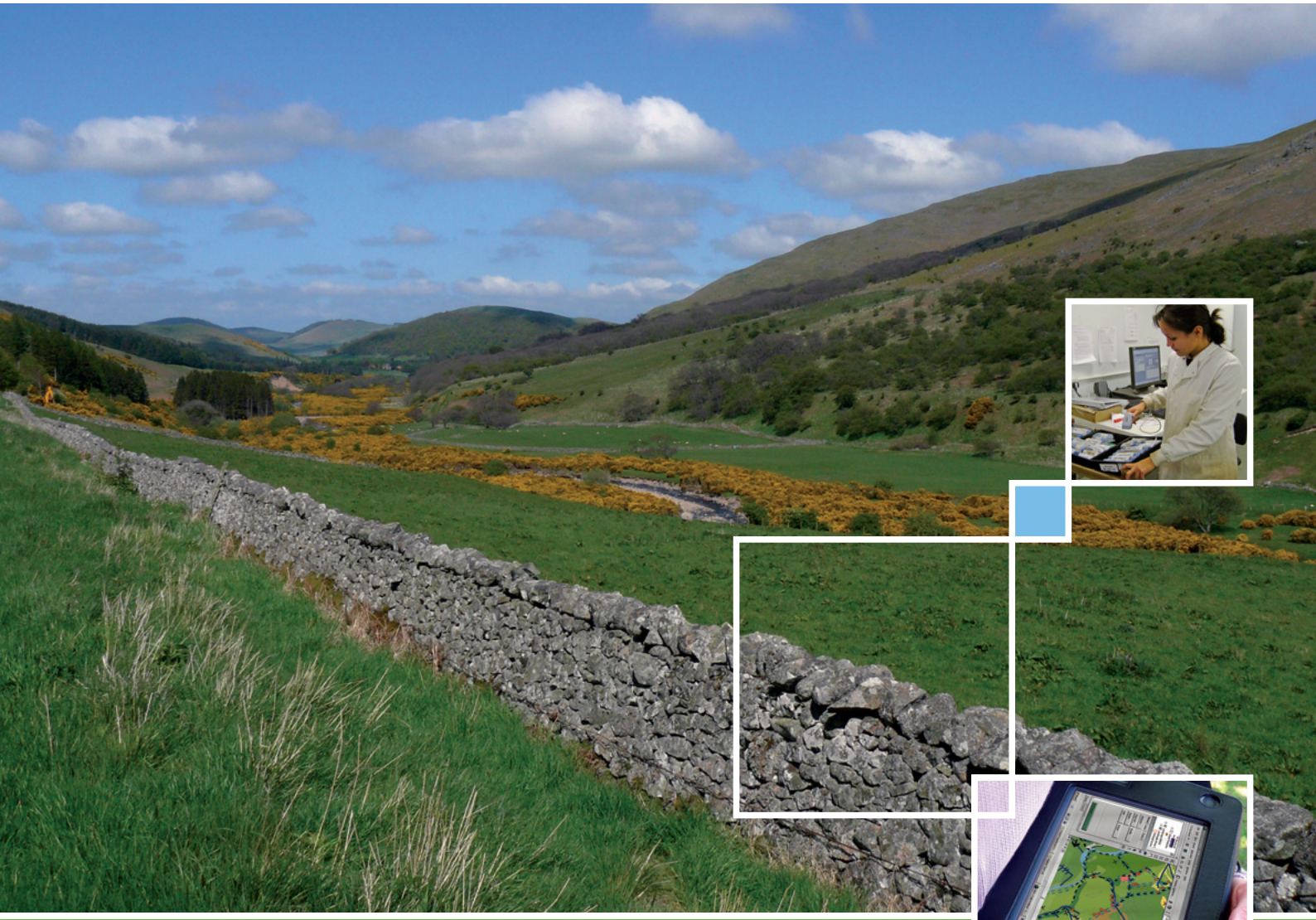
Countryside Survey



Countryside Survey:
England Results from 2007

Foreword by Huw Irranca-Davies MP, Minister for the Natural and Marine Environment, Wildlife and Rural Affairs, Department for Environment, Food and Rural Affairs

Our rich and varied countryside is at the heart of our prosperity. It has sustained us through our long history of settlement and development. Although it has changed over time, it continues to provide us with fertile soils for agriculture, woodlands, flowing waters and a remarkable diversity of wildlife. The interactions between the wildlife, soils and climate have enabled complex ecosystems to evolve, which provide a range of goods and services, such as timber production and carbon storage. The countryside enriches our lives, financially, culturally and spiritually.

To manage the natural resources of our island for the future, it is essential that we understand how the countryside changes, and how our activities can affect it. In addition to natural processes, people have been involved in the shaping of our landscapes, but we also know that climate change, pollution, agricultural practices and demand for land can affect the countryside.

The Countryside Survey is a world-leading method of investigating change across the countryside. It tells us about the changes in our vegetation, soils, freshwaters, habitats and landscape features and enables us to look at interactions between these and to determine possible causes of change. Importantly, though, it provides the scientific evidence we need to inform our policy making decisions.

The Countryside Survey has grown in size and complexity over time, and this year is the first opportunity we have had to produce separate reports for each of the countries in the UK. The England Report provides us with an opportunity to examine changes in the English countryside and helps to give us a clearer focus on the issues affecting our part of the UK.

Many people have been involved in delivering the Countryside Survey, from scientists to land owners who kindly gave permission for access to their land. Its success has depended upon the effective partnership between NERC and the other government partners representing all the devolved administrations and relevant agencies across the UK.

Huw Irranca-Davies

Countryside Survey

▲ Hawthorn in berry, Lancashire • © *Ian Simpson*

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COVER IMAGE: Northumberland landscape • © *Lindsay Maskell*

Countryside Survey:
England Results from 2007

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▲ Directions in the English Countryside • © *Natural England* • *Andrew Baker*

1. Introduction and Methodology[1]

Summary

This Chapter provides an introduction to the Countryside Survey report for England and describes the report structure and content. Where appropriate, references are made to the UK report released in 2008 in which the rationale and methods used to collect the data for Countryside Survey in 2007 and in the preceding Surveys are described in more detail.

The results of the field survey focus on habitats, vegetation, soils (0-15) cm and freshwater. The field survey covered a total of 289 1km x 1km sample squares across three Environmental Zones in England. These 1km sample squares were representative of the variations in the climate and geology present.

The data collected enables estimation of:

- **the extent and change in area of habitats;**
- **the extent and condition of landscape features such as hedges, walls and trees;**
- **the changing condition of vegetation in habitats;**
- **the pH, carbon concentration and bulk density of soils (0-15cm); and**
- **the changing condition of freshwaters and ponds.**

Countryside Survey (CS) is a unique study of the natural resources of the countryside. The survey has been carried out at intervals since 1978 with the latest in 2007. The countryside is sampled and studied using rigorous scientific methods, so that the results can be compared with the findings of the previous surveys in 1998[2], 1990, 1984 and 1978 to measure and analyse change. In this way the gradual and subtle changes that occur can be studied over a 30-year period. Evidence produced is used to review and develop policies that influence the management of our countryside e.g. providing information on progress against the UK Biodiversity Action Plan for Broad and Priority Habitats[3]. The main objectives of Countryside Survey are given in *Box 1*. The findings will be used for a range of scientific *(Box 2)* and policy *(Box 3)* applications.

[1] Full details of the methodology are provided in the *"UK Results from 2007"* and the accompanying Technical Reports available at http://www.countrysidesurvey.org.uk

[2] The Survey carried out in 1998 was published as: Haines-Young et al (2000). *Accounting for Nature, assessing habitats in the UK countryside, Countryside Survey 2000.* Department for the Environment, Transport and the Regions (DETR), London.

[3] http://www.ukbap.org.uk/NewPriorityList.aspx

▲ Mixed farmland in the Cotswolds • © *Natural England* • *Paul Glendell*

Box 1: The overarching objectives of Countryside Survey in 2007 were:

- **To record and report on the amount and condition of widespread habitats, landscape features, vegetation, land cover, soils and freshwaters.**
- **To assess changes in the countryside and improve our understanding of the causes and processes of change, by comparison with data from earlier surveys.**
- **To collect, store and analyse data in ways that optimise the integration of Countryside Survey data through time and make it compatible with other data sources.**
- **To provide access to data and interpreted results that underpin a range of policy and science needs for major environmental zones and landscape types in the UK, Great Britain, England, Scotland, Wales and Northern Ireland.**
- **To contribute to the development of an integrated assessment of the drivers and pressures of change and better understand their effects on the UK countryside and their implications for ecosystem goods and services.**

Box 2: The scientific challenge

To manage land more sustainably we need to know what is there, monitor how it is changing, uncover the causes of change, predict the consequences of future change and assess options for adaptation. Stakeholders increasingly require this complex research challenge be met, whether to develop a more sustainable energy policy, to ensure that soil resources are managed, or that environmental conflicts are resolved. Countryside Survey provides the scientific evidence needed by government decision-making to help deliver a healthy natural environment, ecosystem services and energy in a manner consistent with the goal of achieving sustainable development.

The scientific challenge is to develop a fully integrated ecosystem assessment of UK which will link the key pressures of change to changes in state of the countryside and the effect of these on ecosystem services. Countryside Survey data will make a significant contribution towards this aim and many other areas of science including:

- **Attribution of change in stock of key attributes to a range of pressures and drivers, particularly land management, climate and air pollution.**
- **Analysis of stock and change of indicators within regions, selection between conflicting hypotheses of change and development of process models that can be tested against data from future surveys.**
- **Assessment of stream biological condition in relation to catchment soil characteristics.**
- **Increased understanding of the mechanisms and inter-dependencies between soils, vegetation and water quality parameters, underpinning modelling requirements for linking biodiversity and biogeochemical cycling (e.g. in soil carbon models).**
- **Application of process models of pressure-state relationships to reveal likely trends, sensitivities and time lags of ecosystem indicators.**
- **Development of high-level indicators of ecosystem services.**
- **Spatial analysis of the resilience of vegetation and ecosystem attributes to specific pressures, identifying the situations in which ecosystem change is most likely and ecosystem services at most risk.**
- **Linking of data and models to provide pressure-state-impact assessments of past changes and provide basis for testing of future policy scenarios on ecosystems services in the countryside.**

Box 3: Policy applications of Countryside Survey

The UK Sustainable Development Strategy 'Securing the Future' (2005) committed the Government to undertake a new Countryside Survey in 2007 to assess the status of natural resources in the UK countryside. Countryside Survey has many potential policy applications:

- ***Biodiversity:*** **assessment of status and trends in Broad and Priority Habitats, measuring progress towards the 2010 target of halting biodiversity loss.**
- ***Natural environment:*** **measurement and improved understanding of ecosystem goods and services.**
- ***Sustainable agriculture and agri-environment schemes:*** **understanding effects of agricultural policy on the natural environment, including assessment of farmland habitats such as grasslands, hedges and cereal field margins.**
- ***Water resources:*** **context and baseline assessment for the EU Water Framework Directive, especially for headwater streams and ponds.**
- ***Soil protection:*** **measurement of long-term trends in soil quality, including soil carbon.**
- ***Sustainable forestry:*** **information on isolated trees and plant diversity within woodlands, to supplement the National Inventory of Woodlands and Trees.**
- ***Urban development:*** **estimates of areas of habitat affected by urban development.**
- ***Air quality:*** **assessment of impacts of air pollution on terrestrial habitats, soils and headwater streams.**
- ***Climate change:*** **provide information to help estimate carbon emissions from land cover change and soils, and to detect impacts of climate change in the countryside.**
- ***Uplands:*** **assessment of changes in uplands habitats (such as bracken) and landscape features (such as hedgerows and walls), and changes in land management (such as grazing) and increase in Built Up and Gardens Broad Habitat).**
- ***Pesticides:*** **assessment of plant species richness in cropped areas, and in agricultural landscapes in general.**
- ***Landscape:*** **assessment of changes in landscape features, especially in particular regions of England where particular habitats or features may contribute to landscape quality.**

There are two main elements to Countryside Survey: field surveys (reported here) which focus on habitats, vegetation, soils (0-15 cm) and freshwater; and the Land Cover Map which uses data from satellites to form a digital map of the different types of land cover across the UK and will be published later in 2009. The field survey provides estimates of the extent of the different Broad Habitats (see *Box 4*) and in 2007, for the first time, some Priority Habitats were also reported in the UK Results from 2007 report. The results of the field survey describe the character and condition of the different vegetation types associated with these Broad and Priority Habitats, including both land and freshwater habitats.

Box 4: The Broad Habitat Classification

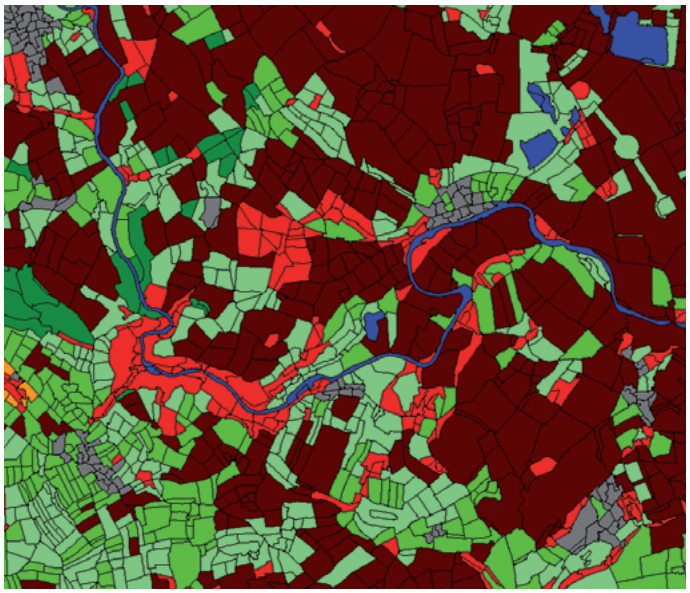
"It is vital to be able to identify and record species and ecological communities of interest that are under threat so that they can be related to a legal framework to ensure their protection. Species and habitat classification provides a language through which data can be communicated at a national and international level.

The Broad Habitat classification was developed as a part of the UK Biodiversity Action Plan. The list of Broad Habitats that was published in the UK Steering Group Report in 1995 has been subject to a recent review to ensure that the whole of the land surface of the UK and the surrounding sea, to the edge of the continental shelf, is covered. This has resulted in a revised list of 27 Broad Habitats but not all are covered by Countryside Survey. The Broad Habitats are the framework through which the Government is committed to meet its obligations for monitoring in the wider countryside..."

(The Joint Nature Conservation Committee – *www.jncc.gov.uk/page-1425*)

The terrestrial **Broad Habitats** covered by Countryside Survey are:

- **Broadleaved, Mixed and Yew Woodland**
- **Coniferous Woodland** • **Boundary and Linear Features**
- **Arable and Horticulture** • **Improved Grassland**
- **Neutral Grassland** • **Calcareous Grassland**
- **Acid Grassland** • **Bracken** • **Dwarf Shrub Heath**
- **Fen, Marsh and Swamp** • **Bog** • **Inland Rock** • **Montane**
- **Standing Open Waters and Canals** • **Rivers and Streams**
- **Littoral Sediment** • **Littoral Rock**
- **Supra-littoral Sediment** • **Supra-littoral Rock**
- **Built-up and Gardens**



▲ Example output from Land Cover Map 2007 • © *CEH*

The UK results of the latest 2007 survey were published in November 2008 and the summary data made accessible via the Countryside Survey website. CS has grown in scale and complexity over the years, and for the first time, the 2007 survey has enabled reporting at individual country level. This report presents the Official Statistics for England and compares differences across three sub-divisions of the country know as Environmental Zones (EZs). The results are presented in chapters structured around the same Broad Habitat groupings used for the UK report. Each chapter is concluded with a discussion which begins to explore the relevance of these results for England with an emphasis on their policy context. CEH is responsible for the scientific evidence presented while Defra, Natural England and the Forestry Commission have contributed to the contextual discussions. Equivalent reports have been produced in parallel for Scotland and Wales.

Details of the field survey methods used to collect the data for CS in 2007 and preceding Surveys are not reproduced in full in this report, since they are presented in ***Chapter 1 of the UK Results for 2007 report*** (available at: *http://www.countrysidesurvey.org.uk*). A short overview of the sampling strategy is provided here with some expansion to cover certain aspects of the methodology that are specific to England and to explain the EZ sub-divisions of the country.

Methodology

Prior to 1998, the CS sampling strategy was designed to provide estimates for GB level reporting, not for reporting at the individual country level. In 2007, the field survey involved an in-depth study of a sample of nearly 600 1km x 1km squares across Great Britain; 289 of these were in England.

Individual survey squares in England were randomly selected so that they represent variations in climate and geology across the country. Widespread terrestrial habitat types are sufficiently well represented to enable robust and reliable statistical analyses. The locations of the survey squares are not disclosed to avoid any deliberate influences that could affect them or the features within them. In this way, the survey squares will remain representative of changes in the wider countryside and will continue to provide a reliable comparison for future surveys.

Areas of habitat were mapped within each square and more detailed samples were made of vegetation in a series of plots. The plots varied in size depending on the feature being sampled, but in all plots the species of plant present and the percentage of the area they covered were recorded. Soil (0-15cm) samples were also collected from five plots in each square. A stream and a pond were also sampled in those squares where they were present. The data collected enables estimates to be made of:

- **the extent and change in area of habitats;**
- **the extent and condition of landscape features such as hedges, walls and trees;**
- **the changing condition of vegetation within habitats;**
- **the pH, carbon concentration and bulk density of soils (0-15cm); and**
- **the changing condition of freshwaters and ponds.**

Further analysis of soils is ongoing to enable estimation of nutrient status, contaminant levels, soil biotic diversity and soil function and will be reported in late 2009[4].

▲ Habitat mapping • © *Defra* • *Helen Pontier*

[4] Details of the soil protocols and methodology are provided in the CS Soils Manual available from http://www.countrysidesurvey.org.uk

The recording framework for Broad Habitats within CS makes it possible to report on both the area and the change in area for Broad and a few Priority Habitats, using the data from the 1990, 1998 and 2007 Surveys. A modified coding system for habitat mapping was introduced in 1998 to enable reporting on Broad and Priority Habitats. The modified system has backwards compatibility to 1990 for most Broad Habitats. Similarly, the methods of recording linear features have been refined over time. Where there has been consistency of recording over time, the length of linear landscape features and the numbers of point features including trees and ponds (and changes in those lengths and numbers) can be reported.

Vegetation, freshwaters and other landscape features were studied in detail within each square (using various types of sampling 'plots') and compared with findings from previous Countryside Surveys, enabling identification of change in the countryside. The results presented here focus on changes in the nine years since the last Countryside Survey in 1998 and, where possible and relevant, they are set within the longer timescale from the first survey carried out in 1978. Changes are only described and discussed where they are statistically significant (where they could only occur by chance in less than 5% of cases).

The condition of the vegetation included in each mapped area of Broad Habitats were reported for the 1990, 1998 and 2007 Countryside Surveys. The position of each vegetation plot is known and so the species data recorded in each plot can be referenced to the Broad Habitat in which it was sited. Assessments of the condition of linear features are confined largely to more recent Countryside Surveys in particular 1998 and 2007. This report also includes details of individual plant species which are occurring with the most increasing or decreasing frequency of occurrence in plots across England.

Priority Habitats are habitats that have been identified as a priority for conservation in the UK Biodiversity Action Plan (BAP)[5], and are assessed on a regular basis. As Countryside Survey represents an unbiased sample of the UK countryside and these Priority Habitats are generally uncommon and/or localised, they are generally not well represented within the CS e.g. Reedbeds. The results for a limited number of Priority Habitats are presented in this report. They represent national estimates based on a sample and should be used in conjunction with other estimates published by the UK BAP. Some CS estimates are very similar to UK BAP while others differ markedly. Neither can be considered definitive at present and will be investigated further. The CS estimate for Hedgerows, Ponds and the condition of Arable Field Margins represent the only national figures for these Priority Habitats.

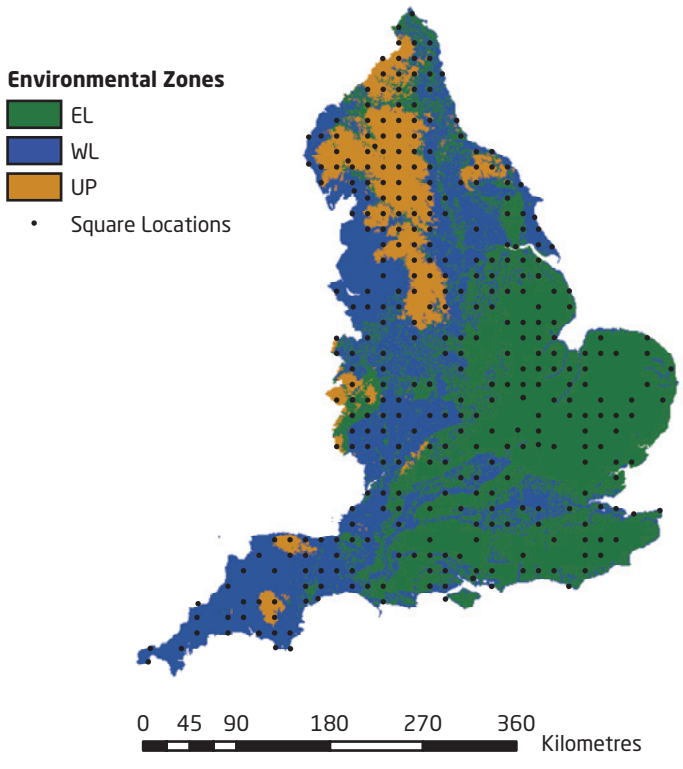
Sub-dividing England, Scotland and Wales into Environmental Zones (EZs) enables changes across the countries and within habitat types to be compared between geographically different regions. The nine EZs used in the 2007 Survey across the UK are summarised in *Table 1.2* and the distribution of those within England relative to survey square locations is presented in *Fig. 1.1*. It is difficult to find succinct names which adequately describe them but they cover the range of environmental conditions found in the UK from the lowlands of the south and east, through to the uplands and mountains of the north and west. The EZs are based on combinations of the underlying sampling units, or land classes, used to identify survey squares for the stratified random sampling of the countryside.

▼ **Table 1.2:** The Environmental Zones used in Countryside Survey.

Environmental Zones	EZ codes
• Easterly Lowlands, England (EL)	EZ1
• Westerly Lowlands, England (WL)	EZ2
• Uplands, England (UP)	EZ3
• Lowlands, Scotland	EZ4
• Intermediate Uplands and Islands, Scotland	EZ5
• True Uplands, Scotland	EZ6
• Northern Ireland (reported separately)	EZ7
• Lowlands, Wales	EZ8
• Uplands, Wales	EZ9

There are three EZs in England: Easterly Lowlands, Westerly Lowlands, and Uplands *(Fig. 1.1)*.

▼ **Figure 1.1:** The distribution of the three Environmental Zones within England relative to survey square locations (EL - Easterly Lowlands, WL - Westerly Lowlands, UP - English Uplands).



[5] http://www.ukbap.org.uk

▲ Vegetation surveying • © *Defra* • *Helen Pontier*

Interpreting Results

Landuse versus landcover

Countryside Survey involves visits to 1km squares to record habitats based on the vegetation present at that time; it is therefore a measure of landcover. This is subtly different to measures of land-use, which are based on what the land is being used for.
The difference between these two definitions can lead to quite different estimates of the national area of a particular habitat. Two obvious examples are woodland (both broadleaved and coniferous) and arable land. In Countryside Survey, a parcel of land must have at least 25% canopy cover of broadleaved or coniferous trees to be classified as woodland, but in land-use surveys such as those by the Forestry Commission, land that has been cleared of trees and awaiting replanting will remain classified as woodland. In Countryside Survey, land in long-term fallow, and formerly set-aside, is classified as grassland whereas in some land-use surveys it may remain classed as arable land.

Statistical change

The statistical tests used to analyse the results can lead to some incidences where small changes are statistically significant and where large changes are not. Small changes can be significant when the sample size is very large, and conversely, large changes may not be statistically significant when the sample size is small. There can be significant changes in some of the characteristics of vegetation tables even if the values remain the same between time periods. For example, it is possible for there to be a significant change in the number of species in vegetation plots between 1998 and 2007 even if both values read as 10.6. This will occur if there are a large number of plots. It should also be borne in mind that 10.6 encompasses the range from 10.551 to 10.649 when these figures are converted to 1 decimal place.

Condition Characteristics: Stress Tolerator, Competitors and Ruderal Scores.

The condition characteristics of vegetation is assessed using the three components of Grime's triangle[5]: Competitor, Stress Tolerator and Ruderal, and plant species are assigned Scores related to these characteristics. Taken together, this can indicate ways in which vegetation is changing. An example might be where a dry open area becomes flooded and invaded by species with a high Competitor Score that can tolerate flooding and a high Stress Tolerator Score e.g. Meadowsweet (*Filipendula ulmaria*). If a site became affected by a mineral pollutant it might be that species with a high Competitor Score would die leaving gaps where only ruderal species and species able to tolerate the stress caused by the minerals could survive. These are extreme examples, but in the wider countryside, the Countryside Survey results tend to show more subtle shifts e.g. from species that prefer open spaces (high Ruderal Score) towards the other two types which could indicate less management, higher nutrients and less drought amongst other factors. Different factors may also be interacting in a many different ways. For example, grazing by livestock can affect the proportions of the three types of characteristic Scores in very different ways. Very heavy grazing can increase the proportion of ruderal species, low levels of grazing will allow species with high Competitor Scores to dominate, while medium to heavy grazing should favour some species with a high Stress Tolerator Score.

[5] Grime, J. P. (1979). *Plant Strategies and Vegetation Processes.* Wiley and Sons, Chichester.

▲ Landscape in the River South Tyne catchment • © *Natural England* • *Charlie Hedley*

2. The National Picture

Summary

Area of Broad Habitats

- England is mainly covered by agricultural Broad Habitats: the area of Arable and Horticulture, Improved Grassland and Neutral Grassland Broad Habitats amounted to 4,002,000, 2,856,000, and 1,453,000ha respectively, totalling 8,311,000ha or 63.1% of the land area of England in 2007.
- Broadleaved Woodland and Coniferous Woodland amounted to 981,000 and 257,000ha respectively, totalling 1,238,000ha or 9.4% the area of England in 2007. Broadleaved Woodland was similar to the area of the Built up and Gardens Broad Habitat (1,038,000ha).
- Dwarf Shrub Heath, Acid Grassland and Bog Broad Habitats amounted to 331,000, 396,000 and 140,000ha respectively, totalling 867,000ha or 6% of the land area of England in 2007.
- Fen, Marsh and Swamp and Standing Open Water and Canals amounted to 117,000 and 97,000ha respectively, totalling 215,000ha or 1.6% of the land area of England in 2007.
- Rivers and Streams (>5m wide) amounted to 29,000ha or 0.2% of the land area of England in 2007.
- Broad Habitats were not evenly distributed across the Environmental Zones, reflecting the differences in climate, topography, underlying geology and history of land use and settlement.
- Most Broad Habitats remained fairly constant in England between 1998 and 2007, apart from an increase in Standing Open Water and Canals, an increase in Neutral Grassland, at the expense of Arable and Horticulture, an increase in Broadleaved Woodland at the expense of Arable and Horticulture and Improved Grassland, and an increase in Dwarf Shrub Heath converted mainly from Acid Grassland. The area of all other Broad Habitats showed no change.

Vegetation condition in Broad Habitats

- Species richness in Main Plots in the Arable and Horticulture Broad Habitat increased, but decreased in Acid Grassland, while there was no detectable change in other Broad Habitats in England between 1998 and 2007. Species richness in areas within Broad Habitats targeted for their botanical interest decreased in Improved, Neutral and Acid Grassland Broad Habitats in England between 1998 and 2007. Species richness and the number of plant species used as food by butterfly caterpillars also decreased in linear plots alongside streams.

- Between 1998 and 2007, there were changes in the condition of vegetation, particularly in Main Plots within agricultural habitats (Arable and Horticulture, Improved and Neutral Grassland Broad Habitats). There were also changes in areas targeted for their botanical interest (Neutral Grassland, Acid Grassland Broad Habitats), and alongside Linear Features (rivers and streams and alongside hedges, field boundaries and roadsides). These changes suggest a shift in community towards later successional types of vegetation, with more competitive, shade casting and fewer ruderal species. There were also increases in competitive species in areas targeted for their botanical interest in Dwarf Shrub Heath and Fen, Marsh and Swamp Broad Habitats. In areas targeted for their botanical interest in Broadleaved Woodland the changes in condition suggested a response to canopy closure and/or reduced management.

- Species richness in Main Plots in 2007 was lowest in the Arable and Horticulture Broad Habitat and highest in Fen, Marsh and Swamp, where as in Targeted Plots it was highest in Calcareous Grassland and lowest in Dwarf Shrub Heath.

- Within Environmental Zones between 1998 and 2007, there were significant changes in condition characteristics, suggesting shifts in the vegetation communities of Broad Habitats, particularly in the agricultural habitats (Arable and Horticulture, Neutral and Improved Grasslands) in the Easterly and Westerly Lowlands Environmental Zones. There were also decreases in species richness, increases in Grass:Forb ratio and increases in competitive species in the Acid Grassland, Dwarf Shrub Heath, Bog and Fen, Marsh and Swamp in the Uplands Environmental Zone. Species richness and plant species used as food by butterfly caterpillars increased in Broadleaved Woodland in the Easterly Lowlands Environmental Zone.

- Plant species changing the most in frequency of occurrence in areas characteristic of all Broad Habitats were typically taller species, associated with later succession (e.g. trees and shrubs): more species increasing in frequency were in the higher canopy height class, reinforcing the signal of successional changes towards taller, more shade casting vegetation.

Linear Features

- The total length of woody linear features was 547,000km in England in 2007, and was distributed mainly between the Easterly and Westerly Lowlands Environmental Zones. The total length of woody linear features decreased by 1.4% (8,000km) in England between 1998 and 2007, following an increase between 1990 and 1998 and a decrease between 1984 and 1990.

- The total length of managed hedgerows[1] was 402,000km in England in 2007, and was distributed mainly between the Easterly and Westerly Lowlands Environmental Zones. The length of managed hedgerows[1] decreased by 6.1% (26,000km) in England between 1998 and 2007, with a large proportion of these managed hedges turning into lines of trees and relict hedges (which increased significantly), as a consequence of less management.

- 50% of managed hedges were in good structural condition, 32% of managed hedges were in good structural condition and had appropriately managed margins but only 12% of those on arable land were in both good structural condition and had appropriately managed margins in England in 2007. A higher proportion of hedges in England were in good condition compared to Great Britain as a whole.

- The total length of walls was 82,000km in England and was distributed mainly in the Upland and Westerly Lowlands Environmental Zone. The length of walls decreased by 1.1% (approximately 900km) overall in England between 1998 and 2007, with the largest losses occurring in the Uplands Environmental Zone.

- The total length of banks and grass strips was 42,000km, with much of this in the Westerly Lowlands Environmental Zone.

Rivers, Streams, Standing Open Water and Canals

- The area of Standing Open Water and Canals increased by 5.3% (6000ha) and the number of ponds by 18% (c. 37,000 ponds) in England between 1998 and 2007, with most of the increases taking place in the Easterly Lowlands Environmental Zone.

[1] The term 'managed hedgerows' does not include relict hedges and lines of trees.

- The physical habitat quality of headwater streams improved between 1998 and 2007, with an increase in frequency of natural features such as debris dams, gravel bars and bank-side trees.

- In contrast to the stream channels, plant species richness in 10m x 1m vegetation sampling plots alongside streams decreased between 1998 and 2007, continuing a trend from 1978.

- The average plant species richness in ponds in England was significantly lower in 2007 than expected for good quality ponds. Almost 80% of ponds were in poor ecological condition in 2007, based on an assessment of a range of vegetation criteria.

Soils

- The mean pH of soil (0-15cm) of all Broad Habitats in England increased (i.e. they became less acidic) between 1998 and 2007, and this occurred in most Broad Habitats but not in Broadleaved and Coniferous Woodlands, in Bog and in Fen, Marsh and Swamp Broad Habitats, continuing a trend observed between 1978 and 1998 for most habitats.

- The mean carbon concentration in the soil (0-15 cm) of all Broad Habitat types in England decreased between 1998 and 2007, but this change was not detected in individual Broad Habitats, except for the significant decrease in carbon concentration in the Arable and Horticulture Broad Habitat. Overall there was no change in carbon concentration in the soil (0-15 cm) in England between 1978 and 2007.

- The mean soil (0-15cm) carbon stock of all Broad Habitats across England in 2007 was calculated to be 57 tC/ha. The carbon stock of Broad Habitats ranged between a mean of 43 tC/ha in the Arable and Horticulture Broad Habitat to a mean of over 88 tC/ha in Dwarf Shrub Heath.

General conclusions

- Countryside Survey has provided a long-term dataset that has increased understanding of changes in the countryside, and informed many policy areas.

- The Broad Habitats and landscape features of England are dynamic, especially where there is agricultural land use, where change can happen quite quickly between Surveys.

- Despite this, there were many positive signals for conservation of biodiversity in terms of area of Broad Habitat (especially conversion from Arable and Horticulture or Improved Grassland to Neutral Grassland or Broadleaved Woodland), and fairly constant species richness among the Broad Habitats between 1998 and 2007, but there were some mixed signals associated with shifts in community (that implies species turnover), and in areas within Broad Habitats targeted by Countryside Survey for their botanical interest, where decreases in species richness and community shifts were evident.

- Since 1990, the proportions of Broad Habitats in the Environmental Zones have changed but the overall character of each Environmental Zone has not.

- Previous work attributed a fraction of the vegetation change in Countryside Survey data across Britain to atmospheric nitrogen deposition as well as eutrophication from local agricultural activity[2]. Between 1998 and 2007, the eutrophication signal was still apparent as significant increases in mean Fertility Scores in the smaller habitat fragments targeted for their botanical interest in Acid, Calcareous and Neutral Grasslands in England as well as on river and stream banks. However, in larger areas of habitat including unenclosed upland habitats the signal, was not seen. Further work is required to determine whether the detection of the eutrophication signal is dependent upon the suppressive effect of successional change as well as the weather.

- The apparently contradictory changes in vegetation response to pH and soil pH change require further analyses to estimate the role of various possible drivers including response to declining sulphur deposition.

[2] Firbank, LG, Petit, S, Smart, SM, Blain, A, Fuller, RJ (2008) Assessing the impacts of agricultural intensification on biodiversity: a British perspective. *Phil. Trans. R. Soc. B* 363, 777-787.

▲ Field surveying • © *NERC* • *Ian Simpson*

2.1 Introduction[3]

Chapter 2 summarises some of the main findings of Countryside Survey in 2007 for England and Environmental Zones within it, and discusses their ecological significance in the context of the findings of previous Surveys. Information is presented on:

- **estimated areas of habitats;**
- **changes in vegetation characteristics;**
- **changes in linear landscape features;**
- **changes to the vegetation alongside boundaries, hedges, roads and streams;**
- **changes in headwater streams and ponds;**
- **changes in soil (0-15cm) characteristics.**

Some discussion of the ecological significance of these changes is given, but further analysis and detailed discussion is given in the subsequent chapters.

2.2 Estimated area of Broad Habitats

- **England is mainly covered by agricultural Broad Habitats: the Arable and Horticulture, Improved Grassland and Neutral Grassland Broad Habitats amounted to 4,002,000, 2,856,000, and 1,453,000ha respectively, totalling 8,311,000ha or 63.1% of the land area of England in 2007.**
- **Broadleaved Woodland and Coniferous Woodland amounted to 981,000 and 257,000ha respectively, totalling 1,238,000ha or 9.4%, and the area of Broadleaved Woodland was similar to the area of the Built Up and Gardens Broad Habitat (1,038,000ha).**
- **Dwarf Shrub Heath, Acid Grassland and Bog Broad Habitats amounted to 331,000, 396,000 and 140,000ha respectively, totalling 867,000ha or 6% of the land area of England in 2007.**
- **Fen, Marsh and Swamp and Standing Open Water and Canals amounted to 117,000 and 97,000ha respectively, totalling 215,000ha or 1.6% of the land area of England in 2007.**
- **Rivers and Streams amounted to 29,000ha, or 0.2% of the land area of England in 2007.**
- **Broad Habitats were not evenly distributed across the Environmental Zones, reflecting the differences in climate, topography, underlying geology and history of land use and settlement.**

Countryside Survey (CS) provides estimates of the area of widespread terrestrial Broad Habitats in England *(Table 2.1)*. Change in area was calculated by comparison with results from previous Surveys *(Table 2.1)*. Details of how the Broad Habitat classification was used in Countryside Survey were given in *Box 1.1* and *Chapter 1.6 of the UK Results for 2007 report*[1]. Detailed results for each Broad Habitat and information on habitat condition are presented in *Chapters 3 to 9*.

Linear features are only recorded as Boundary and Linear Features Broad Habitat by Countryside Survey when they are wider than 5m. All linear features less than 5m wide are recorded by length and summarised results for these are presented in *Chapter 2.5* and in more detail in *Chapter 5*. This approach therefore underestimates the total area of the Boundary and Linear Features Broad Habitat.

The area of Rivers and Streams reported is for those that were greater than 5m wide. Those less than 5m wide are reported by length, and summarised in *Chapter 2.7* and given in more detail in *Chapter 8*.

England is mainly covered by agricultural Broad Habitats: the Arable and Horticulture, Improved Grassland and Neutral Grassland Broad Habitats amounted to 4,002,000, 2,856,000 and 1,453,000ha respectively, totalling 8,311,000ha or 63.1% of the land area of England in 2007 *(Table 2.1)*. Broadleaved Woodland and Coniferous Woodland amounted to 981,000 and 257,000ha respectively, totalling 1,238,000ha or 9.4%, and the area of Broadleaved Woodland was similar to the area of the Built Up and Gardens Broad Habitat (1,038,000ha or 7.9% of the land area of England). The other Broad Habitats together occupied 9.4% of the land area of England. The Broad Habitats were not evenly distributed between Environmental Zones.

[3] **Note:** For further information on the Broad Habitat classification, sampling plots and other Countryside Survey terminology see *Chapter 1 (Methodology) of the UK Results for 2007 report* available at *www.countrysidesurvey.org.uk*

▼ **Table 2.1:** Estimated area ('000s ha) and percentage of land area of Broad Habitats in England from 1990 to 2007. Arrows denote significant change ($p<0.05$) in the direction shown. Note that because of changes in definitions that have been applied retrospectively, the estimates from 1990 are not in all cases directly comparable with later surveys.

Broad Habitats	1990		1998		2007	
	('000 ha)	% area of England	('000 ha)	% area of England	('000 ha)	% area of England
Broadleaved, Mixed and Yew Woodland	887	6.7	927	7.0	981	7.4
Coniferous Woodland	241	1.8	260	2.0	257	1.9
Boundary and Linear Features	380	2.9	354	2.7	353	2.7
Arable and Horticulture	4380	33.2	4389	33.3	4002	30.4
Improved Grassland	3075	23.3	2714	20.6	2856	21.7
Neutral Grassland	994	7.5	1290	9.8	1453	11.0
Calcareous Grassland	42	0.3	33	0.2	30	0.2
Acid Grassland	475	3.6	400	3.0	396	3.0
Bracken	93	0.7	109	0.8	91	0.7
Dwarf Shrub Heath	309	2.3	288	2.2	331	2.5
Fen, Marsh and Swamp	78	0.6	124	0.9	117	0.9
Bog	98	0.7	138	1.0	140	1.1
Standing Open Water and Canals[4]	105	0.8	88	0.7	97	0.7
Rivers and Streams[4]	33	0.2	32	0.2	29	0.2
Built-up Areas and Gardens	999	7.6	1009	7.7	1038	7.9
Other land[5]	564	4.3	596	4.5	580	4.4
Unsurveyed Urban Land	428	3.5	428	3.5	428	3.5
Total	**13180**	**100**	**13180**	**100**	**13180**	**100**

▼ **Table 2.2:** Estimated area ('000s ha) of Broad Habitats in England's three Environmental Zones in 2007.

Broad Habitats	Easterly Lowlands ('000 ha)	Westerly Lowlands ('000 ha)	Uplands ('000 ha)
Broadleaved, Mixed and Yew Woodland	519	422	40
Coniferous Woodland	81	104	72
Boundary and Linear Features	187	149	18
Arable and Horticulture	2907	1061	34
Improved Grassland	1056	1576	225
Neutral Grassland	559	657	237
Calcareous Grassland	23	6	0
Acid Grassland	19	27	349
Bracken	5	30	57
Dwarf Shrub Heath	12	50	270
Fen, Marsh and Swamp	15	52	50
Bog	1	5	134
Built-up Areas and Gardens	538	485	14
Other Broad Habitats and Unsurveyed Urban Land	602	459	74
Total	**6524**	**5083**	**1574**

The Environmental Zones of England created by Countryside Survey separate the country by climate and geology but they also reflect differences in land-use. The Easterly Lowlands Environmental Zone has a high proportion of the arable land, the Westerly Lowlands Environmental Zone is a pastoral landscape and the Uplands Environmental Zone is known for the mixture of rugged upland vegetation combined with grassland for livestock production in the valleys. The distribution of terrestrial Broad Habitats between the Environmental Zones in 2007 reflects these landscape differences *(Table 2.2)*.

The Easterly Lowlands Environmental Zone includes 49.5% of the total area of England, the Westerly Lowlands Environmental Zone 38.6% and the Uplands Environmental Zone 11.9% *(Table 2.2)*.

[4] Standing Open Water and Canals and Rivers and Streams Broad Habitat estimates were calculated using a different statistical model to the other Broad Habitats Hs. It is not appropriate to use the consistent statistical model for these two habitats because of the distribution of the data. Change in these Broad Habitats is calculated independently from the differences between stock estimates.

[5] Other land is made up of the remaining small Broad Habitats and the difference between the sum of the Broad Habitat areas and area of England used to calculate percentage areas.

72.6% of the Arable and Horticulture Broad Habitat and 37.0 % of the Improved Grassland Broad Habitat of England were found in the Easterly Lowlands Environmental Zone in 2007, covering almost four million hectares (60.7% of the total area), emphasising the intensive agriculture found there. The pastoral nature of the Westerly Lowlands Environmental Zone was demonstrated by the proportion of Improved Grassland Broad Habitat (55.1%) and Neutral Grassland Broad Habitat (45.2%) found there in 2007, covering 2.2 million hectares (44% of the total area). The habitats associated with unenclosed areas were predominantly found in the Uplands Environmental Zone: Bog (95.7%); Acid Grassland (88.1%); Dwarf Shrub Heath (81.6%); and Bracken (62.6%).

Woodlands and commercial forestry are an integral part of the English landscape between the farmed land. Broadleaved, Mixed and Yew Woodland covers a similar percentage of the area of the Easterly Lowlands (8.0%) and Westerly Lowlands (8.3%) Environmental Zones whereas in the Uplands Environmental Zone it covers far less (2.5%). Coniferous Woodland, on the other hand, covers proportionately more land in the Uplands Environmental Zone (4.6%) than the Westerly Lowlands Environmental Zone (2.0%) and especially the Easterly Lowlands Environmental Zone (1.2%).

2.3 Change in area of Broad Habitats

- **There was a significant increase in the area of Broadleaved Woodland, Neutral Grassland, Dwarf Shrub Heath and Standing Open Water and Canals Broad Habitats and a significant decrease in the area of Arable and Horticulture Broad Habitat in England between 1998 and 2007. There was no detectable significant change in the other Broad Habitats across England during this period.**

- **There were significant changes in the area of Broad Habitats in the Environmental Zones, between 1998 and 2007. Significant increases in the area of Broadleaved Woodland and Improved Grassland, but decrease in the area of Arable and Horticulture Broad Habitats and were detected in the Easterly Lowlands. Significant decreases in Arable and Horticulture, Calcareous Grassland and Fen, Marsh and Swamp Broad Habitats were detected in the Westerly Lowlands. Significant increases in Neutral Grassland and Built Up and Garden Broad Habitats were detected in the Uplands Environmental Zone.**

Table 2.3 shows the results for the analysis of change in area of Broad Habitats in England for periods between 1990 and 2007.

There was a significant increase in the area of Broadleaved Woodland (5.8%), Neutral Grassland (12.6%), Dwarf Shrub Heath (15.1%) and Standing Open Water and Canals (5.3%[6]) Broad Habitats and a significant decrease in the area of Arable and Horticulture Broad Habitat (8.8%) in England between 1998 and 2007 *(Table 2.3)*.

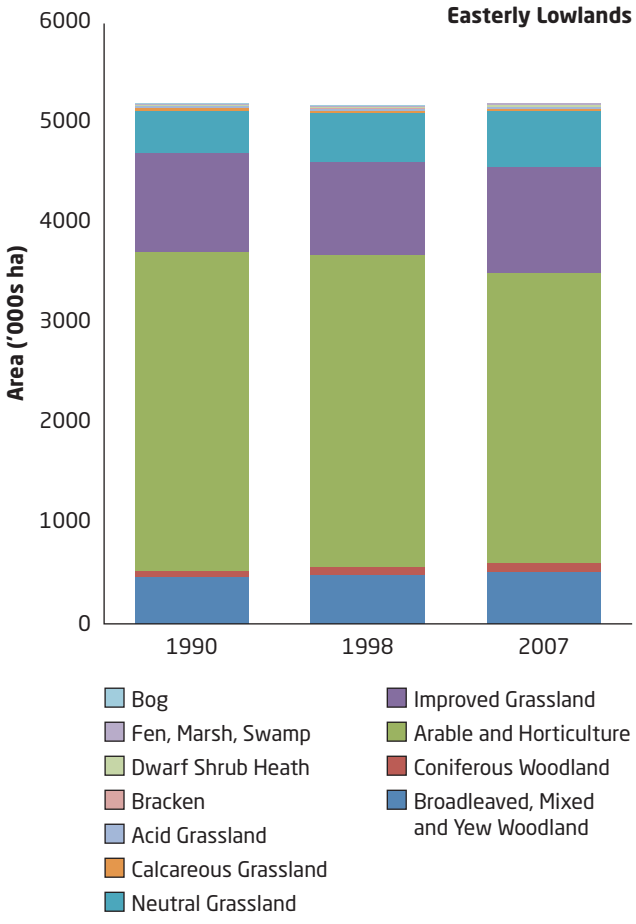
The increase in the area of Dwarf Shrub Heath between 1998 and 2007 followed a decrease in area between 1990 and 1998 (see *Chapter 7*).

The increase in the area of Standing Open Water and Canals[6] recorded in England between 1998 and 2007, continued the increases recorded by Countryside Survey since 1990.

No statistical change in extent was detected in the Coniferous Woodland, Improved Grassland, Bracken, Bog, Fen, Marsh and Swamp and Calcareous Grassland Broad Habitats in England between 1998 and 2007.

Significant changes in areas of Broad Habitats in the Environmental Zones are shown in *Table 2.4*.

▼ **Figure 2.1:** The area of Broad Habitats in the three Environmental Zones of England between 1990 and 2007.



▼ **Table 2.3:** The change in area ('000 ha and percentage) of Broad Habitats in England between 1990 and 2007. Arrows denote significant change ($p<0.05$) in the direction shown.

Broad Habitats	1990 - 1998		1990 - 2007		1998 - 2007		Significant Changes 1998 - 2007
	Change ('000 ha)	% Change	Change ('000 ha)	% Change	Change ('000 ha)	% Change	
Broadleaved, Mixed and Yew Woodland	41	4.6	95	10.7	54	5.8	↑
Coniferous Woodland	19	8	16	6.4	-4	-1.4	
Boundary and Linear Features	-25	-6.6	-26	-6.9	-1	-0.3	
Arable and Horticulture	9	0.2	-378	-8.6	-387	-8.8	↓
Improved Grassland	-361	-11.7	-219	-7.1	142	5.3	
Neutral Grassland	296	29.8	459	46.2	163	12.6	↑
Calcareous Grassland	-10	-22.8	-13	-29.7	-3	-8.9	
Acid Grassland	-74	-15.6	-79	-16.7	-5	-1.2	
Bracken	16	17.1	-2	-2.3	-18	-16.5	
Dwarf Shrub Heath	-21	-6.9	22	7.2	44	15.1	↑
Fen, Marsh and Swamp	46	59.3	39	50.6	-7	-5.5	
Bog	40	40.5	41	42.2	2	1.2	
Standing Open Water and Canals[6]	2	6.7	8	30.1	6	5.3	↑
Rivers and Streams[6]	-1	-5.4	-1	-6.8	-1	-1.5	
Built-up Areas and Gardens	10	1	39	3.9	29	2.9	

[6] Standing Open Water and Canals and Rivers and Streams BH estimates were calculated using a different statistical model to the other BHs. It is not appropriate to use the consistent statistical model for these two habitats because of the distribution of the data. Change in these BHs is calculated independently from the differences between stock estimates.

Within Environmental Zones, there were some statistically significant changes in the areas of Broad Habitats between 1998 and 2007 *(Table 2.4)*. In both the Easterly Lowlands and Westerly Lowlands Environmental Zones there was a significant decrease in the area of the Arable and Horticulture Broad Habitat. In the Easterly Lowlands Environmental Zone this was largely replaced with Improved Grassland whereas in the Westerly Lowlands it was replaced by Neutral Grassland. The increase in the area of Broadleaved Woodland in the Easterly Lowlands Environmental Zone is in keeping with the policy to plant new woodlands on farmland. The significant decrease in the area of Calcareous Grassland in the Westerly Lowlands Environmental Zone, is more difficult to explain.

▼ **Table 2.4:** Changes in the areas of Broad Habitats in the Environmental Zones of England between 1998 and 2007. Arrows denote significant change ($p<0.05$) in the direction shown.

Broad Habitats	Easterly Lowlands	Westerly Lowlands	Uplands
Broadleaved, Mixed and Yew Woodland	↑		
Coniferous Woodland			
Linear Features			↓
Arable and Horticulture	↓	↓	
Improved Grassland	↑		
Neutral Grassland		↑	
Calcareous Grassland		↓	
Acid Grassland			
Bracken	↓		
Dwarf Shrub Heath			
Fen, Marsh and Swamp		↓	
Bog			
Built-up Areas and Gardens			↑

2.4 Vegetation condition in Broad Habitats

Summary

- **Species richness in Main Plots in the Arable and Horticulture Broad Habitat increased, but decreased in Acid Grassland, while there was no detectable change in other Broad Habitats in England between 1998 and 2007. Species richness in areas within Broad Habitats targeted for their botanical interest decreased in Improved, Neutral and Acid Grassland Broad Habitats in England between 1998 and 2007. Species richness and the number of plant species used as food by butterfly caterpillars also decreased in linear plots alongside streams.**

- **Between 1998 and 2007, there were changes in the condition of vegetation, particularly in Main Plots within agricultural habitats (Arable and Horticulture, Improved and Neutral Grassland Broad Habitats). There were also changes in areas targeted for their botanical interest (Neutral Grassland and Acid Grassland Broad Habitats) and alongside Linear Features (rivers and streams and alongside hedges, field boundaries and roadsides). These changes suggest a shift in community towards later successional types of vegetation, with more competitive, shade casting and fewer ruderal species. There were also increases in competitive species in areas targeted for their botanical interest in Dwarf Shrub Heath and Fen, Marsh and Swamp Broad Habitats. In areas targeted for their botanical interest in Broadleaved Woodland the changes in condition suggested a response to canopy closure and/or reduced management.**

- **Species richness in Main Plots in 2007 was lowest in the Arable and Horticulture Broad Habitat and highest in Fen, Marsh and Swamp, where as in Targeted Plots it was highest in Calcareous Grassland and lowest in Dwarf Shrub Heath.**

- **Within Environmental Zones between 1998 and 2007, there were significant changes in condition characteristics, suggesting shifts in the vegetation communities of Broad Habitats, particularly in the agricultural habitats (Arable and Horticulture, Neutral and Improved Grasslands) in the Easterly and Westerly Lowlands Environmental Zones. There were also decreases in species richness, increases in Grass:Forb ratio and increases in competitive species in the Acid Grassland, Dwarf Shrub Heath, Bog and Fen, Marsh and Swamp in the Uplands Environmental Zone. Species richness and plant species used as food by butterfly caterpillars increased in Broadleaved Woodland in the Easterly Lowlands Environmental Zone.**

- **There was no significant change in species richness alongside linear features across England between 1998 and 2007, but there was a significant long-term decrease between 1978 and 2007. Competitive plant species increased in linear plots in England between 1978 and 2007, whilst ruderal species decreased over the same period. Species preferring shady conditions increased alongside linear features between 1998 and 2007. The results show an overall shift towards more shade tolerant species and a reduction in species richness in England.**

- **Plant species changing the most in frequency of occurrence in areas characteristic of all Broad Habitats were typically taller species, associated with later succession (e.g. trees and shrubs): more species increasing in frequency were in the higher canopy height class, reinforcing the signal of successional changes towards taller, more shade casting vegetation.**

▲ Surveying a Boundary Plot • © *NERC*

2.4.1 Introduction

A summary overview of the results presented in the subsequent Chapters of this report is provided here to illustrate the national picture of change in condition characteristics of vegetation in each of the Broad Habitats in England. In addition, the national picture is presented by generalised changes, determined by taking averaged information from repeatedly sampled plots, in all types of vegetation and Broad Habitats.

CS samples Broad Habitats using 200m^2 Main Plots randomly located to assess widespread and common habitat types in the open countryside and Targeted Plots (2m x 2m) positioned by surveyors to assess smaller areas of botanical interest which may be overlooked by the randomly located Main Plots.

Countryside Survey recognises that many plant species in the countryside are restricted to the boundaries of managed land. Linear Plots (10m x 1m) were therefore located at random alongside linear features (field boundaries, hedgerows, streamsides and roadside verges) to ensure the vegetation associated with these features was adequately sampled. An analysis of change in the vegetation of linear features is covered in detail in *Chapters 5 and 8*.

2.4.2 Vegetation condition in Main and Targeted Plots

An overview of vegetation condition changes in Broad Habitats across England between 1998 and 2007 is presented in *Table 2.5*.

