English Nature Research Reports

Number 426

Maritime Cliffs and Slope Inventory

Chris Hill (GeoData Institute)
Dr Julian H Ball (GeoData Institute)
Dr Tom Dargie (Tom Dargie Environmental Consultants)
Dominic Tantram (Blue-Bag Ltd)
George Boobyer (Blue-Bag Ltd)

English Nature Project Officer: Sue Rees

ISSN 0967-876X

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1. Introduction

1.1 The need for an inventory of maritime cliff and slope habitat

Unlike other coastal habitats such as saltmarsh, shingle and sand dunes, maritime cliffs and slope habitat in Britain lacks a national inventory. The results for other habitats, compiled over the past two decades, have provided a valuable overview about national extent and regional variation, as well as assisting with the designation of sites, targeting of conservation initiatives and, in some cases, have influenced policy.

The case for a maritime cliff and slope inventory is strong, for several reasons:

- it is difficult at present to provide an assessment of the resource in nature conservation terms;
- vegetated habitats can support some of the most natural habitats found in the UK, many of which can be sustained without management intervention;
- a considerable amount of this resource has been affected by activities such as coast protection works which have modified the natural processes that influence the vegetation;
- the full extent and quality of unmodified maritime cliffs is not known;
- Maritime Cliff and Slope is a Priority Habitat in the UK Biodiversity Action Plan (UK BAP) and a Habitat Action Plan (HAP) was published in October 1999;
- the Maritime Cliff and Slope HAP has a monitoring and research action requiring, by 2003, a literature review and full survey of the maritime cliff and slope resource in the UK to assess its relative conservation value, how much can be improved by alternative management, and to what extent it is affected by coastal defence and engineering works - an inventory could provide much of this information;
- there is now an opportunity to develop a modern, electronically-based updatable inventory to link in with the National Biodiversity Network (NBN), providing information on resource character, quality and links to species datasets.

1.2 The general types of British cliff and their conservation importance

Approximately 4,000 km of the UK coast has been classified as 'cliff', with approximately 1,100 km of this resource in England. It is composed of hard and soft rock cliffs. Hard cliffs represent the classic seacliff habitat, with vegetation composed of a strong maritime element on ledges and crevices, influenced by salt spray and also, in places, by enrichment from seabird colonies. The vegetation communities of maritime cliffs described within the National Vegetation Classification (NVC) (Rodwell, 2000) is focussed mainly on the hard cliff type, describing types within twelve communities. This repeats a bias in research and review which has existed for some while (Mitchley, 1989).

Soft cliffs are subject to erosion, which is critical for maintaining the biological richness of this habitat by creating a series of microhabitats consisting of bare ground, seepage areas, recolonising areas and patches of more established habitat as the erosion cycles proceed. Relatively little vegetation study has been applied to soft cliff conditions and the NVC probably does not provide full coverage of the distinctive vegetation which occurs here

(Cox, 1997). Unprotected soft cliffs are a relatively scarce habitat, with an estimated length of 256 km in England, which is probably the bulk of the UK extent (Pye & French, 1992). These cliffs are also important in various ways for geomorphology, providing a source of sediment for beaches downdrift, providing excellent examples of mass movement and other landforms, together with fresh exposures for use in geological teaching and research (Pye & French, 1992). There is already concern at the implications of future shoreline management on protected habitats such as cliffs in England and Wales (Fowler & Tittley, 1993; Department of Coastal Management, 1998) and efforts are now being directed at strategies for restoring biodiversity to soft cliffs (Lee ***et al.***, 2000).

Some cliffs are included within SSSIs for biological and geomorphological interests, although many sites of interest are outside designated sites. Overall, there are 36 BAP priority species primarily associated with maritime cliff and slope, and a further 59 are recorded using the habitat (Simonson & Thomas, 1999). The EC Habitats Directive identifies (in Annex 1) 'Vegetated sea cliffs of the Atlantic and Baltic coasts' as a habitat requiring the designation of Special Areas of Conservation (SACs). The coast of the UK supports a significant proportion of EC sea cliff vegetation and a number of candidate SACs have been put forward, although it is recognised that this series is incomplete and further work on designation will be needed when further information is available.

1.3 Organisation of the national inventory

A national inventory of maritime cliff and slope is proposed for England, to be developed by English Nature in a number of distinct phases.

Phase 1

All known sources of data on maritime cliff and slope vegetation on the English coastline will be collated and reviewed. This information is to be used to provide a definition of the habitat. The work for this phase is to include the following:

- extent of coverage of previous surveys, how the data is stored, identify where there are major gaps;
- links needed to geological/geomorphological aspects of cliff behaviour (including reference to extent and effectiveness of coastal protection on maritime cliffs - e.g. 1994, MAFF Coast Protection Survey of England or Shoreline Management Plans;
- links needed to species, especially those covered by the UK BAP, nationally scarce or rare invertebrates and important assemblages (including reference to the Invertebrate Site Register and other important sources).

As output, an interim report is required with a clear definition for maritime cliff and slope that can be used for development of a national inventory and which is suitable for use in relation to BAP implementation and work in relation to statutory site protection. A full bibliography of source data will be listed.

Phase II

This will assess methodologies previously used for vegetation surveys. Following on from this initial step, it will develop and trial a standard methodology in the first year of the study, based on sites where survey work planned or done in Cornwall and the Isle of Wight. Work

will include development of a GIS-based system providing digitised boundaries for each habitat parcel and data for each polygon held in a database (ideally Recorder 2000, or form suitable for importing into Recorder 2000). Links with Local Records Centres (LRC) will need to be established, with data sets ultimately to be usable by LRCs. Output will be an interim report.

Phase III

Using the information collected in Phase I, the significant gaps in survey coverage will be identified. The methodology developed in Phase II, with any required revisions, will be used to develop a complete set of survey data of maritime cliffs and slopes that can be related to coastal process cells.

Phase IV

Following completion of the surveys in Phase III, the main output will be a set of habitat polygons and linked datasets, together with a final written report.

This report covers Phase 1 and Phase 2 of the inventory.

2. Inventory Phase 1: Collation and review of existing data

2.1 Introduction

This section discusses the methods used to identify, obtain, summarise and digitally store existing information relating to maritime cliff and slope habitat, as well as highlighting the extent of coverage of previous survey. Emphasis was concentrated on vegetation sources, but with additional important effort on invertebrate information and geomorphology - geology.

Survey collation has included literature searches, consultations with staff in English Nature teams from all the coastal regional offices and English Nature HQ and other a number of other relevant organisations (Environment Agency, MAFF (now DEFRA) and the National Trust). Library visits were the main methods of identifying and examining existing survey resources.

Metadata to NBN standards has been collected and provides the reference to the individual surveys. The role of metadata in this inventory is described in section 2.3.

Descriptions of the NVC and non-NVC surveys and their survey and recording structures are evaluated in section 2.4. The survey has had a focus on NVC data sources as the basis of evaluating surveys that might feed a HAP approach but has covered non-NVC survey methods which are considerably more numerous.

2.2 Consultations

A comprehensive inventory of the survey on the maritime cliffs and slopes in England has been assembled. This has been targeted on vegetation survey, in particular those carried out to a NVC level, but incorporating those using other formats and classifications. All English Nature Offices in England have been visited or consulted to obtain copies or details of maritime cliff and slope vegetation surveys carried out on the English coastline in their area. Complete copies of reports and maps have been obtained when these include mapping of maritime cliff and slope communities to the NVC level. Site files exist which cover many areas of maritime cliff and slopes and these contain a range of information from occasional faunal, floral and geological notes, habitat sketches to species lists. Limited extracts and references have been taken from these files due to the variable nature of the information.

The National Trust (NT) is a major coastal landowner and has carried out Biological Surveys for all their coastal properties, resulting in a considerable volume of site specific cliff and maritime slope surveys. These typically are both floristic and faunal, and include a number of observations and surveys on invertebrates, bird and soil profiles. Extracts from these reports have been obtained with associated maps to enable a review of the methodology and to provide survey limits and an indication of data quality. Full NT Biological Surveys were only obtained when the surveys were carried out to a NVC level.

During the final stages of consultation, an additional list of maritime cliff NVC surveys has been identified in Cornwall. These are all included in the inventory, but copies have not been obtained from the majority of these sites.

The references for all the surveys have not been presented in the References section of this report as they form part of the Metadata tables explained below (Section 1.3).

2.3 Metadata

Metadata were collected for the project to provide a catalogue of maritime cliff and slope information resources. The metadata were recorded according to the National Biodiversity Network's (NBN) Metadata Standard, using Blue-Bag's MetaTagger software. The NBN Metadata Standard was developed to enable recruitment of standardised information records for the NBN Index of biodiversity information sources (http://www.nbn.org.uk), a web-based metadata catalogue. The NBN metadata standard as implemented and augmented in MetaTagger is compatible with the major metadata standards including Dublin Core and the National Geospatial Data Framework (NGDF). The NBN Index provides searching facilities for all available NBN metadata records. Because the maritime cliff metadata have been recorded in the NBN format they can be added to the NBN Index when required. Because all metadata records collected are linked to the Maritime Cliff and Slope initiative it will be possible in the future to develop a web-based Maritime Cliff Index that provides exclusive access to maritime cliff and slope metadata. This model has been followed for English Nature's Lowland Parklands and Wood-pasture Information System project.

The NBN metadata standard can record a wide range of information about information resources. For this project metadata records included information (where available) as follows:

1. Basic Information	Basic information about the person compiling the metadata record and about the information resource, including the resource title, type, status, abstract and purpose.
2. Related Information	Information relationships with other information resources or initiatives.
3. Access Information	Information on the availability of the resource from one or more organisations and the formats available.
4. Detailed Information	Detail about the scope and content of the resource, including temporal information, standard keywords from the GEMET Thesaurus and NBN standard dictionaries (administrative area, species and biotopes) and spatial reference (point, line or bounding rectangle).
5. Organisation Information	Organisations relevant to the metadata record and the resource. E.g. If the metadata record is completed by someone from a different organisation to that originating or providing access to the resource then two or more organisation records are provided.

6. Person Information — Contact information for people relevant to the metadata record and the resource. As for organisations, multiple records may be provided. If the (contact) person is different in each case then a person record is required for the metadata recorder, the originator of the resource and the provider of the resource. Person records are always linked to organisations.

For this project, metadata records were entered into MetaTagger v.2.0. MetaTagger also enables the collection of information additional to the core NBN model. Such additional fields were employed here to record other attributes useful in the assessment of information sources and their content for this project. Table 2.1 shows the additional fields recorded. Appendix 7 shows some example reports from MetaTagger for four NVC surveys.

Table 2-1 Additional metadata fields recorded for Maritime Cliff and Slope Index

Additional field	***Description***
Length of coast surveyed:	Length in km
Area surveyed:	Area of survey
Habitat surveyed:	Type of habitat surveyed
Region surveyed:	(Local) name of survey region
Surveyor:	Name of surveyor
Duration of survey:	Duration in days spent surveying
Survey methodology:	Roped descents if utilised
Classification used:	Phase I, Phase II, NVC or other.
Community confidence:	TableFit analysis
Mapped definition of habitat boundaries:	Polygons – open, closed, point data
Geology:	Major geological characteristics
NVC communities per closed polygon:	Number of NVC communities placed within a closed polygon
Biological target notes:	Features of interest
Aerial photography verification:	Yes/no
Number of map sheets:	Number and size of map sheets
Final mapping system:	Photocopies, GIS etc

In addition to the augmented fields, a unique sequential code was given to each information resource (for example MC0045). This code was entered within the 'Original data source' field in MetaTagger and enables potential linkage between the MetaTagger MS Access database and an external GIS where this holds the same key. Where an external application does not possess this key, linkage can be made to the (unique) 'Resource ID' field in MetaTagger.

The maritime cliff and slope metadata were used to assess the range and content of information resources available for these habitats and related species. The metadata will provide the basis for information access as the project develops in the future. Because NBN standards have been employed, the metadata can be supplemented and enhanced in the future to provide a current and up-to-date resource to support the Habitat Action Plan.

2.3.1 Limitations and opportunities of metadata

Whilst the metadata records provide a consistent approach to recording the broad categories of maritime cliff and slope data sources there is still the need within such a review to evaluate a wider range of data characteristics than is typically allowed for in standardised NBN or Dublin Core compliant metadata. For this reason sample maps and details of the surveys and outputs from the surveys have also been collated.

Further metadata fields could be generated to enable further information collation and analysis of this information, but it has not been considered relevant at this stage. The metadata here merely acts as a reference to the sources of information used in compiling the survey evaluation and as a potential source for future incorporation into NBN metadata. The metadata represents a signifincat asset in its own right and one that should be maintained within the scope for further cliff and slope surveys.

A key component within Phase III, the identification of gaps in survey, will be facilitated by additional analysis of the results of the survey (using the additional fields collated within MetaTagger) and the mapping of the extent of the surveys already identified. Currently MetaTagger does not have the spatial link to map the extent of survey, but rather records the extents of survey as established within NBN standards. Development of the spatial link to the survey records would greatly assist the representation of the extent of existing survey evaluation in Phase III.

Section 5 identifies the tasks needed to represent the coverage and is established against a detailed (and consistent) coastal datasets (using OS Boundary-Line), which enables the identification and thematic mapping of the results of the inventory and the associated data fields within MetaTagger. This is illustrated later within Phase II (section 5 and Appendix 3) which shows the extent of cliffed coastline and the extent of that which has been surveyed for Cornwall. Thematic mapping based on the attributes of the survey will allow the further distinction of the type and scope of the surveys undertaken.

2.4 Information sources

2.4.1 Quadrat data

Samples of vegetation recorded in quadrats are the basis of all NVC work and many reports contain this information. The largest dataset is probably a spreadsheet of all quadrats collected around the British coast by Dr Andrew Malloch, formerly of the University of Lancaster. The data are deposited with JNCC and contains 2077 quadrats, each with a grid reference and other environmental information which varies in content per quadrat. Species cover abundance is recorded as DOMIN scores. The quadrat geographical distribution has been mapped as a MapInfo point layer and this revealed about 50 quadrats placed in the North Sea and North Atlantic, showing incorrect georeferencing. The great majority of quadrats are correctly located. There are 826 quadrats located on the English coastline (Figure 2.1). All records appear to cover hard cliffs, with no records for key soft cliff localities such as the Isle of Wight, North Yorkshire and Norfolk.

Figure 2-1 Location of maritime cliff quadrat data on the English coast

Source: JNCC Malloch spreadsheet

Malloch's dataset is an important resource and was used in the derivation of the NVC communities in Rodwell (2000). It is not possible to link individual quadrats to those communities and sub-communities because computer listings of that relationship were lost early in the NVC initiative (Professor J.S. Rodwell, pers. comm.). The layout of the data is not optimal for table sorting and any multivariate analysis would require time to restructure data. Quadrats in paper reports could be collated and added to an English quadrat set. This would be very useful in seeking regional variations in cliff vegetation data, as well as investigating the status of potential new NVC types. Such new types do feature in surveys and they are an important component in soft cliff habitats which are clearly undersampled in the Malloch dataset (e.g. Cooper, 1988; Cox, 1997). If the NVC system is going to be a core part of the final inventory, it is essential that there is a central quadrat database to turn to for both storing and analysing the results from individual sectors of the coast. It is recommended that such a central database is started, with a programme of data entry to capture important records from soft cliff areas. It is also recommended that the community structure of quadrats is investigated, to derive regional 'noda' which can be used in comparisons with published NVC types and new NVC variation.

2.4.2 NVC Surveys and vegetation maps

A good number of formal NVC surveys have now been completed on the English coast, although there is insufficient information on overall coverage because little of the work is digitised and no formal collation has previously taken place.

