

# **ENVIRONMENTALLY SENSITIVE AREAS IN NORTHERN IRELAND**

## **Monitoring of the West Fermanagh and Erne Lakeland ESA**

**Biological evaluation of the ESA scheme  
between 1993 and 2003**

**by**

**Agri-environment Monitoring Unit  
Queen's University Belfast**

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## **Agri-environment Monitoring Unit**

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## SUMMARY

1. A monitoring programme was established in 1993 to determine the effectiveness of the ESA scheme in maintaining or enhancing the biodiversity of habitats in the West Fermanagh and Erne Lakeland ESA. Habitats under ESA agreement were resurveyed on participant farms in 2003.
2. Habitat diversity was measured by a combination of plant and invertebrate species richness, vegetation types, proportions of species in each plant strategy theory group, and the frequency and distribution of indicator species. Comparison was made over time to determine changes in biodiversity with respect to participation in the ESA scheme.
3. Monitoring indicates that after ten years the plant and invertebrate species richness of habitats under ESA agreement is being maintained. There were signs of enhancement of plant species composition on participant farms. In many cases the range of plant species on target habitats has changed to include more desirable species from a conservation point of view. Hence a lack of change in overall species number is not necessarily a failure of the scheme to deliver positive enhancements.
4. There was a general increase in the cover of rushes (*Juncus* species) recorded on unimproved grassland, wet pasture and hay meadows between 1993 and 2003. This may be due to reduced stocking densities or through less intensive management. Greater rush control may be necessary, particularly on sites where cover exceeds 50%.
5. Analysis of grassland soils showed there was a significant decrease in mean soil phosphorus level between 1993 and 2003 on wet pasture and limestone grassland under ESA agreement. There was also a decrease in soil phosphorous levels on hay meadows, a trend shown in results in 1999. This decline of soil fertility is most likely due to reduced fertiliser inputs on grassland habitats. This is a positive effect of ESA management as increased plant species diversity is often correlated with decreased soil fertility. On wet

pasture there was a decrease in certain plant species associated with high soil fertility.

6. There was a significant increase in the mean cover of heather (*Calluna vulgaris*) on heather moorland under ESA agreement between 1993 and 2003. Dwarf-shrub cover had increased or been maintained on 85% of agreement sites. On the remaining sites cover remained low, i.e. <25%. These sites of degraded heath may need further reduction in stocking levels if habitat condition is to improve. There was a notable decrease in the frequency of several grass species on heather moorland. In particular, mat grass (*Nardus stricta*) had declined on participant farms indicating an improvement in the quality of the heather moorland. There was a general decrease in bare ground cover and an increase in *Sphagnum* mosses, both indicative of reduced trampling or poaching activity.
7. Ground beetles are indicators of habitat quality. The ground beetle, *Carabus clatratus*, identified as an indicator species on hay meadows, increased in frequency between 1993 and 2003. The species *Carabus nitens* identified as an indicator on heather moorland in 1993, maintained its presence in 2003.
8. Spider species composition is associated with vegetation structure and therefore can be related to habitat management and condition. Changes in spider populations on heather moorland and wet pasture between 1993 and 2003 indicate a more diverse vegetation structure. These habitats are supporting more 'specialist' species with specific habitat preferences, which may be a positive effect of ESA management. Spider species quality scores increased for heather moorland and limestone grassland between 1993 and 2003. All these changes suggest that habitat quality is improving due to less intensive management. There were also four new county records for spiders recorded on habitats under agreement, mainly heather moorland, in 2003.
9. The mean number of plant species recorded in woodland under ESA agreement did not change significantly between 1993 and 2003. However there was an increase in cover of several typical woodland indicators such as

bluebell, wood anemone and wood sorrel. This, together with significant increases in ivy and lesser celandine, may be due to reduced disturbance by livestock. The mean cover of bramble increased slightly in participant woods. Bramble may shade out ground flora species leading to an eventual decline in species diversity. There was also a general decrease in the amount of bare ground. Ungrazed woods had more woody species regenerating than those woods that showed signs of occasional grazing in 2003.

10. The monitoring results indicate that species diversity has been maintained on habitats on participant farms in the West Fermanagh and Erne Lakeland ESA. There are some indications of enhancement of plant and invertebrate communities on habitats under agreement. For example, management prescriptions appear to be having a significant effect on heather moorland with an increase in heather cover on ESA participant farms and a decrease in undesirable species, such as mat grass, probably due to reduced grazing pressure. Possible areas of concern are an increase in bramble in ungrazed woodlands and an increase in rushes on hay meadows, unimproved grassland and wet pastures. These may have implications for management and will need to be monitored and causes investigated in future research.

## **1. INTRODUCTION**

### **1.1. The ESA scheme**

The Environmentally Sensitive Area (ESA) Scheme was introduced in 1988 by the then Department of Agriculture for Northern Ireland (now DARD) to help safeguard areas of the countryside where the landscape, wildlife or historic interest is of particular importance and where that interest would benefit through farmers continuing with or engaging in environmentally sensitive farming practices. The scheme was expanded to cover 20% of the agricultural land area of Northern Ireland. The five designated areas are:

The Mourne and Slieve Croob ESA

The Antrim Coast, Glens and Rathlin ESA

The West Fermanagh and Erne Lakeland ESA

The Sperrins ESA

The Slieve Gullion ESA

Farmers enter into a ten-year agreement and receive annual area-based payments in return for carrying out specific habitat-based management prescriptions.

### **1.2. Monitoring programme**

A long-term monitoring programme was established in 1992 by DANI to determine the effectiveness of the ESA scheme in fulfilling its objectives of maintaining and enhancing biodiversity, landscape and heritage features. Biological and landscape monitoring has been carried out in all ESAs. The West Fermanagh and Erne Lakeland ESA was designated in 1993 and a baseline biological survey was completed in the same year (Hegarty *et al.* 1994). This survey provided baseline data on the wildlife value of a range of sites from target habitats within the ESA boundary. Plant and invertebrate species were monitored on unimproved grassland, wet pasture, hay meadow, limestone grassland, woodland and heather moorland.



Monitoring plant species is the most widely used method of assessing ecological changes in the environment. Vegetation is the key to the entire ecosystem and plant diversity may often be correlated with animal diversity. Therefore monitoring the plant species diversity is indicative of the wildlife value of the habitat. Recording detailed changes at the plant species level is widely used to examine long-term ecological changes, such as the relationship between plant composition and agricultural management (e.g. Hopkins & Wainwright, 1989).

Ground beetles (Carabidae) and spiders (Araneae) were monitored as they are habitat specific, easily trapped in pitfall traps and are good indicators of biological change (Kirby, 1992). The wealth of information on the ecological requirements of individual ground beetle species has proven useful in environmental quality assessment (Eyre & Rushton 1989; Rushton *et al.* 1989; Gardner 1991). Spiders are sensitive to vegetation structure and as such provide useful indicator species. Information on spider distribution, their habitats and ecology has become available more recently with the publication of the provisional atlas of British spiders (Harvey *et al.* 2002) and the species inventory for Northern Ireland spiders (McFerran, 1997). These have proved valuable in determining habitat change indicated by spider populations.

Invertebrate monitoring in association with plant species provides a comprehensive indicator of the biodiversity of a habitat. Species lists of ground beetles and spiders have been compiled for each target habitat. Rare and threatened species have been found within the ESAs and their status and distribution documented (Hegarty *et al.* 1994, 1995). These species act as performance indicator species in assessing the effectiveness of the ESA scheme.

All the Northern Ireland ESAs were monitored three years after baseline, in a partial survey to allow an initial appraisal of the scheme's effectiveness and to facilitate modification of prescriptions if necessary. Complete remonitoring of habitats in the West Fermanagh and Erne Lakeland ESA was carried out in

1999 on participant and non-participant farms (Cameron *et al*, 2000). The present 10-year resurvey in 2003 compares data from habitats under agreement on ESA participant farms with baseline data. This permits a more precise evaluation of the scheme over a longer time period during which the effects of management prescriptions have had a greater opportunity to become apparent.

The main policy driver for biodiversity is currently the UK Biodiversity Action Plan (BAP) (Anon, 1995). Agri-environment schemes are one of the main vehicles by which BAP objectives and targets for many habitats and species are expected to be met and delivered. Therefore monitored habitats within the West Fermanagh and Erne Lakeland ESA are discussed in terms of their contributions to delivering targets for particular BAP priority habitats in Northern Ireland (Northern Ireland Biodiversity Group, 2000).

## 2. METHODS

### 2.1. Re-monitoring field sampling programme

A total of 188 sites were surveyed in 1993, from habitats on farms of both participants and non-participants in the ESA scheme. In 2003 only habitats under agreement on participant farms were surveyed giving a total of 96 sites for botanical monitoring (Table 1). Invertebrate sites were a sub-sample of these. Data were compared between 1993 and 2003 for sites surveyed in both years.

**Table 1.** Number of sample sites for each monitored habitat in 2003 in the West Fermanagh and Erne Lakeland ESA

Habitat	Plant sites	Invertebrate sites
Hay meadow	10	4
Wet pasture	28	10
Limestone grassland	11	2
Unimproved grassland	14	9
Heather moorland	20	6
Woodland	13	1
TOTAL	96	32

### 2.2. Botanical monitoring

Plant monitoring was carried out between April and September 2003, with sites being visited once during this period. Surveys were carried out at the same time of the year as the baseline monitoring. Woodlands were surveyed during May, hay meadows in June, wet grasslands in July, other grasslands in July/August, and heather moorland in August/September. Permanent quadrats initially recorded in 1993 were resurveyed. Plant nomenclature follows Stace (1991), mosses and liverworts follow Watson (1981). Details of specific habitat monitoring techniques are listed below.

### ***Grasslands***

In 1993, a diagonal transect was measured across the chosen field and five permanent equidistant 2m x 2m quadrats were marked out (MAFF 1987). These quadrats were relocated in 2003 using detailed field maps. The estimated percentage cover of each plant species was recorded within a nested 1m x 1m quadrat. Mosses and liverworts were recorded collectively as 'bryophytes'. Any additional species were recorded in the outer 2m x 2m quadrat. Sites were plotted using a Garmin 12 XL Global Positioning System (GPS) in 2003 to aid future relocation.

### ***Heathland and limestone grassland***

The sites were marked by a 1m tall metal stake in 1993 and permanent quadrats were located at 4 equidistant points along each 60m transect. Sites were re-located and the standardised 2m x 2m nested quadrats were used in these habitats and species recorded as above. Individual bryophyte species were recorded for heather moorland, due to their importance in this habitat.

### ***Woodland***

Permanent 200m<sup>2</sup> quadrats were relocated within each site. Plant species and their estimated percentage cover was recorded in a central 2m x 2m quadrat. Trees and shrubs and additional ground flora species were recorded in the outer quadrat. The presence of any tree or shrub regeneration was noted together with any management information.

## **2.3 Invertebrate monitoring**

Ground beetles and spiders were sampled on ESA participant farms during three, four-week periods between April and October in 1993 and 2003. This was achieved at each site using five pitfall traps (polythene containers 9 cm wide and 20 cm deep) part filled with ethylene glycol to prevent the escape and deterioration of specimens before collection. Pitfall traps are the most efficient method of collecting invertebrate samples and produce more species than any other method (Coulson & Butterfield 1985). They also collect animals throughout the time they are in place and so are less labour intensive for the

number of species trapped. Traps were placed 20 m apart in a line through the centre of each site. At the end of each sampling period traps were emptied and removed. At the beginning of the next sampling period, traps were replaced and refilled with a fresh ethylene glycol solution. The contents from all 5 traps were pooled for each sampling site and frozen at -5°C until sorting. All adult ground beetles (carabids) captured in the traps were identified to species using Lindroth (1974). Species identifications were confirmed by Dr. Roy Anderson, (Agriculture and Environmental Science, DARD). All adult spiders were identified to species using Roberts (1985). New species identifications were confirmed by Dr. Peter Merrett (British Arachnological Society).

#### **2.4. Soil sampling**

Five soil samples were taken along the field diagonal transect, during the botanical monitoring programme. Soil was taken from outside the quadrat using a soil auger (15cm deep x 3cm diameter). Samples were placed in polythene bags, labelled, sealed and kept cool until they were returned to the laboratory and air-dried at room temperature. Once dried, the samples were dry-sieved through a 2mm sieve. Soil chemical analyses, pH, available phosphorus and potassium were determined according to Allen (1974).

#### **2.5. Data storage**

Plant and invertebrate records were stored on MS Access database and statistical tests were carried out with MS Excel.

All invertebrate records were stored on the relational database Recorder 2002 and have been transferred to CEDaR (Centre for Environmental Data and Recording) at the Ulster Museum. Recorder facilitates this transfer and provides summary lists and tables compatible with multivariate analysis packages.

## **2.6. Data analysis**

Habitat diversity was measured by a combination of plant and invertebrate species richness, plant strategy theory CSR groups (Grime *et al* 1988) and similarity indices. Diversity indices were calculated for carabid beetle and spider populations.

### ***Species richness***

Species richness, the number of species found on a habitat, is the most widely adopted measure of diversity (Magurran, 1988). To monitor the success of the ESA scheme in maintaining or enhancing the diversity of a habitat, plant and invertebrate species numbers, frequency and abundance on ESA participant farms were recorded.

Changes in species richness over time on habitats under agreement on ESA participant farms were determined by statistically comparing (using paired t-test) the mean number of species per site in 1993 with the mean number of species in 2003. The term higher plant species refers to all vascular plants, i.e. not including mosses, liverworts or lichens.

Plant frequency was determined for each habitat by the percentage of sites that a species occurred on. Mean abundance indicates the mean percentage cover of a plant species within the 1m<sup>2</sup> quadrat (or 4m<sup>2</sup> quadrat for woodlands).

### ***Plant strategy theory***

Plant strategy theory defines plant species in terms of ruderals (R), competitors (C), stress-tolerators (S), or intermediates (Grime *et al* 1988). Each type occurs under different environmental conditions. Ruderals are typically annual weeds, found on disturbed, productive habitats. Competitors are typically fast-growing species, found under conditions of high productivity and low disturbance. Stress-tolerators are found where an environmental factor is limiting productivity, e.g. on low nutrient soils or soils liable to waterlogging. Many stress-tolerator species are vulnerable to intensive

agricultural practices, such as fertiliser application and drainage. By examining the frequency and composition of indicator species and plant species with known ecological requirements and C-S-R plant strategies, indications on the effect of the management practices may be inferred. For example, an increase in stress-tolerator species on grassland habitats may indicate a decrease in productivity and therefore improved habitat quality.

