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BIODIVERSITY

VEGETATED SHINGLE SURVEY - METHODS AND RESULTS

P.J.R.Fitzsimons, K.R.Cole, A.I.Tait, 2007

Yellow Horned-poppy (*Glaucium flavum*) on shingle beach at Tide Mills, East Sussex.

Beaches At Risk is a partnership project part-financed by the European Regional Development Fund (ERDF). The principal partners are the University of Sussex, East Sussex County Council, Kent Wildlife Trust, Université de Rouen, Université de Caen & Université du Littoral.

Vegetated shingle at Rye Harbour Nature Reserve, East Sussex. Sea-kale (*Crambe maritima*), Yellow Horned-poppy (*Glaucium flavum*), Bittersweet (*Solanum dulcamara*) in the foreground and Viper's-bugloss (*Echium vulgare*) in the middle ground with purple flowers visible.

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Please accept our apologies to any one who we have missed out, or whose name we have misspelled.

VEGETATED SHINGLE SURVEY - METHODS AND RESULTS

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1. SUMMARY

A robust method for surveying shingle beaches within the Beaches At Risk (BAR) project area was developed and tested on beaches between 2005 and 2006 on both sides of the Channel.

The survey method has been produced as a pack in both French and English including detailed instructions, a recording sheet, and a photographic identification guide for the species to be looked for.

Fifty-one volunteer recorders attended at least one of 11 training and testing sessions. Of those, at least 15 individuals completed a minimum of one survey post-training without supervision.

Thirty-seven sites in all, twenty-nine on the English coast and eight sites on the French coast, were surveyed. At each site two belt transects, perpendicular to the shore and running inland from the seaward side of the beach were surveyed. Each transect was walked twice, once up the beach and once back down. The presence of selected plant species or species groups was recorded. The plant species selected were.

- Species, subspecies or varieties of species that are typically found on vegetated shingle (or closely associated coastal habitats.
- Rare species found on the coast.
- Species groups that can indicate broad community types on shingle.
- And/or species that have important species associated with them on shingle and other coastal habitats.

Forty-six of the 52 species (or species groups) that were looked for were recorded. Estimations of species distribution and other shingle beach features were also recorded.

These data were used to categorise the beaches in terms of their biodiversity value into one of the following three categories: Excellent, Good or Impoverished. Each site was evaluated with respect to 12 criteria and a Biodiversity Value Category (BVC) for each site was determined by the mean category value for all 12 criteria. Six sites were categorised as Excellent, twenty-two as Good, and nine as Impoverished.

The method described in this paper could be applied to other coastal habitats such as sand dunes and salt marshes with few changes.

2. INTRODUCTION

Shingle beaches

Large sections of the eastern Channel coasts in the Beaches At Risk (BAR) project area are bordered by shingle beaches (277 km out of a total of 470 km) (Table 2.1 and Figure 2.1), much of it composed of flint eroded out of the Chalk. Although most shingle beaches are narrow (< 100m from seaward side to landward side) a few stretch inland over several 100s of metres, such as those at Rye and Dungeness. Although shingle beaches play an important role for coastal defence and recreation, and are fascinating for such disciplines as geology and geomorphology, this study is primarily concerned with their potential to develop into a habitat type known as vegetated shingle made up of unique and rare plant species and communities adapted to grow on natural shingle beaches. For the purposes of this report, the term vegetated shingle applies to all vegetated or potentially vegetated shingle sites found on the coast within the BAR area.

	continuous band	discrete pockets e.g. fringing beaches under chalk cliffs	
England	109 km	42 km	151 km
France	55 km	71 km	126 km
		total extent of shingle	277 km

Table 2.1 - Extent of shingle beaches along the BAR coasts (total coastline 470 km) (after Robinson *et al.*, 2005).

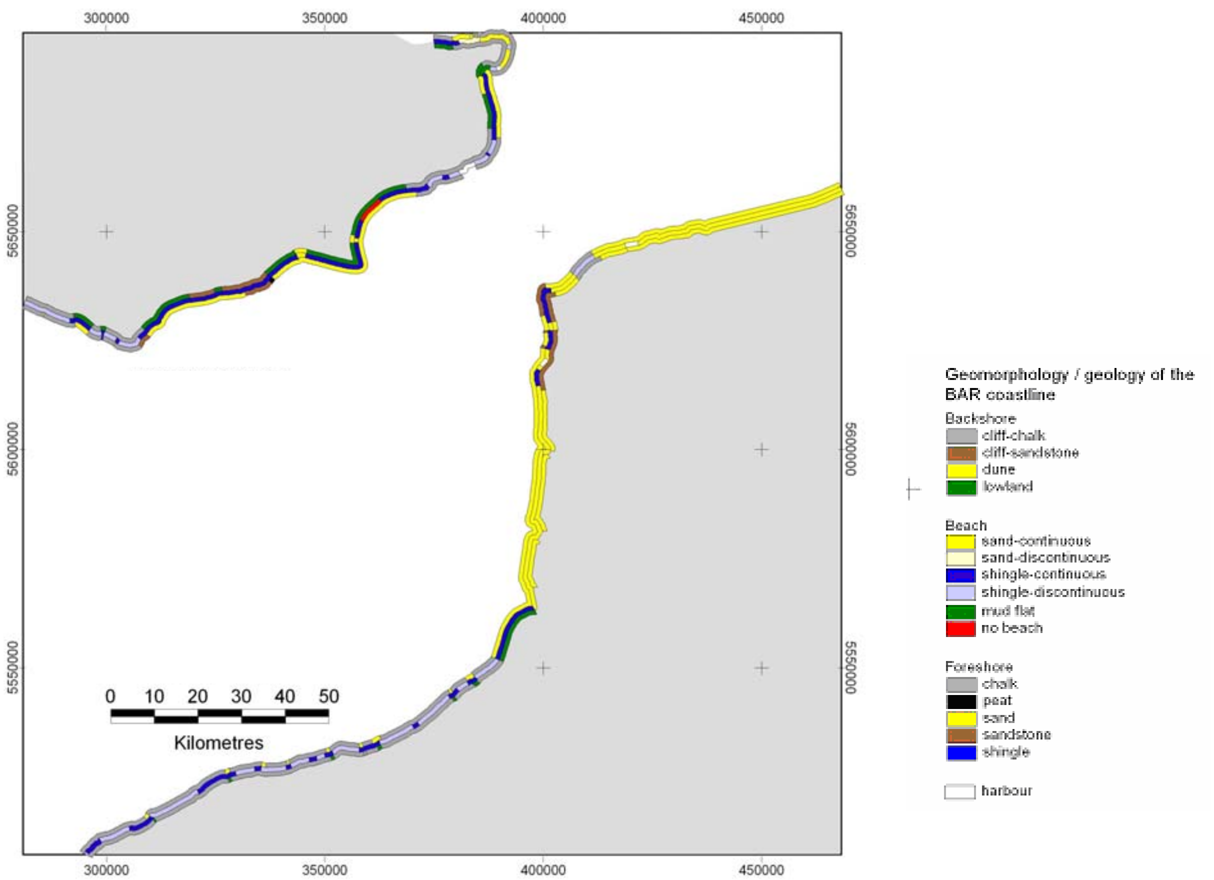

Figure 2.1 - Geomorphology and geology of the coastline in the BAR project area

Vegetated shingle

Shingle beaches are often transient and can undergo massive and rapid change. They are harsh environments, with little soil, very little freshwater, strong winds, salt spray and occasional inundation by the sea, burial under fresh shingle or even the loss of whole ridges during big storms. Nonetheless, some plants and animals have adapted to survive these conditions. Many of these are adapted to intermittent disturbance and may quickly colonise new areas of disturbed shingle. Vegetation communities on shingle beaches depend on the amount of finer materials mixed in with the shingle, how much fresh water there is, climatic conditions, the width of the foreshore, and past management of the site and are strongly influenced by stability (e.g., Scott, 1963; Scott, 1965; Fuller, 1987; Doody and Randall, 2003). The number of species able to colonise the shingle increases as stability increases, so that on older parts of a beach, mature grassland, lowland heath, moss and lichen communities, and sometimes scrub may develop. Note that the longer a community takes to develop the less resistant and resilient to disturbance it is. Many of the species and communities on shingle appear to be specific to it, and some communities are only known from Dungeness (Randall and Sneddon, 2001). For example, bare shingle colonised by prostrate *Cytisus scoparius* (Broom) but is known only at Dungeness (Scott, 1965).

Shingle beaches represent one of the small numbers of habitats where natural primary succession can occur (Randall and Sneddon, 2001). Understanding succession, i.e. the vegetation sequence and the reasons for its development, is an important part of predicting the effects that factors such as climate change or management of a site may have. However, the few studies which have described succession on shingle (reviewed in Randall and Sneddon, 2001) suggest that succession proceeds as an anastomosing (dividing and coming together again) sequence often resulting in site-specific communities, and that succession may be halted at any stage of the sere by the degree of oceanicity (i.e. the influence from the physical attributes of the sea). Nevertheless, they have described a generalised sequence for vegetation on shingle which was adapted for the sites in the BAR area (Figure 2.2).

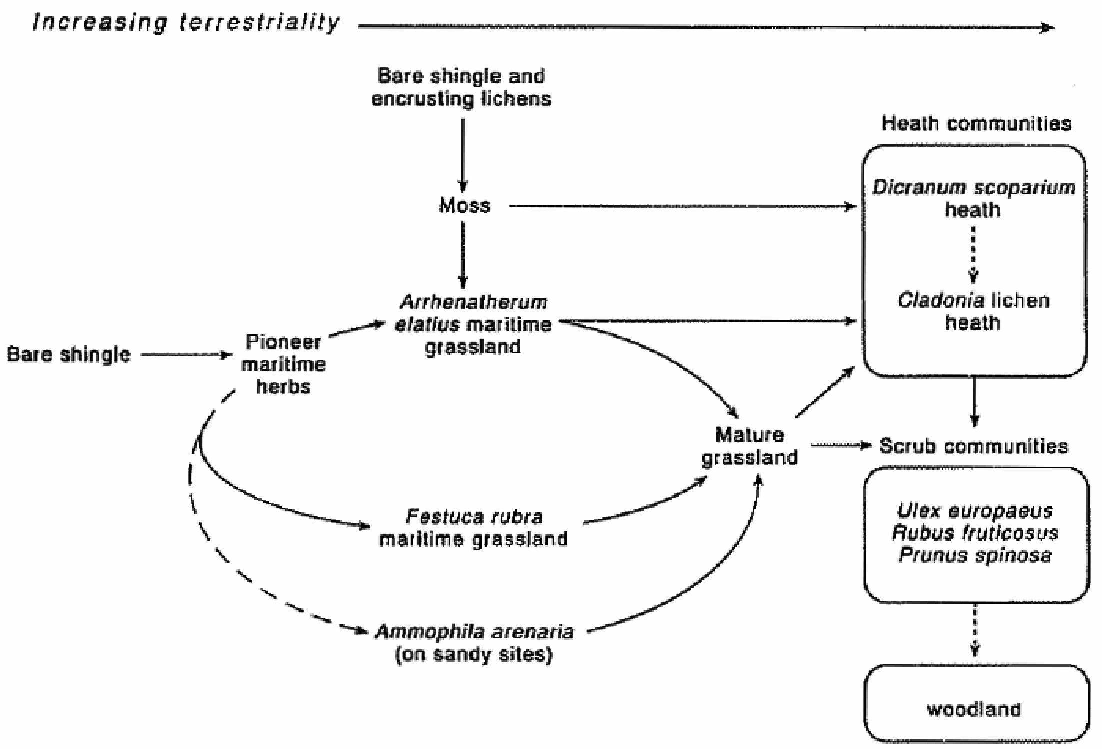

Figure 2.2 - Generalised sequence of vegetation on shingle sites in the BAR project area (adapted from Randall and Sneddon, 2001).

In practice, succession and factors such as oceanicity on shingle generally leads to zonation of the vegetation, especially on beaches that extend inland well beyond the reach of the highest tides, which can be divided into the broad categories shown below.

- **Bare shingle** – describes areas with no vegetation, for example, at the foot of sea-cliffs, on high-energy beaches where beaches are disturbed too frequently to support plant growth (Doody and Randall, 2003). Bare shingle with or without a lichen cover on areas well out of the reach of waves occur and some may remain bare for long periods of time (e.g. at Rye Harbour Nature Reserve, Yates, pers. com.).
- **Ephemeral communities** – occur on parts of the beach which are stable over the growing season only. The vegetation is ephemeral and composed of annual or short-lived perennial species which may form only sparse cover, and may be highly variable both temporally and spatially and both within and between sites. Plants are usually composed of summer annuals (Doody and Randall, 2003). E.g. *Atriplex* species (spp.) (Oraches) on the drift line, especially that left from the previous winter's storms.
- **Pioneer communities** – occur on parts of the beach which have been stable for over three years - include short-lived perennials and may consist of considerable strand and foreshore vegetation. E.g. *Glaucium flavum* (Yellow Horned-poppy), *Rumex crispus* subspecies (ssp). *littoreus* (Curled Dock), *Beta vulgaris* ssp. *maritima* (Sea Beet) (e.g. Randall and Sneddon, 2001; EC, 2003).
- **Established communities** – occur on stable shingle and consist of long-lived perennial species. Communities range from grassland to lichen-heath on beaches still subject to occasional inundation, lichen-heath and/or scrub communities on entirely stable beaches. Increased stability of shingle is often accompanied by an increase in *Festuca rubra* variety (var.) (above, you spell out subspecies before you give the abbreviation, but you don't do that here. Either spell out variety or delete the subspecies above. I'd go for the latter) *rubra* (Red Fescue) or *Arrhenatherum elatius* (False Oat-grass) grading inland to a heath community (e.g. Hubbard, 1970; Fuller and Randall, 1988; Randall and Sneddon, 2001). Although the development of heathland is primarily restricted to areas outside the BAR area, lichen-heath may represent the *Calluna vulgaris* (Heather) equivalent (Randall and Sneddon, 2001) within the BAR area. Encrusting lichens at Dungeness such as *Rhizocarpon* spp. and *Lecanora* spp. found only on otherwise bare shingle indicate that the shingle is stable and therefore suitable for further colonisation, although lichen establishment is not an essential component to succession Scott (1965).

