

The Conservation and Management of Coastal Vegetated Shingle in England

Report of the meeting at Salthouse,
North Norfolk on 18th September 2008



John Houston, Paul Rooney and Pat Doody

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North Norfolk on 18 September 2008**

Organised by the Sand Dune and
Shingle Network on behalf of Natural England

Report prepared by
John Houston, Paul Rooney and Pat Doody

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Foreword

The Sand Dune and Shingle Network supports the dissemination of good practice in coastal dune and shingle management through national and international networking activities, the organisation of conferences, seminars, workshops and training events and contributions to the development of technical advice based on existing knowledge, information and data.

The network was established in 2006 with a grant from the Higher Education Innovation Fund provided through the Higher Education Funding Council for England. The network works closely with the UK statutory agencies for nature conservation and has signed a Memorandum of Agreement with Natural England to deliver a series of tasks, one of which is the 'Shingle Workshop' which makes up this volume.

The establishment of an occasional series of publications allows Liverpool Hope University to disseminate a range of products through the network website at www.hope.ac.uk/coast. The series will include workshop reports, subject reviews, reports of study tours and curriculum materials.

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Glossary and abbreviations

Article 17 report: Obligation under Habitats Directive (EU)
BIG: Biodiversity Integration Group (England)
CHaMP: Coastal Habitat Management Plan
Defra: Department for Environment, Food and Rural Affairs
EBS: England Biodiversity Strategy
GIS: Geographic Information System
HAP: Habitat Action Plan within UKBAP
H1210: Annual vegetation of drift lines (EU Habitat)
H1220: Perennial vegetation of stony banks (EU Habitat)
JNCC: Joint Nature Conservation Committee
LBAP: Local Biodiversity Action Plan
LIFE-Nature: EU funding programme for nature conservation
LNR: Local Nature Reserve
MC6: *Atriplex prostrata*-*Beta vulgaris* spp. *maritima* sea-bird cliff community
NVC: National Vegetation Classification
SD1: *Rumex crispus*-*Glaucium flavum* shingle community
SD2: *Honkenya peploides*-*Cakile maritima* strandline community
SD3: *Matricaria maritima*- *Galium aparine* strandline community
SAC: Special Area of Conservation (Habitats Directive)
SPA: Special Protection Area (Birds Directive)
SSSI: Site of Special Scientific Interest
UKBAP: United Kingdom Biodiversity Action Plan

Introduction

This report is based on a workshop held at Salthouse, North Norfolk on 18 September 2008. The report covers the discussion at the workshop, provides additional information and identifies some of the issues that will need to be considered in the Habitat Action Plan review and updated Implementation Plan for the priority Biodiversity Action Plan habitat Coastal Vegetated Shingle¹.

Shingle is usually defined as being composed of sea-water worn (rounded) pebbles or gravel in the size range 2-200mm. It is generally associated with high energy coasts where waves are strong enough to move the material along and accross the beach, sometimes above the limits of the tides.

Recent reviews of the management of coastal vegetated shingle in the United Kingdom have been given by Randall (2004) and in the published proceedings of the international shingle symposium held in 1999 (Packham *et al.* 2001). Advice on good practice in the restoration and management of coastal vegetated shingle is included in the 'Shingle Guide' (Doody and Randall 2003) published as part of the *Living with the Sea* project outputs (English Nature 2003)².

These reviews and guidelines provide much of the context for the UK Habitat Action Plan (HAP) for coastal vegetated shingle. The aim of the Salthouse workshop was to help develop the research agenda for the management of shingle features and the conservation of habitats and species associated with shingle. The information exchanged at the workshop will assist Natural England deliver its responsibility for this habitat in the UK Biodiversity Action Plan (UKBAP) and the England Biodiversity Strategy (EBS).

1 <http://www.ukbap.org.uk/UKPlans.aspx?ID=29>

2 http://www.english-nature.org.uk/livingwiththesea/project_details/good_practice_guide/shingleCRR/shingleguide/home.htm

Background

Coastal vegetated shingle is a scarce habitat at both UK and European level. The status and condition of the habitat in the UK is described in the UK Habitat Action Plan for coastal vegetated shingle (with targets updated in 2006), in the JNCC Common Standards Monitoring Guidance for vegetated coastal shingle habitats (version August 2004) <http://www.jncc.gov.uk/default.aspx?page=2204> and in the JNCC 'Article 17 reports'³ for the European habitats H1210 Annual vegetation of drift lines and H1220 perennial vegetation of stony banks published in 2007 (www.jncc.gov.uk/article17). Descriptions of these European habitats are given in the Interpretation Manual of European Union Habitats (European Commission 1999). The current status of the habitat in the United Kingdom from these sources can be summarised as follows;

- Article 17 reporting for H1210 Annual vegetation of drift lines⁴ (unfavourable –bad and deteriorating) and H1220 perennial vegetation of stony banks⁵ (unfavourable-bad but improving)
- Sites of Special Scientific Interest (SSSI) condition in England. Based on 4280ha, 46% is in favourable condition, 30% in unfavourable recovering condition, 11% in unfavourable-no change condition and 13% is in unfavourable-declining condition. Overall 76% of shingle habitat is in target condition⁶
- Trends reported in the UK Biodiversity Action Plan, 2005 reporting round: England status: 'declining-slowng', Wales status: 'declining-slowng', Scotland and Northern Ireland status: 'unknown'.

The inadequate condition of shingle habitats is indicated in the various reporting methods. The Article 17 reports give an overall assessment of the condition of the habitat in the UK and this assessment can be compared with Member States within the Atlantic biogeographic region.

3 Under Article 17 of the Habitats Directive Member States are obliged to report to the European Commission on the status of listed habitats and species every six years. The Joint Nature Conservation Committee coordinates the report for the UK.

4 <http://www.jncc.gov.uk/pdf/Article17/FCS2007-H1210-audit-Final.pdf>

5 <http://www.jncc.gov.uk/pdf/Article17/FCS2007-H1220-audit-Final.pdf>

6 Source: Natural England November 2008. Condition of coastal BAP Priority habitats in English SSSIs (% by area) Note: Figures have been derived from interpretation of the main priority habitat listed for SSSI units in ENSIS (English Nature Sites Information System). It is not currently possible to map all relevant habitats to BAP priority types. The information is summarised in the State of the Natural Environment Report (see http://www.naturalengland.org.uk/Images/sone-section3.11_tcm6-4747.pdf for coastal section)

UK Habitat Action Plan targets

The revised UK Habitat Action Plan targets (2006) for vegetated coastal shingle are;

Target 1: Maintain total extent of coastal vegetated shingle habitat throughout the UK, and the structures, sediment and coastal processes that support them, approximately 6200 ha⁷. This is a 'no net loss' target to take account of the dynamic nature of shingle. This includes the maintenance of transitions to other habitats landward and seaward.

In Target 1 an area of coastal vegetated shingle will count as being maintained when the natural coastal processes are still active, the landforms are maintained and the extent and quality of the habitats present are maintained. The target needs to be linked with other HAP targets especially for wetland, heathland and grassland which are often present on more mature stable parts of shingle structures.

Target 2: Achieve favourable or recovering condition by appropriate management of XXha⁸ of coastal vegetated shingle systems currently in unfavourable condition by 2010. This should achieve the retention or enhancement of populations of BAP priority species associated with vegetated shingle

All vegetated coastal shingle in unfavourable condition will be covered in Target 2. The target for Northern Ireland is to bring 50% of the coastal vegetated shingle resource (25ha) into favourable condition by 2010. For the other countries the targets are to be confirmed. Improved management to bring areas towards favourable condition will include cessation of damaging activities (e.g. re-profiling of shingle banks), allowing development of young ridges, access control and replanting of native species. Shingle ridges contribute to flood risk management and their management should be sensitive to the natural vegetation. Quality for some invertebrate assemblages may also be related to vegetation pattern. 'Favourable condition' is based on the attributes and targets for coastal vegetated shingle within JNCC's Common Standard Monitoring guidance for coastal habitats (CSM) available at <http://www.jncc.gov.uk/page-2204>

Target 3: In key locations initiate restoration of shingle communities on arable land over shingle deposits by 2015

Sites identified under Target 3 include parts of the Dungeness /Rye Harbour area where landward areas of shingle have been ploughed for agriculture. The target is for one location to be restored by 2010 and a second by 2015. Both are in England.

