

Sand Dune Vegetation Survey of Great Britain

A national inventory

Part 3: Wales

T.C.D. Dargie
Ecological Consultant

**Loch Fleet View
Skelbo Street
Dornoch
Sutherland
Scotland
IV25 3QQ**



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Financial support was provided by the Countryside Council for Wales for surveys undertaken in 1991 and the production of this national report.

1. Vegetation surveys covering 49 sand dune systems are collated for Wales. Vegetation surveys are based on the National Vegetation Classification (NVC) and survey techniques included the mapping of all vegetation types in each site. The area of each vegetation or other land cover polygon was calculated and results aggregated. Mapping covered 6,406 ha, a dune area excluding large extents of afforested sand. Adding afforested dune area, vegetated dune in Wales totalled 8,101 ha and this probably represents almost all of the vegetated dune resource of Wales.

2. Field survey also recorded geomorphological characteristics of sites and the impact of human activities. This information was used to classify dune systems into types of dune, summarise erosion/accretion data and describe human impacts. Look-up tables are provided to allow rapid selection of individual sites.

3. The general characteristics of Welsh dune vegetation and rare dune species are described.

A full table of NVC communities and sub-communities found in sand dune surveys in Wales is presented, plus tables listing nationally rare and scarce species.

4. Most of the report describes NVC sand dune vegetation, other NVC types recorded on dunes, plus other land cover types marked in mapping. Look-up tables are used to summarise the areas of NVC communities and sub-communities for each site, with data aggregated to give NVC areas for the administrative regions of the Countryside Council for Wales.

5. The nature conservation value of Welsh dunes is discussed in terms of its naturalness, diversity, rarity, fragility, typicalness, ecological/geographical groupings, recorded history, educational value, potential value and intrinsic appeal. Dune size is shown to be an important control of site diversity in vegetation types, naturalness and intrinsic appeal.

1.2 Coastal ecology research by the Nature Conservancy Council and the Joint Nature Conservation Committee

This survey is one of a series of coordinated botanical surveys of major British coastal habitats. These have been planned and executed up to 1991 by the coastal section of the Nature Conservancy Council (NCC) Chief Scientist's Directorate (CSD) as part of an integrated programme of research and survey (Countryside 1990). The work has been continued since April 1991 by the Joint Nature Conservation

The end products from this survey consist of:

- a bibliography of literature relating to British dunes and their vegetation;
- site reports and vegetation maps for each of the sites visited;
- national reports for each of the three countries, summarising the resources of each country;
- a computer database to hold the results of the survey.

1. Introduction

1.1 Coastal dunes

Sand dunes are one of a series of terrestrial habitats that in Britain are almost entirely restricted to the coast. The others are saltmarshes, maritime cliffs and grasslands, vegetated shingle and strandlines.

Sand dunes can form along the coast wherever there is a sufficient supply of sand in the intertidal zone to form a beach plain whose surface dries out between tides. The dry sand can then be blown landward and deposited above the high tide mark. In temperate areas such as Britain this blowing sand can be trapped by specialised grasses. These grow up through successive layers of sand to form characteristically steep, vegetated dunes. Such dunes differ markedly in shape from those formed where vegetation is not important as a stabilising force.

Sand dunes support many specialised plant species and plant communities which are confined to this habitat. They also contain a large number of species and communities with a wider distribution. The diversity of plant life reflects the range of soil chemistry, aspect, water regime and other physical conditions found on dune systems in Britain. To an ecologist, dune vegetation illustrates the ecological principles of zonation and succession with great clarity, and dunes are invaluable for ecological teaching and research.

1.2 Coastal ecology research by the Nature Conservancy Council and the Joint Nature Conservation Committee

This survey is one of a series of coordinated botanical surveys of major British coastal habitats. These have been planned and executed up to 1991 by the coastal section of the Nature Conservancy Council (NCC) Chief Scientist's Directorate (CSD) as part of an integrated programme of research and survey (Galvin 1990). The work has been continued since April 1991 by the Joint Nature Conservation

Committee (JNCC). The other surveys in this series to date are the Saltmarsh Survey (Burd 1989) and the Vegetated Shingle Survey (Sneddon & Randall 1992).

The overall aims of this research programme are:

- to establish the size, location and quality of the main terrestrial coastal habitats in Great Britain;
- to allow the impact of development proposals to be assessed on sites of national importance, and on the resource as a whole;
- to provide guidance on the management of major coastal habitats;
- to investigate the role of physical and biological processes in the maintenance of natural and semi-natural coastal habitats.

1.3 The Sand Dune Survey of Great Britain

The specific objectives of the sand dune survey are:

- to review existing knowledge of British dune vegetation;
- to compile an inventory of the range and extent of dune vegetation throughout Britain;
- to allow the national and regional importance of each individual site to be assessed;
- to provide vegetation maps and descriptions for each site in sufficient detail to support site-specific casework and conservation management planning, and to act as a baseline for future monitoring.

The end products from this survey consist of:

- a bibliography of literature relating to British dunes and their vegetation;
- site reports and vegetation maps for each of the sites visited;
- national reports for each of the three countries, summarising the resource of each country;
- a computer database to hold the results of the survey.

1.4 The dune vegetation survey of Wales

This report is the Welsh component of three national reports comprising the Great Britain survey. It is based upon 47 reports relating to 49 sites or groups of sites (Annex 1). The location of site/site groups is shown in Figure 1.1 and site details are listed in Table 1.1. All site surveys use the National Vegetation Classification (NVC – see Chapter 2) and the report set is made up of two NCC Welsh Field Unit surveys conducted in 1986 and 1987, twelve NCC sand dune surveys completed between 1987 and 1988, plus 33 reports based on survey in 1991 with JNCC support.

The total Welsh dune area covered by these surveys is 8,145.63 ha (Table 1.1). This probably represents virtually all of the Welsh vegetated dune resource apart from c. 100 ha unsurveyed on Ministry of Defence land between Laugharne Burrows and Pendine Sands, uncertain areas unsurveyed on the edges of dune systems at Merthyr Mawr (Ogwr) and Valley (Ynys Mon), and two small areas of wind-blown sand on cliff sites at Creigau Traeth y Mwnt SSSI (SN 194519) and Creigau Penbryn SSSI (SN 286520). The latter two sites are both in Ceredigion.

The report is structured to present survey methods (Chapter 2), a summary of site physical characteristics (Chapter 3), a detailed account of vegetation types which places each site in the national context (Chapters 4–12), and human impacts (Chapter 14).

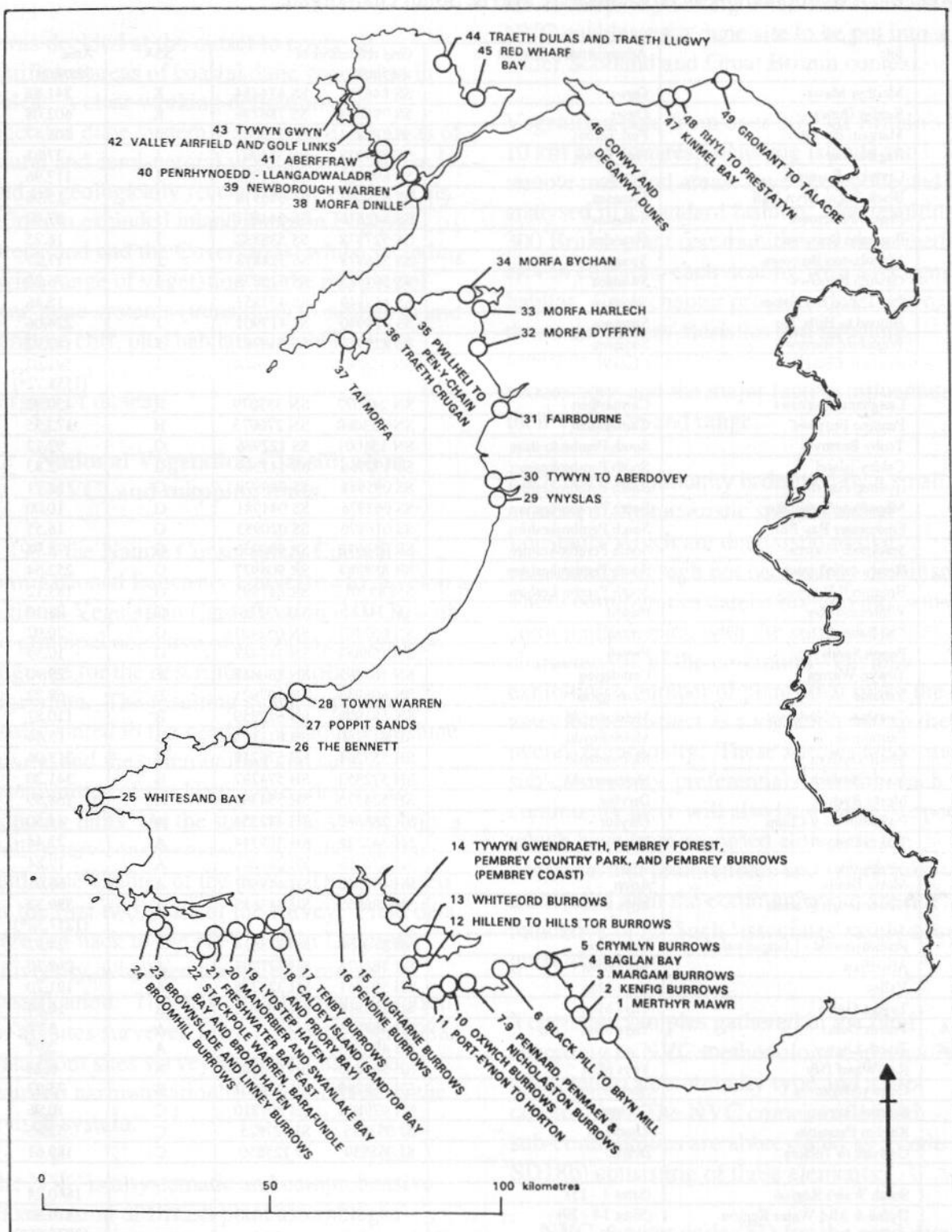


Figure 1.1 Location of dune survey sites in Wales. Site names, district, coordinates and survey area are given in Table 1.1.

Table 1.1 Dune sites surveyed in Wales. Site areas include transitions to saltmarsh but not saltmarsh. * - site area including afforested dune. SSA - SSSI Selection Area: A West Gwynedd; B East Gwynedd; C Clwyd; F Ceredigion; G Preseli & South Pembrokeshire; H Carmarthen & Dinefwr; J West Glamorgan & Llanelli; K Mid & South Glamorgan.

	Site	Administrative District	Grid references of site limits		SSA	Area (hectares)
1	Merthyr Mawr	Ogwr	SS 846787	SS 874784	K	341.88
2	Kenfig Dunes	Ogwr	SS 790834	SS 786796	K	602.08
3	Margam Burrows	Port Talbot	SS 783831	SS 776847	J	101.47
4	Baglan Bay	Port Talbot	SS 724927	SS 734907	J	77.81
5	Crymlyn Burrows	Neath	SS 698922	SS 731936	J	117.96
6	Black Pill to Bryn Mill	Swansea	SS 629907	SS 646918	J	15.96
7	Pennard Burrows	Swansea	SS 542876	SS 544891	J	87.02
8	Penmaen Burrows	Swansea	SS 527878	SS 538882	J	16.75
9	Nicholaston Burrows	Swansea	SS 516878	SS 524878	J	17.27
10	Oxwich Burrows	Swansea	SS 503865	SS 513878	J	76.20
11	Port-Eynon to Horton	Swansea	SS 469849	SS 477857	J	18.86
12	Hillend to Hills Tor	Swansea	SS 429940	SS 413901	J	224.06
13	Whiteford Burrows	Swansea	SS 429940	SS 448967	J	142.92
14	Pembrey Coast	Llanelli	SN 358063	SN 436004	J	591.67 (1558.72*)
15	Laughame Burrows	Carmarthen	SN 240077	SN 333079	H	430.81
16	Pendine Burrows	Carmarthen	SN 233080	SN 270073	H	172.55
17	Tenby Burrows	South Pembrokeshire	SN 131001	SS 122986	G	92.12
18	Caldey Island	South Pembrokeshire	SS 132966	SS 141969	G	2.83
19	Lydstep Haven	South Pembrokeshire	SS 095988	SS 089979	G	22.71
20	Manorbier/Swanlake	South Pembrokeshire	SS 063976	SS 044981	G	10.00
21	Freshwater Bay East	South Pembrokeshire	SS 016976	SS 020983	G	16.55
22	Stackpole Warren	South Pembrokeshire	SR 959938	SR 990953	G	178.98
23	Brownslade/Linney	South Pembrokeshire	SR 888987	SR 908977	G	252.54
24	Broomhill Burrows	South Pembrokeshire	SM 893012	SR 887995	G	183.12
25	Whitesand Bay	Preseli	SM 741270	SM 733267	G	28.19
26	The Bennett	Preseli	SN 057407	SN 052401	G	20.02
27	Poppit Sands	Preseli	SN 158484	SN 149487	G	10.59
28	Towyn Warren	Ceredigion	SN 167493	SN 160485	F	29.90
29	Ynyslas	Ceredigion	SN 608946	SN 607921	F	68.22
30	Tywyn to Aberdovey	Meirionnydd	SN 581998	SN 612959	B	110.81
31	Fairbourne	Meirionnydd	SH 617150	SH 611119	B	15.46
32	Morfa Dyffryn	Meirionnydd	SH 553264	SH 576218	B	313.06
33	Morfa Harlech	Meirionnydd	SH 572353	SH 574297	B	341.20
34	Morfa Bychan	Dwyfor	SH 524375	SH 554369	A	168.59
35	Pwllheli/Pen-y-Chain	Dwyfor	SH 383347	SH 432354	A	44.50
36	Traeth Crugan	Dwyfor	SH 341328	SH 389344	A	22.44
37	Tai Morfa	Dwyfor	SH 278268	SH 287260	A	19.84
38	Morfa Dinlle	Arfon	SH 432582	SH 449607	A	66.61
39	Newborough Warren	Ynys Mon	SH 386655	SH 443613	A	529.32 (1257.32*)
40	Penrhynoedd - Llangadwaladr	Ynys Mon	SH 370650	SH 373664	A	24.92
41	Aberffraw	Ynys Mon	SH 358675	SH 377703	A	248.30
42	Valley	Ynys Mon	SH 301761	SH 328718	A	191.70
43	Tywyn Gwyn	Ynys Mon	SH 293818	SH 294811	A	16.64
44A	Traeth Dulas	Ynys Mon	SH 488885		A	3.72
44B	Traeth Lligwy		SH 494873		A	2.97
45	Red Wharf Bay	Ynys Mon	SH 561805	SH 573809	A	6.28
46	Conwy/Deganwy	Aberconwy	SH 768789	SH 775807	B	75.23
47	Kinmel Bay	Colwyn	SH 979803	SH 997810	C	10.96
48	Rhyl to Prestatyn	Rhuddlan	SJ 057835	SJ 027825	C	52.85
49	Gronant to Talacre	Delyn	SJ 068839	SJ 125850	C	189.61
	South Wales Region	(Sites 1 - 13)				1840.24
	Dyfed & Mid-Wales Region	(Sites 14 - 29)				2110.80 (3077.85*)
	North Wales Region	(Sites 30 - 49)				2455.01 (3183.01*)
	Totals					6406.05 (8101.10*)

2. Methods

2.1 Scope of the survey

It was decided at the outset to cover all significant areas of coastal dune vegetation in Wales. A clear working definition of a vegetated dune system was adopted: all areas of natural and semi-natural vegetation on blown sand of geologically recent marine origin. This definition excluded inland dunes in England (Breckland and the Coversands) whilst including a wide range of vegetation on the margins of some dune systems (transitions to saltmarsh and maritime cliff, plus habitats with only slight maritime influence found towards the inland margins of dunes).

2.2 National Vegetation Classification (NVC) and mapping units

In 1975 the Nature Conservancy Council commissioned Lancaster University to develop a National Vegetation Classification (NVC), with the principal objective of providing a common language for the description of British vegetation. The resulting system appeared ideally suited to the needs of a nationwide dune survey, and the communities and sub-communities of the NVC were adopted as mapping units. At the start of the survey only a preliminary conspectus was available for the sand dune chapter of the NVC. This was used for the first two years of the survey. Field data were fed back to the NVC unit at Lancaster University, who then compiled a revised classification. The new classification was used for all sites surveyed after 1st September 1988. Data from sites surveyed before that date required harmonisation to convert them to the revised system.

The NVC is a systematic and comprehensive classification of British plant assemblages (Rodwell 1991a, 1991b, 1992, in prep.). It aims to provide broad-based descriptions of plant communities from all natural, semi-natural and major artificial habitats throughout Britain. It is intended to be a means of classifying vegetation into types that can be identified in the field and

mapped on the ground. It can, in this way, provide the language, the measure and the means with which to assess vegetation across the country. By setting a national standard the NVC enables each dune site to be put into a wider Scotland and Great Britain context.

Vegetation data from over 80% of Britain's 10 x 10 km grid squares, including islands and remote mainland areas, have been collected and analysed in a standard fashion. The resulting 300 British plant communities are described in eleven chapters, each dealing with a recognised habitat. Each chapter provides descriptions of the communities' floristics and structure, together with their habitat, zonation and successions and the major factors influencing their variation and range.

Each NVC community is defined by a small number of characteristic species called 'constants' which are diagnostic of that community, though not necessarily dominant. These communities can be divided into sub-communities, each with the suite of species characteristic of the community but also exhibiting a number of plants that make the assemblage distinct as a variation within the overall community. These species are termed sub-community 'preferentials'. Within each community there will also be a range of species which have been recorded alongside the constants and preferentials and which are associated with the community but are not indicative of it. Such 'associates' rarely occur in great abundance.

Vegetation samples gathered in the field according to NVC methodology can usually be allocated to a community type and a sub-community. The NVC communities and sub-communities are abbreviated as a code (e.g. SD18b) consisting of three elements:

- NVC chapter code (SD for the sand dune and shingle chapter);
- community number (18);
- sub-community letter (b).

Accompanying the NVC code is the full title of the community and sub-community as stated in the NVC. This is intended to provide an outline of the vegetation assemblage present but the relevant NVC chapter should be consulted for a full description of the community, its distribution and affinities.

The following volumes were all required to classify the vegetation in this national survey of Welsh dunes:

SD	Shingle, strandline and sand dune communities
H	Heaths
M	Mires
MG	Mesotrophic grasslands
CG	Calcicolous grasslands
S	Swamps and tall-herb fens
A	Aquatics
SM	Saltmarsh communities
MC	Maritime cliff communities
U	Calcifugous grasslands and upland communities
W	Woodlands and scrub

2.3 Locating the sites to survey

Sand dune systems were located principally by identification on a series of 1:50,000 Ordnance Survey maps held by the coastal section of the Chief Scientist Directorate of the NCC. From these maps a list of dune sites was compiled with the site name and the approximate grid reference. This list was then checked with regional staff of the NCC and with a list of dune sites afforded statutory protection supplied from the NCC's COREDATA system. Two sites surveyed by the Welsh Field Unit of NCC (Laugharne Burrows, Tenby Burrows) were included, though both were based on an early version of the NVC sand dune chapter and required harmonisation with the current version. Sites in West Glamorgan and Mid-Glamorgan were surveyed before NCC reorganisation in 1991 as part of the Great Britain survey, with all remaining sites being covered in an intensive exercise in the summer of 1991.

2.4 Review of existing sources of information

Prior to this survey there had been no systematic vegetation survey of the dunes of Wales. There were published and unpublished descriptive works on particular sites, mostly covering dune wetland habitats (slacks, plus swamp and tall-herb fens). A literature review of all British dune studies was produced early in the Great Britain project (Radley & Woolven 1990) and these sources were consulted, together with additional information from site files held in NCC regional offices. The literature search revealed that only a few dune systems had been described in detail and that the methodologies of these surveys varied enormously. Most surveys of whole sites were also rather old. Experience from monitoring projects and reserve management has also shown that vegetation can change significantly over periods as short as ten years and it was therefore decided to use 1981 as a cut-off date for survey inclusion. In the event there were no sites in Wales, other than Laugharne Burrows and Tenby Burrows, where existing recent surveys existed and which were compatible with NVC. Fresh survey work was therefore required for the bulk of the Welsh vegetated dune resource.

2.5 Field survey

2.5.1 Vegetation recording

After an initial inspection of the site to assess the overall range and pattern of variation, the vegetation was divided by the surveyor into homogeneous stands. Within each stand type, typical sample areas were chosen and the vegetation recorded from inside 2 x 2 metre quadrats.

The NVC manual recommends that a minimum of five quadrats should be recorded from each stand type at each site. The time constraints of a wide ranging national survey did not allow this recommendation to be followed in all sites, but care was taken to ensure that at least one full quadrat was taken from each major stand type

at each dune system surveyed. In practice, surveyors rapidly became familiar with NVC vegetation types and there was less need to use the recommended number of quadrats for all vegetation stands.

Within the quadrats all vascular plants, bryophytes and macrolichens were identified and recorded using the Domin cover/abundance scale. In the majority of surveys this information was supplemented with data on aspect, soil pH, slope, bare ground, litter layer, vegetation height and grazing. A brief written description was also made of the quadrats and any other relevant features were noted.

Extensive use was made of target notes. These were used for two distinct purposes:

- to note particular features or to comment on land use;
- to supplement quadrat records particularly in areas subject to local disturbance or modification, in the more localised or restricted plant communities and in vegetation mosaics and transitions which are difficult to describe purely by means of quadrats.

The target notes consisted of a written description of the feature or vegetation type(s), with or without a list of species found. In a few cases approximate Domin scores were given to the species recorded. Target note information is often very valuable to site managers and others concerned with site conservation.

2.5.2 Vegetation mapping

The larger sand dune systems posed special problems for vegetation mapping because of their complex terrain and absence of artificial, mapped features. Many Ordnance Survey maps show only the inland boundary and the high water mark. Under these circumstances vegetation boundaries sketched directly onto an Ordnance Survey base map would have been wildly inaccurate. Conventional topographic surveying techniques could produce very accurate results, but would have been too costly and time-consuming. No very accurate

topographic map existed at the time of survey for any Welsh site and an alternative mapping method was required.

An approach using aerial photographs was devised which allowed vegetation boundaries on large dune systems to be drawn in the field quickly, and with reasonable accuracy. The prints were taken into the field and vegetation boundaries drawn upon drafting film overlays using the features and changes in texture on the photographs as landmarks. Experience showed that satisfactory results could be obtained from colour or black and white prints at scales of between 1:10,000 and 1:5,000. An effort was made to obtain the most recent coverage that met these criteria. In no case was photography more than fifteen years old used for mapping.

The boundaries of each apparently uniform stand were sketched on to the aerial photograph, taking advantage of viewpoints such as high dunes and adjacent hills wherever possible. Small areas with a complex mosaic of vegetation types were mapped using the '+' symbol to indicate a mosaic. These mosaics were very common in sand dune systems and mosaics make up c. 25% of the area of some Welsh sites. Areas with transitional vegetation were marked with a '/' symbol. The locations of all quadrats were marked and the stands or features to which target notes referred were clearly labelled. Artificial boundaries and prominent landmarks were drawn in. Fiducial marks (calibration marks on the edge of vertical air photos) were drawn on air photograph overlays to ensure exact re-alignment. All overlays were labelled with the site name, date, recorder and, where applicable, the aerial photograph print number.

2.6 Analysis of survey data

Quadrat data for each site were entered into a microcomputer database using the VESPAN II suite of programs devised by Andrew Malloch of Lancaster University (Malloch 1988). The TABLE program was used to produce quadrat tables, whilst the keys, tables and written descriptions provided in the various chapters of

the National Vegetation Classification (NVC) (Rodwell 1991a, 1991b, 1992, in prep.), were used to allocate each quadrat to an NVC group. However, in several cases non-NVC terms were used to describe the vegetation.

For the larger and more complex sites a TWINSpan (Hill 1979) analysis was performed on these data as an aid to the classification of the quadrats. The end groups resulting from these analysis were compared with the keys, tables and written descriptions provided in the various chapters of the NVC. In most cases these end groups did correspond to an NVC group. Occasionally the TWINSpan analysis split to a different level and some re-interpretation of the end groups was necessary to place all the quadrats in their correct NVC categories. It should be emphasised that the TWINSpan analysis was performed primarily as a means of grouping like quadrats together to aid their manual classification, though the relationship between the end groups did sometimes give insights into the classification of intermediate stands.

Towards the end of the project the MATCH program became available (Malloch 1990). This calculates coefficients of similarity between sample data and the vegetation tables used to define each of the NVC types. This program was used to check some of the manual classifications and to help with the conversion of the data from those sites originally classified using the preliminary version of the sand dune NVC chapter.

2.7 Preparation of vegetation maps

Where aerial photographs are used as the base for mapping there is always some distortion of the image due to tilt and relief displacement. Accurate transfer of information to a map base therefore requires the use of specialised optical equipment. High accuracy can be obtained using stereoplotters but these are slow and require trained operators. In practice sufficient accuracy can be obtained using simpler instruments (Grant Enlarger, Bausch and Lomb stereo zoom transferscope, Zeiss Sketchmaster). The latter

two machines can compensate for differences in scale and for distortions due to tilting. The Grant Enlarger can compensate only for differences in scale. In both cases the procedure was similar: the images of the field overlay and the print to which it relates were super-imposed on the map base and adjusted to fit it using identifiable fixed points. The vegetation boundaries and other features drawn on the field overlay were then transferred on to the map base. Occasionally the distortions on the aerial photographs could not be entirely compensated for. In these cases the boundaries were transferred a piece at a time using local scaling to match sections of the photograph image to sections of the base map. A final map was then prepared using the results of the vegetation analysis to determine the mapping units.

2.8 Collation of other information

Additional information on the sites was obtained from the files of the regional offices of the Nature Conservancy Council, from field observation and from people with local knowledge. For most sites a standard summary form was completed with a series of fields giving details of the type of dune system, land use, management, use by the public and dynamic state.

In the sections where grazing was recorded, the form provided a series of options. The surveyor could select either moderate, light or heavy grazing and grazing in spring, summer, autumn or winter. If an option was selected then a 'Y' was entered; otherwise it was left blank. A similar system was used to record erosion and vehicle damage with the difference that selected options could be recorded as either localised 'L' or widespread 'W'.

In a few cases such as the fields dealing with fires, forestry and golf courses, the surveyors were asked to estimate the area affected. If the feature did not occur then a zero value was recorded. In these fields a blank meant that the information was not recorded.

A distinction was drawn on the form between marine erosion, the term used to describe the removal of dune by the sea, and erosion damage. This second term was used to describe instability within a dune system, normally resulting from human or animal activity, but including the removal of sand by wind.

2.9 Organisation of survey work in Wales

The field survey work was carried out over three field seasons: 1987, 1988 and 1991. In each of these seasons surveyors carried out field surveys between late April and the end of September. External contracts were let for Mid-Glamorgan and West Glamorgan sites in 1987 (P.S. Jones and J.R. Etherington) and 1988 (to P.S. Jones and T.C.D. Dargie). Initial training of contractors was provided by G.P. Radley. Supervision ensured that information was collected in a consistent manner, with one individual (G.P. Radley) remaining in overall control of the Great Britain project for most of its duration. The bulk of 1991 survey was achieved by a team of trained surveyors under the supervision of C. Holder (JNCC), with one site (Brownslade and Linney Burrows) completed by a team from the Field Studies Council.

Quality control was ensured by the following means:

Training in survey methodology

At the start of each field season a field training course was run for the directly employed surveyors. The survey methodology was also demonstrated to the external contractors. Both contractors and directly employed staff were visited in the field at intervals to ensure that their methods remained consistent. Particular attention was paid to the definition of uniform stands and the drawing of boundaries, to the estimation of Domin scores and to the identification of NVC types.

Species identification

Species identification was a major part of the training courses. During the survey samples were taken of any vascular plants that could not

be confidently identified in the field, to allow them to be fully keyed out. In cases where uncertainty remained, specimens were pressed and taken back to base for checking. Only the most unmistakable lichens and bryophytes were identified in the field. In all other cases specimens were collected and identified later in the laboratory or by lower plant specialists.

2.10 Presentation of survey results for individual sites

In order to ensure that the results of the site surveys were available to NCC regional staff as soon as possible after the work was done, the results of each site survey were published separately in either the Contract Surveys or CSD Reports series of NCC, or in JNCC publications. These reports each contain a summary of the methodology, a list of vegetation types, a description of the site, a vegetation map and the field data. Area data for each NVC vegetation type were included for West Glamorgan sites. A full list of these reports is given in Annex 1.

2.11 Area calculation

Before the national inventory of dune vegetation could be compiled it was necessary to measure the area occupied at each site by each of the vegetation types. Funds were made available to digitise maps from 1991 Welsh surveys and the 1985 survey of Tenby Burrows, allowing the calculation of area for each map polygon from vector coordinate data. Area values from digitised polygon data could not be assembled easily into areas for a particular vegetation type, largely due to a very large number of mosaic and transitional types. Polygon areas were therefore imported into a spreadsheet and sorted into vegetation/mosaic/transition types. The total area of each mosaic type was then divided by the number of mosaic elements (ranging from two to seven components) and this value was then added to each mosaic element. This approach assumes that a mosaic is made up of components of equal area.

Alternative approaches were used for measuring areas from the remaining surveys. Mid-Glamorgan sites and Laugharne Burrows (Carmarthen) were sampled by intense line intercept grids (lines spaced at 100 metre intervals parallel with national grid lines) and the percentage cover of large vegetation types estimated as a proportion of total line length (Nature Conservancy Council 1990a). These values were then converted to hectares by estimating total map area using a Romer dot grid. The line intercept approach should produce area estimates within 5% of the precise value for large vegetation types (Canfield 1941). Very small vegetation types were measured individually using a Romer dot grid. West Glamorgan sites had areas that were calculated by weighing vegetation types cut from a copy of the vegetation map.

2.12 Summary tables and maps for the national report

As a final step all vegetation areas per site were assembled into a set of spreadsheets to generate tables for use in this national report for Wales. These tables were also used to prepare maps at the national scale for Wales for NVC communities. Sites of low, moderate and high area are identified at NVC community level, varying the limits for low/moderate/high extent according to the number of sites involved and the area, in hectares, of the vegetation type. The usual map used in this report therefore includes sites without the NVC type, sites with the type present in only small quantity, sites with a moderate area, and sites with large extents. The combination of detailed tabular data for communities and sub-communities, together with a four-class summary map, allows a rapid appraisal of sites in the national context for Wales.

3. Physical nature of the dune resource

3.1 Dune system classification

During the field survey the geomorphological structure of each dune system was recorded using the classification system of Ranwell & Boar (1986). This recognises five main types of coastal dune system: offshore island; prograding dune, ness or cusate foreland; spit; bay; and hindshore. In addition, an extreme form of hindshore dune, hindshore machair, was recognised due to its importance on the western and northern coasts of Scotland, plus two other features of geomorphological interest: the presence of climbing dunes and tombolos. The dune types encountered are recorded on a site basis in Table 3.1. Many sites are composite systems, made up of more than one dune type, though the majority of these have one form predominant. Bay dunes, spits and climbing dunes are the most frequent types.

Classic offshore island dunes tend to develop as linear features in the direction of longshore drift, based on sand or shingle. These are not found in Wales and are largely restricted to eastern England.

Prograding dunes, nesses and cusate forelands build out (prograde) from the coast due to abundant sand supply from longshore drift in two directions to form a foreland, most notably at Morfa Harlech and at the mouth of the Afon Nedd (Crymlyn Burrows and Baglan Burrows). These are rare in Wales and, apart from Morfa Harlech, are comparatively small dune systems. The dunes between Tywyn and Aberdovey might have originated as a prograding system but they are currently eroding for most of their length, possibly as a result of coastal defences further north. The erosion has obscured dune origin and separation between a possible former spit and prograding dune is not possible.

Spit dunes are common in Wales and are well developed at the mouths of several estuaries. The largest spit system, by far, is that at Morfa Dyffryn (313 ha). Some are comparatively

simple structures formed over shingle deposited by storm waves, as at Morfa Dyffryn and Tywyn Gwendraeth at the north end of the Pembrey dunes. The most dynamic processes operate at the distal end and the apex of spit systems show several small recurved spits. Other spit dunes are more complex and imbricate spits are present at Pendine (where a younger spit with its base at Pendine is laid up against an older structure forming the adjacent Laugharne Burrows) and between Gronant and Talacre. The status of Whiteford Burrows is uncertain. It is frequently cited as a classical spit at the entrance to the Burry Inlet but it might instead be a tombolo formed upon shingle deposited between the hard rock shore and a boulder clay island now forming the north (distal) end of the dune system (Baye 1981). Elsewhere spits are very small, again developing at the mouths of streams or small rivers flowing through dunes.

Bay dunes are also common in Wales and are developed upon sand trapped within the shelter of rock headlands, forming a half-moon shape in the beach and outer dune zones. These are very frequent on irregular, rocky coasts with an offshore sand supply (e.g. the bay dune between Port-Eynon and Horton on the south coast of the Gower Peninsula). Relatively small bays on Ynys Mon (Anglesey), the Llyn Peninsula, Pembrokeshire and the Gower coast account for all Welsh examples.

Hindshore systems usually develop initially as bay types but abundant sand supply and onshore prevailing winds drive the sand inland for considerable distances as a series of dune ridges or mobile parabolic dunes, often leaving depressions to windward which develop into slacks. These form the largest and most complex dune systems in Wales, with successive periods of stabilisation and then erosion creating a very varied topography. In some cases mobile sand has been carried over considerable distances inland or deposited as a mantle on adjacent cliff slopes and cliff tops, forming climbing dunes. The largest system is found at Pembrey (1,559 ha), though other hindshore dunes are also very large in a Welsh and British

context, e.g. Newborough Warren (1,257 ha), the Kenfig Dunes (602 ha) and Aberffraw (248 ha). A small hindshore dune system might have been present between Black Pill and Bryn Mill in Swansea but development for housing, education, recreation and a transport corridor has largely destroyed the site, leaving an outer fragmentary line which operates as a bay dune.

Climbing dunes represent sand areas blown up on to terrain inland of a main dune system (e.g. the inner sectors at Merthyr Mawr Warren) or via bay dunes which act as feeder routes for the sand (e.g. the bay dunes of Barafundle Bay and Broad Haven as the most likely sources of sand for Stackpole Warren). Very little sand is being input to climbing dune systems at present and they represent a dune feature created by periods of dune instability during very stormy climatic periods in the past. The extensive climbing dunes of South Wales are known to have inundated settlements in the 14th and 15th centuries, suggesting that these dune types are comparatively recent. Sand was probably derived from the remobilisation of existing stable dunes in the vicinity of settlements.

3.2 Retreat and progradation at the beach/dune interface

The accurate measurement of marine erosion and of dune progradation is complex and requires repeated visits to monitor changes. In its most sophisticated form it involves construction of a beach sediment budget and such work is not available for Welsh dunes. However, an attempt was made during this survey to obtain a rough idea of the processes at work at the time the sites were visited. The surveyors were asked to record signs of current marine erosion or progradation and to estimate the percentage of the active shoreline that was affected.

The main feature used to indicate marine erosion was a steep cliff at the front of the dunes, combined with an absence of embryo dunes. Additional confirmation was sought from signs such as the exposure of marram *Ammophila arenaria* roots in the cliff face or

the presence on it of slumped sections of previously stable dune turf.

Signs used to indicate progradation included series of parallel dune ridges supporting vegetation that became progressively younger towards the sea and the presence at the top of the beach of well developed embryo dune vegetation, often dominated by sand couch-grass *Elymus farctus*.

Aerial photographs used for vegetation mapping, compared with older photography, could sometimes be used to check these interpretations by looking for changes in the position of the shoreline relative to the fixed structures between the date of the photographs and that of the survey.

The results of this survey have been summarised by recording the proportion of beach eroding and prograding, dividing the survey sites into four categories (Table 3.2):

- Sites with net marine erosion: those where the percentage of the shoreline recorded as actively eroding was >10% greater than the percentage recorded as prograding;
- Sites with net progradation: those where the percentage of the shoreline recorded as prograding was >10% greater than that recorded as eroding;
- Sites in approximate equilibrium: those where the percentage of the shoreline in the two categories defined above differed by 10% or less;
- Sites of uncertain status: survey data not available (an estimate made based on map patterns).

A majority of sites (27) show net erosion, six suggest approximate equilibrium, and sixteen show progradation. Two sites lack data and are of uncertain status. This summary of erosion and accretion is based on very crude data and considerably simplifies the complexities occurring within individual sites. Despite such

Table 3.1 Distribution of dune types in Welsh dune systems. FP? = formerly present? P = present. T = trace (small feature). ? = possibly present.

	Site	Prograding dune, ness or cusate foreland	Spit dune	Bay dune	Hindshore dune	Climbing dune	Tombolo
1	Merthyr Mawr				P	P	
2	Kenfig Dunes				P	P	
3	Margam Burrows				P		
4	Baglan Burrows	P					
5	Crymlyn Burrows	P				P	
6	Black Pill to Bryn Mill			P	FP?		
7	Pennard Burrows		T	P		P	
8	Penmaen Burrows		T	T		P	
9	Nicholaston Burrows		P	P		P	
10	Oxwich Burrows		P		P		
11	Port-Eynon to Horton			P		T	
12	Hillend to Hills Tor			P		P	
13	Whiteford Burrows		P			T	?
14	Pembrey Coast		P		P		
15	Laughame Burrows		P				
16	Pendine Burrows		P				
17	Tenby Burrows			P		P	
18	Caldey Island			P			
19	Lydstep Haven			P		P	
20	Manorbier/Swanlake			P			
21	Freshwater Bay East			P		P	
22	Stackpole Warren			P		P	
23	Brownslade/Linney			P		P	
24	Broomhill Burrows				P	P	
25	Whitesand Bay			P		P	
26	The Bennett		P				
27	Poppit Sands	P					
28	Towyn Warren		P			P	
29	Ynyslas		P				
30	Tywyn to Aberdovey	?	?				
31	Fairbourne		P				
32	Morfa Dyffryn		P				
33	Morfa Harlech	P	P				
34	Morfa Bychan			P			
35	Pwllheli/Pen-y-Chain			P			
36	Traeth Crugan		P	P			
37	Tai Morfa			P		P	
38	Morfa Dinlle		P				
39	Newborough Warren		P		P		
40	Penrhynoedd - Llangadwaladr			P		P	
41	Aberffraw				P		
42	Valley		P	P			
43	Tywyn Gwyn		P				
44A	Traeth Dulas			P			
44B	Traeth Lligwy			P			
45	Red Wharf Bay			P			
46	Conwy/Deganwy		P				
47	Kinmel Bay		P				
48	Rhyl to Prestatyn			P			
49	Gronant to Talacre		P				
	Totals	4 (5)	20 (23)	23 (24)	8 (9)	17 (18)	(1)

complexities (which can involve seasonal and short- to long-term cycles in erosion/ progradation balance), the overall conclusion is that there are considerably more sites that are retreating than are advancing. This is consistent with the findings from dune systems surveyed in England and Scotland.

the percentage of the water resources that was utilized.

The main problem was the lack of data on the extent of the water resources. The data on the water resources was very limited and the data on the water resources was very limited and the data on the water resources was very limited.

A majority of sites (27) show net erosion, six appear approximately equilibrium, and sixteen show progradation. Two sites lack data and are of unknown status. This summary of erosion and accretion is based on very crude data and considerably simplifies the complexities existing within individual sites. Despite such

Table 3.2 Erosion and progradation condition of Welsh dune systems. Percentage data refer only to sand beach length at interface zone with vegetated dunes, not to complete site coastline. ? - no erosion/progradation survey, other survey data inadequate for estimate.

	Site	Percentage beach length eroding	Percentage beach length prograding	Site condition
1	Merthyr Mawr	70	30	Net erosion
2	Kenfig Dunes	40	60	Net progradation
3	Margam Burrows	80	20	Net erosion
4	Baglan Burrows	5	95	Net progradation
5	Crymlyn Burrows	5	95	Net progradation
6	Black Pill to Bryn Mill	90	10	Net erosion
7	Pennard Burrows	50	50	Approximate equilibrium
8	Penmaen Burrows	50	50	Approximate equilibrium
9	Nicholaston Burrows	10	90	Net progradation
10	Oxwich Burrows	90	10	Net erosion
11	Port-Eynon to Horton	95	5	Net erosion
12	Hillend to Hills Tor	100	0	Net erosion
13	Whiteford Burrows	40	60	Net progradation
14	Pembrey Coast	80	20	Net erosion
15	Laughame Burrows	?	?	?
16	Pendine Burrows	70	30	Net erosion
17	Tenby Burrows	?	?	?
18	Caldey Island	100	0	Net erosion
19	Lydstep Haven	100	0	Net erosion
20	Manorbier/Swanlake	80	20	Net erosion
21	Freshwater Bay East	25	75	Net progradation
22	Stackpole Warren	40	60	Net progradation
23	Brownslade/Linney	95	5	Net erosion
24	Broomhill Burrows	100	0	Net erosion
25	Whitesand Bay	100	0	Net erosion
26	The Bennett	60	40	Net erosion
27	Poppit Sands	40	60	Net progradation
28	Towyn Warren	90	10	Net erosion
29	Ynyslas	20	80	Net progradation
30	Tywyn to Aberdovey	90	10	Net erosion
31	Fairbourne	50	50	Approximate equilibrium
32	Morfa Dyffryn	100	0	Net erosion
33	Morfa Harlech	0	100	Net progradation
34	Morfa Bychan	95	5	Net erosion
35	Pwllheli/Pen-y-Chain	30	40	Uncertain - prograding?
36	Traeth Crugan	70	30	Net erosion
37	Tai Morfa	95	5	Net erosion
38	Morfa Dinlle	95	5	Net erosion
39	Newborough Warren	20	80	Net progradation
40	Penrhynoedd - Llangadwaladr	0	100	Net progradation
41	Aberffraw	10	90	Net progradation
42	Valley	60	40	Net erosion
43	Tywyn Gwyn	40	60	Net progradation
44A	Traeth Dulas	50	50	Approximate equilibrium
44B	Traeth Lligwy	50	50	Approximate equilibrium
45	Red Wharf Bay	40	60	Net progradation
46	Conwy(C)/Deganwy(D)	C - 50 D - 100	C - 50 D - 0	C - Approximate equilibrium D - Net erosion
47	Kinmel Bay	60	40	Net erosion
48	Rhyl to Prestatyn	100	0	Net erosion
49	Gronant to Talacre	70	30	Net erosion

4. General characteristics of Welsh dune vegetation and rare dune species

4.1 Introduction

The vegetation of sand dunes is shaped by a combination of physical, chemical, biotic and human factors. Within even a small dune system there can be marked gradients of instability, soil pH, moisture content, grazing pressure and trampling. This wide range of conditions is reflected in the diversity of dune vegetation.

In north-west Europe coastal sand dunes are created and maintained by vegetation. The crucial factor in the initiation of dune formation is the ability of certain plant species to grow in, and stabilise, wind-blown sand by growing up through it. In Wales there are three main species, all grasses, which do this: sand couch-grass (*Elymus farctus*), sea lyme-grass (*Leymus arenarius*) and, most important, marram grass (*Ammophila arenaria*). Sand couch-grass has only a modest ability to withstand burial, but its comparative tolerance of salt water (Gimingham 1964) means that it often initiates dune formation in the form of an embryo dune close to the strand line. Sea lyme-grass is a bigger plant, with a greater ability to grow up through fresh sand. It is a predominantly northern species but even in surveyed Scottish dunes it is perhaps less important than might be expected. In Wales it is largely restricted to northern dunes and it is not an important dune former (see section 6.2) – marram thus remains the main dune-building species. It can keep pace with up to 1 metre of fresh sand deposition per annum, as well as producing far-spreading horizontal rhizomes (Gemmell, Greig-Smith & Gimingham 1953; Ranwell 1972). By binding the dune together, and by maintaining the aerodynamic roughness of the surface, marram allows dunes to build up to a considerable height.

Actively growing dunes provide an extremely hostile environment for most plants. Not only is

there constant burial by fresh sand, but the loose sand is also very free-draining and therefore subject to severe drought. Dunes are also poor in nitrogen and phosphorus. Consequently the vegetation is normally composed of only a few, highly specialised species. However, as the rate of sand deposition declines, conditions start to ameliorate. Smaller grasses, annual and perennial herbs start to appear in greater number and these are then joined by sand-binding mosses capable of growing up through a few millimetres of accumulating sand (e.g. *Ceratodon purpureus* and *Tortula ruralis* ssp. *ruraliformis*) (Birse, Landsberg & Gimingham 1957), followed by various pleurocarpous mosses which are intolerant of sand deposition, and then by lichens. Simultaneously the vigour of the marram declines as the rate of burial decreases (Willis *et al.* 1959; Hope-Simpson & Jefferies 1966).

The subsequent course of the succession depends on several factors. In Britain as a whole most dunes have been grazed until relatively recently. Under the influence of grazing some form of dune grassland is likely to develop. The nature and species-richness of this grassland is greatly influenced by the type of sand on which it has developed. Where the sand contains a substantial proportion of calcium, generally in excess of 3% weight, dune grassland can be maintained for long periods. Where the initial calcium content is lower, leaching will, in time, reduce the pH (Wilson 1960) and under these circumstances dune heath can develop.

Very different vegetation develops where the sand is within reach of the freshwater table. This can happen either because the deflation floor of a blowout is close to the water table, or where the water table rises up towards an existing surface as the dune system extends. Under both these conditions dune slacks can develop, often characterised by a marked annual fluctuation in water level. In prograding dune systems the hollows between low dune ridges also develop into slacks, passing through saltmarsh and swamp phases in the process. Water levels in slacks normally reach a peak in early spring, when many are flooded for periods

of several months. They then fall sharply through the summer, reaching up to 2 metres below ground level before starting to rise again in autumn (Ranwell 1959). The vegetation of these areas has had to adapt to these unusual conditions and is largely unique to sand dunes. Not all wet areas on dunes can be described as slacks. Some systems also contain areas of more consistently wet ground, especially where the sand overlies an impermeable substrate. The vegetation of these areas is likely to consist of mire, fen or swamp vegetation, with strong similarities to vegetation of equivalent habitats inland.

Under continued grazing the vegetation of the older parts of dune systems will continue to develop and on some sites it can be seen to grade into grassland and heath communities that are very similar to inland types. This resemblance can be increased further by agricultural or recreational management, promoting the growth of productive or wear-resistant grasses.

If grazing is relaxed then the succession enters a new phase. Existing dune grassland swards can change their composition and appearance, becoming rank and less species-rich.

Simultaneously woody species start to invade and scrub starts to develop. In time this scrub will develop into woodland. One scrub species, sea buckthorn *Hippophae rhamnoides*, is especially associated with British sand dunes, though it is not widely distributed on Welsh systems and is probably native only in the south-east of England. Where present sea buckthorn can invade almost as rapidly as marram grass, even in foredune vegetation a few metres from the tideline. There may never be, under these circumstances, a dune grassland stage. A wide range of other shrub and tree species can also grow on dunes, at least in the more stable areas. Semi-natural scrub and dune woodland is virtually absent in Scotland but it is found in dunes of the Dutch coast and appears to be developing in older stands of scrub at some English and Welsh sites.

In practice vegetation very seldom entirely follows the orderly succession outlined above. Areas of dune frequently become destabilised and then gradually revegetate by secondary succession. Sometimes the original sequence is repeated, at other times a distinctly different succession occurs. Sand sedge *Carex arenaria* and colonising mosses, especially *Tortula ruralis* ssp. *ruraliformis*, play key roles in such secondary successions.

4.2 Dune vegetation in the National Vegetation Classification

Table 4.1 lists the communities and sub-communities covered by the sand dune chapter, plus those communities from other chapters that are most frequently encountered on dunes. Information is included on the distribution of dune communities and sub-communities found in Wales, England and Scotland, plus other non-dune NVC types which occur on Welsh dunes. Ninety NVC communities are found on Welsh dunes, with the list of all communities and sub-communities recorded extending to 156 types. The dune chapter encompasses shingle and strandline, mobile dunes, semi-fixed dunes, dune grasslands, slacks and dune scrub – a sequence which closely approximates a simple dune succession. The mobile dunes are divided into three communities SD4, SD5 and SD6, according to which of the major sand-binding grasses is dominant. The marram-dominated community (SD6) is further subdivided into a series of sub-communities that represent different degrees of mobility. None of the mobile dune types possess more than a fragmentary bryophyte layer. Most of the semi-fixed dune types are grouped together in one community, SD7. Here the sub-communities show geographical differences in distribution and differing degrees of fixation.

Dune grasslands are divided into two communities and these reflect the major division between the grasslands of calcareous sands (SD8) and those of acidic sands (SD12). The sub-communities here reflect variations in base status and soil moisture, along with regional differences. A third community, SD9, is found

mainly on neutral to calcareous sand but contains the taller and possibly somewhat eutrophic grasslands in which false oat-grass *Arrhenatherum elatius* is dominant.

