Countryside Survey

Scotland Results from 2007
Key messages

▲ Surveyor at work in the Cairngorms • © *Simon Smart*

Countryside Survey introduction and summary

Countryside Survey is a unique study of the natural resources of the UK countryside. This leaflet provides a summary of the results for Scotland. The survey has been carried out at intervals since 1978 with the latest in 2007. The countryside is sampled and studied using rigorous scientific methods, so that the results from the 2007 survey can be compared with those from previous years. In this way the gradual and subtle changes that occur in the countryside can be studied over time.

There are two main elements to Countryside Survey: the Land Cover Map and the field surveys. The Land Cover Map uses data from satellites to form a digital map of the different types of land cover across the UK and will be published in 2009. Across Scotland, the field surveys involve an in-depth study of a sample of around 200 1km x 1km squares. This leaflet provides a summary of the main findings from the field survey relating to the extent and condition of Broad Habitats and landscape features, condition of freshwater habitats and changes in soil properties.

Sample and data analysis is ongoing, including analysis of soil samples to enable estimation of nutrient and contaminant levels, soil biota diversity and soil function, and freshwater samples to assess change in biological condition relating to stream macro-invertebrates. Both of these will be reported in late 2009. Additionally, an integrated analysis of the vegetation, soil and water data to identify interactions between these different components of the landscape, and how they relate to ecosystem services, is ongoing and will be reported in 2010.

Key messages...

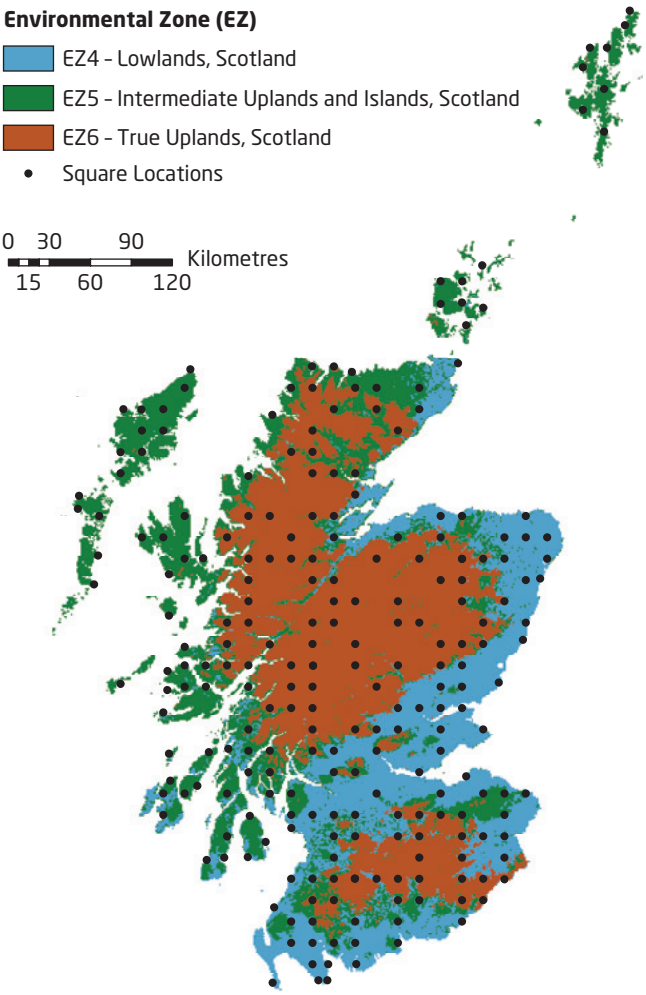
1. **The area of Broadleaved Woodland, Improved Grassland and Acid Grassland Broad Habitats increased between 1998 and 2007. Arable and Horticulture decreased, as did Coniferous Woodland[1]. The area of all other Broad Habitats showed no change.**
2. **Plant species richness declined in most habitats between 1998 and 2007 (~10%) after a period of relative stability between 1978 and 1998, including in linear plots (14%) and areas targeted for their botanical interest (12%).**
3. **Competitive plant species have increased since 1978. Plant species tolerant of harsh environments (stress tolerators) and those associated with open, disturbed conditions (ruderals) have decreased.**
4. **Plant species associated with wetter conditions increased in areas targeted for their botanical interest between 1998 and 2007 and in all plot types between 1978 and 2007. Species associated with shady conditions increased from 1998 to 2007 in linear features and in areas targeted for their botanical interest. Species associated with more fertile conditions decreased between 1998 and 2007.**
5. **The length of managed hedges decreased by 7% between 1998 and 2007. A third of managed hedges were in good structural condition in 2007, with signs of improving condition between 1998 and 2007.**
6. **The extent and condition of drystane dykes (walls) in Scotland, particularly in the True Uplands (EZ6) and the Intermediate Uplands and Islands (EZ5), deteriorated between 1998 and 2007.**
7. **Soils (0-15cm) across all vegetation types became less acidic between 1998 and 2007, continuing a trend observed between 1978 and 1998.**
8. **Carbon concentration in the soil (0-15cm) increased between 1978 and 1998, and decreased between 1998 and 2007. Overall there was no change in carbon concentration in the soil (0-15cm) between 1978 and 2007.**
9. **The mean soil (0-15 cm) carbon content (carbon concentration multiplied by amount of topsoil) across Scotland in 2007 was calculated to be 72t/ha, ranging from 47t/ha in Arable Broad Habitat to 82t/ha in Dwarf Shrub Heath.**
10. **Plant species richness in headwater streams increased between 1998 and 2007. Plants sensitive to nutrient enrichment became more common, suggesting improved water quality. The physical habitat quality of headwater streams also improved between 1998 and 2007.**

[1] potentially due mainly to felling and restocking cycles

Countryside Survey in Scotland

The sampling strategy for the selection of Countryside Survey sample sites is based on topography, climate and geology. For reporting purposes one kilometre squares are grouped into Environmental Zones (EZs) representing geographically different regions. Three EZs have been used within Scotland. These are summarised in *Figure 1* and their distribution to survey square locations is also presented.

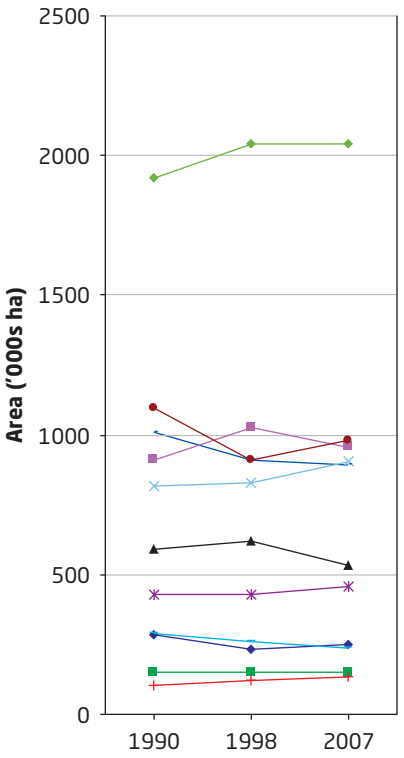
▼ **Figure 1:** The three Scottish Environmental Zones used in Countryside Survey and their distribution within Scotland relative to survey square locations.



▲ Lowland grassland, Keltneyburn • © *SNH*

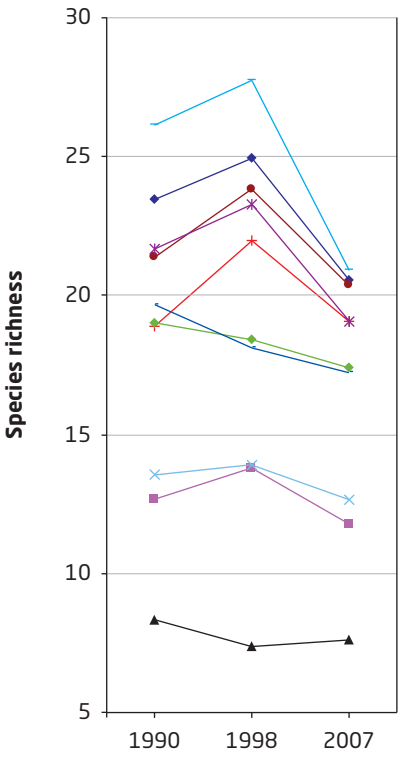
Extent of Broad Habitats

▼ **Figure 2:** Changes in the extents of the most widespread Broad Habitats in Scotland between 1990 and 2007 (* = significant change between 1998 and 2007).

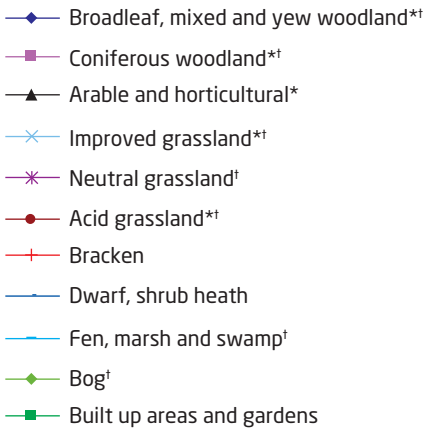


Condition of Broad Habitats – number of species (species richness)

▼ **Figure 3:** Changes in species richness in Broad Habitats between 1990 and 2007 († = significant change between 1998 and 2007).



Vascular plant diversity declined by 10% between 1998 and 2007 across most Broad Habitats. Shade producing and shade tolerant species appear to be out-competing fast growing colonisers in disturbed habitats (such as arable). In open habitats such as grassland, heath and bog, an increase in these species tends to be at the expense of low growing, uncompetitive herbs which depend on a short sward maintained by grazing and low fertility.



Case Study

Which plant species are increasing and decreasing the most?

The three most common species recorded in Countryside Survey plots in Scotland were the same in both 1998 and 2007 *(Table 1)*. Unlike the other species in the top ten, which are characteristic of upland habitats, Yorkshire Fog is a wide-ranging grass species found in many different habitats.

Species that increased between 1998 and 2007 included sedge and rush species which may indicate increasing wetness in a range of habitats *(Table 2)*. Increases in the occurrence of generalist species like Bramble and Nettle are likely to result from decreased management in predominantly lowland habitats, particularly boundary features, road and streamsides.

▼ **Table 1:** The most common species recorded in Countryside Survey main plots in Scotland in 1998 and 2007.

Rank	Scientific name	Common name
1	*Potentilla erecta*	Tormentil
2	*Calluna vulgaris*	Heather (Ling)
3	*Holcus lanatus*	Yorkshire Fog

▲ Tormentil • © *SNH*

▼ **Table 2:** Plant species in rank order showing the largest increase and decrease in frequency of occurrence in Scotland between 1998 and 2007.

Rank	Increasing species		Decreasing species	
	Scientific name	Common name	Scientific name	Common name
1	*Juncus effusus*	Soft Rush	*Poa pratensis sens lat.*	Smooth Meadow Grass
2	*Carex echinata*	Star Sedge	*Festuca ovina agg.*	Sheep's Fescue
3	*Carex binervis*	Green Ribbed Sedge	*Poa trivialis*	Rough Meadow Grass
4	*Rubus fruticosus*	Bramble	*Carex viridula sp.*	Common Yellow Sedge
5	*Urtica dioica*	Nettle	*Bellis perennis*	Daisy

Case Study

Are soils in Scotland recovering from acid rain?

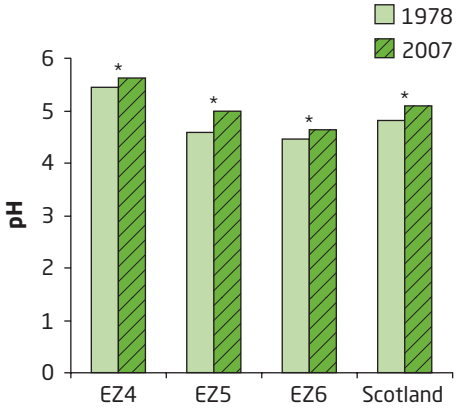
Topography, climate and geology influence habitat formation and soils.

Compared with Great Britain as a whole (no samples in Northern Ireland):

- The mean pH of soils (0-15cm) in Scotland was on average 0.8 pH units lower
- Mean soil (0-15cm) carbon concentration in Scotland was approximately 100g/kg higher
- Bulk density (0-15cm) was 36% lower
- Soil (0-15cm) carbon content (carbon concentration multiplied by amount of topsoil) was 14% higher

Soils were sampled at 0-15cm depth in 1978, 1998 and 2007. Soils in the Lowlands (EZ4) were the least acid (highest pH) ***(Figure 4)***. The pH of soils throughout Scotland increased between 1978 and 2007, consistent with decreases in the deposition of sulphur as 'acid rain' which was a particular issue for high rainfall upland areas with already acid soils.

▼ **Figure 4:** Soil (0-15cm) pH in the three Scottish Environmental Zones and across Scotland as a whole in 1978 and 2007 ('*' = significant difference between years).



▲ Upland bog • © *SNH*

▲ Ploughing, Orkney • © *SNH*

Natural Environment Research Council

Centre for Ecology & Hydrology
Natural Environment Research Council

defra
Department for Environment Food and Rural Affairs

Natural England

Llywodraeth Cymuliad Cymru
Welsh Assembly Government

The Scottish Government

NIEA Northern Ireland Environment Agency
www.ni-environment.gov.uk

An Agency within the Department of the Environment
www.doeni.gov.uk

Forestry Commission

Cyngor Cefn Gwlad Cymru
Countryside Council for Wales

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Further information on Countryside Survey can be found at:

www.countrysidesurvey.org.uk

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Countryside Survey

Scotland Results from 2007

Executive Summary

▲ View of Strathmore towards Loch Broom • © *SNH*

The Countryside Survey is a periodic assessment of the state of the countryside throughout the UK. Results for Scotland from 1990, 1998 and the latest survey undertaken in 2007 were launched by the Minister for Environment at the Royal Highland Show in Edinburgh on 25 June 2009.

The Scottish assessment is based on a survey of around 200 sample squares each measuring 1km by 1km, which represent the diversity of geology, topography and climate. The survey quantifies the extent and change in area of habitats, such as heather moorland; their ecological condition, assessed by botanical characteristics; the length and condition of structural features in the landscape, such as hedges and walls; the acidity, carbon content and density of topsoil (to a depth of 15cm); and the ecological characteristics of streams and ponds.

Results from Countryside Survey help underpin the assessment of government targets, such as halting biodiversity loss by 2010, as well as keeping track of the changing state of the countryside through indicators of botanical diversity and habitat fragmentation.

Changes in the Scottish countryside can be attributed to factors operating across three broad timescales: a) the short-term, such as annual changes in market conditions leading to changes in farming systems; b) the medium-term, such as woodland planting and harvesting; and c) the longer-term cultural history and environmental influences of pollution and climate change.

Key findings from the Countryside Survey between 1998 and 2007 are as follows:

- **A switch from arable to improved grassland: the extent of arable/horticulture decreased by 14% and improved grassland increased by 9%.**
- **The area of broadleaved/mixed woodland increased by 9%, reflecting new planting and the diversification of felled plantation forest. A decrease of 7% in the extent of coniferous woodland is partly accounted for by the felling cycle: in the Countryside Survey, vegetation cover is not categorised as woodland until the canopy cover reaches 25% and the trees are more than a metre high. Results are not directly comparable with forestry statistics due to methodological differences.**
- **The area of acid grassland increased by 8% replacing a range of habitats including moorland and coniferous woodland.**
- **The length of hedges decreased by 7%. A third of actively managed hedges were judged to be in good structural condition in 2007. Species richness in hedgerow margins decreased by 22%, which included declines in food plants of birds (22%) and butterflies (21%).**
- **Surface soils (0-15cm depth) became less acidic (pH increased from 5.02 to 5.09), pointing to gradual recovery from acid deposition in the past.**

- **Carbon in the topsoil decreased between 1998 and 2007 but showed no overall change between 1978 and 2007. Carbon content ranged from 47 t/ha in arable to 82 t/ha in moorland.**
- **Competitive perennial species (such as nettle and bramble) increased in abundance by 2%. These findings partly reflect stream bank protection and woodland establishment. Competitive plant species increased by 1% along stream banks; overall species richness declined by 12%. In woodland, the number of competitive plant species increased by 5%; overall species richness declined by 18%. Further analysis is required to establish causes of this decline, such as changes in the proportions of young and mature woodlands sampled.**
- **Botanical diversity (species richness condition index) throughout the countryside declined by 10% (14% in linear plots, such as road verges, and 12% in places selected for their botanical interest). In open habitats tall perennials tended to displace a variety of low growing, uncompetitive herb-like species which depend on a short sward maintained by grazing. The abundance of bird and butterfly food plants declined by 8%. Open ground colonisers declined by 3%. Species of fertile conditions declined by 2%.**
- **The physical and biological characteristics of headwater streams improved. Plant species richness within headwater streams, including plants sensitive to nutrient enrichment, increased by 9%. The condition of headwater streams based on observed plant communities (trophic rank) increased by 6%, indicative of reduced nutrient enrichment.**
- **The number of ponds increased by 6%, mainly in the lowlands. Some 10% of ponds had high botanical diversity.**

The general picture across the past decade is of improved ecological condition of streams, recovery from acidification in soils and restoration of broadleaved woodland. Less active management of the countryside appears evident from more overgrown conditions in hedgerows and in some areas of the open countryside, resulting in reduced botanical diversity.

The Countryside Survey consortium is led by the Natural Environment Research Council and Defra. The Scottish Government and Scottish Natural Heritage contribute funding and represent Scottish interests on the Board, Steering Group and Topic Groups. The survey is implemented by the Centre for Ecology & Hydrology.

Further information and results can be found on the Countryside Survey web site (*www.countrysidesurvey.org.uk*).

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Sgrùdadh Dùthchail

Geàrr-chunntas Gnìomha bho Brathan Naidheachd is Toraidhean na RA bho 2007

‘S e sgrùdadh sònraichte de ghoireasan nàdarra dùthaich na RA a th’ ann an Sgrùdadh Dùthchail. Tha e a’ gabhail a-steach sgrùdadh làraich mionaideach de dh’àrainnean, fàs-bheatha, uisgeachan is talmhaichean air feadh Shasainn, Alba agus na Cuimrigh. Tha sgrùdadh eile air àrainnean ga ghabhail os làimh ann an Èirinn a Tuath agus far a bheil toraidhean sam bith gan tarraing còmhla airson am foillseachadh dhan RA. Tha na toraidhean air an cleachdadh ann an rannsachadh saidheansail agus airson fiosrachadh a thaobh leasachadh poileasaidh airson rianachd na dùthcha.

Chaidh a’ chiad Sgrùdadh Dùthchail a dhèanamh ann an 1978 agus thathas air a leasachadh is air a leudachadh gach uair a chaidh a ghabhail os làimh ann an 1984, 1990, 1998 agus 2007. Thathas a’ cruinneachadh dàta tro dhòighean mionaideach saidheansail gus an gabh coimeas a dhèanamh eadar sgrùdaidhean a tha a’ leantainn a chèile is feadhainn bho na bliadhnachan roimhe. Tha cruinneachadh dàta thar ùine ga dhèanamh comasach atharrachaidhean mall-cheumach is beaga ann an dùthaich na RA a lorg, a sgrùdadh is a cheangal ri nithean a dh’fhaodadh an adhbhrachadh. Ann an 2007, chruinnich na sgiobaidhean sgrùdaidh dàta bho 591 cheàrnag sampaill (1.0km x 1.0km) ann am Breatainn agus 288 ceàrnagan sampaill (0.5km x 0.5km) ann an Èirinn a Tuath. Chaidh an dàta làraich seo a chlàradh gu dealanach a’ cleachdadh teicneòlas glacaidh ùr didseatach.

Tha toraidhean ìre RA den sgrùdadh mu dheireadh gam foillseachadh ann an dà aithisg:

- Sgrùdadh Dùthchail – Brathan Naidheachd RA bho 2007
- Sgrùdadh Dùthchail – Toraidhean na RA bho 2007

Tha corra lethbhreac cruaidh den aithisg “Brathan Naidheachd RA bho 2007” ri fhaighinn (fios gu : *countrysidesurvey@ceh.ac.uk*) agus faodar na dhà a luchdachadh a-nuas bho làrach-lìn an Sgrùdaidh Dhùthchail aig *www.countrysidesurvey.org.uk*

Chleachd Brathan Naidheachd RA toraidhean 2007 gus sreath cheistean a bh’ air èirigh bho Sgrùdaidhean Dùthchail eile a fhreagairt no feadhainn a bha co-cheangailte ri leasachaidhean poileasaidh a thachair o chionn ghoirid. Chan ann airson na toraidhean uile bhon Sgrùdadh Dùthchail a chòmhdach a tha iad ach airson prìomh bhuilean a thoirt am bàrr air thoiseach air na toraidhean. Tha na ceistean ris an deach dèiligeadh a’ gabhail a-steach na leanas:

- A bheil iomadachd luibheach air atharrachadh air an dùthaich?
- A bheil ceàrnaidh is staid Àrainnean Farsaing air atharrachadh?
- A bheil truailleadh èadhair is susbaintean beathachaidh air buaidh a thoirt air lusan is talmhaichean?
- A bheil dùmhlachd gualain ann an talmhaichean (0-15cm) air atharrachadh?
- A bheilear air buaidh atharrachadh gnàth-shìde a lorg?

Tha Toraidhean RA bho 2007 a’ foillseachadh geàrr-chunntas nas òrdaile de thoraidhean 2007 ann an seòrsaichean àrainnean agus tha iad a’ gabhail a-steach sealladh nas fharsainge air an Dealbh Nàiseanta agus air an Dòigh-obrach. Tha an aithisg a’ toirt seachad nan toraidhean a th’ air cùl nan Ceann Naidheachdan agus barrachd fiosrachaidh. Tha gach caibideil a’ tòiseachadh le geàrr-chunntas de na prìomh thoraidhean agus an uairsin na toraidhean measte: ceàrnaidhean is atharrachaidhean àrainnean; caochlaidhean eadar àrainnean, atharrachaidhean ann an staid fàis-bheatha agus atharrachaidhean ann an suidheachaidhean talmhainn. Tha an aithisg a’ gabhail a-steach beagan mìneachaidh de na toraidhean, ach cha bu chòir gabhail rithe mar mhìneachadh slàn de na h-atharrachaidhean a lorgar. ‘S e rannsachadh san àm ri teachd a mhìnicheas na cinn-fàth is na teannachaidhean a dh’adhbhraich na h-atharrachaidhean. Tha na toraidhean taghte a th’ air an taisbeanadh an seo a’ foillseachadh leud is doimhneachd na còmhdachd ann an Toraidhean na RA.

- Mheudaich ceàrnaidh nan Àrainnean Farsaing: Fearann Choilltean Leathann-duilleach, Fearann Feurach Leasaichte, Fearann Feurach Neo-rèiteachail, Fearann Feurach Searbhagach agus Àrainnean Farsaing nan Uisgeachan Marbh, fhad 's a lùghdaich Àrainnean Farsaing Àitich is Rainich. Cha do mheudaich ceàrnaidh na h-Àrainn Fharsaing Thogalaichean is Ghàrraidhean san àrainneachd dhùthchail [toraidhean 1998-2007 na RA].
- Chòmhdaich Fearann Feurach leasaichte roinn mheaste de 5.1 millean ha, meudachadh de 6% [toraidhean 1998-2007 na RA]. Bha am meudachadh seo an coimeas ri lùghdachadh bho 1984 gu 1998.
- Lùghdaich fad nan callaidean a bhathas roimhe air a rianachadh 6%. Thàinig mòran dhiubh sin gu bhith nan sreathan chraobh agus nan seann challaidean [toraidhean 1998-2007 Bhreatainn].
- Cha robh atharrachadh sam bith ann am beairteas ghnèithean lusan ann an achaidhean, coilltean, am monaidhean is mòintich [toraidhean 1998-2007 Bhreatainn].
- Cha deach atharrachadh a lorg ann am beairteas ghnèithean lusan ann am Fearann Choilltean Leathann-duilleach [toraidhean 1998-2007 Bhreatainn], ach bha ìsleachadh ùine-fhada de 9.3% ann [toraidhean 1990-2007 Bhreatainn].
- Mheudaich gnèithean strìtheil lusan ann an achaidhean, coilltean, am monaidhean is mòintich fhad 's a lùghdaich lusan air talamh bàn [toraidhean 1978-2007 Bhreatainn].
- Mheudaich an àireamh a bha a' soirbheachadh ann an àiteachan na bu bhuige de na gnèithean fàis-bheatha a chaidh a shampladh [toraidhean 1998-2007 Bhreatainn].
- Uile gu lèir, tha gnèithean lusan neo-dhùthchasach a' dèanamh an-àirde faisg air 2% den chòmhdach fhàis-bheatha air an dùthaich [toraidhean 2007 Bhreatainn].
- Mheudaich beairteas ghnèithean lusan ann an uillt [toraidhean 1998-2007 Bhreatainn].
- Thàinig piseach air staid chorporra uillt [toraidhean 1998-2007 Bhreatainn].
- Mheudaich pH thalmhaichean (0-15cm) ann an àrainnean nach robh cho searbhagach [toraidhean 1978-2007 Bhreatainn].
- Cha robh atharrachadh mòr sam bith ann an dùmhlachd gualain thalmhaichean (0-15 cm) [toraidhean 1978-2007 Bhreatainn].

Tuilleadh fiosrachaidh

Gheibhear cruinneachadh cunbhalach de gheàrr-chunntas thoraidhean a chaidh a chleachdadh ann an aithisgean na RA bho làrach-lìn an Sgrùdaidh Dhùthchail ann an cruth grafaigeach. Gheibhear an dàta a chaidh a chleachdadh airson na h-aithisgean ullachadh fo chead, an dèidh foillseachadh nan aithisgean aig ìre nan trì dhùthchannan, aithisgean Shasainn, Alba agus na Cuimrigh. Tha mion-sgrùdadh a' leantainn agus thèid tuilleadh fhoillseachadh, a' gabhail a-steach aithisgean air talamh, fìor-uisge agus measadh aonaichte, agus Mapa ùr de Chòmhdach Talmhainn na RA.

Airson tuilleadh fiosrachaidh mu Sgrùdadh Dùthchail faic *www.countrysidesurvey.org.uk*

No cuir fios gu : Countryside Survey Project Office, Centre for Ecology and Hydrology, Lancaster Environment Centre, Library Avenue, Bailrigg, Lancaster LA1 4AP

Fòn : 01524 595811;Post-d : *countrysidesurvey@ceh.ac.uk*

Chaidh Sgrùdadh Dùthchail ann an 2007 a mhaoineachadh le com-pàirteachas de bhuidhnean a tha maoinichte leis an Riaghaltas is air a stiùireadh le Comhairle Rannsachaidh na h-Àrainneachd Nàdarra (NERC) agus Roinn na h-Àrainneachd, a' Bhidhe agus Chùisean Dùthchail (Defra).

Countryside Survey

Countryside Survey:
Scotland Results from 2007

Foreword by Roseanna Cunningham MSP

Scotland's landscapes and wildlife are part of our national identity, and are fundamental to our health, well-being and prosperity. The countryside sustains important economic sectors, such as farming, forestry and renewable energy production. Society relies upon the natural environment for the services it provides, such as the provision of food and fresh water, the regulation of climate, and the pleasures of recreation and enjoyment. In this year of Homecoming Scotland we can be especially proud of Scotland's international reputation for outstanding landscapes and wildlife – in the knowledge that this is a large part of what makes Scotland so attractive to tourists and visitors.

The Countryside Survey gives us important new factual evidence about the state of the countryside, spanning three decades of immense change. This systematic study of habitat extent and condition, soil and fresh water properties helps us to assess the effectiveness of past policies and will act as a basis for future ones.

Positive changes include the increase in broadleaved woodland, restoring Scotland to a more natural state where biodiversity can flourish. I am struck, however, by the finding that many plant species appear to be in such widespread decline. We will use the survey findings to improve our understanding of how best to protect and enhance Scotland's natural environment, including its landscapes, plants and animals. Dealing with pressures such as climate change, pollution and changing land use requires us to find new ways of balancing the often competing demands we make on our countryside. The Countryside Survey provides evidence to help us do this.

I very much welcome publication of the Countryside Survey report for Scotland. It will assist the Scottish Government in managing the environment for a healthy and prosperous future, and it contributes to a wider knowledge base for education and research.

Completing this latest round of the Countryside Survey has been an immense undertaking. It has relied upon the good-will of many land owners and managers throughout Scotland to enable the survey to take place. I thank them for their support, and thank all who contributed to delivering this vital new evidence on Scotland's countryside.

Roseanna Cunningham

Countryside Survey

▲ Foxgloves, Loch Glencoul • © *Helen M Jones*

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COVER IMAGE: View of Strathmore towards Loch Broom • © *SNH*

Countryside Survey:

Scotland Results from 2007

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Centre for Ecology & Hydrology, Scottish Government, Scottish Natural Heritage

June 2009

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▲ Scots Pine forest • © *SNH*

1. Introduction and methodologies

Summary

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

The results of the field survey, reported here for Scotland, focus on habitats, vegetation, soils (0-15) cm and freshwater. The field survey covered a total of 195 1km x 1km sample squares across the three Environmental Zones in Scotland. These 1km sample squares were representative of the variations in the climate and geology present.

The data collected enables estimates of:

- **the extent and change in area of habitats**
- **the extent and condition of landscape features such as hedges, walls and trees**
- **the changing condition of vegetation in habitats**
- **the pH, carbon concentration, bulk density and carbon content of soils (0-15cm), where carbon content is calculated from the carbon concentration multiplied by the amount of topsoil (0-15 cm)**
- **the changing condition of freshwaters and ponds**

Countryside Survey is a unique study of the natural resources of the countryside. The survey has been carried out at intervals since 1978 with the latest in 2007. The countryside is sampled and studied using rigorous scientific methods, so that the results can be compared with the findings of previous surveys in 1998[1], 1990, 1984 and 1978. In this way the gradual and subtle changes that occur can be measured and analysed over long time-scales. The evidence produced is used to review and develop policies that influence the management of the countryside e.g. providing information that can be used to assess progress against the UK Biodiversity Action Plan for Broad Habitats ***(Box 1.1)***. The data are also being used to contribute to the development of an integrated assessment of the drivers and pressures of change and a better understanding of their effects on the UK countryside and their implications for ecosystem goods and services.

[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.

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)
Ponds ..... (Chapter 8)
Wet woodland ..... (Chapter 6)
Upland Birchwoods ..... (Chapter 6)
Upland Mixed Ashwoods ..... (Chapter 6)
Upland Oak Woods ..... (Chapter 6)

For more information on pond Priority Habitats, please see: http://www.ukbap.org.uk/library/UKBAPPriorityHabitatDescriptionsfinalAllhabitats20081022.pdf

There are two main elements to Countryside Survey: field surveys (reported here) which focus on habitats, vegetation, soils (0-15 cm) and freshwater; and the Land Cover Map, which uses data from satellites to form a digital map of land cover across the UK (to be published later in 2009). The field survey provides estimates of the extent of the different Broad Habitats and describes the character and condition of associated vegetation types, including land and freshwater habitats (see *Section 1.2 UK report*). In 2007, for the first time, results for some Priority Habitats. The results of the field survey describe the character and condition of the different vegetation types associated with these Broad and, where possible, Priority Habitats.

The UK results of the latest 2007 survey were published in November 2008 and the data can be accessed at (*http://www.countrysidesurvey.org.uk/*). This report presents the results for Scotland and compares differences across three bio-geographical sub-divisions of the country known as Environmental Zones (EZs, *Fig 1.1*). The results are presented in chapters structured around the same Broad Habitat groupings used in the UK report. Each chapter concludes with a discussion of the relevance of these results for Scotland and their policy context. Equivalent reports for England and Wales will shortly be available. The results presented here focus on changes in the nine years since the last Countryside Survey in 1998 and, where possible and relevant, they are set within the longer timescale from the first survey carried out in 1978. Changes are only described and discussed where they are statistically significant (where they could only occur by chance in less than 5% of cases).

Details of the field survey methods used to collect the data for Countryside Survey in 2007 and preceding Surveys are presented in Chapter 1 of the "UK results from 2007" [*http://www.countrysidesurvey.org.uk/reports2007.html*]. An overview of the sampling strategy and an explanation of the Environmental Zones are provided below.

▲ Freshwater surveying • © *CEH*

Methodology

Prior to 1998 the CS sampling strategy was designed to provide estimates for GB level reporting, rather than reporting at the country level. In 1998 the number of squares in Scotland was increased to 203 to provide a statistically robust sample at the country level (see ***section 1.3 UK Report***). In 2007 the field survey involved an in-depth study of a sample of 591 1km x 1km squares across Great Britain with 195 of these in Scotland (the sample size was slightly down on that of 1998 largely due to refused access, but the revised sample design remained valid).

Individual survey squares in Scotland were randomly selected based on an underlying stratification to capture variations in climate, geology and widespread terrestrial habitat types. These are all sufficiently well-represented to allow robust and reliable statistical analyses. Survey squares locations are not disclosed to avoid any deliberate influences that could affect them or the features within them. This helps to ensure that the survey squares remain representative of changes in the wider countryside and continue to provide a reliable comparison for future surveys.

Habitat extent was mapped within each square and the botanical condition of vegetation was assessed in a series of sample plots. Soil (0-15cm) samples were collected from five plots in each square, and a stream and a pond were also sampled in many of the squares.

The data collected enable estimates of:

- **the extent and change in area of habitats**
- **the extent and condition of landscape features such as hedges, walls and trees**
- **the changing condition of vegetation in habitats**
- **the pH, carbon concentration, bulk density and carbon content of soils (0-15cm), where carbon content is calculated from the carbon concentration multiplied by the amount of topsoil (0-15 cm)**
- **the changing condition of freshwaters and ponds**

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

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. It should be noted that scores for 'Numbers of Bird and Butterfly larvae Food Plants were developed specifically for lowland farmland situations and are not as relevant for different habitats, although they have been provided for all Broad Habitats. Assessments of the condition of linear features are confined largely to more recent Countryside Surveys in particular 1998 and 2007. This report also includes details of

▲ Lowlands • © *SNH*

[2] Telfer et al (2002) A general method for the calculation of relative range size from biological atlas data. *Biol. Cons.* 107, 99-109.

individual plant species which are increasing and decreasing the most across Scotland. In order to do this a relative change index was calculated from the paired species frequency data for individual taxa in 1998 and 2007. This method expresses the relative change in number of plots occupied having taken account of any overall tendency for more or less species to have been recorded in plots. The approach was a modification of the one applied to calculate change in occupancy of 10km grid squares in the New Atlas of the Flora of the British Isles[2]. Species with the largest change in both numbers of plots occupied and change index can then be confidently regarded as having shown a real change in abundance between surveys.

▲ Intermediate Upland and Islands • © *Helen M Jones*

Some of the Priority Habitats identified in the UK Biodiversity Action Plan (BAP) have important strongholds in Scotland. As CS represents an unbiased sample of the countryside and these Priority Habitats (Purple Moor Grass and Rush Pasture) are generally uncommon and/or localised, they are generally not well represented within the CS. National estimates for Priority Habitats from CS 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 the differences require further investigation. The CS estimate for Hedgerows, Ponds and the condition of Arable Field Margins represent the only national figures for these Priority Habitats.

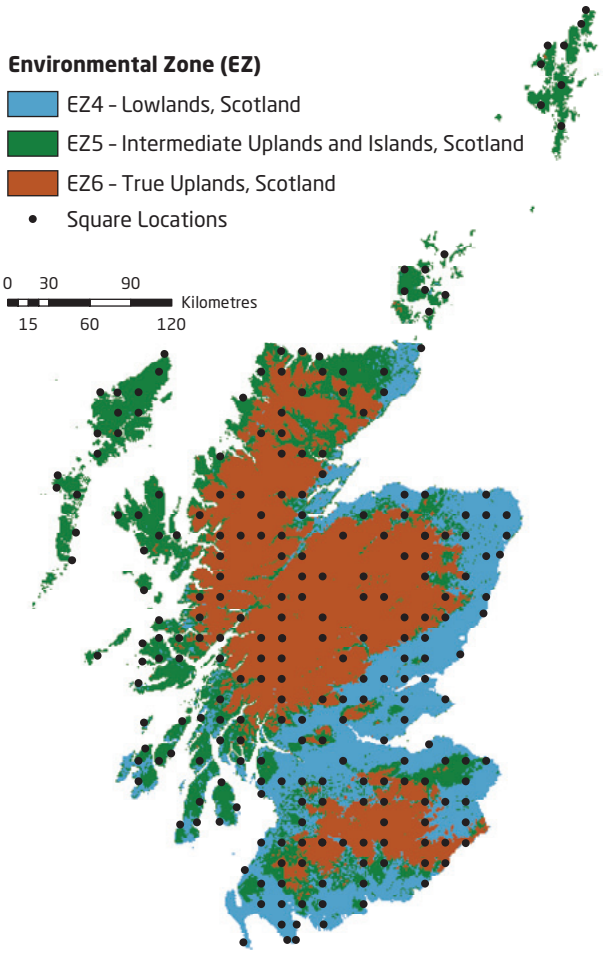
▲ True Uplands • © *SNH*

Sub-dividing England, Scotland and Wales into Environmental Zones (EZs) allows changes across the countries and within habitat types to be compared between geographical different regions. The nine EZs used in the 2007 Survey across the UK are summarised in ***Table 1.1*** and the distribution of those within Scotland relative to survey square locations is presented in ***Figure 1.1***. The EZs cover the range of environmental conditions found in the UK from the lowlands of the south and east, through to the uplands and mountains of the north and west. The EZs are based on combinations of the land classes which form the basis of the stratified random sampling approach used in CS.