Each monitored habitat can be described in terms of the relative proportions of species in each of the CSR groups. These proportions were compared between 1993 and 2003 on ESA participant farms.

### ***Similarity indices***

A similarity index gives a measure of the level of change in the species composition of a sample and can be used to determine the level of change in species between baseline and re-survey. The similarity between 1993 and 2003 for each site has been calculated for carabid beetles and spiders using the Sørensen Index (I):

$$I = \frac{2j}{[a+b]} \times 100$$

This is expressed as a percentage where:-

*a* is the number of species recorded in 1993

*b* is the number of species recorded in 2003

*j* is the number of species common to both years.

This index makes no distinction between the presence of a species represented by the recording of a single specimen or by the recording of a large number of individuals (Coulson & Butterfield, 1985).

### ***Diversity indices for carabid beetles and spiders***

An indication of species diversity at each site was given by alpha of the log series distribution of species abundance data. Alpha species diversity was calculated for carabid beetles and spiders for each site. Alpha ( $\alpha$ ) was estimated by maximum likelihood in:-

$$S = \alpha \ln (1 + N/\alpha)$$

Where:- S is the species total and N is the total individuals of all species at each site (Southwood 1978).

### ***Spider species quality score***

Scoring is a relatively simple method for comparative evaluation of survey sites according to the rarity of spider species present. A quality score for each individual spider species has been derived from all previous agri-environment monitoring data (Cameron *et al*, 2004). Overall quality scores were calculated for each site. This allows some degree of ranking between sites and gives an additional assessment of biodiversity. Changes in scores between years can be used to evaluate changes in the biodiversity value of the habitat.



### 3. BOTANICAL RESULTS

#### 3.1. Grasslands

There were no significant changes in the mean number of higher plant species recorded for each grassland habitat between years (Table 2). Frequency lists of plant species found in 1993 and 2003 have been compiled for each habitat (Appendix 1).

**Table 2.** Mean number of higher plant species per transect for each grassland habitat in the West Fermanagh and Erne Lakeland ESA in 1993 and 2003. (NS =non-significant)

Habitat	n	Mean number of species per transect (se)		p
		1993	2003	
Unimproved grassland	14	34.6 (1.6)	32.8 (1.7)	NS
Wet pasture	28	37.2 (1.8)	33.9 (1.9)	NS
Hay meadow	10	36.0 (1.9)	39.1 (2.3)	NS
Limestone grassland	11	41.3 (2.9)	39.8 (2.3)	NS

#### Unimproved Grassland

Characteristic species of this habitat were sweet-vernal grass (*Anthoxanthum odoratum*), rushes (*Juncus* spp.), yorkshire fog (*Holcus lanatus*), white clover (*Trifolium repens*), meadow buttercup (*Ranunculus acris*), creeping buttercup (*R. repens*), crested dog's tail (*Cynosurus cristatus*), bent grasses (*Agrostis* spp.) and sedges (*Carex* spp.). Generally unimproved grassland sites were fairly poor in terms of herb species. There was very little change in the proportions of species in each of the CSR groups between years.

Rush cover had increased on 79% of sites. The mean cover per transect of soft rush (*Juncus effusus*) increased from 10% to 16% and the mean cover of sharp-flowered rush and/or jointed rush (*Juncus acutiflorus*/*J. articulatus*) increased significantly from 9% to 22%. Rush topping had been recently carried out at two sites.

The mean bare ground cover was fairly low at 4%, with no change between years. Most sites (79%) were cattle grazed and there was some localised poaching observed.

### **Wet Pasture**

There was a slight decrease in the mean number of higher plant species recorded between years but this can be accounted for by results from two sites, otherwise diversity had been maintained. There was variation in the sites with some being species-rich wet grassland whereas others were relatively species-poor.

The most abundant species on wet pasture were soft rush (*Juncus effusus*), creeping bent (*Agrostis stolonifera*), sharp-flowered rush (*Juncus acutiflorus* / *J. articulatus*), rough meadow grass (*Poa trivialis*), white clover (*Trifolium repens*), creeping buttercup (*Ranunculus repens*) and yorkshire fog (*Holcus lanatus*). Characteristic wet grassland herbs present were ladies smock (*Cardamine pratensis*), marsh ragwort (*Senecio aquaticus*), meadowsweet (*Filipendula ulmaria*) and lesser spearwort (*Ranunculus flammula*).

The frequency of several species indicative of fertile soils appeared to have decreased including marsh foxtail (*Alopecurus geniculatus*), silverweed (*Potentilla anserina*) and floating sweet-grass (*Glyceria fluitans*). This suggests a decrease in soil nutrients due to reduced use of fertilisers on fields under ESA agreement. However there was very little change in the proportions of plant species in the CSR groups between years.

Soft rush was present on 93% of sites. The mean cover had significantly increased from 8% to 16% since baseline monitoring and there had been a notable increase on 40% of sites. The mean cover of sharp-flowered/jointed rush had also significantly increased, from 3% to 14%.

There was bare ground present on 68% of sites in 2003. However there was very little at most sites with only 18% having mean bare ground cover greater than 10%, indicating heavy cattle poaching is rare. Cattle grazing occurred on

79% of sites. Of the remaining sites two were sheep grazed and four had no signs of any present grazing by livestock.

### **Limestone Grassland**

Plant diversity was comparatively high on limestone grassland (Table 2). Species recorded on all sample sites were sweet-vernal grass (*Anthoxanthum odoratum*), ribwort plantain (*Plantago lanceolata*), tormentil (*Potentilla erecta*), selfheal (*Prunella vulgaris*) and cat's ear (*Hypochaeris radicata*). Other characteristic species present included glaucous sedge (*Carex flacca*), blue sesleria (*Sesleria caerulea*), quaking grass (*Briza media*), lesser bird's foot trefoil (*Lotus corniculatus*), devil's bit scabious (*Succisa pratensis*), field wood-rush (*Luzula campestris*) and white clover (*Trifolium repens*).

Limestone grassland had a high proportion of stress-tolerating species compared to other grassland habitats. This had increased slightly since 1993 (i.e. 33% to 37%) and the proportion of competitors had decreased (9% to 5%). This suggests a decline of grassland productivity, indicating habitat enhancement. Ruderal species had also decreased (14% to 6%) indicating reduced disturbance.

There was a slight increase in the mean cover of bare ground from 3% to 6%. Cattle were present on all sites and some poaching was evident on 82% of sites.

### **Hay Meadows**

There was an increase in the mean number of higher plant species recorded on hay meadows. Sites were generally species-rich and fairly damp with abundant sharp-flowered rush (*Juncus acutiflorus*). The mean cover of this rush had increased significantly from 12% to 35% between years. Other species occurring on all sites were ragged robin (*Lychnis flos-cuculi*), ladies smock (*Cardamine pratensis*), yorkshire fog (*Holcus lanatus*), meadow buttercup (*Ranunculus acris*), white clover (*Trifolium repens*), sweet-vernal grass (*Anthoxanthum odoratum*), red fescue (*Festuca rubra*) and crested dog's tail (*Cynosurus cristatus*).

In terms of CSR groups the proportions had changed slightly with stress-tolerating species and ruderals having decreased and the proportion of generalist (CSR) species having increased. This is difficult to explain but may be an indication of low disturbance.

The amount of bare ground was low in both years, although it had increased from 0.2% to 3% due to some cattle poaching. It is permitted under ESA management to have cattle grazing the aftermath once hay has been cut, although poaching should be avoided.

### 3.2. Heather moorland

In terms of all plant species recorded, diversity was maintained between 1993 and 2003 (Table 4). However there was a significant decrease in the mean number of higher plant species recorded per transect from 18 to 15.5 species. This is not necessarily a negative effect as it may be due to a decrease of non-heathland species. The total number of higher plant species recorded overall remained the same, although there were a greater number of bryophyte species recorded in 2003 than in 1993.

**Table 4.** Mean number of plant species per transect for heather moorland in the West Fermanagh and Erne Lakeland ESA in 1993 and 2003 (n = 20).

(NS =non-significant, \*=p<0.05)

Species richness	1993	2003	p
Mean number of plant species (se)	26.1 (1.5)	29.2 (1.7)	NS
Mean number of higher plant species (se)	18.0 (1.4)	15.5 (1.5)	*

Sites were dominated by heather (*Calluna vulgaris*), with other frequent species being purple moor-grass (*Molinia caerulea*), tormentil (*Potentilla erecta*), common cotton-grass (*Eriophorum angustifolium*), hare's tail cotton-grass (*Eriophorum vaginatum*), cross-leaved heath (*Erica tetralix*) and deer-grass (*Trichophorum cespitosum*).

Over all sites the mean cover of heather had increased significantly from 41% to 50% ( $p < 0.05$ ). Heather cover had increased or been maintained on 85% of sites. Dwarf-shrub cover was still low on five sites where the mean cover in both years was less than 25%.

There were general decreases in the frequency of certain grasses between 1993 and 2003 (Appendix 1). In particular, the occurrence of mat grass (*Nardus stricta*) had decreased from 60% to 30% of sites. However there was an increase in the mean cover of other grass species within quadrats, for example purple moor-grass increased from 6% to 12%. This may be due to the formation of tussocks due to reduced grazing pressure.

Heather moorland has a high proportion of stress-tolerator species (60%), indicating conditions of low productivity and low disturbance. The proportion of plant species in each of the CSR groups had not changed between years.

The mean cover of *Sphagnum* moss species increased significantly from 6% to 12% ( $p < 0.05$ ), a further indication of reduced grazing and trampling damage. Mean bare ground cover had decreased slightly from 5% to 3%. Bare ground cover had decreased on 65% of sites, probably due to reduced poaching. However there were four sites where bare ground had increased slightly which suggests that present grazing levels may be fairly high on these sites.

### **3.3. Woodlands**

There was no significant change in the mean number of higher plant species recorded between 1993 and 2003 (Table 3). However there was a decrease in the total number of species recorded on all the sites, possibly due to an increase in more competitive species at the expense of other species.

The most frequent tree and shrub species within the 200m<sup>2</sup> woodland quadrats were ash (*Fraxinus excelsior*), bramble (*Rubus fruticosus*), hawthorn (*Crataegus monogyna*), holly (*Ilex aquifolium*) and hazel (*Corylus avellana*). The most common ground flora species were dog violet (*Viola riviniana*), herb

herb robert (*Geranium robertianum*), rough meadow-grass (*Poa trivialis*) and broad-buckler fern (*Dryopteris dilatata*).

**Table 3.** Mean number of higher plant species per quadrat for woodlands in the West Fermanagh and Erne Lakeland ESA in 1993 and 2003 (n = 13). (NS =non-significant)

Species richness	1993	2003	p
Mean number of species per 4m <sup>2</sup> (se)	15.3 (2.6)	15.1 (2.2)	NS
Mean number of species per 200m <sup>2</sup> (se)	40.8 (4.5)	37.0 (2.6)	NS

Bramble showed an increase (not significant) in mean cover within the 4m<sup>2</sup> quadrat from 2% to 8%. There was a significant increase in ground cover of ivy (*Hedera helix*) from 6% to 9%. The mean cover of celandine (*Ranunculus ficaria*) increased significantly from 1% to 10%. There was also an increase in the mean cover of several other typical woodland indicator species such as bluebell (*Hyacinthoides non-scripta*), wood sorrel (*Oxalis acetosella*), wood anemone (*Anemone nemorosa*) and herb robert (*G. robertianum*).

The cover of bare ground decreased from 15% to 4%, probably due to less poaching and disturbance by cattle. However of seven sites that were being actively grazed when baseline monitoring was carried out, six still had some signs of cattle grazing/poaching in 2003. Only four sites had been fenced since 1993 and were ungrazed. The remaining three sites were unfenced but ungrazed.

There was a decrease in the proportion of stress-tolerator species in woodland sites since 1993 from 27% to 18%. This may be due to the fact that these species were being out-competed in conditions of low disturbance. There was also an increase in the proportion of stress-tolerating competitors, mostly woody species, and generalist species.

In terms of regeneration of woody species, ash showed the most regeneration with seedlings present on 85% of woodland sites (and saplings on 39%) in 2003. This compares to 54% of sites recorded as having ash seedlings in

1993. No sycamore seedlings were recorded in 2003 but two sites had saplings. Beech seedlings were present on three sites where mature trees occurred in the canopy. In general, ungrazed woods had more woody species regenerating than woods where occasional grazing occurred, with mean numbers of 3.6 species and 1.5 species per site respectively.

## 4. INVERTEBRATE RESULTS

### 4.1. Carabid beetles

A total of 3891 carabid beetle individuals of 52 species were trapped from 32 sites on habitats under ESA agreement in the field season of 2003 (Table 5). This compares to 3340 individuals of 50 species being trapped 10 years previously.

There were no significant differences in the total or mean numbers of carabid individuals or species on any of the habitats sampled between 1993 and 2003. Similarity indices are fairly high for all habitats. The species composition did not change significantly over ten years, indicating that biodiversity is being maintained on each habitat under ESA agreement (Tables 5 & 6).

**Table 5:** Number of carabid beetle individuals and species captured from habitats under agreement in the West Fermanagh and Erne Lakeland ESA in 1993 and 2003 with calculated Sørensen Index of similarity.

Habitat	No. Beetle Individuals		No. Beetle Species		% Similarity
	1993	2003	1993	2003	
Unimproved grassland	848	842	26	31	67
Wet pasture	1133	2044	29	33	69
Hay meadow	631	429	20	25	76
Limestone grassland	430	285	19	18	70
Woodland	95	49	12	12	67
Heather moorland	203	242	25	26	67
TOTAL all habitats	3340	3891	50	52	69



**Table 6:** Mean number of carabid beetle individuals and species per site captured from habitats under agreement in the West Fermanagh and Erne Lakeland ESA in 1993 and 2003.

Habitat	n	Mean individuals per site (se)		Mean species per site (se)	
		1993	2003	1993	2003
Unimproved grassland	9	94.2 (17)	93.5 (18)	11.4 (1.2)	11.9 (1.7)
Wet pasture	10	113.3 (26)	194.4 (67)	14.5 (0.6)	13.8 (1.5)
Hay meadow	4	157.7 (42)	107.3 (17)	11.5 (0.7)	11.8 (1.4)
Limestone grassland	2	215.0 (35)	142.5 (93)	13.5 (0.5)	11.5 (1.5)
Woodland	1	95.0 (0)	49.0 (0)	12 (0.0)	12.0 (0.0)
Heather moorland	6	33.8 (8)	40.3 (17)	9.1 (2.2)	8.5 (1.4)

Frequency lists of carabid beetle species found in 1993 and 2003 have been compiled for each habitat (Appendix 2). The declining species *Carabus clatratus*, identified as habitat quality indicator, increased in frequency on hay meadows and wet pasture between 1993 and 2003. Another relatively scarce species *Carabus nitens*, identified as an indicator species on heather moorland in 1993, maintained its presence.

