



▲ Enclosed farmland • © Clive Hurford

2. Enclosed Farmland: Arable & Horticulture and Improved Grassland Broad Habitats

Summary

Area

- There were no significant changes in area of Improved Grassland between surveys.
- No significant changes in area of Arable & Horticulture occurred overall across Wales but a small significant increase in area (4,300 ha) was detected in the upland zone between 1998 and 2007.
- 87% of the mapped increase in Arable in survey squares occurred on land mapped as Improved Grassland in 1998.

Vegetation condition

- Too few plots were available for representative analysis of Arable & Horticultural vegetation character reflecting the scarcity of the Broad Habitat in Wales.
- In Improved Grassland, patterns of change in vegetation characteristics in Wales resembled those at the Great Britain level, in particular the increased representation of species favouring wetter and more acid conditions. However, the significant reduction in species richness between 1998 and 2007 in Wales was not observed at the Great Britain level.

Soils

- pH increased significantly in Improved Grassland between 1978 and 2007. No change in pH was detected in Arable & Horticultural land.
- No significant changes were detected in soil carbon concentration.

2.1 Introduction

The two Broad Habitats covered in this chapter are managed primarily to maximise food production. The soils are naturally the most productive in Britain, inputs of energy are high and so outputs of meat, dairy products and crops are also high. Since intensive management aims to divert energy into the growth of the crop, these habitats generally support relatively few other species. However, where management intensity is lower or refuges are provided, such as uncropped and unfertilised margins, a wider range of plants and animals can persist. For example, Arable Field Margins are a Priority Habitat within the UK Biodiversity Action Plan because these areas of transition between crop and adjacent land have the potential to support a range of specialist plant species and invertebrates that may in turn provide food for bird species associated with cultivated land. In Wales, Arable & Horticulture is relatively localised whilst Improved Grassland is extensive and indeed more common than in either England or Scotland.

In landscapes dominated by intensive farming, additional habitat features such as watercourses, hedges, field boundaries and fragments of semi-natural habitat including woods and less intensively managed grassland, can make a valuable contribution to farmland biodiversity. In Wales, intensive farmland is dominated by grassland and the most productive land is restricted in extent by soil depth, geology and slope within the context of a mild yet wet climate. The most improved grasslands tend to be in the lowlands where they dominate the landscape. Smaller areas of less productive habitats and landscape features are then typically embedded in this highly productive matrix. Intensive agriculture therefore has the potential to negatively impact more diverse adjacent habitats but there is also potential for these smaller habitat patches to act as sources for recolonisation when management intensity is reduced. In the unenclosed uplands the situation is reversed because inherently low productivity puts an ecological and economic constraint on the extent to which habitats can be improved so that Improved Grassland and Arable & Horticulture are rare.

The Arable & Horticulture and Improved Grassland Broad Habitats are among those most likely to change in both area and condition over time, because their management is so responsive to the economics of farming, the introduction of new technologies and to changes in agricultural policy.



▲ Young maize, Clwyd • © Stuart Smith

2.2 The Area of Enclosed Farmland in Wales

2.2.1 Arable & Horticulture

In Wales the Arable & Horticultural Broad Habitat made up 3.4% of land cover in 2007 compared with 18.8% of the land cover of the UK (**Table 2.1**). A significant increase in area of 4,300 ha (95% CI; 1,956 ha to 9,764 ha) was estimated to have occurred in the upland Environmental Zone from a small total extent of 5,600 ha in 1998 to 9,900 ha in 2007 (**Table 2.1**). No significant change was detected in Wales as a whole, in contrast to a significant UK wide reduction between 1998 and 2007²³. Examination of the mapped changes in the Welsh upland survey squares showed that small increases were noted within 6 squares, the largest increase being stubble (26% of the mapped change) and then Barley (12%). When surveyed previously in 1998, 87% of the new arable land was then Improved Grassland and 10% Neutral Grassland.