The early work of Cooper (1988) in which selected cliff sectors in Britain were mapped in 1987 in terms of NVC type at 1:7500 recorded quadrats and target notes. The work was commissioned by the Nature Conservancy Council as a pilot exercise to help cost a possible national cliff inventory, but there was no follow-up as an all-Britain initiative. The 1987 surveys were undertaken in England at Cape Cornwall and Lizard (Cornwall), Purbeck (Dorset), Robin Hood's Bay (North Yorkshire) and Trimingham (Norfolk). The latter two sites include soft cliff. Since the late 1980s NVC or near-equivalent surveys have been undertaken widely in England (Figure 2.2).

Striking features of the distribution of surveys are the absence of work in south-eastern England, the north-west and the north-east, and a concentration of effort in Cornwall (see Appendix 3). Quadrat records in datasets are often comprehensive and would be worth abstracting for incorporation in a centralised database (see 2.4.1).

A major loss of map based habitat data has occurred in Cornwall due to insecure storage and consequent rodent damage. This has resulted in incomplete data sets from the NVC surveys completed in Cornwall, but the scale of data loss is unclear. The loss confirms the importance of secure data storage and the capture of data as quickly as possible into a digital format for preservation and duplicated storage.

The Isle of Wight botanical cliff survey was undertaken with roped descents by a botanist with climbing experience, enabling the vegetation communities to be identified and mapped in detail. In comparison, the surveys undertaken in Dorset and on the Lizard Peninsula did not utilise roped descents and consequently the vegetated areas have only been broadly classified or remain unidentified.

A few datasets have already been captured into a GIS: small extents of cliff at Hilbre Island as part of a saltmarsh survey in the Dee Estuary, and almost all of the North Yorkshire coast. The latter survey delimited a cliff slope habitat area and only listed the NVC types present - no boundaries were attempted because of poor access and complex mosaics. A small section of the Isle of Wight NVC survey had also been digitised previously.

The concentration of most survey in South-west England allows a summary of regional cliff NVC vegetation to be produced. As a result of consultations, four separate reports have been identified covering the Isle of Wight, Dorset and Cornwall. The NVC community types identified in those reports are given in Appendix 6. The cliff vegetation surveyed and mapped is variable in these reports due to accessibility. A good spectrum of southern maritime vegetation types is found.

Surveys in North Yorkshire, Norfolk and the Isle of Wight suggest that non-NVC vegetation types are present, often in quantity. The variation is strongly successional, with wet and dry variants present. It is recommended that the quadrat data available are abstracted and assessed formally as provisional new NVC types.

Figure 2-2 Approximate lengths of coast with cliff NVC survey since late 1980s

Source: Metadatabase

3. Additional maritime cliff and slope related data resources

3.1 Information sources

This section focuses on non-vegetation data sources relevant to maritime cliff and slope habitat. It includes information on the location of cliffed coast, geology and geomorphology, coastal protection, and species information.

The rationale for collecting associated data on cliffs is amply shown by the comprehensiveness of the information collected by Malloch, which was effectively used to describe the edaphic and ecophysiological conditions favoured by the NVC communities based on the analysis of his data. The field collection or secondary attribution (such as substrate, stability etc) of survey sites helps to distinguish and classify the range of sites and habitats.

Additionally the associated information enables the assessment of the coverage of surveys of maritime cliff and slope collated for this survey to be assessed in relation to the overall population of cliff around the English coast. A number of datasets are apparently available which have attempted a broad inventory of cliffed coastline, albeit without attributes of more detailed surveys. Additional datasets of specific relevance to the cliff and slope description are geology and geological sections and where cliffs are also geological SSSIs designation documents will describe the specific features of interest.

Wider resources are available within research studies, and geotechnical investigations, especially where these have been conducted on unstable cliffs and rapidly retreating sections.

3.1.1 Location of maritime cliffs and slopes on the English coastline

The 'Maritime Cliff Database' is held by the JNCC was co-ordinated by Pat Doody and carried out by Andrew Malloch between 1986 and 1989. A data file contains start and end nodes (grid references) of 1781 maritime cliff sections, covering the whole coastline of Britain, including offshore island groups such as the Scillies.

Appendix 2 indicates the distribution of cliff sections from this data source. The associated data field for a cliff section from the Isle of Wight is provided. Assessment of these data suggests that a number of cliffed areas round the UK coastline were not represented in this study. The mapping does not accurately reflect the form of the coastline, as only start and end nodes are provided for each cliff section. The JNCC Maritime Cliff Database was used as a source to produce the 'Coastal sites sensitive to oil pollution' by the Nature Conservancy Council and the Marine Pollution Control Unit in 1990. The maps printed at 1:100,000 show areas of sea cliff, but again do omit certain maritime cliffs and slopes. The information is limited based on the oil spill response requirement and does not form a good basis for inventory framework.

Despite its limitations, the Maritime Cliff Database should be considered for updating. The start and end nodes for each coastal stretch should be snapped to the digital High Water Mark to generate a cliffed section for that part of the coast.

3.1.2 Coast Protection Survey of England

A 'National Flood and Coastal Asset Database' is currently being developed by the Environmental Agency in Oracle, which will jointly hold data on flood and coast protection defences. At the time of writing, this asset inventory holds data only on flood defence structures.

The Coast Protection Survey of England database was originally built in 1994 by the Ministry of Agriculture, Fisheries and Food and was updated annually until 1997. The 1997 dataset contains some 5,500 separate defence structures. An extract of the defences in the Solent and the Isle of Wight is included in Appendix 5 with a listing of all the associated fields. Coast Protection relates to those areas of the coastline susceptible to erosion rather than the low lying (non-cliffed) coastline that might be subject to flooding. The latter is covered by Environment Agency sea defence survey datasets and asset inventories in some parts of the coastline.

The Coast Protection Survey of England, although now marginally out of date, provides the location of all coast protection structures in England. It has a large number of associated data fields which include, cliff appearance, angle of slope, structure and geology. Such information is rare in other data sources. Associated data is of course limited to those sites where there are coast protective structures. The residual life of sea defence structures would be of interest to this study. Around the coastline of England structures have been given a range of residual lives. There are 422 structures with a residual life of <5 years, 1091 defences with a residual life of 5-10 years and 3664 structures with a residual life of > 10 years, with a number unclassified.

The value of this data to the maritime cliff and slope inventory is limited. The descriptions are sparse and the categorisation is crude, although it does help identify the extent and form of the level of protection of the cliffline in England.

3.1.3 Shoreline Management Plans

Shoreline Management Plans (SMP's) were produced by Coastal Authority Groups around the English and Welsh coast and grant-aided by MAFF using guidance from MAFF and the Welsh Office "Shoreline management plans: a guide for coastal defence authorities". (MAFF 1995). SMP's have been subject to supplementary guidance as Advisory Notes (MAFF 1996) and numerous reviews and performance assessments (Croucher 1998, Brooke 2000). Further development of the SMP into Scheme Strategies and SMP reviews is guided by further advice from MAFF (2000).

The extent to which the SMPs and associated plans have met their natural environment objectives has been assessed by Brooke (2000). However, the ability to meet these objectives has depended both on defining clearly what the objectives or supplementary objectives are and the ability within the limitations of the SMP process (which undertook no new surveys) to address the details of site specific issues at the strategic level of the SMP.

As far as cliff and maritime slopes are concerned there has been little concentration within the SMPs other than where the cliffs are eroding rapidly and where built environment is closely adjacent to the cliff top. This has occurred at sites like Fairlight Cove (in Sussex), a geological SSSI and unstable cliffline partly protected by an offshore (cliff toe) rock bund. There is generally little other information that is collected consistently round the coastline

associated with the SMP documents or digital datasets. Rates or retreat have not been consistently recorded or assessed.

It is concluded that SMPs within the first generation do not provide a valuable source of information for assessment within the maritime cliff inventory, although there are some notable exceptions. More selective studies for coastal defence surveys and broader research surveys are likely to be more instructive (MAFF 1995a, MAFF 1997, MAFF 1997a). The studies following from SMPs may be more valuable in this respect and the research within FutureCoast in particular may provide a valuable additional input to understanding the rates of cliff retreat.

3.1.4 Species Inventories

In order to target biological records for this study, a listing of floral and faunal species has been generated which is derived from the 'Long List of Globally Threatened/Declining Species' from 'Biodiversity: The UK Steering Group Report Volume 2: Action Plans'. A synthesis of information for maritime cliffs is held as a spreadsheet by English Nature and the species on this habitat list are given in Appendix 1.

Threatened Plant database

The 'Threatened Plant database' is maintained by English Nature. A copy has also been lodged with the BSBI, who have supplied data in MapInfo readable format for this study. The database is in a DOS-based Recorder format.

Invertebrate Site Register

The database is held and maintained by the JNCC. A copy is also held by the BSBI and used to provide data extracts for this study. The database is again in DOS-based Recorder, and extraction is possible into a format that is directly read by MapInfo. The 'Invertebrate Site Register' has been interrogated for Globally threatened/Declining species and Appendix 4 shows the distribution of records for all species. One of the species, ***Osmia xanthomelana,*** a mason bee, once occurred widely, but is now confined to the southern coast of the Isle of Wight on landslips and cliffs and utilises ***Lotus corniculatus*** and ***Hippocrepis comosa*** as a food source.

National Scarce Moth Recording Network

The National Scarce Moth Recording Network use Recorder for all logged sightings of moths in England and Wales.

Data resolution is variable in all the 3 species recording databases with ranges from 10km to 100m. The data sources are of importance in determining current and past distributions of threatened species and provide the opportunity to investigate why there have been changes in a number of the populations. Although the distribution of a number of species is not solely confined to coastal cliffs and slopes, GIS analysis enables those records to be highlighted, within the limitations of the data. Habitat descriptions do not accompany any of the species records.

Scarce and threatened bees, wasps and ants associated with coastal cliffs

A monograph by Falk (1991) was selected for use in examining the methods for focussing on the potential of species groups associated with maritime cliff and slopes habitat. This was done following discussion of potential sources with the Nominated Officer and David Sheppard (English Nature Entomologist). The monograph lists species which are endangered (RDB1), vulnerable (RDB2), rare (RDB3), insufficiently known (RDBK) and nationally scarce (Notable A - 16-30 modern 10 km squares; Notable B - 31-100 modern 10 km squares). Each species of bee, wasp or ant is described systematically on a data sheet. These descriptions were scrutinised, comparing distribution information (Watsonian vice-counties, place names) with habitat detail (e.g. rock cliffs, soft cliffs, landslides by the coast). All species with a clear statement of association with maritime cliffs were entered into a spreadsheet and brief details on name, status and coastal distribution in Britain added (Table 3.1). A total of 90 species was abstracted. The majority are found in association with soft cliff conditions but it is impossible in all cases to georeference distributions precisely. Vice-county and place name detail, matched with a mention of cliff, is insufficient in many cases to be certain of even a 10 km square record and this data source therefore seems very limited for capture into a GIS. The species list could however be used in conjunction with the Invertebrate Site Register to obtain improved locational detail. Only four species are regarded as BAP Priority Species (***Anergates atratalus, Lasioglossum angusticeps, Nomada errans, Osmia xanthomelana***) but the list includes 25 endangered and vulnerable (RDB1, RDB2) species, suggesting that the importance of cliffs (particularly soft rock systems) is of even greater importance than suggested by the list of BAP Priority Species (Table 3.1).

Table 3-1 Scarce and threatened bees, wasps and ants associated with maritime cliffs in Great Britain

Source: Falk (1991) * BAP Priority Species

Scientific_name	*Common_name*	*Cliff_type_detail*	*Status*	*References_distribution*
Alysson lunicornis	A solitary wasp	Soft, Landslip	Notable A	Coastal distribution uncertain
Andrena alfkenella	A mining bee	Eroding cliffs	Rare	Devon
Andrena bimaculata	A mining bee	Landslip	Notable B	Coastal distribution uncertain
Andrena bucephala	A mining bee	Landslip	Notable A	Coastal distribution uncertain
Andrena fulvago	A mining bee	Landslip	Notable A	Coastal distribution uncertain
Andrena hattorfiana	A mining bee	Cliff tops, Landslip	Rare	Coastal distribution uncertain
Andrena humilis	A mining bee	Landslip	Notable B	Coastal distribution uncertain
Andrena labiata	A mining bee	Soft, Landslip	Notable A	Coastal distribution uncertain
Andrena marginata	A mining bee	Landslip	Notable A	Coastal distribution uncertain
Andrena nigriceps	A mining bee	Landslip	Notable B	Coastal distribution uncertain
Andrena nitidiusculus	A mining bee	Soft, Landslip	Rare	Coastal distribution uncertain
Andrena niveata	A mining bee	Cliffs, Landslip	Vulnerable	Coastal distribution uncertain
Andrena ocreata	A mining bee	Cliffs	Notable B	Coastal distribution uncertain
Andrena pilipes	A mining bee	Cliff tops, Soft, Landslip	Notable B	Coastal distribution uncertain
Andrena proxima	A mining bee	Soft, Landslip	Rare	Coastal distribution uncertain
Andrena rosae	A mining bee	Cliff tops, Soft, Landslip	Vulnerable	Coastal distribution uncertain
Andrena simillima	A mining bee	Soft, Landslip	Vulnerable	Kent: Folkestone, other coastal distribution uncertain
Andrena Trimmerana	A mining bee	Cliff tops, Soft, Landslip	Notable B	Coastal distribution uncertain
Anergates atratalus*	Dark Guest Ant	Stony, landslips	InsufKnown	Barrett 1979 (S.Devon: Bolt Head-Bolberry Down)
Anthophora quadrimaculata	The Four-spotted Flower Bee	Cliffs	Notable B	Coastal distribution uncertain
Anthophora retusa	The Potter Flower Bee	Cliffs, Landslip	Endangered	IoW, other coastal distribution uncertain
Aporus unicolor	A spider wasp	Soft, Landslip	Notable A	Coastal distribution uncertain
Arachnospila minutula	A spider wasp	Soft, Landslip	Notable B	Coastal distribution uncertain
Argogorytes fargei	A solitary wasp	Soft, Landslip	Notable A	Coastal distribution uncertain
Cerceris quadrincincta	A solitary wasp	Sand on chalk cliff	Endangered	Kent: Ramsgate, other coastal distribution uncertain)
Cerceris quinquefasciata	A solitary wasp	Soft, Landslip	Rare	Coastal distribution uncertain
Colletes marginatus	The Margined Colletes (a mining bee)	Soft	Notable A	Cornwall
Crossocerus palmipes	A solitary wasp	Landslip	Notable B	Coastal distribution uncertain
Cryptocheilus notatus	A spider wasp	Soft, Landslip	Vulnerable	Coastal distribution uncertain
Dasypoda altercator	A mining bee	Soft	Notable B	Coastal distribution uncertain

