from the whole of the British Isles. Frequency class is assigned on a scale of I to V.

The species in classes IV and V are termed 'constant' species. This is an important note for interpreting floristic data, with constant species being present in 60% or more of samples (e.g. a 'constant' species may be absent in 40% of stands nationwide). The abundance values used are simply the range of Domin values recorded for each species in all quadrats, in particular species where the Domin is 8 or over (see table 3) can give the impression of overwhelming dominance in a stand.

Frequency Scale

The frequency scale uses Roman numerals I-V and used in the published NVC and is a measure of the percentage of samples in which each species is recorded. Those that occur in >60% of samples (frequency class IV and V) are considered to be 'constant' in that community.

Table 2: Frequency scale

% samples	Frequency
80-100	V
60-79	IV
40-59	III
20-39	II
0-19	I

Preferential and differential species and the keys

Preferential and differential species are used extensively in the published NVC volumes to help distinguish between different communities and sub-communities. Preferential species are those which tend to have a higher than average frequency or constancy within a certain sub-community and differential species have a lower than average frequency. These species form the basis of the dichotomous (rarely polytomous) keys given in the published volumes to help identify vegetation

communities. The keys rely on the overall floristics of stands of vegetation, drawing on both the frequency and abundance of species.

Philosophy for assigning NVC communities in this survey

The NVC user's handbook (Rodwell 2006) provides a pragmatic approach to implementing the NVC, accepting the continuous variation in vegetation and the difficulty of defining precise units. The implementation of the NVC on a wide range of field surveys by NRW has led to the development of a specific approach to application and interpretation of the NVC. This approach was specified for these surveys and followed as closely as possible. In particular, the approach is based on assigning vegetation to an NVC community in the field, and not relying on *post hoc* computer assisted analysis. The approach used also favours taking a wider view of the vegetation, using published communities wherever possible, even for stands of vegetation that are some way from the 'typical' community description. This approach was dutifully implemented in the field survey, allowing much of the vegetation to be placed into the existing NVC communities, even where the vegetation represents significant local variation. There was also an active decision to avoid mapping transitional stands of vegetation unless there was no clear alternative: vegetation that was intermediate between two communities was assigned to the community to which it had the strongest affinities, with a note added to state its transitional nature. In many cases, such stands were mapped as mosaics, as they typically incorporated small areas of both ends of the transition as well as areas of mixed communities.

Methods

Field Survey

Dates and Survey team

The field surveys were completed between May and August 2019 by a team of ecologists from JBA Consulting and sub-contractors. The survey team included JBA botanists Steven Heathcote, Kieran Sheehan, Laura Thomas and Chris Toop, assisted by JBA ecologists Catherine Porter, Catherine Rodd (nee Jones), Jennifer Pullen, Jon Harrison, Laura Hodgkinson, Mairi Gillis and Plantlife's Elizabeth Cooke. The expert botanical sub-contractors who completed the survey were Alan Orange, Lucia Ruffino, Richard Finch, and Barry Stewart. Additional support with the identification of lichens was provided by Plantlife's Dave Lamacraft.

Field Mapping

All homogeneous stands of vegetation were identified and described to NVC sub-community level whenever possible. These stands were mapped onto ortho-rectified aerial photographs and OS *MasterMap* base maps to a scale of 1:5000. Vegetation was primarily mapped using the set of aerial photographs covering all of Wales, recorded in 2013. However, for the dynamic coastline, particularly foredune vegetation, these images were not possible to use and in these situations up-to-date satellite imagery was used (e.g. Bing Images, Google Earth) which showed the ortho-rectified satellite images from 2019. Vegetation was assigned to the published communities and intermediate communities were only used in exceptional circumstances, with the communities mapped using the codes set out above in NVC codes and naming conventions. However, vegetation within the site displayed complex and gradual transitions between communities reflecting subtle variations in environmental parameters and mapping should be viewed as a simplification of this complexity.

Transition zones to terrestrial, marine and freshwater habitats were mapped. In many cases the SAC boundary does not reach the edge of the blown sand, so no transitions were present within the surveyed site. However, the transition to beach sand or shingle was mapped using marine biotope survey method where appropriate (JNCC 2015). Transitions to terrestrial and freshwater vegetation were generally mapped using the NVC, and in many cases recognisable mosaics and transitions were present.

Mosaics of communities were mapped where different communities or sub-communities occurred in intimate association, or within complex, ill-defined boundaries. Vegetation mosaics were mapped as discrete parcels and an estimate of the relative proportions of the component sub-communities of mosaics were included on the map or in a target note.

Quadrat Samples

Quadrat samples were recorded for each sub-community and further samples were collected wherever difficulties with the NVC placement were encountered or for large or variable stands. Stands of scrub or woodland vegetation occurring in intimate association with sand dune communities were sampled and mapped, with additional target notes.

A quadrat size of 2m x 2m (or equivalent area on restricted, e.g. narrow, vegetation stands) was used, except in stands of scrub and woodland where larger quadrats were used in line with Rodwell (2006).

Within quadrats the cover of every taxon of vascular plant, bryophyte and lichen were recorded using the Domin scale, with cover assessed by eye as a vertical projection on the ground of the live, above ground parts of the plants in the quadrat. A record was made of the total cover and height (maximum and minimum of each layer) of the layers together with the cover of any bare sand, soil, litter, rock or open water. A record was also made of grazing level and grazing animal, as well as other obvious management interventions.

Domin Scale

The Domin scale is the standard measure of cover used in NVC surveys (Rodwell 2006). The cover is based on projected cover, separated by layer where vegetation has a complex structure. The projected cover range and corresponding Domin value are shown in the table.

Table 3: Domin scale

Cover	Domin
<4% (few individuals)	1
<4% (several individuals)	2
<4% (many individuals)	3
4-10%	4
11-25%	5
26-33%	6
34-50%	7
51-75%	8
76-90%	9
91-100%	10

Target Notes

Target notes were made by surveyors to supplement the mapping and quadrat data. Target notes were used to describe important features, additional species and other notable characteristics of the vegetation. Target notes are included in the GIS data.

Notable Species

The location of rare, scarce, uncommon or notable vascular and non-vascular plant species were noted during the survey. Notable species included those listed on the designated site citations, species listed under one of the threatened categories on the Welsh or British Red Lists, Section 7 of the Environment (Wales) Act 2016, and Nationally Rare and Scarce species. However, no systematic search was made for such species, and the records collected here should be viewed as incidental findings.

Data Analysis

Mosaics and Habitat Areas

The area of each habitat presented in the report includes both 'pure' stands and stands which occur in a mosaic. The area of each vegetation type from a mosaic is based on the percentage cover in each mosaic assigned to each vegetation type from the field survey. The total area of the mapped polygon is measured from the GIS and divided into the relative proportion of each component. This figure should be treated with some caution and mosaics were typically complex and assigning proportions to the relevant components is one of the most subjective elements of the survey.

Statistical Analysis of Quadrats

Although not used as the primary method for mapping the NVC communities some *post hoc* analysis of quadrats was completed. This was carried out using Tablefit (Marrs *et al.* 2019) implemented through *JVeg*, JBA's bespoke Microsoft Excel-based wrapper tool for collating and analysing vegetation coverage data. This programme allocates a goodness-of-fit ratio for the quadrat surveyed to the published NVC tables.

Nomenclature

The vegetation communities follow the names given in the published volumes (Rodwell, 1991a; 1991b; 1992; 1995; 2000), in a few instances supplemented with communities in Mountford (2011). Sub-communities are noted with the letters assigned in the published volume. Where necessary in the text, stands which could not be differentiated are assigned the letter 'u' to denote undifferentiated to distinguish them from the overall community discussion.

Botanical nomenclature follows Stace (2019) except where a species name is part of the NVC title where the original names have been preserved so they are directly traceable to the vegetation types in the published volumes. The NVC name and currently accepted name in Stace (2019) are given in the table below. The text generally uses scientific names, but common names are given on the first mention of each species. Bryophyte nomenclature follows Blockeel *et al.* (2014) and lichens follow the British Lichen Society's Lichen Taxon Dictionary (BLS 2020).

Table 4: Species with different names in the NVC community titles and Stace (2019)

NVC code	NVC name	Stace 2019 name	Common Name
SD3	<i>Matricaria maritima</i>	<i>Tripleurospermum maritimum</i>	Sea Mayweed
SD4, SD5b, SD6a, SD6b	<i>Elymus farctus</i> ssp. <i>boreali-atlanticus</i>	<i>Elymus junceiformis</i>	Sand Couch
SD11	<i>Cornicularia aculeata</i>	<i>Cetraria aculeata</i>	a lichen
SD14a	<i>Carex serotina</i>	<i>Carex viridula</i>	Small-fruited Yellow-sedge
SD15	<i>Calliergon cuspidatum</i>	<i>Calliergonella cuspidata</i>	Pointed Spear-moss
CG7	<i>Hieracium pilosella</i>	<i>Pilosella officinarum</i>	Mouse-ear Hawkweed
CG7	<i>Thymus praecox/pulegioides</i>	<i>Thymus drucei</i>	Thyme
OV27	<i>Epilobium angustifolium</i>	<i>Chamaenerion angustifolium</i>	Rosebay Willowherb
OV41	<i>Parietaria diffusa</i>	<i>Parietaria judaica</i>	Pellitory-of-the-wall
S8	<i>Scirpus lacustris</i> ssp. <i>Lacustris</i>	<i>Schoenoplectus lacustris</i>	Common Club-rush
S21	<i>Scirpus maritimus</i>	<i>Bolboschoenus maritimus</i>	Sea Club-rush
SM24	<i>Elymus pycnanthus</i>	<i>Elymus athericus</i>	Sea Couch

Overview of the NVC Communities

The following summary presents an overview of the ecology of the communities found in the survey, working from the pioneer vegetation on the most dynamic part of the dune systems through to the vegetation of long-stable dunes. It outlines the structure used in the following, more detailed chapters.

Shingle and Strandline Communities

The first communities are the strandline and shingle communities which occupy a narrow zone which still has significant tidal influence at the boundary of the dunes with the sea, and also around the mouths of rivers. For most of the sites included in this survey, this is a transition from a sandy beach, but also includes some areas of shingle beach (most extensive at Morfa Dinlle) and rarely (only at Morfa Harlech) from saltmarsh found on the seaward side of the sand dunes. Vegetation in this zone is described in the NVC communities **SD1 *Rumex crispus-Glaucium flavum* shingle community**, **SD2 *Honckenya peploides-Cakile maritima* strandline community**, **SD3 *Matricaria maritima-Galium aparine* strandline community**.

These vegetation types are characterised by very open swards with much bare sand or shingle, with a high proportion of annual species. The strandline provides abundant nutrients from the high nitrification rates of decomposing seaweed (Ellenberg 1988) and the vegetation can develop rapidly over a growing season, but is often lost annually through storm erosion, most often over the winter.

Foredune Communities

The perennial grass *Elymus junceiformis* (Sea Couch) is the most tolerant of tidal inundation of all the dune grasses and begins to establish and stabilise embryo dunes against erosion at, or just above the highest high tide line. If there is a suitable sand budget and space in front of the existing foredune ridge, it can begin the build-up of a new dune ridge. Vegetation of these embryo dunes in which *Elymus junceiformis* is constant and the most abundant grass are referable to the NVC type **SD4 *Elymus farctus* ssp. *boreali-atlanticus* foredune community**.

Leymus arenarius (Lyme-grass) is almost as tolerant of inundation as *Elymus junceiformis* and locally replaces it in embryo dunes, but *Leymus arenarius* is close to its south-western limit of distribution in Wales and is not common. Stands where this is the dominant grass are placed in **SD5 *Leymus arenarius* mobile dune community**.

Once these young dunes are raised above tidal influence by sand accretion, **SD6 *Ammophila arenaria* mobile dune community** becomes the predominant vegetation type. It also occurs where the sand movement is caused by erosion leading to instability. In this habitat *Ammophila arenaria* (Marram) is dominant and vigorous, affecting the movement of sand and helping build, or resisting the erosion of, tall dunes. This vegetation can also be prominent around inland dune ridges where there are blowouts and lots of sand movement.

Semi-fixed and Fixed Dune Communities

As the sand stabilises, increasing numbers of plant species form the vegetation. If the position of the stabilising surface is above the upper limits of the dune aquifer, then a suite of dry grassland communities develop. Where there is still some sand movement the **SD7 *Ammophila arenaria-Festuca rubra* semi-fixed dune community** is the most common vegetation, still with some open areas and much, relatively vigorous *Ammophila arenaria* in the sward but now with more fine-leaved grasses including *Festuca rubra* (Red Fescue) and *Poa humilis* (Spreading Meadow-grass) and a range of low-growing bryophytes and lichens.

With increasing stability an increasing range of species are able to persist, and these fixed dune swards are referable to the NVC types **SD8 *Festuca rubra-Galium verum* fixed dune grassland** in calcareous sands with the characteristically colourful perennials *Galium verum* (Lady's Bedstraw) and *Lotus corniculatus* (Bird's-foot Trefoil), and **SD12 *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland** on decalcified or acidic sands where *Anthoxanthum odoratum* (Sweet Vernal-grass), *Agrostis capillaris* (Common Bent), *Carex arenaria* (Sand Sedge), and *Festuca ovina* (Sheep's Fescue) become the most abundant grasses. On fixed sands, in the absence of grazing, **SD9 *Ammophila arenaria-Arrhenatherum elatius* dune grassland** can develop with increased cover the coarse grass *Arrhenatherum elatius* (False Oat-grass).

These dune grassland swards are all distinguished from other grassland in the NVC by the presence of a suite of species able to tolerate the highly-porous sandy soil with low organic content and poor retention of nutrients and often high water deficits. Where there are larger disturbances in areas with low sand movement, *Carex arenaria* can become the most abundant species, with vegetative spread from its long runners, forming the **SD10 *Carex arenaria* dune community**.

Dune Slacks and Fens

Where the water table is at or near the surface for some of the year, dune slack communities develop which are primarily included across five vegetation communities, the occurrence of which is determined by a combination of the depth and length of inundation, the age and extent of sand deposition, and the base status and organic matter accumulation.

The youngest slacks and slacks with the most sand movement are typically referable to the NVC type **SD13 *Sagina nodosa-Bryum pseudotriquetrum* dune-slack community**. Slightly more mature slacks but with a high base status, often maintained by moderate sand deposition, and normally grazed, are referable to **SD14 *Salix repens-Campyllum stellatum* dune-slack community**. Well-established slacks with deeper and more prolonged inundation develop into the **SD15 *Salix repens-Calliargon cuspidatum* dune-slack community**, whereas shallow and shorter inundation leads to the development of the **SD16 *Salix repens-Holcus lanatus* dune-slack community**. On less base-rich sands the slacks often support the **SD17 *Potentilla anserina-Carex nigra* dune-slack community**.

Dune Scrub and Dune Annuals

Hippophae rhamnoides (Sea Buckthorn) is a thorny, woody species with an ability to spread from vigorous suckering and seeds. It is not native to the Welsh coast, and there have been ongoing efforts to remove it from many dune sites. Where *Hippophae rhamnoides* forms a constant cover in the vegetation, stands are referable to the NVC type **SD18 *Hippophae rhamnoides* dune scrub**.

In dry dune grasslands disturbance can result in a change of vegetation composition. Small-scale, regular disturbance (e.g. rabbits or drought) can create opportunities for the **SD19 *Phleum arenarium*-*Arenaria serpyllifolia* dune annual community** to develop amongst fixed or semi-fixed vegetation. This vegetation is composed of a range of diminutive annuals among a carpet of bryophytes, with the annual component often completing their life cycle early in the year when moisture deficits are at their lowest during the growing season.

Calcareous Grassland, Acid Grassland and Heath

The occurrence of calcareous and acid grassland on the sites surveyed was very uncommon, with only very small areas of CG6 *Avenula pubescens* grassland, CG7 *Festuca ovina*-*Hieracium pilosella*-*Thymus praecox/pulegioides* grassland, U4 *Festuca ovina*-*Agrostis capillaris*-*Galium saxatile* grassland and U5 *Nardus stricta*-*Galium saxatile* grassland being recorded. These stands all occur as a result of a unique set of conditions, often related to management or the underlying geology so that the influence of the blown sand substrate is not longer an important factor in determining the vegetation composition.

Heath was recorded more extensively than calcareous or acid grassland, mostly as the typical dune community **H11 *Calluna vulgaris*-*Carex arenaria* heath**. The calcareous nature of the sands at all of the survey sites means this vegetation was limited to small pockets of stable sand, and often with a strong component of dune grassland present so that stands were sometimes difficult to separate from the decalcified dune grassland (SD12).

Coastal Grassland

Stands of coastal grassland were recorded at several sites. Only at one site was **MC6 *Atriplex prostrata*-*Beta vulgaris* ssp. *maritima* sea-bird cliff community** present as a strandline community. Elsewhere, this vegetation was typical of shingle interstitially filled with sand in locations with a notable influence of salinity. In such situations the **MC5 *Armeria maritima*-*Cerastium diffusum* ssp. *diffusum* maritime therophyte community**, **MC8 *Festuca rubra*-*Armeria maritima* maritime grassland** and **MC10 *Festuca rubra*-*Plantago* spp. maritime grassland** were recorded.

Mesotrophic Grassland

Where the harsher elements of water deficit and nutrient leaching of sandy soils are reduced by some build-up of organic matter, the sward often transitions to mesotrophic grassland with, in particular, *Ammophila arenaria* absent from such vegetation. In the absence of management **MG1 *Arrhenatherum elatius* grassland** is the typical community. With grazing, trampling or mowing, the **MG5 *Cynosurus***

crispatus-Centaurea nigra grassland, **MG6 Lolium perenne-Cynosurus crispatus** grassland and **MG7 Lolium perenne** leys and related grasslands have all been recorded in the survey. On wetter soils, **MG9 Holcus lanatus-Deschampsia cespitosa** grassland, **MG10 Holcus lanatus-Juncus effusus** rush-pasture, and **MG11 Festuca rubra-Agrostis stolonifera-Potentilla anserina** grassland were also recorded, the latter is also found around the margins of transitions from blown sand to saltmarsh.

Mire

Some fen vegetation can also develop over blown sand, notably as slacks accumulate organic matter, and both **M27 Filipendula ulmaria-Angelica sylvestris** mire and **M28 Iris pseudacorus-Filipendula ulmaria** mire were recorded. Where there is grazing of slacks with organic soils rush pasture vegetation is often present, with **M22 Juncus subnodulosus-Cirsium palustre** fen-meadow and **M23 Juncus effusus/acutiflorus-Galium palustre** rush-pasture were both recorded. Very small amounts of vegetation assigned to **M13 Schoenus nigricans-Juncus subnodulosus** mire, **M24 Molinia caerulea-Cirsium dissectum** fen-meadow, and **M25 Molinia caerulea-Potentilla erecta** mire were also recorded.

Open Vegetation

Three types of open vegetation were recorded. In areas of dry grassland with well-developed soils subject to regular disturbance the **OV21 Poa annua-Plantago major** community and **OV23 Lolium perenne-Dactylis glomerata** community were recorded, characterised by an abundance of annuals typical of enriched ground.

Stands of tall herbs were recorded at all sites, with small amounts of **OV24 Urtica dioica-Galium aparine** community the **OV25 Urtica dioica-Cirsium arvense** community and the **OV26 Epilobium hirsutum** community. Stands of **OV27 Epilobium angustifolium** community were more widespread, reflecting the ability of *Chamaenerion angustifolium* to invade dune grassland, particularly following fires. **OV41 Parietaria diffusa** community and **OV42 Cymbalaria muralis** community were recorded on one site each, where a wall and a rock outcrop provided a suitable substrate.

Aquatic Vegetation, Swamp and Wetland

These are not common in dune systems *per se*, but can be extensive where the dunes incorporate a large area of freshwater. A very diverse selection of aquatic, swamp and wetland vegetation communities occur in and around the wetland areas, with 26 different communities noted.

Saltmarshes

Many of the sites surveyed feature a natural transition from the sand dunes to saltmarsh vegetation. The nature of the transitions varied between sites, but often included elements of the **SM16 Festuca rubra salt-marsh** community and the **SM18 Juncus maritimus salt-marsh** community. Only areas of saltmarsh adjacent to, or transitional with, the sand dunes were mapped in this survey.

Woodland, Scrub and Bracken

Woody species can invade most dune vegetation, typically where there is little sand movement and no grazing or mowing. In wetter places the **W1 *Salix cinerea-Galium palustre* woodland** is the most common type of scrub, but stands of other wet woodland including **W2 *Salix cinerea-Betula pubescens-Phragmites australis* woodland**, **W4 *Betula pubescens-Molinia caerulea* woodland**, **W5 *Alnus glutinosa-Carex paniculata* woodland**, **W6 *Alnus glutinosa-Urtica dioica* woodland** and **W7 *Alnus glutinosa-Fraxinus excelsior-Lysimachia nemorum* woodland** were all recorded in the survey.

In drier places a range of scrub (including *Pteridium aquilinum* (Bracken) stands) can develop including W21 *Crataegus monogyna-Hedera helix* scrub, W22 *Prunus spinosa-Rubus fruticosus* scrub, W23 *Ulex europaeus-Rubus fruticosus* scrub, W24 *Rubus fruticosus-Holcus lanatus* underscrub, and W25 *Pteridium aquilinum-Rubus fruticosus* underscrub as well as a range of woody species that can form monospecific stands such as *Rubus caesius* (Dewberry) and *Clematis vitalba* (Traveller's-joy). Small areas referable to the NVC type W8 *Fraxinus excelsior-Acer campestre-Mercurialis perennis* woodland were also recorded.

Shingle and strandline – SD1, SD2 & SD3

Table 5: Areas (ha) of SD1, SD2 and SD3 recorded in the survey

Site	SD1u	SD1a	SD1b	SD2	SD3u	SD4/SM strandline
Tywyn Aberffraw	-	-	-	0.06	-	-
Newborough Warren	-	-	-	1.83	0.02	-
Morfa Dinlle	0.02	0.57	0.09	-	0.06	-
Morfa Harlech	-	-	-	6.16	-	-
Morfa Dyffryn	-	0.24	-	0.13	0.06	0.10
Laugharne-Pendine Burrows	-	-	-	4.33	-	-
Pembrey Coast	-	-	-	6.84	0.04	-
Whiteford Burrows	-	-	-	2.03	-	-
Kenfig	-	-	-	0.04	0.00	-
Merthyr Mawr	-	-	-	0.62	0.04	-
Total (ha)	0.02	0.81	0.09	22.04	0.22	0.10

SD2 *Honckenya peploides*-*Cakile maritima* strandline community

The presence of shingle and strandline vegetation was common in the survey sites. The typical vegetation on sandy beaches is the **SD2 *Honckenya peploides*-*Cakile maritima* strandline community**. This was recorded at all sites, except for Morfa Dinlle, as discussed below. The floristics of SD2 are straight forward, typically comprising scattered individuals of *Cakile maritima* (Sea Rocket), *Honckenya peploides* (Sea Sandwort) and *Salsola kali* ssp. *kali* (Prickly Saltwort). The main difficulty in assigning these communities is determining when the presence of the sand-fixing grasses *Elymus junceiformis* and *Ammophila arenaria* attain sufficient presence for the vegetation to be assigned to embryo dunes (SD4 or SD6). *Atriplex* (orache) species were occasionally associated with SD2, but not in any significant quantity.

SD1 *Rumex crispus*-*Glaucium flavum* shingle community

Only Morfa Dinlle had an extensive shingle beach, although half of this was not available to survey. Much of the beach at Morfa Dinlle is eroding, so the strandlines on the shingle are best developed at the northern end of the site. Here stands of **SD1a *Rumex crispus*-*Glaucium flavum* shingle community, typical sub-community** are common, marking out strandlines. They are fairly typical of the published SD1, with the constant species *Rumex crispus* (Curled Dock), mostly recorded as subspecies *littoreus* (where checked), but with *Glaucium flavum* (Yellow Horned-poppy) present throughout. In the samples here *Silene uniflora* (Sea Campion) was also constant, a species which only has a constancy of III in the published data. There is a relatively long list of associates, more so than would be expected from a few samples, owing to the infilling of some of the shingle by sand, allowing species more typical of sandy ground to grow in the shingle.

SD3 *Matricaria maritima*-*Galium aparine* strandline community

Small areas of shingle were present elsewhere, often around river mouths or associated with spit structures. The majority of these were assigned to **SD3 *Matricaria maritima*-*Galium aparine* strandline community**. These stands were characterised by constant and abundant *Tripleurospermum maritimum* (Sea Mayweed) with other tall ruderals; *Galium aparine* (Cleavers) was not always constant. They were also distinguished from SD1, with which there is considerable floristic overlap, by the increased abundance of perennials over annuals.