2.2.2 Improved Grassland

Improved Grassland was estimated to make up 34% of Wales in 2007, a much higher proportion than any other country in the UK apart from Northern Ireland¹³. No significant change in area of Improved Grassland occurred in Wales between 1998 and 2007 (**Table 2.2**).

²³ Carey et al (2008) *Countryside Survey 2007; UK results*. Online at: www.countrysidesurvey.org.uk

▼ **Table 2.1:** Estimates of the area ('000s ha) and percentage of land area of Arable & Horticultural Broad Habitat in Wales and in each environmental zone from 1998 to 2007 are shown. Arrows denote significant change ($p < 0.05$) in the direction shown.

	1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	
Lowland	55	5	63	6	
Upland	6	0.6	10	1	↑
Wales	61	3	73	3	

▼ **Table 2.2:** Estimates of the area ('000s ha) and percentage of land area of Improved Grassland Broad Habitat in Wales and in each environmental zone from 1998 to 2007 are shown. No statistically significant changes were seen between survey years.

	1998		2007		Direction of significant changes 1998-2007
	Area ('000s ha)	%	Area ('000s ha)	%	
Lowland	457	42	467	43	NO SIGNIFICANT CHANGE
Upland	249	24	263	26	
Wales	706	33	731	34	

▼ **Table 2.3:** Change in the characteristics of vegetation in 200m² Main Plots in the Arable & Horticulture Broad Habitat across Wales between 1990 and 2007. W=Wales, Lo=Lowland zone, Up=Upland zone. No statistically significant changes were seen between survey years.

	Mean values (Wales)			Direction of significant changes 1998 - 2007			Direction of significant changes 1990 - 1998			Direction of significant changes 1990 - 2007		
	1990	1998	2007	W	Lo	Up	W	Lo	Up	W	Lo	Up
Vegetation Condition Measures												
Species Richness (No. of Species)	14.1	11.3	11.8	NO SIGNIFICANT CHANGE			NO SIGNIFICANT CHANGE			NO SIGNIFICANT CHANGE		
No. of Bird Food Species	8.5	6.2	6.6									
No. of Butterfly Food Species	4.9	4.2	4.8									
Grass:Forb Ratio	-0.12	1.26	1.42	NO SIGNIFICANT CHANGE			NO SIGNIFICANT CHANGE			NO SIGNIFICANT CHANGE		
Competitor Score	2.16	2.36	2.39									
Stress Tolerator Score	1.42	1.59	1.71									
Ruderal Score	3.75	3.49	3.55									
Light Score	7.05	6.96	7.02									
Fertility Score	6.40	6.24	6.28									
Ellenberg pH Score	6.55	6.39	6.51									
Moisture Score	5.11	4.94	5.00									

2.3 The condition of the Broad Habitats of enclosed farmland

2.3.1 Arable & Horticulture

Very few Main Plots were available for analysis of vegetation condition on cultivated land ($n_{1990}=13$, $n_{1998}=16$, $n_{2007}=19$). Such small sample sizes have low power to detect statistically significant changes and hence to make conclusions about changes across the population of arable fields in Wales. Indeed, no significant changes were detected across Wales or within either of the environmental zones (**Table 2.3**). In addition, all changes in vegetation characteristics were examined for effect size but all were either small or medium. This suggests that despite small sample size no major ecological changes had occurred in the sample.

Because of the limited extent of the Broad Habitat in Wales there were too few Targeted Plots associated with the Arable & Horticultural Broad Habitat for analysis to be carried out.

2.3.2 Improved Grassland

The most common species recorded in Main and Targeted Plots within areas mapped as Improved Grassland are listed in **Table 2.4**.

Main Plots: Between 1998 and 2007, species richness of Improved Grassland declined significantly in both upland and lowland zones and across Wales (**Table 2.5**). Overall, numbers of lowland farmland bird food plants also declined significantly between 1998 and 2007, and 1990 and 2007. Numbers of butterfly larval food plants also declined significantly between 1998 and 2007 with an overall significant decline between 1990 and 2007 of 1.5 species per plot (**Table 2.5**). None of the standardized effect sizes were large suggesting possibly minor impacts on the vegetation.