One of the most striking aspects of the changes in condition characteristics shown in *Table 2.5* are the differences in changes in species richness, and numbers of plant species used by birds or butterfly caterpillars as food between the Main Plots and Targeted plots within particular Broad Habitats. The increases shown in Main Plots in Broadleaved Woodland (numbers of plants used as food by butterfly caterpillars) and Arable and Horticulture Broad Habitats (species richness and numbers of food plants used as food by birds and butterfly caterpillars) are not detected in the plots targeted for their botanical interest. In contrast, the decreases in species richness, and/or the numbers of plant species used by birds or butterfly caterpillars as food detected in Targeted Plots in Improved Grassland and Neutral Grassland were not detected in Main Plots. There were also decreases in species richness in Targeted Plots in Acid Grassland, and in Linear Plots along rivers and streams. This suggests a loss of diversity in areas which may be important refuges for biodiversity. The other striking aspect of changes in condition shown in Table 2.5 is the number of changes in condition characteristics in the Main Plots in the Arable and Horticulture, Improved Grassland and Neutral Grassland Broad Habitats and in Targeted Plots in almost every Broad Habitat and in the plots sampling the Linear Features. This suggests community shifts have occurred, particularly in areas targeted for botanical diversity, towards taller, shadier and more competitive, or later successional types of vegetation. Further details are given in *Chapters 3 to 8*.

▲ Green-veined white butterfly (*Pieris napi*) • © *Natural England • Peter Wakely*

▼ **Table 2.5:** A summary of the changes in vegetation condition by Broad Habitat in the Main, Targeted and Linear Plots in England between 1998 and 2007. Greyed cells with diagonal strikethrough denote insufficient data for analyses.

		Vegetation Condition Measures										
	Broad Habitat	Species Richness (No. of Species)	No. of Bird Food Species	No. of Butterfly Food Species	Grass:Forb Ratio	Competitor Score	Strees Tolerator Score	Ruderal Score	Light Score	Fertility Score	Ellenburg pH Score	Moisture Score
Main Plots	Broadleaved, Mixed and Yew Woodland			↑								
	Coniferous Woodland											
	Arable and Horticulture	↑	↑	↑	↓	↓		↑	↓	↓	↓	
	Improved Grassland				↓		↑		↓		↓	
	Neutral Grassland					↑	↑	↓	↓			↑
	Calcareous Grassland											
	Acid Grassland	↓									↑	
	Bracken											
	Dwarf Shrub Heath				↑	↑						↑
	Fen, Marsh and Swamp		↓									
	Bog											
Targeted Plots	Broadleaved, Mixed and Yew Woodland				↓		↑	↓	↓			↓
	Coniferous Woodland											
	Arable and Horticulture							↓	↓			
	Improved Grassland	↓		↓					↓			
	Neutral Grassland	↓	↓	↓	↓	↑		↓	↓	↑		
	Calcareous Grassland		↓	↑						↑		
	Acid Grassland	↓				↑	↓			↑		
	Bracken								↓			
	Dwarf Shrub Heath		↓			↑						
	Fen, Marsh and Swamp					↑						
	Bog											
Linear Plots*	Rivers and Streams	↓		↓	↓	↑		↓	↓	↑	↑	↓
	Boundary and Linear Features		↑		↓	↑	↑	↓	↓			↑

* The linear Broad Habitats plot data presented in this summary were selected based on landscape location sampled to make it consistent with the data presented for other Broad Habitats: Rivers and Streams includes Streamside Plots only; Boundaries and Linear Features includes Hedgerow, Field Boundary and Roadside Plots. See ***Chapter 2.4.3*** for further details about Linear Plots.

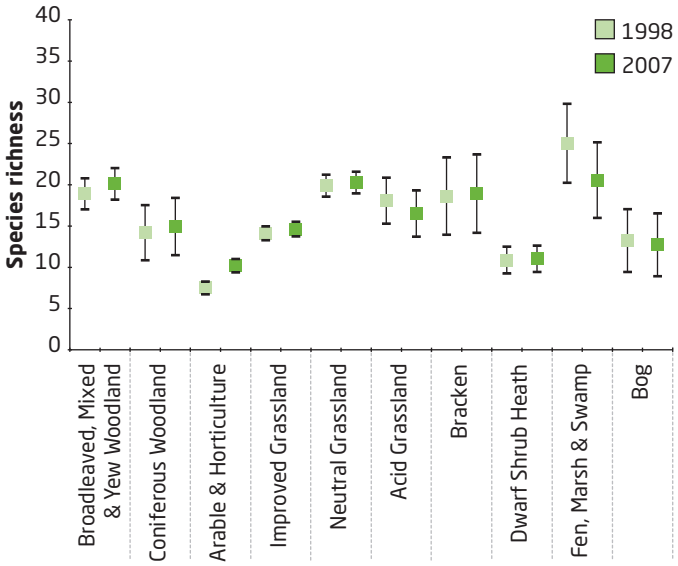
Species richness in Broad Habitats across England

Plant species richness of different Broad Habitats in England in 1998 and 2007 are presented for Main and Targeted Plots in *Figures 2.2* and *2.3*, respectively. It should be noted that this measure of species richness is not an absolute value and it is therefore the relative comparisons between habitats and years that are most important.

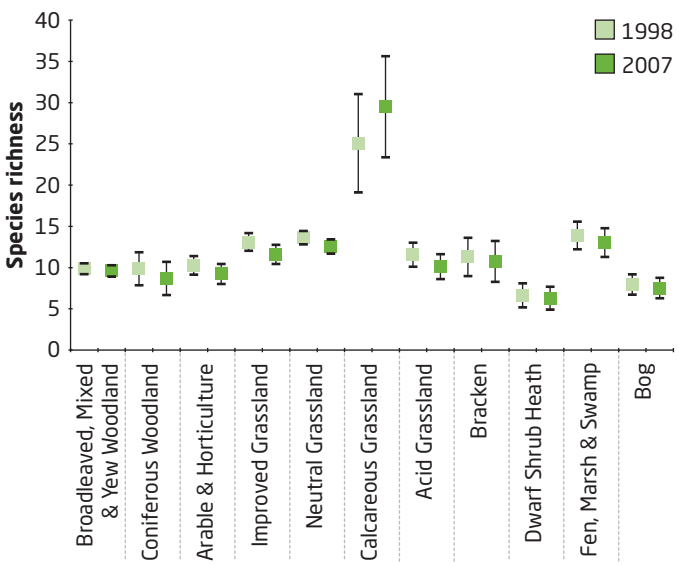
The mean species richness in 200m^2 Main Plots in Broad Habitats across England in 2007 ranged from 10.2 species per Main Plot in Arable and Horticulture to 20.6 species per Main Plot in Fen, Marsh and Swamp. There was a significant increase between 1998 and 2007 in species richness of Main Plots in Arable and Horticulture Broad Habitat, and a significant decrease in Acid Grassland Broad Habitat *(Table 2.5)*.

The mean Species richness in within Broad Habitats by Countryside Survey in 2007 ranged from 6.3 species per 2m x 2m Targeted Plot in Dwarf Shrub Heath to 29.5 species per Targeted Plot in Calcareous Grassland. There were significant decreases between 1998 and 2007 in species richness in Targeted Plots in Improved, Neutral and Acid Grassland Broad Habitats *(Table 2.5)*.

▼ **Figure 2.2:** A comparison of species richness in 200m² Main Plots across different Broad Habitats in England in 1998 and 2007. Error bars presented are 95% confidence intervals. There were insufficient data for Main Plots in Calcareous Grassland.



▼ **Figure 2.3:** A comparison of species richness in 2m x 2m Targeted Plots across different Broad Habitats in England in 1998 and 2007. Error bars presented are 95% confidence intervals.



▼ **Table 2.6:** Changes in the number of plant species in 200m² Main Plots in the Environmental Zones of England between 1998 and 2007. Arrows denote significant change ($p<0.05$) in the direction shown. Greyed cells with diagonal strikethrough denote insufficient data for analyses.

Broad Habitats	Easterly Lowlands	Westerly Lowlands	Uplands
Broadleaved, Mixed and Yew Woodland	↑		
Coniferous Woodland			
Arable and Horticulture	↑		
Improved Grassland			
Neutral Grassland		↑	
Acid Grassland			↓
Bracken			↓
Dwarf Shrub Heath			
Fen, Marsh and Swamp			↑
Bog			
All Broad Habitats	↑	↑	↓

Species richness in Broad Habitats in Environmental Zones

There are enough data to provide statistics for the changes in condition of most of the Broad Habitats in the individual Environmental Zones, but not for Calcareous Grassland. For some other Broad Habitats sufficient data are only available to report on some of the Environmental Zones.

The number of species found within 200m² Main Plots in all Broad Habitats increased in both the Easterly and Westerly Lowlands Environmental Zones, but decreased in the Uplands between 1998 and 2007 *(Table 2.6)*. There were relatively few significant changes in the number of species found within Main Plots in different Broad Habitats in the different Environmental Zones *(Table 2.6)*.

There were significant decreases in the number of species in Main Plots in the Acid Grassland and Bracken Broad Habitats in the Uplands but no significant decreases in the other two Environmental Zones. There was a significant increase in the number of species per Main Plot in the Fen, Marsh and Swamp Broad Habitat in the Uplands. There were significant increases in the number of species in Main Plots in the Easterly Lowlands Environmental Zone in the Broadleaved, Mixed and Yew Woodland and Arable and Horticulture Broad Habitats and also in the Neutral Grassland Broad Habitat in the Westerly Lowlands Environmental Zone.

In areas within all Broad Habitats targeted by Countryside Survey for their botanical interest, species richness decreased in the Easterly Lowlands and in the Uplands Environmental Zones. In areas within Broad Habitats targeted by Countryside Survey for their botanical interest, the number of species per plot decreased

▼ **Table 2.7:** Changes in the number of plant species in 2m x 2m Targeted Plots in the Environmental Zones of England between 1998 and 2007. Arrows denote significant change ($p<0.05$) in the direction shown. Greyed cells with diagonal strikethrough denote insufficient data for analyses.

Broad Habitats	Easterly Lowlands	Westerly Lowlands	Uplands
Broadleaved, Mixed and Yew Woodland			
Coniferous Woodland			↓
Arable and Horticulture			
Improved Grassland		↓	
Neutral Grassland			↓
Acid Grassland			↓
Bracken			
Dwarf Shrub Heath		↓	
Fen, Marsh and Swamp			
Bog			
All Broad Habitats	↓		↓

▼ **Table 2.8:** Changes in Competitor, Stress Tolerator and Ruderal Scores for vegetation observed in 200m² Main Plots in the Environmental Zones of England between 1998 and 2007. Arrows denote significant change ($p<0.05$) in the direction shown. Greyed cells with diagonal strikethrough denote insufficient data for analyses.

Broad Habitats	Competitor Score			Stress Tolerator Score			Ruderal Score		
	Easterly Lowlands	Westerly Lowlands	Uplands	Easterly Lowlands	Westerly Lowlands	Uplands	Easterly Lowlands	Westerly Lowlands	Uplands
Broadleaved, Mixed and Yew Woodland								↓	
Coniferous Woodland									
Arable and Horticulture	↓	↓					↑	↑	
Improved Grassland							↓		
Neutral Grassland	↑				↑		↓	↓	
Acid Grassland									
Bracken									
Dwarf Shrub Heath									
Fen, Marsh and Swamp									
Bog			↑						
All Broad Habitats									

in Improved Grassland and Dwarf Shrub Heath in the Westerly Lowlands Environmental Zone between 1998 and 2007. There were significant decreases in the number of species found in Targeted Plots within Acid and Neutral Grassland and in Coniferous Woodland in the Uplands Environmental Zone *(Table 2.7)*.

Other changes in condition characteristics in Broad Habitats in Environmental Zones

There were no significant changes in the proportions of competitive species, stress tolerating species and ruderal species in 200m² Main Plots across the Environmental Zones of England between 1998 and 2007 *(Table 2.8)* but there were changes within some of the individual Broad Habitats. The proportion of competitive species increased in the Neutral Grassland Broad Habitat in the Easterly Lowlands Environmental Zone and in Bog Broad Habitat in the Uplands Environmental Zone. Competitive species decreased in the Arable and Horticulture Broad Habitat in the Easterly and Westerly Lowlands Environmental Zones whilst ruderal species increased in those zones. The only change in the proportion of stress tolerating species was an increase in the Neutral Grassland Broad Habitat in the Westerly Lowlands Environmental Zone. Ruderal species decreased in Broadleaved, Mixed and Yew Woodland and Neutral Grassland Broad Habitats in the Westerly Lowlands Environmental Zone and also in Improved and Neutral Grassland Broad Habitats in the Easterly Lowlands Environmental Zone.

Further details on the values of the measures of the condition of vegetation can be found at *www.countrysidesurvey.org.uk*, and in *Chapters 3 to 8* of this report.

2.4.3 Vegetation condition in Linear Plots alongside linear features

Changes in vegetation characteristics for all 10m x 1m Linear Plots alongside linear features like field boundaries, roads and streams (excludes Hedge Plots – see *Chapter 5*) are summarised for England between 1978 and 2007 in *Table 2.9*.

▼ **Table 2.9:** Changes in the characteristics of vegetation in all 10m x 1m Linear Plots (excluding Hedge Plots) in all vegetation types across England, between 1978 and 2007. Mean values for 1998 and 2007 are presented; those for 1978 and 1990 are available at *www.countrysidesurvey.org.uk*. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3 of the UK Results from 2007 report***.

Vegetation Condition Measures	Mean values (England)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1978 - 1990				Direction of significant changes 1978 - 2007			
	1998	2007	E	EL	WL	UP	E	EL	WL	UP	E	EL	WL	UP	E	EL	WL	UP
Species Richness (No. of Species)	14.5	14.9					↓	↓	↓						↓		↓	
No. of Bird Food Species	6.5	7	↑	↑			↓		↓			↓			↓			
No. of Butterfly Food Species	6.1	6.4		↑			↓	↓	↓						↓		↓	
Grass:Forb Ratio	0.35	0.22		↓			↓		↓	↓	↓	↓	↓		↓	↓	↓	↓
Competitor Score	3.08	3.12		↑											↑			↑
Stress Tolerator Score	1.87	1.93	↑	↑					↑		↓	↓	↓					
Ruderal Score	2.54	2.45	↓	↓					↓						↓		↓	
Light Score	6.57	6.49	↓	↓									↓		↓		↓	
Fertility Score	6.2	6.18									↑	↑	↑		↑		↑	↑
Ellenberg pH Score	6.54	6.54				↑					↑	↑	↑	↑	↑	↑	↑	↑
Moisture Score	5.31	5.31					↑	↓			↓			↑				

Species richness alongside linear features

While there was no significant change in the averaged species richness of all linear plots, the number of species used by farmland birds as food increased significantly (from 6.5 to 7 species per plot) across England between 1998 and 2007 *(Table 2.9)*. Over the longer period 1978 to 2007, the plant species richness alongside linear features decreased significantly across England. This is also reflected in decreases in the numbers of food plant species for farmland birds and butterfly caterpillars *(Table 2.9)*.

There was a significant increase in the number of food plant species for farmland birds and butterfly caterpillars in the Easterly Lowlands Environmental Zone, where other significant changes in condition were also detected between 1998 and 2007. There were significant decreases in the species richness and numbers of food plant species for butterfly caterpillars in linear plots in the Westerly Lowlands over the long-term, 1978-2007 *(Table 2.9)*.

Other condition characteristics alongside linear features

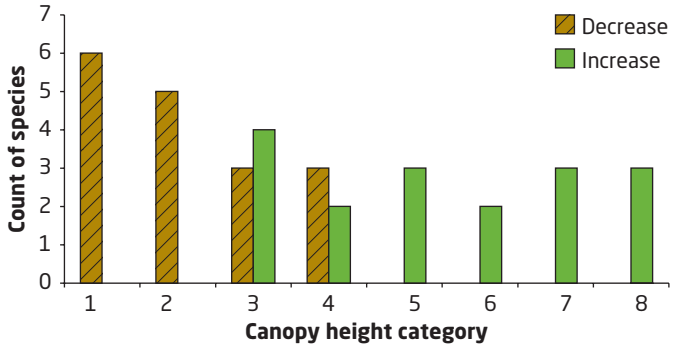
Ruderal and Light Scores decreased in linear plots across England between 1998 and 2007 whilst the Stress Tolerator Score increased. Competitive plant species increased between 1978 and 2007, whilst ruderal species decreased over the same period. The results show an overall shift towards more shade tolerant species and away from those species preferring more open conditions suggesting that the vegetation alongside linear features has become denser and taller *(Table 2.9)*.

There were significant decreases in Grass:Forb ratio, Ruderal and Light Scores but increases in Competitor and Stress Tolerator species in linear plots in the Easterly Lowlands between 1998 and 2007, which together with the changes in bird and butterfly caterpillar food plants, indicates a significant shift in community in this Environmental Zone *(Table 2.9)*.

Ellenberg pH increased significantly in the all linear plots in the Uplands Environmental Zone between 1998 and 2007 *(Table 2.9)*.

Over the long-term, 1978-2007, there were many significant changes in condition attributes in the Westerly Lowlands and Uplands Environmental Zones *(Table 2.9)*.

▼ **Figure 2.4:** Count of species in each canopy height category* (when mature) for the 10% percentile of species with increasing and decreasing frequency in all vegetation types in England, between 1998 and 2007 (See ***Table 2.10*** for species listed).



***Canopy height categories: 1,** <100mm; **2,** 101-299mm; **3,** 300-599mm; **4,** 600-999mm; **5,** 1.0-3.0m; **6,** 3.1-6.0m; **7,** 6.1-15m; **8,** >15m.

2.4.4 Changes in frequency of species in vegetation sampling plots

The plant species that increased in frequency the most in vegetation sampling plots across England between 1998 and 2007 were typically those plants, which are taller when mature (e.g. trees are taller than grasses) *(Fig. 2.4)*. Later successional species such as trees and shrubs have increased at the expense of early successional species *(Table 2.10)*.

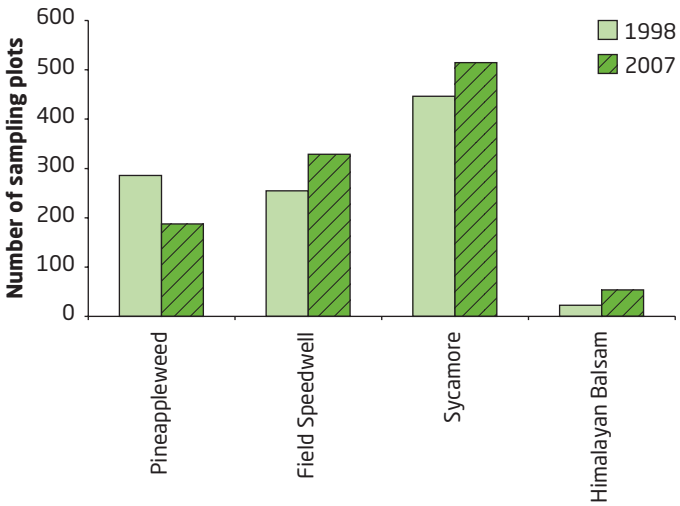
▲ Pill sedge (*Carex pilulifera*) – one of the species decreasing in frequency • © *Natural England* • *John Martin*

Plant species that can benefit from a reduced intensity of habitat management have become more prevalent. Climbing species (e.g. Bramble, *Rubus fruticosus* agg.) and species that have a more westerly distribution in Europe (e.g. Holly, *Ilex aquifolium*) have also increased. Consistent with the increase in arable fallow and the more widespread successional trend, decreasing species included short gap-colonisers such as Pearlwort (*Sagina* sp.), Red Deadnettle (*Lamium purpureum*), Pineappleweed (*Matricaria discoidea*) and Sheep's Sorrel (*Rumex acetosella*).

Non-native plant species[9]

Overall tests of change in richness of non-native plants by plot type, showed no significant changes had occurred across England between 1998 and 2007. A number of common non-native plants did however have high change indices ***(Fig. 2.5)***. Pineappleweed (*Matricaria discoidea*) a common non-native plant was among the listed species declining in frequency ***(Table 2.10)***, which may be related to the decrease in Wheat and Barley crops and an increase in fallow land. The increase in occurrence of Sycamore (*Acer pseudoplatanus*) was consistent with the trend towards less disturbed vegetation particularly along linear features. While still relatively uncommon in the survey, two invasive aliens increased in frequency with relatively high change indices: Himalayan Balsam (*Impatiens glandulifera*), increased from 22 records in 1998 to 53 in 2007 (change index of 0.62) and Japanese Knotweed (*Fallopia japonica*) increased from 1 record to 7 (change index 0.65). Non-native species in ponds are reported in the Pond Report due in late 2009.

▼ **Figure 2.5:** Changes in occupancy of repeat plots between 1998 and 2007 for non-native species that had the highest change indices.



2.5 Changes in linear landscape features

- **The total length of woody linear features was 547,000km in England in 2007, and was distributed mainly between the Easterly and Westerly Lowlands Environmental Zones. The total length of woody linear features decreased by 1.4% (8,000km) in England between 1998 and 2007, following an increase between 1990 and 1998 and a decrease between 1984 and 1990.**

- **The total length of managed hedgerows[10] was 402,000km in England in 2007, and was distributed mainly between the Easterly and Westerly Lowlands Environmental Zones. The length of managed hedgerows[1] decreased by 6.1% (26,000km) in England between 1998 and 2007, with a large proportion of these managed hedges turning into lines of trees and relict hedges (which increased significantly), as a consequence of less management.**

▲ Relict hedge, Cumbria • © *NERC* • *Lisa Norton*

[9] Defined as alien casuals and neophytes (introduced after 1500)

[10] The term 'managed hedgerows' does not include relict hedges and lines of trees.

▼ **Table 2.10:** Plant species that increased and decreased the most in terms of the number of repeat[7] plots occupied between 1998 and 2007 and where the Change Index agreed with the increase or decrease in the number of plots occupied. Growth form: w = woody; f = forb; g = grass. Fertility Score ranges from 0 = infertile soils to 9 = extremely fertile soils. The Change Index was calculated using an adaptation of the method presented in the New Atlas of the British and Irish Flora[8].

Species	Common Name	Growth Form	Number of plots occupied in 2007	Number of plots occupied in 1998	Change in the number of plots occupied	Change Index
Rubus fruticosus agg.	Bramble	w	3430	2748	682	0.98
Tamus communis	Black Bryony	w	349	148	201	0.97
Hedera helix	Ivy	w	1751	1302	449	0.84
Urtica dioica	Stinging nettle	f	2945	2680	265	0.77
Crataegus monogyna	Hawthorn	w	2795	2662	133	0.70
Quercus robur & petraea	Oak	w	1044	802	242	0.68
Fraxinus excelsior	Ash	w	1263	1024	239	0.68
Prunus spinosa	Blackthorn	w	1544	1352	192	0.65
Poa trivialis	Rough Meadow Grass	g	1811	1640	171	0.65
Geum urbanum	Wood Avens	f	423	273	150	0.65
Anthriscus sylvestris	Cow Parsley	f	1447	1285	162	0.62
Sonchus asper	Prickly Sow Thistle	f	484	353	131	0.58
Senecio vulgaris	Groundsel	f	399	280	119	0.57
Heracleum sphondylium	Hogweed	f	1426	1331	95	0.57
Sambucus nigra	Elder	w	1087	974	113	0.55
Corylus avellana	Hazel	w	856	734	122	0.54
Ilex aquifolium	Holly	w	488	375	113	0.53
Carex pilulifera	Pill Sedge	s	26	107	-81	-1.28
Sagina sp.	Pearlworts	f	60	148	-88	-0.78
Carex nigra	Common Sedge	s	115	254	-139	-0.61
Lamium purpureum	Red Dead-nettle	f	96	179	-83	-0.49
Hordeum distichon sens.lat.	Two-Rowed Barley	g	135	211	-76	-0.29
Stellaria uliginosa	Bog Stitchwort	f	121	182	-61	-0.28
Carex panicea	Carnation Sedge	s	149	234	-85	-0.28
Rumex acetosella	Sheep's Sorrel	f	127	191	-64	-0.27
Leontodon autumnalis	Autumn Hawkbit	f	173	269	-96	-0.25
Holcus mollis	Creeping Soft-grass	g	328	564	-236	-0.24
Matricaria discoidea	Pineappleweed	f	187	285	-98	-0.22
Achillea millefolium	Yarrow	f	558	626	-68	-0.22
Cardamine hirsuta/flexuosa	Hairy Bittercress	f	239	340	-101	-0.12
Poa pratensis sens.lat.	Smooth Meadow Grass	g	510	788	-278	-0.08
Phleum pratense sens.lat.	Timothy	g	377	544	-167	-0.06
Chenopodium album agg.	Fat Hen	f	219	286	-67	-0.06
Rumex crispus	Curled Dock	f	241	309	-68	-0.03

- **50% of managed hedges were in good structural condition, 32% of managed hedges were in good structural condition and had appropriately managed margins but only 12% of those on arable land were in both good structural condition and had appropriately managed margins in England in 2007. A higher proportion of hedges in England were in good condition compared to Great Britain as a whole.**
- **The total length of walls was 82,000km in England and was distributed mainly in the Upland and Westerly Lowlands Environmental Zone. The length of walls decreased by 1.1% (approximately 900km) overall in England between 1998 and 2007, with the largest losses occurring in the Uplands Environmental Zone.**
- **The total length of banks and grass strips was 42,000km, with much of this in the Westerly Lowlands Environmental Zone.**

Detailed analyses of change in linear landscape features are discussed in *Chapter 5*, but the summary is reproduced here. The length of managed hedges decreased by 6.1% in England between 1998 and 2007, and there were corresponding increases in the length of remnant and relict hedges and in the length of lines of trees (14.1% in total). This finding suggests a reduction in the management and maintenance of some hedgerows. For hedgerows remaining in the managed category there were signs of improvements in condition, with a significant increase in hedges over 2m high between 1998 and 2007; overall 50% of hedges sampled were in good structural condition but this falls to 32% if those without appropriately managed margins are excluded (see *Chapter 5*).

▲ Soil core ready to be returned to the lab for analysis • © *NERC* • *Ian Simpson*

2.6 Changes in soils (0-15cm) in all habitats

- **The mean pH of soil (0-15cm) of all Broad Habitats in England increased (i.e. they became less acidic) between 1998 and 2007, and this occurred in most Broad Habitats but not in Broadleaved and Coniferous Woodlands, in Bog and in Fen, Marsh and Swamp Broad Habitats, continuing a trend observed between 1978 and 1998 for most habitats.**

- **The mean carbon concentration in the soil (0-15 cm) of all Broad Habitat types in England decreased between 1998 and 2007, but this change was not detected in individual Broad Habitats, except for the significant decrease in carbon concentration in the Arable and Horticulture Broad Habitat. Overall there was no change in carbon concentration in the soil (0-15 cm) in England between 1978 and 2007.**

- **The mean soil (0-15cm) carbon stock of all Broad Habitats across England in 2007 was calculated to be 57 tC/ha. The carbon stock of Broad Habitats ranged between a mean of 43 tC/ha in the Arable and Horticulture Broad Habitat to a mean of over 88 tC/ha in Dwarf Shrub Heath.**

Introduction

Samples of soil (0-15cm) were collected in Main Plots in 1978, 1998 and 2007 for chemical and physical measurements. The upper soil (humus layer) from 0-8 cm depth was also sampled for analysis of soil biota. Initial results for soil (0-15cm) pH, carbon concentration, bulk density and stock of carbon are presented here for different habitat types across England. Further analysis is ongoing and more soils results will be reported in a separate technical report to be published later in 2009, supported by a number of scientific papers.

Soil (0-15cm) pH

The pH of soil (0–15 cm) *(Table 2.11)* in all vegetation types increased (became less acidic) from a mean pH of 6.20 to 6.51 between 1998 and 2007. The increase continued a trend in England from 1978 to 1998. The same trend was evident in six of the Broad Habitats where sample size was large enough to make an estimate (Arable and Horticulture, Improved, Neutral and Grasslands, Bracken and Dwarf Shrub Heath). The other Broad Habitat types showed no change between 1998 and 2007. All habitats apart from Coniferous Woodland, Fen, Marsh and Swamp, and Bog, showed a long-term increase in pH from 1978 and 2007. These trends are consistent with a long-term recovery from acid deposition, though other factors such as liming and fertiliser use on agricultural land would also contribute to changes in some habitats. Attribution of change to different drivers for individual habitats is ongoing.

Changes in soil pH in relation to changes in the vegetation condition

The relationship between soil pH and Ellenberg pH Scores[11] for the vegetation condition merit further investigation and this will be undertaken as part of ongoing Integrated Assessment work that will reported in 2010. By way of an introduction of what is to come, it is interesting to note the significant changes in Ellenberg pH Scores that are summarised in *Table 2.12* and to compare these with the soil (0-15cm) pH results from the Main Plots. The expectation would be for Ellenberg pH Score to follow soil pH trends i.e. decreasing or increasing trends in both.

The most evident changes in Ellenberg pH Scores are the decreases observed in Main Plots in Arable and Horticulture and Improved Grassland Broad Habitats across England and the Environmental Zones between 1990, 1998 and 2007 (see *Chapter 3*). There was also a significant decrease in Ellenberg pH in Main Plots in Neutral Grassland in the Westerly Lowlands Environmental Zone between 1998 and 2007. In contrast, there was a significant increase in the Ellenberg pH in Main Plots in the Acid Grassland across England between 1998 and 2007 and in Fen, Marsh and Swamp between

[11] An indirect measure of soil pH. It reflects the abundance of plants known to be associated with different levels of pH based on the Ellenberg value for soil reaction of each species (1 = acidic to 9 = alkali).

▼ **Table 2.11:** Changes in the pH and carbon concentration of soils (0-15cm depth) within all vegetation types and some selected Broad Habitats across England. Arrows denote a significant change ($p<0.05$) in the direction shown.

	Mean pH		Mean carbon concentration (g/kg)		Direction of significant changes 1998 - 2007		Direction of significant changes 1978 - 1998		Direction of significant changes 1978 - 2007	
Broad Habitat	**1998**	**2007**	**1998**	**2007**	**pH**	**Carbon Conc.**	**pH**	**Carbon Conc.**	**pH**	**Carbon Conc.**
Broadleaved, Mixed and Yew Woodland	5.83	6.07	74.0	63.2			↑		↑	
Coniferous Woodland	4.13	4.44	140.7	116.8						
Arable and Horticulture	7.02	7.43	29.8	27.2	↑	↓	↑		↑	↓
Improved Grassland	6.29	6.58	49.6	48.2	↑		↑		↑	
Neutral Grassland	6.18	6.41	62.8	58.7	↑		↑	↑	↑	
Acid Grassland	4.51	4.74	183.4	190.6	↑		↑		↑	
Bracken	4.08	4.89	104.1	131.3	↑				↑	
Dwarf Shrub Heath	4.12	4.4	203.8	208.1	↑				↑	
Fen, Marsh and Swamp	5.83	5.48	242.9	220.3						
Bog	4.09	4.01	385.3	353.5						
Average for all vegetation types	6.20	6.51	72.0	68.3	↑	↓	↑		↑	

▼ **Table 2.12:** A summary of changes in Ellenberg pH Scores in Main Plots in different Broad Habitats across England between 1990 and 2007. Arrows denote significant change ($p<0.05$) in the direction shown. Greyed cells with diagonal strikethrough denote insufficient data for analyses.

	Ellenberg pH Scores (England)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Broad Habitats	**1998**	**2007**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**
Broadleaved, Mixed and Yew Woodland	5.85	5.93												
Coniferous Woodland	4.74	4.85												
Arable and Horticulture	6.73	6.68	↓	↓			↓	↓	↓		↓	↓	↓	
Improved Grassland	6.21	6.17	↓		↓	↓	↓	↓	↓		↓	↓	↓	↓
Neutral Grassland	6.02	5.97			↓									
Acid Grassland	3.62	3.71	↑											
Bracken	4.06	4.15												
Dwarf Shrub Heath	2.96	2.98												
Fen, Marsh and Swamp	4.60	4.50					↑			↑	↑			
Bog	3.08	3.00												

1990 and both 1998 and 2007 across England and between 1990 and 1998 in the Uplands Environmental Zone. The acidity of the soil (0-15cm) decreased between 1978 and 2007 in all of the Broad Habitats where changes were detected except for Fen, Marsh and Swamp and therefore the relationship between soil pH and Ellenberg pH Scores needs further investigation before any conclusions can be drawn regarding these apparently contradictory trends. Possibilities include a lag in vegetation response to changes in soil pH and/or involvement of other confounding factors influencing the vegetation Ellenberg pH Score.

Soil (0-15cm) carbon concentration

Overall for England, there was no significant difference between the mean carbon concentration in 2007 and 1978 nor between 1998 and 2007. Soil carbon concentration of soil (0-15 cm) decreased between 1998 and 2007 in the Arable and Horticulture Broad Habitat but no changes to other Broad Habitats were detected.

▲ Tormentil (*Potentilla erecta*) a species which thrives in acidic soils conditions • © *Natural England* • *Peter Wakely*

Many factors can affect soil carbon concentrations including land management, climate change and nitrogen deposition.

Soil (0-15cm) bulk density and carbon stock (0-15cm)

Bulk density of soil (0-15cm) was measured for the first time in 2007. Bulk density combined with carbon concentration provides an estimation of the carbon stock within soils (0-15cm). Note that as the relationship between carbon concentration and bulk density is non-linear, the average carbon stock is not calculated directly from the average carbon concentration and average bulk density values. Bulk density was measured for the first time in 2007, so it is not possible to report on change.

▼ **Table 2.13:** Bulk density and carbon stock in soils (0-15cm) in all vegetation types for England and selected Broad Habitats in 2007.

Broad Habitat	2007	
	Mean bulk density g/cm^3	Mean carbon stock tC/ha
Broadleaved, Mixed and Yew Woodland	0.87	62.7
Coniferous Woodland	0.67	69.9
Arable and Horticulture	1.25	42.6
Improved Grassland	1.02	58.8
Neutral Grassland	0.95	59.9
Acid Grassland	0.48	87.0
Bracken	0.46	81.4
Dwarf Shrub Heath	0.47	87.6
Fen, Marsh and Swamp	0.42	75.6
Bog	0.22	73.5
Average for all vegetation types	0.99	56.7

As soils rich in carbon often have a low mass per unit volume, the range of carbon stocks in soil (0-15cm) across different Broad Habitats is more restricted than might be expected from the carbon concentrations alone. The carbon stocks in soil (0-15cm) in Broad Habitats in England ranged from 42.6 tC/ha in Arable and Horticulture to 87.6 tC/ha in Dwarf Shrub Heath, with an overall mean of 56.7 tC/ha *(Table 2.13)*.

These values for soils (0-15cm) do not represent the total soil carbon stock of the different habitats. For example, there are large stocks of carbon in bog soils, since they are deeper and richer in carbon compared to most other habitats. Nevertheless, the top soil horizons are thought to be the most susceptible to change over time as they are more immediately affected by land management activities and environmental change.

The estimates of change in soil (0-15cm) carbon concentration from Countryside Survey differ markedly from the large decrease estimated for England and Wales by the National Soil Inventory Monitoring Programme[12]. This illustrates the difficulty of estimating national soil carbon concentrations, and also the value of having different studies to compare. Further analysis is continuing to examine different soil and habitat types in different parts of the country.

▲ Marsh marigold (*Clatha palustris*) is widespread but newly recorded by CS along streamsides • © *Natural England* • *Paul Glendell*

2.7 Rivers, Streams, Standing Open Water and Canals

Summary

- **The area of Standing Open Water and Canals increased by 5.3% (6000ha) and the number of ponds by 18% (c. 37,000 ponds) in England between 1998 and 2007, with most of the increases taking place in the Easterly Lowlands Environmental Zone.**
- **The physical habitat quality of headwater streams improved between 1998 and 2007, with an increase in frequency of natural features such as debris dams, gravel bars and bank-side trees.**
- **In contrast to the stream channels, plant species richness in 10m x 1m vegetation sampling plots alongside streams decreased between 1998 and 2007, continuing a trend from 1978.**
- **The average plant species richness in ponds in England was significantly lower in 2007 that expected for good quality ponds. Almost 80% of ponds were in poor ecological condition in 2007, based on an assessment of a range of vegetation criteria.**

[12] http://randd.defra.gov.uk/Document.aspx?Document=SP0124_875_FRP.pdf

Headwater streams represent the large majority, by length, of all watercourses in England and their status can greatly affect the quality of the water flowing into downstream watercourses. Countryside Survey provides data to assess the condition of headwater streams by sampling animal and plant life within the stream channel itself and within the streamside habitat.

Ponds were added to the UK BAP list of Priority Habitats in 2007 and their condition was assessed for the first time by CS in 2007. The data provide an important baseline for Priority Habitat Ponds but can also be compared to the Lowland Pond Survey that took place in 1996.

Results for freshwater habitats are presented in ***Chapter 8*** and a brief summary is provided here. Results of stream macroinvertebrate samples were not available for this report, so changes in stream condition reported here are based on data for aquatic plants only.

The area of Standing Open Water and Canals increased by 5.3% (6000ha) in England, with most of the increase taking place in the Easterly Lowlands. Associated with the increase in the area of Standing Open Water and Canals, the number of ponds increased by 18% (amounting to 37,000 ponds) in England between 1998 and 2007, with most of the increase taking place in the Easterly Lowlands. There was no significant change in the area of Rivers and Streams (<5m wide).

On average, species richness in headwater streams increased by 44% from 2.7 to 3.9 plant species per stream section between 1998 and 2007. Plants such as Bittersweet (*Solanum dulcamara*), Creeping Bent grass (*Agrostis stolonifera*) and Branched Bur-weed (*Sparganium erectum*) became more prevalent between the two Surveys. Pink Water-speedwell (*Veronica catenata*) and Marsh marigold (*Caltha palustris*) were among the 29 species newly-recorded at CS stream sites in 2007. The physical habitat quality of headwater streams also improved between 1998 and 2007, with an increase in frequency of natural features such as debris dams, gravel bars and bank-side trees.

In contrast to the stream channels, plant species richness in 10m x 1m vegetation sampling plots alongside streams decreased between 1998 and 2007, continuing a trend from 1978. Numbers of plant species used for food by butterfly caterpillars also decreased. Competitive plant species increased and ruderal species decreased. Unlike most other habitats, the Fertility Score increased. These results continue the trend, previously found in 1998, towards less intensively managed, more fertile and less species rich streamsides.

The average plant species richness in ponds in England was poor in 2007, with only seven species on average per pond, compared to an expected richness of 20 species in good quality ponds. Almost 80% of ponds in England were in poor condition and only 9% were considered to be in good condition in 2007, based on assessment of a range of vegetation criteria known to be indicative of degradation.

▲ Course woody debris in a woodland stream, Derbyshire • © *Natural England* • *Paul Glendell*

2.8 Discussion and Conclusions

2.8.1 Summary and overview

England is mainly covered by agricultural Broad Habitats: the area of Arable and Horticulture, Improved Grassland and Neutral Grassland Broad Habitats totalled 8,311,000ha or 63.1%, while Broadleaved Woodland and Coniferous Woodland Broad Habitats totalled 1,238,000ha or 9.4%, Built Up and Gardens Broad Habitat amounted to 7.9%, other land and un-surveyed urban land amounted a total of 995,000ha or 7.8%. Dwarf Shrub Heath, Acid Grassland and Bog Broad Habitats totalled 867,000ha or 6% of the land area of England in 2007. These Broad Habitats were not evenly distributed across the Environmental Zones, reflecting the differences in climate, topography, underlying geology and history of land use and settlement. The changes in the areas of Broad Habitats in England are broadly similar to those for the UK and are in line with conservation objectives as expressed in the UK Biodiversity Action Plan[13]. The Arable and Horticulture Broad Habitat has decreased in extent largely through conversion to Improved or Neutral Grassland and there has been a marked shift from Coniferous to Broadleaved, Mixed and Yew woodland, but there were differences in the direction of changes between Broad Habitats in the three Environmental Zones of England.

Species richness of the vegetation in the characteristic areas of most Broad Habitats did not change across England, except in Arable and Horticulture (increase) and in Acid Grassland (decrease) Broad Habitats, but there were significant changes in species richness in some Broad Habitats in some Environmental Zones. In discrete areas within the Broad Habitats targeted by Countryside Survey for their botanical interest, species richness decreased in the grassland habitats (Improved, Neutral and Acid Grassland Broad Habitats) between 1998 and 2007, and there was a significant decrease over the longer term (1990-2007) in Broadleaved Woodland across England. There were also differences between Environmental Zones in changes species richness of these targeted areas within Broad Habitats.

[13] http://www.ukbap.org.uk/

Despite signals that species richness was relatively constant, the other condition characteristics signal changes in community, particularly changes in Light Scores and other condition scores in Arable and Horticulture and Improved, Neutral and Acid Grassland Broad Habitats, which suggest that the vegetation is becoming denser, more shaded, and with more competitive species.
The decrease in species richness in discrete areas within the Arable and Horticulture, Improved, Neutral and Acid Grassland Broad Habitats targeted by Countryside Survey for their botanical interest is of particular interest, because these areas contain much of the surviving plant diversity in the wider countryside and provide important habitats for a wide range of wildlife.
These areas could also help to confer resilience in a period of rapid climate change as they provide a diversity of micro-habitats, species and genotypes, and sites suitable as sources for dispersal and niches for colonisation or occupation. There were also signals of changes in Dwarf Shrub Heath, such as increases in competitive species, and in Broadleaved Woodland, such as the decrease in ruderal species, suggesting canopy closure.

CS has shown that vegetation has become less disturbed in nature and succession has taken place, especially in and alongside linear features. In headwater streams the 'in channel' habitat condition has improved but surrounding vegetation has become more overgrown and less diverse.

The results also show that there are differences between Environmental Zones, and that the Broad Habitats and vegetation communities within these zones are responding differently, both positively and negatively and at different rates to a range of possible environmental pressures, which requires further investigation to inform targeted policy approaches.

2.8.2 Agricultural Habitats: Arable and Horticulture, Improved and Neutral Grassland Broad Habitats

The agricultural landscapes of England are productive, and subject to rapid changes under agricultural management. Agriculture contributes around £6 billion to UK GDP, approx 11.7 % of the GDP for England in 1998. The total turnover for agriculture, fishing, production and distribution services in England in 2006 was estimated at £2,271,290m, while the income from farming was estimated at £1,494m in 2007 (Government Statistics). There have been relatively rapid changes in agriculture, with declines in stock of dairy, beef and sheep over the long-term, since 1983 (although sheep peaked at 20.8 million in 1990), which will have affected grazing pressure and the habitat and species diversity of vegetation in the landscape.

Environmental Accounts for Agriculture[14] estimates the landscape value of semi-natural habitats and linear features in agricultural landscapes as £143.5m, and the biodiversity value of habitats (SSSIs) and species as £628.8m in 2007. These are rough estimates used to estimate flows and relationships between benefits and damages of agricultural landscapes, but they also serve as an indication of the value of these landscapes, aside from the financial information.

These habitats support a range of BAP species, such as the Shrill Carder Bee (*Bombus sylvarum*), Grey Partridge (*Perdix perdix*), Brown Hare (*Lepus europaeus*) and Lapwing (*Vanellus vanellus*).

The quality of agricultural landscapes and the species they support are important, and used for reporting on the government's progress towards objectives in the UK Sustainable Development Strategy. One of the sustainable development indicators 'for natural resource protection and enhancing the environment' is for birds and includes the farmland bird indicator[15], with the numbers of birds being taken as a proxy for the health of the wider environment. This reports on the Public Service Agreement to reverse the decline in farmland birds by 2020. Countryside Survey provides information about the condition of the farmland habitats, and could help interpret changes in farmland birds.

In addition, the Arable and Horticulture, Improved, Neutral (and Acid) Grassland Broad Habitats contribute greatly to the quality of our landscape, giving distinctive character to each National Character area. Prime examples include; 138 Hampshire Downs (arable), 106 Seven and Avon Vales (horticulture, particularly the Avon Vale), and 65 Shropshire Hills (Improved, Neutral and Acid Grasslands). Changes in agriculture have not greatly affected the character of these landscapes[16].

Agricultural land also provides a carbon store in the underlying soils, which Countryside Survey has shown to hold fairly modest carbon stocks at 0-15cm depth in the Arable and Horticulture, Improved and Neutral Grassland Broad Habitats, but they cover a large proportion of the land area (63.1%).

Countryside Survey is at present the only source of information for reporting on targets in Arable Field Margin and Hedgerows Priority Habitats and is used, for example, for reporting on: *T5. Achieve good condition on an increasing proportion of the resource of arable field margins.* Countryside Survey also provides data for biodiversity indicators[17]; which reports on trends in plant diversity in fields and field margins and change in extent of farmland features, hedges, walls and ponds. Countryside Survey data can also be used to interpret signals from other biodiversity indicators: like populations of farmland birds and butterflies on farmland in England.

[14] https://statistics.defra.gov.uk/esg/reports/envacc/

[15] available at http://defraweb/sustainable/government/progress/national/20.htm

[16] https://statistics.defra.gov.uk/esg/indicators/d603_data.htm

[17] available at http://defraweb/wildlife-countryside/biodiversity/indicator.htm

Countryside Survey has found some evidence of positive changes since 1998, most notably through increased species richness in the Arable and Horticulture Broad Habitat, and the evidence of an increase in numbers of plant species that are used by farmland wildlife for food. However, the ongoing decline in species richness of areas targeted for their botanical interest within these Broad Habitats is a concern given the contribution of such habitats to supporting biodiversity in intensively managed agricultural landscapes. At this time, it is not clear whether the current agri-environment schemes are playing an effective role; albeit the 2007 survey may have been too early to detect full impacts of the introduction of Environmental Stewardship in 2005.

2.8.3 Acid Grassland, Dwarf Shrub Heath and Bog

Acid Grassland is the predominant Broad Habitat type in the Uplands Environmental Zone, but it also occurs in the Easterly and Westerly Lowlands Environmental Zones, where species within it can survive the harsh conditions and soil types. Countryside Survey has shown conversions to Dwarf Shrub Heath were mainly from Acid Grassland, and significant long-term changes associated with increasing nutrient status, and increasing competitive species and decreasing species richness over the short-term in this Broad Habitat, which is likely to be sensitive to changes in environmental pressures, particularly grazing. There is a degree of dynamism, between Dwarf Shrub Heath, Acid Grassland and Bog Broad Habitats, as they frequently occur as mosaics in the landscape, where they may shift between these habitat types in response to environmental pressures, such as grazing or burning.

Dwarf Shrub Heath is an assemblage of plants able to tolerate extreme conditions: nutrient poor acidic soils, rainfall between 600 and 1,100mm a year and a history of 1000s of years of human intervention. It contributes to the characteristic appearance of the Uplands and a few National Character Areas in the Westerly Lowlands (136 South Purbeck, 67 Cannock Chase and Cank Wood and 131 New Forest). The appearance and the cultural and historical importance of these areas not only attract visitors, but has resulted in some form of national landscape designation.

The UK holds some 20% of the world's lowland heathland, and it supports rare and specialised species such as the Sand Lizard (*Lacerta agilis*), Heath Tiger Beetle (*Cicindela sylvatica*) and Dartford Warbler (*Sylvia undata*). There are 43 species of invertebrate on the UK BAP Priority Species and Red Data Book 1 and 2, lists, and 67 species of rare plant species associated with heathland habitats were listed by Symes and Day[18]. Almost 90% of it is now protected as Specials Site of Scientific Interest, Special Protection Area or Special Area for Conservation.

While the area of Dwarf Shrub Heath increased, largely at the expense of Acid Grassland, there were few signals of changes in condition.

Soils underlying the areas of Dwarf Shrub Heath, Bog and Acid Grassland are likely to include deep peat layers, not sampled by Countryside Survey. Nevertheless, the Survey showed that at 0-15 cm deep, these soils contained substantial carbon stock, more than any other of the Broad Habitats. This gives an appreciable value to their contribution in providing regulatory ecosystem services, with respect to storing carbon, particularly as they occur on relatively low value, marginal land and in the harsh conditions of the Uplands.

2.8.4 Broadleaved and Coniferous Woodlands

Since the creation of the Forestry Commission in 1919, there have been several national strategies for woodlands in the UK. The most recent strategy for England is *A Strategy for England's Trees, Woods and Forests*[19].

Woodland Facts and Figures for the UK, published by the Forestry Commission[20], showed an increase in harvest of soft wood from 8,314 to 9,007 thousand green tonnes between 2003 and 2007, while harvest of hard woods decreased from 562 to 440 thousand green tonnes over the same period. It also shows that the proportion of the UK population visiting woodlands for recreation increased from 67% to 77% between 1999 and 2007. The FC statistics show that the UK has one of the lowest proportions of woodland cover in Europe, which could confer extra value on the wooded areas of England, in relation to *A Strategy for England's Trees, Woods and Forests*[19], which emphasised goals towards accessible woodlands, and to increase the contribution that woodland and forests to our quality of life. Forestry, logging and related activities had an estimated turnover of £502m in England in 2006 (Government Statistics).

Expansion and restoration of broadleaved woodland are also targets within the woodland habitat action plans that are part of the UK Biodiversity Action Plan[21], so the increase in Broadleaved Woodland reported by Countryside Survey is a positive message. Policies to protect ancient and native woodland have been strengthened since 1998 with the introduction of the government's *Keepers of Time* forestry policy and the special recognition given to ancient woods in Planning Policy Statement 9[22].

In addition to timber production, and recreational access, woodland provides another important ecosystem service, in carbon storage in the biomass and soils. Although Countryside Survey does not estimate biomass, it has demonstrated some of the value of carbon stock in woodland soils (0-15cm) and given an appreciation of the proportion of England covered by woodland Broad Habitats.

[18] Symes, N. and Day, J. (2003) A practical guide to restoration and management of lowland heathland, The RSPB, Sandy

[19] Defra (2007). A strategy for England's trees, woods and forests. Defra/Forestry Commission, London.

[20] available at http://www.forestry.gov.uk/forestry/infd-7aqdgc

[21] English Nature (1998). *UK Biodiversity Group: tranche 2 action plans (volumes 1 and 2).* English Nature, Peterborough. and HMSO (1995) *Biodiversity: the UK steering group report.* HMSO, London.

[22] Forestry Commission (2005) *Keepers of Time: A Statement of Policy for England's Ancient & Native Woodland.* Forestry Commission, Cambridge.
ODPM (2005) *Planning Policy Statement 9: Biodiversity and geological conservation.* ODPM, London.

Woodland is not evenly distributed across England, and like the grassland and agricultural habitats, it contributes greatly to the landscape value, particularly in 122 High Weald, 110 Chilterns, 49 Sherwood and 5 Border Moores and Forests National Character Areas. The increase in woodland in the Easterly Lowlands Environmental Zone is likely to have an impact on landscape quality.

Although CS reported no change in plant species richness of Main Plots (despite increase in numbers of species used as food by birds and butterfly caterpillars), the decrease in ruderal species coupled with increasing frequency of Holly (*Ilex aquifolium*), decreasing frequency of grasses and the reduction of species richness in Targeted Plots are consistent with expanding woodland canopy and reduced signs of recent management. These signals are difficult to distinguish as the results include new woodlands as well as old established woodlands, but CS provides context for other detailed site based surveys. Further details are given in ***Chapter 6***.

2.8.5 Headwater Streams and Ponds

The 5.3% (6000ha) increase in the area of Standing Open Water and Canals in England, and associated increase 18% (amounting to 37,000 ponds) in England between 1998 and 2007 is a positive message. Ponds were added to the UK BAP list of Priority Habitats in 2007 and their condition was assessed for the first time by CS in 2007. The data provide an important baseline for Priority Habitat Ponds but can also be compared to the Lowland Pond Survey that took place in 1996, which will be reported in the Pond Report, due late 2009.

The increase in physical habitat quality of streams is another positive message, because headwater streams represent the large majority, by length, of all watercourses in England and their status can greatly affect the quality of the water flowing into downstream watercourses. The Water Framework Directive has imposed targets to achieve good ecological condition of water bodies by 2015, and a number of policies and agri-environment schemes have been implemented to protect and enhance the freshwater environment. The government's water strategy: Future Water, was published in 2008, which set out a framework for water management including sustainable delivery of water supplies, improved and protected water environment and sustainable and effective management of surface water.

Under Environmental Stewardship (ES), which started in 2005, there are many options that could reduce impacts of agricultural run-off on water bodies (such as buffer strips, low input agricultural practices, or changes in land use from arable to grassland), and several for the management or enhancement of aquatic habitats, including ponds with high wildlife value. Between 2005 and the end of 2007, ES committed £131 million for options that could reduce the impacts of agricultural runoff, and a further £95,000 specifically for management of high wildlife value ponds. The Countryside Survey in 2007 was probably too early to detect effects of these schemes.

The signals of reduced management and decrease in species richness along streamsides detected by Countryside Survey between 1998 and 2007 suggest a reduction in intensity of management, and warrant further investigation, particularly because of complex relationships between terrestrial land management and water quality.

Land management can have profound implications for water quality and quantity, especially in upland areas. Our uplands are important sources of a sustainable supply of water due to their high rainfall and water storage capacity. Habitats such as blanket bog, mires and dwarf shrub heath act as natural 'sponges' that have the potential to retain water and release this slowly throughout the year and thus support a sustainable drinking water supply to many lowland areas. Land management actions such as drainage, burning, and over-grazing can significantly affect the capacity of the uplands to retain water, leading to pollution of water courses and flash floods that have severe economic impacts in downstream lowland areas. The impacts of the upland land management practices affect drinking water supply and costs, recreational use of water, farming, biodiversity and carbon fluxes linked to climate change.

