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Validation Network project:
A pilot study

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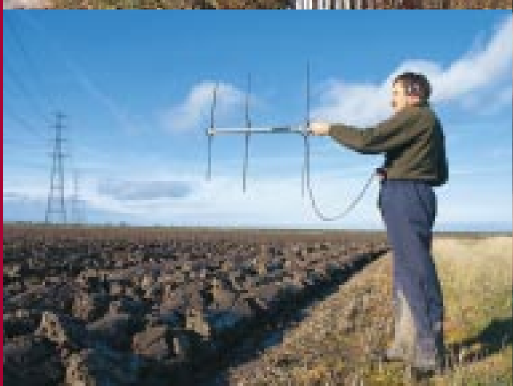


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Validation Network project:
A pilot study

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Summary

1. English Nature together with the other UK statutory nature conservation agencies are committed to monitoring condition on designated sites under the Common Standards framework. This sets out the timing and broad structure for monitoring approaches in each agency. English Nature is committed to establish a system for assessing the condition of SSSI features in order to meet the Government's Public Service Agreement target of 95% of SSSI features in favourable condition by 2010. Information on the trends in feature condition is needed to identify obstacles that are preventing favourable condition being achieved for all SSSI features.

2. The Validation Network project has an overall objective to ensure that data on the condition of individual features on SSSIs is accurate, consistent and scientifically robust. The means to achieve this outcome is through a sample of sites on which quantitative monitoring is undertaken on a regular basis in parallel with the cycles of condition assessment for SSSIs.

3. This document reports on pilot work carried out as a precursor to the full suite of Validation Network monitoring. A number of monitoring methods were trialled on a range of habitats for vegetation monitoring and a trial of invertebrate monitoring methods was also carried out.

4. The range of methods provided enough sensitivity to detect differences in vegetation (botanical species and community composition and structure) even where differences in condition could not be assigned to separate categories. External driver variables correlated logically with suspected causes of differences in plot vegetation condition.

5. Methods for invertebrate monitoring and data analysis were also sensitive enough to detect differences in invertebrate assemblage quality between plots in the same habitat.

6. Overall, this pilot study has successfully trialled a suite of field and analytical methods which will be applied to the full Validation Network monitoring study. Further trials, which are not reported on here, have also been carried out on other, discrete Priority habitats plus a trial looking into the accuracy of mapping complex habitats.

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1. Introduction

1.1 Background to the Validation Network

English Nature is committed to establishing a system for assessing the condition of SSSI features in order to meet the Government's Public Service Agreement target of all SSSI features in favourable condition by 2010. Information on the trends in feature condition is needed to identify obstacles that are preventing favourable condition being achieved for all SSSI features.

The wider needs of UK reporting require consistency of approaches across the country agencies in Scotland, Wales, Northern Ireland and England. This issue has been addressed through agreement on "a Statement of Common Standards Monitoring" published by the JNCC in 1998. This statement sets out the timing and broad structure for monitoring approaches in each agency. English Nature has developed an approach of condition assessment to support these standards and we use ENSIS as the database to hold and report the condition of SSSI features.

There are over 8,240 features distributed on 21,578 units across English SSSIs (as of 12/2/02). This number of individual assessment units cannot be assessed by traditional quantitative monitoring methods given the resources available to English Nature. The condition assessment approach that is being implemented does no more than standardise a rapid, visual assessment technique, focusing on key attributes of each feature. Given the importance of this information it is important that this approach is quality assured and validated in order to give us, and others, confidence in this statistic.

The 'validation network' concept has its origins in the 1992 SSSI Monitoring Strategy and work to date takes its lead from that strategy. It is important that the validation network project is properly resourced in the long term to ensure that the condition assessment methodologies are scientifically robust and practically applicable.

1.2 Project aims

The overall objective of the Validation Network project is to ensure that data on the condition of individual features on SSSIs are accurate, consistent and scientifically robust. The means to achieve this outcome will be through a sample of sites on which quantitative monitoring is undertaken on a regular basis. The project will establish such a system and this system will operate in parallel with the cycles of condition assessment for SSSIs.

The aims of the project are:

- to validate the condition assessment methodology in England through testing the suitability of attributes and associated targets in assessing quality and trend in condition;
- to establish a set of control sites to ensure that individual site assessments match regional or national changes in feature condition over time;
- to contribute to a wider network of monitoring sites that will allow a better understanding of the drivers of change.

1.3 Pilot study

Aims and rationale for this part of the study have already been outlined in a previous paper (*Validation Network Pilot Study*). In summary, the study has been designed to investigate the following:

1. Compare data gathered using different recording methods within the same sample plot and to test which of the background environmental variables (taken from favourable condition tables) explain most variation in the data.

2. Perform 'sensitivity' analyses on these data to see whether quantitative data from habitat features accurately reflect the range of more qualitatively assessed (favourable-unfavourable) conditions.

3. Look at other questions regarding stratification of habitat (eg NVC, Priority Habitat), and placement of monitoring plots within condition monitoring units.

This will provide information to aid decisions over which habitat recording methods will be used in the production of a 'tool-box' of methodologies for the Validation Network; it will aid in the above process but will also enable analytical methods to be refined for use in the Validation Network; it may provide only partial answers to questions of stratification of habitat monitoring and placement; this is likely to be an on-going development.

2. Methods

2.1 Habitat feature monitoring

2.1.1 Within-feature compatibility of methods

This part of the project is designed to investigate the compatibility of vegetation and associated habitat data recorded by different techniques. The method employed was to carry out a hierarchical survey of quadrats at the same location using increasingly detailed methods of assessing botanical species composition. This involved the following suites of methodologies:

1. Where only UCPE style (Hodgson & Colasanti, 1995) methods have been/are to be used, presence-absence data were obtainable from quadrats at six scales of 'nest' where $1m^2$ quadrats were used. Overall abundance (% cover) of each species in the largest 'nest' were also estimated. In some cases, ECN Fine-grain plots (see below) were super-imposed on the UCPE plot and data compared.

2. Where non-nested quadrats have been used, nested quadrats were positioned within these and recorded as above.

3. Where ECN Fine-grain plots (Sykes & Lane, 1996) have been used, the ten 40x40cm quadrats formed the basis of the recording plot. 1x1m quadrats were super-imposed on the 40x40cm quadrats* and recorded using presence-absence at the six 'nest' scales. If independent survey data from the ECN were not available, data for 40x40cm cells can be derived from these data. An additional expanded area was marked out,

ensuring that the plot is entirely situated in qualitatively the same vegetation type. A further 20-30 1x1m nested quadrats were recorded from random locations within this expanded area. For all quadrats, overall abundance (% cover) of each species in the largest 'nest' was also estimated.

* 1x1m quadrats to be positioned such that no overlap occurs.

2.1.2 Between-feature compatibility

This part of the project was designed to investigate the compatibility of vegetation communities in terms of grouping for Condition Assessment purposes.

Existing data sets plus data gathered during the pilot work for within-feature compatability were used.

2.1.3 Condition assessment attributes requiring testing under the pilot programme

For each habitat feature, there will be a series of attributes which may need to be quantifiably tested under the full Validation Network programme. Methods for quantitative testing will be largely drawn from existing published techniques and will be tailored to each habitat feature where necessary. Details are not given here. The following table lists the generic attributes drawn from Condition Tables for the key (Broad/Priority/Annex 1) habitats under major headings:

Extent

- Baseline extent of habitat 'unit' (community, woodland layer).
- Proportion of managed area (eg peat/reed cut).

Vegetation and associated measures

- Communities/species: positive indicators, rare species, extent of aquatics beds, supporting vegetation
  - negative indicators.
  - representative NVCs, range, zonation/transitions, patterning.
- Structure: height
  - diversity, tussocks.

