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

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▲ Dyffryn Ogwen, Wales • © *NERC*

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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.

Arable Field Margins .... (Chapter 3)
Blanket Bog .... (Chapter 7)
Hedgerows .... (Chapter 5)
Lowland Calcareous Grassland .... (Chapter 4)
Lowland Mixed Deciduous Woodland .... (Chapter 6)
Ponds .... (Chapter 8)
Upland Birchwoods .... (Chapter 6)
Upland Calcareous Grassland .... (Chapter 4)
Upland Heathland .... (Chapter 7)
Upland Mixed Ashwoods .... (Chapter 6)
Upland Oak Woods .... (Chapter 6)

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.

England, Wales and Scotland are divided into 'land classes', according to the major environmental gradients found at national scales.

These 'land classes' are used to identify a stratified random sample of the 1km x 1km grid squares across Great Britain.

● Sample square resurveyed
● New sample square in 2007

Within each 1km x 1km sample square, details of the habitats and landscape features are recorded together with change since the last survey.

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.

Linear features:
Walls, hedges, fences, roads, railways and other transport features.

Soils:
Samples were taken from 5 of the plots in each square. A range of characteristics have been analysed such as pH and organic matter.

Freshwater features:
Rivers, streams, lakes and ponds. The largest river or stream in the square was sampled and surveyed along a 500m length. One pond in each square was surveyed in detail.

Vegetation plots:
Up to 67 plots were located in each 1 km square in different landscape situations. Details of the different types of plot are listed in *Table 1.3.*

Land use:
e.g. commercial or recreational woodland, grazing for beef cattle or sheep.

Land cover:
Land cover was mapped using a series of detailed codes e.g. acid grassland.

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 400m² (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.
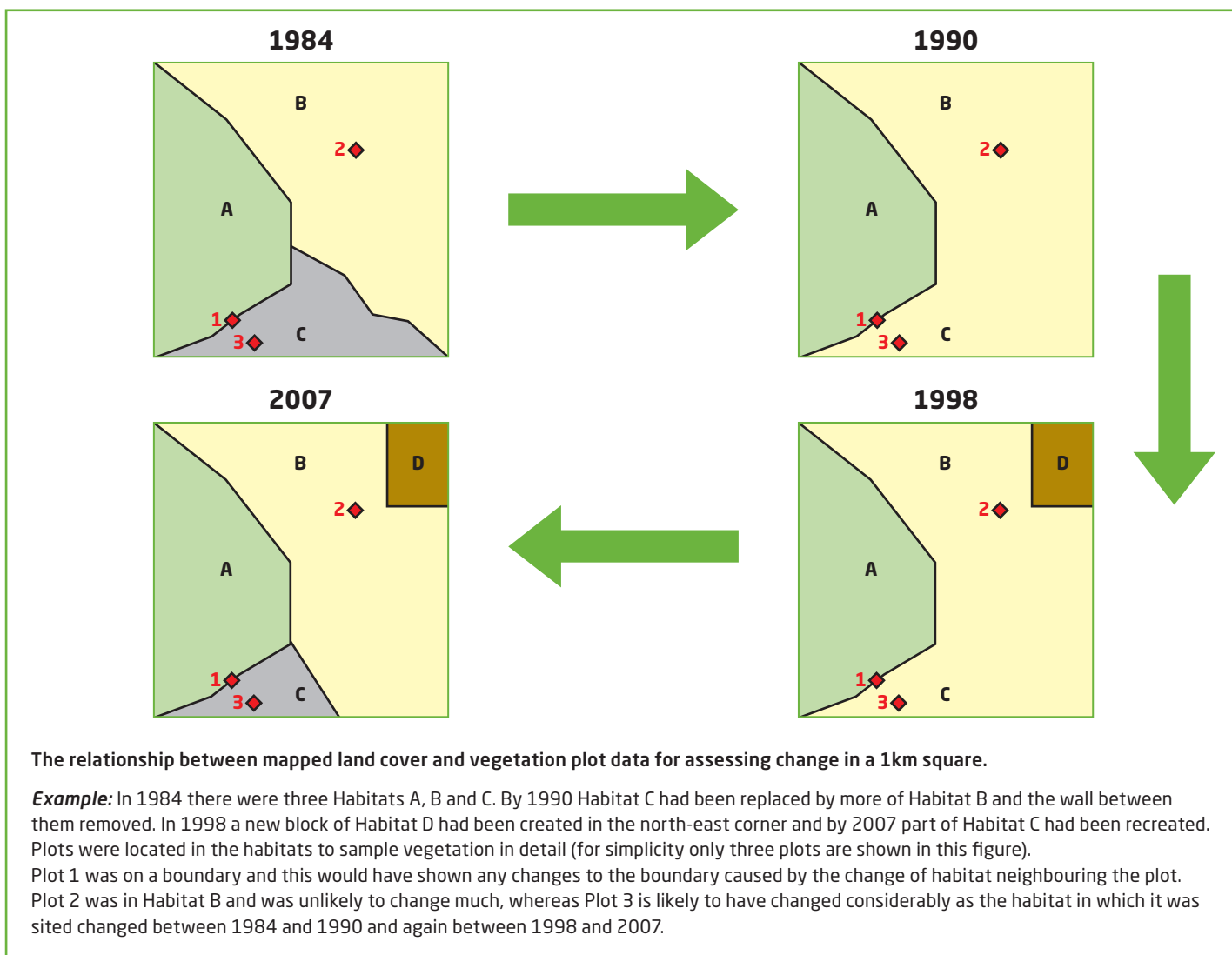
Broad and Priority Habitats were identified using a key developed in 1998 for CS 2000 and updated with improvements between 2001 and 2006, utilising advice from many experts on UK BAP definitions. The key is available in *Annex 2*.