The issue of water quality, where particulate matter, dissolved organic carbon and chemical pollution are involved, is a serious problem for water companies. The current costs of water treatment to address the issues of degraded peat, most notably colour, run into millions of pound per year. One well-known example of catchment-based uplands restoration is the United Utilities Sustainable Catchment Management Programme (SCaMP)[23]. This project is investing £10million over a five year period to explore options for improving water quality by restoring internationally important upland habitats in Lancashire's Forest of Bowland and the Peak District National Park. Habitats have already been restored by blocking drainage channels and seeding areas of bare peat with grass and heather seed. Areas that were once generating particulate matter and high levels of peat coloration in water are now green with sphagnum mosses, cotton grass or heather moorland. Although this is a long term project and all the benefits will take some time to show, all this activity has already had an impact on the quantity of peat colour and sediment in some streams and rivers. This shift in land management benefits around 7 million people living in north-west England.

Countryside Survey provides information about condition of headwater streams and ponds as detailed in ***Chapter 8***, as well as information about the surrounding habitats and landuse of the sample square containing the sampled water body. Further analysis is required to interpret some of the changes reported in relation to surrounding land use. Dedicated reports, containing more detailed analyses, will be published on Headwater Streams and Ponds in late 2009 and will also include the physical, chemical and macroinveretbrate results.

[23] Project details available at www.unitedutilities.com/scamp.htm

2.8.6 Linear Features and Hedgerows

All hedgerows mainly made of native species of tree and shrub, are now recognised as a Priority Habitat within the UK Biodiversity Action Plan. They support 125 BAP species including a wide range of animal species, and they are also important to the cultural heritage and landscape quality of England National Character Areas where hedgerows and walls contribute strongly to landscape character, particularly in 151 South Devon (ancient pattern of hedge banks), 72 Mease / Sence Lowlands (rectilinear late enclosure pattern) and 21 Yorkshire Dales (dry stone walls, various ages).

Through the 1990s increasing attention was paid to support of hedgerows by legislative protection (including the Hedgerow Regulations, 1997) and by financial support for restoration and management. The Countryside Stewardship Scheme funded the restoration of 14,100km of hedgerows between 1991 and 2000[24]. Between 1998 and 2004, a further 8,600km were restored under the Environmentally Sensitive Areas Scheme[25]. Since 2005, support for new agreements has come from the Environmental Stewardship Scheme, where there are a number of options to assist hedgerow establishment and management.

The Countryside Survey results from 2007 indicated that despite policies and incentives to improve the extent and condition of managed hedgerows as targeted under the UK BAP, there has been a reduction in both extent and condition on arable land, particularly in the failure to maintain their structure and the associated margins in the Easterly Lowlands, so that many are now classified by CS as relict hedges and lines of trees.

There was a significant decrease in the length of hedgerows that were between 1m and 2m tall and a significant increase in the length of hedgerows that were greater than 2m tall, while 50% of managed hedges were in good structural condition, 32% of managed hedges were in good structural condition and had appropriately managed margins but only 12% on arable land were in both good structural condition and had appropriately managed margins in England in 2007. There were also changes in condition of linear features alongside roads, field boundaries and streams suggesting a shift in vegetation community towards later succesional types of vegetation. In addition, there were some adverse changes in condition of walls, another important linear feature for landscape value. Further details are given in ***Chapter 5***.

2.8.7 Signals of succession and eutrophication

Interpretation of the signals of botanical change between previous surveys highlighted the likely importance of eutrophication[26] and reduced disturbance as processes contributing to widespread vegetation change in susceptible vegetation types across Britain[27]. While these changes were often subtle and of small magnitude, they were clearly visible in the data. Indeed, in some cases, suspected links with drivers such as unchecked growth of trees and shrubs, atmospheric nitrogen deposition and local agricultural intensification were confirmed by subsequent correlative studies[28]. These analyses took a GB-wide perspective but emphasised the importance of changes in lowland Britain where small habitat patches and the linear network showed the largest changes in vegetation condition along gradients of nutrient availability and succession. Because of the dominance of lowland landscapes in England these results provide a useful context against which to consider the most recent changes between 1998 and 2007.

Signals of both eutrophication and succession are apparent in the survey data. The clearest is perhaps the successional signal since both linear Broad Habitat types – Rivers & Streams plus Boundaries & Linear Features – saw reductions in the abundance of weedy species intolerant of shaded conditions. This pattern was also seen in small habitat fragments in England that were located in Broadleaved Woodland, Arable & Horticulture and Neutral Grassland Broad Habitats. Although based on fewer indicators, a shift to more closed, taller vegetation was also seen in small habitat fragments in Improved Grassland, Bracken, Fen, Marsh and Swamp and Dwarf Shrub Heath Broad Habitats. Like the patterns seen between previous surveys, the strongest signals still seem to be evident in those elements of the landscape that typically have a high amount of edge to area. These are often characterised by an existing complement of trees and shrubs and are less likely to experience direct agricultural management but may still be exposed to nutrient surpluses from adjacent land. With fields and larger areas of habitat, the successional signal was restricted to Arable & Horticulture, Improved and Neutral Grasslands. The drivers for these changes require further investigation. In arable systems an increase in fallow margins and an ongoing setaside signal are consistent with the some of the changes observed. In the grasslands, the known reduction in nutrient inputs since the late nineties plus weather impacts are plausible factors, particularly given the increase in Stress-Tolerator Score and Moisture Score.

Signals of the eutrophication of English habitats are less pronounced in the data. In fields and larger areas of habitat sampled by the Main Plots, the only signal was for reduced inputs in Arable & Horticulture again consistent with local increases in fallow land. However, as observed in earlier surveys, the tell-tale increase in Fertility Score that indicates increased abundance of more nutrient-demanding species was again evident on streamsides in the Rivers & Streams Broad Habitat and in small habitat fragments located within the less-improved Neutral, Calcareous and Acid Grassland Broad Habitats.

[24] Ecoscope Applied Ecologists & CPM (2003) Review of agri-environmental schemes – monitoring information and R & D results (Ref: RMP1596) Final Report Part A – Chapters 1 – 9 Available at: http://randd.defra.gov.uk/Document.aspx?Document=MA01001_3342_FRP.pdf

[25] Catherine Bickmore & Associates (2004) Hedgerow management and restoration in agri environment schemes: Executive summary 2004. Report to Defra, Available at: randd.defra.gov.uk/Document.aspx?Document=MA01008_5771_EXE.pdf

[26] Can be defined as the biological effects of increasing macro-nutrient concentrations in terrestrial and aquatic ecosystems

[27] Haines-Young *et al* (2000) Accounting for Nature.

[28] Firbank *et al* (2008) Phil.Trans.R.Soc B. 363, 777-787; Smart *et al* (2006) J.Appl.Ecol 43, 1128-1137; Smart *et al* (2004) Water Air Soil Poll. Focus 4, 269-278.

2.8.8 Landscape

As well as the biodiversity interest and delivery of ecosystem goods and services mentioned above, it is worth noting the intrinsic value of our landscapes. Over 2.07m hectares (15% the land area of England) are Areas of Outstanding Natural Beauty and National Parks cover a further 1.05m hectares (8% of the area of England). The National Parks receive around 10.2 m visitors a year, and a survey by the Association of the National Parks Authorities in 2005 showed that 85% of the visitors were motivated by quality of the landscape and scenery[29]. The quality of the landscape and scenery reflect changes in our history, society, economics and agriculture over millennia, and is a manifestation of the relationship between people and the land.

Since 1990, the proportions of Broad Habitats in the Environmental Zones have changed but the overall character of each Environmental Zone has not. The character of the English landscape was not always so defined. Research looking back to the First Land Utilisation Survey of the 1930s (Swetnam, 2007)[30] showed that Countryside Survey squares mirror changes in the countryside as a whole. Since the 1930s England has become more wooded (6% in 1930, 9% in 2007), there has been a loss of heath and moorland and an increase in built-up land. The proportion of arable to grassland has remained remarkably steady throughout the period 1930 to 2007. However, areas that were predominantly arable in the 1930s have become increasingly so whilst the number of mixed farms in the west decreased as farming became more specialised. From these historic results, we can infer that since 1990 the move towards specialisation in broad landscape terms (i.e. at the level of the Environmental Zone) has stabilised to some extent even if this may prove to be a temporary phenomenon.

The Rural White Paper (2000) committed the government to report on an indicator of landscape quality, and the results from Countryside Survey have been used together with other information for landscape quality analysis for England, at the level of National Character Areas, in Countryside Quality Counts[31] which reported on change in landscape quality over two periods (1990-1998 and 1999-2003). The 2007 results will contribute to the data sets used to update the assessment, including an assessment of the condition and quality of the ecosystem services provided by England's landscapes in a new project led by Natural England: Condition and Quality of England's Landscapes (CQuEL)[32].

▲ Open countryside in Lancashire with views towards the Lake District fells • © *Ian Simpson*

2.8.9 Reporting to Policy Areas

The Countryside Survey report for England has given information or relevance to many policy areas as summarised in *Table 2.14* and further details are given in each Chapter. It is important to recognise that further data analyses and interpretation are ongoing that will enhance or detail key messages for policy, as well as focus areas requiring further investigation.

[29] Heritage Counts, The state of England's historic environment, 2005, English Heritage, available at ww.heritagecounts.org.uk

[30] Swetnam, R. D. (2007) Stability mapping: a tool to understand rural land use change dynamics with examples from England and Wales, 1930- 1998. Landscape and Urban Planning, 81(1-2): 91-103.

[31] http://countryside-quality-counts.org.uk

[32] http://www.landscapecharacter.org.uk/files/u1/pdfs/Natural_England_ELC_ActionPlan_08-09.pdf

▼ **Table 2.14:** A Summary of Policy Applications of Countryside Survey and relevant results for England

Policy Application	Countryside Survey Result
The UK Sustainable Development Strategy Securing the Future (2005) commits the Government to build on existing research and monitoring initiatives by undertaking a new Countryside Survey in 2006 and 2007 to assess the status of natural resources in the UK countryside[33] (Commitment 125).	The field survey element of Countryside Survey was undertaken in 2007, and has reported at UK and country levels. In addition, Land Cover Map and further specialist reports on Integrated Assessment, Headwater Streams, Ponds and Soils will be delivered in the remainder of 2009 and in 2010.
Biodiversity Countryside Survey will provide underpinning evidence on extent, condition and change of terrestrial Broad Habitats and some widespread Priority Habitats at UK and country level, allowing assessment of status and trends and identification of major threats and the cumulative outcomes of policy interventions. Specifically results will contribute to assessment of achievement of the 2010 biodiversity target through updating of indicators on plant diversity, extent of habitat features and habitat fragmentation at UK and country levels. Results for Priority Habitats will contribute to assessment of Favourable Conservation Status under EU Habitats Directive.	Countryside Survey data will be used to update Biodiversity Indicators (A4 and A5), including a new indicator for habitat connectivity, based on the 1km x 1km sample square data. It is the only source of information to report on the Arable Field Margin Priority Habitat, and it provides nationwide information to report on Hedgerows. Further work is progressing to meet these reporting requirements. The results from 2007 showed some positive signals for conservation of biodiversity at a broad geographic scale in Broad Habitats across England, but these signals became more mixed at the finer scale of the Environmental Zones and patches within Broad Habitats targeted for their botanical interest. Some examples of the positive and less positive messages for England are listed here. **Positive messages:** • Plant species richness remained relatively constant across most widespread and common habitats in the open countryside and increased in the Arable and Horticulture Broad Habitat. • There was an increase in frequency of the plant species used as food by butterfly caterpillars and farmland birds in Broadleaved Woodland and Arable and Horticulture Broad Habitats, as well as along hedgerows. • Plant species richness in headwater streams increased by 44% (2.7 to 3.9 species per plot) and the score for the physical habitat quality of headwater streams increased by 11% (with an increase in frequency of natural features such as debris dams, gravel bars and bank-side trees) between 1998 and 2007. • Across most widespread and common habitats in the open countryside there is little evidence of a eutrophication signal (nutrient enrichment) between 1998 and 2007. Indeed, vegetation change within the Arable and Horticulture Broad Habitat suggests local reductions in management intensity. **Less positive messages:** (Messages for Linear Features and Hedges are given under Sustainable Agriculture and Environmental Stewardship) • Almost 80% of ponds in England were in poor condition in 2007, based on the assessment of a range of vegetation criteria known to be indicative of degradation. Only 9% of ponds were considered to be in good condition. The average plant species richness in ponds was poor in 2007, with only 7 species on average per pond, compared to an expected richness of 20 species in good quality ponds. • There were significant decreases in plant species richness in discrete areas within Broad Habitats targeted by Countryside Survey for their botanical interest in Improved, Neutral and Acid Grassland Broad Habitats, between 1998 and 2007, as well as in Broadleaved Woodland over the longer term. • There were signs of shifts in plant communities towards later successional types of vegetation, with taller, more competitive or shrubby species in the vegetation of several Broad Habitats. There was also some indication of changes in the herb layer in response to canopy closure of Broadleaved Woodland.

[33] Where possible analyses will be undertaken at UK, country and regional levels. Analysis at the UK level relies on co-ordination with the Northern Ireland Countryside Survey (NICS).

Policy Application	Countryside Survey Result
Some data will be available to quantify the impact/ spread of some widely occurring invasive non-native species. The Invasive Non-Native Species Framework Strategy for Great Britain was published in 2007 (*www.nonnativespecies.org*)	Overall tests of change in richness of non-native plants by plot type, showed no significant changes had occurred across England between 1998 and 2007. A number of common non-native plants did however have high change indices. Pineappleweed (*Matricaria discoidea*) a common non-native plant was among the listed species declining in frequency, which may be related to the decrease in Wheat and Barley crops and an increase in fallow land. The increase in occurrence of Sycamore (*Acer pseudoplatanus*) was consistent with the trend towards less disturbed vegetation particularly along linear features. While still relatively uncommon in the survey, two invasive aliens increased in frequency with relatively high change indices: Himalayan Balsam (*Impatiens glandulifera*), increased from 22 records in 1998 to 53 in 2007 (change index of 0.62) and Japanese Knotweed (*Fallopia japonica*) increased from 1 record to 7 (change index 0.65). Non native species in ponds are reported in the Pond Report due in late 2009.
Natural Environment The Whole Ecosystem Approach was published in 2007. This action plan identifies a number of clear priority areas for action that will be fundamental to our success and to securing wider engagement at the national, regional and local levels. The main priorities included: i) promoting joined-up working within Defra and the Defra network to deliver ii) identifying opportunities for mainstreaming an ecosystems approach iii) using case studies that demonstrate the benefits of taking an ecosystems approach iv) developing ways of valuing ecosystem services v) developing a robust evidence base Countryside Survey will contribute to the quantification and improved understanding of the dynamics and spatial distribution of ecosystem services[34] at national and regional scales, supporting development of ecosystems approaches to natural environment policy and frameworks for considering ecosystem services in the broad range of decisions that impact on the natural environment. The methodology of land cover and habitat accounts, previously developed and applied within Countryside Survey, will be extended where possible to other environmental assets.	Further analysis of the results in conjunction with other data sets is being carried out as part of Integrated Assessment (due in 2010). CS is represented on the National Ecosystem Assessment Steering Group.

[34] Relevant services include: carbon sequestration, soil nutrient cycling, maintaining water quality, landscape character, recreation...

Policy Application	Countryside Survey Result
Sustainable Agriculture and Environmental Stewardship Countryside Survey will provide national estimates of environmental change in the farmed countryside, ranging from changes in extent and distribution of major crop types, conversion between agricultural uses, extent and condition of farmland habitats (e.g. hedgerows, uncultivated semi-natural land, small woods and set-aside), and landscape features (e.g. dry stone walls, veteran trees) to condition of aquatic habitats (headwater streams and ponds) and soils. With reference to the time series extending over 30 years, and by cross-comparison with other administrative and agricultural data, the influence of agri-environment schemes and changes in agricultural policy will be established. The survey will be the main tool for assessing progress towards the BAP target for hedgerows. Data will be available to help explain changes in farmland bird populations and inform related policy interventions. Land cover data will contribute to targeting of agri-environment schemes. Specifically in England, Countryside Survey will contribute to the assessment of effectiveness of Environmental Stewardship and indicators used by the Agriculture Change and Environment Observatory. Countryside Survey will also contribute to evaluation of effectiveness to the Environmental Impact and Hedgerow Regulations and quantification of spread and impact of pernicious weeds (e.g. Ragwort).	The Countryside Survey Results for England in 2007 report a substantial significant change from arable to grassland habitat types, although this may be a temporary change due to crop prices. **Managed Arable Field Margins** The Managed Margin Plots, which sample areas under agri-environment schemes had the highest plant species richness and the highest percentage cover of plants compared to Main Plots in the cropped area and plots along the unmanaged crop margin, whereas Main Plots had the lowest plant species richness. **Managed Hedges** The total length of managed hedgerows[35] was 402,000km in England in 2007, and was distributed mainly between the Easterly and Westerly Lowlands Environmental Zones. The total length of woody linear features decreased by 1.4% and the total length of managed hedgerows[35] decreased by 6.1% between 1998 and 2007, with a large proportion of these managed hedges turning into lines of trees and relict hedges, reflecting a reduction in management intensity. 50% of managed hedges were in good structural condition, 32% of managed hedges were in good structural condition and had appropriately managed margins but only 12% on arable land were in both good structural condition and had appropriately managed margins in 2007. A higher proportion of hedges in England were in good condition compared to Great Britain as a whole. Following significant decreases in plant species richness along the base of hedges between 1978, 1990 and 1998, no change was detected in England between 1998 and 2007. (see ***"Water Resources"*** for Steamsides and Ponds)
Water Resources Countryside Survey will provide contextual and baseline information to inform development of plans for meeting the requirements of the EU Water Framework Directive (WFD). The Countryside Survey freshwater sampling strategy focuses on headwater streams and ponds and is therefore be complementary to the WFD surveillance monitoring network of larger water courses and water bodies. Methods used are compatible with those of the environment protection agencies. Countryside Survey will investigate factors contributing to long-term trends in biological water quality, biodiversity and habitat structure of headwater streams and ponds, including land use of upstream catchments and diffuse pollution, at national and regional scales.	Full details of the freshwater data analysis (including chemical analysis and biodiversity) will be available in the Headwater Streams and the Pond reports (both due in late 2009). There was an increase in the number of ponds. Only 9% of ponds were in the Good PYSM quality category (based on their vegetation) and only 4.8% of ponds surveyed were of Priority Habitat quality (based on their vegetation). Plant species richness in streams increased and there was a high turnover of species; only 61% of all 114 aquatic plant taxa were recorded in both years. The score for physical habitat quality of headwater streams increased by 11% in England. The greatest increase in quality was recorded in the Westerly Lowlands, with a 13% increase in HQA.

[35] The term 'managed hedgerows' does not include relict hedges and lines of trees.

Policy Application	Countryside Survey Result
Soil Protection Countryside Survey will quantify and investigate long-term change in physical, chemical and biological soil quality at national and regional scales and identify the major drivers of change. The results of Countryside Survey have and will continue to inform development of the new Soil Strategy for England to be published later this year. Specifically, data collection and analysis will quantify trends in acidification and eutrophication of soils, storage of heavy metals deposited from the atmosphere, carbon storage and soil biodiversity and their inter-dependence. The soils data is also fundamental to understanding of ecosystem process under policy areas of natural environment, biodiversity, water resources and air quality.	The CS report for England presents results for soil (0-15cm) pH, bulk density, carbon concentration and carbon stock. Full details of the soils results (including chemical analysis and biodiversity) and any differences between Environmental Zones will be available in the Soils Report (due late 2009) and supporting papers. The soil pH (0-15cm) increased in many Broad Habitats- Arable and Horticulture, Improved Grassland, Neutral Grassland, Acid Grassland, Bog and Dwarf Shrub Heath Broad Habitats, associated with recovery from previous high levels of acid deposition, though the impacts of these changes on vegetation are less obvious. The carbon concentration in soil (0-15 cm) increased in Arable and Horticulture Broad Habitat. Bulk density was presented, and used to calculate carbon stock in soils (0-15cm) which ranged from 42.6 in Arable and Horticulture Broad Habitat to 87.6 tC/ha in Dwarf Shrub Heath Broad Habitat. Since 1998, an increase in mean carbon concentration in soil (0-15 cm) in some habitats between 1978 and 1998 has slowed or reversed. The spatial and temporal changes in soil carbon concentration are important for our understanding of feedbacks with the global climate system. The results will be of interest to those investigating carbon sequestration, as well as being of ecological interest. Combining the soil data with the vegetation sampling plot data will further the understanding of soil carbon and nitrogen dynamics, how they affect the growth of vegetation and how diversity above and below-ground can affect soil processes.
Sustainable Forestry Countryside Survey is designed to be complementary to the second National Inventory of Woodlands and Trees (NIWT2). In particular, Countryside Survey provides additional information on trends in plant diversity within woodlands, habitat conversion to and from woodland and soil quality within woodlands. Countryside Survey also provides an important source of relevant information on trees outside of woodlands	There has been an increase in Broadleaved Woodland (5.8%) between 1998 and 2007, especially in the Easterly Lowlands Environmental Zone. CS allocates rather more woodland to the Broadleaved and Mixed Broad Habitat than NIWT (981,000ha rather than 761,000ha[36], but correspondingly less to pure Coniferous Woodland (257,000 versus 366,000ha). Both surveys show increases in Broadleaved Woodland.
Urban Development The design of Countryside Survey is not optimised for assessment of built-up areas or impacts of urbanisation but it can provide national estimates of habitat types lost to development in rural areas.	There was no significant increase in the area lost to road building and development in rural areas of England. There was a significant loss of area to the Built-up and Gardens Broad Habitat in the English Uplands. Much of this was to gardens rather than buildings.
Air Quality Countryside Survey provides assessments of impacts of air pollution (acid and nitrogen deposition, and heavy metals) on condition/quality of terrestrial habitats, soils and headwater streams and an evaluation of long-term change. Data will be used subsequently in other work to further develop modelling of ecosystem responses to air pollution, contributing to UK commitments to deliver model outputs on target loads for acidity and nutrient nitrogen.	Previous work attributed some vegetation change in Countryside Survey data across Britain to atmospheric nitrogen deposition and eutrophication from local agricultural activity[37]. Between 1998 and 2007, the eutrophication signal was still apparent as significant increases in mean Fertility Scores in the smaller habitat fragments targeted for their botanical interest, of Acid, Calcareous and Neutral Grasslands in England as well as on river and stream banks. However, in larger areas of habitat including unenclosed upland habitats the signal, was not seen. The apparently contradictory changes in vegetation response to pH and soil pH change requires further investigation to understand the role of various possible drivers including response to declining sulphur deposition.

[36] Forestry Facts and Figures (2008) Forestry Commission, Edinburgh

[37] Firbank, LG, Petit, S, Smart, SM, Blain, A, Fuller, RJ (2008) Assessing the impacts of agricultural intensification on biodiversity: a British perspective. *Phil. Trans. R. Soc. B* 363, 777-787.

Policy Application	Countryside Survey Result
Climate Change Countryside Survey is the main source of information for the land cover/land use change component of the National Inventory of Greenhouse Gases. It provides national estimates of land cover change from which carbon emissions are calculated. Analyses of land cover change, vegetation and soil carbon, alongside information from other sources, also provides an improved basis for estimating emissions, and attributing these to policy interventions. Countryside Survey will also provide information relevant to long-term impacts of climate change and adaptation/mitigation strategies affecting land use, biodiversity, water resources and soils. The Survey also provides a useful framework for scaling-up results of more local, detailed studies (for example Environmental Change Network) to national levels.	There are differences between the changes reported in area and condition characteristics in Broad Habitats between the Westerly Lowlands Environmental Zone (which is influence by wet warm oceanic climate), the Easterly Lowlands Environmental Zone, (which is influenced by warm, dry continental climate), and the Uplands Environmental Zone (which is influenced by cooler, wetter northern climate), which require further investigation. In the GB-level analyses a tendency for plants preferring wet conditions to increase was more apparent and may have reflected the wet years of 1988 and 2007 and a general increase in rainfall over the last 15 years. However, this signal was largely absent from England-only analyses. The increase in Neutral Grassland may be important, for mitigation in terms of carbon storage, given the conversion from Arable and Horticulture Broad Habitat, which showed a decrease in soil (0-15cm) carbon concentration between 1998 and 2007. Similarly, the increase in Broadleaved Woodland by conversion from Improved Grassland and Arable and Horticulture and may also be important, as soils in the converted Broad Habitats tend to have lower carbon concentrations.
Landscape The Rural White Paper (2000) committed the government to report on an indicator of landscape quality. The results from Countryside Survey have been used together with other information for landscape quality analysis for England, at the level of National Character Areas, in Countryside Quality Counts which reported on change in landscape quality within National Character Areas over two periods (1990-1998 and 1999-2003). The Countryside Survey results from 2007 will contribute to the data sets used to update the assessment.	The changes in area of Broad Habitats in different parts of the country could affect landscape quality, which will need further investigation. Countryside Survey reported increases in area of Broadleaved Woodland and Improved Grassland but decreases in Arable and Horticulture Broad Habitats (and the number of Ponds) in the Easterly Lowlands; decreases in Arable and Horticulture, Calcareous Grassland and Fen, Marsh and Swamp in the Westerly Lowlands, and increases in Improved Grassland and Built Up and Gardens in the Uplands Environmental Zone. The losses and deterioration of walls, especially in the Uplands could also affect landscape quality at local levels.
Uplands-Rural Development and Bracken In 2008, the Government announced that the existing Hill Farming Allowance Scheme will be replaced with Uplands Entry Level Stewardship. This is designed to ensure that farmers are supported and rewarded for their efforts to maintain England's historic upland landscape, such as the Cumbrian Fells, Dartmoor and the Peak District. Through the scheme, which will be available from July 2010, hill farmers will be rewarded for maintaining the biodiversity and natural resources of the area, including the maintenance of iconic features of the landscape such as dry stone walls and stone-faced hedge banks.	Countryside Survey showed changes in the Broad Habitats in the Uplands Environmental Zone. There were increases in Neutral Grassland, Bog and Built Up and Gardens Broad Habitats in the Uplands but the area of Bracken Broad Habitat did not change. Species richness decreased across widespread areas of Acid Grassland and Bracken Broad Habitats, and in the areas within Neutral and Acid Grassland targeted by Countryside Survey for their botanical interest. The losses and deterioration of walls in the Uplands could also affect landscape quality at local levels.

Policy Application	Countryside Survey Result
Pesticides Although it is difficult to attribute a specific decline in biodiversity to the use of individual plant protection products (pesticides), there is sufficient evidence to indicate that pesticides do adversely affect biodiversity including having an indirect effect on bird populations. The existing EC pesticides Authorisation Directive (91/414/EEC) provides that pesticides should be approved where the short and long-term impacts on non-target species, populations and communities (birds, aquatic organisms (including fish), bees, earthworms and micro organisms in soil) from single, prolonged or repeated exposure comply with specified standards. However, this system alone will not eliminate the effects on non-target species altogether nor tackle certain indirect effects of pesticides. Other initiatives are likely to have a major part to play in supplementing regulatory controls. The current UK Pesticides Strategy Biodiversity Action Plan integrates and build upon these, and other, regulatory and voluntary initiatives.	Countryside Survey showed that in Arable and Horticulture Broad Habitats there was an increase in the number of plant species within the cropped area, or increased 'weediness', which could suggest a more sensitive use of chemical controls.
Unexpected Changes From previous experience, Countryside Survey has a known value in picking up unexpected changes in the countryside that are of policy or scientific relevance. By definition these cannot be anticipated but could be of major significance.	The significant increase in total species richness on arable land between 1998 and 2007 was a welcome sign especially since it brought with it concomitant increased richness of food plants for lowland farmland birds and butterfly larvae. The magnitude of these changes and their likely impact have yet to be evaluated. The persistence of any effects is also uncertain if the pervasiveness of the signal depends upon the setaside mechanism. This is because the removal of land from production is a response to excess supply and international price movement rather than to positive farm management. Further analysis should therefore seek to separate the relative importance of setaside from the impact of new fallow field margins implemented under the broad-shallow Entry Level Scheme. Given concerns about climate change and invasive non-native species, it is interesting and again a positive sign that these taxa remain relatively uncommon in the wider countryside. Whilst two invasive species did increase in frequency between 1998 and 2007 the changes were small leaving both still uncommon by 2007.

▲ Arable fields in Cumbria • © *Natural England* • *Charlie Hedley*

3. Enclosed Farmland: Arable and Horticulture and Improved Grassland Broad Habitats

Summary

Area and Change

- The Arable and Horticulture Broad Habitat covered about 4.0 million ha or 30.4% of the area of England in 2007. Most was in the Easterly Lowlands Environmental Zone.
- The Improved Grassland Broad Habitat covered an area of approximately 2.9 million ha or 21.7% of the area of England in 2007. Most was in the Westerly Lowlands Environmental Zone.
- Since 1998, the area of land in the Arable and Horticulture Broad Habitat decreased significantly by 8.8% (387,000ha) in England, and by 7.0% (approx 220,000ha) and 13.3% (approx 160,000ha) in the Easterly and Westerly Lowlands Environmental Zones respectively.
- The area of Improved Grassland increased by 5.2% in England between 1998 and 2007, although this was not statistically significant. There was a significant increase of 14% (approx 130,000ha) in the Easterly Lowlands.

Condition of Arable and Horticulture Broad Habitat

- Plant species richness in the Main Plots within the cropped area of the Arable and Horticulture Broad Habitat increased by 36% (from 7.5 to 10.2 species per plot), including species used as food by farmland birds and butterfly caterpillars in England between 1998 and 2007.
- There were significant decreases in Light, Competitor, Fertility, Ellenberg pH Scores and Grass:Forb ratio but a significant increase in Ruderal Scores of Main Plots in the cropped area of the Arable and Horticulture Broad Habitat across England between 1998 and 2007. Most of these changes were also significant in the Easterly Lowlands Environmental Zone.
- In contrast to the results for the Main Plots, the species richness in plots targeted for their botanical interest in the Arable and Horticulture Broad Habitat decreased significantly across England from 13.0 to 9.2 species per Targeted Plot between 1990 and 2007.

- **Arable margins had a higher species richness and cover of plants than arable fields or the edges of crops in England in 2007. The species richness was 10.7, 8.5 and 5.1 species per 2m x 2m core plot in Margin (where at least 6m wide strip was present), Crop Edge and Main Plots (within the cropped area) respectively.**

Condition of Improved Grassland Broad Habitat

- **There was no significant change in species richness in Main Plots in Improved Grassland Broad Habitat between 1998 and 2007 or between 1990 and 2007. This contrasts to the report for Great Britain where a significant decrease was observed between 1990 and 2007. The average was 14.6 species per 200m^2 Main Plot in England in 2007.**

- **There were significant decreases in the Grass:Forb ratio, Light and Ellenberg pH Scores and an increase in stress tolerating species in Main plots in the Improved Grassland Broad Habitats across England between 1998 and 2007. Most of these significant changes were also detected in the Westerly Lowlands Environmental Zone, but the Easterly Lowlands showed a significant decrease in ruderal species and Light Score. A significant decrease in Ellenberg pH was detected in the Uplands Environmental Zone .**

- **Plant species richness in Improved Grassland in areas targeted for their botanical interest decreased significantly by 11% (from 13.1 to 11.6 species per Targeted Plot) in England between 1998 and 2007 and by 25% (from 15.5 to 11.6 species per Targeted Plot) between 1990 and 2007.**

Soils

- **pH in soil (0-15cm) increased in both Arable and Horticulture (from 7.02 to 7.43) and Improved Grassland (from 6.29 to 6.58) Broad Habitats in England between 1998 and 2007, continuing the trend from 1978.**

- **There was a significant decrease in the concentration of carbon in soil (0-15cm) from 29.8g/kg to 27.2g/kg in Arable and Horticulture Broad Habitat in England between 1998 and 2007. This is the only Broad Habitat where soil (0-15cm) carbon concentrations were significantly lower in 2007 than in 1978. There was no difference in concentration of carbon in soil (0-15cm) in Improved Grassland.**

Extra analysis

- **Set-aside and agri-environment schemes are the most probable cause of the increase in plant species richness of the Arable and Horticulture Broad Habitat in England between 1998 and 2007.**

▲ Oilseed Rape field, Cambridgeshire • © *Sue Wallis*

3.1 Introduction[1]

Approximately 60% of the land area of England is composed of enclosed farmland that belongs in two Broad Habitats: Arable and Horticulture and Improved Grassland. These contain the most intensively farmed and managed land, providing much of the agricultural produce of the UK. Intensive management of cultivated land has generally resulted in environments with relatively few plant species, in which small pockets of less intensively managed (or unmanaged) land provide an important refuge for plant species. Within the Arable and Horticulture Broad Habitat (henceforth Arable Broad Habitat), Arable Field Margins form a Priority Habitat and other areas of fallow or set-aside land are important sources of diversity. The presence of linear features *(Chapter 5)* and small patches of other habitat types such as woodland *(Chapter 6)* also make a significant contribution in terms of biodiversity to areas otherwise dominated by the Broad Habitat types covered here.

▲ Brent geese stubble feeding in West Sussex • © *Natural England • Peter Wakely*

[1] **Note:** For further information on the Broad Habitat classification, sampling plots and other Countryside Survey terminology see *Chapter 1 (Introduction and Methodology).*

▼ **Table 3.1:** The estimated area ('000s ha) and percentage of land area of Arable and Horticulture Broad Habitat in England from 1990 to 2007. Arrows denote significant change ($p<0.05$) in the direction shown.

	1990		1998		2007		Direction of significant changes 1998 - 2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
England	4380	33.2	4389	33.3	4002	30.4	↓
Easterly Lowlands	3191	48.9	3127	47.9	2907	44.6	↓
Westerly Lowlands	1147	22.6	1223	24.1	1061	20.9	↓
Uplands	41	2.6	39	2.5	34	2.2	

▼ **Table 3.2:** The estimated area ('000s ha) and percentage of land area of Improved Grassland Broad Habitat in England from 1990 to 2007. Arrows denote significant change ($p<0.05$) in the direction shown.

	1990		1998		2007		Direction of significant changes 1998 - 2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
England	3075	23.3	2714	20.6	2856	21.7	
Easterly Lowlands	983	15.1	926	14.2	1056	16.2	↑
Westerly Lowlands	1809	35.6	1537	30.2	1576	31	
Uplands	284	18	250	15.9	225	14.3	

The two Broad Habitats covered in this Chapter are among those most likely to change in both area and condition over time, because their management is so responsive to the economics of farming, the introduction of new technologies and to changes in agricultural policy.

Countryside Survey describes the condition of these two Broad Habitats using several linked approaches: in both Broad Habitats the randomised Main Plots describe the condition of the habitats as a whole whilst Targeted Plots explore change in those pockets of less intensively managed land within otherwise intensively farmed land. Specific to the Arable Broad Habitat, two additional types of plot (Crop Edge and Managed Margin) explore the quality of habitat provided at the crop/boundary interface, where policy instruments have in recent years sought to reduce the impacts of intensive management.

3.2 Area and condition of Broad Habitats of enclosed farmland

- **The Arable and Horticulture Broad Habitat covered about 4.0 million ha or 30.4% of the area of England in 2007. Most was in the Easterly Lowlands Environmental Zone.**
- **The Improved Grassland Broad Habitat covered an area of approximately 2.9 million ha or 21.7% of the area of England in 2007. Most was in the Westerly Lowlands Environmental Zone.**
- **Since 1998, the area of land in the Arable and Horticulture Broad Habitat decreased significantly by 8.8% (387,000ha) in England, and by 7.0% (approx 220,000ha) and 13.3% (approx 160,000ha) in the Easterly and Westerly Lowlands Environmental Zones respectively.**
- **The area of Improved Grassland increased by 5.2% in England between 1998 and 2007, although this was not statistically significant. There was a significant increase of 14% (approx 130,000ha) in the Easterly Lowlands.**

3.2.1 Change in Area

The Arable and Horticulture Broad Habitat covered about 4.0 million ha or 30.4% of the area of England in 2007 compared to about 4.4 million ha in 1998, an 8.8% decrease, marking a shift away from the relatively constant area that had been observed in Countryside Survey between 1990 and 1998 *(Table 3.1)*. A significant decrease was observed in the Easterly and Westerly Lowlands Environmental Zones.

The Improved Grassland Broad Habitat in England covered an area of approximately 2.9 million ha in 2007, with the largest area in the Westerly Lowlands. The area of Improved Grassland in England increased by 5.2% (142,000ha) between 1998 and 2007, although this was not statistically significant. This increase followed decreases from 1984 to 1998 *(Table 3.2)*. A significant increase of 14% (approx 130,000ha) was observed in the extent of Improved Grassland in the Easterly Lowlands, where the Arable and Horticulture Broad Habitat was the predominant agricultural habitat type *(Table 3.1)*.

3.2.2 Changes between Broad Habitats

Over 90% of land in the Arable and Horticulture Broad Habitat in 1998 remained in the same Broad Habitat in 2007, but CS recorded net flows from Arable to Improved and Neutral Grasslands (see *www.countrysidesurvey.org.uk*)

Approximately 75% of the Improved Grassland Broad Habitat in 1998 was also recorded as Improved Grassland in 2007. Nearly all of the losses of Improved Grassland was to Neutral Grassland.

This was more than compensated by net flows from the Arable and Neutral Grassland Broad Habitats, leading to the significant overall increase in area of this Broad Habitat observed.

3.3 The condition of the Broad Habitats of enclosed farmland

3.3.1 Arable and Horticulture Broad Habitat

- **Plant species richness in the Main Plots within the cropped area of Arable and Horticulture Broad Habitat increased by 36% (from 7.5 to 10.2 species per plot), including species used as food by birds and butterfly caterpillars in England between 1998 and 2007.**

- **There were significant decreases in Light, Competitor, Fertility, Ellenberg pH Scores and Grass:Forb ratio but a significant increase in Ruderal Scores of Main Plots in the cropped area of the Arable and Horticulture Broad Habitat across England between 1998 and 2007. Most of these changes were also significant in the Easterly Lowlands Environmental Zone.**

- **In contrast to the results for the Main Plots, the species richness in plots targeted for their botanical interest in the Arable and Horticulture Broad Habitat decreased significantly across England from 13.0 to 9.2 species per Targeted Plot between 1990 and 2007.**

- **Arable margins had a higher species richness and cover of plants than arable fields or the edges of crops in England in 2007. The species richness was 10.7, 8.5 and 5.1 species per 2m x 2m core plot in Margin (where at least 6m wide strip was present), Crop Edge and Main Plots (within the cropped area) respectively.**

▲ Brown-banded carder bee *(Bombus humilus)* on red clover • © *Natural England* • *Mike Edwards*

▲ Corn marigolds and poppies – arable weeds, Cornwall • © *Natural England* • *Paul Glendell*

Main Plots[2]

Plant species richness: The number of plant species found in Main Plots within the Arable and Horticulture Broad Habitat increased (from 7.5 to 10.2 species per plot) between 1998 and 2007, continuing the trend from 1990 to 1998 *(Table 3.3)*. Corresponding increases were seen in the observed numbers of plant species used as food by farmland birds and butterfly caterpillars *(Table 3.3)*. In addition to changes in the numbers of species present, there were also changes in the percentage of cover (see *Table 3.5*).

Other condition characteristics: The condition characteristics of the vegetation in Main Plots in the Arable and Horticultural Broad Habitat showed variability in those characteristics that changed and also in the direction of change for all periods since 1990.

Between 1998 and 2007, there were significant decreases in Light, Competitor, Fertility, Ellenberg pH Scores and Grass:Forb ratio but significant increases in Ruderal Scores of Main Plots in the cropped area of the Arable and Horticulture Broad Habitat across England. The change in Grass:Forb ratio indicates that the cover of forbs increased at the expense of grasses, but the ecological significance of this in the context of arable fields is uncertain. Most of these changes were also significant in the Easterly Lowlands Environmental Zone *(Table 3.3)*.

▲ Arable field margin, Suffolk • © *Natural England* • *Peter Wakely*

[2] Main Plots (200m^2) are randomly located to assess widespread and common habitat types in the open countryside.

▼ **Table 3.3:** Change in the characteristics of vegetation in 200m² Main Plots in the Arable and Horticulture Broad Habitat across England (E) and the three Environmental Zones (EL - Easterly Lowlands, WL - Westerly Lowlands, UP - English Uplands) between 1990 and 2007. Mean values for condition measures in 1998 and 2007 are presented; those for 1990 are available at *www.countrysidesurvey.org.uk*. Arrows denote significant change ($p<0.05$) in the direction shown. The condition measures are described in ***Box 1.3 of the UK Results from 2007 report***. Greyed cells with diagonal strikethrough represent insufficient samples for reliable analysis.

	Mean values (England)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**
Species Richness (No. of Species)	7.5	10.2	↑	↑			↑	↑	↑		↑	↑	↑	
No. of Bird Food Species	3.7	4.8	↑	↑			↑	↑			↑	↑	↑	
No. of Butterfly Food Species	2.3	2.9	↑	↑			↑	↑	↑		↑	↑	↑	
Grass:Forb Ratio	1.17	0.27	↓	↓			↑	↑	↑					
Competitor Score	2.29	2.08	↓	↓	↓						↓	↓		
Stress Tolerator Score	1.34	1.34					↑		↑		↑	↑	↑	
Ruderal Score	3.64	3.8	↑	↑	↑									
Light Score	7.14	7.05	↓		↓						↓	↓	↓	
Fertility Score	6.63	6.52	↓	↓			↓		↓		↓	↓	↓	
Ellenberg pH Score	6.73	6.68	↓	↓			↓	↓	↓		↓	↓	↓	
Moisture Score	4.98	4.98					↑	↑	↑		↑	↑	↑	

▼ **Table 3.4:** Change in the characteristics of vegetation in 2m x 2m Targeted Plots in the Arable and Horticulture Broad Habitat across England (E) and the three Environmental Zones (EL - Easterly Lowlands, WL - Westerly Lowlands, UP - English Uplands) between 1990 and 2007. Mean values for condition measures in 1998 and 2007 are presented; those for 1990 are available at *www.countrysidesurvey.org.uk*. Arrows denote significant change ($p<0.05$) in the direction shown. The condition measures are described in ***Box 1.3 of the UK Results from 2007 report***. Greyed cells with diagonal strikethrough represent insufficient samples for reliable analysis.

	Mean values (England)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**
Species Richness (No. of Species)	10.26	9.21		↓			↓	↓	↓		↓	↓	↓	
No. of Bird Food Species	4.37	4.24					↓	↓	↓		↓	↓		
No. of Butterfly Food Species	4.22	3.85					↓	↓	↓		↓	↓		
Grass:Forb Ratio	0.31	0.21												
Competitor Score	3.11	3.2												
Stress Tolerator Score	1.75	1.81												
Ruderal Score	2.61	2.42	↓	↓							↓	↓		
Light Score	6.68	6.58	↓		↓						↓		↓	
Fertility Score	6.30	6.26												
Ellenberg pH Score	6.56	6.57												
Moisture Score	5.45	5.52			↑									

The decreases in Competitor, Fertility, Ellenberg pH and Ellenberg Light Scores in addition to an increase in Moisture Score were also significant across the long-term, between 1990 and 2007. These significant changes were also detected in the Westerly and Easterly Lowlands Environmental Zones *(Table 3.3)*.

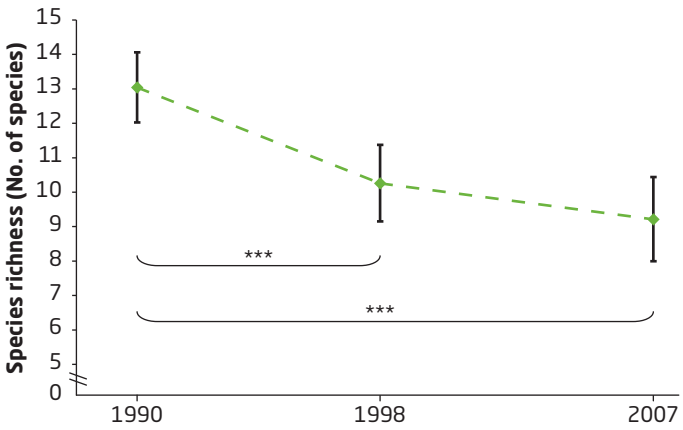
This was consistent with moderately less intensive management on this most intensively managed of all Broad Habitat types. Taken together, the changes in plant Species Richness Score and condition in the Main Plots of the Arable Broad Habitat are consistent with an increase in the number of non crop plants (i.e. weediness) within the cropped area between 1998 and 2007.

Targeted Plots[3]

Plant species richness: Fragments of uncultivated or unmanaged land within the Arable and Horticulture Broad Habitat (e.g. corners of fields, areas around field trees, or areas sometimes termed 'mid-field islets') can provide important wildlife refuges for a range of species that would not otherwise persist in intensive agricultural landscapes. These areas are sampled by Targeted Plots. In contrast to the results for the Main Plots in the cropped areas, (which showed a significant increase in plant Species Richness) in Targeted Plots species richness decreased significantly across England from 13.0 to 9.2 species per Targeted Plot *(Fig. 3.1)* and it also

[3] Targeted Plots (2m x 2m) are positioned by surveyors to assess small areas of botanical interest which may be overlooked by the randomly located Main Plots.

▼ **Figure 3.1:** Changes in plant Species Richness Score within 2m x 2m Targeted Plots within the Arable and Horticulture Broad Habitat across England, between 1990 and 2007. Significant changes (*** p<0.001) are shown between the dates bracketed. 95% confidence intervals are shown for each data point.



decreased significantly in the Easterly and Westerly Environmental Zones between 1990 and 2007. A similar pattern of decreases was also observed in the numbers of plant species used as food by farmland birds and butterfly caterpillars. No significant changes were observed across England between 1998 and 2007, but the Species Richness continued to decrease in the Easterly Lowlands Environmental Zone *(Table 3.4)*.

Other condition characteristics: In contrast to Main Plots, Ruderal Scores decreased in Targeted Plots across England and in the Easterly Lowlands Environmental Zone between 1998 and 2007. Over the same period Light Scores decreased across England and in the Westerly Lowlands Environmental Zone and Moisture Scores increased in the Westerly Zone *(Table 3.4)*.

Arable field margins: Crop Edge Plots of 100m length were recorded within the first metre of crop from the edge of the field in both 1998 and 2007. An average of 15.5 species per plot were found in 1998 and 16.5 species per plot in 2007 but this apparent increase was not significant. In contrast to the results found for Main Plots, in Crop Edge Plots there was no significant increase in the number of plant species used as food by farmland birds and there was a significant decrease in the number of plant species used as food by butterfly caterpillars, from 5.1 per plot in 1998 to 4.7 in 2007. Other condition measures of the Crop Edge Plots were broadly similar to those in the Main Plots.

Managed Margin Plots were recorded for the first time in 2007, to help understand the impacts of incentives for managing field margins through agri-environment schemes. Managed Margin Plots were recorded where a field margin of a minimum width of 6m was present, in those arable fields where a Main Plot was located. A total of 87 such plots were recorded in England. On average 11 plant species were found in each Managed Margin Plot.

The Managed Margin Plots, Main Plots and Crop Edge Plots are of different sizes but all have a central 2m x 2m core that allows overall comparison of key measures *(Table 3.5)*. This shows that the Managed Margin Plots had the highest plant Species Richness Score (10.7) and the highest percentage cover of plants (21.1%), whereas Main Plots had the lowest plant Species Richness Score (5.1). The percentage cover of plants was similar in Main Plots (16.4%) and Crop Edge Plots (16.1%).

▼ **Table 3.5:** A comparison of the 2m x 2m core of Main Plots, the core of Crop Edge Plots and Managed Margin Plots in the Arable and Horticulture Broad Habitat. The mean cover of plants includes crop.

	2007 2m x 2m core of Main Plots	2007 Crop Edge Plots	2007 Managed Margin Plots
Species Richness	5.1	8.5	10.7
Mean Cover (%)	16.4	16.1	21.1

3.3.2 *Improved Grassland Broad Habitat*

- **There was no significant change in species richness in Main Plots in Improved Grassland Broad Habitat between 1998 and 2007 or between 1990 and 2007. This contrasts to the report for Great Britain where a significant decrease was observed between 1990 and 2007. The average was 14.6 species per 200m² Main Plot in England in 2007.**

- **There were significant decreases in the Grass:Forb ratio, Light and Ellenberg pH Scores and an increase in stress tolerating species in Main plots in the Improved Grassland Broad Habitats across England between 1998 and 2007. Most of these significant changes were also detected in the Westerly Lowlands Environmental Zone, but the Easterly Lowlands showed a significant decrease in ruderal species and Light Score. A significant decrease in Ellenberg pH was detected in the Uplands Environmental Zone.**

- **Plant species richness in Improved Grassland in areas targeted for their botanical interest decreased significantly by 11% (from 13.1 to 11.6 species per Targeted Plot) between 1998 and 2007 and by 25% (from 15.5 to 11.6 species per Targeted Plot between 1990 and 2007.**

Main Plots

Plant species richness: There was no change in the number of plant species found in plots within the Improved Grassland Broad Habitat since 1990 in England. There was also no change in the frequency of food plant species for farmland birds or butterfly caterpillars.

Other vegetation characteristics: The decrease in the ratio of grasses to forbs and the value of the Light Score between 1998 and 2007 *(Table 3.6)* suggests that Improved Grassland swards became denser and more shaded, favouring shade-tolerant species.

▼ **Table 3.6:** Change in the characteristics of vegetation in 200m² Main Plots in the Improved Grassland Broad Habitat across England (E) and the three Environmental Zones (EL - Easterly Lowlands, WL - Westerly Lowlands, UP - English Uplands, between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available at *www.countrysidesurvey.org.uk*. Arrows denote significant change (p<0.05) in the direction shown. The condition measures are described in ***Box 1.3 of the UK Results form 2007 report***.

	Mean values (England)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	1998	2007	E	EL	WL	UP	E	EL	WL	UP	E	EL	WL	UP
Species Richness (No. of Species)	14.1	14.6							↓					
No. of Bird Food Species	8.8	9.2										↑		
No. of Butterfly Food Species	7.2	7.1											↓	
Grass:Forb Ratio	1.68	1.47	↓		↓									
Competitor Score	2.73	2.75							↑	↓	↑	↑		↓
Stress Tolerator Score	1.85	1.88	↑							↓	↑	↑	↑	
Ruderal Score	3.19	3.16		↓						↑	↓	↓		↑
Light Score	7.11	7.07	↓	↓	↓						↓		↓	
Fertility Score	5.84	5.79			↓		↓	↓			↓	↓	↓	
Ellenberg pH Score	6.21	6.17	↓		↓	↓	↓	↓	↓		↓	↓	↓	↓
Moisture Score	5.31	5.33					↑		↑	↑	↑	↑	↑	

Unlike the results for Great Britain there was no detectable increase in competitive species and no decrease of ruderal species, but there was an increase in stress tolerating species.

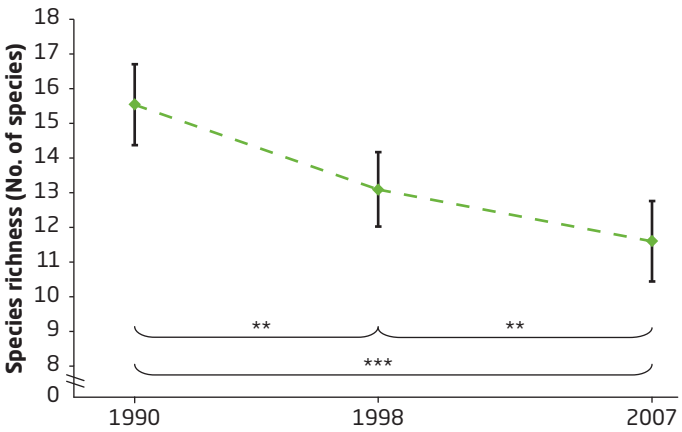
▲ Fertiliser spreading on improved grassland • © *Natural England* • *Peter Wakely*

Over the longer term, 1990-2007, there were significant increases in Competitor, Stress Tolerator and Moisture Scores and significant decreases in Ruderal, Light, Fertility and Ellenberg pH Scores in the Improved Grassland Broad Habitat in England, most of which were also significant in the Easterly and Westerly Lowlands Environmental Zones. The significant decrease in Competitor, and increase in Ruderal Scores in this Broad Habitat in the Uplands Environmental Zone contrasts with the significant trends shown in the other Environmental Zones, while the decrease in Ellenberg pH is consistent with significant trends shown in the other Environmental Zones and England as a whole.

Targeted Plots

The Species Richness Score in areas targeted for their botanical interest within the Improved Grassland Broad Habitat decreased by 11% (from 13.1 to 11.6 species per Targeted Plot) between 1998 and 2007 and by 25% (from 15.5 to 11.6 species per Targeted Plot between 1990 and 2007. This was similar to findings in the Arable and Horticulture Broad Habitat *(Fig. 3.2)*.

▼ **Figure 3.2:** Changes in the Species Richness Score in 2m x 2m Targeted Plots in the Improved Grassland Broad Habitat across England between 1990 and 2007. Significant changes (**p<0.01,*** p<0.001) are shown between the dates bracketed. 95% CI are shown for each data point.



▲ Tractor preparing field for planting, Cotswolds
• © *Natural England* • *Nick Turner*

3.4 Changes in soils (0-15cm) in the Broad Habitats of enclosed farmland

- **pH in soil (0-15cm) increased in both Arable (from 7.02 to 7.43) and Horticulture and Improved Grassland (from 6.29 to 6.58) Broad Habitats in England between 1998 and 2007, continuing the trend from 1978.**
- **There was a significant decrease in the concentration of carbon in soil (0-15cm) from 29.8g/kg to 27.2g/kg in Arable and Horticulture Broad Habitat in England between 1998 and 2007. This is the only Broad Habitat where soil (0-15cm) carbon concentrations were significantly lower in 2007 than in 1978. There was no difference in concentration of carbon in soil (0-15cm) in Improved Grassland.**

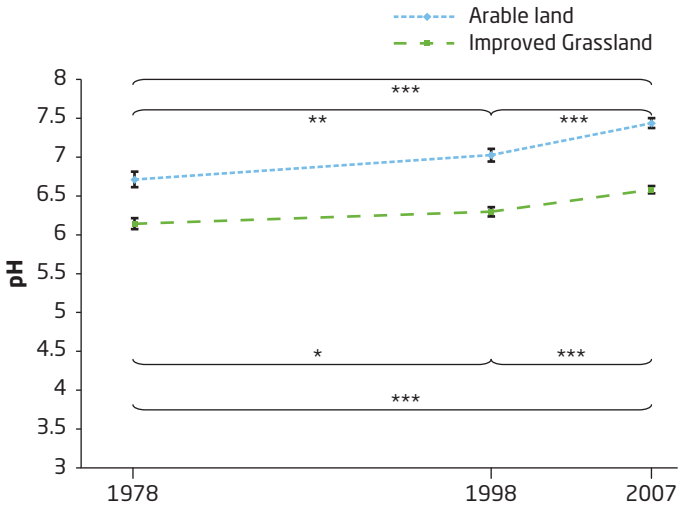
3.4.1 Soil (0-15cm) pH

The mean pH of soil (0-15cm) samples from the Arable and Horticulture Broad Habitat in England increased significantly from 7.02 to 7.43 between 1998 and 2007. Coupled with the increase between 1978 and 1998, a trend is apparent between 1978 and 2007 (See *Fig. 3.3* and *Chapter 2, Table 2.11*).