Increasing terrestriality – decreasing oceanicity

Animals

Although this study is predominately concerned with plants, many animals also depend on vegetated shingle. Many species of bird, for example *Sterna* spp. (terns) and *Charadrius* spp. (plovers) nest on shingle, while some waders will use the sparsely vegetated areas on the seaward side of a beach as high-tide roosts. There is a very distinctive invertebrate fauna associated with shingle habitats (Shardlow, 2001). A large number of invertebrate species breed, feed or live on shingle plants, e.g. the caterpillar of the rare *Calophasia lunula* () is found almost exclusively on shingle at a few sites in East Sussex and Kent. There are several spiders which are only found on shingle beaches and a completely new species of fly (*Megaselia* spp. Family Phoridae) was recently found living deep within the beach at Rye Harbour (see Doody and Randall, 2003; Shardlow, 2001 for comprehensive lists).

Main ongoing threats

Shingle supply

Some of the main long-term threats to vegetated shingle are as a result of interference with natural coastal processes (Doody and Randall, 2003). Cliff protection works affect the source of shingle and structures such as harbour arms influence its movement by longshore drift, which alters the recharge rate of shingle to beaches. In many places the rate of shingle accretion is exceeded by its loss through longshore drift. The movement of shingle is likely to be accelerated by sea level rises. To counteract falling beach levels, beaches are often topped up with sand and shingle taken from elsewhere which may significantly alter the structure of the matrix in which previous vegetated shingle communities had developed. Natural shingle vegetation may not be able to colonise and any potential communities that develop may be very different to those originally there.

Coastal squeeze and climate change

As sea levels rise the vegetation on a beach may not be able to migrate inland as it is “squeezed” between the sea on one side and immovable land structures (artificial or natural) on the other (Doody and Randall, 2003). Climate change is likely to affect shingle habitats in other ways as for example, the summers become dryer and winters wetter, or through human behavioural responses, e.g. increased water extraction lowering the water table, increased visitor pressure on beaches.

Lack of public awareness

Shingle vegetation is fragile; the wear and tear caused by access on foot, and particularly by vehicles, has damaged many sites. There is a lack of public awareness of the value of the shingle habitat. Fringing beaches in particular are threatened by human-related damage such as development, introduction of exotic species, vegetation stripping, trampling, dumping, burning, dog fouling and other forms of enrichment. Such disturbance can also affect breeding birds.

Biodiversity value

The Convention on Biological Diversity defines “biological diversity” as “..the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems” (CBD, 1992). For the purposes of this study, the terms “biodiversity” and “high biodiversity” will generally refer to plant species and a high species richness of typical shingle plant species respectively.

The value we assign to biodiversity is determined by subjective opinion, albeit one generally reached by experts. Biodiversity value in this study was determined by value criteria concerned with rarity and 'naturalness' of plant species, and community types. Therefore, a beach’s biodiversity value was characterised mainly by the presence and distribution of typical coastal plant species and communities, both rare and less rare. A beach with high biodiversity value had a relatively higher number and wider distribution of such species and communities relative to a beach with low biodiversity value. Other value systems which involve other biodiversity measures such as genetic diversity, economic value or potential as future biological resources were beyond the scope of this study.

Conservation

Vegetated shingle is an internationally rare habitat with few occurrences outside north-west Europe, Japan and New Zealand (N.B. different species are found in Japan and New Zealand). Within Europe, it is scarce with the UK supporting a high proportion of the European resource (Doody and Randal, 2003). Estimations of the area covered by vegetated shingle in the UK vary from about 4000 to over 6000 hectares (e.g. UK Biodiversity Group, 1999; JNCC, 2007a; Rich *et al*., 2005a), a large part of which is at just two sites, Rye Harbour Nature Reserve (East Sussex) and Dungeness (Kent and East Sussex) (Doody and Randall, 2003). These values are likely to be underestimates, missing areas that could potentially become vegetated. The French resource in the BAR area is much smaller and is based mainly between Ault and le Hourdel on the south side of Baie de Somme. Many vegetated shingle sites are outside designated areas and therefore receive no direct form of protection.

The following describes some of the more important legislation protecting vegetated shingle.

Natura 2000

The European Community (now the European Union) adopted two Directives to meet its obligations as a signatory of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention, 1979) namely, Council Directive 79/409/EEC (EC Birds Directive), and Council Directive 92/43/EEC (EC Habitats Directive). They protect species and habitats of European importance, particularly by means of a network of Sites of Community Importance (SCIs). Once adopted, these are designated by Member States as Special Areas of Conservation (SACs), and along with Special Protection Areas (SPAs) classified under the EC Birds Directive, form a network of protected areas known as Natura 2000. In France the equivalent of SACs and SPAs are “Les zones spéciales de conservation” (ZSC) and “Les zones de protection spéciale” (ZPS) respectively. Vegetated shingle is listed under two habitat types on Annex I of the EC Habitats Directive.

- H1210: "Annual vegetation of driftlines”, “Végétation annuelle des laissés de mer”.
- H1220: "Perennial vegetation of stony banks", “Végétation vivace des rivages de galets”.

H1210 describes communities that occur on shingle lying at or above mean high-water spring tides, generally on fringing beaches that are periodically displaced or overtopped by high tides and storms. Although a large part of the BAR coastline is fringed by shingle or sand/shingle beaches (Figure 2.1), much of it is too dynamic to sustain drift-line vegetation. The beaches that do are small, and annual vegetation may exist in one location in one year but not another. Therefore, although widespread, sites where H1210 is persistent are rare. H1220 describes several kinds of communities that occur on shingle above the limit of high tides, on more permanent ridges out of reach of storm waves (see Cole *et al*., 2005 pages 3-8; JNCC, 2007a for more details). There are only a few extensive examples of H1220 in Europe, a significant part of which occur in the BAR area (Rye Harbour Nature Reserve and Dungeness in the UK, South of Baie de Somme in France) (JNCC, 2007a).

Convention on Biological Diversity

England and France are also signatories to the Convention on Biological Diversity (CBD), one of the key agreements adopted at the 1992 Earth Summit in Rio de Janeiro. The CBD obliged member states to produce and implement national strategies and action plans to conserve, protect and enhance biodiversity. The European Union (EU) further committed itself to halting the rate of biodiversity loss by 2010 at the Gothenburg Summit in 2001, and both England and France, along with other Heads of Government committed themselves to achieving a significant reduction in the rate of biodiversity loss by 2010 at the World Summit on Sustainable Development in Johannesburg, 2002 (UKBP, 2006).

Legislation - England

The main piece of legislation relating to nature conservation in Great Britain is the Wildlife and Countryside Act 1981 (as amended). Under the Act, Natural England (formerly English Nature) has responsibility for identifying and protecting Sites of Special Scientific Interest (SSSIs) which gives legal protection to the best sites for wildlife and geology in England. The SSSI legislative regime was significantly enhanced through the Countryside and Rights of Way (CRoW) Act 2000 and the Natural Environment and Rural Communities (NERC) Act 2006. For example, the NERC Act created a duty for public and statutory bodies to integrate biodiversity into their decision-making (Defra, 2006). Planning Policy Statement 9: Biodiversity and Geological Conservation (PPS9) set out the Government's national policies on different aspects of planning in England, a key principle of which being that development plan policies and planning decisions should be based upon up to date information about the relevant biodiversity resources of the area (ODPM, 2005).

The UK's legalisation to meet the Birds and Habitats Directives' obligations in England are the Conservation (Natural Habitats, & c.) Regulations 1994 (as amended). All Natura 2000 sites in England are also SSSIs. The additional designations are recognition that some or all of the wildlife and habitats are particularly valued in a European context.

The UK Government's response to the CBD was to produce a UK Biodiversity Action Plan (UK BAP) (Department of the Environment, 1994), the first step in describing the UK's biodiversity and detailing plans for its protection and enhancement. Under the plan there are 436 costed and targeted national action plans for threatened habitats and species in the UK (although these targets are currently under review plans to reduce and streamline the number of actions (UK BAP, 2007a)), and these are supported by approximately 150 Local biodiversity action plans, often at County level (UK Biodiversity Partnership, 2006).

Coastal vegetated shingle is listed as a priority habitat under this plan and a specific Habitat Action Plan (HAP) was produced in 1999 (UK Biodiversity Group, 1999). There are also nine BAP priority species with significant populations on vegetated shingle sites: *Calophasia lunula*, *Hadena albimacula* (white spot), *Crepis foetida* (Stinking Hawk's-beard), *Silene gallica* (Small-flowered Catchfly), endemic *Limonium* spp (Sea-lavenders), *Galeopsis angustifolia* (Red Hemp-nettle), *Bombus humilis* (brown-banded carder bee), *Bombus ruderatus* (large garden bumble bee), *Bombus subterraneus* (short haired bumble bee), and the hopper *Aphrodes duffieldi*.

The England Biodiversity Group advises the Government on the implementation of the UK BAP in England. In particular, it oversees development and delivery of the biodiversity strategy for England as set out in "Working with the grain of nature: a biodiversity strategy for England" (Defra, 2002). Its approach comprises a combination of protecting the best wildlife sites, promoting the recovery of declining species and habitats, embedding biodiversity in all sectors of policy and decision-making, enthusing people and developing the evidence base (Defra, 2006). Of particular relevance to the method described in this report are the two latter points.

France

The main piece of legislation relating to nature conservation in France is the "Environmental Code" (Loi nº 2002-276 du 27 février 2002 art. 132 Journal Officiel du 28 février 2002, (as amended)) (Legifrance, 2007). Under the Act, the "Conservatoire de l'espace du littoral et des rivages lacustres" (Coastal Protection Agency) ensures the protection of outstanding natural areas on the coast. It can acquire land either privately, through legacies, by first refusal on coastal areas, or more rarely, through compulsory purchase. Once acquired, the land becomes inalienable, meaning that it cannot be resold. The Conservatoire own land, or have first refusal on a large expanse of coast in the BAR area, including vegetated shingle around Hâble-d'Ault (Conservatoire du littoral, 2007). Areas can also be protected under the act by an "Arrêté Préfectoral de Protection de Biotope" which aims to protect sites with high biodiversity value, and includes the "Cordon de galets de La Mollière", 262 hectares of vegetated shingle between Cayeux-sur-Mer and Baie de Somme.

France's legalisation for designation of Natura 2000 sites comes under "Le décret n° 2001-1031 du 8 novembre 2001 relatif à la procédure de désignation des sites Natura 2000 et modifiant le code rural" (Legifrance, 2007). France has a contractual rather than a legislative policy for the management of Natura 2000 sites under "Charte Natura 2000" (Natura 2000 Charter). A management plan called a "Document d'objectif" is established for every site. Landowners can sign a voluntary contract ("Contrat Natura 2000") by which they get financial support to change practices that damage biodiversity. New plans and projects can undergo an impact assessment and can be refused, although this does not apply to ongoing activities (MNHN, 2003-2006). "Cahier d'habitats" (habitat notes), an up-to-date summary of the scientific knowledge and an overall approach to conservation management of the habitats and species making up Natura 2000 sites have been written (MNHN, 2003-2006).

The French Government's response to the CBD was the "Stratégie nationale pour la biodiversité (National strategy for biodiversity)" (MEDD, 2004) with a similar function to the UK BAP, including halting biodiversity loss by 2010. Ten "Plan d'actions" (Action Plans) were published during 2006, including "Plan d'action patrimoine naturel", (Action Plan for natural heritage) and "Plan d'action mer" (Action Plan for the sea) which both make reference to "Le Littoral" (The Coast), although vegetated shingle is not specifically mentioned and "Plan d'action recherche" (Research) addressing the need for data (MEDD, 2006). Its approach, in a similar vein to the UK Biodiversity Strategy, includes the following ideas: protecting and promoting the recovery of declining species and habitats, the inclusion of all the "actors", including key socio-professional sectors (i.e. companies, farmers, seaworkers) in the implementation of the strategy, improving public awareness of biodiversity loss as well as its responsibility for protecting it, and developing baseline data and surveying/monitoring techniques (MEDD, 2004). Again, of particular relevance to the method described in this report are the two latter points.

Targets

Both the UK and France have committed themselves to reducing biodiversity loss by 2010. The UK Government has a Public Service Agreement (PSA) target to bring "…. into favourable condition, by 2010, 95% of all nationally important wildlife sites" (HM Treasury, 2004). A baseline assessment of the condition of all SSSIs showed that 73% of coastal habitats within SSSIs were in "favourable" condition in 2003, which increased to 85% in March 2006 (Defra, 2006). However, although there were positive signs of progress under the UK BAP between 2002 and 2005, there was continuing or accelerating declines in a number of coastal habitats reflecting a range of pressures, including coastal squeeze (Defra, 2006). The biggest concern was the limited progress made towards BAP targets for habitat restoration and expansion (Defra, 2006). Revised national BAP targets require the achievement of "favourable" or "recovering" condition of an as yet unspecified (but likely to be c. 95%) area by 2010. Condition of vegetated shingle is currently only assessed on SSSIs so there are few data for many of the shingle sites within the BAR area. There are even less data for much of Europe outside the UK (Doody and Randall, 2003). In order to reach biodiversity strategy targets there have to be good baseline data for, and an effective way of monitoring shingle sites. Non-designated sites should also be surveyed and monitored especially as they may help achieve, for example, BAP targets for habitat restoration and expansion.