Other significant changes included an increase in Moisture Score across Wales, especially in the upland zone between 1998 and 2007, and between 1990 and 2007 (**Table 2.5**). At the same time as Moisture Score increased, Ellenberg pH Score declined

significantly, indicating that species preferring relatively more acid conditions increased their representation among the species present in plots (*Table 2.5*).

The increase in Moisture Score and decrease in Ellenberg pH Score in the upland zone were based on large standardized effect sizes (*Table 2.5*). This indicates that the changes in species composition tracked by these indices were substantial relative to the variation across the sample, and could indicate important ecological impacts on the vegetation as well as detectable responses to possible drivers such as rainfall in the years of survey. However, Improved Grassland is typically species-poor and of low conservation value so that any change is likely to be relatively unimportant in biodiversity policy terms. An increase in Moisture Score was also seen across Britain in the same intervals in Improved Grassland Main Plots.

Targeted Plots: Within the Improved Grassland Broad Habitat, the Targeted Plots would have sampled a range of species assemblages less typical of the Broad Habitat, often including fragments of more valuable semi-natural habitat as evidenced by their lower mean Fertility Score, higher Moisture Score and higher Stress Tolerator Score relative to the Main Plots in *Table 2.5*. Overall, fewer changes were seen in the Targeted Plots than in the Main Plots. Across Wales only plant species richness showed a significant change between 1998 and 2007, declining by an average 3 species per plot between 1998 and 2007 (*Table 2.6*). However, all three species richness measures declined significantly in the lowland zone in the same interval. Across Wales, Grass:Forb Ratio and Fertility Score both increased significantly between 1990 and 1998 while Fertility Score also increased overall from 1990 to 2007. Stress Tolerator Score decreased overall between 1990 and 2007. This pattern of change indicates a reduction in the contribution of species more typical of unproductive habitats (*Table 2.6*).

All but one of the significant changes were based on medium or small standardized effect sizes suggesting minor impacts on the vegetation. The only large effect size in the Improved Grassland Targeted Plots was the reduction in Stress Tolerator Score in the upland zone between 1990 and 1998 (*Table 2.6*). This highlights a substantial decline in the contribution of this sensitive species group. The effect size for the overall change between 1990 and 2007 was 0.7, just below the criterion for a large effect (0.8)²⁴ but indicating that a possibly important decline was seen over the whole 17 year period covered by the three surveys (*Table 2.6*).



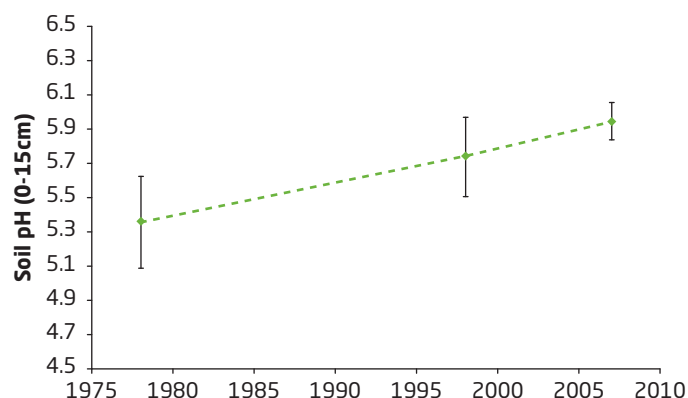
▲ Pass above Dinas Mawddwy • © Michael D Smith

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

2.4.1 Soil (0-15cm) pH

The mean pH of soils (0-15cm) increased significantly in the Improved Grassland Broad Habitat in Wales between 1978 and 1998, and between 1978 and 2007 but did not change significantly between 1998 and 2007 (*Fig 2.1*). For the Arable & Horticulture Broad Habitat, there was only sufficient data for analyses to be carried out between 1978 and 2007, and no significant change was detected.