The mean pH of soil (0-15cm) samples from the Improved Grassland Broad Habitat in England increased significantly from 6.29 to 6.58 between 1998 and 2007. Coupled with the increase between 1978 and 1998 a trend is apparent between 1978 and 2007 (See *Fig. 3.3* and *Chapter 2, Table 2.11*).

These increases were not reflected in changes to Ellenberg pH Scores associated with vegetation *(Tables 3.3, 3.6)*, probably reflecting the effects of intensive management on vegetation of these habitats and a time lag in responses where management intensity has been reduced.

▼ **Figure 3.3:** The change in pH in soils (0-15cm) from Arable and Horticulture, and Improved Grassland Broad Habitats in England, between 1978 and 2007. Significant changes which are similar across time periods for both Broad Habitats (*p<0.05, p<0.01, *** p<0.001) are shown between the dates bracketed. 95% CI are shown for each data point (but are very small).



3.4.2 Soil (0-15cm) carbon concentration

There was a significant decrease in the mean carbon concentration of soil (0-15cm) in the Arable and Horticulture Broad Habitat between 1998 and 2007. It was 29.8g/kg in 1998 and 27.2g/kg in 2007. This is the only Broad Habitat where soil (0-15cm) carbon concentrations were significantly lower in 2007 than in 1978. This is consistent with a significant decrease in carbon concentration over the long-term, between 1978 and 2007 (See also *Chapter 2, Table 2.11*).

There was no detectable change in the mean carbon concentration of soil (0-15cm) in the Improved Grassland Broad Habitat between 1998 and 2007. It was 49.6g/kg in 1998 and 48.2g/kg in 2007. The carbon concentration also did not change significantly between 1978 and 2007 (See also *Chapter 2, Table 2.11*).

3.4.3 Bulk density and soil (0-15cm) carbon stock

The mean bulk density of soils (0-15cm) in the Arable and Horticulture Broad Habitat in England in 2007 was 1.25 g/cm^3 which when combined with soil (0-15cm) carbon concentration gave a soil (0-15cm) carbon stock estimate of approximately 43tC/ha . This was the lowest carbon stock estimate of all Broad Habitats (See also *Chapter 2, Table 2.13*).

The mean bulk density of soils (0-15cm) in the Improved Grassland Broad Habitat in England in 2007 was 1.02 g/cm^3, which when combined with soil (0-15cm) carbon concentration gave a soil (0-15cm) carbon stock estimate of approximately 59tC/ha (See also *Chapter 2, Table 2.13*).

3.5 Further analysis and discussion to explain changes in the Arable and Horticulture and Broad Habitats

3.5.1 Arable and Horticulture Broad Habitat

- **Set-aside and agri-environment schemes are the most probable cause of the increase in plant species richness of the Arable and Horticulture Broad Habitat in England between 1998 and 2007.**

In 2007, the Arable Broad Habitat occupied 33% of the land area in England *(Table 3.1)*. The total area increased slightly between 1990 and 1998 but decreased by 8.8% (0.4 million ha) between 1998 and 2007, mainly through conversion to Improved and Neutral Grassland.

Plant species richness within Main Plots in Arable land increased by 45%, between 1990 and 2007 (from 6.3 to 10.2 species) and by 36% between 1998 and 2007. The most likely explanation for this increase is a combination of the impacts of set-aside and agri-environment schemes. This follows a decrease in plant species richness between 1978 and 1990 reported in previous Countryside Surveys. Increases in the numbers of plants which provide food for farmland birds and butterfly caterpillars are accompanied by increases in the percentage cover of non-crop species in arable fields. These changes are likely to be a result of marked increases in the area of set-aside and fallow land, which could have been driven by low commodity prices as well as direct policy *(Table 3.7)*.

Although Crop Edge Plots in the Arable Broad Habitat showed no detectable change in Species Richness between 1998 and 2007, plots within the subdivisions (attributes recorded by surveyors) of 'arable crops' and 'annual early successional vegetation' did show change. Both Main Plots and Crop Edge Plots in land with early successional vegetation (possibly set-aside) contained more species than cropped land in 2007 *(Table 3.8)*. In 1998 Crop Edge Plots contained more species when they were next to arable crops rather than adjacent to annual early successional fields. While arable crops as represented by Main Plot data are less species-rich than crop-edges, fields potentially under set-aside management have roughly the same species richness as the crop-edge. The end of compulsory set-aside in 2008 is likely to result in a large reduction in the area of annual early successional habitat and a subsequent decrease in numbers of plants species used as food by farmland birds and butterfly caterpillars.

▼ **Table 3.8:** Plant Species Richness Scores in 200m^2 Main Plots in land recorded by the codes 'arable crops' and 'annual early successional' (an indicator of set-aside and other fallow land) in the Arable and Horticulture Broad Habitat in England between 1998 and 2007.

	Arable crops		Annual early successional	
	1998	2007	1998	2007
Main Plots (No. of species)	6.3	9	8.2	17.7
Crop Edge Plots (No. of species)	14.9	16.3	10.2	17.4

The change in overall plant diversity in crop edges in Great Britain between 1998 and 2007 was not statistically significant, but the numbers of plants which provide food for butterfly caterpillars decreased. The vegetation changes both within crops (Main Plots) and on the edges of crops (Crop Edge Plots) suggest a reduction in soil fertility. In contrast to results based on vegetation analysis, a significant increase in soil (0-15 cm) pH and a decrease in soil (0-15cm) carbon concentration was detected between 1978 and 2007.

Field margins established under agri-environment schemes have more species than the crop area as measured by Main Plots, but the plant species richness and cover are still low (on average 11 species per plot and 21% cover) when compared to other Broad Habitats and to set-aside land. The results demonstrate that many arable field margins are comprised of relatively simple sown grass mixes and are almost as species-poor as the cropped area although

▼ **Table 3.7:** Change in estimated area ('000s ha) of land recorded by the code 'annual early successional' (an indicator of set-aside and other fallow land) in England between 1990 and 2007. Arrows denote significant change ($p<0.05$) in the direction shown.

Annual early successional code	1990	1998	2007	Change 1998 - 2007 %	Direction of significant changes 1998 - 2007
	Area ('000s ha)	Area ('000s ha)	Area ('000s ha)		
England	22	35	149	330	↑
Easterly Lowlands	18.5	16.8	111.8	563.8	↑
Westerly Lowlands	3.5	17.2	36.7	113	
Uplands	0.001	0.5	0.06	-87.1	

percentage cover is higher. However, they provide structural diversity which is valuable for a range of wildlife as well as shelter and food for invertebrates.

3.5.2 Improved Grassland

In 2007 the estimated area of Improved Grassland was 2.9 million ha, around a fifth of the land area of England. The area of Improved Grassland decreased significantly between 1990 and 1998 but increased again between 1998 and 2007, largely as a result of conversion of arable land to grassland.

Although the plant species richness of Improved Grassland in England has not changed significantly since 1990 those areas targeted for their botanical interest in the 1990 Countryside Survey showed species richness had decreased by 25% by 2007. The vegetation plots in Improved Grassland also changed in ecological character between 1998 and 2007 with a shift towards later successional, shaded vegetation and slightly less alkaline/more acidic conditions.

3.6 Discussion and Conclusions

3.6.1 General Trends in Enclosed Farmland

Enclosed farmland encompasses the two Broad Habitats that are dominated by intensive agriculture and are responsible for the bulk of food production in England. Changes observed by Countryside Survey in the land-use and biodiversity of enclosed farmland are likely to be responses to economic and technological drivers affecting farming at global or national scales, as well as to policy responses delivered at the Europe and England levels (See also *Chapter 4 Semi-improved Grassland*, and *Chapter 5 Boundary and Linear Features*).

The Arable and Horticulture Broad Habitat in the UK is dominated by production of cereals and oilseeds. Economically, the period between the 1998 and 2007 surveys was largely characterised by low arable commodity prices on world markets, leading to pressure on farm profitability. Improved Grassland supports productive livestock enterprises, primarily dairying and beef and sheep rearing. Trends in these sectors have been less clear-cut: the dairy sector has seen ongoing supply-chain driven pressure on milk prices, forcing many smaller producers out of the sector, and where dairying has remained viable, the pressure has been to reduce costs through maximising utilisation of grassland. The beef and sheep sector has seen fluctuating meat prices during the period under review.

Within the European Union, the Common Agricultural Policy (CAP) provides the overarching framework for farm support, and has been subject to an ongoing process of reform since 1998; the Agenda 2000 reforms introduced the concept of the two 'pillars' of the CAP; the first (Pillar 1) making direct subsidy payments to farmers, but balanced by a second (Pillar 2), intended to promote rural development and moderate the environmental footprint of farming. Subsequently, from 2005, the basis for Pillar 1 to support itself has fundamentally changed, through the decoupling of the direct subsidies from production. In England, the new framework involves a single area-based payment, linked to a series of cross-compliance measures designed to enhance the quality of basic environmental management. England has also taken the opportunity to 'modulate' a proportion of Pillar 1, using it to enhance the resources available for incentive schemes under Pillar 2. This enabled the roll-out in 2005 of Entry Level Stewardship as an agri-environment scheme intended to be attractive and available to almost all farmers. Most recently, the decision was taken to abandon the use of compulsory set-aside as a production limiting measure. This is not likely to have impacted on the Countryside Survey data for 2007, but may have implications in the future.

CAP reform, and in particular the growth of Pillar 2, is in part a response to increased policy awareness of the negative externalities of agriculture, particularly in relation to impacts on water quality and biodiversity, resulting in market failure. For England, policy responses have been developed across both Pillars of the CAP, involving a range of voluntary, incentive-driven and regulatory measures. Taken together, these encourage farmers to evaluate the environmental impacts of their farm business and to modify management to reduce its external impacts. The data set generated by Countryside Survey offers an opportunity to assess the success of these measures in an integrated way.

There has been increased recognition since the mid 1970's that effective conservation of biodiversity requires action beyond sites of known high wildlife value. This emerged from recorded declines in characteristic farmland wildlife, especially bird species such as Tree Sparrow (*Passer montanus*) and Corn Bunting (*Emberiza calandra*). This has been a key driver in the evolution of agri-environment policies from those addressing specific cases (Broads Grazing Scheme, 1986), to high landscape value areas (Environmentally Sensitive Areas Schemes, from 1987), to targeted landscapes in the wider countryside (Countryside Stewardship, 1991; Arable Stewardship Pilot, 1998), to a scheme designed to provide benefits across all landscapes (Entry Level Stewardship, 2005). Combined with effective regulation and supported by availability of conservation advice, there is a policy expectation that adverse trends in biodiversity in the wider countryside can be reversed, as exemplified by the Government commitment made in 2000 to reverse declines in farmland bird numbers by 2020, and articulated in a biodiversity strategy for England[4].

There is also an Implementation Group, charged with taking forward the Biodiversity Action Plan developed under the UK strategy for the sustainable use of plant protection products. The authorisations system aims to limit the adverse effects of pesticides on non-target species. These controls are under continuous development. However, the authorisation system alone will not eliminate effects on non-target species altogether and other initiatives are likely to have a major part to play in supplementing the pesticide regulatory controls. Initiatives are also required to address the indirect effects of pesticides on biodiversity. The Biodiversity Action Plan[5] is based around taking some of these key initiatives forward.

[4] *"Working with the grain of nature: a biodiversity strategy for England"* and available at http://www.defra.gov.uk/wildlife-countryside/biodiversity/action-uk/e-biostrat.htm

[5] available at http://www.pesticides.gov.uk/environment.asp?id=1834

▲ Bee keeper smoking hive, Oxfordshire • © *Natural England* • *Nick Turner*

3.6.2 Arable and Horticulture Broad Habitat

The Arable and Horticulture Broad Habitat is highly influenced by large-scale trends in agriculture which have a significant impact on farm-scale planning, often within short cycles, and some of these impacts are clearly visible in Countryside Survey data. In particular, low commodity returns have made arable cropping less profitable on marginal land, and have driven widespread reversion to grassland, either voluntarily through long-term set-aside or through diversification of farm enterprises. In many cases, however, these decisions will have taken into account the potential to utilise agri-environment incentives, where arable reversion has been targeted to enhance biodiversity, reinforce landscape character, conserve historic features and latterly to protect vulnerable water-bodies. It is very likely that a combination of these drivers and policy mechanisms explains the observed 8.8% decrease in the area of the Arable and Horticulture Broad Habitat and the corresponding 5.2% increase in area of Improved Grassland between 1998 and 2007.

Countryside Survey identified increases in plant species richness in the Arable and Horticulture Broad Habitat, including species used as food by farmland birds and butterfly caterpillars, which might be seen as a positive response to the range of policy measures designed to reduce the environmental footprint of farming. The increases may have been driven by a combination of set-aside and agri-environment measures. These measures, added to the optimisation of pesticide use caused by low crop prices will have benefited wildlife. There is a risk that these increases in species richness may not be sustained with the ending of compulsory set-aside and also increased grain prices which make the increased use of pesticides more likely.

The survey identifies the relative importance of field margins as refuges for biodiversity in the arable landscape. Arable field margins are targeted as a Priority Habitat within the UK Biodiversity Action Plan and are a key element of agri-environment schemes[6]. A range of options are available that include grass margins, pollen and nectar mixes and wild bird cover. In general, field margin options are popular with farmers as they can be managed separately from the cropped area. Uptake has been high and the initial UKBAP target was met ahead of schedule in England[7]. The results from CS are encouraging in demonstrating that the enclosed farmland habitats, especially the margins of arable fields, support plant biodiversity which also supports a range of animals, including pollinators and predatory species that provide ecosystem services for farmed land. The CS results indicate that not only did overall plant species richness increase, but those species of specific value to farmland birds and butterflies also increased and the habitat became weedier between 1998 and 2007. However, despite this apparent good news, the Farmland Bird Index has continued to decline over this period reaching its lowest ever level in 2007, so the CS results need to be interpreted carefully and other data analysis is needed to explore the relationship between the changes in the vegetation and numbers of farmland birds.

3.6.3 Improved Grassland Broad Habitat

Countryside Survey has found the species richness of Improved Grassland since 1990 to be fairly constant in terms of number of species per plot. Improved Grassland is typically very intensively managed, such as management for silage. It is perhaps less likely to respond to agri-environment delivery than the Arable Broad Habitat, where it is possible to deliver environmental management separately to the intensively farmed area.

3.6.4 Habitat Fragments in Enclosed Farmland

Countryside Survey measures species richness in plots targeted as residual areas of botanical interest within otherwise intensively managed farmland. In the Arable Broad Habitat, a significant decline was identified from 1990 to 1998 but not repeated in 2007, although there are indications that the trend has not been reversed.

[6] information and claim forms available at http://www.naturalengland.gov.uk/ourwork/farming/funding/es/default.aspx

[7] The 1995 BAP target for England was to maintain, improve and restore by management the biodiversity of some 12,725ha of cereal field margins by 2010. The target was assessed as met (exceeded) in the 2005 reporting round (26,242ha). Further details are available at http://www.ukbap.org.uk/GenPageText.aspx?id=105

Within the Improved Grassland Broad Habitat, a continued decline of 11.4% has been observed since 1998. 'Patches' of habitat are seen as important for maintaining the overall biodiversity value of farmland, and are targeted for positive management through agri-environment schemes, including action to buffer and link patches. It is possible that population effects resulting from isolation[8, 9], (island biogeography) could be outweighing the benefits of positive management; it is also possible that 2007 is too early to evaluate any impact of the introduction of Entry Level Environmental Stewardship in 2005. In the context of the policy emphasis now being placed on Ecosystem Services, in particular regulatory services associated with mitigation of climate change, it will be important to understand the scale of habitat required to maintain functioning habitat networks at landscape scale.

3.6.5 Soils

In terms of ecosystems services, the enclosed farmland Broad Habitats provide us with our food, fibre and even sources of renewable energy, so the fertility and structures of the soils are essential to human well being, and wealth of the nation.

Sustainable use of soil has been increasingly identified as a key policy goal, with the first Soil Action Plan published by Defra in 2004[10] and the adoption of the Soil Protection Review as a cross-compliance requirement for the single area payment, and a recognition that soil management may have a contributory role in climate change mitigation. Countryside Survey has identified an increase in the pH of topsoil between 1998 and 2007 in both enclosed land Broad Habitats, extending a trend from the first survey in 1978. It is possible that the key driver has been a decrease in acid deposition, as a result of regulation to encourage less pollution from burning of industrial and domestic fossil fuels. These soils will also be affected by changes in agricultural management, for example through lime fertiliser additions which will influence soil pH.

The reduction in carbon concentration in soils recorded in the Arable and Horticulture Broad Habitat was not reflected in the Improved Grassland Broad Habitat, indeed it is the only Broad Habitat where a decline has been observed since 1978. It is not immediately clear why a continued decline in carbon concentration is evident, but intensity of management, reductions in ley management and changes to stubble treatment may be factors and this will be explored further in future work. Maintenance of soil organic matter provides both agronomic and environmental benefits. Recently, in response to economic and environmental drivers, there has been an increase in direct crop drilling and other forms of minimum tillage, with incentives provided in defined circumstances through Environmental Stewardship. Land management practices to reduce green house gasses have been promoted in the Natural England guidance document, *Carbon Management by Land and Marine Managers Natural England Research Report NERR026.*

▲ Intensive arable farming, Cambridgeshire • © *Sue Wallis*

3.6.6 Conclusions

The Broad Habitats discussed in this chapter occupy approximately half the land area of England, especially across much of the lowland landscape and they are managed primarily within intensive agricultural systems. The impact of post-war agricultural intensification across our landscapes has been well documented and has resulted in policy responses designed to mitigate the impact of agriculture, most recently through the introduction of Entry Level Environmental Stewardship (ELS) in 2005.

Countryside Survey has found some evidence of positive change since 1990, most notably through increased species richness in the Arable and Horticulture Broad Habitat, and the evidence of an increase in numbers of plant species that are used by farmland wildlife for food. However, it is not clear whether the benefits observed are driven by policy or economic responses, and hence whether they will be sustained. In contrast, the main change observed in Improved Grassland has been an increase in its extent whilst species richness has not changed.

[8] JNCC Report No: 383 *'The conservation of genetic diversity: Science and policy needs in a changing world'*

[9] Storfer, A., Murphy, M.A., Evans, J.S., Goldberg, C.S., Robinson, S., Spear, S.F., Dezzani, R., Delmelle, E., Vierling, L. and Waits, L.P. (2007). *Putting the 'landscape' in landscape genetics.* Heredity (98), 128-142.

[10] Available at: http://www.defra.gov.uk/ENVIRONMENT/land/soil/sap/

The ongoing decline in species richness of habitat fragments within both Broad Habitats is a concern given the contribution such habitats may make as sanctuaries, sources of colonists and to delivery of ecosystem services. This could be particularly important in policies addressing the need to make provisions for biodiversity to adapt to climate change. The policy intention would be that these environmental features would be managed through agri-environment schemes and in particular ELS. At this time it is not clear whether the current schemes are playing an effective role; albeit the 2007 survey may have been too early to detect full impacts of the introduction of ELS.

▲ Improved Grassland, Lancashire • © *Ian Simpson*

▲ Sheep grazing in Gloucestershire • © *Natural England* • *Nick Turner*

4. Semi-Natural Grasslands: Neutral, Calcareous and Acid Grasslands

Summary

Area and Change

- The area of Neutral Grassland was 1,453,000ha or 11% of the area of England in 2007, with most found in the Westerly and Easterly Lowlands Environmental Zones. This represented an increase of 12.6% (163,000ha) between 1998 and 2007; there was a significant increase of 13% (75,400ha) in the Westerly Lowlands Environmental Zone.

- The area of Calcareous Grassland was 30,000ha or 0.2% of the area of England in 2007, with most in the Easterly Lowlands Environmental Zone. The area did not change significantly between 1998 and 2007, but a significant decrease (30% amounting to 13,000ha) in the area of this habitat has been seen over the longer term from 1990 to 2007 and a significant decrease (25% amounting to 2,000ha) was detected in the Westerly Lowlands Environmental Zone between 1998 and 2007.

- The area of Acid Grassland was 396,000ha or approximately 3.0% of England in 2007, with most in the Uplands. There was no significant change in the area of Acid Grassland between 1998 and 2007. This followed a significant decrease of 15.7% between 1990 and 1998. Taken overall, the decrease of 16.7% (79,000ha) between 1990 and 2007 was significant.

Condition of Neutral Grassland

- In the main areas of characteristic Neutral Grassland, plant species richness did not change significantly across England, but there was a significant increase from 18.6 to 20.4 species per Main Plot in the Westerly Lowlands Environmental Zone between 1998 and 2007.In the main areas of characteristic Neutral Grassland, there was a significant increase in competitive and stress tolerating species at the expense of ruderal species, and a significant increase in Moisture Score, which along with the significant decrease in the mean Light Score in Main Plots, suggests that Neutral Grassland became wetter, more densely vegetated and more shaded across England between 1998 and 2007.

- In the areas within Neutral Grassland targeted by Countryside Survey for their botanical interest, the plant Species Richness Score decreased significantly from 13.6 to 12.5 species per plot across England between 1998 and 2007, following a similar decrease between 1990 and 1998. This contrasts with the results from Main Plots in the areas of more characteristic habitat.

- The decrease in species richness in areas within Neutral Grassland targeted by Countryside Survey for their botanical interest was reflected by a significant reduction in number of food plants for butterfly caterpillars and farmland birds. These decreases were also detected in all Environmental Zones over the longer term, 1990-2007 (except for numbers of species of food plants for farmland birds in the Uplands Environmental Zone). This suggests that in these important species refuges decreases in species richness may potentially affect animals too.

- The areas within Neutral Grassland targeted by Countryside Survey for their botanical interest showed a significant decrease in Grass:Forb ratio, Ruderal and Light Scores, and a significant increase in Fertility and Competitor Scores across England and in the Easterly Lowland Environmental Zone between 1998 and 2007. This suggests they became more densely vegetated and shaded, a similar trend to that seen in the signal from Main Plots in the more homogeneous habitat.

- Generally the results suggest that the more botanically interesting areas of Neutral Grassland are becoming less species rich whilst the larger less diverse areas of this habitat are being maintained.

Condition of Acid Grassland

- In the main areas of characteristic Acid Grassland, plant species richness decreased significantly (from 18.1 to 16.5 species per Main plot) across England between 1998 and 2007, but there was no significant change in numbers of food plants for farmland birds and butterfly caterpillars. A significant decrease in species richness was also detected in the Uplands Environmental Zone, where this is the predominant grassland Broad Habitat. This reversed the significant increase in species richness reported between 1990 and 1998.

- The decrease in species richness in larger characteristic areas of Acid Grassland was mirrored within discrete areas of this Broad Habitat targeted by Countryside Survey for their botanical interest.

- There were no detectable changes in condition characteristics in the Acid Grassland Broad Habitat, in England between 1998 and 2007, except for a significant increase in Ellenberg pH Scores in Main Plots. Over the longer term, between 1990 and 2007, there were significant increases in Fertility and Competitor Scores in Main Plots across England and in the Uplands Environmental Zone, but a decrease in stress tolerating species across England. This contrasts with signals of changing condition in the areas of Acid Grassland targeted for their botanical interest.

- In the areas within Acid Grassland targeted by Countryside Survey for their botanical interest, there was a significant decrease in species richness from 11.6 to 10.1 species per Targeted Plot, across England and from 11.9 to 10.1 species per Targeted Plot in the Uplands Environmental Zone between 1998 and 2007. This matched the signal of decreasing species richness from the Main Plots used to sample more characteristic areas of Acid Grassland.

- In the areas within Acid Grassland targeted by Countryside Survey for their botanical interest, Competitive species and Fertility Scores increased, while Stress Tolerator Scores decreased significantly across England between 1998 and 2007.

- In areas within Acid Grassland targeted by Countryside Survey for their botanical interest, there was a significant increase in Grass:Forb ratio across England, over the longer term, 1990-2007, which was also detected in the Uplands Environmental Zone over this period.

- Compared with the result for Main Plots, this suggests that long-term changes 1990-2007 in the main areas of Acid Grassland are starting to be reflected in the recent (1998-2007) changes in those areas targeted for their botanical interest.

Soils in Neutral Grassland

- The mean pH of soil (0-15cm) from Neutral Grassland in England increased significantly from 6.18 to 6.41 between 1998 and 2007. Earlier increases in pH between 1978 and 1998 and overall from 1978 to 2007 were also significant. The mean Ellenberg pH Score of the vegetation did not change consistently with the soil pH.

- There was no detectable change in the mean carbon concentration of soil (0-15cm) in Neutral Grassland between 1998 and 2007. It was approximately 59g/kg in 2007.

- **The mean bulk density of soils (0-15cm) in the Neutral Grassland in England in 2007 was 0.95g/cm^3 and the estimated carbon stock of soil (0-15cm) was approximately 60tC/ha.**

Soils in Acid Grassland

- **The mean pH of soil (0-15cm) samples from Acid Grassland in England increased significantly from 4.51 to 4.74 between 1998 and 2007. This contrasts with the results from Great Britain.**
- **There was no change in the mean carbon concentration of soil (0-15cm) in Acid Grassland between 1998 and 2007.**
- **The mean bulk density of soils (0-15cm) in the Acid Grassland in England in 2007 was 0.48g/cm^3 and the estimated carbon stock of soil (0-15cm) was approximately 87tC/ha. This was the second largest carbon stock reported for Broad Habitats in England, after Dwarf Shrub Heath.**

4.1 Introduction[1]

While the most productive grasslands in England fall within the Improved Grassland Broad Habitat (representing 25% of England's land area), there are still large areas of semi-improved and semi-natural grassland within the Neutral, Calcareous and Acid Grassland Broad Habitats. These have been managed traditionally for livestock grazing and/or hay, making a significant contribution to national dairy, beef and lamb production. These habitats now tend to be associated with smaller farms or small areas on larger farms where intensification has been impractical for physical or financial reasons. Typically, grasslands in this category represent a spectrum of management intensity from semi-natural to semi-improved. At the semi-natural end of the scale are those which have not been agriculturally improved by ploughing, re-seeding, use of inorganic fertilisers or widespread application of herbicides. Semi-improved grasslands have typically been subject to improvement through fertiliser use and other intensive management but are typically not subject to regular reseeding.

Small areas of Neutral, Calcareous or Acid Grassland Broad Habitats (typically less than 0.5ha) may also persist as fragments within otherwise intensively managed landscapes. As such they may potentially have significant value as residual wildlife refuges and are targeted by Countryside Survey for assessment of their botanical interest using 'Targeted Plots'. Such areas may be too small to warrant protection or designation and may often be difficult to manage, vulnerable to intensive land-use or lack of management.

The three Broad Habitats reported in this chapter are characteristic of soils with differing pH values.

Neutral Grassland: Neutral Grassland occurs on soils that are neither strongly acid nor lime-rich (pH 5.5-6.5). This includes all semi-improved and unimproved grassland occurring on neutral soil. It includes enclosed and managed grassland such as pastures, a range of wet grasslands where the vegetation is dominated by grasses, sown grassland strips alongside arable fields, long-term set-aside or fallow land and tall unmanaged grasslands. It does not include improved species-poor grassland which is described in *Chapter 3*. It can be very difficult to classify grasslands at different points along the fertility gradient. Previous surveys did not attempt to do so and there was no definition of semi-improved neutral grassland, such grasslands were either described as fertile agricultural grass or herb-rich grassland. The semi-natural definition has been added to the 2007 survey and habitat and species descriptions used to re-allocate previous surveys. This was more difficult to do for the 1990 survey.

Calcareous Grassland: Consists of vegetation on dry ground with scattered sedges and many calcicoles present. It can be relatively species poor but is often species rich with >50% forb cover. It is found on calcareous soils (pH>6.5), usually rendzinas on chalk or limestone.

Acid Grassland: Acid Grassland occurs on acid soils (pH<5.5). Fine grasses predominate in generally dry situations e.g. *Agrostis capillaris*, *Festuca ovina* and *Anthoxanthum odoratum* usually on brown podzolic soils or rankers. Species indicative of acid conditions are present and include, e.g. *Galium saxatile*, *Potentilla erecta*, *Pleurozium schreberi* and *Rumex acetosella*. This Broad Habitat also includes moorland grass dominated by *Nardus stricta* and *Molinia caerulea*, which is characteristic of moorlands and lowland heaths on peat or peaty gley soils. Similarly to the Neutral Grassland there have been some changes in the way that Acid Grassland has been recorded since 1990 which does present some inconsistencies between 1990 results and the more recent surveys.

The semi-natural habitats associated with these soil types are defined more narrowly within the UK Biodiversity Action Plan as Priority Habitats. Whilst Countryside Survey may contribute to their assessment, the random sampling involved does not enable reliable reporting at Priority Habitat scale.

The England estimates of extent and change in grasslands reported here derive from a random sample of the countryside and are representative of the constituent Broad Habitats in the wider countryside rather than the blocks of semi-natural habitat targeted by the UK BAP often on designated sites.

4.2 Area of Grassland Broad Habitats

- **The area of Neutral Grassland was 1,453,000ha or 11% of the area of England in 2007, with most of this in the Westerly and Easterly Lowlands Environmental Zones.**

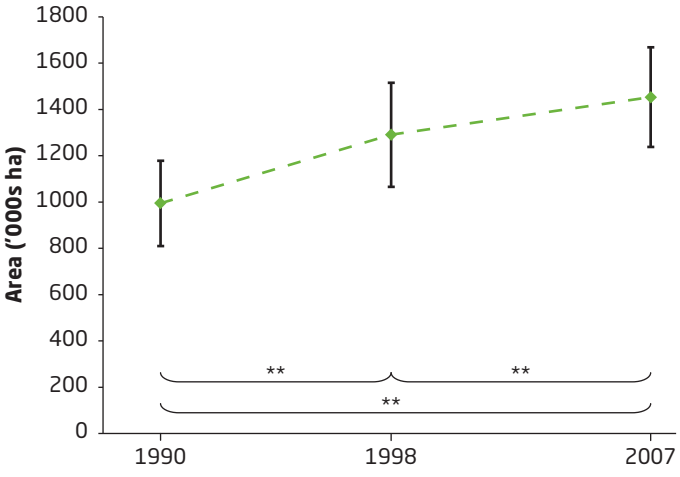
[1] **Note:** For further information on the Broad Habitat classification, sampling plots and other Countryside Survey terminology see *Chapter 1 (Introduction and Methodology)*.

- **The area of Calcareous Grassland was 30,000ha or 0.2% of the area of England in 2007, with nearly all of it in the Easterly Lowlands Environmental Zone, and only a small amount in the Westerly Lowlands Environmental Zone, consistent with the pattern of geological outcrops of chalk and limestone.**
- **The area of Acid Grassland was estimated to cover approximately 396,000 ha or approximately 3.0% of England in 2007, with most of it in the Uplands, and some occurring in the Easterly and Westerly Lowlands Environmental Zones.**
- **The area of Neutral Grassland increased by 12.6% (163,000ha) in England between 1998 and 2007; there was a significant increase of 13% (75,400ha) in the Westerly Lowlands Environmental Zone.**
- **The area of Calcareous Grassland did not change significantly between 1998 and 2007, but there was a significant decrease in the area of this habitat over the longer term from 1990 to 2007 and a significant decrease (25% amounting to 2,000ha) was detected in the Westerly Lowlands Environmental Zone between 1998 and 2007.**
- **There was no significant change in the area of Acid Grassland between 1998 and 2007. This followed a significant decrease of 15.7% between 1990 and 1998. Overall there was a significant 16.7% (79,000ha) decrease between 1990 and 2007.**

4.2.1 Neutral Grassland

The area of Neutral Grassland was estimated to cover 1,453,000 ha or approximately 11% of England in 2007 *(Table 4.1)*. This represents a significant increase of 12.6 % (163,000ha) since 1998 and contributed to the significant increase of 46% between 1990 and 2007 *(Fig. 4.1)*.

▼ **Figure 4.1:** Change in the area of Neutral Grassland across England between 1990 and 2007. Significant changes (** p<0.01) are shown between the dates bracketed. 95% CI are shown for each data point.

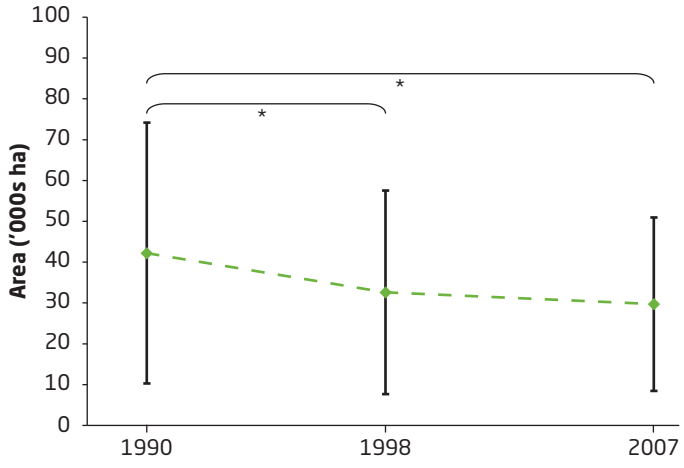


▲ Species-rich neutral grassland, Cambridgeshire • © *Natural England* • *Peter Wakely*

4.2.2 Calcareous Grassland

The area of Calcareous Grassland was estimated as approximately 30,000 ha in 2007 or 0.2% of England *(Table 4.2)*. The area and distribution makes it difficult for the sampling strategy of Countryside Survey to detect small changes in the area of this Broad Habitat and none were detected between 1998 and 2007, although this followed a significant decrease in Great Britain between 1990 and 1998, which was also significant over the longer term from 1990 to 2007. A significant decrease (2,000ha) in the Westerly Lowlands Environmental Zone was detected between 1998 and 2007 *(Table 4.2, Fig. 4.2)*.

▼ **Figure 4.2:** Change in the area of Calcareous Grassland across England between 1990 and 2007. Significant changes (* p<0.05) are shown between the dates bracketed. 95% CI are shown for each data point.



▼ **Table 4.1:** Estimates of the area ('000s ha) and percentage of land area of Neutral Grassland in England between 1990 and 2007. Arrows denote significant change ($p<0.05$) in the direction shown. Note that because of changes in definitions that have been applied retrospectively, the estimates from 1990 are not in all cases directly comparable with later surveys.

	1990		1998		2007		Direction of significant changes 1998 - 2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
England	994	7.5	1290	9.8	1453	11	↑
Easterly Lowlands	428	6.6	486	7.4	559	8.6	
Westerly Lowlands	423	8.3	582	11.4	657	12.9	↑
Uplands	142	9	223	14.1	237	15.1	

▼ **Table 4.2:** Estimates of the area ('000s ha) and percentage of land area of Calcareous Grassland in England between 1990 and 2007. Arrows denote significant change ($p<0.05$) in the direction shown. Note that because of changes in definitions that have been applied retrospectively, the estimates from 1990 are not in all cases directly comparable with later surveys.

	1990		1998		2007		Direction of significant changes 1998 - 2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
England	42	0.3	33	0.3	30	0.2	
Easterly Lowlands	30	0.5	24	0.4	23	0.4	
Westerly Lowlands	12	0.2	8	0.2	6	0.1	↓
Uplands	0	0	0	0	0	0	

▼ **Table 4.3:** Estimates of the area ('000s ha) and percentage of land area of Acid Grassland in England between1990 and 2007. Arrows denote significant change ($p<0.05$) in the direction shown. Note that because of changes in definitions that have been applied retrospectively, the estimates from 1990 are not in all cases directly comparable with later surveys.

	1990		1998		2007		Direction of significant changes 1998 - 2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
England	475	3.6	400	3	396	3	
Easterly Lowlands	11	0.2	16	0.2	19	0.3	
Westerly Lowlands	7	0.1	31	0.6	27	0.5	
Uplands	456	29	354	22.5	349	22.2	

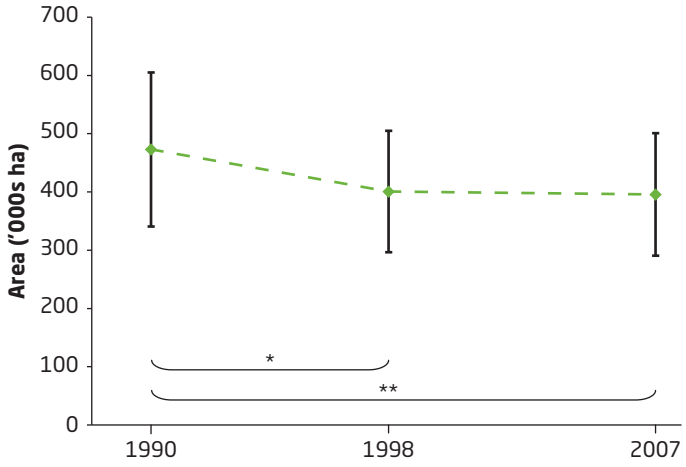
▲ Acid grassland, Cumbria • © *Natural England* • *Charlie Hedley*

4.2.3 Acid Grassland

The area of Acid Grassland was estimated to cover approximately 396,000 ha or approximately 3.0% of England in 2007 *(Table 4.3)*. There was no significant change in the area of Acid Grassland between 1998 and 2007. This followed a decrease of 15.7% between 1990 and 1998. Overall there was a 16.7% decrease between 1990 and 2007 *(Table 4.3, Fig. 4.3)*.

The introduction of new recording categories for Broad Habitats in 1998 may have affected the estimates of changes between 1990 and 1998 in Neutral and Acid Grasslands. The change estimates between 1998 and 2007 are more reliable because the same mapping codes were used in both surveys.

▼ **Figure 4.3:** Change in the area of Acid Grassland across England between 1990 and 2007. Significant changes (*p<0.05,** p<0.01) are shown between the dates bracketed. 95% CI are shown for each data point.



4.3 Conversions between grassland habitats

Most Neutral Grassland remained as the same Broad Habitat between 1998 and 2007. There were broadly equivalent conversions to and from Improved Grassland and a net increase in Neutral Grassland at the expense of the Arable and Horticulture Broad Habitat. This is consistent with the substantial increase in set-aside during the period. In addition, a net shift from arable crops to semi-improved neutral grassland and tall neutral grassland, associated with increased set aside was confirmed by an investigation of the conversions between habitat types based on more detailed mapping information.

There was only a relatively low level of flux between the Calcareous Grassland Broad Habitat and the Neutral Grassland Broad Habitat between 1998 and 2007 There were small conversions from the Bracken Broad Habitats to and from Acid Grassland between 1998 and 2007 (see *www.countrysidesurvey.org.uk*).

4.4 The Condition of Neutral, Calcareous and Acid Grasslands

4.4.1 Changes in the Condition of the Neutral Grassland Broad Habitat

- **In the main areas of characteristic Neutral Grassland, plant species richness did not change significantly (from 19.9 to 20.3 species per Main Plot) across England, but there was a significant increase from 18.6 to 20.4 species per Main Plot in the Westerly Lowlands Environmental Zone between 1998 and 2007.**
- **In the main areas of characteristic Neutral Grassland, there was a significant increase in competitive and stress tolerating species at the expense of ruderal species, and a significant increase in Moisture Score, which along with the significant decrease in the mean Light Score in Main Plots, suggests that Neutral Grassland became wetter, more densely vegetated and more shaded across England between 1998 and 2007. Some of these changes were also significant in the Easterly and Westerly Lowlands Environmental Zones.**
- **The shift in vegetation in the more homogeneous areas of Neutral Grassland towards denser, more shade and moisture loving communities is supported by the plant species that decreased most, which were predominantly species of short turf and the increase in frequency of species typically associated with wet meadows.**
- **In the areas within Neutral Grassland targeted by Countryside Survey for their botanical interest, the plant Species Richness Score decreased significantly from 13.6 to 12.5 species per plot across England between 1998 and 2007, following a similar decrease between 1990 and 1998. This contrasts with the results from Main Plots in the areas of more characteristic habitat. It was also significant in the Uplands Environmental Zone between 1998 and 2007, and over the longer term.**
- **In the areas within Neutral Grassland targeted by Countryside Survey for their botanical interest, the significant decrease in species richness was also reflected by a significant reduction in the number of food plants for butterfly caterpillars and farmland birds. Significant reductions in species richness, numbers of species of food plants for butterfly caterpillars and farmland birds were detected in all Environmental Zones over the longer term, 1990-2007 (except for numbers of species of food plants for farmland birds in the Uplands Environmental Zone). This suggests that these important species refuges have not just deteriorated for plants but potentially for some animals too.**
- **In the areas within Neutral Grassland targeted by Countryside Survey for their botanical interest there was a significant decrease in Grass:Forb ratio, Ruderal and Light Scores, and a concurrent significant increase in Fertility and Competitor Scores across England and in the Easterly Lowlands Environmental Zone between 1998 and 2007. This suggests they became more densely vegetated and more shaded between 1998 and 2007, similar to the signal from Main Plots in the more characteristic habitat, but differing in the increase of Fertility Scores and the lack of a significant increase in stress tolerating species in the Targeted Plots.**

▼ **Table 4.4:** Change in the characteristics of vegetation in 200m² Main Plots in the Neutral Grassland Broad Habitat across England (E) and the three Environmental Zones (EL - Easterly Lowlands, WL - Westerly Lowlands, UP - English Uplands) between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available at *www.countrysidesurvey.org.uk*. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3 in Chapter 1 of the UK Results from 2007 report***.

	Mean values (England)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**
Species Richness (No. of Species)	19.9	20.3			↑				↓					↓
No. of Bird Food Species	10.3	10.5							↓					
No. of Butterfly Food Species	9.4	9.6				↓			↓					
Grass:Forb Ratio	1.16	1.1						↓				↓		
Competitor Score	2.78	2.85	↑	↑										
Stress Tolerator Score	2.11	2.16	↑		↑									
Ruderal Score	2.96	2.87	↓	↓	↓						↓	↓	↓	
Light Score	7.02	6.98	↓	↓								↓		
Fertility Score	5.32	5.28			↓									
Ellenberg pH Score	6.02	5.97			↓									
Moisture Score	5.4	5.47	↑		↑								↑	

- **Generally the results suggest that the more botanically interesting areas of Neutral Grassland are becoming less species rich whilst the larger less diverse areas of this habitat are being maintained.**

Main Plots in Neutral Grassland: Within characteristic areas of Neutral Grassland, randomly placed 200m² Main Plots[2] were used to assess the condition of this Broad Habitat.

Plant species richness in Main Plots in Neutral Grassland: Between 1998 and 2007, the small change in species richness from 19.9 to 20.3 species per Main Plot in Neutral Grassland in England was not significant across England, but there was a significant increase from 18.6 to 20.4 plant species per Main Plot in the Westerly Lowlands Environmental Zone between 1998 and 2007 *(Table 4.4)*.

Other condition characteristics in Main Plots in Neutral Grassland: The significant increase of competitive and stress tolerating species at the expense of ruderal species in Main Plots along with the significant decrease in the mean Light Scores *(Table 4.4)* show that Neutral Grasslands became more densely vegetated and more shaded across England between 1998 and 2007. Wetter conditions are indicated by the increases in the mean Moisture Scores *(Table 4.4)*.

Some of these changes were also significant in the Easterly and Westerly Lowlands Environmental Zones. A significant decrease in Fertility and Ellenberg pH Scores as well and an increase in Stress Tolerator, and Moisture Scores and a decrease in Ruderal Scores was detected in the Westerly Lowlands Environmental Zone between 1998 and 2007. A significant decrease in Ruderal and Light Scores and an increase in Competitor Scores was detected in the Easterly Lowlands Environmental Zone between 1998 and 2007.

▲ An area of botanical interest in neutral grassland • © *Defra* • *Helen Pontier*

The shift in vegetation in the more homogeneous areas of Neutral Grassland towards denser, more shade and moisture loving communities is supported by the list of plant species that decreased most, as they are predominantly species of short turf *(Table 4.5)*. Wetter conditions indicated by the increases in the mean Moisture Score *(Table 4.4)* are also illustrated by increases in frequency of species typically associated with wet meadows *(Table 4.5)*.

Targeted Plots in Neutral Grassland: The Targeted Plots[3] may have been located in small patches of Priority Habitat within larger Neutral Grassland areas or within patches of other habitats such as scrub, providing a range of habitats from those of highest conservation value to those that are merely unusual in the context of their surroundings.

[2] Main Plots (200m²) are randomly located to assess widespread and common habitat types in the open countryside.

[3] Targeted Plots (2m x 2m) are positioned by surveyors to assess small areas of botanical interest which may be overlooked by the randomly located Main Plots.

▼ **Table 4.5:** The 10 plant species with the largest increase and decrease in the number of Main Plots in which they were recorded in Neutral Grassland between 1998 and 2007. These changes were supported by the calculation of a Broad Habitat wide Change Index.

Species with increasing frequency		Rank Order	Species with decreasing frequency		Rank Order
Ranunculus acris	Meadow Buttercup	1	*Phleum pratense sens lat*	Timothy	1
Lathyrus pratensis	Meadow Vetchling	2	*Cirsium vulgare*	Spear Thistle	2
Holcus lanatus	Yorkshire Fog	3	*Taraxacum agg.*	Dandelion	3
Alopecurus pratensis	Meadow Foxtail	4	*Leontodon autumnalis*	Autumn Hawkbit	4
Trifolium repens	White Clover	5	*Senecio jacobaea*	Ragwort	5
Cirsium arvense	Creeping Thistle	6	*Hypochaeris radicata*	Cat's Ear	6
Agrostis capillaris	Common Bent	7	*Convolvulus arvensis*	Field Bindweed	7
Cirsium palustre	Marsh Thistle	8	*Lolium multiflorum*	Italian Rye-grass	8
Crataegus monogyna	Hawthorn	9	*Poa annua*	Annual Meadow-grass	9
Glyceria fluitans	Floating Sweet-grass	10	*Stellaria media*	Common Chickweed	10

▼ **Table 4.6:** Change in the characteristics of vegetation in 2m x 2m Targeted Plots in the Neutral Grassland Broad Habitat across England (E) and the three Environmental Zones (EL - Easterly Lowlands, WL - Westerly Lowlands, UP - English Uplands) between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available at *www.countrysidesurvey.org.uk*. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3 in Chapter 1 of the UK Results from 2007 report***.

	Mean values (England)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	1998	2007	E	EL	WL	UP	E	EL	WL	UP	E	EL	WL	UP
Species Richness (No. of Species)	13.6	12.5	↓			↓	↓	↓	↓		↓	↓	↓	↓
No. of Bird Food Species	6	5.7	↓				↓	↓			↓	↓	↓	
No. of Butterfly Food Species	6.2	5.8	↓			↓	↓	↓	↓		↓	↓	↓	↓
Grass:Forb Ratio	0.76	0.55	↓											
Competitor Score	3.06	3.12	↑	↑			↑				↑	↑		
Stress Tolerator Score	2.09	2.11												
Ruderal Score	2.6	2.53	↓	↓							↓	↓		
Light Score	6.91	6.85	↓	↓	↓						↓	↓		
Fertility Score	5.46	5.56	↑	↑					↑		↑	↑	↑	
Ellenberg pH Score	6.14	6.16							↑					
Moisture Score	5.67	5.69			↑									

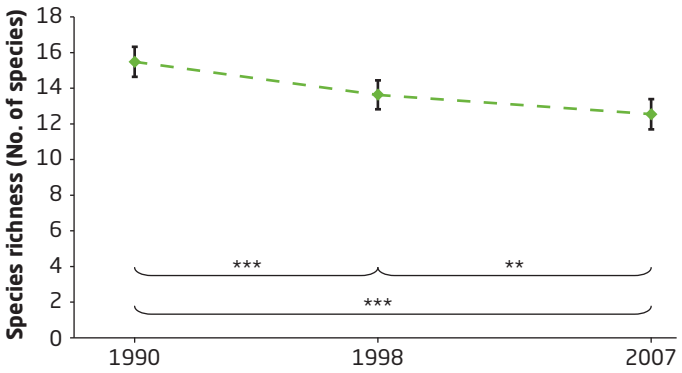
Plant species richness in Targeted Plots in Neutral Grassland: In areas of Neutral Grassland targeted by Countryside Survey for their botanical interest, there was a significant decrease in species richness from 13.6 to 12.5 species per Targeted Plot across England between 1998 and 2007, and this continued the decline since 1990 and was also significant across the longer term 1990-2007. It was also significant in the Uplands Environmental Zone between 1998 and 2007, and over the longer term *(Table 4.6, Fig. 4.4)*.

The significant decrease in species richness was also reflected by a significant reduction in the number of food plants for butterfly caterpillars and farmland birds *(Table 4.6,* and *Figs. 4.4-4.6)*. It is notable that the significant reductions in species richness and richness of food plants for butterfly caterpillars and farmland birds were detected in all Environmental Zones over the longer term 1990-2007 (except for food plants used by farmland birds in the Uplands Environmental Zone) *(Table 4.6)*.

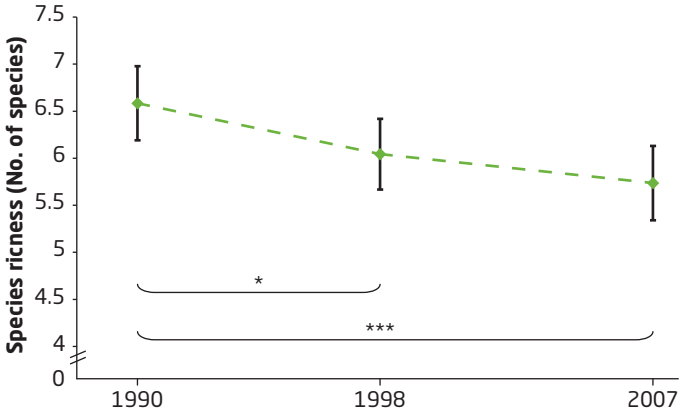
▲ Five-spot burnet moth • © *Natural England* • *Robert Goodison*

The decrease in the number of plant species used by farmland birds as food (6.6 in 1990 to 5.7 in 2007) *(Fig. 4.5)* and those used by butterfly caterpillars as food (6.8 in 1990 to 5.8 in 2007) *(Fig. 4.6)* in areas of Neutral Grassland targeted by Countryside Survey for their botanical interest between 1990 and 2007 shows that these refuges have not just deteriorated for plants but potentially for some animals too *(Table 4.6)*.

▼ **Figure 4.4:** Change in the Species Richness Score in 2m x 2m Targeted Plots in the Neutral Grassland Broad Habitat across England between 1990 and 2007. Significant changes (**p<0.01, *** p<0.001) are shown between the dates bracketed. 95% CI are shown for each data point.

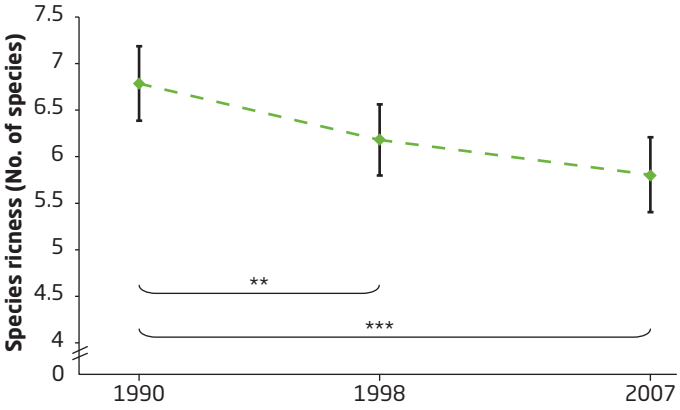


▼ **Figure 4.5:** Change in the number of species of Farmland Bird Food Plants in 2m x 2m Targeted Plots in the Neutral Grassland Broad Habitat across England between 1990 and 2007. Significant changes (* p<0.05, *** p<0.001) are shown between the dates bracketed. 95% CI are shown for each data point.



Other condition characteristics in Targeted Plots in Neutral Grassland: Areas of Neutral Grassland targeted for their botanical interest by Countryside Survey showed significant decrease in the Grass:Forb ratio, Ruderal and Light Scores, and a concurrent significant increase in Fertility and Competitor Scores across England and in the Easterly Lowlands Environmental Zone between 1998 and 2007 *(Table 4.6)*.

▼ **Figure 4.6:** Change in the number of species of Butterfly Food Plants in 2m x 2m Targeted Plots in the Neutral Grassland Broad Habitat across England between 1990 and 2007. Significant changes (** p<0.01, *** p<0.001) are shown between the dates bracketed. 95% CI are shown for each data point.



The significant increase of competitive species at the expense of ruderal species in areas within Neutral Grassland targeted by Countryside Survey for their botanical interest *(Table 4.6)*, along with the significant decrease in the mean Light Scores show that areas of Neutral Grasslands in these areas became more densely vegetated and more shaded between 1998 and 2007, matching to some extent the signal from Main Plots in the more homogeneous habitat *(Table 4.4)*. However, only competitive species show a significant increase in the areas targeted by Countryside Survey for their botanical interest and the generally more desirable stress tolerating species have not, which may indicate that these grasslands are being managed less and also becoming more nutrient rich, as the mean Fertility Scores indicates *(Table 4.6)*. The increase in Fertility Scores in areas targeted by Countryside Survey for their botanical interest was not matched in Main Plots. The reduction in Grass:Forb ratio in areas targeted by Countryside Survey for their botanical interest is more difficult to interpret, but generally the results suggest that the more botanically interesting areas of Neutral Grassland are becoming less species rich whilst the larger less diverse areas of this Broad Habitat are being maintained. Neutral Grassland is frequently associated with areas known to act as refuges for meadow species, these are the areas targeted by Countryside Survey for their botanical interest. The results show a continuing trend (1990-98) of rankness and loss of diversity, which may have significant implications for such species.