Enthusing people

Both the UK's and France's biodiversity strategies recognise that more people need to be engaged in taking action to maintain and enhance biodiversity as part of their everyday lives. For example, priorities for 2006-2010 in the UK's Biodiversity Strategy include raising awareness and understanding of open spaces with high biodiversity as an important component for a good quality of life, engaging a million new people to take part in enhancing and protecting biodiversity, improving communication, education, participation and action for biodiversity activities (Defra, 2006).

Developing the evidence base

The ability to identify species, monitor their population trends and determine their habitat preferences, or at least, their level of association with a particular habitat is essential for any conservation effort. By surveying important habitats regularly we can for example, locate particularly rare species or identify declines in habitat quality. This kind of information is vital for effective conservation management. "Collecting basic data on coastal habitats is an important first step in identifying the most ecologically significant sites, and establishes a baseline for monitoring and understanding the impact of management practices and developments on them" (Sneddon and Randall, 1994, p5).

In the UK, the National Vegetation Classification (NVC) is the standard system used for identifying vegetation habitats (Birnie *et al*., 2005), is used for the selection of biological SSSIs, and has also been used to interpret EC Habitats Directive Annex I habitats. Vegetated shingle is covered under "Shingle, strandline and sand-dune communities", but only one of 19 communities is found on coastal shingle (SD1). Two communities are associated with strandlines (SD2 *Honkenya peploides – Cakile maritima* and SD3 *Matricaria maritima – Galium aparine*), and the remaining sixteen are sand-dune communities (Rodwell, 2000; see also Cole *et al*., 2005, page 3-8). SD1 is accepted as being comparable with H1220. H1210, less easy to classify using the NVC, can include NVC types SD2 and SD3 on stony substrates, MC6 *Atriplex prostrata – Beta vulgaris* ssp. *maritima* sea-bird cliff community and other vegetation with abundant *Atriplex* spp. (JNCC, 2007b).

Although useful at a national scale the limited number of NVC categories does not adequately describe the variety of vegetation on shingle beaches. Therefore, commissioned by the Nature Conservancy Council (now Natural England, *inter alios*) in 1987, Sneddon & Randall (1993) carried out a major survey describing 60 UK shingle sites with a permanent flora above the strandline using the NVC system. They described 124 communities, only 31 of which were closely matched by NVC communities, suggesting the uniqueness of many of the communities on shingle. These were further divided into 25 major communities in six divisions (pioneer, secondary pioneer, mature grasslands, grasslands, heath and scrub) (Sneddon and Randall, 1993; see Cole *et al*., 2005, page 5). Other studies (e.g. Ferry *et al*., 1990; Williams and Cooke, 1993; Ryland, 1993) have each suggested other divisions with differing plant assemblages. These studies and studies on succession have highlighted the difficulties in classifying vegetated shingle. Furthermore, they have relied on labour- and expertise-intensive methods. For example, NVC is a slow and labour-intensive method requiring botanical expertise; additionally it is not designed as a monitoring tool (Birnie *et al*., 2005).

The limited number of NVC categories applicable to shingle, the large number of communities described by other studies, and the time, labour and expertise needed by these methods may not provide the most effective way of discriminating between sites. Additionally, a high level of expertise is needed to analyse the data (Birnie *et al*., 2005). This report and previous work by Cole *et al*. (2005) have also emphasised the need to survey and monitor all vegetated shingle sites within the BAR area, including those without statutory or local protection (mainly the smaller fringing beaches) which have been missed by previous studies (e.g. Ryland, 1993; Williams and Cooke, 1993; Sneddon and Randall, 1993) or are not included in national monitoring targets (e.g. the Joint Nature Conservation Committee (JNCC) guidelines for monitoring coastal vegetated shingle are designed for designated sites (Doody and Randall, 2003)).

The method described in this report was designed to be easily and objectively applicable over the whole BAR project area. The method was also designed to be doable by people with little or no previous experience of surveying, or of shingle plants, but who are likely to be interested in, and have current knowledge of the state of their local beaches. It was also developed to allow non-experts a simple and objective way of assigning the same biodiversity value to a site as might an expert. This was achieved by identifying easily measurable parameters for a site, and a range of criteria that allowed a site to be assigned a biodiversity value dependent on those parameters.

3. AIMS

East Sussex County Council's role in the BAR project was to develop a method for evaluating the quality of a shingle beach in terms of its biodiversity so that individual beaches could be placed into one of three biodiversity value categories, namely: Excellent, Good or Impoverished.

Objectives

- To develop a method of recording the vegetation on shingle beaches using a relatively simple and repeatable method, that was quick and simple to apply with a minimum of training.
- To develop a method to assess the relative biodiversity value of surveyed sites.
- To involve volunteer recorders in the survey work to validate the survey methodology and raise awareness of the importance of vegetated shingle as a natural habitat, and encourage the involvement of local communities.

4. METHODS

A methodology that would enable the biodiversity value of a shingle beach to be evaluated was developed. The method involved determining the presence and distribution of selected species and community types, and various other attributes from a shingle beach. The data needed were selected to provide sufficient information in which to assess biodiversity value, but also so that non-experts could collect them simply, quickly, and in an objective way with a minimum of training. Criteria were also developed against which the data were matched so that a beaches' biodiversity value could be assessed.

A list of species was prepared using the criteria described below and refined (checked by Paul Harmes, Dr. Barry Yates, Dr Roland Randall pers. com.) so that it included species that were easy to identify throughout the survey season with a minimum of training. Selected taxa that only needed to be identified to groups, for example, grasses, mosses and lichens were added to the list. To identify these to species level needs a high level of expertise and a fair amount of time to achieve. Furthermore the period over which the survey ran would have made it hard for even the very experienced to identify for example, grasses at the end of the survey in contrast to many of the herbs which remain identifiable even after they have died. However, although these taxa were not identified to species they provided useful, if broad, indicators of the communities that were potentially present on a site (see section 2).

A vegetated shingle survey workshop was held during the BAR conference at Dunkirk 2006, during which ecologists and non-ecologists discussed and tested various methodologies. This useful exercise helped make the final method accessible to, and doable by non-experts.

Species chosen

The plant species (or species groups) included in the survey (Table 4.1) were selected to match at least one of the following criteria.

- Species, subspecies or varieties of species that are typically found on vegetated shingle, or closely associated coastal habitats.
- Rare species found on the coast. In England these were species that are listed in the Wildlife & Countryside Act, the JNCC list of rare species and/or are a UK BAP species (see below for details). In France these were species with either national or regional protection within the BAR area.
- Species groups that can indicate important community types on shingle, e.g. mosses, which may be an important precursor to the development of shingle sere where nutrient input is minimal (Sneddon and Randall, 2001).
- Species that have important species associated with them on shingle and other coastal habitats, e.g. *Linaria* spp (Toadflax species) are eaten by the caterpillars of *Calophasia lunula* (toadflax brocade moth) which has a Species Action Plan in the UK.

Species name	English common name	French common name
Armeria maritima	Thrift	Gazon d'Olympe
Beta vulgaris ssp. *maritima*	Sea Beet	Betterave (de mer)
Brassica oleracea	Wild Cabbage	Chou sauvage
Cakile maritima	Sea Rocket	Cakilier
Calystegia soldanella	Sea Bindweed	Liseron soldanelle
Centranthus ruber	Red Valerian	Valériane rouge
Cerastium tormentosum	Snow-in-summer	Céraiste tomenteux
Crambe maritima	Sea-kale	Chou marin
Crithmum maritimum	Rock Samphire	Criste marine
Cytisus scoparius	Broom	Genêt à balai
Echium vulgare	Viper's-bugloss	Vipérine commune
Eryngium maritimum	Sea-holly	Panicault de mer
Euphorbia paralias	Sea Spurge	Euphorbe maritime
Frankenia laevis	Sea-heath	Frankénie
Galeopsis angustifolia	Red Hemp-nettle	Galéopsis à feuilles
Geranium robertianum ssp. *maritimum*	Herb Robert	Herbe à Robert
Glaucium flavum	Yellow Horned-poppy	Pavot cornu
Hippophae rhamnoides	Sea-buckthorn	Argousier
Honckenya peploides	Sea Sandwort	Pourpier de mer
Lactuca saligna	Least Lettuce	Laitue à feuilles de saule
Lathyrus japonicus (*Lathyrus japonicus* ssp. *maritimus* (éteint))	Sea Pea	Gesse maritime
Lavatera arborea	Tree Mallow	Lavaterre arborescente
Plantago coronopus	Buck's-horn Plantain	Plantain corne-de-bœuf
Polygonum maritimum	Sea Knotgrass	Renouée maritime
Prunus spinosa	Blackthorn	Epine noire, Prunellier
Raphanus raphanistrum ssp. *maritimus*	Sea Radish	Radis (de mer)
Rumex acetosella	Sheep's Sorrel	Petite oseille
Rumex crispus ssp. *littoreus*	Curled Dock	Patience crépu
Salsola kali	Prickly Saltwort	Soude salsovie
Sambucus nigra	Elder	Sureau
Senecio cineraria	Silver Ragwort	Séneçon cinéraire
Senecio viscosus	Sticky Groundsel	Séneçon visqueux
Silene uniflora	Sea Campion	Silène à une seule fleur
Solanum dulcamara var. *marinum* (*Silene vulgaris* ssp. *maritima*)	Bittersweet	Douce amère
Teucrium scorodonia	Wood Sage	Sauge des bois
Trifolium squamosum	Sea Clover	Trèfle maritime
Tripleurospermum maritimum (*Matricaria maritima* ssp. *maritima*)	Sea Mayweed	Matricaire (de mer)
Ulex europaeus	Gorse	Ajonc d'Europe
Urtica dioica	Common Nettle	Grande ortie
Species groups		
Atriplex spp.	Orache species	Arroches
	Grasses (cropped)	Herbes (taillées)
	Grasses (tussocks)	Herbes (touffes)
	Lichens (black,	Lichens (taches noires)
	Lichens (greyish	Lichens (verts, touffues)
	Lichens (yellow)	Lichens (jaune)
	Mosses	Mousses
Limonium spp.	Sea-lavender species	Statices
Linaria spp.	Toadflax species	Linaires
Rubus spp.	Brambles	Ronces
Sedum spp.	Stonecrop species	Orpins
Suaeda spp.	Sea-blite	Soudes

Table 4.1 - Species and species groups selected for the vegetated shingle survey. Species' Binomial name (Stace, 1999), English and French common names are shown. Species in purple represent country's rare species. The binomial names in brackets indicate where Stace and the Inventaire National du Patrimoine Naturel differ (MNHN 2003-2006). A more comprehensive table can be seen in Appendix 1.

To select these species the following databases were used.

In the UK

To assess the distribution of plant species

- New Atlas of the British and Irish Flora (Preston *et al*., 2002). Used to identify both species with a predominately coastal distribution, and species which may occur as maritime subspecies or varieties (e.g. *Geranium robertianum* ssp. *maritimum* (Herb-Robert) and *Solanum dulcamara* var. *marinum* (Bittersweet).

To assess the conservation status of plant species

- The Wildlife and Countryside Act, 1981 (Schedule 8 plants) provides the principle mechanism for the legislative protection of wildlife in the UK. All wild plants are protected against unauthorised uprooting under Section 13 of the Act. Plants listed on Schedule 8 of the Act have extra protection against picking, uprooting, destruction and sale.
- The Vascular Plant Red Data List for Great Britain (Cheffings *et al*., 2005) uses the IUCN (2001) criteria to assess the conservation status of UK species (see IUCN web site for details of the categories).
- Nationally rare and nationally scarce. In addition to the Red list, there are also criteria to define nationally rare and nationally scarce defined to be (JNCC, 2007c):
    - Nationally rare (NR) - Occurring in 15 or fewer hectads in the UK.
    - Nationally scarce (NS) - Occurring in 16-100 hectads in the UK.
- Species Action Plans (SAPs) set priorities for nationally and locally important species (UK BAP, 2007).
- The Sussex Rare Species Inventory (SxRSI, 2002). Species are selected according to strict criteria of rarity associated with their occurrence in Sussex. The aim is to list the rare species of Sussex in all taxa.
- Kent Red Data Book. Includes species on national Red Data Book, nationally rare and scarce and Priority UK BAP species that occur in Kent. Does not add any species not already covered by other databases (KRDB, 2006).

In France

- Le Inventaire National du Patrimoine Naturel (INPN, 2003-2006). This database includes an inventory of plants in France collected by the Muséum national d'Histoire naturelle, including their current protection status and known distribution.
- SOPHY (Ruffay *et al*., 2000 – 2007) is a French database which includes descriptions of plant distributions in France.

N.B. The data from these sources reflect current knowledge and cannot be regarded as exhaustive.

Additional species

The following species, which did not match the criteria above but were considered important to monitor, were also added. *Urtica dioica* (Common nettle) can indicate excessive enrichment of a site; *Cerastium tomentosum* (Snow-in-summer) and *Centranthus ruber* (Red Valerian) have the potential to be invasive on shingle. All three species indicate the potential for native shingle specific plants and communities to be extirpated through competition with non-shingle specific species. *Teucrium scorodonia* (Wood Sage), although common and not confined to the coast, with no maritime variety, and with no known associated SAP species, was also included as it is often found on older and more stable sections of shingle (Scott, 1965; Hubbard, 1970; Ferry *et al*., 1990; Rose, 1995).

