Queen's University Belfast

BIOLOGICAL MONITORING OF CUILCAGH MOUNTAIN

1999-2004

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

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SUMMARY

1 Cuilcagh Mountain contains a unique and interesting collection of habitats, geophysical and biological features and has the second largest expanse of intact blanket bog in Northern Ireland. The summit contains a good example of montane heath, a scarce habitat in Northern Ireland. Limestone grassland occurs on the lower slopes.

2 Cuilcagh Mountain has been traditionally grazed by sheep and to a lesser extent cattle. Some areas have also been subjected to hand and machine peat cutting. Sporadic uncontrolled burning has also occurred. These factors have affected the condition of the vegetation, particularly the blanket bog.

3 Various designations and ownerships apply to the area. Part of Cuilcagh Mountain was designated an ASSI in 1994. This area was subsequently submitted as a candidate SAC and also designated as a Ramsar site. Cuilcagh Mountain falls within the West Fermanagh and Erne Lakeland Environmentally Sensitive Area and the majority of the land has been managed under ESA agreement since 1993. In 1999 an area of land was leased by Fermanagh District Council and is known as the Cuilcagh Mountain Park.

4 Plant and invertebrate communities were monitored in 1999 to determine the effect of current designations on aspects of the biodiversity of Cuilcagh Mountain. The mountain was split into eight monitoring units based on ownership and management. Botanical survey and trapping of invertebrates was carried out at representative transects. This baseline survey reflected the major vegetation types, carabid beetle and spider communities within each unit.

5 A full resurvey of plant and invertebrate monitoring sites was carried out in 2004. This enabled the effects of management practices on the dominant communities in each unit to be determined. The condition of

the vegetation at monitoring sites was assessed using criteria including heather cover and height, *Sphagnum* cover and the amount of bare ground present.

6 Overgrazing of some areas of the mountain has led to degradation of habitat. Blanket bog vegetation is easily damaged through poaching by livestock, which leads to bare ground and a decrease in *Sphagnum* cover. Management of land under ESA scheme agreement has meant a reduction in stocking levels on Cuilcagh since 1993. This has led to an apparent gradual improvement in the condition of the vegetation. Monitoring results suggest that plant and invertebrate species diversity had been maintained on most areas under ESA agreement. Blanket bog in the Cuilcagh Mountain Park, under a lower stocking rate than the other areas of heather moorland, had shown an increase in dwarf-shrub cover since 1999.

7 The sites on Aghatirourke, where cattle grazing had occurred until recent fencing of whole area, still showed signs of damage. However there were indications of improvement, for example an increase in *Sphagnum* cover. It is likely that a combination of both burning and overgrazing in some areas, such as the Gortalughany sites, had resulted in damage to the vegetation. This area was still subjected to cattle grazing in 2004 and as such the blanket bog vegetation remained in poor condition.

8 Heavy grazing by sheep was apparent on the area of common grazing not under ESA agreement. In particular the lower sites showed no improvement in vegetation condition since 1999 with a high cover of bare ground and little heather.

9 Recovery of blanket bog vegetation after severe damage by machine peat cutting is known to be an extremely slow process. Monitoring has indicated good regeneration of vegetation over bare peat on the cutover sites, with increases in heather, cotton-grasses and mosses occurring

between 1999 and 2004. There has been a programme of drain blockage on the cutover areas in an attempt to raise the water table. However any significant restoration of vegetation to active blanket bog on these areas may take years to occur. In particular it may prove difficult to establish *Sphagnum* on the cutover peat surface.

10 The limestone grassland under ESA management was heavily sheep grazed resulting in a very short sward. There was a significant decrease in plant species diversity on the monitored sites between 1999 and 2004.

11 The monitoring units were chosen as they represented different management units on the mountain. Units tend to divide the area into blocks running up the mountain whereas the vegetation and invertebrate communities generally showed altitudinal divisions. Management of stock within these units without altitudinal sub-division may therefore prove problematic.

12 The biological monitoring programme has resulted in measurable criteria which can be used to assess whether vegetation and invertebrate communities have changed in response to current management practices. Changes in vegetation can be difficult to detect over a short period of time as ecological processes may be slow. Cuilcagh offers a unique opportunity to assess the impact of land management and designations on a range of habitat types within a relatively small and diverse area. Therefore extended monitoring of Cuilcagh Mountain over a longer period of time is essential.

1. INTRODUCTION

Cuilcagh Mountain lies 20km south-west of Enniskillen in County Fermanagh. The summit is the highest point in the county at 667m, and the summit ridge forms the border with County Cavan in the Irish Republic. The area contains a unique and interesting collection of flora and fauna, habitats and geophysical features. The mountain has the second largest expanse of intact blanket bog in Northern Ireland and the summit ridge contains a good example of *Racomitrium* moss heath, a scarce habitat in Northern Ireland. Heath and grassland communities are also well represented, producing a varied and diverse mosaic of habitats. The distribution of vegetation types on Cuilcagh is determined largely by geology, slope, drainage and nutrient conditions. Three broad categories can be identified: the montane heath of the summit slopes, blanket bog covering the gentle middle slopes and limestone grasslands on the lower slopes. The site is also important for breeding birds, especially Golden Plover *Pluvialis apricaria* and Merlin *Falco columbarius*.

Cuilcagh Mountain has been traditionally grazed by sheep and to a lesser extent cattle. Some areas have also been subjected to hand and machine peat cutting. Sporadic uncontrolled burning has also occurred. The condition of habitats on Cuilcagh Mountain has been affected by these factors. Parts of the mountain, particularly the blanket bog, have been damaged or have vegetation in a poor condition. Therefore designations have been put in place to ensure the maintenance and enhancement of the conservation status of the area.

In 1994, part of Cuilcagh Mountain (2744.45ha) was designated an Area of Special Scientific Interest (ASSI). The whole of the ASSI was subsequently included in the list of candidate Special Areas of Conservation (SAC) submitted to the European Commission by the UK Government. Cuilcagh Mountain was primarily included as it supports an active blanket bog habitat, identified on Annex I of the EC “Habitats Directive” (92/43/EEC) as a priority habitat. Other SAC selection features included the montane heath, wet heath, dry heath, scree slopes, lakes and pool systems. A management plan was drawn up for the

SAC/ASSI (Gunn, 1999) and the primary conservation objective is to maintain each habitat in favourable condition.

Cuilcagh Mountain is within the West Fermanagh and Erne Lakeland Environmentally Sensitive Area (ESA) which was designated by the Department of Agriculture for Northern Ireland (now DARD) in 1993. Prior to the introduction of the ESA scheme there was grazing all year round on the mountain with high stocking densities which resulted in large parts of the blanket bog becoming degraded. The majority of farmers with land on the mountain entered the ESA scheme, with 1490ha of land under agreement. The scheme provides mechanisms for positive management to maintain and enhance habitats and biodiversity. Management prescriptions for heather moorland include control of grazing by limiting stock levels (2 ewes/ha) and exclusion of stock during winter. Some parts of the mountain are grazed as common land and not under ESA agreement. Therefore stocking rates here have not been as controlled, although with introduction of cross-compliance this should change.

In July 1997, Fermanagh District Council (FDC) entered into a long-term lease on an area of land on Cuilcagh, now known as the Cuilcagh Mountain Park (CMP). This area is also under ESA agreement. It contains around 237ha of blanket bog and a 28ha area of severely degraded, machine-cut bog. A management plan was prepared (Gunn & Walker, 1999) and the Park was formally opened in June 1999. The main area of active blanket bog (102ha) in the CMP was fenced and a lower stocking rate of 0.5 ewes per ha has applied since then. Areas of machine-cut bog (excluded from SAC/ASSI) are currently being restored by FDC by a programme of drain blockage.

The Aghatirourke Forest Nature Reserve (AFNR) forms the upper part of the Florence Court Forest Park, stretching from Cove Rock to the summit. This area (695ha) is owned by the Forest Service and has been leased to the FDC since 2003. Although not under ESA management, agreed stocking rate has been low for some years (<1ewe/ha). However there had been problems with control of livestock not owned by the lessee, particularly cattle, but complete fencing of the

AFNR in 2004 aimed to prevent this. The AFNR is managed in partnership with the RSPB.

The overall management of Cuilcagh Mountain is fraught with difficulties because of the multiplicity of ownership and designations that apply. The range of habitats means there is potential for conflict of interests between objectives for each type. Scientific monitoring has proved an invaluable tool in determining the effectiveness of management practices in Environmentally Sensitive Areas. Monitoring of plant and invertebrate communities was initiated to determine the effect of current designations, particularly the ESA scheme, on aspects of the biodiversity of Cuilcagh Mountain. A baseline survey of sample sites across the area was carried out by QUB in 1999 (Cameron *et al*, 2000). A partial resurvey was carried out in 2001 of the summit, CMP and AFNR. The following report details results of a full resurvey of all monitoring sites carried out in 2004. Changes in species diversity and vegetation condition are discussed in relation to management of particular monitoring units.

