Managing Coastal Soft Cliffs for Invertebrates

Andrew Whitehouse

Buglife – The Invertebrate Conservation Trust

buglife
The Invertebrate Conservation Trust

Conserving the small things that run the world

A summary report is available, for a copy please contact Buglife:
info@buglife.org.uk
Buglife – The Invertebrate Conservation Trust,
170A Park Road, Peterborough, PE1 2UF.

www.buglife.org.uk

This report is funded by the Esmée Fairbairn Foundation

Buglife - The Invertebrate Conservation Trust is a company limited by guarantee, registered in England.

Registered charity no. 1092293
Company no. 4132695

This report should be referenced as:
Whitehouse, A.T. (2007) Managing Coastal Soft Cliffs for Invertebrates. Buglife - The Invertebrate Conservation Trust, Peterborough.

Contents

Foreword

I have a soft spot for soft cliffs. They are mainly on very scenic coasts and have a quality of being wild and natural. For thousands of years these cliffs have been actively shaped by the same processes of weathering, hydrology and sea erosion that are still active today. This is one of the few habitats where pioneer communities of invertebrates have been able to survive without disruption by man.

It is perhaps nearly 60 years ago that I first visited Barton cliffs as a child, amazed that the seaside could look so primeval. I was to become a geologist in the Nature Conservancy, presenting at a public inquiry the case against the erection of sea defences on this geological Site of Special Scientific Interest of international importance: we won that round. I then became responsible for invertebrates in the re-named Nature Conservancy Council: some years later I went back to Barton cliffs to investigate the insects and found that much of the cliffs had been drained, terraced and defended from the sea. We can never assume wild places and their invertebrate fauna will remain natural.

When Buglife became established just over 5 years ago, it was essential to define the priorities to address, and in particular to focus on issues that others were neglecting, especially where our actions could make a real difference.

The Biodiversity Action Plan defines Priority Habitats, one of which is Maritime Cliffs. When originally put forward, conservationists were thinking of hard rock cliffs with special flora and major sea bird colonies. The definition had to be adjusted to include soft rock cliffs whose wildlife values were almost entirely concerned with invertebrates.

In this report, Buglife presents an overview of the soft rock resource as a habitat and the geographical variation in invertebrate fauna. The work has focused on England so as to fill the main gap in knowledge, and taken account of the survey work by the Countryside Council for Wales, thus embracing the greater part of the maritime habitat resource for north-west Europe.

The threats are evaluated, the consequences of global warming and rising sea level included. But more important are the solutions to ensuring continuity of habitat and invertebrate faunas. In particular, attention needs to be paid to cliff top habitat quality, and restoring grassland flora along marginal belts. That fit is well with promoting tourism through provision of quality land along coastal footpaths. More broadly, the continued presence of natural cliffs provides local distinctiveness that will be lost were cliffs to become more widely graded back and stabilised. Many of these cliffs have geological values, notably the Dorset coast much of which is a World Heritage Site, so a sharing of some aspects of cliff character objectives is advantageous.

We are very grateful to the Esmée Fairbairn Foundation for its grant to support our three year project. This report focuses on the resource and how to provide for its future. We believe it should be an essential context document in coastal planning, water resource planning and in cliff top improvement for tourism, and sets a new basis for informing conservation policy

Alan Stubbs
Chairman, Buglife

Summary

Coastal soft rock cliffs are an important, yet neglected, habitat for invertebrates. They support rich invertebrate assemblages and are a refuge for many rare and specialised species.

The importance of coastal soft cliffs for invertebrates hinges on their capacity to provide a historical continuity of micro-habitats rarely fond with predictability elsewhere. The key features are bare ground and early succession pioneer vegetation supporting a rich wildflower resource, both are maintained by natural processes of coastal erosion and land-slippage. Additional features of high value to invertebrates include groundwater-fed seepages, flushes, reedbeds and pools, and physical attributes such as topography and temperature. Warm, south-facing bare ground can support impressive nesting aggregations of solitary bees and wasps, whilst freshwater features support rich assemblages of aquatic and semi-aquatic beetles and flies.

Twenty-nine invertebrates are only found on coastal soft cliffs in the UK; of these twenty-seven are Red Data Book species. These include the Cliff tiger beetle *Cylindera germanica*, the Large mason bee *Osmia xanthomelana* and Morris's Wainscot moth *Chortodes morrisii morrisii*. Alongside these species restricted to soft cliffs there are at least another 75 invertebrates that have a strong affinity to the habitat.

Coastal soft cliffs are a key component of the UK Biodiversity Action Plan (BAP) Priority Habitat 'Maritime Cliffs and Slopes'. The main biodiversity importance of this habitat is often the invertebrate fauna. A number of UKBAP Priority Species are dependent on the habitat, including the Glanville Fritillary butterfly *Melitaea cinxia*, the mining bee *Lasioglossum angusticeps*, and the Dotted bee-fly *Bombylius discolor*.

Many soft cliff sites have been given statutory protection as Sites of Special Scientific Interest (SSSIs), although the invertebrate interest of sites has not always been recognised and many of the sites are only notified for their geological interest. A number of sites have also been selected as Special Areas of Conservation (SACs) under the EU Habitats Directive.

Coastal soft cliffs are amongst the most natural habitats in the UK, on many sites human intervention or management is not required to maintain the habitat and species diversity. However, due to a lack of recognition for their nature conservation interest much of the UK resource has been altered or lost behind coastal protection schemes, or degraded through artificial drainage or insensitive cliff top management. These issues continue to threaten a number of sites, alongside additional threats associated with climate change. However, there are opportunities for restoring and enhancing sites, in particular through the improvement of cliff top habitats.

This report describes the importance of coastal soft cliff sites for invertebrate conservation in the UK, identifies a number of current and future threats to soft cliff sites, and provides management guidance for protecting and enhancing the invertebrate faunas of soft cliff sites. Regional gazetteers provide further detail and specific site management recommendations. The report is intended to be an essential resource for coastal planners, conservation practitioners, land managers and other stakeholders.

The report represents the findings of a three year Buglife project, funded by the Esmée Fairbairn Foundation. The project has collated data for soft cliff sites around the UK for the first time, and presented them in an accessible form. New survey work by Buglife has increased the available survey data for many regions and has raised the profile of soft cliffs amongst those in the conservation sector. A number of survey reports accompany this report, plus a non-technical summary, and a leaflet/poster - all of which are available from Buglife.

1. Coastal soft rock cliffs

1.1 A definition

Soft cliffs can be defined as: *"lithologies of any geological age which are poorly consolidated or poorly cemented, including glacial till, outwash deposits, head, friable sands, weakly consolidated clays and shales. Areas of variable lithology, for example limestones or sandstones overlying clays, are included where the soft lithology at the base of the cliff leads to failure"* (Pye & French, 1993). This definition has been expanded in Welsh studies to include sites where soft sedimentary materials and drift deposits overlie resistant bedrock, provided that these are raised little above the high water mark and the soft materials are eroding (Howe, 2002; Knight & Howe, 2006).

For continuity and to promote the compatibility between our work and previous geological and ecological studies this report will adopt this definition. Hard Chalk and other resistant limestones are not included in the definition used where cliffs are behaving as hard rock, including vertical cliffs. However, where cliff outcrops of Chalk and limestone are crumbling, leading to cliff profiles with soft cliff invertebrate habitat, such sites are included.

This report concentrates exclusively on coastal soft cliffs.

Whereas 'hard' cliffs are very resistant to erosion, soft cliffs are less resistant and tend to form unstable sloping or terraced cliffs which are more readily colonised by vegetation. The cliffs are subject to frequent slumping and land slippage caused by rain and frost, cracking-up of clay by alternate wetting and drying, and percolating groundwater, together with wave and storm erosion at the cliff base. The continued erosion of the cliff and movement of material provides a constant renewal or rejuvenation of bare ground, early successional habitats and pioneer plant communities. Bird (2000) gives a good introduction into soft cliff geomorphology.

1.2 The UK resource

Free functioning, unprotected coastal soft cliff is a scarce and limited resource. Of the 4059km of cliffed coast in the UK as little as 400km is soft cliff (Howe, 2003). By country this is divided into:

England	257km	(2.4% of the total coastline)
Wales	101km	(6.8%)
Scotland	18km	(0.2%)
Isle of Man	18km	(11.3%)
Northern Ireland	7km	(1.1%)
(Republic of Ireland	>250km	(3.5%))

(Pye & French, 1993; Howe, 2002; Dargie, 1996c)

England and Wales contain the greatest soft cliff resource in the UK with 257km and 101 km respectively. Estimates for Scotland amount to approximately 18km of soft cliff comprised of small fragmented sites. In Northern Ireland, the major stretches of glacial-till cliffs are found on the east coast (Cooper and Butler, 1997). The figure given for the Republic of Ireland is likely to be an over-estimate when compared to figures from Quelennec (1989) – table 3. On the Isle of Man, over 1% of the coast is comprised of soft cliff (Dargie, 1996c); this is concentrated in the north of the island. A useful overview of the UK resource can be found in May & Hansom (2003).

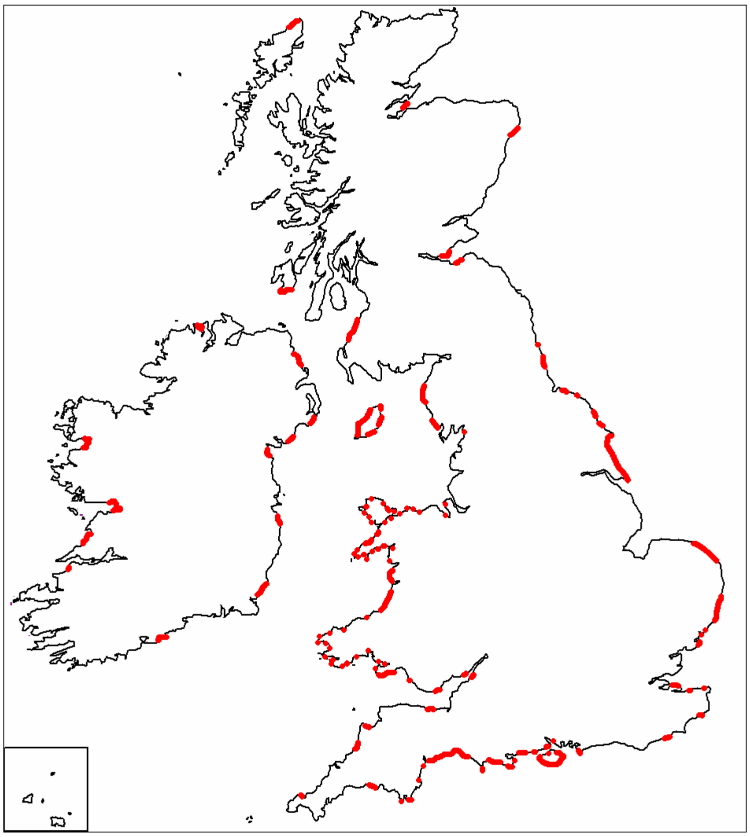


Figure 1. The distribution of coastal soft cliff in the UK. The approximate positions of areas of coastal soft cliff are outlined in red. Note that small stretches of cliff are not mapped. (from Howe, 2003)

The breakdown of the English resource by county is shown in table 1. Significant stretches of unprotected soft cliff occur in Yorkshire (including Humberside), Norfolk, Suffolk, the Isle of Wight, Dorset and Devon. More detailed information on the geology and morphology of these areas can be found in the JNCC Coastal Directories Series for Devon (Dargie, 1996b), Dorset (Dargie, 1996a & b), Norfolk (Dargie, 1995b), Suffolk (Dargie, 1995c), Yorkshire (Dargie, 1995a & b) and the Isle of Wight (Dargie, 1996a). The estimates quoted from Pye & French (1993) represent the only attempt to quantify the English resource from a conservation perspective; where these estimates have been verified using GIS techniques (Hunnisett & Edwards, 2006) they have been found to be fairly accurate, and so we have seen no need to recalculate them.

Measuring soft cliff habitat in terms of coastal length does somewhat undersell its significance as a coastal habitat type. For example, the length of soft-cliffed coast in Dorset is 34.66km, whereas the area of soft cliff habitat for the county is 564.66 hectares (Hunnisett & Edwards, 2006). This is a truer reflection of the extensive undercliffs in the county. Unfortunately this data is not available for many counties in the UK, so for comparisons we will keep to the linear values.

Table 1. The English unprotected coastal soft cliff resource (after Pye & French, 1993)

county	coastal length (km)	coastal soft cliff (km)	% of total length
Humberside	484.43	54.00	11.2
Isle of Wight	183.00	41.50	22.7
Yorkshire	220.35	33.15	15.0
Dorset	391.46	31.45	8.0
Devon	790.65	20.05	2.5
Norfolk	956.52	12.70	1.3
Suffolk	467.99	11.40	2.4
Kent	827.38	9.39	1.1
Cumbria	624.75	8.35	1.3
Durham	24.94	8.00	32.1
Hampshire	398.61	7.15	1.8
Sussex	435.83	5.95	1.4
England	**10676.81**	**255.60**	**2.4**

A detailed inventory of the Welsh soft cliff resource is provided by Howe (2003), which represents the only quantification of the resource from a conservation perspective. The major part of the Welsh resource occurs in Caernarvonshire (44km), with lesser amounts in Glamorgan (17km) and Cardiganshire (12km). Further information can be found in Dargie (1995d) - the breakdown by vice-county is shown in table 2. In comparison to England the Welsh resource is more fragmented with many sites being small (< 500m in length) (Howe, 2003), however there are still significant sections, including the south Gower coast, the Llyn Peninsula and the south Cardigan coast.

Table 2. The Welsh coastal soft cliff resource (after Howe, 2002)

vice-county	coastal length (km)	coastal soft cliff (km)	% of total length
Caernarvonshire	228.60	44.41	19.4
Glamorgan	168.00	17.10	10.2
Cardiganshire	91.99	12.13	13.2
Anglesey	270.00	9.55	3.5
Merionethshire	91.90	7.80	8.5
Pembrokeshire	351.83	4.61	1.3
Camarthenshire	140.82	3.28	2.3
Monmouthshire	55.00	0.55	1.0
Denbighshire	22.70	0.50	2.2
Flintshire	64.60	0.40	0.6
Wales	**1485.44**	**100.33**	**6.8**

1.3 An international context

There is a paucity of data on the significance of the UK soft cliff resource at a European or biogeographic region level. May (1977) highlights regions in northern France, Denmark, and Sweden; Bird (2000) includes examples in Australia, New Zealand, Canada, the US, Poland and Portugal. It would seem that the Danish Boulder Clay cliffs are situated on the Baltic or western lagoonal situations, rather than the North Sea coast and are relatively low (Roger Key, pers comm.). Gallois (2005) gives an account of the Normandy coast and describes cliffs of Kimmeridge Clay, although these are far from as extensive as their Dorset counterparts.

A European Union report published in the late 1980s identifies the UK as a major contributor of the European resource of ‘erosive rocky coast’ (Quelennec, 1989). However, ‘erosive rocky coast’ is defined as “rocks and/or cliffs constituted of erodible materials; presence of rocky debris (sand, pebbles) on the strand”. This definition will have included Chalk, other limestones, Old Red Sandstone and other geologies which we would consider to be eroding hard cliffs rather than soft cliffs. In this case the definition does not fit with our definition of a ‘soft cliff’, nor that of Pye & French (1993) and other publications. This is well illustrated by the figure given for the UK of 3,514km of erosive soft cliff (table 3) – this would represent 87% of the entire UK cliff resource! Doody (2001) provides a useful map of the cliffed coast of Europe, however this also does not distinguish between hard and soft cliffs.

Table 3. The erosive rocky coast resource in Europe (after Quelennec, 1989) (note this does not equate to our definition of soft cliff)

UK	3,514 km
Spain	2,917 km
Italy	2,104 km
Greece	1,136 km
France	914 km
Denmark	337 km
Portugal	258 km
Ireland	129 km
Germany	127 km

Although these figures cannot be used as a measure of the coastal soft cliff resource in Europe, they do give an indication of the significance of the UK resource in a European context. The significance of which when considering that the Italian, Greek and southern Spanish coasts are not within our biogeographic region. Therefore it is very likely that the UK has the majority of the coastal soft cliff habitat within the Atlantic biogeographic region.

2. The biodiversity of soft rock cliffs

Coastal soft cliffs are some of the most natural habitats in the UK, supporting rich invertebrate assemblages, including many rare or scarce species – some of which are entirely restricted to the habitat. 29 species of invertebrate are found only on coastal soft rock cliffs in the UK, of these 27 are Red Data Book species. Well represented groups are the Hymenoptera (bees and wasps), Coleoptera (beetles), Lepidoptera (butterflies and moths) and Diptera (flies). Alongside the invertebrates restricted to soft cliffs, 78 species with weaker affinities to the habitat have been identified (Howe, 2002; Howe, 2003; Howe *et al*, 2007).

The importance of soft cliffs for invertebrates has been recognised for some time within entomological circles. For example Norfolk's soft cliffs have been on the 'entomological map' since the 1800s with the recording of the ground beetle *Nebria livida* from Cromer in 1887 (Fowler, 1887), and the discovery of the rove beetle *Bledius filipes* as new to science by Sharp in 1911. However the ecological interest of soft cliffs has been rather neglected amongst the wider nature conservation sector and remains virtually unknown to the general public.

Why has the ecological interest of coastal soft cliffs been so undervalued in the past? Nature conservation efforts in the UK have largely been driven by enigmatic vertebrate megafauna or by plants, neither of which are particularly well represented on soft cliffs. The mobility of soft cliffs means that they are unable to support nesting colonies of seabirds; there are no mammals with an affinity to the habitat. Nevertheless, a number of soft cliff sites support regionally important colonies of sand martins (*Riparia riparia*), important assemblages of lichens (Gilbert, 2003), and the abundance of invertebrates provides a source of prey for birds, small mammals and bats (Parsons *et al*, 2001). A similar situation is true of plants, the vegetation communities of soft cliffs are poorly described, and in fact they were largely ignored during the process of developing a National Vegetation Classification (NVC) for maritime communities (Rodwell, 2000). Soft cliffs are not well known for supporting large numbers of rare and notable plants. For example on the Dorset soft cliffs there are records of only three such vascular plants (Hunnisett & Edwards, 2006). Pioneer plant communities and habitat features such as bare ground have been somewhat undervalued by conservation efforts driven by vertebrates and the NVC. However the selection of Special Areas of Conservation (SACs), as required under the Habitats Directive, did recognise that soft cliffs provided an important element of the range of variation of the Annex I habitat 'Vegetated sea cliffs of the Atlantic and Baltic coasts'. As a result, a number of SACs were selected because they supported good examples of this type of habitat.

Invertebrates in general have been neglected by the conservation sector, and habitats where the invertebrate fauna is the main interest feature, such as soft cliffs, have been neglected too.

2.1 Soft cliff ecology

The invertebrate interest of soft cliffs is largely a result of their dynamic nature. Periodic erosion and landslippage events provide a historic continuity of bare ground and pioneer ecological conditions, with complex mosaics of microhabitats that alone and in combination provide ideal conditions for a range of invertebrates. The most significant of these microhabitats are:

2.1.1 Bare ground

Bare ground is of key importance to invertebrates on soft cliffs and other habitats (Key, 2000). Bare areas are favoured hunting grounds for visual predators such as the Cliff tiger beetle *Cylindera germanica* and other ground beetles. Specialist 'pit predators' such as the larvae of *C. germanica* also favour bare ground where they wait in burrows to ambush prey.

Friable bare ground offers nesting sites for burrowing bees and wasps. Solitary bees provision their nests with pollen and nectar, whilst the wasps collect various prey items (such as weevils) – depending on the species. The most suitable substrates are sufficiently friable to allow burrowing, but firm enough to prevent burrows collapsing. Crevices in bare ground provide refuges for both predators and prey. The nocturnal ground beetle *Nebria livida* is thought to depend on cracks in clay at the base of soft cliffs as a refuge during the day.

Southerly-facing cliffs and slopes provide the warm conditions required by thermophilic (warmth-loving) species. Warm basking areas allow these species to remain active in cooler conditions. Many soft cliff thermophiles are at the northern edge of their European range, they are restricted to bare, south facing soft cliffs as these are the only locations with consistently high enough temperatures to support these species in the UK.

2.1.2 Pioneer and ruderal plant communities

The dynamic, unstable slopes of soft cliffs are constantly colonised by plants. Pioneer plant communities are generally dominated by flowering herbs such as Common Bird's-foot Trefoil *Lotus corniculatus*, Kidney Vetch *Anthyllis vulneraria*, Horseshoe Vetch *Hippocrepis comosa*, Wild Carrot *Daucus carota* and Common Fleabane *Pulicaria dysenterica*. These plants provide valuable nectar and pollen sources for a variety of insects, some of which are monolectic (dependent on the pollen and nectar of one species of flower). The plants are also the food plants of many phytophagous (plant eating) insects (such as the weevil *Baris analis*) and their predators, including many of the solitary wasps that nest on soft cliffs.

The unstable nature of soft cliffs and slopes constantly creates bare ground and suppresses ecological succession. Whereas in other situations herb-rich pioneer communities are ephemeral features (they naturally progress into open grassland, closed grassland and then scrub), the instability of the cliff substrate suppresses this change thereby maintaining a continuity of early successional vegetation.

The micro-moth *Scrobipalpula tussilaginis* is a leaf miner of Colt's foot *Tussilago farfara* and is confined to soft cliffs featuring this early colonising plant. The Glanville Fritillary butterfly *Melitaea cinxia* is confined to areas of later successional pioneer vegetation on the south coast of the Isle of Wight. Although the larval foodplant of this species – Ribwort plantain *Plantago lanceolata* – is widespread, the butterfly is confined to areas of short grassland on soft cliff slopes.

2.1.3 Hydrological features

Hydrological features are of particular significance for soft cliff invertebrate faunas. Groundwater seepages on soft cliffs provide a range of freshwater habitats from spring-fed streams to mossy trickles to damp ground. On many sites the full range of vegetation succession is present from wet bare ground to reedbed – each with its specific invertebrate interest. Seepages provide habitat for aquatic invertebrates or those with an aquatic stage in their life cycle. They also provide food plants and refuge for insects that have specific associations with aquatic plants – for example the solitary wasp *Mimumesa atratina* which is confined to soft cliff sites in the Isle of Wight and nests in dead *Phragmites* stems. Thin films of water running over muddy or silty ground, and through moss or algae are important breeding sites for many flies and beetles, including a number of species of *Bledius* rove beetles which graze on algae and dig burrows into the soft sediment. Seepages and pools also provide the wet muds that are required by many species of bees and wasps for nest construction, these include the mason bee *Osmia xanthomelana* and the Black-headed mason wasp *Odynerus melanocephalus*.

On many sites the position of freshwater features remains relatively constant from year to year; however on others the habitats are more ephemeral. This is a result of three main processes. Natural annual fluctuations of water supply or water level as in temporary pools; irregular geological activity such as land movement can re-route water supplies reducing freshwater inputs or completely shutting them off to an area; vegetation succession changes the range of microhabitats and plant species available to the invertebrate fauna and can promote further change - for example through vegetation trapping silt. This is well illustrated in Armitage (1983) who described many temporal changes to the streams and flushes of the Axmouth-Lyme Regis NNR. Of the 15 freshwater sites studied by Armitage in 1980 eight no longer existed by 1983.

Hydrological features are incredibly important to soft cliff invertebrate faunas. There are numerous examples within the regional reviews (Section 4) of sites with depauperate faunas due to a lack of seepage habitats. Our work on micro-habitat affinities (Section 2.3) clearly highlights the significance of these freshwater habitats, with over half of the species restricted to soft cliffs in the UK being associated with freshwater micro-habitats.

2.1.4 Habitat mosaics and continuity

On most soft cliff sites there are a range of these microhabitats, plus others such as calcareous grassland and scrub. Habitat variation on a very small spatial scale can produce an incredibly complex environment in terms of temperature, exposure, vegetation type and structure, stability, substrate compaction, and water availability. The high level of microhabitat variation within sites is likely to be one of the main drivers of species diversity on soft cliff sites. If you have lots of different habitats within a site you will also find the range of invertebrate assemblages associated with those habitats. However, it is often not the presence of one single habitat feature but the juxtaposition of a range of microhabitats that makes a site so important for a particular species. Invertebrate species often rely upon a range of habitat features to complete their life cycles - if one piece of this set of requirements is missing then a site is not suitable for the species. For example, burrowing bees require friable materials in which to excavate nests, but will also depend upon nectar and pollen sources in close proximity. The mason bee *Osmia xanthomelana* requires both a source of pollen and nectar as well as seepages to provide wet muds for nest construction.

The other key to the apparent concentration of rare or scarce invertebrates on soft cliff sites is their capacity to offer a continuity of habitats rarely found elsewhere, in particular those early successional habitats such as bare ground and pioneer plant communities (both wet and dry). These open habitats were once common in the wider countryside, however changes in agriculture and an intensification of land use has lead to the loss of these features. Where soft cliffs continue to offer these habitats with continuity they act as a refuge for many species that were previously more widespread. The Potter Flower Bee *Anthophora retusa* is one such species, being reliant on patches of bare sandy or clay soil plus good stands of Bird's-foot trefoil *Lotus corniculatus* (Mike Edwards pers comm.). Once fairly widespread across southern England, *A. retusa* is now almost entirely restricted to soft cliff sites on the south coast (figure 2).

The habitat resources available to animal and plant communities of soft cliffs are ephemeral, both through the dynamic nature of the underlying geology or geomorphology, and the process of ecological succession. To ensure the survival of a particular species on a site there must be a historical continuity of its habitat within its dispersal range. For example, the distribution of a species requiring bare ground will follow the patches of most recent geomorphological activity - as bare ground is colonised by plants the population will move on to more suitable habitat within the site. Metapopulations of species are able to withstand local extinctions as long as sites are large enough or connected in some way to other suitable habitat. Where the size of a site (or length of a section of soft cliff) is reduced or the site is fragmented – for example through the construction of coast protection – then the ability of that site to support populations of some species is compromised.

It comes of no surprise that the more extensive soft cliff sites such as the Charmouth to Seaton cliffs in Dorset are able to support the most diverse invertebrate assemblages.

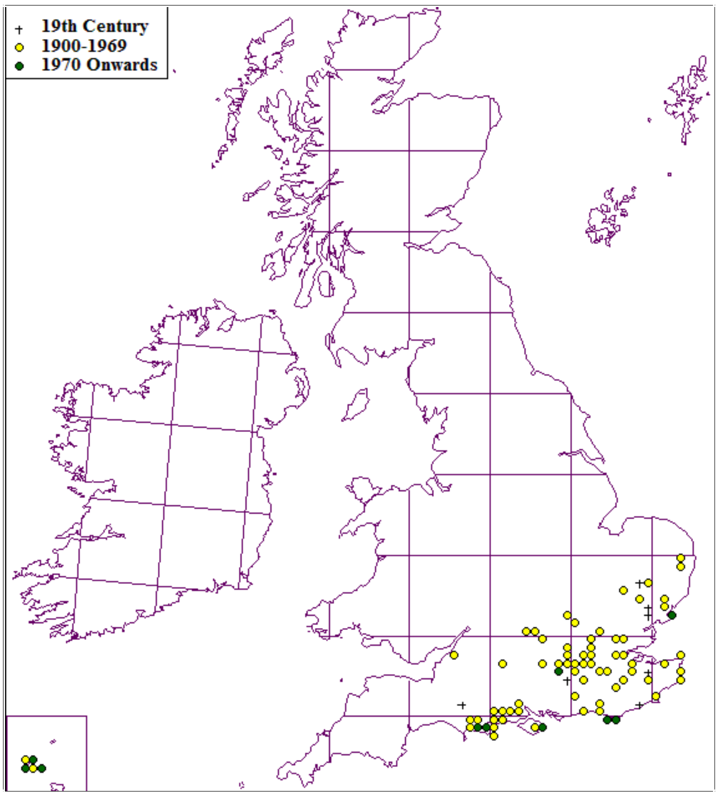


Figure 2. UK distribution of the Potter Flower Bee *Anthophora retusa.*
(© BWARS, 2007)

2.2 Soft cliff invertebrate specialists

A great range of invertebrate species can be found on most soft cliff sites. Complex habitat mosaics provide suitable conditions for a rich invertebrate fauna. Within this fauna are species with more specific habitat requirements which are found on no other habitat in the UK. Other species have a strong affinity to the habitat but are not confined to soft cliffs.

As part of a wider review, Kirby (1994) identified 57 species associated with coastal soft cliffs in the UK, 12 of which were confined to the habitat. Similar reviews have also been carried out by Hill *et al* (2002) and Alexander *et al* (2005), although neither provide an assessment of habitat affinity, and do not clearly distinguish between hard and soft cliffs.

A more thorough review was completed by Howe (2002), which identified 103 species with an affinity to coastal soft cliffs in the UK. These species were graded according to their fidelity to the habitat (table 4).

Table 4. Definitions used to determine the fidelity of invertebrate species associated with coastal soft cliffs in the UK (as defined by Howe (2002)).

Grade 1 species	are restricted to coastal soft cliff in the UK and dependent, for at least some stage of their life cycle, on soft cliff habitats. These include species which have always been restricted to coastal soft cliff and others which were once more widespread but are now confined to this habitat.
Grade 2 species	are strongly associated with coastal soft cliff in the UK, for at least some stage of their life cycle, with the majority of populations or the strongest populations occurring at such localities. However, they can also be found in other habitat types where extensive areas of bare ground and pioneer vegetation, or seepages and fen vegetation occur, such as sand dunes, dry sandy heathland, coastal grassland, sand or gravel pits, inland seepages and reedbeds.
Grade 3 species	are associated with coastal soft cliff in the UK, at least in some part of their geographic range, but also occur in a wide range of habitat types where the presence of bare ground, pioneer vegetation, seepages or fen vegetation is of fundamental importance for some of their life cycle.

The review identified 27 Grade 1 species which included the Cliff tiger beetle *Cylindera germanica*, the Glanville Fritillary butterfly *Melitaea cinxia*, the mining bees *Lasioglossum angusticeps* (figure 3) and *L. laticeps*, and the cranefly *Symplecta chosenensis* (figure 4). These species have only ever been recorded from coastal soft cliff in the UK. Also listed in the Grade 1 species are those which were once more widespread and are now entirely restricted to soft cliffs, for example the mining bee *Osmia xanthomelana* (figure 5) and the cuckoo bee *Nomada sexfasciata*. In addition, 20 Grade 2 species and 56 grade 3 species were also identified.

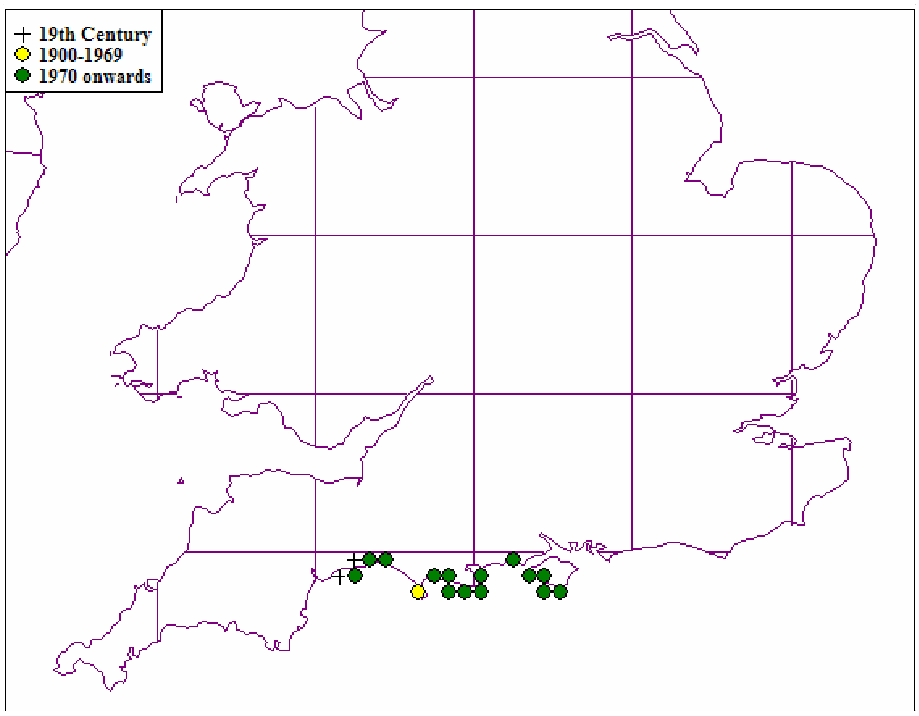


Figure 3. UK distribution of *Lasioglossum angusticeps*, a mining bee restricted to soft cliffs on the south coast of England.
(© BWARS, 2007)

Figure 4. UK distribution of *Symplecta chosenensis*, a cranefly restricted to coastal soft cliff in the UK. (from Howe *et al* (in press)) © DMap

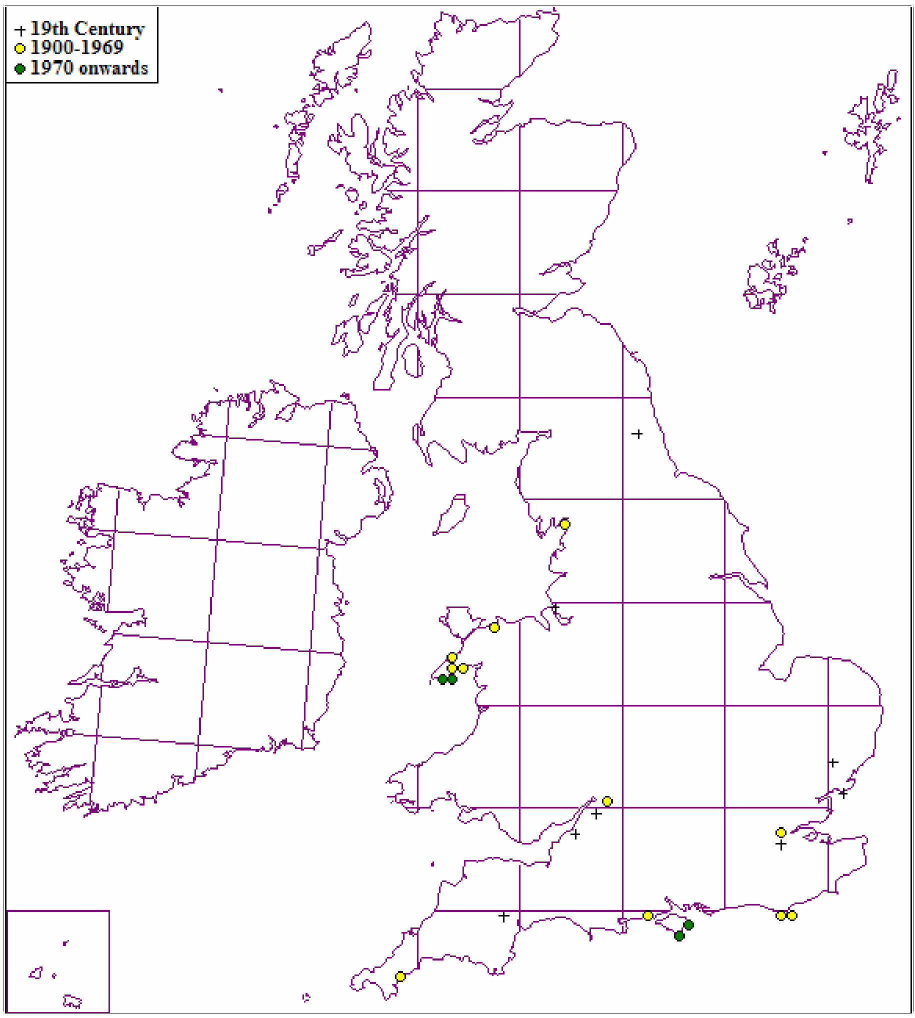


Figure 5. UK distribution of *Osmia xanthomelana*, a mason bee now restricted to soft cliffs on Llyn Peninsular in Wales.
(© BWARS, 2007)

Changes to the list of graded species have followed, although the original review was sufficiently comprehensive that amendments have been few. Two species were added to the Grade 1 list by Howe (2003) – the Red Data Book ground beetle *Chlaenius nitidulus* and the cranefly *Dicranomyia lackschewtzi*. Since then two Grade 1 species - the spider *Callilepis nocturna* and the solitary wasp *Mimumesa unicolor* - have been relegated to Grade 3, the Chalk Carpet moth *Scotopteryx bipunctaria cretata* has been added as a Grade 3 species, and the micro-moths *Scrobipalpula tussilaginis* and *Metzneria littorell*a have both been recognised as a Grade 1 species (Howe *et al*, in press). The current list of soft cliff associates is in tables 5, 6 and 7.

The Grade 3 criteria are a lot broader than those for Grade 1 or 2 species, as such there are many more species that could be added. For example, there are many more seepage species that could potentially qualify under the Grade 3 criteria such as the soldierflies *Oxycera morrisii* (Nb), *O. pygmaea* (Nb) and *Stratiomys potamida* (Nb), and the Horsetail Weevil *Grypus equiseti* (Nb). In recent reviews we have decided to concentrate on the Grade 1 and 2 species lists as are more indicative of the quality of soft cliff habitats.

New information on the distributions and habitat associations of species will cause this list to change again. Additionally, the distributions of these species may change through our warming climate, especially thermophilic species. Many of our soft cliff associates are not strictly coastal species, being also present in continental Europe on a range of other inland habitats. In the UK they are restricted to soft cliffs either because they are at the northern edge of their range and confined to warm sites, or soft cliffs are the only places which reliably provide their habitat requirements. A warming climate may allow some of these species to spread to other habitats further inland.

Climate change will also bring new species to the UK, many of which will first become established on the soft cliffs of the English south coast. We already have reports of a breeding colony of Spanish fly *Lytta vesicatoria* on soft cliffs on the Isle of Wight (Adam Wright pers comm.), and the Clouded Yellow butterfly *Colias croceus* breeding on the soft cliffs of south Devon and Dorset.

A number of recent publications provide useful information on the ecology of soft cliff species, these include work on the Cliff tiger beetle *Cylindera germanica* (Else, 1993; Hunnisett *et al*, 2006), the mason bee *Osmia xanthomelana* (Clee, 1995, 1999; Clee & Green, 2000, 2001a, 2001b, 2002, 2003), Black-headed mason wasp *Odynerus melanocephalus* (Hunnisett, 2006), the Dotted bee-fly *Bombylius discolor* (Gibbs, 2004), and the Glanville Fritillary (Pope, 1988; Bourn and Warren, 1997).

Table 5. Invertebrate species which are restricted to coastal soft cliffs in the UK (Grade 1 species).

Hemiptera (true bugs)		
Saldula arenicola	Na	Shore bug restricted to pools and seepages on clay cliffs on the south coast of England.
Coleoptera (beetles)		
Drypta dentata	RDB1	Ground beetle associated with seepages, restricted to a few soft cliff sites on the Isle of Wight and in Dorset.
Chlaenius nitidulus	RDB1	Ground beetle associated with cliff seepages at coastal sites in Dorset, East Sussex and the Isle of Wight. Old record from Carmarthenshire.
Cylindera germanica	RDB3, UKBAP	Cliff tiger beetle restricted to soft cliff sites in Dorset, Devon and the Isle of Wight. 1954 record from Carmarthenshire. (NB until recently this species was known as *Cicindela germanica*)
Tachys micros	Na, UKBAP	Ground beetle associated with sandy coastal cliffs in Dorset, Sussex and Caernarvonshire.
Bledius crassicollis	RDB1	Adults and larvae of this rove beetle burrow in moist sand and clay, feeding on algae. Last recorded on the Isle of Wight in 1973; old records from East Kent.
Bledius filipes	RDB1	Rove beetle found burrowing in the coastal soft cliffs in Norfolk.
Scopaeus laevigatus	RDB1	Rove beetle associated with springs and pools in coastal chines and sandy cliffs in Devon and Dorset.
Scopaeus minutus	pRDB1	Rove beetle restricted to soft clay cliffs from Axmouth to Lyme Regis.
Sphaerius acaroides	RDB1	Mud beetle historically found on fens throughout England, now restricted to soft cliff at Eype's Mouth in Dorset.
Sitona gemellatus	RDB1	Weevil which feeds on legumes on soft cliff in Dorset and Caernarvonshire.
Baris analis	pRDB2	Weevil feeding on Common fleabane (*Pulicaria dysenterica*) on slumping cliffs in Dorset and on the Isle of Wight.
Lepidoptera (butterflies and moths)		
Grapholita gemmiferana	pRDB1	Micro-moth whose larvae feed on vetches on coastal landslips in Hampshire, Devon and on the Isle of Wight.
Scrobipalpula tussilaginis	RDB1	Micromoth first recorded in the UK in 1983. Larvae mine the leaves of Colt's-foot *Tussilago farfara* on bare, rapidly-eroding muddy coastal cliffs in south Devon, Dorset and Hampshire.
*Metzneria littorell*a	pRDB3	A micro-moth confined to coastal soft cliffs on the Isle of Wight. The larva feeds on the seeds of Buck's-horn plantain (*Plantago coronopsis*).
Melitaea cinxia	RDB3 pUKBAP	The larvae of the Glanville Fritillary butterfly feed on plantain (*Plantago*) on soft cliff sites on the Isle of Wight.
Idaea degeneraria	RDB3	The Portland Ribbon Wave moth is found on grassy and bushy undercliff on the Isle of Portland, possibly feeding on Dock (*Rumex*) and Dandelion (*Taraxacum*).

(Table 5 cont.)		
Chortodes morrisii morrisii	RDB1	Morris's Wainscot moth is associated with grassy undercliff in Devon and Dorset, larvae feeding on Tall fescue (*Festuca arundinacea*).
Diptera (flies)		
Dicranomyia lackschewitzi	RDBK	Cranefly thought to be confined to soft cliff seepages on the Isle of Wight, recently recorded at Eype in Dorset.
Symplecta chosenensis	RDBK	Cranefly known from soft cliff localities in England and Wales. This species relies on early succession permanent seepages on Boulder Clay.
Helius hispanicus	RDBK	Cranefly known only from soft cliff seepages at a single site in Devon.
Campsicnemus umbripennis	RDBK	Marsh fly recently recorded new to UK from a single soft cliff locality in Dorset.
Platycephala umbraculata	RDB2	Chloropid fly recorded from *Phragmites* growing on soft cliff in Dorset and a single locality on the Severn Estuary.
Hymenoptera (bees, wasps, ants)		
Mimumesa atratina	RDB2	Solitary wasp associated with *Phragmites* at the base of clay cliffs or landslips on the south coast of the Isle of Wight where it preys on leafhopper bugs.
Lasioglossum angusticeps	RDB3, UKBAP	Mining bee which nests in exposed clay on soft cliff on the south coast of England.
Lasioglossum laticeps	RDB2	Mining bee which nests in clay soils on undercliff and landslips in Dorset and Devon visiting a wide range of flowers.
Osmia xanthomelana	RDB1, UKBAP	The Large mason bee was once widespread, with records from inland localities, but it is now restricted to coastal soft cliff on the Llyn Peninsula and possibly the Isle of Wight - although it has not been recorded there for several years. Females gather pollen from Common Bird's-foot trefoil (*Lotus corniculatus*).
Nomada errans	RDB1	Nomad bee restricted to a short stretch of soft cliff on the Dorset coast where it is a cleptoparasite of the mining bee *Andrena nitidiusculus*.
Nomada sexfasciata	RDB1	Once more widespread, this nomad bee is now restricted to a single locality on the south Devon coast, where it is a cleptoparasite of *Eucera longicornis*.

Table 6. Invertebrate species which are strongly associated with coastal soft cliffs in the UK (Grade 2 species).

