Natural England Commissioned Report NECR054

Coastal Vegetated Shingle

Development of an evidence base of the extent and quality of shingle habitats in England to improve targeting and delivery of the coastal vegetated shingle HAP

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Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. This work was jointly funded by the National Trust, Defra and managed by Natural England with support of a project steering group. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Background

Vegetated shingle is a Biodiversity Action Plan priority habitat because it is so rare and so valuable for wildlife. All the major examples of the habitat and many of the minor ones have been notified for their wildlife value. To help identify restoration targets and monitor the habitat we need to know what there is, where it is, its geomorphology and the activities taking place that could affect it.

This study was commissioned to provide a spatial dataset of the inventory for coastal vegetated shingle in England. It takes forward a key recommendation of the earlier review NECR015 *Development of a Coastal Vegetated Shingle Inventory for England* and updates the extent of shingle habitat using selected habitat mapping and secondary data interpretation to develop the new spatial dataset.

This study represents the most up-to-date national inventory of coastal vegetated shingle habitats and the evidence will provide the basis for monitoring environmental change and shingle status assessment, especially related to long-term climate change and sea level rise.

The data and other products will also be used by Natural England and partner organisations in other contexts, such as the evaluation of shingle resources within flood risk management applications; incorporating the scales of change that have been observed and allowing assessment of options for longer term adaptation to climate change. Whilst recognising the limitations of the work, this will inform the strategic management activities proposed and undertaken.

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Further information
This report can be downloaded from the Natural England website: **www.naturalengland.org.uk**. For information on Natural England publications contact the Natural England Enquiry Service on 0845 600 3078 or e-mail **enquiries@naturalengland.org.uk**.

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Summary

This study provides a spatial dataset of the BAP priority habitat inventory for coastal vegetated shingle in England. The work takes forward a key recommendation of earlier review and updates the extent of shingle habitat using selected habitat mapping and secondary data interpretation to develop the new spatial dataset. This represents the most up-to-date national inventory of coastal vegetated shingle habitats.

The extent of the coastal vegetated shingle resource within England is estimated from the 2008 inventory layer at 42.76 km^2 in England, which is some 6.8 km^2 more than from the 1990 Phase 2 layer. This considerable increase (19%) reflects more the inclusion of sites that were previously missed by the 1990 Phase 2 inventory and not previously mapped rather than the gross change in the actual extent of coastal vegetated shingle areas.

New areas mapped within this inventory include those that were not within the scope of the earlier 1990's field surveys and that were not included in the previous inventory (1990's Phase 2). This has included a number of small sites such as cheniers, the shingle and shell banks fronting saltmarsh areas, together with some larger sites that were not the focus of the previous surveys (for example, Hurst Castle). The vegetated shingle extent on the Isles of Scilly was also updated, and although not surveyed in the field were added based on expert interpretation and site knowledge by Roland Randall.

Having created the 2008 inventory layer it has been possible, within the limits of the data, to assess the habitat change. The limitations for comparison relate to the inconsistent mapping methods used in previous inventory and the nature and rate of coastal change, which has been rapid in some locations. A number of area changes to sites are noted within the comparison of the detailed site investigations, especially related to coastal morphological changes and change to shingle structure extents and extensions of spits (for example, Porlock and Church Norton).

This project has also generated a number of other useful outputs which further our understanding of coastal vegetated shingle habitat extent and quality within England. These include:

- A review of the existing literature on coastal vegetated shingle in England. The existing data varies in content and detail and the aims and specifications for site based mapping often do not suit the purposes of inventory generation which are more concerned with the outer boundaries than internal detail. There is a need for greater standardisation among surveys and also nationally about how habitat surveys can feed into inventory generation.

- A habitat survey methodology and mapping rule base is proposed for the capture and creation of updated inventory information from field based survey and mapping standards. These protocols have been tested within the field survey of twelve selected shingle sites during this project for which individual site profiles have been developed.

- The project has also provided digital versions of the original Sneddon and Randall (1993) Report and for the Appendices (Site Reports for Wales Scotland and England) which were previously only available as hard copies and which are now out of print. During this process, the classification system developed by Sneddon and Randall has been captured, and a cross-tabulation with National Vegetation Classification (NVC) habitats has been created. This makes the Sneddon and Randal Classification much more widely available to users and provides additional detail where NVC is currently lacking.

- Species lists of plants and invertebrates occurring within shingle habitats or other habitats on shingle are also included and represent Natural England's most recent understanding of species relevant to vegetated shingle.

In terms of forward planning, this evidence base provides the basis for environmental change analysis and more robust shingle status assessment, especially related to long-term climate change and sea level rise.

There is a need for the other coastal inventories to meet these same standards to fully use the inventory information in this way but the data have been incorporated in the biodiversity vulnerability assessments at regional (South East) level.

The data can also be used in other contexts, such as the evaluation of shingle resources within flood risk management applications; incorporating the scales of change that have been observed and allowing assessment of options for longer term adaptation to climate change. Whilst recognising the limitations of the work, this will inform strategic management activities which are undertaken.

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1 Introduction

Background

1.1 Good quality information that can be shared and reliably updated using standard techniques is a vital element of targeting and monitoring action for biodiversity. For all habitats it is important to have the best understanding of likely trends so that conservation and management can focus on the most suitable areas. As with other coastal habitats, shingle systems can be very dynamic and vulnerable to a range of impacts, including flood risk management operations and climate change.

1.2 This project complements ongoing work by Natural England to enhance the understanding of habitat location through the updating of habitat inventories. It will address some of the issues relevant to the mapping of dynamic coastal habitats, and the use of species data in habitat inventories as a starting point for integrating their needs into habitat-based actions. This is a key part of the new framework to deliver the England Biodiversity Strategy.

1.3 Benefits of credible inventories include:

- Effective plan policies for the conservation, restoration and recreation of priority habitats through local and regional spatial strategies, planning control and local sites systems.
- Change in areas of priority habitats and populations of associated species as part of Annual Monitoring Reports.
- Reporting on the condition of UK BAP priority habitats through sample surveys
- More effective targeting of Environmental Stewardship and more effective delivery through identification of appropriate options and prescriptions for habitats and associated species.
- Reporting on Agri-Environment outcomes
- Ecosystem modelling at a landscape scale to support integrated strategies for habitat restoration and expansion and climate change adaptation.

1.4 The GIS-based inventory of coastal vegetated shingle BAP habitat was first developed from pre-existing data (Land Use Consultants 2004), largely from the surveys from 1988-90 (Sneddon and Randall 1993). This was subsequently reviewed and validated with some modifications to site boundaries by exeGesIS and Doody in 2007 (exeGesIS SDM Ltd and Doody 2009) to generate the current inventory layer, provided as a download from Natural England's website. Although the earlier inventory layer was generated in 2004 and updated in 2007 the origins of the data refer to 1994, and this process did not undertake a comprehensive update of shingle extent and thus the dataset is essentially refers to data published in 1994 (note that survey work wase done in 1988-1990, therefore for some sites data were up to 6 years old at the time of publication). A key recommendation of the work commissioned by Natural England in 2007 (exeGesIS SDM Ltd and Doody 2009) was to bring this inventory layer up to date, with targeted ground-truthing combined with the use of remotely sensed information.

1.5 Given the origins and nature of the capture process, the rule base for generating the inventory and the sites covered by earlier surveys, it was acknowledged (and subsequently verified by exeGesIS SDM Ltd and Doody 2009) that the 1994 inventory contains omissions of sites and missing areas of shingle habitat. In addition, the changes to the dynamic coastal morphology, habitat development and management have altered the extent of the habitat resource in the intervening 16-plus years since the original survey and potentially the quality of sites. It is thus timely to update the inventory and ensure that future updates are more streamlined and based on a more repeatable and robust evidence base for coastal vegetated shingle habitat action plans.

1.6 Key issues for the development of the habitat inventory layers are the establishment of mapping rule bases that reflect the nature of the data from which the inventory will be developed and

emerging standards for national inventory datasets. In order for subsequent vegetated shingle habitat surveys to contribute effectively to inventory update, it is useful to establish survey and mapping standards; even if the survey objectives differ from those of developing an inventory. This approach has been used for other maritime habitat inventories (maritime cliff and slope inventory, Hill et. al. 2002) with the advantage that the inventory can be subsequently reliably be updated from broader scale habitat survey data that meet minimum standards.

1.7 The GeoData Institute were commissioned by Defra and National Trust (with input from other key organisations including Natural England) to review this past work, to develop procedures that sought to test and standardise survey approaches and to develop and apply a rule base to generate an up-to-date (2008) coastal vegetated shingle inventory layer.

The Vegetated Shingle Inventories
Throughout this document reference is made to the different inventory layers. These are named and described as follows:

1990s layer (Phase 1 2004). This GIS layer for England was compiled from the Sneddon & Randall Coastal Vegetated Shingle Structures of Great Britain (Sneddon & Randall, 1994) by Land Use Consultants. It provides an indication of the key locations for this habitat at the time of the original surveys between 1988-1990.

1990s layer (Phase 2 2007). This GIS layer created by exeGesIS & Doody) was the result of further work to address inconsistencies identified in the 1990s layer (Phase 1 2004). It provides a more accurate boundary of the extent of the shingle habitat in the 1990s. This is the inventory layer which will be the starting point for this further phase of work. This has been published by NBN as 'Coastal Vegetated Shingle BAP Priority Habitat - England v2.0'.

2008 layer. This new layer (created by the GeoData Institute) will be one of the main deliverables of this project. It will provide an up-to-date inventory of current extent of this habitat, and enabling a comparison with the previous 1990s layer (Phase 2 2007), subject to limitations of methodologies used.

Figure 1 Vegetated Shingle Inventories

Project Aims

1.8 The aims of the project were broken down into three components:

Component 1 Review and development of methods

1a. Transpose existing material within the Sneddon and Randall (1993) JNCC reports to make these more widely available, as these are hard copies only at present, and now out of print.

1b. Undertake a literature review of post-2000 vegetation and BAP-list surveys in order to establish surveys that could effectively contribute to the update of the inventory layer

1c. Development of standards for field-based shingle habitat survey

Component 2 Validation site survey and collation of information

2a. establish priority sites for ground truthing to feed into the evaluation of the survey and habitat quality measures

2b. undertake survey of the selected sites (2a) to generate site profiles and assess the change between 1990s layer and 2008 layer (generated from 3a) of extents of shingle vegetated communities

2c. collate species level information for the surveyed sites from secondary sources.

Component 3 – Production of the 2008 layer

3a. to develop a habitat mapping rule base, working from the existing structure (1990s Phase 2 layer and NBN South West Pilot project rule bases (NBN, 2004) from which to generate a 2008 BAP Priority Habitat geospatial data layer and metadata.

Within the subsequent text the suffix to the headings relates to the original objectives (eg 3.5 Species information (2c) relates to component 2c).

Project outputs

1.9 The project has generated a series of outputs:

- Digital PDF copies of the original Sneddon and Randall (1993) main report and Appendices (site descriptions for Wales, Scotland and England).
- A cross tabulation of Sneddon and Randall"s shingle classes with NVC habitat classification and a review of relationships to other classifications.
- GIS data layers for the habitat inventory.
- Metadata for the inventory geospatial data.
- Programme technical report (this report).
- Appendices (field survey profiles, site data, including species information).
- Field survey and mapping protocol.
- A revised rule base for mapping coastal vegetated shingle for inventory purposes.

2 Component 1 – Review and development of methods

Transpose existing vegetated shingle report materials [1a]

2.1 The Sneddon and Randall (1993) Main Report and Appendices for England, Scotland and Wales published by the Joint Nature Conservation Committee (JNCC) form the most comprehensive study of coastal vegetated shingle habitats in the UK. These documents are now out of print; in order to preserve access to the contents (particularly the classification system developed by Sneddon and Randall) and make them more widely available, the reports have been scanned and text recognised using Optical Character Recognition - OCR software to provide searchable, PDF versions of the documents.

2.2 This covers all four volumes published by the JNCC to be hosted on the JNCC website:

- Coastal vegetated shingle structures in Great Britain.
- Coastal vegetated shingle structures in Great Britain Appendix 1 Wales.
- Coastal vegetated shingle structures in Great Britain Appendix 2 Scotland.
- Coastal vegetated shingle structures in Great Britain Appendix 3 England.

2.3 The classification contained within these reports has been entered into a relational database (Microsoft Access, 2007) in order that it could be searched and compared with corresponding habitats within other classifications, such as National Vegetation Classification (NVC).

2.4 Copies of the PDF files are available to download from the JNCC website.

2.5 The database is available for download from the JNCC website and from the GeoData Institute website.

Literature Review of Post 2000 vegetation and BAP-list surveys [1b]

Introduction

2.6 This stage provides a literature review of the post-2000 vegetation surveys and species surveys for shingle sites; primarily evaluating the suitability of the datasets to form inputs into the habitat inventory mapping. Different surveys have used different classification systems (Sneddon and Randall, NVC and IHS) but it is clear that there is not always a clear correspondence between classifications or common standards used in survey or collation and treatment of the data. A recurring theme within the more detailed and field-based surveys (as distinct from the aerial photographic interpretation dominated surveys) is the presence of communities classed as shingle and shingle transitions that are not adequately described by the current published NVC shingle communities (Rodwell, 2000).

2.7 Other literature on vegetated shingle has also been sought where these provide insight into the habitat demarcation, site dynamics, habitat classification and community descriptions.

2.8 More general review of the NVC coverage (Rodwell *et al* 1999) highlighted additional pioneer communities of shingle within the SD3 *Matricaria maritima – Galium aparine* strandline - *Raphanus maritimus- Matricaria maritima* community as a variant equivalent to the SH12 and SH13 assemblages identified by Sneddon and Randall (1993). It is evident from the field surveys and the reviews that the NVC classification may not effectively describe the communities

encountered and especially transitions into saltmarsh, dunes and maritime grasslands. However, where quadrat data have been collected for surveys the resulting communities are often described by their affinity to NVC, but often mapped as variants.

2.9 The surveys investigated essentially date from the last collation within the inventory data layer of the 2000s – whereas the Phase 1 and 2 inventory had utilised surveys prior to this date. In fact, information within the Phase I of the inventory pre-dates the 2000 datasets and thus earlier data have not been excluded from consideration; for example, Pagham 1996 data were not incorporated in the mapping of the Phase 1 inventory and have thus been considered in the current project. Shingle survey data has been examined from a range of sources, concentrating on those studies that have undertaken vegetation / habitat surveys of some kind, to feed into the assessment and mapping of the national inventory, rather than individual quadrat or single species surveys. Surveys have not been standardised and the inclusion and exclusion of bare shingle structures within the surveys makes direct BAP habitat mapping comparison difficult.

2.10 It is clear that digital map data of vegetated shingle since 1990 are sparse, but the most recent BRANCH data (described below) provides a significant area of high quality data for the South East coast and it is understood that newer aerial interpretation surveys are being conducted for the South West, although these were not available to the project. A number of sites have previously escaped any habitat mapping and inclusion in inventories and, especially where these are narrow fringing beaches or shingle chenier banks, many sites may have no survey coverage. However, a number of the larger shingle structures were also omitted from or not fully covered by earlier surveys (Sneddon and Randall (1993) and inventory mapping (both1990 Phase1 and 1990 Phase 2) layer. These have been included within the 2008 inventory.

2.11 A range of other site and generic research on the shingle habitat has related to the classification of the communities and the understanding of the pressures and management of shingle areas, physical (Randall and Sneddon 2001) and ecological research. This literature is not reviewed in detail here, although a number of these reports are useful in setting the inventory in context, especially in relation to morphology (Pye and Blott, 2009) and management (for example, Packham et al 2001, Randall and Doody 2001) and habitat quality.

Coastal Vegetated shingle habitat mapping

2.12 The communities of vegetated shingle include the two habitats listed in Annex I of the Habitats Directive the Habitats Directive, i) H1210 Annual vegetation of drift lines and ii) H1220 Perennial vegetation of stony banks. Descriptions of these communities are contained within JNCC 2007 Conservation status assessment for H1210 and JNCC 2007a Conservation status assessment for H1220 and the Interpretation manual of European Union habitats (EC 2007).**http://ec.europa.eu/environment/nature/legislation/habitatsdirective/docs/2007_07_im.pdf**.

2.13 There are also descriptions in the SAC Selection pages on the JNCC website.

2.14 Coastal vegetated shingle is also one of the UK BAP priority habitats for which an action plan (UK BAP Action Plan 2008) **https://www.ukbap-reporting.org.uk/plans/national_plan.asp?S=shingle&L=&O=&SAP=&HAP=%7BA9DB9FBB-26A6-4D52-B264-13FCA4C482E4%7D&submitted=1&flipLang=&txtLogout=&radiobutton=radiobutton** has been developed. This action plan is the key driver for the BAP inventory layer in enabling the assessment of the 2006 targets for the habitat in terms of total extent and no net loss, achievement of favourable habitat status and the targeted restoration actions for shingle communities. Understanding the current extent and trends will enable more effective reporting against these targets.

2.15 The secondary datasets sought by this review include specific survey of the shingle vegetation classes as well as broad-scale habitat mapping that includes vegetated shingle cover amongst wider vegetation surveys. Specific surveys and datasets are briefly reviewed below.

BRANCH Biodiversity, Spatial Analysis and Climate Change (Published Report / Datatset)

2.16 The BRANCH EU-funded programme developed a habitat map for the South East Coast from the Thames Estuary round to the Solent. Mapping habitats was to the Integrated Habitat System (IHS) the survey classification system (although there was some regional customisation) and was completed in 2005. The survey was for complete coverage of all habitats and was not specifically targeted to the BAP habitat class, but mapped to a high resolution of a nominal resolution of 0.1ha. The BRANCH programme used the data to assess local scale losses of habitats against different scenarios of climate change.

