Countryside Survey

Countryside Survey:
UK Results from 2007

Foreword by Rt. Hon. Hilary Benn, M.P. Secretary of State for Environment, Food and Rural Affairs

The countryside lies at the heart of our prosperity, our health and our well-being. It provides us with food and water, it helps deal with flooding and store carbon, and it enriches our lives.

Now, more than ever, we cannot afford to take the countryside for granted. Faced with new pressures we must rebalance our relationship with the natural world. We must ensure that the landscapes, wildlife and ecosystems that provide us with the essentials of life are not only looked after but are improved for future generations.

The health of the countryside is increasingly affected by climate change, pollution and the demand for land. These powerful, constantly shifting forces threaten the benefits that the natural world provides. So in responding it is vital that we improve our understanding of their impact.

The UK Countryside Survey helps us to do that. It provides the hard scientific evidence that we need to build a clear picture of the plants, habitats, soils and watercourses which determine the health of the countryside as a whole. I will be studying the findings of this report very carefully.

Carrying out a national survey on this scale is an impressive undertaking and I am greatly indebted to the team of research scientists and surveyors who worked through the exceptionally wet summer of 2007 to make it happen. I would like to acknowledge the support of the many land owners and managers throughout the country who gave permission for the survey to take place. The project was also made possible by the relationship between the Natural Environment Research Council and the other government partners representing all the devolved administrations and relevant agencies across the UK.

Hilary Benn

Foreword by Professor Alan Thorpe, Chief Executive, Natural Environment Research Council

The issue of the changing ecology of the UK countryside is of growing scientific and political importance, driven by concerns about land use changes, climate change, increased flood risks and sustainable energy resources.

The UK Countryside Surveys bring together the policy and scientific communities, and provide the basis to deal with a great number of scientific issues. They offer a unique way to monitor the changes in the environment's ecosystems brought about by our constant and varied demands on land and water resources, and by the impacts of climate change and air pollution. They analyse the relationships between soils, vegetation and water quality and identify when and how these affect biodiversity.

We now have a remarkably detailed 30 year record of where environmental changes have occurred. This is vital scientific evidence for policy makers and all those with interests in sustainable land management. The results from these surveys help to answer questions about why the changes have happened, and decide what policy decisions are needed to manage future change. They will be an invaluable data source for other strategic programmes, such as the 'Living With Environmental Change' partnership.

The Natural Environment Research Council is very proud to support this important scientific initiative, which addresses the environmental, social and economic challenges of providing a sustainable countryside for the UK.

Alan Thorpe

Countryside Survey

▲ Dyffryn Ogwen, Wales • © *NERC*

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▲ Surveyor at work, Scotland• © *NERC*

1. Countryside Survey Methodology

Summary

This chapter describes the rationale and methods that have been used to collect the data for Countryside Survey in 2007 and in the preceding Surveys.

Countryside Survey is made up of two main parts:

a) **the Field Survey (reported here) focuses on habitats, vegetation, soils (0-15 cm) and freshwater; and**

b) **the Land Cover Map (which will be published in 2009) is a digital map using satellite data from space.**

The Field Survey covered a total of 591 1km x 1km sample squares spread across England, Scotland and Wales, representative of the variations in the climate and geology of the three countries. Data are also included where appropriate, from a separate survey of 0.5km x 0.5km squares undertaken in Northern Ireland. The two surveys are undertaken separately but the results are brought together where possible in this report for the UK.

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, and a stream and a pond were also sampled in many of the squares.

The data collected enables estimates of:

- **the area of habitats and the change in area of habitats;**
- **the changing condition of vegetation;**
- **the pH, carbon concentration and bulk density of soils (0-15cm); and**
- **the changing condition of freshwaters and ponds.**

1.1 Introduction

Countryside Survey (CS) is made up of two main parts: the Field Survey which is the focus of this report and the Land Cover Map, a survey using satellite data from space to create a digital map, which will be published in 2009.

The first CS was carried out in 1978, followed by Surveys in 1984, 1990, 1998[1] and 2007, increasing the long-term series of data each time. With the completion of the 2007 Survey, the whole CS data set now provides information about changes in the British countryside over a 30-year period and, by combining with data from NICS, change in the UK countryside between 1998 and 2007.

Since the introduction of the Broad Habitat classification system in 1998, CS data have been used to provide information on progress against the UK Biodiversity Action Plan for Broad Habitats and for some Priority Habitats. Since 1990, CS has been used with other statistics to help inform policy makers on changes in the rural environment.

Box 1.1: Broad and Priority Habitats

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. 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 Horticultural Land** • **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**

Priority Habitats

Priority Habitats are those which have been identified in the UK Biodiversity Action Plan as being at risk: such as those with a high rate of decline; those that are functionally critical; and those which are important for Priority Species.

Priority Habitats are all sub-classifications within one or more of the Broad Habitats. In the UK there are currently 65 Priority Habitats.

Countryside Survey is able to produce preliminary statistics for some **Priority Habitats** listed below, see the relevant chapter.

[1] 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.

1.2 The Field Survey

The core of CS is the Field Survey. It provides national and regional estimates of the extent of the different Broad Habitats found in the countryside *(Box 1.1)* and in 2007, for the first time, some Priority Habitats. The Field Survey describes the character and condition of the different vegetation types associated with these Broad and Priority Habitats, including both land and freshwater habitats. It also provides estimates of the extent and condition of important landscape features such as hedges, walls, ponds and trees.

Some habitats have been identified as a priority for conservation in the UK Biodiversity Action Plan (BAP) and are known as Priority Habitats *(Box 1.1)*, and are assessed on a regular basis. As CS 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. Reedbed. The results for a limited number of Priority Habitats *(Box 1.1)* are presented in this report. They represent national estimates based on a sample and should be used in conjunction with 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 further investigated. The CS estimate for Hedgerows, Ponds and the condition of Arable Field Margins represent the only national figures for these Priority Habitats.

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 Priority Habitats, using the data from the 1990, 1998 and 2007 Countryside 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, and for some there is backwards compatibility to 1984. The system also provides backwards compatibility to 1990 for some Priority Habitats. Similarly, the methods of recording linear features have been refined over time and so 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.

The condition of the vegetation included in each mapped area of Broad Habitats can also be reported for the 1990, 1998 and 2007 Countryside Surveys. This is because the position of each vegetation plot is known and so the species data recorded in each plot can be referenced to a Broad Habitat. As Broad Habitats were not mapped in 1978, plots cannot be allocated to Broad habitats for that year. Instead the vegetation data from the plots are analysed using the classification by Aggregate Classes (ACs), which can be applied consistently across all years.

ACs are the vegetation types produced from a quantitative hierarchical classification of the different species found in sample plots, based on a statistical analysis of the data[2]. The eight ACs used for assessing vegetation condition are listed in ***Table 1.1***. A Broad Habitat may be characterised by a particular AC (e.g. the AC Fertile Grassland fits well within the Improved Grassland Broad Habitat), whilst other Broad Habitats contain a mixture of different ACs (e.g. Acid Grassland Broad Habitat contains both the ACs of Infertile Grassland and Moorland Grass Mosaics).

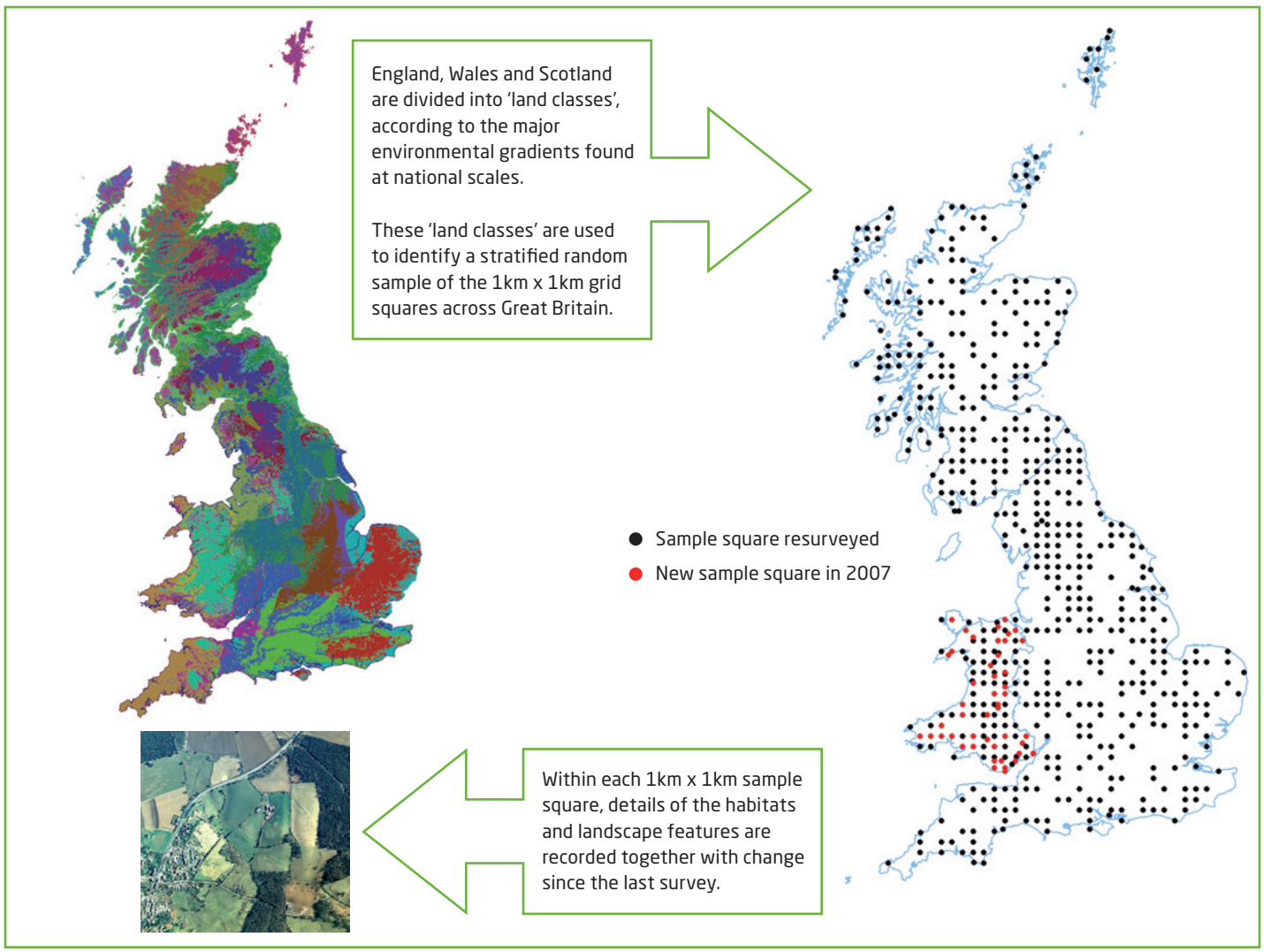
Assessments of the condition of linear features are confined largely to more recent Countryside Surveys, in particular 1998 and 2007.

▼ **Table 1.1:** The Aggregate Classes (ACs) used for assessment of vegetation condition in Countryside Surveys from 1978 to 2007 (see ***Chapters 2*** and ***10***).

Aggregate Class (AC)	Description
AC1 Crops and Weeds	Weedy communities of cultivated and disturbed ground, including species-poor arable and horticultural crops.
AC2 Tall Grass and Herb	Less intensively managed tall herbaceous vegetation typical of field edges, roadside verges, streamsides and hedge bottoms.
AC3 Fertile Grassland	Agriculturally improved or semi-improved grassland. Often intensively managed agricultural swards with moderate to high abundance of perennial rye grass.
AC4 Infertile Grassland	Less-productive, unimproved and often species rich grasslands in a wide range of wet to dry and acid to basic situations.
AC5 Lowland Wooded	Vegetation dominated by shrubs and trees in neutral or basic situations, generally in lowland Britain. Includes many hedgerows.
AC6 Upland Wooded	Vegetation of broadleaved and conifer woodland often in more acidic situations, generally in upland Britain.
AC7 Moorland Grass Mosaics	Extensive, often unenclosed and sheep grazed hill pastures throughout Britain.
AC8 Heath and Bog	Vegetation dominated by heathers. Includes drier heaths as well as bog. Mostly in the uplands.

[2] Bunce et al (1999). *Vegetation of the British Countryside. ECOFACT Volume 1.* Department of the Environment Transport and the Regions, London.

▼ **Figure 1.1:** A) The 32 ITE Land Classes used to stratify Great Britain for selection of the random 1km squares visited in Countryside Survey. B) Countryside Survey 1km x 1km sample squares in 2007.



1.3 The sampling strategy

A complete field survey of the entire UK countryside would be prohibitively expensive and impractical to run. CS uses a sample-based approach, to collect information at the level of detail required for national reporting[3]. It is important to remember that the results of CS are therefore calculated *estimates* and not absolute numbers derived from a complete coverage of the country.

The sampling strategy used for CS is based on a rigorous, statistical approach. Great Britain was stratified first into Land Classes[4] based on the major environmental gradients across the countryside. This permitted the sample to be structured to give reliable national statistics and also ensured that the sample is representative of the range of different environments found in Great Britain (England, Scotland and Wales). A similar approach was used within the Northern Ireland Countryside Survey (NICS) *(see* ***Section 1.6****)*.

The sample consists of a set of 'sample squares' measuring 1km x 1km, selected randomly from the Ordnance Survey grid within the various Land Classes ***(Fig. 1.1)***. Altogether, 591 sample squares were surveyed in 2007; 289 were in England, 107 in Wales, and 195 in Scotland. Sufficient sample squares were selected from each geographical region, to enable reliable statistical reporting for Great Britain as a whole and for each separate country. Data from the NICS (based on 288 squares, 0.5km x 0.5km, see ***Section 1.6***) are also added to provide estimates for the UK.

As far as possible, the same squares are sampled each time CS is repeated, so the vast majority of the sample squares visited in 1978 were also visited subsequently in 1984, 1990, 1998 and 2007. Each successive CS has included greater numbers of sample squares ***(Table 1.2)***. The estimates of change presented in this report use a statistical modelling technique to infer missing values so that changes between each year of the survey can be made using the maximum data available (see ***Annex 5*** to this Report at *www.countrysidesurvey.org.uk*).

[3] Bunce, R.G.H., Shaw, M.W. (1973). *A standardized procedure for ecological survey.* Journal of Environmental Management **1**: 239-258.

[4] Bunce R.G.H., Barr C.J., Clarke R.T., Howard D.C., Lane A.M.J. (1996). *The ITE Merlewood Land Classification of Great Britain.* Journal of Biogeography **23**, 625-634.

▼ **Table 1.2:** Number of squares surveyed in each country of Great Britain in successive Countryside Surveys.

Country	1978	1984	1990	1998	2007
England	126	187	264	302	289
Wales	22	32	47	64	107
Scotland	108	163	195	203	195
Total	**256**	**382**	**506**	**569**	**591**

CS is essentially a sample-based study of the rural environment, which includes countryside around towns, cultivated land and grassland, and more remote areas including moorlands, mountains and islands. The sample is *statistically representative* of conditions in the wider countryside, excluding only urban and sea areas. As only land above the High Water Mark is covered, estimates of the stock and change of intertidal habitats may be lower than other national estimates. Squares containing more than 75% of developed land or more than 90% of sea were not included in the Field Survey. If a surveyed sample square subsequently changed so that more than 75% of its area was developed, it was surveyed once more to give the area of Broad and Priority Habitats being lost to developed land. The square was then replaced by a new square in subsequent Countryside Surveys.

In 2007 a single headwater stream was surveyed in those sample squares that contained one or more such streams (373 squares). Data on various aspects of within-channel and adjacent habitat condition were collected. Likewise, in 2007, one pond was surveyed in (262) sample squares in which one or more ponds were found, although not necessarily with a headwater stream. Data on the condition of ponds were not collected in previous Countryside Surveys, but in 1996 a separate survey of lowland ponds *(see Section 1.4.4)* used the same sampling framework. It has been possible to analyse change between 1996 and 2007 for this sub-set of ponds.

Four soil (0-15cm) samples were collected from each of five random locations (i.e. Main Plots) within each sample square. The exact sampling points varied between survey years to avoid both disturbance to the plot and sampling soil disturbed in previous Countryside Surveys. In 2007 soil (0-15cm) was collected from all sample squares, in 1978 and 1998 soil was collected only from the squares surveyed in 1978.

1.4 Data collection

The field survey was carried out by teams of botanical and freshwater surveyors, after they had undergone an intensive four-week training course to ensure high standards and consistency of methodology, identification and recording across CS.

▲ Surveyors at work, Scotland • © *NERC*

In 2007, new electronic data capture methods were developed for and used in CS for the first time. The move from mapping on paper (as in all preceding Countryside Surveys) to electronic methods created greater efficiency in terms of data entry and also eliminated a significant potential source of error. Improvements to data quality also resulted from: the inclusion of mandatory data entry fields for each area or feature; a mask to assess completeness of data entry electronically; and the ability to validate changes made to mapped data whilst in the field.

Mapping was carried out using a bespoke Geographical Information System (GIS) program developed by the Centre for Ecology and Hydrology (CEH) in conjunction with ESRI UK and in co-operation with the Forestry Commission. The software was mounted on Itronix® Duo-Touch lap-tops designed for work in rugged conditions. These machines proved to be durable and coped well with the demanding conditions in the field.

Increased computing power and software developments have enabled data from the whole sequence of Countryside Surveys to be placed in a single geographically referenced database. This database incorporates and links the mapped data, vegetation plot data, soil collection points and the freshwater survey data, facilitating analysis and data access for all potential users

The surveyors were able to regularly download and upload data for each sample location at regular intervals, through a web-based data management system.

▼ **Figure 1.2:** Data gathered from a typical Countryside Survey sample square.

1.4.1 Habitat and landscape feature mapping

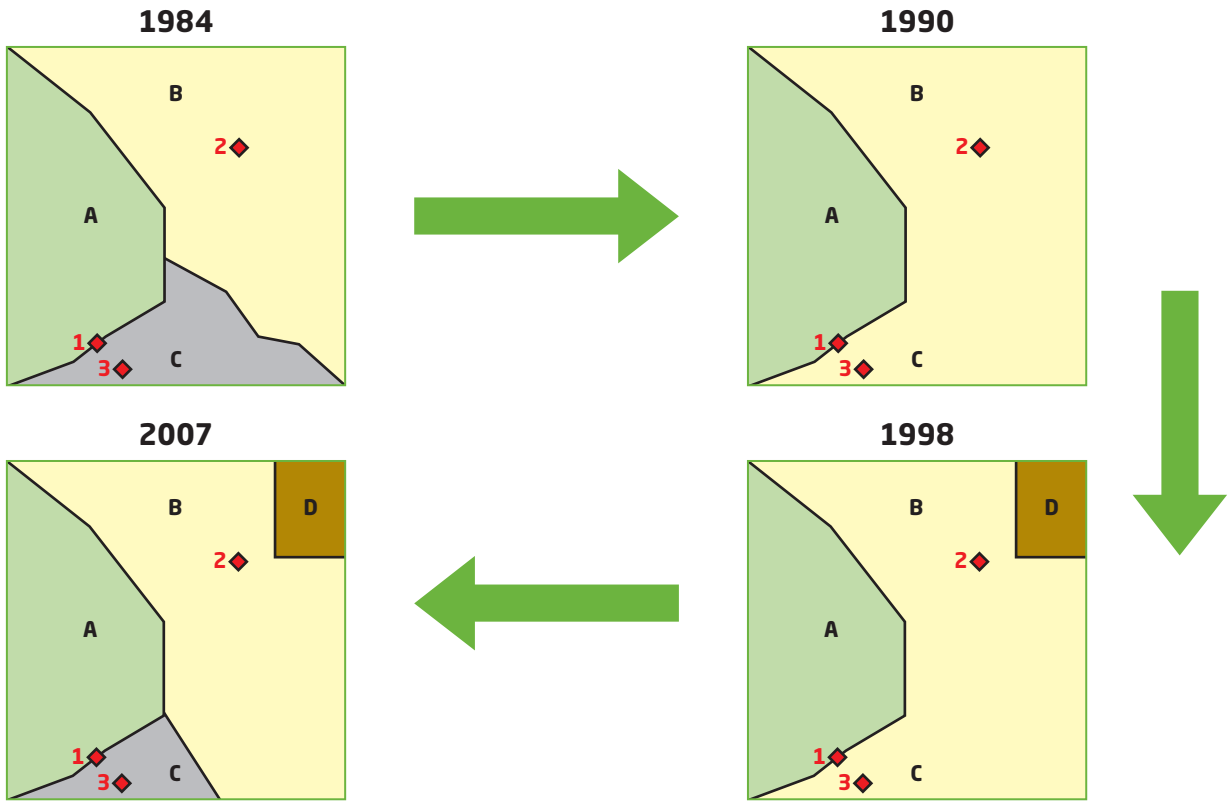
The habitats in the whole of each sample square were mapped, providing data required to estimate the areas and changes in areas of Broad and Priority Habitats, and the lengths and numbers of landscape features *(see Fig. 1.2)*. All Broad and Priority Habitats and features were mapped (urban areas and agricultural curtilage were excluded) using a minimum mappable area of 400m^2 (20m x 20m through to 80m x 5m) and, for linear features, a minimum mappable length of 20m. For squares mapped for the first time in 2007 the surveyors started with Ordnance Survey linework without any habitat information; for repeat squares mapping was based on recording change to the maps produced in 1998, with further reference to the maps produced in 1990 where helpful.

Broad and Priority Habitats were identified using a key developed in 1998 for CS 2000 and updated with improvements between 2001 and 2006, utilising advice from many experts on UK BAP definitions. The key is available in *Annex 2*.

Each mapped area of Broad or Priority Habitat forms a polygon on the map of the square *(Fig. 1.3)*. The surveyors entered information about each mapped polygon, including land-use (crop, grazing animals etc.) and at least the two most common species. When surveyors encountered a habitat in 2007 that was different to that mapped in 1998, they were asked to make (and record) a judgement as to whether a real change had occurred or whether the apparent change was a result of the wrong habitat being allocated in 1998. This approach was adopted to replace the system used in 1998 where surveyors recorded codes on maps (not related exactly to Broad Habitats) that were subsequently allocated to Broad Habitats some months later in the laboratory. In 1998 it was difficult in some instances for the digitisers to determine whether changes were real or mapping error. Similarly surveyors were asked to validate 1998 data on other mapped features by recording their judgement as to whether the features had been correctly recorded earlier on the maps. The system in 2007 put the onus on the surveyors in the field to remove any error caused by interpretation in the laboratory.

Linear features were classified using a key developed for CS in 2005-2006. Of these, 'Woody Linear Features', which includes hedges, remnant hedges, and lines of trees, were classified using a key developed in consultation with the Hedgerow Steering Group of the UK BAP.

▼ **Figure 1.3:** Recording detailed changes in habitats and species composition in a Countryside Survey sample square.



The relationship between mapped land cover and vegetation plot data for assessing change in a 1km square.

Example: In 1984 there were three Habitats A, B and C. By 1990 Habitat C had been replaced by more of Habitat B and the wall between them removed. In 1998 a new block of Habitat D had been created in the north-east corner and by 2007 part of Habitat C had been recreated. Plots were located in the habitats to sample vegetation in detail (for simplicity only three plots are shown in this figure).
Plot 1 was on a boundary and this would have shown any changes to the boundary caused by the change of habitat neighbouring the plot.
Plot 2 was in Habitat B and was unlikely to change much, whereas Plot 3 is likely to have changed considerably as the habitat in which it was sited changed between 1984 and 1990 and again between 1998 and 2007.

1.4.2 Vegetation sampling plots

More detailed information about the composition of vegetation (presence and percentage cover of vascular plant species) within each of the sample squares was collected using a series of smaller vegetation sampling plots. Various types of plot were employed and on average 30 plots were completed in each sample square.

Main Plots were located at pre-selected random points within the sample square to provide an unbiased sample of widespread and common habitat types in the open countryside (fields, woods, heaths and moors). Other, smaller plots were positioned randomly by surveyors within areas targeted for their botanical interest. These were often semi-natural habitats missed by Main Plots or in relation to particular landscape features in the sample squares, and so produced an unbiased sample of these habitats and features. Further plots were located within unenclosed land in 1998 to measure habitat condition.

The vegetation sample plot data were entered electronically in the field using CEH software, on the same laptops as used for the mapping exercise. The data fields on the electronic recording forms were almost identical to those collected on paper forms used since 1978.

The different plot types used, their names and the numbers recorded in each CS square are described in *Table 1.3* (for detailed methodology *see Annex 3*).

To analyse change, it is important to relocate the same sampling plots in successive surveys. In previous Countryside Surveys sample plot location was recorded on paper forms and by taking at least two photographs. In 1998 a GPS was used in some remote squares. In 2007 plot location was carefully recorded on the laptops using the in-built GPS (where a GPS signal was available) and also on paper and by photograph, to enable surveyors in subsequent surveys to relocate them. Although some of the vegetation sampling plots that were sampled in 2007 were new, most had been surveyed in 1998 and in 1990 and some of them had records going back to 1978. All vegetation sampling plots can be regarded as fixed in space. Vegetation sampling plot data provide: insights into the state or condition of the Broad and Priority Habitats in which it occurs; changes in the plots over time *(Fig. 1.3)*; and overall vegetation change (see *Box 1.3* at the end of this chapter for the measures analysed). The ACs *(Table 1.1)* are used to group species within the different Broad and Priority Habitats *(Box 1.1)*.

▼ **Table 1.3:** Vegetation plot types that could potentially be mapped in each 1km x 1km Countryside Survey sample square depending on the types of habitats and features present.

Plot type	Name	Size	Maximum no. of plots per sample square	Year that the plot type was introduced to Survey
Fields and other main land cover parcels	Main	14m x 14m (nested)	5	1978
Road verges	Roadside	1m x 10m	2	1978
Additional road verges	Roadside	1m x 10m	3	1990
Stream and riverside	Streamside	1m x 10m	2	1978
Additional stream and riverside	Streamside	1m x 10m	3	1990
Field boundaries	Boundary	1m x 10m	5	1990
Arable field edges	Crop Edge	1m x 100m	5	1998
Margins around arable fields	Managed Margin	2m x 2m	15	2007
Hedgerows	Hedge	1m x 10m	2	1990
Woody species in hedgerows	Hedge Diversity	1m x 30m	10	1998
Targeted Habitat Plots	Targeted	2m x 2m	5	1990
Unenclosed Broad Habitats	Unenclosed	2m x 2m	10	1998

1.4.3 Soil (0-15cm) sampling

As part of the 1978 CS, soil samples from the top 0-15cm were collected 15cm south of the southern corner of the five Main Plots in a sample of 256 1km x 1km squares (see *Table 1.3*). Samples from later Countryside Surveys were collected from the other corners resulting in soil sample locations approximately 2 to 3m apart between Countryside Surveys. These plots were re-sampled in 1998, whilst in 2007 soils were collected in all 591 x 1km squares, from the western corner of Main Plots. The soil (0-15cm) samples enable changes in several key soil characteristics to be studied, including pH, soil (0-15cm) carbon and nitrogen concentration, a measure of available phosphorus, heavy metal concentrations and soil biota. In addition, measurements of potentially mineralisable nitrogen and bulk density were made for the first time. In this Report the results from the analysis of changes in soil (0-15cm) pH (acidity) and soil (0-15cm) carbon concentration are presented along with the 2007 measurements of bulk density. A more detailed Soils Report will be published in 2009.

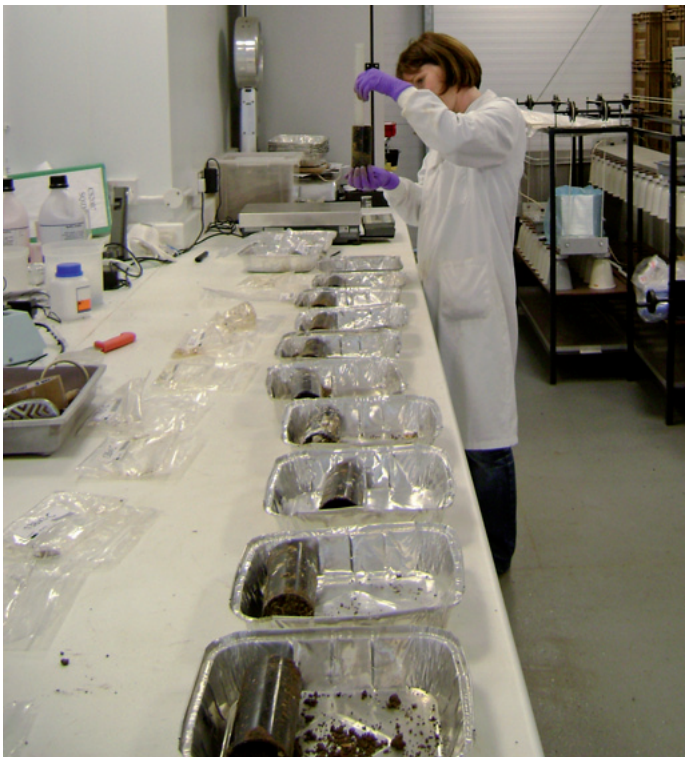
Three soil samples only were collected from each Main Plot from the top 15cm of the soil profile and a fourth, for the invertebrate sample from the top 8cm only. In 1998 and 2007 this was carried out using a plastic corer hammered into the soil and then pulled out with the sample intact. In 1978, a soil pit was dug and soil was collected from the top 15 cm of the profile in the side of the pit. In all three years, loose vegetation and fresh litter were cleared from the soil surface before the sample was taken.

Soil (0-15cm) pH value: This is a measure of the acidity of the soil that uses a logarithmic scale of hydrogen ion concentration, with lower pH values being more acid than higher values. For soil, a pH from 5.5 to 6.5 is considered neutral. Soil pH varies by soil type and is influenced by multiple factors including land use, underlying geology, interaction with overlying vegetation and its decomposition, and also by atmospheric deposition.

Soil (0-15cm) carbon concentration: This is the concentration of carbon in the top 15cm of the soil, expressed on a per unit weight basis (grams of carbon per kilogram of soil, or g C/kg.). It is estimated from the measurement of 'loss on ignition', using the standard conversion factor of 0.5.

Bulk density of soils (0-15cm): This is the weight of soil present in a specified unit volume of soil expressed as grams per cubic centimetre (g/cm^3) of soil.

Full details concerning sampling, analytical methods, quality assurance and statistical techniques used are available in the Countryside Survey Soils Manual *(see **Annex 4**)*.



▲ Soils analysis in progress • © *NERC*

1.4.4 Freshwater sampling

In addition to the mapping of rivers and streams, canals, ponds and lakes within each sample square in the Field Survey, the biological and physical condition of headwater streams and ponds were assessed and recorded in more detail.

Headwater streams: In 2007 a selected stream and its associated bank-side areas (the 'riparian' zone) were surveyed in 373 of the 591 squares surveyed. In the 1990, 1998 and 2007 Countryside Surveys the biological condition of streams was assessed based on the diversity of macro-invertebrates that they supported. In 1998 and 2007, the stream plant community was also surveyed to provide additional information on the pollution status of the watercourses. The physical structure and complexity of the river corridor was first surveyed as part of the 1998 CS and was repeated for 2007.

Stream macro-invertebrates: The macro-invertebrate community living in the stream bed was sampled in one stretch of the selected stream within 350 sample squares, using the national standard method[6]. Three squares were not sampled because the streams were dry when visited. Changes in the biological condition of streams between the survey in 2007 and those in 1990 and 1998 will be quantified and reported in a separate Freshwater Report to be published in Autumn 2009.

Aquatic plants and condition assessment: Aquatic plants were surveyed over a 100m stretch of the stream in 361 sample squares, using the national standard method[7]. Streams that were dry at the time could not be sampled. Plant species were recorded only if submerged or partly submerged in the stream, or rooted on parts of the stream bed which are likely to be submerged for more than 85% of the time.

A similar survey was undertaken at 414 stream sites in CS squares in 1998, but this work was not reported at the time. These data enable an assessment of the changes in the headwater stream plant communities between 1998 and 2007. Changes to the diversity of plants at the level of individual streams and at a regional scale were investigated. Scores were assigned to aquatic plant species according to their known tolerance to nutrient enrichment (eutrophication). The Mean Trophic Rank (MTR) method allows the condition of streams to be assessed based on the observed plant community, and also permits an estimate of the change in nutrient enrichment impact on headwater streams since the last CS. MTR values for a stream site can vary from 10 to 100, with scores less than 25 indicating eutrophic conditions.

Stream physical character: The physical character of the streams was assessed over a 500m stretch using the national standard River Habitat Survey (RHS) method[8] which records both within-stream and bank-side features. The RHS method records different aspects of the physical structure of streams at ten checkpoints along a water channel. Features recorded include bank material, channel substrate and riverside vegetation structure. Overall assessments were also made of the 500m length of watercourse surveyed. All of the data were summarised into an index of physical habitat diversity, the Habitat Quality Assessment (HQA). The HQA is a measure of the diversity of natural features present such as waterfalls and gravel bars; a higher score indicates greater habitat diversity and therefore higher quality. The RHS can be carried out on a dry stream channel. Of the 373 streams surveyed in 2007, 350 were also surveyed in 1998 allowing, for the first time, an analysis of changes to the physical condition of headwaters.

Ponds: In 2007, high quality ponds became a Priority Habitat identified under the UK Biodiversity Action Plan. Five criteria are used to define whether a pond meets priority status. These criteria are wide-ranging and include plant, invertebrate, amphibian and pond-type measures. A pond can qualify as a Priority Habitat Pond on the basis of one or more of the criteria. In CS in 2007, pond condition assessments were based on plant data. These data have been used to identify Priority Habitat Ponds using three plant criteria:

(i) Presence of a Nationally Scarce, Red Data Book, Biodiversity Action Plan or legally protected plant species

(ii) An exceptionally rich site for plants that supports more than 30 wetland plant species

(iii) Classified in the top PSYM ***(Box 1.2)*** category (Good) with a PSYM score more than 75% (available for England and Wales only)

Ponds were mapped in the Countryside Surveys in 1990 and 1998, and in 2007 the biological condition of ponds was also assessed for the first time. In the 260 sample squares that contained ponds, the plant community of one randomly-selected pond was surveyed, using the national standard method[9] ***(Box 1.2)***. Wetland plants at each pond were recorded within the area defined by the upper drawdown zone. This is the area of a pond that remains wet until water levels begin to drop in late spring. Ponds were surveyed by walking across dry and shallow water areas of each pond to record plant species. Plant species inhabiting deeper water areas were surveyed from the water's edge with the aid of a grapnel. Associated environmental information relating to the pond (including amenity use) was also gathered.

[6] Murray-Bligh, J.A.D. (1999). *Procedure for collecting and analysing macroinvertebrate samples.* Environment Agency, Bristol, UK.

[7] Holmes N.T.H., Newman J.R., Chadd S., Rouen K.J., Saint L., Dawson F.H. (1999). *Mean trophic rank, a user's manual.* Environment Agency, Bristol, UK.

[8] *River Habitat Survey guidance manual: 2003 version.* Environment Agency, Bristol, UK.

[9] Biggs J., Fox G., Nicolet P., Walker D., Whitfield M., Williams P. (1998). *A guide to the methods of the National Pond Survey.* Pond Action, Oxford, UK.

A sub-set of 77 ponds had been previously surveyed using the same methodology, as part of the 1996 Lowland Pond Survey. Together with the 2007 data, the 1996 data enabled an assessment of the extent of change in pond condition in lowland areas of Britain.

Box 1.2: PSYM

PSYM, the Predictive SYstem for Multimetrics, is a pond quality assessment method. It assesses quality using a range of measures (metrics) each of which has been shown to vary predictably with degradation. The values from individual metrics are combined to give a single measure which aims to represent the overall ecological quality of the water body. Conceptually, the method is similar to the stream bioassessment tool (RIVPACS) but PSYM assesses overall pond quality, rather than specific water pollution status.

PSYM assessments are usually based on both plant and aquatic invertebrate data, because plants and animals together span a complementary range of sensitivities to potential degradation factors. Plants are, for example, particularly sensitive to the water body's nutrient status, whereas animals typically exhibit greater oxygen sensitivity. PSYM assessments can be made using a single biotic group. In the Countryside Survey of 2007, plants alone were used for this assessment.

There are three plant metrics in PSYM:

- Number of submerged and marginal plant species: floating-leaved species are not included.
- Trophic ranking score (TRS): assigns scores to still-water plant species based on their known tolerance to nutrient enrichment (eutrophication).
- Number of uncommon plant species: number of local, scarce or Red Data Book plant species recorded at each pond.

Different pond types support different plant and animal communities. The PSYM software programme predicts the metric values that would be expected at each different sort of pond if that pond was pristine. The true biological condition of ponds can be judged by comparing the observed value of each metric, then the observed value can be expressed as a percentage of the expected value. In high quality sites the similarity is high (75%-100% similarity). As degradation increases, the percentage similarity between the observed and expected values falls. For reporting purposes percentage similarity is divided into four grades of ecological condition:

0% - 24%	Very Poor
25% - 49%	Poor
50% - 74%	Moderate
75% or above	Good

1.5 Data analysis and reporting (Great Britain)

1.5.1 Habitat classification systems

The Broad Habitat system was devised and introduced by the Joint Nature Conservation Committee in 1998, just before the 1998 CS. Both the CS in 1984 and in 1990 were carried out using earlier definitions for habitats that were not directly related to the Broad Habitat classification and so a translation protocol had to be developed for these past data to be used. The classification system used in 1990 was itself developed from the 1984 system and this 1990 translation was relatively straightforward but not without difficulty. However, the translation of recording codes from 1984 into the Broad Habitats has been difficult for some codes, namely Improved, Neutral, Acid and Calcareous Grasslands and also for Dwarf Shrub Heath, Bog, and Fen, Marsh and Swamp so we have used the previously published 1984 data. The same field codes were used in 1998 and 2007, so reporting changes were much easier.

1.5.2 Broad Habitat area estimates

The area was calculated for each of the 45 Land Classes *(Section 1.3 & Fig 1.1)*; for England, Scotland and Wales individually; and for Great Britain. The estimation of the total area of each Broad Habitat in a Land Class involves multiplying the mean area of each Broad Habitat in the 1km sample squares in a Land Class, by the total land area in the Land Class, excluding unsurveyed urban land and land below the mean high water mark. The estimates of the area of Broad Habitats for Great Britain, England, Scotland and Wales were achieved by the summation of the Land Classes found in each Broad Habitat. The estimates for the area of Broad Habitats for the United Kingdom were calculated by the addition of the areas obtained from Northern Ireland Countryside Survey (NICS) (see *Section 1.6*) to those obtained for Great Britain. The results from Great Britain and Northern Ireland in 1998 were also combined so that the change in area of each Broad Habitat could be calculated and their significance determined.

In past Countryside Surveys, comparison between years has been difficult because of the gradual increase in the number of sample squares in each of the years. In the 1998 CS, the change between 1990 and 1998 was calculated using only data from those squares that were surveyed in both 1990 and 1998. For the analysis in 2007 a new statistical model has been used, so that data from all the squares surveyed in each of the years can be used to create the Broad Habitat area estimates for each CS. This model ensures maximum possible use of the collected data and provides means, standard errors and significance levels for change estimates which were not possible from the earlier model. The earlier model only compared squares surveyed in both 1990 and 1998 (change from 1984 to 1990 was not reported) *(see Annex 5)*.

The mapped data from each CS can be used to investigate how Broad Habitats have converted from one to another. Changes in Broad Habitats as a result of management are slow and the effects

are only detected over the long-term through repeated surveys. The CS surveyors concentrated particularly on identifying and mapping where change had taken place between Countryside Surveys. The results are presented as the total area in '000s of hectares ('000s ha) as well as the proportion of Great Britain for 1984-2007 (labelled as % GB) and of the UK for 1998-2007.

1.5.3 Conversion between Broad Habitats

Flows to show the net conversion to and from the different Broad Habitat types between 1998 and 2007 are described. These are not statistical estimates but serve to provide information on the direction of flow between Broad Habitat types. The flows observed between Broad Habitat areas will include a component of 'noise' linked to mapping and data-processing error, as well as real and hence ecologically important change.

1.5.4 The condition of Broad Habitats between 1990 and 2007

Each of the vegetation sampling plots was assigned to a Broad Habitat on the basis of its location within the mapped parcels *(Fig.1.3)*. The vegetation characteristics and condition of the Broad Habitat was assessed by analysis of the plant species found in each of the sample of vegetation plots within it, and subsequently gave a mean value for the plots in that Broad Habitat. Each of the plot types was analysed in this way for each Broad Habitat.

The measures used to assess Broad Habitat condition are listed and detailed in *Box 1.3 (at the end of this chapter)*. The results of these analyses are presented as summary results tables in each chapter. All significant changes in Broad Habitat condition measures are given at the 0.05 confidence level (see *Section 1.7.1*) and are shown by an arrow indicating the direction of change in the summary results tables; an upward arrow being positive and a downward arrow being negative.

1.5.5 The change in vegetation between 1978 and 2007

Long-term change in vegetation from 1978 to 2007 has also been assessed using the condition measures outlined in *Box 1.3*. Only the plots that were surveyed in each of the Countryside Surveys (1978, 1990, 1998 and 2007) were used for this analysis. Because there were only 256 1km x 1km survey squares recorded in 1978 the number of repeat plots is much smaller than the total number of plots recorded in 2007 when 591 squares were surveyed. To track long-term changes in vegetation before the Broad Habitat classification existed, in these analyses the plot is assigned to the vegetation AC (see *Table 1.1*) to which it was classified in 1978. For example, a plot in an arable field in 1978 would be assigned to the AC Crops and Weeds, and all subsequent changes in condition would contribute to the assessment of this AC even if the plot was later sown with grass or planted with trees (see *Chapter 10*). This permits the fate of a cohort of plots to be followed through the CS time series, where cohort membership was defined by the AC to which the plot was allocated in 1978.

▲ Headwater stream, England • © *NERC*

1.5.6 Estimation of Priority Habitats from Countryside Survey data

In the 2007 Field Survey, the field surveyor assigned the mapped polygons to a Priority Habitat, using the vegetation field key. They could also back-allocate this decision to 1998 if they felt that on the basis of habitat and species recorded last time there had been little change. As well as mapping the Priority Habitat they recorded associated species and were also encouraged to place a 2m x 2m sampling plot (Targeted Plot) in this Priority Habitat if it did not already have an existing plot located in it.

In previous Countryside Surveys (1990 and 1998) existing habitat codes and species attributes were used to assign the polygon to Priority Habitat. This was easier for some Priority Habitats than others (i.e. if there was an existing habitat code that matched the current definition). Even where the same habitat was recorded there may have been subsequent definitional changes, e.g. in Blanket Bog.