▼ **Table 1.1:** The Environmental Zones used in Countryside Survey.

Short-hand descriptions of the Environmental Zones	EZ codes
• Easterly Lowlands, England	EZ1
• Westerly Lowlands, England	EZ2
• Uplands, England	EZ3
• Lowlands, Scotland	EZ4
• Intermediate Uplands and Islands, Scotland	EZ5
• True Uplands, Scotland	EZ6
• Northern Ireland (reported separately)	EZ7
• Lowlands, Wales	EZ8
• Uplands, Wales	EZ9

▼ **Figure 1.1:** The distribution of Environmental Zones within Scotland relative to survey square locations.



Countryside Survey

Further information

More details of the methodology, analyses and results from Countryside Survey can be found in other companion reports and data resources available for the Countryside Survey website [**www.countrysidesurvey.org.uk**] including:

Reports:

- UK Headline Messages – *published November 2008*
- UK Results from 2007 – *published November 2008*
- Detailed Northern Ireland Countryside Survey results – *published April 2009*
- England Results from 2007 – *due to be published August 2009*
- Scotland Results from 2007 – *due to be published June 2009*
- Wales Results from 2007 – *due to be published July 2009*
- Ponds – *due to be published July 2009*
- Streams – *October 2009*
- Soils – *November 2009*
- Integrated Assessment – *2010*

Data resources:

- Web access to **summary data** – a systematic summary of the results used to inform the UK and country level reports – launched in November 2008 and updated in January 2009
- Web access to the **actual data** – data from individual survey squares used to generate all the results presented in Countryside Survey reports from the 2007 survey – licensed access available from June 2009
- The UK Land Cover Map for 2007 – September 2009

The data generated by Countryside Survey will continue to be investigated in conjunction with other information such as climate, pollution and agricultural statistics. It is anticipated that future analysis of Countryside Survey data will lead to many scientific journal articles over the coming years. These investigations will improve understanding about the possible causes of the changes detected in the countryside and, for example, provide an opportunity to explore the results for Priority Habitats in more detail.

Contacts

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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 scene, Skye • © *Lisa Norton*

2. The National Picture

Summary

- The area of Broadleaved Woodland, Improved Grassland and Acid Grassland Broad Habitats increased between 1998 and 2007. Coniferous Woodland and Arable and Horticulture decreased. The area of all other Broad Habitats showed no change.
- Plant species richness in plots sampling the wider Scottish countryside declined significantly between 1998 and 2007 (~10%) after a period of relative stability between 1978 and 1998. There was a similar trend for linear plots (14% decrease since 1998) and areas targeted for their botanical interest (12% decrease).
- Competitive plant species have increased since 1978. Plant species tolerant of harsh environments (stress tolerators) and those associated with open, disturbed conditions (ruderals) have decreased.
- Plant species associated with wetter conditions increased in areas targeted for their botanical interest between 1998 and 2007 and in all plot types between 1978 and 2007. Species associated with shady conditions increased from 1998 to 2007 in linear features and in areas targeted for their botanical interest. Species associated with more fertile conditions decreased between 1998 and 2007.
- The length of managed hedges decreased by 7% between 1998 and 2007. A third of managed hedges were in good structural condition in 2007 with signs of improving condition between 1998 and 2007.
- The extent and condition of drystane dykes (walls) in Scotland, particularly in the True Uplands (EZ6) and the Intermediate Uplands and Islands (EZ5) deteriorated between 1998 and 2007.

▲ Diverse landscape, Atholl • © *SNH*

- **Soils (0-15cm) across all vegetation types became less acidic between 1998 and 2007 continuing a trend observed between 1978 and 1998.**
- **Carbon concentration in the soil (0-15 cm) increased between 1978 and 1998, and decreased between 1998 and 2007. Overall there was no change in carbon concentration in the soil (0-15 cm) between 1978 and 2007.**
- **The mean soil (0-15cm) carbon content (carbon concentration x amount of topsoil) across Scotland in 2007 was calculated to be 72 t/ha, ranging from 47 t/ha in Arable Broad Habitat to 82 t/ha in Dwarf Shrub Heath.**
- **Plant species richness in headwater streams increased between 1998 and 2007. Plant species sensitive to nutrient enrichment became more common, suggesting improved water quality. The physical habitat quality of headwater streams also improved between 1998 and 2007.**
- **Plant species richness in 10m x 1m vegetation sampling plots alongside streams decreased by 12% between 1998 and 2007, with increases in competitive plant species and decreases in species of open/disturbed ground (ruderals).**
- **10% of Scottish ponds had the necessary plant species richness to qualify as Priority Habitats.**

2.1 Introduction[1]

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

- **estimated areas and changes in area of Broad Habitats (2.2 and 2.3)**
- **estimated areas and changes in area of Priority Habitats (2.4)**
- **changes in vegetation condition (2.5)**
- **changes in landscape features (2.6)**
- **changes in soils (0-15cm) (2.7)**
- **changes in headwater streams and ponds (2.8)**
- **results summary, ecological significance of changes and contextual discussion (2.9)**

2.2 Estimated area of Broad Habitats

Countryside Survey (CS) provides estimates of the area of widespread terrestrial Broad Habitats in Scotland. Changes in area were calculated by comparison with results from previous surveys *(Table 2.1)*. Details of how the Broad Habitat classification was used in CS are given in *Box 1.1* and *Chapter 1.6, UK Report*. A breakdown of results for each Broad Habitat and information on habitat condition are presented in subsequent chapters.

▲ Mixed woodland • © *Sandra Marks*

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

	1990		1998		2007		1990-1998		1990-2007		1998-2007		Direction of significant changes 1998-2007
Broad Habitats	'000s ha	% area of Scotland	'000s ha	% area of Scotland	'000s ha	% area of Scotland	Change ('000s ha)	% Change	Change ('000s ha)	% Change	Change ('000s ha)	% Change	
Broadleaved, Mixed and Yew Woodland	284	3.5	229	2.9	251	3.1	-55	-19.3	-33	-11.6	22	9.5	↑
Coniferous Woodland	913	11.4	1030	12.9	956	11.9	117	12.8	43	4.7	-74	-7.1	↓
Linear Features	143	1.8	103	1.3	95	1.2	-40	-28	-48	-33.5	-8	-7.8	↓
Arable and Horticulture	593	7.3	618	7.6	534	6.6	25	4.2	-59	-10	-84	-13.6	↓
Improved Grassland	815	10.1	831	10.4	907	11.2	16	2	92	11.3	76	9.1	↑
Neutral Grassland	429	5.4	430	5.4	461	5.8	1	0.3	32	7.5	31	7.2	
Calcareous Grassland	36	0.4	28	0.4	26	0.3	-8	-22.3	-10	-26.7	-2	-5.5	
Acid Grassland	1095	13.6	911	11.4	983	12.3	-184	-16.8	-112	-10.3	72	7.9	↑
Bracken	107	1.3	121	1.5	132	1.6	14	13.2	24	22.7	10	8.4	
Dwarf Shrub Heath	1007	12.6	912	11.4	894	11.1	-95	-9.5	-113	-11.2	-18	-2	
Fen, Marsh, Swamp	289	3.6	261	3.3	239	3.0	-28	-9.8	-51	-17.5	-22	-8.6	
Bog	1922	24.0	2039	25.5	2044	25.6	117	6.1	122	6.4	5	0.2	
Standing Open Waters	75	0.9	88	1.1	89	1.1	12	16.5	13	17.8	1	1	
Rivers and Streams	21	0.3	20.7	0.3	21.3	0.3	-0.3	1.4	0.3	1.4	0.6	2.9	↑
Montane	n/a	n/a	38	0.5	38	0.5	n/a	n/a	n/a	n/a	1	1.9	
Inland Rock	53	0.7	91	1.1	84	1.0	38	72.6	-31	59.1	-7	-7.8	
Built-up Areas and Gardens	150	1.9	153	1.9	153	1.9	3	2.1	3	2.3	0	0.1	
Other land	48	0.6	77	1.0	74	0.9	n/a	n/a	n/a	n/a	n/a	n/a	
Unsurveyed Urban Land[2]	38	0.5	38	0.5	38	0.5	n/a	n/a	n/a	n/a	n/a	n/a	
Total	**8012**	**100**	**8012**	**100**	**8012**	**100**							

2.3 Change in area of Broad Habitats

- **The area of Broadleaved Woodland, Improved Grassland and Acid Grassland Broad Habitats increased between 1998 and 2007. Coniferous Woodland and Arable and Horticulture decreased. The area of all other Broad Habitats showed no change.**

The area of Broadleaved, Mixed and Yew Woodland (referred to as 'Broadleaved Woodland') increased by 9.5% in Scotland between 1998 and 2007 *(Table 2.1)*. There was a corresponding decrease of 7.1% in the area of Coniferous Woodland[3].

The area of the Arable and Horticulture Broad Habitat decreased by 13.6% between 1998 and 2007 *(Table 2.1)*. There was a corresponding increase of 9.1% in the area of the Improved Grassland, but no significant increase in the area of Neutral Grassland across Scotland as a whole.

The area of Acid Grassland in Scotland increased by 7.9% between 1998 and 2007, with this change being concentrated in the Scottish Uplands (EZ6) (see *Chapter 7*). It is not clear from the changes at the Broad Habitat level *(Table 2.1)* which Broad Habitats have been lost at the expense of the increase in Acid Grassland.

Changes in the Linear Features Broad Habitat may reflect changes in the methodology for recording this Broad Habitat rather than real change, particularly between 1990 and 1998. CS uses different approaches to investigate length and condition of linear features of ecological interest which are reported in *Chapter 5* and below *(2.6)*.

Results presented here for area and change in area of Broad Habitats broadly accord with those presented in CS2000 and in a previous report on Scottish Broad Habitats[4].

[2] The land in urban areas from within Scotland was excluded from the estimation of Broad Habitats.

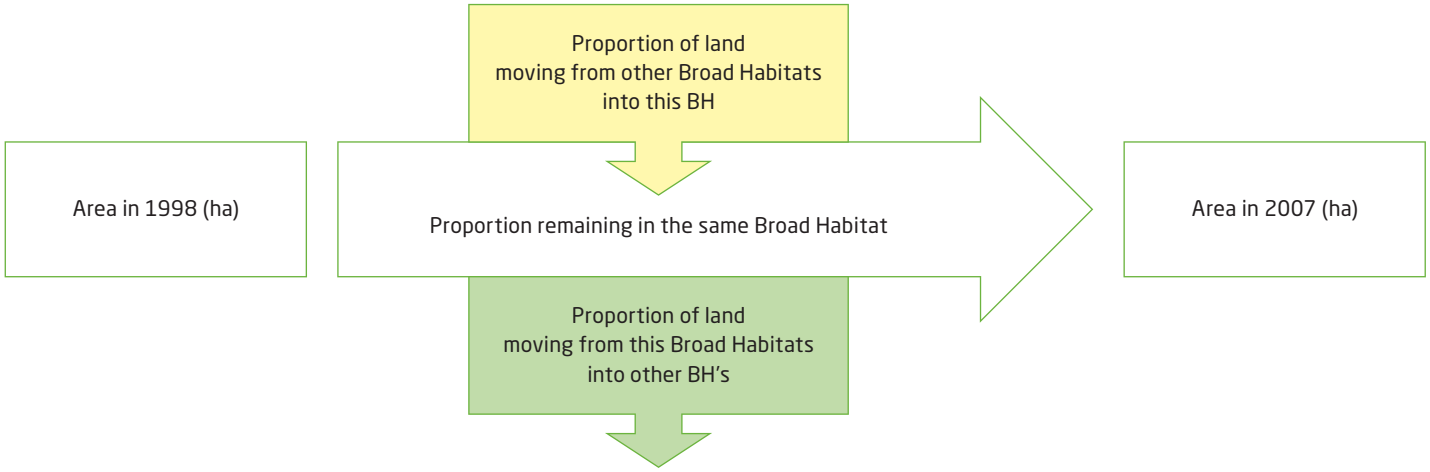
[3] Coniferous Woodland in CS excludes recently felled and newly planted woodland (canopy cover exceeds 25%).

[4] Trends in Broad Habitats, *SNH Report no F00NB03*.

▼ **Table 2.2:** Matrix of flows in extent of Broad Habitats within Scotland between 1998 and 2007. Broad Habitat numbers in 2007 columns are given in 1998 Broad Habitat column. Figures indicate percentages, '+' indicates flows below 1%.

		2007 Broad Habitat																
1998 Broad Habitat		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Broadleaved Woodland	1	85	1	+	+	+	+		+	1	+	+	+		+			+
Coniferous Woodland	2	5	97	+	+	+	6		3	1	1	+	1	+				+
Boundary & Linear	3	+	+	95	+	+	+		+	+	+		+		+		+	2
Arable & Horticultural	4	+	+	1	84	14	4	2				+		+				2
Improved Grassland	5	1	+	1	12	78	14		1	+		2	+	+	1		+	3
Neutral Grassland	6	3	+	1	4	7	69	+	+	2	+	4	+	+	+		2	3
Calcareous Grassland	7				+	+	+	95				+						
Acid Grassland	8	1	+	+	+	+	2		88	6	1	1	+		+			+
Bracken	9	+	+	+		+	+	1	1	80	+	+	+		+			+
Dwarf Shrub Heath	10	+	1	+		+	+	1	3	5	94	1	1		+		+	+
Fen, Marsh, Swamp	11	1	+	+		+	1		2	1	+	90	1	+	1			1
Bog	12	1	+	+		+	+		2	3	2	1	97	+	+		+	+
Standing waters	13	+					+							99				+
Rivers & Streams	14	+		+		+	+		+						98			+
Montane	15								+		+		+			100		
Inland Rock	16	+	+	+			+	1	+	+	+	+		+			96	2
Urban	17	1	+	+	+	1	1		+								2	87
Total		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

▼ **Figure 2.1:** Example diagram representing movements of land into and out of the different Broad Habitats between 1998 and 2007.



Differences between figures produced previously and those presented here are likely to reflect both a change in the analytical approach described in *Chapter 1.3 UK Report*, and work carried out post CS2000[5] to refine BH definitions and re-analyse data accordingly. Broad Habitats which now show different results for the period 1990 to 1998 include: Broadleaved Woodland, which has changed from a significant increase to a significant decrease; Coniferous Woodland, which has changed to a significant increase between 1990 and 1998 from 'no change'; and Fen, Marsh and Swamp, which previously showed an increase between 1990 and 1998 and now shows 'no change'. Post 1998, a close inspection of the data revealed that a large number of areas of wet grassland containing rushes had been incorrectly allocated to the Fen, Marsh, Swamp Broad Habitat[4]. This resulted in a re-allocation of those areas to produce more accurate figures and the outcome of 'no change' between 1990 and 1998.

2.3.2 Conversion of Broad Habitats

Table 2.2 summarises the flows of Broad Habitats within Scotland between 1998 and 2007. Figures indicate percentages, which add up to 100% vertically accounting for the entire amount of each Broad Habitat present in 2007. These figures, which have not been statistically tested, represent the net movements of areas of land between Broad Habitats. In the individual chapters, flows (movements of areas of land) within each Broad Habitat are represented by box and arrow diagrams, as shown in *Fig 2.1*. These diagrams provide an indication of the total area of the Broad Habitat in both 1998 and 2007, the percentage of the land area in the Broad Habitat which has remained in the same Broad Habitat (in the large white central arrow) and percentages of the polygons which have either come from (yellow box and arrow) or moved to (green box and arrow) different Broad Habitats.

[5] *Finding Out Causes and Understanding Significance*, Howard, D.C. et al. (2003).

2.4 Priority Habitats

In 2007, the areas of 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.

▼ **Table 2.3:** Estimated area ('000s ha) of selected Priority Habitats in Scotland 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		13.6
Wet Woodland	16.1	20.2
Upland Oakwood		31.3
Upland Birchwoods		31.9
Lowland Calcareous Grass	16.4	15.8
Upland Calcareous Grass	19.2	18.1
Blanket Bog		1119.9
Lowland Dwarf Shrub Heath	789.6	788.1
Upland Dwarf Shrub Heath	44	40.5
Purple Moor Grass Rush Pasture		37.8

▲ Upland birchwoods • © *SNH*

▲ Small pearl bordered fritillary butterfly • © *SNH*

2.5 Changes in vegetation in all habitat types

- **Plant species richness in plots sampling the wider Scottish countryside declined significantly between 1998 and 2007 (~10%) after a period of relative stability between 1978 and 1998. There was a similar trend for linear plots (14% decrease since 1998) and areas targeted for their botanical interest (12% decrease).**
- **Competitive plant species have increased since 1978. Plant species tolerant of harsh environments (stress tolerators) and those associated with open, disturbed conditions (ruderals) have decreased.**
- **Plant species associated with wetter conditions increased in areas targeted for their botanical interest between 1998 and 2007 and in all plot types between 1978 and 2007. Species associated with shady conditions increased from 1998 to 2007 in linear features and in areas targeted for their botanical interest. Species associated with more fertile conditions decreased between 1998 and 2007.**

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 UK Report*), 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. More comprehensive analysis of changes in condition of different Broad Habitats between 1990 and 2007 is presented in *Chapters 3 to 8*.

▼ **Table 2.4:** Change in the characteristics of all types of vegetation in 200m² Main Plots in Scotland and in each of the Environmental Zones between 1978 and 2007. Mean values for condition measures in 1998 and 2007 are presented; those for 1978 and 1990 are available at *www.countrysidesurvey.org.uk*. Arrows denote significant change (p<0.05) in the direction shown. Analyses are described in ***Box 1.3 UK Report***.

	Mean values (Scotland)		Direction of significant changes 1998 - 2007				Direction of significant changes 1978 - 1990				Direction of significant changes 1990 - 1998				Direction of significant changes 1978 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**
Species Richness (No. of Species)	18.4	16.6	↓	↓	↓	↓		↓	↑	↓			↓		↓	↓		↓
No. of Bird Food Species	5	4.6	↓						↑	↓			↓	↑	↓	↓		
No. of Butterfly Food Species	7.1	6.5	↓		↓			↓	↑	↓			↓		↓	↓	↓	↓
Grass:Forb Ratio	0.93	1					↓		↓									
Competitor Score	2.33	2.37	↑		↑		↑		↑	↑				↑	↑	↑	↑	↑
Stress Tolerator Score	2.99	3.02					↓			↓	↓			↓	↓			↓
Ruderal Score	2.16	2.1	↓	↓														
Light Score	7	7					↓	↓	↓	↓	↑	↑	↑					
Fertility Score	3.6	3.53	↓	↓		↓	↑	↑	↑									
Ellenberg pH Score	4.24	4.19		↓			↑	↑	↑									
Moisture Score	6.28	6.31							↑		↑				↑		↑	

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 Scotland (*Table 2.4* and see *www.countrysidesurvey.org.uk/*).

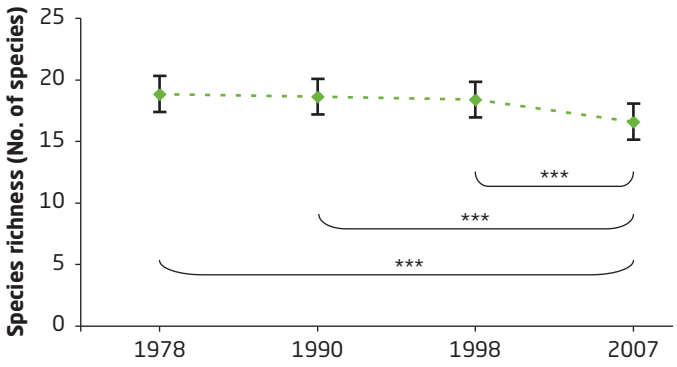
There was a significant decrease of 9.8% in plant species richness in Main Plots in all vegetation types in Scotland between 1998 and 2007. This decrease was consistent across all Environmental Zones (EZs). Plant species richness in 2007 was significantly lower than in all other survey years (which were not significantly different from one another, *Fig 2.2*) resulting in an apparent long term decline in species richness between 1978 and 2007 across Scotland and in the Lowlands (EZ4) and the True Uplands (EZ6).

The overall loss of plant species between 1998 and 2007 was also reflected in decreases in numbers of both Bird and Butterfly larvae Food Plants across Scotland. As the plant species which these counts refer to are particularly associated with lowland farmland, results for all EZs are not always meaningful (see *Methodology, Chapter 1*). However, accelerated species loss, including food plant species, between 1998 and 2007 both across Scotland and in the Lowlands (EZ4) is a key finding.

Other changes between 1998 and 2007 included an increase in competitive species aligned with decreases in plants of open ground (ruderals) and decreases in species associated with fertile conditions. In general competitive species would also be those associated with fertile conditions, but differences in the responses between EZs may account for this. For the period 1978 to 2007 increases in competitive species were consistent across Scotland and all EZs and to some extent aligned with decreases in plants tolerant of harsh conditions (stress tolerators). An increase in species associated with wet conditions was also evident across Scotland and in the Intermediate Uplands and Islands (EZ5).

There were a number of differences between the vegetation characteristics presented in *Table 2.4* for Scotland and those for GB as a whole. These included: higher Species Richness Score in Scotland (16.6) compared to GB (15.7), higher Moisture score in Scotland (6.31) compared to GB (5.82), lower pH in Scotland (4.19) compared to GB (5.14) and lower Fertility in Scotland (3.53) compared to GB (4.55).

▼ **Figure 2.2:** The change in Species Richness Score in 200m² Main Plots in all vegetation types across Scotland between 1978 and 2007. Significant changes (***p<0.001) are shown between the dates bracketed. 95% Confidence Intervals are shown for each data point. Confidence Intervals on change are not shown.



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.

▼ **Table 2.5:** Changes in the characteristics of vegetation in 10m x 1m Linear Plots (excluding Hedge Plots) in all vegetation types across Scotland and in each of the Environmental Zones between 1978 and 2007. Mean values for 1998 and 2007 are presented; those for 1978 and 1990 are available at www.countrysidesurvey.org.uk. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3 UK Report***.

	Mean values (Scotland)		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**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**
Species Richness (No. of Species)	22.0	19.2	↓	↓	↓						↓	↓		↓	↓	↓	↓	
No. of Bird Food Species	7.6	6.5	↓	↓	↓						↓	↓			↓	↓	↓	
No. of Butterfly Food Species	8.3	7.6	↓	↓							↓	↓			↓	↓		
Grass:Forb Ratio	0.65	0.51																
Competitor Score	2.79	2.83			↑		↑								↑	↑	↑	
Stress Tolerator Score	2.23	2.25					↓	↓			↑	↑						
Ruderal Score	2.8	2.75																
Light Score	6.88	6.83	↓	↓			↑		↑		↓		↓					
Fertility Score	5.22	5.22								↑				↓				
Ellenberg pH Score	5.74	5.75																
Moisture Score	5.52	5.55					↑					↑	↑		↑		↑	

▼ **Table 2.6:** Changes in the characteristics of vegetation in 2m x2m Targeted Plots in all vegetation types across Scotland and in each of the Environmental Zones between 1978 and 2007. Mean values for 1998 and 2007 are presented; those for 1990 are available at *www.countrysidesurvey.org.uk*. Arrows denote significant change ($p<0.05$) in the direction shown. Analyses are described in ***Box 1.3 UK Report***.

	Mean values (Scotland)		Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1998**	**2007**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**
Species Richness (No. of Species)	13.1	11.5	↓	↓	↓	↓	↓		↓		↓	↓	↓	↓
No. of Bird Food Species	3.6	3.1	↓	↓	↓	↓			↓		↓	↓	↓	
No. of Butterfly Food Species	5.1	4.6	↓	↓	↓	↓		↑			↓	↓	↓	↓
Grass:Forb Ratio	0.77	0.7		↓			↑	↑		↑	↑			↑
Competitor Score	2.5	2.55	↑	↑	↑		↑	↑		↑	↑	↑	↑	↑
Stress Tolerator Score	3.08	3.06		↓			↓			↓	↓	↓		↓
Ruderal Score	2.04	1.97	↓	↓	↓	↓					↓		↓	
Light Score	6.95	6.93	↓	↓			↑		↑	↑	↑		↑	
Fertility Score	3.54	3.54		↑									↓	
Ellenberg pH Score	4.31	4.3					↓				↓		↓	
Moisture Score	6.41	6.46	↑	↑		↑	↑	↑			↑			

An analysis of change in the vegetation of linear features is covered 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 Scotland *(Table 2.5)*.

As in Main Plots the Species Richness, numbers of Bird and Butterfly larvae Food Plants and Light Score all decreased in Linear Plots across all vegetation types in Scotland between 1998 and 2007. Decreases in species richness and in Bird and Butterfly larvae Food Plants were not apparent in the True Uplands. The trends in Linear Plots indicated that the vegetation of linear features became more shaded and less diverse between 1998 and 2007, part of a long term trend of species decline aligned with increasing numbers of competitive species over the period 1978 to 2007. There was no change in the Moisture Scores in Scotland between 1998 and 2007, but over the longer term, from 1978 to 2007, there was an increase in species associated with wetter conditions both across Scotland and in the Intermediate Uplands and Islands (EZ5).

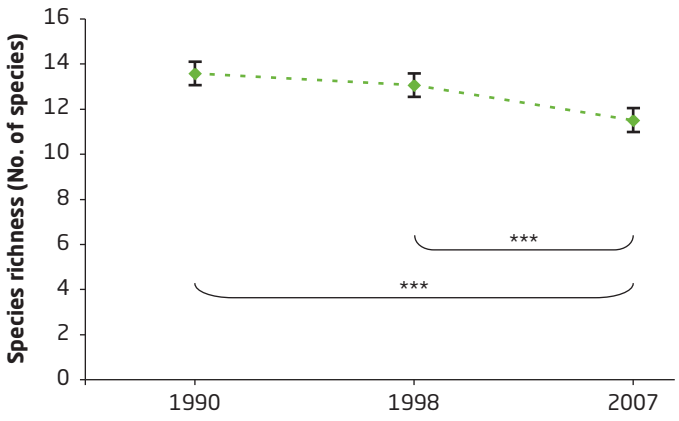
2.5.3 Targeted Plots

Targeted Plots (2m x 2m) were introduced in CS 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)*.

▲ Butterwort • © *SNH*

The Species Richness Score decreased in Targeted Plots across Scotland and in each of the EZs between 1998 and 2007, following a smaller decline across Scotland from 1990 to 1998 *(Fig. 2.3)*. There were also consistent decreases in the number of Farmland Bird and Butterfly larvae Food Plants between 1998 and 2007.

▼ **Figure 2.3:** Change in Species Richness in 2m x2m Targeted Plots in all vegetation types in Scotland between 1990 and 2007. Significant changes (*** p<0.001) are shown between the dates bracketed. 95% Confidence Intervals are shown for each data point. Confidence Intervals on change are not shown.



There were decreases in the Ruderal species and the Light Score, and increases in the Competitor Score and Moisture Score in Targeted Plots in all vegetation types in Scotland and across some or all EZs between 1998 and 2007 *(Table 2.6)*. 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, preferring moist conditions. 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.

Individual species changes within Main, Linear and Targeted Plots: The plant species that increased in frequency the most in all plot types in Scotland between 1998 and 2007 included several plants typical of wet environments (sedges and rushes), competitive species such as bramble and nettle and a number of woody species including ash, sycamore, spruce and oak. Species that decreased in frequency were more likely to be forbs or grasses typical of grasslands and also included species confined to particular habitat types (e.g. Wild Thyme and Common Butterwort) alongside a number of more generalist species such as Couch Grass and Germander Speedwell.

2.6 Changes in landscape features

- **The length of managed hedges decreased by 7% between 1998 and 2007. A third of managed hedges were in good structural condition in 2007 with signs of improving condition between 1998 and 2007.**
- **The extent and condition of drystane dykes (walls) in Scotland, particularly in the True Uplands (EZ6) and the Intermediate Uplands and Islands (EZ5) deteriorated between 1998 and 2007.**

Detailed analyses of change in linear landscape features are discussed in *Chapter 5*. The length of managed hedges decreased by 7% in Scotland between 1998 and 2007. This suggests a reduction in the management and maintenance of some hedgerows. Only around a third of managed hedgerows (36%) were considered to be in good structural condition in 2007.

▲ Bramble • © *SNH*

▼ **Table 2.7:** Plant species whose change indices were in the top 20 or bottom 20 of all species ranked from the biggest increase in the number of plots in which the species was found to the biggest decrease as indicated in the column 'No. & Direction'. Growth form: w = woody; f = forb; g = grass, s= sedge, m=rush, ds=dwarf shrub. No. of plots 2007 indicates how commonly the species was found in plots in 2007. The Change Index was calculated using an adaptation of the method presented in the New Atlas of the British and Irish Flora.

Names		Growth Form	No. of plots 2007	Change index	No. & Direction
Juncus effusus	Soft Rush	m	103	0.52	150
Carex echinata	Star sedge	s	1730	0.51	101
Carex binervis	Green Ribbed Sedge	s	485	0.43	89
Rubus fruticosus	Bramble	w	293	0.58	86
Urtica dioica	Nettle	f	615	0.48	84
Stellaria graminea	Lesser Stitchwort	f	119	0.62	48
Empetrum nigrum	Crowberry	ds	503	0.41	48
Trifolium pratense	Red clover	f	197	0.46	46
Fraxinus excelsior	Ash	w	133	0.54	45
Anthriscus sylvestris	Cow parsley	f	257	0.41	42
Pteridium aquilinum	Bracken	f	484	0.4	41
Selaginella selaginoides	Lesser clubmoss	f	165	0.43	37
Geum urbanum	Wood Avens	f	72	0.69	35
Potomageton polygonifolius	Bog pondweed	m	75	0.66	35
Acer pseudoplatanus	Sycamore	w	108	0.49	34
Blechnum spicant	Hard fern	f	522	0.38	29
Picea sitchensis	Sitka spruce	w	162	0.37	29
Epilobium brunnescens	New Zealand willow herb	f	59	0.64	28
Quercus robur and petraea	Oak	w	62	0.61	28
Luzula sylvatica	Great wood rush	m	132	0.39	28
Ranunculus ficaria	Lesser celandine	f	29	-0.81	-50
Elytrigia repens	Couch grass	g	168	-0.08	-59
Polygonium aviculare agg	Fat hen	f	81	-0.42	-68
Rumex crispus	Curled dock	f	48	-0.7	-69
Equisetum arvense	Horsetail	f	105	-0.32	-72
Veronica chamaedrys	Germander speedwell	f	251	-0.02	-80
Thymus polytrichus	Wild thyme	f	136	-0.25	-80
Pinguicula vulgaris	Common butterwort	f	264	-0.01	-83
Alopecurus geniculatus	Marsh foxtail	g	55	-0.77	-91
Cardamine hirsuta/flexuosa	Hairy bittercress	f	126	-0.33	-92
Danthonia decumbens	Heath grass	g	172	-0.21	-96
Campanula rotundifolia	Harebell	f	82	-0.61	-105
Achillea millefolium	Yarrow	f	321	-0.01	-107
Alopecurs pratensis	Meadow foxtail	m	63	-0.78	-108
Juncus bulbosus	Bulbous rush	m	354	-0.03	-130
Bellis perennis	Daisy	f	271	-0.13	-130
Carex viridula sspp	Common yellow sedge	s	291	-0.17	-162
Poa trivialis	Rough meadow grass	g	453	-0.1	-224
Festuca ovina agg	Sheep's fescue	g	622	-0.01	- 24 8
Poa pratensis sens lat	Smooth meadow grass	g	330	-0.44	-349

In contrast, actively managed hedges did show some signs of improvement with an increase from an average of 1.8 woody species per 30m section in Scotland in 1998 to an average of 2.2 species in 2007, probably because a number of new hedges were included in the 2007 plots. Other data collected at plot level indicated that hedges are now wider than they were in 1998 (see *Chapter 5*).

The extent and condition of drystane dykes (walls) in Scotland and particularly in the True Uplands (EZ6) and the Intermediate Uplands and Islands (EZ5) are deteriorating.

▼ **Table 2.8:** Changes in the pH and carbon concentration of soils (0-15cm depth) within all vegetation types, some selected Broad Habitats across Scotland and in each of the three Environmental Zones. 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	4.85	5.26	155.1	132				↑		↑
Coniferous Woodland	4.52	4.61	222.6	207.6						
Arable and Horticulture	5.98	6.28	32.3	29.4	↑	↓				
Improved Grassland	5.84	5.95	58.4	59			↑		↑	
Neutral Grassland	5.71	5.72	79.4	77.5			↑		↑	
Acid Grassland	4.83	4.82	265.8	226.2		↓			↑	
Bracken	4.81	4.51	196.3	264.4						
Dwarf Shrub Heath	4.63	4.66	300.3	285.8			↑		↑	
Fen, Marsh and Swamp	5.24	5.31	243.4	206.9		↓	↑		↑	
Bog	4.53	4.59	412.6	398.2			↑	↑	↑	
All vegetation types	5.02	5.09	235	220.6	↑	↓	↑	↑	↑	
Environmental Zone										
Lowlands EZ4	5.53	5.63	107.1	95.3		↓		↑	↑	
Intermediate Uplands and Islands EZ5	4.95	5	292.2	277.9		↓	↑	↑	↑	
True Uplands EZ6	4.58	4.64	298.3	280.9		↓			↑	

▲ Upland bog • © *SNH*

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

- **Soils (0-15cm) across all vegetation types became less acidic between 1998 and 2007 continuing a trend observed between 1978 and 1998.**
- **Carbon concentration in the soil (0-15 cm) increased in Scotland 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 Scotland between 1978 and 2007.**
- **The mean soil (0-15cm) carbon content (carbon concentration x amount of topsoil) across Scotland in 2007 was calculated to be 72 t/ha, ranging from 47 t/ha in Arable Broad Habitat to 82 t/ha in Dwarf Shrub Heath.**

Introduction: Samples of soil (0-15cm) were collected in Main Plots in 1978, 1998 and 2007 for chemical and physical measurements. The upper soil (humus layer) from 0-8 cm depth was also sampled for analysis of soil biota. At the time of writing, further analysis of soils is ongoing to enable estimation of soil nutrient status, contaminant levels, soil biotic diversity and soil function. A technical report on soils will be published in 2009. Results for soil (0-15cm) pH, carbon concentration, bulk density and carbon content (where content is calculated from the carbon concentration multiplied by the amount of soil to 15 cm) are presented here for different habitat types across Scotland.

Soil (0-15cm) pH: The mean pH of soil (0–15 cm) *(Table 2.8)* in all vegetation types increased from 5.02 to 5.09 between 1998 and 2007, indicating a decrease in soil acidity. This trend has been consistent since 1978. The Arable Broad Habitat, which is one of the least acidic Broad Habitats, was the only one to show an increase in pH between 1998 and 2007. Other Broad Habitat types showed no change between 1998 and 2007, though the majority of Broad Habitats showed a long-term increase in pH from 1978 and 2007, which is consistent with a long-term recovery from acid deposition. Factors such as liming and fertiliser use which increase soil pH on agricultural land are also important in some habitats. The mean pH of soils Scotland was on average 0.78 lower than that across GB as a whole, reflecting a greater extent of upland semi-natural Broad Habitats in Scotland.

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 235.0 g/kg in 1998 to 220.6 g/kg in 2007 ***(Table 2.8)***. Prior to this, there had been an increase in the same soil sampling plots between 1978 and 1998. Mean soil (0-15cm) carbon concentration has changed little overall since 1978, but since the 1998 survey it has decreased in three Broad Habitats (Arable, Acid Grassland and Fen, Marsh Swamp). 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. Mean soil (0-15cm) carbon concentration in Scotland was approximately 100g/kg higher than that across GB as a whole.

Soil (0-15cm) bulk density and carbon content (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 content within soils (0-15cm). Note that as the relationship between carbon concentration and bulk density is non-linear, the average carbon content 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 content in soils (0-15cm) in all vegetation types for Scotland, the three Environmental Zones and selected Broad Habitats in 2007.