Information on each of these targets can be found on the UKBAP website at https://ukbap-reporting.org.uk/outcomes/targets_nationals .

⁷ This figure was amended during the production of this report. The figure of 5800ha was the original UK estimate based on the surveys of Sneddon and Randall 1993. The most recent estimates of area are now over 6200 ha (6203 ha). The gap in the condition target needs to be determined for each country area, probably based on SSSI condition information.

⁸ The area is not defined in the Habitat Action Plan

The European context

The UK shingle resource is significant at the European level. Whilst there is no equivalent for shingle to the Sand Dune Inventory of Europe (Doody 1991, 2008), the international symposium on coastal shingle (Packham *et al.* 2001) included presentations from several European countries. The preparation of a European inventory, linked to existing information on national and European Commission databases, would be a useful project.



Figure 1. Distribution of main coastal vegetated shingle structures in Europe © J P Doody 2001⁹

The European Commission has assembled and published summaries of the 2006 national reporting round under Article 17 of the Habitats Directive (European Commission 2008). The *conservation status* of each habitat is a summary of assessments of *range, area, specific structures and functions* and *future prospects*.

The 2006 Article 17 reports for driftline habitats (EU habitat code 1210) show that the habitat is widely distributed along coasts in the Atlantic region although absent from much of the North Sea coastline and not listed for either Belgium or the Netherlands. Overall the assessment of conservation status for the Atlantic biogeographical region is *unfavourable-bad* (also known as 'red' using a standard traffic light system of green, amber and red), largely due to the UK assessment. The *unfavourable-bad* rating in the UK is due to bad (red) *future prospects* and *unfavourable-inadequate* (amber) *structures and functions*. The UK assessment affects the overall assessment for the biogeographical region; in other countries the situation is generally better and for Germany the conservation status is *favourable* (green).¹⁰

Driftline habitats are also widespread in the Boreal region, particularly in the Gulf of Bothnia. The habitat is dynamic and often occurs as a series of small patches making estimates of area difficult and unreliable. The habitat is also widespread along coasts of Germany, Denmark and southern Sweden in the Continental region.

9 Doody, J.P., 2001. *Coastal Conservation and Management: an Ecological Perspective*. Conservation Biology Series, 13, Kluwer, Academic Publishers, Boston, USA, 306 pp

10 The definitive report on the Article 17 reporting was published by the European Commission in July 2009. <http://biodiversity.eionet.europa.eu/article17>

Vegetated coastal shingle (EU habitat code 1220) is widespread in the Atlantic region, especially on Atlantic coasts although rarer on North Sea coasts and again not listed for Belgium and the Netherlands. It is not a recognised EU habitat type in the Mediterranean region, although it occurs spasmodically in a few areas, and in the Macaronesian region only occurs on the Azores.

In the Atlantic biogeographical region the range is *favourable*. The overall conservation status for the region, however, is *unfavourable-bad*, largely due to the situation in the UK. The UK hosts some 50% of the habitat by area in the region although this may be overestimated (European Commission 2008). The *unfavourable-bad* conservation status of this habitat is due to a mix of human impact (such as gravel extraction or inappropriate coastal management) and change in sediment supply (which may be due to human activity elsewhere and also possibly linked to climate change).

Vegetated coastal shingle also occurs across the Boreal region but is absent from Lithuania and rare in Latvia. Overall its conservation status in the Boreal region is *favourable* (green). The habitat is widely distributed along the Continental coasts of Germany and Denmark. Here, the overall assessment is *unfavourable-inadequate* (amber) probably due to human impacts.

Data and reports can be found on <http://biodiversity.eionet.europa.eu/article17/habitatsummary/> (European Commission 2008). However, as the summary tables show (see Table 1 below), there is simply not enough information available to make a reliable judgement of conservation status. The information presented for the UK suggests that both habitats (H1210 and H1220) are in unfavourable condition, and markedly so compared to the information presented for other countries. The UK has a particular challenge to improve the conservation status of these habitats before the next assessment in 2012.

Ireland has also reported concerns. The conservation status for both habitats is *unfavourable-inadequate* (NPWS 2008). The listed threats include recreational use, mechanical cleansing, grazing, sand and gravel extraction and sea defence works, including disruption of sediment supply (NPWS 2008).

The final consolidated report of the European Commission was published in July 2009.

Table 1: Overall assessment of habitat area and condition within the Atlantic Biogeographical Region as reported by Member States in the 2006 reporting round.

Table 1a. Overall summary of condition of habitat type 1210 Annual vegetation of drift lines in the Atlantic Biogeographical Region. Data from EIONET European Topic Centre on Biological Diversity

Member State	Area of Habitat	Range	Area	Structure and Function	Future Prospects	Overall Assessment
Germany	400	FV	FV	FV	FV	FV
Denmark	1500	FV	FV	XX	XX	XX
Spain	N/A	XX	XX	XX	XX	XX
France	6700	U1	U1	U1	U1	U1
Ireland	100	FV	U1	FV	U1	U1
Portugal	N/A	FV	U1	U1	XX	U1
United Kingdom	N/A	XX	U1	U2	U2	U2+

N/A= No information available, FV= Favourable, XX= insufficient information/unknown, U1= unfavourable, U2=bad + = improving

Table 1b. Overall summary of condition of habitat type 1220 Perennial vegetation of stony banks in the Atlantic Biogeographical Region. Data from EIONET European Topic Centre on Biological Diversity

Member State	Area of Habitat	Range	Area	Structure and Function	Future Prospects	Overall Assessment
Germany	800	FV	FV	FV	FV	FV
Denmark	100	FV	FV	XX	XX	XX
France	1800	FV	U1	U1	U1	U1
Ireland	200	FV	U1	U1	U1	U1
United Kingdom	5160	FV	U1	U2+	U1+	U2+

FV= Favourable, XX= insufficient information/unknown, U1 = unfavourable, U2=bad, += improving.

The Article 17 assessments use a number of standard codes for pressures and threats on habitats and species. The general threats identified for the annual vegetation of drift lines and vegetated coastal shingle habitats are summarised in Table 2 below;

Table 2a. Summary of reported threats for habitat type 1210 Annual vegetation of drift lines in the Atlantic Biogeographical Region. Data from EIONET European Topic Centre on Biological Diversity

Main threats	Codes	DE	DK	ES	FR	IE	PT	UK
Grazing	140							✓
Sand and gravel extraction, removal of beach material	300, 302			✓	✓	✓	✓	✓
Urbanised areas, dispersed habitation, continuous urbanisation	400, 401, 403	✓			✓			
Paths, tracks and cycling tracks	501				✓			
Walking, horse-riding and non-motorised vehicles, motorised vehicles, outdoor sports, nautical sports, other leisure and tourism impacts	620, 621, 622, 623, 629, 690	✓		✓	✓	✓	✓	✓
Water pollution, air pollution, trampling, over-use, other forms of pollution and human impacts	700, 701, 702, 709, 720, 790	✓	✓	✓	✓	✓	✓	✓
Drainage	810		✓					
Dykes, embankments, sea defences, coast protection, land reclamation	802, 870, 871	✓			✓	✓		
Modification of hydrographic function, modification of marine currents	850, 851		✓		✓			
Erosion, silting up, submersion, inundation	900, 910, 930, 941				✓	✓		✓
Biocenotic evolution, other natural processes	950, 990							✓

Table 2b. Summary of reported threats for habitat type 1220 Perennial vegetation of stony banks in the Atlantic Biogeographical Region. Data from EIONET European Topic Centre on Biological Diversity