## 4.2. Spiders

A total of 4367 spider individuals of 83 species were trapped from 32 sites on habitats under ESA agreement in the field season of 2003. This compares to 6190 individuals of 66 species that were trapped 10 years previously. The significant decrease in individuals ( $p=0.04$ ) was mainly due to a fall in numbers recorded on the damp grassland habitats, i.e. hay meadows and wet pasture. There were four new county records for spiders in 2003 (Appendix 4).

**Table 7.** Number of spider individuals and species captured from habitats under agreement in the West Fermanagh and Erne Lakeland ESA in 1993 and 2003, with calculated Sørensen Index of similarity.

Habitat	No. spider individuals		No. spider species		% Similarity
	1993	2003	1993	2003	
Unimproved grassland	1546	1481	45	46	64
Wet pasture	2585	1266	38	34	72
Hay meadow	1394	776	26	25	71
Limestone grassland	321	317	23	24	60
Woodland	59	40	18	12	33
Heather moorland	285	487	33	49	51
TOTAL all habitats	6190	4367	66	83	66

**Table 8.** Mean number of spider individuals and species captured per site from habitats under agreement in the West Fermanagh and Erne Lakeland ESA in 1993 and 2003.

Habitat	n	Mean individuals per site (se)		Mean species per site (se)	
		1993	2003	1993	2003
Unimproved grassland	9	172 (40)	165 (31)	19.3 (2.4)	16.7 (1.5)
Wet pasture	10	259 (40)	127 (35)	15.5 (1.2)	11.5 (1.6)
Hay meadow	4	349 (25)	194 (113)	17.5 (1.0)	12.5 (1.8)
Limestone grassland	2	161 (29)	159 (8)	16.5 (1.5)	17.0 (3.0)
Woodland	1	59 (0)	40 (0)	20.0 (0.0)	14.0 (0.0)
Heather moorland	6	48 (12)	81 (14)	11.5 (1.9)	17.2 (1.7)

**Table 9.** Mean Alpha Diversity per site and mean species quality score per site of spiders captured on habitats under agreement in the West Fermanagh and Erne Lakeland ESA in 1993 and 2003.

(\*= $p < 0.05$ )

Habitat	Mean Alpha diversity Index per site (se)		Mean species quality score per site (se)	
	1993	2003	1993	2003
Unimproved grassland	6.30 (0.82)	5.14 (0.76)	99.2 (31.7)	70.2 (14.6)
Wet pasture	3.76 (0.30)	3.85 (0.78)	56.2 (12.9)	78.0 (29.9)
Hay meadow	3.91 (0.35)	3.98 (1.03)	51.3 (7.6)	38.5 (7.8)
Limestone grassland	4.73 (0.90)	4.86 (1.09)	53.0 (14.0)	119.0 (66.0)
Woodland	8.83 (0.00)	5.81 (0.00)	71.0 (0.0)	41.0 (0.0)
Heather moorland	7.22 (2.37)	7.41 (1.24)	35.2 (6.9)	*92.0 (20.6)

Frequency lists of spider species found in 1993 and 2003 have been compiled for all habitats (Appendix 3). Changes in spider species diversity and composition for each habitat are discussed below.

### Unimproved grassland

The numbers of spider species and their abundance remained very similar between 1993 and 2003 (Tables 7 & 8). The similarity in species trapped was 64%, showing a possible shift in species composition. Alpha diversity indices of the habitat have decreased slightly due to less species being captured per site. The mean spider species quality score for the habitat showed no significant change (Table 9) despite two rather rare spider species, *Hypselistes jacksoni* and *Trochosa spinipalpis*, being captured.

Twelve previously unrecorded species were captured from this habitat and 11 species were not recaptured in 2003. Of the 12 newly captured species, 6 exhibit no habitat preference and 4 prefer heather and similar low vegetated habitats, e.g. *Lepthyphantes ericaeus* and *Neriene montana*. Of the 11 species not recaptured in 2003, 5 prefer grassy or open sites e.g. *Savignia*

*frontata* and *Allomengea scopigera*. These slight changes in spider species composition may indicate that unimproved grassland is becoming less grassy and more diverse in vegetation structure.

### **Wet pasture**

Fewer spiders were recorded in 2003 than in 1993 (Tables 7 & 8). This fall in individuals is attributed to an unusually dry summer as there were only decreases in numbers on wet habitats. The similarity in species trapped was high at 72% (Table 7), giving a near complete species list of the spider community with relatively little change between years. Alpha diversity of the habitat has not changed significantly (Table 9). The mean spider species quality score for the habitat increased by 39% (Table 9) showing that the vegetation structure of the habitat is being maintained and showing signs of improvement.

Eight previously unrecorded species were captured from this habitat and 12 species were not recaptured from 1993. Of the 8 newly captured species 5 prefer wet habitats. Two of these are notably uncommon, *Trochosa spinipalpis* and *Bathypantes setiger*, which is a new county record for Fermanagh (Appendix 4). Seven of the 12 species not recaptured in 2003 exhibit habitat preferences for a variety of habitats. Spider species assemblages on wet pasture are changing from generalist species to species with specific wetland preferences, which is a positive effect in terms of habitat management for biodiversity.

### **Hay meadows**

The abundance recorded in 2003 was much less than in 1993 (Tables 7 & 8), but the number of species captured only fell by one. As on wet pasture the fall in individuals is attributed to an unusually dry summer. The similarity in species trapped was high at 71% (Table 7), giving a near complete species list of the spider community with relatively little change between years. Alpha diversity of the habitat remained fairly constant and the mean spider species quality score for the habitat showed no significant change (Table 9).

Seven previously unrecorded species were captured from this habitat and 8 species were not recaptured from 1993. Of the 7 newly captured species 4 prefer wet habitats, two of which are notably uncommon; *Trochosa spinipalpis* and *Agyneta olivacea*. Eight species were not recaptured in 2003, 5 of these exhibit habitat preferences for grassy or open sites e.g. *Savignia frontata* and *Tiso vagans*. Changes in spider species composition indicate that a typical hay meadow community is being maintained.

### **Limestone grassland**

The numbers of spider species and their abundance remained very similar between 1993 and 2003 (Tables 7 & 8). The similarity in species trapped was 60% (Table 7), the species composition has therefore changed since 1993. Alpha diversity of the habitat has remained fairly constant (Table 9). The mean spider species quality score for the habitat increased by 125% (Table 9). This suggests that the vegetation structure of the habitat has been maintained and quality is improving. The score is notably higher than other habitats due a small sample size and one site having two rare spider species present; *Segestria senoculata* and *Clubiona neglecta*.

Ten previously unrecorded species were captured from this habitat and 9 species were not recaptured from 1993. Of the 10 newly captured species 4 prefer grassy habitats, *Xysticus erraticus* in particular is commonly found under stones in grazed grassland. A number of species common to wet habitats were not recaptured in 2003, notably *Pirata piraticus* and *Walckenaeria vigilax*, although some new wet habitat species were captured in 2003. This slight shift in spider species composition indicates that the limestone grassland habitat is being maintained.

### **Heather moorland**

Although there were no statistically significant changes in spider numbers on heather moorland (Tables 7 & 8), the abundance recorded in 2003 was greater than previous samples. The similarity in species trapped was 51% (Table 7). This is relatively low and may indicate a change in species composition for this habitat. Alpha diversity of the habitat has remained fairly

constant (Table 9). The mean spider species quality score for the habitat has increased significantly by 162% ( $p=0.02$ ) (Table 9). This may indicate an improvement in the quality of the habitat. Spiders typically reflect the state of vegetation structure and as such the condition of heathland vegetation in the ESA has improved to support a more diverse group of spiders.

This improvement is most noted by the trapping of 28 previously unrecorded species from this habitat and the failure to recapture 12 species recorded in 1993. Of these newly captured species 13 show preference to heather moorland. For example, *Scotina gracilipes* is described as rare, *Gonatium rubens* prefers undisturbed heathland and *Walckenaeria unicornis* is uncommon. *W. unicornis* along with *Hahnia montana* and *Taranucnus setosus* are new county records for Fermanagh (Appendix 4). Twelve spider species were not recaptured in 2003. Most habitat specific species not found preferred open grassy conditions, such as *Centromerita concinna* and *Diplocephalus permixtus*. This change in species composition indicates the habitat is supporting 'specialist' heathland species. This is desirable in terms of species diversity as these more vulnerable species depend on the habitat for survival.

## **Woodland**

Fluctuations in spider species and their abundance were not significant which indicates no change in woodland quality. The sample size for agreement woodland in the West Fermanagh and Erne Lakeland ESA was very small and a larger sample will be analysed in the other ESAs after resurvey in 2004.

## 5. SOIL ANALYSIS

Mean soil pH and potassium levels have not significantly changed between 1993 and 2003 for grassland habitats under agreement in the West Fermanagh and Erne Lakeland ESA (Table 11). Mean soil phosphorus levels have fallen significantly on wet grassland and limestone grassland. Levels have also declined on hay meadows under agreement. This indicates a gradual reduction of phosphorus due to reduction or control of fertiliser application under ESA management prescriptions.

**Table 11.** Mean soil pH, phosphorous and potassium levels (mg/l) for grassland habitats under ESA agreement in 1993 and 2003 ( $\pm$ se).

(NS =non-significant, \* = $p<0.05$ , \*\*= $p<0.01$ )

### Wet Grassland (n=10)

	1993	2003	T-test	p
pH	5.96 (0.30)	6.05 (0.17)	0.67	NS
P	13.40 (2.12)	9.70 (1.22)	0.02	**
K	107.2 (13.6)	115.1 (16.2)	0.42	NS

### Limestone Grassland (n=7)

	1993	2003	T-test	p
pH	5.70 (0.47)	5.92 (0.41)	0.17	NS
P	17.30 (5.92)	11.14 (4.27)	0.04	*
K	110.3 (18.4)	116.6 (42.4)	0.83	NS

### Unimproved Grassland (n=11)

	1993	2003	T-test	p
pH	5.45 (0.07)	5.31 (0.10)	0.25	NS
P	13.55 (1.27)	13.91 (3.37)	0.90	NS
K	102.1 (15.4)	103.5 (13.2)	0.91	NS

### Hay meadows (n=7)

	1993	2003	T-test	p
pH	5.76 (0.21)	5.61 (0.14)	0.42	NS
P	16.41 (4.70)	13.14 (4.17)	0.09	NS
K	74.6 (7.9)	76.6 (10.2)	0.86	NS

## 6. CONCLUSIONS

### ***Unimproved grassland***

Plant species diversity has been maintained on unimproved grassland under ESA agreement. Rush cover appears to have increased, although on most sites mean cover was less than 50%. This may be due to decreased grazing and trampling by cattle. More control of rushes may be necessary if they continue to spread.

Carabid beetle species diversity has been maintained. Changes in spider species composition may indicate that unimproved grassland under agreement is becoming more diverse in terms of vegetation structure.

This habitat is generally species-poor in terms of herb species and often derived from agricultural grassland. Therefore it does not contribute to any particular BAP habitat targets, however there may be the potential for the priority habitat of 'purple moor grass and rush pasture' to develop on certain sites. Unimproved grassland is often rushy and therefore may be important in providing habitat for declining bird species, including BAP priority species such as curlew.

### ***Wet pasture***

Plant species diversity was maintained on monitored wet pastures under ESA agreement. There are possible indications of decreased soil fertility in terms of species composition. There was a general increase in rush cover although the mean cover of *Juncus* species was only greater than 50% on less than one-third of sites. These sites may need greater rush control than at present. Some sites were still subject to moderate or heavy poaching by cattle.

Carabid beetle species diversity and composition have remained unchanged. Spider species assemblages have changed positively in terms of habitat management for biodiversity on wet pasture. The species composition has become more wetland specific. There was also one new spider county record for Fermanagh.



Soil phosphorous levels have fallen significantly, possibly due to reduced fertiliser application. This is a positive effect of ESA management and in the longer term should lead to an increase in plant species diversity on wet pastures.

Many of the sites could be described as species-rich wet grassland. Positive management under the ESA scheme should contribute to delivery of targets for BAP priority habitat of 'purple moor grass and rush pasture'. Northern Ireland, especially Fermanagh, has large proportion of the UK resource for this habitat (NIBG, 2000). Most sites were adjacent to lakes and graded into fen vegetation particularly towards the water margin. 'Fens' are also a BAP priority habitat important in Northern Ireland.

### ***Limestone grassland***

Plant species diversity has been maintained on monitored limestone grassland under ESA agreement. Cattle grazing and poaching may have caused some bare ground increase, particularly on sites on sloping ground. Heavy grazing on thin limestone soils can cause soil erosion and may adversely affect species-richness and structural diversity.

Carabid beetle composition has remained unchanged. Spider species diversity and composition indicate the vegetation structure and biodiversity of the habitat is being maintained.

Soil phosphorous levels have dropped significantly which is likely to be a result of reduced fertiliser application on limestone grassland under ESA agreement.

Limestone grassland management contributes directly to delivery of targets for the BAP priority habitat of 'upland calcareous grassland'. Northern Ireland has a significant proportion of the UK resource for this habitat, an estimated 1,100 ha (UK BSG, 1998). There are around 1030 ha of limestone grassland under agreement in the West Fermanagh and Erne Lakeland ESA. Present management is maintaining this habitat and therefore should continue.

### **Hay meadows**

Plant species diversity on monitored hay meadows under ESA agreement has been maintained. There was a decrease in mean soil phosphorous levels indicating a possible gradual decline due to reduced fertiliser application. The slight increase in mean number of species recorded may be correlated with this decrease in soil fertility. There was an apparent general increase in rush cover, particularly *Juncus acutiflorus*/*J.articulatus*, as on other grassland types.

Carabid beetle diversity has not changed significantly, and abundance of the indicator species *Carabus clatratus* has been maintained. Spider diversity has been maintained and changes in spider species composition indicate that a more typical hay meadow community is being established.