Broad Habitat	2007	
	Mean bulk density g/cubic cm	Mean carbon content t/ha
Broadleaved, Mixed and Yew Woodland	0.58	70.6
Coniferous Woodland	0.46	73.2
Arable and Horticulture	1.14	47.4
Improved Grassland	0.88	63.7
Neutral Grassland	0.81	67.5
Acid Grassland	0.38	80.3
Bracken	0.31	78.6
Dwarf Shrub Heath	0.3	81.9
Fen, Marsh and Swamp	0.42	69.8
Bog	0.17	75.9
All vegetation types	0.5	71.6
Environmental Zone		
Lowlands EZ4	0.81	62
Intermediate Uplands and Islands EZ5	0.38	74.8
True Uplands EZ6	0.31	77.4

As some Broad Habitat soils are rich in carbon but have a low mass of soil per unit volume, there was greater similarity in the carbon content of the soil (as measured in the 0-15cm cores) in 2007 across the different Broad Habitats than might be expected given varying extents of management between them. Values ranged from 47.4 t/ha in Arable to 81.9 t/ha in Dwarf Shrub Heath, with an overall mean of 71.6 t/ha ***(Table 2.9)***. These values are comparable with those across GB as a whole, where they ranged from 44.7t/ha in Arable to 86.2t/ha in Dwarf Shrub Heath.

These values of carbon content 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 soils of most other habitats. For example, many blanket peats are over one metre in depth, so alternative ways will be required for monitoring and measuring any changes in these important national soils. Nevertheless, the upper 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 which impact both on carbon input to soil and storage within the soil.

The estimates of change in soil (0-15cm) carbon concentration from Countryside Survey differ markedly from the large decrease estimated for England and Wales by the National Soil Inventory Monitoring Programme[6]. 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.

2.8 Changes in condition of headwater streams and ponds

- **Plant species richness in headwater streams increased between 1998 and 2007. Plant species sensitive to nutrient enrichment became more common, suggesting improved water quality. The physical habitat quality of headwater streams also improved between 1998 and 2007.**
- **Plant species richness in 10m x1m vegetation sampling plots alongside streams decreased by 12% between 1998 and 2007, with increases in competitive plant species and decreases in species of open/disturbed ground (ruderals).**
- **10% of Scottish ponds had the necessary plant species richness to qualify as Priority Habitats.**

[6] http://randd.defra.gov.uk/Document.aspx?Document+SP0124_875_FRP.pdf

▲ Headwater stream • © *SNH*

Headwater streams, small watercourses within 5km of its source and draining a land area of less than 20km^2, represent over 90% by length of all watercourses in Scotland. The status of these streams 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. Results of stream macroinvertebrate samples are still being processed, so changes in stream condition reported here are based on data for aquatic plants only. Results for freshwater habitats are presented in ***Chapter 8*** and only a brief summary is provided here

Plant species richness in headwater streams increased between 1998 and 2007 and there was a high turnover of species with only 46% of species recorded in both years. The increase was primarily due to an increase in emergent plants such as Brooklime (*Veronica beccabunga*) and Bulbous Rush (*Juncus bulbosus*). Plant species sensitive to nutrient enrichment e.g. Alternate Water Milfoil (*Myriophyllum alterniflorum*) 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 side bars and bank-side trees.

In contrast to the stream channels, plant species richness in 10m x1m vegetation sampling plots alongside streams decreased by 12% between 1998 and 2007, continuing a trend from 1990. Competitive plant species increased and ruderal species decreased. There were significant increases in species preferring fertile conditions in the Lowlands (EZ4) but not across Scotland as a whole.

The average plant species richness in ponds in Scotland was slightly higher than that across GB as a whole, with nine to ten species on average per pond. Only 9.9% of ponds sampled were of Priority Habitat status, as judged by plant criteria. These data will act as baseline for any future assessment of Scottish ponds.

2.9 Summary and Discussion

2.9.1 Summary

The changes in the areas of Broad Habitats in Scotland reflect short-term influences, such as agricultural economics, and medium-term influences, such as woodland planting and harvesting.
The Arable and Horticulture Broad Habitat has decreased in extent largely through conversion to Improved or Neutral Grassland.
Plant species richness within remaining arable habitats has remained stable whilst that of other enclosed habitats has decreased. The length of managed hedges decreased, with a third being assessed as in good condition. In woodland, there has been a marked shift from Coniferous to Broadleaved, Mixed and Yew Woodland, although shifts in Coniferous Woodland may to some extent result from the dynamic cycle associated with felling. 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 there have been no significant changes in the extents of the Broad Habitats with the exception of an increase in the area of Acid Grassland.

The overall trends in plant species richness across all habitat/vegetation types in Scotland and in most cases in each of the three EZs between 1998 and 2007 indicate continuing and increasing declines in all plot types. The continued decrease in species richness across Scotland in areas targeted for their botanical diversity and in linear plots is of particular concern because those areas may constitute refuges and 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.

The vegetation across Scotland has also changed in character. Species that flourish in wetter conditions, competitive species and species that cast or prefer shade (particularly in areas targeted for botanical diversity and linear plots) have increased whilst stress-tolerant species have decreased. 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 while surrounding vegetation has become more overgrown and less diverse.

Soils (0-15cm) show evidence of decreasing acidity associated with recovery from previous high levels of acid deposition, though the impacts of these changes on vegetation are less obvious.
Soils in Scotland have considerably higher carbon concentrations than those across GB as a whole. Since 1998, an 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.

2.9.2 Discussion

Countryside Survey provides an overview of changes in Broad Habitats in Scotland in recent decades. Many of these changes are likely to be a result of shifts in land use and management practices, reflecting legislative requirements, socio-economic and political pressures and environmental factors such as pollution and climate change.

Legislative requirements which influence land use and management in Scotland include the EC Birds and Habitat Directives and the Nature Conservation (Scotland) Act 2004. These exist to conserve and enhance internationally and nationally important rare and threatened habitats and species. Species and habitats of concern are targeted through designated Special Protection Areas (SPAs), Special Areas of Conservation (SACs) and Sites of Special Scientific Interest (SSSIs). Habitats of high biodiversity value may be protected by multiple designations, and include examples of woodlands, semi-natural grassland, and many mountain, moor and heath habitats. The Water Framework Directive, transposed into Scottish law in 2003, aims to reduce pollution and protect and enhance freshwater environments.

Between 1998 and 2007, the UK Biodiversity Action Plan (UK BAP *www.ukbap.org.uk*) was implemented, to fulfil the UK commitment to the Convention on Biological Diversity. A summary of the aims of UK BAP and its framework of Broad and Priority Habitats is given in ***Box 1.1, Chapter 1***. In Scotland, implementation of the plan is managed under the Scottish Biodiversity Strategy (SBS). As part of the SBS, a suite of 22 biodiversity indicators was published by the Scottish Government in 2007 to allow assessment of progress towards UK BAP targets. These are maintained and updated by Scottish Natural Heritage (SNH), and incorporate CS results to assess progress towards the European Union target of halting biodiversity loss by 2010.

In recent decades, there have been changes in policies and legislation affecting agriculture, the water environment and forestry. Changes in market pressures and the mechanisms for delivering agricultural support have influenced farming practices. Single Farm Payments were introduced in 2005 as part of the reform of the Common Agricultural Policy (CAP). This 'decoupling' of agricultural support payments from the number of animals has probably contributed to a reduction in the number of livestock in Scotland, particularly hill sheep[7]. The changes are complex, but it is likely that reduced grazing is contributing to successional change in some Broad Habitats.

Agriculture has a key role to play in maintaining and enhancing biodiversity. Agri-environment schemes, such as Environmentally Sensitive Areas (ESAs) and Rural Stewardship, have been one of the main policy initiatives for supporting the adoption of environmentally friendly management practices in Scotland since 1987. The Scotland Rural Development Programme (SRDP) for 2007-13 aims to deliver economic, social and environmental benefits to rural Scotland through a range of schemes.

Underpinned by the Scottish Rural Development Strategy, the aim is to encourage an integrated, rather than sectoral, approach to managing land in an environmentally friendly and sustainable manner. It incorporates many elements of previous schemes such as the Less Favoured Areas Support Scheme (LFASS) and ESAs, as well as measures relating to Natura 2000 management, forestry LFA support, and aspects of water management. It is anticipated that Countryside Survey will in future provide an indication of the success of these measures in addressing areas of concern such as biodiversity loss.

Evidence from CS helps to assess the effectiveness of agri-environment measures across habitats, such as planting and management of hedgerows, pond creation, and farm woodland planting (***Chapters 5 and 6***). The pattern of decreases in plant species richness alongside increases in competitive, shade tolerant plant species between 1998 and 2007 is suggestive of reduced management, including reduced grazing and less intensive woodland management, across a range of Broad Habitats.

A decline in livestock numbers since 1999, shown in agricultural census returns, increased after the introduction of Single Farm Payments. The influence of livestock subsidy mechanisms particularly affects marginal upland habitats. Reductions in grazing intensity will affect habitat condition and biodiversity in some areas (***Chapter 7***). However, grazing intensity varies across Scotland, with other areas showing changes more consistent with heavy grazing pressure.

▲ Farmed landscape • © *SNH*

[7] *Farming's Retreat from the Hills*, SAC Rural Policy Centre, 2008

Forestry policy in the 1980s gave more emphasis to balancing commercial and environmental interests. By the 1990s, mature conifer plantations were being restructured and more broadleaved species planted to improve habitat diversity, naturalness and connectivity. *The Scottish Forestry Strategy* (2006) builds on this approach, and includes objectives for the conservation of semi-natural woodland and enhancing the biodiversity of other woodlands and forest. The increase in Broadleaved Woodland reflects planting incentives and policy actions which, as shown by annual Scottish Agricultural Census data, have resulted in a steady increase in the area of farm woodland in Scotland (***Chapter 6***).

Pollution, in the form of atmospheric deposition of sulphur and nitrogen, has impacted on the environment since the industrial revolution. Upland habitats such as bogs, are particularly affected, through changes in soil acidity and increased nutrient levels due to nitrogen deposition (***Chapter 7***). Emissions of sulphur dioxide have decreased substantially since the 1970s, reflected in the reduced acidity of surface soils.

The impacts of climate change in Scotland are becoming evident. Since 1961, the growing season now starts on average three weeks earlier and ends two weeks later, with the largest effects in the uplands. As climate changes, the capability of land to support agriculture will be affected. Temperature and precipitation changes are likely to influence future land use patterns.

The role of forestry is vital in adapting to climate change, such as contributing to sustainable flood management, capturing carbon and providing fuel resources and sustainable construction material. Analysis of forest and other habitat networks can help in planning adaptation to climate change, and supporting fully functioning and adaptable ecosystems.

Use of the Scottish countryside needs to meet multiple objectives appropriate to local conditions, in the context of wider environmental factors such as climate change and pollution. More integrated strategies in relation to land use provide a framework for addressing these challenges. The Countryside Survey integrated assessment, due in 2010, will provide further information on the links between land management, biodiversity and ecosystem services.

▲ Wind turbine • © *SNH*

Countryside Survey

Further information

More details of the methodology, analyses and results from Countryside Survey can be found in other companion reports and data resources available for the Countryside Survey website [**www.countrysidesurvey.org.uk**] including:

Reports:

- UK Headline Messages – *published November 2008*
- UK Results from 2007 – *published November 2008*
- Detailed Northern Ireland Countryside Survey results – *published April 2009*
- England Results from 2007 – *due to be published August 2009*
- Scotland Results from 2007 – *due to be published June 2009*
- Wales Results from 2007 – *due to be published July 2009*
- Ponds – *due to be published July 2009*
- Streams – *October 2009*
- Soils – *November 2009*
- Integrated Assessment – *2010*

Data resources:

- Web access to **summary data** – a systematic summary of the results used to inform the UK and country level reports – launched in November 2008 and updated in January 2009
- Web access to the **actual data** – data from individual survey squares used to generate all the results presented in Countryside Survey reports from the 2007 survey – licensed access available from June 2009
- The UK Land Cover Map for 2007 – September 2009

The data generated by Countryside Survey will continue to be investigated in conjunction with other information such as climate, pollution and agricultural statistics. It is anticipated that future analysis of Countryside Survey data will lead to many scientific journal articles over the coming years. These investigations will improve understanding about the possible causes of the changes detected in the countryside and, for example, provide an opportunity to explore the results for Priority Habitats in more detail.

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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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▲ Cattle grazing • © *SNH*

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

Summary

- The area of Arable and Horticulture decreased by 14% across Scotland and by 11% in the Lowlands (EZ4) and 25% in the Intermediate Uplands and Islands (EZ5) between 1998 and 2007.
- The area of Improved Grassland increased by 9% across Scotland between 1998 and 2007.
- Plant species richness in the Arable and Horticulture Broad Habitat remained stable between 1990 and 2007. Plant species richness and plant cover were higher in crop edges than in arable fields or managed arable margins in 2007.
- Plant species richness in Improved Grassland decreased by 8% in Scotland between 1998 and 2007.
- pH in soil (0-15cm) increased in the Arable and Horticulture Broad Habitat in Scotland between 1998 and 2007 and in Improved Grassland across the period 1978 to 2007.
- Carbon concentration in soil (0-15cm) decreased between 1998 and 2007 in Arable and Horticulture Broad Habitats but there was no change in Improved Grasslands.

3.1 Introduction[1]

Enclosed farmland covers 20% of the land area of Scotland, which in Countryside Survey (CS) is comprised of two Broad Habitats, Arable and Horticulture, and Improved Grassland. These Broad Habitats are typically intensively farmed and managed land, with over 72% of their combined extent concentrated on the most nutrient-rich soils in the Lowlands (EZ4) in the east of the country. In these areas farming is as intensive as in comparable areas of England, with the focus on maximum production of crops and animal products. 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. Arable Field Margins, which are a Priority Habitat, and other areas of fallow or set-aside land are important sources of diversity within the Arable and Horticulture Broad Habitat (henceforth Arable Broad Habitat). The presence of linear features (***Chapter 5***), small patches of other habitat types such as woodland (***Chapter 6***) and water features (***Chapter 8***) also contributes to biodiversity in these areas.

The two Broad Habitats covered in this Chapter are among those most susceptible 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 changes in agricultural policy.

Condition of these habitats is assessed using a range of plot types which has been added to over time largely as a result of the importance of these habitats in England. Main Plots sample the main extent of all Broad Habitats; in enclosed farmland this usually consists of managed fields. Targeted Plots sample those fragments of uncultivated or unmanaged land which can provide important wildlife refuges for a range of species that would not otherwise persist in Arable and Improved Grassland Broad Habitats.

▲ Baler at work • © *Crown copyright SASA*

▲ Potato crop • © *Crown copyright SASA*

Cereal field margins in Arable Broad Habitat were sampled using Crop Edge Plots of 100m x 1m which were recorded within the first metre of crop from the edge of the field in both 1998 and 2007. Additional plots of 2m x 2m were recorded in Arable Broad Habitat for the first time in 2007, to improve 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.

3.2 Description of Broad Habitats

The two Broad Habitats covered in this chapter are:

Arable and Horticultural: Vegetation consisting of crops including commercial orchards. The description of this Broad Habitat also encompasses the vegetation types 'annual/early successional with open ground' and 'set-aside'.

Improved Grassland: An extensive Broad Habitat consisting of low botanical quality grassland, with high grazing value. Also includes amenity grassland.

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

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

	1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
EZ4	511	22.5	519	22.9	462	20.4	↓
EZ5	75	2.9	95	3.7	71	2.8	↓
EZ6	7	0.2	4	0.1	2	0.1	
Scotland	593	7.3	618	7.6	534	6.6	↓

3.3 Area of Broad Habitats of enclosed farmland

- **The area of Arable and Horticulture decreased by 14% across Scotland and by 11% in the Lowlands (EZ4) and 25% in the Intermediate Uplands and Islands (EZ5) between 1998 and 2007.**
- **The area of Improved Grassland increased by 9% across Scotland between 1998 and 2007.**

3.3.1 Change in Area

The Arable Broad Habitat covered approximately 0.5 million hectares (ha) of Scotland in 2007 compared to around 0.6 million ha in 1998 *(Table 3.1)*. There was a 14% decrease across Scotland as a whole and decreases of 11% and 25% respectively in the Lowlands (EZ4) and the Intermediate Uplands and Islands (EZ5). The decline contrasted with relative stability in the extent of this Broad Habitat between 1990 and 1998 across Scotland.

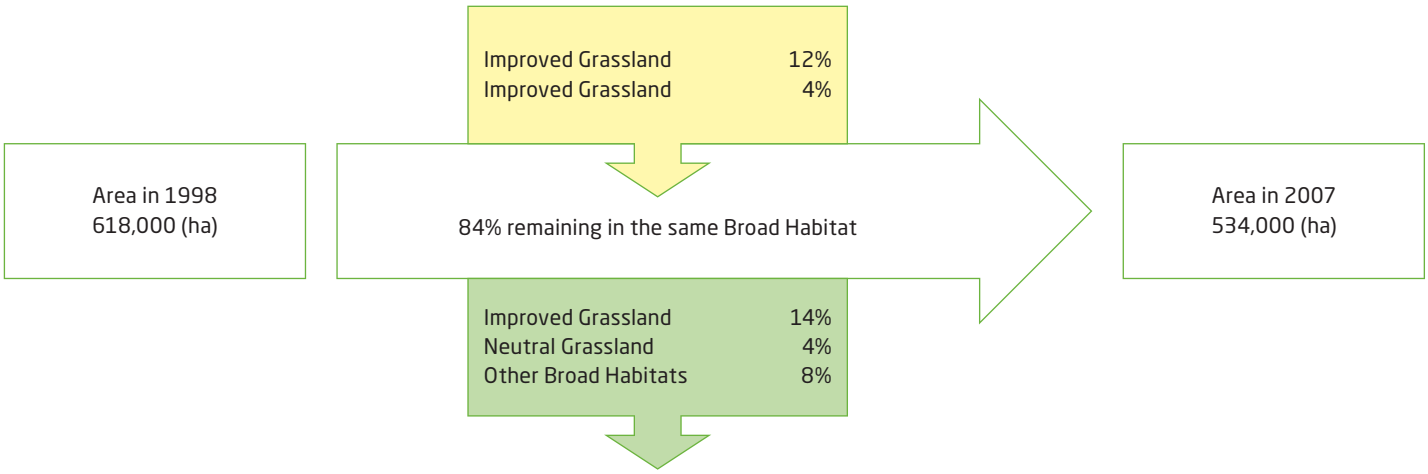
Eighty four percent of land in the Arable Broad Habitat in 2007 was in the same Broad Habitat in 1998 *(Figure 3.1)*.

A significant increase in the extent of Improved Grassland between 1998 and 2007 was detected at the country level. In 2007, Improved Grassland Broad Habitat in Scotland covered an area of approximately 0.9 million ha, a significant increase of 9% from 1998. This increase followed relative stability in extent between 1990 and 1998 *(Table 3.2)*, although increases between 1990 and 2007 are significant both across Scotland as a whole and in the Intermediate Uplands and Islands (EZ5).

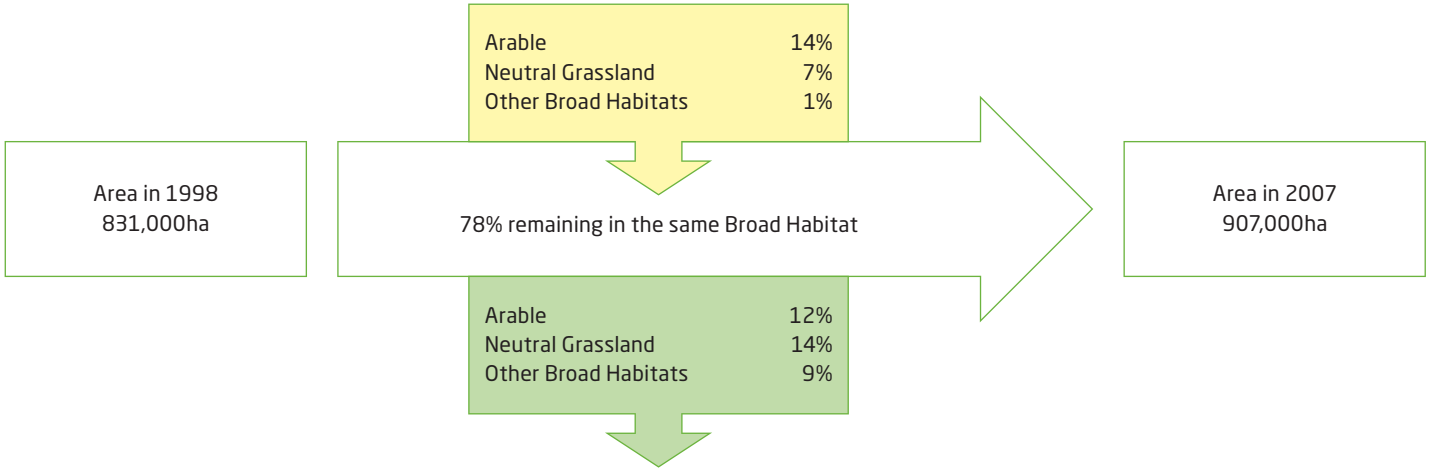
A large part (78%) of the Improved Grassland Broad Habitat in 2007 was recorded as the same Broad Habitat in 1998 *(Figure 3.2)*.

▲ Tayberries • © *Crown copyright SASA*

▼ **Figure 3.1:** Movements of land into and out of Arable and Horticulture between 1998 and 2007.



▼ **Figure 3.2:** Movements of land into and out of Improved Grassland between 1998 and 2007.



▼ **Table 3.2:** The estimated area ('000s ha) and percentage of land area of Improved Grassland Broad Habitat in Scotland and in each Environmental Zone in Scotland from 1990 to 2007 are shown. Where present, arrows denote significant change ($p<0.05$) in the direction shown.

	1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
EZ4	539	23.7	526	23.2	580	25.6	
EZ5	214	8.4	245	9.6	267	10.5	
EZ6	62	1.9	60	1.9	60	1.9	
Scotland	815	10.1	831	10.4	907	11.2	↑

▲ Thistle in oilseed rape crop • © *Crown copyright SASA*

3.4 The condition of the Broad Habitats of enclosed farmland

3.4.1 Arable and Horticulture Broad Habitat

- **Plant species richness in Arable and Horticulture Broad Habitat has remained stable between 1990 and 2007.**
- **Plant species richness and plant cover were higher in crop edges than in arable fields or managed arable margins in 2007.**

Main Plots: The number of plant species found in Main Plots within Arable Broad Habitat has changed little since 1990 *(Table 3.3)*. Similarly, there was little change in the Farmland Bird Food Plants and Butterfly larvae Food Plants counts in this period. Competitive species increased at the expense of more ruderal species both across Scotland and in the Intermediate Uplands and Islands (EZ5), which contains a relatively small percentage of this Broad Habitat. The Fertility Score decreased slightly both across Scotland and in EZ5. Decreases in species associated with fertile conditions are generally aligned with a loss of competitive species, so it is likely that these changes (whilst statistically significant) are not of ecological importance. The number of stress tolerant species has increased in the Intermediate Uplands and Islands (EZ5) since 1990.

Targeted Plots: No changes were detected in the condition of the Targeted Plots in the Arable Broad Habitat in Scotland either between 1998 and 2007 or across the period 1990 to 2007.

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

	Mean values (Scotland)			Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1990**	**1998**	**2007**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**
Species Richness (No. of Species)	10.3	9.2	9.6												
No. of Bird Food Species	6.1	5.4	5.2												
No. of Butterfly Food Species	3.5	2.8	3.1					↓		↓					
Grass:Forb Ratio	1.03	1.27	1.41												
Competitor Score	2.08	1.91	2.19	↑		↑									
Stress Tolerator Score	1.43	1.35	1.44			↑								↑	
Ruderal Score	3.85	4.03	3.73	↓		↓									
Light Score	6.95	6.99	6.97												
Fertility Score	6.42	6.43	6.26	↓		↓						↓			
Ellenberg pH Score	6.51	6.55	6.51												
Moisture Score	5.03	4.97	5.05												

Arable field margins: An average of 15 species per 1m x 100m plot was recorded and no change was detected in plots in Scotland between 1998 and 2007.

Managed Margins: A total of 12 such plots were recorded in Scotland, all of which were in the Lowlands (EZ4) except one in the Intermediate Uplands and Islands (EZ5). On average nine 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 Crop Edge Plots had the highest plant Species Richness Score whereas Main Plots had the lowest plant Species Richness Score and the highest percentage cover.

▼ **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.

	2007 2m x 2m core of Main Plots	2007 Crop Edge Plots	2007 Managed Margin Plots
Species Richness	4.9	8.9	8.6
Mean Cover (%)	25.7	18	19.5

3.4.2 *Improved Grassland Broad Habitat*

- **Plant species richness in Improved Grassland decreased by 8% in Scotland between 1998 and 2007.**

Main plots: The plant Species Richness Score in the Improved Grassland Broad Habitat decreased from 14.4 to 13.2 in Scotland between 1998 and 2007 *(Table 3.5)*. This 8% decrease is not significant across the period 1990 to 2007 due to a marginal increase between 1990 and 1998. The Species Richness Score decreased in this Broad Habitat in the Intermediate Uplands and Islands (EZ5) between 1998 and 2007. The Species Richness Score of plots in the Lowlands (12.0) was markedly different to that of those in the Intermediate Uplands and Islands (16.0).

Other changes in this plot type included a significant but very marginal decrease in the proportion of species associated with non-shaded conditions between 1998 and 2007. Changes in vegetation across the period 1990 to 2007 were more consistent with the period 1990 to 1998 than that from 1998 to 2007 *(Table 3.5)*. Increases in the Grass:Forb ratio and the proportion of species associated with wetter conditions were significant both for Scotland and the Lowlands (EZ4) *(Fig. 3.3)*.

Targeted plots: Little change in vegetation condition in Targeted Plots in Improved Grassland was detected for Scotland either between 1998 and 2007 or across the period 1990 to 2007 *(Table 3.6)*. A number of changes in condition in the Environmental Zones were evident both between 1998 and 2007 and across the period 1990 to 2007. These included a decrease in competitive species and species associated with fertile conditions in the Intermediate Uplands and Islands.

▲ Arable field margin • © *Richard Pywell*

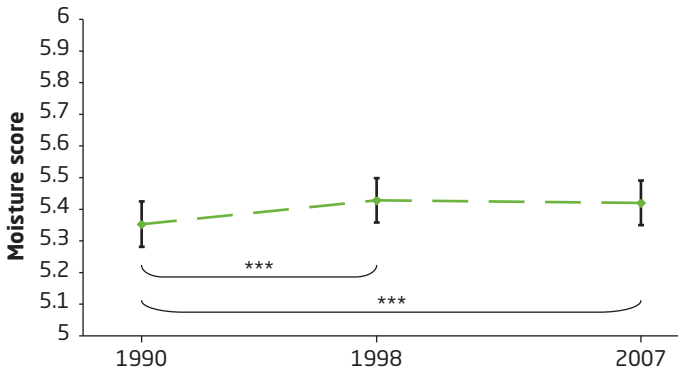
▼ **Table 3.5:** Change in the characteristics of vegetation in 200m² Main Plots in the Improved Grassland Broad Habitat across Scotland, between 1990 and 2007. Mean values for 1998 and 2007 are presented. Arrows denote significant change (p<0.05) in the direction shown. The condition measures are described in ***Box 1.3, UK Report***.

	Mean values (Scotland)			Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	1990	1998	2007	S	EZ4	EZ5	EZ6	S	EZ4	EZ5	EZ6	S	EZ4	EZ5	EZ6
Species Richness (No. of Species)	14.2	14.4	13.2	↓		↓									
No. of Bird Food Species	8.6	8.5	8.2												
No. of Butterfly Food Species	7.0	7.1	6.7												
Grass:Forb Ratio	1.22	1.83	1.73					↑	↑	↑		↑	↑	↑	
Competitor Score	2.65	2.65	2.70							↓				↓	
Stress Tolerator Score	1.96	1.95	1.95							↓			↑		
Ruderal Score	3.24	3.23	3.19												
Light Score	7.07	7.10	7.06	↓	↓			↑							
Fertility Score	5.69	5.60	5.64												
Ellenberg pH Score	6.01	5.92	5.97					↓	↓						
Moisture Score	5.35	5.43	5.42					↑	↑			↑	↑		

▼ **Table 3.6:** Change in the characteristics of vegetation in 2m x2m Targeted Plots in the Improved Grassland Broad Habitat in Scotland between 1990 and 2007. Mean values for 1998 and 2007 are presented. Arrows denote significant change (p<0.05) in the direction shown. The condition measures are described in ***Box 1.3 UK Report***.

	Mean values (Scotland)			Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	1990	1998	2007	S	EZ4	EZ5	EZ6	S	EZ4	EZ5	EZ6	S	EZ4	EZ5	EZ6
Species Richness (No. of Species)	12.8	13.7	12.2												
No. of Bird Food Species	5.7	6.2	6.2												
No. of Butterfly Food Species	5.6	7.0	6.0					↑							
Grass:Forb Ratio	0.64	1.17	1.13												
Competitor Score	2.89	2.87	2.73			↓								↓	
Stress Tolerator Score	2.23	2.42	2.36			↑		↑							
Ruderal Score	2.77	2.53	2.74										↓		
Light Score	6.86	6.92	6.94							↑				↑	
Fertility Score	5.18	4.80	4.95		↑	↓		↓	↓					↓	
Ellenberg pH Score	5.68	5.42	5.46					↓	↓				↓		
Moisture Score	5.79	5.87	5.79												

▼ **Figure 3.3:** Changes in Moisture Score in 200m² Main Plots in the Improved Grassland Broad Habitat across Scotland between 1990 and 2007. Significant changes (*** p<0.001) are shown between the dates bracketed. 95% Confidence Intervals are shown for each data point. Confidence Intervals on change are not shown.



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

- **pH in soil (0-15cm) increased in the Arable and Horticulture Broad Habitat in Scotland between 1998 and 2007 and in Improved Grassland across the period 1978 to 2007.**
- **Carbon concentration decreased in soil (0-15cm) in Scotland between 1998 and 2007 in the Arable and Horticulture Broad Habitat but there was no change in Improved Grassland.**

▲ Ploughing, Orkney • © *SNH*

3.5.1 Arable and Horticultural

Soil (0-15cm) pH: The mean pH of soils (0-15cm) increased significantly in Arable Broad Habitat in Scotland between 1998 and 2007 (*from 5.99 to 6.29*). However, between 1978 (mean pH of *6.15*) and 2007, there was little overall change. The pH of soils in Improved Grassland did not change between 1998 and 2007 (*5.83, 5.94*), but there was a significant increase across the period 1978 (*5.44*) to 2007.

Soil (0-15cm) carbon concentration: Across Scotland, the carbon concentration of soil (0-15cm) decreased in the Arable Broad Habitat between 1998 and 2007 (*from 32.3-29.4*). No significant change in carbon concentration in Improved Grassland occurred between 1998 and 2007 (*58.4, 59.0*) or across the period 1978 (*58.8*) to 2007.

Bulk density and soil (0-15cm) carbon content: The bulk density of soils (0-15cm) in Arable Broad Habitat in Scotland was 1.1 g/cm^3, which when combined with soil carbon concentration in the same horizon indicated a soil (0-15cm) carbon content of 47 t/ha. This was the lowest of all Broad Habitats ***(Table 2.8)***.

3.5.2 Improved Grassland

Soil (0-15cm) pH: The pH of soils in Improved Grassland did not change between 1998 and 2007 (*5.84, 5.95*), but there was a significant increase across the period 1978 (*5.44*) to 2007.

Soil (0-15cm) carbon concentration: No significant change in carbon concentration in Improved Grassland occurred between 1998 and 2007 (*11.68g/kg, 11.80g/kg*) or across the period 1978 (*11.75*) to 2007.

Bulk density and soil (0-15cm) carbon content: For Improved Grassland, the bulk density of soil (0-15cm) was 0.9 g/cm^3 indicating a soil (0-15cm) carbon content of 64 t/ha, similar to many of the other Broad Habitats ***(Table 2.8)***.

3.6 Summary and discussion

3.6.1 Changes in Enclosed Farmland

The Lowlands are particularly important for arable production but also support the majority of intensive livestock production in Scotland. The Intermediate Uplands and Islands support a smaller percentage (13%) of arable production (Arable Broad Habitat) and around 30% of intensive livestock production (Improved Grassland Broad Habitat). Between 1998 and 2007 a decrease in Arable was countered by an increase in the extent of Improved Grassland. Analysis of changes between Broad Habitat types revealed that, as well as conversions between Arable and Improved Grassland, land in these Broad Habitats also converted to and from Neutral Grassland. Results for the Neutral Grassland Broad Habitat are covered in *Chapter 4*.

Plant Species Richness Scores in Scotland showed little change within any of the three plot types sampling in Arable land between 1990 and 2007. In Main Plots in Improved Grassland, Plant Species Richness Score varied across Environmental Zones in Scotland with plots in the Intermediate Uplands and Islands containing 30% more species than those in the Lowlands. Between 1998 and 2007 there was a small decrease in the Plant Species Richness Score in Main Plots in Improved Grassland Broad Habitat. Changes in Improved Grassland between 1990 and 2007 included a shift towards more grass species and species associated with wetter conditions.

Soils (0-15cm) became less acid in Arable Broad Habitat between 1998 and 2007 and in Improved Grassland across the period 1978 to 2007. No corresponding shift in the composition of vegetation was reflected in the Ellenberg pH Score except in Targeted Plots in Improved Grassland in the Lowlands (EZ4) between 1990 and 2007. The Carbon concentration of soils (0-15cm) in Arable Broad Habitat decreased across the period 1998 to 2007 after remaining relatively stable between 1978 and 1998. Further analysis of soils is ongoing to enable estimation of nutrient status, contaminant levels, soil biotic diversity and soil function and will be reported in November 2009.

▲ Skylark on agricultural land • © *SNH*

▲ Enclosed farmland • © *SNH*

3.6.2 Discussion

CS gives a broad indication of changes in Arable and Improved Grassland Broad Habitats in Scotland in recent decades. Conversions between Arable and Improved Grassland between 1998 and 2007 can at least in part be explained by rotational land use. Annual Scottish Agricultural Census returns are consistent with the patterns revealed in CS, and show that there have been marked changes in land use within enclosed farmland over the past few decades. The area of land under arable reached a peak in the 1980s at just over a million ha, mainly at the expense of improved grassland. By 2007, there had been a steady decline in arable by around 16%, whilst the area of improved grassland increased accordingly.

These changes can largely be attributed to the economic influences of the European Economic Community, following UK entry in 1973. With increased food production a priority, farming intensified, exerting a major influence on the agricultural landscape.

Agriculture has a key role to play in maintaining and enhancing biodiversity. Agri-environment schemes were introduced in Scotland in 1987, and have already made substantial contributions to the achievement of UK Biodiversity Action Plan (BAP) targets for certain bird species such as the corncrake. Such schemes aim to encourage farmers to adopt environmentally friendly management practices, and provide support for maintaining and enhancing particular habitats and landscape features. The more outcome-focused approach of the Scotland Rural Development Programme 2007-13 (SRDP; ***see Chapter 2***) offers flexibility for achieving environmental benefits in the future.

Although there has been little change in plant species richness in Arable since the last survey, the end of compulsory set-aside in 2009 is likely to change this, particularly in more intensively farmed lowlands. Land under set-aside is often similar in plant species richness to arable margins, and more diverse than the area of the main crop. Loss of set-aside may lead to loss of plant diversity in the future, but options to support the creation and maintenance of arable margins and beetle banks are available under the SRDP.

Whilst farming in Scotland is predominantly extensive, enclosed farmland occurs in areas where soils are more fertile and the climate more favourable. The rising global demand for food and importance of national food security may mean that the decrease in Arable seen between 1998 and 2007 is reversed in the future. As well as agricultural productivity, requirements for other land-based ecosystem services such as biodiversity and flood management will need to be considered.

As Scotland's climate changes, the capability of land to support agriculture will also change. Increases in temperature and changes in precipitation patterns are likely to be major influences on future arable land use patterns, with the area of prime agricultural land in the south and east likely to increase. If land at higher altitudes becomes more suitable for intensive agriculture, this may exert increased pressure on habitats which are currently under less intensive management. Further analysis of the role of factors such as economics, set-aside and agri-environment schemes are likely to be incorporated into future work on CS including the integrated assessment, due in 2010.

▲ Timothy Grass • © *Crown copyright SASA*

Countryside Survey

Further information

More details of the methodology, analyses and results from Countryside Survey can be found in other companion reports and data resources available for the Countryside Survey website [**www.countrysidesurvey.org.uk**] including:

Reports:

- UK Headline Messages – *published November 2008*
- UK Results from 2007 – *published November 2008*
- Detailed Northern Ireland Countryside Survey results – *published April 2009*
- England Results from 2007 – *due to be published August 2009*
- Scotland Results from 2007 – *due to be published June 2009*
- Wales Results from 2007 – *due to be published July 2009*
- Ponds – *due to be published July 2009*
- Streams – *October 2009*
- Soils – *November 2009*
- Integrated Assessment – *2010*

Data resources:

- Web access to **summary data** – a systematic summary of the results used to inform the UK and country level reports – launched in November 2008 and updated in January 2009
- Web access to the **actual data** – data from individual survey squares used to generate all the results presented in Countryside Survey reports from the 2007 survey – licensed access available from June 2009
- The UK Land Cover Map for 2007 – September 2009

The data generated by Countryside Survey will continue to be investigated in conjunction with other information such as climate, pollution and agricultural statistics. It is anticipated that future analysis of Countryside Survey data will lead to many scientific journal articles over the coming years. These investigations will improve understanding about the possible causes of the changes detected in the countryside and, for example, provide an opportunity to explore the results for Priority Habitats in more detail.