Scientific_name	*Common_name*	*Cliff_type_detail*	*Status*	*References_distribution*
Dufourea vulgaris	A mining bee	Soft	Endangered	Dorset/Hants border: Chewton
Ectemnius sexcinctus	A solitary wasp	Soft, Landslip	Notable B	Coastal distribution uncertain
Eucera longicornis	The Long-horned Eucera (a bee)	Soft, Landslip	Notable A	IoW, other coastal distribution uncertain
Eucera nigrescens	The Tuberculate Eucera (a bee)	Soft, Landslip	Endangered	Coastal distribution uncertain
Euodynerus quadrifasciatus	A mason wasp	Soft, Undercliff	Vulnerable	S. Devon: Prawle Point, Dorset: Portland
Formica exsecta	Narrow-headed Ant		Endangered	Spooner 1968a (E. Cornwall: Morwenstow)
Formica rufibarbis	Red-barbed Ant		Endangered	Yarrow 1941 (Scillies: St Martin's)
Gorytes bicinctus	A solitary wasp	Soft, Landslip	Notable B	Coastal distribution uncertain
Halictus maculatus	A mining bee	Soft, Landslip	Endangered	IoW: Sandown Bay, other coastal distribution uncertain
Hedychridium coriaceum	A ruby-tailed wasp	Soft	Rare	Coastal distribution uncertain
Hedychrum niemelai	A ruby-tailed wasp	Soft	Rare	Coastal distribution uncertain
Hylaeus euryscapus	A Yellow-faced bee	Soft, Landslip	Rare	Coastal distribution uncertain
Lasioglossum angusticeps*	A mining bee	Soft, Landslip	Rare	S. Devon: Sidmouth, Seaton, Dowlands Landslip. Dorset: Lyme Regis-Charmouth Landslip, Chideock, Portland-Weymouth, Ringstead-Holworth Cliff, Durdle Door, Worbarrow Bay, Durlston-Swanage. IoW: Chilton Chine, St. Catherines Point, Luccombe Cliff
Lasioglossum laticeps	A mining bee	Soft, Landslip	Vulnerable	S. Devon/Dorset: Seaton-Charmouth. Dorset: Worbarrow Bay-Kimmeridge
Lasioglossum malachurus	A mining bee	Soft, Landslip	Notable B	Coastal distribution uncertain
Lasioglossum pauperatum	A mining bee	Landslip	Rare	Coastal distribution uncertain
Lasioglossum pauxillum	A mining bee	Soft	Notable A	Coastal distribution uncertain
Lasioglossum puncticolle	A mining bee	Soft, Landslip	Notable B	Coastal distribution uncertain
Lasioglossum xanthopum	A mining bee	Soft, Landslip	Notable B	Coastal distribution uncertain
Leptothorax tuberum	A Slender-bodied Ant		Notable A	Barrett 1979 (W Corn, E Corn, S Dev, N Som, Dorset, IoW, S Hants, Sussex, E Kent, W Kent, S Essex, W Glouces, Glam)
Melecta luctousa	The Scarce Melecta (a bee)	Soft, Landslip	Endangered	Coastal distribution uncertain
Melitta tricincta	A mining bee	Soft, Landslip	Notable B	Coastal distribution uncertain
Mellinus crabroneus	A solitary wasp	Soft, Landslip	Endangered	Coastal distribution uncertain
Methocha ichneumonides	The Tiger-beetle Wasp	Soft, Landslip	Notable B	Coastal distribution uncertain
Myrmica hirsuta	A Guest Ant	Chalk cliff	Insuff Known	Barrett 1979 (E. Kent: Folkestone Warren)
Nomada conjugens	A nomad bee	Cliffs, Landslip	Vulnerable	IoW, other coastal distribution uncertain
Nomada errans*	A nomad bee	Cliff tops, Landslip	Endangered	Dorset: near Swanage
Nomada flavopicta	A nomad bee	Soft, Landslip	Notable B	Coastal distribution uncertain
Nomada fucata	A nomad bee	Soft, Landslip	Notable A	Coastal distribution uncertain

Scientific_name	*Common_name*	*Cliff_type_detail*	*Status*	*References_distribution*
Nomada fulvicornis	A nomad bee	Soft, Landslip	Rare	Coastal distribution uncertain
Nomada guttulata	A nomad bee	Cliffs, Landslip	Endangered	Coastal distribution uncertain
Nomada hirtipes	A nomad bee	Landslip	Rare	Coastal distribution uncertain
Nomada lathburiana	A nomad bee	Soft, Landslip	Rare	Coastal distribution uncertain
Nomada pleurosticta	A nomad bee	Cliffs, Landslip	Notable A	Coastal distribution uncertain
Nomada sexfasciata	The Six-banded Nomad Bee	Soft, Landslip	Endangered	10Km distribution map (p. 14) in Falk 1991. S. Devon
Nysson dimidiatus	A 'cuckoo' wasp	Soft, Landslip	Notable B	Coastal distribution uncertain
Nysson interruptus	A 'cuckoo' wasp	Soft, Landslip	Vulnerable	IoW, other coastal distribution uncertain
Odynerus melanocephalus	A mason wasp	Soft, Landslip	Notable A	Coastal distribution uncertain
Osmia parietina	A mason bee	Rock coast	Rare	Coastal distribution uncertain
Osmia xanthomelana*	A mason bee	Soft, Landslip	Endangered	10Km distribution map (p.15) in Falk 1991. IoW
Philanthus triangulum	The 'Bee-wolf' (a solitary wasp)	Sandy cliffs	Vulnerable	IoW
Podalonia hirsuta	A solitary wasp	Soft, Landslip	Notable B	Coastal distribution unknown
Ponera coarctata	The Indolent Ant	Soft, Landslip	Notable B	Barrett 1979 (Coastal distribution uncertain)
Priocnemis agilis	A spider wasp	Soft, Landslip	Notable B	Coastal distribution uncertain
Priocnemis gracilis	A spider wasp	Soft, Landslip	Notable B	Coastal distribution uncertain
Psen atratinus	A solitary wasp	Clay cliffs, Landslip	Vulnerable	IoW
Psen littoralis	A solitary wasp	Soft	Rare	Dorset: Charmouth-Lyme Regis
Psen unicolor	A solitary wasp	Soft, Landslip	Notable A	IoW, other coastal distribution uncertain
Smicromyrme rufipes	The Small Velvet Ant	Soft	Notable B	Coastal distribution uncertain
Solenopsis fugax	The Small Raider Ant	Cliffs	Rare	Barrett 1979 (W. Corn, S, Devon, N. Som, Dorset, IoW, E. Kent, S. Essex)
Sphecodes crassus	A cuckoo bee	Soft, Landslip	Notable B	Coastal distribution uncertain
Sphecodes niger	A cuckoo bee	Soft	Rare	IoW: Blackgang Chine
Sphecodes reticulatus	A cuckoo bee	Soft, Landslip	Notable A	Coastal distribution uncertain
Sphecodes rubicundus	A cuckoo bee	Soft, Landslip	Notable A	Coastal distribution uncertain
Sphecodes spinulosus	A cuckoo bee	Soft, Landslip	Vulnerable	Dorset: Swanage, Kimmeridge. Devon: Branscombe. Other coastal distribution uncertain
Stelis ornatula	A cuckoo bee	Landslip	Rare	Coastal distribution uncertain
Stelis phaeoptera	A cuckoo bee	Landslip	Vulnerable	10Km distribution map (p. 15) in Falk 1991
Stelis punctulatissima	A cuckoo bee	Soft	Notable B	Coastal distribution uncertain
Strongylognathus testaceus	The Testacous Guest Ant	Stony cliff, Landslip	Rare	Barrett 1979 (S. Devon: Bolt Head)
Tapinoma erraticum	The Erratic Ant	Soft	Notable B	Barrett 1979 (Coastal distribution uncertain)

3.2 Geological Report

UK Regional Geology Guide/Geological Memoirs have been consulted to obtain profiles of exposed cliff surface with their geology. An initial study has been made to classify the geology into 3 main categories, the carbonates, the arsenitic sands, gravel and clastics and clays with mudstone and siltstone. This may be an over simplification but does start to provide varying geological classes that might have different habitat associations.

Consideration should be given to holding the profiles as raster images within the GIS. The profile could be modelled for each length of the coast to build as near as possible the geological profile for the whole of the English coast. The association between the community and the water and base status of the cliff and its stability is explored further in Section 4.

Table 3-2 Listing of consulted associated data sources

Associated Data	*Comment*	*Format (GIS)*	*Appendix*
Maritime Cliff Database	JNCC	MapInfo	2
MAFF Coast Protection Survey of England (CPSE).	Provides start and end nodes for all coastal defence structures with associated fields which include life expectancy, material composition, cliff appearance	MapInfo	5
Threatened Plant database	Data is held by BSBI. Fields include: Status VC Master site, Site Grid, Collector, Date, Curation, Determiner, Year of det., Sex/stage, Abundance, References.	Recorder	
Invertebrate Site Register	Data is located at English Nature, Peterborough but may also be interrogated from BSBI.	Recorder	4
National Scarce Moth Recording Network.	Data maintained by the Butterfly Conservation Society, Lulworth and the JNCC. Data fields include: Locality Grid Ref., Vice County, Date, Abundance, Recorder, Comments	Recorder	
Geological reports	UK Regional Geology Guide/Geological Memoirs. Contain sectional diagrams of cliff sections.	Paper	

4. Habitat definition for maritime cliffs

4.1 Background

Maritime cliff and slope are considered, within the UK Maritime Cliff and Slopes Habitat Action Plan (HAP), to be "sloping to vertical faces on the coastline where a break in slope is formed by slippage and/or coastal erosion" (Anon., 1999). The HAP extends this outline definition, emphasising that there is no accepted definition of the minimum height or angle of slope which constitutes a cliff. However, cliff-top is covered by the HAP and that zone is acknowledged to extend landward to at least the limit of maritime influence (taken in the UK BAP to be the limit of salt deposition). In exposed locations this zone can extend up to 500 m inland. The lowest part of this habitat is taken to be the limit of the supralittoral zone and hence includes splash zone lichens and other species found here. Whole islands and complete headlands are included if their size and exposure to marine conditions produce the above cliff slope and cliff top conditions. The HAP estimates the UK cliffed coastline length to be ***c***. 4000 km.

4.2 Need for a definition

The development of a maritime cliff and slope inventory requires a more detailed definition of maritime cliff and slope habitat for three main purposes:

- the consistent capture of information for use in the inventory;
- for use in relation to BAP implementation and reporting;
- for work in relation to SSSI selection and other statutory site protection.

4.3 Other definition requirements

The fuller definition has to be capable of defining sectors of maritime cliff and slope which do not overlap with other BAP habitats located along the coast (coastal sand dunes, coastal saltmarsh, coastal vegetated shingle, machair), as well as no overlap with other BAP habitats lying inland of the maritime cliff zone. The definition must therefore be precise enough to enable maritime cliff and slope habitat polygons to be constructed accurately around the coast of the UK, and it must therefore include the full range of UK cliff conditions. The boundaries must also be readily identifiable using an inventory methodology, and capable of capture for import into a GIS. The presumption is that the definition will be essential in defining the spatial extent (a 'macro' polygon) of the habitat, as a first stage of the inventory process. The second stage will be the accumulation of information on the internal character of individual polygons (e.g. point, line and polygon features such as locations of invertebrates and an NVC mosaic).

4.4 The importance of UK cliff literature

The definition below reflects the character of the literature on UK cliffs and especially their vegetation. A dichotomy exists in the literature between 'hard' and 'soft' cliff conditions: the best-known vegetation studies concentrate on types which are mainly found on 'hard' cliffs, and much geomorphological work (including classification) concentrates on the much more dynamic forms and processes of 'soft' cliffs. Until recently, relatively little vegetation survey had been undertaken on 'soft' cliffs and these habitats probably contain vegetation types

which are not covered by the NVC system. There are therefore probably gaps in our knowledge of cliff vegetation, as well as for other ecosystem components (particularly invertebrates).

The split into hard and soft types is an obvious simplification, e.g. there are intermediate types between the hard and soft extremes, and some fairly hard rock types such as chalk can behave as soft cliffs with massive failures occurring at regular to sporadic intervals. Nevertheless, the hard and soft dichotomy exists and reflects strong contrasts in the nature of cliff form, spray deposition, vegetation, fauna and slope processes. It is therefore wise to build on this duality and use it as the basis of definition: maritime cliff and slopes habitat thus extends inland as far as either the inland limit of significant salt spray impact (hard cliffs) or as far as the current inland limit of active cliff slope processes (soft cliffs).

4.5 Proposed definition

Maritime cliff and slopes habitat is present on the coast if EITHER of the two following sets of cliff conditions are dominant (Table 4.1 for hard cliffs, Table 4.2 for soft cliffs). The conditions are compiled to cover the known range of variation in the UK. Tables 4.1 and 4.2 have columns listing Phase 1 habitat survey and NVC/Phase 2 categories which fit the sub-habitats found on hard and soft cliffs. In addition, intertidal biotopes from the Marine Nature Conservation Review (Connor ***et al***., 1995) are added for supralittoral and littoral fringe rock in Table 4.1. These lists allow existing survey information to be used as a potential way of delimiting individual 'macro' polygons. Any mapping in this way should be field-checked against other guidance here to assess compatibility between desk-based and fresh mapping. This could be done on a sample basis. Further detailed mapping within 'macro' polygons may well show a fuller list of Phase 1 or NVC types and such results should be used to update Tables 4.1 and 4.2.

The seaward limit of most maritime cliff areas is easily fixed using the Mean High Water Ordinary Spring (MHWOS) line on Ordnance Survey maps in England and Wales. In some cases cliffs might be fronted by dunes or vegetated shingle and a clear separation from these other habitats is necessary, easily made by locating the break of slope at the foot of the cliff. The inland limit is more difficult to define or draw and the following sections deal with this issue.

4.6 Hard cliffs

4.6.1 Boundaries and the vegetation sequence on a declining spray impact gradient

This subsection provides advice and recommendations for delimiting the boundaries of a polygon enclosing maritime cliff and slope conditions in a hard cliff environment. It enlarges on detail in Table 4.1.

On hard cliff sectors with a clear inland decline in spray impacts (indicated by the decline and then loss of salt-tolerant species), the inner boundary in areas of semi-natural vegetation should usually be taken as the inland limit of maritime cliff grassland (usually an MC9 ***Festuca rubra - Holcus lanatus*** type using the NVC system). The cliff top zone should therefore be carefully searched for good indicators (plant species and vegetation types) of a spray effect. On a good natural transition from spray-affected vegetation to other semi-

natural habitat, there will be a marked decline inland of ***Armeria maritima,*** with ***Plantago maritima*** and/or ***P. coronopus*** persisting further. Vegetation types are probably better indicators but the sequence to be found is complex, varying with latitude, rock type, soil thickness, soil wetness, and the presence or absence of grazing.

Generalised diagrams for the zonation mosaics are given in Rodwell (2000). On acidic rocks in northern Britain maritime grassland changes inland from the MC8 ***Festuca rubra - Armeria maritima*** community to the MC9 ***Festuca rubra - Holcus lanatus*** community, and then into H7 ***Calluna vulgaris - Scilla verna*** heath on thinner, more acidic soils. On thicker and less acidic soils MG1 ***Arrhenatherum elatius*** is a marker of ungrazed ground and U4 ***Festuca ovina - Agrostis capillaris - Galium saxatile*** calcifugous grassland is characteristic of grazed ground. There is often a sharp inland boundary inland between the H7 heath and inland heath and blanket peat vegetation. The boundary is more diffuse for MG1 and U4 grassland. In the latter ***Festuca rubra*** can persist due to the spray influence and its loss would be the position for drawing a line. It might be necessary to apply an arbitrary line within MG1 vegetation, based on distance inland for the inner edge nearby. In southern Britain, the MC12 ***Festuca rubra - Hyacinthoides non-scripta*** maritime bluebell community can also be present on deeper soils and its inner edge is likely to form the boundary of the maritime cliff habitat. On limestone cliffs in southern England the transition inland is from MC8 to MC9 and the MC11 ***Festuca rubra - Daucus carota*** ssp. ***gummifer*** community. There is usually a fairly sharp transition to other calcicolous grassland (mainly the ***CG1 Festuca ovina - Carlina vulgaris*** and CG2 ***F. ovina - Avenula pratensis*** communities) and the boundary can be fixed here.

These diagrams are useful but they are unlikely to cover the full range of mosaics present when rock types are multiplied and a more detailed exposure and latitudinal stratification is applied. For example, gneiss in the high rainfall of northwestern Scotland supports CG10 ***Festuca ovina - Agrostis capillaris - Thymus praecox*** vegetation immediately inland of the MC8 and MC9 zones, sometimes forming mosaics with H7 heath. A spray effect seems important in maintaining this type, since it usually rapidly disappears inland as it is replaced by wet heath and blanket mire. Grazed cliff slopes in eastern Scotland (from Borders to Grampian) have grassland similar to types normally considered restricted to southern Britain (CG1 and CG2). These two cases show both the limitations of generalised zonation diagrams and uncertain knowledge of the geographical spread of some NVC types. These are important information gaps and the inventory programme should be designed to accommodate these difficulties. In particular, it is strongly recommended that mapping of maritime cliff and slope habitat should start with the development of a set of generalised regional zonation diagrams using experienced maritime cliff vegetation surveyors, stratifying results according to major rock types and degrees of exposure. The main target of this initial work would be to identify the best indicators (plant species, vegetation types) for identifying the inner edge boundary. Results should be usable by a broad range of surveyors who could be used to complete field mapping of the maritime cliff and slope habitat polygon. Some justification of the inner boundary might be needed and details of inland conditions should be given (e.g. as target notes giving details of the habitats immediately inland).