Main threats	Codes	DE	DK	FR	IE	UK
Abandonment of pastoral systems	141					✓
Sand and gravel extraction, removal of beach material	300, 302			✓	✓	✓
Urbanised areas, discharges, disposal of inert material	400, 420, 423	✓		✓	✓	
Communication networks, paths, tracks and cycling tracks, improved access to sites	500, 501, 530	✓		✓	✓	
Camping and caravan sites, walking, horse-riding and non-motorised vehicles, motorised vehicles, other leisure and tourism impacts	608, 622, 623,690	✓		✓	✓	✓
Air pollution, trampling, over-use, other forms of pollution and human impacts	702, 709, 720, 790		✓	✓	✓	✓
Drainage	810		✓			
Dykes, embankments, sea defences, coast protection,	870, 871	✓		✓	✓	✓
Modification of hydrographic function, modification of marine currents	850, 851		✓	✓		✓
Erosion, submersion	900, 930			✓	✓	✓
Biocenotic evolution, eutrophication, invasion by species, inter-specific competition, other natural processes	950, 952, 954, 969, 990			✓		✓

The Natura 2000 database provides information on the number of sites in the network, the area of the site and the area of EU habitats within each site. The following data for habitat type 1220 have been extracted from the Natura 2000 Network database, elaborated by the European Commission with data updated on December 2006. The surface was estimated on the basis of the habitat cover for each protected site and should be considered only as indicative of the habitat surface included in Natura 2000.

Note: the information will have been updated since December 2006 but this should not have significantly affected the general breakdown of information between regions and countries set out below.

Table 3. Information for surface area of habitat type 1220 perennial vegetation of stony banks extracted from the Natura 2000 database of December 2006.

Biogeographical region	N° of sites	Estimated surface in Natura 2000 (ha)	% of total surface
Atlantic	90	7997	45.2
Continental	107	5066	28.6
Boreal	167	4395	24.8
Macaronesian	16	250	1.4
Countries	N° of sites	Estimated surface in Natura 2000 (ha)	% of total surface
Denmark	43	4574	25.8
United Kingdom	16	3385	19.1
Ireland	36	2515	14.2
Sweden	149	2056	11.6
France	29	1732	9.8
Estonia	13	1687	9.5
Finland	43	1017	5.7
Germany	33	439	2.5
Portugal	16	250	1.4
Latvia	2	53	0.3
TOTAL	381	17,708	

The national context

The UK Habitat Action Plan (UK Biodiversity Group 1999) gives the extent of UK coastal vegetated shingle as 6,203ha (England 5,343 ha, Scotland 700 ha, Wales 110 ha and Northern Ireland 50 ha). However, there is not an agreed single set of figures based on measurement due largely to different results from different surveys. The dynamic nature of the habitat is also a contributing factor.

The confusion over quoted figures is confirmed by the administrators of BARS, the reporting system for the UK Biodiversity Action Plan. The original target was estimated at 5,800ha in the original plan and was published without breakdown between countries.

The most recent estimate of the extent of coastal vegetated shingle in England is 4,495 ha (Natural England 2008) of which 4,28 ha (95%)¹¹ is within SSSI designation. However, only 76% of the resource within SSSIs is in favourable or recovering condition¹². Compared to other habitat types shingle is a relatively rare feature; for comparison the total England resource for sand dune dunes is 12,800 ha, for maritime cliff and slope 14,545 ha and for saline lagoons 1,649 ha (Natural England 2008).

There are some estimates for the extent of driftline vegetation in the UK but a figure has not been submitted as part of the Article 17 reports to the European Commission (JNCC 2007a)¹³. There are probably different interpretations of 'drift-line' between Member States and probably a considerable difference in interpretation between the Atlantic and Mediterranean regions. An exchange of knowledge on this habitat would be useful.

The extent of H1220 Perennial vegetation of stony banks derived from Jackson and McLeod (2002)¹⁴ is 5160 ha (JNCC 2007b)¹⁵. This includes 4,350 ha in England, 670ha in Scotland, 100 ha in Wales and 40 +/- 10ha in Northern Ireland.

The current UK knowledge base is derived from;

Site surveys including;

- Work at Dungeness from the 1980s (Ferry *et al.* 1990)
- All other sites in the early 1990s by Sneddon and Randall (Sneddon and Randall 1993-1994)
- Additional local surveys, e.g. in Sussex

Overviews and inventories, including;

- JNCC Coastal Directories
- 2004 England Inventory: the first phase digitised existing data and mapped 2,771 ha
- 2007 England Inventory update and Quality Assessment: A second phase assisted by data specialists and shingle specialists extended the mapping to 3,596 ha, but still short of the 4,495 ha from previous estimates.
- State of Natural Environment Report 2008 (Natural England 2008)

¹¹ The figure of 98% was quoted by Natural England so these figures also need to be checked.

¹² Favourable: the SSSI land is being adequately conserved and is meeting its 'conservation objectives'.

Unfavourable declining: the special interest of the SSSI unit is not being conserved and will not reach favourable condition unless there are changes to site management or external pressures.

Unfavourable recovering: all the necessary management measures are in place and, provided that work is sustained, the SSSI will reach favourable condition in time.

Unfavourable no change: the special interest of the SSSI unit is not being conserved and will not reach favourable condition unless there are changes to the site management or external pressures. The longer the SSSI unit remains in this condition, the more difficult it will be to achieve recovery.

¹³ <http://www.jncc.gov.uk/pdf/Article17/FCS2007-H1210-audit-Final.pdf>

¹⁴ The 2000 report, updated 2002, (Jackson and McLeod eds.) indicated that the extent of the habitat in Northern Ireland was <10ha. The Article 17 reassessment revises this to 40 ha +/- 10ha.

¹⁵ <http://www.jncc.gov.uk/pdf/Article17/FCS2007-H1220-audit-Final.pdf>

Other studies including;

- FutureCoast
- Geological Conservation Review (May and Hansom 2003)
- Environment Agency /Natural England remote sensing studies

The measurement of the shingle resource has highlighted the discrepancies in mapping. A full check of all sites in England was carried out using ecological as well as mapping expertise (Natural England 2004). The aim was to establish a dataset based on the 1990s extent as the most complete data available. In 2004 the extent of shingle habitat in England in the GIS inventory derived from existing information was mapped at 2,271 ha, well short of the figure of 5,343 ha given in the UKBAP.

In 2007 the data was re-checked, this time using habitat and GIS specialists to quality assure the data sources, arriving at a figure of 3,596ha. The 2007 exercise has checked and adjusted the original hand-drawn mapping from the national inventories prepared by Sneddon and Randall (1993-1994).

To carry out the work the quality of the original data was improved for use in a GIS inventory. Boundaries can now be linked to Ordnance Survey (OS) map layers and air photo layers and new information can be built around this. The outcomes of the 2007 inventory exercise were;

- A more realistic dataset with better metadata
- A baseline extent broadly based on the 1990s surveys
- A new estimate (3,596ha) but still less than the extent from earlier mapping (5,023 ha)
- Identification of locations where further field checks were needed
- A focus on shingle structures, not just vegetation
- Development of a clear rule base for GIS
- Identification of overlaps with the sand dune inventory (also produced in 2004 from GB dune survey data).

Natural England has submitted a bid for funding under Defra's Biodiversity Research and Evidence programme to continue to work to develop and check the database, in particular to update the extent using more recent information and to follow up some key sites with field checks. This year (2009) DEFRA are funding a project for the "Development of an evidence base of extent and quality of coastal shingle habitats in England to improve targeting and delivery of the Coastal Vegetated Shingle HAP".