- Age class (trees, dwarf shrubs).
- Bare ground (extent of natural bare ground, mosaic).
- Litter.
- Grazing levels.
- Disturbance/man-induced problematic features.
- Scrub cover/proportion of woody species.
- Thickness of algal mat, moss-lichen-dwarf shrub mat.
- % population reproducing (aquatic *Ranunculus*).
- Seedlings.

Environmental drivers

- Water levels: relative to ground level, range, water body.
  - drainage rates, proportion covered, area covered.
  - running water.
- Nutrients: NPK, pH as indicator of variable P & N. Other essential soil elements.
- Tufa deposition.
- Hydrological relationships (between bog, peat and soil).
- Physical features/range of physical conditions/topography.
- Substrate composition (sand:org. matter on dunes, silt in rivers).
- Sediment supply and flux (quality and quantity as judged by aquatic algae).
- Substrate mobility.
- Saltmarsh creek patterning.
- River form/profile.
- Water quality (judged by algae/*J.bulbosus*/*E.canadensis*/macrophyte growth).

2.1.4 Sites

2002 threw up severe constraints in terms of choice of sites due to the outbreak of Foot and Mouth Disease which effectively closed the countryside for many months. Initial plans to cover most terrestrial Broad Habitats over England were shelved. However, by May, parts of southern England were being opened up and this presented an opportunity to look at some lowland habitats, particularly in Dorset. Also, limited access was given to a contractor on Moorhouse/Upper Teesdale NNR in Cumbria, who was able to carry out some experimental monitoring on some upland habitats types. One other upland site in Shropshire was accessible later in the summer, adding another habitat type.

Sites and NVC communities located within the sites are shown in Appendix 1.

2.1.5 Invertebrate assemblage quality monitoring

Sites

Assessments were carried out within three areas of calcareous grassland on one site only, Porton Down SSSI in Wiltshire:

1. Roche Court Down.
2. The Breck.
3. Breck East.

Methods

The location of assessments was based on the position of the pitfall trap transect at each location.

a) Environmental characteristics were measured, on 21 and 22 August 2001, at two points between pitfall trap positions and two points beyond the first and last trap. Measurements were repeated 5m to the left and right of this central line. A total of 36 measurements were recorded for each characteristic at each site.

   i) Slope and aspect was measured within each quadrat used to assess ground cover (iii).

   ii) Vegetation height was measured by dropping a light (200g) plastic disc down a graduated measuring pole.

   iii) Ground cover characteristics. A $0.25m^2$ quadrat was positioned at each measurement point. A visual estimate was made of the percentage ground cover comprising; monocotyledonous plants, dicotyledonous plants, bryophytes, lichens and bare ground. The bare ground component was further examined according to the particle sizes of soil and stones present; % of area containing particles < 5mm in diameter, % with particles 5-10mm in diameter, % with particles 10-25mm in diameter and % with particles > 25mm in diameter.

   iv) The characteristics of scrub and tree growth in the vicinity of each trap location was assessed in the following way. The distance to the nearest shrub >1m tall from each pitfall trap position was estimated, the species of this shrub being recorded. The approximate number of shrubs/trees in a circle of 50m radius about the centre of the pitfall trap transect was recorded. The species present were recorded and the percentage of each species making up the whole was estimated. In addition, the distance and direction to the nearest woodland, or dense scrub thicket, edge was recorded.

b) Invertebrate sampling

Assessments of invertebrates were carried out at each site using pitfall trapping, water trapping and sweep netting techniques.

i) Pitfall trapping

At each site a line of five pitfall traps were sited, on 25 July 2001, in similar environmental conditions. The traps were partially filled with ethylene glycol and operated for a period of one month, being emptied on 22 August and 19 September 2001. The catch from each trap was preserved in 70% alcohol for examination.

ii) Water trapping

A single water trap was placed on 1 August 2001, at each site, in the centre of the pitfall trap transect at a height similar to the height of the vegetation. The trap was a white plastic tray covered in chicken wire netting to deter mammals from drinking the contents. The traps were emptied on 8 August 2001. As there were few contents on this occasion the traps were sited again on 14 August and emptied on 22 and 29 August.

iii) Sweep netting

Five sweep net samples were collected at each site on 29 August 2001. Each sample comprised five 'sweeps' taken 5m from each pitfall trap position. Samples were taken from the left and right of each position and the ten 'sweeps' were bulked to form one sample and transferred to a labelled polythene bag and put into a freezer for 24 hours. The catch was then store in 70% alcohol prior to examination.

c) Invertebrate assessments

Invertebrates obtained from each sampling method were examined in the laboratory. The following groups, where present, were determined within each sample. Carabid beetles and spiders, Phytophagous beetles, Homoptera, large Brachycera, crane flies, snails, grasshoppers/crickets, caterpillars, Aculeate Hymenoptera and Tephritidae were all identified to species, where this was possible. One entomologist also expressed an interest in examining Staphylinid beetles so these were also sent to him. Invertebrates other than those mentioned above were retained.

3. Methods for analysis and interpretation of data arising from the Validation Network pilot study

3.1 Analytical methods

3.1.1 Habitat features

Univariate analysis

Botanical composition

For each defined Habitat Feature, species and species groupings were analysed according to membership of the following:

a) Community character and negative indicator species defined under condition assessment criteria for each habitat feature stratification. Groupings differ in number and ecological niche width according to the habitat feature condition assessment stratification from which they are drawn (eg NVC type for lowland calcareous grassland, ‘wet’ or ‘dry’ lowland heathland).

b) C (competitor), S (stress-tolerator) and R (ruderal) strategy scores as proportions per quadrat according to the Grime *et al* (1988) strategy types.

c) Suited species scores according to the scheme developed by Critchley (2000) relating to soil nutrient status, grazing and soil moisture.

d) Ellenburg species scores according to the revised definitions for British plants (Hill, 1999) relating to light levels, soil moisture, reaction (pH), soil nitrogen and salt levels (where applicable).

Mean group scores per plot (and sub-plot where applicable) were used to assess whether species’ group membership reflect condition both between sites and as condition changes over time (where time series data are available). Analysis of C-S-R strategies was carried out using the FIBS package (Hodgson & Colasanti 1995). However, this was not always applicable as the suite of reference species is limited to those used in the FIBS project.

Nested quadrat data were also used to assess species’ changes in abundance in space and time and this was related to changes in habitat feature condition where known or assessable *a posteriori*.

3.1.2 Environmental variables

Most habitat features in the Pilot Study had additional data gathered at the quadrat level and plot level. This had two aims:

1. To evaluate which are the most important local driving variables determining vegetation composition.

2. To determine a simplified system for recording these variables under a full Validation Network monitoring scheme.

Variables were selected according to those chosen for condition assessment monitoring for each habitat feature.

Summary statistics arising from 1. were used to compare structure and environment between qualitative habitat feature conditions. Where time-series data were available and environmental variables have been recorded, these were used to assess changes in vegetation composition.

Data from 2 were compared 'intra-sample' to determine the level of accuracy (and therefore resource), required to record environmental variables related to each habitat feature in the future.

3.1.3 Multivariate analysis

The statistical package CANOCO (**CANO**nical **C**ommunity **O**rdination) (ter Braak and Smilauer, 1998) was used to compare quadrat and plot data according to the process outlined in the Validation Network Scoping Document (Bealey, 2001). This package utilizes Canonical Community Analysis (CCA) and its precursor Detrended Correspondence Analysis (DCA) (Hill, 1979) to analyse community data. Environmental variables were used to help explain ordination axes, either indirectly using regression analysis on DCA or directly within CCA and this process, in turn, determines the most important of these variables. Species number used for the analysis can be reduced according to the community character and negative indicator lists for the habitat features. Separate analyses were performed on data obtained using different methods at the same plots and the results compared to see which data give the greatest degree of sensitivity across conditions. This can then be matched to resource inputs for each method. Separate analyses were also performed on sub-sets of data matching primary attributes (attributes such as vegetation characteristics which are essential for determining condition), and primary and secondary (supporting), attributes combined. This tests the relative importance of primary and secondary attributes as defined under the Condition Assessment programme.

