JOINT NATURE CONSERVATION COMMITTEE

Coastal vegetated shingle structures of Great Britain

Coastal vegetated shingle structures of Great Britain: main report

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Girton College
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Dedication

This report is dedicated to the memory of Dr Philippa Recaldin (Pippa Sneddon) - 1963-2009, who was so instrumental through her work with Roland Randall in the 1990s in providing the first evidence base and thereby our ability to look at environmental change in these communities.

Dedicated to Pippa, a wonderful friend, a devoted wife and mother, a meticulous scientist

Roland Randall.

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Preface

JNCC Coastal Survey Programme

The work reported here was originally commissioned by the Coastal Ecology Branch of the Nature Conservancy Council's Chief Scientist Directorate in 1987. The survey forms part of an attempt to describe the size, location and quality of the main coastal habitats in Great Britain (saltmarshes, sand dunes, vegetated shingle, sea cliffs, strandlines, `reclaimed' land and maritime islands).

The collection of basic data on the main coastal habitats is an important first step in identifying the most important sites, establishing a basis for monitoring and understanding the impact of management operations and major development projects on them.

A survey of saltmarshes in Great Britain was completed in 1991 and surveys of the majority of sand dune sites in England and Wales, and a selection of the most important in Scotland, have been completed. Responsibility for completing the existing round of survey passed to the Coastal Conservation Branch of the Joint Nature Conservation Committee's support unit and the results are being published as part of the Branch's publication programme. This report provides a classification of the main shingle plant communities found on stable or semi-stable shingle structures in Great Britain. It does not attempt to provide an assessment of the comparative nature conservation value of the sites surveyed. The more detailed descriptions presented as appendices to this report can be used to provide a first indication of importance, in relation to size of site and number and representation of the plant communities. Further information can be obtained from:

Dr J.P. Doody, Coastal Conservation Branch, Joint Nature Conservation Committee,
Monkstone House, City Road, Peterborough, PE1 1JY.

Background

A survey of shingle structures in Great Britain was initiated in 1987 under contract to Girton College, Cambridge, from the Nature Conservancy Council.

This report comprises the final definition of communities encountered on the shingle substrate and their relation to existing communities identified by the National Vegetation Classification (Rodwell 1991). It forms part of the wider study of the vegetation of shingle structures in Britain, the results of which are presented in separate appendices to this report for England, Scotland and Wales. This work has been conducted within the framework of the National Vegetation Classification (NVC) in order to assess the applicability of existing NVC categories to the shingle communities and, where appropriate, to extend the NVC by highlighting any new communities identified. At the start of this project only one community was specifically attributed to the shingle substrate - SDI, within which two sub-communities had been recognised. This reflected the limited data supply for this substrate at that time.

This research project provides:

a) written descriptions and maps of the major plant communities at each site surveyed, which are collated into regional reports for Wales, Scotland and England;

b) an overall report which combines all data in order to determine which plant communities are found on shingle at a national level, and how these relate to existing NVC categories.

This report represents a summary classification which is discussed more fully in the detailed account of Sneddon (1992). The site descriptions (Appendix 6, Sneddon 1992) form the major part of three appendices for England, Scotland and Wales to this report.

Acknowledgements

This research has been funded by the Nature Conservancy Council. We would like to thank Dr J.P. Doody who was responsible for the administration of the project at NCC. We also wish to acknowledge the help received from many members of staff in the regional offices of NCC in identifying and gaining access to sites. We wish to thank the National Trust, RSPB and other landowners who allowed research to be conducted on their land. We are most grateful for the help received from those responsible for the National Vegetation Classification, in particular Dr Andrew Malloch. Thanks are also due to Lois Judge and Ian Agnew for their assistance in cartographic work.

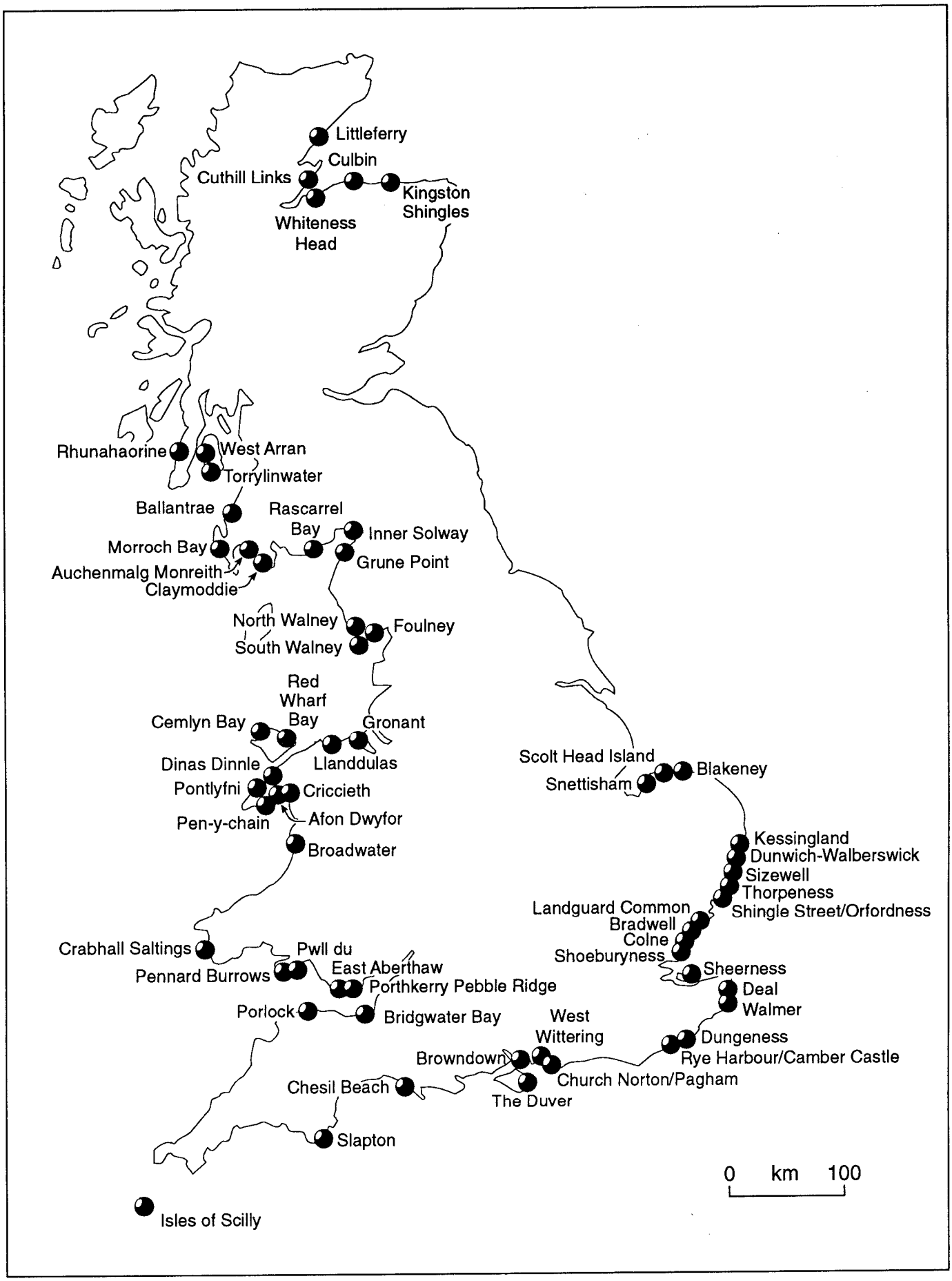

Figure 1. Locations surveyed for vegetated shingle structures. Note that the shingle structure names in this report and in the national appendices may differ from the location names on this figure.

Introduction

The term shingle may be applied to any sediment which has a mean grain size of between 2 and 200 mm. Sediments below that size are termed sand, silt or clay, according to mean grain size, while particles of a diameter greater than 200 mm are termed boulders (see Table 1). This empirical distinction reflects a biological distinction based on environmental factors such as moisture content which lead to differing habitats associated with each sediment.

Table 1. Grain size definitions

Sediment type	Mean particle size (mm)
boulders	200+
shingle	2.0-200
sand	0.63-2.0
silt	0.02-0.63
clay	-0.02

Shingle may occur as a riverine sediment but in the UK it is most commonly found in marine environments around the coast. Indeed, approximately one third of the coastline of England and Wales is bordered by shingle. This marine sediment may have been derived from three major sources:

a) by rivers transporting shingle to the coast;

b) as glacial sediments deposited offshore which have been reworked with rising sea levels to be deposited along the coast;

c) and finally, shingle may result from active erosion of existing coastal cliffs such as the flint shingle derived from chalk cliffs found along much of the south coast.

Geomorphology

Five types of shingle beach have been recognised (Sparks 1972, Chapman 1976). These categories vary according to their mobility and oceanicity and they therefore offer different habitats.

The first type of beach is described as a fringing beach and comprises a narrow strip of shingle in contact with the land along the top of the beach. These are usually subject to regular inundation by the sea and so support only an ephemeral, transient strandline flora (Fig. 2).

Shingle spits are strips of shingle which grow out from the coast where there is an abrupt change in direction of the coastline. They commonly occur, therefore, along coasts which have an irregular coastline. Spits often display recurved hooks along their length and at their distal end where the shingle is, or has been, subject to wave action from two or more directions. Indeed, in many cases it is possible to trace the development of a spit's growth via recurved hooks, seen as lateral projections from the lee of the spit, which locate the position of past distal ends (Fig. 3).

Shingle bars, the third category, are geomorphologically similar to spits representing the extreme case of a spit which has grown across an estuary or coastal indentation. This results in the formation of a lagoon behind the bar which clearly affects the ecology of the leeward slope (Fig. 4).

The fourth type of shingle beach is an apposition beach where a series of shingle ridges are deposited and driven landwards by storm waves. If repeated over time, a series of almost parallel ridges may be produced. Should the predominant wave direction change it leads to the formation of a second set of apposition ridges deposited at a different angle to the original ridges and the subsequent formation of a cuspate foreland, a triangular shaped mass of shingle. Such features often support a terrestrial flora inland of the coastal ridges (Fig. 5).

The final type of shingle formation is the barrier island, formed where a large mass of shingle has been deposited offshore and which often acts as a shingle skeleton for the formation of sand dunes (Fig. 6).

This project is based on the flora of stable shingle beaches rather than strandline communities and therefore focuses on the latter four categories of shingle beach which may be termed shingle structures or beaches with a permanent flora above the strandline, but excluding fringing beaches.

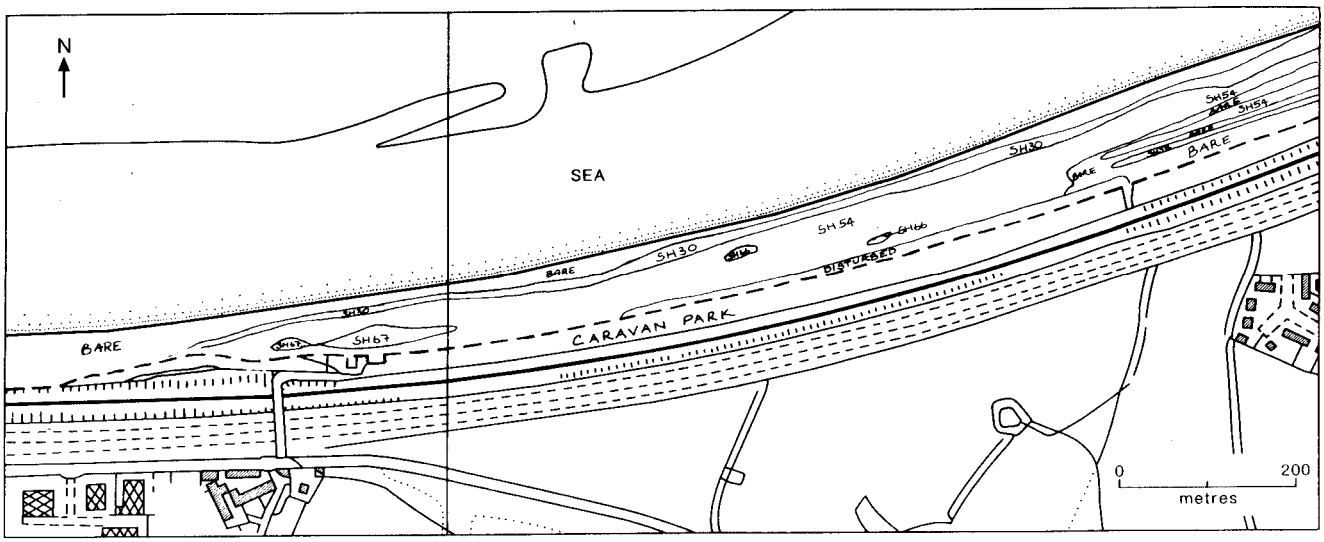

Figure 2. A fringing beach — Llanddulas, N. Wales

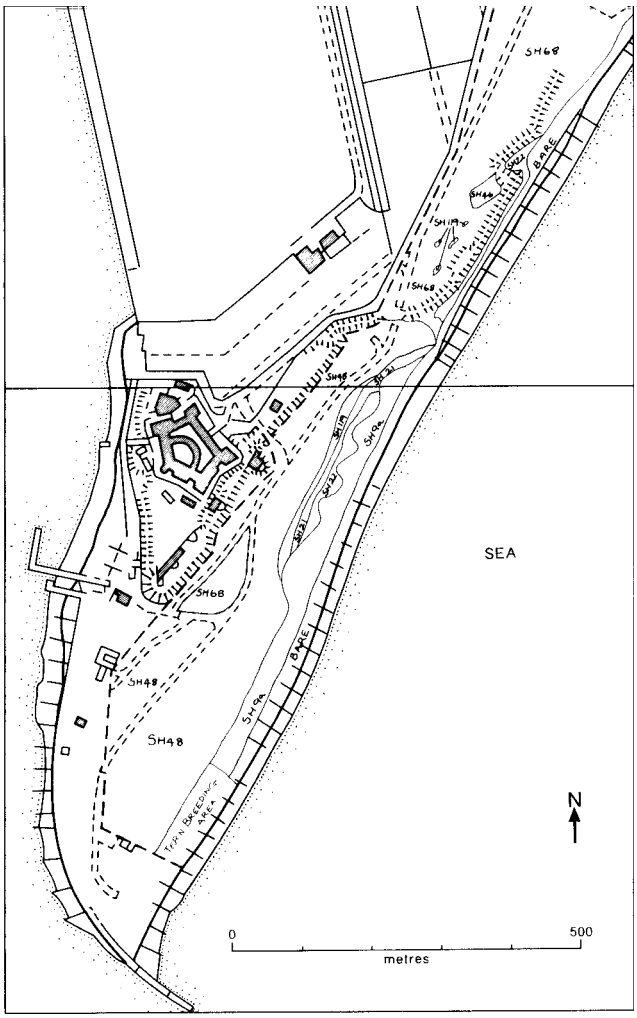

Figure 3. A shingle spit — Landguard Point, Essex

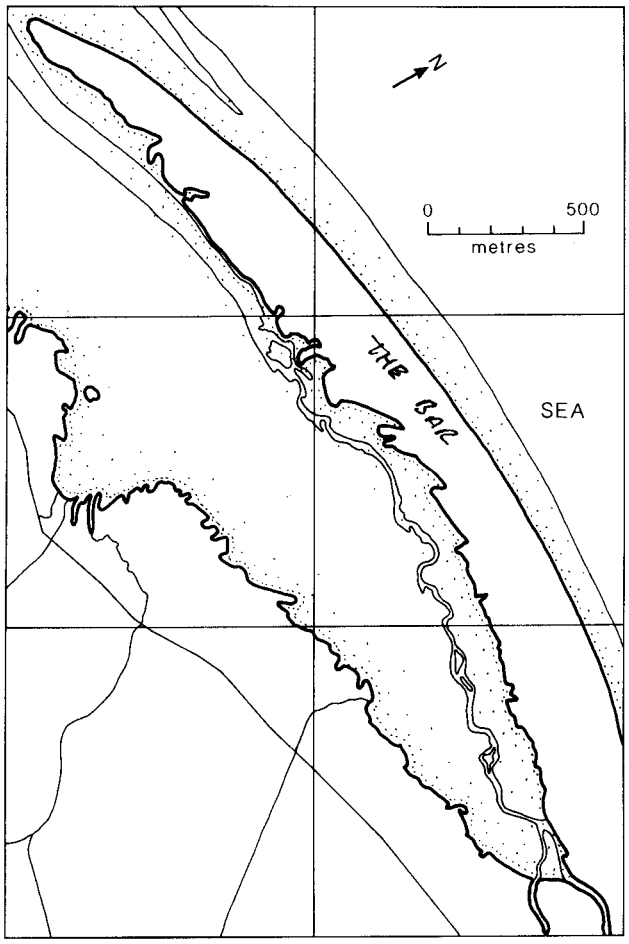

Figure 4. A shingle bar — Culbin Bar, Moray Firth

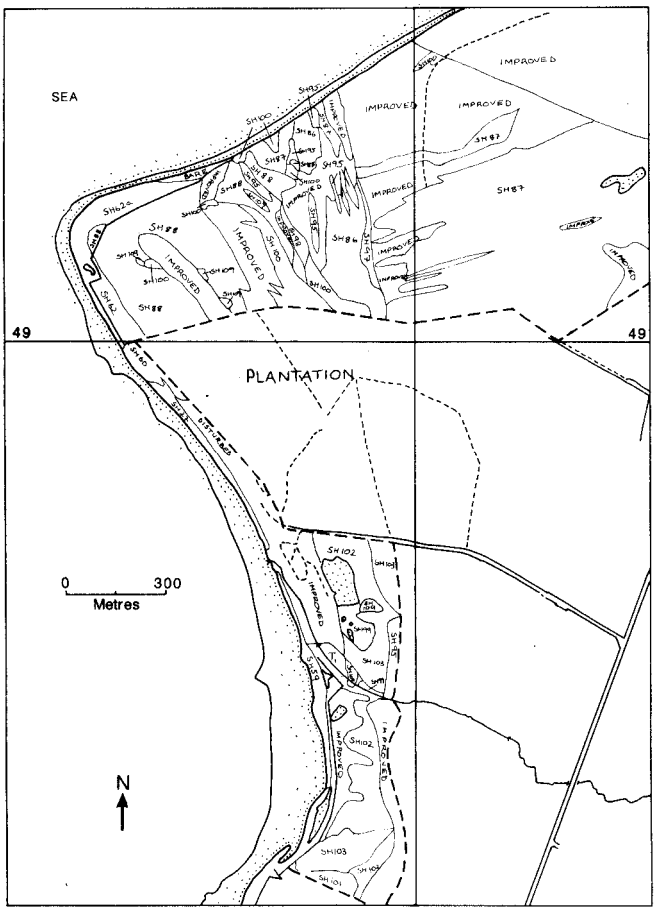

Figure 5. A cuspate foreland — Rhunahaorine Point, Kintyre

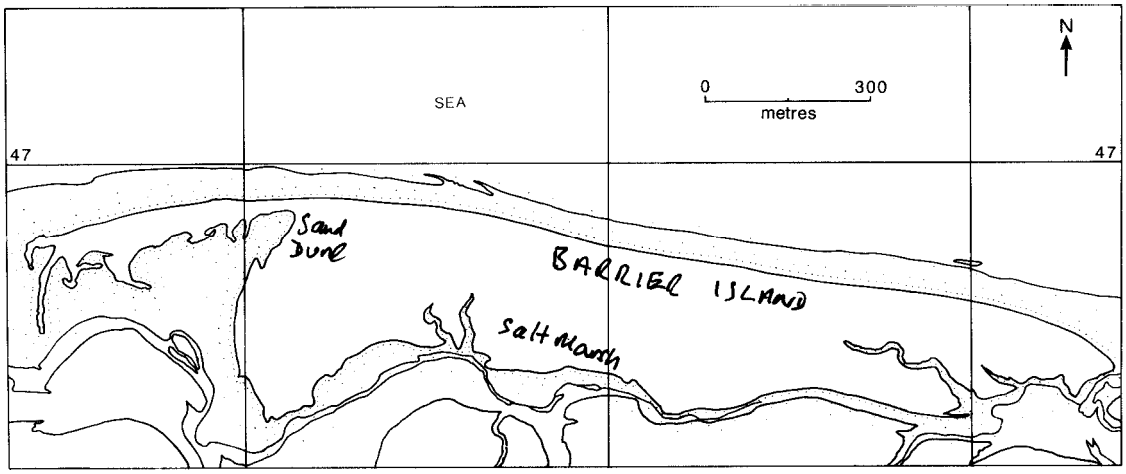

Figure 6. A barrier island — Scolt Head Island, Norfolk

Vegetation

It has been shown by Randall (1977) that three key factors are required to enable the establishment of vegetation on shingle beaches. The first has been mentioned earlier, the mobility of the beach. Clearly, if a beach is highly mobile then a seed is likely to be washed away before it is able to germinate and so the frequency of inundation of a site will have an important influence on the vegetation of that site. Indeed, this factor was recognised by Scott (1963) in his classification of vegetation on shingle which divides shingle vegetation into five categories according to the stability of sites.