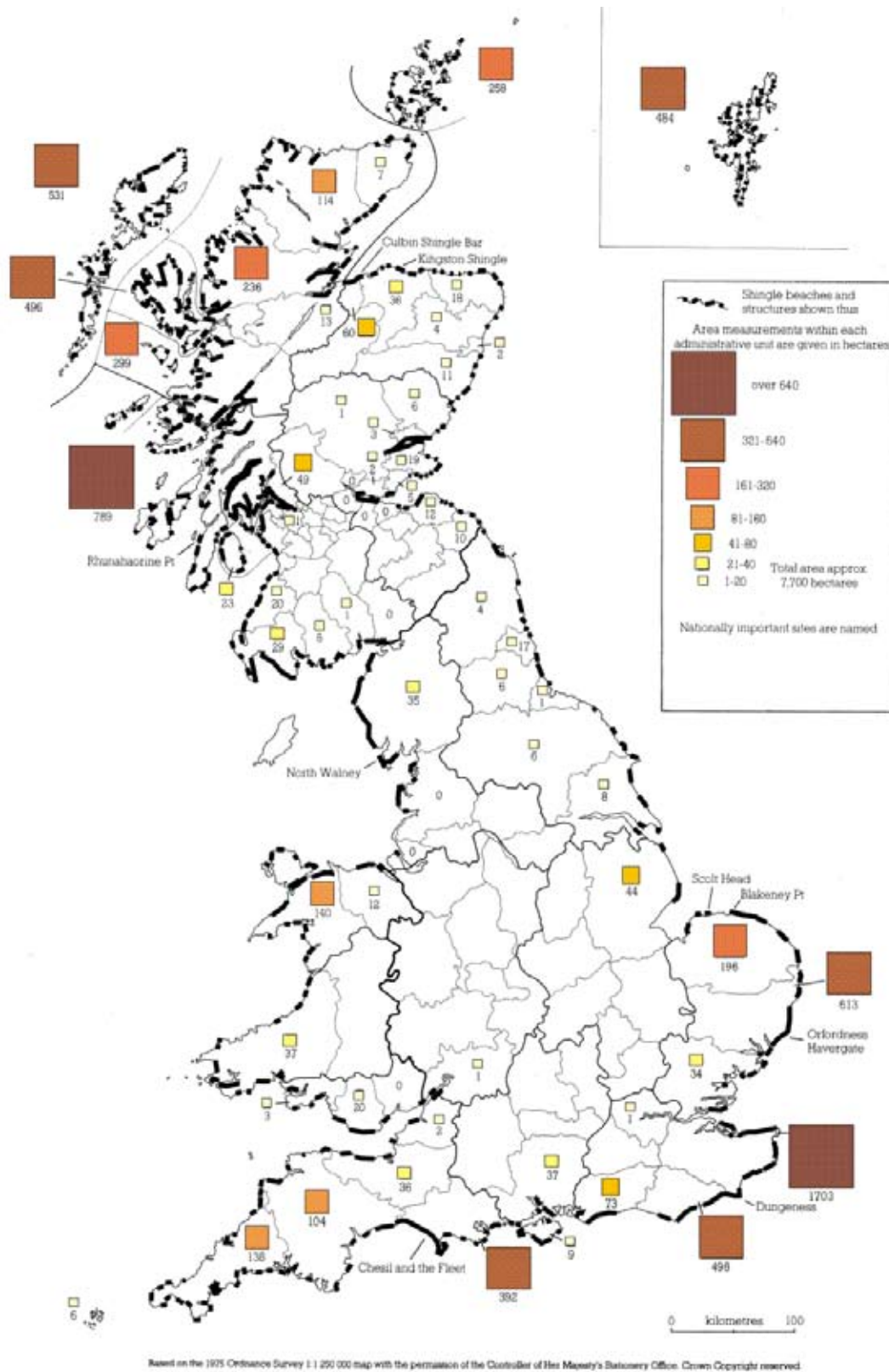


Figure 2. Distribution of shingle beaches and structures in Great Britain, derived from the JNCC Coastal Resources data base. Copyright redrawn J.P. Doody.

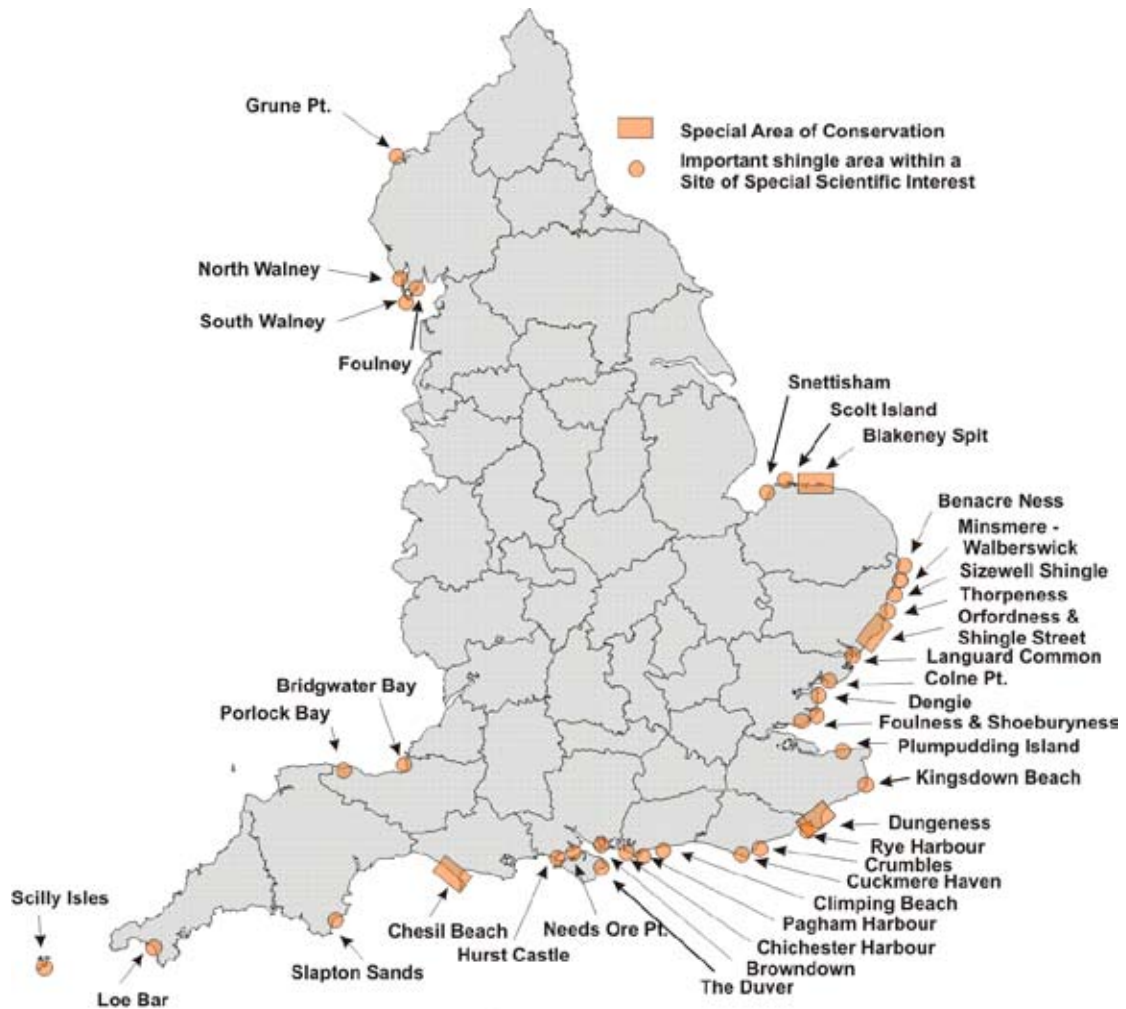


Figure 3. Important shingle areas in England within SSSI and SAC designation © J P Doody

Recommendation: The experience of checking the data with mapping and habitat specialists has been useful and it can be recommended that the approach is applied to the rest of the UK. There is still work to check this new information against the England SSSI dataset which indicated that the area of SSSI units with shingle habitat was 4,495 ha and to assess the quality of the habitat, both inside and outside designated sites.

This work has shown that for dynamic coastal habitats, mapping of extent to 100% accuracy may not be possible. Remote sensing needs to play a part in developing time-series sets of data to enable trends in area to be identified more clearly.

Key issues

Issues of mapping and description

As outlined above coastal vegetated shingle is a difficult habitat to map and describe. The reasons for this stem partly from the lack of nationally agreed survey methods and from the difficulty in describing transitions between vegetated and un-vegetated shingle and between shingle and other habitats such as sand dune, salt marsh and saline lagoon.