2. METHODS

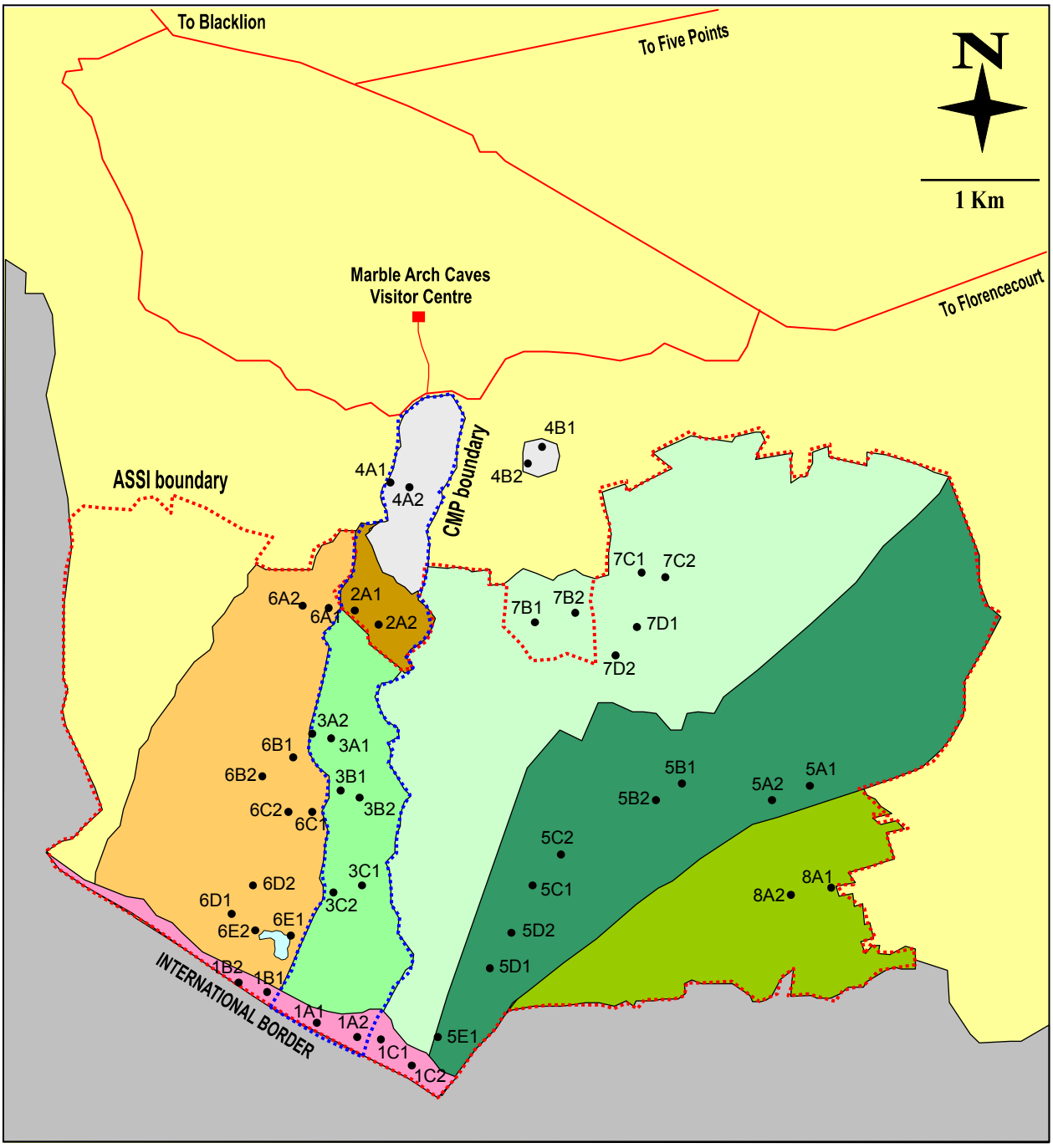
2.1 SAMPLING PROCEDURE

The area was divided into eight monitoring units, representing an approximate stratified sampling procedure (Figure 1). These could be easily assigned to a particular designation or management unit and therefore enabled conclusions to be more easily drawn. Many of the monitoring units were then further stratified into altitude classes (Table 1).

The monitoring units were as follows:

1. The summit area - including land in CMP, ESA and common grazing
2. Cutover area of Cuilcagh Mountain Park (CMP-cutover)
3. Cuilcagh Mountain Park (CMP)
4. Limestone grassland - within and outside CMP
5. Aghatirourke Forest Nature Reserve (AFNR)
6. Commonage – common grazing not under ESA agreement
7. Trien - land under ESA management, including cutover area
8. Gortalughany - land under ESA management, cattle-grazed

Figure 1. Map of Cuilcagh Mountain showing the monitoring units and the position of each transect recorded in 1999 and 2004



Key:			
	Summit		Limestone grassland
	CMP		Trien
	CMP – cutover		AFNR
	Commonage		Gortalughany

2.2 BIOLOGICAL MONITORING

2.2.1 Vegetation monitoring

The method for vegetation monitoring was based on the recording of permanent quadrats as used for the ESA monitoring in Northern Ireland (Hegarty *et al*, 1994). Higher plant nomenclature follows Stace (1997) and bryophytes follow Watson (1981).

A total of 45 sites were surveyed from June to September 1999, with two 100m transects recorded for each sub-unit (Table 1). The location of these sites is shown on Figure 1. The transects were chosen as representative samples of the vegetation within each area. Five nested quadrats were recorded at equidistant intervals along each transect. Plant species (including bryophytes and lichens) and their estimated percentage cover were recorded in each 1m x 1m quadrat. Bryophytes were recorded collectively for the limestone grassland. Any additional species were recorded in an outer 2m x 2m quadrat. The percentage cover of bare ground, rock, leaf litter and dung were also recorded within each quadrat. Dwarf-shrub height was measured at 10 points along each transect.

Two opposite corners of each quadrat were marked with a wooden peg along the line of the transect. Each transect was plotted using a Global Positioning System (Garmin 12 XL GPS linked to a Communication Systems International MBX-3 2 Channel Automatic Differential Beacon Receiver) to facilitate re-location.

Permanent vegetation quadrats were resurveyed in 2004 using same methodology.

2.2.2 Invertebrate monitoring

Ground beetles and spiders have been successfully monitored in ESAs as indicators of biodiversity and environmental change. 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.

Table 1. Sampling sites for plant and invertebrate monitoring of Cuilcagh Mountain

MONITORING UNIT	SAMPLING SITE	SUB-UNITS	NO. OF TRANSECTS	NO. OF QUADRATS	PITFALL TRAPS
SUMMIT	1A1 1A2	CMP	2	10	6
	1B1 1B2	Commonage	2	10	6
	1C1 1C2	ESA	2	10	6
CMP-CUTOVER	2A1 2A2	250-300m	2	10	6
CMP	3A1 3A2	300-350m	2	10	6
	3B1 3B2	350-400m	2	10	6
	3C1 3C2	400-450m	2	10	6
LIMESTONE	4A1 4A2	CMP/ESA	2	10	6
	4B1 4B2	ESA	2	10	6
AFNR	5A1 5A2	300-350m	2	10	6
	5B1 5B2	350-400m	2	10	6
	5C1 5C2	400-450m	2	10	6
	5D1 5D2	450-500m	2	10	6
	5E1	500-550m	1	5	3
COMMONAGE	6A1 6A2	250-300m	2	10	6
	6B1 6B2	300-350m	2	10	6
	6C1 6C2	350-400m	2	10	6
	6D1 6D2	400-500m	2	10	6
	6E1 6E2	500m (lakeside)	2	10	6
TRIEN	7B1 7B2	250-300m (cutover)	2	10	6
	7C1 7C2	350-400m	2	10	6
	7D1 7D2	300-350m	2	10	6
GORTALUGHANY	8A1 8A2		2	10	6
TOTAL			**45**	**225**	**135**

A total of 135 pitfall traps were located on Cuilcagh Mountain (Table 1). Invertebrates were sampled using polythene containers 9cm wide and 20cm deep part filled with ethylene glycol to prevent the escape and deterioration of specimens before collection. Three traps were placed 10m from each vegetation transect at a spacing of approximately 50m. Two collections were made over an eight week period from mid July to mid September. Traps were replaced and refilled with a fresh ethylene glycol solution after the first collection and removed at the end of the collection period. The contents from the three traps at each sampling site were pooled and frozen at -5^{oC} until sorting. All adult ground beetles taken in the traps were identified to species according to Lindroth (1974). Species identifications were confirmed by Dr. Roy Anderson, (Agriculture and Environment Division, Department of Agriculture for Northern Ireland). All adult spiders were identified to species according to Roberts (1985). Species identifications were confirmed by Dr. Damian McFerran (Ulster Museum). All other invertebrate material collected in pitfall traps has been retained for future identification. Pygmy shrews, mice, frogs, newts and lizards sampled in pitfall traps were also recorded for comparison between years (Appendix 5).

2.3 DATA ANALYSIS

All data collected were stored and manipulated using the relational database Microsoft ACCESS and statistics carried out within EXCEL.

Plant diversity of each monitoring unit was measured using the mean number of species recorded per quadrat, and the total number of species recorded in the unit. The frequency and mean percentage cover of each plant species for each unit was calculated. Changes were analysed following resurvey to determine the effects of current management practises on each unit. The presence and abundance of important indicator species, such as heather (*Calluna vulgaris*) and *Sphagnum* moss, were used to detect changes in vegetation. The cover of bare ground, *Sphagnum* species, dwarf-shrubs (i.e. *Calluna*, *Erica* spp., *Vaccinium* and *Empetrum*) and graminoids (i.e. grasses, sedges and rushes) was also assessed for each unit, as these attributes can be used for determining vegetation condition.

Two-way indicator species analysis or TWINSPAN (Hill, 1979) was used to classify the monitored sites into vegetation types on the basis of plant species abundance in $1m^2$ quadrats (see Appendix 1). These groups were used to describe the vegetation on Cuilcagh in terms of the typical species and attributes. Default settings including pseudospecies cut-levels were used.