Coleoptera (beetles)		
Bembidion saxatile	Nb	Ground beetle occurring locally on sand and gravel by water, often at the base of soft cliffs on the coast, but with a number of inland records. Concentrations in Dorset, Yorkshire, SW Scotland, the Isle of Man and Wales.
Nebria livida	Na	Ground beetle associated with slumping boulder clay cliffs and strandline litter in Yorkshire and North Norfolk, and from a couple of inland sites.
Bledius dissimilis	RDB1	Rove beetle which constructs burrows in firm soil cliffs by water. Most records from Yorkshire coast and Humber Estuary, with a single inland locality in a gravel pit in Berkshire.
Mononychus punctumalbum	Na	Weevil restricted to coastal localities in Dorset, Somerset and Isle of Wight, and inland localities in Wiltshire where it feeds on Stinking Iris (*Iris foetidissima*).
Cathormiocerus socius	RDB2	Weevil restricted to maritime grassland and sparsely vegetated cliffs on the south coast of the Isle of Wight. Larvae feed on the roots of Plantain (*Plantago*).
Lepidoptera (butterflies and moths)		
Leucoptera lathyrifoliella	Nb	Micro-moth whose larvae mine the leaves of Narrow-leaved Everlasting-pea (*Lathyrus sylvestris*). Mostly confined to sea cliffs and undercliff in Devon, Hampshire and the Isle of Wight, with a single record from Merionethshire.
Selania leplastriana	pRDB1	Micro-moth feeding on Wild Cabbage (*Brassica oleracea*) on coastal cliffs and slopes in Devon, Dorset and Kent.
Leucochlaena oditis	RDB3	Beautiful Gothic moth whose larvae feed on grasses on coastal cliffs and grassy slopes in south Devon, Dorset and on the Isle of Wight.
Diptera (flies)		
Dicranomyia goritiensis	RDB3	Cranefly associated with seepages on coastal soft cliffs and hard rock faces. Widespread but local.
Idiocera bradleyi	pRDB2	Cranefly associated with sparsely vegetated seepages on boulder clay cliffs in north-east England, south-west Scotland and Wales. Only one modern inland record.
Hymenoptera (bees, wasps, ants)		
Euodynerus quadrifasciatus	RDB2	Potter wasp recorded from coastal soft cliff and pebble beaches in south Devon and Dorset, adults visiting the flowers of Dewberry (*Rubus caesius*) and brambles.
Odynerus melanocephalus	Na, pUKBAP	Mason wasp nesting in exposed, light clay soils on soft cliffs, heaths and disturbed areas, feeding on moths and beetles. Mostly restricted to coastal localities in Dorset and on the Isle of Wight.
Nysson interruptus	RDB2	A solitary wasp cleptoparasitic on *Argogorytes fargei* (a sphecid wasp) which was once widespread but now restricted to soft cliff on the Isle of Wight and a site at Rogate, Sussex.

(Table 6 cont.)

Andrena rosae	RDB2	Mining bee found mostly from coastal soft cliffs, landslips and cliff tops with recent records restricted to south-west England, Kent and south Wales. Pollen is collected from a range of flowers.
Andrena simillima	RDB2	Mining bee typically recorded from coastal soft cliffs and landslips but also from heathland and chalk downland, now known from only a handful of sites in Cornwall, Hampshire and Kent. A wide range of flowers are visited for pollen and nectar.
Andrena spectabilis	Nb	Mining bee mostly associated with coastal locations such as landslips, rough cliff tops and soft cliffs in south and south-west England where pollen and nectar are gathered from a variety of flowers. It has declined substantially from inland heaths and chalk grassland.
Anthophora retusa	RDB1	Potter flower bee which was once widespread in southern England but is now confined to coastal localities, and particularly the soft cliffs on the south coast of the Isle of Wight. A wide range of flowers are visited.
Eucera longicornis	Na	Mason bee which was once widespread and locally common throughout southern England and Wales but is now mostly restricted to coastal localities and particularly to soft cliff sites in south-west England, Kent, Isle of Wight and south Wales. Females are polylectic (pollen generalists).
Isopods (woodlice)		
Eluma purpurascens	Nb	Pill woodlouse occurring naturally on coastal soft cliff but with recent records from inland sites in south-east England.
Aranae (spiders)		
Episinus maculipes	RDB3	Spider confined to undercliff on the Isle of Wight and cliffs near Plymouth.

Table 7. Invertebrate species which are moderately associated with coastal soft cliffs in the UK (Grade 3 species).

Orthoptera (grasshoppers and crickets)		
Platycleis albopunctata	Nb	The Grey Bush Cricket has a mostly coastal distribution and is associated with coarse grasses and rough vegetation on dunes, shingle and south-facing cliffs.
Hemiptera (true bugs)		
Enoplops scapha	local	A squashbug generally found on the coast where it is associated with composites on sand hills, coastal grasslands and soft cliffs. Largely confined to the south and west coast of England and Wales, and to Yorkshire coast.
Trapezonotus ullrichi	RDB3	Seedbug found in short grassland on cliff tops with most records from Devon, Cornwall and south-west Wales.
Coleoptera (beetles)		
Bembidion stephensii	Local	Ground beetle found on bare clayish soil near water, both on the coast and by rivers inland.
Acupalpus elegans	Extinct	Historical records of this ground beetle are from saltmarsh and seepage cliffs on the Kent coast.
Ochthebius poweri	RDB3	Water beetle mostly restricted to seepages on coastal cliffs in Devon and Cornwall, with a few records from south and south-west Wales.
Lesteva hanseni	Nb	Rove beetle usually found in mosses in damp places.
Astenus lyonessius	Local	Rove beetle with a restricted UK distribution.
Eubria palustris	RDB3	A water penny-beetle found in dead grass and other plant remains in water or in very wet conditions.
Heterocerus fusculus	Nb	A mud beetle found on coastal soft cliffs and sand dunes in south and north-west England.
Anostirus castaneus	RDB1, UKBAP	Chestnut click beetle whose larvae feed on the roots of grasses. Recent records confined to a coastal soft cliff site on the Isle of Wight and a site near Harrogate, Yorkshire.
Longitarsus fowleri	Na	A leaf beetle found mostly on the coast, including soft cliff. Feeds on Teasel (*Dipascus*), Thyme (*Thymus*), and Ground ivy (*Glechoma*).
Cathormiocerus maritimus	RDB3	A weevil mostly confined to coastal cliffs and rough open ground on the coast where it is perhaps associated with Buck's-horn plantain (*Plantago coronopus*). Restricted to sites from Hampshire to north Devon, with recent Welsh records.
Barypeithes sulcifrons	Nb	A widespread weevil in dry grassland, maritime cliff vegetation and light woodland feeding on grass roots.
Sitona waterhousei	Nb	Weevil which feeds on the roots of Bird's-foot trefoil (*Lotus corniculatus*) on steep, rocky grasslands, cliffs and undercliffs. Widespread in south England and Wales.
Ceutorhynchus terminatus	Nb	A weevil feeding on Wild carrot (*Daucus carota*) on coastal cliffs and more rarely inland in disturbed grassland.
Trichoptera (caddisflies)		
Limnephilus hirsutus		A caddisfly associated with tiny trickles on unstable bare clay, including seepages on coastal soft cliffs.

(Table 7 cont.)

Lepidoptera (butterflies and moths)		
Dichrorampha senectana	Nb	Micro-moth which frequents coastal undercliffs, landslips and inland quarries mostly in south England where it may be associated with Ox-eye daisy (*Leucanthemum vulgare*).
Diachrysia chryson	Na	The Scarce Burnished Brass moth is found on river banks, fenland, marshes and coastal undercliff, larvae feeding on Hemp-agrimony (*Eupatorium cannabinum*). Mostly in south and south-east England.
Lygephila craccae	RDB3	The Scarce Blackneck moth is restricted to coastal cliff and rocky coast in north Cornwall, north Devon and north Somerset where the larvae feed on Wood vetch (*Vicia sylvatica*).
Scotopteryx bipunctaria	NS, UKBAP	The Chalk Carpet moth is associated with chalk or chalky soil. Recent records indicate that the species is present on most of the main chalk and limestone formations in England and Wales, particularly in the south. It is found on a number of soft cliff sites.
Diptera (flies)		
Arctoconopa melampodia	RDB2	A cranefly recorded from sandy river banks and from coastal soft cliffs.
Gonomyia conoviensis	Nb	A cranefly associated mostly with upland streams or coastal cliff seepages.
Thereva strigata	RDB3	A stiletto fly associated with hot, south-facing coastal cliffs in Kent, Isle of Wight and Devon.
Clinocera nigra	Local	A dance fly found at seepages and trickles on rock faces and coastal cliffs.
Bombylius discolor	Nb	A bee-fly which is a brood parasite of solitary bees, most probably *Andrena*. Widely distributed in southern England where it can be found in open woodland, limestone grassland and dunes. This species was once more widespread but became more restricted to soft cliff sites in the 1960-80s. From the 1990s onwards it has recolonised parts of its former range.
Chrysotoxum elegans	RDB3	A hoverfly found in dry grassland and woodland rides in southern England where the larvae may be predatory on root aphids or occur in ant nests.
Herina oscillans	pRDB3	A fly recorded from coastal soft cliff, coastal grassland, saltmarsh and fens.
Lipara rufitarsis	NS	A small wetland fly that forms slender galls in *Phragmites* stems. Found on soft cliffs and some inland fens in southern England.
Cephalops chlorionae	NS	A fly that is a parasite of leaf hopper bugs of the genus *Chloriona* living on reed (*Phragmites)*. Known from a number of coastal sites and inland in the East Anglian fens.
Policheta unicolor	RDB3	A fly which parasitises *Chrysolina* leaf-beetles, most records from coastal sites in south-west England, and north-west Wales.
Orchisia costata	RDB2	A fly recorded from coastal dunes and from small stands of *Phragmites* on clay cliffs in Dorset.

(Table 7 cont.)		
Hymenoptera (bees, wasps, ants)		
Methocha articulata	Nb	Solitary wasp which parasitises tiger beetles and is quite widespread at sandy sites in south England and coastal sites in Wales.
Priocnemis gracilis	Nb	A spider-hunting wasp recorded from woodland, heathland and sand pits, and coastal soft cliffs and landslips in Kent, Dorset, Isle of Wight as far north as north-east Yorkshire where it preys on spiders including *Clubiona*.
Argogorytes fargeii	Na	A solitary wasp which nests in hot, bare or sparsely vegetated banks in clay, gravel or sand and preys on the 'cuckoo-spit' leafhopper bug *Philaenus spumarius*.
Mimumesa unicolor	Na	Solitary wasp associated with a range of habitats in Essex, Hampshire and Sussex. On the Isle of Wight it is associated with marshy areas with *Phragmites* on soft cliff where it preys on leafhopper bugs.
Hylaeus pictipes	Na	A yellow-faced bee recorded from a variety of habitats in southern England where females collect pollen from a range of flowers.
Hylaeus spilotus	RDB3	A yellow-faced bee recorded from coastal soft cliff, landslips, shingle and dunes on the south coast of England, where females are polylectic (pollen generalists).
Andrena dorsata	Local	A widespread mining bee of sandy places in southern England both inland and on the coast, with a handful of coastal records in Wales.
Andrena fulvago	Na	A mining bee once widespread in southern England, both inland on calcareous grassland and the edges of moorland and on the coast, but now mostly restricted to coastal cliffs, landslips and coastal grassland where females collect pollen from yellow composites.
Andrena humilis	Na	A mining bee which nests in compacted sand or soil, visiting the flowers of Hawkweeds (*Hieracium*) and other yellow composites.
Andrena labiata	Na	A mining bee known from a variety of habitats in southern England including heathland, grassland, open woodland, and coastal landslips and soft cliffs where there is a close association with Germander speedwell (*Veronica chamaedrys*).
Andrena nitidiusculus	RDB3	A mining bee usually associated with exposures of clay on coastal habitats such as soft cliffs and landslips, particularly in Dorset, Hampshire and Sussex, although it can occur on inland heath. Pollen is collected from umbellifers.
Andrena niveata	RDB2	A mining bee known from coastal landslips and cliffs as well as sandy heaths and the margins of fens, although most recent records are restricted to coastal sites in east Kent.
Andrena proxima	RDB3	A mining bee recorded from coastal soft cliff, landslips, heathlands, chalk downland and disturbed banks where pollen is collected from umbellifers. Mostly confined to Devon, Isle of Wight and Kent.
Andrena similis	Nb	A widespread but declining mining bee found in a range of habitats including rough coastal grassland and cliffs, heathland and calcareous grassland where females visit a wide range of flowers.

(Table 7 cont.)		
Andrena trimmerana	Nb	A widely distributed mining bee in southern England where it is found on heathland, moorland, the edges of woodland and coastal soft cliff where females visit a wide range of flowers.
Lasioglossum malachurum	Nb	A mining bee now largely confined to the coast in southern England where the majority of sites are soft cliffs, landslips and the upper parts of beaches. Females are polylectic (pollen generalist).
Lasioglossum puncticolle	Nb	Yellow-footed mining bee - recorded from coastal soft cliff, sandy heaths and clay pits in southern England. Nests in bare clay and collects pollen from Wild carrot (*Daucus carota*).
Lasioglossum xanthopus	Nb	A mining bee which nests in bare soil and closed-grazed turf in southern England, with females visiting a wide range of flowers.
Sphecodes niger	RDB3	A solitary bee which is a cleptoparasite of *Lasioglossum* bees. This species is known from soft cliff sites in the south of England, plus an increasing number of inland sites.
Sphecodes reticulatus	Na	A solitary bee cleptoparasitic on mining bees which is recorded from a variety of habitats including sandy heath, coastal landslips and soft cliffs, open woodland, sandpits and chalk grassland in southern England.
Sphecodes rubicundus	Na	A solitary bee which is a cleptoparasite of the mining bee *Andrena labialis* in southern England – recorded from a variety of habitats including coastal soft cliff and landslips.
Sphecodes spinulosus	RDB2	This solitary bee is a brood parasite of Halictine bees now restricted to a handful of sites on the south coast of England and Wales.
Nomada conjugens	RDB2	This nomad bee parasitises *Andrena proxima* which nests in sunny, bare sandy banks. Most recent records are from coastal cliffs, grasslands and associated landslips in south Devon and the Isle of Wight.
Nomada flavopicta	Nb	A nomad bee which is cleptoparasitic on *Melitta* mining bees and is recorded from a wide variety of habitats in southern England including heathland, chalk downland, fixed dunes and coastal landslips and soft cliff.
Nomada fucata	Na	A nomad bee which parasitises the mining bee *Andrena flavipes* in a variety of sandy and grassy situations, especially coastal landslips and gently sloping soft cliffs, in southern England and south Wales.
Nomada fulvicornis	RDB3	A once widespread nomad bee, this cleptoparasite of *Andrena* is now restricted to sites in Kent and Sussex which include coastal soft cliff, grassland and associated landslips.
Nomada guttulata	RDB1	A nomad bee which parasitises *Andrena labiata* and is found on coastal cliffs and in woodland. Formerly more widespread, it is now known only from Devon.
Nomada integra	Na	A nomad bee parasite of *Andrena humilis* found in disturbed and sandy situations and especially coastal landslips.
Aranae (spiders)		
Callilepis nocturna	RDB1	Spider restricted to coastal localities in south Devon, Pembrokeshire and on the Isle of Wight.

2.3 Invertebrate habitat affinities and site management

Habitat conservation in the UK is primarily based on vegetation classification systems such as the NVC (Rodwell, 2000). This system helps conservation practitioners to recognise and describe different plant communities and informs both selection and monitoring of designated sites (see JNCC Common Standards Monitoring guidance: http://www.jncc.gov.uk/page-2199). The NVC is also used to develop management targets for sites, and is considered an extremely useful tool in nature conservation. However, this system is not always an appropriate basis for the conservation of other taxonomic groups such as invertebrates. A system based on invertebrate assemblages is in development (Webb & Lott, 2006), which follows reviews of a number of the invertebrate communities associated with specific habitats, including freshwater seepages (Boyce, 2002), bare ground (Key, 2000) and calcareous grassland (Alexander, 2003). These assemblages can be used to recognise and describe habitats of importance for invertebrate conservation.

There is a defined soft cliff assemblage (Howe, 2002; Howe *et al*, in press) of 106 species graded according to their affinity to the habitat. However, a finer scale system is needed. Sub-sets of the soft cliff assemblage that are associated with defined micro-habitats will enable conservation practitioners to advise on how changes in site management will influence the invertebrate fauna. For example, having a defined soft cliff bare ground assemblage would enable us to predict the likely impact of losing bare ground habitat through cliff stabilisation.

Buglife survey work in Dorset (Hunnisett & Edwards, 2006) and on the Isle of Wight (Colenutt & Wright, 2006) has gone some way to developing micro-habitat invertebrate assemblages for coastal soft cliffs. Through combining the data from the two surveys with information on known species habitat associations we have been able to define a soft cliff seepage assemblage (table 8). On soft cliff sites these species are entirely restricted to seepages (e.g. the rove beetle *Bledius filipes*, only found in damp sand at seepages on Norfolk soft cliffs) or they are reliant on seepage habitats for critical stages in their life cycle (such as the mason bee *Osmia xanthomelana* which constructs nests from mud gathered at seepages). Our soft cliff seepage assemblage compares well to that of Boyce (2002), and adds to the species list (table 8).

We have also identified a set of thermophilic species that require bare ground or pioneer conditions. We have not listed these species in a separate table as their requirements can be easily deduced from the information in tables 5, 6 and 7. However, they include the majority of our soft cliff bees and wasps, the Grey bush cricket *Platycleis albopunctata*, the Cliff tiger beetle *Cylindera germanica*, the micro-moth *Scrobipalpula tussilaginis*, and the Glanville Fritillary butterfly *Melitaea cinxia*. These species are also reliant on other habitats, for example herb-rich grassland providing pollen and nectar sources for bees. Many invertebrates have complex habitat requirements, often exploiting the resources of a range of habitats or requiring different habitats at different stages of their life cycles. This makes defining specific habitat-based species assemblages problematic, particularly for transitional habitats such as open grassland, closed grassland and scrub. Despite these limitations we can be confident that without sufficient bare ground or pioneer plant communities on a site species from the thermophilic assemblage would not be present.

In terms of managing sites this information is very useful. Using the soft cliffs seepage assemblage it is possible to predict the ecological impact of a decline in the quantity or quality of freshwater reaching a cliff slope or undercliff. Taking the cliffs to the east of Lyme Regis (including Black Ven and the Spittles) as a hypothetical example, it is known that these cliffs support populations of the soft cliff seepage beetles *Bembidion saxatile, Cylindera germanica, Mononychus punctumalbum* and *Tachys micros*, plus the flies *Arctoconopa melampodia, Platycephala umbraculata,* and *Campsicnemus umbripennis*. The loss of seepage habitats through artificial drainage of the cliffs or through increased water abstraction within the catchment area of the cliff would result in the local extinction of these six (4 Red Data Book, 3 Nationally Scarce) species. This of course does not take into account the stabilising effect on the geomorphology of the site that drainage would also bring, and the associated loss of bare ground and open habitats, but it gives an idea of the potential impact of the operations.

Table 8. Invertebrate assemblage of soft cliff freshwater seepage habitats.

Species	Status	Grade	Fidelity to cliff seepages (as given by Boyce, 2002)*
Coleoptera (beetles)			
Bembidion saxatile	Nb	2	A
Bembidion stephensii	local	3	B
Bledius crassicollis	RDB1	1	A
Bledius dissimilis	RDB1	2	B
Bledius filipes	RDB1	1	A
Chlaenius nitidulus	RDB1	1	A
Cylindera germanica	RDB3	1	A
Drypta dentata	RDB1	1	A
Eubria palustris	RDB3	3	A
Lesteva hanseni	Nb	3	B
Mononychus punctumalbum	Na	2	
Ochthebius poweri	RDB3	3	A
Scopaeus laevigatus	RDB1	1	B
Scopaeus minutus	pRDB1	1	A
Sphaerius acaroides	RDB1	1	B
Tachys micros	Na	1	A
Diptera (flies)			
Arctoconopa melampodia	RDB2	3	C
Campsicnemus umbripennis	RDBK	1	
Clinocera nigra	local	3	
Dicranomyia goritiensis	RDB3	2	A
Dicranomyia lackschewitzi	RDBK	1	
Gonomyia conoviensis	Nb	3	A
Helius hispanicus	RDBK	1	A
Idiocera bradleyi	pRDB2	2	A
Platycephala umbraculata	RDB2	1	
Symplecta chosenensis	RDBK	1	(A)
Hemiptera (true bugs)			
Saldula arenicola	Na	1	
Hymenoptera (bees and wasps)			
Mimumesa atratina	RDB2	1	
Mimumesa unicolor	Na	3	
Osmia xanthomelana	RDB1	1	
Lepidoptera (butterflies and moths)			
Diachrysia chryson	Na	3	
Trichoptera (caddisflies)			
Limnephilus hirsutus		3	B

***** in Boyce (2002) habitat affinity is described thus:
Grade A – seepage obligates; Grade B – seepage specialists; Grade C – seepage associates

3. Ranking UK coastal soft cliff sites

The development of a simple mechanism for ranking coastal soft cliff sites on the basis of their invertebrate faunas was an early aim of this project. It is conceived as a valuable tool for helping to identify the most important sites for conservation and protection, to highlight sites requiring further survey work and to put newly-surveyed sites into a wider context.

Although similar evaluations have been made for saproxylic invertebrate faunas (Alexander 2004; Fowles et al. 1999), an evaluation of coastal soft cliffs is arguably more complex because of the range of niches (bare ground, pioneer vegetation, seepages and pools, reedbeds and fen vegetation) and physical attributes (lithology, aspect, climate) involved, and the variable size of a site (ranging from a few metres to several kilometres in length, or from vertical faces of less than a metre to extensive landslip systems of several hectares). A further obstacle is the small number of soft cliff obligates, many of which have very limited distributions in the UK, and our limited knowledge of the ecology of many of the species.

Larger and more heterogeneous sites will support more soft cliff species, and those with a southerly aspect will support more soft cliff thermophiles (warmth-loving species) such as bees and wasps. In general terms there are more rare and scarce invertebrates in the south of the UK than the north, so soft cliff sites in the most southerly regions will inevitably support more of these species. There is probably little real merit, in either ecological or conservation terms, in comparing sites as physically different as the dry, uniform cliffs of the south-west Gower coast with the heterogeneous cliffs of west Dorset, with their suite of hydrological features. Nevertheless, a simple listing of the 104 Grade 1 to 3 coastal soft cliff species by locality, with the greatest weighting given to Grade 1 obligates, at least highlights the key soft cliff sites.

For the purposes of this somewhat crude ranking, individual sites have been amalgamated into 'metasites', either because they form one continuous stretch of coastline, are only narrowly separated and probably represent a single ecological unit in which at least the more mobile species can easily disperse, or are close to one another and share similar physical and biotic attributes. For example the West Dorset Cliffs metasite stretches from Haven Cliff in Devon to West Bay in Dorset, incorporating sites such as the Axmouth to Lyme Regis undercliffs, Black Ven, Golden Cap, and Eype. For each of the metasites, the presence of coastal soft cliff species has been collated from a variety of sources including the recent surveys by Buglife and CCW, historical surveys, maps provided on the National Biodiversity Network (NBN) website, published BRC atlases, data from national recording groups such as BWARS, JNCC invertebrate species reviews and records supplied by amateur entomologists.

The 'West Dorset' Soft Cliffs, stretching from Haven Cliff (Axmouth, Devon) to West Bay, support the highest number of coastal soft cliff species (50) and of coastal soft cliff obligates (18 species: see Tables 9 and 10). The Isle of Wight Western Soft Cliffs (Blackgang Chine to Compton Chine), Isle of Wight Eastern Soft Cliffs (St. Catherine's Point to Culver Cliff) and South Devon Soft Cliffs support impressive overall totals but less than half the number of Grade 1 species. Although Welsh sites and those in south and eastern England support smaller numbers of soft cliff species, they do hold significant populations of individual species or assemblages at the edge of their ranges. For example, the UK distribution of the Large mason bee *Osmia xanthomelana* is confined to the South Llyn Soft Cliffs, the ground beetle *Nebria* *livida* is more or less restricted to coastal soft cliffs in East Norfolk and Yorkshire, *Sitona gemellatus* (a weevil) on the North Llyn Soft Cliffs and *Tachys micros* (a ground beetle) on the South Llyn Soft Cliffs are otherwise only found on the West Dorset soft cliffs. As such, they should not be undervalued. No Grade 1 species have been recorded from the South-West Gower Coast to date, a consequence primarily of the complete absence of hydrological features, and this has a significant effect on its ranking. However, this coastline supports an exceptional bee and wasp fauna (Pavett, 2005) and the presence of 150 species, including 14 coastal soft cliff species, ranks this as the most important aculeate site in Wales. This total includes many regional rarities such as the mining bee *Andrena hattorfiana* which is highly dependent on soft cliffs at this site, if not nationally, as it nests in the eroding cliff faces.

The stretches of coastal soft cliff considered here for ranking represent the major part of the resource in the UK and the most significant soft cliffs for invertebrates. Low-ranking sites should not be considered as poor examples but as within the finest of our coastal soft cliff resource.

A second consideration is that many of the sites included in this exercise are still chronically under-surveyed. For example, in 2006 we carried out the first formal invertebrate survey of a Suffolk soft cliff site (Wright & Whitehouse, 2006). This short survey of just one site doubled the number of soft cliff species known previously from the entire county. Further survey work on this county's soft cliff sites will undoubtedly reveal more species.

Table 9. The number of coastal soft cliff species recorded from important stretches of soft cliff in the UK.
Text in bold indicates areas that have been subject to recent intensive surveys.

Site	Grade 1	Grade 2	Grade 3	Total
West Dorset Soft Cliffs	**18**	**9**	**23**	**50**
Isle of Wight Western Soft Cliffs	**7**	**6**	**23**	**36**
Isle of Wight Eastern Soft Cliffs	6	12	25	43
South Devon Soft Cliffs	6	11	22	39
East Dorset Soft Cliffs	**4**	**8**	**22**	**34**
South Llyn Soft Cliffs	**3**	**3**	**17**	**23**
West Hampshire Soft Cliffs *	3	1	2	6
North Llyn Soft Cliffs	**2**	**4**	**11**	**17**
North Norfolk Soft Cliffs	**2**	**2**	**4**	**8**
Yorkshire Soft Cliffs	**1**	**5**	**7**	**13**
South Ceredigion Soft Cliffs	**1**	**2**	**13**	**16**
South-West Gower Coast	**-**	**2**	**18**	**20**
Castlemartin Peninsula Soft Cliffs	**-**	**2**	**11**	**13**
North Kent Soft Cliffs	-	3	4	7
Essex Soft Cliffs (The Naze, Walton)	**-**	**2**	**6**	**8**
Suffolk Soft Cliffs	-	-	8	8
E Isle of Man Soft Cliffs		1	1	2

***** NB the majority of records for the W Hampshire soft cliffs are historical and the cliffs have subsequently been subjected to considerable cliff protection and stabilisation works. It is likely that these species are no longer present.

Table 10. Coastal soft cliff species recorded from important stretches of soft cliff in the UK.

Site	Coastal Soft Cliff Species
West Dorset 50 soft cliff species	**Grade 1** *Baris analis, Campsicnemis umbripennis, Chlaenius nitidulus, Chortodes morrisii morrisii, Cylindera germanica, Drypta dentata, Dicranomyia lachschewitzi*, *Helius hispanicus, Lasioglossum angusticeps, Lasioglossum laticeps, Platycephala umbraculata, Saldula arenicola, Scopaeus laevigatus, Scopaeus minutus, Scrobipalpula tussilaginis, Sphaerius acaroides, Sitona gemellatus, Tachys micros.* **Grade 2** *Andrena rosae, Andrena simillima, Andrena spectabilis, Bembidion saxatile, Dicranomyia goritiensis, Eucera longicornis, Leucochlaena oditis, Mononychus punctumalbum, Odynerus melanocephalus.* **Grade 3** *Andrena fulvago, Andrena humilis, Andrena nitidiusculus, Andrena proxima, Andrena trimmerana, Arctoconopa melampodia, Bembidion stephensii, Bombylius discolor, Clinocera nigra, Enoplops scapha, Eubria palustris, Gonomyia conoviensis, Herina oscillans, Heterocerus fusculus, Lasioglossum malachurum, Lasioglossum puncticolle, Lasioglossum xanthopus, Methocha articulata, Nomada flavopicta, Nomada fucata, Orchisia costata, Platycleis albopunctata, Sitona waterhousei.*
Isle of Wight West 36 soft cliff species	**Grade 1** *Cylindera germanica, Dicranomyia lackschewitzi, Drypta dentata, Lasioglossum angusticeps, Melitaea cinxia, Mimumesa atratina, Saldula arenicola.* **Grade 2** *Andrena spectabilis, Bembidion saxatile, Dicranomyia goritiensis, Leucochlaena oditis, Mononychus punctumalbum, Odynerus melanocephalus.* **Grade 3** *Andrena dorsata, Andrena nitidiuscula, Andrena proxima, Argogorytes fargeii, Bembidion stephensii, Bombylius discolor, Ceutorhynchus terminatus, Enoplops scapha, Gonomyia conoviensis, Heterocerus fusculus, Lasioglossum malachurum, Lasioglossum puncticolle, Lesteva hanseni, Limnephilus hirsutus, Methocha articulata, Mimumesa unicolor, Nomada fucata, Nomada fulvicornis, Platycleis albopuncata, Sitona waterhousei, Sphecodes niger, Sphecodes reticulatus, Sphecodes rubicundus.*
Isle of Wight East 43 soft cliff species	**Grade 1** *Baris analis, Grapholita gemmiferana, Lasioglossum angusticeps, Mimumesa atratina, Osmia xanthomelana, Saldula arenicola.* **Grade 2** *Andrena spectabilis*, *Anthophora retusa*, *Bembidion saxatile, Cathormiocerus socius*, *Dicranomyia goritiensis, Episinus maculipes, Eucera longicornis, Leucochlaena oditis, Leucoptera lathyrifoliella, Mononychus punctumalbum, Nysson interruptus, Odynerus melanocephalus*. **Grade 3** *Andrena fulvago, Andrena nitidiusculus, Andrena proxima, Andrena trimmerana, Anostirus castaneus, Argogorytes fargeii, Bembidion stephensii, Bombylius discolor, Ceutorhynchus terminatus, Chrysotoxum elegans, Enoplops scapha, Heterocerus fusculus, Lasioglossum malachurum, Lasioglossum puncticolle, Lasioglossum xanthopus, Methocha articulata, Mimumesa unicolor, Mononychus punctumalbum, Nomada conjugens, Nomada fucata, Platycleis albopunctata, Priocnemis gracilis, Sitona waterhousei, Sphecodes niger, Sphecodes reticulatus, Sphecodes rubicundus.*

(Table 10 cont.)	
South Devon 39 soft cliff species	**Grade 1** *Chortodes morrisii morrisii, Grapholita gemmiferana, Lasioglossum angusticeps, Nomada sexfasciata, Scopaeus laevigatus, Sitona gemellatus.* **Grade 2** *Andrena rosae, Andrena simillima, Andrena spectabilis, Bembidion saxatile, Dicranomyia goritiensis, Episinus maculipes, Eucera longicornis, Euodynerus quadrifasciatus, Leucochlaena oditis, Leucoptera lathyrifoliella, Selania leplastriana.* **Grade 3** *Andrena dorsata, Andrena fulvago, Andrena labiata, Andrena nitidiusculus, Andrena niveata, Andrena proxima, Andrena trimmerana, Bembidion stephensii, Bombylius discolor, Callilepis nocturna, Chrysotoxum elegans, Dichrorampha senectana, Eubria palustris, Nomada fucata, Ochthebius poweri, Platycleis albopunctata, Sitona waterhousei, Sphecodes reticulatus, Sphecodes rubicundus, Sphecodes spinulosus, Thereva strigata, Trapezonotus ullrichi.*
East Dorset 33 soft cliff species	**Grade 1** *Lasioglossum angusticeps, Lasioglossum laticeps, Scrobipalpula tussilaginis, Cylindera germanica.* **Grade 2** *Andrena rosae, Andrena spectabilis, Anthophora retusa, Bembidion saxatile, Eucera longicornis, Leucochlaena oditis, Mononychus punctumalbum, Odynerus melanocephalus.* **Grade 3** *Andrena dorsata, Andrena nitidiusculus, Andrena proxima, Andrena similis, Andrena trimmerana, Bembidion stephensii, Bombylius discolor, Chrysotoxum elegans, Enoplops scapha, Gonomyia conoviensis, Lasioglossum malachurum, Lasioglossum puncticolle, Lasioglossum xanthopus, Limnephilus hirsutus, Methocha articulata, Nomada flavopicta, Nomada fucata, Orchisia costata, Platycleis albopunctata, Priocnemis gracilis, Sitona waterhousei, Sphecodes rubicundus.*
South Llyn 23 soft cliff species	**Grade 1** *Osmia xanthomelana, Symplecta chosenensis, Tachys micros.* **Grade 2** *Bembidion saxatile, Dicranomyia goritiensis, Odynerus melanocephalus.* **Grade 3** *Andrena dorsata, Andrena humilis, Andrena labiata, Andrena similis, Andrena proxima, Astenus lyonessius, Bembidion stephensii, Ceutorhynchus terminatus, Clinocera nigra, Enoplops scapha, Eubria palustris, Gonomyia conoviensis, Methocha articulata, Nomada integra, Platycleis albopunctata, Policheta unicolor, Sitona waterhousei.*
West Hampshire * 6 soft cliff species	**Grade 1** *Drypta dentata, Saldula arenicola, Lasioglossum angusticeps.* **Grade 2** *Odynerus melanocephalus.* **Grade 3** *Gonomyia conoviensis, Platycleis albopunctata.*
North Llyn 17 soft cliff species	**Grade 1** *Sitona gemellatus, Symplecta chosenensis.* **Grade 2** *Bembidion saxatile, Dicranomyia goritiensis, Idiocera bradleyi, Odynerus melanocephalus.* **Grade 3** *Andrena dorsata, Andrena humilis, Andrena labiata, Andrena similis, Eubria palustris, Gonomyia conoviensis, Limnephilus hirsutus, Methocha articulata, Nomada flavopicta, Nomada integra, Policheta unicolor.*

(Table 10 cont.)	
North Norfolk 8 soft cliff species	**Grade 1** *Bledius filipes, Symplecta chosenensis.* **Grade 2** *Eluma purpurascens, Nebria livida.* **Grade 3** *Andrena humilis, Argogorytes fargei, Bembidion stephensii, Gonomyia conoviensis*
Yorkshire 13 soft cliff species	**Grade 1** *Symplecta chosenensis.* **Grade 2** *Bembidion saxatile, Bledius dissimilis, Dicranomyia goritiensis, Idiocera bradleyi, Nebria livida* **Grade 3** *Barypeithes sulcifrons, Bembidion stephensi, , Clinocera nigra, Enoplops scapha, Eubria palustris, Gonomyia conoviensis, Limnephilus hirsutus,*
South Ceredigion 16 soft cliff species	**Grade 1** *Symplecta chosenensis.* **Grade 2** *Dicranomyia goritiensis, Idiocera bradleyi.* **Grade 3** *Andrena dorsata, Andrena humilis, Andrena labiata, Andrena similis, Astenus lyonessius, Bembidion stephensii, Clinocera nigra, Dichrorampha senectana, Eubria palustris, Lesteva hanseni, Methocha articulata, Priocnemis gracilis, Sitona waterhousei.*
South-west Gower 20 soft cliff species	**Grade 2** *Andrena rosae, Eucera longicornis.* **Grade 3** *Andrena dorsata, Andrena humilis, Andrena labiata, Andrena niveata, Andrena similis, Andrena trimmerana, Bombylius discolor, Cathormiocerus maritimus, Chrysotoxum elegans, Dichrorampha senectana, Hylaeus pictipes, Lasioglossum puncticolle, Methocha articulata, Nomada flavopicta, Nomada fucata, Platycleis albopunctata, Priocnemis gracilis, Sitona waterhousei.*
Castlemartin Peninsula 13 soft cliff species	**Grade 2** *Dicranomyia goritiensis, Eucera longicornis.* **Grade 3** *Andrena humilis, Andrena labiata, Andrena similis, Andrena trimmerana, Clinocera nigra, Enoplops scapha, Gonomyia conoviensis, Limnephilus hirsutus, Nomada flavopicta, Platycleis albopunctata, Sitona waterhousei.*
Kent 7 soft cliff species	**Grade 2** *Andrena simillima, Andrena spectabilis, Eucera longicornis* **Grade 3** *Bombylius discolor, Lasioglossum puncticolle, Nomada fucata, Sphecodes rubicundus.*
Essex (Walton on the Naze) 8 soft cliff species	**Grade 2** *Andrena spectabilis, Andrena trimmerana.* **Grade 3** *Bembidion stephensi, Lasioglossum malachurum, Nomada fucata, Nomada fulvicornis, Sphecodes niger, Sphecodes rubicundus*
Suffolk 8 soft cliff species	**Grade 3** *Andrena humilis, Andrena proxima, Lasioglossum xanthopum, Lasioglossum malachurum, Lasioglossum puncticolle, Nomada fucata, Sphecodes reticulatus, Sphecodes rubicundus.*
E Isle of Man	**Grade 2** *Bembidion saxatile* **Grade 3** *Bembidion stephensi*

4. UK soft cliff sites - regional guides

4.1 Cornwall

The coastal soft cliff resource in Cornwall is limited to short sections of periglacial head material perched on top of more solid geologies including hard rock platforms. Much of this is above the high tide level and so relatively unaffected by erosion from the sea (such sites therefore do not qualify as soft cliff under our definition). The small size, fragmentation and isolation of sections means that it is hard to quantify the resource in the county. It is also a difficult task to track down data on the invertebrate fauna directly associated with the habitat in these circumstances. Pye and French (1993) note two Cornish sites - cliffs at **Porthmeor Beach** (St Ives) and **Widemouth Bay**, the second site being the more substantial. We have identified two further sites at **Whitesand Bay** near Sennan, and a section of periglacial cliffs to the east of **Marazion**. We do not have any invertebrate data for these four sites, although the first two are both north-facing sites and are unlikely to support hymenoptera populations comparable with those on the south coast. Exposed sections of head material around the Cornish coast are likely to support locally important populations of solitary bees and wasps (aculeate Hymenoptera) through providing a historical continuity of suitable nesting sites. However, data from Welsh surveys of similar sites suggests that these small isolated cliffs of glacial till are unlikely to score highly for graded soft cliff species, even if seepages are present (Knight & Howe, 2006).

Figure 6. Exposed head material at Talland Bay, southeast Cornwall. Similar small, isolated pockets of soft cliff are present around the Cornwall and Devon coast, they provide locally important nesting sites for solitary bees and wasps.

4.2 Devon

The vast majority of Devon's 20km of unprotected soft cliff (Pye & French, 1993) is on the south coast. Arguably, these south-facing slopes feature some of the most important coastal soft cliff sites in the UK.

As with Cornwall, there are pockets of head material perched on or amongst harder geologies all around the Devon coast. These are often very small and hard to identify without site visits, however they are likely to support good populations of solitary bees and wasps, especially those which are south-facing. Between **Prawle Point** and **Start Point** there is an almost continuous 5km stretch of head deposits perched on a raised rock platform. For the most part this is above or at the limit of high water and so somewhat protected from wave action. Unlike similar sections of head deposits which are generally dry, the Prawle stretch features a number of freshwater seepages. Species associated with these seepage features include the cranefly *Dicranomyia goritiensis* (RDB3, Grade 2) (Stubbs, 1994). The dry cliff head deposits are recognised as being of national importance for solitary bees and wasps with over 100 species having been recorded (Prawle Point & Start Point SSSI citation) including many Red Data Book or Nationally Scarce species. The nine Graded soft cliff species recorded at this site include the Long-horned mining bee *Eucera longicornis* (Na, Grade 2) and its cuckoo parasite *Nomada sexfasciata* (RDB1, Grade 1) (Prawle is the only UK site for the latter species in recent years), the Dotted Bee-fly *Bombylius discolor* (Nb, Grade 3) and the Mason wasp *Euodynerus quadrifasciatus* (RDB2, Grade 2). *E. quadrifasciatus* is currently only known from three sites in the UK: East Prawle, Devon; West Weare, Portland (Dorset); Thursley Common, Surrey (Else & Roberts, 2006). Prawle Point is one of the most important sites for solitary bees and wasps (aculeate Hymenoptera) in the UK (Stubbs, 1994) however this site is under-surveyed and likely to yield many more species.

Figure 7. Cliffs to the east of Prawle Point.

The other significant stretch of a similar geology in south Devon is at **Wembury**. The Wembury site is less extensive and does not support the same diversity and numbers of invertebrates. However, dry exposed cliffs at the site support populations of Nationally Scarce solitary bees including *Andrena spectabilis* (Nb, Grade 2), *A.*

trimmerana (Nb, Grade 3) and the cuckoo bee *Nomada fucata* (Na, Grade 3) (Allen *et al*, 2006). Visitor pressure is high at Wembury, but as yet this would appear to have had little impact on the quality of the cliff habitat.

The cliff top land use at the Prawle Point to Start Point and Wembury sites varies from herb-rich cliff top grassland to more intensively managed improved grazing land and arable. Herb-rich areas of cliff top are utilised by invertebrates as nectar and pollen sources and improve connectivity between isolated patches of habitat. Cliff top nectar and pollen sources are of particular importance at Prawle Point as the low, vertical cliff faces only offer limited resources. At this site the large, nationally important nesting aggregations of bees and wasps are almost entirely dependent on the nectar resources of the cliff top. The re-establishment of herb-rich cliff top grassland at Prawle – Start Point should be a management priority for the site.

Sections under arable crop or improved grassland are of limited interest for invertebrates. Cliff top buffer strips of herb rich grassland would enhance the site as would the re-establishment of more natural cliff top grassland. These management recommendations could be easily accommodated within the cliff top management schemes aimed at providing habitat and forage sites for Cirl buntings. Similar recommendations for both sites have been identified by other publications (Lister *et al*, 1992; Burton & Pater, 2005; Allen *et al*, 2006). Large sections of the cliff top on both sites suffer from overgrazing. Where this is the case grazing management should be de-intensified to encourage a more diverse sward in terms of vegetation composition and structure.

Figure 8. Wembury Point,

Moving east we enter the Dorset and East Devon or 'Jurassic Coast' World Heritage Site (WHS), which stretches from Exmouth (Devon) to Studland (Dorset) and includes some of the best soft cliff sites in the UK. At first the cliff geology is dominated by near vertical Triassic sandstones, although to the west of Branscombe there are short sections of accumulated eroded material providing many of the habitat features associated with soft cliffs. The cliffs between Branscombe and Sidmouth also feature some extensive seepages that merit further investigation.

Branscombe itself features significant soft rock cliffs of clay interspersed with hard chalk cliff outcrops. The invertebrate interest at Branscombe is not restricted to the soft cliff habitat: the shingle provides habitat for the Scaly cricket *Pseudomogoplistes vicentae* (RDB3) (Sutton, 1999), and coastal landslip woodlands support a regionally important population of the Wood White butterfly *Leptidea sinapis* (pUKBAP) (Sutton, 2001 & 2004). Seepages and flushes in the undercliff support associated soft cliff specialists including the ground beetle *Drypta dentata* (RDB1, Grade 1), and the shorebug *Saldula arenicola* (Na, Grade 1) (Alexander, 2003). Strands of Common reed *Phragmities communis* associated with the wet areas provide habitat for a number of soft cliff species such as the cranefly *Platycephala umbraculata* (RDB2, Grade 1) and the reed-nesting solitary wasps *Mimumesa atratina* (RDB2 Grade 1) and *M. unicolor* (Na, Grade 3). Hymenopteran (bee and wasp) soft cliff species are also represented by *Andrena rosae* (RDB2, Grade 2), *A. simillima* (RDB2, Grade 2), *A. spectabilis* (Nb, Grade 2), *Euodynerus quadrifasciatus* (RDB2, Grade 2), *Nomada fucata* (Na, Grade 3) and *Sphecodes rubicundus* (Na, Grade 3). Other highlights at Branscombe include the Grey bush-cricket *Platycleis albopunctata* (Nb, Grade 3), the spider *Episinus maculipes* (RDB3, Grade 2), the most westerly records for the Cliff tiger beetle *Cylindera germanica* (RDB3, UKBAP, Grade 1)(Boyce, 2004), and a fairly recent (1982) unconfirmed report of the Giant earwig *Labidura riparia* (Sutton, 2004) which is regarded as extinct in the UK. In addition, disturbed ground resulting from land slippage also creates suitable conditions for Nottingham Catchfly *Silene nutans* which is the food plant of the White spot moth *Hadena albimaculata* (RDB3, UKBAP). This moth is now thought to be restricted to only a few sites on the south coast of England (Parsons, 2002).