▼ **Figure 2.1:** The change in pH in soils (0-15cm) in the Improved Grassland Broad Habitat in Wales, between 1978 and 2007. Significant change (at least $p < 0.05$) occurred between 1978 and 1998, and 1978 and 2007. Error bars are the 95% CI on the mean soil pH in each survey year.



²⁴ See Appendix 1.

▼ **Table 2.4:** Most frequent 15 species in 2007 in the Improved Grassland Broad Habitat in Wales.
See **Appendix 2** for English & Welsh common names.

a) Main Plots (n=201)			b) Targeted Plots (n=40)		
% frequency	Mean cover (%)	Plant name	% frequency	Mean cover (%)	Plant name
95	48	<i>Lolium perenne</i>	58	6	<i>Holcus lanatus</i>
91	12	<i>Trifolium repens</i>	53	8	<i>Agrostis stolonifera</i>
81	3	<i>Ranunculus repens</i>	48	16	<i>Lolium perenne</i>
74	1	<i>Cerastium fontanum</i>	40	7	<i>Juncus effusus</i>
72	11	<i>Holcus lanatus</i>	40	5	<i>Trifolium repens</i>
66	1	<i>Taraxacum agg.</i>	38	9	<i>Agrostis capillaris</i>
63	10	<i>Agrostis capillaris</i>	38	3	<i>Festuca rubra agg.</i>
50	7	<i>Agrostis stolonifera</i>	35	1	<i>Ranunculus repens</i>
47	1	<i>Rumex obtusifolius</i>	33	1	<i>Dactylis glomerata</i>
35	1	<i>Rumex acetosa</i>	30	2	<i>Anthoxanthum odoratum</i>
32	1	<i>Cirsium arvense</i>	28	1	<i>Rumex acetosa</i>
32	3	<i>Cynosurus cristatus</i>	25	2	<i>Poa annua</i>
32	1	<i>Poa annua</i>	23	3	<i>Rubus fruticosus agg.</i>
30	2	<i>Poa trivialis</i>	20	<1	<i>Cardamine pratensis</i>
27	1	<i>Dactylis glomerata</i>	20	<1	<i>Cerastium fontanum</i>

▼ **Table 2.5:** Change in the characteristics of vegetation in 200m² Main Plots in the Improved Grassland Broad Habitat across Wales, between 1990 and 2007. W=Wales, Lo=Lowland zone, Up=Upland zone. Arrows denote significant change (p<0.05) in the direction shown. Red indicates large effect sizes.

Vegetation Condition Measures	Mean values (Wales)			Direction of significant changes 1998 - 2007			Direction of significant changes 1990 - 1998			Direction of significant changes 1990 - 2007		
	1990	1998	2007	W	Lo	Up	W	Lo	Up	W	Lo	Up
Species Richness (No. of Species)	17.3	17.1	14.7	↓	↓	↓				↓		
No. of Bird Food Species	9.9	10.6	9.1	↓	↓	↓	↑	↑		↓		↓
No. of Butterfly Food Species	9	8.5	7.5	↓		↓				↓	↓	↓
Grass:Forb Ratio	1.34	1.53	1.39						↑			
Competitor Score	2.67	2.70	2.73		↑				↑			↑
Stress Tolerator Score	2.02	2.02	1.97	↓		↓						
Ruderal Score	3.19	3.19	3.16		↓			↑	↓			
Light Score	7.05	7.06	7.02	↓		↓						
Fertility Score	5.50	5.49	5.48									
Ellenberg pH Score	6.03	5.98	5.90	↓		↓				↓	↓	↓
Moisture Score	5.34	5.38	5.46	↑		↑			↑	↑		↑

2.4.2 Soil (0-15cm) carbon concentration

No significant changes were detected in the Improved Grassland Broad Habitat. For the Arable & Horticultural Broad Habitat, there was only sufficient data for analyses to be carried out between 1978 and 2007, and no significant change was detected.