Various spatial masks were used in post-survey analysis to delineate the extent of the Priority Habitat. These differentiated habitats into upland or lowland, or in the case of woodlands were much more specific. National estimates were then created using the same methodology used for the Broad Habitats.

Four different spatial masks, or sets of masks, were used in this work:

i) *The SNH mask:* A GIS coverage of Scotland provided by SNH. This divides Scotland into four regions: lowlands, marginal, uplands, and montane.

ii) *JNCC masks:* A number of JNCC masks were used delineating the areas in which certain types of woodland were considered to occur, broken down by country. The woodlands covered are Lowland Beech (England, Wales) (ultimately CS was not able to estimate this Priority Habitat), Lowland Mixed Deciduous (England, Wales), Upland Mixed Ash (England, Scotland, Wales), Upland Oak (England, Scotland, Wales). These masks were based on digitised versions of the indicative range boundaries in *Hall & Kirby (1998)*. They were recorded in terms of whole 1km squares.

iii) *English Natural Areas masks* In England, Natural Areas based masks were used to effect an upland/lowland separation, to aid definition of Lowland Mixed Deciduous, Upland Mixed Ash and Upland Oak woodlands, and to define the Native Beech zone (ultimately CS was unable to estimate this Priority Habitat). Natural area data were obtained from the Natural England website *(www.english-nature.org.uk/pubs/gis/gis_register.asp)*.

iv) *Welsh Upland mask:* The Welsh uplands were defined using an aggregation of land classes in Wales into upland and lowland environmental zones.

1.5.7 Lengths of linear landscape features, numbers of ponds and hedgerow trees

Linear features in the countryside are often highly complex and made up of numerous different components; e.g. a single field boundary may contain a fence, a hedge and a bank. To simplify reporting of these features, a hierarchy of feature types was used to define any linear feature (as described further in ***Chapter 5***). National estimates for linear feature types (in '000s km) were achieved by calculating a mean length for each feature type for the sample squares within a Land Class; then multiplying this figure by the number of 1km squares in the Land Class. This calculation gives an estimate of the total length in the Land Class and subsequently, by summation, of all Land Classes. National estimates of ponds and hedgerow tree numbers are derived in the same way.

1.5.8 Soils analysis

Soil preparation and bulk density: The exact dimensions and weight of the soil core were recorded together with a digital photograph and measurements of soil horizon depths. The soil was air dried, weighed and sieved, after which the separated soil and stones were reweighed. A sub-sample of soil was then dried at 105°C overnight, cooled and weighed. The mass and volume of the stones were also determined. The bulk density was calculated from the mass of soil recorded for each sample, subtracting the stone content, using the exact dimensions of the soil sample to give the volume of soil. Results are expressed as grams per cubic centimetre (g/cm^3).

Soil pH: Soil pH (the measure of acidity or alkanity) was measured on the fresh soil sample, sub-sampled after mixing and before drying, using 10g of field-moist soil in a 50ml plastic beaker to which 25ml of de-ionised water was added, giving a ratio of soil to water of 1:2:5 by weight. The suspension was stirred thoroughly and left to stand for 30 minutes after which time the pH electrode was inserted into the suspension and a reading taken after a further 30 seconds.

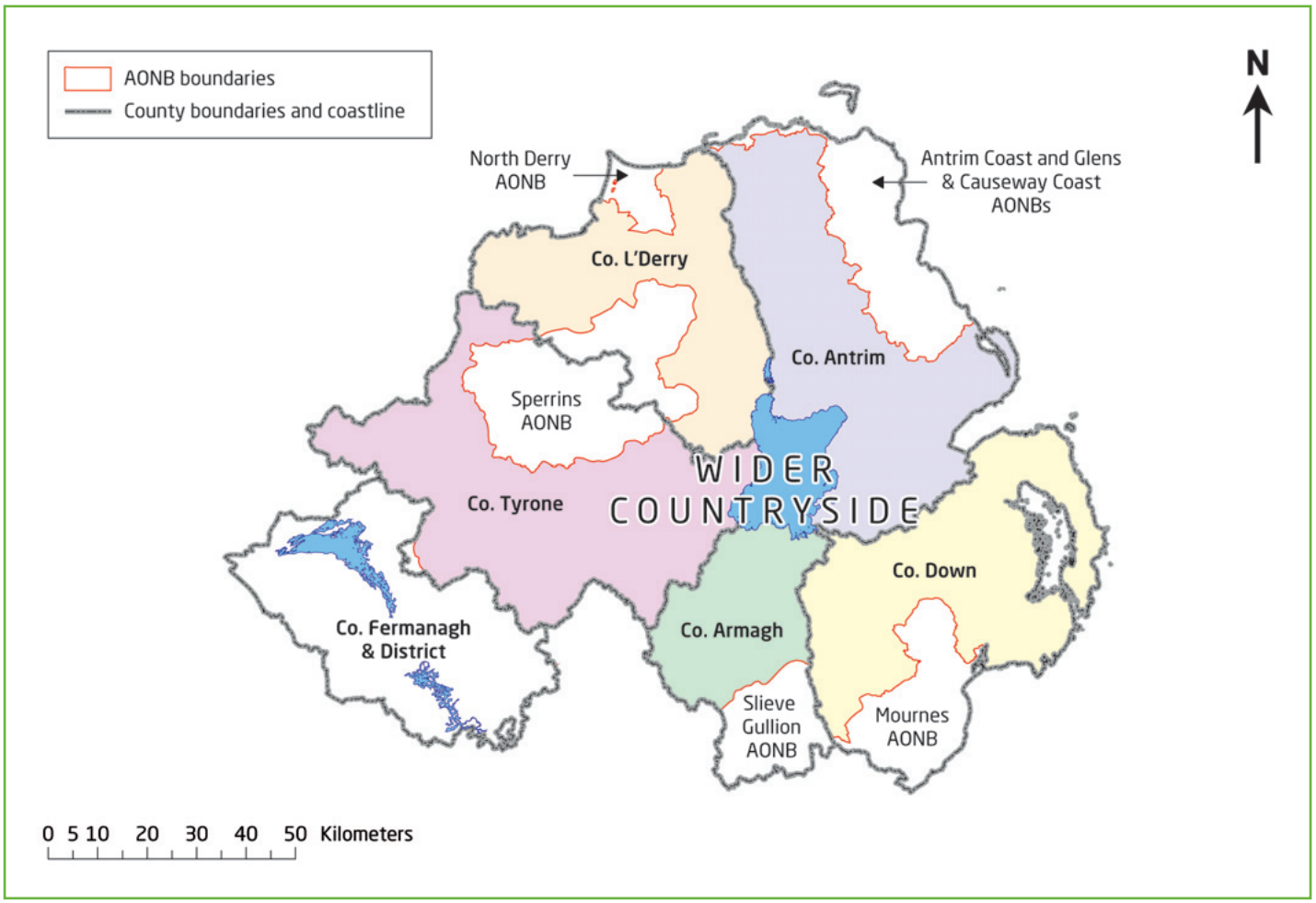
Soil carbon concentration (0-15cm): Loss on ignition was measured in a 10g air dried sub-sample taken after sieving through a 2mm mesh. The sub-sample was dried at 105°C overnight to remove moisture, weighed, then combusted at 375°C for 16 hours. The cooled sample was then weighed and the loss-on-ignition value (%) calculated. Carbon concentration was calculated using the standard value of 50% of loss-on-ignition values and expressed as grams of carbon per kilogram (g C/kg)

Stock of soil (0-15cm) carbon: This value was calculated by multiplying the carbon concentration data by the bulk density value, which when corrected for the area of the original core gave a value of tonnes of carbon per hectare (t/ha).

Statistical analysis: All results were analysed using a bootstrapping method which makes fewer assumptions about the structure of the data and thus gives more accurate measurements of significance.

Detailed information on all methodologies is available in the Countryside Survey Soils Manual available at ***Annex 4****.*

▼ **Figure. 1.4:** Regional sampling strata for Northern Ireland.



1.6 Northern Ireland Countryside Survey (NICS)

The NICS is a habitat monitoring research programme carried out for the Northern Ireland Environment Agency by the University of Ulster. It was developed independently from CS, but is also based on the principle of statistically structured habitat sampling and standardised recording procedures.

Baseline field survey was carried out from 1986 to 1991, in seven regions representing the whole of Northern Ireland *(Fig. 1.4)*. Field mapping was carried out with a Primary Habitat classification, supplemented with habitat attributes (information on species, grazing animals etc.). Habitats were defined and mapped with standardised descriptors and field procedures[10]. They were recorded onto 1:10,000 Ordnance Survey maps with a minimum mapping area of 100m^2 and for field boundaries, a minimum mapping length of 10m. To take account of the small scale of landscape variability in Northern Ireland, sample squares of 0.5km x 0.5km were used. Samples were stratified with a multivariate Northern Ireland land classification[11]; each of the regions of Northern Ireland was sampled separately. Regional Habitat area and field boundary length estimates were derived and their reliability was defined by confidence limits. The samples from each region were subsequently combined to calculate Northern Ireland habitat estimates, with an overall sampling intensity of 1.1% (628 sample squares).

▲ Surveyor at work in N. Ireland • © *Mark Wright*

[10] Cooper, A., McCann, T. (2002). *Habitat change in the Northern Ireland Countryside: technical report of the Northern Ireland Countryside Survey 2000.* Environment and Heritage Service, Department of the Environment for Northern Ireland, Belfast.

[11] Cooper, A. (1986). *The Northern Ireland Land Classification.* Department of Environmental Studies, University of Ulster, Jordanstown.

▼ **Figure 1.5:** GIS field mapping records. Numeric codes represent the Primary Habitat of mapped parcels (A: agricultural grassland and crops; W: woodland and scrub; S: semi-natural vegetation; L: Landscape features e.g. buildings, roads and water bodies).

▲ **Figure 1.5a:** NICS ecological field map of a sample square (1998).

▲ **Figure 1.5b:** NICS field-mapped parcels in 2007, superimposed onto a colour aerial photograph. Only parcels with a changed habitat compared with 1998 are shown.

In 1998, the 628 grid square field sampling programme was repeated to monitor habitat change[12] *(www.science.ulster.ac.uk/nics/)*. Field Survey was validated by independent external assessment; Primary Habitat change in each region and for Northern Ireland as a whole was estimated. Correspondence between the Northern Ireland Primary Habitat and UK Broad Habitat classifications was assessed, by combining Primary Habitats to approximate to the UK Broad Habitat definitions. Broad Habitat estimates were then determined and combined with Great Britain estimates to derive UK Broad Habitats for CS 2000 and 2007.

In 2007, a third phase of field sampling was carried out at an optimised, proportional 0.5% sampling intensity (288 sample squares), to derive N. Ireland estimates of Primary Habitat change. The field data recording structure was extensively modified to give more species composition detail and attributes were added to describe habitat condition[13]. Hedgerow definitions were changed so that they could be defined more precisely by shrub and tree growth form.

Electronic field survey protocols were developed for habitat mapping and attribute recording. Data capture was carried out with: a hand-held computer loaded with electronic data forms; high-performance GPS; 1:2,500 Ordnance Survey maps and NICS ecological maps from 1998 ***(Fig. 1.5a)***. Colour aerial photographs were used as a field mapping aid. For data analysis, GIS was used to relate field database records to OSNI 1:2,500 vector maps, overlaid onto colour digital aerial photography ***(Fig. 1.5b)***. Data were subsequently linked to digitised polygons for database and spatial analysis using ArcGIS.

NICS Broad Habitats, additional to those reported for 1998, were estimated by constructing littoral zone, montane zone and freshwater lake sampling strata appended to the Northern Ireland land classification. Sample squares additional to the NICS sampling programme were allocated in order to survey these strata. The correspondence between Primary Habitat and Broad Habitat classifications was refined, to take account of changes in UK Broad Habitat definitions.

[12] Cooper, A., McCann, T., Meharg, M. (2002). *Habitat change in the Northern Ireland Countryside: summary report of the Northern Ireland Countryside Survey 2000.* Environment and Heritage Service, Department of the Environment for Northern Ireland, Belfast.

[13] McCann, T. Rogers, D., Cooper, A. (2007). *Field methods and technical manual: Northern Ireland Countryside Survey 2007 (NICS 2007).* Environmental Science Research Unit, University of Ulster, Coleraine.

▼ **Table 1.4:** The Reporting Framework.

Reported variables	Years
Area of Broad Habitats ('000s ha) for UK	1998-2007
Change in area of Broad Habitats ('000s ha) for UK	1998-2007
Area of Broad and Priority Habitats ('000s ha) for GB	1990-1998-2007
Change in area of Broad and Priority Habitats for GB ('000s ha)	1990-1998-2007
Condition of Broad and Priority Habitats for GB	1990-1998-2007
Condition of vegetation in Aggregate Classes for GB	1978-2007
Length of Linear feature types ('000s km) for GB	1984-1990-1998-2007
Numbers of ponds for GB	1998-2007
Biological condition of streams for GB	1998-2007
Habitat Quality Assessment of streams for GB	1998-2007
Biological condition of ponds for England and Wales	2007 (but compared to 1996 in lowland Great Britain)
Soil pH by Broad Habitat for GB	1978, 1998, 2007
Soil carbon concentration for GB	1978, 1990, 2007
Soil bulk density for GB	2007
Soil carbon stock for GB	1978, 1998, 2007

1.7 The Reporting Framework

All variables are reported by Great Britain and by country, but Broad Habitat data are reported at the UK, Great Britain and country levels. The emphasis in this report is on the analysis and evaluation of stock and changes at the GB or UK level. Country level reports for England, Scotland and Wales will be published in Spring 2009 and these will give more detailed analysis of relevance to each particular country. Broad Habitat data are reported for the UK and individual Countries. *Table 1.4* summarises the results presented in this Report.

1.7.1. A note on significance of changes

For ease of presentation in tables, a minimum significance level with a probability of 0.05 has been adopted (i.e. there is only a 5% chance of the result occurring by random chance). Arrows are used in the tables to indicate significant changes at the 0.05 probability level and the direction of the arrow indicates if the change was an increase (upward arrow) or a decrease (downward arrow). Many of the results are significant at either 0.01 or 0.001, as indicated in figures where they occur.

Significant changes in the figures between sampling dates are indicated with a bracket between those dates, so a significant change between 1990 and 2007 would have a bracket extending between 1990 and 2007. The significance of the change is indicated by the number of * symbols (* $p<0.05$, ** $p<0.01$, *** $p<0.001$). In the supporting text, brief comments are given on the ecological importance of significant changes. As CS involves numerous records, quite small changes in the values of condition measures can sometimes be statistically significant, although in ecological terms they may mean very little. Means for 1998 and 2007 are provided in the tables to help the reader to see the magnitude of differences between years. In graphs, the variation in the sample around the mean is shown by using 95% confidence limit bars.

The measures of vegetation condition are summarised in *Box 1.3.*

▲ Oat sheaves, N. Ireland • © *NERC*

Box 1.3: Measures of vegetation condition used in Countryside Survey

Condition Measure	Explanatory Notes
Species Richness	Total number of non-native and native taxa per plot (excluding lichens, mosses and liverworts but counting species recorded to genus only or amalgamations of two taxonomically difficult species). This is a simple measure of plant diversity. Increases in plant diversity may not always be beneficial for habitats.
Number of Farmland Bird Food Plants	The number of plant species in each vegetation plot that are known to be important in the diet of a range of declining lowland farmland birds.[4, 6]
Number of Butterfly Food Plants	The number of plant species in each vegetation plot that are known to provide food for butterfly larvae (caterpillars). The list of plants includes those that provide food for common as well as scarce butterfly species.[4]
Grass:Forb Ratio	The natural log of the ratio of the total grass cover in each plot to the total forb cover in each plot. Forbs are: all plant species that are a) not woody, such as trees and shrubs; b) not grass-like; or c) not mosses, lichens or liverworts. • The term is most frequently applied in grasslands where the conservation value of the vegetation is considered to be higher if grass cover is accompanied by high cover of other meadow herbs such as buttercups, yellow rattle, red clover and birds-foot trefoil. • The Grass:Forb Ratio can also be applied in woodlands where 'forbs' would cover plants such as bluebells, wild garlic and ferns. • Strictly speaking, the term 'herbs' also includes grasses, whereas the term 'forbs' excludes grasses. • An increase in grass species results in an increase in the Grass:Forb Ratio.
Competitor Score	Plant strategy theory predicts that under conditions of high fertility and minimal disturbance, tall perennials well adapted to out-compete other plants for light will eventually dominate plant communities. The resulting vegetation may be species-poor. However, woodlands are a good example of a vegetation type dominated by competitors that can be rich in biodiversity. The competitor score is the proportion of competitive species in each plot [3, 4, 5] and is relative to both the Stress tolerator and Ruderal Scores described below.
Stress-tolerator Score	Stress-tolerant plants are typically well adapted to harsh environmental conditions such as extremes of temperature and shortages of nutrients or light. They are often slow growing and vulnerable to disturbance or increased fertility. This group includes some of the rarest plants in the British flora. The stress tolerator score is the proportion of such species in each plot [3, 4, 5] and is relative to both the Competitor and Ruderal Scores described above and below.
Ruderal Score	Ruderals comprise all those plants often thought of as weeds. These plants are early colonisers which disappear as environmental conditions stabilise; they are adapted to take advantage of the often short-lived opportunities for growth and reproduction provided by disturbance. Their strategy is one of quick arrival and quick disappearance. As a result they are often small, fast-growing and produce a lot of seed. The Ruderal Score is the proportion of such species in each plot [3, 4, 5] and is relative to both the Competitor and Stress-tolerator Scores described above.
Light Score	An indirect measure of light availability at ground level. It reflects the abundance of plants that either tolerate shade or cast shade (e.g. woodland plants) through to weeds found in open, often disturbed situations, where there is much less shade. This association is based on the Ellenberg value for light of each species.[1, 2] 1 = Shaded to 9 = Open
Fertility Score	An indirect measure of soil fertility. It reflects the abundance of plants known to be associated with different levels of nutrient availability based on the Ellenberg value for fertlity of each species.[1, 2] 1 = Infertile to 9 = Eutrophic
Ellenberg pH Score	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, 2] 1 = acidic to 9 = alkali
Moisture Score	An indirect measure of soil wetness. It reflects the abundance of plants known to be associated with degrees of wetness, based on the Ellenberg value for soil moisture of each species.[1, 2] 1 = Dry to 12 = Water

[1] Hill, M.O., Mountford, J.O., Roy, D.B., Bunce, R.G.H.(1999). *Ellenbergs' indicator values for British plants.* ECOFACT Volume II,Technical annex: ITE Monks Wood, Huntingdon.

[2] Ellenberg, H., Weber, H.E., Dull, R., Wirth, V., Werner, W., Paulissen, D. (1991). *Zeigerwerte von Pflanten in Mitteleuropa.* Scripta Geobotanica **18**, 1-248.

[3] Thompson, K (1994). *Predicting the fate of temperate species in response to human disturbance and global change.* Biodiversity, Temperate Ecosystems and Global Change (eds. Boyle, T.J.B., and Boyle, C.E.B.), pp.61-76. Springer-Verlag, Berlin.

[4] Smart, S.M., Firbank, L.G., Bunce, R.G.H., Watkins, J.W. (2000). *Quantifying changes in abundance of food plants for butterfly larvae and farmland birds.* Journal of Applied Ecology **37**, 398-414.

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

[6] Wilson, J.D., Arroyo, B.E., Clark, S.C. (1996). *The Diet of Bird Species of Lowland Farmland: A Literature Review.* Dept. of the Environment and English Nature, London.

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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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2. The National Picture

Summary

- The area of Broadleaved Woodland, Improved Grassland, Neutral Grassland, Acid Grassland and Standing Waters Broad Habitats increased in the UK between 1998 and 2007. Arable and Bracken decreased. The area of all other Broad Habitats showed no change.

- No change in plant species richness in the open countryside (fields, woods, heaths and moors) of Great Britain was detected between 1998 and 2007, though there was a long-term decrease of 9.2% between 1978 and 2007. A decrease in species richness between 1998 and 2007 in linear features contributed to a long-term decrease of 15% between 1978 and 2007. In areas targeted for their botanical interest, the decrease between 1998 and 2007 contributed to a long-term decrease of 17% between 1990 and 2007.

- Competitive plant species increased in the open countryside (fields, woods, heaths and moors) and in areas targeted for their botanical interest in Great Britain between 1978 and 2007, whilst ruderal species decreased. In linear features, stress tolerating plant species increased and ruderal species decreased in Great Britain between 1978 and 2007.

- Plant species preferring wetter conditions increased in all types of vegetation sampling plots in Great Britain between 1998 and 2007, continuing the trend from 1990. Species preferring fertile and shady conditions increased from 1998 to 2007 in linear features and in areas targeted for their botanical interest. Species preferring more fertile conditions decreased in the open countryside (fields, woods, heaths and moors) between 1998 and 2007.

- The results from Countryside Survey generally show a shift along an ecological gradient of succession in Great Britain, perhaps a consequence of vegetation responding to a reduced intensity of management.

- pH of the soil (0-15cm) increased between 1998 and 2007 in less acidic habitats (i.e. they became even

less acidic), continuing a trend observed between 1978 and 1998.

- **Carbon concentration in the soil (0-15 cm) increased in Great Britain between 1978 and 1998, and decreased between 1998 and 2007. Overall there was no change in carbon concentration in the soil (0-15 cm) in Great Britain between 1978 and 2007.**
- **The mean soil (0-15cm) carbon stock across Great Britain in 2007 was calculated to be 63 t/ha, ranging between a mean of 43 t/ha in the Arable Broad Habitat to a mean of 82 t/ha in Acid Grassland.**

2.1 Introduction[1]

Chapter 2 summarises some of the main findings of Countryside Survey (CS) in 2007 at the UK or Great Britain level[2], and discusses their ecological significance in the context of the findings of previous Countryside Surveys, information is presented on:

- **estimated areas of habitats;**
- **changes in vegetation;**
- **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; and**
- **discussion of the ecological significance of these changes.**

2.2 Estimated area of Broad Habitats

CS provides estimates of the area of widespread terrestrial Broad Habitats in Great Britain and, by combination with data from the Northern Ireland Countryside Survey, for the UK. By comparison with results from previous surveys changes can be calculated *(Table 2.1)*. Details of how the Broad Habitat classification was used in CS are given in *Box 1.1* and *Chapter 1.6*. A breakdown of results for each Broad Habitat, including the area of each in Wales, Scotland, England, Northern Ireland and information on habitat condition are presented in subsequent chapters.

▲ Acid Grassland and Montane Broad Habitats, Scotland • © *NERC*

2.3 Change in area of Broad Habitats

- **The area of Broadleaved Woodland, Improved Grassland, Neutral Grassland, Acid Grassland and Standing Waters Broad Habitats increased between 1998 and 2007 in the UK. Arable and Bracken decreased. The area of all other Broad Habitats showed no change.**

The area of Broadleaved, Mixed and Yew Woodland Broad Habitat (referred to as 'Broadleaved Woodland') increased by 6.9% in the UK between 1998 and 2007 *(Table 2.2)*. The corresponding decrease in Coniferous Woodland Broad Habitat was not statistically significant at the UK or Great Britain levels.

The area of the Arable and Horticulture Broad Habitat decreased by 9.1% in the UK between 1998 and 2007 *(Table 2.2)*. There was a corresponding increase in area of the Improved Grassland and Neutral Grassland Broad Habitats, by 5.4% and 6.0% respectively.

The area of Bracken Broad Habitat declined by 17.4% in the UK between 1998 and 2007, especially in Wales. Partly as a consequence of the decrease in Bracken, the area of Acid Grassland increased by 5.5% *(Table 2.2)* particularly in the uplands of England and Wales (see *Chapter 7*). Note that as the Bracken Broad Habitat is defined as areas with 95 to 100% bracken cover, the reported changes in area inevitably reflect often subtle changes in bracken cover rather than wholesale conversion.

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

[2] Where comparable data from the Northern Ireland Countryside Survey are available the results are presented for the United Kingdom as a whole, otherwise results are presented for Great Britain (i.e. excluding Northern Ireland) only.

▼ **Table 2.1:** Estimated area ('000s ha) and percentage of land area of Broad Habitats in the UK from 1998 to 2007 and Great Britain from 1984 to 2007. Note that because of changes in definitions that have been applied retrospectively, the estimates from 1990 and more especially 1984 are not in all cases directly comparable with later surveys.

	Great Britain								UK			
	1984		1990		1998		2007		1998		2007	
Broad Habitats	'000s ha	% area of GB	'000s ha	% area of GB	'000s ha	% area of GB	'000s ha	% area of GB	'000s ha	% area of UK	'000s ha	% area of UK
Broadleaved, Mixed and Yew Woodland	1317	5.6	1343	5.8	1328	5.7	1406	6.0	1392	5.6	1488	6.0
Coniferous Woodland	1243	5.3	1239	5.3	1386	5.9	1319	5.7	1448	5.9	1380	5.6
Linear Features	491	2.1	581	2.5	511	2.2	496	2.1	540	2.2	527	2.1
Arable and Horticulture	5283	22.7	5025	21.6	5067	21.7	4608	19.8	5124	20.7	4657	18.8
Improved Grassland	5903	25.3	4619	19.8	4251	18.2	4494	19.3	4806	19.4	5067	20.5
Neutral Grassland	467	2.0	1669	7.2	2007	8.6	2176	9.3	2271	9.2	2407	9.7
Calcareous Grassland	75	0.3	78	0.3	61	0.3	57	0.2	63	0.3	59	0.2
Acid Grassland	1476	6.3	1821	7.8	1502	6.4	1589	6.8	1516	6.1	1599	6.5
Bracken	439	1.9	272	1.2	315	1.3	260	1.1	318	1.3	263	1.1
Dwarf Shrub Heath	1388	6.0	1436	6.2	1299	5.6	1343	5.8	1313	5.3	1360	5.5
Fen, Marsh, Swamp	428	1.8	427	1.8	425	1.8	392	1.7	479	1.9	439	1.8
Bog	2303	9.9	2050	8.8	2222	9.5	2232	9.6	2386	9.6	2393	9.7
Standing Open Waters[3]	284	1.2	200	0.9	196	0.8	204	0.9	258	1.0	265	1.1
Rivers and Streams[3]	70	0.3	70	0.3	65	0.3	58	0.2	70	0.3	64	0.3
Montane	41	0.2	na	na	41	0.2	42	0.2	41	0.2	42	0.2
Inland Rock	38	0.2	76	0.3	111	0.5	101	0.4	119	0.5	106	0.4
Built-up Areas and Gardens	1268	5.4	1266	5.4	1279	5.5	1323	5.7	1336	5.4	1397	5.6
Other land	na	na	659	2.8	762	3.3	731	3.1	na	na	na	na
Unsurveyed urban land[4]	na	na	482	2.1	482	2.1	482	2.1	na	na	na	na
Total area[5]	**23313**		**23313**		**23313**		**23313**		**24729**		**24729**	

Following a significant decrease between 1990 and 1998 in Great Britain, no significant change in area of the Dwarf Shrub Heath Broad Habitat in Great Britain or the UK was detected between 1998 and 2007. Indeed, an increase in area of Dwarf Shrub Heath was detected in England (see *Chapter 7*). No change in extent was observed in the Bog, Fen, Marsh and Swamp and Calcareous Grassland Broad Habitats between 1998 and 2007 in the UK.

2.4 Priority Habitats in Great Britain

In 2007, the areas of 12 Priority Habitats were recorded for the first time, following changes to the field survey protocol. The estimates for 1998 have been determined through a retrospective analysis of data codes that were not specifically designed to identify Priority Habitats and therefore the area estimates should be treated with some caution.

The random sampling approach used in CS is less efficient at detecting habitats which are rare, and/or concentrated in particular areas. The estimates for many Priority Habitats therefore have very large confidence intervals and should in most cases be regarded as supplementary to other sources of information.

The results show that area estimates for CS are generally comparable with estimates from other sources. (See *Table 2.3*).

▼ **Table 2.3:** Estimated area ('000s ha) of selected Priority Habitats in Great Britain in 1998 and 2007. Estimates for 1998 could not be calculated for all Priority Habitats.

UK BAP Priority Habitat	1998 ('000s ha)	2007 ('000s ha)
Upland Mixed Ash Wood	na	30
Wet Woodland	62	75
Upland Oakwood	62	61
Lowland Mixed Deciduous	55	60
Upland Birchwoods	na	31
Lowland Calcareous Grass	47	45
Upland Calcareous Grass	22	19
Blanket Bog	na	1234
Lowland Dwarf Shrub Heath	78	93
Upland Dwarf Shrub Heath	1166	1196
Reedbed	na	6
Purple Moor Grass Rush Pasture	na	59

[3] Standing Open Waters and Rivers and Streams BH estimates are calculated using a different statistical model to the other BHs.

[4] The land in urban areas from within Great Britain was excluded from the estimation of Broad Habitats.

[5] Please note that not all the totals are equal to the sum of the column.

▼ **Table 2.2:** The change in area ('000s ha and percentage) of Broad Habitats in the UK between 1998 and 2007 and for Great Britain between 1990 and 2007. Arrows denote significant change ($p<0.05$) in the direction shown.

	Great Britain							UK		
	1990-1998		1990-2007		1998-2007		Direction of significant changes 1998-2007	1998-2007		Direction of significant changes 1998-2007
Broad Habitat	Change ('000s ha)	% Change	Change ('000s ha)	% Change	Change ('000s ha)	% Change		Change ('000s ha)	% Change	
Broadleaved, Mixed and Yew Woodland	-15	-1.1	63	4.7	78	5.9	↑	96	6.9	↑
Coniferous Woodland	147	11.9	80	6.5	-67	-4.8		-69	-4.7	
Linear Features	-70	-12.0	-85	-14.6	-15	-2.9		-13	-2.5	
Arable and Horticulture	43	0.9	-416	-8.3	-459	-9.1	↓	-467	-9.1	↓
Improved Grassland	-368	-8.0	-125	-2.7	243	5.7	↑	261	5.4	↑
Neutral Grassland	338	20.3	507	30.4	169	8.4	↑	136	6.0	↑
Calcareous Grassland	-17	-21.8	-21	-27.2	-4	-7.3		-4	-6.3	
Acid Grassland	-318	-17.5	-232	-12.7	86	5.7	↑	83	5.5	↑
Bracken	43	15.8	-12	-4.4	-55	-17.5	↓	-55	-17.4	↓
Dwarf Shrub Heath	-137	-9.5	-93	-6.5	44	3.4		47	3.6	
Fen, Marsh, Swamp	-1	-0.2	-35	-8.2	-34	-8.0		-40	-8.3	
Bog	172	8.4	182	8.9	10	0.5		7	0.3	
Standing Open Waters[6]	17	8.4	23	11.8	5	2.6	↑	5	1.9	
Rivers and Streams[6]	-3	-3.9	-2	-2.7	0	-0.2		0	0	
Montane	na	na	na	na	1	2.4		1	2.4	
Inland Rock	35	46.1	25	32.3	-10	-9.4		-13	-10.9	
Built-up Areas & Gardens	13	1.0	57	4.5	44	3.4		61	4.6	
Other land								6	5.4	↑

2.5 Changes in vegetation in all habitat types

- **No change in plant species richness in the open countryside (fields, woods, heaths and moors) of Great Britain was detected between 1998 and 2007, though there was a long-term decrease of 9.2% between 1978 and 2007. A decrease in species richness between 1998 and 2007 in linear features contributed to a long-term decrease of 15% between 1978 and 2007. In areas targeted for their botanical interest, the decrease between 1998 and 2007 contributed to a long-term decrease of 17% between 1990 and 2007.**

- **Competitive plant species increased in the open countryside (fields, woods, heaths and moors) and in areas targeted for their botanical interest in Great Britain between 1978 and 2007, whilst ruderal species decreased. In linear features, stress tolerating plant species increased and ruderal species decreased in Great Britain between 1978 and 2007.**

- **Plant species preferring wetter conditions increased in all types of vegetation sampling plots in Great Britain between 1998 and 2007, continuing the trend from 1990. Species preferring fertile and shady conditions increased from 1998 to 2007 in linear features and in areas targeted for their botanical interest. Species preferring more fertile conditions decreased in the open countryside (fields, woods, heaths and moors) between 1998 and 2007.**

- **The results from CS generally show a shift along an ecological gradient of succession in Great Britain, perhaps a consequence of vegetation responding to a reduced intensity of management.**

Analyses of long-term trends use data from the sampling plots surveyed first in 1978, and subsequently in 1990, 1998 and 2007. Whilst the number of plots repeated in every survey since 1978 is small in comparison to the total number of plots (see *Chapter 1.5.5*), the information provided by this subset of plots provides the longest sequence of repeat plots available in CS. Results have been analysed from three different types of sampling plots: Main Plots, Linear Plots and Targeted Plots and further results are presented in *Chapter 10*. More comprehensive analyses of changes in condition of different Broad Habitats between 1990 and 2007 is presented in *Chapters 3 to 9*.

[6] It was not appropriate to use the consistent statistical model for these two habitats because of the distribution of the data. The method used previously in *"Accounting for Nature"* was therefore used to derive areas and changes independently.

▼ **Table 2.4:** Change in the characteristics of all types of vegetation in 200m² Main Plots in Great Britain, England, Scotland and Wales between 1978 and 2007. Mean values for condition measures in Great Britain 1998 and 2007 are presented; those for 1978 and 1990 are available in ***Annex 7***. Arrows denote significant change (p<0.05) in the direction shown. Analyses are described in ***Box 1.3***.

	Mean values (GB)		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**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**
Species Richness (No. of Species)	16.2	15.7		↑	↓					↓	↓	↓			↓		↓	↓
No. of Bird Food Species	6.1	6.2		↑	↓	↓					↓	↓			↓		↓	↓
No. of Butterfly Food Species	6.7	6.5		↑	↓					↓	↓	↓			↓		↓	↓
Grass:Forb Ratio	1.19	1.03	↓	↓		↓	↑	↑		↑	↓	↓	↓			↓		
Competitor Score	2.48	2.52	↑		↑		↑	↑			↑		↑		↑	↑	↑	↑
Stress Tolerator Score	2.48	2.50							↓		↓	↓	↓				↓	
Ruderal Score	2.60	2.54	↓	↓	↓										↓	↓		
Light Score	6.95	6.95							↑		↓		↓					
Fertility Score	4.61	4.55	↓		↓						↑	↑	↑					
Ellenberg pH Score	5.14	5.09	↓				↓	↓			↑	↑	↑					
Moisture Score	5.77	5.82	↑	↑			↑	↑	↑		↓	↓			↑	↑	↑	

2.5.1 Main Plots

Main Plots (200m²) provide information about vegetation within fields, woods, heaths and moors (sampled more than three metres from a field boundary). These plots provide a random sample of vegetation and habitat types across the 'open countryside' of Great Britain (*Table 2.4* and *Annex 7* *see www.countrysidesurvey.org.uk*). Vegetation sampling plots were not included in the Northern Ireland Countryside Survey so results are not available for the UK.

Although part of a long-term declining trend from 1978, the difference in the plant species richness in Main Plots and in all vegetation types in Great Britain between 1998 and 2007 was not significant. There were contrasting trends in Scotland (a decrease) and in England (an increase) between 1998 and 2007 *(Fig. 2.1)*.

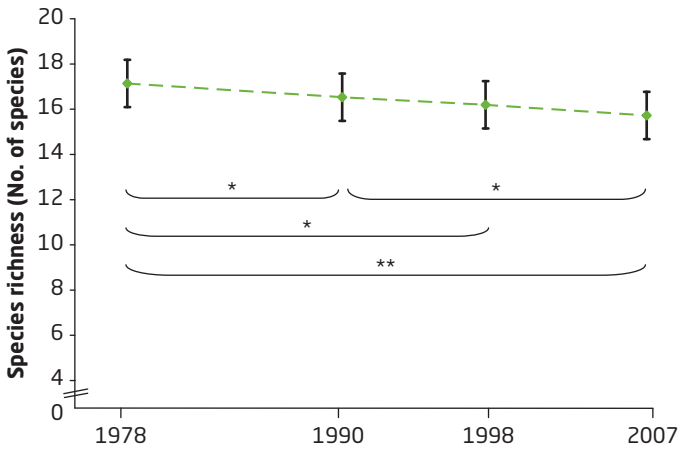
The longer time series, between 1978 and 2007 shows an overall decrease in the plant species richness of 9.2% and a similar decline in numbers of food plants for both farmland birds and butterflies in Great Britain *(Table 2.4)*. However, in England there was an increase in these food plants between 1998 and 2007.

The decrease in the plant species richness and in numbers of plants providing food for farmland birds and butterflies occurred at the same time as a rapid decline in populations of these animal species, noted in other studies.

2.5.2 Linear Plots

Even before the first CS in 1978, it was recognised that many plant species in the countryside were restricted to the boundaries of managed land. Linear Plots (10m x 1m) were located at random alongside linear features (field boundaries, streamsides and roadside verges) to ensure the vegetation associated with these features was sampled as part of CS.

▼ **Figure 2.1:** The change in plant species richness in 200m² Main Plots in all vegetation types across Great Britain between 1978 and 2007. Significant changes (* p<0.05) are shown between the dates bracketed.



Analyses of change in the vegetation of linear features are presented in detail in ***Chapters 5 and 8***. A summary of all Linear Plots (excluding Hedge Plots – *see* ***Chapter 5***) is provided here for the whole of Great Britain *(Table 2.5)*.

The Species Richness Score, Grass:Forb Ratio, Ruderal Score and Light Score all decreased in Linear Plots in across all vegetation types in Great Britain between 1998 and 2007. These trends are similar to those observed in the Main Plots and give a clear signal that the vegetation of linear features became taller, more shaded and less diverse, reinforcing a long-term trend over the period 1978 to 2007. There was no change in the Fertility, Ellenberg pH or Moisture Scores in Great Britain between 1998 and 2007, but over the longer term, from 1978 to 2007, there was an increase.

▼ **Table 2.5:** Changes in the characteristics of vegetation in 10m x 1m Linear Plots in all vegetation types across Great Britain, between 1978 and 2007. Mean values for 1998 and 2007 are presented; those for 1978 and 1990 are available in ***Annex 7***. Arrows denote significant change (p<0.05) in the direction shown. Analyses are described in ***Box 1.3***.

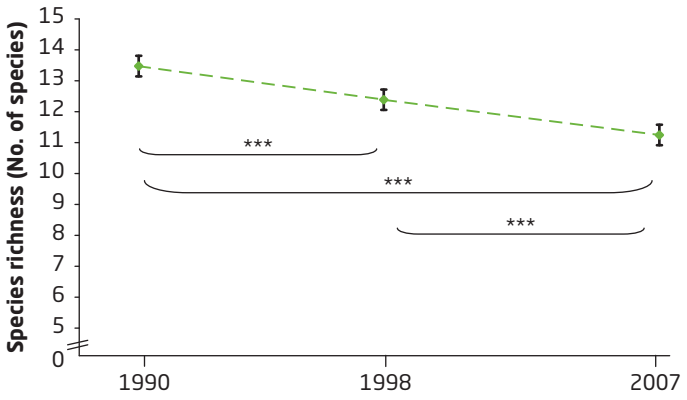
	Mean values (GB)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1978 - 1990				Direction of significant changes 1978 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**
Species Richness (No. of Species)	17.7	17.0	↓		↓		↓	↓			↓		↓	↓	↓	↓	↓	↓
No. of Bird Food Species	7.0	6.9		↑	↓		↓	↓			↓		↓	↓	↓		↓	↓
No. of Butterfly Food Species	7.0	6.9			↓		↓	↓			↓		↓	↓	↓	↓	↓	↓
Grass:Forb Ratio	0.45	0.30	↓				↓	↓			↓	↓		↑	↓	↓		
Competitor Score	2.99	3.02					↑		↑						↑	↑	↑	
Stress Tolerator Score	2.00	2.05	↑	↑					↓		↓	↓	↑	↑				
Ruderal Score	2.60	2.53	↓	↓											↓	↓		
Light Score	6.65	6.57	↓	↓	↓	↓			↑		↓		↓	↓	↓	↓		↓
Fertility Score	5.85	5.84									↑	↑			↑	↑		
Ellenberg pH Score	6.25	6.25								↑	↑	↑			↑	↑		
Moisture Score	5.39	5.40					↑	↑	↑	↑	↓	↓			↑		↑	↑

2.5.3 *Targeted Plots*

Targeted Plots (2m x 2m) were introduced to CS in 1990 to sample the vegetation in areas of botanical interest not otherwise sampled by the Main or Linear Plots. These include smaller fragments of less widely occurring habitats. The 1990 Targeted Plots have been re-sampled in 1998 and 2007 *(Table 2.6)*.

Species richness decreased in Targeted Plots between 1998 and 2007, following a decline from 1990 to 1998 *(Fig. 2.2)*. There were also decreases in the number of plant species used by farmland birds and butterfly caterpillars as food.

▼ **Figure 2.2:** Change in species richness in 2m x 2m Targeted Plots in all vegetation types in Great Britain between 1990 and 2007. Significant changes (*** p<0.001) are shown between the dates bracketed. 95% CI are shown for each data point.



▲ Targeted Plot ready for recording • © *CEH*

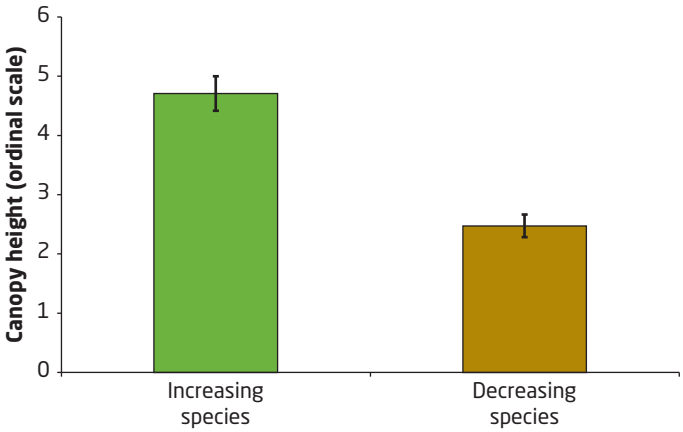
There were decreases in the ratio of grasses to forbs, proportion of ruderal species and the Light Score, and increases in the proportion of competitive species and Fertility Score in Targeted Plots in all vegetation types in Great Britain between 1998 and 2007. Even more so than the Main and Linear Plots, the Targeted Plots highlight an association between a decrease of the plant species richness and a shift towards taller, more competitive species, and a higher nutrient status. Given that these plots were originally selected for their botanical interest, these changes are an indication that the condition of remaining habitat fragments in the wider countryside has deteriorated since 1990.

▼ **Table 2.6:** Changes in the characteristics of vegetation in 2m x 2m Targeted Plots in all vegetation types across Great Britain between 1990 and 2007. Mean values for Great Britain in 1998 and 2007 are presented; those for 1990 and at the country level are available in ***Annex 7***. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3***.