Contacts

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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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Designed by Countryscape.

▲ Lowland neutral grassland • © *SNH*

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

Summary

- The area of Acid Grassland increased by 8% in Scotland between 1998 and 2007 but no significant changes were detected in the areas of Neutral and Calcareous Grassland during this period.
- Plant species richness decreased by around 17% in Neutral Grassland in Scotland since 1998. Species losses included Bird and Butterfly larvae Food Plants.
- Competitive plant species increased at the expense of species of open ground in Neutral Grassland in Scotland between 1998 and 2007.
- Plant species associated with wetter conditions increased in Neutral Grassland in Scotland since 1998.
- Plant species richness decreased in Acid Grassland in Scotland between 1998 and 2007. Losses of species between 1998 and 2007 included Bird and Butterfly larvae Food Plants.
- Competitive plant species associated with wetter conditions increased, while species of open ground decreased in Acid Grassland in Scotland between 1998 and 2007.
- The mean pH of soils (0-15cm) in Neutral Grassland and Acid Grassland did not change in Scotland between 1998 and 2007. There were significant increases in mean pH (0-15cm) in both Broad Habitats across the period 1978 to 2007.
- No significant change was detected in the mean carbon concentration in soils (0-15cm) in Neutral Grassland in Scotland between 1998 and 2007, but for soils (0-15cm) in Acid Grassland, there was a significant decrease in Scotland during the same period.

▲ Surveyor at work, acid grassland • © *CEH*

4.1 Introduction[1]

In Scotland the majority of grasslands fall into the category of semi-natural grasslands. Two thirds of the area of semi-natural grassland is Acid Grassland typical of upland areas with thin soils and agriculturally unproductive grass species, located mainly in the True Uplands (EZ6) and the Intermediate Uplands and Islands (EZ5). Neutral grassland is less extensive in Scotland where it comprises approximately one third of the total area of semi-natural grassland and is mainly found in the Lowlands (EZ4). The Calcareous Grassland Broad Habitat is scarce in Scotland and is only found to any notable extent in the Intermediate Uplands and Islands (EZ5).

Acid Grassland in Scotland tends to be extensively managed for livestock production, particularly for beef and lamb, on land which is unsuitable for any other kind of production. In contrast, Neutral Grassland, concentrated in the Lowlands (EZ4) and Calcareous Grassland in the Intermediate Uplands and Islands (EZ5), may have been subject to previous intensive management and reverted to Neutral or Calcareous Grassland after more extensive management or may never have been agriculturally improved by ploughing, re-seeding or the use of inorganic fertilisers. Also included in the Neutral Grassland Broad Habitat are areas of unmanaged grassland which may be characteristic of semi-urban areas or areas adjacent to rivers and streams and other small areas of neglected or unmanaged land which are not associated with livestock production. More narrowly defined BAP Priority Habitats occur within each of these Broad Habitats but Countryside Survey (CS) data are unable to contribute to their assessment in Scotland as it does not adequately sample their restricted extent.

The three Broad Habitats included in this chapter are characteristic of soils with differing pH values in their whole profiles. 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) such as chalk; and Acid Grassland occurs on acid soils (pH<5.5). Much of the Acid Grassland in Scotland occurs in the uplands and so reference is also made to this Broad Habitat and its interactions with other Broad Habitats in *Chapter 7*.

Condition of these habitats is assessed using two plot types, Main plots sample the main extent of these Broad Habitats and Targeted plots sample smaller fragments of these Habitats which may be present adjacent to more intensively managed land e.g. a small area of botanically diverse Neutral Grassland in the corner of an arable field.

4.2 Description of Broad Habitats

The three Broad Habitats covered in this chapter are:

Neutral Grassland: This includes all semi-improved and unimproved grassland occurring on neutral soil. It includes enclosed and managed grassland such as pastures, a range of wet grasslands where the vegetation is dominated by grasses, and tall and unmanaged grassland.

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

Acid Grassland: Fine grasses predominate in generally dry situations e.g. *Agrostis capillaris*, *Festuca ovina* and *Anthoxanthum odoratum* usually on brown podzolic soils or rankers. Species indicative of acid conditions are present and include, e.g. *Galium saxatile*, *Potentilla erecta*, *Pleurozium schreberi* and *Rumex acetosella*. This Broad Habitat also includes moorland grass dominated by *Nardus stricta* and *Molinia caerulea*, which is characteristic of moorlands and lowland heaths on peat or peaty gley soils.

4.3 Area of Semi-Natural Grasslands

- **The area of Acid Grassland increased by 8% in Scotland between 1998 and 2007 but no significant changes were detected in the areas of Neutral and Calcareous Grassland during this period.**

4.3.1 Neutral Grassland

Neutral Grassland was estimated to cover approximately 461,000 ha in 2007 or approximately 6% of Scotland ***(Table 4.1)***. Although there was a 6% increase in estimated area between 1998 and 2007, this was not significant on account of the high variability of the results. This increase followed a period of stability between 1990 and 1998 ***(Fig. 4.1)***. Most Neutral Grassland occurs in the Lowlands (EZ4) where it constitutes 12.2% of the land area. No statistically significant changes were detected in the extent of Neutral Grassland in any of the Environmental Zones but fluctuations in the estimates between 1990 and 2007 (particularly in the EZs where it is less common) indicate high variability in this Broad Habitat over time.

[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, UK Report (Methodology)*.

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

	1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
EZ4	255	11.3	276	12.2	277	12.2	
EZ5	147	5.8	105	4.1	122	4.8	
EZ6	27	0.8	49	1.5	62	0.8	
Scotland	429	5.4	430	5.4	461	5.8	

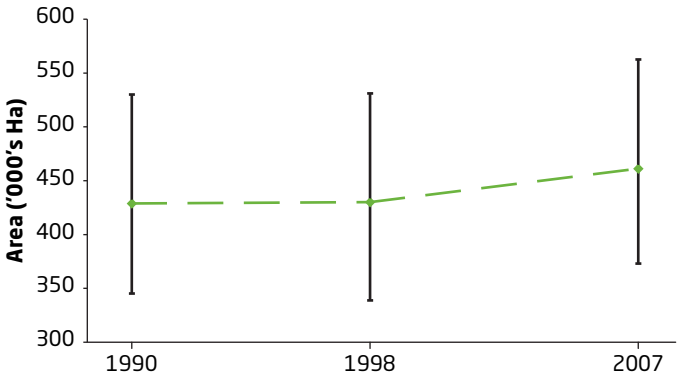
▼ **Table 4.2:** Estimates of the area ('000s ha) and percentage of land area of Calcareous Grassland in each Environmental Zone and in Scotland from 1990 to 2007. Arrows denote significant change ($p<0.05$) in the direction shown. Note that because of changes in definitions that have been applied retrospectively,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

	1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
EZ4	0	0	0	0	0	0	
EZ5	36	1.4	28	1.1	26	1	
EZ6	0	0	0	0	0	0	
Scotland	36	0.4	28	0.4	26	0.3	

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

	1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
EZ4	123	5.5	84	3.8	82	3.7	
EZ5	301	11.8	254	9.9	277	10.8	
EZ6	671	21	573	17.9	624	19.5	↑
Scotland	1095	13.6	911	11.4	983	12.3	↑

▼ **Figure 4.1:** Change in the area of Neutral Grassland across Scotland between 1990 and 2007. 95% Confidence Intervals are shown for each data point. Confidence Intervals on change are not shown.



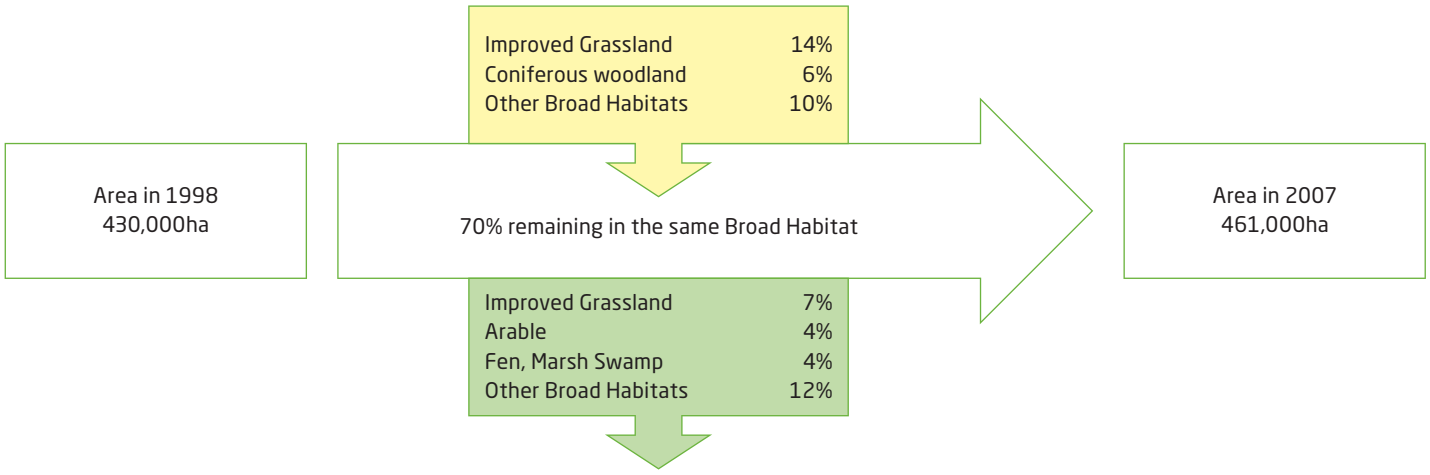
Around 70% of Neutral Grassland polygons remained as that Broad Habitat between 1998 and 2007. Neutral Grassland is a variable Broad Habitat, incorporating a range of different grassland types in different situations and losses and gains to this Broad Habitat included a wide range of different Broad Habitat types *(Fig 4.2)*.

4.3.2 Calcareous Grassland

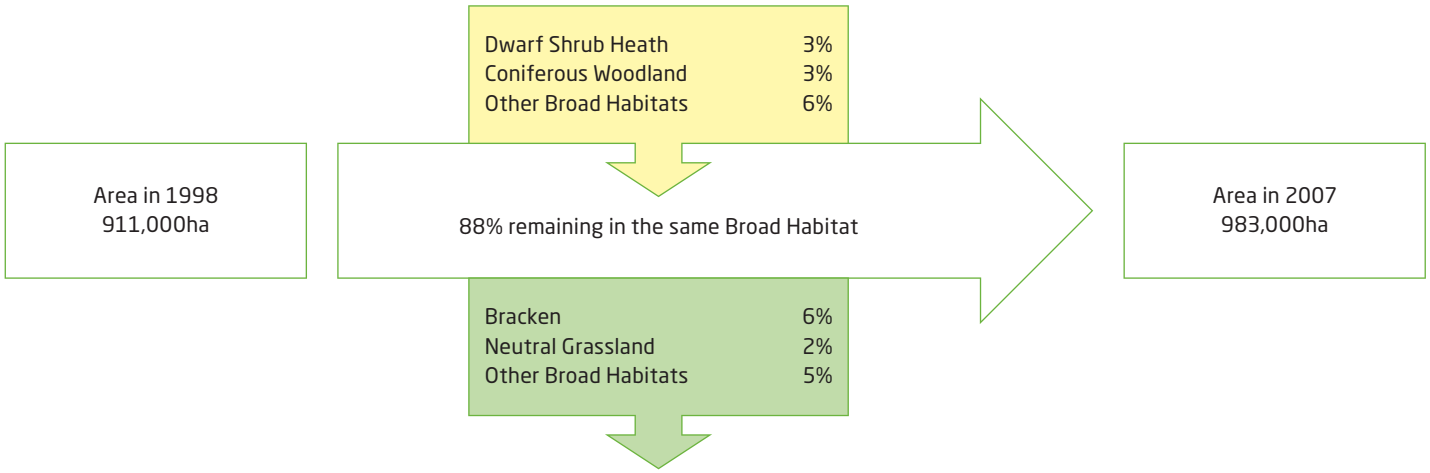
Calcareous Grassland was estimated to cover approximately 26,000 ha (0.3%) of Scotland in 2007 *(Table 4.1)*, the same percentage as for Great Britain. This Broad Habitat is found almost entirely within the Intermediate Uplands and Islands *(Table 4.1)*. Due to the small sample size it is difficult to detect small changes in the area of this Broad Habitat and none has been detected since 1990 in either the Intermediate Uplands and Islands or across Scotland as a whole *(Table 4.2)*.

Over 95% of Calcareous Grassland polygons remained in the same Broad Habitat between 1998 and 2007. There were no notable losses and gains from/to this Broad Habitat.

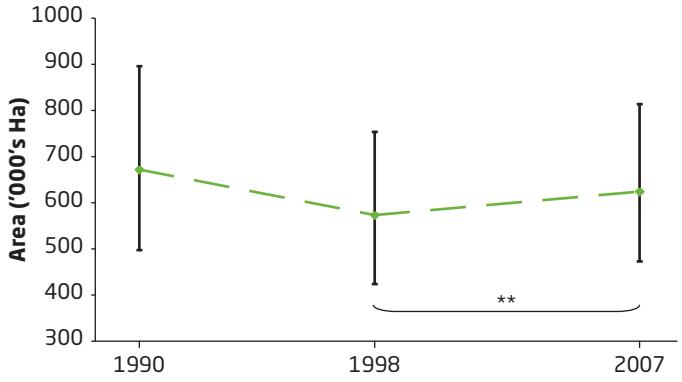
▼ **Figure 4.2:** Movements of land into and out of Neutral Grassland between 1998 and 2007.



▼ **Figure 4.3:** Movements of land into and out of Acid Grassland between 1998 and 2007.



▼ **Figure 4.4:** Change in the area of Acid Grassland across the True Uplands (EZ6) between 1990 and 2007. Significant changes (** p<0.01) are shown between the dates bracketed. 95% Confidence Intervals are shown for each data point. Confidence Intervals on change are not shown.



4.3.3 *Acid Grassland*

Acid Grassland was estimated to cover approximately 983,000 ha in 2007 or approximately 12% of Scotland *(Table 4.1)*. As for other upland habitats, Scotland is a key stronghold for this Broad Habitat containing over 60% of the stock for Great Britain, most of which is concentrated in the True Uplands (EZ6). The area of Acid Grassland increased both across Scotland (by 8%) and in the True Uplands (by 9%) between 1998 and 2007 *(Table 4.3, Fig. 4.4)*. There were no significant changes across Scotland or in any of the EZs between 1990 and 1998 despite large apparent differences between estimates. The introduction of new recording categories for Broad Habitats in 1998 may have affected the estimates of changes between 1990 and 1998 in both Neutral and Acid Grassland. The change estimates between 1998 and 2007 are more reliable because the same codes were used in both surveys.

The majority (88%) of Acid Grassland polygons remained in the same Broad Habitat between 1998 and 2007. Areas of land in this Broad Habitat were mainly lost and gained to other upland Broad Habitats *(Fig 4.3)*.

4.4 The Condition of semi-natural grasslands

4.4.1 *Changes in Neutral Grassland Broad Habitat*

- **Plant species richness decreased by around 17% in Neutral Grassland in Scotland since 1998. Species losses included Bird and Butterfly larvae Food Plants.**

▼ **Table 4.4:** Change in the characteristics of vegetation in 200m² Main Plots in the Neutral Grassland Broad Habitat across Scotland between 1990 and 2007. Mean values for condition measures in 1998 and 2007 are presented. Arrows denote significant change ($p<0.05$) in the direction shown. The condition measures are described in ***Box1.3, UK Report***.

	Mean values (Scotland)			Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1990**	**1998**	**2007**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**
Species Richness (No. of Species)	22.9	24.2	20.0	↓	↓							↓			
No. of Bird Food Species	10.6	10.8	9.5	↓											
No. of Butterfly Food Species	10.4	10.6	9.2	↓											
Grass:Forb Ratio	0.69	0.93	1.12									↑		↑	
Competitor Score	2.67	2.66	2.76	↑	↑								↑		
Stress Tolerator Score	2.36	2.34	2.33												
Ruderal Score	2.92	2.88	2.79	↓	↓							↓	↓		
Light Score	6.95	7.00	6.98					↑							
Fertility Score	4.95	4.92	4.86											↓	
Ellenberg pH Score	5.62	5.57	5.53												
Moisture Score	5.57	5.55	5.67	↑	↑							↑		↑	

▼ **Table 4.5:** Change in the characteristics of vegetation in 2m x 2m Targeted Plots in the Neutral Grassland Broad Habitat across Scotland between 1990 and 2007. Mean values for condition measures in 1998 and 2007 are presented. Arrows denote significant change ($p<0.05$) in the direction shown. The condition measures are described in ***Box 1.3, UK Report***.

	Mean values (Scotland)			Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1990**	**1998**	**2007**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**
Species Richness (No. of Species)	16.1	14.1	12.2	↓	↓	↓		↓	↓			↓	↓	↓	
No. of Bird Food Species	6.7	5.9	5.0	↓	↓			↓		↓		↓	↓	↓	
No. of Butterfly Food Species	6.9	6.3	5.6	↓		↓		↓				↓	↓	↓	
Grass:Forb Ratio	0.56	1.06	0.87					↑	↑						
Competitor Score	2.79	2.87	2.95	↑					↑			↑	↑		
Stress Tolerator Score	2.45	2.46	2.42												
Ruderal Score	2.70	2.58	2.52					↓	↓			↓	↓		
Light Score	6.87	6.89	6.87												
Fertility Score	4.73	4.73	4.85	↑										↑	
Ellenberg pH Score	5.46	5.38	5.48	↑											
Moisture Score	5.80	5.81	5.87												

- **Competitive plant species increased at the expense of species of open ground in Neutral Grassland in Scotland between 1998 and 2007.**

- **Plant species associated with wetter conditions increased in Neutral Grassland in Scotland since 1998.**

Main Plots: The Species Richness Score in Main Plots in Neutral Grassland across Scotland *(Table 4.4, Fig. 4.5)* decreased between 1998 and 2007 by an average of four species per plot. This decrease was aligned with decreases in both Bird and Butterfly larvae Food Species scores by on average one species per plot. Other changes within Main Plots in Neutral Grassland included an increase in the Competitor Score aligned with decreases in the Ruderal Score, indicating that Neutral Grassland is becoming more dominated by established competitive species. An increase in the Moisture Score indicates that those competitive species are more suited to wetter conditions than species present in 1998.

Results for the Scottish Lowlands (EZ4), in which the majority of Neutral Grassland is found, are consistent with those for Scotland *(Table 4.4)*, but there were no other changes within the other two Environmental Zones between 1998 and 2007.

Many of the changes across the period 1990 to 2007 appeared to be largely due to changes between 1998 and 2007 and are consistent with those changes. Other changes included an increase in the Grass to Forb ratio and a decrease in species associated with fertile conditions in the Intermediate Uplands and Islands between 1990 and 2007.

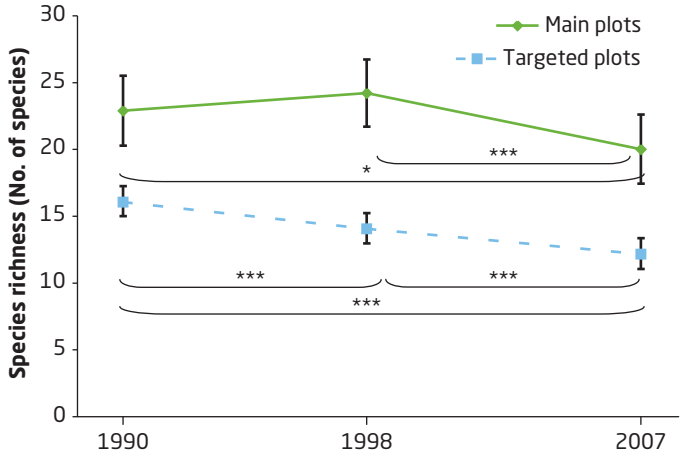
▲ Meadowsweet • © *SNH*

Targeted Plots: In areas targeted in Countryside Survey for their botanical interest, the plant Species Richness score decreased from 14.1 to 12.2 species per plot in Scotland between 1998 and 2007, following a similar decrease between 1990 and 1998 *(Table 4.5, Fig. 4.5)*. The Targeted Plots may have been located in small patches of Priority Habitat within larger Neutral Grassland areas or within patches of Neutral Grassland within other habitats such as scrub. This increase was consistent with increases in species associated with fertile conditions and a higher pH.

Decreases in the Species Richness Score also occurred within both the Lowlands (EZ4) and the Intermediate Uplands and Islands (EZ5). Decreases in the numbers of Bird Food Species also occurred in the Lowlands (EZ4) and in Butterfly larvae Food Species in the Intermediate Uplands and Islands (EZ5).

There were a number of changes in Targeted Plots between 1990 and 2007 (Table 4.5) many of which were consistent with a) changes between 1998 and 2007 and b) changes in Main Plots.

▼ **Figure 4.5:** Change in the Species Richness score in Main and Targeted Plots in the Neutral Grassland Broad Habitat across Scotland between 1990 and 2007. Significant changes (*p<0.05, *** p<0.001) are shown between the dates bracketed. 95% Confidence Intervals are shown for each data point. Confidence Intervals on change are not shown.



Other Characteristics of the vegetation of Neutral Grassland: The changes in the Main and the Targeted Plots are supported by the list of the plant species that increased or decreased the most with only three species showing a significant positive change index *(Table 4.6)*. Decreasing species included both a high proportion of common grasses and some forbs whilst two of the three increasing species are associated with moist conditions.

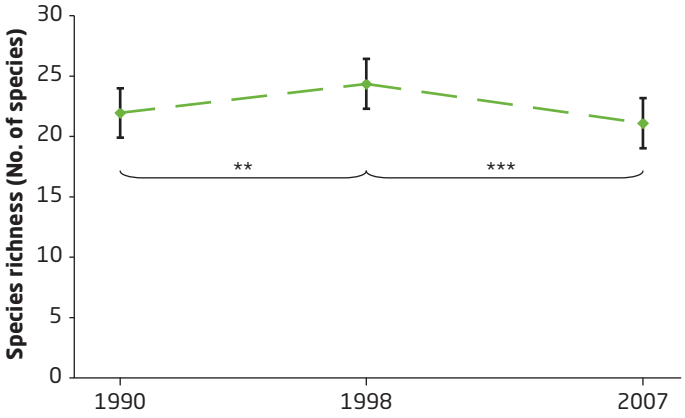
4.5.2 Changes in Calcareous Grassland Broad Habitat

There are too few plots in Calcareous Grassland in Scotland to assess changes in condition.

4.5.3 Changes in Acid Grassland Broad Habitat

- **Plant species richness decreased in Acid Grassland in Scotland between 1998 and 2007, particularly in the True Uplands. Losses of species between 1998 and 2007 included Bird and Butterfly larvae food plants.**
- **Competitive and moisture-preferring plant species increased, while species of open ground decreased in Acid Grassland in Scotland between 1998 and 2007.**

▼ **Figure 4.6:** Change in the Species Richness score in 200m² Main Plots in the Acid Grassland Broad Habitat across Scotland between 1990 and 2007. Significant changes (** p<0.01, *** p<0.001) are shown between the dates bracketed. 95% Confidence Intervals are shown for each data point.



Main Plots: The mean plant Species Richness Score recorded in Main Plots in Acid Grassland increased in Scotland between 1990 and 1998 but had decreased by 2007 *(Table 4.8)*, with no overall change across the entire period *(Fig. 4.6)*. The numbers of Butterfly larvae Food Plant species followed the same pattern.

Other changes within Main Plots in Acid Grassland were very similar to those in Neutral Grassland including an increase in the Competitor Score aligned with decreases in the Ruderal Score, and an increase in the Moisture Score. As in Neutral Grassland these changes indicate that Acid Grassland is becoming more dominated by established competitive species which are more suited to wetter conditions than species present in 1998.

▼ **Table 4.6:** The plant species with the largest increases and decreases in frequency in Main Plots in the Neutral Grassland Broad Habitat across Scotland between 1998 and 2007. Species are ranked according to the difference between the number of plots in which the species was found in 1998 and 2007 as indicated in the column 'No. & Direction'.

Species with increasing frequency		Change Index	No. and Direction	Species with decreasing frequency		Change Index	No. and Direction
Juncus effusus	Soft rush	0.48	6	*Poa pratensis sens lat*	Smooth meadow grass	-0.61	-17
Trifolium pratense	Red clover	0.46	6	*Bellis perennis*	Daisy	-0.23	-9
Cirsium palustre	Marsh thistle	0.18	4	*Veronica chamaedrys*	Germander speedwell	-0.25	-8
				Luzula campestris	Field Wood-rush	-0.21	-8
				Alopecurus pratensis	Meadow foxtail	-0.36	-7
				Poa annua	Annual meadow grass	-0.23	-7
				Lathyrus pratensis	Meadow Vetchling	-0.32	-6
				Agrostis capillaris	Common bent	-0.02	-5
				Ranunculus repens	Creeping buttercup	-0.02	-5
				Agrostis stolonifera	Creeping bent	-0.04	-5

▼ **Table 4.8:** Change in the characteristics of vegetation in 200m² Main Plots in the Acid Grassland Broad Habitat across Scotland between 1990 and 2007. Mean values for condition measures in 1998 and 2007 are presented. Arrows denote significant change ($p<0.05$) in the direction shown. The condition measures are described in ***Box 1.3, UK Report***.

	Mean values (Scotland)			Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1990**	**1998**	**2007**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**
Species Richness (No. of Species)	21.9	24.3	21.1	↓			↓	↑			↑				
No. of Bird Food Species	5.0	5.4	4.8	↓			↓				↑				
No. of Butterfly Food Species	8.9	9.5	8.3	↓		↓	↓	↑			↑			↓	
Grass:Forb Ratio	1.30	1.21	1.34												
Competitor Score	2.18	2.18	2.24	↑					↓			↑			↑
Stress Tolerator Score	3.51	3.47	3.46						↑		↓				↓
Ruderal Score	1.81	1.86	1.81	↓							↓				
Light Score	6.92	6.97	6.98					↑				↑	↑		
Fertility Score	2.94	2.95	2.93						↓						
Ellenberg pH Score	3.67	3.72	3.71								↑				
Moisture Score	6.41	6.37	6.46	↑		↑									

Patterns of change in the mean plant Species Richness score and Bird and Butterfly larvae Food Species scores in the True Uplands (EZ6) were consistent with those for Scotland, as most of the Acid Grassland occurs in EZ6. Changes in the Intermediate Uplands and Islands since 1998 are also consistent with changes across Scotland as a whole.

The results for the True Uplands indicate that the increase in competitive species since 1998 is at the expense of stress-tolerant species.

▲ Harebell • © *SNH*

▼ **Table 4.9:** Change in the characteristics of vegetation in 2m x 2m Targeted Plots in the Acid Grassland Broad Habitat across Scotland between 1990 and 2007. Mean values for condition measures in 1998 and 2007 are presented. Arrows denote significant change ($p<0.05$) in the direction shown. The condition measures are described in ***Box 1.3, UK Report***.

	Mean values (Scotland)			Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	1990	1998	2007	S	EZ4	EZ5	EZ6	S	EZ4	EZ5	EZ6	S	EZ4	EZ5	EZ6
Species Richness (No. of Species)	14.1	15.3	13.2	↓	↓		↓	↑							
No. of Bird Food Species	3.2	3.8	3.4					↑	↑						
No. of Butterfly Food Species	5.8	6.2	5.6	↓	↓		↓								
Grass:Forb Ratio	0.97	1.08	1.13												
Competitor Score	2.20	2.23	2.31	↑	↑							↑	↑		↑
Stress Tolerator Score	3.50	3.45	3.41								↓				↓
Ruderal Score	1.88	1.95	1.92												
Light Score	6.94	6.99	6.95	↓			↓	↑			↑				
Fertility Score	3.05	3.05	3.07												
Ellenberg pH Score	3.93	3.93	3.94												
Moisture Score	6.42	6.39	6.42												

▼ **Table 4.10:** The plant species with the largest increases and decreases in frequency in Main Plots in the Acid Grassland Broad Habitat across Scotland between 1998 and 2007. Species are ranked according to the difference between the number of plots in which the species was found in 1998 and 2007 as indicated in the column 'No. & Direction'.

Species with increasing frequency		Change Index	No. and Direction	Species with decreasing frequency		Change Index	No. and Direction
Carex binervis	Green ribbed sedge	0.31	8	*Agrostis capillaris*	Common bent	-0.26	-19
Cirsium arvense	Spear thistle	0.24	6	*Carex pilulifera*	Pill sedge	-0.3	-15
Urtica dioica	Common nettle	0.2	5	*Luzula campestris*	Field wood-rush	-0.16	-14
Trichophorum caespitosa	Deergrass	0.25	5	*Festuca rubra agg.*	Red fescue	-0.18	-13
Agrostis canina sens lat.	Velvet bent	0.26	5	*Festuca ovina agg*	Sheep's fescue	-0.11	-12
Selaginella selaginoides	Lesser clubmoss	0.16	4	*Carex viridula*		-0.22	-11
Eriophorum vaginatum	Harestail cotton grass	0.19	4	*Deschampsia flexuosa*	Wavy hair grass	-0.06	-10
Cirsium palustre	Marsh thistle	0.16	3	*Galium saxatile*	Heath bedstraw	-0.07	-10
Carex echinata	Star sedge	0.19	3	*Agrostis stolonifera*	Creeping bent	-0.1	-9
Holcus lanatus	Yorkshire fog	0.21	3	*Carex pulicaris*	Flea sedge	-0.24	-9

Targeted plots: The results for the Targeted Plots situated in areas of botanical interest within the Acid Grassland Broad Habitat across Scotland as a whole reveal similar trends to those found in the Main Plots, with decreases in both species richness and numbers of Butterfly larvae Food Plants (but not Bird Food Plants) since 1998 *(Table 4.9)*. An increase in competitive species in these plots was aligned with an increase in shade tolerant species (decreasing Light Score) between 1998 and 2007.

The same patterns as observed for Scotland as a whole were present to varying extents in both the Lowlands (EZ4) and the True Uplands (EZ6).

As in Main plots, increases in the Species Richness Score between 1990 and 1998 as compared to decreases between 1998 and 2007 resulted in no overall change for the period 1990 to 2007.

Other characteristics of vegetation in Acid Grassland: The changes in the Main and the Targeted Plots are supported by the lists of increasing and decreasing plant species *(Table 4.10)*. Increasing plant species include a number of competitive species, notably *Urtica dioica* and *Cirsium arvense* alongside species associated with moist conditions, whilst decreasing species include many typical of dry acid grassland.

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

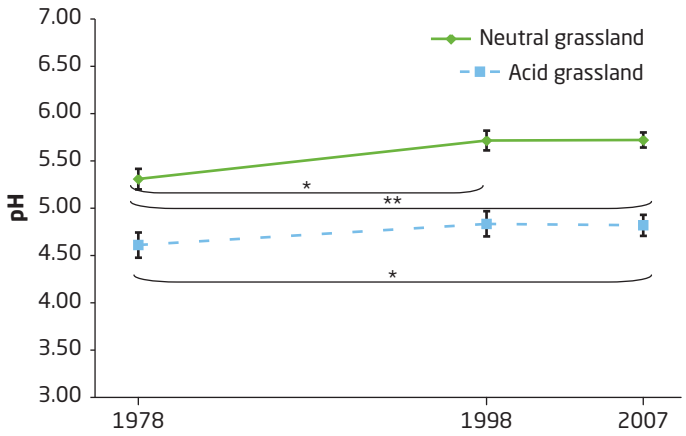
- **The mean pH of soils (0-15cm) in Neutral Grassland and Acid Grassland did not change in Scotland between 1998 and 2007. There were significant increases in mean pH (0-15cm) in both Broad Habitats across the period 1978 to 2007.**

- **No significant change was detected in the mean carbon concentration in soils (0-15cm) in Neutral Grassland in Scotland between 1998 and 2007, but for soils (0-15cm) in Acid Grassland, there was a significant decrease in Scotland 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 Scotland remained stable between 1998 (5.70) and 2007 (5.73). A lower pH in 1978 (5.31) resulted in significant increases between 1978 and 1998 and overall from 1978 to 2007 *(Fig 4.7)*.

▼ **Figure 4.7**: The change in mean pH of soils (0-15cm) from Neutral and Acid Grasslands in Scotland between 1978 and 2007. Significant changes (*p<0.05, **p<0.01) are shown between the dates bracketed. 95% Confidence Intervals are shown for each data point. Confidence Intervals on change are not shown.



Soil (0-15cm) carbon concentration: There was no significant change in the carbon concentration of soil (0-15cm) in Neutral Grassland in Scotland between 1998 (79.4g/kg) and 2007 (77.5g/kg) or between 1978 (85.7 g/kg) and 1998 or over the entire period 1978 to 2007.

Bulk density and soil (0-15cm) carbon content: The mean bulk density of Neutral Grassland soils (0-15cm) in Scotland was 0.81 g/cm^3 (in the top 15cm) which when combined with mean soil (0-15cm) carbon concentration indicated a soil (0-15cm) carbon content of 67.5 t/ha.

4.7.2 Calcareous Grasslands

Too few soil samples were taken from the Calcareous Grassland Main Plots for a statistical analysis to be undertaken for this Broad Habitat.

▲ Neutral grassland • © *Lisa Norton*

4.7.3 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 Scotland, between 1998 (4.83) and 2007 (4.82) *(Table 2.7, Fig. 4.7)*. As in Neutral Grassland, a lower pH in 1978 (4.60) resulted in significant increases across the period 1978 to 2007 (except between 1978 and 1998).

Soil (0-15cm) carbon concentration: There was a significant decrease in the mean carbon concentration of soil (0-15cm) in Acid Grasslands in Scotland between 1998 (265.8g/kg) and 2007 (226.2g/kg) *(Table 2.7)*, whereas there was no significant change between 1978 (238.6g/kg) and 1998, or across the period 1978 to 2007.

Bulk density and soil (0-15cm) carbon content: The mean bulk density of soils (0-15cm) in Acid Grassland in Scotland was 0.38 g/cm^3 which, when combined with mean soil (0-15cm) carbon concentration indicated a soil (0-15cm) carbon content of 80.3 t/ha *(Table 2.8)*.

4.8 Summary and Discussion

4.8.1 Summary - Changes in Semi-Natural Grasslands

Increases in the area of semi-natural grasslands in Scotland resulted from increases in Acid Grassland. There were no other significant changes in extent in semi-natural grassland Broad Habitats.

Plant species richness has decreased since 1998 in Main Plots in semi-natural grasslands and since 1990 in Targeted Plots in Neutral Grassland, with increases in the numbers of competitive species and species associated with wetter conditions. Soil pH increased in both Acid and Neutral Grassland between 1978 and 2007, but there were no significant changes in carbon concentration across the same period. Further analysis is ongoing to enable estimation of soil nutrient status, contaminant levels, soil biotic diversity and soil function and will be reported in November 2009. It was not possible to assess changes in condition or soils in Calcareous Grassland due to small sample sizes.

▲ Acid grassland, Glencoe • © *SNH*

4.8.2 Discussion

The variety of semi-natural grassland communities in Scotland has arisen through the combined effects of soil type, climatic conditions, drainage and centuries of land management, including grazing by sheep and deer.

The changes observed in vegetation condition in the 2007 results are consistent with what would be expected under reduced grazing and cutting, if combined with wetter conditions and higher soil pH. The increase in taller, more competitive species is likely to have suppressed smaller species, subsequently reducing species richness. Losses from Neutral Grassland to Fen, Marsh and Swamp may be partly due to reduced drainage maintenance in wetter grassland areas.

The unique and diverse assemblages of plants associated with Calcareous Grassland and its scarcity in Scotland means this habitat is of considerable importance for biodiversity. Due to small sample size, CS is only able to provide estimates of changes in extent, but it appears that the decrease seen between 1990 and 1998, due mainly to conversion to intensively managed pasture, has not continued.

In the uplands, a major threat to semi-natural grasslands is inappropriate grazing by cattle, deer and, in particular, sheep. In some areas, overgrazing is an issue, whereas in others, undergrazing occurs (see also ***Chapter 7***). Agricultural Census data show that livestock numbers, particularly for sheep, have declined since 1999, largely as a result of farmers downsizing or leaving the industry. The decline is complex but seems to have increased after agricultural payments were decoupled from numbers of animals[2]. Other factors may be involved, such as the increases in deer abundance which may occur where livestock grazing is reduced. Further investigation is needed to improve understanding of the interactions between different grazing animals and the impact they have on habitats and biodiversity.

Other threats to semi-natural grasslands include eutrophication from airborne pollutants and supplementary livestock feeding, which favours species associated with more fertile conditions over less competitive species. Some sites may also be at risk from more localised pollution, such as ground water contamination and herbicide or fertiliser application.