2.17 The dataset is consistent and is provided as GIS shapefiles and provides a classification of the shingle habitat communities. It also maps other habitat types that may be within the coastal vegetated shingle BAP habitat (for example, MG grasslands) that are relevant for the assessment of potential inventory overlaps, although the BRANCH data itself does not represent any overlapping parcels and does not distinguish whether habitats may be on shingle in some instances. The data have been used extensively in mapping the south east coast shingle extent for the BAP habitat although the boundaries have been adjusted where appropriate to reflect coastal change and where some errors in the datasets have been noted.

2.18 The data represent shingle as hierarchical supralittoral sediment marine habitats with 4 classes:

- SS3 - Shingle above high tide mark
- SS31 - Coastal vegetated shingle
- SS311 - Perennial vegetation of stony banks
- SS312 - Annual vegetation of drift lines
- SS3Z - Other shingle above high tide mark
- SS4 - Strandline vegetation

2.19 Whilst the habitat classification of the IHS is limited, this is acknowledged within the BRANCH surveys which added a number of additional, fourth level hierarchy classes, as variants, that extend into the shingle/scrub communities and shingle/mesotrophic grasslands (for example, SS3112) – which may have a closer association to some of the additional categories proposed within other surveys such as those of Randall 2001, Cox and Crowther (2001) and by Sneddon and Randall (1993). These often mark the terrestrial transition communities. The extent to which these new habitat hierarchical divisions relate to NVC or other classifications needs testing.

2.20 BRANCH data cover some areas that are also mapped with other field-based surveys and where this is the case the quality and suitability of each survey is assessed before capturing the extent of the inventory layer.

2.21 Details of the BRANCH programme are available at: **http://webarchive.nationalarchives.gov.uk/20090703091708/http://www.branchproject.org/reports/finalreport.pdf**

Beaches at Risk (Published Report)

2.22 The Beaches at Risk study for vegetated shingle in East Sussex was an Interreg III project (Fitzsimons *et al*., 2007, East Sussex Vegetated Shingle Management Plan, Tim Smith 2009). This programme surveyed twenty-four sites where there were known shingle communities. The survey consists of transect and quadrat data, but did not map the extent of the parcels of different habitats. Survey was conducted across the regions although some well mapped sites were excluded Rye Harbour Nature Reserve, the Midrips and the Wicks. Surveyed sites included:

- Telscombe
- Peacehaven
- West Beach

- Newhaven Tide Mills west
- Newhaven Tide Mills east
- Bishopstone
- Seaford
- Cuckmere Haven (west)
- Cuckmere Haven (east)
- Birling Gap
- Eastbourne main beach
- Sovereign Park
- Sovereign Harbour
- Westham
- Pevensey Bay
- Normans Bay
- Cooden Beach
- Veness Gap
- Bexhill
- Bulverhythe
- Hastings main beach
- Fairlight Cove
- Pett beach
- Winchelsea beach

2.23 Whilst the data highlight sites and the presence of vegetated shingle quadrats these help to confirm the presence rather than assist with the habitat boundary mapping.

Portland Harbour Shore: Chesil and The Fleet, Dorset (2000) (Published Report)

2.24 Report to DETR Randall, R.E. July 2000 Portland Harbour Shore Chesil and The Fleet cSAC Establishment of habitat type CR0231. This survey sought to establish the extent and nature of the shingle vegetation community of the Portland Harbour inner shingle shoreline as part of the Chesil and The Fleet SAC designated for annual vegetation of drift lines and perennial vegetation of stony banks. The field based relevee transect survey was undertaken by Randall. The site is described as having varying depths of sand over shingle as part of the matrix and being heavily disturbed through past modification and recreational access. The survey includes a habitat map describing 16 NVC communities including scrub, saltmarsh and dune communities as well as transitional maritime grassland. The survey was also represented in terms of the classification of Sneddon and Randall 1993 in which vegetation types of shingle structures and substrates were included within a wider definition of vegetated shingle that include sand dune, saltmarsh and maritime cliff communities on shingle. A number of the parcels are below the minimum mappable unit size and therefore would be 'lost' within the inventory mapping. Ditch and driftline communities closer to saltmarsh types occur that are transitions between shingle and saltmarsh.

Chesil and The Fleet, Dorset (2005) (Published Report)

2.25 National Vegetation Classification Survey of Annex I Listed Habitats at Chesil and The Fleet SAC, Dorset. Giles Groome Karl Crowther Consultant Ecologists Report to English Nature Contract No. DM3/Chesil&FleetVegetationSurvey/05/06 November 2005.

2.26 This survey followed detailed surveys from Sneddon and Randall and Lyme Bay Environmental Study (Colombe & Diaz, 1995). Whilst the previous surveys used the Sneddon and Randall classes this survey used NVC. The approach mapped and created digital files for the Annex I habitats and the vegetation but not BAP habitats. This included Annual vegetation of drift lines,

Perennial vegetation of stony banks and Mediterranean and thermo-Atlantic halophilous scrub (often treated as a saltmarsh transition).

2.27 The spatial files have not been available to this project, although the species, quadrat and target notes etc are available. It is understood that the digital GIS data followed mapping standards and mapped to OS MM. The data included environmental factors, negative indicators, and species of vascular, bryophytes and lichens and the 130 quadrats have been evaluated against the MATCH programme. Of the 320 ha of shingle community 66 % was bare shingle and 27% was classed as Perennial Vegetation of Stony Banks.

Dungeness, Kent (Halcrow, 2007) (Published Report)

2.28 A recent and detailed survey of the habitat communities, environmental parameters and disturbance classification of the vegetation of the Dungeness foreland and Lydd Ranges has been conducted as part of the Sea Defence Strategy (Halcrow, 2009) for the Environment Agency. This study has included NVC surveys and lichen and bryophyte surveys, rare species, soil / substrate sampling (Particle Size Distribution -PSD) and condition assessment of the habitat based on the degree of disturbance. The disturbance assessment is based on Green and McGregor 1986 methods; which measures the surface condition, morphology, ridgeline disturbance, damage index and land types. Although not stated it is assumed that the quadrat surveys were within homogeneous communities that have then been visually assessed using aerial photography to map habitat extents.

2.29 As with many shingle habitat mapping programmes where local habitat classification schemes have been used, the classification used by Ferry in earlier Dungeness mapping (Ferry, 1985) do not always map well and unequivocally to the NVC classes.

2.30 Ferry's work actually pre-dated the NVC development and these classes were identified through the MATCH (Malloch, 1990) programme employed within the 24 areas (typically with 5 quadrats within each area) within the Halcrow 2007 study.

2.31 The data incorporate digitisation of the Ferry (1985) datasets including unclassified data from Ferry. Mismatches are not unanticipated as the NVC (Rodwell, 2000) analysis did not incorporate extensive quadrat data from Dungeness.

2.32 The resulting mapped habitats were to a high, but unstated resolution and quadrat samples were assessed against MATCH (Malloch 1999) and unfortunately the habitat and condition mapping spatial data and quadrat location data were not available. However, it is clear that the communities are diverse and include a mosaic of fen, mesotrophic grasslands and water features within the scope of the vegetation of stony banks. These data have been used within the context of the BRANCH data which cover the same area but using IHS classification scheme. The BRANCH data were taken as the principal source for the BAP habitat mapping and formed the basis for modifications to the shingle extent through visual assessment. The extent of the Halcrow survey was linked to the flood risk management strategy and therefore limited to a narrow coastal strip of around 200m to 550m inland although on this site the shingle habitat boundaries may extend several kilometres inland. The shingle shows extensive disturbance, especially inland and consists largely of morphological and vegetation disturbance due to military training use and flood risk management operations near the shoreline.

Dunwich, Suffolk (2000) (Published Report)

2.33 Dunwich Driftline Survey Toby Abrehart (2000). Survey relates to the SAC based on the inclusion of perennial vegetation of stony banks (10.7 ha) and annual vegetation of driftline (9.71ha). The habitat classification merely ascribed the habitats to the two Annex I communities based on survey of five species presence. Maps are paper-based and whilst not providing a habitat map they may help determine the extent of the shingle resource.

Orfordness, Suffolk (2006)

2.34 Monitoring of vegetation on Orfordness after the shingle extraction and recycling to the narrow neck at Slaughden to reduce the risk of the spit breaching (Cooper, 2006). This survey consisted of driftline surveys, transects and quadrats repeated to determine the impacts of shingle recharge and recolonisation. The quadrats were conceived as permanent quadrats allowing repeat surveys and with individual plants clumps mapped, but the surveys have not been associated with any specific vegetation classification. The objectives of this survey do not match well with the inventory habitat mapping requirements.

Snettisham, Norfolk (2005) (Online map and information)

2.35 Vegetation Communities of Snettisham Scalp (Boreham, 2005).

2.36 Habitat mapping of the SSSI note the rapid changes in annual vegetation extents. The habitat map is based on NVC classifications and highlights that part of the site is classified as a mobile dune rather than shingle although some of the dune and marsh communities are likely to be shingle transitions *(Sueda maritima* behind the shingle beach). The data are suitable for the mapping of the habitat inventory although the sand dune components indicate a complex site of mixed habitat inventory.

2.37 Only a single year of published data exists, although subsequent surveys have been undertaken on an annual basis by Steve Boreham and colleagues, who assisted with the definition of the vegetated shingle extent at this site.

Solent, Hampshire (2001) (Published Report)

2.38 Survey of Solent Strandline Vegetation: July – September 2000 A Report to Hampshire County Council J. Cox and K. Crowther February 2001.

2.39 This survey covered areas not previously mapped as shingle within the Sneddon and Randall surveys and not occurring within the 1994 inventory datasets, despite including some of the larger shingle units in the UK. This survey focused on strandline communities of fringing beaches and the numerous spits and included chenier banks and harbour island sites (for example, Portsmouth) not represented elsewhere within the 1994 inventory. The estimates of the shingle habitat resource were lengths rather than areas and the community mapping was based on 140 quadrats that have been used to identify NVC and affinities with NVC community types. These quadrats have extended into transitions with saltmarsh and grasslands. As has been found elsewhere there are many variants that do not match well with the current NVC and where there is overlap with terrestrial and MC community types on a shingle and shingle matrix substrate.

Chenier surveys (Hampshire and Essex) (Published Paper)

2.40 Ground based radar studies have been used to develop a classification of chenier types. Although many of these features are below what might be treated within an inventory as the minimum mappable unit, as a series of morphological features (shingle structures) they would qualify and support vegetation. The Neal, Richards and Pye 2002 classification is a formation-based category of (over washing, overtopping) sedimentation across the whole of a seaward dipping beach face or berm ridge welding onto the upper beach face. These surveys do not include vegetation but annual vegetation of driftlines does occur. Cox and Crowther indicate 'distinctive *Atriplex littoralis* dominated strandline' vegetation and transitions to saltmarsh over which the cheniers override; although many of these structures appear from aerial photographic interpretation to be highly mobile forms.

Pagham, West Sussex (1996) (Local Survey Results)

2.41 Pagham (1996) Antonini and Bennatt survey was undertaken as part of the beach monitoring programme. The survey utilised the Sneddon and Randall classification. The survey also sought

to identify the communities of the Childing Pink (*Petrohagia nanteuilii*) that was found to have a wide habitat range from sand to shingle but was predominantly found on sand (SH48).

Rye harbour (Internal GIS dataset)

2.42 Barry Yates (site manager for Rye) has created a GIS layer of shingle structures at Rye Harbour which was supplied for this project.

Other surveys

2.43 A number of coastal change studies have been undertaken by the Channel Coast Observatory, including studies at Dungeness and Pagham. Matt Dorling (2007) South East Strategic Regional Coastal Monitoring Programme BMP 55 Beach Management Plan Site Report 2007 4cMU13 – Dungeness Power Station. Amos, D. (2005) Beach Management Site Report 2005 – Pagham Harbour BMP 11. These programmes do not map vegetation but do provide information on the nature and scale of coastal change.

2.44 Petchey and Brown (2009) undertook a review of the approaches to shingle ridge identification at Cley Eye and Kelling Hard.

2.45 The vegetated shingle extent on the Isles of Scilly was updated based on expert interpretation of very high resolution aerial photography (Channel Coastal Observatory) and site knowledge by Roland Randall.

Comments on existing surveys

2.46 While several existing surveys have been identified, many of these surveys have not been undertaken to the same standard or have used different methods which are difficult to use in inventory development. For example, several of the sites have detailed quadrat and transect information but this may not be held within GIS format and even if it is, the quadrat data are held separately and are difficult to use in the delineation of boundaries.

2.47 Even where existing GIS datasets exist, the features captured vary in detail from fairly general to the smallest detail where individual stands of vegetation are captured as separate polygons (for example, Dungeness). The capture of these communities in such detail represents an enormous amount of effort and also seems of questionable value, given the dynamic nature of the vegetation, unless similar data are available year on year to allow micro-scale comparison of the distribution. This level of detail is certainly not required for inventory purposes with the data being aggregated up to much larger units.

2.48 In other studies, only part of the site is covered in detail (for example, Snettisham Scalp) yet this forms part of a larger shingle structure. While survey effort may be focussed on the most dynamic areas, there will also be change occurring elsewhere within the wider site which may not be captured between inventories.

Development of standards for field-based shingle habitat survey [1c]

2.49 The objective of the field-based coastal vegetated shingle habitat survey in this project is to provide information for habitat mapping, condition assessment and other purposes. This component also provides standards for vegetation surveys to permit extraction of the shingle BAP habitat boundary to update the inventory layer, from which trends in change of the extent of habitats can be reliably determined. Not all surveys will share a single objective to map vegetated shingle, yet may still assist with update to the inventory, in the same way as the data from past surveys has helped to generate the 2008 layer. More typically, a vegetation survey at the coast may include elements of many inventory layers (shingle, dune, saltmarsh, maritime cliff and slope etc).

2.50 The development of standards for habitat mapping and the geospatial data models that support their outcomes have been considered in the first phase of the maritime cliff and slope BAP habitat inventory (Hill and others 2002) which set a survey and mapping output standard that was then operated in new surveys. A subsequent phase (Hill *et al* 2006) collated surveys since the release of the standard. These were audited and combined into a single spatial dataset. This latter programme also updated the generic standard procedure based on lessons learnt; and review and update of standards is appropriate for vegetated shingle surveys. Changes to mapping standards, baseline data and availability of new technologies (eg in field computers/ GPS) may encourage further modifications to standards.

2.51 It is evident from the data audit that even though a standard specification is made available (and used within subsequent specifications for commissions) its rules and procedures are not always followed through in actual survey and data preparation; yielding problems when seeking to combine surveys. This promotes both the need for a clearer guidance and model specifications (as proposed here in the standalone guidance document) and stronger reinforcement of the project outputs (especially the geospatial outputs) to ensure consistency of recording if there is the desire for the results to contribute to the inventory and a habitat mapping framework. Equally, where projects generate spatial data and digital files (eg images, geospatial data, GPS referenced quadrat locations).

2.52 The approaches adopted within the maritime cliff and slope inventory are relevant to other coastal habitats; especially to ensure compatibility of methods across transitional and adjacent BAP habitats. These same approaches are now being implemented in county level habitat mapping (within the Habitat Mapping Framework), being employed within the regional updates of the heathland inventory and where new habitat datasets are integrated into a common framework with associated data quality metadata. Similar requirements are appropriate for the vegetated shingle inventory.

2.53 Key elements of setting this guidance for standardised data will include issues relating to:

- minimum mappable units, based on the assessment of the viability of mapping separate parcels and digitising standards.
- survey procedures, quadrat data recording, photo records etc.
- treatment of transitional habitats and mosaics within the mapping framework.
- overlaps with other habitat inventories.
- understanding of the habitat classification and its impacts on the ability to extract relevant BAP habitat units.
- boundaries with marine communities and the seaward position of the vegetated shingle or the shingle morphological unit – based currently on mapped OS mean high water mark.

2.54 Classification of vegetated shingle communities using the NVC can also be problematical where there are gaps in the classification and limited number of samples used in the development of the classification. Earlier classifications specific to vegetated shingle are more appropriate, with some modifications, than the use of NVC; unless the NVC is refined for vegetated shingle and this would need to be reflected in the development of data standards for field based shingle habitat survey (see **http://www.jncc.gov.uk/pdf/CSM_coastal_shingle.pdf**).

Habitat Classifications and Correspondence

2.55 Habitat classifications typically are taken from a limited number of standards, although often with modifications and with outlier classes that do not match to the core classification. The most frequently encountered classifications within the vegetated shingle mapping are:

- NVC National Vegetation Classification (Rodwell 2000)
- Phase 1 (JNCC 1983)
- IHS Integrated Habitat Classification (SERC)

- Bespoke shingle classification (Sneddon and Randall 1993)
- BHAP Biodiversity Action Plan Broad Habitat Classification
- HAP Biodiversity Action Plan Priority Habitats
- Annex I habitat definitions
- In Europe the EUNIS classification is becoming the standard for vegetation mapping **http://eunis.eea.europa.eu/habitats.jsp**
- Ferry *et a*l (1990) - Dungeness

2.56 Despite the resolution of the Sneddon and Randall classifications which (as with NVC) was based on an analysis of quadrat data using TWINSPAN, there are few other subsequent surveys that have used this comprehensive division of the community types. This is perhaps due to the fact that it is more complex (being an ecological classification with c.140 classes) than is typically required for mapping for conservation purposes. That is, it is more complex than is required for first level survey and possibly also for the second level. However, the classification could still be used within this context if it were used at a higher level within the hierarchy. The lack of uptake may also be due to the fact that the classification does not have floristic tables and that there was a wide range of habitats included.

2.57 These classifications are important with respect to the creation of an inventory where secondary sources of habitat mapping are used as these will affect the areas that are subsequently interpreted and mapped as vegetated shingle. For example, the Phase I category: H3 Shingle/gravel above high-tide mark provides a single class that might be interpreted as coastal vegetated shingle whilst Sneddon and Randall have 25 divisions and 146 shingle communities identified.

2.58 The IHS classification is a hybrid of other classifications that seeks to allow a high level of community division, based on a series of class divisions that run from BAP habitats through to NVC classes. IHS does not however incorporate the Sneddon and Randall classes and does not include all the sub-communities recorded within NVC. However, it does cross-reference to the BHAP and HAP broad and priority habitats.