Figure 2: SD2 at Laugharne-Pendine Burrows



Figure 3: Bands of SD1a on the shingle strandline at Morfa Dinlle

Foredune vegetation – SD4, SD5 & SD6

Table 6: Areas (ha) of SD4 and SD5 recorded in the survey

-	SD4	SD5a	SD5b
Tywyn Aberffraw	-	-	0.03
Newborough Warren	0.24	3.05	-
Morfa Dinlle	0.07	-	-
Morfa Harlech	7.05	-	-
Morfa Dyffryn	0.03	-	-
Laugharne-Pendine Burrows	4.62	-	-
Pembrey Coast	7.88	-	-
Whiteford Burrows	1.38	-	-
Kenfig	0.94	-	-
Merthyr Mawr	0.20	-	-
Total	22.42	3.05	0.03

In accreting and prograding dune systems there is a natural progression from the strandline vegetation to embryo dunes and then onto the main foredune ridge. However, at many sites this progression is interrupted by erosion, and the sequence described below is incomplete, or absent. In these situations the transition from the beach is immediately to the community exposed by the erosion, often SD7 or a more fixed form of SD6 (SD6e or SD6f).

SD4 *Elymus farctus* ssp. boreali-atlanticus foredune community

Where there is a shallow-gradient beach and good sand supply the transition can be obvious, with **SD4 *Elymus farctus* ssp. boreali-atlanticus foredune community** present on embryo dunes; the grass *Elymus junceiformis* is the sand-binding grass most tolerant of occasional inundation by sea water. These dunes may be absent in sites with a positive sand budget where dune ridges are forming but the foredune ridge has become sufficiently large to support SD6, leaving no room for embryo ridges on the beach until the foredune destabilises and begins landward migration, as is the case at Tywyn Aberffraw. SD4 is characterised by the constant present of *Elymus junceiformis* with a few scattered associates, made up of strandline species and the more mobile species from the foredunes. The stands of SD4 recorded in the survey matched closely to the published community description.

SD5 *Leymus arenarius* mobile dune community

The other dune-binding grass which can form stands in embryo dunes is *Leymus arenarius*, a species which is uncommon on the Welsh coast. Where it becomes constant and at least frequent without abundant *Ammophila arenaria*, stands in the foredunes were mapped as **SD5 *Leymus arenarius* mobile dune community**. These stands, as with SD4, were often species-poor. The most extensive stands were present on the spit to Abermenai Point at Newborough Warren, where they

form an extensive, species-poor strip in front of the main dune ridge. The species-poor nature means this vegetation is best considered to represent **SD5a *Leymus arenarius* mobile dune community, species-poor sub-community**. The small stands at Aberffraw were assigned to the **SD5b *Leymus arenarius* mobile dune community, *Elymus farctus* sub-community**. Interestingly this seems to be a significant expansion of this habitat at Newborough Warren since the Sand Dune Survey of Great Britain (3.05ha compared to 0.74ha).



Figure 4: SD4 at the eastern end of Laugharne-Pendine Burrows

SD6 *Ammophila arenaria* mobile dune community

Table 7: Areas (ha) of SD6 recorded in the survey

-	SD6u	SD6a	SD6b	SD6c	SD6d	SD6e	SD6f	SD6g	Total
Tywyn Aberffraw	-	-	-	-	3.43	3.55	-	0.10	7.09
Newborough Warren	0.01	7.22	-	-	7.07	3.12	-	-	17.42
Morfa Dinlle	-	0.01	-	-	0.07	0.97	0.01	0.02	1.08
Morfa Harlech	-	0.24	-	-	10.71	10.79	0.04	0.10	21.87
Morfa Dyffryn	-	0.46	-	-	41.80	8.36	-	1.19	51.82
Laugharne-Pendine Burrows	-	6.70	0.22	-	5.99	3.51	-	-	16.41
Pembrey Coast	-	11.76	0.06	-	8.49	2.10	0.06	-	22.47
Whiteford Burrows	-	4.18	0.19	0.04	9.39	1.11	-	0.03	14.94
Kenfig	0.04	0.37	-	0.06	5.47	1.44	0.37	0.85	8.62
Merthyr Mawr	-	-	-	-	4.63	4.44	-	-	9.07
Total	0.05	30.94	0.46	0.10	97.06	39.40	0.48	2.29	170.79

With increasing accumulation of sand the vegetation transitions to **SD6 *Ammophila arenaria* mobile dune community**. Stands of SD6 are characterised by the abundance and vigour of *Ammophila arenaria*, the species best able to tolerate sand movement provided there is no saltwater inundation. The published volumes include no other species as constant, something supported in the survey data recorded here. However, amongst the occasional associates, this community includes some distinctive associates, perhaps most notably the thermophilous perennials, which were found throughout the survey sites, although more common on the southern dune sites.

There is a natural succession in the sub-communities, with **SD6a *Elymus farctus* sub-community**, **SD6b *Elymus farctus-Leymus arenarius* sub-community** and **SD6c *Leymus arenarius* sub-community** representing communities transitional from the embryo dunes into the main dune ridge, with the inundation-tolerant *Elymus junceiformis* and *Leymus arenarius* persisting as *Ammophila arenaria* becomes increasingly abundant. Either the spread of *Ammophila arenaria* into SD4 or SD5, or the occasional inundation with seawater on the lower area of the main dune ridge. Since *Leymus arenarius* is uncommon SD6a is the most common of these three, with SD6b and SD6c found only as small stands on the South Wales dune sites.

SD6d *Ammophila arenaria* sub-community is the most species-poor sub-community, where mobile sand prevents the establishment of all but a few species. It is distinguished from the other forms of SD6 by having no other grass species constant. It was a very common vegetation type on the main dune ridge at all sites, and also occurs extensively around inland blow outs. It is of little surprise that this sub-community is most abundant at Morfa Dyffryn, where inland mobile sand is extensive. Some local variation in SD6d was noted, with two distinctive types including those on slightly damp sands with *Agrostis stolonifera*, and an extensive carpet of *Bryum* sp. (mostly *Bryum algovicum*), and a variety with a good representation of the annual species typical of SD19 (e.g. *Catapodium rigidum* (Fern-grass), *Cerastium diffusum* (Sea Mouse-ear), *Phleum arenarium* (Sea Cat's-tail), *Vulpia fasciculata* (Dune Fescue)). This latter type with annual species was found where there was slightly less sand movement, and often *Festuca rubra* was starting to establish, but not yet constant, suggesting a transition to more fixed vegetation. It perhaps represents a very intimate mosaic of SD19, and in places such mosaics were mapped if the annuals were sufficiently common, although these mosaics were much more common between SD7 and SD19.



Figure 5: Large areas of SD6d where there is high sand mobility at Morfa Dyffryn

As the vegetation becomes more fixed, the grasses *Festuca rubra* and *Poa pratensis* s.l. (Smooth Meadow-grass) are able to establish and become constant and often abundant in the sward, forming the **SD6e *Festuca rubra* sub-community**, and **SD6f *Poa pratensis* sub-community**. These two sub-communities are distinguished by the frequency of *Poa pratensis* s.l. (mostly recorded as *Poa humilis* (Spreading Meadow-grass)) which is typically slightly slower to colonise than *Festuca rubra*. These communities grade almost imperceptibly into SD7a, as summarised in the table below. Ordination of the quadrat samples containing SD6e and SD7a (data not shown) show relatively little separation, reflecting the difficulty encountered during field surveys in assigning these stands to one or other vegetation type.

Table 8: Differences between SD6 and SD7 in stabilising dunes

Feature	SD6d	SD6e & SD6f	SD7a
<i>Ammophila arenaria</i>	V (3-10)	V (3-8)	V (1-9)
<i>Festuca rubra</i>	I (1)	V (2-9)	V (2-9)
<i>Poa pratensis</i>	-	SD6e: I (3) SD6f: V (1-7)	V (1-7)
Constant forbs	None	None – but can have high cover locally	<i>Hypochaeris radicata</i> , <i>Taraxacum</i> sp., <i>Jacobaea vulgaris</i>
Bryophytes	None	Can be locally abundant	Patchy
Mean species richness (min-max)	3 (1-9)	7 (9-14)	15 (7-28)

Note: frequency scores used in this table are explained in table 2

The final sub-community is **SD6g *Carex arenaria* sub-community**, a vegetation type associated with inland blow outs, and similar to SD10, but where *Carex arenaria* and *Ammophila arenaria* are both spreading in the mobile sands, with both species being a constant presence in the sward.



Figure 6: SD6g on a seaward face of an inland dune ridge at Tywyn Aberffraw

Thermophilous perennials in the mobile dunes

There are a group of distinctive perennial species, most of which are dune specialists, that occur in SD6 vegetation. Records from quadrats are summarised in the table below. These species are mostly thermophiles, growing most abundantly in the south of the UK. Of these species, only *Matthiola sinuata* is nationally scarce, but the other species are uncommon. They spread beyond SD6 into other dune communities where there is open sand.

Table 9: Distinctive perennial species found on Sands of LIFE Project sites.

Species	Sites*	NVC Communities
<i>Calystegia soldanella</i> (Sea Bindweed)	Ha, Ke, LP, NW	SD6d,e, SD7a,b,c, SD18a, SD19
<i>Cynoglossum officinale</i> (Hound's-tongue)	Dy, Ha, PC	SD6e & SD7a,b & SD8c
<i>Eryngium maritimum</i> (Sea-holly)	Ke, NW, Di, Dy, PC, WB	SD6b,d,e, SD7c, SD10, SD18a, SD19
<i>Euphorbia paralias</i> (Sea Spurge)	Ab, Ha, Ke, NW, Dy, PC, WB	SD4, SD6a,b,d,e,g, SD7b, SD12, SD19
<i>Euphorbia portlandica</i> (Portland Spurge)	Ab, Dy, LP	SD6a,e, SD7a,b,c, SD8b,c, SD19
<i>Matthiola sinuata</i> (Sea Stock)	WB, Ke	SD6b

*Site name abbreviations: Ab – Tywyn Aberffraw; Di – Morfa Dinlle; Dy- Morfa Dyffryn; Ha – Morfa Harlech; Ke – Kenfig; LP – Laugharne-Pendine Burrows; NW – Newborough Warren; PC – Pembrey Coast; WB – Whiteford Burrows



Figure 7: *Cynoglossum officinale* (Hound's-tongue)



Figure 8: *Eryngium maritimum* (Sea-holly)



Figure 9: *Calystegia soldanella* (Sea bindweed)



Figure 10: *Euphorbia paralias* (Sea Spurge)



Figure 11: *Matthiola sinuata* (Sea Stock)

Semi-fixed and fixed dune grassland

Perhaps unsurprisingly this is the largest group of vegetation types recorded in the current survey. Each of the main vegetation types are discussed here in sequence. The main grassland types of the dune plains develop in response to certain edaphic factors, and the most common factors driving the transitions are shown in Figure 12. Of these communities, SD19 and OV27e are discussed in other sections.

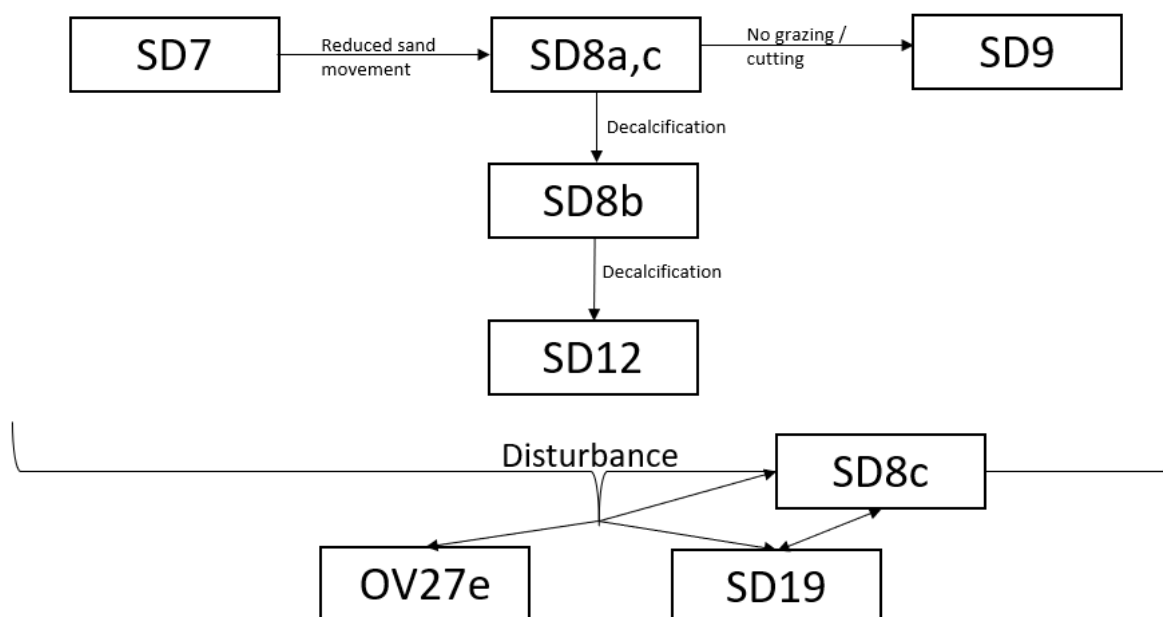


Figure 12: Patterns of vegetation change in fixed dune grasslands

SD7 *Ammophila arenaria-Festuca rubra* semi-fixed dune community

Table 10: Areas (ha) of SD7 recorded in the survey

Site	SD7u	SD7a	SD7b	SD7c	SD7d
Tywyn Aberffraw	1.88	18.23	11.71	16.93	0.07
Newborough Warren	-	21.87	55.91	29.56	-
Morfa Dinlle	-	-	1.96	3.93	-
Morfa Harlech	-	4.40	23.02	38.47	-
Morfa Dyffryn	-	3.60	20.25	55.31	-
Laugharne-Pendine Burrows	-	0.07	7.28	4.33	-
Pembrey Coast	0.59	16.16	10.83	2.35	0.24
Whiteford Burrows	0.06	1.60	2.36	17.52	-
Kenfig	-	0.20	0.94	10.28	0.15
Merthyr Mawr	1.17	1.48	0.15	11.19	-
Total (ha)	3.70	67.62	134.41	189.88	0.46

SD7 *Ammophila arenaria-Festuca rubra* semi-fixed dune community is characterised by the presence of well-developed swards of *Ammophila arenaria*, with

constant often abundant *Festuca rubra* and *Poa pratensis* s.l. with, in the published NVC volumes, the yellow Asteraceae *Hypochaeris radicata* (Common Cat's-ear). In this survey *Hypochaeris radicata* only had a frequency of III (present in 40-60% of samples). *Ononis repens* (Common Restharrow) was a constant species (frequency IV), although it is a defining constant of SD7c, and expected to be absent from SD7a (although it was recorded in some SD7a samples in this survey). The other frequent species (frequency III) in the SD7 swards have a significant overlap with SD6 and SD8, and are *Carex arenaria*, *Galium verum*, *Jacobaea vulgaris* (Ragwort), *Plantago lanceolata* (Ribwort Plantain), and *Rubus caesius* (Dewberry). Of these species, only *Rubus caesius* is more frequent than expected compared to the published NVC data and, consistent with other vegetation types in this survey, appears to be more abundant in a wide range of communities.

The sub-communities of SD7 are relatively simple to distinguish, and it should be noted that the SD7d included in this survey is that used in the final published NVC volumes (Rodwell, 2000). This differs from the draft accounts, where SD7d was an open community roughly similar to a combination of SD7b and SD19, and widely mapped in the SDSGB (Dargie 1995). SD19 was not included in the draft NVC accounts used in the SDSGB.

Table 11: The most frequent species in each of the SD7 sub-communities based on quadrat data from this survey

Sub-community	7a Frq	7a Ab	7b Frq	7b Ab	7c Frq	7c Ab
<i>Ammophila arenaria</i>	V	5-8	V	1-8	V	3-9
<i>Arenaria serpyllifolia</i>	I	2-3	IV	1-3	II	1-6
Bare sand	III	2-5	III	1-7	II	1-8
<i>Carex arenaria</i>	II	2-5	IV	2-6	III	1-5
<i>Festuca rubra</i>	V	4-9	IV	2-8	V	2-10
<i>Holcus lanatus</i>	II	2-4	II	1-2	III	1-4
<i>Galium verum</i>	II	1-3	III	1-6	II	1-5
<i>Homalothecium lutescens</i>	I	2-4	III	2-8	II	2-9
<i>Hypnum cupressiforme</i> var. <i>lacunosum</i>	I	1	III	2-9	I	2-10
<i>Hypochaeris radicata</i>	IV	1-5	IV	1-6	III	1-5
<i>Jacobaea vulgaris</i>	III	1-4	III	1-5	II	1-5
<i>Luzula campestris</i>	I	2	III	1-4	I	1-2
<i>Ononis repens</i>	II	2-4	III	1-7	V	2-9
<i>Plantago lanceolata</i>	III	1-5	II	1-4	III	1-8
<i>Pilosella officinarum</i>	-	-	III	1-7	I	1-4
<i>Poa humilis</i>	III	1-5	II	1-4	II	1-5
<i>Rubus caesius</i>	III	1-6	III	1-7	IV	2-8
<i>Syntrichia ruralis</i> ssp. <i>ruraliformis</i>	I	1	IV	1-8	I	2-9
<i>Taraxacum</i> sp.	II	1	III	1-3	II	1-3
<i>Thymus drucei</i>	-	-	III	2-6	I	2-5

The **SD7a typical sub-community** was widely recorded, absent only from Morfa Dinlle. It is characterised by dense, species-poor swards where the grasses are dominant with relatively few associates. It often represents a subtle transition from SD6e and SD6f and delimiting stands between these three sub-communities was often complicated by the small-scale variation in composition within the foredunes.

SD7b *Hypnum cupressiforme* sub-community is a much more open vegetation in which bryophytes and low-growing perennials make up a significant component of the sward. The floristic data show that preferential species include *Arenaria serpyllifolia* (Thyme-leaved Sandwort), *Carex arenaria*, *Galium verum*, *Homalothecium lutescens*, *Hypnum cupressiforme* var. *lacunosum*, *Luzula campestris* (Field Woodrush), *Pilosella officinarum* (Mouse-ear Hawkweed), *Syntrichia ruralis* ssp. *ruraliformis*, and *Thymus drucei* (Thyme). The combination of these colourful pleurocarpous bryophytes, the purple flowers of *Thymus* and yellows of *Galium verum* give stands of this vegetation a distinctive appearance in the summer.



Figure 13: The colourful SD7b at Morfa Dinlle

SD7c *Ononis repens* sub-community is similar to the typical sub-community but has constant *Ononis repens* and a less dense grass sward. Unlike SD7a it was more often found inland, on migrating dune ridges. It was often found in a similar position to SD8c (or SD8a), with SD7c being better represented at sites such as Morfa Dyffryn, Newborough Warren and Whiteford Burrows, where the sand is more mobile and a semi-fixed vegetation can persist with, or instead of, the more fixed SD8.

SD8 *Festuca rubra*-*Galium verum* fixed dune grassland

SD8 was the most extensive of all the vegetation types recorded in the survey. It is the typical vegetation community of dry, fixed, calcareous sand dunes, and its abundance is therefore not surprising on the calcareous sands of the Welsh coast. The vegetation is defined by the constant and abundant presence of *Festuca rubra*, with the constant presence of *Galium verum*, *Lotus corniculatus*, *Plantago lanceolata*, *Poa pratensis* and *Trifolium repens* (White Clover). All except the latter were constant in the samples recorded in this survey, with *Trifolium repens* recorded in only 20% of quadrats of SD8 and largely absent in the more open and drier stands, particularly of SD8b. *Carex arenaria*, *Holcus lanatus*, and *Ononis repens* were all constant in the SD8 quadrats recorded in this survey. *Rubus caesius* is not listed amongst the

associates of SD8 in the published volumes, but was found to be common and often abundant in the present study, occurring in 55% of all SD8 quadrats. Although pleurocarpous bryophytes as a group were constant in this vegetation, occurring in 76% of all SD8 quadrats, no single species was responsible for this with the three most common species all being fairly evenly represented, namely *Pseudoscleropodium purum* (40% of quadrats), *Homalothecium lutescens* (39%) and *Hypnum cupressiforme* var. *lacunosum* (37%).

Table 12: Area (ha) of SD8 recorded in the survey

Site	SD8u	SD8a	SD8a <i>Rosa spin. variante</i>	SD8ai	SD8b	SD8b <i>Thymus variante</i>	SD8c	SD8d	SD8e	All SD8
Tywyn Aberffraw	3.64	22.34	-	-	56.39	-	15.44	-	2.54	100.35
Newborough Warren	0.14	43.38	-	-	64.69	-	72.03	0.40	0.02	180.66
Morfa Dinlle	0.02	16.43	-	-	3.51	1.79	22.14	-	-	43.89
Morfa Harlech	0.03	21.09	-	-	61.60	-	3.59	-	0.29	86.61
Morfa Dyffryn	0.21	10.52	-	-	14.94	-	6.79	-	0.02	32.48
Laugharne-Pendine Burrows	9.52	33.20	-	-	45.33	-	12.65	-	-	100.70
Pembrey Coast	3.85	13.86	-	-	10.91	-	39.51	0.40	0.36	68.88
Whiteford Burrows	0.13	7.27	-	0.01	18.68	-	15.66	-	-	41.75
Kenfig	4.62	120.76	-	0.16	11.17	-	54.02	-	-	190.74
Merthyr Mawr	0.68	47.35	0.68	-	62.84	0.39	3.91	-	-	115.84
Total (ha)	22.84	336.22	0.68	0.17	350.05	2.18	245.72	0.80	3.24	961.90

All five published sub-communities were recorded in the survey, although only low areas of the more mesophytic SD8d and SD8e were noted. Some stands could not easily be assigned, often where elements of other vegetation types were present or disturbance or modification had created unusual swards. Three of these variations were assigned names and are discussed below under the respective sub-communities. The three sub-communities were often found growing in intimate mosaics, each occupying slightly different places within the complex microtopography of the dunes, and combined sub-communities (e.g. SD8a/c) were a common feature of the SDSGB, something avoided here and replaced by the use of mosaics in which the proportions of each sub-community were estimated.

The **SD8a typical sub-community** acts as something of a 'catch-all' for stands of SD8a with no other distinguishing features. It is typically rank vegetation dominated by grasses with few other associates, and clearly derives from no, or low intensity, management. It is often invaded by spiny shrubs, with *Rubus caesius*, *Rosa spinosissima* (Burnet Rose) and *Rubus fruticosus* agg. (Bramble) often locally abundant, and SD8a, along with SD9 is the main locus for near-pure stands of these *Rubi*. The rank aspect of SD8a stands have similarities to SD9, and in some places the invasion of *Arrhenatherum elatius* was underway. With stands assigned to SD9 only when *Arrhenatherum elatius* became constant with sufficient abundance to achieve cover (Domin 4+).

Where *Rosa spinosissima* is a constant and abundant feature of otherwise typical (if difficult to walk through) SD8a, a distinct variant was recognised in the survey of Merthyr Mawr (Pickard 2020) as the **SD8a *Rosa spinosissima* variant**, and this variant is likely to be more widespread but was not separated from SD8a at the other sites.

In a similar theme, SD8ai has been used to record stands of SD8a where *Pteridium aquilinum* (Bracken) is constant and abundant, the notation marking out the **SD8a *Pteridium aquilinum* variant**. This convention is used in describing variants of MG1, and seems appropriate here. This community was recorded only at Kenfig, where *Pteridium aquilinum* stands are abundant, often spreading into adjacent vegetation.



Figure 14: SD8a at Tywyn Aberffraw towards the front of the dunes

The **SD8b *Luzula campestris* sub-community** is the most decalcified of the SD8 sub-communities and was very widely recorded, being typical of the flatter stable areas of the dune plains. In many places the community was transitional to SD12, and there was some difficulty separating stands of this sub-community from it. This was noted as a problem in the SDSGB (e.g. at Morfa Dinlle), and arises where there is a mix of *Festuca rubra* and *Festuca ovina*, or a sward with abundant *Agrostis capillaris*, *Anthoxanthum odoratum* and *Carex arenaria* but no *Festuca ovina*. This sub-community also has a more open sward than SD8a, and is separated from SD8c

by the presence of calcifugous forbs and bryophytes, compared to the more calcicolous species of SD8c.



