3 Biodiversity

3.1 Introduction

We value our biodiversity for its intrinsic value, because it enriches our lives and for the services that healthy ecosystems provide.

This chapter provides an overview of the biodiversity of England. Adopting the approach set out in the England Biodiversity Strategy, we have structured the chapter around UK Biodiversity Action Plan priority habitats, providing information on some of the important species groups associated with each.

UK Biodiversity Action Plan (UK BAP)
The UK Biodiversity Action Plan, published in 1994, was the UK Government's response to signing the Convention on Biological Diversity (CBD) at the 1992 Rio Earth Summit. It set out a programme for the conservation of the UK's biodiversity and led to the production of 436 action plans to achieve the recovery of many of the UK's most threatened species and habitats.

A review of the UK BAP priority list in 2007 led to the identification of 1,149 species and 65 habitats that meet the BAP criteria at UK level. Priorities for England will be published in 2008 under Section 41 of the NERC Act 2006.

Assessment of progress with implementation of the UK BAP Habitat and Species Action Plans takes place every three years and reports have been completed, in 1999, 2002 and 2005. Data from the 2008 reporting round will be used with other indicators to show how the UK has progressed towards the CBD 2010 target to achieve a significant reduction in the rate of biodiversity loss.

The focus is on semi-natural habitats (habitats which have been modified by man but retain many natural features), in particular the 56 UK BAP priority habitats that occur in England. They are grouped under the following broad habitat types: grassland, heathland, woodland, open water, wetland, inland rock, coastal and marine. In addition, there are sections on 'urban' and 'arable, orchard and hedgerow' biodiversity.

The first section presents an overview of the evidence on the state of semi-natural habitats in England. In the following sections, we look at each habitat group, providing information on geographical extent, importance and inclusion in national and international designated sites. Using our database of SSSI information, we present the most recent assessment of the condition of each habitat group within designated sites. The condition of habitats within SSSIs is described as 'favourable or recovering' or 'unfavourable'. Each of these terms encompasses several more detailed categories of condition (Section 3.2.4). Where evidence is available on the state of habitats outside designated sites, this is also presented.

England Biodiversity Strategy – 'Working with the grain of nature'
Published in October 2002, the England Biodiversity Strategy brings together England's key contributions to achieving the 2010 target to halt biodiversity loss. It seeks to make biodiversity part of the mainstream of our thinking and emphasises that healthy, thriving and diverse ecosystems are essential to everybody's quality of life and wellbeing.

The Strategy has five themes:

- Protecting the best wildlife sites
- Promoting the recovery of declining species and habitats
- Embedding biodiversity in all sectors of policy and decision making
- Enthusing people
- Developing the evidence base

An explicit aim of the strategy is to deliver the UK Biodiversity Action Plan in England, and an important measure of success of conserving England's biodiversity is how the status of priority species and habitats is changing. Natural England is Defra's lead delivery agent for the England Biodiversity Strategy. With our partners, we are developing a new framework that will establish clearer accountabilities for delivery and enhance biodiversity at a landscape scale.

From the 2005 progress report on the UK BAP Priority Action Plans, a series of key threats were identified (BRIG 2006a) and these are summarised in each habitat section for which they are available. Not surprisingly they overlap with many of the adverse reasons that have emerged from the SSSI condition assessments. The key pressures and risks are brought together and analysed in Chapter 5.

The final section in this chapter gives an overview of England's species, bringing together overarching statistics and national indicators.

For each habitat, more detailed analyses have been undertaken, with regional spatial information and more thorough information on each species group. This information will be available in a series of resource documents on Natural England's website.

The economic value of biodiversity

Biodiversity is important to humans for a variety of reasons. It may increase an individual's wellbeing directly (for example, through recreational use or through more passive values gained without actual use) or indirectly through its contribution towards the maintenance of ecosystem functions, such as the regulation of water or carbon cycles. For this reason, the conservation of biodiversity is essential to the wellbeing of current and future generations.

Whilst we can be relatively bold in making this assertion in a general sense, quantifying the intrinsic value of biodiversity (as measured in terms of species richness) remains challenging in a policy context. Much of the research to date has focused on investigating values for individual species and habitats, making aggregation and an understanding of the big picture difficult.

In a study in Northumberland and Cambridgeshire, public understanding of the term biodiversity was generally low but this was overcome to some extent when presented in the right way. The public were willing to pay a positive sum for additional policies aimed at protecting and enhancing biodiversity (ranging between £36-£74 annually per household over five years). Another key finding is that the public expressed relatively high values for the protection of rare unfamiliar species, suggesting that policies should not be restricted to target only familiar and charismatic species.

Source: Christie *et al.* (2004)

3.1.1 Approach to estimating habitat extent

To produce estimates of the extent of habitats we have combined the data on habitats within SSSIs (from our SSSI database) with mapped datasets on undesignated habitats from a variety of sources (see below). Using the SSSI data allows assessment of habitat condition to be made that would be impossible from raw inventories. Also, we have been able to generate a consistent set of data that can be compared across terrestrial habitats, across English regions, and overlaid with other digital datasets.

There is no one definitive estimate of extent of habitats in England. Because of differing methodologies, our estimates differ from others, including targets set for maintaining UK BAP priority habitats (which represent estimates of the extent of habitat of sufficient quality to meet the BAP definitions). The habitat extent estimates presented in this report should not be regarded as definitive. Rather, they represent a further contribution to the habitat evidence base, which will be revised as habitats are resurveyed and inventories updated. This range of estimates of extent highlights the need for further comprehensive work on habitat inventories.

The estimates for grassland, wetland, coastal and heathland habitats outside SSSIs were derived from the BAP priority habitat inventories. The extents of broadleaved woodland, and wood-pasture and parkland were derived from the Forestry Commission's Interpreted Forest Type data (IFT) (Forestry Commission 2001) and historical wood-pasture and parkland data (Haines-Young 2007), respectively. Standing water data were derived from the Great Britain Lakes Inventory (Hughes *et al.* 2004) and canals from the Ordnance Survey 'Strategi' data. For marine habitats, we used the 'UK SeaMap - Seabed Landscapes' data (Connor *et al.* 2006). We used the Countryside Survey 2000 (Haines-Young *et al.* 2000) to estimate the extent of broad habitat types, including inland rock, arable and improved grassland.

Where there are no data on the total area of habitats outside SSSIs (for example rivers and littoral rock), those habitats have been excluded from the extent figures and maps, but the SSSI condition figures and maps have been included within each section.

3.2 Habitats overview

The purpose of this section is to briefly describe England's habitats, to estimate their extent, to give the extent of habitats in designated sites, and to summarise their condition.

3.2.1 The main habitats contributing to England's landscapes

Along with land use and human activity, habitats are a key contributor to both the character and biodiversity of England's landscapes, and they also help define distinctive landscape features and functions. Approximately two-thirds of England is arable, horticultural or improved grassland. The remaining one-third contains the majority of the habitats of biodiversity interest (Figure 3.1).

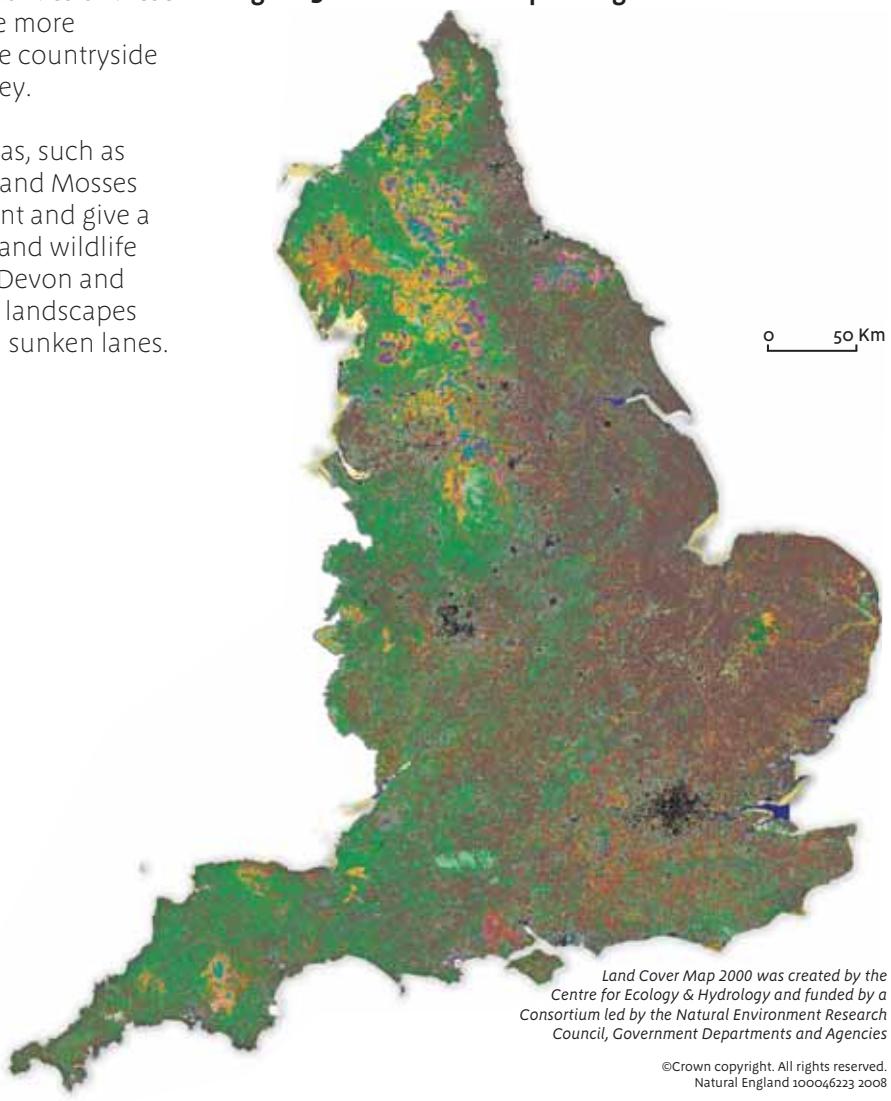
Improved grassland, arable and horticultural land account for the majority of the English countryside, particularly in the lowlands. These habitats and their landscape character are heavily influenced by land management practices, as they are primarily used for food production. Calcareous grasslands on chalk downs in the south, limestone dales in the north and the limestone country of the Chilterns, Cotswolds and Mendips, contribute to the distinctive qualities of these areas. Lowland heaths, which were once more extensive, are still a significant part of the countryside of Cornwall, Dorset, Hampshire and Surrey.

All landscapes are different. In some areas, such as The Broads of East Anglia and the Meres and Mosses of Shropshire, wetlands remain prominent and give a unique character to both the landscape and wildlife of the area. In counties such as Suffolk, Devon and Warwickshire, there are ancient, hedged landscapes of small woods, orchards and fields with sunken lanes.

Semi-natural woodland occurs prominently in the lowlands of England, giving texture and pattern to the countryside and providing interest in what are otherwise often intensively managed areas. These characteristic components of the English countryside are especially significant as very few similar landscapes occur outside Britain.

In the north, a particularly distinctive landscape feature is the limestone pavements of Cumbria and North Yorkshire, which provide a unique habitat for plants. Apart from the mountainous scenery of The Lake District, and the high limestone fells of the Yorkshire Dales, most of our upland landscapes are moorlands with gently undulating plateaux cut by steep-sided valleys. In the wettest parts of the uplands, such as the Pennines, there are blanket bogs, forming large areas of peat landscapes.

Figure 3.1 Land cover map of England 2000



	Area (ha)
Broadleaved/mixed woodland	1,096,941
Coniferous woodland	299,683
Arable & horticultural land	4,829,381
Improved grassland	3,019,911
Neutral grass (grazed/rough)	679,489
Calcareous grass (grazed/rough	788,979
Acid grass (grazed/rough)	278.866
Bracken	70,600
Dense dwarf shrub heath	133,260
Open dwarf shrub heath	123,415
Fen, marsh and swamp	18,127
Bogs (deep peat)	105,776
Water inland	59,429
Inland rock and bare ground	111,573
Suburban/rural development	953,433
Urban and industrial areas	428,441
Supra-littoral rock and sediment	11,318
Littoral rock and bare sediment	170,314
Saltmarsh	33,029

Land Cover Map 2000 was created by the Centre for Ecology & Hydrology and funded by a Consortium led by the Natural Environment Research Council, Government Departments and Agencies

The English coast is a series of varied landscapes, rich in wildlife. The expansive low-lying coasts of East Anglia and Lancashire typically contain intertidal flats and saltmarshes, providing habitat for wading birds. The white chalk cliffs of south-east England are a famous geological feature. The hard rock cliffs and headlands of Devon and Cornwall provide a dramatic landscape and seascape, whose upper slopes also support grassland and heathland.

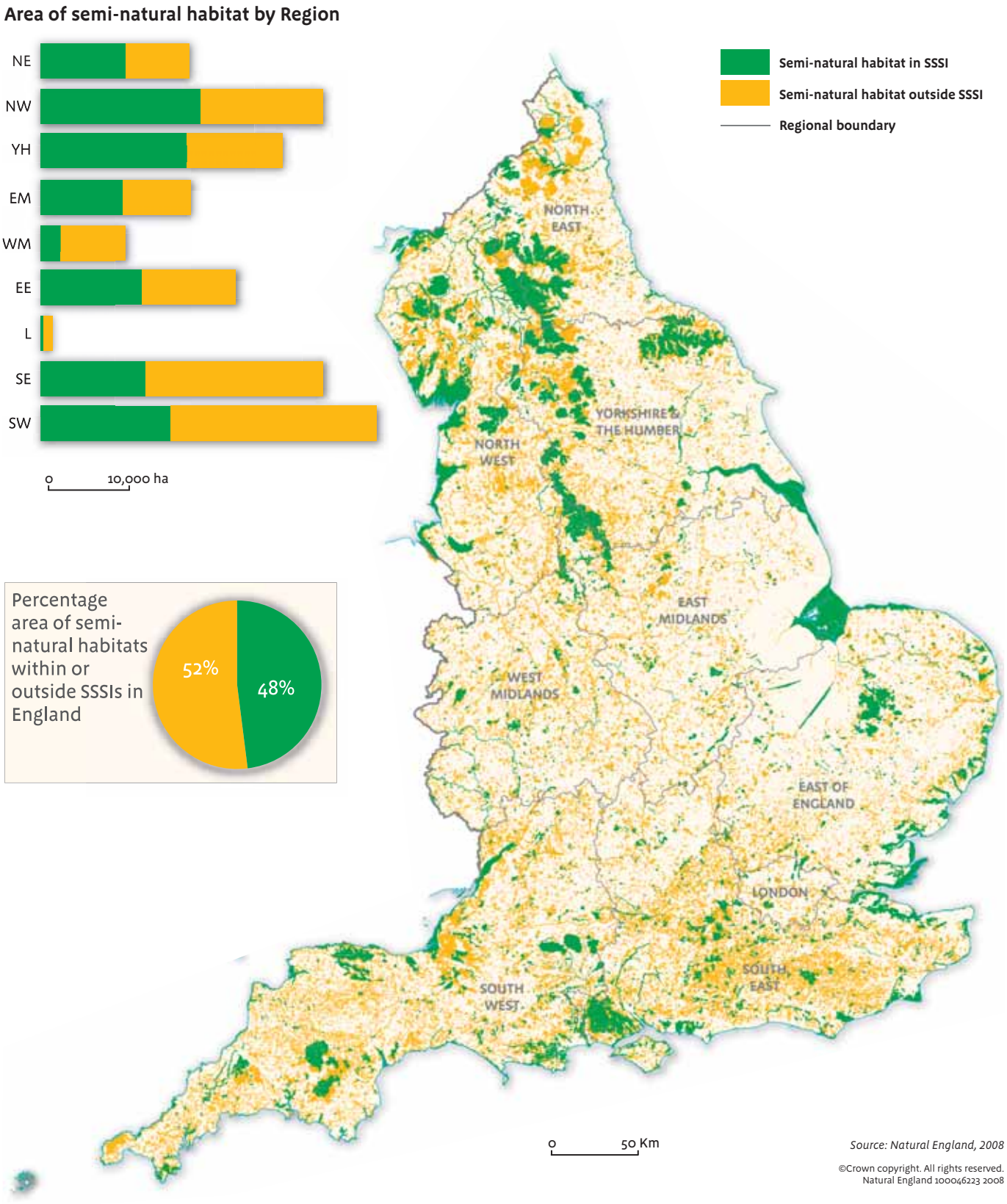
Much of the seabed around England consists of sediments, varying from coarse gravel and sand in areas of high current speed or wave action, through to soft mud where there is little natural disturbance. In some areas, such as around the south-west and north-east coasts, rocky reefs extend deep underwater, and the submerged scenery can be every bit as dramatic as that on land, with rocky pinnacles coming to the surface, deep canyons, and open rocky surfaces.

Nevertheless, over much of England, intensive farming, built development and commercial forestry have resulted in habitats that support a very limited biodiversity. At sea, fishing and aggregate extraction, have also had a negative impact on habitats and species.

3.2.2 The current extent of habitats in the English countryside

The main sources of data on the distribution and abundance of major habitats across England are the Countryside Surveys and Land Cover Maps. Semi-natural habitats of biodiversity interest are spread across the whole of England but with concentrations in northern and southern regions and around the coast (Figure 3.2).

Figure 3.2 Extent of semi-natural habitats in England



Source: Natural England, 2008

3.2.3 Protecting habitats in England through site designation

The most important habitats for biodiversity in England are protected by designation as SSSI. The distribution of SSSIs mirrors the distribution of habitats, with some very large sites in the uplands, on estuaries and the New Forest and Salisbury Plain (Figure 3.2).

On our coasts and in the uplands, some semi-natural habitats such as intertidal saltmarsh and mudflats, upland heath and blanket bog survive as uninterrupted expanses, and a relatively large area of such habitats is designated in relatively few large sites. Conversely, many lowland habitats, such as meadows, heaths and woodlands are represented by small, fragmented sites.

3.2.3.1 Habitats in SSSIs

There is variation in the proportion of habitats that are represented in the suite of SSSIs (Table 3.1). The highest proportions (percentage within SSSI) are for coastal habitats, for example intertidal mudflats and saltmarsh (98%). This reflects the importance of the English coast for habitats and species.

3.2.3.2 Habitats in protected landscapes

Protected landscapes (National Parks and AONBs) hold significant proportions of the national resource of heathlands (80%) and wetlands (48%) (Table 3.2). This is also reflected in the distribution of habitats notified as SSSI (Table 3.3).

Table 3.1 Resource of broad habitats and the areas within designated sites

	Habitat	Estimate of resource (ha)	Area (ha) of habitat within SSSI (or SAC where specified)	% of habitat notified	% of SSSI area in favourable or recovering condition
Grassland	Acid grassland *	12,202	7,305	60	73
	Calcareous grassland	66,238	51,200	77	90
	Neutral grassland	22,402	12,416	55	80
	Purple moor-grass and rush pastures	8,734	3,974	45	90
Heathland	Heathland	316,260	228,201	72	73
Woodland	Broadleaved, mixed & yew woodland	510,292	51,647 **	10	83 ***
	Coniferous woodland	301,020	24,012	8	98
Open water	Rivers and streams	136,000 km	2,500 km	6	28
	Canals	2,624 km	154 km	2	35
	Standing waters	>50,000	20,458	<41	66
Wetlands	Bogs	265,534	185,089	70	70
	Fen, marsh and swamp *	28,305	24,921	88	64
	Coastal and floodplain grazing marsh	235,046	37,288	16	69
Inland rock	Inland rock ****	>8,500	2,429	<29	73
Coastal	Maritime cliffs	14,545	8,484	58	91
	Sand dunes and shingle	17,295	15,209	88	78
	Intertidal mudflats and saltmarsh	231,880	226,156	98	90

* Lowland types only
** Based on area of Interpreted Forest Types (Forestry Commission 2001) within broadleaf woodland SSSIs
*** Condition of broadleaf woodland SSSIs (total area 82,796 ha)
****EC Habitats Directive Annex I inland rock types only

(Source: Natural England, 2008)

Table 3.2 Area of broad habitats within protected landscapes

Habitat	Total area (ha)	Area and (%) within National Parks (ha)	Area and (%) within AONB (ha)	Area and (%) within National Parks and AONB (ha)
Grassland *	109,576	10,166 (9)	20,887 (19)	31,053 (28)
Heathland	316,260	167,557 (53)	85,064 (27)	252,621 (80)
Woodland	1,059,764	59,673 (6)	122,696 (12)	182,369 (17)
Standing waters **	>50,000	9,399 (19)	4,058 (8)	13,457 (27)
Wetland	528,884	143,431 (27)	111,894 (21)	255,325 (48)
Coastal ***	265,369	5,067 (2)	48,449 (18)	53,516 (20)
All land	13,300,000	1,050,886 (8)	2,042,832 (15)	3,093,718 (23)

* Semi-natural grasslands only
** Data for other open water habitats not available
*** Excludes littoral rock and sub-tidal

(Source: Natural England, 2008)

Table 3.3 Area of SSSI habitats within protected landscapes

Habitat	SSSI Area (ha)	Area and (%) of SSSI habitat within National Parks (ha)	Area and (%) of SSSI habitat within AONB (ha)	Area and (%) of SSSI habitat within National Parks and AONB (ha)
Grassland *	98,836	17,019 (17)	36,088 (37)	53,107 (54)
Heathland	228,201	131,532 (58)	69,448 (30)	200,980 (88)
Woodland	116,915	25,307 (22)	27,241 (23)	52,548 (45)
Open Water	28,693	5,346 (19)	2,450 (9)	7,796 (27)
Wetland	247,298	84,942 (34)	78,377 (32)	163,319 (66)
Coastal **	299,699	4,484 (1)	44,637 (15)	49,121 (16)
All SSSIs	1,076,986	286,767 (27)	264,601 (25)	551,368 (52)

* All grassland types within SSSIs ** All coastal types within SSSIs

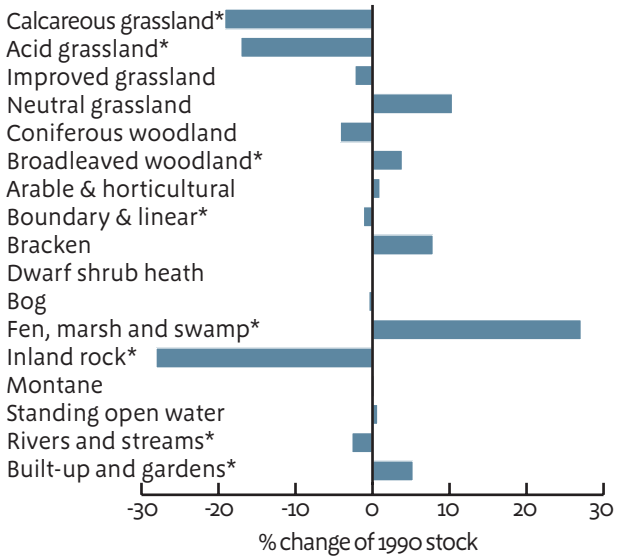
(Source: Natural England, 2008)

3.2.4 Habitat condition

3.2.4.1 Wider countryside

There is no systematic survey of condition across the countryside as a whole. Sample surveys on non-SSSI lowland grassland and lowland heathland sites have been undertaken and in both cases habitat under SSSI designation is in better condition than non-designated habitat. Countryside Survey (Haines-Young *et al*. 2000) provides measures of overall trends in habitat extent (Figure 3.3). Different broad habitat types show varying degrees of losses and gains between 1978 and 1998, with some, such as fen, marsh and swamp, increasing, whilst both calcareous and acid grasslands have declined significantly.

Figure 3.3 Changes in stock of broad habitats between 1990 and 1998

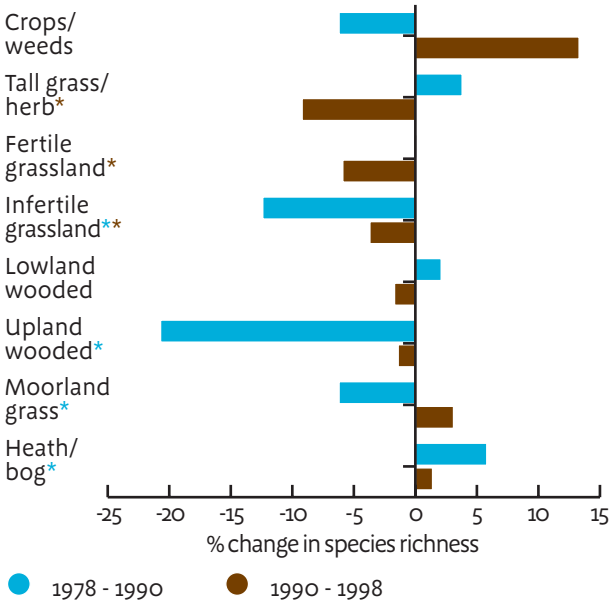


'o' indicates an estimated change of less than 500ha.
Statistically significant changes are marked by *

(Source: Countryside Survey 2000 (CEH, Defra 2000)

Countryside Survey showed that changes in plant diversity between 1990 and 1998 are less marked than in the 1980s, and that losses have mostly been associated with the vegetation found in managed agricultural grasslands, field boundaries and verges. Perhaps of greatest concern is the continuing decline in plant diversity of infertile grasslands, such as wildflower meadows and species-rich banks and verges (Figure 3.4).

Figure 3.4 Changes in species richness in England and Wales between 1990 and 1998



Statistically significant changes are marked by**

(Source: Countryside Survey 2000 (CEH, Defra 2000)

3.2.4.2 SSSIs

As at 1 January 2008 the overall condition of habitats in SSSIs has been assessed as 80% favourable or recovering. SSSI condition varies between habitats (Table 3.1). The only habitats with less than 50% in favourable or recovering condition are rivers and streams, and canals. The habitats with the greatest area in unfavourable condition are bogs, heathlands, and intertidal mudflats and saltmarsh.

The overall condition of SSSIs, and that of most individual habitats, has improved over the period 2003 to 2007, with the exception of open waters (Figure 3.5). On current trends, all other habitats are on track to achieve the government's 2010 target for SSSI condition.

SSSI condition

The Government has a Comprehensive Spending Review 2004 (CSR04) Public Service Agreement (PSA) target to achieve 95% of SSSI area in favourable or recovering condition by December 2010. Under the Comprehensive Spending Review 2007 (CSR07), this PSA target has also become a key indicator of Defra's Departmental Strategic Objective for 'a healthy, resilient, productive and diverse natural environment', which relates to the achievement of the cross-government Natural Environment PSA.

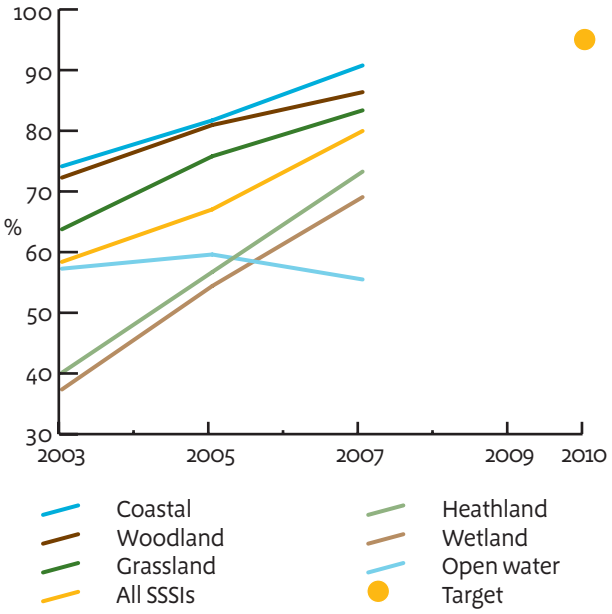
'Favourable or recovering' condition encompasses:

- **Favourable** condition – special habitat and species features are in a healthy state and are being conserved for the future by appropriate management.
- **Unfavourable recovering** condition – all necessary management measures are in place to address reasons for unfavourable condition. Special habitat and species features will 'recover' to a healthy state, but in many cases this takes time.

'Unfavourable' condition encompasses:

- **Unfavourable no change** or **unfavourable declining** condition – some beneficial management measures may be in place, but not all, and the condition may be generally improving but we cannot be sure of recovery to favourable condition. Both mean that a site is not being adequately conserved. Special habitat or species features are either in poor condition and not improving across all the reasons for their unfavourable condition, or their quality is bad and getting worse.
- **Part destroyed** or **destroyed** – there has been fundamental and lasting damage which means that special habitat and species features may have been lost forever and we cannot recover their condition.

Figure 3.5 Progress towards SSSI condition target by main habitat types, 2003 to 2007



(Source: Natural England, 2008)

An analysis of the causes of unfavourable condition and threats to the range of habitats, from both SSSI and BAP data (BRIG 2006a), has revealed the key pressures and risks to be:

Land use change

- Habitat destruction and fragmentation by development.
- Agricultural intensification and changes in agricultural management practices.
- Changes in woodland and forestry management.
- Water abstraction, drainage or inappropriate river management.
- Inappropriate coastal management.
- Lack of appropriate habitat management.

Environmental pollution

- Atmospheric pollution (acid precipitation, nitrogen deposition).
- Water pollution from both point and wider (diffuse) agricultural sources.
- Climate change and sea level rise.

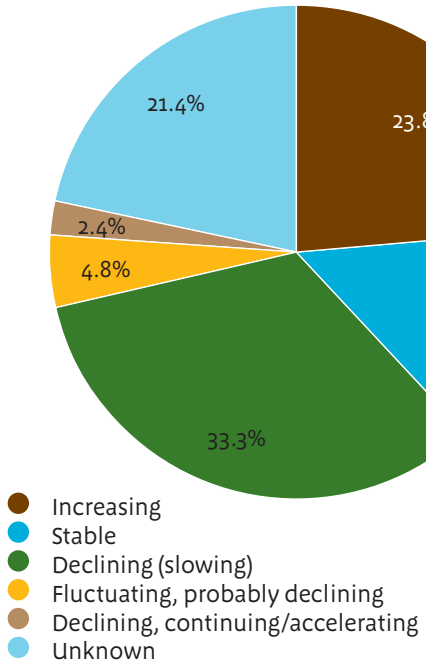
Other

- Sea fisheries practices.
- Recreational pressure and human disturbance.
- Invasive and non-native species.

3.2.4.3 Trends in UK BAP habitats in England

Reporting on the status of UK BAP priority species and habitats follows a three-year cycle, with the first three reporting rounds taking place in 1999, 2002 and 2005. The 2005 assessment (Defra 2006c) indicated that of 42 BAP habitats in England, 10 (24%) were increasing, 6 (14%) stable and 17 (41%) clearly declining (Figure 3.6). The trend has improved for five and worsened for five between 2002 and 2005.

Figure 3.6 Trends in BAP habitats in England in 2005



Total habitat = 42

(Source: English Nature, JNCC 2006)

Trends in UK BAP habitats in England – 2005

Positive trends
Increasing trends were reported for arable field margins, lowland heathland, coastal and floodplain grazing marsh, lowland raised bogs, reedbeds, wet woodland, upland oakwoods, upland mixed ashwoods, lowland beech and yew woodland, and *Sabellaria alveolata* reefs.

Stable trends were reported for hedgerows, upland heathland, maerl beds, saline lagoons, sublittoral sands and gravels, and aquifer-fed naturally fluctuating water bodies.

Negative trends
Declining trends were reported for chalk rivers, mesotrophic lakes, eutrophic standing waters, fens, purple moor-grass, blanket bogs, lowland and upland calcareous grassland, lowland dry acid grassland, lowland and upland meadows, wood-pasture and parkland, limestone pavement, coastal sand dunes, coastal vegetated shingle, coastal saltmarsh, and littoral and sublittoral chalk.

Unknown or no clear trends were reported for seagrass beds, mud habitats in deep water, tidal rapids, sheltered muddy gravels, intertidal mudflats, *Sabellaria spinulosa* reefs, horse mussel beds, maritime cliffs and slopes, and lowland mixed deciduous woodland.

Source: Defra (2006c)

3.3 Grasslands

This section considers all semi-natural grasslands (except coastal and floodplain grazing marshes and calaminarian grasslands, which are covered in Sections 3.8 (Wetlands) and 3.9 (Inland rock) respectively).

Semi-natural grasslands make up a very small proportion of the total area of grassland in England (approximately 3%). The vast majority of grasslands in England consist of sown varieties of perennial rye-grass *Lolium perenne* and white clover *Trifolium repens*, and are managed intensively for agricultural production (for example as silage production and grazing).

Most well-managed semi-natural grasslands are rich in plant species. To keep this character and diversity, they need to be managed by grazing or cutting for hay. These grasslands may be small, isolated meadows, or extensive stretches of chalk downland and upland grazing land.

Semi-improved grasslands (grasslands that have had some improvement, such as application of fertilisers and herbicides, but still retain a limited number of plant species) can nevertheless be important for biodiversity, especially in counties where the resource of semi-natural grasslands is very small (for example in parts of Lincolnshire and Cambridgeshire). Semi-improved and improved grasslands are botanically poor but are often valuable as feeding areas for wintering birds, such as thrushes (including fieldfare *Turdus pilaris* and redwing *T. iliacus*) and other farmland birds. These grasslands are very much under threat from further intensification, but are far less readily identified and mapped than wildflower-rich, semi-natural grasslands.

In the more intensively farmed lowland landscapes, the more diverse species-rich grasslands often occur in situations where there is little active management, such as the fragments of taller, and sometimes more herb-rich, vegetation found in uncultivated field corners, verges, riparian strips and banks.

UK BAP priority grassland habitats in England:

- Lowland calcareous grassland
- Upland calcareous grassland
- Lowland dry acid grassland
- Lowland meadows
- Upland hay meadows
- Purple moor-grass and rush pastures

Capturing the quality benefits of meat produced on biodiverse grassland

The quality of lamb and beef is enhanced in animals that graze biodiverse grassland in the UK. Biodiverse grassland includes species-rich moorland, heath and saltmarshes, which have a larger and more varied range of plant species than improved pastures. Many areas of biodiverse grassland have been converted to improved pasture as part of the drive to increase agricultural productivity.

Taste panels preferred the lamb and beef from biodiverse grassland, remarking on the intensity and distinctiveness of its flavour and the absence of 'abnormal' flavours when compared to products from improved pastures. Consumer focus groups stated they would be willing to pay more for these products, enabling farmers to offset the lower productivity. Indeed, many of the products that were tested are already being sold at prices that are higher than standard supermarket prices.

There are nutritional benefits, particularly of lamb that has grazed biodiverse grassland. The lamb has significantly higher levels of certain nutritionally beneficial fatty acids and the fat has lower levels of skatole (a product of rumen fermentation that adversely affects meat odour during cooking) than lamb produced on improved pasture. Lamb grazed on semi-natural grassland, particularly with heather, also has higher levels of vitamin E (a natural oxidant that improves the shelf life of the meat) than lamb grazed on improved pasture.

These findings add to our knowledge of the benefits of biodiverse grassland for food production and indicate that there are market opportunities for farmers to capture people's willingness to pay for these benefits.

Source: Buller (2007)

Calcareous grasslands occur on shallow, lime-rich soils, generally overlying limestone rocks, including chalk. They are typically managed as part of pastoral or mixed-farming systems. Lime-loving plants are characteristic of these grassland communities.

Lowland acid grasslands typically occur on nutrient-poor, generally free-draining soils overlying acid rocks or sands and gravels. They often occur in a mosaic with lowland heathland and are typically managed as pasture. Upland acid grassland in England is generally not of high nature conservation interest for its plant communities as it is often the product of overgrazing of upland heathland (with the exception of very limited areas of species-rich mat-grass *Nardus stricta* grasslands on high mountain tops in the Lake District). However, it often forms part of a landscape that is important for some species, especially upland breeding birds.

Lowland meadows are enclosed areas of unimproved neutral grassland, including both pastures and true meadows cut for hay, some of which may be seasonally flooded. Upland hay meadows are the product of traditional management for hay, usually found at heights of between 200 and 400 metres. Such unimproved meadows typically occur as scattered fields or isolated groups of fields, and both upland and lowland examples are rich in wildflowers.

Marshy grasslands, such as purple moor-grass *Molinia caerulea* and rush pastures, occur in areas of high rainfall and comprise a mix of fen and mire communities, often found with wet heath and acid grassland. They are typically managed by low-intensity grazing.

3.3.1 Importance of England's grasslands

England holds a large proportion of the UK's lowland calcareous grasslands (95%) and upland hay meadows (97%), as well as 70% of both the upland calcareous grasslands and lowland meadows. Eight grassland types that are found in England are listed in Annex I to the EC Habitats Directive.

Assessing the value of a scientifically important ecosystem: the Culm grasslands

Culm grasslands (marshy unimproved grasslands found in Devon and Cornwall) are home to many rare species including the marsh fritillary butterfly *Eurodryas aurinia* and hazel dormouse *Muscardinus avellanarius*. They support a rich variety of flowering plants, help reduce the risk of flooding and improve water quality. An estimated 90% of this grassland has been lost since the 1900s, largely due to sites being made more agriculturally productive, but the biggest threat now is neglect, which leads to scrub invasion (the sites are reliant on low-intensity grazing and light burning).

Though Culm grasslands are not well known to the British public, people clearly value them. Voluntary nature conservation organisations have drawn on around £3.5 million of funding from agri-environment schemes, the Lottery and charitable trusts to secure future management of sites. However, voluntary donations are likely to underestimate the true value, due to the incentive for people to minimise the cost to themselves and 'free-ride' on the resources of others. An investigation of people's willingness to pay found that the total benefits of conserving and expanding the Culm grasslands by 10% were in excess of £136 million. With costs ranging from £5m to £35m (depending on whether this is achieved through management agreements or land purchases) this suggests that society could be significantly better off if the Culm grasslands were effectively conserved and enhanced.

Source: Burgess *et al.* (2004)

3.3.1.1 Grassland species

Semi-natural grasslands are especially important for vascular plants, fungi and invertebrates (see below), but upland acid grassland, lowland dry grasslands and wet meadows are also of considerable importance for breeding and wintering birds. Semi-natural grasslands also provide foraging areas for bats (Parsons 2007) and can be important for mosses and lichens.

Vascular plants

Semi-natural grasslands are normally very rich in flowering plants, typically with more than 15 species per square metre, but for some calcareous grasslands this can exceed 40 species per square metre. They also support a number of threatened vascular plant species. For example around 54 species typical of semi-natural grassland are threatened or near threatened (Cheffings & Farrell 2005). Examples include snake's head fritillary *Fritillaria meleagris*, lesser butterfly-orchid *Platanthera bifolia* and man orchid *Aceras anthropophorum*. Some two-thirds of Britain's threatened grassland vascular plant species are associated with calcareous grassland.

Invertebrates

For butterflies, the richest and most important farmland habitats are semi-natural grassland pastures, especially calcareous grasslands, which provide a breeding habitat for 48 species (Brereton *et al*. 2007), approximately 85% of the British total. Twenty of these have a substantial proportion of their English population breeding on calcareous grassland, including UK BAP priority species such as small blue *Cupido minimus* and Duke of Burgundy *Hamearis lucina*. Semi-natural grasslands also support a wide diversity of moths, including UK BAP priority species such as the narrow-bordered bee hawk *Hemaris tityus*.

3.3.2 Extent of habitat

There are estimated to be 4.8 million ha of grassland (all types) in England based on Land Cover Map 2000 data. Of this, around 109,576 ha is semi-natural grassland, covering 1% of the total area of England (Figure 3.1). There are a further 235,046 ha of coastal and floodplain grazing marshes, which are covered in Section 3.8. Lowland calcareous grasslands comprise the largest proportion of England's semi-natural grasslands at 49% of the total. Upland hay meadows rich in plant species and other wildlife are now a rare habitat with just 2,024 ha. There is no overall extent figure available for upland acid grassland in England, except for the area within SSSIs (see below).

Pink waxcap

Semi-natural grasslands are very rich in fungi, and some of the most striking are the waxcaps. They are usually brightly coloured, including species that are pink, green, violet and every shade from yellow to deep crimson. They have thick waxy gills and sticky or slimy caps. For this reason, sites are commonly known as 'waxcap grasslands'. Other characteristic grassland fungi include the unusual and delicate fairy clubs, pinkgills and earthtongues.

The number and diversity of 'indicator fungi' in grasslands, such as the rare pink waxcap *Hygrocybe calyptriformis*, can be used to assess the quality of sites for fungi as they are intolerant of agricultural fertilisers.

The UK has a relatively rich resource of important fungi grasslands, which have become scarce across much of Europe. A number of sites are of European significance for their rare and endangered fungi assemblages.