Sections of the cliff at Branscombe have been damaged by the encroachment of holiday accommodation in the form of a number of chalets. These are well established and are likely to have been here for a long time; however any applications to increase their number should be opposed. Many of the chalets have associated garden areas which, in some cases, seem to be expanding beyond their original boundaries, they also feature exotic plant species which have the potential to spread onto the surrounding cliff. There are areas of the undercliff where the vegetation is becoming dominated by Buddleia (*Buddleja davidii*), which is likely to have originated from these gardens. In order to address this, chalet owners need to be provided with guidance on the management of their properties and the significance of the SSSI land that surrounds them. Areas of Buddleia should be cleared as a priority, particularly where it has formed dense thickets.

The calcareous cliff top grassland at Branscombe is within the SSSI boundary and is an interest feature in its own right. The majority of the cliff top land is grazed by sheep or cattle. Parts of the cliff top are overgrazed and currently offer little in terms of structure or function for invertebrates, a less intensive grazing regime will benefit cliff top grasslands and enhance both hard and soft cliffs below.

Seaton features sections of softer sandstone material, although these are limited. These sections provide useful habitat for aculeates, and short visits to the site have recorded a number of common species of solitary bees with associated cleptoparasites, however overall the existing data is very limited for the site. The notable soldierfly *Oxycera pygmaea* (Nb) has also been recorded here, associated with freshwater seepages of which there are few. Unfortunately much of the cliff at Seaton has been modified by artificial drainage, coast protection and a promenade.

Axmouth-Lyme Regis NNR is one of the largest active coastal landslide systems in Europe. The site spans approximately 8.4 km of coast and covers an area of 308 ha. An excellent overview has recently been published (ref: Campbell, 2006) which describes the geology, geomorphology, ecology and history of the site. A recent invertebrate survey (Gibbs, 2003) ranked the site alongside better studied sites in Dorset, and considered that the Axmouth-Lyme Regis soft cliffs are one of the most important invertebrate sites in the country. This is a wonderfully natural site and provides a rare experience of wilderness in the south of England. Geomorphological processes maintain patches of open habitat whilst more stable sections have gradually been colonised by woodland.

Axmouth-Lyme Regis undercliffs are more extensively wooded than equivalent sites in Dorset, with open grassland and slippage areas much more limited in extent. As a result the fauna would be expected to be different and perhaps rather impoverished. Superficially from the results of the Gibbs (2003) survey this would not seem to be the case – 22% of species identified during this survey had Nationally Scarce or RDB status (total species recorded = 292). Soft cliff specialists such as Cliff tiger beetle *Cylindera germanica* (RDB3, UKBAP, Grade 1), the shorebug *Saldula arenicola* (Na, Grade 1), the mining bees *Andrena simillima* (RDB2, Grade 2)*, A. spectabilis* (Na, Grade 2)*, Lasioglossum laticeps* (RDB2, Grade 1) *and L. angusticeps* (RDB3, UKBAP, Grade 1), nomad bee *Nomada fucata* (Na, Grade 3), cranefly *Dicranomyia goritiensis* (RDB3, Grade 2), micro moth *Scrobipalpula tussilaginis* (RDB1, Grade 1), and chloropid fly *Platycephala umbraculata* (RDB2, Grade 1) have all been recorded here (Edwards, 1995; Gibbs, 2003). Within the site more active sections at Haven Cliff, Culverhole, Charlton Bay, Pinhay Warren, and Ware Cliffs are considered to be of highest value to soft cliff species. Pinhay Warren and Ware Cliffs are of particular note (Hunnisett and Edwards, 2006; Gibbs, 2003). Haven Cliff at the eastern end of the site has extensive open landslips with seepages and spring fed streams, the latter supporting the only UK population of the cranefly *Helius hispanicus* (RDBK, Grade 1) (Howe et al, 2001; Stubbs, 1992).

The site is riddled with freshwater seepages and streams, providing an essential resource for associated species. The importance of temporary wet areas, springs and streams has been highlighted by Armitage (1983), in particular to flies (Diptera) with 115 species recorded in the study.

Figure 9. Seepgae-fed reedbed at Axmouth-Lyme Regis undercliffs.

In terms of management, there are issues with invasive alien plant species on this site, the main culprits being Holm oak (*Quercus ilex*), Buddleia and to a lesser extent Pampas grass (*Cortaderia selloana*). Natural England owns and manages the site and the management plan includes a programme of control of these invasive non-native species (Knott, 2003). For much of the cliff top management is not ideal – the general theme is improved grassland for grazing. Goat Island is managed for its calcareous grassland and is an indication of what could be achieved with lower input regimes on the cliff top. However, given the enormous scale of this site the sections of soft cliff are quite a distance from the actual cliff top and in most cases back onto landslip woodland. It is unclear whether efforts to change cliff top management would have a significant impact on the site.

The landslip woodlands are of great importance for invertebrates in their own right. These warm, damp coastal woodlands are probably the closest thing we have in the UK to a temperate rainforest.

There is historical evidence that parts of the site have been grazed (fig. 10) and cultivated in the past (Campbell, 2006). It may be appropriate on some parts of the site to re-introduce livestock grazing to manage succession, particularly on more stable sections.

Figure 10. A disused sheep dip on wooded cliff slopes at Axmouth-Lyme Regis.

4.3 Dorset

The soft cliffs of Dorset are the most important in the country on account of their specialist soft cliff invertebrate faunas. In our ranking exercise (section 3) the 'West Dorset' soft cliffs, stretching from Haven Cliff (Axmouth, Devon) to West Bay, support the highest number of coastal soft cliff invertebrate species (50) and of Grade 1 species (18). The 'East Dorset' soft cliffs (34 soft cliff species, 4 of which are Grade 1) were ranked in the top five, using our method for comparison. Taken as a whole, the soft cliffs of Dorset are known to support 264 Nationally Scarce and Red Data Book invertebrates, this breaks down into 210 Nationally Scarce and 54 RDB species (updated from: Hunnisett & Edwards, 2006).

The Dorset soft cliffs are also considered to be a national stronghold for a number of Grade 1 soft cliff species including the Cliff tiger beetle *Cylindera germanica* (RDB3), the ground beetle *Drypta dentata* (RDB1), the weevil *Sitona gemellatus* (RDB1), and the mining bees *Lasioglossum laticeps* (RDB1) and *L. angusticeps* (RDB3, UKBAP). They are also a significant region for some of the lower-graded species, such as the Iris weevil *Mononychus punctumalbum* (Nb) and the Long-horned mining bee *Eucera longicornis* (Na).

A number of Dorset soft cliffs sites (e.g. Eype Mouth) are well studied. A recent Buglife survey report (Hunnisett & Edwards, 2006) provides a useful overview of the ecology of Dorset's soft cliffs, plus detailed studies of a number of Dorset soft cliff sites. Site survey reports by the National Trust (Gibbs, 2000; Allen *et al*, 2004) are very useful references, as are recent reports focusing on specific taxonomic groups or species (Howe *et al*, 1998; Morris, 2004; Hunnisett, 2006; Hunnisett *et al*, 2006).

The majority of Dorset soft cliffs are free-functioning (i.e. unprotected) and support the full range of notable soft cliff habitats: bare ground, pioneer vegetation, herb-rich coastal grassland, scrub, groundwater seepages. These sites are also extensive with considerable undercliffs; the estimated linear length of unprotected soft cliff in Dorset of 34.7km somewhat under-rates the habitat resource which has an estimated area of 565ha (Hunnisett & Edwards, 2006).

All of the soft cliff resource from Lyme Regis east to Studland receives various levels of protection being within the Dorset Area of Outstanding Natural Beauty (AONB), and three SSSIs: Isle of Portland, South Dorset Coast and West Dorset Coast. All these areas lie within the Sidmouth to West Bay and Isle of Portland to Studland Cliffs Special Areas of Conservation (SAC). In 2001 the coast from Exmouth in Devon to Studland in Purbeck was designated as a UNESCO World Heritage Site for its internationally important geology.

It is a somewhat different story in the east of the county. The Tertiary cliffs from Sandbanks east to Southbourne are almost entirely modified by coastal protection schemes.

The geology of the Dorset soft cliff sites is described in table 11. Tables 12, 13 and 14 list the Graded soft cliff species recorded at the sites.

Table 11. The unprotected soft cliff resource in Dorset (from Hunnisett & Edwards, 2006)

Site	Grid Reference	Area (ha)	Geology
Ware Cliff	SY33189140-33679173	10.92	Lower Lias
Spittles and Black Ven	SY34489231-36399303	67.04	Lower Lias, Greensand
Charmouth - Seatown	SY36739302-41969171	95.31	Middle and Lower Lias
Seatown - Eype	SY42039168-44779102	28.56	Middle and Lower Lias
Eype - West Bay	SY44809100-45849050	6.77	Middle Lias, Middle Jurassic
West Weare	SY67857046-68417326	35.79	Kimmeridge Clay, Portland Stone screes
Cheyne, Penn's & East Weare	SY69767107-68857434	122.39	Kimmeridge Clay, Portland Stone screes
Furzey Cliff - Ringstead	SY69778170-75068133	48.15	Corallian; Kimmeridge Clay
Ringstead Bay - Burning Cliff - White Nothe	SY75378132-77088073	43.16	Kimmeridge Clay; Greensand; Chalk
Durdle Door	SY80568028	1.22	Wealden
Dungy Head	SY81518005	0.94	Wealden
Lulworth Cove	SY82407983-82847990	1.80	Wealden, Chalk
Mupe Bay	SY84257974-84348000	2.50	Wealden
Worbarrow Bay	SY86368029-87067980	7.47	Wealden
Gad Cliff	SY87567946-89177940	21.00	Kimmeridge Clay
Houn's Tout - Chapman's Pool	SY94387728-96357532	62.69	Kimmeridge Clay
Punfield - Ballard Cliff	SZ03378040-04278114	8.95	Wealden; Greensand; Chalk
		564.66	

Table 12. Distribution of Grade 1 soft cliff species on Dorset sites.

		Status	Site
Coleoptera (beetles)			
Baris analis	a weevil	RDB2	East Ebb Cove, Eype
Cylindera germanica	Cliff tiger beetle	RDB3, UKBAP	Black Ven/The Spittles, St Gabriel's, Golden Cap, Seatown, East Ebb, Eype.
Drypta dentata	a ground beetle	RDB1	Golden Cap, Eype
Scopaeus laevigatus	a rove beetle	RDB1	Eype
Scopaeus minutus	a rove beetle	pRDB1	Eype
Sitona gemellatus	a weevil	RDB1	Eype
Sphaerius acaroides	a mud beetle	RDB1	Eype
Tachys micros	a ground beetle	Na, UKBAP	Black Ven/The Spittles, Ringstead, Chapman's Pool
Diptera (flies)			
Campsicnemus umbripennis	a marsh fly	no status - only UK record	Black Ven/The Spittles
Dicranomyia lackschewtzi	A cranefly	RDBK	Eype (east side)
Platycephala umbraculata	a Cholorpid fly	RDB2	Black Ven/The Spittles, Golden Cap, East Ebb Point, Eype Mouth
Hemiptera (true bugs)			
Saldula arenicola	Shore-bug	Na	Eype

(Table 12 cont.)			
Hymenoptera (bees, wasps, ants)			
Lasioglossum angusticeps	a mining bee	RDB3, UKBAP	Ware Cliffs, Black Ven/The Spittles, Golden Cap, Seatown, Eype, West Weare, Ringstead, White Nothe, Worbarrow, Chapman's Pool
Lasioglossum laticeps	a mining bee	RDB2	Black Ven/The Spittles, St. Gabriel's, Golden Cap, Worbarrow, Gad Cliff, Kimmeridge Bay
Lepidoptera (butterflies and moths)			
Idaea degeneraria	Portland Ribbon Wave moth	RDB3	Portland, Ringstead
Photedes morrisii morrisii	Morris's Wainscot moth	RDB1	Ware Cliff, Black Ven/The Spittles, Thorncombe Beacon
Scrobipalpula tussilaginis	a micro-moth	RDB1	St Gabriel's, Eype, Osmington

Table 13. Distribution of Grade 2 soft cliff species on Dorset sites.

		Status	Site
Coleoptera (beetles)			
Bembidion saxatile	a ground beetle	Nb	Black Venn/The Spittles, Eype, Ringstead, Worbarrow, Chapman's Pool
Mononychus punctumalbum	Iris weevil	Na	Black Ven/The Spittles, Eype, Ringstead, White Nothe, Chapman's Pool
Diptera (flies)			
Dicranomyia goritiensis	a cranefly	RDB3	Eype
Hymenoptera (bees, wasps, ants)			
Andrena rosae	a mining bee	RDB3	Black Ven/The Spittles, Ringstead Bay
Andrena spectabilis	a mining bee	Nb	Black Ven/The Spittles, Golden Cap, Thorncombe Beacon, Eype
Eucera longicornis	Long-horned mining bee	Na	Ware Cliffs, Black Ven/The Spittles, St Gabriel's, East Ebb, Eype, Ringstead, White Nothe, Chapman's Pool
Euodynerus quadrifasciatus	Four-banded mason wasp	RDB2	Portland
Nysson interruptus	a cuckoo wasp	RDB2	St Alban's Head
Odynerus melanocephalus	Black-headed mason wasp	Na, UKBAP	Black Ven/The Spittles, St Gabriel's, Seatown, Eype, West Weare, Gad Cliff, Houns-tout, Chapman's Pool
Lepidoptera (butterflies and moths)			
Leucochlaena oditis	a micro-moth	RDB3	St Alban's Head, Lulworth Cove, Portland
Selania leplastriana	a micro-moth	pRDB1	West Cliff, Portland, Purbeck coast

Table 14. Distribution of Grade 3 soft cliff species on Dorset sites.

		Status	Site
Coleoptera (beetles)			
Bembidion stephensii	a ground beetle	local	Eype, Ringstead
Eubria palustris	a water-penny beetle	RDB3	Eype
Sitona waterhousei	a weevil	Nb	St Gabriel's, Eype, Ringstead, White Nothe
Diptera (flies)			
Arctoconopa melampodia	a cranefly	RDB2	Black Ven/The Spittles
Bombylius discolor	Dotted bee-fly	Nb	Seatown
Chrysotoxum elegans	a hoverfly	RDB3	Worbarrow Bay, Chapman's Pool + other coastal sites
Gonomyia conoviensis	a cranefly	Nb	Worbarrow
Liparia rufitarsis	a cranefly	NS	Black Ven/The Spittles
Orchisia costata	a fly	RDB2	St Gabriel's, Golden Cap, Worbarrow
Hemiptera (true bugs)			
Enoplops scapha	a squash bug	local	Eype
Hymenoptera (bees, wasps, ants)			
Andrena fulvago	a mining bee	Na	Houns-tout
Andrena humilis	a mining bee	Na	Black Ven/The Spittles
Andrena labiata	Girdled mining bee	Na	Black Ven/The Spittles, Golden Cap, Seatown, Eype
Andrena nitidiusculus	a mining bee	RDB3	Black Ven/The Spittles, Ringstead
Andrena proxima	a mining bee	RDB3	Black Ven/The Spittles
Andrena trimmerana	Trimmer's mining bee	Nb	Black Ven/The Spittles, St Gabriel's, Eype, Worbarrow
Argogorytes fargei	a sphecid wasp	Na	St Alban's Head
Lasioglossum malachurus	a mining bee	Nb	St Gabriel's, Golden Cap, Eype, Ringstead, White Nothe, Worbarrow, Chapman's Pool
Lasioglossum puncticolle	a mining bee	Nb	Black Ven/The Spittles, St Gabriel's, Golden Cap, Ringstead, White Nothe, Worbarrow, Chapman's Pool
Lasioglossum xanthopum	Yellow-footed mining bee	Nb	White Nothe
Methocha articulata	a solitary wasp	Nb	Golden Cap, Eype
Nomada fucata	a nomad bee	Na	St Gabriel's, Golden Cap, Eype, Ringstead, White Nothe, Chapman's Pool
Nomada fulvicornis	a nomad bee	RDB3	Golden Cap, Seatown
Nomada guttulata	a nomad bee	RDB1	Golden Cap, Seatown
Priocnemis gracilis	a spider-hunting wasp	Nb	Black Ven/The Spittles
Sphecodes rubicundus	a cuckoo bee	Nb	St Gabriel's, Eype, Ringstead
Lepidoptera (butterflies and moths)			
Scotopteryx bipunctaria cretata	Chalk Carpet moth	Nb, UKBAP	Ware Cliff, Black Ven, Golden Cap, Thorncombe Beacon, Eype Mouth, Portland, Durdle Door, Stair Hole, Lulworth Cove, Gad Cliff, St Alban's Head
Orthoptera (grasshoppers and crickets)			
Platycleis albopunctata	Grey bush-cricket	Nb	Black Ven/The Spittles, St Gabriel's, Golden Cap, Eype, Ringstead, White Nothe, Chapman's Pool

Ware Cliffs, to the west of Lyme Regis, are within the **West Dorset Coast SSSI** (and SAC) which extends east to Chesil Beach. Ware Cliff is discussed in the Devon section of this report (4.2) under **Axmouth to Lyme Regis NNR**. In ecological terms both West Dorset Coast SSSI and Axmouth to Lyme Regis Undercliffs SSSI are part of the West Dorset Cliffs metasite which stretches from Axmouth to West Bay (see section 3).

The cliffs between Lyme Regis and Charmouth form the impressive landslip system of **The Spittles** and **Black Ven**. This is the largest active coastal landslip in Europe (Covey, 1997) and forms a complex landscape of multiple slips, mudflows, and steep and shallow cliffs. The Spittles/Black Ven site covers an extensive area, approximately 67 hectares,(Hunnisett & Edwards, 2006), and features large expanses of bare ground and pioneer habitats, plus reedbed and other wetland features fed by groundwater seepages. There is a considerable amount of scrub on the site, mainly developed since the last major phase of slipping, and on the most stable sections this is developing into woodland. This is an entomologically rich site: 10 RDB and 27 Nationally Scarce invertebrate species have been recorded here including seven Grade 1, six Grade 2, and ten Grade 3 soft cliff species (tables 12, 13 and 14). The Spittles is the only known UK site for the marsh fly *Campsicnemus umbripennis* which was recorded here in 1998 (Howe *et* al, 2001), it is also one of just a handful of UK sites for the cranefly *Arctoconopa melampodia*. Non-soft cliff associates include the dung beetle *Onthophagus fracticornis* (RDBK), the picture-winged flies *Myopites inulaedyssentericae* (RDB3) and *Trupanea amoena* (pRDB2), the Dolichopodid flies *Hydrophorus viridis* (RDB3) and *Melanostolus melancholicus* (pRDB3) and the cranefly *Erioptera flavissima* (RDB1). The Gilkicker weevil *Pachytichius haematocephalus* (RDB1) has been recorded at Charmouth, this is a very rare species in the UK, only known on the mainland from one other site in Hampshire. The species has not been recorded at Charmouth since the 1940s (Morris, 2004), however the food plant Bird's-foot trefoil (*Lotus corniculatus*) is abundant on the cliffs, and *P. haematocephalus* is an inconspicuous species so may still be present.

Figure 11. Black Ven.

The next section of the west Dorset cliffs from **Charmouth to Seatown** includes **Cain's Folly**, **St Gabriel's** and **Golden Cap**. Considerable sections of these cliffs are inaccessible, for example Cain's Folly, and as a result invertebrate data is restricted to those areas where access can be gained safely. St Gabriel's was one of five sites surveyed by Buglife and Dorset Environmental Records Centre (DERC) in 2005 (Hunnisett & Edwards, 2006). A steep cliff base is topped by multiple landslips which extend a considerable distance inland to the back scar. These slipped sections are currently relatively stable and feature extensive areas of closed grassland and scrub alongside more open grassland. Bare ground and pioneer vegetation is restricted. The site features extensive seepages and flushes. The cliff top here is largely unimproved acid grassland, this is grazed by cattle that have some access to the undercliff.

At 191m Golden Cap is the highest point along the Dorset coast. The upper terraces of the undercliffs are relatively stable and feature extensive scrub and some wooded areas. More open habitats with pioneer vegetation, bare ground and groundwater seepages complete the habitat mosaic. The cliff top features heath and acid grassland.

A total of 39 RDB and Nationally Scarce species have been recorded on the soft cliffs between Charmouth and Seatown (Hunnisett & Edwards, 2006) including five Grade 1, three Grade 2, and 14 Grade 3 soft cliff species (tables 12, 13, 14). St Gabriel's is known to support a number of rare and scarce flies including the Muscid fly *Orchisia costata* (RDB2, Grade 3), the Empid *Empis melaena* (RDB1), the Lauxanid *Homoneura interstincta* (RDB3) and the Six-spotted cranefly *Idiocera sexguttata* (RDB1, pUKBAP). The population of *I. sexguttata* may represent the only remaining English population of a species that was, until recently, thought to be extinct in the UK (Hunnisett & Edwards, 2006).

Golden Cap is a nationally important site for rare bees and wasps (Gibbs, 2000). Highlights include *Lasioglossum angusticeps* (RDB3, Grade 1), *L. laticeps* (RDB2, Grade 1), *Nomada fulvicornis* (RDB3, Grade 3) and *N. guttulata* (RDB1, Grade 3). Golden Cap is also known to support the Nationally Scarce Black-headed mason wasp *Odynerus melanocephalus* (Grade 2) (Hunnisett, 2006) and the RDB1 ground beetle *Drypta dentata* (Grade 1).

Figure 12. *Phragmites* dominated flush at St Gabriels. This is the habitat of the RDB1 ground beetle *Drypta dentata*.
© Bryan Edwards

Seatown-Eype is one of the richest and best studied soft cliff sites in the UK. The focal point of recording has been the undercliff to the west of **Eype Mouth** which has been on the 'entomological map' for some time. This stretch of soft cliff also includes **East Ebb** and **Thorncombe Beacon**. The undercliffs between Seatown and Eype are known to support 55 species of RDB and Nationally Scarce invertebrates (Hunnisett & Edwards, 2006), including major rarities such as Morris's Wainscot moth *Chortodes morrisii morrisii* (RDB1, Grade 1) and the cranefly *Dicranomyia goritiensis* (RDB3, Grade 2). Seatown-Eype undercliffs are also the richest site in the UK for specialist soft cliff invertebrates with a total of 29 species: twelve Grade 1, six Grade 2, and eleven Grade 3 (tables 12, 13, 14).

The Seatown-Eype undercliffs are also one of the most important sites for rare and threatened beetles in the UK. The site list includes the Cliff tiger beetle *Cylindera germanica* (RDB3, Grade 1), the ground beetle *Drypta dentata* (RDB1, Grade 1), the weevil *Hypera ononidis* (pRDBK) and the rove beetles *Scopaeus laevigatus* (RDB1, Grade 1), *S. minutus* (pRDB1, Grade 1). These cliffs also support populations of the Grade 1 soft cliff weevils *Baris analis* (RDB2) and *Sitona gemellatus* (RDB1), and are thought to be the most important UK site for both species (Morris, 2004).

Other species of note recorded along this stretch include the cranefly *Gonomyia abbreviata* (RDB3), the nomad bee *Nomada lathburiana* (RDB3), an ant-mimic Mirid bug *Myrmecoris gracilis* (RDB3), and a number of Red Data Book moths: *Chrysoclista lathamella, Coleophora fuscicornis, Cosmiotes stabilella* and *Epiblema cnicicolana*.

The clay and sand cliffs between Seatown and Eype are very dramatic, rising to over 150m high at Thorncombe Beacon. The active landslips provide large areas of bare ground and pioneer vegetation. In addition there are freshwater features created by groundwater seepages. Large sections of these cliffs are inaccessible and survey work continues to unearth new populations of rare and scarce species at this entomologically rich site.

Figure 13. Cliffs to the west of Eypes Mouth.

Few invertebrate records exist for most of the next stretch, **Eype to West Bay**, this is in part due to safety aspects and the inaccessibility of the sites. However, many of the rare and scarce species recorded to the west of **Eype** are also found on the undercliffs to the east since the geology is similar for several hundred metres until a major fault introduces very different rocks of middle Jurassic age. In fact, many records are just noted as being from 'Eype' so it is often impossible to separate those from either side of Eype's Mouth. Both sides feature similar habitats (fig.s 13 and 14), although the undercliffs to the east feature more flowing groundwater seepages and streamlets. The soft cliff seepage cranefly *Dicranomyia lackschewtzi* (RDBK, Grade 1) was recorded to the east of Eype in 2007 during a Buglife survey by Alan Stubbs, this is the first UK mainland record for the species, which was previously thought to be restricted to soft cliffs on the Isle of Wight. Buglife surveys (Hunnisett & Edwards, 2006) have improved the dataset for the east Eype undercliffs significantly, recording 307 invertebrate species in 2005.

The habitats of this stretch of coast are similar to those between Seaton and Eype, although towards West Bay the cliffs steepen and vegetation is sparse offering little useful habitat for invertebrates. To the immediate west of West Bay the cliffs are protected from toe erosion by a sea wall, and the slopes have also been reprofiled to reduce the risk of landslips to cliff top properties. The cliff top to the east of Eype's mouth supports a wide band of maritime grassland with large tussocks of Thrift (*Armeria maritima*). This continues east although is squeezed to a thinner strip adjacent to West Bay's housing developments and a cliff top caravan site.

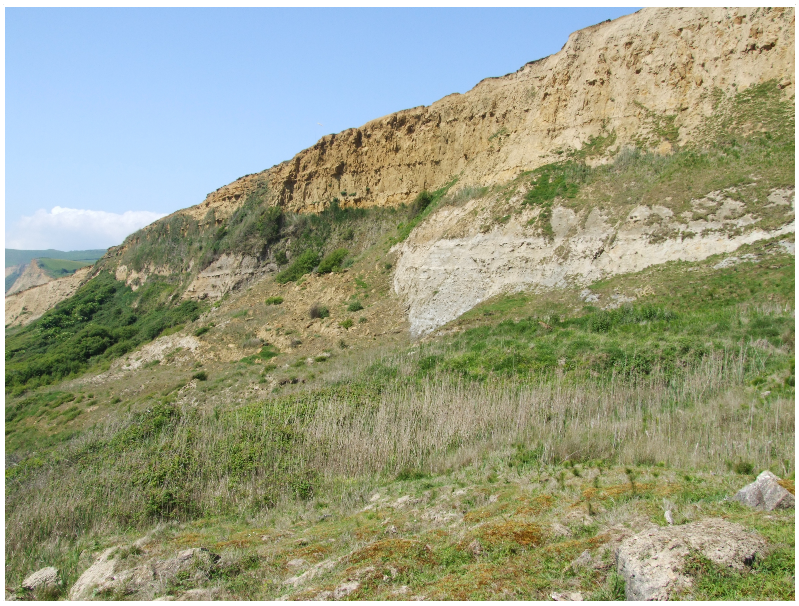


Figure 14. Cliffs to the east of Eypes Mouth.

Heading eastwards, the next significant areas of soft cliff are on the **Isle of Portland**: these are **West Weare**, **Penn's Weare** and **East Weare**. These sites are part of the Isle of Portland SSSI. The three sites feature similar geologies, a complex of both hard and soft rocks. Soft Kimmeridge Clay underlies harder rock of Portland Limestone and causes landslides and rock falls. In addition to the natural screes and fallen material, there is a significant amount of material accumulated through the historic tipping of limestone quarry waste. On the undercliffs the Clay layer is exposed and provides soft cliff habitat, mixed with large fallen blocks of the Portland stone. The undercliffs also feature rich limestone grassland and areas of scrub.

Portland's Weares are known to support populations of six graded soft cliff species including the mining bee *Lasioglossum angusticeps* (RDB3, Grade 1), Black-headed mason wasp *Odynerus melanocephalus* (Na, Grade 2), the micro-moth

Leucochlaena oditis (RDB3, Grade 2), and the Chalk Carpet moth *Scotopteryx bipunctaria cretata* (Na, Grade 3). These sites are of national importance for the Portland Ribbon Wave moth *Idaea degeneraria* (RDB3, Grade 1), Richardson's Case Bearer a micro-moth) *Eudarcia richardsoni* (pRDB3), and the Four-banded mason wasp *Euodynerus quadrifasciatus* (RDB2, Grade 2). *E. quadrifasciatus* is currently only known from three sites in the UK: West Weare, Portland; East Prawle, Devon; Thursley Common, Surrey (Else & Roberts, 2006).

Historically the soft cliffs of east Dorset have been less intensively recorded for invertebrates. Buglife surveys of Burning Cliff-White Nothe, Worbarrow Bay and Chapman's Pool (Hunnisett & Edwards, 2006) have aimed to address this lack of information. Two sites stand out as being particularly rich: Burning Cliff-White Nothe with 48 rare and scarce species, and Worbarrow Bay with 38 species. The east Dorset soft cliff sites are all within the **South Dorset Coast SSSI**, SAC, and are part of the World Heritage Site.

Furzey Cliff-Ringstead includes **Bowleaze Cove**, **Redcliff Point** and **Osmington Cliffs**. Furzy Cliff has landslips in Oxford Clay, the higher cliffs to the west being geologically more complex. The cliffs vary in height from less than 10m to around 80m high, and vary from stable scrubbed up sections to more mobile, almost vertical, bare cliffs. There are areas of open grassland and fairly large sections of reedbed. Scrub is very well developed on some parts of the cliff. Soft cliff species recorded here include the weevil *Sitona waterhousei* (Nb, Grade 3), the micro-moth *Scrobipalpula tussilaginis* (RDB1, Grade 1), and the mining bees *Andrena nitidiusculus* (RDB 3, Grade 3), *A. rosae* (RDB3, Grade 2), and *Lasioglossum angusticeps* (RDB3, Grade 1).

The cliffs at **Ringstead Bay** comprise clay and chalk landslips and undercliff from Ringstead Village to **White Noathe**, the site includes **Burning Cliff**. The site is owned and managed by the National Trust. The slopes and undercliffs support a mosaic of recently slumped cliff, with bare ground and pioneer vegetation, neutral and calcareous grassland, scrub, ponds and seepages. The soft cliff slopes at Ringstead support populations of at least 12 graded soft cliff species including the mining bees *Lasioglossum angusticeps* (RDB3, Grade 1), *Andrena nitidiusculus* (RDB 3, Grade 3) and *Andrena rosae* (RDB3, Grade 2), the Portland Ribbon Wave moth *Idaea degeneraria* (RDB3, Grade 1), and the Iris weevil *Mononychus punctumalbum* (Nb, Grade 2). The site is also known to support the Lulworth Skipper *Thymelicus acteon* (Na, UKBAP), the ant-like flower beetle (Anthicid) *Anthicus tristis* (pRDB1), the Tachinid fly *Bithis modesta* (RDB2), the cranefly *Gonomyia abbreviata* (RDB3),

Figure 15. Ringstead Bay
© Alan Stubbs

and the picture-winged fly *Myopites inulaedyssentericae* (RDB3).

In common with many other south coast sites, Ringstead Bay slopes and undercliffs were grazed extensively in the past. The site has changed in more recent times, the amount of open herb-rich grassland has reduced as more coarse grasses and scrub has increased (Allen *et al*, 2004). Where the slopes are sufficiently geologically unstable the open habitats remain. The re-introduction of grazing to the more stable parts of the site would be of benefit to the ecological interest. The grazing management options for this site are discussed in further detail in the Management section of this report (section 6.3).

The next significant section of soft cliff to the east is **Worbarrow Bay**. Ten soft cliff species have been recorded here including the mining bees *Lasioglossum angusticeps* (RDB3, Grade 1) and *L. laticeps* (RDB2, Grade 1). The site is also of note for rare and threatened flies, with two Red Data book hoverflies *Chrysotoxum elegans* (RDB3, Grade 3) and *C. vernale* (RDB1) having been recorded, alongside the Muscid fly *Orchisia costata* (RDB2) and the Tachinid fly *Bithia modesta* (RDB2). Habitats on site include large areas of pioneer vegetation, closed grassland, gorse scrub, and extensive flushes - particularly at the northern end of the site.

Figure 16. Worbarrow Bay
© Bryan Edwards

Gad Cliff, to the east of Worbarrow Tout, is a larger site. However, invertebrate records are few for this section of cliff, due in part to its relative inaccessibility. Soft cliff species known from this site include the mining bee *Lasioglossum laticeps* (RDB2, Grade 1), Black-headed mason wasp *Odynerus melanocephalus* (Na, Grade 2), and the Chalk Carpet moth *Scotopteryx bipunctaria cretata* (Na, Grade 3).

Houns Tout-Chapman's Pool has a considerable area of soft cliff, around 63ha., and is known to support 21 rare and scarce invertebrate species (Hunnisett & Edwards, 2006). The extensive terraced undercliffs support bare ground, pioneer habitats, open and closed grassland, and many seepage-fed flushes. Moving east, towards St Alban's head there are semi-stable landslips of high potential. Soft cliff species recorded here include the ground beetles *Tachys micros* (Na, Grade 1) and *Bembidion saxatile* (Nb, Grade 2), the mining bee *Lasioglossum angusticeps* (RDB3, Grade 1) and the Long-horned mining bee *Eucera longicornis* (Na, Grade 2). Other noteworthy species recorded at this site include the picture-winged fly *Myoptes eximius* (RDB3) and the spider-hunting wasp *Cryptocheilus notatus* (RDB3).

Figure 17. Chapman's Pool

Management

To a certain extent Dorset soft cliff sites have fewer management issues than elsewhere. Many sites in the county feature extensive undercliffs and terraced systems where the eroding cliff toe is some distance from the cliff top or back scar. With such extensive undercliffs the impacts of insensitive cliff top management are reduced when compared to vertical soft cliffs such as those at Prawle Point in Devon. There is evidence to suggest that the more pristine sites are fairly botanically stable, at least over the past 70 years. Four soft cliff sites studied by Prof. Ronald Good in the 1930s were resurveyed by Dorset Environmental Records Centre in 2005 (Hunnisett & Edwards, 2006). Analysis of the two datasets found that the plant species lists for most survey points have changed very little.

With the exception of the Bournemouth cliffs, historical impacts on the Dorset soft cliffs from cliff protection works have been relatively minimal and localised around centres of high population. As this study has shown, the Dorset soft cliffs are of national and possibly international importance for their invertebrates. Any negative impacts on the cliff ecology through inappropriate coastal management are of high significance, with the potential to damage populations of many nationally rare or threatened species. Even slight changes to erosion rates or cliff top management can degrade or fragment sites and have significant impacts to soft cliff biodiversity.

Improved cliff top management could enhance a number of Dorset soft cliff sites. Suitable cliff top habitats, such as herb-rich cliff top grassland or coastal heath, are important resources for maintaining sustainable populations of many soft cliff invertebrates, in particular bees and wasps. Dense nesting aggregations of mining bees such as *Andrena spectabilis* have been noted on the vertical faces at cliff tops, these often focus foraging activity on the cliff top rather than the slope (Gibbs, 2000). Where such habitats have been lost through agricultural improvement for grazing or through changes in land use, for example holiday parks, there are opportunities for enhancing the nature conservation interest of sites through habitat restoration. There are a number of examples where a useful flora is present, but is overgrazed. Overgrazed grasslands offer little in terms of pollen and nectar sources or vegetation structure. Overgrazing is a management issue that should be more straightforward to address – grazing regimes should be adjusted to manage cliff tops for wildlife.

Extensive management of cliff tops for wildlife and restoration of habitats where necessary have been identified as key nature conservation objectives for soft cliffs by English Nature (Covey, 1997). Another English Nature report (Burton and Pater, 2005) identifies a number of opportunities on Dorset soft cliff sites for the setback of agricultural land and the creation of a cliff top buffer strip of semi-natural vegetation. The recommendations made and opportunities identified by these reports should be implemented.

Recommendations have been made for the reintroduction of grazing on the stable undercliffs at Ringstead Bay (includes Burning Cliff and White Nothe) to reduce scrub and increase the area of open grassland on the site for the benefit of soft cliff invertebrates; these are discussed above, and in section 6.3.

At the time of writing one of the most important soft cliff sites in the UK is under threat from coastal protection. Despite considerable statutory protection (SSSI, SAC, World Heritage Site) cliff protection and stabilisation works at Lyme Regis threaten to impact on the geological and ecological interest of the Spittles/Black Ven landslip system. The landslip is considered to be a threat to a number of properties as well as important infrastructure including a main road into the town. The proposed options for addressing the threat include strengthening and extending the existing seawall, stabilising the slope immediate to the town, and draining groundwater from the western end of the landslip (West Dorset District Council, 2002).

Without inspection of the final proposals it is not appropriate to comment in detail, however some general principles apply. This is an internationally important site for its geology and ecology. The site is also of national importance for its entomological interest. Stabilising the slope and increasing cliff protection is likely to result in the loss of bare ground and pioneer habitats from the slopes. Artificial drainage will destroy the freshwater habitats associated with groundwater seepages. The loss of these habitats will lead to the loss of specialist invertebrates from the development footprint. The impact of this 'nibbling away' of the site on populations of rare invertebrates within the larger landslip area is unknown. As such, we recommend that detailed ecological impact studies are completed to assess the impacts of any proposed schemes on the invertebrate fauna of both the area directly affected by protection, stabilisation and drainage works, plus the indirect impact on the larger Spittles/Black Ven site. The entomological interest of this site must be recognised and taken into consideration for the future management of the landslip.

4.4 Isle of Wight

After Dorset, the Isle of Wight is the most important region area in the UK for the conservation of specialist soft cliff invertebrates. There are a number of soft cliff sites around the island, which range from being of local importance to national and international importance for their geological and ecological interest.

Invertebrate recording on the Isle of Wight has been concentrated on the southern sites, and with good reason: the southerly aspect of the sites favours thermophilic species, plus the southern sites tend to be less stable and with more extensive undercliffs than the north coast sites. As a result the southern sites tend to support a greater number of rare or restricted species and more soft cliff specialists.

The Isle of Wight is a national stronghold for a number of soft cliff species including Glanville Fritillary *Melitaea cinxia*, Cliff tiger beetle *Cylindera germanica*, and the Iris weevil *Mononychus punctumalbum*.

The Isle of Wight has 41.5km of soft cliff (Pye & French, 1993). The southwest coast has the longest section of unprotected soft cliff in the UK, outside of Humberside. The amount of unfragmented habitat combined with extensive undercliffs and a southerly aspect to most of the island's sites has resulted in some of the highest quality soft cliff invertebrate assemblages in the UK.

The northeast coast of the island features stable clay cliffs at **Osborne Bay** and **Woodside Bay**, the latter being within the King's Quay Shores SSSI. These slopes are heavily wooded, some of which is classified as ancient woodland. Where landslips occur there are areas of more open vegetation. We have no data on soft cliff invertebrates for this site, however they are likely to be of low importance for these species given the lack of significant areas of suitable habitat. For other invertebrates the sites are probably of some note, and worth surveying. The slopes offer a rare interface – climax woodland communities reaching the high water mark – which is of high ecological interest in its own right.

Bembridge Ledges and **Whitecliff Bay** (SSSI) is the next significant section of soft cliff (moving clockwise around the coast). Here actively eroding and slipping clay cliffs of up to 40m high support a range of micro-habitats from bare ground to pioneer vegetation, to thick scrub in places. There are also a number of small groundwater seepages. There are few invertebrate records from this site. However, there is a historic record of the ground beetle *Drypta dentata* (RDB1, Grade 1) (Appleton, 2004) and the mining bee *Andrena trimmerana* (Nb, Grade 3), and the presence of suitable habitat warrants further investigation.

Redcliff (Bembridge Down SSSI) is an active landslip where Lower Greensand rests upon Weald Clay stretching for about 1.5km from the Chalk of Whitecliff and Culver Cliff to the cliff protection works at Yaverland. The cliffs towards Yaverland are of a lower quality being lower clay cliffs without a sand capping.

This is a better surveyed site with records of eleven graded soft cliff species. Grade 2 species include the Black headed mason wasp *Odynerus melanocephalus* (Na, pUKBAP), the Long-horned mining bee *Eucera longicornis* (Na), the mining bee *Andrena spectabilis* (Nb), the Potter flower bee *Anthophora retusa* (RDB1) and the ground beetle *Bembidion saxatile* (Nb). Grade 3 species include the nomad bee *Nomada fucata* (Na, Grade 3), spider-hunting wasp *Priocnemis gracilis* (Nb), mining bee *Lasioglossum malachurum* (Nb), Yellow-footed mining bee *L. xanthopum*, and the solitary wasp *Mimumesa unicolor* (Na). Red Cliff is also one of only two known sites in the UK for the RDB2 solitary wasp *Nysson interruptus* (Grade 2). There are records of the large mason bee *Osmia xanthomelana* (RDB1, UKBAP, Grade 1) from the site, although this species has not been recorded here since 1998 and is now thought extinct here. Red Cliff represented the last English population of this bee; the only remaining UK sites for the species are in north Wales.

The records suggest that this site is of national importance for its soft cliff invertebrate fauna, in particular solitary bees and wasps. However this is not reflected in the SSSI citation which does not mention invertebrates at all. We recommend that further invertebrate surveys are completed for this site to confirm that the invertebrate fauna is a notifiable feature of the SSSI.

Figure 18. Red Cliff.
© Alan Stubbs

Lake to Shanklin Cliffs - Lower Greensand cliffs are protected by a promenade. However, in places there is still cliff foot sand with some vegetation (in part behind beach huts). Though of limited value, potentially it may support some interesting invertebrate species.

Shanklin Chine to Luccombe Chine is not notified as SSSI, however it is known to support eight Red Data Book and 49 Nationally Scarce invertebrate species (Stubbs *et al* , 1980; Colenutt & Wright, 2001). This invertebrate assemblage is considered to be of national importance and it has been recommended that the site is notified as SSSI (Colenutt & Wright, 2001). The area of interest does not include Shanklin Chine itself which is behind cliff protection.

The geology of the cliffs is predominantly Lower Greensand resting on clay; there are regular landslides and slumps which maintain areas of bare ground and open vegetation. There are patches of *Equisetum*-dominated wet slumps and other freshwater habitats associated with numerous small seepages. Other parts of the cliff feature sandy scree slopes are present at the base of vertical sand cliffs. On more stable sections scrub and ash and sycamore woodland has developed, principally at Luccombe Chine. Much of the cliff top is also ash and sycamore woodland. Luccombe Chine has a stream, originating from a chalk spring on higher ground, the largest and most significant such stream on the landslips of the Isle of Wight.

Twelve soft cliff species have been recorded at this site including the RDB1 solitary wasp *Mimumesa atratina* (Grade 1), the mining bees *Eucera longicornis* (Na, Grade 2) and *Andrena spectabilis* (Na, Grade 2), the ground beetle *Bembidion saxatile* (Nb). The cliffs of Bordwood Ledge and Luccombe Chine support one of only two UK populations of the RDB1 and UKBAP Chestnut click beetle *Anostirus castaneus* (Grade 3) (Colenutt, 2000; Colenutt & Wright, 2001; Middlebrook, 2004), the other site is near Harrogate in Yorkshire. Grade 3 species recorded between Bordwood ledge and Shanklin Chine: Grey bush-cricket *Platycleis albopunctata* (Nb), the solitary wasp *Mimumesa unicolor* (Na), the mining bees *Andrena trimmerana* (Nb), *Lasioglossum malachurum* (Nb) and *L. puncticolle* (Nb), the cuckoo bees *Sphecodes niger* (RDB3) and *Nomada fucata* (Nb), and the spider *Episinus maculipes* (RDB3) – a species only known from two UK sites, the other is on the south Devon coast.

Buglife support the assessment made by Colenutt & Wright (2001) that the soft cliffs of Luccombe to Shanklin Chine are of national importance for invertebrate conservation and as such should be considered for notification as a SSSI.

Figure 19. Knock Cliff (Luccombe - Shanklin Chine)
© Simon Colenutt, ECOSA

Dunnose, also known as **Bonchurch Landslips** (SSSI), is a well known site for a number of rare invertebrates. However, the SSSI citation does not mention invertebrates as an interest feature. This is despite the undercliffs supporting a nationally important population of the Chestnut click beetle *Anostirus castanaeus* (RDB1, UKBAP, Grade 3), plus the spider *Episinus maculipes* (RDB3, Grade 3). The boundary of the SSSI ends abruptly just to the north of Bordwood Ledge despite the ecological interest of the cliffs continuing to Shanklin Chine (as discussed above).

The Species Action Plan for *Anostirus castanaeus* lists as an action "Consider notifying as SSSIs sites holding key populations of the species where this is necessary to secure their long-term protection and appropriate management" (UK Biodiversity Group, 1999). The undercliffs of Luccombe Chine and Bordwood Ledge are a nationally important site for this species and should be offered statutory protection. This could be achieved through the renotification and extension of the existing Bonchurch Landslips SSSI.