Idealised community data can be added to the analysis to 'force' axes which represent favourable to unfavourable conditions and intermediate categories to aid sensitivity analysis (a process also outlined in the Validation Network Scoping Document). This was not carried out in this study but would be a useful exercise in future research.

3.2 Invertebrate quality assemblages

Methods for calculation and analysis of invertebrate species' assemblages scores followed those of Eyre & Rushton (1989) where species are assigned geometric scores according to their national status. Assemblage scores will be compared to *a priori* qualitative condition of sampled habitat units.

Case Study 1: Scratchy Bottom, South Dorset Coast SSSI, Dorset

Background

This is an area of lowland calcareous grassland within a large coastal SSSI in Dorset, with the main vegetation community being NVC type CG4 (*Brachypodium pinnatum*). Monitoring was set up in 1991 in response to a Section 15 agreement on the site restricting application of fertilizer (Cox, 1996).

Data available

A plot on the site had previously been monitored using the UCPE methodology (see Section 2.1.1), on four occasions: 1991, 1993, 1995 and 1998. More detailed monitoring, based around the UCPE methodology, was undertaken in 2001. Overall percentage cover was recorded for all vascular plant species within each 1x1m quadrat as well as nested quadrat data. Environmental data were recorded at the same quadrat locations relating to: bare ground and litter (frequency at 25 point samples), grazing damage to plant stems within 10cm radius of the 25 points and number rabbit faecal pellets within the 10cm radius of the 25 points. Additionally, whole quadrat assessments were made for:

- cover of rabbit-scraped bare ground,
- drop disc vegetation height, and
- distance of quadrat from the nearest rabbit warren.

Whole plot assessments were made for the total (percentage) cover of each tree and scrub species and the total (percentage) cover of the plot area within an active rabbit warren.

Results

Condition

Data from the 1991-2001 monitoring data were used to assess condition for the following primary attributes:

- sward composition: frequency of positive indicator species/taxa,
- sward composition: frequency and % cover of scrub and tree species, and
- sward composition: frequency and % cover of negative indicator species/taxa.

This showed that 'condition' from these three measures had changed little over the period, passing all three primary attributes in each year of monitoring as shown in Table CS1.1

Table CS1.1

Primary attribute	1991	1993	1995	1998	2001
Positive indicators	*Br pinn* A 7A, 2F, (2R)	*Br pinn* A 6A, 2F, 1O, (1R)	*Br pinn* A 6A, 3F, (2R)	*Br pinn* A 6A, 2F, (4R)	*Br pinn* A 7A, 1F, (3R)
Scrub	Absent	Absent	Absent	Absent	Absent
Negative indicators	1O	1R	1R	2R	1O

Notes for table

Br pinn – Brachypodium pinnatum
A – Abundant, F – Frequent, O – Occasional, R – Rare

Qualification for favourable condition:

Sward composition: frequency of positive indicator species/taxa: ***Brachypodium pinnatum*** plus at least **two** species/taxa **frequent** and **four occasional** throughout the sward.

Sward composition: frequency and % cover of scrub and tree species: no more than **5%** cover.

Sward composition: frequency and % cover of negative indicator species/taxa: no species/taxa more than **occasional** throughout the sward or singly or together more than **5%** cover.

Using data from nested quadrats, combined values for the positive indicator species have declined over three of the four monitoring periods with the cumulative decline being –46 for the whole period (Table CS1.2). However, individual values range from +16 for *Linum catharticum* and +14 for both *Brachypodium pinnatum* and *Asperula cynanchica* to –21 for *Polygala vulgaris* and –33 for *Pilosella officinarum*. These differences may therefore be indicative of community changes under the applied management regime. For example, *Asperula cynanchica* is a CG4 community 'preferential' while *Pilosella officinarum* is a general associate of this and several CG communities. All of these species have either positive or neutral suited species scores for grazing (Critchley pers.comm.) and therefore should not have been adversely affected by the grazing regime at this site.

Table CS1.2: Scratchy Bottom 1991 - 2001

Frequency of species (actual values) within nested quadrats (Species ranked alphabetically)																														
	1991					**1993**					**1995**					**1998**					**2001**					**Indices of change**				
Quadrat nest sizes (cms) >>	**5**	**10**	**20**	**50**	**100**	**5**	**10**	**20**	**50**	**100**	**5**	**10**	**20**	**50**	**100**	**5**	**10**	**20**	**50**	**100**	**5**	**10**	**20**	**50**	**100**	**1991-93**	**1993-95**	**1995-98**	**1998-01**	**1991-01**
Anacamptis pyramidalis	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	-1	2	-2	0
Anthyllis vulneraria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	1	2
Asperula cynanchica	3	5	7	8	13	4	5	9	14	18	4	7	12	17	21	7	7	9	12	16	3	6	10	14	17	14	11	-10	-1	14
Bellis perennis	1	4	7	9	15	4	6	9	15	20	1	1	1	2	3	1	2	6	7	14	2	3	6	7	9	18	-46	22	-3	-9
Blackstonia perfoliata	0	0	0	0	0	0	1	1	7	14	0	0	0	2	7	0	0	0	8	14	0	1	3	12	21	23	-14	13	15	37
Brachypodium pinnatum	14	27	29	30	30	21	28	30	30	30	20	29	30	30	30	25	29	30	30	30	24	30	30	30	30	9	0	5	0	14
Campanula glomerata	4	9	15	23	28	4	5	10	24	27	0	1	5	17	25	0	0	8	25	28	2	4	8	20	26	-9	-22	13	-1	-19
Campanula rotundifolia	5	8	12	18	25	3	7	10	12	22	0	0	3	12	19	0	2	5	12	16	1	4	6	11	16	-14	-20	1	3	-30
Carlina vulgaris	0	2	10	20	24	0	0	3	8	21	1	1	1	9	20	1	1	4	10	14	0	0	1	3	13	-24	0	-2	-13	-39
Centaurium erythraea	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	1	2	2	5	0	0	0	0	0	5	-5	10	-10	0
Cerastium fontanum	0	0	1	3	5	1	1	2	6	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	-17	0	0	-9
Cirsium acaule	3	7	12	23	28	3	4	10	20	25	1	3	6	23	30	1	6	17	27	29	2	5	12	24	28	-11	1	17	-9	-2
Cirsium arvense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	-1	0
Crepis capillaris	0	0	1	1	4	0	4	5	5	9	0	0	0	1	3	0	0	0	0	1	0	0	1	1	4	17	-19	-3	5	0
Daucus carota	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	1	1	1	1	3	4	3	-3	1	9	10
Echium vulgare	0	0	0	1	5	0	0	1	2	5	0	0	0	0	1	0	0	0	0	1	0	0	0	0	2	2	-7	0	1	-4
Erigeron acer	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	-3	0	0	0
Euphrasia agg.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	1	1	3	7	10	-1	1	1	20	21
Galium mollugo	0	0	1	1	2	0	1	1	1	3	0	0	0	0	1	2	3	3	3	4	0	1	1	3	3	2	-5	14	-7	4
Galium verum	1	1	2	4	5	0	1	1	2	3	0	0	0	1	1	0	0	0	0	1	0	1	1	1	1	-6	-5	-1	3	-9
Hippocrepis comosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	2	-2	0
Holcus lanatus	1	3	4	5	6	1	2	2	4	11	0	0	0	1	5	0	0	0	2	5	0	1	2	5	9	1	-14	1	10	-2
Hypochaeris radicata	0	0	0	0	0	0	0	1	2	2	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	5	-3	-2	0	0
Inula conyza	0	0	0	16	23	0	0	0	6	19	0	0	1	4	17	1	1	3	8	11	0	1	1	5	13	-14	-3	2	-4	-19
Iris foetidissima	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2	-2	0	0
Leontodon autumnalis	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	-3	0	0	0

Frequency of species (actual values) within nested quadrats

(Species ranked alphabetically)