Sources: English Nature (2003); Evans *et al*. (2001)

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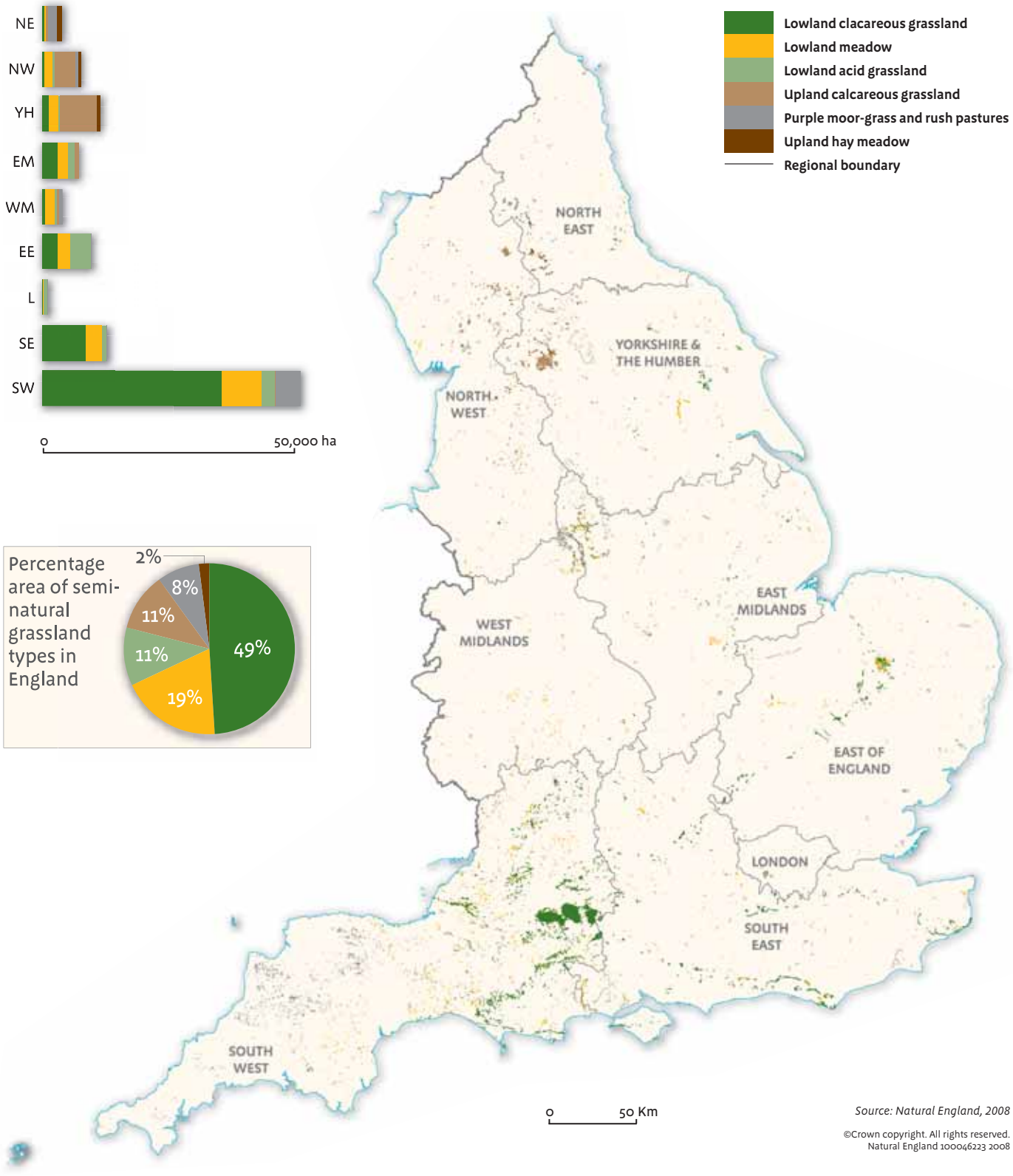
Figure 3.7 Extent of semi-natural grassland in England



Source: Natural England, 2008

Semi-natural grasslands are distributed across England, with lowland meadows in particular being widely scattered across the country, although notable concentrations occur in the South West and West Midlands Regions (Figure 3.7). The South West Region holds almost half of England's overall semi-natural grassland resource (44%). This region also holds a significant proportion of the total England resource of purple moor-grass and rush pastures (57%). In the South West these marshy grasslands occur over rocks of the Culm Measures, hence the local name 'Culm grasslands'. However, it is the calcareous grasslands that contribute the lion's share (61%) of the South West's resource, particularly on the Salisbury Plain plateau, across the Cotswolds and along ridges such as the Blackdown Hills. Other notable concentrations of calcareous grasslands extend across the chalk and limestone escarpments and superficial calcareous deposits of lowland England.

Further north, upland hay meadows and upland calcareous grasslands are largely confined to North Lancashire, Cumbria and the North Pennines. The North East holds a significant proportion of England's Magnesian Limestone grassland, which is confined to a narrow strip characterised by this underlying geology, running from Nottinghamshire to Durham.

Lowland dry acid grasslands occur on sandy soils and on shallow soils over hard igneous rocks, often in association with lowland heathland. The New Forest (Hampshire) and Breckland (Norfolk and Suffolk) support particular concentrations.

Greater London has the smallest area of grassland, with the best examples remaining in the Royal Parks, for example Richmond Park. The North East has substantial expanses of upland but comparatively few lowland grasslands.

3.3.3 Protection

An area of 74,894 ha of semi-natural grassland lies within SSSIs, representing 68% of the total resource in England (Figure 3.8 and Table 3.4). A further 23,942 ha of upland acid grassland is included in SSSIs, mainly because of its importance for breeding birds.

Table 3.4 Area of semi-natural grassland under different designations

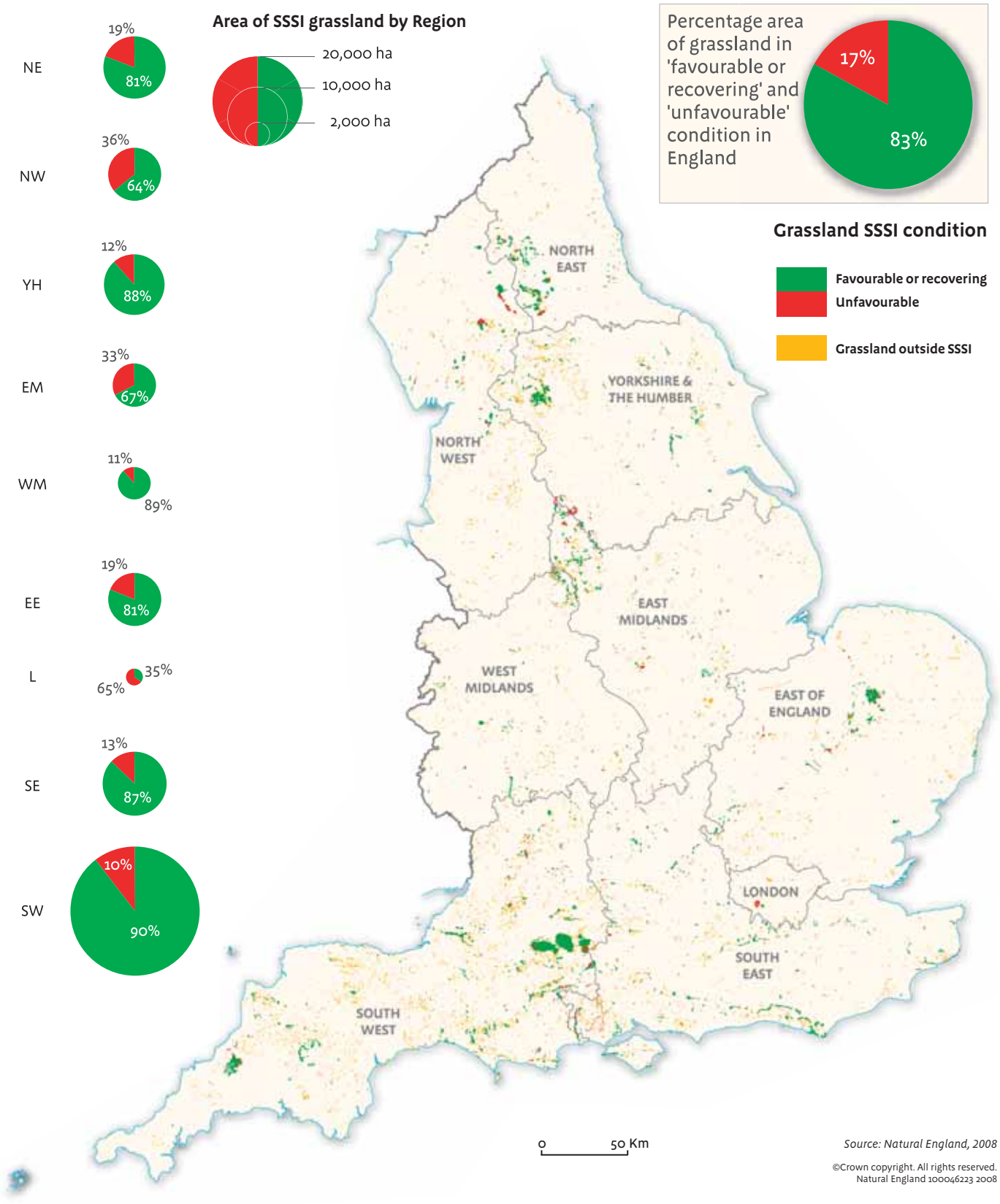
Designation	Total area (ha)	% of total area
Total resource *	109,576	100
SSSI	74,894	68
SAC	43,790	40
SPA	33,992	31
Ramsar site	3,134	3
NNR	6,328	6
Within National Park	10,166	9
Within AONB	20,887	19

* Data for grasslands outside designated sites are not complete and the resource total may change with further survey work

(Source: Natural England, 2008)

Of the semi-natural grassland in England, 43,790 ha (40%) is designated as SACs. The very large Salisbury Plain SSSI and SAC makes up just under half of the total area of lowland semi-natural grassland within designated sites.

Figure 3.8 Grassland SSSI condition in England



Source: Natural England, 2008

Table 3.5 Extent of SSSI notification and condition by grassland type

Habitat	Total resource (ha)	Area SSSI (ha)	% of resource within SSSI	% of SSSI area in favourable or recovering condition
Lowland calcareous grassland	53,945	42,715	79	90
Upland calcareous grassland	12,293	8,485	69	92
Lowland acid grassland	12,202	7,305	60	73
Lowland meadows	20,378	10,946	54	78
Upland hay meadows	2,024	1,470	73	92
Purple moor grass & rush pasture	8,734	3,974	45	90
Total *	**109,576**	**74,984**	**68**	**87**

* Excluding upland acid grassland

(Source: Natural England, 2008)

3.3.4 Condition

By area, 83% of SSSI grassland (all types) is in favourable or recovering condition (Figure 3.8). Of this, 43% (43,153 ha) is in favourable condition and 40% (39,192 ha) is recovering.

There is variation in condition between the semi-natural grassland types and, by area, 73% of lowland acid grassland and 78% of lowland meadows are judged to be in favourable or recovering condition. The other four types are at 90% or above in favourable or recovering condition (Table 3.5). There is little regional variation in condition, with the exception of London's grasslands being in significantly poorer condition.

Upland acid grassland in SSSIs is in poorer condition than most semi-natural grassland with 73% favourable or recovering (generally assessed for upland breeding birds).

The main adverse factors in lowland enclosed grassland SSSIs are undergrazing and lack of scrub control, which contribute to the reasons for unfavourable condition in 30% and 18% respectively of the total area. These factors allow increased dominance of rank grasses and scrub at the expense of more desirable but less competitive species. In contrast, for upland hay meadows the main cause of unfavourable condition is over-intensive management, particularly grazing levels and excessive input of nutrients from both organic manures and artificial fertilisers (Jefferson 2005).

Much (57%) of the unfavourable area of upland grassland pasture SSSIs is a result of overgrazing and poorly-timed grazing, particularly by sheep. Burning and inappropriate stock feeding also affect the condition of upland acid grassland.

Comparatively little information exists on the condition of grasslands outside the SSSI series but a recent survey of 500 lowland semi-natural grasslands revealed that 21% were in favourable condition (Hewins *et al.* 2005). This is significantly poorer than for equivalent semi-natural grassland within SSSIs (49% favourable).

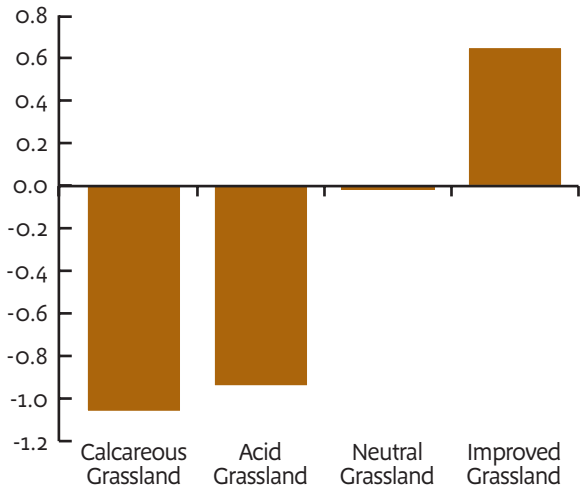
3.3.4.1 Trends in grassland plants

Many characteristic species of semi-natural grassland have declined over the last 40 years (Preston *et al.* 2002a). The greatest average loss is shown by plants of calcareous and acid grasslands, whilst species of neutral grassland have changed least (Figure 3.9). In stark contrast, species of agriculturally improved grasslands have increased in abundance over the same period (Preston *et al.* 2002b, 2003).

There is growing evidence to indicate that eutrophication from atmospheric nitrogen and agricultural fertiliser use is a major cause driving change in the flora of the UK (Preston *et al.* 2002b). The Countryside Survey 2000 showed an overall shift towards vegetation that is more characteristic of nutrient-rich conditions during the period 1990 to 1998 (Haines-Young *et al.* 2000). Studies of species at the county level have also suggested a decline in species of nutrient-poor habitats.

Other studies show the importance of linear grassland strips such as roadside verges and green lanes as refuges for many species that have declined in meadows and pastures. These features have become increasingly important but remain threatened as they exist largely outside protected sites. In Huntingdonshire, sulphur clover *Trifolium ochroleucon* is now virtually confined to protected and appropriately managed road verges. Few populations have survived away from these sites due to ploughing and improvement of meadows (K. Walker, BSBI pers. comm.). General trends show an increase in taller, more competitive species in these habitats due to eutrophication from air pollution and decreased disturbance, such as a decline in cutting.

Figure 3.9 Mean change in plant species by grassland broad habitat



Graph shows the 'average' change index for species associated with different broad grassland habitats over the last 40 years in the UK. A positive value indicates a relative increase, a negative value a relative decrease.

(Source: Countryside Survey 2000 (CEH, Defra 2000)

Pasqueflower

Pasqueflower *Pulsatilla vulgaris* is a very rare perennial herb confined to calcareous grassland. It has declined dramatically due to agricultural changes. By 1968, only 33 populations remained in England. The decline continues, due to abandonment of grazing and the use of herbicides and fertilisers, and only 17 populations remained in 2006.

Other UK BAP priority species of semi-natural grassland which have declined for similar reasons include:

- Burnt orchid *Orchis ustulata*
- Field gentian *Gentianella campestris*
- Purple milk-vetch *Astragalus danicus*
- Slender bedstraw *Galium pumilum*
- Chamomile *Chamaemelum nobile*

Source: Walker *et al.* (in press)

Straw belle moth

- The straw belle moth *Aspitates gilvaria* has been recorded from nine 10 km squares from 2000 onwards. These are confined to the North Downs of Kent and Surrey where there are probably fewer than 20 colonies, many of these small and discrete.

- Formerly recorded from several counties in southern England from Devon to Suffolk, the moth has suffered from scrub encroachment, agricultural improvement and overgrazing.

Other grassland moths and butterflies that have declined for similar reasons include:

- Black-veined moth *Siona lineata*

- Duke of Burgundy butterfly *Hamearis lucina*

- Small blue butterfly *Cupido minimus*

These are all listed as priority species in the UK BAP.

Source: Butterfly Conservation (2000-2008c)

3.3.4.2 BAP grassland action plan threats

The main issues posing a threat to grasslands are (BRIG 2006a):

- **Changes in agricultural management practice,** notably unsuitable grazing management. Undergrazing and scrub encroachment are key issues in the lowlands, whilst overgrazing is the main cause of unfavourable condition in the uplands.

- **Agricultural intensification** such as abandonment of marginal land, drainage, conversion to arable and intensive management of grasslands (particularly herbicide and fertiliser use).

- **Atmospheric nitrogen deposition and climate change** affecting the species composition of sites.

© Bob Gibbons/FLPA

3.4 Heathland

Heathland is an open landscape on poor acid mineral soils or shallow peat. It occurs from sea-level to mountain tops, always characterised by heathers *Calluna* and *Erica* species, and gorse *Ulex* species. Where it is found below altitudes of 300 metres in England, it is generally referred to as 'lowland heathland', and above this altitude it is termed 'upland heathland'. This distinction recognises differences in soils, species composition, and management and conservation issues. Mountain heath and willow scrub, with its abundant bryophytes and lichens adapted to wind-exposed summits, is largely restricted to areas above 600 metres in the north and west of the country.

Lowland heathland consists of a dwarf shrub layer, some areas of gorse, scattered trees and scrub, with areas of grassland and bare ground. Upland heath typically has a range of dwarf shrubs such as heather *Calluna vulgaris*, bilberry *Vaccinium myrtillus*, crowberry *Empetrum nigrum*, bell heather *Erica cinerea* and, in the south and west, western gorse *Ulex gallii*. Wet heath in both the uplands and lowlands is dominated by mixtures of cross-leaved heath *Erica tetralix*, deergrass *Trichophorum cespitosum*, heather and purple moor-grass *Molinia caerulea*, over an understorey of mosses often including carpets of bog-mosses *Sphagnum* species. On many sites, heathlands merge into other habitats, such as woodlands, acid grasslands and bogs, creating very interesting and important transitions.

UK BAP priority heathland habitats in England:

- Lowland heathland
- Upland heathland
- Mountain heaths and willow scrub

The extent of heathland in both the uplands and lowlands increased with the clearance of woodland after the last Ice Age. Lowland heathlands in particular are ancient cultural landscapes, having been maintained for centuries by harvesting, turf extraction, burning and livestock grazing, and many are common land (see Section 2.5.2). Upland heathland is now managed by sheep grazing and burning for driven shooting of red grouse *Lagopus lagopus*. Heathlands throughout England are greatly appreciated as areas for access and recreation (see Chapter 4), for their aesthetic value and for the sense of wilderness they can provide.

3.4.1 Importance of England's heathlands

England has a significant proportion (approximately 18%) of the world total of heathland. Heathland is a habitat of European importance and four types that occur in England are listed in Annex I to the EC Habitats Directive.

3.4.1.1 Heathland species

England's heathlands are particularly important for reptiles and they also provide habitat for upland and lowland birds of European importance. Uncommon invertebrates and rare flowering plants are also found on heathlands. In addition, some types of upland heathland are significant for their lower plants, including rare mosses and liverworts that are particularly associated with the wetter western heaths.

Reptiles

Reptile abundance and species richness is highest on the large lowland heathland blocks of southern England, where the generally open habitats with fine-scale variation in topography and vegetation cover allow effective thermoregulation for these warmth-loving animals. Lowland heathlands are the prime sites for the rare sand lizard *Lacerta agilis* and smooth snake *Coronella austriaca*, with the majority of populations found in Dorset.

Adder

- All reptiles have declined in the 20th century, including common species such as the adder *Vipera berus*.
- As Britain's only venomous snake, adders still suffer persecution, as well as the loss, fragmentation and inappropriate management of their habitats, human disturbance, and general tidying of the countryside.
- Adders have declined severely in parts of the country, most markedly in the Midlands, with decreases reported in Warwickshire, Worcestershire, Shropshire and London. They are extinct in Hertfordshire and persist at only one site in Nottinghamshire.
- Fortunately, there is increasing recognition of adder requirements among landowners and managers, and some success in improving the species' undeservedly poor public image.

Source: Baker *et al.* (2004); Atkins (2005)

Birds

Lowland heathlands in England provide breeding habitat for a specialised suite of birds, including nightjar *Caprimulgus europaeus*, woodlark *Lullula arborea* and Dartford warbler *Sylvia undata* (which also breed on upland heathlands in South West England). All three are listed in Annex I to the EC Birds Directive.

Upland heathlands similarly support important populations of bird species listed in Annex I to the EC Birds Directive, including hen harrier *Circus cyaneus*, merlin *Falco columbarius*, peregrine *F. peregrinus*, short-eared owl *Asio flammeus* and golden plover *Pluvialis apricaria*. Internationally important numbers of twite *Carduelis flavirostris* occur within the South Pennines where they breed on the moor edge.

Moths

Dry heathlands support a variety of specialities, including the nationally scarce dotted-border wave *Idaea sylvestraria* and the southern chestnut *Agrochola haematidea*. The latter species was only discovered in England in 1990 and is now known from a few heathland sites in Hampshire, Dorset and Sussex. Wet heathlands and valley mires also support a wide variety of species, including the very local plume moth *Buckleria paludum*, unusual as the larval stage feeds on the insectivorous round-leaved sundew *Drosera rotundifolia*. The crambid moth Crambus silvella only occurs on boggy heathland in Dorset and Hampshire. Both moths are provisional Red Data Book species.

Shoulder-striped clover moth

The shoulder-striped clover moth *Heliothis maritima subspecies warneckei*, a local resident of the heaths of Dorset, The New Forest and Surrey, has undergone a serious decline. Since 2000 it has only been reported from ten sites, one in each of Surrey and Dorset, the remainder from the New Forest. Formerly, it was recorded in Cornwall. A species of early successional stages, this moth is threatened by habitat loss, fragmentation, and uncontrolled and unplanned fires.

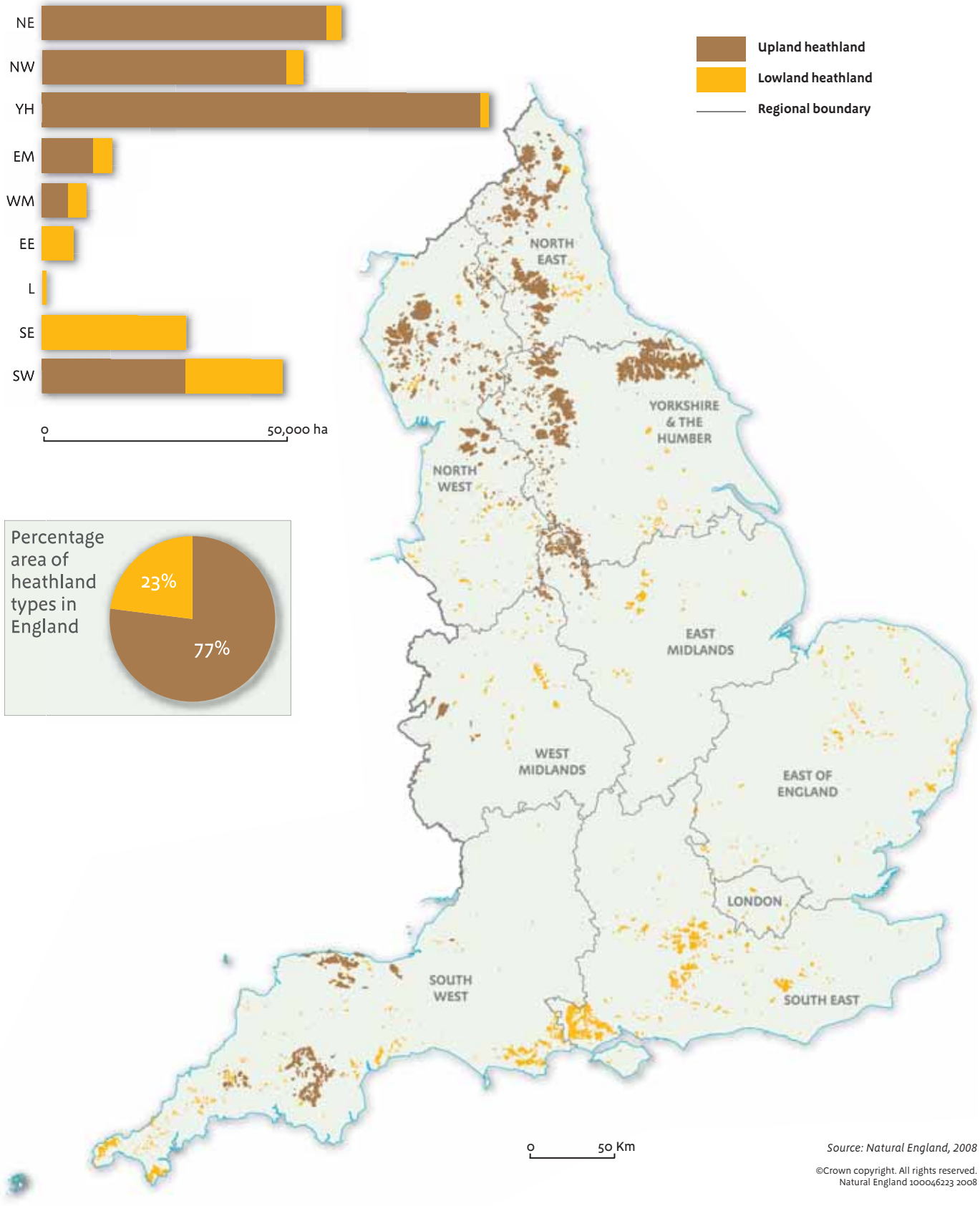
Other UK BAP priority heathland butterflies and moths which have declined for similar reasons include:

- Speckled footman moth *Coscinia cribraria bivittata*
- Silver-studded blue butterfly *Plebejus argus*

Source: Butterfly Conservation (2000-2008b)

© Bill Unwin

Figure 3.10 Extent of heathland in England



Source: Natural England, 2008

3.4.2 Extent of habitat

There are estimated to be 316,260 ha of heathland, covering 2% of the total area of England (Figure 3.10). Of this, upland heathland is the more extensive, comprising 77% of the heathland resource. There are estimated to be 600 ha of the new BAP priority habitat 'mountain heaths and willow scrub'.

Upland heathland occurs extensively across the English uplands. In the North Pennines, Cheviot Hills and Lake District, upland heathland is dominated by a mix of heather and bilberry. In the South Pennines, this community has become impoverished through a longer history of management, so that the heather-wavy hair-grass *Deschampsia flexuosa* community is dominant. On the drier North York Moors, the heathland is almost pure heather. By contrast, in South West England the combination of lower altitudes and milder climatic conditions brought about by proximity to the Atlantic has led to the development of heathland communities dominated by combinations of heather and western gorse or bristle bent *Agrostis curtisii*.

Lowland heathland is mainly concentrated in the three southern regions. There are botanical differences across the range. For example, western gorse characterises those heathlands from West Penwith on the western tip of Cornwall, through Devon and Dorset, whereas dwarf gorse *Ulex minor* appears further east, on the heathlands of Hampshire, Surrey and Sussex. There are also local rarities such as Cornish heath *Erica vagans* and Dorset heath *E. ciliaris*, or the rich flora of the Lizard Peninsula. The East of England has the distinctive heaths of the Suffolk coast and Breckland, with their mosaics of acid and calcareous grassland and lichen heaths. There are also important remaining examples of lowland heathland in other areas including Cannock Chase, Sherwood Forest and the Vale of York.

3.4.3 Protection

An area of 228,201 ha of heathland is within SSSIs, representing 72% of the total heathland resource in England (Figure 3.11 and Table 3.6). Of this, 179,912 ha are upland and 48,290 ha are lowland heathland. Of the heathland in England, 193,844 ha (61%) is designated as SACs under the EC Habitats Directive. Half of the heathland is designated as Special Protection Areas for birds such as nightjar or Dartford warbler in the lowlands, and wading birds and raptors in the uplands.

Table 3.6 Area of heathland under different designations

Designation	tal area (ha)	% of total area
Total resource *	316,260	100
SSSI	228,201	72
SAC	193,844	61
SPA	156,817	50
Ramsar	16,729	5
NNR	7,635	2
Within National Park	167,557	53
Within AONB	85,064	27

* Data for heathlands outside designated sites are not complete and the resource total may change with further survey work

(Source: Natural England, 2008)

3.4.4 Condition

By area, 73% of SSSI heathland is in favourable or recovering condition (Figure 3.11). Of this, 19% (43,299 ha) is in favourable condition and 54% (123,865 ha) is recovering.

Lowland heathland SSSIs are in a better situation with 81% by area in favourable or recovering condition, compared to 71% in the uplands (Table 3.7).

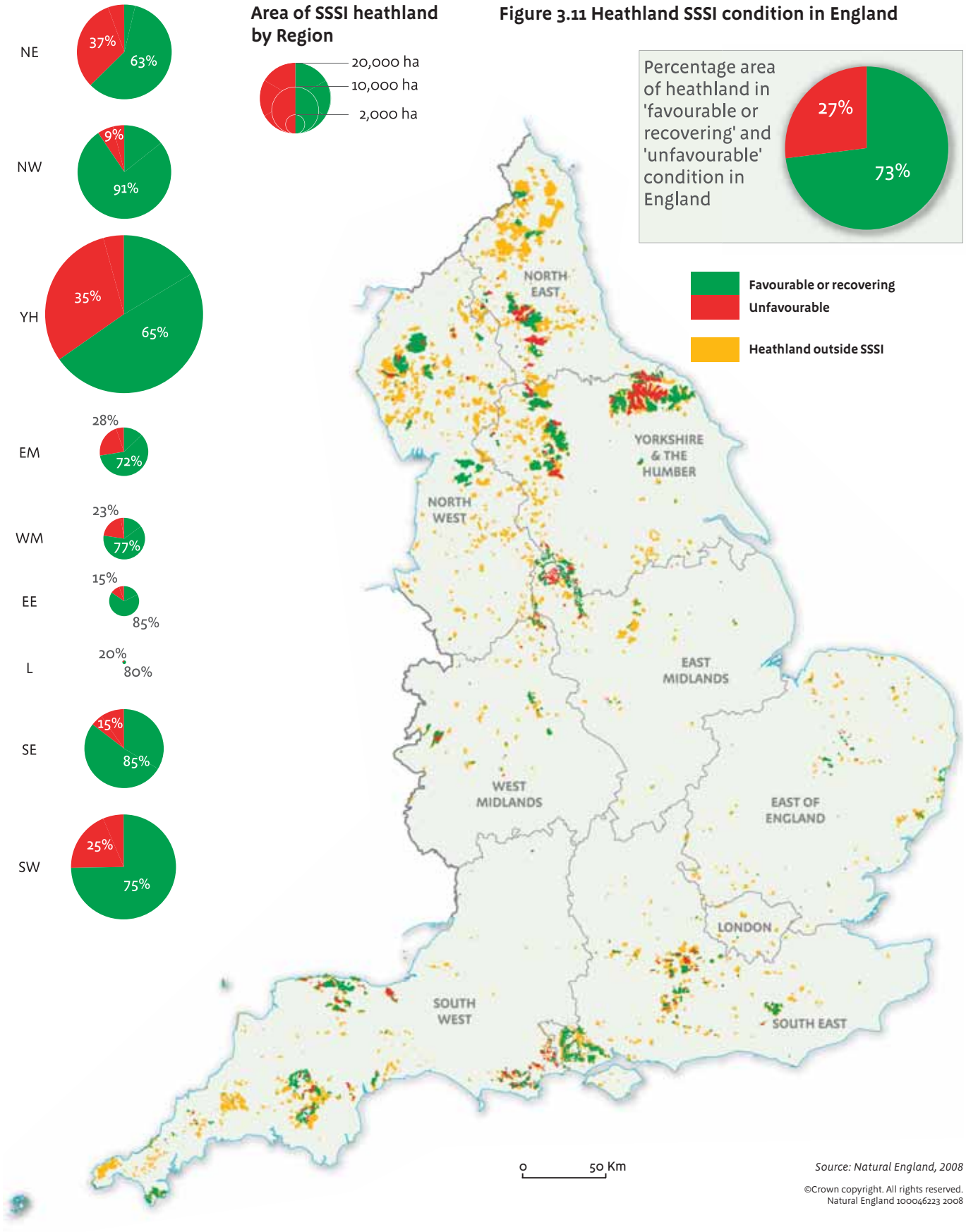
Table 3.7 Extent of SSSI notification and condition by heathland type

Habitat	Total resource (ha)	Area SSSI (ha)	% of resource within SSSI	% of SSSI area in favourable or recovering condition
Lowland heathland	72,331	48,290	67	81
Upland heathland	243,929	179,912	74	71
Total	**316,260**	**228,201**	**72**	**73**

(Source: Natural England, 2008)

The regional variation in heathland condition reflects the distribution of heathland types. The North East and Yorkshire & the Humber Regions contain the major proportion of the North and South Pennines upland heaths, which are in poor condition.

Figure 3.11 Heathland SSSI condition in England



Source: Natural England, 2008

The main adverse factors in upland heathland SSSIs are inappropriate burning and overgrazing, which contribute to the reasons for unfavourable condition in 53% and 31% respectively of the total area. There is variation between regions, with overgrazing being the dominant cause of unfavourable condition in the South West and the Lake District. In the Forest of Bowland and the North Pennines, unfavourable condition is largely due to overgrazing, drainage and inappropriate burning, whilst in the North York Moors burning is the main factor. In the South Pennines, condition has been determined by overgrazing, inappropriate burning, historic atmospheric deposition and wildfires.

Lowland heathlands SSSIs are mainly affected by lack of appropriate management, particularly undergrazing and lack of scrub control, resulting in changes in species composition and vegetation structure. These are contributory factors to unfavourable condition in 34% and 27% respectively of the total area. However, lowland heathlands are also affected by aggregate extraction, housing and transport infrastructure, disturbance (impact on plant and bird populations), and pollution (atmospheric deposition and other nutrient enrichment from agricultural sources).

Outside of SSSIs there is less information but a survey in 2005 and 2006 of 104 randomly selected non-SSSI lowland heathland stands, both inside and outside of agri-environment agreements, and using the same methodology as for SSSIs, revealed that none of the stands was considered to be in a favourable condition (Hewins *et al*. 2007). A similar survey of non-SSSI upland heathland sites is planned for 2008 to 2010.

The economic benefits of upland landscape features

Farming and land management practices in the uplands provide a range of environmental goods and services that are of wider benefit to society. In an effort to help better target subsidy payments (specifically the Hill Farm Allowance) to the provision of these environmental public goods, Hanley *et al*. (2007) explored the extent to which people valued different landscape features in England's uplands using a common choice experiment methodology across different regions.

The study found that whilst people generally had a positive willingness to pay for improved environmental quality – even in those regions like the South-East where people on average only visit upland areas once a year – people's preference for certain landscape features differed across regions.

The study also found that the value of additional landscape features that might be provided by environmental targeting of upland agricultural subsidies could range from £15 million to £56 million per year at a regional level. To put this in context, nationally this would exceed the current budget of the supplementary payments made to farmers through the Hill Farm Allowance in upland areas (£27 million in 2007). However, to assess whether such targeting is in the economic interests of society, further research is needed to assess whether the benefits of providing the features outweigh the costs.

Source: Hanley *et al*. (2007)

3.4.4.1 Trends in heathland birds

Recent national surveys (see box) have shown mixed fortunes for a number of characteristic heathland birds since the 1980s. Birds found on lowland heathland have shown strong recovery of their population size and range in England. The nightjar and woodlark ranges, however, are still much lower compared to the late 1960s. In contrast, a survey of upland sites in 2000 to 2002 (Sim *et al*. 2005), revealed significant declines in breeding wading birds such as curlew *Numenius arquata* and dunlin *Calidris alpina*, as well as ring ouzel *Turdus torquatus* and twite. Low numbers of black grouse *Tetrao tetrix* and upland raptors, such as hen harrier, also remain a concern. For example, only 14 pairs of hen harriers were known to have nested successfully in England in 2007, while Potts (1998) estimated that the English uplands (heathland and blanket bog) are capable of supporting around 230 breeding pairs.

Surveys of designated sites support these findings, with declines in the populations of several breeding species reported in some of our most important upland areas (for example the South Pennines with observed declines of wheatear *Oenanthe oenanthe* (-55%), ring ouzel (-19%) and, especially, twite (-84%) since 1990).

The factors behind the declines in upland heathland birds are changes in land use, grazing levels, predation and perhaps climate change. Heathland restoration and careful management of both heathland and forestry plantations have benefited many lowland heathland birds (for example nightjars and woodlarks).

3.4.4.2 BAP heathland action plan threats

The main issues posing a threat to heathlands are (BRIG 2006a):

- **Changes in agricultural management practice**, especially lack of appropriate grazing and burning. In the uplands, overgrazing has led to a widespread replacement of heathland by grassland communities, while on lowland heathlands, a lack of grazing, cutting or inappropriate burning has led to loss of open habitats and reversion to woodland.
- **Infrastructure and development** particularly housing, industrial developments and road building in the lowlands, and wind farms in the uplands.
- **Atmospheric deposition (especially nitrogen), acid precipitation and climate change** affecting the species composition of sites.

Trends in heathland birds

There have been encouraging increases in a number of threatened heathland bird species in the UK (the majority of nightjars, woodlarks and Dartford warblers are in England). Recent national surveys show that:

- Nightjar numbers have increased since the early 1990s by 35%, to 4,606 'churring' (the song given in aerial display) males in 2004.
- Woodlarks have increased since 1997 by 89%, to an estimated 3,084 pairs in 2006 and have increased in range by 46%, although there have been declines in numbers and distribution on some SPAs (Breckland, New Forest, and the Sandlings in Suffolk).
- Dartford warblers have increased by 70% since 1994, to an estimated population of 3,208 pairs in 2006 and have increased their range by 114%. This represents a real expansion into new areas where they have not been found before, after recovering from a low of only 12 birds following the harsh winter of 1962/63.
- Black grouse numbers have stabilised in England with an estimated 1,521 'lekking' (gatherings of displaying birds) males in 2005 and have increased their range (26% more 5-km grid squares occupied) between 1998 and 2006. However, the range is still small and 63% of the English population is confined to three North Pennine Dales.

The increases for nightjar and woodlark represent partial population recovery, whilst Dartford warblers (pictured) appear to be increasing beyond their historical range, in line with ameliorating winter weather. However, due to their low population sizes, these species remain vulnerable to chance events.

Source: Baines (2005); RSPB (2005, 2006, 2007)

3.5 Woodland, wood-pasture and parkland

This section is primarily about semi-natural, largely broadleaved woodland. However, it also covers plantations, including conifer stands, some of which have both biodiversity and cultural values. Other plantations are relevant because they may have replaced more valuable open habitat (such as bog or lowland heathland). Wood-pastures and parkland are also considered.

Native woodland is defined by the UK BAP as having at least 80% of the canopy comprising species that are suited to the site and are within their natural range, taking into account both history and future climate change. Ancient woodland, defined as a site that has been continuously wooded since AD 1600, is a cross-cutting category, consisting of both ancient semi-natural woodland and plantations (which may be of introduced trees) on ancient woodland sites. Ancient woodland tends to be richer in species than recent woodland, as well as containing a rich heritage of archaeological and historical features. The woods may also have been managed in different ways, for example as coppice, wood-pasture, high forest or minimum intervention.

The most abundant type, lowland mixed deciduous woodland, is found on soils ranging from very acidic to base-rich, and forms most of the semi-natural woodland in southern and eastern England. Oak *Quercus* species and ash *Fraxinus excelsior* tend to be the commonest trees. Such woodland occurs largely within enclosed landscapes at relatively low altitudes.

Lowland beech and yew woodland occurs in a variety of topographical conditions, but mainly in the south-east. Beech *Fagus sylvatica* can grow on both acidic and calcareous soils, although its association with yew *Taxus baccata* tends to be most abundant on calcareous sites.

In the uplands, mainly in the north and west, oakwoods are found on generally acid soils and tend to have an open structure in which stock grazing occurs. Mixed ashwoods, which occur on base-rich soils (rich in alkaline nutrients, especially calcium, potassium or magnesium), are less dependent on grazing and tend to have richer ground floras.

Wet woodland occurs on poorly drained or seasonally wet soils, usually with alder *Alnus glutinosa*, birch *Betula* species and willow *Salix* species as the main tree species. It is found on floodplains, as successional habitat on fens, mires and bogs, along streams and hillside flushes, and in peaty hollows.

Coniferous woodland in England mainly comprises large areas of plantations of introduced species. Often these have replaced more valuable habitats (either broadleaved woodland or open heath, bog and grassland), but conifer stands can be important for some species, particularly birds. Re-creation of open habitats and restoration of plantations on ancient woodland sites to native broadleaves is an increasingly important part of woodland conservation policy and practice (Forestry Commission 2005; Goldberg 2003; Pryor *et al*. 2002).

Wood-pastures and parklands are the products of distinctive historical land management systems. Typically, they comprise large, open-grown trees (often pollards) at varying densities, in a matrix of grazed grassland, heathland or woodland floras. Wood-pasture is, therefore, a category that often overlaps with woods and other habitats.