Steephill Cove to St. Catherine's Point (part of Compton Chine to Steephill Cove SSSI, SAC) includes over 6km of soft cliff comprised of Chalk, Upper Greensand and clay. The undercliffs here are extensive: the back scar of the landslip being over 500m inland from the cliff toe in places. The slopes are also relatively stable, and have been developed into improved agricultural land, and for housing - St Lawrence and Ventnor to the east are built on the landslip. Where undeveloped, stable sections of the undercliff are dominated by scrub or woodland. There are many groundwater seepages which form pockets of reedbed, ephemeral pools and other freshwater features. The more active slopes and the eroding cliff toe feature bare ground, pioneer vegetation and open herb-rich grassland. The back scar foot is wooded along many sections, often dense with an ivy dominant ground flora.

A number of invertebrate surveys have been carried out along this stretch of cliff, with the most comprehensive, in terms of geographical coverage, carried out by the NCC (Sheppard, 1991). More recent survey work has concentrated around Castlehaven where cliff protection works have been constructed (Plant, 1999; Colenutt 2002, 2004a, 2004b). Mitigation for the loss of invertebrate habitat has been included in the scheme and is subject to ongoing monitoring.

The soft cliff slopes and undercliffs from St. Catherine's Point to Steephill Cove are an incredibly rich invertebrate site, particularly for solitary bees and wasps. The site is known to support 13 Red Data Book invertebrates, 5 UKBAP invertebrates and a total of 25 soft cliff species. Grade 1: Glanville fritillary *Melitaea cinxia* (RDB3, pUKBAP), Cliff tiger beetle *Cylindera germanica* (RDB3, UKBAP), and the mining bees *Andrena proxima* (RDB3) and *Lasioglossum angusticeps* (RDB3). Grade 2: Long-horned mining bee *Eucera longicornis* (Na), a mining bee *Andrena spectabilis* (Nb), Iris weevil *Mononychus punctumalbum* (Na), ground beetle *Bembidion saxatile* (Nb). Grade 3: the mining bees *Andrena labiata* (Na), *A. nitidiusculus* (RDB3), *A. trimmerana* (Nb), *Lasioglossum malachurum* (Nb), *L. puncticolle* (Nb), and *L. xanthopum* (Nb); the cuckoo bees *Nomada conjugens* (RDB2), *N. fucata* (Nb), *Sphecodes niger* (RDB3) and *Sphecodes rubicundus* (Na); the solitary wasp *Mimumesa unicolor* (Na); the Dotted bee-fly *Bombylius discolor* (Nb, UKBAP); Grey bush-cricket *Platycleis albopunctata* (Nb); Chalk Carpet moth *Scotopteryx bipunctata* (Nb, UKBAP); and the spider *Episinus maculipes* (RDB3).

Other Red Data Book species recorded at the site include the mining bees *Andrena alfkanella* (RDB3) and *Lasioglossum pauperatum* (RDB3), the cuckoo bee *Stelis ornatula* (RDB3), the solitary bee *Hylaeus gibbus* (RDB3), and the digger wasp *Tachysphex unicolor* (RDBK). Another species of interest is the Spanish fly *Lytta versicatoria* – an oil beetle known from just two colonies in the UK, both of which are on these undercliffs: St. Catherine's Point and Binnel Bay (Colenutt, 2002).

The real soft cliff highlight of the island is the **Southwest Isle of Wight Coast** from **St. Catherine's Point to Compton Chine** (part of Compton Chine to Steephill Cove SSSI, SAC). This 15.6km section of sand and clay cliffs is the longest continuous stretch of unprotected soft cliff in Southern Britain. The section features extensive undercliffs – particularly those between Whale and Blackgang Chines, Shepherd's Ledges (an area of undercliff to the east of Shepherd's Chine), Roughmoor Cliff and Compton Undercliff.

The cliff slopes and undercliffs are relatively dynamic, maintaining large areas of bare ground, pioneer vegetation and open grassland. The instability of cliffs also means that scrub is a limited feature along this coast. There are groundwater fed seepages all along the coast, which form temporary pools and, in places, quite extensive reedbeds and areas of pioneer wet vegetation.

Figure 20. Chilton Chine.

The coast features a number of 'chines' – incised stream channels which cut down through the soft geology of the cliffs. These channels are often steep-sided and can cut down to beach level. The active seaward end of the chine is least stable due to cliff toe erosion by the sea. This instability coupled with salt spray from the sea prevents the development of closed grassland and scrub and maintains habitat favoured by soft cliff invertebrates. Inland the chines become scrubbed up, and eventually wooded.

The presence of large areas of uninterrupted or connected high quality soft cliff habitat, combined with the southerly aspect of this site, promotes a high quality soft cliff invertebrate assemblage characterised by thermophilic species and species associated with groundwater seepages. The cliffs and chines of the southwest Isle of Wight coast are one of the most important soft cliff sites in the UK and are known to support 36 soft cliff species including eight Grade 1, and six Grade 2.

Grade 1 species: Glanville Fritillary butterfly *Melitaea cinxia* (RDB3, pUKBAP), Cliff tiger beetle *Cylindera germanica* (RDB3, UKBAP), the ground beetle *Drypta dentata* (RDB1), the shore bug *Saldula arenicola* (Na), *Mimumesa atratina* (RDB2) a solitary wasp, the mining bee *Lasioglossum angusticeps* (RDB3, UKBAP), and the cranefly *Dicranomyia lackschewitzi* (RDBK). Until recently *Dicranomyia lackschewitzi* was only known from the south Isle of Wight coast in the UK, it is now also known from Eype in Dorset. Grade 2 species: the mining bees *Andrena proxima* (RDB3) and *A. spectabilis* (Nb), the Black-headed mason wasp *Odynerus melanocephalus* (Na), the ground beetle *Bembidion saxatile* (Nb), the Iris weevil *Mononychus punctumalbum* (Na), and the cranefly *Dicranomyia goritiensis* (RDB3). Grade 3 species: the weevil *Sitona waterhousei* (Nb), rove beetle *Lesteva hanseni* (Nb), cranefly *Gonomyia conoviensis* (Nb), Dotted bee-fly *Bombylius* discolor (Nb), Grey bush-cricket *Platycleis albopunctata* (Nb), the solitary wasps *Argogorytes fargei* (Na), *Methocha articulata* (Nb) and *Psen unicolor* (Na), the mining bees *Andrena nitidiuscula* (RDB3), *A. dorsata* (local), *Lasioglossum malachurum* (Nb) and *L. puncticolle* (Nb), and the cuckoo bees *Nomada fucata* (Nb), *N. fulvicornis* (RDB3), *Sphecodes niger* (RDB3), *S. reticulatus* (Na) and *S. rubicundis* (Na).

The RDB1 silver fly (Chamaemyiidae) *Parochthiphila spectabilis* has been found in large numbers on perched reedbed at both Whale and Blackgang Chine (Howe & Howe, 2006b). The site is considered to be the UK stronghold for the species (Alan Stubbs pers comm.). *P. spectabilis* has few recent UK records and is thought to be restricted to just four other sites in the country. Whale Chine is also known to support a population of the rare parasitic fly (Tachinidae) *Linnaemya comta* (RDB3) which also has few contempory UK records (Howe & Howe, 2006a).

As part of a collaborative project with the Environment Agency and Natural England, Buglife carried out ecological surveys of the chines and undercliffs of the south west Isle of Wight coast in 2005, 2006 and 2007 (Colenutt, 2007; Colenutt & Wright 2006, Colenutt & Wright *in prep*). These represent the only formal invertebrate surveys of this coast.

One aim of the Buglife surveys was to study the ecological relationship between the chines and the undercliffs. The surveys have found that the chines do not exhibit a specialised invertebrate fauna. In many cases the invertebrate interest is confined to the mouth of the chine, and especially the immediate frontage containing areas of short grassland and slumping ground with bare soils. The micro-climate of the chines has an influence on the invertebrate fauna. The chines experience cooler temperatures with higher degrees of shade in comparison with the exposed cliff slopes and undercliffs. In addition, all chines on the southwest coast are open to the prevailing south-westerly winds, which are channelled up the chines cooling the temperature further. These windy, cool, shaded chines are not suitable for thermophilic species, or for significant nesting aggregations of bees and wasps to form. This is in contrast to the warm sheltered conditions found on the cliff slopes where large hymenopteran nesting aggregations are common.

Perhaps one significant exception to this is the Glanville Fritillary which appears to achieve its highest abundance in the mouth of the chines rather than on the soft cliff slopes and ledges. This presumably relates to the more rapid rate of erosion on the cliff slopes, which prevents the establishment of the swards where the food plant, Ribwort plantain (*Plantago lanceolata*), becomes established. This is in contrast to the upper reaches of the chine, where the grassland becomes too long and overtops the ribwort plantain making it unsuitable for the Glanville fritillary.

Figure 21. Extensive undercliff ledges between Blackgang and Whale Chines

There are sections of soft cliff on the east coast of the Isle of Wight at **Alum and Totland Bay** (Headon Warren and West High Down SSSI), **Colwell Bay** (Colwell Bay SSSI), **Cliff End**, and **Norton**. These four sections have similar geologies, mainly sands and clays. The terraced undercliffs at Alum and Totland Bays are extensive and feature a range of habitats from bare ground to woodland, the cliff top here is a mixture of lowland heath, woodland and calcareous and neutral grassland. We have few records of soft cliff invertebrates for these sites, although there is a historical record of the Black-headed mason wasp *Odynerus melanocephalus* (Na, Grade 2) at Totland Bay. Totland and Alum Bay is also the last known UK site for the rove beetle *Bledius crassicollis* (RDB1, Grade 1), although the beetle has not been recorded since 1973.

The lower slopes of Headon Warren have some useful seepages, though a concrete revetment has damaged the site from an ecological perspective. At Colwell Bay there are past records of clay seepages with the cranefly *Dicranomyia lackschewitzi* (RDBK, Grade 1), although these too are likely to have been lost through the construction of cliff protection. The cliffs between Cliff End and Niton are unstable in the winter but the clay is subject to drying out in the summer, and thus unlikely for supporting seepage faunas.

These four sites would warrant further survey where useful soft cliff habitat remains.

Bouldnor and Hamstead Cliffs (SSSI) feature extensive terraced undercliffs. The full range of vegetation succession is here, from bare ground on the more active land slips and mud slides, to mature woodland on more stable sections. There are numerous groundwater seepages supporting freshwater habitats, and some significant perched reedbeds. Invertebrate records for this site are few. It is north facing and is unlikely to support an assemblage comparable to those of the south coast, though the site does feature some useful soft cliff habitat. We recommend that invertebrate surveys are carried out at this site.

A similar situation exists for **Thorness Bay** (SSSI) and **Gurnard Bay,** which also feature considerable areas of suitable soft cliff habitat and few invertebrate records. Invertebrate surveys of these sites are necessary to assess their status.

Management

Cliff top management is a major issue on the Isle of Wight. In places, arable land or improved pasture is not far from the cliff edge. Any remaining semi-natural cliff top grassland is reduced to a thin strip. Some work has been done to improve the situation; on the southwest coast an agreement between landowners and Natural England is attempting to establish a 20m strip of semi-natural cliff top grassland along the coastline, the width of the strip being maintained as the cliff recedes (this is discussed in more detail in section 6.2). Ideally this strip would be much wider, restoring whole cliff top fields to wildflower-rich cliff top grassland; however it is a positive step and one which could be replicated in similar situations around the UK. Long term monitoring of the cliff top flora will establish whether the strip is wide enough for useful habitat to develop before the cliff edge retreats, rather than just arable weeds and recruitment crops, and whether it is wide enough to buffer the impacts of arable farming.

The reversion of cliff top land to semi-natural grassland in order to enhance soft cliff sites must be a priority for this region, as has been recommended in reports by SCOPAC (Halcrow, 2001), English Nature (Cox, 1997; Pater, 2004) and Defra (Defra/SEEDA, 2003).

Other cliff top land uses such as housing development and infrastructure increase demand for coastal protection. For example the southwest coast road or “Military Road” runs very close to the eroding cliff edge in places. Long term solutions need to be sought without compromising the ecological and geological interest of the coast. Many of the Isle of Wight’s coastal soft cliff sites are of national or international importance for their wildlife and should be protected as such. Coastal habitats and features need to migrate inland as cliff tops retreat; features such as roads pose a barrier to such movement resulting in coastal squeeze. The Military Road would appear to be truncating the chines and impeding their natural inland development, some (e.g. Whale Chine) actually follow the road. A PhD student from Southampton University is studying the hydrogeology of the chines – this research will tell us more about the long term management of these features.

Water availability is another threat to soft cliff ecology which is linked to cliff top management. Groundwater extraction can reduce the amount of water reaching the cliff slopes in the form of freshwater seepages. The current Environment Agency assessment is that borehole extraction along the southwest of the island is not significantly impacting on the quantity of water reaching the cliffs between Compton Chine and Blackgang (Tim Norton pers comm.). Any increased demand in the future must be assessed in terms of its impact on soft cliff ecology, and in the context of changing precipitation patterns linked to climate change.

Invasive plant species are a lower priority on the Isle of Wight cliffs; however, there is an area of Japanese knotweed at the northern end of Whale Chine which should be dealt with as a matter of urgency.

Future threats to soft cliff habitat on the Isle of Wight from climate change are similar to those general threats discussed in Section 6.5. The impacts of climate change are also discussed in a recently produced report by SCOPAC (Halcrow, 2001), which is a very useful resource. One impact that is already possibly evident is that the south coast sites are likely to be the landing place for new colonisers from continental Europe, the warmer climate offered by the undercliffs is ideal for thermophilic species on the northern edge of their range such as Spanish fly *Lytta versicatoria* – a recent colonist at St Catherine's Point.

4.5 Hampshire

Hampshire contains just over 7km of coastal soft cliff, most of which is concentrated in the west of the county. Hampshire's sand and clay cliffs aren't particularly high - ranging from 34m to just a few metres - although at points the undercliffs are fairly extensive given the height of the cliffs. In terms of actual area of undercliff habitat, Hampshire County Council has recorded 43.1 ha of shoreline cliff in its coastal Phase One survey (Hampshire Biodiversity Partnership, 2003).

The largest section of soft cliff in the county is that of **Barton and Hordle cliffs** (Highcliffe to Milford Cliffs SSSI) which are recognised as being of national importance for their geological exposures and fossils. A large section of the site has been destroyed through the construction of coast protection, artificial drainage and reprofiling of the cliff slope. Where the coast continues to function naturally there is useful invertebrate habitat, with active, south-facing slopes featuring bare ground and pioneer vegetation with perched reedbed, pools and flushes. There are historical records for soft cliff invertebrates including the ground beetle *Drypta dentata* (RDB1, Grade 1), Shore-bug *Saldula arenicola* (Na, Grade 1), Grey bush-cricket *Platycleis albopunctata* (Nb, Grade 3), mining bee *Lasioglossum angusticeps* (RDB3, UKBAP, Grade 1), Black-headed mason wasp *Odynerus melanocephalus* (Na, pUKBAP, Grade 2) and the cranefly *Gonomyia conoviensis* (Nb, Grade 3). Given the availability of suitable habitat, albeit in smaller fragments, it is possible that some of these species may still be present. There is little recent invertebrate data for this site so new survey work is a priority. Hordle cliff also features what is thought to be the only naturally colonised population of Glanville Fritillary *Melitaea cinxia* (RDB3, pUKBAP, Grade 1) on the UK mainland.

Cliff top management above Barton and Hordle Cliffs includes some heavily built up areas, as well as golf course and some improved pasture. There are opportunities for restoring cliff top grassland in the sections topped by golf course or in agricultural use. The stretch of coast features a number of incised stream channels or chines – known locally as a 'bunny' - although unfortunately these are heavily modified and do not appear to be functioning naturally.

Figure 22. Unprotected soft cliff at Barton.

Netley and Hamble cliffs comprise unstable soft cliffs of sands and gravels on the eastern shore of Southampton Water. The cliffs are low, rising to a maximum of 8m. The limited extent of this site coupled with its isolation from similar habitats is perhaps a reason for lack of soft cliff associates. However, the cliff section within Westfield Common is known to support a diverse aculeate fauna (Pinchen, 2006). The lack of flowering plants and floral diversity on the cliff faces and cliff tops is a limitation to the invertebrate interest. Opportunities for increasing the amount of herb-rich cliff top habitats should be identified, however due to the narrow extent of undeveloped cliff top and public access issues success may be limited (Pinchen, 2006).

Elsewhere in the county there are a number of smaller, lower sections of soft cliff including those at Lepe (~1.5 km), Stanswood Bay (~1 km) and Hill Head (~2 km) (Hampshire Biodiversity Partnership, 2003). There are few invertebrate records for these sites.

4.6 Sussex

To the east of **Hastings** are 6km of eroding sand and clay coastal soft cliffs. These are fairly active with erosion rates at the eastern **Fairlight Cove** estimated at approximately 1.5m per year (May & Hansom, 2003). This cliff complex is isolated from other similar sites, to both the east and the west the coastline is low and formed of accretionary features such as beaches and shingle banks.

The site is within Hastings to Pett Beach SSSI, notified for its geological and biological interest, although soft cliff invertebrates are not specifically noted. Part of the site is also designated as a SAC for the Annex I habitat 'Vegetated Sea Cliffs of the Atlantic and Baltic coasts'.

A range of habitats has developed on the cliff slopes and extensive undercliff areas. Bare ground areas are maintained by mudslides, rotational landslips and rock falls. Early successional habitats such as pioneer seepage vegetation and maritime grassland give way to reedbed, coastal heath, scrub and patches of woodland on more stable parts.

The undercliff has extensive freshwater seepages and shallow pools that are known to support the Nationally Scarce (Na) ground beetles *Acupalpus flavicollis* and *Tachys micros* (a Grade 1 soft cliff species). Fairlight Cove was the last known site for the wetland weevil *Lixus algirus*, last recorded here in 1923 and now presumed extinct in the UK (English Nature, 1994).

Drier parts of the cliff also support an interesting invertebrate fauna. The Potter flower bee *Anthophora retusa* (RDB1) and Long-horned mining bee *Eucera longicornis* (Na) have been recorded on the site, both are Grade 2 soft cliff associates. There are historical records for the RDB1 cuckoo bee *Nomada sexfasciata*, a Grade 1 soft cliff specialist, although the species has not been recorded here since the 1800s, and for the mining bee *Andrena rosae* (RDB2, Grade 2) – last recorded at Fairlight in the 1920s. Other invertebrates recorded on the cliff slopes include the Grey bush-cricket *Platycleis albopunctata* (Na, Grade 3) and the ant mimic jumping spider *Myrmarachne formicaria* (Nb). Cliff top maritime grassland within Hastings Country Park is known to support populations of the rare weevil *Cathormiocerus myrmecophilus* (RDB3) and the Nationally Scarce ant mimic ground spider *Micaria romana* (Nb).

The cliff slopes and undercliffs are remote, inaccessible and dangerous, and are therefore under-recorded. However, in 2006 Hastings Borough Council commissioned surveys of the soft cliff resource as part of a larger programme of survey work (a report on this work is expected in 2007).

The majority of this site is within Hastings Country Park. The cliff top features areas of maritime grassland and heath, neutral grassland, amenity grassland, scrub and woodland. These cliff top features enhance the cliff slope and are of ecological interest in their own right.

A recent decision to grant planning permission for an extension to existing coast protection at Fairlight village has the potential to damage the site. The cliffs in question are at the eastern end of the SSSI and outside of the SAC boundary. Recent landslip activity put pressure on Rother District Council to consider local residents' requests for increased coastal protection. English Nature (now Natural England) initially objected to the scheme on the grounds of damage to the geological exposures at the site. However, the objection was withdrawn in 2006, subject to certain conditions being met to meet geological conservation objectives, and the modified works are now to go ahead. The attempt to stabilise the landslip will entail the construction of a rock bund at the toe of the cliff and a series of boreholes along the cliff top. The impacts of this scheme on invertebrates are unknown, however the cliffs in question are currently eroding at such a rate that they are likely to be of limited use to invertebrates. With this in mind, and the limited extent of the new bund, it is hoped that the impact on the invertebrate fauna of the Hastings to Fairlight cliffs will be minor. We recommend that this site is monitored closely.

4.7 Kent

With an estimated 9.3km of unprotected soft cliffs (Pye & French, 1993) the Kent coast has a significant proportion of the UK resource. As with the rest of the UK, the soft cliffs of Kent support a great diversity of invertebrate species, although the majority of sites are north facing and as a result feature fewer of our thermophilic soft cliff species.

The northern coast of the **Isle of Sheppey** features cliffs in London Clay which vary in height from 8 to 52m. These are fairly dynamic landslip systems, with impressive rotational slips creating terraced slopes. Estimates put the erosion rate at just under 1m per year (South East Coastal Group, 2006). This geological instability provides a continuity of bare ground on the site, plus the maintenance of nectar-rich flowering grasslands. Sheppey's soft cliffs are known to support populations of the Grade 2 Yellow-footed mining bee *Lasioglossum puncticolle* (Nb), and the Shrill Carder bumblebee *Bombus sylvarum* (Nb, UKBAP). Highlights at **Warden Point** include the Nationally Scarce cuckoo wasp *Nysson trimaculatus* (Nb) and the plant *Tetragonolobus maritimus* or 'Dragon's Teeth'. There are historical records of the Long-horned mining bee *Eucera longicornis* (Na) from the Sheppey cliffs, although this species has not been here recorded for over 20 years. Although the Clay cliffs become wet and mobile in the winter, they dry out in the summer and there are no seepages and springs along this stretch.

The cliffs at **Reculver** consist of soft sandstones and clay; unfortunately large sections of the cliff here have been damaged by coast protection, artificial drainage and reprofiling. However, where they have been allowed to function naturally they still support interesting wildlife. Reculver cliffs are perhaps better known for supporting one of the largest Sand Martin (*Riparia riparia*) colonies in Kent, however the nesting aggregations of solitary bees and wasps are equally impressive.

Figure 23. Bishopstone Glen - some of the finest Hymenoptera real estate on the north Kent coast.

Within the Reculver cliff complex **Bishopstone Glen** is of particular note. In contrast to the rather exposed, north-facing cliffs faces of the open coast, the Glen offers sheltered faces, some of which are actually south facing and thus experience higher temperatures. The faces with a more southerly aspect tend to feature the highest concentrations of bee and wasp burrows. The Glen also features flower-rich vegetation and areas of freshwater habitats where the stream passes through. These habitats support populations of a number of Nationally Scarce bees and wasps (Hymenoptera), including the Digger wasps *Alysson lunicornis* (Na) and *Ectemnius ruficornis* (Nb), Mining bees *Anthophora quadrimaculata* (Nb) and *Dasypoda hirtipes* (Nb), soft cliff cuckoo bees *Nomada fucata* (Na) and *Sphecodes rubicundis* (Na), the Large Velvet ant *Mutilla europaea* (Nb) and the Bee Wolf

Philanthus triangulum (RDB2 – although status is in need of revision).

The cliff top at Reculver is managed by Canterbury City Council and Kent Wildlife Trust, and features semi-natural cliff top grassland – a scarce resource on the Thanet Coast. This herb-rich grassland provides essential resources for bees and wasps nesting on the cliff face and is a major source of food for the resident sand martins.

Pegwell Bay features short sections of soft clay cliff to the north end of the Bay (figure 24). These vertical soft cliffs represent one of the most important UK sites for the rare Four-banded Weevil wasp *Cerceris quadricincta* (RDB1). The Nationally Scarce mining bee *Andrena spectabilis* (a Grade 2 soft cliff species) has also been recorded here. In addition to cliff nesting sites for burrowing Hymenoptera there are, unusually, large areas of ruderal vegetation in front of the cliffs providing nectar, pollen and prey for these species.

The cliffs at Pegwell are no longer naturally eroding due to the remaining infrastructure from a hoverport which once operated from the Bay. As a result in recent years they had become overgrown with scrub. In the interests of conserving the geological interest of the site (part of the Thanet Coast SSSI), in 2005 English Nature cleared the cliff face of scrub. Fortunately this also increased the available nesting areas for *Cerceris quadricincta* and other burrowing bees and wasps. This is a good example of conservation works benefiting both biodiversity and geodiversity.

Figure 24. Soft cliffs at Pegwell Bay, after clearance works.

Folkestone Warren is a complex site with both hard and soft cliff characteristics. Chalk cliffs are underlain by Gault Clay and Lower Greensand which are exposed at the western end of the site. The underlying clay creates instability in the chalk resulting in a mosaic of cliff ledges, scree, bare faces and undercliffs of varying slope and aspect. This instability also maintains significant areas of open maritime and calcareous grassland, and patches of bare ground and pioneer vegetation on the Clay and Greensand exposures. More stable sections feature scrub and some woodland. Folkestone Warren would seem to support a more diverse hymenopteran fauna than the other Kent sites, most likely on account of its southerly aspect. Soft cliff species recorded here include: the mining bees *Andrena humilis* (Na), *A. nitidiusculus* (RDB3), *A. simillima* (RDB2), and *A. spectabilis* (Nb); the Dotted bee fly *Bombylius discolor* (Nb); and the micro-moth *Selania leplastriana* (pRDB1). The site is also known to support a population of the Fiery clearwing moth *Pyropteron chrysidiformis* (RDB1, UKBAP) and is a particularly important area for Lepidoptera.

It is clear that the soft cliffs of Kent are of regional and national importance for their invertebrate populations. Further surveys of these interesting sites will undoubtedly reveal more.

4.8 Essex

The majority of the Essex coastline is low, with few cliffed sections. The only significant soft cliff site in Essex is **The Naze**, in Walton. The site is a SSSI but only notified for its geological interest, despite supporting an impressive invertebrate species list. The cliffs are formed of London Clay, overlain with shell rich deposits and sands known as the Red Crag. Both geologies are renowned for their fossils at this site.

Figure 25. The Naze – southern end of the site

The invertebrate fauna of The Naze is fairly well recorded. Of particular note is the Hymenoptera (bees and wasps) assemblage, including the grade 2 soft cliff species *Andrena spectabilis* (Nb) and *Andrena trimmerana* (Nb), plus six grade 3 species: *Lasioglossum malachurum, Nomada fucata, Nomada fulvicornis, Sphecodes niger, Sphecodes rubicundus*, and the ground beetle *Bembidion stephensii*. Regardless of soft cliff associates, this site is clearly of regional importance for its invertebrate fauna (9 RDB species, 15 Nationally Scarce), and this should be reflected in its SSSI citation.

A significant proportion of the soft cliff habitat at The Naze has been destroyed through the building of coast protection. A concrete sea wall and rock armour covers the toe, and the slopes have been reprofiled. The flora here is coarse closed grassland and scrub, with patches of compacted bare ground where trampled on the edge of paths, and it is clearly of negligible value to invertebrates. The unprotected cliff slopes offer valuable invertebrate habitat, including bare ground, pioneer vegetation and freshwater seepages. These freshwater seepages have been surveyed for their Diptera (fly) fauna (Gibbs, 1992). The cliff slope features large areas pioneer vegetation dominated by Colt's-foot *Tussilago farfara,* plus stands of more ruderal species such as umbellifers, clovers, vetches and thistles - these provide a range of nectar sources through the season. The undercliffs have formed a series of shallow bays which provide a variation in topography and aspect. Consequently, although the site generally faces east, there are a number of south-facing slopes which are exploited by thermophilic species.

Figure 26. The Naze – northern end of the site

The cliff top management is fairly sensitive. At the town (southern) end of the site there is an area of amenity grassland with a narrow buffer strip (2-5m) at the cliff top where the grass is not cut. Towards the point the grassland is less managed and has a more diverse sward with areas of scrub. It is likely that parts of this site could be threatened with coast protection works in future. Increasing the current extent of coast protection works on this site would be highly damaging to the invertebrate interest.

4.9 Suffolk

The Suffolk coast has 11.4km of unprotected soft cliff (Pye & French, 1993), most of which has never had any formal invertebrate survey. These cliffs of glacial material, crag and clay are generally east-facing and experience relatively rapid erosion rates. May and Hansom (2003) give estimated retreat rates of around 1m per year for the coast between Pakefield and Kessingland, and up to 3m per year at Covehithe. Further information on the geology and geomorphology of Suffolk cliffs can be found in Dargie (1995c).

Many of the sites are well defined, being separated by low coastal features such as shingle banks or sand dune systems. Despite being under-surveyed the sites score well on their aculeate assemblages, many being of regional importance. Freshwater habitats are scarce on the majority of sites that we have data for, which is reflected in the species lists.

Moving south to north, the major sections of soft cliff are Bawdsey, Dunwich cliffs, Easton Bavents, Covehithe, Kessingland and Corton.

The cliffs to the south of **Bawdsey** are known to support populations of four grade 3 soft cliff species: the mining bees *Lasioglossum malachurum* (Nb) and *L. puncticolle* (Nb), as well as the cuckoo bees *Nomada fucata* (Na) and *Sphecodes reticulatus* (Na). There are also records of the RDB3 mining bee *Lasioglossum nitidiuscula*, Five-banded weevil wasp *Cerceris quinquefasciata* (RDB3, UKBAP) and its cleptoparasite the ruby-tailed wasp *Hedychrum niemelai* (RDB3).

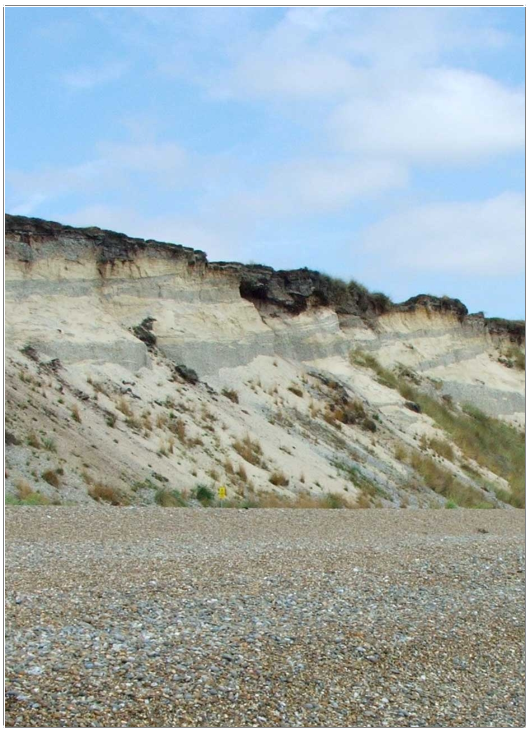


Figure 27. Layers of sand and pebbles at Dunwich cliffs.

Dunwich cliffs are part of the National Trust-owned Dunwich Heath property. They are also included within the Minsmere-Walberswick Heaths and Marshes SSSI and SAC, although the cliffs are not specified as an interest feature. The cliffs are composed of layers of sand and pebbles (fig. 27) and are eroding at approximately 0.75m per year (Allen *et al*, 2006a).

The upper section of the cliff is vertical and unvegetated; the less steep lower sections, where collapsed sandy material accumulates, are partially vegetated by sand dune (such as Marram, *Ammophila arenaria*) and heathland species. Patches of bracken and gorse are present on more stable slopes to the north of the site. Freshwater features are rare, but where present support small stands of common reed *Phragmites australis* at the base of the slope.

Shingle at the cliff base provides some protection from the sea, the beach has built up in recent years and the sea rarely reaches the cliff toe (David Sutton pers comm.). The vegetated shingle with Sea kale *Crambe maritima* and Yellow horned poppy

Glaucium flavum also provides further nectar sources for cliff-nesting bees (fig. 28). The majority of the cliff top is heathland, providing further resources, although there is a caravan park beyond the National Trust property at the northern end of the site which seems to offer little in terms of useful cliff top habitat.

Figure 28. Cliff slope and shingle vegetation at Dunwich

A National Trust survey of 2005 (Allen *et al*, 2006) represents the only formal ecological survey of these cliffs, although this was not intensive (in fact the report recommends further invertebrate surveys as a priority). There are records for eight Nationally Scarce plus four Red Data Book species on the cliffs. However, with a number of datasets it is difficult to extract records specifically from the cliffs from records stating 'Dunwich Heath' as a location. The cliff top heathland is of high invertebrate interest in its own right and is known to support large populations of mining bees, the cliffs may provide additional nest sites for heathland species. A visit by the author in 2006 recorded larval pits of the Suffolk ant lion *Euroleon nostras*, the species has been known at the site since 1996 (Cottle *et* al, 1996; Plant, 1999) however this may be the first record of their presence on the actual cliffs.

Easton Bavents, Covehithe and Kessingland cliffs all fall within Pakefield to Eastern Bavents SSSI. We have no invertebrate records for Easton Bavents. The southern end of the site has been the subject of a controversial, privately funded coastal protection work in the form of a large bund that has largely obscured the geological interest of Easton Bavents Cliff, it is unknown whether any ecological interest has also been affected.

The eroding cliffs at **Covehithe** consist mainly of fluvio-glacial sands, and have a fringing beach of sand and shingle. The citation for Pakefield to Eastern Bavents SSSI states that these are the most rapidly eroding cliffs on the English coast. We have little invertebrate data for Covehithe cliffs beyond some of the locally distributed mining bees – *Andrena flavipes* and *A. dorsata* (Grade 3).

Kessingland cliffs are again sandy and dry. Erosion rates would appear to be higher in the northern end of the site, towards the south the sea rarely reaches the cliff toe – the cliffs being naturally defended by a sand and shingle beach. To the southern end of the site the cliffs grade into a sand dune system with sea couch grass (*Elytrigia atherica*) and Marram. The more stable southern cliffs feature areas of dense scrub. There is a diverse and abundant range of pollen and nectar sources along the length of the site.

Kessingland cliffs were surveyed by Buglife in 2006 (Wright & Whitehouse, 2006). This represents the first formal invertebrate survey of the site. Two survey visits recorded sixteen Nationally Scarce and two Red Data Book species on the section of cliff, including the mining bees *Andrena proxima* (RDB3) and *Lasioglossum nitidiuscula* (RDB3).

Figure 29. Eroding cliff at the northern end of Kessingland
© Ivan Wright

Of the 91 species of aculeate Hymenoptera (bees and wasps) recorded during this survey, seven are Grade 3 soft cliff associates: *Andrena humilis* (Na), *A. proxima* (RDB3), *Lasioglossum xanthopum* (Nb), *L. malachurum* (Nb), *L. puncticolle* (Nb), *Sphecodes rubicundus* (Na) and *Nomada fucata* (Na). The 2005 SSSI citation does not mention the invertebrate fauna of the site as an interest feature, however from this survey, which post-dates notification, it is clear that the site is of regional and possibly national importance for its invertebrate assemblage.

A significant proportion of the **Corton** cliff-line has been subject to coast protection works. These consist of wooden revetments, or harder structures in the form of rock armour or concrete sea wall (fig. 30). Behind the more intermediate structures there is some useful invertebrate habitat due to the unstable nature of the sandy cliffs. The cliffs behind the hard defences are of less value to invertebrates. Where the cliffs are allowed to function naturally the habitat would seem to be of a higher quality.

Figure 30. Sea defences at Corton © Ivan Wright

We have few invertebrate records for this site, however it is known to support the Grade 3 cuckoo bee *Sphecodes reticulatus* (Na), and the leaf-cutter bee *Megachile leachella* (Nb). Buglife are surveying this site in 2007.

In conclusion

Suffolk's coastal soft cliff sites have the potential to be of regional and national importance for their invertebrate populations. Although they generally lack the freshwater habitats of Norfolk sites, they often have a more favourable aspect, which is reflected in impressive bee and wasp faunas. From just two survey visits to Kessingland we have recorded just under 100 species of bees and wasps, including seven soft cliff associates.

However, Suffolk's soft cliff sites are chronically under-surveyed. A lack of understanding of the ecology of the county's soft cliffs is a threat in itself to the future management of these sites. Without information on the significance of these sites in terms of wildlife and biodiversity value, they will continue to be neglected and at risk of damage and destruction through inappropriate management of the coast and its immediate surroundings. Buglife recommend that a priority for the management of the Suffolk coast should be that invertebrate surveys are completed of all soft cliff sites.

The current threat to Suffolk's remaining unprotected soft cliffs from coastal protection would appear to be relatively low. At Dunwich the rate of cliff erosion has actually slowed in recent years as natural shingle banks have built up (Pye & Blott, 2006). Where demand would be highest – around urban or 'built up' areas, coast protection schemes have already been constructed. These schemes, with associated cliff reprofiling and the planting of non-native plants have damaged a significant proportion of Suffolk's soft cliff resource. However some sections may retain some ecological interest, particularly where some instability still remains (for example at Corton) and cliff top management is favourable. Should the opportunity arise to free up such sites they may have the potential to be restored to a more natural state.

Cliff top management is a significant issue in Suffolk. Approximately 20% of cliff tops in Suffolk comprise agricultural land, 40% are semi-natural habitat principally scrub, woodland, heathland or acid grassland. The remainder is developed land (Suffolk Biodiversity Partnership, 2003). Arable farming and outdoor pig rearing produce nutrient rich run-off which can alter the composition of cliff slope plant communities. These agricultural practices also provide little in the way of resources for invertebrates. Where intensive agriculture or intensive management for amenities such as golf courses or caravan parks extends to the cliff top, buffer strips of herb-rich semi-natural cliff top grassland should be re-established.

Work by Natural England into coastal access provision (Thompson, 2007) has included the Suffolk coast as a study area. These studies will help to advise on how best to improve access to coastal land in England. Coastal access routes can be incorporated into cliff top buffer strips providing benefits for people and wildlife. There are many opportunities for achieving this on the Suffolk coast. More information on cliff top management and coastal access can be found in Section 6.2.

4.10 Norfolk

The Norfolk coastline features approximately 29km of soft cliff (Lambley, 1997). Although large sections have been subject to various coast protection schemes and it has been estimated that only 12.7 km of the Norfolk soft cliffs remain unprotected (Pye & French, 1993). The cliffs rise above the shingle at Weybourne in the west and continue eastwards past Sheringham, West Runton, East Runton, Cromer, Overstrand, Trimingham, Mundesley and Happisburgh. The most heavily protected cliffs are around the settlements; other sections of coast feature more intermediate structures in the form of timber palisades.

The North Norfolk coastline is primarily composed of glacial deposits underlain by Chalk bedrock, although this Chalk is only visible at Weybourne and East Runton, and at West Runton at low tide. The glacial deposits of permeable sand and gravels are layered with impermeable clay layers. This causes water to pond and discharge from the cliff face at intervals. The accumulating water also forms saturated layers within the cliff itself causing mud slides, landslides and rotational slips.

The Norfolk soft cliffs are of national, and in many instances international, importance for their geological interest. The cliffs between Cromer and Mundesley are also nationally important for their geomorphological interest demonstrating rotational landslips and other aspects of mass movement. The coast is also known for its fossil interest, in particular the Cromer Forest Beds which are currently exposed at Weybourne, West Runton and Mundesley.

Figure 40. The ground beetle *Nebria livida* – recorded during nocturnal surveys in 2006.

It would not be entirely accurate to describe the invertebrates of the Norfolk soft rock cliffs as poorly known. One of the two main beetle specialities of the Norfolk cliffs, the ground *Nebria livida*, was known from Cromer in the 1800s (Fowler, 1887). The other main beetle speciality, the tunnelling rove beetle *Bledius filipes*, was described as new to science from Norfolk by Sharp in 1911. Whicher (1953) visited various sites in the county to record beetles. The Norfolk cliffs have remained on the 'entomological map' ever since. However, despite the Norfolk cliffs being some of the better studied in the UK, there has never been a published account of the entomological interest of these cliffs and until recently they have not been subject to any formal entomological survey.

The Norfolk soft cliffs begin to the east of **Weybourne** where a shingle beach is backed by low cliffs of soft Chalk overlain by glacial deposits. From Weybourne to **Sheringham** these cliffs rise to 10-20m high. Along this section the cliff faces are steep with very little in the way of undercliff. The cliffs are dry and sandy and are eroded by wave action and weathering. There are historical records for the Grade 2 ground beetle *Nebria livida* (Na) from the cliffs at Sheringham, although this species

Figure 41. Golf course to the east of Sheringham, widening the cliff top buffer strip would be of benefit to wildlife.

has not been recorded here since 1979. The cliffs have never been subject to any intensive invertebrate survey, although the lack of vegetation and seepage habitats on the cliff face will limit the invertebrate fauna. Weybourne cliffs are notified as a SSSI for their geological interest.

A large golf course covers most of the cliff top to the east of Sheringham, and along the cliff edge there is a narrow buffer strip of semi-natural grassland incorporating a cliff path (fig. 41). Widening this buffer strip would be of benefit to the ecology of the cliffs below.

To the east of Sheringham the cliffs continue to rise and reach around 50m at Beeston Regis before dropping again to 10-20m high. Wooden revetments stretch along the beach away from the foot of the cliff until reaching **West Runton**.

As already mentioned, West Runton is well known for its geological interest; the cliffs here have yielded many invertebrate and vertebrate fossils including the “West Runton Mammoth” - a Steppe Mammoth *Mammuthus trogontherii* which was excavated in 1995.

Figure 42. Looking east from West Runton Gap.

The cliffs at West Runton are divided by a defended slipway. To the west of the slipway the cliffs are rather dry, sandy and steep (fig. 42) with few freshwater seepages. The vegetation has a calcareous influence featuring plants such as common restharrow *Ononis repens*.

Damp, fresh cliff faces are riddled with thousands of burrows of *Bledius* rove beetles; it is here that we recorded the RDB1 soft cliff obligate *Bledius filipes* in 2006. This species is known in the UK only from the Norfolk soft cliffs; West Runton is the best known site.

Figure 43. A flush to the east of the slipway at West Runton, *Symplecta chosenensis* was recorded here in 2006. © Mark Telfer

To the east of the slipway the cliffs are of a similar profile, however they are undefended and feature a number of freshwater seepages (fig. 43). Flushes on this section support populations of the soft cliff obligate cranefly *Symplecta chosenensis* (RDBK) (Howe *et al*, 2006; Telfer, 2006a).

West Runton also supports populations of the Nationally Scarce beetles *Nebria livida* (Grade 2), *Asaphidion pallipes,* and *Dyschirius thoracicus*.

The recent report by Buglife (Telfer, 2006) found West Runton to have an invertebrate assemblage of national importance, perhaps the most significant soft cliff site on the Norfolk coast on account of the presence of rare species.

East Runton is also notified as a SSSI for its geological interest, in particular as the source of an impressive haul of vertebrate fossils. Much less is known about its current ecology, and we have little invertebrate data for this site beyond some historical records of *Nebria livida*. The cliff profile and available habitats at East Runton are similar to that of West Runton, although there are fewer seepages.

Figure 44. Overstrand cliffs

The cliff section from Cromer to **Overstrand** provides an excellent variety of habitats for invertebrates. Rotational slumping is frequent here, far more so than anywhere else on the Norfolk coast. This has created a broad undercliff, with occasional ponds or patches of fen vegetation including common reed *Phragmites australis* - a habitat rarely found elsewhere on the Norfolk cliffs. The rather large volume of water, responsible for the rotational slumping, manifests as a large number of flushes or seepages - approximately one for every 10 metres of cliff (fig. 45).

In between the wetland habitats, Overstrand has an excellent mix of bare ground features, including bare faces and loose fallen material, with ruderal vegetation and more mature herb-rich grassland. There is evidence of calcareous influence, both in the presence of calcicolous plants and tufa-depositing seepages. Towards Cromer there are large patches of scrub on the cliff slopes and dotted along the section there are patches of invasive Sea buckthorn *Hippophae rhamnoides*. We recommend that the Sea buckthorn is controlled to ensure that it does not smother the more open habitats of the cliff slope.

There have been two formal invertebrate surveys of Overstrand cliffs in the recent past. Ellis *et al* (2004) recorded the ground beetle *Asaphidion pallipes* (Nb) and the Bee-wolf *Philanthus triangulum* (RDB2 – although status is in need of revision). Recent Buglife surveys (Telfer, 2006) recorded 10 Nationally Scarce species. These included the Grade 3 soft-rock bee *Andrena humilis* (Na) and the ground beetle *Nebria livida* (Na, Grade 2). Other Graded soft cliff species known from the site include *Bledius filipes* (RDB1, Grade 1), the digger wasp *Argogorytes fargei* (Na, Grade 3) and the cranefly *Gonomyia conoviensis* (Nb, Grade 3). Overstrand is also the site of the first record on mainland Britain of the Grade 2 soft cliff woodlouse *Eluma purpurascens* (Nb) (Harding, 1976).