4.6.2 The boundary of cliff top habitat on very sheltered coasts

The habitat gradient controlled by salt spray is often not present behind cliffs that are too high and/or too sheltered (e.g. within estuaries, such as Sedbury Cliffs developed behind saltmarsh in the Severn Estuary, or within sealochs in Scotland). Such sheltered areas with acidic soils often have heathland or blanket peat (in Scotland) running to the top of the cliff

slope. In all such sheltered cases the maritime cliff and slope boundary should be drawn at the top of the cliff slope, with heath, peatland, grassland, bracken and scrub being mapped separately under other HAP initiatives.

4.6.3 Boundaries on developed hard cliff coast

Much hard cliff coast lacks a complete natural or semi-natural transition inland to other habitats. Agriculture commonly extends close to the cliff slope edge, with a wall or fence boundary creating just a narrow band of cliff top habitat. Development (industry, housing) and recreational features such as car parks often act in the same way, confining cliff top habitat to a narrow linear feature which is often of great importance for access to visitors and managers of a cliff area. That band contains clear maritime cliff habitat (e.g. MC8 and MC9 vegetation) on exposed coasts but in more sheltered areas without a dominant spray impact a much more complex range of habitats occurs. In such cases a pragmatic boundary should be applied, taking the cliff top zone inland to the limit of all semi-natural habitat. Details of inland conditions beyond the boundary should be given (e.g. as target notes giving details of the type of conditions present, such as arable agriculture, improved grassland, housing).

4.6.4 The potential limits of salt spray impact

The UK BAP takes the limit of salt deposition to mark the inner edge of maritime cliff and slope. For most of the British coast this limit is unknown. Few studies provide detailed information on spray deposition in relation to distance inland and a modelling study would be needed to extend the scatter of available information to all of England. Nevertheless, this does raise the issue of defining the potential inland limit of the HAP, both for natural and semi-natural transitions (where the above definition excludes ground with low amounts of salt deposition) and for areas of coast where the cliff top is dominated by agriculture, housing and other forms of development. Without the results of a modelling study it is impossible to be certain of the implications for changing 'macro' polygons mapped using the above rules and it is recommended that this issue is deferred until a later stage of the cliffs inventory timetable. In the immediate future it is best to rely on species and vegetation indicators of salt impact (i.e. significant spray deposition).

Table 4-1 Hard Maritime Cliff and Slopes BAP Priority Habitat (UK-wide applicability)

Components	***Phase 1/Marine Nature Conservation Review***	***NVC***
Cliff top - gentle to flat slopes immediately inland of the cliff slope, extending inland to either the limit of significant spray influence (for cases of semi-natural transitions, usually determined by presence of maritime cliff vegetation) or land enclosure (for abrupt transitions to tillage, improved grassland, gardens or buildings). N.B. excludes lowland heath (except H7) and blanket bog on the cliff top - these should be covered by other HAPs. Cliff tops with a short distance to enclosed land (usually <25 metres) and which have little or no maritime cliff vegetation (e.g. rank neutral grassland, bracken, scrub) should be included to allow its use in management plans.		
Maritime cliff grassland, other unimproved grassland, tall-herb vegetation, bracken and scrub	H8.4 Coastal grassland; H8.5 Coastal heathland (part); B3 Calcareous grassland, B2 Neutral grassland, B1 Acid grassland; C3 Other tall herb and fern - C3.2 Non-ruderal; C1 Bracken; A2 Scrub	MC4, MC5, MC8-MC12, CG1, CG2, CG4, CG6, CG10, H7, MG1, MG5, U4, U16, U20, W25, W21-W24
Perched saltmarsh	H2 - Saltmarsh: H2.4 Scattered plants, H2.6 Dense/continuous	SM16, SM18
Perched sand dunes	H6 - Sand dune: H6.4 Dune slack, H6.5 Dune grassland, H6.6 Dune heath, H6.7 Dune scrub, H6.8 Open dune	SD4 - SD19, H11
Guano-affected plateau vegetation of offshore islands with good seabird populations		MC6, MC7
Flushes and running water within maritime cliff grassland, perched saltmarsh and perched sand dunes	E2 Flush and spring, G2 Running water	M6, M10, M13, M27, M28, M35, M37
Cliff slope - generally steep to vertical slopes above littoral zone, ascending to cliff-top. Landslips rare and uncommon. Spray-influenced components often extensive but varied exposure and aspect conditions allow many other sub-habitats to develop. N.B. Scrub and woodland developed on tall, sheltered cliffs and beyond the influence of salt spray be excluded - these are better covered by other HAPs.		
Lichen-covered rock of splash and spray zone	H8.1 Maritime hard cliff MNCR Biotopes: LRK.VER Littoral fringe rock with ***Verrucaria maura*** LRK.PRA Nitrate-enriched supralittoral and littoral fringe rock with ***Prasiola stipitata*** LRK.YG Supralittoral rock with yellow and grey lichens (e.g. ***Caloplaca marina***, ***Xanthoria parietina***, ***Lecanora*** spp.)	
Sea Caves	H8.1 Maritime hard cliff	
Unvegetated crevices and ledges	H8.1 Maritime hard cliff	
Vegetated crevices and ledges, including bird-influenced examples	H8.3 Crevice and ledge vegetation	MC1-MC4, MC6, MC7
Guano-affected vegetation on slopes with soil		MC6, MC7

Components	***Phase 1/Marine Nature Conservation Review***	***NVC***
Maritime cliff grassland; other unimproved grassland; heath; tall-herb vegetation, bracken and scrub	H8.4 Coastal grassland; B3 Calcareous grassland, B2 Neutral grassland, B1 Acid grassland; H8.5 Coastal heathland, C3 Other tall herb and fern - C3.2 Non-ruderal, C1 Bracken; A2 Scrub	MC4, MC5, MC8-MC12; CG1, CG2, CG4, CG6, CG10, H4-H8, MG1, MG5, U4; H10; U16; U20, W25; W21-W24
Climbing dunes	H6 - Sand dune: H6.4 Dune slack, H6.5 Dune grassland, H6.6 Dune heath, H6.7 Dune scrub, H6.8 Open dune	SD2-SD19, H11
Perched saltmarsh	H2 - Saltmarsh: H2.4 Scattered plants, H2.6 Dense/continuous	SM16, SM18
Coastal vegetated shingle	H3 Shingle/gravel above high-tide mark	SD1
Raised beaches, raised stacks and raised arches at cliff foot		Uncertain - wide range of unimproved grassland and mire types
Flushes and springs, running water	E2 Flush and spring, G2 Running water	M6, M10, M13, M27, M28, M35, M37
Strandline	H5 Strandline vegetation	SD1-SD3
Coast protection works (if present)	Not included in Phase 1 system but suggest identify types present (e.g. groynes, rock armour, cliff drainage)	

4.7 Soft cliffs

4.7.1 The implications of different rock type and geological structures

The rapid rate of cliff retreat for many soft cliff sites is due to the unconsolidated nature of much cliff material (e.g. glacial till at Holderness, East Yorkshire, and North Norfolk) or unstable geological structures such as seaward dipping shales with permeable caprock, as in parts of North Yorkshire. Chalk and other soft limestone strata are best considered as soft cliff types because they are prone to mass failure due to cliff undercutting, particularly if softer rocks beneath the limestone are also exposed. Contrasting soft rock combinations are also found on some cliffs, such as the slowly retreating chalk of Flamborough Head capped with boulder clay which is prone to more regular mass movement, developing distinctive upper slope concavities with narrow intervening sloping ridges. These differences in rock type and structure produce a range of retreat rates that can have an influence on land use inland. Very rapid erosion forces abandonment of land and a vegetation succession to rank grassland is possible before the cliff top edge is eroded. Elsewhere, on cliffs with a slower rate of retreat inland, farmers still cultivate as close as safely possible to a retreating cliff edge and an arable crop or improved grassland extends inland. The latter situation is probably the commonest.

4.7.2 The character of soft cliff vegetation

Soft cliff vegetation types are characterised by successional variation. In the larger systems, with massive slope failure as stepped rotational slides, a very wide range of soil bedrock, moisture, slope aspect and slope exposure conditions are created. Early successions occur rapidly and vegetation often diverges according to drainage, with wet and dry sequences occurring. Over a long period of time, sheltered and moist areas at the rear of individual slides can develop into mature woodland if little further slope instability occurs. Vegetation on the cliff slope of soft cliffs is therefore a space-time mosaic complex potentially involving very different sub-habitat types (see Table 4.2). It is essential to retain all these sub-habitats within the soft maritime cliff and slopes HAP, rather than allocating some (such as mature woodland) to other priority HAPs.

4.7.3 Boundaries and the vegetation sequence inland from the top of the cliff slope

On soft cliff sectors there is often only a limited or even no significant salt spray impact on cliff top habitats. This is mainly due to their geographical location on the Channel and North Sea coasts of England. Here, the predominant wind is often parallel with the coast or offshore. Onshore gales are uncommon, with little heavy spray generation for any significant time. As a result, spray-affected vegetation is confined to the very edge of the cliff top. There is usually a clear delimitation between the cliff slope face and the cliff top. The top might have a very narrow band of maritime grassland or, for southern calcareous bedrock, the distinctive MC4 ***Brassica oleracea*** maritime cliff-ledge community (e.g. very prominent east of Kimmeridge in Dorset). The interior is usually agricultural land but housing, gardens and recreational land can also occur. Away from the very edge of the cliff top, an arbitrary distance will be needed inland of the active slope process zone. The inner line should also not be fixed and it should be accepted that the inner boundary line will retreat inland as the cliff recedes.

Table 4-2 Soft Maritime Cliff and Slopes BAP Priority Habitat (UK-wide applicability)

Components	***Phase 1***	***NVC/Phase 2***
Cliff top - gentle to flat slopes immediately inland of the cliff slope, generally extending inland to the limit of the active cliff process zone, perhaps with a short additional arbitrary width to allow for safety and management purposes. The inner boundary will move over time as the cliff retreats inland. Abandoned cliff top which was formerly arable or improved grassland may have a succession to rank grassland or scrub. Significant salt spray influence is often absent. Cliff tops with such a succession should be included to allow its use in management of the eroding soft cliffs		
Abandoned ground (semi-natural vegetation, improved grassland, scrub, woodland, buildings, gardens, roads)	Many Phase 1 habitat types are possible	Usually MG1, U4, U20, W25, W21-W24
Cliff slope - generally steep to vertical slopes above littoral zone, ascending to cliff-top. Evidence of landslips common to extensive, with bare ground common. Open surface extent varied, depending on speed of cliff retreat and speed of vegetation succession in colonising bare soil. Long-term successions in areas with little mass movement can support woodland. Highly varied soil moisture content, with dry to very wet conditions occurring over very short distances. Spray-influenced vegetation often rare. Marine sorting of sediment at cliff foot can create small areas of shingle and dune, with some sand blown on to cliff face (extents very small compared to climbing dunes on some hard cliff systems).		
Mud and clay with <10% vegetation cover	H8.2 maritime soft cliff	
Early-succession vegetation on drier ground	J1.3 Ephemeral/short perennial is perhaps closest but no Phase 1 category adequately describes the successional character of this ground	***Tussilago farfara, Agrostis stolonifera - Tussilago farfara, Holcus lanatus, Ononis repens-Daucus carota-Holcus lanatus, Rumex acetosella-Ulex europaeus*** grassland not described in National Vegetation Classification
Early succession vegetation on wetter ground	G1 Standing water, F1 Swamp	A5, A9, ***Phragmites australis, Phragmites australis-Calamagrostis epigejos - Equisetum telmateia, Phragmites australis - Equisetum telmateia*** pioneer wetland types not described in National Vegetation Classification, OV18
Late succession vegetation on drier ground	Many Phase 1 habitat types are possible: H8.4 Coastal grassland, drier types of acidic (B1), neutral (B2) and calcareous (B3) grassland, scrub (A2) and woodland A1.1.1	MC5, MC8, MC9, MC11, H2, H11, CG1, CG2, U1, MG1, MG5, MG6, MG7, W21-W24, W10, W12
Late succession vegetation on wetter ground	G1 Standing water, F1 Swamp, B5 Marsh/Marshy grassland, A2 Scrub, A1.1.1 Semi-natural broadleaved woodland	A5, A9, S19, S4, S25, M22, MG9, MG11, MG12, W1, W2
Dunes at cliff-foot	H6 - Sand dune	SD10
Coastal vegetated shingle	H3 Shingle/gravel above high-tide mark	SD1, other NVC and non-NVC vegetation on shingle
Strandline	H5 Strandline vegetation	SM28
Coast protection works (if present)	Not included in Phase 1 system but suggest identify types present in other coastal protection surveys (e.g. MAFF categories of groynes, rock armour, cliff drainage, etc.)	

4.8 Possible other habitats within the maritime cliff zone

The definitions of hard and soft maritime cliffs can include habitats which have their own HAPs. Soft cliffs on relatively sheltered coasts can have a very wide range of habitats, from woodland to swamp, most of which are not maritime in character. There are three occasional types of other maritime habitat which can occur in association with exposed hard cliff conditions:

- ***coastal sand dunes*** as banked masses of sand blown up and sometimes over a cliff slope. Such climbing dunes are usually developed at the rear of a dune system fronting cliffs, usually on a transition from cliff to dune along the coastline (e.g. Gwithian and Godrevy Towans, Cornwall and many locations in western and northern Scotland, including machair vegetation in many places). The coastal sand dune habitat should be easily separated from cliff by taking a line along the break of slope at the base of the cliff. Large climbing dunes are largely confined to hard cliff coasts. Small ephemeral cliff foot systems do develop on soft cliff, usually as a narrow band of embryo and semi-fixed dune in sectors where wave sorting of collapsed cliff material brings sand ashore (e.g. Isle of Wight soft cliff coast).
- ***perched coastal saltmarsh***, with saltmarsh species such as ***Glaux maritima*** and ***Juncus gerardii*** maintained by regular sea spray deposition above the normal upper tidal limit. Extent is very variable, e.g. in very small quantities such as in the Moray Firth of Scotland as a narrow patchily-present zone above boulder storm beaches and below cliffed areas inland, through to more extensive areas of at most a few hectares on regularly spray-soaked ground inland from low to moderately high exposed cliffs, such as at Eshaness or the Northmavine coast of Shetland). This habitat is probably confined to hard cliff coast.
- ***vegetated shingle*** accumulating in small, often shallow embayments of the cliff slope, at the head of wide geos, or on shingle fronting cliff (e.g. Benacre Broad, Suffolk). This habitat can be found on both hard and soft cliff shorelines.

These types should be captured within the maritime cliff and slope HAP boundary, separating them carefully from any immediately adjacent cases of larger dune, saltmarsh or shingle systems which require inclusion in separate HAPs.

4.9 Summary and recommendations

This section proposes a definition of maritime cliff and slope suitable for use in survey work for the rapid demarcation of habitat representing these maritime conditions. It aims to permit an evaluation of the extent and quality of this resource in England and elsewhere on the British coast. The primary role of the definition is to enable the consistent delimitation of all ground within the maritime cliff and slope type, particularly the inner boundary of such ground. The different nature of hard and soft cliffs requires separate sets of attributes and rules for fixing the inland limit of the habitat. On hard coasts the limit of visible saline influence is taken, separating maritime cliff top from other conditions (perhaps including terrestrial Priority Habitats). On soft coasts the limit of current or recent instability is suggested. The limit of land enclosure is suggested for narrow strips of cliff top on coast with intensive agriculture or development.