4.4.2 Changes in condition of the Calcareous Grassland Broad Habitat

There were too few Main Plots (17) randomly sited in Calcareous Grassland for an analysis of the condition of this Broad Habitat to be reliable. Random sampling is not able to detect large areas of calcareous grassland which are best studied by selecting sites. Countryside Survey does however sample fragments of calcareous grassland through the Targeted Plots and there were 46 of these in England.

4.4.3 *Changes in Condition of the Acid Grassland Broad Habitat*

- **In the main areas of characteristic Acid Grassland, plant species richness decreased significantly (from 18.1 to 16.5 species per Main Plot), but there was no significant change in the numbers of food plants for farmland birds and butterfly caterpillars, across England between 1998 and 2007. A significant decrease in species richness was also detected in the Uplands Environmental Zone, where this Broad Habitat predominates in grassland habitat types. This reversed the significant increase in species richness between 1990 and 1998.**

- **The mean plant Species Richness Score recorded in Main Plots in Acid Grassland increased across England between 1990 and 1998 and then decreased to 2007, so that there was no significant change over the longer term, 1990-2007 . The number of plant species used as food by farmland birds and butterfly caterpillars followed a similar pattern.**

- **The decrease in species richness in larger characteristic areas of Acid Grassland was mirrored within discrete areas of this Broad Habitat targeted by Countryside Survey for their botanical interest.**

- **There were no detectable changes in the condition characteristics, except for a significant increase in Ellenberg pH Scores in Main Plots in the Acid Grassland Broad Habitat in England or the Environmental Zones between 1998 and 2007. Over the longer term between 1990 and 2007, there were significant increases in Fertility and Competitor Scores in Main Plots across England and in the Uplands Environmental Zone, but a decrease in stress tolerating species across England. This contrasts with signals of changing condition in the areas of Acid Grassland targeted for their botanical interest.**

- **In the areas within Acid Grassland targeted by Countryside Survey for their botanical interest, there was a significant decrease in species richness from 11.6 to 10.1 species per Targeted Plot, across England and from 11.9 to 10.1 species per Targeted Plot in the Uplands Environmental Zone between 1998 and 2007. This matched the signal of decreasing species richness from the Main Plots.**

- **In the areas within Acid Grassland targeted by Countryside Survey for their botanical interest, Competitive species and Fertility Scores increased, while Stress Tolerator Scores decreased significantly across England between 1998 and 2007. This contrasts with the results for Main Plots, where significant short-term changes in condition (except for an increase in Ellenberg pH) were not detected.**

- **In areas within Acid Grassland targeted by Countryside Survey for their botanical interest, there was a significant increase in the Grass:Forb ratio across England, over the longer term, 1990-2007, which was also detected in the Uplands Environmental Zone over this period.**

- **Compared with the result for Main Plots, this suggests that long-term changes 1990-2007 in the main areas of Acid Grassland are starting to be reflected in the recent (1998-2007) changes in those areas targeted for their botanical interest.**

▲ Acid grassland, Lancashire • © *Ian Simpson*

Main Plots in Acid Grassland: Within characteristic areas of Acid Grassland, randomly placed 200m^2 Main Plots were used to assess the condition of this Broad Habitat.

Plant species richness in Main Plots in Acid Grassland: Plant species richness in Main Plots in Acid Grassland decreased significantly (from 18.1 to 16.5 species per Main Plot) across England and also decreased significantly in the Uplands Environmental Zone (where this Broad Habitat is the predominant grassland type) between 1998 and 2007. This reversed an increase across England between 1990 and 1998 so that there was no significant change over the longer-term from 1990 to 2007 *(Table 4.7, Fig. 4.7)*. This was mirrored within areas of Acid Grassland targeted by Countryside Survey for their botanical interest (see Targeted Plots and *Table 4.9*).

Significant increases in the numbers of food plants for farmland birds and butterfly caterpillars were detected between 1990 and 1998 across England and in the Uplands Environmental Zone but there were no changes between 1998 and 2007 *(Table 4.7)*.

▼ **Table 4.7:** Change in the characteristics of vegetation in 200m² Main Plots in the Acid Grassland Broad Habitat across England(E) and the three Environmental Zones (EL - Easterly Lowlands, WL - Westerly Lowlands, UP - English Uplands between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available at *www.contrysidesurvey.org.uk*. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3 of the UK Results from 2007 report***. Greyed cells with diagonal strikethrough represent insufficient samples for reliable analysis.

	Mean values (England)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**
Species Richness (No. of Species)	18.1	16.5	↓			↓	↑			↑				
No. of Bird Food Species	5.3	5					↑			↑				
No. of Butterfly Food Species	8.4	8					↑			↑				
Grass:Forb Ratio	1.44	1.58												
Competitor Score	2.29	2.33					↑			↑	↑			↑
Stress Tolerator Score	3.41	3.39									↓			
Ruderal Score	1.8	1.77												
Light Score	6.78	6.79												
Fertility Score	3.09	3.12					↑			↑	↑			↑
Ellenberg pH Score	3.62	3.71	↑											
Moisture Score	6.08	6.09												

▼ **Table 4.8:** The 10 plant species with the largest increase and decrease in the number of Main Plots in which they were recorded in Acid Grassland between 1998 and 2007. These changes were supported by the calculation of a Broad Habitat wide Change Index.

Species with increasing frequency		Rank Order	Species with decreasing frequency		Rank Order
Trifolium repens	White Clover	1	*Luzula campestris/multiflora*	Woodrush	1
Eriophorum angustifolium	Common Cotton-grass	2	*Carex nigra*	Common Sedge	2
Ranunculus acris	Meadow Buttercup	3	*Festuca ovina agg.*	Sheep's Fescue	3
Carex flacca	Glaucous Sedge	4	*Poa annua*	Annual Meadow-grass	4
Holcus lanatus	Yorkshire Fog	5	*Carex pilulifera*	Pill Sedge	5
Juncus squarrosus	Heath Rush	6	*Poa pratensis sens. lat.*	Smooth Meadow-grass	6
Molinia caerulea	Purple Moor-grass	7	*Veronica officinalis*	Heath Speedwell	7
Galium saxatile	Heath Bedstraw	8	*Carex binervis*	Green-ribbed Sedge	8
Deschampsia flexuosa	Wavy Hair-grass	9	*Rumex acetosella*	Sheep's Sorrel	9
Nardus stricta	Mat-grass	10	*Lolium perenne*	Rye-grass	10

Other condition characteristics in Main Plots in Acid Grassland: There were no detectable changes in the condition characteristics, except for a significant increase in Ellenberg pH Score in Main Plots in the Acid Grassland Broad Habitat in England or the Environmental Zones between 1998 and 2007. Over the longer term between 1990 and 2007, there were significant increases in species preferring fertile conditions and competitive species in Main Plots across England and in the Uplands Environmental Zone, but a decrease in stress tolerating species across England *(Table 4.7)*.

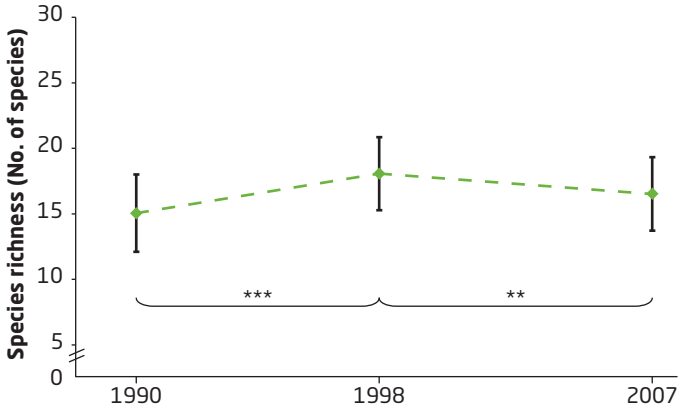
This contrasts with signals of changing condition in the areas of Acid Grassland targeted for their botanical interest *(Table 4.9)*.

Amongst the list of plant species that increased most in frequency in Main Plots in Acid Grassland in England between 1998 and 2007 were several species characteristic of wet conditions e.g. *Juncus squarrosus*, *Tricophorum cespitosum* and *Eriophorum angustifolium* *(Table 4.8)*. However, this pattern is not entirely consistent as some species decreasing in frequency, such as *Carex nigra* also prefer wetter conditions.

Plant species decreasing in frequency also included *Lolium perenne* and *Poa annua*. However, these species are not typical of Acid Grasslands (as they favour nutrient rich conditions) and therefore this reversal of incursions into the uplands reported in the Countryside Survey report of 2000 could be a sign of recovery from eutrophication, but this requires further investigation to confirm.

Targeted Plots in Acid Grassland: The Targeted Plots may have been located in small patches of Priority Habitat within larger Acid Grassland areas or within patches of other habitats, providing a range of habitats from those of highest conservation value to those that are merely unusual in the context of their surroundings.

▼ **Figure 4.7:** Change in the Species Richness Score in 200m² Main Plots in the Acid Grassland Broad Habitat across England between 1990 and 2007. Significant changes (** p<0.01, *** p<0.001) are shown between the dates bracketed. 95% CI are shown for each data point.



Plant species richness in Targeted Plots in Acid Grassland: In areas of Acid Grassland targeted by Countryside Survey for their botanical interest, there was a significant decrease in species richness from 11.6 to 10.1 species per Targeted Plot *(Table 4.9)*, across England and from 11.9 to 10.1 species per Targeted Plot in the Uplands Environmental Zone between 1998 and 2007.

Other condition characteristics in Targeted Plots in Acid Grassland: In areas of Acid Grassland targeted by Countryside Survey for their botanical interest, Competitive species and Fertility Scores increased, while stress tolerating species decreased significantly across England between 1998 and 2007 *(Table 4.9)*.

There was a significant increase in Grass:Forb ratio across England, over the longer term, 1990-2007, which was also detected in the Uplands Environmental Zone.

4.6 Changes to the soils (0-15cm) of grasslands

Neutral Grassland

- **The mean pH of soil (0-15cm) samples from Main Plots within Neutral Grassland in England increased significantly from 6.18 to 6.41 between 1998 and 2007. Earlier increases in pH between 1978 and 1998 and overall from 1978 to 2007 were also significant. The mean Ellenberg pH Score of the vegetation did not change consistently with the soil pH.**

- **There was no detectable change in the mean carbon concentration of soil (0-15cm) in the Neutral Grassland between 1998 and 2007. It was approximately 63g/kg in 1998 and 59g/kg in 2007. Although the carbon concentration was also stable over the long term, between 1978 and 2007, there was a significant increase between 1978 and 1998.**

- **The mean bulk density of soils (0-15cm) in the Neutral Grassland in England in 2007 was 0.95g/cm³ which when combined with soil (0-15cm) carbon concentration gave an estimated carbon stock of soil (0-15cm) of approximately 60tC/ha.**

Calcareous Grassland

- **An insufficient number of soil samples were available from the Calcareous Grassland Main Plots for a statistical analysis to be undertaken and to report on soils for this Broad Habitat.**

Acid Grassland

- **The mean pH of soil (0-15cm) samples from Acid Grassland in England increased significantly from 4.51 to 4.74 between 1998 and 2007. This contrasts with the results from Great Britain.**

- **There was no detectable change in the mean carbon concentration of soil (0-15cm) in Acid Grassland between 1998 and 2007. It was approximately 183g/kg in 1998 and 191g/kg in 2007. There was no significant change between 1978 and 1998. This result differs from those for Great Britain as a whole where there was a significant decrease between 1998 and 2007.**

- **The mean bulk density of soils (0-15cm) in the Acid Grassland in England in 2007 was 0.48g/cm³ which when combined with soil (0-15cm) carbon concentration gave an estimated carbon stock of soil (0-15cm) of approximately 87tC/ha. This was the second largest carbon stock, next to Dwarf Shrub Heath reported for Broad Habitats in England.**

4.6.1 Neutral Grasslands

Soil (0-15cm) pH: The mean pH of soil (0-15cm) samples from Main Plots within Neutral Grassland in England increased significantly from 6.18 to 6.41 between 1998 and 2007. Earlier increases in pH between 1978 and 1998 and overall from 1978 to 2007 were also significant *(Fig. 4.8* and *Chapter 2, Table 2.11)*. The mean Ellenberg pH Score of the vegetation *(Table 4.4)* did not change consistently with the soil pH.

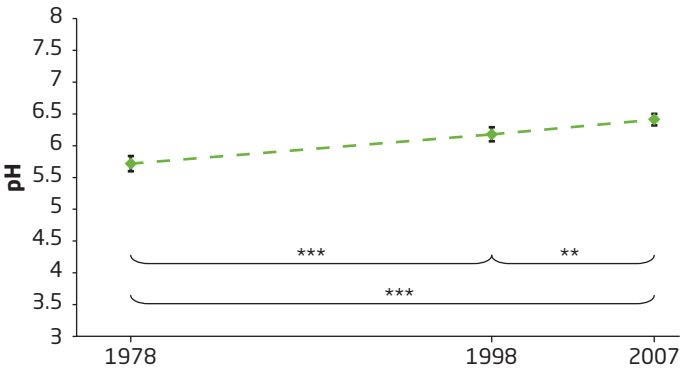
Soil (0-15cm) carbon concentration: There was no detectable change in the mean carbon concentration of soil (0-15cm) in Neutral Grassland Broad Habitat between 1998 and 2007. It was approximately 63g/kg in 1998 and 59g/kg in 2007. Although the carbon concentration was also stable over the long term between 1978 and 2007, between 1978 and 1998 there was a significant increase (See also *Chapter 2, Table 2.11*).

Bulk density and soil (0-15cm) carbon stock: The mean bulk density of soils (0-15cm) in the Neutral Grassland in England in 2007 was 0.95g/cm³ which when combined with soil (0-15cm) carbon concentration, which when combined with soil (0-15cm) carbon concentration gave an estimated carbon stock of approximately 60tC/ha (See also *Chapter 2, Table 2.13*).

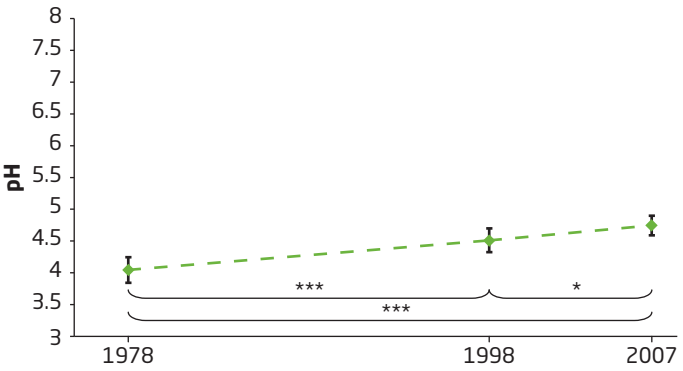
▼ **Table 4.9:** Change in the characteristics of vegetation in 2m x 2m Targeted Plots in the Acid Grassland Broad Habitat across England (E) and the three Environmental Zones (EL - Easterly Lowlands, WL - Westerly Lowlands, UP - English Uplands between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available at *www.countrysidesurvey.org.uk*. Arrows denote significant change (p<0.05) in the direction shown. Analyses are described in ***Box 1.3 of the UK Results from 2007 report***. Greyed cells with diagonal strikethrough represent insufficient samples for reliable analysis.

	Mean values (England)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	1998	2007	E	EL	WL	UP	E	EL	WL	UP	E	EL	WL	UP
Species Richness (No. of Species)	11.6	10.1	↓			↓								
No. of Bird Food Species	3.2	3.2												
No. of Butterfly Food Species	5.2	5												
Grass:Forb Ratio	1.4	1.65					↑				↑			↑
Competitor Score	2.31	2.43	↑											
Stress Tolerator Score	3.37	3.24	↓											
Ruderal Score	1.86	1.96												
Light Score	6.91	6.88												
Fertility Score	3.1	3.29	↑											
Ellenberg pH Score	4	4.03												
Moisture Score	6.32	6.24												

▼ **Figure 4.8:** The change in mean pH of soils (0-15cm) from Neutral Grassland in England between 1978 and 2007. Significant changes (p<0.01, *** p<0.001) are shown between the dates bracketed. 95% CI are shown for each data point.



▼ **Figure 4.9:** The change in pH of soils from Acid Grassland in England between 1978 and 2007. Significant changes (* p<0.05, *** p<0.001) are shown between the dates bracketed. 95% CI are shown for each data point.



4.7.2 Calcareous Grasslands

An insufficient number of soil samples were available from the Calcareous Grassland Main Plots for a statistical analysis to be undertaken and to report on soils for this Broad Habitat.

4.7.3 Acid Grasslands

Soil (0-15cm) pH: The mean pH of soil (0-15cm) samples from Acid Grassland in England increased significantly from 4.51 to 4.74 (still within the acid range) between 1998 and 2007 *(Fig. 4.9)*. This contrasts with the results from Great Britain where there was no significant change detected between 1998 and 2007. The results from 1998 to 2007 continue the trend from 1978 (See also *Chapter 2, Table 2.11*).

Soil (0-15cm) carbon concentration: There was no detectable change in the mean carbon concentration of soil (0-15cm) in Acid Grassland between 1998 and 2007. It was approximately 183g/kg in 1998 and 191/kg in 2007. There was no significant change between 1978 and 1998. This result differs from those for Great Britain as a whole, where there was a significant decrease between 1998 and 2007.

Bulk density and soil (0-15cm) carbon stock: The mean bulk density of soils (0-15cm) in Acid Grassland in England in 2007 was 0.48 g/cm^3, which when combined with soil carbon concentration (0-15cm) gave an estimated carbon stock of approximately 87tC/ha (See also *Chapter 2, Table 2.13*).

▲ Flower meadow, County Durham
• © *Natural England* • *Charlie Hedley*

4.8 Discussion and Conclusions

4.8.1 General Discussion

Neutral, Calcareous and Acid Grasslands, although less intensively managed than Improved Grassland, retain an important agricultural role, especially for beef and lamb production. During the Twentieth Century, these Broad Habitats have been subject to intensive agricultural improvement to increase livestock productivity, resulting in a resource which ranges from semi-improved permanent grasslands (the majority) to the most environmentally valuable semi-natural habitats, which have become increasingly rare and fragmented. Changes observed through Countryside Survey will reflect long-term agricultural economics and policies, the environmental policy responses and external factors such as climate change and levels of atmospheric nitrogen deposition.

Since the first Countryside Survey in 1978, recognition of the scale of loss of semi-natural grasslands has resulted in the development and delivery of policies to facilitate conservation of these habitats, including increased statutory protection and regulation, development of frameworks for facilitating and monitoring conservation action and provision of incentives for positive management of landscapes and habitats through agri-environment schemes. These have been supported with specific targets to bring SSSIs into favourable or recovering condition and through the development of the UK Biodiversity Action Plan as a framework for prioritising and delivering conservation action in a co-ordinated way.

Conservation of these resources remains a high priority, as set out in the England Biodiversity Strategy and UK Biodiversity Action Plan. Statutory protection afforded to key semi-natural grassland habitats has been strengthened, in particular through the Wildlife and Countryside Act 1981 and the CRoW Act 2000. Significant areas of the remaining semi-natural grassland resource have been notified, at UK level as Sites of Special Scientific Interest (SSSI), with the most important also notified at International level under Annex 1 of the Habitats and Species Directive and represented as Special Areas of Conservation in the Natura 2000 series. The importance of the best examples of these habitats has been recognised through a Government target to bring 95% of SSSI's in favourable or recovering condition by 2010.

Incentives to improve the condition of grassland Broad and Priority Habitats are primarily delivered through agri-environment schemes. The shortcomings of first generation agri-environment schemes such as the Environmentally Sensitive Areas and Countryside Stewardship Schemes, introduced in 1987 and 1991 respectively, have been recognised through a major review leading to the introduction of Environmental Stewardship (2004). This has introduced a 'broad and shallow' Entry Level Stewardship (ELS), aimed at securing a high proportion of basic environmental management, whilst a targeted and outcome focused Higher Level Stewardship (HLS) will be used to manage the highest value environmental features. This twin-track approach, linked to a clear framework for delivering restoration and re-creation of habitats, offers potential to maintain the extent of key grassland resources whilst reversing the declines in condition observed in the more diverse grasslands.

Alongside provision of incentives, the regulatory framework for conserving grassland habitats has been strengthened; since 2006, local planning authorities have been required to protect and enhance BAP Priority Habitats through Planning Policy Statement 9 (PPS9). In October 2006 Section 40 of the Natural Environment and Rural Communities Act came into force which places a duty on all public authorities to have regard to the purpose of conserving biodiversity, including BAP Priority Habitats. These requirements represent extensions and strengthening of previous duties of care.

Alongside statutory designation and protection under the planning system Defra has since 2002 implemented a regulatory framework to restrict the agricultural intensification of uncultivated and semi-natural land. The Environmental Impact Assessment Regulations (Agriculture) (England) (No.2) revised in October 2006 require the completion of a full EIA prior to undertaking any agricultural operation that might result in intensification and/or increased productivity of land meeting the criteria of semi-natural or uncultivated. However, since these regulations only apply to operations on land of 2ha of more in area, no protection from intensification is currently afforded to smaller areas of semi-natural grasslands, especially of the type sampled in the Targeted and Linear Habitat Plots.

More recently, policymakers have recognised the need to quantify the environmental services provided by grassland ecosystems to enhance the conservation policy toolkit and to develop the adaptive measures needed to address global climate change. The Climate Change Act, which became law in November 2008, sets out the UK government's commitment to climate change adaptation and mitigation and specifies that Government must report at least every five years on the risks to the UK of climate change, and publish a programme setting out how these impacts will be addressed.

This recognition that semi-natural ecosystems provide goods and services that have socio-economic value is increasing and is supported by a growing body of evidence. Indeed with respect to climate change mitigation, evidence suggests that the majority of European grasslands will be sinks for carbon and that average sequestration could be 0.52 mg C/ha per year[4]. Countryside Survey has provided evidence of the scale of carbon held by different grasslands, highlighting the importance of Acid Grassland. Other work has indicated that low–productivity semi-natural grassland may be better able to capture and immobilise organic N compared to agriculturally improved swards and as a consequence may confer benefits in reducing nitrate leaching to surface water systems[5], helping to improve the water quality of surface waters as required by the EU Nitrates and Water Framework Directive.

Pollination services to UK crops are estimated to be worth approximately £172 million p.a.[6] and reduced pollination rates known to deleteriously impact agricultural crop production; so the role semi-natural grasslands play in sustaining populations of pollinators requires better understanding. A pilot study conducted by the University of Reading has indicated that the abundance of pollinators on a bean crop was a clear function of the proximity of semi-natural habitat features including calcareous grassland. Further, the quantity and quality of the bean crop, measured as % nitrogen content, was a function of the availability of pollinators with the quality of the crop increasing with the abundance of solitary bees. Further targeted research on the role of semi-improved and semi-natural grasslands as nutrient sinks, in soil and water protection and the positive benefits for agro-ecosystems derived from the pollinator and crop pest predator services they might provide is required.

At present it is unclear what impact predicted climate change may have on grasslands and further research is needed. Available evidence indicates that older, established species rich grasslands may have more resistance to climate change than those which are more fertile and early successional in terms of their species composition. Ultimately community level responses will be strongly influenced by the traits of individual species, particularly life history and growth rate and there is evidence for decline and potential loss of boreal species such as Wood Cranesbill (*Geranium sylvaticum*) and Marsh Hawk's Beard (*Crepis paludosa*) and increase in Temperate and Mediterranean continental species, such as Spanish Catchfly (*Silene otites*)[7,8], which may be attributable to warming. CS has shown that while species richness is being maintained in main areas of habitat, it is decreasing in the important habitat fragments targeted by CS for their botanical interest, which could reduce sources of colonists and resilience to the effects of climate change.

4.8.2 Neutral Grassland

The area of Neutral Grassland Broad Habitat was 1,453,000 ha in 2007, representing 11% of the land area of England and making a significant contribution to the core agricultural area (the area of Arable (and Horticulture), Improved Grassland and Neutral Grassland Broad Habitats amounted to 4002, 2856, and 1453 thousand ha respectively, totalling 8311 thousand ha or 63.1% of the land area of England in 2007, see ***Chapter 2***). Countryside Survey estimates that the extent of Neutral Grassland has increased by 46% since 1990. Neutral Grassland is a dynamic habitat with a relatively high rate of change to and from other Broad Habitats. Between 1998 and 2007, the net gain in extent of Neutral Grassland appears to have been mostly at the expense of the Arable and Horticulture Broad Habitat, and this has most likely been driven by allocation of land to set-aside and reversion of arable land to grassland during a period of generally low arable commodity prices. Arable reversion to grassland has been a key target for agri-environment schemes, and these are likely to have been a significant contributory factor.

▲ Species rich haymeadow, Shropshire • © *Natural England* • *Wayne Davies*

[4] Vleeshouwers, L. M. and Verhagen, A. (2002) Carbon emission and sequestration by agricultural land use: a model study for Europe. *Global Change Biology*, 8, 519-530.

[5] Bardgett, R. D. Streeter, T. C. and Bol, R. (2003) Soil microbes compete effectively with plants for organic-nitrogen inputs to temperate grasslands. *Ecology*, 84, 1277-1287.

[6] Carreck, N. and Williams, I. (1998) The economic value of bees in the UK. *Bee World*, 79, 115-123.

[7] Berry, P.M., Dawson, T.P., Harrison, P.A., Pearson, R. & Butt, N. (2003). The sensitivity and vulnerability of terrestrial habitats and species in Britain and Ireland to climate change. *Journal for Nature Conservation*, 11, 15-23

[8] Preston, C.D., Telfer, M.G., Arnold, H.R., Carey, P.D., Cooper, J.M., Dines, T.D., Hill, M.O., Pearman, D.A., Roy, D.B., Smart, S.M. (2002). *The Changing Flora of the UK*. London Defra.

▲ Lady orchid in flower • © *Natural England* • *Dan Tuson*

The observation of no change in plant species richness (including food plants of farmland birds and butterfly caterpillars) in Main Plots between 1998 and 2007 suggests that the condition of Neutral Grassland overall is broadly stable, and the increase in stress tolerating species could be seen as positive. However, in areas within the Broad Habitat surveyed for their botanical interest (using Targeted Plots), plant species richness decreased by 8% between 1998 and 2007 and 19% between 1990 and 2007. The decrease in species richness in targeted plots was associated with a greater incidence of competitive, shade tolerant and nutrient demanding plants and fewer ruderal species. The decrease in species richness, numbers of plants species used as food by birds and butterfly caterpillars and the other changes in condition, such as the increase in fertility scores in areas within Neutral Grassland targeted for their botanical interest suggest that these areas are undergoing changes which may be related adjcent land use. These areas may be acting as buffers storing nutrients which have runoff arable/improved fields.

An implication of these findings is that whilst much of the semi-improved Neutral Grassland resource is stable, declines in condition are being sustained in the most environmentally valuable grasslands. These grasslands would be most vulnerable to agricultural improvement or abandonment, and ongoing decline in condition is of conservation concern, given the policy effort to provide frameworks that encourage positive management of such features.

Soils (0-15cm) in Neutral Grassland have become progressively less acidic (5.5 to 6.4 pH) between 1978 and 2007. This is consistent with a response to decreased acid deposition, but stronger support for a correlative link between the cause and the response detected by CS awaits further analysis.

4.8.3 Calcareous Grassland

The distribution of Calcareous Grassland reflects underlying geological formations and soil type and it has a limited extent compared to other grassland types. As such, it is relatively poorly represented in the Countryside Survey sample. The estimated area of Calcareous Grassland in 2007 was 30,000 ha, well under 1% of the land area of England. Between 1990 and 2007, the area of Calcareous Grassland in Great Britain decreased by almost 30%. Whilst nationally most of this (21%) occurred during the period 1990 to 1998, a small but significant ongoing decline since 1998 was evident in the Westerly Lowlands Environmental Zone.

Calcareous Grassland has traditionally declined as a result of grassland improvement, cultivation or abandonment. Overall, a large proportion of Calcareous Grassland in England is now under some form of conservation management and/or protection; the reduction in the rate of loss suggest that these interventions may be beginning to be effective. The observed decline in the Westerly Lowlands Environmental Zone requires further investigation.

4.8.4 Acid Grassland

In 2007, the total estimated cover of Acid Grassland was 0.4 million ha, about 3 % of the land area of England. Between 1990 and 2007 the area of Acid Grassland fell by 17%, but the bulk of this decrease occurred between 1990 and 1998. Acid Grassland is a relatively stable Broad Habitat with small turnover with other habitats typical of the Upland Environmental Zone, particularly Bracken.

Plots within characteristic areas of Acid Grassland (Main Plots) have shown rather dynamic and contrasting trends in plant species richness, with an increase between 1990 and 1998, followed by a decrease between 1998 and 2007, which was found in both the characteristic areas and areas within these targeted by Countryside Survey for their botanical interest (i.e. both Main and Targeted Plots). Incursion of mesotrophic species into upland habitats was a result arising from CS2000 and it might be a good sign that *Lolium perenne* and *Poa annua*,which are not supposed to be components of Acid Grassland are now decreasing in Main Plot. The reasons for these changes require further investigation, but increases in competitive species would be consistent with the effects of reduced grazing pressure, related to decreases in the numbers of sheep and cattle over the same period (see ***Chapter 7***).

4.8.5 Conclusions

Neutral, Calcareous and Acid Grasslands together occupy 14.2 % of the area of England.

At the England level, the increase in extent of Neutral Grassland and relative stability in the extent of Calcareous and Acid Grasslands (albeit the latter has fluctuated in extent since 1990) may have been encouraged by low arable profitability, leading to the establishment of grasslands through long-term set-aside or the use of agri-environment incentives. Given volatility in commodity prices, the risk remains that increases might not be permanent, particularly in Neutral Grassland, which will continue to be vulnerable to the economics of arable agriculture or other land-uses. The area of Calcareous Grassland may be more likely to remain stable given the scale of conservation intervention, whilst fluctuations in Acid Grassland over time may continue to reflect the transitional nature of the plant communities at the boundaries of Acid Grassland, Bracken and Dwarf Shrub Heath Broad Habitats, which are likely to be responsive to changes in grazing management, control of Bracken etc. (see ***Chapter 7***), encouraged by reforms of upland subsidy and delivery of agri-environment schemes.

The significant decrease in plant species richness in areas targeted by Countryside Survey for their botanical interest within Neutral and Acid Grasslands is of greater concern. Across both habitats taller, more competitive species have increased, indicating that a key driver for species loss may be less intensive or indeed lack of management. Small patches of species rich habitat may be especially vulnerable to neglect, having marginal agricultural value, and are often further compromised by isolation, lacking nearby sources for species to recolonise. Such sites are vulnerable to sub-optimal management, even over short periods. Species-rich habitats are priorities for action through the UK Biodiversity Action Plan, and targeted through agri-environment schemes but remain vulnerable.

The findings of Countryside Survey suggest that agri-environment schemes have made an effective contribution to maintenance of the resource of grassland habitats, but the ongoing reduction in species-richness in areas targeted by Countryside Survey for their botanical interest suggests they may have been less effective at conserving the best habitats. A similar finding was previously reported from monitoring of Upland Hay Meadows (a Priority Habitat within the Neutral Grassland Broad Habitat) in the Pennine Dales ESA[9]. Reversing these trends continues to depend on a combination of regulation and provision of effective incentives.

As the agricultural role and condition of grassland Broad Habitats has changed in response to economics and agricultural developments, an increasingly important justification for effective conservation of species-rich habitats is the contribution made to provision of ecosystem services, and their role in supporting adaptation to, and mitigation of climate change.

[9] Critchley, C.N.R.; Fowbert, J.A; Wright, B.and Parkin A.B., (2004) Upland Hay Meadows in the Pennine Dales Environmentally Sensitive Area: Vegetation Change between 1987 and 2002 and its Relation with Management Practices and Soil Properties. Report to Defra, Project MA01005, April 2004.

▲ Agricultural landscape divided by linear features, Northumberland • © *Natural England* • *Graeme Peacock*

5. Boundary and Linear Features Broad Habitat

Summary

Length and change

- The total length of woody linear features was 547,000km in England in 2007, and was distributed mainly between the Easterly and Westerly Lowlands Environmental Zones.
- The total length of managed hedgerows[1] was 402,000km in England in 2007, and was distributed mainly between the Easterly and Westerly Lowlands Environmental Zones.
- The total length of walls was 82,000km in England and was distributed mainly in the Uplands and Westerly Lowlands Environmental Zone.
- The total length of banks and grass strips was 42,000km, with much of this in the Westerly Lowlands Environmental Zone.
- The total length of woody linear features decreased by 1.4% (8,000km) in England between 1998 and 2007 following an increase between 1990 and 1998 and a decrease between 1984 and 1990.
- The length of managed hedgerows[1] decreased by 6.1% (26,000km) in England between 1998 and 2007 with a large proportion of these managed hedges turning into lines of trees and relict hedges (which increased significantly), reflecting a reduction in management intensity.
- The length of walls decreased by 1.1% (approximately 900km) overall in England between 1998 and 2007, with the largest losses occurring in the Uplands Environmental Zone.

[1] The term 'managed hedgerows' does not include relict hedges and lines of trees.

Condition

- **Species richness in vegetation alongside linear and boundary features in England increased by approximately 3% (from 16.5 to 16.9 species per plot) between 1998 and 2007, which was not significant, but there was a significant decrease of approximately 7% (from 16.1 to 14.9 species per plot over the long-term, between 1978 and 2007, which was less than the 15% decrease across Great Britain.**

- **Following significant decreases in plant species richness along the base of hedges between 1978, 1990 and 1998, no change was detected in England between 1998 and 2007. Stress tolerating plant species increased whilst those of open ground decreased. Plant species characteristic of shaded, fertile and less acidic conditions increased between 1978 and 2007.**

- **There was on average 3.7 woody species per 30m section of hedge in England in 2007, with no detectable change between 1998 and 2007.**

- **50% of managed hedges were in good structural condition in England in 2007 including criteria for the height of the base of the hedge canopy, cross-sectional area, hedge 'gappiness' and the absence of non-native species.**

- **32% of managed hedges were in good structural condition and had margins >2m in England in 2007. Only 12% of managed hedges on arable land were in both good structural condition and had appropriately managed margins in England in 2007. A higher proportion of English hedges were in good condition compared to Great Britain.**

- **No change in plant species richness was detected in Roadside Plots in England between 1998 and 2007, and unlike the results for Great Britain there was no significant decline between 1978 and 2007.**

- **Stress-tolerating species increased significantly in Roadside Plots across Great Britain between 1998 and 2007, at the expense of ruderal species which showed a significant decrease. The significant increase in Stress Tolerators, and the significant decrease in Ruderal and Light Scores in Roadside Plots across England was also detected in the Easterly Lowlands Environmental Zone. There was also a small but significant increase in the number of butterfly caterpillar food plans in Roadside Plots in the Easterly Lowlands Environmental Zone between 1998 and 2007.**

- **Although there was no change in species richness, there was a shift in community structure and roadside vegetation became more shaded and characteristic of less acidic conditions in England, between 1978 and 2007.**

- **Approximately 25% of walls were in either 'sound' or 'excellent' condition in both 1998 and 2007. The majority of walls across England were in 'deteriorating' condition in both 1998 and 2007.**

▲ Dry stone walls, North Yorkshire • © *Natural England* • *Dave Key*

5.1 Introduction[2]

The Boundary and Linear Features Broad Habitat includes many landscape features which characterise the British landscape and reflect the history of its management. Features such as stone walls and species-rich hedgerows help to distinguish different parts of the countryside and provide them with landscape character and a regional identity.

Whilst the historic role of linear features has been largely to mark boundaries and manage stock, ecologically they constitute a very significant Broad Habitat within farmland. Hedgerows in England provide significant habitat for 125 priority BAP species: 70% of these are species are relatively numerous and widespread but are known to be declining rapidly. As well as providing a refuge for woodland and farmland species unable to persist in fields, the Boundary and Linear Features Broad Habitat can provide corridors for the movement and dispersal of a range of species. Hedgerows also provide a large number of other ecosystem services such as provisioning, cultural and aesthetic landscape quality, and carbon sequestration. Earlier findings from Countryside Survey[3] (CS) showed that there was a significant loss of linear features in the landscape between 1984 and 1990. Recognition of the important

[2] **Note:** For further information on the Broad Habitat classification, sampling plots and other Countryside Survey terminology see *Chapter 1 (Introduction and Methodology)*

[3] *See:* Countryside Survey 1990 Series: Summary Report (1993). *DoE, London.*

contribution of these features for biodiversity and concern about their rapid loss led to legislation being introduced in England and Wales in 1997 to regulate hedgerow removal. The findings of CS in 1998 showed no significant decrease in the lengths of either hedges or walls between 1990 and 1998.

Hedgerows are listed as a Priority Habitat in the UK and have a Biodiversity Action Plan[4] (see ***Box 1.1, UK results from 2007 report***); conservation targets have been agreed, based on measures of the extent and condition of hedgerows over time. Various criteria are being used to measure change in condition: some are structural (e.g. cross-sectional area) and others relate to species composition and to adjacent margin management. In this report, condition criteria were only applied to managed hedgerows.

5.2 Reporting on Boundary and Linear Features Broad Habitat

The Countryside Surveys of 1984, 1990, 1998 and 2007 incorporated mapping of Boundary and Linear Features Broad Habitats as part of the habitat mapping of the whole survey square. Improvements in the methodology and in definitions of feature types over time have enabled more consistent national estimates to be made. For example, defining hedges is not a simple process because woody boundary features vary from established species-rich hedgerows to a line of newly planted saplings or lines of remnant scrub, and combinations of these features. The importance of tight definitions became more evident over time and, as with the Broad Habitat data, the most reliable and comparable estimates are for the most recent CS (1998 and 2007). The need to address policy questions has required development of more robust definitions in the current CS of 2007; the use of surveyor input to help revise the 1998 data has reinforced this (see ***Chapter 1*** of the ***UK results from 2007 report***[5]). A further complication with linear features is that they occur as continuous networks and also as features with several elements adjacent to or often overlapping with one another, e.g. a wall and a hedge. It is therefore difficult to map where one feature ends and another begins, especially in a digital format.

Data were collected at a detailed level for the Boundary and Linear Features Broad Habitat, which made it possible to decide on the categorisation of features after data collection according to user requirements. Information in this report is provided at a general level for the six major types of feature type ***(Table 5.1)***. Hedgerows were considered to be more ecologically important and policy relevant than other linear features and were given precedence in reporting when they were found alongside other features. Each type of feature was given a place in a hierarchy consistent with previous CS reporting. This ensured that there would be no double counting of a section of a linear feature that was made up of two components such as a hedge and a ditch; nor triple counting for a hedge, ditch and fence. Data were also collected on the structural condition of the different feature types.

The condition of vegetation associated with hedgerows has been recorded since the first CS in 1978 using a 10m x 1m plot (Hedge Plot) placed alongside hedgerows to sample vegetation forming the hedge an along the hedge base. Numbers and types of plots were increased in subsequent Countryside Surveys to provide information on boundaries and on specific feature types in addition to the original Hedge Plots. These include plots in which vegetation alongside boundary features was recorded; Roadside Plots which were introduced to sample vegetation alongside roads and tracks; and Hedge Diversity Plots, which provide information about the woody species within hedges, but may also be used on other types of woody linear feature. These latter plots span the width of the hedgerow and are 30m long. Alongside species information, other data on the condition of hedgerows and other types of woody linear features were collected at Hedgerow Diversity Plots in 2007.

Results from the Streamside Plots are included in the Rivers and Streams Broad Habitat, covered in ***Chapter 8***; linear Managed Margin Plots are included in the Arable and Horticulture Broad Habitat in ***Chapter 3***. Results for all other linear plot types are reported here.

Data collected on linear features during the mapping of CS squares also provide information on the type and condition of the different feature types, some of which are reported here.

▼ **Table 5.1:** Boundary and Linear Feature types

Linear Features	Description/condition criteria
Hedges	A line of woody vegetation that has been subject to management so that trees no longer take their natural shape. Hedges may be present with any feature below.
Wall	A built structure of natural stone or manufactured blocks, mostly of traditional dry stone wall construction but including mortared walls. Includes walls with fences or banks/grass strips and/or lines of trees or shrubs.
Line of trees/ shrubs and relict hedge and fence	Line of trees or shrubs, in which trees/shrubs take their natural shape, including those originally planted as hedges with a fence. May also include banks/grass strips.
Line of trees/ shrubs and relict hedge	Line of trees or shrubs, in which trees/shrubs take their natural shape, including those originally planted as hedges. Includes avenues of trees. May also include banks/grass strips.
Bank/grass strip	An earth or stone-faced bank or grass strip with or without a fence.
Fence	A permanent post and wire or rail structure, including wooden, concrete or metal posts without any other associated feature other than a ditch or stream. Fences made from slate threaded on wire in Wales are included in this category.

[4] UK Biodiversity Action Plan (UK BAP) (http://www.ukbap.org.uk)

[5] available at www.countrysidesurvey.org.uk

5.3 Length of Boundary and Linear Features

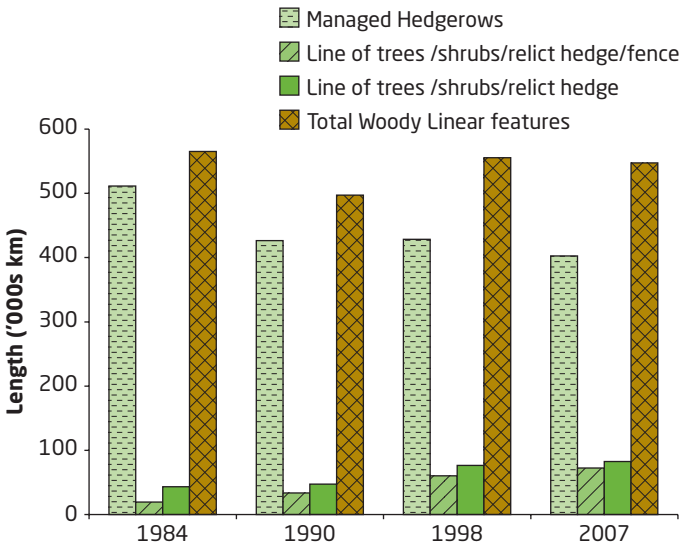
- **The total length of woody linear features was 547,000km in England in 2007, and was distributed mainly between the Easterly and Westerly Lowlands Environmental Zones.**
- **The total length of managed hedgerows was 402,000km in England in 2007, and was distributed mainly between the Easterly and Westerly Lowlands Environmental Zones.**
- **The total length of walls was 82,000km in England and was distributed mainly in the Uplands and Westerly Lowlands Environmental Zone.**
- **The total length of banks and grass strips was 42,000km, with much of this in the Westerly Lowlands Environmental Zone.**
- **The total length of woody linear features decreased by 1.4% (8,000km) in England between 1998 and 2007 following an increase between 1990 and 1998 and a decrease between 1984 and 1990.**
- **The length of managed hedgerows decreased by 6.1% (26,000km) in England between 1998 and 2007 with a large proportion of these managed hedges turning into lines of trees and relict hedges (which increased by 13.2% across both categories), reflecting a reduction in management intensity.**
- **The length of walls decreased by 1.1% (approximately 900km) overall in England between 1998 and 2007, with the largest losses occurring in the Uplands Environmental Zone.**

Results from CS in 2007 showed a significant 6.1% decrease in the length of managed hedges between 1998 and 2007 *(Table 5.2)*. The improvements and modifications to the definitions of woody linear features mean that the categories reported here are not exactly comparable with those reported previously in Countryside Survey. However, the results using the new methods show the same patterns of change for managed hedges, with decreases between 1984 and 1990 and no significant change in the period 1990 and 1998.

The process of back-checking and adjustment was only applied to the 1998 data and not to previous datasets from 1984 and 1990. Comparisons between clearly defined linear features are therefore more rigorous between 1998 and 2007 than between other pairs of years. Investigations of the changes between the six different linear feature types for 1998 and 2007 indicate that the majority of hedges in 1998 were also hedges in 2007.

Regularly managed, stock proof hedges have declined in England from 1984 through to 2007, but with a period of no change between 1990 and 1998. From 1990 onwards the decrease in managed hedgerows has been predominantly through the lack of management leading to conversion to lines of trees/shrubs and relict hedges rather than hedgerow removal. *(Fig. 5.1, Table 5.2)*. The types of woody linear features that increased were clearly those which were less managed, in particular relict hedges and lines of trees/shrubs *(Table 5.2)*.

▼ **Figure 5.1:** The change in total length ('000s km) of woody linear feature types in England between 1984 and 2007.



The length of walls decreased in England between 1998 and 2007 by a small (1.1%) but significant amount from 82,420 to 81,500km *(Table 5.2)*. The change is not evident in the table due to rounding of data. Decreases of 2.2% were also significant in the Uplands Environmental Zone *(Table 5.2)* from 44,880 to 43,900km, where these features make contributions to the landscape character. There were no changes in the Easterly or Westerly Lowlands.

This decrease in the length of walls has occurred despite measures within agri-environment schemes and other local initiatives, for example within National Parks, to help maintain them.

5.4 The condition of vegetation in Boundaries and alongside Linear Features[6]

- **Species richness in vegetation alongside linear and boundary features in England increased by approximately 3% (from 14.5 to 14.9 species per plot) between 1998 and 2007, which was not significant, but there was a significant decrease of approximately 7% (from 16.1 to 14.9 species per plot over the long term, between 1978 and 2007, which was less than the 15% decrease across Great Britain.**

[6] The Aggregate Class system (see ***Chapter 1.2*** of the ***UK Results report***, available at *www.countrysidesurvey.org.uk*) is used in the analysis of vegetation in the Boundary and Linear Features Broad Habitat because of the wide range of environments and vegetation types found within the Broad Habitat.

[7] Described in ***Chapter 1*** of the ***UK results from 2007 report***, available at: *www.countrysidesurvey.co.uk*

▼ **Table 5.2:** The length and standard error ('000s km) and change in length of Boundary and Linear Features in England (E) and the three Environmental Zones (EL - Easterly Lowlands, WL - Westerly Lowlands, UP - English Uplands) , from 1984 to 2007. Arrows denote significant change ($p<0.05$) in the direction shown. SE is standard error.

	Country/ Environmental zone	1984		1990		1998		2007		Direction of significant changes		
		Length ('000s km)	SE	Length ('000s km)	SE	Length ('000s km)	SE	Length ('000s km)	SE	1984-1990	1990-1998	1998-2007
Total woody Linear Features[1]	England	565	22.8	497	19	555	20.4	547	20.1	↓	↑	↓
	EL	263	16.3	234	12.7	266	14.6	264	14.3	↓	↑	
	WL	285	15.8	247	14	268	13.8	263	13.6	↓	↑	↓
	UP	17	3.9	16	4.3	21	4.6	20	4.5		↑	↓
Hedges (managed)	England	511	20.7	426	17.9	428	17.8	402	17	↓		↓
	EL	234	14.6	203	12.2	206	12.7	197	12	↓		↓
	WL	261	14.8	213	13.3	211	12.6	195	12.2	↓		↓
	UP	16	4.1	10	2.9	11	3.1	9	2.7	↓		↓
Line of trees/ shrubs/relict hedge/fence	England	19	2.6	33	2.9	60	4	72	5.3	↑	↑	↑
	EL	8	1.9	13	2.1	23	3.1	28	3.6	↑	↑	↑
	WL	9	1.5	17	1.8	31	2.2	39	3.5	↑	↑	↑
	UP	1	1.1	4	1.1	5	1.4	6	1.5	↑	↑	
Line of trees/ shrubs/relict hedge	England	43	6.3	47	3.9	76	4	82	4.4		↑	↑
	EL	25	5.7	22	2.4	40	3.3	43	3.5		↑	↑
	WL	17	2.4	22	3	30	2.1	34	2.6		↑	↑
	UP	1	0.9	3	1.1	6	1.4	6	1.4		↑	
Wall	England	98	13.2	81	11.4	82	11.6	82	11.6	↓		↓
	EL	19	5.6	14	4.4	13	4.2	13	4.2	↓	↓	
	WL	25	5.2	22	5	25	5.9	25	6	↓	↑	
	UP	54	10.6	45	9.1	45	8.8	44	8.8	↓		↓
Bank/grass strip	England	25	4.4	35	5.5	40	5.3	42	5.5		↑	↑
	EL	7	2.1	10	2.2	13	2	14	2.2			↑
	WL	15	3.6	22	5.1	25	4.9	26	5			
	UP	3	1.5	2	0.7	3	0.8	2	0.7			
Fence	England	309	14.1	348	16.3	347	14.1	363	14.6	↑		↑
	EL	143	10.1	151	11.4	145	9.4	158	9.8			↑
	WL	143	8.5	168	10	168	8.5	172	9.2	↑		↑
	UP	23	4.6	30	4.7	34	4.5	33	4.3	↑	↑	

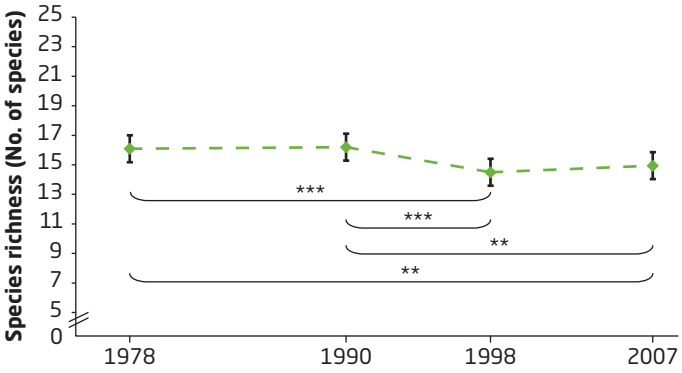
[1] Note that because of the statistical model used the total woody linear features is not simply the sum of hedges, line of trees/shrubs/relict hedge/fence and line of trees/shrubs/relict hedge.

- **Following significant decreases in plant species richness along the base of hedges between 1978, 1990 and 1998, no change was detected in England between 1998 and 2007. Stress tolerating plant species increased whilst those of open ground decreased. Plant species characteristic of shaded and/or fertile and/or less acidic conditions increased between 1978 and 2007.**
- **No change in plant species richness was detected in Roadside Plots in England between 1998 and 2007, and unlike the results for Great Britain there was no significant decline between 1978 and 2007.**
- **Stress-tolerating species increased significantly in Roadside Plots across Great Britain between 1998 and 2007, at the expense of ruderal species which showed a significant decrease. The significant increase in stress tolerators, and the significant decrease in Ruderal and Light Scores in Roadside Plots across England was also detected in the Easterly Lowlands Environmental Zone. There was also a small but significant increase in the number of butterfly caterpillar food plans in Roadside Plots in the Easterly Lowlands Environmental Zone between 1998 and 2007.**
- **Although there was no change in species richness, there was a shift in community structure and roadside vegetation became more shaded and characteristic of less acidic conditions in England, between 1978 and 2007.**

5.4.1 Condition of vegetation alongside linear and boundary features

This analysis is an overview of changes in vegetation condition in all plots alongside linear features (roadsides and field boundaries), with the exception of plots specifically looking at hedges.

▼ **Figure 5.2:** Change in the Species Richness Score of all linear plots (excluding Hedge Plots) alongside a random sample of feature types across England between 1978 and 2007. Significant changes (** p<0.01, *** p<0.001) are shown between the dates bracketed. 95% CI are shown for each data point.



Species richness: There was a 3% increase in the Species Richness Score of all linear plots between 1998 and 2007, but it was not significant. Over the longer-term, a significant decrease of 7.1% (16.1 to 14.9 species per plot) was recorded within all linear plots between 1978 and 2007 *(Fig. 5.2)*. The decrease in England was less than the 15% decrease seen across Great Britain. The decrease in Species Richness Score was also significant in the Tall Herb and Grass Aggregate Class[7] in England between 1978 and 2007. The decrease in Species Richness Score was also significant in the Westerly Lowlands Environmental Zone *(Table 5.3)*. .

5.4.2 Condition of vegetation in Hedge Plots

Hedge Plots (1m x 10m) were first recorded in 1978 on the hedge closest to a Main Plot. They are placed from the centre of a hedge to 1m outwards and are 10m in length.

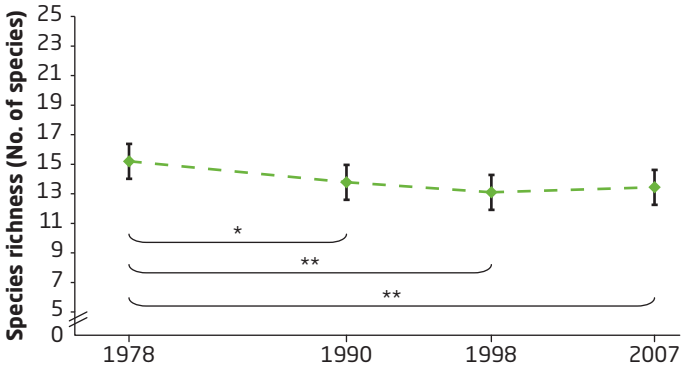
Species richness: There were no significant changes in the Species Richness Score in Hedge Plots in between 1998 and 2007. Over the longer term (1978 to 2007) there was a decrease in the Species Richness Score from 15.2 in 1978 to 13.4 species per plot in Hedge Plots in 2007 *(Fig. 5.3)*. The number of plant species used by butterfly caterpillars as food increased alongside hedges between 1998 and 2007 *(Table 5.4)*.