Slacks are represented by five communities: SD13, SD14, SD15, SD16 and SD17. Each of these is in turn divided into sub-communities. All of these types represent different combinations of physical factors such as soil pH, water regime and successional change. The SD13 and SD14 communities represent the earlier stages of successional development.

The only scrub community included within the dune chapter (SD18) is that dominated by sea buckthorn *Hippophae rhamnoides*. This is divided into two sub-communities according to the stage in the succession that has been reached.

Vegetation in which sand sedge *Carex arenaria* is dominant is recognised as a distinct community, SD10. It is also a component of a rather specialised 'grey dune' SD11 community in which lichens dominate the sward.

Outside the sand dune chapter, only the heathlands section includes a community (H11) that is more or less confined to dunes. This is again characterised by sand sedge, together with ling *Calluna vulgaris*, and it is divided into a series of sub-communities. Several other heath communities can also occur within dune systems. Wet heaths, which are found in dune slacks at several acidic sites, are to be found in the mires chapter. There are examples of a number of different calcicolous, mesotrophic and acidic grassland communities. Some of these fit well with the existing sub-communities, others appear to represent slight variations not fully described in the NVC. Bracken-dominated vegetation is found not infrequently on sand dunes. Most Welsh samples can be referred to the woodland and scrub chapter (W25).

The scrub on dry dunes, apart from that dominated by sea buckthorn, can mostly be referred to the scrubs section of the woodlands chapter (W21 to W24). That which develops in

dune slacks is normally dominated by species of willow *Salix* spp., birch *Betula* spp. and alder *Alnus glutinosa* can be found in communities W1 to W4, plus W6.

The more permanently damp areas on dunes mostly fall either into the mires (on base-poor sites) or into the swamp and tall-herb fen chapters. Permanent open water is less common. It does occur (e.g. Kenfig Pool, Laugharne Burrows, Brownslade/Linney Burrows), but was not tackled in any detail during this survey.

Transitions to other coastal habitats are commonly encountered. Saltmarshes frequently abut dunes, especially in association with prograding types or sectors. There are some communities (SM16, SM18, SM24, SM28) that are particularly characteristic of the transition zone. Where sand has been blown up over nearby cliffs there can also be transitions to maritime cliff grassland communities.

A full vegetation description is not given here for standard NVC communities and sub-communities and readers are referred to NVC chapters for such detail if it is required. This report concentrates more on extent and distribution patterns within surveyed Welsh dunes.

4.3 Nationally rare and scarce plants on Welsh dunes

Nationally rare plants are defined as those occurring in 1–15 of the 10 x 10 km squares of the National Grid. Nationally scarce plants are those found in 16–100 of the 10 x 10 km squares. Throughout Great Britain saltmarshes, shingle, maritime grasslands, cliffs, open areas, dunes and dune slacks taken together support 48 nationally rare and 66 nationally scarce species of higher plant. These represent about 8% of the total British higher plant flora. Nationally rare bryophytes (e.g. *Petalophyllum ralfsii*) and lichens (e.g. *Fulgensia fulgens*) also occur on dunes in Wales but these are not treated in any detail in this account which is restricted to higher plants.

The majority of the nationally rare species characteristic of dunes are found in south-western, southern or western Britain, whilst most of the nationally scarce species have a predominantly southern, south-eastern or scattered distribution. This is because most of these plants belong to the Continental and the Mediterranean elements of the British flora and are reaching the northern and western limits of their range. The dunes of England and Wales therefore support a disproportionate number of nationally rare and scarce plants. Scotland, as a result, has relatively few of these rare and scarce British species.

It is also important to note that many nationally rare and scarce plants found on the coast are not confined to coastal habitat, since some are plants of unstable, ever-changing conditions and others require a strong maritime influence (Table 4.2). Dunes in Wales are locations for purple broomrape *Orobanche purpurea* (a recent discovery, its only current Welsh record), fen orchid *Liparis loeselii* (slacks in South Wales dunes) and early sand-grass *Mibora minima* (dunes in North Wales), all of which are nationally rare species. Five nationally rare and thirteen nationally scarce plants are wholly or mainly confined to dunes and dune slacks (Table 4.3). Two nationally rare dune plants are found in Wales, with dune gentian *Gentianella uliginosa* confined, in Britain, to dunes in South Wales. Dune helleborine *Epipactis dunensis* is found on dunes in North Wales and northern England. Eight nationally scarce dune species are found in Wales: variegated horsetail *Equisetum variegatum*, sea stork's-bill *Erodium maritimum*, sea buckthorn *Hippophae rhamnoides* (introduced, not native), fragrant evening primrose *Oenothera stricta*, Portland spurge *Euphorbia portlandica*, sea spurge *Euphorbia paralias*, seaside centaury *Centaureum littorale* and dune fescue *Vulpia membranacea*. One further nationally scarce species, grey hair-grass *Corynephorus canescens*, was present in South Wales before 1930 but has since not been recorded and might have been lost as a result of industrial development on the dunes around Swansea Bay.

Table 4.1 List of National Vegetation Classification types commonly found on sand dunes, grouped by habitat. * = present in Wales. ** = provisional new dune NVC type, possibly restricted to dunes in Scotland.

Strandline

- SD1a** * *Rumex crispus*-*Glaucium flavum* shingle community,
Typical sub-community.
- SD2** * *Honkenya peploides*-*Cakile maritima* strandline community.
- SD3** * *Matricaria maritima*-*Galium aparine* strandline community.

Mobile dunes

- SD4** * *Elymus farctus* ssp. *boreali-atlanticus* foredune community.
- SD5a** * *Leymus arenarius* mobile dune,
species-poor sub-community.
- SD5b** * *Leymus arenarius* mobile dune,
Elymus farctus sub-community.
- SD5c** * *Leymus arenarius* mobile dune,
Festuca rubra sub-community.
- SD6a** * *Ammophila arenaria* mobile dune,
Elymus farctus sub-community.
- SD6b** * *Ammophila arenaria* mobile dune,
Elymus farctus-*Leymus arenarius* sub-community.
- SD6c** * *Ammophila arenaria* mobile dune,
Leymus arenarius sub-community.
- SD6d** * *Ammophila arenaria* mobile dune,
Typical sub-community.
- SD6e** * *Ammophila arenaria* mobile dune,
Festuca rubra sub-community.
- SD6f** * *Ammophila arenaria* mobile dune,
Poa pratensis sub-community.
- SD6g** * *Ammophila arenaria* mobile dune,
Carex arenaria sub-community.

Semi-fixed dunes

- SD7a** * *Ammophila arenaria*-*Festuca rubra* semi-fixed dune,
Typical sub-community.
- SD7b** * *Ammophila arenaria*-*Festuca rubra* semi-fixed dune,
Hypnum cupressiforme sub-community.
- SD7c** * *Ammophila arenaria*-*Festuca rubra* semi-fixed dune,
Ononis repens sub-community.
- SD7d** * *Ammophila arenaria*-*Festuca rubra* semi-fixed dune,
Tortula ruralis ssp. *ruraliformis* sub-community.
- SD7e** * *Ammophila arenaria*-*Festuca rubra* semi-fixed dune,
Elymus pycnanthus sub-community.
- SD7?f** ** *Ammophila arenaria*-*Festuca rubra* semi-fixed dune,
provisional *Galium verum* sub-community.
- SD7?g** ** *Ammophila arenaria*-*Festuca rubra* semi-fixed dune,
provisional *Heracleum sphondylium* sub-community.

Table 4.1 (continued) List of National Vegetation Classification types commonly found on sand dunes, grouped by habitat. * = present in Wales. ** = provisional new dune NVC type, possibly restricted to dunes in Scotland.

Dune grasslands

- SD8a *** *Festuca rubra-Galium verum* fixed dune grassland,
Typical sub-community.
- SD8b *** *Festuca rubra-Galium verum* fixed dune grassland,
Luzula campestris sub-community.
- SD8c *** *Festuca rubra-Galium verum* fixed dune grassland,
Tortula ruralis ssp. *ruraliformis* sub-community.
- SD8d *** *Festuca rubra-Galium verum* fixed dune grassland,
Bellis perennis-Ranunculus acris sub-community.
- SD8e *** *Festuca rubra-Galium verum* fixed dune grassland,
Prunella vulgaris sub-community.
- SD9a *** *Ammophila arenaria-Arrhenatherum elatius* dune grassland,
Typical sub-community.
- SD9b *** *Ammophila arenaria-Arrhenatherum elatius* dune grassland,
Geranium sanguineum sub-community.
- SD12a *** *Carex arenaria-Festuca ovina-Agrostis capillaris* grassland,
Anthoxanthum odoratum sub-community.
- SD12b *** *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland,
Holcus lanatus sub-community.

Neutral grassland

- MG1a *** *Arrhenatherum elatius* coarse grassland,
Festuca rubra sub-community.
- MG1b *** *Arrhenatherum elatius* coarse grassland,
Urtica dioica sub-community.
- MG1d *** *Arrhenatherum elatius* coarse grassland,
Pastinaca sativa sub-community.
- MG1e *** *Arrhenatherum elatius* coarse grassland,
Centaurea nigra sub-community.
- MG2 *** *Filipendula ulmaria-Arrhenatherum elatius* tall-herb grassland.
- MG5a *** *Cynosurus cristatus-Centaurea nigra* meadow,
Lathyrus pratensis sub-community.
- MG5b *** *Cynosurus cristatus-Centaurea nigra* meadow,
Galium verum sub-community.
- MG6a *** *Lolium perenne-Cynosurus cristatus* pasture,
Typical sub-community.
- MG6b *** *Lolium perenne-Cynosurus cristatus* pasture,
Anthoxanthum odoratum sub-community.
- MG7a *** *Lolium perenne* leys,
Lolium perenne-Trifolium repens leys.
- MG7e *** *Lolium perenne* leys,
Plantago lanceolata sub-community.
- MG9a *** *Holcus lanatus-Deschampsia cespitosa* coarse grassland,
Arrhenatherum elatius sub-community.

Table 4.1 (continued) List of National Vegetation Classification types commonly found on sand dunes, grouped by habitat. * = present in Wales. ** = provisional new dune NVC type, possibly restricted to dunes in Scotland.

Neutral grassland (continued)

- MG10a*** *Holcus lanatus*-*Juncus effusus* rush pasture,
Typical sub-community.
- MG10b*** *Holcus lanatus*-*Juncus effusus* rush pasture,
Juncus inflexus sub-community.
- MG10c*** *Holcus lanatus*-*Juncus effusus* rush pasture,
Iris pseudacorus sub-community.
- MG11a*** *Festuca rubra*-*Agrostis stolonifera*-*Potentilla anserina* inundation grassland,
Lolium perenne sub-community.
- MG12a*** *Festuca arundinacea* coarse grassland,
Lolium perenne-*Holcus lanatus* sub-community.
- MG12b*** *Festuca arundinacea* coarse grassland,
Oenanthe lachenalii sub-community.

Calcicolous grassland

- CG6a *** *Avenula pubescens* grassland.
- CG7b *** *Festuca ovina*-*Hieracium pilosella*-*Thymus praecox* grassland,
Cladonia spp. sub-community.
- CG7c *** *Festuca ovina*-*Hieracium pilosella*-*Thymus praecox* grassland,
Fragaria vesca-*Rumex acetosa* sub-community.

Acidic grassland

- U1c *** *Festuca ovina*-*Agrostis capillaris*-*Rumex acetosella* grassland,
Erodium cicutarium-*Teesdalia nudicaulis* sub-community.
- U4a *** *Festuca ovina*-*Agrostis capillaris*-*Galium saxatile* grassland,
Typical sub-community.
- U4b *** *Festuca ovina*-*Agrostis capillaris*-*Galium saxatile* grassland,
Holcus lanatus-*Trifolium repens* sub-community.
- U5 *** *Nardus stricta*-*Galium saxatile* grassland, undifferentiated.
- U6 *** *Juncus squarrosus*-*Festuca ovina* grassland, undifferentiated.
- U20 *** *Pteridium aquilinum*-*Galium saxatile* community, undifferentiated.

Sand sedge and 'grey' dunes

- SD10a *** *Carex arenaria* dune,
Festuca rubra sub-community.
- SD10b *** *Carex arenaria* dune,
Festuca ovina sub-community.
- SD11 *** *Carex arenaria*-*Cornicularia aculeata* community, undifferentiated.

Heath

- H1 *** *Calluna vulgaris*-*Festuca ovina* heath, undifferentiated.
- H7e *** *Calluna vulgaris*-*Scilla verna* heath,
Calluna vulgaris sub-community.
- H8 *** *Calluna vulgaris*-*Ulex gallii* heath, undifferentiated.
- H10a *** *Calluna vulgaris*-*Erica cinerea* heath,
Typical sub-community.

Table 4.1 (continued) List of National Vegetation Classification types commonly found on sand dunes, grouped by habitat. * = present in Wales. ** = provisional new dune NVC type, possibly restricted to dunes in Scotland.

Heath (continued)

H11a * *Calluna vulgaris*-*Carex arenaria* dune heath,
Erica cinerea sub-community.

H11c * *Calluna vulgaris*-*Carex arenaria* dune heath,
Hypnum cupressiforme sub-community.

Wet heaths and mires

M5 * *Carex rostrata*-*Sphagnum squarrosum* mire.

M10c * *Carex dioica*-*Pinguicula vulgaris* mire,
Gymnostomum recurvirostrum sub-community.

M11 * *Carex demissa*-*Saxifraga aizoides* mire, undifferentiated.

M23 * *Juncus effusus*/*acutiflorus*-*Galium palustre* rush pasture, undifferentiated.

M25b * *Molinia caerulea*-*Potentilla erecta* mire,
Anthoxanthum odoratum sub-community.

M27b * *Filipendula ulmaria*-*Angelica sylvestris* mire,
Urtica dioica-*Vicia cracca* sub-community.

M28a * *Iris pseudacorus*-*Filipendula ulmaria* mire,
Juncus spp. sub-community.

M28b * *Iris pseudacorus*-*Filipendula ulmaria* mire,
Urtica dioica-*Galium aparine* sub-community.

Dune slacks

SD13b * *Salix repens*-*Bryum pseudotriquetrum* dune slack,
Holcus lanatus-*Festuca rubra* sub-community.

SD14a * *Salix repens*-*Campylium stellatum* dune slack,
Carex serotina-*Drepanocladus sendtneri* sub-community.

SD14b * *Salix repens*-*Campylium stellatum* dune slack,
Rubus caesius-*Galium palustre* sub-community.

SD14c * *Salix repens*-*Campylium stellatum* dune slack,
Bryum pseudotriquetrum-*Aneura pinguis* sub-community.

SD14d * *Salix repens*-*Campylium stellatum* dune slack,
Festuca rubra sub-community.

SD15a * *Salix repens*-*Calliergon cuspidatum* dune slack,
Carex nigra sub-community.

SD15b * *Salix repens*-*Calliergon cuspidatum* dune slack,
Equisetum variegatum sub-community.

SD15c * *Salix repens*-*Calliergon cuspidatum* dune slack,
Carex flacca-*Pulicaria dysenterica* sub-community.

SD15d * *Salix repens*-*Calliergon cuspidatum* dune slack,
Holcus lanatus-*Angelica sylvestris* sub-community.

SD16a * *Salix repens*-*Holcus lanatus* dune slack,
Ononis repens sub-community.

SD16b * *Salix repens*-*Holcus lanatus* dune slack,
Rubus caesius sub-community.

SD16c * *Salix repens*-*Holcus lanatus* dune slack,
Prunella vulgaris-*Equisetum variegatum* sub-community.

Table 4.1 (continued) List of National Vegetation Classification types commonly found on sand dunes, grouped by habitat. * = present in Wales. ** = provisional new dune NVC type, possibly restricted to dunes in Scotland.

Dune slacks (continued)

- SD16d** * *Salix repens*-*Holcus lanatus* dune slack,
Agrostis stolonifera sub-community.
- SD17a** * *Potentilla anserina*-*Carex nigra* dune slack,
Festuca rubra-*Ranunculus repens* sub-community.
- SD17b** * *Potentilla anserina*-*Carex nigra* dune slack,
Carex flacca sub-community.
- SD17c** * *Potentilla anserina*-*Carex nigra* dune slack,
Caltha palustris sub-community.
- SD17d** * *Potentilla anserina*-*Carex nigra* dune slack,
Hydrocotyle vulgaris-*Ranunculus flammula* sub-community.

Swamps and tall-herb fens

- S4a** * *Phragmites australis* swamp,
Phragmites australis sub-community.
- S4d** * *Phragmites australis* swamp,
Atriplex hastata sub-community.
- S5** * *Glyceria maxima* swamp.
- S6** * *Carex riparia* swamp.
- S7** * *Carex acutiformis* swamp.
- S8a** * *Scirpus lacustris* ssp. *lacustris* swamp,
S. lacustris ssp. *lacustris* sub-community.
- S10** * *Equisetum fluviatile* swamp, undifferentiated.
- S12b** * *Typha latifolia* swamp,
Mentha aquatica sub-community.
- S14** * *Sparganium erectum* swamp, undifferentiated.
- S18a** * *Carex otrubae* swamp,
Carex otrubae sub-community.
- S19a** * *Eleocharis palustris* swamp,
Eleocharis palustris sub-community.
- S19c** * *Eleocharis palustris* swamp,
Agrostis stolonifera sub-community.
- S20a** * *Scirpus lacustris* ssp. *tabernaemontani* swamp,
Scirpus maritimus sub-community.
- S20b** * *Scirpus lacustris* ssp. *tabernaemontani* swamp,
Agrostis stolonifera sub-community.
- S21a** * *Scirpus maritimus* swamp,
Scirpus maritimus sub-community.
- S21c** * *Scirpus maritimus* swamp,
Potentilla anserina sub-community.
- S25** * *Phragmites australis*-*Eupatorium cannabinum* tall-herb fen.
- S26d** * *Phragmites australis*-*Urtica dioica* tall-herb fen,
Epilobium hirsutum sub-community.
- S28c** * *Phalaris arundinacea* tall-herb fen,
Elymus repens-*Holcus lanatus* sub-community.

Table 4.1 (continued) List of National Vegetation Classification types commonly found on sand dunes, grouped by habitat. * = present in Wales. ** = provisional new dune NVC type, possibly restricted to dunes in Scotland.

Scrub and woodland

- SD18a** * *Hippophae rhamnoides* scrub,
Festuca rubra sub-community.
- SD18b** * *Hippophae rhamnoides* scrub,
Urtica dioica-*Arrhenatherum elatius* sub-community.
- W1** * *Salix cinerea*-*Galium palustre* woodland, undifferentiated.
- W2** * *Salix cinerea*-*Betula pubescens*-*Phragmites australis* woodland, undifferentiated.
- W4** * *Betula pubescens*-*Molinia caerulea* woodland, undifferentiated.
- W6** * *Alnus glutinosa*-*Urtica dioica* woodland, undifferentiated.
- W8** * *Fraxinus excelsior*-*Acer campestre*-*Mercurialis perennis* woodland, undifferentiated.
- W10c** * *Quercus robur*-*Pteridium aquilinum*-*Rubus fruticosus* agg. woodland,
Hedera helix sub-community.
- W21a** * *Crataegus monogyna*-*Hedera helix* scrub,
Hedera helix-*Urtica dioica* sub-community.
- W21b** * *Crataegus monogyna*-*Hedera helix* scrub,
Mercurialis perennis sub-community.
- W22a** * *Prunus spinosa*-*Rubus fruticosus* agg. scrub,
Hedera helix-*Silene dioica* sub-community.
- W22b** * *Prunus spinosa*-*Rubus fruticosus* agg. scrub,
Viola riviniana-*Veronica chamaedrys* sub-community.
- W22c** * *Prunus spinosa*-*Rubus fruticosus* agg. scrub,
Dactylis glomerata sub-community.
- W23a** * *Ulex europaeus*-*Rubus fruticosus* agg. scrub,
Anthoxanthum odoratum sub-community.
- W23b** * *Ulex europaeus*-*Rubus fruticosus* agg. scrub,
Rumex acetosella sub-community.
- W23c** * *Ulex europaeus*-*Rubus fruticosus* agg. scrub,
Teucrium scorodonia sub-community.
- W24a** * *Rubus fruticosus* agg.-*Holcus lanatus* underscrub,
Cirsium arvense-*Cirsium vulgare* sub-community.
- W24b** * *Rubus fruticosus* agg.-*Holcus lanatus* underscrub,
Arrhenatherum elatius-*Heracleum sphondylium* sub-community.
- W25** * *Pteridium aquilinum*-*Rubus fruticosus* agg. underscrub, undifferentiated.
- W?** ** Provisional *Juniperus communis* dune scrub community.

Transitions to other habitats

Maritime cliff (from SD8 dune grassland)

- MC5b** * *Armeria maritima*-*Ceratium diffusum* ssp. *diffusum* maritime therophyte community,
Anthyllis vulneraria sub-community.
- MC5d** * *Armeria maritima*-*Ceratium diffusum* ssp. *diffusum* maritime therophyte community,
Arenaria serpyllifolia sub-community.
- MC8a** * *Festuca rubra*-*Armeria maritima* maritime grassland,
Typical sub-community.
- MC8e** * *Festuca rubra*-*Armeria maritima* maritime grassland,
Plantago coronopus sub-community.

Table 4.1 (continued) List of National Vegetation Classification types commonly found on sand dunes, grouped by habitat. * = present in Wales. ** = provisional new dune NVC type, possibly restricted to dunes in Scotland.

Maritime cliff (from SD8 dune grassland) (continued)

- MC8f *** *Festuca rubra*-*Armeria maritima* maritime grassland,
Anthyllis vulneraria sub-community.
- MC9b *** *Festuca rubra*-*Holcus lanatus* maritime grassland,
Dactylis glomerata sub-community.
- MC10 *** *Festuca rubra*-*Plantago* spp. maritime grassland, undifferentiated.
- MC12a*** *Festuca rubra*-*Hyacinthoides non-scripta* bluebell community,
Silene vulgaris ssp. *maritima* sub-community.

Saltmarsh (from various strandline, dune grassland, dune slack and swamp types - lower saltmarsh types mapped in Wales as part of the dune survey are not included)

- SM15 *** *Juncus maritimus*-*Triglochin maritima* saltmarsh, undifferentiated.
- SM16a*** *Festuca rubra* saltmarsh,
Puccinellia maritima sub-community.
- SM16b*** *Festuca rubra* saltmarsh,
sub-community with *Juncus gerardi* dominant.
- SM16c*** *Festuca rubra* saltmarsh,
Festuca rubra-*Glaux maritima* sub-community.
- SM16d*** *Festuca rubra* saltmarsh,
sub-community with tall *Festuca rubra* dominant.
- SM18a*** *Juncus maritimus* saltmarsh,
Plantago maritima sub-community.
- SM18b*** *Juncus maritimus* saltmarsh,
Oenanthe lachenalii sub-community.
- SM20 *** *Eleocharis uniglumis* saltmarsh.
- SM24 *** *Elymus pycnanthus* saltmarsh.
- SM28 *** *Elymus repens* saltmarsh.

Table 4.2 Nationally rare and nationally scarce plants primarily associated with other habitats but which were recorded on British dunes during the national sand dune survey.

Nationally rare plants	Main habitat
<i>Dryopteris cristata</i> crested buckler-fern	Wet heaths
<i>Matthiola sinuata</i> sea stock	Sea cliffs
<i>Viola kitaibeliana</i> dwarf pansy	Coastal grassland
<i>Silene conica</i> striated catchfly	Sandy pastures
<i>Petrorhagia nantuellii</i> childing pink	Waste ground
<i>Polycarpon tetraphyllum</i> four-leaved allseed	Sandy places
<i>Geranium purpureum</i> ssp. <i>purpureum</i> little robin	Shingle
<i>Geranium purpureum</i> ssp. <i>forsteri</i> little robin	Shingle
<i>Ornithopus pinnatus</i> orange bird's-foot	Open, sandy soil
<i>Rumex rupestris</i> shore dock	Beaches
<i>Limonium bellidifolium</i> matted sea-lavender	Upper saltmarsh
<i>Scrophularia scorodonia</i> balm-leaved figwort	Hedgebanks
<i>Orobanche caryophyllacea</i> clove-scented broomrape	Dry grassland
<i>Orobanche purpurea</i> purple broomrape	Dry grassland
<i>Valerianella eriocarpa</i>	Banks and walls
<i>Allium ampeloprasum</i> wild leek	Rocks
<i>Allium babingtonii</i> Babington's leek	Rocks
<i>Romulea columnae</i> sand crocus	Coastal grassland
<i>Liparis loeselii</i> fen orchid	Fens
<i>Himantoglossum hircinicum</i> lizard orchid	Inland
<i>Poa infirma</i> early meadow-grass	Sandy places
<i>Mibora minima</i> early sand-grass	Wet sandy places
Nationally scarce plants	
<i>Asplenium trichomanes</i> maidenhair spleenwort	Rocks
<i>Ophioglossum azoricum</i> small adder's tongue	Coastal grassland
<i>Ranunculus baudotii</i> brackish water crowfoot	Saltmarshes, flats & creeks
<i>Rhynchosinapis monensis</i> Isle of Man cabbage	Shores and waste places
<i>Raphanus maritimus</i> sea radish	Waste places
<i>Hornungia petraea</i> rock hutchinsia	Limestone rock
<i>Frankenia laevis</i> sea-heath	Upper saltmarsh
<i>Silene nutans</i> Nottingham catchfly	Dry slopes
<i>Dianthus deltoides</i> maiden pink	Inland
<i>Moenchia erecta</i> upright chickweed	Gravelly pastures
<i>Scilla autumnalis</i> autumn squill	Coastal grassland
<i>Suaeda fruticosa</i> shrubby sea-blite	Shingle
<i>Epipactis phyllanthos</i>	Woods
<i>Medicago minima</i> small medick	Heaths
<i>Trifolium ornithopoides</i> bird's-foot clover	Shores and waste places
<i>Trifolium glomeratum</i> clustered clover	Shores and waste places
<i>Trifolium suffocatu</i> suffocated clover	Sandy grassland
<i>Cicuta viros</i> cowbane	Shallow water
<i>Oenanthe pimpinelloides</i>	Meadows
<i>Thesium humifusum</i> bastard toadflax	Calcareous grassland

<i>Polygonum raii</i> Ray's knotgrass	Sandy shores, shingle
<i>Pyrola rotundifolia</i> larger wintergreen	Fens, woods
<i>Primula scotica</i> Scottish primrose	Coastal grassland
<i>Verbascum virgatum</i> twiggy mullein	Waste places
<i>Parentucellia viscosa</i> yellow bartsia	Coastal grassland
<i>Orobanche hederæ</i> ivy broomrape	Coastal districts
<i>Goodyera repens</i> creeping lady's tresses	Pine woods
<i>Coralorhiza trifida</i> coralroot orchid	Woods
<i>Orchis ustulata</i> burnt orchid	Calcareous grassland.
<i>Aceras anthropophorum</i> man orchid	Chalk
<i>Arum italicum</i>	Stony ground
<i>Eleocharis acicularis</i> slender spike-rush	Lakes and pools
<i>Juncus acutus</i> sharp rush	Coastal grassland
<i>Carex punctata</i> dotted sedge	Rocks
<i>Vulpia ambigua</i> bearded fescue	Open and sandy places
<i>Poa bulbosa</i> bulbous poa	Coastal grassland
<i>Hordeum marinum</i> sea barley	Coastal grassland
<i>Apera interrupta</i>	Sandy fields
<i>Parapholis incurva</i> curved hard-grass	Sandy upper saltmarshes

Table 4.3 Nationally rare and nationally scarce plants found mainly or exclusively on dunes in Britain. * = present on dunes in Wales; ** confined to dunes in Wales; *** = formerly present before 1930 on dunes in Wales; + = introduced into Wales, not native.

Nationally rare species characteristic of dunes		Number of 10 x 10 km squares in GB
<i>Orobanche caryophyllacea</i> bedstraw broomrape		2
<i>Gentianella uliginosa</i> dune gentian	**	5
<i>Teucrium scordium</i> water germander		3
<i>Gnaphalium luteoalbum</i> Jersey cudweed		1
<i>Epipactis dunensis</i> dune helleborine	*	9
Nationally scarce species characteristic of dunes		
<i>Equisetum variegatum</i> variegated horsetail	*	89
<i>Erodium maritimum</i> sea stork's-bill	*	77
<i>Hippophae rhamnoides</i> sea buckthorn	*+	36
<i>Oenothera stricta</i> fragrant evening primrose	*+	32
<i>Euphorbia portlandica</i> Portland spurge	*	74
<i>Euphorbia paralias</i> sea spurge	*	92
<i>Centaurium littorale</i> seaside centaury	*	42
<i>Juncus balticu</i> Baltic rush		47
<i>Carex maritima</i> curved sedge		26
<i>Festuca juncifolia</i> rush-leaved fescue		27
<i>Vulpia membranacea</i> dune fescue	*	44
<i>Corynephorus canescens</i> grey hair-grass	***	16

5. Shingle, strandline and foredune communities, transitions to saltmarsh

5.1 NVC communities and rare species

Four shingle, strandline and foredune communities are recognised by the NVC, with only the SD1 *Rumex crispus-Glaucium flavum* shingle community divided into sub-communities. All are associated with the upper beach (shingle or sand), detritus deposited on the strandline, or with sand which has buried strand materials. They thus occur as a narrow but often very lengthy line on the upper beach. Total area (38.5 ha) of all types is low (Table 5.1). All communities become discontinuous and restricted as visitor trampling or coastal erosion increase, with many sites having only small extents of these communities which are short-lived in many cases and easily destroyed by storms and human impact. Significant sites with moderate and large extents of SD2/SD3 strandline and SD4 foredune are shown in Figures 5.1 and 5.2 respectively. The only nationally rare species associated with these communities in Wales is sea stock *Matthiola sinuata*, found occasionally on SD4 foredunes in a few sites in South Wales (it is commoner on mobile dunes further inland).

5.2 SD1a *Rumex crispus-Glaucium flavum* shingle community Typical sub-community

This community is rare in association with sand dunes in Wales and was mapped in only five sites (Table 5.1). It is of very low extent on sand dunes in Wales (0.9 ha) and the site with the largest area, Kenfig Dunes, is anomalous since the community has invaded a fossilised, stable storm beach disturbed by extraction of shingle for building purposes. The community must be regarded as rare when shingle has a sand cover.

5.3 SD2 *Honkenya peploides-Cakile maritima* strandline community

This community is found in small quantities on dunes around all of the Welsh coast (Table 5.1) and is generally absent from eroding sites and those dominated by climbing dunes. The constant species sea sandwort *Honkenya peploides* and sea rocket *Cakile maritima* are often not found together. *H. peploides* tends to be found on flat sand or fine gravel (where it can persist over winter on sheltered beaches), with *C. maritima* preferring very low dunes formed over the strandline during the summer growing season. Species of orache (*Atriplex* spp.) also tend to be commonly associated with each of the main constants. Total extent is only 21 ha and is thus low, reflecting the narrow beach zone to which it is restricted. Its presence in sites around Swansea is so patchy and small in size that it is only recorded as present in surveys of these dunes. Small extents of anomalous types (Other SD2, Table 5.1) and transitions to SD4 foredune are recorded in a few localities. This is the commonest and most extensive strandline community. It is generally very species-poor.

5.4 SD3 *Matricaria maritima-Galium aparine* strandline community

This community is very rare in Wales and was recorded in only two widely separated sites (Merthyr Mawr, Pwllheli to Pen-y-Chain), both with very low extents (Table 5.1, total area 0.7 ha). It is also very uncommon in England and Scotland. It seems to require mats of rotting organic debris which are not covered by blown sand, a rare condition for a full summer in most strand environments upon dunes.

5.5 Other strand types

A distinct strand type was recorded in six sites, all of them in South Wales (Other strand, Table 5.1; the Traeth Dulas record in North Wales is an anomalous type difficult to place in relation to the NVC apart from maritime cliff communities). It is rich in species compared to other strand communities and composition

Table 5.1 Shingle (SD1 *Rumex crispus-Glaucium flavum*) and strandline (SD2 *Honkenya peploides-Cakile maritima*, SD3 *Matricaria maritima-Galium aparine*, Other strand) vegetation in Wales. Areas in hectares. T = trace, present in very low quantity. P = probably present but not mapped, extent unknown.

	Site	SD1	SD1a	All SD1	SD2	SD2/ SD4	Other SD2	All SD2
1	Merthyr Mawr				0.06			0.06
2	Kenfig Dunes	0.49		0.49	T	3.22		3.22
3	Margam Burrows							
4	Baglan Bay							
5	Crymlyn Burrows				T			T
6	Black Pill to Bryn Mill							
7	Pennard Burrows							
8	Penmaen Burrows							
9	Nicholaston Burrows				T			T
10	Oxwich Burrows				T			T
11	Port-Eynon to Horton							
12	Hillend to Hills Tor							
13	Whiteford Burrows				T			T
14	Pembrey Coast				T			T
15	Laughame Burrows				P			P
16	Pendine Burrows				2.03			2.03
17	Tenby Burrows							
18	Caldey Island				0.04			0.04
19	Lydstep Haven							
20	Manorbier/Swanlake	0.06		0.06				
21	Freshwater Bay East						0.05	0.05
22	Stackpole Warren				0.12			0.12
23	Brownslade/Linney				0.14			0.14
24	Broomhill Burrows				0.23			0.23
25	Whitesand Bay							
26	The Bennett				0.48			0.48
27	Poppit Sands				1.16			1.16
28	Towyn Warren		0.02	0.02	0.03			0.03
29	Ynyslas	0.22		0.22				
30	Tywyn to Aberdovey				0.76			0.76
31	Fairbourne	0.04		0.04				
32	Morfa Dyffryn				0.64			0.64
33	Morfa Harlech				0.98	0.69		1.67
34	Morfa Bychan				1.44			1.44
35	Pwllheli/Pen-y-Chain		0.32	0.32	0.55			0.55
36	Traeth Crugan	0.08		0.08	1.33			1.33
37	Tai Morfa							
38	Morfa Dinlle		0.37	0.37				
39	Newborough Warren				0.68	0.12	1.03	1.83
40	Penrhynoedd - Llangadwaladr							
41	Aberffraw				0.56			0.56
42	Valley							
43	Tywyn Gwyn				0.70		0.92	1.62
44A	Traeth Dulas							
44B	Traeth Lligwy							
45	Red Wharf Bay		0.34	0.34				
46	Conwy/Deganwy				1.24			1.24
47	Kinmel Bay				0.34			0.34
48	Rhyl to Prestatyn				1.07			1.07
49	Gronant to Talacre				0.77		0.01	0.89
	South Wales Region	0.49		0.49	0.06	3.22		3.28
	Dyfed & Mid-Wales Region	0.28	0.02	0.30	4.23		0.05	4.28
	North Wales Region	0.12	1.03	1.15	11.06	0.81	1.96	13.94
	National Totals	0.89	1.05	1.94	15.35	4.03	2.01	21.50

Table 5.1 (continued) Shingle (SD1 *Rumex crispus*-*Glaucium flavum*) and strandline (SD2 *Honkenya peploides*-*Cakile maritima*, SD3 *Matricaria maritima*-*Galium aparine*, Other strand) vegetation in Wales. Areas in hectares. T = trace, present in very low quantity. P = probably present but not mapped, extent unknown.

	Site	SD3	SD3/SD4	Other strand	All strand types
1	Merthyr Mawr	0.30			0.36
2	Kenfig Dunes				3.71
3	Margam Burrows				
4	Baglan Bay			6.20	6.20
5	Crymlyn Burrows			2.56	2.56
6	Black Pill to Bryn Mill				
7	Pennard Burrows				
8	Penmaen Burrows				
9	Nicholaston Burrows			0.64	0.64
10	Oxwich Burrows			0.51	0.51
11	Port-Eynon to Horton				
12	Hillend to Hills Tor				
13	Whiteford Burrows			1.86	1.86
14	Pembrey Coast			1.92	1.92
15	Laughame Burrows				P
16	Pendine Burrows				2.03
17	Tenby Burrows				
18	Caldey Island				0.04
19	Lydstep Haven				
20	Manorbier/Swanlake				0.06
21	Freshwater Bay East				0.05
22	Stackpole Warren				0.12
23	Brownslade/Linney				0.14
24	Broomhill Burrows				0.23
25	Whitesand Bay				
26	The Bennett				0.48
27	Poppit Sands				1.16
28	Towyn Warren				0.05
29	Ynyslas				0.22
30	Tywyn to Aberdovey				0.76
31	Fairbourne		0.56		0.60
32	Morfa Dyffryn				0.64
33	Morfa Harlech				1.67
34	Morfa Bychan				1.44
35	Pwllheli/Pen-y-Chain	0.41			1.28
36	Traeth Crugan				1.41
37	Tai Morfa				
38	Morfa Dinlle				0.37
39	Newborough Warren				1.83
40	Penrhynoedd - Llangadwaladr				
41	Aberffraw				0.56
42	Valley				
43	Tywyn Gwyn				1.62
44A	Traeth Dulas			0.27	0.27
44B	Traeth Lligwy				
45	Red Wharf Bay				0.34
46	Conwy/Deganwy				1.24
47	Kinmel Bay				0.34
48	Rhyl to Prestatyn				1.07
49	Gronant to Talacre				0.89
	South Wales Region	0.30		11.77	15.84
	Dyfed & Mid-Wales Region			1.92	6.50
	North Wales Region	0.41	0.56	0.27	16.33
	National Totals	0.71	0.56	13.96	38.67

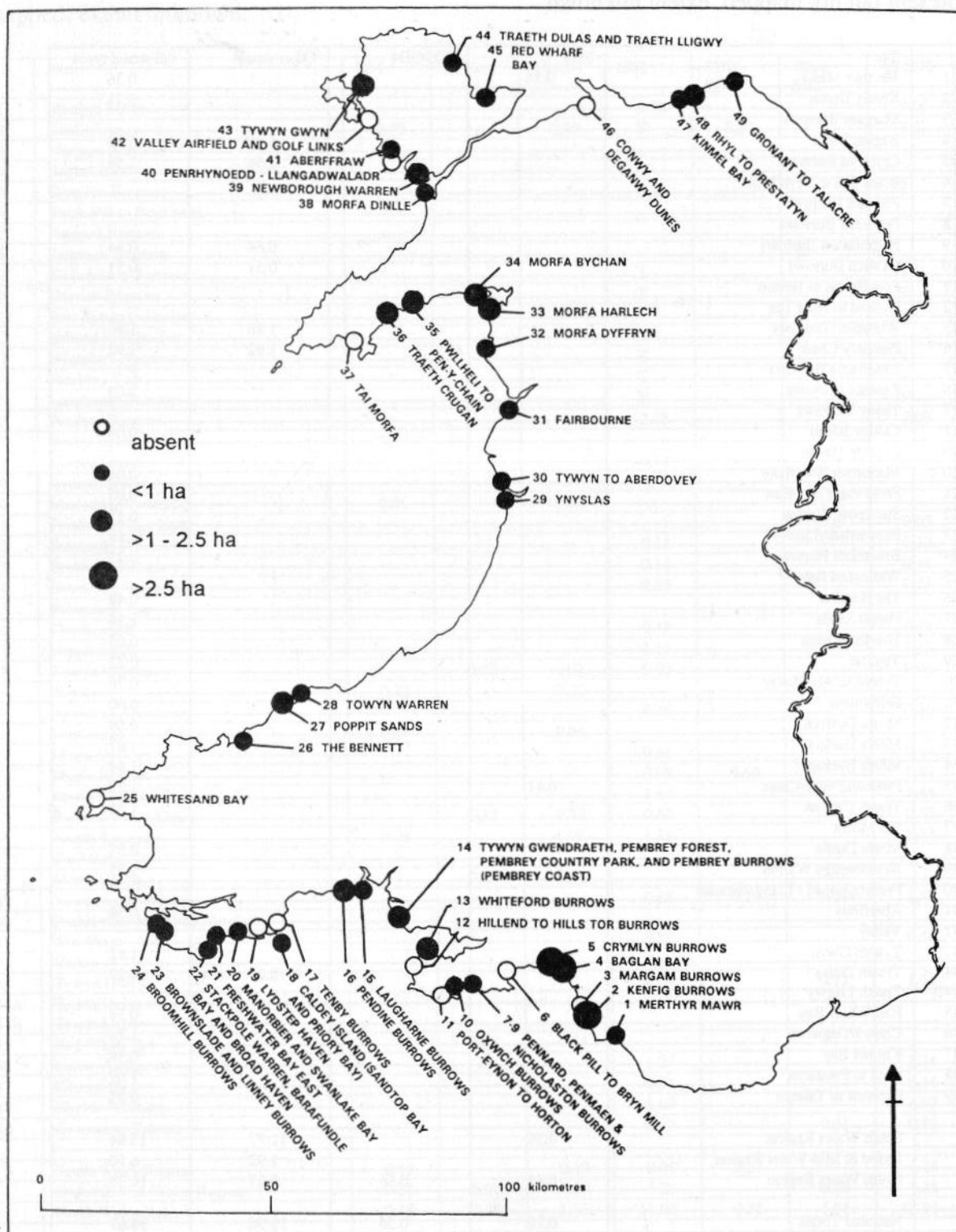


Figure 5.1 Location of sites with strandline (SD2, SD3) vegetation in Wales.

suggests a type transitional between SD2 strandline, SD4 foredune and SM16/SM24 saltmarsh types (e.g. *Elymus farctus* *Honkenya peploides*, *Festuca rubra* *Limonium binervosum* and *Agrostis stolonifera* as constants). The habitat requirements are unusual for the strand environment and involve a sheltered, extensive and very gently shelving strandline zone above saltmarsh, receiving moderate amounts of sand to bury small quantities of tidal litter. The type is clearly transitional in character but is extensive (14 ha), representing an important regional variant for Welsh strandline vegetation. It largely replaces SD2 strandline in south-east Wales and approaches the extent of that community in size at the national scale. It is much larger in area than SD3 strandline.

5.6 SD4 *Elymus farctus* foredune community

Sand couch-grass *Elymus farctus* forms low dunes (generally <0.5 m high) on or above high water mark (springs) around all the Welsh coast (Table 5.2, Figure 5.2) but the community is often rare on exposed and eroding beaches. The community is very species-poor, reflecting extreme environmental conditions of instability. Total extent in Wales is 97.8 ha, with most of the total area derived from three sites (Figure 5.2): Newborough Warren (24.3 ha), Baglan Bay (24.3 ha) and the Pembrey Coast (14.5 ha, most of it from Pembrey Burrows). Sites with moderate extents (>2 ha) include Whiteford Burrows, Laugharne Burrows, Morfa Harlech, Morfa Bychan and Gronant to Talacre. The dunes can migrate up a beach and can thus show a transition to SD5 and SD6 mobile dune types, especially at Newborough Warren. In very sheltered zones it can grade into saltmarsh at lower levels and these types are common in south-east Wales (see section 5.5).

5.7 Transitions to saltmarsh

Saltmarsh is a relatively common habitat in association with sand dunes and some Welsh dune surveys include detailed mapping of large areas of saltmarsh habitat (Table 5.3) – other dune surveys, however, record a transitional

zone only if it is present. Seventeen dune sites were recorded with measured saltmarsh area but this is an underestimate and saltmarsh is also present adjacent to dunes in a further seven sites, giving a total of 24 sites with saltmarsh adjacent to sand dunes. Transitions to saltmarsh are recorded in tables covering other vegetation types, particularly dune slacks (see Table 10.5) and swamp habitats (see Table 10.7). Transitions are in fact comparatively rare and of low extent, indicating a very sharp change from dune to saltmarsh conditions in most cases of co-existence. Relatively small but important transition zones are present at Whiteford and Tywyn Gwendraeth (Pembrey Coast), but the only large area is a slack/saltmarsh SD17/SM18 transition (14.7 ha) in the prograding dune system of Morfa Harlech. The strand/foredune/saltmarsh transition important in south-east Wales also deserves mention here (see section 5.5).

Table 5.2 SD4 *Elymus farctus* foredune vegetation in Wales. Areas in hectares. T = trace, present in very low quantity. ? = uncertain, probably not mapped.

	Site	SD4	SD4 transitions	All SD4
1	Merthyr Mawr	0.12		0.12
2	Kenfig Dunes	0.64		0.64
3	Margam Burrows	0.34		0.34
4	Baglan Bay	24.29		24.29
5	Crymlyn Burrows	1.28		1.28
6	Black Pill to Bryn Mill	1.03		1.03
7	Pennard Burrows	0.64		0.64
8	Penmaen Burrows	0.26		0.26
9	Nicholaston Burrows	T		T
10	Oxwich Burrows	T		T
11	Port-Eynon to Horton	T		T
12	Hillend to Hills Tor	0.90		0.90
13	Whiteford Burrows	2.88		2.88
14	Pembrey Coast	14.54		14.54
15	Laughame Burrows	2.00		2.00
16	Pendine Burrows	0.28		0.28
17	Tenby Burrows	?		?
18	Caldey Island	0.04		0.04
19	Lydstep Haven			
20	Manorbier/Swanlake	0.08		0.08
21	Freshwater Bay East	0.13		0.13
22	Stackpole Warren	0.07		0.07
23	Brownslade/Linney	0.03		0.03
24	Broomhill Burrows	0.33		0.33
25	Whitesand Bay			
26	The Bennett			
27	Poppit Sands	0.28		0.28
28	Towyn Warren			
29	Ynyslas	0.08		0.08
30	Tywyn to Aberdovey	0.12		0.12
31	Fairbourne	0.67		0.67
32	Morfa Dyffryn			
33	Morfa Harlech	6.89		6.89
34	Morfa Bychan	4.04		4.04
35	Pwllheli/Pen-y-Chain	1.24		1.24
36	Traeth Crugan	1.20		1.20
37	Tai Morfa	0.07		0.07
38	Morfa Dinlle	0.33		0.33
39	Newborough Warren	20.68	3.63	24.31
40	Penrhynoedd - Llangadwaladr			
41	Aberffraw	0.71		0.71
42	Valley	1.31	0.03	1.34
43	Tywyn Gwyn			
44A	Traeth Dulas	0.23		0.23
44B	Traeth Lligwy	0.02		0.02
45	Red Wharf Bay	0.48	0.11	0.59
46	Conwy/Deganwy	1.76		1.76
47	Kinmel Bay	1.05		1.05
48	Rhyl to Prestatyn	0.60		0.60
49	Gronant to Talacre	2.38		2.38
	South Wales Region	32.38		32.38
	Dyfed & Mid-Wales Region	17.86		17.86
	North Wales Region	43.78	3.77	47.55
	National Totals	94.02	3.77	97.79

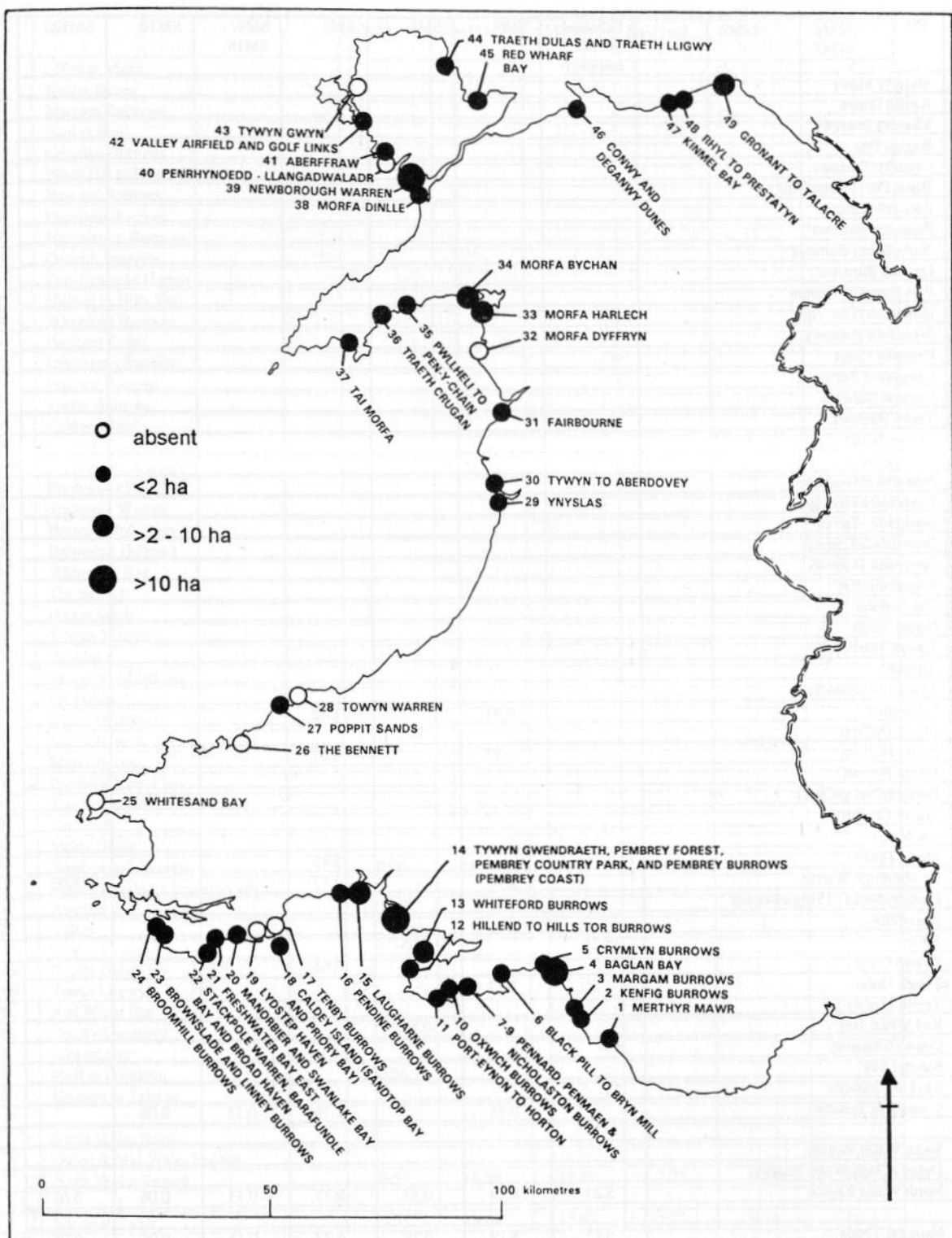


Figure 5.2 Location of sites with SD4 *Elymus farctus* foredune vegetation in Wales.