A second factor determining the establishment of vegetation on shingle is the presence of a fine matrix in the shingle (Fuller 1987). The nature of the fine matrix has been shown to influence the type of vegetation with four types of shingle substrate identified by Scott (1963); pure shingle, shingle with a sand admixture, shingle with silt and, finally, shingle with wrack (rotting seaweed).

The final factor influencing the presence of vegetation on a shingle beach is the hydrological status of the shingle. Clearly, shingle has a high porosity and low water retention. However, this is overcome to some extent by the presence of a fine matrix which serves as a reservoir of water which is critical at the germination stage of seed development. Once established, the vegetation relies on adaptations to drought conditions such as thick leaf cuticles and the mulching effect on wetter shingle of dry shingle layers above to provide an adequate water supply (Fuller 1987).

To sum up, the establishment and maintenance of a permanent flora on shingle beaches is dependent upon the mobility, matrix and moisture conditions of that beach.

Methods

The first stage in the project involved the identification of shingle sites comprising shingle structures and beaches supporting a permanent flora above the strandline. Around sixty such sites were identified using habitat maps, information supplied by regional staff and published sources (see Figure 1, page 6). It should be noted that the largest shingle site, Dungeness, was excluded from this survey as it has been the subject of a three year mapping project, completed in 1989 (Ferry *et al.* 1990).

Each site was surveyed within the framework of the National Vegetation Classification, therefore the field techniques were based on those recommended for that survey.

Fieldwork was conducted over the course of three field seasons, June - October 1988, April - October 1989, and April - July 1990, covering the east coast, west coast and south coast respectively.

Sites were firstly surveyed by eye to identify stands of homogeneous vegetation to be used as mappable units. Within these stands, vegetation was sampled using a 4 x 2 metre quadrat, found to be the most appropriate size for the vegetation types encountered, and consistent with the quadrat size previously adopted at other shingle sites (Ferry & Waters, 1985). Wherever possible, a minimum of five quadrats was placed in each stand of vegetation. However, in some cases time/size constraints permitted only one sample per stand.

All species of vascular plants, bryophytes and lichens (excluding saxicolous lichens) were recorded for each quadrat and each species' abundance/cover measured using the Domin scale. In addition, soil depth and pH were noted, along with the vegetation height and evidence of grazing. More detailed information on soil characteristics will be available in the thesis of which this report comprises one section (Sneddon 1992).

Target notes were used to describe any features of interest, either physical or biological, which may provide a useful supplement to the quadrat data collected in terms of the analysis of community types.

Site data, such as land use and any forms of disturbance, were collected at each site, while additional site information such as % SSSI coverage and past land use were recorded, based on information collected prior to fieldwork.

The quadrat data were entered onto a computer which organised them into classificatory units to be used for mapping. The programmes used were TWINSPAN and TWINTAB as specified by the NVC. These packages combine quadrats of similar floristic composition into groups and these groupings were then compared with those already identified by the draft NVC keys and tables. These units were then used for mapping.

The original analysis of the data was conducted on the full data set comprising 3250 quadrats thrown on shingle sites around the British coastline excluding Northern Ireland and the Isle of Man, which did not fall within the remit of the Nature Conservancy Council.

Twinspan analysis is considered a particularly useful technique for classification purposes because it uses reciprocal averaging to clearly define axes of dissimilarity within data sets (Causton, 1988).The original analysis identified a group of 170 quadrats at the first level of division. These were then readily subdivided at further levels of division but skewed the rest of the classification which contained around 3300 quadrats. Accordingly, large end groups remained in this section of the shingle classification after ten levels of division and the clarity of communities was somewhat obscured. As a result, these 170 quadrats were excluded from the second run of analysis which proved much more stable with the first division of quadrats leading to a 948 - 2132 quadrat separation. Indeed, this analysis on the edited data set is far more robust with few classificatory end groups emerging before the sixth level of division and with most end groups containing less than 30 quadrats even by the tenth level of division. Some end groups, however, remain too large and require further levels of division to test the homogeneity of these units. The communities identified in the second run of analysis are discussed in detail in the main section of this document but it is first important to describe the characteristics of the excluded quadrats.

In general, these quadrats may be described as characteristic of saltmarsh communities which are found on shingle/saltmarsh boundaries. These communities are very different from those in the main shingle classification and may be described as follows.

The major community identified in this section of the classification is SM25 *Suaeda vera* saltmarsh with *Atriplex portulacoides* and *Xanthoria parietina* as the major associates. This community is found across many shingle sites.

Other communities which key out to the saltmarsh assemblages already identified in the NVC include; SM10 transitional low-marsh vegetation with *Puccinellia maritima,* annual *Salicornia* species and *Suaeda maritima;* SM9 *Suaeda maritima* saltmarsh; SM24 *Elymus pycnanthus* saltmarsh; SM8 annual *Salicornia* saltmarsh and SM14 *Atriplex portulacoides* saltmarsh. These communities are found across several shingle sites, primarily spits or barrier islands where shingle structures are found adjacent to marsh sediments.

In addition, there is also one community typical of maritime cliffs which has been identified within this section of the data. This is sampled at several shingle sites and comprises MC6 *Atriplex prostrata - Beta vulgaris maritima* seabird cliff community. It may be that the nutrient status of certain shingle beaches is similar to the heightened status associated with sea bird guano. Also, the combination of a high maritime influence and relatively high levels of disturbance associated with sea birds such as gulls is replicated across many shingle sites.

In the second run of analysis, on the edited data set, 169 end group categories were identified using the Twinspan analysis. Closer inspection of these categories revealed that in several cases the end groups were not sufficiently robust, in terms of numbers of quadrats or levels of dissimilarity, to warrant inclusion as separate shingle communities. These were then incorporated into the closest categories. In addition, there are some units which, even after ten levels of division, contain over 50 quadrats. In these cases, further analysis was conducted on these groups to test the levels of homogeneity within each group, and in some cases this has led to an increase in the final number of classification units.

Two methods for mapping were employed in the field according to the availability of aerial photographs. Where such photographs were readily available at a suitable scale, these would

be used to map units in the field. However, availability was rather limited and the second method was most commonly adopted. This method involved sketching units onto an enlarged 1:10000 map of the sites, on which the position of individual quadrats was marked. The preliminary mapping was used in conjunction with the classification provided by TWINSPAN to allow more accurate mapping onto a final map.

Nomenclature follows Clapham, Tutin & Moore (1987), Dobson (1981) and Watson (1968).

Shingle community classification

This section of the report provides a summary in tabular form of the shingle community classification derived from the TWINSPAN analyses.

Table 2 lists the main divisions of the classification. There are 25 sections into which the communities are grouped. The codes and names of the shingle plant communities identified during this study are listed in Table 3, which is subdivided into the 25 sections.

The community names in Table 3 are, in each case, derived from the presence of constant species in the community. The table lists also the NVC category which provides the closest match with each shingle community. In some cases there is no good match, or only a poor match, with an NVC community. This has been noted in the comments section of Table 3, which also notes, where appropriate, the major differences in species composition between shingle and NVC classifications.

Each of the shingle communities are described in the cmmunity descriptions chapter than follows this table. The order in which the communities are listed in Table 2 and described in the following chapter is broadly from the most landward communities to the most seaward, and the number in this sequence is largely in descending order from SH124 to SH1.

Table 2. Major divisions of the shingle vegetation classification. Divisions are listed in order broadly from the most landward to the most seaward vegetation types. Vegetation communities in each of the sections are listed in Table 3.

1. Scrub communities	1a. *Prunus spinosa* communities	
	1b. *Rubus fruticosus* communities	
	1c. *Ulex europaeus* communities	
2. Heath communities	2a. Wet heaths	
	2b. Dry heaths	2b.i. *Pteridium aquilinum* heath
		2b.ii. *Calluna vulgaris* communities
		2b.iii Moss-rich communities
3. Grassland communities	3a. Saltmarsh-influenced grasslands	
	3b. *Agrostis stolonifera* grasslands	
	3c. *Arrhenatherum elatius* grasslands	
	3d. *Festuca rubra* grasslands	
	3e. Mixed grasslands	
	3f. Sandy grasslands	
4. Mature grassland communities	4a. Mature grasslands	4a.i. Mature grasslands - *Festuca rubra*
		4a.ii. Mature grasslands - *Dicranum scoparium*
		4a.iii. Mature grasslands - *Arrhenatherum elatius*
	4b. Less mature grasslands	4b.i. Less mature grasslands - pure shingle
		4b.ii. Less mature grassland - saltmarsh influence
5. Secondary pioneer communities		
6. Pioneer communities	6a. *Honckenya peploides* dominated communities	
	6b. *Senecio viscosus* dominated communities	
	6c. *Beta vulgaris maritima* dominated communities	
	6d. *Raphanus maritimus* dominated communities	
	6e. Herb-dominated pioneer communities	
	6f. *Silene uniflora* dominated pioneer communities	

Table 3. The codes and names of the shingle plant communities identified during this study, compared with the most similar NVC code and its name. The comments column explains where there are notable differences between shingle and NVC codes.

1. Scrub communities

1a. *Prunus spinosa* communities

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH124	*Prunus spinosa* dominated scrub with *Hedera helix* - *Rubus fruticosus*	**W21a**	*Crataegus monogyna* - *Hedera helix* scrub community, *Hedera helix* - *Urtica dioica* sub-community.	SH124 has more *Prunus spinosa* than expected.
SH123	*Prunus spinosa* dominated scrub with *Rubus fruticosus* - *Dactylis glomerata* - *Rosa pimpinellifolia* community	**W22**	*Prunus spinosa* - *Pteridium aquilinum* community.	This is not a good match.
SH122	*Prunus spinosa* - *Eurynchium praelongum* community.	**W22**	*Prunus spinosa* - *Pteridium aquilinum* community.	This is not a good match.
SH121	*Rubus fruticosus* - *Prunus spinosa* - *Arrhenatherum elatius* - *Crataegus monogyna* community.	**W22**	*Prunus spinosa* - *Pteridium aquilinum* community.	This is not a good match.
SH120	*Prunus spinosa* - *Rubus fruticosus* - *Arrhenatherum elatius* scrub community.	**W22**	*Prunus spinosa* - *Pteridium aquilinum* community.	

lb. *Rubus fruticosus* communities

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH119	*Rubus fruticosus - Arrhenatherum elatius* scrub community.	**W24**	*Rubus fruticosus - Holcus lanatus* underscrub.	The closest match but with less *Holcus lanatus* in **SH119.**
SH118	*Salix cinerea - Rubus fruticosus - Holcus lanatus* community.	**W24**	*Rubus fruticosus - Holcus lanatus* underscrub.	The closest match, but not particularly good. Also close to **Wl** *Salix cinerea - Galium palustre.*
SH118a	*Corylus avellana - Salix cinerea - Rubus fruticosus - Holcus lanatus* community.	**W24**	*Rubus fruticosus - Holcus lanatus* underscrub.	The closest match, but not particularly good. Also close to **Wl** *Salix cinerea - Galium palustre.*
SH117	*Rubus fruticosus - Hypnum cupressiforme - Arrhenatherum elatius - Raphanus maritimus* community.	-	No clear NVC equivalent.	
SH116	*Raphanus maritimus - Arrhenatherum elatius - Rubus fruticosus - Dactylis glomerata* community.	**MG1**	*Arrhenatherum elatius* grassland.	The closest match but this is not particularly good as it contains no *Raphanus maritimus.*
SH115	*Raphanus maritimus - Arrhenatherum elatius - Rubus fruticosus* community.	**MGl**	*Arrhenatherum elatius* grassland.	The closest match but this is not particularly good as it contains no *Raphanus maritimus.*
SH114	*Hedera helix - Rubus fruticosus - Arrhenatherum elatius* community.	-	-	No clear NVC equivalent.
SH113	*Urtica dioica - Galium aparine - Holcus lanatus - Rubus fruticosus* community.	**MG1b**	*Arrhenatherum elatius* grassland, *Urtica dioica* sub-community.	
SH112	*Pteridium aquilinum - Arrhenatherum elatius - Rubus fruticosus* community.	**W25b**	*Pteridium aquilinum - Rubus fruticosus* underscrub, *Teucrium scorodonia* sub-community.	This is not a close match.
SH111	*Pteridium aquilinum - Rubus fruticosus* community.	**W25b**	*Pteridium aquilinum - Rubus fruticosus* underscrub, *Teucrium scorodonia* sub-community.	
SH110	*Dactylis glomerata - Rubus fruticosus - Centaurea nigra* community.	**W23**	*Ulex europaeus - Rubus fruticosus* community.	With additional *Dactylis glomerata.*

1c. *Ulex europaeus* communities

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH109	*Ulex europaeus - Rubus fruticosus - Agrostis capillaris* scrub community.	**W23**	*Ulex europaeus - Rubus fruticosus* community.	
SH108	*Ulex europaeus - Rubus fruticosus* scrub community.	**W23**	*Ulex europaeus - Rubus fruticosus* community.	
SH108a	*Ulex europaeus - Rubus fruticosus* scrub community. *Solanum dulcamara* sub-community.	**W23**	*Ulex europaeus - Rubus fruticosus* community.	
SH107	*Ulex europaeus - Rubus fruticosus - Arrhenatherum elatius* community.	**W23c**	*Ulex europaeus - Rubus fruticosus* community, *Teucrium scorodonia* sub-community.	With additional *Arrhenatherum elatius.*
SH106	*Ulex europaeus - Arrhenatherum elatius - Rubus fruticosus* scrub community.	**W23**	*Ulex europaeus - Rubus fruticosus* community.	With additional *Arrhenatherum elatius.*
SH105	*Arrhenatherum elatius - Rubus fruticosus - Ulex europaeus* community.	**W23c**	*Ulex europaeus - Rubus fruticosus* community, *Teucrium scorodonia* sub-community.	With additional *Arrhenatherum elatius.*
SH104	*Ulex europaeus - Rubus fruticosus - Quercus robur* community.	**W23c**	*Ulex europaeus - Rubus fruticosus* community, *Teucrium scorodonia* sub-community.	With additional *Quercus robur.*

2. Heath communities

2a. Wet heaths

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH103	*Phragmites australis - Mentha aquatica* community.	**S4**	*Phragmites australis* reed bed.	
SH102	*Epilobium palustre - Hydrocotyle vulgaris - Juncus articulatus* community.	**M27a**	*Potentilla palustris - Carex rostrata* fen, *C. rostrata Equisetum fluviatile* sub-community.	
SH101	*Juncus articulatus - Potentilla palustris - Epilobium palustre* community.	**M23**	*Juncus effusus - Galium palustre* pasture.	
SH100	*Juncus effusus - Holcus lanatus - Agrostis canina* community.	**M23**	*Juncus effusus - Galium palustre* pasture.	
SH99	*Salix cinerea - Holcus lanatus - Juncus effusus* community.	**W1** **MG10**	*Salix cinerea - Galium palustre* community, & *Holcus lanatus - Juncus effusus* rush pasture.	
SH98	*Juncus effusus - Molinia caerulea - Agrostis stolonifera* community.	**MG10**	*Holcus lanatus - Juncus effusus rush* pasture.	With *Molinia caerulea* replacing *Holcus lanatus.*

2b. Dry heaths

2b.i *Pteridium aquilinum* heath

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH97	*Pteridium aquilinum* dominated grassland community.	**U20**	*Pteridium aquilinum - Galium saxatile* community.	
SH97a	*Pteridium aquilinum* dominated grassland community, *Teucrium scorodonia* sub-community.	**U20**	*Pteridium aquilinum - Galium saxatile* community.	
SH97b	*Pteridium aquilinum* dominated grassland community, moss-rich sub-community.	**U20**	*Pteridium aquilinum - Galium saxatile* community.	
SH97c	*Pteridium aquilinum* dominated grassland community, *Rubus fruticosus* sub-communitv.	**U20**	*Pteridium aquilinum - Galium saxatile* community.	
SH96	*Calluna vulgaris - Festuca rubra - Pteridium aquilinum* communitv.	**U20**	*Pteridium aquilinum - Galium saxatile* community.	
SH95	*Pteridium aquilinum - Molinia caerulea - Anthoxanthum odoratum* community.	**U20a**	*Pteridium aquilinum - Galium saxatile* community, *Anthoxanthum odoratum* sub-community.	
SH94	*Potentilla erecta - Molinia caerulea - Anthoxanthum odoratum - Calluna vulgaris* community.	-	-	No clear NVC equivalent.

2b.ii *Calluna vulgaris* communities

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH93	*Agrostis capillaris - Ulex europaeus - Rhytidiadelphus saxarrosus* communitv.	**U4a**	*Festuca ovina - Agrostis capillaris - Galium saxatile* grassland.	Typical sub-community with additional *Ulex europaeus.*
SH92	*Calluna vulgaris - Cladonia impexa* communitv.	**H11**	*Calluna vulgaris - Carex arenaria* dune heath.	
SH92a	*Calluna vulgaris - Cladonia impexa* community, *Anthoxanthum odoratum - Festuca ovina* sub-communitv.	**H11**	*Calluna vulgaris - Carex arenaria* dune heath.	
SH91	*Calluna vulgaris - Erica cinerea - Hypogymnia physodes - Cladonia spp.* community.	**H11a**	*Calluna vulgaris - Carex arenaria* dune heath, *Erica cinerea* sub-community.	**SH91** represents a version of this sub-community rich in *Cladonia spp.*
SH90	*Calluna vulgaris - Potentilla erecta - Erica cinerea* community.	**H10c**	*Calluna vulgaris - Erica cinerea* heath, *Festuca ovina - Anthoxanthum odoratum* sub-communitv.	
SH89	*Calluna vulgaris - Dicranum scoparium - Rhacomitrium canescens* communitv.	**H1**	*Calluna vulgaris - Festuca ovina* heath.	
SH88	*Calluna vulgaris - Molinia caerulea - Potentilla erecta* community.	**M15d**	*Trichophorum cespitosum - Erica tetralix* wet heath, *Vaccinium myrtillis* sub-communitv.	
SH87	*Erica tetralix - Myrica gale - Calluna vulgaris* community.	**M15**	*Trichophorum cespitosum- Erica tetralix* wet heath.	SH87 lacks *Trichorphorum cespitosum.*
SH86	*Molinia caerulea - Calluna vulgaris - Eriophorum angustifolium* community.	**M19a**	*Calluna vulgaris - Eriophorum vaginatum* mire.	This is not a close match.

