▲ 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.

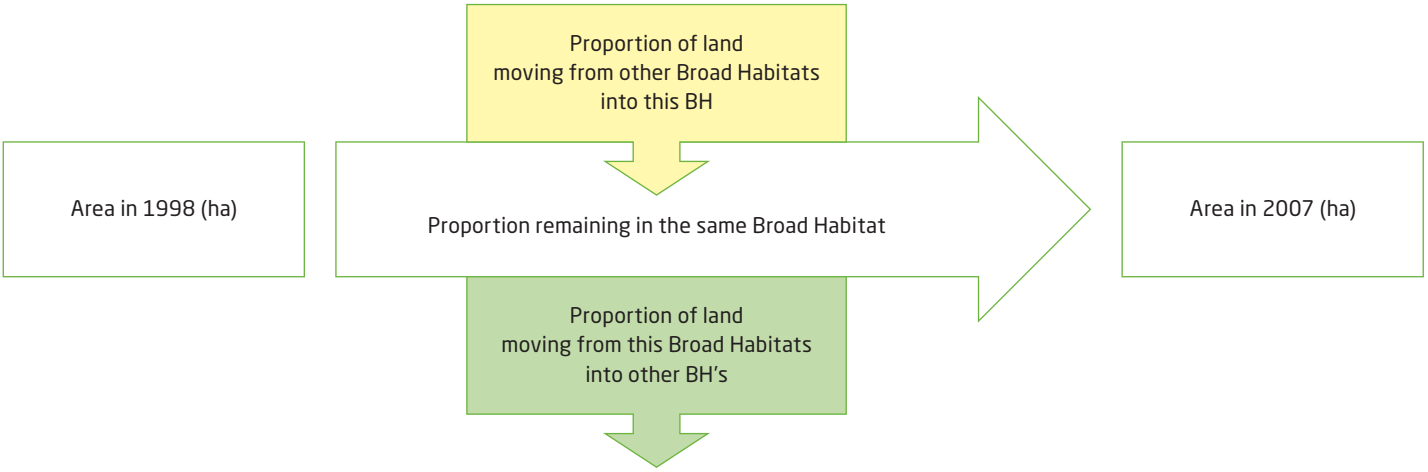
[3] Coniferous Woodland in CS excludes recently felled and newly planted woodland (canopy cover exceeds 25%).

[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/*).

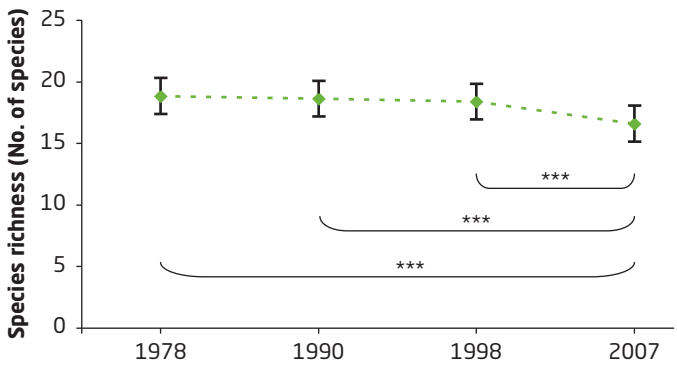
There was a significant decrease of 9.8% in plant species richness in Main Plots in all vegetation types in Scotland between 1998 and 2007. This decrease was consistent across all Environmental Zones (EZs). Plant species richness in 2007 was significantly lower than in all other survey years (which were 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).

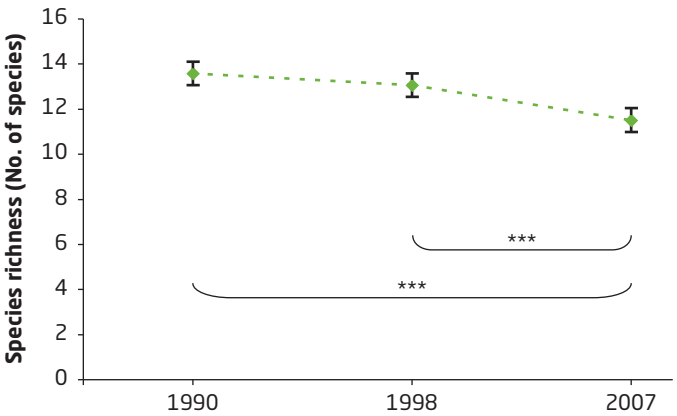
2.5.3 Targeted Plots

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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