Table 5.3 Saltmarsh vegetation types recorded from dune vegetation surveys in Wales. Areas in hectares. Saltmarsh areas are excluded from site area totals unless they form a transitional type with dune or swamp vegetation.

	Site	Saltmarsh (no NVC mapping)	SM6	SM8	SM9	SM9/ SM16	SM10	SM12
1	Merthyr Mawr							
2	Kenfig Dunes							
3	Margam Burrows							
4	Baglan Bay							
5	Crymlyn Burrows							
6	Black Pill to Bryn Mill							
7	Pennard Burrows							
8	Penmaen Burrows							
9	Nicholaston Burrows							
10	Oxwich Burrows							
11	Port-Eynon to Horton							
12	Hillend to Hills Tor							
13	Whiteford Burrows							
14	Pembrey Coast							
15	Laughame Burrows							
16	Pendine Burrows							
17	Tenby Burrows							
18	Caldey Island							
19	Lydstep Haven							
20	Manorbier/Swanlake							
21	Freshwater Bay East							
22	Stackpole Warren							
23	Brownsdale/Linney							
24	Broomhill Burrows							
25	Whitesand Bay							
26	The Bennett							
27	Poppit Sands							
28	Towyn Warren							
29	Ynyslas							
30	Tywyn to Aberdovey							
31	Fairbourne		0.99		1.32			
32	Morfa Dyffryn							
33	Morfa Harlech		1.37		0.07			
34	Morfa Bychan							
35	Pwllheli/Pen-y-Chain							
36	Traeth Crugan							
37	Tai Morfa							
38	Morfa Dinlle				3.45			
39	Newborough Warren		3.70		0.13			0.03
40	Penrhynoedd - Llangadwaladr							
41	Aberffraw							
42	Valley	5.25		0.05				
43	Tywyn Gwyn				0.04			
44A	Traeth Dulas		1.72					
44B	Traeth Lligwy							
45	Red Wharf Bay			0.18				
46	Conwy/Deganwy							
47	Kinnel Bay							
48	Rhyl to Prestatyn							
49	Conant to Talacre		0.41		1.76	0.15	0.06	
	South Wales Region							
	Dyfed & Mid-Wales Region							
	North Wales Region	5.25	8.19	0.23	6.77	0.15	0.06	0.03
	National Totals	5.25	8.19	0.23	6.77	0.15	0.06	0.03

Table 5.3 (continued) Saltmarsh vegetation types recorded from dune vegetation surveys in Wales. Areas in hectares. Saltmarsh areas are excluded from site area totals unless they form a transitional type with dune or swamp vegetation.

	Site	SM13	SM13a	SM13b	SM13c/d	SM13d	SM13/ SM18
1	Merthyr Mawr						
2	Kenfig Dunes						
3	Margam Burrows						
4	Baglan Bay						
5	Crymlyn Burrows						
6	Black Pill to Bryn Mill						
7	Pennard Burrows						
8	Penmaen Burrows						
9	Nicholaston Burrows						
10	Oxwich Burrows						
11	Port-Eynon to Horton						
12	Hillend to Hills Tor						
13	Whiteford Burrows						
14	Pembrey Coast						
15	Laughame Burrows						
16	Pendine Burrows						
17	Tenby Burrows						
18	Caldey Island						
19	Lydstep Haven						
20	Manorbier/Swanlake						
21	Freshwater Bay East						
22	Stackpole Warren						
23	Brownslade/Linney						
24	Broomhill Burrows						
25	Whitesand Bay						
26	The Bennett						
27	Poppit Sands						
28	Towyn Warren						
29	Ynyslas						
30	Tywyn to Aberdovey						
31	Fairbourne				2.72		
32	Morfa Dyffryn						
33	Morfa Harlech					9.11	
34	Morfa Bychan						
35	Pwllheli/Pen-y-Chain						
36	Traeth Crugan						
37	Tai Morfa						
38	Morfa Dinlle						
39	Newborough Warren	0.06	16.88	15.87			
40	Penrhynoedd - Llangadwaladr						
41	Aberffraw						
42	Valley						0.32
43	Tywyn Gwyn	0.23					
44A	Traeth Dulas						
44B	Traeth Lligwy						
45	Red Wharf Bay						
46	Conwy/Deganwy						
47	Kinnel Bay						
48	Rhyl to Prestatyn	0.26					
49	Gronant to Talacre						
	South Wales Region						
	Dyfed & Mid-Wales Region						
	North Wales Region	0.55	16.88	15.87	2.72	9.11	0.32
	National Totals	0.55	16.88	15.87	2.72	9.11	0.32

Table 5.3 (continued) Saltmarsh vegetation types recorded from dune vegetation surveys in Wales. Areas in hectares. Saltmarsh areas are excluded from site area totals unless they form a transitional type with dune or swamp vegetation.

	Site	SM14a	SM14c	SM15	SM16	SM16a	SM16b	SM16c	SM16d
1	Merthyr Mawr								
2	Kenfig Dunes							1.56	
3	Margam Burrows				2.52		0.73		
4	Baglan Bay				0.59				
5	Crymlyn Burrows								
6	Black Pill to Bryn Mill								
7	Pennard Burrows								
8	Penmaen Burrows								
9	Nicholaston Burrows								
10	Oxwich Burrows								
11	Port-Eynon to Horton								
12	Hillend to Hills Tor								
13	Whiteford Burrows								
14	Pembrey Coast								
15	Laughame Burrows								
16	Pendine Burrows								
17	Tenby Burrows								
18	Caldey Island								
19	Lydstep Haven								
20	Manorbier/Swanlake								
21	Freshwater Bay East								
22	Stackpole Warren								
23	Brownslade/Linney								
24	Broomhill Burrows								
25	Whitesand Bay								
26	The Bennett								
27	Poppit Sands								
28	Towyn Warren								
29	Ynyslas								
30	Tywyn to Aberdovey								
31	Fairbourne					2.50			
32	Morfa Dyffryn								
33	Morfa Harlech			3.31				7.13	
34	Morfa Bychan								
35	Pwllheli/Pen-y-Chain								
36	Traeth Crugan								
37	Tai Morfa								
38	Morfa Dinlle								
39	Newborough Warren							1.28	
40	Penrhynoedd - Llangadwaladr								
41	Aberffraw								0.12
42	Valley								
43	Tywyn Gwyr.								
44A	Traeth Dulas		1.77		1.72				
44B	Traeth Lligwy								
45	Red Wharf Bay				1.08				
46	Conwy/Deganwy								
47	Kinmel Bay								
48	Rhyl to Prestatyn				0.47				
49	Gronant to Talacre	5.26	0.37				0.01		0.35
	South Wales Region				3.11		0.73	1.56	
	Dyfed & Mid-Wales Region								
	North Wales Region	5.26	2.14	3.31	3.27	2.50	0.01	8.41	0.47
	National Totals	5.26	2.14	3.31	6.38	2.50	0.74	9.97	0.47

Table 5.3 (continued) Saltmarsh vegetation types recorded from dune vegetation surveys in Wales. Areas in hectares. Saltmarsh areas are excluded from site area totals unless they form a transitional type with dune or swamp vegetation. P = present, extent not mapped. T = trace, extent not mapped.

	Site	SM18	SM18a	SM18b	SM20	SM24	SM28	Total saltmarsh
1	Merthyr Mawr							P
2	Kenfig Dunes			1.56				3.12
3	Margam Burrows	0.15				1.80		5.20
4	Baglan Bay							0.59
5	Crymlyn Burrows			0.85		2.77		3.62
6	Black Pill to Bryn Mill							
7	Pennard Burrows							
8	Penmaen Burrows							P
9	Nicholaston Burrows							P
10	Oxwich Burrows			0.96				0.96
11	Port-Eynon to Horton							
12	Hillend to Hills Tor							T
13	Whiteford Burrows							P
14	Pembrey Coast			1.28		27.93		29.21
15	Laughame Burrows							P
16	Pendine Burrows							
17	Tenby Burrows							
18	Caldey Island							
19	Lydstep Haven							
20	Manorbier/Swanlake							
21	Freshwater Bay East							
22	Stackpole Warren							
23	Brownslade/Linney							
24	Broomhill Burrows							
25	Whitesand Bay							
26	The Bennett							
27	Poppit Sands							
28	Towyn Warren							
29	Ynyslas							P
30	Tywyn to Aberdovey							
31	Fairbourne							7.53
32	Morfa Dyffryn							
33	Morfa Harlech		3.76	19.55	0.03			44.33
34	Morfa Bychan							
35	Pwllheli/Pen-y-Chain							
36	Traeth Crugan							
37	Tai Morfa							
38	Morfa Dinlle	0.32						3.77
39	Newborough Warren	2.49	2.59	1.69				44.72
40	Penrhynoedd - Llangadwaladr							
41	Aberffraw							0.12
42	Valley	10.19						15.81
43	Tywyn Gwyn							0.27
44A	Traeth Dulas	1.72						6.93
44B	Traeth Lligwy							
45	Red Wharf Bay	0.36						1.62
46	Conwy/Deganwy							
47	Kinmel Bay							
48	Rhyl to Prestatyn							0.73
49	Gronant to Talacre						0.81	9.21
	South Wales Region	0.15		3.37		4.57		13.49
	Dyfed & Mid-Wales Region			1.28		27.93		29.21
	North Wales Region	15.08	6.35	21.24	0.03		0.81	135.04
	National Totals	15.23	6.35	25.89	0.03	32.50	0.81	177.74

6. Mobile dune communities

6.1 NVC communities and rare species

Two NVC communities (SD5, SD6) are recognised as mobile dune types, with a total of ten sub-communities. Three rare species are associated with this habitat in Wales: sea stock *Matthiola sinuata*, sea spurge *Euphorbia paralias* and Portland spurge *E. portlandica*.

6.2 SD5 *Leymus arenarius* mobile dune community

Sea lyme-grass *Leymus arenarius*, a tall and tussocky perennial grass, dominates this type of dune vegetation. It forms either open or closed stands and can colonise and fix mobile sand, keeping pace with substantial sand accumulation (though not to the same extent as marram grass *Ammophila arenaria*). It is probably more tolerant of occasional saltwater inundation than marram grass. There are three NVC sub-communities. All show a similar geographical distribution which is largely restricted to North Wales (Figure 6.1), with low total extent (7.0 ha) making the community a rare type of Welsh dune vegetation (Table 6.1). Only two sites have extents which exceed 1 ha: Gronant to Talacre and Red Wharf Bay. Sea lyme-grass is found further south in Wales as scattered, small patches which are too small to consider as mappable SD5 examples. Some stands could not be allocated to a sub-community and remain undifferentiated. In a few cases mapping recorded SD5 transitions to other mobile dune types.

SD5a Species-poor sub-community

In this type *Leymus arenarius* can be the only species present. It is restricted to six sites and total extent is only 0.44 ha.

SD5b *Elymus farctus* sub-community

Leymus arenarius remains dominant in this sub-community but sand couch *Elymus farctus* is also consistently present, along with occasional marram grass and some strandline species. It is found in only five sites and total extent is only 1.3 ha.

SD5c *Festuca rubra* sub-community

This sub-community is marked by the consistent presence of red fescue *Festuca rubra* and a range of herbs, including strandline and weedy species such as creeping thistle *Cirsium arvense*. This type is usually associated with locations rich in buried organic matter, forming upon buried strandlines. It is found in only five Welsh sites and total extent is only 3.4 ha.

6.3 SD6 *Ammophila arenaria* mobile dune community

Marram grass *Ammophila arenaria* dominates most Welsh mobile dunes that are high enough to be removed from the risk of salt-water flooding. The community is widespread (Figure 6.2) and is absent from only three sites (Whitesand Bay, Lydstep Haven, Tenby Burrows), all relatively small bay dune systems altered by recreational developments which might have reduced or eliminated sand supply. Sites with low extent (<10 ha) tend to be small bay dune systems with limited sand supply. Moderate and large areas are found on spit dune, hindshore and prograding systems, suggesting that sand supply is still plentiful. One exception is Oxwich Burrows with a small extent (3.3 ha) for a hindshore system, suggesting a problem with sand supply. The largest extent (73.2 ha) is found at Morfa Dyffryn, with further substantial areas (>30 ha) at Kenfig Dunes, Pembrey Coast and Newborough Warren.

Seven NVC sub-communities are recognised. Extents are given in Table 6.2 and total area is 476.2 ha for NVC types and transitions (mainly to the SD7 community).

SD6a *Elymus farctus* sub-community

This is normally a very open type of foredune in which small amounts of sand couch *Elymus farctus* are a constant feature with marram *Ammophila arenaria*. It can grade into strandline and SD4 foredune types, with other salt-tolerant plants such as *Honkenya peploides* occurring frequently but with low cover. It is associated with considerable sand mobility and

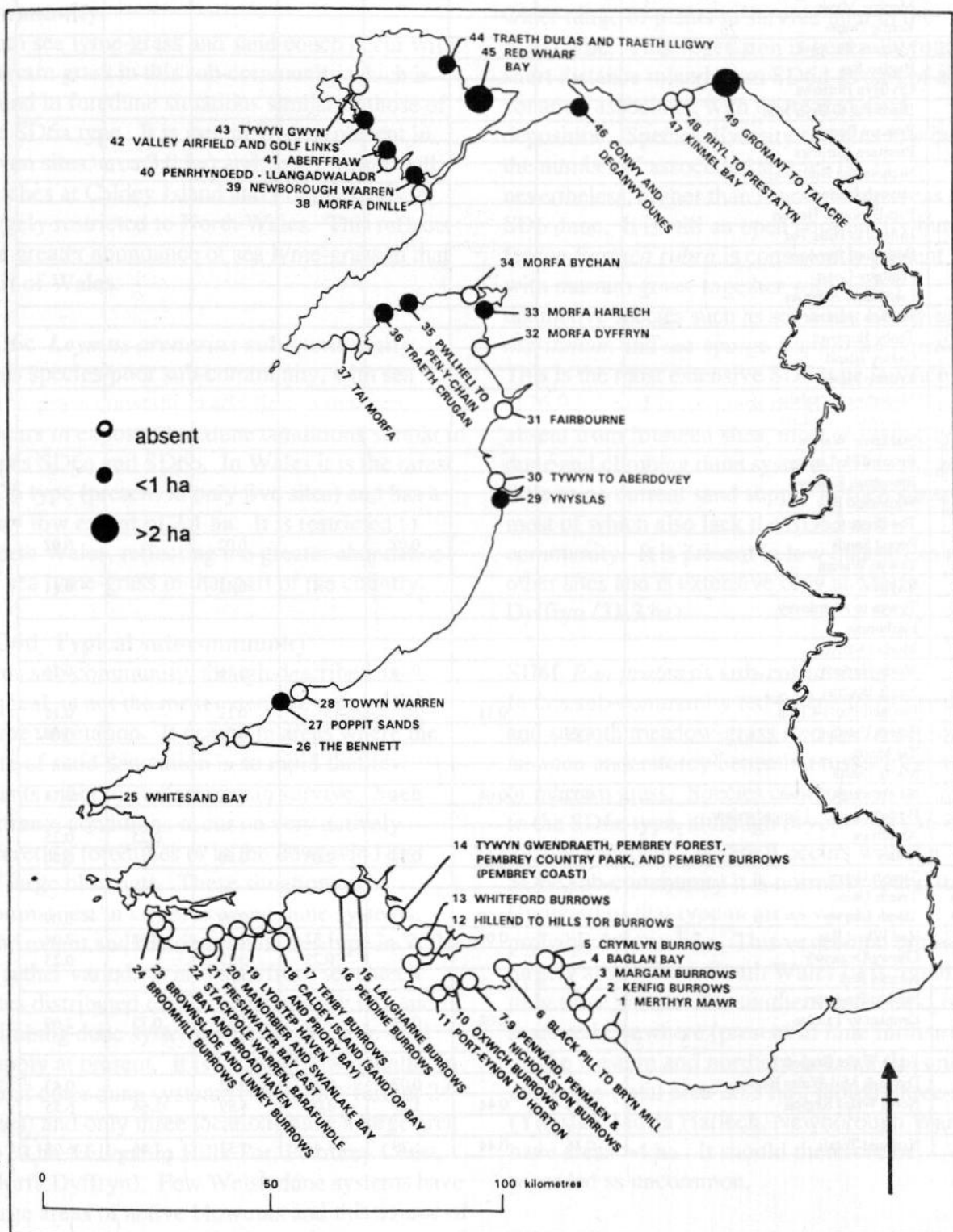


Figure 6.1 Location of sites with SD5 *Leymus arenarius* mobile dune community in Wales.

Table 6.1 SD5 *Leymus arenarius* mobile dune community in Wales. Areas in hectares.

	Site	SD5 undiff.	SD5a	SD5b	SD5c	SD5 NVC total	SD5 transition	All SD5
1	Merthyr Mawr							
2	Kenfig Dunes							
3	Margam Burrows							
4	Baglan Bay							
5	Crymlyn Burrows							
6	Black Pill to Bryn Mill							
7	Pennard Burrows							
8	Penmaen Burrows							
9	Nicholaston Burrows							
10	Oxwich Burrows							
11	Port-Eynon to Horton							
12	Hillend to Hills Tor							
13	Whiteford Burrows							
14	Pembrey Coast							
15	Laughame Burrows							
16	Pendine Burrows							
17	Tenby Burrows							
18	Caldey Island							
19	Lydstep Haven							
20	Manorbier/Swanlake							
21	Freshwater Bay East							
22	Stackpole Warren							
23	Brownslade/Linney							
24	Broomhill Burrows							
25	Whitesand Bay							
26	The Bennett							
27	Poppit Sands			0.02		0.02		0.02
28	Towyn Warren							
29	Ynyslas				0.41	0.41		0.41
30	Tywyn to Aberdovey							
31	Fairbourne							
32	Morfa Dyffryn							
33	Morfa Harlech			0.16		0.16		0.16
34	Morfa Bychan							
35	Pwllheli/Pen-y-Chain		0.11			0.11		0.11
36	Traeth Crugan	0.04				0.04		0.04
37	Tai Morfa							
38	Morfa Dinlle							
39	Newborough Warren	0.12	0.08	0.54		0.74		0.74
40	Penrhynoedd - Llangadwaladr							
41	Aberffraw						0.25	0.25
42	Valley		0.04	0.13	0.63	0.80		0.80
43	Tywyn Gwyn							
44A	Traeth Dulas							
44B	Traeth Lligwy		0.09			0.09		0.09
45	Red Wharf Bay		0.04		1.32	1.36	0.68	2.04
46	Conwy/Deganwy				0.23	0.23		0.23
47	Kinnel Bay							
48	Rhyl to Prestatyn							
49	Gronant to Talacre		0.08	0.44	0.84	1.36	0.73	2.09
	South Wales Region							
	Dyfed & Mid-Wales Region			0.02	0.41	0.43		0.43
	North Wales Region	0.16	0.44	1.27	3.02	4.89	1.66	6.55
	National Totals	0.16	0.44	1.29	3.43	5.32	1.66	6.98

is found on dune systems around all of the Welsh coast, with a total area of 88.5 ha.

SD6b *Leymus arenarius*-*Elymus farctus* sub-community

Both sea lyme-grass and sand couch occur with marram grass in this sub-community which is found in foredune situations similar to those of the SD6a type. It is rare in Wales (present in seven sites, area 3.0 ha) and, apart from small patches at Caldey Island and Poppit Sands, is largely restricted to North Wales. This reflects the greater abundance of sea lyme-grass in that part of Wales.

SD6c *Leymus arenarius* sub-community

This species-poor sub-community, with sea lyme-grass constant in addition to marram, occurs in exposed foredune conditions similar to types SD6a and SD6b. In Wales it is the rarest SD6 type (present in only five sites) and has a very low extent of 2.1 ha. It is restricted to North Wales, reflecting the greater abundance of sea lyme-grass in that part of the country.

SD6d Typical sub-community

This sub-community, though described as typical, is not the most extensive type of SD6 dune vegetation. It occurs in areas where the rate of sand deposition is so rapid that few plants other than marram can survive. Such extreme conditions occur on very actively accreting foredunes or at the downwind end of large blowouts. These situations are commonest in large, exposed dune systems. The extent and distribution of this type in Wales is rather varied. It is absent from seventeen sites distributed on all coasts, mostly bay and climbing dune systems which have little sand supply at present. It is found in low quantity in most other dune systems (<5 ha in a further 24 sites) and only three locations have a large area (>20 ha, Hillend to Hills Tor, Pembrey Coast, Morfa Dyffryn). Few Welsh dune systems have large areas of active blowouts and this source of sand is probably a relatively small component of SD6 area.

SD6e *Festuca rubra* sub-community

This sub-community is found where there is still considerable movement and deposition of sand, but where rates are low enough to permit a wider range of plants to survive than in the SD6d type. This vegetation is generally found a short distance inland from SD6d as part of a zonation associated with decreased sand deposition. Species diversity remains low but the number of associated species is, nevertheless, higher than more mobile areas of SD6 dune. It is still an open community but red fescue *Festuca rubra* is consistently present with marram grass, together with highly distinctive species such as sea holly *Eryngium maritimum* and sea spurge *Euphorbia paralias*. This is the most extensive SD6 type in Wales (176.9 ha) and is frequent on all coasts. It is absent from fourteen sites, most of them bay dune and climbing dune systems. This suggests little or no current sand supply in such sites, most of which also lack the SD6d sub-community. It is present in low quantity in most other sites and is extensive only at Morfa Dyffryn (31.3 ha).

SD6f *Poa pratensis* sub-community

In this sub-community red fescue *Festuca rubra* and smooth meadow-grass *Poa pratensis* form an open understorey beneath a tussocky cover of marram grass. Species composition is similar to the SD6e type, although bryophytes can be locally abundant. Where it occurs with the SD6e sub-community it is normally found to landward of that type in areas which are probably less mobile. This vegetation type is largely absent from South Wales (it is found in only three sites on the southern coast) and is scattered elsewhere (present in nine further sites on the western and northern coasts). It is not extensive (total area 20.3 ha), though three sites (Ynyslas, Morfa Harlech, Newborough Warren) have areas >4 ha. It should therefore be regarded as uncommon.

SD6g *Carex arenaria* sub-community

Sand sedge *Carex arenaria* and marram *Ammophila arenaria* are often the only species to occur in any quantity in this sub-community. It is particularly associated with areas of

secondary instability such as blowouts, especially near the margins of slacks where the ground is a little moister. It is of low extent (8.4 ha total area) and has a scattered distribution in thirteen sites, most of them on the western coast of Wales. Only one site has a large extent (Aberffraw, 6.1 ha) where it might be associated with sand mobilised by rabbit grazing, scraping and burrowing.

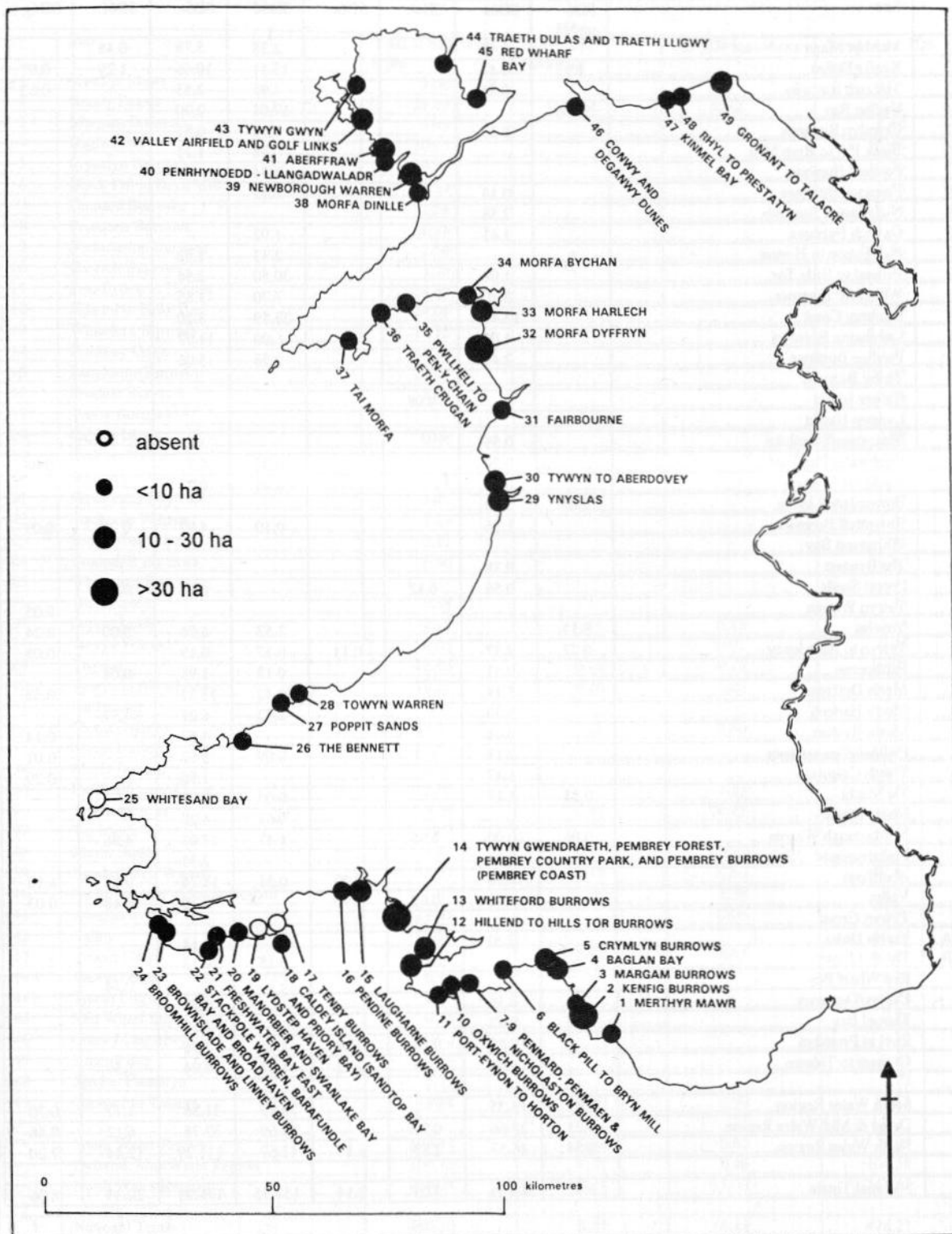


Figure 6.2 Location of sites with SD6 *Ammophila arenaria* mobile dune community in Wales.

Table 6.2 SD6 *Ammophila arenaria* mobile dune vegetation in Wales. Areas in hectares.

	Site	SD6 undiff.	SD6a	SD6b	SD6c	SD6d	SD6e	SD6f	SD6g
1	Merthyr Mawr		0.42			2.38	5.78	0.48	
2	Kenfig Dunes	1.93	0.43			15.11	10.66	1.29	0.07
3	Margam Burrows		0.84			1.95	2.53		0.63
4	Baglan Bay	0.74				17.01	2.90		
5	Crymlyn Burrows		8.33			1.92	0.51		
6	Black Pill to Bryn Mill					0.38	1.15		
7	Pennard Burrows					1.54			
8	Penmaen Burrows		0.13			1.15			
9	Nicholaston Burrows		2.56						
10	Oxwich Burrows		1.41			1.92			
11	Port-Eynon to Horton					2.43	1.92		
12	Hillend to Hills Tor		1.03			20.50	2.56		
13	Whiteford Burrows		3.20			7.70	3.85		
14	Pembrey Coast		13.48			23.59	3.20		
15	Laughame Burrows		4.00			6.00	11.97		
16	Pendine Burrows		2.49			0.56	5.01		
17	Tenby Burrows								
18	Caldey Island			0.08					
19	Lydstep Haven								
20	Manorbier/Swanlake		0.59						
21	Freshwater Bay East		0.59			0.07	0.73		0.08
22	Stackpole Warren		0.18			0.84	0.27		
23	Brownslade/Linney	2.08	0.03						
24	Broomhill Burrows		1.36			0.10	4.97	0.28	0.09
25	Whitesand Bay								
26	The Bennett		0.38						
27	Poppit Sands		0.56	0.12			0.67	0.84	
28	Towyn Warren								0.05
29	Ynyslas	3.13				3.53	6.96	5.00	0.24
30	Tywyn to Aberdovey	0.27	9.37		0.14	0.17	0.19		0.08
31	Fairbourne		0.31			0.18	1.93	0.04	
32	Morfa Dyffryn		5.18			30.42	31.31		0.52
33	Morfa Harlech		5.39			2.72	6.21	4.57	
34	Morfa Bychan		0.01				4.53		0.14
35	Pwllheli/Pen-y-Chain		2.18			0.09	3.02		0.01
36	Traeth Crugan		1.47				1.50		0.29
37	Tai Morfa	0.21	1.17			0.03	0.46		
38	Morfa Dinlle					0.61	4.20		
39	Newborough Warren	0.06	10.90	0.95		4.47	17.03	4.86	
40	Penrhynoedd - Llangadwaladr		0.34				2.33		
41	Aberffraw		0.90		0.09	0.51	18.74	0.66	6.13
42	Valley		3.01	0.62	0.90		5.70	0.48	0.03
43	Tywyn Gwyn								
44A	Traeth Dulas		0.20				0.14		
44B	Traeth Lligwy			0.01		0.15	0.13		
45	Red Wharf Bay							0.24	
46	Conwy/Deganwy		0.14				0.58		
47	Kinmel Bay		0.42				2.39		
48	Rhyl to Prestatyn		0.85	0.19	0.29	2.44	1.96		
49	Gronant to Talacre		4.69	1.06	0.72	1.88	8.94	1.59	
	South Wales Region	2.67	18.35			73.99	31.86	1.77	0.70
	Dyfed & Mid-Wales Region	5.21	23.66	0.20		34.69	33.78	6.12	0.46
	North Wales Region	0.54	46.53	2.83	2.14	43.67	111.29	12.44	7.20
	National Totals	8.42	88.54	3.03	2.14	152.35	176.93	20.33	8.36

Table 6.2 (continued) SD6 *Ammophila arenaria* mobile dune vegetation in Wales. Areas in hectares.

	Site	Total of SD6 NVC types	SD6/SD7 transition	All SD6 transitions	Total of all SD6 types
1	Merthyr Mawr	9.06			9.06
2	Kenfig Dunes	29.49	0.62	0.62	30.11
3	Margam Burrows	5.95			5.95
4	Baglan Bay	20.65			20.65
5	Crymlyn Burrows	10.76			10.76
6	Black Pill to Bryn Mill	1.53			1.53
7	Pennard Burrows	1.54			1.54
8	Penmaen Burrows	1.28			1.28
9	Nicholaston Burrows	2.56			2.56
10	Oxwich Burrows	3.33			3.33
11	Port-Eynon to Horton	4.35			4.35
12	Hillend to Hills Tor	24.09			24.09
13	Whiteford Burrows	14.75			14.75
14	Pembrey Coast	40.27			40.27
15	Laughame Burrows	21.97			21.97
16	Pendine Burrows	8.06			8.06
17	Tenby Burrows				
18	Caldey Island	0.08			0.08
19	Lydstep Haven				
20	Manorbier/Swanlake	0.59		0.14	0.73
21	Freshwater Bay East	1.47			1.47
22	Stackpole Warren	1.29			1.29
23	Brownslade/Linney	2.11			2.11
24	Broomhill Burrows	6.80			6.80
25	Whitesand Bay				
26	The Bennett	0.38			0.38
27	Poppit Sands	2.19	0.15	0.15	2.34
28	Towyn Warren	0.05		0.01	0.06
29	Ynyslas	18.86	0.16	0.16	19.02
30	Tywyn to Aberdovey	10.22	0.26	0.26	10.48
31	Fairbourne	2.46			2.46
32	Morfa Dyffryn	67.43	5.25	5.80	73.23
33	Morfa Harlech	18.89			18.89
34	Morfa Bychan	4.68			4.68
35	Pwllheli/Pen-y-Chain	5.30		3.12	8.42
36	Traeth Crugan	3.26	0.46	0.75	4.01
37	Tai Morfa	1.87			1.87
38	Morfa Dinlle	4.81	0.57	0.57	5.38
39	Newborough Warren	38.27	0.19	1.60	39.87
40	Penrhynoedd - Llangadwaladr	2.67		1.36	4.03
41	Aberffraw	27.03		0.06	27.09
42	Valley	10.74			10.74
43	Tywyn Gwyn		0.61	0.61	0.61
44A	Traeth Dulas	0.34			0.34
44B	Traeth Lligwy	0.29			0.29
45	Red Wharf Bay	0.24			0.24
46	Conwy/Deganwy	0.72			0.72
47	Kinmel Bay	2.81			2.81
48	Rhyl to Prestatyn	5.73			5.73
49	Gronant to Talacre	18.88	0.90	0.90	19.78
	South Wales Region	129.34	0.62	0.62	129.96
	Dyfed & Mid-Wales Region	104.12	0.31	0.46	104.58
	North Wales Region	226.64	8.24	15.03	241.67
	National Totals	460.10	9.17	16.11	476.21

7. Semi-fixed (SD7) and fixed (SD8) dune grasslands

7.1 NVC communities and rare species

Semi-fixed dunes (SD7) in the NVC system are characterised by marram grass *Ammophila arenaria* and red fescue-grass *Festuca rubra* as constant species. They represent a zone inland from SD6 types in which sand deposition decreases and *A. arenaria* declines in importance, eventually to be replaced by a short sward grassland (SD8) in which *F. rubra* and lady's bedstraw *Galium verum* are constant. The SD7 community is the main habitat for four rare species in Wales: dune helleborine *Epipactis dunensis*, sea spurge *Euphorbia paralias*, early sand-grass *Mibora minima* and dune fescue *Vulpia fasciculata*.

7.2 Harmonisation problems

These two NVC communities are treated together here because there are slight problems in harmonising results for these vegetation types mapped in NVC surveys since 1988 and the earlier site studies at Laugharne and Tenby Burrows. Vegetation classification and mapping in the latter two sites were based on an early version of the NVC sand dune chapter. Revision of that chapter in 1988 produced no clear correlation between sub-communities in the SD8 community and its equivalent pre-1988 type (SD10), nor was there any equivalent in the pre-1988 types to the current SD7 community. Results were harmonised as far as possible by comparing the quadrat groups in Laugharne and Tenby results (both derived from TWINSPAN analysis) with current NVC types. It was not possible to identify sub-communities for either the SD7 or the SD8 community and separation was made only at community level. Only the SD7 community was present at Tenby, apart from an SD8/MG6 transition. Both SD7 and SD8 were present in Laugharne results but their relative extents were unclear upon the vegetation map. The balance between these two types was made by dividing their total area by their relative proportions in the contiguous Pendine site. The SD7 and SD8 results for

Laugharne Burrows must therefore be regarded as approximate.

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

The total area of semi-fixed SD7 dune in Wales is 1477.5 ha (Table 7.1) and the community is found in all sites (Figure 7.1) except Kinmel Bay where sufficient sand supply and succession from SD6 vegetation might be interrupted by a continuous sea wall. It is present in small quantities (<25 ha) in 32 Welsh sites, most of which are small bay dune and climbing dune systems which have restricted sand supply. It is much more extensive in the larger spit, hindshore and prograding dune systems where sand supply has been sufficient to produce SD6 mobile dunes and there has been no interruption of succession to SD7 types. Thirteen sites have areas between 25 and 100 ha, with three (Merthyr Mawr, Laugharne Burrows, Newborough Warren) even larger (>100 ha). Much of the Merthyr Mawr area is mapped as transitional SD7/SD8 vegetation. The large 190.8 ha extent at Laugharne Burrows is only approximate due to the treatment of harmonised results (see section 7.2).

Five SD7 sub-communities are recognised and all are present in Wales. Undifferentiated SD7 vegetation is common at Brownslade/Linney, as it is at Laugharne Burrows. Transitions are recorded in several locations but these are of small extent apart from the SD7/SD8 type mapped at Merthyr Mawr.

SD7a Typical sub-community

This sub-community is found where the succession from mobile dune to stable dune grassland is still at an early stage, close to SD6 types. It is less species-rich than others and in Wales is not the commonest SD7 type. It has a total area of 76.6 ha and is rare in South Wales, occurring in small quantities in the west and north. Only one site has a large extent (Newborough Warren, 40.4 ha).

SD7b *Hypnum cupressiforme* sub-community

This sub-community is marked by the abundance of the moss *Hypnum cupressiforme* which forms an extensive carpet over the sand. Winter annuals are another feature of this type which is found on more stable areas than the SD7a sub-community. Total area is 49.0 ha and it is rare in Wales, recorded in only seven sites. The only large extent is at Merthyr Mawr (39.8 ha). Quadrat records from that site show that restharrow *Ononis repens* is at least as common as *H. cupressiforme* and much of the mapped area might be considered as an SD7b/SD7c transition.

SD7c *Ononis repens* sub-community

In this sub-community restharrow *Ononis repens* is abundant and several other plants with a southern distribution occur, such as sea bindweed *Calystegia soldanella*. Neither annuals nor bryophytes are abundant in this type which is found in areas which are still partly unstable. It is the most widespread and extensive (520.3 ha) SD7 type on Welsh dunes. It is absent from only eight sites (excluding Laugharne Burrows), all of which are small bay dune or climbing dune systems with little or no fresh sand supply. Large extents (>40 ha) are present at four sites (and probably Laugharne Burrows in addition): Pembrey Coast, Pendine Burrows, Morfa Dyffryn and Newborough Warren. The abundance of this type, together with large extents of some SD6 types, suggests that the commonest succession pathway in mobile and semi-fixed Welsh dunes is the sequence SD6a-SD6d-SD6e-SD7c.

SD7d *Tortula ruralis* ssp. *ruraliformis* sub-community

This sub-community is found on areas more stable than those occupied by the SD7a and SD7c types, particularly within areas of stable dune on steep, south-facing slopes. Here a combination of harsh microclimate, rabbit scuffing and instability due to soil creep suppresses the vigour of perennial plants and maintains relatively open conditions. This type is characterised by the occurrence of a group of drought-avoiding winter annuals and by

extensive carpets of bryophytes which invade bare sand patches, notably *Tortula ruralis* ssp. *ruraliformis*. It is both widespread and extensive in Wales (total area 433.6 ha). It is present on all coasts but is absent from twenty sites, all of which are small bay dune and climbing dune types. Extensive (>40 ha) areas are found at two sites (and perhaps Laugharne Burrows): Kenfig Dunes and Newborough Warren.

SD7e *Elymus pungens* sub-community

This sub-community is marked by the occurrence within semi-fixed dune vegetation of sea couch *Elymus pungens*. This grass is associated with upper saltmarshes and with sea walls, but can also occur in dunes. Apart from the presence of sea couch there is little to distinguish this type which is often rather species-poor. It is rare in Wales (present in only four sites) and of low extent (3.5 ha). The only site with a large proportion of total area is at Morfa Bychan (2.4 ha).

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

Red fescue *Festuca rubra* and a variety of other grasses, dicotyledons (notably lady's bedstraw *Galium verum*) and mosses form the usual closed turf of this community. It occupies areas of stable, calcareous dune where sand accretion is no longer significant and where there has usually been some soil development. Marram grass may be present but is rarely a major component of the vegetation. Lichens and mosses become particularly important in areas with some leaching of dune soil and heavy grazing.

The total area of SD8 fixed dune grassland in Wales is 1344.2 ha (Table 7.2). It is widespread (Figure 7.2) and absent from only one site, Lydstep Haven, where it has probably been replaced by improved grassland as part of caravan park development. It is present as small areas (<25 ha) in 35 sites, as moderate extents (25–100 ha) in a further ten sites, and as large areas (>100 ha) in three sites (Kenfig Dunes 214.9 ha, Brownslade/Linney 137.5 ha, Morfa

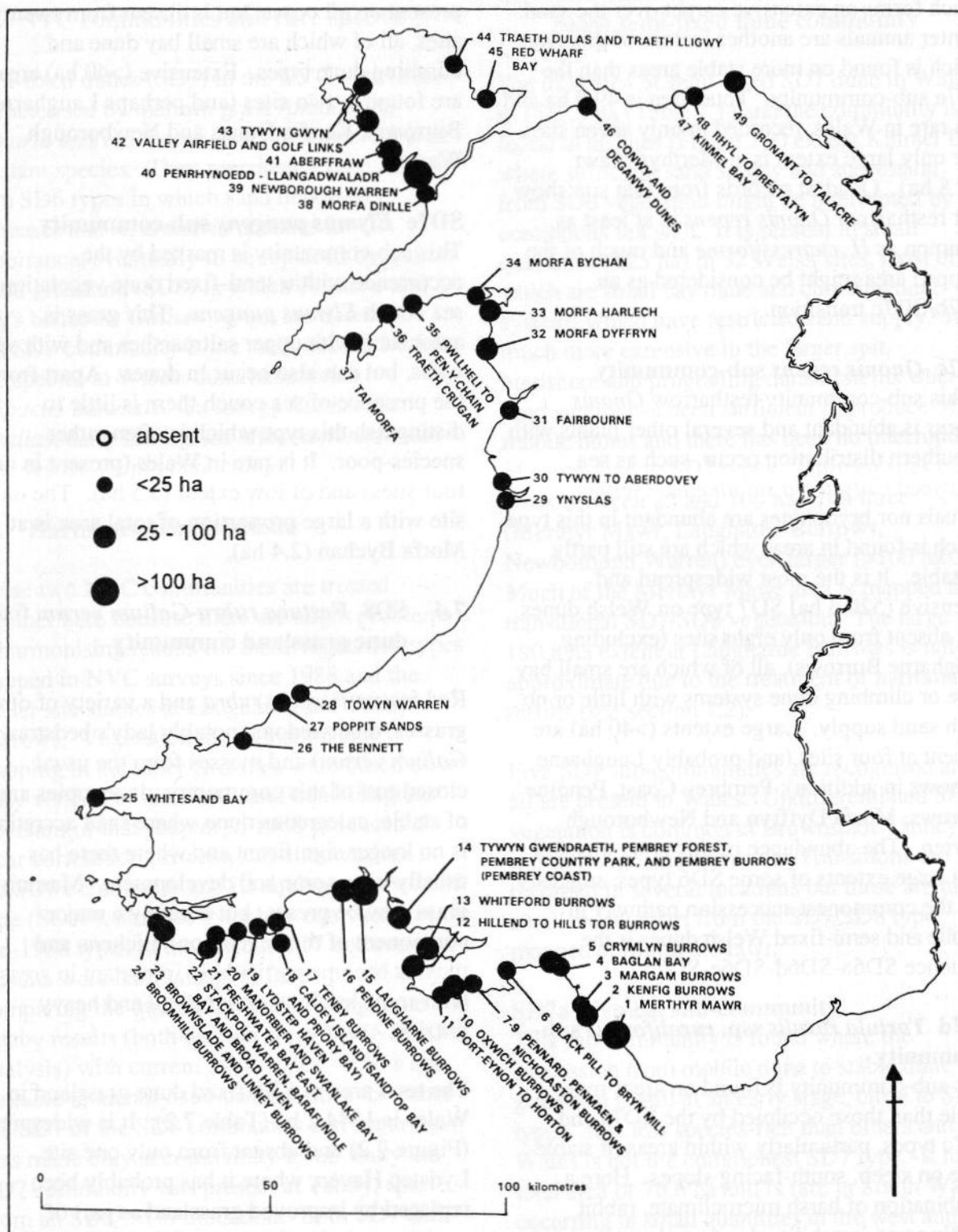


Figure 7.1 Location of sites with SD7 *Ammophila arenaria-Festuca rubra* semi-fixed dune community in Wales.

Table 7.1 SD7 *Ammophila arenaria*-*Festuca rubra* semi-fixed dune community in Wales. Areas in hectares.

	Site	SD7a	SD7b	SD7c	SD7d	SD7e
1	Merthyr Mawr		39.81	12.95	3.68	
2	Kenfig Dunes		0.12	39.29	48.67	
3	Margam Burrows	3.48		2.36	0.81	0.56
4	Baglan Bay			0.49	5.51	
5	Crymlyn Burrows			26.92	5.77	
6	Black Pill to Bryn Mill			1.54		
7	Pennard Burrows			1.03		
8	Penmaen Burrows			0.38		
9	Nicholaston Burrows				4.49	
10	Oxwich Burrows			24.68	10.26	
11	Port-Eynon to Horton			2.56	2.05	
12	Hillend to Hills Tor			31.41	33.97	
13	Whiteford Burrows			27.75	29.75	
14	Pembrey Coast			65.39	33.26	
15	Laughame Burrows					
16	Pendine Burrows			42.73	24.29	
17	Tenby Burrows					
18	Caldey Island	0.31				
19	Lydstep Haven			0.50		
20	Manorbier/Swanlake			0.25		
21	Freshwater Bay East	0.15		0.18	0.89	
22	Stackpole Warren			5.24	0.06	
23	Brownslade/Linney			1.09		
24	Broomhill Burrows	0.22		0.46	6.30	
25	Whitesand Bay	0.58		2.80		
26	The Bennett	0.60	2.03	0.88		
27	Poppit Sands	0.23			0.04	
28	Towyn Warren	1.05				0.37
29	Ynyslas	0.22	0.01	5.73	14.57	
30	Tywyn to Aberdovey	1.67	0.07	11.98	0.28	
31	Fairbourne			0.02		
32	Morfa Dyffryn	5.16		46.71	30.51	
33	Morfa Harlech	5.85	0.39	17.60	16.63	
34	Morfa Bychan	3.92		17.27		2.43
35	Pwllheli/Pen-y-Chain	0.63				
36	Traeth Crugan			1.88		
37	Tai Morfa	1.32		0.39		
38	Morfa Dinlle	0.35		6.64	13.35	
39	Newborough Warren	40.38		58.83	89.48	0.18
40	Penrhynoedd - Llangadwaladr	3.88				
41	Aberffraw		6.61	11.18	27.72	
42	Valley	2.41		30.57	8.65	
43	Tywyn Gwyn			2.81	0.05	
44A	Traeth Dulas	0.39			0.16	
44B	Traeth Lligwy			0.25		
45	Red Wharf Bay			1.13		
46	Conwy/Deganwy	0.56		1.67	2.01	
47	Kinmel Bay					
48	Rhyl to Prestatyn			4.87		
49	Gronant to Talacre	3.23		9.92	20.40	
	South Wales Region	3.48	39.93	171.36	144.96	0.56
	Dyfed & Mid-Wales Region	3.36	2.04	125.25	79.41	0.37
	North Wales Region	69.75	7.07	223.72	209.24	2.61
	National Totals	76.59	49.04	520.33	433.61	3.54

Table 7.1 (continued) SD7 *Ammophila arenaria*-*Festuca rubra* semi-fixed dune community in Wales. Areas in hectares. * = approximate extent (see section 7.2).