The Common Standards Monitoring (CSM) Guidance for Vegetated Coastal Shingle Habitats: Version August 2004 (JNCC 2004) gives the background to the extent of available knowledge on the habitat in the UK.

In the UK vegetated shingle includes two habitat types on Annex I of the Habitats Directive as discussed above, H1210 Annual vegetation of drift lines and H1220 Perennial vegetation of stony banks. The National Vegetation Classification (NVC) does not cover the whole range of shingle vegetation (JNCC 2004), 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 Structures of Great Britain (Sneddon and Randall 1993) and this includes pioneer, lichen/moss communities, heathland, grassland, wetland and scrub.

There are four main classifications that can be used to describe vegetated coastal shingle;

- Phase I habitat classification
- National Vegetation Classification (NVC)
- Sneddon and Randall's classification
- Ferry's classification for Dungeness

Each of the classification systems has its advantages and disadvantages. The NVC has poor coverage of the overlap between dune and shingle plant communities, Sneddon and Randall's classification does not cover drift-lines, Ferry's classification is based on the 'mega-site' at Dungeness and in no classification are lichens fully addressed, nor is the interaction between vegetated and bare shingle or previously damaged shingle addressed.

The differences between surveys are discussed by Randall and Sneddon (2001). They note that one of the key differences seen at Dungeness is the development of stages of humus production. The distinct broom (*Cytisus scoparius*) community described for Dungeness (Ferry 2001) is seen as a major contributor to humus production. They also discuss potential 'climax' communities on shingle sites. Whilst few sites have woodland communities most shingle sites have at least some scrub development (Randall and Sneddon 2001).

Recommendation: Further studies should be supported to address some of these gaps in knowledge, including studies on lichens, the interaction between bare and vegetated shingle, and previously damaged shingle (recent and more long-term) and also on the boundaries between sand/shingle and saltmarsh / shingle.

Flood and coast defence

Shingle features form part of local coast defence structures along many parts of the coast of southeast England. Along several gravel barrier coasts¹⁶ the main shingle ridge is engineered into a high, but often narrow, ridge designed to function as a sea defence structure.

¹⁶ The terms gravel and shingle are used by different workers to describe particle size. Randall (2004) proposes that the term 'shingle' describes sediments composed mainly of rounded pebbles, larger than sand (>2mm) but smaller than boulders (<200mm). All shingle and boulder beaches can be regarded as different types of coarse clastic beaches as described by Carter and Orford 1993.

However, it is increasingly recognised that such approaches are unsustainable and lead to a net loss of sediment from the beach system. Gravel barriers need to be recognised as energy absorbers and not flood protectors. Barriers need to be mobile to maintain their volume and their integrity (Orford, workshop presentation).

Where gravel barriers are held in position through reworking the shingle into an engineered main ridge there is a long-term loss of volume leading to beach slope steepening. Gravel barriers will migrate in response to sea-level rise and overtopping is part of the process which allows barriers to move whilst maintaining their volume.

The responses of shingle beaches and shingle structures to sea-level rise are described by Pye (2001). If the rate of rise is very high shingle structures may be drowned in situ by overstepping. However, where wave exposure is high, the shingle barrier will have a tendency to migrate landwards in response to the forcing factor. This process has led to the aprons of gravel, 'washover fans', seen at Cley-Salthouse following the storms of November 2007. This process of rollover is normal for shingle features and may be enhanced by sea level rise (Pye 2001).



*Wash-over of shingle at Cley-Salthouse resulting from the November 2007 storms
Photo © John Houston 2008*

There has been a natural reluctance for coastal managers and engineers to allow shingle barriers to move landwards, but such policies are considered to be essential for the long term maintenance of the structures (Pye 2001).

At Cley-Salthouse a new approach to beach management has been agreed between the Environment Agency and Natural England where there will be no further intervention in barrier re-profiling to allow a favourable condition to be achieved by the target date of 2010. If required, however, the agreement allows for additional sediment to be added to the system to replace that already lost due to past management policy and to assist rollback.

The approach was put to the test under severe storm conditions on 9 November 2007 which resulted in several breaches of the high ridge created fans of overwash gravel spreading the volume of material over a larger area. At one point the fan of shingle extended 180m covering a fence erected only that year which had been set back to the '10 year line'.



Cley marshes during the storm of November 2007 © Norfolk Wildlife Trust

The Cley Marshes are owned and managed by the Norfolk Wildlife Trust. This organisation is supportive of the need to allow coastal change but like other coastal land managers is in the difficult position of trying to communicate new approaches to shoreline management policy to local communities and members. The importance of this work cannot be over-stated.

Responses to shoreline management which, for example, allow the breaching of the shingle barrier at Porlock in 1996 (Orford 2001) and overwash and migration at Cley-Salthouse are likely to become more common scenarios under second generation Shoreline Management Plans.

A key issue is whether shingle features are provided with accommodation space to allow landward migration (Orford 2001). Barriers need flexible set back lines.

Management guidelines

An overview of the management of coastal vegetated shingle in the UK has been published by Randall (2004). Randall (2004) outlines the key threats to coastal vegetated shingle and discusses measures to prevent damage or to offset unavoidable damage arising from coastal engineering works.

The review (Randall 2004) is linked to the publication of a CD-ROM 'shingle guide' (Doody and Randall 2003) published in 2003 as part of the Living with the Sea project suite of products. This was one element of a wider guide to habitat restoration that covered a range of habitats. The guide identifies two main 'states' for shingle habitats and three further states.

The two main states are described as (i) eroding and (ii) accretional or semi-stable. The other states are (iii) stable, (iv) disturbed and (v) excavated.

The shingle guide is the most up-to-date general source of information on all aspects of the management, restoration and sea defence issues associated with coastal shingle, whilst also recognising gaps in knowledge and understanding.

The guide was designed to assist coastal engineers and other coastal managers in making decisions about beach and shingle management in connection with the development of Shoreline Management Plans, Coastal Habitat Management Plans (CHaMPs) and specific projects. The Cley-Salthouse scheme, visited as part of the meeting, is one such case study where new approaches to coastal engineering are being introduced.

Revised guidance for coastal engineers will be developed through the revision of the CIRIA Beach Management Manual (<http://www.ciria.org/rp787.htm>). In 1996 a first version of a Beach Management Manual was published (CIRIA 1996). This has provided guidance on the design of engineering interventions, such as beach recharge schemes and control structures and (to a lesser extent) beach maintenance. With a move towards performance and risk based flood and erosion management and advances in beach management the Environment Agency, Natural England and others are funding work on the revision of the manual.

The overall aim of the revised manual is to provide coastal managers, regulators and practitioners with practical guidance on managing beaches for coastal defence purposes but also environmental considerations and amenity.

It was clear from the discussions at the workshop that the experience gained from sites such as Porlock, Cley-Salthouse and Dunwich-Walberswick should advise the preparation of the revised guidance.

Nature conservation management

Coastal vegetated shingle is a scarce, internationally important habitat (Randall 2004). Although vegetated shingle is described as a European habitat most shingle foreshores are either unvegetated or sparsely vegetated (Randall 2004). The three foreshore 'stability classes' recognised by Scott (1963) are a useful way to describe vegetated shingle close to the sea. These are;

- Shingle with no vegetation where disturbance is too frequent to support plant growth
- Drift lines and shingle with summer annuals where the beach system is stable only over the summer season, and
- Shingle features with short-lived perennials where the beach is stable for at least three years.



Yellow-horned poppy on shingle beach at Cley-Salthouse © John Houston

Protection from wave activity is needed for long-term stability (Randall 2004). The fine fraction in the shingle matrix is also crucial for the germination and development of many plants. Thus shingle features above the influence of waves but with little fine material may only develop very specialised vegetated shingle communities (e.g. *Crambe maritima*). Water availability is another factor which determines the development of the plant communities on coastal shingle features (Randall 2004).