Figure 45. Seepage at Overstrand.

Overstrand cliffs are notified as SSSI, in part for their soft cliff invertebrate fauna, the cliffs are also notified as a SAC for the maritime cliff and slope habitat. The coast protection works designed to protect Overstrand village have destroyed a significant section of the cliff, however where the cliffs is allowed to function naturally they still support an invertebrate fauna of national importance. Intermediate defence works in the form of a permeable wooden palisade also feature. These have reduced cliff mobility but not completely halted recession and land slippage. Here conditions are currently favourable from an invertebrate aspect, but in the longer term the situation may deteriorate, a matter that requires monitoring.

To the west of Overstrand a large proportion of the cliff top is currently managed as a golf course. Introducing a cliff top buffer strip will enhance the cliff slope ecology here and would improve the experience for walkers using the cliff top path.

Between Overstrand and **Trimingham** the cliffs are generally undefended. They are up to 70m high and feature impressive rotational slips and mudslides. At Trimingham the cliffs are slightly lower at about 60m, with some large mudflows. There are fewer freshwater seepages than at Overstrand and there are marked differences between defended and undefended sections (figs 46 and 47).

On both the defended and undefended sections at Trimingham, a range of soft cliff habitats are represented including bare ground, herb-rich grassland, and freshwater habitats associated with the seepages. However, the difference in erosion rates means that these habitats are represented in different proportions. Early successional habitats are better represented on the undefended section, whilst more closed grassland tends to be more dominant on the defended cliffs.

Soft cliff species recorded at Trimingham include the Grade 2 woodlouse *Eluma pupurescens* (Nb), and Grade 3 species the Digger wasp *Argogorytes fargei* (Na) and ground beetle *Bembidion stephensii* (local). There are historical records for the Grade 1 rove beetle *Bledius filipes*. *Nebria livida* has been reliably recorded here for some time. During the 2006 surveys it was recorded on both the defended and undefended cliffs, although more abundant on the undefended section. The undefended cliff at Trimingham produced the highest numbers of this species for the survey. A rich seepage fauna is also present on the site, including the RDB3 Dolichopid fly *Hydrophorus viridis*. The rich invertebrate fauna on these cliffs is recognised in the SSSI citation for Sidestrand-Trimingham cliffs.

Surveys by Buglife in 2006 (Telfer, 2006) compared the defended and undefended cliffs at Trimingham to study the impact of coast protection on soft cliff ecology. This work represents the only work ever undertaken to study the impact of coast protection on soft cliff invertebrate faunas. The study found the habitats of the undefended cliff to support a richer and better quality assemblage of invertebrates than the defended cliff. The reduced erosion of the defended cliff has lead to a reduction in bare ground, open flushes and early-successional vegetation. This has in turn been reflected in a smaller invertebrate assemblage containing fewer scarce and habitat-specialist invertebrates.

Figure 46. Much of the undefended cliff at Trimingham is subject to rapid erosion and is devoid of vegetation.

Figure 47. Along most of its length, the defended cliff has flowed out to meet the revetments. This picture shows an area of accessible toe habitat - a habitat feature absent from the adjacent undefended section.

Clearly the coast protection at Trimingham is having an influence on the invertebrate fauna of the site, however the situation is far from simple. Although the defended section supports a lower number of specialist invertebrates, it is still providing regionally important habitat for more common species. Any changes to coast protection at this site should be carefully considered, should the decision be made to ‘free up’ this site, as suggested by Lee *et al* (2001) and the Kelling to Lowestoft SMP (Anglian Coastal Authorities Group, 2005), then this should be well managed so that the change in erosion rate is gradual, and the impacts on invertebrates must be monitored.

The majority of the cliff top between Trimingham and Overstrand is under intensive arable agriculture, which extends to the cliff edge. As with other sites in Norfolk suffering from insensitive cliff top management, the site would benefit from a cliff top buffer strip of semi-natural grassland. Arable reversion is likely to be fundable through agri-environment schemes or Natural England's Wildlife Enhancement Scheme (WES). The cliff top at Trimingham currently has no public access, Natural England's new coastal access aims could provide an ideal opportunity to combine new coastal access with cliff top buffer strip to benefit both the public and wildlife.

The majority of the cliff length at **Mundesley** has been stabilised through the construction of coast protection. Various forms of cliff protection are present on the entire length of cliff from Mundesley to Walcott Gap. For the most part the cliffs are characterised by coarse grassland vegetation and scrub – habitats that are of little value to soft cliff invertebrates. Invertebrate records are few for this stretch of coast, and due to the damage caused by the coast protection it would not be considered as a priority site for future survey work. There are historic records for *Nebria livida* (Cox, 1921), although it is doubtful whether suitable habitat for this species still exists. Apparently the cliff slopes still support good numbers of more common species, and the overall invertebrate biomass is relatively high - the cliffs between Mundesley and Bacton are a major foraging site for Barbastelle bats *Barbastella barbastellus* (Parsons *et al*, 2001). Mundesley cliffs are notified as SSSI for their geological interest.

Cliffs at **Happisburgh** are notified as SSSI for their geological exposures. The rate of erosion would seem to be rather high here, with Poulton (2004) estimating erosion rates of up to 8m per year in places. The same article suggests that these high erosion rates are due in part to coast protection elsewhere on the Norfolk coast.

The fast eroding cliffs are vertical with little undercliff or cliff slope vegetation. They are likely to be of limited interest for invertebrates. Although there are historical records for *Nebria livida* at Happisburgh, this species has not been recorded here since the 1960s.

Management

The main threat to soft cliffs on the Norfolk coast is the construction or strengthening of coast protection. Coast protection works designed to protect various settlements along the Norfolk coast have damaged and destroyed a significant proportion of the soft cliff resource. Species such as *Nebria livida,* once distributed along the entire length of the coast from Weybourne to Happisburgh, now appear to be restricted to the remaining unprotected stretches. Where the cliffs continue to function naturally they still support invertebrate faunas of national importance.

The recently produced Kelling to Lowestoft Shoreline Management Plan (Anglian Coastal Authorities Group, 2005) made recommendations for 'freeing up' a number of sections of the Norfolk coast from coast protection in the medium to long term. At the time of writing the political implications of such recommendations have resulted in the SMP not being adopted by North Norfolk council. The future of the North Norfolk soft cliffs remains uncertain for now.

Cliff top management is another issue in this region, with the majority of cliff tops being under management that degrades or threatens to degrade sites. Reversion of cliff top land use to herb-rich cliff top grasslands is recommended for sites identified in the preceding text. This can be achieved through the use of flexible cliff top buffer strips that can retreat inland with the eroding cliff line. Cliff top buffer strips can be combined with coastal access schemes so the changes in land management benefit both people and wildlife. With the proliferation of intensive arable agriculture, golf courses, and other water-hungry land uses inland of many of the Norfolk soft cliff sites, the impact of freshwater abstraction is a potential threat to a number of sites. A high proportion of Norfolk's specialist soft cliff fauna are dependant on freshwater seepage habitats on the cliff slope. If the quantity or quality of freshwater supply to the cliff slopes is reduced by human activities then this must be considered as having a detrimental impact on the quality (or condition) of soft cliff SSSIs, and appropriate action needs to be taken. As such we recommend that an assessment is made of all abstraction licences within the catchment areas of East and West Runton, Overstrand, Sidestrand and Trimingham cliffs.

In summary, the Norfolk soft cliffs are of regional and national importance for their invertebrate assemblages. From available invertebrate data, West Runton, Overstrand and Trimingham cliffs are of national importance. These sites support a specialised fauna of eroding Boulder Clay cliff specialists such as the ground beetle *Nebria livida* and cranefly *Symplecta chosensis*, they are also the only UK location for the rove beetle *Bledius filipes*. All three species are associated with hydrological features such as freshwater seepages.

Sustainable shoreline management policies are the key to the protection of the nature conservation interest of these cliffs. Any expansion of the existing coast protection structures should be resisted, especially on priority sites. The 'freeing up' of sites when current structures come to the end of their lifespan may create useful soft cliff habitat. However any changes should be gradual and carefully monitored. Current coast protection continues to cause changes to cliff top habitats and their invertebrate faunas, and their environmental impacts should be monitored, particularly at Overstrand and Trimingham.

Improved cliff top management will enhance the biodiversity of sites. The cliff tops are widely under intensive agriculture, or caravan parks and golf courses. Reversion of cliff tops to semi-natural grassland should be a conservation priority; this could be achieved through the introduction of buffer zones.

Water quality and water supply are of high significance on these sites, where much of the invertebrate interest is dependent on hydrological features. Groundwater abstraction for agriculture and other uses must be monitored and managed to ensure no impact on the ecological functioning of the cliffs.

4.11 Yorkshire

The Yorkshire coast has over 87km of soft cliff; this can be broken down into the Holderness coast (54km) and N Yorkshire (33.2km) (Pye & French, 1993).

The Yorkshire soft cliffs have long been recognised as being of entomological interest for quite some time. The cliffs of glacial deposits around Bridlington and Scarborough were reported as sites for the soft cliff specialist ground beetle *Nebria livida* in the 1850s (Dawson, 1854). However, much of the resource has not been subject to many formal invertebrate surveys beyond National Trust biological surveys (National Trust, 1988, 1989a, 1989b, 1996; Crossley, 1990a, 1990b; Lister & Alexander, 1997), recent Buglife surveys (Telfer, 2006b) and a couple of independent studies (Archer, 2002; Norris, 2002). These surveys are very localised, concentrating on better known sites such as Cayton Bay. For most sites, and most taxonomic groups, there has been no formal survey.

The **Holderness coast** has more than 20% of England's soft cliff habitat. The cliffs here are generally low and steep, and experience some of the fastest erosion rates in Europe. The Holderness coast has been retreating at an annual average rate of 1.8m since 1852 (Lee, 1995). The process of erosion here has been estimated to supply approximately 10% of the total suspended sediment load of the North Sea per year. This input may be highly significant to the maintenance of not only the Humber, but also The Wash and even the low lying coasts of the Netherlands, Germany and Denmark (English Nature, 1997).

In general the erosion rate along the Holderness coast is so high that the cliffs are of limited interest for invertebrates. The cliffs are simply eroding too fast for vegetation to develop. However, where beach sediment has built up to provide some natural protection from sea erosion, some pioneer communities have been able to develop. Bee and wasp records from this coast are few and far between but the beetle fauna is better recorded. There are records of some soft cliff species including the Grade 2 burrowing rove beetle *Bledius dissimilis* (RDB1) recorded at Barmston. The grade 2 soft cliff ground beetle *Nebria livida* (Nb) has also been recorded on this coast with recent records at Barmston, Fraisthorpe and Holmpton, and historical records at Skipsea.

The cliff top land use along the Holderness coast is predominantly arable agriculture. The high retreat rate has left the vast majority of the cliff line with little or no semi-natural cliff vegetation. The creation of a strip of cliff top grassland may provide some habitat enhancement to the invertebrate fauna of the cliffs. However, the high erosion rate is the main limiting factor on the ecological interest of these cliffs, thus it is debateable whether cliff top improvements would have a significant benefit.

There are sections of soft cliff along the **Humber Estuary** but as they are not strictly coastal they have not been included in this report. However it is worth noting that they provide some of the best such habitat between the Norfolk coast and the Reighton cliffs north of Flamorough Head.

Flamborough Head is famous for its chalk cliffs and seabird colonies. The Chalk is capped by glacial till of varying depths, although this material is rarely in reach of the sea. Although not soft cliff in the strictest sense of our definition, this material is certainly providing useful invertebrate habitat on account of its instability. The most substantial sections of this capping material are at Sewerby cliffs, South Landing, Selwicks Bay, North Landing and Thornwick Bay. We have few invertebrate records for these sites, although there are records of the soft cliff ground beetle *Nebria livida* (Grade 2, Nb), the craneflies *Idiocera bradleyi* (Grade 2, RDB2), *Dicranomyia goritiensis* (Grade2, RDB3) and *Gonomyia conoviensis* (Grade 3, Nb) from Sewerby cliffs (Roy Crossley pers comm.).

To the north of Flamborough Head an extensive section of soft cliff extends from the end of the Chalk cliffs near Speeton to Filey. This large and varied site includes **Speeton Cliffs**, **Black Cliff**, **Reighton Gap** and **Hunmanby Gap**. The cliffs between Reighton Gap and Black Cliff are particularly extensive and have been recently surveyed by Buglife (Telfer, 2006b). There is considerable bare ground on these cliffs from active erosion, as well as areas of sparse ruderal vegetation, established grassland and patches of scrub and woodland further inland. There are many flushes creating a variety of wetland habitats from bare, wet sediments to well established ponds with dense emergent vegetation. A number of Nationally Scarce invertebrates have been recorded at this site, particularly beetles associated with groundwater seepages such as the Grade 3 soft cliff ground beetle *Bembidion stephensii,* the water beetle *Georissus crenulatus* (Na) and the horsetail weevil *Grypus equiseti* (Na). Seepage-associated flies are also well represented including two soft cliff craneflies *Gonomyia conoviensis* (Grade 3, Nb) and *Symplecta chosenensis* (Grade1, pRDB1) (Chandler & Crossley, 2003), and the Nationally Scarce soldierflies *Oxycera morrisii* (Nb), *O. pygmaea* (Nb) and *Stratiomys potamida* (Nb). *Nebria livida* appears not to have been recorded from the site despite the presence of suitable habitat, although there is a 1950s record for ‘Filey Bay’ which could refer to the site (Telfer, 2006b). Given the amount of high quality invertebrate habitat at the site we recommend that further surveys are carried out, particularly for bees and wasps, and for *Nebria livida*.

Figure 48. Speeton Cliffs

The cliffs south from Reighton Gap fall within Flamborough Head SSSI; north of this point to Filey there is no statutory protection. Significant sections of the cliff top here are taken up by caravan and camping sites. Adjacent to these holiday parks there is little natural cliff top habitat and localised environmental impacts of litter and water pollution.

There are further unprotected soft cliffs between **Filey and Filey Brigg**. They are rather steep and are of lesser quality than those to the south of the town. However, we have no ecological data for this site. Parts of this section have been stabilised and artificially drained on a seemingly *ad hoc* basis. Any plans for further cliff protection work should be subject to an environmental impact assessment to include invertebrate surveys. Although Filey Brigg is an SSSI, the cliffs between the Brigg and the town are outside of statutory protection.

Gristhorpe Cliffs are under-recorded for invertebrates and little is known about the ecological value of the site. *Nebria livida* was recorded here in the late 1940s but there are no recent records at the site. Most of the site falls within Gristhorpe Bay and Red Cliff SSSI which is notified for its geological interest. The majority of the cliff top here is developed as a holiday park and there is very little semi-natural cliff top vegetation. We recommend that this site is surveyed in the near future.

Cayton Bay is one of the better studied sites of the Yorkshire coast. The SSSI citation for this site (part of Cayton, Cornelian and South Bays SSSI) notes the soft cliff invertebrate assemblage as a notification feature and states "*The Cayton and Cornelian Bay area is believed to have the richest invertebrate fauna of ground beetles and soldier flies associated with soft-rock cliffs in the whole of Northern England*".

Figure 49. South Cliff, Cayton looking north.

The southern section of the site, known as Tennants' Cliff, would seem to be of greatest interest. Unstable Boulder Clay creates patches of bare or sparsely vegetated ground which combined with wet seepage habitats (bare muds, calcareous seepages, pools) creates a mosaic of high value to invertebrates. The cliff slope grassland is floristically diverse with calcicolous plants such as Pyramidal Orchid (*Anacamptis pyramidalis*) and Quaking grass (*Briza media*). Surveys by Buglife (Telfer, 2006b), the National Trust (Crossley, 1990b), and Archer (2002) have recorded a number of rare and Nationally Scarce invertebrates on Tennants' Cliff. These include a large number of species associated with seepage habitats such as the rare water-penny beetle *Eubria palustris* (Grade 3, RDB3), the ground beetles *Bembidion saxatile* (Grade 2, Nb) and *B. stephensii* (Grade 3), and the soldierflies *Oxycera morrisii* (Nb), *O. pygmaea* (Nb) and *Stratiomys potamida* (Nb). The soft cliff ground beetle *Nebria livida* has been recorded in Cayton Bay although it has not been recorded here since 1985. Crossley (1990b) recorded the RDB3 long-headed fly *Medetera inspissata* at the site along with 15 Nationally Scarce flies. Solitary bees and wasps are also an important feature of this site (Archer, 2002).

The central cliff section of Cayton Bay is more stable but still features a number of small landslips and seepages, along with herb-rich grassland. Less data is available for this section, however, given the close proximity to Tennants' Cliff and the availability of similar habitats the invertebrate fauna is likely to be of similar high value. The cliff slope has been grazed in the past (Lister & Alexander, 1996) an activity which should maintain the more stable areas of grassland and prevent scrub invasion. Future grazing should be managed with the botanical and invertebrate interest in mind.

The north end of Cayton Bay is more stable and is dominated by scrub and semi-natural woodland. This area of scrub and woodland is likely to be of ecological interest in its own right though not for pioneer or open habitat soft cliff invertebrates.

Cornelian Bay to the north is of similar high value to soft cliff invertebrates. The southern end of the site is dominated by scrub and woodland whilst to the north the cliffs are less stable and bare ground, pioneer habitats and open grassland are more common. Recent Buglife surveys (Telfer, 2006b) concentrated on the northern end of the bay, in particular the undercliff and landslips of Frank Cliff. A number of Nationally Scarce invertebrates have been recorded at this site, including the water beetle *Georissus crenulatus* (Na) and the hoverfly *Xanthandrus comtus* (NS), along with the soft cliff ground beetle *Bembidion stephensii.* Solitary bees and wasps are of particular interest at Cayton with 59 species being recorded here including the digger wasps *Ectemnius ruficornis* (Nb) and *E. sexcinctus* (Nb), and the spider hunting wasps *Priocnemis cordivalvata* (Nb) and *P. schioedtei* (Nb) (Archer, 2002).

Figure 50. Cornelian Bay.

Moving north from Scarborough, the stretch of coast from **Scalby Mills to Creek Point** has significant sections of soft cliff interspersed with harder geology. The site forms part of Iron Scar & Hundale Point to Scalby Ness SSSI, which is notified for its geological interest. There are historical records for the ground beetle *Nebria livida* from Scalby, but otherwise invertebrate records for this coast are few, probably due to access problems.

Hayburn Wyke and **Little Cliff** (Hayburn Wyke SSSI) feature Boulder Clay cliffs which are susceptible to landslippage. Groundwater seepage habitats feature here as well as bare ground, open grassland, heath, scrub and woodland. There are records of two Grade 3 soft cliff species from the sites: the ground beetle *Bembidion stephensii* and the squash bug *Enoplops scapha*. The seepage-associated soldierflies *Oxycera pardalina* (NS) and *O. pygmaea* (Nb) are also present (Crossley, 1990a; National trust, 1996).

Beast Cliff (part of Robin Hood's Bay: Maw Wyke to Beast Cliff SSSI) is a large and inaccessible site. Vertical cliffs in resistant rock drop down to ledges and extensive landslips of less resistant material. The site is of national importance for its coastal woodland, which dominates much of the site. This woodland is an important invertebrate habitat in its own right, along with the many seepage streams. There are also areas of pioneer vegetation on recently slumped ground, herb-rich grassland, dry heath, bracken, scrub, flushes and several pools (National Trust, 1989b). Access to the site is not for the faint hearted and predictably the inverts are little recorded bar some ad hoc visits including those reported in a paper on the mollusc fauna (Norris, 2002). The names 'Beast Cliff' and 'Common Cliff' suggest that the undercliffs were grazed historically (Rimington, 1988).

Ravenscar (part of Robin Hood's Bay: Maw Wyke to Beast Cliff SSSI) features sections of slumping soft cliff with the associated bare ground and pioneer habitats, seepages and areas of species-rich grassland. The site has been used for rough grazing in the past, although it is not known when grazing ceased (National Trust, 1989a). Sections of **Robin Hood's Bay** itself are composed of Boulder Clay cliffs, although these are generally rather steep and lack undercliffs. There are no records of graded soft cliff invertebrates from either of these sites.

Saltwick Bay (part of Whitby-Saltwick SSSI), and the section of coast between Whitby and **Sandsend** both feature slumping soft cliff, we have no ecological information for these sites.

Management Recommendations

The majority of Yorkshire soft cliffs sites fall under statutory protection as SSSIs. Coastal protection is scattered and localised along the Yorkshire coast, generally only present near significant centres of population such as the towns of Bridlington, Filey and Scarborough. For most of the Yorkshire coast natural coastal processes are allowed to take their course and achieve a natural balance.

The invertebrate fauna of the Yorkshire soft cliffs has similarities to those of the North Norfolk coast. Arguably, this could be described as a North Sea soft cliff assemblage with the predominant interest being seepage associates, and in particular ground beetles. The seepages, trickles and flushes support an important part of the invertebrate interest of coastal soft cliffs in general. This is especially so for the Yorkshire fauna. These hydrological features are perhaps also the most vulnerable features at sites like Cayton Bay, Cornelian Bay and Reighton. Drainage, water abstraction and other hydrological changes inland of soft cliffs should take into account the potential impact on cliff habitats and species. The presence and flow of water on the cliffs, and the presence and abundance of seepage-dependant invertebrates should be included as part of site monitoring.

Changes in cliff top management could improve a number of sites. There are a number of sites with substantial camping or caravan parks on the cliff top – Gristhorpe Bay, Hunmanby Cliffs and Reighton Cliffs included. The introduction of wide strips of cliff top grassland would enhance the invertebrate fauna of the cliff slope, and buffer any potential impacts of localised pollution to cliff water supply, and litter. Where arable land extends to the eroding cliff edge reversion to semi-natural cliff top grassland should be considered.

Despite targeted survey work, recent Buglife surveys have been unsuccessful in recording the soft cliff ground beetle *Nebria livida* from the north Yorkshire coast. This species is somewhat of a Yorkshire soft cliff speciality with the only other consistent UK sites being Norfolk soft cliffs. However, it has not been recorded north of Flamborough Head since 1985. This species is nocturnal and arguably difficult to locate without undertaking nocturnal fieldwork; nevertheless, it is large and distinctive. A lack of records from this stretch of coast for over 20 years is a major concern – it is possible that the species is now extinct in this region. We recommend that targeted surveys are carried out at historic sites for the species (Cayton Bay, Gristhorpe Bay, Filey Bay), and those with suitable habitat (Cornelian Bay, Reighton-Speeton Cliffs).

4.12 Northeast England

The northeast coast of England features an estimated 13.55km of soft-cliffed coast (Pye & French, 1993). This breaks down by county into Cleveland 3.45km, Durham 8km, and Northumberland 2.1km.

The two main sections of soft cliff on the Cleveland coast are at **Stone Gap** and **Redcar**, the principle geology at both sites is glacial till. These two Cleveland sites are some of the few unprotected soft cliff sites in England of size that are not notified as SSSI.

The Durham Coast features soft cliffs of varying heights and geologies, Pye and French (1993) highlight **Nose Point - Chourdun Point** (glacial till), **Seaham** (glacial till) and **Hendon - Ryhope** (shales). These sites are within the Durham Coast SSSI and SAC.

Soft cliffs on the Durham coast are known to support populations of the soft cliff ground beetle *Bembidion stephensii* (Grade 3) and the Chalk Carpet moth *Scotopteryx bipunctaria cretata* (NS, UKBAP, Grade 3), plus the Shrill carder bee *Bombus sylvarum* (Nb, UKBAP) and the Durham Brown Argus butterfly *Aricia artaxerxes salmacis* - a sub-species of the Northern Brown Argus. The cliffs also have an invertebrate fauna associated with freshwater seepages: species include the Nationally Scarce soldierflies *Oxycera morrisii*, *O. pygmaea* and *Stratiomys potamida*. Selected Durham soft cliff sites are being surveyed by Buglife in 2007, preliminary results include the first county record of the soft cliff cranefly *Symplecta chosenensis* (RDBK, Grade 1) (Telfer & Gibbs, *in prep*).

The Northumberland Shore SSSI features sections of soft cliffs. Elsewhere in the county **Newbiggin** cliffs feature a 1.5km section of glacial till cliffs. We have no data for these sites.

4.13 Northwest England

The northwest coast of England has a minor amount of unprotected soft cliff; sections are short and rather isolated. Invertebrate records for soft cliff sites in this region are limited; however they do feature a number of soft cliff specialists, and the sites warrant further survey.

Within the Mersey Basin there are limited sections of soft cliff, amounting to approximately 20ha. (Tomlinson, 1997). Of most interest is the eastern shore of the **Dee estuary** where there is a stretch of Boulder Clay cliffs between Heswall and Hoylake. These cliffs have been recognised for their geological importance through the notification of the Dee Cliffs SSSI. There are also sections of Boulder Clay cliffs with freshwater seepages on the northern side of the **Mersey estuary** (also SSSI). In both cases the notified biological interest is restricted to botanical.

Further north the next significant stretch is that between **Silecroft** and **Annaside** in Cumbria, also known as Gutterby Banks. This site has been notified as SSSI but only for its geology. A number of Nationally Scarce ground beetles and water beetles have been recorded on this site, although none are known to be soft cliff specialists. This is one of two sites in Cumbria where the cranefly *Symplecta chosenensis* (RDBK, Grade 1) has been recorded, a species which has only recently been recorded in the UK on cliffs in Cumbria, Durham, Wales, Yorkshire and Norfolk (Chandler & Crossley, 2003; Howe *et al*, 2006; Telfer and Gibbs, *in prep*), in all cases on Boulder Clay.

To the south of St Bees, but within **St Bees Head** SSSI, is a section of unprotected soft cliff of approximately 1.4km (Pye & French, 1993) which is notified for its geological interest. The ground beetle *Bembidion saxatile* and the cranefly *Gonomyia conoviensis*, both of which are species associated with soft cliffs, have been recorded at this site. Unstable sections of St Bees Head itself support the only known UK population of the RDB1 ground beetle *Harpalus honestus* (Mark Telfer pers comm.).

4.14 Wales

A comprehensive review of the Welsh soft cliff resource and its importance for invertebrates was completed by the Countryside Council for Wales (CCW) in 2002 (Howe, 2002). This identified 123 coastal soft cliff sites representing 100km of coastline. A set of 26 priority sites was subsequently surveyed and assessed in terms of invertebrate conservation interest by CCW and Liverpool Museum (Knight and Howe, 2006). The most significant Welsh sites are summarised below and in Appendix 3. Much of the following information is derived from the two reports, these should be referenced for further detail.

4.14.1 Gwynedd

The coast of Gwynedd features over 44km of soft cliff – a significant proportion of the Welsh resource. The most dramatic feature is the Llyn Peninsula, much of which is designated as SSSI or within the Seacliffs of Llyn SAC. The most extensive sections of soft cliff on the Peninsula include Aberdaron Bay, Glanllynnau, Porth Ceiriad, Porth Neigwl, Porth Dinllaen, Porth Nefyn, and Porth Pistyll. The geology of the Llyn Peninsula is described by May (2003) with particular attention to Porth Neigwl. In addition to Howe (2002) and Knight & Howe (2006), the invertebrate interest of the Llyn Peninsula sites has been reported upon by Fowles & Boyce (1991), Fowles *et al* (1992), Fowles (1994), Clee (1995, 1999), Clee & Green (2000, 2001a, 2001b, 2002, 2003) and Edwards (1993).

Figure 51. Porth Neigwl on the Llyn Peninsular – the most important site in Wales for soft cliff invertebrates.
© Carl Clee

At **Porth Pistyll** cliffs of glacial sand and gravel range extend for about 1.5km along the coast. The cliffs range from 10-60m in height and are generally of a north-westerly aspect. Seepages and pools on an extensive undercliff support an important invertebrate fauna, wet bare ground and fen also feature. Soft cliff species recorded at the site include species associated with freshwater habitats such as the cranefly *Symplecta chosenensis* (RDBK, Grade 1), the ground beetle *Bembidion saxatile* (Nb, Grade 2) and the Mason wasp *Odynerus melanocephalus* (Na, pUKBAP) which utilises wet mud for nest building.

The soft cliffs at **Porth Nefyn** are similar in aspect and geology to those at Porth Pistyl. The section of soft cliff is approximately 3.2km long and features spring and seepage features, plus extensive areas of active slumping creating both wet and dry bare ground and pioneer communities. The site supports an important assemblage of moisture-loving flies and beetles, including the craneflies *Symplecta chosenensis*, *Idiocera bradleyi* (pRDB2, Grade 2) and *Dicranomyia goritiensis* (RDB3, Grade 2), and the ground beetle *Bembidion saxatile*.

Porth Dinllaen cliffs are lower than the previous two sites and are comprised of glacial sands and gravels. Seepage habitats are present with their associated faunas including *Bembidion saxatile*. Bare ground and pioneer vegetation featuring leguminous swards are habitats of particular importance, supporting a number of grade 3 bees and the Grade 1 weevil *Sitona gemellatus* (RDB1) at its only Welsh locality.

Porth Neigwl (or 'Hell's Mouth') is the most important coastal soft cliff site in Wales (Knight & Howe, 2006). The 6.5km of cliff support a variety of microhabitats including bare ground, sandy substrates, seepages, and extensive leguminous swards. This site, on the south of the Llyn Peninsula, supports 18 of the Graded soft cliff species, including three Grade 1 species. The Large mason bee *Osmia xanthomelana* (RDB1, UKBAP, Grade 1) is currently only known in the UK from here and neighbouring Porth Ceiriad. The ground beetle *Tachys micros* (Na, UKBAP, Grade 1) is restricted in Wales to Porth Neigwl, and the cranefly *Symplecta chosenensis* is known from only a few UK sites. The beetle fauna was highlighted on in the early 1990s (Fowles & Boyce, 1991; Fowles *et* al, 1992). The south-facing slopes suit important assemblages of aculeate Hymenoptera – including the Black-headed mason wasp *Odynerus melanocephalus*. The rich invertebrate fauna is not restricted to species affiliated with soft cliffs - to date 52 RDB and Nationally Scarce species have been recorded here.

Figure 52. Porth Neigwl.
© Carl Clee

Porth Ceiriad has many features in common with neighbouring Porth Neigwl, and supports a similarly impressive invertebrate fauna. Thirteen Grade 1-3 soft cliff species have been recorded here making Porth Ceiriad one of the most important soft cliff sites in Wales. Assemblages of aculeate Hymenoptera, beetles, and craneflies associated with seepages, bare ground and leguminous swards are of particular note. Species with an affinity to the soft cliff habitat recorded here include the Large mason bee *Osmia xanthomelana*, the craneflies *Symplecta chosenensis* (Howe & Howe, 2000) and *Dicranomyia goritiensis*, the mason wasp *Odynerus melanocephalus*, and the ground beetle *Bembidion saxatile*.

The Llyn Peninsula supports the most important soft cliff assemblages in Wales. These assemblages are entirely dependant on a continuity of suitable micro-habitats within the sites. In terms of management, natural processes of erosion and land-slippage should be allowed to continue on these sites - to stabilise these cliffs would be catastrophic for the invertebrate fauna. The quality and quantity of freshwater supply to the cliffs should be maintained undisrupted. Cliff top management should be aiming for extensive semi-natural flower-rich cliff top grasslands, providing ecological linkages between sites such as Porth Ceiriad and Porth Neigwl, and enhancing the biodiversity of the cliff slopes.

4.14.2 Ceredigion

The predominantly west-facing coast of Ceredigion features just over 12km of soft cliff. Howe (2002) identifies ten soft cliff sites along this coastline, with the priority sites being at Aberarth, Traeth Y Mwnt, and Creigiau Gwbert.

Aberarth and sites to the north tend to comprise steep, low-lying eroding cliffs of coarse glacial till with little vegetation and few springs and seepages. Many of the cliff top headlands are agriculturally improved and offer little in the way of forage resources for cliff-nesting aculeates. As such the invertebrate interest is rather limited. Two soft cliff ground beetles have been recorded here: *Bembidion saxatile* (Nb, Grade 2) and *B. stephensii* (Grade 3).

At the two more southern sites of Traeth Y Mwnt and Creigiau Gwbert sands and gravels are mixed with glacial tills, and cliff seepages are more frequent. As a consequence, a greater range of micro-habitats is present and cliff faces support both wet and dry pioneer vegetation.

Traeth Y Mwnt is a relatively short section (200m) of sandy cliffs ranging from 20-40m high. Nevertheless, the site is highly rated and supports 13 Graded soft cliff species including the seepage craneflies *Symplecta chosenensis* (RDBK, Grade 1), *Dicranomyia goritiensis* (RDB3, Grade 2) and *Idiocera bradleyi* (pRDB2, Grade 2). The site also supports a thermophilic Hymenoptera (bees and wasps) fauna including a number of Grade 3 species. Nearby 'set-aside' agricultural land towards the headland at Carreg Lydan is thought to enhance the site by providing pollen and nectar sources.

Creigiau Gwbert is a larger site of 1km with numerous seepages, flushes and areas of fen vegetation. More stable sections support patches of scrub. Part of the site has been damaged in the past – a section of cliff was reprofiled to protect a minor road. Any further attempts to prevent natural processes on this site should be resisted. Creigiau Gwbert supports five Grade soft cliff species including the craneflies *Dicranomyia goritiensis* and *Idiocera bradleyi*.

The soft cliff sites of Ceredigion support regionally and nationally important invertebrate assemblages. Sections of cliff have been destroyed in the past through coast protection works, this could be a threat in the future. Where appropriately managed cliff top habitat could enhance sites, like at Traeth Y Mwnt, opportunities for restoring semi-natural cliff top habitat should be identified.

4.14.3 Pembrokeshire

Coastal soft cliff is relatively scarce in Pembrokeshire, which is more well-known for its hard rock cliffs. The coastline measures 352km, only 4.6km of which is soft cliff –

this is divided between many small sites. Godfrey (2002) reported on the invertebrate interest of a number of Pembrokeshire sites.

Whitesands Bay is a small (150m) section of thin glacial till deposits overlying hard sedimentary rock. Bare ground and seepages are frequent, and the cliff top is dominated by grassland. Three soft cliff species have been recorded here including the RDB3 cranefly *Dicranomyia goritiensis* (Grade 2).

The cliffs at **Druidstone Haven** represent the largest soft cliff site in Pembrokeshire. The west-facing, partially-vegetated, slumping cliffs of glacial till with sands and gravels feature seepages and streams, bare ground, pioneer habitats and areas of stream-side vegetation. The majority of the noteworthy species recorded at this site are associated with the freshwater features, including the cranefly *Dicranomyia goritiensis*. A total of seven soft cliff species have been recorded here.

Westdale Bay cliffs are 180m in length and up to 30m high. The cliffs are very dry and feature extensive bare areas. The only soft cliff species recorded here is the Grade 3 squashbug *Enoplops scapha*.

Little Furzenip and **Great Furzenip** are effectively the same site, separated by a short section of hard limestone cliff. Hard limestone is overlain by eroding head material which reaches the high tide mark. Between them the sites feature a range of micro-habitats including bare ground, seepages, and diverse vegetation communities. These support nine Graded soft cliff species including the cranefly *Dicranomyia goritiensis* and the long-horned mining bee *Eucera longicornis* (Na, Grade 2).

Eroding head deposits of clay and gravel form 100m of soft cliff at **Freshwater East**. The site supports four soft cliff species including the seepage cranefly *Dicranomyia goritiensis*. Within the same SSSI is **Swanlake Bay** – a small site with similar geology to Freshwater East. Seepages and streams are present, along with dry bare cliffs. Six soft cliff species have been recorded here.

Provided that Pembrokeshire sites remain free-functioning then there are few pressing management issues. In some cases improvements to cliff top management would be appropriate. For sites supporting important wet assemblages, in particular Druidstone Haven, the quantity and quality of freshwater reaching the site is critical.

4.14.4 Swansea (Gower Peninsula)

The coastline of the Gower Peninsula is varied and features a number of soft cliff sites. Those on the south coast have particularly important assemblages of aculeate Hymenoptera, although no Grade 1 soft cliff associates have been recorded on these sites. Reports invertebrate interest of Gower soft cliffs, other than Howe (2002) and Knight & Howe (2006), include Edwards & Hodge (2002), Pavett (2005), and Fowles (1994). The Gower's soft cliffs are not entirely restricted to the following five sites but these represent the most significant in terms of their extent and invertebrate faunas.

The low (15-20m) cliffs of head material and blown sand at **Rhossili Bay** extend for 2km. Erosion is relatively high, although more stable vegetated sections are present. There are several springs, seepages and drains which run off Rhossili Down. The cliff top is heavily sheep grazed, although does support dry acid heath and acid grassland, plus a significant dung fauna. Areas of bracken and gorse scrub are also present on the cliff top. The cliffs at Rhossili are under-recorded and little historic invertebrate data is available. As such the soft cliff species list stands at three Grade 3 aculeates. Further survey is likely to extend the list. Rhosili is the only Gower site to support permanent seepages; Rhosili Down and the agricultural land should be managed sympathetically to ensure water quality.

A shorter section of soft cliff is found on the other side of Worm's Head at **Fall Bay**, here 200m of dry head deposits sit on top of limestone. The cliffs are low (5-10m) in height and are steep and bare in parts, although there are some more vegetated sloping sections. Fall Bay supports an important aculeate Hymenoptera assemblage typical of the dry, eroding south Gower cliffs; six soft cliff species have been recorded here, including the largest Welsh population of the Grade 2 Long-horned mining bee *Eucera longicornis* (Na). Whilst the cliff faces are in good condition, the cliff top grasslands are overgrazed by sheep offering little in the way of flowering plants for foraging soft cliff bees and wasps. Other areas are dominated by gorse scrub or bracken. A more sympathetic grazing regime plus the clearance of some of the bracken and gorse is likely to be of benefit to the soft cliff invertebrate fauna.

Overton Mere cliffs comprise 500m of head deposits bounded by limestone. These dry south-facing cliffs are ideal for thermophilic ground-nesting aculeate Hymenoptera which dominate the list of twelve Grade 3 soft cliff invertebrates associated with the site. Pioneer and ruderal plants also support a number of notable weevils. Cliff top headlands of limestone grassland and ungrazed rank grassland offer floristically rich swards, providing forage for cliff-nesting aculeate Hymenoptera. **Overton Cliff** is essentially a 500m extension to the cliffs at Overton Mere. This site also supports a rich invertebrate fauna. Of the species associated with soft cliffs there are eight Grade 3 species and the Grade 2 mining bee *Eucera longicornis*. Overton Cliff also supports a rich assemblage of phytophagous insects including weevils and seed bugs.

Port Eynon Bay is one of the most important coastal soft cliff sites in Wales, and arguably the most important site in Wales for aculeate Hymenoptera; to date 150 species have been recorded here. The soft cliffs at Port Eynon (including **Horton Cliffs**) are 1.6km long with a southerly aspect. Dry, bare cliffs and slopes with areas of pioneer and more established vegetation support populations of 15 Grade 2 and 3 species, including the mining bees *Andrena rosae* (RDB2, Grade 2) and *Eucera longicornis*. Flower-rich limestone grasslands on some sections of the cliff top enhance the site. However, other sections are not so favourably managed. Parts of the cliff top have been agriculturally improved for grazing or are in use as arable land. In places the cliff top has eroded back to meet arable land or improved pasture thus virtually eliminating areas for cliff-nesting invertebrates to forage, hunt or for dispersal. More sympathetic management of the cliff top here through restoration of herb-rich cliff top grasslands or through the introduction of cliff top buffer strips, is vital to maintain the nature conservation interest of this site. This should be a priority for those involved in managing the site.

Figure 53. Low cliffs at Port Eynon Bay, the cliff top grassland is heavily grazed by horses leaving few resources for cliff nesting bees and wasps.
© Guy Knight

The Gower soft cliffs feature some of the best soft cliff sites in the UK; Port Eynon Bay is the most important site in Wales for aculeate Hymenoptera. The main management issue for Gower sites is cliff top management. Cliff top habitats can provide resources for soft cliff species as a source of pollen or nectar for bees, as hunting grounds for wasps, or as corridors for dispersal to other parts of a site or between sections of soft cliff. A number of sites have floristically diverse cliff top grasslands that are overgrazed. The plant diversity may be there but if herbs are not allowed to flower the ecological functioning of the system is suppressed. Sections of Port Eynon Bay are under threat from coastal squeeze. Natural or semi-natural cliff top habitats have been lost to cliff retreat, and now arable or improved pasture extends to the cliff top. Restoring cliff top habitats and sympathetic management are key to the invertebrate biodiversity of these sites.

4.14.5 Summary (for Wales)

Wales has some of the best soft cliff sites in the UK (Section 3). Sections of coastline such as the south Gower and Llyn Peninsula soft cliff sites are of national importance for their invertebrate assemblages.

In comparison to England, Welsh soft cliff sites have been less affected by coastal protection schemes in the past. This is largely due to their lack of proximity to human settlements and infrastructure, and therefore less pressure to ‘defend’ economic or social assets. It is hoped that an improved emphasis on sustainable coastal management (National Trust, 2007), taking into account the value of soft cliffs for nature conservation and as a sediment source, will continue to ensure that these sites are not damaged through coastal protection schemes.

The major management issue on Welsh sites is cliff top management. There are numerous examples of degraded sites where cliff tops have been converted to agriculturally improved pasture or arable. Additionally, even where cliff tops feature semi-natural habitats they can be overgrazed – there are a number of examples of this on the Gower. The invertebrate fauna of Port Eynon Bay cliffs is under particular threat through unsympathetic cliff top management. Where cliff top management is unsympathetic the opportunity should be taken to restore natural herb-rich grasslands through agri-environment schemes, ideally through the restoration of large areas to avoid coastal squeeze as the cliff top retreats, or as flexible buffer zones which retreat with the cliff top. Where overgrazing is an issue changes should be more simple to implement.

4.15 Isle of Man

A significant proportion of the Isle of Man coast consists of soft cliffs. The total coastline has been estimated at 160km, of which 18km (11%) is soft cliff (Dargie, 1996). This resource is concentrated in the north of the island. Information on invertebrates in all habitats on the island is extremely limited, although a short report by Boyce & Fowles (1989) identifies a number of soft cliff sites as being the most important sites for invertebrate conservation.

Soft cliffs in glacial deposits at **Ramsey Bay** have been identified as being of particular importance. They run for about 5km north of Ramsey and feature east-facing cliffs that vary in height from approximately 50m at Shellag Point to 2m at Phurt. These cliffs are more sheltered than those on the west coast and the rate of erosion is slower. The cliffs are composed of a mixture of sands and clays and from a geological perspective are considered to be one of the finest examples in Europe (Garrad, 1972). Compared to other soft cliffs on the island these are likely to be of most interest, as supported by Boyce & Fowles (1989). Moving north from Ramsey the cliffs are initially rather stable and feature rough grassland and bramble and gorse scrub. **Dog Mills** (fig. 53) provides a range of habitats from bare ground to small patches of scrub, and from dry to saturated, there are also stands of marram (*Ammophila arenaria*) at the base of the cliffs where sand has stabilised. This site is likely to be of considerable interest for invertebrates; within the limited data available for this site we have records of a number of Nationally Scarce beetles including the soft cliff specialist ground beetle *Bembidion saxatile* (Nb , Grade 2), *B. pallidipenne* (Nb) and the Horsetail weevil *Grypus equiseti* (Nb). Further north the cliffs at **Shellag** are rather more impressively high and seem to be more active with considerable bare faces. The height of the cliffs then decreases towards **Phurt** where they are reduced to low sandy exposures. At Phurt there are no obvious clay deposits and flushes are less common than at Dog Mills; however, two soft cliff specialists associated with wet habitats have been recorded here – *Bembidion saxatile* (Na, Grade 2) and *B. stephenisi* (Grade 3).

The cliff top management along the soft cliffs of Ramsey Bay is improved pasture. The sites will be enhanced if this can be reverted to herb-rich cliff top grassland; effective targeting of agri-environment schemes could achieve this.

Figure 53. Dog Mills cliffs, Ramsey Bay.