Mapping of the maritime cliff and slope boundary will create a 'macro' polygon which would form the core spatial units in an inventory database, each of which could be populated with

additional information on nature conservation interest (e.g. breeding seabirds, invertebrates, NVC polygons). Once surveyed, the total area and sea frontage length of 'macro' polygons should be calculated to give accurate national statistics for this habitat.

The following recommendations are made on the application of the definitions:

1. Detailed inventory work (e.g. NVC survey) should not be undertaken until the spatial limits of the maritime cliff and slope habitat have been decided for a local stretch of coast.

2. Delimiting of 'macro' polygon boundaries should be preceded by a short phase of sample work by experienced NVC maritime cliff surveyors, constructing generalised zonation diagrams for regional sections of coast, stratified in terms of major rock types and exposure conditions. These should be written up as guidance for surveyors who would actually map 'macro' polygon boundaries. The regional sets of zonation diagrams for all of the English coast should be collated as an initial review of vegetation in maritime cliff and slope habitat.

3. The inland limit of 'macro' polygons is always likely to be difficult to locate with precision. The present guidelines within the definition should be reviewed and modified on the basis of experience.

4. The definition concentrates on readily identified vegetation types and other sub-habitats but the limit of salt deposition may well extend further inland, especially on hard cliff coasts exposed to strong prevailing winds. There is probably a need to model salt deposition to consider the accuracy of boundaries which are largely determined by heavy salt spray effects. A model would also enable an estimate of habitat loss to agriculture and other development, as well as assisting with locating areas where maritime cliff top vegetation could be re-established (e.g. on abandoned agricultural land).

5. Phase II: Evaluation of survey and GIS methodology

5.1 Introduction

The Brief requires that an assessment be made of the methodologies used for vegetation classification of maritime cliffs and slopes. In particular, the Isle of Wight and Lizard Peninsula NVC surveys provide the main focus for this assessment. A methodology is proposed for the integration of the survey data into a GIS-based data management system that would allow the transfer of data to RECORDER 2000. Consideration is also given to an accompanying database to hold data on each habitat polygon.

The first section examines the field survey methodologies that have been utilised for the mapping of maritime cliff and slope NVC communities on the Isle of Wight, Dorset coast and the Lizard Peninsula. Detailed analysis between the reports has been carried out to determine the variation between the methodologies and NVC maps produced by the three different workers.

On the basis of the information content and data quality within these sample surveys a number of criteria have been examined to determine the ease and accuracy of integrating paper based NVC community maps into a GIS system. The results are presented.

From this assessment Section 6 presents an outline specification for future survey standards and procedures and for survey data management through GIS/database.

5.2 Study Areas and dataset description – Lizard Peninsula, Isle of Wight and Dorset

Three surveys have been selected for additional assessment within Phase II of the programme, the development of a methodology and GIS/database structure. These are:

- Isle of Wight (soft cliff geology)
- Lizard (hard cliff - acid)
- Dorset (hard limestone - basic)

The Dorset sites (Edwards 1998a, 1998b) have not been taken through the whole digitisation process here, but is included as an additional source evaluated for the parameters that might be included, based on the high quality of survey and mapping achieved. The survey has been assessed in broader terms of the applied survey methodology given the very complete nature of the records for this site.

5.2.1 Isle of Wight

J. Cox (IoW, 1997) carried out a NVC survey on the Isle of Wight soft rock cliffs in 1997 at a number of locations round the Island. These sites, which covered 41 km of the IoW coast, are mapped in plan and is illustrated in Appendix 9. The survey was conducted as a direct response to the identification of the requirement for survey within the Isle of Wight Shoreline Management Plan; but also as a contribution to the development of the maritime SACs.

Two areas, Whale Chine to St Catherine's Point (W-StC 1-112) and Compton Chine to Nodes (CC-N 1-99) have been selected and integrated into this study. These provide a range of cliff structures and NVC communities.

This survey records a full methodology and details of resources and manpower costs. On foot reconnaissance was made in conjunction with oblique photographs to determine descent routes to ledges and under-cliff. A botanist accessed the cliffs by roped abseil descents from the cliff-top. From roped descents, the cliffs and slopes have been mapped at Phase 1 and 2, using NVC communities and target notes on particular species, with some indication of the geology. The final mapping was carried out onto 1:10,000 scale Ordnance Survey maps by ascribing each area with the survey number and colour coding the community with confidence and abundance.

TableFit was used to assist in the identification of NVC communities. Community confidence of <50% and confidence >50% are indicated on the original mapping of NVC communities (Appendix 11 and within the Digital representation, Appendix 12).

Samples of the data recording formats, keys and records are appended.

- Appendix 10 - data sheet for surveys 72 & 73 for Whale Chine to St Catherine's.
- Appendix 11& 12 - The original and the digital interpretation of NVC communities for Whale Chine to St Catherine's Point.

5.2.2 Lizard

The NVC survey carried out by Perks and Longbottom (1991) on the Lizard Peninsula during the summer of 1991 provides only limited details of the survey methodology. Each site was surveyed utilising quadrats and a NVC community class determined for each homogeneous area.

This area within the Lizard was also covered by the NVC based survey undertaken by Liz Cooper 1987. The degree of similarity in results has not been assessed at this stage, but would be relevant to use of data for habitat/community change analysis.

The original survey maps, which included overlays of community classifications and which show the distribution of quadrats, have been severely damaged by rodents, but the final collated map of NVC communities still exists in A4 extract sections.

Samples of the data recording formats, keys and records are appended.

- Appendix 13 NVC Record Sheet for Site 23.
- Appendix 14 Mapped NVC extract survey adjacent to the Lizard Lighthouse.

5.2.3 Dorset

The NVC survey and mapping conducted for Dorset (Edwards 1998) has provided an NVC classification of St Albans Head to Durlston Head cSAC and Portland to Studland Cliffs cSAC areas. The survey concentrates on the cliff top vegetation on limestone and chalk geologies and does not cover the cliff slope and merges with landward communities within land parcels (cliff top fields).

Survey maps were produced at 1;10,000 based on field survey during June and July 1998. Areas were surveyed primarily using 2 x 2 m quadrats together with environmental data including: slope, aspect and sward height. Data were recorded using grassland inventory cards or (Dorset Environmental Record Centre (DERC) NVC habitat cards on maritime slope areas. Nationally or locally rare species were plotted and a compartment species list generated.

NVC communities were checked through MATCH and community tables compiled and final maps produced at 1:10,000 scale with the aid of the rough field boundaries and aerial photographs.

Table 5.1 identifies some of the key parameters in establishing a robust spatial data model and the difficulties experienced in handling these datasets within the sample areas. These issues may direct the approach taken to the field survey, post-survey processing and data management (GIS and database), based on the three sample surveys. The consideration of the technical survey and mapping requirements has considered other datasets collated within the inventory and wider advice on data structures, formats and standards provided by English Nature GIS unit.

Table 5-1 Potential parameters for a standard NVC mapping methodology

Parameter	***IOW***	***Lizard***	***Dorset***
All sections of report available, mapping and datasheets	✓	✗	✓
Complete methodology provided	✓	✗	✓
Mapping scale correct to enable clear delineation of boundaries	✗	✓	✗
Broad homogenous vegetation types mapped	✓	✓	✓
Communities clearly defined by thin lines	✓	✓	✗
NVC codes written on map	✗	✓	✗
NVC communities colour coded on map	✗	✗	✓
NVC confidence colour mapped	✓	✗	✗
Unidentifiable colour codes due to photocopying degradation	✗	N/A	✓
NVC boundaries contiguous with neighbours	✗	✓	✗
NVC boundaries all closed	✗	✗	
Area (ha) provided for each NVC community	✗	✗	✓
Mapped polygons linked to field survey sheet	✓	✗	✓
Field sheets provide community mosaic structure	✓	✓	
Mosaic communities indicated/mapped	✗	✗	✗
Non-vegetated areas delimited	✗	✗	✗
All areas of maritime cliff and slope surveyed	✗	✗	✗
Mapping of communities beyond MC	✓	✓	✓
MC sub-communities indicated	✓	✓	✓

The data sources show enormous variations at all levels. This ranges from fundamental problems of the maps being missing with no further copies being available. More specifically it has been found in all cases that areas of the study remain unsurveyed. This may indicate that these areas are unvegetated or that these sites were inaccessible. No attempt has been made to use other classifications (e.g. Phase 1 habitats, MNCR biotopes) to map unvegetated ground on hard cliffs in the Lizard and Dorset examples. The delineation of habitat boundaries also appears to be very different by the three workers. The Isle of Wight study indicates that the maritime cliff vegetation is composed of a very complex mosaic of NVC communities, which contain in their midst pioneer species and unclassifiable communities. No attempt has been made in the other surveys to provide this information,

indicating that the Dorset and Lizard maritime cliffs have clearly recognised NVC types and lack early succession conditions due to their hard cliff character.

The paper based NVC mapping is variable. The boundary delimitation ranges from very thick lines to precise boundaries on OS base maps. Often the linework does not faithfully map to underlying map features making the translation to a digital format difficult to assess.

Community boundaries have been found to be open or confused when there are islands of a different type within a community as enclaves within larger site NVC classifications. Not all closed boundaries delineated on the maps were found to contain NVC community codes; with no explanation as to whether attribution was impossible or whether the mapping was in error. In other cases more than one NVC code is ascribed, and these are discussed later in this section.

5.3 Data processing and outputs

5.3.1 Processing

MapInfo has been utilised for the handling of GIS associated data within this Brief. Data are held within Browser tables rather than in separate databases.

A number of digital data has been supplied from English Nature for this project which include:

- Boundary-Line – MHWM for the coastline of England, Wales and Scotland. This was requested as the basis for mapping the extent of the shoreline, although the files supplied were a post-processed version.
- 1:10,000 Ordnance Survey Raster for the Isle of Wight and Lizard Peninsula – black and white
- 1:50,000 Ordnance Survey Raster for England – black and white

These data appear not to tile precisely, indicating that these perhaps are one of the older products of Ordnance Survey.

5.4 Methodology of incorporation of paper based habitat boundaries into a GIS Format

The original maps (or copies of these) were digitised into the GIS using heads-up digitising of scanned maps. The scans were undertaken at 200 dpi at 24 bit colour, which provides sufficient resolution and colour match to accurately use these datasets within MapInfo. These have been geo-rectified using control points, keeping the error within prescribed limits and collecting sufficient nodes to faithfully reflect the linework on the original maps. The habitat boundaries were traced on screen, to produce a new vector map layer of closed polygons.

It was not found necessary to deskew or warp the images, as the registration was seen to be good with a high level of correspondence between the scanned and registered maps, however this may be necessary with larger format maps or more distorted originals.

The survey produced closed polygons of habitat boundaries directly onto the underlying Ordnance Survey maps. These polygons have been attributed with the NVC communities. Where target notes and quadrat locations have been recorded within the survey these have been captured as points.

5.5 Basemap data and their limitations

The NVC surveys for the Lizard Peninsula, Dorset and the Isle of Wight have illustrated a number of limitations when attempting to digitally capture map-based data.

- Ordnance Survey paper-based maps utilised were at a variety of scales and within the surveys these have been reproduced and re-scaled making accurate scanning and registration problematic. Appropriate deskewing and georectification should be applied to reduce mis-registration.
- Overlays of boundaries have been produced and recombined with OS base maps with the consequence of some mis-registration of the images.
- Complex mosaics of ephemeral and transitional vegetation communities commonly associated with maritime cliffs and slopes, particularly on soft cliff systems.

Table 5.2 illustrates the variations encountered. Both the Dorset and Lizard surveys portray that one NVC community is associated with one closed polygon. The summary data from the Dorset surveys suggest that there are indeed more than one NVC community per closed polygon, but fails to provide an indication of their locations. The Isle of Wight surveys indicate a very complex picture, with the cliff and maritime slopes being composed of a complex mosaic of transient communities that are not mapped, being only portrayed as occurring within homogeneous vegetation types.

Table 5-2 Map-based NVC community representation

	NVC Community	***% cover***	***NVC Community***	***% cover***	***NVC Community***	***% cover***
IOW Survey J. Cox						
Whale Chine – St Catherines Site 75	MC11b	55%	Pioneer species	? - 45%		
Whale Chine – St Catherines Site 70	MC11	42%	S4a		A5	62%
Whale Chine – St Catherines Site 71	W21c	64%				
Dorset NVC Survey B. Edwards						
Portland-Studland Cliffs Rings Hill Quadrat 15	CG4a/b					
Portland-Studland Cliffs Newland Warren Quadrat 1	MG6/7					
Portland-Studland Cliffs Lulworth Cove – Mupe 6	MC11					
Lizard Survey						
	MC8f					

When more than one NVC code is associated with one closed polygon, this may be depicted in a GIS by a number of mechanisms, which are illustrated in Table 5. A layer may be generated for associated NVC code which means that in the example given in Table 5.3,

two maps would have to be produced; the first would be of the dominant MC1 community and the second the W2 secondary community. Alternatively, a code may be given which represents the combination of MC1 and W2. The dominant community could still be represented, but the order would have to carry a meaning. For example, MC1/W2 would mean that MC1 occurred in equal proportions or was dominant to W2, whereas W2/MC1 would indicate that W2 was dominant or occurred in equal proportions to MC1. The preferred methodology would enable all the NVC communities to be displayed.

Table 5-3 Method of representation of polygons with more than one ascribed NVC community

	MC1 60%	***MC8 40%***	***MC1 & MC8***
Field 1	✓		
Field 2		✓	
Field 3			✓

This model assumes that the data is not held within a database, but rather within browser tables within MapInfo. Similar approaches have been taken previously within saltmarsh mapping (Dargie 1999) where habitat mosaics were distinguished within a single polygon. Here the browser tables recorded the full combination of NVC community elements and approximate percentage cover. There is no realistic way that these can be represented within the GIS using unique depiction, as there would be too many potential habitat classes.

In addition to the whole class of any polygon, the hierarchical classification is able to ascribe the dominant community class and use this as the representation of the cover. Sub-classes can be portrayed as thematic overlays. This approach still delivers multiple class structures that may not be helpful when the survey is designed to also consider the representation of broad habitats. The fitting of the complex mosaics to a dominant NVC cover class seems inevitable at least in cartographic terms even if it is a coarse representation of the cliff vegetation.

5.6 NVC colour code designation

There are currently no ascribed standard colour categories for NVC communities, which is in contrast to a standard set for Littoral, Infralittoral and Circalittoral communities in Phase 1 habitat survey and the Marine Nature Conservation Review (Connor ***et al.*** (1977) Marine biotope classification for Britain and Ireland).

Standard NVC colour codes are a proposed requirement by English Nature. A tentative colour key has been developed and used here for maritime cliff, mesotrophic grassland and chalk grassland communities occurring within the communities encountered within the sample areas. The numerous NVC communities and sub-communities are not easy to represent cartographically. The approach adopted is to use hatching to identify a community type with a community class identified by the use of background colour. No attempt has been made to devise a structure to incorporate sub-communities classes. The ability to represent the categories also relies on the data structure adopted within the spatial database, with the requirement for flexible recording of the categories and query of multiple classifications.

Whilst the tentative colour key is proposed for the NVC communities it may be better to consider this more broadly for all NVC communities if there is a desire to achieve some form of national standard. A provisional colour key is included in Appendix 8.

5.7 Summary of difficulties using existing paper map sources

A large number of difficulties have been found in attempting to adapt existing paper information into a digital format held by GIS. There is no mapping standard for NVC survey or the other survey types examined within the survey evaluation. Many of the problems stem from ***ad hoc*** procedures used for only one or a few surveys. Without rope descents, maritime cliff surveys are always likely to have areas, which are unmapped or only covered sketchily, resulting in gaps in the coverage. Often these areas of inaccessible land may be mapped to NVC based on appearance at a distance/ through binoculars. Although this may be considered to be sub-optimal it may be the only pragmatic approach achievable in some circumstances.

In other respects NVC survey (especially on the cliff top) should be no more difficult than other habitats. It is therefore important to propose and maintain a sound NVC mapping and data standard. Suggestions for this are given in the next sub-section, with fuller discussion in section 6.