Terrestrial shingle formations are less common than foreshore shingle features and include the large sites on the Isle of Arran and Jura, Dungeness, Chesil Beach, Culbin Bar, Blakeney Point, Scolt Head Island and Orfordness (Randall 2004, Shardlow 2001).

Conservation actions for coastal vegetated shingle are addressed through the UK Habitat Action Plan. A review in 2009-2010 will take account of the experiences of implementing the plan to date and will develop some of the issues discussed at the workshop.

Grazing

Although the influence of grazing is relatively limited across the whole resource (Randall 2004) it has potential as a management tool at a number of the terrestrial sites. At Dungeness grazing was generally considered to be detrimental to the communities of vegetated shingle (Brian Banks, workshop presentation) and from the 1970s to 1990s grazing was taken off the site and a policy of non-intervention applied. However, it became clear that some features, especially transition mire communities, were losing species-richness. There is now more information available on past grazing practices and grazing has been introduced on a trial basis in the wetland habitats following scrub clearance. The early results suggest that grazing in this situation will improve species-richness.

There is also some evidence from a study on ants which found one species to be more common in the grazed areas than the ungrazed areas. Bumblebees are characteristic species of the Dungeness shingle preferring the shingle /marsh interface and the populations responded well to the grazing experiment.

However, in another case, grazing by rabbits was found to prevent the establishment of Stinking Hawksbeard (*Crepis foetida*) at Rye Harbour LNR to where it was re-introduced. In 2001 and 2003 two plants were recorded and in 2004 none were recorded. A rabbit-proof fence was erected around the introduction site and numbers have subsequently grown from 10 in 2005, 47 in 2006, 353 in 2007 to 417 in 2008. Clearly in this situation the lack of grazing is allowing the plant to thrive.

The conclusions from these studies at Dungeness are that the issues of grazing on vegetated shingle sites are complicated, with some species benefiting and others not. There is a call, therefore, for more research on this subject. Grazing by hares on Orfordness may also be important, although little is known about their impact.

Importance of vegetated shingle for invertebrates

Both saline-shingle beaches and terrestrial shingle habitats are important for invertebrates (Shardlow 2001). The strandline provides a key niche for invertebrates associated with shingle. 393 species of conservation importance have been recorded including 148 Red Data Book species and 17-18 species included in the UK Biodiversity Action Plan. 33 species are thought to be restricted to shingle. Almost all the rare species are linked to the larger terrestrial sites such as Dungeness, Orfordness and Chesil Beach.

Recommendation: Further study is recommended into (a) species associated with groundwater and (b) surveys of sites such as Blakeney Point in Norfolk and Culbin Spit in Moray (Shardlow, workshop presentation).

Coastal lagoons

Saline lagoons are a feature of several coastal shingle barrier beach structures. Conservation issues are described in the Saline Lagoon Management Guide (2001) published on behalf of the Saline Lagoon Working Group. This gives guidance on the management and creation of saline lagoons.

It is important to note that appropriate nature conservation management of gravel and shingle barrier beaches is likely to afford greater resilience and functionality to coastal lagoons, where associated with these systems. Therefore in regions where the habitats coincide environmentally sustainable management of shingle can bring considerable benefits for a scarce European habitat. Indeed, coastal (saline) lagoons are an Annex I habitat of the Habitats Directive and a priority UK BAP habitat. Several specialised flora and fauna, which have evolved to survive within the inherently variable physico-chemical environment, are associated with this 'stressful' habitat.

Inappropriate management of barrier beaches and coastal shingle structures (e.g. bull-dozing of ridges to facilitate flood defence) is known to adversely affect coastal lagoons. These impacts can manifest in a number of ways, for example:

- Reduction of higher salinity extremes due to disruption of seawater percolation through interstitial spaces of shingle barrier e.g. by mechanical re-working of the shingle
- Increased rates of in-filling by shingle (due to high magnitude episodic over-washing events) when unsustainably managed systems are 'released' to evolve naturally
- Reduction in extent when squeezed between shingle 'rolling back' and hard flood defence structures.

Coastal percolation lagoons, by their nature, are ephemeral in time frames of tens to thousands of years. This temporal and spatial variation is due to the overriding geophysical coastal processes associated with barrier beaches and shingle structures. In a naturally functioning system it would be expected, with time, that percolation lagoons will eventually be lost once they are squeezed against natural topographical features of higher elevation as a result of increased storms and sea level rise associated with global warming.

As shoreline management policies move towards natural processes re-shaping and overtopping shingle features some existing coastal lagoon features may be threatened by infilling at faster rates than when engineering works maintained a seaward ridge. The lagoon 'Half-moon pond' at Cley-Salthouse has gradually reduced in volume through the movement of the shingle barrier.



Half-moon pond at Cley-Salthouse April 2007 © Sue Rees



Half-moon pond at Cley-Salthouse March 2008 © Ian Reach

Recommendation: There needs to be dialogue and integration between habitat groups and biodiversity interests in the context of coastal zone and shoreline management to set what might be short to medium term conservation priorities against long-term coastal change and adaptation to sea-level rise. The England Biodiversity Group coastal work stream will be addressing some of these issues through the establishment of a coastal Biodiversity Integration Group.

Restoration

The Habitat Action Plan supports actions to restore vegetation communities. This is seen as a priority for action in southeast England. However, there are species, which are most associated with a degree of disturbance and so a balance between undisturbed and lightly disturbed areas should be sought where these species are known to occur.

Sea kale (*Crambe maritima*), for example, is relatively robust whilst several of the associated species are susceptible to trampling pressure. Decisions may have to be made on natural recovery or active restoration. On young shingle ridges natural recovery may be the best option with the use of boardwalks to reduce trampling pressure.

In older parts of the shingle system the natural vegetation communities may be so disrupted that it becomes necessary to re-introduce species. On part of the Dungeness system used for military training the impact of over 60 years of disturbance had reduced the vegetation to scattered holly bushes, a unique feature described by Peterken & Hubbard (1972). Restoration techniques have included the translocation of 'turves' of mature vegetated shingle, using seed in tubes and young plants of broom. Brush piles from scrub clearance from wetland areas are used to provide some cover to the emerging plants.

The review of the UK Habitat Action Plan for coastal vegetated shingle

The Habitat Action Plan for coastal vegetated shingle was originally published in 1999 (UK Biodiversity Group 1999). The targets were revised in 2007 and progress on actions will be reviewed in 2009-2010.

The 2008 UKBAP reporting round assembled progress reports on the delivery of HAP actions. The progress reports will help to advise the review of the main actions of the plan and support the preparation of updated Implementation Plans.

The increased understanding of what we have in terms of shingle extent will help with the delivery of the HAP, even if the total figures have to be adjusted downwards.

There are 20 Local Biodiversity Action Plans in the UK which have reported targets for vegetated coastal shingle. Whilst most of the obvious areas (e.g. Kent, Sussex) are represented there is no specific link given, for example, to North Norfolk. It is difficult, therefore, to make a clear link from the national Habitat Action Plan to local plans and also to get feedback from the local plans. For England, the Biodiversity Integration Groups (BIG) formed in 2009 will be addressing this issue.

Coastal vegetated shingle is a significant habitat in a number of Local Biodiversity Action Plans.

As an example the Coastal Vegetated Shingle Action Plan for Kent has five objectives and clear targets;

Objective	Target
Ensure no net loss of coastal vegetated shingle, unless subject to natural coastal changes	Ensure no net loss of current extent of the 691 ha of coastal vegetated shingle resource in Kent
Restore coastal vegetated shingle to favourable condition or unfavourable recovering condition with the proviso that patterns of coastal evolution may erode shingle from the coastline	Restore 555ha by 2010 (95% of SSSI), 602 ha by 2020 (100% SSSI and 25% SNCI) and 619 ha by 2026 (100% SSSI and 50% SNCI).
Ensure that all areas of qualifying vegetated shingle are protected by appropriate designations	Enhance and restore 136 ha by 2010 (100% of total resource minus 95% SSSI), 89 ha by 2020 (100% total resource minus 100% SSSI and 25% SNCI) and 72 ha by 2026 (100% total resource minus 100% SSSI and 50% SNCI)
Restore open fen communities on Dungeness to suitable wetland areas	By 2010 restore open fen communities on Dungeness to ponds (pits number 5 and 6) and identify the extent of willow scrub appropriate to be maintained around the other ponds
Restore natural coastal processes as far as is possible to all areas of the coast	

Similarly the Sussex Local Biodiversity Action Plan has five objectives for coastal vegetated shingle;

1. Protect existing resource in Sussex in terms of both area and quality of vegetation.
2. Recreate vegetated shingle habitat where possible and appropriate following guidelines.
3. Make use of opportunities to restore previously damaged shingle.