Figure 15: Stands of SD8b, such as this one at Newborough, support a colourful array of flowers.

The **SD8b *Thymus* variant** has been used for the lichen-rich stands of vegetation at Morfa Dinlle and Merthyr Mawr. The classification of this vegetation is difficult and in the SDSGB the Morfa Dinlle stands were placed in **SD11 *Carex arenaria-Cornicularia aculeata* dune community**, a vegetation type not recorded in this survey (and only at Morfa Dinlle and Stackpole Warren in the SDSGB). Further analysis showed these stands to be floristically closer to SD12 than SD11 (Rhind *et al.* 2006). However neither SD12 nor SD11 were used here owing to the more calcareous nature of these swards, with the community constant calcifugous lichen *Cetraria aculeata* absent from the stands. The paucity of graminoids in the swards makes them difficult to assign, and some of the more diverse stands at Morfa Dinlle have affinities to lowland examples of Welsh *Scapanietum asperae* (Pilkington, 2017) being on very free-draining, stable, calcareous soils (although again are significantly different from this for it not to be a satisfactory assessment here). Stands were therefore placed in SD8b, reflecting the mix of calcareous and calcifugous elements, but assigned a distinctive variant on the basis of the prominent and colourful *Thymus drucei* which is a constant feature of the stands.



Figure 16: SD8b Thymus variant at Morfa Dyffryn



Figure 17: SD8b Thymus variant at Merthyr Mawr

SD8c *Tortula ruralis* ssp. *ruraliformis* sub-community is the moss-rich facies of SD8, and stands were readily identified by the presence of often luxurious carpets of *Syntrichia ruralis* ssp. *ruraliformis*, *Homalothecium lutescens* and *Hypnum cupressiforme* var. *lacunosum*. It was otherwise similar in floristics at SD8a, but is derived from it by disturbance of the sward, such as by grazing animals, that creates sufficient open space for low-growing species to persist.

SD8d *Bellis perennis*-*Ranunculus acris* sub-community and **SD8e *Prunella vulgaris* sub-community** are more mesotrophic sub-communities, found in areas with poorer drainage or closer to the water table. They are relatively easily separated from other SD8 communities by the presence of the mesotrophic herbs including *Bellis perennis* (Daisy), *Euphrasia* spp. (Eyebrights), *Prunella vulgaris* (Selfheal) and often wetland mosses including *Calliergonella cuspidata*. They are more typical of dunes in Scotland, and here were recorded in greatest abundance at Tywyn Aberffraw, but distributed across five sites. The swards were clearly referable to SD8, have a predominantly grassy sward and little or no *Salix repens*. As well as the mesophytic herbs mentioned above, slack species were also commonly present including *Equisetum variegatum* (Variegated Horsetail), *Carex flacca* (Glaucous Sedge), *Dactylorhiza incarnata* (Early Marsh-orchid).

SD9 *Ammophila arenaria*-*Arrhenatherum elatius* dune grassland

SD9 *Ammophila arenaria*-*Arrhenatherum elatius* dune grassland is the typical dry dune vegetation of largely unmanaged places. It is characterised by the constant and abundant presence of the dune grasses *Ammophila arenaria*, *Festuca rubra* and *Poa pratensis* typical of SD7 and SD8, but here joined by *Arrhenatherum elatius* as a constant presence. The only other community constant in the published volumes is *Achillea millefolium*, which was not found to be a constant in this survey.

Quadrats from the survey included constant *Ononis repens* and *Plantago lanceolata* (both occasional associates in the published data), with more *Rosa spinosissima* and *Anthoxanthum odoratum* than expected (occasional here but rare in the published data). The swards often have similarities to MG1, but are distinguished by the presence of sand dune specialists. It was recorded at all the sites surveyed, although at many it was limited to corners or areas of site fenced from grazing or between areas used for other purposes (e.g. golf, camping). It was most extensive at Laugharne-Pendine Burrows, where the Pendine Burrows end of the site is ungrazed and much of both the dune plain and ridges, almost up to the beach, support SD9. It was also extensive at Kenfig in areas of low grazing pressure to the south and in the golf course section of Morfa Harlech. Both sub-communities were recorded along with a small number of undifferentiated stands.

Table 13: Area (ha) of SD9 recorded in the survey

Site	SD9u	SD9a	SD9b	SD9
Tywyn Aberffraw	-	10.95	-	10.95
Newborough Warren	-	8.50	-	8.50
Morfa Dinlle	-	12.44	-	12.44

Morfa Harlech	-	22.04	3.39	25.44
Morfa Dyffryn	-	4.11	-	4.11
Laugharne-Pendine Burrows	-	136.71	6.51	143.23
Pembrey Coast	0.38	23.68	0.67	24.74
Whiteford Burrows	0.10	1.38	7.32	8.80
Kenfig	-	62.12	0.25	62.38
Merthyr Mawr	34.49	4.34	-	38.83
Total (ha)	34.97	286.28	18.15	339.40



Figure 18: Stands of SD9a were widespread at Pendine Burrows

SD9a typical sub-community is the more species-poor sub-community, characterised by the present of nitrophilous herbs such as *Cirsium vulgare* (Spear Thistle), *Heracleum sphondylium* (Hogweed) and *Jacobaea vulgaris*.

SD9b *Geranium sanguineum* sub-community is a more species-rich form of SD9, which in its typical form has constant *Geranium sanguineum* (Bloody Crane's-bill). This community was recorded even beyond the native range of *Geranium sanguineum*, being separated from SD9a by the more open sward with reduced dominance of rank species and increased presence of low-growing perennials. Even without *Geranium sanguineum*, some species-rich stands of SD9 were assigned to this sub-community on the basis of sward richness and structure.

SD10 *Carex arenaria* dune community and SD12 *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland

Two of the three vegetation types where *Carex arenaria* is a key component of the grassy sward were recorded in the survey, with the third such community (SD11) not found.

SD10 *Carex arenaria* dune community is the vegetation of disturbed areas of sand dunes where *Carex arenaria* is prominent amongst the primary species recolonising the bare ground, the lines of shoots of this species marking the paths of the

underground runners can make a very striking impression. There are no other constant species overall, either in the published volume nor the data collected for this survey. The sub-communities are separated by the presence of *Festuca rubra* (SD10a *Festuca rubra* sub-community) or *Festuca ovina* (SD10b *Festuca ovina* sub-community) and, in situations where neither or both of these were very common, stands were not assigned to a sub-community.



Figure 19: SD10b recolonising stable sand in an old camping area currently not in use at Morfa Dyffryn

Site	SD10u	SD10a	SD10b	SD10	SD12u	SD12a	SD12b	SD12y	SD12
Tywyn Aberffraw	0.04	-	-	0.04	1.81	34.13	0.36	-	36.30
Newborough Warren	1.33	0.15	0.12	1.60	0.72	12.77	-	-	13.49
Morfa Dinlle	-	-	-	0.00	0.50	20.02	2.87	0.17	23.56
Morfa Harlech	0.73	0.14	0.08	0.95	13.30	29.94	6.64	-	49.88
Morfa Dyffryn	1.11	0.98	0.46	2.55	1.72	3.92	-	3.19	8.83
Laugharne-Pendine Burrows	0.01	0.17	-	0.18	-	-	-	-	0.00
Pembrey Coast	0.02	0.19	-	0.21	-	0.31	-	-	0.31
Whiteford Burrows	0.07	0.06	-	0.13	0.10	-	-	-	0.10
Kenfig	0.14	0.48	-	0.62	-	-	-	-	0.00
Merthyr Mawr	0.34	-	-	0.34	1.47	-	-	-	1.47
Total (ha)	3.80	2.17	0.66	6.63	19.62	101.09	9.87	3.36	133.94

SD12 *Carex arenaria*-*Festuca ovina*-*Agrostis capillaris* dune grassland is also a community where *Carex arenaria* is a prominent part, but here in a grassy community of decalcified dunes. Along with *Carex arenaria*, the other community constants are *Agrostis capillaris*, *Ammophila arenaria*, *Festuca ovina* and *Poa pratensis*. Samples in this survey lacked *Ammophila arenaria* as a constant element, but did include constant *Anthoxanthum odoratum* and *Luzula campestris*. Representation of species more typical of SD8 were also a notable feature of SD12, highlighting the strong overlap of these vegetation types, with the quadrats assigned to SD12 having constant *Festuca rubra*, *Lotus corniculatus* and *Pseudoscleropodium purum* and *Plantago lanceolata* more frequently than expected.

All the sites in the survey have calcareous sands, so this vegetation is most common where the dune plain has been sufficiently stable for much of the calcium content to have leached from the sand without replacement from fresh-blown sand. The decalcification is further enhanced in the wet climate where high rainfall increases the rate of leaching. This vegetation was best developed in the landward areas of Tywyn Aberffraw, Newborough Warren, Morfa Dinlle and Morfa Harlech. It was rare at Morfa Dyffryn with its mobile sand, and very scarce at all the southern sites.



Figure 20:SD12a is widespread in the most landward part of Aberffraw, showing the prominent *Rumex acetosella*

Separation of the SD12 sub-communities is known to be problematic (Dargie 1995) and most stands were assigned to the **SD12a *Anthoxanthum odoratum* sub-community**, particularly if *Rumex acetosella* (Sheep's Sorrel) was a constant presence even if it was joined by constant *Holcus lanatus*, one of the preferential species of the **SD12b *Holcus lanatus* sub-community**. Stands of SD12b were generally mapped where there was a clear grassy element with less open ground and fewer bryophytes and lichens in the sward. As well as the difficulties separating the SD12 sub-communities, there was also difficulty separating stands of SD8b from SD12 (Box 5). Some stands were not assigned to a sub-community, and these often had distinctive features, such as increased representation of mesophytic species

where there was a transition towards dune slack vegetation, or decreased management leading to invasion by rank species in swards with some similarities to SD9.

Some stands of SD12 were noted as 'improved' where they occurred with mesophytic species, particularly *Lolium perenne* (Perennial Rye-grass) and *Vulpia bromoides* (Squirreltail Fescue). These stands had clearly been subject to some disturbance and enrichment of the soil, either deliberately or as a result of livestock congregating. In some places there had likely been attempts to establish *Lolium perenne* to improve palatability of the sward. The original nature of the SD12 was not lost, but the vegetation was distinctly different from typical SD12. Although it was not regularly mapped separately, it is sufficiently distinct to be recognised as variety of SD12, and in a few places stands were separated.



Figure 21: Swards of 'improved' SD12 with *Lolium* amongst *Carex arenaria* and *Rumex acetosella* in the northern part of Morfa Harlech

One sub-community identified in the Scottish Sand Dune Survey of Great Britain was also recorded in Wales. Stands of **SD12y *Carex arenaria* sub-community** were mapped where there was very rank SD12. This sub-community arises where areas of SD12 are no longer grazed or mown with the same intensity and a dense grassy sward develops. It was recorded on road verges at Morfa Dinlle and an ungrazed field at Morfa Dyffryn.



Figure 22: Grassy SD12y in the ungrazed field by the airport at Morfa Dyffryn

Dune slacks

The NVC classification recognised five dune slack communities (SD13-SD17) and acknowledged the presence on dunes of wetland vegetation types included in other volumes such as fens (**M27 *Filipendula ulmaria-Angelica sylvestris* mire**), fen meadow (**M23 *Juncus effusus/acutiflorus-Galium palustre* rush-pasture**) and swamp habitat (**S19 *Eleocharis palustris* swamp**). The five main communities distinguished from the floristic data reflect patterns of succession and inundation.

The typical dune slack communities found on calcareous sands (SD13-SD16) are united by the constant and abundant presence of *Salix repens*. The relationship between different dune slack communities with two main axes of variation (substrate pH and substrate stability) are shown in Figure 24. Although this is shown as a linear progression to more developed slacks with fixed vegetation, the movement of sand can reverse this process, as is happening naturally at Morfa Dyffryn (Figure 23). Pleurocarpous bryophytes are a prominent feature of dune slack vegetation, with two species *Campylium stellatum* and *Calliergonella cuspidata* defining communities as constant species (SD14 and SD15 respectively). Locally these species can be replaced by some rare mosses which have their stronghold in Welsh dune slacks



Figure 23: New slack developing on mobile sand at Morfa Dyffryn

Another important axis is the degree of inundation, and although there is significant overlap in hydrological conditions (Davy *et al.* 2006, Curreli *et al.* 2013), SD15 is notably the wettest of the *Salix repens* communities. Within each community, the sub-communities often pick out variations of the communities along the wetness gradient. Where slacks occur on acid or decalcified sands or stands flushed by base-poor water, the SD17 community is the typical dune slack vegetation, with a reduction in the frequency and abundance of *Salix repens*.

The eventual transition to fen and wet pasture vegetation takes place as organic matter accumulates in the soil and rushes or tall herb fen species (e.g. *Filipendula ulmaria* (Meadowsweet)) can rise to dominance. M27 was particularly common on all the dune sites. There is a complex relationship between flooding duration and nitrogen uptake, but Rhymes *et al.* (2016; 2018) have shown that, with increasing dryness, slacks will increase the rates of nitrogen uptake. The effect of this might be to increase the area of M27 at the expense of the other dune slack communities, a process only likely to be reversed (in the short-term) where conservation interventions remove the fixed vegetation creating deeper dune slacks.

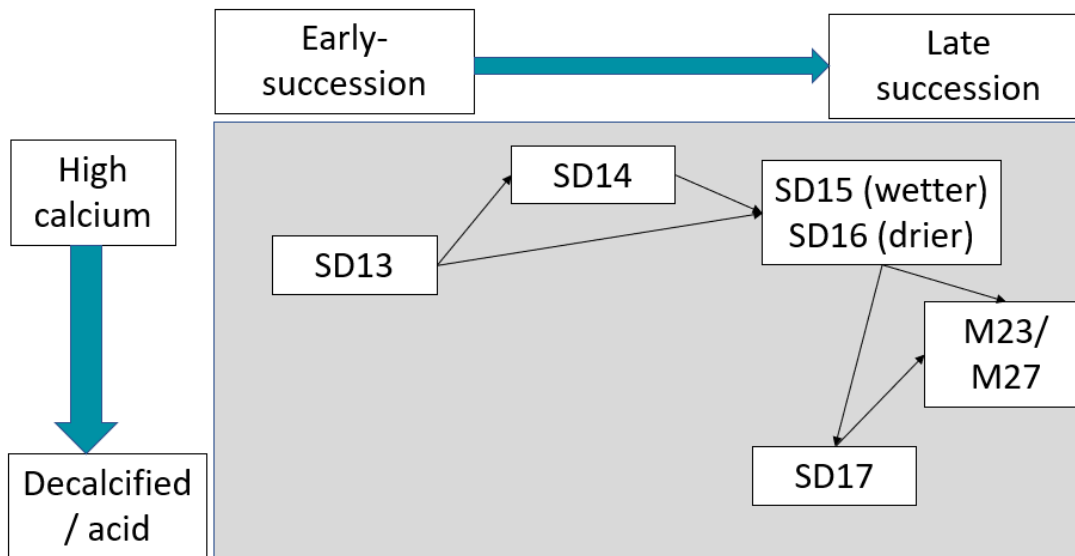


Figure 24: The relationship between different dune slack vegetation types.

SD11 *Carex arenaria*-*Cornicularia aculeata* dune community

This vegetation type was not recorded in these surveys. It is a lichen-rich community of acidic, or strongly decalcified sands. It is most common on the east coast of England, and the published community was based on samples exclusively from this region. The dune sands in the SoLIFE sites are all calcareous, although areas of decalcified sand are present. Rhind *et al.* (2006) reviewed the presence of SD11 in Wales and concluded that at Morfa Dinlle, stands were closer to SD12. The same vegetation is here assigned to SD8b *Thymus* variant but could also be considered a calcareous sub-community of SD11. This was not used as *Cetraria aculeata* was never a constant presence in any of the stands. *Cetraria aculeata* was not widely recorded, present only at Tywyn Aberffraw in two quadrats, assigned to SD8c and SD12a.

SD8b to SD12 transitions

Throughout the survey there was some difficulty assigning vegetation of dry, decalcified sands that had characteristics of both SD8b and SD12. It is likely this is a genuine transition with increasing leaching of calcium from the sand. At most sites, there is some amelioration of this process by fresh deposits of blown sand that occur during winter storms. The result is that many areas of dune plain support vegetation with both *Festuca rubra* and *Festuca ovina*, two grasses which mark out the different communities in the published description. The most prominent herbs of each community are also often found growing together, with *Rumex acetosella* (more typical in SD12) and *Lotus corniculatus*, *Plantago lanceolata* and *Thymus drucei* (more typical of SD8). The post hoc analysis of quadrat data shows there is separation of each community along axis 1, with clusters of clearly differentiated samples, but that there is a strong overlap in the centre, with many stands of very similar composition assigned to each of the two communities. The species that have the strongest influence on the axis 1 score and occur in more than 10% of the 81 quadrats analysed, are shown in the table below. Although many of these were not

used as field indicators of the two communities, based on the quadrat data, they were the most likely to be recorded in one community over the other.

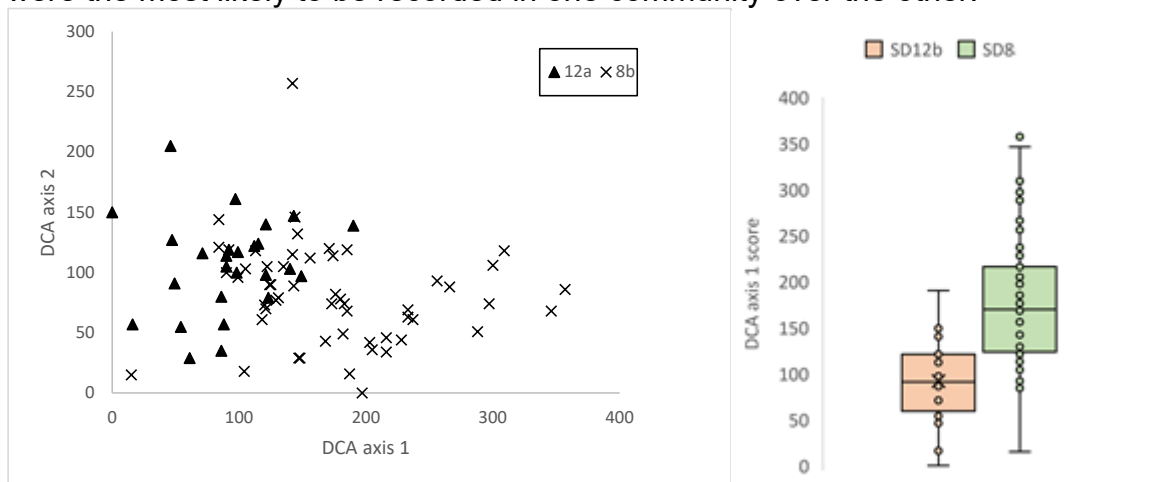


Figure 25: Schematics showing the comparison of SD12 and SD8b

Table 14: Comparison of SD12 and SD8b indicators.

SD12a indicators	-	-	SD8b indicators	-	-
Species	Axis 1 score	% samples	Species	Axis 1 score	% samples
<i>Festuca ovina</i>	-30	31	<i>Pilosella officinarum</i>	259	41
<i>Salix repens</i>	-24	12	<i>Thymus drucei</i>	265	41
<i>Hylocomium splendens</i>	-19	28	<i>Bromus hordeaceus</i>	289	14
<i>Dicranum scoparium</i>	-15	15	<i>Crepis capillaris</i>	289	25
<i>Carex caryophyllea</i>	-8	11	<i>Anthyllis vulneraria</i>	291	19
<i>Rumex acetosella</i>	-6	17	<i>Ononis repens</i>	291	49
<i>Cynosurus cristatus</i>	11	14	<i>Homalothecium lutescens</i>	326	28
<i>Rhytidiadelphus squarrosus</i>	11	35	<i>Arenaria serpyllifolia</i>	344	19
<i>Rhytidiadelphus triquetrus</i>	13	33	<i>Polygala vulgaris</i>	358	11
<i>Veronica officinalis</i>	20	11	<i>Rubus caesius</i>	360	27

SD13 *Sagina nodosa*-*Bryum pseudotriquetrum* dune-slack community

Table 15: Areas (ha) of SD13 recorded in the survey

Site	Embryo Slack	SD13u	SD13a	SD13b	Total
Tywyn Aberffraw	-	-	-	-	-
Newborough Warren	-	0.40	-	0.78	1.19
Morfa Dinlle	-	-	-	-	-
Morfa Harlech	-	-	-	-	-
Morfa Dyffryn	0.27	2.29	0.15	0.02	2.73
Laugharne-Pendine Burrows	-	-	-	0.10	0.10
Pembrey Coast	-	-	-	0.21	0.21
Whiteford Burrows	-	0.24	0.16	-	0.40
Kenfig	0.26	0.55	1.24	0.84	2.90
Merthyr Mawr	-	-	0.12	-	0.12
Total (ha)	0.53	3.48	1.68	1.95	7.64

The **SD13 *Sagina nodosa*-*Bryum pseudotriquetrum* dune-slack community** is the vegetation type which covers much of the vegetation in young, developing dune slacks. The constant species listed in the published volumes were listed as *Carex arenaria*, *Juncus articulatus* (Jointed Rush), *Leontodon hispidus* (Rough Hawkbit), *Sagina nodosa* (Knotted Pearlwort), *Salix repens* (Creeping Willow), *Aneura pinguis* and *Bryum pseudotriquetrum*. In the quadrats recorded in this survey, only *Bryum pseudotriquetrum*, *Juncus articulatus* and *Salix repens* were constant, although all the other species were recorded in the samples. Instead, *Agrostis stolonifera* (Creeping Bent), and *Carex flacca* were both constant. These species are typically found in a very open community of damp ground, and the community was as much recognised by its appearance as the mix of species, with a long and rather variable list of associates of low frequency. These species were generally present in the SD13 recorded in this survey but constants were not many and some of these species were absent from each stand.

The absence of many of the species in slacks that are clearly young, developing SD13 slacks were included as **embryo slacks** (Figure 26). Stands of SD13 were present at all sites except Tywyn Aberffraw and Morfa Dinlle. The largest extent of SD13 was recorded at Morfa Dyffryn where the natural instability of the dunes means there is natural rejuvenation of dune slacks. This is unique amongst the sites surveyed, except perhaps the 'roadside' slacks of Laugharne-Pendine Burrows. At Laugharne-Pendine Burrows there are areas of slack with SD13 and SD14 vegetation in a close mosaic present adjacent to one of the main testing tracks, maintained in an early-successional stage by mowing and occasional disturbance from vehicles.



Figure 26: A close-up view of the embryo dune slack at Morfa Dyffryn with flowering *Lysimachia maritima* and young *Salix repens*



Figure 27: The SD13 and SD14 vegetation at Laugharne-Pendine Burrows

Other sites with relatively extensive SD13 have this vegetation present as the result of deliberate conservation interventions, notably at Kenfig and Newborough Warren. The **SD13a *Poa annua*-*Moerckia hibernica* sub-community** includes the more open, bryophyte-rich vegetation with **SD13b *Holcus lanatus*-*Festuca rubra* sub-community** in longer-established swards that are transitional to the grassy SD16 slacks.

SD14 *Salix repens*-*Campylium stellatum* dune-slack community

Table 16: Area (ha) of SD14 recorded in the survey

Site	SD14u	SD14a	SD14b	SD14c	SD14d	Total
Tywyn Aberffraw	0.59	-	-	0.24	0.40	1.24
Newborough Warren	5.35	0.38	-	2.86	3.12	11.71
Morfa Dinlle	-	-	-	-	-	-
Morfa Harlech	0.14	-	-	0.12	-	0.26
Morfa Dyffryn	2.59	0.08	5.51	3.71	-	11.89
Laugharne-Pendine Burrows	1.77	-	0.26	0.16	0.90	3.09
Pembrey Coast	-	0.45	-	0.45	2.04	2.94
Whiteford Burrows	0.02	0.40	0.13	-	0.05	0.59
Kenfig	1.34	2.02	6.29	0.47	2.18	12.30
Merthyr Mawr	-	-	-	-	-	-
Total (ha)	11.80	3.34	12.18	8.02	8.69	44.02

The species-rich dune slacks referable to the NVC type **SD14 *Salix repens*-*Campylium stellatum* dune-slack community** are characterised by open swards with constant *Agrostis stolonifera*, *Carex flacca*, *Epipactis palustris* (Marsh Helleborine), *Equisetum variegatum*, *Hydrocotyle vulgaris* (Marsh Pennywort), *Mentha aquatica* (Watermint), *Salix repens*, *Calliergonella cuspidata* and *Campylium stellatum*. Remarkably, for such diverse vegetation there was very close floristic match between the survey data and published community, with only minor discrepancies where some species expected to be frequent were only present as a rare association, such as *Carex arenaria* and *Scorzoneroidea autumnalis* (Autumn Hawkbit). These slacks often have very striking displays of *Epipactis palustris* in the right season and were one of the most diverse vegetation types encountered on the survey, with a long list of species recorded in quadrats. Large, natural extents of this vegetation are present at Newborough Warren, and Morfa Dyffryn. Large areas are present at Kenfig, but many of these are the result of deliberate conservation intervention and support the conservation priority species *Liparis loeselii* (Fen Orchid).