UK BAP priority woodland, wood-pasture and parkland habitats in England:

- Lowland beech and yew woodland
- Lowland mixed deciduous woodland
- Upland mixed ashwoods
- Upland oakwood
- Wet woodland
- Wood-pasture and parkland

3.5.1 Importance of England's woodlands, wood-pastures and parklands

English woods are important and distinct in a European context because of features such as bluebells *Hyacinthoides non-scripta* (of which the UK holds approximately half of the global population (Pilgrim & Hutchinson 2004)), holly *Ilex aquifolium* and moss carpets; our ash-dominated woodlands on limestone; and the many veteran trees in our old parks and wood pastures (Rodwell & Dring 2001). Nine of the woodland types listed in Annex I to the EC Habitats Directive occur in England.

Wood-pastures and parklands are not specifically identified within the EC Habitats Directive, but they are often the best sites in England for old-growth features (veteran trees and dead wood that support many invertebrates and fungi). Hence many of the sites selected as SACs for woodland habitats are wood-pastures.

The social and environmental benefits of forests in Great Britain

As well as providing marketable timber, forests provide numerous benefits including: recreational use, landscape amenity, biodiversity benefits, carbon sequestration and flood risk mitigation.

Social and environmental benefits of forests in Britain	Annual value £m
Recreation	393
Landscape	150
Biodiversity	386
Carbon fixation and sequestration	94
Total *	1,023

* This total includes the benefits of forestry and woodlands improving air quality

Compared to the overall value of woodlands, the marketable value of timber is quite small, in many cases only 10% of the total value. A problem is that it is often difficult for owners of woodlands, who have to pay for management, to receive income for the provision of certain ecosystem services because they are public goods for example carbon sequestration, landscape and biodiversity.

Sources: Forestry Commission (2003a, b)

3.5.1.1 Woodland, wood-pasture and parkland species

There are woodland specialists linked with all stages in the woodland cycle. Some fritillary butterflies are associated with open spaces, particularly the temporary clearings resulting from coppice management. Their populations have declined in recent years, in part because of the declines in woodland management (Asher *et al*. 2001). Some bird species that prefer open habitat, such as woodlark *Lullula arborea*, use the glades or felled areas.

A range of woodland plants are largely confined to or are most abundant in ancient woods (Peterken & Game 1984; Rackham 1976). For example, bluebells and primroses *Primula vulgaris* are iconic species for English woods. Atlantic oakwoods of Cumbria, Devon and Cornwall are noted for their rich bryophyte (liverworts, hornworts and mosses) communities associated with the mild humid climate (Ratcliffe 1968; Rodwell 2001).

England has a particularly rich heritage of veteran trees (Read 2000), which are important in their own right, but also as hosts for rich communities of epiphytic lichens and deadwood invertebrates, including two species listed in Annex II to the EC Habitats Directive (violet click beetle *Limoniscus violaceus* and stag beetle *Lucanus cervus*). The rot holes and decay in these trees provide opportunities for hole-nesting birds and bats.

Birds

Atlantic oakwoods are important for a distinct assemblage of breeding birds, including wood warbler *Phylloscopus sibilatrix*, redstart *Phoenicurus phoenicurus*, pied flycatcher *Ficedula hypoleuca* and tree pipit *Anthus trivialis*. Young coniferous plantations may support internationally important numbers of breeding birds in the uplands (hen harrier *Circus cyaneus*, merlin *Falco columbarius* and short-eared owl *Asio flammeus*) and lowlands (nightjar *Caprimulgus europaeus* and woodlark).

Mammals

The hazel dormouse *Muscardinus avellanarius*, a priority BAP species, depends on the range of shrub species and the woodland structure for movement through stands. Red squirrels *Sciurus vulgaris*, now one of England's most endangered mammals, have more or less disappeared from most of their former range (Gurnell *et al*. 2007). Their remaining strongholds are woodlands in the far north of England, and the Isle of Wight. The pine marten *Martes martes*, the rarest carnivore in England, is found at low densities in woodlands in Northumberland, North Yorkshire and Cumbria only (Birks *et al*. 2005). Woodlands sustain many species of bats, providing roosting sites, shelter and foraging opportunities.

Lower plants

Atlantic oakwoods are particularly important for lower plants and support many lichen species such as the string-of-sausages lichen *Usnea articulata* and the large and distinctive tree lungwort lichen *Lobaria pulmonaria*. Two rare species of lichen, *Lecanactis lyncea* and *Arthonia astroidestera*, also occur here on old trees.

Lowland wood-pasture and parkland is an important habitat for a number of UK BAP priority species including the lichens *Bacidia incompta*, *Enterographa sorediata, Schismatomma graphidioides*, orange-fruited elm lichen *Caloplaca luteoalba* and New Forest parmelia *Parmelia minarum*, and the fungi, royal bolete *Boletus regius* and oak polypore *Buglossoporus pulvinus*.

Bechstein's bat

Bechstein's bats *Myotis bechsteinii* are woodland specialists, roosting deep within tree cavities, emerging at night to feed within the cover of woodland.

Because of past declines, Bechstein's bat is a priority species for conservation in England and Europe. No detailed baseline information on population size or distribution exists, but they are at the northern limit of their distribution in England. Roosts have been located in Sussex, Surrey, Kent, Hampshire and Isle of Wight.

Bechstein's bat colonies are found in high canopy oak woodland with a well-developed understorey. Throughout the year, Bechstein's bats move roosts and, during the maternity season, each female Bechstein's bat has her own foraging area of about 1 ha.

Source: Greenaway & Hill (2004); Hill & Greenaway (2008)

3.5.2 Extent of habitat

England has 1,059,764 ha of forest or woodland (Forestry Commission 2001). The 'broadleaved, mixed and yew woodland' broad habitat category in the UK BAP largely equates to the 'broadleaved woodland, coppice and coppice-with-standards' categories in the Forestry Commission's National Inventory of Woodland and Trees. These cover about 510,292 ha (Forestry Commission 2001) in woods over 2 ha (Figure 3.12). Young, coniferous and mixed woodlands (mainly plantations) cover around 549,471 ha (Forestry Commission 2001), but not all of this is of high biodiversity value. Within the broadleaved, mixed and yew broad BAP category, lowland mixed woodland is the most abundant. Ancient woodland covers about 331,000 ha, including both semi-natural stands and areas that have been replanted, often with conifers.

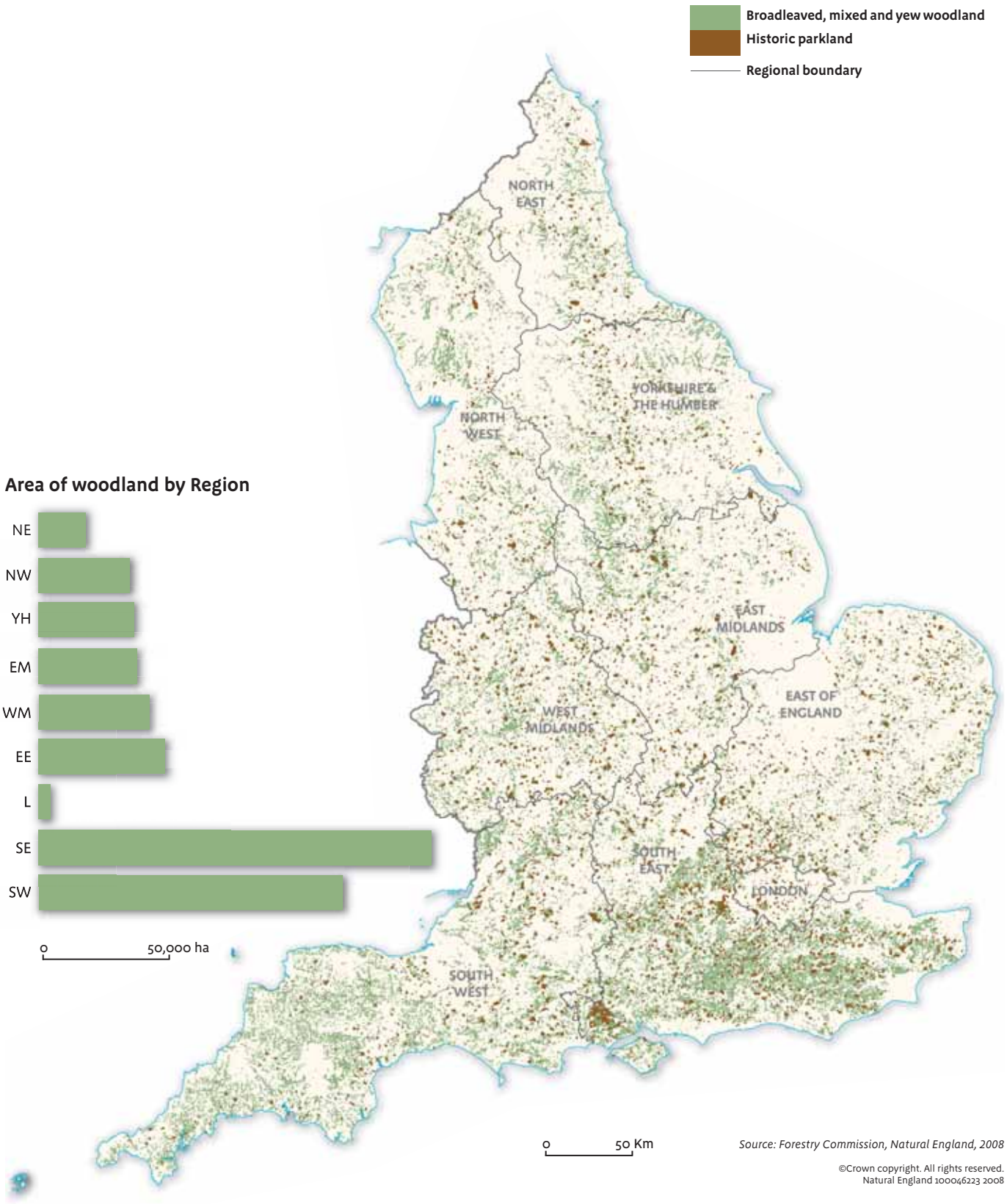
Distinct patterns of woodland can often be related to landscape history: large gaps in the distribution of broadleaved woodland often correspond to former lowland wetlands, such as the Fens or Somerset Levels; linear woods along valley sides or rivers are typical of the uplands of Cumbria or Northumberland; clusters of quite large woods tend to be associated with former Royal Forests such as Rockingham (Northamptonshire), or where there were extensive wood-using industries (the Weald and Chilterns); while in prime farming counties such as Suffolk and Leicestershire the ancient woods are often small and scattered.

Broadleaved woodland and ancient woodland show similar distributions, with a concentration in south-east England. There are, however, few areas of England that do not have at least a few ancient or broadleaved woodland sites. By contrast, coniferous woodland (virtually all planted, and not depicted in Figure 3.12) is more common in the north and west, where more land was available for creating large plantations during much of the 20th century.

There is no precise figure for the extent of wood-pasture and parkland in England because it comprises a mixture of land-cover types, from relatively dense tree-cover in the New Forest to open stands of veteran trees in parkland. About 4,400 parklands were identified as part of the Countryside Quality Counts (CQC) process (Haines-Young 2007), covering almost 260,000 ha (Figure 3.12). However, this does not include the whole wood-pasture and parkland resource and the UK BAP habitat action plan estimates approximately 6,000 sites in England.

Similarly, there is no overall distribution map for wood-pastures and parkland. Historic parkland has been mapped in Figure 3.12 and the broad distribution of other wood-pastures probably follows that for ancient woodland more generally. However, there is increasing evidence that large areas of previously unrecognised wood-pasture may be widespread in the upland fringes, such as in Cumbria around Ullswater and along the Welsh Marches. The 'Ancient Tree Hunt' (Woodland Trust 2008) has helped to identify over 4,000 records of ancient and veteran trees throughout the countryside. These are of great conservation value as individual trees, and as habitats for a range of other species such as lichens, fungi, bats and invertebrates. In addition, clusters of such trees could highlight the presence of hitherto unrecorded parkland and wood-pasture.

Figure 3.12 Woodland extent in England



Source: Forestry Commission, Natural England, 2008

3.5.3 Protection

An area of 116,915 ha of woodland and wood-pasture lies within SSSIs, representing 11% of the total resource in England (Figure 3.13 and Table 3.8). This includes 82,796 ha designated for broadleaved, mixed and yew woodland, or its associated species. This 82,796 ha, comprises 51,647 ha of broadleaf BAP habitat, which constitutes 10% (Forestry Commission 2001) of the broadleaf BAP resource in England; the remaining 31,149 ha is young, mixed and conifer stands, which will mostly develop into broadleaf BAP habitat over time. Overall, about 25% of England's ancient semi-natural woodland is within SSSIs. England's SSSIs contain 24,012 ha of coniferous woodland and 10,106 ha of wood-pasture and parkland, although the latter figure is probably an underestimate in that many wood-pastures now lie within broadleaved woodlands.

The areas given above do not include a further 39,658 ha of broadleaved, mixed and yew woodland that is within SSSIs (Forestry Commission 2001). These are small areas of broadleaved woodland and scrub amongst other habitats, such as on the edges of fen, grassland and heathland sites, some of which may ultimately be removed to restore open habitats.

Table 3.8 Area of woodland under different designations

Designation	Total area (ha)	% of total area
Total resource	1,059,764	100
SSSI	116,915	11
SAC	37,520	4
SPA	40,569	4
Ramsar	14,455	1
NNR	9,885	1
Within National Park	59,673	6
Within AONB	122,696	12

(Source: Natural England, 2008)

Of the woodland in England 37,520 ha (4%) has been designated as SACs under the EC Habitats Directive (all types, but primarily the broadleaved woodland). This comprises primarily the larger sites. Relatively few broadleaved woodlands are classified as SPAs (the main exception being the New Forest) but large areas of rotationally-managed coniferous woodland are SPAs for the nightjars and woodlarks that nest predominantly in the clear-felled areas.

It is not possible to assess the coverage of wood-pasture and parkland sites because of the uncertainties over the extent and total distribution of the overall resource. However, it is unlikely that many large sites remain to be identified and notified, and there is often a wood-pasture element in many existing woodland SSSIs.

3.5.4 Condition

By area, 86% of SSSI woodland and wood-pasture is in favourable or recovering condition (Figure 3.13). Of this, 51% (59,548 ha) is in favourable condition and 35% (41,258 ha) is recovering.

All types of woodland and wood-pasture are greater than 80% (by area) in favourable or recovering condition, with coniferous woodland approaching 100% (Table 3.9).

The main causes of unfavourable condition in woodland SSSIs are inappropriate or lack of management, and grazing or browsing by deer, which contribute to the adverse reasons in 52% and 17% respectively of the total area. There is no comparable assessment of woodland or wood-pasture condition outside the SSSI series.

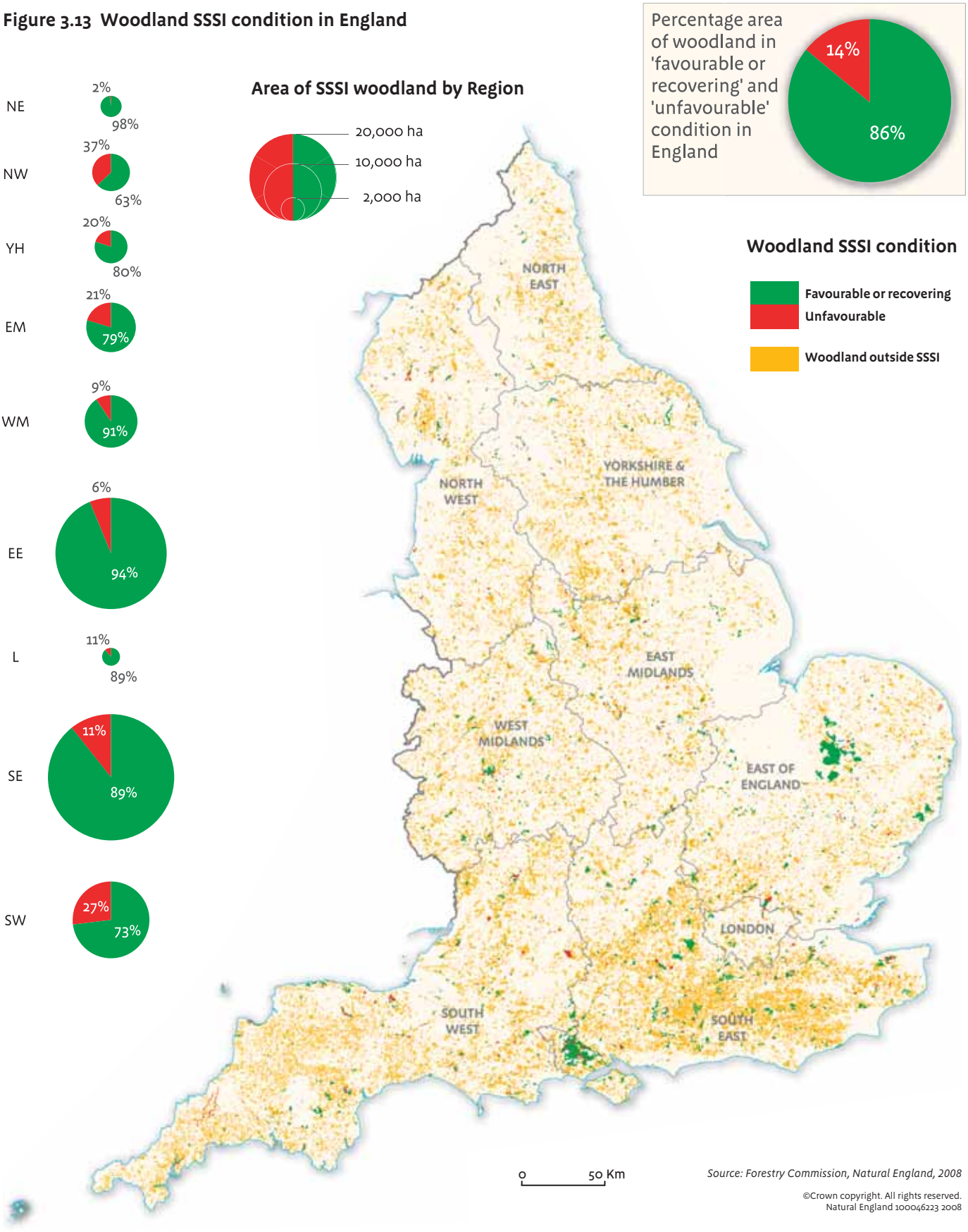
Table 3.9 Extent of SSSI notification and condition by woodland type

Habitat	Area SSSI (ha)	% of SSSI area in favourable or recovering condition
Broadleaved, mixed and yew woodland	82,796 *	83
Conifer woodland	24,012	98
Wood-pasture and parkland	10,106	86
Total	**116,915**	**86**

* This figure also includes 31,149 ha of young, mixed and conifer stands

(Source: Natural England, 2008)

Figure 3.13 Woodland SSSI condition in England

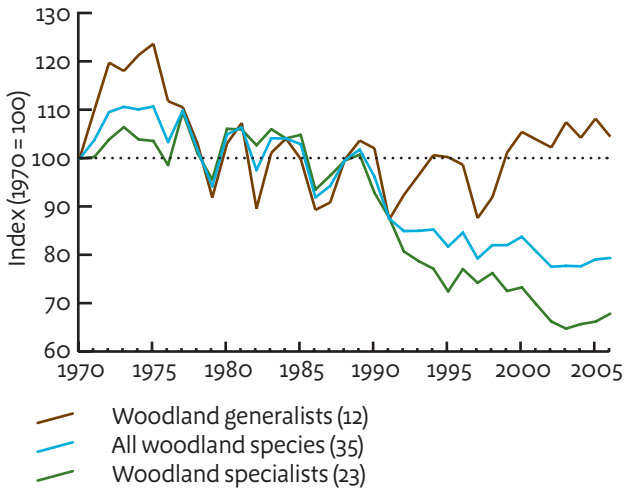


Source: Forestry Commission, Natural England, 2008

3.5.4.1 Trends in woodland species

There are 41 threatened and near-threatened woodland plants, approximately 10% of all the vascular plants (including flowering plants, conifers and ferns) that are associated with woodland (Cheffings & Farrell 2005). A study of 103 woodlands in Britain (75 in England) analysed ecological change in woods over 30 years (Kirby *et al*. 2005). The ground flora has changed in many woods with a 36% decline in vascular plant species richness at the plot level.

Figure 3.14 Population trends of woodland birds in England, 1970 to 2006



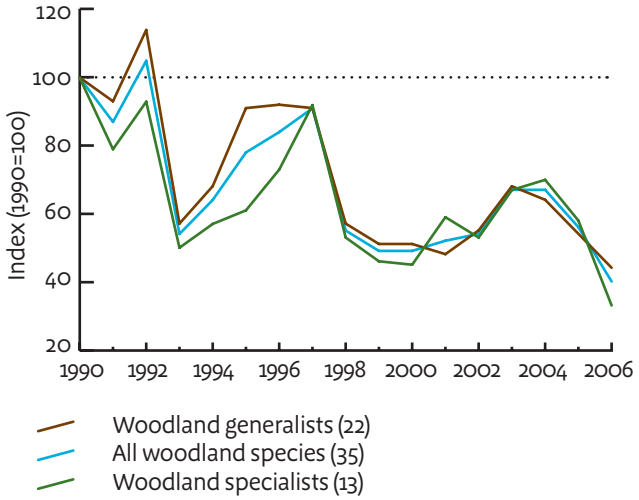
(Source: BTO, RSPB, JNCC, Defra, 2008a)

Overall, England's populations of woodland birds decreased by around 20% during the 1990s, and have been at around this level ever since (Figure 3.14). Many of the species showing the greatest declines overall are woodland specialists (those that breed or feed mainly or solely in woodland). Lesser redpoll *Carduelis cabaret*, willow tit *Poecile montanus*, wood warbler, spotted flycatcher *Muscicapa striata* and tree pipit have declined particularly severely, and are now below 25% of their 1970 baseline levels (Defra 2008a). By contrast, common woodland resident species such as chaffinch *Fringilla coelebs*, coal tit *Periparus ater*, robin *Erithacus rubecula* and wren *Troglodytes troglodytes* have shown considerable increases since the 1980s.

The Repeat Woodland Bird Survey (Amar *et al*. 2006) showed that, of 34 species recorded, eight declined significantly (by more than 25%) between the 1980s and 2003 to 2004, whereas 11 species increased significantly (by more than 25%). The survey identified declines in long-distance migrants (for example, willow warbler *Phylloscopus trochilus*, redstart and spotted flycatcher) and showed that scarcer resident species such as hawfinch *Coccothraustes coccothraustes* and lesser spotted woodpecker *Dendrocopos minor* had also suffered substantial declines.

These declines are also mirrored in studies of woodland butterflies. Over three-quarters of the butterfly species found in England regularly occur in woodlands. Some species breed in the canopy but many rely on open spaces or recently felled or coppiced woodland. Trends from the UK Butterfly Monitoring Scheme (Figure 3.15) show that there has been a major decline in woodland butterflies and numbers have almost halved over the last 16 years (Defra 2008a). The declines have been equally severe for generalist and specialist species, highlighting broad-scale problems for butterflies in woodlands.

Figure 3.15 Population trends of woodland butterflies in England, 1990 to 2006



(Source: Butterfly Conservation, CEH, JNCC, Defra, 2008a)

3.5.4.2 BAP woodland, wood-pasture and parkland action plan threats

The main issues posing a threat to woodlands are (BRIG 2006a):

- **Overgrazing,** particularly by deer in the lowlands and sheep in the uplands, leading to altered woodland structure, impoverished ground flora and lack of regeneration.
- **Changes in woodland and forestry management,** in particular cessation of traditional management practices, such as coppicing and pollarding, and neglect leading to successional changes in woods that were formerly managed.
- **Inappropriate development** including housing, quarrying, and tourist and recreational facilities, leading to increased trampling, disturbance and pollution.
- **Widespread impacts** of air pollution (nitrogen deposition), climate change and agricultural changes on adjacent land (nutrient enrichment).

The main issues posing a threat to wood-pasture and parkland are (BRIG 2006a):

- **Changes in agricultural management practice,** especially unsuitable grazing management and pasture loss through conversion to arable or improvement through re-seeding and fertiliser use.
- **Changes in woodland and forestry management,** in particular cessation of traditional management practices such as pollarding, and removal of veteran trees for safety and tidiness reasons leading to the lack of continuity of dead wood habitat and loss of species dependent on old trees.
- **Isolation and fragmentation** of remaining parkland and wood-pasture sites.

3.6 Arable, orchards and hedgerows

Enclosed farmland habitats cover 60% of England, and make up the typical 'English countryside' that has such a strong hold on the affections of people living in England and visitors from abroad. The two main components are cultivated crop land (arable) and grassland (meadows and pastures). These lowland habitats are divided up into a patchwork by field boundaries of hedgerows, walls and fences. Small orchards of apple, pear, plum and cherry trees are scattered through this patchwork, adding their particular character to the landscape. Grassland habitats are covered in more detail in Section 3.3. The biodiversity of the other habitats is covered below.

Arable agriculture changed hugely in the latter part of the 20th century. It is now based upon a very narrow range of crops. Land sown with cereals, mainly wheat and barley, comprises 67% of the arable area. Oil-seed rape is another major crop (16% of the arable land). Spring-sown crops are now much less common than autumn-sown crops, with the result that winter stubble fields are also less common. Spring-sown wheat and barley declined from 70% of the total in 1968 to less than 20% in 1998 (Buckwell & Armstrong-Brown 2004). Most of the intensively grown crops provide a uniform habitat of low value to wildlife. Habitats on arable land that are of more value for biodiversity include temporarily unused land known as set-aside, and margins of fields or areas within the fields that are deliberately managed for wildlife, for example sown wild bird food areas, fallow plots for nesting birds and wildflower strips.

The orchards of England can be divided into two groups according to the intensity of management for fruit production. Traditional orchards (the UK BAP priority habitat) are usually grazed by cattle or sheep and chemical pesticides and fertilisers are rarely used. The trees are long-lived and reach the veteran, gnarled stage, with hollows and decaying wood. The combination of fruit trees, the grassland on the floor and hedgerow boundaries or scrub mean that these orchards resemble miniature parklands or wood-pastures. In England, traditional orchards occur on a wide range of soil types, slopes and aspects in England. Intensively managed orchards are of less value for wildlife and are characterised by inputs of chemicals such as pesticides and inorganic fertilisers, frequent mowing of the orchard floor rather than grazing or cutting for hay, and the planting of short-lived, high-density, dwarf or bush fruit trees.

The green network of hedgerows, which is such a dominant feature of the English countryside, is highly valued as wildlife habitat, as an attractive part of our landscapes and for its links to England's culture, history and archaeology. Hedgerows composed mainly of native trees and shrubs are a priority habitat under the UK BAP. This includes both ancient hedgerows and more recent hedgerows planted during the time of the Enclosure Acts in the 18th and 19th centuries.

UK BAP priority arable, orchard and hedgerow habitats in England:

- Arable field margins
- Hedgerows
- Traditional orchards

Multiple values of traditional orchards

Biodiversity
Traditional orchards are hotspots for biodiversity as demonstrated by the study of three small orchards on the edge of the Wyre Forest by the Wyre Forest Study Group. In 2004, a grand total of 1,868 species of wild plants and animals was recorded from the orchards, including vascular plants, bryophytes, fungi, lichens, vertebrates and invertebrates. The orchards supported 56 nationally rare, nationally scarce or declining species, including two Red List birds and eight Amber List birds.

Source: Smart & Winnall (2006)

Community
Wilsons' Orchard near Northampton is a 100-year-old apple orchard purchased by Persimmon Homes during their residential development of the surrounding area. The development company recognised the value of the orchard to the local community and generously conveyed it to South Court Environmental Ltd (SCE) in 2000. SCE is a worker's co-operative with the aims of conservation and enjoyment of the environment by the local community, and, together with 'The Apple Cause', as the friends of Wilsons' Orchard are known, they manage the orchard. Community events such as Apple Day are well supported, as are other activities, including learning more about the wildlife in the orchard. SCE has started pruning old trees to re-invigorate fruit production and has planted new trees, including other fruit species such as pear, plum and quince. Apple juice is one of the community crops from the orchard, illustrating the part such orchards can play in promoting healthy eating.

Source: English Nature (2005)

Economy
Within the three counties of Herefordshire, Worcestershire and Gloucestershire, 24 small-scale producers rely on traditional orchard fruit to make around 0.29 million litres of cider and perry a year, estimated to contribute at least £0.5 million a year to the local economy. If the value of services provided by suppliers and tourism income from visitors attracted to the area is included, the estimate for the economic value of traditional orchards in the area could be in excess of £1.5 million a year.

Source: Natural England (unpublished data)

3.6.1 Importance of England's arable, orchard and hedgerow habitats

England has the bulk of the UK's farmland habitats, including around 97% of traditional orchards and about 69% of hedgerows. Farmland habitats are not included in Annex I to the EC Habitats Directive but Article 10 of the Directive requires member states to encourage the management of hedges (and other linear features) in their land use planning and development policies and, in particular, with a view to improving the ecological coherence of the Natura 2000 network. In addition, farmland habitats are important for several species listed in Annex II to the Directive, including greater horseshoe bat *Rhinolophus ferrumequinum* and great crested newt *Triturus cristatus*.

3.6.1.1 Arable, orchard and hedgerow species

The farmland habitat mosaic, including pasture, is important at a landscape scale for wide-ranging species that require a combination of habitats to successfully complete their life cycles.

Vascular plants

Over 150 plant species are characteristic of arable habitats, sharing the same ecological niche as the crops amongst which they grow (Still & Byfield 2007). Many are now regarded as ancient introductions (archaeophytes) into Britain, including rapidly declining species such as corn buttercup *Ranunculus arvensis*, shepherd's-needle *Scandix pecten-veneris*, spreading hedge-parsley *Torilis arvensis* and broad-fruited cornsalad *Valerianella rimosa*.

On arable land, 200 key sites have been identified for their importance for arable plants (Wilson & Byfield 2005). These sites are known as Important Arable Plant Areas (Figure 3.16). Seven sites are of European importance and a further 151 sites are listed as being of national importance. The richest areas for arable plants are in southern and eastern England, particularly where soils are light and chalky.

Lower plants

Arable land has a distinctive bryophyte flora, particularly associated with autumn and over wintering stubbles. At least 17 liverworts and hornworts and 76 mosses have been recorded in arable habitats, comprising 9% of the total British and Irish bryoflora (Porley 2000). Among bryophytes on the UK BAP priority list are several species associated with arable land, including the sausage beard-moss *Didymodon tomaculosus*, starry earth-moss *Ephemerum stellatum* and spreading-leaved beardless-moss *Weissia squarrosa* (Porley 2000).

Hedgerow trees

There are estimated to be over 1.6 million hedgerow trees in England of which more than a third are thought to be over 100 years old. Hedgerow trees are a traditional part of England's lowland landscapes and provide havens for many species of wildlife. Since the late 18th century England has witnessed the dramatic decline of these hedgerow trees. Intensive agricultural practice, Dutch elm disease and poor management have led to the removal of many hedges and their trees.

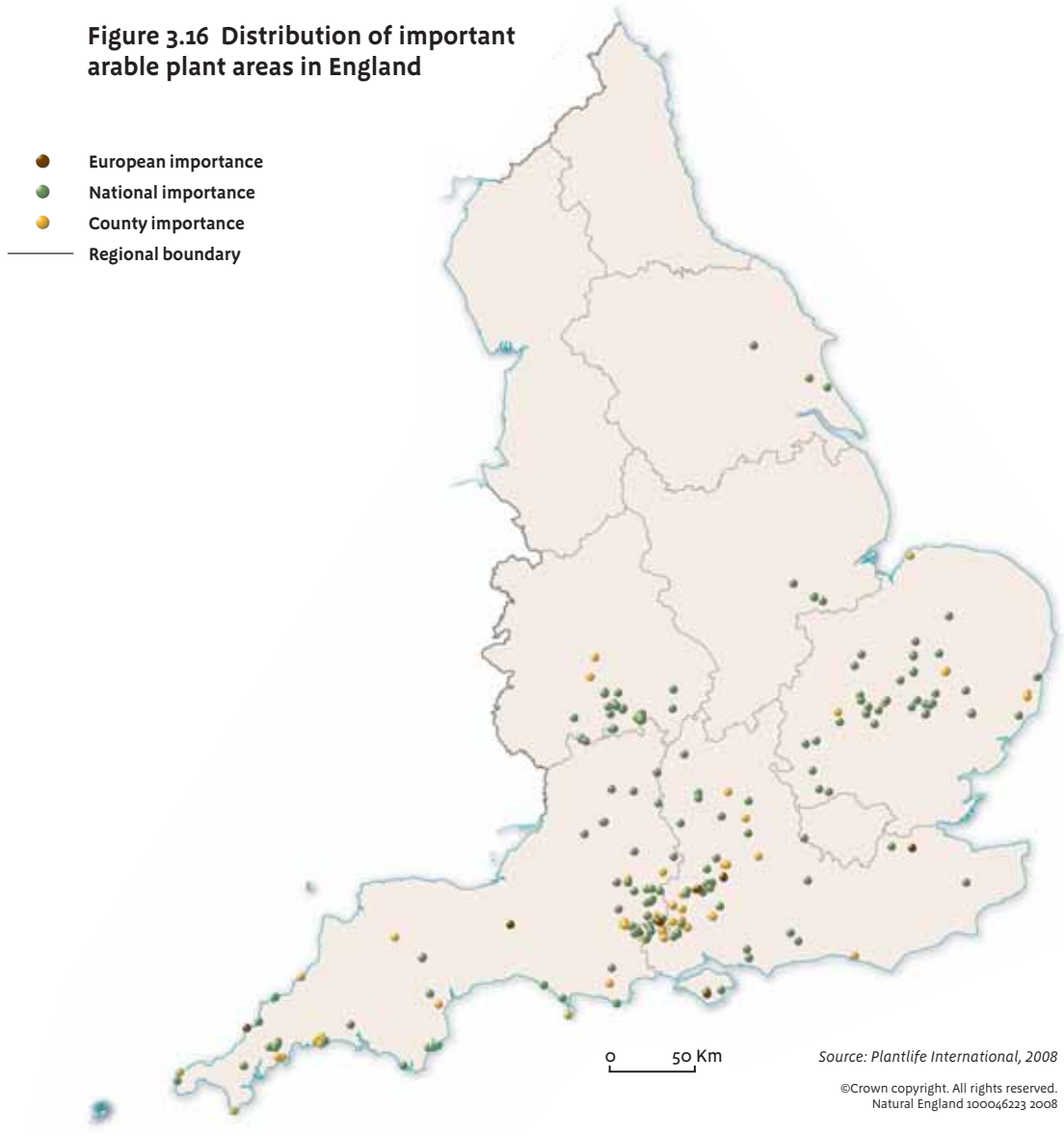
Over 200 lichen species have been recorded growing on elms *Ulmus* species in Britain. Old elms have a rough alkaline bark, which is particularly suitable for a species-rich lichen community to develop. This is characterised by the brightly coloured leafy lichen *Xanthoria parietina*, along with grey and brown species belonging to the *Physcia* genus.

In many parts of central, southern and eastern England these species are joined by a number of elm specialists including three UK BAP priority species:

- Sap-groove lichen *Bacidia incompta*
- Orange-fruited elm-lichen *Caloplaca luteoalba*
- Clustered mini-jelly lichen *Collema fragrans*

Source: Edwards (2005)

Figure 3.16 Distribution of important arable plant areas in England



Source: Plantlife International, 2008

Invertebrates

Over 20 of the butterfly species found in lowland England breed in hedgerows, including the brown hairstreak *Thecla betulae*, a UK BAP priority species, which lays its eggs on blackthorn *Prunus spinosa* (Asher *et al*. 2001). The rare barberry carpet moth *Pareulype berberata*, another UK BAP priority species, also breeds in hedgerows. Hedgerow trees and the veteran trees in traditional orchards provide habitats for a whole range of insects and other invertebrates that rely on old and decaying wood. To date, 403 species specialising in wood-decay habitats have been recorded in traditional orchards, including 102 Red Data Book or nationally scarce species (Mountford & Strachan 2007). The noble chafer *Gnorimus nobilis* is a priority UK BAP beetle species that is almost entirely restricted to traditional orchards.

Mammals

The hazel dormouse *Muscardinus avellanarius* (a UK BAP priority species) nests and forages in hedgerows and uses them as dispersal corridors (Bright & MacPherson 2002). Greater horseshoe bats (listed in Annex II to the EC Habitats Directive) and other bat species use hedgerows as flyways for commuting to and from their roosts and as foraging routes (Entwistle *et al*. 2001).

Birds

Arable fields provide a range of plant and invertebrate food resources for many declining farmland birds, such as grey partridge *Perdix perdix*, corn bunting *Emberiza calandra*, turtle dove *Streptopelia turtur* and yellowhammer *Emberiza citrinella*, both in summer and winter (Vickery *et al*. 2002). Some crop types are important for birds, for example sugar beet fields are widely used by internationally important numbers of wintering pink-footed geese *Anser brachyrhynchus*, where the crop is traditionally grown close to the east coast. Hedgerows are important for many farmland and woodland birds, including 28 threatened species, such as bullfinch *Pyrrhula pyrrhula* and tree sparrow *Passer montanus* (Mountford & Strachan 2007).

UK BAP species of farmland landscapes

Most farmland birds and mammals need a range of habitats to survive.

Yellowhammer

The yellowhammer *Emberiza citrinella* nests in low hedges and grassy ditch margins and feeds its chicks on grasshoppers and other invertebrates found in these habitats and in semi-improved grasslands. In winter, the adult birds feed on the seeds of weeds found in crop stubbles.

© Neil Bowman/FLPA

Greater horseshoe bat

Greater horseshoe bats *Rhinolophus ferrumequinum* range over several kilometres from their summer roosts in old buildings to hunt for insects. Their insect prey is especially abundant in landscapes that are mixtures of woodland, old orchard and permanent pasture, linked by 'flyways' formed by tall, bushy hedgerows and lines of trees.

Source: English Nature (2004b)

© Natural England/Michael Hammett

3.6.2 Extent of habitat

The extent of the different arable, orchard, hedgerow and related habitats is given in Table 3.10. Of the three UK BAP habitats, arable field margins comprise around 60,000 ha of permanent grassland margins, 7,000 ha of cultivated margins, 9,000 ha of wild bird mix and 3,600 ha of flower margins for bumblebees and other insects (based on current management options under agri-environment schemes). Traditional orchards cover an estimated 24,600 ha, while about 84% of hedgerows are classed as BAP habitat (BRIG 2006b).

Orchards are dispersed throughout the lowlands of England (Figure 3.17) but there are concentrations, particularly in Kent, Herefordshire, Worcestershire, Cambridgeshire, Norfolk and Somerset. Most of the intensive orchards occur in these six counties (80%), while just over 50% of the traditional orchard area is within them (Mountford & Strachan 2007).