The UK Biodiversity Action Plan (BAP) includes Habitat Action Plans (HAPs) which include maintenance, restoration and re-establishment targets for five types of lowland grassland in Scotland. In addition, many semi-natural grassland areas are protected under statutory nature conservation designations, e.g. as Sites of Special Scientific Interest. Agri-environment measures have been one of the main policy initiatives for delivery of biodiversity objectives in semi-natural grasslands since 1987.

Schemes with measures targeted at semi-natural grasslands included Environmentally Sensitive Areas (ESAs) and Rural Stewardship. Such schemes aimed to encourage the maintenance of semi-natural grasslands of existing high biodiversity value. Under the Scotland Rural Development Programme (SRDP), introduced in 2007, there are various outcome-focused options available to enhance as well as maintain species-rich unimproved grassland, or grasslands previously degraded by agricultural improvement or neglect. However, it will be some years before it is possible to assess the impact of these.

It may be that unimproved grasslands will increase in extent in future decades, as maintenance of improved grasslands in marginal areas becomes less financially viable. Appropriate grazing management would still be required, as in the long-term ungrazed grasslands will turn into scrub and woodland.

▲ Species-rich grassland • © *SNH*

[2] *Farming's Retreat from the Hills*, SAC Rural Policy Centre, 2008

Countryside Survey

Further information

More details of the methodology, analyses and results from Countryside Survey can be found in other companion reports and data resources available for the Countryside Survey website [**www.countrysidesurvey.org.uk**] including:

Reports:

- UK Headline Messages – *published November 2008*
- UK Results from 2007 – *published November 2008*
- Detailed Northern Ireland Countryside Survey results – *published April 2009*
- England Results from 2007 – *due to be published August 2009*
- Scotland Results from 2007 – *due to be published June 2009*
- Wales Results from 2007 – *due to be published July 2009*
- Ponds – *due to be published July 2009*
- Streams – *October 2009*
- Soils – *November 2009*
- Integrated Assessment – *2010*

Data resources:

- Web access to **summary data** – a systematic summary of the results used to inform the UK and country level reports – launched in November 2008 and updated in January 2009
- Web access to the **actual data** – data from individual survey squares used to generate all the results presented in Countryside Survey reports from the 2007 survey – licensed access available from June 2009
- The UK Land Cover Map for 2007 – September 2009

The data generated by Countryside Survey will continue to be investigated in conjunction with other information such as climate, pollution and agricultural statistics. It is anticipated that future analysis of Countryside Survey data will lead to many scientific journal articles over the coming years. These investigations will improve understanding about the possible causes of the changes detected in the countryside and, for example, provide an opportunity to explore the results for Priority Habitats in more detail.

Contacts

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Telephone: **01524 595811**
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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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▲ Newly planted hedge • © *SNH*

5. Boundary and Linear Features Broad Habitat

Summary

- The total length of woody linear features decreased by 5% in Scotland between 1998 and 2007 following an increase between 1990 and 1998 and 1984 and 1990.
- The length of managed hedgerows decreased by approximately 7% in Scotland between 1998 and 2007 after a period of increase between 1990 and 1998.
- The length of walls decreased marginally in upland areas of Scotland between 1998 and 2007.
- The Species Richness Score in Hedge Plots in Scotland decreased by 22% between 1998 and 2007. Decreases in species richness were aligned with decreases in the number of plant species used for food by farmland birds or butterfly caterpillar food plants across the same period. Grass species characteristic of shaded conditions increased between 1998 and 2007.
- There was no change in the Species Richness Score in Roadside Plots across Scotland between 1998 and 2007, but there was a decrease of approximately 4 species per plot from 21.9 to 17.8 between 1978 and 2007. The Species Richness Score in Roadside Plots has decreased significantly since 1998 in the Lowlands (EZ4).
- Species richness in vegetation associated with boundary features in Scotland has decreased by 13% since 1998 and by 23% since 1978.
- The numbers of woody species increased in vegetation associated with boundary features in Scotland, a continuing trend since 1978.
- Competitive species increased in Roadside Plots in the Intermediate Uplands and Islands (EZ5) between 1998 and 2007; in the Lowlands (EZ4) and the Intermediate Uplands and Islands (EZ5) they have increased since 1978.

- **An average of 2.2 woody species per 30m section of hedge was recorded in Scotland in 2007, an increase from 1.8 species in 1998.**
- **Thirty six percent of managed hedges were in good structural condition in Scotland in 2007.**
- **Only 6% of managed hedges on arable land were in both good structural condition and had appropriately managed margins in Scotland in 2007.**
- **Approximately one third of walls (35%) in the Lowlands (EZ6) were in 'sound' condition, but walls in the Intermediate Uplands and Islands (EZ5) and in the True Uplands (EZ6) were more likely to be classified as 'derelict' (37% and 55% respectively).**

5.1 Introduction[1]

The Boundary and Linear Features Broad Habitat includes many landscape features which characterise the landscape and reflect the history of its management. Within Scottish landscapes linear features are concentrated mainly in the Lowlands (EZ4).

Whilst the role of linear features has always been to mark boundaries and manage stock, ecologically they constitute an important Broad Habitat within enclosed 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.

The recording and reporting of the lengths of linear features is complex as they often occur at the same location. An explanation of the approach taken in Countryside Survey (CS) in 2007 is provided in *Section 5.2 of the UK Report*. Data were collected on both the lengths of different feature types *(Table 5.1)* and their structural condition. Hedgerows (including managed hedgerows, lines of trees/shrubs and relict hedges) are listed as a Priority Habitat in the UK and have a Biodiversity Action Plan (see *Box 1.1*). This includes agreed conservation targets, 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 the following analyses condition criteria were only applied to managed hedgerows.

The condition of vegetation associated with linear features has been recorded since the first CS in 1978, using a 10m x 1m plot (Boundary Plot) placed alongside field boundaries of all types (hedgerows; roads and tracks; streams, ditches and riversides). Numbers and types of plots have been increased in subsequent Countryside Surveys to provide information on specific feature types in addition to the original Boundary Plots. These include: Hedge Plots in which vegetation forming the hedge and also along the hedge bottom were recorded; Roadside Plots which were

▲ Managed hedgerow • © *SNH*

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 both 1998 and 2007, but only that collected in 2007 allows a full assessment of Hedge condition against a range of criteria.

Results showing species richness for all linear plot types use Aggregate Classes as reporting categories (see *section 1.2, UK Report*).

▼ **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.

[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 5.2:** The length and standard error ('000s km) and direction of change in length of Boundary and Linear Features in Scotland, from 1984 to 2007. SE = Standard Error, 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[2]	Scotland	37.6	5.6	42.3	5.3	49.1	5.9	46.5	5.5	↓	↑	↓
	EZ4	34.1	5.3	35.6	5.0	39.1	5.4	37.0	5.0			↓
	EZ5	3.2	1.7	6.0	1.9	8.3	2.6	7.8	2.5	↑	↑	
	EZ6	0.2	0.1	0.7	0.4	1.7	0.8	1.7	0.9		↑	
Hedges	Scotland	27.5	5.1	21.2	4.1	22.9	4.3	21.2	4.0	↓		↓
	EZ4	25.6	4.9	20.2	4.0	20.1	4.1	18.6	3.8	↓		↓
	EZ5	1.9	1.3	1.0	1.0	2.8	1.3	2.6	1.2	↓	↑	
	EZ6	0	0	0	0	0	0	0	0			
Line of trees/ shrubs/relict hedge/fence	Scotland	5.9	1.3	9.0	1.3	12.2	1.8	12.1	1.8	↑	↑	
	EZ4	4.3	1.2	6.1	1.0	9.2	1.4	9.3	1.5		↑	
	EZ5	1.4	0.7	2.8	0.9	2.8	1.1	2.6	1.1	↑		
	EZ6	0.2	0.1	0	0	0.2	0.1	0.2	0.1	↓	↑	
Line of trees/ shrubs/relict hedge	Scotland	4.6	1.0	12.1	1.7	13.8	1.7	13.1	1.6	↑		
	EZ4	4.4	0.9	9.2	1.3	9.8	1.3	9.1	1.2	↑		↓
	EZ5	0.1	0.2	2.2	0.8	2.6	0.7	2.4	0.6	↑		
	EZ6	0	0.1	0.7	0.4	1.5	0.8	1.6	0.9		↑	
Wall	Scotland	78.8	10.0	79.5	9.8	80.2	9.5	78.6	9.5			↓
	EZ4	44.2	7.8	46.2	7.5	44.8	7.3	44.6	7.3			
	EZ5	20.9	4.8	21.8	4.8	22.1	4.7	21.6	4.6			↓
	EZ6	13.7	4.0	11.5	4.1	13.3	4.2	12.4	4.0		↑	↓
Bank/grass strip	Scotland	15.4	3.9	3.4	0.8	6.0	1.1	6.2	1.1	↓	↑	
	EZ4	10.3	3.6	1.2	0.4	2.3	0.5	2.2	0.5	↓	↑	↓
	EZ5	3.5	0.8	1.7	0.5	3.1	0.8	2.9	0.8	↓	↑	
	EZ6	1.5	1.0	0.5	0.5	0.7	0.4	1.0	0.4	↓		
Fence	Scotland	208.6	18.5	223.7	18.6	231.9	18.5	226.6	18.3	↑		↓
	EZ4	110.2	8.9	116.0	9.2	114.8	8.5	112.2	8.3			↓
	EZ5	63.3	8.9	70.2	8.6	77.5	8.9	76.5	8.7	↑	↑	
	EZ6	35.1	13.7	37.5	13.6	39.6	13.8	37.8	13.8			↓

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 5% in Scotland between 1998 and 2007 following an increase between 1990 and 1998 and 1984 and 1990.**
- **The length of managed hedgerows decreased by approximately 7% in Scotland between 1998 and 2007 after a period of increase between 1990 and 1998.**
- **The length of walls decreased marginally in upland areas of Scotland between 1998 and 2007.**

[2] **Note:** that because of the statistical model used (see *Annex 6*) 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.

▲ Field boundary landscape • © *Colin Barr*

Results from CS in 2007 showed a 5.3% decrease in the length of woody linear features between 1998 and 2007 ***(Table 5.2 gives rounded values)***. 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 as reported previously for Great Britain, with decreases between 1984 and 1990 and no significant change in the period 1990 and 1998.

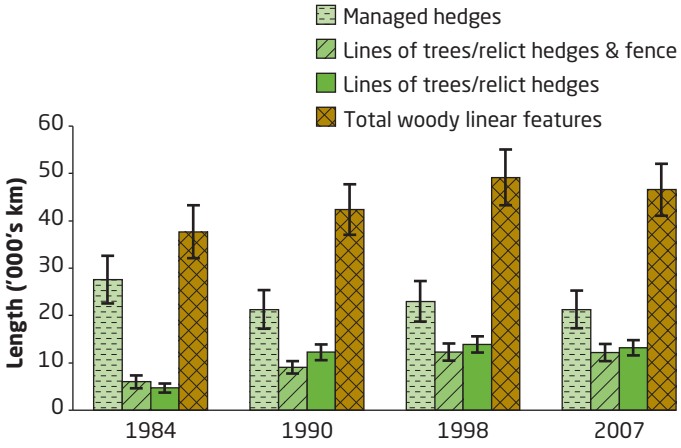
The process of back-checking and adjustment was only applied to the 1998 data and not to previous datasets from 1984 and 1990. This means that the comparison of clearly defined linear features in the 1998 and 2007 data is more rigorous than for other pairs of years. Reduced variability in the estimates for 1998 and 2007 allowed the change between estimates to be identified as significant. When comparing results for years where the estimates are less precise, e.g. between 1990 and 1998, changes are less likely to be significant even though the difference between stock estimates may be larger.

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 across the period 1998 and 2007 were quite limited. Fewer than 2% of 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 Scotland from 1984 through to 2007, but with a period of stability between 1990 and 1998 during which there were apparent increases in the Intermediate Uplands and Islands (EZ5). This result requires further investigation as it may be the result of analytical anomalies rather than a true change. In contrast to the results across Great Britain, the decrease in managed hedgerows between 1998 and 2007 does not appear to have been primarily due to conversion to trees/shrubs and relict hedges ***(Fig. 5.1, Table 5.2)***. Whilst analysis suggests that some movement from managed hedges to relict hedges and lines of trees/shrubs has occurred, there were no increases in the length of these feature types in that time period, although they did increase between 1990 and 1998 ***(Table 5.2)***. The long-term pattern of change from 1984 to 2007 is a decrease in managed hedges and an increase in relict hedges and lines of trees/shrubs ***(Fig 5.1)***.

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



There were small but significant changes in the lengths of walls between 1998 and 2007 ***(Table 5.2)***. The results indicate a number of changes in banks/grass strips which may have arisen from both the transient nature of grass strips and the likelihood that banks are relatively easily overlooked and are therefore recorded inconsistently. Changes in the lengths of fences indicate that, in contrast to previous decades, the lengths of fences in Scotland decreased between 1998 and 2007, particularly in the Lowlands and True Uplands.

▲ Drystane dyke • © *SNH*

5.4 The condition of vegetation in Boundaries and beside Linear Features[3]

- **The Species Richness Score in Hedge Plots in Scotland decreased by 22% between 1998 and 2007. Decreases in species richness were aligned with decreases in the number of plant species used for food by farmland birds or butterfly caterpillar food plants across the same period. Grass species characteristic of shaded conditions increased between 1998 and 2007.**
- **There was no change in the Species Richness Score in Roadside Plots across Scotland between 1998 and 2007, but there was a decrease of approximately four species per plot from 21.9 to 17.8 between 1978 and 2007. The Species Richness Score in Roadside Plots has decreased significantly since 1998 in the Lowlands (EZ4).**
- **Species richness in vegetation associated with boundary features in Scotland has decreased by 13% since 1998 and by 23% since 1978.**
- **The numbers of woody species increased in vegetation associated with boundary features in Scotland, a continuing trend since 1978.**
- **Competitive species increased in Roadside Plots in the Intermediate Uplands and Islands (EZ5) between 1998 and 2007; in the Lowlands (EZ4) and the Intermediate Uplands and Islands (EZ5) they have increased since 1978.**

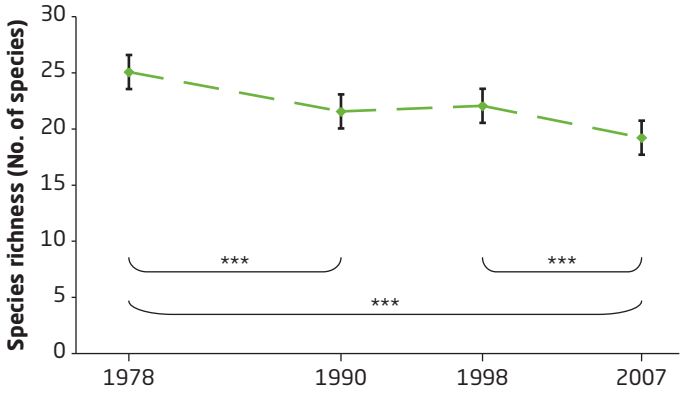
▲ Flag fencing • © *SNH*

▲ Relict hedegrow • © *Lisa Norton*

5.4.1 Condition of vegetation in Boundary Plots

Species Richness: The Species Richness Score of all linear plots (excluding Hedge Plots) decreased by 13% between 1998 and 2007. Over the longer term (since 1978), a significant decrease of 23% (25.1 to 19.2 species per plot) was recorded in these plots *(Fig. 5.2)*. There was also a significant decrease in Species Richness Score in these plot types in Scotland in Infertile Grassland and Moorland grass mosaics between 1998 and 2007. A decrease occurred in all Aggregate Classes represented within these plot types between 1978 and 2007, except for the Heath and Bog AC *(Table 5.3)*.

▼ **Figure 5.2:** Change in the Species Richness Score of all linear plots (excluding Hedge Plots) alongside a random sample of feature types across Scotland between 1978 and 2007. Significant changes (*** p<0.001) are shown between the dates bracketed. 95% Confidence Intervals are shown for each data point. Confidence Intervals on change are not shown.



[3] Footnote required???

▼ **Table 5.3:** Changes in mean Species Richness Score of all linear plots (excluding Hedge Plots) in different vegetation Aggregate Classes alongside linear features across Scotland 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 (Scotland)		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**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**
All Classes	22	19.2	↓	↓	↓						↓	↓		↓	↓	↓	↓	
Crops and weeds																		
Tall grass and herb	16.4	15.6									↓	↓			↓	↓		
Fertile grassland	17.7	16.4						↓			↓	↑			↓			
Infertile grassland	23.9	19	↓	↓				↑			↓	↓			↓	↓		
Woodland (upland & lowland)	22.1	20.3									↓		↓		↓	↓		
Moorland grass mosaic	23.2	20	↓	↓							↓	↓		↓	↓	↓		↓
Heath & Bog	23.2	21.3																

▼ **Table 5.4:** Changes in the characteristics of vegetation in 10m x1m Hedge Plots across Scotland between 1978 and 2007. Mean values for 1998 and 2007 are presented; those for 1978 and 1990 are available on the website, www.countrysidesurvey.co.uk. Arrows denote significant change ($p<0.05$) in the direction shown. The condition measures are described in ***Box 1.3, UK Report***.

	Mean values (Scotland)		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**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**
Species Richness (No. of Species)	18.9	14.7	↓															
No. of Bird Food Species	10.1	7.9	↓															
No. of Butterfly Food Species	8.8	7	↓															
Grass:Forb Ratio	0.47	0.44	↓	↓											↓	↓		
Competitor Score	3.22	3.32																
Stress Tolerator Score	1.97	1.97																
Ruderal Score	2.47	2.38																
Light Score	6.55	6.37	↓	↓														
Fertility Score	6.04	6.14																
Ellenberg pH Score	6.25	6.35																
Moisture Score	5.43	5.47																

In a further analysis the mean number of woody species recorded per linear plot was investigated. Across all linear plot types (excluding plots exclusively associated with hedges), the cover of woody species significantly increased from 1.6 to 2.1 species in Scotland between 1998 and 2007, and from 1.3 to 2.1 species per plot between 1978 and 2007.

5.4.2 Condition of vegetation in Hedge Plots

Of the 60 Hedge Plots across Scotland used in this analysis, 56 were in the Lowlands (EZ4). The remaining four plots were in the Intermediate Uplands and Islands (EZ5) and did not constitute a large enough sample to provide results for EZ5.

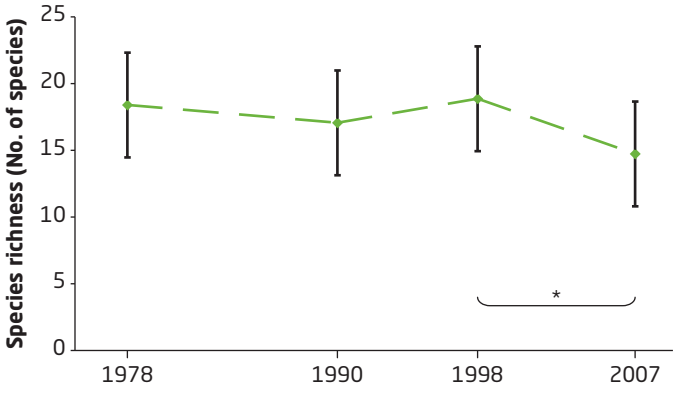
Species Richness: Species Richness Score decreased in Hedge Plots in Scotland between 1998 and 2007 by 22%. Over the longer term (1978 to 2007) there was a non-significant decrease of similar magnitude from 18.4 species in 1978 to 14.7 in 2007 ***(Fig. 5.3)***.

Other characteristics: Decreases in species richness were aligned with decreases in the number of plant species used for food by farmland birds or butterfly caterpillar food plants between 1998 and 2007 ***(Table 5.4)***. Across this same period, grass species became more dominant in hedgerow both in the Lowlands (EZ4) and across Scotland. This increase in grass species was also evident between 1978 and 2007 in the Lowlands (EZ4) and across Scotland.

▲ Roadside hedge • © *SNH*

Over the period 1998 to 2007 Hedge Plots also became more shaded as demonstrated by the significant decrease in the mean Light Score *(Table 5.4)*.

▼ **Figure 5.3:** The change in Species Richness Score in 10m x1m Hedge Plots across Scotland between 1978 and 2007. Significant changes (* p<0.05) are shown between the dates bracketed. 95% Confidence Intervals are shown for each data point. Confidence Intervals on change are not shown.



5.4.3 Condition of vegetation in Roadside Plots

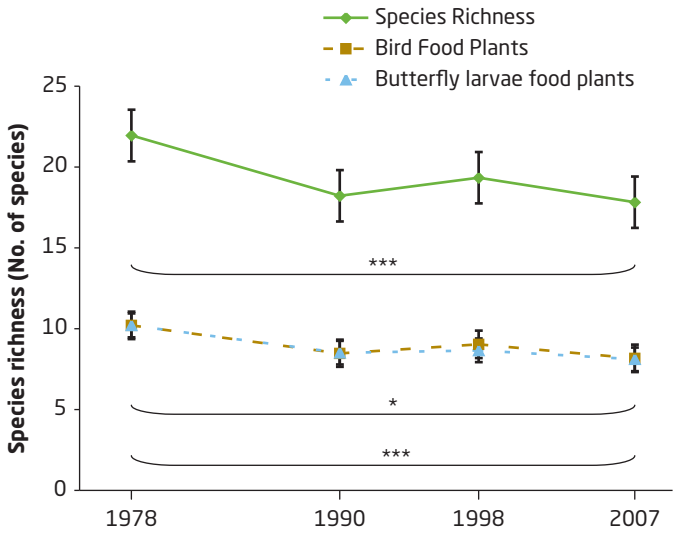
Species Richness: There was no change in the Species Richness Score in Roadside Plots in Scotland between 1998 and 2007 across Scotland, but there was a decrease of approximately four species per plot from 21.9 to 17.8 between 1978 and 2007 *(Fig. 5.4, Table 5.5)*. There was a significant decrease in species richness in Roadside Plots between 1998 and 2007 in the Lowlands (EZ4) where the majority of plots of this type were located. This decrease was also evident across the period 1978 to 2007.

Other characteristics: The number of species used as food plants by farmland birds decreased across Scotland and in the Lowlands (EZ4) in Roadside Plots between 1998 and 2007 by approximately one species *(Table 5.5)*. There was also an overall decrease in both Bird and Butterfly larvae Food Plants both across Scotland and in the Lowlands (EZ4) between 1978 and 2007. The only other significant change in Roadside plots between 1998 and 2007 was an increase in competitive species in the Intermediate Uplands and Islands (EZ5). This increase was also evident across the period 1978 to 2007 for Scotland, the Lowlands (EZ4) and the Intermediate Uplands and Islands (EZ5). There was also an increase in species associated with wetter conditions in Roadside Plots both across Scotland and in the Intermediate Uplands and Islands (EZ5) between 1978 and 2007.

5.5 Condition of Boundary and Linear Features

- **An average of 2.2 woody species per 30m section of hedge was recorded in Scotland in 2007, an increase from 1.8 species in 1998.**
- **Thirty six percent of managed hedges were in good structural condition in Scotland in 2007.**
- **Only 6% of managed hedges on arable land were in both good structural condition and had appropriately managed margins in Scotland in 2007.**
- **Approximately one third of walls (35%) in the Lowlands (EZ6) were in 'sound' condition, but walls in the Intermediate Uplands and Islands (EZ5) and in the True Uplands (EZ6) were more likely to be classified as 'derelict' (37% and 55% respectively).**

▼ **Figure 5.4:** The changes in Species Richness Score, No. of Bird Food Plant species and No. of Butterfly Food Plant Species in 10m x1m Roadside Plots across Scotland between 1978 and 2007. Significant changes (* p<0.05, ***p<0.001) are shown only for the entire period 1978 to 2007, others given in ***Table 5.5***. 95% Confidence Intervals are shown for each data point. Confidence Intervals on change are not shown.



▼ **Table 5.5:** Changes in the characteristics of vegetation in 10m x1m Roadside Plots across Scotland 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. The condition measures are described in ***Box 1.3, UK Report***.

	Mean values (Scotland)		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	S	EZ4	EZ5	EZ6	S	EZ4	EZ5	EZ6	S	EZ4	EZ5	EZ6	S	EZ4	EZ5	EZ6
Species Richness (No. of Species)	19.3	17.8		↓				↑			↓	↓			↓	↓		
No. of Bird Food Species	9	8.2	↓	↓							↓	↓		↓	↓	↓		
No. of Butterfly Food Species	8.7	8.1									↓	↓			↓	↓		
Grass:Forb Ratio	1	0.95																
Competitor Score	2.72	2.77			↑		↑								↑	↑	↑	
Stress Tolerator Score	2.25	2.28					↓											
Ruderal Score	2.86	2.82																
Light Score	6.93	6.9					↑		↑		↓		↓					
Fertility Score	5.16	5.14								↑				↓				
Ellenberg pH Score	5.7	5.69																
Moisture Score	5.53	5.56					↑						↑		↑		↑	

▲ Species-rich hedge-bottom • © *SNH*

5.5.1 Woody species richness of hedgerows

The mean number of native woody species per 30m length of hedgerow increased significantly in Scotland between 1998 and 2007 from 1.8 to 2.2 (*see further information at www.countrysidesurvey.co.uk*). The increase in the Lowlands (EZ4) where most hedges are located was also significant from 1.7 to 2.2 species. This is probably due to planting of new 'species rich' hedges under agri-environment schemes, and the policy to sample new hedges in CS in 2007 which resulted in a number of Hedge Diversity Plots being places on new hedges in Scotland. Hedge Diversity Plots were not recorded before 1998.

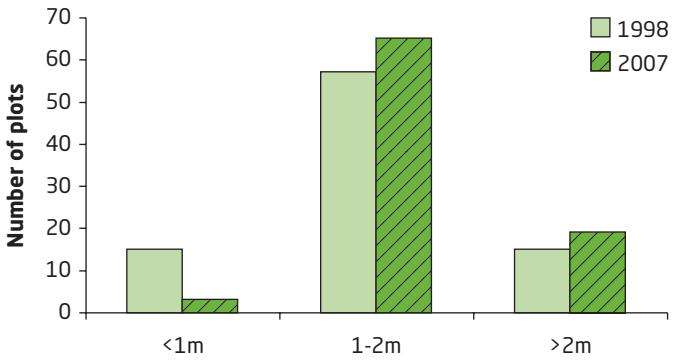
5.5.2 Structural condition of hedgerows

Condition criteria collected at Hedgerow Diversity Plots reveal that around a third (36%) of the managed hedges in Scotland, which comprised 46% of all woody linear features surveyed, were in good structural condition in 2007. Good structural condition was determined by a number of different criteria as outlined in *Table 5.6*. Hedgerow condition also depends on two criteria relating to adjacent land *(Table 5.6)*. If the distance from the centre of the hedge to adjacent disturbed ground is taken into account alongside structural condition measures, 16% of all hedgerows on arable land in Scotland would then meet condition criteria. A further criterion is the width of perennial vegetation at the base of the hedge, which should be greater than 1m. Applying all criteria, only approximately 11% of managed hedges in Scotland were in overall good condition on all land, including arable. As the majority of hedges in Scotland are located in the Lowlands (EZ4), (93% of Hedgerow Diversity Plots were located in EZ4) results are given for Scotland only. Data collected on Hedgerow Diversity Plots revealed that managed hedges in Scotland were wider in 2007 than in 1998 *(Fig. 5.5)*.

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

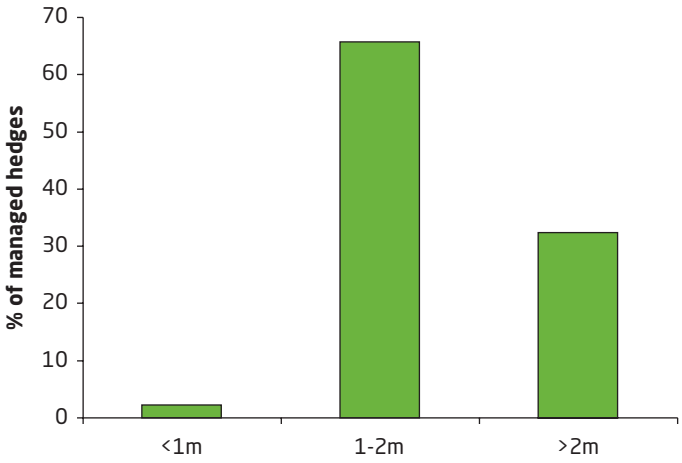
▼ **Figure 5.5:** Hedgerow width in hedgerow Diversity Plots in Scotland in 1998 and 2007.



5.5.3 Hedgerow height and management

The 2007 results indicate that approximately 69% of hedges were between 1-2m high, 30% were over 2m and less than 1% were less than 1m high. In terms of management, over 70% were cut with a flail or saw, 25% showed no signs of recent management and the remaining 5% were newly planted hedges *(Fig 5.6)*. Results pre-2007 are not sufficient to enable reporting on change in hedgerow height and management.

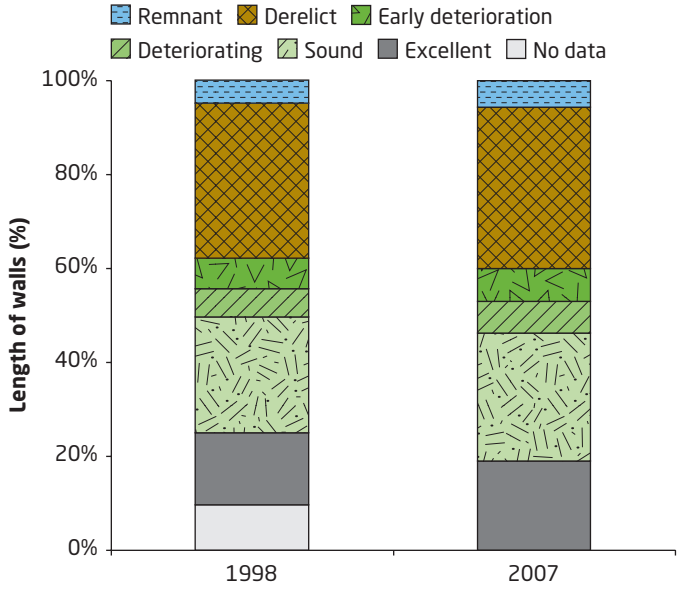
▼ **Figure 5.6:** Hedgerow height on mapped managed hedges in Scotland in 2007



5.5.4 Structural condition of walls

More walls across Scotland fell into the 'Derelict' condition category than any other in both 1998 and 2007 *(Fig 5.7)*. Wall condition in 2007 varied across Scotland with around a third of walls in 'sound' condition (35%) in the Lowlands (EZ4). In the Intermediate Uplands and Islands (EZ5), around a third of walls were in 'derelict' condition (37%), rising to 55% in the True Uplands (EZ6). As with condition of mapped hedgerow features, changes are difficult to detect as a result of missing data in 1998.

▼ **Figure 5.7:** The percentage of the total length of walls in different structural condition categories across Scotland in 1998 and 2007.



▲ Derelict drystane dyke, uplands • © *Stuart Greig*

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). Some of these features were planted avenues of trees but in most cases they were relict hedges. Individual trees were recorded in 2007, as they have been previously in CS. Analysis of data on the occurrences of both individual trees and trees associated with woody linear features will be presented in a future report.

5.6 Summary and Discussion

5.6.1 Summary – Changes in Boundary and Linear Features

The 2007 Countryside Survey results 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. The condition of the vegetation associated with the Boundary and Linear Broad Habitat in Scotland has generally deteriorated with decreases in species in linear plot types both between 1998 and 2007 and longer-term between 1978 and 2007. Hedge-bottom vegetation became less species-rich and more shaded between 1998 and 2007, and since 1978 Roadside Plots have shown long-term reductions in species richness including loss of Bird and Butterfly larvae Food Plants. The extent and condition of walls in the True Uplands (EZ6) and the Intermediate Uplands and Islands (EZ5) also appear to be deteriorating.

5.6.2 Discussion

Most boundaries prior to the late 18th century in Scotland were marked by stone walls or turf banks, with hedgerows distributed within the lowland farmed landscapes of central and southern Scotland. Between the late 1940s and 1980s, there was a reduction in boundary habitats as farming intensified. Many hedges and dykes were removed to create larger fields, or replaced by fencing. The use of pesticides and fertilizers in intensively farmed areas has contributed to a loss of biodiversity in boundary features.

Actively managed hedges appear to be in reasonable condition in terms of the woody components (species composition, height and width), suggesting that advice and incentives through agri-environment schemes are effective. The percentage of newly planted hedges picked up in the survey is likely to be a reflection of take-up of hedge-planting incentives. However, many managed hedgerows failed to meet the criteria applied for condition of associated vegetation, particularly those in arable situations. 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 for birds, mammals and insects for a time, but if they are not maintained, their value for wildlife can eventually decline.

Drystane dykes form the dominant field boundary type in upland Scotland. From a biodiversity perspective, although they tend to support fewer species than hedgerows, dykes provide an important wildlife habitat for lichens, mosses, ferns and flowering plants, as well as small mammals and amphibians. The percentage of dykes in derelict condition remains high, particularly in the uplands, possibly reflecting reductions in rural labour and traditional skills.

▲ Newly planted hedge • © *SNH*

Although there was no significant decrease in species richness in Roadside Plots between 1998 and 2007, the longer-term decline since 1978 remains significant. Some species-rich road verges continue to be threatened by inappropriate management including herbicide spraying and frequent cutting, which may prevent flowering of some species. Cutting twice a year has been shown to result in the highest species-richness for road verges, whereas if verge cutting ceases, this may allow invasion of taller grasses and scrub. However, diversity is also influenced by eutrophication, impacts of salt spray from gritting, and airborne pollution.

Boundary and linear features are identified as UK BAP Priority Habitats, and options for current and future management of hedgerows, hedgerow trees and drystane dykes are available to farmers and landowners under the Scotland Rural Development Programme 2007-13 (SRDP). Success in halting the loss of biodiversity and increasing the extent of boundary and linear features is promoted by these options.

Countryside Survey

Further information

More details of the methodology, analyses and results from Countryside Survey can be found in other companion reports and data resources available for the Countryside Survey website [**www.countrysidesurvey.org.uk**] including:

Reports:

- UK Headline Messages – *published November 2008*
- UK Results from 2007 – *published November 2008*
- Detailed Northern Ireland Countryside Survey results – *published April 2009*
- England Results from 2007 – *due to be published August 2009*
- Scotland Results from 2007 – *due to be published June 2009*
- Wales Results from 2007 – *due to be published July 2009*
- Ponds – *due to be published July 2009*
- Streams – *October 2009*
- Soils – *November 2009*
- Integrated Assessment – *2010*

Data resources:

- Web access to **summary data** – a systematic summary of the results used to inform the UK and country level reports – launched in November 2008 and updated in January 2009
- Web access to the **actual data** – data from individual survey squares used to generate all the results presented in Countryside Survey reports from the 2007 survey – licensed access available from June 2009
- The UK Land Cover Map for 2007 – September 2009

The data generated by Countryside Survey will continue to be investigated in conjunction with other information such as climate, pollution and agricultural statistics. It is anticipated that future analysis of Countryside Survey data will lead to many scientific journal articles over the coming years. These investigations will improve understanding about the possible causes of the changes detected in the countryside and, for example, provide an opportunity to explore the results for Priority Habitats in more detail.

Contacts

For further information on Countryside Survey see **www.countrysidesurvey.org.uk** or contact:
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Lancaster Environment Centre, Library Avenue,
Bailrigg, Lancaster LA1 4AP

Telephone: **01524 595811**
Email: **enquiries@ceh.ac.uk**

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The Countryside Survey partnership has endeavoured to ensure that the results presented in this report are quality assured and accurate. Data has been collected to estimate the stock, change, extent and/or quality of the reported parameters. However, the complex nature of the experimental design means that results can not necessarily be extrapolated and/or interpolated beyond their intended use without reference to the original data.

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Designed by Countryscape.

▲ Coniferous woodland • © *SNH*

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

Summary

- The area of Broadleaved Woodland increased by 10% in Scotland between 1998 and 2007.
- The area of Coniferous Woodland decreased by 7.1% in Scotland between 1998 and 2007.
- The Species Richness Score decreased by five species in Broadleaved Woodland in Scotland between 1998 and 2007, but there was no longer-term decrease between 1990 and 2007.
- Competitive species increased in Broadleaved Woodland in Scotland between 1998 and 2007, whilst species of open ground decreased.
- Species richness decreased by 12% in Coniferous Woodland in Scotland between 1998 and 2007.
- No changes in soil (0-15cm) pH in either Coniferous or Broadleaved Woodland have been observed in Scotland since 1978.
- Soil (0-15cm) carbon concentration has remained stable in Coniferous Woodland in Scotland but increased in Broadleaved Woodland since 1978.

▲ Woodland planting • © *SNH*

Note on Chapter 6:

- **The sampling of woodland habitats in Countryside Survey (CS) is different to the approach taken by other agencies reporting on woodlands.**
- **In CS, woodland is defined as 'having over 25% canopy cover of trees and shrubs, over a metre high'. Other bodies include areas of felled and newly planted woodland in statistics for woodland cover, whilst in CS these areas fall into other Broad Habitats dependent on the dominant vegetation type.**

6.1 Introduction[1]

In CS, the 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***). Coniferous Woodland is the most extensive woodland type in Scotland making up 79% of the total woodland area, half of which is found in the True Uplands (EZ6). In contrast, the percentage of Scotland covered in Broadleaved Woodland is approximately half that of England and Wales, with the majority concentrated in the Lowlands (EZ4).