Other vegetation characteristics: There was a decrease in the number of ruderal species per plot alongside hedges between 1998 and 2007 and this was at the expense of stress-tolerating plant species. Over the longer-term, and especially between 1990 and 1998, there were many more changes. Grasses became less dominant, competitive species increased and ruderal species decreased, species casting or preferring shade increased, and species preferring fertile conditions increased *(Table 5.4)*. Together these measures indicate that vegetation alongside hedgerows has become less managed.

The significant changes in the Uplands Environmental Zone are related to the relatively small length of hedgerows, but included a reduction in stress tolerators, and increase in Fertility Score and an increase in Ellenberg pH.

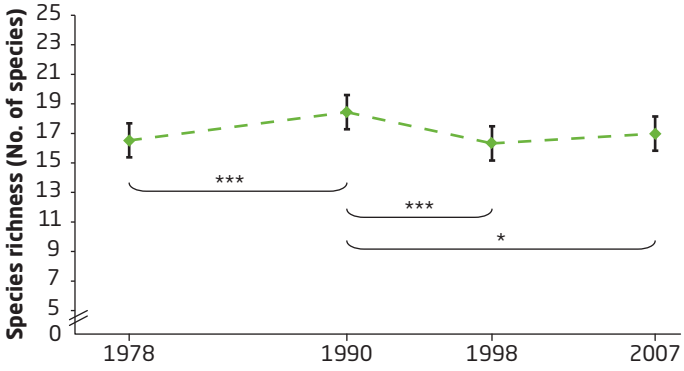
5.4.3 Condition of vegetation in Roadside Plots

▼ **Figure 5.3:** The change in Species Richness Score in 10m x 1m Hedge Plots across England between 1978 and 2007. Significant changes (* p<0.05, ** p<0.01) are shown between the dates bracketed. 95% CI are shown for each data point.



Species richness: There was no change in the Species Richness Score in Roadside Plots in England between 1998 and 2007 and unlike the results for Great Britain there was no significant decrease between 1978 and 2007 *(Fig. 5.4, Table 5.5)*. There were however, significant changes between 1978 and 1990 and 1990 and 1998 acting in opposite directions.

▼ **Figure 5.4:** The change in Species Richness Score in 10m x 1m Roadside Plots across England between 1978 and 2007. Significant changes (* p<0.05, ***p<0.001) are shown between the dates bracketed. 95% CI are shown for each data point.



▼ **Table 5.3:** Changes in mean Species Richness Score of all linear plots in different vegetation Aggregate Classes alongside linear features across England (E) and the three Environmental Zones (EL - Easterly Lowlands, WL - Westerly Lowlands, UP - English Uplands) between 1998 and 2007. Arrows denote significant change ($p<0.05$) in the direction shown. Greyed cells with diagonal strikethrough represent insufficient samples for reliable analysis.

	Mean values (England)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1978 - 1990				Direction of significant changes 1978 - 2007			
AC Class	1998	2007	E	EL	WL	UP	E	EL	WL	UP	E	EL	WL	UP	E	EL	WL	UP
All classes	14.5	14.9					↓								↓			
Crops and weeds	13.4	15.4									↑							
Tall grass and herb	14.3	14.3					↓	↓	↓						↓		↓	
Fertile grassland	14.8	16					↓	↓	↓		↑		↑					
Infertile grassland	14.7	17	↑				↓				↓			↓				
Woodland (upland & lowland)	14.3	14.4							↓								↓	
Moorland grass mosaic	18	13.6	↓			↓	↑											

▼ **Table 5.4:** Changes in the characteristics of vegetation in 10m x 1m Hedge Plots in England (E) and the three Environmental Zones (EL - Easterly Lowlands, WL - Westerly Lowlands, UP - English Uplands) between 1978 and 2007. Mean values for 1998 and 2007 are presented; those for 1978 and 1990 are available at *www.countrysidesurvey.co.uk*. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3 of the UK Results from 2007 report***.

	Mean values (England)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1978 - 1990				Direction of significant changes 1978 - 2007			
Vegetation Condition Measures	1998	2007	E	EL	WL	UP	E	EL	WL	UP	E	EL	WL	UP	E	EL	WL	UP
Species Richness (No. of Species)	13.1	13.4									↓		↓		↓		↓	
No. of Bird Food Species	6.7	7.3									↓		↓			↓		↑
No. of Butterfly Food Species	5.7	6.3	↑			↑	↓				↓		↓		↓		↓	
Grass:Forb Ratio	0.05	-0.19		↓											↓	↓		
Competitor Score	3.29	3.34									↑		↑		↑	↑	↑	
Stress Tolerator Score	1.93	1.98	↑	↑		↓			↑		↓	↓	↓					↓
Ruderal Score	2.13	2.03	↓	↓											↓	↓	↓	
Light Score	6.27	6.22		↓											↓	↓		
Fertility Score	6.34	6.34				↑					↑	↑	↑		↑		↑	↑
Ellenberg pH Score	6.66	6.65				↑				↑	↑	↑	↑		↑	↑	↑	↑
Moisture Score	5.35	5.35					↑			↓	↓		↑	↑				

▼ **Table 5.5:** Changes in the characteristics of vegetation in 10m x 1m Roadside Plots across England (E) and the three Environmental Zones (EL - Easterly Lowlands, WL - Westerly Lowlands, UP - English Uplands) between 1978 and 2007. Mean values for 1998 and 2007 are presented; those for 1978 and 1990 are available at *www.countrysidesurvey.co.uk*. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3 of the UK Results from 2007 report***.

	Mean values (England)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1978 - 1990				Direction of significant changes 1978 - 2007			
Vegetation Condition Measures	1998	2007	E	EL	WL	UP	E	EL	WL	UP	E	EL	WL	UP	E	EL	WL	UP
Species Richness (No. of Species)	16.3	17					↓		↓		↑		↑					
No. of Bird Food Species	7.7	8					↓	↓	↓		↑		↑					
No. of Butterfly Food Species	7.3	7.6		↑			↓	↓										
Grass:Forb Ratio	0.95	0.99									↓		↓		↓		↓	
Competitor Score	2.9	2.92							↑									
Stress Tolerator Score	1.8	1.87	↑	↑							↓	↓						
Ruderal Score	2.91	2.83	↓	↓					↓							↓		
Light Score	6.82	6.73	↓	↓	↓										↓		↓	
Fertility Score	6.1	6.07									↑	↑	↑					
Ellenberg pH Score	6.47	6.47					↓	↑			↑	↑	↑		↑		↑	↑
Moisture Score	5.26	5.27					↑	↓			↓							

There were no significant changes in the ratio of grasses to forbs in Roadside Plots between 1998 and 2007 but there was a significant increase in the proportion of forb species between 1978 and 2007 *(Table 5.5)*.

Other characteristics: Stress-tolerating species increased significantly in Roadside Plots across England between 1998 and 2007, at the expense of ruderal species which showed a significant decrease *(Table 5.5)*.

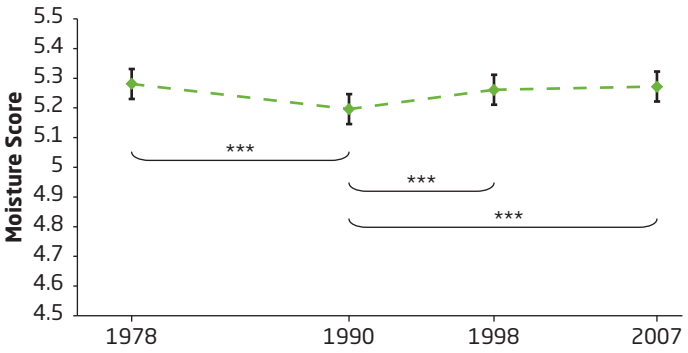
There was a significant decrease in the mean Light Score in Roadside Plots between 1998 and 2007. This result was consistent with results for the period 1978 to 2007 indicating increased shading of this plot type, a similar result to the Hedge Plots. There was a significant increase in the mean Ellenberg pH Score in Roadside Plots across England between 1978 and 2007. There was a significant increase in the Moisture Score between 1990 and 1998, following a significant decrease between 1978 and 1990 *(Fig. 5.5)* and unlike the results for Great Britain there was no long-term increase in the Moisture Score between 1978 and 2007 (*Table 5.5* and *Fig. 5.5*).

The significant increase in Stress Tolerator, and the significant decrease in Ruderal and Light Scores in Roadside Plots across England was also detected in the Easterly Lowlands Environmental Zone *(Table 5.5)*.

There was also a small but significant increase in the number of species of plants used by butterfly caterpillars as food in Roadside Plots (from 7.3 to 7.6 species per plot) in the Easterly Lowlands Environmental Zone between 1998 and 2007.

▲ Roadside verges, Cumbria • © *Natural England* • *Charlie Hedley*

▼ **Figure 5.5:** The change in the Moisture Score in 10m x 1m Roadside Plots across England between 1978 and 2007. Significant changes (*** p<0.001) are shown between the dates bracketed. 95% CI are shown for each data point.



5.5 Condition Assessment of the Boundary and Linear Features

- **There was on average 3.7 woody species per 30m section of hedge in England in 2007, with no detectable change between 1998 and 2007.**
- **50% of managed hedges were in good structural condition in England in 2007.**
- **32% of managed hedges were in good structural condition and had margins <2m in England in 2007. Only 12% of managed hedges on arable land were in both good structural condition and had appropriately managed margins in England in 2007. A higher proportion of English hedges were in good condition compared to Great Britain as a whole.**
- **Approximately 25% of walls were in either 'sound' or 'excellent' condition in both 1998 and 2007. The majority of walls across England were in 'deteriorating' condition in both 1998 and 2007**

5.5.1 Woody species richness of hedgerows

The mean number of native woody species (approximately 3.7 species) per 30m length of hedgerow did not change significantly in hedgerows between 1998 and 2007. Hedge Diversity Plots were not recorded before 1998 (See further information at *www.countrysidesurvey.co.uk*).

▲ Hedgerow in good structural condition, Lancashire • © *Ian Simpson*

▲ Hedgerow in poor structural condition, South Downs • © *Natural England • Mike McGoran*

5.5.2 Structural condition of hedgerows

Half (50%) of the managed hedges in England, which comprised 73% of all woody linear features surveyed, were in good structural condition in 2007. Good structural condition was determined by a number of different criteria *(Table 5.6)* including the height of the base of the hedge canopy, the cross-sectional area, hedge 'gappiness' and the absence of non-native species.
Hedgerow condition also depends on a number of other factors including the distance between the centre of the hedge and the disturbed ground; if these are taken into account alongside structural information, 32% of hedgerows would then meet condition criteria. A further criterion is the width of perennial vegetation at the base of the hedge, which should be greater than 1.0m.

Applying all criteria, only about 12% of managed hedges on arable land were in overall good condition *(Fig. 5.6)*. A higher proportion of the hedgerows of England were in good condition compared with the hedgerows across all of Great Britain.

▼ **Table 5.6:** The structural and margin condition criteria assessed by surveyors in Countryside Survey in 2007.

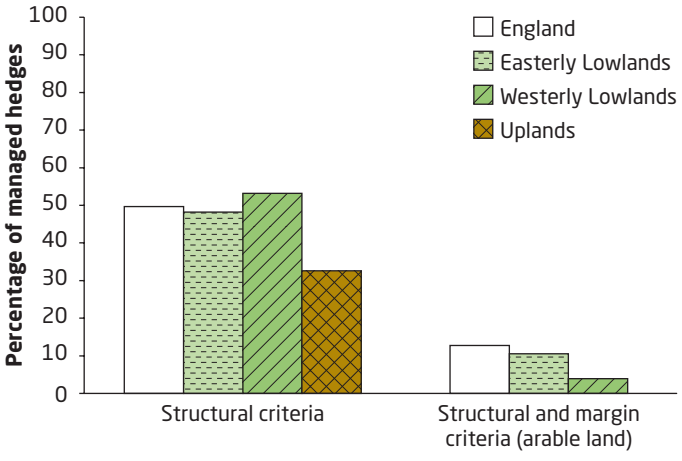
Structural Condition Criteria	Margin Condition Criteria
Height >1m	Distance between centre of hedge and disturbed ground >2m
Width >1.5m	Width of perennial vegetation 1.0m
Horizontal gappiness <10%	
No gaps >5m	
Non-native species at >10% cover	
Height of base of canopy <0.5m	

5.5.3 Hedgerow height and management

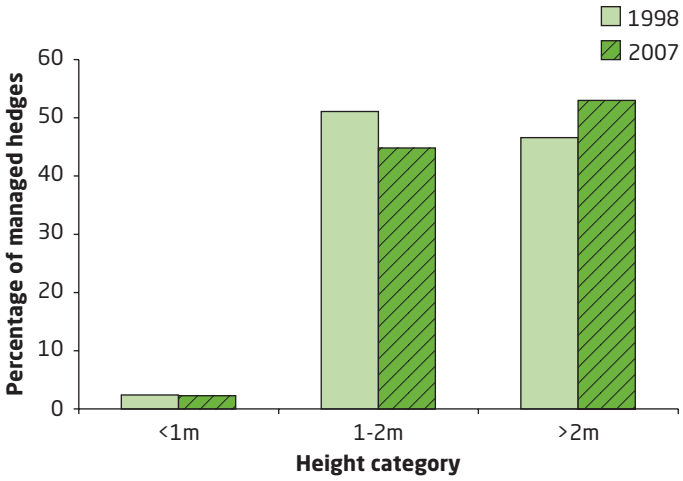
In England, there was no change in the length of hedgerows that were less than 1m tall, there was a significant decrease in the length of hedgerows that were between 1 and 2m tall and a significant increase in the length of hedgerows that were greater than 2m tall *(Fig. 5.7)*. The proportion of hedges not assigned to a hedge category in 1998 was greater than in 2007 (data not shown).

In England, the majority of hedgerows mapped by surveyors were recorded as managed by cutting in 1998 (53%) and in 2007 (56%). There were significant decreases in the lengths of hedges that were not managed, were newly planted, or were managed by laying or coppicing between 1998 and 2007.

▼ **Figure 5.6:** The percentage of 30m long Hedgerow Diversity Plots in managed hedges in: England, and the Environmental Zones in which managed hedges met condition criteria. NB there were no upland hedges that met all condition criteria.



▼ **Figure 5.7:** The changes in the percentage of length of hedgerows in different height categories across England between 1984 and 2007. The increase in the percentage of hedgerows >2m between 1998 and 2007 was statistically significant at p<0.01.



5.5.4 Structural condition of walls

Approximately 25% of walls were in either 'sound' or 'excellent' condition in both 1998 and 2007. This is different to the 50.3% of the length of walls that were in either excellent or sound condition across all of Great Britain in 2007. The majority of walls across England were in 'deteriorating' condition in both 1998 and 2007. Changes in the condition of walls between 1998 and 2007 are not straightforward to interpret due to incomplete recording in 1998. A decrease in the length of walls in a 'derelict' state between 1998 and 2007 is potentially the only significant change *(Fig. 5.8)*.

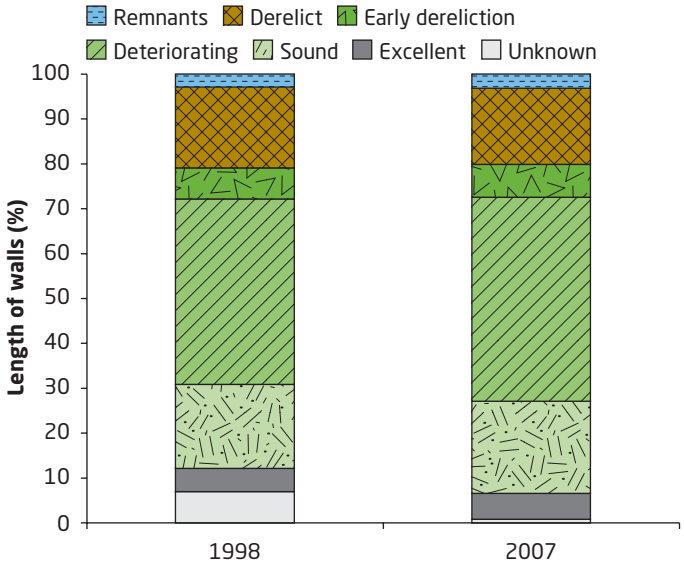
▲ Dry stone wall in excellent condition, Lancashire • © *Ian Simpson*

▲ 750 year old yew tree, West Sussex • © *Natural England* • *Peter Wakely*

5.5.5 Individual trees

Individual trees were recorded in 2007, as they have been previously in CS. Analysis of data on the occurrences of both individual trees and trees associated with woody linear features will be reported in the future.

▼ **Figure 5.8:** The percentage of the total length of walls in different structural condition categories across England between 1998 and 2007.



5.6 Discussion and Conclusions

5.6.1 Overall results for the Boundary and Linear Features Broad Habitat

The results for England show that there has been a decline of 3.2% in the length of woody linear features since 1984. This average figure hides a more dynamic picture over time and space, and in the condition of the features. The total length decreased by 12% between 1984 and 1990, but recovered substantially by 1998, only to decrease again by 1.4% between 1998 and 2007.
The main net loss of woody features since 1984 has been in the Westerly Lowlands Environmental Zone, where the length has decreased by 7.7%, with the length in the Easterly Lowlands showing no net change over the period and the Uplands showing an 18% increase.

5.6.2 Hedgerows

Of all the linear habitats, managed hedgerows have shown the largest changes with a decrease of 6.1% between 1998 and 2007. There were also significant decreases in the lengths of hedges that were not managed, were newly planted, or were managed by laying or coppicing.

As the length of managed hedgerows has declined, the length of relict hedgerows and lines of trees has increased substantially. For England overall, the length of these features has increased by 248% since 1984 and by 13% since 1998.

The policy context of these results is that through the 1990s increasing attention was paid to support of hedgerows by legislative protection (including the Hedgerow Regulations, 1997), and by financial support for restoration and management.
The Countryside Stewardship Scheme funded the restoration of 14,100km of hedgerows between 1991 and 2000[8].
Between 1998 and 2004, a further 8,600km were restored under the Environmentally Sensitive Areas Scheme[9]. Since 2005, support for new agreements has come from the Environmental Stewardship Scheme, where there are a number of options to assist hedgerow establishment and management[10].

Managed hedges are beneficial to the landscape and wildlife, as well as useful for farmers. Where hedges no longer serve an agricultural purpose they may remain beneficial as food and shelter resources for birds, mammals and insects for a time, but eventually neglect will result in them having reduced value for wildlife.

▲ Managed hedge, Lancashire • © *Ian Simpson*

Hedgerows, hedge-ditch systems, and walls are important in our cultural history. They gave clear markers of land ownership or rights, such as the Royal Hunting Forests between the 11th and 12th centuries. They changed through time, as land rights changed, such as after the Enclosure Acts 18th and early 19th centuries, which affected about a quarter of the landscape of England , although 7 million ha was enclosed without the act and this resulted in contrasting landscape patterns between the 'unplanned' landscapes of south west England and the more regular 'planned' landscapes across the rest of the county. The pattern and structure of hedges across the country contributes a great deal to defining the 159 distinct Landscape Character Areas in England[11].
Many hedges are well over 1,000 years old, marking parish boundaries and most are over 200 years old.

All hedgerows mainly made of native species of tree and shrub, are now recognised as a Priority Habitat within the UK Biodiversity Action Plan. They are also important for a large number of threatened or rare species. These include plants like the Plymouth pear, insects like the brown hairstreak butterfly, birds like the cirl bunting and mammals like the dormouse. The very high importance of hedgerows for birds is clearly illustrated by the facts that over 21 priority BAP bird species are associated with hedgerows, and for 13 of these, hedgerows are a primary habitat. Similarly, as many as 16 out of the 19 birds used by Government to assess the state of farmland wildlife are associated with hedgerows, with 10 using them as a primary habitat.

[8] *Ecoscope Applied Ecologists & CPM (2003)* Review of agri-environment schemes - monitoring information and R&D results (Ref: RMP/1596) Final Report Part A – Chapters 1 – 9
Available at: http://randd.defra.gov.uk/Document.aspx?Document=MA01001_3342_FRP.pdf

[9] Catherine Bickmore & Associates (2004) Hedgerow management and restoration in agri environment schemes: Executive summary 2004.
Report to Defra, available at: randd.defra.gov.uk/Document.aspx?Document=MA01008_5771_EXE.pdf

[10] Defra, English Nature (2008) Environmental Stewardship Review of Progress. Available at:http://collections.europarchive.org/tna/20081027092120/http://defra.gov.uk/erdp/schemes/es/es-report.pdf

[11] National Landscape Areas (formerly Joint Character Areas) http://www.naturalengland.org.uk/ourwork/landscape/englands/character/areas/default.aspx

Hedgerows only stay in existence as hedgerows if they are actively managed. A hedge which is not cut or laid from time to time will eventually change its structure and will no longer be classified as a hedge. Hence, a hedge needs to be managed appropriately to remain in existence.

The lead partner for Hedgerows is Defra, who also act as secretariat for the Hedgerow Habitat Action Plan Steering Group, the partner body from which Hedgelink[12] developed. Hedgelink is the partnership that brings everyone interested in hedgerows together, to share knowledge and ideas, to encourage and inspire, and to work with farmers and other land managers to conserve and enhance our hedgerow heritage. Hedgelink has a particular responsibility for helping to deliver the Habitat Action Plan for hedgerows that forms part of the UK's Hedgerow Biodiversity Action Plan.

5.6.3 Roadsides

There was no change in the Species Richness Score in Roadside Plots in England between 1978 and 2007 but there were significant fluctuations in the intervening surveys and increases in the proportion of forb species and the mean Ellenberg pH Score. Between 1998 and 2007 in England as whole and the Easterly Lowlands stress-tolerating species increased at the expense of ruderal species and like the Hedge Plots the mean Light Score decreased indicating an overall trend towards species favouring greater shade and less disturbance.

5.6.4 Walls

Walls are another important landscape and distinctive feature of some parts of the English countryside. The analysis shows a statistically significant decline in the overall length of walls in England between 1998 and 2007. However, the size of this decline is relatively small, amounting to 920km or 1.1% of the total. Countryside Survey is able to detect this very small change because it revisits the same plots at subsequent surveys. Almost the whole of this loss is attributable to losses in the Uplands Environmental Zone (where the loss of walls was 2.2%), where walls form a characteristic landscape feature.

In 2008, the Government announced that the existing Hill Farming Allowance Scheme will be replaced with Uplands Entry Level Stewardship. This is designed to ensure that farmers are supported and rewarded in their efforts to maintain England's historic upland landscape, such as the Cumbrian Fells, Dartmoor and the Peak District. Through the scheme, which will be available from July 2010, hill farmers will be rewarded for maintaining the biodiversity and natural resources of the area, including the maintenance of iconic features of the landscape such as dry stone walls and stone-faced hedge banks.

5.6.5 Banks/Grass strips

There was a significant increase in the length of banks and grass strips in England between 1998 and 2007, with a 4.8% increase in England as a whole and a 10.4% increase in the Easterly Lowland Environmental Zone. This habitat feature has been encouraged by agri-environment schemes, and a greater awareness of the conservation and production advantages of grass strips and beetle banks, which probably explains the increase of about 2,000 km between 1998 and 2007.

5.6.6 Condition of Linear Features

The condition of the vegetation associated with the area at the bases of hedges and along roadsides of England showed no long-term decrease in species diversity, in contrast to the results reported for Great Britain. There was a shift in community, with an increase in taller and more competitive species alongside hedgerows; but this deterioration was slowed or halted between 1998 and 2007. Although the vegetation alongside linear features in England showed signs of a reduction in management the changes were not as extreme as for Great Britain.

5.6.7 Conclusions

The continued decline in appropriate hedgerow management leading to an increase in lines of trees and relict features, and the generally poor condition of those hedgerows that are managed, must inevitably be followed by a decline in associated biodiversity, landscape value and the many other environmental services which hedgerows provide. However, there are signs that new policies and incentives, in particular Environmental Stewardship, are at least reducing the rate of decline if not starting to assist recovery. It is expected that further analysis of Countryside Survey data will be able to quantify this. It is clear that there will need to continue to be a concerted and well-resourced push towards the appropriate hedgerow management if we are not to risk further loss of one of our most characteristic and environmentally-valuable landscape features.

It is encouraging to note that the significant decline in species richness in the vegetation at the base of hedges recorded between 1990 and 1998 was not detected between 1998 and 2007 and there has been no detectable loss of woody species in the hedges. Although species richness along the hedgerow base did not change, the shift in community structure, to more competitive shade tolerant or casting species and fewer grasses and ruderal species, also reflects the reduction in hedgerow management.

A similar signal of community shift towards more shaded and dense vegetation with stress tolerators increasing at the expense of ruderals was also evident in roadside vegetation, especially in the Easterly Lowlands. The number of plant species used by butterfly caterpillars as food per Roadside Plot also increased, which may indicate the need to examine these regional responses more carefully and perhaps a need to review recent management preferences for reduced mowing to encourage wildflowers.

[12] http://www.hedgelink.org.uk

▲ Linear features in the landscape, Pennines • © *NERC*

The significant increase in the length of banks and grass strips in England between 1998 and 2007, was 4.8% in England and a 10.4% increase in the Easterly Lowlands Environmental Zone. This habitat feature has been encouraged by agri-environment schemes, and a greater awareness of the conservation and production advantages of grass strips and beetle banks, which may explain the increase of about 2,000 km between 1998 and 2007.

There was a statistically significant decline in the overall length of walls in England between 1998 and 2007. Although the size of this decline is relatively small, amounting to 920km or 1.1% of the total, almost the whole of this loss is attributable to losses in the Uplands Environmental Zone (where the loss of walls was 2.2%).

The majority of walls remaining across England are also 'deteriorating'. Only 25% are in either 'sound' or 'excellent' condition. The reasons for this can only be speculated, but the deterioration and loss of walls could detract from the character of the English landscapes where they occur.

▲ Hawthorn scrub, Cotswolds • © *Natural England* • *Nick Turner*

6. Woodlands: Broadleaved, Mixed and Yew Woodland; and Coniferous Woodland Broad Habitats

Summary

Area and change

- Broadleaved Woodland and Coniferous Woodland together amounted to a total of 1,238,000 ha or 9.4% the area of England in 2007.
- Broadleaved Woodland covered 981,000ha or 7.4% of the area of England in 2007.
- There was an increase of 5.8% (54,000ha) in the area of Broadleaved Woodland in England between 1998 and 2007 and a 10.6% (40,000ha) increase between 1990 and 2007.
- Coniferous Woodland covered 257,000ha or 1.9% of the area of England in 2007.
- There was no detectable change in the area of Coniferous Woodland in England between 1998 and 2007.

Condition

- No change was detected in species richness in 200m^2 Main Plots in Broadleaved Woodland in England between 1998 and 2007, although there was a significant increase in the Easterly Lowlands Environmental Zone, reversing a significant decline between 1990 and 1998.
- The number of plant species used by butterfly caterpillars as food increased significantly from 6.2 to 6.9 species per 200m^2 Main Plots in Broadleaved Woodland in England between 1998 and 2007, especially in the Easterly Lowlands Environmetal Zone.
- There was significant decrease in Ruderal Score from 2.05 to 1.99 species per Main Plot in Broadleaved Woodland in the Westerly Lowlands between 1998 and 2007, which may reflect the closing over of the canopy in new woodland and consequent loss of open ground species.

- **The species that increased most in Broadleaved Woodland was Holly (*Ilex aquifolium*), while the four species that decreased most were all grasses which suggests maturation and a closure to the canopy.**
- **No significant change was detected in the number of species recorded in 2m x 2m Plots targeted for their botanical interest within Broadleaved Woodland in England between 1998 and 2007, which differs from the results for Great Britain where a significant decrease was detected.**
- **There was a significant decrease of 19% from a mean of 11.9 species to 9.6 species per 2m x 2m plot targeted for their botanical interest, in Broadleaved Woodland over the longer-term, between 1990 and 2007 which includes the reduction in the number of plant species used by butterfly caterpillars as food from 4.3 to 3.5 species per plot in England.**
- **No significant changes in the condition of Coniferous Woodland were recorded across England between 1998 and 2007, 1990 and 1998 or 1990-2007.**

Soils

- **There was no significant change in soil (0-15cm) pH in Broadleaved Woodland in England between 1998 and 2007. Soil pH (0-15 cm) was 5.83 in 1998 and 6.07 in 2007. Soil (0-15 cm) pH in 2007 was significantly higher than in 1978 due mainly to the significant increase between 1978 and 1998. No significant change in soil (0-15cm) pH (4.13 in 1998 to 4.44 in 2007) was detected in Coniferous Woodland, between 1998 and 2007 or since 1978.**
- **Soil (0-15cm) carbon concentration did not change significantly in Broadleaved Woodland (from 74.0 to 63.2g/kg) or in Coniferous Woodland (from 140.7 to 116.8g/kg) in England between 1998 and 2007.**
- **Carbon stock of soil (0-15cm) was estimated as 63tC/ha for Broadleaved Woodland and 70t/Cha for Coniferous Woodland in England in 2007.**

6.1 Introduction[1]

The Countryside Survey definition of woodland covers two Broad Habitats including all broadleaved and coniferous woodlands as well as scrub. Lines of trees and hedges are covered separately as woody linear features, in the Boundary and Linear Features Broad Habitat *(Chapter 5)*.

In CS, a parcel of land must have over 25% canopy cover of trees and shrubs, over a metre high, to be classified as woodland.

This is subtly different to measures of land-use such as those used by the Forestry Commission in which land that has been cleared of trees and is awaiting replanting will remain classified as woodland. Furthermore in CS, the dividing line between whether woodlands are classified as Broadleaved, Mixed and Yew Woodland or Coniferous Woodland is dependent on whether the percentage of coniferous trees in the canopy is more or less than 20%. Together with differences in the size of the minimum mapping unit, such definitional difference from those used by other surveys can lead to different estimates of the national area of woodland. CS estimates that the total area of woodland in England in 2007 was 1,238,000 ha, where as the Forestry Commission puts the estimate at 1,127,000 ha[2]. Despite such differences in stock definitions, trends over time should be comparable between the two surveys.

6.2 Woodland habitats

The two main Broad Habitat woodland types in England are: Broadleaved, Mixed and Yew Woodland (henceforth referred to as Broadleaved Woodland); and Coniferous Woodland (mostly plantations) of Scot's Pine (not considered a native species in England) and various introduced conifers (particularly Corsican Pine, Sitka and Norway Spruce, Larches and Douglas Fir).

An area mapped as a woodland Broad Habitat may also encompass other small patches of vegetation that are a distinctive part of the woodland environment, but not big enough to have been mapped separately. These include areas of grassland within the wood (rides, clearings etc); watercourses; glades opened up by coppicing or wind-throw that may support tall-herb vegetation such as bracken; and waterlogged areas supporting wetland plant communities. There may also be felled areas awaiting replanting or development of natural regeneration. The use of the two plot types, Main Plots and Targeted Plots, enables the differences between the large areas of habitat and the smaller patches within it to be sampled.

6.3 The Area of Woodlands

- **Broadleaved Woodland and Coniferous Woodland together amounted to a total of 1,238,000 ha or 9.4% the area of England in 2007.**
- **Broadleaved Woodland covered 981,000ha or 7.4% of the area of England in 2007.**
- **There was an increase of 5.8% (54,000ha) in the area of Broadleaved Woodland in England between 1998 and 2007 and a 10.6% (40,000 ha) increase between 1990 and 2007.**
- **Coniferous Woodland covered 257,000ha or 1.9% of the area of England in 2007.**
- **There was no detectable change in the area of Coniferous Woodland in England between 1998 and 2007.**

[1] **Note:** For further information on the Broad Habitat classification, sampling plots and other Countryside Survey terminology see *Chapter 1 (Introduction and Methodology)*

[2] Forestry Facts and Figures (2008). Forestry Commission, Edinburgh.

▼ **Table 6.1:** Estimates of the area ('000s ha) and percentage of land area of Broadleaved, Mixed and Yew Woodland in England 1990 to 2007. Arrows denote significant change (p<0.05) in the direction shown. Note that because of changes in definitions that have been applied retrospectively, the estimates from 1990 are not in all cases directly comparable with later surveys.

	1990		1998		2007		Direction of significant changes 1998 - 2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
England	887	6.7	927	7	981	7.4	↑
Easterly Lowlands	470	7.2	489	7.5	519	8	↑
Westerly Lowlands	378	7.4	400	7.9	422	8.3	
Uplands	39	2.5	38	2.4	40	2.6	

▼ **Table 6.2:** Estimates of the area ('000s ha) and percentage of land area of Coniferous Woodland in England from 1990 to 2007. Arrows denote significant change (p<0.05) in the direction shown. Note that because of changes in definitions that have been applied retrospectively, the estimates from 1990 are not in all cases directly comparable with later surveys.

	1990		1998		2007		Direction of significant changes 1998 - 2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
England	241	1.8	260	2	257	1.9	
Easterly Lowlands	58	0.9	78	1.2	81	1.2	
Westerly Lowlands	97	1.9	102	2	104	2	
Uplands	86	5.5	80	5.1	72	4.6	

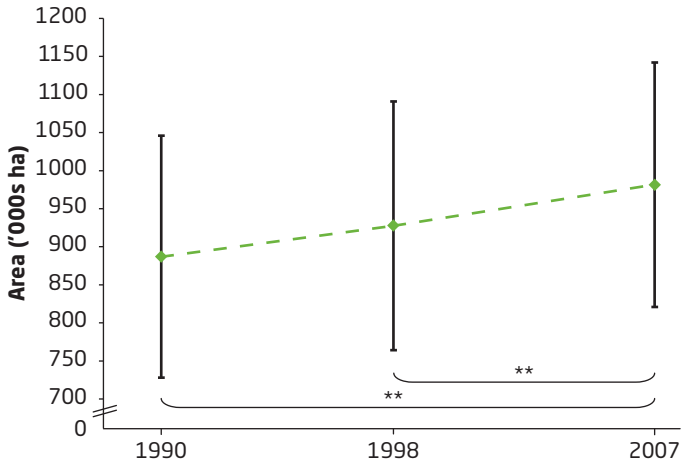
6.3.1 Broadleaved, Mixed and Yew Woodland

Broadleaved Woodland covered 981,000ha or 7.4% of the area of England in 2007 *(Table 6.1, Fig. 6.1)*.

The area of Broadleaved Woodland increased significantly by 5.8% in England, between 1998 and 2007, by an estimated 54,000ha *(Fig. 6.1)*. An increase of 40,000ha in the area of Broadleaved Woodland was recorded in England between 1990 and 1998 *(Table 6.1)* so that overall the change between 1990 and 2007 was an increase of 10.6%. The increase in England between 1990 and 1998 contrasts with a decrease in Broadleaved Woodland in Great Britain.

As with the total woodland areas there is a difference in the breakdown between Broad Habitat types between CS and the National Inventory of Woodland and Trees, because of how mixed woodland is treated. CS allocates rather more woodland to the Broadleaved and Mixed category (981,000ha rather than 761,000ha[3], but correspondingly less to pure coniferous woodland (257,000 versus 366,000ha). Both sets of surveys however show increases in broadleaved woodland cover.

▼ **Figure 6.1:** Change in the area of Broadleaved, Mixed and Yew Woodland in England between 1990 and 2007. Significant changes (** p<0.01) are shown between the dates bracketed. 95% CI are shown for each data point.



6.3.2 Coniferous Woodland

Coniferous Woodlands are distributed throughout England and proportionately make up more of the Uplands Environmental Zone than the Lowlands. In 2007, the estimated area of Coniferous Woodland was 257,000ha and covered 1.9% of the land surface of England. Overall, there was no significant change to the area of Coniferous Woodland in England between 1998 and 2007 or between 1990 and 2007. The apparent trend of decline in Coniferous Woodland in the Uplands Environmental Zone is not statistically significant, but it could reflect a combination of felling and young re-growth which has not reached the required canopy cover to classify as woodland.

[3] Forestry Facts and Figures (2008) Forestry Commission, Edinburgh

▲ Thinned coniferous plantation with regeneration of beech and oak, Suffolk • © *Natural England* • *Peter Wakely*

6.4 Conversion between Broad Habitats

6.4.1 Broadleaved, Mixed and Yew Woodland

Most (93%) of the Broadleaved Woodland recorded in 2007 was also recorded as this Broad Habitat type in 1998. Those Broadleaved Woodlands recorded for the first time in 2007 were mainly in areas previously recorded as Arable and Horticulture and Improved Grassland Broad Habitats – consistent with the direction of policy and incentives over the last 20 years. There is necessarily a time-lag in detecting new woodland. The recorded shift to woodlands from Improved Grassland are therefore new woodlands planted or regenerating in the early 1990s have only now (in 2007) reached the 25% canopy cover required to be recorded as woodland by CS.

6.4.2 Coniferous Woodland

Most (95%) of the Coniferous Woodland recorded in 1998 was also recorded as Coniferous Woodland in 2007. The loss of Coniferous Woodland recorded in 2007 occurred where felling had taken place and it had been replaced by Neutral Grassland, Arable and Horticulture or Fen Marsh and Swamp Broad Habitats. There may be a temporary peak in the extent of stands that have been recently felled over the next ten years reflecting the very high rates of upland planting that took place from the 1960s through to the mid-1980s.

6.5 The condition of woodlands

- **No change was detected in species richness in 200m² Main Plots in Broadleaved Woodland in England between 1998 and 2007, although there was a significant increase in the Easterly Lowlands Environmental Zone, reversing a significant decline between 1990 and 1998.**
- **The number of plant species used by butterfly caterpillars as food increased significantly from 6.2 to 6.9 species per 200m² Main Plots in Broadleaved Woodland in England between 1998 and 2007, especially in the Easterly Lowlands Environmental Zone.**
- **There was significant decrease in Ruderal Score from 2.005 to 1.99 species per Main Plot in Broadleaved Woodland in the Westerly Lowlands between 1998 and 2007, which may reflect the closing over of the canopy in new woodland and consequent loss of open ground species.**
- **The species that increased most in Broadleaved Woodland was Holly (*Ilex aquifolium*), while the four species that decreased most were all grasses which suggests maturation and a closure to the canopy.**
- **No significant change was detected in the number of species recorded in 2m x 2m Plots targeted for their botanical interest within Broadleaved Woodland in England between 1998 and 2007, which differs from the results for Great Britain where a significant decrease was detected.**
- **There was a significant decrease of 19% from a mean of 11.9 species to 9.6 species per 2m x 2m plot targeted for their botanical interest in Broadleaved Woodland over the longer term, between 1990 and 2007, which includes the reduction in the number of plant species used by butterfly caterpillars as food from 4.3 to 3.5 species per plot in England.**
- **No significant changes in the condition of Coniferous Woodland were recorded across England between 1998 and 2007, 1990 and 1998 or 1990-2007.**

▼ **Table 6.3:** Change in the characteristics of vegetation in 200m² Main Plots in the Broadleaved, Mixed and Yew Woodland Broad Habitat across England (E) and the three Environmental Zones (EL - Easterly Lowlands, WL - Westerly Lowlands, UP - English Uplands) between 1990 and 2007. Mean values for 1998 and 2007 are presented: those for 1990 are available at *www.countrysidesurvey.org.uk*. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Chapter 1, Box 1.3 of the UK Results from 2007***.

	Mean values (England)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**
Species Richness (No. of Species)	18.9	20.1		↑			↓	↓						
No. of Bird Food Species	8.8	9.3												
No. of Butterfly Food Species	6.2	6.9	↑	↑										
Grass:Forb Ratio	0.9	1.07					↓		↓		↓		↓	
Competitor Score	3.06	3.1									↑		↑	
Stress Tolerator Score	2.34	2.36												
Ruderal Score	2.05	1.99			↓		↓				↓		↓	
Light Score	5.92	5.93							↓				↓	
Fertility Score	5.53	5.55												
Ellenberg pH Score	5.85	5.93												
Moisture Score	5.53	5.51												

▼ **Table 6.4:** The 10 plant species with the largest increase and decrease in the number of Main Plots in which they were recorded in Broadleaved, Mixed and Yew Woodland between 1998 and 2007. These changes were supported by the calculation of a Broad Habitat wide Change Index.

Species with increasing frequency		Rank Order	Species with decreasing frequency		Rank Order
Ilex aquifolium	Holly	1	*Lolium perenne*	Rye Grass	1
Rumex conglomeratus	Clustered Dock	2	*Deschampsia flexuosa*	Wavy Hair-grass	2
Quercus robur & petraea	Oak	3	*Poa trivialis*	Rough Meadow-grass	3
Geum urbanum	Wood Avens	4	*Agrostis stolonifera*	Creeping Bent	4
Viola riviniana/reichbechiana	Dog-violet	5	*Stachys sylvatica*	Hedge Woundwort	5
Heracleum sphondylium	Hogweed	6	*Sorbus aucuparia*	Rowan	6
Deschampsia cespitosa	Tufted Hair-grass	7	*Geranium dissectum*	Cut-leaved Cranesbill	7
Cirsium palustre	Marsh Thistle	8	*Alopecurus pratensis*	Meadow Foxtail	8
Anthriscus sylvestris	Cow Parsley	9	*Rumex obtusifolius*	Broad-leaved Dock	9
Agrimonia eupatoria	Agrimony	10	*Conopodium majus*	Pignut	10

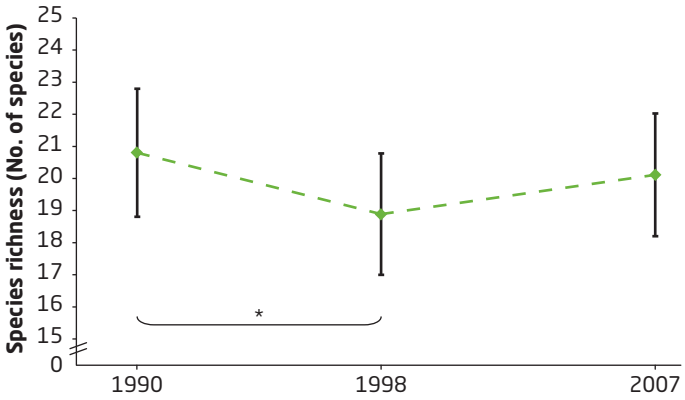
▲ Oak-Birch Wood • © *Natural England* • *Tom Holland*

6.5.1 *Changes in the condition of Broadleaved, Mixed and Yew Woodland*

The Species Richness Score of Main Plots[4] in Broadleaved Woodland did not change significantly across England; there was no significant difference between the mean number of plant species per plot in 1990 (20.8) and 2007 (20.1) *(Fig. 6.2)*. It increased significantly in the Easterly Lowlands Environmental Zone between 1998 and 2007, reversing a decrease between 1990 and 1998 *(Table 6.3)*. The number of plant species used by butterfly caterpillars as food increased significantly between 1998 and 2007 especially in the Easterly Lowlands. There was a significant decrease in Ruderal Score from 2.05 to 1.99 in Broadleaved Woodland between 1998 and 2007.

[4] Main Plots (200m²) are randomly located to assess widespread and common habitat types in the open countryside.

▼ **Figure 6.2:** Changes in the mean Species Richness in 200m² Main Plots in the Broadleaved, Mixed and Yew Woodland Broad Habitat across England between 1990 and 2007. Significant changes (* p<0.05) are shown between the dates bracketed. 95% CI are shown for each data point.



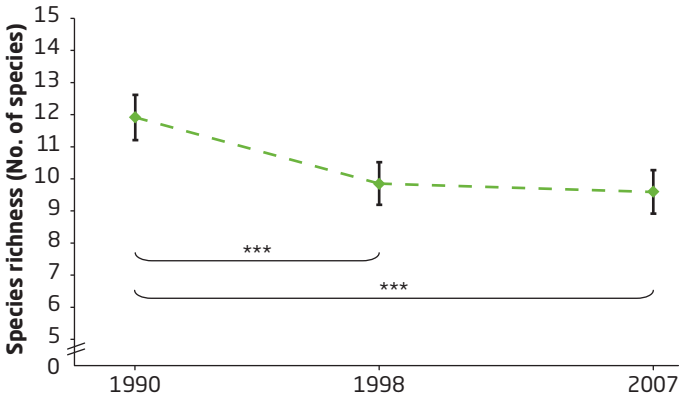
Species that increased most in Broadleaved Mixed and Yew Woodland plots had few shared characteristics. The species that increased most was Holly (*Ilex aquifolium*), consistent with the trend reported by Kirby *et al.*, 2005[5]. The four species that decreased most were all grasses which suggests maturation and a closure of the canopy ***(Table 6.4)***.

Apart from the decrease in frequency of grasses and low growing species, there were no significant changes in the vegetation characteristics of Main Plots within Broadleaved Woodland between 1998 and 2007 ***(Table 6.3)***.

▲ Wild garlic in woods, Hampshire • © *Natural England* • *Mike McGoran*

Within Broadleaved Woodland small patches can be found of different habitats that are of different conservation value to the wood itself. These can be glades or rides, or patches of long established Priority Habitat woodlands in amongst planted stands of broadleaved trees. These areas were targeted by Countryside Survey for their botanical interest, and the Targeted Plots[6], described in ***Chapter 1 of the UK Results from 2007***[7] report, were designed to sample them. In England over the period 1990 to 2007 there was a significant decrease of 19% from a mean of 11.9 species to 9.6 species per plot ***(Fig. 6.3)***. This includes a reduction in the number of plant species used by butterfly caterpillars as food from 4.3 to 3.5 species per plot over the same period, but no significant change was detected in the number of species recorded in Targeted Plots within Broadleaved Woodland in England between 1998 and 2007, which differs from the results for Great Britain where a further significant decrease was detected.

▼ **Figure 6.3:** Change in plant Species Richness recorded in 2m x 2m Targeted Plots in the Broadleaved, Mixed and Yew Woodland Broad Habitat across England between 1990 and 2007. Significant changes (* p<0.001) are shown between the dates bracketed. 95% CI are shown.



6.5.2 Changes in the condition of Coniferous Woodland

No significant changes in the condition of Coniferous Woodland were recorded across England between 1998 and 2007, 1990 and 1998 or 1990-2007.

[5] Kirby, K.J., Smart, S.M., Black, H.I.J., Bunce, R.G.H., Corney, P.M. and Smithers, R.J. (2005). *Long term ecological change in British woodland (1971-2001).* Peterborough: English Nature (Research Report 653).

[6] Targeted Plots (2m x 2m) are positioned by surveyors to assess small areas of botanical interest which may be overlooked by the randomly located Main Plots.

[7] ***UK Results from 2007***, available at *www.countrysidesurvey.org.uk*

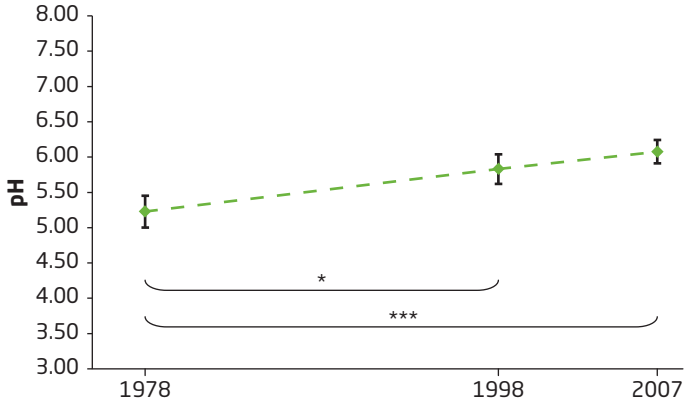
6.6 Changes in soils (0-15cm) in Woodland Broad Habitats

- **There was no significant change in soil (0-15cm) pH in Broadleaved Woodland in England between 1998 and 2007. Soil pH (0-15 cm) was 5.83 in 1998 and 6.07 in 2007. Soil (0-15 cm) pH in 2007 was significantly higher than in 1978 due mainly to the significant increase between 1978 and 1998. No significant change in soil (0-15cm) pH (4.13 in 1998 to 4.44 in 2007) was detected in Coniferous Woodland, between 1998 and 2007 or since 1978.**
- **Soil (0-15cm) carbon concentration did not change significantly in Broadleaved Woodland (from 74.0 to 63.2g/kg) or in Coniferous Woodland (from 140.7 to 116.8g/kg) in England between 1998 and 2007.**
- **Carbon stock of soil (0-15cm) was estimated as 63tC/ha for Broadleaved Woodland and 70tC/ha for Coniferous Woodland in England in 2007.**

6.6.1 Broadleaved, Mixed and Yew Woodland

Soil (0-15cm) pH: The mean pH of soil (0-15cm) samples in Broadleaved Woodland across England was 6.07 in 2007 compared to 5.83 in 1998. This change was not significant and the soils fall within the mildly acidic range. The significant increase in soil (0-15cm) pH between 1978 and 2007 is due mainly to the significant change between 1978 and 1998 (*Fig. 6.4*, see also *Chapter 2, Table 2.11*).

▼ **Figure 6.4:** The change in pH in soils (0-15cm) from Broadleaved, Mixed and Yew Woodland in England between 1978 and 2007. Significant changes (*p<0.05,*** p<0.001) are shown between the dates bracketed. 95% CI are shown for each data point (but are very small).



In comparison, the mean Ellenberg pH Score in vegetation sampling Main Plots did not change significantly between 1990 and 2007. The change in soil (0-15cm) pH was of relatively low magnitude, which may not have triggered a response from the woodland vegetation.

Soil (0-15cm) carbon concentration: There was no statistically significant change in the mean carbon concentration of soil (0-15cm) in the Broadleaved Woodland Broad Habitat in England between 1998 and 2007. It was 74.0g/kg in 1998 and 63.2g/kg in 2007. The carbon concentration was also stable between 1978 and 2007 (See also *Chapter 2, Table 2.11*). This is consistent with the results from Kirby *et al.* (2005)[8] for a sample of broadleaved woods recorded in 1971 and 2001.

Bulk density and soil (0-15cm) carbon stock: The mean bulk density of soils (0-15cm) in the Broadleaved Woodland Broad Habitat in England in 2007 was 0.87g/cm^3, which when combined with soil (0-15cm) carbon concentration gave a carbon stock estimate of approximately 63tC/ha (See also *Chapter 2, Table 2.13*).

6.6.2 Coniferous Woodland

Soil (0-15cm) pH: The mean pH of soil (0-15cm) samples from Coniferous Woodland Broad Habitat in England did not change significantly between 1998 and 2007. The pH in Coniferous Woodland was 4.13 in 1998, and in 2007 it was 4.44. This is consistent with a no significant change since 1978, although it is still within the acidic range (See also *Chapter 2, Table 2.11*).

Soil (0-15cm) carbon concentration: There was no detectable change in the mean carbon concentration of soil (0-15cm) in the Coniferous Woodland Broad Habitat in England between 1998 and 2007, or over the longer-term, 1978-2007. The carbon concentration in Coniferous Woodland was 140.7g/kg in 1998, and in 2007 it was 116.8g/kg (See also *Chapter 2, Table 2.11*).

Bulk density and soil (0-15cm) carbon stock: The mean bulk density of soils (0-15cm) in the Coniferous Woodland Broad Habitat in England in 2007 was 0.67g/cm^3, which when combined with soil (0-15cm) carbon concentration gave a carbon stock estimate of approximately 70tC/ha (See also *Chapter 2, Table 2.13*). The greater carbon stock of soils in Coniferous Woodland than in Broadleaved Woodland may reflect the different soil types selected for Coniferous Woodland plantations as well as habitat differences.

[8] Kirby, K.J., Smart, S.M., Black, H.I.J., Bunce, R.G.H., Corney, P.M. and Smithers, R.J. (2005). Long term ecological change in British woodland (1971-2001). Peterborough: English Nature (Research Report 653).

▲ Sloe in flower • © *Natural England* • *Peter Dullaghan*

6.7 Discussion and conclusions

6.7.1 Introduction

Since the creation of the Forestry Commission in 1919 there have been several national strategies for woodlands in the UK. The most recent for England is the Defra publication *"A Strategy for England's Trees, Woods and Forests"*[9].

Expansion of the woodland resource is given slightly lower profile in the document compared with its predecessor[10]. The last two decades have seen increased rates of creation of new native woodlands on farmland and in old industrial areas; there has also been the replacement of felled conifers with broadleaved native trees, particularly as a result of the government's approach to the conservation of ancient woodland[11].

Expansion and restoration of broadleaved woodland are also targets within the woodland habitat action plans that are part of the UK Biodiversity Action Plan[12]. This is being implemented through the actions of organisations such as the Forestry Commission on it's own estates and through its grants to landowners and the Woodland Trust and at least 52 local biodiversity action partnerships[13], which include actions to meet the specific targets for the woodland Priority Habitats.

In considering the CS results, it should be born in mind that woodland takes a long time to develop, around 50 years to mature, and new woodlands may not have achieved the canopy required to classify as woodland under CS methodology. Woodland can also change very quickly, by felling or windthrow events, although the former is carefully controlled via licences from the Forestry Commission.

6.7.2 Broadleaved, Mixed and Yew Woodland

Broadleaved Woodland and Coniferous Woodland together amounted to a total of 1,238,000ha or 9.4% the area of England in 2007, and most of this was Broadleaved Woodland.

The area of Broadleaved Woodland increased by 5.8% between 1998 and 2007, and has increased by an estimated 10.6% (from 887,000ha in 1990 to 981,000ha in 2007) ***(Table 6.1)*** to cover an estimated 7.4% of the land area of England in 2007. This gives an average annual rate of increase in the area of Broadleaved Woodland (from both new woodland and conversion of Coniferous Woodland) of 5500 ha per annum over this period. The greatest coverage was in the Easterly Lowlands (8.0%), with least coverage in the Uplands (2.6%).

The expansion of this woodland between 1998 and 2007 was mainly by net conversion from the Arable and Horticulture and Improved Grassland Broad Habitats. This increase partly reflects policy actions to increase woodland on farmed land and incentives to replace felled conifers with broadleaved trees; it also reflects some natural processes, where reduced grazing or intervention has allowed vegetation to develop into woodland by natural succession. Locally the changes have been substantial, for example in the community forests and National Forest; in the latter the woodland cover has increased from approximately 6% to 18% since 1991 albeit not all of this has been broadleaved (*www.nationalforest.org*).