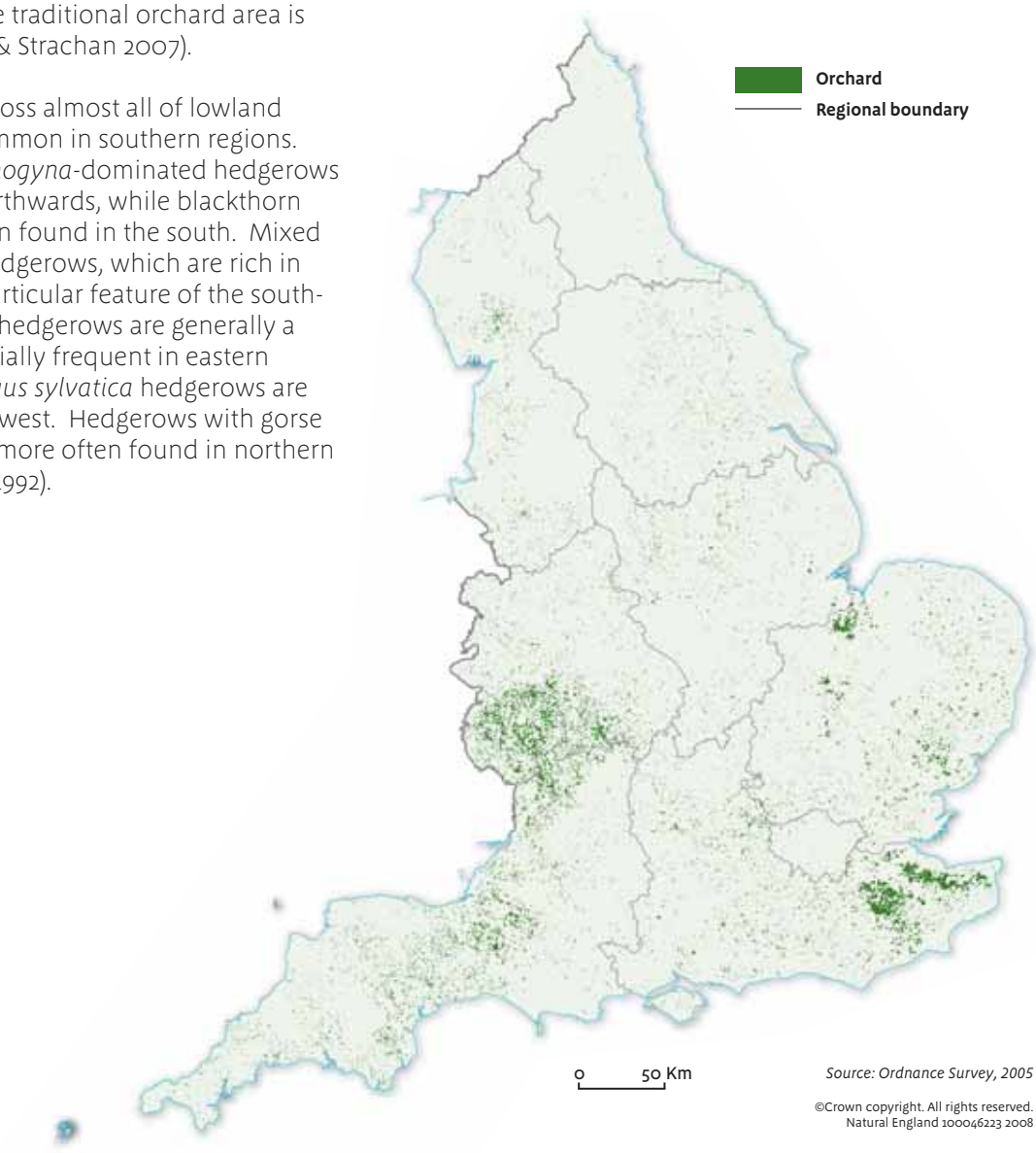
Hedgerows are found across almost all of lowland England but are most common in southern regions. Hawthorn *Crataegus monogyna*-dominated hedgerows increase in frequency northwards, while blackthorn hedgerows are more often found in the south. Mixed hazel *Corylus avellana* hedgerows, which are rich in trees and shrubs, are a particular feature of the south-west. Elm *Ulmus* species hedgerows are generally a southern type, and especially frequent in eastern England, while beech *Fagus sylvatica* hedgerows are commonest in the south-west. Hedgerows with gorse *Ulex* species are rare but more often found in northern England (Cummins *et al*. 1992).

Table 3.10 Farmland habitats in England

Habitat	England resource (ha or km)
Arable crops and temporary grass in crop rotations	3,709,000 ha
Fallow land and set aside	1,158,000 ha
Orchards	40,000 ha
Hedgerows	515,000 km
Walls	90,000 km
Fences	350,000 km
Boundary banks/grass strips	51,000 km

(Source: BTO, RSPB, JNCC, Defra, 2008)

Figure 3.17 Orchard extent in England



Source: Ordnance Survey, 2005

3.6.3 Protection

There are 14,066 ha of arable habitats within SSSIs, largely in one site, Breckland Farmland SSSI (most of which is also within Breckland SPA). This site supports breeding stone curlews *Burhinus oedicnemus* in numbers of European importance. Nine SSSIs are notified for arable plants and a further 50 SSSIs support some arable plant interests (Pinches *et al*. unpublished). Statutory protection of traditional orchards is very limited. There are only two SSSIs in England containing the habitat, both notified for deadwood invertebrates. SSSI notification is not a significant protection measure for hedgerows. Important hedgerows are protected from removal by the Hedgerows Regulations 1997.

3.6.4 Condition

By area, 98% of SSSI arable land is in favourable or recovering condition. Of this, 97% (13,694 ha) is in favourable condition and 1% (149 ha) is recovering. There are currently no measures of condition of BAP arable field margins but criteria are being developed (Critchley *et al*. 2007).

Many traditional orchards are suffering from neglect and becoming overgrown by scrub. In Cambridgeshire and Peterborough in 2004 and 2005, over 30% of traditional orchards had unmanaged grassland and less than 50% had signs showing that trees were being managed (East of England Apples and Orchards Projects 2005).

Applying the condition assessment method developed by the UK Hedgerow Habitat Action Plan group to Countryside Survey 2000 data, only 22% of hedgerows in Great Britain are estimated to be in favourable condition (Defra 2007c).

3.6.4.1 Trends in arable, orchard and hedgerow species

There has been a catastrophic decline in the distribution of arable flowering plants during the last half century and they are now amongst the most threatened elements of our flora (Smith 1989; Rich & Woodruff 1996; Sutcliffe & Kay 2000; Wilson & King 2000; Preston *et al*. 2002b). Of the 30 vascular plant species that have shown the greatest relative declines across Britain, no fewer than 18 are characteristic of arable and other cultivated ground (Preston *et al*. 2002b). Seven species are extinct in arable habitats, including downy hemp-nettle *Galeopsis segetum*, and many others, such as the cornflower *Centaurea cyanus*, are rare. However, one of the extinct species, the interrupted brome *Bromus interruptus*, has recently been reintroduced to three sites. The arable bryophyte flora is less well known but also appears to be declining (Porley 2000).

Other plants have also suffered declines. The species richness of the herbaceous flora at the base of hedgerows declined between 1990 and 1998 (Haines-Young *et al*. 2000). Declines in plants on arable land and in hedgerows are related to the widespread use of herbicides and fertilisers, more efficient seed-cleaning techniques and loss of winter stubbles and summer fallow land.

Trends in farmland birds

The populations of farmland birds in England declined by over a half between the late-1970s and late-1990s. Declines in England mostly affected farmland specialist species (those species that breed solely or mainly on farmland).

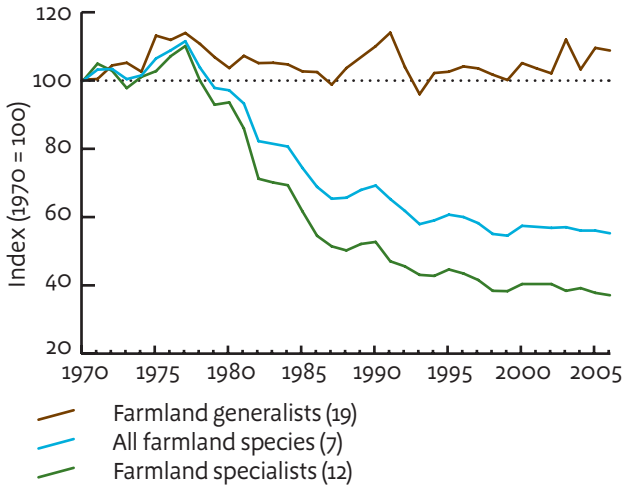
Of those species that have experienced major declines over the last three decades some, such as grey partridge *Perdix perdix*, turtle dove *Streptopelia turtur* and starling *Sturnus vulgaris*, continue to decrease. Tree sparrow *Passer montanus*, and perhaps reed bunting *Emberiza schoeniclus*, are the only declining species where the decreases have levelled out since the late 1990s.

Declines in farmland birds have been associated with changes in agricultural practices, including increased specialisation and mechanisation, switching to autumn sowing of cereals, intensification of grassland management, increased use of agro-chemicals, and loss of field margins and hedges.

The farmland bird index also includes trends for seven increasing farmland generalist species, including woodpigeon *Columba palumbus* and stock dove *C. oenas*, which may have benefited from changes such as increased area of oil-seed rape production.

Source: Defra (2008a)

Population trends of farmland birds in England, 1970 to 2006



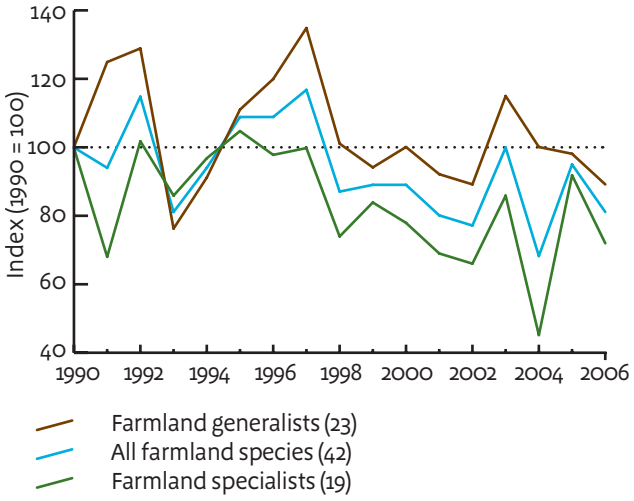
(Source: BTO, RSPB, JNCC, Defra, 2008a)

Trends in farmland butterflies

- Data from the UK Butterfly Monitoring Scheme shows that the abundance of butterflies on farmland sites (mostly semi-natural grasslands) has fallen by nearly a fifth over the last 17 years.
- In 2004, specialist species (low mobility species restricted to semi-natural habitats) declined to a low point of 45% of the 1990 baseline, but have since partially recovered to 28% below the baseline in 2006. Specialist species include Adonis blue *Lysandra bellargus*, Duke of Burgundy *Hamearis lucina*, heath fritillary *Melitaea athalia*, northern brown argus *Aricia artaxerxes* subspecies *salmacis*, and silver-studded blue *Plebejus argus*.
- Generalist species (mobile species that occur in a wide range of habitats) have fared better, with a relatively stable trend over the period. Species that have declined most are those associated with varied turf height that are sensitive to overgrazing. Generalist species include peacock *Inachis io*, purple hairstreak *Neozephyrus quercus* and comma *Polygonia c-album*.

Sources: Defra (2008a); Fox *et al.* (2006)

Population trends of farmland butterflies in England, 1990 to 2006



(Source: Butterfly Conservation, CEH, JNCC, Defra, 2008a)

The Duke of Burgundy (pictured right) requires structurally diverse grassland, usually with a scatter of scrub or hedgerows. Numbers have declined by over 50% in the last ten years due to habitat fragmentation and lack of suitable management.

© Martin Garwood/NHPA

3.6.4.2 BAP arable, orchard and hedgerow action plan threats

The main issues posing a threat to arable field margins are (BRIG 2006a):

- **Changes in agricultural management practice,** when arable land is lost to grassland in areas increasingly specialising in livestock production.
- **Agricultural intensification,** resulting in both loss of field margins of wildlife value when intensively cultivated arable areas are enlarged and damage from drift of herbicides and pesticides from in-field farming operations.

The main issues posing a threat to traditional orchards are (BRIG 2006a):

- **Changes in agricultural management practice,** including undergrazing of traditional orchards in areas specialising in arable production, leading to neglect and scrub invasion, and lack of new planting to replace trees at the end of their lives.
- **Agricultural intensification,** leading to further loss of traditional orchards to other agricultural uses.
- **Inappropriate development,** including housing, leading to loss of orchards.

The main issues posing a threat to hedgerows are (BRIG 2006a):

- **Changes in agricultural management practice,** notably neglect (no trimming and laying or coppicing) leading to the development of gaps and loss of connectivity in the hedgerow network. Gaps also appear through too frequent and badly timed trimming. Lack of replacement of hedgerow trees is a threat to the hedgerow tree population.
- **Agricultural intensification,** such as use of herbicides, pesticides and fertilisers close to the bases of hedgerows, resulting in a decline in plant species richness, and increased livestock numbers causing damage through browsing and trampling.

© Natural England/Mike Kipling

3.7 Open waters

This section encompasses the full range of open freshwater habitats: standing waters (lakes, reservoirs and ponds), canals and running waters (rivers and streams). Water bodies are commonly fringed by other important wetland habitats such as reedbed, fen, marshy grassland and wet woodland (these are covered in other sections of this report).

The character of open waters is fundamentally determined by the underlying geology of the catchment, which influences the water chemistry, hydrology, and physical and biological characteristics. Nutrient status is a key example of this:

- Water flowing from areas with hard rock geology is low in dissolved plant nutrients leading to low productivity waters, termed 'oligotrophic'.
- Waters from soft rock catchments or where there are thick glacial drift deposits carry higher levels of nutrients. Such waters are naturally productive or 'eutrophic'.
- Between these extremes, often on sedimentary rocks, 'mesotrophic' waters occur.
- In the case of standing waters in areas with extensive peat deposits, waters are 'dystrophic' or driven by nutrient production outside the lake basin.

UK BAP priority open water habitats in England:

- Aquifer fed naturally fluctuating water bodies
- Eutrophic standing waters
- Mesotrophic lakes
- Oligotrophic and dystrophic lakes
- Ponds
- Rivers

Standing waters include natural lakes and ponds, and artificial waters (for example gravel pits and reservoirs). The focus here is on those that are important freshwater habitats in their own right, although many standing waters are notified for important numbers and assemblages of birds.

Ponds vary enormously in their origin; for example some natural ponds are the result of glacial activity, such as 'pingos'. Man-made ponds have been created for a wide variety of uses, including agricultural water supply and early industry (for example mill and hammer ponds). Temporary ponds that may hold water for only a few months of the year have a unique ecology and support a number of rare species (Nicolet *et al*. 2004).

Although older standing waters tend to be richer in species, new water bodies are important for species associated with early stages of succession, for example stoneworts (charophytes), and new ponds can rapidly develop significant biodiversity interest (Williams *et al*. 1998). The Norfolk Broads were created by medieval peat digging but are now one of our most important wetland complexes. Reservoirs created for water supply purposes may become important habitats for waterfowl in areas where large natural water bodies are scare. Occasionally their operation may result in ideal conditions for plant species associated with bare substrate exposed during drawdown.

Canals are man-made watercourses that cut across natural catchment boundaries and may be fed by waters with markedly different characteristics from those of the surrounding natural waterbodies. The canal network and its associated infrastructure provide a range of habitats and conditions, including feeder channels, weirs and backwaters.

The habitats and species of canals have similarities with lowland river systems and lowland shallow, standing waters. A large proportion of the canal network is operational and used for a variety of functions. Without human intervention, through management and operation, canals may not receive sufficient disturbance to retain open water habitats, leading to succession into swamp and, ultimately, terrestrial habitats. Greatest wildlife value is associated with low to moderate levels of disturbance. At higher levels of disturbance (more than 1,000 boat passages per year), the development of diverse plant and animal assemblages may be restricted (Willby & Eaton 2002).

Running waters range from tiny headwater streams to large alluvial rivers running across floodplains to the sea. Individual rivers show great variation in their character from source to sea as they increase in size (width, depth and flow), decline in gradient and collect increasing amounts of nutrients and fine sediment. This provides a range of environmental conditions suited to different plants and animals.

The swift-flowing waters of upland rivers scour the bed and leave the channel dominated by gravels, cobbles and boulders. These rivers tend to be oligotrophic and are dominated by salmonid fish, aquatic mosses and liverworts, and invertebrates such as stoneflies, which are adapted to cool, swift waters and coarse bed sediments. Lowland areas give rise to more gently flowing rivers and streams, containing finer bed sediments, and tend to be dominated by coarse fish, aquatic flowering plants and invertebrates more adapted to warm, eutrophic waters.

Specialist plants and animals of headwater streams that only carry water for part of the year (ephemeral streams) have developed a range of mechanisms and strategies for surviving periods without flow, depending on the length of drought (Mainstone 1999).

3.7.1 Importance of England's open waters

England has a number of important lake types that are poorly represented in Europe outside the UK. These include oligo-mesotrophic base-rich waters and lowland oligotrophic waters on acidic sand deposits. In a UK context, England has proportionately more eutrophic lakes than the other countries due to the geology of its lowlands. Six standing water types that occur in England are listed in Annex I to the EC Habitats Directive.

Canals can provide habitats similar to more widespread natural freshwater habitats which have suffered throughout western Europe from pollution associated with urbanisation and agricultural intensification. They are typically divorced from the general land drainage network, so canals have escaped some of the worst excesses of nutrient enrichment. Canals therefore provide temporary refuges for species currently driven from their natural habitats by declines in water and habitat quality, such as the rare grass-wrack pondweed *Potamogeton compressus*. Canals are not recognised as a habitat in the EC Habitats Directive but some English canals, for example the Rochdale Canal, support species included in Annex II to the Directive.

The EC Habitats Directive recognises a broad river habitat type occurring in England characterised by a high abundance of submerged vegetation, including water-crowfoot *Ranunculus* species. Examples on chalk that occur in southern England are uncommon in the rest of Europe. Rivers also have a strong functional importance as linear networks linking the uplands, lowlands and coast that are essential for otter *Lutra lutra* and migratory fish, such as Atlantic salmon *Salmo salar*, lamprey *Lampetra* and *Petromyzon* species, and shad *Alosa* species (all listed in Annex II to the EC Habitats Directive).

Chalk rivers

England has more chalk rivers than any other country in Europe (around 3,900 km), reflecting the distribution of chalk from Dorset to Kent, and north to Yorkshire. There are about 2,500 km of river that have water-crowfoot *Ranunculus* species cover in England and Wales.

Chalk rivers and associated wetlands have a range of rich plant communities, sometimes with more than 50 aquatic species per kilometre, more than any lowland river type in the UK. The plant community is characterised by submerged species, such as water-crowfoots (pictured below), water-starworts *Callitriche* species, and lesser water-parsnip *Berula erecta*, which form a patchwork on the riverbed. Waterside plants such as water-cress *Rorippa nasturtium-aquaticum*, water forget-me-not Myosotis scorpioides and brooklime *Veronica beccabunga* encroach into the river.

These riverbed and marginal habitats are particularly important for the wildlife of chalk rivers, especially invertebrates and over-wintering juvenile brown trout *Salmo trutta* subspecies *fario* and Atlantic salmon *Salmo salar*.

Sources: Environment Agency (2004d)

3.7.1.1 Open water species

Semi-natural open water habitats have diverse plant, fish and invertebrate communities. Man-made pits and reservoirs are important for birds, and can also support interesting plants and invertebrates. Relatively few mammal species are closely associated with open waters, with the exception of the water vole *Arvicola terrestris* and otter (both UK BAP priority species).

Vascular plants

Two English canals (in the North West and West Midlands) are of international importance for the rare floating water-plantain *Luronium natans*, a species listed in Annex II to the EC Habitat Directive. In England this plant is found in very few of its natural habitats, which range from deep upland lakes to shallow temporary heathland ponds. It spread through the canal network from upland Welsh feeder lakes and reservoirs.

Lower plants

Many mosses and liverworts appear in early winter or spring following lowering of water levels, which exposes bare mud. Several species that grow on the edges of pools, lakes and reservoirs are threatened in Britain and throughout Europe, including the violet crystalwort *Ricca huebeneriana*, clustered earth-moss *Ephemerum cohaerens* and beaked beardless-moss *Weissia rostellata* (Plantlife International 2006). The routine operation of some reservoirs is essential for the continued survival of certain species at these sites.

Rivers and streams host a rich variety of mosses, liverworts and lichens. Some species are able to grow permanently submerged, such as the river jelly lichen *Collema dichotomum* and the endemic Derbyshire *Thamnobryum angustifolium* and Yorkshire feather-mosses *T. cataractarum* (all UK BAP priority species), which are found in clear unpolluted waters. Many species are characteristic of the flood zone, growing on rocks or tree bases that are occasionally inundated, including the UK BAP priority moss species multi-fruited cryphaea *Cryphaea lamyana* and water rock-bristle *Seligeria carniolica*, which are restricted to this habitat.

Stoneworts (Charophytes) are generally found where water quality is very good and have been lost from many of our standing waters due to eutrophication. Nevertheless, some English sites are still strongholds for the 17 threatened UK species. Indeed, 54 key sites in England have been identified as Important Stonewort Areas, of which 16 are of European importance (Stewart 2004).

Invertebrates

Around 4,000 of the UK's invertebrate species live in freshwater and up to two-thirds of these occur in ponds (Williams *et al*. 1998). Amongst these are about 300 threatened freshwater invertebrate species, including the vulnerable freshwater white-clawed crayfish *Austropotamobius pallipes* and the endangered freshwater pearl mussel *Margaritifera margaritifera*.

Exposed river sediments, such as shingle beds and sand bars and eroding cliffs along river banks, support a very diverse fauna, including ground and rove beetles, spiders and flies. This includes a very large number of rare invertebrates. For example, 180 beetles associated with exposed riverine sediments are nationally rare or scarce. A national survey of river flies in 2005 (Drake *et al*. 2007) found over 850 species associated with bare or recently vegetated river sediments, indicating the high species richness of this habitat type. For example, the survey found that two UK BAP priority stiletto-flies, *Cliorismia rustica* and *Spiriverpa lunulata*, were greatly expanding their known ranges.

Amphibians

England has seven native amphibian species, two of which (natterjack toad *Bufo calamita* and pool frog *Rana lessonae*) are extremely rare and localised. Parts of the Sefton coast, Cumbrian coast, Dorset, Surrey and Norfolk have particularly important amphibian communities.

English populations of the great crested newt *Triturus cristatus* and pool frog are considered important in a European context. Orton Pit SSSI, in Peterborough, is believed to have the largest population of great crested newts in Europe, as well as hosting stonewort (charophyte) populations of European importance. Natterjack toad populations are at their northern limit in England and demonstrate interesting patterns of genetic diversity.

Fish

There are 42 native freshwater fish in England (Maitland & Lyle 1992), of which eight species are of European importance (listed in Annex II to the EC Habitats Directive) and 15 are included on the UK BAP priority list.

England's mesotrophic lakes are particularly important for the rare species they support, for example vendace *Coregonus albula*, charr *Salvelinus alpinus* and powan *Coregonus lavaretus*. All three species have a limited distribution in England and are now confined to a small number of lakes in Cumbria. The herring-like vendace is England's most threatened freshwater fish, known only from Derwent Water and Bassenthwaite Lake.

There are around 50 key rivers in England that support salmon populations, with strongholds in the north and south-west. It can be found in river systems not affected by poor water quality or barriers to upstream migration. In southern regions, salmon are still found in chalk rivers and streams, particularly the Rivers Itchen and Avon in Hampshire.

3.7.2 Extent of habitat

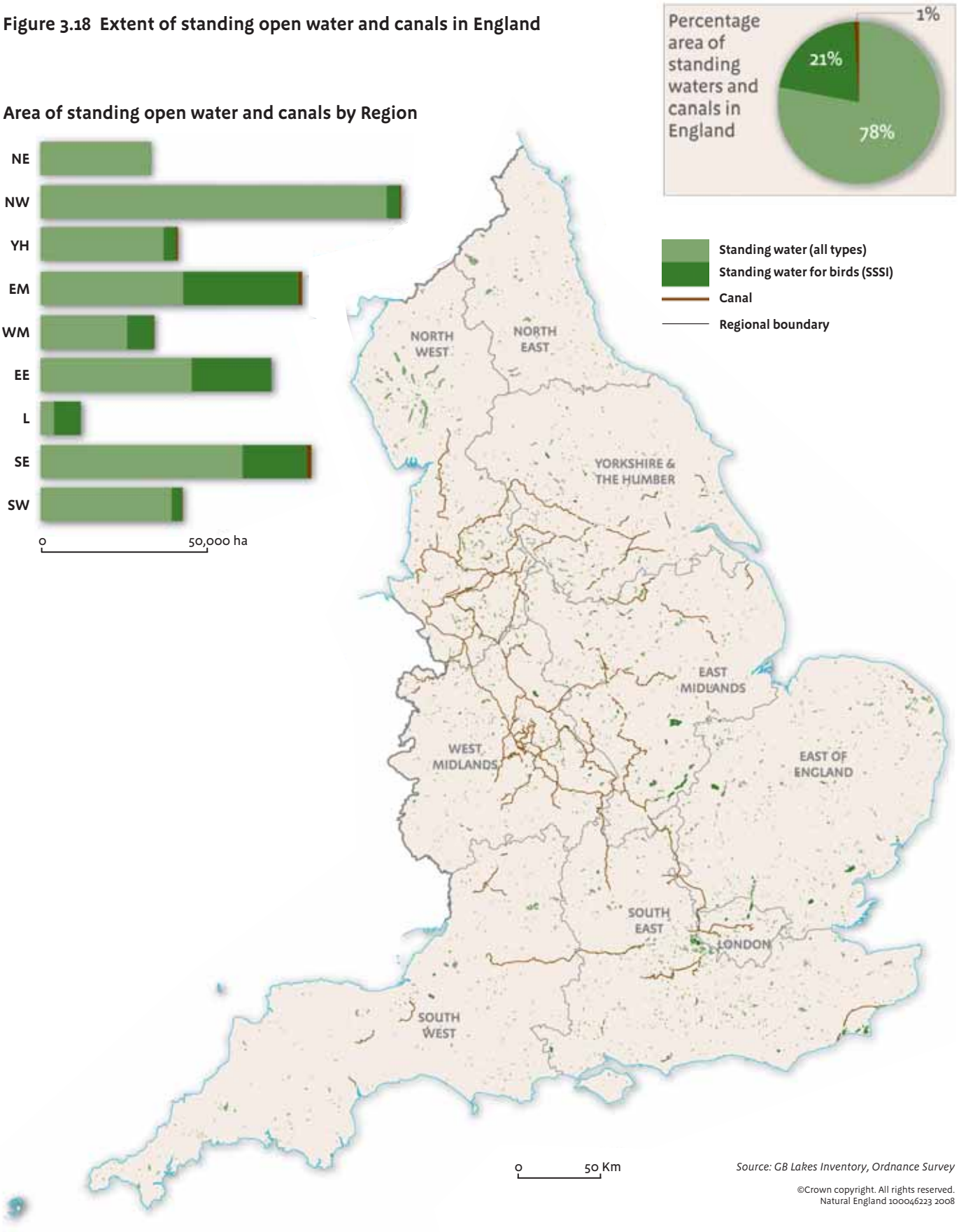
There is no overall estimate of the total area of open waters in England, due to the fact that river extent is expressed in terms of length rather than area. The extent of standing waters and canals is shown in Figure 3.18.

3.7.2.1 Standing waters

England has approximately 6,000 lakes over one hectare in size (Hughes *et al*. 2004), covering approximately 50,000 ha. A high proportion of the resource is eutrophic (approximately 60% by area), with mesotrophic and oligotrophic lakes each accounting for approximately 20%. There are estimated to be around 231,000 lowland ponds in England and Wales (Haines-Young *et al*. 2000).

Small water bodies are found throughout England, but the Cheshire plain and the pingo areas of the Norfolk Breckland have particularly high densities. Larger water bodies are concentrated in the three 'lake districts' of England: the Cumbrian Lake District, the Norfolk Broads and the West Midlands Meres. Some English regions, such as the South West, have very few natural lakes and in others, such as the South East, artificial water bodies (such as water storage reservoirs) are more numerous than natural lakes.

Figure 3.18 Extent of standing open water and canals in England



Source: GB Lakes Inventory, Ordnance Survey

There are distinct patterns in the distribution of different lake types, corresponding to the distribution of rock types across the country. Thus oligotrophic and mesotrophic waters are generally located in the north and west, whilst in the south and east most water bodies are naturally eutrophic. However, there are notable exceptions where local geology leads to lakes that do not fit with this general pattern. In particular, the acid sands associated with lowland heathlands support oligotrophic waters (eg Little Sea in Dorset) that have a species assemblage more typical of northern water bodies. Such lakes are rare across Europe.

3.7.2.2 Canals

England has approximately 2,624 km of canals (Ordnance Survey 2007). Canals are found in most regions of England but the most important canal types are concentrated in the North West and the Midlands. The canals of southern England and the Midlands tend to be lowland in character and eutrophic, whereas the canals of the North West, which receive much of their water from the Pennines, are mesotrophic.

3.7.2.3 Running waters

Total river length in England is estimated to be around 136,000 km (Ordnance Survey 2007). Small headwater streams dominate the resource, comprising around 70% of the total length of the river network in England.

3.7.3 Protection

There are 28,693 ha of open water within SSSIs in England (Figure 3.19 and Table 3.11). Of this, 20,458 ha are standing waters (of which 10,067 ha are of special interest for open water habitats in their own right, whilst the remaining 10,391 ha are designated for their bird interests), 354 ha are canals and 7,881 ha are rivers and streams. There are 44 rivers with at least a part notified as SSSI, covering just over 2,500 km of river length.

SACs include 9,308 ha of open water habitat. This includes 33 lakes or groups of lakes covering 4,628 ha; 17 rivers, which are mainly large, whole-river sites, covering a length of 1,744 km, and the Rochdale and the Cannock Extension canals. Large areas of open water (6,615 ha) are also designated as SPAs, mainly for wintering waterbirds.

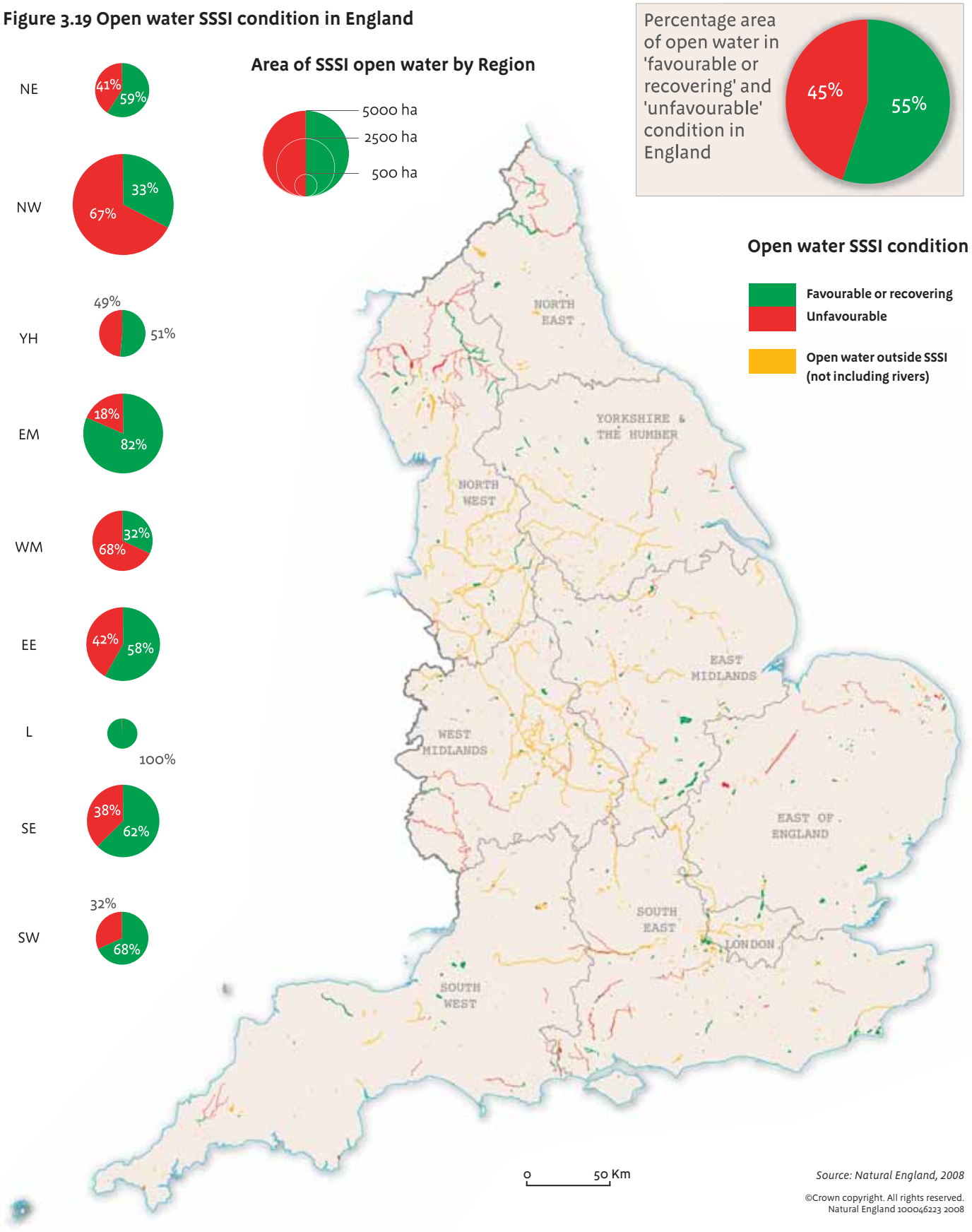
Table 3.11 Area of open water under different designations

Designation	Total area (ha)
SSSI	28,693
SAC	9,308
SPA	6,615
Ramsar	6,013
NNR	1,972
Within National Park	9,339 *
Within AONB	4,058 *

* Larger water bodies only. Data on other open water habitats not available.

(Source: Natural England, 2008)

Figure 3.19 Open water SSSI condition in England



Source: Natural England, 2008

3.7.4 Condition

By area, 55% of SSSI open waters are in favourable or recovering condition (Figure 3.19). Of this, 44% (12,830 ha) is in favourable condition and 11% (3,055 ha) is recovering.

Standing waters notified for their bird interests are in the best condition (86% favourable or recovering), due to the relatively limited habitat requirements of many waterbirds (particularly wintering populations). The other three types (which include all SSSIs of importance for open water habitats in their own right) are all less than 50% favourable or recovering, amongst the worst of all habitats in England's SSSIs (Table 3.12).

The main cause of unfavourable condition in open water SSSIs is eutrophication from both point sources (such as sewage outfalls) and diffuse sources (such as run-off of agricultural fertilisers). These are contributory factors to unfavourable condition in 70% and 40% respectively of the total unfavourable area.

Standing waters in particular are natural sinks for sediments and nutrients within the landscape. From a sample of 100 SSSI lakes, over 80% were found to be affected by eutrophication (Carvalho & Moss 1998).

The causes of unfavourable condition in canals within the SSSI network vary according to whether they are navigable or un-navigable. Where boats are present, high levels of traffic are generally the main cause of unfavourable condition. Conversely, those SSSIs where navigation is no longer possible frequently require sympathetic dredging or other management to prevent sediment build-up and succession.

There is little regular lake quality monitoring outside of SSSIs. However, the risk assessment exercise undertaken for the Water Framework Directive River Basin Characterisation report (UKTAG 2005) for England and Wales indicated that 41% of water bodies (433) were at risk of failing to meet good ecological status due to enrichment by phosphates (see Chapter 5). Smaller water bodies receive even less monitoring attention but the 1996 Lowland Pond Survey showed that at least 50% of ponds in the wider countryside are highly degraded, with evidence of enrichment and other diffuse pollution impacts (Williams *et al*. 1998). There is growing concern that even ponds in semi-natural habitats are at risk from airborne pollution (for example acidification and atmospheric nitrogen) and climate change, to which shallow ponds are recognised as being particularly vulnerable (Mountford & Strachan 2007).

The condition of the wider river network reflects that of SSSI rivers. The Environment Agency's general water quality monitoring scheme shows that in 2006, 55% of rivers in England had high concentrations of phosphate (greater than 0.1 mg per litre) and over 31% of rivers also had high concentrations of nitrate (greater than 30 mg per litre). Rivers in the south and east of England have the highest phosphate and nitrate levels (Environment Agency 2008).

Table 3.12 Extent of SSSI notification and condition by open water type

Habitat	Total resource (ha)	Area SSSI (km or ha)	% resource notified	% in favourable or recovering condition
Canal	2,624 km	154 km (354 ha)	6	35
River and streams	136,000 km **	2,500 km (7,881 ha)	2	28
Standing waters (all)	>50,000 *	20,458	<41	66
Standing waters for habitat interest		10,067		47
Standing water for birds		10,391		86
Total		**28,693**		**55**

* Estimate of larger water bodies in England

** Taken from a 1:100,000 scale map

(Source: Natural England, 2008)

The economic benefits of improving water quality

The implementation of the Water Framework Directive is expected to result in significant improvements in the health of the aquatic environment, recreation opportunities and aesthetic benefits. Many people in England and Wales place notable value on improvements in water quality in rivers, lakes, coastal waters and other water bodies. However, some low income households placed a high value on the improvements, while some high income households put no value on it at all. On average, households expressed a willingness to pay £45 per year (this is a conservative estimate) on a shift to 95% of water bodies being of good ecological status by 2015 (by way of comparison, 15% of water bodies in England and Wales were of good ecological status, 41% moderate and 44% low).

Source: NERA (2007)

Southern damselfly

The southern damselfly *Coenagrion mercuriale* is one of Europe's most endangered insects. The UK holds one-quarter of the world population.

The southern damselfly is found in shallow calcareous streams and old water-meadow ditches on chalk rivers, with strongholds in the New Forest and the Rivers Test and Itchen in Hampshire. Since the 1960s, the population has declined by 30% across its range and today only 16 ten-km squares in England support southern damselfly populations.

The reasons for its decline include drainage, abstraction, nutrient pollution and insufficient grazing of bankside vegetation.

Sources: Harvey (2005); Purse (2001)

© Robin Chittenden/FLPA

3.7.4.1 Trends in open water species

Mammals

Water voles were once widespread on lowland rivers but, in recent years, they have become England's most rapidly declining mammal, due to predation by American mink *Mustela vison* and habitat deterioration (Strachan & Moorhouse 2006). Water voles may benefit from otters recolonising much of their former range and displacing mink (Bonesi & Macdonald 2004).

Between the 1950s and 1970s, otters were lost from many catchments across England. Otters have since been recovering and spreading into more southern English rivers (Crawford 2003). This recovery appears to be a response to the withdrawal of agricultural organochlorine pesticides and continuing improvements in water and habitat quality.

Amphibians

All amphibian species have declined since the middle of the 20th century, largely because of agricultural intensification, development and passive neglect of habitats. Declines have been most severe for those with specialist habitat requirements, such as the natterjack toad. Since the start of the 20th century, the natterjack toad has lost over three-quarters of its former range and the great crested newt has been lost from around half of its former breeding sites (Beebee 1975, 1976; Buckley & Beebee 2004).

Even the common toad *Bufo bufo*, a species generally considered abundant and of low conservation concern, has suffered declines of 50% or more in parts of southern and eastern England during the period 1985 to 2000 (Carrier & Beebee 2003).

Pool frog

The pool frog *Rana lessonae* is restricted and threatened in Europe and is now considered to have been native to parts of England. Unfortunately the species suffered a massive decline in eastern England and the last known population went extinct in the 1990s.

Pool frogs require networks of ponds in close proximity, with suitable terrestrial habitat in between. The decline in suitable ponds leading to reduced breeding success is a possible cause for their extinction.

From 2005 to 2007, pool frogs taken from the wild in Sweden were released at a specially prepared site in Norfolk. Further reintroductions are planned for 2008. Monitoring of the site indicates that released pool frogs are in good health.

Source: Beebee *et al.* (2005)

Freshwater fish

The great majority of freshwater fish including most of the protected species are not systematically monitored.

The Environment Agency and the Centre for Environment, Fisheries and Aquaculture Science (Cefas) publish an annual assessment of the state of salmon stocks in England and Wales. Stocks have declined dramatically over the last 25 years and have remained at low levels since the 1990s. In 2002, 70% of rivers failed to meet the requirements of their conservation limits, with 46% of rivers achieving less than 50% of the conservation limit (Environment Agency 2004b). However, on some rivers including the Tyne and Tees in the North East, stocks have recovered dramatically. In recent years, there have been also been marked declines in catches of fish which have spent more than one winter at sea, particularly from those rivers (notably the Severn, Wye and Dee) that were once renowned for them.

The formerly common European eel *Anguilla anguilla*, has declined by 90% throughout its European range since the mid-1980s (ICES 2006). Elver (juvenile eel) recruitment is estimated to have declined by 95% in recent years and current populations are estimated at about 5% of the level in the 1970s. The reasons for the decline are unclear, but changes in the marine environment may be particularly significant (Environment Agency 2004b).

The vendace has declined due to pollution from nutrient enrichment, habitat destruction and the introduction of non-native fish species. The Bassenthwaite Lake population is thought to be in very poor condition, partly due to the introduction of ruffe *Gymnocephalus cernuus*, which are known to feed on vendace eggs while they lie exposed on the lake bed. In contrast, the Derwentwater population is considered to be stable, with evidence of recruitment (Maitland & Lyle 1992).

3.7.4.2 BAP open water action plan threats

The main issues posing a threat to open waters are (BRIG 2006a):

- **Pollution** from both point (sewage and industrial) and wider agricultural sources (for example manure and fertiliser application and sheep-dip), as well as acidification and nitrogen enrichment from atmospheric sources.
- **Invasive and non-native species,** particularly plants such as Australian swamp stonecrop *Crassula helmsii* and animals such as non-native crayfish.
- **Inappropriate physical modification,** including channel widening, deepening and straightening, which has led to widespread loss of characteristic species, riparian habitats and connectivity to the floodplains.
- **Drainage** (for agriculture, flood defence and development) and water abstraction (either direct from the river or from groundwater) intensify ecological stress throughout the year but particularly at times of natural low flows.
- Other pressures such as **inappropriate fish stocking** may be significant locally.