2b.iii Moss-rich communities

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH85	*Pseudoscleropodium purum - Polypodium vulgare - Dicranum scoparium* community.	-	-	There is no clear NVC equivalent.
SH84	*Holcus lanatus - Rosa pimpinellifolia - Festuca rubra* heath community.	**H11**	*Callum vulgaris - Carex arenaria* heath with additional *Holcus lanatus and Festuca rubra.*	
SH83	*Agrostis capillaris - Dicranum scoparium - Hypnum cupressiforme - Galium saxatile* community.	**U4**	*Festuca ovina - Agrostis capillaris - Galium saxatile* grassland offers the closest match.	
SH82	*Salix repens - Carex panicea - Agrostis stolonifera* community.		**SD14** *Salix repens - Campylium stellatum* dune slack.	With additional wetland species such as *Empetrum nigrum*, *Carex panicea*, *C. nigra* and *Schoenus nigricans.*
SH81	*Salix cinerea - Evernia prunastri - Hypogymnia physodes* community.	-	There is no close NVC match.	It seems to be a sub-community of **Wl** *Salix cinerea - Galium palustre* woodland.

3. Grassland communities

3a. Saltmarsh-influenced grasslands

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH80	*Agrostis stolonifera - Festuca rubra* saltmarsh community.	**SM16**	*Festuca rubra* saltmarsh.	
SH79	*Festuca rubra - Agrostis stolonifera* community.	**MGll**	*Festuca rubra - Agrostis stolonifera - Potentilla anserina* inundation grassland.	
S1178	*Elymus pycnanthus - Vicia cracca* community.	**SM28**	*Elymus repens* saltmarsh.	The closest match but not particularly good.
SH77	*Glaux maritima - Festuca rubra - Juncus maritimus* community.	**SM18**	*Juncus maritimus* saltmarsh.	
SH76	*Spergularia maritima - Plantago maritima - Puccinellia maritima* community.	**SM13**	*Puccinellia maritima* saltmarsh.	

3b. *Agrostis stolonifera* grasslands

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH75	*Agrostis stolonifera - Festuca ovina - Plantago maritima* community.	-	-	The presence of *F. ovina* with maritime herbs causes problems in matching the data.
SH74	*Agrostis stolonifera - Trifolium repens - Festuca rubra* community.	**MG11**	*Festuca rubra - Agrostis stolonifera - Potentilla anserina* inundation grassland.	

3c. *Arrhenatherum elatius* grasslands

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH73	*Arrhenatherum elatius - Raphanus maritimus* community.	**MG1b**	*Arrhenatherum elatius* grassland, *Urtica dioica* sub-community.	The closest match but does not include *Raphanus maritimus.* This may be a new sub-community.
SH73a	*Arrhenatherum elatius - Raphanus maritimus* community, *Holcus lanatus* sub-community.	**MG1b**	*Arrhenatherum elatius* grassland, *Urtica dioica* sub-community.	The closest match but does not include *Raphanus maritimus.* This may be a new sub-community.
SH72	*Arrhenatherum elatius - Rubus fruticosus - Dactylis glomerata* community.	**MGla**	*Arrhenatherum elatius* grassland, *Festuca rubra* sub-community.	SH72 has additional *Rubus fruticosus.*
SH71	*Arrhenatherum elatius* grassland community.	**MG1a**	*Arrhenatherum elatius* grassland, *Festuca rubra* sub-community.	**SH71** represents a species-poor version of **MG1a**.

3d. *Festuca rubra* grasslands

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH68	*Festuca rubra - Plantago lanceolata - Poa pratensis* community.	**SD8a**	*Festuca rubra - Galium verum* fixed dune, typical sub-community.	
SH67	*Festuca rubra - Dactylis glomerata - Lolium perenne - Bromus hordeaceus* community.	**SD8a**	*Festuca rubra - Galium verum* fixed dune, typical sub-community.	
SH66	*Festuca rubra - Plantago lanceolata - Lotus corniculatus* community.	**SD8a**	*Festuca rubra - Galium verum* fixed dune, typical sub-community.	
SH65	*Festuca rubra - Achillea millefolium - Lotus corniculatus* community.	**SD8a**	*Festuca rubra - Galium verum* fixed dune, typical sub-community.	

3e. Mixed grasslands

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH64	*Festuca rubra - Holcus lanatus - Plantago lanceolata - Rumex acetosa* communitv.	**SD8**	*Festuca rubra - Galium verum* fixed dune.	
SH63	*Festuca rubra - Plantago lanceolata - Dicranum scoparium* communitv.	**SD8a**	*Festuca rubra - Galium verum* fixed dune, typical sub-communitv.	
SH62	*Festuca rubra - Agrostis stolonifera - Poa pratensis - Anthoxanthum odoratum* community.	**SD8**	*Festuca rubra - Galium verum* fixed dune.	
SH62a	*Festuca rubra - Agrostis stolonifera - Poa pratensis - Anthoxanthum odoratum* community, *Trifolium repens* sub-community.	**SD8**	*Festuca rubra - Galium verum* fixed dune.	
SH60	*Agrostis stolonifera - Holcus lanatus - Trifolium repens - Plantago lanceolata* communitv.	**SD8a**	*Festuca rubra - Galium verum* fixed dune, typical sub-community.	**SH60** contains less *Festuca rubra* and *Galium verum* than would be expected.
SH60a	*Agrostis stolonifera - Holcus lanatus - Trifolium repens - Plantago lanceolata* community, *Poa trivialis* and *Lolium perenne* sub-community.	-	-	No clear NVC equivalent.

3f. Sandy grasslands

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH61	*Festuca rubra - Anthoxanthum odoratum - Lotus corniculatus* community.	**SD12a**	*Carex arenaria - Festuca ovina - Agrostis capillaris* grassland, *Anthoxanthum odoratum* sub-community.	This is not a close match.
SH59	*Ammophila arenaria - Carex arenaria - Festuca rubra* community.	**SD7**	*Ammophila arenaria - Festuca rubra* semi-fixed dune.	
SH58	*Ulex europaeus - Festuca rubra - Poa pratensis* mixed grassland community.	**SD7**	*Ammophila arenaria - Festuca rubra* fixed dune.	Closest match but with additional *Ulex europaeus.*
SH57	*Festuca rubra - Poa pratensis - Ammophila arenaria - Carex arenaria* grassland.	**SD8**	*Festuca rubra - Galium verum* fixed dune.	
SH56	*Festuca rubra - Peltigera canina - Senecio jacobaea* community.	**SD12**	*Carex arenaria - Festuca ovina - Agrostis capillaris* dune grassland.	SH56 has *F. rubra* instead of *F. ovina*.
SH56a	*Festuca rubra - Peltigera canina - Senecio jacobaea* community, *Armeria maritima - Sedum acre* sub-community.	**SD12**	*Carex arenaria - Festuca ovina - Agrostis capillaris* dune grassland.	SH56a has *F. rubra* instead *of F. ovina.*
SH55	*Holcus lanatus - Agrostis capillaris - Ammophila arenaria - Hypochoeris radicata* grassland community.	**SD7**	*Ammophila arenaria - Festuca rubra* semi-fixed dune.	The closest match but **SH55** is more species-rich.

4. Mature grassland communities

4a. Mature grasslands

4a.i. Mature grasslands – *Festuca rubra*

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH51	*Cladonia Arcata - Festuca rubra - Cochlearia danica* grassland.	**MC5**	*Armeria maritima - Cerastium diffusum* maritime therophyte community.	This is not a close match.
SH50	*Festuca rubra - Aira praecox - Plantago coronopus* grassland.	**MC5**	*Armeria maritima - Cerastium diffusum* maritime therophyte community.	
SH49	*Festuca rubra - Lotus corniculatus - Thymus praecox arcticus - Cladonia furcata* grassland.	**SD7** **CG7**	*Ammophila arenaria - Festuca rubra* semi-fixed dune community; and *Festuca ovina - Hieracium pilosella - Thymus praecox arcticus* grassland.	SH49 appears to be intermediate between **SD7** and **CG7**.
SH48	*Festuca rubra - Hypnum cupressiforme - Lotus corniculatus - Plantago lanceolata* community.	**SD7**	*Ammophila arenaria - Festuca rubra* semi-fixed dune community.	
SH47	*Festuca rubra - Lotus corniculatus - Plantago lanceolata* community.	**SD8a**	*Festuca rubra - Galium verum* fixed dune community.	
SH46	*Festuca rubra - Ceratodon purpureus - Sedum* spp. grassland.	**SD7**	*Ammophila arenaria - Festuca rubra* semi-fixed dune community.	The closest match but there is no *Ammophila arenaria* in **SH46**.
SH45	*Vulpia bromoides - Bromus hordeaceus - Hypochoeris radicata* grassland community.	**U1f**	*Festuca ovina - Agrostis capillaris - Rumex acetosella* grassland, *Hypochoeris radicata* sub-community.	This is not a close match.

4a.ii. Mature grasslands - *Dicranum scoparium*

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH44	*Dicranum scoparium - Rumex acetosella - Aira praecox* community.	**U1**	*Festuca ovina - Agrostis capillaris - Rumex acetosella* grassland.	The closest match but *F. rubra* substitutes for *F. ovina.*
SH43	*Dicranum scoparium - Festuca rubra - Plantago lanceolata* grassland community.	**SD7**	*Ammophila arenaria - Festuca rubra* semi-fixed dune community.	
SH43a	*Dicranum scoparium - Festuca rubra - Plantago lanceolata* grassland community, *Sedum anglicum* sub-community.	-	-	No clear NVC equivalent.
SH42	*Dicranum scoparium - Cladonia impexa - Festuca rubra* grassland.	**H11**	*Calluna vulgaris - Carex arenaria.*	The closest match but **SH42** contains less *Calluna vulgaris* and *Carex arenaria* than expected.

4a.iii. Mature grasslands - *Arrhenatherum elatius*

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH41	*Arrhenatherum elatius - Festuca rubra - Plantago lanceolata - Silene uniflora* grassland.	-	-	No clear NVC community. Closest match is **SD7** *Ammophila arenaria - Festuca rubra* semi-fixed dune.
SH40	*Arrhenatherum elatius - Festuca rubra - Silene maritima - Hypochoeris radicata* grassland.	-	-	No clear NVC equivalent.
SH39	*Silene uniflora - Arrhenatherum elatius moss-* and lichen-rich community.	-	-	No clear NVC equivalent.
SH38	*Silene uniflora - Hypnum cupressiforme - Arrhenatherum elatius - Rumex acetosella* grassland.	-	-	No clear NVC equivalent.
SH37	*Arrhenatherum elatius - Silene maritima* grassland.	-	-	No clear NVC equivalent.

4b. Less mature grasslands

4b.i. Less mature grasslands - pure shingle

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH70	*Festuca rubra - Silene maritima - Lotus corniculatus* community.	**SD7c**	*Ammophila arenaria - Festuca rubra* semi-fixed dune, *Ononis repens* sub-community.	
SH69	*Festuca rubra - Achillea millefolium - Lotus corniculatus - Silene uniflora* community.	**SD7c**	*Ammophila arenaria - Festuca rubra* semi-fixed dune, *Ononis repens* sub-community.	
SH54	*Festuca rubra - Plantago lanceolata - Lotus corniculatus* grassland.	**SD8a**	*Festuca rubra - Galium verum* fixed dune grassland.	
SH53	*Festuca rubra - Ononis repens - Anthyllis vulneraria* grassland.	**SD7b**	*Ammophila arenaria - Festuca rubra* semi-fixed dune, *Ononis repens* sub-community.	
SH52	*Ammophila arenaria - Ceratodon purpureus* community.	**SD6**	*Ammophila arenaria* mobile dune.	

4b.ii. Less mature grassland - saltmarsh influence

Shingle code	**Shingle community** name	NVC **code**	NVC name	Comments
SH36	*Elymus pycnanthus - Festuca rubra* grassland.	**SM24**	*Elymus pycnanthus* saltmarsh.	
SH35	*Armeria maritima* rich *Festuca rubra* grassland.	**MC8e**	*Festuca rubra - Armeria maritima* maritime grassland, *Plantago coronopus* sub-community.	
SH34	*Festuca rubra - Armeria maritima - Plantago maritima* grassland.	**MC8**	*Festuca rubra - Armeria maritima* maritime grassland.	
SH33	*Plantago coronopus - Armeria maritima - Festuca rubra* grassland.	**MC8e**	*Festuca rubra - Armeria maritima* maritime grassland, *Plantago coronopus* sub-community.	
SH32	*Festuca rubra - Plantago coronopus* grassland.	**SM16d**	*Festuca rubra* saltmarsh, *Festuca rubra* sub-community.	

5. Secondary pioneer communities

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH27	*Tripleurospermum maritimum - Atriplex prostrata - Rumex crispus* pioneer community.	**SD1a**	*Rumex crispus littoreus - Glaucium flavum* shingle community, typical sub-community.	
SH27a	*Tripleurospermum maritimum - Atriplex prostrata - Rumex crispus* pioneer community, *Potentilla anserina* sub-community.	**SD1**	*Rumex crispus littoreus - Glaucium flavum* shingle community.	
SH25	*Silene uniflora - Rumex crispus - Tripleurospermum maritimum* community.	**SD1**	*Rumex crispus littoreus - Glaucium flavum* shingle community.	This is not a close match.
SH24	*Rumex crispus littoreus - Tripleurospermum maritimum - Glaucium flavum* pioneer community.	**SD1**	*Rumex crispus littoreus - Glaucium flavum* shingle community.	
SH24a	*Rumex crispus littoreus - Tripleurospermum maritimum - Glaucium flavum* pioneer community, *Cerastium diffusum* sub-community.	**SD1a**	*Rumex crispus littoreus - Glaucium flavum* shingle community, typical sub-community.	
SH23	*Tripleurospermum maritimum - Silene uniflora - Euphorbia paralias* community.	**SD1** **SD4**	*Rumex crispus littoreus - Glaucium flavum* shingle community; and *Elymus farctus boreali-atlanticus* foredune community.	SH23 appears to be intermediate between **SD1** and **SD4**.
SH22	*Glaucium flavum* dominated pioneer community.	**SD1**	*Rumex crispus littoreus - Glaucium flavum* shingle community, typical sub-community.	
SH21	*Ammophila arenaria - Rumex crispus - Senecio viscosus* community.	**SD1**	*Rumex crispus littoreus - Glaucium flavum* shingle community.	

6. Pioneer communities

6a. *Honckenya peploides* dominated communities

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH31a	*Honckenya peploides* dominated community.	**SD2**	*Honckenya peploides - Cakile maritima* strandline community.	
SH31b	*Honckenya peploides - Potentilla anserina* community.	**SD2**	*Honckenya peploides - Cakile maritima* strandline community.	
SH30	*Elymus farctus boreali-atlanticus - Honckenya peploides - Eryngium maritimum* community.	**SD4**	*Elymus farctus boreali-atlanticus* foredune.	
SH29	*Elymus farctus boreali-atlanticus - Honckenya peploides - Rumex crispus littoreus* community.	**SD4**	*Elymus farctus boreali-atlanticus* foredune.	
SH28	*Honckenya peploides - Elymus pycnanthus - Ammophila arenaria* community.	**SD2**	*Honckenya peploides - Cakile maritima* strandline community.	
SH26	*Honckenya peploides - Silene maritima* pioneer community.	**SD1**	*Rumex crispus littoreus - Glaucium flavum* shingle community.	

6b. *Senecio viscosus* dominated communities

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH20	*Lolium perenne - Stellaria media - Sedum acre* open community.	-	-	No close NVC community match but it is similar to **MC7** *Stellaria media - Rumex acetosa* sea-bird cliff community.
SH20a	*Lolium perenne - Stellaria media - Sedum acre open* community, *Geranium molle* sub-community.	-	-	No close NVC community match but it is similar to **MC7** *Stellaria media - Rumex acetosa* sea-bird cliff community.
SH19	*Senecio viscosus - Rumex Glaucium*	**SD1**	*Rumex crispus littoreus* -	

6c. Beta vulgaris maritima dominated communities

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH18	*Atriplex* spp. - *Lavatera arborea* - *Rumex crispus littoreus* community.	**MC6** **SD1**	*Atriplex prostrata* - *Beta vulgaris maritima* sea-bird cliff community; and *Rumex crispus littoreus* - *Glaucium flavum* shingle community.	This community appears to be intermediate between **MC6** and **SD1.**
SH17	*Beta vulgaris maritima* - *Solanum dulcamara* - *Tripleurospermum maritimum* community.	**MC6**	*Atriplex prostrata* - *Beta vulgaris maritima* sea-bird cliff community.	
SH17a	*Beta vulgaris maritima* - *Solanum dulcamara* - *Tripleurospermum maritimum* community, *Crithmum maritimum* sub-community.	**MC6**	*Atriplex prostrata* - *Beta vulgaris maritima* sea-bird cliff community.	
SH16	*Beta vulgaris maritima* - *Festuca rubra* - *Tripleurospermum maritimum* grassland.	**MC6**	*Atriplex prostrata* - *Beta vulgaris maritima* sea-bird cliff community.	
SH15	*Beta vulgaris maritima* - *Rumex crispus littoreus* pioneer community.	**SD1**	*Rumex crispus littoreus* - *Glaucium flavum* shingle community.	
SH14	*Cochlearia officinalis* - *Atriplex littoralis* community.	**SM28**	*Elymus repens* saltmarsh.	Not a close match, due to high levels of *Atriplex littoralis* and *Cochlearia officinalis* in **SH14**.

6d. *Raphanus maritimus* dominated communities

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH13	*Atriplex prostrata - Raphanus maritimus - Rumex crispus littoreus* pioneer community.	-	..	No clear NVC equivalent.
SH12	*Raphanus maritimus - Tripleurospermum maritimum - Arrhenatherum elatius* community.	-	-	No clear NVC equivalent.
SH12a	*Raphanus maritimus - Tripleurospermum maritimum - Arrhenatherum elatius* community, *Festuca rubra* sub-community.	-	-	No clear NVC equivalent.
SH12b	*Raphanus maritimus - Tripleurospermum maritimum - Arrhenatherum elatius* community, *Rumex crispus littoreus* sub-community.	-	-	No clear NVC equivalent.

6e. Herb-dominated pioneer communities

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH11	*Lathyrus japonicus* pioneer community.	**SD1b**	*Rumex crispus littoreus - Glaucium flavum* shingle community, *Lathyrus japonicus* sub-community.	
SH10	*Solanum dulcamara - Arrhenatherum elatius* community.	-	-	No clear NVC equivalent.
SH9	*Crambe maritima - Solanum dulcamara* pioneer community.	**SD1**	*Rumex crispus littoreus - Glaucium flavum* shingle community.	Not a close match, due to the only minor presence of *Rumex crispus littoreus* and *Glaucium flavum* in **SH9.**
SH9a	*Crambe maritima - Solanum dulcamara* pioneer community, *Rumex crispus littoreus* sub-community.	**SD1**	*Rumex crispus littoreus - Glaucium flavum* shingle community.	
SH8	*Senecio viscosus - Glaucium flavum - Rumex crispus littoreus* pioneer community.	**SD1**	*Rumex crispus littoreus - Glaucium flavum* shingle community.	

