▲ north Wales • © *Richard Evans*

# 6. Mountain, Moor and Heath: Dwarf Shrub Heath, Bog, Fen, Marsh & Swamp, Bracken, Inland Rock and Montane

## Summary

### *Area*

- The area of land mapped as Bracken decreased by 55% in Wales between 1998 and 2007. This is not thought likely to be explained by land-use change alone but may reflect the suppressive effect on bracken growth of extreme rainfall in the summer of 2007. If bracken cover was extensively reduced to below 95%, then large areas would no longer be mapped as Bracken Broad Habitat despite bracken still being abundant or dominant, and this may account for some of the recorded change.
- Dwarf Shrub Heath, Bog, Fen, Marsh & Swamp, and Inland Rock showed no significant change in area between 1998 and 2007.

### *Vegetation condition*

- Few significant changes in vegetation characteristics were detected across the Mountain, Moor and Heath habitats in Wales.
- Total species richness and richness of butterfly larval food plants increased in the Bracken Broad Habitat between 1998 and 2007, and effect sizes were large. These changes could be correlated with the apparent reduction in bracken cover in 2007.
- In Fen, Marsh & Swamp in Wales, and in the Welsh lowland zone, a reduction in richness of butterfly larval food plants occurred between all survey intervals. Although the change was not large in terms of standardized effect size, mean richness dropped by a noteworthy 3 species per plot across the 17 year period between 1990 and 2007.
- Stress-tolerator Score also decreased in small fragments of habitat within areas of Bog Broad Habitat between 1998 and 2007. Despite the small sample, the large standardized effect size points to a possibly substantial impact on the species composition.

### *Soils*

- **Enough soil samples were only available for analysis of Dwarf Shrub Heath. No changes in mean soil pH or carbon concentration were detected between surveys.**

## 6.1 Introduction

Countryside Survey divides the area of Wales into an upland and a lowland environmental zone. This chapter concerns six Broad Habitats largely but not exclusively found in the upland zone of Wales (48% of the total area of the country). These habitats are: Dwarf Shrub Heath; Bog; Fen, Marsh & Swamp; Bracken; Inland Rock and Montane. Although extensive, the occurrence of these characteristically upland habitats are constrained to some extent by altitude, slope, soil type and land-use. In particular, high sheep numbers have helped shape and maintain a grassland-dominated landscape in upland as well as lowland areas.

Acid Grassland and mosaics of Acid Grassland, Neutral Grassland and Bracken make up much of the marginal uplands and lowland of Wales. Results for these are covered in *Chapter 4*.

## 6.2 The Area of Mountain, Moor and Heath Broad Habitats

### *6.2.1 Bracken*

The Bracken Broad Habitat was estimated to make up 1.8% of the land cover of Wales in 2007. It was unevenly distributed between upland and lowland zones, with 87% occurring in the uplands *(Table 6.1)*. The area of Bracken Broad Habitat declined significantly across Britain between 1998 and 2007, a result that was largely influenced by the decline in area of 46,700 ha (95% CI; -7,400 ha to -55,500 ha) in Wales *(Table 6.1)*.

The 95% bracken cover threshold used in Countryside Survey to define the Bracken Broad Habitat means that even a modest yet widespread reduction in bracken cover could translate into a large estimated loss of the Broad Habitat yet bracken could still remain dominant in the vegetation. Analysis of Welsh Unenclosed Plot data for areas that were Bracken Broad Habitat in 1998 but recorded as a different habitat in 2007 (n=43) showed a highly significant reduction in bracken cover from an average of 29% down to 7% *(Fig 6.1)*. Because the Unenclosed Plots were located entirely at random within mapped areas of unenclosed habitat, they can be used as an independent check on whether changes in species composition were consistent with mapped Broad Habitat change. The result therefore offers a degree of support for the explanation that a reduction in bracken cover underlies the recorded reduction in Bracken Broad Habitat area in Wales. In addition, the species covers recorded by the surveyors in each mapped bracken polygon also show that in 47% of the surveyed land in Great Britain that moved out of Bracken Broad Habitat by 2007, bracken was still

▲ Bracken, north Wales • © *CEH*

present at between 10 and 95% cover. While there is known to have been local managed reduction in bracken between 1998 and 2007, this is unlikely to explain the size of the estimated decline in area and another explanation is likely. Bracken growth is known to be debilitated by particularly wet growing seasons[37] and in Wales and England, the May to July period in 2007 was the wettest since records began in 1766[38]. Rainfall was well over double the usual levels so the above average rainfall in Wales during 2007 could have contributed to less vigorous bracken growth, with cover peaking below the critical 95% threshold. The change in Bracken Broad Habitat could therefore be a seasonal effect reflecting reduced bracken biomass while also indicating the sensitivity of the Broad Habitat definition to a small but widespread change in cover. Further support for this suggested mechanism would come from establishing a spatial correlation between the cover of bracken in plots and cumulative rainfall for the local 1-km$^2$ during the 2007 growing season, up to the time at which plots were surveyed. Differences in timing of survey between 1998 and 2007 were ruled out as a contributory factor since squares were surveyed somewhat later in the season in 2007 rather than earlier, but not so late as to have moved appreciably beyond the timing of peak seasonal cover.