Due to the wetness of Fermanagh soils most hay meadows are likely to be damp and rushy, therefore appropriate management will contribute to delivering targets for the BAP priority habitat 'purple moor grass and rush pasture'. Management under ESA agreement appears to be effective at maintaining this habitat and therefore should continue.

### **Heather moorland**

Overall plant species diversity has been maintained although there were fewer higher plant species recorded. This decrease in the mean number of higher plant species is not necessarily a negative effect as it appears to be due to the decrease of non-heathland species and an increase in heather.

There are several indications that the vegetation condition of heather moorland under ESA agreement is improving. There has been an increase in mean heather cover on 85% of sites. *Sphagnum* mosses are a very important component of the vegetation and their cover has increased significantly. There has been a slight decrease in the mean cover of bare ground. These factors suggest an overall decrease in grazing levels on the sites. However a few sites that were in poor condition in 1993 with low heather cover do not

appear to have improved. It may be that present grazing levels or livestock type are inappropriate. Therefore it is recommended that grazing regimes should be checked and reduced if necessary on individual sites where heather remains degraded. Cattle-grazing was noted on 75% of sites in 2003. Under new ESA prescriptions cattle cannot normally be grazed on wet heath or blanket bog.

High cover of graminoids (i.e. grasses, sedges and rushes) on heather moorland is indicative of poor vegetation condition brought about by past or current inappropriate management such as high grazing pressure or burning. There has been a decrease in the frequency of many grass species recorded but an increase in the cover of some graminoids particularly purple moor-grass and hare's tail cotton-grass. These species which were relatively abundant in 1993 have spread and developed a tussocky structure on sites where grazing was light.

Carabid beetle diversity and composition were maintained. Changes in spider populations indicate an increased structural diversity of vegetation on heather moorland and that the habitat is supporting 'specialist' heathland species. There were also three new county records for Fermanagh.

In terms of BAP priority habitats, 75% of heather moorland sites were 'upland heathland' and the remaining sites were 'blanket bog' (i.e. with peat depth greater than 1m). The main factor affecting these habitats in Northern Ireland is overgrazing. Therefore grazing management under ESA agreement should continue to contribute to the delivery of BAP targets for improving habitat condition.

### **Woodland**

Plant species diversity appears to have been maintained in woods under ESA agreement. There was an increase in the cover of many woodland ground flora species such as wood anemone, ivy and lesser celandine. These are

species that generally prefer undisturbed conditions and so may have spread in the absence of grazing.

Of the woodland sites 80% were unfenced in 2003, although only 30% were subject to occasional grazing. Decrease in grazing levels may have led to an increase in the shrub growth in the understorey, particularly bramble. This in turn may have led to a shading effect on the ground flora with the resultant decline of some species. Some grazing and trampling by livestock may therefore have a positive effect in maintaining species diversity as it controls certain species such as bramble and coarse grasses. Studies have found that low levels of grazing provide a greater diversity in vegetation structure and species composition than either overgrazing or the absence of grazing in fenced woods (Mitchell and Kirby, 1990). Many of the woods were heavily cattle poached at the time of the baseline survey. There was a decrease in the amount of bare ground recorded between 1993 and 2003 due to the reduction in poaching.

Tree and shrub regeneration was apparent, with more species of tree seedlings and saplings recorded in those woods where no grazing had occurred for several years. Ash was the most frequently regenerating species, as would be expected as it is dominant in the canopy of most of the sampled woods. Some level of ground disturbance by livestock may be important for the regeneration of certain tree species as it reduces competition and creates niches for seedling establishment (Pigott, 1983). A recent study of woodlands in Northern Ireland has found that light, controlled grazing can maintain or enhance botanical diversity whilst having the potential to encourage the early stages of tree regeneration (McEvoy, 2004).

In terms of BAP priority habitats most of the woodland sites were 'mixed ashwoods', although sometimes old plantations rather than semi-natural woodlands. There was one wet alder wood that could be described as BAP habitat 'wet woodlands'.

### ***Overall conclusion***

The monitoring programme indicates that after ten years species diversity has been maintained on habitats on ESA participant farms. There were indications of enhancement of plant and invertebrate communities on habitats under agreement. For example management prescriptions are having a positive effect on heather moorland with an increase in heather cover on ESA participant farms. Decreases in soil fertility on wet pasture, limestone grassland and hay meadows under agreement may have led to changes in plant species composition and may in the long-term increase species diversity. Changes in spider populations on heather moorland, wet pasture and limestone grassland suggest an increase in structural diversity of vegetation and an improvement in habitat quality due to less intensive management. Possible areas of concern are an increase in bramble in ungrazed woodlands and an increase in rushes on hay meadows, unimproved grassland and wet pastures. These may have implications for habitat management and will need to be monitored and causes investigated in future research.

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## **APPENDICES**

**Appendix 1.** Percentage frequency of plant species recorded on participant farms in the West Fermanagh and Erne Lakeland ESA in 1993 and 2003.

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**Appendix 2.** Percentage frequency of carabid beetle species captured on participant farms in the West Fermanagh and Erne Lakeland ESA in 1993 and 2003.

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**Appendix 3.** Percentage frequency of spider species captured on participant farms in the West Fermanagh and Erne Lakeland ESA in 1993 and 2003.

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**Appendix 4.** New spider county records from the West Fermanagh and Erne Lakeland ESA, 2003.

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**Appendix 1.** Percentage frequency of plant species recorded on participant farms in the West Fermanagh and Erne Lakeland ESA in 1993 and 2003.

**Heather moorland**  
(n=20)

Species Name	% Freq. 1993	% Freq. 2003	Species Name	% Freq. 1993	% Freq. 2003
<i>Achillea millefolium</i>	0	5	<i>Erica cinerea</i>	45	40
<i>Agrostis</i> spp.	80	85	<i>Erica tetralix</i>	75	65
<i>Anthoxanthum odoratum</i>	65	50	<i>Eriophorum angustifolium</i>	80	80
<i>Aulacomnium palustre</i>	5	0	<i>Eriophorum vaginatum</i>	80	60
<i>Bellis perennis</i>	0	5	<i>Euphrasia officinalis</i> agg.	10	0
<i>Betula pubescens</i>	0	5	<i>Eurhynchium praelongum</i>	20	0
<i>Blechnum spicant</i>	5	20	<i>Festuca ovina</i>	25	10
<i>Breutelia chrysocoma</i>	5	15	<i>Festuca rubra</i>	40	5
<i>Calliargon cuspidatum</i>	0	10	<i>Fissidens adianthoides</i>	15	0
<i>Callitriche stagnalis</i>	10	0	<i>Galium saxatile</i>	20	10
<i>Calluna vulgaris</i>	100	100	<i>Holcus lanatus</i>	15	15
<i>Calypogeia muellerana</i>	0	5	<i>Hylocomium splendens</i>	45	75
<i>Campylopus introflexus</i>	0	25	<i>Hypnum cupressiforme</i>		
<i>Campylopus paradoxus</i>	0	40	<i>/jutlandicum</i>	40	100
<i>Carex binervis</i>	70	55	<i>Hypochaeris radicata</i>	5	10
<i>Carex demissa</i>	5	5	<i>Hypogymnia physodes</i>	5	0
<i>Carex echinata</i>	40	40	<i>Juncus acutiflorus</i>	15	15
<i>Carex lasiocarpa</i>	5	0	<i>Juncus bulbosus</i>	30	35
<i>Carex nigra</i>	55	65	<i>Juncus conglomeratus</i>	0	5
<i>Carex ovalis</i>	10	0	<i>Juncus effusus</i>	35	50
<i>Carex pallescens</i>	15	0	<i>Juncus squarrosus</i>	70	60
<i>Carex panicea</i>	80	60	<i>Kurzia pauciflora</i>	0	15
<i>Carex rostrata</i>	5	0	<i>Leontodon autumnalis</i>	10	10
<i>Cerastium fontanum</i>	5	5	<i>Leucobryum glaucum</i>	0	20
<i>Cirsium palustre</i>	0	5	<i>Lolium perenne</i>	0	5
<i>Cladonia coccifera</i>	0	5	<i>Lophocolea bidentata</i>	0	15
<i>Cladonia floerkeana</i>	20	0	<i>Lophozia ventricosa</i>	15	15
<i>Cladonia portentosa</i>	65	60	<i>Luzula multiflora</i>	30	30
<i>Cladonia pyxidata</i>	15	10	<i>Luzula sylvatica</i>	0	10
<i>Cladonia squamosa</i>	0	10	<i>Lycopodium clavatum</i>	15	0
<i>Cladonia subcervicornis</i>	0	5	<i>Lysimachia nemorum</i>	0	5
<i>Cladonia uncialis</i>	5	10	<i>Molinia caerulea</i>	90	85
<i>Cratoneuron commutatum</i>	15	0	<i>Mylia taylorii</i>	0	15
<i>Cynosurus cristatus</i>	0	10	<i>Myrica gale</i>	10	15
<i>Dactylorhiza maculata</i>	5	5	<i>Nardus stricta</i>	60	30
<i>Danthonia decumbens</i>	10	5	<i>Narthecium ossifragum</i>	25	30
<i>Deschampsia flexuosa</i>	55	40	<i>Odontoschisma sphagni</i>	0	15
<i>Dicranum scoparium</i>	70	45	<i>Pedicularis sylvatica</i>	10	15
<i>Diplophyllum albicans</i>	0	35	<i>Picea sitchensis</i>	0	5
<i>Drosera rotundifolia</i>	5	5	<i>Plagiomnium undulatum</i>	5	5
<i>Empetrum nigrum</i>	25	0	<i>Plagiothecium undulatum</i>	25	10

Species Name	% Freq. 1993	% Freq. 2003
<i>Pleurozia purpurea</i>	0	10
<i>Pleurozium schreberi</i>	30	50
<i>Poa annua</i>	0	5
<i>Poa trivialis</i>	10	5
<i>Pohlia nutans</i>	5	0
<i>Polygala serpyllifolia</i>	15	20
<i>Polypodium vulgare</i>	5	0
<i>Polytrichum alpestre</i>	0	5
<i>Polytrichum commune</i>	50	40
<i>Potentilla erecta</i>	80	90
<i>Prunella vulgaris</i>	0	5
<i>Pseudoscleropodium purum</i>	25	25
<i>Pteridium aquilinum</i>	10	10
<i>Racomitrium lanuginosum</i>	5	20
<i>Ranunculus acris</i>	5	0
<i>Ranunculus repens</i>	0	5
<i>Rhytidiadelphus loreus</i>	0	75
<i>Rhytidiadelphus squarrosus</i>	65	60
<i>Rhytidiadelphus triquetrus</i>	25	10
<i>Rumex acetosa</i>	10	5
<i>Rumex acetosella</i>	5	5
<i>Sagina procumbens</i>	0	5
<i>Salix aurita</i>	0	5

Species Name	% Freq. 1993	% Freq. 2003
<i>Scapania gracilis</i>	0	35
<i>Sphagnum auriculatum</i>	50	30
<i>Sphagnum capillifolium</i>	75	85
<i>Sphagnum compactum</i>	10	15
<i>Sphagnum cuspidatum</i>	15	45
<i>Sphagnum palustre</i>	20	20
<i>Sphagnum papillosum</i>	10	45
<i>Sphagnum recurvum</i>	0	25
<i>Sphagnum subnitens</i>	15	40
<i>Sphagnum tenellum</i>	0	35
<i>Stellaria alsine</i>	0	5
<i>Stellaria graminea</i>	5	0
<i>Stellaria media</i>	5	0
<i>Succisa pratensis</i>	30	40
<i>Thuidium tamariscinum</i>	35	40
<i>Trichophorum cespitosum</i>	80	60
<i>Trifolium repens</i>	15	10
<i>Ulex europaeus</i>	0	15
<i>Vaccinium myrtillus</i>	60	55

## Hay meadow

(n=10)

Species Name	% Freq. 1993	% Freq. 2003
<i>Agrostis canina</i>	10	50
<i>Agrostis capillaris</i>	20	70
<i>Agrostis stolonifera</i>	60	50
<i>Ajuga reptans</i>	80	80
<i>Alopecurus geniculatus</i>	40	30
<i>Alopecurus pratensis</i>	50	60
<i>Angelica sylvestris</i>	20	30
<i>Anthoxanthum odoratum</i>	100	100
<i>Arrhenatherum elatius</i>	0	20
<i>Anthriscus sylvestris</i>	10	0
<i>Bellis perennis</i>	80	90
<i>Berula erecta</i>	10	0
<i>Briza media</i>	30	30
<i>Bromus hordeaceus</i>	60	50
<i>Caltha palustris</i>	30	20
<i>Cardamine flexuosa</i>	0	20
<i>Cardamine pratensis</i>	60	100
<i>Carex binervis</i>	10	0
<i>Carex disticha</i>	0	20
<i>Carex echinata</i>	10	10
<i>Carex elata</i>	0	10
<i>Carex flacca</i>	40	40
<i>Carex hirta</i>	10	30
<i>Carex hostiana</i>	10	10
<i>Carex lasiocarpa</i>	10	0
<i>Carex nigra</i>	70	90
<i>Carex ovalis</i>	20	40
<i>Carex panicea</i>	50	50
<i>Carex pulicaris</i>	0	20
<i>Carex remota</i>	10	0
<i>Carex viridula</i> ssp.	0	20
<i>Cerastium fontanum</i>	90	90
<i>Cirsium dissectum</i>	20	20
<i>Cirsium palustre</i>	10	30
<i>Cirsium vulgare</i>	10	0
<i>Crepis paludosa</i>	0	10
<i>Cynosurus cristatus</i>	80	100
<i>Dactylis glomerata</i>	20	10
<i>Dactylorhiza fuchsii</i>	30	30
<i>Elymus repens</i>	10	0
<i>Epilobium obscurum</i>	0	10
<i>Epilobium palustre</i>	0	20
<i>Epilobium parviflorum</i>	0	10
<i>Equisetum palustre</i>	40	30