6f. *Silene uniflora* dominated pioneer communities

Shingle code	Shingle community name	NVC code	NVC name	Comments
SH11a	*Lathyrus japonicus* pioneer community, *Silene uniflora* sub-community.	**SD1b**	*Rumex crispus littoreus - Glaucium flavum* shingle community, *Lathyrus japonicus* sub-community.	Not a close match due to the species-poor nature of **SH11a**.
SH7	*Silene uniflora* dominated pioneer community.	**SD1a**	*Rumex crispus littoreus - Glaucium flavum* community, typical sub-community.	Not a close match due to the only minor presence of *Glaucium flavum.*
SH6	*Silene uniflora - Crambe maritima* pioneer community.	**SD1**	*Rumex crispus littoreus - Glaucium flavum* shingle community.	
SH6a	*Silene uniflora* dominated pioneer community, *Glaucium flavum* sub-community.	**SD1**	*Rumex crispus littoreus - Glaucium flavum* shingle community.	
SH5	*Cochlearia danica - Silene maritima* community.	**-**	-	No clear NVC equivalent.
SH4	*Rumex crispus littoreus - danica* pioneer community.	**SD1**	*Rumex crispus littoreus - Glaucium flavum* shingle community.	Not a close match due to the major presence of *Silene uniflora* and *Cochlearia danica* in **SH4**.
SH3	*Rumex crispus littoreus - Silene maritima* pioneer community.	**SD1**	*Rumex crispus littoreus - Glaucium flavum* shingle community.	Not a close match due to the lack of any major associates in **SH3** - in particular the lack of *Glaucium flavum.*
SH2	*Geranium robertianum* dominated pioneer community.	**SD1**	*Rumex crispus littoreus - Glaucium flavum* shingle community.	The match is made on the associates. This may be a new sub-community.
SH2a	*Geranium robertianum - Arrhenatherum elatius* open grassland.	**U24**	*Arrhenatherum elatius - Geranium robertianum* community.	
SH1	*Arrhenatherum elatius - Silene maritima - Rumex crispus littoreus*		**SD1** *Rumex crispus littoreus - flavum* shingle community.	

Shingle community descriptions

This section of the report provides a definition of the communities identified in the TWINSPAN analysis. At the beginning of each community description there is a letter and number code, starting with the letters SH. This indicates to which classificatory unit the description corresponds, and is used to compare these units with existing NVC categories. These comparisons are summarised in Table 2 above. It will be noted that these commence with SH124, the most terrestrial community and the first separated by TWINSPAN, and end with SH1, the pioneer shingle community of the foreshore.

The matching of the data is not always close owing to the problems of a relatively limited dataset used for the initial definition of shingle categories in the NVC. In addition there are problems associated with variability inherent in all the communities across a wide spatial area and indeed with the environmental conditions associated with the shingle habitat. These include drought within a freshwater environment and the influence of adjacent matritime stresses. It would seem unlikely, therefore, that the plant assemblages would exactly replicate those found in other habitats. Thus where the match is felt to be particularly poor this has been noted in both Table 2 and the descriptions that follow.

Four major types of vegetation were clearly identified early in the classification. These include the scrub and heath communities which are divided from the more widespread grassland and pioneer communities at the first level of division within the classification. The descriptions below are of the communities as identified in the second run of the analysis. The order in which they are listed follows the pattern with which they emerged in the classification.

1. Scrub communities

It is at the second level of division that the scrub communities are distinguished from the heath communities. Within the general scrub section of the shingle classification, it is possible to identify three major types of scrub formations based on the dominance of three major scrub species.

1a. *Prunus spinosa* communities

The first set of communities are *Prunus spinosa* dominated scrub communities of which there are five distinct categories.

SH124 The first is *a Prunus spinosa* dominated scrub with *Hedera helix* and *Rubus fruticosus* as frequent associates. This community is found across many western sites down to the southern sites such as on the Isle of Wight. As a result of the often total cover offered by the *Prunus spinosa,* the average number of species per quadrat within this community is relatively low (six). *Urtica dioica* is a frequent associate in this community while additional scrub species such as *Ulex europeaus, Sambucus nigra* and *Crataegus monogyna* are found occasionally although only in small amounts.

SH122 A second *Prunus spinosa* dominated community, which is southern in extent being found in small amounts on the larger southern sites, is characterised by the constant presence of *Prunus spinosa* and the shade tolerant moss *Eurynchium praelongum.* In this instance the competitive exclusion strategy of the *Prunus spinosa* is particularly successful with even fewer associates than the more widespread *Prunus spinosa* dominated community, with only four species per quadrat. Interestingly, despite the mature nature of such a community there are occasional maritime associates such as *Raphanus maritimus, Beta vulgaris maritima, Cochlearia danica* or *Elymus pycnanthus.*

SH121 Where *Prunus spinosa* is less dominant, another community is differentiated by the presence of *Rubus fruticosus, Arrhenatherum elatius* and *Crataegus monogyna* as additional major constants. The presence of *Hedera helix* and *Hypnum cupressiforme* in small quantities is also typical of this community which is confined to the shingle sites on the western coast of Scotland, particularly the stretch of coast between Auchenmalg Bay and Claymoddie in Dumfries and Galloway.

SH123 A similar community is found across many western sites, particularly those on the Scottish coast. This community, while characterised by the constant presence of *Prunus spinosa* and *Rubus fruticosus* in large

amounts, is distinguished from the former assemblage by the presence of *Arrhenatherum elatius* and *Dactylis glomerata* as the major Gramineae components with *Rosa pimpinellifolia* and other scrub species along with the moss *Hypnum cupressiforme.*

SH120 The final *Prunus spinosa* community has a distinct maritime element. *Prunus spinosa, Rubus fruticosus* and *Arrhenatherum elatius* are the major components of this vegetation unit with *Galium aparine* and *Raphanus maritimus* as frequent, if minor, associates. Occasional associates include scrub species such as *Rosa canina* agg. and *Hedera helix* along with the grass species *Dactylis glomerata* and *Elymus repens.* The distribution of this community is disjunct with much found on the west coast of Scotland while it is also represented on one of the southern sites at Slapton Bar.

lb. *Rubus fruticosus* communities

The second major type of scrub communities is defined by the constant and major presence of *Rubus fruticosus.*

SH119 The most common of these communities is *a Rubus fruticosus - Arrhenatherum elatius* dominated community. Frequent associates include *Senecio jacobaea, Galium aparine, Dactylis glomerata* and *Sambucus nigra.* These species are found in association with a varied range of species, all present in only small amounts. This community is common across many shingle sites ranging from Arran in the north to Browndown in the south and on both western and eastern sites. This vegetation unit contains over 50 quadrats. However, it appears relatively robust in terms of its homogeneity. Indeed, further analysis on these quadrats picks out only minor variations in the data with *Rubus fruticosus* and *Arrhenatherum elatius* emerging as the constants in each new category identified.

SH118a One scrub community which is split off from the main *Rubus fruticosus - Arrhenatherum elatius* scrub assemblage at the tenth level of division contains only six quadrats and is peculiar to Rascarrel Bay in Scotland. This community differs from the general *Rubus fruticosus - Arrhenatherum elatius* scrub in the presence of *Corylus avellana* and *Salix cinerea* as the canopy, while *Rubus fruticosus, Holcus lanatus, Hedera helix* and *Prunus spinosa* provide the scrub components of this species-rich community (fifteen species per quadrat). While there are only six quadrats in this community it is significantly different from the major *Rubus fruticosus* scrub and as such warrants special mention as a sub-community of this main assemblage.

SH118 There is some evidence of a further sub-division within this woodland assemblage which is local to Rascarrel Bay. This sub-division comprises *a Salix cinerea - Rubus fruticosus - Holcus lanatus* woodland with *Rubus fruticosus* and *Holcus lanatus* as the major components of the understorey and with less emphasis on *Corylus avellana* and *Hedera helix.* The constant presence of *Polystichum aculeatum* serves as an indicator separating the two sub-communities. It may be that this represents a wetter sub-community with *Carex acutiformis, Oxalis acetosella* and *Deschampsia cespitosa* as indicators of wetter conditions. In addition this site is particularly sheltered as it is south facing on the Solway Firth in Scotland, and this may limit maritime influences thus allowing the development of a mature, perhaps climax, community.

SH117 There is a more maritime version of this *Rubus fruticosus* scrub community which has *Rubus fruticosus, Arrhenatherum elatius, Hypnum cupressiforme* and *Raphanus maritimus* as the key constants. This is clearly a mature, well-established community as indicated by the presence of bryophytes such as *Dicranum scoparium* and *Eurynchium praelongum. Rosa canina, Prunus spinosa* and *Crataegus monogyna* are additional scrub associates which may be found in small amounts. This community is confined to western Scottish sites along the coast from Auchenmalg to Claymoddie. The presence of a maritime species such as *Raphanus maritimus* in association with *Rubus fruticosus* may be explained by a delicate equilibrium between airborne salt associated with maritime influences and high levels of rainfall which subdue the maritime effects sufficiently to allow the growth of non-maritime species.

SH116 In some places there are less well developed versions of this scrub found on shingle in Scotland. The first of these communities is defined by the constant presence of *Raphanus maritimus* and *Arrhenatherum elatius* with *Rubus* and *Dactylis glomerata* as additional minor constants. This is a grassy *Raphanus maritimus* scrub community with *Holcus lanatus* and *Agrostis capillaris* as the additional Gramineae species. While this community is found on many of the Scottish sites mentioned above, it is also found on Slapton Bar in Devon, a site which has been largely undisturbed.

SH115 The second of these communities is a more open scrub assemblage characterised by the constant presence of *Arrhenatherum elatius, Rubus fruticosus, Raphanus maritimus, Heracleum sphondylium* and *Galium saxatile.* This community also displays a disjunct distribution being found on the western coast of Scotland and once again at Slapton.

SH114 One *Rubus fruticosus* community which is restricted to southern sites, in particular Slapton and Pagham, appears to be an example of a transition community displaying elements of both terrestrial and maritime floras. In this case *Hedera helix* and *Rubus fruticosus* are major scrub species with *Arrhenatherum elatius* as an important associate, although found in only small amounts. *Raphanus maritimus is* also found as a minor element in this assemblage along with *Heracleum sphondylium*, neither of which offer any great cover (Domin score of two to three on average in each case). In places *Ulex europaeus* becomes a major component in this assemblage, occasionally providing much cover. The maritime influence is seen in the occasional presence of *Tripleurospermum maritimum* and *Rumex crispus littoreus.*

SH113 There is evidence of a ruderal scrub community which is divided off at an early stage in the scrub section of the classification, clearly distinguished from the other scrub communities. It is best described as an *Urtica dioica - Rubus fruticosus - Holcus lanatus - Galium aparine* scrub occasionally found as an understorey within wooded areas where *Fraxinus excelsior* or *Alnus glutinosa* provide canopy cover. Infrequent associates within this assemblage include *Arrhenatherum elatius, Cirsium arvense, Silene dioica* and *Prunus spinosa.* This community is clearly statistically robust as it contains fourteen quadrats which are spread across northern and southern sites.

SH112 The final *Rubus fruticosus* based scrub community may be defined by the constant presence of *Rubus fruticosus, Pteridium aquilinum* and *Arrhenatherum elatius,* while *Hedera helix* and *Raphanus maritimus* are the key associates. *Pteridium aquilinum is* a particularly important component in this assemblage as it provides almost total cover in many quadrats with few understorey associates, most commonly *Galium aparine.* While found on some western Scottish sites, this community is typical of southern sites such as Church Norton and Slapton. Given the invasive nature of *Pteridium aquilinum,* it may be that this community represents an end community where *Pteridium aquilinum* has developed into an almost pure stand.

SH111 Indeed, there is a more open *Pteridium aquilinum* community commonly found in the classification and defined as *a Pteridium aquilinum - Rubus fruticosus* dominated mixed grassland where Gramineae species such as *Holcus lanatus, Arrhenatherum elatius, Dactylis glomerata* and *Agrostis capillaris* are more important components of the assemblage. This community is more common than that previously described. It may be that this is an earlier stage in the *Pteridium aquilinum* community development.

SH110 A northern community similar to this *Pteridium aquilinum - Rubus fruticosus* mixed grassland is found across several sites in south west Scotland. This community is less dominated by the *Pteridium aquilinum* with *Dactylis glomerata, Rubus fruticosus* and *Centaurea nigra* as the key indicators while *Agrostis capillaris, Plantago lanceolata, Ulex europaeus* and *Pteridium aquilinum* are the most frequent associates. This community is particularly rich in herb species such as *Filipendula ulmaria, Teucrium scorodonia, Potentilla erecta, Vicia cracca, Cerastium fontanum triviale, Daucus carota* and *Angelica sylvestris* as common herb associates. Indeed, the community is species rich

relative to many of the scrub communities with, on average, twelve species per quadrat. This is clearly a very early stage in a scrub succession.

lc. *Ulex europaeus* communities

The following group of communities may be defined as *Ulex europaeus* based scrub communities.

SH109 The most common of these is a *Ulex europaeus - Rubus fruticosus - Agrostis capillaris* scrub assemblage which is found across many sites from NE Scotland down to the south coast. The *Ulex europaeus is* not only a constant, but it is dominant across the community with an average Domin score of 8.5. Indeed, it often offers total cover. Not surprisingly, therefore, this community has few major associates other than *Rubus fruticosus* and *Agrostis capillaris* (seven species per quadrat on average). *Holcus lanatus, Festuca rubra* and *Dactylis glomerata* are the most frequent associates along with shade tolerant bryophytes such as *Hypnum cupressiforme* and *Eurynchium praelongum.*

While these major elements of this assemblage may be found in association with a wide range of additional species, it is the dominance of the *Ulex europaeus* which provides the definitive characteristic of this community. Even at the tenth level of division, this classificatory unit contains seventy one quadrats thus illustrating the homogenous nature of this unit. Indeed, in order to test this hypothesis, further analysis of this unit has been conducted and reveals no further useful divisions in the data.

SH108 The second major *Ulex europaeus* community is similar to the first but is characterised by the absence of *Agrostis capillaris.* In this case *Rubus fruticosus is* a more important component of the assemblage and the combination of the *Ulex europaeus* and *Rubus fruticosus* provides much cover with the moss *Eurynchium praelongum* as the major associate. However, *Holcus lanatus, Arrhenatherum elatius, Teucrium scorodonia* and *Rosa pimpinellifolia* are also found in this assemblage, but in minor amounts. This may be a less mature version of the previous community with slightly less cover offered by the *Ulex europaeus* and the concurrent presence of heath species. This community also spans a wide geographical range and is represented by forty four quadrats.

SH107 A less common scrub community may be defined by the constant presence of *Ulex europaeus, Rubus fruticosus* and *Arrhenatherum elatius* with *Teucrium scorodonia* as a frequent associate. In this community *Rubus fruticosus* plays a more important role as a major associate. However, other associates are rather restricted with an average of only five species per quadrat. *Raphanus maritimus* and *Dactylis glomerata* are the most usual associates although these are only found in small quantities. The major difference between this community and those described earlier is the absence of any bryophyte species suggesting that this may be a less mature community or subject to greater levels of maritime influence and so is less stable. This assemblage is also widespread across shingle sites in Scotland and on the south coast, although there is little evidence on the east coast. It may be that this community relies on the presence of wrack in the matrix at an early stage in the development and wrack is not commonly found within the flint shingle on the east coast.

SH106 A similar community is split off at the tenth level of division in the classification. This assemblage is more mixed in nature with the *Ulex europaeus* less dominant, allowing a more obvious presence of *Rubus fruticosus* and *Arrhenatherum elatius.* Initially, this community seems to resemble closely that described above. However, closer inspection reveals that the associates are quite different with *Holcus lanatus, Galium aparine* and *Senecio jacobaea* as most frequent associates, while *Heracleum sphondylium* and *Digitalis purpurea* are minor elements.

This community is found across many sites but is rarely found in association with the previous assemblage suggesting that these are representative of very different ecological conditions. The soil analysis data, which is available in Sneddon (1992), may help to explain this distribution.

SH108a A southern version of the *Ulex europaeus* scrub, found along the south coast only, is a *Ulex europaeus - Rubus fruticosus - Solanum dulcamara* community where the importance of *Ulex europaeus* in relation to *Rubus fruticosus* may vary but the constant presence of the three indicator species is the important distinguishing feature. This classificatory unit, while being divided off at the ninth level of division, contains only five quadrats and displays a wide variation in associated species. This heterogeneity, along with the small number of quadrats, suggests that this should be considered a southern sub-community of a wider *Ulex europaeus - Rubus fruticosus* community.

SH105 A less mature version of the *Ulex europaeus - Rubus fruticosus* scrub is divided off at a relatively early stage in the classification hierarchy and, while found on a couple of Scottish sites, is largely southern in extent. This is a scrubby grassland community with *Arrhenatherum elatius, Ulex europaeus* and *Rubus fruticosus* as the major constants. In this instance, however, the *Ulex europaeus* is less dominant and it is *Arrhenatherum elatius* and other Gramineae species, in particular *Anthoxanthum odoratum* and *Holcus lanatus,* which distinguish this from other scrub communities. The presence of *Anthoxanthum odoratum* may illustrate more alkaline conditions. In some areas *Raphanus maritimus* is an additional major component of the assemblage. Clearly, this may represent an early invasion by scrub or, in the case of Slapton, the degeneration of old scrub and subsequent increase in grass species as cover is reduced.

SH104 A community which is largely restricted to Browndown in the south and is split off from the *Ulex europaeus* scrub communities at the sixth level of division may be defined as *a Ulex europaeus - Rubus fruticosus* scrub with *Quercus robur* and, indeed, *Quercus ilex* as frequent associates. The frequent presence of *Silene nutans* also serves as a characteristic indicator of this community. The assemblage is very rare nationally due to the presence of *Quercus ilex* and is represented primarily at Browndown and at the Duver, IoW.

2. **Heath communities**

The other major separation at the second level of division in this part of the classification hierarchy is between heathland communities typical of wetter acid conditions. These are found on many of the larger shingle sites in Britain.

2a. Wet heaths

SH103 Among the communities indicative of wetter conditions, one emerges as a clear unit at only the fourth level of division. This comprises *a Phragmites* dominated community. *Mentha aquatica, Iris pseudacorus* and *Epilobium palustre* are additional, if minor, constants in the otherwise species-poor assemblage (on average four species per quadrat). This community is found across many sites from NE and NW Scotland to Wales and the south coast sites.

The remaining wetter communities are found only in Scotland. Two Scottish shingle sites offer particularly wet conditions not normally associated with the shingle habitat. These are Kingston shingles on the Moray Firth where past gravel extraction has lowered the levels of the shingle in some areas, and Rhunahaorine on the west coast where a raised shingle beach has impeded drainage in certain areas, and where a shingle spit has enclosed a wet lowland behind it towards the south of the site. Indeed, three communities are unique to Rhunahaorine.

SH102 The first of these is defined by the constant presence of *Juncus articulatus, Epilobium palustre, Hydrocotyle vulgaris, Potentilla palustris* and *Mentha aquatica.* This is a mixed mire community with no one species dominating. This vegetation unit represents the wetter extreme of these communities and is indicated by the associated species such as *Iris pseudacorus, Galium palustre, Equisetum fluviatile* and *Ranunculus flammula.*

SH101 It is this wetness that distinguishes SH102 from a similar community also found at Rhunahaorine in Scotland. This second community (SH101) is identified by the constant presence of *Juncus articulatus, Epilobium palustre* and *Potentilla palustris.* In

this instance *Juncus articulatus is* the dominant species providing high levels of cover (8-9 Domin score). Despite this level of cover the unit is characterised by a diverse range of associates (on average fifteen species per quadrat) which are typical of slightly drier conditions. The major associates include the herbs *Succisa pratensis, Hydrocotyle vulgaris, Viola palustris, Angelica sylvestris* and *Potentilla erecta* along with the grass *Agrostis canina.* This is clearly a very rich community found on those parts of the Rhunahaorine site which are better drained than those supporting the previous community.

The two remaining wetter communities are also found at Rhunahaorine but in these cases the communities are also found at other shingle sites surveyed.