	Site	SD7 undiff.	SD7b/d	SD7/SD8	Other SD7 transitions	Total SD7
1	Merthyr Mawr		2.85	76.36	1.54	137.19
2	Kenfig Dunes					88.08
3	Margam Burrows					7.21
4	Baglan Bay					6.00
5	Crymlyn Burrows					32.69
6	Black Pill to Bryn Mill					1.54
7	Pennard Burrows					1.03
8	Penmaen Burrows					0.38
9	Nicholaston Burrows					4.49
10	Oxwich Burrows					34.94
11	Port-Eynon to Horton					4.61
12	Hillend to Hills Tor					65.38
13	Whiteford Burrows					57.50
14	Pembrey Coast					98.65
15	Laughame Burrows	190.82*				190.82
16	Pendine Burrows		0.84			67.86
17	Tenby Burrows	2.93				2.93
18	Caldey Island				0.91	1.30
19	Lydstep Haven					0.50
20	Manorbier/Swanlake	0.04				0.29
21	Freshwater Bay East			0.50	0.19	1.91
22	Stackpole Warren	3.50		0.95	0.68	10.43
23	Brownslade/Linney	69.49				70.58
24	Broomhill Burrows	0.09		3.23	0.85	11.15
25	Whitesand Bay				0.02	3.40
26	The Bennett			0.69		4.20
27	Poppit Sands				0.03	0.30
28	Towyn Warren	0.12			0.22	1.76
29	Ynyslas			0.89	0.18	21.60
30	Tywyn to Aberdovey				1.55	17.10
31	Fairbourne					0.02
32	Morfa Dyffryn	1.81				84.19
33	Morfa Harlech	0.07	13.06		1.31	54.91
34	Morfa Bychan	0.10			1.15	24.87
35	Pwllheli/Pen-y-Chain				0.13	0.76
36	Traeth Crugan	0.15			0.12	2.15
37	Tai Morfa					1.71
38	Morfa Dinlle	0.17	3.26			23.77
39	Newborough Warren	0.06			1.04	189.97
40	Penrhynoedd - Llangadwaladr				1.04	4.92
41	Aberffraw	0.03		1.57		47.11
42	Valley	0.58			0.09	42.30
43	Tywyn Gwyn				0.04	2.90
44A	Traeth Dulas				0.32	0.87
44B	Traeth Lligwy					0.25
45	Red Wharf Bay					1.13
46	Conwy/Deganwy					4.24
47	Kinnel Bay					
48	Rhyl to Prestatyn					4.87
49	Gronant to Talacre	0.04	3.89	4.92		42.40
	South Wales Region		2.85	76.36	1.54	441.04
	Dyfed & Mid-Wales Region	266.99	0.84	6.26	3.08	487.68
	North Wales Region	3.01	20.21	6.49	6.79	550.44
	National Totals	270.00	23.90	89.11	11.41	1479.16

Figure 7.1 Location of sites with SD7 *Ammophila arenaria*-*Festuca rubra* semi-fixed dune community in Wales.

Harlech 110.3 ha). Some large sites, notably Newborough Warren (23.9 ha) and Gronant to Talacre (8.3 ha) have surprisingly low areas given the extent of their SD7 vegetation, suggesting they have more instability than other comparable dune systems.

Five NVC sub-communities are recognised (Table 7.2). The first three are variants found on free-draining soils, the last two are characteristic of damper conditions. A large number of transitional types are mapped in addition, both between SD8 sub-communities and between SD8 and other vegetation. Most transitions are not extensive and total area is generally <10 ha, but those involving change to neutral grasslands (MG1 31.1 ha, MG6 40.3 ha, MG7 25.1 ha) are important in the overall transition total of 179.9 ha (13.4% of all SD8 extent). The transitions to neutral grassland illustrate both reduced grazing (SD8/MG1) and grassland improvement (SD8/MG6, SD8/MG7). A large amount of the SD8 total (513.2 ha, 38.2%) is not allocated to a sub-community, notably at Kenfig Dunes, Pennard Burrows, Hillend to Hills Tor, Pembrey Coast, Brownslade/Linney and Broomhill Burrows (all >25 ha). Most of this undifferentiated area is confined to South Wales and probably reflects reduced grazing in recent decades, allowing rank SD8 types to develop which are not easily allocated to SD8 sub-communities or transitions. Further evidence of a grazing role is found in the very frequent presence of dewberry *Rubus caesius* in SD8 records from many sites in South Wales. This species invades readily when stock grazing is relaxed and it is not eaten by rabbits.

SD8a Typical sub-community

This type is usually less species-rich than other sub-communities. Mosses tend not to be very prominent and coarse grasses may occur. It is often found on sites, or parts of sites, which are rather undergrazed. This sub-community is the most frequent and extensive (346.4 ha) type in Wales. It is found on all coasts but there is a major gap in the south-east between Baglan Bay and Laugharne Burrows where mapped

undifferentiated SD8 probably approximates this type.

SD8b *Luzula campestris* sub-community

This sub-community is generally species-rich. Field woodrush *Luzula campestris* is frequent, with the grasses common bent *Agrostis capillaris*, sweet vernal grass *Anthoxanthum odoratum* and sheep's fescue *Festuca ovina* present in many records. Wild thyme *Thymus praecox* is constant and abundant in some samples. Moss cover can be high, with *Rhytidiadelphus squarrosus* common and generally accompanied by *R. triquetrus*, *Brachythecium albicans* and *Pseudoscleropodium purum*. Some species are also characteristic of stable grasslands on acidic dunes and the sub-community can be regarded as a leached, well-grazed SD8 type. It is rare in South Wales (present in only three sites, but with large extents at Kenfig Dunes and Stackpole Warren) and on the north coast (present only at Rhyl to Prestatyn in sites further north and east of Aberffraw). On the west coast and the south-western shores of Ynys Mon (Anglesey) it is widespread, with large extents at Tywyn to Aberdovey, Morfa Dyffryn, Morfa Harlech and Aberffraw. This geographical distribution might be the result of heavier grazing than other sites and perhaps sand of a lower carbonate content.

SD8c *Tortula ruralis* ssp. *ruraliformis* sub-community

Local, unstable conditions in SD8 grasslands can occur on steep slopes or areas subject to rabbit scuffing. The bare sand exposed is generally colonised by this sub-community which has a high cover of the moss *Tortula ruralis* ssp. *ruraliformis*. The mosses *Homalothecium lutescens* and *Rhytidiadelphus squarrosus* are often present, annual species can be abundant and marram grass can be present. It is rare in Wales and is present in only eight sites. Total extent is small (40.5 ha) and large areas are confined to two dune systems: Brownslade/Linney (15.0 ha) and Aberffraw (22.4 ha).

SD8d *Ranunculus acris*-*Bellis perennis* sub-community

This sub-community is more typical of northern and western Britain where it is the dominant vegetation of much Scottish machair dune. Cool, oceanic conditions are typical of such areas, combined with grazing. In drier regions of Britain it tends to be found in depressions and around slacks where the water table can provide moisture at times of drought. It is rare in Wales (present in six sites) and of low extent (37.2 ha). The largest areas are found at Tywyn to Aberdovey (17.1 ha) and Morfa Dyffryn (11.0 ha).

SD8e *Prunella vulgaris* sub-community

The British distribution of this sub-community is very similar to the SD8d type. Self-heal *Prunella vulgaris* is a constant species in Scottish samples (it is only relatively frequent in Wales). The sub-community occurs in wetter conditions than the SD8d type and in Wales is confined to slack margins. It is rare (present in only five sites) and of low total extent (23.6 ha). The only sites with areas >5 ha are Brownslade/Linney and Broomhill Burrows, possibly the most oceanic of Welsh dune sites.

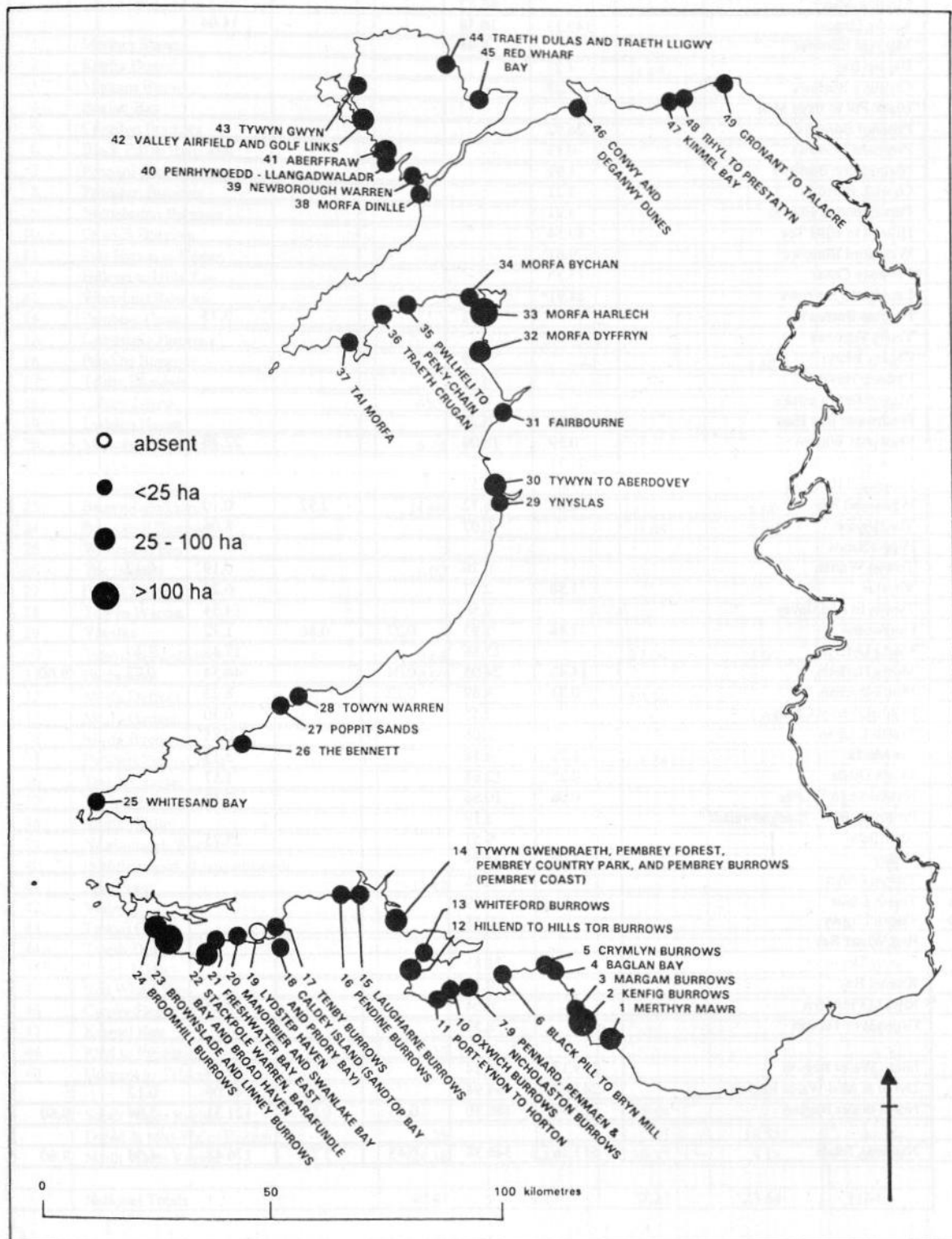


Figure 7.2 Location of sites with SD8 *Festuca rubra*-*Galium verum* fixed dune community in Wales.

Table 7.2 SD8 *Festuca rubra*-*Galium verum* fixed dune grassland vegetation in Wales. Areas in hectares. * = approximate extent (see section 7.2).

	Site	SD8	SD8a	SD8a/b	SD8a/d	SD8b	SD8b/c	SD8b/d
1	Merthyr Mawr		83.62					
2	Kenfig Dunes	149.13	10.58			14.04		
3	Margam Burrows		6.94					
4	Baglan Bay	4.23						
5	Crymlyn Burrows	1.28						
6	Black Pill to Bryn Mill							
7	Pennard Burrows	26.92						
8	Penmaen Burrows	0.13						
9	Nicholaston Burrows	1.92						
10	Oxwich Burrows	3.21						
11	Port-Eynon to Horton	3.21						
12	Hillend to Hills Tor	49.54						
13	Whiteford Burrows	9.61						
14	Pembrey Coast	73.33						
15	Laughame Burrows	24.91*						
16	Pendine Burrows		4.41			3.73		
17	Tenby Burrows							
18	Caldey Island		0.09					
19	Lydstep Haven							
20	Manorbier/Swanlake		0.50					
21	Freshwater Bay East	0.18	0.26					
22	Stackpole Warren	0.59	18.09			22.79		
23	Brownslade/Linney	97.71						
24	Broomhill Burrows	39.07	35.57					
25	Whitesand Bay	0.84	3.32		2.92	0.10		
26	The Bennett		0.07			8.06		
27	Poppit Sands							
28	Towyn Warren		0.26			0.19	0.12	
29	Ynyslas	4.38	2.37			6.22		
30	Tywyn to Aberdovey		7.50			14.34		
31	Fairbourne	2.46	1.93	0.27	0.86	1.72		
32	Morfa Dyffryn		15.86			17.43	3.17	
33	Morfa Harlech	14.43	24.05	0.04		44.54	0.77	9.60
34	Morfa Bychan	0.31	8.89	0.12		8.23		
35	Pwllheli/Pen-y-Chain		2.55			0.30		
36	Traeth Crugan		2.06			0.85		
37	Tai Morfa	1.39	4.18			3.15		
38	Morfa Dinlle	0.25	12.68			1.57		
39	Newborough Warren	0.06	10.66			3.40		
40	Penrhynoedd - Llangadwaladr		3.17					
41	Aberffraw		9.51			23.75		
42	Valley	4.07	38.19					
43	Tywyn Gwyn		2.36					
44A	Traeth Dulas		0.19					
44B	Traeth Lligwy		0.18					
45	Red Wharf Bay							
46	Conwy/Deganwy		21.85					
47	Kinmel Bay		0.14					
48	Rhyl to Prestatyn		6.04			2.03		
49	Gronant to Talacre		8.31					
	South Wales Region	249.18	101.14			14.04		
	Dyfed & Mid-Wales Region	241.01	64.94		2.92	41.09	0.12	
	North Wales Region	22.97	180.30	0.43	0.86	121.31	3.94	9.60
	National Totals	513.16	346.38	0.43	3.78	176.44	4.06	9.60

Table 7.2 (continued) SD8 *Festuca rubra*-*Galium verum* fixed dune grassland community in Wales. Areas in hectares.

	Site	SD8c	SD8c/e	SD8d	SD8e	Total SD8 NVC types
1	Merthyr Mawr			1.36		84.98
2	Kenfig Dunes			4.49		178.24
3	Margam Burrows					6.94
4	Baglan Bay					4.23
5	Crymlyn Burrows					1.28
6	Black Pill to Bryn Mill					
7	Pennard Burrows					26.92
8	Penmaen Burrows					0.13
9	Nicholaston Burrows					1.92
10	Oxwich Burrows					3.21
11	Port-Eynon to Horton					3.21
12	Hillend to Hills Tor					49.54
13	Whiteford Burrows					9.61
14	Pembrey Coast					73.33
15	Laughame Burrows					24.91
16	Pendine Burrows				1.62	9.76
17	Tenby Burrows					
18	Caldey Island	0.47				0.56
19	Lydstep Haven					
20	Manorbier/Swanlake	0.76				1.26
21	Freshwater Bay East					0.44
22	Stackpole Warren					41.47
23	Brownsdale/Linney	14.99			9.69	122.39
24	Broomhill Burrows			2.05	7.20	83.89
25	Whitesand Bay					7.18
26	The Bennett	0.07				8.2
27	Poppit Sands					
28	Towyn Warren					0.57
29	Ynyslas					12.97
30	Tywyn to Aberdovey	0.64		17.09	4.05	43.62
31	Fairbourne	0.97				8.21
32	Morfa Dyffryn			10.96		47.42
33	Morfa Harlech				1.08	94.51
34	Morfa Bychan					17.55
35	Pwllheli/Pen-y-Chain			1.28		4.13
36	Traeth Crugan					2.91
37	Tai Morfa					8.72
38	Morfa Dinlle					14.5
39	Newborough Warren					14.12
40	Penrhynoedd - Llangadwaladr					3.17
41	Aberffraw	22.42				55.68
42	Valley		9.11			51.37
43	Tywyn Gwyn					2.36
44A	Traeth Dulas					0.19
44B	Traeth Lligwy					0.18
45	Red Wharf Bay					
46	Conwy/Deganwy					21.85
47	Kinmel Bay					0.14
48	Rhyl to Prestatyn	0.15				8.22
49	Gronant to Talacre					8.31
	South Wales Region			5.85		370.21
	Dyfed & Mid-Wales Region	16.29		2.05	18.51	386.93
	North Wales Region	24.18	9.11	29.33	5.13	407.16
	National Totals	40.47	9.11	37.23	23.64	1164.3

Table 7.2 (continued) SD8 *Festuca rubra*-*Galium verum* fixed dune grassland community in Wales. Areas in hectares.

	Site	SD8/ SD9	SD8/ SD10	SD8/ SD12	SD8/ SD16	SD8/ MG1	SD8/ MG5	SD8/ MG6	SD8/ MG7
1	Merthyr Mawr								
2	Kenfig Dunes	2.93				31.05			
3	Margam Burrows	3.06							
4	Baglan Bay								
5	Crymlyn Burrows								
6	Black Pill to Bryn Mill							9.84	
7	Pennard Burrows								
8	Penmaen Burrows								
9	Nicholaston Burrows								
10	Oxwich Burrows								
11	Port-Eynon to Horton								
12	Hillend to Hills Tor							14.20	
13	Whiteford Burrows								
14	Pembrey Coast								
15	Laughame Burrows								
16	Pendine Burrows								
17	Tenby Burrows							0.36	
18	Caldey Island								
19	Lydstep Haven								
20	Manorbier/Swanlake								
21	Freshwater Bay East								
22	Stackpole Warren		1.76	2.92					14.35
23	Brownslade/Linney							13.33	
24	Broomhill Burrows		0.01				0.36	1.26	0.29
25	Whitesand Bay								0.21
26	The Bennett								
27	Poppit Sands		0.04						
28	Towyn Warren								
29	Ynyslas								
30	Tywyn to Aberdovey						0.08		
31	Fairbourne								
32	Morfa Dyffryn								
33	Morfa Harlech					0.04		1.31	10.25
34	Morfa Bychan								
35	Pwllheli/Pen-y-Chain								
36	Traeth Crugan								
37	Tai Morfa								
38	Morfa Dinlle			6.17					
39	Newborough Warren				9.78				
40	Penrhynoedd - Llangadwaladr								
41	Aberffraw				0.04				
42	Valley								
43	Tywyn Gwyn								
44A	Traeth Dulas								
44B	Traeth Lligwy								
45	Red Wharf Bay								0.04
46	Conwy/Deganwy								
47	Kinmel Bay								
48	Rhyl to Prestatyn								
49	Gronant to Talacre								
	South Wales Region	5.99				31.05		24.04	
	Dyfed & Mid-Wales Region		1.81	2.92			0.36	14.95	14.85
	North Wales Region			6.17	9.82	0.04	0.08	1.31	10.29
	National Totals	5.99	1.81	9.09	9.82	31.09	0.44	40.30	25.14

Table 7.2 (continued) SD8 *Festuca rubra*-*Galium verum* fixed dune grassland community in Wales. Areas in hectares.

	Site	SD8/ CG6	SD8/ MC8	SD8/ W21	SD8/ W25	Other SD8 trans.	All SD8 trans.	All SD8 types
1	Merthyr Mawr							84.98
2	Kenfig Burrows				2.66		36.64	214.88
3	Margam Burrows						3.06	10.00
4	Baglan Bay							4.23
5	Crymlyn Burrows							1.28
6	Black Pill to Bryn Mill						9.84	9.84
7	Pennard Burrows							26.92
8	Penmaen Burrows							0.13
9	Nicholaston Burrows							1.92
10	Oxwich Burrows							3.21
11	Port-Eynon to Horton							3.21
12	Hillend to Hills Tor						14.20	63.74
13	Whiteford Burrows							9.61
14	Pembrey Coast							73.33
15	Laughame Burrows							24.91
16	Pendine Burrows							9.76
17	Tenby Burrows	5.40					5.76	5.76
18	Caldey Island	0.14					0.14	0.70
19	Lydstep Haven							
20	Manorbier/Swanlake							1.26
21	Freshwater Bay East					0.17	0.17	0.61
22	Stackpole Warren	0.76	11.01	14.37	2.42	1.40	48.99	90.46
23	Brownslade/Linney					1.80	15.13	137.52
24	Broomhill Burrows					4.55	6.47	90.36
25	Whitesand Bay						0.21	7.39
26	The Bennett				4.47		4.47	12.67
27	Poppit Sands						0.04	0.04
28	Towyn Warren							0.57
29	Ynyslas							12.97
30	Tywyn to Aberdovey						0.08	43.70
31	Fairbourne							8.21
32	Morfa Dyffryn							47.42
33	Morfa Harlech		4.21				15.81	110.32
34	Morfa Bychan							17.55
35	Pwllheli/Pen-y-Chain					2.88	2.88	7.01
36	Traeth Crugan							2.91
37	Tai Morfa							8.72
38	Morfa Dinlle						6.17	20.67
39	Newborough Warren						9.78	23.90
40	Penrhynoedd - Llangadwaladr							3.17
41	Aberffraw						0.04	55.72
42	Valley							51.37
43	Tywyn Gwyn							2.36
44A	Traeth Dulas							0.19
44B	Traeth Lligwy							0.18
45	Red Wharf Bay						0.04	0.04
46	Conwy/Deganwy							21.85
47	Kinmel Bay							0.14
48	Rhyl to Prestatyn							8.22
49	Gronant to Talacre							8.31
	South Wales Region				2.66		63.74	433.95
	Dyfed & Mid-Wales Region	6.30	11.01	14.37	6.89	7.92	81.38	468.31
	North Wales Region		4.21			2.88	34.80	441.96
	National Totals	6.30	15.22	14.37	9.55	10.80	179.92	1344.22

8. Other dry grassland communities on dunes

8.1 NVC communities and rare species

This chapter covers communities ranging from other dry dune grasslands and lichen-rich communities (SD9, SD10, SD11, SD12) to several mesotrophic (MG1, MG5, MG6, MG7), calcicolous (CG2, CG6, CG10), calcifugous (U1, U2, U4, U5, U13) and maritime cliff (MC5, MC8, MC9, MC10, MC12) types which tend to be found on the edge of dune systems, forming either transition zones over bedrock or areas modified by agricultural improvement and golf course maintenance. Bracken communities (U20, W25) are discussed in Chapter 11. No rare species are generally associated with these vegetation types on sand dunes in Wales.

8.2 Dune grasslands featuring *Arrhenatherum elatius* (SD9, MG1)

These vegetation types, featuring high cover and constancy for false oat-grass *Arrhenatherum elatius*, represent neutral grasslands which might also have had some slight soil enrichment from past grazing. Under moderate and heavy grazing conditions they become rare and their presence, especially in large extents, is a good indicator of reduced grazing in the last one or two decades (also often associated with scrub expansion - see Chapter 11).

Species-poor mixes of false oat-grass and marram grass, with no clear SD9 *Ammophila arenaria*-*Arrhenatherum elatius* dune grassland sub-community associates, are common in South Wales and quite extensive at Hillend to Hills Tor and Merthyr Mawr (Table 8.1, Figure 8.1). The undifferentiated SD9 type is in transition to bracken at Kenfig Burrows. The SD9a Typical sub-community is recorded on all coasts and large extents are present at Newborough Warren and Pendine Burrows. It is the commonest mapped type. The SD9b *Geranium sanguineum* sub-community is infrequent and most sites are found in North Wales. The only large extent is at Morfa

Harlech. The total extent of all SD9 types (301.3 ha) is much more extensive than MG1 *Arrhenatherum elatius* coarse grassland (142.9 ha, Table 8.2) which lacks marram grass, suggesting that false oat grass entry into open SD6 and SD7 marram communities is more prevalent than into SD8 or other closed grassland types.

Undifferentiated MG1 *Arrhenatherum elatius* coarse grassland is the only common MG1 type and is moderately frequent in West and North Wales, though the only large extents are confined to South Wales (Figure 8.2; Kenfig Burrows, Pembrey Coast). Clear sub-communities are of very low extent and frequency, as are transitions to saltmarsh, dune wetland and scrub (Table 8.2).

8.3 Calcifugous dune grasslands (SD12)

Stable dunes low in calcium carbonate content can be leached over time to produce an acidic type, SD12 *Carex arenaria*-*Festuca ovina*-*Agrostis capillaris* dune grassland. This is uncommon in Wales (Table 8.3, Figure 8.3) and suggests that high carbonate levels and dune instability are the norm in most sites. The undifferentiated SD12 type and the SD12a *Anthoxanthum odoratum* sub-community have similar extents and moderate frequency, but the SD12b *Holcus lanatus* sub-community is very rare and confined to a small area of Stackpole Warren. The largest covers are at Pennard Burrows and Aberffraw, but total extent is low (124.3 ha). Transitions are rare and the only site with a large extent is Pennard Burrows (19.2 ha), where grazing and winter feeding of stock have probably created a transition to semi-improved grassland (SD12/MG6).

8.4 Other calcifugous grasslands (U1, U4, U5, U6)

Very small areas of various calcifugous (acidic) grassland are also present around the inland edge of some Welsh dune systems, mainly on thin acidic sand overlying bedrock (Table 8.4). These vegetation types (U1c *Festuca ovina*-*Agrostis capillaris*-*Rumex acetosella* grassland,

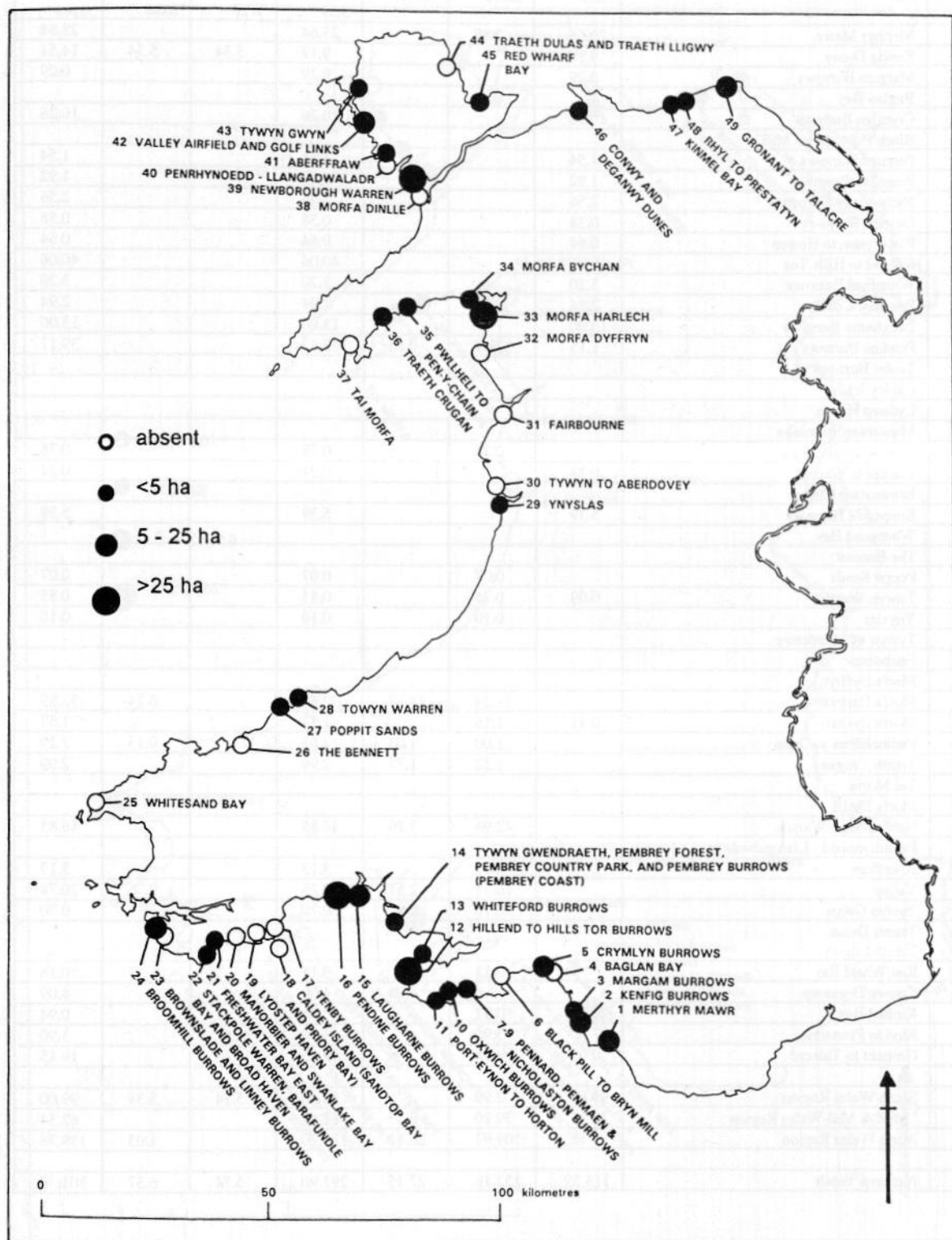


Figure 8.1 Location of sites with SD9 *Ammophila arenaria*-*Arrhenatherum elatius* dune grassland in Wales.

Table 8.1 SD9 *Ammophila arenaria*-*Arrhenatherum elatius* dune grassland in Wales. Areas in hectares.

	Site	SD9	SD9a	SD9b	Total SD9	SD9/W25	All SD9 trans	All SD9 types
1	Merthyr Mawr	20.65	2.99		23.64			23.64
2	Kenfig Dunes	9.17			9.17	5.34	5.34	14.51
3	Margam Burrows	0.29			0.29			0.29
4	Baglan Bay							
5	Crymlyn Burrows	10.26			10.26			10.26
6	Black Pill to Bryn Mill							
7	Pennard Burrows	1.54			1.54			1.54
8	Penmaen Burrows	1.92			1.92			1.92
9	Nicholaston Burrows	2.56			2.56			2.56
10	Oxwich Burrows	0.38			0.38			0.38
11	Port-Eynon to Horton	0.64			0.64			0.64
12	Hillend to Hills Tor	40.06			40.06			40.06
13	Whiteford Burrows	3.20			3.20			3.20
14	Pembrey Coast	2.94			2.94			2.94
15	Laughame Burrows	13.00			13.00			13.00
16	Pendine Burrows	1.15	37.49	0.53	39.17			39.17
17	Tenby Burrows							
18	Caldey Island							
19	Lydstep Haven							
20	Manorbier/Swanlake							
21	Freshwater Bay East		0.78		0.78			0.78
22	Stackpole Warren	0.24			0.24			0.24
23	Brownslade/Linney							
24	Broomhill Burrows	5.39			5.39			5.39
25	Whitesand Bay							
26	The Bennett							
27	Poppit Sands		0.07		0.07			0.07
28	Towyn Warren	0.09	0.76		0.85			0.85
29	Ynyslas		0.10		0.10			0.10
30	Tywyn to Aberdovey							
31	Fairbourne							
32	Morfa Dyffryn							
33	Morfa Harlech		19.28	13.33	32.61		0.14	32.89
34	Morfa Bychan	0.41	1.16		1.57			1.57
35	Pwllheli/Pen-y-Chain		1.00	1.03	2.03		0.13	2.29
36	Traeth Crugan		1.22	1.77	2.99			2.99
37	Tai Morfa							
38	Morfa Dinlle							
39	Newborough Warren		42.96	3.89	46.85			46.85
40	Penrhynoedd - Llangadwaladr							
41	Aberffraw		3.13		3.13			3.13
42	Valley		16.75	2.51	19.26		0.76	20.78
43	Tywyn Gwyn		0.70		0.70			0.70
44A	Traeth Dulas							
44B	Traeth Lligwy							
45	Red Wharf Bay		0.18		0.18			0.18
46	Conwy/Deganwy			4.09	4.09			4.09
47	Kinmel Bay	0.63	0.31		0.94			0.94
48	Rhyl to Prestatyn		3.90		3.90			3.90
49	Gronant to Talacre	0.07	19.38		19.45			19.45
	South Wales Region	90.67	2.99		93.66	5.34	5.34	99.00
	Dyfed & Mid-Wales Region	22.81	39.20	0.53	62.54			62.54
	North Wales Region	1.11	109.97	26.62	137.70		1.03	139.76
	National Totals	114.59	152.16	27.15	293.90	5.34	6.37	301.30

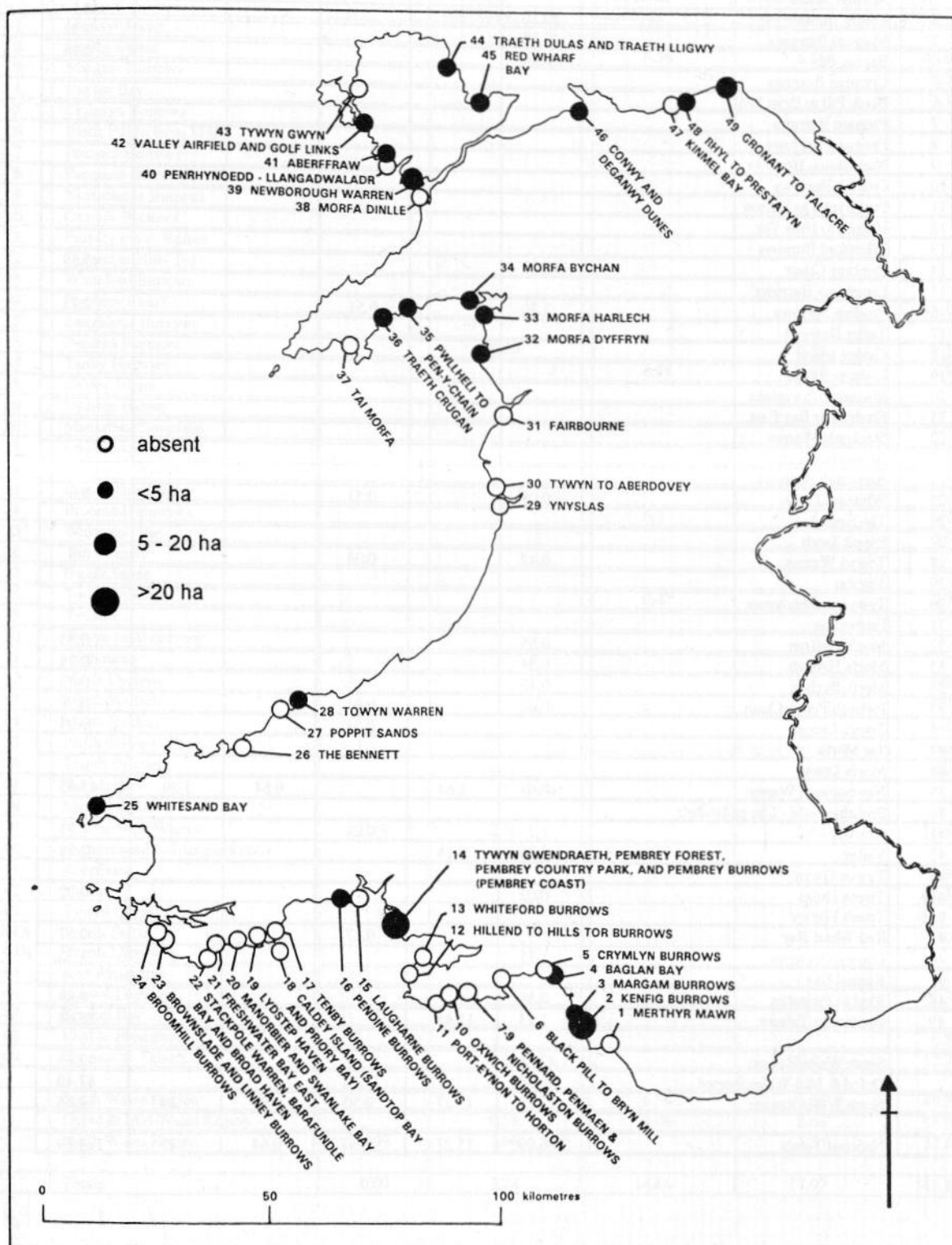


Figure 8.2 Distribution of MG1 *Arrhenatherum elatius* coarse grassland in Welsh dunes.

Table 8.2 MG1 *Arrhenatherum elatius* coarse grassland in Welsh dunes. Areas in hectares.

	Site	MG1	MG1a	MG1b	MG1d	MG1e	MG1 total
1	Merthyr Mawr						
2	Kenfig Dunes	40.10					40.1
3	Margam Burrows	0.38					0.38
4	Baglan Bay	2.16					2.16
5	Crymlyn Burrows						
6	Black Pill to Bryn Mill						
7	Pennard Burrows						
8	Penmaen Burrows						
9	Nicholaston Burrows						
10	Oxwich Burrows						
11	Port-Eynon to Horton						
12	Hillend to Hills Tor						
13	Whiteford Burrows						
14	Pembrey Coast	43.59					43.59
15	Laughame Burrows						
16	Pendine Burrows	2.20		0.51			2.71
17	Tenby Burrows						
18	Caldey Island						
19	Lydstep Haven						
20	Manorbier/Swanlake						
21	Freshwater Bay East						
22	Stackpole Warren						
23	Brownslade/Linney						
24	Broomhill Burrows						
25	Whitesand Bay	0.09		0.51			0.6
26	The Bennett						
27	Poppit Sands						
28	Towyn Warren	0.42		0.08			0.5
29	Ynyslas						
30	Tywyn to Aberdovey						
31	Fairbourne						
32	Morfa Dyffryn	0.85					0.85
33	Morfa Harlech	0.34					0.34
34	Morfa Bychan	0.45					0.45
35	Pwllheli/Pen-y-Chain	0.08		0.01			0.09
36	Traeth Crugan			0.04			0.04
37	Tai Morfa						
38	Morfa Dinlle						
39	Newborough Warren	10.08	1.64		0.64	1.29	13.65
40	Penrhynoedd - Llangadwaladr						
41	Aberffraw	1.7		0.28			1.98
42	Valley	0.16	2.18				2.34
43	Tywyn Gwyn						
44A	Traeth Dulas	0.02					0.02
44B	Traeth Lligwy						
45	Red Wharf Bay			0.17			0.17
46	Conwy/Deganwy	1.35					1.35
47	Kinmel Bay						
48	Rhyl to Prestatyn	0.89					0.89
49	Gronant to Talacre	1.23	11.45				12.68
	South Wales Region	42.64					42.64
	Dyfed & Mid-Wales Region	46.30		1.10			47.40
	North Wales Region	17.15	15.27	0.50	0.64	1.29	34.85
	National Totals	106.09	15.27	1.60	0.64	1.29	124.89

Table 8.2 (continued) MG1 *Arrhenatherum elatius* coarse grassland in sand dunes of Wales. Areas in hectares.

	Site	MG1/SM18	MG1 wet transitions	MG1 scrub transitions	Total MG1 transitions	Total MG1
1	Merthyr Mawr					
2	Kenfig Dunes			6.56	6.56	46.66
3	Margam Burrows					0.38
4	Baglan Bay					2.16
5	Crymlyn Burrows					
6	Black Pill to Bryn Mill					
7	Pennard Burrows					
8	Penmaen Burrows					
9	Nicholaston Burrows					
10	Oxwich Burrows					
11	Port-Eynon to Horton					
12	Hillend to Hills Tor					
13	Whiteford Burrows					
14	Pembrey Coast					43.59
15	Laughame Burrows					
16	Pendine Burrows		0.58		0.58	3.29
17	Tenby Burrows			6.98	6.98	6.98
18	Caldey Island					
19	Lydstep Haven					
20	Manorbier/Swanlake					
21	Freshwater Bay East					
22	Stackpole Warren					
23	Brownslade/Linney					
24	Broomhill Burrows			0.7	0.7	0.7
25	Whitesand Bay					0.6
26	The Bennett					
27	Poppit Sands					
28	Towyn Warren			0.4	0.4	0.9
29	Ynyslas					
30	Tywyn to Aberdovey					
31	Fairbourne					
32	Morfa Dyffryn					0.85
33	Morfa Harlech					0.34
34	Morfa Bychan					0.45
35	Pwllheli/Pen-y-Chain					0.09
36	Traeth Crugan					0.04
37	Tai Morfa					
38	Morfa Dinlle					
39	Newborough Warren	0.09	2.56		2.65	16.3
40	Penrhynoedd - Llangadwaladr					
41	Aberffraw					1.98
42	Valley					2.34
43	Tywyn Gwyn					
44A	Traeth Dulas					0.02
44B	Traeth Lligwy					
45	Red Wharf Bay					0.17
46	Conwy/Deganwy					1.35
47	Kinmel Bay					
48	Rhyl to Prestatyn					0.89
49	Gronant to Talacre		0.1		0.1	12.78
	South Wales Region			6.56	6.56	49.20
	Dyfed & Mid-Wales Region		0.58	8.08	8.66	56.06
	North Wales Region	0.09	2.66		2.75	37.60
	Totals	0.09	3.24	14.64	17.97	142.86

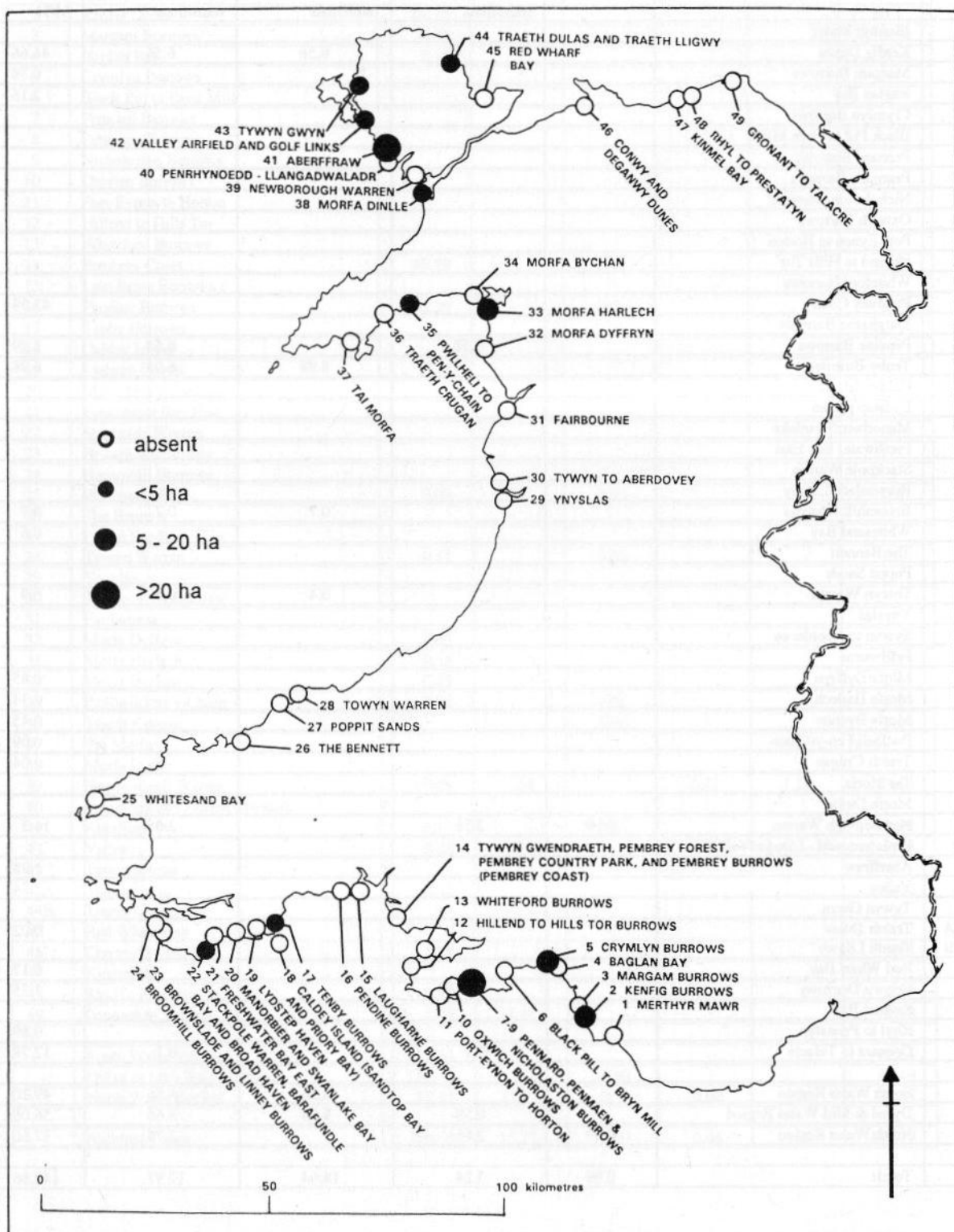


Figure 8.3 Distribution of SD12 *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland community in Welsh dunes.

Table 8.3 SD12 *Carex arenaria-Festuca ovina-Agrostis capillaris* dune grassland community in Wales. Areas in hectares.

	Site	SD12	SD12a	SD12b	All SD12	SD12/ MG6	Other SD12 trans.	All SD12 trans.	SD12 total
1	Merthyr Mawr								
2	Kenfig Dunes	10.05			10.05				10.05
3	Margam Burrows								
4	Baglan Bay								
5	Crymlyn Burrows	11.54			11.54	5.13		5.13	16.67
6	Black Pill to Bryn Mill								
7	Pennard Burrows	16.02			16.02	19.23		19.23	35.25
8	Penmaen Burrows	3.85			3.85				3.85
9	Nicholaston Burrows								
10	Oxwich Burrows								
11	Port-Eynon to Horton								
12	Hillend to Hills Tor								
13	Whiteford Burrows								
14	Pembrey Coast								
15	Laughame Burrows								
16	Pendine Burrows								
17	Tenby Burrows	0.47			0.47				0.47
18	Caldey Island								
19	Lydstep Haven								
20	Manorbier/Swanlake								
21	Freshwater Bay East								
22	Stackpole Warren			0.02	0.02				0.02
23	Brownslade/Linney								
24	Broomhill Burrows								
25	Whitesand Bay								
26	The Bennett								
27	Poppit Sands								
28	Towyn Warren								
29	Ynyslas								
30	Tywyn to Aberdovey								
31	Fairbourne								
32	Morfa Dyffryn								
33	Morfa Harlech		14.85		14.85				14.85
34	Morfa Bychan								
35	Pwllheli/Pen-y-Chain		0.05		0.05				0.05
36	Traeth Crugan								
37	Tai Morfa								
38	Morfa Dinlle	2.55	0.21		2.76				2.76
39	Newborough Warren								
40	Penrhynoedd - Llangadwaladr								
41	Aberffraw	6.19	27.60		33.79				33.79
42	Valley	0.67	0.72		1.39		0.22	0.22	1.61
43	Tywyn Gwyn	0.07	4.86		4.93				4.93
44A	Traeth Dulas						0.04	0.04	0.04
44B	Traeth Lligwy								
45	Red Wharf Bay								
46	Conwy/Deganwy								
47	Kinnel Bay								
48	Rhyl to Prestatyn								
49	Gronant to Talacre								
	South Wales Region	41.46			41.46	24.36		24.36	65.82
	Dyfed & Mid-Wales Region	0.47		0.02	0.49				0.49
	North Wales Region	9.48	48.29		57.77		0.26	0.26	58.03
	National Totals	51.41	48.29	0.02	99.72	24.36	0.26	24.62	124.34

Erodium cicutarium-*Teesdalia nudicaulis* sub-community; U4a *Festuca ovina*-*Agrostis capillaris*-*Galium saxatile* grassland, Typical sub-community; U4b *Holcus lanatus*-*Trifolium repens* sub-community; U5 *Nardus stricta*-*Galium saxatile* grassland; U6 *Juncus squarrosus*-*Festuca ovina* grassland) are very rare and five occurrences (one for each type) total only 2.1 ha. All are confined to northern Wales where acidic rocks and soils on the edges of dunes are much commoner than further south. The sites are not mapped at the national scale.

8.5 Other dry mesotrophic grasslands (MG5, MG6, MG7)

Stock grazing, together with re-seeding of recreational areas, or the unintentional sowing of seed in hay from improved grasslands elsewhere, produce various mesotrophic grassland types which vary considerably in their frequency and extent in Wales. The MG5 *Cynosurus cristatus*-*Centaurea nigra* meadow (8.9 ha, Table 8.5) and MG6 *Lolium perenne*-*Cynosurus cristatus* pasture (10.8 ha, Table 8.6) are uncommon and of low cover. These reflect heavy grazing on dune swards, probably with winter feed in some cases (Tywyn to Aberdovey, Newborough Warren, Morfa Dyffryn), but their rarity and low extent suggests that such impacts are not severe. Neither type is mapped at national scale. MG7 *Lolium perenne* leys are much commoner (total extent 200.5 ha), with most types undifferentiated except for a concentration of the MG7e *Plantago lanceolata* sub-community (characteristic of mown and trampled areas) in North Wales (Table 8.6, Figure 8.4). Such grasslands are all improved by re-seeding and fertiliser addition, with low species diversity resulting from the strong growth of the competitive dominant perennial rye-grass (*L. perenne*). The largest extent (65.4 ha) is found in restored grasslands of Pembrey Country Park where there is heavy recreational pressure requiring a resistant type of grass cover. Other moderate extents are often associated with improved fairways of golf courses (most notably at Conwy and Deganwy). Relatively few cases seem to involve grassland improvement for

grazing, hay or silage (examples include Broomhill Burrows and Morfa Bychan), though it is possible that improved agricultural grassland on sand (beyond the main tracts of natural and semi-natural dune grassland) was not mapped in its entirety.