Species Name	% Freq. 1993	% Freq. 2003
<i>Euphrasia officinalis</i> agg.	0	20
<i>Festuca pratensis</i>	80	60
<i>Festuca rubra</i>	80	100
<i>Filipendula ulmaria</i>	80	80
<i>Galium palustre</i>	50	60
<i>Geum urbanum</i>	10	0
<i>Glyceria fluitans</i>	0	20
<i>Helictotrichon pubescens</i>	0	10
<i>Holcus lanatus</i>	100	100
<i>Hypericum</i> sp.	10	0
<i>Hypochaeris radicata</i>	70	70
<i>Juncus acutiflorus</i>		
<i>/articulatus</i>	100	100
<i>Juncus conglomeratus</i>	0	70
<i>Juncus effusus</i>	70	70
<i>Lathyrus linifolius</i>	0	10
<i>Lathyrus pratensis</i>	40	50
<i>Leontodon autumnalis</i>	30	20
<i>Leucanthemum vulgare</i>	20	0
<i>Linum catharticum</i>	10	0
<i>Listera ovata</i>	10	10
<i>Lolium perenne</i>	80	50
<i>Lotus corniculatus</i>	10	20
<i>Luzula campestris</i>	100	80
<i>Lychnis flos-cuculi</i>	80	100
<i>Mentha aquatica</i>	10	0
<i>Molinia caerulea</i>	0	10
<i>Montia fontana</i>	10	20
<i>Myosotis discolor</i>	50	90
<i>Myosotis secunda</i>	0	20
<i>Nardus stricta</i>	10	0
<i>Orchis mascula</i>	20	10
<i>Phleum pratense</i>	30	60
<i>Plantago lanceolata</i>	80	70
<i>Poa annua</i>	20	10
<i>Poa pratensis</i>	0	10
<i>Poa trivialis</i>	70	80
<i>Polygala vulgaris</i>	30	0
<i>Potentilla anserina</i>	0	10
<i>Potentilla erecta</i>	50	20
<i>Primula vulgaris</i>	20	10
<i>Prunella vulgaris</i>	30	70
<i>Ranunculus acris</i>	80	100
<i>Ranunculus bulbosus</i>	20	0

<b>Species Name</b>	<b>% Freq. 1993</b>	<b>% Freq. 2003</b>
<i>Ranunculus flammula</i>	40	20
<i>Ranunculus repens</i>	50	80
<i>Rhinanthus minor</i>	0	30
<i>Rumex acetosa</i>	70	80
<i>Rumex acetosella</i>	10	0
<i>Rumex crispus</i>	20	0
<i>Rumex obtusifolius</i>	10	20
<i>Senecio aquaticus</i>	80	40
<i>Stellaria alsine</i>	0	20
<i>Stellaria graminea</i>	50	20
<i>Stellaria holostea</i>	10	0
<i>Succisa pratensis</i>	30	30

<b>Species Name</b>	<b>% Freq. 1993</b>	<b>% Freq. 2003</b>
<i>Taraxacum officinale</i> agg.	80	50
<i>Trifolium dubium</i>	30	50
<i>Trifolium pratense</i>	80	80
<i>Trifolium repens</i>	90	100
<i>Urtica dioica</i>	10	10
<i>Veronica chamaedrys</i>	10	10
<i>Vicia cracca</i>	30	30
<i>Vicia sepium</i>	10	10

**Limestone grassland**  
(n=11)

Species Name	% Freq. 1993	% Freq. 2003
<i>Achillea millefolium</i>	55	45
<i>Agrostis canina</i>	18	18
<i>Agrostis capillaris</i>	64	91
<i>Agrostis stolonifera</i>	55	55
<i>Ajuga reptans</i>	9	9
<i>Alchemilla vulgaris</i> agg.	55	36
<i>Alopecurus geniculatus</i>	9	0
<i>Alopecurus pratensis</i>	45	27
<i>Antennaria dioica</i>	27	9
<i>Anthoxanthum odoratum</i>	100	100
<i>Arrhenatherum elatius</i>	45	9
<i>Bellis perennis</i>	82	64
<i>Blechnum spicant</i>	9	0
<i>Briza media</i>	55	73
<i>Bromus hordeaceus</i>	9	0
<i>Calluna vulgaris</i>	0	9
<i>Campanula rotundifolia</i>	0	18
<i>Cardamine pratensis</i>	36	36
<i>Carex binervis</i>	18	18
<i>Carex caryophyllaea</i>	9	45
<i>Carex echinata</i>	0	9
<i>Carex flacca</i>	45	91
<i>Carex hirta</i>	9	0
<i>Carex nigra</i>	45	27
<i>Carex ovalis</i>	0	18
<i>Carex pallescens</i>	36	0
<i>Carex panicea</i>	73	64
<i>Carex pilulifera</i>	0	9
<i>Carex pulicaris</i>	0	36
<i>Centaurea nigra</i>	27	0
<i>Centaureum erythraea</i>	0	9
<i>Cerastium fontanum</i>	73	73
<i>Cirsium</i> spp.	82	82
<i>Conopodium majus</i>	27	27
<i>Crataegus monogyna</i>	9	9
<i>Cynosurus cristatus</i>	82	82
<i>Dactylis glomerata</i>	55	55
<i>Dactylorhiza fuchsii</i>	18	9
<i>Danthonia decumbens</i>	82	64
<i>Deschampsia cespitosa</i>	27	27
<i>Deschampsia flexuosa</i>	9	9
<i>Empetrum nigrum</i>	9	0
<i>Epilobium obscurum</i>	0	9
<i>Equisetum arvense</i>	9	9
<i>Euphrasia officinalis</i> agg.	45	45
<i>Festuca ovina</i>	73	64

Species Name	% Freq. 1993	% Freq. 2003
<i>Festuca pratensis</i>	45	9
<i>Festuca rubra</i>	100	73
<i>Filipendula ulmaria</i>	9	9
<i>Galium saxatile</i>	55	27
<i>Galium verum</i>	18	0
<i>Geum rivale</i>	0	9
<i>Glyceria fluitans</i>	0	9
<i>Helictotrichon pubescens</i>	18	0
<i>Holcus lanatus</i>	100	91
<i>Holcus mollis</i>	27	0
<i>Hypericum perforatum</i>	9	0
<i>Hypericum pulchrum</i>	9	27
<i>Hypochaeris radicata</i>	100	100
<i>Isolepis setacea</i>	0	9
<i>Juncus acutiflorus</i>	0	9
<i>Juncus bulbosus</i>	9	27
<i>Juncus effusus</i>	64	64
<i>Juncus squarrosus</i>	9	18
<i>Juniperis communis</i>	0	9
<i>Koeleria macrantha</i>	0	27
<i>Lathyrus pratensis</i>	55	27
<i>Leontodon autumnalis</i>	9	9
<i>Leucanthemum vulgare</i>	27	27
<i>Linum catharticum</i>	0	45
<i>Listera ovata</i>	9	9
<i>Lolium perenne</i>	55	73
<i>Lotus corniculatus</i>	64	82
<i>Luzula campestris</i>	91	82
<i>Lychnis flos-cuculi</i>	45	9
<i>Luzula multiflora</i>	27	0
<i>Molinia caerulea</i>	27	0
<i>Myosotis arvensis</i>	18	0
<i>Nardus stricta</i>	18	18
<i>Orchis mascula</i>	9	9
<i>Pedicularis sylvatica</i>	18	27
<i>Pilosella officinarum</i>	18	73
<i>Plantago lanceolata</i>	91	100
<i>Poa annua</i>	36	9
<i>Poa pratensis</i>	0	36
<i>Poa trivialis</i>	73	55
<i>Polygala serpyllifolia</i>	27	36
<i>Polygala vulgaris</i>	9	9
<i>Potentilla erecta</i>	91	100
<i>Potentilla sterilis</i>	0	9
<i>Primula vulgaris</i>	18	18
<i>Prunella vulgaris</i>	82	100

<b>Species Name</b>	<b>% Freq. 1993</b>	<b>% Freq. 2003</b>
<i>Prunus spinosa</i>	9	9
<i>Pteridium aquilinum</i>	18	18
<i>Ranunculus acris</i>	91	73
<i>Ranunculus bulbosus</i>	27	45
<i>Ranunculus flammula</i>	0	9
<i>Ranunculus repens</i>	18	55
<i>Rumex acetosa</i>	82	64
<i>Rumex acetosella</i>	9	9
<i>Rumex crispus</i>	9	0
<i>Rumex obtusifolius</i>	9	9
<i>Sagina procumbens</i>	0	18
<i>Senecio aquaticus</i>	9	18
<i>Senecio jacobea</i>	82	82
<i>Sesleria caerulea</i>	91	55
<i>Stellaria alsine</i>	0	18

<b>Species Name</b>	<b>% Freq. 1993</b>	<b>% Freq. 2003</b>
<i>Stellaria graminea</i>	64	27
<i>Stellaria holostea</i>	9	0
<i>Stellaria media</i>	0	9
<i>Succisa pratensis</i>	82	82
<i>Taraxacum officinale</i> agg.	27	36
<i>Thymus praecox</i>	64	55
<i>Trifolium pratense</i>	64	73
<i>Trifolium repens</i>	91	91
<i>Vaccinium myrtillus</i>	9	9
<i>Veronica chamaedrys</i>	82	55
<i>Veronica serpyllifolia</i>	9	9
<i>Viola riviniana</i>	45	45

**Unimproved grassland**  
(n=14)

Species Name	% Freq. 1993	% Freq. 2003
<i>Achillea millefolium</i>	14	7
<i>Achillea ptarmica</i>	0	14
<i>Agrostis canina</i>	64	86
<i>Agrostis capillaris</i>	71	86
<i>Agrostis stolonifera</i>	79	71
<i>Ajuga reptans</i>	14	14
<i>Alnus glutinosa</i>	7	7
<i>Alopecurus geniculatus</i>	7	14
<i>Alopecurus pratensis</i>	29	14
<i>Anemone nemorosa</i>	7	0
<i>Anthoxanthum odoratum</i>	100	100
<i>Bellis perennis</i>	43	29
<i>Briza media</i>	7	7
<i>Calluna vulgaris</i>	14	21
<i>Caltha palustris</i>	14	0
<i>Cardamine hirsuta</i>	43	0
<i>Cardamine pratensis</i>	71	79
<i>Carex binervis</i>	21	14
<i>Carex diandra</i>	7	0
<i>Carex echinata</i>	36	43
<i>Carex flacca</i>	7	7
<i>Carex hirta</i>	21	21
<i>Carex nigra</i>	79	79
<i>Carex ovalis</i>	21	29
<i>Carex pallescens</i>	29	0
<i>Carex panicea</i>	86	79
<i>Carex pilulifera</i>	0	7
<i>Carex pulicaris</i>	0	7
<i>Carex remota</i>	7	0
<i>Carex rostrata</i>	36	0
<i>Carex viridula</i> ssp.	7	43
<i>Cerastium fontanum</i>	57	79
<i>Cirsium</i> spp.	79	72
<i>Cynosurus cristatus</i>	93	86
<i>Dactylorhiza fuchsii</i>	7	0
<i>Deschampsia cespitosa</i>	0	14
<i>Deschampsia flexuosa</i>	21	0
<i>Elymus repens</i>	7	0
<i>Epilobium montanum</i>	0	7
<i>Epilobium obscurum</i>	0	29
<i>Epilobium palustre</i>	14	7
<i>Equisetum arvense</i>	14	7
<i>Equisetum palustre</i>	0	14
<i>Eriophorum angustifolium</i>	7	0
<i>Eriophorum vaginatum</i>	7	0
<i>Festuca ovina</i>	21	14

Species Name	% Freq. 1993	% Freq. 2003
<i>Festuca pratensis</i>	14	21
<i>Festuca rubra</i>	71	71
<i>Filipendula ulmaria</i>	14	14
<i>Fraxinus excelsior</i>	0	7
<i>Galium palustre</i>	29	29
<i>Galium saxatile</i>	14	14
<i>Glyceria fluitans</i>	14	29
<i>Hedera helix</i>	7	7
<i>Holcus lanatus</i>	100	93
<i>Holcus mollis</i>	7	0
<i>Hydrocotyle vulgaris</i>	0	7
<i>Hypericum perforatum</i>	7	0
<i>Hypericum pulchrum</i>	14	0
<i>Hypochaeris radicata</i>	36	57
<i>Isolepis setacea</i>	0	7
<i>Juncus acutiflorus</i>		
<i>/articulatus</i>	93	93
<i>Juncus bufonius</i>	64	14
<i>Juncus bulbosus</i>	0	57
<i>Juncus conglomeratus</i>	0	21
<i>Juncus effusus</i>	93	100
<i>Juncus inflexus</i>	7	7
<i>Juncus squarrosus</i>	14	21
<i>Lathyrus pratensis</i>	21	21
<i>Leontodon autumnalis</i>	36	29
<i>Lolium perenne</i>	21	43
<i>Lotus corniculatus</i>	7	0
<i>Luzula campestris</i>	43	57
<i>Luzula multiflora</i>	14	0
<i>Luzula sylvatica</i>	0	7
<i>Lychnis flos-cuculi</i>	50	36
<i>Lysimachia nemorum</i>	0	7
<i>Lysimachia nummularia</i>	14	0
<i>Mentha aquatica</i>	0	14
<i>Molinia caerulea</i>	14	7
<i>Myosotis discolor</i>	7	7
<i>Nardus stricta</i>	36	36
<i>Pedicularis sylvatica</i>	7	7
<i>Phleum pratense</i>	14	14
<i>Pilosella officinarum</i>	0	7
<i>Pinguicula vulgaris</i>	7	0
<i>Plantago lanceolata</i>	57	36
<i>Poa annua</i>	7	7
<i>Poa pratensis</i>	36	36
<i>Poa trivialis</i>	86	71
<i>Polygala serpyllifolia</i>	0	7



Species Name	% Freq. 1993	% Freq. 2003
<i>Polygonum persicaria</i>	0	7
<i>Potentilla anserina</i>	14	14
<i>Potentilla erecta</i>	57	71
<i>Potentilla sterilis</i>	7	7
<i>Primula vulgaris</i>	7	7
<i>Prunella vulgaris</i>	79	50
<i>Pteridium aquilinum</i>	7	7
<i>Ranunculus acris</i>	79	100
<i>Ranunculus flammula</i>	71	71
<i>Ranunculus repens</i>	50	86
<i>Rosa canina</i>	7	0
<i>Rubus fruticosus</i> agg.	7	7
<i>Rumex acetosa</i>	64	64
<i>Rumex crispus</i>	7	14
<i>Rumex obtusifolius</i>	7	0
<i>Sagina</i> sp.	43	21
<i>Salix aurita</i>	7	0

Species Name	% Freq. 1993	% Freq. 2003
<i>Senecio aquaticus</i>	79	86
<i>Senecio jacobea</i>	14	14
<i>Sesleria albicans</i>	7	0
<i>Stellaria alsine</i>	0	36
<i>Stellaria graminea</i>	29	14
<i>Stellaria media</i>	14	7
<i>Succisa pratensis</i>	64	64
<i>Taraxacum officinale</i> agg.	21	14
<i>Trichophorum cespitosum</i>	29	0
<i>Trifolium pratense</i>	7	29
<i>Trifolium repens</i>	93	100
<i>Veronica chamaedrys</i>	7	0
<i>Veronica serpyllifolia</i>	0	7
<i>Vicia sepium</i>	7	0
<i>Viola palustris</i>	0	14
<i>Viola riviniana</i>	7	7