SH100 The first of these is a damp grassland characterised by the constant presence of *Juncus effusus, Holcus lanatus* and *Agrostis canina.* Major associates include *Festuca rubra, Juncus articulatus* and the herbs *Rumex acetosa, Potentilla erecta* and *Ranunculus repens* in this relatively rich grassland (twelve species per quadrat). This community is representative of northern sites and is found in several Scottish sites, both on the east and west coasts.

SH99 The second wetter community displays elements of the previous assemblage with both *Juncus effusus* and *Holcus lanatus* as major constants. However, it is the additional dominating presence of *Salix cinerea* at a canopy level which distinguishes this assemblage from the previous community. Additional herb associates in the understorey include *Angelica sylvestris* and *Galium palustre* while the shade tolerant moss *Eurynchium praelongum* and *Calliergon cuspidatum,* a moss typical of wet conditions, are also characteristic of this community. This assemblage is also northern in extent.

SH98 *Molinia caerulea* forms an important component in a wetter community found at Rhunahaorine. In this community *Juncus effusus is* the dominant constant with the grass species *Molinia caerulea* and *Agrostis stolonifera* as the key additional constants throughout while *Poa pratensis, Anthoxanthum odoratum* and *Holcus lanatus* are seen as minor constants. This community appears to be an acid grassland indicative of poorly drained soils.

2b. Dry heaths

Among the drier heathland communities there is a further division between those which are invaded by *Pteridium* and those which are true acid heathland communities.

2b.i. *Pteridium aquilinum* heath

There are clearly differing levels of *Pteridium aquilinum* invasion within these communities.

SH97 The major *Pteridium aquilinum* heath community, which is an example of the extreme end of the invasion scale, is characterised by the dominance of *Pteridium aquilinum* which frequently provides total cover. The successful competitive strategy of the invasive *Pteridium aquilinum is* reflected in the paucity of frequent associates within this community with only seven species per quadrat found on average. The major associates are the grasses *Agrostis capillaris* and *Holcus lanatus,* each found in small amounts throughout the assemblage, while *Galium saxatile* and *Potentilla erecta* form the major herb component. This assemblage is characteristic of northern shingle sites and is found widely on the west coast of Arran and at Rhunahaorine.

SH97a A sub-community is distinguished from the major community by the presence of *Pteridium aquilinum* and *Agrostis capillaris* in association with *Festuca ovina* and *Teucrium scorodonia.* This is a very species-poor community which is found only at Browndown and may indicate former disturbance as the site is used extensively for military purposes.

SH97b Another variation of the main community is found on one Arran site, where *Pteridium aquilinum* continues to dominate with *Agrostis capillaris* and *Potentilla erecta* as minor associates but the presence of bryophytes *Pseudoscleropodium purum* and *Hypnum cupressiforme* distinguishes this from the major community above. This assemblage contains

few quadrats and is local to one site only. This, along with the fact that it is divided off only at the final level of division, suggests that it would be more appropriate to consider this assemblage as a sub-community of the original community.

SH97c The same criteria may be applied to an end group which is identified at the ninth level of division. In this case, the *Pteridium aquilinum is* less dominant (with a Domin score of 8 on average). While *Agrostis capillaris* and *Galium saxatile* are present in small amounts within this community, the other associates are rather different, being more heath-like in nature. For example, *Calluna vulgaris* and *Rubus fruticosus* are important constants along with *Rhacomitrium canescens.* This community again is found only at one site and appears to offer a southern sub-community of the general *Pteridium aquilinum* assemblage.

SH96 There is a major *Pteridium aquilinum* heath community identified at the sixth level of division. While *Pteridium aquilinum* maintains its role as a major constant, the cover it provides is much less, thus allowing the presence of additional heathland constants, in particular, *Calluna vulgaris, Festuca ovina, Potentilla erecta* and *Vaccinium myrtillus.* This community is relatively species-rich compared with other *Pteridium aquilinum* communities, with *Agrostis capillaris, Anthoxanthum odoratum, Pleurozium schreberi* and *Erica cinerea* as less frequent associates. This mixed *Pteridium aquilinum* heath is found primarily on Arran but is also seen at Browndown on the south coast. This may represent a transitional community with *Pteridium aquilinum* invading a mature heathland as a result of disturbance such as grazing.

SH95 There is also a community which represents a northern *Pteridium aquilinum* heathland which is unique to Rhunahaorine, a site which generally has poor drainage. This community is dominated by *Pteridium aquilinum* which in this instance provides much cover but also has *Molinia caerulea, Anthoxanthum odoratum, Potentilla erecta* and *Deschampsia flexuosa* as additional constants although often found in only small amounts. *Galium saxatile* and *Agrostis capillaris* are less frequent associates.

SH94 Another northern heath community found on the west coast of Scotland is defined by the constant presence of *Molinia caerulea* and *Potentilla erecta* which are found in association with *Calluna vulgaris, Anthoxanthum odoratum, Festuca rubra* and *Rhytidiadelphus squarrosus.*

2b.ii. *Calluna vulgaris* communities

SH93 An additional scrub community is found in this section of the classification, a division which is based on the occasional presence of *Erica cinerea* and *Calluna vulgaris* within it. *Agrostis capillaris* and *Ulex europaeus* are the major constants within this scrubby grassland with *Festuca rubra, Anthoxanthum odoratum, Rhytidiadelphus squarrosus* and *Pseudoscleropodium purum* as the additional constants. This community is widespread in Scotland being found across both eastern and western sites and also in NE England.

Within the heath proper section of the classification there is a clear trend based on levels of moisture.

SH92 The major heathland community is a *Calluna vulgaris - Cladonia impexa* mature heathland which is largely confined to north eastern shores. This community is characterised by the constant presence of the two descriptive species with *Calluna vulgaris* forming the major component in the assemblage offering levels of cover ranging from 6 - 10 on the Domin scale. Lichens form an important indicator of this community with *Hypogymnia physodes* and *Peltigera canina* found most frequently as additional associates while *Erica cinerea* and *Empetrum nigrum* are the main herb associates. *Agrostis capillaris* and *Festuca rubra* comprise the Gramineae component in this heath, while bryophytes are also frequent associates, in particular, *Dicranum scoparium, Pleurozium schreberi* and *Hypnum cupressiforme.* This is a very rich assemblage with an average of nineteen species per quadrat.

SH92a A similar community is separated from SH92 at the final level of division. It is also defined by the constant presence of *Cladonia impexa* and *Calluna vulgaris.* Although in this instance the emphasis shifts towards the

importance of the *Cladonia impexa, Calluna vulgaris* remains an important constant. However, it is the additional presence of *Anthoxanthum odoratum* and *Festuca ovina* as minor constants which distinguishes this from the major heath community. *Galium verum, Hylocomium splendens* and *Rhytidiadelphus triquetrus* also serve as indicators of this assemblage, which may be considered a sub-community of the major *Cladonia impexa - Calluna vulgaris* heath. This sub-community is mainly found at one site, Littleferry in Scotland, where the proportion of sand in the matrix is relatively high. Once again, this is a very diverse community with nineteen species per quadrat with herbs playing a more important role than lichens in terms of frequency and cover provided.

SH91 A third heathland community is common on eastern Scottish sites and may be defined as a *Calluna vulgaris - Erica cinerea - Hypogymnia physodes* heathland, once again a species-rich heathland with bryophytes and lichens forming a major component in the community. Among the diverse range of lichens which may be present, *Cladonia verticillata, C. impexa* and C. *uncialis* are most commonly found as associates, while *Polytrichium piliferum* and *Dicranum scoparium* comprise the main bryophyte element. The high proportion of lichens may reflect the inherently mature nature of this vegetation unit or a low nutrient status, both of which imply that it occupies a stable area which is not subject to regular disturbance. This community differs from the two described above in its general lack of herbaceous associates.

SH90 There is a western version of SH91 which may be indicative of wetter conditions. *Calluna vulgaris* remains the dominant constant with *Erica cinerea, Potentilla erecta* and *Pleurozium schreberi* as important, if minor, constants. The major Gramineae species within this community are *Festuca ovina, Agrostis stolonifera* and, less importantly, *Anthoxanthum odoratum. Dicranum scoparium, Vaccinium myrtillus* and *Hypnum cupressiforme* are also important indicators in this community. This assemblage is less diverse than the eastern and southern heathlands, containing on average fifteen species per quadrat.

SH89 There is a heathland community which represents a southern version of that described above, and which is unique to one site on the Hampshire coast - Browndown. This assemblage is dominated by *Calluna vulgaris.* This dominance is reflected in the lack of associates in the community - six species per quadrat on average. The major additional constant is *Dicranum scoparium* with *Rhacomitrium canescens* and *Ceratodon purpureus* as minor associates along with the lichens *Cladonia verticillata* and C. *foliacea.* The paucity of associates may reflect the fact that this area of well established lowland heath had been flooded in the high tides earlier in 1990. This saline intrusion into an area of freshwater influence may have excluded any annual or biennial species normally associated with such a heathland community such as *Crepis* spp., *Poa annua* and *Sagina apetala.* The presence of a wide range of *Cladonia spp.,* lichens, although in small amounts, indicates the stability of the community otherwise.

The following communities have fallen into this section of the shingle classification due to the presence of *Calluna vulgaris* and so, while indicative of wet heaths, it seems more appropriate to discuss them in this section of the report.

SH88 A wetter heathland is split from the *Calluna vulgaris - Erica cinerea - Potentilla erecta - Pleurozium schreberi* community at the seventh level of division. In this case, while *Calluna vulgaris* remains the dominant constant, with *Potentilla erecta* as a minor constant, it is the presence of *Molinia caerulea, Hypnum cupressiforme* and *Deschampsia flexuosa* which distinguishes this community from the first. Indeed, many of the key associates are different from the original community; these include *Carex vesicaria, Juncus squarrosus* and the moss *Leucobryum glaucum,* an indicator of moist conditions. This community is local to Rhunahaorine on the west coast of Scotland, an area which has high rainfall and poor drainage.

Two further heathland communities typical of wetter, poorly drained areas are also identified at this level of division.

SH87 The major community is characterised by the presence of *Myrica gale, Calluna vulgaris* and *Eleocharis multicaulis* as the key constants with *Erica tetralix, Eriophorum angustifolium* and *Molinia caerulea* as minor constants. This wet heath is typical of the raised beach at Rhunahaorine where drainage has been impeded. Although such a community would not normally be associated with a free-draining substrate such as shingle, the raising of this beach through isostatic movements since the last glaciation has led to impeded drainage.

SH86 The final wet heath, which is also found at Rhunahaorine, comprises *a Molinia caerulea - Calluna vulgaris - Eriophorum angustifolium* heath with other indicators of wetter conditions, in particular, *Sphagnum* and *Leucobryum glaucum.* Additional heathland elements within this community include *Erica tetralix, Potentilla erecta* and, occasionally, *Erica cinerea.*

2b.iii. Moss-rich communities

There are several moss-rich communities, particularly grasslands, found on shingle. These emerge in the heathland section of the classification, and are clearly the precursors to the full heathland communities representative of a later stage in the heathland sequence.

SH85 The first of these grassy heathland communities is identified by the constant presence of the mosses *Pseudoscleropodium purum, Dicranum scoparium* and *Rhytidiadelphus triquetrus* along with *Polypodium vulgare* as the key indicator species. *Erica cinerea* and *Calluna vulgaris* are found as occasional associates suggesting that this may be an early stage in the heath sere. Minor but typical associates include *Deschampsia flexuosa, Hylocomium splendens* and *Hypnum cupressiforme.* This assemblage is confined to eastern Scottish sites.

SH84 Another grassy heathland assemblage, also found in eastern Scotland, is defined by the constant and often dominant presence of *Holcus lanatus.* The most frequent associates include *Rosa pimpinellifolia, Festuca rubra* and the lichens *Hypogymnia physodes* and *Evernia prunastri.* This is a relatively species-rich assemblage with quadrats containing sixteen species on average. Two further grass species are associated with this community, *Agrostis capillaris* and *Anthoxanthum odoratum.* The heath elements are found as infrequent associates although they become locally important. These are *Erica cinerea, Ulex europaeus* and *Calluna vulgaris.*

SH83 A further scrubby grassland which is restricted to eastern Scotland in distribution is defined by the constant presence of *Agrostis capillaris* as the key constant. There is a major bryophyte component in this vegetation unit with particular emphasis on the presence of *Dicranum scoparium* and, in smaller amounts, *Hypnum cupressiforme. Galium saxatile* is the most frequent herb associate although it, too, is only found in small amounts (Domin scores of 1 - 3). The major scrub elements in this assemblage comprise *Rubus fruticosus* and *Cytisus scoparius,* both of which are found widely throughout the community. *Calluna vulgaris* is found as an occasional associate, as are *Ammophila arenaria* and *Carex arenaria,* giving evidence of the sandy nature of the substrate.

Two wet communities are found in this section of the shingle classification. The first is a very distinct community being identified at the sixth level of division in the classification. This is a woodland indicative of very damp conditions and is confined to one shingle site on the east coast of Scotland. While it might be expected that wet communities be located on the west coast with its higher levels of rainfall, this community is found in an area of old excavated shingle where the surface level has been lowered to below the winter water table and within the upper limit of the summer water table. This community is a testament to man's influence on the landscape.

SH82 *Salix repens* and *Caliergon cuspidatum* are the major indicators of this community, found in association with *Agrostis stolomfera, Carex panicea, Juncus bulbosus, Campylium stellatum* and dwarf *Salix cinerea* as minor constants. The presence of seven constants is indicative of the homogeneity of this community and of the richness of the assemblage, which contains an average of

twenty species per quadrat. Most frequent associates in this fen/mire include many sedges such as *Carex flacca* and C. *nigra*, along with *Holcus lanatus, Juncus balticus* and *Phragmites australis.* Low growing *Betula pendula is* found occasionally throughout the community on drier areas within the general community. The major herb associates are *Prunella vulgaris, Ranunculus flammula, Lotus corniculatus* and *Empetrum nigrum.*

SH81 The second assemblage indicative of wetter conditions is an example of a damp woodland, characterised by the dominant presence of *Salix cinerea* as the canopy. The epiphytic lichen *Evernia prunastri is* the second constant while *Hypogymnia physodes is* a key associate. The understorey in this woodland is dominated by the presence of *Deschampsia caespitosa* and *Agrostis canina*, the major Gramineae associates, with *Equisetum arvensis.* Bryophytes also form a major component in the community with much cover provided by *Dicranum scoparium* and *Eurynchium praelongum.* Here too, *Betula pendula is* an occasional associate in the canopy. There is some evidence of scrub development in the understorey with *Rubus fruticosus, Pteridium aquilinum* and *Crataegus monogyna* also found occasionally. This community is found across eastern and western sites in Scotland. Similar wetland communities are seen at Dungeness around the Open Pits (Ferry & Waters 1985).

This completes the top half of the classification dendrogram. Within the remaining, and larger, section of the classification, there are several clear divisions in the type of communities identified. The major distinction is between grassland communities which are most frequently found on the shingle substrate, and the more pioneer communities which offer less overall cover.

3. Grassland communities

Within the grassland communities, there are further divisions found, based primarily on substrate influences (i.e. saltmarsh influenced communities compared with those which display obviously sandy influences), and also on geographical distribution and levels of maturity within a grassland. Superimposed upon such distinctions are further divisions based on the dominant grass species within each community.

3a. Saltmarsh-influenced grasslands

Turning firstly to the grassland communities which display clear saltmarsh influences, these are separated off at a relatively early stage in the classification (fourth level of division).

SH80 The major community, which is found across sites all over the country, is defined by the constant presence of *Agrostis stolonifera* and *Festuca rubra.* The major associates within this relatively species-poor community (six species per quadrat) are *Potentilla anserina, Plantago maritima* and *Glaux maritima.* Additional maritime associates which are found occasionally in this assemblage include the rush *Juncus gerardii,* typical of upper marshes, *Rumex crispus littoreus, Cochlearia officinalis* and *Armeria maritima.* This community is more typical of higher saltmarshes, which are less frequently inundated and so less subject to saline conditions. It is, therefore, not surprising that such a community would be found on a relatively free-draining substrate which had a high fine fraction in its matrix. This community is represented across many shingle sites ranging from the south coast up to Scotland.

SH79 A similar community is identified at an earlier stage in the classification. Here again, *Festuca rubra* and *Agrostis stolonifera* are the major constants although in this case *Festuca rubra is* the more important species providing most cover. However, the key associates in this community include *Juncus effusus*, which is typical of non-marine communities, suggesting that this is a terrestrial version of the maritime grassland discussed above. Additional associates include *Potentilla anserina, Cerastium fontanum triviale* and *Elymus pycnanthus* all found occasionally throughout this community.

SH78 *Elymus pycnanthus* forms a major element in a community separated from the previous assemblage at the seventh level of division. In this community *Elymus pycnanthus* is the key constant while *Festuca rubra* and the

herbs *Vicia cracca, Lotus corniculatus* and *Potentilla anserina* are additional, if minor, constants. This community is more diverse with, on average, twelve species per quadrat. Occasional associates include *Petroselinum crispum, Sonchus arvensis, Iris pseudacorus, Juncus inflexus* and *Agrostis stolonifera.*

SH77 Another major saltmarsh grassland found on shingle sites on western coasts of Scotland is characterised by the constant presence of *Juncus maritimus, Glaux maritima* and *Festuca rubra.* The cover provided by the constants, in particular *Juncus maritimus,* limits the number of associates commonly found in this maritime grassland with only eight species per quadrat. The key associates comprise mainly maritime herbs such as *Plantago maritima, Armeria maritima* and *Triglochin maritima* found with *Agrostis stolonifera* and *Juncus gerardii,* all typical of such saltmarsh conditions.

SH76 Another community more typical of saltmarsh environments is found in small amounts across several shingle sites. In this case it is a community more typical of lower marshes with *Spergularia maritima, Plantago maritima, Puccinellia maritima* and *Cochlearia officinalis* as the major constants while *Festuca rubra is* the key associate. This community is clearly subject to increased maritime influences seen in the presence of the halophytic *Puccinellia maritima.* This occurs in areas where shingle overlays marsh sediments and is subject to frequent inundation. Such areas are commonly found around the edge of shingle spits.

3b. *Agrostis stolonifera* grasslands

Two maritime grassland communities based on *Agrostis stolonifera* are separated off at the sixth level of division.

SH74 The more widespread of the two is an *Agrostis stolonifera - Trifolium repens* grassland which is found across many sites, largely northern in distribution although there is some representation in Wales. The key associates in this assemblage comprise the Gramineae species *Festuca rubra* and *Poa pratensis* along with the herb *Plantago maritima.* Indeed, this is a herb-rich grassland with *Leontodon autumnalis, Plantago lanceolata, Sagina nodosa, Lotus corniculatus, Potentilla anserina* and *Rumex crispus littoreus* found most frequently as associates in the grassland. The diverse range of herbs is reflected in the relatively high number of species per quadrat (twelve).

SH75 The second community is distinguished from SH74 by the presence of *Festuca ovina* along with *Agrostis stolonifera* as major constants. There is also an increased importance of *Plantago maritima* which is a minor constant within this assemblage rather than merely an associate. Once again, there is a high proportion of herb associates, in particular *Leontodon autumnalis, Lotus corniculatus, Aira praecox, Plantago lanceolata, Trifolium repens* and *Campanula rotundifolia* along with the moss *Hypnum cupressiforme.* This is a herb- and moss-rich assemblage with seventeen species per quadrat. It is typically found on western Scottish sites particularly the west coast of Arran. These latter two communities are not found on saltmarshes. It is the presence of *Agrostis stolonifera* in large quantities which has led to their inclusion in this part of the classification.

3c. *Arrhenatherum elatius* grasslands

The next section of the classification contains four grassland communities in which *Arrhenatherum elatius* forms a major component.