	1991					**1993**					**1995**					**1998**					**2001**					**Indices of change**				
Quadrat nest sizes (cms) >>	**5**	**10**	**20**	**50**	**100**	**5**	**10**	**20**	**50**	**100**	**5**	**10**	**20**	**50**	**100**	**5**	**10**	**20**	**50**	**100**	**5**	**10**	**20**	**50**	**100**	**1991-93**	**1993-95**	**1995-98**	**1998-01**	**1991-01**
Leontodon hispidus/saxatilis	12	19	23	28	28	13	19	24	28	29	1	6	18	28	28	5	13	19	27	29	4	14	19	26	30	3	-32	12	0	-17
Linum catharticum	0	4	8	13	23	0	3	5	9	14	2	4	7	7	14	2	2	4	13	15	1	7	13	19	24	-17	3	2	28	16
Lotus corniculatus	20	25	27	29	29	25	29	30	30	30	20	27	29	30	30	24	29	30	30	30	20	26	29	30	30	14	-8	7	-8	5
Medicago lupulina	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	2	-2	1	3	4
Picris hieracioides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	4	0	0	0	2	3	0	1	8	-4	5
Pilosella officinarum	14	24	27	28	28	21	25	25	26	29	18	26	27	30	30	15	21	22	26	29	7	12	17	25	27	5	5	-18	-25	-33
Plantago lanceolata	2	6	6	11	16	1	5	8	11	19	2	2	4	13	17	0	5	9	14	16	0	5	14	23	26	3	-6	6	24	27
Polygala vulgaris	0	0	4	9	13	0	5	6	9	11	0	2	7	9	13	0	2	5	6	7	0	0	0	2	3	5	0	-11	-15	-21
Prunella vulgaris	0	1	2	4	6	0	1	2	3	3	0	0	0	2	3	0	2	2	2	2	0	0	0	1	1	-4	-4	3	-6	-11
Ranunculus bulbosus	0	1	6	9	14	2	2	4	6	10	0	0	0	0	1	0	0	0	3	8	0	1	4	12	14	-6	-23	10	20	1
Sanguisorba minor	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	-1	2	-1	-1	-1
Senecio erucifolius	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	-1	1	1
Senecio jacobaea	0	1	2	2	11	0	0	1	1	4	0	0	0	1	3	0	0	0	0	2	1	1	1	4	7	-10	-2	-2	12	-2
Serratula tinctoria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
Spiranthes spiralis	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	1	-1	4	-4	0
Taraxacum agg.	2	5	16	23	28	1	2	10	17	21	0	0	1	12	17	1	3	8	10	19	0	3	9	16	20	-23	-21	11	7	-26
Teucrium scorodonia	0	0	0	2	7	0	0	1	5	11	0	0	0	3	10	1	1	4	7	12	0	0	1	6	13	8	-4	12	-5	11
Thymus polytrichus	8	14	21	27	28	5	8	16	21	24	12	17	23	26	29	12	20	22	25	27	13	17	22	24	27	-24	33	-1	-3	5
Tragopogon pratensis	0	0	0	2	4	0	0	0	1	6	0	0	3	8	16	0	0	0	2	5	1	1	1	4	7	1	20	-20	7	8
Trifolium campestre	0	0	0	0	0	0	0	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	-5	0	0	0
Trifolium dubium	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	4	1	1	1	1	1	2	-2	5	0	5
Trifolium pratense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	2	-1	1
Trifolium repens	0	1	1	4	7	2	3	6	6	14	0	0	0	0	0	1	1	1	3	5	0	0	1	1	1	18	-31	11	-8	-10
Veronica arvensis	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-3	0	0	0	-3
Veronica chamaedrys	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	1	1	2	2	-2	0	4	2	4
Veronica officinalis	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	2	2	-4	0
Viola hirta	0	0	0	0	1	0	1	1	1	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	3	-1	-3	0	-1

Within-year condition

The plots were split into two sub-plots according to apparent condition in the current monitoring year. Qualitatively, the lower slopes appeared to be botanically less diverse, with a more 'ragged' appearance due to the presence of the mesotrophic grass species *Holcus lanatus*. Six quadrats were located in this sub-plot and these were subsequently used for a comparative within-year analysis with the twenty-four in the remainder of the plot. Results of this analysis for the same primary attributes given above are shown in Table CS1.3

Table CS1.3

Primary attribute	Favourable	Unfavourable
Positive indicators	*Br pinn* A, 7A, 1F, (2R)	*Br pinn* A, 4A, 4F, (2R)
Scrub	Absent	Absent
Negative indicators	1O	Absent

The Table shows that the 'unfavourable' sub-plot is not actually unfavourable according to the primary attributes but is relatively less favourable by these measures.

Analysis of the environmental measures taken at the same quadrats within the sub-plots also shows some differences in secondary attributes, namely drop-disc vegetation height (mean 6.0 cm in 'unfavourable' versus 5.6 cm in 'favourable'), bare ground (1.33% cover in 'unfavourable' versus 0.54% in 'favourable'), rabbit scraped bare ground (0.33% cover in 'unfavourable' versus 0.18% in 'favourable'). None of these differences were statistically significant but showed a trend towards the measures showing less favourable condition as supporting attributes. However, litter (0.83% cover in 'unfavourable' versus 2.04% in 'favourable') and number of rabbit pellets (0.5 in 'unfavourable' versus 3.17 in 'favourable'), both showed opposite trends to that expected.

C, S and R strategy scores

A FIBS analysis of the whole plot revealed a large proportion of species (44%) having a stress-tolerating strategy, with most of the others showing indeterminate strategies (see Appendix CS1.1). This is a fairly typical profile of a calcareous grassland on thin soils where drought stress is paramount (Grime *et al* 1988).

When sub-plots were compared (Appendix CS1.2 and CS1.3), differences between strategy scores were only apparent with the stress tolerators, with the 'favourable' sub-plot showing a much larger proportion (48%) compared to the 'unfavourable' (38%), although there was also a subsequent increase in species of indeterminate strategy in the latter (from 23% to 32%). Stress tolerance is an adaptation shown by many species indicative of calcareous grasslands (Grime *et al* 1988) and results from the need to persist under summer drought conditions on thin soils and to grow under nutrient-limiting conditions. The strategy scores probably reflect the difference between the species growing on thin-soiled upper slopes and those growing on the lower slopes where either the soil is deeper and/or there is an increased level of nutrient input from stock.

Ellenburg scores

Species Ellenburg scores from ‘favourable’ and ‘unfavourable’ sub-plots in 2001 were compared for Light, Moisture, pH and Nitrogen scores. Mean scores are shown in Table CS1.4. None of the mean scores shown in the table showed significant differences between ‘favourable’ and ‘unfavourable’ sub-plots.

Table CS1.4

Ellenburg Indicator	Favourable	Unfavourable
Light	7.455 (± 0.627)	7.442 (± 0.59)
Moisture	4.455 (± 0.761)	4.465 (± 0.767)
PH	6.614 (± 0.945)	6.628 (± 0.976)
Nitrogen	3.295 (± 1.25)	3.395 (± 1.348)

The biggest difference is shown by the Ellenburg Nitrogen values, which, although non-significant ($t = -0.395$, $df = 85$; $P = 0.721$), shows the ‘unfavourable’ sub-plot having an increase in overall mean value compared to the ‘favourable’ sub-plot. This result concords well with that for the C-S-R analysis above.

Suited species scores

Species Suited Species scores from ‘favourable’ and ‘unfavourable’ sub-plots in 2001 were compared for Grazing, Nutrient and Wet scores. Mean scores (as calculated by Robertson *et al*, 2000), are shown in Table CS1.5

Table CS1.5

Suited Species Score	Favourable	Unfavourable
Grazing	0.375	0.425
Nutrient	-0.55	-0.5
Wet	-0.4	-0.425

The greatest difference is shown by the grazing suited species where the ‘unfavourable’ sub-plot contains more grazing suited species on average than the ‘favourable’ although the difference is not significant. This again points to more palatable species being present in the ‘unfavourable’ sub-plot, which would tend to grow on deeper soils and/or where nutrient enrichment has occurred.