5.8 New vegetation surveys for the MCS inventory

Over the past few years there has been a steady increase in the standards demanded of surveyors within briefs issued for survey contracts. As a result, survey and data capture methods are well specified. As an example of a recent brief, the following details are probably close to what should be applied to future surveys to ensure that all field and data capture work is done efficiently and to a high standard. These methods should be applied to variation within the macro-polygons identified in a first stage of habitat recognition (see section 4).

6. Specification for Field Survey and Data Management

6.1 Introduction

The habitat definition in section 4 and review in section 5 of the previous field methodologies and subsequent data management provide the perspective, and in some instances best practice, for any new surveys of maritime cliff and slope habitats. The principle of the specification of new inventory survey is that they apply only to ground within macro-polygons delimiting maritime cliff and slope habitat, conform as closely as possible to NVC format but use other classifications for unvegetated habitat, and adopt a digital data handling strategy for both the spatial and species recording.

This assessment shows that most existing mapping of cliff surveys has been undertaken at a scale of 1:10,000. Often the basemaps on which mapping has been conducted has been somewhat out of date, and often considerably so where the cliff is subject to mass movement and rapid cliff-foot retreat. Such mismatch of the underlying data to the survey data is often hard to resolve and rarely is there the scope for new physical survey. This results at best in the misrepresentation of the areas of habitat based on changes in slope, and at worst on a wholly incorrect mapping of habitats, forced to fit the historic base data rather than the current topographic position.

6.2 Proposed survey and data management specification

It is proposed that surveys should be carried out in two stages. In the first, macro-polygons should be delimited using the habitat definitions in section 4 for hard and soft cliff. The inner edge of the maritime cliff and slope habitat will often be difficult to map on hard cliffs and a consistent application of the definitions will be required to avoid overlap with other habitat types such as lowland heath and various grasslands. Experienced maritime cliff and slope surveyors should be used to provide macro-polygon boundaries and this phase should also develop generalised diagrams and accounts showing two types of vegetation sequence. First, on hard cliffs, the changes found on declining spray gradients inland should be recorded in relation to soil variation and grazing. Second, on soft cliffs, the vegetation types associated with rock type, soil variability and successional stage should be illustrated. These generalised accounts of vegetation should be developed on a regional basis and used later to seek wider-scale patterns in maritime cliff and slope habitats.

In the second stage, sub-habitats within macro-polygons should be mapped to a high standard. Phase 1 habitat codes (or MNCR biotope codes for supralittoral and littoral fringe conditions) should be used for unvegetated ground. For vegetated ground surveys should be to NVC standards, but with some modification for very active soft cliffs where complex early succession mosaics occur in very close proximity. The relevant chapters of the NVC will provide the framework for most of the community definitions. Much of the vegetation on hard cliffs will be covered in the NVC maritime vegetation volume (Rodwell 2000) but for other vegetation types including grasslands or swamp communities it will be necessary to refer to other NVC volumes. The field methodology outlined in Rodwell (2000) should be followed as closely as possible. At each sub-site, all homogeneous stands of vegetation should be identified and described to NVC sub-community level whenever possible. Intermediate categories should only be used in exceptional circumstances. A decision on the mapping effort of especially dynamic sites will need to be made on a site-by-site basis, as change is

likely to alter the vegetation types frequently. Where community dynamics may, in itself be a particular research objective, a higher effort and more frequent survey may be desirable.

Survey results in a number of separate data formats and consequently a number of digital data formats: These are:

Survey feature	***Data type***
Habitat areas	polygon and attributes
Photographic	raster image
Quadrat Sites	point and attributes
Target Notes	point and attributes
Quadrat records	textual

The vegetation should be mapped in the field using one of two techniques. In the first, basemaps can be printed of OS Land-Line® digital data to a scale of 1:2500 (occasionally 1:1250) and vegetation mapped on to these as thicker, clear lines. The positioning of boundaries should where possible use differential GPS to aid accuracy. The second technique is to use a field computer equipped with GIS and a differential GPS receiver. The OS Land-Line® data can be downloaded in advance and vegetation boundaries can be snapped to these lines if they coincide. The GPS can be used to mark in boundaries that are not present in the downloaded OS data. In both techniques it is essential that each polygon recorded be checked for closure.

The polygon-based data from Ordnance Survey, the Digital National Framework (DNF) data, which is due for release in November 2001, may influence the way that data is handled. A Topographic Identifier (TOID- a 16digit identifier) is assigned to each land parcel (which includes the vegetation divisions mapped by OS) and attribute information may be associated (within a database) against the TOID reference number. Although these parcel boundaries may not match to all habitat boundaries the same approach as built for DNF may be adopted to hold additional lines that break DNF polygons and attributes (of NVC code/s and environmental variables) may be assigned to the TOID.

Vegetation mosaics will be important features of many sites and should be recorded as a string of mosaic components, including an estimate of the relative proportions of the component (sub-)communities and any unvegetated ground. An example of such a string might be MC1 (5) + MC8a (10) + LRKYG(85), representing a mix of MC1 (5% cover), MC8a (10% cover) and supralittoral rock with yellow and grey lichens (85% cover).

Sufficient samples (usually at least 5) should be recorded for each sub-community on each site and further samples should be collected wherever difficulties with the NVC placement are encountered, or for large and/or variable stands. Additional samples should also be taken of restricted communities of high conservation interest and where significant changes in land management are apparent. Stands of scrub, sand dune, vegetated shingle, grassland or swamp vegetation occurring in intimate association with maritime cliff and slope communities should be sampled and mapped, with target notes. Any evidence of invertebrate interest should also be noted, particularly in areas of soft cliffs which are now known to be of great importance for several BAP and many other nationally rare species (see section 3).

A quadrat size of 2m x 2m (or equivalent area on restricted, e.g. narrow, vegetation stands) should generally be used. Holder (2000) used 10x10m on scrub, 4x4m on rock crevice communities and 2x2m on maritime grassland and therophyte communities. The sample areas were modified where the stands were too small to accommodate square quadrats. Similar flexibility of the sampling framework may be necessary in such cliff locations.

The cover abundance of every taxon of vascular plant, bryophyte, lichen should be recorded using the Domin scale, with cover assessed by eye as a vertical projection on the ground of the live, above-ground parts of the plants in the quadrat. Where the vegetation is obviously layered the species within the different strata should be listed separately as part of the same sample. A record should also be made of the total cover and height of the layers together with the cover of any bare soil, peat, litter, rock or open water.

Vascular plant species additional to those recorded in the quadrat samples in each stand type should be listed and all recorded species should be assigned a measure of frequency/cover using a standardised DAFOR scale.

Each sample should be numbered and its location marked on the vegetation map and noted using a site name and full grid reference and documented on a standard NVC sample card.

Details of vegetation structure and microhabitats may assist in the assessment of sites for their potential invertebrate fauna. Features such as flushes, stream outflows, pools/ saltpans, old embankments, shingle/sand ridges, rock armour and other coastal protection should be noted and marked on the map.

Indications of biotic effects, especially land use factors including - grazing, dunging, browsing, trampling, mowing, burning, past cultivation or settlement patterns, or amenity use should be recorded. Effort should be made to ascertain the influence of such factors, both from ground observations and during any contacts with landowners or occupiers. Additionally, aspect, slope and soil variables may be recorded. Such records are likely to best be captured as target notes.

6.3 Specification for Digitising

Macro-polygons recording the boundary of all maritime cliff and slope habitat should be developed as a separate data base to NVC. These should be recorded as accurately as possible in the field using either basemaps printed from OS digital products (Land-Line or its forthcoming replacement), or captured in the field using a computer equipped with GIS, differential GPS and downloaded OS digital data. Each macro-polygon should be assigned a unique site code that will be used in recording habitat sub-polygons present within the macro-polygon boundary. Aerial photographic interpretation (or orthorectified images) may assist in the delineation of community boundaries.

The following are specifications apply to surveys undertaken within each macro-polygon. They assume National Vegetation Classification (NVC) and other survey information (or new maritime cliff and slope surveys) has been captured on paper maps into a digital format that can be used by English Nature's Geographical Information System (GIS). If habitat boundaries are captured in the field using GPS in conjunction with GIS (see 6.2 above), the paper map data capture phase is redundant. This digital format incorporates a number of

elements; the spatial extent of the habitats, specific features and quadrat locations and the details of the quadrat records.

6.3.1 Quadrat record database

A database recording format has not been defined in detail for the recording of quadrat survey data and species recording. This would need to be a relational database model, such as that adopted by Recorder 2000, although a fuller assessment of the specific requirements of cliff survey data and reporting would be needed to define an appropriate specification.

Whilst the spatial data object fundamental level proposed is the polygon_ID within the database the survey_ID (or equivalent field) would be the fundamental unit (object) allowing for many surveys within a single polygon_ID area. If Recorder 2000 is to be used as the quadrat recording platform there is a further need to extend its functionality to either integrate with GIS, or export to other GIS. Alternatively other databases (e.g. MS Access) may be linked directly to GIS packages such as MapInfo. The Recorder database is currently unsuitable for the depiction of the spatial characteristics of NVC surveys.

The Recorder 2000 data recording has a number of benefits:

- links to wider NBN recording;
- data standards and taxon dictionaries;
- sophisticated low cost package;
- supported via resellers.

However, there is currently limited GIS functionality and lack of direct compatibility with English Nature / LRC GIS systems. This limits the ability to use Recorder as part of an analytical GIS to support later stages of the Phase III evaluation of coverage, and further consideration should be given to the recording formats. If a fully integrated (bespoke GIS/database) application were adopted the full functional design specification would be needed.

6.3.2 Baseline topographic data

Land-Line® is the preferred base map scale for mapping and is part of the Service Level Agreement (SLA) between OS and English Nature, permitting the use by English Nature and its contractors.

This scale is generally at 1:2,500 in rural areas and 1:10,000 in mountain areas. Rarely, coastal cliffs will be mapped at 1:1,250 “urban” scale.

It is also recognised that there is a limit to the contextual data available from the Land-Line® vector datasets, with no contours, which are often a useful indicator of slope and habitat boundaries. The 1:10,000 black and white rasters also do not show the contours so the best available scale of OS product available within English Nature is LandForm PANORAMA 1:50,000 derived height data available in digital format. LandForm PROFILE, which is height data derived at 1:10,000, is not currently within the terms of the SLA.

Land-Line Plus ® data includes additional vegetation boundaries that may assist in the delimitation of the mapped community boundaries. These boundaries include unenclosed vegetational boundaries (such as areas of dense scrub or bracken) and a physical feature such as breaks of slope. The latter may be very valuable in delimiting the habitat areas that are defined by slope characteristics.

6.3.3 Data supplied by English Nature

- Digitised SSSI boundary (digitised to 1:10,000 for England and supplied via Internet).
- Relevant Ordnance Survey Land-Line® vector data at 1:2,500 and 1:1,250 scale, or forthcoming OS equivalent data (see section 6.8) in MapInfo format or NTF.
- Relevant Ordnance Survey 1:10,000 raster maps with MapInfo geo-reference file.

All above data sets should be loaned for the purpose of the survey project only and must be returned or destroyed once digitising is complete.

- Table templates in MapInfo format for each data type as described below. For vegetation data, templates will be supplied for both the mapped NVC features and the mosaic composition information. It is recommended that once English Nature has adopted a template for the NVC that it distributes this to contractors to assist compliance with the system adopted.

6.4 Summary of the data types to be included in the maritime cliff and slope inventory

This section summarises the data sets supplied as part of the spatial data capture. Full survey would also include the quadrat records, that are unlikely to be stored directly within the GIS, but rather in the linked database.

Macro-polygon boundaries: Boundaries delimiting the spatial extent of maritime cliff and slope habitat, captured either from paper maps or in digital format using a field computer

Vegetation data: NVC vegetation boundaries marked on paper maps or captured with a field computer should be represented as a single layer of polygons in MapInfo format. NVC mosaics should be represented as a single polygon with a unique polygon ID. This will then be linked to a secondary table containing the mosaic composition information.

Quadrat data: Quadrat locations marked on the paper maps or captured with a field computer should be represented by a single layer of point data in MapInfo format

Target Note data: Target Note locations marked on the paper maps or captured with a field computer should be represented by a single layer of point data in MapInfo format

6.5 Data Specification

All digitised data should be supplied in MapInfo's (native) format (i.e. *.tab, *.map, *.id, *.dat). MapInfo Version 6

For each of the data types described 2 above, the following specifications apply:

6.5.1 Vegetation data

- Vegetation polygons should be stored as a single MapInfo table, using the table template supplied by English Nature.
- Vegetation polygons should be digitised to register, where appropriate, with detail on the OS Land-Line® base maps (or forthcoming equivalent OS products - see section 6.8)
- Where the vegetation boundary follows the digitised boundary of the SSSI, the SSSI boundary should be followed
- Each vegetation polygon should have a unique record in the MapInfo data table.
- Each record should have the following attributes (the data type for each attribute is shown in brackets):
    - ***site_code*** (character) - each polygon should be attributed with the agreed site code for the site surveyed (probably based on a macro-polygon code);
    - ***poly_ID*** (character)- each polygon should be given a unique alpha-numeric value based on a combination of the site code (31WHJ) and a sequential numeric value for each polygon. Therefore the first polygon will we 31WHJ/1, the next 31WHJ/2, the next 31WHJ/3 etc;
    - ***vegetation_type*** (character) - this represents the NVC coding (e.g. MC8a, H8c, MG5a) or other description of the vegetation and should match the coding given to the vegetation on the paper maps. The exact wording, including upper and lower case, must follow the standard NVC codes agreed for production of paper maps and the project report.

Where vegetation mosaics are present the vegetation type should be entered as ***mosaic***.

Details of the mosaic composition should be recorded in a secondary table, which will contain only text and have no map features. A template for the secondary table will be supplied by English Nature, and will have the following attributes:

- ***poly_ID*** (character) - will match the poly_ID given to the mosaic record in the primary table;
- ***vegetation_type_mosaic*** (character) - the NVC coding for the composite part of the mosaic. The exact wording, including upper and lower case, must follow the standard NVC codes agreed for use on the paper maps and the project report;
- ***percentage*** (integer) - the percentage cover of each component part of the mosaic.

As a mosaic can be made up of many composite vegetation classes, each vegetation class will be recorded as a separate record in the secondary table. For example, if polygon 31WHJ/2 is a mosaic, consisting of 30% MC8a, 20% MC8b, and 50% MC9a, then the secondary table will include 3 records, each with a poly_ID of 31WHJ/2. For each record the

vegetation_type_mosaic and percentage values will reflect the appropriate NVC code and percentage figure which makes up the mosaic. Therefore, the first record the vegetation_type_mosaic will be MC8a and the percentage will be 30, the next record the vegetation_type_mosaic will be MC8b and the percentage 20 etc.

Note: In all instances the summed value of the percentage for each unique Poly_ID in the secondary table will equal 100, which therefore equates to 100% vegetation coverage for that polygon.

6.5.2 Quadrat data

- Quadrat locations should be stored as a single MapInfo table, using the table template supplied by English Nature. They will be shown as point features and should be placed to match their exact location based on survey maps.
- Each record will have the following attributes (the data type for each attribute is shown in brackets):
  - ***quadrat_number*** (character) - each point feature should be assigned its unique quadrat number given to it during the survey.
  - ***site_code*** (character) - each point feature should be attributed with the agreed site code given to the site surveyed (probably based on macro-polygon code).
  - ***quadrat_ID*** (character) - each point feature should be given a unique alpha-numeric value based on a combination of the site code (31WHJ) and a concurrent numeric value for each point. Therefore the first point will be 31WHJ/1, the next 31WHJ/2, the next 31WHJ/3 etc.