8.6 Calcareous grasslands (CG2, CG6, CG7)

Calcareous grasslands are rare upon dunes in Wales (Table 8.7) and are largely confined to thin sand covers in climbing dune systems overlying outcrops of limestone. Total extent is 25.8 ha and only Tenby Burrows (19.9 ha) has a large area, of CG6 *Avenula pubescens* grassland. At Lystep Haven a small area of this community is in transition to W22 *Prunus spinosa*-*Rubus fruticosus* agg. scrub. All other types (CG7b *Festuca ovina*-*Hieracium pilosella*-*Thymus praecox* grassland, *Cladonia* spp. sub-community, CG7c *Fragaria vesca*-*Rumex acetosa* sub-community) are rare and occur in only small extents. Sites with calcareous grasslands are not mapped at the national scale.

8.7 Dunes dominated by *Carex arenaria* and lichens (SD10, SD11)

The bulk of these communities are established either as small patches of sand sedge *Carex arenaria* invading bare sand on the edges of blowouts and parabolic dunes (SD10 types), or on sands where heavy grazing opens up the turf to allow lichens to colonise (SD11).

The SD10 *Carex arenaria* dune community (Table 8.8, Figure 8.5) is made up of two sub-communities. Small areas of undifferentiated SD10 vegetation are scattered on all coasts, with low total extent (2.7 ha). The SD10a *Festuca rubra* type is probably characteristic of calcareous mobile dune and is more frequent and has a higher, but still small, total cover (11.7 ha). On more acidic mobile sand the SD10b *Festuca ovina* sub-community is recorded and this is very rare, recorded only for two Ynys Mon (Anglesey) sites at Newborough Warren and Aberffraw. In the latter it occurs

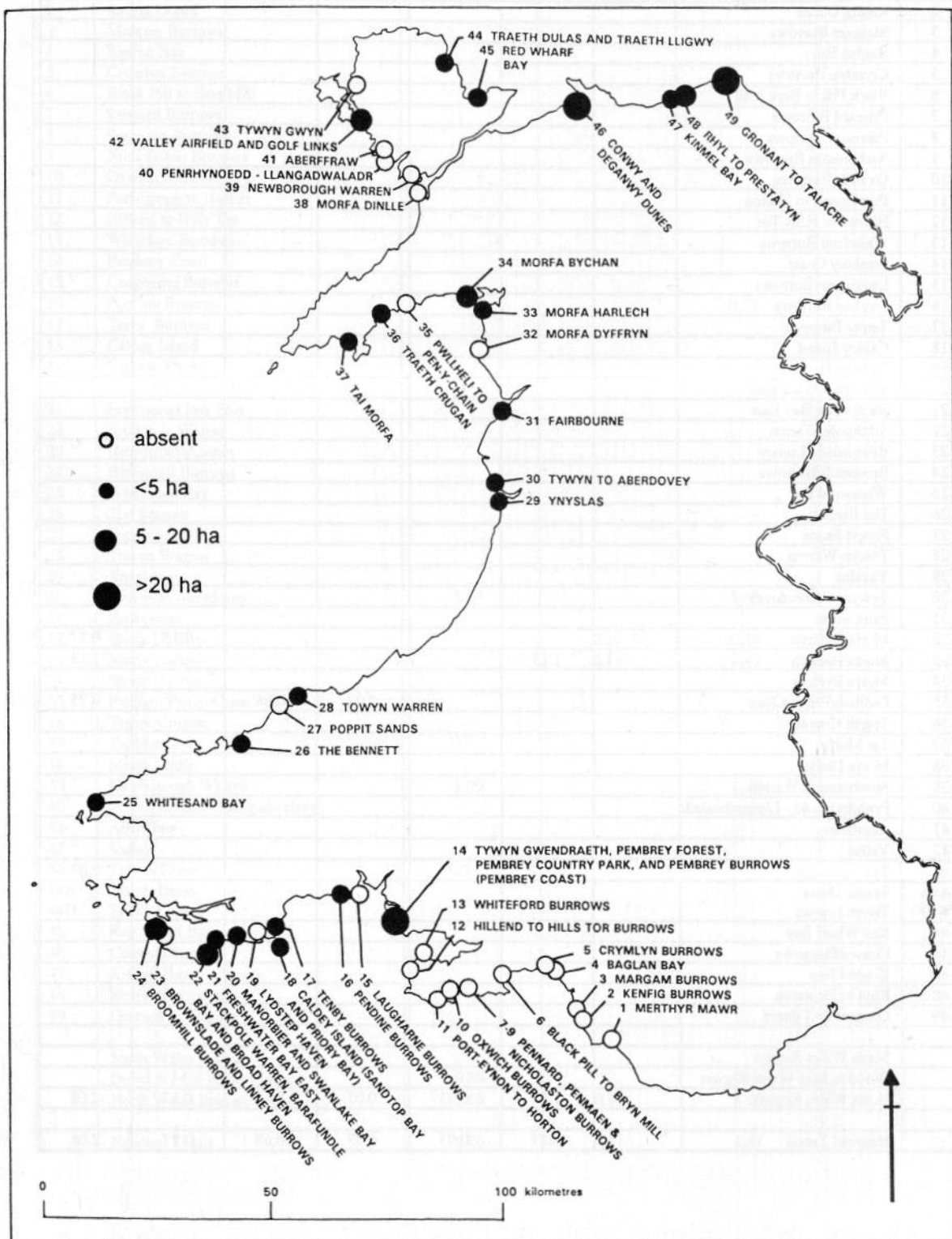


Figure 8.4 Distribution of MG7 *Lolium perenne* leys in Welsh dunes.

Table 8.4 Calcifugous grasslands (U1, U4, U5, U6) in Welsh sand dunes. Areas in hectares.

	Site	U1c	U4a	U4b	U5	U6	Total U
1	Merthyr Mawr						
2	Kenfig Dunes						
3	Margam Burrows						
4	Baglan Bay						
5	Crymlyn Burrows						
6	Black Pill to Bryn Mill						
7	Pennard Burrows						
8	Penmaen Burrows						
9	Nicholaston Burrows						
10	Oxwich Burrows						
11	Port-Eynon to Horton						
12	Hillend to Hills Tor						
13	Whiteford Burrows						
14	Pembrey Coast						
15	Laughame Burrows						
16	Pendine Burrows						
17	Tenby Burrows						
18	Caldey Island						
19	Lydstep Haven						
20	Manorbier/Swanlake						
21	Freshwater Bay East						
22	Stackpole Warren						
23	Brownslade/Linney						
24	Broomhill Burrows						
25	Whitesand Bay						
26	The Bennett						
27	Poppit Sands						
28	Towyn Warren						
29	Ynyslas						
30	Tywyn to Aberdovey						
31	Fairbourne						
32	Morfa Dyffryn					0.17	0.17
33	Morfa Harlech	1.13					1.13
34	Morfa Bychan						
35	Pwllheli/Pen-y-Chain			0.07	0.68		0.75
36	Traeth Crugan						
37	Tai Morfa						
38	Morfa Dinlle						
39	Newborough Warren						
40	Penrhynoedd - Llangadwaladr						
41	Aberffraw						
42	Valley						
43	Tywyn Gwyn		0.03				0.03
44A	Traeth Dulas						
44B	Traeth Lligwy						
45	Red Wharf Bay						
46	Conwy/Deganwy						
47	Kinmel Bay						
48	Rhyl to Prestatyn						
49	Gronant to Talacre						
	South Wales Region						
	Dyfed & Mid-Wales Region						
	North Wales Region	1.13	0.03	0.07	0.68	0.17	2.08
	National Totals	1.13	0.03	0.07	0.68	0.17	2.08

Table 8.5 MG5 mesotrophic grassland types in Welsh sand dunes. Areas in hectares.

	Site	MG5	MG5a	Total MG5
1	Merthyr Mawr			
2	Kenfig Dunes			
3	Margam Burrows			
4	Baglan Bay			
5	Crymlyn Burrows			
6	Black Pill to BrynMill			
7	Pennard Burrows			
8	Penmaen Burrows			
9	Nicholaston Burrows			
10	Oxwich Burrows			
11	Port-Eynon to Horton			
12	Hillend to Hills Tor			
13	Whiteford Burrows			
14	Pembrey Coast			
15	Laughame Burrows			
16	Pendine Burrows	0.38		0.38
17	Tenby Burrows			
18	Caldey Island			
19	Lydstep Haven			
20	Manorbier/Swanlake			
21	Freshwater Bay East			
22	Stackpole Warren			
23	Brownslade/Linney			
24	Broomhill Burrows			
25	Whitesand Bay			
26	The Bennett			
27	Poppit Sands			
28	Towyn Warren			
29	Ynyslas			
30	Tywyn to Aberdovey	5.69		5.69
31	Fairbourne			
32	Morfa Dyffryn		0.38	0.38
33	Morfa Harlech		0.43	0.43
34	Morfa Bychan			
35	Pwllheli/Pen-y-Chain			
36	Traeth Crugan			
37	Tai Morfa			
38	Morfa Dinlle			
39	Newborough Warren	1.99		1.99
40	Penrhynoedd - Llangadwaladr			
41	Aberffraw			
42	Valley			
43	Tywyn Gwyn			
44A	Traeth Dulas			
44B	Traeth Lligwy			
45	Red Wharf Bay			
46	Conwy/Deganwy			
47	Kinnel Bay			
48	Rhyl to Prestatyn			
49	Gronant to Talacre			
	South Wales Region			
	Dyfed & Mid-Wales Region	0.38		0.38
	North Wales Region	7.68	0.81	8.49
	National Totals	8.06	0.81	8.87

Table 8.6 MG6 and MG7 mesotrophic grasslands in Welsh sand dunes. Areas in hectares.

	Site	MG6	MG6a	MG6b	All MG6	MG7	MG7a	MG7e	All MG7
1	Merthyr Mawr								
2	Kenfig Dunes								
3	Margam Burrows								
4	Baglan Bay								
5	Crymlyn Burrows								
6	Black Pill to Bryn Mill								
7	Pennard Burrows								
8	Penmaen Burrows								
9	Nicholaston Burrows								
10	Oxwich Burrows								
11	Port-Eynon to Horton								
12	Hillend to Hills Tor								
13	Whiteford Burrows								
14	Pembrey Coast					65.38			65.38
15	Laughame Burrows								
16	Pendine Burrows		1.32		1.32	0.08		0.32	0.40
17	Tenby Burrows					0.59			0.59
18	Caldey Island					0.09			0.09
19	Lydstep Haven								
20	Manorbier/Swanlake						0.42		0.42
21	Freshwater Bay East					0.10			0.10
22	Stackpole Warren					5.41			5.41
23	Brownslade/Linney								
24	Broomhill Burrows					13.00		4.22	17.22
25	Whitesand Bay					3.12			3.12
26	The Bennett					0.31			0.31
27	Poppit Sands								
28	Towyn Warren					0.52			0.52
29	Ynyslas		0.49		0.49	0.59			0.59
30	Tywyn to Aberdovey					1.26			1.26
31	Fairbourne					0.79			0.79
32	Morfa Dyffryn	8.12			8.12				
33	Morfa Harlech					1.59		0.02	1.61
34	Morfa Bychan					10.92		2.36	13.28
35	Pwllheli/Pen-y-Chain								
36	Traeth Crugan					2.59			2.59
37	Tai Morfa		0.56		0.56	0.74			0.74
38	Morfa Dinlle								
39	Newborough Warren								
40	Penrhynoedd - Llangadwaladr								
41	Aberffraw								
42	Valley					9.19			9.19
43	Tywyn Gwyn								
44A	Traeth Dulas		0.02	0.17	0.19	0.01			0.01
44B	Traeth Lligwy					0.24			0.24
45	Red Wharf Bay					0.47			0.47
46	Conwy/Deganwy					0.13	0.06	20.99	21.18
47	Kinnel Bay					1.82		0.63	2.45
48	Rhyl to Prestatyn					10.73		8.51	19.24
49	Gronant to Talacre	0.14			0.14	29.46		3.83	33.29
	South Wales Region								
	Dyfed & Mid-Wales Region		1.81		1.81	89.19	0.42	4.54	94.15
	North Wales Region	8.26	0.58	0.17	9.01	69.94	0.06	36.34	106.34
	National Totals	8.26	2.39	0.17	10.82	159.13	0.48	40.88	200.49

Table 8.7 Calcareous grassland types (CG6 and CG7) on Welsh sand dunes. Areas in hectares.

	Site	CG6	CG6/W22	CG7	CG7b	CG7c	Total CG types
1	Merthyr Mawr			0.42			0.42
2	Kenfig Dunes				0.28		0.28
3	Margam Burrows						
4	Baglan Bay						
5	Crymlyn Burrows						
6	Black Pill to Bryn Mill						
7	Pennard Burrows						
8	Penmaen Burrows			0.38			0.38
9	Nicholaston Burrows			0.51			0.51
10	Oxwich Burrows						
11	Port-Eynon to Horton						
12	Hillend to Hills Tor						
13	Whiteford Burrows						
14	Pembrey Coast						
15	Laughame Burrows						
16	Pendine Burrows						
17	Tenby Burrows	19.92					19.92
18	Caldey Island						
19	Lydstep Haven		0.75				0.75
20	Manorbier/Swanlake						
21	Freshwater Bay East	2.96					2.96
22	Stackpole Warren						
23	Brownslade/Linney					0.53	0.53
24	Broomhill Burrows						
25	Whitesand Bay						
26	The Bennett						
27	Poppit Sands						
28	Towyn Warren						
29	Ynyslas						
30	Tywyn to Aberdovey						
31	Fairbourne						
32	Morfa Dyffryn						
33	Morfa Harlech						
34	Morfa Bychan						
35	Pwllheli/Pen-y-Chain			0.01			0.01
36	Traeth Crugan						
37	Tai Morfa						
38	Morfa Dinlle						
39	Newborough Warren						
40	Penrhynoedd - Llangadwaladr						
41	Aberffraw						
42	Valley						
43	Tywyn Gwyn						
44A	Traeth Dulas						
44B	Traeth Lligwy						
45	Red Wharf Bay						
46	Conwy/Deganwy						
47	Kinnel Bay						
48	Rhyl to Prestatyn						
49	Gronant to Talacre						
	South Wales Region			1.31	0.28		1.59
	Dyfed & Mid-Wales Region	22.88	0.75			0.53	24.16
	North Wales Region			0.01			0.01
	National Totals	22.88	0.75	1.32	0.28	0.53	25.76

commonly and total area is 7.4 ha, most of the Welsh resource. It is mainly associated with bare sand in the region of heavy rabbit grazing.

Stands with prominent lichens and low vascular plant cover were mapped as the SD11 *Carex arenaria-Cornicularia aculeata* community but quadrat records suggest that such vegetation is a poor fit to this community. This vegetation type is present in only two sites (Stackpole Warren and Morfa Dinlle) and is associated with local heavy rabbit grazing pressure on thin soils over bedrock. Stands at Stackpole Warren are often a mix of patches dominated by the rare southern lichen *Fulgensia fulgens* or the common *Cladonia impexa*, with some resemblance to the SD11b *Festuca ovina* sub-community (though *F. rubra* is recorded from the single quadrat record in the NVC survey). Total extent is small (1.2 ha). A larger area is recorded at Morfa Dinlle (9.9 ha) but all is anomalous, with very heavy rabbit grazing in areas of shingle and sand allowing an assemblage of annual plants and some lichens, notably *Cladonia rangiformis*, to be developed. These stands contain no *Cornicularia aculeata* or most other SD11 lichen associates: they are mapped as non-NVC vegetation but their character places them as a very anomalous SD11 type. True SD11 vegetation is therefore very rare in Wales and is probably confined to Stackpole Warren, and even there it is somewhat atypical in character.

8.8 Maritime cliff communities on dunes (MC5, MC8, MC9, MC10, MC12)

The edges of some bay dune and climbing dune systems have sand thinning over other soil and rock which is within a zone of heavy salt spray deposition. These areas, all very small in size apart from two larger zones at Kenfig Dunes and Tenby Burrows, support maritime cliff vegetation (Table 8.9). The only extensive type is the MC8 *Festuca rubra-Armeria maritima* community. Most maritime cliff vegetation is only mapped at NVC community level and probably represents spray modification of SD8 *Festuca rubra-Galium verum* dune grassland,

particularly the addition of sea thrift *Armeria maritima*.

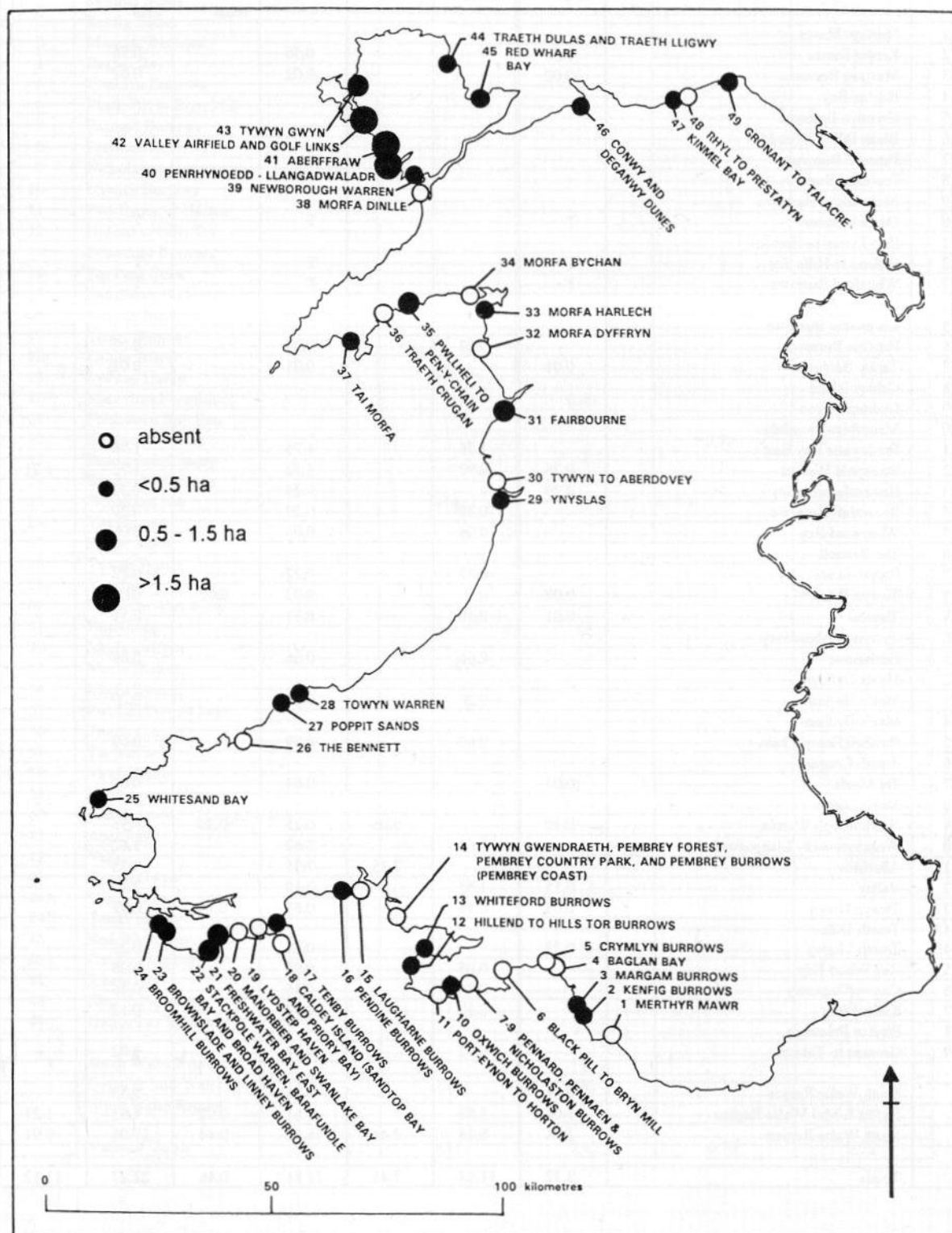


Figure 8.5 Location of sites with SD10 *Carex arenaria* dune.

Table 8.8 SD10 *Carex arenaria* dune and SD11 *Carex arenaria*-*Cornicularia aculeata* dune communities in Wales. Areas in hectares. T = trace, very small extent present and not mapped.

	Site	SD10	SD10a	SD10b	All SD10	SD10 trans.	SD10 total	SD11
1	Merthyr Mawr							
2	Kenfig Dunes	0.56			0.56		0.56	
3	Margam Burrows	0.02			0.02		0.02	
4	Baglan Bay							
5	Crymlyn Burrows							
6	Black Pill to Bryn Mill							
7	Pennard Burrows							
8	Penmaen Burrows							
9	Nicholaston Burrows							
10	Oxwich Burrows	T			T		T	
11	Port-Eynon to Horton							
12	Hillend to Hills Tor	T			T		T	
13	Whiteford Burrows	T			T		T	
14	Pembrey Coast							
15	Laughame Burrows							
16	Pendine Burrows		0.03		0.03		0.03	
17	Tenby Burrows	0.01			0.01		0.01	
18	Caldey Island							
19	Lydstep Haven							
20	Manorbier/Swanlake							
21	Freshwater Bay East		1.76		1.76		1.76	
22	Stackpole Warren	0.75	0.97		1.72		1.72	1.21
23	Brownsdale/Linney	0.29			0.29		0.29	
24	Broomhill Burrows		0.39		0.39		0.39	
25	Whitesand Bay		0.06		0.06		0.06	
26	The Bennett							
27	Poppit Sands		0.22		0.22		0.22	
28	Towyn Warren	0.02			0.02	0.02	0.04	
29	Ynyslas	0.01	0.10		0.11		0.11	
30	Tywyn to Aberdovey							
31	Fairbourne		0.66		0.66		0.66	
32	Morfa Dyffryn							
33	Morfa Harlech		0.20		0.20		0.20	
34	Morfa Bychan							
35	Pwllheli/Pen-y-Chain		0.69		0.69		0.69	
36	Traeth Crugan							
37	Tai Morfa	0.04			0.04		0.04	
38	Morfa Dinlle							9.91
39	Newborough Warren	0.19		0.06	0.25	0.30	0.55	
40	Penrhynoedd - Llangadwaladr		3.62		3.62		3.62	
41	Aberffraw			7.35	7.35		7.35	
42	Valley	0.55	1.55		2.10		2.10	
43	Tywyn Gwyn	0.05	0.78		0.83	0.14	0.97	
44A	Traeth Dulas							
44B	Traeth Lligwy	0.23			0.23		0.23	
45	Red Wharf Bay		0.05		0.05		0.05	
46	Conwy/Deganwy		0.46		0.46		0.46	
47	Kinmel Bay		0.12		0.12		0.12	
48	Rhyl to Prestatyn							
49	Gronant to Talacre		0.02		0.02		0.02	
	South Wales Region	0.58			0.58		0.58	
	Dyfed & Mid-Wales Region	1.08	3.53		4.61	0.02	4.63	1.21
	North Wales Region	1.06	8.15	7.41	16.62	0.44	17.06	9.91
	Totals	2.72	11.68	7.41	21.81	0.46	22.27	11.12

Table 8.9 Maritime cliff vegetation (MC5, MC8, MC9, MC10, MC12) on Welsh sand dunes. Areas in hectares.

	Site	MC5	MC5b	MC5d	MC6
1	Merthyr Mawr				
2	Kenfig Dunes				
3	Margam Burrows				
4	Baglan Bay				
5	Crymlyn Burrows				
6	Black Pill to Bryn Mill				
7	Pennard Burrows				
8	Penmaen Burrows				
9	Nicholaston Burrows				
10	Oxwich Burrows				
11	Port-Eynon to Horton				
12	Hillend to Hills Tor				
13	Whiteford Burrows				
14	Pembrey Coast				
15	Laughame Burrows				
16	Pendine Burrows				
17	Tenby Burrows				
18	Caldey Island				
19	Lydstep Haven				
20	Manorbier/Swanlake		0.43		
21	Freshwater Bay East				
22	Stackpole Warren			0.70	
23	Brownslade/Linney				
24	Broomhill Burrows				
25	Whitesand Bay	0.34			
26	The Bennett				
27	Poppit Sands				
28	Towyn Warren				
29	Ynyslas				
30	Tywyn to Aberdovey				
31	Fairbourne				
32	Morfa Dyffryn				
33	Morfa Harlech				
34	Morfa Bychan				
35	Pwllheli/Pen-y-Chain				
36	Traeth Crugan				
37	Tai Morfa				
38	Morfa Dinlle				
39	Newborough Warren				
40	Penrhynoedd - Llangadwaladr				
41	Aberffraw				
42	Valley				0.72
43	Tywyn Gwyn				
44A	Traeth Dulas				
44B	Traeth Lligwy				
45	Red Wharf Bay				
46	Conwy/Deganwy				
47	Kinmel Bay				
48	Rhyl to Prestatyn				
49	Gronant to Talacre				
	South Wales Region				
	Dyfed & Mid-Wales Region	0.34	0.43	0.70	
	North Wales Region				0.72
	National Totals	0.34	0.43	0.70	0.72

Table 8.9 (continued) Maritime cliff vegetation (MC5, MC8, MC9, MC10, MC12) on Welsh sand dunes. Areas in hectares.

	Site	MC8	MC8a	MC8e	MC8f
1	Merthyr Mawr				
2	Kenfig Dunes	4.52			
3	Margam Burrows				
4	Baglan Bay				
5	Crymlyn Burrows				
6	Black Pill to Bryn Mill				
7	Pennard Burrows				
8	Penmaen Burrows				
9	Nicholaston Burrows				
10	Oxwich Burrows				
11	Port-Eynon to Horton				
12	Hillend to Hills Tor				
13	Whiteford Burrows				
14	Pembrey Coast				
15	Laughame Burrows				
16	Pendine Burrows				
17	Tenby Burrows	5.33			
18	Caldey Island	0.19			
19	Lydstep Haven				
20	Manorbier/Swanlake				
21	Freshwater Bay East				
22	Stackpole Warren				
23	Brownslade/Linney				
24	Broomhill Burrows				0.13
25	Whitesand Bay		0.17		
26	The Bennett				
27	Poppit Sands				
28	Towyn Warren				
29	Ynyslas				
30	Tywyn to Aberdovey				
31	Fairbourne				
32	Morfa Dyffryn				
33	Morfa Harlech				
34	Morfa Bychan				
35	Pwllheli/Pen-y-Chain				
36	Traeth Crugan			0.12	
37	Tai Morfa			0.24	
38	Morfa Dinlle				
39	Newborough Warren				
40	Penrhynoedd - Llangadwaladr	1.18			
41	Aberffraw				
42	Valley		1.11		
43	Tywyn Gwyn		0.10		
44A	Traeth Dulas				
44B	Traeth Lligwy				
45	Red Wharf Bay				
46	Conwy/Deganwy				
47	Kinmel Bay				
48	Rhyl to Prestatyn				
49	Gronant to Talacre				
	South Wales Region	4.52			
	Dyfed & Mid-Wales Region	5.52	0.17		0.13
	North Wales Region	1.18	1.21	0.36	
	National Totals	11.22	1.38	0.36	0.13

Table 8.9 (continued) Maritime cliff vegetation (MC5, MC8, MC9, MC10, MC12) on Welsh sand dunes. Areas in hectares.

	Site	MC9	MC9b	MC10	MC12a	Total MC
1	Merthyr Mawr			0.42		0.42
2	Kenfig Dunes			1.42		5.94
3	Margam Burrows					
4	Baglan Bay					
5	Crymlyn Burrows					
6	Black Pill to Bryn Mill					
7	Pennard Burrows					
8	Penmaen Burrows					
9	Nicholaston Burrows					
10	Oxwich Burrows					
11	Port-Eynon to Horton					
12	Hillend to Hills Tor					
13	Whiteford Burrows					
14	Pembrey Coast					
15	Laughame Burrows					
16	Pendine Burrows					
17	Tenby Burrows					5.33
18	Caldey Island					0.19
19	Lydstep Haven					
20	Manorbier/Swanlake		1.29			1.72
21	Freshwater Bay East					
22	Stackpole Warren				0.26	0.96
23	Brownslade/Linney					
24	Broomhill Burrows					0.13
25	Whitesand Bay		0.46		0.16	1.13
26	The Bennett					
27	Poppit Sands					
28	Towyn Warren					
29	Ynyslas					
30	Tywyn to Aberdovey					
31	Fairbourne					
32	Morfa Dyffryn					
33	Morfa Harlech					
34	Morfa Bychan	0.38	0.47			0.85
35	Pwllheli/Pen-y-Chain					
36	Traeth Crugan					0.12
37	Tai Morfa					0.24
38	Morfa Dinlle					
39	Newborough Warren	1.33				1.33
40	Penrhynoedd - Llangadwaladr					1.18
41	Aberffraw					
42	Valley					1.83
43	Tywyn Gwyn					0.10
44A	Traeth Dulas					
44B	Traeth Lligwy					
45	Red Wharf Bay					
46	Conwy/Deganwy					
47	Kinmel Bay					
48	Rhyl to Prestatyn					
49	Gronant to Talacre					
	South Wales Region			1.84		6.36
	Dyfed & Mid-Wales Region		1.75		0.42	9.46
	North Wales Region	1.71	0.47			5.65
	National Totals	1.71	2.22	1.84	0.42	21.47

9. Dry heath and wet heath

9.1 NVC communities

This section covers dune heath and other dry heath vegetation described in the heathland chapter (H) of the NVC. It also includes wet heath and allied communities which are covered in the mires chapter (M) of the NVC. Virtually all occurrences of heath on Welsh dunes are restricted to sands which are low in calcium carbonate, allowing leaching to produce acidic soils. Such sands are generally restricted to stable areas at the rear or edge of dune systems, often climbing dunes, where there has been sufficient time for leaching to occur.

9.2 H11 *Calluna vulgaris*-*Carex arenaria* dune heath

This type of heathland is exclusively associated with the dune environment and is most clearly separated from more general heath communities by the presence of sand sedge *Carex arenaria*. There are three sub-communities, with the following order to be adopted in the published chapter (Rodwell 1991b):

- H11a *Erica cinerea* sub-community;
- H11b *Empetrum nigrum nigrum* sub-community;
- H11c *Hypnum cupressiforme* sub-community.

The H11 community is rare and total extent is only 40.9 ha (Table 9.1). More than half of the Welsh H11 dune heath area is undifferentiated in terms of sub-communities, including the largest dune heath area in Wales at Crymlyn Burrows (23.1 ha). The H11b sub-community is absent and is probably confined to Scotland. Sites with the remaining two sub-communities all have small extents and are restricted to northern Wales. There is a large area of heath transitional to calcifugous grassland (H11/U5) at Valley. The largest extents of H11 dune heath are in South Wales but the type is more frequent in North Wales, perhaps due to sands which are less calcareous or to acidic soil types (Figure 9.1).

9.3 Other dry heath types (H1, H7, H8, H10, H11)

Six sites contain a very small area of additional NVC heath types but the total extent is very small (2.7 ha, Table 9.2). The largest area at Valley is mapped as transitional to H11 dune heath (1.5 ha, H8/H11). Additional dry heath is therefore very rare in Wales.

9.4 Wet heath (M15 *Scirpus cespitosus*-*Erica tetralix*)

Wet heath on dunes, as elsewhere, is characterised by the occurrence of cross-leaved heath *Erica tetralix*. A solitary case of M15 *Scirpus cespitosus*-*Erica tetralix* wet heath is recorded for Wales as a small damp depression at Kenfig which is mapped as transitional to H11 dune heath (Table 9.1). No clear wet heath is therefore found in Wales.

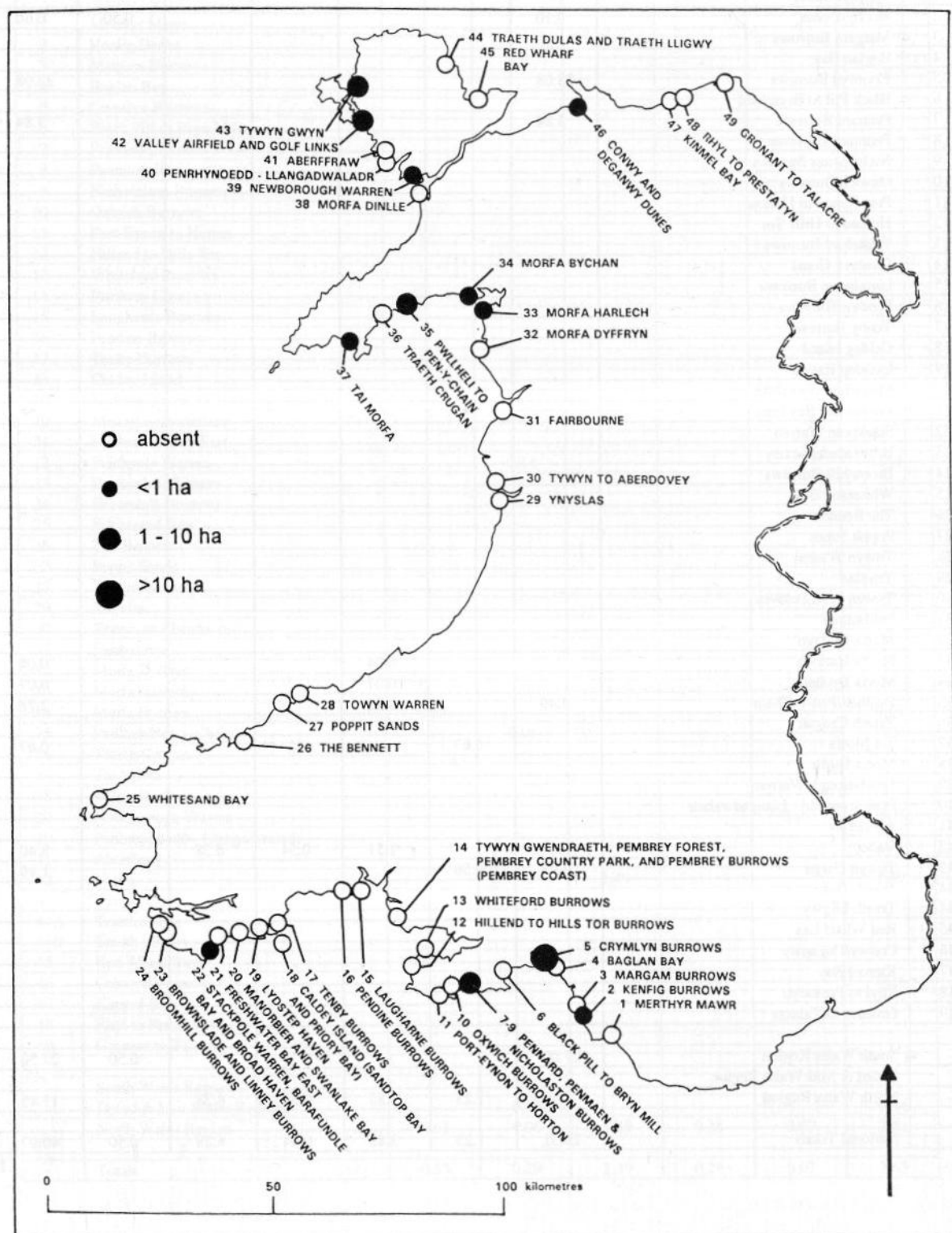


Figure 9.1 Distribution of H11 *Calluna vulgaris*-*Carex arenaria* dune heath and other dry heath types (H1, H7, H8, H10) on Welsh dunes.

Table 9.1 H11 *Calluna vulgaris*-*Carex arenaria* dune heath in Wales. Areas in hectares.

	Site	H11	H11a	H11c	H11/ W23	H11/U5	H11/ M15	All H11
1	Merthyr Mawr							
2	Kenfig Dunes	0.10					0.50	0.60
3	Margam Burrows							
4	Baglan Bay							
5	Crymlyn Burrows	23.08						23.08
6	Black Pill to Bryn Mill							
7	Pennard Burrows	3.84						3.84
8	Penmaen Burrows							
9	Nicholaston Burrows							
10	Oxwich Burrows							
11	Port-Eynon to Horton							
12	Hillend to Hills Tor							
13	Whiteford Burrows							
14	Pembrey Coast							
15	Laughame Burrows							
16	Pendine Burrows							
17	Tenby Burrows							
18	Caldey Island							
19	Lydstep Haven							
20	Manorbier/Swanlake							
21	Freshwater Bay East							
22	Stackpole Warren							
23	Brownslade/Linney							
24	Broomhill Burrows							
25	Whitesand Bay							
26	The Bennett							
27	Poppit Sands							
28	Towyn Warren							
29	Ynyslas							
30	Tywyn to Aberdovey							
31	Fairbourne							
32	Morfa Dyffryn							
33	Morfa Harlech			0.04				0.04
34	Morfa Bychan			0.07				0.07
35	Pwllheli/Pen-y-Chain	0.49		2.23				2.78
36	Traeth Crugan							
37	Tai Morfa		0.67					0.67
38	Morfa Dinlle							
39	Newborough Warren							
40	Penrhynoedd - Llangadwaladr							
41	Aberffraw							
42	Valley	0.07		1.51	0.54	6.28		8.40
43	Tywyn Gwyn	0.93	0.56					1.49
44A	Traeth Dulas							
44B	Traeth Lligwy							
45	Red Wharf Bay							
46	Conwy/Deganwy							
47	Kinmel Bay							
48	Rhyl to Prestatyn							
49	Gronant to Talacre							
	South Wales Region	27.02					0.50	27.52
	Dyfed & Mid-Wales Region							
	North Wales Region	1.49	1.23	3.85	0.54	6.28		13.45
	National Totals	28.51	1.23	3.85	0.54	6.28	0.50	40.97

Table 9.2 Other dry heath types on dunes in Wales (H1, H7, H8, H10). Areas in hectares.

	Site	H1	H7e	H8/H11	H10	H10a	Total all other heath
1	Merthyr Mawr						
2	Kenfig Dunes						
3	Margam Burrows						
4	Baglan Bay						
5	Crymlyn Burrows						
6	Black Pill to Bryn Mill						
7	Pennard Burrows						
8	Penmaen Burrows						
9	Nicholaston Burrows						
10	Oxwich Burrows						
11	Port-Eynon to Horton						
12	Hillend to Hills Tor						
13	Whiteford Burrows						
14	Pembrey Coast						
15	Laughame Burrows						
16	Pendine Burrows						
17	Tenby Burrows						
18	Caldey Island						
19	Lydstep Haven						
20	Manorbier/Swanlake						
21	Freshwater Bay East						
22	Stackpole Warren		0.14				0.14
23	Brownslade/Linney						
24	Broomhill Burrows						
25	Whitesand Bay						
26	The Bennett						
27	Poppit Sands						
28	Towyn Warren						
29	Ynyslas						
30	Tywyn to Aberdovey						
31	Fairbourne						
32	Morfa Dyffryn						
33	Morfa Harlech						
34	Morfa Bychan	0.63					0.63
35	Pwllheli/Pen-y-Chain		0.06				0.06
36	Traeth Crugan						
37	Tai Morfa						
38	Morfa Dinlle						
39	Newborough Warren					0.07	0.07
40	Penrhynoedd - Llangadwaladr						
41	Aberffraw						
42	Valley			1.49			1.49
43	Tywyn Gwyn						
44A	Traeth Dulas						
44B	Traeth Lligwy						
45	Red Wharf Bay						
46	Conwy/Deganwy				0.26		0.26
47	Kinmel Bay						
48	Rhyl to Prestatyn						
49	Gronant to Talacre						
	South Wales Region						
	Dyfed & Mid-Wales Region		0.14				0.14
	North Wales Region	0.63	0.06	1.49	0.26	0.07	2.51
	Totals	0.63	0.20	1.49	0.26	0.07	2.65

10. Dune wetlands

10.1 NVC communities and rare species

Dune wetlands comprise dune slack communities (SD13, SD14, SD15, SD16, SD17), plus a wide range of mire (NVC M chapter), swamp and tall-herb fen (NVC S chapter), wet mesotrophic grassland types (NVC MG chapter) and aquatic vegetation. In addition some forms of wet woodland occur (NVC W chapter) if grazing is relaxed and trees tolerant of wet conditions can invade. This diversity of types reflects the range of moisture and successional conditions in which dune wetland is established, including the swampy edges of open water in some dune systems.

Slack communities in Wales are habitats for several rare and nationally scarce vascular and pteridophyte species: *Epipactis dunensis*, *Equisetum variegatum*, *Gentianella uliginosa* and *Liparis loeselii*. Rare mosses and liverworts also occur, e.g. *Petalophyllum ralfsii*.

10.2 Dune slack communities (SD13–SD17)

The five NVC dune slack communities represent vegetation developed in relation to soil pH, water regime and successional stage. SD13 and SD14 represent early succession types. SD17 is recognised as more acidic in character than other mature types. SD15 and SD16 types cover more basic slacks, with SD15 representing vegetation with a swamp/tall-herb fen character and SD16 drier conditions. Sub-communities of all types are probably related to different water regime characteristics.

Total slack area (the sum of all SD13–SD17 types, including transitions) is 614.6 ha (Table 10.1), with a very uneven distribution between sites. Large extents are present at Kenfig (130.7 ha) and Newborough Warren (128.7 ha) and six other sites (Whiteford, Pembrey Coast, Laugharne Burrows, Morfa Dyffryn, Morfa Harlech, Aberffraw) have extents >30 ha (Figure 10.1). Areas in other sites are usually much smaller and 23 sites have no slack habitat

at all. The large extents in a few sites result from parabolic dune activity in large hindshore and spit dunes, plus slacks formed between ridges in large prograding systems or imbricated spits. The small sand area and a lack of deep depressions close to a water table are the principal reasons for the low extent or absence of slacks in many bay and climbing dunes.

SD13 *Salix repens*-*Bryum pseudotriquetrum* dune slack

This is a very rare community (15.1 ha, three sites) and is largely confined to the Kenfig Dunes, plus a small area at Newborough Warren and very small patches at Whiteford Burrows (Table 10.1). Most is mapped only at community level but small areas of the SD13b *Holcus lanatus*-*Festuca rubra* sub-community are recorded at Kenfig and Newborough Warren.

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

This is the commonest young succession dune slack type and all four sub-communities are recorded for Wales. Total extent is 137.5 ha, most of this area being in South Wales (Table 10.2). Only ten sites have the community and hence it is uncommon. A large proportion of the community either is not differentiated into sub-communities (25.1 ha) or is recorded as intermediate between SD14 and SD15 (36.6 ha). The SD14a *Carex serotina*-*Drepanocladus sendtneri* sub-community is very rare (0.7 ha, only at Newborough Warren). The SD14b *Rubus caesius*-*Galium palustre* sub-community is the most extensive (52.1 ha) but is only mapped for Kenfig and Margam Burrows in South Wales. The SD14c *Bryum pseudotriquetrum*-*Aneura pinguis* sub-community is recorded from only three sites and most of the total area (5.0 ha) is found at Newborough Warren. The SD14d *Festuca rubra* sub-community is recorded from two sites but is of moderate extent (18.0 ha), almost all of this at Kenfig. Overall, the most important location by far is Kenfig with 80.8 ha. There is no clear explanation for the abundance of young slacks in this site.

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

Seventeen sites have this community. Total extent including transitions is 133.4 ha, with the largest areas in South Wales and Dyfed/Mid-Wales (Table 10.3). The sites with the largest areas are Kenfig (34.0 ha) and Laugharne Burrows (30.0 ha). More than half of the mapped area is not differentiated into sub-communities. The SD15a *Carex nigra*, SD15b *Equisetum variegatum* and SD15c *Carex flacca*-*Pulicaria dysenterica* sub-communities are all moderately extensive (16.9–20.0 ha) but the SD15d *Holcus lanatus*-*Angelica sylvestris* sub-community is recorded from only two sites and has a small total area (1.4 ha).

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

Seventeen sites have this community but the total extent (including transitions) of 225.2 ha (Table 10.4) is largely found at only four locations: Newborough Warren (97.4 ha), Pembrey Coast (35.6 ha), Aberffraw (29.1 ha) and Morfa Dyffryn (25.3 ha). It is the most extensive slack community type in Wales. More than half of total mapped area is not differentiated into sub-communities. The four sub-communities (SD16a *Ononis repens*, SD16b *Rubus caesius*, SD16c *Prunella vulgaris*-*Equisetum variegatum*, SD16d *Agrostis stolonifera*) range in total area between 6.8 and 38.2 ha, with almost all found in North Wales. Transitions are very rare and the total area involved is very small.

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

Twenty sites have this community but the total extent of 103.4 ha is largely found in North Wales, with one site (Morfa Harlech, 45.2 ha) predominant (Table 10.5). A large proportion of the Morfa Harlech area is a transition to saltmarsh (SD17/SM18, 14.7 ha), the only large slack/saltmarsh transition in Wales. Other transitions are rare and of low extent. A large proportion of SD17 extent is not differentiated into sub-communities (17.8 ha). All sub-communities are present (SD17a *Festuca rubra*-*Ranunculus repens*, SD17b *Carex flacca*, SD17c *Caltha palustris*, SD17d *Hydrocotyle*

vulgaris-*Ranunculus flammula*), with total areas ranging from 7.4 ha for SD17a to 33.0 ha for SD17d. Transitions between sub-communities are mapped in a small number of sites.

10.3 Mire communities on sand dunes in Wales

A diverse set of seven NVC mire communities (excluding M15 wet heath: see Chapter 9) is found on surveyed dunes (Table 10.6), though total extent is small (29.4 ha) and only fifteen sites have any occurrence (Morfa Bychan, Newborough Warren and Aberffraw are the only sites with >5 ha of mire). Most mire communities and sub-communities occur in small quantities but two types, M27 *Filipendula ulmaria*-*Angelica sylvestris* mire (8.7 ha) and M28 *Iris pseudacorus*-*Filipendula ulmaria* mire (14.4 ha), are present in a few large stands. The NVC syntaxonomy of other mires listed in Table 10.6 is given in Table 4.1. Mire habitat is very rare in South Wales and Dyfed/Mid-Wales. It is concentrated in North Wales and might reflect a combination of acidic wetland, higher rainfall and lower evapotranspiration compared with other parts of coastal Wales.

10.4 Swamps and tall-herb fens on sand dunes in Wales

As with mires, a diverse set of swamp and fen types (fifteen NVC communities) is present on Welsh dunes covering a total area of 70.8 ha (Table 10.7). Most communities, sub-communities and transitions occur in only a few sites and as small extents. The exceptions are S4 *Phragmites australis* swamp (36.5 ha, including one large transition area at Pembrey to S21 *Scirpus maritimus* swamp) and S7 *Carex acutiformis* swamp (12.6 ha, all at Brownslade/Linney Burrows). Thirty sites have some form of swamp (Figure 10.2) but large extents (>10 ha) are restricted to Pembrey Coast, Laugharne Burrows and Brownslade/Linney Burrows. The most diverse set of swamp communities and sub-communities is found at Gronant to Talacre (nine types), followed by Laugharne Burrows with seven

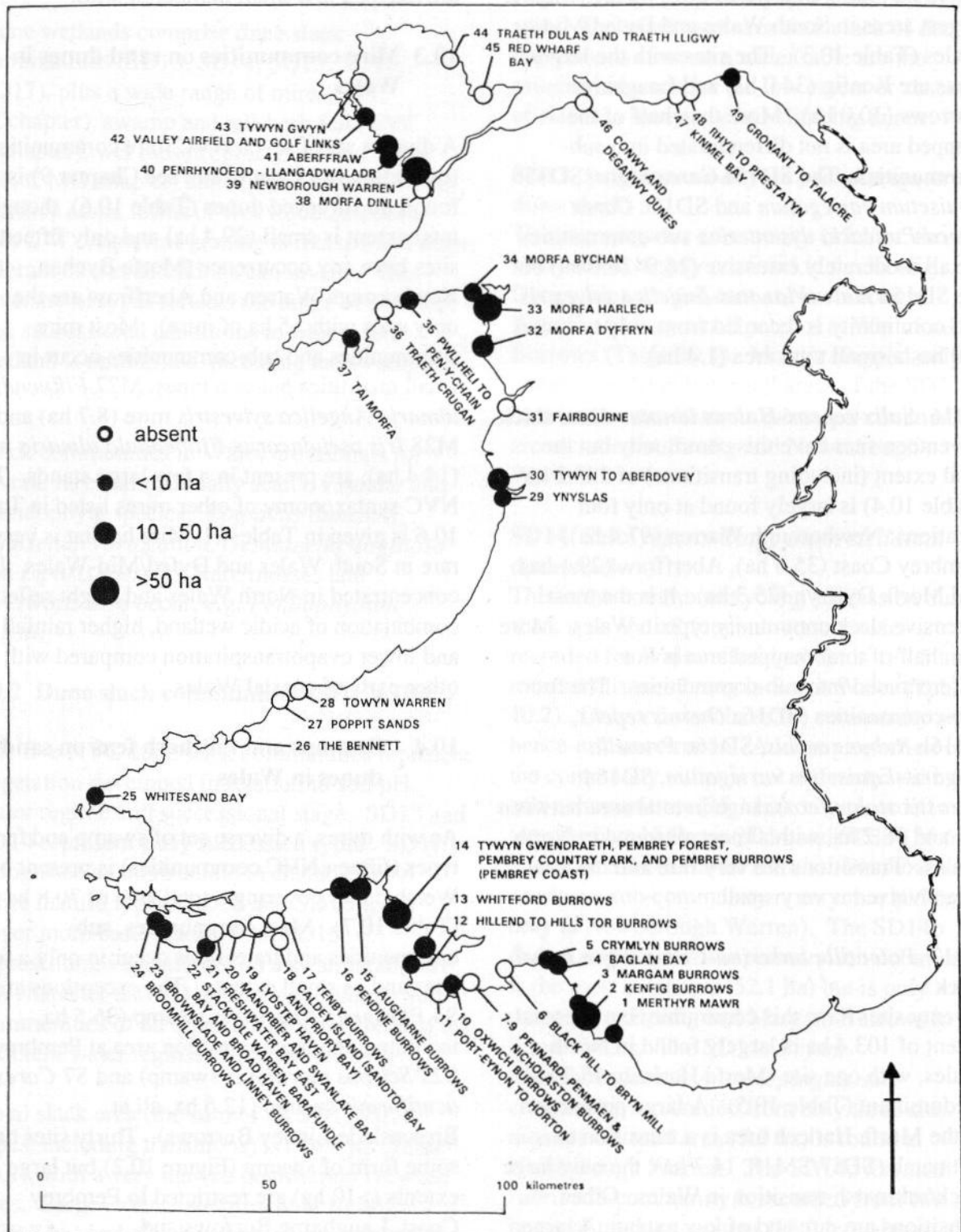


Figure 10.1 Location of sites with dune slack vegetation (SD13–SD17) in Wales.