The quadrat data from the sites was compared to the National Vegetation Classification (NVC) using the program TABLEFIT (Hill, 1993). This identifies the vegetation type at each site according to the goodness-of-fit with defined NVC communities. These communities are detailed in Rodwell (1991). This classification is derived from data from Great Britain and therefore Irish vegetation does not necessarily show a good fit.

Mean numbers of carabid beetle and spider individuals and species were calculated for each transect (Luff, 1996). An indication of species diversity for each unit was given by calculating the Shannon-Wiener diversity index for each site (Kent & Coker, 1992). This index takes into account the number of species and the relative proportion of individuals of each species.

3. RESULTS

3.1 Botanical data

Plant species lists for each monitoring unit were compiled from the quadrat data (Appendix 2). Species diversity varied considerably between each monitoring unit (Table 2). Sites on CMP and AFNR were separated for purposes of analysis into blanket bog and poor fen (i.e. rushy) sites, based on the TWINSPAN classification (Appendix 1). Limestone grassland had a much higher species diversity than the peatland habitats. Poor fen vegetation tended to have a higher number of higher plant species than blanket bog or heath sites. Of the blanket bog vegetation the species diversity on the cutover had increased significantly but remained lower than other units.

Table 2. Mean number (and standard error) of plant species recorded per $4m^2$ quadrat on Cuilcagh Mountain for each monitoring unit in 1999 and 2004. Statistical comparison using paired t-test (NS=non–significant, *=p<0.05, **=p<0.01, ***=p<0.001).

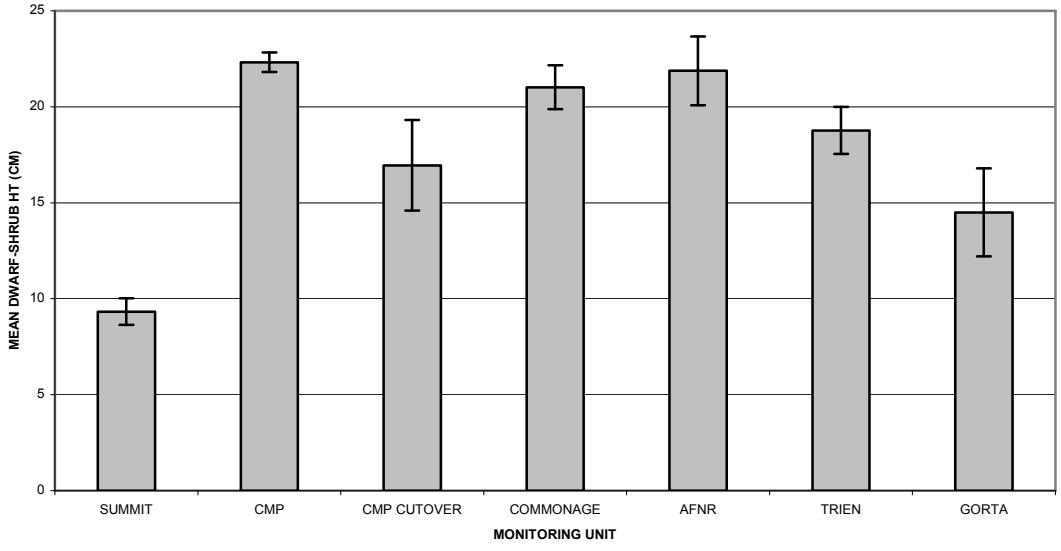
Monitoring unit	n	Mean no. of higher plants			Mean no. of species		
		1999	2004	p	1999	2004	p
Summit	30	6.5 (0.3)	5.6 (0.3)	NS	11.9 (0.6)	10.7 (0.5)	NS
CMP cutover	10	3.9 (0.4)	5.1 (0.2)	**	5.3 (0.5)	7.2 (0.4)	*
CMP blanket bog	20	6.8 (0.4)	7.9 (0.4)	*	9.8 (0.6)	15.3 (0.8)	**
CMP poor fen	10	7.6 (0.9)	10.6 (0.6)	*	11.0 (0.9)	11.5 (2.4)	NS
AFNR blanket bog	35	6.5 (0.3)	6.9 (0.4)	NS	12.6 (0.8)	11.2 (0.6)	NS
AFNR poor fen	10	13.5 (0.8)	11.4 (0.5)	*	20.1 (1.1)	17.6 (1.0)	NS
Commonage	50	7.4 (0.4)	7.4 (0.3)	NS	11.6 (0.7)	14.0 (0.6)	*
Trien	30	7.0 (0.4)	6.7 (0.2)	NS	9.4 (0.4)	11.1 (0.5)	*
Gortalughany	10	9.6 (1.3)	8.3 (0.8)	NS	14.2 (1.7)	14 (0.6)	NS
Limestone	20	34.0 (0.9)	30.0 (0.7)	***	na	na	-

Changes between years in the mean cover of vegetation attributes such as heather and bare ground cover were analysed for each monitoring unit (Table 3). These are discussed in the following section. Mean dwarf-shrub height for each monitoring unit in 2004 gives an indication of the growth phase and condition of heather (Figure 2). Height was lowest on the summit due to wind-clipping. On units where there has been damage to vegetation in the past either through peat cutting or overgrazing, dwarf-shrub height was lower than comparable areas of active blanket bog on the CMP.

Table 3. Mean percentage cover (and standard error) of vegetation attributes of each peatland monitoring unit on Cuilcagh Mountain in 1999 and 2004. Statistical comparison using paired t-test (NS=non–significant, *=p<0.05, **=p<0.01, ***=p<0.001).

Monitoring unit		*Calluna vulgaris*			Bare ground			*Sphagnum* spp.			Dwarf-shrub			Graminoids		
	n	1999	2004	p	1999	2004	p	1999	2004	p	1999	2004	p	1999	2004	p
SUMMIT	30	56.9 (9.4)	60.5 (5.5)	NS	0.9 (0.5)	1.6 (0.9)	NS	1.3 (1.0)	3.0 (1.9)	NS	57.9 (8.5)	68.7 (5.0)	NS	13.3 (7.7)	17.2 (7.4)	NS
CMP-CUTOVER	10	10.2 (6.8)	14.3 (5.7)	NS	65.2 (1.0)	20.0 (5.0)	**	0.3 (0.3)	0.2 (0.2)	NS	13 (8.3)	20.1 (9.3)	NS	7.5 (2.1)	44.3 (9.5)	*
CMP-BLANKET BOG	20	26.3 (10.3)	36.8 (14.4)	*	5.1 (1.3)	2.8 (1.8)	*	17.2 (3.5)	22.1 (7.2)	NS	29.4 (5.4)	41.1 (6.8)	*	33.9 (5.4)	57.3 (4.2)	*
CMP-POOR FEN	10	24.5 (9.5)	25.5 (2.5)	NS	0.5 (0.5)	0 (0)	NS	33.6 (3.4)	36.2 (2.0)	NS	28.4 (11.2)	34.1 (5.7)	NS	44.2 (11.4)	54 (5.8)	NS
AFNR-BLANKET BOG	30	35 (6.8)	32.7 (8.4)	NS	10.3 (6.5)	10 (3.4)	NS	16.9 (4.2)	22.7 (4.7)	**	38.8 (6.8)	36 (8.4)	NS	32.8 (4.8)	49.9 (4.9)	*
AFNR-POOR FEN	15	9.5 (3.2)	9.7 (3.6)	NS	4.5 (2.6)	0.8 (0.5)	NS	16.1 (5.3)	14.6 (4.3)	NS	10 (3.1)	10.8 (3.6)	NS	56.8 (6.5)	68.3 (7.5)	NS
COMMONAGE	45	38.6 (6.1)	32.9 (7.2)	NS	19.5 (8.5)	14.8 (5.7)	NS	11.7 (3.4)	14.4 (3.9)	NS	40 (7.2)	38.9 (7.4)	NS	23.4 (3.5)	46 (4.9)	***
TRIEN	30	21.0 (5.1)	27.1 (5.9)	NS	13 (5.7)	8.2 (3.6)	NS	9.8 (3.5)	8.7 (2.7)	NS	26.1 (6.3)	33.5 (7.5)	NS	46.1 (5.5)	54.6 (5.8)	NS
GORTALUGHANY	10	10.4 (1.0)	5.8 (1.8)	NS	19.4 (7.6)	15.2 (5.8)	NS	6.3 (0.9)	5.0 (0.6)	NS	14.5 (3.9)	9.3 (4.9)	NS	49.2 (6.0)	59.2 (11.8)	NS

Figure 2. Mean dwarf-shrub height (with standard error) in each peatland monitoring unit on Cuilcagh Mountain in 2004



3.2 Invertebrate data

3.2.1 Carabid beetle species

There were 32 carabid beetle species and 2121 individuals captured in 2004 compared to 35 species and 3064 individuals in 1999. Full species lists for each monitoring unit can be found in Appendix 3. In terms of mean number of species per site recorded in 2004, limestone grassland had the greatest diversity, followed by CMP and the summit sites (Table 4). The sites at Gortalughhany had the lowest mean number of carabid species and individuals captured. The only unit where the mean number of beetle species had significantly changed was AFNR, which had a lower number recorded in 2004 than in 1999.

In general there were fewer individuals caught in 2004 than in 1999, with the exception of the summit and Trien. Most species were recorded in fewer numbers than in 1999, suggesting that decline was due to natural fluctuations caused by climate or weather conditions affecting trap efficiency (Luff, 1982). In particular there were large decreases in the number of *Nebria* species captured. However the commonage was the only monitoring unit where there was a significantly lower mean number of beetle individuals recorded per site (Table 4).