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

The bulk density of soils (0-15cm) in the Arable & Horticultural Broad Habitat in Wales was 1.1 g/cm³, which when combined with soil carbon concentration in the same horizon indicated a soil (0-15cm) carbon stock of 33 t/ha. The comparable figure for Great Britain was 43 t/ha reflecting the larger area of organic matter rich, high grade agricultural land in parts of England and Scotland.

In Improved Grassland in Wales, the bulk density of soil (0-15cm) was 0.9 g/cm³ indicating a soil (0-15cm) carbon stock of 62 t/ha comparable to 61 t/ha for the Improved Grassland Broad Habitat at the Great Britain level.

2.5 The results in context

This chapter has considered two Broad Habitats that occupy the intensively managed end of the habitat spectrum that characterises most enclosed farmland in Wales. Other less intensively managed habitats that occur within farmed landscapes, including more biologically diverse types such as unimproved forms of grassland, are considered in **Chapters 3 and 6**. Boundary features associated with these habitats, such as hedges and walls, are also dealt with separately in **Chapter 4**.

▼ **Table 2.6:** Change in the characteristics of vegetation in 4m² Targeted Plots in the Improved Grassland Broad Habitat across Wales, between 1990 and 2007. W=Wales, Lo=Lowland zone, Up=Upland zone. Arrows denote significant change (p<0.05) in the direction shown. Red indicates large effect sizes.

	Mean values (Wales)			Direction of significant changes 1998 - 2007			Direction of significant changes 1990 - 1998			Direction of significant changes 1990 - 2007		
	1990	1998	2007	W	Lo	Up	W	Lo	Up	W	Lo	Up
Vegetation Condition Measures												
Species Richness (No. of Species)	15.8	15.4	12.6	↓	↓		NO SIGNIFICANT CHANGE			↓	↓	
No. of Bird Food Species	6.1	6.1	5.0		↓						↓	
No. of Butterfly Food Species	6.1	6.25	5.3		↓						↓	
Grass:Forb Ratio	0.36	1.19	1.05	NO SIGNIFICANT CHANGE			↑					
Competitor Score	2.74	2.73	2.84									
Stress Tolerator Score	2.56	2.45	2.35						↓	↓		↓
Ruderal Score	2.65	2.67	2.61									
Light Score	6.8	6.79	6.78									
Fertility Score	4.46	4.74	4.88				↑			↑		
Ellenberg pH Score	5.36	5.46	5.51									↑
Moisture Score	6.12	6.04	6.08									

Improved Grassland is generally perceived as having limited biodiversity value though one localised type – Coastal and floodplain grazing marsh – is recognised as a Priority Habitat in the UK Biodiversity Action Plan. Much arable land is viewed similarly, though in some specific situations conservation interest is high, as reflected in the identification of Arable Field Margins as a Priority Habitat in the UK Biodiversity Action Plan. A high proportion of the land cover of Wales is Improved Grassland. Arable & Horticulture occupies a much smaller area with concentrations confined to areas such as South Pembrokeshire, the Vale of Glamorgan and the Vale of Clwyd.

▼ **Table 2.7:** Comparative estimates of the extent of these habitats ('000s ha) are available from the Habitat Survey of Wales, and from Welsh Agricultural Statistics. 95% CI on the 2007 estimates are given in brackets.

	Arable & Horticulture	Improved grassland
Countryside Survey (2007)	73 (42.4-110.9)	731 (625.4-875.3)
Habitat Survey of Wales (1979 - 1997)	60	1,037
Welsh Agricultural Statistics (2007)	67	1,001*

* 'Permanent grass'



▲ Enclosed farmland, Montgomeryshire • © David Allen

In comparing estimates of extent from Countryside Survey with the Habitat Survey of Wales, perhaps especially the extent of Arable & Horticulture, account must be taken of the long interval between the different surveys. Agricultural statistics for the period 1992-1997 (coinciding roughly with the period during which Habitat Survey of Wales surveyed lowland Wales) show the area of arable fluctuating between 68,000 and 76,000 ha, consistently higher than the Habitat Survey of Wales estimate. The Countryside Survey estimate is higher than that shown in Agricultural Statistics though the Agricultural Statistics figure falls within the 95% confidence interval of the Countryside Survey estimate, as does the Habitat Survey of Wales figure (**Table 2.7**). There is some difference between surveys in how they treat temporary grasslands, and this is likely to have contributed to some degree to differences in estimates of the extent of arable.