2.59 Given the lack of NVC equivalents for many of the 1993 surveyed communities and more recent surveys and recommendations for additional communities (Cox and Crowther 2001) and surveys by Ferry *et a*l (1990), the Sneddon and Randall classification (1993) has been used for this mapping exercise. Additional comments are needed where new community structures are envisaged and where the vegetation of driftlines (which were largely excluded from their mapping) have been incorporated.

2.60 Correspondence is the matching between one classification and another. There is an extensive literature and tabular programme to conduct this type of matching. An interactive spreadsheet containing the correspondences between Phase 1 types and those identified in other mainstream vegetation/habitat classification systems is available via the following download: NBN dictionary habitat correspondences (see also the National Biodiversity Network Habitats Dictionary). A more comprehensive review of the correspondence between the NVC and Annex I types is provided via the National Biodiversity Network Habitats Dictionary (**http://habitats.nbn.org.uk/habitatClassList.asp**) and in Appendix 2 of Jackson and McLeod (2000).

2.61 A number of the past surveys have also focused on the Natura site monitoring where the habitats are defined in terms of the Annex I Annual vegetation of drift lines (H1210) and Perennial vegetation of stony banks (H1220) classes. The UK guidance on conservation objectives for monitoring designated sites (CSM 2004) sets out the correspondence between NVC and H1210 and H1220 habitats and their transitions. These are not represented in the spreadsheet of correspondence between the Sneddon and Randall and NVC classifications so are repeated in Table 1 and Table 2.

Table 1 Summary of the Annex I habitats and relationship to NVC community types

Interest feature: Shingle Includes the following NVC types. The NVC does not cover the whole range of shingle vegetation, only the pioneer phases have a specific NVC classification: SD1, SD2, SD3, MC6. A full list of NVC equivalents is provided in the Coastal Vegetated Shingle Structures of Great Britain (Sneddon and Randall 1993) and this includes pioneer, lichen/moss communities, heathland, grassland, wetland and scrub.
Annex I habitats: **Annual vegetation of drift lines (H1210)** which includes the following NVC types: SD2 *Cakile maritima–Honkenya peploides* strandline community and the SD3. *Matricaria maritima-Galium aparine* strandline community. MC6 *Atriplex prostrata – Beta vulgaris* ssp. *maritima* sea-bird cliff community may also be present and other vegetation types not described in the NVC, for example, monospecific stands of *Atriplex* spp. **Perennial vegetation of stony banks (H1220)** which includes the NVC type SD1 *Rumex crispus-Glaucium flavum* shingle community and a wide range of other vegetation types (see section 2).
Transitions: including saltmarsh communities (for example, SM13, SM28) brackish mire (M28), swamp communities (for example, S4, S5, S19, S20, S21), grassland (for example, MG1, MG11) heathland (for example, H1, H11).

CSM 2004

Table 2 Summary of habitat classifications and correspondence with Annex I habitats

Classification	Correspondence with Annex I type	Comments
Sneddon and Randall shingle classification	This provides a detailed analysis of the range of vegetation types found on shingle structures in the UK on both the upper beaches and inland on mature and stable shingle. The shingle (SH) communities are based on analysis of quadrat data collected from shingle habitat surveys, covering most of the range of variation that can be found in this Annex I type.	Refer to Sneddon, P. and Randall, R.E., 1993a. The SH communities have also been related to closest NVC equivalents in this study. This study did not cover the driftline communities included in H1210 Annual vegetation of drift lines. The table below gives a breakdown of the main types of habitat. There are 124 communities described overall. Note that there is a cyclical process of habitat succession unique to shingle, related to particle size range and stability of the shingle structure. (see Doody 2003)
NVC	The NVC only describes part of the pioneer phase of perennial shingle vegetation found on the upper beaches of great shingle banks, namely: • SD1 *Rumex crispus – Glaucium flavum* shingle community	All examples of this NVC community and subcommunities on shingle are part of this habitat. There is a wider range of communities found on shingle, however. Some of these can be matched to other coastal NVC types (for example, maritime cliffs) or other noncoastal NVC types (for example, heaths or grasslands). These NVC types are shown as equivalents to the Sneddon and Randall shingle classification below.
Vegetation communities of Dungeness (Ferry et al. 1990)	This provides a detailed analysis of the range of vegetation types found on the largest shingle structure in Europe on both the upper beaches and inland on mature and stable shingle. The communities are described according to the sequence of primary and secondary colonisation.	The communities relevant to H1220 are C *Crambe* strandline (NVC equivalent SD1); B3 *Arrenatherum* grassland (NVC equivalent (MG1/MG1a); A2, A2S, A3 & B1 calcifuge grasslands (NVC equivalent U1/U1a); A2F Maritime *Festuca rubra* grassland (NVC equivalent MC8/MC8c/MC5); B2 wetland vegetation (NVC equivalent W24/M23); Scrub vegetation (NVC equivalent W23/W23b plus others with no NVC equivalent); *Geranium* community (no NVC equivalent)
EU Interpretation Manual	Perennial vegetation of the upper beaches of great shingle banks, formed by *Crambe maritima, Honkenya peploides* and other perennial species. A wide range of vegetation types can exist on large shingle structures inland of the upper beach. On more mature, stable shingle, coastal forms of grassland, heath and scrub vegetation may develop. Some areas of unusual vegetation dominated by lichens and bryophytes are found on more mature shingle.	Although only SD1 is shown as a corresponding NVC community, the range of communities is much wider, reflecting the variation in the habitat type. This variation is described in the Sneddon and Randall classification and the description of vegetation types found on Dungeness (Ferry et al. 1990), see below.
BAP priority habitat type	Coastal vegetated shingle.	The BAP priority type is broader as it also includes annual vegetation of driftlines.
CSM reporting categories	Coastal vegetated shingle.	The CSM category is broader as it covers all types of shingle habitat and also includes annual vegetation of driftlines.

Source: JNCC

2.62 Sneddon and Randall matched their community classification to NVC where appropriate, based on the closest match. However, in the context of the vegetated shingle communities there are a number of surveys that highlight that there are 'missing' NVC categories where the vegetation types do not follow the NVC categories and do not account for atypical and local specific classes. It is a recommendation from these surveys that the community classification for vegetated shingle might usefully be reviewed with the collated quadrat data for additional sites over those used in the current NVC.

2.63 Quadrat data will generally be matched, as far as possible, to the NVC community descriptions within the field survey. Rodwell acknowledged that in the case of vegetated shingle the NVC classes were not comprehensive and he did not use the data from Sneddon and Randall (1993) or Ferry (1998) to generate the community types so the classes within NVC may be less useful and limited to pioneer communities. Sneddon and Randall highlight the communities of more mature sites (more stable shingle) and their NVC equivalents from other habitat types scrub, heath and mature grasslands communities. Thus Sneddon and Randall classification may be preferable to NVC or IHS in this instance; or at least until the NVC community classification is extended. The cross tabulation which is due to be published online (most likely on the JNCC website) will make the Sneddon and Randall classification clearer to a wider range of users.

Survey approach

2.64 Survey planning and operation consists of a series of stages:

- Survey objectives
- Define survey objective
- Define scope of the surveyed parameters
- Select classification
- Select sampling strategy
- Define analysis and data management approaches

2.65 The specification of a survey approach depends on the objectives of the survey. In the context of a habitat inventory GIS data layer, typically only the outer boundary of the habitat is represented, rather than any habitat subdivisions, although within the context of the condition monitoring (JNCC 2004) the internal structure becomes relevant. However, the scope of surveys contributing to the inventory are typically undertaken as separate habitat surveys that *do* capture the individual habitats, matrix information, land use, environmental and management parameters that are later integrated into a habitat layer. This is the approach that has been adopted for the 1990 (Phase 2 2007) layer that have been derived from the Sneddon and Randall surveys and selected additional habitat mapping that undertook the detailed survey. Rarely have field surveys been undertaken specifically for just mapping the BAP inventory boundaries.

2.66 Hence the specification components presented here seek to define the elements needed within any vegetation survey that will subsequently be used to generate an inventory layer, in terms of internal habitat boundaries, quadrats to help define classification, attributes and associated environmental information. Some survey types will be easier to extract the relevant elements for the inventory than others by virtue of the quality of the habitat mapping and the classification of the habitat employed.

2.67 It is also relevant to examine the mapping of non-vegetated shingle resource. This is a different target to terrestrial habitat surveys which tends *not* to include 'bare ground' in quite the same way. In order to examine these factors the surveys here have included a range of descriptive elements, quadrats and environmental variables.

2.68 Survey specification here generally follows principles established within the review of the Maritime Cliff and Slope inventory (Hill and others 2002, Hill and others 2006) and GeoData 2007 Maritime Cliff and Slope Inventory 2004/05 NERR 003. This approach sought to develop a standard that was suitable for BAP inventories and since one inventory should match the

standards of other inventories if they are to be used together it is important that common standards are used. However, since the start of this work in 2002 further developments have taken place, including wider use of other classification systems (IHS), further advice on habitat mapping and NVC quadrat surveys (Rodwell 2006) and the production of the Common Standards Monitoring protocols to consider (JNCC 2004) as well as improved resolution datasets available within the coastal zone (Channel Coast Observatory aerial photos and Lidar data; false colour infrared aerial photos).

Quadrat parameters

2.69 Parameters are to be captured, based on the following elements (Table 3) and described for each quadrat sample. The approaches are designed to be rapid assessments rather than detailed repeat measurements. In addition, broader scale, site-level descriptions of the site are included to characterise the wider area (Table 4).

Table 3 Physical Environmental data parameters from quadrats

Parameter	Description at a quadrat
Average Vegetation Height/s	Estimated height of the vegetation within the quadrat for i) ground layer, ii) field or sub-shrub layer, iii) shrub layer/understorey and iv) canopy. All measurements should be in metres.
Altitude (proximity to tidal frame / sea level rise)	Not so relevant in vegetated shingle, and may be determined from secondary sources (Lidar) more easily than from the ground.
Slope	Slope measurement (degrees).
Aspect	Octants (compass directions).
Geology of substrate	Principal geology of the shingle material (for example, chert, flint, shell).
Matrix materials	Estimate of the extent of matrix (sand, soil debris) within the shingle and the extent of litter.
Substrate Particle Size	Particle size based on B axis measurements or estimated based on Comparison Cards categories.
Sorting	Extent of sorting of the particle size. Based on comparison card estimates.
Succession signs	Signs of succession: variations in the vigour of species, the predominance of growth phases, the age structure of populations of individuals, or signs of senescence, death or regeneration as indicated by Rodwell (2000).
Internal morphology	Morphology at the location of the quadrat / habitat for example, apposition ridges.
Management	Management classes within the vegetation adjacent to the quadrat: grazing (by which stock), recreational, cutting etc.
Land use	Land use within the vegetation adjacent to the quadrat – broadscale classification of the land use.
Pressures	Pressures and impacts adjacent to the quadrat location. Grazing (all types of stock), recreational pressure, waste disposal etc.

Table 4 Parameters at a site level

Parameter	Description at a quadrat
Morphology	Morphological type, More than one class may apply Fringing beach, majority of beaches – parallel and connected to the backshore Apposition beach, / Cuspate foreland (for example, Dungeness, Kent) Shingle Spit, (for example, Pagham, East Sussex) Shingle bar, (for example, Chesil Beach, Dorset) Barrier island, (for example, Scolt Head, Norfolk) Chenier (for example, The Solent, Hampshire
Management	Management actions on the site – general description
Land use	General level land use of the site
Pressures	Pressures and impacts adjacent to the quadrat location. Grazing (all types of stock), recreational pressure, waste disposal, etc

2.70 Data sources used for the surveys or other habitat mapping will include (Table 5).

Table 5 Data Sources

Data Source	Description
Aerial photography – colour	Vertical aerial photography used to defined the boundaries between habitats, and the extents of matrix vegetation classes, site pressures and modifications.
Aerial photography (false colour infrared)	False colour infrared data are available for some coastal localities at variable resolutions and may enhance the ability to distinguish the shingle vegetated areas.
OS MasterMap	Used as the basis for capturing habitat extents where the habitat boundaries match features represented in the topographic mapping. This includes the extent of the High and Low Water Marks as represented on the OS MM data.
Lidar	Terrain data that can help evaluate the morphological pattern of the vegetated shingle areas.
Other habitat inventories	Past inventory and habitat survey information will prove useful in establishing the potential extent of the areas. Wetland and other coastal and transitional habitats mapping provide a basis for checking the boundaries/transitions of the vegetated shingle habitats. Dune and coastal wetland inventories (saltmarsh, fen) are relevant but other coastal vegetation, grasslands, woodlands may also form terrestrial transitions.

2.71 These sources will be used to familiarise the surveyor with the site and habitats. Where past surveys exist these will be helpful in this familiarisation process and can help to establish the likely size of the habitat and flag areas where there are discrepancies between previous surveys and the current vegetation pattern (either through change or original omissions etc). These data sources also help to determine the boundaries of the vegetation and the extents of any bare shingle or excluded areas within the shingle complex.

Generic survey specification

2.72 The current requirements include:

- Mapping the extent of homogeneous vegetation stands within vegetated shingle
- Transect and Quadrat surveys
- Photographs
- Creation of geospatial files

Seasonality

2.73 Ideally, survey would be undertaken from late Spring to the end of August, although some annuals may be lost in later surveys, and driftline vegetation is usually only evident in later months. Surveys should avoid very dry periods and heavy grazing pressures that can affect the ability to identify species.

Quadrat and transect approaches

2.74 Transects to be taken across the shingle from the foreshore extending beyond the last habitat that is considered to be vegetated shingle (so that the adjacent habitat is also described). The number of transects within a site is not fixed and can be selected based on the complexity of the vegetation pattern present and the morphological formation of the shingle. The transect forms a standard repeatable alignment that allows for analysis of changes in widths of communities and the validation of habitat boundaries. Note: the coastal shingle CSM guidance (JNCC 2004) recommends a 'W' structured walk within each surveyed unit, with 10 stops in a unit, but this is addressing a condition assessment objective rather than a baseline habitat mapping requirement. CSM also recommends transects for zonation.

2.75 Mark the transect on a map or aerial photograph. GPS grid locations should be used if possible to 12 figures. Along the transect mark the points at which in the field the community type changes. There is a degree of subjectivity where transitions are not clear, but this acts as a guide to aerial photographic interpretation of the habitat boundaries. The boundaries can be classified into simple classes to express uncertainty (sharp (S), diffuse (D), convoluted (c), gradual (G) , complex mosaic (M)). These initials should be drawn on the map to describe the boundaries between communities (as shown below in the image below, an example only). This mapping forms a ground validation of the more generalised habitat mapping (7).

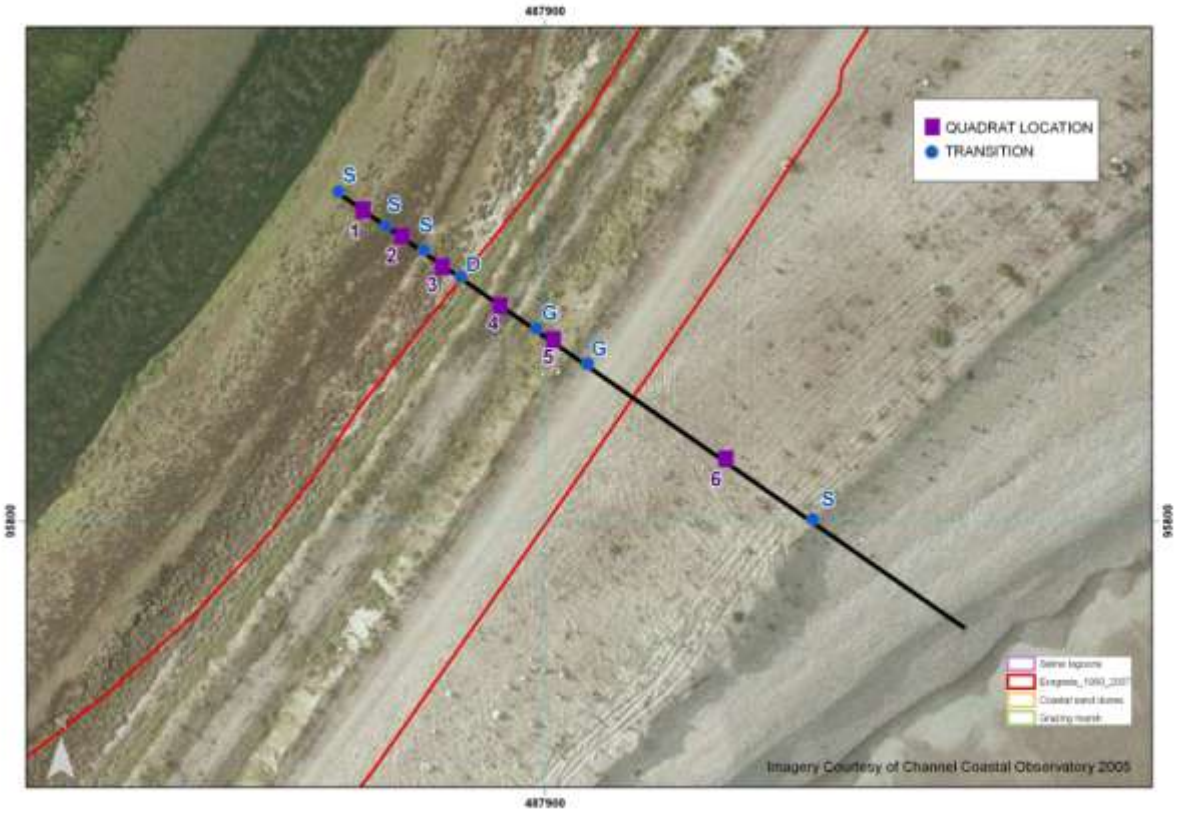

Figure 2 Quadrat and transect mapping, showing community transitions

2.76 Quadrats to be taken at appropriate scales, typically this will be via a 2 x 2 m (for vegetated shingle 5x5m may be a better standard size with smaller 2x2m quadrats for grass dominated communities) (4m2) quadrat, but may be larger within woody vegetation communities. Quadrats to be located within each homogeneous vegetation type. The need for multiple quadrats within a stand should be considered, but may not be needed to identify the vegetation type.