Multivariate analysis

A Decorana analysis was carried out on the 2001 quadrat data using percentage cover data for all species recorded. A DCA species plot for the first two axes is shown in Figure CS1.1. Only species deemed to be of ecological significance are named on the plot, including positive and negative indicator species from the CG4 Condition Monitoring table. Positive indicators are shown in bold on the plot. The plot shows that the positive indicators are all (except one), situated along the positive part of axis 1 while there is a tendency for the more mesotrophic species to be placed on the negative part of axis 1 and to some extent towards the lower right quadrant of the plot. These species include the three *Trifolium* species and *Agrostis stolonifera*.

A DCA plot of site (quadrat) scores for these first two axes is shown in Figure CS1.2. Axis 1 is correlated with vegetation height (Spearman rank correlation: $r_s = -0.644$, $n = 30$, $P < 0.001$), and litter cover ($r_s = -0.508$, $n = 30$, $P < 0.005$). Axis 2 is correlated only with percent frequency of bare ground ($r_s = -0.371$, $n = 30$, $P < 0.05$). Quadrats placed in the 'unfavourable' sub-plot are shown (marked 'U') with a tendency to be placed towards the lower score end of axis 2. In fact, the position of the quadrats from the 'unfavourable' sub-plot on axis 2 differs significantly from those from the 'favourable' sub-plot (Mann-Whitney U-test: $U = 32.0$, $n = 6, 24$, $P = 0.038$). The grouping of the quadrats from the 'unfavourable' sub-plot is better shown by plotting site scores from axes 2 and 3 of the ordination. This is shown in Figure CS1.3. Axis 3 is significantly correlated with rabbit activity namely the number of rabbit pellets ($r_s = 0.37$, $n = 30$, $P < 0.05$) and cover of rabbit scraped ground ($r_s = 0.375$, $n = 30$, $P < 0.05$).

Discussion and conclusions

Despite the fact that the site has as a whole unit, been in favourable condition throughout the monitoring period, these analyses have shown that it is possible to distinguish between 'relatively unfavourable' and 'relatively favourable' condition by using community data. The condition assessment method does not readily distinguish the relative quality either between years or between the sub-units within-year by information at the functional group (ie indicator species), level. However, more detailed analysis has revealed that substantial population changes in important members of the calcicolous grassland community, both between years and between sub-plots have occurred and might signal forthcoming changes in condition which would not otherwise have been detected.

Case Study 2: Stiperstones NNR, Shropshire

Background

This is an upland (mainly) dry heath NNR. The main habitats are H12 *Calluna vulgaris-Vaccinium myrtillus* heath on the tops with H8 *Calluna vulgaris-Ulex gallii* heath on the marginal slopes. These habitats represent a transition from a true upland dry heath form (H12) to a marginal type (H8). The heath is mainly managed by rotational burning although some small plots are cut instead.

No previous vegetation monitoring of relevance to the pilot study had been undertaken.

Data available

A plot was identified with the help of the Site Manager, where livestock are introduced to the site by commoners and there is therefore a perceived problem of over-grazing before the stock disperse over the heathland. A plot of 250 by 130 metres was marked out away from the lowest slopes where there is some obviously high grazing pressure due to the dominance of grass communities and dung. Thirty 1x1m quadrats were randomly located within the plot. Percentage cover was recorded for all vascular plant, bryophyte and lichen species within each 1x1m quadrat. Environmental data were recorded at the same quadrat locations on:

- Vegetation height (ruler and drop-disk)
- Litter
- Dung
- Water
- *Calluna* age – proportion of pioneer, building, mature and degenerate age classes
- Bare ground – proportion of natural, disturbed and wet
- Amount of grazed *Calluna* and other vulnerable species (*Empetrum nigrum*, *Vaccinium vitis-idaea*, *Erica tetralix* or *Nardus stricta*)
- Amount of young (< 6 years) and old (> 5 years) burn or recently cut *Calluna*
- Proportion of flowering *Calluna*
- Proportion of *Calluna* shoots
- Proportion of *Calluna* growth form of normal, drumstick, topiary and carpet type
- Maximum height of *Calluna* shoots
- Proportion of dead *Calluna*

Whole plot assessments were made for:

- Proportion of each *Calluna* age class
- Total number of trees/shrubs
- Total (% cover) Bracken cover

- Nature and % total area of erosion
- Total (% area) and age of burn
- % of plot heavily grazed

Results

Eight quadrats located on the lower slopes of the plot were objectively rated as being within the area of higher grazing pressure. This area represented a band of 250m long by 40m wide and was used to compare with the rest of the plot.

Condition

Condition was assessed for the two sub-plots for the following attributes:

- Dwarf-shrub cover
- Dwarf-shrub diversity
- Bryophyte/lichen abundance
- Age structure
- Grazing impact

Assessments were made according to the system in English Nature's *Upland management handbook* (Anon. 2000) and are shown in Table CS2.1.

Table CS2.1

Primary attribute	Favourable	Unfavourable
Dwarf-shrub cover	26-75% D-s cover	26-75% D-s cover
Dwarf-shrub diversity	1 sp widespread & frequent	1 sp widespread & frequent
Bryophyte/lichen abundance	Frequent patches	Frequent patches
Age structure	>25% late mature/degenerate	>25% late mature/degenerate
Grazing impact	Light	Moderate-heavy

This results in unfavourable grades of 2 in the 'Favourable' and 3-4 in the 'Unfavourable' sub-plots according to the points system given in the Upland Management Handbook (higher scores = more unfavourable).

C, S and R strategy scores

A FIBS analysis of the plot sub-divided into 'Favourable' and 'Unfavourable' revealed a change in proportion of species between the competitive (C) and stress-tolerator (S). This is shown in Appendix CS2.1 and CS2.2. The 'Favourable' sub-plot shows a lower proportion of C species (6 compared to 19) and a higher proportion of S species (28 compared to 18) than the 'Unfavourable' sub-plot. This difference is most likely to be due to the increased presence of competitive species favoured by grazing in the 'Unfavourable' sub-plot. This is backed up by differences in strategies relating to regenerative strategy, seed weight and vegetative spread, which all point to more competitive, grazing-tolerant species in the 'Unfavourable' sub-plot.

Multivariate analysis

A Decorana analysis was carried out on the 2001 quadrat data using percentage cover data for all species recorded. One quadrat which was placed in a small area of *Sphagnum* bog was excluded from the analysis. A DCA species plot for the first two axes is shown in Figure CS2.1. Only species deemed to be of ecological significance are named on the plot. Several of the species characteristic of grazed dry heath are located towards the high score end of axis one. These include *Agrostis capillaris* and *Nardus stricta*. The species more susceptible to grazing pressure, such as the two *Vaccinium* species, are in contrast located towards the low score end of axis one.

A DCA site score plot for the first two axes is shown in Figure CS2.2. Quadrats within the 'unfavourable' sub-plot are shown marked 'U' and grouped with the ellipse. Most of these quadrats are towards the higher score end of axis 1. These 'unfavourable' quadrats have a significantly higher score on axis 1 than the 'favourable' (Mann-Whitney U-test: $U = 130.0$, $n = 8, 22$, $P = 0.025$). There is no difference between these two groups of quadrats along axis 2 (Mann-Whitney U-test: $U = 82.0$, $n = 8, 22$, NS). Axis 1 is correlated with environmental variables: natural bare ground ($r_s = 0.435$, $n = 30$, $P < 0.02$), mature *Calluna* ($r_s = 0.382$, $n = 30$, $P < 0.05$), carpet growth form of *Calluna* ($r_s = 0.378$, $n = 30$, $P < 0.05$) and presence of dung ($r_s = 0.371$, $n = 30$, $P < 0.05$) towards the higher score 'unfavourable' end and grazing of non-ericoids ($r_s = -0.526$, $n = 30$, $P < 0.005$), old/degenerate *Calluna* ($r_s = -0.484$, $n = 30$, $P < 0.01$) and general vegetation height ($r_s = -0.392$, $n = 30$, $P < 0.05$). Most of these variables are clearly related to grazing pressure although grazing of non-ericoids appears to be correlated with the areas experiencing lower grazing pressure. Examination of the raw data shows quadrats with high values for this variable are scattered among the whole plot and may be related to local by-product of grazing among grassy patches.