	Mean values (GB)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**
Species Richness (No. of Species)	12.39	11.25	↓	↓	↓	↓	↓	↓	↓		↓	↓	↓	↓
No. of Bird Food Species	4.3	4.0	↓		↓	↓	↓	↓			↓	↓	↓	↓
No. of Butterfly Food Species	5.0	4.6	↓	↓	↓	↓	↓	↓			↓	↓	↓	
Grass:Forb Ratio	0.57	0.43	↓	↓		↓	↑		↑	↑		↓	↑	
Competitor Score	2.79	2.84	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Stress Tolerator Score	2.64	2.63				↓	↓		↓	↓	↓		↓	↓
Ruderal Score	2.19	2.11	↓	↓	↓		↓	↓			↓	↓	↓	
Light Score	6.76	6.69	↓	↓	↓	↓		↓	↑		↓	↓	↑	
Fertility Score	4.50	4.54	↑	↑		↑					↑	↑		↑
Ellenberg pH Score	5.16	5.17					↓	↓	↓				↓	
Moisture Score	6.11	6.12			↑				↑	↑	↑		↑	

▲ Lowland mire, England • © *Sue Wallis*

▼ **Figure 2.3:** Mean canopy height of those species that increased or decreased the most (top or bottom 10%) in frequency in all vegetation types in Great Britain, between 1998 and 2007. Canopy height was classified according to Grime et al (1998)[7] as follows:
1. foliage <100mm in height; *2.* 101-299mm; *3.* 300-599mm; *4.* 600-999mm; *5.* 1.0-3.0m; *6.* 3.1-6.0m; *7.* 6. 1-15.0m; *8.* >15m.



2.5.4 *Changes in frequency of species within Main, Linear and Targeted Plots*

The plant species that increased in frequency the most in all plot types in Great Britain between 1998 and 2007 are typically those plants which are taller when mature (e.g. trees are taller than grasses) *(Fig 2.3)*. Later successional species such as trees and shrubs have increased at the expense of early successional species *(Table 2.7)*. Plant species that can benefit from a reduced intensity of habitat management have become more prevalent. Climbing species and species that have a more westerly distribution (e.g. Bramble, *Rubus fruticosus agg.*) have also increased.

The number of non-native or 'alien' plant species recorded in Great Britain has increased greatly in the past sixty years. Most non-native species remain relatively scarce in the CS sampling plots (over 14,000 plots in this analysis), although locally they can be very abundant e.g. Rhododendron and Japanese Knotweed. Together, non-native species now account for nearly 2% of the vegetation cover of the British countryside.

[7] Grime, J.P. et al (1988). *Comparative Plant Ecology*. Unwin, Hyman. London.

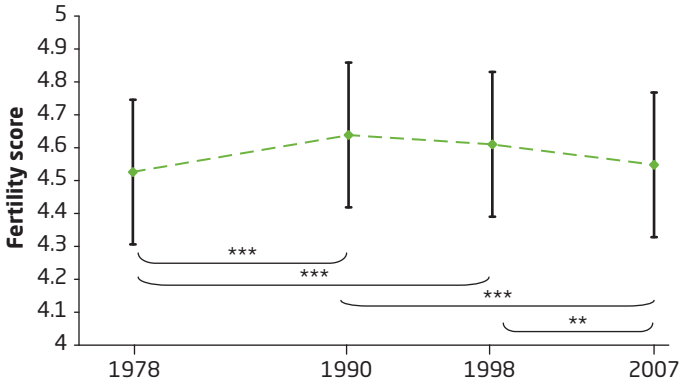
▼ **Table 2.7:** Plant species whose change indices were in the top 25 or bottom 25 of all species ranked by change in numbers of vegetation sampling plots occupied between 1998 and 2007. Growth form: w = woody; f = forb; g = grass. Fertility Score ranges from 1 = infertile soils to 9 = extremely fertile soils. The Change Index was calculated using an adaptation of the method presented in the New Atlas of the British and Irish Flora. Canopy categories follow Grime *et al.* (1998) - ***see Fig. 2.3***.

Names		Growth Form	Fertility Score	Change index	Direction	Canopy height category
Tamus communis	Black Bryony	w	6	0.57	+	5
Geum urbanum	Wood Avens	f	7	0.40	+	3
Hedera helix	Ivy	w	6	0.40	+	8
Crepis capillaris	Smooth Hawk's-beard	f	4	0.36	+	2
Sonchus asper	Prickly Sow-thistle	f	6	0.35	+	5
Fraxinus excelsior	Ash	w	6	0.30	+	8
Senecio vulgaris	Groundsel	f	7	0.29	+	3
Picris echioides	Bristly Oxtongue	f	6	0.28	+	4
Alopecurus myosuroides	Black Grass	g	6	0.27	+	4
Calystegia sepium	Hedge Bindweed	f	7	0.26	+	5
Ilex aquifolium	Holly	w	5	0.25	+	7
Dryopteris filix-mas	Male-fern	f	5	0.25	+	5
Alnus glutinosa	Alder	w	6	0.24	+	8
Corylus avellana	Hazel	w	6	0.24	+	6
Fagus sylvatica	Beech	w	5	0.23	+	8
Urtica dioica	Stinging Nettle	f	8	0.23	+	4
Veronica persica	Common Field Speedwell	f	7	0.22	+	1
Lonicera periclymenum	Honeysuckle	w	5	0.22	+	6
Acer pseudoplatanus	Sycamore	w	6	0.22	+	8
Geranium dissectum	Cut-leaved Cranesbill	f	6	0.22	+	3
Atriplex patula	Common Orache	f	7	0.22	+	4
Impatiens glandulifera	Himalayan Balsam	f	7	0.21	+	5
Epilobium parviflorum	Hoary Willowherb	f	5	0.21	+	4
Prunus spinosa	Blackthorn	w	6	0.21	+	6
Salix cinerea	Grey Willow	w	5	0.21	+	7
Carex pallescens	Pale Sedge	s	4	-0.27	-	2
Phleum pratense sens.lat.	Timothy	g	6	-0.28	-	4
Sambucus racemosa	Red-berried Elder	w	7	-0.28	-	5
Holcus mollis	Creeping Soft-grass	g	3	-0.28	-	2
Juncus bulbosus	Bulbous Rush	m	2	-0.28	-	1
Pinguicula vulgaris	Common Butterwort	f	2	-0.29	-	1
Pisum sativum	Garden Pea	f	7	-0.30	-	5
Alopecurus pratensis	Meadow Foxtail	g	7	-0.31	-	2
Festuca gigantea	Giant Fescue	g	7	-0.31	-	3
Polypodium vulgare sens.lat.	Polypody	f	3	-0.31	-	2
Lamium purpureum	Red Dead-nettle	f	7	-0.31	-	3
Glyceria fluitans	Floating Sweet-grass	g	6	-0.33	-	4
Bromopsis ramosa	Hairy Brome	g	7	-0.33	-	3
Phegopteris connectilis	Beech Fern	f	4	-0.33	-	3
Carex pilulifera	Pill Sedge	s	2	-0.35	-	1
Koeleria macrantha	Crested Hair-grass	g	2	-0.36	-	1
Myosotis scorpioides	Water Forget-me-not	f	6	-0.38	-	2
Campanula rotundifolia	Harebell	f	2	-0.39	-	2
Carex dioica	Dioecious Sedge	s	2	-0.40	-	2
Fragaria vesca	Wild Strawberry	f	4	-0.46	-	2
Salix aurita	Eared Willow	w	3	-0.51	-	5
Valeriana dioica	Marsh Valerian	f	3	-0.51	-	2
Alopecurus geniculatus	Marsh Foxtail	g	6	-0.53	-	1
Drosera intermedia	Oblong-leaved Sundew	f	1	-0.53	-	1
Epilobium montanum	Broad-leaved Willowherb	f	6	-0.73	-	4

Between 1998 and 2007 four non-native species showed larger individual increases in the number of plots occupied within CS than others. Himalayan Balsam, New Zealand Willowherb and Common Field Speedwell increased in local abundance. Sycamore is a common tree species which continues to increase. Lack of disturbance on stream sides favours Himalayan Balsam, while less intensive arable field margin management encourages the spread of Common Field Speedwell. New Zealand Willowherb has increased continuously since 1978 in its favoured sites on bare, damp soil along upland streams and flushes.

The ratio of grasses to forbs decreased across all vegetation types in fields, woods, heaths and moors in Great Britain between 1998 and 2007 ***(Table 2.6)***. Competitive species increased and ruderal species (plants associated with disturbed ground) decreased. Stress tolerating species decreased between 1978 and 1990 but not between 1998 and 2007. Taken together, these condition measures show a general increase in shade tolerant herb species at the expense of lower-growing grasses and annual plants, and an overall reduction in species richness, possibly related to a general reduced intensity of management.

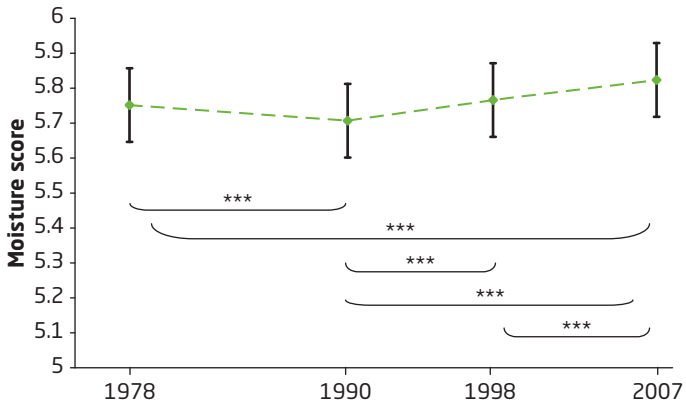
▼ **Figure 2.4:** The change in mean Fertility Score in 200m² Main Plots in all vegetation types across Great Britain between 1978 and 2007. Significant changes (* p<0.05, ** p<0.01, *** p<0.001) are shown between the dates bracketed. 95% CI are shown for each data point.



The Fertility Score (an indicator of nutrient status) decreased in Main Plots in Great Britain between 1998 and 2007, continuing a downward trend from 1990 ***(Fig. 2.4)***. This follows a marked increase in the Fertility Score, measured across all vegetation types, between 1978 and 1990. Previous Countryside Surveys have reported a trend towards higher Fertility Scores in a number of different habitats/vegetation types and have linked this to nutrient inputs from atmospheric nitrogen and agricultural fertilizers and livestock. The increase now appears to have reversed, but further analysis is required in different habitats (linking also to soil properties) to understand the possible causes and consequences.

Moisture Scores increased in Main Plots across all vegetation types in Great Britain between 1998 and 2007, continuing an increase from 1990. Moisture Scores decreased from 1978 to 1990 ***(Fig. 2.5)***. Changes in the Moisture Score between 1978 and 2007 were in the opposite direction to those for the Fertility Score.

▼ **Figure 2.5:** Changes in the mean Moisture Score in 200m² Main Plots in all vegetation types across Great Britain between 1978 and 2007. Significant changes (* p<0.05, ** p<0.01, *** p<0.001) are shown between the dates bracketed. 95% CI are shown.



2.6 Changes in landscape features

Detailed analyses of change in linear landscape features are discussed in ***Chapter 5***. The length of 'managed' hedges decreased by 6% in Great Britain 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. 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 48% of hedges were in good structural condition *(see **Chapter 5**)*.

▲ Newly planted hedgerow, England • © *Ian Simpson*

▼ **Table 2.8:** Changes in the pH and carbon concentration of soils (0-15cm depth) within all vegetation types and some selected Broad Habitats across Great Britain. 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	5.46	5.75	93.1	80.7	↑		↑	↑	↑	↑
Coniferous Woodland	4.40	4.51	201.2	179.1		↓				
Arable and Horticulture	6.81	7.20	30.5	27.9	↑	↓	↑		↑	↓
Improved Grassland	6.06	6.27	53.2	51.7	↑		↑		↑	
Neutral Grassland	6.00	6.14	64.1	61.9	↑		↑		↑	
Acid Grassland	4.72	4.78	233.7	208.1		↓	↑		↑	
Bracken	4.48	4.64	142.5	180.7		↑			↑	↑
Dwarf Shrub Heath	4.50	4.55	271.5	259.5			↑		↑	
Fen, Marsh and Swamp	5.35	5.46	229.8	208.2			↑		↑	
Bog	4.49	4.51	409.0	393.5			↑	↑	↑	
All vegetation types	5.67	5.87	133.1	124.5	↑	↓	↑	↑	↑	

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

- **pH of the soil (0-15cm) increased between 1998 and 2007 in less acidic habitats (i.e. they became even less acidic), continuing a trend observed between 1978 and 1998.**
- **Carbon concentration in the soil (0-15 cm) increased in Great Britain between 1978 and 1998, and decreased between 1998 and 2007. Overall there was no change in carbon concentration in the soil (0-15 cm) in Great Britain between 1978 and 2007.**
- **The mean soil (0-15cm) carbon stock across Great Britain in 2007 was calculated to be 63 t/ha, ranging between a mean of 43 t/ha in the Arable Broad Habitat to a mean of 82 t/ha in Acid Grassland.**

2.7.1 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. At the time of writing, analysis of soils is still in progress and a technical report on soils will be published in 2009. Initial results for soil (0-15cm) pH, carbon concentration, bulk density and stock of carbon are presented here for different habitat types across Great Britain. Soils were not sampled as part of the Northern Ireland Countryside Survey.

2.7.2 Soil (0-15cm) pH

The pH of soil (0–15 cm) *(Table 2.8)* in all vegetation types increased from a mean pH of 5.67 to 5.87 between 1998 and 2007, becoming less acidic. The increase continued a trend from 1978 to 1998 in Great Britain. The same trend was evident in four of the least acidic Broad Habitats (Broadleaved Woodland, Arable, Improved and Neutral Grassland). The other Broad Habitat types showed no change between 1998 and 2007, though all habitats apart from Coniferous Woodland, 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 are also important in some habitats.

2.7.3 Soil (0-15cm) carbon concentration

There was a 6% decrease in the carbon concentration of soil (0-15 cm) in all vegetation types from a mean of 133.1 g/kg to 124.5 g/kg between 1998 and 2007 in Great Britain *(Table 2.8)*. This decrease followed an increase in the same soil sampling plots between surveys in 1978 and 1998. Overall for Great Britain there was no significant difference between the mean carbon concentration in 2007 and 1978. Soil carbon concentration of soil (0-15 cm) also decreased between 1998 and 2007 in three Broad Habitats (Coniferous Woodland, Arable and Acid Grassland). It also increased in Bracken. Many factors can affect soil carbon concentrations including land management, weather variations, climate change and nitrogen deposition. Analyses are ongoing to understand how these factors may have contributed to the trends observed.

2.7.4 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 cannot be calculated directly from the average carbon concentration and average bulk density values. As bulk density was only measured in 2007 no change data are available.

▼ **Table 2.9:** Bulk density and carbon stock in soils (0-15cm) in all vegetation types for Great Britain and selected Broad Habitats in 2007.

Broad Habitat	2007	
	Mean bulk density gm/cubic cm	Mean carbon stock t/ha
Broadleaved, Mixed and Yew Woodland	0.77	66.3
Coniferous Woodland	0.51	73.9
Arable and Horticulture	1.23	43.0
Improved Grassland	0.97	61.0
Neutral Grassland	0.90	62.4
Acid Grassland	0.43	82.3
Bracken	0.43	77.1
Dwarf Shrub Heath	0.35	81.6
Fen, Marsh and Swamp	0.45	75.1
Bog	0.17	77.8
All vegetation types	0.78	63.0

As some Broad Habitats are rich in carbon but have a low mass of soil per unit volume, the stock of carbon in the soil (0-15cm) is rather similar across the different Broad Habitats, ranging from 43.0 t/ha in Arable to 82.3 t/ha in Acid Grassland, with an overall mean of 63.0 t/ha *(Table 2.9)*.

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 CS differ markedly from the large decrease estimated for England and Wales by the National Soil Inventory Monitoring Programme[8]. This illustrates the difficulty of estimating national soil carbon concentrations, and also the value of having different studies to compare. Further analysis, looking at different soil and habitat types in different parts of the country is continuing. (see *Table 2.9*).

▲ Lowland stream, England • © *NERC*

2.8 Changes in condition of headwater streams and ponds

Headwater streams represent over 90% by length of all watercourses in Great Britain and their status can greatly affect the quality of the water flowing into downstream watercourses. CS 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 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. Condition assessment of headwater streams and ponds was not included in the Northern Ireland Countryside Survey.

Results for freshwater habitats are presented in *Chapter 8* and only a brief summary is provided here. Results of stream macroinvertebrate samples are still being processed, so changes in stream condition reported here are based on data for aquatic plants only.

On average, plant species richness in headwater streams increased by 40% from 3.0 to 4.2 plant species per stream section between 1998 and 2007. The increase was primarily due to an increase in emergent plants such as Brooklime *(Veronica beccabunga)* and Water Forget-me-not *(Myosotis scorpioides)*. Plant species sensitive to nutrient enrichment became more frequent suggesting a possible reduction in phosphate inputs to streams. 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.

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

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 Farmland Bird and Butterfly Food Plants 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 Great Britain was poor in 2007, with only eight species on average per pond, compared to an expected richness of 20 species in good quality ponds[9]. In the repeat survey of lowland ponds, species richness had decreased by 20% since 1996, with the greatest reductions seen in submerged and emergent species. 80% of ponds in England and Wales were in poor condition in 2007, based on assessment of a range of criteria known to be indicative of degradation.

2.9 Discussion and conclusions

The changes in the areas of Broad Habitats in the United Kingdom are broadly in line with conservation objectives as expressed in the UK Biodiversity Action Plan. The Arable and Horticulture Broad Habitat has decreased in extent largely through conversion to Improved or Neutral Grassland. Plant species richness within surviving arable habitats has increased. This suggests that generally arable landscapes have become more diverse, including more set-aside, cereal field margins and areas of Neutral Grassland, which all should have benefits for farmland biodiversity. On the other hand, there is a continuing trend for 'managed' hedges to revert to relict hedges or lines of trees/shrubs, though nearly half of hedges are assessed as in good condition. In woodland, there has been a marked shift from Coniferous to Broadleaved, Mixed and Yew Woodland. In general terms the extent of Broadleaved, Mixed and Yew Woodland has increased whilst species richness of the ground flora within them has decreased. In the uplands the changes have been more subtle, with a shift from bracken dominated areas to Acid Grassland. Other Broad Habitats remain unchanged in extent, though there was an increase in Dwarf Shrub Heath in England.

The overall trends in plant species richness across all habitat/vegetation types in Great Britain show that longer term declines have slowed between 1998 and 2007 in the open countryside (fields, woods, heaths and moors), in linear features and in areas especially targeted for their botanical interest. However, the continued decrease in species richness in both linear features and in areas targeted for their botanical interest (including Priority Habitats) is of concern 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 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.

▲ Flowering species on dry chalk grassland, England • © *Sue Wallis*

The vegetation across Great Britain has also changed in character. Species that prefer wetter conditions and species that cast or prefer shade have increased. These species tend to be more competitive and less ruderal. 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.

Soils (0-15cm) show evidence of increasing pH associated with recovery from previous high levels of acid deposition, though the impacts of these changes on vegetation are less obvious.

Between 1998 and 2007, a preceding increase in mean carbon concentration in soil (0-15 cm) in some habitats between 1978 and 1998 has slowed or reversed. These 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 and how they affect the growth of vegetation.

The initial CS results from 2007 focus on the different elements of the Field Survey and the relationships between these components of the ecosystem. The possible causes and consequences of the changes observed have not yet been investigated in any detail. Further reports on soils, freshwater and the Land Cover Map will follow in due course, and an integrated assessment of the components of CS is now in progress. Data will be made available for wide application in assessment and analysis of status and dynamics of the UK countryside.

[9] Applies to ponds in England and Wales.

Countryside Survey

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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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▲ Potato crop and margin, England • © *NERC*

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

Summary

- The area of land in the Arable and Horticulture Broad Habitat decreased by 9.1% and the area of Improved Grassland increased by 5.4% in the UK between 1998 and 2007.
- Plant species richness in the Arable and Horticulture Broad Habitat increased by 30% in Great Britain between 1998 and 2007, including species used as food by birds and butterflies.
- Arable margins had a higher species richness and cover of plants than arable fields or the edges of crops in Great Britain, between 1998 and 2007.
- Plant species richness in Improved Grassland in areas targeted within the Countryside Survey for their botanical interest decreased by 11.9% in Great Britain between 1998 and 2007 and by 21.8% between 1990 and 2007.
- pH in soil (0-15cm) increased in both Arable and Horticulture and Improved Grassland Broad Habitats in Great Britain between 1998 and 2007, continuing the trend from 1978.
- There was a significant decrease in the concentration of carbon in soil (0-15cm) between 1998 and 2007 in Arable and Horticulture Broad Habitats but there was no difference in Improved Grasslands.
- 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 Great Britain between 1998 and 2007.

3.1 Introduction[1]

Over 40% of the land area of the UK is composed of enclosed farmland that belongs in two Broad Habitats: Arable and Horticulture and Improved Grassland. These two Broad Habitats are typically the most intensively farmed and managed land, providing much of the agricultural produce of the UK. Intensive management of cultivated land generally results in environments with relatively few plant species, in which the less intensively managed (or unmanaged) areas 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 primarily dominated by the Broad Habitat types covered here.

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.

3.2 Area and condition of Broad Habitats of enclosed farmland

- **The area of land in the Arable and Horticulture Broad Habitat decreased by 9.1% and the area of Improved Grassland increased by 5.4% in the UK between 1998 and 2007.**

3.2.1 Change in area

The Arable Broad Habitat covered about 4.7 million ha of the UK in 2007 compared to about 5.1 million ha in 1998, a 9.1% decrease, marking a shift away from the relatively stable level observed in CS up to 1998 *(Table 3.1)*.

The Improved Grassland Broad Habitat in the UK covered an area of approximately 5.1 million ha in 2007, an increase of 5.4% from 1998. This increase followed decreases previously reported from 1984 to 1998 *(Table 3.2)*.

3.2.2 Changes between Broad Habitats

Most land in the Arable Broad Habitat in 1998 was still in the same Broad Habitat in 2007, but CS recorded net flows from Arable to Improved and Neutral Grassland *(see **Annex 6** at www.countrysidesurvey.org.uk)*.

A large part of the Improved Grassland Broad Habitat in 1998 was also recorded as the same Broad Habitat in 2007, but the significant increase in area of this Broad Habitat between 1998 and 2007 was largely due to net flows from the Arable and Neutral Grassland Broad Habitats *(see **Annex 6**)*.

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

3.3 The condition of the Broad Habitats of enclosed farmland

3.3.1 Arable and Horticulture Broad Habitat

- **Plant species richness in the Arable and Horticulture Broad Habitat increased by 30% in Great Britain between 1998 and 2007, including species used as food by birds and butterflies.**

- **Arable margins had a higher species richness and cover of plants than arable fields or the edges of crops in Great Britain between 1998 and 2007.**

Plant species richness: The number of plant species found in Main Plots within the Arable Broad Habitat increased in Great Britain between 1998 and 2007, continuing the trend from 1990 to 1998 *(Table 3.3)*. This increase was significant in England, but not in Scotland or Wales where the sample sizes for plots in this Broad Habitat are considerably lower. Changes in the number of plant species used by farmland birds and butterfly caterpillars as food mirrored these increases. There was a decrease in the ratio of grasses to forbs, showing 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.

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

▼ **Table 3.1:** The estimated area ('000s ha) and percentage of land area of Arable and Horticulture Broad Habitat in the UK from 1998 to 2007 and for Great Britain from 1984 to 2007 are shown. Arrows denote significant change ($p<0.05$) in the direction shown. Data not available = na.

	1984		1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
GB	5283	22.7	5025	21.6	5067	21.7	4608	19.8	↓
England	na	na	4380	33.2	4389	33.3	4002	30.4	↓
Scotland	na	na	593	7.3	618	7.6	534	6.6	↓
Wales	na	na	52	2.5	61	2.9	73	3.4	
Northern Ireland	na	na	na	na	57	4.0	49	3.5	
UK	na	na	na	na	5124	20.7	4657	18.8	↓

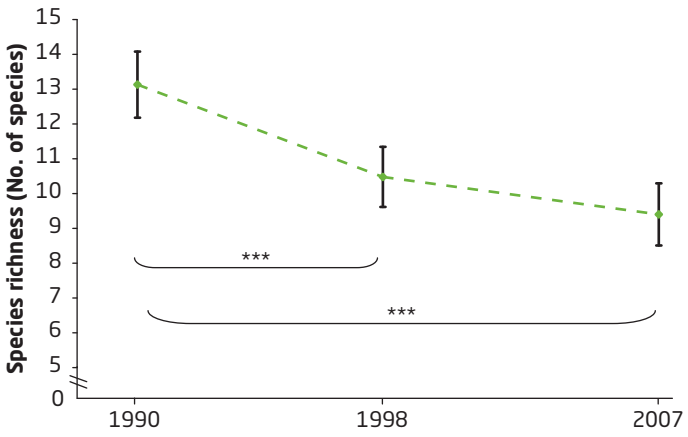
▼ **Table 3.2:** The estimated area ('000s ha) and percentage of land area of Improved Grassland Broad Habitat in the UK from 1998 to 2007 and for Great Britain from 1984 to 2007 are shown. Arrows denote significant change ($p<0.05$) in the direction shown. Note that because of changes in definitions that have been applied retrospectively, the estimates from 1990 and more especially 1984 are not in all cases directly comparable with later surveys. Data not available = na.

	1984		1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
GB	5903	25.3	4619	19.8	4251	18.2	4494	19.3	↑
England	na	na	3075	23.3	2714	20.6	2856	21.7	
Scotland	na	na	816	10.1	831	10.4	907	11.2	↑
Wales	na	na	726	34.2	706	33.3	731	34.4	
Northern Ireland	na	na	na	na	555	39.2	573	40.5	
UK	na	na	na	na	4806	19.4	5067	20.5	↑

▼ **Table 3.3:** Change in the characteristics of vegetation in 200m² Main Plots in the Arable and Horticulture Broad Habitat across Great Britain between 1990 and 2007. Mean values for condition measures in 1998 and 2007 are presented; those for 1990 are available in ***Annex 7***. Arrows denote significant change ($p<0.05$) in the direction shown. The condition measures are described in ***Box 1.3***.

	Mean values (GB)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	1998	2007	GB	E	S	W	GB	E	S	W	GB	E	S	W
Species Richness (No. of Species)	7.9	10.3	↑	↑			↑	↑			↑	↑		
No. of Bird Food Species	4.1	5.0	↑	↑			↑	↑			↑	↑		
No. of Butterfly Food Species	2.5	3.1	↑	↑			↑	↑	↓		↑	↑		
Grass:Forb Ratio	1.19	0.47	↓	↓			↑	↑						
Competitor Score	2.23	2.10	↓	↓	↑							↓		
Stress Tolerator Score	1.35	1.38					↑	↑			↑	↑		
Ruderal Score	3.70	3.78		↑	↓									
Light Score	7.11	7.04	↓	↓							↓	↓		
Fertility Score	6.58	6.46	↓	↓	↓		↓	↓			↓	↓	↓	
Ellenberg pH Score	6.68	6.64	↓	↓			↓	↓			↓	↓		
Moisture Score	4.98	4.99					↑	↑			↑	↑		

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



Targeted Plots: Fragments of uncultivated or unmanaged land within the Arable 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 diverse areas are sampled by Targeted Plots, which in the case of the Arable Broad Habitat were in habitat fragments. In contrast to the results for the Main Plots which showed an increased plant species richness within the cropped area, the results in Targeted Plots showed a decrease in species richness across Great Britain from 13.1 in 1990 to 9.4 in 2007 *(Fig. 3.1)*. The change from 1998 to 2007 was not significant.

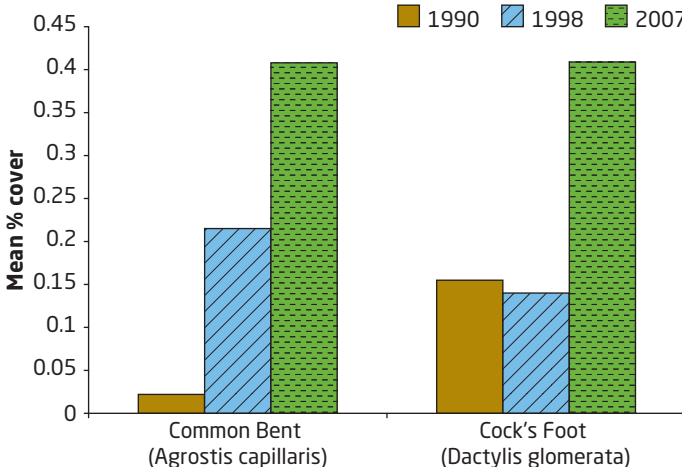
Other vegetation characteristics: The proportion of competitive plant species, the ratio of grasses to forbs and the Fertility Score all decreased between 1998 and 2007 *(Table 3.3)*. This was consistent with a moderately less intensive management regime across this most intensively managed of all Broad Habitat types. Taken together, the changes in plant species richness and condition in the Main Plots of the Arable Broad Habitat are consistent with an increase in the number of 'weeds' between 1998 and 2007, within cropped areas.

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. There were on average 16 species per plot and no change was detected in Great Britain between 1998 and 2007. In contrast to the results found for Main Plots, there was no significant increase in the number of plant species used by farmland birds as food in Crop Edge Plots and there was a significant decrease in the number of plant species used by butterfly caterpillars as food, from 5.2 per plot in 1998 to 4.9 in 2007, across Great Britain (at the country level, these changes were only found in England). Other condition measures of the Crop Edge Plots were similar to those in the Main Plots.

Managed Margin Plots were recorded for the first time in 2007, to enable understanding of 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 113 such plots were recorded, 87 of which were in England. On average 10 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 can be compared *(Table 3.4)*. This comparison shows that the Managed Margin Plots had the highest plant species richness and the highest percentage cover of plants, whereas Main Plots had the lowest plant species richness. The mean percentage cover of weeds in Arable and Horticulture Broad Habitat Main Plots has increased markedly since 1998 but is still less than 1%. Changes in percentage cover of two of the most important species for butterflies and farmland birds are shown in *Fig. 3.2*.

▼ **Figure 3.2:** Changes in the mean percentage cover of two species of plant important as food plants for Butterfly caterpillars and Farmland Birds in 200m² Main Plots in the Arable and Horticulture Broad Habitat across Great Britain, between 1990 and 2007.



▼ **Table 3.4:** 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 crops.

	1998 2m x 2m core of Main Plots	2007 2m x 2m core of Main Plots	2007 Crop Edge Plots	2007 Managed Margin Plots
Species Richness	4.0	5.1	8.8	10.0
Mean Cover (%)	9.9	17.5	16.3	22.9

▼ **Table 3.5:** Change in the characteristics of vegetation in 200m² Main Plots in the Improved Grassland Broad Habitat across Great Britain, between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available in ***Annex 7***. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3***.

	Mean values (GB)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**
Species Richness (No. of Species)	14.7	14.3			↓	↓					↓			↓
No. of Bird Food Species	9.1	9.0				↓				↑				↓
No. of Butterfly Food Species	7.4	7.1	↓			↓					↓			↓
Grass:Forb Ratio	1.68	1.50	↓	↓			↑		↑				↑	
Competitor Score	2.71	2.74									↑	↑		
Stress Tolerator Score	1.90	1.92		↑		↓					↑	↑		
Ruderal Score	3.20	3.17									↓	↓		
Light Score	7.09	7.05	↓	↓	↓	↓			↑		↓	↓		
Fertility Score	5.71	5.68					↓	↓			↓	↓		
Ellenberg pH Score	6.09	6.06	↓	↓		↓	↓	↓	↓		↓	↓		↓
Moisture Score	5.35	5.38	↑			↑	↑	↑	↑		↑	↑	↑	↑

▲ Arable margins • © *Natural England*

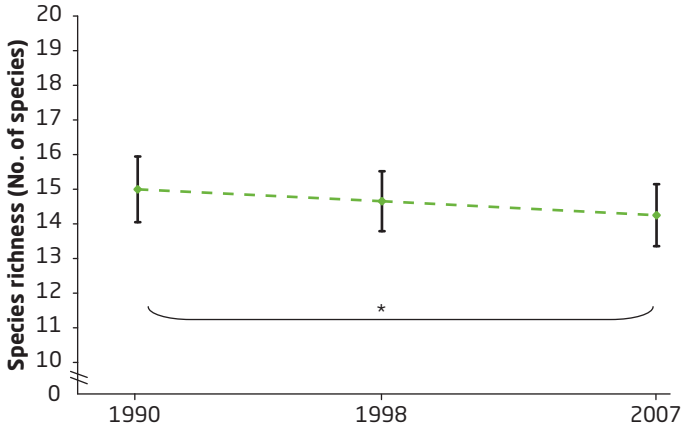
3.3.2 *Improved Grassland Broad Habitat*

- **Plant species richness in Improved Grassland in areas targeted within the CS for their botanical interest decreased by 11.9% in Great Britain between 1998 and 2007 and by 21.8% between 1990 and 2007.**

Species richness: A slight decrease in plant species richness score of 3% in the Improved Grassland Broad Habitat in Great Britain between 1998 and 2007 ***(Table 3.5, Fig.3.3)*** continued the decrease recorded between 1990 and 2007. The 5% decrease between these dates was significant. The number of food plants used by farmland birds did not change but there was a significant decrease in the food plants used by butterflies.

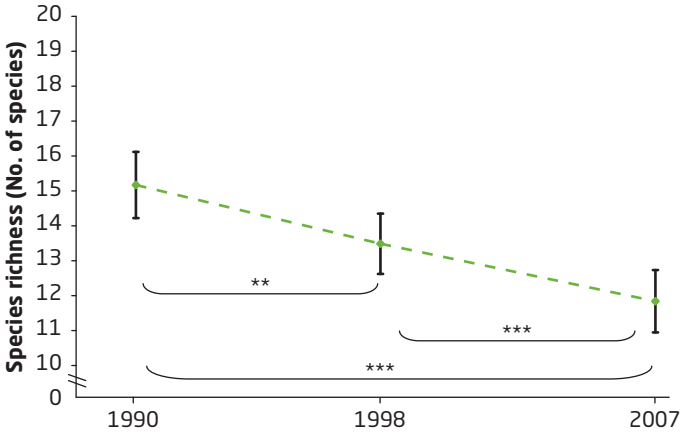
The species richness decreased in areas targeted in CS for their botanical interest, within Improved Grasslands in Great Britain between 1998 and 2007. This was similar to findings in the Arable Broad Habitat, and contributed to an overall decrease in Great Britain between 1990 and 2007 from 15 to 12 species per plot ***(Fig. 3.4)***.

▼ **Figure 3.3:** Changes in the species richness in 200m² Main Plots in the Improved Grassland Broad Habitat across Great Britain, between 1990 and 2007. Significant changes (* $p<0.05$) are shown between the dates bracketed. 95% CI are shown for each data point.



Other vegetation characteristics: The decrease in the ratio of grasses to forbs, the increase in competitive species and the decrease of ruderal species and the value of the Light Score between 1998 and 2007 ***(Table 3.5)*** all suggest that Improved Grassland swards became denser and more shaded, favouring competitive and shade-tolerant species. The increase in the value of the Moisture Score seen across Great Britain between 1998 and 2007 ***(Table. 3.5)***, continued the earlier trend from 1990 to 1998.

▼ **Figure 3.4:** Changes in the species richness in 2m x 2m Targeted Plots in the Improved Grassland Broad Habitat across Great Britain between 1990 and 2007. Significant changes (*** p<0.001) are shown between the dates bracketed. 95% CI are shown for each data point.



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

- **pH in soil (0-15cm) increased in both Arable and Horticulture and Improved Grassland Broad Habitats in Great Britain between 1998 and 2007, continuing the trend from 1978.**
- **There was a significant decrease in the concentration of carbon in soil (0-15cm) in Great Britain between 1998 and 2007 in the Arable and Horticulture Broad Habitat but there was no difference in Improved Grasslands.**

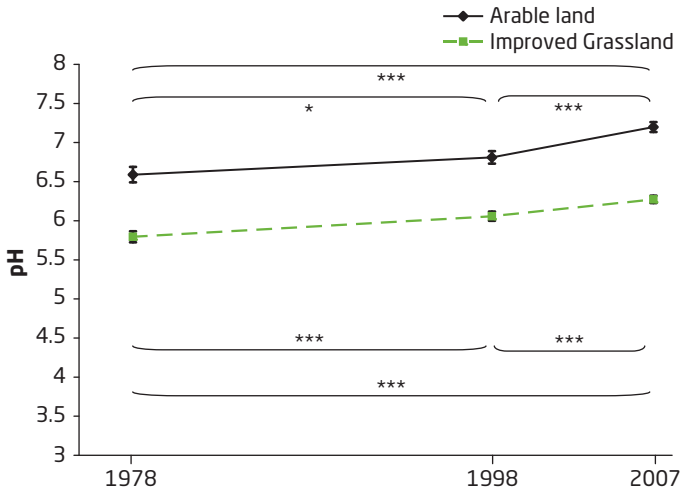
3.4.1 Soil (0-15cm) pH

The mean pH of soils (0-15cm) increased significantly in both Arable and Improved Grassland Broad Habitats in Great Britain between 1998 and 2007 *(Table 2.8)*. This continued the trend of significant pH increases in both Broad Habitats between 1978 and 1998 and across the entire period from 1978 to 2007 *(Fig. 3.5)*.

3.4.2 Soil (0-15cm) carbon concentration

Across Great Britain, the carbon concentration of soil (0-15cm) decreased from 31 to 28 g/kg in the Arable Broad Habitat between 1998 and 2007 *(Table 2.8)*. This is the only Broad Habitat in Great Britain where soil (0-15cm) carbon concentrations were significantly lower in 2007 than in 1978. There was no significant change in carbon concentration in Improved Grassland in Great Britain between 1998 and 2007 *(Table 2.8)*.

▼ **Figure 3.5:** The change in pH in soils (0-15cm) from Arable and Horticulture, and Improved Grassland Broad Habitats in Great Britain, between 1978 and 2007. Significant changes which are similar across time periods for both Broad Habitats (* p<0.05, *** p<0.001) are shown between the dates bracketed. 95% CI are shown for each data point (but are very small).



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

The bulk density of soils (0-15cm) in the Arable Broad Habitat in Great Britain was 1.2 g/cm^3, which when combined with soil carbon concentration in the same horizon indicated a soil (0-15cm) carbon stock of 43 t/ha. This was the lowest of all Broad Habitats *(Table 2.9)*. For Improved Grassland, the bulk density of soil (0-15cm) was 1.0 g/cm^3 indicating a soil (0-15cm) carbon stock of 61 t/ha, similar to many of the other Broad Habitats *(Table 2.9)*.

▲ Arable and grassland, N. Ireland • © *NERC*

▼ **Table 3.6:** 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 Great Britain 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)	%	
GB	27	43	166	284	↑
England	22	35	149	330	↑
Scotland	4	8	15	83	
Wales	0	1	3	300	↑

3.5 Further analysis and discussion to explain changes in the Arable and Horticulture and Improved Grassland 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 Great Britain between 1998 and 2007.**

In 2007, the Arable and Horticulture Broad Habitat (Arable Broad Habitat) made up about a fifth (19%) of the land area of the UK and as much as 30% of land area in England. The area of the Arable Broad Habitat increased slightly between 1990 and 1998 but fell by 9% (0.47 million ha) between 1998 and 2007. The decrease in Arable Broad Habitat was mainly through conversion to Improved and Neutral Grassland.

Plant species richness was investigated in the Arable Broad Habitat using four types of vegetation plot: Main Plots looked at vegetation within the field (within the crop if there was one); Targeted Plots investigated areas targeted within CS for their botanical interest in uncultivated land in the corners of fields or in uncultivated areas within fields; Crop Edge Plots looked at the first metre of the crop from the sown edge; and Managed Margin Plots investigated vegetation in the margins of fields that have been set up as part of agri-environment schemes.

Plant species richness within Main Plots in Arable land increased by 45%, from 7.1 to 10.3 species between 1990 and 2007 and by 30% between 1998 and 2007. The increase is likely to be the result of a combination of the impacts of set-aside and agri-environment schemes and follows the decrease in plant species richness between 1978 and 1990 reported in previous Countryside Surveys. The increase in the numbers of plants which provide food for farmland birds and butterfly caterpillars is associated with increases in both the numbers of plant species and their percentage cover within crops. These changes are likely to be related to the marked increase in the area of set-aside and fallow land *(Table 3.6)*.

Although Crop Edge Plots in the Arable Broad Habitat showed no detectable change in Species Richness Scores 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 (usually set-aside) contained more species than cropped land *(Table 3.7)*. While an arable crop has less species than the edge of a crop, a field in set-aside management has roughly the same species richness as the edge of a crop. The end of set-aside in 2008 is likely to result in a large reduction in the area of the annual early successional habitat and a subsequent decrease in Farmland Bird and Butterfly Food Plants.

▼ **Table 3.7:** The change in plant Species Richness Scores recorded in 200m² 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 Great Britain between 1998 and 2007.

	Arable crops		Annual early successional	
	1998	2007	1998	2007
Main Plots (No. of Species)	6.5	8.8	14.6	17.6
Crop Edge Plots (No. of Species)	15.0	16.3	12.2	18.2

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 butterflies decreased. The vegetation changes both within crops (Main Plots) and on the edges of crops (Crop Edge Plots) suggest a reduction in soil fertility and increased acidity. In contrast to the results of the vegetation analysis, a significant decrease in soil (0-15cm) acidity (i.e. an increase in soil pH) was detected between 1978 and 2007 and soil (0-15cm) carbon concentration also decreased by 10% over the same period.

The margins of fields established under agri-environment schemes have more species than the Main Plots in fields, but the plant species richness and cover are still low (on average 10 species per plot and 23% 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 as species-poor as the cropped area although percentage cover is higher. However, they do provide shelter and food for invertebrates as well as structural diversity.

3.5.2 Improved Grassland

In 2007 the estimated area of Improved Grassland was 5.1 million ha, around a fifth of the land area of the UK. The area of Improved Grassland fell in England and Wales between 1990 and 1998 but increased again between 1998 and 2007, because of the conversion of arable land to grassland.

A small decrease (5.0%) in plant species richness in 200m^2 Main Plots in Improved Grassland was detected between 1990 and 2007, across Great Britain. In the most recent period, 1998 and 2007, statistically significant decreases in plant diversity were detected in Wales and Scotland, but not in England. Areas targeted within CS for their botanical interest in 1990 experienced a larger decrease of 22% in plant species richness between 1990 and 2007. The vegetation plots in Improved Grassland also changed in ecological character with a shift towards vegetation more typical of wetter, more acidic and more shaded conditions.