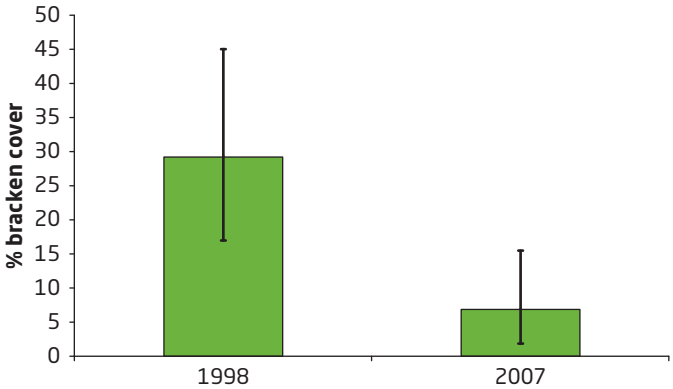
▼ **Table 6.1:** Estimates of the area ('000s ha) and percentage of land area of Bracken Broad Habitat in Wales from 1998 to 2007. Arrows denote significant change ($p<0.05$) in the direction shown.

| | 1998 | | 2007 | | Direction of significant changes 1998-2007 |
|---|---|---|---|---|---|
| | Area ('000s ha) | % | Area ('000s ha) | % | |
| Lowland | 24 | 2.2 | 4 | 0.4 | |
| Upland | 60 | 5.8 | 33 | 3.2 | ↓ |
| Wales | 84 | 4 | 38 | 1.8 | ↓ |

[37] Le Duc, M.G. *et al* (2003) *J. Appl.Ecol.* **40**, 508-522.

[38] Pitt, M. (2008) *The Pitt Review: Learning Lessons from the 2007 Floods.* Online at: http://archive.cabinetoffice.gov.uk/pittreview/thepittreview/final_report.html

▼ **Figure 6.1:** Bracken cover in Unenclosed (4m²) Habitat Plots (n=43) that were mapped as Bracken Broad Habitat in 1998 but not in 2007. Error bars are the 95% confidence intervals on the mean cover in each survey year. The difference between years was significant at p<0.001.




▲ Cotton grass, Snowdonia • © *Richard Evans*

## 6.2.2 Dwarf Shrub Heath

Dwarf Shrub Heath was estimated to cover 117,000 ha (5.5%) of Wales in 2007 with 96% of the total occurring in the upland zone *(Table 6.2)*. No significant change in extent occurred between any of the surveys since 1990.

▼ **Table 6.2:** Estimates of the area ('000s ha) and percentage of land area of Dwarf Shrub Heath Broad Habitat in Wales from 1998 to 2007. No statistically significant change was seen between survey years.

| | 1998 | | 2007 | | Direction of significant changes 1998-2007 |
|---|---|---|---|---|---|
| | Area ('000s ha) | % | Area ('000s ha) | % | |
| Lowland | 8 | 0.7 | 5 | 0.5 | NO SIGNIFICANT CHANGE |
| Upland | 91 | 8.9 | 112 | 11 | |
| Wales | 99 | 4.7 | 117 | 5.5 | |

▲ Upland heath, Carneddau • © *Clive Hurford*

## 6.2.3 Bog

Bog was estimated to make up 2.4% of Wales in 2007, 83% of which was found in the upland environmental zone *(Table 6.3)*. No changes in the extent of the Bog Broad Habitat were detected in Wales in line with the pattern across Great Britain.

▼ **Table 6.3:** Estimates of the area ('000s ha) and percentage of land area of Bog Broad Habitat in Wales from 1998 to 2007. No statistically significant change was seen between survey years.

| | 1998 | | 2007 | | Direction of significant changes 1998-2007 |
|---|---|---|---|---|---|
| | Area ('000s ha) | % | Area ('000s ha) | % | |
| Lowland | 8 | 0.7 | 8 | 0.7 | NO SIGNIFICANT CHANGE |
| Upland | 36 | 3.5 | 40 | 3.9 | |
| Wales | 45 | 2.1 | 48 | 2.3 | |

## 6.2.4 Fen, Marsh and Swamp

The area of this habitat did not change significantly between 1998 and 2007 in Wales or across the rest of Britain *(Table 6.4)*. The habitat type is found in lowland (1.3% of the zone) as well as upland (2.1% of the zone) areas favoured by the wet oceanic climate and the presence of poorly drained soils that are found throughout the country.