The ground beetle *Carabus nitens* was found on the lower slopes of the CMP (including the cutover) and the commonage in both years. This species is highly dependent on upland peat habitat having only been found on upland or lowland blanket bog and northern wet heath in previous ESA monitoring (McFerran *et al*. 1996). It is recorded in the British Red Data Book (Shirt, 1987) as nationally scarce and listed as a species of conservation concern in the Northern Ireland Biodiversity Strategy Proposals (NI Biodiversity Group 1999). The Northern Ireland populations appear to be relatively important in a European context (Anderson *et al*., 2000).

Trechus rivularis, a rarely recorded species found on fens and mires in Ireland (Anderson & Cameron, 1992), had increased in frequency and abundance since 1999.

Table 4. Mean number of carabid species and individuals trapped per site on each monitoring unit in 1999 and 2004, and Shannon-Wiener diversity index. Statistical comparison using paired t-test (NS=non–significant, *=p<0.05, **=p<0.01, ***=p<0.001).

SUMMIT		**1999**		**2004**		
	n	mean	s.e.	mean	s.e.	p
Mean no. of individuals per site	6	55.2	16.6	78.5	31.2	NS
Mean no. of species per site	6	9.7	1.9	8.3	0.8	NS
Mean diversity index per site	6	1.8	0.2	1.5	0.1	NS

CMP CUTOVER		**1999**		**2004**		
	n	mean	s.e.	mean	s.e.	p
Mean no. of individuals per site	2	63	0	20.5	7.5	NS
Mean no. of species per site	2	8.5	0.5	7.5	0.5	NS
Mean diversity index per site	2	1.5	0.4	1.7	0.1	NS

CMP		**1999**		**2004**		
	n	mean	s.e.	mean	s.e.	p
Mean no. of individuals per site	6	54.7	5.8	40.8	12.4	NS
Mean no. of species per site	6	8.7	0.9	8.5	1	NS
Mean diversity index per site	6	1.6	0.1	1.7	0.02	NS

LIMESTONE		**1999**		**2004**		
	n	mean	s.e.	mean	s.e.	p
Mean no. of individuals per site	4	171.25	59.6	67.5	17.1	NS
Mean no. of species per site	4	8	0.6	9.5	1.9	NS
Mean diversity index per site	4	1.3	0.1	1.7	0.1	**

AFNR		**1999**		**2004**		
	n	mean	s.e.	mean	s.e.	p
Mean no. of individuals per site	9	47.8	12.5	46.3	15.3	NS
Mean no. of species per site	9	9.7	0.9	6.9	0.9	**
Mean diversity index per site	9	1.8	0.1	1.4	0.1	*

COMMONAGE		**1999**		**2004**		
	n	mean	s.e.	mean	s.e.	p
Mean no. of individuals per site	10	96.5	19.2	41.6	5.3	*
Mean no. of species per site	10	9.8	1.2	8	0.3	NS
Mean diversity index per site	10	1.5	0.2	1.7	0.1	NS

TRIEN		**1999**		**2004**		
	n	mean	s.e.	mean	s.e.	p
Mean no. of individuals per site	6	24.3	8.4	40.3	17.2	NS
Mean no. of species per site	6	5.8	1.4	6.2	1.7	NS
Mean diversity index per site	6	1.2	0.3	1.2	0.2	NS

GORTALUGHANY		**1999**		**2004**		
	n	mean	s.e.	mean	s.e.	p
Mean no. of individuals per site	2	26	1	9.5	2.5	NS
Mean no. of species per site	2	7	1	5	0	NS
Mean diversity index per site	2	1.4	0.1	1.5	0.1	NS

4. DISCUSSION

Summit

The summit sites were montane heath characterised by short vegetation with high cover and frequency of *Calluna vulgaris* and the moss *Racomitrium lanuginosum*. They were classified by TABLEFIT as NVC communities H10 *Calluna-Erica cinerea* heath or H14 *Calluna-Racomitrium* heath. Two sites (1A1 and 1B1) were on areas of slightly deeper peat and characterised by *Calluna vulgaris*, bilberry (*Vaccinium myrtillus)* and hare's tail cottongrass (*Eriophorum vaginatum*) and corresponded more closely with NVC community M19 *Calluna –Eriophorum* blanket mire.

There was no significant increase in mean number of all plant species or higher plants recorded per $4m^2$ between 1999 and 2004 (Table 2). This indicates that overall plant species diversity had been maintained on the summit.

The condition of the heath vegetation recorded along the transects was generally favourable, meeting the targets for montane heath (English Nature, 1998). There was no significant increase in cover of *Calluna vulgaris* or dwarf-shrubs recorded within the quadrats (Table 3). However dwarf-shrub cover had increased from 57.9% to 68.7%, i.e. favourable. A non-significant increase in *Racomitrium lanuginosum* was also recorded, from 16.5% to 20.0% (Table 3). Dwarf-shrub height was between 5 and 10cm (Figure 2). There was no significant cover of bare ground recorded within the quadrats. However a large area of CMP summit had bare peat and rock, due to natural erosion and possibly past heavy grazing. Montane heath is particularly vulnerable to damage through trampling by livestock or people. Vegetation on the summit was short with little bare ground or grass cover, possibly indicating a low grazing intensity.

The summit and upper slopes supported distinct beetle and spider communities and provided habitat for *Hilaira frigida* a small upland spider not previously recorded in Northern Ireland. There were no significant changes in carabid species diversity between 1999 and 2004.

Cuilcagh Mountain Park – cutover area

This was an area of previously machine-cut blanket bog with a high cover of bare peat that was being recolonised by pioneer peatland species, particularly common cotton-grass (*Eriophorum angustifolium*) and the alien moss *Campylopus introflexus*.

Plant species diversity remained low on cutover areas compared with areas of intact blanket bog. However there was a significant increase in the mean number of species recorded per $4m^2$ from 5.3 to 7.2 ($p<0.05$) and higher plants from 3.9 to 5.1 ($p<0.01$) (Table 2). No new higher plant species appear to have colonised the area but those species already present have spread. Bryophyte species numbers may have increased as they are primary colonisers on the bare peat surface.

There was a significant decrease in the amount of bare peat cover (including algal mats) between 1999 and 2004 from 65.2 to 20% ($p<0.01$). On site (2A1) particularly this was due to the spread of *Campylopus introflexus* (an undesirable species) over the bare peat surface (from 26.6% in 1999 to 59% in 2004) and the large increase in the cover of common cotton-grass from 4.8% to 47% ($p<0.05$). The mean cover of *Calluna vulgaris* increased from 10.2% to 14.3% (NS). Pioneer heather plants and seedlings were quite numerous, indicating active regeneration. There were some patches of mature bushes present, which obviously still remained after cutting.

There was a significant increase in total graminoid cover, mainly *Eriophorum* spp. and *Scirpus*, between years ($p<0.05$). The mean cover of *Sphagnum* moss remained very low (0.2%) along both transects. The peat surface appeared to be too dry over most of the area for re-colonisation by *Sphagnum* species at present, particularly at 2A1. However cotton-grasses (*Eriophorum* spp.) may be a precursor to *Sphagnum* mosses by acting as 'nursery' species to provide suitable conditions for colonisation (Brooks & Stoneman, 1997). Increase in the cover of common cotton-grass may also suggest a rising water table. FDC have attempted to restore the former bog vegetation since 1998 by blocking the drainage channels to raise the water level.

Species diversity for spider populations was low at baseline on the cutover area in comparison to the other peatland units reflecting the low structural diversity of the vegetation. There were no significant changes in carabid diversity between 1999 and 2004.

Cuilcagh Mountain Park

The sites on the lower and mid-slopes of the CMP (3A/3B) were blanket bog characterised by high frequency and cover of deer-grass (*Scirpus cespitosus*), cotton-grasses (*Eriophorum* spp.), heather (*Calluna vulgaris*) and *Sphagnum* species. They were best described as NVC community M17 *Scirpus cespitosus – Eriophorum vaginatum* blanket mire. The two higher sites (3C) were located on rush-dominated poor fen with patches of wet heath. These were classified as NVC type M6 *Carex echinata-Sphagnum recurvum/auriculatum* mire.

On the blanket bog sites plant species diversity had significantly increased between 1999 and 2004 (Table 2). The mean number of higher plants per quadrat had increased from 6.8 to 7.9 ($p<0.05$), whilst the mean number of both higher and lower plants combined had increased from 9.8 to 15.3 ($p<0.01$).

The cover of *Calluna vulgaris* significantly increased over the four blanket bog sites from 26.3% to 36.8% ($p<0.05$) between 1999 and 2004. Heather was generally in building/mature phase and height was generally 15-25cm. There was no significant increase in cover of *Sphagnum* species. The cover of bare ground although already low, decreased significantly from 5.1% to 2.8% ($p<0.05$). There was a significant increase in graminoid cover from 33.9% to 57.3% ($p<0.05$) on these sites. This was due to large increases in the recorded cover of common cotton-grass and deer-grass. These changes in vegetation may be indications of vegetation change due to the reduced grazing pressure of 0.5 ewe/ha on the fenced section of the CMP.

Graminoid cover greater than 50% for blanket bog may indicate unfavourable condition (English Nature, 1998). Otherwise the targets for favourable vegetation condition were met, including dwarf-shrub cover greater than 33% and *Sphagnum*

species frequent and widespread. Grazing impacts were light over most of the grazing unit, with very little bare ground recorded.