2.77 Employ the Domin scale if collecting cover / abundance values. Domin values for the cover can exceed 100% cover because of overlap.

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

2.78 Positions of the quadrats, photos, target notes should be referenced via a 12 figure grid reference and marked on map.

2.79 Record the environmental and characterising variables at each quadrat, but also note general conditions across the site (for example, land use factors, management, changes, erosion, grazing, trampling, mowing, burning and amenity etc). Effort should be made to ascertain the origins and influence of these factors from land managers and ground observation. This should also cover negative indicators including non-native species (eg *Lupinus arboreus*, *Centranthus*

ruber, Tamarix gallica), invasive species indicative of changes in nutrient status (eg *Urtica dioica, Cirsium vulgare*) and species not characteristic of typical communities (eg *Pteridium aquilinum*).

2.80 Record species within the stand but outside the quadrat, especially if these species are rare or threatened.

2.81 The exact survey approach may depend on the resources available and the objectives of the survey. Typically, cover and abundance of species including lichens and bryophytes would be needed, but alternatives of presence / absence of species, or of a more limited set of angiosperms may be recorded. However, if the surveys are related to condition cover/abundance of all species may be preferable.

2.82 Documentary evidence is needed of the community classes within the specific issues being investigated (for example, boundaries) and therefore quadrats are required. However, quadrat data from surveys should be visually matched to the NVC using the surveyor experience and to the Sneddon and Randall vegetation classes, based on the habitat descriptions. Identification to sub-community level should also consider closeness of fit to NVC. Use of computer aided vegetation classifications such as MATCH or TABLEFIT are considered to be of little value in shingle vegetation classification due to the limited coverage of shingle vegetation in published volumes of the NVC. In the case of habitats not matching to the NVC classes, these should be described and interpretation of the habitat made.

2.83 Where mapping the extent of habitat polygons in the field these should be mapped onto the aerial photograph to identify the major vegetation boundaries – to mark polygons of more or less homogenous vegetation (composition and structure) where these are above 0.1ha. Ground truthing and the transect data (2) will help delimit the boundaries. The identification of the homogeneous stands is based on expert judgement using vegetation pattern and vertical layering. Inclusion of bare shingle within the habitat mapping area (the macro polygon) is typically done by exclusion (not mapped) but within the inventory these areas are mapped as included within the inventory layer.

2.84 A vertical photograph of each quadrat area to be taken, with scale (for example, ruler, or quadrat). The objective of this is to assist in the classification and characterisation of the substrate.

2.85 Oblique photographs along the line of the transect to be taken to illustrate the features and vegetation.

2.86 Other descriptive photos, special features etc that illustrate pressures, management and other changes should be taken and referenced with a twelve-figure NGR plus the octant (compass direction).

2.87 Target note locations should be stored as a single GIS table (or geodatabase), using the table template supplied by Natural England **http://naturalengland.etraderstores.com/NaturalEnglandShop/TIN010**. 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):

- **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);
- **target_ID** (character) - each point feature should be given a unique alpha-numeric value based on a combination of the site code (for example, 31WHJ) and a concurrent numeric value for each point. Therefore 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. These should be no more than 254 characters.

2.88 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.

Quadrat data are entered into an EXCEL spreadsheet. Spreadsheet data should be compatible with NBN entry requirements.

Photographs

2.89 Digital site photographs should be generated to a minimum resolution of 3 megapixels, 24 bit images. Higher resolutions should be used where appropriate to the local detail. The specifications recommend that a spatial link will be made between the image file and the GIS, even if this is not part of the vegetation survey deliverables.

2.90 The minimum attributes for the photo files should be:

- **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/character) - each photograph orientation should be recorded based on compass bearing or octant;
- **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.
- **X coordinate** (6 fig) of each photo location
- **Y coordinate** (6 fig) of each photo location

Mapping of vegetation and habitat boundaries and associated data

2.91 This specification provides a minimum requirement for field mapping of habitat boundaries, although the boundaries are likely to be refined when field data are digitised. Proposals for GIS mapping of community boundaries essentially follows GeoData 2007 for habitat mapping; although some specific updates to the habitat classifications may warrant changes to the attribute tables.

2.92 Mapping on site should normally be of the communities comprising the macro-polygon. Hill *et al* (2002) defined a *macro-polygon*, as encompassing all the vegetation community polygons comprising a survey area. The macro-polygon (the extent of the survey) may not necessarily be the extent of the Vegetated Shingle habitat inventory layer depending on the objective of the survey, as some vegetation polygons may be omitted as not forming part of that BAP habitat extent or may relate to other BAP inventories.

2.93 The *vegetation polygons* are those polygons that delimit the different vegetation types within the survey. A separate table, *vegetation mosaic*, holds the entries for the component vegetation communities within a vegetation polygon and is in a ‘one to many’ relationship with the vegetation polygon.

2.94 These mapping and recording approaches were based on the use of MapInfo and used tabular structures to record attributes for each vegetation polygon and the mosaics and percentages (where these existed). The approaches have evolved and Natural England is now adopting new data structures and software that may alter the most appropriate recording formats. The increasing use of the IHS classification systems, with its complex of *habitat, matrix, formation, management* and *complex* prompts an additional attribute table structure in order to record these variables. However the resulting BAP inventory attributes may differ from the detailed habitat mapping requirements.

2.95 GIS mapping / digitisation approach:

- Define the extent of whole polygons of OS MM even where only part of the polygon is vegetated shingle. Over-plotted aerial photos with OS MM vector topographic data will assist in matching boundaries to the features on the map.
- Map *macro polygons* using AP interpretation and Lidar etc, these are essentially the outer extent of discrete polygons of vegetated shingle (or other habitat mapping). Map the homogeneous vegetation boundaries (*vegetation polygons*) and any exclusions (for example, built up areas, concrete, etc). These are mapped and attributed in the same way, but given specific codes to indicate the cover / use etc.
- Mapping should be to OS MM topographic features wherever the alignment of the habitat boundary closely matches the underlying topographic detail. Where the habitat boundary does not match, capture to create a natural habitat boundary alignment at a sufficient resolution to provide an accurate depiction of the area at the source mapping scale. All boundaries should be topologically complete. Where vegetation boundaries do not match boundary or features on the OS MM data the boundary of the vegetation should be followed and the OS MM polygon spilt and attributed accordingly. All polygons formed by the mapping should be attributed, even if there is an unclassified area, in which case it must be so marked.
- Record the vegetation polygons to a minimum habitat area of 0.1 ha (although exceptions to this may be defined for specific features (for example, cheniers). All vegetation polygons should map within the macro polygon boundary and where the boundaries are the same the individual vertices should be coincident between the two datasets.
- Excluded areas (for example, developments) within the macro polygon may either be attributed appropriately or excluded. In the case of naturally bare or disturbed shingle it is recommended that these are separately attributed as the bare shingle may form part of the inventory layer and it will be easier to extract if the classification is ascribed at the time of survey.
- Record the locations of interest features where taken, for example, flushes, outflows, structures where these are not mapped as specific habitat polygons. These can be mapped and commented as target notes against a Target_ID and Target_Note. All point-level information should be treated as separate features and mapped separately. Thus photographic locations, interest features/Target notes will have separate layers, or separate features within a geodatabase.
- Record any Target Notes against a unique reference number and locate using a 12 fig NGR (and or mark on a large scale plan).
- Compare the mapping with adjacent habitat inventory results to establish any overlap or resolution of overlaps.
- Quality assure and validate:
  - the topological accuracy of all records
  - all polygons have habitat attributes
  - point-based layers (photos / target notes) to be accurately mapped and attributed
- Appropriate level metadata should be generated for the vegetation map using the UK Gemini standard. Metadata records for the 1994 and the 2008 data layers are provided in Appendix 1.

Field survey outputs

2.96 The field survey outputs should include:

- Standard formats of quadrat datasets (as EXCEL file)
- Transect data and other feature /photo data and related GIS layer
- Derived habitat map in GIS formats
- Report that describes *inter alia* the community classification and community match to NVC.

Analysing the data to generate the Inventory layer

2.97 The field survey output does not explicitly or automatically generate a BAP inventory layer, there is some QA and processing that may be required to generate the appropriate inventory layer.

2.98 The development of the inventory has to be judged on the basis of the polygon areas selected. If a large area is chosen as the habitat unit then a macro-polygon may not qualify as a BAP habitat if the parcel has less habitat than the qualifying area / percentage for the BAP habitat. Given the scale of the minimum mappable unit (0.1ha) this should help define and guide whether parcels are divided to ensure that shingle communities are included (especially where these are narrow linear forms).

2.99 The inventory layer will be developed as the field survey macro-polygon boundary minus any number of polygons that do not match the mapping rule base for vegetated shingle (for example, below mappable unit) or where the habitats mapped from the field survey relate to other inventories.

2.100 This process should be undertaken as a processing query and the results validated against aerial photography and individual site knowledge.

2.101 The inventory layer will have a different attribute structure to the field survey data thus translation to the appropriate structure will be required.

2.102 A generalised BAP habitat inventory layer that matches the mapping rule base and attribute standards should generate appropriate MEDIN metadata, this will be a different record to that of the vegetation survey.

3 Component 2 – Validation site survey and collation of information

Validation site survey

3.1 A site survey programme was undertaken as part of this project. This was not a full ecological site survey but an assessment of sites to resolve some key issues for inventory mapping and to provide focused examination of survey methods on shingle and adjacent habitats. Thus the methods used within this validation survey may not be appropriate for future surveys, depending on the objectives.

3.2 The survey consisted of prioritising sites for field surveys, rapid site survey and generation of site level profiles and input to the 2008 layer generation.

3.3 The surveys undertaken within the context of this programme have concentrated on specific aspects of defining the inclusion of habitats within the shingle vegetation community and the condition of the habitat. This has concentrated on the boundaries of the vegetated shingle and other habitats, especially where there are complexities of classification and the parameters that are measured as part of the Common Standards Monitoring from which quality assessment is made.

3.4 Survey work for this project was conducted from August to early October. This was not an ideal time for ecological purposes or CSM monitoring requirements, but was considered suitable for resolving some of the mapping issues. The original intention was to test the method in the field and review if needed, but time was not available to achieve this due to a later project start than anticipated.

Priority Sites for Ground-truthing [2a]

Overview

3.5 This section briefly lists the sites selected for field validation surveys in order to assess the extent and quality of coastal vegetated shingle habitat.

Rationale for sites selection

3.6 It was originally intended that the site selection be based upon a multi-criteria assessment of the different sites in terms of what they might contribute to the study. This was to include factors such as size, type, existence of recent habitat survey etc. Unfortunately, due to the necessity to mobilise the field surveyors before the end of the season, a pragmatic approach to site selection was taken. This involved working with the Steering Group and using the ecological expertise and local knowledge of the project team to complete a criteria spreadsheet . There was also extensive discussion on this with the project lead and site staff in order to ensure that the sites selected were appropriate. The results of the Doody (2009) evaluations of sites contributed to site selection. Some of the sites included in the revised site selection spreadsheet may be artificial shingle (i.e. brick and other introduced rubble), now colonising with vegetated shingle species (for example, Sefton) as highlighted in Natural England's dataset, but are included here for completeness.

3.7 The criteria spreadsheet is held by Natural England as it will be relevant to future survey requirement and priority setting. This document is available digitally as a project output in Microsoft Excel format.

3.8 The sites selected were largely determined by:

- Geographical feasibility given the budget for this project. This excludes the Isles of Scilly and sites in north west England but also allowed several sites to be covered in a single visit.
- Guidance of experts – based upon their experience and knowledge of the sites and their issues.
- Project Steering Group's comments (including those of National Trust who own a range of shingle sites).
- Availability of Recent Survey: obviously there is little point in visiting somewhere that has been thoroughly surveyed recently. This excluded Snettisham, Chesil and the Sussex sites covered by the *Beaches at Risk* surveys. In some instances while we were aware of a potential survey it was not always possible to know if it covered the entire area of interest.
- Potential to Highlight Issues Relevant to this Study: These would include boundary issues with other habitats, and man-made features, evidence of past disturbance and potential for re-colonisation etc.

Sites Selected

3.9 The selected sites along with a rationale for their selection is given below (Table 6 and Figure 3). Sites are divided into East of England sites and Southern sites based on a pragmatic requirement to divide the field validation activity between the surveyors. The sites are considered to reflect the broad range of types, size classes and give a reasonable geographic spread given the project constraints and also represent the range of issues within the limitations of the scale of the survey.

3.10 Whether the spread of sites chosen are characteristic of all sites covered by the inventory is uncertain, and it is appreciated that north west England sites and the Isles of Scilly sites may be important floristically, but are not selected here. However, the target of the ground survey was less focused on the habitat community classification and was sufficient to explore the validation / boundary issues that are the focus of this project and the evaluation of the field survey methods.

3.11 Some fringing beaches were not included in the sites selected because they were not covered by the Sneddon and Randall (1993) surveys which meant that analysis of change was not possible. In addition, the vegetated shingle is often patchy in such locations and it was felt that this was not the best use of the limited survey time available, despite the potential for some of these sites being important for individual species.

3.12 Elsewhere, sites were selected for survey based on the fact that they had ***not*** previously been surveyed or included in the Phase 2 1990 inventory and represent gaps in our understanding both of significant sites and their communities (for example, Hurst Spit, a heavily modified site and the Lymington cheniers, due to the unusual nature of this type of shingle feature).

Table 6 Site selection for field validation

East of England sites	Rationale for inclusion
Blakeney Point, extending to Cley / Salthouse ridge	A large site, barrier / spit feature that has boundaries with sand dunes changes to flood risk management on part of site since original survey.
Sizewell and Thorpeness	Fringing beach / apposition beach – modified and with the potential to explore recovery. Difficulties highlighted at landward boundary. Issues with Power station.
Orfordness	Contrast of disturbance types, also impacts related to shingle recycling operations for flood risk management on part of the site.
Shingle Street	Site has apparently reduced in size over time.
Landguard Common	A smaller site not typically receiving much attention.
Southern sites	**Rationale for inclusion**
Rye Harbour	Apposition beach, changes to flood risk management since original survey, range of disturbance.
Pagham and Church Norton	Spits, Interesting human disturbance (breach), recent change, boundaries with saltmarsh.
Browndown	Apposition beach – former military use, disturbance and longer term recovery.
Pylewell and Keyhaven	Cheniers / small scale site, not studied recently.
Hurst Spit	Heavily modified Spit, saltmarsh boundary, not studied recently.
Porlock Beach	Fringing beach – that has changed its position and shape since original survey in 1990 due to cessation of shingle recycling, larger shingle grain size at this site.

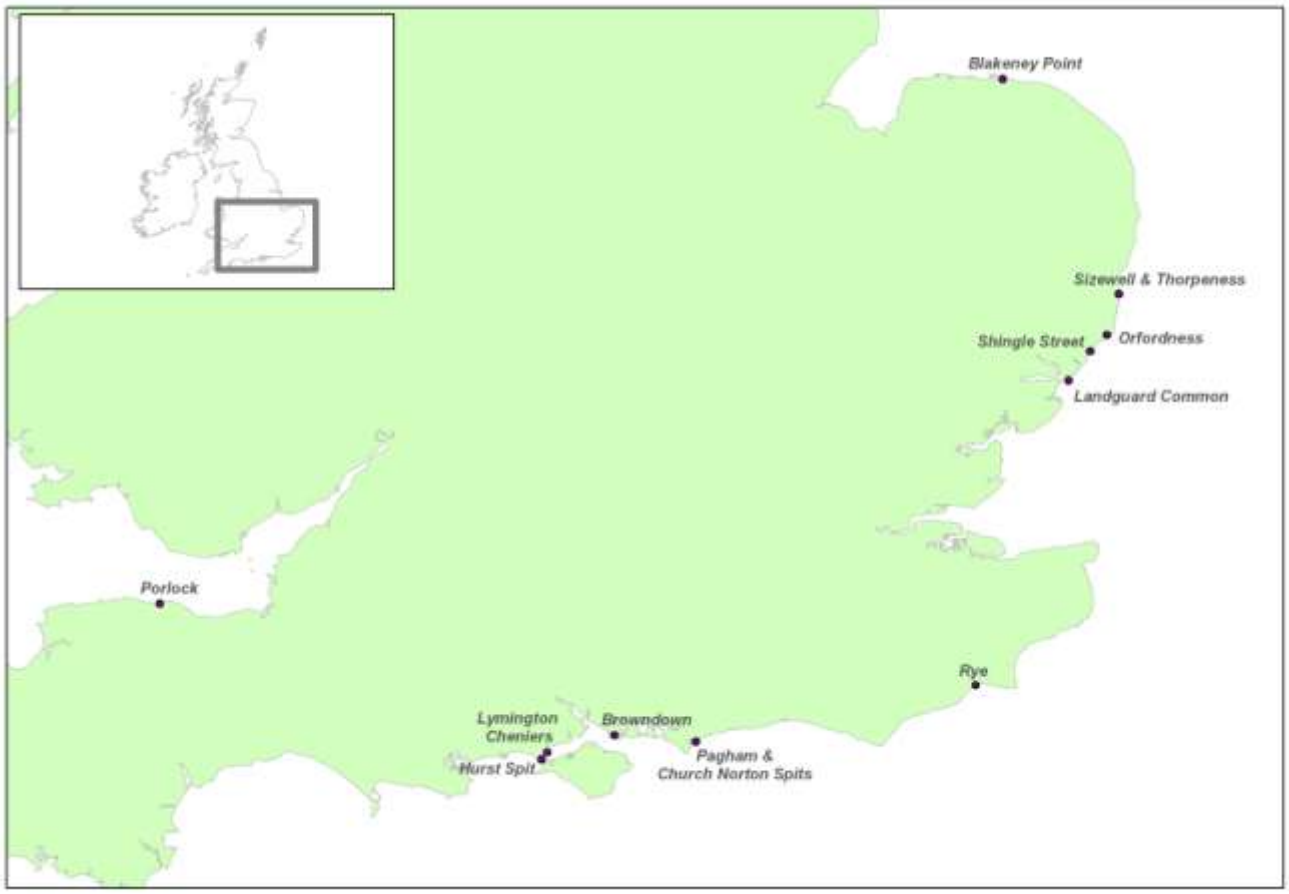

Figure 3 Locations of field validation sites

2b Survey of Selected Sites

3.13 Forms were designed for the quadrat attribute collection (Table 7) although in the event the surveyors typically used their own forms for species recording, but these illustrate the datasets anticipated at a quadrat site. This form therefore provides a reminder of the attributes appropriate to collate at a site.