▼ **Table 6.4:** Estimates of the area ('000s ha) and percentage of land area of Fen Marsh and Swamp Broad Habitat in Wales from 1998 to 2007. No statistically significant change was seen between survey years.

| | 1998 | | 2007 | | Direction of significant changes 1998-2007 |
|---|---|---|---|---|---|
| | Area ('000s ha) | % | Area ('000s ha) | % | |
| Lowland | 15 | 1.4 | 14 | 1.3 | NO SIGNIFICANT CHANGE |
| Upland | 24 | 2.3 | 22 | 2.1 | |
| Wales | 40 | 1.9 | 36 | 1.7 | |

▲ Fen, lowland Wales • © *Sue Wallis*

### 6.2.5 Montane and Inland Rock Broad Habitats

Although in 2007, proportionally more of Wales was sampled than any other country, the survey is still not optimal for estimating highly localised habitats. Hence, no estimate is available for the Montane Broad Habitat.

Inland Rock includes natural rock exposures as well as quarries, and was estimated to make up 0.3% of Wales in 2007 although the confidence interval was large (3,100 ha to 12,200 ha). No change in area of Inland Rock was detected between 1998 and 2007 *(Table 6.5)*.

▼ **Table 6.5:** Estimates of the area ('000s ha) and percentage of land area of Inland Rock Broad Habitat in Wales from 1998 to 2007. No statistically significant change was seen between survey years.

| | 1998 | | 2007 | | Direction of significant changes 1998-2007 |
|---|---|---|---|---|---|
| | Area ('000s ha) | % | Area ('000s ha) | % | |
| Lowland | 1 | 0.1 | 1 | 0.1 | NO SIGNIFICANT CHANGE |
| Upland | 7 | 0.7 | 6 | 0.6 | |
| Wales | 8 | 0.4 | 7 | 0.3 | |

## 6.3 Changes in the vegetation condition of Mountain, Moor and Heath Broad Habitats

### 6.3.1 Bracken Broad Habitat

The most common species recorded in this Broad Habitat are listed in *Table 6.6*.

▼ **Table 6.6:** Most frequent 15 species in 2007 in Main Plots in the Bracken Broad Habitat in Wales (n=10).

| % frequency | Mean cover (%) | Plant name |
|---|---|---|
| 90 | 3 | *Galium saxatile* |
| 90 | 44 | *Pteridium aquilinum* |
| 80 | 17 | *Agrostis capillaris* |
| 70 | 4 | *Festuca ovina agg.* |
| 60 | 4 | *Holcus lanatus* |
| 60 | 1 | *Juncus effusus* |
| 60 | 1 | *Potentilla erecta* |
| 60 | 11 | *Rhytidiadelphus squarrosus* |
| 50 | 1 | *Anthoxanthum odoratum* |
| 50 | 1 | *Cerastium fontanum* |
| 50 | 1 | *Digitalis purpurea* |
| 50 | 1 | *Luzula campestris/multiflora* |
| 50 | 1 | *Vaccinium myrtillus* |
| 40 | 3 | *Agrostis canina sens.lat.* |
| 40 | <1 | *Cirsium palustre* |

***Main plots:*** Increases in species richness (total species number and numbers of butterfly larval food plants) were detected within the Bracken Broad Habitat between 1998 and 2007 *(Table 6.7)*. Total species richness also increased in Bracken plots in the upland zone. The Grass:Forb ratio decreased across Wales and in the upland zone. Sample sizes were small ($n_{1998}$=17, $n_{2007}$=10) for all Welsh Main Plots in Bracken yet the changes in species richness between 1998 and 2007 were based on large standardized effect sizes and reflect a substantial increase of 6 species on average per plot. The increase may be correlated with the apparent decrease in bracken cover in 2007.

***Targeted plots:*** No significant changes were observed in small patches of habitat targeted within the Bracken Broad Habitat.

▲ Reedbed; part of the Fen, Marsh & Swamp Broad Habitat • © *Richard Evans*

▼ **Table 6.7:** Change in the characteristics of vegetation in 200m² Main Plots in the Bracken Broad Habitat across Wales between 1990, 1998 and 2007. Lo=Lowland zone, Up=Upland zone. Arrows denote significant change (p<0.05) in the direction shown. Large effect sizes are indicated in red.

| | Mean values (Wales) | | | Direction of significant changes 1998 - 2007 | | | Direction of significant changes 1990 - 1998 | | | Direction of significant changes 1990 - 2007 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Vegetation Condition Measures** | **1990** | **1998** | **2007** | **W** | **Lo** | **Up** | **W** | **Lo** | **Up** | **W** | **Lo** | **Up** |
| Species Richness (No. of Species) | 17.8 | 14.9 | 20.6 | ↑ | | ↑ | NO SIGNIFICANT CHANGE | | | NO SIGNIFICANT CHANGE | | |
| No. of Bird Food Species | 5.8 | 4.8 | 6.8 | | | | | | | | | |
| No. of Butterfly Food Species | 7.3 | 6.4 | 8.8 | ↑ | | | | | | | | |
| Grass:Forb Ratio | -0.31 | -1.00 | -0.71 | NO SIGNIFICANT CHANGE | | | ↓ | | ↓ | NO SIGNIFICANT CHANGE | | |
| Competitor Score | 2.63 | 2.65 | 2.63 | | | | | | | | | |
| Stress Tolerator Score | 2.99 | 3.04 | 2.99 | | | | | | | | | |
| Ruderal Score | 1.95 | 1.84 | 1.97 | | | | | | | | | |
| Light Score | 6.34 | 6.44 | 6.50 | | | | | | | | | |
| Fertility Score | 3.88 | 3.56 | 3.66 | | | | | | | | | |
| Ellenberg pH Score | 4.26 | 3.93 | 4.03 | | | | | | | | | |
| Moisture Score | 5.68 | 5.64 | 5.78 | | | | | | | | | |