Where possible, plant nomenclature follows Stace (1999) for the English side of the project and the INPN (2003-2006) for the French side of the project. There are a few cases where the binomial name for a species differs between the two sides of the channel. Most of the species selected were likely to be present on both sides of the channel. Exceptions were *Lathyrus japonicus* (Sea Pea) considered extinct in France, and *Linaria purpurea* (Purple Toadflax) not found in France. However, it is also important to note that some species are relatively more abundant on one or the other side of the channel. For example, *Crambe maritima* (Sea-kale) is much rarer in France (INPN, 2003-2006), where it is nationally protected, than in the UK. This report will use binomial names throughout, followed by the English common name when it is first mentioned. French common names can be found in Table 4.1.

The species and species groups selected were divided into three broad community types; pioneer, grassland/lichen-heath, and scrub (as suggested by Randall and Sneddon's (2001) generalised sequence of vegetation - Figure 2.2) by reference to the literature and communication with two shingle plant specialists, Mr Paul Harmes and Dr Barry Yates (Figure 4.1).

Depending on conditions such as sand content and hydrological regime, vegetated shingle is often found in association with other important coastal habitats including sand dunes and saltmarsh. Species that could indicate a transition to these associated habitats were noted (Figure 4.1).

Broad community indicators for method: **pioneer species**

Authority	Orache species	Sea-kale	Yellow Horned-poppy	Curled Dock	Bittersweet	Herb Robert	Black lichens	Yellow lichens	Red Hemp-nettle	Rock Samphire	Sea Beet	Sea Campion	Sea Knotgrass	Sea-lavender spp.	Sea Mayweed	Sea Pea	Sea Radish	Silver Ragwort	Sticky Groundsel	Stonecrop spp.	Toadflax spp.	Tree Mallow	Viper's-bugloss	Wild Cabbage	Least Lettuce	Prickly Saltwort	Sea Bindweed	Sea-holly	Sea Rocket	Sea Sandwort	Sea Spurge	Sea-blite	Sea Clover	Sea-heath	Sea Purslane
may indicate:																									sand	sand	sand	sand	sand	sand	sand	saltmarsh	saltmarsh	saltmarsh	saltmarsh
1210/1220 - habitats directive	1	1	1								1	2			1	1													1	1					
Brightmore & White, 1963																1																			
Brightmore, 1979																																		2	
Hubbard, 1970	1	1	1	1							1																								
Pakeman & Lee, 1991																										1			1	1					
Packham & Spiers, 2001	1																									1			1	1					
cited in Randall & Fuller, 2001	1	1	1	1								1				1				2															
cited in Randall and Sneddon, 2001	1	1		1			1	1			1	1				1	1		1											1					
Scott, 1963			1																																
Scott, 1965												1																							
Sneddon & Randall, 1993	1	1	1	1	1	1				1	1	1			1	1	1		1	1		1						1	1	1	1				
Toffs, 2004						2																													
Woodell & Dale, 1993																																			
Harmes (pers. com)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Yates (pers. com)	1	1	1	1	1	1	1	1	1	1	1	1		1		1	1		1	1	1		1		1	1								1	
Mean	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

Broad community indicators for method: **grassland, lichen heath**

Authority	Buck's-horn Plantain	Grasses (cropped)	Grasses (tussocks)	Green lichens	Mosses	Sheep's Sorrel	Thrift	Wood Sage
1210/1220 - habitats directive							2	
Brightmore & White, 1963								
Brightmore, 1979								
Hubbard, 1970		2	2	2	2	2		2
Pakeman & Lee, 1991								
Packham & Spiers, 2001								
cited in Randall & Fuller, 2001		2	2	2	2	2	2	
cited in Randall and Sneddon, 2001		2	2	2	2		2	
Scott, 1963								
Scott, 1965								
Sneddon & Randall, 1993	2	2	2	2	2		2	
Toffs, 2004								
Woodell & Dale, 1993							2	
Harmes (pers. com)	2	2	2	2	2	2	2	2
Yates (pers. com)								
Mean	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**

Broad community indicators for method: **scrub**

Authority	Blackthorn	Brambles	Broom	Elder spp.	Gorse	Sea-buckthorn
1210/1220 - habitats directive	3		3			
Brightmore & White, 1963						
Brightmore, 1979						
Hubbard, 1970						
Pakeman & Lee, 1991						
Packham & Spiers, 2001						
cited in Randall & Fuller, 2001						
cited in Randall and Sneddon, 2001	3	3			3	
Scott, 1963						
Scott, 1965	3	3		3	3	
Sneddon & Randall, 1993	3	3	3		3	
Toffs, 2004						
Woodell & Dale, 1993						
Harmes (pers. com)	3	3	3	3	3	3
Yates (pers. com)	2	2	2		3	1
Mean	**3**	**3**	**3**	**3**	**3**	**2**

Broad community types:
1 = Pioneer
2 = Established
3 = Scrub

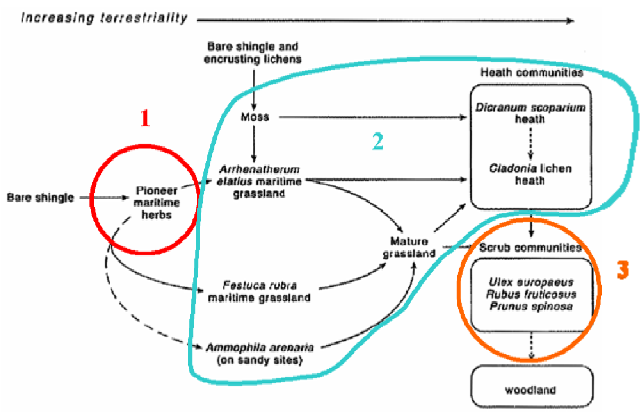

Figure 4.1 - Broad community type for each selected species or species group. A broad community type (numbers refer to three broad community types; pioneer, grassland/lichen-heath, and scrub as suggested by Randall and Sneddon's (2001) generalised sequence of vegetation – refer also to Figure 2.2) was assigned to each species/species group with reference to the literature and the opinion of two specialists, Paul Harmes and Dr Barry Yates. Although Sea-buckthorn was assigned a mean value of 2 it was placed in the scrub category because of its physical characteristics.

Vegetated Shingle Survey

The methodology is described in the following section.

The survey method is available as a pack and includes detailed instructions on all aspects of the methodology, and recording sheets designed to make it as simple as possible to record the necessary data (in both English and French). The pack also contains a photographic identification guide for the plant species that need to be looked for. For each plant, there are several photographs showing its diagnostic features at different times of the year, and a short descriptive text. It also contains an identification guide for a small selection of rare insect species that may be seen, examples of shingle features to look for and a risk assessment for recorders (see Appendix 2). It also available to download from the BAR web site.

http://www.geog.sussex.ac.uk/BAR/index.html

Site selection

Shingle beach sites were initially chosen from aerial photographs using different databases for East Sussex, Kent, and France, followed by visits where possible. Some beaches were chosen by volunteer recorders who had local knowledge of suitable and accessible beaches.

Surveys took place between June and October 2006, the period over which the selected species were considered identifiable.

Transects

At each site two belt transects, perpendicular to the shore and running inland from the seaward side of the beach were surveyed. Each transect was walked twice, once up the beach and once back down, and the presence of selected plant species or species groups was recorded. Estimations of species distribution and other shingle beach features were also recorded as described later.

The location for the starting point of the first transect was either predefined and indicated by an X on a map, or marked on a map *in situ* with reference to a suitable (and assumed permanent) landmark. It was desirable that transects should record as good a representation of the vegetation on the beach as possible. Therefore, if the recorder thought that a transect from the predetermined starting point would not achieve this, they could select a new starting point.

Criteria were developed to locate the actual starting point of each transect. Wherever possible, transects were started from the highest strandline (not necessarily the newest strandline, especially later in the season), considered the easiest feature to locate on many beaches. For beaches where there was no obvious strandline (e.g. where beaches had been cleaned or recharged) the top of the highest ridge along the shore, seaward of the majority of the vegetation was used as a starting point. If the criteria above could not be matched start points were located subjectively and an appropriate description given.

A 100 m surveyors' tape was run along the middle of the transect (Figure 4.2). The area approximately two and half metres either side of this central line was surveyed. Although most beaches were less than 100 m, the method allowed for up to a 200 m transect to be surveyed for each beach in two 100 m sections.

Figure 4.2 – Transect at Tide Mills, Newhaven showing surveyors' tape.

Data collected

At each site the data described under the following headings were collected.

Proportion of bare shingle

The percentage of bare shingle within the transect was estimated over 10 m sections (effectively 5 by 10 m rectangles). The area covered by vegetation was further divided according to the height of the vegetation, and percentage cover in each of the following height categories estimated: low (i.e. cropped and/or prostrate), medium (i.e. vegetation up to waist high) and high (i.e. above the waist). For any cover that did not fit the categories so far described, two further categories were used: exposed shingle in soil/sand and bare soil/sand.

Presence and distribution of pre-selected species

Both the first and last occurrence of the preselected species or species group within the transect were measured in metres from the starting point of the transect. Their presence in every 10 m section along the transect was also recorded to give an idea of their distribution on the beach. If a plant occurred on the seaward side of where the transect started its first occurrence was measured as a negative value.

Structured walk

A V or W-shaped walk (depending on length of transects) was made between transects so that any of the preselected species not already found in transects could be recorded.

Shingle characteristics

Characteristics of the shingle were recorded by estimating to the nearest 5%, the percentage occurring in colour, size and shape categories at the start, the middle and end of a transect.

Other features of interest

The presence of, or evidence for any other features such as vehicular activity, fire damage, trampling etc. were also recorded. A brief description of what surrounded the site, which could be compared against aerial photographs, was recorded. Recorders were also asked to make a note of any other species not on the pre-selected list that they felt was worth recording.

For further details see survey pack in Appendix 1.

Volunteer recorders

The survey method was designed to be easily doable by people with no particular expertise in either plant species or surveying. To help achieve this aim, we enlisted the help of volunteer recorders. They were recruited in a variety of ways including magazine and newspaper articles, flyers distributed at events, direct contact with conservation groups and by word of mouth.

Training sessions were organised so that all volunteer recorders had surveyed at least one transect and correctly filled in a recording sheet under supervision. Each volunteer had access to a Vegetated Shingle Survey Pack (Figure 4.3).

Figure 4.3 - Volunteer recorders at Pevensey Bay (top) and Rye Harbour Nature Reserve (bottom).

Biodiversity Value Category

Three biodiversity value categories were selected as follows:

- **Excellent -** the highest category for sites with e.g. SSSI equivalent (Rye, Dungeness).
- **Good -** typical species well represented, good distribution, some rare species.
- **Impoverished -** the lowest category for sites that had few or none of the species described previously.

These categories were chosen to provide a useful tool by which coastal managers might assess the implications for biodiversity that any disturbance, both anthropogenic and non-anthropogenic might have. A simple example of how this may be applied is to use a risk matrix to determine the required action for a particular site dependent on its biodiversity value and the risk of damage because of, for example, sea level rise, or sea defence works (Figure 4.4).

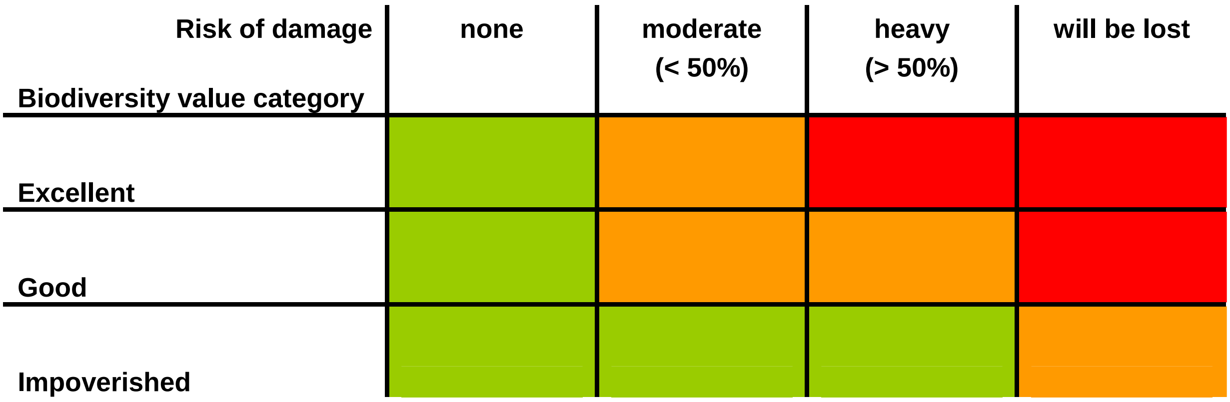

Figure 4.4 – Example of a simple risk matrix. The colour of the box determines the required action for a particular site dependent on its biodiversity value and the risk of damage. Red = protection /mitigation required, amber = some protection mitigation may be required, green = no action required.

Biodiversity value (see section 2, page 9) was determined mainly by the presence and distribution of the species and communities recorded at a site. Twelve criteria by which each site could be evaluated were developed (Table 4.2). They are as follows (including an indication of the community types they relate to):

Ephemeral communities

1. Orache. This criterion refers to the presence of *Atriplex* spp., and is an indicator for ephemeral communities (Doody and Randall, 2003). Early in the season they may be present as very small seedlings. Volunteer recorders were trained to look carefully for the presence of these seedlings, especially along the storm ridges on the seaward side of a beach. *Atriplex* spp. distribution is highly variable throughout the survey season and generally occurs in a narrow band, making it difficult to score its distribution as in the following criteria. Therefore value was awarded for presence only, and within 30 metres from the start of the vegetation on the seaward side of the transect. [It is only possible to score either 1 or 3 for this criterion which has a small effect on the mean category, i.e. the mean category can never be exactly 2.]