Table 10.1 Total slack (SD13–SD17) areas and SD13 *Salix repens*-*Bryum pseudotriquetrum* dune slack in Wales. Areas in hectares.

	Site	Total slack area	SD13	SD13b	All SD13
1	Merthyr Mawr	7.08			
2	Kenfig Dunes	130.69	13.22	0.42	13.64
3	Margam Burrows	4.74			
4	Baglan Bay	0.30			
5	Crymlyn Burrows	2.00			
6	Black Pill to Bryn Mill				
7	Pennard Burrows				
8	Penmaen Burrows				
9	Nicholaston Burrows				
10	Oxwich Burrows	8.85			
11	Port-Eynon to Horton				
12	Hillend to Hills Tor	6.34			
13	Whiteford Burrows	32.57			T
14	Pembrey Coast	65.18			
15	Laughame Burrows	32.17			
16	Pendine Burrows	12.68			
17	Tenby Burrows				
18	Caldey Island				
19	Lydstep Haven				
20	Manorbier/Swanlake				
21	Freshwater Bay East				
22	Stackpole Warren	0.02			
23	Brownslade/Linney	0.72			
24	Broomhill Burrows	1.63			
25	Whitesand Bay	0.07			
26	The Bennett				
27	Poppit Sands				
28	Towyn Warren				
29	Ynyslas	3.63			
30	Tywyn to Aberdovey	14.59			
31	Fairbourne				
32	Morfa Dyffryn	37.78			
33	Morfa Harlech	65.03			
34	Morfa Bychan	5.11			
35	Pwllheli/Pen-y-Chain	0.32			
36	Traeth Crugan				
37	Tai Morfa	1.35			
38	Morfa Dinlle				
39	Newborough Warren	128.68		1.49	1.49
40	Penrhynoedd - Llangadwaladr	2.09			
41	Aberffraw	44.12			
42	Valley	5.43			
43	Tywyn Gwyn				
44A	Traeth Dulas				
44B	Traeth Lligwy				
45	Red Wharf Bay				
46	Conwy/Deganwy				
47	Kinmel Bay				
48	Rhyl to Prestatyn				
49	Gronant to Talacre	1.43			
	South Wales Region	192.57	13.22	0.42	13.64
	Dyfed & Mid-Wales Region	116.10			
	North Wales Region	305.93		1.49	1.49
	National Totals	614.60	13.22	1.91	15.13

Table 10.2 SD14 *Salix repens*-*Campyllum stellatum* dune slack community in Wales. Areas in hectares.

	Site	SD14	SD14a	SD14b	SD14c	SD14d	SD14/ SD15	All SD14
1	Merthyr Mawr	0.06			0.77			0.83
2	Kenfig Dunes	14.75		48.55		17.55		80.85
3	Margam Burrows			3.54				3.54
4	Baglan Bay							
5	Crymlyn Burrows							
6	Black Pill to Bryn Mill							
7	Pennard Burrows							
8	Penmaen Burrows							
9	Nicholaston Burrows							
10	Oxwich Burrows						5.13	5.13
11	Port-Eynon to Horton							
12	Hillend to Hills Tor						2.88	2.88
13	Whiteford Burrows						15.00	15.00
14	Pembrey Coast						13.62	13.62
15	Laughame Burrows							
16	Pendine Burrows							
17	Tenby Burrows							
18	Caldey Island							
19	Lydstep Haven							
20	Manorbier/Swanlake							
21	Freshwater Bay East							
22	Stackpole Warren							
23	Brownslade/Linney							
24	Broomhill Burrows							
25	Whitesand Bay				0.07			0.07
26	The Bennett							
27	Poppit Sands							
28	Towyn Warren							
29	Ynyslas							
30	Tywyn to Aberdovey							
31	Fairbourne							
32	Morfa Dyffryn	0.55						0.55
33	Morfa Harlech							
34	Morfa Bychan							
35	Pwllheli/Pen-y-Chain							
36	Traeth Crugan							
37	Tai Morfa							
38	Morfa Dinlle							
39	Newborough Warren	9.74	0.68		4.12	0.47		15.01
40	Penrhynoedd - Llangadwaladr							
41	Aberffraw							
42	Valley							
43	Tywyn Gwyn							
44A	Traeth Dulas							
44B	Traeth Lligwy							
45	Red Wharf Bay							
46	Conwy/Deganwy							
47	Kinmel Bay							
48	Rhyl to Prestatyn							
49	Gronant to Talacre							
	South Wales Region	14.81		52.09	0.77	17.55	23.01	108.23
	Dyfed & Mid-Wales Region				0.07		13.62	13.69
	North Wales Region	10.29	0.68		4.12	0.47		15.56
	National Totals	25.10	0.68	52.09	4.96	18.02	36.63	137.48

Table 10.3 SD15 *Salix repens*-*Calliergon cuspidatum* dune slack community in Wales. Areas in hectares.

	Site	SD15	SD15a	SD15b	SD15c	SD15d
1	Merthyr Mawr					
2	Kenfig Dunes	20.56	6.81	6.60	0.07	
3	Margam Burrows	0.91	0.29			
4	Baglan Bay		0.30			
5	Crymlyn Burrows					
6	Black Pill to Bryn Mill					
7	Pennard Burrows					
8	Penmaen Burrows					
9	Nicholaston Burrows					
10	Oxwich Burrows				2.56	
11	Port-Eynon to Horton					
12	Hillend to Hills Tor				3.20	
13	Whiteford Burrows				11.54	
14	Pembrey Coast	15.06				
15	Laughame Burrows	30.00				
16	Pendine Burrows	0.08	7.35	0.13		0.21
17	Tenby Burrows					
18	Caldey Island					
19	Lydstep Haven					
20	Manorbier/Swanlake					
21	Freshwater Bay East					
22	Stackpole Warren			0.02		
23	Brownslade/Linney					
24	Broomhill Burrows				0.46	
25	Whitesand Bay					
26	The Bennett					
27	Poppit Sands					
28	Towyn Warren					
29	Ynyslas				0.02	
30	Tywyn to Aberdovey					
31	Fairbourne					
32	Morfa Dyffryn	1.55				
33	Morfa Harlech	2.01			0.70	
34	Morfa Bychan					
35	Pwllheli/Pen-y-Chain					
36	Traeth Crugan					
37	Tai Morfa					
38	Morfa Dinlle					
39	Newborough Warren	2.87	2.17	8.75		
40	Penrhynoedd - Llangadwaladr					
41	Aberffraw			4.46		
42	Valley					
43	Tywyn Gwyn					
44A	Traeth Dulas					
44B	Traeth Lligwy					
45	Red Wharf Bay					
46	Conwy/Deganwy					
47	Kinmel Bay					
48	Rhyl to Prestatyn					
49	Gronant to Talacre	0.22				1.16
	South Wales Region	21.47	7.40	6.60	17.37	
	Dyfed & Mid-Wales Region	45.14	7.35	0.15	0.48	0.21
	North Wales Region	6.65	2.17	13.21	0.70	1.16
	National Totals	73.26	16.92	19.96	18.55	1.37

Table 10.3 (continued) SD15 *Salix repens*-*Calliergon cuspidatum* dune slack community in Wales. Areas in hectares.

	Site	SD15/SD16	SD15/M28	SD15/other wetland	SD15/W1	All SD15
1	Merthyr Mawr					
2	Kenfig Dunes					34.04
3	Margam Burrows					1.20
4	Baglan Bay					0.30
5	Crymlyn Burrows					
6	Black Pill to Bryn Mill					
7	Pennard Burrows					
8	Penmaen Burrows					
9	Nicholaston Burrows					
10	Oxwich Burrows					2.56
11	Port-Eynon to Horton					
12	Hillend to Hills Tor					3.20
13	Whiteford Burrows					11.54
14	Pembrey Coast					15.06
15	Laughame Burrows					30.00
16	Pendine Burrows	0.41	2.44		0.03	10.65
17	Tenby Burrows					
18	Caldey Island					
19	Lydstep Haven					
20	Manorbier/Swanlake					
21	Freshwater Bay East					
22	Stackpole Warren					0.02
23	Brownsdale/Linney					
24	Broomhill Burrows					0.46
25	Whitesand Bay					
26	The Bennett					
27	Poppit Sands					
28	Towyn Warren					
29	Ynyslas			0.44		0.46
30	Tywyn to Aberdovey					
31	Fairbourne					
32	Morfa Dyffryn					1.55
33	Morfa Harlech					2.71
34	Morfa Bychan					
35	Pwllheli/Pen-y-Chain					
36	Traeth Crugan					
37	Tai Morfa					
38	Morfa Dinlle					
39	Newborough Warren					13.79
40	Penrhynoedd - Llangadwaladr					
41	Aberffraw					4.46
42	Valley					
43	Tywyn Gwyn					
44A	Traeth Dulas					
44B	Traeth Lligwy					
45	Red Wharf Bay					
46	Conwy/Deganwy					
47	Kinmel Bay					
48	Rhyl to Prestatyn					
49	Gronant to Talacre					1.38
	South Wales Region					52.84
	Dyfed & Mid-Wales Region	0.41	2.44	0.44	0.03	56.65
	North Wales Region					23.89
	National Totals	0.41	2.44	0.44	0.03	133.38

Table 10.4 SD16 *Salix repens*-*Holcus lanatus* dune slack community in Wales. Areas in hectares.

	Site	SD16	SD16a	SD16b	SD16c	SD16c/d	SD16d
1	Merthyr Mawr	1.78		0.83	1.27		
2	Kenfig Dunes	1.12	0.10				
3	Margam Burrows						
4	Baglan Bay						
5	Crymlyn Burrows	0.85					
6	Black Pill to Bryn Mill						
7	Pennard Burrows						
8	Penmaen Burrows						
9	Nicholaston Burrows						
10	Oxwich Burrows	1.03					
11	Port-Eynon to Horton						
12	Hillend to Hills Tor	0.26					
13	Whiteford Burrows	5.77					
14	Pembrey Coast	35.58					
15	Laughame Burrows	2.17					
16	Pendine Burrows		0.07		0.53		0.70
17	Tenby Burrows						
18	Caldey Island						
19	Lydstep Haven						
20	Manorbier/Swanlake						
21	Freshwater Bay East						
22	Stackpole Warren						
23	Brownslade/Linney						
24	Broomhill Burrows				0.61	0.10	0.10
25	Whitesand Bay						
26	The Bennett						
27	Poppit Sands						
28	Towyn Warren						
29	Ynyslas		0.02				
30	Tywyn to Aberdovey						
31	Fairbourne						
32	Morfa Dyffryn	25.26					
33	Morfa Harlech	17.00					0.15
34	Morfa Bychan						
35	Pwllheli/Pen-y-Chain						
36	Traeth Crugan						
37	Tai Morfa						
38	Morfa Dinlle						
39	Newborough Warren	39.10	10.95	5.92	15.42		25.44
40	Penrhynoedd - Llangadwaladr						
41	Aberffraw	6.31	2.48			9.33	11.02
42	Valley	1.50			0.99		0.81
43	Tywyn Gwyn						
44A	Traeth Dulas						
44B	Traeth Lligwy						
45	Red Wharf Bay						
46	Conwy/Deganwy						
47	Kinmel Bay						
48	Rhyl to Prestatyn						
49	Gronant to Talacre	0.02				0.03	
	South Wales Region	10.81	0.10	0.83	1.27		
	Dyfed & Mid-Wales Region	37.75	0.09		1.14	0.10	0.80
	North Wales Region	89.19	13.43	5.92	16.41	9.36	37.42
	National Totals	137.75	13.62	6.75	18.82	9.46	38.22

Table 10.4 (continued) SD16 *Salix repens*-*Holcus lanatus* dune slack community in Wales. Areas in hectares.

	Site	SD16/M27	SD16/MG1	SD16/SD18	All SD16
1	Merthyr Mawr				3.88
2	Kenfig Dunes				1.22
3	Margam Burrows				
4	Baglan Bay				
5	Crymlyn Burrows				0.85
6	Black Pill to Bryn Mill				
7	Pennard Burrows				
8	Penmaen Burrows				
9	Nicholaston Burrows				
10	Oxwich Burrows				1.03
11	Port-Eynon to Horton				
12	Hillend to Hills Tor				0.26
13	Whiteford Burrows				5.77
14	Pembrey Coast				35.58
15	Laughame Burrows				2.17
16	Pendine Burrows				1.3
17	Tenby Burrows				
18	Caldey Island				
19	Lydstep Haven				
20	Manorbier/Swanlake				
21	Freshwater Bay East				
22	Stackpole Warren				
23	Brownslade/Linney				
24	Broomhill Burrows				0.81
25	Whitesand Bay				
26	The Bennett				
27	Poppit Sands				
28	Towyn Warren				
29	Ynyslas				0.02
30	Tywyn to Aberdovey				
31	Fairbourne				
32	Morfa Dyffryn				25.26
33	Morfa Harlech				17.15
34	Morfa Bychan				
35	Pwllheli/Pen-y-Chain				
36	Traeth Crugan				
37	Tai Morfa				
38	Morfa Dinlle				
39	Newborough Warren	0.13	0.33	0.12	97.41
40	Penrhynoedd - Llangadwaladr				
41	Aberffraw				29.14
42	Valley				3.30
43	Tywyn Gwyn				
44A	Traeth Dulas				
44B	Traeth Lligwy				
45	Red Wharf Bay				
46	Conwy/Deganwy				
47	Kinnel Bay				
48	Rhyl to Prestatyn				
49	Gronant to Talacre				0.05
	South Wales Region				13.01
	Dyfed & Mid-Wales Region				39.88
	North Wales Region	0.13	0.33	0.12	172.31
	National Totals	0.13	0.33	0.12	225.20

Table 10.5 SD17 *Potentilla anserina*-*Carex nigra* dune slack community in Wales. Areas in hectares.

	Site	SD17	SD17a	SD17b	SD17b/d	SD17c	SD17c/d	SD17d
1	Merthyr Mawr	2.37						
2	Kenfig Dunes							0.47
3	Margam Burrows							
4	Baglan Bay							
5	Crymlyn Burrows	1.15						
6	Black Pill to Bryn Mill							
7	Pennard Burrows							
8	Penmaen Burrows							
9	Nicholaston Burrows							
10	Oxwich Burrows	0.13						
11	Port-Eynon to Horton							
12	Hillend to Hills Tor							
13	Whiteford Burrows	0.26						
14	Pembrey Coast	0.92						
15	Laughame Burrows							
16	Pendine Burrows			0.59				0.07
17	Tenby Burrows							
18	Caldey Island							
19	Lydstep Haven							
20	Manorbier/Swanlake							
21	Freshwater Bay East							
22	Stackpole Warren							
23	Brownslade/Linney	0.72						
24	Broomhill Burrows							0.23
25	Whitesand Bay							
26	The Bennett							
27	Poppit Sands							
28	Towyn Warren							
29	Ynyslas	0.35		1.00		0.16	0.06	1.58
30	Tywyn to Aberdovey		3.88	3.18		5.65		1.88
31	Fairbourne							
32	Morfa Dyffryn	6.88		0.04		0.40		2.93
33	Morfa Harlech	0.39		7.27		3.75		17.93
34	Morfa Bychan	0.31	1.67	2.93				0.20
35	Pwllheli/Pen-y-Chain	0.32						
36	Traeth Crugan							
37	Tai Morfa	0.84						0.51
38	Morfa Dinlle							
39	Newborough Warren	0.02	0.48			0.04		0.44
40	Penrhynoedd - Llangadwaladr	2.09						
41	Aberffraw	1.05			2.67		0.27	6.32
42	Valley		1.34	0.15				0.46
43	Tywyn Gwyn							
44A	Traeth Dulas							
44B	Traeth Lligwy							
45	Red Wharf Bay							
46	Conwy/Deganwy							
47	Kinmel Bay							
48	Rhyl to Prestatyn							
49	Gronant to Talacre							
	South Wales Region	3.91						0.47
	Dyfed & Mid-Wales Region	1.99		1.59		0.16	0.06	1.88
	North Wales Region	11.90	7.37	13.57	2.67	9.84	0.27	30.67
	National Totals	17.80	7.37	15.16	2.67	10.00	0.33	33.02

Table 10.5 (continued) SD17 *Potentilla anserin-Carex nigra* dune slack community in Wales.
Areas in hectares.

	Site	SD17/U4	SD17/W1	SD17/S10	SD17/S20
1	Merthyr Mawr				
2	Kenfig Dunes				
3	Margam Burrows				
4	Baglan Bay				
5	Crymlyn Burrows				
6	Black Pill to Bryn Mill				
7	Pennard Burrows				
8	Penmaen Burrows				
9	Nicholaston Burrows				
10	Oxwich Burrows				
11	Port-Eynon to Horton				
12	Hillend to Hills Tor				
13	Whiteford Burrows				
14	Pembrey Coast				
15	Laughame Burrows				
16	Pendine Burrows				
17	Tenby Burrows				
18	Caldey Island				
19	Lydstep Haven				
20	Manorbier/Swanlake				
21	Freshwater Bay East				
22	Stackpole Warren				
23	Brownslade/Linney				
24	Broomhill Burrows				
25	Whitesand Bay				
26	The Bennett				
27	Poppit Sands				
28	Towyn Warren				
29	Ynyslas				
30	Tywyn to Aberdovey				
31	Fairbourne				
32	Morfa Dyffryn			0.06	
33	Morfa Harlech		0.84		0.33
34	Morfa Bychan				
35	Pwllheli/Pen-y-Chain				
36	Traeth Crugan				
37	Tai Morfa				
38	Morfa Dinlle				
39	Newborough Warren				
40	Penrhynoedd - Llangadwaladr				
41	Aberffraw	0.21			
42	Valley				
43	Tywyn Gwyn				
44A	Traeth Dulas				
44B	Traeth Lligwy				
45	Red Wharf Bay				
46	Conwy/Deganwy				
47	Kinmel Bay				
48	Rhyl to Prestatyn				
49	Gronant to Talacre				
	South Wales Region				
	Dyfed & Mid-Wales Region				
	North Wales Region	0.21	0.84	0.06	0.33
	National Totals	0.21	0.84	0.06	0.33

Table 10.5 (continued) SD17 *Potentilla anserina*-*Carex nigra* dune slack community in Wales. Areas in hectares.

	Site	SD17/ MG1	SD17/ MG11	SD17/ M14	SD17/ M27	SD17/ SM18	SD17/ other wetland	All SD17
1	Merthyr Mawr							2.37
2	Kenfig Dunes		0.47					0.94
3	Margam Burrows							
4	Baglan Bay							
5	Crymlyn Burrows							1.15
6	Black Pill To Bryn Mill							
7	Pennard Burrows							
8	Penmaen Burrows							
9	Nicholaston Burrows							
10	Oxwich Burrows							0.13
11	Port-Eynon To Horton							
12	Hillend To Hills Tor							
13	Whiteford Burrows							0.26
14	Pembrey Coast							0.92
15	Laughame Burrows							
16	Pendine Burrows	0.07						0.73
17	Tenby Burrows							
18	Caldey Island							
19	Lydstep Haven							
20	Manorbier/Swanlake							
21	Freshwater Bay East							
22	Stackpole Warren							
23	Brownsdale/Linney							0.72
24	Broomhill Burrows						0.13	0.36
25	Whitesand Bay							
26	The Bennett							
27	Poppit Sands							
28	Towyn Warren							
29	Ynyslas							3.15
30	Tywyn To Aberdovey							14.59
31	Fairbourne							
32	Morfa Dyffryn				0.11			10.42
33	Morfa Harlech					14.66		45.17
34	Morfa Bychan							5.11
35	Pwllheli/Pen-y-Chain							0.32
36	Traeth Crugan							
37	Tai Morfa							1.35
38	Morfa Dinlle							
39	Newborough Warren							0.98
40	Penrhynoedd - Llangadwaladr							2.09
41	Aberffraw							10.52
42	Valley			0.09	0.09			2.13
43	Tywyn Gwyn							
44A	Traeth Dulas							
44B	Traeth Lligwy							
45	Red Wharf Bay							
46	Conwy/Deganwy							
47	Kinnel Bay							
48	Rhyl To Prestatyn							
49	Gronant To Talacre							
	South Wales Region		0.47					4.85
	Dyfed & Mid-Wales Region	0.07					0.13	5.88
	North Wales Region			0.09	0.20	14.66		92.68
	National Totals	0.07	0.47	0.09	0.20	14.66	0.13	103.41

types. The largest regional extents are found in Dyfed and Mid-Wales where there are sizeable swampy margins to open water or upper saltmarsh in several sites (notably Pembrey Coast, Laugharne Burrows and Brownslade/Linney on the southern coast). The regional pattern in swamp and tall-herb fens is therefore different from that for mire habitats.

10.5 Wet mesotrophic grasslands on sand dunes in Wales

Five NVC mesotrophic grassland communities are mapped on Welsh dunes but these are recorded for only twelve sites and total extent is only 17.3 ha (Table 10.8). Such habitat is therefore rare. Only the MG10 *Holcus lanatus*-*Juncus effusus* rush pasture has a large area (12.0 ha). Some wet mesotrophic grassland might represent former attempts to drain and improve wet dune grassland, allowing smooth rush *Juncus effusus* to invade an area. If this is the case such impacts are not very extensive.

10.6 Other wetland and open water on sand dunes in Wales

Target notes for 27 sites suggest, on the basis of species content, non-NVC types of wetland which total 63.5 ha (Table 10.9). This represents 7.6% of all dune wetland (slacks and all other wetland habitats, total area 835 ha), suggesting that it is possible to allocate more than 92% of these diverse habitats into NVC categories at community and sub-community level. Few sites have large areas of non-NVC vegetation (Laugharne Burrows and Morfa Harlech are the only locations with >10 ha of such vegetation) and in general anomalous wetland is not common.

Open water bodies on dunes are rare in Wales. They are mapped in only twelve sites and only two locations have a large extent: Kenfig (with the very important Kenfig Pool, 29.4 ha) and Laugharne Burrows (7.8 ha). Total extent is 39.6 ha. Aquatic NVC vegetation types were not mapped as part of the national dune survey and comment on their importance is not possible.

10.7 Wet woodland and scrub on sand dunes in Wales

Woodland and scrub are found in wet dune habitats of Wales in a total of 26 sites. They are therefore moderately common and total extent is also of reasonable quantity (118.4 ha, Table 10.10). Four NVC woodland communities are involved: W1 *Salix cinerea* - *Galium palustre* woodland, W2 *Salix cinerea*-*Betula pubescens*-*Phragmites australis*, W4 *Betula pubescens*-*Molinia caerulea* woodland and W6 *Alnus glutinosa*-*Urtica dioica* woodland. All communities are not differentiated into sub-communities, usually due to a combination of a small number of quadrats and poor visual fit with sub-communities which were probably originally defined without samples from wooded dune wetland. Most occurrences represent wet ground which has lacked grazing (or has had insufficient grazing) for several years, allowing *Salix cinerea*, *Betula pubescens* and *Alnus glutinosa* to invade and in time establish closed woodland.

The largest extents of woodland are found on the southern coast of Wales, especially on the Pembrey Coast (38.9 ha), Laugharne Burrows (18.4 ha) and Oxwich Burrows (13.5 ha). These three sites are not grazed by stock (apart from recent goat grazing experiments at Oxwich) and in the case of Pembrey woodland has developed in former slacks surrounded by afforested land. The commonest and most extensive community is the W1 *Salix cinerea*-*Galium palustre* type and some of this is young and scrubby in character. The W6 *Alnus glutinosa*-*Urtica dioica* community is more restricted to the south-east coast but is characteristic of the transition zone between saltmarsh and sand dune at Oxwich and Whiteford Burrows. Scrubby W6 stands are present here and mature stands are found at Margam, Crymlyn, Oxwich, Whiteford, Pembrey and Laugharne Burrows. The W2 and W4 types are rare and total extent is not large.

Table 10.6 Mire communities (M5, M10, M11, M23, M25, M27, M28) on Welsh dunes. Areas in hectares.

	Site	M5	M10c	M11	M23	M25	M25b
1	Merthyr Mawr						
2	Kenfig Dunes						
3	Margam Burrows						
4	Baglan Bay						
5	Crymlyn Burrows						
6	Black Pill To Bryn Mill						
7	Pennard Burrows						
8	Penmaen Burrows						
9	Nicholaston Burrows						
10	Oxwich Burrows						
11	Port-Eynon To Horton						
12	Hillend To Hills Tor						
13	Whiteford Burrows						
14	Pembrey Coast						
15	Laughame Burrows						
16	Pendine Burrows						
17	Tenby Burrows						
18	Caldey Island						
19	Lydstep Haven						
20	Manorbier/Swanlake						
21	Freshwater Bay East						
22	Stackpole Warren						
23	Brownslade/Linney						
24	Broomhill Burrows						
25	Whitesand Bay						
26	The Bennett						
27	Poppit Sands						
28	Towyn Warren						
29	Ynyslas						
30	Tywyn To Aberdovey						
31	Fairbourne						
32	Morfa Dyffryn						
33	Morfa Harlech	0.06			1.26		
34	Morfa Bychan					0.05	
35	Pwllheli/Pen-y-Chain				0.47		1.07
36	Traeth Crugan						
37	Tai Morfa						
38	Morfa Dinlle						
39	Newborough Warren				0.45	1.17	
40	Penrhynoedd - Llangadwaladr						
41	Aberffraw						
42	Valley			0.22		0.17	
43	Tywyn Gwyn		0.01			0.29	0.71
44A	Traeth Dulas						
44B	Traeth Lligwy						
45	Red Wharf Bay						
46	Conwy/Deganwy						
47	Kinnel Bay						
48	Rhyl To Prestatyn						
49	Gronant To Talacre						
	South Wales Region						
	Dyfed & Mid-Wales Region						
	North Wales Region	0.06	0.01	0.22	2.18	1.68	1.78
	National Totals	0.06	0.01	0.22	2.18	1.68	1.78

Figure 10.2 Location of sites with NVC swamp and salt marsh species communities in Wales.

Table 10.6 (continued) Mire communities (M5, M10, M11, M23, M25, M27, M28) on Welsh dunes. Areas in hectares.

	Site	M27	M27b	M27/ W24	M28	M28a	M28b	All mire types
1	Merthyr Mawr	0.54						0.54
2	Kenfig Dunes							
3	Margam Burrows							
4	Baglan Bay							
5	Crymlyn Burrows							
6	Black Pill To Bryn Mill							
7	Pennard Burrows							
8	Penmaen Burrows							
9	Nicholaston Burrows							
10	Oxwich Burrows							
11	Port-Eynon To Horton							
12	Hillend To Hills Tor							
13	Whiteford Burrows							
14	Pembrey Coast							
15	Laughame Burrows	0.07						0.07
16	Pendine Burrows							
17	Tenby Burrows				3.47			3.47
18	Caldey Island							
19	Lydstep Haven							
20	Manorbier/Swanlake							
21	Freshwater Bay East							
22	Stackpole Warren							
23	Brownslade/Linney							
24	Broomhill Burrows	0.23						0.23
25	Whitesand Bay							
26	The Bennett							
27	Poppit Sands							
28	Towyn Warren			0.32	0.11	0.22		0.65
29	Ynyslas							
30	Tywyn To Aberdovey				0.04	1.26		1.30
31	Fairbourne							
32	Morfa Dyffryn	0.38			0.11			0.49
33	Morfa Harlech							1.32
34	Morfa Bychan				5.86			5.91
35	Pwllheli/Pen-y-Chain							1.54
36	Traeth Crugan							
37	Tai Morfa							
38	Morfa Dinlle							
39	Newborough Warren	3.2	0.57		0.04			5.43
40	Penrhynoedd - Llangadwaladr							
41	Aberffraw	3.31	0.38		2.26		0.38	6.33
42	Valley							0.39
43	Tywyn Gwyn	0.02						1.03
44A	Traeth Dulas							
44B	Traeth Lligwy							
45	Red Wharf Bay							
46	Conwy/Deganwy							
47	Kinnel Bay							
48	Rhyl To Prestatyn							
49	Gronant To Talacre				0.68			0.68
	South Wales Region	0.54						0.54
	Dyfed & Mid-Wales Region	0.30		0.32	3.58	0.22		4.42
	North Wales Region	6.91	0.95		8.99	1.26	0.38	24.42
	National Totals	7.75	0.95	0.32	12.57	1.48	0.38	29.38

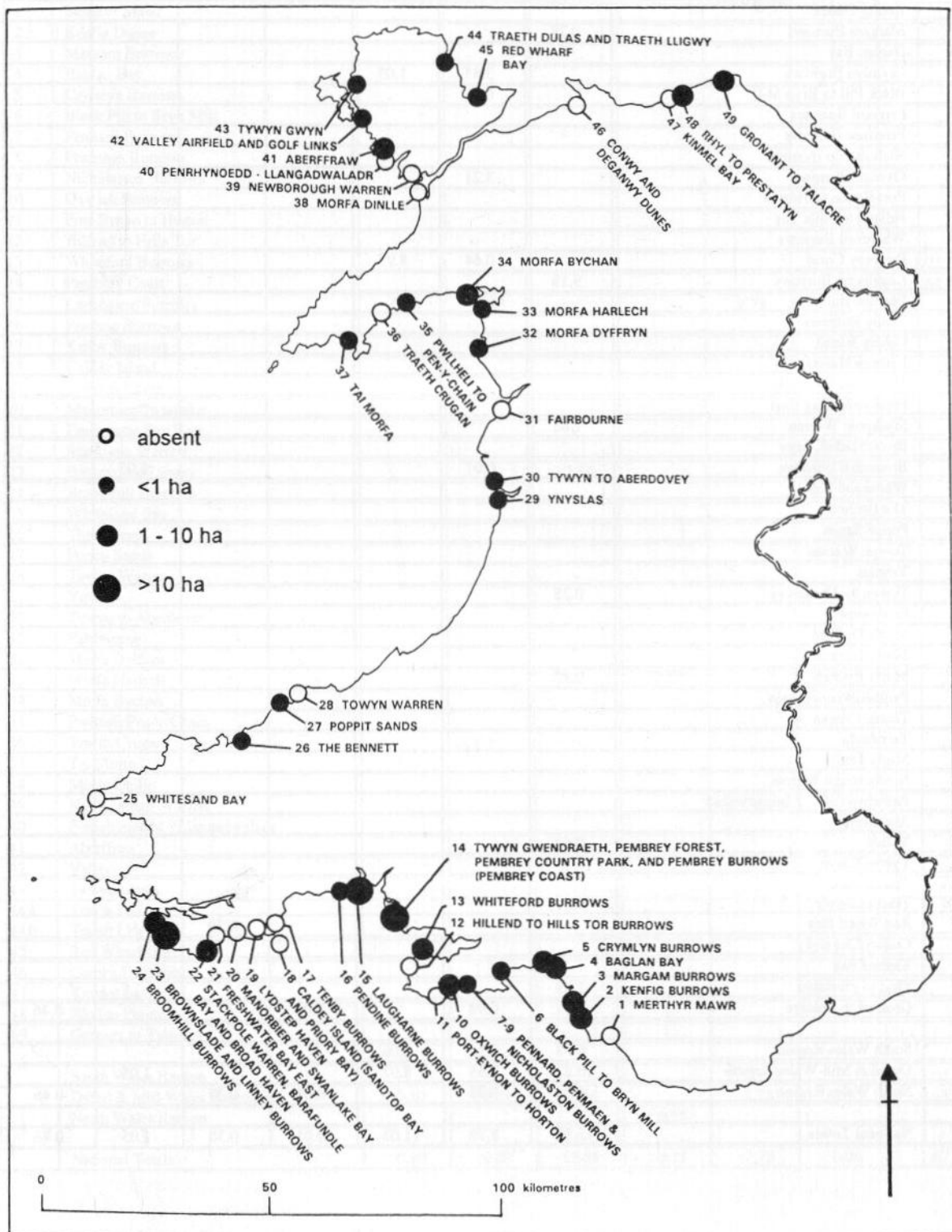


Figure 10.2 Location of sites with NVC swamp and tall-herb fen communities in Wales.

Table 10.7 Swamp and tall-herb fen NVC communities on Welsh dunes. Areas in hectares.

	Site	S4	S4a	S4/S21	S4/SM15	S4/SM18	S4/M27	S4/W1
1	Merthyr Mawr							
2	Kenfig Dunes							
3	Margam Burrows	0.78						
4	Baglan Bay							
5	Crymlyn Burrows		3.85	1.03				
6	Black Pill to Bryn Mill		0.10					
7	Pennard Burrows							
8	Penmaen Burrows							
9	Nicholaston Burrows			1.03				
10	Oxwich Burrows		3.21					
11	Port-Eynon to Horton							
12	Hillend to Hills Tor							
13	Whiteford Burrows							
14	Pembrey Coast		0.64	8.97				
15	Laughame Burrows	9.19						
16	Pendine Burrows							
17	Tenby Burrows							
18	Caldey Island							
19	Lydstep Haven							
20	Manorbier/Swanlake							
21	Freshwater Bay East							
22	Stackpole Warren	1.03						
23	Brownslade/Linney							
24	Broomhill Burrows		0.01				1.05	
25	Whitesand Bay							
26	The Bennett							
27	Poppit Sands							
28	Towyn Warren							
29	Ynyslas							
30	Tywyn to Aberdovey	0.28						
31	Fairbourne							
32	Morfa Dyffryn							
33	Morfa Harlech							
34	Morfa Bychan	0.80						
35	Pwllheli/Pen-y-Chain							
36	Traeth Crugan							
37	Tai Morfa							
38	Morfa Dinlle							
39	Newborough Warren							
40	Penrhynoedd - Llangadwaladr							
41	Aberffraw							
42	Valley	0.62						
43	Tywyn Gwyn							
44A	Traeth Dulas							
44B	Traeth Lligwy	0.06						
45	Red Wharf Bay					0.30		
46	Conwy/Deganwy							
47	Kinmel Bay							
48	Rhyl to Prestatyn	1.29						
49	Gronant to Talacre	1.33	0.98		0.01			0.46
	South Wales Region	0.78	7.16	2.06				
	Dyfed & Mid-Wales Region	10.22	0.65	8.97			1.05	
	North Wales Region	4.38	0.98		0.01	0.30		0.46
	National Totals	15.38	8.79	11.03	0.01	0.30	1.05	0.46

Table 10.7 (continued) Swamp and tall-herb fen NVC communities on Welsh dunes. Areas in hectares.

	Site	S5	S6	S7	S8a	S10	S12	S12b
1	Merthyr Mawr							
2	Kenfig Dunes							
3	Margam Burrows							
4	Baglan Bay							
5	Crymlyn Burrows							
6	Black Pill to Bryn Mill							
7	Pennard Burrows							
8	Penmaen Burrows							
9	Nicholaston Burrows							
10	Oxwich Burrows							
11	Port-Eynon to Horton							
12	Hillend to Hills Tor							
13	Whiteford Burrows							1.03
14	Pembrey Coast							0.64
15	Laughame Burrows	0.10	0.03			2.78		
16	Pendine Burrows							
17	Tenby Burrows							
18	Caldey Island							
19	Lydstep Haven							
20	Manorbier/Swanlake							
21	Freshwater Bay East							
22	Stackpole Warren							
23	Brownslade/Linney			12.56				
24	Broomhill Burrows							
25	Whitesand Bay							
26	The Bennett						0.06	
27	Poppit Sands							
28	Towyn Warren							
29	Ynyslas							
30	Tywyn to Aberdovey							
31	Fairbourne							
32	Morfa Dyffryn							
33	Morfa Harlech				0.35			
34	Morfa Bychan							
35	Pwllheli/Pen-y-Chain							
36	Traeth Crugan							
37	Tai Morfa							
38	Morfa Dinlle							
39	Newborough Warren							
40	Penrhynoedd - Llangadwaladr							
41	Aberffraw							
42	Valley							
43	Tywyn Gwyn							
44A	Traeth Dulas							
44B	Traeth Lligwy							
45	Red Wharf Bay							
46	Conwy/Deganwy							
47	Kinmel Bay							
48	Rhyl to Prestatyn							
49	Gronant to Talacre							
	South Wales Region							1.03
	Dyfed & Mid-Wales Region	0.10	0.03	12.56		2.78	0.06	0.64
	North Wales Region				0.35			
	National Totals	0.10	0.03	12.56	0.35	2.78	0.06	1.67

Table 10.7 (continued) Swamp and tall-herb fen NVC communities on Welsh dunes. Areas in hectares.

	Site	S14	S18a	S19	S19a	S19c	S19/W1
1	Merthyr Mawr						
2	Kenfig Dunes						
3	Margam Burrows						
4	Baglan Bay						
5	Crymlyn Burrows						
6	Black Pill to Bryn Mill						
7	Pennard Burrows						
8	Penmaen Burrows						
9	Nicholaston Burrows						
10	Oxwich Burrows						
11	Port-Eynon to Horton						
12	Hillend to Hills Tor						
13	Whiteford Burrows						
14	Pembrey Coast						
15	Laughame Burrows	0.31					
16	Pendine Burrows				0.03		
17	Tenby Burrows						
18	Caldey Island						
19	Lydstep Haven						
20	Manorbier/Swanlake						
21	Freshwater Bay East						
22	Stackpole Warren						
23	Brownslade/Linney						
24	Broomhill Burrows				0.03	0.23	
25	Whitesand Bay						
26	The Bennett						
27	Poppit Sands						
28	Towyn Warren						
29	Ynyslas						
30	Tywyn to Aberdovey						
31	Fairbourne						
32	Morfa Dyffryn						
33	Morfa Harlech			0.01			0.44
34	Morfa Bychan			0.31			
35	Pwllheli/Pen-y-Chain				0.11		
36	Traeth Crugan						
37	Tai Morfa					0.07	
38	Morfa Dinlle						
39	Newborough Warren						
40	Penrhynoedd - Llangadwaladr						
41	Aberffraw						
42	Valley			0.07			
43	Tywyn Gwyn			0.03			
44A	Traeth Dulas						
44B	Traeth Lligwy						
45	Red Wharf Bay						
46	Conwy/Deganwy						
47	Kinmel Bay						
48	Rhyl to Prestatyn						
49	Gronant to Talacre		0.61				
	South Wales Region						
	Dyfed & Mid-Wales Region	0.31			0.06	0.23	
	North Wales Region		0.61	0.42	0.11	0.07	0.44
	National Totals	0.31	0.61	0.42	0.17	0.30	0.44

Table 10.7 (continued) Swamp and tall-herb fen NVC communities on Welsh dunes. Areas in hectares.

	Site	S20	S20a	S20b	S21	S21a	S21c	S21/ SM6
1	Merthyr Mawr							
2	Kenfig Dunes							
3	Margam Burrows							
4	Baglan Bay				4.04			
5	Crymlyn Burrows							
6	Black Pill to Bryn Mill							
7	Pennard Burrows							
8	Penmaen Burrows							
9	Nicholaston Burrows							
10	Oxwich Burrows							
11	Port-Eynon to Horton							
12	Hillend to Hills tor							
13	Whiteford Burrows							
14	Pembrey Coast							
15	Laughame Burrows	2.91						
16	Pendine Burrows			0.04				
17	Tenby Burrows							
18	Caldey Island							
19	Lydstep Haven							
20	Manorbier/Swanlake							
21	Freshwater Bay East							
22	Stackpole Warren							
23	Brownslade/Linney							
24	Broomhill Burrows				0.23			
25	Whitesand Bay							
26	The Bennett							
27	Poppit Sands							
28	towyn Warren							
29	Ynyslas						0.04	
30	Tywyn to Aberdovey							
31	Fairbourne							
32	Morfa Dyffryn							
33	Morfa Harlech							
34	Morfa Bychan							
35	Pwllheli/Pen-y-Chain							
36	Traeth Crugan							
37	Tai Morfa							
38	Morfa Dinlle							
39	Newborough Warren							
40	Penrhynoedd - Llangadwaladr							
41	Aberffraw	0.64						0.15
42	Valley							
43	Tywyn Gwyn							
44A	Traeth Dulas							
44B	Traeth Lligwy							
45	Red Wharf Bay					0.12		
46	Conwy/Deganwy							
47	Kinnel Bay							
48	Rhyl to Prestatyn							
49	Gronant to Talacre		0.08	0.67		3.42	0.08	
	South Wales Region				4.04			
	Dyfed & Mid-Wales Region	2.91		0.04	0.23		0.04	
	North Wales Region	0.64	0.08	0.67		3.54	0.08	0.15
	National totals	3.55	0.08	0.71	4.27	3.54	0.12	0.15

Table 10.7 (continued) Swamp and tall-herb fen NVC communities on Welsh dunes. Areas in hectares. P = present, extent not mapped.

	Site	S25	S26	S26d	S28	S28c	All swamp types
1	Merthyr Mawr						
2	Kenfig Dunes						P
3	Margam Burrows	0.29					1.07
4	Baglan Bay						4.04
5	Crymlyn Burrows						4.88
6	Black Pill to Bryn Mill						0.10
7	Pennard Burrows						
8	Penmaen Burrows						
9	Nicholaston Burrows						1.03
10	Oxwich Burrows						3.21
11	Port-Eynon to Horton						
12	Hillend to Hills Tor						
13	Whiteford Burrows						1.03
14	Pembrey Coast						10.25
15	Laughame Burrows				0.06		15.38
16	Pendine Burrows						0.07
17	Tenby Burrows						
18	Caldey Island						
19	Lydstep Haven						
20	Manorbier/Swanlake						
21	Freshwater Bay East						
22	Stackpole Warren						1.03
23	Brownslade/Linney						12.56
24	Broomhill Burrows						1.55
25	Whitesand Bay						
26	The Bennett						0.06
27	Poppit Sands					0.01	0.01
28	Towyn Warren						
29	Ynyslas						0.04
30	Tywyn to Aberdovey						0.28
31	Fairbourne						
32	Morfa Dyffryn			0.24			0.24
33	Morfa Harlech						0.80
34	Morfa Bychan						1.11
35	Pwllheli/Pen-y-Chain						0.11
36	Traeth Crugan						
37	Tai Morfa						0.07
38	Morfa Dinlle						
39	Newborough Warren						
40	Penrhynoedd - Llangadwaladr						
41	Aberffraw		0.95				1.74
42	Valley				0.01		0.70
43	Tywyn Gwyn						0.03
44A	Traeth Dulas						
44B	Traeth Lligwy						0.06
45	Red Wharf Bay						0.42
46	Conwy/Deganwy						
47	Kinmel Bay						
48	Rhyl to Prestatyn						1.29
49	Gronant to Talacre						7.64
	South Wales Region	0.29					15.36
	Dyfed & Mid-Wales Region				0.06	0.01	40.95
	North Wales Region		0.95	0.24	0.01		14.49
	National Totals	0.29	0.95	0.24	0.07	0.01	70.80

Table 10.8 Wet mesotrophic grassland communities on Welsh dunes. Areas in hectares.

	Site	MG2	MG9b	MG10	MG10a	MG10b	MG10b/c	MG10c
1	Merthyr Mawr							
2	Kenfig Dunes	0.14						
3	Margam Burrows							
4	Baglan Bay							
5	Crymlyn Burrows							
6	Black Pill to Bryn Mill							
7	Pennard Burrows							
8	Penmaen Burrows							
9	Nicholaston Burrows							
10	Oxwich Burrows							
11	Port-Eynon to Horton							
12	Hillend to Hills Tor							
13	Whiteford Burrows							
14	Pembrey Coast							
15	Laughame Burrows							
16	Pendine Burrows				1.86	1.86	5.35	0.21
17	Tenby Burrows							
18	Caldey Island							
19	Lydstep Haven							
20	Manorbier/Swanlake							
21	Freshwater Bay East							
22	Stackpole Warren							
23	Brownslade/Linney							
24	Broomhill Burrows					0.12		
25	Whitesand Bay							
26	The Bennett							
27	Poppit Sands							
28	Towyn Warren			0.11				
29	Ynyslas							
30	Tywyn to Aberdovey			0.46				
31	Fairbourne							
32	Morfa Dyffryn			0.45				
33	Morfa Harlech							
34	Morfa Bychan		0.23					
35	Pwllheli/Pen-y-Chain							
36	Traeth Crugan							
37	Tai Morfa							
38	Morfa Dinlle							
39	Newborough Warren							
40	Penrhynoedd - Llangadwaladr							
41	Aberffraw				0.12			
42	Valley							
43	Tywyn Gwyn							
44A	Traeth Dulas							
44B	Traeth Lligwy							
45	Red Wharf Bay							
46	Conwy/Deganwy							
47	Kinnel Bay							
48	Rhyl to Prestatyn							
49	Gronant to Talacre			1.16	0.02	0.11		
	South Wales Region	0.14						
	Dyfed & Mid-Wales Region			0.11	1.86	1.98	5.35	0.21
	North Wales Region		0.23	2.07	0.14	0.11		
	National Totals	0.14	0.23	2.18	2.00	2.09	5.35	0.21

Table 10.8 (continued) Wet mesotrophic grassland communities on Welsh dunes. Areas in hectares.

	Site	MG10/ MG11	MG10/ MG12	MG10/ W23	MG11	MG11a	MG11/ S4 +	MG11/ W1
1	Merthyr Mawr				1.01			
2	Kenfig Dunes							
3	Margam Burrows							
4	Baglan Bay							
5	Crymlyn Burrows							
6	Black Pill to Bryn Mill							
7	Pennard Burrows							
8	Penmaen Burrows							
9	Nicholaston Burrows							
10	Oxwich Burrows							
11	Port-Eynon to Horton							
12	Hillend to Hills Tor							
13	Whiteford Burrows							
14	Pembrey Coast							
15	Laughame Burrows							
16	Pendine Burrows							
17	Tenby Burrows							
18	Caldey Island							
19	Lydstep Haven							
20	Manorbier/Swanlake							
21	Freshwater Bay East							
22	Stackpole Warren							
23	Brownslade/Linney							
24	Broomhill Burrows	0.01	0.90		1.26	0.12		0.14
25	Whitesand Bay							
26	The Bennett							
27	Poppit Sands							
28	Towyn Warren							
29	Ynyslas				0.51			
30	Tywyn to Aberdovey							
31	Fairbourne							
32	Morfa Dyffryn							
33	Morfa Harlech					0.05		
34	Morfa Bychan							
35	Pwllheli/Pen-y-Chain							
36	Traeth Crugan							
37	Tai Morfa							
38	Morfa Dinlle							
39	Newborough Warren							
40	Penrhynoedd - Llangadwaladr							
41	Aberffraw			0.02				
42	Valley				0.62	0.03		
43	Tywyn Gwyn							
44A	Traeth Dulas							
44B	Traeth Lligwy							
45	Red Wharf Bay							
46	Conwy/Deganwy							
47	Kinnel Bay							
48	Rhyl to Prestatyn							
49	Gronant to Talacre						0.01	
	South Wales Region				1.01			
	Dyfed & Mid-Wales Region	0.01	0.90		1.77	0.12		0.14
	North Wales Region			0.02	0.62	0.08	0.01	
	National Totals	0.01	0.90	0.02	3.40	0.20	0.01	0.14

Table 10.8 (continued) Wet mesotrophic grassland communities on Welsh dunes. Areas in hectares.