Distinguishing the sub-communities of SD14 was one of the more complicated parts of the survey, with all surveyors reporting difficulty or included notes of uncertainty over quadrats. In many places this is exacerbated by the tendency of SD14 to be part of complex mosaics of slacks where it occurs in natural situations, and at other sites for it to be the result of conservation interventions. Curreli *et al.* (2013) found the sub-communities of SD14 to occupy distinct ecological niches, although they assigned vegetation from quadrats purely using computer analysis of each sample, rather than the field-based assessment used here. Detrended correspondence analysis of our samples shows that there is significant overlap between the quadrats assigned to different sub-communities (Figure 28).

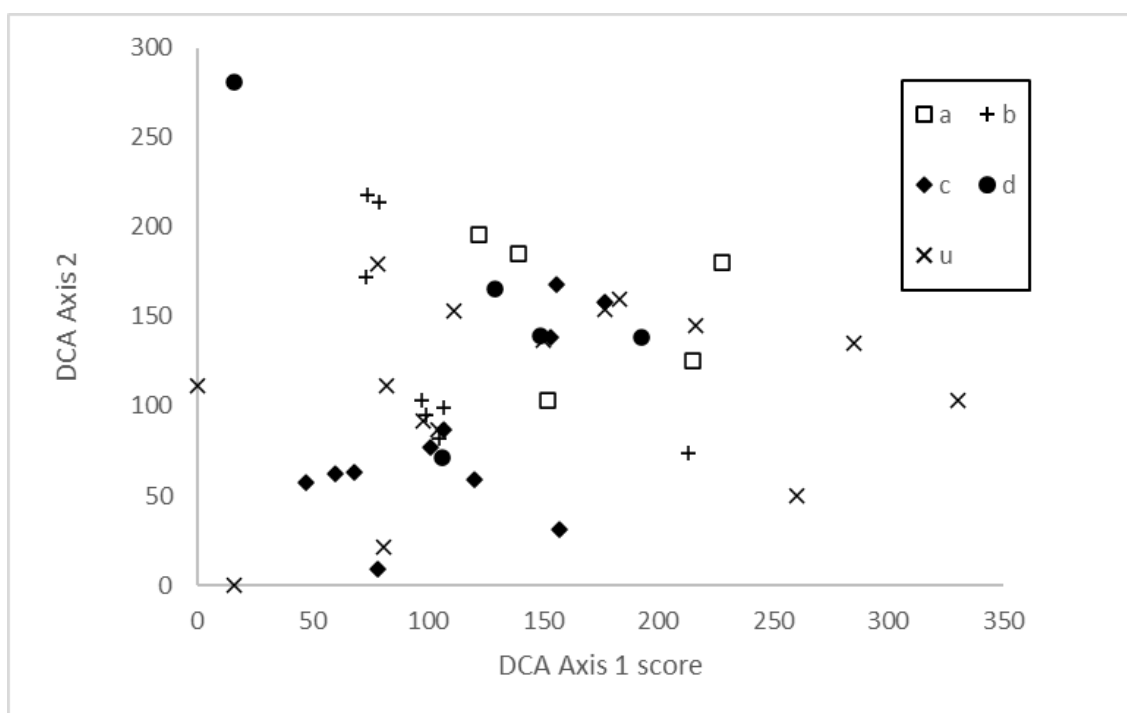


Figure 28: Detrended correspondence analysis of SD14 quadrats



Figure 29: SD14 at Tywyn Aberffraw with abundant *Ophioglossum vulgatum*

In this survey, the sub-communities were distinguished following the keys in Rodwell (2000), with the constant presence of *Carex arenaria* used to separate SD14a and SD14b from SD14c and SD14d. **SD14a *Carex serotina*-*Drepanocladus sendtneri* sub-community** is the most species-rich sub-community and occasional (but not abundant) *Epipactis palustris* with *Carex viridula*. Finally **SD14b *Rubus caesius*-*Galium palustre* sub-community** was recognised by the constant *Galium palustre* (Marsh Bedstraw), *Ranunculus flammula* (Lesser Spearwort) and *Rubus caesius*. *Epipactis palustris* is reported to be constant in this sub-community, compared to

occasional in SD14a, but this distinction was found to be unsupported in the field with stands of *Epipactis palustris* patchily abundant in vegetation assigned to both of these sub-communities.

The other two sub-communities with only scattered *Carex arenaria* are the **SD14c *Bryum pseudotriquetrum- Aneura pinguis* sub-community** and the **SD14d *Festuca rubra* sub-community**. The first of these is characterised by the abundance of liverworts (particularly *Aneura pinguis*) and acrocarpous mosses, and has affinities to SD13. The latter is a more closed, grassy sward with more *Festuca rubra* with *Trifolium repens*, and *Trifolium pratense* (Red Clover). Overall these differences were difficult to detect in the field. Examples include, at Tywyn Aberffraw, where grazing opens up the sward of SD14d, allowing the bryophytes indicative of SD14c to persist patchily, but constantly over larger areas, within the sward.



Figure 30: Extensive slack at Morfa Dyffryn. The mobile sand means they can accumulate up to 1cm sand per year maintaining an open sward of SD14



Figure 31: Typical SD14 at Morfa Dyffryn with abundant *Epipactis palustris*

Rare pleurocarpous mosses in dune slacks

There is a small group of rare pleurocarpous mosses that are regularly found in dune slacks and form a key part of the SSSI notable bryophyte assemblage. These species are *Campyliadelphus elodes*, *Drepanocladus sendtneri*, and *Pseudocalliergon lycopodioides*. The first two of these species are difficult to confirm in the field and require microscopic examination. They were all recorded in the survey, but their true abundance is likely to be greater than indicated owing to the scale of the survey and consequent limit to the number of samples that could be taken back for examination.

Pleurocarpous mosses feature prominently in SD14, where *Campylium stellatum* is a community constant often with high abundance, and SD15, where *Calliergonella cuspidata* is constant and of very high abundance (normally forming a very dense layer beneath the *Salix repens* canopy). At both Newborough Warren and Kenfig, *Pseudocalliergon lycopodioides* can take the place of either of these species, replacing them as the dominant moss over large areas. The other three species are typically recorded in amongst the *Campylium stellatum*, and rarely if ever entirely in place of it.

Other pleurocarpous mosses can also be locally prominent in slacks, with *Drepanocladus polygamus* and *Scorpidium cossonii* sometimes found in dune slacks occasionally as the dominant bryophyte over small areas of slack, as well as a range of pleurocarps from drier dune habitats.

Species	Sites	NVC Communities
<i>Campyliadelphus elodes</i>	Ab, NW, PC	SD14c, SD15, SD16b, SD16c
<i>Drepanocladus sendtneri</i>	Pc, Ke	SD14a, SD14c, SD15a, SD16b, SD17d, M22
<i>Pseudocalliergon lycopodioides</i>	NW, Ke	SD14a, SD14b, SD15, SD16b, SD16c



Figure 32: Extensive *Pseudocalliergon lycopodioides* at Newborough Warren

SD15 *Salix repens*-*Calliergon cuspidatum* dune-slack community

Table 17: Area (ha) of SD15 recorded in this survey

Site	SD15 u	SD15 acid variant	SD15 <i>C. epigejos</i> variant	SD15 a	SD15 b	SD15 c	SD15 d	SD15 t	Total
Tywyn Aberffraw	5.13	-	-	0.20	0.22	-	0.09	-	5.64
Newborough Warren	7.41	-	-	0.44	0.50	3.81	-	-	12.16
Morfa Dinlle	-	-	-	-	-	-	-	-	-
Morfa Harlech	0.31	-	-	8.33	0.12	-	-	-	8.77
Morfa Dyffryn	2.88	-	-	4.10	-	0.13	1.35	-	8.45
Laugharne-Pendine Burrows	1.34	-	-	3.78	0.10	-	2.59	-	7.81
Pembrey Coast	0.23	-	-	-	0.80	0.74	5.25	-	7.02
Whiteford Burrows	1.27	-	-	0.40	4.15	5.21	0.44	0.29	11.76
Kenfig	3.55	0.12	0.80	8.13	3.93	13.49	17.48	-	47.48
Merthyr Mawr	-	-	-	-	-	-	-	-	-
Total (ha)	22.11	0.12	0.80	25.38	9.83	23.37	27.20	0.29	109.10

The stands of **SD15 *Salix repens-Calliergon cuspidatum* dune-slack community** incorporate the wettest dune slacks where *Salix repens* forms a dense canopy over a dense carpet of *Calliergonella cuspidata*. Other constant species include the fen species *Hydrocotyle vulgaris* and *Mentha aquatica*. This was consistent with the floristic data recorded in this survey, with *Rubus caesius* joining the list of constant species, being only frequent in the published description. A small number of stands were assigned to site-specific variants. SD15 was present at all sites except the very dry Morfa Dinlle and Merthyr Mawr, and almost four times as extensive at Kenfig than the next most extensive site.

Typical stands of the SD15 sub-communities were relatively easy to assign, but problematic stands were present in a number of situations. The floristic data from this survey shows that at sub-community level there are few preferential species to separate the vegetation, with the **SD15a *Carex nigra* sub-community** being distinguished by the constant presence of *Carex nigra* (Common Sedge) and *Galium palustre*. This sub-community however, presented problems due to overlap in species composition with SD17d.

Sub-communities **SD15b *Equisetum variegatum* sub-community** and **SD15c *Carex flacca-Pulicaria dysenterica* sub-community** are both fairly species-rich and characterised by constant *Carex flacca*, and reportedly *Equisetum variegatum*, although this was not always present in the samples in this survey. Generally SD15b was a shorter, more open and overall slightly grassier vegetation. SD15c is very similar but has a greater presence of tall herbs, such as *Pulicaria dysenterica* (Common Fleabane) and *Eupatorium cannabinum* (Hemp-agrimony).

Table 18: Constant species of SD15 sub-communities from the quadrat data

Species	u	a	b	c	d
<i>Agrostis stolonifera</i>	III	III	V	IV	II
<i>Calliergonella cuspidata</i>	V	V	V	V	IV
<i>Carex arenaria</i>	II	II	III	III	I
<i>Carex flacca</i>	IV	II	V	V	II
<i>Carex nigra</i>	III	IV	I	II	II
<i>Epipactis palustris</i>	III	I	II	III	I
<i>Equisetum variegatum</i>	I	I	II	III	I
<i>Galium palustre</i>	III	IV	III	I	II
<i>Holcus lanatus</i>	III	I	III	III	II
<i>Hydrocotyle vulgaris</i>	V	V	IV	V	IV
<i>Lotus corniculatus</i>	III	I	II	III	I
<i>Mentha aquatica</i>	III	IV	III	IV	IV
<i>Potentilla anserina</i>	III	III	III	II	II
<i>Ranunculus flammula</i>	I	III	I	III	I
<i>Rubus caesius</i>	IV	IV	V	III	III
<i>Salix repens</i>	V	V	V	V	V
<i>Trifolium repens</i>	II	I	II	III	I



Figure 33: Typical SD15 at Newborough Warren with a dense carpet of *Calliergonella cuspidata* under *Salix repens* and *Hydrocotyle vulgaris*

The final sub-community, **SD15d *Holcus lanatus*-*Angelica sylvestris* sub-community** was more distinctive with a slightly more acidic and fen nature as the organic component of the soil increases. The presence of *Molinia caerulea* (Purple Moor-grass) or *Phragmites australis* (Common Reed), along with tall herbs typical of fens such as *Angelica sylvestris* help separate this stand, although no one of these elements was ever constant.

Three distinct variants of the above communities were recognised in the survey. An '**acid variant**' was recorded at Harlech for stands that were somewhat intermediate to U5, with the constant presence of *Nardus stricta* (Mat-grass) particularly notable. Also at Kenfig, stands of fairly typical SD15, but lacking any clear sub-community preferentials, and with constant and abundant *Calamagrostis epigejos* (Wood Small-reed) were assigned to the **SD15 *Calamagrostis epigejos* variant**. Where *Calamagrostis epigejos* was constant and abundant in SD15, but the vegetation retained a clear affinity to one of the sub-communities, these stands were not distinguished; the *Calamagrostis epigejos* variant was reserved for situations where the floristics have been changed sufficiently by the growth of *C. epigejos* to mask

some of the subtle differences in the sub-communities. With further development of *C. epigejos*, or where it is invading more fen-like vegetation, stands were tentatively placed in S24c (S24 *Phragmites australis*-*Peucedanum palustre* tall-herb fen).

The other distinctive form of SD15 mapped here was from the eastern edge of the sand dunes at Whiteford Burrows where there is some saline influence at the sand dune-saltmarsh interface. Here stands were called **SD15t** in reference to the transitional nature of the vegetation, which included elements of saltmarsh and dune slack which sits somewhere between SD15 and SM18. *Salix repens*, *Juncus maritimus* (Sea Rush), *Potentilla anserina* (Silverweed), *Trifolium repens*, *Carex flacca*, *Festuca rubra* and *Agrostis stolonifera* are all constant. This vegetation is probably also present at the northern end of Morfa Harlech in the extensive interface between sand dune and saltmarsh, and here stands of SD15 and stands were mapped as SD17 and SM18 *Juncus maritimus* salt-marsh community, often in close mosaics. A more detailed study of the interaction between dune slacks and saltmarsh vegetation at the point at which blown sand is inundated by the highest tides would be needed to reveal some of the detail of the vegetation that develops at this interface.



Figure 34: SD15t at Whiteford Burrows with some halophytes present

SD16 *Salix repens*-*Holcus lanatus* dune-slack community

The grassy vegetation covered in the **SD16 *Salix repens*-*Holcus lanatus* dune-slack community** is the driest of the dune slack vegetation communities and was the most widespread type of dune slack vegetation recorded in the survey.

Table 19: Area (ha) of SD16 recorded in this survey

Site	SD16u	SD16 acid variant	SD16a	SD16b	SD16c	SD16d	Total
Tywyn Aberffraw	3.86	-	10.46	10.00	3.57	2.65	30.54
Newborough Warren	14.15	2.90	0.30	29.33	15.52	7.35	69.55
Morfa Dinlle	-	-	-	-	-	5.87	5.87
Morfa Harlech	4.21	-	0.23	0.04	0.03	0.12	4.63
Morfa Dyffryn	6.49	-	1.79	8.00	1.99	2.12	20.39
Laugharne-Pendine Burrows	0.07	-	0.19	6.79	-	-	7.05
Pembrey Coast	0.81	-	0.04	7.75	-	0.86	9.47
Whiteford Burrows	1.43	-	0.23	5.58	0.55	0.15	7.94
Kenfig	1.02	-	1.51	22.46	5.65	3.38	34.03
Merthyr Mawr	-	-	0.48	-	1.57	-	2.05
Total (ha)	32.05	2.90	15.23	89.95	28.88	22.50	191.51

The constant species of the published community area *Carex flacca*, *Festuca rubra*, *Holcus lanatus*, *Lotus corniculatus* and *Salix repens*, and these were also constant in the survey data, with *Festuca rubra* and *Carex flacca* more so than the published data (frequency V compared to IV). The only notable differences in the survey data compared to the published communities was the increased frequency of *Agrostis stolonifera*, *Calliergonella cuspidata*, *Pseudoscleropodium purum* and *Plantago lanceolata*, with less *Ononis repens* than expected.



Figure 35: SD16 is common in the extensive, grazed slacks at Newborough Warren

In general the sub-communities of SD16 were fairly straight forwards to assign, although the general abundance of *Rubus caesius*, which was more common across a range of vegetation types than might be expected from the NVC vegetation descriptions, in a range of slacks may have resulted in more stands being placed into **SD16b *Rubus caesius* sub-community** than might have been expected. This sub-community is the driest form of SD16, with the constant and abundant presence of *Rubus caesius* being a defining character. It also included two constant species more typical of SD8, *Plantago lanceolata*, and *Pseudoscleropodium purum*, which were at most occasional associates of the other sub-communities.

Table 20: Constant species from the SD16 sub-communities from quadrat data

Species	u	a	b	c	d
<i>Agrostis stolonifera</i>	II	-	III	IV	III
<i>Anthoxanthum odoratum</i>	IV	III	I	II	II
<i>Calliergonella cuspidata</i>	III	I	III	II	IV
<i>Carex flacca</i>	V	III	V	V	V
<i>Festuca rubra</i>	IV	V	V	V	IV
<i>Holcus lanatus</i>	V	IV	V	V	IV
<i>Hydrocotyle vulgaris</i>	-	I	III	II	V
<i>Lotus corniculatus</i>	IV	IV	IV	V	IV
<i>Luzula campestris</i>	III	II	II	III	I
<i>Ononis repens</i>	II	IV	I	I	I
<i>Plantago lanceolata</i>	III	III	IV	II	II
<i>Pseudoscleropodium purum</i>	V	II	IV	III	-
<i>Rubus caesius</i>	II	V	V	III	II
<i>Salix repens</i>	V	III	V	V	IV

SD16a *Ononis repens* sub-community is the sub-community that comes closest to the mesotrophic forms of SD8 (SD8d/e), with constant *Ononis repens* and preferential *Carex arenaria*, *Hypochaeris radicata* and *Galium verum*. The quadrats recorded in this survey show that the community constants *Salix repens* and *Carex flacca* are less often present in this sub-community than the others.



Figure 36: A colourful stand of SD16a at Kenfig

SD16c *Prunella vulgaris-Equisetum variegatum* sub-community is the most species-rich type of SD16, and was often distinguished by the presence of species such as *Equisetum variegatum* and *Pyrola rotundifolia* (Round-leaved Wintergreen). However, difficulties occurred where these species were present but with constant *Rubus caesius*, in stands intermediate between this and SD16b. It was often separated on the basis of the uncommon but diverse associates.



Figure 37: *Parnassia palustris* in SD16c at Tywyn Aberffraw

SD16d *Agrostis stolonifera* sub-community is a distinctive form of SD16 with *Agrostis stolonifera* replacing *Festuca rubra* as the dominant grass species. This is most often the wettest form of SD16, and the increased abundance of species typical of wetter slacks, such as *Hydrocotyle vulgaris* and *Ranunculus flammula* help pick out stands of this sub-community.

SD17 *Potentilla anserina*-*Carex nigra* dune-slack community

Table 21: Areas (ha) of SD17 recorded in the survey

Site	SD17u	SD17a	SD17b	SD17c	SD17d	Total
Tywyn Aberffraw	0.70	3.34	0.27	1.35	0.13	5.78
Newborough Warren	0.71	-	0.08	-	-	0.79
Morfa Dinlle	-	-	-	-	0.39	0.39
Morfa Harlech	5.22	1.69	2.10	1.64	23.63	34.28
Morfa Dyffryn	0.15	-	-	-	0.24	0.39
Laugharne-Pendine Burrows	0.03	0.32	0.06	0.12	1.41	1.94
Pembrey Coast	0.91	0.18	-	-	3.12	4.21
Whiteford Burrows	-	-	-	-	-	0.00
Kenfig	0.27	0.04	0.03	-	1.53	1.87
Merthyr Mawr	0.07	-	-	-	-	0.07
Total (ha)	8.05	5.57	2.54	3.11	30.45	49.72

The **SD17 *Potentilla anserina*-*Carex nigra* dune-slack community** includes dune slacks in decalcified areas, acid sands or slacks fed by acidic water. It was recorded at all of the project sites, and was common at Tywyn Aberffraw and Pembrey Coast, but most abundant at Morfa Harlech. It is characterised by constant *Agrostis stolonifera*, *Carex nigra*, *Potentilla anserina* and *Calliergonella cuspidata*, with *Salix repens* often present but not constant and rarely abundant. The data from the survey showed a good match with all the constants matching; *Ranunculus repens* was however notably less frequent than expected.



Figure 38: SD17 in the large slack in the central part of Morfa Harlech

The sub-communities were relatively straight-forwards to separate, although a significant area (around 15% of the total area) could not be assigned. A large amount of this was at Morfa Harlech where stands occurred in transitions to swamp, and also in very large slack mosaics where significant overlap of species made the separation of SD15 and SD17 very difficult.

Stands of **SD17a *Festuca rubra*-*Ranunculus repens* sub-community** were identified by the increased abundance of *Festuca rubra* in a sward with a grassy appearance, along with *Bellis perennis*, *Ranunculus repens* (Creeping Buttercup) and *Trifolium repens*.

Neither **SD17b *Carex flacca* sub-community** nor **SD17c *Caltha palustris* sub-community** were widely recorded, although some large stands of SD17c were present at Tywyn Aberffraw, identified by the presence of mesotrophic grassland species including *Cynosurus cristatus* (Crested Dog's-tail), *Rhinanthus minor* (Yellow-rattle) and *Trifolium pratense*, although *Caltha palustris* (Marsh-marigold) was absent. SD17b was characterised by the constant presence of *Carex flacca* and *Prunella vulgaris*.



Figure 39: SD17c at Tywyn Aberffraw with a mesotrophic character

The **SD17d *Hydrocotyle vulgaris-Ranunculus flammula* sub-community** is characterised by the presence of *Hydrocotyle vulgaris*, *Ranunculus flammula*, *Eleocharis palustris* (Common Spike-rush) and *Galium palustre*, with *Salix repens* more abundant than the other communities. Whilst stands of this composition are relatively distinct from other sub-communities of SD17, they share a lot in common with SD15a, and vegetation was often difficult to place between these two.

Comparison of the floristics of SD15a and SD17d

Despite being placed in different communities, there is significant overlap in species composition in stands of SD15a *Salix repens-Calliargon cuspidatum* dune-slack community, *Carex nigra* sub-community and SD17d *Potentilla anserina-Carex nigra* dune-slack community, *Hydrocotyle vulgaris-Ranunculus flammula* sub-community. The data on the constant species from Rodwell (2000) and quadrats from this survey are presented in the table below. Species that were good preferentials for SD15a from both the published data and the survey were *Mentha aquatica*, *Rubus caesius* and *Salix repens*. Similarly, for SD17d the preferentials were *Potentilla anserina* and *Ranunculus flammula*.

Table 22: The comparison of SD15a and SD17d vegetation

Species	SD15a		SD17d	
	Rodwell	SoLIFE	Rodwell	SoLIFE
-	Rodwell	SoLIFE	Rodwell	SoLIFE
<i>Agrostis stolonifera</i>	II (4)	III (6)	IV (9)	IV (8)
<i>Calliergonella cuspidata</i>	V (10)	V (10)	IV (10)	IV (9)
<i>Carex nigra</i>	IV (10)	IV (5)	V (10)	V (8)
<i>Equisetum palustre</i>	IV (9)	I (3)	II (5)	I (2)
<i>Galium palustre</i>	IV (5)	IV (2)	III (6)	III (3)
<i>Hydrocotyle vulgaris</i>	V (9)	V (9)	V (10)	III (8)
<i>Mentha aquatica</i>	IV (7)	IV (4)	II (4)	I (6)
<i>Potentilla anserina</i>	II (5)	III (4)	IV (9)	IV (8)
<i>Ranunculus flammula</i>	I (4)	III (4)	IV (4)	IV (2)
<i>Rubus caesius</i>	V (8)	IV (8)	I (5)	II (4)
<i>Salix repens</i>	V (10)	V (10)	III (9)	II (5)

Dune Scrub and Dune Annuals

Two vegetation types were included in the published NVC volume with the sand dune vegetation, scrub dominated by *Hippophae rhamnoides* (SD18) and an associated of annual species in areas of open ground on relatively stable sands (SD19).