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.

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.
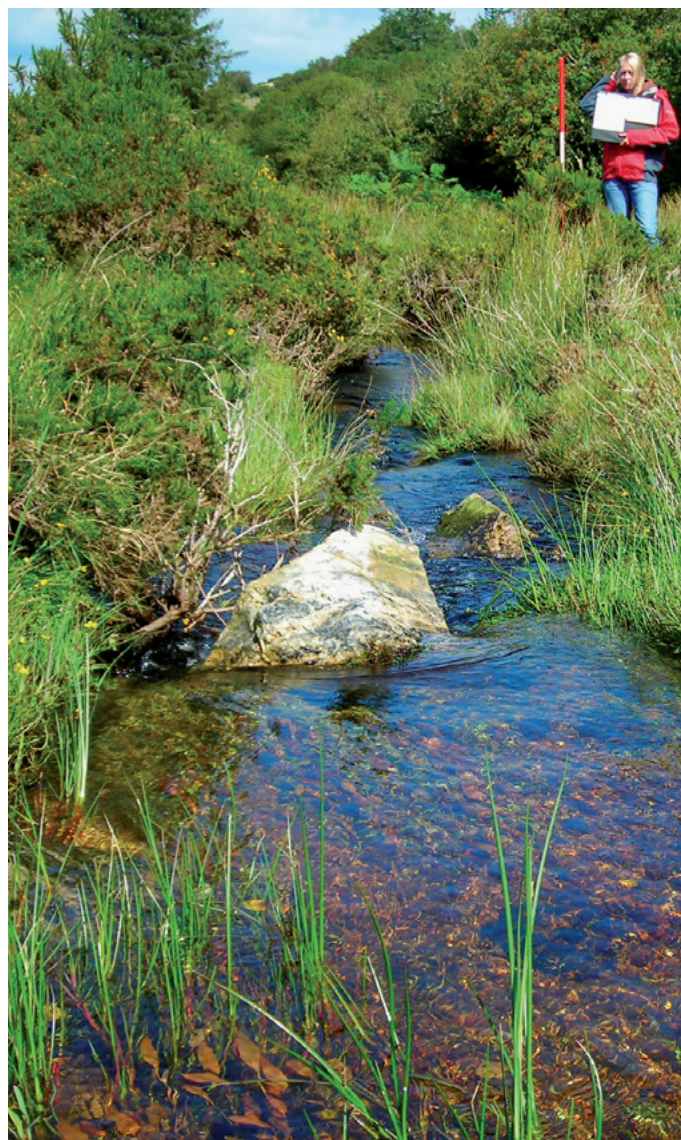
1.5.4 The condition of Broad Habitats between 1990 and 2007

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/cm³).