6.5.3 Target note data

- Target note locations should be stored as a single MapInfo table, using the table template supplied by English Nature.
- Target note locations should be stored as a single MafInfo table, using the table template supplied by English Nature. They should be shown as point features and should be placed to match their exact location based on survey maps. Each record should have the following attributes (the data type for each attribute is shown in brackets):
  - Target note locations should be stored as a single MapInfo table, using the table template supplied by English Nature;
  - ***site code (***character) - each point feature should be attributed with the agreed site code given tothe site surveyed (probably based on macro-polygon code);
  - ***target ID*** (character) - each point feature should be given a unique alpha-numeric value based on a combination fo the site code (31WHJ) and a concurrent numeric value for each point. There fore the first point will be 31WHJ/1, the next 31WHJ/2 etc;
  - ***target note*** (character) - the target note given for each location should be entered as typed text such that it matches any target notes placed on the paper maps. Note that MapInfo tables will only accept up to 254 characters, therefore the length of the target note must be within this limit.

The target note may be attributed to the polygon_ID through GIS analysis of a point in polygon selection or by directly associating with the polygon_ID rather than the site_code.

6.5.4 Photographs

Site photographs provide a valuable record of the habitat structure and physical status of the site, quadrat etc. The storage of digital photos and their association within the GIS offers a broader spatial data recording strategy for the cliff habitats. The recording of site photos may be considered to be a special case of target note recording, and may be handled in much the same manner (i.e. as a point features in a MapInfo table with the following attributes).

- ***site_code*** (character) - each point feature should be attributed with the agreed site code given to the site surveyed (probably based on macro-polygon code);
- ***poly_ID*** (character) - will match the poly_ID given in which the photograph is taken;
- ***photo_ID*** (character) - each photograph should be attributed with the unique number;
- ***photo_DEG*** (numeric) - each photograph orientation should be recorded based on compass bearing;
- ***target_note*** (character) - the target note given for each photograph should be entered to briefly describe the photographed subject. Note that MapInfo tables will only accept up to 254 characters, therefore the length of the target note must be within this limit.

Digital recording of photographs is preferred based either on digital origination of scanning of 35 mm slides. Resolution for digital origination should be at least 1024 x 768 24 bit images. Higher resolutions should be used where conditions dictate or local detail is required. The specifications will allow a GIS spatial hyperlink (hotlink) between the digital photographic image file.

6.6 Accuracy

6.6.1 Linework

- Where vegetation boundaries follow features on the Land-Line® data (or forthcoming equivalent data - see section 6.8), they should be "snapped" to the Land-Line® data. As such no slivers of unclassified areas between the Land-Line® feature and vegetation boundary should exist.
- Where vegetation boundaries follow the SSSI boundary, they should be "snapped" to the SSSI boundary. Therefore no "daylight" should be visible between the SSSI and vegetation boundaries.
- Where vegetation boundaries do not follow the SSSI boundary or features on the Land-Line® data, the boundary accuracy should be within +/-0.2mm at the scale of the original (hard copy) maps. (NB. 0.2mm at 1:10,000 = 2m at ground scale) There is a limit to the accuracy of the underlying maps and no greater accuracy can be achieved by applying more detailed digitization standards thus a somewhat lower accuracy may be acceptable given the nature of the surveys and basedata survey tolerances.
- All polygons formed by the mapping should be attributed, even if there is an unclassified area, in which case it must be so marked.

6.6.2 Point features

The accuracy of the location of point features should be within +/-0.2mm at the scale of the original (hard copy) maps. Rarely will it be possible to achieve this level of accuracy within the field survey, but digitisation should attempt to accurately record the locations as mapped. Use of GPS at sub metre accuracy provides an alternative method of capturing point data in the field.

6.6.3 Attributes

The accuracy of all attributes within the tables is expected to be 100%

6.7 Products

All data should be supplied in MapInfo (native) format as described above. Vegetation data as a single polygon layer and quadrat and target note data as individual point layers.

Photographs of survey sites should be supplied in a format agreed by EN. As a default these should be at least 1024x 768 24 bit .tif images if in digital format (preferred) or as 35mm slides and mastered onto a CD-ROM. Hotlinks to images will need to point to the CD drive if the photos are to be read direct from CD storage.

6.8 Future developments

This specification is based on the current base datasets and data formats available to English Nature. However, a number of advances in data models and new data sources with potential to enhance the mapping of coastal habitats will need to be considered in the future. The specification should be reviewed in the light of these data sources and modified to take advantage of the advances. The inter-compatibility and comparability of survey methodology should be considered before changes are adopted.

The Ordnance Survey base data forms the basis of both the field mapping and the representation of the area and point data. This mapping is based on information held within the National Topographic Database, which provides the highest resolution, nationally consistent mapping of the country. It is also the base data from which other mapping scales are generated. This data is being updated, particularly in areas where there is little demand for up to date mapping, by the Rural Revision Survey. Coastal and cliffed areas are particular focuses for some of the National Interest mapping tasks.

As noted within section 6.2, development of a new data model by Ordnance Survey, the Digital National Framework (DNF) has profound implications for mapping and especially area-based mapping suitable for habitat depiction. This dataset will introduce unique parcel identifiers called Topographic Identifiers (TOIDS) which will relate to closed polygon boundaries depicting land parcels. This development should greatly enhance the ability to map vegetation classifications at a parcel level and to share datasets; however, where the vegetation boundary divides a polygon additional dividing lines will be needed to subdivide polygons (together with individually ascribed TOIDS). Release of DNF in Autumn 2001 should provide a focus for re-examination and testing of the data handling approaches, especially in relation to the area-based datasets such as land cover mapping.

Ortho-rectified imagery and aerial photos offer additional capacity to map the boundaries of NVC communities and habitat boundaries along coastal cliff and maritime slopes. The vertical component and displacement of aerial photographs can be removed by the ortho-rectification procedures, but is problematic in steeply cliffed sections with poor terrain mapping control. However, the increasing availability of Lidar data or the generation of a network of interpolated digital elevation model (DEM) points based on GPS surveyed stations offers better DEMs for image rectification. Calculation of accurate areas of habitats within sloping situations requires inclusion of the slope component. Koh and Edwards (2000) describe procedures for developing DEM from stereo imagery of Black Ven, a Dorset coast landslip complex, which is then used to orthorectify and drape imagery (colour infrared) over a 3D surface. Such procedures and the availability of colour aerial othrophotography for much of the UK coast provides new opportunities for integrating such products with the cliff and maritime slope inventory.

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Appendix 1. BAP Priority species associated with maritime cliff and slopes

Source: English Nature (1999) Biodiversity: making the links

Species group	***Ecology***		***Geographical distribution***
Invertebrates			
Anergates atratulus - Dark guest ant	Social parasite of ant ***T.caespitum***, dry sandy heaths, coastal zones, sparse vegetation cover	Regional	South coast of England - Dorset, Hampshire, Surrey and Kent
Anostirus castaneus - a click beetle	Sandy grassland, bare ground often maintained by disturbance; coastal cliffs	Local	Two recent localities - Luccombe Chine (IoW) and Birk Crag nr Harrogate (N Yorkshire)
Bembecia chrysidiformis - Fiery clearwing	Coastal - warm south-facing slopes; feeds on curled dock and common sorrel	Local	Several small colonies in locality - coastal (Kent)
Bembidion nigropiceum - a ground beetle	Stony or sandy coastal sites - shingle and course sand, as well as among rubble at the base of cliffs	Regional	South coast of England from Kent to Pembrokeshire.
Bombylius discolor - Dotted bee-fly	Open places with dry soil where host bees nest, incl dry grassland in woodland, coastal cliff (soft rock), quarries, dune slacks	Regional	Coastal sites in southern England and S Wales; inland sites - south Gloucestershire, Warwickshire and Worcestershire
Cathormiocerus britanicus - a broad-nosed weevil	Coastal cliffs - short, herb-rich grassland at the edges of cliffs	Local	Sites on the Lizard Peninsula and Dorset
Ceutorhynchus insularis - a weevil	Coastal areas - feeds on common scurvygrass	Local	Scotland - St Kila archipelago only
Cicindela germanica - Cliff tiger beetle	On or near the base of coastal softrock cliffs or steep slopes, on bare or little vegetated sand or silt near freshwater seepages	Regional	South coast of England - Dorset & Isle of Wight (formerly Carmarthernshire)
Hadena albimacula - White spot moth	Coastal, shingle or calcareous cliffs; feeds on Nottingham catchfly	Local	Single populations - several sites Kent (Dungeness), Hants (Gosport), south coast of Devon and Isle of Wight
Harpalus dimidiatus - a ground beetle	Open, dry sites, either on inland or coastal calcareous grassland, dunes and on sandy coastal cliffs	Local	Scattered localities - southern England (north Somerset, Dorset, Surrey, Worcestershire, east Sussex and Kent)
Harpalus parallelus - a ground beetle	Mostly coastal - open dry ground on chalk soils - coastal dune grassland and chalk grassland/quarries/cliffs grasslands/heaths	Local	SE England & E Midlands only - Folkstone (Kent), Beachy Head and Rye Harbour (Sussex), Ventnor (Isle of Wight) and Great Morton (Northants.)
Idaea dilutaria - Silky wave moth	Coastal - open calcareous grassland; feeds on rock rose	Local	3 sites - Great Orme -N Wales, Gower coast of Glamorgan and a site near Bristol Channel

Species group	***Ecology***		***Geographical distribution***
Lasioglossum angusticeps - a solitary bee	South-facing, soft-rock cliffs - open, exposed areas on clay which have slumped at the base of cliffs (natural land slippage)	Regional	Restricted distribution - Isle of Wight and eastern Devon
Lygephila craccae - Scarce black-neck moth	Coastal cliffs; successional habitat - periodic rock slippage	Local	Few isolated colonies on the coasts of north Cornwall, north Devon and Somerset
Nomada errans - a cuckoo bee	Limestone grassland and landslips; cleptoparasite of a mining bee	Local	Known historically from only Durlston Head, Dorset
Ochthebius poweri - a water beetle	Seepages on sea cliffs, within the spay zone	Local	Distinct distribution in southern England and Wales - Dorset to Pembrokeshire. An association with New red Sandstone exposures around Exmouth (partly climatic and structure of rock - aquifers)
Osmia xanthomelana - a mason bee	South-facing soft-rock coastal cliffs	Local	Only post-1970 records from coastal cliffs on Isle of Wight/Lleyn Peninsula (Wales)
Polymixix xanthomista - Black-banded moth	Entirely coastal - mainly on cliffs	Regional	Isles of Scilly, along the coasts of Devon, Cornwall, Pembrokeshire, Cardiganshire and on the Isle of Man
Psylliodes luridipennis - Lundy cabbage flea beetle	Coastal cliffs - stems of Lundy cabbage	Local	Restricted to the island of Lundy - endemic
Scotopteryx bipunctaria - Chalk carpet moth	On chalk & limestone grasslands. Bare ground/short-grazed areas; including embankments, coastal cliffs, quarries and sheep tracks	Regional	Southern England and Wales - limestone in N Derbyshire, the coastal chalk in Yorkshire particularly around Flamborough Head, chalk and magnesian limestone in County Durham. Old records from Cumbria and Northumberland coast
Tachys micros - a ground beetle	Softrock cliffs - areas of damp sand at base of south-facing cliff slippages	Regional	South and west coasts of Britain from Kent to Caernarvonshire
Zygaena loti scotica - Slender Scotch burnet moth	Calcareous flushes on coastal cliffs; steep south or south-west facing slopes, usually below coastal cliffs	Local	Scotland only - Mull
Zygaena viciae argyllensis - New Forest burnet moth	Calcareous flushes on coastal cliffs	Local	Scotland only - western Argyll
Vascular plants			
Asparagus officinalis ssp. ***prosrtatus*** - Wild asparagus	On coastal heathland, cliff-tops by the sea and coastal dunes	Regional	Western Cornwall, Dorset, SW Wales and Ireland
Cochleria scotica - Scottish scurvygrass	Variety of northern coastal habitats - including cliff-top grassland	Regional	Scotland - Lochaber, Wester Ross, Sutherland, Caithness, Herbrides, Orkney & Shetland. Also Isles of Scilly
Coincya wrightii - Lundy cabbage	Coastal cliffs and slopes	Local	Endemic to Lundy Island

Species group	***Ecology***		***Geographical distribution***
Cotoneaster integerrimus - Wild cotoneaster	On rocky calcareous turf/limestone cliffs	Local	Known only from Gt Orme's Head near Llandudno, Wales
Euphrasia campbelliae - an eyebright	On damp heathy sea-cliffs	Local	Confined to Lewis in the Outer Hebrides
Euphrasia rotundifolia - an eyebright	Flushed, basic turf on sea-cliffs	Local	Restricted to northern coast of Scotland - Sutherland
Hieracium Sect ***Alpestria*** - Hawkweeds	Coastal rocks, sea banks and sea-cliffs	Regional	Shetland only
Limonium britannicum - Sea lavender	Sea-cliffs and coastal rocks	Regional	West coasts of England and Wales between south Devon and Lancashire
Limonium dodartiforme - Sea lavender	Chalk sea-cliffs - large expanses of bare chalk, also on stabilised shingle	Local	Restricted to Dorset coast
Limonium loganicum - Sea lavender	Granitic rock outcrops, cliffs and coastal scree	Local	Restricted to short stretch of coast south of Land's End, Cornwall
Limonium paradoxum - Sea lavender	Sea-cliffs - basic igneous rock outcrops and cliff ledges/edges	Local	Shingle locality - Pembrokeshire coast
Limonium parvum - Sea lavender	Steep rocky cliff-tops, rock crevices - carboniferous limestone	Local	Shingle population - Pembrokeshire coast
Limonium procerum - Sea lavender	Variety of coastal habitats - sea-cliffs, shingle banks and saltmarsh	Regional	West coasts of England and Wales between Dorset and Cumbria
Limonium recurvum - Sea lavender	Limestone cliff-tops, quarry cliffs, ledges and stabilised quarry spoil	Local	Restricted to the isle of Portland - Dorset
Limonium transwallianum - Sea lavender	Steep south-facing limestone cliff-slopes	Local	Restricted to shingle site - Giltar Point, Pembrokeshire
Rumex rupestris - Shore dock	Mostly on rocky shores by sea cliffs and more rarely on wet cliff-ledges, also in dune slacks & strand lines (littoral sediment).	Regional	Channel Islands, Isles of Scilly, coasts of SW England and Wales, and Angelsey
Lower plants			
Acaulon triquetrum - Triangular pygmy-moss	South-facing slopes on coastal cliffs and banks; calcareous ground kept open by soil slippage	Local	South coast of England - from Devon to East Sussex
Claoplaca aractina - a lichen	Steeply sloping, sunny acidic rocks on coast above high water mark - serpentine rocks	Local	Lizard Peninsula - Cornwall, formerly west coast of Cumbria, Argyll and Lochaber
Cladonia peziziformis - a lichen	Peaty soils, mainly in coastal or montane heathland	Local	Lowland and upland heath; lowland in England - Devon, coastal in Wales - Pembrokeshire, Mull Scotland
Heterodermia leucomelos - Ciliate strap-lichen	Exposed coastal cliff-tops - moss-lichen turf, mossy rocks	Regional	Cornwall, Isles of Scilly, Bardsey Island, the Lleyn Peninsula and Angelsey