SH71 The main community which is found across northern and southern sites comprises a species-poor *Arrhenatherum elatius* dominated assemblage with an average species content of six per quadrat. The major associates include *Cirsium arvense* and Gramineae species including *Dactylis glomerata, Festuca rubra, Agrostis stolonifera* and *Holcus lanatus.* This is a mature *Arrhenatherum elatius* mixed grassland. While this community is found in southern Scotland, it is more commonly seen on southern sites such as Orfordness or Rye Harbour.

SH72 A second *Arrhenatherum elatius* community is divided from that described above at the eighth level of division. In this case *Rubus fruticosus is* the major additional constant found in association with *Arrhenatherum elatius. A Rubus fruticosus - Arrhenatherum elatius* scrub assemblage has already been described earlier in the classification. However, in this case

Arrhenatherum elatius is the dominant constant, and the community is generally more diverse with eleven species per quadrat. The major associates in this scrubby grassland are *Dactylis glomerata, Plantago lanceolata* and *Senecio jacobaea.* Additional, if less important, associates include *Festuca rubra, Heracleum sphondylium* and *Rumex acetosa.* This appears to be a northern grassland, and it is particularly common on Arran and the SW coast of Scotland.

Another series of *Arrhenatherum elatius* dominated communities are seen at the eighth and ninth levels in the classification structure.

SH73 The most important of these may be defined by the constant presence of *Arrhenatherum elatius,* the maritime herb *Raphanus maritimus* and *Dactylis glomerata,* found in a coarse grassland which contains an average of ten species per quadrat. The key associates within this community are *Heracleum sphondylium, Festuca rubra, Galium saxatile* and *Plantago lanceolata.* Indeed, this is a relatively herb-rich grassland with *Achillea millefolium, Artemisia vulgaris, Daucus carota, Centaurea nigra* and *Geranium molle* found in small amounts throughout it. There is some evidence of maritime influences in the minor associates within the assemblage, e.g. *Beta vulgaris maritima* and *Rumex crispus littoreus.* This community is found in small amounts on the sheltered SW coast of Scotland but is most well developed at Slapton in Devon.

In the western Scottish locations *Raphanus maritimus* becomes more important, often providing almost total cover (Domin score 9-10). In these cases, *Arrhenatherum elatius* remains a minor constant but *Holcus lanatus* becomes a more important element. This is a variant of the general *Arrhenatherum elatius - Raphanus maritimus - Holcus lanatus* assemblage.

SH73a A sub-community is divided off at the eighth level of division and this is a southern version of the *Arrhenatherum elatius - Raphanus maritimus* community. In this case *Heracleum sphondylium is* an additional important constant with *Echium vulgare, Festuca rubra, Teucrium scorodonia, Ononis repens* and *Lotus corniculatus* as major associates. This sub-community is found at Slapton only and is relatively species-rich with an average of thirteen species per quadrat.

3d. *Festuca rubra* grasslands

The following set of communities may be defined as mixed herb-rich *Festuca rubra* based grasslands.

SH68 The most important of these communities, in terms of the extent of coverage on shingle sites in Great Britain, comprises *a Festuca rubra - Plantago lanceolata - Poa pratensis* herb-rich grassland. This is not a particularly rich grassland with eleven species per quadrat. The major Gramineae associates include *Arrhenatherum elatius, Dactylis glomerata* and *Holcus lanatus,* each found in varying proportions, while the major herb associates include *Silene uniflora, Achillea millefolium, Galium verum* and *Senecio jacobaea.* This assemblage is identified at the final level of division and yet this end group contains 100 quadrats. In order to test the degree of homogeneity within this community, further analysis has been conducted on these quadrats but no major divisions were evident in the data.

SH67 A second major grassland assemblage is divided off from the first at the final level of division, indicating the inherent similarities between the two. This mixed grassland community is defined by the constant presence of *Festuca rubra, Dactylis glomerata, Lolium perenne* and *Bromus hordeaceus hordeaceus.* Indeed, it is the major presence of *Lolium perenne* and *Bmmus hordeaceus hordeaceus* within this assemblage which act as indicators for this separation. The key herb associates include *Bellis perennis, Plantago lanceolata, Vicia sativa* and *Cirsium arvensis* which are largely different from those in the original assemblage. This community is southern in extent with Red Wharf Bay in Anglesey being the northernmost limit on shingle.

SH66 Another large end group is identified at the final level of division (62 quadrats) and may require further analysis. In the initial run of analysis, the definition of this community is based on the constant and dominant role of *Festuca rubra* - on average a Domin score of 7. The second constant, which is found in small amounts throughout this grassland, is *Plantago lanceolata*

with *Lotus corniculatus, Silene uniflora* and *Achillea millefolium* as the key herb indicators, along with the minor presence of *Galium verum* and *Ononis repens. Poa pratensis* and, to a lesser degree, *Dactylis glomerata* are the most frequent Gramineae associates within this herb-rich grassland. This community is widespread across shingle sites in Great Britain although further analysis may lead to clear regional patterns within this general community.

SH65 Indeed, a southern community restricted to Slapton Bar only is divided from this original assemblage at the final level of division. This is defined by the constant presence of *Festuca rubra, Achillea millefolium* and *Lotus corniculatus.* This is a particularly rich community with sixteen species per quadrat and a major emphasis on herb species, such as *Centaurea nigra, Galium saxatile, Heracleum sphondylium, Daucus carota* and *Galium verum,* serving as key indicators of this assemblage along with the minor presence of *Leontodon hispidus* and *Agrostis capillaris.* Given that this is limited in extent, it seems more appropriate to consider this unit as a sub-community of the general *Festuca rubra - Plantago lanceolata - Lotus corniculatus* community.

3e. Mixed grasslands

While the above communities are primarily *Festuca rubra* dominated herb-rich grassland, the following section of the shingle classification represents more mixed communities where *Festuca rubra* continues to be a constant but plays a less dominant role.

SH64 The most common of these mixed communities comprises *a Festuca rubra - Holcus lanatus - Plantago lanceolata - Rumex acetosa* herb rich mixed grassland. It is the major presence of *Holcus lanatus* which serves as the indicator to distinguish this assemblage from the *Festuca rubra* dominated communities. This category is characterised by a high constancy in many other grass species which is reflected in the number of species per quadrat, in this instance sixteen. The main grass associates are *Dactylis glomerata, Poa pratensis, Anthoxanthum odoratum, Arrhenatherum elatius* and *Agrostis stolonifera.* The key herb associates are *Achillea millefolium, Lotus corniculatus, Galium verum* and *Centaurea nigra,* as with the earlier communities. This very rich assemblage is found mainly in northern sites although it is also seen at Dunwich in the south and at Crabhall Saltings in Wales.

SH63 Another *Festuca rubra* rich community is defined by the additional constant, if minor, presence of *Plantago lanceolata* and *Dicranum scoparium.* This appears to be an early stage in a grassy heathland. The frequent associates are *Anthoxanthum odoratum, Rumex acetosa, Thymus polytrichus britannicus, Pseudoscleropodium purum, Arrhenatherum elatius, Rosa pimpinellifolia* and *Teucrium scorodonia.* It is a relatively rich shingle community (sixteen species per quadrat) and is found on western Scottish sites with some heath elements (e.g. *Calluna vulgaris* found in small amounts). While heathland communities have been discussed earlier, the very minor nature of the heath influence on this community leads to its inclusion in this section of the classification.

SH62 A slightly different community from that detailed above emerges at the final level of division. This assemblage is distinguished by the presence of seven key constants which are, in order of dominance, *Festuca rubra, Agrostis stolonifera, Poa pratensis, Anthoxanthum odoratum, Rhytidiadelphus squarrosus, Plantago lanceolata* and *Lotus corniculatus.* This is a particularly diverse assemblage with eighteen species per quadrat and the presence of the moss *Rhytidiadelphus squarrosus* serves as a key indicator to differentiate this from earlier *Festuca rubra* based communities. Additional herbs which are frequently found in association with these constants include *Trifolium repens, Campanula rotundifolia, Achillea millefolium* and *Galium verum* while *Rumex acetosa, Potentilla erecta, Centaurea nigra* and *Euphrasia officinalis* are occasional associates. This community is found across many north western sites in Scotland.

SH62a A similar community is separated off at the ninth level of division. In this instance it is the only minor presence of *Anthoxanthum odoratum* and *Holcus lanatus* which

distinguishes this unit. The key constants in this assemblage are *Festuca rubra, Poa pratensis, Agrostis stolonifera, Trifolium repens* and *Plantago lanceolata* with *Lotus corniculatus* and *Rhytidiadelphus squarrosus* as major associates. There are slightly different herb associates within this assemblage, namely *Plantago maritima, Aira praecox* and *Trifolium hybridum.* This community is also northern in extent but confined to the west coast of Scotland.

Festuca rubra has been seen as a major constant in the previous mixed grassland communities, but in the following two communities, *Festuca rubra is* less important in the mixed grasslands.

SH60 The first of these is characterised by the constant presence of *Agrostis stolonifera* and *Holcus lanatus* with *Poa pratensis* and the herbs *Plantago lanceolata* and *Trifolium repens* as the most frequent associates. This community may be described as a coarse, herb-rich grassland. Additional grass species found in small amounts throughout include *Lolium perenne, Festuca rubra, Dactylis glomerata, Cynosurus cristatus, Anthoxanthum odoratum* and *Arrhenatherum elatius. Leontodon autumnalis, Rumex acetosa, Achillea millefolium* and *Cerastium fontanum triviale* form the major herb component. In addition, the bryophytes *Rhytidiadelphus squarrosus* and *Hypnum cupressiforme* are found frequently throughout the community.

SH60a The presence of *Poa trivialis* along with *Agrostis stolonifera* and, in small amounts, *Lolium perenne* leads to the separation of a small number of quadrats local to one site - Camber Castle - from the main community above. Additional herb constants include *Bellis perennis* and *Trifolium repens.* This may be considered a sub-community of that listed above and is typical of a low, damp area which has been heavily grazed and disturbed.

3f. Sandy grasslands

The final set of mixed grassland communities in this section of the classification represent a more sandy influence on the general shingle substrate with clearly arenicolous elements within the communities.

SH59 The first community is an *Ammophila arenaria - Carex arenaria - Festuca rubra* grassland which is found across all sandy sites in the country. The major associates include *Senecio jacobaea, Hypochoeris radicata, Cerastium fontanum triviale, Plantago lanceolata* and the grasses *Holcus lanatus, Poa pratensis* and *Dactylis glomerata.* This assemblage is rich in herbs with *Honckenya peploides, Rhinanthus minor, Ononis repens, Galium verum* and *Achillea millefolium* as occasional associates.

SH57 Another major sandy grassland community is defined by the constant presence of *Festuca rubra, Ammophila arenaria, Poa pratensis, Carex arenaria* and *Rhytidiadelphus squarrosus. Elymus pycnanthus is* a frequent associate along with *Agrostis stolonifera* and *A. capillaris* which are found to a lesser degree. This assemblage is very rich in herbs and the major herb associates include *Vicia lathyroides, Achillea millefolium, Cerastium fontanum triviale* and *Trifolium repens.* The moss *Pseudoscleropodium purum is* also a frequent associate. It is a community which is found on the sites which have a particularly sandy matrix, mainly in the north of England.

SH58 A scrubby version of this mixed grassland, which is associated with sites which suffer annual disturbance, is divided off at the ninth level of division. *Ulex europaeus* joins *Festuca rubra* and *Poa pratensis* as the key constants while additional Gramineae associates include *Agrostis capillaris* and *Elymus pycnanthus.* The presence of *Achillea millefolium, Cerastium fontanum triviale* and *Vicia lathyroides* as the herb component and of the mosses *Rhytidiadelphus squarrosus* and *Pseudoscleropodium purum* illustrate the similarity of SH57 and SH58. The *Ulex europaeus* serves as the key indicator along with the only minor presence of *Ammophila arenaria* and *Carex arenaria* in defining this community. In addition, this assemblage is less diverse with only eleven species per quadrat compared with fourteen in the previous grassland. Clearly, the cover provided by the *Ulex europaeus* precludes the growth of some associates.

SH56 One major sandy community is largely restricted to north-eastern sandy sites such as

Culbin and Whiteness Head. It is characterised by the constant presence of *Festuca rubra, Pleurozium schreberi* and, to a lesser degree, *Peltigera canina* and *Senecio jacobaea. Ammophila arenaria* and *Carex arenaria* are frequently found in association within this very rich assemblage (eighteen species per quadrat). Among the herb associates, *Vicia lathyroides, Cerastium fontanum triviale, Lotus corniculatus* and *Galium verum* are found most frequently. However, the key associates are commonly grasses, such as *Poa pratensis, Agrostis stolonifera, Holcus lanatus,* and bryophytes, in particular *Pseudoscleropodium purum, Rhytidiadelphus triquetrus* and *R. squarrosus.*

SH56a The presence of more maritime herbs such as *Armeria maritima* and, in particular, *Sedum acre* have led to the separation of certain quadrats into a sub-community defined as *Poa pratensis, Festuca rubra, Lotus corniculatus* and *Peltigera canina* with *Geranium molle, Sedum acre* and *Agrostis stolonifera* as minor constants. This sub-community is restricted to Whiteness Head.

SH55 A similar community to the general sandy grassland is defined by the constant presence of *Holcus lanatus, Hypochoeris radicata, Vicia lath yroides* and *Peltigera canina* found in a mixed grassland with *Agrostis capillaris, Ammophila arenaria* and *Poa pratensis* as the most frequent associates. *Dicranum scoparium* is commonly found in the assemblage with *Pleurozium schreberi* and *Pseudoscleropodium purum* as locally important indicators. This is a particularly rich assemblage with, on average, twenty species per quadrat and, hence, no one species dominates. It represents a mature, nutrient-poor, acid sandy grassland as illustrated by the presence of many lichens, e.g. *Peltigera polydactyla, Cladonia rangiformis, C. furcata* and C. *gracilis.*

SH61 There is another sandy grassland with a scrubby element within. However, in this case, the assemblage represents an early stage in the development of a sandy lowland heath. *Festuca rubra* and *Anthoxanthum odoratum* are the constants throughout the community. The major associates in this assemblage comprise *Agrostis stolonifera, Ulex europaeus, Hypochoeris radicata* and a major bryophyte element including *Dicranum scoparium,Hypnum cupressiforme* and *Pleurozium schreberi. Calluna vulgaris* and *Erica cinerea* are additional associates which become locally dominant in places. This is also a very diverse community with nineteen species per quadrat with a high lichen content with particular emphasis on *Cladonia tenuis, Hypogymnia physodes, Peltigera canina, C. fimbriata* and C. *verticillata.* This community is mainly found on the north eastern coast of Scotland, although it is also seen on sandy sites in the south.

4. Mature grassland communities

The following section of the shingle classification details the mature grassland communities which are frequently found on more terrestrial areas of shingle sites.

4a.i. Mature grassland communities - *Festuca rubra*

These communities represent more stable *Festuca rubra* grasslands.

SH51 The first community is defined by the constant presence of *Cladonia furcata* in a herb rich *Festuca rubra* grassland. The main herb associates are maritime in nature, e.g. *Armeria maritima, Silene uniflora, Cochlearia danica,* along with non-maritime species such as *Plantago coronopus* and *Cerastium diffusum.* The stability of the areas occupied by this assemblage is illustrated by the frequent presence of the mosses *Ceratodon purpureus* and *Hypnum cupressiforme* along with a major lichen component, in particular *Cladonia rangiformis, C. crispata, C. verticillata, C. impexa* and C. *foliacea.* This lichen-rich *Festuca rubra* grassland is largely southern in extent with Blakeney Point in Norfolk representing the northernmost limit. This community is separated from a similar *Festuca rubra* grassland at the ninth level of division.

SH50 In this case *Festuca rubra* and the herbs *Aira praecox, Plantago coronopus* and *Silene uniflora* comprise the major indicator species. There is evidence that this may represent a sandy version of the more mature *Festuca rubra*

grassland as illustrated in the frequent presence of arenicolous species such as *Sedum acre, Carex arenaria, Desmazeria marina, Brachythecium albicans* and *Ammophila arenaria* within the assemblage. In addition, *Armeria maritima, Ceratodon purpureus* and *Lotus corniculatus* are also commonly found in association. This assemblage is distinguished from other mature *Festuca rubra* grasslands by the lack of a lichen content with the only occasional presence of *Cladonia verticillata* and *C. furcata* found in small quantities. This assemblage is also southern in extent, found from Blakeney in north Norfolk to the Isles of Scilly in the south west. This may be an example of an earlier stage in the development of the *Festuca rubra* grassland described above.

SH48 Another major *Festuca rubra* shingle grassland is defined by the constant presence of *Festuca rubra, Hypnum cupressiforme* and *Lotus corniculatus* with *Plantago lanceolata, Sedum acre* and *Aira praecox* as the prime associates. Although the lichen content in this assemblage is not as diverse as in the others, nor, indeed, as important, in places *Cladonia furcata* and C. *verticillata* become locally important. Additional associates are herbaceous with particular emphasis on *Hypochoeris radicata, Senecio jacobaea, Plantago coronopus* and *Cerastium diffusum* as the minor associates. This community is represented at many sites which are largely southern in distribution. This herb-rich assemblage is separated from another mature grassland community at the final level of division.

SH47 In this instance it is the presence of maritime herbs along with additional grass species which serve as indicators of the assemblage. This community is characterised by the constant presence of *Festuca rubra* and *Lotus corniculatus* while *Plantago lanceolata, Hypnum cupressiforme* and *Hypochoeris radicata* are the major associates. However, it is the presence of additional Gramineae species, in particular *Poa pratensis* and *Holcus lanatus* which are found frequently throughout the assemblage although in varying amounts, which distinguishes this community from other *Festuca rubra* grasslands. Additional herbs are both maritime and non-maritime in nature, e.g. *Silene uniflora, Armeria maritima, Sedum anglicum* and *Aira praecox.* This is a relatively rich community with seventeen species per quadrat on average, most of which are herbs with the occasional presence of lichens and bryophytes in small quantities. This community is widespread across shingle sites in Great Britain.

SH49 A less maritime grassland community is separated from these two at the ninth level of division. This appears to be a more mature community. The constant presence of *Festuca rubra* and *Lotus corniculatus* defines this community also but it is the major associates which differentiate it from the others, in particular *Thymus polytrichus britannicus, Cladonia furcata, C. impexa, C. rangiformis, Hypochoeris radicata, Plantago lanceolata* and *Dicranum scoparium.* The major lichen component illustrates the stability of the areas which support this community, which is also very rich in species (nineteen species per quadrat). Key minor associates include *Peltigera canina, Aira praecox, Hieracium pilosella, Hypnum cupressiforme, Luzula campestris* and *Sedum anglicum.* This community is, once again, largely confined to southern sites.

SH46 Another *Festuca rubra* grassland typical of southern sites is characterised by the presence of *Ceratodon purpureus, Sedum acre* and *Senecio jacobaea* as the major associates within a relatively species rich assemblage (fifteen species per quadrat on average). Bryophytes form an important element in this community with particular emphasis on *Hypnum cupressiforme* and *Brachythecium albicans* while herbs such as *Plantago lanceolata, Echium vulgare, Hieracium pilosella, Aira praecox* and *Arenaria serpyllifolia* are frequently found in association and often provide significant levels of cover (Domin scores range from 1 to 7). The occasional presence of *Bromus hordeaceus hordeaceus* in small amounts in this assemblage has led to it appearing in close proximity to a separate community which is local to one southern site (Camber Castle).