	Site	MG11/ Other wetland	MG12a	MG12b	All wet mesotrophic grassland
1	Merthyr Mawr				1.01
2	Kenfig Dunes				0.14
3	Margam Burrows				
4	Baglan Bay				
5	Crymlyn Burrows				
6	Black Pill to Bryn Mill				
7	Pennard Burrows				
8	Penmaen Burrows				
9	Nicholaston Burrows				
10	Oxwich Burrows				
11	Port-Eynon to Horton				
12	Hillend to Hills Tor				
13	Whiteford Burrows				
14	Pembrey Coast				
15	Laughame Burrows				
16	Pendine Burrows				9.28
17	Tenby Burrows				
18	Caldey Island				
19	Lydstep Haven				
20	Manorbier/Swanlake				
21	Freshwater Bay East				
22	Stackpole Warren				
23	Brownslade/Linney				
24	Broomhill Burrows	0.34	0.06		2.95
25	Whitesand Bay				
26	The Bennett				
27	Poppit Sands				
28	Towyn Warren				0.11
29	Ynyslas				0.51
30	Tywyn to Aberdovey				0.46
31	Fairbourne				
32	Morfa Dyffryn				0.45
33	Morfa Harlech			0.12	0.17
34	Morfa Bychan				0.23
35	Pwllheli/Pen-y-Chain				
36	Traeth Crugan				
37	Tai Morfa				
38	Morfa Dinlle				
39	Newborough Warren				
40	Penrhynoedd - Llangadwaladr				
41	Aberffraw				0.14
42	Valley				0.65
43	Tywyn Gwyn				
44A	Traeth Dulas				
44B	Traeth Lligwy				
45	Red Wharf Bay				
46	Conwy/Deganwy				
47	Kinmel Bay				
48	Rhyl to Prestatyn				
49	Gronant to Talacre				1.30
	South Wales Region	0.34	0.06		1.15
	Dyfed & Mid-Wales Region				12.85
	North Wales Region			0.12	3.40
	National Totals	0.34	0.06	0.12	17.40

Table 10.9 Other (non-NVC) wetland vegetation, open water and non-slack wetland habitat totals for dunes in Wales. Areas in hectares.

	Site	Other (non-NVC) wetland	Open water	Total of swamp, mire, wet mesotrophic grassland, other wetland and open water
1	Merthyr Mawr			1.55
2	Kenfig Dunes	2.24	29.36	31.60
3	Margam Burrows		0.15	1.22
4	Baglan Bay			4.04
5	Crymlyn Burrows			4.88
6	Black Pill to Bryn Mill			0.10
7	Pennard Burrows			
8	Penmaen Burrows			
9	Nicholaston Burrows			1.03
10	Oxwich Burrows			3.21
11	Port-Eynon to Horton			
12	Hillend to Hills Tor			
13	Whiteford Burrows			1.03
14	Pembrey Coast			10.25
15	Laughame Burrows	11.15	7.84	34.44
16	Pendine Burrows	0.94		10.29
17	Tenby Burrows	2.61		6.08
18	Caldey Island			
19	Lydstep Haven			
20	Manorbier/Swanlake	0.50		0.50
21	Freshwater Bay East		0.01	0.01
22	Stackpole Warren	6.98		8.01
23	Brownslade/Linney		0.09	12.65
24	Broomhill Burrows	1.40	1.11	7.24
25	Whitesand Bay	0.19		0.19
26	The Bennett	0.08		0.14
27	Poppit Sands	0.01		0.02
28	Towyn Warren	0.11		0.87
29	Ynyslas	0.99	0.34	1.88
30	Tywyn to Aberdovey	0.78		2.82
31	Fairbourne			
32	Morfa Dyffryn	7.31	0.35	8.84
33	Morfa Harlech	11.61	0.17	14.07
34	Morfa Bychan	3.39		10.64
35	Pwllheli/Pen-y-Chain	2.45		4.10
36	Traeth Crugan			
37	Tai Morfa	0.66		0.73
38	Morfa Dinlle	0.24		0.24
39	Newborough Warren	0.22	0.05	5.70
40	Penrhynoedd - Llangadwaladr	0.14		0.14
41	Aberffraw	2.08		10.29
42	Valley	3.66		5.40
43	Tywyn Gwyn	0.06		1.12
44A	Traeth Dulas	0.07		0.07
44B	Traeth Lligwy	0.14	0.06	0.26
45	Red Wharf Bay			0.42
46	Conwy/Deganwy			
47	Kinmel Bay			
48	Rhyl to Prestatyn			1.29
49	Gronant to Talacre	3.52	0.04	13.18
	South Wales Region	2.24	29.51	48.66
	Dyfed & Mid-Wales Region	24.96	9.39	92.57
	North Wales Region	36.33	0.67	79.31
	National Totals	63.53	39.57	220.54

Table 10.10 Wet woodland and scrub on sand dunes in Wales. Areas in hectares.

	Site	W1	W2	W4	W6	Total wet woodland
1	Merthyr Mawr	0.54		7.45	0.95	8.94
2	Kenfig Dunes	0.28				0.28
3	Margam Burrows		2.77		2.28	5.05
4	Baglan Bay					
5	Crymlyn Burrows	2.43			3.20	5.63
6	Black Pill to Bryn Mill					
7	Pennard Burrows					
8	Penmaen Burrows					
9	Nicholaston Burrows	0.38				0.38
10	Oxwich Burrows	7.05			6.40	13.45
11	Port-Eynon to Horton					
12	Hillend to Hills Tor	0.83				0.83
13	Whiteford Burrows	2.56			1.28	3.84
14	Pembrey Coast	20.83			18.05	38.88
15	Laughame Burrows	13.40			5.03	18.43
16	Pendine Burrows	1.77				1.77
17	Tenby Burrows	1.46				1.46
18	Caldey Island					
19	Lydstep Haven					
20	Manorbier/Swanlake	0.50				0.50
21	Freshwater Bay East					
22	Stackpole Warren				0.64	0.64
23	Brownslade/Linney					
24	Broomhill Burrows					
25	Whitesand Bay	0.06				0.06
26	The Bennett					
27	Poppit Sands					
28	Towyn Warren					
29	Ynyslas	0.24				0.24
30	Tywyn to Aberdovey	3.01				3.01
31	Fairbourne					
32	Morfa Dyffryn	2.93				2.93
33	Morfa Harlech	6.60				6.60
34	Morfa Bychan	2.69				2.69
35	Pwllheli/Pen-y-Chain	0.10				0.10
36	Traeth Crugan					
37	Tai Morfa					
38	Morfa Dinlle					
39	Newborough Warren	1.22				1.22
40	Penrhynoedd - Llangadwaladr					
41	Aberffraw					
42	Valley					
43	Tywyn Gwyn					
44A	Traeth Dulas	0.01				0.01
44B	Traeth Lligwy	0.70				0.70
45	Red Wharf Bay					
46	Conwy/Deganwy	0.22				0.22
47	Kinnel Bay					
48	Rhyl to Prestatyn					
49	Gronant to Talacre	0.34	0.24			0.58
	South Wales Region	14.07	2.77	7.45	14.11	38.40
	Dyfed & Mid-Wales Region	38.26			23.72	61.98
	North Wales Region	17.82	0.24			18.06
	Totals	70.15	3.01	7.45	37.83	118.44

11. Scrub, bracken and woodland

11.1 NVC communities

This chapter presents results for scrub, bracken and woodland mapped on dry dune habitats (scrub and woodland found in dune wetland are discussed in Chapter 10). No NVC woodland type is restricted to dunes in Britain and only one NVC scrub type is recognised for this habitat: SD18 *Hippophae rhamnoides* dune scrub. Other types of scrub are also present on dunes and are described in the woodland and scrub (W) NVC volume (W21, W22, W23, W24). These are described here, together with non-NVC scrub types recorded in target notes or mapped as a distinct type (notably privet *Ligustrum vulgare*). Bracken is also quite frequent and most cases are more closely related to the W25 underscrub type than to the more acidic U20 vegetation, though examples of the latter are recorded in a few cases in Wales. Woodland other than afforested dune is rare in Wales but two NVC types are mapped on dune sand: W8 and W10. Non-NVC woodland (including afforested areas and sycamore *Acer pseudoplatanus*) is also considered in this chapter.

11.2 SD18 *Hippophae rhamnoides* dune scrub

Sea buckthorn *Hippophae rhamnoides* dune scrub is mapped in fifteen sites and has a total mapped extent of 178.3 ha (Figure 11.1, Table 11.1). It is not native in Wales and has been introduced to several dune systems to control dune erosion, spreading to other sites by seeds which are probably dispersed in bird droppings. Most of the national area is found in only two sites (105.1 ha, Pembrey Coast; 39.9 ha, Merthyr Mawr). The extent in the latter site is an underestimate, taken from a vegetation map restricted to SSSI boundaries and using 1988 aerial photography. More recent survey (Dargie 1992) covering all blown sand at Merthyr Mawr and using 1992 air photographs estimated sea buckthorn area at 53.8 ha, part of an exponential rate of increase which can be traced

since 1.5 ha was mappable on 1957 air photographs. An area of 27.6 ha in vegetation maps is not mapped to sub-community level in eight sites. A further 59.3 ha of the SD18a *Festuca rubra* sub-community is also recorded in seven sites and the more mature SD18b *Urtica dioica*-*Arrhenatherum elatius* sub-community has an area of 91.5 ha in six sites. Most of the national extent is found on the southern coast, with little west of Stackpole Warren. Stands formerly present at Whiteford Burrows NNR have been removed as part of a deliberate eradication policy for this species.

11.3 Other scrub on sand dunes in Wales

In the absence of grazing rank grassland and scrub can develop on sand dunes. Sites with a large area (>5 ha) of rank grassland (SD9, MG1: Chapter 8) also tend to have a high shrub cover, involving a range of NVC and non-NVC vegetation types. These scrub types are discussed in this section and, along with the extent of rank grassland, are an indirect, inverse measure of the stock grazing pressure on a site. They probably relate less strongly to rabbit grazing pressure since rabbits tend to use scrub and rank grass for shelter whilst grazing largely on short sward grasslands: they do little to retard the advance of scrub once it starts to invade an area.

W21 *Crataegus monogyna*-*Hedera helix* scrub

This NVC scrub type is uncommon on dunes in Wales and is found in eleven sites with a total area of 25.6 ha (Table 11.2). It is present in all recorded sites as a scatter of small stands. The largest extent is at Newborough Warren (9.1 ha) but no sub-community is recorded. The W21a *Hedera helix*-*Urtica dioica* sub-community is found in low quantities in six sites, with the W21b *Mercurialis perennis* sub-community only in one site. A transition from W23 *Ulex europaeus*-*Rubus fruticosus* agg. scrub is recorded from Poppit Sands.

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

This NVC scrub type is common on dunes in Wales and is found in 29 sites, with a moderate total extent of 44.2 ha (Table 11.3). Only two sites (Newborough Warren, Freshwater Bay East) have areas >5 ha. Most stands are not differentiated into sub-communities but between five sites small extents of the W22a *Hedera helix*-*Silene dioica*, W22b *Viola riviniana*-*Veronica chamaedrys* and W22c *Dactylis glomerata* sub-communities are recorded.

W23 *Ulex europaeus*-*Rubus fruticosus* agg. scrub

This NVC scrub type is also common on dunes in Wales and is found in 26 sites, with the largest area of other scrub types (96.6 ha, Table 11.4). Seven sites have extents >5 ha (Towyn Warren the largest with 18.2 ha, plus Conwy/Deganwy, Valley, Whitesand Bay, Pennard, Aberffraw and Morfa Harlech). The largest areas are found in North Wales and might reflect less calcareous sands in this region which also has the largest extents of acidic grasslands. Most mapped areas are not differentiated into sub-communities but between five sites there is a very small mapped total with the W23a *Anthoxanthum odoratum*, W23b *Rumex acetosella* and W23c *Teucrium scorodonia* sub-communities.

W24 *Rubus fruticosus* agg.-*Holcus lanatus* underscrub

This NVC scrub type is also common on dunes in Wales and is present in 27 sites, with a total extent of 74.8 ha (Table 11.5). Six sites have total areas >5 ha: Penmaen, Hillend to Hills Tor, Stackpole Warren, Newborough Warren, Gronant to Talacre. As with other types of scrub, most mapped areas are not differentiated into sub-communities. Five sites have the W24a *Cirsium arvense*-*Cirsium vulgare* and W24b *Arrhenatherum elatius*-*Heracleum sphondylium* sub-communities.

Other non-NVC scrub

A heterogeneous set of other scrub types is recorded frequently on dunes in Wales. The majority are described only by brief target notes

and cover privet *Ligustrum vulgare* (11.5 ha, Table 11.5) and several other scrub types (Other scrub in Table 11.5, 29.6 ha): elder *Sambucus nigra* stands, thick clones of dewberry *Rubus caesius* and blackberry *R. fruticosus* agg., thick prostrate clumps of old man's beard *Clematis vitalba* and mixed stands of *R. fruticosus*, gorse *Ulex europaeus* and hawthorn *Crataegus monogyna* which could not be allocated to a precise NVC community or clear transition. Few sites have large extents but *Ligustrum vulgare* is extensive at Merthyr Mawr (11.6 ha) and undescribed scrub covers 6.0 ha at Laugharne Burrows.

11.4 Bracken on dunes in Wales

Bracken *Pteridium aquilinum* is common on dunes in Wales and was mapped in 24 sites, with a total extent of 92.2 ha (Table 11.5). It is extensive (>5 ha) at only six sites: Kenfig Dunes (17.1 ha), Merthyr Mawr (14.1 ha), Pwllheli/Pen-y-Chain (13.0 ha), Stackpole Warren (12.5 ha), The Bennett (5.9 ha), Whitesand Bay (5.4 ha). Bracken is the dominant species in two NVC communities: W25 *Pteridium aquilinum*-*Rubus fruticosus* agg. underscrub and the U20 *Pteridium aquilinum*-*Galium saxatile* community. The latter is rare in Wales and is mapped only at Pwllheli/Pen-y-Chain and Tywyn Gwyn. The remainder of sites have vegetation which fits the W25 type better, though quadrat information is not plentiful and exact status is uncertain. Transitions are rare and involve small areas. The only exception is an SD8/W25 transition at Kenfig Dunes (5.3 ha, Table 8.1) where bracken is probably best displaying its invasive habit. Elsewhere trends in its extent are largely unknown. A programme of control by mowing has been operating for several years at Oxwich Bay NNR.

11.5 Woodland on sand dunes in Wales

NVC woodland vegetation is very rare on dunes in Wales and is mapped for only three sites (Merthyr Mawr, Oxwich Burrows, Pembrey Coast), with a low total extent of 11.9 ha (Table 11.6). At Merthyr Mawr an absence of stock

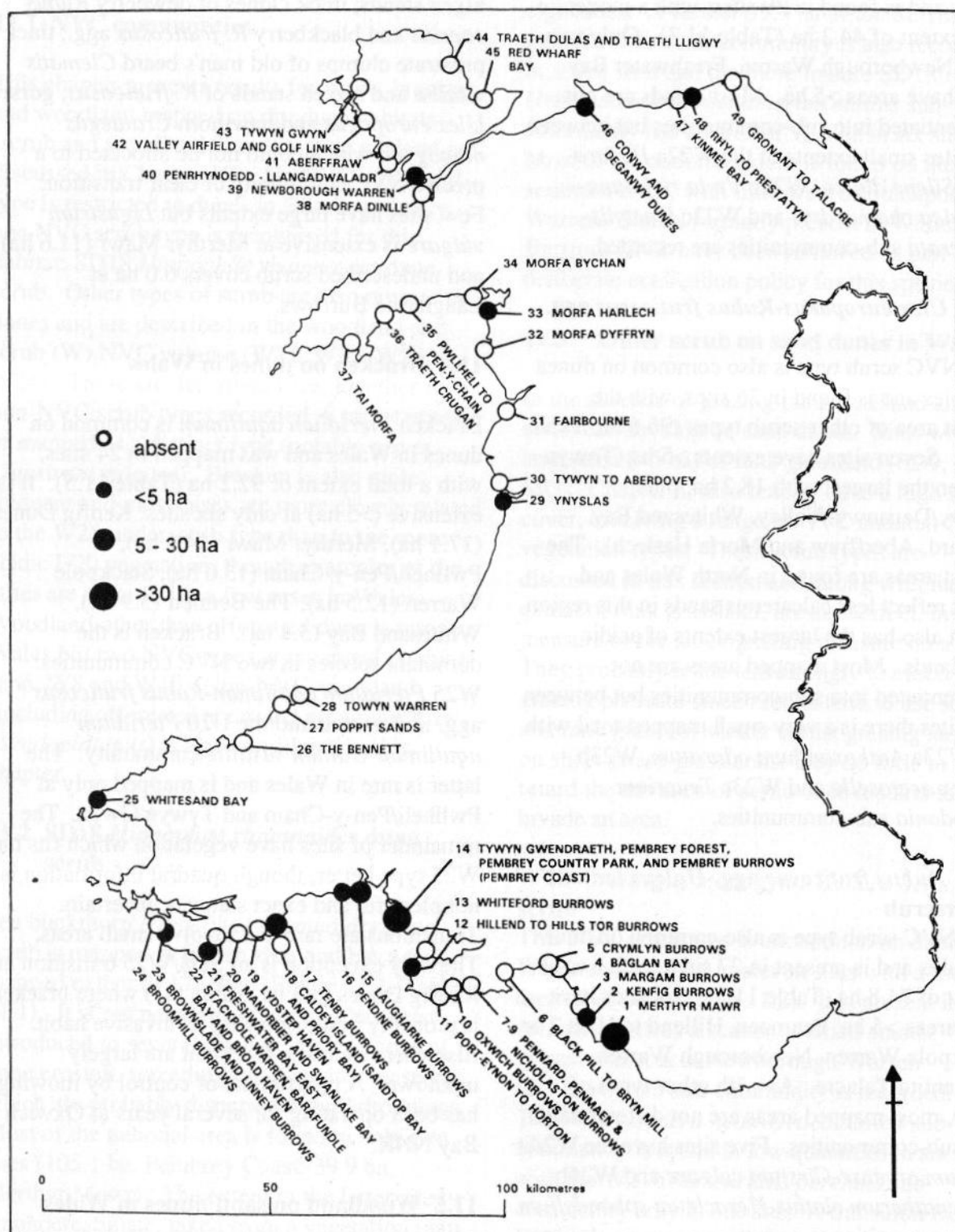


Figure 11.1 Distribution of SD18 *Hippophae rhamnoides* dune scrub in Wales.

Table 11.1 SD18 *Hippophae rhamnoides* dune scrub in Wales. Areas in hectares.

P = present as amenity planting, very low total area.

	Site	SD18 undifferentiated	SD18a	SD18b	Total SD18
1	Merthyr Mawr		8.60	31.30	39.90
2	Kenfig Dunes	0.63			0.63
3	Margam Burrows				
4	Baglan Bay				
5	Crymlyn Burrows				
6	Black Pill to Bryn Mill	P			
7	Pennard Burrows				
8	Penmaen Burrows				
9	Nicholaston Burrows				
10	Oxwich Burrows				
11	Port-Eynon to Horton				
12	Hillend to Hills Tor			1.28	1.28
13	Whiteford Burrows				
14	Pembrey Coast		47.41	57.69	105.10
15	Laughame Burrows	10.30			10.30
16	Pendine Burrows	4.95			4.95
17	Tenby Burrows	9.90			9.90
18	Caldey Island				
19	Lydstep Haven				
20	Manorbier/Swanlake				
21	Freshwater Bay East				
22	Stackpole Warren	0.82	0.02	1.08	1.92
23	Brownslade/Linney			0.07	0.07
24	Broomhill Burrows				
25	Whitesand Bay			0.03	0.03
26	The Bennett				
27	Poppit Sands				
28	Towyn Warren				
29	Ynyslas	0.03			0.03
30	Tywyn to Aberdovey				
31	Fairbourne				
32	Morfa Dyffryn				
33	Morfa Harlech				
34	Morfa Bychan		0.32		0.32
35	Pwllheli/Pen-y-Chain				
36	Traeth Crugan				
37	Tai Morfa				
38	Morfa Dinlle				
39	Newborough Warren	0.82	2.28		3.10
40	Penrhynoedd - Llangadwaladr				
41	Aberffraw				
42	Valley				
43	Tywyn Gwyn				
44A	Traeth Dulas				
44B	Traeth Lligwy				
45	Red Wharf Bay				
46	Conwy/Deganwy	0.16	0.56		0.72
47	Kinmel Bay				
48	Rhyl to Prestatyn		0.07		0.07
49	Gronant to Talacre				
	South Wales Region	0.63	8.60	32.58	41.81
	Dyfed & Mid-Wales Region	26.00	47.43	58.87	132.30
	North Wales Region	0.98	3.23		4.21
	National Totals	27.61	59.26	91.45	178.32

Table 11.2 W21 *Crataegus monogyna*-*Hedera helix* scrub on dunes in Wales. Areas in hectares.

	Site	W21 undiff.	W21a	W21b	W21/W23	Total W21
1	Merthyr Mawr					
2	Kenfig Dunes					
3	Margam Burrows					
4	Baglan Bay					
5	Crymlyn Burrows		0.13			0.13
6	Black Pill to Bryn Mill					
7	Pennard Burrows	1.41				1.41
8	Penmaen Burrows		1.92			1.92
9	Nicholaston Burrows		1.55			1.55
10	Oxwich Burrows		1.02			1.02
11	Port-Eynon to Horton					
12	Hillend to Hills Tor					
13	Whiteford Burrows					
14	Pembrey Coast					
15	Laughame Burrows					
16	Pendine Burrows		1.06			1.06
17	Tenby Burrows	0.61				0.61
18	Caldey Island					
19	Lydstep Haven					
20	Manorbier/Swanlake					
21	Freshwater Bay East					
22	Stackpole Warren		0.79	2.18		2.97
23	Brownsiade/Linney					
24	Broomhill Burrows					
25	Whitesand Bay					
26	The Bennett					
27	Poppit Sands				5.26	5.26
28	Towyn Warren					
29	Ynyslas					
30	Tywyn to Aberdovey					
31	Fairbourne					
32	Morfa Dyffryn					
33	Morfa Harlech					
34	Morfa Bychan					
35	Pwllheli/Pen-y-Chain					
36	Traeth Crugan					
37	Tai Morfa					
38	Morfa Dinlle					
39	Newborough Warren	9.10				9.10
40	Penrhynoedd - Llangadwaladr					
41	Aberffraw					
42	Valley					
43	Tywyn Gwyn					
44A	Traeth Dulas					
44B	Traeth Lligwy					
45	Red Wharf Bay					
46	Conwy/Deganwy					
47	Kinmel Bay					
48	Rhyl to Prestatyn					
49	Gronant to Talacre	0.57				0.57
	South Wales Region	1.41	4.62			6.03
	Dyfed & Mid-Wales Region	0.61	1.85	2.18	5.26	9.90
	North Wales Region	9.67				9.67
	National Totals	11.69	6.47	2.18	5.26	25.60

Figure 11. Distribution of *Crataegus monogyna*-*Hedera helix* scrub on dunes in Wales

Table 11.3 W22 *Prunus spinosa*-*Rubus fruticosus* agg. scrub on dunes in Wales. Areas in hectares.

	Site	W22 undiff.	W22a	W22b	W22c	W22/ W23	W22/ W24	Total W22
1	Merthyr Mawr							
2	Kenfig Dunes							
3	Margam Burrows							
4	Baglan Bay							
5	Crymlyn Burrows	1.03						1.03
6	Black Pill to Bryn Mill							
7	Pennard Burrows	0.51						0.51
8	Penmaen Burrows							
9	Nicholaston Burrows							
10	Oxwich Burrows							
11	Port-Eynon to Horton	0.64						0.64
12	Hillend to Hills Tor	0.26						0.26
13	Whiteford Burrows	1.92						1.92
14	Pembrey Coast	3.52						3.52
15	Laughame Burrows							
16	Pendine Burrows	1.64						1.64
17	Tenby Burrows	0.80						0.80
18	Caldey Island		0.09			0.24		0.33
19	Lydstep Haven							
20	Manorbier/Swanlake		2.58			0.35		2.93
21	Freshwater Bay East	6.73						6.73
22	Stackpole Warren	0.05						0.05
23	Brownslade/Linney					4.12		4.12
24	Broomhill Burrows	0.05			0.01			0.06
25	Whitesand Bay	0.44						0.44
26	The Bennett	0.07						0.07
27	Poppit Sands							
28	Towyn Warren							
29	Ynyslas	0.33					0.13	0.46
30	Tywyn to Aberdovey	0.31						0.31
31	Fairbourne							
32	Morfa Dyffryn	0.80						0.80
33	Morfa Harlech	3.57		0.13				3.70
34	Morfa Bychan	2.36	0.19					2.55
35	Pwllheli/Pen-y-Chain					0.12		0.12
36	Traeth Crugan	0.23						0.23
37	Tai Morfa							
38	Morfa Dinlle							
39	Newborough Warren	7.42						7.42
40	Penrhynoedd - Llangadwaladr	0.07						0.07
41	Aberffraw							
42	Valley	0.05						0.05
43	Tywyn Gwyn							
44A	Traeth Dulas	0.21						0.21
44B	Traeth Lligwy							
45	Red Wharf Bay	0.02						0.02
46	Conwy/Deganwy	3.19						3.19
47	Kinmel Bay							
48	Rhyl to Prestatyn							
49	Gronant to Talacre							
	South Wales Region	4.36						4.36
	Dyfed & Mid-Wales Region	13.63	2.67		0.01	4.71	0.13	21.15
	North Wales Region	18.23	0.19	0.13		0.12		18.67
	National Totals	36.22	2.86	0.13	0.01	4.83	0.13	44.18

Table 11.4 W23 *Ulex europaeus*-*Rubus fruticosus* agg. scrub on dunes in Wales. Areas in hectares.

	Site	W23 undiff.	W23a	W23b	W23b/c	W23c	W23/W24	Total W23
1	Merthyr Mawr	1.25						1.25
2	Kenfig Dunes	0.73						0.73
3	Margam Burrows							
4	Baglan Bay							
5	Crymlyn Burrows	1.15						1.15
6	Black Pill to Bryn Mill							
7	Pennard Burrows	7.57						7.57
8	Penmaen Burrows	1.28						1.28
9	Nicholaston Burrows							
10	Oxwich Burrows							
11	Port-Eynon to Horton							
12	Hillend to Hills Tor							
13	Whiteford Burrows							
14	Pembrey Coast	1.60						1.60
15	Laughame Burrows							
16	Pendine Burrows							
17	Tenby Burrows	2.72						2.72
18	Caldey Island							
19	Lydstep Haven							
20	Manorbier/Swanlake							
21	Freshwater Bay East							
22	Stackpole Warren	4.13						4.13
23	Brownslade/Linney							
24	Broomhill Burrows	0.06			0.57			0.63
25	Whitesand Bay	7.76					0.19	7.95
26	The Bennett	0.80						0.80
27	Poppit Sands					0.66		0.66
28	Towyn Warren	18.22						18.22
29	Ynyslas							
30	Tywyn to Aberdovey	1.95						1.95
31	Fairbourne							
32	Morfa Dyffryn	0.73						0.73
33	Morfa Harlech	5.06	0.98	0.21				6.25
34	Morfa Bychan	4.64						4.64
35	Pwllheli/Pen-y-Chain	4.49	0.03					4.52
36	Traeth Crugan	1.83						1.83
37	Tai Morfa	0.83						0.83
38	Morfa Dinlle							
39	Newborough Warren	0.35						0.35
40	Penrhynoedd - Llangadwaladr							
41	Aberffraw	5.86						5.86
42	Valley	8.47	1.21					9.68
43	Tywyn Gwyn							
44A	Traeth Dulas	0.17						0.17
44B	Traeth Lligwy							
45	Red Wharf Bay							
46	Conwy/Deganwy	8.47						8.47
47	Kinnel Bay							
48	Rhyl to Prestatyn	2.58						2.58
49	Gronant to Talacre							
	South Wales Region	11.98						11.98
	Dyfed & Mid-Wales Region	35.29			0.57	0.66	0.19	36.71
	North Wales Region	45.43	2.22	0.21				47.86
	National Totals	92.70	2.22	0.21	0.57	0.66	0.19	96.55

Table 11.5 W24 *Rubus fruticosus* agg.-*Holcus lanatus* underscrub, W25 *Pteridium aquilinum*-*Rubus fruticosus* agg. underscrub, U20 *Pteridium aquilinum*-*Galium saxatile* community and other scrub types on dunes in Wales. Areas in hectares. T = trace, very small extent.

	Site	W24 undiff.	W24a	W24b	Total W24	Coastal privet scrub	Other scrub	Bracken W25 or U20*
1	Merthyr Mawr	0.42			0.42	11.63		14.12
2	Kenfig Dunes							17.07
3	Margam Burrows							
4	Baglan Bay							
5	Crymlyn Burrows	0.13			0.13			
6	Black Pill to Bryn Mill	1.92			1.92			
7	Pennard Burrows	2.57			2.57			
8	Penmaen Burrows	5.13			5.13	T		1.92
9	Nicholaston Burrows	0.52			0.52			
10	Oxwich Burrows	3.85			3.85			3.85
11	Port-Eynon to Horton					T		1.02
12	Hillend to Hills Tor	9.10			9.10			
13	Whiteford Burrows					T		
14	Pembrey Coast	2.56			2.56	T		
15	Laughame Burrows						6.02	
16	Pendine Burrows					0.11	4.82	
17	Tenby Burrows	2.17			2.17		1.16	4.63
18	Caldey Island					0.12	0.14	
19	Lydstep Haven						2.76	
20	Manorbier/Swanlake							0.17
21	Freshwater Bay East						0.79	
22	Stackpole Warren	9.94			9.94	0.33	2.51	12.47
23	Brownslade/Linney							
24	Broomhill Burrows	0.07	4.98	0.29	5.34			2.17
25	Whitesand Bay	2.27			2.27			5.40
26	The Bennett						0.25	5.90
27	Poppit Sands							
28	Towyn Warren			0.41	0.41		2.10	1.73
29	Ynyslas	0.02			0.02		0.10	
30	Tywyn to Aberdovey	0.41			0.41		0.61	
31	Fairbourne		0.01		0.01			
32	Morfa Dyffryn	0.17			0.17		1.16	3.33
33	Morfa Harlech	2.53			2.53		0.73	
34	Morfa Bychan	0.35			0.35		1.58	2.00
35	Pwllheli/Pen-y-Chain	0.05			0.05		0.30	13.02*
36	Traeth Crugan						0.12	0.18
37	Tai Morfa						0.07	
38	Morfa Dinlle						0.03	0.02
39	Newborough Warren	9.27			9.27		2.48	
40	Penrhynoedd - Llangadwaladr							1.29
41	Aberffraw	0.01		0.34	0.35			
42	Valley	0.07			0.07			0.05
43	Tywyn Gwyn							0.01*
44A	Traeth Dulas						0.05	1.17
44B	Traeth Lligwy							0.48
45	Red Wharf Bay	0.08			0.08			0.07
46	Conwy/Deganwy	1.04			1.04	0.13	0.43	0.11
47	Kinmel Bay						0.01	
48	Rhyl to Prestatyn	1.05			1.05	0.16	0.16	
49	Gronant to Talacre	0.94		12.09	13.03		1.26	
	South Wales Region	23.64			23.64	11.63		37.98
	Dyfed & Mid-Wales Region	17.03	4.98	0.70	22.71	0.56	20.65	32.47
	North Wales Region	15.97	0.01	12.43	28.41	0.29	8.99	21.73
	National Totals	56.64	4.99	13.13	74.76	12.48	29.64	92.18

grazing for several decades, plus the effects of myxomatosis in reducing rabbit grazing, has allowed young groves of W8 *Fraxinus excelsior*-*Acer campestre*-*Mercurialis perennis* and W10 *Quercus robur*-*Pteridium aquilinum*-*Rubus fruticosus* agg. woodland to develop (7.7 ha), associated with a large number of individual trees, mainly on shallower areas of sand overlying limestone at the rear of the main dune system. Stands at Oxwich and Pembrey Coast are smaller and mapped as the W10c *Hedera helix* sub-community: in both areas the woodland probably developed from seed sources on nearby adjacent hills, aided by an absence of stock grazing (and perhaps relaxed rabbit grazing following myxomatosis).

Non-NVC woodland was recorded in several sites (Table 11.6). Sycamore *Acer pseudoplatanus* woodland (total area 29.8 ha) is present in nine sites (Pennard, Nicholaston, Port-Eynon to Horton, Whiteford, Pembrey, Tenby, Stackpole, Conwy/Deganwy, Gronant to Talacre) but is extensive (>5 ha) only at Stackpole Warren (23.2 ha). Other broadleaved plantation is rare (Tenby Burrows). Coniferous plantation is mapped at five sites (Margam, Whiteford, Pembrey Coast, Morfa Harlech, Newborough Warren, Valley) and is also present on sand beyond SSSI boundaries at Merthyr Mawr (precise extent unknown). Total area is very large (1737.6 ha) but only two sites have sizeable extents: Pembrey Coast (967.0 ha) and Newborough Warren (737.8 ha). Mixed plantation is very rare and is mapped only at Stackpole Warren (9.4 ha).

Table 11.6 W8 *Fraxinus excelsior*-*Acer campestre*-*Mercurialis perennis* woodland, W10 *Quercus robur*-*Pteridium aquilinum*-*Rubus fruticosus* agg. woodland and plantation woodland on dunes in Wales. Areas in hectares. P = present, extent not known.

	Site	W8	W10	W10c	Plantation woodland
1	Merthyr Mawr	5.28	2.43		P
2	Kenfig Dunes				
3	Margam Burrows				6.26
4	Baglan Burrows				
5	Crymlyn Burrows				
6	Black Pill to Bryn Mill				
7	Pennard Burrows				1.16
8	Penmaen Burrows				
9	Nicholaston Burrows				1.03
10	Oxwich Burrows			3.21	
11	Port-Eynon to Horton				0.77
12	Hillend to Hills Tor				
13	Whiteford Burrows				25.83
14	Pembrey Coast			1.02	968.71
15	Laughame Burrows				
16	Pendine Burrows				
17	Tenby Burrows				0.60
18	Caldey Island				
19	Lydstep Haven				
20	Manorbier/Swanlake				
21	Freshwater Bay East				
22	Stackpole Warren				32.52
23	Brownslade/Linney				
24	Broomhill Burrows				
25	Whitesand Bay				
26	The Bennett				
27	Poppit Sands				
28	Towyn Warren				
29	Ynyslas				
30	Tywyn to Aberdovey				
31	Fairborne				
32	Morfa Dyffryn				
33	Morfa Harlech				1.36
34	Morfa Bychan				
35	Pwllheli/Pen-y-Chain				
36	Traeth Crugan				
37	Tai Morfa				
38	Morfa Dinlle				
39	Newborough Warren				732.91
40	Penrhynoedd - Llangadwaladr				
41	Aberffraw				
42	Valley				0.13
43	Tywyn Gwyn				
44A	Traeth Dulas				0.61
44B	Traeth Lligwy				
45	Red Wharf Bay				
46	Aberconwy				0.21
47	Kinnel Bay				
48	Rhyl to Prestatyn				
49	Gronant to Talacre				0.27
	South Wales Region	5.28	2.43	3.21	35.05
	Dyfed & Mid-Wales Region			1.02	1001.83
	North Wales Region				735.49
	National Totals	5.28	2.43	4.23	1772.37

12. Other miscellaneous vegetation and land cover types

12.1 Other miscellaneous vegetation types

Target note information and report descriptions list a residuum of other vegetation types which do not fit NVC types. Species lists allow these to be grouped (Table 12.1) into three categories: tall ruderal (dominated by rosebay willowherb *Chamaenerion angustifolium*), disturbed ground (ephemeral and hemicryptophyte ruderals frequent) and remaining vegetation (all dry ground in terms of species content). The tall ruderal type is very rare and is recorded in very low quantity (0.1 ha) only at Morfa Harlech and Valley. Vegetation indicating disturbed ground on dunes is frequent (mapped in 33 sites) and has a moderate total extent (89.2 ha), though only two sites have areas >5 ha: Laugharne Burrows (49.5 ha) and Broomhill Burrows (8.1 ha). Military training is responsible for the disturbed ground at Laugharne Burrows (the site report contains no detail) but at Broomhill Burrows a mixture of poaching by stock and recreational path development are the two main factors involved. In general the extent of mapped disturbed ground is low in Welsh dunes. Species lists for other dry ground suggest no clear ecological factors – total extent is low (33.6 ha) and no site has a large area (>5 ha).

12.2 Other land cover types

A wide range of other types of land cover is mapped (Table 12.2), including bare sand, bare ground, sea defence structures, concrete and buildings, dumps, arable land, sand and gravel extraction sites, car parks, caravan parks, residential buildings and map polygons with no data (recorded as no information or blank). The extent of bare sand is important as an indicator of dune mobility and availability of a scarce habitat which is important for a range of invertebrates. Mapped area totals 135.1 ha, with large extents (>5 ha) at Merthyr Mawr, Hillend to Hills Tor, Brownslade/Linney

Burrows, Morfa Dyffryn, Morfa Harlech, Newborough Warren, Aberffraw and Gronant to Talacre. Reports suggest that little of this area is the result of recreational erosion and sites with large extents of bare sand probably contain much of the current very mobile dune resource of Wales. Bare ground (total extent 72.4 ha) is dominated by an old road and a tip (complete area not mapped) for steel production waste at Margam Burrows (32.4 ha) and motorway (M4) and railway sidings at Kenfig Dunes (13.9 ha). Extents elsewhere are much lower and maps/target notes often lack detail on the cause of bare ground. Sea defences are not large in area (total extent 7.4 ha) but their ecological impact is likely to cover a much larger zone beyond actual installations. The largest set is probably found at Tywyn to Aberdovey (3.1 ha) but other areas with defences (e.g. Black Pill to Bryn Mill, Kinnel Bay) lack precise data on maps and the full extent is not known. Concrete and buildings (often part of old military coastal defences) are not common (total extent 19.6 ha) and only the remains of old munitions stores and new country park facilities at Pembrey Coast are large (11.9 ha). Dumps of agricultural waste and fly tipping are occasionally found but their total extent (8.9 ha) is low and only one site (Brownslade/Linney) is large (4.0 ha). Arable land is uncommon on dune sand (mapped extent is 23.0 ha, mostly at Broomhill Burrows, possibly not of all of this on sand) but not all occurrences on sand will have been mapped due to lack of access. The precise extent is therefore unknown. Sand and gravel extraction is rare (recorded from five sites, extent 4.2 ha), though this still occurs from a large area (3.9 ha) within the dunes at Merthyr Mawr.

All car parks on the edge of dunes have not probably been mapped (e.g. a large park at Oxwich Bay) or are recorded as bare ground. Certain cases are recorded at eleven sites but total area is low (4.06 ha). Caravan sites on dunes are rare (five sites) but two sites have a large area (54.5 ha at Morfa Bychan, 20.1 ha at Lydstep Haven) and other sites have large sites on adjacent land (e.g. Merthyr Mawr).

Residential housing on dune sand is very rare

(mapped only at Port-Eynon to Horton) but access difficulties might have prevented all cases being mapped on the edge of all dune systems. Unlabelled map polygons (generally on the edge of dune systems and perhaps representing arable land beyond the limit of blown sand) are common but extent is low in most sites. Military land without access at Laugharne Burrows is an exception (33.3 ha).

Table 12.1 Other miscellaneous vegetation types on dunes in Wales. Areas in hectares.

	Site	Tall Ruderal (<i>Chamaenerion angustifolium</i>)	Vegetation with indicators of disturbed ground	Other vegetation indicating dry ground	Total of miscellaneous vegetation types
1	Merthyr Mawr				
2	Kenfig Dunes		0.89		0.89
3	Margam Burrows				
4	Baglan Bay				
5	Crymlyn Burrows		0.15		0.15
6	Black Pill to Bryn Mill				
7	Pennard Burrows				
8	Penmaen Burrows				
9	Nicholaston Burrows				
10	Oxwich Burrows				
11	Port-Eynon to Horton				
12	Hillend to Hills Tor				
13	Whiteford Burrows			1.28	1.28
14	Pembrey Coast		1.28		1.28
15	Laughame Burrows		49.50		49.50
16	Pendine Burrows		0.45	0.62	1.07
17	Tenby Burrows		0.53	3.59	4.12
18	Caldey Island		0.03	0.05	0.08
19	Lydstep Haven		0.92		0.92
20	Manorbier/Swanlake				
21	Freshwater Bay East		0.02	0.02	0.04
22	Stackpole Warren		0.30	3.01	3.31
23	Brownslade/Linney		1.65	1.75	3.40
24	Broomhill Burrows		8.10	0.32	8.42
25	Whitesand Bay		0.81	0.27	1.08
26	The Bennett		0.07		0.07
27	Poppit Sands		0.14		0.14
28	Towyn Warren		4.18	0.83	5.01
29	Ynyslas		0.48	0.85	1.33
30	Tywyn to Aberdovey		1.11	0.98	2.09
31	Fairbourne		0.09		0.09
32	Morfa Dyffryn		3.14	2.68	5.82
33	Morfa Harlech	0.03	1.30	0.96	2.29
34	Morfa Bychan		2.54	3.27	5.81
35	Pwllheli/Pen-y-Chain		4.42		4.42
36	Traeth Crugan		0.09	0.85	0.94
37	Tai Morfa		0.60		0.60
38	Morfa Dinlle		0.28	3.23	3.51
39	Newborough Warren			0.70	0.70
40	Penrhynoedd - Llangadwaladr			3.39	3.39
41	Aberffraw		1.13	0.36	1.49
42	Valley	0.08	2.08	2.3	4.46
43	Tywyn Gwyn		0.08		0.08
44A	Traeth Dulas			0.18	0.18
44B	Traeth Lligwy		0.54		0.54
45	Red Wharf Bay				
46	Conwy/Deganwy		1.09	0.84	1.93
47	Kinnel Bay		1.08	0.19	1.27
48	Rhyl to Prestatyn			0.30	0.30
49	Gronant to Talacre		0.16	0.74	0.90
	Totals	0.11	89.23	33.56	122.90

Table 12.2 Other land cover types on dunes in Wales. Areas in hectares.

	Site	Bare sand	Bare ground	Sea defence	Concrete and buildings	Dump	Arable	Sand or gravel extraction
1	Merthyr Mawr	13.76						3.92
2	Kenfig Dunes		13.93		0.81		2.35	
3	Margam Burrows		32.42	1.12	2.72			
4	Baglan Bay				0.79			
5	Crymlyn Burrows	0.64	3.64					
6	Black Pill to Bryn Mill							
7	Pennard Burrows	3.04						
8	Penmaen Burrows	0.22						
9	Nicholaston Burrows	0.08						
10	Oxwich Burrows	0.24						
11	Port-Eynon to Horton	0.16						
12	Hillend to Hills Tor	5.96	0.44					
13	Whiteford Burrows	1.40						
14	Pembrey Coast	1.76	2.52		11.92			
15	Laughame Burrows							
16	Pendine Burrows	1.62	0.85	0.05	0.27	0.58		
17	Tenby Burrows	1.79	0.63			0.13		
18	Caldey Island	0.06						
19	Lydstep Haven			0.42				
20	Manorbier/Swanlake	0.75	0.26		0.03			
21	Freshwater Bay East							
22	Stackpole Warren	1.62	0.41		0.02			
23	Brownslade/Linney	18.51				3.98		
24	Broomhill Burrows	4.31	0.18		0.03	0.64	20.67	
25	Whitesand Bay	0.17	0.04					0.03
26	The Bennett	0.03		0.12				
27	Poppit Sands	0.03						
28	Towyn Warren	0.06	0.44	0.02		0.01		
29	Ynyslas	2.55	1.81					
30	Tywyn to Aberdovey	1.74	0.42	3.11	0.14	0.14		0.13
31	Fairbourne	0.74	1.21					
32	Morfa Dyffryn	35.91	0.81			0.45		
33	Morfa Harlech	5.85	2.65	0.07				
34	Morfa Bychan	1.07			0.3			0.04
35	Pwllheli/Pen-y-Chain	1.52	1.57		0.27	0.06		
36	Traeth Crugan		0.27	1.71				
37	Tai Morfa	1.44				0.27		
38	Morfa Dinlle	0.88	2.58	0.77	0.08	0.35		
39	Newborough Warren	6.96	0.21		0.01			
40	Penrhynoedd - Llangadwaladr	0.21						
41	Aberffraw	5.85				0.15		0.03
42	Valley	4.87	0.80		0.26	1.03		
43	Tywyn Gwyn	0.05				0.05		
44A	Traeth Dulas							
44B	Traeth Lligwy	0.14						
45	Red Wharf Bay		0.48					
46	Conwy/Deganwy	0.47	0.48			0.09		
47	Kinmel Bay	1.05	0.85		1.96			
48	Rhyl to Prestatyn	1.02				0.62		
49	Gronant to Talacre	6.60	2.52			0.30		
	Totals	135.13	72.42	7.39	19.61	8.85	23.02	4.15

Table 12.2 (continued) Other land cover types on dunes in Wales. Areas in hectares.

	Site	Car park	Caravan park	Residential	No information	Blank	Total of other cover types
1	Merthyr Mawr					1.16	18.84
2	Kenfig Dunes					4.15	21.24
3	Margam Burrows				23.60	0.15	60.01
4	Baglan Bay					9.15	9.94
5	Crymlyn Burrows						4.28
6	Black Pill to Bryn Mill						
7	Pennard Burrows						3.04
8	Penmaen Burrows						0.22
9	Nicholaston Burrows						0.08
10	Oxwich Burrows						0.24
11	Port-Eynon to Horton		2.28	2.20			4.64
12	Hillend to Hills Tor	0.96	4.72				12.08
13	Whiteford Burrows						1.40
14	Pembrey Coast		3.80				20.00
15	Laughame Burrows				33.27		33.27
16	Pendine Burrows				2.25	0.89	6.51
17	Tenby Burrows	1.35			15.93	1.84	21.67
18	Caldey Island				0.08		0.14
19	Lydstep Haven		20.12				20.54
20	Manorbier/Swanlake	0.47					1.51
21	Freshwater Bay East						
22	Stackpole Warren				1.30	0.05	3.40
23	Brownslade/Linney						22.49
24	Broomhill Burrows				0.27	1.00	27.10
25	Whitesand Bay				0.16		0.40
26	The Bennett	0.41				0.34	0.90
27	Poppit Sands	0.05					0.08
28	Towyn Warren					0.17	0.70
29	Ynyslas				0.68		5.04
30	Tywyn to Aberdovey				0.51	1.88	8.07
31	Fairbourne						1.95
32	Morfa Dyffryn	0.09			2.97	0.76	40.99
33	Morfa Harlech				2.55	2.95	14.07
34	Morfa Bychan		54.49		9.88	1.27	67.05
35	Pwllheli/Pen-y-Chain				1.80	0.30	5.52
36	Traeth Crugan						1.98
37	Tai Morfa						1.71
38	Morfa Dinlle				0.39		5.05
39	Newborough Warren				1.04	2.94	11.16
40	Penrhynoedd - Llangadwaladr					2.10	2.31
41	Aberffraw				1.39	1.08	8.50
42	Valley				4.23	1.76	12.95
43	Tywyn Gwyn				0.17	0.07	0.34
44A	Traeth Dulas				0.08	0.23	0.31
44B	Traeth Lligwy				0.03		0.17
45	Red Wharf Bay					0.03	0.51
46	Conwy/Deganwy	0.10				0.93	2.07
47	Kinnel Bay	0.30			0.41	0.08	4.65
48	Rhyl to Prestatyn				1.15	0.25	3.04
49	Gronant to Talacre	0.33			6.87	1.50	18.12
	Totals	4.06	85.41	2.20	111.01	37.03	510.28

13. The nature conservation value of Welsh dunes

13.1 Assessing nature conservation value

A survey of this type which is aimed at defining the national resource must consider the overall nature conservation value of the resource, the range of quality and the controls of quality. Assessing nature conservation value is inevitably subjective (Usher 1986) but Ratcliffe (1977, 1986) has proposed a series of criteria against which judgements can be made in a structured way. These criteria include: naturalness, diversity, fragility, rarity, typicalness and position in an ecological/geographical unit, recorded history and educational value, potential value and intrinsic appeal. They are widely accepted and underpin the selection of sites for statutory conservation protection (Nature Conservancy Council 1989). These criteria are therefore discussed here, though in a wider and modified form compared with that employed for statutory site selection. A formal comparison of sites in terms of value is not attempted here since there is no agreement on approach (Usher 1986).

13.2 Naturalness

No dune system in Wales is entirely natural but natural processes have played a major and obvious part in the formation of all dune systems. Geomorphological processes leading to formation can still be determined and in many cases are still operating in an almost unconstrained fashion. The most natural dune sectors are mobile dune communities (SD5, SD6), where geomorphological processes usually operate without human modification. Further inland geomorphology is still important as a factor in the stabilisation of vegetation cover, and in producing the more complex topography associated with secondary destabilisation and restabilisation. The vegetation of most, if not all, Welsh dunes has been influenced by a long history of stock grazing, though documentation is often lacking. This form of human intervention has operated over sufficient time to produce, in interaction

with geomorphological factors, the complex and apparently sustainable mosaic of semi-fixed dunes, dune grassland and sometimes dune heath which are all highly valued semi-natural habitats.