On the west coast the cliffs are more exposed to the prevailing winds, and certain sections are eroding at such a rate that little vegetation has become established. It is likely that they are of lower interest for invertebrate conservation. Much of the **Glen**

Mooar cliffs are of unstable clay and sand, with a lack of freshwater seepages (fig. 54). These cliffs are very active in parts and this will limit their invertebrate fauna, although a short visit by Boyce and Fowles (1989) recorded *Bembidion saxatile* (Nb, Grade 2). **Glen Wyllian** features similar cliff habitats to Glen Mooar. This site is likely to be under threat from coast protection and cliff stabilisation in the near future as a result of a poorly planned recent housing development at the cliff top. Should such works be proposed we recommend that a full invertebrate survey of the site is carried out as part of any environmental impact assessment. Further north the cliffs at **The Cronk** are much lower and are fronted by embryo dunes. Further assessment of these sites was not possible due to the timing of site visits. As with the cliffs on the east coast, there are a number of opportunities for enhancing sites through improvements to the cliff top grazing land.

Figure 54. Glen Mooar cliffs, Isle of Man west coast.

None of the soft cliff sites on the Isle of Man have any legal protection, either as ASSIs or from any similar conservation site designation. We recommend that invertebrate surveys are carried out at all the sites, plus the sites should also be assessed for their geological importance, with a possible outcome being the notification of at least the most important sites as ASSI. Based on current available data, priority sites for survey are those within Ramsey Bay.

4.16 Northern Ireland

Northern Ireland supports approximately 7km of soft cliff (Howe, 2003). Stretches of glacial-till cliffs are found to the north of **Larne** in Co. Antrim. In Co Down there are sections of low cliffs formed of fluvio-glacial deposits such as those at **Ballyhornan Bay**, **Killard Point**, **Ballymartin** and south of **Kilkeel** (Cooper and Butler, 1997; Northern Ireland Biodiversity Group, 2005).

There is very little invertebrate data for soft cliff sites in Northern Ireland. Anderson (1996) lists records of carabid beetles from various sites, including the Grade 2 species *Bembidion saxatile* at Killard Point, Kilkeel beach and Bendeberg Bay. There also reports of *Bembidion stephensii* (Grade 3) at coastal soft cliff sites in the county (Anderson, 1996).

The only site afforded statutory protection is Killard Point which is notified for its geology and wildlife, although not specifically soft cliff invertebrates which is likely to be down to a lack of records. We recommend that the major soft cliff sites in Northern Ireland are surveyed for their invertebrates, particularly if any changes in management are planned.

5. Key coastal soft cliff sites in England

Principal coastal soft cliff sites in Wales have been identified according to their known invertebrate assemblages and the potential of sites based on the presence of key habitats (Howe, 2002; Howe & Knight, 2006). A similar exercise for England has been completed (table 16) using the same criteria (table 15) to ensure comparability.

Table 15. Definitions used to determine the importance of coastal soft cliff sites for invertebrates (Howe, 2002).

Grade A sites: those which support coastal soft cliff species or soft cliff invertebrate assemblages of national importance, meriting notification as SSSI.

Grade B sites: those which support coastal soft cliff species or soft cliff invertebrate assemblages which are of local significance, and support large areas of soft cliff habitat with key features such as bare ground, pioneer vegetation, seepages and fen vegetation. Further recording may raise their status.

Grade C sites: those which support large areas of soft cliff habitat with key features such as bare ground, pioneer vegetation, seepages and fen vegetation, but for which there is little existing or recent invertebrate information.

To some extent the site gradings reflect survey effort and availability of data. However, on the whole the exercise provides a useful guide to the key sites. The grading is based on current available data: as with the ranking exercise (Section 3) the lower grade sites should not be discounted, with further survey work many of these sites are likely to move up a grade.

Table 16 Graded soft cliff sites in England (further information on these sites including spatial references is provided in Appendix 2)

Grade A	
Yorkshire	Cornelian Bay – Cayton Bay
Norfolk	West Runton
	Overstrand
	Sidestrand/Trimingham
Essex	The Naze, Walton
Isle of Wight	St Catherine's Point to Steephill Cove
	South-west Isle of Wight Coast
	Luccombe Chine to Shanklin Chine
	Red Cliff
Dorset	Chapman's Pool - Houns Tout
	Ringstead Bay
	West Cliff
	Thorncombe Beacon
	Seatown
	Golden Cap - Cains Folly
	Black Ven / The Spittles
Devon	Axmouth-Lyme Regis
	Branscombe
	Prawle Point

(Table 16 cont)

Grade B

Yorkshire	Ravenscar-Scarborough
	Filey Bay - Reighton to Filey
	Filey Bay – Speeton Cliffs
Norfolk	East Runton
	Mundesley Cliffs
Suffolk	Corton
	Kessingland Cliffs
	Dunwich Cliffs
	Bawdsey
Kent	Warden
	Reculver & Bishopstone Glen
	Folkestone Warren
Sussex	Fairlight Cove
Hampshire	Hordle Cliff
	Highcliffe
Dorset	Warren Hill
	Kimmeridge Bay
Devon	Wembury

Grade C

Northumberland	Newbiggin Moor
	Seaton Sluice
Durham	Hendon – Ryhope
	Seaham
	Nose Point - Chourdun Point
Cleveland	Redcar
	Stone Gap
Yorkshire	Cowbar Nab
	Staithes – Runswick
	Runswick Bay
	Upgang Beach
	Robin Hoods Bay
	Gristhorpe
	Filey Bay - Filey to Filey Brig
Humberside	Hilderthorpe – Hornsea
	Holderness Coast
	Withernsea – Easington
Norfolk	Weybourne
	Happisburgh Cliffs
Suffolk	Covehithe Cliffs
	Eastern Bavents
Kent	East End, Sheppey
Hampshire	Stanswood Bay
	Stone Point
Isle of Wight	Whitecliff Bay and Bembridge Ledges
	Dunnose
	Totland - Alum Bay
	Colwell Bay
	West Hill / Cliff End
	Norton
	Bouldner & Hamstead Cliffs
	Thorness Bay
	Gurnard Bay
Cornwall	Whitesand Bay
Devon	Bucks Mills
Somerset	Blue Anchor Bay
Avon	Aust Cliff
Merseyside	Dee Cliffs
Lancashire	Sunderland Brows
Cumbria	Borwick Rails
	Silecroft - Annaside
	St Bees

6. Management of coastal soft cliff sites – threats, solutions and opportunities

Although coastal soft cliffs themselves require no management, human activities have damaged or destroyed a significant number of sites and continue to threaten their nature conservation interest. The main threats and management issues associated with coastal soft cliffs are: coast protection and cliff stabilisation schemes, insensitive cliff top management, a reduction in groundwater supplies to cliff slopes (e.g. through water abstraction), and future risks from climate change. Lower priority management issues of grazing and invasive plants are also discussed in this section.

6.1 Managing soft cliffs - coast protection and shoreline management

Over the last few centuries the various stimuli for managing the coast – transport, trade, recreation, land reclamation, prevention of loss of land, property and infrastructure – have favoured attempts to stabilise and "protect" cliffs, thereby preventing or greatly reducing their natural recession. As a consequence, the majority of soft cliffs in England and Wales have been modified in some way through coast protection (Brampton, 1998; Doody, 2002). This is somewhat more pronounced in England than Wales. Developments at risk of erosion are often in inappropriate locations, a legacy of times when the control over development in the coastal zone did not take erosion risk into account. Planning controls are now much tighter (Babtie Group, 2000), however there is an inheritance of development on eroding cliff tops. This causes problems for the local communities, planning authorities and conservation bodies.

Many coast protection schemes have had significant impacts on cliff habitats. Seawalls or rock revetments have stopped natural erosion, and slopes have been stabilised by drainage, reprofiling and landscaping. As a result geological exposures have been obscured, coarse grasses of low conservation value have replaced bare ground and pioneer habitats, and hydrological features have dried out. A significant proportion of the soft cliff resource has been affected in this way resulting in the loss and degradation of sites of national and international value for nature conservation.

Impacts of coast protection on soft cliff ecology

Useful overviews of the range of approaches for coast protection include Brampton (1998), and Lee & Clark (2002). The impacts of coast protection on soft cliff ecology are summarised in figure 55.

Conventional coast protection strategies often take the form of a seawall or revetment at the toe of the cliff, designed to prevent or greatly reduce cliff base erosion by the sea. Cliff slopes are often regraded or reprofiled to increase stability further. The heavily defended cliffs at Bournemouth are a good example of this approach. Cliff protection schemes are expensive and so generally focus on larger settlements such as Bournemouth, or Ventnor on the Isle of Wight.

Cliff erosion is the major source of beach sediment in the UK (Lee and Clark 2002). The volume of sediment contributed by soft cliffs is incredible – the annual sediment input from the West Dorset soft cliffs alone has been estimated at 300,000m^3 (Allison, 1992). Protecting cliffs 'locks up' this sediment and has local, and regional impacts on the behaviour of beaches, saltmarsh, sand dunes and other accretionary coastal features, many of which are of high nature conservation and landscape value. It has been estimated that sediment inputs could have declined by as much as 50% over the last 100 years (Lee and Clark 2002). The cliff protection at Bournemouth has been so successful that the local beaches now have to be artificially replenished. For this 'beach nourishment' sand is imported from elsewhere – often obtained through offshore dredging.

Coast protection and cliff stabilisation have destroyed and damaged a significant proportion of the UK soft cliff resource. When the natural processes of erosion, cliff recession and land slippage are halted or impeded the habitats that rely on natural instability are lost. Bare ground and pioneer habitats are lost to ecological succession and quickly degrade into lower value habitats. Closed grasslands and scrub dominate and the specialist invertebrate fauna of the site is lost. Soft cliff habitat can be fragmented through this process. As fragments become isolated the movement of less mobile or more sensitive species is prevented by the development of unsuitable habitat. Both the Cliff tiger beetle *Cylindera germanica* and the Grey bush-cricket *Platycleis albopunctata* (Gottschalk *et al*, 2003) are unable to disperse across areas of scrub. The invertebrate fauna of smaller isolated fragments is impoverished when compared to more extensive or well connected sites. Reprofiling sites reduces habitat heterogeneity and leads to the loss of hydrological features such as seepages, reedbeds or pools.

The geological and geomorphological interest of the site is often damaged as well, through the interruption of geomorphological processes and loss of geological exposures.

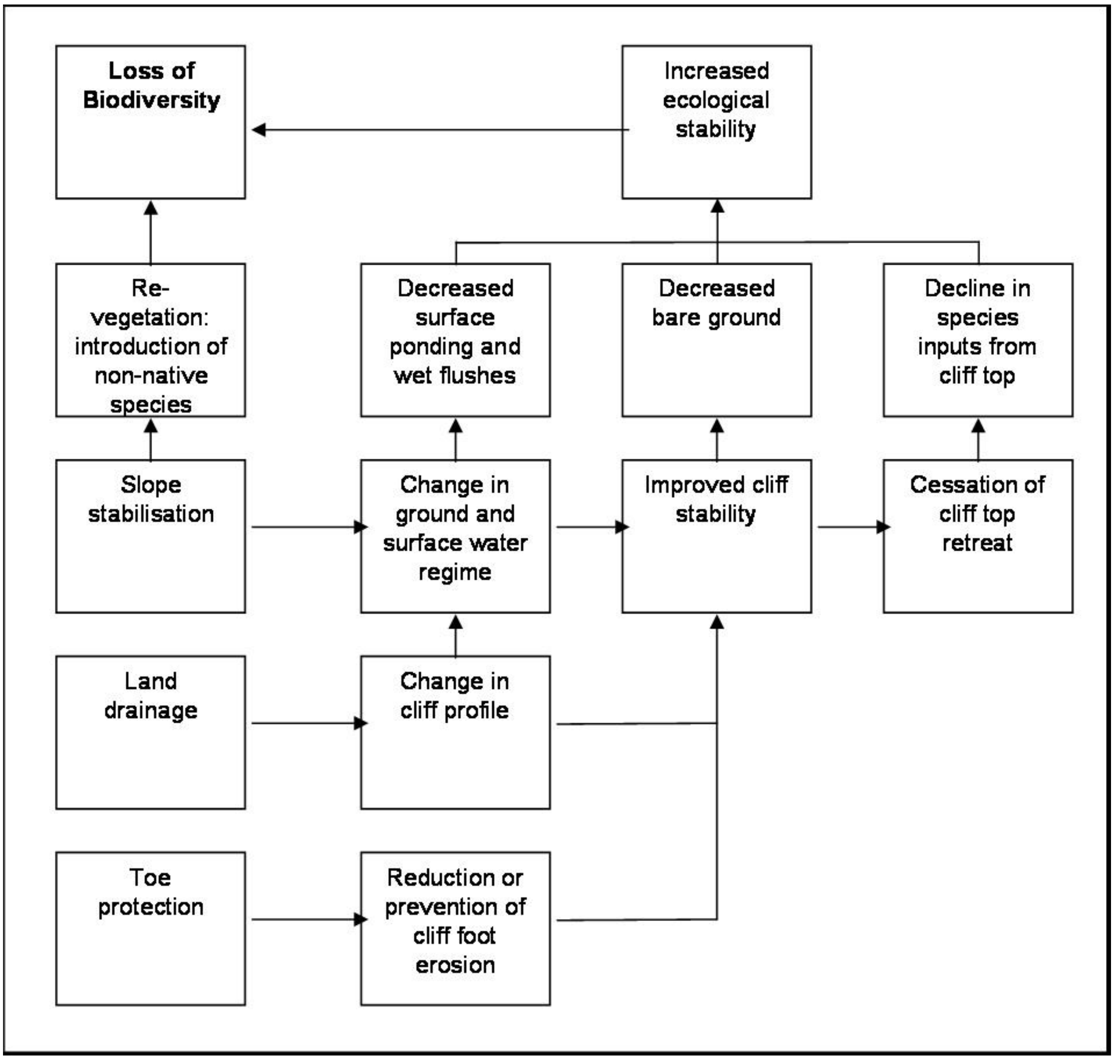


Figure 55. A summary of the impacts of soft cliff ecology associated with coast protection (from Lee *et al*, 2001)

Intermediate coast protection methods seek to reduce erosion rates rather than halt them completely. Structures such as timber palisades parallel to the cliff aim to reduce the power of wave action hitting the cliff base. Offshore breakwaters parallel to the shore aim are designed to reduce wave energy before it hits the beach. Groynes (perpendicular to the cliff line) and artificial beach recharge aim to build up beach sediment to create wider and higher beaches to protect the cliff base from wave attack.

These methods can be less damaging to the nature conservation interest of soft cliffs as they allow some erosion and slope instability. However they can still have a detrimental impact on habitat quality, as even partial stabilisation can result in the loss of useful invertebrate habitat. A study by Buglife (Telfer, 2006a) comparing sections of cliff with and without timber palisades found that the protected sections had less bare ground and open habitats, and lower numbers of rare and specialist soft cliff invertebrates than unprotected sections. This particular study represents the only monitoring of the impact of coast protection on soft cliff invertebrates; clearly further research is needed on more sites to build upon the knowledge base and improve the quality of information that can advise shoreline management planning.

Management of sites for nature conservation is never straightforward, and it has even been suggested that soft engineering methods or intermediate cliff protection may be of some benefit where fast eroding coastlines are receding too rapidly for useful invertebrate habitats to develop. It is accepted that some sites may benefit from reductions in recession rates, and artificial control of erosion may be of benefit in response to increased erosion rates predicted as resulting from climate change. However, such schemes would need to be carefully considered in the wider context of shoreline management for the whole sediment cell.

It is difficult to design a coastal protection scheme which allows a predetermined rate of erosion that is acceptable to both property owners and the needs of wildlife. This is because there is no simple relationship between wave attack and erosion rate. It is difficult to design a scheme which would deliver a target reduction in recession rate with any degree of confidence (Lee, 1998). Many soft cliff systems are very sensitive to wave attack, and even intermediate protection schemes can significantly reduce landsliding and change the cliff slope habitats.

Coast protection and slope stabilisation are often combined with artificial drainage of soft cliffs to increase stability further. These aim to reduce groundwater levels within the cliff and prevent groundwater-driven slippage events. This has two main impacts of soft cliff invertebrates: firstly, cliff instability is essential to the maintenance of bare ground and pioneer habitats; and secondly, the loss of seepages, flushes, perched reedbed and other hydrological features will result in the loss of whole suites of associated species from the cliff slope.

There is no easy middle way with coast protection. All coast protection and slope stabilisation schemes alter soft cliff habitats. Based on current available data we must assume that these changes are generally negative and result in the loss of important invertebrate habitat from the cliff slope. Furthermore, there are no tried and tested methods of mitigating for coastal protection to conserve invertebrates. Intermediate schemes should not be viewed as a mutually beneficial compromise where partial defence will deliver some protection for property whilst delivering on some nature conservation issues.

Shoreline Management Planning

Shoreline Management Plans (SMPs) provide a strategic framework for decisions on the management of the erosion and flood risk for a specified length of coast. They take account of natural coastal processes together with human and environmental influences and needs. SMPs generally cover an area of coast defined as a discrete cell or subcell, on the basis of geomorphological processes and natural boundaries to sediment movement.

SMPs provide an opportunity for protecting the geological and nature conservation interest of soft cliffs. In England and Wales biodiversity targets are increasingly being taken into account in shoreline management as part of the Strategy for Flood and Coastal Defence led by DEFRA. These include the revised guidance for the development of SMPs (DEFRA, 2001), the High Level Targets for coastal operating authorities (MAFF, 1999), and guidance on the appraisal of coastal defence projects (MAFF, 2000). The MAFF High Level Targets state that when carrying out works coastal authorities must aim to ensure that there is no net loss to habitats covered by biodiversity action plans (MAFF 1999). Updated guidance for the development of SMPs was published in 2006 as part of the DEFRA revised flood and coastal management strategy “Making Space for Water” (DEFRA, 2004, 2006).

Further protection is given to soft cliff sites through statutory protection: the majority of UK sites are designated as SSSIs and/or SACs, and the resource as a whole is afforded some protection through UKBAP targets.

The EU Habitats Regulations (see Chapter 6.6) have had a significant influence on the way in which some cliffs are managed in the UK. The Regulations set out measures intended to maintain at, or restore to, "favourable conservation status" the Annex I habitats across their whole range (i.e. not just the habitat within SACs).

To date nine coastal soft cliff sites have been selected as SACs because they support good examples of the Annex 1 habitat 'vegetated sea cliffs of the Atlantic and Baltic coasts'. These include sites in Gwynedd, East Devon, West Dorset, the Isle of Wight and Norfolk. The Habitats Directive requires the Government to take appropriate steps to avoid the deterioration of the habitat on these sites. For example, a coast protection scheme that might affect the integrity of the soft cliff habitats can only be approved if there are no alternatives and there are imperative reasons of over-riding public interest. In such circumstances compensation measures would be required as part of the scheme e.g. the creation of replacement soft cliff habitat outside the boundary of the SAC (Lee *et al*, 2001).

The Maritime Cliff and Slope Habitat Action Plan contains targets (revised in 2006) which in essence introduce a "no net loss" policy for maritime cliff and slope habitats, with the aspiration of achieving, over time, a net gain (UK Biodiversity Group, 2006). It follows that if new coast protection works are to be constructed there would need to be an abandonment of a matching or greater length elsewhere. These targets cover soft cliffs around the UK regardless of their status as protected sites.

In theory the SMP process now operates with an assumption that natural coastal processes should not be disrupted. As coastal management policy changes towards a more flexible and integrated management of dynamic coastal processes a more sensitive approach to the management of eroding soft coasts is emerging. New policies such as those of the National Trust (National Trust, 2005, 2007) are favouring the management of 'living coasts' and the need to take adaptive measures. This approach also has a clear recognition that cliff erosion provides an important supply of sediment to beaches and estuaries, There is also acknowledgement that decision-making in these changing circumstances will be difficult and sometimes controversial, and that public support is essential.

Public and political pressure still favours the ongoing or new protection of human assets against coastal erosion. However, environmental considerations are now given consideration alongside economic or social interests, and the need for long-tem adaptation is also now recognised. This needs to be supported by planning measures and practical mechanisms to enable people to accept change at the coast. This can be helped with an improved understanding and greater recognition of the ecological importance of soft cliffs. Surveys such as the recent work by Buglife and CCW are improving the provision and availability of data on the nature conservation interest of sites. Through this work we are providing decision-making 'tools' that can be applied to the SMP process.

Such changes will take time to implement, and there are still immediate concerns that need to be addressed. At the time of writing, Kelling to Lowestoft SMP - which covers the Norfolk soft cliffs (ACAG, 2006) - is yet to be adopted by North Norfolk District Council, and there are proposals for coast protection and cliff drainage to the east of Lyme Regis (Dorset) despite the site designations of SSSI, SAC and UNESCO World Heritage Site.

French (2004) provides a useful overview of the SMP process and the issues surrounding public acceptance of changes in coastal management.

Future coastal defence demands and 'free up' sites

Despite the commitment of coastal authorities to sustainably manage our coasts with an assumption that natural processes should not be disrupted, coast protection continues to be a major threat to soft cliff sites. A study by MAFF in 1994 (MAFF, 1994) identified the potential demand for a further 90km of coast protection on soft cliffs in England and Wales over the following 10 years (i.e. 1994-2004). All indications are that the actual increase in new protection since 1994 is much lower than the MAFF estimate (Rees, 2002); however we have been unable to obtain any figures from DEFRA. A 'National Flood and Coastal Asset Database' is currently being developed by the Environmental Agency, which will jointly hold data on flood risk and coast protection structures (Hill *et al* 2002). In the future this should be able to provide more accurate and up-to-date figures. At the time of writing, this inventory only holds data on flood defence structures. In addition, there are proposals to develop 'erosion risk mapping' as part of the Defra Making Space for Water strategy. This will be similar to the current flood risk maps available on the Environment Agency website. Erosion risk mapping will be a critical element of future coastal management policy development for soft cliffs.

Beyond the timescale of the MAFF estimates, Lee *et al* (2001) estimate a demand for some 22km of new coast protection works in England over the next 50 years; largely concentrated on the North Norfolk and North Yorkshire coasts.

A key part of the "no net loss" UKBAP target for soft cliffs is the 'freeing up' or restoration of natural processes to protected coastlines. Freeing up sites is discussed in depth by Lee *et al* (2001), in which 14km of currently protected coastline is identified as potential free up sites. This figure for potential free up coastline, balanced with new coastal protection, gives a net loss of about 8km of habitat over the next 50 years.

Freeing up stretches of coast is not an instant solution. Previously protected sites that are freed up will take a long time to reach a geomorphological equilibrium, and even longer to be colonised by soft cliff invertebrates, particularly if isolated from unprotected soft cliffs. Any plan to reduce or remove coast protection from soft cliffs would need to be done in such a way to gradually increase rates of erosion and allow the system time to adapt. Any sudden change to stabilising systems, such as the protected soft cliffs at Trimingham in Norfolk, could be catastrophic to the ecological interest of the site (Telfer, 2006a).

The limitations of using free up as mitigation for new coast protection must be acknowledged by coastal managers. This should not be treated as a 'like for like' exchange. The invertebrate fauna of a freed up site may never recover from the impacts of coast protection. High quality virgin soft cliff sites lost to coast protection schemes cannot be replaced by free up sites.

Summary

- Natural processes of cliff erosion and land slippage are vital to the specialist invertebrate fauna of soft cliffs.

- Coast protection prevents these processes and destroys or degrades the ecological and geological interest of soft cliffs. Many nationally and internationally important sites have been damaged in this way.
- The construction of new coast protection or attempts to stabilise soft cliffs should be resisted, particularly on those sites of high value to invertebrates. Where sufficient data is not available detailed invertebrate surveys should be carried out to inform environmental impact assessments.
- Coast protection remains the major threat to soft cliff invertebrates.

6.2 Managing soft cliffs - cliff top management

Insensitive cliff top management is a major threat to the ecology of coastal soft cliffs. Agricultural improvement of coastal grasslands and conversion to arable on the cliff top can have significant impacts on the ecology of the cliff slope. Appropriately managed cliff tops can provide a range of resources, including: acting as a source of plant material for the eroding cliff face; providing forage for bees, wasps and others; and potentially providing ecological linkages between favourable sites.

Many coastal soft cliff sites have been damaged or degraded through the inappropriate management of cliff tops. This subtle effect is not as obvious as the impact of coast protection; similarly it is more difficult to establish cause and effect. However, an examination of the contribution of cliff top habitats to the ecological functioning of soft cliffs allows us to draw some conclusions that are based on sound science.

Influence on cliff slope vegetation

Cliff tops are often of ecological value in their own right. They provide habitat for many rare or restricted invertebrate species, probably in part because of the mild climatic conditions and warm soil that such species may require, and the rare habitats such as coastal heath or calcareous grassland that they support. The flora of the cliff top influences the flora of the cliff slope through acting as a major source of plant material and propagules, for example seed rain. Where a cliff top flora is impoverished through intensive management for grazing, or if the cliff top has been converted to arable agriculture, this can result in an impoverished or limited cliff slope flora.

Cliff tops do not act solely as a source of plant propagules, in many instances intact sections of cliff top habitat slump down the cliff slope through rotational slips and landslides. Thus rather than merely influencing soft cliff habitat, the cliff top actually becomes part of the cliff slope and its flora and fauna. If the cliff top habitat is of low ecological value then it will not enhance or maintain the ecological interest of the cliff slope.

Historically, cliff top management would have been less intensive and cliff top habitats were more floristically rich. Unimproved grasslands and heathland would have been the main feature of much our coast. Today, intensive farming has too often encroached right up to the cliff edge, so that slumping edges can be floristically very poor. Similarly on hard rock cliffs, intensive farming often encroaches close to the cliff edge, so that there are no flower resources to supplement those on the cliff itself, to the detriment of bees and other insects. In this manner, the whole cliff ecology is being impoverished. The influence of the cliff top on the vegetation of the cliff slope should not be underestimated; the quality of cliff top vegetation communities must be a major consideration in any management of soft cliff sites.

A resource for cliff slope invertebrates

As well as influencing the vegetation of the cliff slope, cliff top habitats can provide additional resources for invertebrates inhabiting the cliff slope or face. Suitable habitat can provide over-wintering sites for some species, e.g. dead plant stems and old flower heads. More importantly, flower-rich habitats or patches of scrub often provide essential nectar sources for bees nesting in the cliff face, and foraging areas where solitary wasps can catch their prey. This is of particular importance where the cliff is vertical or does not support adequate nectar sources through the season. Prawle Point in south Devon is an excellent example of this. At Prawle the cliffs are low (1-3m) and vertical, they are also south facing and so offer excellent nesting habitat for solitary bees and wasps (aculeate Hymenoptera). With over 100 species recorded at the site, including many Red Data Book or Nationally Scarce species, Prawle Point is one of the most important sites for aculeates in the UK (Stubbs, 1994). The morphology of the cliffs impedes the development of vegetation; as a result the cliffs themselves do not feature significant nectar resources. At this site the large nesting aggregations of bees and wasps are almost entirely reliant on the nectar resources of the cliff top.

A similar situation is found at Port Eynon on the Gower Peninsula. The cliffs at Port Eynon are also rather low and vertical, and south facing. This is arguably the most important site in Wales for the aculeate Hymenoptera. As with Prawle, due to a lack of flowering plants on the cliff slopes this nationally important invertebrate assemblage is almost entirely dependent on cliff top nectar sources.

Prawle Point and Port Eynon are not alone in being reliant on cliff top resources to support a nationally important invertebrate community. There are a number of similar sites where cliffs are either vertical, very dynamic, or not extensive enough to support significant nectar sources. In addition, many more sites feature nesting aggregations of aculeates that are concentrated on vertical surfaces at the very top of the cliff. Casual observation of aculeate activity suggests that, where suitable habitat is present, significant foraging is directed at the cliff top. Further study of the foraging behaviour of these populations is likely to reveal more and establish clearer links between cliff top management and aculeate diversity on soft cliffs.

Cliff top scrub can be a useful additional resource. Bramble, gorse, sallow, blackthorn and other species can extend the flowering season, as well as providing shelter and over-wintering sites.

Figure 56. Cliff tops can provide a major source of nectar for cliff-nesting bees. © Bryan Edwards.

Improving habitat connectivity

Where soft cliff sites are fragmented through natural changes in geology - e.g. soft-cliffed coasts interrupted by sections of hard cliff - or through coastal protection works the faunas are often impoverished. Small and isolated sites are unable to support a wide range of micro-habitats, are susceptible to habitat loss or degradation, and are vulnerable to local invertebrate extinctions. Suitable cliff top habitats can facilitate the movement of invertebrates and thus provide linkages between otherwise isolated sites. Connectivity of suitable habitat can be crucial to the survival of many species, particularly those that have poor dispersal abilities or exhibit metapopulation dynamics.

On the south Gower the 17km stretch of coast between Fall Bay and Oxwich Point is characterised by low soft cliffs of eroding head separated by varying lengths of hard limestone cliffs, or stretches of dune. Much of this coast is backed by flower-rich limestone grassland or heathland (albeit heavily grazed in places) which provides additional forage habitat and increased connectivity between the soft cliff sites. Recent surveys of sites along this stretch of coast have revealed them to have very similar faunas - particularly for the aculeates (Knight & Howe, 2006) - which would support the theory that the cliff tops are providing some ecological connectivity between sites.

Cliff top management issues

As already discussed, natural or semi-natural cliff top habitats can provide a range of resources to soft cliff invertebrate communities and perform an important role in the ecological functioning of soft cliff systems.

However, many stretches of coastline habitats such as cliff top grassland and heath have been replaced by intensive grazing management, arable agriculture, or other uses such as caravan parks and golf courses. These land uses are of negligible value to invertebrates. For a large number of the UK's soft cliff sites natural or semi-natural cliff top habitats been reduced to a thin strip along the top of the cliff, often incorporating public footpaths. In some areas, particularly on the east coast of England, arable land may reach right to the cliff edge, especially where erosion rates are high. For example, the Holderness coast, which has been retreating at an annual average rate of 1.8m since 1852 (Lee, 1995), has virtually no semi-natural cliff top vegetation.

The situation is comparable on the north Norfolk coast, where much of the cliff top is under intensive arable management with little or no buffer habitat at the cliff edge. Where a buffer exists it is often incredibly narrow and dominated by arable weeds.

At Prawle Point (Devon) and Port Eynon (Gower, S Wales) cliffs, despite the value of cliff top habitats as a forage resource for cliff nesting aculeates being recognised, the cliff top management is not all appropriate. Prawle Point features some good cliff top habitat, however some sections are under arable management or improved grazing, this should be reverted back to more semi-natural grassland or heathland (Lister *et al*, 1992). Restoring cliff top habitats at Prawle Point is of vital importance to conserve the invertebrate interest of the site.

Sections of Port Eynon Bay are under threat from coastal squeeze. Parts of the cliff top have been agriculturally improved for grazing or are in use as arable land. In places the cliff top has eroded back to meet arable land or improved pasture, virtually eliminating areas of natural or semi-natural cliff top habitats (fig. 57). Restoration of unimproved cliff top grassland must be a priority for this site, which otherwise risks losing its nationally important assemblage of aculeates.

Restoration or creation of cliff top habitats will also help to deliver biodiversity gain beyond the soft cliffs themselves. Coastal erosion is one of the threats to maritime grassland and heath identified by English Nature in 1993 (Pye & French, 1993). This threat was considered more acute on soft-cliffed coasts. Clearly a strategic approach of cliff top restoration, increasing landward extent to allow roll back as the cliff line recedes and avoid 'coastal squeeze', is needed.

Figure 57. Port Eynon Bay, South Gower. Overgrazing has left sections of this site lacking essential nectar sources on the cliff top.
© Guy Knight.

Where cliff top vegetation is seemingly appropriate there can still be problems. Over-grazing of semi-natural cliff top grassland severely reduces its value to invertebrates. There are many examples of floristically diverse grasslands that quite simply do not flower or offer little in the way of structure. The resources that these areas could be providing – nectar, pollen, shelter – are not present. Over-grazing or the use of inappropriate livestock has compromised potentially valuable areas of cliff top grassland in West Dorset, South Devon and the Gower Peninsula. These represent some of the best soft cliff invertebrate faunas in the UK, therefore enhancing these sites should be a conservation priority. A significant proportion of these grasslands are under the ownership or management of conservation bodies so addressing these management issues should hopefully be fairly straightforward. There are many useful references on grazing management of cliff top grasslands (Mitchley & Malloch, 1991; Oates *et al*, 1998).

Figure 58. Cliff top grazing should be managed to promote a varied vegetation structure and maximise nectar sources on unimproved grasslands.

Cliff top management solutions and opportunities

The restoration of unimproved coastal grasslands would enhance many sites significantly. This could be achieved through the creation of buffer zones flexible enough to move inland with the retreating cliff to avoid coastal squeeze, thus maintaining the area of cliff top habitat. These would also need to be sufficiently wide that the impacts of insensitive management are reduced and so that the buffer strips can be practically managed.

This approach can be illustrated by an example on the south-west coast of the Isle of Wight (fig. 59). Re-notification of a SSSI on cliffs there included a strip of cliff-top land to allow for the functioning of the cliff system and to ensure that geomorphological and biological special interests would still be within the site boundary even if the cliffs retreated. This was determined by a geomorphological study that extrapolated the rate of recession for the next 50 years. In the past intensive arable agriculture reached up to the cliff edge in many areas. Agreements with owners and occupiers were set up in those areas to ensure that a minimum of 20m from the cliff top was managed in a way that would promote the establishment of semi-natural grassland. This 20m strip will move inland as the cliff recedes. Whilst not strictly a buffer strip, as it is included within the SSSI as part of the geomorphological functioning of the site, the strip is buffering the ecological interest of the cliff slope from the impacts of intensive agriculture. It is also providing resources for cliff slope invertebrates. The use of this approach is a workable solution that can be applied to sites with similar management issues, such as those in north Norfolk, Yorkshire and the Llyn Peninsula in Wales.

Figure 59. Cliff top strip of semi-natural vegetation to the west of Whale Chine, Isle of Wight.

How wide does such a strip need to be to enable healthy ecological functioning of soft cliff habitats? Of course the ideal would be to have extensive unimproved cliff top grasslands or heath extending several kilometres from the cliff edge. In practice this is unrealistic. The reality for most sites is a narrower strip, although there is little ecological information on which to base recommendations for the width. Consequently there is no generic guidance. The width and design should be specific to each site, a number of considerations will have to be taken into account including:

- Target cliff top habitats for restoration/creation.
- Time taken for new cliff top habitats to establish.

- Known ecology of the site, including historical land use/management and current cliff top land use.
- Linkages with other sites – where can habitat restoration be most effectively targeted to improve links between sites?
- Cliff retreat rate – current and predicted under climate change scenarios.
- Practical implementation – funding, links with other schemes, co-cooperativeness of landowners.
- Future management of the strip – practicalities of grazing or cutting?

The current and predicted rate of cliff retreat is of particular importance. A cliff top buffer strip must be able to accommodate cliff top retreat for at least the next 50 years and still provide useful cliff top habitat. If the management of a site calls for a cliff top buffer of at least 50m, and the retreat rate on site is 1m per year, a buffer strip of at least 100m would be required to absorb 50 year's worth of erosion. On some sites landowners may be encouraged to improve management of whole fields which is perhaps easier to manage from the point of view of entering into agri-environment schemes.

An alternative to the approach of having a static buffer is to use flexible, moving buffers. These would retreat with the cliff line, maintaining a set width of cliff top habitat. With the flexible buffer approach less land would have to be taken out of production at the outset, this approach may be more acceptable to land owners. The south-west Isle of Wight example is a combination of the two - a minimum of 20m that would move inland as the cliff recedes, but within an overall width of 50m to allow for future change.

It is important to consider implementation and ongoing management. Landowners may need incentives in order to remove agricultural land from production. North Norfolk is a prime example, as much of the cliff top land is of high value to arable crop production. The solution is effective targeting of agri-environment schemes and adequate payments designed to maintain or enhance the nature conservation interest of SSSIs such as Environmental Stewardship in England and Wales. However, funds for this are limited and there will be a need for effective targeting.

The proposed Coastal Access Project (Thompson, 2007) is an opportunity to deliver cliff top habitat restoration on many sites. Natural England is currently providing advice to Government on the best means of delivering the stated vision: *'A coastal environment where rights to walk along the length of the English coast lie within a wildlife and landscape corridor that offers enjoyment, understanding of the natural environment and a high quality experience; and is managed sustainably in the context of a changing coastline'.* This drive for increased public access to our coast can deliver benefits for both people and wildlife. Where there is no coastal access provision coupled with insensitive cliff top management there is most potential for wildlife gain. If coastal access is established in such areas along with the re-establishment of wide, appropriately managed cliff top buffer zones there are likely to be benefits to soft cliff invertebrates. From a walkers' perspective a cliff top walk through semi-natural flower-rich grassland is much preferable, and safer than, to a trudge through arable fields or being confined to the first couple of metres of the cliff top.

Norfolk is a good example of where there are opportunities for significant enhancements to cliff top management through coastal access projects. Norfolk has a significant proportion of the UK soft cliff resource, however for much of the cliffed coast in the county there is no public access to the cliff top. Instead there is often intensively managed arable land with little or no buffer to the cliff slope. Introducing cliff top access incorporated within a wide buffer zone of re-established cliff top grassland is likely to enhance nationally important soft cliff sites such as Overstrand, Trimingham, and West Runton.

As with most schemes there are potential negative impacts of the establishment of coastal access to cliff top areas. Visitor pressure can lead to heavy localised erosion and disturbance. Where public access to the coast has the potential to damage the wildlife interest a solution can often be found through routing paths inland. Where visitor pressure is high sites can suffer localised soil compaction or erosion: this is relevant to both hard and soft cliffed coasts, good examples of this include Bedruthan Steps in Cornwall, and Lulworth Cove in Dorset. Although moderate trampling can maintain useful bare ground habitat, excessive compaction is not ideal.

Another potential conflict between management of sites for wildlife and public access is that of livestock. The exclusion of stock through the erection of fences beside cliff top paths can lead to the development of scrub on more stable sections which will overshadow low-growing plants and may act as a barrier to the movement of species form the cliff top to the slope and vice-versa. There are large sections of the southwest coast path in this condition.

However, in general the promotion of coastal access provides a great opportunity for improving cliff top management on many sites. In particular, the objective of enhancing the cliff top habitat relates directly to enhancing cliff top visual quality, and could have economic benefits to the local economy through tourism.

Water quality and quantity

The management of cliff tops and adjacent land can damage or destroy freshwater habitats and their associated invertebrate faunas. Such habitats include groundwater seepages, cliff face springs, perched reedbed and small streams. F reshwater habitats are of vital importance for the conservation of a significant number of soft cliff invertebrates, as an illustration, 17 of the 29 Grade 1 species are associated with these features.

Drainage of cliff top pastures to provide drier grazing for livestock alters natural drainage patterns and can result in the loss of seepages and other freshwater habitats from the cliff slope. Artificial drains often cause localised accelerated erosion. Fertilizer and pesticide runoff from intensively managed cliff tops or adjacent land can affect water quality. Nutrient enrichment from these sources can alter vegetation communities. Promoting cliff top grassland restoration on arable land through agri-environment schemes is one solution for protecting cliff seepage water quality from fertilizer and pesticide runoff (Reid & Grice, 2001).

A greater impact on hydrological features comes from groundwater abstraction within the catchment of the coastline. The abstraction of water inland can reduce supply to the cliffs, with impacts on the viability of freshwater habitats - crucial components of cliff ecology for invertebrates. Demand for water abstraction from groundwater aquifers can increase considerably during periods of drought, at a time when freshwater habitats are most vulnerable.

Licensed water abstractions within the catchment of soft cliff sites should be assessed to ensure that there will be no significant reduction in water supply to the cliffs. Any assessment must take into account periods of drought and future climate change scenarios. We recommend that the assessments should include existing licenses as well as new applications.

Summary
Appropriate management of cliff top habitats is critical to the sustainable management of our soft cliff resource for insects and other invertebrates. The whole functional system from cliff slopes to cliff tops needs to be considered, for example in the provision of nectar and forage for invertebrates. Cliff top ecological resources can be an essential element of the viability of invertebrate populations of cliff invertebrates. Where coastal protection works have reduced the available area of naturally functioning soft cliffs and isolate fragments of habitat, sensitively managed cliff top habitat improves the connectivity of sites. Connectivity of suitable habitat is crucial to the conservation of invertebrates that have poor dispersal abilities or exhibit metapopulation dynamics.

Many cliff top habitats have been converted to intensive agriculture and other uses. This has damaged and impoverished a significant number of soft cliff sites in the UK and continues to threaten the nature conservation interest of others. There are numerous opportunities for recreating natural or semi-natural cliff top habitats such as herb-rich cliff top grassland or coastal heath. Ensuring that cliff top management enhances rather than degrades the ecology of soft cliff slopes should be a priority in any site management.

The importance of hydrology is crucial on many sites. The quality and quantity of water reaching soft cliff sites can have a major impact on the ecology and invertebrate assemblages associated with seepages and other freshwater habitats. Water management within the catchment of soft cliff sites must take this into account, in particular with respect to inland surface or groundwater abstraction.

6.3 Managing soft cliffs – grazing

Until relatively recently coastal slope grasslands and heaths were regarded as valuable grazing land. All but the most inaccessible or unstable cliff slopes and undercliff areas in the UK have been grazed by livestock at some point in the past (Oates, 1999). Although the majority of soft cliff sites do not require active management, there are some which may benefit from the re-introduction of grazing.

In much of western and southern Britain coastal slopes were utilised as rich winter feeding grounds, due to the almost continuous growth of grass throughout the seasons. For example, sheep from Dartmoor used to be wintered along the south Devon cliffs (Oates, 1999). There is also a history of cultivation on some sites: an early potato crop and other vegetables were grown at Branscombe and Axmouth-Lyme Regis on the south Devon cliff coast (Campbell, 2006). Grazing on much of England and Wales' coastal slopes was abandoned by the 1930s (Oates, 1999), and large areas were maintained by rabbits up to the spread of myxomatosis in the early 1950s (Oates *et al*, 1998). A number of sites are still maintained, to a certain extent, through rabbit grazing. Deer also feature on the more extensive undercliffs, although not in sufficient numbers to have a significant impact.

Figure 60. Disused sheep dip within soft cliff woodland at Axmouth-Lyme Regis.

The loss of livestock grazing on coastal slopes will have resulted in significant changes to the flora and fauna, especially where exposure and instability is less of a controlling factor on vegetation succession. More geologically stable sites will have experienced open grasslands being replaced by more rank, coarse grassland, bramble, bracken and scrub. At the same time as grazing on cliff slopes was reduced or lost, in contrast, cliff top grasslands were 'improved' to provide higher productivity grazing. Changes in animal husbandry and stock breeds have led to the cliff top pastures being fenced off from the slopes. Thus cliff habitats have changed quite dramatically over the last 100 years or so, the cliff top systems experiencing more intensive agricultural practices and the cliff slope being effectively neglected. Cliff top management is discussed further in Section 6.2.

Where sites are more stable and soils are deeper and more fertile, extensive scrub can start to dominate sites. Scrub can be of ecological value in its own right, providing habitat for birds and some invertebrates. On some sites blackthorn and gorse provide an essential source of nectar and pollen at times when then the resource is in short supply like early spring. However, in the absence of grazing scrub can replace useful grassland and heathland habitats. Much of the scrub along the UK coast is of relatively recent origin, developing since the loss of livestock grazing, the drop in the rabbit population through myxomatosis (Oates *et al*, 1998), and the cessation of collecting gorse, bracken and other material for fuel or winter animal feed.

Grazing is not always the most appropriate management for grassland invertebrates. Invertebrates often have specialised needs and rely on features such as vegetation structure and function as well as botanical diversity. There are studies which show grazed grasslands to have impoverished faunas compared to ungrazed grasslands (Morris, 1969). However, well managed grazing can increase the botanical diversity of a grassland, and a diverse invertebrate fauna can follow a diverse flora. Grazing can open up closed grassland swards, and be used to knock back bracken and scrub invasion. For some soft cliff sites there may be a case for reintroducing targeted light grazing. These will be the more geologically stable slopes that have been grazed in the past.

Sites which are more mobile will not require any grazing management. In these unstable systems the continuity of habitat is maintained by the slippage and slumping of cliff material. Introducing grazing to these sites would be highly damaging to the ecological interest and inappropriate from an animal welfare perspective.