An area mapped as a woodland Broad Habitat may also encompass other small patches of vegetation without woodland cover that are a distinctive part of the woodland environment, but not big enough to have been mapped separately. These include 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. The use of the two plot types to assess condition, Main Plots and Targeted Plots, allows the differences between the large areas of habitat and the smaller patches within it to be sampled.

6.2 Description of Broad Habitats

Two main Broad Habitat types distinguish woodland types in Scotland:

Broadleaved, Mixed and Yew Woodland (henceforth referred to as Broadleaved Woodland): Canopy of tree species including mixed broadleaved and yew species with less than 20% of conifers in the canopy. Also includes areas of *Ulex europaeus* scrub at greater than 25% cover.

The Broadleaved 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 Wet Woodland, Upland Mixed Ash Woodland, Upland Birchwoods and Upland Oak Woodland Priority Habitats. The ability to report on changes in extent of woodland Priority Habitats relies on consistent definitions between surveys which is not always possible since CS preceded the designation of Priority Habitats.

Coniferous Woodland: Coniferous Woodland is woodland consisting of greater than 20% coniferous tree species and may be native, as in the Scots Pine forests of the Scottish Highlands or may be commercially planted native or non-native species in either large forests or smaller wood lots.

Commercial Coniferous Woodland also includes clear-felled areas awaiting replanting, areas where young trees are establishing and do not yet have 25% canopy cover and areas of natural regeneration, typically along the forest edges to encourage a more natural structure. CS records the vegetation present in these areas and assigns them to Broad Habitats on the basis of that vegetation rather than on the basis of their longer term land use.

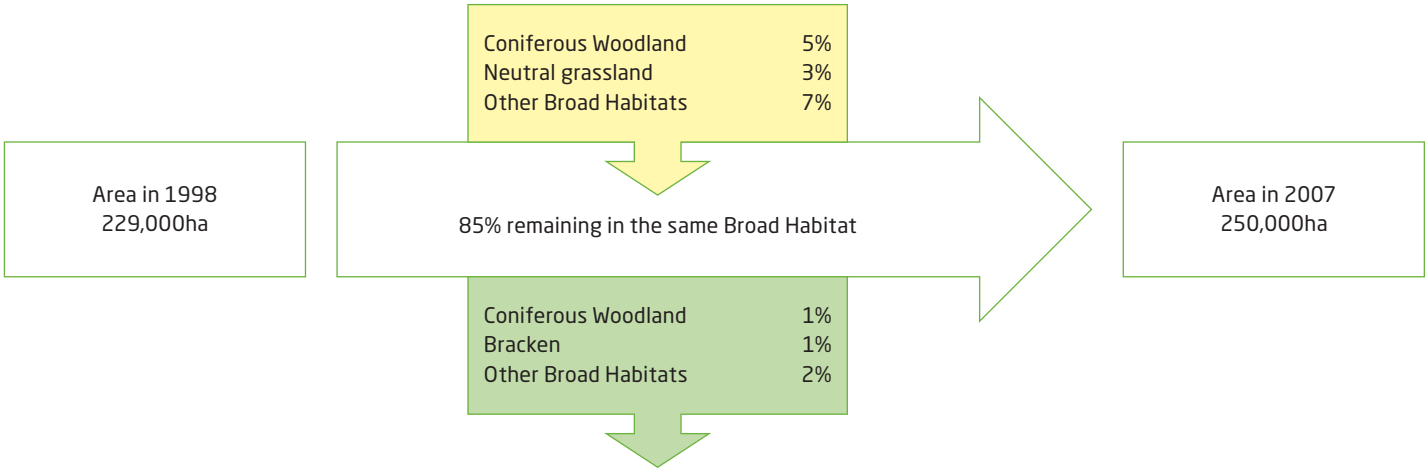
▲ Broadleaved woodland • © *Lisa Norton*

[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 (Introduction and methodologies).*

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

	1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
EZ4	105	4.7	118	5.2	131	5.8	↑
EZ5	75	2.9	52	2.0	63	2.5	↑
EZ6	104	3.2	59	1.8	57	1.8	
Scotland	284	3.5	229	2.9	251	3.1	↑

▼ **Figure 6.1:** Movements of land into and out of Broadleaved, Mixed and Yew Woodland between 1998 and 2007.



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

	1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
EZ4	156	6.9	172	7.6	182	8.0	
EZ5	307	12.1	355	14.0	293	11.5	↓
EZ6	450	14.0	503	15.7	481	15.0	
Scotland	913	11.5	1030	13.0	956	12.0	↓

6.3 The Area of Woodlands

- **The area of Broadleaved Woodland increased by 10% in Scotland between 1998 and 2007.**
- **The area of Coniferous Woodland decreased by 7.1% in Scotland between 1998 and 2007.**

6.3.1 Broadleaved, Mixed and Yew Woodland

Broadleaved Woodland covered 251,000 ha and made up 3.1% by area of Scotland in 2007 *(Table 6.1, Fig. 6.1)*.

The area of Broadleaved Woodland has increased by an estimated 22,000ha (10%) across Scotland since 1998 *(Fig 6.1)*. This contrasts with a much greater recorded decrease of 55,000 ha in the area of Broadleaved Woodland between 1990 and 1998 *(Table 6.1)*. However, changes to the Broad Habitat reporting framework between 1990 and 1998 mean that comparisons between 1990 and 1998 are less robust.

The overall pattern of change for Scotland (decreases 1990-1998, followed by increases 1998-2007) masks different directions of change at the EZ level. Broadleaved Woodland in the Scottish Lowlands (EZ4) has increased in area since 1990, whilst decreasing in the True Uplands (EZ6) during this period. Only in the Intermediate Uplands and Islands (EZ5), which has the smallest amount of Broadleaved Woodland of all the EZ's, does the trend reflect that of Scotland as a whole.

Most of the Broadleaved Woodland (85%) recorded in 2007 was also recorded as this Broad Habitat type in 1998 *(Figure 6.1)*.

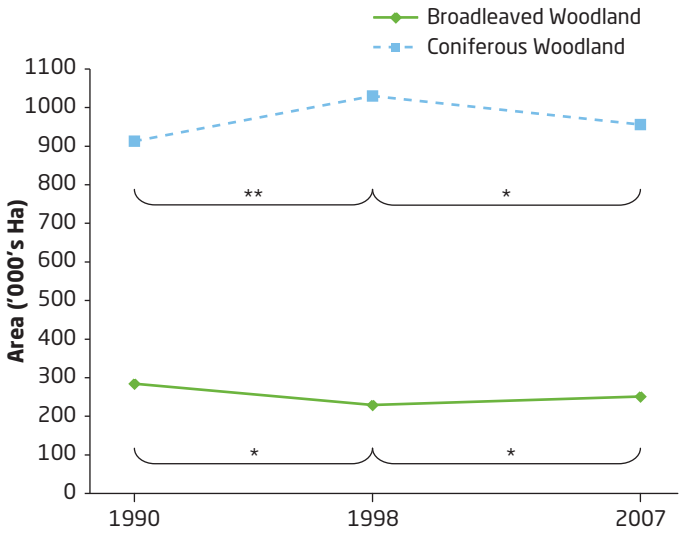
▲ Scots Pine forest • © *SNH*

There is necessarily a time-lag in detecting new woodland. The recorded shift to woodlands from other Broad 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.

6.3.2 Coniferous Woodland

In 2007, the estimated area of Coniferous Woodland in Scotland was 956,000ha covering 12% of Scotland *(Table 6.2)*. Since 1998, it has decreased in area by 7.1% , which contrasts with a previous increase of 12.8% between 1990 and 1998 *(Figure 6.2)*. As for Broadleaved Woodland, changes to the Broad Habitat reporting framework between 1990 and 1998 mean that comparisons between 1990 and 1998 are less robust than those between 1998 and 2007.

▼ **Figure 6.2:** Change in the area of Broadleaved, Mixed and Yew Woodland and Coniferous Woodland in Scotland between 1990 and 2007. Significant changes (** p<0.05, **p<0.01) are shown between the dates bracketed. 95% Confidence Intervals are shown for each data point. Confidence Intervals on change are not shown.



The pattern of change for Scotland as a whole was consistent with that in both the Intermediate Uplands and Islands (EZ5) and the True Uplands (EZ6) but only the decrease in EZ5 between 1998 and 2007 was significant *(Table 6.2)*. In the Lowlands (EZ4) the increase between 1990 and 1998 was significant.

Almost all of the Coniferous Woodland recorded in 2007 was also recorded as Coniferous Woodland in 1998 (97%) *(Figure 6.3)*.

6.4 The condition of woodlands

- **The Species Richness Score decreased by five species in Broadleaved Woodland in Scotland between 1998 and 2007, but there was no longer-term decrease between 1990 and 2007.**
- **Competitive species increased in Broadleaved Woodland in Scotland between 1998 and 2007, whilst species of open ground decreased.**
- **Species richness decreased by 12% in Coniferous Woodland in Scotland between 1998 and 2007.**

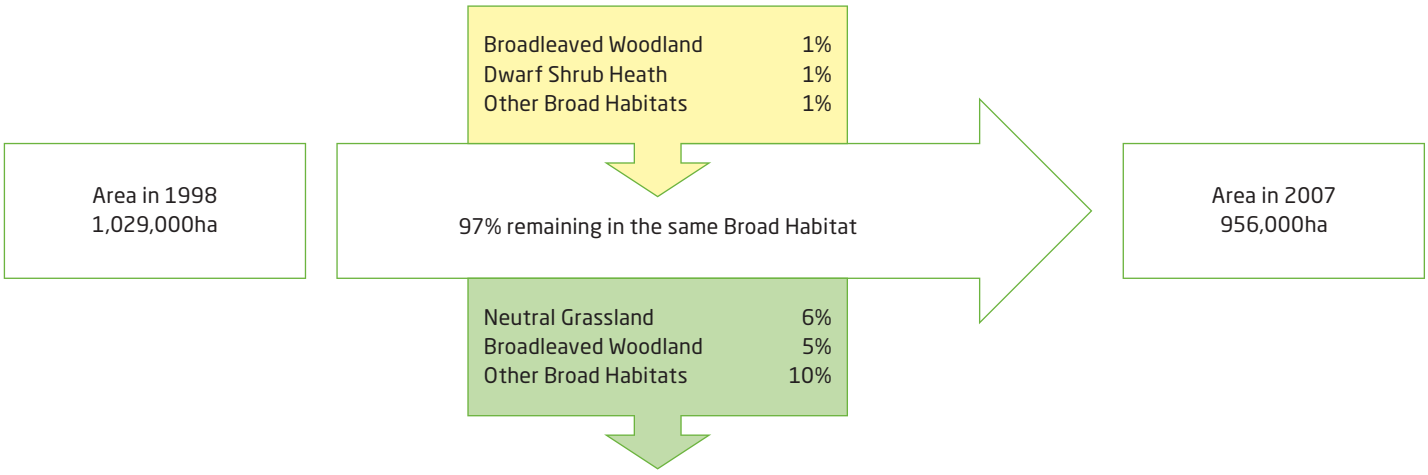
6.4.1 Changes in Broadleaved, Mixed and Yew Woodland

Main plots: The Species Richness Scores of Main Plots in Broadleaved Woodland indicate a decrease of approximately five species between 1998 and 2007 *(Fig. 6.4)*. This decrease was significant in the Intermediate Uplands and Islands (EZ5) and the True Uplands (EZ6) but since 1990, a longer-term decline is only evident in the True Uplands (EZ6).

Other changes in the Main Plots since 1998 indicate an increase in competitive species both across Scotland and in the Intermediate Uplands and Islands (EZ5) and True Uplands (EZ6), and a decrease in species of open/disturbed ground across Scotland and in the Intermediate Uplands and Islands (EZ5). Results for the period 1990 to 2007 support the idea that the latter may be part of a longer-term trend potentially indicating an increase in canopy cover. Across this period there were also significant increases in species associated with less fertile, more acidic conditions *(Table 6.3)*. The Change Index for species in Broadleaved Woodland Main Plots in Scotland was so small that changes in frequency of plant species can be considered negligible and results are not presented here.

▲ Song thrush • © *SNH*

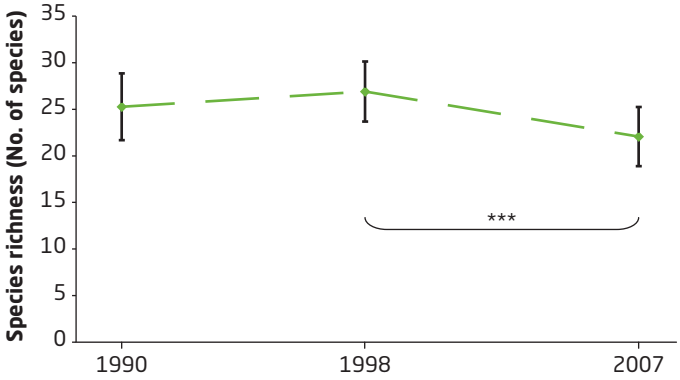
▼ **Figure 6.3:** Movements of land into and out of Coniferous Woodland between 1998 and 2007.



▼ **Table 6.3:** Change in the characteristics of vegetation in 200m² Main Plots in the Broadleaved, Mixed and Yew Woodland Broad Habitat across Scotland between 1990 and 2007. Mean values for condition measures in 1998 and 2007 are presented. Arrows denote significant change ($p<0.05$) in the direction shown. The condition measures are described in ***Box 1.3, UK Report***.

	Mean values (Scotland)			Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1990**	**1998**	**2007**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**
Species Richness (No. of Species)	25.2	26.9	22.1	↓		↓	↓		↑						↓
No. of Bird Food Species	8.1	9.0	7.3	↓											
No. of Butterfly Food Species	8.8	9.7	8.6				↓								
Grass:Forb Ratio	-0.05	0.33	0.14												
Competitor Score	2.64	2.61	2.73	↑		↑	↑								
Stress Tolerator Score	2.83	2.90	2.86						↑						
Ruderal Score	2.13	2.13	1.99	↓		↓						↓	↓	↓	
Light Score	6.32	6.39	6.37												
Fertility Score	4.46	4.28	4.21					↓	↓	↓		↓	↓	↓	
Ellenberg pH Score	4.93	4.78	4.68							↓		↓	↓	↓	
Moisture Score	5.71	5.72	5.76												

▼ **Figure 6.4:** Changes in the mean Species Richness in 200m² Main Plots in the Broadleaved, Mixed and Yew Woodland Broad Habitat across Scotland between 1990 and 2007. Significant changes (*** $p<0.001$) are shown between the dates bracketed. 95% Confidence Intervals are shown for each data point. Confidence Intervals on change are not shown.



Targeted Plots: The number of species recorded in Targeted Plots within Broadleaved Woodland decreased significantly in Scotland between 1998 and 2007. This contributed to a long-term decrease of 15% from a mean of 12.6 species to 10.7 species per plot between 1990 and 2007.

Other changes in Targeted Plots were similar to those in Main Plots, with increases in competitive species and decreases in species of open ground between 1998 and 2007, though not always in the same EZs *(Tables 6.3 and 6.5)*. Increases in species associated with fertile conditions in Scotland and the Lowlands (EZ4) between 1998 and 2007 and across Scotland between 1990 and 2007 contrasted with trends in Main Plots.

▼ **Table 6.5:** Change in the characteristics of vegetation in 2m x2m Targeted Plots in the Broadleaved, Mixed and Yew Woodland Broad Habitat across Scotland between 1990 and 2007. Mean values for condition measures in 1998 and 2007 are presented. Arrows denote significant change ($p<0.05$) in the direction shown. The condition measures are described in ***Box 1.3, UK Report***.

	Mean values (Scotland)			Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1990**	**1998**	**2007**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**
Species Richness (No. of Species)	12.6	12.8	10.7	↓	↓							↓			
No. of Bird Food Species	4.4	4.6	3.9	↓	↓				↑						
No. of Butterfly Food Species	4.5	4.9	4.0	↓	↓					↑					
Grass:Forb Ratio	-0.27	0.15	-0.06								↑				↑
Competitor Score	2.76	2.80	2.99	↑	↑							↑	↑		
Stress Tolerator Score	2.69	2.66	2.59		↓										
Ruderal Score	2.24	2.27	2.06	↓	↓	↓						↓	↓		
Light Score	6.35	6.44	6.38												
Fertility Score	4.57	4.55	4.75	↑	↑					↑		↑			
Ellenberg pH Score	5.04	5.04	5.15												
Moisture Score	6.05	6.01	6.01			↓									

▼ **Table 6.6:** Change in the characteristics of vegetation in 200m² Main Plots in the Coniferous Woodland Broad Habitat across Scotland 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. The condition measures are described in ***Box 1.3, UK Report***.

	Mean values (Scotland)			Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1990**	**1998**	**2007**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**
Species Richness (No. of Species)	14.2	15.6	13.7	↓											
No. of Bird Food Species	3.6	3.9	3.4	↓			↓				↑				
No. of Butterfly Food Species	5.2	5.5	4.8	↓							↑		↓		
Grass:Forb Ratio	0.60	0.41	0.60								↓				
Competitor Score	2.55	2.58	2.57										↑		
Stress Tolerator Score	3.19	3.17	3.22												
Ruderal Score	1.79	1.72	1.70							↓		↓			
Light Score	6.36	6.38	6.38												
Fertility Score	3.35	3.39	3.32												
Ellenberg pH Score	3.62	3.68	3.58												
Moisture Score	6.21	6.18	6.23												

6.4.2 *Changes in the condition of Coniferous Woodland 1990-2007*

Main Plots: The Plant Species Richness Score has decreased by 12% since 1998 *(Table 6.6)*. No changes were evident at EZ level since 1998, with the exception of the decrease in bird food plant species in the True Uplands (EZ6) which is unlikely to be of importance in this habitat.

Changes since 1990 include a decrease in species of open/disturbed ground across Scotland, increases in competitive species and decreases in Butterfly larvae Food Plant Species in the Lowlands (EZ4). 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.

▲ Speckled wood butterfly • © *SNH*

Targeted Plots: Across Scotland there were few changes in Targeted Plots between 1998 and 2007. A decrease in the Bird Food Species Score from 3.4 to 1.9 is probably aligned to a decrease in species associated with open/disturbed ground, which was significant in the Lowlands (EZ4), as was a decrease from 10.7 to 6.3 in the Species Richness Score.

Changes in this plot type across the period 1990 to 2007 included decreases in Species Richness Score (Scotland and the Lowlands (EZ4)) and the numbers of bird (Scotland and the Lowlands (EZ4)) and Butterfly (Scotland) larvae Food Plant Species. There was also a decrease in species associated with open/disturbed ground in the Lowlands (EZ4).

▲ Coniferous woodland • © *Crown copyright Scottish Government*

6.5 Woodland Priority Habitats

6.5.1 The area of Priority Habitat woodlands

Wet Woodland: The area of Wet Woodland was estimated to be approximately 16,000 ha in Scotland in 2007 *(Table 6.7)*, which represents an increase of 25% since 1998. There are two possible reasons for this: a) An increase in willow saplings that have invaded boggy ground and now have a canopy cover of 50%, or b) 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 Scotland from 1998 to 2007. Arrows denote significant change ($p<0.05$) in the direction shown

	1998 Area ('000s ha)	2007 Area ('000s ha)	Direction of significant changes 1998-2007
EZ4	14	16	
EZ5	2	3	
EZ6	0.2	1.2	↑
Scotland	16	20	↑

Upland Mixed Ashwood: The area of Upland Mixed Ashwood Priority Habitat was estimated to be 13,000 ha in Scotland in 2007 *(Table 6.8)*.

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

	Area ('000s ha)
EZ4	0
EZ5	5
EZ6	8
Scotland	13

Upland Oakwood: The area of Upland Oakwood in 2007 was estimated to be 32,000 ha in Scotland which alongside Wales is where most of this Priority Habitat is found in Great Britain *(Table 6.9)*.

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

	Area ('000s ha)
EZ4	8.4
EZ5	15
EZ6	8.1
Scotland	32

Upland Birchwood: Upland Birchwood is restricted to Scotland where it covered an estimated area of 32,000 ha in 2007 *(Table 6.10)*.

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

	Area ('000s ha)
EZ4	4.6
EZ5	4.3
EZ6	22.9
Scotland	32

▲ Oak woodland • © *SNH*

▲ Woodland at Loch Lowes • © *SNH*

6.6 Changes in woodland soils (0-15cm)

- **No changes in soil (0-15cm) pH in either Coniferous or Broadleaved Woodland were observed in Scotland from 1978 to 2007.**
- **Soil (0-15cm) carbon concentration remained stable in Coniferous Woodland in Scotland but increased in Broadleaved Woodland between 1978 and 2007.**

6.6.1 Broadleaved, Mixed and Yew Woodland

Soil (0-15cm) pH: There were no significant changes in the mean pH of soil (0-15cm) samples in Broadleaved Woodland in Scotland between 1998 and 2007 (*4.84, 5.26*).

In contrast, there were significant decreases in the mean Ellenberg pH score in vegetation sampling plots between 1990 and 2007 indicating an increase in species associated with more acidic conditions.

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 Scotland between 1998 and 2007 (*155.1, 132.0*). 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 November 2009.

Bulk density and soil (0-15cm) carbon content: The mean bulk density of soils (0-15cm) in Broadleaved Woodland in Scotland was 0.58 g/cm^3. Combined with mean soil (0-15cm) carbon concentration, the estimated soil (0-15cm) carbon content is 70.6 t/ha.

6.6.2 Coniferous Woodland

Soil (0-15cm) pH: No change in the mean pH of soils (0-15cm) in Coniferous Woodlands was detected in Scotland between 1998 and 2007 (*4.54, 4.63*).

Soil (0-15cm) carbon concentration: The carbon concentration of soil (0-15cm) in the Coniferous Woodland Broad Habitat for Scotland did not change between 1978, 1998 and 2007 (*222.6, 207.6*).

Bulk density and soil (0-15cm) carbon content: The mean bulk density of of soils (0-15cm) in Coniferous Woodland in Scotland was 0.46 g/cm^3, which when combined with mean soil (0-15cm) carbon concentration, indicated a soil (0-15cm) carbon content of 73.2 t/ha.

6.7 Summary and Discussion

6.7.1 Changes in Woodlands

The extents of the two different woodland types in Scotland changed in different directions between 1998 and 2007 with decreases in Coniferous Woodland and increases in Broadleaved Woodland. These shifts in woodland type are at least to some extent a direct replacement of one woodland type with another as indicated by the analysis on conversion between Broad Habitat types. There was also recruitment of additional woodland from grassland Broad Habitats. The directions of change between 1998 and 2007 completely reversed those between 1990 and 1998. The introduction of Broad Habitats shortly before 1998 resulted in definitional changes which are likely to have affected woodland estimates and the comparability of 1990 estimates with those for 1998 and 2007. Further analyses of the nature of changes in woodland, in discussion with other bodies, will help to clarify the changes presented here.

Between 1998 and 2007 plant species richness decreased in both woodland types. The Species Richness Score in both plot types in Broadleaved Woodland decreased markedly. Decreases in Coniferous Woodland were less marked (with species richness already considerably lower in this woodland type) but were still significant across Scotland in Main Plots. Aligned with the decreases in Broadleaved Woodland were changes in the types of species recorded with increases in competitive species at the expense of those of more open habitats. Species of open habitats also decreased in Coniferous Woodland. It is possible that decreases in species in both woodland types may be due to canopy closure or to particular weather patterns in the survey year resulting in dominance by particular species. Further analysis is required to understand the reasons for species loss, but the results for Scotland are consistent with previous results indicating species loss in Scottish woodlands (Kirby et al. 2005).

Soils under woodland appear to be fairly stable although carbon concentration is increasing in Broadleaved Woodland. Further analysis of soils is ongoing to enable estimation of nutrient status, contaminant levels, soil biotic diversity and soil function and will be reported in November 2009.

6.7.2 Discussion

Since the creation of the Forestry Commission in 1919, there have been several national strategies for woodlands in the UK. During the 1980s, there was a major shift in emphasis in forestry

▲ Timber production • © *Crown copyright Scottish Government*

policy towards balancing timber production with natural heritage considerations. This resulted in marked changes in the composition and structure of forests and woodlands becoming apparent in the 1990s, as mature conifer plantations were restructured and more planting of broadleaved species took place to improve habitat diversity, naturalness and connectivity.

The most recent strategy published for Scotland, the Scottish Government's *Scottish Forestry Strategy* (2006) sets out a framework for an integrated, cross-sectoral approach to the use and enjoyment of woodlands and forests into the future. Objectives include the conservation of semi-natural woodland and enhancing the biodiversity of other woodlands and forest.

The last two decades have seen an increase in incentives and policy actions relating to planting of new broadleaved woodlands on farmland and in old industrial areas, and replacing felled conifers with broadleaved native trees. Annual Agricultural Census data show that the area of farm woodland in Scotland has continued to increase steadily, following a doubling in area between 1991 and 2000.

A large part of the increase in broadleaved woodland seen in the 2007 results can therefore be attibuted to these policy changes, but natural processes will also have contributed, such as where reductions in grazing or intervention have allowed vegetation to develop into woodland by natural succession.

The CS definition of woodland as having over 25% crown cover at least a metre high means that survey results for woodland extent are not comparable with other woodland statistics (see ***section 6.1***). The reduction in extent recorded for Coniferous Woodland is likely to be a reflection of felling and replanting cycles. Most newly planted woodland areas will not be allocated to a woodland Broad Habitat category for an estimated 10-15 years after planting, and most areas of plantations will be allocated to a different Broad Habitat (based on vegetation cover) between harvesting and the restocked area achieving 25% crown cover.

The reduction in species richness in woodland (including woodland patches) is consistent with surveys[2] specifically designed to track long-term changes in British deciduous woodlands and it is likely that areas of Coniferous Woodland are undergoing similar processes. Longer-term decreases (1990 to 2007) in species associated with fertile conditions and increases in species of acid soils in Broadleaved Woodland may indicate maturing of woodland.

Broadleaved 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 and reduced thinning and coppicing of woods. Similar processes may be operating in maturing stands of coniferous woodland.

Whilst deer or livestock grazing can prevent tree regeneration, if appropriately managed, it can also produce conditions that allow woodland flora and fauna to thrive. The relationship between densities of large herbivores and damage to young trees and ground flora is important for informing future management of commercial and non-commercial woodlands. Semi-natural woodlands, particularly broadleaved woodlands, may also be threatened by development pressure, inappropriate management and invasive species, all of which can contribute to species loss and fragmentation.

The Scottish Biodiversity Strategy (*www.biodiversityscotland.gov.uk/*) provides a plan for the conservation and restoration of Broadleaved Woodlands. Within this framework, Local Biodiversity Action Plans include actions to meet the specific targets for woodland Priority Habitats such as Upland Oakwoods and Upland Ashwoods, and many areas where these occur are also protected by designation as Sites of Special Scientific Interest (SSSIs). Woodlands of high biodiversity value may also be protected as Special Areas of Conservation under Natura 2000. The Scottish Forestry Strategy also places importance on reversing the effects of fragmentation on woodland biodiversity via the creation of forest habitat networks, through restoration and improvement of existing woodland and targeted planting.

The role of forestry is vital in adapting to climate change, such as contributing to sustainable flood management, capturing carbon and providing fuel resources and sustainable construction material. Analysis of forest habitat networks, which aim to support fully functioning and adaptable ecosystems, can help in planning adaptation to climate change.

▲ Scots pine, Loch Maree • © *SNH*

[2] Kirby et al (2005) *Long-term ecological change in British woodland (1971-2001).* English Nature Research report **653**. Peterborough, UK.

Countryside Survey

Further information

More details of the methodology, analyses and results from Countryside Survey can be found in other companion reports and data resources available for the Countryside Survey website [**www.countrysidesurvey.org.uk**] including:

Reports:

- UK Headline Messages – *published November 2008*
- UK Results from 2007 – *published November 2008*
- Detailed Northern Ireland Countryside Survey results – *published April 2009*
- England Results from 2007 – *due to be published August 2009*
- Scotland Results from 2007 – *due to be published June 2009*
- Wales Results from 2007 – *due to be published July 2009*
- Ponds – *due to be published July 2009*
- Streams – *October 2009*
- Soils – *November 2009*
- Integrated Assessment – *2010*

Data resources:

- Web access to **summary data** – a systematic summary of the results used to inform the UK and country level reports – launched in November 2008 and updated in January 2009
- Web access to the **actual data** – data from individual survey squares used to generate all the results presented in Countryside Survey reports from the 2007 survey – licensed access available from June 2009
- The UK Land Cover Map for 2007 – September 2009

The data generated by Countryside Survey will continue to be investigated in conjunction with other information such as climate, pollution and agricultural statistics. It is anticipated that future analysis of Countryside Survey data will lead to many scientific journal articles over the coming years. These investigations will improve understanding about the possible causes of the changes detected in the countryside and, for example, provide an opportunity to explore the results for Priority Habitats in more detail.

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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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▲ Moorland landscape with muirburn • © *Caspian Richards*

7. Mountain, Moor and Heath

Summary

- No significant changes were detected in the overall extents of the six Broad Habitats which make up the upland landscape mosaic across Scotland as a whole between 1998 and 2007. There were significant changes in the areas of two of these Broad Habitats in specific Environmental Zones (EZ) within Scotland.
- The area of Bracken Broad Habitat in the Intermediate Uplands and Islands (EZ5) increased by 27% between 1998 and 2007.
- The area of Bog Broad Habitat in the Lowlands (EZ4) decreased by 2.5% between 1998 and 2007.
- A substantial decline of over 113,000ha was detected in the area of Dwarf Shrub Heath between 1990 and 2007 but changes between 1998 and 2007 were not significant.
- No increases were detected in plant species associated with higher nutrient levels (eutrophication) in any of the mountain, moor and heath Broad Habitats between 1998 and 2007.
- Over the period 1990 to 2007, there was a significant decrease of 12% in the mean Species Richness Score in the Dwarf Shrub Heath Broad Habitat from an average of 20.3 to 17.8 plant species per plot. Plant species richness also decreased between 1998 and 2007 (by 23%) in Fen Marsh and Swamp Broad Habitat and by 11% in Bog.
- In Dwarf Shrub Heath and Bog Broad Habitats the cover of grass species relative to forbs increased between 1998 and 2007. Competitive plant species also increased in Bog suggesting deterioration in the condition of Bog Broad Habitat. Competitive species also increased in Bracken.

- **In Dwarf Shrub Heath, Bog, and in 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 acidic in 2007 compared to 1978, due mainly to a pH increase between 1978 and 1998.**
- **The acidity of soils (0-15cm) in Bracken Broad Habitat has not changed significantly between any of the surveys or across the period as a whole.**
- **In soils (0-15cm) in Bracken, Dwarf Shrub Heath and Bog Broad Habitats, the carbon concentrations in 2007 were not significantly different from 1978 values.**
- **In soil (0-15cm) in Fen, Marsh and Swamp Broad Habitat, carbon concentration decreased significantly between 1998 and 2007; the concentration of soil (0-15cm) carbon in 2007 in this Broad Habitat was not significantly different from that of 1978.**

7.1 Introduction[1]

Six Broad Habitats make up the mosaic of open, unenclosed landscapes in the UK that many people associate with wild land and enjoy as semi-natural, and in some sense, 'unspoilt' mountain, moor and heathland. The majority of these Broad Habitats (75% of the UK extent) are found in Scotland, predominantly in upland areas. Many of these areas, e.g. the Cairngorms, and Loch Lomond and the Trossachs, are also designated as National Parks or National Scenic Areas, Special Protection Areas or Sites/Areas of Special Scientific Interest.

Detailed descriptions of the six Broad Habitats are provided below. Within these six Broad Habitats there are a number of UK BAP Priority Habitats, the most significant of which is Blanket Bog which is particularly extensive in Caithness and Sutherland and the Western Isles. Descriptions of these Priority Habitats are provided in Section 7.5. The UK BAP includes targets to maintain the area and condition of these Priority Habitats for which Scotland is of key importance.

Condition of these habitats is assessed using a range of plot types which has been added to over time (see *Section 1.4.2, UK Report*) to enhance the ability of Countryside Survey (CS) to monitor change in these upland more unenclosed landscapes. Main Plots sample the main extent of these Broad Habitats. Targeted Plots tend to be used in these habitats to sample atypical areas of vegetation (where present) such as particularly wet/dry or rocky areas and areas of Priority habitat not sampled by other plot types. Unenclosed Plots (2 x 2m) were introduced into the survey in 1998 with the specific purpose of providing more information about the habitats of mountain, moor and heath which tend to be quite difficult to map precisely.

▲ Surveyor at work • © *NERC*

7.2 Description of the Broad Habitats

The six Broad Habitats covered in this chapter are:

Bracken: areas with a 95-100% cover of bracken plants (CS definition). If cover is less than this the area will be recorded as the underlying vegetation (potentially Acid Grassland) with bracken recorded as a species with a cover value. The Bracken Broad Habitat is included in this Chapter as it is most usually associated with the uplands, although it is found throughout Scotland.

Dwarf Shrub Heath: characterised by areas dominated by small shrubby heath species such as heather (*Calluna vulgaris*), Cross-Leaved Heath (*Erica tetralix*) and/or Blaeberry (*Vaccinium myrtillus*). 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 extensive upland areas in Scotland, as well as lowland and coastal regions.

Bog Broad Habitat: this includes blanket, raised and valley bogs. 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.

[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, UK Report (Methodology).*

▲ Upland landscape, Loch Lomond • © *Helen M Jones*

Fen, Marsh and Swamp: includes varied, often small, wetland habitats that are fed by ground or river waters as well as 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, this is very much a feature of the True Uplands. Natural exposed rock surfaces largely devoid of vegetation form most of this Broad Habitat, alongside smaller areas found in man-made situations such as quarries.

Montane: this Broad Habitat covers a very small area of the UK, and is almost entirely confined to Scottish peaks. It includes montane heath and snow bed communities alongside moss and lichen dominated heaths of mountain summits. As a result of its relative rarity and confined distribution, few areas of this Broad Habitat fall within the CS sample.

The Acid Grassland Broad Habitats and mosaics of Acid Grassland, Bracken and Bog make up much of the marginal upland areas of Scotland. The results for Acid Grassland are reported in *Chapter 4*.

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

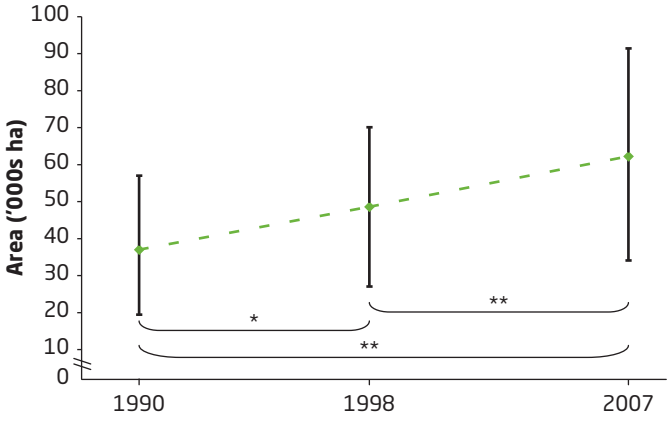
- **No significant changes were detected in the overall extents of the six Broad Habitats which make up the upland landscape mosaic across Scotland as a whole between 1998 and 2007. There were significant changes in the areas of two of these Broad Habitats in specific Environmental Zones (EZ) within Scotland.**
- **The area of Bracken Broad Habitat in the Intermediate Uplands and Islands (EZ5) increased by 27% between 1998 and 2007.**
- **The area of Bog Broad Habitat in the Lowlands (EZ4) decreased by 2.5% between 1998 and 2007.**
- **A substantial decline of over 113,000ha was detected in the area of Dwarf Shrub Heath between 1990 and 2007 but changes between 1998 and 2007 were not significant.**

7.3.1 Bracken

The estimated area of Bracken Broad Habitat in 2007 was approximately 131,000 ha, which represents 1.6% of the land area (see *Table 7.1*). The area of Bracken changed little in the Lowlands and True Uplands (EZ 4 & 6) but increased by approximately 27% in the Intermediate Uplands and Islands (EZ 5) between 1998 and 2007, following an increase of 32% 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, so the area estimates can be affected by small changes in bracken cover between surveys (e.g. a decrease from 95% to 90% bracken cover would result in a change in the Broad Habitat classification) *(Fig. 7.1)*.

▲ Bracken • © *SNH*

▼ **Figure 7.1:** Change in the area of the Bracken Broad Habitat between 1990 and 2007 in the Intermediate Uplands and Islands (EZ5). Significant changes (* p<0.05,** p<0.01) are shown between the dates bracketed. 95% Confidence Intervals are shown for each data point. Confidence Intervals on change are not shown.