3.5.3 Enclosed farmland

The increase in plant species richness in the Arable and Horticulture Broad Habitat may have been driven by a range of factors including farm economics, scale of set-aside and uptake of agri-environment schemes. Within the expanse of enclosed farmland, areas of more species-rich land that were targeted within CS for their botanical interest in 1990 continue to show a reduction in species richness, and so their ability to act as refuges for plants and animals are lessened.

Further investigations into how and why factors such as economics, set-aside and agri-environment schemes have affected enclosed farmland are continuing.

▲ Improved grassland, England • © *Sue Wallis*

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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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▲ Acid grassland, Scotland • © *NERC*

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

Summary

- The area of Neutral Grassland increased by 6.0% and the area of Acid Grassland increased by 5.5% in the UK between 1998 and 2007; the area of Calcareous Grassland did not change between these dates.
- Plant species richness was unchanged in Neutral Grassland but decreased in areas of Neutral Grassland targeted in Countryside Survey for their botanical interest in Great Britain between 1998 and 2007.
- Competitive and stress tolerating plant species increased at the expense of species of open ground in Neutral Grassland in Great Britain between 1998 and 2007.
- Plant species preferring fertile soils with high pH decreased while species preferring wetter conditions and/or prefer shadier conditions increased in Neutral Grassland in Great Britain between 1998 and 2007.
- The vegetation characteristics of Calcareous Grassland changed little in Great Britain between 1998 and 2007.
- Plant species richness decreased in Acid Grassland in Great Britain between 1998 and 2007.
- Competitive plant species and plant species preferring wetter conditions increased, while species of open ground decreased in Acid Grassland in Great Britain between 1998 and 2007.
- The mean pH of Neutral Grassland soils (0-15cm) increased in Great Britain between 1998 and 2007, but the mean pH of Acid Grassland soils (0-15cm) did not change significantly in Great Britain between 1998 and 2007.
- There was no detectable change in the mean carbon concentration in Neutral Grassland soils (0-15cm) in Great Britain between 1998 and 2007, but in Acid Grassland soils (0-15cm) there was a significant decrease in Great Britain during the same period.

4.1 Introduction[1]

While the most productive grasslands in the UK fall into the Improved Grassland Broad Habitat (19% of Great Britain's land area), large areas of semi-improved grassland still exist and these have been traditionally managed for livestock grazing and/or hay. They make a large contribution to national dairy, beef and lamb production and now tend to be associated with smaller farms and high quality produce or small areas on larger farms where intensification has been impractical for physical or financial reasons. Typically, these grasslands have been in existence for many decades or centuries and those examples with the highest conservation value have not been agriculturally improved by ploughing, re-seeding or the use of inorganic fertilisers. A large majority of these grasslands are now protected either as nature reserves, SSSIs or are under sympathetic management in agri-environment schemes.

These measures have been aimed at achieving the favourable condition of the best examples of these semi-natural grasslands; and maintaining or restoring other grasslands.

Small areas of semi-natural grassland (typically less than 0.5ha) are too small to attract protection or designation and may often be difficult to manage, yet will have been sampled by Countryside Survey (CS) plots. Although of lower conservation value than larger blocks of semi-natural habitat, these small areas are especially vulnerable to intensive land-use pressures. Conversely, the small areas are also susceptible to lack of management leading to succession to tall grassland, scrub and ultimately woodland. The changes in semi-natural grassland reported here derive from a random sample of the countryside and are therefore more representative of the Broad Habitats in the wider countryside rather than the often larger (but proportionally fewer) blocks of semi-natural habitat found on designated sites.

The three Broad Habitats included in this chapter are characteristic of soils with differing pH values. Neutral Grassland occurs on soils that are neither strongly acid nor lime-rich (pH 5.5-6.5); Calcareous Grassland occurs on lime rich soils (pH>6.5); and Acid Grassland occurs on acid soils (pH<5.5). Much of the Acid Grassland in Great Britain occurs in the uplands and so reference is also made to this Broad Habitat in *Chapter 7*. More narrowly defined BAP Priority Habitats occur within each of these Broad Habitats and CS data may contribute to their assessment.

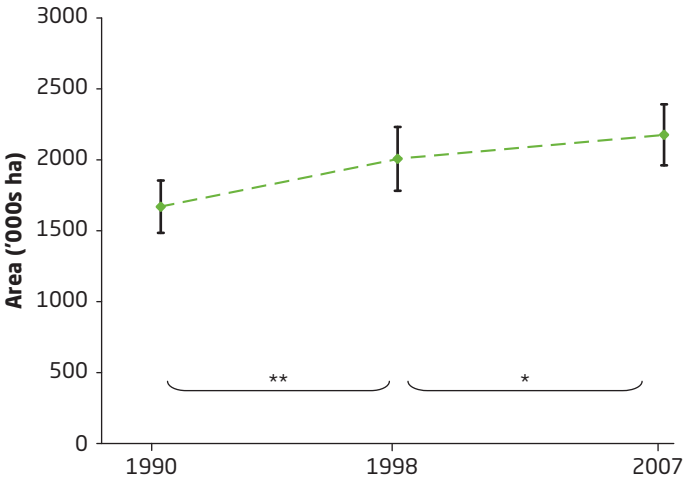
4.2 Area of semi-natural grasslands

- **The area of Neutral Grassland increased by 6.0% and the area of Acid Grassland increased by 5.5% in the UK between 1998 and 2007; the area of Calcareous Grassland did not change.**

4.2.1 Neutral Grassland

The area of Neutral Grassland was estimated to cover approximately 2.4 million ha in 2007 or 10% of the UK *(Table 4.1)*. A 6% increase from 1998. This followed a 20% increase between 1990 and 1998 *(Fig. 4.1)*. In contrast, there was a significant 12.5% decrease in Neutral Grassland in Northern Ireland between 1998 and 2007.

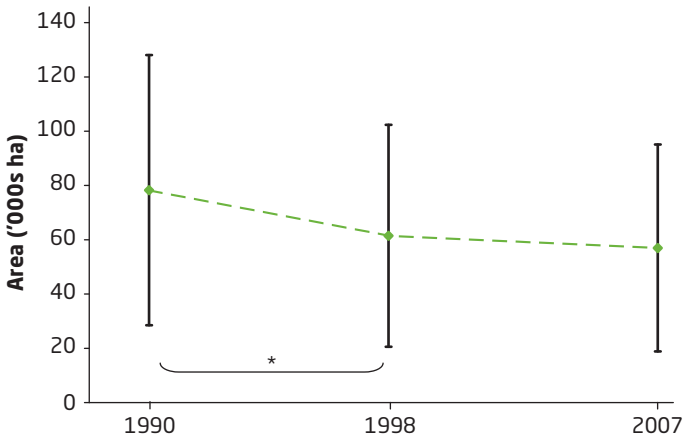
▼ **Figure 4.1:** Change in the area of Neutral Grassland across Great Britain between 1990 and 2007. Significant changes (* p<0.05, ** p<0.01) are shown between the dates bracketed. 95% CI are shown for each data point.



4.2.2 Calcareous Grassland

The area of Calcareous Grassland was estimated to cover approximately 59,000 ha in 2007 or approximately 0.2% of the UK *(Table 4.1)*. The small sample size makes it difficult to detect small changes in the area of this Broad Habitat and none were detected in the UK or Great Britain between 1998 and 2007, although there was a significant decrease in Great Britain between 1990 and 1998 *(Table 4.2, Fig. 4.2)*.

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



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

▼ **Table 4.1:** Estimates of the area ('000s ha) and percentage of land area of Neutral Grassland in the UK from 1998 to 2007 and Great Britain from 1984 to 2007 are shown. 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 and more especially 1984 are not in all cases directly comparable with later surveys. Data not available = na.

	1984		1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
GB	467	2.0	1669	7.2	2007	8.6	2176	9.3	↑
England	na	na	994	7.5	1290	9.8	1453	11.0	↑
Scotland	na	na	428	5.4	430	5.4	461	5.8	
Wales	na	na	247	11.7	287	13.5	263	12.4	
Northern Ireland	na	na	na	na	264	18.6	231	16.3	↓
UK	na	na	na	na	2271	9.2	2407	9.7	

▼ **Table 4.2:** Estimates of the area ('000s ha) and percentage of land area of Calcareous Grassland in the UK from 1998 to 2007 and Great Britain from 1984 to 2007 are shown. 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 and more especially 1984 are not in all cases directly comparable with later surveys. Data not available = na.

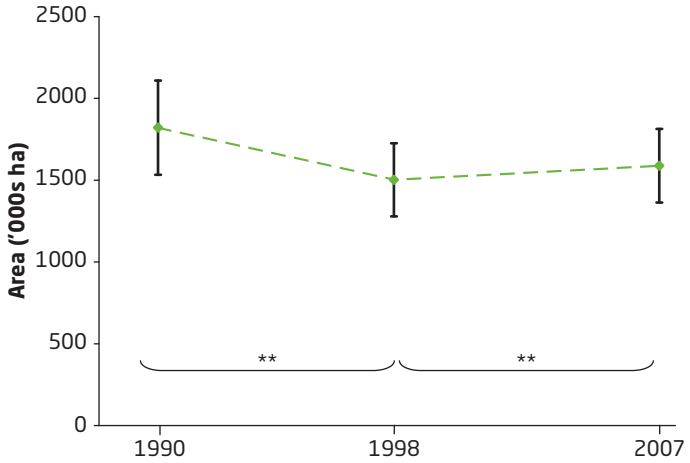
	1984		1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
GB	75	0.3	78	0.3	61	0.3	57	0.2	
England	na	na	42	0.3	33	0.2	30	0.2	
Scotland	na	na	36	0.4	28	0.4	26	0.3	
Wales	na	na	1	0.1	1	0.1	1	0.1	
Northern Ireland	na	na	na	na	2	0.1	2	0.1	
UK	na	na	na	na	63	0.3	59	0.2	

▲ Neutral grass with anthills, England • © *Peter Stroh*

4.2.3 Acid Grassland

The area of Acid Grassland was estimated to cover approximately 1.6 million ha in 2007 or approximately 6.5% of the UK *(Table 4.3)*. In Great Britain the area of Acid Grassland increased by 5.7% between 1998 and 2007. This followed a larger decrease of 17.5% between 1990 and 1998. Overall there was a 12.7% decrease between 1990 and 2007 *(Table 4.3, Fig. 4.3)*.

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



▼ **Table 4.3:** Estimates of the area ('000s ha) and percentage of land area of Acid Grassland in the UK from 1998 to 2007 and Great Britain from 1984 to 2007 are shown. 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 and more especially 1984 are not in all cases directly comparable with later surveys. Data not available = na.

	1984		1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
GB	1476	6.3	1821	7.8	1502	6.4	1589	6.8	↑
England	na	na	475	3.6	400	3.0	396	3.0	
Scotland	na	na	1095	13.6	911	11.4	983	12.3	↑
Wales	na	na	256	12.1	191	9.0	211	9.9	
Northern Ireland	na	na	na	na	13	0.9	10	0.7	
UK	na	na	na	na	1516	6.1	1599	6.5	

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 Grassland. The change estimates between 1998 and 2007 are more reliable because the same codes were used in both surveys.

4.3 Changes between the semi-natural grassland habitats

Most Neutral Grassland remained as that Broad Habitat between 1998 and 2007. There were conversions to and from Improved Grassland which virtually cancelled each other out and more Arable and Horticulture Broad Habitat became Neutral Grassland than the reverse. This pattern is consistent with the substantial increase in set-aside during the period. The pattern was also confirmed by an investigation of the conversions based on the primary mapping codes recorded by surveyors, which indicated a net shift from arable crops to semi-improved neutral grassland and tall neutral grassland. A small amount of Coniferous Woodland became Neutral Grassland after felling and a similar amount of Neutral Grassland became Broadleaved, Mixed and Yew Woodland *(Annex 6, www.countrysidesurvey.org.uk)*.

There were very few changes in the conversions to and from Calcareous Grassland Broad Habitat between 1998 and 2007. There were small conversions to and from Neutral Grassland but little else *(Annex 6)*.

There were small conversions from the Broad Habitats: Bog; Fen, Marsh and Swamp; Bracken; and Coniferous Woodland to Acid Grassland, and a small flow from Acid Grassland to Dwarf Shrub Heath, between 1998 and 2007 *(Annex 6)*.

▲ Semi-natural grassland, England • © *Sue Wallis*

4.4 Condition of semi-natural grasslands

4.4.1 Changes in the Neutral Grassland Broad Habitat

- **Plant species richness was unchanged in Neutral Grassland but decreased in areas of Neutral Grassland targeted in CS for their botanical interest in Great Britain between 1998 and 2007.**
- **Competitive and stress tolerating plant species increased at the expense of species of open ground in Neutral Grassland in Great Britain between 1998 and 2007.**
- **Plant species preferring fertile soils with high pH decreased while species preferring wetter conditions and/or prefer shadier conditions increased in Neutral Grassland in Great Britain between 1998 and 2007.**

▼ **Table 4.4:** Change in the characteristics of vegetation in 200m² Main Plots in the Neutral Grassland Broad Habitat across Great Britain between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available in ***Annex 7***. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3***.

	Mean values (GB)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**
Species Richness (No. of Species)	21.2	20.4			↓								↓	
No. of Bird Food Species	10.6	10.4			↓									
No. of Butterfly Food Species	9.9	9.7			↓									
Grass:Forb Ratio	1.10	1.10											↑	
Competitor Score	2.75	2.81	↑	↑	↑									
Stress Tolerator Score	2.19	2.23	↑	↑										
Ruderal Score	2.95	2.87	↓	↓	↓						↓	↓	↓	
Light Score	7.01	6.98	↓	↓					↑					
Fertility Score	5.16	5.10	↓			↓					↓			
Ellenberg pH Score	5.86	5.80	↓			↓					↓			↓
Moisture Score	5.45	5.52	↑	↑	↑						↑		↑	

▼ **Table 4.5:** Change in the characteristics of vegetation in 2m x 2m Targeted Plots in the Neutral Grassland Broad Habitat across Great Britain between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available in ***Annex 7***. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3***.

	Mean values (GB)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**
Species Richness (No. of Species)	14.3	12.9	↓	↓	↓	↓	↓	↓	↓	↑	↓	↓	↓	
No. of Bird Food Species	6.2	5.6	↓		↓	↓	↓	↓	↓	↑	↓	↓	↓	
No. of Butterfly Food Species	6.4	5.9	↓		↓	↓	↓	↓	↓		↓	↓	↓	
Grass:Forb Ratio	0.86	0.67	↓				↑		↑					
Competitor Score	2.98	3.04	↑	↑	↑		↑	↑			↑	↑	↑	
Stress Tolerator Score	2.23	2.23												
Ruderal Score	2.6	2.55	↓	↓					↓		↓	↓	↓	
Light Score	6.91	6.86	↓	↓							↓	↓		
Fertility Score	5.17	5.26	↑	↑	↑						↑	↑		
Ellenberg pH Score	5.87	5.91			↑					↓				
Moisture Score	5.74	5.76				↓								

Species richness: While there was no change in plant species richness in Main Plots across Great Britain *(Table 4.4)*, a decrease was recorded in Scotland. In areas targeted in CS for their botanical interest, plant species richness decreased from 14.3 to 12.9 species per plot in Great Britain between 1998 and 2007, following a similar decrease between 1990 and 1998 *(Table 4.5, Fig. 4.4)*. The Targeted Plots may have been located in small patches of Priority Habitat within larger Neutral Grassland areas or within patches of other habitats such as scrub. The increase in the ratio of grasses to forbs between 1990 and 1998 and the subsequent decrease between 1998 and 2007 requires further investigation.

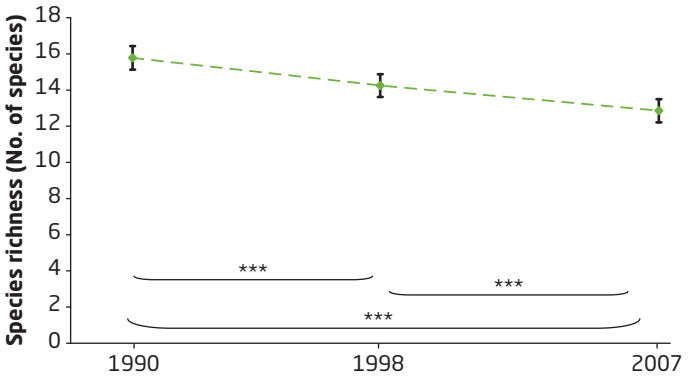
The decrease in both the number of plant species used by farmland birds as food (6.6 in 1990 to 5.6 in 2007) *(Fig. 4.5)* and those used by butterfly caterpillars as food (6.9 in 1990 to 5.9 in 2007) *(Fig. 4.6)* in Neutral Grassland Targeted Plots between 1990 and 2007 shows that these refuges have not just deteriorated for plants but possibly for animals too *(Table 4.5)*.

Other Characteristics of the vegetation of Neutral Grassland: The significant increase of competitive species at the expense of ruderal species in Main Plots *(Table 4.4)* and Targeted Plots *(Table 4.5)*, along with the significant decrease in the mean Light Score *(Tables 4.4 and 4.5)* show that Neutral Grasslands became more densely vegetated and more shaded across

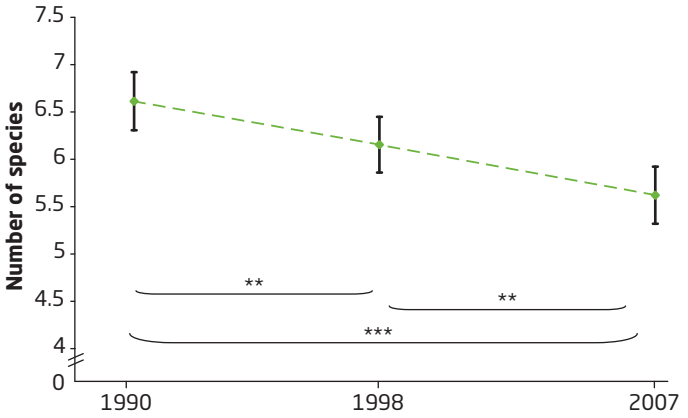
▼ **Table 4.6:** The 10 plant species with the largest increase and decrease in frequency in Main Plots in the Neutral Grassland Broad Habitat across Great Britain between 1998 and 2007.

Species with increasing frequency		Change Index	Species with decreasing frequency		Change Index
Glyceria fluitans	Floating Sweet-grass	0.37	*Phleum pratense sens. lat.*	Timothy	-0.45
Juncus effusus	Soft Rush	0.32	*Poa annua*	Annual Meadow-grass	-0.33
Ranunculus bulbosus	Bulbous Rush	0.29	*Leontodon autumnalis*	Autumn Hawkbit	-0.32
Ranunculus acris	Meadow Buttercup	0.27	*Cirsium vulgare*	Spear Thistle	-0.29
Cirsium palustre	Marsh Thistle	0.27	*Poa pratensis sens. lat.*	Smooth Meadow-grass	-0.26
Holcus lanatus	Yorkshire Fog	0.25	*Convolvulus arvensis*	Field Bindweed	-0.25
Vicia sativa	Common Vetch	0.24	*Anagallis arvensis*	Scarlet Pimpernell	-0.24
Rubus fruticosus agg.	Bramble	0.23	*Alopecurus geniculatus*	Marsh Foxtail	-0.22
Carex hirta	Hairy Sedge	0.21	*Bellis perennis*	Daisy	-0.22
Molinia caerulea	Purple Moor-grass	0.20	*Senecio jacobaea*	Ragwort	-0.20

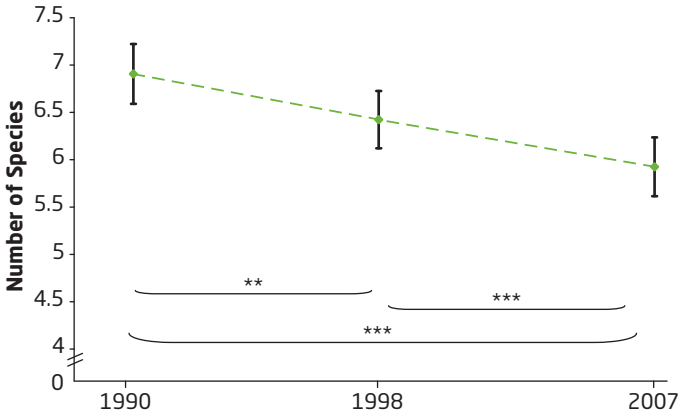
▼ **Figure 4.4:** Change in plant species richness in 2m x 2m Targeted Plots in the Neutral Grassland Broad Habitat across Great Britain between 1990 and 2007. Significant changes (*** p<0.001) are shown between the dates bracketed. 95% CI are shown for each data point.



▼ **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 Great Britain 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 4.6:** Change in the number of species of Butterfly Food Plants in 2m x 2m Targeted Plots in the Neutral Grassland Broad Habitat across Great Britain 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.



▲ Flowering species of chalk grassland, England • © *Sue Wallis*

Great Britain between 1998 and 2007. This is supported by the list of plant species that decreased most, as they are predominantly species of short turf *(Table 4.6)*. Wetter conditions are indicated by the increases in the mean Moisture Score *(Table 4.4)*. These changes in character are illustrated by increases in frequency of species typically associated with wet meadows *(Table 4.6)*.

The mean Fertility Score decreased in Main Plots *(Table 4.4)* but increased in Targeted Plots *(Table 4.5)* within Neutral Grassland in Great Britain between 1998 and 2007. The mean Ellenberg pH Score decreased significantly in Main Plots across Great Britain between 1990 and 2007 *(Table 4.4)*, with most of the decrease occurring between 1998 and 2007.

4.4.2 Changes in the Calcareous Grassland Broad Habitat

- **The vegetation characteristics of Calcareous Grassland changed little between 1998 and 2007.**

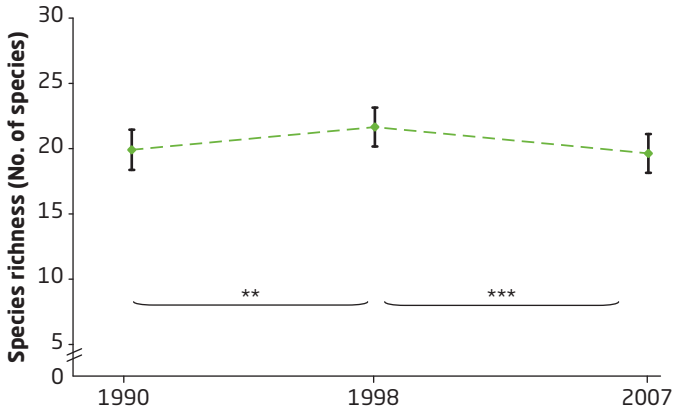
Species richness: There was a significant increase in the plant species richness (1990 to 2007) and numbers of plant species used by butterfly caterpillars as food (1990 to 1998) in the very small number of Main Plots in Calcareous Grassland (n=9) *(Table 4.7)*.

There were no detectable changes in any of the other characteristics analysed between 1998 and 2007 and none in the Targeted Plots within Calcareous Grassland.

4.4.3 Changes in the Acid Grassland Broad Habitat

- **Plant species richness decreased in Acid Grassland in Great Britain between 1998 and 2007.**
- **Competitive and moisture preferring plant species increased, while species of open ground decreased in Acid Grassland in Great Britain between 1998 and 2007.**

▼ **Figure 4.7:** Change in plant species richness in 200m² Main Plots in the Acid Grassland Broad Habitat across Great Britain 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.



▼ **Table 4.7:** Change in the characteristics of vegetation in 200m² Main Plots in the Calcareous Grassland Broad Habitat across Great Britain between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available in ***Annex 7***. Arrows denote significant change (p<0.05) in the direction shown. Grey columns with diagonal strikethrough denote insufficient data for analysis. Analyses are described in ***Box 1.3***.

	Mean values (GB)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	1998	2007	GB	E	S	W	GB	E	S	W	GB	E	S	W
Species Richness (No. of Species)	41.1	43.0									↑			
No. of Bird Food Species	14.6	14.1					↑							
No. of Butterfly Food Species	14.1	15.5									↑			
Grass:Forb Ratio	-0.67	-0.14					↓							
Competitor Score	2.02	2.21												
Stress Tolerator Score	3.04	2.99												
Ruderal Score	2.54	2.51												
Light Score	7.19	7.13												
Fertility Score	3.91	3.97												
Ellenberg pH Score	6.07	6.03												
Moisture Score	5.06	5.14												

▼ **Table 4.8:** Change in the characteristics of vegetation in 200m² Main Plots in the Acid Grassland Broad Habitat across Great Britain between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available in ***Annex 7***. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3***.

	Mean values (GB)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	1998	2007	GB	E	S	W	GB	E	S	W	GB	E	S	W
Species Richness (No. of Species)	21.6	19.6	↓	↓	↓		↑	↑	↑					
No. of Bird Food Species	5.6	5.2	↓		↓		↑	↑						
No. of Butterfly Food Species	9.2	8.4	↓		↓		↑	↑	↑					
Grass:Forb Ratio	1.41	1.49								↑				
Competitor Score	2.23	2.29	↑		↑			↑			↑	↑	↑	
Stress Tolerator Score	3.42	3.40									↓	↓		
Ruderal Score	1.87	1.83	↓		↓		↑							
Light Score	6.90	6.91					↑		↑		↑		↑	
Fertility Score	3.05	3.05						↑				↑		
Ellenberg pH Score	3.72	3.75		↑										
Moisture Score	6.24	6.30	↑		↑									

Species richness: The plant species richness recorded in Main Plots in Acid Grassland increased in Great Britain between 1990 and 1998 and then decreased to 2007 *(Table 4.8)*, so that there was no overall change *(Fig. 4.7)*. The number of plant species used by farmland birds and butterfly caterpillars as food followed the same pattern, the decrease in butterfly food plant species being particularly noticeable in Scotland. This decrease was mirrored within areas of Acid Grassland targeted in CS for their botanical interest, with the exception of numbers of food plants for farmland birds *(Table 4.9)*. Grasses became more dominant in these Targeted Plots between 1990 and 2007.

Other characteristics of vegetation in Acid Grassland: Competitive species increased significantly in Main *(Table 4.8)* and Targeted Plots *(Table 4.9)* in Acid Grassland in Great Britain between 1998 and 2007 continuing the increase between 1990 and 1998. Stress tolerating species decreased in both Main and Targeted Plots across Great Britain between 1990 and 2007. Ruderal species increased significantly in Great Britain between 1990 and 1998 in Main Plots then decreased significantly between 1998 and 2007. The Fertility Score was unchanged in Acid Grassland in Main Plots in Great Britain between 1998 and 2007 but increased in Targeted Plots. Like other grasslands, the Moisture Score increased in Acid Grassland in Great Britain between 1998 and 2007. Amongst the list of plant species that increased most in frequency are several species characteristic of wet conditions e.g. *Juncus squarrosus, Tricophorum cespitosum* and *Eriophorum angustifolium* are all characteristic of very wet areas *(Table 4.10)*. It is unclear why *Carex nigra, C.pulicaris* and *C.viridula* decreased as they also prefer wet conditions.

▲ Acid grassland, Wales • © *NERC*

▼ **Table 4.9:** Change in the characteristics of vegetation in 2m x 2m Targeted Plots in the Acid Grassland Broad Habitat across Great Britain between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available in ***Annex 7***. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3***.

	Mean values (GB)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**
Species Richness (No. of Species)	13.8	12.3	↓	↓	↓				↑		↓			
No. of Bird Food Species	3.4	3.3							↑					
No. of Butterfly Food Species	5.8	5.4	↓		↓									
Grass:Forb Ratio	1.33	1.41					↑	↑		↑	↑	↑		
Competitor Score	2.27	2.35	↑	↑	↑	↑					↑		↑	
Stress Tolerator Score	3.42	3.34	↓	↓		↓					↓			↓
Ruderal Score	1.90	1.91												
Light Score	6.96	6.93			↓		↑		↑	↑				↑
Fertility Score	3.03	3.12	↑	↑		↑								
Ellenberg pH Score	3.90	3.92												
Moisture Score	6.39	6.39												

▼ **Table 4.10:** The 10 plant species with the largest increase and decrease in frequency in Main Plots in the Acid Grassland Broad Habitat across Great Britain between 1998 and 2007.

Species with increasing frequency		Change Index	Species with decreasing frequency		Change Index
Juncus squarrosus	Heath Rush	0.26	*Luzula campestris/multiflora*	Woodrush	-0.37
Holcus lanatus	Yorkshire Fog	0.25	*Carex pilulifera*	Pill Sedge	-0.34
Trichophorum cespitosum	Deergrass	0.24	*Carex nigra*	Common Sedge	-0.28
Urtica dioica	Stinging Nettle	0.23	*Poa annua*	Annual Meadow- grass	-0.27
Empetrum nigrum	Crowberry	0.23	*Agrostis capilliaris*	Common Bent	-0.26
Trifolium repens	White Clover	0.22	*Juncus bulbosus*	Bulbous Sedge	-0.24
Senecio jacobaea	Ragwort	0.20	*Carex pulicaris*	Flea Sedge	-0.24
Ranunculus acris	Meadow Buttercup	0.20	*Festuca ovina agg.*	Sheep's Fescue	-0.24
Eriophorum angustifolium	Common Cotton-grass	0.20	*Carex viridula ssp*	Yellow Sedge	-0.24
Cirsium arvense	Creeping Thistle	0.19	*Bellis perennis*	Daisy	-0.19

4.5 Priority Habitats of semi-natural grassland

4.5.1 Lowland Calcareous Grassland

In 1990 and 1998 the Calcareous Grassland Broad Habitat was recorded by surveyors and a digital altitude mask was used to differentiate between upland and lowland. In 2007 the emphasis on differentiating Lowland and Upland Calcareous Grassland was by botanical composition of the grasslands. The indicator species for Lowland Calcareous Grassland were *Bromus erectus, Brachypodium pinnatum, Linum catharticum, Carlina vulgaris, Cirsium acaule, Hippocrepis comosa, Asperula cynanchica, Briza media, Koeleria macrantha* and *Helianthemum nummularia*. The estimated area of Lowland Calcareous Grassland in Great Britain for 2007 was 45,000 ha *(Table 4.11)*. The variance in the estimate reflects the low representation of this nationally scarce and scattered Broad Habitat in CS *(Annex 6)*.

▼ **Table 4.11:** Change in estimated area ('000s ha) of Lowland Calcareous Grassland in Great Britain from 1998 to 2007. Arrows denote significant change ($p<0.05$) in the direction shown.

Lowland Calcareous Grassland	1998 Area ('000s ha)	2007 Area ('000s ha)	Direction of significant changes 1998-2007
GB	47.4	44.5	
England	30.7	28.5	
Scotland	16.4	15.8	
Wales	0.3	0.2	

4.5.2 Upland Calcareous Grassland

As with Lowland Calcareous Grassland, Upland Calcareous Grassland was identified in 1998 using a digital altitudinal mask. In 2007, Upland Calcareous Grassland was identified by the botanical indicators *Sesleria albicans, Thymus praecox* and *Galium sterneri.* Montane forms sometimes contain Arctic-Alpine plants, such as *Alchemilla alpina, Polygonum viviparum, Dryas octopetala* and *Silene acaulis.* The area estimate for Great Britain in 2007 was 19,000 ha, a decrease between 1998 and 2007 ***(Table 4.12)***. There is high variance in the estimates for this Priority Habitat because it is so scarce ***(Annex 6)***. Most of this Priority Habitat is found in a few large well known sites that are not within the CS sample.

▼ **Table 4.12:** Change in estimated area ('000s ha) of Upland Calcareous Grassland in Great Britain from 1998 to 2007. Arrows denote significant change (p<0.05) in the direction shown.

Upland Calcareous Grassland	1998 Area ('000s ha)	2007 Area ('000s ha)	Direction of significant changes 1998-2007
GB	21.47	18.89	↓
England	1.99	0.59	
Scotland	19.24	18.05	
Wales	0.15	0.15	

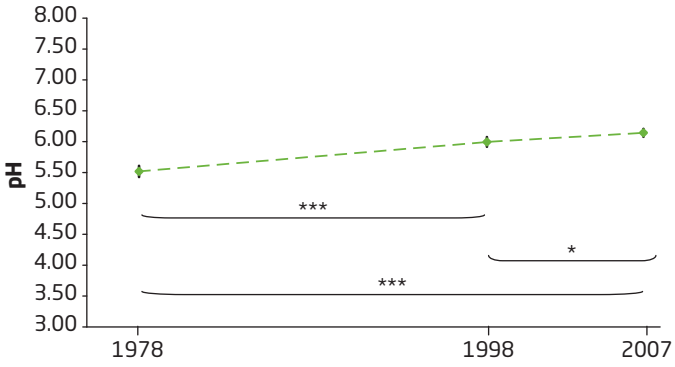
4.6 Changes to the soils (0-15cm) of semi-natural grasslands

- **The mean pH of Neutral Grassland soils (0-15cm) increased significantly in Great Britain between 1998 and 2007, but the mean pH of Acid Grassland soils (0-15cm) did not change significantly in Great Britain between 1998 and 2007.**
- **There was no significant change in the mean carbon concentration in Neutral Grassland soils (0-15cm) in Great Britain between 1998 and 2007, but in Acid Grassland soils (0-15cm) there was a significant decrease in Great Britain during the same period.**

4.6.1 Neutral Grasslands

Soil (0-15cm) pH: The mean pH of soil (0-15cm) samples in Main Plots within Neutral Grassland in Great Britain increased significantly between 1998 and 2007, from pH 6.00 to 6.14. Earlier increases in pH between 1978 and 1998 and overall from 1978 to 2007 were also significant ***(Table 2.8, Fig 4.8)***. The mean Ellenberg pH Score of the vegetation ***(Table 4.4)*** did not change consistently with the soil pH.

▼ **Figure 4.8:** The change in mean pH of soils (0-15cm) from Neutral Grasslands in Great Britain 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.



Soil (0-15cm) carbon concentration: There was no significant change in the carbon concentration of soil (0-15cm), approximately 62 g/kg, in Neutral Grassland in Great Britain between 1998 and 2007 or between 1978 and1998 or between 1978 and 2007 ***(Table 2.8)***.

Bulk density and soil (0-15cm) carbon stock: The mean bulk density of Neutral Grassland soils (0-15cm) in Great Britain was 0.9 g/cm^3 (in the top 15cm) which when combined with mean soil (0-15cm) carbon concentration indicated a soil (0-15cm) carbon stock of 62 t/ha ***(Table 2.9)***.

4.6.2 Calcareous Grasslands

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

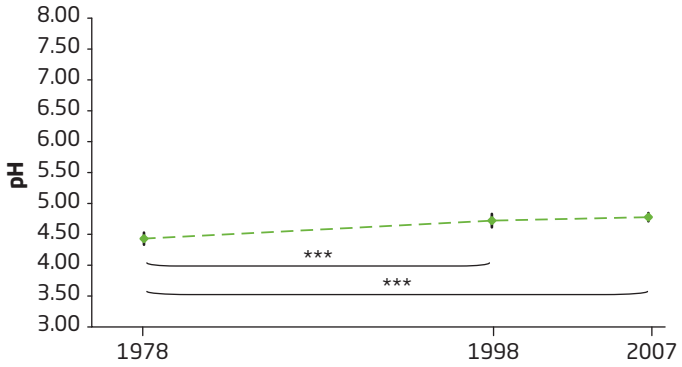
4.6.3 Acid Grasslands

Soil (0-15cm) pH: There was no significant change in the mean pH of soil (0-15cm) samples in the Main Plots within Acid Grasslands in Great Britain, between 1998 and 2007 ***(Table 2.8, Fig. 4.9)***. This contrasts with the significant increase from pH 4.43 in 1978 to pH 4.72 in 1998, which also largely accounts for the significant increase in soil (0-15cm) pH between 1978 and 2007.

Soil (0-15cm) carbon concentration: There was a significant decrease in the mean carbon concentration of soil (0-15cm) in Acid Grasslands for Great Britain between 1998 and 2007 ***(Table 2.8)***, whereas there was no significant change between 1978 and 1998. A significant decrease in soil (0-15cm) carbon concentration was also observed between 1998 and 2007 in the relatively carbon-rich Acid Grassland soils in Scotland, but there were no significant changes in England and Wales.

Bulk density and soil (0-15cm) carbon stock: The mean bulk density of Acid Grassland soils (0-15cm) in Great Britain was 0.4 g/cm^3 which, when combined with mean soil (0-15cm) carbon concentration indicated a soil (0-15cm) carbon stock of 82 t/ha ***(Table 2.9)***.

▼ **Figure 4.9:** The change in pH of soils from Acid Grasslands in Great Britain 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.



4.7 Discussion and conclusions

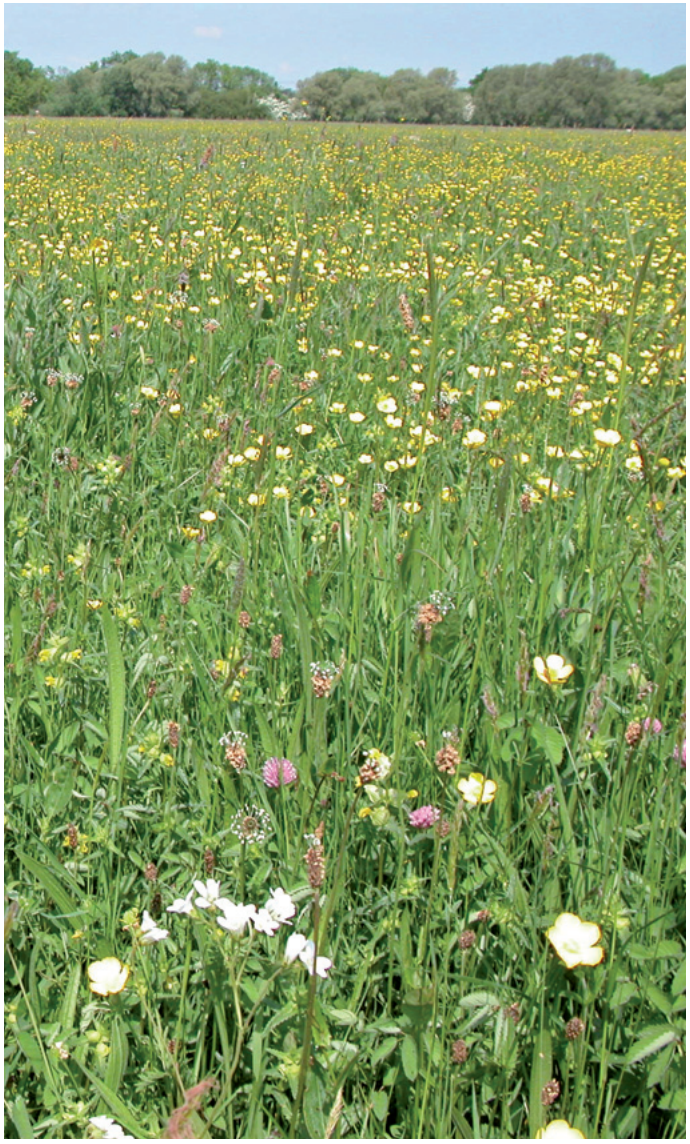
4.7.1 Neutral Grassland

The area of the Neutral Grassland Broad Habitat was 2.4 million ha in 2007, 10% of the land area of the UK, and two thirds of this was found in England. The area of Neutral Grassland increased in Great Britain by 30% between 1990 and 2007. Neutral Grassland is a dynamic habitat with proportionately high conversions to and from other Broad Habitats. Between 1998 and 2007, Neutral Grassland gained mostly at the expense of Arable and Horticulture and Coniferous Woodland Broad Habitats.

Between 1998 and 2007, in the 200m^2 Main Plots that represented widespread examples of Neutral Grassland, reductions in plant species richness (including food plants of farmland birds and butterfly caterpillars) were detected only in Scotland. However, in areas targeted in CS for their botanical diversity (Targeted Plots), the plant Species Richness Score decreased by 9.8% between 1998 and 2007 in Great Britain, and 13% between 1990 and 2007. These losses in plant species richness were associated with a shift towards more competitive, shade tolerant and nutrient demanding plants, with a decrease in ruderal species. This suggests a successional change in these more diverse patches within the Neutral Grassland Broad Habitat.

It is not yet clear why the decrease in Fertility Score occurred in Main Plots in Neutral Grassland, as many of the more competitive, shade tolerant species are also those that prefer fertile conditions. Both atmospheric nitrogen deposition and sheep grazing intensity have been previously linked weakly with an increase in Fertility Score within semi-natural grassland in Great Britain between 1978 and 1998, but a clear signal of nutrient overload (eutrophication) was not detected between 1998 and 2007 in Neutral Grasslands. This apparent stability coincided with a period during which atmospheric nitrogen deposition remained relatively stable but cattle and sheep numbers decreased.

The significant increase in mean Fertility Score in the Targeted Plots in Neutral Grassland between 1990 and 2007 is more understandable. It indicates a clear shift toward more nutrient-demanding species but the reduction in mean Light Score and increase in mean Competitor Score also indicate greater shade and taller vegetation. These plots tend to sample small patches of agriculturally marginal but botanically more interesting vegetation embedded in intensive farmland. So, when first recorded in 1990, they started relatively richer in species more typical of low fertility but have been subsequently affected by lack of management and exposure to nutrient surpluses from nearby sources. This is a somewhat different picture from that seen in the Main Plots in the Neutral Grassland Broad Habitat, where the Fertility Score actually decreased across Great Britain between 1998 and 2007.



▲ Species rich meadow, England • © *Sue Wallis*

Soils (0-15cm) in Neutral Grassland became increasingly neutral (5.5 to 6.1 pH) between 1978 and 1998, and between 1998 and 2007.

4.7.2 Calcareous Grassland

Calcareous Grassland has a limited extent compared to other semi-natural and improved grassland types in the UK and is consequently relatively poorly represented in the CS sample. The estimated area of Calcareous Grassland in 2007 was 59,000 ha, well under 1% of the land area of the UK. Between 1990 and 2007, the area of

Calcareous Grassland in Great Britain decreased by 27% but most of this (22%) occurred in the period 1990 to 1998.

In the more extensive areas of Calcareous Grassland (Main Plots) a small increase (17%) in plant Species Richness Score was detected in Great Britain between 1990 and 2007 and no change was detected between 1998 and 2007. In more fragmented examples of Calcareous Grassland, and of other habitats within Calcareous Grassland represented by Targeted Plots there was no significant change in plant species richness between 1990 and 2007. However, there were increases in the number of plant species used by butterfly caterpillars as food between 1998 and 2007, associated with increases in competitive and nutrient demanding species.

A large proportion of the Calcareous Grassland of Great Britain is now under conservation management and/or protection. The reduction in the rate of loss and also the lack of changes in vegetation characteristics suggest that interventions are beginning to be effective.