Although the majority of Broadleaved Woodland (93%) was also broadleaved in 1998, there has been some turnover of woodland. The two largest conversions were from Broadleaved Woodland to Lowland Calcareous Grassland (1%), and to Bracken (1%) but there were smaller conversions to most of the other Broad Habitats.

▲ Coppiced hazel, Hertfordshire • © *Natural England* • *Paul Glendell*

[9] Defra (2007). *A strategy for England's trees, woods and forests.* Defra/Forestry Commission, London.

[10] Forestry Commission (1998). *A new focus for England's woodlands.* Forestry Commission, Cambridge.

[11] Forestry Commission (2005b) *Keepers of Time: A Statement of Policy for England's Ancient & Native Woodland.* Forestry Commission, Cambridge.

[12] English Nature (1998). *UK Biodiversity Group: tranche 2 action plans (volumes 1 and 2).* English Nature, Peterborough. and HMSO (1995). *Biodiversity: the UK steering group report.* HMSO, London.

[13] www.ukbap.org.uk

Some losses will represent a gain in biodiversity – for example restoration of chalk grassland from invading scrub and new woodland, but losses of ancient woodland, particularly to development have a negative effect. Policies to protect ancient and native woodland have been strengthened since 1998 with the introduction of the government's *Keepers of Time* forestry policy and the special recognition given to ancient woods in Planning Policy Statement 9[14].

Between 1990 and 1998, the plant Species Richness Score recorded in Main Plots in Broadleaved Woodland decreased and then recovered between 1998 and 2007. The significant changes in condition characteristics (increase in species richness and butterfly caterpillar food plants in Main Plots), occurred in the Broadleaved Woodland in the Easterly Lowlands but the significant decrease in ruderal species occurred in the Westerly Lowlands.

There was a marked decrease in species richness (19%) in the areas targeted by Countryside Survey for their botanical interest, typically the less widespread habitats within this Broad Habitat type, with a significant decrease between 1990 and 1998. This decline in species richness is consistent with the marked reduction in ground flora species richness observed in 2001 in the GB-wide resurvey of broadleaved woodlands that were first recorded in 1971. The reduction was strongly correlated with expanding woodland canopy and reduced signs of recent management[14]. Unlike the results for Great Britain as a whole, there was no further decrease between 1998 and 2007. The reduction in species richness in these patches as well as in the Main Plots is consistent with survey work specifically designed to track long-term changes in British deciduous woodlands[15].

There were far fewer changes in the condition of vegetation in English woodlands compared to those of Great Britain as a whole. This may reflect that the main impacts in England, for example the intensification of agriculture and impacts of a decline in broadleaved woodland management that occurred earlier (e.g. in the period 1970-1990) compared to the rest of the country. Over the period 1990 to 2007, competitive species increased, which may reflect continuing effects of eutrophication. There was significant decrease in Ruderal Score from 2.05 to 1.99 in Broadleaved Woodland between 1998 and 2007. The reduction in ruderal species may reflect the closing over of the canopy in new woodland and consequent loss of open ground species.

Between 1978 and 2007, soils (0-15cm) in Broadleaved Woodland became significantly less acidic, although still within the mildly acidic range. As Broadleaved Woodland grows on almost any soil type and in most regions of the country, the decrease in acidity reflects the changes across the whole of England, and indeed Great Britain. The analysis of sampling plots presented here showed no overall corresponding changes in the composition of vegetation in Broadleaved Woodlands as measured by the Ellenberg pH Score.

Kirby *et al.* (2005)[15] similarly recorded an increase in soil pH (1971-2001) across 103 broadleaved woods in GB but not a corresponding change in the Ellenberg pH Score. They suggested that this may be in part because species with higher pH scores also often tend to have higher Light Scores; hence if woodland shade is also increasing this might counteract the effect of increasing pH in terms of Ellenberg Scores. The estimated carbon stock of Broadleaved Woodland soils (0-15cm) was approximately 63tC/ha in 2007.

Further analysis may reveal different trends associated with different soil types and/or in different regions of England.

6.7.3 Coniferous Woodland

The estimated area of Coniferous Woodland in England did not change significantly between 1990 and 2007. In 2007, Coniferous Woodland covered an estimated 1.9% of the land area of England. The greatest coverage was in the Westerly Lowlands, in contrast to the greater coverage of Broadleaved Woodland in the Easterly Lowlands, which may reflect climatic or soil preferences for these different woodland types and different patterns of historic land use. The least coverage was in the Uplands.

No change in the diversity and character of vegetation was detected.

There was no shift in pH observed in the soils (0-15cm) in Coniferous Woodland between 1978 and 2007. Coniferous plantations tend to be established on the more acid soils and tend to have a more acidifying effect (through their litter) on the soil beneath them than broadleaves. This may over-ride any lessening of acidification from the atmosphere. The vegetation also showed no change in mean Ellenberg pH Score. The estimated stock of carbon in Coniferous Woodland soils (0-15cm) was approximately 70tC/ha in 2007.

6.7.4 Ecosystem Services and Climate Change

Carbon sequestration and storage in soils is a regulatory ecosystem service. CS does not estimate carbon stored in the biomass, but results from the GB-wide woodland resurvey[15] suggest that it is likely to have increased as basal area of growing trees increased.

Broadleaved and Coniferous Woodland occupied a total of 9.4% of the land area of England. Given the current interest in mitigation of climate change, it is interesting to note that the averaged soil (0-15cm) carbon stock estimate of both woodland Broad Habitats (63tC/ha for Broadleaved and 70tC/ha for Coniferous Woodland) in England is within the middle of the range for all Broad Habitats (42.6 to 87.6 tC/ha, see also ***Chapter 2***), which when added to the carbon held as biomass makes woodland a 'high carbon storage habitat'.

The Climate Change Act[16] has set new targets to reduce carbon emission, and to change towards more renewable energy resources. This could affect the way we manage and value our woodlands in the future.

[14] Forestry Commission (2005) *Keepers of Time: A Statement of Policy for England's Ancient & Native Woodland.* Forestry Commission, Cambridge.
ODPM 2005. *Planning Policy Statement 9: Biodiversity and geological conservation.* ODPM, London.

[15] Kirby, K.J., Smart, S.M., Black, H.I.J., Bunce, R.G.H., Corney, P.M. and Smithers, R.J. (2005). *Long term ecological change in British woodland (1971-2001).* Peterborough: English Nature (Research Report 653).

[16] available at http://www.defra.gov.uk/environment/climatechange/uk/legislation/

6.7.5 Conclusions

The Coniferous Woodland cover in England appears to be relatively stable in both its extent and composition. Increases due to planting may be being matched by clearance of stands to restore open habitats such as bog or lowland heath. In addition, an increase in temporary open ground within commercial forests is likely over the next 10 years, as the extensive areas planted between 1950 and 1980 reach felling age.

There is more dynamic change within the Broadleaved, Mixed and Yew Woodland resource. The decline in species richness between 1998 and 2007 was much slower than between 1990 and 1998, and there have been other changes in the overall composition of the vegetation between 1990 and 2007 – for example the increase in competitive species. Interpreting these changes is complicated by the continuing increase in the area of Broadleaved Woodland, so that the main results include the effect of the addition of plots that were formally in open ground and have now become woodland.

The Countryside Survey results are crucial in fitting other surveys into the context of change within the whole landscape. These other surveys can assist with untangling different impacts. For example, at the individual site level factors such as land-use surrounding the sampled woods, climate change, pollution (sulphur and nitrogen deposition), shading and increasing deer grazing pressure have been shown to be important influences on woodland condition[17]. Further interrogation of the CS data, in conjunction with other data sets would also help, for example comparing the trends for key groups of plants from different types of surveys and scales of survey (e.g. CS, Plant Atlas[18]) cross referencing changes in woodland plots against whether the sites are ancient or not; or examining the trajectory for individual plots might be informative.

Given the current interest in mitigation of climate change, it is interesting to note that the averaged soil (0-15cm) carbon stock estimate of both woodland Broad Habitats (63tC/ha for Broadleaved and 70tC/ha for Coniferous Woodlands) in England is within the middle of the range for all Broad Habitats (42.6 to 87.6tC/ha), which when added to the carbon held as biomass makes woodland a 'high carbon storage habitat' (see also *Chapter 2*). Woodland occupies 9.4% of the land area of England. The Climate Change Act[19] has set new targets to reduce carbon emission, and to change towards more renewable energy resources. This could affect the way we manage and value our woodlands in the future.

[17] Kirby, K.J.; Smart, S.M.; Black, H.I.J.; Bunce, R.G.H.; Corney, P.M. and Smithers, R.J. (2005). *Long term ecological change in British woodland (1971-2001).* Peterborough: English Nature (Research Report 653) and Williams, J M. (2006). *Commons standards monitoring for designated sites: first six years report.* Peterborough, Joint Nature Conservation Committee.

[18] Preston, C.D.; Pearman, D.A and Dines, T.D. (2002). *New Atlas of the British and Irish Flora.* Botanical Society of the British Isles

[19] available at http://www.defra.gov.uk/environment/climatechange/uk/legislation/

▲ Heather moorland, County Durham • © *Natural England* • *Charlie Hedley*

7. Mountain, Moor and Heath: Bracken, Dwarf Shrub Heath, Bog and Fen, Marsh and Swamp Broad Habitats

Summary

Area and change

- The estimated area of the Bracken Broad Habitat was approximately 91,000ha, or 0.7% of the area of England in 2007. Most of this was in the Uplands Environmental Zone, with some in the Westerly Lowlands and very little in the Easterly Lowlands.
- The estimated area of Dwarf Shrub Heath Broad Habitat was approximately 331,000ha, or 2.5% of the land area of England in 2007. It was mainly in the Uplands Environmental Zone, with some occurring in the Westerly Lowlands, and less in the Easterly Lowlands.
- The estimated area of Bog Broad Habitat was approximately 140,000ha, which represents 1.1% of the land area of England, and it occurred mainly in the Uplands Environmental Zone.
- The estimated area of Fen, Marsh and Swamp Broad Habitat was approximately 117,000ha, or 0.9% of the land area of England in 2007.
- There was a significant 15% increase (43,000ha) in area of Dwarf Shrub Heath in England between 1998 and 2007, as determined by the vegetation present. There was no significant increase in any of the Environmental Zones, but the area did increase in each of them, with the greatest area of increase in the Uplands Environmental Zone.
- The area of Bracken, Bog and of Fen, Marsh and Swamp Broad Habitats did not change significantly in England between 1998 and 2007.
- There was a significant decrease from 9,000 to 5,000ha in the area of Bracken in the Easterly Lowlands Environmental Zone, where this habitat type is rare, between 1998 and 2007.

- **There was a significant decrease in the area of Fen, Marsh and Swamp Broad Habitat from 61,000 to 52,000ha in the Westerly Lowlands between 1998 and 2007. This contrasts with previous significant increases in area between 1990 and 1998.**

- **The habitats of Mountain, Moor and Heath showed relative constancy with only small areas changing from one Broad Habitat to another in England between 1998 and 2007. The increase in Dwarf Shrub Heath came mainly from a conversion from Acid Grassland.**

Condition

- **Very few changes in the plant species richness or vegetation characteristics of plots within the Bracken, Dwarf Shrub Heath, Bog or Fen, Marsh and Swamp Broad Habitats were detected in England between 1998 and 2007, which is a marked difference from the results for Great Britain.**

- **There was a slight increase (from 18.6 to 18.9 plant species per 200m^2 Main Plot) in Bracken between 1998 and 2007, which was significant only in the Uplands Environment Zone.**

- **There was a significant increase in the ratio of grasses to forbs and the proportion of competitive species in Main Plots in the Dwarf Shrub Heath Broad Habitat in England between 1998 and 2007. The increase in the ratio of grasses to forbs was also significant in the Uplands Environmental Zone.**

- **There was a significant increase in the proportion of competitive species in Targeted Plots in Fen, Marsh and Swamp in England and a significant decrease in the proportion of stress tolerating plants in this Broad Habitat in the Uplands Environmental Zone between 1998 and 2007.**

- **The lack of overall change in vegetation characteristics in Dwarf Shrub Heath between 1998 and 2007 is in contrast to many significant changes between 1990 and 1998.**

Soils

- **There was a significant increase in the pH of soil (0-15cm) (although it remained within the acidic range) in Bracken (from 4.08 to 4.89) and Dwarf Shrub Heath (from 4.12 to 4.40) Broad Habitats in England between 1998 and 2007. In Bog, and in Fen, Marsh and Swamp, there was no significant change in pH between 1998 and 2007.**

- **In Bracken, Dwarf Shrub Heath, in Bog and in Fen, Marsh and Swamp soils (0-15cm) the carbon concentrations across England in 2007 were not significantly different from 1978 values.**

- **Dwarf Shrub Heath contained the largest stock of soil (0-15cm) carbon (88tC/ha) of all the Broad Habitats sampled in England in 2007.**

7.1 Introduction[1]

Six Broad Habitats make up the mosaic of open, unenclosed landscapes of England that many people associate with 'wilderness' and their enjoyment of the extensive landscapes of mountain, moor and heathland. The Fen, Marsh and Swamp Broad Habitat in England is better described as part of enclosed cultural landscapes, often occurring in fairly small patches. A large proportion of these Broad Habitats are found in the upland areas of north of England, Dartmoor and Exmoor and over substantial areas of unenclosed lowland habitats in the south of England, such as the New Forest, Dorset heaths, Ashdown Forest and Breckland. Many of these areas are also designated as National Parks, Areas of Outstanding Natural Beauty or Sites/Areas of Special Scientific Interest, reflecting their 'naturalness' compared to the intensive agricultural land use of much of England.

▲ Bog in Upper Teesdale • © *Natural England* • *Peter Wakely*

The geographically restricted nature of the Montane and Inland Rock Broad Habitats in England means that they occur in relatively few CS sample squares and these are not discussed here.

The presentation of data within three Environmental Zones; Uplands, Easterly Lowlands and Westerly Lowlands gives a feel for the relevance of these unenclosed Broad Habitats in the English Uplands and Lowlands *(Chapter 1)*. They show that whilst the Uplands have retained extensive areas of semi-natural vegetation there are very important areas of Bog, Dwarf Shrub Heath and Fen, Marsh and Swamp Broad Habitats in lowland England.

[1] **Note:** For further information on the Broad Habitat classification, sampling plots and other Countryside Survey terminology see *Chapter 1 (Introduction and Methodology)*

▲ Heather and moorland, Northumberland • © *NERC*

The changes that have occurred in unenclosed landscapes broadly reflect those from other Broad Habitats, but with less emphasis on agricultural management and perhaps more on conservation actions under the Biodiversity Action Plan (BAP) and to improve condition of habitats designated under European legislation; for both plants and animals. Many of these are rare animal or plant species, whose dynamics are better monitored by other schemes including those set up in response to the species and habitat action plans in the UK BAP. CS provides a unique contextual picture by measuring large-scale and increasingly long-term changes in the extent and condition of the more widespread habitats which characterise open landscapes.

7.2 Description of the Broad Habitats

The Broad Habitats covered in this chapter are:

Bracken: included in this Chapter as it is most usually associated with the uplands, although it is found throughout England. In CS, for an area to be included in the Bracken Broad Habitat it must have a 95-100% cover of bracken plants.

Dwarf Shrub Heath: characterised by areas dominated by heather species and/or Bilberry (*Vaccinium myrtillus*) on mineral or shallow peaty soils (wet heath). Heaths dominated by Western Gorse (*Ulex gallii*) occur mostly in south-west England. Note that stands of Common or European Gorse (*Ulex europaeus*), are included in Broadleaved, Mixed and Yew Woodland Broad Habitat. Dwarf Shrub Heath is associated with upland areas but it also occurs on acid soils in the lowlands, where it includes the Priority Habitat of Lowland Heath.

Bog: includes blanket bogs, raised and valley bogs and mires. It is predominantly found in the uplands where number of rain days per year (c.180 days plus) is high. The water chemistry is nutrient-poor and tends to be acidic and the habitat is dominated by acid-loving plant communities, especially *Sphagnum* mosses. This Broad Habitat occurs on deep peat and can be misclassified when degraded and dominated by the grasses (*Molinia* spp.) or heather.

Fen, Marsh and Swamp: includes varied, often small wetland habitats that are fed by ground or river waters rather than directly by rainfall. The peaty or mineral soils are permanently, seasonally or periodically wet with vegetation dominated by herbs, sedges and rushes rather than grasses.

Acid Grassland and mosaics of Acid Grassland, Bracken and Bog make up much of the marginal upland and lowland areas of England. Results for Acid Grassland are reported in *Chapter 4*.

7.3 Changes in the area of mountain, moor and heath Broad Habitats

Summary

- **The estimated area of the Bracken Broad Habitat was approximately 91,000ha, or 0.7% of the area of England in 2007. Most of this was in the Upland Environmental Zone, with some in the Westerly Lowlands and very little in the Easterly Lowlands.**
- **The estimated area of Dwarf Shrub Heath Broad Habitat was approximately 331,000ha, or 2.5% of the land area of England in 2007. It was mainly in the Uplands Environmental Zone, with some occurring in the Westerly Lowlands, and less in the Easterly Lowlands.**
- **The estimated area of Bog Broad Habitat was approximately 140,000ha, which represents 1.1% of the land area of England, and it occurred mainly in the Uplands Environmental Zone in 2007.**
- **The estimated area of Fen, Marsh and Swamp Broad Habitat was approximately 117,000ha, or 0.9% of the land area of England in 2007.**
- **There was a significant 15% increase (43,000ha) in area of Dwarf Shrub Heath in England between 1998 and 2007, as determined by the vegetation present. There was no significant increase in any of the Environmental Zones, but the area did increase in each of them, with the greatest area of increase in the Uplands Environmental Zone.**
- **The area of Bracken, Bog and of Fen, Marsh and Swamp Broad Habitats did not change significantly in England between 1998 and 2007.**

- **There was a significant decrease from 9,000 to 5,000ha in the area of Bracken in the Easterly Lowlands Environmental Zone, where this habitat type is rare, between 1998 and 2007.**

- **There was a significant decrease in the area of Fen, Marsh and Swamp Broad Habitat from 61,000 to 52,000ha in the Westerly Lowlands between 1998 and 2007. This contrasts with previous significant increases in area between 1990 and 1998.**

7.3.1 Bracken

The estimated area of the Bracken Broad Habitat in 2007 was approximately 91,000 ha, which represents 0.7% of the land area, with most of this in the Uplands Environmental Zone (see *Table 7.1*). The area of Bracken in England remained unchanged between 1998 and 2007 with the exception of a decrease in the Easterly Lowlands where this Broad Habitat is rare. This constancy of Bracken extent in England contrasts with the significant decline reported for Great Britain as a whole.

7.3.2 Dwarf Shrub Heath

The estimated area of Dwarf Shrub Heath Broad Habitat in 2007 was approximately 331,000ha or 2.5% of the land area of England *(Table 7.2)*. It was mainly in the Uplands Environmental Zone, with some occurring in the Westerly Lowlands, and less in the Easterly Lowlands Environmental Zone. There was a significant 15% increase (43,000ha) in area of Dwarf Shrub Heath in England between 1998 and 2007. There was no significant increase in any of the Environmental Zones, but the area did increase in each of them, with the greatest area of increase in the Uplands Environmental Zone.

The published estimate of Dwarf Shrub Heath for England is 316,260ha based upon habitat inventories and interpretation of soils and vegetation community surveys[2]. This roughly equates to the area estimate from Countryside Survey in 2007, but other sources suggest that it has not increased significantly over recent decades, with only some limited expansion as a consequence of targeted schemes in the last decade.

▲ Bilberry and Topiary Heather • © *Natural England* • *Tom Holland*

7.3.3 Bog

The estimated area of Bog Broad Habitat was approximately 140,000ha, which represents 1.1% of the land area *(Table 7.3)*. It occurred mainly in the Uplands Environmental Zone. There was no detectable change in the estimated area of Bog in England between 1998 and 2007, following the significant increase between 1990 and 1998.

The published figures for England, based on habitat inventories[2], peat deposit mapping and survey information gives an estimate of 265,535ha of Blanket Bog and Lowland Raised Bog on SSSIs alone, with an additional third more outside designated areas[2]. This is greater than the area of Bog Broad Habitat reported by Countryside Survey in 2007. This is most likely attributable to definitional limitations which can result in degraded Bog being classified as Dwarf Shrub Heath or Acid Grassland on the basis of their surface vegetation.

7.3.4 Fen, Marsh and Swamp

The estimated area of Fen, Marsh and Swamp Broad Habitat in 2007 was approximately 118,000ha, or 0.9% of the land area of England. There was no statistically detectable change in the area of Fen, Marsh and Swamp across England between 1998 and 2007, although there was a significant decrease from 61,000 to 52,000ha in the Westerly Lowlands Environmental Zone. This contrasts with significant increases in area between 1990 and 1998.

7.4 Conversion between Broad Habitats

Summary

- **The habitats of mountain, moor and heath showed relative constancy with only small areas changing from one Broad Habitat to another in England between 1998 and 2007. The increase in Dwarf Shrub Heath came mainly from a conversion from Acid Grassland.**

7.4.1 Bracken

Nearly 90% of Bracken Broad Habitat in 1998 was also Bracken in 2007. Areas of Bracken were both lost and gained from many of the other Broad Habitats between 1998 and 2007, with flows to and from Acid Grassland and Dwarf Shrub Heath most common.

7.4.2 Dwarf Shrub Heath

Most of the increase in the area of Dwarf Shrub Heath between 1998 and 2007 came from Acid Grassland in 1998 and to a lesser extent Bracken.

[2] Hewins,E.;, Toogood,S.; Alonso ,I.; Glaves, D.; Cooke, A., and Alexander, R. (2008) The Condition of Lowland Heathland: results a sample survey of non-SSSI stands in England. Natural England Research Report, NERR002. Natural England, Sheffield, England. Available at: http://naturalengland.etraderstores.com/NaturalEnglandShop/Product.aspx?ProductID=23cc3e1c-fa50-4c8f-9f4e-5b9dff9eef3d

▼ **Table 7.1:** Estimated area ('000s ha) and percentage of land area of the Bracken Broad Habitat in England from 1990 to 2007. Arrows denote significant change ($p<0.05$) in the direction shown.

	1990		1998		2007		Direction of significant changes 1998 - 2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
England	93	0.7	109	0.8	91	0.7	
Easterly Lowlands	8	0.1	9	0.1	5	0.1	↓
Westerly Lowlands	34	0.7	37	0.7	30	0.6	
Uplands	52	3.3	64	4	57	3.6	

▼ **Table 7.2:** Estimated area ('000s ha) and percentage of land area of Dwarf Shrub Heath Broad Habitat in England from 1990 to 2007. Arrows denote significant change ($p<0.05$) in the direction shown.

	1990		1998		2007		Direction of significant changes 1998 - 2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
England	309	2.3	288	2.2	331	2.5	↑
Easterly Lowlands	8	0.1	9	0.1	12	0.2	
Westerly Lowlands	54	1.1	32	0.6	50	1	
Uplands	247	15.7	247	15.7	270	17.1	

▼ **Table 7.3:** Estimates of the area ('000s ha) and percentage of land area of Bog Broad in England from 1990 to 2007. Arrows denote significant change ($p<0.05$) in the direction shown. Note that because of changes in definitions that have been applied retrospectively, the estimates from 1990 are not in all cases directly comparable with later surveys.

	1990		1998		2007		Direction of significant changes 1998 - 2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
England	98	0.7	138	1	140	1.1	
Easterly Lowlands	10	0.2	5	0.1	1	0	
Westerly Lowlands	4	0.1	7	0.1	5	0.1	
Uplands	84	5.3	126	8	134	8.5	

▼ **Table 7.4:** Estimated area ('000s ha) and percentage of land area of Fen, Marsh and Swamp Broad Habitat in England from 1990 to 2007. Arrows denote significant change ($p<0.05$) in the direction shown. Note that because of changes in definitions that have been applied retrospectively, the estimates from 1990 are not in all cases directly comparable with later Surveys.

	1990		1998		2007		Direction of significant changes 1998 - 2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
England	78	0.6	124	0.9	117	0.9	
Easterly Lowlands	9	0.1	16	0.2	15	0.2	
Westerly Lowlands	34	0.7	61	1.2	52	1	↓
Uplands	35	2.2	47	3	50	3.2	

7.4.3 Bog

Bog is a very constant habitat, 93% remained the same, and there were few changes between 1998 and 2007. There were some conversions to and from Acid Grassland and some Coniferous Woodland became Bog after felling.

▲ Bog habitat in Hampshire • © *Natural England* • *Peter Wakely*

7.4.4 Fen, Marsh and Swamp

Changes of Fen, Marsh and Swamp to Acid and Neutral Grasslands were almost balanced by conversions from those Broad Habitats to Fen, Marsh and Swamp. Small areas of Improved Grassland and Coniferous Woodland converted to and from Fen, Marsh and Swamp. These flows reflect both real change and some randomly distributed mapping and allocation inconsistencies at classification boundaries.

7.5 Changes in vegetation of the Mountain, Moor and Heath Broad Habitats

Summary

- **Very few changes in the plant species richness or vegetation characteristics of plots within the Bracken, Dwarf Shrub Heath, Bog or Fen, Marsh and Swamp Broad Habitats were detected in England between 1998 and 2007, which is a marked difference from the results for Great Britain.**
- **There was a slight increase (from 18.6 to 18.9 plant species per 200m² Main Plot) in Bracken in England between 1998 and 2007, which was significant only in the Uplands Environment Zone.**
- **There was a significant increase in the ratio of grasses to forbs and the proportion of competitive species in Main Plots in the Dwarf Shrub Heath Broad Habitat in England between 1998 and 2007. The increase in the ratio of grasses to forbs was also significant in the Uplands Environmental Zone.**
- **There was a significant increase in the proportion of competitive species in Targeted Plots in Fen, Marsh and Swamp in England and a significant decrease in the proportion of stress tolerating plants in this Broad Habitat in the Uplands Environmental Zone between 1998 and 2007.**
- **The lack of overall change in vegetation characteristics in Dwarf Shrub Heath between 1998 and 2007 is in contrast to many significant changes between 1990 and 1998.**

7.5.1 Changes in the condition of Bracken

There have been few changes in the Species Richness Score of 200m² Main Plots[3] in Bracken in the period 1990 to 2007. There was a slight but not statistically significant increase (from 18.6 to 18.9 plant species per 200m² Main Plot) between 1998 and 2007. The increase in Species Richness Score was significant only in the Uplands Environment Zone during this period *(Table 7.5)*.

There were no changes in the condition of vegetation associated with the Bracken Broad Habitat in England between 1998 and 2007.

7.5.2 Changes in the condition of Dwarf Shrub Heath

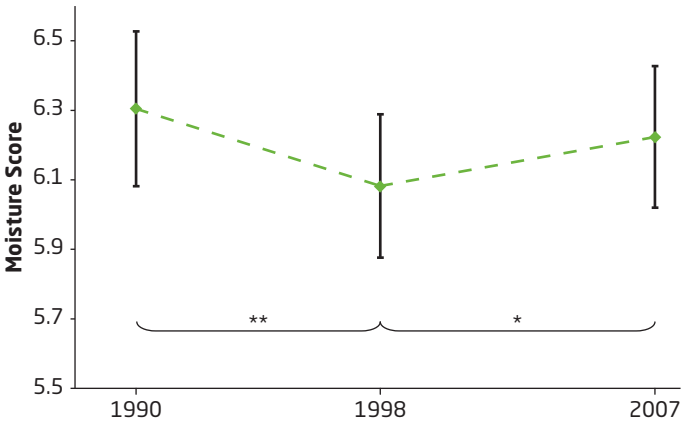
Main Plots:

Species richness: No significant change was detected in mean Species Richness Score in the Main Plots in the Dwarf Shrub Heath Broad Habitat between 1998 and 2007. Unlike results across all of Great Britain, for England there was no significant decrease in the mean Species Richness Score between 1990 and 1998 or 1990 and 2007. There were no changes in the numbers of plant species used by farmland birds or butterfly caterpillars as food between 1998 and 2007. There was a significant increase in the ratio of grasses to forbs and the proportion of competitive species in Main Plots in England between 1998 and 2007, which may lead to deterioration in the quality of this Broad Habitat, but may also be an indication that some of the Dwarf Shrub Habitat has recently been formed following the increase in the area of this Broad Habitat. The increase in the ratio of grasses to forbs was also significant in the Uplands Environmental Zone between 1998 and 2007.

Many of the species which became less frequent in Main Plots between 1998 and 2007 *(Table 7.7)* were small, less nutrient demanding herbs. The species increasing in frequency typically prefer wet heaths and damper places.

Other condition characteristics: Between 1998 and 2007, there was no significant increase in the mean Fertility Score in Main Plots within Dwarf Shrub Heath in England, following the significant increases in the previous reporting period 1990 to 1998. There was a significant increase in the mean Moisture Score in Main Plots in Dwarf Shrub Heath between 1998 and 2007 *(Fig. 7.1)*, but this must be considered alongside the significant decrease between 1990 and 1998. This measure includes two component habitats; wet and dry heath which occur on different soil types and have very different moisture ranges and therefore is an average of two extremes.

▼ **Figure 7.1:** The changes in mean Moisture Score in 200m² Main Plots in the Dwarf Shrub Heath Broad Habitat across England between 1990 and 2007. Significant changes (*p<0.05) are shown between the dates bracketed. 95% CI are shown for each data point.



[3] Main Plots are randomly located to assess widespread and common habitat types in the open countryside

▼ **Table 7.5:** Change in the characteristics of vegetation in 200m² Main Plots in the Bracken Broad Habitat across England (E) and the three Environmental Zones (EL - Easterly Lowlands, WL - Westerly Lowlands, UP - English Uplands) between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available at *www.countrysidesurvey.org.uk*. Arrows denote significant change ($p<0.05$) in the direction shown. Insufficient data for analysis denoted by grey cells with diagonal strikethrough. Analyses are described in ***Box 1.3 of the UK Results from 2007 report***.

	Mean values (England)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**
Species Richness (No. of Species)	18.6	18.9				↑								
No. of Bird Food Species	5.4	5.6												
No. of Butterfly Food Species	8.1	7.9												
Grass:Forb Ratio	-0.46	-0.48												
Competitor Score	2.5	2.64												
Stress Tolerator Score	3.07	2.96												
Ruderal Score	1.84	1.89												
Light Score	6.54	6.47												
Fertility Score	3.5	3.68												
Ellenberg pH Score	4.06	4.15												
Moisture Score	5.73	5.75												

▼ **Table 7.6:** Change in the characteristics of vegetation in 200m² Main Plots in the Dwarf Shrub Heath Broad Habitat across England (E) and the three Environmental Zones (EL - Easterly Lowlands, WL - Westerly Lowlands, UP - English Uplands) between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available at *www.countrysidesurvey.org.uk*. Arrows denote significant change ($p<0.05$) in the direction shown. Insufficient data for analysis denoted by grey cells with diagonal strikethrough. Analyses are described in ***Box 1.3 of the UK Results from 2007 report***.

	Mean values (England)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**
Species Richness (No. of Species)	10.9	11												
No. of Bird Food Species	2.4	2.4					↑			↑	↑			↑
No. of Butterfly Food Species	6.2	6.1												
Grass:Forb Ratio	1.02	1.39	↑			↑	↓			↓				
Competitor Score	2.32	2.41	↑				↓			↓				
Stress Tolerator Score	3.53	3.46												
Ruderal Score	1.43	1.42					↑							
Light Score	6.76	6.82												
Fertility Score	2.54	2.54					↑			↑	↑			↑
Ellenberg pH Score	2.96	2.98												
Moisture Score	6.08	6.22	↑			↑	↓			↓				

Targeted Plots:

The Dwarf Shrub Heath Broad Habitat constitutes a wide range of sub-habitat types in upland and lowland situations, including some Priority Habitats. These areas within Dwarf Shrub Heath were targeted by CS for their botanical interest using the Targeted Plots[4]. Examples of these areas would include Dry Acid Grassland Priority Habitat, bog and flushes.

Species richness: The Species Richness score in Targeted Plots within Dwarf Shrub Heath in England did not change significantly between 1998 and 2007 *(Table 7.8)*, in contrast to the results across Great Britain where there was a significant decrease. There was a significant decrease in the Species Richness Score in Targeted Plots in Dwarf Shrub Heath in England between 1990 and 2007. There was a significant decrease in the number of plant species used by farmland birds as food in Targeted Plots in Dwarf Shrub Heath between 1998 and 2007 and the number of plant species used by butterfly caterpillars as food in Targeted Plots also decreased over the longer time period, 1990 to 2007.

[4] Targeted Plots (2m x 2m) are positioned by surveyors to assess small areas of botanical interest which may be overlooked by the randomly located Main Plots

▼ **Table 7.7:** The 10 plant species with the largest increase and decrease in the number of Main Plots in which they were recorded in Dwarf Shrub Heath between 1998 and 2007. These changes were supported by the calculation of a Broad Habitat wide Change Index.

Species with increasing frequency		Rank Order	Species with decreasing frequency		Rank Order
Juncus effusus	Soft Rush	1	*Carex viridula*	Common Yellow Sedge	1
Agrostis canina sens lat	Velvet Bent	2	*Campanula rotundifolia*	Harebell	2
Carex binervis	Green-ribbed Sedge	3	*Festuca ovina agg.*	Sheep's Fescue	3
Carex echinata	Star Sedge	4	*Festuca rubra agg.*	Red Fescue	4
Viola riviniana/reichenbachiana	Dog Violet	5	*Aira praecox*	Early Hair-grass	5
Vaccinium vitis-idaea	Cowberry	6	*Carex nigra*	Common Sedge	6
Rumex acetosella	Sheep's Sorrel	7	*Holcus mollis*	Creeping Soft-grass	7
Molinia caerulea	Purple Moor-grass	8	*Erica cinerea*	Bell Heather	8
Salix repens agg.	Creeping Willow	9	*Poa pratensis sens.lat*	Smooth Meadow-grass	9
Hypericum pulchrum	Slender St John's-wort	10	*Carex flacca*	Glaucous Sedge	10

▼ **Table 7.8:** Change in the characteristics of vegetation in 2m x 2m Targeted Plots in the Dwarf Shrub Heath Broad Habitat in England (E) and the three Environmental Zones (EL - Easterly Lowlands, WL - Westerly Lowlands, UP - English Uplands) between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available at *www.countrysidesurvey.org.uk*. Arrows denote significant change ($p<0.05$) in the direction shown. Insufficient data for analysis denoted by grey cells with diagonal strikethrough. Analyses are described in ***Box 1.3 of the UK Results from 2007 report***.

	Mean values (England)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	1998	2007	E	EL	WL	UP	E	EL	WL	UP	E	EL	WL	UP
Species Richness (No. of Species)	6.6	6.3									↓		↓	
No. of Bird Food Species	1.5	1	↓											
No. of Butterfly Food Species	3.5	3.4					↓		↓		↓		↓	
Grass:Forb Ratio	1.32	1.18												
Competitor Score	2.37	2.52	↑		↑	↑								
Stress Tolerator Score	3.45	3.36			↓									
Ruderal Score	1.47	1.38												
Light Score	6.8	6.86												
Fertility Score	2.6	2.46												
Ellenberg pH Score	3.25	3.08												
Moisture Score	6.21	6.26					↓			↓				

▼ **Table 7.9:** Change in the characteristics of vegetation in 200m² Main Plots in the Bog Broad Habitat across England (E) and the three Environmental Zones (EL - Easterly Lowlands, WL - Westerly Lowlands, UP - English Uplands) between 1990 and 2007. Mean values for condition measures in 1998 and 2007 are presented; those for 1990 are available at *www.countrysidesurvey.org.uk*. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3 of the UK Results from 2007 report***.

	Mean values (England)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	1998	2007	E	EL	WL	UP	E	EL	WL	UP	E	EL	WL	UP
Species Richness (No. of Species)	18.3	17.2												
No. of Bird Food Species	2.2	1.8												
No. of Butterfly Food Species	6.7	6.4								↑				
Grass:Forb Ratio	1.14	1.38												
Competitor Score	2.15	2.18				↑								↑
Stress Tolerator Score	3.67	3.68												
Ruderal Score	1.41	1.37												
Light Score	7.27	7.26												
Fertility Score	2.13	2.08												
Ellenberg pH Score	3.08	2.99												
Moisture Score	7.11	7.12												

▲ Cowberry (*Vaccinium vitis-idaea*) in fruit – one of the species increasing in frequency in Dwarf Shrub Heath
• © *Natural England* • *Peter Dullaghan*

Other condition characteristics: The proportion of competitive plants within Targeted Plots increased between 1998 and 2007. A similar increase in competitive species was reported for the Main Plots randomly situated in the Broad Habitat, but unlike the Main Plots, no change in Moisture Score was detected.

7.5.3 Changes in the condition of Bog

Main Plots:

Species richness: No changes in the mean plant Species Richness Score and vegetation characteristics of Main Plots within the Bog Broad Habitat were detected across England as a whole between 1998 and 2007 *(Table 7.9)*.

Other condition characteristics: The significant changes in Competitor Score in Bog Broad Habitat was detected only in the Uplands Environmental Zone, where sample sizes are much larger than in other Zones *(Table 7.9)*.

Targeted Plots:

Small patches of other habitats occur within areas of Bog Broad Habitat including Priority Habitats e.g. Blanket Bog, and also flushes, pools and drier outcrops of Upland Dwarf Shrub Heath. These areas were targeted by CS for their botanical interest using 2m x 2m Targeted Plots.

No changes were detected in the mean Species Richness Score or vegetation condition measures in Targeted Plots used to sample areas targeted by CS for their botanical interest in areas of the Bog Broad Habitat between 1998 and 2007.

7.5.4 Changes in the condition of Fen, Marsh and Swamp

Main Plots:

Unlike the results for Great Britain as a whole there was no decrease in the Species Richness Score in Main Plots within Fen, Marsh and Swamp across England, between 1998 and 2007.

Targeted Plots:

In common with the results for the Main Plots randomly sited in the Broad Habitat, there was no significant change in the mean plant Species Richness Score in the Targeted Plots used to sample areas targeted by CS for their botanical interest *(Table 7.11)*.

There was a significant increase in the proportion of competitive species and a significant decrease in the proportion of stress tolerating plants in Targeted Plots in Fen, Marsh and Swamp between 1998 and 2007.

▲ Fen, Marsh and Swamp, Herefordshire
• © *Natural England* • *Peter Wakely*

▼ **Table 7.10:** Change in the characteristics of vegetation in 200m² Main Plots in the Fen, Marsh and Swamp Broad Habitat across England (E) and the three Environmental Zones (EL - Easterly Lowlands, WL - Westerly Lowlands, UP - English Uplands) between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available at *www.countrysidesurvey.org.uk*. Arrows denote significant change ($p<0.05$) in the direction shown. Insufficient data for analysis denoted by grey cells with diagonal strikethrough. Analyses are described in ***Box 1.3 of the UK Results from 2007 report***.

	Mean values (England)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**
Species Richness (No. of Species)	25	20.6					↑			↑				
No. of Bird Food Species	8.8	5.7	↓				↑							
No. of Butterfly Food Species	9.2	8					↑							
Grass:Forb Ratio	0.96	0.55									↓			
Competitor Score	2.56	2.69												
Stress Tolerator Score	2.83	2.8												
Ruderal Score	2.16	1.97												
Light Score	7.01	6.94								↑				
Fertility Score	3.85	3.77												
Ellenberg pH Score	4.6	4.5					↑			↑	↑			
Moisture Score	6.65	6.72												

▼ **Table 7.11:** Change in the condition of vegetation in 2m x 2m Targeted Plots in the Fen, Marsh and Swamp Broad Habitat across England (E) and the three Environmental Zones (EL - Easterly Lowlands, WL - Westerly Lowlands, UP - English Uplands) between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available at *www.countrysidesurvey.org.uk*. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3 of the UK Results from 2007 report***.

	Mean values (England)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**
Species Richness (No. of Species)	13.9	13												
No. of Bird Food Species	4.6	4.2												
No. of Butterfly Food Species	5.1	4.6					↑							
Grass:Forb Ratio	0.42	0.58				↑								↑
Competitor Score	2.97	3.09	↑		↑	↑					↑			↑
Stress Tolerator Score	2.36	2.3				↓		↑				↑		↓
Ruderal Score	2.24	2.15			↓									
Light Score	6.9	6.87												
Fertility Score	4.71	4.78					↑		↑		↑		↑	
Ellenberg pH Score	5.29	5.34												
Moisture Score	6.81	6.83					↓	↓	↓		↓	↓		↓

7.7 Changes in soils (0-15cm) in Mountain, Moor and Heath Broad Habitats

- **There was a significant increase in the pH of soil (0-15cm) (although it remained within the acidic range) in Bracken (from 4.08 to 4.89) and Dwarf Shrub Heath (from 4.12 to 4.40) Broad Habitats in England between 1998 and 2007. In Bog, and in Fen, Marsh and Swamp, there was no significant change in pH between 1998 and 2007.**
- **In Bracken, Dwarf Shrub Heath, in Bog and in Fen, Marsh and Swamp soils (0-15cm) the carbon concentrations across England in 2007 were not significantly different from 1978 values.**
- **Dwarf Shrub Heath contained the largest stock of soil (0-15cm) carbon (88tC/ha) of all the Broad Habitats sampled in England in 2007.**

7.7.1 Bracken

Soil (0-15cm) pH: The mean pH of soil (0-15cm) samples from Bracken Broad Habitat in England increased significantly from 4.08 to 4.89 between 1998 and 2007. This change was the greatest in magnitude of all significant changes in soil (0-15cm) pH. The difference in pH between 1978 and 2007 was also significant, although it was still within the acidic range (See also *Chapter 2, Table 2.11*).

Soil (0-15cm) carbon: There was no significant change in the mean carbon concentration of soil (0-15cm) in the Bracken Broad Habitat in England between 1998 and 2007. It was 104.1g/kg in 1998 and 131.3g/kg in 2007. The carbon concentration of soils (0-15cm) also showed no statistically significant change between 1978 and 2007 (See also *Chapter 2, Table 2.11*).

Bulk density and soil (0-15cm) carbon stock: The mean bulk density of soils (0-15cm) in the Bracken Broad Habitat in England in 2007 was 0.46 g/cm^3 which when combined with soil (0-15cm) carbon concentration gave a carbon stock estimate of approximately 81tC/ha (See also *Chapter 2, Table 2.13*).

7.7.2 Dwarf Shrub Heath

Soil (0-15cm) pH: The mean pH of soil (0-15cm) samples from the Dwarf Shrub Heath Broad Habitat in England increased slightly, but significantly from 4.12 to 4.40 between 1998 and 2007. The difference in pH between 1978 and 2007 was also significant, although it was still within the acidic range (See also *Chapter 2, Table 2.11*).

Soil (0-15cm) carbon: There was no significant change in the mean carbon concentration of soil (0-15cm) in the Dwarf Shrub Heath Broad Habitat in England between 1998 and 2007. It was 203.8g/kg in 1998 and 208.1g/kg in 2007. The carbon concentration of soils (0-15cm) also showed no statistically significant change between 1978 and 2007 (See also *Chapter 2, Table 2.11*).

Bulk density and soil (0-15cm) carbon stock: The mean bulk density of soils (0-15cm) in the Dwarf Shrub Heath Broad Habitat in England in 2007 was 0.47 g/cm^3, which when combined with soil (0-15cm) carbon concentration gave a soil (0-15cm) carbon stock estimate of approximately 88tC/ha (See also *Chapter 2, Table 2.13*). This is the largest stock of soil (0-15 cm) carbon of all the Broad Habitats sampled in England in 2007 but it is a possibility that some degraded Bog Broad Habitat has been classified as Dwarf Shrub Heath on the basis of its vegetation cover. Further investigation would be needed to verify this.

7.7.3 Bog

Soil (0-15cm) pH: The mean pH of soil (0-15cm) samples from Bog Broad Habitat in England did not change significantly but altered from 4.09 to 4.01 between 1998 and 2007. There was no significant change between 1978 and 2007 and soils remained in the acidic range (See also *Chapter 2, Table 2.11*).

Soil (0-15cm) carbon: There was no significant change in the mean carbon concentration of soil (0-15cm) in the Bog Broad Habitat in England between 1998 and 2007. It was 385.3g/kg in 1998 and 353.5g/kg in 2007. The carbon concentration also showed no statistically significant change between 1978 and 2007 (See also *Chapter 2, Table 2.11*).

Bulk density and soil (0-15cm) carbon stock: The mean bulk density of soils (0-15cm) in the Bog Broad Habitat in England in 2007 was 0.22g/cm^3 which when combined with soil (0-15cm) carbon concentration gave a soil (0-15cm) carbon stock estimate of approximately 74tC/ha (See also *Chapter 2, Table 2.13*). The very large carbon concentration in these soils is offset by the low bulk density, to yield a moderately large carbon stock in topsoil when compared to other Broad Habitats. It should be noted that this Broad Habitat typically occurs over deep peaty layers, which were not sampled by Countryside Survey.

7.7.4 Fen, Marsh and Swamp

Soil (0-15cm) pH: The mean pH of soil (0-15cm) samples from Fen, Marsh and Swamp Broad Habitat in England did not change significantly but altered from 5.83 to 5.48 between 1998 and 2007. There was no significant change between 1978 and 2007 and soils remained in the acidic range (See also Chapter 2, Table 2.11).

Soil (0-15cm) carbon: There was no detectable change in the mean carbon concentration of soil (0-15cm) in the Fen, Marsh and Swamp Broad Habitat in England between 1998 and 2007. It was 242.9g/kg in 1998 and 220.3g/kg in 2007. The carbon concentration also showed no statistically significant change between 1978 and 2007 (See also *Chapter 2, Table 2.11*).

Bulk density and soil (0-15cm) carbon stock: The mean bulk density of soils (0-15cm) in the Fen, Marsh and Swamp Broad Habitat in England in 2007 was 0.42g/cm^3 which when combined with soil (0-15cm) carbon concentration gave a soil (0-15cm) carbon stock estimate of approximately 76tC/ha (See also *Chapter 2, Table 2.13*).

▲ Bog Asphodel • © *Sue Wallis*

7.8 Discussion and Conclusions

7.8.1 General trends in unenclosed Broad Habitats

During the 1998 to 2007 reporting period of CS, the unenclosed Broad Habitats have been subject to some important policy changes and unplanned events.

A key driver of change during the 1998 to 2007 reporting period has been the policies over rural funding through first the themed targeting in Countryside Stewardship and latterly, through the England Rural Development Programme. Lessons were learned from previous schemes and improved prescriptions were used in the Environmental Stewardship Schemes. These provide funding for both baseline improvement on all farmland and specific action through the Higher Level Scheme. All of these schemes should improve the management of these six Broad Habitats, through securing what are considered more sustainable grazing regimes and restoring appropriate management where needed.

The main management tool for these Broad Habitats is grazing by cattle, sheep or ponies but the outbreak of Foot and Mouth Disease in February 2001 resulted in the slaughter of over 4 million animals and devastation of grazing stock over large parts of northern England. This loss of grazing had a dramatic impact on the uplands and movement restrictions meant further reductions in grazing pressure across England. A consequence of such extensive loss of livestock meant that many farmers re-evaluated their options and diversified where possible; with implications for the grazing pressure on these unenclosed Broad Habitats.

Land use pressures have changed direction since the last CS in 1998 for example, overall sheep numbers have reduced to levels last seen in the early 1980s, while the conversion of areas of land to conifer plantations has reduced in favour of replanting existing stands with broadleaved trees or restoration of heathland ***(Chapter 6)***. Much of the Uplands is also managed by burning for both agriculture and grouse shooting. Evidence is showing an increase in burning management over the last 20 years[5].

Other important policy changes in England have affected the way people experience unenclosed land and also the way in which land is conserved and managed. The Countryside and Rights of Way (CROW) Act 2000 provided greater opportunity for public access and enjoyment of unenclosed land in England. The period from 1998 to 2007 also coincided with the gradual implementation of the UK Biodiversity Action Plan (UK BAP see *http://www.ukbap.org.uk*). This includes specific targets for the restoration and maintenance of scarce and internationally important Priority Habitats embedded within the Mountain, Moor and Heath landscape. During this period, new Sites of Special Scientific Interest (SSSIs) were designated, all Special Areas of Conservation (SAC) and Special Protection Areas (SPA) designations were made, hence increasing the likely delivery of management prescription on many of these Broad Habitats.

Potentially important drivers of change in the period 1998 to 2007 could also include climate change and the general improvement of air, soil and water quality as policies restricting emissions took effect. For example, emissions of sulphur dioxide causing 'acid rain' have decreased substantially since the 1970s, with a consequent reduction in the amount of upland habitat exposed to potentially harmful levels of deposition. Long-term climate change could pose particular threats to upland species. There is an assumption that, at large scales, the distribution of species is controlled by climate. For upland species, as conditions generally become warmer the areas of suitable climate will tend to be limited to smaller areas at high altitudes, or in very exposed areas that are more isolated from one another. There has been an increase in the length of the average growing season by at least two weeks[6], with the largest advances occurring in the uplands. This increase could affect the interactions between plant species and the animals that are dependent upon them. For lowland areas drought stress will affect wetlands and plant communities on the unenclosed habitats and increase the risk of fires.

7.8.2 Bog Broad Habitat

The Bog Broad Habitat is unchanged in extent or vegetation characteristics over the period 1998-2007 after a significant increase in extent in England in the period 1990-1998. This category includes priority habitats, such as Lowland Raised Bog, that have been subject to specific policy interventions and restoration management yet the results indicate non-significant reductions in the Lowlands Environmental Zones and increases in the Uplands Environmental Zone where conversions from felling coniferous woodland and increased wetness of acid grassland have compensated for any losses. The impact of past drainage, where still present, is likely to be leading to continued deterioration of this habitat.

[5] Yallop, A.R.; Thacker, J.; Thomas, G.; Stephens, M.; Clutterbuck, B.; and Sannier, C. (2006) The extent and intensity of management burning in the English uplands. *Journal of Applied Ecology*. 43 (6) 1138-2664.

[6] http://www.defra.gov.uk/environment/statistics/globatmos/gakf19.htm

This Broad Habitat is characterised by vegetation lying over deep peat with a high water table. In England, there have been significant changes to this habitat as a consequence of attempts at agricultural improvement through drainage and from removal of the peat through direct extraction or the oxidation or erosion of drying peats through management pressures. The differences in previously published extent of Blanket Bog and Lowland Raised Bog Priority Habitats and the figures in CS reflect differences in interpretation. Vegetation cover samples under-estimate the extent of Bog Broad Habitat where degraded peat bodies are colonised by ericaceous shrubs and take on the appearance of Dwarf Shrub Heath, or Molinia dominated communities that can be mapped as Acid Grassland. The focus of CS is on land cover as measured at the point of survey and thus some degraded bogs will be reported as Dwarf Shrub Heath or Acid Grassland Broad Habitat.

The increasing interest in carbon sequestration as part of mitigation for climate change over the latest reporting period has not yet had any detectable impacts on this Broad Habitat. Recovery of Lowland Raised Bog is currently underway and has not yet been detectable by CS. The naturally wet, high carbon content of peaty soils in bogs make them a key focus for conservation activities. Their naturally acidic state as shown by soil pH has remained unchanged over the full range of reporting years and, in contrast with other Broad Habitats, presumably as a consequence of their buffering capacity.

7.8.3 Bracken Broad Habitat

Bracken Broad Habitat was unchanged in England in contrast to an overall decrease in extent reported across Great Britain. This stability in extent is apparent for the Uplands and Westerly Lowlands Environmental Zones, but with a significant decrease in the Easterly Lowlands. Chemical control of bracken is the main mechanism for reducing extent and this has been subject to review, following concern over the impact of Asulox on public water supply. Policies to stem the spread of bracken have been vigorously applied in some areas of the country and the lack of significant change in England may be an equilibrium between expansion and the impacts of control methods. It is not understood how climate change may affect bracken dynamics, as increased length of growing season and drought act in opposite ways.

▲ Bracken encroaching on heather • © *Natural England* • *Paul Glendell*

7.8.4 Dwarf Shrub Heath Broad Habitat

The dramatic increase in area of Dwarf Shrub Heath Broad Habitat in England is one of the headline results for CS in 2007. The analysis of CS samples, using vegetation cover as the definition indicates an increased in area by 15% and the increase has been seen in all three Environmental Zones in England. The attribution of samples to this Broad Habitat used the vegetation cover data alone, whilst the definition of this in BAP terms relies upon information about the underlying soil type. Heathlands typically overlie mineral soils, with wet heath occurring over shallow peats. The interpretation of this Broad Habitat needs to be seen in this context.

This Broad Habitat and its constituent Priority Habitats; Lowland Heathland and Upland Heathland, have been the focus of considerable targeted action during the 1998 to 2007 reporting period. A series of policy interventions were introduced in the 1998 to 2007 reporting period specifically Tomorrow's Heathland Heritage [7], Countryside Stewardship and latterly the Higher Level Scheme in Environmental Stewardship. All these have contributed to the restoration and recreation of Lowland Heathland to meet the targets set out in the Biodiversity Action Plan. An estimated 58,000 ha is now being maintained in extent, with improvement in the quality of individual sites. Similarly Upland Heaths were targeted by Countryside Stewardship and then Environmental Stewardship schemes. These policy initiatives have undoubtedly had a strong impact on the extent of Dwarf Shrub Heath in England, with reductions in grazing pressure allowing recovery of areas previously denuded of heather cover. This habitat was particularly affected by the Foot and Mouth outbreak in 2001 and part of the increased extent may be attributed to reversion from Acid Grassland on areas that had been Dwarf Shrub Heath in the past and prior to heavy grazing.

Rotational heather burning is used as a management tool in the uplands to encourage new growth for sheep and also as a way of managing grouse moors. Changes in the extent and intensity of moorland burning are difficult to determine since there is no consistent monitoring at the large scale. Regional surveys suggest that managed burning frequency has steadily increased in the English uplands, but recent trends elsewhere are uncertain.

The trends in this habitat show increases in Moisture Score, Grass:Forb ratio and Competitor species; all attributes that are expected in recently restored or created swards of this habitat. Dwarf Shrub Heath Broad Habitat has been subject to considerable pressures in the last two decades, with climate change, fires, aerial deposition, habitat degradation through neglect or inappropriate management or conversion for agriculture. Many of these issues have been tackled to help reverse declines in extent.