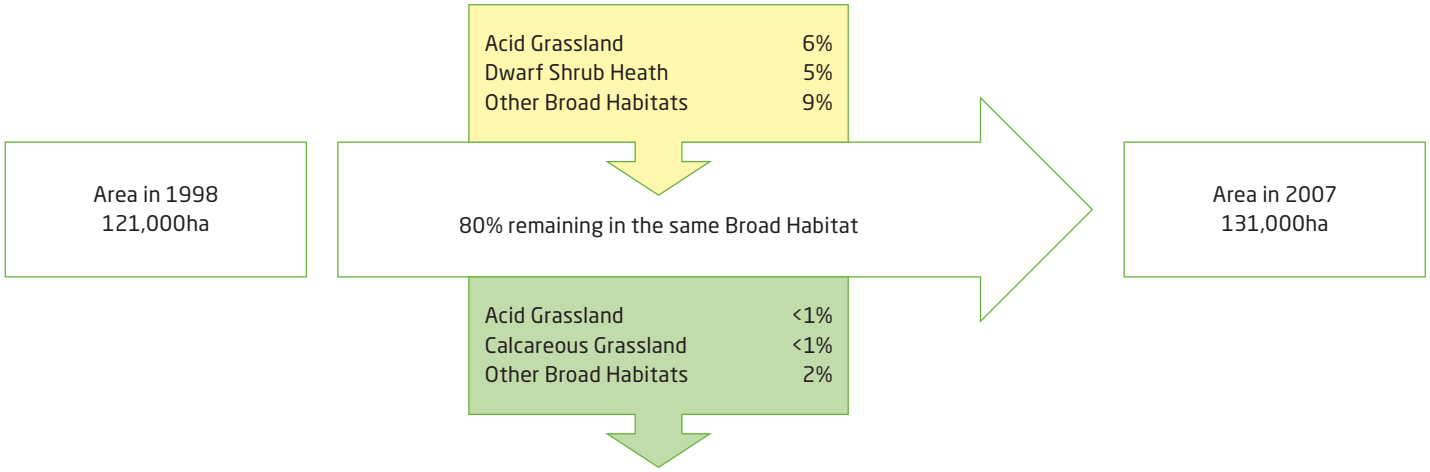
▼ **Table 7.1:** Estimated area ('000s ha) and percentage of land area of the Bracken Broad Habitat in each Environmental Zone and across Scotland from 1990 to 2007. Arrows denote significant change ($p<0.05$) in the direction shown.

	1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
EZ4	21	1.0	25	1.1	23	1.0	
EZ5	37	1.4	49	1.9	62	2.4	↑
EZ6	49	1.5	47	1.5	46	1.4	
Scotland	107	1.3	121	1.5	131	1.6	

▼ **Table 7.2:** Estimated area ('000s ha) and percentage of land area of Dwarf Shrub Heath Broad Habitat in each Environmental Zone and across Scotland from 1990 to 2007. Where present, arrows denote significant change ($p<0.05$) in the direction shown. Note that because of changes in definitions that have been applied retrospectively, the estimates from 1990 are not in all cases directly comparable with later surveys.

	1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
EZ4	77	3.4	71	3.2	68	3.1	
EZ5	236	9.2	208	8.1	207	8.1	
EZ6	695	21.7	633	19.8	619	19.3	
Scotland	1007	12.6	912	11.4	894	11.1	

▼ **Figure 7.2:** Movements of land into and out of Bracken between 1998 and 2007.



▲ Moorland • © *Sandra Marks*

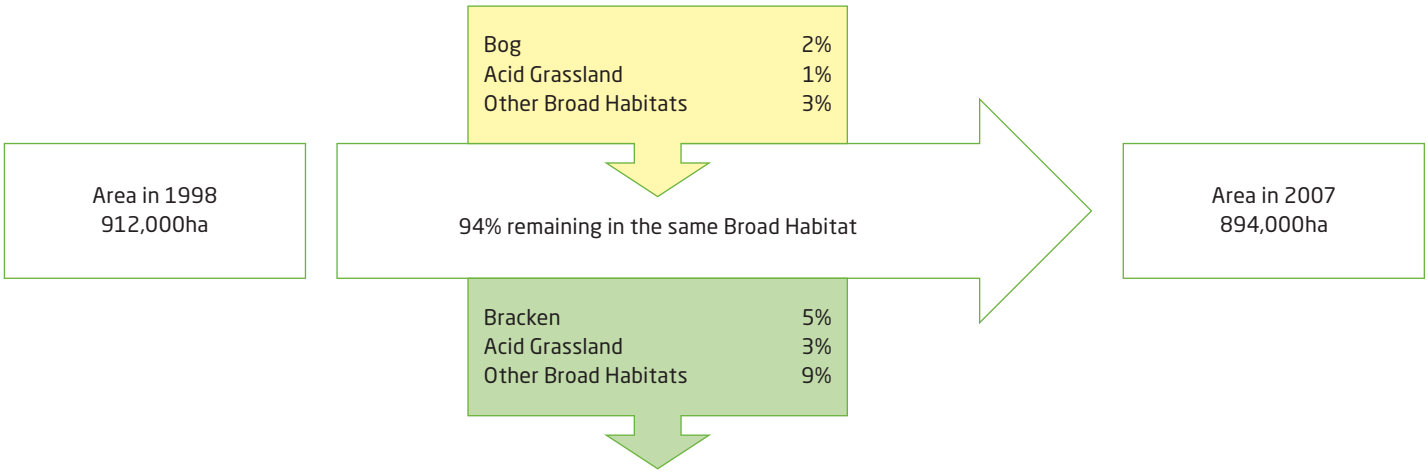
Approximately 80% of the polygons in the Bracken Broad Habitat in 2007 had been Bracken in 1998. Areas of Bracken were both lost to and gained from other Broad Habitats between 1998 and 2007 *(Figure 7.2)*.

7.3.2 Dwarf Shrub Heath

The estimated area of Dwarf Shrub Heath Broad Habitat in 2007 was 894,000ha, representing over 65% of the total area of this habitat in the UK *(Table 7.2)*. Dwarf Shrub Heath covered approximately 11% of Scotland and around 19% of the True Uplands (EZ6). Little change was detected in the extent of this habitat between 1998 and 2007 but there was a decrease of 113,000 ha across the period 1990 to 2007 for the whole of Scotland.

Ninety four percent of polygons in Dwarf Shrub Heath in 2007 were also in Dwarf Shrub Heath in 1998. Changes are shown in *Figure 7.3*.

▼ **Figure 7.3:** Movements of land into and out of Dwarf Shrub Heath between 1998 and 2007.



▼ **Table 7.3:** Estimates of the area ('000s ha) and percentage of land area of Bog Broad Habitat in each Environmental Zone and across Scotland from 1990 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 are not in all cases directly comparable with later surveys.

	1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
EZ4	158	7.1	160	7.2	156	7.0	↓
EZ5	832	32.6	872	34.1	890	34.8	
EZ6	932	29.1	1006	31.4	998	31.2	
Scotland	1922	24.0	2039	25.5	2044	25.6	

▲ Bog pool • © *SNH*

7.3.3 Bog

The estimated area of Bog Broad Habitat in 2007 was 2,044,000 ha, which represents over 85% of the total UK stock. In Scotland, Bog makes up 26% of the land area *(Table 7.3)*. No change was detected in the estimated area of Bog across Scotland as a whole between 1998 and 2007, but there was a decrease of 2.5% in the Lowlands (EZ4).

The overall area of Bog has remained relatively constant; 97% of the stock in 2007 was also Bog in 1998 *(Figure 7.4)*.

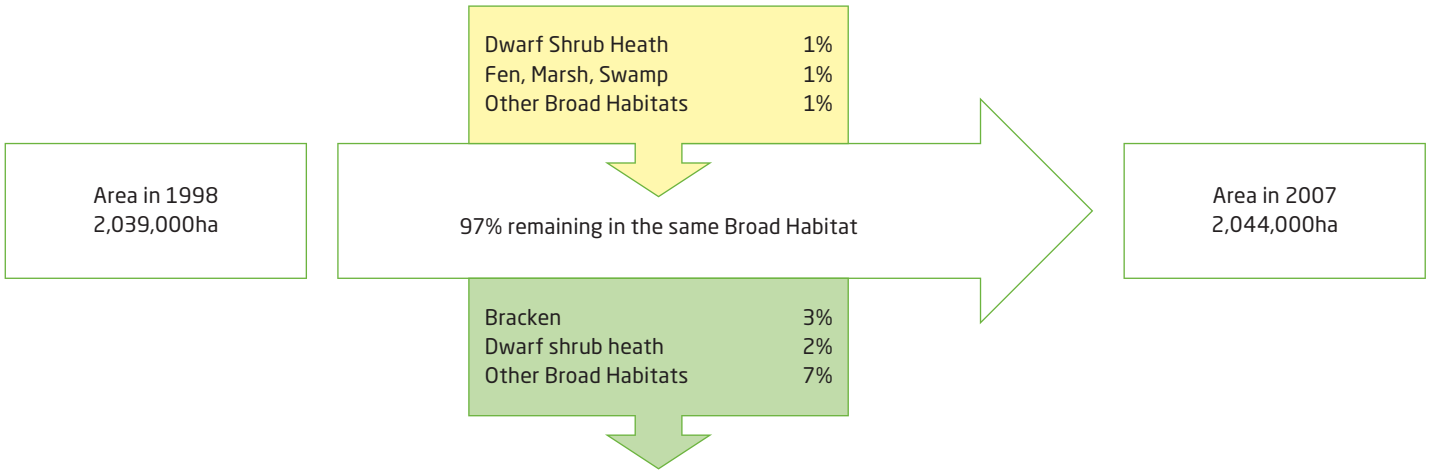
7.3.4 Fen, Marsh and Swamp

The estimated area of Fen, Marsh and Swamp Broad Habitat in 2007 was 238,000 ha, which represents approximately 54% of the UK stock. No change was detected in the area of Fen, Marsh and Swamp between 1998 and 2007.

Approximately 90% of the polygons in Fen, Marsh and Swamp in 2007 were also Fen, Marsh and Swamp in 1998 *(Figure 7.5)*.

▲ Upland landscape with acid grassland • © *Helen M Jones*

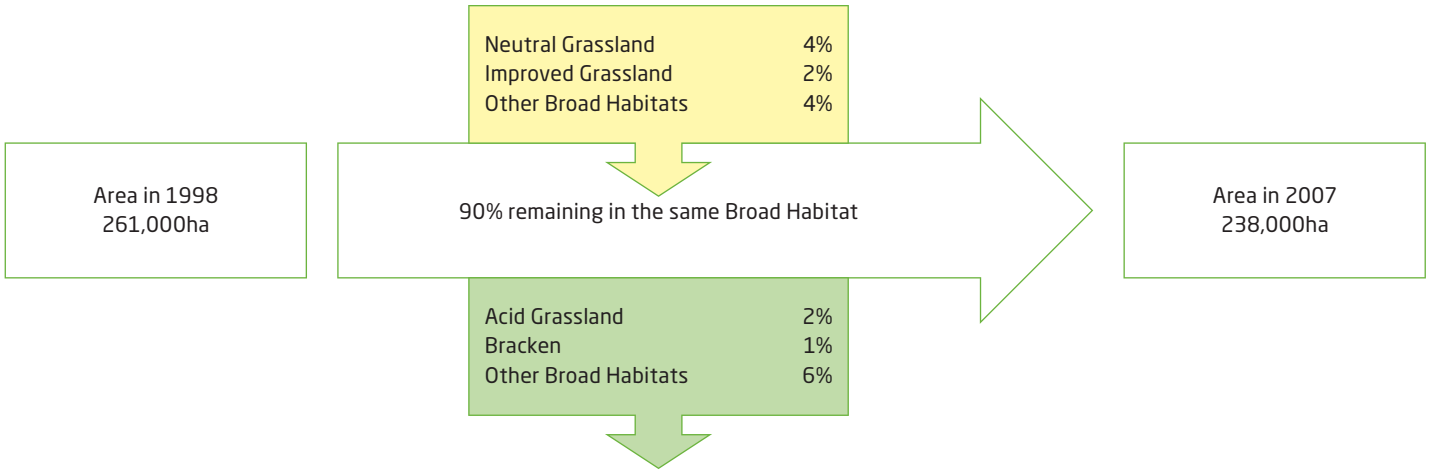
▼ **Figure 7.4:** Movements of land into and out of Bog between 1998 and 2007.



▼ **Table 7.4:** Estimated area ('000s ha) and percentage of land area of Fen, Marsh and Swamp Broad Habitat in each Environmental Zone and across Scotland from 1990 to 2007. Where present, arrows denote significant change ($p<0.05$) in the direction shown. Note that because of changes in definitions that have been applied retrospectively, the estimates from 1990 are not in all cases directly comparable with later Surveys.

	1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
EZ4	58	2.6	72	3.2	71	3.2	
EZ5	151	5.9	109	4.3	95	3.7	
EZ6	80	2.5	80	2.5	72	2.2	
Scotland	289	3.6	261	3.3	238	3.0	

▼ **Figure 7.5:** Movements of land into and out of Fen, Marsh, Swamp between 1998 and 2007.



7.3.5 Inland Rock

The area of Inland Rock Broad Habitat in 2007 was estimated at 84,000ha which represents 1% of the Scottish land area, and 94% of the stock of this Broad Habitat in the UK. The majority (70%) of this Broad Habitat is concentrated in the True Uplands (EZ 6). No changes in the area of Inland Rock Broad Habitat were detected between 1990 and 2007 ***(Table 2.1** [in National Picture Chapter])*. The only flows in this habitat were those between Inland Rock and Urban areas reflecting changes in features such as quarries.

7.3.6 Montane

All Montane Broad Habitat in the UK occurs in the True Uplands (EZ6) where the estimated 38,000ha in 2007 (0.5% of the Scottish land area) constituted approximately 90% of the UK total area for this Broad Habitat.). No changes in the area of Broad Habitat were detected between 1990 and 2007 ***(Table 1.1** [in National Picture Chapter])*. Non-significant changes between 1990 and 1998/2007 values are likely to reflect methodological and definitional improvements in the survey, rather than changes in the extent of Montane Broad Habitat.

▼ **Table 7.5:** Change in the characteristics of vegetation in 200m² Main Plots in the Bracken Broad Habitat across Scotland between 1990 and 2007. Mean values for 1998 and 2007 are presented. Arrows denote significant change (p<0.05) in the direction shown. The condition measures are described in ***Box 1.3, UK Report***.

	Mean values (Scotland)			Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1990**	**1998**	**2007**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**
Species Richness (No. of Species)	19.3	22.8	20.2												
No. of Bird Food Species	4.7	5.8	5.2												
No. of Butterfly Food Species	8.5	9.1	7.9												
Grass:Forb Ratio	0.06	0.96	0.42	↓		↓		↑		↑					
Competitor Score	2.48	2.37	2.49	↑											
Stress Tolerator Score	3.25	3.39	3.26												
Ruderal Score	1.80	1.79	1.72												
Light Score	6.72	6.70	6.73												
Fertility Score	3.34	3.20	3.25												
Ellenberg pH Score	3.81	3.75	3.81												
Moisture Score	6.22	6.02	6.19	↑				↓							

7.4 The condition of mountain, moor and heath Broad Habitats

- **No increases were detected in plant species associated with higher nutrient levels (eutrophication) in any of the mountain, moor and heath Broad Habitats between 1998 and 2007.**
- **Over the period 1990 to 2007, there was a significant decrease of 12% in the mean Species Richness Score in the Dwarf Shrub Heath Broad Habitat from an average of 20.3 to 17.8 plant species per plot. Plant species richness also decreased between 1998 and 2007 (by 23%) in Fen Marsh and Swamp Broad Habitat and by 11% in Bog.**
- **In Dwarf Shrub Heath and Bog Broad Habitats the cover of grass species relative to forbs increased between 1998 and 2007. Competitive plant species increased in Bog suggesting deterioration in condition.**

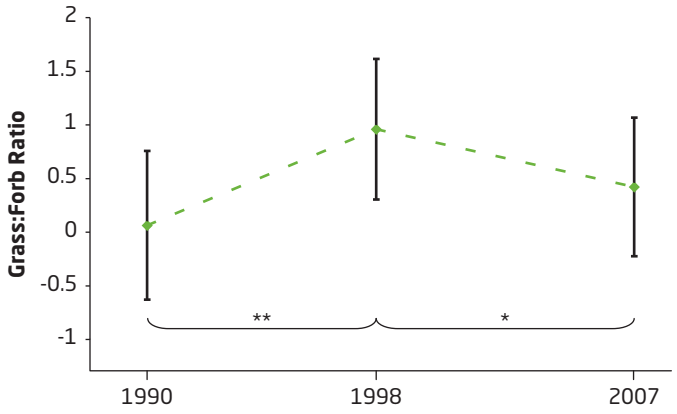
7.4.1 Changes in the Bracken Broad Habitat

Main and Unenclosed Plots: No changes were detected in the Species Richness of 200m² Main Plots in Bracken across the period 1990 to 2007 *(Table 7.5)*.

The ratio of grasses to forbs decreased in Main Plots within Bracken across Scotland and in the Intermediate Uplands and Islands (EZ5) between both 1998 and 2007 *(Fig. 7.6)*, and increased between 1990 and 1998. Both the mean Competitor and the mean Moisture Score in these Plots increased significantly across Scotland between 1998 and 2007. The mean Moisture Score result shows a reverse of the downward trend between 1990 and 1998.

To help assess condition of the Broad Habitats in unenclosed areas, extra 2m x 2m plots (see *Chapter 1*) were surveyed in 1998 and repeated in 2007. The Unenclosed Plots showed that grasses had become less prominent in Bracken habitats across Scotland and in both the Lowlands and Intermediate Uplands and Islands (EZ4 & 5).

▼ **Figure 7.6:** The changes in Grass:Forb ratio in 200m² Main Plots in the Bracken Broad Habitat across Scotland, between 1990 and 2007. Significant changes (*p<0.05,** p<0.01) are shown between the dates bracketed. 95% Confidence Intervals are shown for each data point. Confidence Intervals on change are not shown.



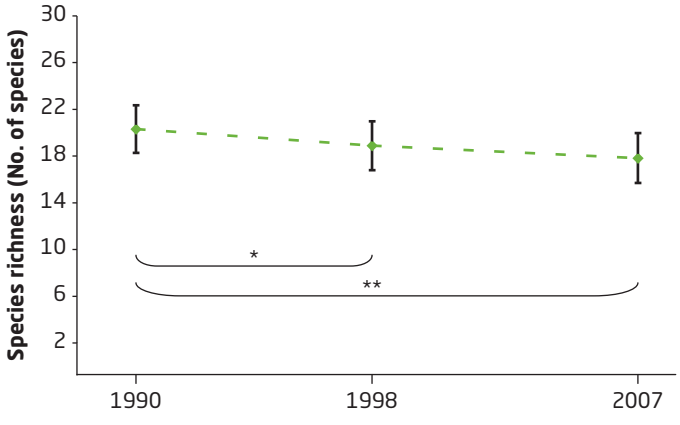
Targeted Plots: Targeted Plots (2m x 2m) showed decreases in mean Species Richness and plant species used by birds both across Scotland and in the Intermediate Uplands and Islands (EZ5) between 1998 and 2007. Significant decreases were also detected in the mean number of plant species used by butterflies and the mean Ruderal and Light Scores for these Plots in Scotland between 1998 and 2007.

▲ Heather • © *SNH*

7.4.2 Changes in the Dwarf Shrub Heath Broad Habitat

Main and Unenclosed Plots: No significant change was detected in mean Species Richness Score in the Main Plots in the Dwarf Shrub Heath Broad Habitat in Scotland between 1998 and 2007, although there was a decrease in the Intermediate Uplands and Islands (EZ 5) *(Table 7.6)*. Over the period 1990 to 2007, there was a decrease of 12% in the mean Species Richness Score in Main Plots across Scotland from an average of 20.3 to 17.8 plant species per plot *(Fig 7.7)*. Plant species used by butterfly caterpillars as food decreased in Main Plots across Scotland from 7.4 species per plot in 1998 to 6.9 in 2007, forming part of a longer-term decrease between 1990 and 2007. An increase in the mean ratio of grasses to forbs in Main Plots in Scotland and the True Uplands (EZ6) where much of this habitat is located may indicate further deterioration in the quality of this Broad Habitat. No significant change in the mean Fertility Score in Main Plots within Dwarf Shrub Heath was detected in Scotland between 1990 and 2007 or between 1998 and 2007. Significant changes in Main Plots at the Environmental Zone level indicate increases in competitive species at the expense of non-competitive species in the Intermediate Uplands and Islands (EZ5) and an increase in moisture tolerant species in the Lowlands (EZ4).

▼ **Figure 7.7:** The changes in mean Species Richness in 200m² Main Plots in the Dwarf Shrub Heath Broad Habitat across Scotland 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. Confidence Intervals on change are not shown.



Unenclosed Plots in Dwarf Shrub Heath showed small decreases in both Species Richness and in the number of food plants used by butterflies between 1998 and 2007 both across Scotland and in the Intermediate Uplands and Islands (EZ5).

Targeted Plots: The Dwarf Shrub Heath Broad Habitat consists of 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 (2m x 2m). Examples of these areas would include Dry Acid Grassland Priority Habitat, wet heath, bog and flushes. Targeted Plots in this Broad Habitat showed a decrease across Scotland in Species Richness between 1998 and 2007 from a mean of 13.0 plants per plot to 11.1 *(Table 7.7)*.
A decrease in Species Richness was also found in the Intermediate Uplands and Islands (EZ5). Trends for the period 1990 to 2007 indicate the same pattern with decreases in mean Species Richness and the number of food plants for butterflies across Scotland. Increases in the mean ratio of grasses to forbs and mean Competitor Score for these plots were found across Scotland as a whole and were also significant for the True Uplands (EZ6).

7.4.3 Changes in the Bog Broad Habitat

Main and Unenclosed Plots: The mean plant Species Richness Score of Main Plots within the Bog Broad Habitat in Scotland decreased by 6% from 19.0 to 17.8 species per plot, between 1998 and 2007, which was also the major component of the decrease between 1990 and 2007 *(Fig. 7.8)*.

▲ Mountain Avens • © *SNH*

▼ **Table 7.6:** Change in the characteristics of vegetation in 200m² Main Plots in the Dwarf Shrub Heath Broad Habitat across Scotland between 1990 and 2007. Mean values for 1998 and 2007 are presented. Arrows denote significant change ($p<0.05$) in the direction shown. The condition measures are described in ***Box 1.3, UK Report***.

	Mean values (Scotland)			Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1990**	**1998**	**2007**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**
Species Richness (No. of Species)	20.3	18.9	17.8			↓		↓		↓		↓		↓	
No. of Bird Food Species	3.4	3.1	2.9		↓							↓		↓	
No. of Butterfly Food Species	8.0	7.4	6.9	↓		↓		↓		↓		↓		↓	
Grass:Forb Ratio	0.65	0.59	0.81	↑			↑								
Competitor Score	2.15	2.18	2.21			↑						↑		↑	
Stress Tolerator Score	3.68	3.64	3.63			↓									
Ruderal Score	1.50	1.48	1.47		↓										
Light Score	6.95	7.01	7.00					↑			↑	↑		↑	
Fertility Score	2.45	2.39	2.38												
Ellenberg pH Score	3.19	3.15	3.10												
Moisture Score	6.53	6.55	6.60		↑										

▼ **Table 7.7:** Change in the characteristics of vegetation in 2m x2m Targeted Plots in the Dwarf Shrub Heath Broad Habitat in Scotland between 1990 and 2007. Mean values for 1998 and 2007 are presented. Arrows denote significant change ($p<0.05$) in the direction shown. The condition measures are described in ***Box 1.3, UK Report***.

	Mean values (Scotland)			Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1990**	**1998**	**2007**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**
Species Richness (No. of Species)	13.0	12.2	11.1	↓		↓						↓		↓	
No. of Bird Food Species	2.6	2.4	2.3												
No. of Butterfly Food Species	5.2	4.9	4.5		↓	↓						↓		↓	
Grass:Forb Ratio	0.62	0.94	1.03								↑	↑			↑
Competitor Score	2.23	2.29	2.32								↑	↑			↑
Stress Tolerator Score	3.55	3.51	3.52								↓				
Ruderal Score	1.64	1.61	1.56											↓	
Light Score	6.88	6.93	6.90							↑					
Fertility Score	2.70	2.64	2.60							↓				↓	
Ellenberg pH Score	3.44	3.35	3.33												
Moisture Score	6.39	6.44	6.48												

A decrease in the number of species used by butterfly caterpillars and farmland birds as food and an increase in the proportion of grass species in the Bog Broad Habitat were detected between 1998 and 2007. The proportion of competitive species increased at the expense of ruderal species in Main Plots within the Bog Broad Habitat across Scotland between 1998 and 2007, suggesting a reduction in disturbance. Changes in species are given in *Table 7.9*. These changes may indicate deterioration in the condition of this Broad Habitat, although whilst changes are statistically significant they are not large.

Results for the Unenclosed Plots in the Bog Broad Habitat show similar trends to those for the Main Plots, with decreases in Species Richness, Bird and Butterfly larvae Food Plants and a small increase in the ratio of grasses to forbs across Scotland. Both the Fertility Score and Ellenberg pH Score also decreased.

▲ Crowberry • © *SNH*

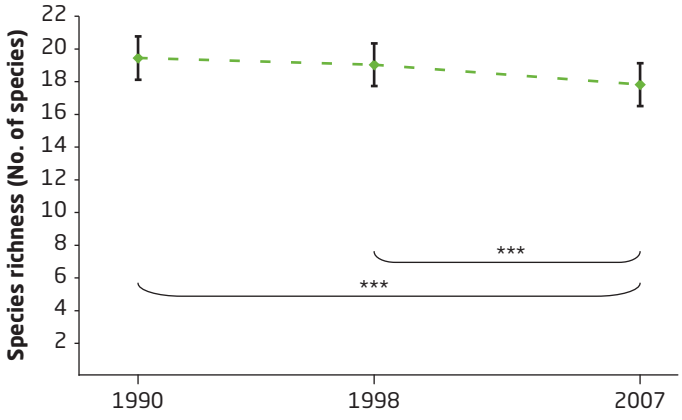
▼ **Table 7.8:** Change in the mean condition characteristics of vegetation in 200m² Main Plots in the Bog Broad Habitat in Scotland, between 1990 and 2007. Mean values for 1998 and 2007 are presented. Arrows denote significant change (p<0.05) in the direction shown. The condition measures are described in ***Box 1.3, UK Report***.

	Mean values (Scotland)			Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	1990	1998	2007	S	EZ4	EZ5	EZ6	S	EZ4	EZ5	EZ6	S	EZ4	EZ5	EZ6
Species Richness (No. of Species)	19.4	19.0	17.8	↓	↓	↓				↓		↓		↓	
No. of Bird Food Species	1.9	2.1	1.7	↓		↓	↓								
No. of Butterfly Food Species	7.0	6.7	6.4	↓		↓				↓		↓		↓	
Grass:Forb Ratio	1.11	0.99	1.26	↑		↑	↑								
Competitor Score	2.13	2.12	2.15	↑		↑				↓	↑				
Stress Tolerator Score	3.72	3.70	3.71				↑				↓				
Ruderal Score	1.40	1.42	1.38	↓			↓								
Light Score	7.25	7.30	7.30					↑		↑		↑		↑	
Fertility Score	2.14	2.09	2.04	↓			↓	↓			↓	↓		↓	↓
Ellenberg pH Score	3.10	3.09	3.00	↓		↓	↓					↓		↓	↓
Moisture Score	7.17	7.17	7.19												

▼ **Table 7.9:** The ten plant species showing the largest increases and decreases in the 200m² Main Plots in the Bog Broad Habitat across Scotland, between 1998 and 2007. Species at the top of the table show the largest changes. The Change Index was calculated using an adaptation of the method presented in the New Atlas of the British and Irish Flora.

Increasing Species		Change Index	Decreasing Species		Change Index
Carex echinata	Star sedge	0.34	*Pinguicula vulgaris*	Common butterwort	-0.29
Empetrum nigrum	Crowberry	0.34	*Festuca rubra agg*	Red fescue	-0.81
Huperzia selago	Fir clubmoss	0.47	*Carex panicea*	Carnation sedge	-0.13
Euphrasia officinali	Common eyebright	0.35	*Pedicularis sylvatica*	Lousewort	-0.23
Juncus conglomeratus	Compact rush	0.4	*Dactylorhiza sp*	Orchid sp.	-0.16
Dryopteris dilatata	Broad buckler fern	0.81	*Carex viridula*		-0.31
Juncus effusus	Soft rush	0.24	*Juncus bulbosus*	Bulbous rush	-0.25
Erica tetralix	Cross-leaved heather	0.36	*Erica cinerea*	Bell heather	-0.03
Salix repens agg.	Creeping willow	0.42	*Succisa pratensis*	Devilsbit scabious	-0.05
Rhynchospora alba	White beak sedge	0.42	*Viola palustris*	Marsh violet	-0.22

▼ **Figure 7.8:** The changes in Species Richness in 200m² Main Plots in the Bog Broad Habitat across Scotland between 1990 and 2007. Significant changes (*** p<0.001) are shown between the dates bracketed. 95% Confidence Intervals are shown for each data point. Confidence Intervals on change are not shown.



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 from 13.1 to 11.6 species across Scotland between 1990 and 2007, and also decreased between 1998 and 2007 *(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. Decreases in mean Species Richness and butterfly food plant species were apparent in the Lowlands and Intermediate Uplands and Islands (EZ 4& 5) but not in the True Uplands (EZ6) which contains the greatest extent of this Broad Habitat. It should be noted that lowland farmland birds are unlikely to use upland habitats to any great extent and this score is more appropriate for lowland farmed habitats.

▼ **Table 7.10:** Change in the characteristics of vegetation in 2m x2m Targeted Plots in the Bog Broad Habitat across Scotland, between 1990 and 2007. Mean values for 1998 and 2007 are presented. Arrows denote significant change ($p<0.05$) in the direction shown. The condition measures are described in ***Box 1.3, UK Report***.

	Mean values (Scotland)			Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1990**	**1998**	**2007**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**
Species Richness (No. of Species)	13.1	12.4	11.6	↓	↓	↓		↓	↑	↓		↓		↓	
No. of Bird Food Species	2.0	1.7	1.4	↓	↓	↓	↓	↓		↓		↓		↓	
No. of Butterfly Food Species	4.8	4.5	4.2	↓	↓	↓		↓		↓		↓		↓	
Grass:Forb Ratio	0.71	0.91	0.92												
Competitor Score	2.22	2.24	2.26		↑										
Stress Tolerator Score	3.60	3.55	3.58				↑				↓				
Ruderal Score	1.60	1.59	1.52	↓			↓					↓		↓	
Light Score	7.13	7.20	7.23	↑				↑		↑		↑		↑	↑
Fertility Score	2.47	2.42	2.28	↓		↓	↓					↓		↓	↓
Ellenberg pH Score	3.44	3.37	3.25	↓		↓	↓					↓		↓	
Moisture Score	7.08	7.04	7.17	↑		↑	↑					↑		↑	

▼ **Table 7.11:** Change in the characteristics of vegetation in 200m² Main Plots in the Fen, Marsh and Swamp Broad Habitat across Scotland between 1990 and 2007. Mean values for 1998 and 2007 are presented. Arrows denote significant change ($p<0.05$) in the direction shown. The condition measures are described in ***Box 1.3, UK Report***.

	Mean values (Scotland)			Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1990**	**1998**	**2007**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**
Species Richness (No. of Species)	27.0	28.7	22.2	↓	↓		↓		↑		↑	↓		↓	
No. of Bird Food Species	7.4	7.9	6.2	↓	↓										
No. of Butterfly Food Species	10.2	10.3	8.5	↓	↓							↓	↓		
Grass:Forb Ratio	0.96	0.65	0.68												
Competitor Score	2.40	2.42	2.47												
Stress Tolerator Score	3.15	3.12	3.10												
Ruderal Score	2.09	2.12	2.04												
Light Score	7.03	6.98	6.97												
Fertility Score	3.40	3.43	3.43												
Ellenberg pH Score	4.31	4.32	4.27												
Moisture Score	6.62	6.58	6.57												

The Targeted Plots showed a decrease in the Fertility Score and the Ellenberg pH Score across Scotland between 1998 and 2007 as found in the Main Plots. However, in contrast with the Main Plots, the Targeted Plots showed increases in both the Light and Moisture Scores.

7.4.4 Changes in the Fen, Marsh and Swamp Broad Habitat

Main and Unenclosed Plots: A 23% decrease in the Species Richness Score occurred in Main Plots within Fen, Marsh and Swamp between 1998 and 2007. Between 1990 and 2007 the decrease in Species Richness in this Broad Habitat was 18% *(Fig. 7.9)*. Decreases between 1998 and 2007 appear to be particularly concentrated in the Lowlands (EZ4), where decreases in species richness and plant species for both birds and butterflies are consistent with those across Scotland as a whole.

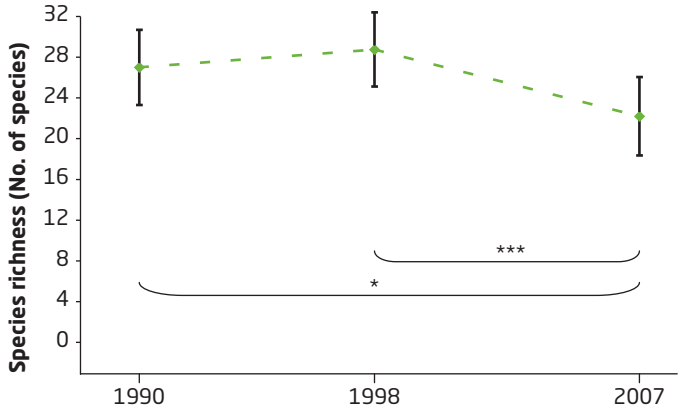
In Unenclosed Plots in Fen, Marsh and Swamp species richness decreased by 10% across Scotland and by 14% in the Intermediate Uplands and Islands (EZ5).

Targeted Plots: In common with the results for the Main Plots randomly sited in the Broad Habitat, there was a 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 14% from a mean of 15.4 to 13.3 plant species per Targeted Plot in Scotland between 1998 and 2007, compared with no significant change (15.9 and 15.4 species) between 1990 and 1998 *(Table 7.12)*. There was a simultaneous decrease in the number of Butterfly larvae Food Plants between 1998 and 2007.

▼ **Table 7.12:** Change in the characteristics of vegetation in 200m² Targeted Plots in the Fen, Marsh and Swamp Broad Habitat across Scotland between 1990 and 2007. Mean values for 1998 and 2007 are presented. Arrows denote significant change (p<0.05) in the direction shown. The condition measures are described in ***Box 1.3, UK Report***.

	Mean values (Scotland)			Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	1990	1998	2007	S	EZ4	EZ5	EZ6	S	EZ4	EZ5	EZ6	S	EZ4	EZ5	EZ6
Species Richness (No. of Species)	15.9	15.4	13.3	↓								↓		↓	
No. of Bird Food Species	4.3	4.2	3.9												
No. of Butterfly Food Species	4.93	5.11	4.29	↓											
Grass:Forb Ratio	0.48	0.28	0.40				↑								
Competitor Score	2.54	2.57	2.61												
Stress Tolerator Score	2.90	2.90	2.84												
Ruderal Score	2.25	2.22	2.21												
Light Score	7.05	7.07	7.03			↓									
Fertility Score	3.75	3.72	3.71												
Ellenberg pH Score	4.70	4.62	4.60							↓				↓	
Moisture Score	6.99	6.94	7.01												

▼ **Figure 7.9:** Changes in mean Species Richness Score per 200m² Main Plot in Fen, Marsh and Swamp Broad Habitat across Scotland, between 1990 and 2007. Significant changes (*p<0.05,***p<0.001) are shown between the dates bracketed. 95% Confidence Intervals are shown for each data point. Confidence Intervals on change are not shown.



7.5 Priority Habitats of mountain, moor and heath

The UK BAP Priority Habitats[2] are sub-sets of the Broad Habitats. The CS in 2007 is the first time that information on Priority Habitats has been included. Data for 1998 have also been analysed and are given for most Priority Habitats.

The data in this section are provided with a caution. There has been difficulty in separating the data between the Priority Habitats within the Broad Habitats. In particular it has been difficult to differentiate floristically between the Blanket Bog Priority Habitat and the other elements of the Bog and Dwarf Shrub Heath Broad Habitats.

▲ Bog vegetation • © *CEH*

7.5.1 Blanket Bog

The 1998 estimate has not been given for the Blanket Bog Priority Habitat due to differences in the definitions used during each survey giving non-comparable results. The area of Blanket Bog in 2007 was estimated at over 1.1 million ha which represents 14% of the area of Scotland *(Table 7.13)* and the vast majority of the area of this Priority Habitat in Great Britain. Blanket Bog is particularly abundant in the Intermediate Uplands and Islands and True Uplands (EZ5 & 6).