4.7.3 Acid Grassland

In 2007, Acid Grassland had a total estimated cover of 1.6 million ha, about 6.5% of the land area of the UK. Most of this grassland (62%) occurs in Scotland. Between 1990 and 2007 the area of Acid Grassland fell by 13%, but the decrease was greater between 1990 and 1998 and there was a substantial increase in area between 1998 and 2007 in the uplands of Scotland and Wales. Acid Grassland is a relatively stable Broad Habitat with small conversions between similar Broad Habitat types, and particularly Bracken.

Plots within extensive areas of Acid Grassland (Main Plots) exhibited contrasting trends in plant species richness, with increases between 1990 and 1998 followed by decreases between 1998 and 2007. However, despite these contrasts in plant species richness there were consistent trends towards more competitive and plant species casting or preferring shade (generally taller plants). Similar trends were observed in areas targeted in CS for their botanical diversity (Targeted Plots) but there was also a decrease in stress tolerating species and an increase in nutrient-demanding species.

Reasons for the changes in Acid Grassland require further investigation, but the increases in competetive species and taller plant 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.

4.7.4 Semi-natural grasslands as a whole

The significant continued loss of plant species richness in areas targeted in CS for their botanical interest within semi-natural grasslands could be related to less intensive management. Reduced stocking rates and cutting, would, when combined with wetter conditions and higher soil pH, lead to the changes in vegetation characteristics that were observed. Taller, more competitive species increased, suppressing smaller species and subsequently reducing species richness.

The increase in the area of Semi-Natural Grasslands between 1998 and 2007 might not be permanent. Whilst the area of Calcareous Grassland is now likely to remain more stable because of conservation intervention, much of the new Neutral Grassland could be ploughed again or reforested. The area of Acid Grassland varies over time because of the transitional nature of the plant communities at the boundaries between Acid Grassland, Bracken and Dwarf Shrub Heath Broad Habitats. A larger effect may be caused by changes in the livestock density in the uplands, along with management to remove bracken and positive conservation management of Dwarf Shrub Heath.

▲ Mixed upland grass, N Ireland • © *Mark Wright*

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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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▲ Dry stone wall, Wales • © *NERC*

5. Boundary and Linear Features Broad Habitat

Summary

- The total length of woody linear features decreased by 1.7% in Great Britain 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 6.2% in Great Britain between 1998 and 2007 with a large proportion of these 'managed' hedges turning into lines of trees and relict hedges, due to lack of management.
- The length of walls decreased by 1.1% in Great Britain between 1998 and 2007.
- Following significant decreases in plant species richness alongside hedges between 1978, 1990 and 1998, no change was detected in Great Britain between 1998 and 2007. More competitive 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 alongside roads in Great Britain between 1998 and 2007, although there was an overall decline of 6.5% between 1978 and 2007. Species of open ground decreased while competitive species increased in Great Britain between 1998 and 2007, continuing the trend from 1978.
- Species richness in vegetation associated with all types of landscape boundaries in Great Britain decreased by 4.0% between 1998 and 2007 and by 14.6% between 1978 and 2007.
- Woody species increased in vegetation associated with landscape boundaries by 14.0% between 1998 and 2007 and by nearly 80% in Great Britain between 1978 and 2007.

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

- **Roadside vegetation became more shaded, wetter and characteristic of less acidic conditions in Great Britain, between 1978 and 2007.**
- **There were on average 3.7 woody species per 30m section of hedge in Great Britain in 2007, with no detectable change between 1998 and 2007.**
- **48% of 'managed' hedges were in good structural condition in Great Britain in 2007.**
- **31% of 'managed' hedges were in good structural condition and had appropriately managed margins in Great Britain in 2007. Only 10% of 'managed' hedges on arable land were in both good structural condition and had appropriately managed margins in Great Britain in 2007.**
- **There was no change in the structural condition of walls in Great Britain between 1998 and 2007.**

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 differentiate parts of the countryside and provide them with a regional identity.

Whilst the role of linear features has always been to mark boundaries and manage stock, ecologically they constitute a very significant Broad Habitat within farmland. As well as providing a refuge for species unable to persist in managed fields, the Boundary and Linear Features Broad Habitat can provide corridors for the movement and dispersal of a range of species. 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 contribution of these features for UK 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 (see ***Box 1.1***); 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 CS, condition criteria were only applied to 'managed' hedgerows.

▲ 'Managed' hedge, England • © *Ian Simpson*

5.2 Reporting the 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***). 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.

In order to make the recording and reporting of the Boundary and Linear Features Broad Habitat practical, data were collected at a detailed level, 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)***. Hedges were

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

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

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

Linear Features	Description/condition criteria
Hedge	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. These are also known as 'managed' hedgerows.
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.

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 linear features has been recorded since the first CS in 1978, using a 10m x 1m plot placed alongside boundaries of all types (hedgerows; roads and tracks; streams, ditches and riversides). Numbers and types of plots were increased in subsequent Countryside Surveys to provide information on specific feature types in addition to the original Boundary Plots. These include: Field Boundary Plots; in 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 hedge 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 Waterside 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 (*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.

5.3 Length of Boundary and Linear Features

- **The total length of woody linear features decreased by 1.7% in Great Britain 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 6.2% in Great Britain between 1998 and 2007 with a large proportion of these 'managed' hedges turning into lines of trees and relict hedges, due to lack of management.**
- **The length of walls decreased by 1.1% in Great Britain between 1998 and 2007.**

Results from CS in 2007 showed a significant 6.2% 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 CS. 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.

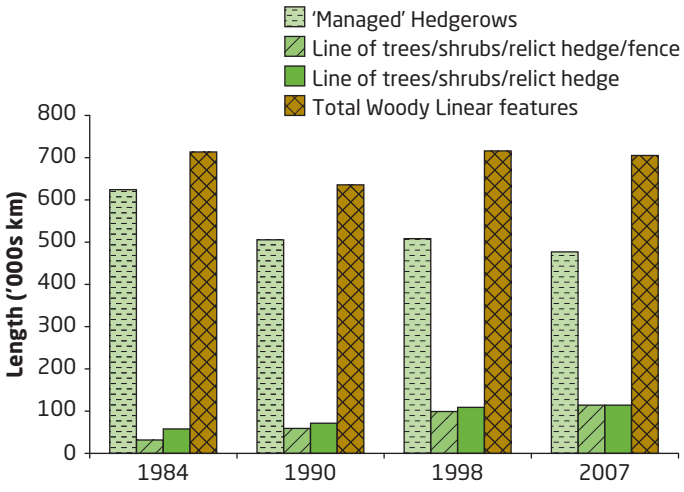
Investigations of the changes between the six different linear feature types for 1998 and 2007 indicate that the vast majority of hedges in 1998 were also hedges in 2007. Changes between woody linear feature types between 1998 and 2007 were quite limited. About 5% of 'managed' hedges moved into either of the 'line of trees/shrubs, relict hedge (+ /- fence)' categories. The only other shifts between feature types which exceeded 1% were movements between the 'line of trees/shrubs, relict hedge (+/- fence)' categories dependent on the addition or removal of fences.

Regularly managed, stock-proof hedges have declined in Great Britain from 1984 through to 2007, but with a period of stability between 1990 and 1998. From 1990 onwards the decrease in 'managed' hedgerows has been predominantly through conversion to 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)*.

▼ **Table 5.2:** The length and standard error ('000s km) and change in length of Boundary and Linear Features in Great Britain, from 1984 to 2007. Arrows denote significant change ($p<0.05$) in the direction shown.

	Country	1984		1990		1998		2007		Direction of significant shanges		
		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[4]	GB	710	26.0	631	21.3	712	22.6	700	22.3	↓	↑	↓
	Scotland	38	5.6	42	5.3	49	5.9	46	5.5	↓	↑	↓
	England	565	22.8	497	19.0	555	20.4	547	20.1	↓	↑	↓
	Wales	107	11.4	91	7.6	107	8.0	106	7.9		↑	
Hedges	GB	624	23.3	506	19.1	508	19.2	477	18.3	↓		↓
	Scotland	28	5.1	21	4.1	23	4.3	21	4	↓	.	↓
	England	511	20.7	426	17.9	428	17.8	402	17	↓		↓
	Wales	86	10.3	58	6	57	6	54	5.6	↓		↓
Line of trees/ shrubs/relict hedge/fence	GB	32	4.4	59	4.3	99	5	114	6.2	↑	↑	↑
	Scotland	6	1.3	9	1.3	12	1.8	12	1.8	↑	↑	
	England	19	2.6	33	2.9	60	4	72	5.3	↑	↑	↑
	Wales	7	3.2	17	2.7	27	2.4	30	2.5	↑	↑	↑
Line of trees/ shrubs/relict hedge	GB	58	6.6	71	4.7	109	4.6	114	5		↑	↑
	Scotland	5	1	12	1.7	14	1.7	13	1.6	↑		
	England	43	6.3	47	3.9	76	4	82	4.4		↑	↑
	Wales	10	1.7	12	1.7	19	1.9	19	1.8	↑	↑	
Wall	GB	198	17.8	173	14.9	176	15	174	14.9	↓		↓
	Scotland	79	10	80	9.8	80	9.6	79	9.5			↓
	England	98	13.2	81	11.4	82	11.6	82	11.6	↓		↓
	Wales	22	8.2	12	2.4	14	2.8	14	2.8			
Bank/grass strip	GB	56	6.7	57	6.7	62	5.7	64	5.8			
	Scotland	15	3.9	3	0.8	6	1.1	6	1.1	↓	↑	
	England	25	4.4	35	5.5	40	5.3	42	5.5		↑	↑
	Wales	16	3.2	19	3.6	16	1.8	16	1.7			
Fence	GB	571	24.7	644	25.5	653	23.4	664	23.6	↑		↑
	Scotland	208	18.5	224	18.6	232	18.5	227	18.3	↑		↓
	England	309	14.1	348	16.3	347	14.1	363	14.6	↑		↑
	Wales	53	9	72	4.4	74	4.3	74	4.5	↑		

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



The length of walls decreased in Great Britain between 1998 and 2007 by a small (1.1%) but significant amount *(Table 5.2)*. 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. Further analysis of the situations in which walls were lost, and more detailed assessment of changes in condition, will be undertaken within the CS country-level reports.

Results from Northern Ireland (to be reported in full at a later date) indicate little overall net change in total field boundary length, the total field boundary estimate for 2007 at 226,000km was very close to a re-estimate for 1998. The stability of the overall figure masks small changes, there was a 4% increase in boundaries in the uplands and a 1.5% decrease in the lowlands.

[4] **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.

5.4 The condition of vegetation in Boundaries and beside Linear Features

- **Following significant decreases in plant species richness alongside hedges between 1978, 1990 and 1998, no change was detected in Great Britain between 1998 and 2007. More competitive 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 alongside roads in Great Britain between 1998 and 2007, although there was an overall decline of 6.5% between 1978 and 2007. Species of open ground decreased while competitive species increased in Great Britain between 1998 and 2007, continuing the trend from 1978.**
- **Species richness in vegetation associated with landscape boundaries in Great Britain decreased by 4.0% between 1998 and 2007 and by 14.6% between 1978 and 2007.**
- **Woody species increased in vegetation associated with landscape boundaries by 14.0% between 1998 and 2007 and by nearly 80% in Great Britain between 1978 and 2007.**
- **Roadside vegetation became more shaded, wetter and characteristic of less acidic conditions in Great Britain, between 1978 and 2007.**

5.4.1 Condition of vegetation in linear features

Species richness: There was a 4.0% decrease in plant species richness of all linear plots across Great Britain between 1998 and 2007. Over the longer term, a significant decrease of 14.6% (19.9 to 17.0 species per plot) was recorded, across Great Britain within all Linear Plots (excluding Hedge Plots) between 1978 and 2007 *(Fig. 5.2)*. A decrease occurred in all Aggregate Classes (ACs) represented within these plot types between 1978 and 2007, except for the Crops and Weeds AC where there was an increase. In the Fertile Grassland and Heath and Bog ACs there was no detectable change *(Table 5.3)*.

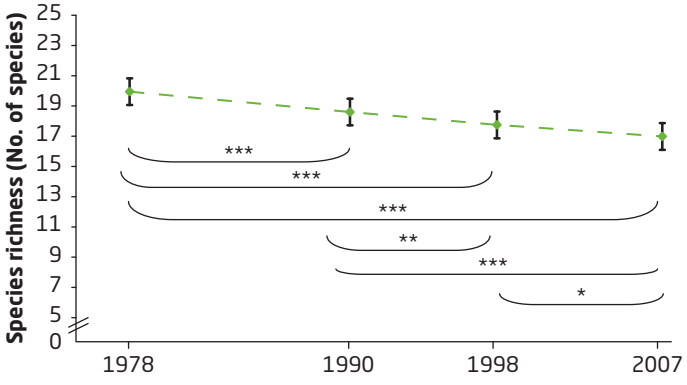
There was no detectable change in species richness in linear plots in Great Britain between 1998 and 2007, for most ACs *(Table 5.3)*. The Moorland Grass Mosaic AC was the exception as there was a 14.5% decrease in the Species Richness Score.

In a further analysis the mean number of woody species recorded per linear plot was investigated. Across all linear plot types recorded since 1978 across Great Britain, the cover of woody species increased significantly from a mean of 6% in 1978 to 23% in 2007.

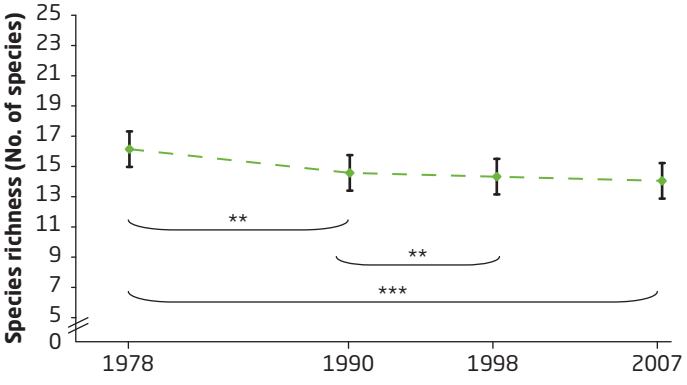
5.4.2 Condition of vegetation in Hedge Plots

Species richness: There were no significant changes in plant species richness in Hedge Plots in Great Britain between 1998 and 2007 but there was a significant decrease in Scotland during this period. Over the longer term (1978 to 2007) there was a decrease in plant species richness from 16.1 in 1978 to 14.0 in 2007 across all Aggregate Classes, in Great Britain *(Fig. 5.3)*. This longer term decrease was significant in England, but not in Scotland or Wales.

▼ **Figure 5.2:** Change in plant species richness of all linear plots alongside a random sample of feature types (hedges, roads and streamsides) across Great Britain between 1978 and 2007. Significant changes (* p<0.05, ** p<0.01, *** p<0.001) are shown between the dates bracketed. 95% CI are shown for each data point.



▼ **Figure 5.3:** The change in species richness in 10m x 1m Hedge Plots across Great Britain between 1978 and 2007. Significant changes (* p<0.05, ** p<0.01, *** 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 Great Britain between 1998 and 2007. Arrows denote significant change ($p<0.05$) in the direction shown. Grey cells with diagonal strikethrough indicate that insufficient data were available for analysis.

	Mean values (GB)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1978 - 1990				Direction of significant changes 1978 - 2007			
Aggregate Class	**1998**	**2007**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**
All Classes	17.7	17.0	↓		↓		↓	↓			↓		↓	↓	↓	↓	↓	↓
Crops and weeds	14.3	16.5									↑	↑			↑			
Tall grass and herb	15.1	14.8					↓	↓							↓	↓	↓	
Fertile grassland	16.3	16.4					↓	↓				↑	↓				↓	
Infertile grassland	19.7	18.4		↑	↓			↓			↓	↓	↓	↓	↓		↓	
Woodland (upland & lowland)	15.3	15.2									↓		↓	↓	↓		↓	↓
Moorland grass mosaic	22.2	18.9	↓	↓	↓			↑			↓		↓		↓		↓	
Heath & Bog	21.3	19.7																

▼ **Table 5.4:** Changes in the characteristics of vegetation in 10m x 1m Hedge Plots across Great Britain between 1978 and 2007. Mean values for 1998 and 2007 are presented; those for 1978 and 1990 are available in ***Annex 7***, www.countrysidesurvey.co.uk. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3***.

	Mean values (GB)		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**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**
Species Richness (No. of Species)	14.3	14.0			↓						↓	↓			↓	↓		
No. of Bird Food Species	7.3	7.6			↓						↓	↓			↓			
No. of Butterfly Food Species	6.3	6.4		↑	↓			↓			↓	↓		↓	↓	↓		↓
Grass:Forb Ratio	0.05	-0.32	↓		↓	↓									↓	↓	↓	↓
Competitor Score	3.27	3.32									↑	↑		↓	↑	↑		
Stress Tolerator Score	1.96	2.00		↑							↓	↓		↑				
Ruderal Score	2.17	2.07	↓	↓											↓	↓		
Light Score	6.28	6.21	↓		↓										↓	↓		
Fertility Score	6.27	6.29									↑	↑			↑	↑		
Ellenberg pH Score	6.57	6.58									↑	↑			↑	↑		
Moisture Score	5.37	5.38					↑	↑			↓	↓						

Hedgerow vegetation became more dominated by grass species between 1998 and 2007 *(Table 5.4)*. There was no change in the number of plant species used for food by farmland birds or butterfly caterpillars across Great Britain between 1998 and 2007, but there was a decrease in Scotland. There was also a decrease in these species between 1978 and 2007 *(Table 5.4)*.

Other vegetation characteristics: Ruderal species decreased in Hedge Plots in Great Britain between 1998 and 2007. During the period 1978 to 2007 competitive species became significantly more prominent, at the expense of stress tolerating and ruderal species. Over the period 1978 to 2007 Hedge Plots also became more shaded across Great Britain demonstrated by the significant decrease in the mean Light Score *(Table 5.4)*. There were significant increases in the mean Fertility Score and Ellenberg pH Score.

5.4.3 Condition of vegetation in Roadside Plots

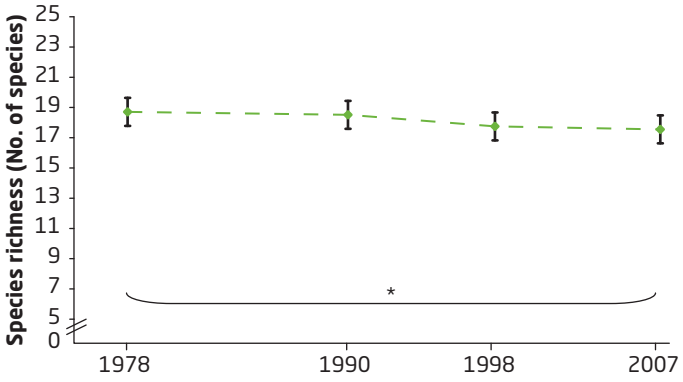
Species Richness: There was no change in plant species richness in Roadside Plots in Great Britain between 1998 and 2007, but there was a 6.5% decrease from 18.7 to 17.5 species per plot between 1978 and 2007 *(Fig. 5.4, Table 5.5)*.

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)*. The number of species used as food plants by farmland birds and butterflies remained stable between 1998 and 2007, but decreased significantly in Roadside Plots across Great Britain between 1978 and 2007.

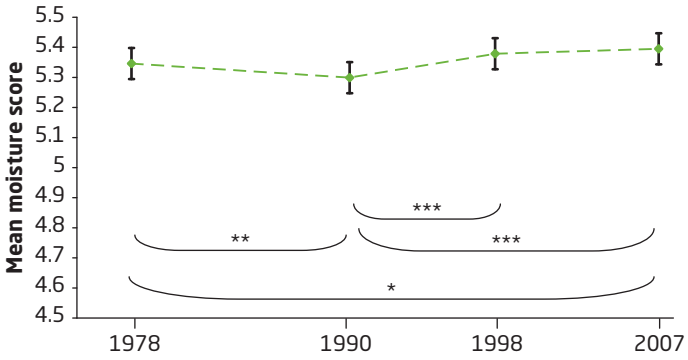
▼ **Table 5.5:** Changes in the characteristics of vegetation in 10m x 1m Roadside Plots across Great Britain between 1978 and 2007. Mean values for 1998 and 2007 are presented; those for 1978 and 1990 are available in ***Annex 7***. Arrows denote significant change (p<0.05) in the direction shown. Analyses are described in ***Box 1.3***.

	Mean values (GB)		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**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**
Species Richness (No. of Species)	17.7	17.5						↓				↑	↓		↓		↓	
No. of Bird Food Species	8.3	8.2			↓			↓				↑	↓		↓		↓	
No. of Butterfly Food Species	7.9	7.8						↓			↓		↓		↓		↓	↓
Grass:Forb Ratio	0.97	0.93										↓		↑	↓	↓		
Competitor Score	2.85	2.86					↑		↑								↑	
Stress Tolerator Score	1.98	2.04	↑	↑			↓		↓			↓						
Ruderal Score	2.87	2.81	↓	↓											↓			
Light Score	6.85	6.76	↓	↓		↓	↑		↑		↓		↓		↓	↓		↓
Fertility Score	5.74	5.71									↑	↑						
Ellenberg pH Score	6.17	6.16						↓		↑	↑	↑			↑	↑		
Moisture Score	5.38	5.40					↑	↑	↑	↑	↓	↓			↑		↑	↑

▼ **Figure 5.4:** The change in species richness in 10m x 1m Roadside Plots across Great Britain between 1978 and 2007. Significant changes (* p<0.05) are shown between the dates bracketed. 95% CI are shown for each data point.



▼ **Figure 5.5:** The change in the Moisture Score in 10m x 1m Roadside Plots across Great Britain between 1978 and 2007. Significant changes (* p<0.05, ** p<0.01, *** p<0.001) are shown between the dates bracketed. 95% CI are shown for each data point.



Other characteristics: 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 decrease in ruderal species is also shown in the results for 1978 to 2007.

There was a significant decrease in the mean Light Score in Roadside Plots across Great Britain 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 Great Britain between 1978 and 2007. There was also a significant increase in the Moisture Score between 1978 and 2007, despite a significant decrease between 1978 and 1990 *(Fig. 5.5)*.

▲ Road verge, Scotland • © *NERC*

▲ Linear boundaries, England • © *NERC*

5.5 Condition of Boundary and Linear Features

- **There were on average 3.7 woody species per 30m section of hedge in Great Britain in 2007, with no detectable change between 1998 and 2007.**
- **48% of 'managed' hedges were in good structural condition in Great Britain in 2007.**
- **31% of 'managed' hedges were in good structural condition and had appropriately managed margins in Great Britain in 2007. Only 10% of 'managed' hedges on arable land were in both good structural condition and had appropriately managed margins in Great Britain in 2007.**
- **There was no change in the structural condition of walls in Great Britain between 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 across Great Britain between 1998 and 2007 (see further information at *www.countrysidesurvey.org.uk*). There was a slight increase in the mean number of species in Scotland which is probably due to planting of new 'species rich' hedges under agri-environment schemes, and a number of Hedge Diversity Plots in Scotland were placed on new hedges. Hedge Diversity Plots were not recorded before 1998.

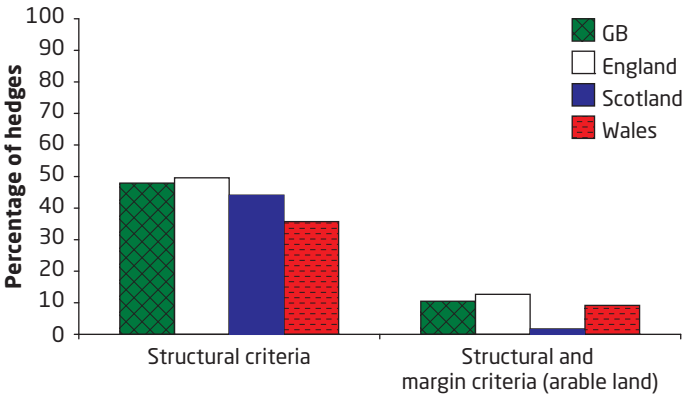
5.5.2 Structural condition of hedgerows

Nearly half (48%) of the 'managed' hedges in Great Britain, which comprised 68% 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, 31% of hedgerows would then meet the condition criteria. A further criterion is the width of perennial vegetation at the base of the hedge, which should be greater than 1m. Applying all criteria, only about 10% of 'managed' hedges on arable land were in overall good condition *(Fig.5.6)*.

▼ **Table 5.6:** The structural and margin condition criteria used by Countryside Survey surveyors 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 1m
Vertical gappiness <10%	
No gaps >5m	
Non-native species at >10% cover	
Height of base of canopy <0.5m	

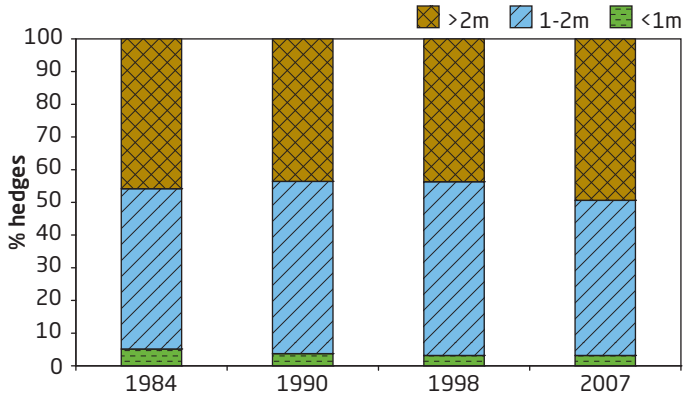
▼ **Figure 5.6:** The percentage of 30m long Hedgerow Diversity Plots in 'managed' hedges in Great Britain, England, Scotland and Wales, in which 'managed' hedges meet condition criteria.



5.5.3 Hedgerow height and management

The majority of condition measures were only collected consistently by CS in 2007. In previous CS, some of the codes for condition were used by surveyors optionally whereas in 2007 they became mandatory fields imposed by the digital data recording methodology. However, for a limited number of condition criteria sufficient data are available to make a longer term assessment. There was a significant increase in the number of hedges greater than 2m high across Great Britain between 1998 and 2007 *(Fig. 5.7)*. Management practices remained consistent between 1998 and 2007, with the majority of hedges (around 60%) cut with a flail or saw.

▼ **Figure 5.7:** The changes in the percentage of length of hedgerows in different height categories across Great Britain between 1984 and 2007. The increase in the percentage of hedgerows >2m between 1998 and 2007 was statistically significant at $p<0.05$.



5.5.4 Structural condition of walls

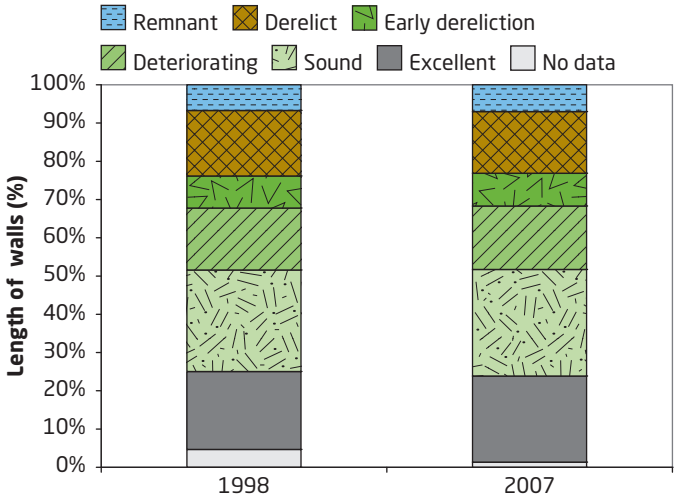
50.3% of the length of walls was in either excellent or sound condition in Great Britain in 2007. Wall condition was stable over time with proportions of the total length of walls in the various condition categories remaining approximately the same across Great Britain between 1998 and 2007 *(Fig. 5.8)*.

5.5.5 Lines of trees, individual trees

Where trees taking their natural shape were recorded as a woody linear feature they were recorded in CS as lines of trees/shrubs or relict hedges (where they showed signs of historic management). In most cases these features represented former hedgerows which were no longer managed as hedges. Some may also have represented planted avenues of trees. Individual trees were recorded in 2007, as they have been previously in CS.

▲ Relict hedge, England • © *Lisa Norton*

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



5.6 Discussion and conclusions

The results of the CS in 2007 indicate that despite a halt in the loss of 'managed' hedgerows between 1990 and 1998, the overall trend for the period 1984 to 2007 was a steady decrease in these features. Whereas between 1984 and 1990 this loss was largely due to the removal of features, subsequent losses appear to be due to reduced management and deterioration to become other woody linear feature types such as relict hedges and lines of trees and shrubs. Hedges that are continuing to be managed appear to be stable or improving in condition in terms of the woody components, suggesting that advice and incentives through agri-environment schemes are being effective for these hedges. However, many 'managed' hedgerows still failed to meet the condition criteria applied.

'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 negligible value for wildlife as well as for the farmer.

The condition of the vegetation associated with hedge bottoms and roadsides showed a long-term deterioration with a decline in species diversity and an increase in taller and more competitive species; but this deterioration was slowed or halted between 1998 and 2007. The condition of walls did not change detectably between 1998 and 2007.

The Boundary and Linear Features Broad Habitat is likely to show change between surveys at any scale, because of the management changes that occur through time. The period between 1998 and 2007 has shown changes consistent with a relaxation of management regimes.

▲ Hedge and fence, England • © *Andrew Stott*

Countryside Survey

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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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▲ Oak trees in broadleaved woodland, England • © *Sue Wallis*

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

Summary

- There was an increase of 6.9% in the area of Broadleaved Woodland in the UK between 1998 and 2007 and a 4.7% increase in Great Britain between 1990 and 2007.
- There was no detectable change in the area of Coniferous Woodland in the UK, but there was a decrease of 7.2% in Scotland between 1998 and 2007.
- No change was detected in species richness in Broadleaved Woodland in Great Britain between 1998 and 2007, but there was a longer term decrease of 9.3% between 1990 and 2007.
- Soil (0-15cm) pH increased in Broadleaved Woodland in Great Britain between 1998 and 2007, continuing the trend from 1978. No change in soil (0-15cm) pH in Coniferous Woodland was observed between 1978 and 2007.
- Soil (0-15cm) carbon concentration remained stable in Broadleaved Woodland but decreased in Coniferous Woodland in Great Britain between 1998 and 2007.

▲ Wooded hillside, England • © *Lisa Norton*

6.1 Introduction[1]

In Countryside Survey (CS), woodland is defined as 'having over 25% canopy cover of trees and shrubs, over a metre high'. Two woodland Broad Habitats include 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**)*.

6.2 Woodland habitats

Two main Broad Habitat types distinguish woodland types in the UK: Broadleaved, Mixed and Yew Woodland (henceforth referred to as Broadleaved Woodland); and Coniferous Woodland which may be native, as in the Scots Pine forests of the Scottish Highlands or may be commercially planted non-native species (and a small area of planted Scots Pine). The woodland Broad Habitats also include a number of Priority Habitats, which are more restricted in their distribution, and only the more widespread are effectively sampled by CS. These Priority Habitats are defined by the species cover and composition of the woodland canopy *(see **Chapter 1**)*. CS provides some limited information on Lowland Mixed Deciduous Woodland, Wet Woodland, Upland Mixed Ash Woodland and Upland Oak Woodland Priority Habitats.

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. In commercial woodland there will also be clear-felled areas awaiting replanting and areas of natural regeneration, typically along the forest edges where a more natural structure is being encouraged. 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.

Since the creation of the Forestry Commission just after the First World War, there have been several national strategies for woodlands in the UK. The most recent strategies published are: the Defra publication (2007) *"A Strategy for England's Trees, Woods and Forests"*; the Scottish Government publication (2006) *"The Scottish Forestry Strategy"*, the Welsh Assembly Government's publication (2001) *"Woodlands for Wales"* and *"Northern Ireland Forestry – A Strategy for Sustainability and Growth"* (2006).

Consistent with the visions within these documents, the last two decades have seen an increasing willingness to plant new deciduous woodlands on farmland and in old industrial areas; and to replace felled conifers with broadleaved native trees.

In addition, the UK Biodiversity Action Plan (UK BAP, first published in 1998) provides a plan for the conservation and restoration of Broadleaved Woodlands. This has been implemented through at least 52 Local Biodiversity Action Plans *(www.ukbap.org.uk)*, which include actions to meet the specific targets for the woodland Priority Habitats.

6.3 Area of woodlands

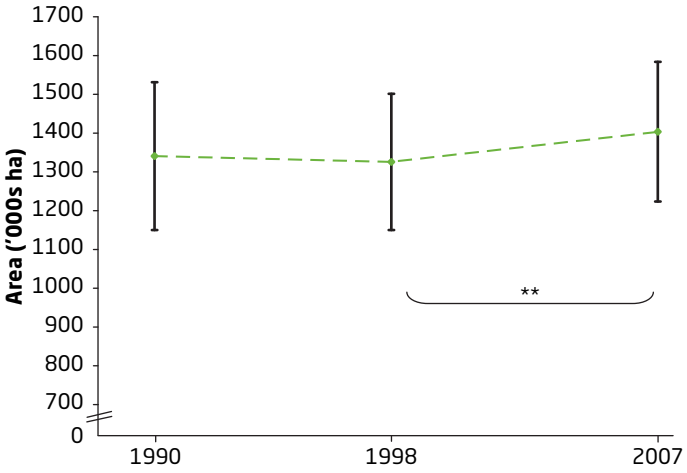
- **There was an increase of 6.9% in the area of Broadleaved Woodland in the UK between 1998 and 2007 and a 4.7% increase in Great Britain between 1990 and 2007.**
- **There was no detectable change in the area of Coniferous Woodland in the UK, but there was a decrease of 7.2% in Scotland between 1998 and 2007.**

6.3.1 Broadleaved, Mixed and Yew Woodland

Broadleaved Woodland covered 1.5 million ha and made up 6.0% by area of the UK in 2007 *(**Table 6.1**)*.

The area of Broadleaved Woodland increased significantly by 6.9% in the UK, between 1998 and 2007, an estimated extra 93,000 ha. A decrease of 15,000 ha in the area of Broadleaved Woodland was recorded in Great Britain between 1990 and 1998 *(**Table 6.1, Fig 6.1**)* so that overall the change between 1990 and 2007 was an increase of 4.7%.

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



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

▼ **Table 6.1:** Estimates of the area ('000s ha) and percentage of land area of Broadleaved, Mixed and Yew Woodland in the UK from 1998 to 2007 and Great Britain from 1984 to 2007 are shown. 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 and more especially 1984 are not in all cases directly comparable with later surveys. Data not available = na.

	1984		1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
GB	1317	5.6	1343	5.8	1328	5.7	1406	6.0	↑
England	na	na	887	6.7	927	7.0	981	7.4	↑
Scotland	na	na	284	3.5	229	2.9	251	3.1	↑
Wales	na	na	173	8.2	172	8.1	174	8.2	
Northern Ireland	na	na	na	na	64	4.5	82	5.8	↑
UK	na	na	na	na	1392	5.6	1488	6.0	

▼ **Table 6.2:** Estimates of the area ('000s ha) and percentage of land area of Coniferous Woodland in the UK from 1998 to 2007 and Great Britain from 1984 to 2007 are shown. 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 and more especially 1984 are not in all cases directly comparable with later surveys. Data not available = na.

	1984		1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
GB	1243	5.3	1239	5.3	1386	5.9	1319	5.7	
England	na	na	241	1.8	260	2.0	257	1.9	
Scotland	na	na	913	11.4	1030	12.9	956	11.9	↓
Wales	na	na	85	4.0	96	4.5	106	5.0	
Northern Ireland	na	na	na	na	62	4.4	61	4.3	
UK	na	na	na	na	1448	5.9	1380	5.6	

6.3.2 *Coniferous Woodland*

Coniferous Woodlands are distributed throughout the UK but predominantly occur in the marginal uplands of Great Britain. In 2007, the estimated area of Coniferous Woodland was 1.4 million ha and covered 5.6% of UK and 12% of Scotland *(Table 6.2)*. Overall, there was no significant change to the area of Coniferous Woodland in the UK between 1998 and 2007 or in Great Britain between 1990 and 2007. However, Coniferous Woodland decreased significantly by 7.2% in Scotland between 1998 and 2007.

6.4 Conversion between Broad Habitats

6.4.1 *Broadleaved, Mixed and Yew Woodland*

Most of the Broadleaved Woodland recorded in 2007 was also recorded as this Broad Habitat in 1998. Those Broadleaved Woodlands recorded for the first time in 2007 were mainly in areas previously recorded as Neutral Grassland, Coniferous Woodland, Improved Grassland, or Arable and Horticulture Broad Habitats. There is necessarily a time-lag in detecting new woodland. The recorded shift to woodlands from Neutral and Improved Grassland Habitats may be because new woodlands planted in the early 1990s have only now (in 2007) reached the 25% canopy cover required to be recorded as woodland by CS.

▲ Woodland ground flora, England • © *Natural England*

6.4.2 *Coniferous Woodland*

Most 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, Acid Grassland or Bog Broad Habitats.

▼ **Table 6.3:** Change in the characteristics of vegetation in 200m² Main Plots in the Broadleaved, Mixed and Yew Woodland Broad Habitat across Great Britain between 1990 and 2007. Mean values for 1998 and 2007 are presented: those for 1990 are available in ***Annex 7***. Arrows denote significant change (p<0.05) in the direction shown. Analyses are described in ***Box 1.3***.

	Mean values (GB)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	1998	2007	GB	E	S	W	GB	E	S	W	GB	E	S	W
Species Richness (No. of Species)	21.2	20.9			↓			↓			↓			↓
No. of Bird Food Species	8.9	9.0			↓									
No. of Butterfly Food Species	7.6	7.7		↑										↓
Grass:Forb Ratio	-0.40	-0.60					↓	↓			↓	↓		
Competitor Score	2.91	2.97	↑		↑						↑	↑		↑
Stress Tolerator Score	2.54	2.53												
Ruderal Score	2.09	2.01	↓		↓		↓	↓			↓	↓	↓	↓
Light Score	6.11	6.10												
Fertility Score	5.05	5.06							↓				↓	
Ellenberg pH Score	5.45	5.47											↓	
Moisture Score	5.60	5.60											↑	

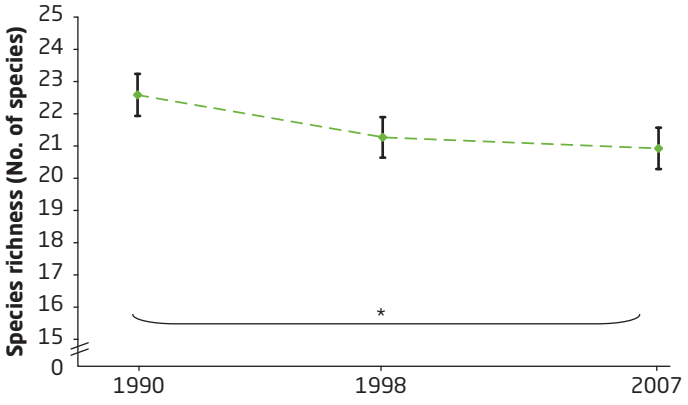
6.5 The condition of woodlands

- **No change was detected in species richness in Broadleaved Woodland in Great Britain between 1998 and 2007, but there was a longer term decrease of 9.3% between 1990 and 2007.**

6.5.1 *Changes in Broadleaved, Mixed and Yew Woodland*

No change in plant species richness of Main Plots in Broadleaved Woodland was detected in Great Britain between 1998 and 2007, but it decreased significantly by 9.3% between 1990 and 2007. The recorded plant Species Richness Score fell from 22.6 to 20.9 species per plot *(Fig. 6.2, Annex 7)*.

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



Five of the top ten plant species increasing in frequency of occurrence in Main Plots in Broadleaved Woodland in Great Britain between 1998 and 2007 were trees, whilst those decreasing in frequency were mostly grasses and other low growing plants. These results indicate that woodland is maturing and the canopy cover is becoming denser *(Table 6.4)*.

▲ Bluebells in broadleaved woodland, England • © *Sue Wallis*

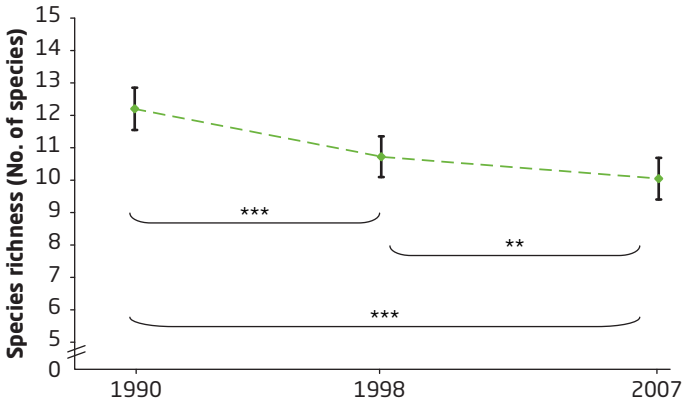
▼ **Table 6.4:** Change in the frequency of 10 most increasing and decreasing plant species in 200m² Main Plots in the Broadleaved, Mixed and Yew Woodland Broad Habitat across Great Britain between 1998 and 2007. *See **Chapter 1** for an explanation of the Change Index.*

Species with increasing frequency		Change Index	Species with decreasing frequency		Change Index
Ilex aquifolium	Holly	0.18	*Agrostis stolonifera*	Creeping Bent	-0.17
Galeopsis tetrahit	Common Hemp-nettle	0.15	*Lolium perenne*	Rye Grass	-0.14
Viola riviniana/reichbechiana	Violet	0.15	*Stachys sylvatica*	Hedge Woundwort	-0.14
Anthriscus sylvestris	Cow Parsley	0.14	*Poa pratensis sens. lat.*	Smooth Meadow -grass	-0.12
Rumex conglomeratus/ sanguineus	Dock	0.14	*Carex pilulifera*	Pill Sedge	-0.12
Cirsium palustre	Marsh Thistle	0.14	*Poa trivialis*	Rough Meadow-grass	-0.11
Fagus sylvatica	Beech	0.14	*Conopodium majus*	Pignut	-0.11
Quercus robur & petraea	Oak	0.13	*Luzula campestris/multiflora*	Woodrush	-0.11
Corylus avellana	Hazel	0.12	*Alopecurus pratensis*	Meadow Foxtail	-0.10
Fraxinus excelsior	Ash	0.12	*Crataegus monogyna*	Hawthorn	-0.10

In addition to the decrease in frequency of grasses and low growing species, the only significant changes in the vegetation characteristics of Main Plots within Broadleaved Woodland between 1998 and 2007 were an increase in competitive species, and the decrease in ruderal species *(Table 6.3)*. This may be a response to increasing canopy cover. Both of these changes were apparent between 1990 and 2007 and over this same timescale, a decrease in the ratio of grasses to forbs was recorded.