3.8 Wetlands

This section covers the wetland habitats of blanket and lowland raised bogs, fens, reedbeds and grazing marshes.

Blanket bog only forms in situations with high rainfall, low evapotranspiration and flat or gently sloping land, which allow the growth of bog-mosses *Sphagnum* species. It is these waterlogged acidic conditions that leads to *Sphagnum* and associated plants forming blanket peat.

Lowland raised bogs develop at the heads of estuaries, along river floodplains and in topographic depressions. In England, lowland raised bogs are a particular feature of cool, humid regions such as the North West, but once occurred in other parts of the country. The surface of a 'natural' lowland raised bog is waterlogged, acidic and deficient in plant nutrients. This gives rise to a distinctive suite of vegetation types which, although low in overall diversity, support specialised plant assemblages dominated by a colourful range of *Sphagnum* mosses as well as vascular plants adapted to waterlogged conditions, such as cottongrasses *Eriophorum* species, sundews *Drosera* species and bog-rosemary *Andromeda prolifolia*.

UK BAP priority wetland habitats in England:

- Blanket bog
- Coastal and floodplain grazing marsh
- Lowland fens
- Lowland raised bogs
- Reedbeds
- Upland fens, flushes and swamps

3.8.1 Importance of England's wetlands

England holds approximately 40% of the UK's fen and lowland raised bog, and over half of the reedbed resource. Nine of the wetland types listed in Annex I to the EC Habitats Directive occur in England.

Coastal and floodplain grazing marsh is not recognised within the EC Habitats Directive explicitly, but some of its constituent grassland habitats are represented in two of the grassland communities listed in Annex I to the Directive. In addition, wetlands are recognised for their international importance for birds, and examples of all the listed habitats are classified as SPAs under the EC Birds Directive.

The term 'fen' applies to wetlands that receive water and nutrients from surface and groundwater sources, as well as from rainfall. This is the key feature of fens that separates them from bogs, which are exclusively fed by rainfall. Fens are found on soils that are at least periodically waterlogged, and comprise a wide range of wetlands occurring on both peat and mineral-based substrates. Fens are present within ill-drained valley bottoms and basins, floodplains, transitions to open water, dune grasslands and flushed or spring-fed slopes. They can be very small, such as calcareous spring fens a few metres square, dominated by low-growing sedges and mosses, through to tall floodplain fens extending to hundreds of hectares.

The term 'grazing marsh' describes flat, open, low-lying expanses of wet grassland, dissected by ditches. The habitat occurs in river and coastal floodplains that experience high water levels during winter. The grassland is extensively grazed or cut for hay or silage, with much of it having experienced some degree of agricultural improvement and of little value for biodiversity. Some grazing marsh complexes, however, still retain large areas of species-rich grassland.

Reedbeds are wetlands dominated by stands of common reed *Phragmites australis*, where the water table is at or above ground level for most of the year. They tend to include areas of open water and ditches, and small areas of wet grassland and carr woodland may be associated with them.

The economic value of wetlands

Wetlands are often complex ecological systems, whose structure and characteristics can provide humans with a range of direct benefits through extraction (eg fish or reeds) or non-extractive uses (such as recreation). Wetland ecosystem processes also provide us with ecologically related services, supporting or protecting human activities or human properties without being used directly (for example, flood risk management services, clean water, carbon storage services). In addition, we can expect there to be significant non-use values associated with these systems (such as biodiversity).

The stock of wetlands is, therefore, a multifunctional resource with potentially substantial economic value. However, the flow of benefits resulting from any wetland system is likely to be very context specific, with the 'value' of one wetland likely to be very different from that of another.

Of the many different functions that wetland ecosystems provide, an analysis (based on a review of a large number of wetland contingent valuation studies from across the world) found that willingness-to-pay estimates tend to be highest for flood control measures. The supply of water, water quality and biodiversity were the next most highly valued functions respectively. The study concluded that more work is needed to ensure the validity of existing value estimates before use in any future benefits transfer exercises.

Source: Brouwer *et al.* (1997)

3.8.1.1 Wetland species

Wetlands provide a home for specialised plants and animals, such as *Sphagnum* mosses and insectivorous plants in bogs, dragonflies and rare plants in fens, rich assemblages of water beetles in grazing marsh ditches, and rare breeding birds in reedbeds.

Birds

Blanket bog is an important nesting or feeding habitat for rare upland breeding bird species, including golden plover *Pluvialis apricaria* and dunlin *Calidris alpina*. Grazing marshes are particularly important for declining wetland breeding birds, such as lapwing *Vanellus vanellus*, redshank *Tringa totanus*, snipe *Gallinago gallinago* and yellow wagtail *Motacilla flava* subspecies *flavissima*. Internationally important populations of wintering wildfowl also occur including Bewick's *Cygnus columbianus* subspecies *bewickii* and whooper swans *C. cygnus*, geese and ducks, especially wigeon *Anas penelope*. Reedbeds are particularly important for specialist species such as bittern *Botaurus stellaris*, marsh harrier *Circus aeruginosus*, bearded tit *Panurus biarmicus* and the globally threatened aquatic warbler *Acrocephalus paludicola*.

Vascular plants

A total of 653 vascular plant species have been found in fens, some of which are rare and restricted to this habitat (Wheeler 1993), and individual sites can have up to 550 species (Eades *et al*. 2003). A number of nationally rare or threatened plants, such as fen orchid *Liparis loeselii*, fen violet *Viola persicifolia*, fen ragwort *Senecio paludosus* and marsh saxifrage *Saxifraga hirculus* are now confined to a few sites.

Lower plants

The prime formers of bogs are mosses of the genus *Sphagnum* and their dominance in the living vegetation layer gives a bog its characteristically 'spongy' surface. The UK BAP priority species Baltic bog-moss *Sphagnum balticum* is primarily associated with the habitat and there are also six species of *Sphagnum* that are nationally rare or scarce.

Invertebrates

Many Red Data Book invertebrate species are specific to fens and several are restricted to just a few sites. The swallowtail butterfly *Papilio machaon* subspecies *britannicus* is found in association with certain tall fen communities in Broadland (East of England). The fen raft spider *Dolomedes plantarius* is only found at a few sites (see box), and is one of a number of rare spiders confined to fens. Rove and aquatic beetles are the largest groups found in wetlands generally; indeed, approximately a quarter of all beetles are dependent on wetlands (Eades *et al*. 2003).

Bogs support a range of unusual invertebrates. For example, Thorne and Hatfield Moors (Yorkshire & the Humber) have at least five national peatland rarities, including mire pill beetle *Curimopsis nigrita* and the ground beetle *Bembidion humerale*. Acidic pools on bogs support the most diverse dragonfly assemblages of any habitat in Britain (Brooks 1997) because their larvae are often the top predator in such acidic waters. The white-faced darter *Leucorrhinia dubia* is only found on bogs and the small red damselfly *Ceriagrion tenellum* is found on acidic valley bogs in southern England.

Fen raft spider

The fen raft spider *Dolomedes plantarius* is one of Britain's largest spiders and rarest animals. It is currently found at two locations in England – Redgrave and Lopham Fen NNR and the Pevensey Levels (and a third in Wales), but problems with water quality and quantity, and decline of traditional management practices, jeopardise these populations.

On the NNR, raft spiders are restricted to areas of fen dominated by great fen sedge *Cladium mariscus*, where they occur around the margins of pools that were created by traditional peat digging for fuel.

Since 1991, a Species Recovery Programme project has undertaken systematic monitoring and positive habitat management at Redgrave and Lopham Fen NNR, including re-instating rotational cutting of the great fen sedge, scrub removal, creation and deepening of ponds, and the introduction of an irrigation supply.

Sources: Smith (2000)

© Natural England/Peter Wakely

Marsh mallow moth

The marsh mallow moth *Hydraecia osseola* subspecies *hucherardi*, a UK BAP priority species, is confined to just two 10 km squares in this country, occurring on six sites in Kent and East Sussex. Two of these sites are along the Medway, the remainder on Romney Marsh.

First found in England in 1951, this species is also very local in Europe. The moth occurred widely on Romney Marsh in the 1950s and 1960s, but became scarcer from the late 1960s and into the 1970s.

Its foodplant, the nationally scarce marsh-mallow *Althaea officinalis*, must occur in large stands to support colonies of the moth, the caterpillar of which feeds within the rootstock.

The plant is not as widespread on Romney Marsh as it once was and has been lost through drainage and dredging of ditches, inappropriate grazing and trampling, spraying and competition from other plants.

Source: Butterfly Conservation (2000-2008a)

© Dave Green/Butterfly Conservation

3.8.2 Extent of habitat

It is estimated that there are 528,884 ha of wetland habitat, which is roughly 4% of England's land area (Figure 3.20). Blanket bog and grazing marsh comprise 93% of the wetland resource, with the other three habitats (fens, reedbeds and lowland raised bogs) combined contributing 7% of the total area. Wetlands cover just under half the total area of England's SSSI series.

Both the type and extent of wetlands vary between regions. The regions that have extensive upland or coastal areas or major fluvial floodplains support the greatest area of wetland. The South West Region holds the largest proportion of lowland wetlands, of which the majority is coastal and floodplain grazing marsh on the Somerset Levels. Other important areas are concentrated in the South East and East of England Regions.

3.8.3 Protection

Wetland SSSIs cover 247,298 ha, representing 47% of the wetland resource in England (Figure 3.21 and Table 3.13). Grazing marsh is the least well represented with only 16% of the resource included in SSSI, whereas fens and lowland raised bogs approach 90% (Table 3.14).

Of the wetland in England, 179,188 ha (34%) has been designated as SACs under the EC Habitats Directive, including large proportions of the fen and bog habitats. Large areas (169,779 ha) have been classified as SPAs under the EC Birds Directive, particularly of blanket bog, grazing marsh and reedbed.

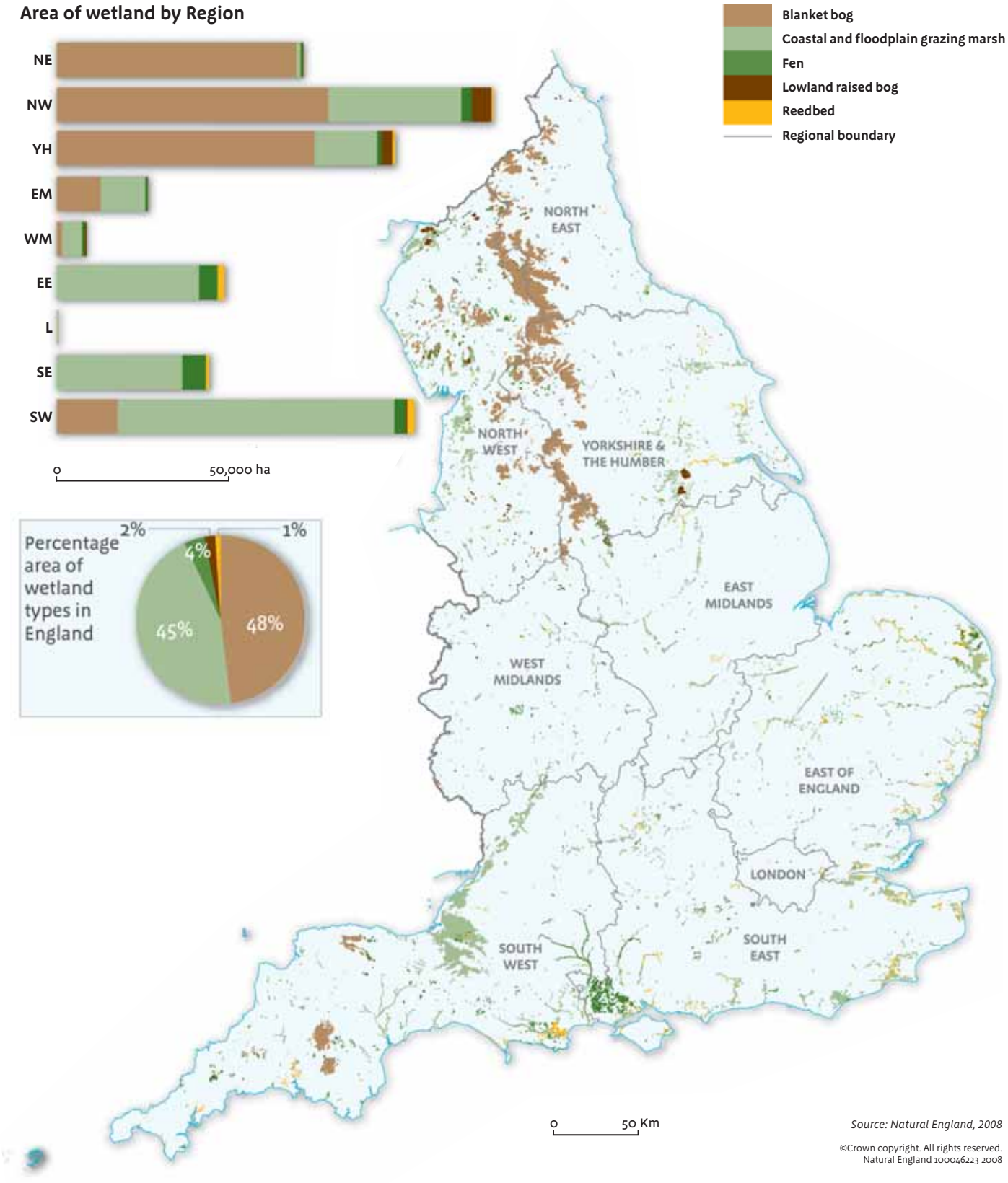
Table 3.13 Area of wetland under different designations

Designation	Total area (ha)	% of total area
Total resource *	528,884	100
SSSI	247,298	47
SAC	179,188	34
SPA	169,779	32
Ramsar	44,986	9
NNR	25,333	5
Within National Park	143,431	27
Within AONB	111,894	21

* Data for wetlands outside designated sites are not complete and the resource total may change with further survey work

(Source: Natural England, 2008)

Figure 3.20 Extent of wetland in England



Source: Natural England, 2008

3.8.4 Condition

By area, 69% of SSSI wetland is in favourable or recovering condition (Figure 3.21). Of this, 21% (52,308 ha) is in favourable condition and 48% (118,671 ha) is recovering.

Over 80% of reedbed is in favourable or recovering condition, compared with around 60% of lowland raised bog and fen (Table 3.14).

In the uplands, dominated by blanket bog, the main causes of unfavourable condition in wetland SSSIs are overgrazing, burning and drainage, which contribute to the adverse reasons in 58%, 36% and 23% respectively of the total area. In the lowlands the causes are more evenly spread, with the main contributory reasons being water pollution (29% of the total area), drainage (21%) and inappropriate water levels (17%).

Comprehensive data on the condition of wetlands outside the SSSI network are not available for the whole of England. Results of a sample survey of grazing marsh being restored under agri-environment schemes estimated that roughly two-thirds (approximately 7,000 ha) was in good condition, when assessed against features required by breeding waders or ditch condition (Dutt 2004). A recent sample survey of non-SSSI fens in Norfolk reported that 31% were in favourable or recovering condition, compared with 51% for SSSI fens in the county (NWT 2006).

3.8.4.1 Trends in wetland birds

Recent national surveys have shown marked declines for a number of characteristic wetland birds over the last 20 years (Wilson *et al*. 2005), although some have recently fared better following historical declines. There have been major declines in the breeding populations of wading birds. Between 1982 and 2002, 61% of breeding snipe, 40% of lapwing and curlew *Numenius arquata*, and 21% of redshank were lost from lowland wet grassland sites (Wilson *et al*. 2005). Historically, these birds were widespread nesters in the uplands and on lowland wet grasslands across the countryside, with some species, particularly lapwing, also nesting on spring-cropped arable land.

A disproportionate number of lowland wet grassland species breed on a very small number of well-managed sites, the majority of which are SSSIs or within Environmentally Sensitive Areas (Wilson *et al*. 2005). The Lower Derwent Valley, Nene and Ouse Washes, North Kent Marshes, the Broads (Norfolk and Suffolk), and Somerset Levels hold 25% of the lowland wet grassland resource, but support 40% of lapwings, 71% of snipe and 57% of redshank breeding in this habitat. This highlights the importance of nature reserves and designated sites for breeding waders and the extremely unfavourable situations outside these areas, where half the lowland wet grassland sites surveyed in 2002 held no breeding waders at all (Wilson *et al*. 2005).

Trends in wading birds more characteristic of the uplands, particularly blanket bog, are mixed, with numbers of breeding golden plover stable, whilst dunlin and curlew breeding populations are both declining (Sim *et al*. 2005).

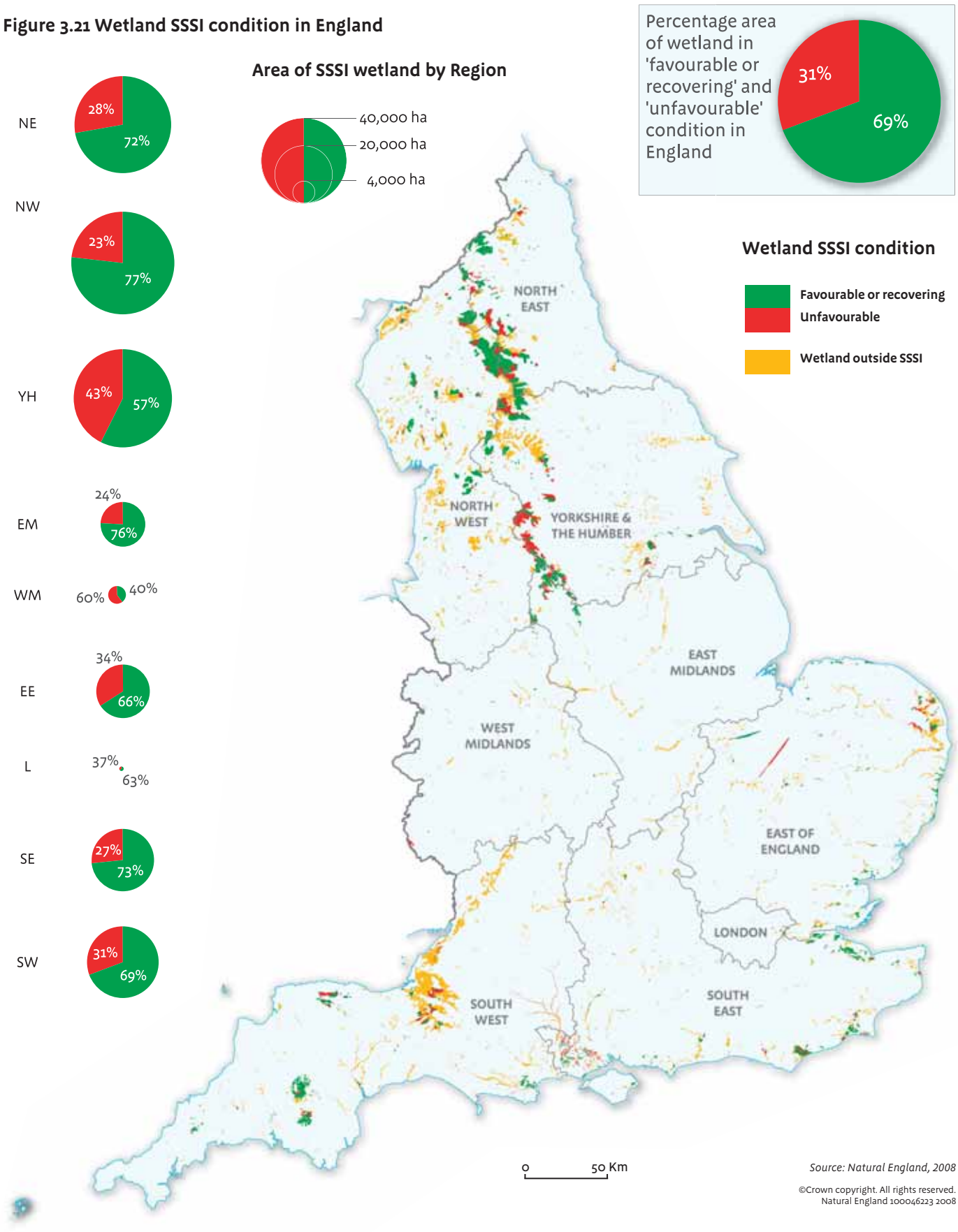
Table 3.14 Extent of SSSI notification and condition by wetland types

Habitat	Total resource (ha)	Area SSSI (ha)	% of resource within SSSI	% of SSSI area in favourable or recovering condition
Blanket bog	255,308	176,140	69	70
Coastal & floodplain grazing marsh	235,046	37,288	16	69
Fen*	21,927	19,533	89	60
Lowland raised bogs	10,227	8,949	88	63
Reedbed	6,378	5,388	84	81
Total	**528,884**	**247,298**	**47**	**69**

* Areas given for fen are significant overestimates, because the total includes other habitats existing within the mosaic.

(Source: Natural England, 2008)

Figure 3.21 Wetland SSSI condition in England



Source: Natural England, 2008

Snipe

Snipe *Gallinago gallinago* breeding in lowland wet grasslands in England and Wales declined by 61% between 1982 and 2002. This figure masks some even sharper declines (90%) in central and southern regions (East Midlands, West Midlands, South East and South West), whilst in the north of England snipe have faired a little better with declines of between 40 to 50%.

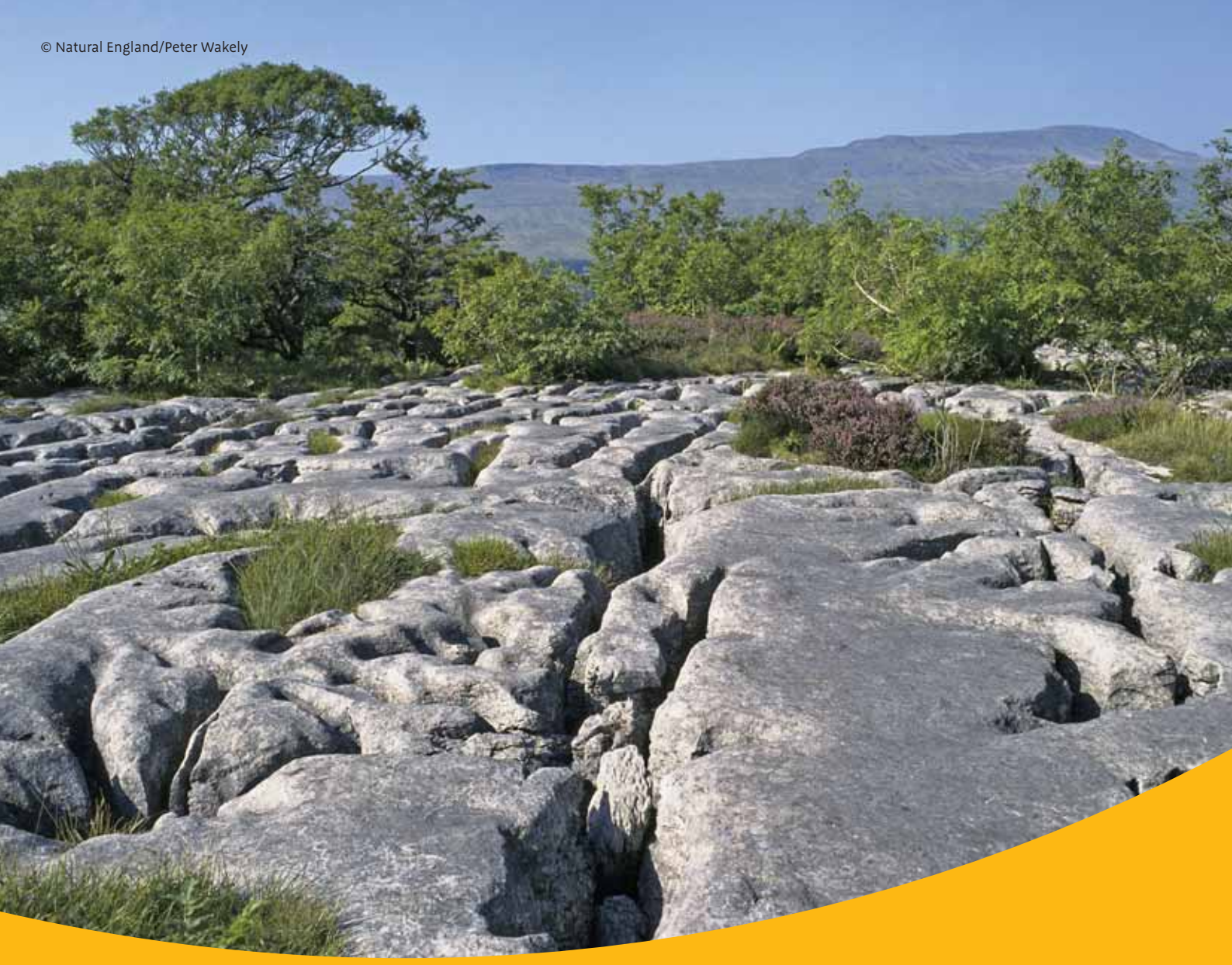
Around 16% of the lowland wet grassland waders recorded in 1982 were snipe, but by 2002 this had fallen to 6%. Most were concentrated in the East of England (64%), especially on the Ouse and Nene Washes, and in Yorkshire & the Humber (15%), primarily in the Lower Derwent Valley.

Source: Wilson *et al.* (2005)

3.8.4.2 BAP Wetland Action Plan threats

The main issues posing a threat to wetlands are (BRIG 2006a):

- **Changes in agricultural management practice,** especially lack of appropriate management such as grazing, water level and ditch management practices. In the uplands, overgrazing and burning practices have had a significant impact on vegetation, whilst lowland wetlands have suffered from lack of management, leading to succession to scrub and woodland.
- **Drainage and water abstraction,** in particular for agriculture, flood defence, and infrastructure and housing development in the lowlands, and to improve the quality of grazing in the uplands.
- **Diffuse pollution** from both point and wider agricultural sources (fertiliser application) leading to nutrient enrichment of sites, as well as acidification and nitrogen enrichment from atmospheric sources.



3.9 Inland rock

This section focuses on the biological interest of natural and semi-natural rock habitats (the geodiversity interest is discussed in Section 2.4). The term 'inland rock' describes all exposed rock surfaces, whether natural or artificial, as well as skeletal soils over rock. It includes inland cliffs, caves, limestone pavements and scree, as well as quarries and quarry wastes. It also includes calaminarian grassland. However, coastal cliffs are covered in Section 3.11 as they form part of the 'maritime cliff and slope' UK BAP priority habitat.

Limestone pavements are large areas of rock exposed by the scouring of glaciers during the Ice Ages and then weathered over thousands of years. They contain complex patterns of deep crevices known as grikes, between which are massive blocks of worn limestone, called clints. The vegetation of limestone pavements is unusual because of its structure, and includes woodland edge species and rocky habitat species.

Calaminarian grasslands occur on soils that have high levels of heavy metals, such as lead, zinc, chromium and copper, which are toxic to most plant species. They typically occur on artificial sites associated with past mining activities. However, near-natural examples are found on serpentine rock and mineral vein outcrops. Calaminarian grasslands also occur on stable river gravels rich in lead and zinc, where the heavy metal content may be partly a result of past mining activity in the river catchment.

Natural rock exposures and scree habitats occur on a wide range of rock types, from acidic to highly calcareous. They are found throughout the uplands, and are particularly characteristic of higher altitudes in northern England. Many rock habitats, especially cliff faces, rock ledges, gorges and boulder fields are inaccessible to grazing animals. Others are more accessible, such as fine screes and gently sloping rock outcrops, where grazing may keep the vegetation closely cropped.

Natural caves are formed by the erosion of soluble rocks, such as limestone. They typically form the subterranean components of a distinctive 'karst' landscape, and are associated with various topographic features, including gorges, dry valleys and limestone pavements.

UK BAP priority inland rock habitats in England:

- Calaminarian grassland
- Inland rock outcrops and scree habitats
- Limestone pavement

A number of vegetation types are associated with rock habitats. These include:

- Chasmophytic vegetation (plant communities that colonise the cracks and fissures of rock faces).
- Certain types of tall herb and fern vegetation vulnerable to grazing, now largely confined to areas inaccessible to grazing animals, such as cliff faces and ledges.
- Early pioneer communities on skeletal substrates often associated with quarries and other 'brownfield' land.

3.9.1 Importance of England's inland rock habitats

Limestone pavements are scarce and non-renewable, and within Europe only occur in the UK, Ireland and Sweden (English Nature 2001). England holds a large proportion of the UK's resource of limestone pavement (80%). Eight inland rock and scree habitat types that are found in England are listed in Annex I to the EC Habitats Directive.

3.9.1.1 Inland rock species

Over much of upland England, rock outcrops and screes act as refuges for species that have been lost from more accessible habitats by centuries of grazing pressure. They are among the few near-natural habitats remaining in England. By contrast, habitats in the lowlands, such as sand and gravel workings, railway cuttings and quarries, may be colonised by a range of opportunistic species, some of which might otherwise be absent because of the lack of an equivalent natural habitat.

Limestone pavements support unusual combinations of plants, including woodland and woodland-edge species. Plants grow mainly within the grikes, which provide sheltered, humid conditions with very thin soils. One rare species, the rigid buckler fern *Dryopteris submontana*, has its main centre of population in limestone pavement and, in common with two other rare species, dark-red helleborine *Epipactis atrorubens* and angular Solomon's-seal *Polygonatum odoratum*, flourishes in the low to mid-altitude pavements. Other rare species, such as baneberry *Actaea spicata*, green spleenwort *Asplenium viride* and the English sandwort *Arenaria norvegica* subspecies *anglica*, occur in more montane pavements.

The limestone habitats around Morecambe Bay in Cumbria are important for their butterfly populations such as the high brown *Argynnis adippe* subspecies *vulgoadippe*, pearl-bordered *Boloria euphrosyne* and small pearl-bordered *B. selene* fritillaries, and northern brown argus *Aricia artaxerxes* subspecies *salmacis* (all UK BAP priority species). These species make use of the nectar and larval food plants, the shelter of the glades and grikes, and warm conditions for basking on the limestone (Webb & Glading 1998).

Natural rock exposures and screes support a wide range of species. The inaccessibility of rock habitats to grazing animals, especially of rock ledges and scree, provides a refuge for many vascular plants that are sensitive to grazing. These include numerous local and rare species, such as alpine lady-fern *Athyrium distentifolium*, rock sedge *Carex rupestris* and bird's-foot sedge *Carex ornithopoda*, and the UK BAP priority species alpine blue-sow-thistle *Cicerbita alpina* and oblong woodsia *Woodsia ilvensis*. Chasmophytic vegetation (that which grows in rock crevices) supports a number of uncommon ferns, including green spleenwort, brittle bladder-fern *Cystopteris fragilis* and Wilson's filmy fern *Hymenophyllum wilsonii*. Bryophytes and lichens also occur in crevices but are able to flourish on the open rock surfaces, where there is a lack of competition from vascular plants (see box).

Rock and scree habitats, Ingleborough NNR (North Yorkshire)

Rock and scree habitats have been studied less than most other upland habitats and, where investigations have taken place, they have tended to concentrate on higher plants. An investigation of the lichen and bryophyte communities on rock habitats in upland Britain, focusing upon 16 selected SACs including Ingleborough, was completed in 2006. At Ingleborough, 13 different communities were found, including over 30 species that are regarded as being nationally rare or scarce.

Calcareous scree – main habitat for the near-threatened lichens *Lemmopsis arnoldiana* and *Leptogium massiliense*, and the nationally scarce lichen *Clauzadea metzleri*.

Rock crevices and fissures – main habitat for nationally scarce short-beaked thyme-moss *Mnium thomsonii*.

Source: Orange (2008)

Calaminarian grasslands and associated rock outcrops are typically species-poor but provide a habitat for several scarce plants, including the forked spleenwort *Asplenium septentrionale*, spring sandwort *Minuartia verna*, alpine penny-cress *Thlaspi caerulescens* and Young's helleborine *Epipactis youngiana*. Heavy metal toxicity of the soils, perhaps combined with a low nutrient status, is believed to maintain the open vegetation and retard succession. The rarer species are favoured by lack of competition from colonists that are otherwise more vigorous.

Natural caves are important for their cave-dwelling species (cavernicoles), including bacteria, algae, fungi and various groups of invertebrates (for example insects, spiders and crustaceans). The endemic crustacean *Niphargellus glenniei* is only found in Devon in the UK. Some caves also provide hibernation sites for bat species, including all four species listed in Annex II to the EC Habitats Directive (for example lesser *Rhinolophus hipposideros* and greater horseshoe bats *R. ferrumequinum*) (pictured overleaf).

3.9.2 Extent of habitat

There are estimated to be 112,700 ha of inland rock (all types) in England based on Land Cover Map 2000 data, covering 1% of the total area of England. The total area of limestone pavement in England is 2,340 ha (English Nature 2001) and the rare calaminarian grassland type is estimated to cover less than 200 ha (Mountford & Strachan 2007). Reliable extent data are not available for other types of natural rock exposures and scree habitats but the Joint Nature Conservation Committee (JNCC) gives broad estimates for those listed in Annex I to the EC Habitats Directive that occur in England (Table 3.15). There are also around 1,300 active mineral extraction and quarry sites in England, covering over 64,000 ha of land, of which around 87% has the potential to support one or more BAP priority habitats (Davies 2006).

The most extensive limestone pavements occur on the Carboniferous limestone of northern England, from Morecambe Bay in Cumbria to the Yorkshire Dales. The rare calaminarian grassland type is very locally distributed with its main concentrations in the Derbyshire White Peak and the North Pennines. Inland rock and scree habitats are widespread in upland areas of England, with more limited occurrence in the lowlands. Acidic rock and scree are widespread, whereas calcareous communities are more restricted, and good stands of tall-herb ledge vegetation also tend to be confined by heavy grazing. Natural caves, which are important for their specialist fauna, are particularly characteristic of the limestone areas of the North Pennines, the Peak District and the Mendips.

Table 3.15 Inland rock and scree habitats in England

Habitat	Estimated extent in England (ha)
Inland rock habitat (broad habitat)	112,700
Limestone pavement	2,340
Calaminarian grasslands	200
Siliceous rock and scree types	4,000–5,000
Calcareous rock and scree types	400–1,000
Tall-herb ledge vegetation	Unknown
Natural caves (host specialist or endemic cave species)	Unknown

(Source: Countryside Survey 2000, JNCC 2007b)

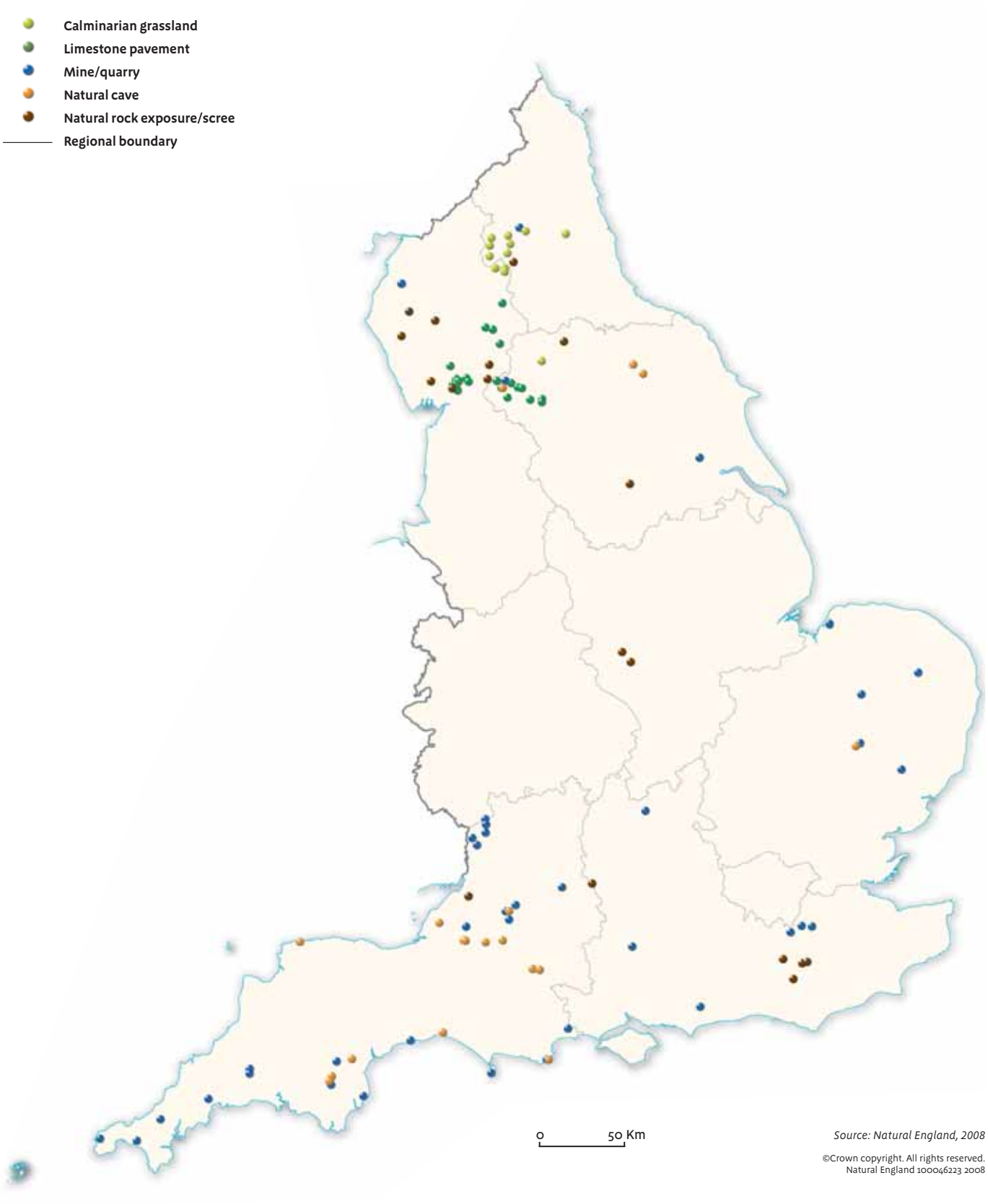
3.9.3 Protection

There are 23 SSSIs containing 1,396 ha of limestone pavement in England (60% of the total resource) (English Nature 2001). Twelve SSSIs contain a total of 76 ha of calaminarian grassland (38% of the resource) and a further 18 SSSIs have been notified for other rock and scree habitats (957 ha). Over 600 SSSIs have been designated in former quarries or mines, of which 38 are for biodiversity interests (the remainder for their geodiversity exposed by the extraction process). The locations of these SSSIs (excluding geodiversity sites) are shown in Figure 3.22.

Sites of European importance designated as SACs for inland rock habitats include the Asby Complex, Morecambe Bay Pavements and Lake District High Fells in the North West; the Craven Limestone Complex and Ingleborough in Yorkshire & the Humber; Moor House - Upper Teesdale in the North East and North West, and the Peak District Dales in the East and West Midlands.

Limestone pavement has special protection under Section 34 of the Wildlife & Countryside Act 1981, which allows Limestone Pavement Orders to be issued by local authorities to protect pavements. There are currently 99 Limestone Pavement Orders, covering the best sites in England.

Figure 3.22 Distribution of SSSIs with inland rock habitat in England



Source: Natural England, 2008

3.9.4 Condition

By area, 73% of SSSI inland rock is in favourable or recovering condition. Of this, 28% (2,004 ha) is in favourable condition and 45% (3,265 ha) is recovering.

Calaminarian grassland is in the poorest condition with only 37% favourable or recovering, compared to 70% of limestone pavement and 85% of other rock and scree habitats.

The main cause of unfavourable condition in inland rock SSSIs is overgrazing, which contributes to the adverse reasons in 57% of the total area. Other factors include inappropriate management practices, public access and disturbance from recreational activities.

Bloody crane's-bill

Overgrazing on upland limestone pavements threatens characteristic species such as bloody crane's-bill *Geranium sanguineum* that are intolerant of grazing. The pavements of the Asby area on the eastern side of Ingleborough NNR, North Yorkshire, illustrate the effects of high levels of sheep grazing, where species such as bloody crane's-bill survive only in deep grikes. In contrast, lower grazing pressure at Scar Close allows the species to grow out of the grikes and onto the clint tops.

Source: English Nature (2001)

In the Peak District, 50% of 'lead rakes' (calaminarian grasslands created by former lead mining activity) have been lost over the last century, and losses are continuing (Peak District National Park Authority 2008). Calaminarian grasslands on river deposits in Northumberland are declining rapidly and, of those that remain, it is estimated that no more than 12 ha are in favourable condition (Northumberland County Council 2007).

3.9.4.1 Changes in inland rock habitats and species

Many natural or semi-natural rock habitats have undergone less change than habitats that are more actively managed. Some of the particular factors affecting inland rock habitats are:

- Increase in mineral extraction, especially in lowland river valleys, which has created (at least temporarily) large areas of quarried land.
- Road cuttings, which have given rise to new rock exposures, sometimes in areas where there are few natural rock outcrops.
- 'Landscaping' of quarried land and the use of gravel pits and quarries for landfill, which has destroyed some of the available habitat.
- Mechanised removal of limestone pavement in the uplands has had a dramatic effect: by 1975 only 61% of the total area was intact and only 3% of the remaining pavements were undamaged (Braithwaite *et al*. 2006).