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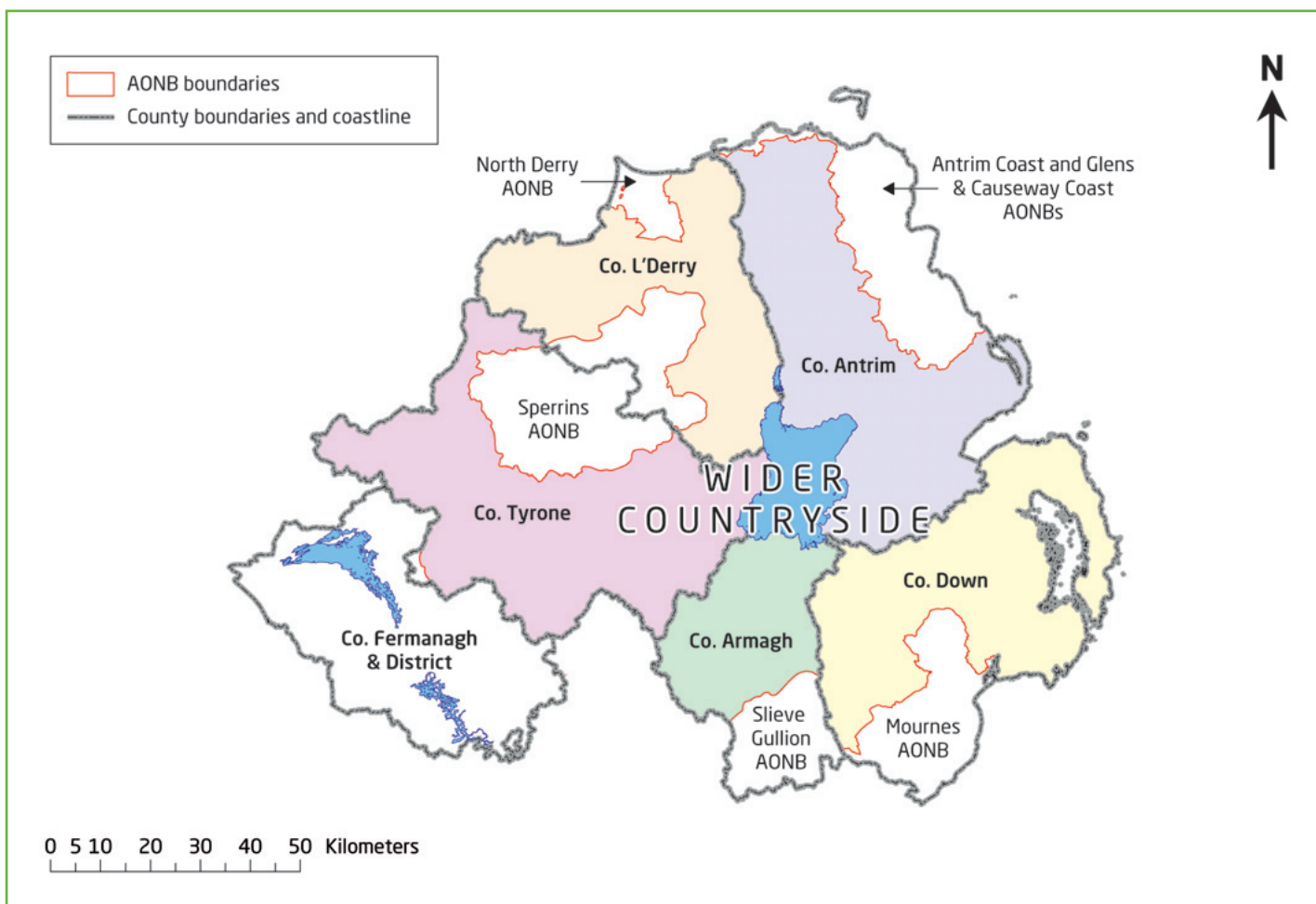
Stock of soil (0-15cm) carbon: This value was calculated by multiplying the carbon concentration data by the bulk density value, which when corrected for the area of the original core gave a value of tonnes of carbon per hectare (t/ha).

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.

Legend:
- ▭ AONB boundaries
- ‑‑‑ County boundaries and coastline

N

North Derry AONB

Antrim Coast and Glens & Causeway Coast AONBs

Co. L'Derry

Co. Antrim

Sperrins AONB

WIDER COUNTRYSIDE

Co. Tyrone

Co. Down

Co. Fermanagh & District

Co. Armagh

Slieve Gullion AONB

Mournes AONB

0 5 10   20   30   40   50 Kilometers

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 100m² 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).
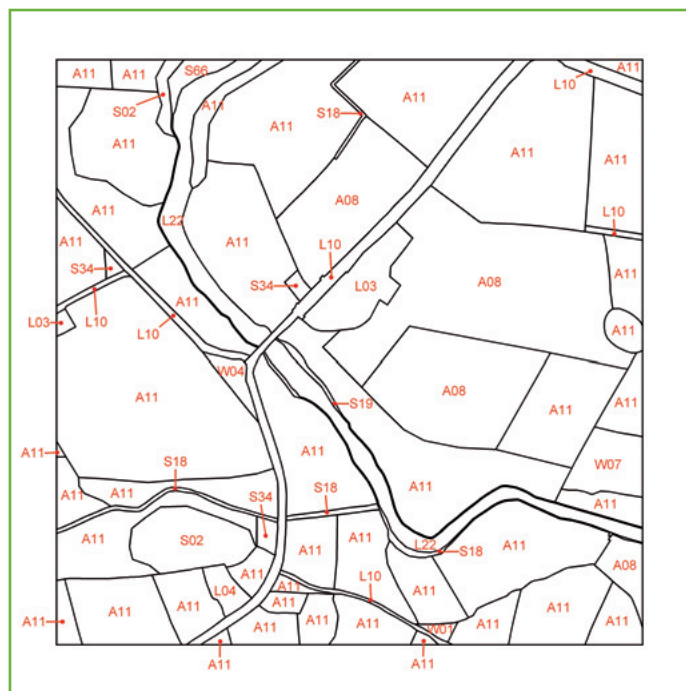

▲ Surveyor at work in N. Ireland • © *Mark Wright*

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[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.

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[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.

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 fertility 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.

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[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.

Countryside Survey

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