▼ **Table 7.13:** Estimated area ('000s ha) and percentage of land area of Blanket Bog Priority Habitat in Scotland in 2007.

Blanket Bog	2007	
	Area ('000s ha)	%
EZ4	84	3.7
EZ5	382	14.9
EZ6	649	20.2
Scotland	1115	14

7.5.2 Upland Dwarf Shrub Heath

The area of Upland Dwarf Shrub Heath in 2007 was estimated at 778,000 ha. This Priority Habitat is more abundant in Scotland than in other countries in Great Britain. There was no significant change from the 1998 estimate.

▼ **Table 7.14:** Estimated area ('000s ha) and percentage of land area of Upland Dwarf Shrub Heath Priority Habitat in Scotland from 1998 to 2007. Where present, 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)	%	
EZ4	35	1.5	36	1.5	
EZ5	160	6.3	160	6.3	
EZ6	595	18.6	582	18.2	
Scotland	790	9.9	778	9.8	

7.5.3 Lowland Dwarf Shrub Heath

Lowland Dwarf Shrub Heath covered an estimated area of 41,000ha in 2007. As with Upland Dwarf Shrub Heath this Priority Habitat is more abundant in Scotland than in other countries in Great Britain. There was no significant change from the 1998 estimate.

▼ **Table 7.15:** Estimated area ('000s ha) and percentage of land area of Lowland Dwarf Shrub Heath Priority Habitat in Scotland from 1998 to 2007. Where present, 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)	%	
EZ4	14	0.6	13	0.6	
EZ5	15	0.6	14	0.6	
EZ6	15	0.5	14	0.5	
Scotland	44	0.6	41	0.5	

7.5.4 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 which occurs in poorly drained, high rainfall areas mainly in the south west, particularly concentrated in the Stewarty region of Dumfries and Galloway. 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 Scotland for 2007 was 38,000 ha *(Table 7.16)* with the majority being found in the Intermediate Uplands and Islands (EZ5).

▼ **Table 7.16:** Estimated area ('000s ha) and percentage of land area of Purple Moor Grass and Rush Pasture Priority Habitat in Scotland in 2007.

Purple Moor grass and Rush Pasture	2007	
	Area ('000s ha)	%
EZ4	5	0.2
EZ5	25	1
EZ6	8	0.2
Scotland	38	0.5

▲ Upland scene • © *Helen M Jones*

▲ Vegetation survey on moorland • © *CEH*

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

- **In Dwarf Shrub Heath, Bog, and in 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 acidic in 2007 compared to 1978, due mainly to a pH increase between 1978 and 1998.**
- **The acidity of soils (0-15cm) in Bracken Broad Habitat has not changed significantly between any of the surveys or across the period as a whole.**
- **In soils (0-15cm) in Bracken, Dwarf Shrub Heath and Bog Broad Habitats, the carbon concentrations in 2007 were not significantly different from 1978 values.**
- **In soil (0-15cm) in Fen, Marsh and Swamp Broad Habitat, carbon concentration decreased significantly between 1998 and 2007; the concentration of soil (0-15cm) carbon in 2007 in this Broad Habitat was not significantly different compared to 1978.**

7.6.1 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 (*4.80, 4.43*). No changes were observed between 1978 and 1998 or across the entire survey period.

Soil (0-15cm) carbon concentration: No significant change in the mean carbon concentration of soil (0-15cm) was detected in the Bracken Broad Habitat between 1998 and 2007 (*196.3 g/kg, 264.4 g/kg*). There were no changes between 1978 and 2007 or between 1978 and 1998.

Bulk density and soil (0-15cm) carbon content: The mean bulk density of soils (0-15cm) in the Bracken Broad Habitat in 2007 was 0.31 g/cm^3 which when combined with soil (0-15cm) carbon concentration gave a soil (0-15cm) carbon content estimate of 78.6 t C/ha ***(Table 2.8)***.

7.6.2 Dwarf Shrub Heath

Soil (0-15cm) pH: No significant change was detected in the mean pH of soils (0-15cm) within Plots in the Dwarf Shrub Heath Broad Habitat between 1998 and 2007 (*4.63, 4.66*). The difference in pH between 1978 and 2007 was significant, mainly due to the large rise from pH 4.31 in 1978 to pH 4.63 in 1998.

Soil (0-15cm) carbon concentration: No significant change in the mean carbon concentration of soil (0-15cm) was detected in the Dwarf Shrub Broad Habitat between 1998 and 2007 (*300.3 g/kg, 285.8 g/kg*) or from 1978 to 1998 or from 1978 to 2007 ***(Table 2.7)***.

Bulk density and soil (0-15cm) carbon content: The mean bulk density of soils (0-15cm) in the Dwarf Shrub Heath Broad Habitat in 2007 was 0.30 g/cm^3 which when combined with soil (0-15cm) carbon concentration gave a soil (0-15cm) carbon content estimate of 81.9 t C/ha ***(Table 2.8)***.

7.6.3 Bog

Soil (0-15cm) pH: No significant change in mean soil (0-15cm) pH was detected in the Bog Broad Habitat between 1998 and 2007 (*4.53, 4.59*). An overall increase in pH from 1978 to 2007 was significant due mainly to the large significant increase from pH 4.34 in 1978 to pH 4.53 in 1998 ***(Table 2.7)***.

Soil (0-15cm) carbon concentration: No significant change in the mean soil (0-15cm) carbon concentration in the Bog Broad Habitat was detected between 1998 and 2007 (*412.6 g/kg, 398.2 g/kg*), although there was a significant increase between 1978 and 1998 ***(Table 2.7)***.

Bulk density and soil (0-15cm) carbon content: The mean bulk density of soils (0-15cm) in the Bog Broad Habitat in 2007 was 0.17 g/cm^3 which when combined with soil (0-15cm) carbon concentration gave a soil (0-15cm) carbon content estimate of 75.9 t C/ha ***(Table 2.8)***. The very large carbon concentration in these soils is offset by the low bulk density, to yield a moderately large carbon content when compared to other Broad Habitats.

7.6.4 Fen, Marsh and Swamp

Soil (0-15cm) pH: No significant change was detected in the mean pH of soils (0-15 cm) in the Fen, Marsh and Swamp Broad Habitat between 1998 and 2007 (*5.25, 5.32*). Between 1978 and 2007, the mean value increased significantly from pH 4.57 to pH 5.32, due mainly to the large significant increase between 1978 and 1998.

Soil (0-15cm) carbon concentration: A significant decrease was detected in the carbon concentration of soil (0-15cm) in the Fen, Marsh and Swamp Broad Habitat between 1998 and 2007 (*243.4 g/kg, 206.9 g/kg*). No significant changes were observed from 1978 to 1998 or from 1978 to 2007 ***(Table 2.7)***.

▲ Upland landscape with blanket bog • © *SNH*

Bulk density and soil (0-15cm) carbon content: The mean bulk density of soils (0-15cm) in the Fen, Marsh and Swamp Broad Habitat was 0.42 g/cm^3 which when combined with soil (0-15cm) carbon concentration gave a soil (0-15cm) carbon content estimate of 69.8 t C/ ha ***(Table 2.8)***.

7.8 Summary and discussion

7.8.1 Changes in mountain, moor and heath

Mountain, moor and heath habitats grade into one another and are difficult to define. Often surveyors will choose to interpret these habitats as complex mosaics and assign a proportion to each of the constituent habitats. This complexity, both of the habitats themselves and of their definitions inevitably results in some uncertainty around the estimates of their extent. In order to detect changes in the extents of mountain moor and heath habitats substantial shifts in vegetation would need to have taken place. CS found no ecologically significant changes in the extents of the Broad Habitats described in this chapter between 1998 and 2007 but the data do indicate a longer-term decline in the extent of Dwarf Shrub Heath (1990-2007). The reasons for this decline are not immediately apparent, though factors such as increases in Bracken, particularly in the Intermediate Uplands and Islands and increases in numbers of grazing animals may be important.

The most apparent change in the condition of the Broad Habitats was the decrease in the Species Richness Scores in Dwarf Shrub Heath, Bog and Fen, Marsh and Swamp. In some cases these were aligned with increases in competitive species and grass species but not in all. There was no evidence of increases in nutrient availability associated with eutrophication, between 1998 and 2007. Further analyses would need to be undertaken to understand the implications of a decline in Species Richness Score for habitat condition as decreases may not always indicate a deterioration.

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

7.8.2 Bracken

In 2007, the Bracken Broad Habitat covered 131,000 ha, 1.6% of the Scottish land area. Approximately half of the total extent of this Broad Habitat in Great Britain was located in Scotland. Although the overall extent of Bracken did not change significantly between 1998 and 2007, there was an increase in the Intermediate Uplands and Islands (EZ5) both in this period and between 1990 and 1998. Bracken increases were at the expense of a range of upland habitats including Bog, Acid Grassland, Dwarf Shrub Heath and Fen, Marsh and Swamp. The 95% cover threshold that defines the Bracken Broad Habitat means that shifts in and out of this Broad Habitat are likely to result from fluctuations in the cover of bracken in a particular area which may reflect factors such as annual weather conditions or more long-term patterns of vegetation change. The condition of the Bracken Broad Habitat changed little between 1998 and 2007, with only a reversal of the signal for grasses becoming more prominent observed between 1990 and 1998 across Scotland and in the Intermediate Uplands and Islands (EZ5). Soil conditions under the Bracken Broad Habitat have changed little since 1978.

▲ Acid grassland with bracken • © *Helen M Jones*

7.8.3 Dwarf Shrub Heath

Dwarf Shrub Heath covered almost 900,000 ha in Scotland in 2007, representing over 70% of the total area of this habitat in the UK. There was no significant change in the extent of this Broad Habitat between 1998 and 2007 but there was a significant downward trend in extent across the period 1990-2007. Shifts away from Dwarf Shrub Heath between 1998 and 2007 were primarily as a result of increases in Bracken and Acid Grassland Broad Habitats.

Decreases in plant Species Richness Scores occurred in all plot types in this Broad Habitat with decreases in the numbers of Butterfly larvae Food Plants constituting part of this decrease in plots. An increase in grass species at the expense of forbs is likely to have contributed to this decline.

Soil (0-15cm) pH changed in Dwarf Shrub Heath Broad Habitat 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.

▲ Upland bog • © *Caspian Richards*

7.8.4 Bog

Bog (including Blanket Bog and Lowland Raised Bog) covered approximately 10% of the UK land area in 2007. At over 2 million hectares, the area of bog in Scotland constituted around 85% of the UK total and made up 26% of the Scottish land area. There was no detectable change in the estimated area of Bog as a whole between 1998 and 2007, although there were significant but small decreases in the Lowlands. The extent of the Bog Broad Habitat was very stable between 1998 and 2007, with negligible movements to and from other mountain, moor and heath Broad Habitats.

The plant Species Richness Score in all plots in the Bog Broad Habitat decreased between 1998 and 2007, 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.

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 increase in the pH 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.

7.8.5 Fen, Marsh and Swamp

Fen, Marsh and Swamp Broad Habitat covered approximately 1.7% of the area of Great Britain in 2007, with 61% of this habitat (239,000ha, 3.0% of the Scottish land area) 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 the CS 2000 report. Estimates now indicate very little change in the extent of this habitat since 1984 and there were no significant changes in the extent of this Broad Habitat between 1990 and 2007. Movements between Fen, Marsh and Swamp and other habitats were small and largely involved Acid and Neutral Grasslands.

Vegetation condition has deteriorated since 1990 in the Fen, Marsh and Swamp Broad Habitat. The total Species Richness Score, as well as the number of plant species used by butterfly caterpillars as food, decreased in all plot types between 1998 and 2007.

A long-term reduction in the acidity of soils (0-15cm) in Fen, Marsh and Swamp Broad Habitat was due mainly to the large pH increase between 1978 and 1998. The carbon concentration of soils (0-15cm) decreased significantly between 1998 and 2007, but there was no significant change over the period as a whole.

7.9 Discussion

Mountain, moor and heathland habitats occupy over half of the landscape in Scotland, and comprise 60% of the UK total for these habitats. Associated land-based activities, such as hill farming, game management, tourism and recreation, play a part in Scotland's rural economy. These activities exert, and are influenced by, a variety of environmental, economic, legislative and political pressures, some of which have changed in their prevalence and intensity since the first CS in 1978. Long-term environmental pressures include the effects of climate change, which are likely to affect upland species and habitats. The uplands have also been affected by major changes in the economic environment over the past ten years, particularly following the reform of the Common Agricultural Policy (CAP).

Moor and heathland habitats are the product of centuries of management by muirburn and extensive grazing. These cultural landscapes are important for recreation, tourism and as sporting estates, and are also of international conservation importance for their distinctive assemblages of birds and mammals. Their future depends on well-planned management which seeks to balance a range of sometimes conflicting uses. Identification and maintenance of the most appropriate grazing and burning regimes for achieving desired outcomes is key to maintaining habitats in good condition. Future land use will need to meet multiple objectives appropriate to local conditions, while responding to the ways in which the impacts of grazing and burning interact with changes in climate and deposition of air pollution.

Many areas of mountain, moor and heath are protected under international and national nature conservation designations. The EC Birds and Habitat Directives and the Nature Conservation (Scotland) Act 2004 aim to protect internationally and nationally important rare and threatened habitats and species, which are targeted through designated Special Protection Areas (SPAs), Special Areas of Conservation (SACs) and Sites of Special Scientific Interest (SSSIs). Mountain, moor and heath habitats are also targeted through the UK BAP and the Scottish Biodiversity Strategy (SBS), which include specific targets for the restoration and maintenance of Priority Habitats.

Grazing in the uplands is strongly influenced by livestock subsidy mechanisms and other economic factors. Since the Single Farm Payment (SFP) scheme was introduced in 2005 as part of CAP reform, support is no longer based on the number of animals. This has contributed to a steady reduction in the numbers of hill sheep, particularly in the north and west, with Scottish Agricultural Census returns showing reductions in sheep and, to a lesser extent, cattle since 1999. The impact of the decline is complex, due to factors such as local variations and interactions with wild grazers such as deer. Changes to upland farming and grazing will have consequences for habitats and biodiversity resulting from possible undergrazing in some areas.

▲ Deer-proof fencing • © *Caspian Richards*

Air pollution in the form of atmospheric deposition of sulphur and nitrogen has been impacting on upland habitats since the industrial revolution through changes to acidity and nutrient status. Emissions of sulphur dioxide have decreased since the 1970s and reductions in the acidity of upland soils reflect this between 1978 and 1998. On the basis of critical load assessments, upland habitats, and bogs in particular, are considered to be at risk from increasing nutrient levels due to nitrogen deposition. A greater understanding is needed of the interaction between the impacts of nitrogen deposition with grazing and burning impacts. The increase in species associated with acid conditions appears inconsistent with the decrease in soil acidity observed between 1998 and 2007. However, this may be due to time lags in vegetation responses to changes in soils. More detailed analysis may help with understanding the interactions over long timescales that are involved in vegetation changes in upland habitats.

▲ Muirburn mosaic • © *CEH*

The increase in Bracken over the last ten years is likely to be related to heavy grazing pressure, as the species-poor grassland that often results is more prone to bracken invasion than heather moorland. Bracken infestation is a problem in many areas of upland Scotland, as it has limited grazing potential, acts as a reservoir for ticks and is associated with loss of biodiversity. Bracken thrives in mild, damp conditions such as those found in the south and west of Scotland, so it is possible that climate change will favour its spread in the future.

Many of the changes that have occurred in upland habitats are closely linked to changes in agricultural practices, which over the past ten years have been influenced by reforms to subsidies and changing market pressures. The importance of an integrated approach to dealing with the many pressures on upland habitats is reflected in the move towards agricultural support schemes which incorporate a wide range of environmental, economic and social outcomes. The effects of climate change are likely to become increasingly evident in the landscape. CS provides a contextual picture by measuring large-scale and long-term changes of widespread habitats in the uplands.

▲ Sheep grazing on heather • © *SNH*

Countryside Survey

Further information

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- The UK Land Cover Map for 2007 – September 2009

The data generated by Countryside Survey will continue to be investigated in conjunction with other information such as climate, pollution and agricultural statistics. It is anticipated that future analysis of Countryside Survey data will lead to many scientific journal articles over the coming years. These investigations will improve understanding about the possible causes of the changes detected in the countryside and, for example, provide an opportunity to explore the results for Priority Habitats in more detail.

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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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▲ River Etive, Highlands • © *Sandra Marks*

8. Rivers, Streams and Standing Waters

Summary

- The areas of Standing Waters and Canals Broad Habitat did not change in Scotland between 1998 and 2007. The areas of Rivers and Streams Broad Habitat increased slightly over the same period.
- The number of ponds increased by 6% in Scotland between 1998 and 2007.
- In 2007, ponds in Scotland supported an average of 9.6 wetland plant species per pond. In total, 9.9% of ponds met Priority Habitat status based on quality criteria for plants.
- Plant species richness of streamsides decreased by 12% in Scotland between 1998 and 2007. Since 1990 there has been a successional change, with vegetation becoming taller and with more competitive species.
- Plant species richness within streams increased in Scotland between 1998 and 2007 and there was a high turnover of species.
- The physical characteristics of streams improved in Scotland between 1998 and 2007.

Note on Chapter 8:

- **The methodology for sampling these Freshwater Habitats differs substantially from other terrestrial habitats.**
- **For further information on the Broad Habitat classification and terminology see *Chapter 1 Methodology (UK Report)*.**

8.1 Introduction

This Chapter presents the results for the two freshwater Broad Habitats: Standing Waters and Canals, and Rivers and Streams. In Scotland extensive areas are covered by sea and freshwater lochs which are not adequately sampled using Countryside Survey (CS) methodology and do not form part of the estimates of these Broad Habitats. Hence it is more useful to look at changes in CS estimates rather than their actual values. The freshwater Broad Habitats are important features of the Scottish landscape, both aesthetically and functionally, as they collect and transport water, sediment, nutrients and pollutants through the countryside. When in good condition, these freshwater habitats can support a wide range of plants and animals, many of which are listed in the UK Biodiversity Action Plan. Particular types of freshwater habitat are also listed as Priority Habitats e.g. ponds, rivers and lakes. Freshwater habitats also provide a valuable economic and recreational resource for people.

▲ Canal scene • © *SNH*

▲ Bog pool • © *SNH*

8.2 Description of Broad Habitats

The Standing Waters and Canals Broad Habitat includes ponds, lochs, 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.

In 2007 CS estimated the current area of both Broad Habitats in Scotland and the changes from previous surveys. For the first time in 2007, CS is able to report the estimated number of ponds across all of Scotland.

The condition of certain water body types within these Broad Habitats was assessed in a number of different ways (*Section 1.4.4 and Chapter 8, UK Report*). Measures of vegetation and habitat quality of streams (*section 8.5*) refer to headwater streams, defined as small watercourses within 5km of its source and draining a land area of less than 20km^2.

8.2 Area of Habitat

- **The areas of Standing Waters and Canals Broad Habitat did not change in Scotland between 1998 and 2007. The areas of Rivers and Streams Broad Habitat increased slightly over the same period.**
- **The number of ponds increased by 6% in Scotland between 1998 and 2007.**

Standing Waters and Canals, as sampled by CS, covered 89,000ha in 2007 *(Table 8.1)*. There was no significant change in the area of Standing Waters and Canals Broad Habitat over the past decade *(Table 8.1)*.

▼ **Table 8.1:** Estimated area ('000s ha) and percentage of land area of the Standing Waters and Canals Broad Habitat in each Environmental Zone and in Scotland from 1990 to 2007. Arrows denote significant change (p<0.05) in the direction shown.

	1990		1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	Area ('000s ha)	%	
EZ4	5	0.2	6	0.3	6	0.3	
EZ5	35	1.4	36	1.4	35	1.4	
EZ6	35	1.1	45	1.4	47	1.5	
Scotland	75	0.9	88	1.1	89	1.1	

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

	1998			2007			Direction of significant changes 1998-2007
	Lower 95% CL	Number of ponds ('000s)	Upper 95% CL	Lower 95% CL	Number of ponds ('000s)	Upper 95% CL	
EZ4	9	14	20	11	18	25	↑
EZ5	44	126	262	49	130	265	↑
EZ6	30	48	70	32	50	72	
Scotland	100	187	330	110	198	344	↑

▲ Lowland pond • © *SNH*

Rivers and Streams covered 21,000ha (0.3%) in Scotland in 2007, a small increase of 600ha on the 1998 estimate, with 7,000ha in each of the three Environmental Zones (EZs) where they comprised between 0.2 and 0.3% of the EZ area.

The area covered by the two freshwater Broad Habitats is small in relation to other Broad Habitats, together representing about 1.4% of Scotland. While the area of Rivers and Streams in each of the three EZs is approximately equal, across the three Environmental Zones, the majority of Standing Waters and Canals are in the Intermediate Uplands and Islands (EZ5) and True Uplands (EZ6) of Scotland.

8.2.1 Number of Ponds

There was a 6% increase in the number of ponds in Scotland between 1998 and 2007 to an estimated total of 198,000 ponds.

The increase in pond numbers was particularly large in the Lowlands (EZ4) 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. New ponds may help reverse the losses in the middle years of the 20th century that followed the intensification of agriculture.

8.3 Habitat Condition

- **In 2007, Scottish ponds supported an average of 9.6 wetland plant species per pond. In total, 9.9% of ponds met Priority Habitat status based on quality criteria for plants.**

8.3.1 Biological condition of Ponds

The CS in 2007 data provide a baseline describing the condition of ponds across Scotland, based on their plant communities. There were not sufficient ponds surveyed in the Lowlands (EZ4) or True Uplands (EZ6) to report reliably on plant species richness in these zones.

In 2007, Scottish ponds supported an average of 9.6 (± 1.4, 95% CI) wetland plant species per pond. Ponds in the Intermediate Uplands and Islands (EZ5) contained on average 9.4 (± 1.6, 95%CI) wetland plant species per pond. Across all 81 ponds surveyed in Scotland, 137 different plant species were recorded; 33 were submerged species, 6 were floating-leaved species and 98 were species associated with pond margins.

▲ Upland river • © *SNH*

8.3.2 Assessment of Pond Priority Habitat

The CS pond condition assessments in 2007 were based on plant data. These data have been used to identify priority ponds in Scotland using two plant criteria:

- **Criterion 1:** ***the presence of rare plant species.*** Of the ponds surveyed, eight (9.9%) qualified as Priority Habitat Ponds on the basis of this criterion.
- **Criterion 2:** ***species-rich plant communities.*** None of the surveyed ponds qualified on the basis of this criterion.

In total, 9.9% of the ponds qualified as Priority Habitat Ponds using these two plant-based criteria. It is probable that more of the surveyed ponds would qualify if groups like invertebrates and amphibians were also surveyed. This means that the current CS can only be used to provide a minimum estimate of the number of Priority Habitat Ponds in Scotland and a baseline for comparison with future surveys.

8.4 Change in vegetation condition alongside rivers and streams

- **Plant species richness of streamsides decreased by 12% in Scotland between 1998 and 2007. Since 1990 there has been a successional change, with vegetation becoming taller and with more competitive species.**

8.4.1 Changes in the Rivers and Streams Broad Habitat (1990-2007)

The vegetation growing alongside streams, ditches and rivers was sampled in 10m long x 1m wide 'Streamside Plots' (*Table 1.3, UK Report*). Most of these Plots were on small headwater streams, defined as small watercourses within 5km of its source and draining a land area of less than 20km^2 (because they are more frequent in the countryside), but some Plots were also placed alongside larger rivers.

Between 1998 and 2007 there was a significant and widespread decrease in plant species richness and numbers of Bird and Butterfly larvae Food Plant species along watercourses in Scotland; this trend was not evident between 1990 and 1998 ***(Table 8.3)***. This decrease was aligned with increases in competitive species and shade casting/shade-tolerant species and decreases in plant species of open/disturbed ground indicating that streamsides may be becoming overgrown as a result of reduced management. Many of the changes were consistent across the whole of Scotland, although there were fewer changes in types of vegetation present in streamsides in the True Uplands (EZ6) between 1998 and 2007.

Changes between 1990 and 2007 were consistent with those since 1998 ***(Table 8.3)***. Species associated with fertile conditions increased along watercourses in the Lowlands (EZ4), but there was no change in upland areas.

8.5 Changes in the vegetation and physical quality of streams

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

▲ Yellow flag • © *SNH*

The diversity and cover of aquatic (within the river) plants were recorded over a 100m length of stream channel at 162 sample squares in both 1998 and 2007.

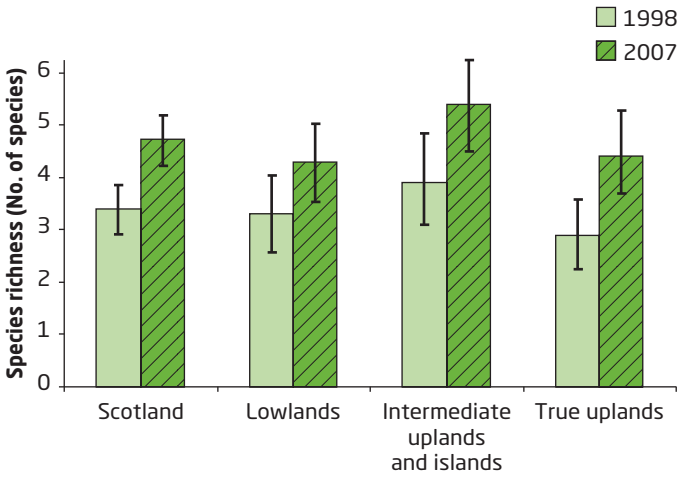
▼ **Table 8.3:** Changes in the characteristics of vegetation in 10m x1m Streamside Plots in the Rivers and Streams Broad Habitat across Scotland between 1990 and 2007. Arrows denote significant change ($p<0.05$) in the direction shown. The condition measures are described in ***Box 1.3, UK Report***.

	Mean values (Scotland)			Direction of significant changes 1998 - 2007				Direction of significant changes 1990 - 1998				Direction of significant changes 1990 - 2007			
Vegetation Condition Measures	**1990**	**1998**	**2007**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**	**S**	**EZ4**	**EZ5**	**EZ6**
Species Richness (No. of Species)	21.7	21.7	19.2	↓	↓	↓	↓					↓	↓	↓	↓
No. of Bird Food Species	6.2	6.1	5.3	↓	↓	↓	↓		↓		↑	↓	↓	↓	↓
No. of Butterfly Food Species	7.8	7.8	6.9	↓	↓	↓	↓					↓	↓	↓	↓
Grass:Forb Ratio	0.53	0.57	0.51												
Competitor Score	2.54	2.57	2.6	↑		↑		↑	↑			↑	↑	↑	↑
Stress Tolerator Score	2.97	2.94	2.94					↓	↓			↓			
Ruderal Score	2.14	2.11	2.08	↓	↓	↓		↓	↓			↓	↓	↓	
Light Score	6.79	6.82	6.77	↓	↓	↓		↑		↑	↑		↓		↑
Fertility Score	3.88	3.88	3.9		↑								↑		
Ellenberg pH Score	4.63	4.61	4.62												
Moisture Score	6.5	6.54	6.56			↑		↑	↓	↓		↑	↓		

8.5.1 *Species richness in headwater streams*

The number of plant species in Scottish streams increased between 1998 and 2007 *(Fig. 8.1)*. This trend was seen in all three EZs and continues a trend of increasing diversity in streams recorded between 1990 and 1998 (based on macroinvertebrates). Pooled plant species richness across (see *Glossary, Annex 1: UK Report*) Scotland as a whole increased between 1998 and 2007, with a particularly substantial increase in the True Uplands (EZ6) *(Table 8.4)*.

▼ **Figure 8.1:** Change in mean headwater stream plant richness across Scotland and in each Environmental Zone between 1998 and 2007. Asterisks denote a statistically significant change between surveys (* $p< 0.05$). 95% Confidence Intervals are shown for each data point.



There was a considerable turnover of plant species between 1998 and 2007. Only 46% of all 137 aquatic plant taxa encountered were recorded in both years. Of the 63 persistent taxa, 36 increased in frequency across Scotland between 1998 and 2007, while 19 decreased in frequency, though none substantially.

▲ Freshwater surveyor • © *SNH*

▼ **Table 8.4:** Change in pooled headwater stream plant species richness across Scotland and in each Environmental Zone between 1998 and 2007. Arrows denote significant change (p<0.05) in the direction shown.

	1998 Total richness	2007 Total richness	Change total richness	Direction of significant changes 1990-2007
EZ4	49	56	+7	
EZ5	69	74	+5	
EZ6	41	60	+19	↑
Scotland	93	107	+9	↑

▼ **Table 8.5:** Change in Mean Trophic Rank (MTR) score per headwater stream site in Scotland and in each Environmental Zone between 1998 and 2007. Arrows denote significant change (p<0.05) in the direction shown.

	1998 MTR	2007 MTR	MTR change	Mean change MTR	MTR change Upper 95%	Direction of significant changes 1990-2007
EZ4	47.4	52.1	-0.4	4.7	10.8	
EZ5	64.3	68.1	-1.4	3.8	9.4	
EZ6	78	81.6	-1.7	3.6	8.8	
Scotland	63.8	67.8	1	4	7.2	↑

▲ Stream, Orkney • © *SNH*

The predominantly emergent vascular plants e.g. Brooklime (*Veronica beccabunga*), Bulbous Rush (*Juncus bulbosus*), Marsh Violet (*Viola palustris*) and Creeping Bent grass (*Agrostis stolonifera*) became more prevalent between 1998 and 2007, as did the submerged Alternate Water Milfoil (*Myriophyllum alterniflorum*) and the bryophytes *Racomitrium aciculare* and *Pellia*.

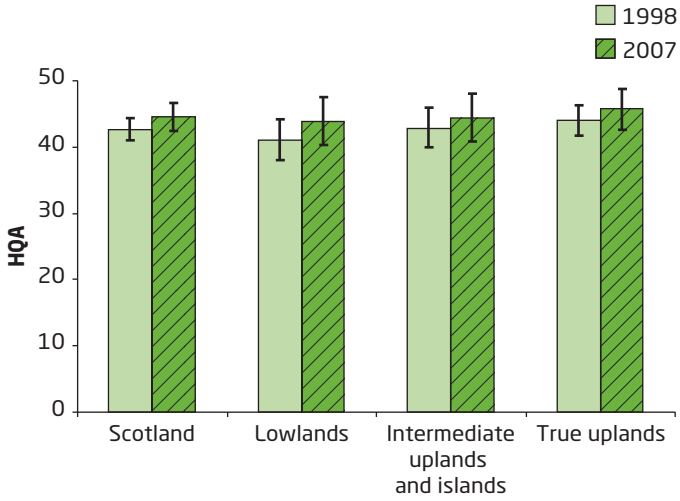
The temporal variability of the aquatic plant species pool in Scotland was also evident in each of the three EZs, with between 40 and 48% of taxa occurring in each EZ in both 1998 and 2007. The turnover of species shows the highly dynamic nature of the streamside habitat, resulting both from its location between land and water as well as from changes in the quality of the water and the physical structure of streams.

The significant increase in the Mean Trophic Rank (MTR) score (***see Glossary, Annex 1: UK Report***) in Scotland since 1998 ***(Table 8.5)*** indicates that nutrient enrichment of small watercourses has reduced. As would be expected, there was a gradient of increasing MTR scores, indicating lower nutrient levels in streams, going from the Lowlands (EZ4) to the True Uplands (EZ6).

8.5.2 Headwater Stream Physical Habitat Diversity

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

▼ **Figure 8.2:** Change in the Habitat Quality Assessment (HQA) of headwater streams across Scotland and in each Environmental Zone between 1998 and 2007. Asterisks denote statistically significant change (* P< 0.05). 95% Confidence Intervals are shown for each data point.



There were small but significant improvements in habitat quality of headwater streams in Scotland between 1998 and 2007 ***(Fig. 8.2)***, though the trends were not significant by EZ. Between 1998 and 2007, natural riparian land cover (within 50 m of the stream) increased e.g. woodland and in-stream woody debris, and natural bank features e.g. gravel side bars.

▲ Lochan at Inshriach • © *SNH*

8.6 Summary and Discussion

8.6.1 Summary – Changes in Freshwaters

The extent of Scottish freshwater Broad Habitats has remained stable over the past decade, though the number of ponds has increased. With an average of fewer than 10 plant species, Scottish ponds (lochans) are some way short of the richness expected for ponds in good condition, although in nutrient poor conditions, as found in many upland habitats, fewer species would be expected.

In the Rivers and Streams Broad Habitat there has been a continued improvement in the biological and physical condition of Scottish headwater streams across most areas of Scotland. Streamside vegetation has continued to shift toward a late-successional assemblage, with an associated loss of species and increase in competitive herbaceous plants and woody species

CS also collects information on the stream-bed macroinvertebrate fauna in headwater streams, which can be used to provide a robust assessment of change in biological condition back to 1990. These data are currently being processed and will be reported in the CS Headwater Streams Report (due October 2009) where they will be compared to the results presented here.

8.6.2 Discussion

Standing Water and Canals Broad Habitat

Overall, the area of Standing Water and Canals Broad Habitat in Scotland has changed little since 1990. In the Lowlands, the significant increase in area between 1990 and 1998 was probably due to particularly wet conditions during 1998. The lack of change since then may also be a result of wet conditions having occurred again during the 2007 survey period, which may also in part account for the larger number of ponds recorded.

Pond numbers in Scotland declined during the second half of the 20th century, as many were infilled or lost following damage from land use intensification and pollution from agricultural run-off and acid deposition. Part of the increase in pond numbers in the Lowlands since 1998 may be due to pond creation, suggesting that incentives have been effective, although the inclusion of temporary ponds in the results makes interpretation difficult without further analysis. The effects of nutrient pollution and water body isolation caused by previous pond loss may still be contributing to poor pond quality; this also requires further analysis.

Data from CS in 2007 will provide useful baseline information for future monitoring of pond quality. Ponds were assessed against only two of the Priority Habitat criteria, on the basis of plant information. Information on aquatic macroinvertebrates, adult insects or amphibians was not assessed, and although incomplete, this assessment should provide a useful baseline against which any future data can be compared. If animal groups and other criteria are included in future assessments, it should be possible to obtain an improved estimate of the number of Priority Habitat ponds in Scotland.

Rivers and Streams Broad Habitat

Since 1998, the greatest changes in vegetation condition in Rivers and Streams Broad Habitat have been in the Lowlands (EZ4) and Intermediate Uplands and Islands (EZ5). The decline in the number of species along watercourses, including Bird and Butterfly larvae Food Plants, is potentially of concern. Increased numbers of competitive plant species associated with fertile soils indicate that eutrophication and succession are continuing to take place, the latter suggesting reduced physical disturbance from adjacent agricultural practices. This may be related to the fencing off of watercourses as a diffuse pollution control measure. Generally such fenced off areas are relatively unmanaged, leading to reductions in disturbance and direct nutrient input (e.g. from livestock). Changes in prevalence of non-native, invasive plant species may also have contributed to changes in vegetation condition, but it is not possible to use Countryside Survey to assess this due to insufficient data in either 1998 or 2007.

Catchment-sensitive management practices to reduce the impacts of diffuse pollution are now being encouraged. Options for managing water margins previously available under agri-environment schemes such as Rural Stewardship have now been incorporated into the Scotland Rural Development Programme (SRDP). They include a requirement for maintaining appropriate grazing management to reduce invasive or competitive plant species, and control of non-native invasive plant species. Take-up of these options should enhance biodiversity whilst protecting water margins from erosion and watercourses from pollution by agricultural run-off.

In the True Uplands (EZ6), where fewer changes in vegetation condition since 1998 were recorded, watercourses are often small, fast flowing streams, with little or no aquatic vegetation. Thus the species most often recorded tend to be those associated with the habitats through which the rivers and streams flow, rather than typical species of marginal aquatic, or aquatic habitats.

The significant increase in Mean Trophic Rank (MTR) in headwater streams suggests that the changes observed in stream plant communities are, in general, indicative of an improvement in condition; however, this trend should be treated with caution because CS sites, in common with sites generally in any river or stream, often have restricted MTR species richness such that the assessment can only be based on between one and three scoring species. This makes the MTR score vulnerable to even slight changes in species composition. Within Scottish streams across all EZs, the trend of increasing diversity since 1990 and the increase in the number of plant species between 1998 and 2007 requires further analysis to ascertain whether this represents improved biological condition.

Continuing improvements in the biological and physical condition of headwater streams in Scotland may well be a consequence of efforts made over the past 20 years to strengthen environmental regulations and improve management of rivers and streams. Most recently, this includes the introduction of a regulatory framework, as part of the implementation of the Water Framework Directive (WFD), which should contribute to the protection and continued improvement of Scotland's water environment into the future.

Countryside Survey

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The data generated by Countryside Survey will continue to be investigated in conjunction with other information such as climate, pollution and agricultural statistics. It is anticipated that future analysis of Countryside Survey data will lead to many scientific journal articles over the coming years. These investigations will improve understanding about the possible causes of the changes detected in the countryside and, for example, provide an opportunity to explore the results for Priority Habitats in more detail.

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