SH45 This separate community is defined by the constant presence of *Vulpia bromoides,*

Bromus hordeaceus hordeaceus and the herbs *Hypochoeris radicata, Trifolium striatum* and *Plantago lanceolata* found in a short turf which has been heavily grazed.The species content is fairly high with an average of ten species per quadrat. The most common associates include *Rumex acetosella, Hypnum cupressiforme, Erodium cicutarium, Galium verum* and *Brachythecium albicans.* This vegetation category contains only ten quadrats in total which implies that it might be considered a sub-community of a broader grassland category. However, the levels of similarity with the *Festuca rubra* grassland above are not sufficient to allow such an amalgamation.

4a.ii. Mature grasslands - *Dicranum scoparium*

The following communities appear in a sub-section of the general grassland section of the classification and have been separated according to the importance of *Dicranum scoparium* within the *Festuca rubra* based grassland.

SH43 The most widespread of these communities is defined as *a Dicranum scoparium - Festuca rubra - Plantago lanceolata - Cladonia furcata* mature grassland which occurs across many sites, mainly southern in extent although it has been sampled at one sheltered Scottish site. The maturity of such a grassland is clearly illustrated in the major bryophyte and lichen element with *Hypnum cupressiforme* and *Cladonia impexa* frequently found in association with the constants. Additional associates include the grasses *Aira praecox* and *Arrhenatherum elatius* and the herbs *Sedum anglicum* and *Senecio jacobaea.* These major species may be found with a variety of minor associates in a community which has thirteen species per quadrat. This assemblage emerges at the ninth level of the classification where it is differentiated from SH43a, another similar *Dicranum scoparium* grassland.

SH43a In this case, the main constants are *Dicranum scoparium, Festuca rubra, Sedum anglicum, Ceratodon purpureus* and *Agrostis* spp., in a herb-rich grassland. It is the importance of the moss *Ceratodon purpureus* and *Agrostis spp.*, along with the frequent occurrence of *Teucrium scorodonia,* which distinguishes this community. *Aira praecox* and *Silene uniflora* are the major associates in this assemblage which was sampled at only one site in southern England - Browndown. Consequently, this should be considered a sub-community of the more widespread *Dicranum scoparium - Festuca rubra - Plantago lanceolata - Cladonia furcata* assemblage.

SH44 Another southern moss-rich grassland community is divided off at the eighth level of division. The importance of *Dicranum scoparium* relative to *Festuca rubra* serves to differentiate this community from the other grasslands. In this instance the community is defined by the constant presence of *Dicranum scoparium, Aira praecox* and *Rumex acetosella* with *Festuca rubra* as a major associate. In terms of the cover provided, the *Dicranum scoparium is* most important among the constants. Indeed, this is reflected in the occurrence of fewer associates than in the communities discussed above. The minor associates, found in only small amounts, are herbaceous in nature and include *Sedum anglicum, Senecio jacobaea* and *Plantago lanceolata.*

SH42 The final *Dicranum scoparium* dominated community is northern in extent and is indicative of very stable areas. This community is characterised by the constant presence of *Dicranum scoparium, Cladonia impexa* and *Peltigera canina* within *a Festuca rubra* grassland. Indeed, lichens and bryophytes comprise the major component of this assemblage, with particular emphasis on the frequent presence of *Cladonia macilenta, C. verticillata, C. fimbriata, C. furcata* and *Hypogymnia physodes* among the lichens with *Hypnum cupressiforme* and *Polytrichium piliferum* as the main moss associates. *Agrostis stolonifera* and *Lotus corniculatus* along with some dwarf *Ulex europaeus* are also found throughout this assemblage. The major role played by lichens within this vegetation unit indicates its maturity and the low levels of disturbance of the areas it occupies (Culbin and Whiteness) both of which are isolated Scottish sites with limited recreational or vehicular access.

4a.iii. Mature grasslands - *Arrhenatherum elatius*

The next set of communities are distinguished by the presence of *Arrhenatherum elatius* as an indicator species.

SH40 The major assemblage is characterised by the constant presence of *Festuca rubra, Arrhenatherum elatius, Silene uniflora, Hypochoeris radicata* and *Cerastium semidecandrum* in a diverse grassland. Despite the occurrence of the maritime herb *Silene uniflora,* this community appears to represent a mature grassland normally associated with relatively stable locations away from maritime influences, with the lichens *Cladonia crispata* and *C. furcata* found as frequent associates along with *Plantago lanceolata, Rumex acetosella, Hypnum cupressiforme, Aira praecox* and *Tortula ruralis.* This vegetation unit is typical of sites on the south eastern coast, particularly in East Anglia.

SH41 A more maritime, less mature version of the grassland described above emerges at the ninth level of division where the two communities are divided. In this case, *Arrhenatherum elatius, Festuca rubra, Plantago lanceolata, Silene uniflora* and *Rumex crispus littoreus* are the key indicators with a major herb element among the associates. The key associates include *Hypochoeris radicata, Cerastium semidecandrum, Lathyrus japonicus* and *Geranium robertianum.* Clearly this assemblage is closely related to the previous community with many of the same constants and major associates. However, it is the absence of any lichens or bryophytes which distinguishes this community and which may indicate the less mature nature of this unit. This, along with the constant presence of maritime herbs, may indicate that this is an earlier stage in the development of this type of grassland. The distribution of this community is largely northern, although it is also found at one southern location, which incidentally also supports the previous community. This community is also less rich in species than the former with an average of ten species per quadrat as opposed to sixteen in the former.

SH39 Another moss- and lichen-rich community also emerges in this section of the classification but in this case *Festuca rubra is* a less important component in the assemblage. *Arrhenatherum elatius* and *Silene uniflora* are the key constants providing most cover, with *Rumex acetosella, Cladonia impexa, Dicranum scoparium, Hypnum cupressiforme* and *Cladonia furcata* as most frequent associates. *Festuca rubra* and *Hypogymnia physodes* are the minor associates although the *Festuca rubra* becomes locally important in places within this assemblage which is generally species-poor, having an average of only six species per quadrat. This community is typical of southern sites and is particularly common at Orfordness. The presence of a major lichen component in this assemblage suggests that it is relatively mature although the generally species-poor nature would normally conflict with this. In this instance, it may be that this vegetation unit is a mature community indicative of stable areas with limited nutrient input.

SH38 The community above is identified at the final stage of the classification where it is differentiated from *a Silene uniflora - Hypnum cupressiforme* assemblage where *Arrhenatherum elatius* and *Rumex acetosella* play a less important role. This *Silene uniflora - Hypnum cupressiforme* assemblage is a more diverse community with an average of eleven species per quadrat. There is a major lichen element among the associates including *Cladonia arbuscula, C. coniocraea, C. furcata* and C. *tenuis.* Indeed, these species form the basis of the separation of the two communities. Additional key associates include *Cerastium semidecandrum* and *Sedum anglicum.* This community is mainly found at Orfordness, as with the previous assemblage, and may represent a more mature development of the community or an area with a greater nutrient supply.

SH37 The final category in this section of the classification emerges at an early stage (level seven of the classification). This assemblage is characterised by the major presence of *Arrhenatherum elatius* which provides relatively high levels of cover (Domin score 7 - 9). The major associate, although often found in only

small amounts, is *Silene uniflora,* with *Senecio jacobaea, Hypnum cupressiforme* and *Ceratodon purpureus* as the most frequent of the minor associates. This is also a very species-poor community with a species per quadrat rating of only six, and it may be that this is the precursor of the above communities. This is a southern community found across several shingle sites and is also described at Dungeness by Ferry *et al.* (1990).

4b. Less mature grasslands

4b.i. Less mature grassland communities - pure shingle

SH70 One community, which is found across many shingle sites although largely found in Wales and on southern sites, comprises a *Festuca rubra* grassland with *Silene uniflora* and *Lotus corniculatus* as the most frequent associates. This is an assemblage which is characterised by a high proportion of maritime herbs. The major associates include *Rumex crispus littoreus, Armeria maritima, Tripleurospermum maritimum, Beta vulgaris maritima* and *Cochlearia danica,* along with some non-maritime herbs, in particular *Plantago lanceolata* and *Hypochoeris radicata.* This is a relatively species-poor community (seven species per quadrat) and many of the associates are only found in small quantities throughout the community.

SH69 A similar community is separated off at the final level of division, although in this case the distribution of the community is southern in extent with its northern limit at Traeth Tanybwlch in Wales. This is a richer community than that described above with around twelve species per quadrat. It comprises *a Festuca rubra - Achillea millefolium - Lotus corniculatus - Silene uniflora* grassland. The major herb associates in this grassland include *Plantago lanceolata, Hypochoeris radicata, Ononis repens* and *Armeria maritima.* An additional indicator species is the grass *Desmazeria marina* an indication of the sandy nature of this community. This is also illustrated by the occasional presence of *Glaucium flavum* along with *Echium vulgare, Taraxacum officinale* agg., *Raphanus maritimus* and *Heracleum sphondylium.* It is the presence of *Hypochoeris radicata, Achillea millefolium, Ononis repens* and *Desmazeria marina* which serve as indicators for this community.

SH54 A separate *Festuca rubra* community is defined by the importance of *Festuca rubra* within the assemblage as it offers more cover than in the previous communities. However, despite this, the community is still diverse with, once again, a rating of twelve species per quadrat. The key indicators of this community are *Festuca rubra, Plantago lanceolata* and *Lotus corniculatus* with *Ononis repens* and *Taraxacum officinale agg.,* as the major associates. The sand influence on this assemblage is also seen in both the Gramineae and herb components of the occasional associates. The occasional grasses *Desmazeria marina* and *Elymus farctus boreali-atlanticus* while *Cerastium diffusum* and *Sedum acre* comprise the herbaceous element. It is the lack of *Silene uniflora* in this community which distinguishes it from the former assemblage. This sandy *Festuca rubra* grassland is particularly typical of many Welsh sites although it is also found in other southern sites.

SH53 A more clearly sandy *Festuca rubra* grassland is identified at the ninth stage of the analysis and is also found across Welsh and southern sites. This assemblage is defined by the constant presence of *Festuca rubra,* in association with arenicolous herbs such as *Ononis repens* and *Anthylis vulneraria* as key associates. Additional herb associates include *Cerastium diffusum, Lotus corniculatus, Hypochoeris radicata, Sedum acre* and *Cochlearia danica* while the occasional presence of *Desmazeria marina, Ammophila arenaria* and *Carex arenaria is* also indicative of the sandy nature of the matrix on these sites.

SH52 The sandy influence is also seen in a separate community which closely corresponds to SD6 *Ammophila arenaria* mobile dune community. This assemblage is defined by the constant presence of *Ammophila arenaria* and *Ceratodon purpureus* with *Plantago coronopus, Festuca rubra* and *Sedum acre* as occasional associates. The *Ammophila arenaria* becomes locally dominant in this assemblage and this is

reflected in the generally species-poor nature of this community (six species per quadrat). This assemblage is typical of many eastern shingle sites of England and Scotland where the shingle component in the matrix is relatively small.

4b.ii. Less mature grasslands - saltmarsh influence

The following section of the classification contains grassland communities which display a saltmarsh influence with more maritime influence than seen in many of the previous saltmarsh-type grasslands.

SH34 This is one of the major communities. It is widespread and found on many sites, particularly on shingle spits which occur in conjunction with saltmarshes. This assemblage is defined by the constant presence of *Festuca rubra* and the maritime herbs *Armeria maritima* and *Plantago maritima.* These constants are commonly found in association with additional maritime herbs, such as *Silene uniflora, Cochlearia officinalis, Plantago coronopus* and *Tripleurospermum maritimum. Festuca rubra* is a particularly important species within this community, not only because it is constant, but also in terms of the cover it provides (Domin score 8, on average). This dominance is reflected in the relatively low species per quadrat rating, which is only seven.

SH35 A southern version of this community is differentiated from this one at the ninth level of division. The southern version is found at Crabhall Saltings and on the Isles of Scilly. It contains only nine quadrats and should be considered a sub-community of the previous assemblage. This sub-community has *Festuca rubra* and *Armeria maritima* as the key constants while *Beta vulgaris maritima* and *Tripleurospermum maritimum* are the major associates. This community is more diverse than the earlier one, with an average of ten species per quadrat, and has a clear saltmarsh influence. The minor associates include *Elymus pycnanthus, Plantago coronopus, Cochlearia officinalis, Crithmum maritimum* and *Lolium perenne.* This sub-community is distinguished from the main community by the less important role of *Plantago coronopus* and in the additional presence of *Beta vulgaris maritima* and *Elymus pycnanthus.*

SH36 *Elymus pycnanthus* is also an indicator in another community which is identified at the eighth level of the classification. This community comprises *a Festuca rubra - Elymus pycnanthus* assemblage with the maritime herbs *Atriplex portulacoides, Plantago maritima* and *Armeria maritima* as the key associates. However, the dominance of *Festuca rubra* (Domin score 8 on average) precludes the presence of many associates and this is reflected in the average number of species per quadrat, which is seven. This community is clearly typical of shingle sites with a high proportion of fine fraction within the shingle matrix and closely resembles a saltmarsh community. This is reinforced in the occurrence of marsh species such as *Beta vulgaris maritima, Artemisia maritima* and *Limonium vulgare* as occasional associates in the assemblage. The distribution of this community is largely southern.

SH32 Another community which displays clear saltmarsh influences is identified at an earlier stage in the classification (fifth level of division). This is distinguished by the dominance of *Festuca rubra* which is found with *Plantago coronopus* as the minor constant. This is a depauperate community with only four species per quadrat. The main associates illustrate the saltmarsh influences with *Atriplex prostrata* and *Spergularia media* occurring most frequently. Infrequent associates include *Hordeum marinum, Plantago maritima, Agrostis stolonifera* and *Parapholis strigosa.* This assemblage is found on the west coast only, and is particularly typical of Bridgwater Bay.

SH33 The final community in this section of the classification emerges at the sixth level of division and is characterised by the presence of *Plantago coronopus* and *Armeria maritima* as the major constants though they are both found in relatively small amounts (Domin score 4 on average). The key associates are *Festuca rubra* and *Cladonia furcata* which illustrate the stability of the sites. Additional minor associates include Gramineae species such as *Elymus pycnanthus* and *Agrostis stolonifera,* along with maritime herbs *Limonium vulgare* and *Silene*

maritima, and the lichen *Cladonia rangiformis*, which becomes locally important. This community is largely southern in extent although it is also seen in a few sites in northern England.

5. Secondary pioneer communities

The following set of communities includes many secondary pioneer communities. These are less open than true pioneer communities on shingle and commonly contain more species per quadrat. These communities represent areas which are less frequently disturbed than those supporting the pioneer communities but are clearly subject to high levels of maritime influence.

SH27a One of these secondary pioneer assemblages, which is found across many shingle sites, is identified at the ninth stage in the classification. It may be described as a *Rumex crispus littoreus - Tripleurospermum maritimum - Potentilla anserina* open community. *Atriplex prostrata* and the Gramineae species *Festuca rubra* and *Agrostis stolonifera* are the main associates. There are, on average, eight species per quadrat in this community.

SH27 Another community, which is distinguished at the ninth level of division, contains only six species per quadrat. In this case the community is defined by the constant presence of *Tripleurospermum maritimum, Rumex crispus littoreus* and *Atriplex prostrata.* This appears to be an earlier stage in the development of the *Rumex crispus littoreus - Tripleurospermum maritimum* community which has been invaded by Gramineae species. Additional minor associates in the sub-community include *Galium aparine, Sonchus arvensis* and *Leymus arenarius,* which becomes locally important in some places.

SH25 Another secondary pioneer community is characterised by the constant presence of *Silene uniflora* with additional pioneer herbs found in association. The major associates are *Rumex crispus* and *Tripleurospermum maritimum* while Gramineae species such as *Festuca rubra, Elymus pycnanthus* or *Arrhenatherum elatius* are also commonly found in this assemblage, usually in small amounts although the *Festuca rubra* is locally dominant. This assemblage is relatively rich in species, seven per quadrat, although cover remains sparse. This community is typical of many shingle sites in Britain ranging from Chesil Beach in the south up to Arran in Scotland.

SH24 Another widespread community emerges in this section of the classification. This is defined as *a Rumex crispus littoreus - Tripleurospermum maritimum -Glaucium flavum* pioneer community with none of these constants providing any great cover (Domin score 6 is the maximum associated with any species in this assemblage). On average there are only five species per quadrat and this is reflected in the lack of any major associates. A wide variety of pioneer and Gramineae species are found in association with the three constants, many of which are arenicolous in nature (e.g. *Silene uniflora, Elymus pycnanthus* and *Sedum anglicum).* This assemblage is identified at the final level of division. However, it still contains fifty quadrats. Further analysis was conducted on this vegetation unit in order to test the degree of homogeneity. The additional analysis, however, did not lead to the identification of any further community definitions.

SH24a A less common vegetation unit is differentiated from this *Rumex crispus littoreus - Tripleurospermum maritimum - Glaucium flavum* community at the final stage in the classification. SH24a may be defined by the constant presence of maritime herbs, in particular *Tripleurospermum maritimum, Cerastium diffusum* and *Rumex crispus littoreus.* Indeed, it is the occurrence of *Cerastium diffusum* which serves as an indicator to differentiate between this and the previous community. Additional herbs which are frequently found in association with these constants include *Honckenya peploides, Aira praecox, Armeria maritima, Desmazeria marina* and *Cochlearia officinalis.* This assemblage clearly displays an arenicolous influence illustrated through the occasional associate herbs and grasses, e.g. *Glaucium flavum, Ammophila arenaria* and *Euphorbia paralias.* It is relatively species-rich compared with other secondary pioneer communities, containing nine species per quadrat. There is no

clear geographical trend in the distribution of this community. This unit is separated at a late stage in the classification suggesting a high degree of similarity with the previous community. This, combined with the fact that this unit is not particularly widespread, suggests that this should be termed a sub-community of the former assemblage.

SH23 At the eighth level of division a vegetation unit is divided off from the communities discussed above. This assemblage is largely southern in extent and is represented at only three sites (Broadwater, West Wittering and Slapton Bar). It is defined by the constant presence of *Tripleurospermum maritimum, a* common pioneer shingle species. *Euphorbia paralias* and *Silene uniflora* are the prime associates with *Centranthus ruber, Glaucium flavum, Lotus corniculatus, Echium vulgare* and *Ononis repens* occasionally found in association. Overall cover provided by this community remains low, a function of the low species per quadrat rating (six) and the very low average cover provided by individual species (Domin score 1 on average, maximum 4).

Two major communities which display an arenicolous element emerge at the ninth level of the classification analysis.

SH21 The first is a widespread community found across many shingle sites. It is an example of a secondary pioneer community typical of shingle sites with a high proportion of sand within the shingle matrix. This assemblage is characterised by the constant presence of *Ammophila arenaria* which is often found to dominate in terms of the cover it provides. However, this is not typical throughout the community which is distinguished by its major associates, *Rumex crispus littoreus* and *Senecio viscosus,* both of which are found frequently throughout the assemblage although neither has a Domin score greater than 4. Additional arenicolous species which may occasionally be found in association include *Honckenya peploides, Glaucium flavum, Desmazeria marina* and *Carex arenaria. Festuca rubra, Cirsium vulgare* and the rare shingle species *Lathyrus japonicus* are also found as occasional community components. On average each quadrat contains only eight species.

SH22 A separate community is differentiated from this at the ninth level of division in the analysis. This new assemblage is also pioneer in nature but in this case *Glaucium flavum* has become more important and is the constant indicator. *Rumex crispus littoreus is* the main associate with *Senecio jacobaea* and *Senecio viscosus* also frequently found in association. The occasional presence of *Sedum acre, Silene uniflora, Cirsium vulgare, Festuca rubra* and *Cirsium arvense is* also typical of this community. Indeed, *Senecio jacobaea, Sedum acre* and *Silene uniflora* serve as the indicators to distinguish this community from the previous one, along with the importance of *Glaucium flavum.* This community also contains, on average, nine species per quadrat. This *Glaucium flavum - Rumex crispus littoreus* community is confined to southern sites, particularly along the East Anglian coast.