▼ **Table 6.8:** Most frequent 15 species in 2007 in the Dwarf Shrub Heath Broad Habitat in Wales.

| a) Main Plots (n=27) | | | b) Targeted Plots (n=21) | | |
|---|---|---|---|---|---|
| **% frequency** | **Mean cover (%)** | **Plant name** | **% frequency** | **Mean cover (%)** | **Plant name** |
| 96 | 30 | *Vaccinium myrtillus* | 67 | 14 | *Calluna vulgaris* |
| 89 | 6 | *Deschampsia flexuosa* | 52 | 5 | *Festuca ovina agg.* |
| 74 | 23 | *Calluna vulgaris* | 48 | 11 | *Vaccinium myrtillus* |
| 74 | 9 | *Festuca ovina agg.* | 43 | 3 | *Deschampsia flexuosa* |
| 70 | 3 | *Galium saxatile* | 43 | 6 | *Nardus stricta* |
| 70 | 13 | *Pleurozium schreberi* | 43 | 2 | *Rhytidiadelphus squarrosus* |
| 63 | 4 | *Agrostis capillaris* | 38 | 2 | *Agrostis capillaris* |
| 63 | 2 | *Cladonia sp.* | 33 | 1 | *Potentilla erecta* |
| 52 | 9 | *Hylocomium splendens* | 29 | 2 | *Cladonia sp.* |
| 52 | 4 | *Juncus squarrosus* | 29 | <1 | *Danthonia decumbens* |
| 52 | 11 | *Nardus stricta* | 29 | 2 | *Erica tetralix* |
| 52 | 5 | *Rhytidiadelphus squarrosus* | 29 | 7 | *Molinia caerulea* |
| 44 | 2 | *Carex binervis* | 29 | <1 | *Polygala vulgaris/serpyllifolia* |
| 41 | 1 | *Potentilla erecta* | 24 | 1 | *Carex panicea* |
| 37 | 1 | *Erica cinerea* | 24 | 1 | *Galium saxatile* |

### *6.3.2 Dwarf Shrub Heath Broad Habitat*

The most common species recorded in this Broad Habitat are listed in *Table 6.8*.

***Main plots:*** No significant changes were detected in the vegetation characteristics of Dwarf Shrub Heath in Wales *(Table 6.9a)*.

***Targeted plots:*** No significant changes in vegetation character were observed in Wales within small fragments of other habitats embedded in areas of Dwarf Shrub Heath *(Table 6.9b)*.

### *6.3.3 Bog Broad Habitat*

The most common species recorded in the Bog Broad Habitat are listed in *Table 6.10*.

***Main plots:*** Despite the very low sample size ($n_{1998}$=9, $n_{2007}$=13), a significant reduction in Grass:Forb ratio was detected between 1998 and 2007 *(Table 6.11a)* but the effect size was not large hence the size of the change would have been minor in comparison with the variability on the sample. The direction of the change was different in Wales from the rest of Britain where a significant increase occurred largely reflecting changes in the Scottish uplands.

▼ **Table 6.9:** Change in the characteristics of vegetation in ***a) 200m² Main Plots*** and ***b) 4m² Targeted Plots, in the Dwarf Shrub Heath Broad Habitat across Wales between 1990 and 2007.*** W=Wales, Lo=Lowland zone, Up=Upland zone. No statistically significant change was seen between survey years.

| a) Main Plots | Mean values (Wales) | | | Direction of significant changes 1998 - 2007 | | | Direction of significant changes 1990 - 1998 | | | Direction of significant changes 1990 - 2007 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vegetation Condition Measures | 1990 | 1998 | 2007 | W | Lo | Up | W | Lo | Up | W | Lo | Up |
| Species Richness (No. of Species) | 14.9 | 14.5 | 13.9 | NO SIGNIFICANT CHANGE | | | NO SIGNIFICANT CHANGE | | | NO SIGNIFICANT CHANGE | | |
| No. of Bird Food Species | 2.9 | 3.2 | 2.9 | | | | | | | | | |
| No. of Butterfly Food Species | 7.2 | 7.4 | 6.6 | | | | | | | | | |
| Grass:Forb Ratio | 0.89 | 1.36 | 0.76 | NO SIGNIFICANT CHANGE | | | NO SIGNIFICANT CHANGE | | | NO SIGNIFICANT CHANGE | | |
| Competitor Score | 2.24 | 2.2 | 2.27 | | | | | | | | | |
| Stress Tolerator Score | 3.66 | 3.65 | 3.64 | | | | | | | | | |
| Ruderal Score | 1.47 | 1.48 | 1.37 | | | | | | | | | |
| Light Score | 6.73 | 6.74 | 6.68 | | | | | | | | | |
| Fertility Score | 2.62 | 2.63 | 2.57 | | | | | | | | | |
| Ellenberg pH Score | 2.82 | 3.12 | 2.91 | | | | | | | | | |
| Moisture Score | 6.14 | 6.15 | 6.08 | | | | | | | | | |