**Wet pasture**  
(n=28)

Species Name	% Freq. 1993	% Freq. 2003
<i>Achillea ptarmica</i>	0	4
<i>Agrostis canina</i>	61	61
<i>Agrostis capillaris</i>	43	4
<i>Agrostis stolonifera</i>	93	100
<i>Ajuga reptans</i>	39	7
<i>Alisma plantago-aquatica</i>	4	4
<i>Alnus glutinosa</i>	0	4
<i>Alopecurus geniculatus</i>	86	50
<i>Alopecurus pratensis</i>	46	39
<i>Anagallis tenella</i>	4	4
<i>Angelica sylvestris</i>	0	4
<i>Anthoxanthum odoratum</i>	68	71
<i>Anthriscus sylvestris</i>	11	0
<i>Apium nodiflorum</i>	4	0
<i>Bellis perennis</i>	18	11
<i>Berula erecta</i>	4	4
<i>Betula pubescens</i>	0	4
<i>Briza media</i>	4	4
<i>Bromopsis ramosa</i>	4	0
<i>Callitriche stagnalis</i>	4	4
<i>Caltha palustris</i>	32	29
<i>Cardamine flexuosa</i>	11	7
<i>Cardamine pratensis</i>	79	89
<i>Carex acutiformis</i>	4	0
<i>Carex binervis</i>	7	0
<i>Carex disticha</i>	0	18
<i>Carex echinata</i>	7	29
<i>Carex elata</i>	4	11
<i>Carex flacca</i>	57	7
<i>Carex hirta</i>	50	32
<i>Carex laevigata</i>	7	0
<i>Carex lasiocarpa</i>	25	0
<i>Carex nigra</i>	64	79
<i>Carex ovalis</i>	21	43
<i>Carex pallescens</i>	18	0
<i>Carex panicea</i>	39	46
<i>Carex pendula</i>	7	0
<i>Carex pseudocyperus</i>	4	0
<i>Carex pulicaris</i>	0	4
<i>Carex remota</i>	4	0
<i>Carex riparia</i>	4	0
<i>Carex rostrata</i>	11	32
<i>Carex vesicaria</i>	14	36
<i>Carex viridula ssp.</i>	4	11
<i>Centaurea nigra</i>	4	0
<i>Cerastium fontanum</i>	54	43

Species Name	% Freq. 1993	% Freq. 2003
<i>Cirsium arvense</i>	25	0
<i>Cirsium palustre</i>	18	14
<i>Cirsium vulgare</i>	7	0
<i>Conopodium majus</i>	4	0
<i>Corylus avellana</i>	4	0
<i>Crepis capillaris</i>	4	0
<i>Cynosurus cristatus</i>	46	54
<i>Dactylis glomerata</i>	4	0
<i>Danthonia decumbens</i>	0	4
<i>Daucus carota</i>	4	0
<i>Deschampsia cespitosa</i>	54	50
<i>Eleocharis palustris</i>	0	18
<i>Elymus repens</i>	4	0
<i>Epilobium hirsutum</i>	4	0
<i>Epilobium montanum</i>	0	4
<i>Epilobium obscurum</i>	0	18
<i>Epilobium palustre</i>	39	18
<i>Equisetum fluviatile</i>	21	54
<i>Equisetum palustre</i>	18	14
<i>Eriophorum angustifolium</i>	0	14
<i>Euphrasia officinalis agg.</i>	0	4
<i>Festuca arundinacea</i>	11	14
<i>Festuca pratensis</i>	57	71
<i>Festuca rubra</i>	50	39
<i>Filipendula ulmaria</i>	71	50
<i>Fraxinus excelsior</i>	0	4
<i>Galium aparine</i>	7	0
<i>Galium palustre</i>	71	68
<i>Galium uliginosum</i>	36	0
<i>Geum rivale</i>	7	0
<i>Glyceria fluitans</i>	68	46
<i>Glyceria maxima</i>	4	4
<i>Gnaphthium uliginosum</i>	0	4
<i>Holcus lanatus</i>	79	75
<i>Holcus mollis</i>	7	0
<i>Hydrocotyle vulgaris</i>	32	43
<i>Hypericum tetrapterum</i>	0	4
<i>Hypochaeris radicata</i>	7	0
<i>Iris pseudacorus</i>	29	25
<i>Isolepis setacea</i>	0	11
<i>Juncus acutiflorus</i>		
<i>/articulatus</i>	71	89
<i>Juncus bufonius</i>	7	11
<i>Juncus bulbosus</i>	25	11
<i>Juncus conglomeratus</i>	0	4
<i>Juncus effusus</i>	89	93

Species Name	% Freq. 1993	% Freq. 2003
<i>Juncus inflexus</i>	21	32
<i>Lathyrus pratensis</i>	14	11
<i>Leontodon autumnalis</i>	46	36
<i>Leucanthemum vulgare</i>	7	0
<i>Lolium perenne</i>	54	50
<i>Lotus uliginosus</i>	39	29
<i>Luzula campestris</i>	7	0
<i>Luzula multiflora</i>	21	0
<i>Lychnis flos-cuculi</i>	25	46
<i>Lycopus europaeus</i>	0	4
<i>Lysimachia nemorum</i>	18	0
<i>Lysimachia nummularia</i>	46	61
<i>Lythrum salicaria</i>	0	4
<i>Mentha aquatica</i>	46	50
<i>Menyanthes trifoliata</i>	21	7
<i>Molinia caerulea</i>	4	0
<i>Myosotis laxa</i>	11	18
<i>Myosotis scorpioides</i>	54	46
<i>Myosotis secunda</i>	0	7
<i>Myrica gale</i>	4	0
<i>Nardus stricta</i>	7	0
<i>Odontites verna</i>	0	4
<i>Oenanthe fistulosa</i>	18	29
<i>Parnassia palustris</i>	0	4
<i>Pedicularis palustris</i>	0	4
<i>Pedicularis sylvatica</i>	0	4
<i>Persicaria bistorta</i>	4	0
<i>Phalaris arundinacea</i>	21	14
<i>Phleum pratensis</i>	29	50
<i>Phragmites australis</i>	4	0
<i>Plantago lanceolata</i>	14	7
<i>Plantago major</i>	7	7
<i>Poa annua</i>	14	11
<i>Poa pratensis</i>	57	46
<i>Poa trivialis</i>	93	93
<i>Polygonum amphibum</i>	36	0
<i>Polygonum aviculare</i>	0	7
<i>Polygonum hydropiper</i>	0	4
<i>Polygonum persicaria</i>	4	25
<i>Potamogeton</i> sp.	4	0
<i>Potentilla anserina</i>	57	25
<i>Potentilla erecta</i>	7	7
<i>Potentilla palustris</i>	43	32
<i>Prunella vulgaris</i>	4	29
<i>Ranunculus acris</i>	93	89
<i>Ranunculus ficaria</i>	14	0
<i>Ranunculus flammula</i>	71	71
<i>Ranunculus repens</i>	96	93
<i>Rorippa palustris</i>	0	7
<i>Rorippa sylvestris</i>	0	7

Species Name	% Freq. 1993	% Freq. 2003
<i>Rosa canina</i>	7	0
<i>Rubus fruticosus</i> agg.	4	0
<i>Rumex acetosa</i>	50	39
<i>Rumex acetosella</i>	7	0
<i>Rumex conglomeratus</i>	0	29
<i>Rumex crispus</i>	43	21
<i>Rumex hydrolapathum</i>	4	4
<i>Rumex obtusifolius</i>	7	11
<i>Sagina nodosa</i>	7	0
<i>Sagina procumbens</i>	25	36
<i>Salix aurita</i>	4	0
<i>Salix</i> sp.	0	4
<i>Samolus valerandi</i>	0	4
<i>Scutellaria galericulata</i>	0	4
<i>Senecio aquaticus</i>	89	86
<i>Sonchus arvensis</i>	4	0
<i>Sparganium erectum</i>	0	4
<i>Stachys palustris</i>	4	4
<i>Stellaria alsine</i>	0	21
<i>Stellaria graminea</i>	25	7
<i>Stellaria holostea</i>	7	25
<i>Stellaria media</i>	14	14
<i>Succisa pratensis</i>	25	11
<i>Symphytum tuberosum</i>	4	0
<i>Taraxacum officinale</i> agg.	36	25
<i>Trifolium dubium</i>	4	0
<i>Trifolium pratense</i>	14	11
<i>Trifolium repens</i>	96	96
<i>Triglochin palustris</i>	0	4
<i>Umbilicus rupestris</i>	0	4
<i>Urtica dioica</i>	4	4
<i>Vaccinium myrtillus</i>	4	0
<i>Valeriana officinalis</i>	11	0
<i>Veronica beccabunga</i>	0	4
<i>Veronica chamaedrys</i>	7	0
<i>Veronica scutellata</i>	0	18
<i>Veronica serpyllifolia</i>	11	11
<i>Vicia cracca</i>	4	4
<i>Vicia sepium</i>	7	0
<i>Viola palustris</i>	0	7
<i>Viola riviniana</i>	4	0

## Woodland

(n=13)

Species Name	% Freq. 1993	% Freq. 2003	Species Name	% Freq. 1993	% Freq. 2003
<i>Acer pseudoplatanus</i>	23	23	<i>Chamerion angustifolium</i>	15	0
<i>Aegopodium podagraria</i>	8	0	<i>Chrysosplenium oppositifolium</i>	31	46
<i>Aesculum hippocastaneum</i>	8	15	<i>Circaea lutetiana</i>	46	62
<i>Agrostis canina</i>	8	23	<i>Cirsium arvense</i>	15	0
<i>Agrostis capillaris</i>	23	8	<i>Cirsium dissectum</i>	0	8
<i>Agrostis stolonifera</i>	46	46	<i>Cirsium palustre</i>	23	23
<i>Ajuga reptans</i>	38	23	<i>Cirsium vulgare</i>	8	0
<i>Alchemilla glabra</i>	15	0	<i>Conopodium majus</i>	62	46
<i>Alliaria petiolata</i>	0	8	<i>Corylus avellana</i>	46	62
<i>Allium ursinum</i>	8	8	<i>Crataegus monogyna</i>	85	85
<i>Alnus glutinosa</i>	23	31	<i>Cynosurus cristatus</i>	0	8
<i>Alopecurus geniculatus</i>	38	0	<i>Cystopteris fragilis</i>	38	0
<i>Alopecurus pratensis</i>	31	0	<i>Dactylis glomerata</i>	31	23
<i>Anemone nemorosa</i>	46	62	<i>Dactylorhiza fuchsii</i>	15	0
<i>Angelica sylvestris</i>	8	23	<i>Deschampsia cespitosa</i>	54	54
<i>Anthoxanthum odoratum</i>	23	15	<i>Deschampsia flexuosa</i>	8	0
<i>Anthriscus sylvestris</i>	8	8	<i>Dryopteris dilatata</i>	54	77
<i>Arctium minus</i>	0	8	<i>Dryopteris filix-mas</i>	15	54
<i>Arrhenatherum elatius</i>	15	0	<i>Epilobium hirsutum</i>	23	8
<i>Arum maculatum</i>	69	62	<i>Epilobium obscurum</i>	23	23
<i>Asplenium adiantum-nigrum</i>	8	0	<i>Epilobium palustre</i>	8	0
<i>Athyrium filix-femina</i>	46	31	<i>Equisetum arvense</i>	8	8
<i>Bellis perennis</i>	8	8	<i>Equisetum palustre</i>	8	0
<i>Berula erecta</i>	8	0	<i>Euonymus europaeus</i>	0	8
<i>Betula pubescens</i>	23	23	<i>Fagus sylvatica</i>	15	23
<i>Blechnum spicant</i>	38	31	<i>Festuca pratensis</i>	8	0
<i>Brachypodium sylvaticum</i>	31	23	<i>Festuca rubra</i>	15	0
<i>Bromopsis ramosa</i>	8	8	<i>Filipendula ulmaria</i>	62	46
<i>Caltha palustris</i>	15	15	<i>Fragaria vesca</i>	8	23
<i>Cardamine flexuosa</i>	38	54	<i>Fraxinus excelsior</i>	85	100
<i>Cardamine pratensis</i>	31	38	<i>Galium aparine</i>	62	38
<i>Carex binervis</i>	8	0	<i>Galium odoratum</i>	8	15
<i>Carex demissa</i>	0	8	<i>Galium palustre</i>	15	23
<i>Carex elata</i>	8	8	<i>Geranium lucidum</i>	0	8
<i>Carex flacca</i>	8	15	<i>Geranium robertianum</i>	77	69
<i>Carex hirta</i>	8	0	<i>Geum urbanum</i>	54	46
<i>Carex nigra</i>	31	15	<i>Glyceria fluitans</i>	23	23
<i>Carex ovalis</i>	0	8	<i>Hedera helix</i>	77	92
<i>Carex panicea</i>	23	23	<i>Heracleum sphondylium</i>	15	23
<i>Carex pendula</i>	23	15	<i>Holcus lanatus</i>	38	31
<i>Carex pulicaris</i>	0	8	<i>Hyacinthoides non-scripta</i>	46	38
<i>Carex remota</i>	0	46	<i>Hypericum perforatum</i>	23	0
<i>Carex spicata</i>	8	0	<i>Hypericum pulchrum</i>	0	8
<i>Carex sylvatica</i>	15	46	<i>Hypericum tetrapterum</i>	8	0
<i>Cerastium fontanum</i>	23	8	<i>Hypochaeris radicata</i>	8	8