No significant changes in vegetation were recorded on the two poor-fen transects between 1999 and 2004 (Table 3). However a significant increase in the number of higher plant species per quadrat was observed from 7.6 to 10.6 ($p<0.05$). N.B. Quadrat marker posts were not located for these transects at resurvey.

There were no significant changes in carabid species diversity on the CMP between 1999 and 2004. The indicator species *Carabus nitens* was newly recorded within the CMP in 2004, being recorded at two sites. The frequency of *Trechus rivularis* had increased from 17% to 67%.

Aghatirourke Forest Nature Reserve

This unit consisted of a mosaic of blanket bog and poor fen/flush, with wet heath on steeper upper slopes. Blanket bog sites were characterised by *Calluna vulgaris*, deer-grass, cotton-grasses and *Sphagnum capillifolium.* These were classified as NVC communities M17 *Scirpus -Eriophorum* mire or M19 *Calluna – Eriophorum* mire. The sites on poor fen were characterised by presence of rushes (*Juncus* spp.), sedges (*Carex* spp.), bent grasses (*Agrostis* spp.) and sweet-vernal grass (*Anthoxanthum odoratum)*, *Sphagnum* species and the moss *Polytrichum commune*.

There was no change in plant species diversity on the blanket bog sites between 1999 and 2004. *Sphagnum* cover increased significantly from 1999 to 2004 from 16.9% to 22.7% ($p<0.01$) on the bog sites. Mean bare ground cover on these sites showed no change. However on site 5B1 there was a large increase in bare ground cover between years from 1.4% to 9%, due to signs of old cattle trampling and associated erosion. Site 5A1 had a particularly high cover of bare ground (23%) and very low *Sphagnum* cover (less than 5%), indicating poor condition. Graminoid cover increased from 32.8 to 49.9% ($p<0.05$) approaching the 50% cover assessed as being of unfavourable condition for blanket bog (English Nature, 1998). Overall dwarf-shrub cover was greater than 36% and remained

unchanged from the 1999 baseline survey. Much of the heather along recorded transects was in the late mature growth phase and up to 40cm in height.

On the three rushy, poor fen sites there was an increase in the cover of heath rush (*Juncus squarrosus*) from 15.1% to 20.4%. Total graminoid cover also increased considerably which may indicate heavy grazing pressure by sheep, particularly on site 5E. These grassy areas are likely to be preferentially grazed by sheep.

Grazing by cattle was seen in 2001 during the interim survey on the lower slopes of the AFNR. No evidence of recent grazing by cattle was observed in 2004, however the effects of past poaching were still apparent. Damage by trampling and poaching by sheep was still apparent on the wetter areas of bog in 2004. However, the increase in abundance of Sphagnum and graminoids since 1999 may indicate a decrease in grazing pressure. Changes and improvement in vegetation condition should become more apparent following fencing of the area in 2004.

Over the AFNR there was a significant decrease in carabid species numbers ($p<0.01$) and diversity index ($p<0.05$) between 1999 and 2004.

Commonage

The monitored sites were mainly on blanket bog, with nine of the sampled transects corresponding to NVC M19 *Calluna -Eriophorum vaginatum* mire. The remaining site was classified as NVC M6 *Carex echinata-Sphagnum recurvum* poor fen and was dominated by rushes. The upper sites in the area around Lough Atona were drier with relatively high cover of heather but also high cover of bare ground probably due to a combination of erosion and stock damage.

A significant increase in all plant species recorded per quadrat from 11.6 to 14 was observed between years ($p<0.05$) although the number of higher plants remained the same. The fact that more bryophytes were recorded in 2004 could be due to recorder differences between years rather than any change in vegetation.

Overall, the heather cover was relatively high with a mean cover of 33%, with no significant change since the baseline survey in 1999. However, cover was extremely variable with very low coverage on the lower slopes and high coverage further up the mountain. Heather heights generally ranged from 15-25cm with the majority of heather bushes being classed as mature

A highly significant increase in graminoid cover was observed from 23.4% to 46% cover ($p<0.001$) approaching the 50% cover assessed as being an unfavourable condition for blanket bog (English Nature, 1998). This may be due to the sustained overgrazing that has occurred in this area giving competitive advantage to graminoids over *Calluna* and other dwarf shrubs that cannot regenerate so vigorously after browsing and defoliation.

Bare ground cover was high in comparison to other areas of the mountain, with a reduction in cover from 19.5 to 14.8% (NS) between 1999 and 2004. The amount of bare ground cover was variable and very high in places indicating heavy trampling and possibly past burning concentrated mainly on the blanket bog of the lower slopes. Sheep grazing is moderate to high over most of the area and evidence of frequent quad-bike use is common in the form of badly churned up patches of bare peat.

There was a significant decrease in the numbers of carabid individuals recorded between years although the mean number of species per site had not significantly decreased.

Trien

The area around Trien was blanket bog grading to wet heath on the steeper slopes. The monitored sites were five areas of NVC M17 *Scirpus cespitosus-Eriophorum vaginatum* blanket bog and one area of NVC M15 *Scirpus cespitosus-Erica tetralix* wet heath on the higher slopes. The most frequent species were heather (*Calluna vulgaris)*, bog asphodel (*Narthecium ossifragum*), cross-leaved heath (*Erica tetralix*) and common bog-cotton (*Eriophorum angustifolium*).

The lower slopes of Trien have been extensively cutover in the past by machine and are badly damaged and dissected by large drainage channels. Many of the ditches have been blocked by FDC/CMP staff to raise the water table and encourage the recolonisation of characteristic bog vegetation.

Mean plant species diversity had increased between years ($p<0.05$) although there was still a low total number of species recorded in comparison to the CMP or AFNR.

The area of bare peat had reduced from 13% to 8.7 % since 1999 (NS), with corresponding increases in dwarf shrubs and graminoids (NS). Sphagnum cover remained unchanged at approximately 9%.

Mean heather cover had increased from 21% to 27% cover since 1999. Heather height varied from 15-25cm with bushes ranging in maturity from building to degenerate. In particular heather cover on the cutover sites (7B1 and 7B2) had significantly increased from 8% to 17.5% ($p<0.05$). This may be due to recovery since machine peat cutting ceased. This area has been excluded from the SAC due to the unfavourable condition of the bog. However, the area appears to be slowly recovering and may warrant inclusion in the future if conditions continue to improve favourably.

This unit had a comparatively low carabid species diversity and there were no significant changes between 1999 and 2004.

Gortalughany

The monitored sites were two transects of *Scirpus cespitosus-Eriophorum vaginatum* blanket bog (NVC M17) characterised by a high cover of deergrass (*Scirpus cespitosus)* and common bog-cotton (*Eriophorum angustifolium)*. This area occurred at the boundary of the SAC and on the edge of a damaged area of cutover peat. There had been hand cutting in the past and there were signs of recent cattle grazing.

There was no change in plant species diversity between years. The mean cover of bare ground, *Sphagnum*, dwarf shrub and graminoids had all remained relatively unchanged since the baseline survey in 1999. Cover of bare ground remained high due to damage caused by cattle poaching and possibly quad-bike usage.

Heather cover appeared to have declined from 10.4% to 5.8% between 1999 and 2004. However this result was non-significant due to the small sample size. Heather height was generally 10-20cm tall, with a mixture of pioneer, building and mature bushes present. Low heather and *Sphagnum* cover together with the dominance of *Scirpus* and high frequency of carnation sedge (*Carex panicea*) may indicate past burning of the vegetation and overgrazing. In particular cattle were still present this area, leading to continued damage to *Sphagnum* through poaching.

There were no significant changes in carabid species diversity between 1999 and 2004. This unit had the lowest mean number of carabid species and individuals recorded in 2004.

Limestone grassland

The limestone grassland had a relatively high cover of fescue (*Festuca ovina* and *F. rubra*), crested dog's tail (*Cynosurus cristatus*) and daisy (*Bellis perennis*). Characteristic species included carnation sedge (*Carex flacca*), ladies bedstraw (*Galium verum*), ribwort plantain (*Plantago lanceolata*), yarrow (*Achillea millefolium*), thyme (*Thymus praecox*), bulbous buttercup (*Ranunculus bulbosus*) and bird's foot trefoil (*Lotus corniculatus*).

The species diversity of the limestone grassland in the CMP and in the ESA area was high with a mean number of 30 higher plant species recorded per $4m^2$ quadrat and a total of 62 species recorded in 2004. Similar species richness was found on both areas of grassland. However there was a significant decrease in the number of plant species recorded since 1999 ($p<0.001$). The vegetation was grazed by sheep, which has resulted in a low sward height (generally below 5cm). Heavy grazing and trampling can result in loss of plant diversity and structure on

limestone grassland. Bracken (*Pteridium aquilinum*) was present on all sites, being particularly abundant on some areas of the CMP.

The limestone area at the base of the mountain had different carabid beetle and spider communities to those found on the blanket bog and summit habitats. Characteristic beetle species found on the limestone grassland were *Calathus fuscipes, Nebria brevicollis* and *Pterostichus madidus*. Although the limestone grassland supported a reasonable number of carabid species the diversity index of this area at was reduced by the high abundance of these three fairly common species. The numbers of individuals captured in 2004 was only 40% of those captured in the baseline. There was an increase in the number of carabid species recorded in 2004 (NS) and significant increase in the Shannon diversity index between years ($p<0.01$).