A CANOCO analysis was performed on the same data set as that used for the Decorana analysis, but with the environmental variables included for concurrent analysis. Site scores for the first two CCA axes are shown in Figure CS2.3 together with biplot scores of the eight most important environmental variables. 'Unfavourable' quadrats are shown marked 'U' as in the Decorana plot. Values for inter-set correlations of these variables with the first two axes are given in Appendix CS2.3.

It can be seen from Figure CS2.3 that CCA axis 1 is mainly related to healthy, flowering *Calluna* towards the higher score end and several measures of high grazing pressure and/or stressed *Calluna* towards the low score end. Most of the 'Unfavourable' quadrats are situated towards the negative score end of axis 1 although their scores only approach significance when compared to scores of the 'Favourable' quadrats (Mann-Whitney U-test: $U = 118.0$, $n = 8, 22$, $P = 0.097$). There is no difference between these groups along axis 2 (Mann-Whitney U-test: $U = 72.0$, $n = 8, 22$, $P = 0.558$).

This method appears to produce a better relationship between the ordination axes and environmental variables but not such a good separation between 'Unfavourable' and 'Favourable' quadrats as with the Decorana analysis. However, as the site scores are constrained by the overall correlation with environmental variables (ter Braak, 1987), and the fact that there is likely to be a gradation from relatively 'Favourable' to 'Unfavourable' sub-plots, the overall result of this analysis is highly promising.

Discussion and conclusions

It is probable that both sub-plots in this case study have been negatively influenced by over-grazing, representing a common situation in the English uplands. Although there are not enough data to provide correlative statistics, there appears to be a good relationship between the condition assessment and the results of the more detailed analysis. The CANOCO analysis, in particular, appears to be a powerful method of relating the background environmental variables indicative of contrasting condition to the requisite 'favourable' and 'unfavourable' quadrats.

Case Study 3: Studland Heath NNR, Dorset

Background

Monitoring on this site was set up in 1996 following clearance of scrub, mostly sallows plus some downy birch,on M6/M23/M29 mire communities adjacent to Little Sea, Studland. The scrub was overshadowing out the mire communities which are important for both botanical interest and wetland invertebrates. The site receives grazing by deer and infrequent cutting of rushes.

Data available

UCPE type monitoring was established in a small plot (0.25 ha approximately), and the plot was re-surveyed in 1997, 1998, 1999 and 2001 giving time-series data. Twenty-one 1x1m quadrats were randomly located within the plot. More detailed monitoring, based around the UCPE methodology, was undertaken in 2001. Overall percentage cover was recorded for all vascular plant species within each 1x1m quadrat as well as nested data. Environmental data were recorded at the same quadrat locations with reference to:

- Vegetation height (ruler and drop-disk)
- Litter
- Water level relative to ground level
- Bare ground – proportion of natural, disturbed and wet
- Evidence of grazing
- No. of *Molinia* tussocks
- No. of *Sphagnum* hummocks

Whole plot assessments were made for:

- Scrub regrowth

Results

Nested scores and species' frequencies were available for all five monitoring years.

Condition

Information from the 1996-2001 monitoring data were used to assess condition for the following primary attributes for an M6a community:

- Frequency of positive indicator species/taxa,
- Frequency and % cover of scrub and tree species

The results of this are shown in Table CS3.1

Table CS3.1

Primary attribute	1996	1997	1998	1999	2001
Positive indicators	1A, 2F, 3O, 1 missing	4A, 1F, 2R	4A, 1F, 1R, 1 missing	4A, 1F, 1O, 1 missing	4A, 1F, 2R
Scrub	Frequent-Abundant	Frequent-Abundant	Frequent-Abundant	Frequent-Abundant	Frequent

Notes for table

Qualification for Favourable condition:

Sward composition: frequency of positive indicator species/taxa: eponymous species and species of constancy V and IV for the community (Meade 2000), should be abundant.

Sward composition: frequency and % cover of scrub and tree species: no more than occasional.

It can be seen from the table that in terms of positive indicators for an M6a community, all years after the first monitoring year approached favourable condition, although only 57% of required species were abundant. There was, however, a clear ‘improvement’. For all years, scrub (re-growth) was at least frequent and therefore showed unfavourable condition for this attribute.

C, S and R strategy scores

A FIBS analysis was not performed on the monitoring data as the species were not suited to this type of analysis (see Section 3).

Ellenburg scores

Species Ellenburg scores from the plot for the period 1996-2001 were compared for Light, Moisture, pH, Salt and Nitrogen scores. Mean scores are shown in Table CS3.2.

Table CS3.2

Ellenburg Indicator	1996	1997	1998	1999	2001
Light	6.923	6.935	7.0	7.0	7.0
Moisture	8.08	7.933	8.0	7.885	7.846
PH	4.808	4.774	4.931	4.778	4.704
Nitrogen	3.654	3.71	3.897	3.852	3.741
Salt	0.154	0.129	0.138	0.148	0.111

Two discernible trends can be seen from these figures. Firstly, mean moisture scores show a decline over the period, reflecting a drying-out of the plot following removal of the scrub canopy. This is reflected in the rise of the mean light score. Secondly, there is a rise and then fall of mean nitrogen scores over the period, peaking during 1998. This in turn may be related to the pH scores which also peaked in 1998. Changes in nitrogen and pH scores may possibly be linked to winter flooding events depositing nutrients in the plot or disturbing the soil.

Suited Species Scores

Suited Species scores from the plot for the period 1996-2001 were compared for Grazing, Nutrient and Wet scores. Mean scores (as calculated by Robertson and others 2000), are shown in Table CS3.3.

Table CS3.3

Suited Species Score	1996	1997	1998	1999	2001
Grazing	-0.039	-0.1	-0.152	-0.138	-0.125
Nutrient	-0.346	-0.333	-0.242	-0.207	-0.281
Wet	0.539	0.467	0.485	0.483	0.5

The first thing to note here is that Suited Species Scores for Nutrient and Wet correlate well with Ellenburg Nitrogen and Moisture scores over all years ($r_s = 0.9$, $n = 5$, $P = 0.05$ for both pairs of tests). This is not surprising as both types of value relate to similar ecophysiological processes in the plant species being monitored. The Suited Species Grazing scores are negatively correlated with both Suited Species Nutrient scores ($r_s = -0.9$, $n = 5$, $P = 0.05$) and Ellenburg Nutrient scores ($r_s = -1.0$, $n = 5$, $P = 0.025$) over all years and this reflects the higher nutrient status of species which invaded the clearing following initial management. This rapid (over two years-see Table CS3.3), change quickly stabilized and has since declined as less palatable species such as the rushes (*Juncus* spp) have become more frequent.

Nest scores

Nested quadrat values and indices of change are shown in Table CS3.4 with species ordered according to 1996-2001 indices of change. Species with the largest positive changes include a number indicative of drier mire communities. Of these, four of the seven positive indicators are included in the top six ranked species. Aquatic or semi-aquatic species have nearly all shown declines according to the indices. Of these, the positive indicator *Carex echinata* has shown the greatest decline excepting species that have been physically removed. These changes may also be linked to the large increase in the cover of rushes which has occurred in the plot since 1996, and which overshadows shorter and less vigorous vegetation.