Species group	***Ecology***		***Geographical distribution***
Petalophyllum ralfsii – Petalwort	Calcareous coastal cliff top grassland and damp calcareous dune slacks	Regional	South-West England, Merseyside, Northumberland, Ross and Cromarty and Wales
Pseudocyphellaria aurata - a lichen	Strongly oceanic species - maritime heath, cliff-tops on Isles of Scilly	Local	Channel Islands - Sark, Isles of Scilly - St Agnes; possibly extinct?
Teloschistes chrysopthalmus - a lichen	Sea cliff-top blackthorn scrub and small trees, previously old orchards, hedgerows and fence posts in coastal areas	Local	Only one recent site; formerly widespread along the south coast of England, from West Sussex through the Isle of Wight to Cornwall
Additional BAP species which may be found on maritime cliff and slope			
Species group	***Ecology***		***Geographical distribution***
Vertebrates			
Acrocephalus palustris - Marsh warbler	Migrant, breeding in waterside thickets, damp spots on coastal cliffs	Regional	South coast of England - Kent coast , Worcestershire in the Severn and Avon valleys
Bufo calamita - Natterjack toad	Mostly in dunes/saltmarshes & dry heath, open ground and temporary shallow pools	Regional	SD/SM of Irish Sea coast from Liverpool Bay north to Solway estuary; east coast SD in Norfolk and Lincolnshire; also on LH in Norfolk, Suffolk, Staffordshire, Bedfordshire, Surrey, Hants, Dorset.
Carduelis cannabina - Linnet	Coastal scrub for breeding, weed rich open ground for feeding, e.g. set-aside	Widespread	Breeding throughout England, Wales, eastern Scotland and Ireland but more scare in uplands and NW Scotland; with highest densities mainly along the east coast from Kent to Aberdeenshire.
Emberiza cirlus - Cirl bunting	Tall hedgerows, coastal scrub - mosaic of unkempt hedges (nesting) unimproved grass (chick food), winter stubble (winter adult food), low intensity mixed farming.	Regional	Southern England - south Devon
Triturus cristatus - Great crested newt	Mosiac - widespread in habitats with ponds, not specifi, dune slacks/grassland with breeding pools	Widespread	Widespread but local in UK; numerous locally in parts of lowland England and Wales but is absent or rare in Cornwall and Devon; it is absent in N.Ireland.
Invertebrates			
Aricia artaxerxes - Northern brown argus	Well-drained, and usually base-rich sites on thin soils; including limestone pavements/grassland and river edge grasslands; also coastal valleys, cliff-top grassland and quarries	Regional	Northern England and midlands - Derbyshire, Peak District, Yorkshire, Cumbria and Durham. S Scotland - Borders, along east coast northwards through Fife and Grampian, and in Dumfries and Galloway in the west. N Wales - Clwyd

Species group	***Ecology***		***Geographical distribution***
Bombus humilis - Brown-banded carder bumble bee	Areas of meadowland (herb-rich)/coastal grassland, supporting plant families Lamiaceae/Fabaceae	Regional	Once widespread now restricted to SW coast of England/southern coast of Wales
Bombus ruderatus - Large garden bumblebee	Areas of meadowland (herb-rich)/coastal grassland, supporting plant families Lamiaceae/Fabaceae	Local	Fewer than 10 confirmed post 1980 sites - mostly in East Anglia
Bombus subterraneus - Short haired bumblebee	Extensive areas of grassland - including sand dunes, coastal shingle & coastal grassland	Local	No specimens found. Declared extinct in UK by WWF in 1998.
Cerceris quadricincta - a solitary wasp	Open sandy grassland areas on south facing slopes	Local	Restricted to Kent and Essex
Cerceris quinquefasciata - a solitary wasp	Open sandy grassland areas with bare ground for nesting	Regional	Largely in SE England (Essex, Kent, Norfolk, Oxfordshire & Suffolk)
Hemaris tityus - Narrow-bordered bee hawk-moth	Margins of wet areas, bogs and chalk downland on devil's bit scabious; also chalk cliffs	Regional	10-50 sites - western Britain especially SW England from Cornwall to Wiltshire. Scattered colonies in W Wales and W coast of Scotland and N Ireland
Maculinea arion - Large blue	Warm, well drained unimproved grassland; also coastal cliff grassland	Local	Six populations - Cornwall (Dartmoor), Atlantic coast of Devon, Cotswolds and Somerset (Polden/Mendip Hills)
Plebejus argus - Silver studded blue	Coastal cliffs/heath & dune grassland	Regional	Remains widespread on Dorset/Hampshire heaths , although strong populations occur in north Wales, Sussex and Cornwall.
Tyta luctuosa - Four-spotted moth	Feeds on bind weed on hot, dry, south facing slopes on well drained soils chiefly on limestone grassland; also coastal cliffs	Regional	Counties in England south of the Wash - Dorset, Oxfordshire/ Buckinghamshire area, Bedforshire, Northamptonshire, Linconlshire, Cambridgeshire, Nottinghamshire, and Breckland
Vascular plants			
Trichomanes speciosum - Killarney fern	Damp,wooded coastal cliffs (set back from coast)??	Local	Western coasts of Britain
Lower plants			
Lejeunea mandonii - Atlantic lejeunea	Epiphytic in Atlantic woodland or on rocks by streams, also sheltered coastal sites	Local	Cornwall, W Scotland
Microglossum olivaceum - an earth tongue	Short turf habitats such as grassland on limestone sea-cliffs	Local	Single sites in each of Lancashire, Devon, Bristol, Brecknoch and Ceredigion
Weissia multicapsularis - a moss	Muddy or sandy clay soils - woodland rides, fallow fields, also banks/tracksides on seacliffs	Local	SW England - Cornwall and south Wales

Appendix 2. Inventory of Coastal Cliffs

(A. Malloch 1986-1989) Appendix 3. ***Maritime cliff and slopes in Cornwall.***

Appendix 3. Maritime cliff and slopes in Cornwall

Appendix 4. Output from Invertebrate Site Register 'Long List' species (Isle of Wight Region)

Appendix 5. Extract from Coastal Defence Database 1997 (with associated data fields)

Appendix 6. Coverage of NVC types and other vegetation in NCC pilot surveys of maritime cliffs in England.

Sources: (Cooper 1988a-e, Cox 1991, Perks & Longbottom 1991, Edwards 1998). Shaded NVC types are restricted to Scotland (Source: Rodwell 2000).
NB. Individual pioneer communities are not indicated on the Cox maps

NVC code	***NVC detail***	***2 Cape Cornwall***	***3 Lizard***	***4 Purbeck***	***7 Trimingham***	***8 Robin Hood's Bay***	***IOW***	***Dorset***	***Lizard***
MC1	***Crithmum maritimum-Spergularia rupicola*** rock crevice community	*	*	*					
MC1a	Typical sub-community		*					*	*
MC1b	***Inula crithmoides*** sub-community								*
MC1c	***Aster tripolium*** sub-community		*	*					*
MC2	***Armeria maritima-Ligusticum scoticum*** rock crevice community								
MC3	***Rhodiola rosea-Armeria maritima*** cliff-ledge community								
MC4	***Brassica oleracea*** cliff-ledge community			*				*	
MC4a	***Beta vulgaris*** ssp. ***Maritima*** sub-community								
MC4b	***Ononis repens*** sub-community								
MC5	***Armeria maritima-Cerastium diffusum*** maritime therophyte community	*	*	*			*		
MC5a	***Desmazeria maritima*** sub-community		*						
MC5b	***Anthyllis vulneraria*** sub-community		*						
MC5c	***Aira praecox*** sub-community		*	*					
MC5d	***Arenaria serpyllifolia*** sub-community							*	
MC6	***Atriplex prostrata-Beta vulgaris*** ssp. ***maritima*** sea-bird community	*	*						
MC7	***Stellaria media-Rumex acetosa*** sea-bird cliff community								
MC8	***Festuca rubra-Armeria maritima*** maritime grassland	*	*	*			*		
MC8a	Typical sub-community	*	*						
MC8b	***Crithmum maritimum*** sub-community	*	*	*				*	*

NVC code	*NVC detail*	*2 Cape Cornwall*	*3 Lizard*	*4 Purbeck*	*7 Trimingham*	*8 Robin Hood's Bay*	*IOW*	*Dorset*	*Lizard*
MC8c	***Ligusticum scoticum*** sub-community								
MC8d	***Holcus lanatus*** sub-community	*	*						
MC8e	***Plantago coronopus*** sub-community	*	*	*				*	
MC8f	***Anthyllis vulneraria*** sub-community	*	*					*	*
MC8g	***Armeria maritima*** dominated sub-community	*	*						
MC9	***Festuca rubra-Holcus lanatus*** maritime grassland	*	*	*			*		
MC9a	***Plantago maritima*** sub-community								
MC9b	***Dactylis glomerata*** sub-community	*	*						*
MC9c	***Achillea millefolium*** sub-community								*
MC9d	***Primula vulgaris*** sub-community	*							
MC9e	***Anthoxanthum odoratum*** sub-community								
MC10	***Festuca rubra-Plantago*** species maritime grassland	*	*						
MC10a	***Armeria maritima*** sub-community		*						
MC10b	***Carex panicea*** sub-community		*						
MC10c	***Schoenus nigricans*** sub-community								
MC11	***Festuca rubra-Daucus carota gummifera*** maritime grassland			*			*		
MC11a	***Bromus hordeaceus ferronii*** sub-community							*	*
MC11b	***Ononis repens*** sub-community							*	*
MC11c	***Sanguisorba minor*** sub-community							*	
MC12	***Festuca rubra-Hyacinthoides non-scripta*** community	*							*
MC12a	***Ranunculus ficaria*** sub-community	*							
MC12b	***Silene uniflora*** sub-community	*							*
A5	***Ceratophyllum demersum*** community						*		
A9	***Potamogeton natans*** community						*		
H2	***Calluna vulgaris - Ulex minor*** heath						*		
H5	***Erica vagans - Schoenus nigricans*** heath		*						
H6	***Erica vagans - Ulex europaeus*** heath		*						
H7	***Calluna vulgaris - Scilla verna*** heath	*	*						
H8	***Calluna vulgaris - Ulex gallii*** heath	*	*			*			
H11	***Calluna vulgaris - Carex arenaria*** heath						*		

NVC code	***NVC detail***	***2 Cape Cornwall***	***3 Lizard***	***4 Purbeck***	***7 Trimingham***	***8 Robin Hood's Bay***	***IOW***	***Dorset***	***Lizard***
MG1	***Arrhenatherum elatius*** coarse grassland		*	*	*	*	*		
MG1d	***Pastinaca sativa*** sub-community							*	
MG5	***Cynosurus cristatus - Centaurea nigra*** meadow and pasture			*			*		
MG5a	***Lathyrus pratensis*** sub-community							*	
MG5b	***Galium verum*** sub-community							*	
MG6	***Lolium perenne - Cynosurus cristatus*** pasture						*		
MG6c	***Trisetum flavescens*** sub-community							*	
MG7	***Lolium perenne*** leys					*	*		
MG9	***Holcus lanatus - Deschampsia cespitosa*** grassland					*	*		
MG10b	***Holcus lanatus - Juncus effusus*** rush-pasture, ***J. inflexus*** sub-community							*	
MG11	***Festuca rubra - Agrostis stolonifera - Potentilla anserina*** inundation grassland						*		
MG12	***Festuca arundinacea*** coarse grassalnd						*		
CG1	***Festuca ovina - Carlina vulgaris*** grassland						*		
CG1e	***Koeleria macrantha*** sub-community							*	
CG2	***Festuca ovina - Avenula pratensis*** grassland						*		
CG2aii	***Cirsium acaule - Asperula cynanchica*** sub-community							*	
CG3	***Bromus erectus*** grassland						*		
CG4	***Brachypodium pinnatum*** grassland			*					
CG4a	***Avenula pratensis - Thymus praecox*** sub-community							*	
CG4b	***Centaurea nigra - Leontodon hispidus*** sub-community							*	
CG4c	***Holcus lanatus*** sub-community							*	
CG5a	***Bromus erectus - Brachypodium pinnatum*** grassland, Typical sub-community							*	
CG6	***Avenula pubescens*** grassland				*				
CG7a	***Festuca ovina - Hieracium pilosella - Thymus*** spp. grassland, ***Koeleria macrantha*** sub-community							*	
OV18	***Polygonum aviculare - Chamomilla suaveolens*** community						*		

NVC code	***NVC detail***	***2 Cape Cornwall***	***3 Lizard***	***4 Purbeck***	***7 Trimingham***	***8 Robin Hood's Bay***	***IOW***	***Dorset***	***Lizard***
P1	***Tussilago farfara*** community						?		
P2	***Tussilago farfara-Agrostis stolonifers*** community						?		
P3	***Holcus lanatus*** pioneer grassland community						?		
P4a	***Phragmites australis*** pioneer inundation community						?		
P4b	***Mixed Phragmites australis-Equisetum telmateia*** inundation community						?		
P5	***Ononis repens-daucus carolta-Holcus lanatus*** pioneer calcareous grassland						?		
P6	***Rumex acetosella-Ulex europaeus*** sandy community						?		
SD1	***Rumex crispus - Glaucium flavum*** shingle community						*		
SD11	***Carex arenaria - Cornicularia aculeata*** dune community						*		
SM28	***Elymus repens*** saltmarsh						*		
U1	***Festuca ovina - Agrostis capillaris - Rumex acetosella*** grassland						*		
U4	***Festuca ovina - Agrostis capillaris - Galium saxatile*** grassland	*	*						
U16c	***Luzula sylvatica-Vaccinium myrtillus*** tall-herb community					*			
W1	***Salix cinerea - Galium palustre*** wet woodland								
W2	***Salix cinerea - Betula pubescens - Phragmites australis*** wet woodland								
W8	***Fraxinus excelsior - Acer campestre - Mercurialis perennis*** woodland						*		
W10	***Quercus robur - Pteridium aquilinum - Rubus fruticosus*** woodland						*		
W12	***Fagus sylvatica - Mercurialis perennis*** woodland						*		
W21	***Crataegus monogyna - Hedera helix*** scrub		*	*		*	*	*	
W22	***Prunus spinosa - Pteridium aquilinum*** scrub			*		*	*	*	*
W23	***Ulex europaeus - Rubus fruticosus*** scrub	*					*		*

NVC code	***NVC detail***	***2 Cape Cornwall***	***3 Lizard***	***4 Purbeck***	***7 Trimingham***	***8 Robin Hood's Bay***	***IOW***	***Dorset***	***Lizard***
W23b	***Rumex acetosella*** sub-community								*
W23c	***Teucrium scorodonia*** sub-community								*
W24	***Rubus fruticosus - Holcus lanatus*** underscrub						*		
W25	***Pteridium aquilinum - Rubus fruticosus*** underscrub	*				*	*		
W25a	***Hyacinthoides non-scripta*** sub-community								*
	Undefined scrub and woodland					*			
S4	***Phragmites australis*** reedbed						*		
S10	***Equisetum fluviatile*** reedbed					*			
S19	***Eleocharis palustris*** swamp						*		
S23	Other water-margin vegetation		*	*					
S25	***Peucedanum palustris - Phragmites australis*** fen			*			*		
M22	***Juncus subnodulosus - Cirsium palustre*** fen-meadow						*	*	
M25	***Molinia caerulea - Potentilla erecta*** mire	*							
Provisional new NVC type	***Agrostis stolonifera -Tussilago farfara***				*	*			

Appendix 7 Output from METATagger 2.0 of the NVC coastal surveys

Isle of Wight Sea Cliff Survey – J. Cox 1977

These reports are not exhaustive, but show examples of information resource records using the standard report within MetaTagger. NVC codes are translated to community names by MetaTagger to avoid confusion where one or more classification systems use the same biotope code (e.g. H1 in NVC and Phase 1). More complex reports can be generated using MS Access or any other industry compliant database-reporting tool (such as Crystal Reports etc.). For a live demonstration of the NBN Index web application, which provides powerful searching capabilities, see http://www.nbn.org.uk.

Appendix 8. Proposed colour chart for NVC habitat representation of maritime cliff, slope and associates

Appendix 9. Survey sites ‘ Isle of Wight Sea Cliff survey sites’

Source: J. Cox 1997

Appendix 10. Data sheet and Target notes for Whale Chine to St Catherine's Point - survey number 72 & 73

Source: J. Cox 1997

Appendix 11. Original mapping of NVC communities for Whale Chine - St Catherine's Point

Source: J. Cox 1997

Appendix 12. Digital representation of NVC communities for Whale Chine - St Catherine's Point

Source: J. Cox 1997

Appendix 13. Original mapping of NVC communities and Site 23

Source: Lizard Point NVC Survey – Perks and Longbottom 1991

Appendix 14. Digital representation of NVC survey adjacent to the Lizard Lighthouse

Source: Lizard Point NVC Survey – Perks and Longbottom 1991