6. Pioneer communities

The remaining communities are more pioneer in nature than those discussed above as illustrated by the very open nature of the assemblages and the lack of many species in each. The first set of communities in this section of the classification display a clearly sandy nature.

6a. *Honckenya peploides* dominated communities

Two similar pioneer communities emerge at the eighth level of division on the classification. They are both characterised by the constant presence of *Honckenya peploides* as the major constant.

SH31b The first community, however, has *Potentilla anserina* and *Elymus repens* as key associates with the occasional presence of *Tripleurospermum maritimum* and *Atriplex prostrata* as very minor associates in this relatively depauperate community (only four species per quadrat).

SH31a In the second community, however, the *Honckenya peploides* becomes dominant with fewer associates (three species per quadrat), primarily *Silene uniflora* and *Tripleurospermum maritimum.* These associates are only found in small amounts (average

Domin score of 1) in this very open community. These are clearly closely related communities both of which are confined to sites in western Scotland. Neither community is obviously the major community of which the other could be considered a sub-community, containing fifteen and seventeen quadrats respectively. They represent an extreme of a series of pioneer communities characterised by the presence of *Honckenya peploides.*

SH26 Another similar community, but which has a wider applicability to shingle, is defined by the presence of the grasses *Festuca rubra* and *Ammophila arenaria* as occasional associates in *a Honckenya peploides - Silene uniflora* community. In this instance the community is more diverse with the *Honckenya peploides* generally offering less cover than in the previous communities while the *Silene uniflora* is a more important component. While the species rating per quadrat is only four, there is a range of associates in this case including *Rumex crispus littoreus, Atriplex sp., Arenaria serpyllifolia, Armeria maritima* or *Crithmum maritimum.* This assemblage is found across many shingle sites ranging from Ballantrae in the north to the Isles of Scilly.

SH28 The community above is separated off from another sandy pioneer community at the ninth stage of the analysis. The separation is made on the basis of the presence of additional arenicolous species such as *Ammophila arenaria, Eryngium maritimum* and *Euphorbia paralias* which are found alongside the major constants of *Honckenya peploides* and *Elymus pycnanthus.* This is also a very open assemblage typical of most pioneer communities with little cover offered even by the major constants. There are on average five species per quadrat. This is also a widespread community characteristic of many sandy shingle sites.

Two further grassland communities are seen in this section of the classification, emerging at the ninth level of division.

SH29 The most widespread of the two communities comprises an *Elymus farctus boreali-atlanticus - Honckenya peploides* assemblage with *Rumex crispus littoreus* and *Leymus arenarius* as the major associates. Occasional associates in this generally species-poor community (six species per quadrat) are typical pioneer species, including *Atriplex prostrata, Tripleurospermum maritimum, Taraxacum officinale* agg., and *Eryngium maritimum.* This assemblage is commonly found across shingle sites on the west coast.

SH30 Some sites in Wales support a more open *Elymus farctus boreali-atlanticus* pioneer community with *Eryngium maritimum* and *Taraxacum officinale* agg., as the major associates, although these are only found in small amounts. *Daucus carota* and *Glaucium flavum* are found as occasional associates and these serve to distinguish this community, along with the lack of *Honckenya peploides.*

6b. *Senecio viscosus* dominated communities

SH19 A southern pioneer assemblage is identified at the eighth level of division in the classification. In this case *Senecio viscosus* and *Rumex crispus littoreus* are the only constants which may be found in association with a variety of species, many of which are grasses, but which are not, in themselves, indicative of pioneer conditions. *Agrostis stolonifera is* the grass most commonly associated with the *Rumex crispus littoreus - Senecio viscosus* assemblage although *Holcus lanatus* and *Arrhenatherum elatius* are occasional associates. Among the herb associates *Sonchus aspen* and *Sonchus arvensis* are most frequently found within this community although *Chamaenerion angustifolium* becomes locally important in places. This assemblage is relatively species-poor, seven per quadrat. While it is represented across several southern sites, it is most typical of Orfordness.

SH20 The second assemblage in this part of the classification comprises a rather ruderal type of grassland defined by the constant presence of *Lolium perenne, Senecio viscosus* and *Stellaria media* along with more maritime herbs such as *Sedum acre* and *Tripleurospermum maritimum.* The major associates include *Geranium molle, Cochlearia officinalis* and *Rumex crispus littoreus.* This vegetation unit emerges at the seventh stage of the analysis although it is found at only one shingle site.

SH20a A similar community is defined by the major presence of *Lolium perenne.* The key associates are *Stellaria media* and *Geranium molle* while additional herb species are found in small amounts throughout the community. These include *Sisymbrium officinale, Taraxacum officinale* agg. and *Erodium cicutarium.* This community is found at Walney Island, a site which is subject to inundation in high tides during winter and is actively grazed and these may account for the rather ruderal nature of the vegetation.

6c. *Beta vulgaris maritima* dominated communities

The basis of the separation of the following set of communities is the presence of *Beta vulgaris maritima.* Several of these communities are unique to the Isles of Scilly in the south west.

SH17 The major category in this section of the classification is defined by the constant presence of *Beta vulgaris maritima, Solanum dulcamara* and *Tripleurospermum maritimum* although *Beta vulgaris maritima* is the dominant constant in terms of the cover it offers. The major associates within this assemblage are maritime herbs, in particular *Armeria maritima, Carex arenaria* and *Atriplex* spp., each of which become locally important along with *Lavatera arborea* and *Rumex crispus littoreus* which are the less common associates. This assemblage is generally southern in distribution but is particularly common in the Isles of Scilly.

SH17a At the final level of division in the classification, a separate vegetation unit emerges, based on the presence of *Daucus carota, Elymus pycnanthus* and *Crithmum maritimum* as indicator species. It comprises a *Beta vulgaris maritima - Crithmum maritimum* pioneer assemblage. These two constants provide much cover between them (maximum Domin score 7 each). Despite this, there are a number of key associate species, in particular *Elymus pycnanthus, Tripleurospermum maritimum, Atriplex* spp., *Carex arenaria, Daucus carota, Rumex crispus littoreus* and *Solanum dulcamara.* The relatively high number of such associates is reflected in the average figure of nine species per quadrat. This vegetation unit may be considered a sub-community of the more general *Beta vulgaris maritima - Solanum dulcamara - Tripleurospermum maritimum* community given that it is restricted to the Isles of Scilly and only emerges as a separate unit at the final level of division and thus displays a high degree of similarity.

SH18 *Lavatera arborea* is a major component in a community which is identified at the ninth stage of the analysis in this section of the classification. In this instance *Lavatera arborea* and *Atriplex* spp. comprise the constants in a depauperate community (four species per quadrat). *Rumex crispus littoreus* is most commonly found in association with the constants while *Beta vulgaris maritima* and *Cochlearia officinalis* are frequently found in this assemblage along with *Tripleurospermum maritimum,* although this species is only an occasional associate found in small quantities. This assemblage is also unique to shingle in the Isles of Scilly. However, it is significantly different from other communities described above and, as such, warrants inclusion as a separate community.

SH16 The other major community in the *Beta vulgaris maritima* dominated section of the classification may be defined as *a Beta vulgaris maritima - Festuca rubra - Tripleurospermum maritimum* grassland which is dominated by the first two species in terms of the cover provided. Indeed, this level of cover is reflected in the low number of species per quadrat (six). The most frequent associates are *Rumex crispus littoreus, Atriplex prostrata* and *Elymus pycnanthus* while *Bromus hordeaceus hordeaceus, Plantago lanceolata* and *Solanum dulcamara* are found occasionally throughout this community. This represents a southern maritime grassland community typical of many southern shingle sites.

SH15 Another southern community in this section of the classification comprises a more open assemblage defined by the constant presence of *Beta vulgaris maritima* and *Rumex crispus littoreus.* Of these constants, *Beta vulgaris maritima* is more important in terms of cover, which ranges from Domin score 3 to 9. The key associate species are *Sisymbrium officinale, Stellaria media* and *Sedum acre,* while

Geranium robertianum and *Atriplex littoralis* are occasionally found in association. The Gramineae species *Festuca rubra, Dactylis glomerata* and *Poa pratensis* are found in small amounts within this community which is primarily found on southern sites although it also occurred at Walney and Foulney.

SH14 A similar distribution to SH15 is displayed by a community which emerges at the sixth level of division in the classification. This assemblage represents a pioneer community typical of saltmarsh/shingle margins where there is a high silt content in the shingle matrix. *Cochlearia officinalis* and *Atriplex littoralis* are the indicators of this assemblage which is generally depauperate (four species per quadrat, on average). *Elymus repens, Puccinellia maritima, Festuca rubra, Spergularia maritima* and *Atriplex prostrata* are the associates most commonly sampled although other halophytic species may be found occasionally within this community.

6d. *Raphanus maritimus* dominated communities

The communities described above have been separated from another set of pioneer units at the fifth level of division. The separation is made on the presence of *Beta vulgaris maritima* in the first set of communities and on the presence of *Raphanus maritimus* and *Arrhenatherum elatius* in the second set which are described below.

SH12 The most common assemblage in this section of the classification is *a Raphanus maritimus - Tripleurospermum maritimum - Arrhenatherum elatius* pioneer community. *Raphanus maritimus is* the dominant indicator with an average Domin score of 7 (although the maximum score associated with this species is 10). As a result there are relatively few associates in this pioneer assemblage with an average of four species per quadrat. *Atriplex prostrata* and *Festuca rubra* are most commonly associated with the constants. This assemblage is largely northern in extent being typical of north western shingle sites in Scotland.

SH12a There is a very similar assemblage which is divided off from the community above at the final stage in the analysis. The distinction has been made on the importance of *Festuca rubra* relative to *Arrhenatherum elatius* within the *Raphanus maritimus - Tripleurospermum maritimum* assemblage. In the second community there is more emphasis on *Festuca rubra* which is an additional constant while there is no *Arrhenatherum elatius* present. *Raphanus maritimus* continues to dominate the community and the associate species remain the same as those listed above. The separation of these two communities only at the final stage in the analysis suggests a high level of similarity and it appears that the second assemblage may be considered a *Festuca rubra* sub-community of the general *Raphanus maritimus - Tripleurospermum maritimum - Arrhenatherum elatius* community. The sub-community is confined to two sites along a section of the western Scottish coast running from Auchenmalg Bay to Claymoddie in Dumfries-shire.

SH13 This stretch of coast supports another *Raphanus maritimus* dominated community. In this case, the assemblage is defined by the constant presence of *Atriplex prostrata* along with *Raphanus maritimus,* both of which provide much cover (average Domin scores of 6 and 8 respectively). Frequent associates include *Rumex crispus littoreus, Tripleurospermum maritimum* and *Arrhenatherum elatius* in a generally species-poor assemblage (five species per quadrat). This may be considered a very early stage in the development of the more mature communities such as those discussed above.

SH12b The final *Raphanus maritimus* community is found on the same stretch of coastline but also occurrs in the Isles of Scilly. It comprises a *Raphanus maritimus - Rumex crispus littoreus - Arrhenatherum elatius* unit with few associate species. *Tripleurospermum maritimum* and *Rubus fruticosus* are most commonly found in association and even these are found only in very small quantities within the community. This assemblage is identified at the ninth level of division thus indicating its general similarity to the major *Raphanus maritimus - Arrhenatherum elatius - Tripleurospermum*

maritimum community discussed above and it would seem to represent a second sub-community in which *Rumex crispus littoreus* becomes a locally important species.

6e. Herb-dominated pioneer communities

The following communities are herb-rich pioneer assemblages which are unique to the shingle substrate.

SH11 A southern community which emerges in this section of the classification is defined by the dominance of the nationally rare *Lathyrus japonicus.* This represents a shingle pioneer community in which overall cover is usually low and mostly *Lathyrus japonicus.* There are very few associates in this assemblage with, on average, three species per quadrat. *Rumex crispus littoreus, Cirsium arvense, Glaucium flavum* and *Sonchus asper* are the species most commonly found in association with *Lathyrus japonicus.* This community is typical of many southern shingle sites reflecting the distribution of *Lathyrus japonicus.*

SH9 Another species-poor, southern pioneer community is identified at the ninth level of division in this section of the classification. This community is defined by the constant presence of *Crambe maritima* and *Solanum dulcamara* although neither species provides any great cover in this open assemblage. Frequent associates include *Lathyrus japonicus, Senecio viscosus* and *Rumex crispus littoreus,* all found in small amounts. This community is also unique to the shingle substrate and is particularly well represented at Rye Harbour.

SH9a A separate community is also identified at the eighth level where it is divided off from the assemblage above. This comprises *a Crambe maritima - Rumex crispus littoreus* pioneer community which is once again depauperate. The major associates illustrate the sandy nature of the shingle in these areas, with *Ammophila arenaria* and *Glaucium flavum* most commonly found in the community. This assemblage contains relatively few quadrats and is only identified at the eighth level of division. Therefore it seems more appropriate to consider it a sub-community of the more common *Crambe maritima - Solanum dulcamara* community.

SH8 Another pioneer community is identified at the eighth level of division, although in this case *Crambe maritima is* a less important component, being found as a minor associate. This community is characterised by the constant presence of *Senecio viscosus,* which is found with the major associates *Glaucium flavum, Solanum dulcamara* and *Rumex crispus littoreus.* There are on average six species per quadrat in this assemblage with *Arrhenatherum elatius* and *Senecio jacobaea* as minor associates along with *Crambe maritima.* The community is commonly found on southern shingle sites, although it has also been recorded on sheltered Scottish sites. This reflects the distribution of *Senecio viscosus.*

SH10 The final pioneer community in this section of the classification is found on only two southern shingle sites - Rye Harbour and Chesil Beach. This assemblage comprises *a Solanum dulcamara - Arrhenatherum elatius* open pioneer grassland. Here too, *Crambe maritima* is an associate. Indeed, it is most frequently found in association with the above two species in this otherwise species-poor community (three species per quadrat). In places, *Tamarix gallica* becomes an important element in the assemblage often providing almost total cover at a canopy level with the constants found as ground cover. This community emerges at a relatively early stage in the classification (the sixth level of the analysis).

6f. *Silene uniflora* dominated communities

The following set of communities is characterised by the importance of *Silene uniflora* within each assemblage.

SH6 The major category in this section is defined by the constant presence of the maritime herbs *Silene uniflora* and *Crambe maritima,* an assemblage which is typical of the shingle substrate. This is another species-poor pioneer community (three species per quadrat) with *Glaucium flavum, Rumex crispus littoreus* and *Tripleurospermum maritimum* most frequently found in association with the two constants. This community is seen on several shingle sites but is particularly common at Chesil Beach in Dorset. This site is particularly undisturbed and represents a pure shingle substrate, two factors

which may encourage the growth of *Crambe maritima.*

SH6a A similar assemblage is differentiated from the *Crambe maritima - Silene uniflora* community detailed above at the eighth level of division. The separate assemblage has *Silene uniflora* and *Glaucium flavum* as the key indicators found throughout the community, along with *Rumex crispus littoreus* which is the major associate. This community is also southern in extent as above. In addition, it only emerges at a late stage in the analysis and so it may be more appropriate to consider this as a sub-community of the previous assemblage, which is the more widespread of the two.

The remaining *Silene uniflora* communities are local to Chesil Beach.

SH7 The first may be described as *a Silene uniflora* dominated community. Once again, *Glaucium flavum* occurs as one of the major associates but in this instance *Convolvulus arvensis, Sonchus asper* and *Atriplex* spp. are also frequent associates although none of these offer much cover. Indeed, this is a particularly open pioneer community with only three species per quadrat on average.

SH11a A further assemblage which emerges in this section of the classification is characterised by the constant presence of *Silene uniflora* and *Lathyrus japonicus.* Indeed, the dominance of these species is reflected in the low species per quadrat rating - two on average. Despite this, there are a few associates which are found occasionally in the assemblage, including *Rumex crispus littoreus, Cochlearia danica* and *Geranium robertianum.* This assemblage is clearly close to the *Lath yrus japonicus* community detailed earlier in the report (see section 6e) and it is only the major presence of *Silene uniflora* which has caused this unit to appear in this section of the classification. Given the depauperate nature of these pioneer communities and the fact that this community occurs at only one site, it seems that this should be considered a sub-community of the *Lathyrus japonicus* assemblage.

SH5 Another community unique to Chesil Beach is defined by the constant presence of *Cochlearia danica* along with *Silene uniflora,* although they are each found in small amounts within an open pioneer community. The major associates are *Arrhenatherum elatius* and *Beta vulgaris maritima* in an otherwise species-poor assemblage (three species per quadrat). Although this may seem like a pioneer community in certain characteristics such as the level of cover, it is relatively stable as shown by the occasional presence of the lichen *Xanthoria parietina.* It may be that the nutrient status of these areas is poor, thus limiting the development of a more closed community.

SH3 The final assemblage confined to Chesil Beach comprises a *Rumex crispus littoreus - Silene uniflora* pioneer community which is identified at the ninth level of division. These two constants dominate the assemblage (which has an average of two species per quadrat). The most common associates in this community are *Cochlearia danica* and *Geranium robertianum* although neither is found in large amounts (Domin score 1 on average). This community occupies a large area of Chesil Beach in Dorset.

SH4 *Cochlearia danica* can be locally important within the previous assemblage, forming *a Rumex crispus littoreus - Silene uniflora - Cochlearia danica* sub-community. In some places this sub-community is associated with *Tamarix gallica* as a canopy species but, in general, the major associate is *Geranium robertianum,* as with the main community.

SH2 It is the presence of *Geranium robertianum* which serves as an indicator of another community unique to shingle substrates. This is *a Geranium robertianum* dominated open pioneer community with *Rumex crispus littoreus* and *Silene uniflora* as the key associates. This is an uncommon community.

SH2a Another *Geranium robertianum* assemblage is found on a few shingle sites (mainly in Wales). In this case *Geranium robertianum* is found in association with fewer pioneer species, in particular *Arrhenatherum elatius* and dwarf *Prunus spinosa,* while cover remains very open. This community is found on stable areas and may indicate a poor nutrient status associated with little fine material within the shingle matrix. It is not a common

community but is found on several sites, including Dungeness.

SH1 The final community in the shingle classification comprises an *Arrhenatherum elatius - Silene uniflora - Rumex crispus littoreus* pioneer grassland found on many shingle sites around the country. *Arrhenatherum elatius is* dominant in terms of cover and this is reflected in the relatively low number of associates (on average five species per quadrat). The major associates include species less maritimein character than those seen in previous communities, suggesting that this may represent a more mature or secondary pioneer grassland. *Holcus lanatus* is the major associate with *Cerastium fontanum triviale, Hypochoeris radicata, Rumex acetosa, Senecio jacobaea* and *S. viscosus* as the occasional associates. This community is found in both northern and southern sites and across western and eastern sites.

It should be noted that there is one species assemblage which is found on a few shingle sites (particularly Scottish sites), but which, due to its rare nature, was not widely sampled. Hence, it does not emerge in the national classification. However, it is an important assemblage in terms of its rarity and so should be discussed.

This assemblage is characterised by the major presence of the rare maritime herb *Mertensia maritima.* This species is found on the strandline as it requires a major nutrient source to sustain growth. It is this location, along with its susceptibility to any form of disturbance, which has led to the rarity of the assemblage. Indeed, the assemblage was lost from many sites on the west coast of Arran during the storms of 1988. The common associates include *Tripleurospermum maritimum* and other pioneer species such as *Honckenya peploides* and *Silene uniflora.* The assemblage was not identified as a community during the TWINSPAN analysis.

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