Analysis of the results of the two national vascular plant atlas surveys has shown that many characteristic species of inland rock habitats have declined over the last 40 years (Preston *et al*. 2002b). The decline has been greatest in northern and western parts of England, while in some lowland areas, there has been a relative increase in species abundance (Braithwaite *et al*. 2006). Studies at a local level have also shown a decline in species of inland rock habitats. For example, a study of limestone pavements in the Ingleborough area of North Yorkshire showed that most pavements lost more species than they gained between 1975 and 1985 (Margules *et al*. 1994). The main causes of decline were thought to be due to recreational pressure and high levels of grazing on limestone pavements.

3.9.4.2 BAP inland rock action plan threats

The main issues posing a threat to inland rock habitats are (BRIG 2006a):

- **Unsuitable grazing management,** especially overgrazing, which is the main cause of unfavourable condition on upland sites.
- **Lack of suitable management,** leading to development of scrub and woodland at the expense of open, species-rich vegetation.
- **Recreational pressure** from walkers and climbers, causing damage to fragile vegetation communities.
- **Redevelopment,** which is targeted on 'brownfield' land, such as quarries, including housing, industrial and commercial use, and landfill.
- **Atmospheric pollution** (nitrogen deposition, acid precipitation) and **climate change** affecting species composition.

3.10 Urban and brownfield land

The development of urban areas represents extreme modification of the natural environment. The impact of this applies not only to the direct footprint of the built-up area, but also to the adjacent habitats within or close to the urban area. Species are able to exploit a wide range of niches in the urban environment from buildings to parks, gardens, areas of encapsulated countryside and previously developed or 'brownfield land', large expanses of which can also be found away from centres of population.

Brownfield or previously developed land that has not been subject to reclamation is rich in early successional habitats. It comprises mosaics of bare ground with, typically, very early pioneer communities on skeletal substrates (thin soils, low in plant nutrients), more established open grasslands, scrub and patches of other habitats, such as heathland, swamp, ephemeral pools and inundation grasslands. High quality examples include unmanaged flower-rich grasslands with sparsely-vegetated areas developed over many years on poor substrates (Harvey 2000). As a result of the increased awareness of the biodiversity interest of certain types of brownfield land, a new UK BAP priority habitat of 'open mosaic habitats on previously developed land' was recognised in 2007.

Gardens typically have an ecologically unusual assemblage of plant structure and diversity, with the majority of plant species being non-natives. A study of 267 urban domestic gardens across five UK cities recorded a total of 1,056 species making up the garden flora, of which only 30% were native (Loram *et al*. 2008). However, approximately 55% of the 20 most frequently recorded species were natives. Species richness was found to be greater in the garden habitats of cities compared to other city habitats (including limestone grasslands and urban brownfield sites). Gardens with few native plant species can be just as rich in invertebrates as those with many native plants (Smith *et al*. 2006). However, some non-native species have spread from gardens and created major problems when they invaded semi-natural habitats (see Section 5.3).

Urban trees

Urban trees provide nesting sites for birds and bats, may provide food in the form of berries, and support a wide variety of invertebrates, which themselves are a food source for other wildlife. They have a number of other environmental, social and health benefits. Trees filter out pollutants including ozone, nitrogen dioxide and particles. They also help to reduce erosion, improve water quality by intercepting pollution, and reduce groundwater run-off. Elsewhere, careful positioning of trees has led to energy savings by providing shelter, thus reducing heat loss from buildings during winter. They also provide shade in the summer, whilst the evapo-transpiration of water from the leaf surface has a general cooling effect on surrounding air.

Sources: Hewitt *et al*. (2002), Coder (1996)

3.10.1 Importance of England's urban habitats

The growth of urban areas might be seen simply as a threat to biodiversity. However, it also results in the creation of man-made habitats, in close proximity to where people live and work. Urban habitats and the wildlife they support are consequently the parts of the natural environment with which most people have greatest direct contact and are most familiar. Domestic gardens make up a significant proportion of urban green space, typically accounting for between 20% and 25% of the urbanised area of cities in the UK, and between 36% and 47% of the overall green space within them (Gaston *et al*. 2005). As such they are likely to make a major contribution to the maintenance of biodiversity and the provision of ecosystem services in urban areas.

3.10.1.1 Urban species

Some species that have suffered marked population declines in the wider countryside, such as the common frog *Rana temporaria*, song thrush *Turdus philomelos* and hedgehog *Erinaceus europaeus*, are found in significant numbers in urban areas and particularly domestic gardens.

Plants

Brownfield sites support a range of notable vascular plant, moss and lichen species. These often include species declining in the wider countryside, such as bee orchid *Ophrys apifera*, fragrant orchid *Gymnadenia conopsea* (on alkaline wastes), royal fern *Osmunda regalis* (in acid sandstone quarries), the lichens *Peltigera rufescens* (on lime waste and pulverised fuel ash), *Cladonia pocillum* (on calcareous wastes) and *Diploschistes muscorum* (on pulverised fuel ash), and petalwort *Petalophyllum ralfsii* (on pulverised fuel ash), a UK BAP priority species.

Birds

Some areas are important for birds that are primarily associated with previously developed or brownfield land such as little ringed plover *Charadrius dubius* and black redstart *Phoenicurus ochruros*, as well as more widespread, UK BAP priority species including song thrush, willow tit *Poecile montanus* and linnet *Carduelis cannabina*. The habitat provides secure breeding and feeding areas commonly absent from land under agricultural management.

Invertebrates

In recent years, the interest in the conservation importance of brownfield land has grown as many sites have been found to harbour a particularly species-rich invertebrate community including scarce or rare species (Eyre *et al*. 2002; 2003). In particular, they provide vital habitat for many invertebrate species which require bare ground for basking and nesting, and nectar sources for feeding adults, especially aculeate *Hymenoptera* and *Coleoptera*. Between 12% and 15% of all nationally rare and nationally scarce insects are recorded from brownfield sites (Gibson 1998). At least 40 invertebrate species are wholly confined to brownfields and at least 18 of the UK BAP priority invertebrate species have key populations on brownfield sites (Mountford & Strachan 2007). Non-native plants contribute to the value of the habitat for invertebrates because their extended flowering season provides food for nectar-feeding species over a longer period (Bodsworth *et al*. 2005).

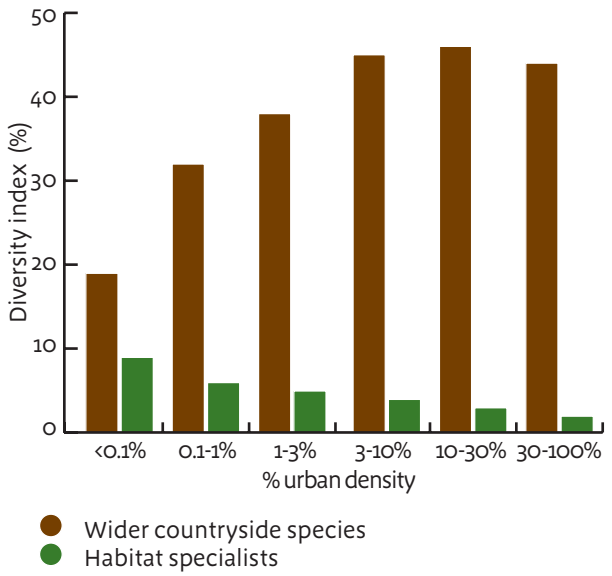
Canvey Wick, Essex

Previously developed (but unused) as an oil refinery, Canvey Wick SSSI has a combination of open sandy soils and nectar-rich plants (many non-native) that is ideal for many invertebrates. Recent surveys have revealed around 1,300 invertebrate species, including 30 Red Data Book species and UK BAP priority species such as the shrill carder bee *Bombus sylvarum* (pictured below) and the solitary wasps *Cerceris quinquefasciata* and *C. quadricincta*.

Source: Buglife (2008a)

The *Butterflies for the New Millennium* recording scheme has shown that wider countryside species occupy a range of urban habitats, while habitat specialists tend to be absent from such areas (Figure 3.23). Indeed, 'wider countryside' butterfly species may now be more likely to be found in suburban areas than in rural areas. This may reflect the high structural and botanical diversity of suburban gardens and parks, compared to the rather uniform conditions created and maintained by intensive agriculture across much of lowland England (Fox *et al*. 2006).

Figure 3.23 Chart showing an index of butterfly species richness in different urban density bands



(Source: Fox *et al*. 2006).

Bats

Certain species of bat, such as serotines *Eptesicus serotinus*, pipistrelles *Pipistrellus* species and Leisler's bats *Nyctalus leisleri*, make use of cavities and internal building voids for hibernation and breeding. In fact, more than half the known summer roosts of common *Pipistrellus pipistrellus* and soprano pipistrelle *P. pygmaeus* are in buildings less than 30 years old. Their association with man-made structures has rendered bats vulnerable to developments and improvements on buildings, and yet also provides an opportunity for people to observe nature on their doorstep.

3.10.2 Extent of habitat

England is one of the most densely populated and urbanised land areas on earth, with urban land cover projected to rise from 10.6% in 1991 to 11.9% in 2016 (DETR 1996). In 2006, there were an estimated 62,700 ha of previously developed land of which an estimated 34,900 ha (55%) were vacant or derelict (DCLG 2007). Buglife's *All of a Buzz in the Thames Gateway* project has provided an extensive assessment of the invertebrate interest of brownfield land. The project assessed 5,046 ha of previously developed land in the Thames estuary during 2005 to 2007; the results show that 24% of sites (55% of the total habitat area) are likely to support a high level of invertebrate biodiversity (Buglife 2008b).

Although there is lack of data concerning the exact extent of gardens, it is generally estimated that garden cover for England and Wales is around 400,000 ha (Gilbert 1989).

3.10.3 Protection

SSSIs in England include approximately 39,000 ha of land (Figure 3.24) in, or within 500 m of, urban areas. Few, if any, of these SSSIs include domestic gardens. No information is available at present on the extent of the new UK BAP priority habitat (open mosaic habitats on previously developed land) that has been notified as SSSI, although there are examples, such as Canvey Wick SSSI and former quarry or mine sites.

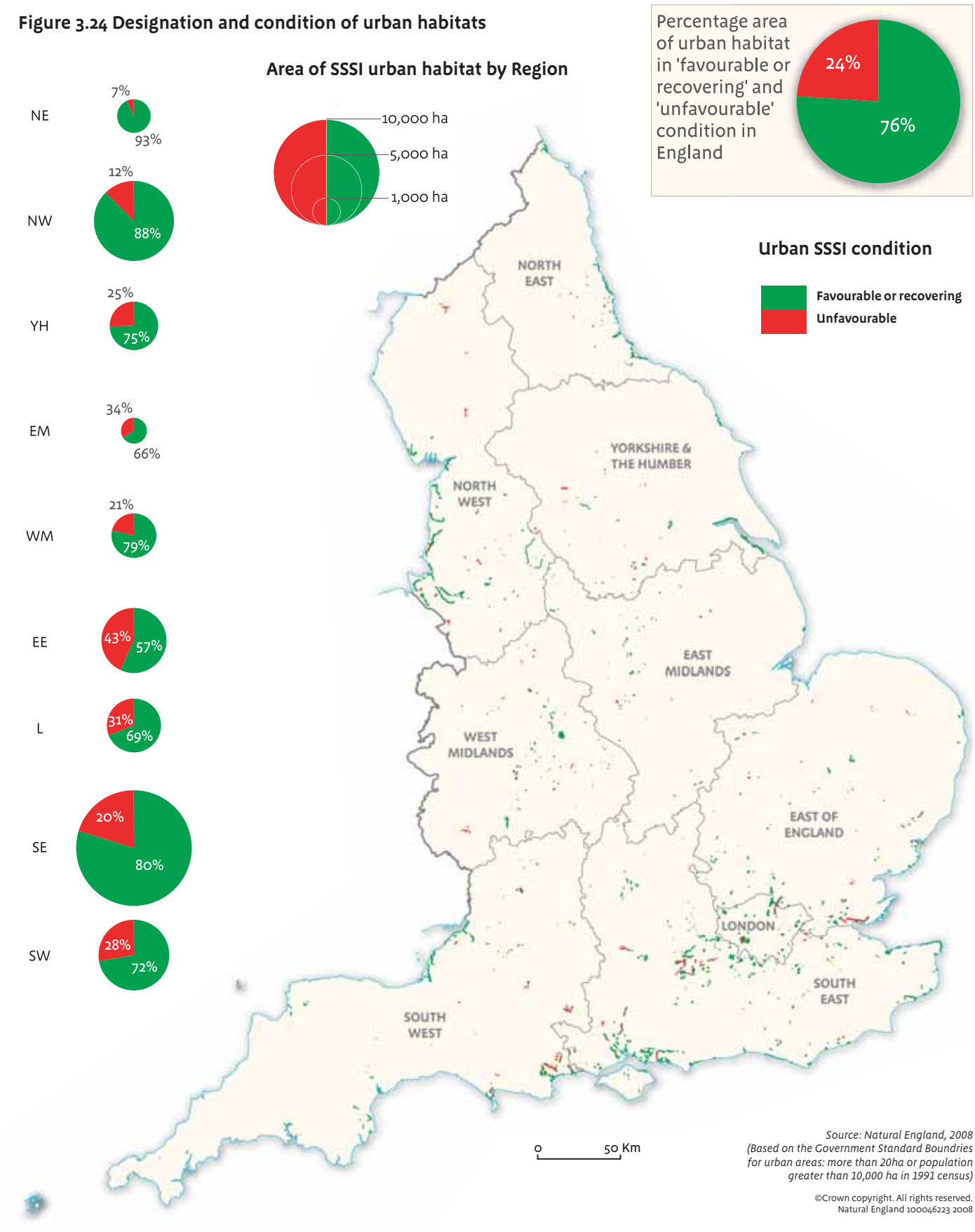
Most 'urban' SSSIs comprise patches of 'encapsulated countryside' or areas of semi-natural habitat on the urban fringe. As such, the majority are included in the other habitat sections of this chapter but a summary is provided here because the urban setting of these habitats may give them a significantly different character to examples in rural areas. Coastal habitats cover the largest area (42% of the urban SSSI total), which reflects the fact that many of our large towns and cities are adjacent to estuaries, but there are also significant areas of woodland (17%), grassland (11%) and heathland (12%), many of which are encapsulated within urban areas (Table 3.16).

Table 3.16 Habitat types within urban SSSIs

Habitat		% of urban SSSI area	% of SSSI area in favourable or recovering condition
Woodland	Broadleaved, mixed and yew woodland	14	79
	Coniferous woodland	2	91
	Wood-pasture and parkland	1	97
Heathland	Lowland heathland	12	63
Grassland	Lowland acid grassland	4	48
	Lowland calcareous grassland	4	80
	Lowland meadows	3	70
Wetland	Fen	2	49
	Coastal and floodplain grazing marsh	3	66
	Reedbed	1	64
Open Water	Standing water	2	67
	Standing water for birds	4	95
	Rivers and streams	1	9
Coastal	Intertidal mudflat and saltmarsh	34	84
	Sand dunes	3	79
	Sub-tidal	2	100
	Maritime cliff and slope	1	97
	Littoral rock	2	100
Other		4	69
All SSSIs		-	77

(Source: Natural England, 2008)

Figure 3.24 Designation and condition of urban habitats



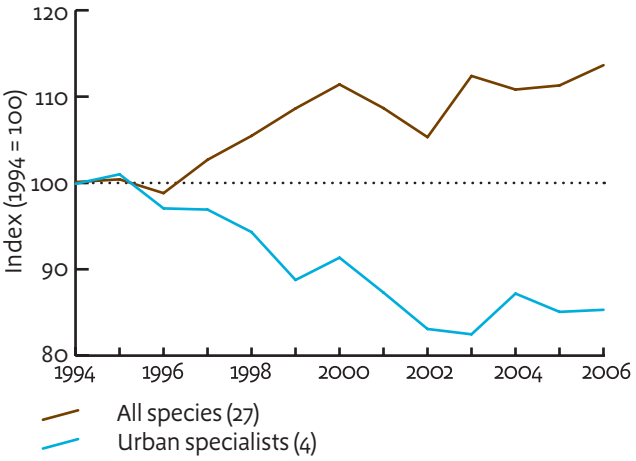
Source: Natural England, 2008
(Based on the Government Standard Boundries for urban areas: more than 20ha or population greater than 10,000 ha in 1991 census)

3.10.4 Condition

Of England's urban SSSIs, 76% by area are in favourable or recovering condition (Figure 3.24).

There are many adverse factors contributing to the area in unfavourable condition, due to the diverse range of habitats within urban SSSIs. However, undergrazing and inappropriate scrub control are the two principal factors, contributing to unfavourable condition in 28% and 22% respectively of the area of urban SSSIs. This reflects the relatively large proportion of heathland and grassland in urban SSSIs, which are vulnerable to these pressures. Similarly, the large areas of coastal habitat within urban SSSIs mean that coastal squeeze (where intertidal habitats are trapped between fixed sea defences and rising sea levels) is also a key factor adversely affecting 20% of the total area. This is exacerbated by the reduced opportunity for realignment of sea defences where there are major urban developments.

Figure 3.25 Population trends of breeding town and garden birds in England 1994 to 2006



(Source: BTO, RSPB, JNCC, Defra, 2008a)

3.10.4.1 Trends in urban birds

From 1994 to 2006, the overall populations of urban birds have increased by 14% (Figure 3.25), with the majority of the increase occurring before 2000 (Defra 2008a). Woodpigeons *Columba palumbus* have more than doubled in numbers over this period and there have been notable increases for green woodpecker *Picus viridis* (103%), goldfinch *Carduelis carduelis* (56%) (pictured), greenfinch *C. chloris* (36%), chaffinch *Fringilla coelebs* (47%), blackcap *Sylvia atricapilla* (45%), robin *Erithacus rubecula* (41%) and great tit *Parus major* (38%). However, urban specialists (such as swift *Apus apus*, house martin *Delichon urbicum*, collared dove *Streptopelia decaocto* and house sparrow *Passer domesticus*) have declined by 15% over this period (despite a 28% increase for collared dove), with house sparrow having fallen by a third.

3.10.4.2 BAP urban action plan threats

The main issues posing a threat to the new UK BAP priority habitat 'open mosaic habitats on previously developed land' (Mountford & Strachan 2007) are:

- **Redevelopment,** including housing (which is targeted at brownfield land), industrial and commercial use, and landfill.
- **'Reclamation'** of bare ground and early successional habitats as amenity greenspace, typically involving re-grading of landforms, burial of existing substrates beneath imported fertile soils, sowing of amenity grass mixtures, and planting of shrubs and trees.
- **Lack of suitable management,** leading to development of tall tussock grassland and scrub, at the expense of open, flower-rich grassland.

3.11 Coastal

England's coastline is estimated to be over 7,000 km in length (Land Use Consultants 2006). It supports a diverse range of habitats and forms some of our most distinctive landscapes.

Variations in geology, sediment type, wave exposure and tidal currents, along with the change in climate from south to north, interact to produce a varied mosaic of coastal habitats, supporting a wide diversity of wildlife. These habitats often have the added benefit of providing natural coastal flood defences. Sediment transfer between eroding and accreting areas maintains the form and geomorphological development of cliffs, spits, estuaries, mudflats, saltmarshes and dunes. These coastal processes operate at a variety of scales, from the daily tidal cycle to much longer geological timescales, such as the effects of isostatic rebound (the south-east of England is 'sinking' as the north-west of Britain 'rises', following the retreat of glaciers after the last Ice Age).

Intertidal mudflats are widespread around the coast where there is shelter from the open sea. Species and communities vary depending on the sediment type, sediment mobility and salinity of the overlying water. Coastal saltmarshes comprise the vegetated, landward part of intertidal mudflats. The vegetation of a natural saltmarsh displays a zonation according to the frequency of tidal inundation and consists of a limited number of halophytic (salt-tolerant) species.

Lagoons are bodies of saline water partially separated from the adjacent sea but which retain water at low tide. They vary in size and may develop as brackish, fully saline or hyper-saline water bodies. Lagoons can contain a variety of substrata, and support tasselweeds *Ruppia* species, stoneworts (charophytes), and filamentous green and brown algae.

Dunes are built up by the accumulation of wind-blown sand from the beach plain above the high tide level, which is then trapped by dune-forming grasses. Dune systems include fore dunes, yellow dunes, dune grassland, dune slacks, dune heath and dune scrub, and the distribution of these zones can change over time. Factors such as degree of stability and moisture retention in these different stages determine what species are present.

UK BAP priority coastal habitats in England:

- Coastal saltmarsh
- Coastal sand dunes
- Coastal vegetated shingle
- Intertidal boulder communities
- Intertidal chalk
- Intertidal mudflats
- Maritime cliff and slopes
- Saline lagoons

Shingle beaches form in high-energy environments where the sea can pile up pebbles above the tide line. Ephemeral plant communities occur on the strandline, where coastal processes deposit seeds and essential nutrients. On the larger systems, such as at Dungeness, where older shingle ridges have been left behind by the sea, unusual forms of grassland, heathland, scrub, and moss and lichen-dominated vegetation occur.

Exposure to the sea is a key determinant of the type of plant communities found on vegetated sea cliffs. The most exposed areas support maritime vegetation dominated by a range of salt-tolerant plants. Where exposure is less extreme, the communities are closely related to those found on similar substrates inland, with only a minor maritime element in the flora.

The homogenous and soft, porous nature of chalk usually results in the formation of vertical cliffs, edged by a horizontal wave-cut platform when exposed to the sea. These physical characteristics have a marked effect on the flora and fauna present, including foliose red algae and small brown algae on upward facing surfaces, turfs of hydroids and bryozoans, and an abundance of sponges and animals that bore into the soft rock.

Relationship between coastal and marine sections
Although this report contains separate sections on coastal and marine habitats, they are really two parts of the maritime environment. The maritime environment functions as a whole ecosystem with transitions to, and connections and overlaps with, terrestrial and freshwater habitats.

3.11.1 Importance of England's coastal wildlife

Some of England's coastal habitats are of national and international importance both in their own right and for the species they support. Seventeen types of coastal and intertidal habitat that occur in England are listed in Annex I to the EC Habitats Directive. England has over half of the European resource of chalk coasts and some of the most important shingle sites in Europe. Lagoons found in association with shingle beaches are particularly rare elsewhere in Europe. Nearly 20% of Europe's Atlantic and North Sea estuaries are in England.

3.11.1.1 Coastal species

England's coastline is important for a large number of species. All main species groups are represented, with seal breeding sites, large numbers of breeding and wintering birds, and diverse assemblages of rare and scarce vascular plants, lower plants and invertebrates. Saltmarshes also provide sheltered nursery sites for several species of fish, whilst sand dunes support rare reptiles and amphibians.

Birds

England's sea-cliffs are important breeding grounds for internationally important numbers of gannets *Morus bassanus*, razorbills *Alca torda*, guillemots *Uria aalge*, shags *Phalacrocorax aristotelis* and kittiwakes *Rissa tridactyla*. For example, the cliffs at Flamborough-Bempton support the largest known kittiwake colony in the North Atlantic, as well as England's only, and Britain's largest, mainland gannet colony. Sand dunes and shingle beaches hold important breeding colonies of gulls and terns, as do saltmarshes, which are also a key breeding habitat for waders, such as redshank *Tringa totanus*. England hosts about 36% of the global population (and over half of the biogeographic population) of the *graellsii* race of lesser black-backed gull *Larus fuscus*, about 10% of the global Sandwich tern *Sterna sandvicensis* and shag populations, and over 5% of the biogeographic populations of little tern *Sternula albifrons* and puffin *Fratercula arctica* (Brown & Grice 2005).

Mudflats often contain very dense populations of invertebrates that are food for large numbers of non-breeding waders, wildfowl and gulls, especially in spring, autumn and winter. The most recent estimate is that England supports some 4.3-4.7 million such birds in winter (approximately 70% to 80% of the Great Britain total) and a large proportion of these use coastal habitats. The Wash alone supports a peak of some 400,000 birds in winter (Brown & Grice 2005). England's coastal habitats also provide vital stop-over sites for huge numbers of waders on migration between their breeding grounds in the high Arctic and wintering areas in southern Europe and West Africa.

Plants

Maritime cliffs and slopes support a wide diversity of plant communities. The most exposed areas support maritime vegetation dominated by a range of salt-tolerant plants and rich lichen communities. A number of specialised plants occur on these cliffs including Lundy cabbage *Coincya wrightii*, which is only found on Lundy and is host to an endemic beetle. The rare curved hard-grass *Parapholis incurva*, wild asparagus *Asparagus prostratus* and the rock sea-lavender *Limonium recurvum* are now confined to cliff-top habitats.

Fixed dunes are extremely species-rich and include a number of rare and scarce species, such as sand crocus *Romulea columnae*, fragrant evening-primrose *Oenothera stricta*, bedstraw broomrape *Orobanche caryophyllacea*, sand catchfly *Silene conica* and lizard orchid *Himantoglossum hircinum*. Scarce bryophytes are also found on dunes including a number of thread-mosses *Bryum* species. Dune slacks, which are areas of wetland within the dune system, support scarce plants such as dune helleborine *Epipactis dunensis*, fen orchid *Liparis loeselii* and important bryophytes, including petalwort *Petalophyllum ralfsii*.

Many shingle beaches support large populations of specialised and scarce plants adapted to periods of disturbance, such as least lettuce *Lactuca saligna*, sea-kale *Crambe maritima*, sea pea *Lathyrus japonicus*, Nottingham catchfly *Silene nutans* and yellow horned poppy *Glaucium flavum*. On more stabilised shingle further inland distinctive grassland, heath, moss and lichen communities often develop that support scarce species tolerant of open dry conditions.

England's saltmarshes support a distinctive range of salt-tolerant plant species adapted to regular immersion by the tides. The rare small cord-grass *Spartina maritima* community (listed in Annex I to the EC Habitats Directive) is only found in three areas of the UK (including Essex estuaries).

Invertebrates

Coastal habitats support distinctive assemblages of invertebrates with a high proportion of nationally scarce species (Key *et al*. 2000).

Soft cliffs, often of boulder clay deposits, are of European significance for their invertebrate assemblages because of the juxtaposition of freshwater seepages, bare ground and nectar-rich vegetation (see box). Hard rock cliffs in the south-west support more oceanic invertebrate assemblages. Important species of hard rock cliffs include the green snail *Ponentina subvirescens*, weevils, including the endangered *Cathormiocerus attaphilus*, and moths, such as Barrett's marbled coronet *Hadena luteago* subspecies *barrettii*. Other species are confined to certain rock types. For example, the fiery clearwing *Pyropteron chrysidiformis* is restricted to the chalk cliffs of Kent and Sussex, and the water beetle *Ochthebius poweri* occurs predominantly in small seepages on red sandstone cliff faces in south-west England.

Coastal lagoons contain invertebrates rarely found elsewhere, including lagoonal specialists such as sea-firs, anemones, sea-mats, sea-slugs, snails and bivalves, shrimps and polychaete worms. For example, the starlet anemone *Nematostella vectensis* is found in a few lagoons on the south coast, and the trembling sea-mat *Victorella pavida* occurs only in Swanpool near Falmouth. At the Fleet in Dorset, a unique assemblage of molluscs lives in seawater springs on the edge of the lagoon, including the De Folin's lagoon snail *Caecum armoricum*, which has only ever been found at two sites in the World (Little *et al*. 1989).

Importance of soft cliff habitats for invertebrates

Unprotected coastal soft cliff habitat is now a highly localised resource in England with 256 km remaining. Around 80% is found in just six counties (Devon, Dorset, Isle of Wight, Norfolk, Suffolk and Yorkshire).

Around 30 species of invertebrate are restricted to this habitat and a further 78 species have a strong affinity. Specialist invertebrates include solitary bees, wasps and ground beetles associated with friable soils, hot substrates and open conditions. Flies and water beetles are often associated with wet pools and seepage zones.

The cliffs along the south coast of England offer the most diverse range of habitats, from eroding bare ground to mature woodland on more stable areas of undercliff, and from open seepages to reedbeds and fens. Consequently, they support both a rich invertebrate fauna and species found nowhere else.

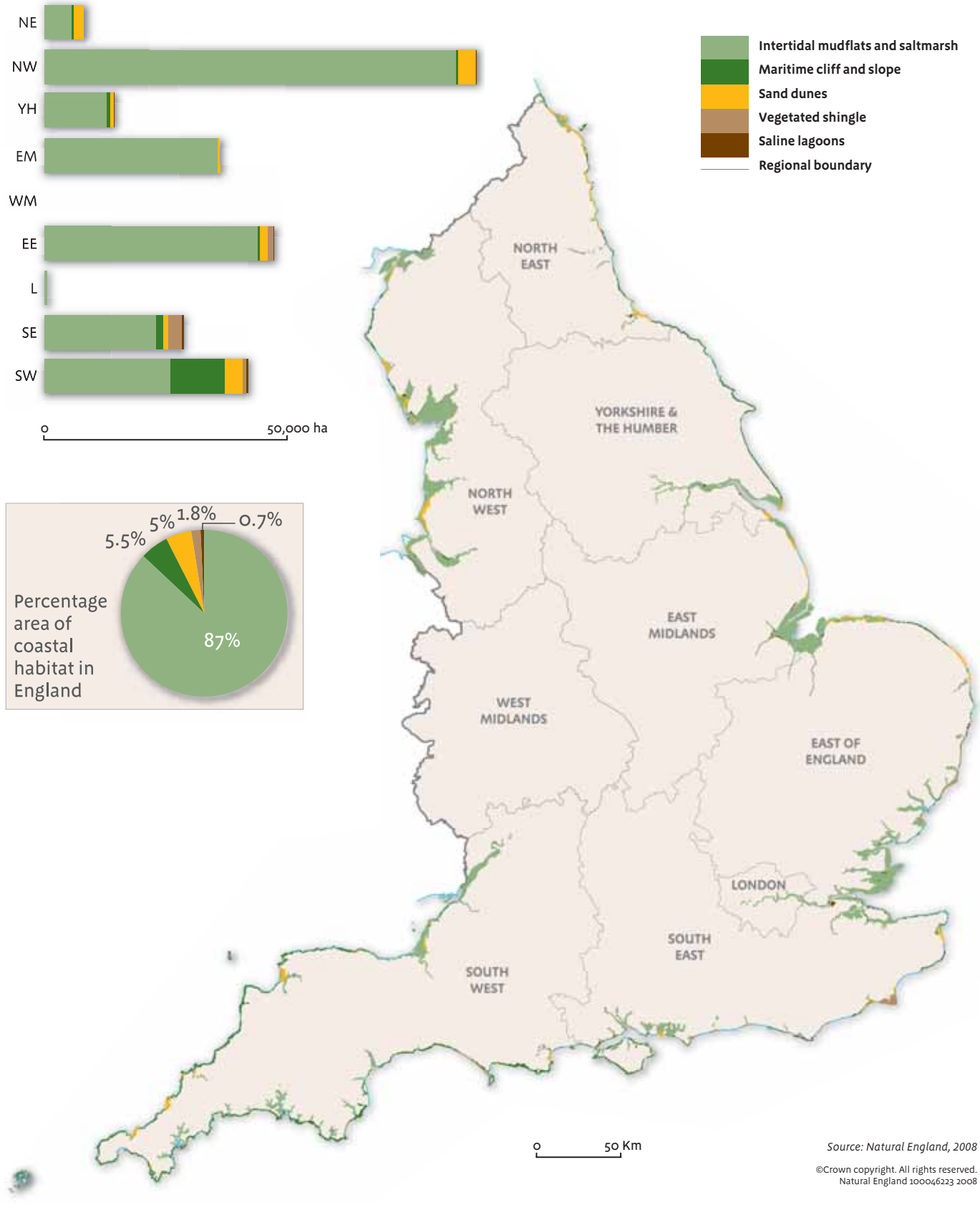
The extensive and often dramatic mudrock cliffs of Dorset (which are part of the 'Jurassic Coast' World Heritage Site - Section 2.4.2.1) and the Isle of Wight are arguably the most important soft cliff localities in the UK (Howe 2003). Over 50 soft cliff species have been recorded on the west Dorset coast.

Sources: Howe (2003); May & Hansom (2003); Pye & French (1993); Woodhouse (2007)

UK BAP priority species associated with soft cliffs in England include:

- Glanville fritillary butterfly *Melitaea cinxia* (pictured)
- A mining bee *Lasioglossum angusticeps*
- A cuckoo bee *Nomada errans*

Figure 3.26 Extent of Coastal habitat in England



Source: Natural England, 2008

3.11.2 Extent of habitat

There are an estimated 265,369 ha of coastal UK BAP priority habitats (excluding littoral rock for which no estimate is available), covering 2% of the total area of England (Figure 3.26). Intertidal mudflats and saltmarsh comprise 87% of the coastal resource, with coastal lagoons and vegetated shingle combined contributing just 2.5% of the total area. There are around 113 km of coastal chalk in England, covering less than 2% of the English coastline.

3.11.3 Protection

SSSIs include 251,302 ha of coastal UK BAP priority habitats, representing 95% of the coastal resource in England (Figure 3.27 and Table 3.17). There is a further 2,930 ha of littoral rock and 45,467 ha of sub-tidal areas within SSSIs. Estuarine habitats form the largest proportion of coastal habitats within SSSIs covering 226,156 ha (90%), including intertidal mudflats and saltmarsh.

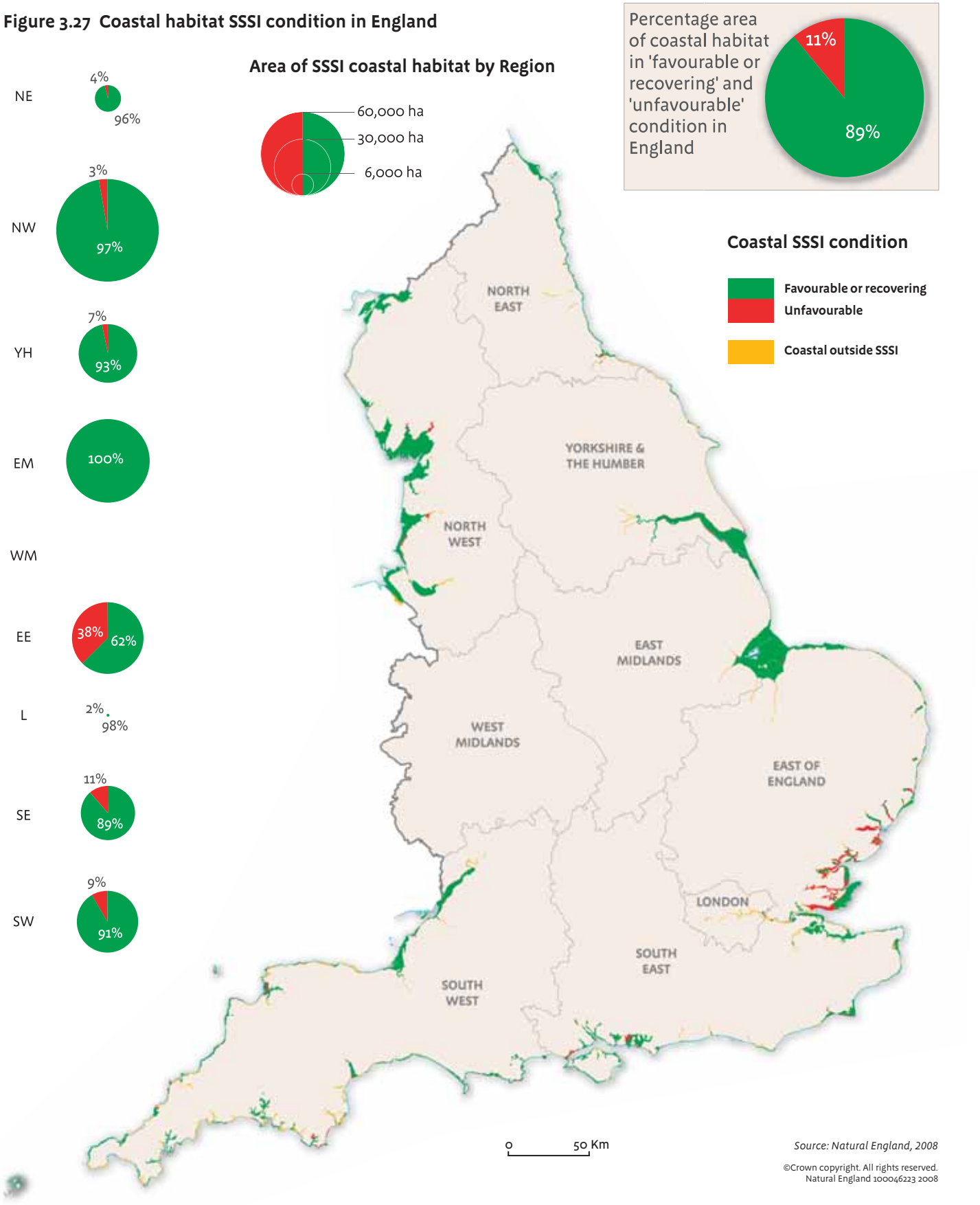
Of the coastal UK BAP priority habitats in England, 199,111 ha (75%) has been designated as SACs. Large areas (220,265 ha) of coastal habitat are also designated as SPAs for breeding seabirds, and wintering and migrating waterbirds.

Table 3.17 Area of coastal habitat under different designations

Designation	Total area (ha)	% of total area
Total resource *	265,369	100
SSSI	251,302	95
SAC	199,111	75
SPA	220,265	83
Ramsar	218,830	82
NNR	36,356	14
Within National Park	5,067	2
Within AONB	48,449	18

* Excluding littoral rock and sub-tidal (Source: Natural England, 2008)

Figure 3.27 Coastal habitat SSSI condition in England



Source: Natural England, 2008

3.11.4 Condition

By area, 91% of SSSI coastal habitat is in favourable or recovering condition (Figure 3.27). Of this, 80% (239,061 ha) is in favourable condition and 11% (33,198 ha) is recovering.

Five UK BAP priority habitats are around 90% or higher in favourable or recovering condition but the remaining two are in significantly poorer condition. Vegetated shingle and sand dunes both have less than 80% in favourable or recovering condition (Table 3.18).

Coastal squeeze (where intertidal habitats are trapped between fixed sea defences and rising sea levels) and water pollution are the two greatest causes of unfavourable condition in coastal SSSIs, contributing to the adverse reasons in 74% and 21% respectively of the total area.

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Fisher's estuarine moth

Fisher's estuarine moth *Gortyna borelii* subspecies *lunata* is a rare and highly threatened species throughout Europe.

It is restricted in England to low-lying coastal grassland habitats that support its sole larval food plant, hog's fennel *Peucedanum officinale*. Its main site on the Essex coast is threatened by rising sea levels, which result in loss of habitat through flooding and coastal erosion.

Work is underway to secure the long-term future of the moth by creating a network of sites with suitable habitat within 5 km of the coast of north Essex.

Other UK BAP priority species which are threatened by rising sea levels and habitat loss in England include:

- Saltmarsh colletes *Colletes halophilus* (a mining bee). A saltmarsh species that is vulnerable to loss of sea aster *Aster tripolium* and areas of bare ground from rise in sea level and changes in saltmarsh management, for example managed realignment.
- Fiery clearwing *Pyropteron chrysidiformis*. Associated with early successional habitats on calcareous and shingle habitats, it is susceptible to coastal erosion and coastal defence works.
- Shore dock *Rumex rupestris*. Found on rocky shores by sea cliffs, the species is vulnerable to coastal erosion and coastal defence works.

Source: Ringwood (2007)

Table 3.18 Extent of SSSI notification and condition by coastal type

Habitat	Total resource (ha)	Area SSSI (ha)	% of resource within SSSI	% of SSSI area in favourable or recovering condition
Saline lagoons	1,649	1,453	88	93
Maritime cliff and slope	14,545	8,484	58	91
Sand dunes	12,800	10,928	85	79
Vegetated shingle	4,495	4,281	95	76
Intertidal mudflats and saltmarsh	231,880	226,156	98	90
Littoral rock	Not available	2,930	-	100
Sub-tidal areas	Not available	45,467	-	100
Total	**265,369 ***	**299,699**	**-**	**91**

* Excluding littoral rock and sub-tidal

(Source: Natural England, 2008)

3.11.4.1 Coastal losses

Coastal habitats have been affected directly by losses as a result of development and reclamation, and indirectly by the protection of land from erosion and flooding, which results in the interruption of coastal processes. Changes can have long-lasting effects in terms of sediment depletion or interference with longshore drift, which may not be seen until many years after the initial impact. Other losses have led to the truncation of natural habitat transitions from sea to land.