Within Broadleaved Woodland small patches of different habitats that are of different conservation value to the wood itself can be found. 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 CS for their botanical interest, and the Targeted Plots described in *Chapter 1* were designed to sample them. The number of species recorded in Targeted Plots within Broadleaved Woodland decreased significantly in Great Britain between 1998 and 2007. This contributed to a long-term decrease of 18% from a mean of 12.2 species to 10.0 species per plot between 1990 and 2007 *(Fig. 6.3)* and includes the reduction in the number of plant species used by butterfly caterpillars as food over the same period, from 4.4 to 3.6 species per plot.

▼ **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 Great Britain between 1990 and 2007. Significant changes (* p<0.05) are shown between the dates bracketed. 95% CI are shown.



6.5.2 Changes in Coniferous Woodland 1990-2007

Few changes in the condition of Coniferous Woodland were recorded, and none within Great Britain as a whole, but in Scotland there was a significant decrease in plant species richness, including the number of plant species used by farmland birds and butterfly caterpillars as food, between 1998 and 2007 *(Table 6.5)*.
The Change Index for species in Coniferous Woodland Main Plots was so small that changes in frequency of plant species can be considered negligible and results are not presented here.

▲ Conifer plantation, Scotland • © *NERC*

▼ **Table 6.5:** Change in the characteristics of vegetation in 200m² Main Plots in the Coniferous Woodland Broad Habitat across Great Britain between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available in ***Annex 7***. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3***.

	Mean values (GB)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	1998	2007	GB	E	S	W	GB	E	S	W	GB	E	S	W
Species Richness (No. of Species)	15.3	14.1			↓									
No. of Bird Food Species	4.7	4.4			↓									
No. of Butterfly Food Species	5.0	4.7			↓									
Grass:Forb Ratio	-0.12	-0.07								↑				
Competitor Score	2.77	2.78												
Stress Tolerator Score	2.97	2.98												
Ruderal Score	1.7	1.69											↓	
Light Score	6.17	6.17												
Fertility Score	3.86	3.84												
Ellenberg pH Score	4.05	4.02												
Moisture Score	6.03	6.07												

6.6 Woodland Priority Habitats

6.6.1 The area of Priority Habitat woodlands

Lowland Mixed Deciduous Woodland: The area of Lowland Mixed Deciduous Woodland was estimated to be approximately 60,000 ha in 2007, distributed between England and Wales. This estimate had a large variance and no change was detected in the area between 1998 and 2007 *(Table 6.6)*. The estimate by CS is considerably lower than that of the latest UK BAP. It is likely that surveyors were unlikely to designate a wood as Priority Habitat in many cases, as the definition used by UK BAP is very broad.

▼ **Table 6.6:** Change in the area ('000s ha) of Lowland Mixed Deciduous Woodland in Great Britain from 1998 to 2007.

Lowland Mixed Deciduous Woodland	1998 Area ('000s ha)	2007 Area ('000s ha)	Direction of significant changes 1998-2007
GB	55	60	
England	37	42	
Scotland	0	0	
Wales	18	19	

Wet Woodland: The area of Wet Woodland was estimated to be approximately 75,000 ha in Great Britain in 2007 *(Table 6.7)*, distributed across all three countries with the greatest amount being in England. The area increased by 22.5% in Great Britain between 1998 and 2007 with a significant increase in all three countries. There are two possible reasons for this increase. There has been an increase in willow saplings that have invaded boggy ground and now have a canopy cover of 50%.

Secondly, there has been an increase in the dry woodland around the edges of mapped wet woodland, that was not large enough to be mapped separately; it was joined (following written protocols) to the wet woodland correctly by surveyors, and therefore classified overall as Wet Woodland.

▼ **Table 6.7:** The area ('000s ha) of Wet Woodland in Great Britain from 1998 to 2007. Arrows denote significant change ($p<0.05$) in the direction shown.

Wet Woodland	1998 Area ('000s ha)	2007 Area ('000s ha)	Direction of significant changes 1998-2007
GB	62	75	↑
England	33	38	↑
Scotland	16	20	↑
Wales	12	18	↑

Upland Mixed Ashwood: The area of Upland Mixed Ashwood Priority Habitat was estimated to be 30,000 ha in GB in 2007 *(Table 6.8)*.

▼ **Table 6.8:** The area ('000s ha) of Upland Mixed Ashwood in Great Britain in 2007.

Upland Mixed Ashwood	2007 Area ('000s ha)
GB	30
England	13
Scotland	13
Wales	4

Upland Oakwood: The area of Upland Oakwood in 2007 was estimated to be 61,000 ha, mostly concentrated in Scotland and Wales *(Table 6.9)*.

▼ **Table 6.9:** The area ('000s ha) of Upland Oakwood in Great Britain from 1998 to 2007.

Upland Oakwood	1998 Area ('000s ha)	2007 Area ('000s ha)	Direction of significant changes 1998-2007
GB	62	61	
England	5	6	
Scotland	33	29	
Wales	24	26	

Upland Birchwood: The Upland Birchwood is by definition restricted to Scotland, so the area estimates for Great Britain and Scotland are the same, 31,000 ha in 2007 *(Table 6.10)*.

▼ **Table 6.10:** The area ('000s ha) of Upland Birchwood in Great Britain in 2007.

Upland Birchwood	2007 Area ('000s ha)
GB	31
England	0
Scotland	31
Wales	0

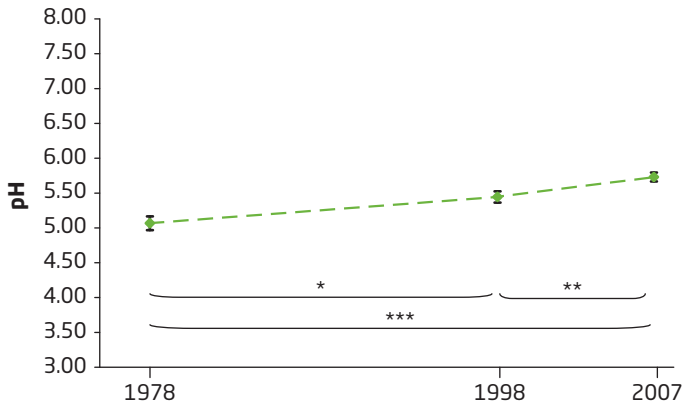
6.7 Changes in woodland soils (0-15cm)

- **Soil (0-15cm) pH increased in Broadleaved Woodland in Great Britain between 1998 and 2007, continuing the trend from 1978. No change in soil (0-15cm) pH in Coniferous Woodland was observed since 1978.**
- **Soil (0-15cm) carbon concentration remained stable in Broadleaved Woodland but decreased in Coniferous Woodland in Great Britain between 1998 and 2007.**

6.7.1 Broadleaved, Mixed and Yew Woodland

Soil (0-15cm) pH: The mean pH of soil (0-15cm) samples in Broadleaved Woodland increased significantly from 5.46 to 5.75 (becoming less acidic) across Great Britain, between 1998 and 2007 *(Table 2.8)*. This is consistent with the trend of significant increases between 1978 and 1998 and over the whole period, 1978 to 2007 *(Fig. 6.4)*. The soil (0-15cm) pH in Broadleaved Woodland samples in England and Wales increased significantly between 1978 and 1998, and between 1978 and 2007. There were no significant changes in Scotland between 1978, 1998 and 2007.

▼ **Figure 6.4:** The change in pH in soils (0-15cm) from Broadleaved, Mixed and Yew Woodland in Great Britain between 1978 and 2007. Significant changes (* 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).



In comparison, the mean Ellenberg pH Score in vegetation sampling plots did not change significantly between 1990 and 2007. This suggests that either there is a time-lag in the response of vegetation to the changing soil pH or that woodland vegetation is not particularly responsive to changes in soil (0-15cm) pH.

Soil (0-15cm) carbon concentration: There was no significant change in the mean carbon concentration of soil (0-15cm) in Main Plots within Broadleaved Woodland in Great Britain between 1998 and 2007 *(Table 2.8)*. Over the longer term, 1978 to 2007, there was a significant increase in soil (0-15cm) carbon concentration. Changes in woodland structure and management and other potential drivers of change in soil (0-15cm) carbon concentration are being investigated as part of the additional analyses of soils in CS, due to be reported in 2009.

Bulk density and soil (0-15cm) carbon stock: The mean bulk density of Broadleaved Woodland soils (0-15cm) in Great Britain was 0.8 g/cm^3. Combined with mean soil (0-15cm) carbon concentration, the estimated soil (0-15cm) carbon stock is 66 t/ha *(Table 2.9)*.

▲ Mixed woodland, Wales • © *NERC*

6.7.2 Coniferous Woodland

Soil (0-15cm) pH: No change in the mean pH of soils (0-15cm) in Coniferous Woodlands was detected in Great Britain between 1978, 1998 and 2007 *(Table 2.8)*.

Soil (0-15cm) carbon concentration: There was a significant decrease in the carbon concentration of soil (0-15cm) in the Coniferous Woodland Broad Habitat for Great Britain between 1998 and 2007, following no significant changes between 1978 and 1998 *(Table 2.8)*.

Bulk density and soil (0-15cm) carbon stock: The mean bulk density of Coniferous Woodland soils (0-15cm) in Great Britain was 0.5 g/cm^3, which when combined with mean soil (0-15cm) carbon concentration indicated a soil (0-15cm) carbon stock of 74 t/ha *(Table 2.9)*.

6.8 Discussion and conclusions

6.8.1 Broadleaved, Mixed and Yew Woodland

Broadleaved Woodland covered an estimated 6.0% of the land area of the UK in 2007, an increase of 6.9% between 1998 and 2007. In Great Britain the area of Broadleaved Woodland has increased by an estimated 4.7% (from 1.3 million ha in 1990 to 1.4 million ha in 2007) *(Table 6.1)*.

The expansion of this woodland between 1998 and 2007 was mainly by net conversion from the Neutral Grassland, Improved Grassland, Coniferous Woodland and Arable and Horticulture 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.

Between 1990 and 2007 plant species richness in Main Plots in Broadleaved Woodland decreased by 7% from an average 21.7 species to 20.4 species. The greatest decrease occurred between 1990 and 1998 and no change was detected between 1998 and 2007. The decrease in species richness was more marked (18%) in the areas targeted by CS for their botanical interest, typically the less widespread habitats within this Broad Habitat type, with a significant decrease in both periods (1990 to 1998 and 1998 to 2007). Such patches of vegetation within a wood can be strongly influenced by shading from the expanding canopy of trees and shrubs. The reduction in species richness in these patches as well as in the Main Plots is entirely consistent with survey work specifically designed to track long-term changes in British deciduous woodlands[2].

Woodland communities have been shifting towards higher forest types, associated with the decrease of shade sensitive species, plant species used by butterfly caterpillars as food and increases in tree and competitive species. The factors which could contribute to these changes include the gradual ageing of trees, reduced thinning and coppicing of woods.

Between 1978 and 2007, soils (0-15cm) in Broadleaved Woodland across Great Britain became significantly less acidic. As woodlands can grow on almost any soil type and in most regions of the country, the increase in acidity reflects the changes across the whole of 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. Further analysis may reveal different trends associated with different soil types and/or in different regions of Great Britain.

6.8.2 Coniferous Woodland

The estimated area of Coniferous Woodland in Great Britain did not change significantly between 1984 and 2007. In 2007, Coniferous Woodland covered an estimated 5.6% of the UK land area. Significant decreases of Coniferous Woodland occurred mostly between 1998 and 2007 in Scotland where Coniferous Woodland was mainly converted or restored to the Neutral Grassland, Acid Grassland and Bog Broad Habitats. Some of this area may be restocked with trees.

Little overall change in the diversity and character of vegetation was detected, apart from a decrease in plant species richness in Scotland between 1998 and 2007 which was probably due to the maturation of young stands and the subsequent closure of the canopy.

There was no shift in pH observed in the soils (0-15cm) in Coniferous Woodland between 1978 and 2007. The vegetation also showed no change in mean Ellenberg pH Score.

6.8.3 Conclusions

The results from CS 2007 show that there was a reduction in the rate of decrease in species richness between 1998 and 2007, although the decrease has continued within areas targeted by CS for their botanical interest.

Drivers of change in woodland habitat condition are known to have increased in intensity, such as deer grazing pressure. Factors such as land-use surrounding the sampled woods, climate change or pollution (sulphur and nitrogen deposition) may also be important. More detailed analysis is required to determine and distinguish the possible roles of the drivers of the changes reported here for the woodlands of Great Britain.

[2] Kirby et al (2005) *Long-term ecological change in British woodland (1971-2001).* English Nature Research report **653**. Peterborough, 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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▲ Surveyor working on heather moorland, Scotland • © *NERC*

7. Mountain, Moor and Heath

Summary

- The area of Bracken Broad Habitat decreased by 17% in the UK between 1998 and 2007.
- The area of Dwarf Shrub Heath, the area of Bog and the area of Fen, Marsh and Swamp Broad Habitats did not change in the UK between 1998 and 2007.
- The area of Dwarf Shrub Heath Broad Habitat in England increased by 15% between 1998 and 2007.
- The habitats of mountain, moor and heath showed relative stability with only small areas changing from one Broad Habitat to another in Great Britain between 1998 and 2007.
- No change was detected in plant species associated with higher nutrient levels (eutrophication) in Bracken, Dwarf Shrub Heath or Fen, Marsh and Swamp Broad Habitats in Great Britain between 1998 and 2007. There was an increase in these species in Dwarf Shrub Heath in England between 1990 and 1998.
- Plant species associated with higher nutrient levels (eutrophication) decreased in the Bog Broad Habitat in Great Britain between 1998 and 2007.
- Plant species preferring wetter conditions increased in the Bracken and Dwarf Shrub Heath Broad Habitats in Great Britain between 1998 and 2007.
- In Dwarf Shrub Heath and Bog Broad Habitats, competitive species and the cover of grass species relative to forbs increased in Great Britain between 1998 and 2007. In Bog especially these changes suggest deterioration in condition. Competitive species also increased in Bracken.
- Plant species richness decreased by 20% in Fen Marsh and Swamp in Great Britain between 1998 and 2007. Competitive plant species increased in relation to ruderal species, suggesting a reduction in disturbance in this Broad Habitat.

- **In Bracken, Dwarf Shrub Heath, Bog and Fen, Marsh and Swamp there was no significant change in soil (0-15cm) pH between 1998 and 2007. However, all four Broad Habitats were less acid in 2007 compared to 1978 due mainly to the changes between 1978 and 1998.**

- **In Bracken, soil (0-15cm) carbon concentration increased across Great Britain between 1998 and 2007; this Broad Habitat had a significantly higher concentration of soil (0-15cm) carbon in 2007 compared to 1978.**

- **In Dwarf Shrub Heath, Bog, and Fen, Marsh and Swamp soils (0-15cm), no change was detected in the carbon concentrations across Great Britain between 1998 and 2007 nor between 1978 and 2007.**

7.1 Introduction[1]

The six Broad Habitats covered in this chapter contribute to the mosaic of open, unenclosed landscapes in the UK that many people associate with 'wilderness' and enjoy as natural, and in some sense, 'unspoilt' mountain, moor and heathland. A large proportion of these Broad Habitats are found in the upland areas of north-west Britain and Northern Ireland, and there are also substantial areas of unenclosed lowland habitats in the south of England, such as the New Forest, Dartmoor, Exmoor, Ashdown Forest and the Norfolk Breckland. Many of these areas are also designated as National Parks, Areas of Outstanding Natural Beauty or Sites/Areas of Special Scientific Interest.

Several pressures particularly affect unenclosed, upland areas and some of these pressures have changed in their prevalence and intensity since the first Countryside Survey (CS) in 1978. 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, 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.

Land use pressures have changed direction since the last CS in 1998. Since then, 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, especially in England and Wales (see *Chapter 6*).

▲ Heather, England • © *NERC*

Rotational heather burning is used as a management tool to encourage grass 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 the frequency of managed burning has steadily increased in the English uplands, but recent trends elsewhere are uncertain. In contrast to sheep and cattle grazing intensity, deer grazing has increased, especially in Scotland.

Pollution and atmospheric deposition of sulphur and nitrogen also can affect upland habitats by changing the acidity and nutrient status of soils, which can have effects on the vegetation. Emissions of sulphur dioxide causing 'acid rain' have decreased substantially since the 1970s, with a consequent reduction in the amount of upland habitat in the UK exposed to potentially harmful levels of deposition. Deposition of nitrogen has remained stable since records began in 1986.

Other important policy changes in England and Wales 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 and Wales. The period from 1998 to 2007 also coincided with the gradual implementation of the UK Biodiversity Action Plan (UK BAP). This includes specific targets for the restoration and maintenance of scarce and internationally important Priority Habitats embedded within the mountain, moor and heath landscape.

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

▼ **Table 7.1:** Estimated area ('000s ha) and percentage of land area of the Bracken Broad Habitat in the UK from 1998 to 2007 and in Great Britain from 1984 to 2007 are shown. Arrows denote significant change ($p<0.05$) in the direction shown. Data not available = na.

	1984		1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
GB	439	1.9	272	1.2	315	1.3	260	1.1	↓
England	na	na	93	0.7	109	0.8	91	0.7	
Scotland	na	na	107	1.3	121	1.5	132	1.6	
Wales	na	na	71	3.5	84	4.0	37	1.8	↓
Northern Ireland	na	na	na	na	3	0.2	3	0.2	
UK	na	na	na	na	318	1.3	263	1.1	

The changes that have occurred in unenclosed landscapes will have affected different species in different ways. Many of these species 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 upland landscapes.

7.2 Description of the Broad Habitats

The six 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 the UK. 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*). Heaths dominated by Western Gorse (*Ulex gallii*) occur mostly in south-west England, south-west Wales and Northern Ireland. 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 rainfall 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. Blanket Bog is one of the Priority Habitats that has been studied in more detail for this report. The UK BAP includes targets to maintain the area and condition of Blanket Bog. Lowland Raised Bog is a much rarer Priority Habitat that is included in this Broad Habitat, but there are insufficient samples for CS to report specifically on this Priority Habitat.

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.

Inland Rock: where it occurs naturally, is very much a feature of the true uplands and includes the Limestone Pavement Priority Habitat (although this is also found at lower altitudes). Inland Rock Broad Habitat is also found in man-made situations such as quarries.

Montane: this Broad Habitat covers a very small area of the UK, almost entirely confined to Scotland. CS can report on the extent of this Broad Habitat, but does not have sufficient samples to report on changes in condition.

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

▲ Montane landscape, Scotland • © *NERC*

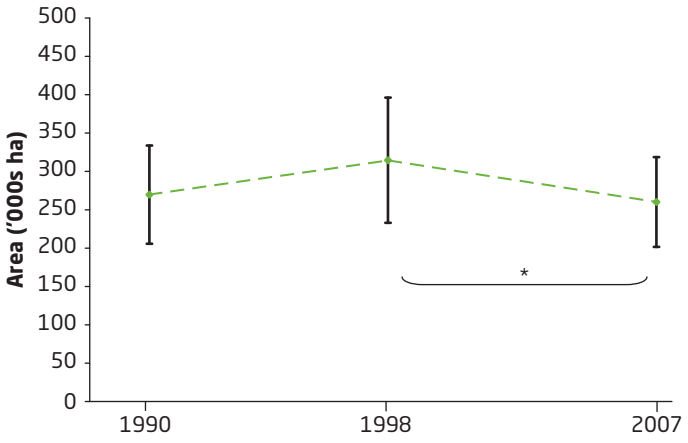
7.3 Changes in the area of mountain, moor and heath Broad Habitats

- **The area of Bracken Broad Habitat decreased by 17% in the UK between 1998 and 2007.**
- **The area of Dwarf Shrub Heath, the area of Bog and the area of Fen, Marsh and Swamp Broad Habitats did not change in the UK between 1998 and 2007.**
- **The area of Dwarf Shrub Heath Broad Habitat in England increased by 15% between 1998 and 2007.**

7.3.1 Bracken

The estimated area of the Bracken Broad Habitat in the UK in 2007 was approximately 263,000 ha, which represents 1.1% of the land area *(see Table 7.1)*. The area of Bracken decreased by approximately 17% in the UK between 1998 and 2007. Most of this decrease occurred in Wales (see *section 7.5.1*). The reduction in area of Bracken in Great Britain between 1998 and 2007 reversed an increasing trend that was reported between 1990 and 1998. This is a variable habitat, and the density of bracken cover determines whether an area is recorded as Bracken Broad Habitat; consequently the area estimates can be affected by small changes in bracken cover between Countryside Surveys *(Fig. 7.1)*.

▼ **Figure 7.1:** Change in the area of the Bracken Broad Habitat between 1990 and 2007 in Great Britain. Significant changes (* p<0.05) are shown between the dates bracketed. 95% CI are shown for each data point.



7.3.2 Dwarf Shrub Heath

The estimated area of Dwarf Shrub Heath Broad Habitat in the UK in 2007 was approximately 1.4 million ha which represents 5.5% of the land area *(Table 7.2)*. Dwarf Shrub Heath covers approximately 11.1% of Scotland, 5.5% of Wales, 2.5% of England and 1.2% of Northern Ireland. No changes were detected in the UK between 1998 and 2007. In England there was a 15% increase in area between 1998 and 2007.

7.3.3 Bog

The estimated area of Bog Broad Habitat in the UK in 2007 was approximately 2.4 million ha, which represents 9.7% of the land area *(Table 7.3)*. The majority of Bog is found in Scotland where it makes up 25.6% of the land area. The estimated proportion of land area covered by Bog Broad Habitat in Northern Ireland was 11.4%, in England it was 1.1% and in Wales 2.3%. There was no detectable change in the estimated area of Bog in the UK or Great Britain between 1998 and 2007.

7.3.4 Fen, Marsh and Swamp

The estimated area of Fen, Marsh and Swamp Broad Habitat in the UK in 2007 was approximately 0.4 million ha, which represents 1.8% of the land area. There was no detectable change in the area of Fen, Marsh and Swamp in the UK between 1998 and 2007. This Broad Habitat covers a greater proportion of the land area in Northern Ireland (3.3%) and Scotland (3.0%) than in Wales (1.7%) or England (0.9%) *(see Table 7.4)*.

7.3.5 Montane and Inland Rock

The area of Montane Broad Habitat in the UK in 2007 was estimated at 42,000 ha which represents 0.2% of the land area. There were no detectable changes in area between 1984 and 2007 *(Table 2.1)*.

The area of Inland Rock Broad Habitat in the UK in 2007 was estimated at 89,000 ha which represents 0.4% of the land area.

7.4 Conversion between Broad Habitats

- **The habitats of mountain, moor and heath showed relative stability with only small areas changing from one Broad Habitat to another in Great Britain between 1998 and 2007.**

7.4.1 Bracken

Areas of Bracken were both lost to, and gained from, other Broad Habitats between 1998 and 2007. There were net flows to Bracken from Acid Grassland and Dwarf Shrub Heath between 1998 and 2007. There were also smaller flows from Broadleaved and Coniferous Woodland to Bracken (see *Annex 6 at www.countrysidesurvey.org.uk*). These gains were more than compensated for by losses of Bracken to Acid Grassland and Dwarf Shrub Heath, and to a lesser extent to Broadleaved, Mixed and Yew Woodland and also to Coniferous Woodland.

7.4.2 Dwarf Shrub Heath

Areas of Dwarf Shrub Heath were relatively stable between 1998 and 2007 with some small flows to and from Acid Grassland and Bracken Broad Habitats.

▼ **Table 7.2:** Estimated area ('000s ha) and percentage of land area of Dwarf Shrub Heath Broad Habitat in the UK from 1998 to 2007 and in Great Britain from 1984 to 2007 are shown. 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 and more especially 1984 are not in all cases directly comparable with later Surveys. Data not available = na.

	1984		1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
GB	1388	6.0	1436	6.2	1299	5.6	1343	5.8	
England	na	na	309	2.3	288	2.2	331	2.5	↑
Scotland	na	na	1007	12.6	912	11.4	894	11.1	
Wales	na	na	120	5.7	99	4.7	117	5.5	
Northern Ireland	na	na	na	na	14	1.0	17	1.2	
UK	na	na	na	na	1313	5.3	1360	5.5	

▼ **Table 7.3:** Estimates of the area ('000s ha) and percentage of land area of Bog Broad Habitat in the UK from 1998 to 2007 and in Great Britain from 1984 to 2007 are shown. 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 and more especially 1984 are not in all cases directly comparable with later surveys. Data not available = na.

	1984		1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
GB	2303	9.9	2050	8.8	2222	9.6	2232	9.6	
England	na	na	98	0.7	138	1.0	140	1.1	
Scotland	na	na	1922	24.0	2039	25.5	2044	25.6	
Wales	na	na	30	1.4	45	2.1	48	2.3	
Northern Ireland	na	na	na	na	164	11.6	161	11.4	
UK	na	na	na	na	2386	9.6	2393	9.7	

▼ **Table 7.4:** Estimated area ('000s ha) and percentage of land area of Fen, Marsh and Swamp Broad Habitat in the UK from 1998 to 2007 and in Great Britain from 1984 to 2007 are shown. 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 and more especially 1984 are not in all cases directly comparable with later Surveys. Data not available = na.

	1984		1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
GB	428	1.8	427	1.8	425	1.8	392	1.7	
England	na	na	78	0.6	124	0.9	118	0.9	
Scotland	na	na	289	3.6	261	3.3	239	3.0	
Wales	na	na	60	2.8	40	1.9	36	1.7	
Northern Ireland	na	na	na	na	53	3.7	47	3.3	
UK	na	na	na	na	479	1.9	439	1.8	

7.4.3 Bog

Differences in the estimates of area of the Bog Broad Habitat between 1984 and 1998 relate to changes in definitions used. Some Bog became Acid Grassland and some Coniferous Woodland became Bog after felling *(**Annex 6**)*.

7.4.4 Fen, Marsh and Swamp

Changes of Fen, Marsh and Swamp to Acid and Neutral Grassland 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 *(**Annex 6**)*. These flows reflect real change as well as some randomly distributed mapping and allocation errors.

7.5 Changes in vegetation of the mountain, moor and heath Broad Habitats

- **No change was detected in plant species associated with higher nutrient levels (eutrophication) in Bracken, Dwarf Shrub Heath or Fen, Marsh and Swamp Broad Habitats in Great Britain, between 1998 and 2007, but there was an increase in these species in Dwarf Shrub Heath in England between 1990 and 1998.**
- **Plant species associated with higher nutrient levels (eutrophication) decreased in the Bog Broad Habitat in Great Britain between 1998 and 2007.**
- **Plant species preferring wetter conditions increased in the Bracken and Dwarf Shrub Heath Broad Habitats in Great Britain between 1998 and 2007.**
- **In Dwarf Shrub Heath and Bog Broad Habitats, competitive species and the cover of grass species relative to forbs increased in Great Britain between 1998 and 2007. In Bog especially these changes suggest a deterioration in condition. Competitive species also increased in Bracken.**
- **Plant species richness decreased by 20% in Fen Marsh and Swamp Broad Habitat in Great Britain between 1998 and 2007. Competitive plant species increased in relation to ruderal species, suggesting a reduction in disturbance in this habitat.**

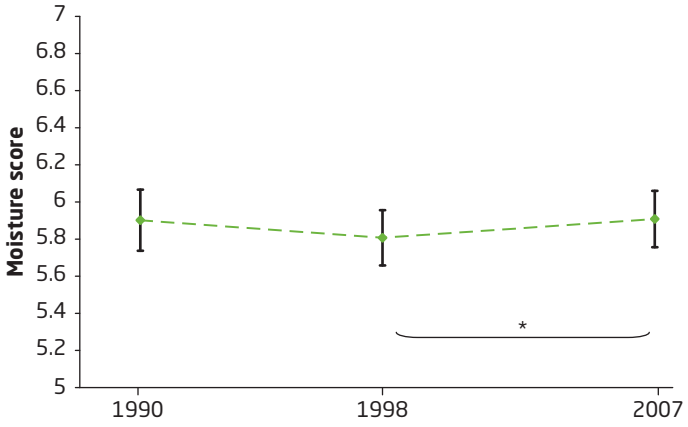
7.5.1 Changes in the condition of Bracken Broad Habitat

There have been few changes in the Species Richness Score of 200m² Main Plots in Bracken across Great Britain, in the period 1990 to 2007. There was an increase in species richness in Wales between 1998 and 2007. *(see Table 7.5)*.

Competitive species increased at the expense of stress-tolerating species in Main Plots within Bracken across Great Britain, between 1998 and 2007. The mean Moisture Score in these Plots also increased significantly between 1998 and 2007, which reversed the previous downward trend between 1990 and 1998 *(Fig. 7.2)*.

To help assess condition in the Bracken Broad Habitat, extra 2m x 2m 'Unenclosed Plots' (see *Chapter 1*) were surveyed in 1998 and repeated in 2007. To reduce complexity, the results are not presented here but they are available in *Annex 7*. The Unenclosed Plots showed that grasses had become less prominent and that the cover of Bracken plants had increased, and they also showed an increase in the Fertility Score and Ellenberg pH Score.

▼ **Figure 7.2:** The changes in mean Moisture Score in 200m² Main Plots in the Bracken Broad Habitat across Great Britain, between 1990 and 2007. Significant changes (* p<0.05) are shown between the dates bracketed. 95% CI are shown for each data point.



In Main Plots that were classified as Bracken Broad Habitat in 1998 but not in 2007, the mean cover of Bracken decreased from 29.2% to 6.9%. This suggests that the decrease in the estimated area of Bracken Broad Habitat between 1998 and 2007 *(Table 7.1)* is associated with a decrease in the density of the Bracken cover (below the 95% definitional threshold) rather than the complete loss/eradication of Bracken plants. This interpretation is also supported by the increase in the species richness score in Wales, suggesting that Bracken stands have become more open and diverse.

▲ Bracken on Welsh hillside • © *NERC*

▼ **Table 7.5:** Change in the characteristics of vegetation in 200m² Main Plots in the Bracken Broad Habitat across Great Britain between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available in ***Annex 7***. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3***.

	Mean values (GB)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**
Species Richness (No. of Species)	19.1	19.3				↑								
No. of Bird Food Species	5.4	5.6												
No. of Butterfly Food Species	8.0	7.9				↑								
Grass:Forb Ratio	-0.08	-0.20			↓			↓	↑					
Competitor Score	2.49	2.59	↑		↑									
Stress Tolerator Score	3.19	3.08	↓											
Ruderal Score	1.83	1.83												
Light Score	6.57	6.56												
Fertility Score	3.39	3.51												
Ellenberg pH Score	3.90	3.99												
Moisture Score	5.81	5.91	↑		↑				↓					

▼ **Table 7.6:** Change in the characteristics of vegetation in 200m² Main Plots in the Dwarf Shrub Heath Broad Habitat across Great Britain between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available in ***Annex 7***. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3***.

	Mean values (GB)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**
Species Richness (No. of Species)	16.6	15.9							↓		↓		↓	
No. of Bird Food Species	3.0	2.8						↑				↑	↓	
No. of Butterfly Food Species	7.1	6.7	↓		↓				↓		↓		↓	
Grass:Forb Ratio	0.76	0.96	↑	↑	↑			↓						
Competitor Score	2.21	2.27	↑	↑				↓			↑		↑	
Stress Tolerator Score	3.62	3.59												
Ruderal Score	1.47	1.45						↑						
Light Score	6.90	6.91							↑				↑	
Fertility Score	2.46	2.44						↑				↑		
Ellenberg pH Score	3.10	3.05												
Moisture Score	6.37	3.43	↑	↑				↓						

7.5.2 *Changes in the condition of Dwarf Shrub Heath*

Main and Unenclosed Plots: No significant change was detected in Species Richness Score in the Main Plots in the Dwarf Shrub Heath Broad Habitat in Great Britain between 1998 and 2007. Over the period 1990 to 2007, there was a significant decrease of 9.1% in the mean Species Richness Score from an average of 17.6 to 16.1 plant species per plot. Plant species used by butterfly caterpillars as food also decreased from 10.2 species per plot in 1990 to 8.5 in 2007. There was a corresponding increase in the ratio of grasses to forbs and the proportion of competitive species in Main Plots in Great Britain between 1998 and 2007, which may lead to further deterioration in the quality of this Broad Habitat. *(see Table 7.4)*.

To help assess condition in Dwarf Shrub Heath, extra 2m x 2m 'Unenclosed' Plots were recorded in 1998 and repeated in 2007. To reduce the complexity of the results presented here the results table from these Unenclosed Plots is not shown, but is available at *Annex 7*. As with the Main Plots, in these Unenclosed Plots plant species used by butterfly caterpillars as food also decreased and grass species also increased in proportion to forbs.

▼ **Table 7.7:** Change in the frequency of the 10 most increasing and decreasing plant species in 200m² Main Plots in the Dwarf Shrub Heath Broad Habitat across Great Britain, between 1998 and 2007. See ***Chapter 1*** for an explanation of the Change Index.

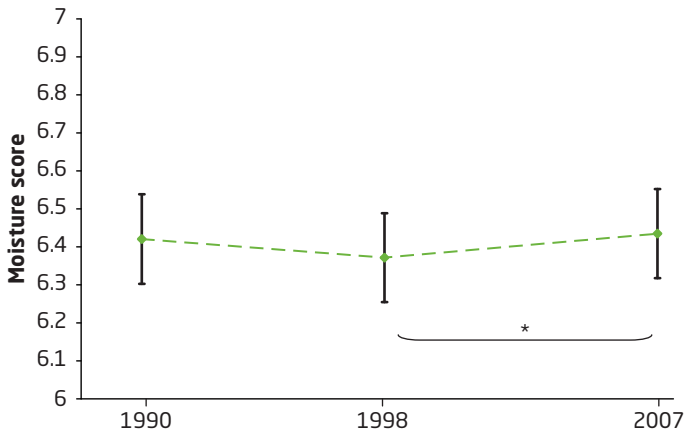
Species with increasing frequency		Change Index	Species with decreasing frequency		Change Index
Juncus effusus	Soft Rush	0.44	*Carex viridula*	Common Yellow Sedge	-0.20
Agrostis canina sens lat	Velvet Bent	0.37	*Campanula rotundifolia*	Harebell	-0.17
Carex binervis	Green-ribbed Sedge	0.18	*Festuca ovina agg.*	Sheep's Fescue	-0.16
Carex echinata	Star Sedge	0.17	*Festuca rubra agg.*	Red Fescue	-0.14
Viola riviniana/reichenbachiana	Violet	0.16	*Aira praecox*	Early Hair-grass	-0.14
Vaccinium vitis-idaea	Cowberry	0.14	*Carex nigra*	Common Sedge	-0.13
Rumex acetosella	Sheep's Sorrel	0.13	*Holcus mollis*	Creeping Soft-grass	-0.13
Molinia caerulea	Purple Moor-grass	0.12	*Erica cinerea*	Bell Heather	-0.13
Salix repens agg.	Creeping Willow	0.12	*Poa pratensis sens.lat*	Smooth Meadow-grass	-0.13
Hypericum pulchrum	Slender St John's-wort	0.11	*Carex flacca*	Glaucous Sedge	-0.12

Many of the species which became less frequent in Main Plots between 1998 and 2007 *(Table 7.7)* were fine-leaved species that are not particularly competitive. The species increasing in frequency typically prefer wet heaths and damper places.

There was no significant change in the mean Fertility Score in Main Plots within Dwarf Shrub Heath in Great Britain between 1990 and 2007, though a significant increase was detected in England between 1990 and 1998.

There was a significant increase in the mean Moisture Score in Main Plots in Dwarf Shrub Heath in Great Britain, between 1998 and 2007 *(Fig. 7.3)* but this must be considered alongside the non-significant decrease between 1990 and 1998. In the 2m x 2m Unenclosed Plots; the Light, Fertility and Moisture Scores all showed changes opposite to those recorded in Main Plots, these contradictions require further investigation.

▼ **Figure 7.3:** The changes in mean Moisture Score in 200m² Main Plots in the Dwarf Shrub Heath Broad Habitat across Great Britain between 1990 and 2007. Significant changes (* p<0.05) are shown between the dates bracketed. 95% CI are shown for each data point.



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. Examples of these areas include Dry Acid Grassland Priority Habitat, wet heath, bog and flushes.

The Species Richness Score in Targeted Plots within Dwarf Shrub Heath decreased by approximately 8%, from 10.7 plant species per plot in 1998 to 9.8 in 2007, across Great Britain *(Table 7.8)*. This continued a significant decrease detected between 1990 and 1998. The number of plant species used by butterfly caterpillars as food in Targeted Plots also decreased over the longer time period, 1990 to 2007.

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 Fertility Score or Moisture Score was detected.

▲ Heather and moorland, England • © *NERC*

▼ **Table 7.8:** Change in the characteristics of vegetation in 2m x 2m Targeted Plots in the Dwarf Shrub Heath Broad Habitat in Great Britain between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available in ***Annex 7***. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3***.

	Mean values (GB)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**
Species Richness (No. of Species)	10.7	9.8	↓		↓		↓				↓	↓	↓	
No. of Bird Food Species	2.2	1.9		↓										
No. of Butterfly Food Species	4.5	4.3					↓	↓			↓	↓	↓	
Grass:Forb Ratio	1.08	1.17											↑	
Competitor Score	2.29	2.35	↑	↑							↑		↑	
Stress Tolerator Score	3.52	3.50												
Ruderal Score	1.55	1.50												
Light Score	6.90	6.89												
Fertility Score	2.61	2.54												
Ellenberg pH Score	3.29	3.23									↓			
Moisture Score	6.36	6.39						↓						

▼ **Table 7.9:** Change in the mean condition characteristics of vegetation in 200m² Main Plots in the Bog Broad Habitat in Great Britain, between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available in ***Annex 7***. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3***.

	Mean values (GB)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**
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	↓		↓									
Ellenberg Light Score	7.27	7.26					↑		↑		↑		↑	
Ellenberg Fertility Score	2.13	2.08	↓		↓		↓		↓		↓		↓	
Ellenberg pH Score	3.08	2.99	↓		↓						↓		↓	
Moisture Score	7.11	7.12				↓								

7.5.3 Changes in Bog Broad Habitat

Main and Unenclosed Plots: The mean plant Species Richness Score of Main Plots within the Bog Broad Habitat in Great Britain decreased by 7.0% from 18.3 to 17.2 species per plot, between 1998 and 2007, which was also the major component of the decrease between 1990 and 2007 *(Fig. 7.4)*. The decrease in species richness was detected in Scotland but not in England or Wales *(Table 7.9)*.

There was a significant decrease in the number of plant species used by butterfly caterpillars and farmland birds as food and an increase in the proportion of grass species in the Bog Broad Habitat between 1998 and 2007. The list of species increasing or decreasing in frequency (excluding mosses and liverworts) is not easy to interpret and requires further investigation but it appears that bog species increased and non-bog species decreased *(Table 7.11)*.

▼ **Table 7.11:** Change in the frequency of 10 most increasing and decreasing plant species in 200m² Main in the Bog Broad Habitat across Great Britain, between 1998 and 2007. See ***Chapter 1*** for an explanation of the Change Index.

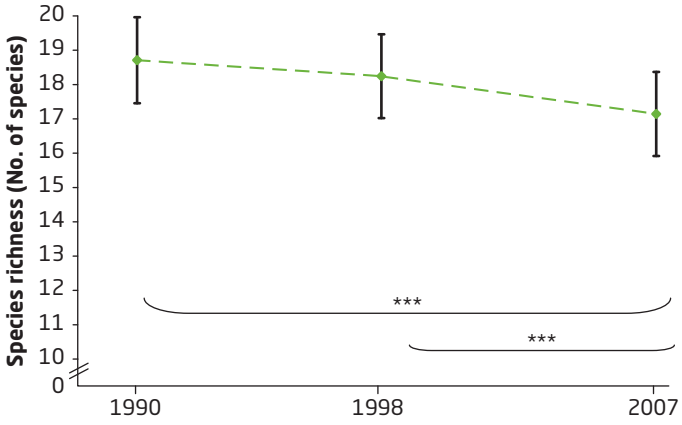
Species with increasing frequency		Change Index	Species with decreasing frequency		Change Index
Drosera longifolia	Great Sundew	1.73	*Festuca rubra agg.*	Red Fescue	-0.76
Dryopteris dilatata	Broad Buckler Fern	0.56	*Selaginella selaginoides*	Lesser Clubmoss	-0.70
Epilobium palustre	Marsh Willowherb	0.49	*Drosera intermedia*	Oblong-leaved Sundew	-0.63
Agrostis canina sens lat	Velvet Bent	0.45	*Agrostis stolonifera*	Creeping Bent	-0.59
Hypochaeris radicata	Cat's Ear	0.43	*Holcus mollis*	Creeping Soft-grass	-0.58
Salix repens agg.	Creeping Willow	0.41	*Anemone nemorosa*	Wood Anemone	-0.53
Empetrum nigrum	Crowberry	0.40	*Triglochin palustre*	Marsh Arrowgrass	-0.41
Rhynchospora alba	White Beak-sedge	0.38	*Taraxacum agg.*	Dandelion	-0.38
Juncus conglomeratus	Compact Rush	0.37	*Thymus polytrichus*	Thyme	-0.38
Juncus effusus	Soft Rush	0.34	*Carex viridula*	Common Yellow Sedge	-0.37

To help assess condition in the Bog Broad Habitat, extra 2m x 2m Unenclosed Plots were recorded in 1998 and repeated in 2007. To reduce the complexity of the results presented here the results table from these Unenclosed Plots is not shown, but is available at *Annex 7*. The results from these Plots confirmed that species richness decreased and that the proportion of grass species increased.

The proportion of competitive species increased significantly at the expense of ruderal species in Main Plots within the Bog Broad Habitat across Great Britain between 1998 and 2007, suggesting a reduction in disturbance. The proportion of ruderal species also decreased in the Unenclosed Plots in the Bog Broad Habitat during that period confirming the result from the Main Plots. Both the Fertility Score and Ellenberg pH Score also decreased. Over the longer time period, 1990 to 2007, there was an increase in the Light Score indicating a more open canopy of shorter species.

The decrease in Ellenberg pH Score happened at the same time as a significant increase in soil (0-15cm) pH (see below).

▼ **Figure 7.4:** The changes in species richness in 200m² Main Plots in the Bog Broad Habitat across Great Britain between 1990 and 2007. Significant changes (* p<0.05) are shown between the dates bracketed. 95% CI are shown for each data point.



There was a significant increase in the ratio of grasses to forbs in Main Plots within the Bog Broad Habitat across Great Britain, between 1998 and 2007 *(Table 7.8)* which when added to the decrease in the species richness score and the increase of competitive species suggests a possible deterioration in the condition of this Broad Habitat. Some of the other condition measures appear to be contradictory and need further investigation.