Species Name	% Freq. 1993	% Freq. 2003	Species Name	% Freq. 1993	% Freq. 2003
<i>Ilex aquifolium</i>	77	77	<i>Ranunculus flammula</i>	15	15
<i>Iris pseudacorus</i>	8	15	<i>Ranunculus repens</i>	0	31
<i>Juncus acutiflorus</i>	15	15	<i>Rhododendron ponticum</i>	8	0
<i>Juncus bufonius</i>	31	8	<i>Rosa canina</i>	38	31
<i>Juncus bulbosus</i>	0	8	<i>Rubus fruticosus</i> agg.	92	100
<i>Juncus conglomeratus</i>	0	15	<i>Rumex acetosa</i>	8	15
<i>Juncus effusus</i>	38	31	<i>Rumex obtusifolius</i>	8	0
<i>Juncus inflexus</i>	8	0	<i>Rumex sanguineus</i>	46	46
<i>Juncus squarrosus</i>	15	0	<i>Salix</i> sp.	38	23
<i>Lapsana communis</i>	8	8	<i>Sambucus nigra</i>	8	8
<i>Larix decidua</i>	8	8	<i>Sanicula europaeus</i>	31	54
<i>Lathyrus linifolius</i>	0	8	<i>Senecio aquaticus</i>	23	23
<i>Lathyrus pratensis</i>	8	0	<i>Senecio jacobaea</i>	31	0
<i>Leontodon autumnalis</i>	15	8	<i>Sorbus aucuparia</i>	15	15
<i>Lolium perenne</i>	8	0	<i>Stellaria alsine</i>	0	15
<i>Lonicera periclymenum</i>	46	54	<i>Stellaria graminea</i>	23	0
<i>Lotus corniculatus</i>	8	0	<i>Stellaria holostea</i>	0	8
<i>Luzula campestris</i>	8	8	<i>Stellaria media</i>	8	0
<i>Luzula sylvatica</i>	23	0	<i>Succisa pratensis</i>	15	15
<i>Luzula multiflora</i>	23	0	<i>Taraxacum officinale</i> agg.	54	62
<i>Lychnis flos-cuculi</i>	15	8	<i>Taxus baccata</i>	8	8
<i>Lysimachia nemoralis</i>	38	31	<i>Trifolium pratense</i>	15	8
<i>Lysimachia nummularia</i>	0	8	<i>Trifolium repens</i>	23	15
<i>Melica uniflora</i>	15	8	<i>Ulex europaeus</i>	8	8
<i>Mentha aquatica</i>	23	8	<i>Ulmus glabra</i>	8	8
<i>Myosotis scorpioides</i>	8	0	<i>Urtica dioica</i>	31	38
<i>Oenanthe crocata</i>	8	0	<i>Valeriana officinalis</i>	0	15
<i>Orchis mascula</i>	38	54	<i>Veronica beccabunga</i>	8	0
<i>Oxalis acetosella</i>	69	62	<i>Veronica chamaedrys</i>	31	31
<i>Phyllitis scolopendrium</i>	31	31	<i>Veronica montana</i>	62	23
<i>Plantago lanceolata</i>	8	8	<i>Veronica serpyllifolia</i>	8	0
<i>Poa annua</i>	8	0	<i>Viburnum opulus</i>	8	23
<i>Poa pratensis</i>	23	0	<i>Vicia sepium</i>	46	38
<i>Poa trivialis</i>	69	77	<i>Viola odorata</i>	8	0
<i>Polypodium vulgare</i>	8	15	<i>Viola riviniana</i>	85	85
<i>Polystichum aculeatum</i>	0	8			
<i>Polystichum setiferum</i>	0	15			
<i>Potentilla anserina</i>	0	15			
<i>Potentilla erecta</i>	15	15			
<i>Potentilla palustris</i>	8	8			
<i>Potentilla reptans</i>	8	0			
<i>Potentilla sterilis</i>	62	23			
<i>Primula vulgaris</i>	69	62			
<i>Prunella vulgaris</i>	0	23			
<i>Prunus laurocerasus</i>	0	8			
<i>Prunus spinosa</i>	31	31			
<i>Pteridium aquilinum</i>	31	8			
<i>Quercus</i> sp.	15	38			
<i>Ranunculus acris</i>	38	38			
<i>Ranunculus auricomus</i>	0	15			
<i>Ranunculus ficaria</i>	54	62			

**Appendix 2.** Percentage frequency of carabid beetle species captured on participant farms in the West Fermanagh and Erne Lakeland ESA in 1993 and 2003.

**Unimproved grassland**  
(n=9)

<b>Species Name</b>	<b>% Freq. 1993</b>	<b>% Freq. 2003</b>
<i>Abax parallelepipedus</i>	22	22
<i>Agonum assimile</i>	0	11
<i>Agonum fuliginosum</i>	33	56
<i>Agonum moestum</i>	0	44
<i>Agonum muelleri</i>	100	33
<i>Agonum obscurum</i>	11	0
<i>Agonum viduum</i>	22	0
<i>Amara aenea</i>	0	11
<i>Amara ovata</i>	0	11
<i>Bembidion aeneum</i>	22	0
<i>Bembidion bruxellense</i>	0	11
<i>Bembidion guttula</i>	0	22
<i>Bembidion mannerheimi</i>	11	0
<i>Calathus melanocephalus</i>	11	0
<i>Carabus arvensis</i>	0	11
<i>Carabus clatratus</i>	22	11
<i>Carabus glabratus</i>	0	11
<i>Carabus granulatus</i>	89	56
<i>Carabus nemoralis</i>	22	0
<i>Chlaenius nigricornis</i>	0	22
<i>Elaphrus cupreus</i>	44	78
<i>Loricera pilicornis</i>	78	44
<i>Nebria brevicollis</i>	100	67
<i>Nebria salina</i>	33	0
<i>Patrobus assimilis</i>	0	33
<i>Pelophila borealis</i>	0	11
<i>Pterostichus anthracinus</i>	44	44
<i>Pterostichus diligens</i>	44	56
<i>Pterostichus madidus</i>	67	44
<i>Pterostichus melanarius</i>	56	44
<i>Pterostichus minor</i>	11	22
<i>Pterostichus niger</i>	78	100
<i>Pterostichus nigrita</i>	67	89
<i>Pterostichus rhaeticus</i>	33	100
<i>Pterostichus strenuus</i>	78	56
<i>Pterostichus vernalis</i>	22	22
<i>Pterostichus versicolor</i>	22	33
<i>Synuchus nivalis</i>	0	11

**Wet pasture**  
(n=10)

<b>Species Name</b>	<b>% Freq. 1993</b>	<b>% Freq. 2003</b>
<i>Abax parallelepipedus</i>	0	10
<i>Agonum albipes</i>	0	10
<i>Agonum assimile</i>	0	10
<i>Agonum dorsale</i>	0	10
<i>Agonum fuliginosum</i>	20	90
<i>Agonum gracile</i>	0	10
<i>Agonum moestum</i>	0	80
<i>Agonum muelleri</i>	90	60
<i>Agonum obscurum</i>	20	20
<i>Agonum piceum</i>	10	0
<i>Agonum viduum</i>	70	0
<i>Amara ovata</i>	10	0
<i>Bembidion aeneum</i>	80	40
<i>Bembidion bruxellense</i>	0	10
<i>Bembidion guttula</i>	10	0
<i>Bembidion mannerheimi</i>	20	10
<i>Bembidion tetracolum</i>	10	0
<i>Carabus clatratus</i>	20	30
<i>Carabus granulatus</i>	90	100
<i>Carabus nemoralis</i>	0	10
<i>Carabus problematicus</i>	0	10
<i>Chlaenius nigricornis</i>	50	40
<i>Clivina fossor</i>	20	10
<i>Elaphrus cupreus</i>	80	70
<i>Leistus fulvibarbis</i>	20	0
<i>Loricera pilicornis</i>	80	50
<i>Nebria brevicollis</i>	90	70
<i>Patrobus assimilis</i>	0	40
<i>Pelophila borealis</i>	20	0
<i>Pterostichus anthracinus</i>	90	90
<i>Pterostichus diligens</i>	90	70
<i>Pterostichus madidus</i>	50	20
<i>Pterostichus melanarius</i>	20	40
<i>Pterostichus minor</i>	30	30
<i>Pterostichus niger</i>	40	90
<i>Pterostichus nigrita</i>	100	100
<i>Pterostichus rhaeticus</i>	0	30
<i>Pterostichus strenuus</i>	60	30
<i>Pterostichus vernalis</i>	50	20

## Hay meadow

(n=4)

Species Name	% Freq. 1993	% Freq. 2003
<i>Agonum dorsale</i>	0	25
<i>Agonum fuliginosum</i>	0	25
<i>Agonum moestum</i>	50	50
<i>Agonum muelleri</i>	100	25
<i>Agonum viduum</i>	50	0
<i>Amara aenea</i>	0	50
<i>Bembidion aeneum</i>	50	0
<i>Calathus melanocephalus</i>	25	25
<i>Carabus clatratus</i>	25	75
<i>Carabus glabratus</i>	0	25
<i>Carabus granulatus</i>	75	75
<i>Chlaenius nigricornis</i>	25	50
<i>Clivina fossor</i>	0	25
<i>Cychrus caraboides</i>	0	25
<i>Elaphrus cupreus</i>	100	50
<i>Loricera pilicornis</i>	100	100
<i>Nebria brevicollis</i>	100	100
<i>Nebria salina</i>	0	25
<i>Patrobus assimilis</i>	0	25
<i>Pterostichus anthracinus</i>	25	25
<i>Pterostichus diligens</i>	50	25
<i>Pterostichus madidus</i>	25	0
<i>Pterostichus melanarius</i>	50	75
<i>Pterostichus niger</i>	50	100
<i>Pterostichus nigrata</i>	100	25
<i>Pterostichus rhaeticus</i>	50	100
<i>Pterostichus strenuus</i>	75	25
<i>Pterostichus vernalis</i>	25	25



**Limestone grassland**  
(n=2)

<b>Species Name</b>	<b>% Freq. 1993</b>	<b>% Freq. 2003</b>
<i>Abax parallelepipedus</i>	50	100
<i>Agonum muelleri</i>	50	0
<i>Amara aenea</i>	0	50
<i>Amara aulica</i>	100	50
<i>Amara communis</i>	50	0
<i>Calathus fuscipes</i>	100	100
<i>Calathus melanocephalus</i>	50	50
<i>Carabus granulatus</i>	50	50
<i>Carabus nemoralis</i>	50	100
<i>Carabus problematicus</i>	50	50
<i>Cychrus caraboides</i>	0	50
<i>Elaphrus cupreus</i>	0	50
<i>Laemostenus terricola</i>	50	0
<i>Loricera pilicornis</i>	50	0
<i>Nebria brevicollis</i>	100	100
<i>Nebria salina</i>	100	50
<i>Notiophilus aquaticus</i>	50	0
<i>Pterostichus diligens</i>	50	0
<i>Pterostichus madidus</i>	100	100
<i>Pterostichus melanarius</i>	100	50
<i>Pterostichus niger</i>	0	50
<i>Pterostichus nigrata</i>	100	50
<i>Pterostichus rhaeticus</i>	0	50
<i>Pterostichus strenuus</i>	100	50

## Woodland

(n=1)

Species Name	% Freq. 1993	% Freq. 2003
<i>Agonum fuliginosum</i>	100	100
<i>Bembidion guttula</i>	0	100
<i>Bembidion mannerheimi</i>	100	0
<i>Carabus clatratus</i>	100	0
<i>Carabus granulatus</i>	100	100
<i>Carabus nemoralis</i>	0	100
<i>Clivina fossor</i>	0	100
<i>Elaphrus cupreus</i>	0	100
<i>Nebria brevicollis</i>	100	100
<i>Pterostichus anthracinus</i>	100	100
<i>Pterostichus madidus</i>	100	100
<i>Pterostichus melanarius</i>	100	100
<i>Pterostichus niger</i>	100	100
<i>Pterostichus nigrata</i>	100	0
<i>Pterostichus strenuus</i>	100	100
<i>Trechus obtusus</i>	100	0

## Heather moorland

(n=6)

Species Name	% Freq. 1993	% Freq. 2003
<i>Abax parallelepipedus</i>	33	33
<i>Agonum assimile</i>	0	17
<i>Agonum fuliginosum</i>	17	33
<i>Amara lunicollis</i>	17	17
<i>Bembidion lampros</i>	33	0
<i>Bradycellus harpalinus</i>	17	0
<i>Calathus fuscipes</i>	17	0
<i>Carabus arvensis</i>	67	33
<i>Carabus clatratus</i>	17	0
<i>Carabus glabratus</i>	0	33
<i>Carabus granulatus</i>	67	33
<i>Carabus nemoralis</i>	50	17
<i>Carabus nitens</i>	33	17
<i>Carabus problematicus</i>	67	67
<i>Cychrus caraboides</i>	17	17
<i>Elaphrus cupreus</i>	0	17
<i>Harpalus latus</i>	0	17
<i>Nebria brevicollis</i>	0	17
<i>Nebria salina</i>	33	17
<i>Notiophilus aquaticus</i>	17	0
<i>Notiophilus biguttatus</i>	0	33
<i>Notiophilus germinyi</i>	0	17
<i>Notiophilus palustris</i>	17	0
<i>Olisthopus rotundatus</i>	33	0
<i>Patrobus assimilis</i>	0	17
<i>Pterostichus diligens</i>	50	33
<i>Pterostichus madidus</i>	50	83
<i>Pterostichus melanarius</i>	50	33
<i>Pterostichus niger</i>	83	100
<i>Pterostichus nigrata</i>	17	17
<i>Pterostichus rhaeticus</i>	67	100
<i>Pterostichus strenuus</i>	33	17
<i>Pterostichus versicolor</i>	17	0

**Appendix 3.** Percentage frequency of spider species captured on participant farms in the West Fermanagh and Erne Lakeland ESA in 1993 and 2003.