3.11.4.2 BAP coastal action plan threats

The main issues posing a threat to coastal habitats are considered to be (BRIG 2006a):

- **Inappropriate development,** particularly from housing, industrial infrastructure and development on the coast.
- **Inappropriate coastal management,** particularly where sea defences and cliff stabilisation lead to over-stabilisation, interruption of coastal processes and loss of habitats due to **coastal squeeze** against sea defences.
- **Water pollution** from both point (sewage/industrial) and wider agricultural sources (fertiliser/pesticide application), as well as acidification and nitrogen enrichment from atmospheric sources.
- **Changes in agricultural management practice,** especially unsuitable grazing management.
- **Climate change and rising sea levels** as a result of global warming.
- Other pressures, such as **public access and disturbance** particularly from unsustainable recreational activities, or **exploitation** such as wildfowling or bait digging, may be very significant locally.

Saltmarsh losses

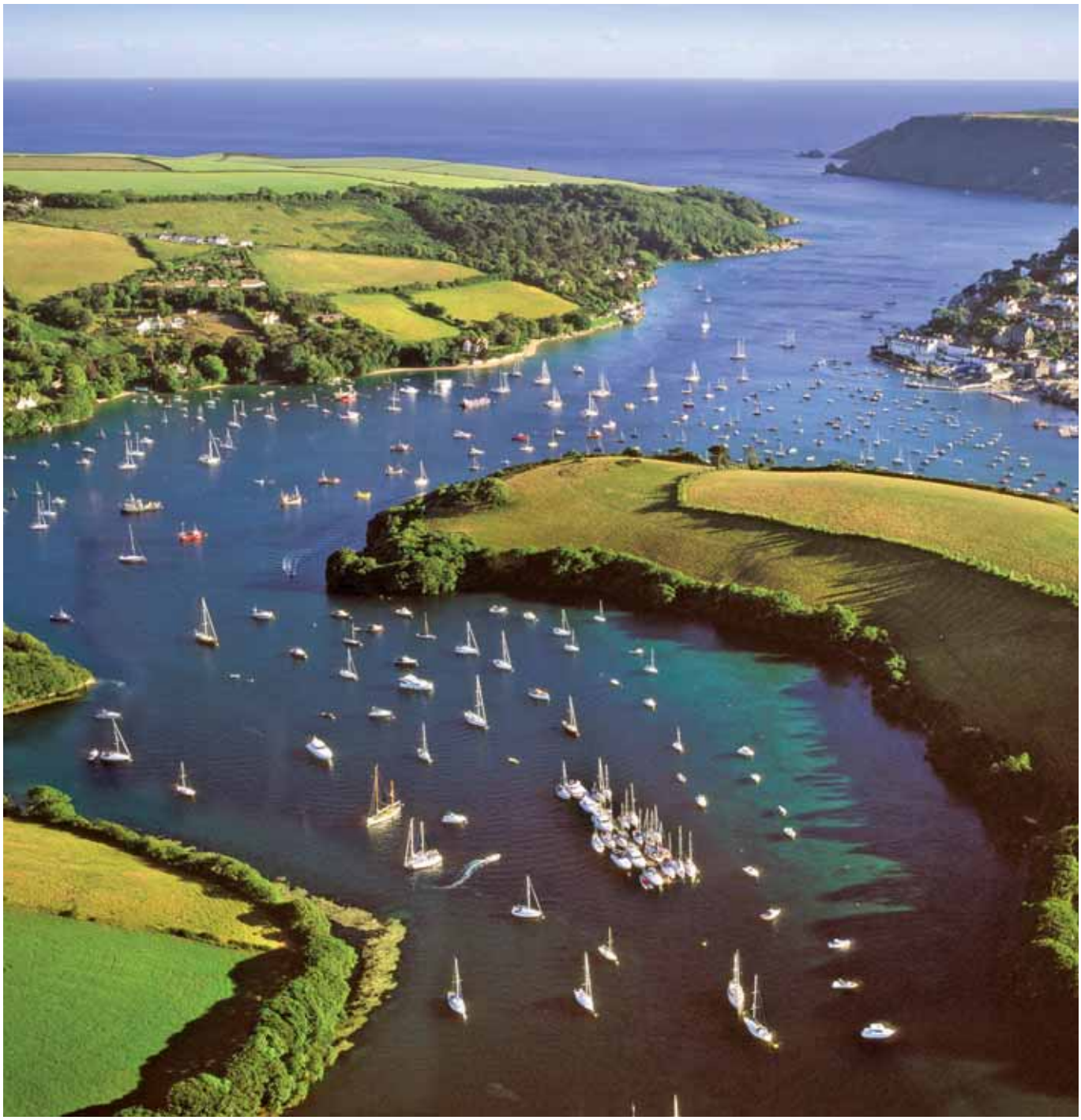
Loss of saltmarsh is occurring in southern and eastern England because sediment accretion cannot keep pace with sea level rise. This is exacerbated by coastal squeeze due to flood defences protecting reclaimed land. In south Suffolk, Essex and north Kent estuaries, 10% to 44% of the saltmarsh area was lost during the period 1973 to 1988. Further work has confirmed the ongoing loss of saltmarsh habitat in south Suffolk and Essex since 1988. In the 25 years between 1973 and 1998, over 1,000 ha of saltmarsh in south Suffolk and Essex was lost to coastal squeeze and development (see below). This pattern is repeated on the south coast of England, where areas of saltmarsh in nine estuaries declined from 1,700 ha in the 1970s to 1,080 ha by 2001. It is estimated that saltmarsh has been lost at a rate of over 1% annually since 1994 in parts of southern and eastern England and at 1.5% annually since 1946 for areas in the Solent region.

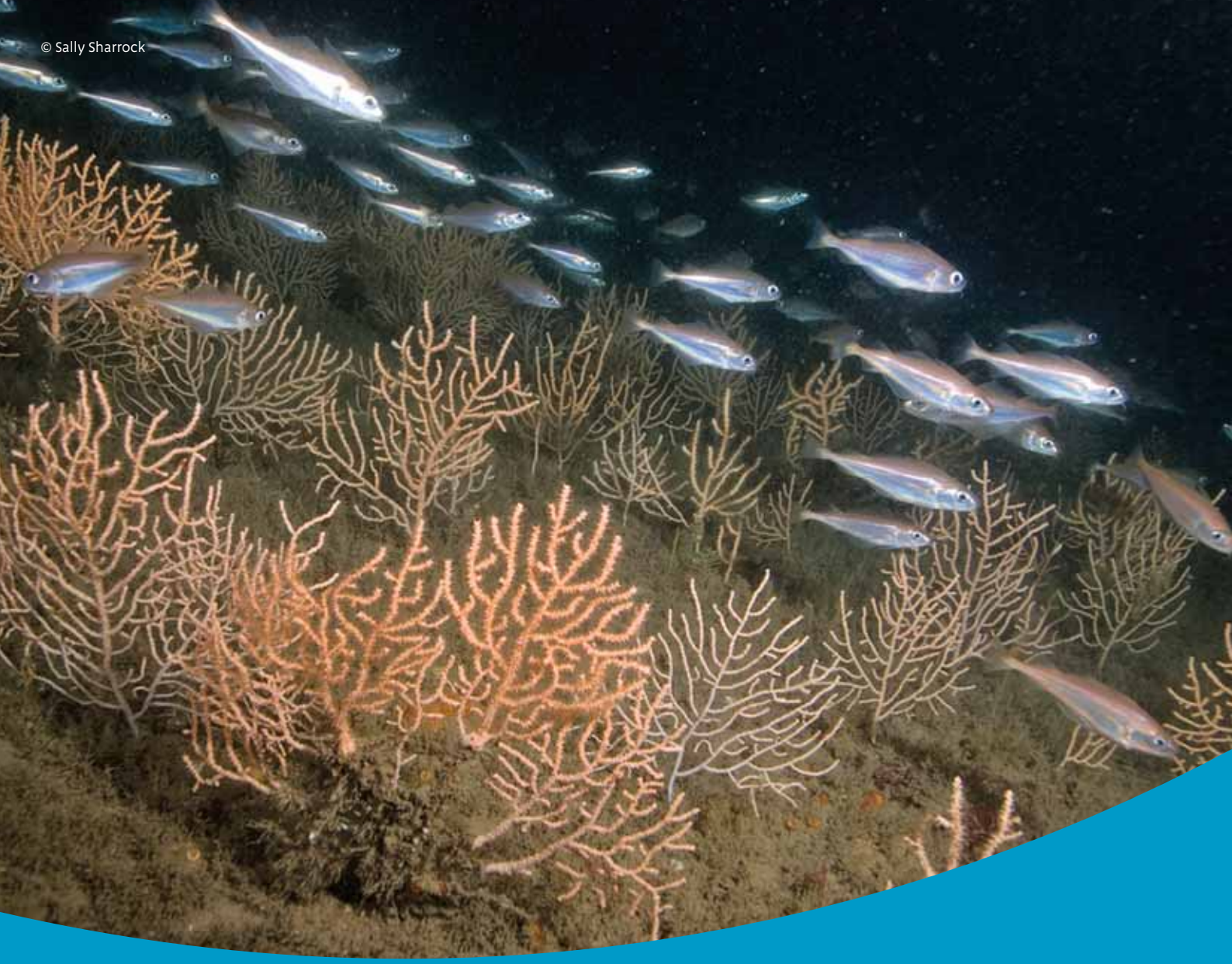
Sources: Baily & Pearson (2001); Burd (1992); Cooper *et al.* (2001); Cope *et al.* (2008); JNCC (2008)

Saltmarsh losses in south Suffolk and Essex between 1973 and 1998

	Area (ha)			Area (%) lost 1973-1997/98
	1973	1988	1997/98	
Orwell	100	70	54	46 (46)
Stour	264	148	107	157 (59)
Hamford Water	876	765	621	255 (29)
Colne	792	744	695	97 (12)
Blackwater	880	739	684	197 (22)
Dengie	474	437	410	64 (14)
Crouch	467	347	308	159 (34)
North Thames – Essex	366	197	181	185 (49)
Total	**4,219**	**3,447**	**3,060**	**1,160**

(Source: Coope *et al.* 2001)





3.12 Marine

The seabed around England is composed of a rich variety of substrata ranging from the rocky granite reefs around Cornwall to mobile sandbanks off North Norfolk. It is this variety of seabed type, coupled with the influence of both colder Arctic and warmer Mediterranean waters around our shores, that results in the diverse range of marine species and habitats.

In the north-east, the seabed tends to slope away uniformly from the coast to a depth of about 60 m, with the exception of the Farne Deeps trench, which is over 100 m deep. Water temperatures in this region are some of the coldest in the UK. Sand and gravel covers much of the offshore seabed. However, there are outcrops of bedrock along the Northumberland coast and around the Farne Islands. This area sits within the Boreal biogeographic region and its wildlife is influenced by water flowing into the North Sea off the east coast of Scotland. This cool current brings with it the larvae of species that occur along the east coast of Scotland and the island groups of Orkney and Shetland to the north. The contrast in sea surface temperatures from winter to summer contributes to the diverse and unusual range of species present, with some species reaching their northernmost biogeographical extent in this area.

To the south, in the southern North Sea, conditions reflect the movement of warmer water through the Dover Strait from the English Channel. The seabed here is largely composed of sand (often highly mobile) and mixed sand and gravel sediments, with water depths sometimes no more than 20 m. Areas off the Norfolk coast and in the outer Thames are characterised by extensive series of sandbanks and tidal sand ridges.

Further around the coast in the eastern English Channel there is a transition between Atlantic and North Sea influences. This occurs in conjunction with a transition from hard substrates to soft substrates. Water depths vary from between 30 m in the east to over 100 m in the west. Much of the seabed here is composed of mixed sand and gravel sediments, particularly to the south and west of the Isle of Wight. Areas of chalk substrate are also present within the area (particularly south of the Isle of Wight); these are of national and international importance.

Relationship between coastal and marine sections

Although this report contains separate sections on coastal and marine habitats, they are really two parts of the maritime environment. The maritime environment functions as a whole ecosystem with transitions to, and connections and overlaps with, terrestrial and freshwater habitats. For the purposes of this report, the marine environment refers to all areas seaward of the mean low water mark (including subtidal channels of estuaries) out to the limit of territorial waters (generally 12 nautical miles).

UK BAP priority marine habitats in England:

- Blue mussel beds
- Estuarine rocky habitats
- Fragile sponge and anthozoan communities on subtidal rocky habitats
- Horse mussel beds
- Maerl beds
- Mud habitats in deep water
- Peat and clay exposures
- *Sabellaria alveolata* reefs
- *Sabellaria spinulosa* reefs
- Seagrass beds
- Sheltered muddy gravels
- Subtidal chalk
- Subtidal sands and gravels
- Tide-swept channels

To the west, the marine conditions of the western English Channel are influenced by the meeting of warmer and colder water which, together with the varied geology in the area, produces a diverse marine community. Water temperatures here are some of the highest experienced in the UK. Water depths in this area range from 50 m to 120 m. The near-shore seabed is composed of an assortment of mixed sediments (especially gravel and shells) with sand and, in sheltered locations, mud. There are also occasional and sometimes extensive exposures of bedrock and boulder reefs, often occurring off headlands, particularly around south Devon and Cornwall. Of particular note are spectacular rocks and reefs, many of which rise steeply from the deep seabed to within a few metres of the surface. Many species in this region are considered to be at the edge of their range and more normally associated with warmer Mediterranean waters. Turtles and some exotic fish species are occasionally reported.

Much further around the coast in the Irish Sea, the seabed is covered by mobile sediments, ranging from the well-defined muddy-sand belt off the south-west Cumbrian coast, to the large areas of gravel-sand substrata, which cover much of the seabed. The water depth in this area seldom exceeds 60 m, though localised areas of deep water do occur. While the colder water in this region attracts species of colder water origin, it also limits the migration of warmer water species into the area.

3.12.1 Importance of England's marine habitats

Some of England's marine habitats are of European importance and four types are listed in Annex I to the EC Habitats Directive. Our large shallow inlets and bays include rias (river valleys 'drowned' by rising sea levels) in south-west England, which occur only in the British Isles, France and northern Spain (McLeod *et al*. 2005). Chalk reefs are more abundant in England than anywhere else in Europe, as are sea caves in chalk (McLeod *et al*. 2005). The great diversity of animals and plants that live on or in our sea floor is amongst the highest in Europe (Defra 2005a).

Plankton

Plankton are the free-floating microscopic plants and animals that form the base of the marine food chain, and thus provide the foundation for most other marine species. There are considerable spatial differences in the plankton diversity around the seas of England due to its location at the junction between warm temperate and Boreal (cold water) faunas. For example, the composition of the planktonic community in the northern North Sea is more seasonally variable than the southern North Sea because Boreal and warmer oceanic waters carry diverse oceanic and shelf edge communities into the area.

These patterns highlight that temperature and oceanic processes play a key role in the distribution of marine plankton, and the latter can be used as indicators of climate change. Patterns associated with climate change have already been observed around UK waters with movement of warm water and cold water plankton, and shifts in growing seasons. The diversity and abundance of fish (and therefore seabirds and marine mammals) is highly dependent on patterns of growth, composition and abundance of the plankton.

Sources: Covey & Laffoley (2002); Defra (2005c)

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3.12.1.1 Marine species

The seas around the British Isles provide habitat for over 10,000 species (Hiscock 1996). There are few flowering plants (for example eelgrasses *Zostera* species) but over 800 species of algae. Below approximately 25 m depth, there is insufficient light for any plants and the animals take over. More than twice the number of major animal groups (phyla) is found in England's seas than on the land.

The economic value of grey seals in South West England

In South West England, grey seals *Halichoerus grypus* impose costs on the fishing industry by biting fish caught in fishing nets, making them unmarketable. The fishing industry in turn is 'costly' to the seals because about 80 of the South West's population of 400 grey seals are thought to be killed as by-catch in fishing nets per year.

Visitors to the National Seal Sanctuary in Cornwall, and people who had been on seal viewing boat trips in the South West, might be willing to pay a voluntary donation (on average £2.63) towards seal conservation. If all visitors to the National Seal Sanctuary made this average donation, this would generate £526,000 per year, which exceeds the estimated £100,000 per year costs that the seals cause to the fishing industry. Such donations could potentially be used to fund work to reduce both seal by-catch and the damage caused by seals to fish in nets. More of the economic value people place on seals could be captured by the South West's economy if more boat trips provided facilities for young children. Training and accreditation of boat trip operators by the 'Wildlife Safe' programme would minimise any potential disturbance to the seals.

Source: Bosetti & Pearce (2003)

Birds

England's seas provide food for some of the most important breeding seabird populations and non-breeding waterbird and seabird congregations on Earth. This includes breeding populations of seven species of gulls, five of terns, four of auks, fulmar *Fulmarus* glacialis, Manx shearwater *Puffinus puffinus*, European storm-petrel *Hydrobates pelagicus*, gannet *Morus bassanus*, cormorant *Phalacrocorax carbo* and shag *P. aristotelis*. In winter, our seas also support internationally important numbers of divers, grebes and seaducks.

Marine mammals

There are 20 cetaceans listed as priority species the UK BAP. The commonest in English waters are the harbour porpoise *Phocoena phocoena* and bottle-nosed dolphin *Tursiops truncatus* (both listed in Annex II to the EC Habitats Directive). Harbour porpoises occur throughout our coastal waters, particularly off south-west England and the Northumberland coast. Bottle-nosed dolphins are also widely distributed, especially off south and south-west England. The most frequent species of baleen whale is the minke whale *Balaenoptera acutorostrata*. It occurs regularly off the coast of south-west England, and is seen occasionally along the Northumberland coast and offshore from Flamborough Head, mainly between June and September, which may be related to the plankton frontal system in this area. Other species, including long-finned pilot whale *Globicephala melaena*, common *Delphinus delphis*, white-beaked *Lagenorhynchus albirostris* and Atlantic white-sided dolphins *L. acutus* and killer whale *Orcinus orca*, are only found infrequently in near-shore English waters.

Two species of seal regularly occur in English waters, the grey seal *Halichoerus grypus* and the common seal *Phoca vitulina* (both listed in Annex II to the EC Habitats Directive). Grey seals can be seen regularly throughout the North Sea, south-west England and the Irish Sea (typically in the near-shore zone). Approximately 3,600 individuals (or 75% of England's grey seal population) are present off the Northumberland Coast during the breeding season (Duck 1995). A large breeding colony of common seals is found in the southern North Sea, particularly in the Wash and around the North Norfolk coast.

Fish

More than 330 species of fish have been recorded from the continental shelf (less than 200 m depth) surrounding the British Isles. The influence of cold northern waters and warmer waters from the south affects the distribution of marine fish around England. Species diversity is highest in the south west and lowest in the southern North Sea (Defra 2005d). The following description of the main fish assemblages in England's marine waters is summarised from a report (Defra 2005d) produced to support *Charting Progress - An Integrated Assessment of the State of the UK Seas* (Defra 2005a).

In the North Sea and the eastern English Channel, commercial fish populations are dominated by haddock *Melanogrammus aeglefinus* and the following UK BAP priority species: whiting *Merlangius merlangus*, mackerel *Scomber scombrus*, herring *Clupea harengus*, plaice *Pleuronectes platessa* and sole *Solea solea*. Sand-eels (including the UK BAP priority species Raitt's sandeel *Ammodytes marinus*) are abundant and these are important prey for many other fish, marine mammals and seabirds. Short-snouted *Hippocampus hippocampus* and long-snouted *H. guttulatus* seahorses are also priority species in the UK BAP. They breed in shallow coastal waters with seagrass beds, macro-algae and rocky areas off the south and south-west coasts during spring and summer, and then retreat to the relative stability of deeper waters in winter.

The western English Channel, Celtic Sea and Bristol Channel support south-western species, and warm temperate and sub-tropical species sometimes occur. The fish fauna of this area includes the following UK BAP priority species: Angler *Lophius piscatorius*, blue shark *Prionace glauca*, porbeagle *Lamna nasus*, hake *Merluccius merluccius*, common skate *Dipturus batis*, basking shark *Cetorhinus maximus* (see box) and, in the Bristol Channel, shad *Alosa* species and lampreys *Lampetra* and *Petromyzon* species which migrate up some of the rivers.

Basking shark

The basking shark *Cetorhinus maximus* is the second largest fish in the world. It can attain lengths of 12 m and weigh up to 7 tonnes. Basking sharks feed on zooplankton, which they strain from the surface waters of the seas. Comb-like appendages on the gills, called gill-rakers, act to filter out the plankton as water passes through the cavernous mouth and over the gills. The volume of an Olympic-sized swimming pool can be processed in just one hour.

Basking sharks are commonly seen in English waters from early summer along the south coast and south-west peninsula. They appear to follow the oceanic front systems which concentrate plankton in particular areas. These planktonic pulses (blooms) move northwards as the summer progresses and the seas warm in response. In recent years, sightings indicate that basking sharks are moving northwards in greater numbers. This may be linked to prey species shifting northwards in response to global climate change.

These large fish were believed to be seasonal visitors to English waters but recent satellite tagging has revealed that basking sharks are present around the coasts of England all year. In the winter months they follow the zooplankton to greater depths and are not seen at the surface until the following spring.

Source: Sims *et al.* (2005); Southall *et al.* (2005).

Turtles

English waters are considered to be part of the natural ranges of leatherback *Dermochelys coriacea* and loggerhead turtles *Caretta caretta*. Leatherback turtles are found off English coasts in summer and early autumn. Recent evidence indicates they select areas where jellyfish aggregations appear seasonally. Other marine turtles are sometimes found in our waters but these are usually 'cold-stunned' animals outside their normal range. Sightings often arise through chance encounters or following strandings. We do not fully understand the significance of turtles in English waters in terms of overall breeding populations, which are critically endangered.

Invertebrates

The invertebrate communities of our seas are extremely diverse and include groups that are almost entirely restricted to the marine environment, such as sponges, hydroids (sea-firs), sea anemones, bryozoans (sea-mats), echinoderms (sea urchins, starfish and their relatives) and ascidians (sea-squirts). There are 13 UK BAP priority species and many of them, such as the sunset cup coral *Leptopsammia pruvoti*, pink sea fan *Eunicella verrucosa* (see box) and spiny lobster *Palinurus elephas*, are associated with the rocky reefs around our south and south-west coasts. The tall sea pen *Funiculina quadrangularis* is found on areas of muddy seabed in the north-west, whilst the native oyster *Ostrea edulis* occurs in shallow coastal water habitats, mostly along the south coast. The gooseneck barnacle *Mitella pollicipes* is an oceanic species that arrives on our shores, often attached to driftwood.

Marine algae

England's marine algal flora includes six UK BAP priority species. Notable amongst these are the common maerl *Phymatolithon calcareum* and coral maerl *Lithothamnion corallioides*, which can form extensive beds on coarse sediments in the rias and estuaries of south-west England. They provide an important habitat for marine invertebrates and fish.

Pink sea fan

The pink sea fan *Eunicella verrucosa* occurs from the eastern Mediterranean to south-west Britain. Sea fans are a type of horny coral that catch suspended food using the anemone-like polyps along their branches, which face into the prevailing current. They usually live at depths of 15 m or more.

Sea fans provide a home for the nationally rare sea-fan anemone *Amphianthus dohrnii*, as well as being a source of food for the sea slug *Tritonia nilsodhneri* and the 'poached egg shell' *Simnia patula*, which are both camouflaged to resemble the sea fan. The highest densities of pink sea fans in the UK occur off Plymouth and the Lizard where there may be up to 20 per square metre.

The pink sea fan receives special protection by virtue of being listed in Schedule 5 to the Wildlife and Countryside Act 1981. However, sea fans have suffered damage from fishing operations, such as scallop dredging in Lyme Bay, and are also vulnerable to the effects of nutrient enrichment, disease and climate change.

Source: Hiscock *et al.* (2005)

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3.12.2 Extent of habitats

Providing a comprehensive assessment of the area of marine habitats around the coast of England is not possible. This is because the relatively few existing surveys are restricted to a few areas. A broad picture of marine habitats has emerged following a two-year project to produce a new map of the sea that shows 44 large-scale 'undersea landscapes' (Figure 3.28). This 'UKSeaMap' project (Connor *et al*. 2006) has identified that undersea landscapes contain the equivalent of mountains, valleys and plains, together with major habitat types.

Based on the UKSeaMap data, there are almost 5 million ha of undersea landscapes in England's seas, of which the overwhelming majority is coarse (47%) or sandy (32%) substrate (Figure 3.28). Although England's territorial waters comprise a relatively small proportion of the wider UK continental shelf waters, they are more diverse and show finer-scale variation of substrate types, tide stress and physiographical features compared to offshore areas.

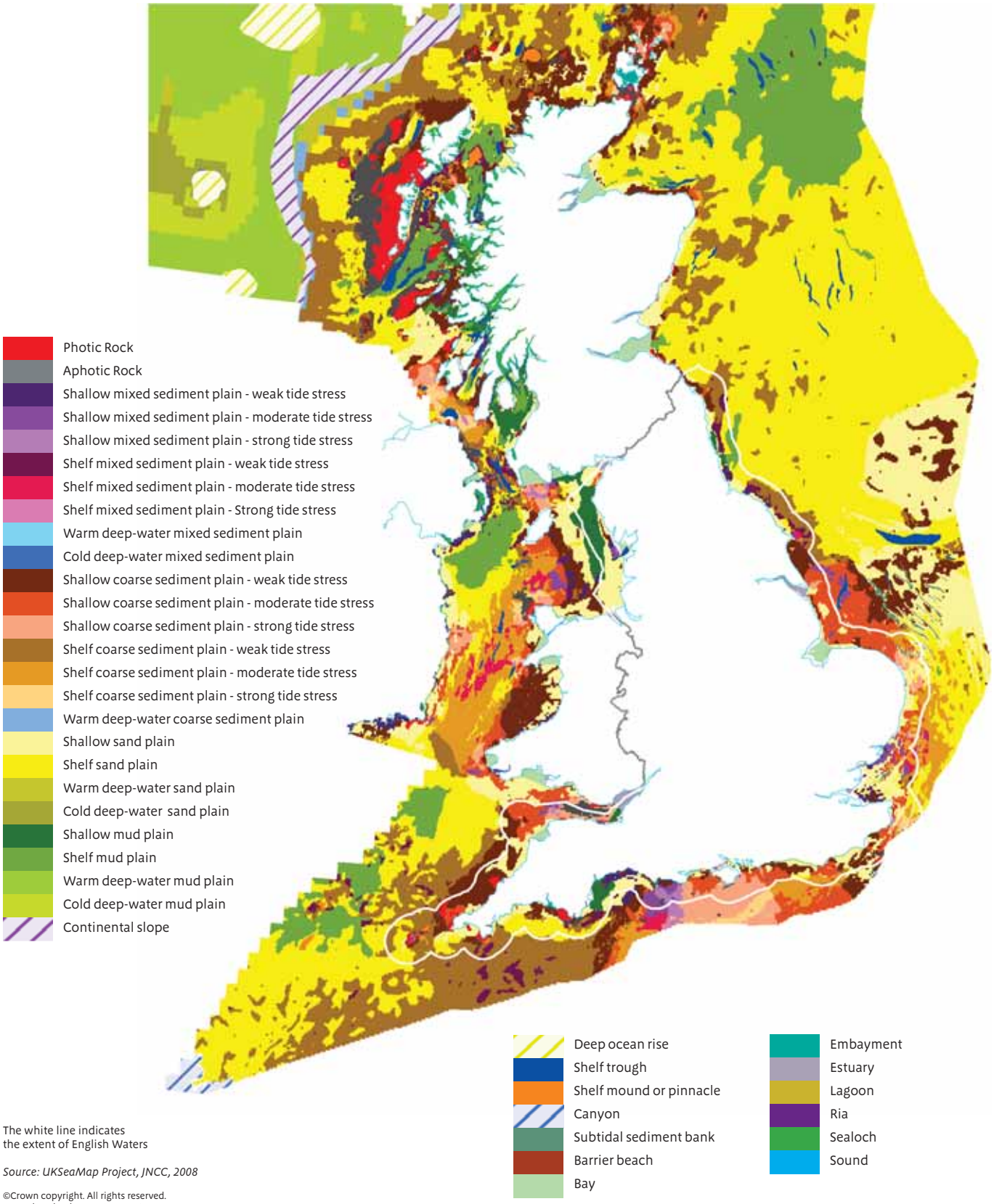
3.12.3 Protection

This section only describes the protection afforded by SACs and Marine Nature Reserves (MNR), which both include subtidal habitats, including substantial areas outside of estuaries and other inlets. (Subtidal areas within SSSIs, SPAs and Ramsar sites are reported on in the coastal section: this is because these designations do not currently extend to subtidal areas beyond estuaries.)

Marine SACs (beyond the areas within SSSIs) include 247,000 ha of marine habitat, representing 5% of the marine resource in England (Figure 3.29). Of this, approximately 106,000 ha are coarse or mixed sediments, 60,000 ha are sand or mud, 14,000 ha are rocky, and 46,000 ha consist of coastal physiographic features (such as bays, embayments, estuaries or rias). This largely reflects the nature of the habitat types for which SACs have been selected in England's marine environment (subtidal sandbanks, large shallow inlets and bays, reefs, and sea caves).

Only one Marine Nature Reserve (MNR) has been designated in England, covering an area of 3,065 ha of the shores and sea around Lundy off the north Devon coast. This area overlaps entirely with the Lundy SAC. In 2003, 330 ha of sea on the eastern side of Lundy MNR and SAC were confirmed as England's first statutory No Take Zone (NTZ), to provide enhanced protection for the island's marine wildlife.

Figure 3.28 UKSeaMap – Seabed landscapes in the UK



The white line indicates
the extent of English Waters

Source: UKSeaMap Project, JNCC, 2008

Figure 3.29 Marine SACs outside SSSIs

Source: Natural England, 2008

3.12.4 Condition

The best available assessment of the UK conservation status of the four Annex I marine habitats for which SACs have been designated in England is provided by JNCC (2007b). It reported that two of the habitats, 'sandbanks which are slightly covered by sea water all the time' and 'large shallow inlets and bays', were unfavourable. The main threats identified were climate change, fishing activity and aggregate extraction. Risk assessments undertaken for the Water Framework Directive identified 22% of UK large shallow inlets and bays as being 'at risk' of failing to meet the standard of Good Environmental Status (Environment Agency 2006b). The conservation status of the remaining two Annex I habitats, 'reefs' and 'submerged or partially submerged sea caves', was not known (JNCC 2007b).

Defra (2005b) identified a wide range of different human activities which have impacts upon the marine environment. These include fishing; marine pollution, including nutrient enrichment and toxic chemicals; extractive uses, such as aggregate dredging and oil and gas extraction; shipping; and invasive non-native species (see Chapter 5).

The Worldwide Fund for Nature's (WWF) marine health check (Hiscock *et al*. 2005) reported on the threats to habitats that have seriously declined over the last 50 years or more:

- Seagrass beds - physical disturbance, invasive non-native species, disease and nutrient enrichment.
- Horse mussel beds - fishing (particularly the use of heavy trawl gear), climate change, coastal development and dredging.
- Maerl beds - commercial extraction, fishing, aquaculture and nutrient enrichment.

In spite of such observations, insufficient knowledge and information continue to hamper full assessments of our seas. This was a particular issue for Defra (2005a) in its first integrated assessment of the UK's seas. It highlighted that information shortfalls were evident, co-ordination was a problem, and indicators and detailed objectives were absent. This was similarly apparent in the 2005 assessment of 14 marine UK BAP priority habitats (BRIG 2006a). The status of nine was unknown and the conclusions for the remaining five were acknowledged to have been largely based on expert judgement, limited by the lack of a systematic surveillance programme.

Valuing people's preferences for sea angling

Recreational sea angling is enjoyed by people of all ages and from all backgrounds. An estimated total of 1.45 million people (5% of households) from all walks of life in England and Wales went sea angling in 2003.

Recreational anglers do not typically pay an access or licence fee to fish in the sea but this does not mean that the activity is not of value to them. A day's fishing had an average value of £26 to a shore angler, £42 to an angler fishing from a charter boat and £104 if they fished from their own boat. Anglers value the experience more highly if they catch bigger fish (they were willing to pay £0.22 for each 1% increase in size in the fish that they caught) and if there is greater diversity of fish (they were willing to pay £8.86 to catch a different type of fish to usual). This highlights the important role of fisheries management in influencing the value to people of a day's angling. In general, the diminished status of many fish stocks is decreasing the number and size of fish that anglers catch.

Sources: Drew Associates (2004)

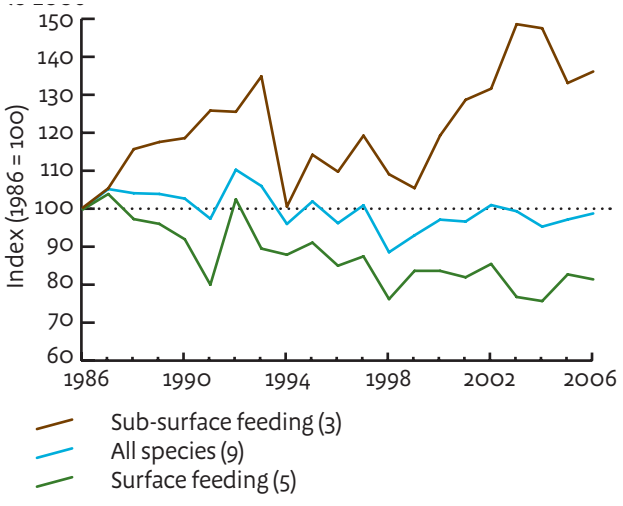
3.12.4.1 Trends in seabirds

Between 1986 and 2006, the index of seabird populations (which is mostly derived from counts of breeding adults) in England has remained relatively stable (Figure 3.30). Within this overall position, surface feeding species such as Sandwich tern *Sterna sandvicensis* (pictured) and kittiwake *Rissa tridactyla* have declined and continue to do so. These two species are now at 82% and 62% of their baselines, respectively, the lowest numbers on record. Overall, the trend for surface feeding species is at 19% below the 1986 baseline (Defra 2008a).

Trends of sub-surface feeding species such as cormorant, shag and guillemot *Uria aalge* have increased overall by 35% since 1986, largely due to guillemots more than doubling in numbers to 136% above the 1986 baseline (Defra 2008a).

The seabird index may not yet fully reflect the low breeding success rates of some species during recent years, because seabirds take several years to reach maturity. There will therefore be a lag before the results of reduced breeding success manifest themselves as a decline in breeding adults. In most species, poor breeding success is a direct result of food shortages during the breeding season, but it is not yet clear whether over-fishing, climate change, or some combination of both factors is the ultimate cause.

Figure 3.30 Population trends of seabirds in England, 1986 to 2006



(Source: BTO, RSPB, JNCC, Defra 2008a)

3.12.4.2 BAP marine action plan threats

The main issues posing a threat to marine habitats and species are (BRIG 2006a):

- Habitat loss and degradation from **infrastructure development,** such as coastal defence works, dredging and, to a lesser extent, industrial and port infrastructure.
- **Fisheries practices,** especially damage caused by bottom-trawling fishing gear and dredging for molluscs, fisheries by-catch and over-fishing.
- **Poor water quality** from oil slicks, sewage, sediment, domestic and commercial sources, as well as run-off to estuarine waters from inland agricultural sources (fertilisers and pesticides).
- **Climate change,** including sea level rise and warming waters (affecting species distributions).
- Other pressures, including **human disturbance** (particularly from recreational activities, such as water sports and fishing), may be very significant locally.

3.13 Species overview

In the previous sections we highlighted the importance and population trends of species characteristic of each habitat type. However, some species are not readily associated with a single habitat type, as they use several habitats across the landscape. Here we provide an overview of England's species and their protection, including that afforded through site designation. We also present the major available trend data for each species group.

England's position at the edge of Europe, together with its complex geology, varied land-use and relatively wet and warm climate have resulted in a rich, distinctive mix of species, with representatives of Boreal, Baltic, central European, Atlantic fringe and Mediterranean zones. Limited opportunities for colonisation during interglacial periods mean that most terrestrial species groups have lower diversity here than in nearby continental Europe. In contrast, England's position on the edge of the European continental shelf means it is particularly rich in coastal and marine species.

England's species are probably the best studied in the world, with a history of recording by amateur naturalists dating back three centuries. This provides unrivalled opportunities to investigate changes in species' distributions and status.

3.13.1 International importance of England's species

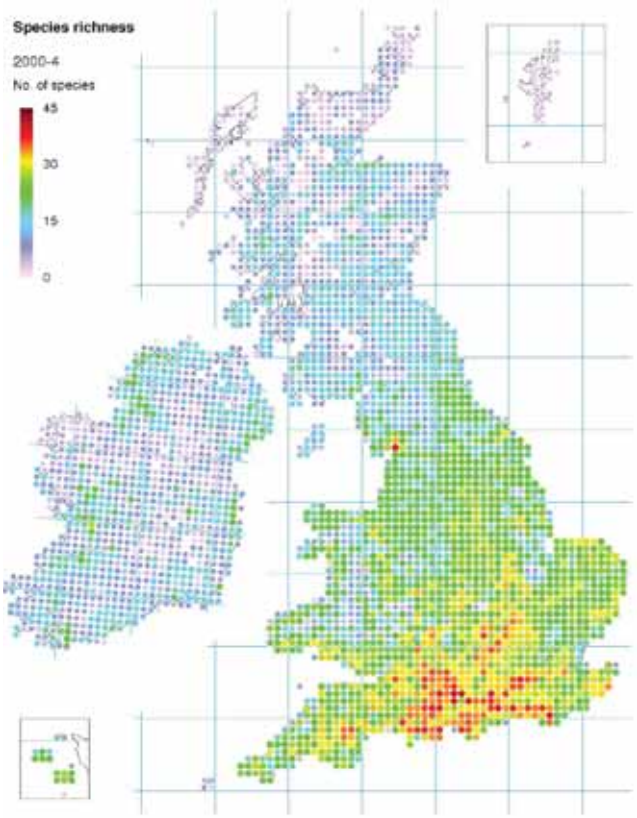
England has globally important populations of some species. Our coasts and seas support some of the most important breeding populations of seabirds in the world (Brown & Grice 2005). England's populations of non-breeding waders, wildfowl and gulls are also of global significance, which is reflected by the fact that three-quarters of England's SPAs are classified wholly or partially for them.

England holds internationally important populations of several species of bats. Bechstein's *Myotis bechsteinii*, barbastelle *Barbastella barbastellus*, and lesser *Rhinolophus hipposideros* and greater horseshoe bats *R. ferrumequinum* are of international conservation concern and are amongst our rarest bats. Some of these populations are significant in being the most northerly in Europe. At least 10% of the world population of Chinese water deer *Hydropotes inermis* is found in the east of England (Cooke & Farrell 1998; Ward 2005) which, despite this being non-native, is important as the species is in decline within its natural range (Battersby 2005).

Only two of England's amphibians and reptiles are of international significance, great crested newt *Triturus cristatus* and pool frog *Rana lessonae*. However, several species' populations (sand lizard *Lacerta agilis*, smooth snake *Coronella austriaca* and natterjack toad *Bufo calamita*) are important in a northern European context or because they demonstrate interesting patterns of genetic diversity at the edge of their range. England does not have any endemic freshwater fish, but eight of our species are of sufficient European importance to be listed in Annex II to the EC Habitats Directive.

Although we have a somewhat limited invertebrate fauna when compared with mainland Europe, England's fauna includes a unique biogeographical mix of species, including elements of northern, Baltic, central European, Atlantic fringe and southern species. There are currently considered to be no more than 12 endemic species of invertebrate in the whole of the UK. In addition, only eight species of invertebrates that occur in England are listed as internationally threatened by the International Union for Conservation of Nature (IUCN). However, some elements are better represented here than in mainland Europe, notably some Atlantic fringe species and also the fauna of veteran trees in our ancient woodlands and parklands, of which England holds a high proportion of the European resource. Our wetlands and coasts also have important populations of invertebrates. A very large number of species of invertebrate have the edge of their British or European range in England and are therefore especially sensitive to climatic and ecological changes.

Butterfly species richness (number of species per 10 km square) in Britain and Ireland 2000-2004



54 of the 56 resident UK species of butterfly occur in England. Species richness is highest in the south of England, particularly associated with calcareous vegetation (for example, Salisbury Plain, the Isle of Purbeck in south Dorset, the North Downs and South Downs), and elsewhere (for example Morecambe Bay Pavements in North West England).