[7] http://www.naturalengland.org.uk/ourwork/conservation/biodiversity/protectandmanage/thhprogramme.aspx

The high carbon content of Dwarf Shrub Heath soils, the highest of any Broad Habitat, may be partly explained by definitional issues; degraded bog, which has deep peaty soils develops a surface vegetation that classifies as Dwarf Shrub Heath. This requires closer examination as the statistic of high carbon content in Dwarf Shrub Heath could lead to inappropriate policy responses to a well understood ecological phenomenon of habitat degradation leading to vegetation change.

7.8.5 Fen, Marsh and Swamp Broad Habitat

The area of Fen, Marsh and Swamp Broad Habitat remained unchanged between 1998-2007 after significant increases in extent between 1990 and 1998. The overall trend (between 1990 and 2007) is still an increase. Wetlands in general have been the focus of policy attention and the period 1998-2007 has seen dynamic changes between this Broad Habitat and Acid and Neutral Grassland. Thus, Fen, Marsh and Swamp is seen as no significant change in overall extent, but with dynamic change between Fen, Marsh and Swamp and drier associated Broad Habitats occurring locally under the influence of management. The overall trend 1900-2007 is still an increase of this habitat and is supported by continued conservation focus on wetlands as both of value for wildlife and water management.

Precipitation is a key influence in the Bog and Fen, Marsh and Swamp Broad Habitats with both surface and groundwater flows affecting their quality and quantity . With increased pressure on aquifers in many parts of England for public water supply and irrigation these wetlands will continue to suffer from reduced flows and periodic droughts. These factors will not be picked up through changes in extent, but will be reflected in change in biodiversity quality. These habitats now fall largely outside conventional agriculture as a result of their low productivity and treacherous terrain and consequently suffer from neglect through lack of management. This is apparent from the increase of competitors and grassiness of the Targeted Plots in this Broad Habitat and the significant reduction in stress tolerating plant species. These changes may be related to the influence of nutrient enrichment and management neglect that influence change in this Broad Habitat. Nutrient enrichment is a severe problem, particularly in basin and valley fens in the lowlands as these are highly susceptible to agricultural run-off within their catchments. The interaction between eutrophication, neglect and changes in water regime is difficult to unpick, but all play a part in the loss of stress-tolerators and increase in competitors. Neglect and eutrophication were identified as key factors in the unfavourable and declining status of various fen types in the recent UK Favourable Conservation Status assessment of Annex 1 habitats[8].

7.8.6 Conclusions

All Broad Habitats in this chapter are typically unenclosed habitats, with exception of Fen, Marsh and Swamp, that have marginal value for agriculture and are limited by climatic or edaphic factors such as water table or soil types. Thus the changes in these Broad Habitats are likely to be indicative of wider environmental change and the weather patterns of years preceding the survey.

The decrease in species richness in the unenclosed habitats seen in Great Britain as a whole between 1998-2007 was not apparent in England. This atypical trend in England may be a consequence of improved management regimes resulting from adoption of environmental stewardship schemes. However, the overall message is one of vegetation stability.

Interpretation of results of Bog and Dwarf Shrub Heath Broad Habitats for policy use needs to recognise the differences between the habitat definitions under the Biodiversity Action Plan and the perceived application of these categories in Countryside Survey in 2007. The CS methodology measures vegetation cover, whilst the BAP definitions include peat depth and hydrological factors when distinguishing Bog from Dwarf Shrub Heath. The observed increase in carbon content of soils in Dwarf Shrub Heath Broad Habitat could be attributed to plots being on degraded Bog, rather than BAP Dwarf Shrub Heath, but this requires further investigation. Similarly the increase in extent of Dwarf Shrub Heath is likely to include definitional differences as well as real change in the BAP Broad Habitat.

The Uplands unenclosed habitats described here, along with some grassland and woodland Broad Habitats occur as mosaics across the landscape. Change in extent is largely at the expense of other elements of the mosaic and under the influence of edaphic factors and land management. Over the 1998 to 2007 reporting period, there has been a change in management emphasis with the reduction of grazing pressure from sheep and a shift from coniferous plantation to broadleaved woodland or restoration to open moorland. These management shifts have been accompanied by reduction of atmospheric deposition of sulphur, apparently consistent with as seen in the increase in pH of Bracken and Dwarf Shrub Heath in the latest reporting period. The trends shown in vegetation composition and quality are likely to continue into the future.

The impacts of climate change are likely to have greatest impact in the Uplands as temperature rise and weather patterns influence the interactions between plants, animals and agricultural practices that shape them. The unenclosed Broad Habitats here are the main depositories of peat in England. Increasing efforts are being made to prevent carbon loss from peatlands and restore their functionality in sequestration processes. The impact of land management practices such as ditching and burning, are understood whilst the impact of climate change on carbon fluxes is less well known. This fact alone makes these unenclosed Broad Habitats a key area for research and further policy development.

[8] http://www.jncc.gov.uk/pdf/Article17/FCS2007-H7230-audit-Final.pdf

▲ River Eye, Gloscestershire • © *Natural England* • *Nick Turner*

8. Rivers, Streams and Standing Waters

Summary

Area and Change

- The area of Standing Open Water and Canals increased by 5.3% (6000ha)[1] in England between 1998 and 2007, with most of the increase taking place in the Easterly Lowlands Environmental Zone.
- Associated with the increase in the area of Standing Open Waters and Canals, the number of ponds increased by 18% (amounting to 37,000 ponds) in England between 1998 and 2007, with most of the increase taking place in the Easterly Lowlands Environmental Zone.
- The area of Rivers and Streams Broad Habitat did not change significantly between 1998 and 2007, as might be expected in established and managed catchments.

Condition

- In 2007, ponds in the English countryside supported an average of 6.9 wetland plant species per pond.
- Only 9% of ponds were in the Good PYSM quality category (based on their vegetation) and only 4.8% of ponds surveyed were of Priority Habitat quality (based on their vegetation).
- Plant species richness of streamsides decreased by 4% (from 15.7 to 15.1 species per Streamside Plot) in England between 1998 and 2007. There has been a successional process over time, with vegetation becoming more shade tolerant and an increasing proportion of competitive species, particularly in lowland areas of England.
- Plant species richness in streams increased (from 2.7 to 3.9 species per plot) in England between 1998 and 2007 and there was a high turnover of species; only 61% of all 114 aquatic plant taxa were recorded in both years.
- The physical habitat quality of headwater streams increase by 11%, from an HQA of 37.4 to 41.6 in England between 1998 and 2007. The greatest increase in quality was recorded in the Westerly Lowlands Environmental Zone, with a 13% increase in HQA.

[1] Standing Open Waters and Rivers and Streams BH estimates were calculated using a different statistical model to the other BHs. It is not appropriate to use the consistent statistical model for these two habitats because of the distribution of the data. Change in these BHs is calculated independently from the differences between stock estimates.

8.1 Introduction

Note to readers of Chapter 8:

The methodology for sampling freshwater habitats differs substantially from the terrestrial habitats. See the *UK Results from 2007 report* for further details at *www.countrysidesurvey.org.uk*

This chapter presents the results for the two freshwater Broad Habitats:

1. **The Standing Open Water and Canals Broad Habitat** includes ponds, lakes, canals, ditches and reservoirs;

2. **The Rivers and Streams Broad Habitat** includes running watercourses ranging from small headwater streams to large rivers.

Both habitats are important features of the English landscape, as they collect and move water, sediment, nutrients and pollutants through the countryside and also add aesthetic character. When in good condition, these freshwater habitats can support a wide range of plants and animals, many of which are listed in the UK Biodiversity Action Plan. Particular types of freshwater habitat are also listed as Priority Habitats (Ponds, Oligotrophic and Dystrophic Lakes, Mesotrophic Lakes, Aquifer Fed Naturally Fluctuating Water Bodies, Eutrophic Standing Waters, Rivers). Freshwater habitats also provide a valuable economic and recreational resource for people.

The freshwater Broad Habitats include the open water itself and the vegetation along the water's edge. They can be extremely variable in character depending on the size of the water body, catchment geology, the nature of the local terrain and degree of physical modification.

In 2007, Countryside Survey (CS) estimated the current area of both Broad Habitats in England and the changes since previous CS. For the first time, CS reports the estimated number of ponds across all of England.

The condition of certain water body types within these Broad Habitats was assessed in a number of different ways (*Chapter 8.4* and *8.5*).

8.2. Area of Habitat

- **The area of Standing Open Water and Canals (including ponds) increased by 5.3% (6000ha)[2] in England between 1998 and 2007, with most of the increase taking place in the Easterly Lowlands Environmental Zone.**

- **Associated with the increase in the area of Standing Open Water and Canals, the number of ponds increased by 18% (37,000 ponds) in England between 1998 and 2007, with most of the increase taking place in the Easterly Lowlands Environmental Zone.**

- **The area of Rivers and Streams Broad Habitat did not change significantly between 1998 and 2007, as might be expected in established and managed catchments.**

The area covered by the two Broad Habitats is relatively small, together representing about 1% of the England. The significant increase in the area of Standing Open Water and Canals Broad Habitat *(Table 8.1)* occurred almost entirely in the Easterly Lowlands of England and may be linked to the substantial increase in the number of ponds discussed in *Chapter 8.2.1*. The trend of increasing area of Standing Open Water and Canals Broad Habitat between 1998 and 2007 reversed a trend of decline between 1990 and 1998. In Countryside Survey, only ponds above 20 x 20m will be included in the Standing Open Water and Canals Broad Habitat, while smaller ponds will be counted as point features. It does not include ponds in gardens.

▲ Shaded pond, Shropshire • © *Natural England* • *Tom Holland*

8.2.1 Number of Ponds

The 18% increase in the number of ponds in England between 1998 and 2007 was confined to lowlands areas, and particularly to the Easterly Lowlands *(Table 8.2)*. It is interesting to note that 68% of the ponds in England were in the small size class, 0.0025-0.04ha and only 1% in the larger size class, 1-2ha. The number of new ponds in England was estimated at 48,300; while an estimated 14,900 were lost between 1998 and 2007. Further analysis of the pond data, including physical and chemical condition, and biological quality, will be available in the Pond Report, due late 2009.

[2] Standing Open Waters and Rivers and Streams BH estimates were calculated using a different statistical model to the other BHs. It is not appropriate to use the consistent statistical model for these two habitats because of the distribution of the data. Change in these BHs is calculated independently from the differences between stock estimates.

▼ **Table 8.1:** Area estimates ('000s ha) of the Standing Open Water and Canals, and the River and Streams Broad Habitats in England from 1990 to 2007. Arrows denote significant change ($p<0.05$) in the direction shown.

The Area of Standing Open Water and Canals Broad Habitat	1990		1998		2007		Direction of significant changes 1998 - 2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
England	105	0.8	88	0.7	97	0.7	↑
Easterly Lowlands	88	1.3	68	1	77	1.2	↑
Westerly Lowlands	8	0.2	13	0.2	14	0.3	
Uplands	8	0.5	6	0.4	6	0.4	

The Area of Rivers and Streams Braod Habitat	1990		1998		2007		Direction of significant changes 1998 - 2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
England	33	0.2	32	0.2	29	0.2	
Easterly Lowlands	17	0.3	15	0.2	15	0.2	
Westerly Lowlands	13	0.2	12	0.2	10	0.2	
Uplands	3	0.2	5	0.3	3	0.2	

▼ **Table 8.2:** Change in the number of ponds (000s) in England between 1998 and 2007. Arrows denote significant change ($p<0.05$) in the direction shown.

	1998 number (x 1000)	95% confidence limits	2007 number (x 1000)	95% confidence limits	Direction of significant changes 1998 - 2007
England	197	(165, 230)	234	(195, 272)	↑
Easterly Lowlands	114	(87, 143)	141	(108, 176)	↑
Westerly Lowlands	75	(57, 92)	83	(64, 103)	↑
Uplands	9	(5, 14)	10	(5, 15)	

8.3 Habitat Condition

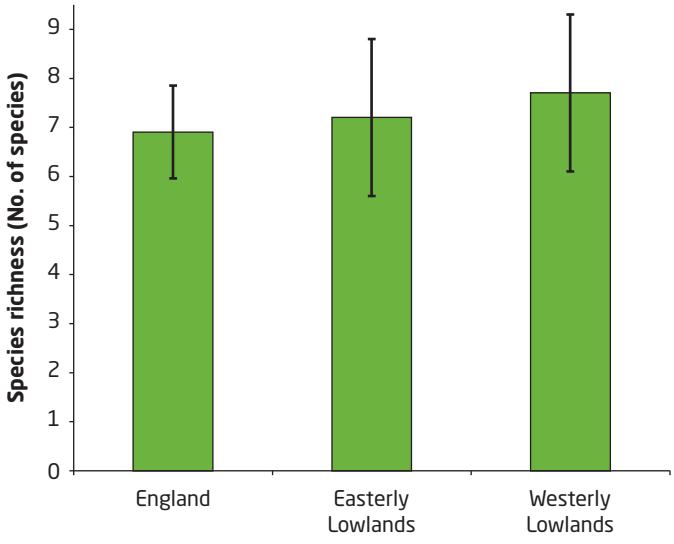
- **In 2007, ponds in the English countryside supported an average of 6.9 wetland plant species per pond.**
- **Only 9% of ponds were in the Good PYSM quality category (based on their vegetation) and only 4.8% of ponds surveyed were of Priority Habitat quality (based on their vegetation).**

▲ Pond in heathland, Dorset • © *Natural England* • *Peter Wakely*

8.3.1 Biological Condition of Ponds

The CS data from 2007 provide a baseline that describes the condition of ponds (based on their plant communities) across England. There was an insufficient sample of ponds in the Uplands to report reliably on plant species richness.

▼ **Figure 8.1:** Mean wetland plant richness in ponds across England in 2007. 95% CI are shown for each data point. It was not possible to report reliably on plant species richness estimates for the Uplands, due to insufficient sample size.

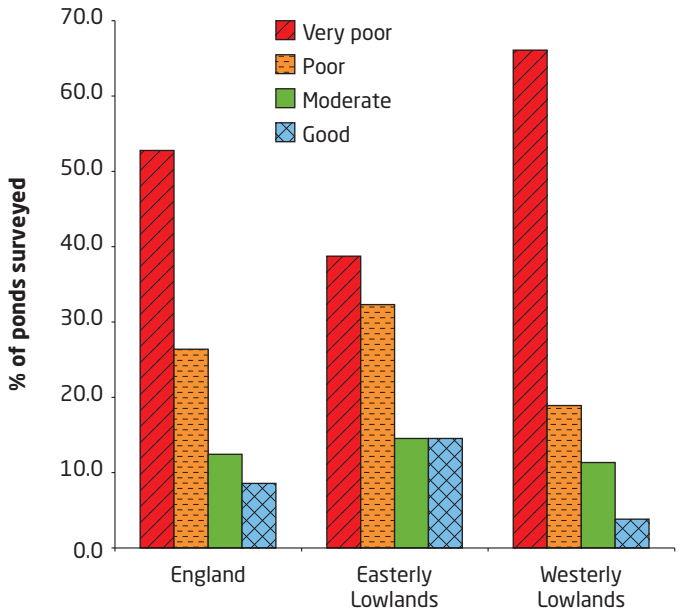


In 2007, English ponds supported an average of 6.9 wetland plant species per pond *(Fig. 8.1)*. There was no significant difference in species richness between the Easterly and Westerly Lowlands. Across all 150 ponds surveyed in England, 141 different plant species were recorded; 28 were submerged species, 12 were floating-leaved species and 101 were species associated with the pond margins.

8.3.2 Ecological Quality of Ponds

The ecological quality of the ponds in England was evaluated by applying the software package PSYM to the data collected. (see *Chapter 1.4.14 of the UK Results from 2007* report at *www.countrysidesurvey.org.uk*)

▼ **Figure 8.2:** The percentage of ponds falling into four PSYM quality categories in England and its Environmental Zones in 2007. It was not possible to report reliably on pond condition for the Uplands, due to insufficient sample size.



Most ponds in England (79%) fell into the two lowest PSYM categories: Poor or Very Poor. Only 9% were good quality (i.e. similar to the reference state) *(Fig. 8.2)*. These findings confirm that degradation is considerable and widespread amongst ponds in England. A greater proportion of ponds were in Poor or Very Poor category in the Westerly Lowlands than in the Easterly Lowlands.

8.3.3 Priority Habitat

CS pond condition assessments in 2007 were based on vascular plant data. These data have been used to identify Priority Habitat Ponds in England using three plant criteria:

- **Criterion 1:** ***The presence of rare plant species.*** Only 0.8% of the ponds surveyed qualified as Priority Habitat Ponds on the basis of Criterion 1.
- **Criterion 2:** ***Species-rich plant communities.*** Less than 1% of the ponds surveyed qualified on the basis of this criterion.
- **Criterion 3:** ***PSYM assessments.*** Just over 4 % of the ponds surveyed qualified on the basis of PSYM assessments.

In total, only 4.8% of the ponds surveyed qualified as Priority Habitat Ponds on the basis of all plant criteria. It is important to recognise that using plant data alone to assess whether a pond meets priority status under-estimates the proportion of priority ponds in 2007. More of the surveyed ponds would undoubtedly qualify if groups like invertebrates and amphibians were also surveyed. This means that the current Countryside Survey can be used to provide only a minimum estimate of the number of sites surveyed in England that could be classed as Priority Habitat Ponds.

8.4 Change in Condition of Vegetation Alongside Rivers and Streams (1990-2007)

- **Plant species richness of streamsides decreased by 4% (from 15.7 to 15.1 species per Streamside Plot) in England between 1998 and 2007. There has been a successional process over time, with vegetation becoming more shade tolerant and an increasing proportion of competitive species, particularly in lowland areas of England.**

▲ Vegetation surveying by a canal • © *NERC*

8.4.1 Changes in the Rivers and Streams Broad Habitat

As explained in *Chapter 1 of the UK Results from 2007 report* (available at *www.countrysidesurvey.org.uk*), a particular set of vegetation sampling plots were set out alongside watercourses. These 'Streamside Plots' were 10m long x 1m wide. Most of the Streamside Plots were placed alongside streams, ditches and small rivers.

▼ **Table 8.3:** Change in characteristics of vegetation in 10 x 1m Streamside Plots in the Rivers and Streams Broad Habitat across England and the three Environmental Zones (EL - Easterly Lowlands, WL - Westerly Lowlands, UP - English Uplands) between 1990 and 2007. Arrows denote significant change (p<0.05) in the direction shown. Analyses are described in ***Box 1.3 of the UK Results from 2007 report***, at *www.countrysidesurvey.org.uk*.

	Mean values (England)			Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1990**	**1998**	**2007**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**	**E**	**EL**	**WL**	**UP**
Species Richness (No. of Species)	17.8	15.7	15.1	↓			↓	↓	↓	↓		↓	↓	↓	↓
No. of Bird Food Species	7.0	6.1	6.1				↓	↓	↓	↓		↓	↓	↓	
No. of Butterfly Food Species	6.1	5.6	5.4	↓			↓	↓	↓	↓	↑	↓	↓	↓	
Grass:Forb Ratio	-0.01	-0.06	-0.28	↓	↓	↓				↓		↓		↓	
Competitor Score	3.11	3.19	3.22	↑		↑	↑	↑	↑	↑		↑	↑	↑	↑
Stress Tolerator Score	2.08	2.12	2.12		↑		↓	↑		↑		↑	↑	↑	↓
Ruderal Score	2.34	2.20	2.13	↓	↓	↓		↓	↓	↓		↓	↓	↓	
Light Score	6.49	6.44	6.37	↓	↓	↓	↓	↓		↓		↓	↓	↓	
Fertility Score	5.70	5.69	5.75	↑		↑	↑					↑			↑
Ellenberg pH Score	6.00	5.98	6.04	↑		↑	↑				↓	↑		↑	
Moisture Score	6.15	6.16	6.11	↓		↓		↓			↓	↓	↓	↓	↓

There has been a significant decline in plant species richness along English watercourses over the past two decades. In the Uplands, the decline was significant between 1998 and 2007 and over the long-term, between 1990 and 2007, while in the lowlands it was significant between 1990 and 1998 and over the long-term, between 1990 and 2007 *(Table 8.3)*. There was a broadly similar pattern for plant species used as food by farmland birds and butterfly caterpillars.

In lowland areas of England, the continued significant increase of competitive species and the decrease in the Grass:Forb ratio between 1998 and 2007 *(Table 8.3)* indicate that streamside vegetation has become less managed and more overgrown, over the period 1990 to 2007. This is supported by reduction in the Light and Ruderal Scores. In the Uplands of England, changes in streamside vegetation has been observed only between 1998 and 2007, with increase in competitive and nutrient demanding species, and reduction in light tolerant species. These changes could help explain the reported decreases in overall streamside species richness, and that of plant species used as food by farmland birds and butterfly caterpillars.

In Streamside Plots, the Ellenberg pH Scores increased in the Westerly Lowlands and Uplands, in line with most other Broad Habitats. Increases in the Fertility Score in the same Environmental Zones were unusual because they contrast with the results for the other Broad Habitats where Ellenberg Fertility Scores did not change over the past decade. Without further investigation, it is unclear why this may have occurred. Similarly unusual was the decrease in the Moisture Score for streamside vegetation across England *(Table 8.3)*, which contrasts with the increase in this Score for most Broad Habitats between 1998 and 2007. The results could be indicative of increased nutrient status over two decades and are possibly linked to changes in flow regimes/nutrient inputs, or more simply, related to changes in riparian management, which are not reflected in other Broad Habitat types as their direct management may not have changed or changed in different ways.

8.5 Changes in the vegetation and physical characteristics of streams

- **Plant species richness in streams increased (from 2.7 to 3.9 species per plot) in England between 1998 and 2007 and there was a high turnover of species; only 61% of all 114 aquatic plant taxa were recorded in both years.**
- **The physical habitat quality of headwater streams increase by 11%, from an HQA of 37.4 to 41.6 in England between 1998 and 2007. The greatest increase in quality was recorded in the Westerly Lowlands, with a 13% increase in HQA.**

The diversity and cover of aquatic (within the river) plants were recorded over a 100m length of stream channel within 131 sample squares in England in 1998 and 2007.

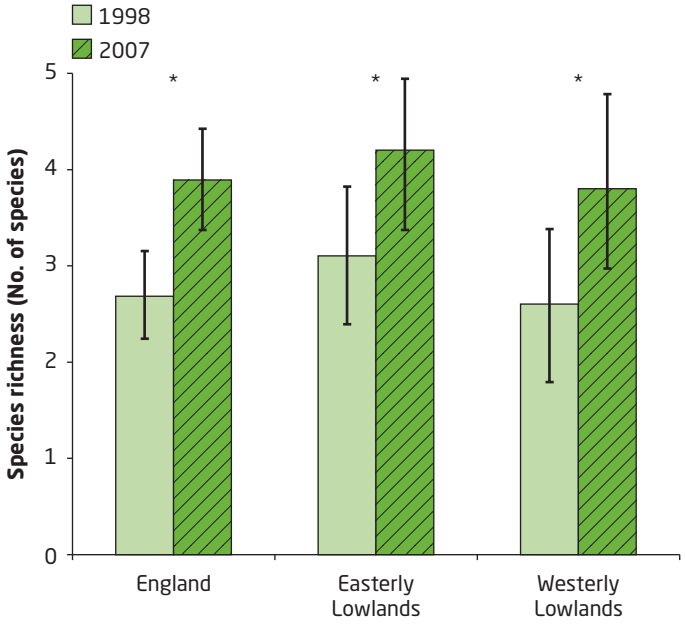
8.5.1 Species Richness in Headwater Streams

Headwater stream plant richness in England increased from an average 2.7 to 3.9 species per plot between 1998 and 2007 *(Fig. 8.3)*. Pooled plant species richness increased across England between 1998 and 2007 *(Table 8.4)*.

▼ **Table 8.4:** Change in pooled headwater stream plant species richness across England and in Environmental Zones between 1998 and 2007. It was not possible to report reliably on pooled richness estimates for the Uplands, due to insufficient sample size. Arrows denote significant change (p<0.05) in the direction shown.

	1998 Total richness	2007 Total richness	Change Total richness	Change
England	85	98	13	↑
Easterly Lowlands	54	62	8	
Westerly Lowlands	53	62	9	
Uplands				

▼ **Figure 8.3:** Change in mean headwater stream plant richness across England and in individual Environmental Zones between 1998 and 2007. It was not possible to reliably report plant species richness estimates for the Uplands, due to insufficient sample size. Asterisks denote a statistically significant change between surveys (* p< 0.05). 95% CI are shown for each data point.



▲ River Habitat Surveying • © *NERC*

There was a considerable turnover of plant species between the two Surveys. Only 61% of all 114 aquatic plant taxa encountered were recorded in both years. Of the 69 persistent taxa, 36 had increased in frequency across England since 1998, while only 18 decreased in frequency; none of which had substantial declines. It was the predominantly riparian and emergent vascular plants such as Bittersweet (*Solanum dulcamara*), Creeping Bent Grass (*Agrostis stolonifera*) and Branched Bur-weed (*Sparganium erectum*) that became more prevalent between the two Surveys. Pink Water-speedwell (*Veronica catenata*) and Marsh Marigold (*Caltha palustris*) were among the 29 species newly-recorded at CS stream sites in 2007. The constancy of the regional aquatic plant species pools was investigated, and revealed that the Westerly Lowlands had the greatest turnover of taxa between the two Surveys, with only 44% of species occurring in both Surveys. In the Easterly Lowlands, 52% of taxa recorded were found in both Surveys. In all three zones, more species were newly-recorded than were lost from the surveyed plots. The turnover of species shows the highly dynamic nature of the habitat, which could be a combination of both its inherent characteristics and the changes brought about in the quality of the water and the physical structure of stream and so, indicates the need for caution in drawing conclusions about overall habitat quality from trends in species richness alone.

There was no significant change in the biological condition of headwater streams in England, as assessed by the Mean Trophic Rank (***Table 8.5*** and ***for definition, see glossary of the UK Results from 2007 report*** at *www.countrysidesurvey.org.uk*) indicating that the degree to which such small watercourses are impacted by nutrient enrichment has not reduced over the past decade.

The summary data suggest a continuation of the 1990 to 1998 trend of increasing species diversity that was based on macro-invertebrate diversity. It is possible that at least some of the changes could be indicative of oligotrophic (nutrient poor) systems becoming more eutrophic (nutrient rich). A further possible explanation is diversification through increased encroachment by riparian species. *Solanum* and *Agrostis* are not aquatic species, but rather encroaching riparian species that would benefit from reduced physical management just as much as species driving changes in streamside vegetation. *Sparganium* is a true emergent, but is very characteristic of reduced channel maintenance.

8.5.2 Headwater Stream Physical Habitat Diversity

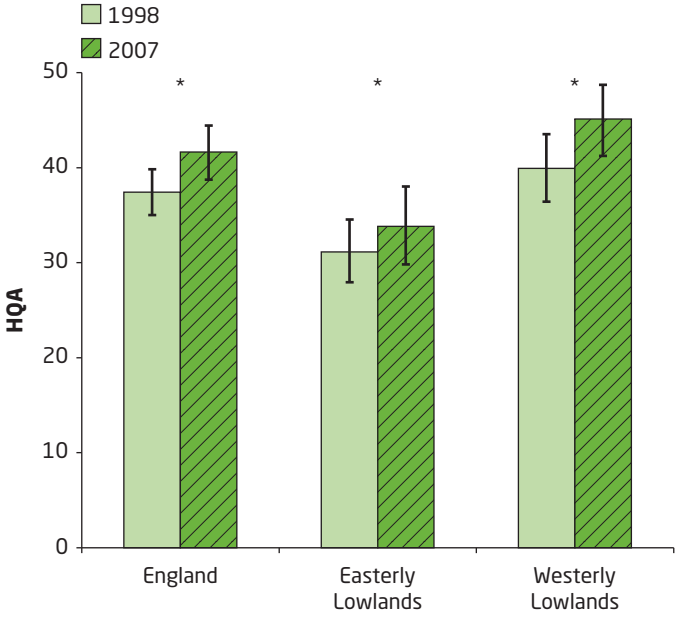
A River Habitat Survey (RHS) (see ***Annex 1: Glossary of the UK Results from 2007 report*** at *www.countrysidesurvey.org.uk*) was included in Countryside Survey for the first time in 1998 and the repeat Survey in 2007 provided the first comparison over time.

The physical habitat quality of headwater streams increased by 11%, from an HQA of 37.4 to 41.6 in England between 1998 and 2007 ***(Fig. 8.4)***. The greatest increase in quality between 1998 and 2007 was recorded in the Westerly Lowlands, with a 13% increase in HQA (see ***Annex 1: Glossary, of the UK results from 2007 report*** at *www.countrysidesurvey.org.uk*). The significant improvements in physical habitat quality of headwater streams in England ***(Fig. 8.4)*** reflect an increased occurrence of various natural stream bank features e.g. in-stream gravel bars, river-side trees and a greater diversity of channel vegetation types.

▼ **Table 8.5:** Change in Mean Trophic Rank or MTR bio-assessment score per headwater stream site in England and in Lowlands Environmental Zones between 1998 and 2007. It was not possible to report reliably on MTR scores for the Uplands, due to insufficient sample size (indicated by greys cells with diagonal strikethrough). Arrows denote significant change (p<0.05) in the direction shown.

	1998 MTR	2007 MTR	Mean change MTR	95% Confidence limits	Change
England	42.5	43.6	1.1	(-2.6, 4.8)	
Easterly Lowlands	33.8	38.1	4.2	(-0.5, 9.1)	
Westerly Lowlands	43.4	42.1	-1.3	(-5.86, 3.84)	
Uplands					

▼ **Figure 8.4:** Change in the Habitat Quality Assessment (HQA) across England and in Lowlands Environmental Zones between 1998 and 2007. It was not possible to reliably report MTR scores for the Uplands, due to insufficient sample size. Asterisks denote statistically significant change (* P<0.05). 95% CI are shown for each data point.



8.6 Discussion and Conclusions

8.6.1 Changes in Freshwaters

English freshwater Broad Habitats are continuing to undergo change. The area of Standing Open Water and Canals and the number of ponds increased over the past decade but the current biological condition of ponds is generally poor. In 2007, CS has documented continuing improvement in the physical condition of English headwater streams, some diversification of in-channel plant assemblages, and a shift towards coarse and more competitive vegetation along streamsides, with an associated loss of species and increase in nutrient-demanding and competitive plants.

Countryside Survey collects information on the stream-bed macroinvertebrate fauna in headwater streams, which can be used to provide a robust assessment of change in biological condition since 1990. These data are currently being processed to enable a comparison with vegetation for reporting in the Countryside Survey Headwater Streams report (due late 2009).

8.6.2 Discussion

There are many factors that influence the quality of freshwaters, the condition of associated habitats and biodiversity, and the way that our aquatic ecosystems function. Ponds in particular are effective at storing water, removing and storing sediments and pollutants, and alleviating flooding. The flowing nature of streams make them more varied along their length than ponds and allows a range of physical, chemical and biological processes to operate that affect the water quality. Both habitats are highly dynamic and sensitive to environmental change, especially in quantity and quality of water.

Pollution arising from a range of sources, including effluents, agriculture and road run-off are known to have significant effects on the quality of freshwaters and the biodiversity it supports[3]. Abstraction, low flows and climate change can also affect the hydrology, water quality and biodiversity of freshwaters[4]. The physical management of freshwater habitats is also a critical determinant of the quality of freshwater habitats for characteristic flora and fauna[5].

The countryside of England supports an array of diverse catchments, and as *Chapters 2*, *3* and *4* of this report have shown, agricultural land use is prevalent and likely to be a major contributing factor in the changes observed in freshwaters streams and ponds. However, it is difficult to attribute the effects of agriculture on these habitats using data at the country level. Another study classified the freshwater habitats of the agricultural landscape of Great Britain into 12 cultivated landscape types and one non-cultivated class (mountain and moorland areas, and urban landscapes)[6] and demonstrated significant differences in the physical structure of the freshwater environment and the composition of biotic assemblages in each of these landscape types.

[3] Mainstone C. P.; Wils, R.M.; Withers, P.J.A. (2008) Controlling sediment and phosphorous transfer to receiving waters – a strategic management perspective for England and Wales, Journal of Hydrology, 350, pp 131-143

[4] Mainstone, C.P. and Clarke, S.J. (2008) Managing multiple stressors on sites with special protection for freshwater wildlife – the concept of Limits of Liability, Freshwater Reviews (2008) 1, pp 175-187

[5] Mainstone, C.P. and Holmes, N. T. H. (In Press, 2009) Embedding a strategic approach to river restoration in operational management processes – experiences in England. *Aquatic Conservation: marine and freshwater ecosystems.*

[6] Brown CD, Turner N, Hollis J, Bellamy P, Biggs J, Williams P, Arnold D, Pepper T, Maund S (2006). Morphological and physico-chemical properties of British aquatic habitats potentially exposed to pesticides. *Agriculture Ecosystems & Environment*, 113: 307-319, and

Biggs, J., Williams, P., Whitfield, M., Nicolet, P., Brown, C. Hollis, J., Arnold, D., Pepper, T. (2007). The freshwater biota of British agricultural landscapes. *Agriculture Ecosystems & Environment* 122: 137-148

These subtle differences cannot be clearly distinguished when reporting CS results at country level, but they may be explored further using the services available at *www.countrysidesurvey.org.uk* which allow users to interrogate CS data through a range of different political and environmental stratifications.

The effects of agricultural policies such as cross-compliance (Good Agricultural and Environmental Condition (GAEC)[7] and the development in England over time of agri-environment schemes, including incentives to protect and enhance the freshwater environment, are difficult to distinguish from other possible drivers of change, such as climate change or abstraction and low flows, but further research is ongoing.

The data presented here could be compared with other relevant local datasets (e.g. river hydrographs) to look for associations and to enable more detailed presentation of underlying patterns behind changes in plant species richness. This could include, for example, any trends in rare/vulnerable species, occurrence of non native species or undesirable disturbance in species preferring oligotrophic (nutrient poor) conditions, and any data relating to changes in management regimes.

The plant community changes alongside and in rivers may be related to two management trends that are taking place in the countryside: increased bankside fencing and reduced channel maintenance activity.

Bankside fencing is being promoted strongly as part of work to buffer the river network against bankside erosion, direct pollution by livestock, and enriched/sediment-laden run-off. Increased bankside fencing and associated control of bank erosion induced by livestock leads to development of tall and woody vegetation along river banks, increased encroachment of marginal vegetation into the channel, and an increase in submerged vegetation that is freed from the effects of livestock trampling. Agricultural policy mechanisms have contributed substantially to the trend to fence off river banks. The Environmental Stewardship Scheme, cross-compliance measures and the Catchment Sensitive Farming Initiative all promote the creation of riparian buffer zones involving the exclusion of livestock through fencing.

Reduced channel maintenance activity can lead to increased prevalence of emergent and submerged species. Active channel maintenance activity has declined in recent years as a result of operational cost-saving measures by the Environment Agency's Flood Risk Management Function. Reduced channel maintenance for flood risk purposes allows natural recovery of submerged and marginal vegetation and physical habitat diversity. However, much of this maintenance activity is focused on larger river sections downstream of headwater streams, so it is unclear how much of a role this has played in the changes reported by CS.

It is possible that reduced riparian management/grazing pressure explains most of the changes observed in both riparian and channel vegetation. Encroaching marginal plant species (rather than true river channel species) seem to be responsible for most of the observed changes in channel vegetation, which is consistent with reduced riparian management allowing greater invasion of the channel. This effect will be much more significant in headwater streams than in larger river sections downstream, due to the narrow channel widths which enables encroaching species to dominate the whole channel.

The types of changes observed in riparian and in-channel vegetation can allow natural recovery of the physical form of the river, as stands of plants (herbaceous and woody) impede the passage of water and create more complex patterns of flow and erosion/sedimentation. Vegetation-led diversification of physical habitat is commonly observed in small streams, and could explain the improved physical habitat diversity reported by CS.

The increase in nutrient demanding species and other successional changes reported for Streamside Plots, may be at least partly attributable to increased nutrient enrichment of the riparian zone. This is possible if riparian areas being used as buffer zones for agricultural run-off are becoming more effective at retaining nutrients and eroded soil. It is important to recognise that riparian zones are important habitats, supporting a wide range of wetland and river-associated plant and animal species, and that their use as a pollution buffer can have consequences for their ecology.

The plant community changes in streams and along streamsides probably do not reflect any tightening of the regulatory regimes affecting freshwaters, in terms of pollution control or abstraction management. Action to reduce nutrient inputs from sewage effluents under the on-going capital investment programme of the water industry is probably not a significant mechanism, since improvement works are focused on effluents that discharge into larger rivers. Water quality of headwater streams is largely dictated by levels of pollution from diffuse and small point sources, particularly from agriculture and septic tanks, and these currently both largely fall outside of the regulatory regime.

▲ Drainage ditch, Somerset • © *Natural England* • *Trevor Mansfield*

[7] Defra (2009) Consultation on changes to standards in cross compliance Good Agricultural and Environmental Condition (GAEC)

▲ Sheep grazing alongside River Coln, Gloucestershire • © *Natural England* • *Nick Turner*

There is a need to explore the data further, especially the chemical quality and macro invertebrate data, to determine whether some of these apparently desirable biodiversity gains are reflecting environmental degradation of naturally oligotrophic systems (characteristic species being outcompeted by more competitive species at higher nutrient levels). There are also possibilities to re-analyse the data to determine possible reasons for differences in change (e.g. stress tolerating and competitive species in Streamside Plots between the Westerly and Easterly Lowlands or the Uplands). The Headwater Streams report (due autumn 2009) will provide further analysis of the evidence to help inform policy decisions.

The Water Framework Directive (WFD) requires objectives to be met for ecological status. WFD, at least as implemented in England, will not set ecological objectives for small water bodies, including ponds, small lakes and headwater streams. Countryside Survey in 2007 has focused on small water bodies, which will demonstrate in future years the consequences of not including them in the WFD. Although specific monitoring is required for WFD reporting, the Countryside Survey data will provide an important baseline against which to evaluate the outcomes of WFD implementation.

Results for ponds have been made difficult to interpret because the results could have been confounded by the wet weather and high water conditions during 2007, compared to 1998.
The increase in number of ponds in England is encouraging, but the assessment of quality needs to include the full complement of quality assessments. There is a need to return to the data analysis, including an assessment of their biological and chemical quality, to distinguish new from old ponds, and to set their condition assessment within context of the surrounding land use. It will also be important to assess possible effects of uptake and implementation of agri-environment schemes, or creation of water reservoirs on farms to combat effects of climate change.

The Pond report, which is due for publication in autumn 2009 will include such assessments and give a clearer picture of the implications of the results for policy decisions.

8.6.3 Conclusions

The general conclusions that can be drawn from the Countryside Survey results for the fresh water habitats in England are:

- The number of ponds has greatly increased in England, probably due to the concerted efforts of landowners, conservation bodies and agri-environment policies, but many seem to be in poor condition based on the vegetation alone.
- Streamside vegetation has undergone successional process that is likely to be linked to reduced management of the banks and a reduction in grazing.
- The botanical evidence suggests that water quality of headwater streams continues to improve but the data from chemical analysis and invertebrate data are required to complete the picture.
- It appears the policies to improve the quality of headwaters, lakes and ponds are having a positive effect on these habitats, but further analysis in required to determine the ecological significance of the changes observed, especially for oligotrophic (nutrient poor) systems.
- Further detailed analysis will be available in the Headwater Streams report and the Pond report in late 2009

▲ Small development in a rural area • © *Natural England* • *Andrew Baker*

9. Developed Land in Rural Areas

Summary

- **The area of Built-up and Gardens Broad Habitat associated with the rural environment (i.e. not part of the un-surveyed urban land), was estimated at 1,038,000ha, occupying 7.9% of the land area of England in 2007, with most of this divided between the Easterly and Westerly Lowlands and only 14,000ha in the Uplands Environmental Zone.**
- **The Built-up and Gardens Broad Habitat was estimated to have increased in total area by 2.9% (29,000ha) in England between the 1998 and 2007. Although this was not statistically significant at a national level, it was significant in the Uplands Environmental Zone.**
- **The area occupied by buildings in the rural environment was 753,000ha in England in 2007, an increase of 3.9% (28,000ha) since 1998. Although these changes were not statistically significant at national and Environmental Zone level, they may impact local areas.**
- **There was no detectable change in the estimated area covered by roads and tracks between 1998 and 2007. There was a significant increase from 192,000ha in 1984 to 240,000ha in 1990, but since then there has been little change, so that by 2007 the estimate was 250,000ha.**

9.1 Introduction[1]

This Chapter examines the changes in the extent of the built environment in the countryside as detected by the Survey. Here developed land refers to residential and farm buildings and their associated infrastructure, such as gardens and service roads. It also includes other man-made structures such as industrial estates, retail parks, waste and derelict ground, mineral workings, airports and urban parkland. All developed land in the countryside, apart from transport features, is included in the Broad Habitat type: Built-up and Gardens. Roads and tracks are included within the Boundary and Linear Features Broad Habitat *(Chapter 5)*.

[2] **Note:** For further information on the Broad Habitat classification, sampling plots and other Countryside Survey terminology see *Chapter 1 (Introduction and Methodology)*

Countryside Survey (CS) was not designed to survey changes in the built environment, in either rural or urban areas. Survey squares containing more than 75% of developed land on the date of first survey (1978) were excluded. The extent of the developed area is measured as is the area occupied by buildings and their curtilage. Developed areas within survey squares are not included in the vegetation survey and therefore do not contain any plots. The evidence which CS can report is therefore limited to the change in total extent of this habitat, but this has underlined some of the changes previously reported elsewhere.

9.2 Area of the Habitat

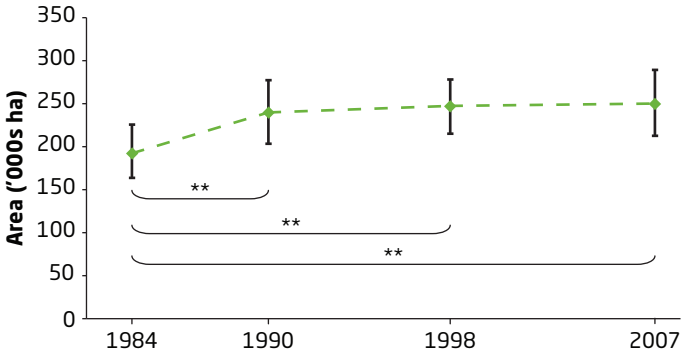
9.2.1 Built-up and Gardens Broad Habitat

The area of Built-up and Gardens Broad Habitat associated with the rural environment (i.e. not part of the un-surveyed urban land, where a 1km square contained more than 75% urban land in 1978) was estimated at 1,038,000ha in 2007 *(Table 9.1)* and occupied 7.9% of the land area of England. This habitat type was estimated to have increased in total area by 29,000ha between the 1998 and 2007. This is not statistically significant in a national context, but the impact of such change at a local level may be. CS detected a significant statistical increase from 13,000ha to 14,000ha in the area of Built-up and Gardens Habitat in the Uplands Environmental Zone in England between 1998 and 2007. In all instances it is the context of the change which is in important as well as the amount of habitat which has been converted.

The area occupied by buildings in the rural environment was 753,000ha or 5.7% of the land area of England in 2007, an increase of 3.9% (28,000ha) since 1998, which was not statistically significant. This reversed the trend of decrease of 74,000ha between 1990 and 1998. Although the area of land taken by buildings has decreased since 1990, by an estimated 46,000ha *(Table 9.2)*, the sustained increase in area of the Built up and Gardens Broad Habitat across this time indicates that despite a loss of buildings the land cover has remained broadly urban.

There was no detectable change in the estimated area covered by roads and tracks between 1998 and 2007. There was a significant increase from 192,000ha in 1984 to 240,000ha in 1990, but since then there has been little change so that by 2007 the estimate was 250,000ha *(Fig. 9.1)*.

▼ **Figure 9.1:** The change in the area of roads and tracks in the rural environment in England between 1984 and 2007. Significant changes (**p<0.01) are shown between the dates bracketed. 95% CI are shown for each data point.



9.3 Changes between Broad Habitats

Developed land is a relatively stable land use, in that it very rarely changes Broad Habitat type. The majority of the Built-up and Garden Broad Habitat in 1998 remained in that category in 2007. There was some transfer to and from Neutral and Improved Grassland. Most of the new development detected by CS was in the Arable and Horticulture Broad Habitat (see *www.countrysidesurvey.org.uk*).

9.4 Condition of the Built-up and Gardens Broad Habitat

Habitat condition is not recorded for the Built-up and Gardens Broad Habitat. The only plot type which records Broad Habitats in urban settings is the linear Roadside Plot *(Chapter 5)*.

9.5 Discussion and Conclusions

CS did not detect any change in the area of Built-up and Gardens Broad Habitat across England between 1998 and 2007 but there was a statistically significant increase in the English Uplands. The survey is unable to detect whether the number of buildings has increased or whether more land around buildings is now taken up by gardens or both. The Survey does not record new buildings in the urban environment within a survey square, nor within the curtilage of existing buildings such as farmsteads or large residential properties. CS does not attempt to assess development of existing buildings, for example it does not make the distinction between a barn and a barn conversion.

▼ **Table 9.1:** Estimated area ('000s ha) and percentage of land area of the Built-up and Gardens Broad Habitat in England from 1990 to 2007. Arrows denote significant change (p<0.05) in the direction shown. ***Note:*** estimates exclude the area of un-surveyed urban land.

	1990		1998		2007		Direction of significant changes 1998 - 2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
England	999	7.6	1009	7.7	1038	7.9	
Easterly Lowlands	521	8	537	8.2	538	8.2	
Westerly Lowlands	465	9.1	459	9	485	9.5	
Uplands	13	0.8	13	0.8	14	0.9	↑

▼ **Table 9.2:** Estimated area ('000s ha) and percentage of land area occupied by buildings in the rural environment in England from 1990 to 2007. Arrows denote significant change (p<0.05) in the direction shown. ***Note:*** estimates exclude the area of un-surveyed urban land.

Buildings	1990		1998		2007		Direction of significant changes 1998 - 2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
England	799	6.1	725	5.5	753	5.7	
Easterly Lowlands	351	5.4	327	5	337	5.2	
Westerly Lowlands	440	8.7	391	7.7	409	8	
Uplands	8	0.5	7	0.4	7	0.4	

The sampling strategy of CS is designed to detect changes which are distributed widely across the countryside, which are classifiable into the Broad Habitat types. The nature of the built environment in the countryside does not fit readily into Survey design. It is not surprising therefore that the results from the 2007 Survey show that the wider countryside has not been altered by development since 1998. However, it is known that significant changes, in terms of the character of the countryside have occurred since 1998. Whilst it is possible to speculate on the drivers for this change a better prospect can be obtained from evidence generated solely for the purpose of understanding the nature of development in the countryside, such as Countryside Quality Counts[1].

The CS estimate of the area occupied by buildings in the rural environment was 753,000ha in England in 2007, an increase of 3.9% (28,000ha) since 1998, is entirely consistent with the estimate of land converted for settlement and dwellings beyond the urban fringe by Countryside Quality Counts, for the period 1998-2003. Countryside Quality Counts reported that the area beyond the urban fringe accommodated far more newly built dwellings and has seen a greater net increase in the overall dwelling stock than the urban fringe. The nature and pattern of this development varied across the country. For instance, a number of areas experienced considerable settlement intensification. This was particularly apparent in hamlets and isolated farmsteads where the increase in stock by conversion and subdivision exceeded that of new buildings.

CS has detected this change in terms of the total area change by Broad Habitat type, though it would seem likely that CS has probably underestimated the total area, as the Countryside Quality Counts data relates to the period 1998 – 2003, whereas CS is measuring change for 1998 - 2007. Although these changes are not significant in statistical terms, they are significant in terms of the context in which the change has occurred. An increase in the number of people living in the countryside, as consequent of the increase in the total dwelling stock has major implications not only for the physical character of the countryside, but also the character of the population which resides there. In social and economic terms, these new country dwellers represent the continuing shift away from a rural population which looks to the land for employment to a population which looks over the horizon to large urban centres for economic and cultural identity.

Our understanding of the character of the built environment found within the countryside i.e. the size, pattern and density is provided by the 2004 ONS Rural and Urban Definition[2]. This classification was developed by The Countryside Agency, ONS and partners and it is embodied within the Government's Rural Strategy. It defines settlements of over 10,000 people as 'urban' and defines smaller 'rural' settlements into three categories: 'town and fringe', 'villages', or 'hamlets and isolated dwellings'. Additionally, the settlement are defined by their location as either being a 'spare' or 'less spare' area. This definition is intended for use with nearly all official Government statistics.

[1] Countryside Quality Counts – Tracking Change in the Character of the English Landscape, 1999-2003, Natural England 2007, NE42. The CQC Project commissioned the following report which is available from the CQC website - *Land Use Change at the Urban : Rural Fringe and in the Wider Countryside, The Countryside Agency 2006. Department of town and Regional Planning, University of Sheffield, P. Bibby.*

[2] Office of National Statistics (2004) Urban and Rural Definition

Futher exploration of the relationship between the 2004 Urban and Rural Definition and the CS square data may cast more light onto the applicability of CS data to policy review and development. The relationship between the ecological data of CS and the built physical structure of the countryside may shed new light on the state and condition of both environments.

CS did not detect any further increase in the area of land occupied by road building or road widening following the large increases recorded from 1984 to 1990 and from 1990 to1998. This is consistent with the sharp reduction in road building which occurred in the late 1990s and continued, with a few nationally significant exceptions. It should be noted that development of major new roads which are not included in the Survey, in the years 1998-2003 has occurred. The most striking example is probably the M6 Toll to the north-east of the West Midlands conurbation. Others include the A46 between Newark-on-Trent and Lincoln the A417 and A419 between Gloucester/Cheltenham and Swindon; the A30 north-east of Exeter and the M20 between Maidstone and Folkestone.

Conclusions

The area of Built-up and Gardens Broad Habitat associated with the rural environment (i.e. not part of the un-surveyed urban land), was estimated by CS at 1,038,000ha or 7.9% of the area of England in 2007. A significant increase of 1,000ha in the area occupied by this Broad Habitat since 1998 was detected only in the Uplands Environmental Zone, where only 14,000ha was present in 2007.

The area occupied by buildings in the rural environment was 753,000ha or 5.7% of the land area of England in 2007, an increase of 3.9% (28,000ha) since 1998, which was not statistically significant. Although the area of land taken by buildings has decreased since 1990, by an estimated 46,000ha, the sustained increase in area of the Built up and Gardens Broad Habitat across this time indicates that despite a loss of buildings the land cover has remained broadly urban.

The changes detected may not be statistically significant at National or Environmental Zone levels, but they could impact on the character of the landscape at more local levels, particularly in social and economic terms where new developments represent the continuing shift away from a rural population which looks to the land for employment to a population which looks over the horizon to large urban centres for economic and cultural identity.

The estimates of change in area of the Built-up and Gardens Broad Habitat provided by CS are consistent with other evidence from Countryside Quality Counts, which was generated solely for the purpose of understanding the nature of development in the countryside, but unlike Countryside Quality Counts, the CS methodology is not designed to detect changes in character.

Further exploration of the relationship between the 2004 Urban and Rural Definition and the CS square data may cast more light onto the applicability of CS data to policy review and development. The relationship between the ecological data of CS and the built physical structure of the countryside may shed new light on the state and condition of both environments.

Countryside Survey

Further information

More details of the methodology, analyses and results from Countryside Survey can be found in other companion reports and data resources available for the Countryside Survey website [**www.countrysidesurvey.org.uk**] including:

Reports:

- UK Headline Messages – *published November 2008*
- UK Results from 2007 – *published November 2008*
- Scotland Results from 2007 – *published June 2009*
- Wales Results from 2007 – *published July 2009*
- England Results from 2007 – *this report, published September 2009*
- Northern Ireland Countryside Survey results – *published April 2009*
- CS Technical Report No.1/07: Field Mapping Handbook – *November 2008*
- CS Technical Report No.2/07: Vegetation Plots Handbook – *November 2008*
- CS Technical Report No.3/07: Soils Manual – *November 2008*
- CS Technical Report No.4/07: Statistical Report – *November 2008*
- CS Technical Report No.5/07: Freshwater Manual – *November 2008*
- Ponds – *late 2009*
- Headwater Streams – *late 2009*
- Soils – *late 2009*
- Integrated Assessment – *2010*

Data resources:

- Web access to **summary data** - a systematic summary of the results used to inform the UK and country level reports – launched in November 2008 and updated in January 2009
- Web access to data from **individual survey squares** used to generate the results presented in Countryside Survey reports from the 2007 survey – licensed access available from June 2009
- The UK Land Cover Map for 2007 (to be released in 2010)

The data generated by Countryside Survey will continue to be investigated in conjunction with other information such as climate, pollution and agricultural statistics. The data is being used in the UK National Ecosystem Assessment. Phase 1 will report in February 2010 and Phase 2 in February 2011 [see http://www.unep-wcmc.org/eap/ukNationalEA.aspx]. It is anticipated that future analysis of Countryside Survey data will lead to scientific journal articles over the coming years. These investigations will improve understanding about the possible causes of the changes detected in the countryside and, for example, provide an opportunity to explore the results for Priority Habitats in more detail.

Contacts

For further information on Countryside Survey see **www.countrysidesurvey.org.uk** or contact:
Countryside Survey Project Office,
Centre for Ecology and Hydrology,
Lancaster Environment Centre, Library Avenue,
Bailrigg, Lancaster LA1 4AP

Telephone: **01524 595811**
Email: **enquiries@ceh.ac.uk**

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The Countryside Survey partnership has endeavoured to ensure that the results presented in this report are quality assured and accurate. Data has been collected to estimate the stock, change, extent and/or quality of the reported parameters. However, the complex nature of the experimental design means that results can not necessarily be extrapolated and/or interpolated beyond their intended use without reference to the original data.

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