| b) Targeted Plots | Mean values (Wales) | | | Direction of significant changes 1998 - 2007 | | | Direction of significant changes 1990 - 1998 | | | Direction of significant changes 1990 - 2007 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vegetation Condition Measures | 1990 | 1998 | 2007 | W | Lo | Up | W | Lo | Up | W | Lo | Up |
| Species Richness (No. of Species) | 7.6 | 8.7 | 9.5 | NO SIGNIFICANT CHANGE | | | NO SIGNIFICANT CHANGE | | | NO SIGNIFICANT CHANGE | | |
| No. of Bird Food Species | 1.5 | 1.6 | 1.6 | | | | | | | | | |
| No. of Butterfly Food Species | 4.3 | 4.0 | 4.8 | | | | | | | | | |
| Grass:Forb Ratio | 2.8 | 1.72 | 1.97 | NO SIGNIFICANT CHANGE | | | NO SIGNIFICANT CHANGE | | | NO SIGNIFICANT CHANGE | | |
| Competitor Score | 2.38 | 2.19 | 2.21 | | | | | | | | | |
| Stress Tolerator Score | 3.66 | 3.73 | 3.74 | | | | | | | | | |
| Ruderal Score | 1.25 | 1.32 | 1.38 | | | | | | | | | |
| Light Score | 6.82 | 6.88 | 6.88 | | | | | | | | | |
| Fertility Score | 2.44 | 2.43 | 2.35 | | | | | | | | | |
| Ellenberg pH Score | 3.26 | 3.08 | 2.98 | | | | | | | | | |
| Moisture Score | 6.48 | 6.33 | 6.22 | | | | | | | | | |

▼ **Table 6.10:** Most frequent 15 species in 2007 in the Bog Broad Habitat in Wales.

| a) Main Plots (n=13) | | | b) Targeted Plots (n=16) | | |
|---|---|---|---|---|---|
| % frequency | Mean cover (%) | Plant name | % frequency | Mean cover (%) | Plant name |
| 85 | 3 | *Vaccinium myrtillus* | 81 | 13 | *Molinia caerulea* |
| 77 | 27 | *Molinia caerulea* | 75 | 25 | *Eriophorum angustifolium* |
| 77 | 10 | *Polytrichum commune* | 63 | 13 | *Eriophorum vaginatum* |
| 77 | 11 | *Sphagnum (green/thin)* | 50 | 24 | *Sphagnum (green/thin)* |
| 69 | 15 | *Eriophorum vaginatum* | 44 | 4 | *Erica tetralix* |
| 69 | 3 | *Festuca ovina agg.* | 44 | 20 | *Sphagnum (green/fat)* |
| 69 | 1 | *Galium saxatile* | 38 | <1 | *Anthoxanthum odoratum* |
| 69 | 8 | *Juncus squarrosus* | 38 | 4 | *Calluna vulgaris* |
| 69 | 5 | *Rhytidiadelphus squarrosus* | 38 | 2 | *Juncus squarrosus* |
| 54 | 16 | *Calluna vulgaris* | 38 | 3 | *Polytrichum commune* |
| 54 | 1 | *Carex panicea* | 31 | 1 | *Carex echinata* |
| 54 | 2 | *Eriophorum angustifolium* | 31 | 4 | *Festuca ovina agg.* |
| 54 | 4 | *Pleurozium schreberi* | 31 | 1 | *Narthecium ossifragum* |
| 46 | <1 | *Cladonia spp.* | 31 | 2 | *Rhytidiadelphus squarrosus* |
| 46 | 2 | *Deschampsia flexuosa* | 25 | <1 | *Agrostis vinealis* |

***Targeted plots:*** Within mapped areas of the Bog Broad Habitat, the Targeted Plots reflect the fortunes of other small fragments of habitat such as flushes, eroded patches and drier areas of grassland and heath too small to map. The mean Stress-tolerator and Ellenberg pH Scores of the small Welsh sample suggest that the vegetation targeted was not very different in these respects from the Main Plots located within the wider areas of Bog. Two significant changes were observed in the Targeted Plots; an increase in Competitor Score and a decrease in Stress-tolerator Score *(Table 6.11b)*. Although the small size of the dataset (n=14 in both 1998 and 2007) cautions against over-interpreting the importance of the reduction in Stress-tolerator Score, the mean changed by 92% of the standard deviation of the combined sample indicating a large effect size and therefore a potentially ecologically important shift in the abundance of some of the most sensitive plant species found in the habitat.