4. Increase public awareness and understanding of the shingle habitat for example by the creation of demonstration shingle habitat areas.
5. There should be no further net loss of shingle to development or agriculture.

The workshop at Salthouse did not discuss the review of the current Habitat Action Plan action-by-action. However some of the key points arising from the workshop could be considered in subsequent reviews.

Some of the ideas arising out of the workshop discussions and from the activities of local BAP groups are highlighted below.

- There will be a need to update the general policy position in light of the experience at Porlock Bay where the breaching of the shingle bar has led to the development of new salt marsh (National Trust 2008) and at Cley-Salthouse where the storms of November 2007 led to the breakdown of the engineered shingle ridge allowing natural landward movement of the gravel barrier. Other examples from the UK could be used to help advise the review of Shoreline Management Plans in England¹⁷ and Wales and the CIRIA Beach Management Manual.
- The experience of allowing shingle barriers to migrate in response to storms and coastal change has raised the issue of the potential need to provide additional shingle to the system to allow migrating barriers to maintain function and integrity. The situation arises where past engineering activity has resulted in a loss of material from the seaward side of the barrier. It is not yet clear at Cley-Salthouse whether this material has been lost from the coastal system and whether new material will have to be brought into the system. Dredging may therefore be necessary to restore and maintain the integrity of the shingle feature.
- The Sussex LBAP raises the interesting proposition that the need for coast defence works might be to the benefit of the extent of the resource. Although this statement needs to be treated with caution there may be examples where new habitat can be created in situations where natural rollback is no longer an option. Ideas for creative conservation could be explored.
- Both the SAC and SSSI designations need to be kept under review to ensure that the boundaries reflect the dynamic nature of the habitat to ensure that natural changes are not leading to features migrating beyond designated boundaries. This is a national and international issue which affects all soft coast features.
- Despite designations some areas of shingle will still fall through the protective net and any review of the habitat action plan will need to address this issue. The Sussex LBAP includes a number of sites where statutory protection is lacking.
- The use of Higher Level Stewardship and other incentives on shingle sites needs to be reviewed in order to prepare revised guidance for management agreements. For example at Rye Harbour and Dungeness, agriculturally damaged areas could be restored to vegetated shingle by ceasing annual cultivation, halting the application of pesticide and fertiliser and reinstating grazing at a low intensity in selected areas (Sussex LBAP <http://www.biodiversitysussex.org/vegetatedshingle.htm>). However it is noted in the Sussex LBAP that under current agri-environment programmes it would be very difficult to find funding for the management of the narrow, fringing shingle communities.
- In terms of habitat restoration more work is required to bring together the results of current work at Dungeness and other sites. Work at Dungeness includes the work described by Banks (this report) on the establishment of broom and other transplanting techniques.
- The focus of action to conserve wetland features has been within the Dungeness shingle complex. The results of scrub cutting followed by grazing on the vegetation are reported by Banks (this report). The applicability of this management to other sites with wetland communities should be assessed.

¹⁷ <http://www.defra.gov.uk/environment/flooding/policy/guidance/smp.htm>

- Case study sites are included in the shingle guide, including the results of the Orfordness LIFE-Nature project. These, and others, could be maintained as demonstration sites by updating information and the results of management work. It is important that the funding is secured for selected sites to ensure that management and restoration actions are monitored and reported. In addition, case studies should be sought from outside the UK to broaden the scope of experience.
- The Habitat Action Plan supports policies which would allow natural landward movement of shingle features. This would, in some cases, affect other habitats such as saline lagoons, grazing marsh, fens and reedbeds, some of which will be designated sites. The implementation groups for the relevant HAPs need to work together to develop landscape-scale approaches to coastal habitat management.
- Breaching has already taken place at Porlock Beach where saltmarsh vegetation is developing behind the breached shingle ridge. At Cley-Salthouse the shingle ridge is being encouraged to migrate landwards in response to coastal processes but still retains its structure and function. The Living with the Sea LIFE-Nature project explored many of the issues arising from the potential conflict of one habitat type being replaced by another, particularly the issue where a landward-migrating SAC feature threatens an existing SPA feature. The experiences from these projects and sites need to inform the revision of the action plan.
- There is thus a need to engage with the other HAP groups to identify, well in advance of potential conflicts, where coastal change predictions (the CHaMP approach) identify both threats and opportunities.
- The National Trust's '*Shifting Shores*' policy intends to put this approach into practice as far as their property is concerned. The guidelines prepared by the National Trust reflect current thinking on adaptation to climate change and sea-level rise.
- In terms of assessing damage to sites there is a need to be precise in identifying what problems occur where and which sites require restoration over and above normal good management. Sites identified for restoration should be subject to further assessment to agree the problem, the reasons for the problem and the objectives for restoration. As restoration may take several years or decades it is vital to set out and justify the management options.
- The extent of the habitat is unclear and several quite wide-ranging estimates are used. It will be important for the review to present the best estimate of habitat extent to help inform the action plan and set targets for restoration. Remote sensing is a potential tool for regular monitoring and can be used to determine the changes in extent and quality of habitat and also to monitor progress towards revised targets.
- There is a need to collate and publish information from the restoration projects at Dungeness (surface damage), Rye Harbour (agricultural damage) and Spey Bay (afforestation) and to use these to review targets.
- There appears to be no specific, targeted research on the relationship between offshore shingle banks and onshore shingle structures. The recharge of shingle beaches by offshore aggregates is often cited as being very expensive, but an overview has not been carried out.
- Increasing public awareness of the function and value of shingle features is a priority for action by local BAP groups through the Habitat Action Plan. There appears to be little dissemination of good practice between groups, despite several innovative projects, and little coordination or funding from the national agencies.
- Projects which have helped to raise the profile of shingle habitats and conservation issues include the Orfordness LIFE-Nature project, West Sussex Vegetated Shingle Project, West Sussex Nature Coast Project, East Sussex Coastal Biodiversity Project and the Beaches at Risk project.

- For example the West Sussex Nature Coast Project and the East Sussex Biodiversity Project have raised public awareness through presentations, events, articles and displays. Specific outputs have included vegetated shingle cab cards for contractors working on shingle beaches, a vegetated shingle video, a shingle survey and seed collection associated with coastal defence works and a 'growing shingle plants' leaflet to encourage local people to plant native shingle flora in their gardens. See <http://www.biodiversitysussex.org/vegetatedshingle.htm> .
- In terms of significant funding for the Habitat Action Plan sponsorship could be sought from aggregate companies and others with an economic interest in the resource.