5. CONCLUSIONS

Plant and invertebrate communities have been monitored in order to determine the effect of current designations and describe changes in the biodiversity of Cuilcagh Mountain. Baseline information has been compared with resurvey data following a five-year period. Although the area was divided into eight monitoring units to aid comparison, care should be taken in comparing one monitoring unit to another as the area has been subjected to various undocumented past management practices such as haphazard burning and grazing at undefined levels. The monitoring units were chosen to represent different management units on the mountain. Units tend to divide the area into blocks running up the mountain whereas the vegetation generally shows altitudinal divisions. Management of stock within these units without altitudinal sub-division may therefore prove problematic.

Cuilcagh Mountain is a very large and heterogeneous area with a mosaic of vegetation types falling within each monitoring unit. This survey reflected the major vegetation types, carabid beetle and spider communities within each unit and gave an indication of the effects of management practices on the dominant communities in each unit. However, it should be noted that some less dominant communities within the mosaic of a monitoring unit may exhibit responses to management which are not consistent with the rest of the unit.

Changes in plant species diversity for each monitoring unit were analysed as an indication of whether habitat was being maintained or enhanced by current management. Upland heath and bog communities often have comparatively low plant species diversity due to the harsh conditions. Only a small range of specialised stress-tolerant species are adapted to live under such conditions. These can tolerate environmental stress such as low nutrient availability or waterlogged soils. Therefore high numbers of species do not necessarily indicate higher quality vegetation. High species diversity can be due to the heterogeneity of vegetation within the sample site.

The presence or absence of some species is useful in monitoring change, although changes in species composition tend to lag behind environmental

changes. Particular indicator species can be used to detect changes, for example increases in *Sphagnum* cover suggest recovery of degraded bog (Rowell, 1988). The complement and cover of *Sphagnum* species is of primary importance when monitoring blanket bog communities. Multivariate techniques have been used to analyse vegetation data, which has been useful for descriptive purposes. These groups can also be related to any environmental information.

The reduction in stocking levels since 1993 by farmers in the ESA scheme appeared to have led to a gradual improvement in the quality of the vegetation. The blanket bog sites on the CMP had lower grazing levels than other areas under ESA management. Results show that the vegetation here was in a favourable condition and showed signs of enhancement indicated by increased plant species diversity and heather cover.

Waterlogged bog vegetation is easily damaged through poaching, particularly by cattle, which leads to the destruction of the *Sphagnum* carpet. Other, drier communities can tolerate a greater degree of grazing and are maintained by light grazing. However they are still liable to damage through overgrazing. These communities were generally present on the mid and higher altitude sites. Areas of blanket bog where there was recent or continued cattle grazing (i.e. AFNR and Gortulughany) had a high cover of bare ground and low *Sphagnum* cover due to poaching damage. Cattle grazing is no longer allowed on blanket bog under the new ESA scheme. Improvement in vegetation condition on the AFNR should become more apparent following fencing of the area in 2004.

Overgrazing has been identified as a continuing problem on the lower sites of the commonage. It is likely that a combination of both burning and overgrazing in some areas such as the Gortalughany sites has resulted in the poor condition of the vegetation. Blanket bog communities are severely affected by burning. However, drier sites where heather has become over mature can benefit from controlled burning. Due to the close proximity of wet bog and drier heath on Cuilcagh, any management by burning should be approached with extreme caution.

Recovery of bog vegetation after severe damage by machine peat cutting is known to be an extremely slow process and there can be no guarantee in success of attaining an actively growing mire surface (Rowell, 1988). Since 1999, there has been an increase in plant species diversity on the cutover areas of blanket bog. The amount of bare ground has reduced considerably with associated increases in heather, moss and graminoid cover. The effects of peat cutting and drainage may lead to the development of wet heath vegetation on cutover peat rather than active blanket mire. Research on peatland restoration (Rochefort, 2003) has shown that three factors are paramount to the success of *Sphagnum* establishment on bare peat surfaces: i) active introduction of spores, ii) presence of a protective mulch, or 'nursery' plants such as *Eriophorum* species, to improve microclimatic conditions, and iii) rewetting of the site by blocking the former drainage system. The restoration of the cutover area of the CMP through drain blocking to raise water levels does not yet appear to have been successful in increasing the *Sphagnum* cover. However it should be noted that although the vegetation transects were chosen to be representative, they cover a limited area and so more *Sphagnum* establishment may be occurring on different parts of the cutover.

The baseline monitoring programme resulted in measurable criteria which were compared at resurvey to assess whether vegetation and invertebrate communities had changed in response to current management practices. Changes in vegetation can be difficult to detect over a short period of time, as ecological processes may be slow, and so extended monitoring over a longer period of time may prove to be of value. The biological monitoring programme has provided further evidence of the conservation value of Cuilcagh Mountain and has added considerably to the base of knowledge on its ecology and biodiversity.

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7. APPENDICES

1. Vegetation classification using TWINSPAN.

2. Plant species recorded in each monitoring unit in 2004

3. Carabid beetle species found on each of the monitoring units on Cuilcagh Mountain, 1999 and 2004.

4. Spider species found on each of the monitoring units on Cuilcagh Mountain, 1999 and 2004.

5. Small vertebrates recorded on each of the monitoring units

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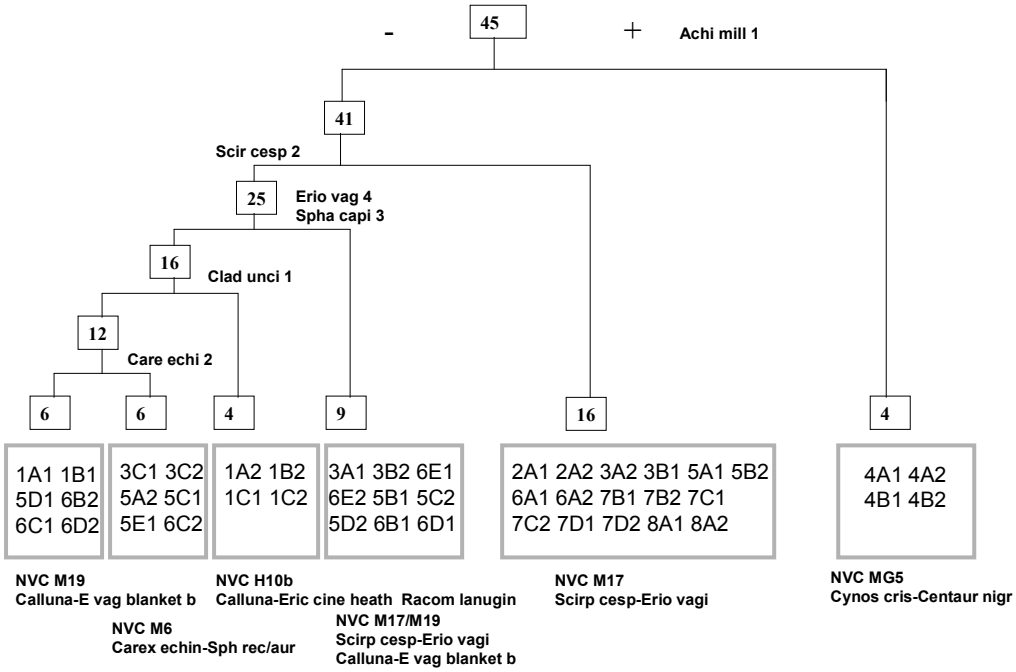
Appendix 1. Vegetation classification using TWINSPAN

Classification of monitored sites

The 45 transects were split using TWINSPAN into six distinct groupings (Figure 1). Sites were further analysed using TABLEFIT to prescribe each site to an NVC community. TWINSPAN and TABLEFIT analyses showed good similarity, with TWINSPAN groups broadly falling into NVC classifications. Groupings are described in detail below.

Figure 1. Dendrogram showing end-groups and indicator species derived from TWINSPAN classification of vegetation sample on Cuilcagh Mountain, 2004.



Description of the TWINSPAN vegetation groups

Group 1

The sites in this group were blanket bog sites characterised by heather *Calluna vulgaris* and hare's tail cotton-grass *Eriophorum vaginatum*. Other frequent species included mosses *Sphagnum capillifolium*, *S. papillosum* and *Hypnum cupressiforme*.

Sites were on areas scattered across the mountain, including two summit sites on deeper peat, three commonage sites and one from AFNR.

All of the sites were classified by TABLEFIT as NVC type M19 *Calluna- Eriophorum vaginatum* blanket mire.

Group 2

The sites in this group were poor fen sites characterised by the presence of star sedge *Carex echinata* and *Sphagnum recurvum*. Other frequent species included tormentil *Potentilla erecta*, *Polytrichum commune*, marsh horsetail *Equisetum palustre* and soft rush *Juncus effusus*.

Sites were scattered across the mountain with two sites on the CMP, two sites on AFNR and one site on the commonage.

All the sites were classified by TABLEFIT as M6 *Carex echinata-Sphagnum recurvum/auriculatum* mire.

Group 3

These sites were heath on shallow peat characterised by the presence of the lichen *Cladonia uncialis*. Other frequent species included *Carex bigelowii*, *Huperzia selago*, *Racomitrium lanuginosum* and *Hypnum cupressiforme*. The sites were exclusively found on the summit.

All of the sites were classified by TABLEFIT as H10b *Calluna vulgaris-Erica cinerea* sub-community *Racomitrium lanuginosum* heath.

Group 4

These sites were a mixture of blanket bog sites characterised by the high cover of hare's tail cotton-grass *Eriophorum vaginatum* and *Sphagnum capillifolium.* Other frequent species included *Rhytidiadelphus loreus*, *Hylocomium splendens*, *Carex echinata* and bilberry *Vaccinium myrtillis*.

These sites were scattered over the survey area, with four transects in the commonage, two in the CMP and three in AFNR.