▼ **Table 6.11:** Change in the characteristics of vegetation in ***a) 200m² Main Plots*** and ***b) 4m² Targeted Plots, in the Bog Broad Habitat across Wales in 1998 and 2007.*** W=Wales, Lo=Lowland zone, Up=Upland zone. Arrows denote significant change (p<0.05) in the direction shown. Large effect sizes are indicated in red.

| a) Main Plots | Mean values (Wales) | | Direction of significant changes 1998 - 2007 | | |
|---|---|---|---|---|---|
| Vegetation Condition Measures | 1998 | 2007 | W | Lo | Up |
| Species Richness (No. of Species) | 16.2 | 16.8 | NO SIGNIFICANT CHANGE | | |
| No. of Bird Food Species | 2.1 | 2.1 | | | |
| No. of Butterfly Food Species | 6.8 | 6.1 | | | |
| Grass:Forb Ratio | 2.92 | 2.14 | ↓ | | ↓ |
| Competitor Score | 2.24 | 2.26 | | | |
| Stress Tolerator Score | 3.71 | 3.69 | | | |
| Ruderal Score | 1.3 | 1.29 | | | |
| Light Score | 7.05 | 7.02 | | | |
| Fertility Score | 2.15 | 2.25 | | | |
| Ellenberg pH Score | 2.91 | 2.97 | | | |
| Moisture Score | 6.93 | 6.76 | | | |

| b) Targeted Plots | Mean values (Wales) | | Direction of significant changes 1998 - 2007 | | |
|---|---|---|---|---|---|
| Vegetation Condition Measures | 1998 | 2007 | W | Lo | Up |
| Species Richness (No. of Species) | 12.9 | 11.1 | NO SIGNIFICANT CHANGE | | |
| No. of Bird Food Species | 1.7 | 1.6 | | | |
| No. of Butterfly Food Species | 4.6 | 4.5 | | | |
| Grass:Forb Ratio | 1.47 | 1.44 | | | |
| Competitor Score | 2.1 | 2.31 | ↑ | | ↑ |
| Stress Tolerator Score | 3.79 | 3.56 | ↓ | | ↓ |
| Ruderal Score | 1.46 | 1.48 | | | |
| Light Score | 7.3 | 7.33 | | | |
| Fertility Score | 2.1 | 2.15 | | | |
| Ellenberg pH Score | 3.12 | 3.14 | | | |
| Moisture Score | 7.23 | 7.33 | | | |

▲ Rush pasture species; part of the Fen, Marsh & Swamp Broad Habitat • © *Ian Simpson*

### 6.3.4 Fen, Marsh and Swamp Broad Habitat

The most common species recorded in this Broad Habitat are listed in *Table 6.12*.

***Main Plots:*** A significant decline in richness of butterfly larval food plants was detected in Fen, Marsh & Swamp across Wales between 1998 and 2007 and 1990 and 2007. The reduction was largely concentrated in the lowland zone *(Table 6.13a)*. While the standardized effect size for the reduction between 1990 and 2007 was medium, indicating a variable sample relative to the mean change, the estimated loss of an average of 3 species per Main Plot in the 17 year interval is noteworthy. The 1990 to 2007 changes compare with a large effect sized reduction in Fen, Marsh & Swamp in lowland Scotland but contrast with a large effect sized increase in England in the same interval. A significant reduction in richness of food plants for lowland farmland birds was also seen in the Welsh lowland zone between 1990 and 1998, and between 1990 and 2007.

Significant increases in Competitor Score and decreases in Ruderal Score also occurred in the Welsh lowland zone *(Table 6.13a)* but none of these changes were based on large standardized effect sizes and so their impact on the vegetation may well be minor.

***Targeted plots:*** Within areas of habitat mapped as Fen, Marsh & Swamp, the Targeted Plots will have picked out slightly atypical patches of vegetation missed by the random Main Plots. Comparing the vegetation characteristics of the Targeted versus Main Plots shows that the vegetation targeted by surveyors reflected wetter conditions but was similar in other respects *(Tables 6.13 a and b)*. Between 1998 and 2007, the only significant changes to have occurred in the Targeted Plots were a reduction in richness of food plants for lowland farmland birds and a reduction in Ruderal Score suggesting less open and disturbed vegetation. Between 1990 and 1998 the only significant change was an increase in Grass:Forb ratio *(Table 6.13b)*. None of the changes were based on large standardized effect sizes hence the impact on the vegetation of any of the significant changes is likely to have been modest.