Table 23: Areas (ha) of SD18 and SD19 recorded in the survey

Site	SD18u	SD18a	SD18b	SD18	SD19
Tywyn Aberffraw	-	-	-	-	5.15
Newborough Warren	-	0.02	-	0.02	3.37
Morfa Dinlle	-	-	-	-	-
Morfa Harlech	-	-	-	-	1.37
Morfa Dyffryn	-	-	-	-	4.93
Laugharne-Pendine Burrows	0.27	25.20	22.72	48.19	0.07
Pembrey Coast	0.79	2.46	12.08	15.34	1.07
Whiteford Burrows	-	-	-	-	4.19
Kenfig	-	0.10	0.28	0.37	2.70
Merthyr Mawr	35.14	-	-	35.14	8.27
Total (ha)	36.20	27.79	35.08	99.07	31.12

SD18 *Hippophae rhamnoides* dune scrub

The presence of the nationally scarce *Hippophae rhamnoides* is generally not welcomed in Wales, where it is not native, and has a tendency to aggressive invasion of sand dune vegetation. If left to develop it forms extensive, dense, spiny thickets that are impenetrable. Eradication programmes have been in place on several of the project sites since the 1960s and, as the low total extent of this vegetation type within

the surveyed areas shows, these programmes have been largely successful at sites including Newborough Warren, Whiteford Burrows and Kenfig. Where it remains present in larger quantities, at Laugharne-Pendine Burrows, Pembrey Coast and Merthyr Mawr removal of *Hippophae rhamnoides* is also still taking place. *Hippophae rhamnoides* is the only community constant, and stands were typically mapped where *Hippophae rhamnoides* reaches cover of around 25% over an area of at least 0.04ha, although smaller but mature clumps were often mapped too.

Two sub-communities are recognised, young stands are assigned to **SD18a *Festuca rubra* sub-community**, where the stands have a recognisable character of the vegetation being invaded by the shrub. Stands of **SD18b *Urtica dioica*-*Arrhenatherum elatius* sub-community** are more mature, and the shade of the *Hippophae rhamnoides* canopy alters the composition of the ground flora eliminating light-demanding species. Stands of SD18b were often surrounded by a ring of SD18a spreading out into the adjacent vegetation.

Areas of cleared SD18 were present at most sites and generally the clearance had completely removed the plants. However, in a few locations the bushes were found to be regenerating from the stumps, with much of the ruderal element of SD18b (e.g. *Arrhenatherum elatius*, *Jacobaea vulgaris*, *Urtica dioica* (Common Nettle)) forming the vegetation around the regenerating bushes, but joined by a range of annuals and ephemerals in the disturbed ground created by the clearance.



Figure 40: SD18a invading SD8 at Laugharne-Pendine Burrows



Figure 41: Mature SD18b with some *Sambucus nigra* in the canopy at Tywyn Gwendraeth (Pembrey Coast)

SD19 *Phleum arenarium*-*Arenaria serpyllifolia* dune annual community

The dune annual community was not included in the draft of the original NVC volumes used in the Sand Dune Survey GB, instead much of the annual component was included in “SD7d”, a mix of which has ended up as SD7b and SD19. The separation has proved useful as SD19 was recorded amongst a range of vegetation types, as well as in larger pure stands. The vegetation is characterised by a range of annual vascular plants and perennial bryophytes that form on disturbed areas of sand but where there is relatively little sand movement. The disturbance is likely to be from a range of sources, such as regular drought (e.g. on steeper slopes near dune ridges) or rabbit disturbance, but not from the instability of the dunes themselves. Many of the annuals in this vegetation die back early in the year, leaving a scattering of perennials and the bryophyte and lichen layer to help distinguish stands. This, combined with the small scale of the stands, means that distinguishing this vegetation from the open, bryophyte-rich ground amongst communities such as SD7b, SD8b and SD8c is not always simple, and is sometimes a matter of the scale used. In general, the presence of *Phleum arenarium*, and/or *Vulpia fasciculata* and/or *Aira praecox* (Early Hair-grass) with annual forbs such as *Arenaria serpyllifolia*, *Cerastium diffusum* and *Cerastium semidecandrum* (Lesser Mouse-ear) were used to identify stands of this vegetation, often marked as a minor part of the mosaic in large areas of SD7 and SD8 (rarely SD6e/f or SD9). The constant species in the published descriptions are *Ammophila arenaria*, *Arenaria serpyllifolia*, *Carex arenaria*, *Festuca rubra* and *Phleum arenarium*. In the samples recorded here these species were all constant, with *Syntrichia ruralis* ssp. *ruraliformis*, *Ononis repens* and *Hypochaeris radicata* also found to be constant.



Figure 42: *Phleum arenarium* amongst bare sand in SD19 (Tywyn Aberffraw)



Figure 43: *Vulpia fasciculata* often formed conspicuous patches in SD19, here at Tywyn Aberffraw

Calcareous Grassland, Acid Grassland and Heathland

Neither communities placed in calcareous grassland (CG) nor those placed in acid grassland (U) were common on the survey sites, with four communities overall, each recorded at only a single site.

Table 24: Areas (ha) of GC6, CG7, other calcicolous grassland, U4 and U5 recorded in the survey

Site	CG6	CG7	Other calcicolous grassland	U4	U5
Tywyn Aberffraw	0.01	-	-	-	-
Newborough Warren	-	-	-	-	-
Morfa Dinlle	-	-	-	-	-
Morfa Harlech	-	-	-	1.28	-
Morfa Dyffryn	-	-	-	-	-
Laugharne-Pendine Burrows	-	-	-	-	-
Pembrey Coast	-	-	-	-	-
Whiteford Burrows	-	-	-	-	-
Kenfig	-	-	-	-	0.04
Merthyr Mawr	-	0.20	0.06	-	-
Total (ha)	0.01	0.20	0.06	1.28	0.04

CG6 *Avenula pubescens* grassland and CG7 *Festuca ovina-Hieracium pilosella-Thymus praecox/pulegioides* grassland

The stand of **CG6 *Avenula pubescens* grassland** at Tywyn Aberffraw was mapped where *Avenula pubescens* (Downy Oat-grass) is locally dominant in association with a rather parched form of SD8 where *Festuca rubra* is very sparse. The vegetation lacks many of the calcicoles typical of CG6 stands, and could be considered more like a very extreme form of SD8. The stands of **CG7 *Festuca ovina-Hieracium pilosella-Thymus praecox/pulegioides* grassland** and other calcicolous grassland at Merthyr Mawr reflect the influence of the limestone bedrock beneath the surface of the climbing dunes.

U4 *Festuca ovina-Agrostis capillaris-Galium saxatile* grassland and U5 *Nardus stricta-Galium saxatile* grassland

Stands of **U4 *Festuca ovina-Agrostis capillaris-Galium saxatile* grassland** were present at Morfa Harlech in marginal areas of the golf course, where the management of the golf course rough has created decalcified sands with some mesotrophic influence. The constant presence of *Potentilla erecta* (Tomentil) and the absence of *Ammophila arenaria* make this vegetation distinct from SD12.



Figure 44: The U4 'rough' at Morfa Harlech

Very small areas of **U5 *Nardus stricta*-*Galium saxatile* grassland** were recorded in the southern part of Kenfig, where grazed, climbing dunes have developed a sward with *Nardus stricta* abundant in a small area.

H11 *Calluna vulgaris*-*Carex arenaria* heath

The calcareous sands that make up the dunes of the survey sites mean that dune heath is generally rare. All the stands recorded were assigned to the typical dune heath community, H11. Also included here is a small area at Morfa Harlech where a slack has been cleared and re-planted with *Calluna vulgaris* (Heather), forming an open vegetation that is not easily placed in the NVC scheme, but likely to develop into H11 over time.

Table 25: Areas (ha) of heath recorded in the survey

Row Labels	H11	H11c	Other (Calluna)	Total
Tywyn Aberffraw	2.08	-	-	2.08
Newborough Warren	-	-	-	-
Morfa Dinlle	0.06	-	-	0.06
Morfa Harlech	0.47	0.02	0.05	0.54
Morfa Dyffryn	-	-	-	-
Laugharne-Pendine Burrows	-	-	-	-
Pembrey Coast	-	-	-	-
Whiteford Burrows	-	-	-	-
Kenfig	0.34	-	-	0.34
Merthyr Mawr	-	-	-	-
Total (ha)	2.95	0.02	0.05	3.02

Stands of H11 are similar to other heath communities but are distinguished by the constant presence of *Carex arenaria*. *Carex arenaria* was present in all areas with constant *Calluna vulgaris* so all heaths were comfortably placed in H11, although many stands were noted as transitional with SD12. Compared to the published community, *Erica cinerea* (Bell Heather), expected to be a frequent associate, was absent, and one particularly species-poor stand was placed in **H11c species-poor sub-community**.

At Kenfig this vegetation is rare, only found on the climbing dunes at the south of the site and, at Morfa Dinlle, was present only in an area of previously modified ground now reverting to natural vegetation. The presence in many stands of *Anthoxanthum odoratum*, *Holcus lanatus* (Yorkshire-fog), *Thymus drucei* and *Rumex acetosa* (Common Sorrel) at much higher frequency than expected emphasise the similarities with SD12 (Figure 45).



Figure 45: An area of H11 at Tywyn Aberffraw

Coastal Grassland

Coastal grassland (MC) is the typical vegetation found on maritime cliffs. These are generally not present in the survey sites, the main exception being a small section of cliff at the south of the beach at Tywyn Aberffraw. However, vegetation with strong affinities to the coastal grassland communities was recorded in a number of places where stable shingle infilled with sand was present. This was most often the case on the landward part of terminal spits, although in the case of Newborough it also occurred on the seaward side. There is also one coastal grassland community (MC6) which is typical of strandlines. The 'cobble mosaic vegetation' of Merthyr Mawr is included in this section too.

Table 26: Areas (ha) of coastal grassland communities recorded in the survey

Site	MC	MC5	MC5d	MC6	MC8a	MC8b	MC8e	MC10	Cobble mosaic veg.
Tywyn Aberffraw	-	-	-	-	-	0.03	0.02	-	-
Newborough Warren	-	0.66	-	-	-	-	-	-	-
Morfa Dinlle	-	-	-	0.20	0.08	-	-	-	-
Morfa Harlech	-	-	-	-	-	-	-	-	-
Morfa Dyffryn	-	-	-	-	-	-	-	-	-
Laugharne-Pendine Burrows	-	-	-	-	-	-	-	-	-
Pembrey Coast	-	-	1.63	-	-	-	-	-	-
Whiteford Burrows	0.05	-	-	-	-	-	-	0.39	-
Kenfig	-	-	-	-	-	-	-	-	-
Merthyr Mawr	-	0.48	-	-	-	-	-	0.68	2.10
Total (ha)	0.05	1.14	1.63	0.20	0.08	0.03	0.02	1.07	2.10

MC5 *Armeria maritima*-*Cerastium diffusum* ssp. *diffusum* maritime therophyte community

Areas of **MC5 *Armeria maritima*-*Cerastium diffusum* ssp. *diffusum* maritime therophyte community** were recorded at both Newborough around the end of the spit to Abermenai Point and at Merthyr Mawr amongst the extensive cobbles. This vegetation was distinguished by open swards of *Armeria maritima* (Thrift), *Festuca rubra*, *Plantago coronopus* (Buck's-horn Plantain) often with *Sedum* spp.. It was also found on the north side of the southern spit at Pembrey Burrows, recorded as the **MC5d *Arenaria serpyllifolia* sub-community**, where it occurred in a mosaic with

the SM16 *Festuca rubra* salt-marsh community in the transition from sand dune to saltmarsh vegetation on the sheltered side of the spit.

MC6 *Atriplex prostrata*-*Beta vulgaris* ssp. *maritima* sea-bird cliff community

MC6 *Atriplex prostrata*-*Beta vulgaris* ssp. *maritima* sea-bird cliff community was recorded only as a narrow band around the eastern projection of the blown sand at Morfa Dinlle. Here a distinctive band of the strandline was dominated by *Atriplex prostrata* (Spear-leaved Orache) with scattered *Beta vulgaris* ssp. *maritima* (Sea Beet).



Figure 46: MC5 at Pembrey Coast with flowering *Sedum acre* and *Armeria maritima*

MC8 *Festuca rubra*-*Armeria maritima* maritime grassland

MC8 *Festuca rubra*-*Armeria maritima* maritime grassland was recorded at both Tywyn Aberffraw on the cliffs present at the south end of the beach, and is characterised by dense swards of *Festuca rubra* with some halophytes, most prominently *Armeria maritima*. These cliffs are contiguous with those of the Penrhynoedd Llangadwaladr SSSI, a site designated for its coast cliff vegetation. The small sections within the survey area were assigned to **MC8b *Crithmum maritimum* sub-community** and **MC8e *Plantago coronopus* sub-community**. At Morfa Dinlle vegetation referable to the **MC8a *Festuca rubra*-*Armeria maritima* maritime grassland, typical sub-community** was recorded on an artificial shingle spit.

MC10 *Festuca rubra*-*Plantago* spp. maritime grassland

Vegetation referable to the **MC10 *Festuca rubra*-*Plantago* spp. maritime grassland** was recorded at Whiteford Burrows and Merthyr Mawr. This is a more fixed grassland type with a grassy *Festuca rubra* sward, but with constant *Agrostis stolonifera*, and *Plantago* spp.. At Whiteford there were also stands referred to 'MC' reflecting their affinities to the MC10 vegetation, but these were poorly developed and it was not possible to place these definitively in any community.



Figure 47: MC8 on the cliffs at the south of the beach at Tywyn Aberffraw



Figure 48: MC10 vegetation at the tip of the recurved spit at Whiteford Burrows

Mesotrophic Grassland

Mesotrophic grasslands were very common in the sites surveyed, most commonly at the landward extent of sites, often in areas modified for amenity or agriculture, and occasionally at the edges of saltmarsh.

MG1 *Arrhenatherum elatius* grassland

Table 27: Area (ha) of MG1 recorded in the survey

Row Labels	MG1	MG1a	MG1av	MG1avi	MG1b	MG1c	MG1e	Total
Tywyn Aberffraw	0.34	2.92	0.13	-	3.64	0.73	1.78	9.52
Newborough Warren	-	-	-	-	0.31	0.50	1.60	2.41
Morfa Dinlle	0.03	-	-	-	0.03	-	-	0.06
Morfa Harlech	2.69	2.26	-	-	0.52	-	-	5.47
Morfa Dyffryn	-	3.81	-	-	0.41	0.06	-	4.29
Laugharne-Pendine Burrows	4.72	0.75	-	-	2.06	0.69	-	8.23
Pembrey Coast	-	0.19	-	-	0.51	0.05	0.03	0.78
Whiteford Burrows	-	-	-	-	-	-	-	-
Kenfig	0.51	7.05	-	2.90	0.10	0.07	-	10.63
Merthyr Mawr	-	-	-	-	-	-	-	0.00
Total (ha)	8.29	16.98	0.13	2.90	7.58	2.10	3.41	41.39

MG1 *Arrhenatherum elatius* grassland was widespread, occupying large areas at some sites. It is characterised by constant *Arrhenatherum elatius* and *Dactylis glomerata* (Cock's-foot) in rank swards. *Arrhenatherum elatius* is intolerant of regular mowing or grazing, so tends to occur where there is little management. At sites with extensive grazing, such as Newborough Warren and Kenfig this vegetation is limited to the landward periphery of the sites. At Tywyn Aberffraw it is common along the north side of the Afon Ffraw where there is no grazing. Stands of MG1 recorded in the survey had many of the typical species of MG1, but with *Festuca rubra* constant (perhaps reflecting the prevalence of the **MG1a *Festuca rubra* sub-community** in the samples) and the dune specialists *Carex arenaria*, *Poa humilis*, *Rosa spinosissima* and *Rubus caesius* all recorded in this vegetation in the survey but not expected from the published data.

The most widely recorded sub-community was the **MG1a *Festuca rubra* sub-community**, characterised by the constancy of *Festuca rubra*. Two variants of this sub-community were identified, the **MG1av *Epilobium angustifolium* variant**, and a new variant the **MG1avi *Pteridium aquilinum* variant**, where in both cases the coarse grasses are replaced as the dominant species by *Chamaenerion angustifolium* and *Pteridium aquilinum* respectively.

The **MG1b *Urtica dioica* sub-community** is distinguished by the presence of tall herbs, particularly *Urtica dioica* and *Heracleum sphondylium* and is indicative of significant enrichment. The **MG1c *Filipendula ulmaria* sub-community** occurs where there are more poorly-draining soils allowing the wetland species to persist in the sward.



Figure 49: Stand of MG1b at Tywyn Aberffraw adjacent to the Afon Ffraw

MG1e *Centaurea nigra* sub-community is a more species-rich sub-community, and was recorded at both Tywyn Aberffraw and Newborough Warren. It is probably derived from the enrichment of SD8 swards so that species such as *Ammophila arenaria* and *Carex arenaria* are lost, but many of the more distinctive forbs can persist and species such as *Centaurea nigra* (Common Knapweed) are often conspicuous.

MG5 *Cynosurus cristatus*-*Centaurea nigra* grassland

Table 28: Areas (ha) of MG5, MG6 and MG7 recorded in the survey

Row Labels	MG5	MG5 b	MG5 c	MG6	MG6 a	MG6 b	MG7	MG7 b	MG7 e
Tywyn Aberffraw	0.93	0.30	-	-	0.25	0.28	-	-	-
Newborough Warren	-	-	0.62	-	-	-	-	-	-
Morfa Dinlle	-	-	-	-	-	-	0.04	-	-
Morfa Harlech	0.95	-	-	0.08	6.46	0.60	-	-	-
Morfa Dyffryn	-	-	-	0.04	2.16	0.34	-	-	-
Laugharne- Pendine Burrows	0.16	1.64	-	-	4.54	0.61	-	1.16	-
Pembrey Coast	-	-	-	-	-	-	-	-	0.69
Whiteford Burrows	-	-	-	-	-	-	-	-	-
Kenfig	0.05	-	-	-	-	-	0.02	-	-
Merthyr Mawr	-	-	-	-	-	-	-	-	-
Total (ha)	2.09	1.94	0.62	0.12	13.4 0	1.82	0.06	1.16	0.69

Small stands of **MG5 *Cynosurus cristatus*-*Centaurea nigra* grassland** were recorded at five of the sites, although nowhere is it very extensive. MG5 is a much-valued community type, being the typical species-rich lowland meadow vegetation which requires a long history without significant disturbance or improvement. There is a notable overlap of the constant species of SD8 and MG5, including species such as *Festuca rubra*, *Lotus corniculatus*, and *Plantago lanceolata*. Stands generally develop where there is some amelioration of the harsh conditions of blown sand through development of organic soils which help retain some soil moisture and nutrients. In the Scottish part of the SDSGB, stands with affinities to both SD8 and MG5 were assigned a new sub-community of SD8, **SD8x *Centaurea nigra*-*Daucus carota* sub-community**. Although no stands of this were mapped in this survey, many of the stands mapped as MG5 have strong affinities to SD8. In this survey the stands mapped as MG5 were marked out by the presence of *Centaurea nigra* agg., a species largely absent from the sand dune communities, and *Cynosurus cristatus*, a species normally limited to dune slacks rather than dry grassland on sand dunes. However, the swards have notable differences to typical Welsh MG5 from inland sites (Stevens et al. 2005), including a range of dune species such as *Carex arenaria* and *Rubus caesius*.



Figure 50: MG5 at Laugharne-Pendine Burrows

MG6 *Lolium perenne*-*Cynosurus cristatus* grassland

Stands of **MG6 *Lolium perenne*-*Cynosurus cristatus* grassland** are typically the result of some attempts at agricultural improvement, resulting in the spread of *Lolium perenne* and some nitrophilous species such as *Trifolium repens*. Stands are typically grazed for a significant part of the year or regularly mown. It was most common at Morfa Harlech, in areas around the golf course in the southern part of the site, and also in areas in the north of the site around the main cattle access point. At Laugharne-Pendine Burrows it is present in the agricultural fields to the north of the site, where it typically forms a mosaic with M23. Small stands were present on mown ground at the campsite at Morfa Dyffryn. Stands were assigned to the species-poor **MG6a typical sub-community** and the more calcifuge **MG6b *Anthoxanthum odoratum* sub-community**. Stands of MG6 are likely to be more widespread on blown sand where it extends beyond the boundaries of the designated sites and is used for agriculture.

MG7 *Lolium perenne* leys and related grasslands

The most strongly 'improved' grasslands have species-poor swards with dominant *Lolium perenne* and includes some regularly-mown road verges, as at Laugharne-Pendine Burrows and Morfa Dinlle.

MG9 *Holcus lanatus*-*Deschampsia cespitosa* grassland

Table 29: Areas (ha) of MG9, MG10 and MG11 recorded in the survey

Row Labels	MG9	MG10	MG10 a	MG10 b	MG11	MG11 b	MG11 c
Tywyn Aberffraw	0.03	-	0.30	0.01	0.12	-	0.07
Newborough Warren	-	0.25	-	-	-	-	-
Morfa Dinlle	-	-	-	-	-	-	-
Morfa Harlech	-	0.19	-	-	-	-	-
Morfa Dyffryn	-	-	1.23	-	1.67	0.13	-
Laugharne-Pendine Burrows	0.23	0.11	0.08	1.14	0.82	-	-
Pembrey Coast	-	-	-	-	0.18	-	-
Whiteford Burrows	-	-	-	-	-	-	-
Kenfig	0.05	0.03	-	0.33	-	-	-
Merthyr Mawr	-	-	-	-	-	2.46	-
Total (ha)	0.31	0.57	1.61	1.47	2.79	2.59	0.07

Stands of **MG9 *Holcus lanatus*-*Deschampsia cespitosa* grassland** are characterised by coarse tussocky swards of *Deschampsia cespitosa* (Tufted Hair-grass) with other rank grasses in wet conditions. Small stands were recorded in slacks at Tywyn Aberffraw, Laugharne-Pendine Burrows and Kenfig. The small isolated stands are difficult to relate to the published sub-communities.

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

Stands of **MG10 *Holcus lanatus*-*Juncus effusus* rush-pasture** were of limited extent, with most rush pasture present on the sand dunes referred to M23. The stands assigned to MG10 tended to be located in areas of land actively used for agriculture and where there is some enrichment of the soil and are identified by *Juncus effusus* (Soft-rush) as the most abundant rush. Both the **MG10a typical sub-community** and the **MG10b *Juncus inflexus* sub-community** were recorded. The four samples of this vegetation from the survey showed a good match to the community floristics, although over twenty species not recorded in the published NVC community were associated with stands, including constant *Rubus caesius*.

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

Areas of MG11 were uncommon, characterised by constant *Agrostis stolonifera*, *Festuca rubra* and *Potentilla anserina*. The four quadrat samples from this vegetation showed a good match to the published community, with only *Lolium perenne* absent showing the development of these stands largely in the absence of agricultural influence. *Rubus caesius* was constantly present in the quadrat samples, a species not present in the published floristic tables. There was a large area in wet pasture at

the landward side of Morfa Dyffryn that supported stands dominated by *Agrostis stolonifera*. The **MG11b *Atriplex prostrata* sub-community** was recorded at both Morfa Dyffryn and Merthyr Mawr where saltmarsh has developed on the banks of rivers that run through the dunes, and are characterised by the presence of halophytes. A small area of the **MG11c *Honckenya peploides* sub-community** was found at Tywyn Aberffraw.

Mires

Areas of vegetation referable to the mire communities in the NVC are typically found in stable locations where wet ground conditions have allowed the accumulation of sufficient organic matter in the sandy soil. Where this takes place in slacks the vegetation often develops a slightly acidic character owing to the humus, and the soils are better able to retain nutrients.