Pioneer communities

2. Typical 1. Value was awarded as a function of the presence of three typical vegetated shingle species, *Crambe maritima*, *Glaucium flavum* and *Rumex crispus* ssp. *littoreus* (Rodwell, 2000; EC, 2003).

3. Distribution of at least one of above. The method allowed the spread up the beach of each species recorded to be measured. Value was awarded as a function of the distance that was covered by at least one of the three species cited in criterion 2.

4. Typical 2. Value was awarded as a function of the presence of a further four typical vegetated shingle species, *Beta vulgaris* ssp. *maritima, Silene uniflora, Solanum dulcamara* var*. marinum* and *Tripleurospermum maritimum* (EC, 2003).

5. Distribution of at least one of above. The method allowed the spread up the beach of each species recorded to be measured. Value was awarded as a function of the distance that was covered by at least one of the three species cited in criterion 4.

6. Remaining 27 pioneer species. Value was awarded as a function of the number of the remaining pioneer species not already covered in criteria 1, 2 and 3 (Figure 4.1).

7. Distribution of black & yellow lichens. Value was awarded as a function of the distance that was covered by either black or yellow lichens. Although these taxa were not identified to species they provided a useful indicator of how stable and therefore suitable for further colonisation a beach may be (e.g. Scott,1965).

Grassland, lichen-heath communities

8. Distribution of Grassland. Value was awarded as a function of the distance up the beach that was covered by any one of the taxa used as an indicator of community type (Figure 4.1), if there was grass distributed over at least 20 metres.

9. Green lichens Value was awarded as a function of the distance that was covered by green lichens. Although these taxa were not identified to species they may suggest the presence of a community type that can take decades to establish and may contain very rare lichens (Simon Davey, pers. com.).

Scrub communities

10. Scrub. Value was awarded as a function of the distance up the beach that was covered by any one of the taxa used as an indicator of this community type (Figure 4.2).

Miscellaneous

11. Rare species. Value was awarded as a function of the presence of species considered rare (section 4.1). There were nine species, although some were different, for both the English and French coasts (Table 4.1). This score was not awarded when the Sea-lavender recorded was known to be the non-native species *Limonium hyblaeum* (Rottingdean Sea-lavender).

12. Potential for Migration inland. Value was awarded as a function of the distance that a beach could potentially migrate inland. This was calculated from aerial photographs, maps and recorder observations and takes no account of landownership or proposed developments.

	Criteria	Excellent	Good	Impoverished
		Biodiversity Value Category		
1	**Orache**	present within first 30m of vegetation on seaward side of transect		none found
2	**Typical 1** – *Crambe maritima, Glaucium flavum, Rumex crispus* ssp. *littoreus*	>= 2 present	1 present	none found
3	**Distribution of at least one of above**	>= 40 m	>= 20 m	< 20 m
4	**Typical 2** - *Beta vulgaris* ssp. *maritima, Silene uniflora, Solanum dulcamara* var. *marinum* , *Tripleurospermum maritimum*	>= 3 present	>= 1 present	none found
5	**Distribution of at least one of above**	>= 40 m	>= 20 m	< 20 m
6	**Remaining 27 pioneer species**	>= 6 present	>= 3 present	< 3 present
7	**Distribution of black & yellow lichens**	>= 40 m	>= 20 m	< 20 m
8	**Distribution of Grassland**	>= 40 m	>= 20 m	< 20 m
9	**Green lichens**	>= 20 m	< 10 m	none found
10	**Scrub**	at least 2 species >= 40 m	at least 2 species >= 20 m	none or few recorded
11	**Rare species**	>= 2 present	>= 1 present	none found
12	**Potential for Migration inland**	Very large extent (e.g. Rye, Dungeness) >= 100 m	possible < 100 m	impossible

Table 4.2 Criteria selected for assigning biodiversity value to a shingle beach. See text for explanation.

5. RESULTS

Sites surveyed

Twenty-nine sites along the English coast were surveyed during June to October 2006 (Figure 5.1). Eight sites were surveyed in France at the end of July, 2006 (Figure 5.2). A full list of the sites surveyed showing their locations, the dates they were surveyed and by who is shown in Appendix 3. The mean transect length was 63 m (Figure 5.3).

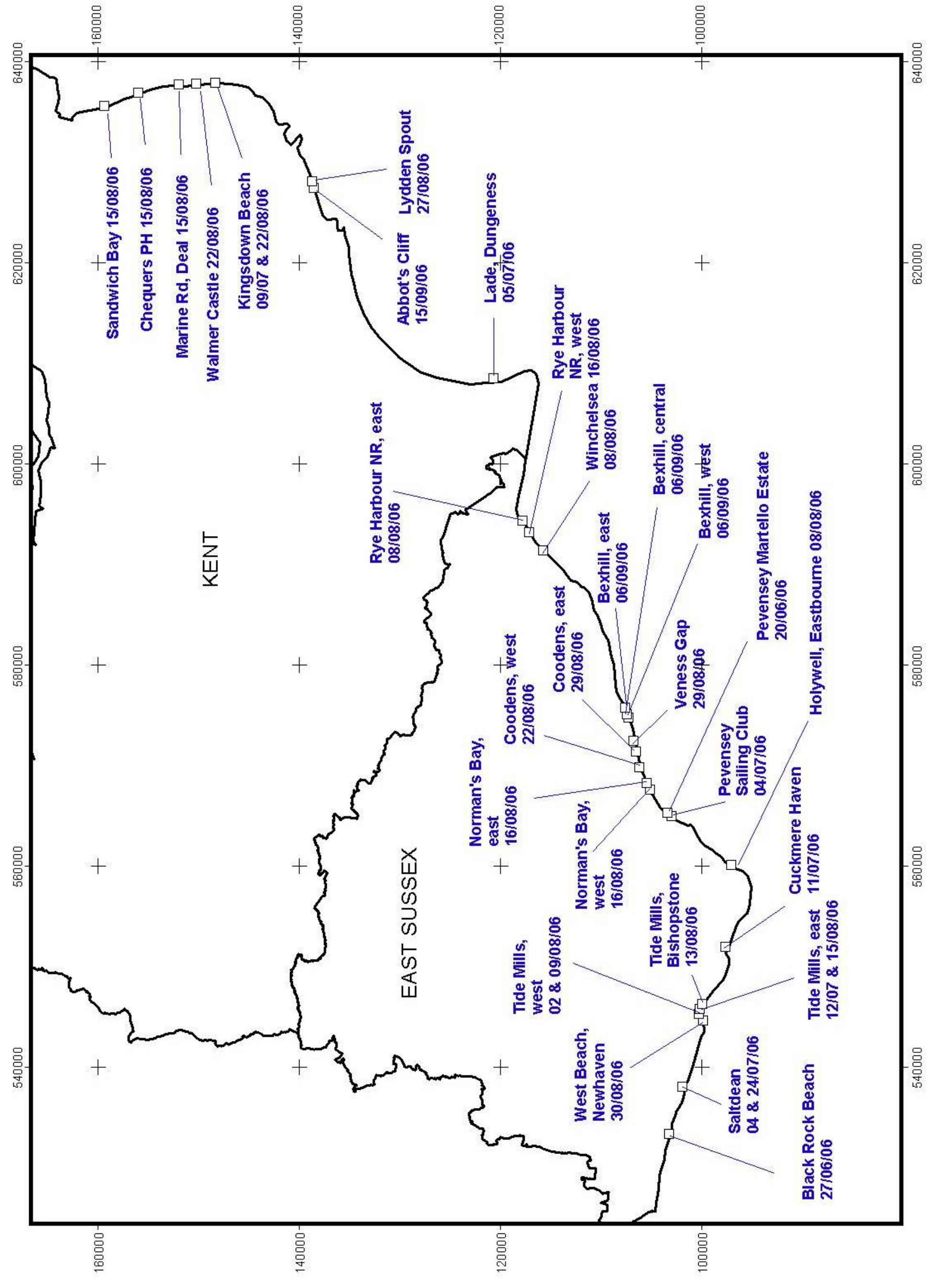

Figure 5.1 - Locations of sites and dates when they were surveyed on shingle beaches along the English coast of the BAR project area. The coastline runs from Brighton & Hove in the west to Sandwich Bay in the east. Grid squares represent 20 km^2. Reproduction of this map is not allowed without prior permission from East Sussex County Council.

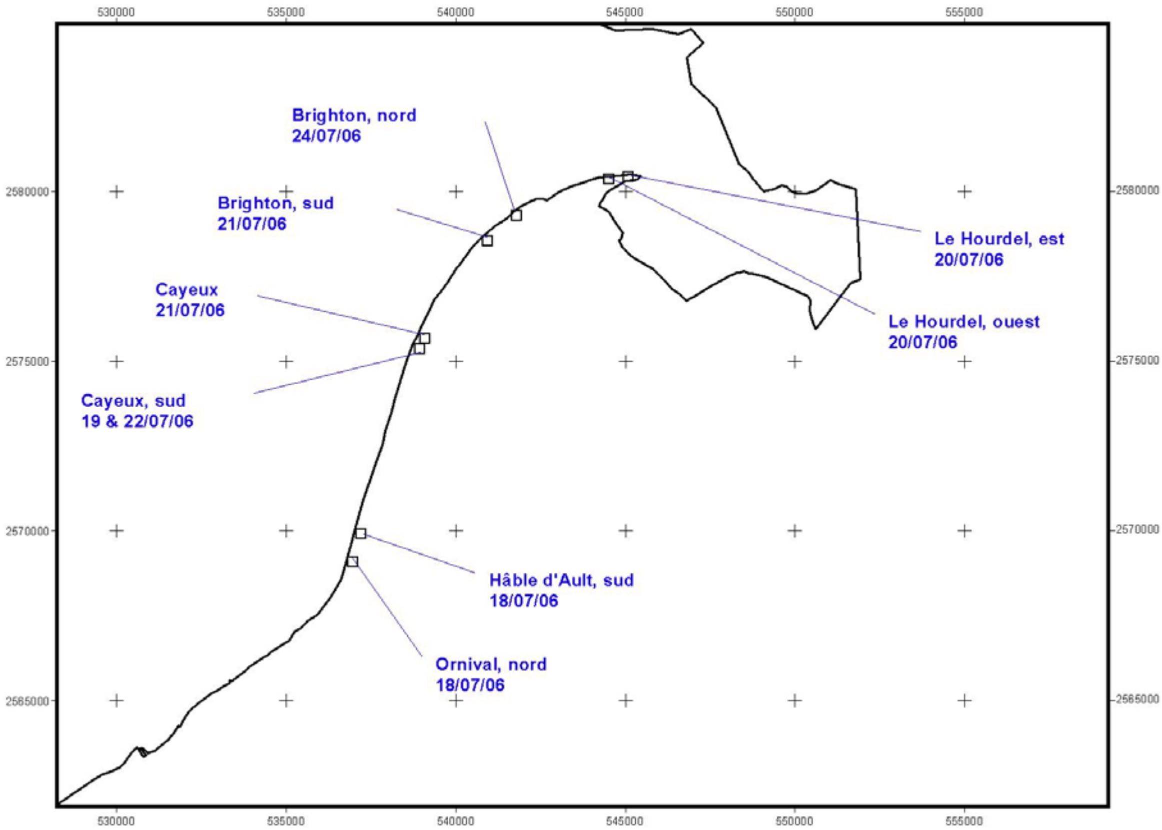

Figure 5.2 - Locations of 2006 transect surveys and dates they were surveyed on shingle beaches along the French coast of the BAR project area. The coastline runs from le Tréport in the west to le Crotoy in the east. Grid squares represent 5 km^2. Reproduction of this map is not allowed without prior permission from East Sussex County Council.

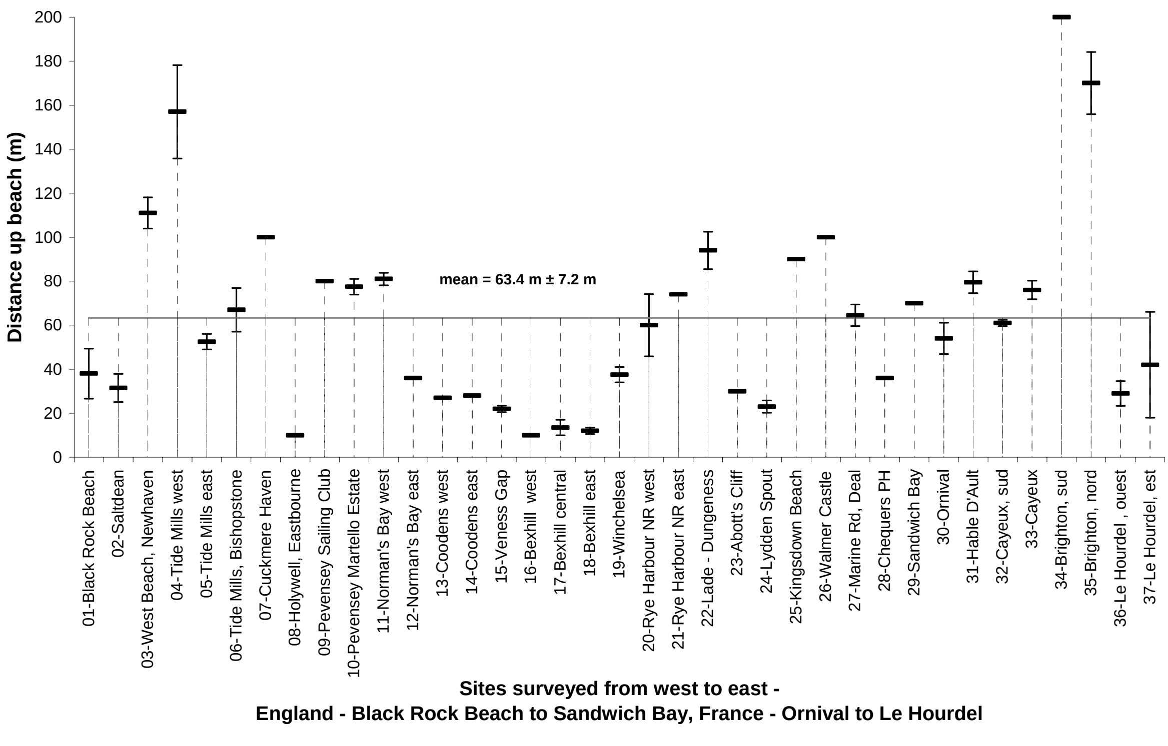

Figure 5.3 - Mean transect length ± standard error of the mean (SEM) of the 37 sites surveyed during 2006.