▼ **Table 6.12:** Most frequent 15 species in 2007 in the Fen, Marsh & Swamp Broad Habitat in Wales.

| a) Main Plots (n=16) | | | b) Targeted Plots (n=53) | | |
|---|---|---|---|---|---|
| % frequency | Mean cover (%) | Plant name | % frequency | Mean cover (%) | Plant name |
| 81 | 4 | *Holcus lanatus* | 58 | 16 | *Juncus effusus* |
| 81 | 22 | *Juncus effusus* | 57 | 7 | *Juncus articulatus/acutiflorus* |
| 75 | 5 | *Agrostis stolonifera* | 51 | 6 | *Holcus lanatus* |
| 69 | 1 | *Rumex acetosa* | 51 | 2 | *Lotus pedunculatus* |
| 63 | 4 | *Agrostis capillaris* | 49 | 1 | *Cirsium palustre* |
| 63 | 1 | *Galium palustre* | 43 | 5 | *Agrostis stolonifera* |
| 63 | 6 | *Juncus articulatus/acutiflorus* | 40 | <1 | *Galium palustre* |
| 56 | 7 | *Festuca rubra agg.* | 38 | 12 | *Molinia caerulea* |
| 50 | 1 | *Cirsium palustre* | 34 | 4 | *Festuca rubra agg.* |
| 50 | 1 | *Lotus pedunculatus* | 34 | 1 | *Rumex acetosa* |
| 50 | 1 | *Potentilla erecta* | 28 | 4 | *Filipendula ulmaria* |
| 50 | 3 | *Rhytidiadelphus squarrosus* | 25 | 3 | *Agrostis capillaris* |
| 44 | 1 | *Anthoxanthum odoratum* | 25 | 1 | *Anthoxanthum odoratum* |
| 44 | 4 | *Deschampsia cespitosa* | 25 | <1 | *Cardamine pratensis* |
| 44 | 1 | *Luzula campestris/multiflora* | 25 | <1 | *Potentilla erecta* |

▼ **Table 6.13:** Change in the characteristics of vegetation in ***a) 200m² Main Plots*** and ***b) 4m² Targeted Plots, in the Fen, Marsh & Swamp Broad Habitat across Wales 1990 and 2007.*** W=Wales, Lo=Lowland zone, Up=Upland zone. Arrows denote significant change (p<0.05) in the direction shown. None of the significant changes reflected a large effect size.

| a) Main Plots | Mean values (Wales) | | | Direction of significant changes 1998 - 2007 | | | Direction of significant changes 1990 - 1998 | | | Direction of significant changes 1990 - 2007 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vegetation Condition Measures | 1990 | 1998 | 2007 | W | Lo | Up | W | Lo | Up | W | Lo | Up |
| Species Richness (No. of Species) | 26.8 | 26.4 | 23.3 | | | | | | | | | |
| No. of Bird Food Species | 10.1 | 8.0 | 6.9 | | | | | ↓ | | | ↓ | |
| No. of Butterfly Food Species | 11.7 | 10.8 | 8.5 | ↓ | ↓ | | | ↓ | | ↓ | ↓ | |
| Grass:Forb Ratio | 0.51 | 1.12 | 0.93 | | | | NO SIGNIFICANT CHANGE | | | | | |
| Competitor Score | 2.69 | 2.6 | 2.79 | ↑ | ↑ | | | | | | | |
| Stress Tolerator Score | 2.69 | 2.84 | 2.73 | | | | | | | | | |
| Ruderal Score | 2.45 | 2.35 | 2.25 | | ↓ | | | | | | ↓ | |
| Light Score | 6.84 | 6.94 | 6.95 | | | | | | | | | |
| Fertility Score | 4.23 | 3.97 | 4.05 | | | | | | | | | |
| Ellenberg pH Score | 4.98 | 4.78 | 4.83 | | | | | | | | | |
| Moisture Score | 6.39 | 6.38 | 6.53 | | | | | | | | | |

| b) Targeted Plots | Mean values (Wales) | | | Direction of significant changes 1998 - 2007 | | | Direction of significant changes 1990 - 1998 | | | Direction of significant changes 1990 - 2007 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vegetation Condition Measures | 1990 | 1998 | 2007 | W | Lo | Up | W | Lo | Up | W | Lo | Up |
| Species Richness (No. of Species) | 15.6 | 15.1 | 13.5 | | | | NO SIGNIFICANT CHANGE | | | | ↓ | |
| No. of Bird Food Species | 5.2 | 5.0 | 4.1 | | ↓ | | | | | | ↓ | |
| No. of Butterfly Food Species | 5.4 | 5.6 | 5.2 | | | | | | | | | ↑ |
| Grass:Forb Ratio | 0.67 | 1.2 | 1.25 | | | | | | ↑ | | | |
| Competitor Score | 2.67 | 2.74 | 2.84 | | | | | | | ↑ | | |
| Stress Tolerator Score | 2.75 | 2.71 | 2.64 | | | | | | | | | |
| Ruderal Score | 2.33 | 2.39 | 2.30 | | ↓ | | | | | | ↓ | |
| Light Score | 6.94 | 6.97 | 6.93 | | | | | | | | | |
| Fertility Score | 3.83 | 3.9 | 3.96 | | | | | | | | | |
| Ellenberg pH Score | 4.78 | 4.73 | 4.8 | | | | | | | | | |
| Moisture Score | 7.02 | 6.92 | 6.93 | | | | | | | | | |