3.14 Site level maps and aerial photos were provided as the basis for mapping and navigation. Access arrangements were agreed in advance for all site surveys.

3.15 Maps available for surveys were for:

- navigation to and orientation within the sites. These are based on the Ordnance Survey 1:10k raster data.
- location of specific communities / target notes within the site. These are based on the aerial photography and where available, false colour infrared.

3.16 Maps were produced to also show the extents of the existing shingle inventory where this existed as well as other coastal inventory layers. Maps were provided with a 100m grid over them and produced at a 1:2,500 scale for mapping work.

3.17 Surveyors noted that printouts on glossy paper were clearer and easier to interpret than standard printed paper.

3.18 Example field maps shown below for Pagham / Church Norton (Figure 4 and Figure 5).

Table 7 Shingle Inventory validation Survey Form

Site No			**Quadrat No**			**Quadrat Grid Ref.**	
Site Name							
Geology	Chert		**Substrate**	Coarse sand		**Management (D/P)**	
	Flint		**(D/P)**	Very coarse sand		Grazing (sheep)	
	Shell			Fine gravel		Grazing (cattle)	
	Other			Medium gravel		Grazing (horses)	
Aspect (octant)				Coarse gravel		Cutting	
Slope (deg)				Fine cobble		Fencing	
				Coarse cobble		Agriculture	
Vegetation hgt m)			**Sorting**	Very Well		Plantations	
ground				Well		Restoration	
field or sub-shrub				Moderate		**Pressures**	
shrub /understorey				Poorly		Recreation	
canopy						Extraction	
Angularity	**Sphericity**		**Matrix**	Sand		Waste disposal	
Angular	Low (flat)			Soil /silt / clay		Erosion	
Sub-angular	Medium			Litter/OM		Encroachment /dev	
Sub rounded	High			None		MOD training	
Rounded	V. High (Sphere)					Vehicle damage	
						Invasive	
Photo number						Recharge	
						Sea defences	
						Reprofiling	

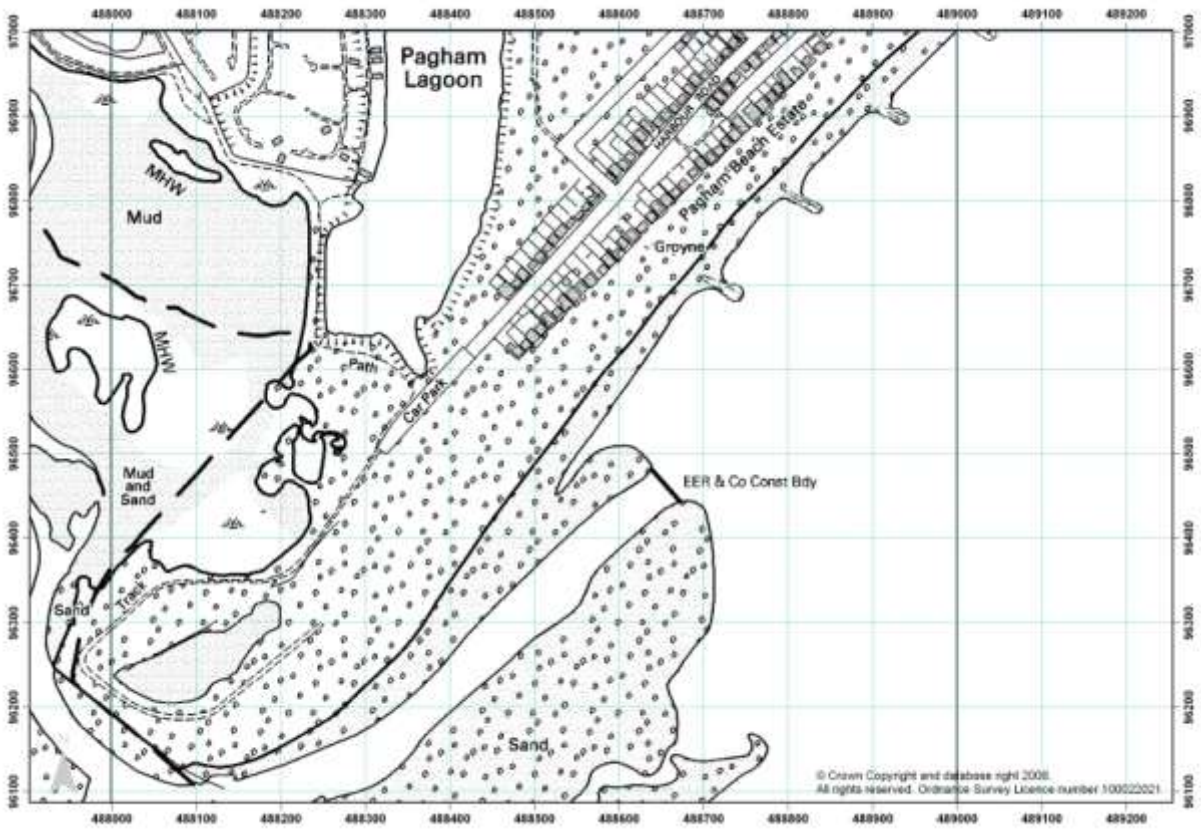

Figure 4 Example field map for site surveys

(Imagery Courtesy of the Channel Coastal Observatory. **www.channelcoast.org**)

Figure 5 Aerial photograph for field mapping and showing former inventory extent

Species information (2c)

3.19 Species level information was sought for the surveyed sites to assist the mapping and increase confidence if ascribing parcels to coastal vegetated shingle. The species spreadsheet for each site is provided with the site profiles.

3.20 This species list was provided by Natural England and was based on recent research (Webb et al, 2010) to identify species that are specifically characteristic of particular BAP habitats, including vegetated shingle. The list was derived from the Natural Environment Rural Communities list (which itself is largely derived from BAP list) through consultation with experts in Natural England and other NGOs. It is acknowledged that the list is incomplete, some species have a very limited distribution and many more species (including rare and Red Data Book species) can occur in mosaics of shingle and other coastal habitats. (See Appendix 2, which covers vascular plants and invertebrates). However the list represents a starting point for linking species to habitats.

3.21 *Limonium* was included in the list of species however *Limonium* species are no longer BAP–listed following 2006. The recent molecular research and re-analysis of data carried out by Kew and funded by English Nature has clarified issues relating to the taxonomy of this species and in doing so undermines the present taxonomic treatment of the group in that very little genetic variation across the aggregate has been shown (although morphological differences occur). The work suggests that the aggregate is neither rare, threatened nor, as a whole, endemic. Publication of this work is awaited. (Simon Leach, Natural England. *pers comm*.)

3.22 Data for species were requested from multiple sources including: Local Record Centres, NBN and reserve managers etc.

Table 8 List of species of BAP significance

Species	Common name	Division	Class	Typical habitat
Galeopsis angustifolia	Red Hemp-nettle	Vascular plants	vascular plant	coastal sand and shingle
Pseudeuophrys obsoleta	a jumping spider	Terrestrial invertebrates	spider	shingle and beaches
Philorhizus vectensis	a ground beetle	Terrestrial invertebrates	beetle	coastal shingle and soft rock cliffs
Bombus subterraneus	Short-haired bumble-bee	Terrestrial invertebrates	bee	coastal dunes, vegetated shingle
Pyropteron chrysidiformis	Fiery Clearwing	Terrestrial invertebrates	moth	cliffs and vegetated shingle
Temnothorax interruptus	Long-spined Ant	Terrestrial invertebrates	ant	coastal vegetated shingle
Salticella fasciata	Dune Snail-killing Fly	Terrestrial invertebrates	fly	dunes and shingle
Lactuca saligna	Least Lettuce	Vascular plants	vascular plant	sandy shingle; sea wall
Crepis foetida	Stinking Hawk`s-Beard	Vascular plants	vascular plant	shingle
Sterna dougallii dougallii	Roseate Tern	Vertebrates	bird	shingle and offshore islands
Thalera fimbrialis	Sussex Emerald	Terrestrial invertebrates	moth	vegetated shingle
Idaea ochrata subsp. *cantiata*	Bright Wave	Terrestrial invertebrates	moth	vegetated shingle, sand dune
Scleranthus annuus	Annual Knawel	Vascular plants	vascular plant	(shingle)
Scleranthus annuus subsp. *annuus*	Annual Knawel	Vascular plants	vascular plant	(shingle)
Salsola kali subsp. *kali*	Prickly Saltwort	Vascular plants	vascular plant	sand and shingle beaches; drift line
Limonium species	Sea Lavenders	Vascular plants	vascular plant	Shingle, saltmarsh muddy saline lagoons

Source Webb *et al*, 2010

Challenges in accessing the species data

3.23 The England Biodiversity Strategy stresses the importance of integration between action at a habitat level to provide benefits for species. There are a wide range of data on species. This project aimed to demonstrate the practicalities of linking species data into habitat datasets to help target relevant actions.

3.24 Sourcing species level information is not without some challenges in the selection and resolution of the data, that makes use of the information for site based assessment difficult:

- Some LRCs are able to take GIS layers of a search area and supply back as GIS site records, others provided access to their records that have been placed on NBN.
- Non-standard records may be returned (GIS layer as points, GIS layer as polygons – with records stacked at the same geographic location, NBN access and download, with NGR's in 'non-GIS friendly formats' and at different resolutions (for example, SU34, SU3142 etc).
- Non-standard attributes (not all records had dates and or ranges of dates, for example "1850 – 2009") which may not fulfil the role for species information within inventory mapping.
- Georeferencing of the records - it is not always clear whether records are in the search area or are for the species records themselves.
- There is also known to be significant under reporting (for example, in well studied areas such as Blakeney).

3.25 The difficulties of data collation at site level would most likely also apply for other rare/red-listed species and would represent a considerable undertaking at a national level. The collation work undertaken here for BAP-list species highlights the issue but further work is recommended on the standardisation of species records as this would better suite this type of evaluation and allow for much wider comparisons.

Analysis of change between 1994 - 2008

3.26 Analysis of change in the extent of habitat parcels was undertaken for the 12 sample sites. It was not possible to run this analysis across the whole of the English inventory dataset as the quality of the 1990s data would not support effective comparison and statistical presentation; too many of the sites were not represented in the earlier inventory and many of the other sites were incompletely covered to provide a valid interpretation of habitat extent change. However, for a smaller number of sites it is possible to look in more detail at the extent and nature of the changes.

3.27 Change analysis relies on the GIS comparative analysis of the 1990 layer Phase2 versus the 2008 layer, offering a period of around 16 or more years of change. In fact, the period over which change is analysed will vary across the datasets as the original survey dates from which the England inventory is built range from 1988 to 1990. As far as possible the dates of origin of the data are defined.

3.28 exeGesIS SDM Ltd and Doody (2009) undertook some cleaning and augmentation of the 1990 Phase1 layer (Land Use Consultants, 2004) inventory in the 2007 work, and also highlighted areas where they considered there were potential shortfalls in the 1990 Phase 1 inventory coverage of the habitat. The processing also corrected for the Positional Accuracy Improvement (PAI) – such that the data are better aligned to OS MM. It is this dataset (1990 layer Phase 2), developed to represent the 1990s extent of shingle habitat, that has been used for the comparison.

3.29 The analysis of change also relies on having data files that are topologically correct, that the extent of the 'site' is known and equivalent between periods. These conditions are not always met and therefore there are challenges to assessing change reliably. In addition the volume of material making up the site could also change significantly. This was not assessed here and would require analysis of LiDAR data for the different periods.

Table 9 Analysis of change in BAP habitats between 1990 and 2008 inventories

Surveyed site	1990 Area ha	2008 Area ha	Change Area ha	Comments
Blakeney Point	121.0	78.9	-42.1	The area at the end of the spit is uncertain but it is noticeable that the 1990 data showed shingle extending to the end of the spit and recurved section.
Sizewell + Thorpeness	133.4	38.7	-94.7	The extent at this site is much smaller than that depicted in the previous inventory. The area to the north of Sizewell becomes sandy with the depth of sand greater than 30cm and therefore cannot be classed as vegetated shingle. In addition, the long strip of fringing beach which extended this site in the previous inventory all the way to Kessingland is either made up of sandy substrates, or is no longer vegetated due to the dynamic nature of the sediments. Between Sizewell and Thorpeness the shingle is now unvegetated, due to the dynamic of sediments and human disturbance along the Aldeburgh frontage.
Orfordness	412.4	*508.7*	*96.3*	Orfordness extent has increased in size as the previous surveys did not include the large 'fan-like' structures associated with the BBC World Service radio mast locations (although these deposits are highly disturbed, the vegetation present is classified as shingle habitat).
Shingle Street	18.9	43.9	+25.00	The vegetated shingle extent was artificially truncated in the1990s layer which simply copied the map from Sneddon and Randall Appendix 3. The site extends some way southwards. There has been some erosion of the shingle, leading to the loss of the habitat (SH36) shown in the Sneddon and Randall, 1993 report (Appendix 3 - England), this shingle appears to have moved along the beach to build out on the earlier extent around the Coastguard cottages.
Landguard Common	24.8	27.8	-3.0	There were very minor changes associated with the definition of the back of site in the 2008 layer. This site has expanded along the foreshore due to accretion, since the 1990s layer was produced.
Rye Harbour	234.9	165.0	-69.9	There is quite a discrepancy between the 1990s layer and the 2008 layer here. We had the view that at Rye intact shingle structures supporting semi-natural vegetation should be included in the inventory as should disturbed shingle supporting coastal vegetation. Other disturbed shingle with no coastal influence or shingle vegetation could be targeted for restoration but were not included in the inventory.
Pagham and Church Norton Spits	43.5	58.7	+15.2	A good like-for-like comparison here in terms of the overall extents captured by both inventories, although the site has been extended southwards to capture some adjoining fringing beach. Some small modifications have also been made at the back of the site which affect the extent. However, this site has undergone significant coastal change of the spits themselves with the reworking of the spit most noticeable on the Church Norton side - the tip of the spit has extended over 650m from its previous 1990 location. Pagham spit is defended and the shingle has only really extended on the seaward facing section of the spit.

Table continued...

Surveyed site	1990 Area ha	2008 Area ha	Change Area ha	Comments
Browndown	59.4	52.4	-7.0	Nearly all the change between the 1990s (Phase 2) and 2008) inventories was due to data capture staff making modifications to the boundary at the back of the site. The data capture team who created the previous inventory highlighted the woodland at the back of the site as suspect and following the site visit, this was confirmed and has been excluded from the 2008 layer, with the landward extent being determined by the significant break in slope adjacent to the path at the back of the site. There has been a minor natural change in extent at the vegetated shingle extent along the foreshore but this is compensatory, eroding in one place and accreting further along the beach.
Pylewell - Keyhaven chenier banks (Hants)	N/A	1.3	N/A	The Chenier banks of Pylewell and Keyhaven were not surveyed in the 1990s work, they contribute a further 1.3 ha extent to the inventory. The dynamics of these sites makes change analysis difficult as both the shorewards and backshore positions change and the general shift of the extent of the saltmarsh over which they sit has also moved landward in most cases. The project team noted significant shifts in position and extent of these features over different aerial photographs taken only a few years apart. Change analysis is more appropriate of total extent rather than the changes at or within a site.
Hurst Spit	N/A	18.2	N/A	Hurst Spit was not surveyed in the 1990's work and although in parts this is artificial and heavily disturbed, the site does contribute a further 18.2 ha to the inventory. The historic extent of the Hurst Spit vegetation could be generated from the extensive mapping and aerial photo archives for the area, including false colour infrared images from the 1990's. However, this was beyond the scope of this project.
Porlock Beach	35.7	5.2	-30.5	The extent of vegetated shingle here is much less than that depicted in the previous inventory. There are large areas of unvegetated cobble that are not really 'shingle'. It was felt that it would be difficult to include these as vegetated shingle, although the substrate is mixed. Some of the larger boulders support a range of lichen species.

3.30 A number of potential errors in the analysis of change may arise:

- The original Sneddon and Randall work (the main source for the 1990's layer) only covered the perennial vegetation of stony banks and not the drift line communities – and although some drift line communities are included in sites that Sneddon and Randall mapped the main drift line areas are excluded – therefore this habitat type has been excluded from the original inventory data.
- 1990 data snapped to OS Land Line MHW, but as shown here this may not represent the appropriate boundaries in locations where the coastal processes produce dynamic shingle forms.
- The original 1990 layer was based on varied date data, up to 2003 within the MAGIC distributed layer (dating from 2004 for the Younghusband 2003 surveys). So the actual period of the 1990 layer spans a broad period so comparison of change will be influenced by the period between the previous survey and this new layer which has a smaller date range (which dates to a range 2007-2008).
- Errors within the 2007 version of the inventory have reduced the ability to accurately make comparisons.
- Previous MAGIC versions of the inventory noted parcels that were attributed as 'definitely is' but there is a question for change analysis where there is uncertainty in the classification and inclusion. The 2007 version included a number of uncertain parcels.

- Changes in extent of features and their substrates may be uncertain, for example at Blakeney where the previous inventory included the end of the Spit although evidence suggests that this was sand dune at that time and is sand dune now. The accuracy of the original classification is in doubt in some locations even though the attributes include ‘definitely is’.