Several factors combine to reduce the naturalness of some Welsh dunes and these are reviewed in Chapter 14 and below, but the general level of naturalness is high by the standards of other lowland habitats in Wales. It is not possible to suggest a site which is the most natural since all have a history of management. Some large dune systems (e.g. Kenfig Dunes, Laugharne Burrows, Morfa Dyffryn, Morfa Harlech, Newborough Warren, Aberffraw) contain extensive tracts of dune with a high degree of naturalness, though at least one is much modified (Pembrey Coast, by afforestation). Smaller dune systems tend to be more modified by recreational pressure, lack of grazing, or development (e.g. Margam Burrows, Black Pill to Bryn Mill, Lydstep Haven, The Bennett, Traeth Dulas, Traeth Lligwy, Kinnel Bay). Size is therefore an important factor in retaining naturalness over much of a dune area.

13.3 Diversity

The overall diversity of Welsh dunes is reflected in the large total of National Vegetation Classification (NVC) dune (SD) communities and sub-communities recorded, plus many other NVC communities and sub-communities (Table 4.1). Such diversity reflects four major types of gradient which operate upon Welsh dunes: successional/stabilisation trends, moisture gradients, transitions to other coastal habitats (including saltmarsh), and transitions to other non-maritime habitats in inland sectors. Site size is also an important factor influencing the diversity of habitats in a particular site, with larger sites usually having a wider range of the underlying gradients affecting diversity. The pattern of diversity for vegetation types also reflects contrasting dune geomorphology and land use differences between sites.

The role of site area is illustrated in Figures 13.1 and 13.2 for six sites representing large (Kenfig 602 ha, Newborough Warren 529 ha), intermediate (Morfa Harlech 341 ha, Brownslade/Linney 253 ha) and small size (Morfa Dinlle 67 ha, Fairbourne 15 ha). In Figure 13.1 the large sites, plus Morfa Harlech, have a large number of NVC sand dune communities, including sizeable areas of mobile and semi-fixed dune, plus large extents of slack. In smaller sites the range of NVC dune communities is much reduced, there is little mobile or semi-fixed dune, and slacks are absent. This pattern of diversity contrast associated with site size is even stronger if NVC sub-communities are considered. The role of area is equally strong for other (non-dune) NVC communities (Figure 13.2).

13.4 Fragility

Dune environments are something of a paradox in relation to this criterion. They are clearly robust in that they are capable of rapid recovery following disturbance (e.g. dune stabilisation measures using *Ammophila arenaria*). Aerial photographs of dunes in South Wales show considerable dune mobility in the 1950s and 1960s, probably resulting from disturbance initiated by military training in the 1940s. Later photographs demonstrate that much stabilisation has occurred naturally in the last two decades. Dune systems are also fragile and are vulnerable to heavy visitor pressure (e.g. Penmaen Burrows, The Bennett), turf modification (Conwy/Deganwy) and some habitat conversion and loss (e.g. dune heath at Crymlyn Burrows) upon golf courses, and to loss of diversity following loss of grazing and scrub expansion (e.g. much of Towyn Warren). Some loss of diversity might also be the result of over-zealous protection and several dune systems are either re-introducing grazing in a controlled manner (e.g. Newborough Warren, Oxwich Burrows) or are using a mowing regime to maintain a shorter grass sward (Kenfig Dunes).

Large sectors of the more stable landward areas of dunes have been used for development and, in addition to habitat loss, new buildings, fences,

walls and roads destroy the most fragile aspect of dunes, the subjective and unquantifiable quality of wilderness. This has been a major pattern in dunes around Swansea Bay and elsewhere.

13.5 Rarity

Rarity requires examination at three levels of dune nature conservation: geomorphological type, vegetation community and biological species. Large hindshore, spit and prograding dune types are the most uncommon types, with sites such as Kenfig, Laugharne Burrows, Morfa Harlech, Morfa Bychan, Newborough Warren and Aberffraw each representing outstanding examples of geomorphological type (see section 3.1).

Dune vegetation, due to its specialised nature, is a scarce resource in Wales. A total extent of c. 8,101 ha (Table 1.1) is very small (0.4%) in relation to a national area of 2,064,000 ha. The balance between vegetation types in this small total area is very uneven and, in the case of NVC sand dune communities, some types are rare in terms of total extent. At NVC community and sub-community level for dune (SD) vegetation types there are seventeen types with a total area <10 ha and 43 types <100 ha, out of a total of 51 communities and sub-communities (excluding communities not recorded to sub-community level). As a group, the seventeen NVC sub-community types of dune slacks are by far the rarest, with the largest sub-community (SD14b) covering only 52 ha. The total extent of NVC dune slack vegetation in Wales is only 615 ha (Table 10.1) and a small number of sites contain most of this extent and the rare sub-community types (Kenfig Dunes, Newborough Warren, Pembrey Coast, Morfa Harlech, Aberffraw, Morfa Dyffryn, Whiteford Burrows and Laugharne Burrows). Dune heathland (H11) is also very rare and only 41 ha is found in Wales. It is largely restricted to Crymlyn Burrows, Valley and Pennard Burrows.

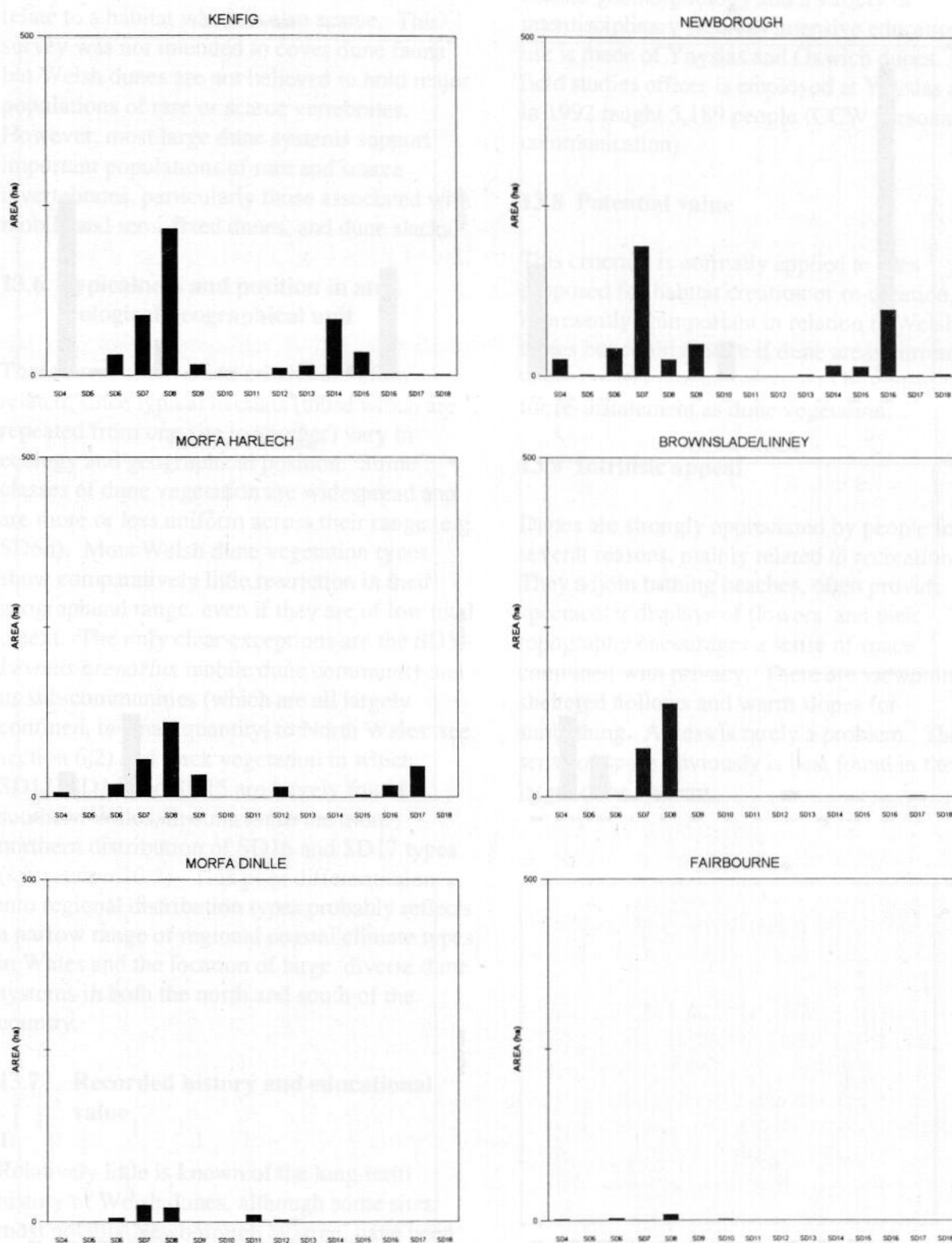


Figure 13.1 Range and area of NVC sand dune community types in six selected dune sites of varying size.

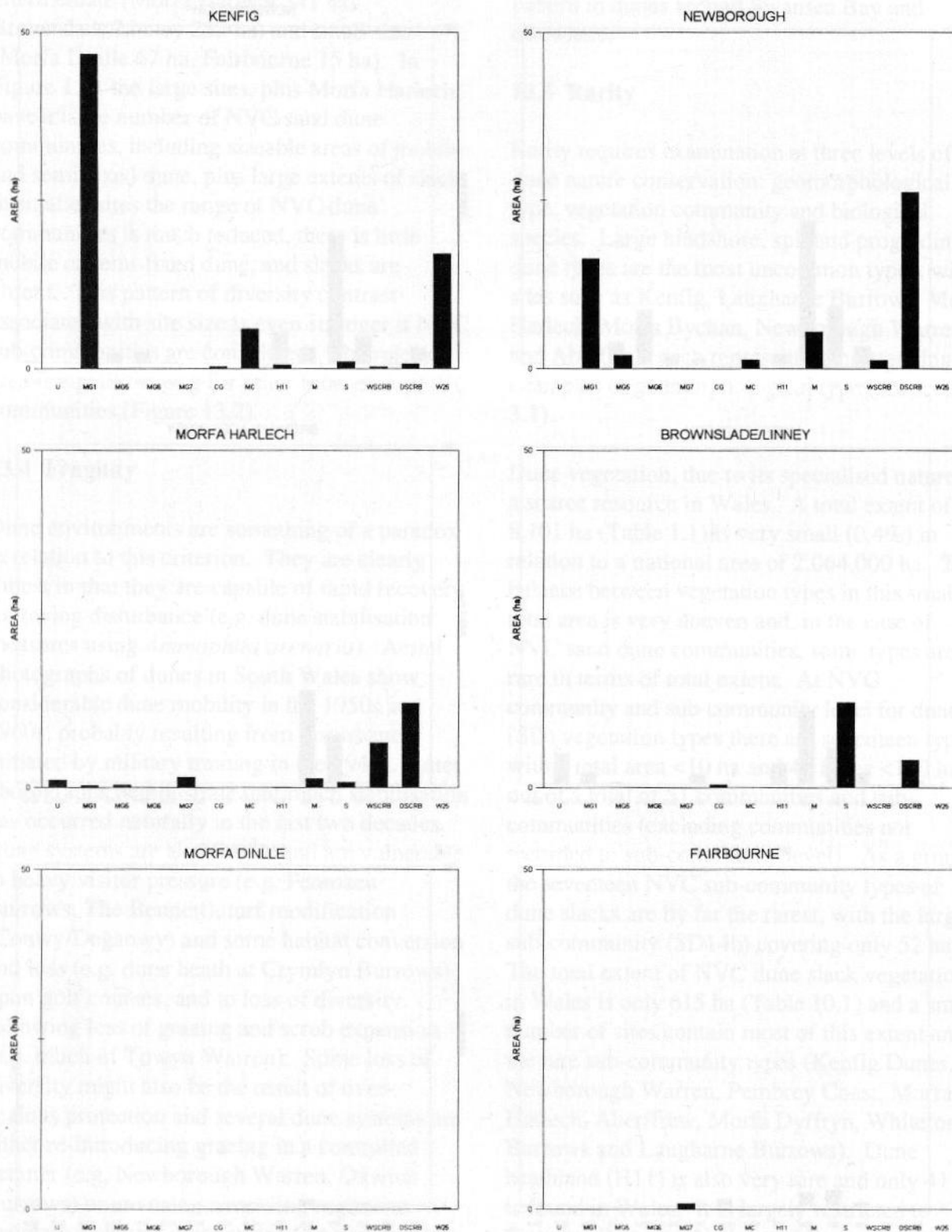


Figure 13.2 Range and area of NVC non-dune community types and community aggregates in six selected dune sites of varying size.

Rare and scarce higher plant species on dunes in Wales are few in number (see section 4.3); most of interest are found in dune slacks and thus relate to a habitat which is also scarce. This survey was not intended to cover dune fauna but Welsh dunes are not believed to hold major populations of rare or scarce vertebrates. However, most large dune systems support important populations of rare and scarce invertebrates, particularly those associated with mobile and semi-fixed dunes, and dune slacks.

13.6 Typicalness and position in an ecological/geographical unit

These two conservation criteria are often related, since typical habitats (those which are repeated from one site to another) vary in ecology and geographical position. Some classes of dune vegetation are widespread and are more or less uniform across their range (e.g. SD6d). Most Welsh dune vegetation types show comparatively little restriction in their geographical range, even if they are of low total extent. The only clear exceptions are the SD5 *Leymus arenarius* mobile dune community and its sub-communities (which are all largely confined, in small quantity, to North Wales: see section 6.2) and slack vegetation in which SD13, SD14 and SD15 are largely found in southern Wales, in contrast to the more northern distribution of SD16 and SD17 types (see section 10.2). This poor differentiation into regional distribution types probably reflects a narrow range of regional coastal climate types in Wales and the location of large, diverse dune systems in both the north and south of the country.

13.7 Recorded history and educational value

Relatively little is known of the long-term history of Welsh dunes, although some sites, most notably Newborough Warren, have been the subject of detailed successional study over the short time-period of one to two decades (Ranwell 1960a, 1960b). Dunes make excellent ecological classrooms where succession, zonation, competition, dispersal and

survivorship can be demonstrated with unusual clarity. They are also important in teaching coastal geomorphology and a variety of interdisciplinary studies. Intensive educational use is made of Ynyslas and Oxwich dunes. A field studies officer is employed at Ynyslas and in 1992 taught 5,189 people (CCW personal communication).

13.8 Potential value

This criterion is normally applied to sites proposed for habitat creation or re-creation. It is presently unimportant in relation to Welsh dunes but could feature if dune areas currently under conifer plantation were to be considered for re-instatement as dune vegetation.

13.9 Intrinsic appeal

Dunes are strongly appreciated by people for several reasons, mainly related to recreation. They adjoin bathing beaches, often provide spectacular displays of flowers, and their topography encourages a sense of space combined with privacy. There are viewpoints, sheltered hollows and warm slopes for sunbathing. Access is rarely a problem. The sense of space obviously is best found in the larger dune systems.

14. The impact of human activities

14.1 Interpretation and limitations of the data

Information on the impact of human activities on dunes was collected in site survey (see Chapter 2). The most serious limitation of such data is that they are heavily dependent on information collected during a single visit to each site, generally during the summer months. Although other sources of information were sought to supplement the field recording it is inevitable that some forms of activity, especially seasonal ones, will have been under-recorded.

Another limitation that should be borne in mind when considering these data is that for most activities the information was collected in a qualitative rather than a quantitative fashion. For example, a dune where there is small-scale sand removal for agriculture would have been recorded as having mineral extraction in the same way as one with a large commercial quarry. There is also some imprecision in those cases where the surveyor was asked to estimate subjectively the level of an activity. This was the case for grazing, erosion and vehicle damage.

Other information on human impacts was derived from the areas of modified dune vegetation or other land cover (e.g. improved grassland, car or caravan park, coniferous plantation) recorded on vegetation maps. All non-dune vegetation types of cover were not consistently mapped for the full wind-blown sand area of every site, largely due to private ownership and thus difficulty in obtaining access permission. Such cover types are therefore under-recorded but information is still useful in identifying sites with much alteration.

Despite limitations the information collected on human activities does have the advantage of having been collected from sites in Wales within the period 1987-91. It is moreover based largely on direct observation. As such it

provides a useful summary of the current state of human activity on dunes.

14.2 Agriculture

The dunes of Wales have probably been shaped and moulded by agriculture for most of their existence. The characteristic semi-natural vegetation of most stable dunes is grasslands or heathlands which have developed as a result of grazing of the indigenous vegetation by sheep, rabbits and cattle. In the absence of such grazing some areas of stable dune would probably have developed into scrub - a common feature on many Welsh dunes. Dune woodlands are rare in Wales (apart from a few very large forestry plantations) but are common elsewhere abroad, notably in The Netherlands where the tradition of pastoral management of dunes is much less widespread.

During this survey grazing by domestic stock was recorded from eighteen out of 49 sites (Table 14.1), a figure suggesting that undergrazing is the current norm for the resource at a national scale. Most large sites are still grazed, usually by sheep or cattle but also occasionally by ponies and goats. Grazing intensity is uncertain for most sites and it probably varies considerably with season and from area to area within a single dune system. Some sites with recorded stock might have little or no grazing over large sectors of dune. Excessive grazing is very rare and heavy grazing was recorded only at Tywyn Gwyn where it had also induced dune erosion. Stock feeding was recorded only at Kenfig Dunes, though the practice is probably more widespread and applied in winter. No problems of excessive winter feeding were noted in Wales. One site (Newborough Warren) is the location for a long-term grazing monitoring experiment by the Institute of Terrestrial Ecology, using Soay sheep as grazers in a 9.7 ha area divided into two replicated groups of sixteen paddocks (with varied grazing intensity and seasonality as treatments) and two ungrazed paddocks as controls (Ashall, Duckworth & Smart 1992). Small sites are rarely grazed (Penmaen and Pennard on the Gower Peninsula are notable

exceptions). A small number of larger sites (Merthyr Mawr, Laugharne and Pendine Burrows) are also ungrazed by stock, though the latter two sites do have deer populations as alternative grazers. The lack of grazing management at Merthyr Mawr might be affecting the conservation value of the site, allowing rank grassland and scrub to develop over large areas. The absence of grazing from the majority of sites is largely due to displacement by other land uses. Recreation and leisure development are the main reasons in most sites, with military use for Laugharne and Pendine Burrows.

Agricultural improvement (re-seeding, ploughing, fertiliser application, etc.) was recorded in fourteen sites (Table 14.1), most of them in southern Wales. The actual extent of dune land impacted by agriculture in this way is uncertain. Areas of agricultural land on blown sand, with no natural or semi-natural vegetation and located on the edge of vegetated dune, were not surveyed as part of this project and this lost dune vegetation habitat has therefore not been recorded in full. The historical loss of dune vegetation to intensive agriculture is likely to have been very significant but cannot be estimated from these data.

Rabbits were formerly raised in large numbers in warren systems on dunes and have since spread to become widely established as wild animals (Sheail 1971). Rabbits were recorded in 41 out of 49 sites in this survey (Table 14.1) and are probably present in most sites with no information. They are probably absent only from the Black Pill to Bryn Mill site in Swansea where heavy recreational pressure throughout the year might prevent colonies becoming established. Rabbits are thus distributed around all parts of the Welsh coast and represent the most widespread grazing animal on dunes. Grazing intensity by rabbits is generally only light or moderate and only eight sites were recorded with heavy levels in Pembrokeshire, at Ynyslas, and in North Wales (notably at Aberffraw). Prior to the outbreak of myxomatosis in the 1950s rabbit grazing might have been much heavier in character but

numbers have probably not fully recovered and there might be an important correlation with the reduction in stock grazing on dunes. Rabbits in The Netherlands are regarded as 'structure followers', extending grazing into short sward grasslands only where this is created by domestic stock ('structure leaders') – they do not by themselves create short swards from rank vegetation (Wallage Drees 1988). Tall, rank swards have probably increased considerably in Wales as stock grazing has fallen over the past three to four decades, at a time when rabbit numbers were depressed following myxomatosis. Rabbit grazing might therefore have been insufficient to maintain large areas of short grass sward, allowing rank grasses and some scrub to invade.

14.3 Recreation

The extent to which sand dunes are used for recreation is not easily quantified. A number of indirect indicators of the level of recreational activity were used in this study: presence of car parks, caravan parks, camp sites and other leisure complexes (with an indication of large size involving dune habitat loss and change); presence of golf courses and the degree of modification of dune turf on fairways; degree of path erosion and presence of dune stabilisation works (fencing, marram planting, boardwalk, brushwood barriers, sea buckthorn planting). Results are summarised in Table 14.2.

Several authors have documented the effects of visitors, which can include a proliferation of path networks and widespread erosion (Liddle & Greig-Smith 1975a, 1975b; Boorman & Fuller 1977; Richards & Stead 1978; Southern *et al.* 1985; Southern 1987; Williams & Randerson 1989). An attempt was therefore made during the present survey to categorise subjectively the degree of erosion damage as a measure of recreational use. Moderate or heavy erosion of path systems in dunes was found in twelve sites, most of them in South Wales. Most have associated dune stabilisation works (fenced areas with marram planting, often with netting and brushwood laid to aid sand accumulation; boardwalk to minimise footpath

wear and tear). Only one site, Merthyr Mawr, had moderate erosion and no attempt to stabilise dunes. Other locations had attempts to reduce erosion using boardwalk but parts of the sites away from such measures were badly trampled and eroding, particularly the climbing dunes on steep slopes at Pennard and Penmaen on the Gower coast. Light path erosion was recorded in a further fifteen sites (mostly in West and North Wales) and hence dune erosion by paths can be considered widespread around the coast of Wales. A few dune sites had local dune stabilisation measures to control eroding blowouts created by natural processes but these were comparatively rare and small in scale in comparison with efforts to cope with recreational pressure.

Recreational trampling can be particularly heavy in the foredune zone at the top of a beach, interfering with the natural creation of embryo dunes, foredunes and the base of the main outer dune – several fencing schemes had been installed to restore dunes badly damaged in these zones. In two cases (Black Pill to Bryn Mill, Port-Eynon to Horton) the upper beach zone of heavily managed locations is scraped clean of seaweed and other tidal debris and litter. Such material is also important in forming embryo dunes and foredunes, acting as a barrier to sand movement and, once buried, a nutrient source for plants. Removal of material inhibits this process and restricts the natural development of outer dune features.

Car parks were recorded in 23 sites, with three of sufficient size (Oxwich, Port-Eynon to Horton, Pembrey Burrows) to entail significant loss of dune habitat at the site scale. Fifteen sites also had caravan parks, camp sites or large leisure complexes on sand or directly adjacent to a dune system. In five cases (Port-Eynon to Horton, Pembrey Coast, Lydstep Haven, Towyn Warren, Morfa Bychan) these were sufficiently large to have entailed significant loss or change of dune habitat. In the case of Pembrey Country Park a large leisure facility has been created from a former munitions manufacturing and storage facility constructed upon the dunes. Some areas of significant habitat loss on the

edges of dune systems were not mapped in full due to access problems and hence the precise extent of such recreational impact is uncertain. In total, 27 sites had car parks and/or caravan parks, camp sites or major leisure developments present and these were distributed around all sectors of the Welsh coast.

One particular aspect of the leisure industry that warrants special attention is the use of dunes as golf courses. The game of golf is believed to have originated on the dune grasslands or 'links' of eastern Scotland (Nature Conservancy Council 1989) and the oldest Welsh course is reputedly that on dunes at Ynyslas. Golf courses were recorded on fifteen sites distributed around all sectors of the Welsh coast. Golf courses only rarely result in the total destruction of semi-natural vegetation but the modern game does seem to require the greens and tees to be converted to a completely artificial sward, whilst the fairways are normally at least part-modified in character. The least modified dune vegetation is usually found in the areas of rough. A total of fifteen golf courses was recorded in this survey, around all sectors of the Welsh coast. Part-modified and improved fairways were recorded at the majority of golf courses, with major alteration present at Morfa Bychan, Deganwy and Rhyl to Prestatyn.

Recreation is thus a very widespread and important activity which ranks as a major form of land use on dune systems. It probably affects many more sites than the traditional use of such areas for stock grazing. Relatively few sites have little recreational pressure and its absence is in general due to industrial development of the area (Margam Burrows, Baglan Bay) or military usage (Laugharne and Pendine Burrows). All other sites with low impact are small and relatively isolated (Penrhynoedd-Llangadwaladr, Tywyn Gwyn, Traeth Dulas/Traeth Lligwy).

14.4 Urban and industrial development

Some Welsh dunes are remote from urban and industrial development and hence show little

impact from these land uses. The exceptions are dune systems located close to the major urban and industrial areas of Wales, particularly in the south between Swansea and Cardiff (Tables 14.3 and 14.4). A large length of dune has been lost to development for the steel industry between Baglan Bay and Kenfig Dunes (the extent and quality of loss is unknown) and major tipping continues at Margam Burrows. Petrochemical works and car plants are adjacent to Baglan Bay and Crymlyn Burrows, with pipework running through both sites and gas storage tanks located on the western parts of the Crymlyn system. The Pembrey area was formerly used for munitions production and storage but this area has been converted into a country park which still contains remnants of old buildings. A more modern industrial estate is also located on part of the Pembrey dune system. Sewage treatment works are located in two dune systems at Merthyr Mawr and Morfa Harlech.

Sand and underlying shingle have been traditionally extracted from dune systems but this practice is now restricted in Wales to six dune systems (Table 14.3). Sand or shingle removed from the beach zone can induce or increase erosion by wave action but this is now probably very rare in Wales.

Eight dune systems in North and South Wales are directly adjacent to residential developments (Table 14.4), with most of the former dune system between Black Pill and Bryn Mill in Swansea converted into housing, car parking and higher education facilities. Roads and railway lines are also routed through ten dune systems, notably the M4 in Kenfig Dunes. Transport corridors running parallel with the coast impose a major boundary within dune systems which interrupts changes in natural zonation patterns and can allow easier access for people and vehicles into sensitive parts of an area. Fly tipping (noted in eight sites) is a further problem, usually associated with tracks into dunes rather than major roads, though it was always very local in scale.

Urban and industrial areas are therefore common in areas adjacent to many Welsh dunes and in several cases occupy or have replaced dune systems. Their major direct impacts are land take leading to habitat loss, dumping of industrial waste and extraction of dune materials. There are also less quantifiable impacts of emissions and discharges which were not examined in this survey.

14.5 Sea defence

Erosion is frequently seen as a threat to dunes. Erosion is, however, also the counterpart of accretion in the dynamic processes which shape and maintain coastal dunes. The presence of sea defences can profoundly affect those dynamic processes. This in turn can have major implications for the vegetation.

A total of 21 dune systems were recorded with some form of sea defence measure in place (Table 14.5) and several other dune systems were adjacent to coastal sectors with groynes and sea walls, structures which change the nature of coastal erosion, sediment transport and sand inputs to the beach zone. In most cases defences were not extensive and consisted of gabions or rocks placed at the junction of dune and hard rock coast to protect residential property, industrial buildings or a sector of golf course from erosion. Such defences were inadequate for the dunes between Rhyl and Prestatyn in the winter storms of 1989/90, with some areas behind the sea wall damaged by standing salt water. In three cases (Black Pill to Bryn Mill in South Wales, Kinmel Bay and Rhyl to Prestatyn in North Wales) sea walls formed large lengths of defence, isolating dunes to landward from a sand supply and hence any realistic opportunity for further natural development to seaward. A new system of large rock boulder groynes was under construction at Rhyl to Prestatyn at the time of dune survey. In the case of dunes between Tywyn and Aberdovey coastal defences to the north might have greatly reduced sand supply, allowing erosion to predominate along all of the beach zone. These four cases probably make up the most serious impacts of sea defence upon

Table 14.1 Agricultural impacts upon Welsh sand dunes (including rabbit grazing).

P = present. L = light. M = moderate. H = heavy. ? = uncertain.

	Site	Stock grazing	Stock feeding	Serious erosion by stock	Agricultural improvement	Rabbit grazing
1	Merthyr Mawr					L
2	Kenfig Dunes	P	P			L/M
3	Margam Burrows					L/M
4	Baglan Bay					?
5	Crymlyn Burrows				P	L/M
6	Black Pill to Bryn Mill					
7	Pennard Burrows	P			P	L/M
8	Penmaen Burrows	P			P	L/M
9	Nicholaston Burrows				P	L/M
10	Oxwich Burrows	P				L/M
11	Port-Eynon to Horton					L
12	Hillend to Hills Tor				P	L/M
13	Whiteford Burrows	P				L/M
14	Pembrey Coast				P	L
15	Laughame Burrows					L/M
16	Pendine Burrows				P	L/M
17	Tenby Burrows				P	?
18	Caldey Island	P				L
19	Lydstep Haven					?
20	Manorbier/Swanlake					L
21	Freshwater Bay East					H
22	Stackpole Warren	P			P	H
23	Brownslade/Linney				P	L/M
24	Broomhill Burrows	P			P	L/M
25	Whitesand Bay				P	?
26	The Bennett					L
27	Poppit Sands					L
28	Towyn Warren				P	?
29	Ynyslas					H
30	Tywyn to Aberdovey					M
31	Fairbourne					?
32	Morfa Dyffryn	P				L/M
33	Morfa Harlech	P				M
34	Morfa Bychan					M
35	Pwllheli/Pen-y-Chain	P			P	L
36	Traeth Crugan					L
37	Tai Morfa	P				M
38	Morfa Dinlle					H
39	Newborough Warren	P				M
40	Penrhynoedd - Llangadwaladr	P				H
41	Aberffraw	P				H
42	Valley	P				M/H
43	Tywyn Gwyn	PH		P		H
44A	Traeth Dulas					L
44B	Traeth Lligwy					L
45	Red Wharf Bay					L
46	Conwy/Deganwy					L/M
47	Kinmel Bay					L
48	Rhyl to Prestatyn					L
49	Gronant to Talacre	P				L/M

Table 14.2 Recreational impacts on Welsh sand dunes. P = present. * = large size, involving habitat loss or change. Golf course fairways: U = unmodified turf; M = part-modified turf; I = improved turf; ? = no information. Path erosion: L = light; M = moderate; H = heavy.

	Site	Car park	Caravan or camp site, other leisure complex	Golf course	Path and other dune erosion	Dune stabilisation works
1	Merthyr Mawr	P			M	
2	Kenfig Dunes	P		P?		
3	Margam Burrows					
4	Baglan Bay					
5	Crymlyn Burrows	P		M	L	
6	Black Pill to Bryn Mill			M		
7	Pennard Burrows			M	H	P
8	Penmaen Burrows				H	P
9	Nicholaston Burrows				H	P
10	Oxwich Burrows	P*	P		M	P
11	Port-Eynon to Horton	P*	P*		M	P
12	Hillend to Hills Tor	P	P		L	P
13	Whiteford Burrows				L	P
14	Pembrey Coast	P*	P*	M	L	P
15	Laughame Burrows					
16	Pendine Burrows					
17	Tenby Burrows	P	P	M/I	?	?
18	Caldey Island					
19	Lydstep Haven		P*			
20	Manorbier/Swanlake	P			M	P
21	Freshwater Bay East	P			M	P
22	Stackpole Warren				L	
23	Brownslade/Linney				?	?
24	Broomhill Burrows	P				
25	Whitesand Bay	P	P	M/I		
26	The Bennett	P			H	P
27	Poppit Sands	P			M	P
28	Towyn Warren	P	P*			P
29	Ynyslas	P	P	U/M	L	P
30	Tywyn to Aberdovey			M	H	P
31	Fairbourne	P			L	P
32	Morfa Dyffryn	P	P		L	P
33	Morfa Harlech			U/M	L	P
34	Morfa Bychan	P	P*	I	M	P
35	Pwllheli/Pen-y-Chain	P	P		L	P
36	Traeth Crugan			U/M		
37	Tai Morfa	P			L	P
38	Morfa Dinlle					
39	Newborough Warren	P			L	P
40	Penrhynoedd - Llangadwaladr					
41	Aberffraw				L	P
42	Valley			U/M		
43	Tywyn Gwyn					
44A	Traeth Dulas					
44B	Traeth Lligwy					
45	Red Wharf Bay	P				
46	Conwy/Deganwy	P	P	M/I		
47	Kinnel Bay		P			
48	Rhyl to Prestatyn		P	I	L	P
49	Gronant to Talacre		P		L	P

Table 14.3 Dune sites with adjacent industry or used for dumping, mineral extraction or for sewage treatment. P = present. F = formerly used for this purpose. * = large-scale impact.

	Site	Adjacent industrial development	Dumping	Mineral extraction	Sewage works
1	Merthyr Mawr		F	P	P
2	Kenfig Dunes	P			
3	Margam Burrows	P	P*	F	
4	Baglan Bay	P			
5	Crymlyn Burrows	P			
6	Black Pill to Bryn Mill				
7	Pennard Burrows				
8	Penmaen Burrows				
9	Nicholaston Burrows				
10	Oxwich Burrows				
11	Port-Eynon to Horton				
12	Hillend to Hills Tor				
13	Whiteford Burrows				
14	Pembrey Coast	P and F		F	
15	Laughame Burrows				
16	Pendine Burrows				
17	Tenby Burrows				
18	Caldey Island				
19	Lydstep Haven				
20	Manorbier/Swanlake				
21	Freshwater Bay East				
22	Stackpole Warren				
23	Brownslade/Linney			P	
24	Broomhill Burrows			F	
25	Whitesand Bay				
26	The Bennett				
27	Poppit Sands				
28	Towyn Warren				
29	Ynyslas				
30	Tywyn to Aberdovey				
31	Fairbourne				
32	Morfa Dyffryn				
33	Morfa Harlech	P			P
34	Morfa Bychan				
35	Pwllheli/Pen-y-Chain				
36	Traeth Crugan				
37	Tai Morfa				
38	Morfa Dinlle				
39	Newborough Warren		P	P	
40	Penrhynoedd - Llangadwaladr			P and F	
41	Aberffraw		P	P	
42	Valley				
43	Tywyn Gwyn			P	
44A	Traeth Dulas				
44B	Traeth Lligwy				
45	Red Wharf Bay				
46	Conwy/Deganwy				
47	Kinnel Bay	P			
48	Rhyl to Prestatyn				
49	Gronant to Talacre				

Table 14.4 Dune systems influenced by residential and suburban land, fly tipping and presence of a transport corridor. P = present.

	Site	Adjacent residential and suburban land	Fly tipping	Transport corridor
1	Merthyr Mawr	P		
2	Kenfig Dunes			P
3	Margam Burrows			P
4	Baglan Bay			P
5	Crymlyn Burrows		P	P
6	Black Pill to Bryn Mill	P		P
7	Pennard Burrows	P		
8	Penmaen Burrows			
9	Nicholaston Burrows			
10	Oxwich Burrows			P
11	Port-Eynon to Horton	P		
12	Hillend to Hills Tor			
13	Whiteford Burrows			
14	Pembrey Coast		P	
15	Laughame Burrows		P	
16	Pendine Burrows	P	P	
17	Tenby Burrows			P
18	Caldey Island			
19	Lydstep Haven			
20	Manorbier/Swanlake			
21	Freshwater Bay East			
22	Stackpole Warren			
23	Brownslade/Linney			
24	Broomhill Burrows			
25	Whitesand Bay			
26	The Bennett			
27	Poppit Sands			
28	Towyn Warren			
29	Ynyslas			
30	Tywyn to Aberdovey			
31	Fairbourne			P
32	Morfa Dyffryn			
33	Morfa Harlech		P	
34	Morfa Bychan			
35	Pwllheli/Pen-y-Chain			
36	Traeth Crugan		P	
37	Tai Morfa			
38	Morfa Dinlle		P	
39	Newborough Warren			
40	Penrhynoedd - Llangadwaladr			
41	Aberffraw			
42	Valley		P	
43	Tywyn Gwyn			
44A	Traeth Dulas			
44B	Traeth Lligwy			
45	Red Wharf Bay			
46	Conwy/Deganwy	P		
47	Kinmel Bay	P		P
48	Rhyl to Prestatyn	P		P
49	Gronant to Talacre	P		

Welsh dunes. Very few examples of the newer 'soft engineering' type of defences were encountered during this survey.

14.6 Forestry

Large-scale, state-financed afforestation with conifers has been carried out on two large Welsh dune systems (Table 14.5). The largest plantations are on dunes of the Pembrey Coast, with 967 ha of conifers in Pembrey Forest, comprising first generation areas of Corsican pine *Pinus nigra* (planted in the early 1930s) and second generation plantings of Corsican pine and Sitka spruce *Picea sitchensis*. At Newborough Warren a further 728 ha of Corsican pine were planted in the late 1940s and the 1950s on the western sectors of dune. In both cases plantings have replaced large extents of dune grassland and slack habitat. The forest extent at Pembrey is so large that the remaining areas of dune interest are largely confined to spit dunes at either end of the system, the bulk of the vegetation in the very large hindshore sector being lost to tree cover (though the main dune and slack topography remains). Older stands have good structural diversity, with a developing shrub layer. The remaining fragments of dune interest within the forest have been mapped by the Forestry Commission and incorporated into a conservation plan. Planting at Newborough Forest did not extend into the wetter slacks and these still retain biological interest, with several nationally rare higher plant species more abundant or confined to the forest area. The planted area is therefore rated as a Site of Special Scientific Interest. Recreational facilities are also provided by the Forestry Commission at Newborough Warren.

Planting on a much smaller scale is present elsewhere, including broadleaved species (mainly sycamore *Acer pseudoplatanus*) and mixed woodland (e.g. at Merthyr Mawr and Stackpole Warren). Conifers on the main dune sector at Whiteford Burrows have been felled and dune vegetation is being allowed to re-establish, though a plantation at the southern end of the dune system has been retained as a distinct landscape feature. The total extent of

coniferous plantation, broadleaved and mixed woodland plantings recorded during survey was 1,772 ha. This comprises 21.8% of surveyed dune area (8,146 ha, Table 1.1) and is thus the largest human impact upon Welsh dunes, measured in terms of highly altered vegetation cover. Forestry Commission plantations make up 96% of all planted tree cover and these are the major component of all such cover.

14.7 Military usage

The coastal zone has long been of military importance. This form of land use reached a peak during the Second World War when many British dune systems had some form of defence installation and larger sites were intensively used for battle training. Defence installations were recorded in five sites (Pembrey Coast, Laugharne Burrows, Brownslade/Linney, Morfa Dyffryn, Valley) and recent military ownership is also known for Merthyr Mawr, a further sector at Pembrey (now developed as Pembrey Country Park), Ynyslas and Morfa Dinlle. The scale of past and present impact is very varied, with some areas only being used as rifle ranges and others as major proof/experimental testing locations or for munitions manufacture and storage. Ground disturbance is extensive at Laugharne Burrows, less so at Tywyn Gwendraeth (the northern spit dune on the Pembrey Coast). The area involved is uncertain (it is not mapped accurately for Laugharne Burrows) but in the case of Tywyn Gwendraeth it has involved excavation to below water table and thus the creation of some wetland habitat of ecological interest. Military ownership also restricts access and recreational impacts are generally few in locations used for testing. This is not the case for the airfield site at Valley and dune areas beyond the military boundary fence have been, in part, developed. In general military use is not a major impact on dune vegetation in Wales.

14.8 Conservation

The management of land for nature conservation is a comparatively recent phenomenon. Nature conservation was

recorded as a land use from a large number of locations. Twenty-four sites were recorded as SSSIs, ten as National Nature Reserves (Kenfig Pool and Dunes; Oxwich Bay, including Nicholaston and Oxwich Burrows; Whiteford Burrows, Stackpole Warren, Ynyslas, Morfa Dyffryn, Morfa Harlech, Newborough Warren), one as a Local Nature Reserve (Morfa Bychan, maintained by North Wales Wildlife Trust). Several fall within the boundaries of the Pembrokeshire Coast and Snowdonia National Parks, some are managed for conservation by the National Trust (e.g. Penmaen), a large number are within the Gower Area of Outstanding Natural Beauty (offering some protection for coastal landscape) and three sites fall within the Llyn Peninsula Environmentally Sensitive Area. In total 35 sites had some form of conservation status. Those excluded tend to be small, highly altered dune systems of reduced ecological value. Much of the Welsh dune resource therefore has some form of protection in place, reflecting the high quality of much of the remaining habitat.

Designated site area was often smaller than survey area, and at least two sites (Margam and Tenby Burrows) are parts of areas designated primarily for other coastal habitat. Other sites (e.g. Oxwich Bay and Whiteford/Llandisfarne saltmarsh) comprise other important coastal habitats in addition to high-quality dunes. Conservation is rarely the sole use of land over the whole survey area, though conservation management has reduced the impact of some other activities. Apart from stabilisation of eroding dunes caused by recreational impact, active management for conservation was noted in several sites including scrub clearance (total eradication of sea buckthorn *Hippophae rhamnoides* from Whiteford Burrows, gorse *Ulex europaeus* clearance from parts of Towyn Warren), felling of coniferous plantations at Whiteford Burrows, and bracken mowing at Oxwich Burrows. The commonest management was by grazing (and, in the case of Kenfig Dunes, mowing) to maintain short-sward grasslands and removal of birch and alder scrub from slacks. All these programmes directly affect the course of natural succession and aim

to maintain open dune grassland and slack vegetation with high species diversity.

Table 14.5 Sea defences, military use, forestry and conservation status of Welsh dunes.

P = present. F = former use. * = very large impact. SSSI = Biological Site of Special Scientific Interest. NNR = National Nature Reserve. LNR = Local Nature Reserve. NP = present in National Park. ESA = Environmentally Sensitive Area. GAONB = Gower Area of Outstanding Natural Beauty.

	Site	Sea defences	Military use	Forestry	Conservation status
1	Merthyr Mawr	P	F	P	SSSI
2	Kenfig Dunes				SSSI, NNR
3	Margam Burrows			P	SSSI
4	Baglan Bay				
5	Crymlyn Burrows	P		P	SSSI
6	Black Pill to Bryn Mill	P*			
7	Pennard Burrows				GAONB
8	Penmaen Burrows				GAONB
9	Nicholaston Burrows				SSSI, NNR, GAONB
10	Oxwich Burrows	P			SSSI, NNR, GAONB
11	Port-Eynon to Horton				GAONB
12	Hillend to Hills Tor	P			GAONB
13	Whiteford Burrows			P	SSSI, NNR, GAONB
14	Pembrey Coast		P and F	P*	SSSI
15	Laughame Burrows		P		SSSI
16	Pendine Burrows	P			SSSI
17	Tenby Burrows				SSSI
18	Caldey Island				
19	Lydstep Haven				NP
20	Manorbier/Swanlake				NP
21	Freshwater Bay East	P			NP
22	Stackpole Warren			P	SSSI, NNR, NP
23	Brownslade/Linney		P		SSSI, NP
24	Broomhill Burrows				SSSI, NP
25	Whitesand Bay	P			NP
26	The Bennett	P			NP
27	Poppit Sands				NP
28	Towyn Warren	P			SSSI
29	Ynyslas	P	F		SSSI, NNR
30	Tywyn to Aberdovey	P			
31	Fairbourne	P			
32	Morfa Dyffryn		P		SSSI, NNR, NP
33	Morfa Harlech				SSSI, NNR, NP
34	Morfa Bychan	P			SSSI, LNR, ESA
35	Pwllheli/Pen-y-Chain	P			ESA
36	Traeth Crugan	P			
37	Tai Morfa				SSSI, ESA
38	Morfa Dinlle		F		
39	Newborough Warren	P		P*	SSSI, NNR
40	Penrhynoedd - Llangadwaladr				SSSI
41	Aberffraw				SSSI
42	Valley	P	P		
43	Tywyn Gwyn				
44A	Traeth Dulas				
44B	Traeth Lligwy				
45	Red Wharf Bay				
46	Conwy/Deganwy	P			
47	Kinnel Bay	P*			
48	Rhyl to Prestatyn	P*			
49	Gronant to Talacre	P			SSSI

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Annex 1 NVC dune surveys - site reports

- Site 1** *Merthyr Mawr, 1989.* P.S. Jones. National sand dune vegetation survey, Site report No. 43. Peterborough, Nature Conservancy Council, 1989. (Contract Surveys, No. 57).
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- Site 3** *Margam Burrows, 1989.* P.S. Jones. National sand dune vegetation survey. Site report No. 44. Peterborough, Nature Conservancy Council, 1989. (Contract Surveys, No. 92.)
- Site 4** *Baglan Burrows, 1989.* P.S. Jones. National sand dune vegetation survey, Site report No. 45. Peterborough, Nature Conservancy Council. (Contract Surveys, No. 93.)
- Site 5** *Crymlyn Burrows, 1989.* T.C.D. Dargie. National sand dune vegetation survey. Site report No. 46. Peterborough, Nature Conservancy Council, 1989. (Contract Surveys, No. 96.)
- Site 6** *Black Pill to Bryn Mill, 1989.* T.C.D. Dargie. National sand dune vegetation survey. Site report No. 47. Peterborough, Nature Conservancy Council, 1989. (Contract Surveys, No. 97.)
- Sites 7-10** *Oxwich, Nicholaston, Penmaen and Pennard Burrows, 1989.* T.C.D. Dargie. National sand dune vegetation survey. Site report No. 48. Peterborough, Nature Conservancy Council, 1989. (Contract Surveys, No. 98.)
- Site 11** *Port-Eynon to Horton, 1989.* T.C.D. Dargie. National sand dune vegetation survey. Site report No. 49. Peterborough, Nature Conservancy Council. (Contract Surveys, No. 99.)
- Site 12** *Hillend, Llangenith, Broughton, Delvid and Hills Burrows, 1989.* T.C.D. Dargie. National sand dune vegetation survey. Site report No. 50. Peterborough, Nature Conservancy Council, 1989. (Contract Surveys, No. 100.)
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- Site 17** *Tenby Burrows, 1987.* A.M. Burn. Botanical survey of Tenby sand dunes (part of Tenby Cliffs SSSI). Unpublished. Nature Conservancy Council, 1987. (Wales Field Unit Report.)
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- Site 19** *Lydstep, S. Pembrokeshire, 1991.* J. Ashall, J. Duckworth & C. Holder. Sand dune survey of Great Britain, Site report No. 102. Peterborough, Joint Nature Conservation Committee. (JNCC Report No. 64.)
- Site 20** *Manorbier and Swanlake Bay, South Pembrokeshire, 1991.* J. Ashall, J. Duckworth & J. Holder. Sand dune survey of Great Britain. Site report No. 103. Peterborough, Joint Nature Conservation Committee 1992. (JNCC Report No. 65.)
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- Site 31** *Fairbourne, Meirionnydd, 1991.* J. Ashall, C. Holder & S. Smart. Sand dune survey of Great Britain. Site report No. 114. Peterborough, Joint Nature Conservation Committee, 1992. (JNCC Report No. 82.)
- Site 32** *Morfa Dyffryn, Meirionnydd, 1991.* J. Ashall, J. Duckworth, C. Holder & S. Smart. Sand dune survey of Great Britain. Site report No. 115. Peterborough, Joint Nature Conservation Committee, 1992. (JNCC Report No. 90.)
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- Site 39** *Newborough Warren and Forest, Ynys Mon, 1991.* J. Ashall, J. Duckworth, C. Holder & S. Smart. Sand dune survey of Great Britain. Site report No. 122. Peterborough, Joint Nature Conservation Committee, 1992. (JNCC Report No. 92.)

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- Site 41** *Aberffraw, Ynys Mon, 1991.* J. Ashall, J. Duckworth, C. Holder & S. Smart. Sand dune survey of Great Britain. Site report No. 123. Peterborough, Joint Nature Conservation Committee, 1992. (JNCC Report No. 45.)
- Site 42** *Valley Airfield and Golf Links, Ynys Mon, 1991.* J. Ashall, J. Duckworth & C. Holder. Sand dune survey of Great Britain. Site report No. 124. Peterborough, Joint Nature Conservation Committee, 1992. (JNCC Report No. 93.)
- Site 43** *Tywyn Gwyn, Ynys Mon, 1991.* J. Ashall, J. Duckworth & C. Holder. Sand dune survey of Great Britain. Site report No. 125. Peterborough, Joint Nature Conservation Committee, 1992. (JNCC Report No. 94.)
- Site 44** *Traeth Lligwy and Traeth Dulas, Ynys Mon, 1991.* J. Duckworth & C. Holder. Sand dune survey of Great Britain. Site report No. 126. Peterborough, Joint Nature Conservation Committee, 1992. (JNCC Report No. 95.)
- Site 45** *Red Wharf Bay, Ynys Mon, 1991.* J. Duckworth & C. Holder. Sand dune survey of Great Britain. Site report No. 127. Peterborough, Joint Nature Conservation Committee, 1992. (JNCC Report No. 96.)
- Site 46** *Conwy and Deganwy Dunes, Aberconwy, 1991.* J. Ashall & C. Holder. Sand dune survey of Great Britain. Site report No. 128. Peterborough, Joint Nature Conservation Committee, 1992. (JNCC Report No. 97.)
- Site 47** *Kinnel Bay, Colwyn, 1991.* J. Ashall, J. Duckworth & C. Holder. Sand dune survey of Great Britain. Site report No. 129. Peterborough, Joint Nature Conservation Committee, 1992. (JNCC Report No. 98.)
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- Site 49** *Gronant to Talacre, Delyn, 1991.* J. Ashall, J. Duckworth, C. Holder & S. Smart. Sand dune survey of Great Britain. Site report No. 131. Peterborough, Joint Nature Conservation Committee, 1992. (JNCC Report No. 46.)