▼ **Table 6.14:** Comparative estimates of the extent of the mountain, moor and heath Broad Habitats ('000s ha) are available from the Habitat Survey of Wales. 95% CI on the Countryside Survey estimates are given in brackets.

| | Dwarf Shrub Heath | Bog | Fen, Marsh & Swamp | Bracken | Inland rock |
|---|---|---|---|---|---|
| Countryside Survey (2007) | 117 (39.3-174.0) | 48 (4.8-80.1) | 36 (23.5-59.1) | 38 (22.5-50.9) | 7 (3.1-12.2) |
| Habitat Survey of Wales (1979 - 1997) | 92 | 58 | 85 | 63 | Not available |

## 6.4 Changes in soils (0-15cm) in mountain moor and heath vegetation

Of the Broad Habitats reported in this chapter, sample size was only sufficient for meaningful analysis within the Dwarf Shrub Heath Broad Habitat.

### *6.4.1 Dwarf Shrub Heath*

***Soil (0-15cm) pH:*** There was no significant change in the mean pH of soils (0-15cm) within plots in the Dwarf Shrub Heath Broad Habitat in Wales between any of the survey years. This contrasts with the significant increase across Britain between 1978 and 2007[39].

***Soil (0-15cm) carbon:*** There was no significant change in the mean carbon concentration of soil (0-15cm) in the Dwarf Shrub Broad Habitat across Wales between any of the surveys. Nor was any change found across Britain in the same period.

***Bulk density and soil (0-15cm) carbon stock:*** The mean bulk density of Dwarf Shrub Heath soils (0-15cm) in Wales in 2007 was 0.34 g/cm$^3$ which when combined with soil (0-15cm) carbon concentration indicated a soil (0-15cm) carbon stock estimate of 88 t C/ha. Bulk density and therefore C stock estimates, were only available for 2007.

## 6.5 The results in context

This chapter refers to six Broad Habitats that are especially characteristic of upland Wales, though all but one type – Montane – also have a significant, albeit smaller, presence in the lowlands. Dwarf Shrub Heath is found from sea level to high peaks in the uplands, being replaced by Montane heath at high altitude only in the mountains of Eryri in North Wales. Dwarf Shrub Heath is divided into two Priority Habitats covered by the UK Biodiversity Action Plan – Lowland Heathland and Upland Heathland. Two Priority Habitats Blanket Bog and Lowland Raised Bog are recognised within the Bog Broad Habitat. The Fen, Marsh & Swamp Broad Habitat includes a range of habitat types, of which Lowland Fens; Upland Flushes, Fens and Swamps; Purple Moor-grass and Rush Pastures; and Reedbeds are recognised as Priority Habitats. Various priority types occur within the Inland Rock Broad Habitat, and a single type with the Montane Broad Habitat. Bracken-dominated stands are recognised as a separate Broad Habitat but this type has no associated Priority Habitats. The Montane Broad Habitat is encountered too infrequently by Countryside Survey to allow for its extent to be estimated separately in Wales.

Countryside Survey encounters most of the Priority Habitats too infrequently to enable separate assessments of their state in Wales. However, in an attempt to optimise coverage of these habitats, the 2007 survey mapped Priority Habitat areas where they were found in each survey square and recorded new vegetation plot data from within these areas. These data have yet to be fully analysed. However, in Wales it is possible that the new baseline data could make a contribution to assessment of the condition or extent of a number of Priority Habitat assemblages in the wider countryside. These included Fens, Purple Moor-grass and Rush Pasture, Upland Dwarf Shrub Heath, Blanket Bog and a number of woodland Priority Habitats.

For Dwarf Shrub Heath and Bog, the estimates from Habitat Survey of Wales fall within the confidence interval of the Countryside Survey estimate *(Table 6.14)*. However, in the cases of Fen, Marsh and Swamp, and Bracken, the Habitat Survey of Wales estimates lie outside the confidence intervals. Again, the different approaches taken by the two surveys in allocating vegetation types to Broad Habitats may have contributed to this. Furthermore, the Countryside Survey estimate of bracken may have been influenced by interaction between weather and classification sensitivity. The largest difference is in relation to Fen, Marsh & Swamp. This is likely to reflect the greater allocation in Countryside Survey of wet, species-poor yet rush-dominated acid grassland to the Acid Grassland Broad Habitat rather than to Fen, Marsh & Swamp.

### *Key results and follow-up questions:*

- **The large change in area of land mapped as bracken – can we tell how much is related to classification sensitivity and how much to management intervention?**
- **A progressive decrease in species richness of plants used as food by butterfly larvae in Fen, Marsh & Swamp – is this part of a more general pattern?**

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

[39] Carey *et al* (2008) *Countryside Survey: UK results from 2007*. Online at www.countrysidesurvey.org.uk/reports2007.html

Countryside Survey

## 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.

## Contacts

For further information on Countryside Survey see **www.countrysidesurvey.org.uk** or contact:
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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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