The sites were classified using TABLEFIT as a mixture of M17 *Scirpus cespitosus-Eriophorum vaginatum* blanket mire and M19 *Calluna- Eriophorum vaginatum* blanket mire.

Group 5

These sites were characterised by the frequency of species such as wavy-hair grass *Deschampsia flexuosa*, heath rush *Juncus squarrosus*, and mosses *Polytrichum commune* and *Plagiothecium undulatum*.

These sites included all of Trien, Gortulughany, the cutover area of CMP, two commonage sites, two sites on the CMP and two sites on AFNR.

Using TABLEFIT these sites were predominantly classified as M17 *Scirpus cespitosus-Eriophorum vaginatum* blanket mire.

Group 6

These sites were characterised by the presence of yarrow *Achillea millefolium*. Other species included ribwort plantain *Plantago lanceolata*, ladies bedstraw *Galium verum*, spring sedge *Carex caryophyllea* and daisy *Bellis perennis*.

The sites included the areas of limestone grassland within the CMP and in the adjacent sample area. Using TABLEFIT they were classified as MG5 *Cynosurus cristatus* mesotrophic grassland. A more detailed study of the bryophyte flora is likely to give a more accurate classification of limestone grassland.

Appendix 2. Plant species recorded in each monitoring unit on Cuilcagh Mountain, 2004.

SUMMIT (n = 6)

Calluna vulgaris
Calypogeia muellerana
Campylopus paradoxus
Carex bigelowi
Carex binervis
Carex nigra
Cladonia portentosa
Cladonia pyxidata
Cladonia uncialis
Deschampsia flexuosa
Dicranum scoparium
Diplophyllum albicans
Empetrum nigrum
Eriophorum angustifolium
Eriophorum vaginatum
Galium saxatile
Huperzia selago
Hylocomium splendens
Hypnum cupressiforme
Juncus bulbosus
Juncus squarrosus
Lophozia ventricosa
Mylia taylorii
Plagiothecium undulatum
Pleurozia purpurea
Pleurozium schreberi
Polytrichum alpestre
Polytrichum commune
Potentilla erecta
Racomitrium lanuginosum
Rhytidiadelphus loreus
Scirpus cespitosus
Scapania sp.
Sphagnum capillifolium
Sphagnum tenellum
Vaccinium myrtillus

CMP (n = 6)

Agrostis canina
Agrostis capillaris
Anthoxanthum odoratum
Aulacomnium palustre
Calluna vulgaris
Calypogeia muellerana
Campylopus paradoxus
Carex echinata
Carex nigra
Carex panicea
Cladonia portentosa
Deschampsia flexuosa
Dicranum scoparium
Diplophyllum albicans
Drosera rotundifolia
Epilobium sp.
Erica tetralix
Eriophorum angustifolium
Eriophorum vaginatum
Galium saxatile
Hylocomium splendens
Hypnum cupressiforme
Juncus bulbosus
Juncus conglomeratus
Juncus effusus
Juncus squarrosus
Kurzia pauciflora
Lophocolea bidentata
Lophozia ventricosa
Luzula multiflora
Luzula sylvatica
Molinia caerulea
Mylia taylorii
Narthecium ossifragum
Odontoschisma sphagni
Pellia epiphylla
Plagiothecium undulatum
Pleurozia purpurea
Pleurozium schreberi
Potentilla erecta
Racomitrium lanuginosum
Rhytidiadelphus loreus
Rhytidiadelphus squarrosus
Sagina procumbens
Scirpus cespitosus
Scapania sp.
Sphagnum auriculatum
Sphagnum capillifolium
Sphagnum cuspidatum
Sphagnum palustre
Sphagnum papillosum
Sphagnum recurvum
Sphagnum subnitens
Sphagnum tenellum
Vaccinium myrtillus

CMP - CUTOVER (n = 2)

Calluna vulgaris
Campylopus introflexus
Cladonia portentosa
Cladonia pyxidata
Erica tetralix
Eriophorum angustifolium
Eriophorum vaginatum
Hypnum cupressiforme
Narthecium ossifragum
Plagiothecium undulatum
Polytrichum commune
Scirpus cespitosus
Sphagnum capillifolium
Sphagnum papillosum
Sphagnum tenellum

LIMESTONE GRASSLAND (n= 4)

Achillea millefolium
Agrostis canina
Agrostis capillaris
Agrostis stolonifera
Alchemilla agg.
Anthoxanthum odoratum
Bellis perennis
Briza media
Campanula rotundifolia
Cardamine pratensis
Carex caryophylla
Carex flacca
Carex pulicaris
Centaurea nigra
Cerastium fontanum
Cirsium palustre
Cirsium vulgare
Crataegus monogyna
Cynosurus cristatus
Dactylis glomerata
Danthonia decumbens
Euphrasia agg.
Festuca sp.
Galium saxatile
Galium verum
Hieracium pilosella
Holcus lanatus
Hypochaeris radicata
Isolepis setacea
Juncus acutiflorus
Juncus effusus
Koelaria cristata
Leontodon autumnalis
Leucanthemum vulgare
Linum catharticum
Lolium perenne
Lotus corniculatus
Luzula campestris
Pilosella officinarium
Plantago lanceolata
Plantago major
Poa annua
Poa pratensis
Poa trivialis
Polygala vulgaris
Potentilla erecta
Potentilla sterilis
Prunella vulgaris
Pteridium aquilinum
Ranunculus acris
Ranunculus bulbosus
Rumex acetosa
Sagina procumbens
Senecio jacobea
Sesleria caerulea
Succisa pratensis
Taraxacum officinale agg.
Thymus praecox
Trifolium pratense
Trifolium repens
Veronica chamedrys
Viola riviniana

COMMONAGE (n = 10)

Agrostis canina
Agrostis capillaris
Anthoxanthum odoratum
Arctostaphylos uva-ursi
Aulacomnium palustre
Calluna vulgaris
Calypogeia muellerana
Campylopus introflexus
Campylopus paradoxus
Campylopus pyriformis
Carex echinata
Carex nigra
Carex panicea
Cladonia flerkiana
Cladonia furcata
Cladonia portentosa
Cladonia pyxidata
Cladonia sp.
Cladonia uncialis
Dactylorhiza maculata
Deschampsia flexuosa
Dicranum scoparium
Diplophyllum albicans
Drosera rotundifolia
Empetrum nigrum
Equisetum palustre
Erica cinerea
Erica tetralix
Eriophorum angustifolium
Eriophorum vaginatum
Festuca ovina
Galium saxatile
Hylocomium splendens
Hypnum cupressiforme
Juncus bulbosus
Juncus conglomeratus
Juncus effusus
Juncus squarrosus
Leucobryum glaucum
Listera cordata
Lophocolea bidentata
Lophozia ventricosa
Luzula sylvatica
Mnium hornum
Molinia caerulea
Mylia taylorii
Nardus stricta
Narthecium ossifragum
Odontoschisma sphagni
Plagiothecium undulatum
Pleurozia purpurea
Pleurozium schreberi
Poa annua
Polytrichum alpestre
Polytrichum commune
Polytrichum juniperinum
Potentilla erecta
Pseudoscleropodium purum
Racomitrium lanuginosum
Rhytidiadelphus loreus
Rhytidiadelphus squarrosus
Rumex acetosa
Scirpus cespitosus
Scapania sp.
Sphagnum capillifolium
Sphagnum cuspidatum
Sphagnum palustre
Sphagnum papillosum
Sphagnum recurvum
Sphagnum subnitens
Sphagnum tenellum
Thuidium tamariscinum
Vaccinium myrtillus

TRIEN (n = 6)

Calluna vulgaris
Campylopus introflexus
Campylopus paradoxus
Carex panicea
Cladonia furcata
Cladonia portentosa
Cladonia pyxidata
Cladonia squamosa
Cladonia uncialis
Dicranum scoparium
Diplophyllum albicans
Drosera rotundifolia
Erica cinerea
Erica tetralix
Eriophorum angustifolium
Eriophorum vaginatum
Hypnum cupressiforme
Juncus conglomeratus
Lophozia ventricosa
Molinia caerulea
Mylia taylorii
Narthecium ossifragum
Odontoschisma sphagni
Pleurozia purpurea
Polygala serpyllifolia
Potentilla erecta
Racomitrium lanuginosum
Scirpus cespitosus
Sphagnum capillifolium
Sphagnum cuspidatum
Sphagnum palustre
Sphagnum papillosum
Sphagnum subnitens
Sphagnum tenellum
Splachnum sphaericum
Vaccinium myrtillus

GORTALUGHANY (n = 2)

Agrostis canina
Calluna vulgaris
Campylopus introflexus
Campylopus paradoxus
Carex demissa
Carex echinata
Carex nigra
Carex panicea
Carex vesicaria
Cladonia portentosa
Cladonia sp.
Cladonia uncialis
Dicranum scoparium
Diplophyllum albicans
Drosera rotundifolia
Equisetum palustre
Erica cinerea
Erica tetralix
Eriophorum angustifolium
Eriophorum vaginatum
Huperzia selago
Hypnum cupressiforme
Juncus bulbosus
Kurzia pauciflora
Lophozia ventricosa
Molinia caerulea
Narthecium ossifragum
Odontoschisma sphagni
Polytrichum commune
Potentilla erecta
Racomitrium lanuginosum
Rhytidiadelphus loreus
Rhytidiadelphus squarrosus
Scirpus cespitosus
Sphagnum capillifolium
Sphagnum cuspidatum
Sphagnum palustre
Sphagnum papillosum
Sphagnum subnitens
Sphagnum tenellum
Succisa pratensis