Species recorded

Of the 52 pre-selected species, 46 were found (Table 5.1). The number of species recorded from each site varied from 26 (Rye Harbour Nature Reserve west) to three (Veness Gap and Bexhill central). Several characteristic species of pioneer shingle communities *Atriplex* spp*.,* *Beta vulgaris* ssp. *maritima, Crambe maritima*, *Glaucium flavum* and *Rumex crispus* ssp. *littoreus* (e.g. Williams & Cooke, 1993; EC, 2003) were well represented, with *Crambe maritima* being recorded on the most sites (32/37). *Crambe maritima*, considered rare in France was found on all French sites surveyed, although its distribution at Hâble d'Ault was very low. Rare species such as *Galeopsis angustifolia* (four sites) and *Lathyrus japonicus* (five sites) were also found but only on the English coast.

Urtica dioica, selected as an indicator of excessive enrichment, was only recorded on two sites; Rye Harbour Nature Reserve west and Pevensey Martello Estate (Table 5.1). The potentially invasive species *Centranthus ruber* was recorded on no French sites, but on 12 out of 29 English sites, whereas *Cerastium tomentosum* was only recorded on one site (Pevensey Sailing Club). *Teucrium scorodonia*, selected as it is often found on older, more stable shingle, was only recorded from two sites in England (Tide Mills west and Pevensey Sailing Club) and none in France.

Species	20-Rye Harbour NR west	34-Brighton, sud	04-Tide Mills west	21-Rye Harbour NR east	35-Brighton, nord	05-Tide Mills east	06-Tide Mills, Bishopstone	10-Pevensey Martello Estate	11-Norman's Bay west	33-Cayeux	02-Saltdean	09-Pevensey Sailing Club	07-Cuckmere Haven	26-Walmer Castle	32-Cayeux, sud	29-Sandwich Bay	01-Black Rock Beach	12-Norman's Bay east	22-Lade, Dungeness	36-Le Hourdel , ouest	25-Kingsdown Beach	28-Chequers PH	37-Le Hourdel, est	19-Winchelsea	27-Marine Rd, Deal	30-Ornival	31-Holywell, Eastbourne	31-Hâble D'Ault	03-West Beach, Newhaven	13-Coodens west	14-Coodens east	18-Bexhill east	23-Abott's Cliff	24-Lydden Spout	16-Bexhill west	15-Veness Gap	17-Bexhill central	TOTAL A
Sea-kale	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X		X	X				32
Grasses (tussocks)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X		X				32
Curled Dock	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X							29
Yellow lichens	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X		X	X	X	X	X		X			X						X	X	X	27
Sea Beet		X	X	X	X	X	X		X	X	X		X		X	X	X	X				X	X	X	X	X		X	X	X	X	X	X	X		X		27
Orache species		X	X	X	X	X	X	X	X	X	X				X	X	X	X				X		X	X	X	X	X	X	X	X	X				X	X	26
Black lichens	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X												X	26
Yellow Horned-poppy	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X		X		X			X	X	X	X			X	X	X					25
Mosses	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X		X							X			X			23
Bittersweet	X	X	X	X	X	X	X	X	X		X	X		X	X			X	X	X	X	X		X			X						X					21
Stonecrop spp.	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X			X	X	X	X	X															20
Buck's-horn Plantain	X	X	X	X	X	X	X			X	X		X		X	X			X			X	X			X		X		X		X			X			20
Sea Mayweed		X	X	X	X	X	X			X	X		X		X	X	X							X		X		X	X									16
Viper's-bugloss	X		X	X		X		X	X	X		X	X	X		X		X	X	X	X				X													16
Sticky Groundsel	X	X	X		X	X	X		X	X			X	X				X						X	X	X												14
Grasses (cropped)	X	X	X	X			X	X	X	X			X				X													X		X			X			13
Brambles	X	X	X		X			X	X	X		X	X					X		X	X												X					13
Sea Campion	X	X		X				X	X	X		X			X					X			X			X		X										12
Red Valerian	X		X	X		X		X				X		X				X	X		X			X			X											12
Green lichens	X		X	X			X	X	X	X		X		X	X																	X						11
Rock Samphire	X			X		X	X				X						X										X		X				X	X				10
Toadflax spp.	X						X							X					X		X									X								6
Sea Sandwort		X			X									X		X	X								X													6
Sea-buckthorn		X			X										X					X			X					X										6
Sea-lavender spp.		X			X	X					X																X											5
Sea Pea	X			X										X										X	X													5
Herb Robert	X			X															X												X							4
Red Hemp-nettle	X			X					X										X																			4
Thrift	X		X			X	X																															4
Sea Purslane		X			X																		X															3
Sea Radish																											X		X									2
Silver Ragwort											X																X											2
Tree Mallow											X																				X							2
Wild Cabbage																																	X	X				2
Sea Bindweed											X						X																					2
Sea-holly		X														X																						2
Sea Spurge		X			X																																	2
Sea-blite		X			X																																	2
Sheep's Sorrel								X				X																										2
Wood Sage			X									X																										2
Elder spp.					X																												X					2
Gorse	X		X																																			2
Common Nettle	X							X																														2
Least Lettuce	X																																					1
Prickly Saltwort		X																																				1
Snow-in-summer												X																										1
Sea Knotgrass																																						0
Sea Rocket																																						0
Sea Clover																																						0
Sea-heath																																						0
Blackthorn																																						0
Broom																																						0
TOTAL B	**26**	**25**	**22**	**22**	**21**	**19**	**19**	**18**	**18**	**18**	**17**	**16**	**15**	**15**	**15**	**14**	**13**	**13**	**13**	**13**	**12**	**12**	**12**	**11**	**11**	**11**	**10**	**10**	**9**	**8**	**8**	**8**	**8**	**5**	**4**	**3**	**3**	

Table 5.1 - Grid showing presence of species recorded on every site. Presence of a species at a particular site is denoted by a grey square. Sites and species recorded are ranked so that the most species-rich site, and the most recorded species are top left. **Total A** in the far right hand column is the number of sites (out of 37) on which each species was recorded. **Total B** in the bottom row is the number of individual species recorded at each site. French sites are in blue.

Site profiles

For each site the data are represented visually as follows. Two examples are given (Figures 5.4 and 5.5). The profiles for all sites are shown in Appendix 4.

Figures 5.4 and 5.5 - Profiles for sites 13 – Coodens, west and 21 – Rye Harbour Nature reserve, east.

For each site the data are represented visually as follows:

- The site name and date(s) when it was surveyed are shown.
- Going up the page, the site is shown in 10-metre sections from the seaward side to the landward side.
- On the left of the page, the mean percentage of shingle, sand and vegetation (in three height categories) in 10 m sections is shown.
- On the right of the page, the cumulative distribution of each species over the two transects in 10 m sections is shown.
- If the transects were less than 100 m long their length is denoted by a blue line. Transects of different lengths are shown by two blue lines (and may be reflected in the shingle percentage diagram if the difference between the two transects lengths was more than 10 m). If there is no blue line then both transects were 100 (or 200 m) long.
- The note on the landward end of the species section describes briefly the habitat beyond the transects.
- Species are grouped together into three broad community types; pioneer, grassland/lichen-heath and scrub. Potentially invasive species are in a final group.
- Species are colour coded to aid interpretation.
- Species noted as being present on the beach but not recorded in the transects are shown in grey.
- The total number of species in each grouping is shown in the first four columns of the graph in the bottom right. The last column, [rare], shows species that were given a rare classification and are already included in the first four columns and do not need to be added to the species total.

(See Appendix 4 for the remaining sites.)

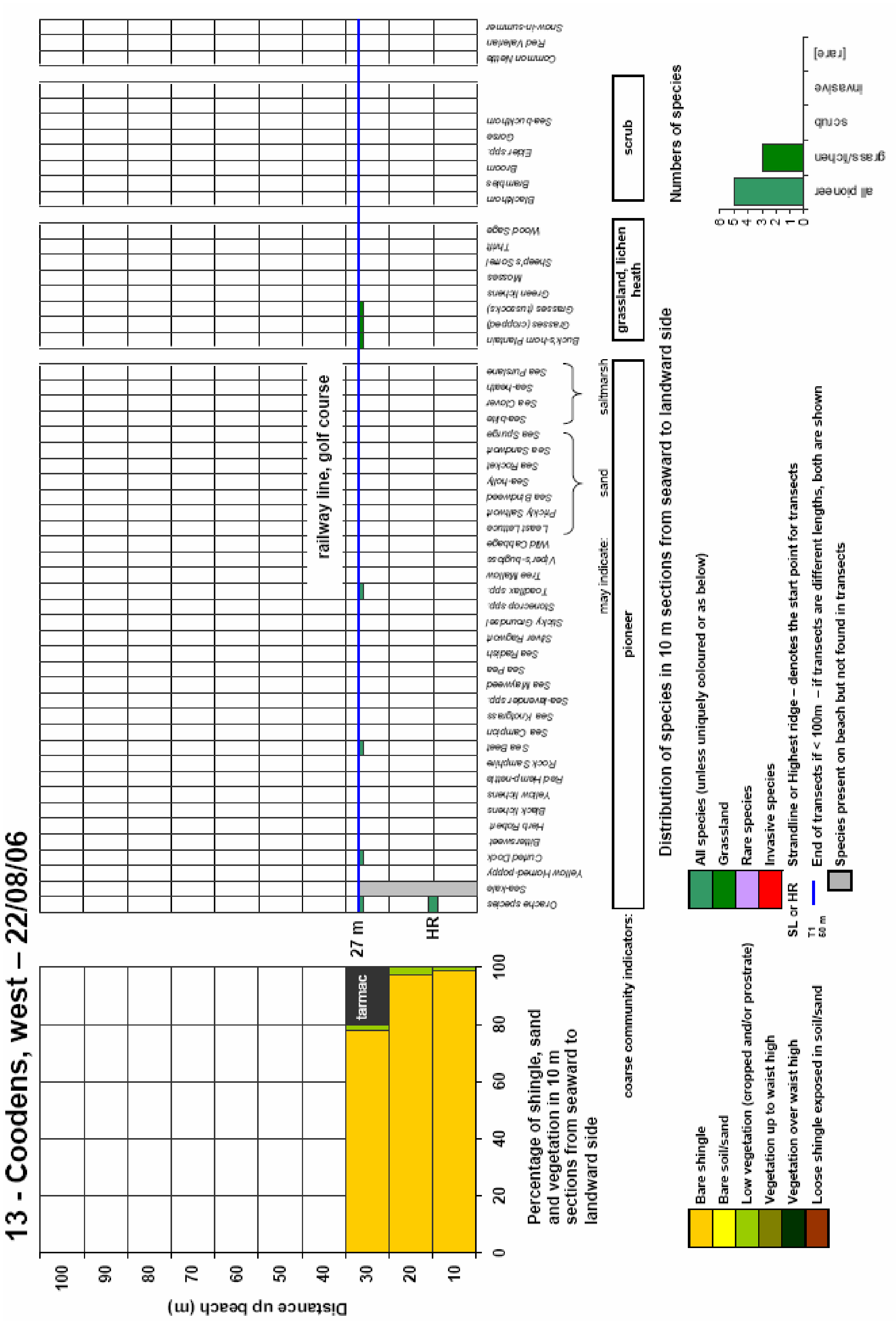

Figure 5.4 – Profile of Site 13 – Coodens, west. See previous page for explanation.