Table 30: Area (ha) of M13, and M22-M25 recorded in the survey

Row Labels	M13	M22	M22 b	M22 d	M23	M23 a	M23 b	M24	M25
Tywyn Aberffraw	-	-	-	-	-	0.18	-	0.24	-
Newborough Warren	0.08	-	-	-	-	0.53	0.04	-	-
Morfa Dinlle	-	-	-	-	-	-	-	-	-
Morfa Harlech	-	-	-	-	4.38	1.77	0.27	-	-
Morfa Dyffryn	-	-	-	-	0.03	7.37	2.44	-	0.02
Laugharne-Pendine Burrows	-	1.20	-	-	0.24	-	16.34	-	-
Pembrey Coast	-	2.46	-	-	-	-	-	-	-
Whiteford Burrows	-	0.07	-	-	-	0.67	-	-	-
Kenfig	-	-	0.03	0.06	-	-	-	-	0.01
Merthyr Mawr	-	-	-	-	-	-	-	-	-
Total (ha)	0.08	3.72	0.03	0.06	4.64	10.53	19.09	0.24	0.03

Row Labels	M27	M27 a	M27 b	M27 c	Tot al	M28	M28 a	M28 b	M28 c	Tot al
Tywyn Aberffraw	5.30	2.03	1.95	0.51	9.80	0.90	-	0.68	-	1.59
Newborough Warren	2.24	0.12	-	0.65	3.01	0.06	1.15	-	-	1.21
Morfa Dinlle	-	-	-	-	-	-	-	-	-	-
Morfa Harlech	0.40	-	-	-	0.40	2.07	-	-	-	2.07
Morfa Dyffryn	-	-	-	-	-	-	-	-	-	-
Laugharne-Pendine Burrows	0.82	4.11	-	7.22	12.15	0.18	1.72	-	0.26	2.15
Pembrey Coast	0.25	-	-	-	0.25	-	-	-	-	-
Whiteford Burrows	1.15	-	-	-	1.15	-	0.62	-	-	0.62
Kenfig	1.00	-	2.61	-	3.60	0.11	-	-	-	0.11
Merthyr Mawr	<0.01	-	-	-	<0.01	0.01	-	-	-	0.01
Total (ha)	11.16	6.27	4.56	8.38	30.37	3.32	3.49	0.68	0.26	7.75

M13 *Schoenus nigricans*-*Juncus subnodulosus* mire

Only one small, species-poor slack at Newborough Warren was assigned to **M13 *Schoenus nigricans*-*Juncus subnodulosus* mire**. In this slack, outside the grazed

area, *Schoenus nigricans* (Black Bog-rush), which is present in many slacks, has become the dominant species in tussocky fen vegetation which has a deep leaf litter. The vegetation is a poor fit to M13, lacking many several of the species typical of this vegetation, but stands of M13 are noted in Rodwell (1992) as sometimes being very poor in species and the overall appearance is one of the tussocky form of M13.

M22 *Juncus subnodulosus*-*Cirsium palustre* fen-meadow

This rushy vegetation is characterised by abundant and locally dominant *Juncus subnodulosus* (Blunt-flowered Rush), often with a rich group of associates typical of fens. It is maintained by either mowing or grazing, both of which applied to stands found during the survey. It is described in the published volumes as 'very variable in structure and composition'. It was only present on sites in the south of the survey area, *Juncus subnodulosus* being very uncommon on sand dunes in the north of Wales. Of the community constants, stands recorded in this survey had less *Cirsium palustre* (Marsh Thistle), *Equisetum palustre* (Marsh Horsetail) and *Mentha aquatica* than expected, with *Phragmites australis* and *Vicia cracca* (Tufted Vetch) present as constant associates but only listed as occasional in the published data. Many of the stands found in the survey formed part of a mosaic in the larger slacks, and there is a strong overlap in species composition with M27. The key feature for distinguishing stands of M22 was the abundance of *Juncus subnodulosus*. At Kenfig stands were assigned to either **M22b *Briza media*-*Trifolium* spp. sub-community** or **M22c *Carex elata* sub-community**.



Figure 51: M22 in a large slack at Tywyn Gwendraeth (Pembrey Coast) where it forms a mosaic with SD15

M23 *Juncus effusus*/*acutiflorus*-*Galium palustre* rush-pasture

M23 *Juncus effusus*/*acutiflorus*-*Galium palustre* rush-pasture represents a very widespread form of rush pasture in Wales with either *Juncus effusus* or *Juncus acutiflorus* constant and abundant with the other constant species listed as *Galium palustre*, *Holcus lanatus* and *Lotus pedunculatus* (Greater Bird's-foot Trefoil). It is

less grassy and has a higher abundance of fen species compared to the similar MG10 (MG10 *Holcus lanatus*-*Juncus effusus* rush-pasture), with which there is continuous variation. The vegetation was most common where there are enclosed, grazed fields within the SAC boundary, such as at Laugharne-Pendine Burrows or the southern and eastern parts of Morfa Dyffryn. The thirteen quadrat samples here show a good match to the community constants from the published data, but with *Potentilla anserina* and *Anthoxanthum odoratum* being additionally constant, highlighting the links to the SD17 dune slack vegetation. Stands were assigned to the **M23a *Juncus acutiflorus* sub-community** or the **M23b *Juncus effusus* sub-community** on the basis of the dominant rush species, but some stands with roughly equal mixtures of both were unassigned.



Figure 52: M23b at Laugharne-Pendine Burrows

M24 *Molinia caerulea*-*Cirsium dissectum* fen-meadow and M25 *Molinia caerulea*-*Potentilla erecta* mire

Molinia caerulea, the main dominant in both the **M24 *Molinia caerulea*-*Cirsium dissectum* fen-meadow** and the **M25 *Molinia caerulea*-*Potentilla erecta* mire** is present in a range of dune wetland communities, notably SD15 and SD17, but is rarely dominant in stands of vegetation on sand dunes. At Tywyn Aberffraw a stand of M24 was recorded adjacent to the main road in a low-lying wetter area. Very small areas of species-poor M25 were recorded at Kenfig and Morfa Dyffryn.

M27 *Filipendula ulmaria*-*Angelica sylvestris* mire

Stands of **M27 *Filipendula ulmaria*-*Angelica sylvestris* mire** were very common and appear to represent a natural succession for wetter, fixed dune slack vegetation which escape significant scrub invasion. *Filipendula ulmaria* (Meadowsweet) occurs in a range of NVC communities but, where it becomes constant and abundant in fen vegetation, the stands are placed in M27. There are no other constants in the published description, perhaps reflecting the large number of situations in which this vegetation can develop. Consistent with this variability, the fourteen samples from the survey had only *Filipendula ulmaria* as a constant, with notable discrepancies being

the absence of *Ranunculus repens* and the increased frequency of *Carex nigra*, *Equisetum palustre*, and *Hydrocotyle vulgaris* (all III in the survey data). With the occasional presence of *Potentilla anserina* these species give a distinctive 'dune slack' element to the vegetation making it, visually at least, similar to SD17 in appearance.

The largest extents of M27 were recorded at Aberffraw, particularly around Llyn Coron and the Afon Ffraw, but also in the fixed sand plains at the back of the site towards Llyn Coron, and at Laugharne-Pendine Burrows around the freshwater marsh.



Figure 53: M27b by Llyn Coron at Aberffraw

Although a significant area of stands are not assigned to any sub-community, stands were assigned to all three of the published sub-communities. **M27a *Valeriana officinalis-Rumex acetosa* sub-community** recognised where rushes and reeds and *Urtica dioica* were uncommon, in contrast to each of the other sub-communities. **M27b *Urtica dioica-Vicia cracca* sub-community** encompassed stands with some enrichment, often with *Phragmites australis* and clumps of *Urtica dioica* and frequently *Rubus fruticosus* agg.. Stands were also mapped as **M27c *Juncus effusus-Holcus lanatus* sub-community** and were recognised by the prominence of tussocks of rushes and grasses.

M28 *Iris pseudacorus-Filipendula ulmaria* mire

Stands of **M28 *Iris pseudacorus-Filipendula ulmaria* mire** are similar to M27, but characterised by the constant and abundant presence of *Iris pseudacorus* (Yellow Iris). It was found in similar situations to M27, but more often associated with the banks of channels and slightly deeper water areas. Compared to the published community description, *Filipendula ulmaria* was less frequent than expected with *Equisetum palustre*, *Holcus lanatus*, *Juncus acutiflorus* (Sharp-flowered Rush) and *Potentilla anserina* all joining *Iris pseudacorus* as constant elements in the vegetation, albeit based on a small number of samples (4). M28 unassigned and

M28a *Juncus effusus*-*J. acutiflorus* sub-community were the most common designations within M28, with a few stands of **M28b *Urtica dioica*-*Galium aparine* sub-community** where there is some enrichment, and **M28c *Atriplex prostrata*-*Samolus valerandi* sub-community** where there is some influence of the salinity either as salt spray or groundwater influence.



Figure 54: Stands of M28 in grazed land in the north part of Morfa Harlech

Open Vegetation

The open vegetation communities cover a range of different vegetation physiognomies. In this survey two communities of dry grassland were recorded (OV21, OV23), along with four tall herb communities (OV24-OV27) and two communities of rock outcrops (OV41, OV24). A large area of 'other open vegetation' was also noted, this category was used for dry, disturbed grassland with a high annual and bryophyte sward component.

Table 31: Area (ha) of OV21, OV23 and other open vegetation recorded in the survey

Row Labels	OV21	OV21b	OV23	OV23a	OV23c	Other (OV)	Other (OV/MG)
Tywyn Aberffraw	-	-	0.02	-	-	0.32	-
Newborough Warren	-	-	-	-	-	-	-
Morfa Dinlle	-	-	0.01	-	-	0.47	-
Morfa Harlech	-	-	-	-	-	1.30	-
Morfa Dyffryn	-	-	0.26	0.21	4.36	0.31	-
Laugharne-Pendine Burrows	0.06	-	1.97	-	-	0.28	-
Pembrey Coast	0.04	0.17	0.08	-	-	0.82	0.11
Whiteford Burrows	-	-	-	-	-	0.03	-
Kenfig	-	-	-	0.22	0.03	0.59	-
Merthyr Mawr	-	-	-	-	-	1.36	-
Total (ha)	0.10	0.17	2.34	0.43	4.38	5.48	0.11

Table 32: Area (ha) of OV24-OV26 recorded in the survey

Row Labels	OV24	OV25	OV26	OV26b	OV26c	OV26e
Tywyn Aberffraw	-	-	0.04	0.32	0.13	0.09
Newborough Warren	-	-	0.10	-	0.18	-
Morfa Dinlle	-	-	-	-	-	-
Morfa Harlech	-	0.09	-	-	-	-
Morfa Dyffryn	0.07	-	-	-	-	-
Laugharne-Pendine Burrows	-	-	-	-	0.62	-
Pembrey Coast	-	-	-	-	-	-
Whiteford Burrows	0.25	-	-	-	-	-
Kenfig	-	0.12	-	-	-	-
Merthyr Mawr	-	-	-	-	-	-
Total	0.32	0.21	0.15	0.32	0.92	0.09

OV21 *Poa annua*-*Plantago major* community

A small area of vegetation was assigned to the **OV21 *Poa annua*-*Plantago major* community**, including the **OV21b *Lolium perenne* sub-community**. This vegetation is characterised by the open swards of *Matricaria discoidea* (Pineapple Weed), *Poa annua* (Annual Meadow-grass) and *Plantago major* (Greater Plantain), often in enriched disturbed and compacted soil in areas such as gateways and livestock holding areas.

OV23 *Lolium perenne*-*Dactylis glomerata* community

Stands of the **OV23 *Lolium perenne*-*Dactylis glomerata* community** are found in coarse weedy places. It was often present around car parks and public access places and small scattered stands, being more extensive around the campsite at Morfa Dyffryn and along the verges of the extensive surfaced roads at Laugharne-Pendine Burrows.

Other Open Vegetation

Stands of other open vegetation were common across all sites, and typically encompassed grassy, disturbed places. Annual species are well represented in all stands. They are notable as they often include uncommon species such as *Logfia minima* (Small Cudweed) at Morfa Harlech and *Silene conica* (Sand Catchfly) at Pembrey Burrows.



Figure 55: *Silene conica* along the sandy track at Pembrey Burrows

OV24 *Urtica dioica*-*Galium aparine* community

Stands of the **OV24 *Urtica dioica*-*Galium aparine* community** were recorded at Morfa Dyffryn around old feeding and watering locations for livestock in the enclosed fields at the back of the site. At Whiteford Burrows a large stand was present adjacent to the site boundary where runoff from the adjacent enclosed field has resulted in soil enrichment and the development of a large nettlebed. OV24 was used for stands where species such as *Holcus lanatus* and *Poa trivialis* (Rough-stalked

Meadow-grass) were prominent, compared to stands with *Cirsium arvense* (Creeping Thistle) and *Cirsium vulgare* which were assigned to OV25.

OV25 *Urtica dioica*-*Cirsium arvense* community

Nettlebeds with an increased abundance of thistles were assigned to **OV25 *Urtica dioica*-*Cirsium arvense* community**, with stands occurring at Morfa Harlech and Kenfig in areas of scrub clearance where enough nutrient-rich organic matter remains in the soil following clearance, allowing the tall herbs to dominate the resulting vegetation. An unusual stand of vegetation found on the strandline at Harlech Point at the northern end of Morfa Harlech was also assigned to this community. This stand consisted of dense *Carduus crispus* (Wet Thistle) with a few plants of *Urtica dioica*.

OV26 *Epilobium hirsutum* community

Stands of **OV26 *Epilobium hirsutum* community** are typically tall herb vegetation found in moist, mesotrophic soils around the margins of wetlands. They are characterised by *Epilobium hirsutum* (Greater Willowherb) and *Urtica dioica* with a range of other fen species. Stands were recorded at Tywyn Aberffraw around Llyn Coron and at Newborough Warren around Llyn Rhos-ddu.



Figure 56: OV26c south of Llyn Coron at Tywyn Aberffraw

OV27 *Epilobium angustifolium* community

Stands of the **OV27 *Epilobium angustifolium* community** are characterised by constant and typically abundant *Chamaenerion angustifolium*, a species which can invade a wide range of vegetation types following disturbance, most notably fire. The **OV27e *Ammophila arenaria* sub-community** is specifically noted from sand dunes, and was recorded from all sites.

Table 33: Areas (ha) of OV27 recorded in the survey

Row Labels	OV27 u	OV27 a	OV27 b	OV27 c	OV27 e	Total
Tywyn Aberffraw	0.57	0.35	0.04	-	0.01	0.96
Newborough Warren	-	-	-	-	8.60	8.60
Morfa Dinlle	-	-	-	-	0.04	0.04
Morfa Harlech	0.45	-	-	-	4.48	4.92
Morfa Dyffryn	-	-	-	-	5.49	5.49
Laugharne-Pendine Burrows	0.01	0.05	-	-	0.85	0.91
Pembrey Coast	0.04	-	-	-	0.52	0.55
Whiteford Burrows	0.01	-	-	0.01	0.11	0.13
Kenfig	0.04	-	-	-	1.10	1.14
Merthyr Mawr	-	-	-	-	0.68	0.68
Total (ha)	1.12	0.39	0.04	0.01	21.87	23.43

Unsurprisingly the floristics of the quadrat samples reflect OV27e, with dune species such as *Ammophila arenaria*, *Carex arenaria* and *Festuca rubra* frequent and *Rubus caesius* replacing *Rubus fruticosus* agg.; also a frequent element of the vegetation. *Chamaenerion angustifolium* was noted to be present amongst SD6, SD7, SD8 and SD9, and the vegetation composition of OV27e often reflected which of the SD communities were being invaded, such that variants of OV27e could probably be recognised that reflect the nature of the original dune vegetation prior to *Chamaenerion angustifolium* becoming dominant.



Figure 57: Stands of OV27e at Newborough, with *Chamaenerion angustifolium* still at an early growth stage at the end of May

A few stands of the OV27a *Holcus lanatus-Festuca ovina* sub-community, OV27b *Urtica dioica-Cirsium arvense* sub-community and OV27c *Rubus fruticosus* agg.-*Dryopteris dilatata* sub-community were recognised where *Chamaenerion angustifolium* was becoming abundant in different situations. OV27a was noted towards the rear, more strongly decalcified part of Tywyn Aberffraw in areas of *Ulex europaeus* clearance.

OV41 *Parietaria diffusa* community and OV42 *Cymbalaria muralis* community

Two vegetation types typical of walls and rock outcrops were recorded in the survey. The **OV41a *Parietaria diffusa* community, *Homalothecium sericeum-Tortula muralis* sub-community** was recorded on a natural rock outcrop amongst the climbing dunes at Kenfig, characterised by *Parietaria judaica* (Pellitory-of-the-wall) with scattered small ferns and bryophytes including *Homalothecium sericeum* and *Tortula muralis*. The **OV42 *Cymbalaria muralis* community** was noted on the wall of Fort Belan, which forms the SAC boundary at Morfa Dinlle. This vegetation is characterised by *Cymbalaria muralis* (Ivy-leaved Toadflax) and a range of bryophytes and small ferns on the stonework.



Figure 58: The rock exposure amongst climbing dunes at Kenfig

Aquatic Vegetation, Swamps and Reedbeds

A number of the survey sites support areas of freshwater, as running water where rivers enter the sea via dunes, as naturally occurring lakes or as ponds, most often artificially created to supply water for livestock. A wide range of aquatic and swamp vegetation was associated with these freshwater bodies. The scope of the survey excluded the systematic sampling of aquatic vegetation, but where accessible stands were noted by the survey team. Swamps were surveyed more systematically, but where they occurred in or on the margin of deeper water they were not assessed in detail.

Table 34: Area (ha) of open water, aquatic vegetation and S1, S2 recorded in the survey

Site	Open water	A5	A11a	A18	<i>Chara vulgaris</i> pond	Other aquatic	S1	S2
Tywyn Aberffraw	29.13	-	-	0.10	-	-	-	-
Newborough Warren	2.40	-	-	-	0.02	-	-	-
Morfa Dinlle	0.26	-	-	-	-	-	-	-
Morfa Harlech	0.13	-	-	-	-	-	-	-
Morfa Dyffryn	1.58	-	-	-	-	-	-	-
Laugharne-Pendine Burrows	4.34	-	-	-	-	-	0.03	-
Pembrey Coast	0.09	-	-	-	-	-	-	-
Whiteford Burrows	-	-	-	-	-	-	-	-
Kenfig	17.26	1.91	3.63	-	-	0.08	-	0.02
Merthyr Mawr	-	-	-	-	-	-	-	-
Total (ha)	55.17	1.91	3.63	0.10	0.02	0.08	0.03	0.02

Table 35: Area (ha) of S4 and S5 recorded in the survey

Site	S4	S4a	S4b	S4c	S4d	S5	S5a
Tywyn Aberffraw	0.16	-	-	-	-	-	-
Newborough Warren	-	-	-	-	-	-	-
Morfa Dinlle	-	-	-	-	-	-	-
Morfa Harlech	-	-	-	-	-	-	-
Morfa Dyffryn	4.58	0.82	-	-	-	-	-
Laugharne-Pendine Burrows	-	11.63	1.26	-	-	-	6.61
Pembrey Coast	3.78	-	-	-	-	-	-
Whiteford Burrows	0.80	-	-	-	1.03	-	-
Kenfig	5.79	2.34	0.38	0.01	-	0.03	-
Merthyr Mawr	<0.01	-	-	-	-	-	-
Total (ha)	15.11	14.79	1.64	0.01	1.03	0.03	6.61

Table 36: Area (ha) of S6-S12 recorded in the survey

Site	S6	S7	S8	S8a	S10	S10a	S12	S12a
Tywyn Aberffraw	1.93	-	-	-	0.12	-	-	-
Newborough Warren	-	-	-	-	-	<0.01	0.05	-
Morfa Dinlle	-	-	-	-	-	-	-	-
Morfa Harlech	-	-	-	-	-	0.06	-	-
Morfa Dyffryn	-	-	-	0.04	-	-	-	-
Laugharne-Pendine Burrows	0.63	-	-	-	-	-	0.16	-
Pembrey Coast	-	-	-	-	-	-	-	-
Whiteford Burrows	-	-	-	-	-	-	-	-
Kenfig	0.04	0.08	0.01	-	0.35	-	0.03	0.07
Merthyr Mawr	-	-	-	-	-	-	-	-
Total (ha)	2.61	0.08	0.01	0.04	0.46	0.07	0.24	0.07

Table 37: Area (ha) of S14-S18a recorded in the survey

Site	S14	S14a	S14b	S14c	S15a	S17	S18a
Tywyn Aberffraw	0.15	0.25	-	0.10	-	-	-
Newborough Warren	0.02	-	-	-	-	-	-
Morfa Dinlle	-	-	-	-	-	-	-
Morfa Harlech	-	-	-	-	-	-	-
Morfa Dyffryn	-	-	-	-	-	-	-
Laugharne-Pendine Burrows	0.15	-	0.04	-	-	0.01	1.30
Pembrey Coast	-	-	-	-	-	-	-
Whiteford Burrows	-	-	-	-	-	-	-
Kenfig	0.12	0.08	-	-	0.28	-	-
Merthyr Mawr	-	-	-	-	-	-	-
Total (ha)	0.45	0.33	0.04	0.10	0.28	0.01	1.30

Table 38: Area of S19-S21 recorded in the survey

Site	S19	S19a	S19c	S20	S20a	S20b	S21	S21a
Tywyn Aberffraw	0.10	0.02	-	0.13	-	-	-	-
Newborough Warren	-	-	-	-	-	-	-	-
Morfa Dinlle	-	-	-	-	-	-	-	-
Morfa Harlech	<0.01	0.09	0.04	-	-	-	-	-
Morfa Dyffryn	0.07	-	-	-	-	-	-	-
Laugharne-Pendine Burrows	0.06	-	-	0.15	1.11	-	0.15	-
Pembrey Coast	0.15	-	-	-	-	-	-	-
Whiteford Burrows	-	-	-	-	-	2.64	-	-
Kenfig	-	0.06	-	1.43	0.32	0.08	0.77	0.22
Merthyr Mawr	-	-	-	-	-	-	0.20	-
Total	0.39	0.17	0.04	1.71	1.44	2.72	1.13	0.22

Table 39: Area (ha) of S22-S25 and other swamp recorded in the survey

Site	S22a	S22b	S23	S24c	S25	S25a	Other (swamp)
Tywyn Aberffraw	-	-	0.08	-	0.03	-	-
Newborough Warren	-	-	-	-	-	-	-
Morfa Dinlle	-	-	-	-	-	-	-
Morfa Harlech	-	-	-	-	-	-	0.55
Morfa Dyffryn	0.01	-	-	-	-	-	-
Laugharne-Pendine Burrows	-	-	-	-	0.53	-	0.25
Pembrey Coast	-	-	-	0.04	-	-	-
Whiteford Burrows	-	-	-	-	-	-	-
Kenfig	-	0.04	-	1.08	0.02	0.18	0.24
Merthyr Mawr	-	-	-	-	-	-	-
Total (ha)	0.01	0.04	0.08	1.12	0.57	0.18	1.03

Table 40: Area (ha) of S14-S18a recorded in the survey

Site	S26	S26b	S26c	S27	S27a	S28	S28a
Tywyn Aberffraw	0.26	-	0.69	-	-	0.70	-
Newborough Warren	-	-	-	0.27	0.47	-	-
Morfa Dinlle	-	-	-	-	-	-	-
Morfa Harlech	-	-	-	-	-	-	-
Morfa Dyffryn	0.34	-	-	-	-	-	-
Laugharne-Pendine Burrows	-	0.02	-	-	-	0.12	-
Pembrey Coast	-	-	-	-	-	-	-
Whiteford Burrows	-	-	-	-	-	-	-
Kenfig	0.11	-	-	-	-	0.05	0.08
Merthyr Mawr	-	-	-	-	-	0.07	-
Total (ha)	0.71	0.02	0.69	0.27	0.47	0.94	0.08

The aquatic vegetation recorded in the survey was limited to some stands of the A8 *Nuphar lutea* community and the A11a *Potamogeton pectinatus-Myriophyllum spicatum* community, *Potamogeton pusillus* sub-community and other aquatic vegetation around the margins of Kenfig Pool and the A18 *Ranunculus fluitans* community in the Afon Ffraw at Tywyn Aberffraw. Examples of the *Chara vulgaris* pond community (Rodwell *et al.* 2000b) were noted in the newly-dug ponds at Newborough Warren. This community consisted mostly of pure stands of *Chara vulgaris*, but in places *Ranunculus baudotii* (Brackish Water-crowfoot) was present.

Several of the sites included in the survey are Important Stonewort Areas, and these ponds on dune sands, along with the dune slacks, are likely to be an important habitat for notable stoneworts (Stewart & Hatton-Ellis 2020).



Figure 59: Ponds at Newborough Warren often have abundant *Chara vulgaris*

Uncommon swamp types with single-species dominant

Stands of S1 *Carex elata* sedge-swamp, S2 *Cladium mariscus* swamp and sedge-beds, S6 *Carex riparia* swamp, S7 *Carex acutiformis* swamp, S8 *Scirpus lacustris* ssp. *lacustris* swamp, S10 *Equisetum fluviatile* swamp, S12 *Typha latifolia* swamp, S14 *Sparganium erectum* swamp, S15 *Acorus calamus* swamp, S17 *Carex pseudocyperus* swamp, S18 *Carex otrubae* swamp, S21 *Scirpus maritimus* swamp, S22 *Glyceria fluitans* water-margin vegetation and S28 *Phalaris arundinacea* tall-herb fen were noted around freshwater areas. These communities are all characterised by the dominance of the species included in the community name, with a few aquatic and emergent associates. A small area of S23 Other water margin vegetation was also recorded on the margins of the Afon Ffraw, consisting of more of a mix of marginal emergent vegetation in freshwater.