3.31 Where there are historic records of the extent of shingle vegetation it would be feasible to repeat the mapping exercise to ensure a more closely comparable dataset from which to analyse change. This is unlikely to be available for the whole of the English vegetated shingle but a number of sites have good quality records to provide a repeat analysis based on common data capture standards against OS MM.

Site Profiles

3.32 Site survey profiles are the primary outputs from the field-based validation surveys. These are provided as separate documents with this report (see Annex A which accompanies this report for detailed site profiles).

4 Creation of the 2008 coastal vegetated shingle inventory layer

Background

4.1 This section outlines the data capture methodology and rule base for the creation of the 2008 coastal vegetated shingle inventory layer within GIS and provides a generic rule base for future incorporation of existing habitat mapping and inventory creation. This rule base reflects the nature of the inventory creation, that uses multiple secondary sources of data rather than undertaking specific *de novo* survey to generate an inventory layer.

4.2 Only limited field survey was undertaken for this project and in this case the emphasis was on developing better shingle survey methods and on broadly validating extents and significant changes since the last survey and on ensuring that any field habitat survey procedures supports the later generation or update of the inventory layers. Therefore, the update to the inventory relies mainly upon secondary survey sources and upon additional aerial photo interpretation.

1990s layer – the previous vegetated shingle inventory

4.3 This project updates the previous version of the vegetated shingle inventory layer which was derived from the maps contained within the various appendices of the Sneddon and Randall (1993) report. However, that was a limited survey that focused on vegetation of stony banks and did not really attempt to survey strandline communities. Despite some additional field survey data being incorporated within the mapping of the 1990 inventory it did not attempt to fill the evident gaps in coverage, merely collated existing data and undertook quality control. The conversion of the 1990 maps was undertaken by Land Use Consultants (2004).

4.4 Subsequently, the inventory was validated by a 2007 project undertaken by exeGesIS SDM Ltd and Doody (2009) which corrected some boundaries and included some areas within the sites that were known to have been missed by earlier surveys. The resulting layer, referred to here as the 1990s layer represented the best understanding of the national extent of vegetated shingle prior to the current project, albeit with known omissions to the layer. It sought to represent the extent of shingle at a period (rather than a point) in time, by virtue of the spread of the source data used in its compilation. The data were re-mapped to OS MasterMap data rather than the Land-Line data used by Land Use Consultants.

4.5 The validation work for the 1990s dataset also produced some additional GIS layers of value to this project, including a site gazetteer and also geographically-referenced notes indicating sites where further survey / amendments should be undertaken. These recommendations were considered during the creation of the 2008 inventory.

2008 vegetated shingle layer

4.6 This project updates the inventory with any surveys which have been conducted since 2000 and also highlights areas which would have been missed (for example, Solent sites as identified by Cox and Crowther 2001) to provide an inventory based around a date of 2008. In this instance the period of cover is more closely constrained than was possible for the 1990's layer as the whole of the English coastline has been evaluated against the 2006/2009 dated aerial photographic cover. This gives a narrower temporal period even where some existing surveys have been used as inputs.

4.7 The mapping of habitat inventories relies upon a rule base that abstracts away from the detail of individual habitat extents to map the BAP habitat as a whole. To achieve this consistently a rule base is applied at both the data capture stage and in some instances may be applied at post-processing (ie to remove small features mapped at below the minimum mappable unit level).

4.8 The rule base on which the 2008 inventory was based was revised to the extent that the former rule base was not explicit, left some areas of this linear habitat excluded from the inventory due to minimum mappable units. The rule base applied is set out in section 6.

Attributes

4.9 The attributes of the inventory are fixed by the national standard and these have not been changed within the current version. However it should be noted that many of these attributes relate to the IHS habitat classification that may not be available within secondary data not surveyed to IHS community classes.

4.10 This list is derived from list of inventory attributes supplied by Natural England when downloading inventory layers from their Website. Here only attributes categorised as “Publish” are included, as other attributes relate only to internal settings with the Habitat Capture Tool.

Table 10 Attribute list for habitat inventory spatial datasets

Name	Alias	Publish	Description
Incid	Polygon id	✓	This is a unique id for each habitat inventory polygon. It is of the form SSSU:NNNNNN, for example, (site id, user, polygon number)
Habdefver	Habitat definition version	✓	Habitat definition version used for determination of habitat (for example, 1.3)
Prihab		✓	IHS field
Prihabtxt	Priority habitat	✓	Priority habitat name for example, *Lowland heathland*
Nbnprihab		✓	NBN Habitat Dictionary biotope key for priority habitat type for example, *NBNSYS0000004618*
Broadhab		✓	This is the NBN Habitat Dictionary biotope key for the corresponding broad habitat.
Pridet	Priority qualifier	✓	Categorises the accuracy with which the priority habitat has been determined for example, *Definitely is*
Interpqual	Reliability of interpretation	✓	A combination of the assessment of the quality of the original habitat identification in the data source and the relationship between the original habitat type and the priority habitat type for example, Medium (2)
Pridetcom	Determination comment	✓	A free text field and is compulsory to explain priority determination other than Definitely is
Phabfeanot	Feature note	✓	A list of other key habitat features that are of relevance to the habitat
Targetnote		✓	Target note
Ihsmainhab		✓	IHS field
Ihsmatrix1		✓	IHS field
Ihsmatrix2		✓	IHS field

Table continued...

Name	Alias	Publish	Description
Ihsform1		✓	IHS field
Ihsform2		✓	IHS field
Ihsman1		✓	IHS field
Ihsman2		✓	IHS field
Ihsmhabtxt		✓	IHS field
Ihsmat1txt		✓	IHS field
Ihsmat2txt		✓	IHS field
Ihsfrm1txt		✓	IHS field
Ihsfrm2txt		✓	IHS field
Ihsmantxt1		✓	IHS field
Ihsmantxt2		✓	IHS field
Ihsversion		✓	IHS field
Source1		✓	Index to Metadata entry in Access database
Source1txt		✓	Title of source data set
S1captdate		✓	The date of the source information used
S1habclass		✓	The classification, if any, used with this source information
S1habtype		✓	Habitat type for the source dataset from which the priority habitat determination was made.
S1boundary		✓	Indicates if this source was used as the Primary or Secondary source for the boundary.
S1habid		✓	Indicates if source provides a *Primary* or *Secondary* source of the resolved PHT or is it just a *Contributor*?
Source2		✓	[Source 2 attributes as per Source 1]
Source2txt		✓	""
S2captdate		✓	""
S2habclass		✓	""
S2habtype		✓	""
S2boundary		✓	""
S2habid		✓	""
Source3		✓	[Source 3 attributes as per Source 1]
Source3txt		✓	""
S3captdate		✓	""
S3habclass		✓	""
S3habtype		✓	""
S3boundary		✓	""

Table continued...

Name	Alias	Publish	Description
S3habid		✓	""
Bsmapscale		✓	Map scale for the primary boundary data source, for example, 1:10000
Digquality		✓	Digitising quality for example, Snapped to OS MasterMap
Fileref		✓	Any file reference(s) that may be available this feature. (Non-mandatory)
Siteref		✓	Any site reference(s) that may be available this feature.
Createdate		✓	Date inventory polygon captured
Createdby		✓	Name of individual capturing data
Moddate		✓	Date polygon was last modified
Modby		✓	Name of individual last modifying polygon
Modsmade		✓	Modification made for example, Boundary
Modsreason		✓	Reason for modification for example, Change in habitat distribution
Modscommen		✓	Update comment
Generalcom		✓	Any additional comments about the polygon, habitat etc NOT included elsewhere, and which are necessary to give a proper understanding of the site.

Data capture rule base development

Rule base development and future survey

4.11 It is important to note that the application of the rule base is based on the use of existing habitat survey in compiling the inventory and thus the input data survey standards vary.

4.12 Therefore, a component of this project is also to set out minimum standards applicable to field habitat survey that will both improve the habitat survey and help the resulting data serve the dual purpose of generation of the inventory layer in the future (section 2.6).

4.13 The fundamentals of the rule base are that it:

- defines the outer boundary of the extent of the BAP habitat definition.
- excludes areas internal to the boundary where these are above a MMU and are not part of the habitat definition.
- allows overlaps with other inventories only when the community types on one community overlap with the definition of another habitat definition.
- maps effectively to topographic features only where these are closely aligned to the habitat boundaries.
- clearly explains the rules used so that the limitations of change analysis can be understood.

4.14 This section describes the rule base used within the 1990 layer generation, reviews the rule base used within the 1990 inventory layers, the rule base applied within the South West Pilot and the approach adopted within the 2008 inventory. Changes to rule bases are to be resisted as this makes comparison more uncertain, but where necessary for the quality of the resulting data changes have been made.

1990s layer rules

4.15 A GIS rule base and attribute structure was developed for the creation of the 1990s layer (exeGesIS SDM Ltd and Doody (2009)) and forms a logical starting point for the rule base used in this project. Many of the rules used in creating the 1990's layer are essentially those adopted by the original Sneddon and Randall (1990) paper maps and their transcription to digital format. Others which are relevant are described below.

Vehicle Tracks

4.16 Tracks made by vehicles crossing the habitat were included within the inventory but flagged as 'damaged'. Only when metalled roads cross the habitats and other 'permanent' manmade structures were they used to segment the habitat polygons, based upon OS MasterMap layer. In some cases this is not always clear from aerial photography / OS MasterMap (for example, Orfordness, where metalled roads are 'smeared' with shingle for some sections). In such cases OS Mastermap was followed.

Protocols for making edits to polygons

4.17 The 1990s rule base included small updates made to the habitat extent as separate polygons in order to keep an audit trail of modifications. This rule was not used in the current inventory layer, as it creates an overly complicated view of the shingle extent and it is not necessary for most users to see this detailed audit trail, when the sources are documented in the metadata and when a master copy (containing this detail) could be retained centrally. In the previous inventory, the Natural England Habitat Data capture tool was used to modify the 1990 layer polygons and to generate metadata describing the audit trail.

Developing vegetated shingle habitat mapping rules

4.18 The National Biodiversity Network South West Pilot project (2004) created a priority habitat definition statement (v1.4) for coastal vegetated shingle which can also inform the rule base creation here. The SW Pilot also created definitions for other habitats which are relevant in achieving consistency where there is potential for habitat definition overlap. Within this survey the defined minimum mappable units, seaward limits and upper limits, inclusions and exclusions of other inventories are modified but the principles are those of the SW pilot.

The Minimum Mappable Unit (MMU)

4.19 The Minimum Mappable Unit (MMU) for a shingle habitat polygon is given as 0.1ha within the NBN South West Pilot, which is suggested to be the minimum size for an ecologically viable unit. However, assumption has been relaxed in relation to ***cheniers***, as they are small features which would not usually attain the MMU, yet are an interesting component of shingle habitats and one which has not been included in the inventories before and form semi-continuous banks that may have a combined area greater than the MMU.

4.20 Similarly, we have also relaxed this MMU assumption for some beaches on the Isles of Scilly, which are similar scale features to the cheniers and would otherwise be missed. It was felt important to include these patches as they influence the appreciation of the extent and spatial limits of their UK geographic range and are important for the viability of vegetated shingle and the range of vegetation community types on the Isles of Scilly.

The Lower (seaward) limit and vegetated shingle structures

4.21 Although the SW pilot rule base recommends mapping of vegetated shingle extent down to the Mean High Water (MHW) Mark (as shown on Ordnance Survey mapping) in order to capture the 'bare shingle' which could become vegetated, this was felt to require modification or at least clarification.

4.22 The mapped MHW mark may be from older maps and may not have been updated. Therefore, it may not reflect the current position of the equivalent tidal level and because of coastal change and colonisation may radically alter extents in some dynamic situations (eg Pagham and Church Norton Spits). Capturing uncritically to MHW would lead to the inclusion of some areas which are now intertidal or (even sub-tidal – Hurst Castle, Figure 6 BRANCH data (red) showing extent of shingle to be below MHW depicted on the OS MasterMap (blue) and in to the subtidal, against the most recent aerial photographic cover). This is perhaps less of an issue for shingle structures in the South West pilot where MHW marks relate to more stable solid geologies with less mobile sediments and greater representation of fringing beach rather than recurving spit morphological unit types.

4.23 Therefore, guided by our vegetated shingle experts, we have adopted a pragmatic rule that looks at the vegetated shingle extent on the aerial photography and then seeks to identify the drift line or a significant change in slope indicative of the MHW mark on the foreshore. This process can be assisted by LiDAR data which is available for the whole coastline and recent data are available from the Channel Coast Observatory (www.channelcoast.org) along with very high resolution aerial coverage.

4.24 If this alignment closely matches the OS MM definition of MHW, then the polygon will be captured to the OS MasterMap feature. Where the foreshore depicted on the underlying aerial photography shows a marked deviation from the MHW line, the parcel will follow the aerial photography and map to driftlines and significant breaks in slope which would be more indicative of the mean high water position in these cases.

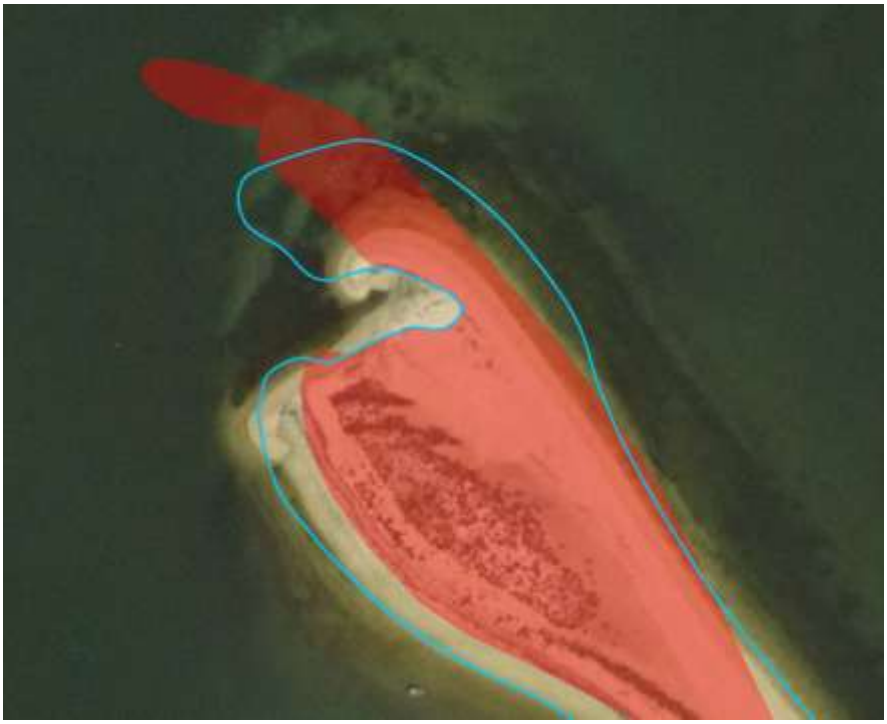

Figure 6 BRANCH data (red) showing extent of shingle to be below MHW depicted on the OS MasterMap (blue) and in to the subtidal, against the most recent aerial photographic cover

4.25 The concept of the ‘shingle structure’ is used to include shingle adjacent to vegetated shingle that is part of the morphological form above the high water mark. This is based on the potential for this resource to have seasonal vegetation cover. This approach does not seek to include all bare shingle above high water whether or not there is any vegetation, so that sites with no vegetation on a shingle structure (and which were very unlikely to generate vegetation, due to the constant reworking of sediments by waves and storms) are excluded from the inventory. This makes it quite difficult to judge whether some sites should be mapped and what extents should be included, especially where the feature is a linear fringing beach where only part of the site has

vegetated shingle. In these instances the section of shingle fronting the vegetation is included within the inventory but not the whole extent of the shingle structure.

The Upper (landward) Limit

4.26 The South West Pilot suggests that the upper limit of shingle should be determined by the limit of the predominant particle size (i.e. 2-200mm). However, there is no national geological or geomorphological dataset at sufficient resolution that can provide this information and therefore this can only be used as a field technique.

4.27 The upper limit used in this study reflects a change in habitat or land cover at the back of the site (eg sea walls, gardens, roads etc). Polygons are mapped to OS MM topographic features wherever the alignment of the habitat boundary matches. Where the habitat boundary does not match, capture to create a natural habitat boundary alignment at a sufficient resolution to provide an accurate depiction of the area at the source mapping scale. No precise scale is given here of source mapping scale, although the source derivation of the OS MM at 1:1250 and 1:2500 may provide a guide to the resolution.

Overlaps with other inventories

4.28 Capture of the vegetated shingle inventory polygons can also be guided by existing GIS inventories for other BAP habitat types, whilst recognising the quality and completeness of these other inventories. The South West Pilot provides a table of relationships between vegetated shingle and other BAP habitats and in many cases there is an 'allowable overlap' between shingle and the other habitats (Coastal Sand Dunes, Lowland Acid Grassland, Lowland Heathland and Saline Lagoons), as these overlaps are the natural transitions from one habitat to another. These allowable overlaps take into account broad habitat tolerances of certain habitats and cross over between community types included within the BAP definitions.

4.29 The following rules are proposed for dealing with overlaps.

Table 11 Habitat inventory correspondence between coastal vegetated shingle and other BAP habitats

Habitat	Rules
Coastal saltmarsh	Separate on substrate particle size (shingle is defined as sediments from 2mm to 200mm).
Littoral and sublittoral chalk	Separate based on Mean High Water. Vegetated shingle only occurs above Mean High Water mark.
Lowland meadows	Separate on the basis of sediment size (shingle ranges from 2mm to 200mm).
Mudflats	Separate based on high tide mark and substrate particle size. Vegetated shingle occurs above normal high tide mark.
Sand dunes	Allowable overlaps, especially where sand occurs over shingle and often where habitats are established on sane where the sand is not windblown.
Lowland Acid Grassland	Transitional community at the landward margins, allowable overlap.
Lowland Heathland	Occurs widely on some areas of vegetated shingle (eg Browndown), allowable overlap.
Saline Lagoons	Allowable overlap, in a number of locations (for example, Pagham Harbour) saline lagoons may occur within shingle depressions, where smaller than the MMU these are treated as part of the Vegetated shingle inventory.