Source: Fox *et al.* (2006)

There are thought to be 23 vascular plant species endemic to England, plus a further 21 Great Britain or 'Great Britain and Ireland' endemics that occur in England. A provisional assessment of 'international responsibility' (Cheffings & Farrell 2005) identified those plant species for which Great Britain is thought to support greater than a quarter of the European population. This includes the endemics, as well as species with restricted ranges in mainland Europe that are frequent in parts of England, for example English scurvygrass *Cochlearia anglica*, northern marsh-orchid *Dactylorhiza purpurella*, ivy-leaved crowfoot *Ranunculus hederaceus* and spring squill *Scilla verna*. A large number of vascular plant species in England occur at or near the limits of their European range, including many Mediterranean-Atlantic and southern-temperate taxa at their absolute northern European limit (Preston 2007). The conservation value of these 'edge-of-range' species is considerable.

England has just over half of the bryophyte species occurring in the European flora (with three endemic species). This is a much higher proportion than for flowering plants (less than a fifth), emphasising the importance of England for bryophytes in the European context. The only known world occurrence of the many-fruited beardless-moss *Weissia multicapsularis* is at two sites in England (both in Cornwall), and its strongest population is at risk and currently not designated. The British Isles are internationally renowned for their Atlantic communities of bryophytes (Church *et al.* 2004) and the Borrowdale Woodlands complex in Cumbria harbours some rich examples, with deceptive featherwort *Adelanthus decipiens*, rock fingerwort *Lepidozia cupressina*, straggling pouchwort *Saccogyna viticulosa* (all liverworts) and sparkling signal-moss *Sematophyllum micans*. Western rustwort *Marsupella profunda* is an oceanic liverwort found in England (Cornwall), but otherwise only known from Portugal and the Azores. The English populations are thought to be the largest in Europe.

Britain holds around one third of the European lichen flora and is of international importance for its high proportion of oceanic lichen species. Of particular significance are sheltered valley woodlands along the west coast where the combination of high rainfall, cool summers and mild winters favours the development of rich lichen communities. Many oceanic species, although not threatened in England, have a very restricted international distribution and some are included in the European Red Data List (Church *et al.* 1996). Ancient woodlands and open parklands are also significant for lichens on veteran trees.

Over 100 key sites in England have been identified as Important Fungus Areas because of their European importance and rich fungi assemblages (Evans *et al.* 2001). These complement the suite of Important Plant Areas (see box).

Important Plant Areas

Important Plant Areas (IPAs) are the most important places in the UK for wild plants. The IPA concept identifies a network of the most valuable sites for plant diversity as a basis for prioritising conservation action at the site and landscape levels.

The Global Strategy for Plant Conservation seeks to ensure the protection of 50% of the world's most important areas for plant diversity by 2010. Identifying IPAs is the first step towards achieving this.

IPAs have at least one of the following:

- a significant population of one or more species of international conservation concern
- an exceptionally rich flora in a European context
- an outstanding example of a habitat of international plant conservation and botanical importance.

To date 91 IPAs have been identified in England. Examples include The Lizard in Cornwall, Upper Teesdale in Durham and The Broads in Norfolk and Suffolk. The Atlantic coast of the South West is internationally renowned for assemblages of bryophytes and lichens, giving rise to a concentration of IPAs.

Number of IPAs in England (IPAs can have more than one group represented):

- Freshwater algae 3
- Marine algae 6
- Bryophytes 23
- Lichens 31
- Stoneworts 11
- Vascular plants 44

Source: Plantlife International (2008)

3.13.2 Number of species in England

It is difficult to produce a definitive list of the number of species in England, due to the discovery of new species and taxonomic changes. Table 3.19 shows current estimates for each group, which are subject to change and refinement.

About 550 bird species have been recorded in England. None of these are endemic to England. Some 236 species regularly breed or spend the non-breeding season in England. Many hundreds of non-native species have been found in the country but just 10 appear on the formal 'British List' because these have apparently self-sustaining populations.

England has an impoverished mammalian fauna compared with mainland Europe, with less than one-quarter of Europe's terrestrial mammals (Temple & Terry 2007). There are 64 terrestrial mammals and 22 (regularly occurring) marine species (Yalden 1999; Macdonald & Tattersall 2001). This includes 20 non-native terrestrial species of which, two (Chinese muntjac *Muntiacus reevesi* and red-necked wallaby *Macropus rufogriseus*) are not found elsewhere in Europe (Macdonald & Tattersall 2001).

The economic value of charismatic species

Otter *Lutra lutra* and water vole *Arvicola terrestris* are both UK BAP priority species. The otter population has increased in numbers and distribution over the past ten years, following a historical decline as a result of poisoning by organochlorine pesticides. Water voles were once a familiar sight throughout England but have declined significantly due to deterioration in habitat quality and predation by mink *Mustela vison*.

People in North Yorkshire were willing to make an average one-off payment of £10.92 towards the BAPs for the otter and water vole. If everyone over the age of 20 living in North Yorkshire was willing to make this average payment the total value that they placed on conservation of these species would be £5.8 million. This benefit for people in North Yorkshire alone is more than double the estimated present value of the cost of the action plans for conserving otters and water voles across the whole of the UK (£1.8 million). This indicates that not only that there is public support for conservation of the otter and the water vole, but that it is in the interests of society to conserve them.

Source: White *et al.* (1997)

Table 3.19 Estimated numbers of species in England

Species group	Estimated number of native species	UK BAP priority species (England)	Estimated number of non-native species
Birds	550	53	10
Mammals (terrestrial)	64	18	20
Amphibians	7	4	8
Reptiles (terrestrial and marine)	7	7	4
Freshwater fish	42	13	33
Invertebrates (terrestrial and freshwater)	40,000 *	380	474
Vascular plants (terrestrial and freshwater)	2,744	160	1,846
Bryophytes	935	76	18
Lichens	>1,700 *	98	n/a
Fungi	12,000 - 20,000 *	60	198
Marine mammals	22	17	0
Marine fish	>300 *	35	0
Marine plants/algae	>900 *	6	25
Marine invertebrates	>7,000 *	19	39

* Estimate for United Kingdom

(Source: Maitland & Lyle 1992, Arnold 1995, Church *et al.* 1996, Evans *et al.* 2001, Key *et al.* 2000, Macdonald & Tattersall 2001, Preston *et al.* 2002a, Church *et al.* 2004, Defra 2005c, Brown & Grice 2005, Hill *et al.* 2005, BRIG 2007)

No formal analysis has been made to define England's invertebrate fauna, but there are around 40,000 invertebrate species in the UK. Based on a sample study of 14 groups, Key *et al*. (2000) estimated that as many as 98% of Great Britain's invertebrate species may occur in England (Table 3.20). Within this, around 22% (range 8% to 40%) seem to occur only in England. This would equate to over 6,600 of the British invertebrate fauna being restricted to England.

As there is no formal list of 'English' vascular plants, we present a provisional total produced for us for this report by the Botanical Society of the British Isles (BSBI), which estimated 2,744 native species. The total includes species, subspecies, micro-species, hybrids and (selected) cultivars known to occur (or to have occurred in the past) in England. However, our native flora has been hugely affected by the introduction of non-natives, including recently introduced species and 'cultivars' which are continuing to escape from gardens and become established in the wild.

To date there is no comprehensive list of fungi in England. A conservative estimate for the whole of the UK is about 12,000, but new species are being discovered each year and added to the national list, so the true number might be nearer 20,000 (Evans *et al*. 2001). Individual sites may support many species of fungi and the best recorded sites in Britain are Esher Common (Surrey) with 3,100 species and Slapton Ley (Devon) with 2,500.

Table 3.20 Number of invertebrate species within sample groups occurring in England and Great Britain

Invertebrate species group	England total (restricted to England)	Great Britain
Dragonflies	37 (9)	40
Grasshoppers/crickets	27 (11)	27
Ants	41 (13)	42
Bumblebees	25 (2)	25
Ground beetles	331 (108)	337
Click beetles	75 (29)	77
Snail killing flies	66 (7)	66
Lesser dung flies	27 (5)	27
Butterflies	54 (13)	56
Moths (noctuid)	303 (46)	313
Leeches	16 (2)	16
Harvestmen	23 (2)	24
Millepedes	48 (14)	48
Molluscs	171 (32)	174

(Source: Key *et al*. 2000)

3.13.3 Protection

Many species of birds, other animals and plants receive some protection directly through a variety of national legislation, notably the Wildlife & Countryside Act 1981 (as amended). Some species are subject to special protection under the aforementioned Act (those listed in Schedules 1, 5 and 8 of the Act). The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) (the 'Habitats Regulations') list European protected species, including all cetaceans, marine turtles and bats, two other terrestrial mammals, two reptiles, two amphibians, one invertebrate and nine vascular plants. The Habitats Regulations transpose the relevant provisions of the EC Habitats Directive into national law, whilst the Wildlife and Countryside Act does the same for the EC Birds Directive.

Many species are also afforded protection through site designation. In some cases this is indirect, through the designation of SSSIs, SACs and Ramsar sites for important habitats. In addition, some SSSIs and SACs are designated specifically for their species interests and SPAs are classified specifically for birds. Ramsar sites are designated for internationally important wetland habitats and species.

In England, 1,517 SSSIs have been notified (in whole or in part) for species, with birds, invertebrates and vascular plants having the largest numbers (Table 3.21 and Figure 3.31). Some individual species or species groups are particularly strongly represented: of the 131 SSSIs notified for mammals, 63 (48%) are for bats and 41 (31%) for otter *Lutra lutra*, and of the 47 SSSIs notified for amphibians, 31 (66%) are for great crested newts.

Eighty-one SPAs have been classified for birds and 125 SACs designated for other species (Figure 3.32). The effectiveness of European site designations is examined in Chapter 6.

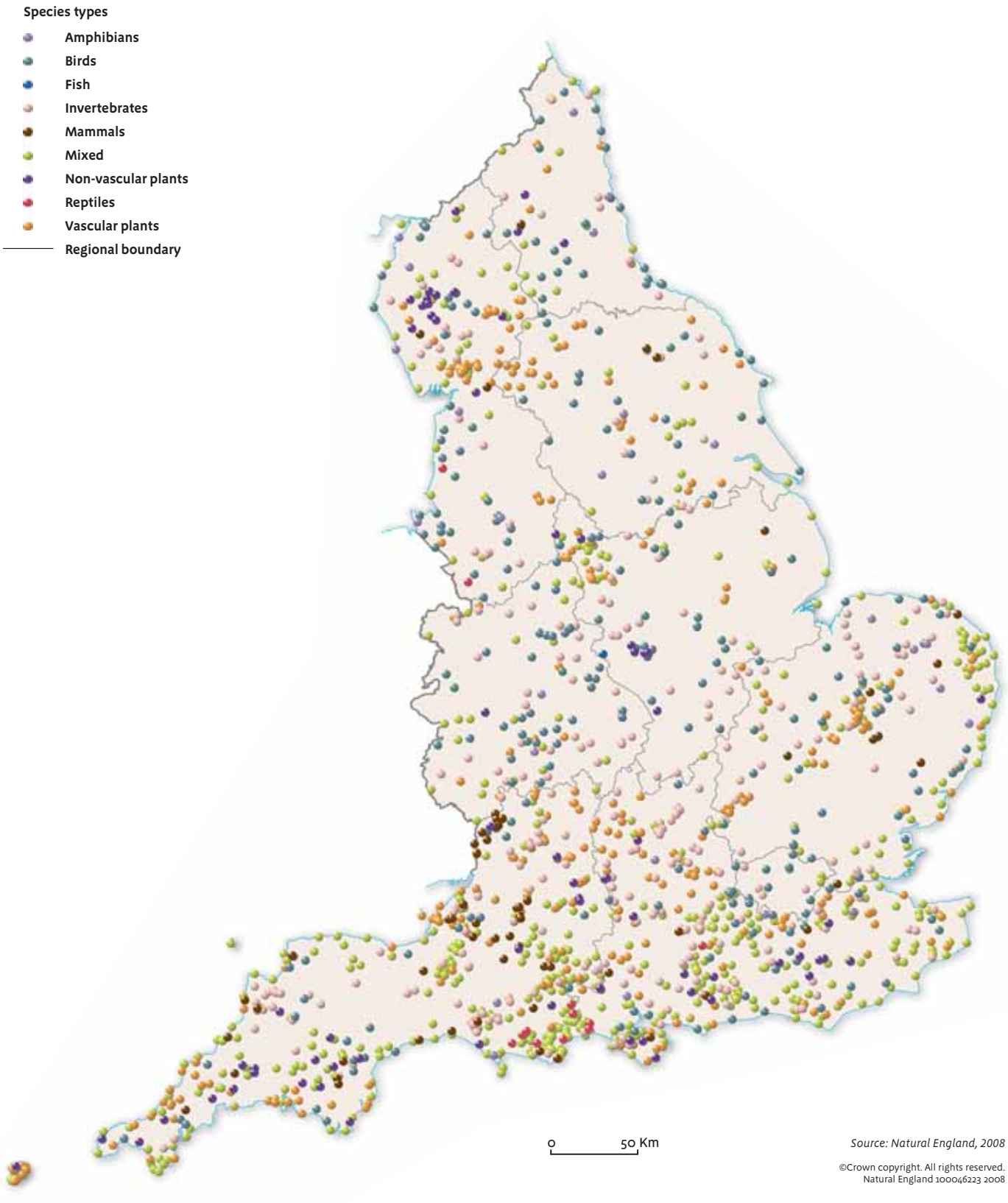
Table 3.21 Designated sites for species in England

Species group	Number of SSSIs with species as notified feature	Number of SACs or SPAs
Birds	570	81
Invertebrates	692	42
Mammals	131	36
Amphibians	47	24
Reptiles	59	0
Fish	29	25
Vascular plants	617	27
Non-vascular plants	184	12
All species	**1,517**	**206**

Note: A SSSI or SAC can have more than one species group interest and SPAs and SACs often overlap with more than one SSSI.

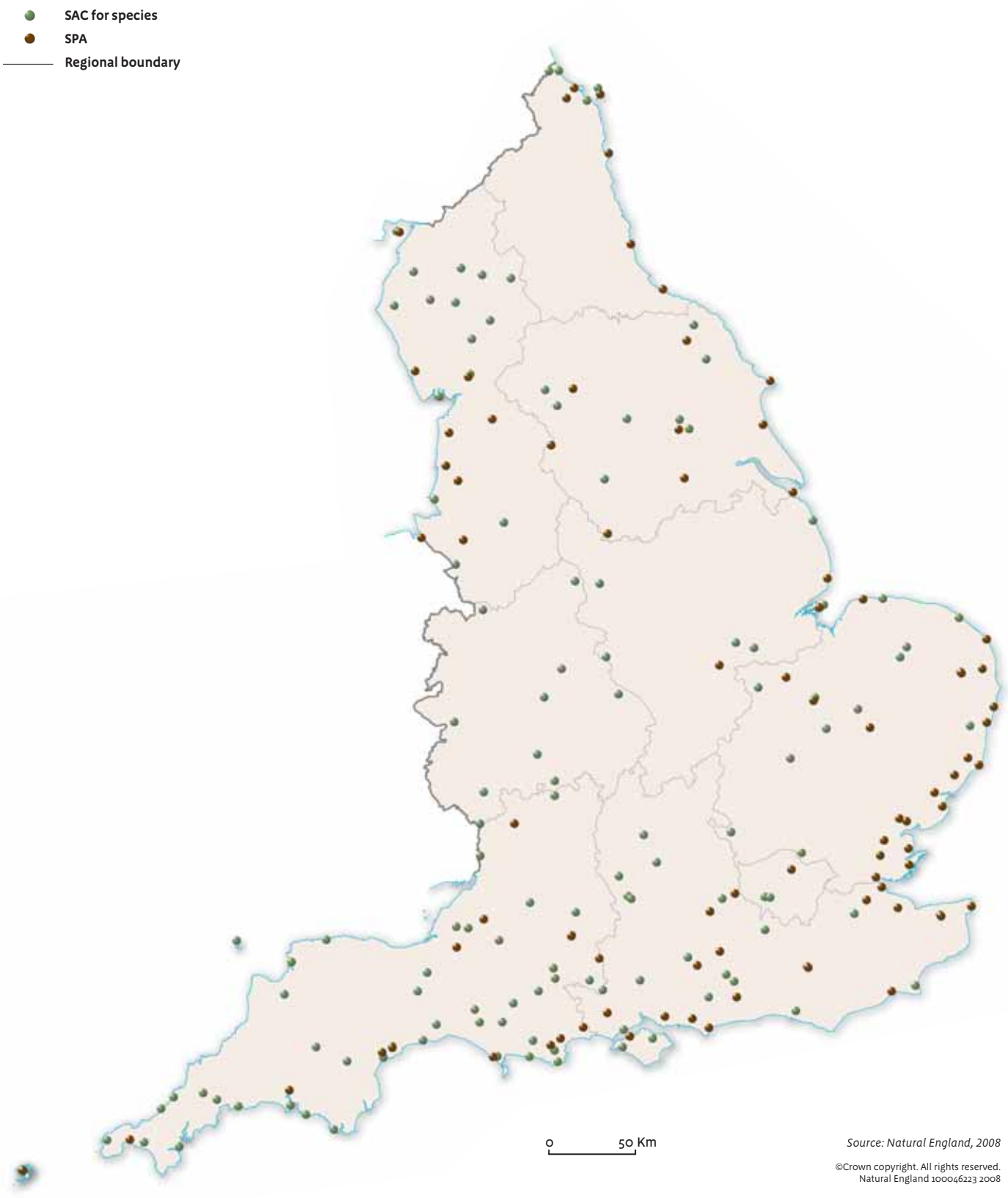
(Source: Natural England, 2008)

Figure 3.31 Distribution of SSSIs in England with species interest features



Source: Natural England, 2008

Figure 3.32 Distribution of SACs with species interest and SPAs in England



Source: Natural England, 2008

3.13.4 Condition

3.13.4.1 Trends in species groups

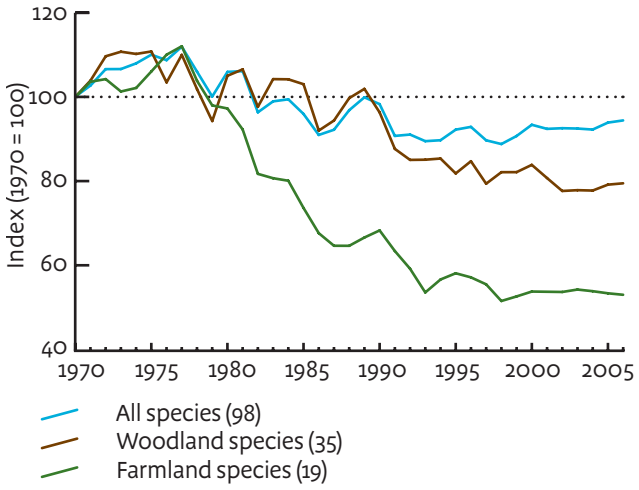
The quality of data on the state of species in England varies greatly between groups. Long-running monitoring datasets are available for birds, bats, butterflies, moths and vascular plants. However, for many other groups, there are few time-series datasets, especially for species that are not of economic or sporting importance. For some species, many of the existing data are anecdotal. Here we present the significant trend data for species not covered in the earlier habitat sections.

Birds

Nearly all wild bird species in England are monitored annually or periodically by the Government's wildlife conservation agencies and their voluntary sector partners the British Trust for Ornithology (BTO), Royal Society for the Protection of Birds (RSPB) and Wildfowl and Wetlands Trust (WWT). Therefore, there exists an extremely strong body of evidence for change in our wild bird populations and this allows us to examine both species-specific and broader changes. Bird populations are considered to be a good indicator of the wider state of biodiversity because they occupy a wide range of habitats, they tend to be near the top of the food chain and there are good long-term data available. Consequently, populations of wild birds in England feature as one of the headline indicators in the England Biodiversity Strategy (Defra 2006c). The England Biodiversity Strategy's all-species indicator (Figure 3.33) shows that, following a low point in the late-1990s, the population index of 98 breeding bird species in England had recovered to 6% below the 1970 baseline in 2006 (Defra 2008a).

However, the habitat-related indicators for breeding woodland and farmland birds (described in Sections 3.5.4.1 and 3.6.4.1, respectively) show different trends to the all-species indicator (Figure 3.33). Since 1970, woodland birds and, in particular, farmland birds have decreased. In recent years all the indicators have levelled off. However, for both woodland and farmland birds, it is the specialist rather than the generalist species that have shown the major declines. The relevant habitat sections describe the trends in urban birds since 1994 (Section 3.10.4.1) and seabirds since 1986 (Section 3.12.4.1).

Figure 3.33 Population trends of wild birds in England, 1970 to 2006

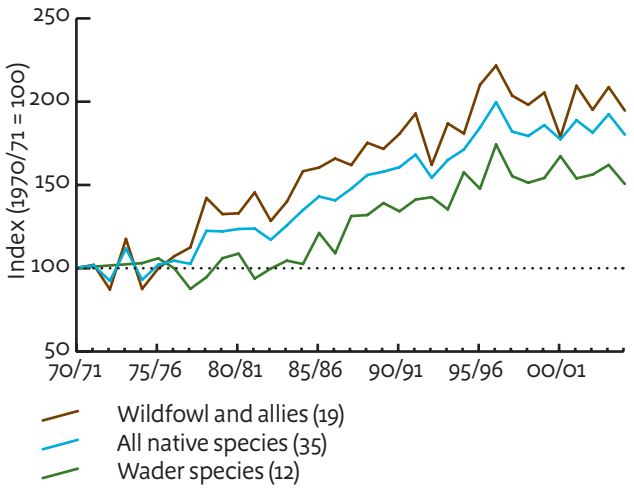


(Source: BTO, RSPB, JNCC, Defra 2008a)

The wintering wetland birds indicator (Figure 3.34), covering species that winter on England's inland and coastal wetlands and open waters, doubled between 1975/76 and 1996/97, but has since been relatively stable at around 180% of the 1970/71 baseline up to 2004/05 (Defra 2008a). The index for wintering wader species (including for example oystercatcher *Haematopus ostralegus* and curlew *Numenius arquata*) has increased by around 50% since 1984/85, whilst that for wildfowl (including for example mute swan *Cygnus olor* and pink-footed goose *Anser brachyrhynchus*) follows the all-wintering wetland birds indicator, but with a more pronounced peak in 1996/97. Some birds have shown massive increases (for example gadwall *Anas strepera*, light-bellied brent goose *Branta bernicla* subspecies *hrota* and whooper swan *Cygnus cygnus*), whilst others have suffered varying degrees of decline (Defra 2008a).

High alerts (more than 50% decline) have been triggered for European white-fronted goose *Anser albifrons* subspecies *albifrons* over the medium- (10 years) and long-term (25 years) up to 2004/05 (Maclean & Austin 2008). A further seven species have triggered medium alerts (more than 25% decline): dark-bellied brent goose *Branta bernicla* subspecies *bernicla* (medium-term), mallard *Anas platyrhynchos* (long-term), pintail *Anas acuta* (long-term), scaup *Aythya marila* (short-term - 5 years), eider *Somateria mollissima* (short-, medium- and long-term), goosander *Mergus merganser* (short-term) and purple sandpiper *Calidris maritima* (short- and medium-term). The distributions of many species are changing, with a general shift away from south-western sites to those in the north and east, in line with expectations from global climate change (see Section 5.2).

Figure 3.34 Populations of wintering waterbirds In England, 1970/71 to 2005/06



(Source: BTO, RSPB, JNCC, Defra 2008a)

In addition, many essentially 'southern' species, including Mediterranean gull *Larus melanocephalus*, little egret *Egretta garzetta*, woodlark *Lullula arborea* and Dartford warbler *Sylvia undata*, are thriving and extending their distributions northwards. All of these species' UK distributions are concentrated in England.

Many of the rare bird species that are subject to intensive conservation action are also doing well. The stone curlew *Burhinus oedicnemus*, for example, has steadily increased in numbers from 149 breeding pairs in 1994 to an estimated 347 pairs in 2006 (Natural England & RSPB unpublished data); a direct result of Natural England and its partners' conservation action for birds.

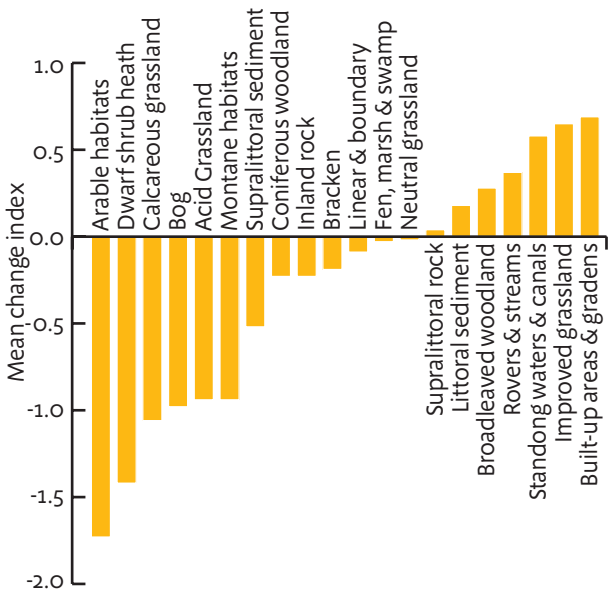
Plants

Although very few species have been lost from England as a whole in recent decades, there appear to have been a considerable number of extinctions at local (county) scale (Marren 2000, 2001; Preston 2000; Preston *et al*. 2002b; Walker 2003, 2007). A detailed analysis by Walker (2003) found an average extinction rate at county scale of one species every two years for the 20th century as a whole, with the highest rates occurring in lowland counties and in southern and eastern England. Further analysis by Walker (2007) showed an overall increase in average extinction rates during the 20th century, with the highest rates being recorded since the 1960s.

The publication of the New Atlas of the British and Irish Flora (Preston *et al*. 2002a) has shown how the composition and distribution of the British (and English) flora has changed (Figure 3.35). Species associated with arable habitats, heathland, calcareous grassland, montane habitats, bogs and acid grassland have declined since the 1930s, whereas species associated with woodland, rivers and streams, standing open waters, improved grassland and built-up areas and gardens have apparently increased (Preston *et al*. 2002b, 2003). Within this broad picture, it is important to note that some groups (for instance woodland herbaceous plants) have declined.

For some declining species, designated sites are vitally important, with virtually all their populations on SSSIs, for example late spider- *Ophrys fuciflora*, early spider- *O. sphegodes* and burnt *Orchis ustulata* orchids.

Figure 3.35 Mean change in plant species by different broad habitat type



Graph shows the 'average' change index for species associated with different broad habitats over the last 40 years in the UK. A positive value indicates a relative increase, a negative value a relative decrease.

(Source: CEH, BSBI, Defra 2003)

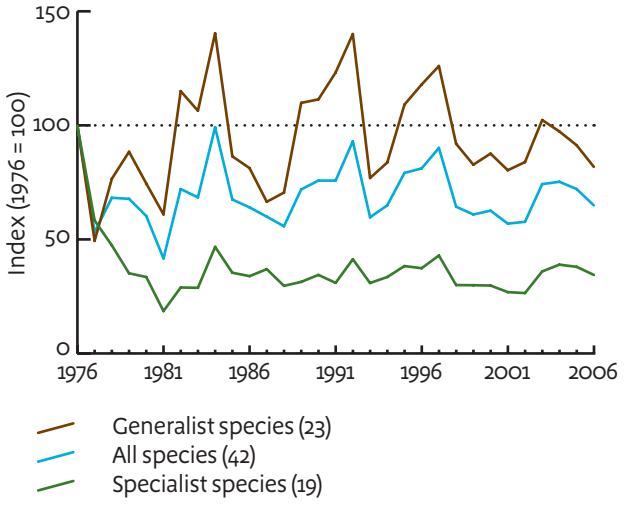
Invertebrates

Our knowledge of trends is limited to a few easily observable groups, notably butterflies, moths and bumblebees.

Butterflies are good indicators of the state of the environment because they are easily monitored and respond rapidly to changes in their habitats and environment. They play a complementary role to birds by providing an indicator of the state of the environment at a finer scale. Populations of butterflies in England now feature as one of the headline indicators in the England Biodiversity Strategy (Defra 2006c).

The *Butterflies for the New Millennium* recording scheme found that three-quarters of butterfly species have declined in distribution over the last 25 years (Fox *et al*. 2006). The UK Butterfly Monitoring Scheme, which assesses numbers of 42 species on a network of over 675 sites in England, shows that there have been major fluctuations in abundance since the scheme began in 1976 (Figure 3.36).

Figure 3.36 Population trends of butterflies in England, 1976 to 2006



(Source: Butterfly Conservation, CEH, JNCC, Defra 2008a)

Butterfly numbers have fluctuated from year-to-year according to weather conditions and natural cycles (Defra 2008a). The constant wet weather of 2007 caused numbers of several species to fall to their lowest ever recorded numbers. Over the past 30 years, habitat specialists have fared worse and, after a rapid decline to 1981, have remained low, being at 37% of the 1976 baseline in 2006. In contrast, wider countryside generalists have fluctuated around the 1970 baseline, but with a decline since 2003 to around 80% of the 1970 baseline by 2006. Some of the generalist species have also extended their breeding ranges substantially in England over recent decades (for example Essex skipper T*hymelicus lineola*, comma *Polygonia c-album*, speckled wood *Pararge aegeria* and gatekeeper *Pyronia tithonus*).

A review of the state of Britain's **moths** has shown that 62 species have become extinct in the 20th century, but new species have colonised (Fox *et al*. 2007). Data from Rothamsted's network of light trap sites in Britain for the period 1968 to 2002 show that there has been a major decline in moth abundance, with overall numbers falling by almost one-third since 1968. Long-term population trends for 337 widespread larger moths show that 67% have declined in abundance since 1968, with over 20% decreasing so severely that they meet UK Biodiversity Action Plan and IUCN criteria for threatened species. For example, in 35 years there have been declines in figure of eight *Diloba caeruleocephala* (95%), lackey *Malacosoma neustria* (90%), cinnabar *Tyria jacobaeae* (83%) and magpie *Abraxas grossulariata* (69%). These commoner species underlie the food chains and ecosystems that maintain our diversity, and their declines suggest a widespread and pervasive environmental degradation.

For one species, the causes of population decline have been studied: the garden tiger's *Arctia caja* decline by 89% is linked to wetter winters and warmer springs, as expected from climate change predictions. This species is predicted to decline further in many areas as climate change continues.

In contrast, 89 species have colonised successfully, many of these feeding on non-native plant species in our gardens and parks. South East England has had more of the extinctions and colonisations. Sixty-nine widespread moth species in Britain have increased by more than 50% over the 35 year period. For example, the population of Blair's shoulder-knot *Lithophane leautieri* subspecies *hesperica* is 200 times higher than its 1968 level and it has spread from the Isle of Wight to Scotland since colonising England in 1951. This moth feeds on non-native cypress trees including Leyland cypress *x Cupressocyparis leylandii*.

The social **bumblebees** have declined in population size with only six of the 25 resident British species now considered common. Seven species are listed as priorities under the UK BAP (including the red-tailed *Bombus ruderarius* and shrill carder-bees *B. sylvarum*, and large garden *B. ruderatus* and carder bumble bees *B. humilis*), one of which, the short-haired bumble bee *B. subterraneus*, is now regarded as extinct in the UK. Two others, the mountain *B. monticola* and broken-belted bumble bees *B. soroeensis*, are considered to be in serious decline (Benton 2006).

There has been a marked decline in range and species density of bumblebees since 1960 (Williams 2008). Widespread local species have been lost from large areas of southern and central lowland England, generally retreating northwards and westwards. Southern local species have retreated further south and east, and have become increasingly localised within their reduced range. Systematic recording work carried out since the 1980s through the Bees, Wasps and Ants Recording Scheme (BWARS) continues to indicate severe declines in populations of all except six widespread and common bumblebee species (Benton 2006).

Mammals

Legal protection and conservation initiatives have meant that in the last two decades the long-term decline of some species of mammal has slowed or even reversed. The Tracking Mammals Partnership (TMP) currently reports trends for 35 species (54% of our land mammal fauna). Sixteen species (46%) have increasing populations, 11 species (34%) are stable, and six species (17%) are declining (TMP 2008). For example, over the last ten years, otters have increased (Crawford 2003), as have a number of bat species.

The National Bat Monitoring Programme (NBMP), run by the Bat Conservation Trust, is the longest running multi-species monitoring programme for mammals in the UK. It currently produces population trends for 11 of the UK's 17 resident bat species. There have been significant increases in the populations of four bat species and no significant decreases in the others since the mid-1990s. Two species on the increase are UK BAP priority species: lesser horseshoe bat (44%) and common pipistrelle *Pipistrellus pipistrellus* (64%). Other species on the increase are Daubenton's *Myotis daubentonii* (27%) and Natterer's bats *Myotis nattereri* (36%). However, other species such as noctule *Nyctalus noctula* and brown long-eared bats *Plecotus auritus*, have been added to the UK BAP list due to concerns about future stability of their populations, based on recent trends (Bat Conservation Trust 2007, 2008). The mouse-eared bat *Myotis myotis* was known to breed in England until the 1970s and was declared extinct in 1990.

The National Dormouse Monitoring Programme (NDMP) has detected a significant downward trend in hazel dormouse *Muscardinus avellanarius* populations from the early 1990s to 2002 (Battersby 2005). Analysis shows that hazel dormouse populations have declined in abundance and distribution in all landscapes, except areas of southern England, where populations appear to be stable. The greatest change has been observed at the edge of the species' current range in Britain (Sanderson 2004).

Summary comparisons between trends in species groups

Repeated comprehensive surveys of species groups over the last 20 to 40 years allow comparison of population trends. There have been major declines in moths, butterflies and bumblebees, and also in woodland birds, farmland birds, arable plants and amphibians. In contrast, there has been a significant increase in wintering waterbirds.

In the past decade, there has been a levelling off in the long-term decline of a number of indicators including farmland birds and butterflies. However, the trend for some groups is still downwards. For example, the flora, birds and butterflies most associated with our woodland are all continuing to decline. There has been a particular decline in specialist species – those species that have very specific habitat requirements – revealed in the monitoring of plants, birds, bumblebees and butterflies. For example, the specialist grassland Duke of Burgundy butterfly (*Hamearis lucina*) has declined by 50% in the last ten years.

There have been major declines in populations of breeding wading birds on unprotected lowland wetland grasslands, notably the snipe (*Gallinago gallinago*) which is down by 90% in some regions.

In contrast, some of the trends over the last ten years show real increases. There have been major increases in heathland bird populations for example nightjar *Caprimulgus europaeus*, woodlark *Lullula arborea* and Dartford warbler *Sylvia undata* – and the last of these has increased its range by over 100% due to milder winters. Nevertheless, due to their low population sizes, these species remain vulnerable. Some wetland birds have shown massive increases (eg gadwall, whooper swan), the recovery of the otter has continued, and four bat species are increasing significantly.

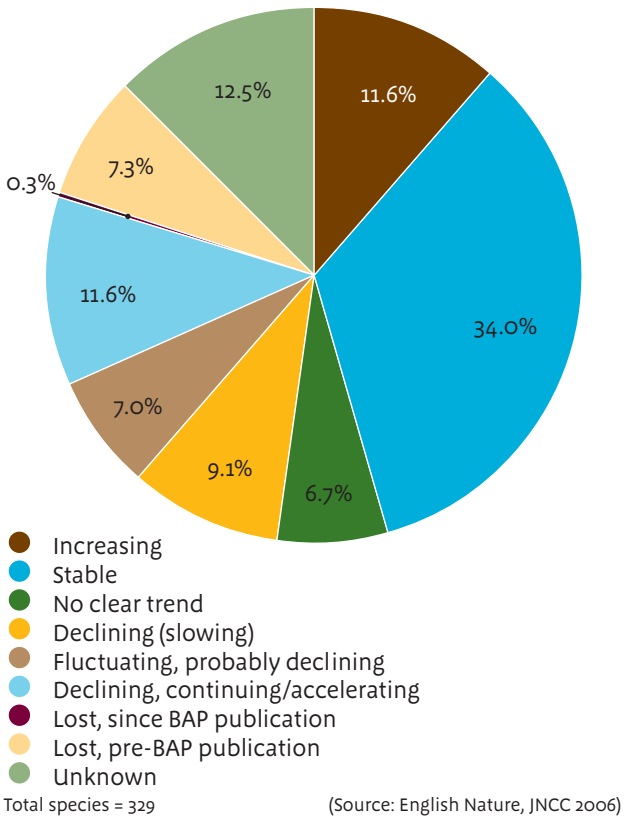
These repeated surveys also allow spatial comparison between groups. Overall, 71% of butterfly species have declined in range (number of occupied 10 km squares) between 1970-1982 and 1995-1999, substantially more than the range declines recorded for British birds (54% between 1968 to 1972 and 1988 to 1991) and plants (28% between 1954 to 1960 and 1987 to 1999). The greater range reductions of butterfly species may foreshadow similar declines in mammals, birds and plants, as insect populations typically respond more rapidly to adverse environmental changes (Thomas *et al*. 2004).

Research into other invertebrate groups (for example bumblebees and moths) shows similar declines (as described above). The decline in common widespread moths indicates wider changes that are likely to have knock-on effects on other species. Although the link between the decline of common moths and their predators and parasitoids has not been proven exclusively (Fox *et al.* 2007), there is growing evidence that demonstrates such links amongst farmland birds and their insect prey (Vickery *et al.* 2001; Benton *et al.* 2002). There is also a strong positive correlation between farmland moth abundance and the behaviour of bats that feed mainly on moths (Wickramasinghe *et al.* 2004).

3.13.4.2 Trends in UK BAP species in England

Reporting on the status of UK BAP priority species and habitats follows a three-year cycle with the first three reporting rounds taking place in 1999, 2002 and 2005. The 2005 assessment (Defra 2006c) indicated that of 329 BAP species in England, 38 (12%) were increasing, 112 (34%) stable, 91 (28%) clearly declining (Figure 3.37). Of 172 species for which data are available for 2002 and 2005 (and in some cases 1999), the trend has improved for 37 and deteriorated for 17.

Figure 3.37 Trends in BAP priority species in England in 2005



Total species = 329 (Source: English Nature, JNCC 2006)

Trends in UK BAP species in England – 2005

Positive trends

Increasing trends were reported for 38 species including:

Stone curlew *Burhinus oedicnemus*, sand lizard *Lacerta agilis*, lesser horseshoe bat *Rhinolophus hipposideros*, otter *Lutra lutra*, ladybird spider *Eresus sandaliatus*, field cricket *Gryllus campestris*, silver-spotted skipper *Hesperia comma*, Adonis blue *Lysandra bellargus* and Killarney fern *Trichomanes speciosum*.

In 2002, the pool frog *Rana lessonae* and interrupted brome *Bromus interruptus* were reported to have been lost. They are now classed as 'increasing' following re-introductions.

Negative trends

Continuing declines were reported for over 60 species including:

Red squirrel *Sciurus vulgaris*, turtle dove *Streptopelia turtur*, spotted flycatcher *Muscicapa striata*, pearl-bordered fritillary butterfly *Boloria euphrosyne*, fen raft spider *Dolomedes plantarius*, freshwater white-clawed crayfish *Austropotamobius pallipes*, freshwater pearl mussel *Margaritifera margaritifera*, red hemp-nettle *Galeopsis angustifolia*, corn cleavers *Galium tricornutum*, juniper *Juniperus communis*, starfruit *Damasonium alisma* and grass-wrack pondweed *Potamogeton compressus*.

A further 30 species declines were reported as slowing.

Source: Defra (2006c)

3.13.4.3 BAP species action plan threats

The main issues posing a threat to a high proportion of species are (BRIG 2006a):

Habitat loss and degradation

- Agricultural intensification and changes in agricultural management practices (including lack of appropriate habitat management).
- Habitat destruction, fragmentation and development.
- Changes in woodland and forestry management practices.
- Drainage, water abstraction and inappropriate river management.
- Inappropriate coastal management and coastal squeeze.
- Sea fisheries practices.

Environmental pollution

- Atmospheric pollution (such as acid precipitation and nitrogen deposition) affecting the species composition of sites.
- Water pollution from both point and wider agricultural and industrial sources (including nutrient enrichment).
- Climate change and sea level rise as a result of global warming.

Other

- Intrinsic factors (such as poor recruitment, limited dispersal, low population size, slow growth rates and natural fluctuations).
- Invasive and non-native species.
- Recreational pressure and human disturbance.
- Changes in native species dynamics (including competition, disease, predation, and declines in prey and food sources).
- Natural disasters (such as droughts, floods and storms).
- Harvesting and collection of species (including hunting).
- Over-fishing and fisheries by-catch.

Chapter 3 Biodiversity

Evidence gaps

Areas where we believe we need more evidence on the condition of England's natural environment, how it is used and the most effective mechanisms to address the challenges we face.

1 **Better evidence on the extent, distribution and condition of some habitats, especially outside of designated sites at national and regional levels.**

2 **Better evidence on marine habitats and species.**

3 **Better surveillance of mammals, fish, invertebrates, lower plants and fungi.**

4 **Evidence of links between habitat condition and species survival.**

5 **Analysis of long term trends in habitats and species and functional links between them.**