▲ Bog Asphodel, England, • © *Sue Wallis*

▼ **Table 7.10:** Change in the characteristics of vegetation in 2m x 2m Targeted Plots in the Bog Broad Habitat across Great Britain, between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available in ***Annex 7***. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3***.

	Mean values (GB)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**
Species Richness (No. of Species)	11.6	10.8	↓		↓		↓		↓		↓		↓	
No. of Bird Food Species	1.6	1.3	↓		↓				↓		↓		↓	
No. of Butterfly Food Species	4.3	4.1	↓		↓			↑	↓		↓		↓	
Grass:Forb Ratio	1.06	1.15					↑				↑			
Competitor Score	2.26	2.30	↑			↑								
Stress Tolerator Score	3.56	3.55				↓								
Ruderal Score	1.54	1.49	↓		↓						↓		↓	
Light Score	7.19	7.21			↑		↑		↑		↑		↑	
Fertility Score	2.37	2.27	↓		↓						↓		↓	
Ellenberg pH Score	3.28	3.19	↓		↓		↓	↓			↓		↓	
Moisture Score	7.05	7.14	↑		↑			↓				↓	↑	

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.

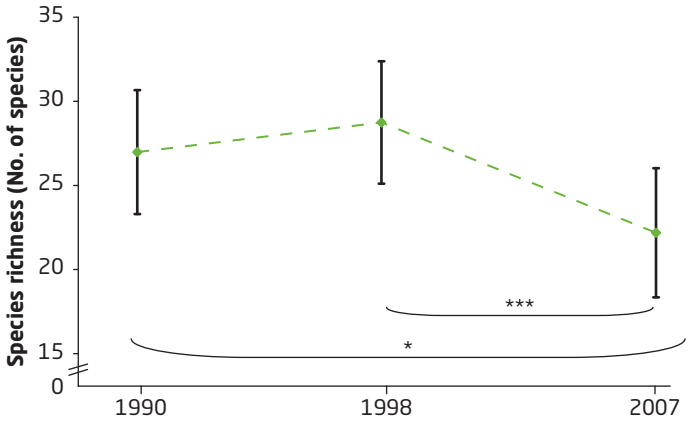
The mean Species Richness Score per Targeted Plot in the Bog Broad Habitat decreased significantly from 12.2 to 10.8 species, in Great Britain between 1990 and 2007. This decrease was also significant in Scotland, but it was not detected in England or Wales *(Table 7.10)*. This reduction in the Species Richness Score per plot was similar to that reported for Main Plots randomly sited in the Broad Habitat. There was a simultaneous reduction in number of plant species used by butterfly caterpillars as food. Lowland farmland birds do not use this Broad Habitat to any great extent and the reduction in the number of plant species used by birds as food detected is probably not of importance ecologically.

Like the Main Plots, the Targeted Plots showed a shift from ruderal to competitive species, and a decrease in the Fertility Score and the Ellenberg pH Score across Great Britain between 1998 and 2007. However, in contrast with the Main Plots, the Targeted Plots showed increases in the Moisture Score.

7.5.4 Changes in Fen, Marsh and Swamp Broad Habitat

Main Plots: There was a 20.0% decrease in the Species Richness Score in Main Plots within Fen, Marsh and Swamp across Great Britain, between 1998 and 2007. Between 1990 and 2007 the decrease in this Broad Habitat was 14.8%, across Great Britain *(Fig. 7.5 and Table 7.12)*.

▼ **Figure 7.5:** Changes in species richness per 200m² Main Plot in Fen, Marsh and Swamp Broad Habitat across Great Britain, 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.



Targeted Plots: In common with the results for the Main Plots randomly sited in the Broad Habitat, there was a significant reduction in the mean plant Species Richness Score in the Targeted Plots used to sample areas targeted by CS for their botanical interest. Species richness decreased by 10.1% from a mean of 14.8 to 13.3 plant species per Targeted Plot in Great Britain between 1998 and 2007, and this reduction continued the trend of decreasing species richness between 1990 and 1998 *(Table 7.13)*.

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 in Great Britain between 1998 and 2007. The proportion of species casting and/or preferring shade also increased in Great Britain, continuing previous trends established between 1990 and 1998.

▼ **Table 7.12:** Change in the characteristics of vegetation in 200m² Main Plots in the Fen, Marsh and Swamp Broad Habitat across Great Britain between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available in ***Annex 7***. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3***.

	Mean values (GB)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**
Species Richness (No. of Species)	27.4	21.9	↓		↓			↑			↓		↓	
No. of Bird Food Species	8.2	6.4	↓	↓	↓			↑			↓			
No. of Butterfly Food Species	10.3	8.4	↓		↓	↓		↑			↓		↓	↓
Grass:Forb Ratio	0.80	0.72										↓		
Competitor Score	2.50	2.60	↑			↑					↑			
Stress Tolerator Score	2.99	2.95												
Ruderal Score	2.18	2.08	↓											
Light Score	6.97	6.95												
Fertility Score	3.64	3.64												
Ellenberg pH Score	4.48	4.45						↑				↑		
Moisture Score	6.55	6.60												

▼ **Table 7.13:** Change in the condition of vegetation in 2m x 2m Targeted Plots in the Fen, Marsh and Swamp Broad Habitat across Great Britain between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available in ***Annex 7***. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3***.

	Mean values (GB)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**
Species Richness (No. of Species)	14.8	13.3	↓		↓						↓		↓	
No. of Bird Food Species	4.5	4.0												
No. of Butterfly Food Species	5.2	4.6	↓		↓			↑						
Grass:Forb Ratio	0.5	0.62												
Competitor Score	2.74	2.82	↑	↑							↑	↑		↑
Stress Tolerator Score	2.68	2.62	↓								↓			
Ruderal Score	2.26	2.21												
Light Score	6.99	6.95	↓											
Fertility Score	4.09	4.12						↑				↑		
Ellenberg pH Score	4.87	4.90												
Moisture Score	6.89	6.93					↓	↓				↓		

7.6 Priority Habitats of mountain, moor and heath

7.6.1 Blanket Bog

The area of Blanket Bog in 2007 was estimated at 1.2 million ha which represents 5.3% of the area of Great Britain *(Table 7.14)*. Blanket Bog is abundant in Scotland where it covers 13.9% of the country. In Wales, Blanket Bog covers 0.8% and in England it covers 0.8%.

▼ **Table 7.14:** Estimated area ('000s ha) and percentage of land area of Blanket Bog Priority Habitat in Great Britain in 2007.

Blanket Bog	2007	
	Area ('000s ha)	%
GB	1234	5.3
England	101	0.8
Scotland	1115	13.9
Wales	18	0.8

7.6.2 Upland Dwarf Shrub Heath

The area of Upland Dwarf Shrub Heath in 2007 was estimated at 1.2 million ha. This Priority Habitat is most abundant in Scotland. There was no significant change in area in Great Britain between 1998 and 2007. There were small conversions to and from Upland Dwarf Shrub Heath, Blanket Bog, Acid Grassland, Bracken, Bog and Coniferous Woodland. *(Table 7.15)*.

▼ **Table 7.15:** Estimated area ('000s ha) and percentage of land area of Upland Dwarf Shrub Heath Priority Habitat in Great Britain from 1998 to 2007. Arrows denote significant change ($p<0.05$) in the direction shown.

Upland Dwarf Shrub Heath	1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	
GB	1116	4.8	1196	5.1	
England	280	2.1	302	2.3	
Scotland	790	9.9	778	9.7	
Wales	94	4.4	114	5.4	

7.6.3 Lowland Dwarf Shrub Heath

Lowland Dwarf Shrub Heath covered an estimated area of 93,000 ha in 2007. It was found in England, Wales and Scotland and it increased significantly in England. As above, conversions were recorded with Blanket Bog, Acid Grassland, Bracken, Bog and Coniferous Woodland between 1998 and 2007. In addition there were flows between Lowland Dwarf Shrub Heath, Neutral Grassland and Broadleaved Woodland. *(Table 7.16)*.

▼ **Table 7.16:** Estimated area ('000s ha) and percentage of land area of Lowland Dwarf Shrub Heath Priority Habitat in Great Britain from 1998 to 2007. Arrows denote significant change ($p<0.05$) in the direction shown.

Lowland Dwarf Shrub Heath	1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	
GB	78	0.3	93	0.4	
England	27	0.2	44	0.3	↑
Scotland	44	0.5	41	0.5	
Wales	7	0.3	9	0.4	

▲ Purple Moor Grass, England • © *Lisa Norton*

7.6.4 Purple Moor Grass and Rush Pasture

It was not possible to identify Purple Moor Grass and Rush Pasture from past CS data as there was no comparable classification, so estimates are only provided for 2007. This is a species-rich fen meadow and rush pasture with a particular geographical distribution. It is identified in the field by indicator species such as Wavy St John's Wort (*Hypericum undulatum*), Water Mint (*Mentha aquatica*), Sneezewort (*Achillea ptarmica*), Marsh Horsetail (*Equisetum palustre*) and Cuckoo Flower (*Cardamine pratensis*). The estimated area for Purple Moor Grass Rush Pasture in Great Britain for 2007 was 59,000 ha ***(Table 7.17)***.

▼ **Table 7.17:** Estimated area ('000s ha) and percentage of land area of Purple Moor Grass and Rush Pasture Priority Habitat in Great Britain in 2007.

Purple Moor grass and Rush Pasture	2007	
	Area ('000s ha)	%
GB	59	0.3
England	9	0.1
Scotland	38	0.5
Wales	12	0.6

7.6.5 Reedbed

Reedbed is a scarce Priority Habitat, consisting of stands of the Common Reed (*Phragmites australis*). It was not possible to estimate the area of this Priority Habitat from Countryside Surveys before 2007. The area estimated for Reedbed Priority Habitat was 6,000 ha across Great Britain in 2007 ***(Table 7.18)***.

▼ **Table 7.18:** Estimated area ('000s ha) and percentage of land area of Reedbed Priority Habitat in Great Britain in 2007.

Reedbed	2007	
	Area ('000s ha)	%
GB	6	0.0
England	5	0.0
Scotland	<1	0.0
Wales	<1	0.0

7.7 Changes in soils (0-15cm) in mountain, moor and heath Broad Habitats

- **In Bracken, Dwarf Shrub Heath, Bog, and in Fen, Marsh and Swamp, there was no significant change in pH between 1998 and 2007. However, all four Broad Habitats were less acidic in 2007 compared to 1978, due mainly to a pH increase between 1978 and 1998.**
- **In Bracken, soil (0-15cm) carbon concentration increased across Great Britain between 1998 and 2007; this Broad Habitat had a significantly higher concentration of soil (0-15cm) carbon in 2007 compared to 1978.**
- **In Dwarf Shrub Heath, Bog, and Fen, Marsh and Swamp soils (0-15cm), no change was detected in the carbon concentrations across Great Britain between 1998 and 2007 nor between 1978 and 2007.**

7.7.1 Bracken

Soil (0-15cm) pH: Between 1998 and 2007, there was no significant change in the mean pH of soil (0-15cm) samples from Bracken Broad Habitat across Great Britain ***(Table 2.8)*** but between 1978 and 2007 pH increased from 4.16 to 4.64.

Soil (0-15cm) carbon: There was a significant increase in the mean carbon concentration of soil (0-15cm) in the Bracken Broad Habitat for Great Britain, from 143 g/kg in 1998 to 181 g/kg in 2007 ***(Table 2.8)***. The carbon concentration also increased significantly between 1978 and 2007, but there was no significant change between 1978 and 1998.

Bulk density and soil (0-15cm) carbon stock: The mean bulk density of Bracken soils (0-15cm) in Great Britain in 2007 was 0.4 g/cm^3 which when combined with soil (0-15cm) carbon concentration gave a soil (0-15cm) carbon stock estimate of 77 t/ha ***(Table 2.9)***.

7.7.2 Dwarf Shrub Heath

Soil (0-15cm) pH: There was no significant change in the mean pH of soils (0-15cm) within Plots in the Dwarf Shrub Heath Broad Habitat in Great Britain between 1998 and 2007 ***(Table 2.8)***. The difference in pH between 1978 and 2007 was significant, mainly due to the large significant rise from pH 4.20 in 1978 to pH 4.50 in 1998.

Soil (0-15cm) carbon: There was no significant change in the mean carbon concentration of soil (0-15cm) in the Dwarf Shrub Broad Habitat across Great Britain between 1998 and 2007 or from 1978 to 1998, or from 1978 to 2007 ***(Table 2.8)***.

Bulk density and soil (0-15cm) carbon stock: The mean bulk density of Dwarf Shrub Heath soils (0-15cm) in Great Britain in 2007 was 0.3 g/cm^3 which when combined with soil (0-15cm) carbon concentration gave a soil (0-15cm) carbon stock estimate of 82 t/ha ***(Table 2.9)***.

7.7.3 Bog

Soil (0-15cm) pH: There was no significant change in mean soil (0-15cm) pH in the Bog Broad Habitat in Great Britain between 1998 and 2007. An overall increase in pH from 1978 to 2007 was significant due mainly to the large significant increase from pH 4.29 in 1978 to pH 4.49 in 1998 ***(Table 2.8)***.

Soil (0-15cm) carbon: There was no significant change in the mean soil (0-15cm) carbon concentration in the Bog Broad Habitat across Great Britain between 1998 and 2007, although there was a significant increase between 1978 and 1998 ***(Table 2.8)***.

Bulk density and soil (0-15cm) carbon stock: The mean bulk density of Bog soils (0-15cm) in Great Britain in 2007 was 0.2 g/cm^3 which when combined with soil (0-15cm) carbon concentration gave a soil (0-15cm) carbon stock estimate of 78 t/ha ***(Table 2.9)***. The very large carbon concentration in these soils is offset by the low bulk density, to yield a moderately large carbon stock when compared to other Broad Habitats.

7.7.4 Fen, Marsh and Swamp

Soil (0-15cm) pH: There was no significant change in the mean pH of soils (0-15 cm) in the Fen, Marsh and Swamp Broad Habitat across Great Britain between 1998 and 2007 ***(Table 2.8)***. Between 1978 and 2007, the mean value increased significantly from pH 4.65 to pH 5.46, due mainly to the large significant increase between 1978 and 1998.

Soil (0-15cm) carbon: There was no change in the carbon concentration of soil (0-15cm) in the Fen, Marsh and Swamp Broad Habitat across Great Britain between 1998 and 2007, or from 1978 to 1998, or from 1978 to 2007 ***(Table 2.8)***.

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 Great Britain was 0.4 g/cm^3 which when combined with soil (0-15cm) carbon concentration gave a soil (0-15cm) carbon stock estimate of 75 t C/ ha ***(Table 2.9)***.

7.8 Discussion and conclusions

7.8.1 Bracken

In 2007, the Bracken Broad Habitat covered 263,000 ha, 1.1% of the UK land area, about half of which was in Scotland. In Great Britain, following an increase between 1990 and 1998, the overall cover of Bracken decreased by 17% between 1998 and 2007 to slightly below 1990 levels. This decrease was most marked in Wales where the area of Bracken more than halved (a 55% decrease).
The 95% cover threshold that defines the Bracken Broad Habitat means that even a modest yet widespread reduction in bracken cover could translate into a large estimated loss of the Broad Habitat but where bracken still remains abundant in the vegetation. Analysis of Unenclosed Plot data (n = 50) in Wales for areas that were Bracken Broad Habitat in 1998 but moved out of Bracken by 2007, showed a significant reduction in bracken cover from an average of 29% down to just 7%. The recorded species cover in each mapped polygon showed that in about half of the land that moved out of Bracken Broad Habitat between 1998 and 2007, bracken was still present at between 10% and 95% cover.
These results suggest that the large decrease in area of Bracken Broad Habitat in Wales was at least in part due to a reduction in the cover density of bracken. Bracken growth is known to be debilitated by particularly wet growing seasons and so the above average rainfall in Wales during 2007 could have contributed to less vigorous bracken growth and biomass, peaking below the critical

▲ Lowland Fen, Marsh and Swamp, England • © *NERC*

95% threshold. The change in Bracken Broad Habitat could therefore be a seasonal effect reflecting reduced bracken biomass cover while also indicating the sensitivity of the Broad Habitat definition to a small but widespread change in cover.

Between 1998 and 2007 vegetation sampling plots in Bracken showed a shift from species adapted to stress to those adapted to competition and also species more typical of wetter conditions. The vegetation composition also indicated increasing nutrient status and decreasing soil acidity.

There was no change in the acidity of soils (0-15cm) in the Bracken Broad Habitat between 1998 and 2007, although soils (0-15cm) became less acid between 1978 and 2007. The carbon concentration of soils (0-15cm) in this Broad Habitat was significantly higher in 2007 than it was in 1978.

7.8.2 Dwarf Shrub Heath

Dwarf Shrub Heath covered 1.4 million ha in the UK, comprising 5.5% of the land area. Two-thirds of this is found in Scotland. In Great Britain between 1990 and 2007, the area of Dwarf Shrub Heath decreased by about 6.5%, nearly all accounted for by a 10% decrease in Scotland mostly in the 1990s. In contrast, there was a 15% increase in the area of Dwarf Shrub Heath in England between 1998 and 2007. The increase occurred at a time when agri-environment schemes and conservation organisations were putting strong emphasis on recreating heather moorland. Where observed, the increase in Dwarf Shrub Heath was primarily at the expense of Bracken and Acid Grassland Broad Habitats.

Plant species richness, including plants used as food for butterflies, decreased in the 200m^2 Main Plots across Great Britain from 1990 to 2007. A decrease in plant species richness was also observed in the more recent period (1998 to 2007) in the 2m x 2m Plots in areas targeted by CS for their botanical interest. Grasses and competitive plants became more prominent in the vegetation of Dwarf Shrub Heath. The nutrient status of the Main Plots increased between 1990 and 2007 in England, with most of the increase between 1990 and 1998.

Soil (0-15cm) pH increased in Dwarf Shrub Heath across Great Britain between 1978 and 2007, becoming less acidic (but still within the range of acid soil pH), with the increase mostly between 1978 and 1998. Soil (0-15cm) carbon concentrations have not changed over the past 30 years.

7.8.3 Bog

Bog (including Blanket Bog and Lowland Raised Bog) covered approximately 10% of the UK land area in 2007. The vast bulk of the estimated area of 2.4 million ha occurred in Scotland, where it makes up 26% of the land area. The Bog Broad Habitat was relatively stable between 1998 and 2007, with only very small (statistically insignificant) net gains from Dwarf Shrub Heath and Coniferous Woodland, and very small net losses to Acid Grassland.

Plant species richness in the Main and Targeted Plots of Bog Broad Habitat decreased between 1998 and 2007 in Great Britain and in Scotland, including food plants for butterfly caterpillars. Grasses and other competitive plants increased, whereas ruderal plants, associated with disturbance decreased. The other vegetation changes were indicative of an overall decreasing nutrient status and increasing acidity. These changes suggest a deterioration in the vegetation condition of the Bog Broad Habitat but further investigation is required.

Changes in the vegetation were not consistent with measurements of soil (0-15cm) pH, which showed a long-term reduction in acidity mainly because of the significant changes value between 1978 and 1998. Soil (0-15cm) carbon concentration increased in the Bog Broad Habitat between 1978 and 1998, but there was no change between 1998 and 2007, nor was there any significant change over the period as a whole.

7.8.4 Fen, Marsh and Swamp

Fen, Marsh and Swamp covered approximately 1.8% of the area of the UK in 2007, with 54% of this Habitat occurring in Scotland. Previous problems in defining the Broad Habitat during Field Survey and when processing mapping data have led to revised estimates of status since reporting the 1998 results. No change in extent of this Broad Habitat has been detected between 1984 and 2007.

Plant species richness, as well as the number of plant species used by butterfly caterpillars as food, decreased in Great Britain between 1990 and 1998, and again between 1998 and 2007. At the same time more competitive species increased in abundance. These changes occurred in areas targeted by CS for their botanical interest as well as in larger areas of the Broad Habitat. A significant reduction in plant species richness was also noted in unenclosed areas of Fen, Marsh and Swamp in Scotland. These changes appear to be consistent with a process of succession and lack of management in small remnant areas of the Broad Habitat. As a whole, the results suggest a deterioration in condition in the Fen, Marsh and Swamp Broad Habitat between 1990 and 2007.

7.8.5 Changes in mountain, moor and heath

The main changes in the extent of the Broad Habitats described in this chapter were the decrease in Bracken in the UK and an increase in Dwarf Shrub Heath in England, between 1998 and 2007. The decrease in Bracken was mostly due to a decrease in cover of bracken plants below the 95% cover threshold which defines the Bracken Broad Habitat. This decrease was largely balanced by an increase in Acid Grassland (see *Chapter 4*).

The major change in the condition of vegetation in mountain, moor and heath between 1998 and 2007 was the increase of competitive species at the expense of either stress-tolerating species and/or ruderal species, in many of the Broad Habitats. The proportion of grass to forb species also increased in Dwarf Shrub Heath and Bog. Plant species decreased overall in Fen, Marsh and Swamp, and Bog. These changes may reflect a reduction in management and disturbance. In Bog these changes might suggest a deterioration in condition but further analysis is required.

There was no evidence, through changes in the Fertility Score, of increases in nutrient availability associated with eutrophication, between 1998 and 2007. But evidence of an increase in more nutrient-demanding species was found in Dwarf Shrub Heath in England between 1990 and 1998. Fertility Score decreased in Bog between 1998 and 2007.

Soil (0-15cm) acidity was reduced in mountain, moor and heath between 1978 and 1998, but further reductions in acidity were not found between 1998 and 2007, despite continuing reductions in levels of sulphur deposition. The composition of vegetation in the Bog Broad Habitat actually showed an increase in species associated with more acidic conditions, between 1998 and 2007. The different trends in soils (0-15cm) and vegetation may be due to other factors affecting the vegetation and requires further investigation.

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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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▲ Upland stream, Scotland • © *NERC*

8. Rivers, Streams and Standing Waters

Summary

- **The area of the Standing Waters and Canals Broad Habitat increased by 2.6% in Great Britain between 1998 and 2007.**
- **The number of ponds increased by 12.5% in Great Britain between 1998 and 2007.**
- **Plant species richness in lowland ponds decreased in Great Britain between 1996 and 2007. Only 8% of ponds were in good condition and the quality of lowland ponds deteriorated between 1996 and 2007. 8% of ponds met Priority Habitat status, based on quality criteria for plants.**
- **Plant species richness of streamsides decreased by 7.5% in Great Britain between 1998 and 2007. Since 1990 there has been a successional change, with vegetation becoming taller and with more competitive species.**
- **Plant species richness in streams increased in Great Britain between 1998 and 2007, and there was a high turnover of species.**
- **The physical characteristics of streams improved in Great Britain between 1998 and 2007.**

8.1 Introduction[1]

This chapter presents the results for the two freshwater Broad Habitats: Standing Waters and Canals; and Rivers and Streams. Both Habitats are important features of the UK landscape, as they collect and move water, sediment, nutrients and pollutants through the countryside, they 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 (UKBAP). Particular types of freshwater habitat are also listed as Priority Habitats e.g. ponds, rivers and lakes. Freshwater habitats provide a valuable economic and recreational resource for people.

[1] The methodology for sampling these Freshwater Habitats differs substantially from other terrestrial habitats. For further information on the Broad Habitat classification, vegetation Aggregate Classes (ACs), sampling plots and other Countryside Survey terminology see *Chapter 1 (Methodology)*.

The Standing Waters and Canals Broad Habitat includes ponds, lakes, canals, ditches and reservoirs. The Rivers and Streams Broad Habitat includes running watercourses ranging from small headwater streams to large rivers. Both these 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 and the nature of the local terrain.

There have been previous estimates of pond numbers in lowland Britain as part of the 1996 Lowland Pond Survey (LPS1996) and the Countryside Survey (CS) in 1998, but this is the first time CS has reported the estimated number of ponds across all of Great Britain. Ponds in Northern Ireland were not counted.

The condition of certain water body types within these Broad Habitats was assessed in a number of different ways *(Chapter 1, see 1.4.4)*. Information about the biological condition of streams and ponds was not collected in Northern Ireland.

8.2 Area of Standing Waters and Canals and Rivers and Streams Broad Habitats

- **The area of the Standing Waters and Canals Broad Habitat increased by 2.6% in Great Britain between 1998 and 2007.**
- **The number of ponds increased by 12.5% in Great Britain between 1998 and 2007.**

8.2.1 Change in areas of Standing Waters and Canals, Rivers and Streams and numbers of ponds

The area covered by the two Broad Habitats is relatively small, together representing about 1.4% of the UK. The change in the area of the Standing Water and Canal Broad Habitat *(Table 8.1)* corresponds with the increase in the number of ponds *(Table 8.2)*.

The number of ponds in Great Britain increased by 12.5% between 1998 and 2007, to an estimated total of 478,000 ponds in 2007.

▼ **Table 8.2:** Change in the number of ponds ('000s) in Great Britain between 1998 and 2007. Arrows denote significant change ($p<0.05$) in the direction shown.

	1998 Number of ponds ('000s)	2007 Number of ponds ('000s)	% Change	Direction of significant changes 1998-2007
GB	425	478	12.5	↑
England	197	234	18.3	↑
Scotland	187	199	5.5	↑
Wales	40	47	16.9	↑

This follows a 6% increase in lowland ponds between 1990 and 1998, reported previously[2]. Numbers of lowland ponds, using different definitions of what is a pond, declined between 1984 and 1990.

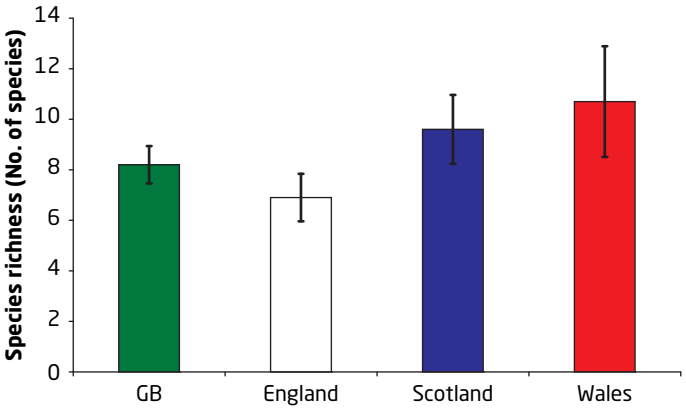
8.3 Habitat Condition

- **Plant species richness in lowland ponds decreased in Great Britain between 1996 and 2007. Only 8% of ponds were in good condition and the quality of lowland ponds deteriorated between 1996 and 2007. 8% of ponds met Priority Habitat status, based on quality criteria for plants.**

8.3.1 Plant diversity in ponds

In the past, pond condition data were collected from lowland areas within the CS sample as part of the Lowland Pond Survey 1996. In 2007, CS extended these data to provide a baseline describing the condition of ponds across Great Britain, including (for the first time) upland ponds. It is possible to assess change in lowland pond condition over the last decade based on data from those ponds surveyed in both 1996 and 2007.

▼ **Figure 8.1:** Mean wetland plant species richness in ponds across Great Britain in 2007. 95% CI are shown for each bar.



In 2007, ponds supported an average of 8.2 wetland plant species per pond. Ponds in England contained significantly fewer species than ponds in Scotland and Wales *(Fig. 8.1)*.

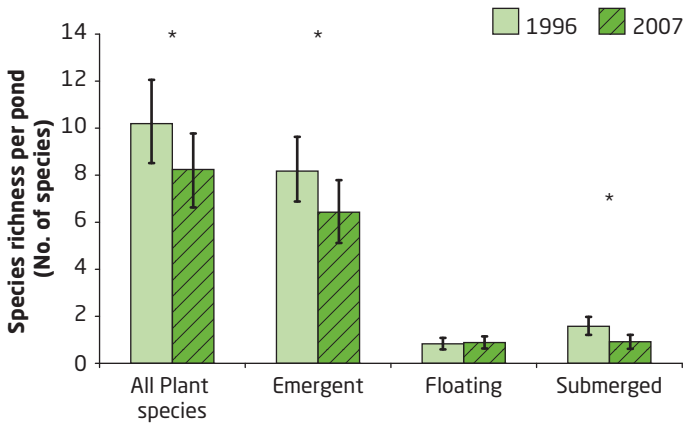
[2] The Survey carried out in 1998 was published as: Haines-Young et al (2000). *Accounting for Nature, assessing habitats in the UK countryside, Countryside Survey 2000.* Department for the Environment, Transport and the Regions (DETR), London.

▼ **Table 8.1:** Estimated area ('000s ha) of **a) the Standing Waters and Canals,** and **b) the River and Streams Broad Habitats** in the UK from 1998 to 2007, and in Great Britain from 1984 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 and more especially 1984 are not in all cases directly comparable with later surveys. Data not available = na.

a) Standing Water and Canals Broad Habitat									
	1984		1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
GB	284	1.2	200	0.9	196	0.8	204	0.9	↑
England	na	na	105	0.8	88	0.7	97	0.7	↑
Scotland	na	na	75	0.9	87	1.1	88	1.1	
Wales	na	na	20	0.9	21	1.0	18	0.9	
Northern Ireland	na	na	na	na	62	4.0	64	3.5	
UK	na	na	na	na	258	1.0	265	1.1	

b) Rivers and Streams Broad Habitat									
	1984		1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
GB	70	0.3	70	0.3	65	0.3	58	0.2	
England	na	na	33	0.2	32	0.2	29	0.2	
Scotland	na	na	21	0.2	21	0.2	21	0.2	
Wales	na	na	16	0.8	12	0.6	8	0.4	
Northern Ireland	na	na	na	na	5	4.0	6	3.5	
UK	na	na	na	na	70	0.3	64	0.3	

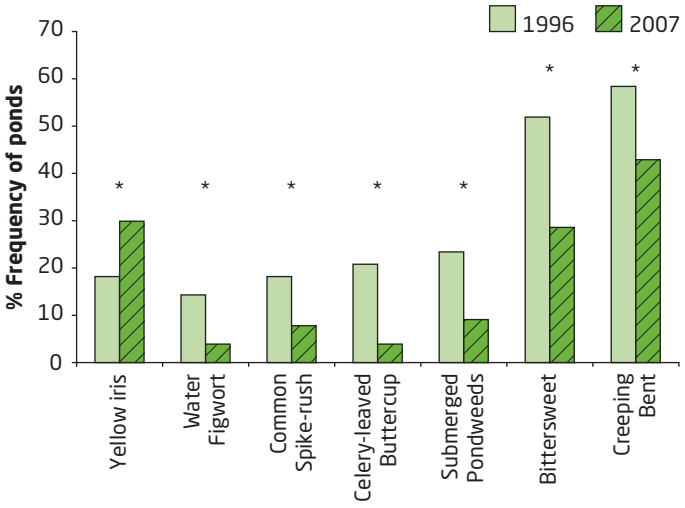
▼ **Figure 8.2:** Change in wetland plant species richness in lowland ponds across Great Britain between 1996 and 2007, with a breakdown for emergent, floating and submerged plants. Asterisks indicate a statistically significant change between surveys (* $p<0.05$). 95% CI are shown for each bar.



The plant species richness in lowland ponds decreased by 24% in Great Britain between 1996 and 2007, from on average 10.2 to 8.3 species per pond. The decrease was observed in emergent and submerged species *(Fig. 8.2)*. Pooled plant species richness for the ponds (i.e. the total number of plant species recorded from all lowland ponds) did not vary significantly between the two surveys showing that there was no decrease in diversity at a national scale.

▲ Lowland pond, England • © *NERC*

▼ **Figure 8.3:** Change in the frequency of selected wetland plant species in lowland ponds across Great Britain between 1996 and 2007. Asterisks indicate a statistically significant change between surveys (* p<0.05).

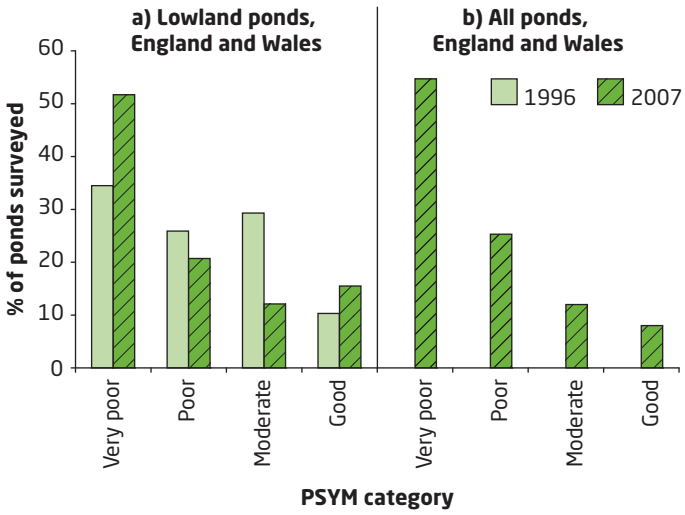


There was a substantial turnover in plant species between the two surveys. A total of 160 wetland plant taxa (*see* ***Glossary at Annex 1*** *www.countrysidesurvey.org.uk*) were recorded in LPS1996 and CS in 2007, of which 106 (66%) were common to both surveys. There were 24 taxa recorded in 1996 that were not recorded in 2007 and 30 taxa newly-recorded in 2007. Six plant taxa decreased significantly in frequency between the two surveys including an aggregate of all *Potamogeton* species (Pondweeds). Only one plant, Yellow Iris, significantly increased its occurrence between 1996 and 2007 ***(Fig. 8.3)***.

8.3.2 Ecological quality of ponds

The ecological quality of the ponds in England and Wales was evaluated by applying the software package PSYM ***(Box 1.2)*** to the data collected.

▼ **Figure 8.4:** The percentage of ponds falling into four PSYM quality categories in England and Wales: a) Comparison of lowland ponds in England and Wales in 1996 and 2007; b) All ponds in England and Wales in 2007.



Most ponds in England and Wales (80%) fell into the two lowest PSYM categories in 2007: Poor or Very Poor. Only 8% were Good quality, similar to the reference state ***(Fig. 8.4)***. These findings confirm that relative to reference sites, degradation is considerable and widespread amongst ponds in England and Wales.

Comparison of the 1996 and 2007 data show that, based on wetland plant measures, the ecological quality of lowland ponds in England and Wales has significantly decreased, with the percentage of sites that are Moderate or Good dropping from 40% to 28%, and the number of Poor or Very Poor sites increasing from 60% to 72% ***(Fig. 8.4)***.

8.3.3 Assessment of Pond Priority Habitat

The CS pond condition assessments in 2007 were based on plant data. Three criteria were used to identify ponds of Priority Habitat status:

- *Criterion 1: the presence of rare plant species.* Only 4% of the 260 ponds surveyed qualified as Priority Habitat Ponds on the basis this criterion. The majority of these ponds were in Scotland (Table 8.3).
- *Criterion 2: species-rich plant communities.* Less than 1% of the surveyed ponds qualified on the basis of this criterion.
- *Criterion 3: PSYM assessments.* Just over 4 % of ponds in England and Wales qualified on the basis of PSYM assessments. No PSYM assessments were made for Scotland.

▼ **Table 8.3:** Percentage of ponds qualifying as Priority Habitats across Great Britain in 2007, using three plant criteria.

		Rare species (% of ponds)	More than 30 plant species (% of ponds)	PSYM >75% (% of ponds)	Total Priority Habitat Ponds (% of ponds)
GB	(260)	3.9	0.4	4.6*	8.1*
England	(150)	0.8	0.4	4.2	4.6
Scotland	(81)	3.1	0.0	na	3.1*
Wales	(29)	0.0	0.0	0.4	0.4
** The total excludes PSYM assessments in Scotland*					

In total, 8% of the ponds met Priority Habitat status on the basis of three plant criteria, excluding PSYM assessments in Scotland. Most ponds qualified on the basis of only one criterion. Only one pond qualified on all three criteria.

▼ **Table 8.4:** Change in condition of vegetation in 10m x 1m Streamside Plots in the Rivers and Streams Broad Habitat across Great Britain between 1990 and 2007. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3***.

	Mean values (GB)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**	**GB**	**E**	**S**	**W**
Species Richness (No. of Species)	18.6	17.2	↓	↓	↓		↓	↓		↓	↓	↓	↓	↓
No. of Bird Food Species	6.3	5.9	↓		↓		↓	↓		↓	↓	↓	↓	↓
No. of Butterfly Food Species	6.6	6.1	↓	↓	↓	↓	↓	↓		↓	↓	↓	↓	↓
Grass:Forb Ratio	0.26	0.12	↓	↓							↓	↓		
Competitor Score	2.92	2.94	↑	↑	↑		↑	↑	↑	↑	↑	↑	↑	↑
Stress Tolerator Score	2.48	2.48						↑	↓			↑	↓	
Ruderal Score	2.18	2.13	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Light Score	6.57	6.51	↓	↓	↓	↓	↓	↓	↑		↓	↓		↓
Fertility Score	4.91	4.95	↑	↑							↑	↑		
Ellenberg pH Score	5.38	5.42	↑	↑								↑		
Moisture Score	6.34	6.31	↓	↓		↓	↓	↓			↓	↓		↓

It is important to recognise that basing assessments on plant data only under-estimates the proportion achieving Priority Habitat status; more of the ponds surveyed would undoubtedly have qualified if animal groups like invertebrates and amphibians were also surveyed. This means that the current CS can be used to provide only a minimum estimate of the number of Pond Priority Habitat sites in Great Britain.

8.4 Change in vegetation alongside rivers and streams

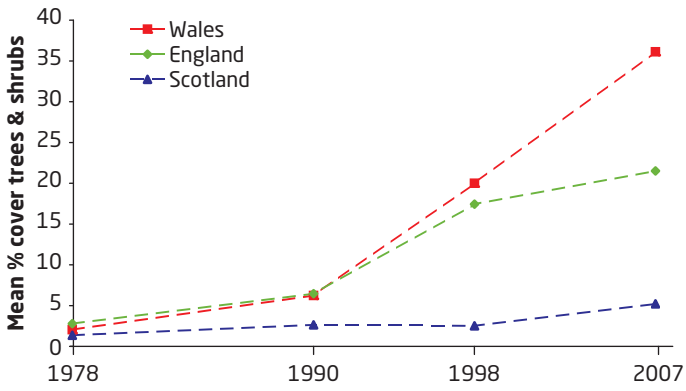
- **Plant species richness of streamsides decreased by 7.5% in Great Britain between 1998 and 2007. Since 1990 there has been a successional change, with vegetation becoming taller and with more competitive species.**

The vegetation growing alongside streams, ditches and rivers was sampled in 10m long x 1m wide 'Streamside Plots' *(Table 1.3)*. Most of these Plots were on small headwater streams (because they are more frequent in the countryside), but some Streamside Plots were also placed alongside larger rivers.

There was a continued increase of competitive species in Great Britain between 1998 and 2007, as well as a continued decrease in the ratio of grasses to forbs and in the Light Score between 1998 and 2007 *(Table 8.4)*. These changes indicate that the streamside vegetation element of the Rivers and Streams Broad Habitat has become less managed and more overgrown, over the period 1990 to 2007. The overgrown vegetation might help explain the decreases in plant species richness and the number of plant species used by farmland birds and butterfly caterpillars as food.

When the analysis was restricted to the subset of 442 Streamside Plots that were first surveyed in 1978 and revisited in all subsequent Countryside Surveys, the changes seen over the 1978 to 2007 period were largely consistent with those reported in *Table 8.4*. The overall successional trend in streamside vegetation over the 29-year period is most clearly seen by the increase in cover of trees and shrubs *(Fig. 8.5)*.

▼ **Figure 8.5:** Change in % cover of woody species in Streamside Plots in Wales, England and Scotland, based on repeat Streamside Plots between 1978 and 2007.



The Ellenberg pH Score increased in line with most other Broad Habitats but the increase in the Fertility Score was unusual in the context of the period 1998 to 2007, as in most Broad Habitats there was neither an increase nor a decrease. Without further investigation it is unclear why this may have occurred. Similarly unusual was the decrease in the Moisture Score in England and Wales *(Table 8.4)*, where for most Broad Habitats this index increased between 1998 and 2007.

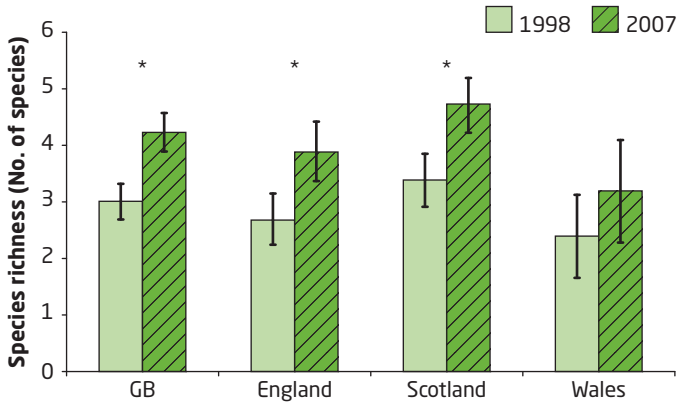
8.5 Changes in the vegetation and physical quality of headwater streams

- **Plant species richness in streams increased in Great Britain between 1998 and 2007 and there was a high turnover of species.**
- **The physical characteristics of streams improved in Great Britain between 1998 and 2007.**

8.5.1 Changes in aquatic plant species richness in headwater streams

The diversity and cover of aquatic (within the water) plants were recorded over a 100m length of stream channel in 332 CS sample squares in both 1998 and 2007.

▼ **Figure 8.6:** Change in mean headwater stream aquatic plant species richness across Great Britain and in England, Scotland and Wales between 1998 and 2007. Asterisks denote a statistically significant change between surveys (* p<0.05). 95% CI are shown for each bar.



▲ Aquatic vegetation • © *NERC*

The increase in plant species richness *(Fig. 8.6)* indicates a continuation of the 1990 to 1998 trend (based on macroinvertebrate diversity) for a gradual improvement in the biological condition of streams. Pooled plant species richness remained stable across Great Britain as a whole, between 1998 and 2007, but there were substantial increases in both England and Scotland *(Table 8.5)*.

▼ **Table 8.5:** Change in pooled headwater stream plant species richness across Great Britain and in individual countries between 1998 and 2007. Arrows denote significant change (p<0.05) in the direction shown.

	Pooled species richness		Change in pooled species richness 1998 - 2007	Direction of significant changes 1998 - 2007
	1998	2007		
GB	136	138	2	
England	85	98	13	↑
Scotland	93	107	14	↑
Wales	51	48	-3	

There was a considerable turnover of plant species between 1998 and 2007. Only 102 (59%) of all 174 aquatic plant taxa encountered were recorded in both years. Of the 102 persistent taxa, 65 had increased in frequency across Great Britain since 1998, while only 22 decreased in frequency. Algal taxa such as *Cladophora* and *Spirogyra* were among those taxa with the most substantial decreases, while it was the predominantly emergent vascular plants such as Brooklime (*Veronica beccabunga*), Bulbous Rush (*Juncus bulbosus*), Water Forget-me-not (*Myosotis scorpioides*) and Creeping Bent (*Agrostis stolonifera*) that became more prevalent by 2007. The stability of the national aquatic plant species pools was investigated, revealing that Scotland had the greatest turnover of headwater stream aquatic plants between 1998 and 2007, with only 46% of taxa occurring in both 1998 and 2007. At the other extreme, just over 60% of taxa found in England were recorded in both 1998 and 2007. 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 streams.