S4 *Phragmites australis* swamp and reed-beds

Reedbeds were common around areas of freshwater and also in the transition to saltmarsh, and relatively species-poor stands in deeper water form **S4 *Phragmites australis* swamp and reed-beds**. Many stands were unassigned as they were not sampled in detail, the presence of dominant *Phragmites australis* in closed stands with few associates being sufficient to place the vegetation without attempting to penetrate into the tall reeds. The largest areas associated with the transition to saltmarsh were present at Morfa Dyffryn, Pembrey Coast and Whiteford Burrows, although only at the latter were they sampled in sufficient detail to be assigned to **S4d *Phragmites australis* swamp and reed-beds, *Atriplex prostrata* sub-community**. Extensive species-poor stands of **S4a *Phragmites australis* sub-community** were recorded around Whitchett Pool at Laugharne-Pendine Burrows

and Kenfig Pool. At Laugharne-Pendine richer stands were assigned to the **S4b *Galium palustre* sub-community** and a single stand at Kenfig was assigned to the **S4c *Menyanthes trifoliata* sub-community**.

S5 *Glyceria maxima* community

A large stand of the **S5a *Glyceria maxima* community, *Glyceria maxima* sub-community** is present in the wide basin that feeds water towards Whitchett Pool at Laugharne-Pendine Burrows. Smaller undifferentiated stands are also present at this site and at Kenfig. These stands are characterised by the overwhelming dominance of *Glyceria maxima* (Reed Sweet-grass).

S19 *Eleocharis palustris* swamp

Eleocharis palustris (Common Spike-rush) is present as a distinctive associate of **SD17d**, but where *Eleocharis palustris* becomes constant and abundant, and the dune species such as *Potentilla anserina* and *Carex nigra* as well as a long list of typical slack associates become occasional or disappear, stands are referred to the **S19 *Eleocharis palustris* swamp**. It is likely that more prolonged inundation, or a longer duration of flooding, encourages the development of this vegetation in slacks and reduces the number of species able to tolerate the conditions. *Agrostis stolonifera* and *Ranunculus flammula* are constant associates of this vegetation on sand dunes.

S20 *Scirpus lacustris* ssp. *tabernaemontani* swamp

This vegetation, dominated by *Schoenoplectus tabernaemontani*, was more abundant than other swamp communities, largely owing to the extensive stands around the Afon Cynffig and in the large slack in the prograding dunes at Whiteford Burrows.



Figure 60: Stand of S20 in the slack amongst prograding dunes at Whiteford Burrows

S24 *Phragmites australis*-*Peucedanum palustre* tall-herb fen

Some stands of *Calamagrostis epigejos* at Kenfig were assigned to the **S24c *Phragmites australis*-*Peucedanum palustre* tall-herb fen, *Symphytum officinale* sub-community**. This community is the only one in the NVC volumes where *Calamagrostis epigejos* can be the dominant species in fen-like vegetation. Neither *Peucedanum palustre* (Milk-parsley) nor *Symphytum officinale* (Comfrey) were recorded in this vegetation. *Calamagrostis epigejos* invades a number of wetland communities at Kenfig, creating distinctive forms of dune slack vegetation (notably SD15), but only when it invaded fen-like vegetation with none of the typical dune slack species were stands assigned to S24c.

S25 *Phragmites australis*-*Eupatorium cannabinum* tall-herb fen, S26 *Phragmites australis*-*Urtica dioica* tall-herb fen

These two vegetation communities are united by the constant and often abundant presence of *Phragmites australis* in fen vegetation. Stands are more species-rich than those assigned to S4, likely as a result of shorter and/or shallower inundation. **S25 *Phragmites australis*-*Eupatorium cannabinum* tall-herb fen** is characterised by the abundance of tall wetland herbs amongst the *Phragmites australis*, in the absence of more eutrophic species found in the **S26 *Phragmites australis*-*Urtica dioica* tall-herb fen**. Both stands are found as small patches in larger areas of wetlands and when the tall herbs are in flower they can form very striking stands.



Figure 61: S25 vegetation at Kenfig with the striking yellow flowers of *Lysimachia vulgaris*

S27 *Carex rostrata*-*Potentilla palustris* tall-herb fen

A couple of small stands of **S27 *Carex rostrata*-*Potentilla palustris* tall-herb fen** including **S27a *Carex rostrata*-*Equisetum fluviatile* sub-community** were found at Newborough Warren around Llyn Rhos-ddu. *Carex rostrata* (Bottle-sedge) was replaced by *Carex diandra* (Lesser Tussock-sedge) in some of these stands and

Eriophorum angustifolium (Common Cotton-grass) and *Menyanthes trifoliata* (Bog-bean) are prominent features.

Saltmarsh

All of the sites included in the survey, with the exception of Kenfig, have areas where the sand dunes transition directly into saltmarsh vegetation, with large areas of saltmarsh often part of the SACs. The saltmarsh itself was not systematically surveyed, but vegetation around the transitions was recorded, often extending to areas of saltmarsh adjacent to the dunes. A wide range of saltmarsh vegetation was recorded, but the most common saltmarsh communities associated with the sand dunes was the **SM18 *Juncus maritimus* salt-marsh community**. Large areas of **SM16 *Festuca rubra* salt-marsh community** were also noted in the survey, being a common vegetation type of sandy areas that are occasionally inundated by the highest tides. Uncommon transitions included the sandy strandline around the edge of saltmarsh with *Elymus junceiformis* mixed with saltmarsh annuals at Morfa Dinlle, and disturbed sandy saltmarsh with SD10 and SM16 at Laugharne-Pendine Burrows. The most typical transitions were between SD15 or SD17 and SM18 saltmarsh, with *Juncus maritimus* (Sea Rush) able to persist in dune slacks even away from areas with regular tidal inundation. Extensive slacks with this transition were present at Morfa Harlech and the Pembrey Coast. Stands of **SM24 *Elymus pycnanthus* salt-marsh community** and **SM28 *Elymus repens* salt-marsh community** were also noted in association with sandy soils, and in places the species-poor **SM15 *Juncus maritimus*-*Triglochin maritimum* salt-marsh community** formed part of mosaics in the large slacks at Tywyn Gwendraeth (Pembrey Coast).



Figure 62: Areas of mosaics of SD15 and SM18 at the northern end of Morfa Harlech

Woodland, Scrub and Bracken

The development of scrub and woodland on dunes is a straightforward process. In general, where there are areas of fixed dunes, woody species are able to establish and in the absence of grazing or mowing they slowly develop, to form scrub or woodland. The woodland can spread either through vegetation spread (e.g. *Hippophae rhamnoides*, *Prunus spinosa* (Blackthorn)) or through seeding (*Salix cinerea* (Grey Willow), *Betula* spp. (Birches)).

The transition to woodland can happen in both dune slacks and dry vegetation giving rise to different scrub and woodland communities. In all situations there is an element of transition when the woody species become constant in vegetation that is recognisably a non-woody community. In some cases this is recognised in specific sub-communities (e.g. SD15a) but in many cases is a transitional vegetation not specifically covered, and in this survey often mapped as a mosaic, or even as the original vegetation noting the abundance of woody species. Eventually the impact of the woody species, particularly shade and drying out of substrates, but in some cases protection from grazing, start to alter the vegetation forming communities that mostly correspond to the published descriptions. In many cases the remnant dune flora in the woodland creates dune variants of the published communities making them difficult to assign to specific sub-communities. A simplified version of patterns of development of different woodland types in dune slack and fen situations are shown in Figure 63. Different species invade dry vegetation, the process is summarised in Figure 64.

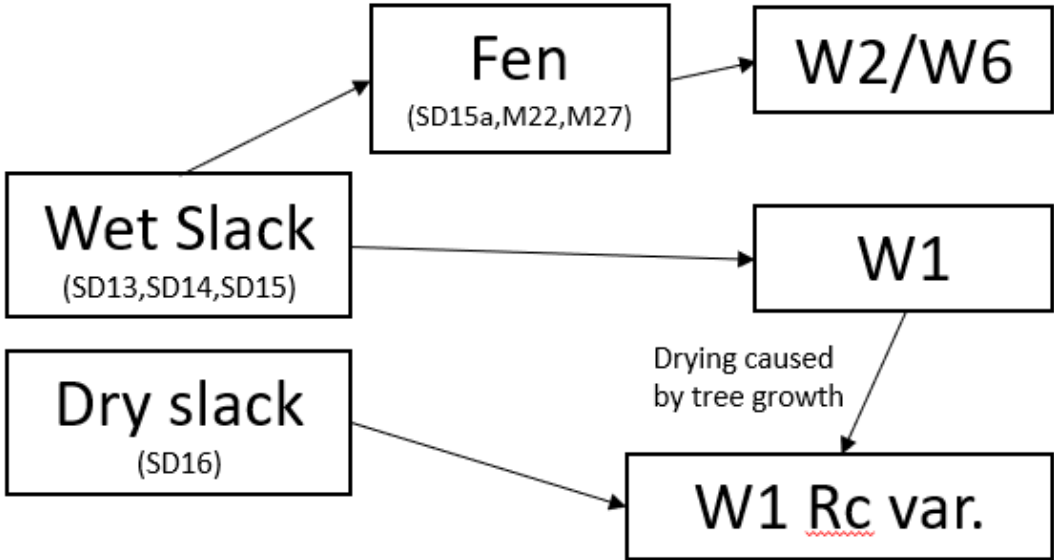


Figure 63: Typical patterns of dune woodland development.

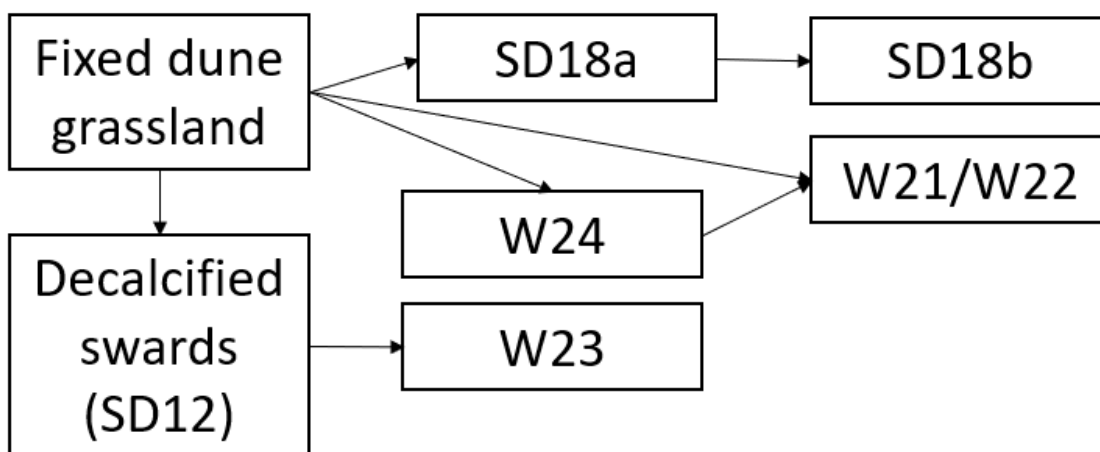


Figure 64: Patterns of succession to dry scrub.

Areas of scrub and woodland are most developed in ungrazed sites, notably at Merthyr Mawr, Pembrey Coast (Tywyn Gwendraeth) and Laugharne-Pendine Burrows. Scrub was once more extensive at Newborough Warren, but the introduction of grazing and the targeted clearance of scrub have led to significant decreases in areas of scrub.

Table 41: Area (ha) of W1-W5 recorded in the survey

Site	W1	W1 <i>Rubus caesius</i> variant	W2	W2a	W4	W5	W5a
Tywyn Aberffraw	0.68	0.09	0.17	-	-	-	-
Newborough Warren	3.36	0.13	-	-	0.66	-	-
Morfa Dinlle	-	-	-	-	-	-	-
Morfa Harlech	0.78	-	0.95	-	-	-	-
Morfa Dyffryn	3.05	5.98	2.33	-	-	-	-
Laugharne-Pendine Burrows	73.20	0.20	1.03	-	0.55	-	-
Pembrey Coast	3.82	2.34	-	-	-	-	-
Whiteford Burrows	2.46	0.61	-	-	-	-	-
Kenfig	16.60	0.71	5.00	0.72	1.93	0.66	0.35
Merthyr Mawr	2.16	-	-	-	25.75	-	-
Total (ha)	106.10	10.05	9.48	0.72	28.88	0.66	0.35

Table 42: Area (ha) of W6 & W7 recorded in the survey

Site	W6	W6a	W6b	W6c	W6d	W6e	W7	W7b
Tywyn Aberffraw	1.77	-	-	-	-	-	-	-
Newborough Warren	-	-	-	-	-	0.29	-	-
Morfa Dinlle	-	-	-	-	-	-	-	-
Morfa Harlech	-	-	-	-	-	-	0.07	-
Morfa Dyffryn	0.29	-	-	-	-	-	-	-
Laugharne-Pendine Burrows	21.33	1.23	-	-	1.91	-	-	-
Pembrey Coast	1.18	8.08	-	-	-	-	-	-
Whiteford Burrows	-	1.02	-	-	-	-	-	-
Kenfig	0.65	0.42	0.22	0.07	0.13	15.41	0.57	3.07
Merthyr Mawr	-	0.56	-	-	-	-	-	-
Total (ha)	25.22	11.32	0.22	0.07	2.04	15.69	0.65	3.07

W1 *Salix cinerea*-*Galium palustre* woodland

Stands of **W1 *Salix cinerea*-*Galium palustre* woodland** were common on the dunes but often as small stands invading individual slacks. More extensive stands were also present around the larger areas of freshwater wetlands at Kenfig, Laugharne-Pendine Burrows and to a lesser extent at Newborough Warren. There are no formal sub-communities in the published description, with only the only constants in the vegetation being *Salix cinerea* and *Galium palustre*. However, stands dominated by *Salix cinerea* found in this survey were differentiated into two types. In the typical vegetation, *Galium palustre* was present along with a wide range of typical fen species in stands assigned to typical W1.

However, a consistent type of woodland dominated by *Salix cinerea* but without constant *Galium palustre* and only a few fen species was also recorded. These typically had constant *Rubus caesius*, and were often associated with *Salix repens* and a few more shade tolerant slack species such as *Filipendula ulmaria*, *Iris pseudacorus* and *Poa trivialis*. These stands were assigned to the **W1 *Rubus caesius* variant**, although the vegetation was found consistently across several sites and may deserve recognition at sub-community level. It appears to develop in slacks and dune wetlands where there is an eventual lowering over the water table such that typical fen species can no longer persist, and only deeper rooted species (e.g. *Salix repens*) retain access to the water table.



Figure 65: Typical W1 at Laugharne-Pendine Burrows



Figure 66: W1 *Rubus caesius* variant at Morfa Dyffryn

W2 *Salix cinerea*-*Betula pubescens*-*Phragmites australis* woodland

Stands of **W2 *Salix cinerea*-*Betula pubescens*-*Phragmites australis* woodland** were mapped at several sites with larger areas of wetland; the largest area was at Kenfig. They were differentiated from W1 by the constant presence of *Phragmites australis* in the understory of *Salix cinerea* and *Betula pubescens* (Downy Birch).

W4 *Betula pubescens*-*Molinia caerulea* woodland

Extensive areas of **W4 *Betula pubescens*-*Molinia caerulea* woodland** were recorded at Merthyr Mawr, with lesser areas around freshwater wetlands at Kenfig and small stands at Laugharne-Pendine Burrows and Newborough Warren. Stands

at Merthyr Mawr lacked *Molinia caerulea*, but in the wettest areas had canopies of *Betula pubescens* over areas of the wetland moss *Fontinalis antipyretica*. Drier stands had constant *Rubus caesius*, and perhaps were more similar to the *Rubus caesius* variant of W1. At other sites, stands of *Betula pubescens* with a damp, slightly rank field layer were placed in W6e which may fit some of the drier Merthyr Mawr stands placed in W4. At the other sites *Molinia caerulea* was present and often a conspicuous part of the woodland field layer.

W5 *Alnus glutinosa*-*Carex paniculata* woodland

Stands of **W5 *Alnus glutinosa*-*Carex paniculata* woodland** were recorded in the northern part of Kenfig. Two stands were present in low-lying, wetter areas that have become completely wooded, surrounded by W6e on slightly drier ground. The other stand, assigned to the **W5a *Phragmites australis* sub-community** is present in the wet woodlands around the Afon Cynffig along the northern edge of the site. The presence of tussocky *Carex paniculata* (Greater Tussock-sedge) was the distinguishing feature of these stands, which were typically wetter than the surrounding woodland that enclosed them.

W6 *Alnus glutinosa*-*Urtica dioica* woodland

Stands of **W6 *Alnus glutinosa*-*Urtica dioica* woodland** were common in the survey. They included typical *Alnus glutinosa*-dominated stands with relatively dense *Urtica dioica* particularly at the margins, making stands appear rather uninviting. These stands were common around the wetlands at Laugharne-Pendine Burrows and the southern part of Tywyn Gwendraeth. These stands were often referable to the NVC type **W6a typical sub-community**. Kenfig supported all sub-communities of W6, and was the only site with **W6b *Salix fragilis* sub-community**, and the **W6c *Salix viminalis/triandra* sub-community** which are recognised by the dominance of other willows in the canopy. Stands of the **W6d *Sambucus nigra* sub-community** were most common at Laugharne-Pendine Burrows where a tall canopy often supports *Acer pseudoplatanus* (Sycamore), *Fraxinus excelsior* (Ash) or *Quercus robur* (Common Oak), with an understory of *Sambucus nigra* (Elder).



Figure 67: Stands of W6a either side of the large, mown slack in the south of Tywyn Gwendraeth (Pembrey Coast)

Stands of relatively dry woodland dominated by *Betula pubescens* and to a lesser extent *Betula pendula* (Silver Birch) were mapped as the **W6e *Betula pubescens* sub-community**. These stands were particularly common at Kenfig, and it is likely some of the W4 at Merthyr Mawr would be better placed in this sub-community.



Figure 68: Birch woodland at Kenfig assigned to W6e

W7 *Alnus glutinosa*-*Fraxinus excelsior*-*Lysimachia nemorum* woodland

Stands of the **W7 *Alnus glutinosa*-*Fraxinus excelsior*-*Lysimachia nemorum* woodland** were uncommon, with a small, atypical stand with *Acer pseudoplatanus* instead of *Fraxinus excelsior* mapped at Morfa Harlech and two large stands of **W7b *Carex remota*-*Cirsium palustre* sub-community** present along the northern boundary at Kenfig.

W8 *Fraxinus excelsior*-*Acer campestre*-*Mercurialis perennis* woodland

Stands of the **W8 *Fraxinus excelsior*-*Acer campestre*-*Mercurialis perennis* woodland** were uncommon, except at Merthyr Mawr where stands of mixed broadleaved woodland including *Acer pseudoplatanus* and *Fraxinus excelsior*, locally replaced by a low canopy of *Corylus avellana* (Hazel) were prominent in the eastern extent of the site. Small stands, mainly of *Fraxinus excelsior*, were mapped at Morfa Harlech, Laugharne-Pendine Burrows (planted *Corylus avellana* woodland) and Whiteford Burrows.

Table 43: Area (ha) of W8, W21 & W22 recorded in the survey

Site	W8	W8d	W21	W21 a	W21 d	W22	W22 a	W22 b	W22 c
Tywyn Aberffraw	-	-	0.10	0.02	-	0.16	-	-	-
Newborough Warren	-	-	0.08	-	-	3.22	-	0.18	-
Morfa Dinlle	-	-	-	-	-	0.00	-	-	-
Morfa Harlech	0.06	-	0.19	-	-	2.89	-	0.30	-
Morfa Dyffryn	-	-	-	-	-	1.00	-	-	0.03
Laugharne- Pendine Burrows	-	0.34	0.65	0.06	-	14.5 0	0.03	0.17	0.16
Pembrey Coast	-	-	8.91	1.81	-	0.30	-	-	-
Whiteford Burrows	0.22	-	1.52	0.04	-	1.71	0.15	0.14	-
Kenfig	-	-	2.09	-	-	3.22	0.03	0.01	0.23
Merthyr Mawr	13.4 9	-	-	-	25.0 9	2.41	-	-	-
Total (ha)	13.7 7	0.34	13.5 4	1.93	25.0 9	29.4 2	0.21	0.81	0.42

Table 44: Area (ha) of W23-W25 recorded in the survey

Site	W23	W23a	W24	W24a	W24b	W25	W25a	W25b
Tywyn Aberffraw	7.53	-	1.52	0.05	-	0.52	-	-
Newborough Warren	0.15	-	0.80	-	-	-	-	-
Morfa Dinlle	0.07	-	0.37	0.01	-	-	-	-
Morfa Harlech	2.05	0.40	4.50	-	-	0.29	-	-
Morfa Dyffryn	0.37	-	2.94	-	0.45	1.38	0.63	3.14
Laugharne- Pendine Burrows	0.07	-	1.97	-	0.33	-	-	-
Pembrey Coast	1.78	0.50	0.20	-	5.11	-	-	-
Whiteford Burrows	-	-	0.58	-	-	-	-	-
Kenfig	0.26	-	4.90	-	-	28.71	8.17	-
Merthyr Mawr	0.01	-	1.58	-	-	-	7.89	-
Total (ha)	12.30	0.90	19.36	0.06	5.89	30.90	16.69	3.14

W21 *Crataegus monogyna*-*Hedera helix* scrub

Areas of mixed scrub with *Crataegus monogyna* as a prominent component were present on almost all dune systems and assigned to **W21 *Crataegus monogyna*-**

***Hedera helix* scrub**, although only at Tywyn Gwendraeth and Merthyr Mawr does it occupy more area than W22. The stands on dunes were rarely a good fit to the published sub-communities and many stands were mapped as undifferentiated. The presence of dune species including *Hippophae rhamnoides*, *Rosa spinosissima* and *Rubus caesius* often with scattered tussocks of *Ammophila arenaria* give the stands a distinctive dune feel.

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

Stands of **W22 *Prunus spinosa*-*Rubus fruticosus* scrub** were common on the sand dunes, and the spiny suckers help the species to spread even where there is some grazing.



Figure 69: A dense wall of *Prunus spinosa* at Pendine Burrows, with a low fringe of advancing suckers in front of the mature stand.



Figure 70: The interior of W22, here seen at Pendine Burrows, can be surprisingly species-rich

W23 *Ulex europaeus*-*Rubus fruticosus* scrub

Stands of **W23 *Ulex europaeus*-*Rubus fruticosus* scrub** were present at most sites, and are identified by a dominant canopy of *Ulex europaeus* (Gorse) often associated with coarse vegetation, although the calcareous sands make the general dune plains less suitable for *Ulex europaeus* than other scrub. Stands were often small, in relatively stable locations that had escaped grazing or removal for conservation management. However, more extensive stands were present in the decalcified vegetation in the most landward part of Tywyn Aberffraw. In this grazed area *Ulex europaeus* appears to have colonised lower-lying areas amongst SD12.



Figure 71: Stands of W23 at Tywyn Aberffraw

Most stands were not a good match the published sub-communities, although some **W23a *Anthoxanthum odoratum* sub-community** was recorded. The four quadrats recorded in W23 lacked some of the typical acid grassland species such as *Agrostis capillaris*, *Galium saxatile* (Heath Bedstraw) and *Rhytidiadelphus squarrosus* but do support frequent nitrophilous species including *Brachythecium rutabulum*, *Galium aparine* and *Urtica dioica* along with dune species, including *Rubus caesius*.

W24 *Rubus fruticosus*-*Holcus lanatus* underscrub

Areas of **W24 *Rubus fruticosus*-*Holcus lanatus* underscrub** were common and widespread. Relatively species-poor stands of *Rubus fruticosus* agg., sometimes lacking *Holcus lanatus*, were assigned to undifferentiated W24. Given the rather prickly nature of the vegetation, very few stands were sampled. Small areas of **W24a *Cirsium arvense*-*Cirsium vulgare* sub-community** were mapped where stands occurred on enriched soils with constant *Cirsium* spp.. Larger areas of the **W24b *Arrhenatherum elatius*-*Heracleum sphondylium* sub-community** were mapped, particularly at Pembrey Coast, where W24b is the main understory community in the c. 0.6 ha of conifer plantation included within the SAC boundary to the southern end of Tywyn Gwendraeth.