Any strategy for reintroducing grazing will have to be carefully considered and well monitored. These sites often feature intricate habitat mosaics, some of which need management whilst others do not. Grazing can radically alter more sensitive habitats, even by slight changes in the regime such as choice of stock or timing of grazing. Grazing has the potential to damage the invertebrate interest of a site and so the invertebrate fauna must be surveyed before any management changes are explored, and the impacts of management must be monitored for many years. Any new grazing scheme should have clear targets taking into account the existing interest of the site and the historical information on past management or the extent of habitat features, such as scrub, in the past. There are many references available on nature conservation grazing including Oates (2000), Oates *et al* (1998), Crofts & Jefferson (1999), and Watts (2006).

With the subsequent changes in farming methods and issues such as public access on coastal footpaths, the re-introduction of grazing to coastal slopes will be a challenge to nature conservation organisations and site managers. Practical issues such as fencing or water supply, sourcing appropriate stock, or appropriate animal husbandry skills will not be easy to overcome. Coastal access issues such as regular users not appreciating changes to the coastal landscape, or compatibility issues with dog walkers, all come into play.

However, there may be a handful of sites where the reintroduction of grazing is practical, and would be of benefit to the nature conservation interests of coastal soft cliffs.

Case study: Ringstead Bay, Dorset

Ringstead Bay in Dorset comprises clay and chalk landslips and undercliff from Ringstead Village to White Noathe, and includes Burning Cliff. Notified as a SSSI, a designated SAC and part of the Dorset and East Devon World Heritage Site, the site is owned and managed by the National Trust. The slopes and undercliffs support a mosaic of recently slumped cliff with bare ground and pioneer vegetation, neutral and calcareous grassland, scrub, ponds and seepages. The soft cliff slopes at Ringstead support a number of Red Data Book and Nationally Scarce invertebrates, including at least 12 Graded soft cliff species (see Section 4.3 for more information on the site's invertebrate assemblage).

In common with many other south coast sites, Ringstead slopes and undercliffs were grazed extensively in the past. The site has changed in more recent times: the amount of open herb-rich grassland has reduced as the extent of coarse grasses and scrub has increased (Allen *et al*, 2004), although where the slopes are sufficiently geologically unstable the open habitats remain.

The National Trust and Natural England assessment of the site is that the encroachment of scrub and closed grassland has replaced ecologically important habitats and left part of the site in unfavourable condition. Following discussion between the National Trust, Buglife and other relevant stakeholders it has been agreed that the re-introduction of grazing to the more stable parts of the site would be of benefit to the ecological interest.

Introducing livestock onto the undercliffs will open up areas of closed grassland, prevent further scrub encroachment and may knock back some of the scrub which has recently developed. There are, of course, a number of practical considerations. Cattle would be the preferred stock; these would need to be hardy breeds and small in stature. The undercliffs would require an extensive grazing system with a low stocking density and the ability to control livestock movements to prevent damage to sensitive areas. Parts of the site do not need grazing management, these include the unstable slopes, mudslides and seepages which naturally maintain bare ground and early successional habitats.

From a practical viewpoint, provision of a water supply will be necessary, plus fencing, a stock manager, and alternative grazing land as the stock will not be on site year round. One solution would be to work with the Lulworth estate (east of the site) to graze both National Trust and Lulworth properties with cattle (Simon Ford pers comm.).

There will undoubtedly be some challenges between balancing the botanical and invertebrate interest of the site, however it is thought that these will be minor and that the new management will provide net gain for wildlife. Introducing stock to the undercliff will lead to a reduction in coarse grasses such as Tor grass (*Brachypodium pinnatum*), the foodplant of the Lulworth Skipper butterfly *Thymelicus acteon,* and so the resident population of this butterfly is likely to be reduced. However, this change should be tolerated in view of the likely benefits to the overall ecological quality of the site. Stock grazing should at first concentrate on small areas of the site and be well monitored for impacts on the invertebrate fauna and other ecological interest. Although the site has been surveyed for invertebrates in the past (Allen *et al*, 2004; Hunnisett & Edwards, 2006), we would recommend an intensive survey of the site before any changes in management take place. This site would make a good case study for grazing reintroductions on other soft cliff sites.

6.4 Managing soft cliffs – invasive plants

As for many other habitats of high conservation value, invasive plants pose a threat to the nature conservation interest of coastal soft cliffs. Invasive plants can quickly dominate substantial areas of the cliff slope, altering the vegetation dramatically. Invasive plants are a particular problem on more stable slopes where they are better able to establish.

This is a very localised threat but a significant one nonetheless; species of concern include Buddleia (*Buddleia davidii*), Holm oak (*Quercus ilex*) and Sea buckthorn (*Hippophae rhamnoides*). Buddleia is often introduced to sites from domestic gardens or through the dumping of garden waste onto soft cliff sites, it is a particular problem at Branscombe in East Devon where it seems to have escaped from the gardens of holiday chalets on the cliff slope. Sea buckthorn has been noted as a problem on coasts in the east of England, for example Overstrand in Norfolk where the plant is spreading rapidly and forming large thickets. A future potential threat is Hottentot fig (*Carbobrotus edulis*) which has already damaged a number of sand dune and cliff sites in south Devon, Cornwall and the Isles of Scilly. With the predicted rise in winter temperatures due to climate change this species may be able to spread to more sites.

Where monitoring shows that invasive plants are having a negative impact on sites they should be controlled to prevent further expansion, and eradicated if appropriate. Eradication is most effective if problem species are identified at an early stage before they became too established. Strategies for preventing introduction of invasive species also need to be developed.

Figure 61. Buddleia-dominated vegetation at Branscombe, south Devon.

6.5 Managing soft cliffs - climate change

Future climate scenarios

The scientific consensus is that the earth is experiencing anthropogenically-driven climate change, with average global temperatures predicted to rise over the coming years. The UK Climate Impacts Programme (UKCIP) have calculated a range of global warming scenarios by the year 2100 of between 2.1ºC and 4.8ºC higher than the 1961-1990 average. The scenarios for the UK range from 2.0º to 3.9ºC for the same time periods (Hulme *et al*, 2002).

This change in climate will bring about a number of changes, most of which are likely to have some impact on the ecology of coastal soft cliffs in the UK. Alongside a rise in average temperature the changes that have been suggested in future climate change scenarios are: a rise in sea level, changes to precipitation patterns, increased storm frequency and storm ferocity.

In broad terms a rise in sea level is the result of two processes – eustatic and isostatic sea-level changes. Eustatic sea level changes are on a global scale, and are the consequence of the thermal expansion of seawater, and the release of water stored as ice on land or as floating ice (table 17). Isostatic change operates on a more local scale and refers to a relative change of the level of the land to the sea; in the UK the most significant cause of isostatic change is the movement of tectonic plates in response to the unloading of ice sheets following the last glaciation. The result is that through isostatic change the north of Britain is rising whilst the south is sinking (table 18). The combination of both eustatic and isostatic sea level change means that net sea level rise is not constant around the coast of the UK (table 18).

Table 17. Global average sea-level change (cm) relative to the 1961-1990 average, for the highest and lowest predictions from the IPCC range. (Hulme *et al*, 2002).

	2020s	2050s	2080s
Low Emissions - 'Low' IPCC estimate	4	7	9
High Emissions - 'High' IPCC estimate	14	36	69

The scenarios for changes in precipitation patterns forecast wetter winters and drier summers across the whole of the UK (Hulme *et al*, 2002). The relative changes are more extreme in the south and east, where summer precipitation may decrease by 50% or more by the 2080s, and winter precipitation may increase by up to 30%. Summer soil moisture may decrease by 40% in southern and eastern England. Along with an average increase in winter precipitation, there is a predicted increase in heavy precipitation events for the season.

Future climate scenarios also feature increases in the frequency and ferocity of storm events throughout the seasons, but particularly in winter.

Increased cliff retreat rates

The factors influencing cliff erosion incorporating climate change and sea-level rise impacts are summarised in figure 62.

In general terms a rise in sea level coupled with increased storm frequency and ferocity are likely to increase the rate of toe erosion. This will differ between regions as the predicted sea level rise is not equal around the UK coast (table 18), plus the exposure to storms varies around the coast.

The geology of a cliff also plays a part. Soft cliffs are a major source of sediment and eroded materials that remain on the shore provide a natural source of protection from the sea. Cliffs with a higher proportion of sand are likely to adjust to sea-level rise more effectively than those where clay is the major component. The erosion rate at clay cliffs may be intensified because fewer of the products of erosion can contribute to the shore profile (Bray and Hooke, 1997).

Predicted future rates of cliff erosion have been produced for most regions. For example, in the south coast of England a sea level rise of 0.22m has been predicted, with an increased rate of retreat estimated at between 22% and 133% (Bray & Hooke, 1997).

Increased coastal erosion has been recognised as a threat to both human and nature conservation interests by a number of regional climate impacts studies (Wade *et al*, 1999; Halcrow, 2001, UKCIP, 2002a; UKCIP, 2002b; Metcalf *et al*, 2003).

Table 18. Predicted sea level change for the UK (taken from UKCIP, 2005) - the net sea-level change figures (based on IPCC data) incorporate isostatic change data (estimated from Shennan & Horton, 2002).

	Regional isostatic uplift (+ve) or subsidence (-ve) (mm/yr)	Net sea-level change (cm) relative to 1961-90					
		Low Emissions Low' IPCC estimate			High Emissions High' IPCC estimate		
		2020s	2050s	2080s	2020s	2050s	2080s
East of England	-0.8	8	13	17	18	42	77
East Midlands	-0.8	8	13	17	18	42	77
London	-0.8	8	13	17	18	42	77
Northern Ireland	no isostatic adjustment data available						
NE England	+0.2	3	5	6	13	34	66
NW England	+0.6	1	2	3	11	31	63
Scotland	+0.8	0	1	0	10	30	60
SE England	-0.5	6	11	14	16	40	74
SW England	-1.0	9	15	20	19	44	80
Wales	-0.5	6	11	14	16	40	74
West Midlands	no coastline or tidal estuaries (at present time)						
Yorkshire & Humberside	-0.7	8	13	17	18	42	77

Changes to cliff morphology

Predictions of cliff recession rates in response to sea level rise and other climate change impacts are driven by assessment of impacts on human assets. Therefore most models concentrate on cliff edge (back scar) retreat rates. Current information on predicted changes to cliff slope morphology is limited, probably due to a lack of economic drivers for such research.

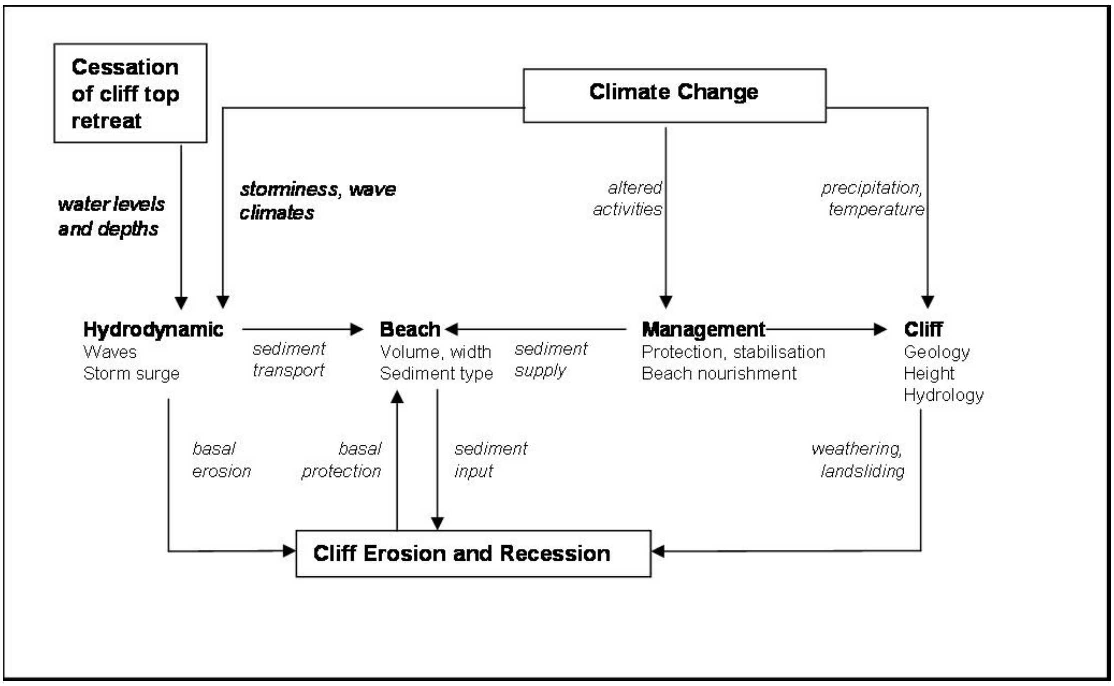
From a sea-level rise perspective, erosion rate and changes in slope morphology are determined by the transmission of enhanced basal (cliff toe) erosion up through the cliff system to the coastal back scar. This is influenced by a number of variables including: cliff height, geology, current morphology, landslide history and contemporary activity.

Bray and Hooke (1997) represents one of the few publications to discuss the impact of climate change on soft cliff morphology. They conclude that for simple low cliffs the response is likely to be relatively rapid – the cliff profile should steepen rapidly and failures of the whole slope may ensue soon after basal undercutting. However these systems are often steep or vertical in their present state, so they may retain their form but retreat more rapidly.

In high compound cliffs, for example the extensive landslip system of Black Venn in Dorset, wide slippages zones have partly decoupled the back scar from erosion at the cliff toe. As such, the response of the cliff system to increased toe erosion may be much slower. Ultimately, higher, more complex systems may eventually switch their forms to new steeper slope profiles characterised by higher magnitude erosion events (Bray and Hooke, 1997). A steepening of cliff slopes reduces the distance from cliff toe to back scar, and effectively reduces the total area of cliff slope or undercliff.

The referenced models based the impact of sea level rise do not include the influence of altered precipitation patterns on the behaviour of soft cliffs. On many soft cliff sites the primary cause of erosion is groundwater-driven landslip activity, rather than erosion by the sea. The scale of this can be incredible – Black Ven in Dorset is the largest active landslip system in Europe (Covey, 1997). This landsliding activity is commonly associated with periods of heavy rainfall or storms (Brunsden & Lee, 2004) which elevate groundwater levels. A major threat to human assets is the reactivation of stable or relict landslip systems due to these raised groundwater levels, which could lead to catastrophic cliff failures.

Figure 62. Summary of factors influencing cliff erosion, including the impacts of climate change and sea-level rise. (from Bray & Hooke, 1997)



Implications for soft cliff ecology

It is incredibly difficult to predict the impact of climate change on ecological systems. There are an enormous range of interactions to take into account and the underlying ecological information and abiotic data is often not available. There is a paucity of autecological information for many invertebrate species. If we do not have a clear picture of their habitat requirements then we have little chance of predicting those in a changing environment. The geomorphological response of cliff systems to the various climate change scenarios is understudied, and the climate change scenarios are wide ranging and constantly being updated. So to try and predict the impacts of climate change on the invertebrate assemblages of UK coastal soft cliffs could be seen as considerable extrapolation. However, so that we can be better prepared for the future some extrapolation is appropriate (and necessary) - providing that the discussion is based on sound ecological knowledge, and the limitations of the exercise are recognised.

The spatial distribution of species may change in response to climatic changes, many species in the UK are temperature limited and so a warming of the climate may allow some range expansion. This includes some of our current soft cliff specialists which may extend their UK ranges beyond soft cliff sites, in addition they are likely to be joined by new species. Many of the graded soft cliff species are thermophilic, often on the northern edge of their European range. They are not maritime species, or wholly restricted to soft cliffs on mainland Europe, for example the Cliff tiger beetle *Cylindera germanica* is present in a range of habitats on the continent. In the UK these species are restricted to soft cliffs, and particularly those with plenty of bare ground and open habitats and a southerly aspect - locations which provide higher than average temperatures. An increase in average UK temperature (or perhaps more importantly an increase in minimum temperatures) may enable these species to spread into suitable habitats in the wider countryside, providing that such habitats exist within the dispersal ability of the organism.

The warming of our climate may also favour new arrivals to the UK. Soft cliffs on the south coast of England are likely to be the first port of call for new colonists from the European mainland. Many of the first records of the recent colonist *Colletes hederae* – the Ivy mining bee - were soft cliff sites; there are also records of the Clouded yellow butterfly *Colias croceus* breeding for the first time in the UK on soft cliffs in south Devon, and of a breeding colony of the Spanish fly (a blister beetle) *Lytta vesicatoria* on a soft cliff site on the Isle of Wight (Adam Wright pers comm.).

Not all new species to soft cliff sites will be benign. Increased temperature may encourage the spread of invasive exotic plants that change the character of soft cliff habitats. One species of particular concern is the Hottentot fig *Carbobrotus edulis*, this species invades cliffs and dunes and is already a problem on sites in Cornwall and West Devon. Rising temperatures may allow this species to spread onto soft cliff sites of high ecological importance in East Devon and Dorset.

The altered precipitation patterns predicted in climate change scenarios are also likely to have a significant impact on soft cliff invertebrate faunas. As noted in Section 3, over half of our graded soft cliff species are associated with hydrological features. With reduced summer rainfall and an increased frequency of summer droughts the amount of freshwater reaching cliff systems is likely to be reduced; hydrological features on cliffs such as seepages and reedbeds will be compromised and may disappear altogether on some sites, particularly those in the south and east (Halcrow, 2001). Increased human demand for water during drought periods will exacerbate the situation. Species relying on freshwater habitats will be highly vulnerable to local and even national extinctions. For example the RDB2 solitary wasp *Mimumesa atratina* is restricted to soft cliff reedbed on the south coast of the Isle of Wight, this region will experience some of the more extreme drought predictions and this wasp will be at risk of extinction in the UK. The importance of hydrological features on soft cliff sites must be recognised and taken into account when planning for current drought events, and future climate scenarios to ensure that they are afforded protection.

The predicted rise in sea-level, increased storm frequency and ferocity, and increased winter rainfall scenarios are likely to, alone and in combination, increase the rate of soft cliff erosion and decrease the stability of soft cliff slopes. There is a delicate balance between too little erosion to suppress vegetation succession and create bare ground habitats, and too much instability which will prevent the colonisation of slopes by plants and invertebrates and not allow any useful habitat to form. The reactivation of more stable systems as a result of higher winter rainfall and increased erosion rates could create more open habitats on some sites. However the net impact of soft cliff habitats and invertebrates is likely to be a negative one. Sites which are already classed as being of high importance for invertebrates are likely to become degraded, damaged, and reduced in area. The predicted reduction in the extent and quality of soft cliff habitat on sites has implications for the delivery of current nature conservation targets such as those in the UKBAP Habitat Action Plan for Maritime Cliffs and Slopes, which requires that there is no net loss of soft cliff habitat and that the condition of the resource is improved.

At a species-specific level, an overall increased rate of cliff erosion could reduce the capacity of sites to support burrowing invertebrates. It is likely that populations of burrowing invertebrates such as nesting aculeates would suffer local extinctions if the erosion rate is such that their burrows are destroyed. Species will be affected to different degrees depending on their ecology, for example deep burrowing species would be more resilient than shallow burrowers. The seasonality of erosion events will also mean that some species are more vulnerable than others. Increased winter erosion events will impact upon species that over-winter within or on cliff faces.

The metapopulation dynamics of soft cliff invertebrates are resilient to local extinctions as habitats are lost or become unfavourable for the particular species. It is uncertain whether the metapopulations of some species will be able to cope with significant changes to the rate or scale of habitat change that is likely to occur as a result of increased erosion rates and instability.

Increased erosion will also put pressure on cliff top habitats as land is lost and current semi-natural cliff top maritime grassland is reduced in extent. Estimates of losses of cliff top habitats on European protected sites (SACs, SPAs) amount to 103ha by 2050, which could represent as much as 73% of the existing maritime cliff grassland in the UK (Lee, 1998). Many soft cliff sites have already been degraded through the loss of natural and semi-natural cliff top habitats (Section 6.2), and further loss will exacerbate the situation. Where nectar sources are likely to be lost from cliff slopes through greater slope instability, cliff top nectar sources will increase in importance. Provision must be made to ensure that the accelerated retreat and associated loss of cliff top habitats is effectively mitigated for – for example the creation of wide and flexible cliff top buffer zones to expand the extent of such habitats further inland.

An increase in coastal erosion will also increase demand for coast protection to protect human assets, with the associated implications for soft cliff habitats. There is some potential for the use of soft coast protection to protect the nature conservation interest of sites in the face of increased erosion rates, perhaps through the use of artificial beach replenishment or offshore structures such as artificial reefs. However this may ultimately prevent sites from reaching a natural equilibrium, as well as creating coastal management problems down drift if a major sediment source is compromised.

Impacts of climate change on species are often broken down into potential ‘winners’ and ‘losers’, this is a rather crude instrument to describe complex ecological systems but can be of some use for a simplified overview.

Potential ‘Winners’

- Thermophilic species that are able to expand their ranges into other habitats.
- New arrivals to the UK, expanding the northern limit of their distribution in Europe.

Potential ‘Losers’

- Species reliant on hydrological features.
- Species reliant on later successional habitats on soft cliffs.
- Species reliant on large sites to support viable populations.
- Species that are unable to contend with increased erosion.
- Less mobile species.

Summary

- Future climate change and sea level rise will change the soft cliff environment.
- From an ecological perspective increased rates of erosion and the destabilising of coastal slopes at the extreme end of the scale are likely damage many of our most important soft cliff sites.
- There is likely to be an overall negative impact on the invertebrate assemblage associated with coastal soft cliffs.
- Changes in precipitation patterns put those assemblages associated with hydrological features such as seepages at particular risk.
- New colonists to the UK are likely to appear on southern soft cliff sites, and some species currently restricted to soft cliff sites may spread into other habitats.
- The individual responses of invertebrate species to climate change scenarios are largely unknown and understudied. This should be a conservation research priority if we are to prevent species extinctions and maintain sustainable populations of invertebrates in the UK.
- Shoreline management and the management of cliff top habitats must take climate change into account with respect to meeting biodiversity targets and maintaining the existing nature conservation resource.

6.6 Managing soft cliffs - site safeguard

Statutory protection

The majority of soft cliff sites in England, Wales and Northern Ireland are afforded protection through national and international statutory site designations. Many of the national designations are because the sites support geological or geomorphological interest features. In England some 224km of soft cliff are within SSSIs – 87% of the total resource. With the exception of Luccombe Chine to Shanklin Chine on the Isle of Wight, sites that are not notified are all Grade C sites (see Section 5), and over half (16.6km) are rapidly eroding sites of limited invertebrate interest on the Holderness coast. In Wales approximately 66km (66%) of the soft cliff resource is notified as SSSI (Howe, 2002).

Coastal soft rock cliffs are a component of the EU Habitats Directive Annex 1 habitat 'vegetated sea cliffs of the Atlantic and Baltic coasts'. A number of UK sites representing this habitat have been designated as Special Areas of Conservation (SACs) as part of the 'Natura 2000' network of European designated sites. The Conservation (Natural Habitats, &c.) Regulations 1994, more commonly referred to as the 'Habitats Regulations', implement the EU Directive in the UK and contain provisions for the assessment of plans and projects affecting Natura 2000 sites, as well as a requirement to maintain or restore favourable condition across the whole range of the habitat. The SACs which have been selected for the Annex I feature 'vegetated sea cliffs of the Atlantic and Baltic coasts' include a number of soft cliff sites listed in table 19 (further information on these and other SACs can be found on the JNCC website: www.jncc.gov.uk).

Table 19. UK SACs with a coastal soft cliff component

Clogwyni Pen Llyn/Seacliffs of Llyn	Gwynedd
South Devon Shore Dock	Devon
Sidmouth to West Bay	Devon and Dorset
Isle of Portland to Studland Cliffs	Dorset
South Wight Maritime	Isle of Wight
Hastings Cliffs	East Sussex
Overstrand Cliffs	Norfolk
Beast Cliff	North Yorkshire
Durham Coast	Durham

Limitations of statutory protection for invertebrate conservation

The geological and geomorphological interest of soft cliffs is well recognised and is reflected in the SSSI series. Coastal soft cliffs provide attractive coastal scenery, and they are a source of material for accretionary coastal features such as beaches. They provide geological exposures for teaching and research, and can be used to study geomorphological features such as landslips and mudslides. Many sites have been at the heart of geological science, for example the paleontological work of Mary Anning and geological type sections of international importance at Lyme Regis.

Following the site grading exercise detailed in Section 5, we have taken the SSSI citations for English sites and compared our list of 'Grade A' sites (those which, in our assessment, support coastal soft cliff species or soft cliff invertebrate assemblages of national importance, meriting notification as SSSI) with the notified interest features of the sites taken from SSSI citation documents.

The majority of Grade A sites do list soft cliff invertebrates as an interest feature of the SSSI. However, there are some major omissions: South Dorset Coast SSSI (includes Chapman's Pool and Ringstead Bay); Red Cliff (Bembridge Down SSSI) on the Isle of Wight; The Naze in Essex; and West Runton in Norfolk. We recommend that the soft cliff invertebrate interest of these three sites should be recognised as SSSI interest features and afforded protection accordingly.

South Dorset Coast SSSI forms a large proportion of the 'East Dorset cliffs' metasite, identified in Section 3 as the 5^{th} most important site in the UK for soft cliff invertebrates. It is known to support 10 RDB invertebrates and over 25 Nationally Scarce species. This site is clearly of national importance for its soft cliff invertebrate assemblage.

Records collated by Buglife suggest that Red Cliff supports a soft cliff invertebrate assemblage of national importance. This is one of only two known sites in the UK for the RDB2 solitary wasp *Nysson interruptus*. Further surveys are necessary to update historical records for a number of species and to confirm the status of the site.

The Naze near Walton is one of the most important invertebrate sites in Essex. It is known to support 11 RDB and over 25 Nationally Scarce species. Our assessment is that the invertebrate fauna of the site is a notifiable feature, yet The Naze SSSI is only notified for its geological interest.

West Runton is one of a handful of UK sites known to support the RDB1 staphylinid beetle *Bledius filipes*, the RDBK cranefly *Symplecta chosenensis* and the Nationally Scarce (Na) carabid beetle *Nebria livida*. Although the site does not support a high number of scarce or threatened species it is likely that it supports a significant proportion of the UK population of the three species listed. The SSSI citation for West Runton details the geological interest of the site but does not mention any biological interest features.

Sites of national importance for invertebrates not being recognised within the SSSI series is an issue that goes beyond soft cliffs. This is partly attributable to the current lack of clear notification guidelines for SSSIs with invertebrate interests (beyond butterflies or dragonflies and damselflies) (Nature Conservancy Council, 1989). There is a pressing need to revise the SSSI selection guidelines for terrestrial and freshwater invertebrates.

Sites supporting SSSI quality invertebrate fauna risk losing this nature conservation interest if it is not recognised in the list of SSSI interest features. Where the invertebrate interest of a site is not stipulated on the SSSI citation there is a risk of site management or site safeguard not taking invertebrates into account. For example, impact assessments of operations with potential to damage SSSIs may not take impacts on the invertebrate fauna into account.

Similarly, when SSSIs are subject to site condition assessments by the statutory agencies, if the invertebrate interest is not a notified feature it will not be included as part of the assessment. Sites which are notified for their geological interest alone could be in favourable condition for geological features. However, because the invertebrate interest would not be assessed in such a situation, there is a risk that the ecological (invertebrate) interest is unfavourable.

Where the invertebrate interest of a site is not recognised as a SSSI interest feature there is the risk of this being lost or damaged despite other features of the site being under statutory protection. The only way to truly protect the invertebrate interest of sites is through adding this onto site interest feature lists and SSSI citations. If the invertebrate interest of a site is at risk, there needs to be a process of improving and collating the scientific data to enable statutory conservation bodies responsible for SSSI notification (or ASSI in Northern Ireland) to develop and implement a strategy for strengthening the contribution of the current site series to invertebrate conservation. In the absence of such a process it would seem that the only way to truly protect the invertebrate interest of sites is through adding this onto site interest feature lists and SSSI citations – this would require significant resources from the statutory agencies.

Notification of new SSSIs

Luccombe Chine to Shanklin Chine on the Isle of Wight is not notified as SSSI at all, however it is considered to be of national importance for its invertebrate fauna (see Section 4.4), and has it has been recommended that the site is notified as SSSI (Colenutt & Wright, 2001). The site is known to support eight Red Data Book and 49 Nationally Scarce invertebrate species, including twelve soft cliff species. This site supports one of only two UK populations of the Chestnut click beetle *Anostirus castaneus* (RDB1, UKBAP) and one of the two UK populations of the spider *Episinus maculipes* (RDB3). Buglife support the assessment made in 2001 (Colenutt & Wright, 2001) that the soft cliffs of Luccombe to Shanklin Chine are of national importance for invertebrate conservation and as such should be considered for notification as a SSSI.

Non-statutory protection

Around 1525km of the coast of England and Wales has Heritage Coast status (Lee, 1995). Public enjoyment of the coast is encouraged through the provision of recreational activities that are consistent with the conservation of scenery, heritage and nature conservation features. Heritage Coasts with soft cliff components include Gower, Llyn, East Devon, Tennyson (Isle of Wight), Suffolk, North Yorkshire and Cleveland.

The East Devon and Dorset World Heritage Site, or 'Jurassic Coast' adds an international dimension to site safeguard for this stretch of coast, and provides a high level of conservation status.

Many soft cliffed coasts also fall within Areas of Outstanding Natural Beauty (AONB) or National Parks.

UK Biodiversity Action Plan

The UKBAP commits the UK government and BAP partner organisations to a number of targets formulated to protect and enhance priority species and habitats.

Soft cliffs are a major component of the UKBAP priority habitat 'Maritime cliffs and slopes'. Revised targets for the Maritime cliffs and slopes BAP (UK Biodiversity Group, 2006) are listed in table 20. The targets include what is essentially a 'no net loss' policy for maritime cliff and slope habitats, with the aspiration of achieving, over time, a net gain. There are also targets for the restoration of semi-natural cliff top habitat.

Table 20. Revised targets for Maritime Cliff and Slope UKBAP Priority Habitat (UK Biodiversity Group, 2006).
Further detail is available at http://www.ukbap-reporting.org.uk)

1. Maintain the existing free-functioning maritime cliff & slope resource (including of cliff-top and slope habitat), estimated to be have a length of about 4500 km. This is essentially a ‘no net loss’ target that should take account of the balance between the extent of coast protection works and free-functioning cliff systems.
2. No overall net loss of cliff and slope functionality as a result of coast protection or engineering works (applicable to England and Wales only).
3. Increase the extent of Maritime Cliff and Slope unaffected by coastal engineering/coast protection from 250km to 275km by 2020 (applicable to England only).
4. Increase the area of cliff-top semi-natural habitats by at least 500 ha (minimum) by 2015.
5. Achieve favourable or recovering condition for 1,500 km/30% of maritime cliff and slope including cliff-top vegetation, by 2010.

Maritime cliffs and slopes are the third most important UKBAP priority habitat in terms of the number of associated BAP priority species (Simonson & Thomas, 1999). A total of 26 priority species are associated with the habitat, with a further 59 priority species listed as using the habitat. Seven of our graded soft cliff species feature in the current UKBAP priority species list: the Luccombe click beetle *Anostirus castaneus*, the Cliff tiger beetle *Cylindera germanica*, the ground beetle *Tachys micros*, the mining bee *Lasioglossum angusticeps*, the Large mason bee *Osmia xanthomelana*, the Dotted bee fly *Bombylius discolor*, and the Chalk Carpet moth *Scotopteryx bipunctaria*. At the time of writing the UKBAP review for terrestrial and freshwater invertebrates (Biodiversity Reporting and Information Group, 2007) has added two more of our soft cliff species: the Glanville Fritillary butterfly *Melitaea cinxia* and the Black headed mason wasp *Odynerus melanocephalus*.

7. Recommendations for further work

The study of the biodiversity of coastal soft cliffs should not end with the publication of this report; there are still many sites in need of survey and research requirements to inform site management. The implementation of the recommendations made in this report is vital to the management of many nationally important soft cliff sites.

This report details generic threats and management issues relating to coastal soft cliffs and translates these into specific guidance for selected sites. The generic recommendations should be applied to all sites as appropriate regardless of a specific mention in the report.

This project has collated existing ecological data for soft cliff sites around the UK for the first time, undertaking new surveys to fill gaps in knowledge where necessary, to give an up-to-date picture of the invertebrates found on each soft cliff site. We hope that by presenting this information in an accessible form, this report and the datasets produced from the data collection and collation exercises will provide a valuable conservation management tool for conservation practitioners, coastal planners, and other stakeholders.

It is important to note that the report should not be considered comprehensive. Sites will doubtless have other invertebrate interest, and other ecological and geological interest. Listing all of these features is a hugely ambitious undertaking, and clearly beyond the scope of this report. All ecological and geological features of interest on coastal soft cliff sites should be taken into consideration in their management. In most cases the conservation of the ecological and geological interest of soft cliff sites have similar requirements. The maintenance of natural coastal processes and the sensitive management of cliff top habitats are of primary importance.

Further survey work

Coastal soft cliffs are an important wildlife habitat that have been underrated and neglected by conservation bodies and coastal managers in the past. One reason is the lack of available data due to problems with surveying sites. Many sites are inaccessible and there are significant health and safety issues attached to surveying remote, unstable coastal sites. The bulk of invertebrate recording on soft cliff sites has been on an *ad hoc* basis by individuals or special interest groups. Prior to the Buglife project, few formal invertebrate surveys had been carried out, with the exception of National Trust surveys on some key sites, and the surveys of Welsh sites by CCW. Survey effort in England has focussed on a small number of better known sites, such as Eype in Dorset or Cayton Bay in Yorkshire, and has been concentrated on the sections of those sites close to access points such as public footpaths and car parks. New survey work by Buglife has increased the available survey data for many regions and has raised the profile of soft cliffs amongst those in the conservation sector. The project has stimulated a new interest in the habitat, prompting new survey work by other organisations such as surveys of the Hastings cliff by Hastings Borough Council, and autecological studies by Hymettus (Hunnisett, 2006).

Despite the extra survey work carried out and stimulated by the Buglife Soft Cliffs Project, many sites remain under surveyed or not surveyed at all. Survey priorities include:

- New invertebrate survey of Prawle Point to Start Point soft cliffs in Devon.
- Invertebrate surveys of most Suffolk sites.
- Surveys of other soft cliff sites Graded as A or B, which have not been recently surveyed.

Autecological research on soft cliff species, including:

- What are the dispersal abilities of species such as the Cliff tiger beetle *Cylindera germanica* and Cliff comber ground beetle *Nebria livida*?
- Targeted searches for *Nebria livida* are needed on the north Yorkshire coast to determine its current status.
- What is the impact of habitat fragmentation on these species?
- Is there a need for species reintroduction on sites formally within their range, e.g. Large mason bee *Osmia xanthomelana* on the Isle of Wight, and what is the likelihood of success?

More research in the impact of climate change on soft cliff ecology, including:

- Finer scale impacts of changes in cliff recession rates and associated changes to cliff morphology on soft cliff ecology.
- Impacts of changing precipitation patterns on groundwater seepages.
- Species responses to climate change scenarios; will species be able to find suitable habitat within their dispersal abilities? Are species likely to use alternative inland habitats; if so what/where are these likely to be? Are restricted and highly specialised species especially vulnerable to local extinction through future climate change scenarios?
- How can we better ‘climate proof’ soft cliff ecology and soft cliff invertebrate species?

Research and monitoring of cliff protection schemes:

- Cliff protection mitigation schemes such as those employed at Castlehaven on the Isle of Wight should be monitored on a long-term basis in order to determine the effectiveness of such schemes to maintain soft cliff biodiversity, recommendations published to improve the exchange of information.
- Buglife surveys in Norfolk included a basic assessment of the impact of cliff protection structures on soft cliff ecology. Further fine-scale work is needed in this area to build up a more detailed picture applicable to the wider UK coast.
- Where cliff protection structures are coming to the end of their life and are not due for renewal (for example along the North Norfolk coast) the ecology of soft cliff sites should be monitored carefully to assess the impact of this change.

Research and monitoring of cliff top restoration schemes in order to develop guides to best practice, and to advise agri-environment schemes and site management.

- Existing schemes should be monitored to assess their effectiveness at restoring natural/semi-natural vegetation to cliff tops.
- The use of buffer strips to improve cliff top habitats needs more research. Where narrow strips have been employed, for example on the southwest Isle of Wight coast, they should be monitored for their effectiveness. More specifically, buffer strips should be assessed to determine whether they are wide enough for suitable habitat to establish and for the impacts of insensitive inland land use to be buffered.

Assess the impact of water abstraction within the catchment of soft cliff sites.

- All existing and future groundwater abstraction licences should be assessed for their impact on water supply to soft cliff sites which support rich assemblages of seepage invertebrates (or associated species of conservation concern).

Renotify SSSIs
Despite some sites being known to be of national importance for their invertebrate faunas for some time the SSSI citations do not always reflect that. The report recommends that the following sites are considered for renotification to include the soft cliff invertebrate assemblage as an interest feature of the SSSI: South Dorset Coast SSSI, Bembridge Down SSSI (Isle of Wight), The Naze (Essex), West Runton (Norfolk). In addition, we recommend that Luccombe Chine to Shanklin Chine undercliffs are considered for notification as a SSSI.

Implement cliff top habitat restoration
Targeted management to improve cliff top habitats is required on a number of sites to increase areas of forage, improve site connectivity, and buffer sites from insensitive land management. This can be achieved through the effective targeting of agri-environment schemes, promoting arable reversion and more extensive conservation-aimed grazing management. Priority sites for cliff top improvement, where action is vital to maintain sustainable populations of rare and threatened invertebrates, include Prawle Point in Devon, and the south Gower coast in Wales.

Opportunities for improving cliff top habitats may emerge through the Coastal Access Project in England, and the benefits to coastal wildlife should be actively promoted through the process.

Influence Shoreline Management Plans
The information contained within this report should be used to inform the Shoreline Management Process and ensure that future coastal management is sustainable and promotes the biodiversity of soft cliffs.

Acknowledgements

Buglife would like to thank the Esmée Fairbairn Foundation for funding the three year "Sustainable Management of Coastal Soft Cliffs for their Invertebrate Biodiversity" project, and for providing ongoing support to invertebrate conservation generally.

We would also like to thank the following organisations that have funded extra survey work over the course of the project: Natural England, the Environment Agency, the Courtyard Farm Trust, Norfolk Biodiversity Partnership, Durham Biodiversity Partnership, and the Kent & Medway Biological Records Centre.

A big thank you to our Steering Group members, who have helped to shape and guide this project and have provided valuable input into this report: Mike Howe (Countryside Council for Wales), Sue Rees and Roger Key (Natural England), Mark Parsons (Butterfly Conservation), Andy Foster (National Trust), Bryan Edwards (Dorset Environmental Records Centre), Phil Stirling (Dorset County Council), and Duncan Huggett (Environment Agency). My thanks also to all the Buglife staff who have contributed to this project, in particular Jamie Roberts, Alan Stubbs, Matt Shardlow and Kathy Wormald.

Thank you to all of the individuals and organisations who have contributed to this project including:
BWARS (Mike Edwards and Stuart Roberts), Simon Colenutt, Martin Drake, Essex Field Club, Environment Agency (Tim Sykes, Tim Norton), Green Passion Creative, John Hunnisett, Kent Field Club (John Badmin), Guy Knight (Liverpool Museum), Adrian Knowles, Peter Lambley, Andy Lees (Durham Biodiversity Partnership), National Trust (Matthew Oates), Natural England (Robbie Fisher, Andy Gordon, Anna Weatherall, Jon Webb), Scott Perkin (Norfolk Biodiversity Partnership), Andy Phillips (Hastings Borough Council), Mark Telfer, Adam Wright, Ivan Wright, Yorkshire Naturalists' Union (Michael Archer, Roy Crossley, Bob Marsh, Adrian Norris).

References

Alexander, K.N.A. & Lutley, W. (1982) *South Down Farm and Burning and White Nothe Cliff, Dorset. National Trust Biological Survey.* National Trust, unpublished report.

Alexander, K.N.A. (2003) The Hemiptera of Devon. *Bulletin of the Devon Invertebrate Forum*, 10, pp. 6-8.

Alexander K.N.A. (2003) *A review of the invertebrates associated with lowland calcareous grassland*. English Nature Research Report 512. English Nature, Peterborough.

Alexander, K.N.A. (2004) *Revision of the Index of Ecological Continuity as used for saproxylic beetles.* English Nature Research Report 574. English Nature, Peterborough.

Alexander, K., Colenutt, S., Denton, J., Falk, S.,Godfrey, A., Hammond, P., Ismay, J., Lee, P., Macadam, C., Morris, M., Murray, C., Plant, C., Ramsay, A., Schulten, B., Shardlow, M., Stewart, A., Stubbs, A., Sutton, P., Telfer, M., Wallace, I., Willing, M. & Wright, R. (2005) *Managing Priority Habitats for Invertebrates: Habitat Section 21 Maritime Cliff and Slopes*. Buglife - The Invertebrate Conservation Trust, Peterborough.

Allen, R., Brash, P.R. & Foster, A.P. (2004) *National Trust Nature Conservation Evaluation – Ringstead Bay, Dorset*. National Trust, Swindon.

Allen, R., Brash, P.R. & Foster, A.P. (2006a) *National Trust Nature Conservation Evaluation - Dunwich Heath, Beach and Mount Pleasant Farm, Suffolk*. National Trust, Swindon.

Allen, R., Brash, P.R. & Foster, A.P. (2006b) *National Trust Nature Conservation Evaluation - Wembury Point and The Great Mewstone, Devon*. National Trust, Swindon.

Allison, R.J. (Ed.) (1992) *The Coastal Landforms of West Dorset*. Geologists' Association, London.

Anderson, R (1996) *Species Inventory for Northern Ireland – Carabid Beetles*. Environment & Heritage Service Northern Ireland.

Anglian Coastal Authorities Group (2005) *Kelling to Lowestoft Shoreline Management Plan*. ACAG.

Anglian Coastal Authorities Group (2006) *Kelling to Lowestoft Shoreline Management Plan*: First review. ACAG.

Appleton, D. (2004) Scarcer Coleoptera in Hampshire and Isle of Wight 1964-2001. *The Coleopterist*, 13(2), pp. 41-80.

Armitage, P.D. (1983) The invertebrates of some freshwater habitats on the Axmouth-Lyme Regis National Nature Reserve. *Proceedings of the Dorset Natural History and Archaeological Society*, 104, pp. 149-154.

Babtie Group (2000) *Coastal development in high risk locations. An examination of policy and practice in England since 1992 with recommendations for good practice*. English Nature Research Report 380. English Nature, Peterborough.

Biodiversty Reporting and Information Group (2007) *Species and Habitat Review Draft UK BAP List of Species and Habitats - Report to Standing Committee.* UK Biodiversity Group.

Bird, E. (2000) *Coastal Geomorphology*. John Wiley & Sons, Chichester.

Bourn, N.A.D. & Warren, M.S. (1997) *Species Action Plan: Glanville Fritillary Melitaea cinxia*. Butterfly Conservation, East Lulworth.

Boyce, D.C. (2002) *A review of seepages invertebrates in England.* English Nature Research Report 452. English Nature, Peterborough.

Boyce, D.C. (2004) *Scarce Ground Beetle Project - Final Report on work 2000-2004*. Report to English Nature.

Boyce, D.C. & Fowles, A.P. (1989) *Invertebrate Conservation in the Isle of Man – An Assessment of Selected Sites of Ecological Interest.* Unpublished Report.

Brampton, A.H. (1998) Cliff conservation and protection: methods and practices to resolve conflicts. In: *Coastal Defence and Earth Science Conservation.* Ed. J.M. Hooke. pp. 21-31, Geological Society Publishing.

Brunsden, D. & Lee, E.M. (2004) Behaviour of coastal landslide systems: an interdisciplinary view. *Annals of Geomorphology*. Sppl. Vol. 134.

Burton, S. & Pater, C., eds. (2005) *Coastal Biodiversity Opportunities in the South West Region*. English Nature Research Report 640. English Nature, Peterborough.

Campbell, D. (2006) *Exploring the Undercliffs. The Axmouth to Lyme Regis National Nature Reserve – A 50th Anniversary Guide*. Coastal Publishing, Wareham.

Cappitt, I. (2005) *Identification of biodiversity and geological conservation opportunities in three coastal Natural Areas: Tyne to Tees, Saltburn to Bridlington and Bridlington to Skegness.* English Nature Research Report 639. English Nature, Peterborough.