Table CS3.4: Studland Clearing 1996 - 2001

Studland clearing A. 1996-2001
Frequency of species (actual values) in nested quadrats
(Species ranked according to 1996-2001 indices of change)

	1996						**1997**						**1998**						**1999**						**2001**						**INDICES OF CHANGE**				
	10	**20**	**30**	**40**	**50**	**100**	**10**	**20**	**30**	**40**	**50**	**100**	**10**	**20**	**30**	**40**	**50**	**100**	**10**	**20**	**30**	**40**	**50**	**100**	**10**	**20**	**30**	**40**	**50**	**100**	**1996-97**	**1997-98**	**1998-99**	**1996-99**	**1996 - 2001**
Juncus effusus	3	4	5	5	6	11	8	9	10	12	12	19	8	9	11	14	14	16	15	15	16	16	16	16	9	12	12	13	14	19	**36**	**2**	**22**	**60**	**45**
Hydrocotyle vulgaris	4	6	8	9	10	11	5	6	9	10	10	15	4	7	9	10	12	14	8	11	12	13	16	18	8	11	15	15	16	17	**7**	**1**	**22**	**30**	**34**
Carex nigra	0	2	4	4	4	7	1	5	6	6	7	11	1	1	2	2	2	4	4	8	9	10	11	11	4	7	9	10	10	10	**15**	**-24**	**41**	**32**	**29**
Juncus acutiflorus	3	6	8	9	9	13	10	12	13	14	14	15	11	12	13	14	14	15	7	9	10	10	11	16	10	11	12	13	14	15	**30**	**1**	**-16**	**15**	**27**
Galium palustre	1	1	2	2	2	3	0	0	1	2	2	3	0	0	0	0	0	6	0	1	1	1	1	3	2	4	5	5	6	7	**-3**	**-2**	**1**	**-4**	**18**
Molinia caerulea	3	6	6	8	8	10	7	9	9	12	13	16	7	7	10	12	13	16	6	9	14	14	15	16	7	7	9	10	11	15	**25**	**-1**	**9**	**33**	**18**
Myrica gale (shrubs)	0	0	0	1	1	3	1	2	2	2	3	3	1	1	2	2	2	3	0	1	1	1	1	4	2	2	2	2	2	4	**8**	**-2**	**-3**	**3**	**9**
Sparganium erectum	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	1	1	1	1	1	1	2	2	2	**1**	**1**	**1**	**3**	**9**
Sphagnum palustre	0	0	0	0	0	0	1	1	1	1	1	2	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	**7**	**-6**	**5**	**6**	**7**
Potentilla erecta	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	**5**	**-5**	**0**	**0**	**6**
Scutellaria minor	0	1	1	1	1	3	0	0	0	0	1	4	0	0	0	0	0	2	0	0	0	0	1	4	1	1	2	2	2	5	**-2**	**-3**	**3**	**-2**	**6**
Myrica gale (s)	0	0	0	0	0	0	0	1	1	1	1	3	0	0	0	2	3	5	0	1	1	1	1	3	0	1	1	1	1	1	**7**	**3**	**-3**	**7**	**5**
Anthoxanthum odoratum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	1	**0**	**0**	**1**	**1**	**4**
Juncus conglomeratus	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	1	2	**1**	**2**	**3**	**6**	**3**
Pteridium aquilinum	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	1	1	2	**-1**	**0**	**0**	**-1**	**3**
Hypericum elodes	1	1	3	4	4	4	0	0	1	1	2	3	2	2	2	2	2	3	2	2	2	3	3	4	1	3	3	4	4	4	**-10**	**6**	**3**	**-1**	**2**
Lonicera periclymenum	1	2	2	4	5	7	0	0	3	4	7	9	0	0	2	3	3	7	0	0	1	2	2	6	0	1	3	4	5	10	**2**	**-8**	**-4**	**-10**	**2**
Epilobium sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	**0**	**1**	**-1**	**0**	**1**
Lotus pedunculatus	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	**0**	**6**	**-6**	**0**	**1**
Typha latifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	0	0	0	0	0	1	**0**	**1**	**4**	**5**	**1**
Anagallis tenella	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**-1**	**0**	**0**	**0**
Ilex aquifolium (s)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**-1**	**0**	**0**	**0**
Quercus sp. *(s.)*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**1**	**-1**	**0**	**0**
Sphagnum recurvum	0	0	0	0	0	0	2	3	3	3	3	4	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	**18**	**-13**	**-5**	**0**	**0**
Betula sp. (shoots)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**-1**	**0**	**0**	**-1**	**-1**
Juncus bulbosus	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**-1**	**0**	**0**	**-1**	**-1**

Studland clearing A. 1996-2001																																			
Frequency of species (actual values) in nested quadrats																																			
(Species ranked according to 1996-2001 indices of change)																																			
	1996						**1997**						**1998**						**1999**						**2001**						**INDICES OF CHANGE**				
	10	**20**	**30**	**40**	**50**	**100**	**10**	**20**	**30**	**40**	**50**	**100**	**10**	**20**	**30**	**40**	**50**	**100**	**10**	**20**	**30**	**40**	**50**	**100**	**10**	**20**	**30**	**40**	**50**	**100**	**1996-97**	**1997-98**	**1998-99**	**1996-99**	**1996 - 2001**
Sphagnum squarrosum	8	8	9	10	11	16	3	7	8	10	12	14	10	10	14	15	15	17	9	12	12	14	14	19	8	9	9	10	11	14	**-8**	**27**	**-1**	**18**	**-1**
Osmunda regalis	0	0	0	0	0	2	0	0	0	1	1	3	0	0	0	1	1	2	0	0	0	0	0	4	0	0	0	0	0	0	**3**	**-1**	**0**	**2**	**-2**
Sphagnum auriculatum	3	4	4	4	5	5	2	5	6	6	6	6	1	3	3	3	3	3	2	2	2	2	2	7	1	4	4	4	5	5	**6**	**-15**	**1**	**-8**	**-2**
Sphagnum fimbriatum	2	3	3	3	3	3	1	1	2	3	3	6	1	1	1	2	4	6	0	0	1	2	3	7	1	1	3	3	3	4	**-1**	**-1**	**-2**	**-4**	**-2**
Agrostis canina	14	14	14	15	18	19	16	17	20	20	20	21	18	20	20	20	20	21	15	16	16	16	17	21	8	12	16	16	18	21	**20**	**5**	**-18**	**7**	**-3**
Lycopus europaeus	0	0	0	1	1	2	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	**-3**	**0**	**0**	**-3**	**-3**
Dryopteris sp.	0	0	1	1	3	7	0	1	1	2	2	6	0	1	3	3	4	6	0	0	0	1	1	7	1	1	1	1	1	3	**0**	**5**	**-8**	**-3**	**-4**
Menyanthes trifoliata	0	0	0	0	2	3	0	1	1	1	1	1	0	0	0	1	2	2	0	0	0	1	1	2	0	0	0	0	0	1	**0**	**0**	**-1**	**-1**	**-4**
Rubus fruticosus	0	0	1	1	1	4	1	1	1	1	1	1	0	0	0	0	1	1	0	0	0	0	0	2	0	0	0	0	0	3	**-1**	**-4**	**0**	**-5**	**-4**
Agrostis stolonifera	1	1	1	1	1	2	1	1	1	1	1	1	0	1	2	2	2	2	0	0	1	1	1	1	0	0	0	0	0	0	**-1**	**3**	**-5**	**-3**	**-7**
Holcus lanatus	1	3	4	4	5	7	1	1	1	2	2	5	0	0	0	0	0	2	0	0	0	1	1	4	2	2	2	3	3	5	**-12**	**-10**	**4**	**-18**	**-7**
Phragmites australis	1	1	2	2	2	2	1	1	1	2	2	2	0	1	1	1	1	2	0	1	1	1	1	1	0	0	0	0	1	1	**-1**	**-3**	**-1**	**-5**	**-8**
Ranunculus flammula	0	1	1	3	3	3	0	0	0	0	2	2	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	**-7**	**-1**	**-3**	**-11**	**-9**
Mentha aquatica	1	1	1	2	2	3	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**-9**	**0**	**-1**	**-10**	**-10**
Hedera helix	1	1	1	4	5	5	0	0	0	1	1	1	0	1	1	1	1	2	0	0	0	0	0	1	0	1	1	1	1	1	**-14**	**3**	**-5**	**-16**	**-12**
Potamogeton polygonifolius	1	2	2	2	2	3	0	0	0	1	1	2	1	1	1	2	2	4	0	0	0	0	0	1	0	0	0	0	0	0	**-8**	**7**	**-10**	**-11**	**-12**
*Myriophyllum alterniflorum**	1	2	3	3	3	3	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**-12**	**-3**	**0**	**-15**	**-15**
Carex echinata	0	2	4	4	6	7	1	1	2	2	2	4	2	4	6	7	7	11	3	4	5	5	5	6	0	0	0	0	1	4	**-11**	**25**	**-9**	**5**	**-18**
Salix sp. (shoots)	3	3	3	4	6	9	1	1	1	4	4	5	1	1	1	1	2	3	1	1	1	1	1	4	0	0	0	0	0	0	**-12**	**-7**	**0**	**-19**	**-28**
Salix sp. (s)	5	6	9	11	11	14	3	5	7	7	8	12	2	3	5	6	6	10	2	2	6	6	6	10	0	0	2	2	2	5	**-14**	**-10**	**0**	**-24**	**-45**
Betula sp. (s)	9	11	12	12	14	18	4	8	11	16	16	20	4	8	10	13	16	19	0	2	8	12	14	17	1	3	4	5	5	11	**-1**	**-5**	**-17**	**-23**	**-47**