References

- Barnes, R.S.K. 2001. The geomorphology and ecology of the shingle-impounded coastal lagoon systems of Britain. In: Ecology & Geomorphology of Coastal Shingle, eds., J.R. Packham, R.E. Randall, R.S.K. Barnes & A. Neal. Westbury Academic & Scientific Publishing, Otley, West Yorkshire, 320-335.
- Burnham, C.P. and Cook, H.F. 2001. Hydrology and soils of coastal shingle with specific reference to Dungeness. In: Ecology & Geomorphology of Coastal Shingle, eds., J.R. Packham, R.E. Randall, R.S.K. Barnes & A. Neal. Westbury Academic & Scientific Publishing, Otley, West Yorkshire, 107-131.
- Cadbury, J. and Ausden, M. 2001. Birds of coastal shingle and lagoons. In: Ecology & Geomorphology of Coastal Shingle, eds., J.R. Packham, R.E. Randall, R.S.K. Barnes & A. Neal. Westbury Academic & Scientific Publishing, Otley, West Yorkshire, 304-319.
- Carter, R.W.G. and Orford, J.D. 1993. The morphodynamics of coarse clastic beaches and barriers: a short and long term perspective. *J. Coastal Res.* 15: 158-179.
- CIRIA, 1996. Beach Management Manual. Simm, J.D. (ed), Brampton, A.H., Beech, N.W. et al. CIRIA.
- Coates, T.T., Brampton, A.H. and Powell, K.A. 2001. Shingle beach recharge in the context of coastal defence: principles and problems. In: Ecology & Geomorphology of Coastal Shingle, eds., J.R. Packham, R.E. Randall, R.S.K. Barnes & A. Neal. Westbury Academic & Scientific Publishing, Otley, West Yorkshire, 394-408.
- Cooper, E.A., Crawford, I., Malloch, A.J.C. & Rodwell, J.S. (1992). Coastal vegetation survey of Northern Ireland. Lancaster, Lancaster University
- Doody, J.P. 2001. Perspective: the importance of conserving coastal shingle in Europe. In: Ecology & Geomorphology of Coastal Shingle, eds., J.R. Packham, R.E. Randall, R.S.K. Barnes & A. Neal. Westbury Academic & Scientific Publishing, Otley, West Yorkshire, 421-440.
- Doody, J.P. & Randall, R.E. 2003. A guide to the management and restoration of coastal vegetated shingle. http://www.english-nature.org.uk/livingwiththesea/project_details/good_practice_guide/shingleCRR/shingleguide/home.htm
- English Nature, 2004. Coastal Vegetated Shingle (England) GIS inventory. Available at http://www.english-nature.org.uk/pubs/gis/gis_register.asp
- European Commission, 1999. Interpretation Manual of European Union Habitats- EUR 15/2. pp.12-13.
- European Commission, 2008. Article 17 reporting. http://ec.europa.eu/environment/nature/knowledge/rep_habitats/index_en.htm
- Ferry, B., Lodge, B., & Waters, S. 1990. Dungeness: A vegetation survey of a shingle beach. Research and Survey in Nature Conservation No. 26, Nature Conservancy Council, Peterborough.
- Ferry, B. 2001. Vegetation of the Dungeness shingle: aspects of biodiversity. In: Ecology & Geomorphology of Coastal Shingle, eds., J.R. Packham, R.E. Randall, R.S.K. Barnes & A. Neal. Westbury Academic & Scientific Publishing, Otley, West Yorkshire, 224-241.
- Fuller, R.M. 1985. An assessment of the damage to the shingle beaches and their vegetation. In: Dungeness Ecology and Conservation. Focus on Nature Conservation No. 12. Nature Conservancy Council, Peterborough.
- JNCC. 2005. Common Standards Monitoring (CSM). Joint Nature Conservation Committee, Peterborough www.jncc.gov.uk/page-2217

JNCC 2007a. <http://www.jncc.gov.uk/pdf/Article17/FCS2007-H1210-audit-Final.pdf>

JNCC 2007b. <http://www.jncc.gov.uk/pdf/Article17/FCS2007-H1220-audit-Final.pdf>

Lambley, P.W. and Hodgetts, N.G. 2001. Lichens and bryophytes of British coastal shingle. In: Ecology & Geomorphology of Coastal Shingle, eds., J.R. Packham, R.E. Randall, R.S.K. Barnes & A. Neal. Westbury Academic & Scientific Publishing, Otley, West Yorkshire, 380-392.

May, V.J. & Hansom, J.D. 2003. Coastal Geomorphology of Great Britain. Geological Conservation review series No. 28. Joint Nature Conservation Committee, Peterborough

Moore, D. and Wilson, F. (1999). National Shingle Beach Survey. Unpublished report to the National Parks and Wildlife Service, Dublin.

National Trust (2008). Shifting shores in the South West: Living with a changing coastline. National Trust. www.nationaltrust.org.uk

Natural England 2008. State of the Natural Environment. www.naturalengland.org.uk

Orford, J.D., Jennings, S.C. and Forbes, D.L. 2001. Origin, development, reworking and breakdown of gravel-dominated coastal barriers in Atlantic Canada: future scenarios for the British coast. In: Ecology & Geomorphology of Coastal Shingle, eds., J.R. Packham, R.E. Randall, R.S.K. Barnes & A. Neal. Westbury Academic & Scientific Publishing, Otley, West Yorkshire, 23-55.

Packham, J.R. & Willis, A. J. 1997. Ecology of Dunes, Salt Marsh and Shingle. Chapman & Hall.

Packham, J.R., Randall, R.E., Barnes, R.S.K. & Neal, A. 2001. Ecology and Geomorphology of Coastal Shingle. Westbury Academic & Scientific Publishing, Otley, West Yorkshire.

Peterken, G.F. and Hubbard, J.C.E. 1972. The Shingle vegetation of Southern England: the holly wood on Holmestone beach. Dungeness. Journal of Ecology, 60: 547-571.

Pye, K & French, P.W. 1992. Targets for coastal habitat re-creation. English Nature Science Series No 35. English Nature, Peterborough.

Pye, K., 2001. The nature of geomorphology of coastal shingle. In: Ecology & Geomorphology of Coastal Shingle, eds., J.R. Packham, R.E. Randall, R.S.K. Barnes & A. Neal. Westbury Academic & Scientific Publishing, Otley, West Yorkshire, 2-22.

NPWS. 2008. The Status of EU Protected Habitats and Species in Ireland. National Parks and Wildlife Service www.npws.ie

Randall, R.E. and Sneddon, P. 2001. Initiation, development and classification of vegetation on British shingle beaches: a model for conservation management. In: Ecology & Geomorphology of Coastal Shingle, eds., J.R. Packham, R.E. Randall, R.S.K. Barnes & A. Neal. Westbury Academic & Scientific Publishing, Otley, West Yorkshire, 202-223.

Randall, R.E. 2004. Management of coastal vegetated shingle in the United Kingdom. Journal of Coastal Conservation, 10.159-168.

Rees, S.M (ed) 2005. Coastal Evolution in Suffolk: an evaluation of geomorphological and habitat change. English Nature Research Reports No. 647. English Nature, Peterborough.

Rodwell, J.S., (ed.) 2000. British Plant Communities. Volume 5: Maritime communities and vegetation of open habitats. Cambridge University Press.

Ryle, T., Connolly, K., Murray, A. and Swann, M. (2007) Coastal Monitoring Project 2004-2006: A report

prepared for the National Parks and Wildlife Service, Research Branch Contract Reference D/C/79 (Unpublished).

Shardlow, M. 2001. A review of the conservation importance of shingle habitats for invertebrates in the United Kingdom (UK). In: Ecology & Geomorphology of Coastal Shingle, eds., J.R. Packham, R.E. Randall, R.S.K. Barnes & A. Neal. Westbury Academic & Scientific Publishing, Otley, West Yorkshire, 355-376.

Sneddon, P., & Randall, R.E. 1993. *Coastal vegetated shingle structures of Great Britain: Main report*. Joint Nature Conservation Committee, Peterborough.

Sneddon, P., & Randall, R.E. 1993/1994. Coastal vegetated shingle structures of Great Britain: Appendix 1 - Wales; Appendix 2 -Scotland; Appendix 3 - England. Joint Nature Conservation Committee, Peterborough.

UK Biodiversity Group, 1999. Tranche 2 Action Plans- Volume V: Maritime species and habitats p. 117.

UKBAP website; www.ukbap.org.uk

UK Vegetated Shingle Habitat Action Plan. www.jncc.gov.uk

Walmsley, C.A. and Davy, A.J. 2001. Habitat creation and restoration of damaged shingle communities. In: Ecology & Geomorphology of Coastal Shingle, eds., J.R. Packham, R.E. Randall, R.S.K. Barnes & A. Neal. Westbury Academic & Scientific Publishing, Otley, West Yorkshire, 409-419.

Annex: Workshop participants

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