AFNR (n = 9)

Agrostis canina
Agrostis capillaris
Anthoxanthum odoratum
Aulacomnium palustre
Calluna vulgaris
Campylopus introflexus
Campylopus pyriformis
Carex binervis
Carex curta
Carex echinata
Carex nigra
Carex panicea
Cladonia furcata
Cladonia portentosa
Cladonia pyxidata
Cladonia squamosa
Cladonia uncialis
Dactylorhiza maculata
Erica cinerea
Deschampsia flexuosa
Dicranum scoparium
Diplophyllum albicans
Drosera rotundifolia
Empetrum nigrum
Equisetum palustre
Erica tetralix
Eriophorum angustifolium
Eriophorum vaginatum
Galium saxatile
Hylocomium splendens
Hypnum cupressiforme
Juncus acutiflorus
Juncus acutiflorus
Juncus bulbosus
Juncus effusus
Juncus squarrosus
Kurzia pauciflora
Lophocolea bidentata
Lophozia ventricosa
Luzula multiflora
Luzula sylvatica
Molinia caerulea
Nardus stricta
Narthecium ossifragum
Odontoschisma sphagni
Plagiothecium undulatum
Pleurozia purpurea
Pleurozium schreberi
Polytrichum commune
Potentilla erecta
Rhytidiadelphus loreus
Rhytidiadelphus squarrosus
Rumex acetosa
Scirpus cespitosus
Sphagnum capillifolium
Sphagnum cuspidatum
Sphagnum palustre
Sphagnum papillosum
Sphagnum recurvum
Sphagnum subnitens
Sphagnum tenellum
Succisa pratensis
Thuidium tamariscinum
Vaccinium myrtillus

Appendix 3. Carabid beetle species found on each of the monitoring units on Cuilcagh Mountain, 1999 and 2004

SUMMIT

Abax parallelepipedus
Agonum assimile
Bradycellus verbasci
Calathus melanocephalus
Carabus clathratus
Carabus problematicus
Loricera pilicornis
Nebria brevicollis
Nebria salina
Notiophilus aquaticus
Notiophilus biguttatum
Notiophilus germinyi
Notiophilus palustris
Patrobus assimilis
Pelophila borealis
Pterostichus adstrictus
Pterostichus melanarius
Pterostichus niger
Pterostichus rhaeticus
Trechus obtusus

CUILCAGH MOUNTAIN PARK

Abax parallelepipedus
Agonum fuliginosum
Calathus melanocephalus
Carabus problematicus
Leistus fulvilabris
Leistus rufescens
Loricera pilicornis
Nebria salina
Notiophilus biguttatum
Patrobus assimilis
Pterostichus adstictus
Pterostichus niger
Pterostichus rhaeticus
Trechus obtusus
Trechus rivularis

CMP CUTOVER

Calathus melanocephalus
Carabus nitens
Carabus problematicus
Loricera pilicornis
Nebria brevicollis
Nebria salina
Olisthopus rotundatus
Patrobus assimilis
Pterostichus adstictus
Pterostichus rhaeticus

LIMESTONE GRASSLAND

Abax parallelepipedus
Amara aulica
Calathus fuscipes
Calathus melanocephalus
Carabus nemoralis
Clivina fossor
Cychrus caraboides
Loricera pilicornis
Nebria brevicollis
Nebria salina
Pterostichus madidus
Pterostichus melanarius
Pterostichus niger
Pterostichus rhaeticus
Pterostichus strenuus

AGHATIROURKE FOREST NATURE RESERVE

Abax parallelepipedus
Agonum fuliginosum
Calathus melanocephalus
Carabus problematicus
Leistus rufescens
Loricera pilicornis
Nebria brevicollis
Nebria salina
Notiophilus aquaticus
Notiophilus biguttatum
Olisthopus rotundatus
Patrobus assimilis
Pterostichus adstictus
Pterostichus diligens
Pterostichus madidus
Pterostichus melanarius
Pterostichus niger
Pterostichus rhaeticus
Trechus obtusus
Trechus rivularis

COMMONAGE

Abax parallelepipedus
Agonum fuliginosum
Calathus melanocephalus
Carabus nitens
Carabus problematicus
Leistus rufescens
Loricera pilicornis
Nebria brevicollis
Nebria salina
Notiophilus aquaticus
Notiophilus biguttatum
Notiophilus palustris
Olisthopus rotundatus
Patrobus assimilis
Pterostichus adstictus
Pterostichus diligens
Pterostichus melanarius
Pterostichus niger
Pterostichus rhaeticus
Pterostichus vernalis
Trechus obtusus

TRIEN - UNDER ESA AGREEMENT

Abax parallelepipedus
Agonum fuliginosum
Calathus melanocephalus
Carabus problematicus
Cychrus caraboides
Leistus rufescens
Nebria brevicollis
Nebria salina
Olisthopus rotundatus
Patrobus assimilis
Pterostichus diligens
Pterostichus niger
Pterostichus rhaeticus
Trechus obtusus
Trechus rivularis

GORTALUGHANY

Agonum fuliginosum
Carabus problematicus
Cychrus caraboides
Leistus rufescens
Nebria brevicollis
Nebria salina
Olisthopus rotundatus
Patrobus assimilis
Pterostichus diligens

Appendix 4. Spider species found on each of the monitoring units on Cuilcagh Mountain, 1999 (2004 data not available at present)

SUMMIT

Agroeca proxima
Agyneta decora
Allomengea scopigera
Centromerita concinna
Dicymbium nigrum
Erigone atra
Erigone dentipalpis
Gonatium rubens
Hilaira frigida
Lephtyphantes tenuis
Lepthyphantes flavipes
Lepthyphantes pallidus
Lepthyphantes zimmermanni
Lophomma punctatum
Micrargus herbigradus
Oedothorax retusus
Pardosa palustris
Pardosa pullata
Porrhomma pygmaeum
Robertus lividus
Saaristoa abnormis
Walckenaeria acuminata
Walckenaeria clavicornis

CUILCAGH MOUNTAIN PARK

Agroeca proxima
Antistea elegans
Diplocephalus permixtus
Gonatium rubens
Hilaira frigida
Lepthyphantes mengei
Lepthyphantes zimmermanni
Pardosa pullata
Pirata piraticus
Robertus lividus
Saaristoa abnormis
Trochosa terricola
Walckenaeria nudipalpis
Xysticus cristatus

CMP CUTOVER

Agyneta olivacea
Bathyphantes luteolus
Erigone atra
Erigone dentipalpis
Pirata piraticus

LIMESTONE GRASSLAND

Alopecosa pulverulenta
Bathyphantes gracilis
Erigone atra
Erigone dentipalpis
Lephtyphantes tenuis
Lepthyphantes zimmermanni
Oedothorax fuscus
Oedothorax retusus
Ostearius melanopygius
Pachygnatha degeeri
Pardosa amentata
Pardosa palustris
Pardosa pullata
Saaristoa abnormis
Tiso vagans
Trochosa terricola
Walckenareia cuspidata
Xysticus cristatus

AGHATIROURKE FOREST NATURE RESERVE

Agroeca proxima
Antistea elegans
Clubiona trivialis
Diplocephalus permixtus
Erigone atra
Erigone dentipalpis
Gonatium rubens
Haplodrassus signifer
Lephtyphantes tenuis
Lepthyphantes mengei
Lepthyphantes zimmermanni
Lophomma punctatum
Pachygnatha clercki
Pardosa pullata
Pirata piraticus
Trochosa terricola
Walckenaeria acuminata
Walckenaeria nudipalpis
Xysticus cristatus

COMMONAGE

Agroeca proxima
Agyneta subtilis
Allomengea scopigera
Bathyphantes gracilis
Erigone atra
Erigone dentipalpis
Lepthyphantes ericaeus
Lepthyphantes mengei
Lepthyphantes zimmermanni
Lophomma punctatum
Micrargus herbigradus
Monocephalus fuscipes
Oedothorax fuscus
Pardosa amentata
Pardosa pullata
Pirata piraticus
Robertus arundineti
Robertus lividus
Stemonyphantes lineatus
T.longid
Trochosa terricola
Walckenaeria acuminata
Walckenaeria nudipalpis
Xysticus cristatus

TRIEN- UNDER ESA AGREEMENT

Antistea elegans
Clubiona trivialis
Erigone dentipalpis
Gonatium rubens
Lephtyphantes tenuis
Lepthyphantes zimmermanni
Oxyptila trux
Pachygnatha clercki
Pardosa pullata
Pirata piraticus
Saaristoa abnormis
Trochosa terricola
Walckenaeria acuminata
Walckenaeria nudipalpis
Xysticus cristatus

GORTALUGHANY

Aphileta misera
Diplocephalus permixtus
Drepanotylus uncatus
Erigone atra
Erigone dentipalpis
Lepthyphantes mengei
Lepthyphantes zimmermanni
Pachygnatha clercki
Pardosa pullata
Pirata piraticus
Saaristoa abnormis
Trochosa terricola

Appendix 5. Small vertebrates recorded on Cuilcagh Mountain, 1999 & 2004

	Frogs		Shrews		Mice		Lizards	
	1999	2004	1999	2004	1999	2004	1999	2004
Summit		1	1	3				
CMP	1	1	7	4				
CMP cutover	1			1				
Limestone grassland		1	2		1			
AFNR	4	1		3				1
Commonage	7	171	6	4				
Trien - ESA	6	2	2	8				
Gortalughany	2						1	1
TOTAL	**21**	**177**	**18**	**23**	**1**	**0**	**1**	**2**