The Mean Trophic Rank (MTR) score (*see* ***Annex 1: Glossary***) of aquatic plants in headwater streams increased significantly in Great Britain between 1998 and 2007, indicating a reduction in nutrient enrichment in headwater streams *(Table 8.6)*. However, this trend should be treated with caution because the CS sites, in common with sites generally in any river or stream, often have restricted MTR species richness and the assessment can be based on only 1-3 scoring species. This makes the MTR score vulnerable to even slight changes in species composition.

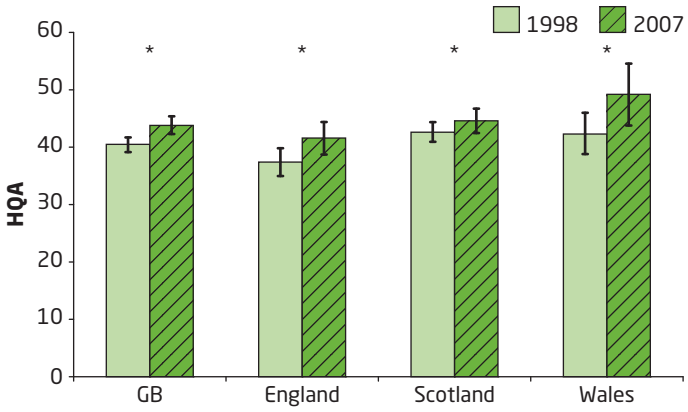
▼ **Table 8.6:** Change in Mean Trophic Rank or MTR bioassessment score per headwater stream site across Great Britain and in England, Scotland and Wales between 1998 and 2007. Arrows denote significant change (p<0.05) in the direction shown.

	Mean Trophic Rank		Change in Mean Trophic Rank 1998 - 2007	95% Confidence Interval	Direction of significant changes 1998 - 2007
	1998	2007			
GB	55.8	59.0	3.2	(0.9, 5.6)	↑
England	42.5	43.6	1.1	(-2.6, 4.8)	
Scotland	63.8	67.8	4.0	(1.0, 7.2)	↑
Wales	56.8	63.2	6.4	(-3.5, 16.5)	

8.5.2 *Physical habitat diversity of headwater strreams*

A River Habitat Survey (RHS) (*see* ***Annex 1: Glossary***) was included in CS for the first time in 1998; the repeat survey in 2007 provided the first comparison over time.

▼ **Figure 8.7:** Change in the Habitat Quality Assessment (HQA) across Great Britain and in England, Scotland and Wales between 1998 and 2007. Asterisks denote statistically significant change (* P<0.05). 95% CI are shown for each bar.



The significant improvements in habitat quality of headwater streams in Great Britain ***(Fig. 8.7)*** were driven by an increase in the number of various natural features e.g. gravel bars, river-side trees and side-channels. The greatest increase in quality was recorded in Wales, with a 16% increase in HQA (*see* ***Annex 1: Glossary***) between 1998 and 2007, but there were also significant improvements detected in England and Scotland.

The improvement in stream physical condition (HQA) was not significantly related to improvements in biological condition (MTR) at any spatial scale. There was no relationship between stream habitat quality and stream plant diversity at any scale. These findings are unexpected and will be investigated in more detail as part of the ongoing CS research programme.

▲ Headwater stream, Wales • © *NERC*

8.6 Discussion and conclusions

The area of Standing Waters and Canals Broad Habitat and the number of ponds continued to increase between 1998 and 2007, following a previously reported rise to 1998, but the condition of existing ponds deteriorated. Further analysis is required to understand the factors contributing to poor pond quality, as assessed by plant species richness. Important factors are likely to include nutrient pollution, management of adjacent land and water body isolation, caused by loss of ponds and other wetlands over the middle to latter half of the 20th Century, largely attributed to the intensification of agriculture. The recent listing of ponds meeting specified quality criteria as a Priority Habitat should provide the mandate for focussed action to address the conservation of high quality ponds. CS in 2007 provides a national baseline assessment for the Pond Priority Habitat against which future changes can be assessed.

Trends in the Rivers and Streams Broad Habitat were more positive. CS in 2007 documented a continuing improvement in the biological and physical condition of headwater streams in Great Britain. These outcomes may well be a consequence of the substantial efforts made over the past 20 years to strengthen environmental regulations and improve management of rivers and streams.

The streamside vegetation community has continued to shift toward a late-successional assemblage, with an associated loss of species and increase in nutrient-demanding, competitive herbaceous plants and woody species. These changes suggest that the riparian areas of headwater streams are generally becoming less physically disturbed by adjacent agricultural practices. They are likely to be a consequence of catchment-sensitive management practices which aim to reduce the impacts of diffuse pollution, e.g. grants for watercourse fencing.

CS collected information in 2007 on the stream-bed macroinvertebrate fauna in headwater streams, which will be used to provide a robust assessment of change in biological condition back to 1990. These data are currently being processed and will be reported separately. It will be interesting to see if the trends from the stream plants and invertebrate results concur.

The 12.5% increase in the number of ponds in Great Britain between 1998 and 2007 help reverse the losses in the middle years of the 20th Century and could be beneficial to the fauna and flora that are characteristic of these habitats, but only if the new ponds are at least of equivalent biological condition to existing and lost ponds.

▲ Streamside vegetation, England • © *NERC*

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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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▲ Wind farm, England• © *Sue Wallis*

9. Developed Land in Rural Areas

Summary

- **The area of the Built-up and Gardens Broad Habitat in the rural environment did not increase in the UK between 1998 and 2007.**
- **The increase in the area of roads and tracks seen in Great Britain between 1984 and 1998 has not continued to 2007.**

9.1 Introduction[1]

This chapter examines changes in the area of the built environment related to development in rural areas. Development in this context includes new buildings and the infrastructure required to service them, forming one of the key pressures on the UK countryside. Countryside Survey (CS) is not designed to survey changes in truly urban areas and therefore survey squares that contained more than 75% of developed land on the date of first survey were excluded from the sample of squares (i.e. 'unsurveyed urban land') and replaced with another survey square.

All developed land in rural areas, apart from transport features, is included in the Broad Habitat known as 'Built-up and Gardens'. It covers both urban and rural settlements, farm buildings, and all man-made structures such as industrial estates, retail parks, waste and derelict ground, mineral workings, airports and urban parkland.

Roads, tracks and railways in rural areas are included within the Boundary and Linear features Broad Habitat but, as mentioned in *Chapter 5*, these features are more conveniently dealt with in the present chapter.

In CS, land in this Broad Habitat is only mapped; no sampling plots are recorded for assessing vegetation condition.

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

9.2 Area of the Habitat

- **The area of the Built-up and Gardens Broad Habitat in the rural environment did not increase in the UK between 1998 and 2007.**
- **The increase in the area of roads seen in Great Britain between 1984 and 1998 has not continued to 2007.**

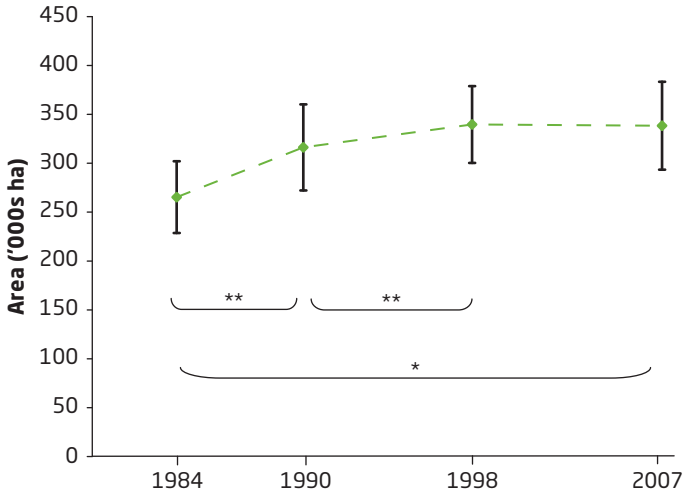
9.2.1 Built-up and Gardens Broad Habitat

The area of Built-up and Gardens Broad Habitat associated with the rural environment (i.e. not part of the unsurveyed urban land core), was estimated at 1.4 million ha in the UK in 2007 *(Table 9.1)*, which is not a statistically significant change from 1998. In Wales and Northern Ireland there were significant increases in the area of Built-up and Gardens between 1998 and 2007, these will be investigated further in their respective country reports.

The majority of the Built-up and Gardens Broad Habitat in the rural environment is made up of buildings. There was an increase in the area of buildings in the rural environment of Great Britain between 1998 and 2007 *(Table 9.2)*.

There was no detectable change in the estimated area covered by roads and tracks in Great Britain between 1998 and 2007 *(Table 9.3)*. The increase seen between 1984 and 1998 *(Fig. 9.1)* has halted in the countryside as a whole.

▼ **Figure 9.1:** The area of roads and tracks in the rural environment in Great Britain between 1984 and 2007. Significant changes (* p<0.05, ** p<0.01) are shown between the dates bracketed. 95% CI are shown for each data point.



▲ Development in the countryside, England • © *Natural England*

9.3 Changes between Broad Habitats

Developed land is a very stable habitat or land use. The vast 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, but most of the new development was on Arable and Horticultural land (*see* ***Annex 6*** *at 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, see ***Chapter 5***.

▼ **Table 9.1:** Estimated area ('000s ha) and percentage of land area of the Built-up and Gardens Broad Habitat in the UK from 1998 to 2007 and Great Britain from 1990 to 2007 are shown (1984 figures are not available). Arrows denote significant change ($p<0.05$) in the direction shown. Data not available = na. Note: estimates exclude the area of unsurveyed urban land.

	1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
GB	1266	5.4	1279	5.5	1323	5.7	
England	999	7.6	1009	7.7	1038	7.9	
Scotland	150	1.9	153	1.9	153	1.9	
Wales	117	5.5	117	5.5	132	6.2	↑
Northern Ireland	na	na	57	4.0	74	3.5	
UK	na	na	1336	5.4	1397	5.6	

▼ **Table 9.2:** Estimated area ('000s ha) and percentage of land area of buildings in the rural environment in Great Britain from 1984 to 2007. Arrows denote significant change ($p<0.05$) in the direction shown. Note: estimates exclude the area of unsurveyed urban land.

Buildings	1984		1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
GB	966	4.3	1032	4.6	911	4.0	953	4.2	↑
England	na	na	799	6.3	725	5.7	753	5.9	
Scotland	na	na	134	1.7	115	1.4	121	1.5	
Wales	na	na	100	4.7	72	3.4	79	3.8	

▼ **Table 9.3:** Estimated area ('000s ha) and percentage of land area of roads and tracks in the rural environment in the UK from 1998 to 2007 and Great Britain from 1984 to 2007 are shown. Arrows denote significant change ($p<0.05$) in the direction shown. Note: estimates exclude the area of unsurveyed urban land.

Roads	1984		1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
GB	265	1.2	316	1.4	340	1.5	338	1.5	
England	na	na	240	1.9	247	2.0	250	2.0	
Scotland	na	na	50	0.6	54	0.7	55	0.7	
Wales	na	na	27	1.3	39	1.9	33	1.6	
Northern Ireland	na	na	na	na	29	4.0	31	3.5	↑
UK	na	na	na	na	369	1.5	369	1.5	

9.5 Discussion and conclusions

The results showed no increase in the area of Built-up and Gardens between 1998 and 2007, which might be surprising as many observers would say that there has been an increase. 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. The Survey does not record new buildings in the urban environment within a survey square, nor within the curtilage of existing buildings such as farmhouses and their gardens.

There have also been some large developments on the fringes of towns and several new towns built, these large but localised changes are unlikely to be sampled within the random stratified approach used within CS. The sampling strategy of CS is better suited to detecting changes which are distributed widely across the countryside. Results from the 2007 Survey show that the wider countryside has not been altered radically by development since 1998.

CS did not detect any further increase in the area of land taken by road building or road widening following the large increases recorded from 1984 to 1990 and from 1990 to 1998. Road building has large impacts locally but is not detectable on an area sampling basis at a national scale.

▲ Farm buildings converted to offices, England • © *Sue Wallis*

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▲ Flowering species in grassland, England • © *Sue Wallis*

10. Changes in Countryside Vegetation System Aggregate Classes between 1978 and 2007

Summary

- Between 1978 and 1990 63% of all sampling plots in fields, woods, heaths and moors remained in the same vegetation Aggregate Class. This figure increased to 75% between 1998 and 2007. Changes were more frequent and marked in vegetation associated with arable farming while in upland vegetation changes were more gradual and less frequent.
- Plant species richness increased in plots originally located in Crops and Weeds in 1978, in Great Britain between 1998 and 2007. Species preferring wet conditions, low fertility and more acid conditions increased.
- There was a 21% decrease in the plant species richness in plots located in Infertile Grassland in 1978, in Great Britain between 1978 and 2007. However, no change was detected in these plots between 1998 and 2007.
- The number of ancient woodland indicator plant species in plots located within Woodlands in 1978 decreased by 36% in Great Britain between 1978 and 2007. A decrease was also detected between 1998 and 2007.
- Competitive plant species increased while species of open ground decreased in Moorland Grass Mosaics in Great Britain between 1978 and 2007. There was little change between 1998 and 2007 in this Aggregate Class.
- The Fertility Score of plots located within the Heath and Bog Aggregate Class in 1978 increased, in Great Britain between 1978 and 2007. However, between 1998 and 2007 the Fertility Score decreased in these plots, following a large increase between 1978 and 1990.

10.1 Introduction[1]

The Countryside Survey (CS) data set provides additional opportunities to examine long-term changes in the vegetation in Great Britain, using the Countryside Vegetation System to assess changes in fixed sampling plots recorded since 1978. The analyses presented in *Chapters 3 to 9* present the results for sampling plots remaining within the same Broad Habitats between surveys in 1990, 1998 and 2007. The analyses presented in this chapter are different in that they follow the changes to vegetation sampling plots over time independently of any changes to the Broad Habitats in which they were located.

Vegetation plots were originally surveyed in 1978 in 256 sample squares. The vegetation in each plot was assigned to one of the eight Aggregate Classes (ACs) from the Countryside Vegetation System according to the mix of species present, as outlined in *Chapter 1*. Many of the plots surveyed in 1978 have subsequently been surveyed in 1990, 1998 and 2007, providing a unique opportunity to study changes in the vegetation of Great Britain over almost 30 years. A proportion of the plots will have stayed in the same AC (and Broad Habitat) throughout the period, but others will have switched between ACs, for example from an arable field (Crops and Weeds AC) to improved grassland (Fertile Grassland AC) or vice versa.

10.2 Turnover of Aggregate Classes

- **Between 1978 and 1990 63% of all sampling plots in fields, woods, heaths and moors remained in the same vegetation Aggregate Class. This figure increased to 75% between 1998 and 2007. Changes were more frequent and marked in vegetation associated with arable farming while in upland vegetation changes were more gradual and less frequent.**

The degree to which vegetation remains the same, gradually changes, or changes in a sudden way is likely to vary depending on the habitat and its management. Certain vegetation types are transient because of the way that they are managed: e.g. Crops and Weeds and Tall Grass and Herb ACs, which can vary from year-to-year within farmed systems. In contrast, upland habitats such as Moorland Grass Mosaic AC have been more or less grazed by animals for centuries.

Between 1978 and 1990, 63% of all Main Plots stayed within the same AC. The most stable AC was Heath and Bog, and the least stable was Tall Herb and Grass which is a variable vegetation type often occurring in small areas and hence contain few Main Plots *(Table 10.1)*.

In the period 1978 to 1990, in lowland fields and other large areas of lowland habitat (i.e. as sampled by Main Plots), a net shift occurred from Crops and Weeds AC to the less intensively managed and perennial dominated Tall Herb and Grass AC, and from the typically more intensively managed Fertile Grassland AC to Tall Herb and Grass AC. There was also a large turnover between Crops and Weeds and Fertile Grassland as would be expected from crop/grass rotations. The small number of plots allocated to the Lowland Wooded AC in 1978 increased by 42% in 1990. In the uplands there were small movements from Infertile Grassland, Moorland Grass Mosaic and Heath and Bog ACs to Upland Wooded AC, possibly a consequence of afforestation. The small net flow from Heath and Bog AC to Moorland Grass Mosaic AC may be a consequence of overgrazing.

Between 1990 and 1998, 72% of all Main Plots stayed within the same vegetation AC *(Table 10.2)*. There was again a high rate of turnover between Crops and Weeds, Tall Grass and Herb, Fertile and Infertile Grassland, with a small net gain in Infertile Grassland. There was also a continuing net shift from Heath and Bog AC to Moorland Grass Mosaic and to Upland Wooded. The number of plots classified as Heath and Bog decreased by 10%.

Between 1998 and 2007, 74% of Main Plots stayed within the same vegetation AC.

In the period 1998 to 2007 there was an overall shift of plots from Crops and Weeds to Fertile and Infertile Grassland. The number of plots classified as Crops and Weeds decreased by 12% and those classified as Fertile Grassland increased by 13%. There was also an overall shift from Moorland Grass Mosaic AC to Infertile Grassland and to Heath and Bog. The number of plots classified as Moorland Grass Mosaic AC decreased by 12% but those classified as Heath and Bog increased by 5%, partially reversing previous changes. Lowland Wooded AC gained from a range of other ACs, including Upland Wooded. The number of plots classified as Lowland Wooded increased by 22% *(Table 10.3)*. In the following sections, the condition of the 1215 vegetation sampling Main Plots first surveyed in 1978 *(Table 10.1)* is followed through time. The plots were allocated to the AC in which they were classified in 1978 and were analysed according to that cohort of plots, whether or not they subsequently changed AC.

▲ Arable weeds in cereal crop • © *Ian Simpson*

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

▼ **Table 10.1:** Matrix of change showing the change in allocation of Main Plots to Aggregate Classes, in Great Britain between 1978 and 1990. The shaded diagonal cells show the number of plots that stayed within the same Aggregate Class.

		Aggregate Class Membership 1978								
		Crops and Weeds	Tall Grass and Herb	Fertile Grass-land	Infertile Grass-land	Lowland Wooded	Upland Wooded	Moor-land Grass Mosaic	Heath and Bog	Total number of plots 1990
Aggregate Class Membership 1990	Crops and Weeds	175	3	46	11					235
	Tall Grass and Herb	41	4	16	5	2	1			69
	Fertile Grassland	43	5	107	52		1		2	210
	Infertile Grassland	6	2	48	150	1	2	11	3	223
	Lowland Wooded		2	3	4	15	10			34
	Upland Wooded				4	6	43	14	11	78
	Moorland Grass Mosaic				7		15	75	37	134
	Heath and Bog			1	1		4	25	201	232
	Total number of plots 1978	**265**	**16**	**221**	**234**	**24**	**76**	**125**	**254**	**1215**
	% stable	**66**	**25**	**48**	**64**	**63**	**57**	**60**	**79**	

▼ **Table 10.2:** A matrix of change of Aggregate Classes of vegetation recorded in Main Plots across Great Britain between 1990 and 1998. The diagonal shows the number of plots that stayed within the same Aggregate Class.

		Aggregate Class Membership 1990								
		Crops and Weeds	Tall Grass and Herb	Fertile Grass-land	Infertile Grass-land	Lowland Wooded	Upland Wooded	Moor-land Grass Mosaic	Heath and Bog	Total number of plots 1998
Aggregate Class Membership 1998	Crops and Weeds	296	65	55	5					421
	Tall Grass and Herb	56	41	27	5	3	2		1	135
	Fertile Grassland	60	20	277	59			2		418
	Infertile Grassland	4	7	69	308		5	12		405
	Lowland Wooded		4			63	9			76
	Upland Wooded		2		7	13	113	25	13	173
	Moorland Grass Mosaic				9		21	196	61	287
	Heath and Bog						8	22	383	413
	Total number of plots 1990	**416**	**139**	**428**	**393**	**79**	**158**	**257**	**458**	**2328**
	% stable	**71**	**29**	**65**	**78**	**80**	**72**	**76**	**84**	

▼ **Table 10.3:** A matrix of change of Aggregate Classes of vegetation recorded in Main Plots across Great Britain between 1998 and 2007. The diagonal shows the number of plots that stayed within the same Aggregate Class.

		Aggregate Class Membership 1998								
		Crops and Weeds	Tall Grass and Herb	Fertile Grass-land	Infertile Grass-land	Lowland Wooded	Upland Wooded	Moor-land Grass Mosaic	Heath and Bog	Total number of plots 2007
Aggregate Class Membership 2007	Crops and Weeds	257	52	21						330
	Tall Grass and Herb	41	30	22	5	7	3			108
	Fertile Grassland	62	20	261	72			1		416
	Infertile Grassland	12	6	61	324		6	19		428
	Lowland Wooded	2	7	2	1	48	13			73
	Upland Wooded	1	2	1	8	5	121	25	10	173
	Moorland Grass Mosaic		2		7		20	219	20	268
	Heath and Bog						9	39	364	412
	Total number of plots 1998	**375**	**119**	**368**	**417**	**60**	**172**	**303**	**394**	**2208**
	% stable	**69**	**25**	**71**	**78**	**80**	**70**	**72**	**92**	

▼ **Table 10.4:** Change in the characteristics of vegetation in 200m² Main Plots located in the Crops and Weeds Aggregate Class in 1978, across Great Britain between 1978 and 2007. Arrows denote significant change ($p<0.05$) in the direction shown. Mean values for 1998 and 2007 are presented; those for 1978 and 1990 are available in ***Annex 7*** *(see www.countrysidesurvey.org.uk/)*. Analyses are described in ***Box 1.3***. There were insufficient data to carry out an analysis for Wales (grey columns with diagonal strikethrough).

	Mean values (GB)		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	GB	E	S	W	GB	E	S	W	GB	E	S	W	GB	E	S	W
Species Richness (No. of Species)	8.7	10.9	↑	↑														
No. of Bird Food Species	4.5	5.5	↑	↑								↓						
No. of Butterfly Food Species	3.3	4.2	↑	↑											↑	↑		
Grass:Forb Ratio	1.97	1.17	↓	↓			↑	↑			↓	↓						
Competitor Score	2.41	2.38					↑	↑			↑		↑		↑	↑	↑	
Stress Tolerator Score	1.49	1.53					↑	↑	↓				↑		↑	↑	↑	
Ruderal Score	3.52	3.48					↓	↓	↓		↓		↓		↓	↓	↓	
Light Score	7.06	7.04																
Fertility Score	6.40	6.25	↓		↓			↓					↓		↓		↓	
Ellenberg pH Score	6.63	6.49	↓	↓	↓						↑	↑	↓		↓		↓	
Moisture Score	5.03	5.12	↑	↑			↑	↑	↑		↓	↓			↑	↑		

10.3 Crops and Weeds Aggregate Class

- **Plant species richness increased in plots located in the Crops and Weeds Aggregate Class in 1978, in Great Britain between 1998 and 2007. Species preferring wet conditions, low fertility and more acid conditions increased.**

Species richness: The plant species richness within Main Plots located within the Crops and Weeds AC in 1978 increased across Great Britain between 1998 and 2007. Herbs to Forb species increased relative to grasses between 1998 and 2007 and this ratio increased and decreased between successive surveys, probably reflecting the shifting management of the original 1978 plots between arable crops, grassland and fallow/set-aside *(Table 10.4)*. There was also an increase in the number of plant species used as food by farmland birds and butterfly caterpillars in Great Britain between 1998 and 2007.

Other vegetation characteristics: In Main Plots located within the Crops and Weeds AC in 1978, stress-tolerating and competitive species increased at the expense of ruderal species, across Great Britain between 1978 and 2007 *(Table 10.1)* but there was no detectable change between 1998 and 2007.

The Fertility Score decreased significantly in Main Plots located within the Crops and Weeds AC in 1978, across Great Britain between 1998 and 2007, continuing a trend from 1978 to 1998. The decrease was most pronounced from 1990 to 2007.
The Moisture Score in Main Plots located within the Crops and Weeds AC in 1978 increased between 1998 and 2007 continuing the increase seen between 1990 and 1998, but following a decrease between 1978 and 1990. Over the whole period (1978 to 2007) the proportion of plant species preferring wetter conditions increased. A decrease in the Ellenberg pH Score was recorded across Great Britain between 1998 and 2007, and overall between 1978 and 2007, despite an increase between 1978 and 1990. This corresponds with the pattern of change found by the direct analysis of soil (0-15cm) samples *(Table 2.8)*.

▲ Tall Herb and Grass AC, England • © *Simon Smart*

▼ **Table 10.5:** Change in the characteristics of vegetation in 200m² Main Plots located within the Fertile Grassland Aggregate Class in 1978, across Great Britain between 1978 and 2007. Arrows denote significant change ($p<0.05$) in the direction shown. Mean values for 1998 and 2007 are presented; those for 1978 and 1990 are available in ***Annex 7***. Analyses are described in ***Box 1.3***.

	Mean values (GB)		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	GB	E	S	W	GB	E	S	W	GB	E	S	W	GB	E	S	W
Species Richness (No. of Species)	13.1	13.9														↑		
No. of Bird Food Species	8.1	8.5																
No. of Butterfly Food Species	6.3	6.3																
Grass:Forb Ratio	1.72	1.56							↑				↓			↓		
Competitor Score	2.63	2.73	↑	↑									↓			↑		
Stress Tolerator Score	1.81	1.85																
Ruderal Score	3.30	3.17	↓	↓											↓	↓		
Light Score	7.07	7.05									↓		↓		↓	↓	↓	
Fertility Score	5.85	5.81					↓	↓							↓			
Ellenberg pH Score	6.18	6.21			↑		↓	↓	↓			↑						
Moisture Score	5.30	5.32					↑	↑	↑		↓	↓	↓			↑		

10.4 Tall Herb and Grass Aggregate Class

There were almost no detectable changes in the species richness or condition of Main Plots located within the Tall Herb and Grass AC in 1978, in Great Britain between 1978 and 2007, or within any of the intermediate time periods. This probably reflects the small sample size and the very dynamic and variable nature of this vegetation type *(Tables 10.1 to 10.3)*, so that no consistent changes were detected.

10.5 Fertile Grassland Aggregate Class

Species richness: There was no change in the plant Species Richness Score of Main Plots located within the Fertile Grasslands AC in 1978, across Great Britain between 1978 and 2007.

Other vegetation characteristics: The proportion of competitive species increased at the expense of ruderal species in Main Plots located within the Fertile Grassland AC in 1978, across Great Britain between 1998 and 2007. There were no changes in any other measures of vegetation condition between 1998 and 2007. Over the longer timescale, there were reductions in both Fertility and Light Scores. This suggests that between 1978 and 2007 the vegetation within these plots became less open and more dominated by species that cast and/or prefer shade, but also those that prefer less fertile conditions *(Table 10.5)*.

▲ Fertile grassland, England • © *Simon Smart*

▼ **Table 10.6:** Change in the characteristics of vegetation in 200m² Main Plots located within the Infertile Grassland Aggregate Class in 1978, across Great Britain between 1978 and 2007. Arrows denote significant change ($p<0.05$) in the direction shown. Mean values for 1998 and 2007 are presented; those for 1978 and 1990 are available in ***Annex 7***. Analyses are described in ***Box 1.3***.

	Mean values (GB)		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	GB	E	S	W	GB	E	S	W	GB	E	S	W	GB	E	S	W
Species Richness (No. of Species)	20.1	19.3				↓	↓				↓	↓	↓	↓	↓	↓	↓	↓
No. of Bird Food Species	10.0	9.8				↓			↓		↓	↓		↓	↓	↓	↓	↓
No. of Butterfly Food Species	9.5	9.1				↓	↓				↓	↓	↓	↓	↓	↓	↓	↓
Grass:Forb Ratio	1.25	1.04	↓			↓				↑								
Competitor Score	2.70	2.78	↑	↑	↑		↑											
Stress Tolerator Score	2.23	2.27									↓		↓					
Ruderal Score	2.96	2.85	↓	↓	↓													
Light Score	6.98	6.94	↓															
Fertility Score	5.15	5.09									↑	↑	↑		↑	↑		
Ellenberg pH Score	5.81	5.73	↓			↓					↑	↑						↓
Moisture Score	5.43	5.52	↑	↑	↑		↑	↑							↑	↑	↑	↑

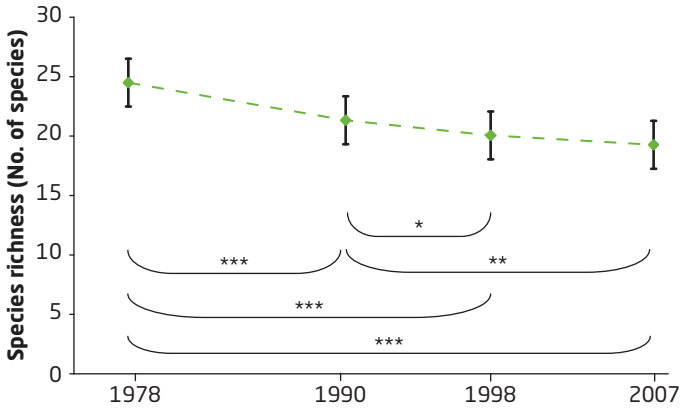
10.6 Infertile Grassland Aggregate Class

- **There was a 21% decrease in the plant species richness in plots located in Infertile Grassland in 1978, in Great Britain between 1978 and 2007. However, no change was detected in these plots between 1998 and 2007.**

Species richness: The Infertile Grassland AC includes vegetation of unimproved and often species-rich grassland, mainly in lowland Great Britain. There was a 21% decrease (from 24.5 to 19.3 species) in the plant Species Richness Score in Main Plots originally located within the Infertile Grassland AC in 1978, across Great Britain between 1978 and 2007 ***(Table 10.6 and Fig 10.1)***. Numbers of plant species used by farmland bird and butterfly caterpillars as food also decreased over this period, and plots became more dominated by grass species. However, there was no change in species richness or numbers of plant species used by farmland bird and butterfly caterpillars as food in these plots between 1998 and 2007.

Other vegetation characteristics: Competitive species increased at the expense of ruderal species between 1998 and 2007. In addition, plant species that cast or prefer shade increased, as did plant species that prefer wet conditions. Plots that were in the Infertile Grassland AC in 1978 had an increased proportion of plant species that prefer more fertile conditions in 2007. Species preferring wetter conditions also increased between 1978 and 2007.

▼ **Figure 10.1:** Change in species richness in 200m² Main Plots located within the Infertile Grassland Aggregate Class in 1978, across Great Britain between 1978 and 2007. Significant changes (* $p<0.05$, ** $p<0.01$,*** $p<0.001$) are shown between the dates bracketed. 95% CI are shown for each data point.



10.7 Woodland Aggregate Classes

- **The number of ancient woodland indicator plant species in plots located within the Woodland Aggregate Classes in 1978 decreased by 36% in Great Britain between 1978 and 2007. A decrease was also detected between 1998 and 2007.**

Woodland plant communities are classified into Upland and Lowland Wooded ACs (see *Chapter 1*). However, as there were few plots sampled in each of these for statistical analysis, the data from the two classes have been analysed together. The combined class is referred to as the Woodland AC.

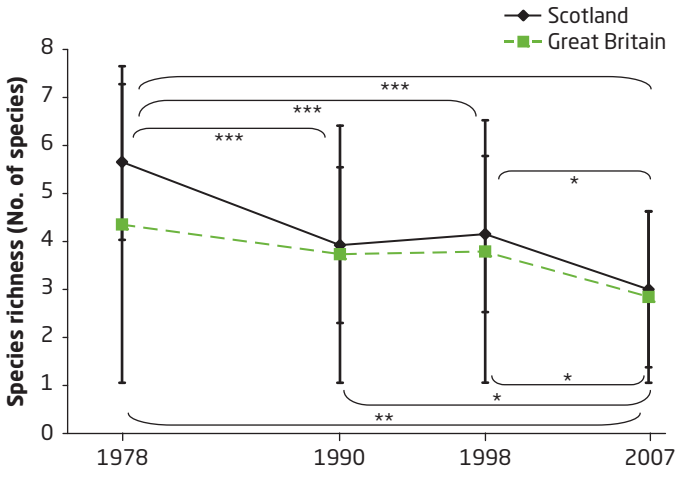
▼ **Table 10.7:** Changes in the number of ancient woodland indicator species in 200m² Main Plots located within the Woodland Aggregate Class in 1978 across Great Britain between 1978 and 2007. Arrows denote significant change (p<0.05) in the direction shown. Mean values for 1998 and 2007 are presented; those for 1978 and 1990 are available in ***Annex 7***. Data not available = na.

	Mean values		Direction of significant change 1998 - 2007	Direction of significant change 1990 - 1998	Direction of significant change 1978 - 1990	Direction of significant changes 1978 - 2007
	1998	2007				
GB	3.8	2.8	↓			↓
England	3.5	2.6				
Scotland	4.2	3.0	↓		↓	↓
Wales	na	na	na	na	na	na

Species richness: There was a 16% decrease (from 21.1 to 17.8 species) in plant species richness in Main Plots originally located within the Woodland AC in 1978, across Great Britain between 1978 and 2007. However no change in species richness was detected in these plots between 1998 and 2007 *(see **Annex 7**)*.

The numbers of ancient woodland indicator species in Main Plots located within the Woodland AC in 1978 decreased, by 36%, in Great Britain between 1978 and 2007, from a mean of 4.4 to 2.8 per plot ***(Table 10.7)***. When broken down by country, the reduction is largely attributable to changes in plots in Scotland ***(Fig. 10.2)***.

▼ **Figure 10.2:** Changes in the number of ancient woodland indicator species in 200m² Main Plots located in the Woodland Aggregate Classes in 1978, in Great Britain and Scotland between 1978 and 2007. Significant changes (* p<0.05,*** p<0.001) are shown between the dates bracketed for Scotland only. 95% CI are shown for each data point.



Other vegetation characteristics: There were few changes in the other characteristics of Main Plots located within the Woodland AC in 1978, across Great Britain between 1998 and 2007. There were no significant changes over the longer time-scale, from 1978 to 2007.

▲ Infertile grass, England • © *Simon Smart*

10.8 Moorland Grass Mosaic Aggregate Class

Species richness: There was a 13% decrease in plant Species Richness Score, and a decrease in the number of plant species used as food plants by butterfly caterpillars, in the Main Plots located within the Moorland Grass Mosaic AC in 1978, in Great Britain between 1998 and 2007. This continued a decrease recorded from 1978 ***(Table 10.8)***.

Other vegetation characteristics: There were no notable changes in the characteristics of Main Plots located within the Moorland Grass Mosaic AC in 1978, in Great Britain between 1998 and 2007. Over the longer term, there were relative increases in competitive plant species and those preferring wetter conditions, and decreases in ruderal species between 1978 and 2007.

▼ **Table 10.8:** Change in the characteristics of vegetation in 200m² Main Plots located within the Moorland Grass Mosaic Aggregate Class in 1978, across Great Britain between 1978 and 2007. Mean values for 1998 and 2007 are presented; those for 1978 and 1990 are available in ***Annex 7***. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3***.

	Mean values (GB)		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	GB	E	S	W	GB	E	S	W	GB	E	S	W	GB	E	S	W
Species Richness (No. of Species)	23.2	20.1	↓		↓			↑						↑				
No. of Bird Food Species	6.1	5.7						↑						↑				
No. of Butterfly Food Species	9.3	8.4	↓		↓					↓				↑	↓		↓	
Grass:Forb Ratio	1.04	1.11								↑	↓		↓					
Competitor Score	2.34	2.39					↑		↑						↑		↑	
Stress Tolerator Score	3.30	3.27					↓		↓						↓		↓	↓
Ruderal Score	1.96	1.94												↑				
Light Score	6.87	6.88								↑								
Fertility Score	3.25	3.26												↑				
Ellenberg pH Score	3.92	3.92																
Moisture Score	6.30	6.37													↑		↑	

10.9 Heath and Bog Aggregate Class

- **The Fertility Score of plots located within the Heath and Bog Aggregate Class in 1978, increased in Great Britain between 1978 and 2007. However, between 1998 and 2007 the Fertility Score decreased in these plots, following a large increase between 1978 and 1990.**

Species richness: There was a 7% decrease (from 16.2 to 15.0 species) in the plant Species Richness Score in Main Plots located within the Heath and Bog AC in 1978, across Great Britain between 1998 and 2007. However, no change in species richness was detected in these plots over the longer term between 1978 and 2007 *(Table 10.9)*.

Other vegetation characteristics: The proportion of stress-tolerating species decreased while the proportion of competitive and ruderal species increased in Main Plots located within the Heath and Bog AC in 1978, across Great Britain between 1978 and 2007. The relative increase in ruderal species occurred mostly between 1978 and 1990.

Between 1978 and 1990, the Fertility and Ellenberg pH Scores increased in these plots, followed by a decrease between 1998 and 2007. The overall trend was an increase between 1978 and 2007 *(Table 10.9)*. The signal of increasing nutrient status and alkalinity could help explain the decrease in stress-tolerating species.

▲ Moorland grass and heather mosaic, Scotland • © *NERC*

▼ **Table 10.9:** Change in the characteristics of vegetation in 200m² Main Plots located within the Heath and Bog Aggregate Class in 1978, across Great Britain between 1990 and 2007. Mean values for 1998 and 2007 are presented; those for 1978 and 1990 are available in ***Annex 7***. Analyses are described in ***Box 1.3***. Grey columns with diagonal strikethrough denote insufficient data to carry out an analysis for Wales.

	Mean values (GB)		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	GB	E	S	W	GB	E	S	W	GB	E	S	W	GB	E	S	W
Species Richness (No. of Species)	16.2	15.0	↓		↓													
No. of Bird Food Species	1.9	1.7	↓								↑		↑					
No. of Butterfly Food Species	5.9	5.5	↓		↓		↓		↓						↓		↓	
Grass:Forb Ratio	0.87	1.15	↑		↑		↓	↓	↓		↓		↓					
Competitor Score	2.20	2.20									↑		↑		↑		↑	
Stress Tolerator Score	3.62	3.64									↓		↓		↓		↓	
Ruderal Score	1.46	1.43						↑			↑		↑		↑		↑	
Light Score	7.07	7.11						↓			↓		↓		↓	↓		
Fertility Score	2.29	2.21	↓		↓						↑		↑		↑		↑	
Ellenberg pH Score	3.08	3.00	↓		↓						↑		↑		↑		↑	
Moisture Score	6.83	6.89									↓		↓			↓		

10.10 Discussion and conclusions

The dynamics of the vegetation of Great Britain varies. Lowland habitats, especially those associated with arable cropping change frequently and markedly. Upland habitats are more stable.

The results presented in this chapter build on the results presented in *Chapter 2* by tracing the changes in vegetation plots surveyed in 1978 and each of the following Countryside Surveys, using the ACs of the Countryside Vegetation System. This chapter adds extra contextual information to support the analysis of the Broad Habitats presented in *Chapters 3-9*.

The plots that were classified as Crops and Weeds AC in 1978 are the only ones in which species richness and the number of plant species used by farmland birds and butterfly caterpillars as food increased between 1998 and 2007, though over the full period, 1978 to 2007, there was no detectable change. These plots were already species-poor in 1978 and changes since then, including crop rotations, conversion to grassland and set-aside, have contributed to the maintenance, and since 1998, increase in plant species diversity. Crops and Weeds AC plots showed a high turnover between surveys and plots classified as Crops and Weeds AC and Fertile Grassland AC tended to switch between surveys.

The plots that were classified as Fertile Grassland AC in 1978 changed little between 1998 and 2007. Over the full period, 1978 to 2007, there was a shift in composition favouring taller, shade tolerant species at the expense of ruderal species, and species indicating higher levels of fertility decreased. About 20% of plots converted to the closely associated Tall Herb and Grass and Infertile Grass ACs between surveys.

▲ Bog vegetation, Scotland • © *NERC*

The plots that were classified as Infertile Grassland AC in 1978 have changed markedly. Plant species richness declined by 21% in these plots between 1978 and 2007. The vegetation composition also changed, with increases in species characteristic of more fertile and wetter conditions over this period. Between 1998 and 2007 these plots also had an increase in competitive species at the expense of ruderal species and an increase in shade tolerant species. Over 20% of plots converted to closely associated Tall Grass and Herb, Fertile Grassland and Moorland Grass Mosaic ACs between each survey. Around 10% of Infertile Grassland AC plots showed more marked changes between surveys and these often converted to Upland Wooded AC. The decrease in species richness in these plots is likely to be a major contributor to the overall decrease seen in all plots across Great Britain (see *Chapter 2*). However, between 1998 and 2007, no change in species richness was detected, indicating that factors contributing to the decline in these plots where more prevalent before 1998. The overall proportion of plots classified as Infertile Grassland remained the same between 1978 and 2007.

The decrease in the species richness in plots classified in the Woodland ACs in 1978 supports the findings of the *Woodland Survey 1971-2001*[2], and was associated with a sharp decrease in ancient woodland indicator species between 1978 and 2007. No clear signals emerge from the analysis of vegetation condition in these plots.

The plots classified as Moorland Grass Mosaic AC in 1978 showed no overall change in plant species richness from 1978 to 2007, but there was a decrease between 1998 and 2007. Between 1978 and 2007 there were increases in competitive species at the expense of stress-tolerating species and there was a shift towards species preferring wetter conditions. Plots located in the Moorland Grass Mosaic AC were more stable than the lowland grassland ACs and interchanged with Heath and Bog over the period 1978 to 2007.

The plots classified as Heath and Bog AC also showed no overall change in plant species richness from 1978 to 2007, but there was a decrease in species richness between 1998 and 2007. Many changes in vegetation condition occurred between 1978 and 1990: competitive and ruderal species increased at the expense of stress-tolerating species. There was a shift towards species preferring more nutrient rich and less acid conditions. In the most recent period, between 1998 and 2007, these changes were reversed with a shift towards species preferring more nutrient poor and more acidic conditions. Plots located in Heath and Bog were relatively stable compared to plots in the other ACs but there was an interchange of between 5% and 15% of plots with Moorland Grass Mosaic in each survey period. A smaller proportion (<6 %) of plots were converted to the Upland Wooded AC.

Further analysis of the trends from the vegetation sampling plots repeated in each survey is required to help identify and assess the significance of the factors causing the changes in vegetation.

▲ Mixed lowland wood, England • © *Sue Wallis*

[1] Kirby et al (2005). *Long-term ecological change in British woodland (1971-2001).* English Nature Research Reports Number **653**.

Countryside Survey

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