²⁵ The difference between the 1994-99 mean and the 2000-08 mean amounts to 47,000 ha.

This different treatment of temporary grasslands, combined with variation between surveys in where the line is drawn in differentiating Improved Grassland from other grassland types, probably accounts for a large part of the variation between surveys in estimates of the extent of Improved Grassland. Hence, much of the Neutral Grassland mapped in Countryside Survey is likely to have been described as Improved Grassland by Habitat Survey of Wales, and included within the definition of permanent grassland used in agricultural statistics.

Trends in data reported annually as Welsh Agricultural Statistics provide a useful context for assessing changes recorded by Countryside Survey. Readily available data exist for the period 1994-2006, and some additional data for 2007 and 2008 have been made available. The total area of agricultural land has decreased, with a step change amounting to a reduction of 45-50,000 ha²⁵ occurring in 1999. Within this total area of agricultural land, the proportion of different types of farmland has changed:

- Permanent grassland increased steadily from 55% in 1994 to 62% in 2008.
- Rough grazing decreased steadily from 29% in 1994 to 23% in 2008.
- Temporary grassland decreased steadily from 9% in 1994 to 5% in 2008.
- Total tillage mostly remained stable at around 4%.
- Woodland was stable at around 2% from 1994 to 2003, but increased thereafter to 3% by 2006 (the latest date for which data has been made available).

Permanent grassland includes a range of grassland types and is difficult to compare directly with Countryside Survey data. The decrease in rough grazing suggests a possible loss of semi-natural vegetation, and is consistent with the decrease in bracken reported by Countryside Survey but is not obviously reflected in reductions of other semi-natural habitats. The recent increase in woodland is consistent with the increase in broadleaved woodland detected by Countryside Survey in lowland Wales (see *Chapter 5*).

Key results and follow-up questions:

- **An increase in the extent of arable land in the upland zone - is this consistent with biodiversity and/or agri-environment objectives?**
- **A decrease in the species richness of Improved Grassland - what implications for achievement of biodiversity objectives?**
- **What is the ecological significance of the reduction in Stress-tolerator Score in habitat fragments embedded within areas of Improved Grassland in the uplands?**
- **Is the increase in pH of surface soils under Improved Grassland part of a general trend of recovery from acidification?**

These questions, together with those identified in each of the other habitat chapters, are considered further in *Chapter 9*.

Further information and future analysis

More details of the methodology, analyses and results from Countryside Survey can be found in other companion reports and data resources available from the Countryside Survey website.

This report for Wales is one of a suite of reports that have either already been published or are scheduled for publication in the next year or two. The UK results of Countryside Survey were published in November 2008, and this report is one of several country reports that are being produced in summer 2009.

More detailed analysis of particular components of the survey – soils, streams and ponds – will be reported later in 2009 in separate themed reports. A detailed, integrated assessment of Countryside Survey data alongside other datasets, exploring what the results mean for provision of selected ecosystem goods and services, will be reported in 2010. While these reports will make use of the fuller Countryside Survey dataset, rather than a single country dataset, the results will have considerable relevance for Wales. Rather than marking the end of our evaluation of what Countryside Survey results mean for the Welsh countryside, this current report only marks the beginning.

Reports:

- UK Headline Messages – *published November 2008*
- UK Results from 2007 – *published November 2008*
- Detailed Northern Ireland Countryside Survey results – *published 2010*
- England Results from 2007 – *due to be published August 2009*
- Scotland Results from 2007 – *published 25th June 2009*
- Ponds – *due to be published Summer 2009*
- Streams – *due to be published October 2009*
- Soils – *due to be published November 2009*
- Integrated Assessment – *due to be published 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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