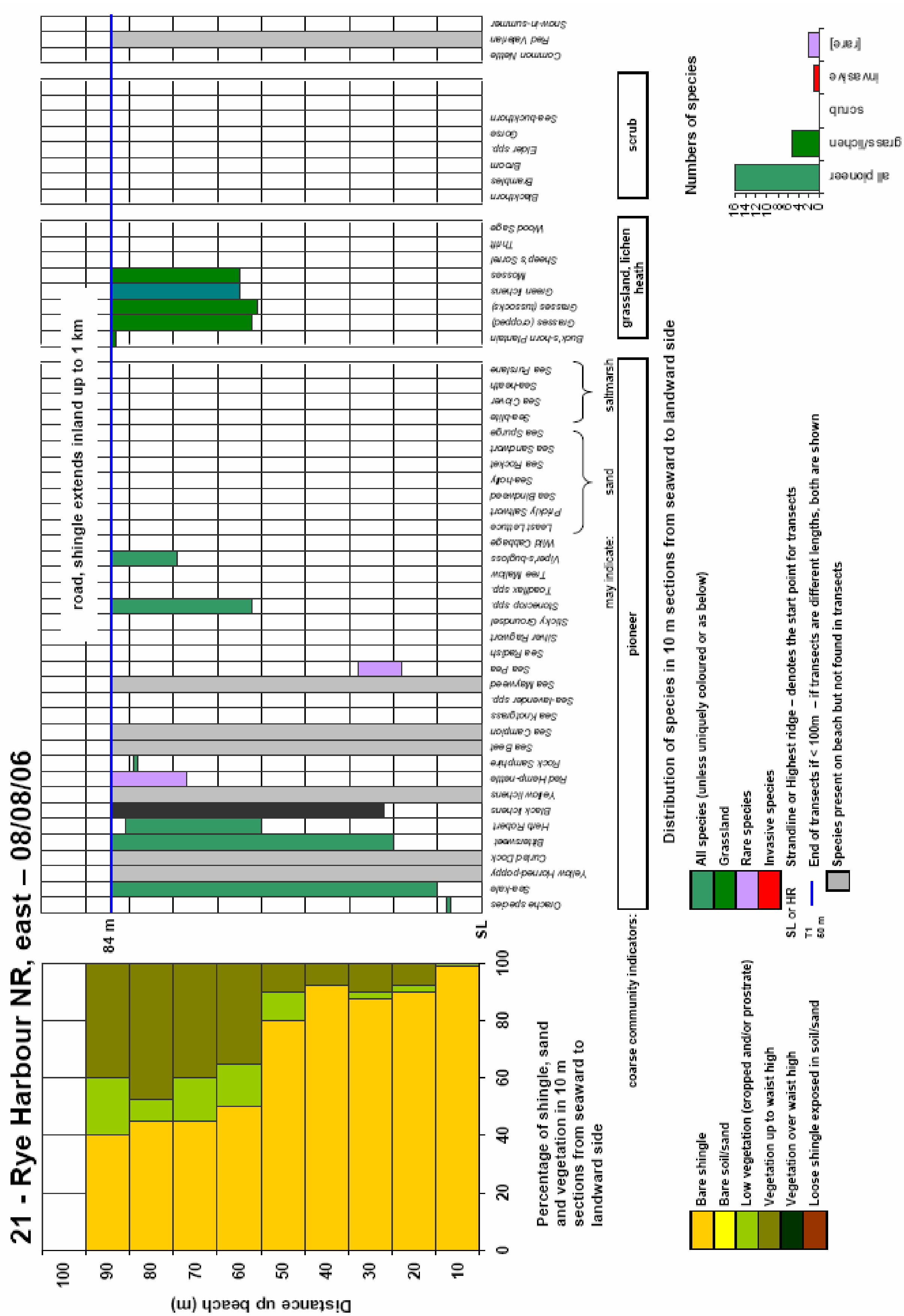

Figure 5.5 – Profile of Site 21 – Rye Harbour Nature Reserve, east. See page 33 for explanation.

The mean distribution of each species from its mean start point for all the sites combined is presented in Figure 5.6. Zonation of the vegetation is apparent (the distribution of species that were only recorded at a few sites are not necessarily representative). For example, *Atriplex* spp. were rarely found more than 20 m and grasses rarely less than 40 m from the seaward side of transects. Plants such as *Crambe maritima*, *Glaucium flavum* and *Lathyrus japonicus* which can withstand periodic disturbance (Randall and Sneddon, 2001) were more widely distributed from the seaward end of the transect up to the point where grassland species were first recorded.

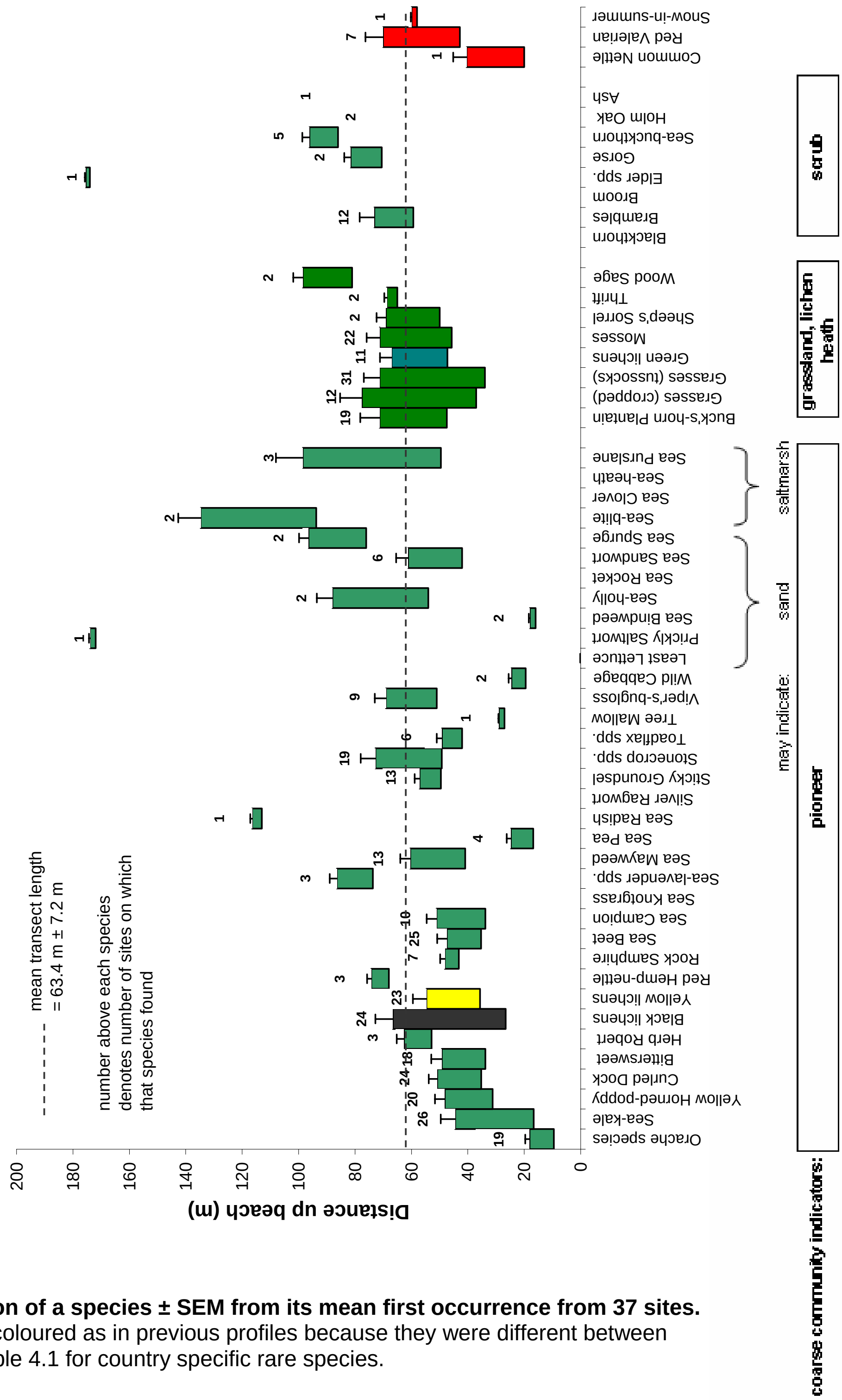

Figure 5.6 - Mean distribution of a species ± SEM from its mean first occurrence from 37 sites. Rare species have not been coloured as in previous profiles because they were different between England and France. See Table 4.1 for country specific rare species.

Biodiversity Value Category

Each site was evaluated with respect to each criterion and scored either 1 (representing Impoverished), 2 (Good) or 3 (Excellent). The Biodiversity Value Category (BVC) for each site was determined by the mean category value for all 12 criteria. The modal biodiversity value(s) i.e. the most common category for each criterion was also calculated for each site. Using the mean value, six sites were categorised as Excellent, 22 as Good and nine as Impoverished (Figure 5.7 and Table 5.2).

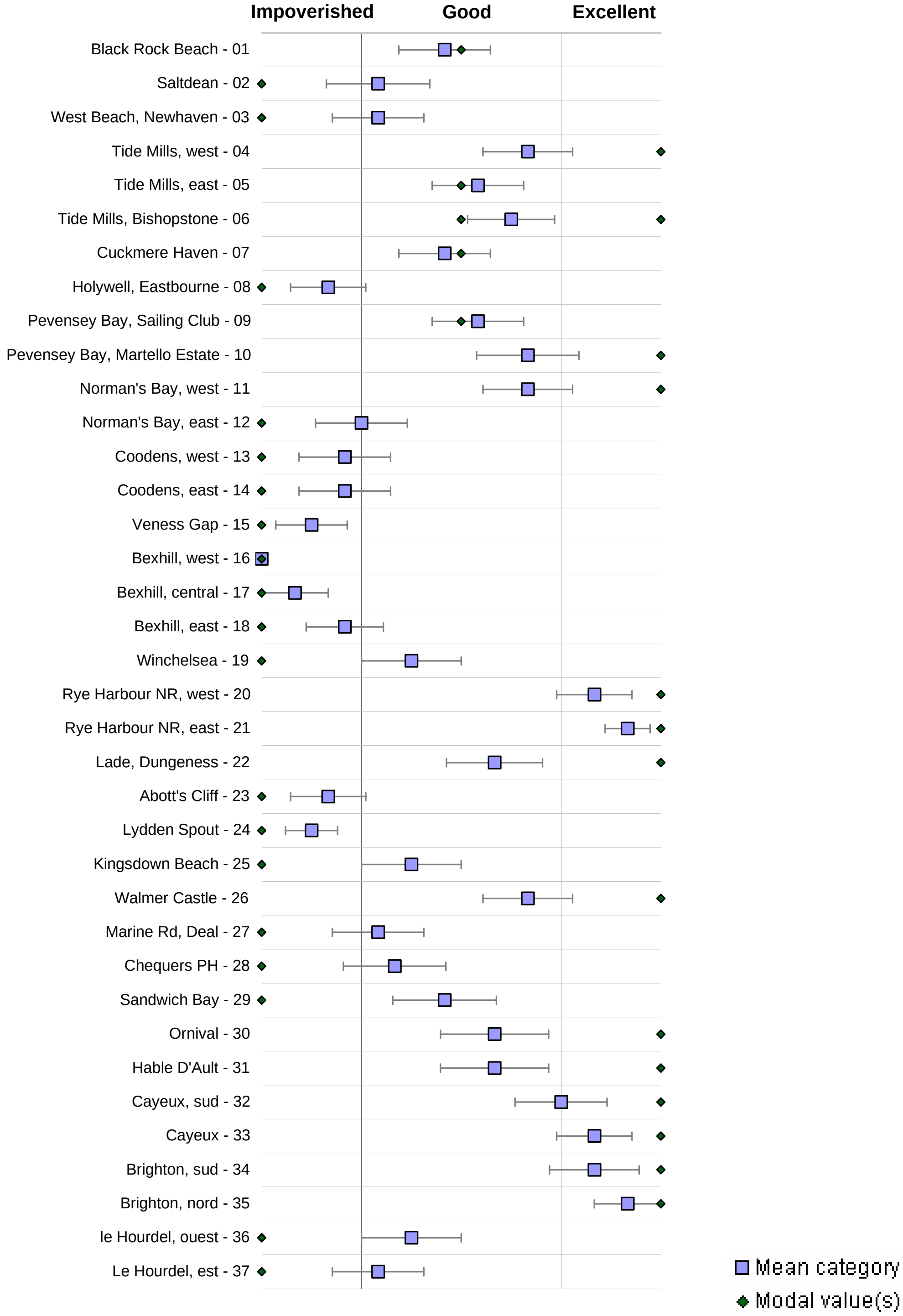

Figure 5.7 - Mean category ± SEM and modal value(s) for biodiversity value for 37 sites. Biodiversity Value Categories are on the x-axis.