Adapted from the South West Pilot inventory rule base.

4.30 However, using these rules in practice presents a number of challenges. Firstly, the different inventories vary in date, quality and completeness and are likely to be based on poorer resolution data than is available for this project.

4.31 In addition, the other rules proposed rely on additional data in order to separate the habitats.

4.32 *Sediment size* is proposed for differentiating shingle from coastal saltmarsh and lowland meadows. However, this is really only appropriate for field-based assessment and there are no GIS datasets at sufficient resolution for use remotely.

4.33 The boundary between shingle and saltmarsh is an 'allowable overlap' and this is confirmed by the 2009 field surveys sites visited (for example, Pagham, Hurst) where shingle / saltmarsh is a transitional interface and saltmarsh communities occur within shingle substrates and vice versa.

4.34 It is also likely that the lowland meadows will be fenced and as such be represented as identifiable parcels on Ordnance Survey MasterMap which again would form the logical boundary in these cases.

4.35 Therefore, in such cases, the vegetated shingle habitat limit will be defined using the seaward and landward limit rules described earlier.

4.36 The South West Pilot also suggests that the *MHW line* can be used to separate between shingle and littoral and sublittoral chalk and mudflats. Again, the ability to use MHW lines derived from Ordnance Survey mapping will depend on the degree and direction of recent coastal change. Therefore, in these cases, the limit will be determined using the lower limit rules described earlier.

2008 inventory rule base and inventory layer

4.37 The rule base for the 2008 layer was established by review of the existing rule bases and the associated habitat rule bases and in light of the existing datasets that would be used to generate the inventory.

4.38 The final rule base is presented in section 5, as a standalone, generic document.

4.39 Once the rule base is in place, the capture of the 2008 inventory geospatial layer can be seen as stepwise process:

- Collation of existing secondary survey data from post-2000 records from NE, LRC and other agencies
- Evaluation of quality and contribution to the mapping from existing records – this data audit should seek to objectively define the quality of the resource to help define inclusion or exclusion from the inventory development.
- Collation of base layers (OS MM, Aerial photography)
- Evaluation of the extents of the outer boundary of the shingle based on use of the multiple streams of data: including existing shingle inventory, post 2000 data and aerial photographic coverage. This process will vary depending on the nature of data available for any area
- Exclude non-habitat features from the inventory layer where these are larger than the MMU
- Sweep-up evaluation using aerial photographic data – especially to confirm position and extent of coastal change and habitat changes (especially if the secondary field based data are older)
- Evaluation of the mapping against the existing other coastal habitat inventories (recognising that these themselves may be old or contain errors)
- Quality assurance of resulting inventory for topographic and habitat extent
- Publication of 2008 data layer (in MapInfo and Shapefile) – with an associated metadata record (Appendix 1).

Attributes and the use of the Natural England Habitat Tool

4.40 The Natural England inventory data capture tool was NOT used for the creation of the 2008 layer (although its use was tested) as it is more appropriate for use when several different habitat types are being entered. Here only coastal vegetated shingle polygons are being created and much of the information entered will be identical for each polygon or is not relevant in this context (for example, IHS attributes). The remainder of the attribution can be more efficiently entered outside of the tool. In addition, from the trials of the tool, there were numerous software bugs which hampered the data capture process.

4.41 The attribute structure (see section 4.3.1) of the layer that the tool generates *has* been used because despite it having several redundant fields within *this* context, several of the other fields that would need to be captured were already generated and in a form which the other inventories conform to.

Data inputs

4.42 Where creating an inventory layer the source data and secondary data should seek to be close to the same date. Within dynamic morphological systems the changes to coastal configuration and colonisation may result in quite rapid changes that make mapping more complex and provide difficulties in matching to the OS MM framework where topographic details have yet to be updated by Ordnance Survey.

4.43 Since aerial photography is typically orthorectified and matches closely with the OS MM underlying topographic detail can be collected from the aerial photographs.

4.44 Where False Colour Infra-red (FCIR) aerial coverage is available it is useful in distinguishing vegetated cover, and can be helpful in picking out vegetation at strandline positions and sparse cover. These data should be used with the full colour aerial coverage. Coverage of FCIR data at high resolution are limited and have been restricted to certain sites (for example, the Channel Coastal Observatory survey of the Chesil Beach).

4.45 The principle of using secondary base data is to use all the contributory datasets where they can help distinguish and delineate the extent of the sites.

4.46 Other habitat data can contribute to the inventory where the habitat mapping quality assessment (currency, suitability of the classification, resolution etc) indicates that this is a suitable source. Data may be whole habitat surveys or habitat specific surveys, often captured to different standards. The ideal secondary habitat survey datasets might be considered to be those that are contemporary, map all the habitat components and match to an appropriate habitat classification that can resolve out the shingle components.

4.47 Point based data, transect and other secondary data, that are not habitat maps may be helpful in establishing transitional boundary characteristics. Use of other inventory data may also help resolve overlaps.

Use of existing habitat data

4.48 The rule base has to be developed in the light of the datasets from which the inventory will be generated, unless the field survey has been specifically designed to also generate the inventory (the scope of the guidance on habitat field survey). If the minimum mappable unit of the existing surveys is larger than the proposed MMU within the rule base then it is likely that sites will be ‘missed’. However, the sweep-up using aerial photos / false colour infrared data may fill these gaps. The habitat classification used within existing surveys is also important to appreciate and understand as this may treat shingle definitions differently.

4.49 A number of post-2000 habitat surveys contain mapped and textual information on coastal vegetated shingle. These vary considerably in extent, coverage, quality and format (paper and

digital). As this inventory is only being supported by very limited field survey these datasets have the potential to inform the shingle extent created for this project.

4.50 Reference should be made to existing datasets during the data capture: All GIS datasets on shingle habitat (for example, BRANCH) should be loaded into the GIS and be available during the capture.

4.51 Where the datasets are of sufficient quality the polygons depicting vegetated shingle can form the basis for data capture. These may be overlain with the aerial photography and edited to include / exclude any areas. In some cases it may be easier to simply recapture the extent but where possible the GIS forms the starting point. In dynamic sites the extents of these parcels should be checked and modified to the aerial photographic extent of the shingle structure.

4.52 Non-GIS information from reports (including some report maps) were available both digitally and as hard copies. However, in many cases it was not deemed worth georeferencing and capturing these extents as some are hand drawn or sites have changed significantly since survey. In these cases the information was used to guide the capture of the parcels, for example, showing broad extent of the sites, especially when not previously mapped.

4.53 Internal boundaries of detailed habitat surveys are NOT retained in the final output, although an interim layer may be retained (as a working copy) to show the precise delineation of the different sources of the boundaries

4.54 The final inventory will be shown as the outer boundary subdivided by non-habitat features.

GIS Workspaces

4.55 Data capture was undertaken within MapInfo GIS. MapInfo was selected as it has superior handling (including creation) of national scale coverage (for example, OS MasterMap, aerial photography). In addition, the editing tools are also very intuitive and allow the display of individual feature geometry nodes which is required for efficient capture to OS MasterMap.

4.56 A workspace was created containing the following datasets:

- Ordnance Survey base data
- Aerial photography
- False colour infrared images, for selected sites
- LiDAR data (where available) – high resolution coastal LiDAR is available for the South Coast
- 1990s layer (and notes from 1990s data capture team
- Other BAP inventories
- Other existing GIS habitat datasets (for example, BRANCH)
- 2008 layer for editing

Validation

4.57 Validation of the extent of the inventory layer should be undertaken where possible by providing the mapped habitat boundary to site managers and wardens, which may result in modifications and clarifications that should be updated within the inventory layer.

4.58 Where possible, the changes should be accompanied by evidence of the shingle extent and vegetation. In more complex sites that have relied heavily on secondary data to map the inventory sites may be prioritised for earlier field confirmation.

4.59 Metadata should be generated for the validated layer. This will be a single metadata record to Marine Environmental Data and Information Network (MEDIN) marine metadata standards for the whole 2008 inventory layer.

Summary of 2008 coastal vegetated shingle data layer

Extent across England

4.60 Summary statistics on the extent of the coastal vegetated shingle habitats in England are presented in Table 12.

Table 12 Extent of vegetated shingle habitats in England, 2008 summary statistics

Extent of coastal vegetated shingle	Value (in km^2)	Value (in ha)
Extent of vegetated shingle within 1990 BAP inventory layer	35.96	3,596
Extent of coastal vegetated shingle within the 2008 data layer	42.76	4,276
Extent of 2008 extent within Sites of Special Scientific Interest	38.62	3,862
Extent of 2008 extent within Natura 2000 areas	34.87	3,487
Extent of 2008 layers within landscape protection (National Trust, AONB, National Parks combined)	10.03	1,003
Extent of coastal vegetated shingle by County / Unitary Authority		
CITY of PORTSMOUTH	0.13	13
CITY of SOUTHAMPTON	0.00	0
CUMBRIA	0.40	40
DEVON	0.07	7
DORSET	3.18	318
EAST SUSSEX	4.07	407
ESSEX	0.33	33
HAMPSHIRE	1.44	144
ISLES OF SCILLY	0.27	27
ISLE OF WIGHT	0.21	21
KENT	23.25	2,325
MEDWAY	0.02	2
NORFOLK	1.12	112
SOMERSET	0.11	11
SOUTHEND ON SEA	0.11	11
SUFFOLK	6.72	672
BRIGHTON AND HOVE	0.01	1
WEST SUSSEX	1.26	126

Evaluation

4.61 The total extent of vegetated shingle in the 2008 inventory is estimated to be c. 4,276 ha compared with 3,596 ha in the previous (1990) inventory.

4.62 This extent of vegetated shingle implies a net increase, but care is needed in interpreting such change. In general the gross area of shingle within 1990 versus that estimated within this 2008 mapping is a response to the standards of mapping and the additional sites not covered within the earlier surveys. The two figures are the result of different methods and hence will produce different results.

4.63 In addition to the net gains at particular vegetated shingle sites surveyed in 1990's there are a number of locations where artificial shingle nourishment or protection have made shingle resources more stable and thus encouraged coastal vegetation community establishment. Perhaps the largest of these sites is at Elmer (West Sussex) where the offshore groynes and coastal recharge have become colonised behind the defence, where no shingle habitat was recorded in the 1990 inventory. Similar issues have affected the colonisation of the shingle recharge described at Slaughden (Cooper, M. 2006) and the colonisation of the landward slope of the shingle ridge on Hurst Castle Spit.

4.64 The inventory includes an estimated 7.0 hectares of cheniers.

5 Vegetated Shingle Habitat Capture Rule Base

Data Capture Rules

5.1 In mapping the coastal vegetated shingle inventory a standardised rule base should be applied to the identification and mapping of the extent of the habitat.

5.2 *Seaward limit* – Capture shingle habitat down to Mean High Water (MHW) mark defined in OSMM where it is a good definition of the current coastline shown on the aerial photograph. In areas which have undergone recent coastal change, digitise to visible drift lines or changes of slope, which better indicate the approximate MHW position. Where available LIDAR data may assist in identifying a suitable alignment.

5.3 *Shingle Structure* – the shingle structure, the morphological form above MHW, may be included within the inventory where there is some evidence of vegetation, even though at the time of mapping it may be bare (because of seasonal growth of annuals) or it may be naturally bare due to factors affecting colonisation, such as wave action or recent storm events.

5.4 *Landward limit* – Where possible map to OS MM topographic features wherever the alignment of the habitat boundary matches or closely approximates to the OS MM. Where the habitat boundary does not match OS MM topographic detail, capture from aerial photography to create a natural habitat boundary alignment at a sufficient resolution to provide an accurate depiction of the area at the source mapping scale. The standard data capture scale when digitising solely from aerial photography was set to 1;2:500 based upon the fact that this is the source scale for rural areas (not rural towns) within Ordnance Survey MasterMap, which most of these areas will fall within. This allows sufficient detail to be captured and makes the digitisation more manageable. In most cases the inventory would be mapped against a 1:10:000 base, therefore, this was felt to be more than sufficient detail.

5.5 *Minimum Mappable Unit* (MMU) – Polygons should be larger than 0.1ha. Exceptions to this are where narrow and divided linear (semi-continuous) features, when taken together as a unit, are larger than the MMU. This will include cheniers and beaches on Isles of Scilly (to be treated as a unit). Use the MMU polygon as a guide.

5.6 Overlaps with other inventories – where habitat boundaries overlap existing inventories adopt the rules:

- Littoral and sublittoral chalk and mudflats use seaward limit rules.
- Lowland meadow and saltmarsh use landward and seaward limit rules.
- Coastal Sand Dunes, allowable overlaps.
- Lowland Acid Grassland, allowable overlaps.
- Lowland Heathland, allowable overlaps.
- Saline Lagoons, allowable overlaps.

5.7 Follow the priority list which has been created from the data quality audit of potential source data in order to prioritise the data capture and to ensure methodical coverage around the coast. Capture sites in this order:

- sites surveyed for this project.
- others identified in the 1990s layer (or previous inventory layer).

- sites suggested by National Trust and others.
- a systematic sweep of the rest of the coast.
- Data judged to be of poor quality may be ignored.

5.8 Use the 1990s layer as the starting point for identification of sites, check for comments from the 1990s data capture team that may help with updating the polygons and also check whether there are overlaps with boundaries of other habitat inventories. This does not imply use of the existing boundaries from the 1990's inventory and given that many sites were not collected by the 1990 survey other surveys provide the basis for extending the site mapping.

5.9 Check whether there is a more up-to-date GIS habitat dataset that can be used from the habitat survey inventory (for example, BRANCH) to map the extents of the shingle habitat. Preference for the most recent first and highest objective quality indicators, GIS datasets over non-GIS.

- If YES – copy the shingle polygons for the site or modify these polygons where necessary through additional aerial photo interpretation. Evaluate the habitat classification and the shingle qualifying habitats within the survey. Existing data coverage may need to retain all the habitat boundaries to explore the potential overlaps with other inventories.
- If NO – capture the shingle extent from aerial photo interpretation using the 1990s layer as a guide to what was formerly shingle.

5.10 Remove urban and other 'non-habitat' features (i.e. metalled roads, buildings, paved areas etc) based on overlay with OSMM features present at the site. This layer has been created already for the entire coast.

5.11 Attribute the polygons with the data sources used and any comments.

Quality Assurance Rules

5.12 QA of coverage - Systematically move around the coast to check areas have not been missed and to assess the capture of extents, especially focused on dynamic sites.

5.13 Where possible validation may be extended to seeking confirmation from site managers and wardens, and making suitable evidence-based adjustments, especially on those sites where mapping has been based on secondary data.

5.14 QA of topology – use standard QA procedures to remove topological errors – polygons smaller than MMU (outside the Isles of Scilly and not cheniers), region checks, topology checks etc.

5.15 QA of attributes – use standard QA procedure - spelling, completeness, data type etc.

6 Discussion and further work

6.1 This section presents opportunities to improve the process and products of habitat inventory mapping for vegetated shingle in particular and for other inventories in general. This section does not seek to provide specifications but introduces topic and research areas and outlines the various benefits which arise from this work:

6.2 The project has provided an updated evidence base for the extent and quality of coastal vegetated shingle. This has been based on the best available data and has been supported by (limited) site visits and through consultation with site managers. In addition, new sites have been added (eg cheniers, Hurst Spit etc). This indicates a considerable increase of habitat extent over previous inventories, based largely on the more comprehensive mapping, rather than significant changes in the actual extent due to environmental changes.

6.3 The mapping of the 2008 inventory, especially where there was little contextual or other survey information relies on aerial photographic interpretation. There was only limited ground validation of the areas within this project which may lead to local inaccuracies, Additional ground truthing of these site would improve the quality and confidence in the 2008 layer, in particular where the distinctions are between the substrate size. This approach should concentrate on the transitions between shingle and other habitats and therefore should also consider the validation of other habitat inventories where appropriate.

6.4 This project has completed the 2008 inventory for England. The surveys by Sneddon and Randall for JNCC also took in Scotland and Wales. The results of the surveys here and the update of the English inventory suggest that the shingle habitat resource is likely to have changed in Wales and Scotland, in that un-surveyed sites and coastal change will both have modified the extent of sites and that new unidentified sites are likely to exist that extend the coverage of vegetated shingle representation. It is recommended that additional mapping and field survey with quadrats be undertaken to help identify the regional community types. In addition, there was a desire to seek to also map the shingle on the Isles of Scilly and this would be an additional target area for follow-on surveys – where this has been based on site knowledge and expert opinion within this inventory layer.

6.5 The evidence of changes to the coastal margins suggests that there is a need for an effective way of mapping the habitat changes both from transitions and coastal dynamics. In those areas where there is rapid coastal adjustment it would be useful to update the shingle inventory on a more regular basis than the current 16-plus year interval.

6.6 The programme noted the difficulty for field surveyors in ascribing some habitats to an NVC class where this was desired. This is perhaps not surprising given the transitional nature of much of the habitat and the exclusion from the NVC analysis of two of the largest surveys that have conducted shingle vegetation surveys (Sneddon and Randall (1993) and Ferry (1990)) even though the results were informed by these surveys. Consequently, the ability to map Sneddon and Randall classes to NVC in particular and the increasing number of surveys of driftline communities (not extensively surveyed by these earlier surveys) introduces potentially new communities and variants on shingle. This suggests that resolving the community classifications for the driftline communities in particular and shingle communities more generally may be a priority to enable effective subsequent surveys. This might be achieved by drawing together and analysing the existing quadrat records from driftline sites round the UK and evaluating and describing the associations. This should then be used to update the NVC community classifications that can be applied to the habitat survey.

6.7 Allowed habitat overlaps and calculations of extent of BAP habitats from repeat inventories are dependent on having data of equivalent quality between different survey dates and between different inventories. Unfortunately, many of the other coastal habitat inventories (wetlands,

saltmarsh, sand dunes) are in a similar position to the Phase 2 2007 in being incomplete and not mapping to the same extent which effectively limits the scope for area change mapping. There is a need to bring these other inventories to a common mapping standard and completeness that would improve the scope for change analysis and provide a better evaluation of transitional communities and the ability to test the validity of genuine overlapping community classifications in dynamic coastal systems.