Figure 72: Stands of W24 at Morfa Dinlle, here invading SD9

W25 *Pteridium aquilinum*-*Rubus fruticosus* underscrub

All areas dominated by *Pteridium aquilinum* were assigned to the **W25 *Pteridium aquilinum*-*Rubus fruticosus* underscrub**, with no areas of U20 recorded in the survey. Areas of W25 were largest at Kenfig and Merthyr Mawr, particularly on the climbing dunes at Kenfig. There were relatively few differences between the published community and the survey data, with *Arrhenatherum elatius* and *Festuca rubra* both more frequent.



Figure 73: W25 on the climbing dunes at Kenfig

Single species scrub

Table 45: Area (ha) of single-species scrub recorded in the survey

Site	<i>Salix caprea</i> scrub	<i>Salix cinerea</i> scrub	<i>Hedera</i> scrub	<i>Ligustrum ovalifolium</i> scrub	<i>Ligustrum vulgare</i> scrub	<i>Rosa rugosa</i> stand	<i>Rubus caesius</i> scrub	<i>Clematis vitalba</i>
Tywyn Aberffraw	-	0.24	-	-	-	0.04	0.06	-
Newborough Warren	-	-	-	-	-	-	-	-
Morfa Dinlle	-	-	-	-	-	-	0.14	-
Morfa Harlech	1.35	0.56	0.12	-	-	-	0.25	2.02
Morfa Dyffryn	-	0.38	-	-	-	-	0.66	-
Laugharne-Pendine Burrows	-	0.17	-	0.02	0.06	0.17	-	0.37
Pembrey Coast	-	-	-	-	-	0.01	-	-
Whiteford Burrows	-	-	-	-	-	-	-	0.76
Kenfig	-	-	-	-	0.12	-	0.04	-
Merthyr Mawr	-	-	-	-	0.38	0.08	-	0.63
Total (ha)	1.35	1.34	0.12	0.02	0.56	0.32	1.15	3.77

Along with the typical woody scrub species, stands of woody climbers can also form dense stands on sand dunes, so are included here with the scrub. The most common woody species to form dense stands on the dunes was *Clematis vitalba*, mapped as ***Clematis vitalba* vegetation**, with larger areas noted at Morfa Harlech. It tends to colonise areas of sloping dune with SD6 and SD7 vegetation, spreading vegetatively to form large carpets that smother other vegetation. *Ammophila arenaria* is often able to persist in the stands with a few taller dune herbs and often a low, sparse bryophyte layer.



Figure 74: Patches of *Clematis vitalba* in the dunes at Morfa Harlech

In much the same way that *Rubus fruticosus* agg. can form dense stands on dunes (W24), so *Rubus caesius* can do the same and such stands were mapped as ***Rubus caesius scrub***. The vegetation was typically species-poor, with the *Rubus caesius* smothering the vegetation it grows over, with only some of the taller grasses able to cope. These stands are not recognised in the NVC, but it is likely that intensive sampling would reveal vegetation similar to SD7 and SD9 but with *Rubus caesius* as the dominant.

A stand of ***Hedera scrub*** was noted at Morfa Harlech. There was a dense carpet of *Hedera hibernica* (Irish Ivy) independent of the scattered scrub nearby, and with scattered ferns (*Asplenium scolopendrium* (Hart's-tongue Fern), *Dryopteris affinis* (Scaly Male-fern) and *Dryopteris filix-mas* (Male-fern)), with the appearance of a woodland without trees. This vegetation was also noted on dunes at Pembrey Coast outside the survey area.

Small stands with canopies of *Salix caprea* (Goat Willow), *Salix cinerea* and *Ligustrum vulgare* (Privet) were all noted on the dunes, possibly indicating the start of a transition to, or the remnants of, small areas of wet woodlands (e.g. W1, W2). They are unremarkable stands which, partly due to their small size and consequently relatively small influence on ground flora, except where they encourage livestock to congregate, are not possible to place into existing NVC communities. Stands of *Ligustrum vulgare* were noted to have young *Ligustrum vulgare*, and probably represent an extreme form of W21 which will slowly become more typical W21 over time if left unmanaged.

Stands of the non-natives *Rosa rugosa* (Japanese Rose) and *Ligustrum ovalifolium* (Garden Privet) were also recorded as dense species-poor stands.

Plantations

Small areas of broadleaved plantation and larger areas of conifer plantation are present on the dunes. Conifer plantation is often excluded from the SAC boundaries, but notable areas also occur within the dunes.

Table 46: Areas of plantation recorded in the survey

Row Labels	Broadleaved plantation	Conifer plantation
Tywyn Aberffraw	-	-
Newborough Warren	-	-
Morfa Dinlle	-	-
Morfa Harlech	-	8.18
Morfa Dyffryn	-	-
Laugharne-Pendine Burrows	-	-
Pembrey Coast	-	0.23
Whiteford Burrows	-	5.32
Kenfig	0.24	0.02
Merthyr Mawr	0.05	-
Total (ha)	0.29	13.74

The conifer plantations tend to result in some acidification of the soil, and typically have understories of vegetation similar to SD12. In many places plantations are being cleared from areas of dune.



Figure 75: Conifer plantation at Harlech Forest with *Lupinus arboreus* under the planted trees

Miscellaneous habitat types

Other

A number of vegetation parcels were recorded in the survey and mapped as 'other'. These are a range of different vegetation types that represent unique conditions at a site, and are not thought to represent consistent assemblages likely to be found more widely. Details of each of these are given in the relevant site-specific reports.

Amenity grassland

Areas were mapped as amenity grassland where they were closely and regularly mown swards that were not assessed in detail. The largest extent was the golf course at Morfa Harlech, but some areas were noted on the campsite at Morfa Dyffryn and around the MOD buildings at Laugharne-Pendine Burrows.

Anthyllis-Silene community

A stand of vegetation mapped as the 'Anthyllis-Silene community', a name assigned in this survey based on the constant species in the sward, was present at Newborough Warren. This vegetation occurred as an open sward in a slack at the very upper end of the tidal reach, on the inside corner of the spit to Abermenai Point. It formed a strikingly colourful vegetation type.



Figure 76: The stand of *Anthyllis-Silene* vegetation at Abermenai Point

Crocoshmia ×crocoshmiiflora stands

Laugharne-Pendine had a number of *Crocoshmia ×crocoshmiiflora* (Montbretia) stands that were large enough to be mapped, consisting of this invasive non-native species invading fixed dune vegetation, typically SD8 or SD9.

Juncus acutus slack

Stands of *Juncus acutus* (Sharp-rush) occur at Kenfig where *Juncus acutus*, which is present as scattered individuals around the margins of a number of slacks, forms denser stands and becomes constant and abundant. The large spiny plants limit grazing in the immediate vicinity with subtle shifts in the composition of species, although not enough to really alter the overall species composition. *Juncus acutus* was recorded from most of the sites in the survey, but at no other site did it reach sufficient density to merit mapping as unique stands.

Petasites fragrans stands

At Laugharne-Pendine Burrows the non-native *Petasites fragrans* (Butterbur) formed stands large enough to be mapped individually. These consisted of *Petasites fragrans* with a few ruderal species scattered amongst the stand.

Miscellaneous

Many of the sites included areas of surfaced tracks and car parks, buildings and remains of historic infrastructure within the SAC boundary, all of which were mapped.

Annex 1 habitats

There is an established correspondence between the NVC and Annex 1 habitats that are used as Qualifying Interest (QI) features for the SAC designations applied to these sites. There are five Annex 1 dune habitats listed as QIs for the sites surveyed:

- 2110 Embryonic shifting dunes
- 2120 Shifting dunes along the shoreline with *Ammophila arenaria* (“white dunes”)
- 2130* Fixed coastal dunes with herbaceous vegetation (“grey dunes”) (*priority habitat)
- 2170 Dunes with *Salix repens* ssp. *argentea* (*Salicion arenariae*)
- 2190 Humid dune slacks

The Annex 1 habitat H2150 Atlantic decalcified fixed dunes (*Calluno-Ulicetea*) corresponds to H11 (except H11b which is not found in Wales) and is present on these SAC sites, but is not a qualifying interest feature.

The same applies to H1210 Annual vegetation of drift lines, which includes SD2, SD3 and MC6, all of which were recorded in this survey. However, they are only considered to represent the Annex 1 habitat where they occur on shingle deposits. This would apply to around 0.25ha of drift line vegetation recorded at Morfa Dinlle (SD3, MC6) on the landward boundary with the tidal areas, and <0.1 ha of SD3 on shingle around river outfalls at each of Newborough Warren, Morfa Dyffryn, Pembrey Coast and Kenfig, but otherwise most of the drift lines were on predominantly sandy substrates. H1210 is therefore not included in Table 47:

Other non-dune Annex 1 habitats also listed on the SAC citations include:

- 1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)
- 3140 Hard oligo-mestrophic water with benthic vegetation of *Chara* spp. (Kenfig SAC)
- 3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* type vegetation (Abermenai to Aberffraw Dunes SAC)

The area of these five Annex 1 dune habitats recorded at each site is shown in Table 47. These areas are based on the correspondence provided in the NRW’s internal features spreadsheet (v2) (unpublished). This has a slightly narrower definition of the Annex 1 habitats than the standard JNCC correspondences (JNCC 2020). The main differences in the JNCC classification in relation to sand dunes are the inclusion of SD5 as forms of both H2110 and H2120. In this assessment we have taken this to mean that SD5a, which is a species-poor sub-community of open dunes represents H2110, separate from the better developed swards of SD5b and SD5c which are forms of H2120. SD10 is included as a form of H2130. Areas of the Annex 1 habitats with these included are shown in brackets in Table 47.

Table 47: Area (ha) of each Annex 1 habitat type recorded in the survey based on NRW's features spreadsheet. Numbers in brackets show larger area when using JNCC correspondence.

Annex 1	NVC	Twynn Aberffraw	Newborough Warren	Morfa Dinlle	Morfa Harlech	Morfa Dyffryn	Laugharne-Pendine	Pembrey Coast	Whiteford Burrows	Kenfig	Merthyr Mawr	Total
2110	SD4 (SD5a)	0.0	0.2 (3.3)	0.1	7.1	0.1	4.6	7.9	1.4	0.9	0.2	22.5 (25.6)
2120	SD6, SD5b	7.1	17.4	1.1	21.9	51.8	16.4	22.5	14.9	8.6	9.1	170.8
2130	SD7, SD8, SD9, SD12, SD19, (SD10)	201.6	313.4 (315.0)	85.8	229.2 (230.1)	129.5 (132.1)	255.7 (255.9)	125.2 (125.4)	76.4 (76.5)	267.4 (268.0)	178.4 (178.7)	1862.4 (1869)
2150	H11	2.1	-	0.1	0.5	-	-	-	-	0.3	-	3.0
2170	SD16	30.5	69.5	5.9	4.6	20.4	7.1	9.5	7.9	34.0	2.1	191.5
2190	SD13, SD14, SD15, SD17	12.7	25.8	0.4	43.3	23.2	12.9	14.4	12.7	64.3	0.2	210.0
Site total (ha)	-	251.9	429.5	93.2	306.1	225.0	296.7	179.4	113.4	375.3	189.9	2469.9

Conservation Interventions and Vegetation

One notable feature of the vegetation survey is the extent to which conservation interventions are already making a significant contribution to the patterns of vegetation at the survey sites. In many cases these interventions have been ongoing for some time, with many noted in the Sand Dune Survey GB (SDSGB) surveys. Details of the interventions at each site are given in the site reports. Some of the interventions are difficult to identify from the vegetation recorded in a single survey, such as the introduction of conservation grazing. The difference at sites such as Newborough Warren, when comparing the vegetation recorded in this survey to that noted from past surveys, in this case the Sand Dune Survey GB and an earlier survey (Primrose 1985; Ashall *et al.* 1992b) is clear. Many of the interventions that are more than 10 years old are difficult to determine too: in this timeframe it seems that altered dune communities are able to develop a natural appearance.



Figure 77: Conservation grazing has transformed the vegetation at Newborough Warren

Scrub clearance has led to a range of interesting vegetation types, some recognisable, such as the development of SD10 or W24, and others forming mixtures of ephemeral and ruderal species that are not included in the NVC. Such stands cover large areas at Tywyn Gwendraeth (Pembrey Coast) where stands with a striking abundance of *Coincya monensis* ssp. *cheiranthos* (Wallflower Cabbage) are present in cleared SD18 and W21.



Figure 78: Cleared scrub at Tywyn Gwendraeth (Pembrey Coast) with prominent *Coincya monensis* ssp. *cheiranthos*

Dune notches and the associated fans created inland are another intervention that remains a prominent landscape feature, relatively simple to detect, but which, depending on the sand budget of the adjacent beach, can vegetate relatively quickly with vegetation of mobile sands, this being composed of species that are able to cope with significant disturbance and sand movement. These notches are now fairly extensive at Kenfig, Merthyr Mawr and Newborough Warren (Pye & Blott, 2016). They do not seem to result in the instability of sand seen naturally at Morfa Dyffryn and this is reflected in the higher proportion of vegetation assigned to early-successional and mobile sand communities in the hind dunes.



Figure 79: Artificial dune notch at Kenfig

The scraping of dune slacks has also been taking place for some time, notably at Kenfig where it has resulted in the successful change of fortunes for *Liparis loeselii* as well as a suite of species reliant on early-successional dune slacks. These 'artificial' scrapes are present at most of the survey sites, and result in vegetation referable to the NVC type SD13 and SD14, unless made deep enough to develop SD15. Only Morfa Dyffryn and Whiteford Burrows now support areas of natural SD13.

The slack scrapes are very effective at creating, in the short to medium term, these early successional assemblages, with many notable species recorded here. The vegetation that develops is often only loosely referable to the SD13 or SD14 communities. This is perhaps due to them not being subject to high levels of sand deposition that might be expected in natural systems, so that species intolerant of burial can persist. They are also likely to have a pre-existing diaspore bank, unlike slacks derived naturally. The diaspore bank is probably critical for the conservation of rare species lost to vegetation succession, but means the resulting vegetation is likely to differ from naturally occurring SD13, and will have an increased stamp of the previous vegetation.



Figure 80: A typical scraped slack, here at Morfa Harlech

Notable Species

Details of the notable species recorded during the survey are given in each of the site reports. The survey did not set out to systematically record notable species, but details were recorded when encountered. They show that many of the characteristic species of conservation value remain present at these sites. A summary of the notable species is given in the table below.

Table 48: Number of records of notable species recorded at each site in this survey

Scientific name	Status	Aberffraw	Tywyn	Newborough Warren	Morfa Dinlle	Harlech	Morfa Dyffryn	Morfa Pendine B.	Laugharne Coast dunes	Pembrey	Whiteford Burrows	Kentig Dunes
<i>Abietinella abietina</i> var. <i>abietina</i>	NS,Wal:EN	7	-	-	-	-	-	-	-	-	-	-
<i>Althaea officinalis</i>	NS	-	-	-	-	-	-	-	-	2	-	-
<i>Amblyodon dealbatus</i>	NS,Wal:EN	-	-	-	-	-	-	-	2	-	-	1
<i>Amblystegium radicale</i>	NR,GB:NT	1	-	-	-	-	-	-	-	-	-	-
<i>Arthonia parietinaria</i>	NE,NS	-	1	-	-	-	-	-	-	-	-	-
<i>Baldellia ranunculoides</i>	GB:NT	-	-	-	-	-	-	-	-	-	-	9
<i>Bryum dyffrynense</i>	NR,Wal:VU,GB:NT	-	-	-	-	1	-	-	-	-	-	-
<i>Bryum mildeanum</i>	Wal:EN	-	-	-	-	-	-	2	-	-	2	-
<i>Bryum warneum</i>	S7,Wal:EN,GB:NT	-	-	-	-	-	-	-	-	1	-	-
<i>Butomus umbellatus</i>	Wal:VU	-	-	-	-	-	-	-	-	-	-	1
<i>Caloplaca maritima</i>	NS	1	-	-	-	-	-	-	-	-	-	-
<i>Campyliadelphus elodes</i>	NS	7	5	-	-	-	-	4	-	-	-	-
<i>Carex diandra</i>	GB:NT	-	2	-	-	-	-	-	-	-	-	-
<i>Carex pseudocyperus</i>	Wal:NT	1	-	-	-	-	1	-	-	-	-	-
<i>Carex punctata</i>	NS	-	-	-	-	-	5	3	-	-	-	-
<i>Catillaria nigroclavata</i>	NS	-	-	-	1	-	-	-	-	-	-	-
<i>Centaureum littorale</i>	NS	3	12	-	-	3	-	1	-	-	-	-
<i>Cynoglossum officinale</i>	GB:NT	2	-	-	3	3	-	1	2	-	-	-
<i>Cyperus longus</i>	GB:NT,NS	-	-	-	-	1	-	-	-	-	-	-
<i>Dianthus deltooides</i>	GB:NT,Wal:NT,NS	-	-	-	5	-	-	-	-	-	-	-
<i>Didymellopsis pulposi</i>	NR	-	-	-	2	1	-	-	-	-	-	-
<i>Drepanocladus sendtneri</i>	NS,Wal:EN	-	-	-	-	-	-	7	-	-	3	-
<i>Epipactis phyllanthes</i>	NS; Wal:VU	-	-	-	-	2	-	-	-	-	-	-
<i>Equisetum variegatum</i>	NS	17	21	-	5	10	4	7	8	39	-	-
<i>Erodium aethiopicum</i>	NS	2	3	-	-	-	-	1	4	-	-	-
<i>Festuca arenaria</i>	NS	1	-	-	-	-	-	-	-	-	-	-
<i>Gentianella amarella</i> ssp. <i>occidentalis</i>	NR,S7,WCA-Sch8,GB:VU,Wal:VU	-	-	-	-	-	-	-	1	-	-	-
<i>Gymnadenia densiflora</i>	S7	-	-	-	-	-	3	-	-	-	6	-
<i>Hippuris vulgaris</i>	Wal:NT	-	1	-	4	-	2	-	-	-	-	-
<i>Hornungia petraea</i>	NS	-	-	-	-	-	-	-	1	1	-	-
<i>Hyacinthoides non-scripta</i>	WACA-Sch8	1	-	-	-	3	-	-	-	-	-	-
<i>Hygroamblystegium humile</i>	NS,Wal:VU	1	-	-	-	-	1	-	-	-	1	-
<i>Jasione montana</i>	Wal:NT	-	8	-	1	-	-	-	-	-	-	-
<i>Juncus acutus</i>	NS	-	-	-	9	17	6	9	12	23	-	-
<i>Leptogium biatorinum</i>	NS	-	-	-	-	1	-	-	-	-	-	-
<i>Leptogium tenuissimum</i>	NS	-	2	-	-	-	-	-	-	-	-	-
<i>Linum radiola</i>	GB:NT	-	-	-	1	-	-	-	-	-	-	-

Scientific name	Status	Tywyn Aberffraw	Newborough Warren	Morfa Dinlle	Morfa Harlech	Morfa Dyffryn	Morfa Pendine B.	Laugharne Coast dunes	Pembrey Coast dunes	Whiteford Burrows	Kenfig Dunes
<i>Liparis loeselii</i>	GB:EN,NR,S7,WCA-Sch8,HabReg-Sch5	-	-	-	-	-	-	-	-	-	5
<i>Matthiola sinuata</i>	GB:VU,NR,S7	-	-	-	-	-	-	-	-	1	5
<i>Mentha arvensis</i>	Wal:VU	-	-	-	-	-	-	-	-	-	1
<i>Oenanthe fistulosa</i>	GB:VU,S7	-	-	-	-	-	1	-	-	-	3
<i>Parentucellia viscosa</i>	Wal:NT	-	-	-	-	-	-	2	3	-	-
<i>Peltigera neckeri</i>	NS	-	2	6	6	4	-	-	-	-	1
<i>Petalophyllum ralfsii</i>	S7,WCA-Sch8,HabReg-Sch5	-	-	-	-	1	1	-	-	-	-
<i>Platanthera bifolia</i>	GB:VU,S7	-	-	-	1	-	-	-	-	-	-
<i>Platanthera chlorantha</i>	GB:NT	-	-	-	3	-	-	-	-	-	-
<i>Pleurochaete squarrosa</i>	NS	9	-	-	-	1	-	-	3	-	-
<i>Pseudocalliergon lycopodioides</i>	S7; NS,Wal:EN,GB:NT	-	13	-	-	-	-	-	-	-	1
<i>Pyrola minor</i>	Wal:EN	1	-	-	-	-	-	-	-	-	-
<i>Riccia cavernosa</i>	(previously NS)	-	-	-	-	-	2	-	-	-	1
<i>Salsola kali subsp. kali</i>	GB:VU,S7	-	-	-	2	4	9	3	13	1	1
<i>Silene conica</i>	GB:VU,Wal:VU,NS	-	-	-	-	-	-	3	-	-	-
<i>Southbya tophacea</i>	NR,GB:VU	1	-	-	-	-	-	-	-	-	-
<i>Tolypella glomerata</i>	NS	-	-	-	-	-	-	-	-	-	1
<i>Toninia sedifolia</i>	S7	1	-	-	-	-	-	-	-	-	-
<i>Tortella inclinata</i>	NS,Wal:NT	1	6	-	-	3	-	-	-	-	-
<i>Trifolium fragiferum</i>	GB:VU	3	-	-	-	-	1	-	7	-	-
<i>Viola canina</i>	GB:NT	13	11	1	10	16	2	3	3	3	1
<i>Vulpia fasciculata</i>	NS	9	11	1	5	4	-	14	30	15	15



Figure 81: *Matthiola sinuata* (Sea Stock) is one of the more striking notable species recorded on the dunes, seen here at Kenfig

Discussion

Vegetation Types

This NVC survey of some of the largest and most important dune systems in Wales has provided an up-to-date record of the vegetation communities across these dune systems. The data shows that all the sites support typical sand dune vegetation in natural associations determined by edaphic conditions, geomorphological processes and active dune management.

Condition

The survey provides only a snapshot of the vegetation, but showed most of the vegetation to represent swards typical of blown sand that would be expected given the geographic location of the sites. Impacts of undesirable anthropogenic disturbance were limited and nowhere does it seem to be creating significant problems for the dune systems. Where present, grazing appears to be managed appropriately, with the only evidence of overgrazing and attempts at agricultural improvement seen in enclosed private land beyond the open dunes, but sometimes still within the SAC boundary; such areas are very small.

Some historic activities are still impacting on the condition of the dunes. Conifer plantations are present on several of the dune sites. Their impact, in particular by acidifying the soil, is notable in the vegetation types recorded in and adjacent to them, especially on sites which otherwise lack calcifuge vegetation such as Whiteford Burrows. Historic drainage is probably also still influencing vegetation patterns on some of the dune sites. Detailed hydrogeology studies at Tywyn Aberffraw show the Afon Ffraw is artificially over-deep due to historic dredging to increase conveyance and consequently there are likely to be fewer dune slacks close to it (Todd-Burley *et al.* 2020). Modified drainage is also present in places at Laugharne-Pendine Burrows and there is evidence of artificial channels at other sites too, although overall their impact on the condition of dune vegetation is likely to be small.

Much of the conservation work, including the SoLIFE project itself, is based on the premise that the dunes are more fixed than they have been historically. Such an assessment is not possible to make from a single visit, but a comparison of the communities recorded in the Sand Dune Survey of GB to the current survey would yield interesting results in this respect, with the data being collected in such a way as to make it comparable between individual surveys, a significant strength of using the NVC.

Conservation Assessment

Conservation assessments covering the sites are given in each of the site reports, but all the sites included in the survey are clearly of exceptionally high value in terms of the range, diversity and uniqueness of habitats and the coherence with which they occur over large, natural areas.

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Data Archive Appendix

Data outputs associated with this project are archived in Sands of LIFE (SoLIFE) DMS folders (D1 Physical Monitoring) on server-based storage at Natural Resources Wales.

The data archive contains:

- [A] The final report in Microsoft Word and Adobe PDF formats.
- [B] An excel with the combined quadrat data for all sites.
- [C] A series of GIS layers on which the maps are based with a series of word documents detailing the data processing and structure of the GIS layers.
- [D] A full set of images produced in jpg format.

All other data outputs are listed with the site-based reports. Metadata for this project is publicly accessible through Natural Resources Wales' Library Catalogue <https://libcat.naturalresources.wales> (English Version) and <https://catllyfr.cyfoethnaturiol.cymru> (Welsh Version) by searching 'Dataset Titles'. The metadata is held as record no NRW_DS124915.



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