**Unimproved grassland**  
(n=9)

Species Name	% Freq. 1993	% Freq. 2003	Species Name	% Freq. 1993	% Freq. 2003
<i>Agyneta subtilis</i>	0	11	<i>Oedothorax retusus</i>	56	33
<i>Allomengea scopigera</i>	11	0	<i>Oxyptila trux</i>	0	22
<i>Alopecosa pulverulenta</i>	44	44	<i>Pachygnatha clercki</i>	78	33
<i>Antistea elegans</i>	11	22	<i>Pachygnatha degeeri</i>	89	78
<i>Baryphyma gowerense</i>	11	0	<i>Pardosa amentata</i>	100	89
<i>Baryphyma trifons</i>	0	11	<i>Pardosa nigriceps</i>	11	0
<i>Bathypantes approximatus</i>	11	11	<i>Pardosa palustris</i>	67	33
<i>Bathypantes gracilis</i>	67	89	<i>Pardosa pullata</i>	100	100
<i>Centromerita bicolor</i>	22	22	<i>Pirata piraticus</i>	78	100
<i>Centromerita concinna</i>	11	11	<i>Pocadicnemis pumilla</i>	0	11
<i>Clubiona reclusa</i>	0	11	<i>Robertus lividus</i>	33	11
<i>Dicymbium nigrum</i>	56	67	<i>Saaristoa abnormis</i>	11	0
<i>Diplocephalus permixtus</i>	44	33	<i>Savignia frontata</i>	11	0
<i>Dismodicus bifrons</i>	0	11	<i>Tiso vagans</i>	44	22
<i>Drassodes lapidosus</i>	11	0	<i>Trochosa spinipalpis</i>	0	44
<i>Drepanotylus uncatus</i>	33	11	<i>Trochosa terricola</i>	67	44
<i>Erigone atra</i>	100	100	<i>Walckenaeria acuminata</i>	11	0
<i>Erigone dentipalpis</i>	100	78	<i>Walckenaeria nudipalpis</i>	11	0
<i>Erigone longipalpis</i>	11	0	<i>Walckenaeria vigilax</i>	22	33
<i>Erigonella hiemalis</i>	0	11	<i>Xysticus cristatus</i>	56	22
<i>Gnathonarium dentatum</i>	33	0			
<i>Gongylidiellum vivum</i>	44	11			
<i>Gongylidium rufipes</i>	0	11			
<i>Hypomma bituberculatum</i>	11	33			
<i>Hypselistes jacksoni</i>	0	11			
<i>Labulla thoracica</i>	11	0			
<i>Lepthyphantes angulatus</i>	11	11			
<i>Lepthyphantes ericaeus</i>	0	11			
<i>Lepthyphantes tenuis</i>	78	78			
<i>Lepthyphantes zimmemanni</i>	67	44			
<i>Leptorhoptrum robustum</i>	56	22			
<i>Lophomma punctatum</i>	78	56			
<i>Micrargus herbigradus</i>	33	22			
<i>Monocephalus fuscipes</i>	11	22			
<i>Neriere montana</i>	0	11			
<i>Oedothorax fuscus</i>	67	89			
<i>Oedothorax gibbosus</i>	22	0			

**Wet pasture**  
(n=10)

Species Name	% Freq. 1993	% Freq. 2003
<i>Alopecosa pulverulenta</i>	20	10
<i>Araeoncus crassiceps</i>	10	10
<i>Bathypantes approximatus</i>	30	50
<i>Bathypantes gracilis</i>	80	60
<i>Bathypantes nigrinus</i>	10	0
<i>Bathypantes setiger</i>	0	10
<i>Centromerita bicolor</i>	10	0
<i>Ceratinella brevipes</i>	10	0
<i>Dicymbium nigrum</i>	40	20
<i>Diplocephalus latifrons</i>	10	0
<i>Diplocephalus permixtus</i>	40	30
<i>Drepanotylus uncatus</i>	20	30
<i>Erigone atra</i>	100	80
<i>Erigone dentipalpis</i>	100	60
<i>Erigone longipalpis</i>	40	10
<i>Erigonella hiemalis</i>	0	10
<i>Gnathonarium dentatum</i>	10	30
<i>Gongylidiellum vivum</i>	20	20
<i>Haplodrassus signifer</i>	10	0
<i>Hypomma bituberculatum</i>	40	30
<i>Lepthyphantes ericaeus</i>	0	10
<i>Lepthyphantes tenebricola</i>	10	0
<i>Lepthyphantes tenuis</i>	90	60
<i>Lepthyphantes zimmermanni</i>	10	0
<i>Leptorhoptrum robustum</i>	40	40
<i>Lophomma punctatum</i>	40	30
<i>Oedothorax fuscus</i>	100	80
<i>Oedothorax gibbosus</i>	40	0
<i>Oedothorax retusus</i>	30	30
<i>Pachygnatha clercki</i>	90	80
<i>Pachygnatha degeeri</i>	90	30
<i>Pardosa amentata</i>	90	80
<i>Pardosa palustris</i>	30	20
<i>Pardosa pullata</i>	90	40
<i>Pirata piraticus</i>	100	80
<i>Porrhomma pygmaeum</i>	0	10
<i>Robertus lividus</i>	10	0
<i>Savignia frontata</i>	20	10
<i>Silometopus elegans</i>	0	10
<i>Tallusia experta</i>	0	20
<i>Tiso vagans</i>	10	0

Species Name	% Freq. 1993	% Freq. 2003
<i>Trochosa ruricola</i>	10	0
<i>Trochosa spinipalpis</i>	0	20
<i>Trochosa terricola</i>	40	30
<i>Walckenaeria vigilax</i>	10	0
<i>Xysticus cristatus</i>	0	10

## Hay meadow

(n=4)

Species Name	% Freq. 1993	% Freq. 2003
<i>Agyneta decora</i>	0	25
<i>Agyneta olivacea</i>	0	25
<i>Alopecosa pulverulenta</i>	0	25
<i>Antistea elegans</i>	25	25
<i>Araeoncus humilis</i>	25	0
<i>Bathypantes gracilis</i>	100	75
<i>Clubiona trivialis</i>	0	25
<i>Dicymbium nigrum</i>	50	50
<i>Diplocephalus latifrons</i>	50	0
<i>Diplocephalus permixtus</i>	100	25
<i>Drepanotylus uncatus</i>	25	50
<i>Erigone atra</i>	100	75
<i>Erigone dentipalpis</i>	100	75
<i>Gnathonarium dentatum</i>	25	0
<i>Gongylidiellum vivum</i>	75	0
<i>Hypomma bituberculatum</i>	0	25
<i>Lepthyphantes tenuis</i>	100	50
<i>Lepthyphantes zimmermanni</i>	25	0
<i>Leptorhoptrum robustum</i>	50	50
<i>Lophomma punctatum</i>	0	25
<i>Monocephalus fuscipes</i>	25	25
<i>Oedothorax fuscus</i>	100	75
<i>Oedothorax retusus</i>	75	0
<i>Pachygnatha clercki</i>	75	50
<i>Pachygnatha degeeri</i>	100	100
<i>Pardosa amentata</i>	100	75
<i>Pardosa palustris</i>	75	75
<i>Pardosa pullata</i>	75	75
<i>Pirata piraticus</i>	75	75
<i>Savignia frontata</i>	75	0
<i>Tiso vagans</i>	25	0
<i>Trochosa spinipalpis</i>	0	50
<i>Trochosa terricola</i>	100	25

## Limestone grassland

(n=2)

Species Name	% Freq. 1993	% Freq. 2003
<i>Agyneta cauta</i>	50	0
<i>Agyneta olivacea</i>	50	0
<i>Agroeca proxima</i>	50	0
<i>Alopecosa pulverulenta</i>	100	100
<i>Bathypantes gracilis</i>	0	50
<i>Centromerita concinna</i>	0	100
<i>Clubiona diversa</i>	0	50
<i>Clubiona neglecta</i>	0	50
<i>Dicymbium nigrum</i>	50	100
<i>Drassodes cupreus</i>	0	100
<i>Erigone atra</i>	100	50
<i>Erigone dentipalpis</i>	50	50
<i>Lepthyphantes tenuis</i>	50	50
<i>Lepthyphantes zimmermanni</i>	50	0
<i>Lophomma punctatum</i>	0	50
<i>Monocephalus fuscipes</i>	0	50
<i>Oedothorax fuscus</i>	100	0
<i>Oedothorax retusus</i>	50	0
<i>Pachygnatha degeeri</i>	100	100
<i>Pardosa amentata</i>	50	100
<i>Pardosa nigriceps</i>	50	50
<i>Pardosa palustris</i>	100	100
<i>Pardosa pullata</i>	100	100
<i>Pirata piraticus</i>	50	0
<i>Segestria senoculata</i>	0	50
<i>Tiso vagans</i>	100	50
<i>Trochosa spinipalpis</i>	0	50
<i>Trochosa terricola</i>	100	100
<i>Walckenaeria acuminata</i>	50	0
<i>Walckenaeria antica</i>	100	50
<i>Walckenaeria vigilax</i>	50	0
<i>Xysticus cristatus</i>	100	100
<i>Xysticus erraticus</i>	0	50

## Woodland

(n=1)

Species Name	% Freq. 1993	% Freq. 2003
<i>Bathyphantes nigrinus</i>	0	100
<i>Ceratinella brevis</i>	100	0
<i>Dicymbium nigrum</i>	100	100
<i>Diplocephalus latifrons</i>	100	100
<i>Diplocephalus permixtus</i>	100	0
<i>Erigone atra</i>	100	0
<i>Erigone dentipalpis</i>	100	0
<i>Erigonella hiemalis</i>	0	100
<i>Gongyliidium vivum</i>	0	100
<i>Lepthyphantes flavipes</i>	100	0
<i>Lepthyphantes menzei</i>	100	0
<i>Lepthyphantes obscurus</i>	100	0
<i>Lepthyphantes tenebricola</i>	100	0
<i>Lepthyphantes zimmermanni</i>	100	100
<i>Micrargus herbigradus</i>	0	100
<i>Monocephalus fuscipes</i>	100	100
<i>Oedothorax fuscus</i>	100	0
<i>Pachygnatha clercki</i>	100	0
<i>Pachygnatha degeeri</i>	0	100
<i>Pardosa amentata</i>	100	0
<i>Pardosa palustris</i>	100	0
<i>Pardosa pullata</i>	0	100
<i>Pirata piraticus</i>	0	100
<i>Trochosa terricola</i>	100	100
<i>Walckenaeria acuminata</i>	100	0



**Heather moorland**  
(n=6)

Species Name	% Freq. 1993	% Freq. 2003
<i>Agroeca proxima</i>	17	33
<i>Agyneta decora</i>	0	17
<i>Agyneta olivacea</i>	0	67
<i>Agyneta subtilis</i>	0	17
<i>Allomengea scopigera</i>	17	0
<i>Alopecosa pulverulenta</i>	33	83
<i>Antistea elegans</i>	33	67
<i>Aphileta misera</i>	0	17
<i>Bathypantes gracilis</i>	0	33
<i>Bolyphantes luteolus</i>	17	17
<i>Centromerita bicolor</i>	0	17
<i>Centromerita concinna</i>	17	0
<i>Ceratinella brevipes</i>	17	17
<i>Clubiona diversa</i>	0	17
<i>Cnephalocotes obscurus</i>	17	0
<i>Dictyna arundinacea</i>	0	17
<i>Diplocephalus permixtus</i>	17	0
<i>Drepanotylus uncatus</i>	0	17
<i>Erigone atra</i>	33	0
<i>Erigone dentipalpis</i>	17	0
<i>Erigonella hiemalis</i>	0	33
<i>Gonatium rubens</i>	0	50
<i>Gongyliidiellum vivum</i>	17	0
<i>Hahnna montana</i>	0	17
<i>Haplodrassus signifer</i>	17	0
<i>Hilaira excisa</i>	0	17
<i>Lepthyphantes alacris</i>	17	33
<i>Lepthyphantes ericaeus</i>	0	17
<i>Lepthyphantes mengei</i>	0	17
<i>Lepthyphantes tenebricola</i>	17	0
<i>Lepthyphantes tenuis</i>	33	50
<i>Lepthyphantes zimmemanni</i>	50	50
<i>Leptorhoptrum robustum</i>	17	0
<i>Lophomma punctatum</i>	0	33

Species Name	% Freq. 1993	% Freq. 2003
<i>Monocephalus fuscipes</i>	0	50
<i>Oedothorax fuscus</i>	17	17
<i>Oedothorax retusus</i>	0	17
<i>Oxyptila atomaria</i>	0	17
<i>Oxyptila trux</i>	33	50
<i>Pachygnatha clercki</i>	83	83
<i>Pachygnatha degeeri</i>	50	67
<i>Pardosa amentata</i>	17	17
<i>Pardosa nigriceps</i>	67	67
<i>Pardosa pullata</i>	100	100
<i>Peponocranium ludicrum</i>	0	17
<i>Pirata piraticus</i>	83	33
<i>Pirata uliginosus</i>	0	17
<i>Pocadicnemis pumilla</i>	0	17
<i>Robertus arundineti</i>	17	0
<i>Robertus lividus</i>	50	33
<i>Saaristoa abnormis</i>	17	0
<i>Scotina gracilipes</i>	0	33
<i>Tapinopa longidens</i>	0	17
<i>Taranucnus setosus</i>	0	33
<i>Tiso vagans</i>	0	17
<i>Trochosa terricola</i>	100	100
<i>Walckenaeria acuminata</i>	50	33
<i>Walckenaeria antica</i>	0	17
<i>Walckenaeria unicornis</i>	0	17
<i>Walckenaeria vigilax</i>	17	33
<i>Xysticus cristatus</i>	50	67

**Appendix 4.** New spider county records from the West Fermanagh and Erne Lakeland ESA, 2003.

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*Walckenaeria unicornis* O.P.-Cambridge, 1861

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A small money spider (1.8-3.1mm) found amongst detritus, moss and grass as well as taller vegetation and scrub. Widespread but uncommon in Britain and Ireland. It has been widely trapped throughout the Republic of Ireland and has been recorded from Cos Antrim, Armagh and Londonderry in Northern Ireland. This record ♂ (9 May 2003) is from heather moorland at Moneyourgan, Letterbreen, Co Fermanagh. (H125408).

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*Hahnia montana* (Blackwall, 1841)

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A small money spider (1.5-2mm) found in leaf litter, moss, damp situations especially in woodland. It has been recorded from various other habitats including grassland, heathland, fen and sand dunes. Its distribution is common and widespread but scattered throughout Britain. Irish records exist for Cos Antrim, Clare, Dublin, Galway and Mayo. This record ♂ (1 September 2003) is from heather moorland on Topped Mountain, Enniskillen, Co. Fermanagh (H310456).

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*Taranucnus setosus* (O.P.-Cambridge, 1863)

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A rather rare money spider (2.5-3.4mm) found in wet habitats and sometimes heather moorland. It has a widespread but local distribution. In Ireland it has records from Cos Antrim, Down, Kerry, Londonderry, Wexford and Tyrone. Both these records are from heather moorland in Co Fermanagh. One ♂ (9 May 2003) was found at Moneyourgan, Letterbreen (H125408). The other ♀ (8 July 2003) was found near Belleek (G993557).

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*Bathyphantes setiger* F.O.P.-Cambridge, 1894

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An uncommon money spider (1.7-2.2mm) found in wet habitats such as wet heath and riverbanks. It has a widespread but local distribution. Records exist for Cos Carlow, Clare, Kildare, Monaghan, Tipperary and Tyrone. This record ♀ (10 September 2003) is from wet pasture near Galloon Bridge, Newtownbutler, Co Fermanagh (H469290).

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