Site	Biodiversity Value Category	Mean	SEM	1	2	3	4	5	6	7	8	9	10	11	12	M	M(2)
01 - Black Rock Beach, England	Good	1.92	0.23	3	3	3	2	2	2	2	2	1	1	1	1	2	
02 - Saltdean, England	Good (Impoverished)	1.58	0.26	3	3	1	3	1	2	1	1	1	1	1	1	1	
03 - West beach, Newhaven, England	Good (Impoverished)	1.58	0.23	3	3	2	2	2	1	1	1	1	1	1	1	1	
04 - Tide Mills, west, England	Good (Excellent)	2.33	0.22	3	3	2	3	3	2	3	3	2	1	1	2	3	
05 - Tide Mills, east, England	Good	2.08	0.23	3	3	3	3	2	2	1	2	1	1	2	2	2	
06 - Tide Mills, Bishopstone, England	Good (Impoverished & Excellent)	2.25	0.22	3	3	2	3	2	2	3	3	2	1	1	2	3	2
07 - Cuckmere Haven, east, England	Good	1.92	0.23	1	3	2	2	1	2	3	2	1	2	1	3	2	
08 - Holywell, Eastbourne, England	Impoverished	1.33	0.19	1	3	1	2	1	2	1	1	1	1	1	1	1	
09 - Pevensey Bay, Sailing Club, England	Good	2.08	0.23	1	3	3	2	2	1	3	3	2	2	1	2	2	
10 - Pevensey Bay, Martello estate, England	Good (Excellent)	2.33	0.26	3	3	3	2	3	2	3	3	3	1	1	1	3	
11 - Norman's Bay, west, England	Good (Excellent)	2.33	0.22	3	3	2	3	2	2	3	3	3	1	2	1	3	
12 - Norman's Bay, east, England	Good (Impoverished)	1.50	0.23	3	3	1	2	1	2	1	1	1	1	1	1	1	
13 - Coodens, west, England	Impoverished	1.42	0.23	3	3	1	2	1	1	1	1	1	1	1	1	1	
14 - Coodens, east, England	Impoverished	1.42	0.23	3	3	1	2	1	1	1	1	1	1	1	1	1	
15 - Veness Gap, England	Impoverished	1.25	0.18	3	1	1	2	1	1	1	1	1	1	1	1	1	
16 - Bexhill, west, England	Impoverished	1.00	0.00	1	1	1	1	1	1	1	1	1	1	1	1	1	
17 - Bexhill, central, England	Impoverished	1.17	0.17	3	1	1	1	1	1	1	1	1	1	1	1	1	
18 - Bexhill, east, England	Impoverished	1.42	0.19	3	2	1	2	1	1	1	1	2	1	1	1	1	
19 - Winchelsea, England	Good (Impoverished)	1.75	0.25	3	3	1	3	1	2	2	1	1	1	2	1	1	
20 - Rye Harbour Nature Reserve, west, England	Excellent	2.67	0.19	1	3	3	2	3	3	3	3	3	2	3	3	3	
21 - Rye Harbour Nature Reserve, east, England	Excellent	2.83	0.11	3	3	3	3	3	3	3	2	3	2	3	3	3	
22 - Lade, Dungeness, England	Good (Excellent)	2.17	0.24	1	3	3	2	1	2	3	3	1	2	2	3	3	
23 - Abott's Cliff, England	Impoverished	1.33	0.19	1	3	1	2	1	1	1	1	1	1	2	1	1	
24 - Lydden Spout, England	Impoverished	1.25	0.13	1	2	1	2	1	1	1	1	1	1	2	1	1	
25 - Kingsdown Beach, England	Good (Impoverished)	1.75	0.25	1	3	1	2	1	2	3	3	1	2	1	1	1	
26 - Walmer Castle, England	Good (Excellent)	2.33	0.22	1	3	3	2	1	3	3	3	3	2	2	2	3	
27 - Marine road, Deal, England	Good (Impoverished)	1.58	0.23	3	3	1	2	1	2	1	1	1	1	2	1	1	
28 - Chequers PH, England	Good (Impoverished)	1.67	0.26	3	3	2	2	1	1	1	1	1	1	1	3	1	
29 - Sandwich Bay, England	Good (Impoverished)	1.92	0.26	3	3	1	2	1	2	2	3	1	1	1	3	1	
30 - Ornival, France	Good (Excellent)	2.17	0.27	3	3	2	3	3	1	1	2	1	1	3	3	3	
31 - Hâble d'Ault, France	Good (Excellent)	2.17	0.27	3	3	1	3	2	1	1	3	1	2	3	3	3	
32 - Cayeux-sur-Mer, sud, France	Excellent	2.50	0.23	3	3	2	3	3	1	3	3	2	1	3	3	3	
33 - Cayeux-sur-Mer, France	Excellent	2.67	0.19	3	3	2	3	3	2	3	3	3	1	3	3	3	
34 - Brighton-sur-Mer, sud, France	Excellent	2.67	0.22	3	3	3	3	1	3	3	3	1	3	3	3	3	
35 - Brighton-sur-Mer, nord, France	Excellent	2.83	0.17	3	3	3	3	3	3	3	3	1	3	3	3	3	
36 - Le Hourdel, ouest, France	Good (Impoverished)	1.75	0.25	1	3	1	2	1	2	1	1	1	3	2	3	1	
37 - Le Hourdel, est, France	Good (Impoverished)	1.58	0.23	1	3	1	2	1	2	1	1	1	1	2	3	1	

Table 5.2 - Biodiversity Value Category (BVC) for 37 sites. BVC given is calculated from the mean category value shown in 3rd column. The modal value(s) is in brackets if it was different to the mean category value. Values for all 12 criteria are in columns 1-12 and the modal value(s) are in columns headed M and M(2).

Use of volunteer recorders

The survey methodology was tested and applied by volunteer recorders and one of us (Fitzsimons) between May and October 2006. Of 72 people who approached us expressing an interest in taking part in the survey, 51 volunteer recorders attended at least one of 11 training and testing sessions. Of those, at least 15 individuals submitted completed surveys post-training without supervision. One volunteer recorder (Linda Stark) submitted eight completed surveys, and others (Phillippa Morrison-Price, Sylvia Parsons, Fred Booth and the Kent group) submitted more than one each.

6. DISCUSSION

The methodology presented in this report allows sites to be quickly and objectively surveyed. Excel templates have been designed so that the data collected can be entered in a straightforward way, allowing a Biodiversity Value Category to be calculated automatically. It is important to stress that one survey will only give a snapshot of the site, and this is especially relevant in such a potentially dynamic environment. Rich *et al*. (2005a) for example, recommend that the vegetation on shingle beaches be monitored every three years.

The sites surveyed were biased towards those with vegetation, especially on the French side. On the French side time constraints only allowed a percentage of the coast to be sampled and species-rich beaches just south of Baie de Somme were chosen over the species-poor beaches further to the south. A much wider range of sites were surveyed on the English coast, although there was probably a natural inclination for recorders to choose sites with vegetation cover. Whilst the presence of some vegetation is obviously a pre-requisite for a survey of vegetated shingle beaches from a purely botanical point of view, it should be borne in mind that a lack of vegetation does not necessarily mean that the beach has no intrinsic interest. Areas of bare shingle are of importance to birds (Doody and Randall, 2003) and invertebrates (e.g. Shardlow, 2001), and it is suggested that areas of unconsolidated but stable shingle may favour lichen and bryophyte growth when there is insufficient organic material for higher plants to colonise (Lambley & Hodgetts, 2001). They are also of interest to coastal geologists and geomorphologists.

Although a large part of the BAR coastline that supports vegetated shingle is designated at a national or sometimes international level, limiting surveys to those areas which already receive some protection ignores the potential of other areas. Only five out of the 27 sites surveyed on the English coast fall within SSSI designated in part for vegetated shingle (designations in Appendix 5). All French sites fell within designated sites, but as mentioned previously, shingle beaches south of Ornival, some of which are known to be vegetated were not surveyed (unpublished data from previous BAR study). The current study (plus the study by Cole *et al*., 2005) has provided a baseline from which to monitor future change, has highlighted some areas that currently receive no formal protection but should still be considered important in their own right, and some that have the potential to achieve sufficient status to merit protection through designation with appropriate management. For example, the beach at site 26 - Walmer Castle, evaluated as Good (Excellent) is a wide shingle beach with a range of communities and species including *Crambe maritima* and the rare *Lathyrus japonicus*. The proximity of the popular Walmer Castle to the beach means that this would also be an ideal site to introduce vegetated shingle to the general public who may otherwise not have realised its biodiversity value. The beach at site 10 – Pevensey Martello Estate, also evaluated as Good (Excellent), is one of the last remaining fragments of the cuspate shingle foreland known as the Crumbles, most of which has been lost through development. The site showed succession from an ephemeral *Atriplex* spp. community, through to grassland/lichen-heath, and in calculating the BVC, it scored highly for the presence and distribution of characteristic species. However, the invasive species *Centranthus ruber* was present over much of the site, possibly as a result of its proximity to housing. The BVC value did not take its presence into account as we believe there was insufficient data about its possible negative effects. However, monitoring of sites where it is present would enable its distribution to be tracked. The effect of its removal at selected sites could be compared to sites where it was left in place to determine any potential effects on the distribution of native shingle species.

The method was designed to allow enthusiasts to monitor their local beach, often in places that would receive very little attention through more established or formal surveys. Volunteers can play a major role in large-scale monitoring programs and can potentially make significant financial- and time-savings for conservation (Newman *et al*., 2003; Foster-Smith and Evans, 2003; Macdonald and Tattersall, 2003; Irving, 2003). For example, the

National Bat Monitoring Programme relies heavily on volunteers 1133 volunteers took part in surveys and contributed data during 2005 (BCT, 2006). The efficacy of 155 volunteers in various wildlife monitoring tasks were evaluated by Newman *et al*. (2003) who found that they performed well and consistently, compared with professionals. Similarly, Foster-Smith and Evans (2003) found that although 13 volunteers collecting marine ecological data made recording errors, so did experienced scientists. Most other errors were the result of insufficient training and guidelines, emphasising the need for rigorous methodology.

It was anticipated that there would be some sampling error through factors such as recorders estimating percentages differently, not locating or misidentifying species, and weather affecting the survey effort. Nevertheless, it was assumed that between-category variations would be greater than within-category variations. We carried out limited testing which suggested that this was the case, but more formal testing was beyond the scope of this study. Therefore, not all the data collected were used in the evaluation. The data used for the evaluation consisted of those which we were confident had been collected in the same way by different recorders on different beaches. These data consisted mainly of the species present and measurements about their distribution up the beach, and data that could be measured from maps or aerial photographs.

It is fairly common practice to select a representation of a site to survey, and set permanent transects for future monitoring, however the data collected should not be extrapolated much beyond the actual location of the survey (Tucker *et al*., 2005). Therefore, coastal managers wishing to use this method should apply it the location that is likely to be affected by disturbance, and it is important to consider the Biodiversity Value Categories as relevant to that location.

Belt transects were used because they are particularly useful for monitoring vegetation changes along environmental gradients (Rich *et al*., 2005b), i.e. they will pick up the zonation of vegetation discussed in the introduction (section 1). By recording the presence of species and measurements of their position along a fixed line, we kept the data collection as objective as possible. An accurate estimate of species abundance at a site would take a lot longer to collect than a record of their presence and is potentially open to more subjectivity if several recorders are involved over numerous sites. Furthermore the collection of presence data is preferred by volunteers over estimating abundance, which means it may be easier to recruit recorders and the area surveyed (Bart and Klosiewski, 1989). However, some of the data collected did require recorders to make estimates, e.g. percentage of bare shingle, and this was where the most discrepancy between recorders was apparent. Although these data were not used to calculate the BVC, they were considered accurate enough to give an added indication of the zonation along the transect. Further testing would determine the actual level of discrepancy both within and between recorder surveys.

Despite not using all the data, it was worth collecting, as it did not particularly increase the difficulty of, or time spent doing the survey, and provided useful baseline data for a site. For example, shingle characteristics can vary a lot between (and within) beaches especially when compared with beaches in France. The colour for example can give an indication of the age of the shingle. Flint eroded from present day chalk cliffs are generally black or blue-black in colour, whereas yellowish, orangey shingle comes from flints that were first exposed around 65 million years ago to the warm humid climate of the early tertiary period. Whether or not this affects the ecology we do not know but size of shingle and the amount of sand can (e.g. Scot, 1963). We believe that it could play a role in future evaluations but further testing and training should be carried out.

Future work should include an evaluation of the criteria used and the data collected. There may be important species that have not been included in the current survey. This could be especially relevant for the French coast for which our expertise and access to databases was less than that for the English coast. Similarly, we may be collecting data that does not affect the final BVC. It might also be possible to refine the identification of species groups, without greatly increasing the time or expertise needed, so that the information they indicate is more robust. The time and expertise needed to survey sites were a major consideration for the methodology. On average, two transects could generally be done within a couple of hours. However, future tests should determine whether two transects gives a true picture of the site. It would also be useful to compare the biodiversity value assigned to sites by a range of experts and the methodology. Although not formally described here, a pilot study suggested that the criteria used could assign the same biodiversity value to a site as would a specialist. However, we anticipate that specialists may not always agree. Although the criteria were used to assign an absolute BVC to the site there was much variation possible at the criterion level, as reflected in the mean category values and standard error of the mean. This creates an area of uncertainty at the boundaries between BVCs, an inherent feature of any kind of grouping system and especially so for such a variable landscape. The modal biodiversity value(s) i.e. the most common category for each criterion was also calculated for each site. It provides more instant information about the BVC when the actual mean category value ± SEM is not quoted. A beach rated as Good (Impoverished) will tend to lie at the boundary of Impoverished and Good compared to one rated Good (Excellent). However, these criteria and the data collected could easily be adjusted without altering the main methodology if future work determined it necessary.

The instructions for the survey methodology fit onto two sides of one A4 sheet of paper that can easily be taken out into the field. It is comprehensive and includes diagrams. Future trials could determine whether it is possible to carry out a survey accurately without the need for formal training. The accompanying recording sheet was also designed to fit onto two sides of an A4 sheet of paper. There were two reasons for this. Firstly as much information as possible was on view at all times making it less likely to miss filling sections in and secondly, it is easier to deal with one sheet than several sheets especially on a beach with a strong sea breeze. The disadvantage is that the writing and recording boxes may be considered quite small. With some care and experience, this should not prove an obstacle to accurate recording. Moreover, even after just one training session, only two out of 18 volunteers (11%) wanted a 4-sided recording sheet with bigger print.

Of the 72 people who expressed an interest in the survey 51 attended at least one of 11 training and testing sessions that we held during the summer. These sessions lasted between 1 ½ and 3 hours and were mainly attended by people who apart from a few exceptions had both little botanical knowledge and no surveying experience. Nevertheless, these sessions seemed to be well received and the method was not thought daunting. Of four choices in a questionnaire given to 18 volunteers after they had received one training session, none felt that the method was impossible to do, only one (6%) felt they needed a lot more training, seven (38%) only wanted a little more training, and eight (44%) were confident that they could carry out a survey without supervision. The few occasions when it was possible to test the repeatability of the method by comparing the results of two groups on the same site or by one of us checking a site surveyed by a volunteer suggested that repeatability was consistent. These tests should be carried out more formally in the future. At least 15 individuals went on to complete a minimum of one survey post-training without the supervision of the authors. In addition, 10 groups or individuals expressed an interest in carrying on monitoring at 10 sites over the coming years. This suggests that the method is very doable, is considered important and may even be enjoyable to a wide range of people.

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APPENDICES