6.8 The collation of species data from Local Records Centres for use within this project proved challenging. Whilst LRC staff were extremely helpful in providing the data, the lack of standardisation of species records and the varied recording of species location meant that data came in a variety of different formats (GIS, tabular, online download) and at different spatial resolutions. It is recommended that further work would be beneficial in helping make species data more accessible and useable within this context, by incorporating a species level data format and record content standardisation. This is particularly relevant given the relatively small size of most shingle structures and the linear nature of coastal habitats.

7 Conclusions

7.1 This project has generated a number of useful outputs which further our understanding of coastal vegetated shingle habitat extent and quality within England. These include:

- **A review of the existing literature** on coastal vegetated shingle in England. The data varies in content and detail and the aims and specifications for site based mapping often do not suit the purposes of inventory generation which are more concerned with the outer boundaries than internal detail. There is a need for greater standardisation among surveys and also nationally about how habitat surveys can feed into inventory generation.
- **Development of standards for field-based shingle habitat survey –** Approaches to field survey for shingle habitat mapping have been detailed including a survey form, quadrats and transects, photographs and how this can be used to support inventory mapping. Previously, there has been varied adherence to habitat survey standards (even when they exist) which makes it difficult to combine different datasets when more strategic assessment of habitat extents is required.
- **Digital versions of the Sneddon and Randall (1993) Reports –** these were previously only available as paper copies and are now out of print. The searchable PDFs and cross tabulation (described below) will make the Sneddon and Randall classification more widely available.
- **A cross tabulation of the Sneddon and Randall and NVC Shingle Classifications –** Matches Sneddon and Randall's shingle communities to their NVC equivalents. The poor matches and gaps in NVC indicate there is scope to extend NVC's description of shingle communities.
- **Species lists of rare/scarce vascular plants and invertebrates occurring within shingle habitats** or other habitats on shingle, derived in conjunction with Natural England specialists.
- **Site profiles –** present an updated summary of vegetated shingle extent and quality for the 12 visited shingle sites
- **GIS data capture rule base** for coastal vegetated shingle inventory. There is a need to look at the generation of inventories more widely in order to standardise methods and outputs. Currently, the datasets vary considerably, in quality, attributes etc. which makes it difficult to deal with overlaps between different habitats and to analyse change year on year.
- **GIS data layer of 2008 shingle extent –** Represents the most up-to-date national inventory of coastal vegetated shingle habitats The estimated national extent is 42.76 sq km. This represents an increase in the estimates from previous inventories although this is most likely due to variations in methodology and coverage than to actual changes in the habitat extent. Locally however, real changes in extent have been observed at some of the sites visited for this project, which reflect coastal change processes, including losses (for example, Porlock) and gains (for example, Church Norton).
- **Analysis of change –** While the area of coastal vegetated shingle habitat has increased from the previous inventory by an estimated 6.8 km^2 (19%), this change is mostly due to variations in the methodologies used and the fact that some areas were missed in previous work. Locally there is change due to coastal processes which includes losses and gains of this habitat. In order to map future changes in extent and quality, data capture would need to be standardised.

7.2 In terms of forward planning, this evidence base provides the basis for environmental change analysis and more robust shingle status assessment, especially related to long-term climate change and sea level rise.

7.3 There is a need for the other coastal inventories to meet these same standards to fully use the inventory information in this way but the data have been incorporated in the biodiversity

vulnerability assessments at regional (South East) level. In particular, the data layer can be used to highlight the relationship between shingle systems and wetlands in the coastal flood plain.

7.4 The data can also be used in other contexts, such as the evaluation of shingle resources within flood risk management applications; incorporating the scales of change that have been observed and allowing assessment of options for longer term adaptation to climate change. Whilst recognising the limitations of the work, this will inform strategic management activities which are undertaken.

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Appendix 1 Metadata for the 1994 layer (derived from MAGIC) and the 2008 BAP inventory layer

Table A Metadata for the 1994 data layer for coastal vegetated shingle

Name	Coastal Vegetated Shingle (England) Map Topic(s) MAGIC Metadata Coastal and Marine Resource Atlas
Abbrev Name	
Theme	This is a draft GIS inventory of the Biodiversity Action Plan habitat Coastal Vegetated Shingle, and represents our best assessment of its distribution, based on existing nationally available datasets.
Labelling Convention	
Definition	
Domain of Use	England
Owner	Natural England Version 1.1
Version Date	26/03/2004
Parent Child	
Responsible Authority	Natural England
Frequency of Supply	
Source	Sneddon and Randall (1993), Coastal Vegetated Shingle Structures of Great Britain: Main Report; Sneddon and Randall, (1994), Coastal Vegetated shingle structures of Great Britain: Appendix 3. Shingle sites in England; Antonini and Bennat (1996) Title unknown (Pagham Harbour); Williams and Cooke (1993), Vegetated shingle survey of the Sussex coast; Ferry, Lodge and Waters (1990), Dungeness: A vegetation survey of a shingle beach including maps by Fuller (1989); Ferry and Waters (1985), Dungeness Ecology and Conservation; Younghusband (2003), Environmental Monitoring of Vegetated Shingle Habitats in East Sussex.
Quality	No updating of boundaries has occurred; therefore future work will be needed to ensure the inventory accurately reflects the current distribution of coastal vegetated shingle.
Scale	Mixed large scale Data Capture Process Head up digitising.
Positional Accuracy	All 441 polygons attributes as 'Definitely is'.

Table continued...

Name	Coastal Vegetated Shingle (England) Map Topic(s) MAGIC Metadata Coastal and Marine Resource Atlas
Precision	In general the base maps were scanned in and Land-Line (LL) data were used to georeference each map to the British National Grid. LL was also used to aid the accurate mapping of shingle. Two of the publications use 1:10,000 base maps (Sneddon and Randall and Williams and Cooke), while Fuller uses 1:2,500. These smaller scales allow less precise mapping than much of the LL data (1:1,250 / 1:2,500), resulting in a discrepancy between the location of the lines on the base map and those on the LL. Where it was clear that the base line (shingle) data were following the same feature as the LL, the LL was snapped to, in all other cases the base map was followed. For example, shingle boundaries followed the mean high tide line in many of Sneddon and Randall's maps. As this is easily identifiable in the LL it was possible to snap to the LL mean high water line.
Measurement	
Unit of Measure	
Dimension	
Other information	
Comments	

Table B Metadata record for the 2008 BAP inventory layer (note that this adopts the UK Gemini2 (MEDIN) metadata standard.

Element Name	Element Value
Resource title	Coastal Vegetated Shingle (England) 2008
Alternative resource title	NA
Resource language	English
Resource abstract	GIS inventory of the Biodiversity Action Plan (BAP) habitat for Coastal Vegetated Shingle in England. This dataset represents our best assessment of its distribution, based on existing nationally available datasets and aerial photographic interpretation. Data have been generated by GeoData.
Topic category	Environment
Keywords	BAP, Inventory, Habitat
Temporal extent	2008 - 2010
Date of publication	2010
Date of last revision	30/04/2010
Date of creation	2010

Table continued...

Element Name	Element Value
Lineage	Based on the extraction of data from surveys between 2000 and 2008 that include vegetated shingle habitats and the field validation exercises that occurred under the 2010 programme to remap the extent of coastal vegetated shingle. The extents have been mapped to OS MM.
West bounding longitude	-0.7035741806030273
East bounding longitude	-0.7026758193969727
North bounding latitude	52.16073226928711
South bounding latitude	52.16017532348633
Extent	England
Vertical extent information	NA
Spatial reference system	OSGB 36
Spatial resolution	1:1250
Resource locator	NA
Data format	ESRI Shapefile format, MapInfo file format
Responsible party	Natural England
Originator	GeoData Institute, University of Southampton, SO17 1BJ
Data point of contact	GeoData Institute
Frequency of update	NA
Limitations on public access	Freely accessible
Conditions for access and use constraints	Licence
Additional information source	NA
Metadata language	MEDIN 2.3.1
Date of update of metadata	30/04/2010
Metadata point of contact	GeoData Institute, University of Southampton
Unique resource identifier	TBC
Spatial data service type	NA
Coupled resource	NA
Resource type	Geospatial data
Originating Controlled Vocabulary	NA
Degree of conformity	NA
Specification	NA
Metadata standard name	MEDIN
Metadata standard version	2.3.1

Appendix 2 Species Lists

Vascular Plants

Suggested vascular plant species occurring either in shingle vegetation or in other habitats (for example, saltmarsh) overlying shingle:

- *Asparagus prostratus*
- *Bupleurum tenuissimum* (incl. saltmarsh transitions overlying shingle)
- *Carex maritima* (Scotland)
- *Corrigiola litoralis* (Slapton Ley)
- *Crepis foetida*
- *Galeopsis angustifolia*
- *Hordeum marinum* (saltmarsh overlying shingle or saltmarsh-shingle transitions)
- *Rumex rupestris* (beach-head sand/shingle and cliffs/boulders),
- *Salsola kali subsp. kali*
- *Scleranthus annuus*
- *Silene gallica*
- *Limonium procerum/britannicum/binervosum*
- *Parapholis incurva*
- *Suaeda vera* or *Hordeum marinum* on shingle-saltmarsh transitions.

Other rare/scarce/red list spp associated with shingle habitats (in the broadest sense) include:
Alopecurus bulbosus (saltmarsh-shingle transitions)

- *Cynodon dactylon* (sand mainly?)
- *Festuca arenaria* (mainly sand dunes)
- *Frankenia laevis* (saltmarshes overlying shingle)
- *Gnaphalium luteoalbum* (sand dunes, but also on Dungeness)
- *Hypochaeris glabra*
- *Lathyrus japonicus*
- *Limonium bellidifolium* (saltmarsh on firm sandy shingle),
- *Limonium binervosum* (sand and saltmarsh overlying shingle)
- *Limonium britannicum subsp. transcanalis*
- *Limonium dodartiforme* (Chesil)
- *Limonium procerum*,
- *Marrubium vulgare*,
- *Medicago minima*,
- *Medicago polymorpha*,
- *Mertensia maritima*,
- *Petrorhagia nanteuilii*,
- *Poa bulbosa* (sand over shingle)
- *Polygonum maritimum* (sandy foreshores, fine shingle)
- *Puccinellia rupestris* (saltmarsh overyling shingle?)
- *Romulea columnae* (sand and gravel -- Dawlish Warren)
- *Ruppia cirrhosa* (brackish ditches associated with shingle/saltmarsh complexes, for example, N. Norfolk, The Fleet/Chesil, etc.)

- *Sarcocornia perennis*
- *Silene conica*,
- *Suaeda vera*
- *Trifolium glomeratum* (grassland on sand/shingle mixtures)
- *Trifolium suffocatum* (ditto), *Vicia lutea*, *Vulpia ciliata* & *Vulpia fasciculata* (incl. sandy shingle).

Table C Invertebrates associated with Vegetated Coastal Shingle

MOLLUSCA	GASTROPODA	Styllomatophora	Vertiginidae	*Truncatella subcylindrica*	RDB3
		Mesogastropoda	Assimineidae	*Paludinella littorina*	RDB3
			Caecidae	*Caecum armoricum*	RDBK
			Ellobiidae	*Leucophytia bidentata*	
	CHILOPODA		Lithobiidae	*Lithobius lapidicola*	RDBK
				Pachymerium ferrugineum	Nb
				Schendyla peyerimhoffi	Nb
				Geophilus fucorum	Nb
				Geophilus pusillifrater	Nb
				Strigamia maritime	
	DIPLOPODA	Julida	Nemasomatidae	*Thalassisobates littoralis*	Nb
	CRUSTACEA	Ispoda	Trichoniscidae	*Miktoniscus patience*	Nb
				Trichoniscoides saeroeensis	Nb
			Buddelundiellidae	*Buddelundiella cataractae*	Nb
			Halophilosciidae	*Halophiloscia couchi*	Nb
				Stenophiloscia zosterae	Nb
	ARACHNIDA	Araneae	Dictynidae	*Lathys stigmatisata*	RDB3
			Gnaposidae	*Haplodrassus dalmatensis*	Nb
				Haplodrassus minor	RDB3
				Zelotes longipes	
				Zelotes petrensis	Na
				Zelotes subterraneus	
			Liocranidae	*Apostethus fuscus*	RDB1
				Agraecina striata	Nb
			Salticidae	*Heliophanus auratus*	RDB2
				Pellenes tripunctatus	RDB1

Table continued...

				Neon pictus	
				Neon robustus	RDBK
				Pseudeuophrys obsoleta	RDB3
				Sitticus inexpectus	Na
				Phlegra fasciata	RDB3
			Lycosidae	*Arctosa fulvolineata*	RDB3
			Agelenidae	*Hahnia candida*	RDB2
			Theridiidae	*Crustulina sticta*	Nb
			Aranaeidae	*Argiope bruennichi*	Na
			Linyphiidae	*Maso gallicus*	Na
				Trichoncus affinis	RDB2
				Trichoncus hackmani	RDB2
				Trichoncus saxicola	Nb
				Trichopterna cito	RDB2
				Hypomma fulvum	Na
		Pseudoscorpiones	Neobisiidae	*Neobisum carpenteri*	RDBK
	INSECTA	Orthoptera	Tettigoniidae	*Platycleis albopunctata*	Nb
			Mogoplistidae	*Pseudomogoplistes squamiger*	RDB1
			Tetrigidae	*Tetrix ceperoi*	Na
			Acrididae	*Chorthippus brunneus*	
				Chorthippus parallelus	
				Myrmeleotettix maculates	
		Dermaptera	Forfuculidae	*Forficula auricularia*	
		Dictyoptera	Pseudomopidae	*Ectobius panzer*	Nb
		Homoptera	Cicadellidae	*Aphrodes duffieldi*	RDBK
				Euscelis ohausi	Nb
			Ulopidae	*Ulopa trivia*	Nb
			Cixiidae	*Cixius remotes*	Nb
				Trigonocranus emmeae	Nb
			Delphacidae	*Calligypona reyi*	RDBK
		Heteroptera	Cydnidae	*Legonotus picipes*	Nb
			Pentatomidae	*Sciocoris cursitans*	Nb

Table continued...

		Coreidae	*Bathysolen nubilus*	Nb
			Spathocera dahlmanni	Na
		Rhopalidae	*Corizus hyoscyami*	local
			Rhopalus rufus	RDB3
		Stenocephalidae	*Dicranocephalus agilis*	Nb
		Lygaeidae	*Aphanus rolandri*	Na
			Graptopeltus lynceus	Nb
			Henestrias laticeps	local
			Heterogaster artemisiae	Nb
			Megalonotus dilatatus	Nb
			Megalonotus praetextatus	Nb
			Megalonotus sabulicola	Nb
			Tropistethus holosericeus	Nb
		Beytinidae	*Berytinus hirticornis*	Nb
		Tingidae	*Kalama tricornis*	local
		Microphysidae	*Myrmedobia inconspicua*	
		Miridae	*Capsodes sulcatus*	Nb
			Monosynamma maritima	RDB3
			Strongylocoris luridus	Nb
			Systellonotus triguttatus	Nb
	Lepidoptera	Sesiidae	*Pyropteron chrysidiformis*	
		Geometridae	*Idaea ochrata cantiata*	
			Thalera fimbrialis	
		Noctuidae	*Calophasia lunula*	
			Luperina nickerlii	
	Coleoptera	Carabidae	*Aepus murinus*	Nb
			Dromius vectensis	RDB3
			Cymindis axillaris	Na
			Harpalus serripes	Nb
			Licinus punctatulus	Na
			Lionychus quadrillum	RDB3
			Masoreus wetterhalli	Na
			Omophron limbatum	RDB1

Table continued…

			Ophonus rupicola	Nb
			Trechus fulvus	Nb
		Staphylinidae	*Medon brunneus*	
			Medon fusculus	RDB1
			Medon ripicola	N
			Cypha pulicaria	N
			Scopaeus gracilis	RDBK
			Scopaeus ryei	RDB1
			Scopaeus sulcicollis	
			Hydrosmectina delicatissima	RDBK
			Mycetoporus angularis	
		Chrysomelidae	*Psylliodes luridipennis*	RDB2
			Dibolia cynoglossi	RDB1
			Cassida hemisphaerica	Na
			Chrysolina haemoptera	Na
			Longitarsus ganglbaureri	Na
			Longitarsus plantagomaritimus	Nb
			Phyllotreta cruciferae	Nb
		Curculionidae	*Pachytrichius haematocephalus*	RDB1
			Ethelcus verrucatus	RDB3
			Limobius mixtus	RDB1
			Lixus scabricollis	RDBK
			Protapion dissimile	Nb
			Ceutorhynchus pumilio	Na
			Mogulones geographicus	Nb
	Diptera	Syrphidae	*Paragus albifrons*	RDB2
		Tephritidae	*Myopites exima*	RDB3
			Paroxyna lhommei	RDB1
			Polydaspis sulcicollis	RDB1
		Opomyzidae	*Geomyza subnigra*	N
		Sciomyzidae	*Salticella fasciata*	
	Hymenoptera	Formicidae	*Temnothorax interruptus*	
		Apidae	*Bombus subterraneus*	

KEY:

RDB 1 – species appear in the Red Data Book and are categorised as endangered.

RDB 2 – species appear in the Red Data Book and are categorised as vulnerable.

RDB 3 – species appear in the Red Data Book and are categorised as rare.

RDB K – species appear in the Red Data Book but the status is unknown, although they are thought to be rare.

N – species are nationally notable and have been recorded in 16-100 ten kilometre squares in Great Britain.

Na – species are nationally notable and have been recorded in 16 – 30 ten kilometre squares in Great Britain.

Nb – species are nationally scarce and have been recorded in 31 – 100 ten kilometre squares in Great Britain.

Annex A Site profiles

See Annex A for detailed site profiles.