Chandler, P. & Crossley, R. (2003) *Symplecta chosenensis* (Alexander, 1940) (Diptera, Limoniidae) new to Britain, with comments on the status of *S.scotica* (Edwards, 1938). *Dipterists Digest,* Vol. 10, pp. 49-54.

Clee, C. (1995) *A survey of selected sites on the Lleyn peninsula, Caerns., in 1995, for the endangered mason bee Osmia xanthomelana (Kirby) (Hym.: Megachilidae).* CCW Contract Science. 136. Countryside Council for Wales.

Clee, C. (1999) *Distribution of aculeate Hymenoptera at Porth Ceiriad SSSI, Gwynedd, June 1998, with special reference to Osmia xanthomelana (Kirby).* Liverpool Museum.

Clee, C. & Green, T. (2000) *The status and ecology of the mason bees Osmia xanthomelana (Kirby) and Osmia parietina (Curtis) in north-west Wales, with* *particular reference to coastal soft cliff sites on the Llyn peninsula.* CCW Contract Science. 396. Countryside Council for Wales.

Clee, C. & Green, T. (2001a) *The status and ecology of the mason bee Osmia xanthomelana (Kirby) at coastal soft cliff sites on the Llyn Peninsula.* CCW Contract Science 459. Countryside Council for Wales.

Clee, C. & Green, T. (2001b) *The status of the mason bee Osmia parietina Curtis in north-west Wales.* CCW Contract Science 460. Countryside Council for Wales.

Clee, C. & Green, T. (2002) *The status and ecology of the mason bee Osmia xanthomelana (Kirby) at coastal soft cliff sites on the Llyn Peninsula.* CCW Contract Science 524. Countryside Council for Wales.

Clee, C. & Green, T. (2003) *The status and ecology of the RDB1 mason bee Osmia xanthomelana (Kirby) at Porth Neigwl, Gwynedd, 2002.* CCW Contract Science 593. Countryside Council for Wales.

Colenutt, S. (2000) *Survey for* Anostirus castaneus *at Luccombe Chine, Isle of Wight.* Report for Action for Invertebrates.

Colenutt, S. (2002) *Invertebrate survey of niton to St. Lawrence and Puckaster Cove to Ventnor, Isle of Wight.* Report for English Nature.

Colenutt, S. (2004a) *Castlehaven coast protection scheme environmental management plan.* Report for the Isle of Wight Council Centre for the Coastal Environment.

Colenutt, S. (2004b) *Castlehaven invertebrate and vegetation monitoring: 2003 baseline survey.* Report for the Isle of Wight Council Centre for the Coastal Environment.

Colenutt, S. (2007) *Ecological Surveys of the Isle of Wight Chines 2005: vegetation surveys.* Buglife - The Invertebrate Conservation Trust, Peterborough.

Colenutt, S. & Wright, A. (2001) *Invertebrate survey of proposed SSSI at Luccombe to Shanklin Chine, Isle of Wight.* ECOSA report for English Nature.

Colenutt, S. & Wright, A. (2006) *Ecological Surveys of the Isle of Wight Chines 2005: invertebrate surveys.* Buglife - The Invertebrate Conservation Trust, Peterborough.

Colenutt, S. & Wright, A. (in prep) *Ecological Surveys of the Southwest Isle of Wight Undercliffs 2006-2007: invertebrate surveys.* Buglife - The Invertebrate Conservation Trust, Peterborough.

Cooper, A. & Butler, C. (1997) Cliffs and cliff-top vegetation. In: *Coasts and seas of the United Kingdom. Region 17 Northern Ireland.* Coastal Directories Series. Eds. J.H. Barne, C.F. Robson, S.S. Kaznowska, J.P. Doody, N.C. Davidson & N.L. Buck, pp. 43-46. Joint Nature Conservation Committee, Peterborough.

Cottle, R., Edwards, M. & Roberts, S. (1996) *Euroleon nostras* (Fourcroy, 1785) (Neur: Myrmeleontidae) confirmed as breeding in Britain. *Entomologist's Record* 108, pp. 301-302.

Covey, R. (1997) *Lyme Bay - a nature conservation profile.* English Nature, Peterborough.

Cox, J. (1997) *Isle of Wight Natural Area Profile.* English Nature, Peterborough.

Cox, L.G. (1921) *Nebria livida* F. at Mundesley, Norfolk. *Entomologist's Monthly Magazine*, 57, p. 233.

Crofts, A. & Jefferson, R.G. (1999) *The Lowland Grassland Management Handbook – 2nd edition.* English Nature & The Wildlife Trusts.

Crossley, R. (1990a) *Insect Survey of Hayburn Wyke, North Yorkshire Coast*. Unpublished report for the National Trust.

Crossley, R. (1990b) *Insect Survey of Cayton Bay, North Yorkshire Coast*. Unpublished report for the National Trust.

Dargie, T.C.D. (1995a) 3.1 Cliffs and cliff-top vegetation. In: *Coasts and seas of the United Kingdom. Region 5 North-east England: Berwick-upon-Tweed to Filey Bay*. Coastal Directories Series. Eds. J.H. Barne, C.F. Robson, S.S. Kaznowska, J.P. Doody & N.C. Davidson, pp. 37-38. Joint Nature Conservation Committee, Peterborough.

Dargie, T.C.D. (1995b) 3.1 Cliffs and cliff-top vegetation. In: *Coasts and seas of the United Kingdom. Region 6 Eastern England: Flamborough Head to Great Yarmouth*. Coastal Directories Series. Eds. J.H. Barne, C.F. Robson, S.S. Kaznowska, J.P. Doody & N.C. Davidson, pp. 41-43. Joint Nature Conservation Committee, Peterborough.

Dargie, T.C.D. (1995c) 3.1 Cliffs and cliff-top vegetation. In*: Coasts and seas of the United Kingdom. Region 7 South-east England: Lowestoft to Dungeness*. Coastal Directories Series. Eds. J.H. Barne, C.F. Robson, S.S. Kaznowska, J.P. Doody, N.C. Davidson & A.L. Buck, pp. 41-44. Joint Nature Conservation Committee, Peterborough.

Dargie, T.C.D. (1995d) 3.1 Cliffs and cliff-top vegetation. In: *Coasts and seas of the United Kingdom. Region 12 Wales: Margam to Little Orme.* Coastal Directories Series. Eds. J.H. Barne, C.F. Robson, S.S. Kaznowska & J.P. Doody, pp. 41-43. Joint Nature Conservation Committee, Peterborough.

Dargie, T.C.D. (1996a) 3.1 Cliffs and cliff-top vegetation. In: *Coasts and seas of the United Kingdom. Region 9 Southern England: Hayling Island to Lyme Regis*. Coastal Directories Series. Eds. J.H. Barne, C.F. Robson, S.S. Kaznowska, J.P. Doody & N.C. Davidson, pp. 38-40. Joint Nature Conservation Committee, Peterborough.

Dargie, T.C.D. (1996b) 3.1 Cliffs and cliff-top vegetation. In: *Coasts and seas of the United Kingdom. Region 10 South-west England: Seaton to the Roseland Peninsula.* Coastal Directories Series. Eds. J.H. Barne, C.F. Robson, S.S. Kaznowska, J.P. Doody, N.C. Davidson & A.L. Buck, pp. 34-36. Joint Nature Conservation Committee, Peterborough.

Dargie, T.C.D. (1996c) 3.1 Cliffs and cliff-top vegetation. In: *Coasts and seas of the United Kingdom. Region 13 Northern Irish Sea: Colwyn Bay to Stranraer, including the Isle of Man.* Coastal Directories Series. Eds. J.H. Barne, C.F. Robson, S.S.

Kaznowska, J.P. Doody & N.C. Davidson, pp. 44-47. Joint Nature Conservation Committee, Peterborough.

Dawson, J.F. (1854) *Geodephaga Britannica. A monograph of the carnivorous Ground beetles indigenous to the British Isles*. John van Voorst, London.

Department for Environment, Food and Rural Affairs (2001) *Shoreline Management Plans: A guide for coastal defence authorities.* DEFRA, London.

Department for Environment, Food and Rural Affairs (2004) *Making space for water - developing a new Government strategy for flood and coastal erosion risk management in England*. DEFRA, London.

Department for Environment, Food and Rural Affairs (2006) *Shoreline Management Plan guidance. Volume 1: Aims and requirements/Volume 2: Procedures*. DEFRA, London.

Doody, J.P. (2001) *Coastal Conservation and Management – An Ecological Perspective*.

Doody, J.P. (2002) Protecting the Coast – Myth and Magic. *Littoral 2002, The Changing Coast*. EUROCOAST/EUCC, Portugal.

Doody, J.P., & Malloch, A.J. eds. *Vegetation maps of British Sea Cliffs and Clifftops.* CSD Report, No. 858*.* Nature Conservancy Council and University of Lancaster.

Edwards, M. (1993) *Report on the Aculeates (bees and wasps) surveyed at various National Trust properties, Gwynedd, July 1991*. National Trust, unpublished report.

Edwards, M. (1995) *An Entomological Survey of the Axmouth to Lyme Regis NNR*. Unpublished report for English Nature.

Edwards, M. & Hodge, P. (2002) *A preliminary survey of coastal soft-rock habitats in selected areas of south Wales.* CCW Contract Science. 493. Countryside Council for Wales.

Ellis, B., Goodger, B., Mellings, J. & Stevenson, R. (2004) *Surveys of Overstrand Cliffs SSSI and cSAC, Norfolk*. Unpublished report for English Nature.

Else, G. & Roberts, S. (2006) Provisional observations on the autecology of *Euodynerus quadrifasciatus* (Fabricius, 1793) (Hymenoptera, Vespidae, Eumeninae) at the Isle of Portland, Dorset, June 2006. In: *Aculeate Conservation Group/Hymettus Report for 2006*. Ed. M Edwards, pp.23-29. Hymettus, Midhurst.

English Nature (1994) *Species Conservation Handbook*. English Nature, Peterborough.

English Nature (1997) *Bridlington to Skegness Maritime Natural Area Profile*. English Nature, Peterborough.

Farrar, J.F. and Vaze, P. (Ed.s) (2000) *Wales: Changing Climate, Challenging Choices - a Scoping study of climate change impacts in Wales*. Report for the National Assembly for Wales.

Fowler, W.W. (1887) *The Coleoptera of the British Islands*. Volume 1. L. Reeve and Co, London.

Fowles, A.P. (1994) *Invertebrates of Wales: a review of important sites and species*. Joint Nature Conservation Committee, Peterborough.

Fowles, A.P. & Boyce, D.C. (1991) The coleopterous fauna of soft-rock cliff habitats at Porth Neigwl, Lleyn. *North Wales Invertebrate Group Newsletter*, 4: 6.

Fowles, A.P., Owen, J.A., & Boyce, D.C. (1992) The coleopterous fauna of soft-rock cliff habitats at Porth Neigwl, Lleyn. Part 2: Fauna list. *North Wales Invertebrate Group Newsletter*, 5: 2-3.

Fowles, A.P., Alexander, K.N.A. & Key, R.S. (1999) The Saproxylic Quality Index: evaluating wooded habitats for the conservation of dead-wood Coleoptera. *The Coleopterist,* 8, pp. 121-141.

French, P.W. (2004) The changing nature of, and approaches to, UK coastal management at the start of the twenty-first century. *The Geographical Journal*, 170, pp. 116-125.

Gallois, R.W. (2005) On the Kimmeridgian (Jurrassic) succession of the Normandy coast, northern France. *Proceedings of the Geologists' Association*, 116, pp. 33-43.

Garrad, L.S. (1972) *The naturalist in the Isle of Man.* David and Charles, Newton Abbot.

Gibbs, D. (1992) Flies of the Essex Coast. *Dipterists Digest*, 11, pp.4-16.

Gibbs, D. (2000) *Invertebrate Survey of Goldne Cap Estate.* Report for the National Trust.

Gibbs, D. (2003) *Invertebrate Survey of Axmouth to Lyme Regis Undercliffs, Devon*. Unpublished report for English Nature.

Gibbs, D. (2004) *The dotted bee-fly (Bombylius discolor Mikan 1796). A report on the survey and research work undertaken between 1999 and 2003.* English Nature Research Report 583. English Nature, Peterborough.

Gilbert, O. (2003) The lichen flora of unprotected soft sea cliffs and slopes. *The Lichenologist*, 35, pp.245-254.

Godfrey, A. (2002) *A reconnaissance of coastal soft cliff sites in south and south-west Wales to determine their importance for invertebrates.* CCW Contract Science, 506, Countryside Council for Wales.

Gottschalk, E., Griebeler, E.M., Waltert, M. & Mühlenberg, M. (2003) Population dynamics in the Grey Bush Cricket *Platycleis albopunctata* (Orthoptera: Tettigoniidae) – What causes interpopulation differences? *Journal of Insect Conservation*, 7, pp. 45–58.

Hampshire Biodiversity Partnership (2003) *Biodiversity Action Plan for Hampshire: Volume Two*.

Harding, P.T. (1976) *Eluma purpurascens* Budde-Lund (Crustacea: Isopoda) a woodlouse new to Britain from Norfolk. *Transactions of the Norfolk and Norwich Natural History Society*, 23, 267-268.

Halcrow (2001) *Preparing for the impacts of climate change. A strategy for long term planning and management of the shoreline in the context of climate change predictions*. Report to SCOPAC.

Hill, C., Ball, J.H., Dargie, T., Tantrum, D., Boobyer, G. (2002) *Maritime Cliff and Slope Inventory.* English Nature Research Report 426. English Nature, Peterborough.

Hosking, A. & McInnes, R. (2002) Preparing for the impacts of climate change on the central south coast of England: a framework for future risk management. *Journal of Coastal Research*, Special Issue 36, pp. 381-389.

Howe, M.A. (2002) *A review of the coastal soft cliff resource in Wales, with particular reference to its importance for invertebrates*. CCW Natural Science Report. 02/5/1. Countryside Council for Wales, Bangor.

Howe, M.A. (2003) Coastal soft cliffs and their importance for invertebrates. *British Wildlife*, 14(5), 323-331.

Howe, M.A & Howe, E.A. (2000) Two recent records of the cranefly *Symplecta novaezemblae scotica* (Edwards) (Diptera, Limoniidae), including a first for Wales. *Dipterists Digest*, 7, p. 23.

Howe, M.A & Howe, E.A. (2006a) Recent records of scarce tachinid flies (Diptera, Tachinidae) from England and Wales. *Dipterists Digest*, 13, pp. 95-96.

Howe, M.A & Howe, E.A. (2006b) *Parochthiphila spectabilis* (Loew, 1858) (Diptera, Chamaemyiidae) on the Isle of Wight. *Dipterists Digest*, 13, pp. 171-172.

Howe, M.A., Knight, G.T. & Mawdsley, T.H. (2006) The status of *Symplecta chosenensis* in the UK. *Cranefly Recording Scheme Newsletter*, pp. 3-5.

Howe, M.A., Parker, M.J. & Howe, E.A. (1998) *Dipterists Forum Occasional Publication No.1. Dorset Field Meeting, 1998*. Dipterists Forum.

Howe, M.A., Parker, M.J. & Howe, E.A. (2001) A review of the Dipterists Forum summer field meeting in Dorset, 1998. *Dipterists Digest*, 8, pp. 135-148.

Howe, M.A., Whitehouse, A.T. & Knight, G.T. (in press) Life on the Edge - Key coastal soft cliffs for invertebrates in England and Wales. *British Wildlife*.

Hulme, M., Jenkins, G.J., Lu, X., Turnpenny, J.R., Mitchell, T.D., Jones, R.G., Lowe, J., Murphy, J.M., Hassell, D., Boorman, P., McDonald, R. and Hill, S. (2002) *Climate Change Scenarios for the United Kingdom: The UKCIP02 Scientific Report*. Tyndall Centre for Climate Change Research, Norwich.

Hunnisett, J. (2006) Odynerus melanocephalus. In: *Aculeate Conservation Group/Hymettus Report for 2006*. Ed. M Edwards, pp.23-29. Hymettus, Midhurst.

Hunnisett, J. & Edwards, B. (2006) *A survey of invertebrates and vegetation at selected soft rock cliff sites in Dorset*. Buglife - The Invertebrate Conservation Trust, Peterborough.

Hunnisett, J., Allen, T. & Edwards, B. (2006) *A Survey of selected BAP Invertebrates in South Wessex area (Dorset)*. Dorset Environmental Records Centre report for the Environment Agency.

Kirby, P. (1994) *Habitat fragmentation: species at risk. Invertebrate group identification.* English Nature Research Reports 89. English Nature, Peterborough.

Knight G.T. & Howe, M.A. (2006) *The conservation value for invertebrates of selected coastal soft cliff sites in Wales.* CCW Contract Science Report No. 761. Countryside Council for Wales, Bangor.

Knott, A. (2003) *Axmouth-Lyme Regis Undercliffs NNR Management Plan.* Unpublished document by English Nature.

Lambley, P. (1997) *Natural Area Profile 47: North Norfolk.* English Nature.

Lee, E.M. (1995) Coastal cliff recession in Great Britain: the significance for sustainable coastal management. In: M.G. Healy & J.P. Doody (eds) *Directions in European Coastal Management*, 185-194. Samara Publishing.

Lee E M. (1998) *The implications of future shoreline management on protected habitats in England and Wales*. Environment Agency R&D Technical Report W150.

Lee E.M., Brunsden, D., Roberts, H., Jewell, S. & Innes, R. (2001) *Restoring Biodiversity to Soft Cliffs*. English Nature Research Report 398. English Nature, Peterborough.

Lee, E.M. & Clarke A.R. (2002) *Investigation and management of soft rock cliffs*. Thomas Telford.

Lister, J.A, Grove, S. & Alexander, K.N.A. (1992) *National Trust Biological Survey: Salcombe, Devon.* National Trust, Swindon.

Lister, J. & Alexander, K.N.A. (1997) *National Trust Biological Survey: Cayton Bay & Knipe Point*. National Trust, Swindon.

MAFF (1999) *High Level Targets for Flood and Coastal Defence and Elaboration of the Agency's Flood defence Supervisory Duty.* MAFF, London.

MAFF (2000) *Flood and Coastal Defence Project Appraisal Guidance: Environmental Appraisal*. MAFF, London.

May, V.J. 2003. Porth Neigwl, Gwynedd. In: *Coastal Geomorphology of Great Britain.* Geological Conservation Review. 28. Eds. V.J. May & J.D. Hansom, pp. 191-194. Joint Nature Conservation Committee, Peterborough.

May V.J. & Hansom, J.D. (2003) *Coastal Geomorphology of Great Britain*. Geological Conservation Review 28. Joint Nature Conservation Committee, Peterborough.

Metcalf, G., Chambers, F., Charlesworth, A., Forrest, V., Hunt, J., McEwen L., Russell, K., and Schofield, S. (Eds) (2003) *Warming to the Idea South West Region Climate Change Impacts Scoping Study – Technical Report.* Cheltenham, UK

Middlebrook, I. (2004) *Species Dossier:* Anostirus castaneus *– Chestnut click beetle.* Action for Invertebrates.

Milligan, J., O'Riordan, T. & Watkinson, A. (2006) *Designing coastlines fit for the future.*
English Nature Research Report 702. English Nature, Peterborough.

Mitchley, J. & Malloch, A.J.C. (1991) *Sea cliff management handbook for Great Britain.* University of Lancaster and Joint Nature Conservation Committee in association with the National Trust.

Morris, M.G. (1969) Populations of invertebrate animals and the management of chalk grasslands in Britain. *Biological Conservation*, 1, pp. 225-231.

Morris, M.G. (2004) The weevils (Insecta: Coleoptera, Curculionoidea) of the Dorset coast and their conservation. *Proceedings of the Dorset Natural History and Archaeological Society,* 126, pp. 85-109.

National Trust (1988) *National Trust Biological Survey. Robin Hoods Bay: Boggle Hole.* National Trust, Swindon.

National Trust (1989a) *National Trust Biological Survey. Robin Hoods Bay: Ravenscar.* National Trust, Swindon.

National Trust (1989b) *National Trust Biological Survey. Robin Hoods Bay: Beast Cliff.* National Trust, Swindon.

National Trust (1996) *National Trust Biological Evaluation. Hayburn Wyke, North Yorkshire.* National Trust, Swindon.

National Trust (2005) *Shifting Shores – living with a changing coastline.* National Trust, London.

National Trust Wales (2007) *Shifting Shores – living with a changing coastline.* National Trust, Cardiff.

Nature Conservancy Council (1989) *Guidelines for selection of biological SSSIs.* NCC, Peterborough.

Norris, A. (2002) The Mollusca of Beast Cliff, Ravenscar, North Yorkshire. *Yorkshire Naturalists' Union Bulletin*, 38, pp.11-13.

Northern Ireland Biodiversity Group (2005) *Northern Ireland Habitat Action Plan – Maritime Cliff and Slope.*

Oates, M. (1999) Sea cliff slopes and combes – their management for nature conservation. *British Wildlife*, 10, pp.394-402

Oates, M. (2000) Grazing for nature conservation: rising to the challenge. *British Wildlife*, 11, pp. 348-353.

Oates M.R., Harvey, H.J. & Glendell, M. (eds) (1998) *Grazing sea cliffs and dunes for nature conservation*. The National Trust, Cirencester.

Parsons, M.S. 2002. Notes on the distribution of the White Spot *Hadena albimacula* (Borkh.) (Lep.: Noctuidae) in Great Britain. *Entomologist's Record & Journal of Variation*, 114, pp. 23-32.

Parsons, S.M., George, B.P. & George, E.L. (2001) Barbastelle Bats at Paston Great Barn 1998-2000. *Transactions of the Norfolk & Norwich Naturalists' Society*, 34, 307-317.

PATER C.I.S., (ed.) (2004) *Identifying Biodiversity opportunities to inform SMP Review: Sheringham to Lowestoft; North Kent Coast; East Kent Coast; Folkestone to Selsey Bill; and Solent and Poole Bay Natural Areas*. English Nature Research Report 565. English Nature, Peterborough.

Pavett, P.M. (2005) The aculeate Hymenoptera of Horton National Nature Reserve, Gower, west Wales. *British Journal of Entomology and Natural History,* 18, pp. 213-217.

Pinchen, B.J. (2006) *Westfield Common Insect Survey*. Unpublished report for Eastleigh Borough Council.

Plant, C.W. (1999) The Suffolk ant-lion *Euroleon nostras*. *British Wildlife,* 10 (5), pp. 303-309.

Plant, C.W. (1999) *Invertebrates on the coastal landslip at Castlehaven, Isle of Wight.* Report to English Nature & Hampshire and Isle of Wight Wildlife Trust.

Pope, C.R. (1988) The status of the Glanville Fritillary on the Isle of Wight. *Proceedings of the Isle of Wight Natural History and Archaeological Society*, 8, pp. 33-42.

Poulton, C. (2004) Disappearing Coasts. *Planet Earth,* Summer 2004, pp.26-27. NERC.

Pye, K. & French, P.W. (1993) *Targets for Coastal Habitat Re-creation*. English Nature Science 13. English Nature, Peterborough.

Pye, K. & Blott, S.J. (2006) Coastal processes and morphological change in the Dunwich-Sizewell Area, Suffolk, UK. *Journal of Coastal Research*, 22, pp. 453-473.

Quelennec, R.E. (1989) *The Corine Coastal Erosion Project: Identification of Coastal Erosion problems and data base on the littoral environment of eleven European countries*. Coastal Zone '89. pp. 4594-4601. European Commission.

Reid, C. & Grice, P. (2001) *Wildlife gain from agri-environment schemes: recommendations from English Nature's habitat and species specialists.* English Nature Research Report 431. English Nature, Peterborough.

Rendel Geotechnics (1998). *The Investigation and Management of Soft Rock Cliffs in England and Wales.* Report to MAFF.

Rees, S. (2002) Restoration of natural processes and biodiversity to soft cliffs. *Littoral 2002, The Changing Coast*. EUROCOAST/EUCC, Portugal.

Rimington, F.C. (1988) *The History of Ravenscar and Staintondale.* Archaeological and Historical Society.

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

Shennan, I. & Horton, B. (2002) Holocene land- and sea-level changes in Great Britain. *Journal of Quaternary Science*, 17, pp. 511-526.

Sheppard, D.A. (1991) *An invertebrate survey of the Isle of Wight Undercliff: St. Catherine's Point to Ventnor*. Nature Conservancy Council, Peterborough.

South East Coastal Group (2006) *Isle of Grain to South Foreland Shoreline Management Plan Review*.

Stubbs, A.E. (1992) *Helius hispanicus* Lackschewitz, 1928 (Diptera, Tipulidae) new to Britain. *British Journal of Entomology and Natural History*, 5, p. 135.

Stubbs, A.E. (1994) *1993 Terrestrial Invertebrate Survey of Prawle Point-Start Point SSSI, South Devon.* English Nature Research Report 126. English Nature, Peterborough.

Stubbs, Else, Appleton, Dickson, Emmet & Preece (1980) *Invertebrate Site Register: Luccombe Bay*. Nature Conservancy Council, Peterborough.

Suffolk Biodiversity Partnership (2003) *Habitat Action Plan – Maritime Cliffs and Slopes*.

Sutton, P.G. (1999) The Scaly Cricket in Britain. A complete history from discovery to citizenship. *British Wildlife*, 10, pp.145-151

Sutton, P.G. (2001) Observation of the Wood White Butterfly *Leptidea sinapsis* (L.) (Lepidoptera: Pieridae) in Devon. *Bulletin of the Devon Invertebrate Forum*, 6, pp. 2-4.

Sutton, P.G. (2004) Classic Entomological Sites: Branscombe Beach and Undercliff, East Devon. *Bulletin of the Amateur Entomologists' Society*, Vol. 63, No. 453, pp. 47-67.

Telfer, M.G. (2006a) *Invertebrate survey of the soft-rock cliffs of Norfolk*. Buglife, the Invertebrate Conservation Trust, Peterborough.

Telfer, M.G. (2006b) *Invertebrate survey of the soft-rock cliffs of Yorkshire*. Buglife, the Invertebrate Conservation Trust, Peterborough.

Telfer, M.G. & Gibbs, D. (in prep) *Invertebrate survey of the soft-rock cliffs of Durham*. Buglife, the Invertebrate Conservation Trust, Peterborough.

Thompson, G. (2007) *Improving Coastal Access*. Natural England Board Paper.

Tomlinson, R. (1997) *The Urban Mersey Basin Natural Area – A Nature Conservation Profile.* English Nature, Peterborough.

UK Biodiversity Group (1999) Action Plan for *Anostirus castaneus*. *Tranche 2 Action Plans - Volume IV: Invertebrates.* UK Biodiversity Group.

UK Biodiversity Group (2006) *Revised BAP Targets for Maritime Cliff and Slope*. UKBAP Biodiversity Action Reporting System.

UKCIP (2002a) *Living with climate change in the East of England.* Sustainable Development Round Table for the East of England.

UKCIP (2002b) *Warming up the region. Yorkshire and Humber Climate Change Impact Scoping Study.* Yorkshire and Humber RDA & Yorkshire and Humber Assembly.

UKCIP (2005) *Update to UKCIP02 sea-level change estimates, December 2005.* UKCIP, Oxford.

Wade, S., Hossell, J., Hough, M. & Fenn, C. (Eds.) (1999) *The Impacts of Climate Change in the South East: Technical Report.* WS Atkins, Epsom.

Watts, C. (2006) *Managing farmland habitats for invertebrates: grassland*. Buglife - The Invertebrate Conservation Trust, Peterborough.

Webb, J.R. & Lott, D.A. (2006) The development of ISIS: a habitat-based invertebrate assemblage classification system for assessing conservation interest in England. *Journal of Insect Conservation*, 10, pp. 179-188.

West Dorset District Council (2002) *Lyme Regis Environmental Improvements: Strategy Plan*. West Dorset District Council, Dorchester.

Whicher, L.S. (1953) *Nebria livida* L. and other beetles from the Norfolk coast. *Entomologist's Monthly Magazine*, 89, p.32.

Wright, I. & Whitehouse, A.T. (2006) *Kessingland Coast - survey of aculeate Hymenoptera*. Buglife - The Invertebrate Conservation Trust

Appendices

1. British conservation status categories for invertebrates
2. English soft cliff sites
3. Welsh soft cliff sites

Appendix 1: British conservation status categories for invertebrates – definitions.

Red Data Book (RDB) category 1 – Endangered
Species in danger of extinction and whose survival is unlikely if causal factors continue to operate. Endangered species either (a) occur as only a single population within one 10km square, or (b) only occur in especially vulnerable habitats, or (c) have been declining rapidly or continuously for twenty years or more to the point where they occur in five or fewer 10km squares, or (d) may already have become extinct.

Red Data Book category 2 – Vulnerable
Species believed likely to move into the endangered category in the near future if the causal factors continue operating. Vulnerable species are either (a) declining throughout their range, and/or (b) only occur in vulnerable habitats.

Red Data Book category 3 – Rare
Species which occur in small populations and although not currently either Endangered or Vulnerable are at risk. Rare species exist in 15 or fewer 10km squares, or are more widespread than this but dependent on small areas of especially vulnerable habitat.

Red Data Book category I – Indeterminate
Species considered to be Endangered, Vulnerable or Rare, but where there is not enough information to say which of the three categories (RDB1 to 3) is appropriate.

Red Data Book category K – Insufficiently Known
Species suspected to merit either Endangered, Vulnerable, Rare or Indeterminate status but lacking sufficient information. Species included in this category may have only recently been discovered in Britain, or may be very poorly recorded for a variety of reasons.

pRDB
The prefix 'p' before any Red Data Book category implies that the grading is provisional, pending the publication of a future edition of the relevant Red Data Book.

Nationally Scarce Category A, Na
Species which do not fall within Red Data Book categories but which are nonetheless uncommon in Great Britain and thought to occur in 30 or fewer (typically between 16 and 30) 10km squares of the National Grid, or for less well recorded groups, in seven or fewer vice-counties.

Nationally Scarce Category B, Nb
Species which do not fall within Red Data Book categories but which are nonetheless uncommon in Great Britain and thought to occur in between 31 and 100 10km squares of the National Grid, or for less well recorded groups, between eight and twenty vice-counties.

Nationally Scarce, NS (N)
Species which do not fall within Red Data Book categories but which are nonetheless uncommon in Great Britain. This status category has been used where information has not been sufficient to allocate a species to either Na or Nb. These species are thought to occur in between 16 and 100 10km squares of the National Grid.

Appendix 2: English soft cliff sites

county	site name	SSSI name	status	grid reference	length (km)	cell	Principle lithology
Northumberland	Newbiggin Moor	Cresswell and Newbiggin Shores	SSSI	NZ3188	1.5	1	glacial till
Northumberland	Seaton Sluice	Northumberland Shore	SSSI	NZ3476	0.6	1	shales
Durham	Hendon - Ryhope	Durham Coast	SSSI, SAC	NZ4055-NZ4152	5.0	1	shales/limestone
Durham	Seaham	Durham Coast	SSSI, SAC	NZ4251-NZ4250	1.5	1	glacial till
Durham	Nose Point - Chourdun Point	Durham Coast	SSSI, SAC	NZ4347-NZ4446	1.6	1	glacial till
Cleveland	Redcar		none	NZ6223-NZ6323	1.9	2	glacial till
Cleveland	Stone Gap		none	NZ6522	1.6	2	glacial till
Yorkshire	Crowbar Nab	Staithes - Port Mulgrave	SSSI	NZ7818	0.1	2	glacial till
Yorkshire	Staithes - Runswick	Staithes - Port Mulgrave	SSSI	NZ7918-NZ8116	4.0	2	shales & clays
Yorkshire	Runswick Bay		none	NZ8115-NZ8215	2.8	2	glacial till
Yorkshire	Upgang Beach		none	NZ8112	1.0	2	glacial till
Yorkshire	Robin Hoods Bay	Robin Hoods Bay: Maw Wyke to Beast Cliff	SSSI	NZ9603	1.5	2	glacial till
Yorkshire	Ravenscar-Scarborough	Robin Hoods Bay: Maw Wyke to Beast Cliff	SSSI, SAC	NZ9801-TA0392	12.7	2	glacial till
Yorkshire	Cornelian Bay-Cayton Bay	Cayton Cornelian & South Bays	SSSI	TA0586-TA0784	4.5	2	glacial till
Yorkshire	Gristhorpe	Gristhrope Bay & Red Cliff	SSSI	TA0884-TA1082	2.0	2	glacial till
Yorkshire	Filey Bay - Filey to Filey Brig	Filey Brig	part SSSI	TA1181	1.2	2	glacial till
Yorkshire	Filey Bay - Speeton Cliffs	Flamborough Head	part SSSI	TA1279-TA1675	6.6	2	glacial till
Humberside	Hilderthorpe - Hornsea		none	TA1764-TA2049	16.6	2	glacial till
Humberside	Holderness Coast	inc Withow Gap, Skipsea & Dimlington Cliff	part SSSI	TA2146-TA3329	21.9	2	glacial till
Humberside	Withernsea - Easington	Dimlington Cliff	part SSSI	TA3526-TA4019	15.5	2	glacial till
Norfolk	Weybourne	Weybourne Cliffs	SSSI	TG1143-TG1443	3.9	3	glacial till
Norfolk	West Runton	West Runton Cliffs	SSSI	TG1843-TG1943	1.5	3	glacial till
Norfolk	East Runton	East Runton Cliffs	SSSI	TG1943-TG2042	1.1	3	glacial till
Norfolk	Overstrand	Overstrand Cliffs	SSSI, SAC	TG2241-TG2441	2.2	3	glacial till
Norfolk	Sidestrand/Trimmingham	Sidestrand & Trimmingham	SSSI	TG2640-TG2938	3.8	3	glacial till
Norfolk	Mundesley Cliffs	Mundesley Cliffs	SSSI	TG3235-TG3434	2.5	3	glacial till & sands
Norfolk	Happisburgh Cliffs	Happisburgh Cliffs	SSSI	TG3731-TG3831	3	3	glacial till & sands
Suffolk	Corton	Corton Cliffs	SSSI	TM5399-TA5498	2.0	3	glacial till & sands
Suffolk	Kessingland Cliffs	Pakefield to Easton Bavents	SSSI	TM5389-TM5397	2.5	3	clay
Suffolk	Covehithe Cliffs	Pakefield to Easton Bavents	SSSI	TM5382-TM5281	1.5	3	sands
Suffolk	Eastern Bavents	Pakefield to Easton Bavents	SSSI	TM5178-TM5177	1.2	3	sands
Suffolk	Dunwich Cliffs	Minsmere-Walberswick Heaths and	SSSI	TM47-TM4767	2.5	3	clays & sands

		Marshes					
Suffolk	Bawdsey	Bawdsey Cliff	SSSI	TM3539-TM3438	1.5	3	sands & gravels
Essex	The Naze	The Naze	SSSI	TM2635	0.8	3	clay
Kent	East End, Sheppey	Sheppy Cliffs and Foreshore	SSSI	TQ9673-TQ9973	3.5	4	clay
Kent	Warden	Sheppy Cliffs and Foreshore	SSSI	TR0271-TR0370	1.0	4	clay
Kent	Reculver & Bishopstone Glen	Thanet Coast	SSSI, SAC	TR2169	1.4	4	sands
Kent	Folkestone Warren	Folkestone Warren	SSSI	TR2638-TR2437	3.5	4	Gault clay
Sussex	Fairlight Cove	Hastings Cliff to Pett Beach	SSSI, SAC	TQ8812-TQ8510	5.2	4	sands
Hampshire	Stanswood Bay	North Solent	SSSI	SU4700-SZ4698	2.6	5	clay & gravel
Hampshire	Stone Point	North Solent	SSSI	SZ4598	2.0	5	sands & gravels
Hampshire	Hordle Cliff	Highcliffe to Milford Cliffs	SSSI	SZ2492-SZ2692	2.1	5	Barton Beds
Hampshire	Highcliffe	Highcliffe to Milford Cliffs	SSSI	SZ2293	0.5	5	sands & gravels
Isle of Wight	Osborne Bay		none	SZ5493-SZ5196	4.9	5	clays
Isle of Wight	Woodside Bay	Kings Quay Shore	SSSI	SZ5593	0.5	5	clays
Isle of Wight	The Priory	Brading Marshes to St Helen's Ledges	SSSI	SZ6390	0.6	5	clays
Isle of Wight	Whitecliff Bay and Bembridge Ledges	Whitecliff Bay and Bembridge Ledges	SSSI, SAC	SZ6586-SZ6687	2.0	5	clays
Isle of Wight	Red Cliff	Bembridge Down	SSSI, SAC	SZ6285	1.5	5	shales & clays
Isle of Wight	Luccombe to Shanklin Chine		None	SZ5879-SZ580	1.5	5	chalk/U.Gs &clay
Isle of Wight	Dunnose	Bonchurch Landslips	SSSI, SAC	SZ5878	0.8	5	chalk/U.Gs &clay
Isle of Wight	St. Catherine's Point to Steephill Cove	Compton Chine to Steephill Cove	SSSI, SAC	SZ5276-SZ5577	6.0	5	chalk/U.Gs &clay
Isle of Wight	South-west Isle of Wight Coast	Compton Chine to Steephill Cove	SSSI, SAC	SZ3784-SZ4876	15.6	5	sands & clays
Isle of Wight	Totland - Alum Bay	Headon Warren and West High Down	SSSI, part SAC	SZ3186-SZ3085	2.2	5	sands & clays
Isle of Wight	Colwell Bay	Colwell Bay	SSSI	SZ3288	1.3	5	sands & clays
Isle of Wight	West Hill / Cliff End		none	SZ3389	1.1	5	sands & clays
Isle of Wight	Norton		none	SZ3489	0.7	5	sands & clays
Isle of Wight	Bouldner and Hamstead Cliffs	Bouldnor and Hamstead Cliffs	SSSI	SZ3991-SZ3790	2.5	5	muds
Isle of Wight	Burnt Wood	Thorness Bay	SSSI	SZ4493-SZ4293	2.1	5	clays & muds
Isle of Wight	Northwood	Thorness Bay	SSSI	SZ4695-SZ4694	0.9	5	marls over clays
Isle of Wight	Gurnard		none	SZ4796	1.9	5	Lmt. over clays
Dorset	Warren Hill	Poole Bay Cliffs	SSSI	SZ1790-SZ1690	1.3	5	
Dorset	Chapman's Pool - Houns Tout	South Dorset Coast	SSSI, SAC, WHS	SY9576-SY9477	1.4	5	Kimmerage Clay
Dorset	Kimmerage Bay	South Dorset Coast	SSSI, SAC, WHS	SY9074-SY9078	1.0	5	Kimmerage Clay
Dorset	Gad Cliff	South Dorset Coast	SSSI, SAC, WHS	SY8779-SY8879	2.0	5	Kimmerage Clay
Dorset	Worbarrow Bay	South Dorset Coast	SSSI, SAC, WHS	SY8680-SY8679	1.5	5	Wealden
Dorset	Ringstead Bay	South Dorset Coast	SSSI, SAC, WHS	SY8680-SY7581	2.0	5	Wealden

Dorset	Ringstead Bay - Redcliffe Point	South Dorset Coast	SSSI, SAC, WHS	SY7581-SY7181	5.4	5	shales & mudstone
Dorset	Furzy Cliff	South Dorset Coast	SSSI, SAC, WHS	SY6981-SY7081	1.5	5	clays
Dorset	West Cliff	West Dorset Coast	SSSI, SAC, WHS	SY4590	0.9	6	U. Lias clays
Dorset	Thorncombe Beacon	West Dorset Coast	SSSI, SAC, WHS	SY4391-SY4491	1.1	6	U. & M. Lias
Dorset	Seatown	West Dorset Coast	SSSI, SAC, WHS	SY4191	0.9	6	L. & M. Lias
Dorset	Golden Cap - Cains Folly	West Dorset Coast	SSSI, SAC, WHS	SY3792-SY3992	3.5	6	Lias clays
Dorset	Black Ven - The Spittles	West Dorset Coast	SSSI, SAC, WHS	SY3452-SY3593	2.3	6	Gst & Lias clay
Devon	Axmouth-Lyme Regis	Axmouth to Lyme Regis Undercliffs	SSSI, SAC, WHS, NNR	SY3391-SY2690	8.4	6	U. Gst & Gault
Devon	Branscombe	Sidmouth - Beer Coast SSSI	SSSI, SAC, WHS	SY1387-SY2389	0.7	6	
Devon	Ladrum Bay - River Otter		none	SY0985-SY0882	3.9	6	sands
Devon	Budleigh Salterton	Budleigh Salterton Cliffs	SSSI	SY0681-SY0480	2.8	6	marls & sands
Devon	Prawle Point-Start Point	Prawle Point and Start Point	SSSI, SAC	SY7735-SY8036	3.7	6	head
Devon	Wembury	Wembury Point	SSSI	SX5048-SX5148	1.2	6	head
Cornwall	Whitesand Bay	Aire Point to Carrick Du	SSSI	SW3627	0.5	6	head
Cornwall	Widemouth Bay		none	SS1901-SS1902	1.3	7	head
Devon	Bucks Mills	Hobby to Peppercombe	SSSI	SS3524-SS3624	2.0	7	shales & clays
Somerset	Blue Anchor Bay	Blue Anchor to Lilstock Coast	SSSI	ST0343	0.5	7	L. Lias
Avon	Aust Cliff	Aust Cliff	SSSI	ST5689-ST5790	0.7	7	mudstone
Merseyside	Dee Cliffs	Caldy Banks	SSSI	SJ2185-SJ2482	2.5	10	clay
Lancashire	Sunderland Brows		none	SD4256	0.3	10	clay
Cumbria	Borwick Rails		none	SD1979-SD1878	1.4	10	clay
Cumbria	Silecroft - Annaside	Annaside & Gutterby Banks	SSSI	SD1181-SD0856	5.6	10	Boulder clay
Cumbria	St Bees	St Bees Head	SSSI	NX9511-NX9610	1.4	10	clay

Appendix 3: Welsh soft cliff sites

site name	SSSI name	status	central grid ref	length (km)	cell	principle geology
Porth Pistyll	Porth Dinllaen i Borth Pistyll	SSSI, SAC	SH327428	1.5	10	glacial till
Porth Nefyn	Porth Dinllaen i Borth Pistyll	SSSI, SAC	SH305409	3.2	10	glacial sands and gravels
Porth Dinllaen	Porth Dinllaen i Borth Pistyll	SSSI, SAC	SH282408	3.1	10	glacial sands and gravels
Porth Neigwl	Porth Ceiriad, Porth Neigwl ac Ynysoedd Sant Tudwal	SSSI, SAC	SH269273	6.5	9	glacial till
Porth Ceiriad	Porth Ceiriad, Porth Neigwl ac Ynysoedd Sant Tudwal	SSSI, SAC	SH311248	1	9	glacial till and blown sand
Aberarth	Aberarth - Carreg Wylan	SSSI	SN476638	2	9	glacial till
Traeth y Mwnt	Aberarth - Carreg Wylan	SSSI	SN194519	0.2	9	glacial till with sands and gravels
Creigiau Gwbert	Aberarth - Carreg Wylan	SSSI	SN162492	1	9	glacial till with sands and gravels
Whitesands Bay	St. David's Peninsula Coast	SSSI	SM733269	0.2	9	glacial till and head material
Druidston Haven	Arfordir Niwgwl - Aber Bach	SSSI	SM861171	0.3	8	glacial till with sands and gravels
Westdale Bay	Dale and South Marloes Coast	SSSI	SM799059	0.2	8	glacial till
Great Furzenip	Castlemartin Cliffs and Dunes	SSSI	SR889982	0.7	8	head with blown sand
Little Furzenip	Castlemartin Cliffs and Dunes	SSSI	SR886990	inc. in above	8	head with blown sand
Freshwater East	Freshwater East Cliffs to Skrinkle Haven	SSSI	SS024981	0.4	8	clays and gravels
Swanlake Bay	Freshwater East Cliffs to Skrinkle Haven	SSSI	SS045980	0.2	8	head overlying Old Red Sandstone
Rhossili Bay	Rhossili Down	SSSI	SS415892	2.1	8	head and blown sand overlying Old Red Sandstone
Fall Bay	Rhossili to Porteynon	SSSI	SS411873	0.2	8	head over Carboniferous Limestone
Overton Cliff & Overton Mere	Rhossili to Porteynon	SSSI	SS458848	1.5	8	head over Carboniferous Limestone
Port-Eynon Bay	Horton, Eastern & Western Slade	SSSI	SS489854	1.6	8	head