Multivariate analysis

A Decorana analysis was carried out on the 1996-2001 quadrat data using frequency data. A DCA species plot for the first two axes is shown in Figure CS3.1. Species of the wetter mire communities (the M29 type which was included as a variant in the original classification of the plot), are situated towards the the negative end of axis 1. These include *Juncus bulbosus* and *Potamogeton polygonifolius*. Species of drier parts of mires are situated towards the positive end of axis 1. The M9a positive indicators (marked in bold in Figure CS3.1) are generally situated on the positive side of axis 1with *Potentilla erecta* having the highest score of all species on axis 1. Species scores generally show less spread along axis 2. Using Ellenburg and Suited Species scores to explain these axes reveals that only the Ellenburg Light scores are correlated with one axis, axis 2 ($r_s = 0.302$, $n = 34$, $P < 0.05$), no other measure is significant.

Yearly site scores for the whole plot on the first two DCA axes are shown in Figure CS3.2. This shows that the site scores have moved mainly along axis 1 with two large movements between 1996-97 and 1999-2001. This clearly indicates a major change in the botanical community following initial management while smaller annual changes have occurred since. The 'direction of travel' of the site scores along axis 1 indicates that community composition has involved a decrease in more aquatic species (such as *Juncus bulbosus, Myriophyllum alterniflorum* and *Mentha aquatica*) and an increase in species requiring lower ground water and less frequent flooding (such as *Juncus conglomeratus* and *Typha latifolia*). This strongly reflects the observed changes in Ellenburg moisture scores discussed above.

The sudden change in site scores along axis 2 involving 1997 and 1998 data may simply be due to the occurrence of two shrub species in each of these years, despite a correlation of this axis with Ellenburg light values in the species plot. The spread of site scores along axis 2 was not good due to the lack of variance arising from frequency data.

A plot of axis 1 site scores against cumulative nest scores for positive indicators is shown in Figure CS3.3. This shows a large increase in nest scores during the first period, a smaller increase over the next two years, followed by a decline over the final period. This has accompanied two large changes in community composition during the first and last monitoring periods as discussed above. A second order polynomial regression has been fitted to the data to smooth the relationship.

Discussion and conclusions

Intrepretation of the Decorana analysis, coupled with the univariate analyses, would appear to indicate that the community rapidly became relatively favourable following scrub management pre-1996, but is 'drifting' towards a relatively unfavourable condition as the area becomes increasingly dominated by rushes which overshadow the slower-growing and shorter species, and which may also facilitate drier soil conditions.

In this case study, therefore, interpretation of detailed analyses has revealed the slow processes which will involve a deflection of condition back towards a relatively unfavourable state, but probably involving a different NVC community.

The inclusion of relatively ‘dry’ mire species in the set of positive indicators, due to their high relative abundance in NVC tables may not indicate stability or progression towards a target M6a community.

Case Study 4: Moorhouse NNR, Cumbria

Background

This site, part of Moorhouse and Upper Teesedale NNR, has been an Environmental Change Network (ECN) monitoring site since 1993. The ECN has one of the best long-term monitoring data sets over a range of habitats in the UK and, as such, may provide a suitable basis for Validation Monitoring on the ECN sites which are SSSIs. The aim of this study was to look at the comparability between communities within the ECN Fine-grain (10x10m) plots and wider areas considered to be contiguous habitats with these plots.

Data available

Two plots, ECN Fine-grain plot numbers 61 and 206, were surveyed under the ECN monitoring programme during July 2001. The ECN Fine-grain monitoring protocol was used to obtain presence-absence data within 40x40cm cells. This gives an overall frequency per species per plot. These plots were then re-visited in August 2001 and areas of similar vegetation to the dominant type within the ECN plot delineated around the ECN plot. Plot 206, containing M19/M20 a Blanket Bog community, was extended to a square 18x18m plot (ie 3.24 times the ECN plot size). Plot 61, an M6 mire with U5/6 acid grassland, was extended to an elongated plot of approximately 28m by 5m. This plot was therefore only slightly larger overall than the ECN plot but took in an area of 78m outside the ECN plot. 1x1m quadrats were stratified-randomly located within the extended plots and species' frequencies recorded.

Results

Differences in frequencies were compared between ECN and extended plots using Chi-square (χ^2) tests with one degree of freedom.

Plot 61

46 species were recorded in the ECN plot compared to 52 in the extended plot. Of the co-occurring species, 9 species with high enough frequencies showed significant differences in frequency between the two plots. These are shown in Table CS4.1.

Table CS4.1

Species	% Frequency in ECN plot	% Frequency in extended plot	χ^2 value
Agrostis stolonifera	30	83	25.44 ***
Anthoxanthum odoratum	30	80	25.0 ***
Cirsium palustre	40	93	21.33 ***
Galium palustre/uliginosum	40	53	5.44 *
Juncus acutiflorus	30	53	5.44 *
Juncus bulbosus	40	17	4.08 *
Juncus effusus	30	60	9.0 **
Philonotis Fontana	40	63	4.08 *
Plagiomnium sp.	30	57	20.17 **

Plot 206

14 species were recorded in the ECN plot while 21 species were recorded in the extended plot. Of the co-occurring species, only one showed a significant difference in frequency between the two plots (see Table CS 4.2).

Table CS 4.2

Species	% Frequency in ECN plot	% Frequency in extended plot	χ^2 value
Sphagnum capillifolium	40	73	8.33 **

Note for table

Significance levels * P<0.05, ** P<0.01, *** P,0.001

Discussion and conclusions

These results are mixed in terms of determining whether the relatively small ECN plots can be representative of wider communities in the uplands. On the one hand, the M6 flush type mire community is typically more linear and a square plot is not particularly representative, even on a small scale. On the other hand, the wider M19 blanket bog community is well represented by the ECN plot (apart from one species) and we would be fairly happy to monitor changes on the smaller plot as representative of the community as a whole.

These are important considerations as clearly, intensive monitoring of the ECN plot, representing an area of $1.6m^2$, is far less resource-hungry than intensive monitoring of $30m^2$, as represented by the extended plot.

Case Study 5: Invertebrate assemblage quality

Background

This part of the pilot programme was carried out at Dstl Porton Down. This site has a large, contiguous, area of high quality calcareous grassland and plots in three areas were chosen from within the site, one of relatively favourable condition and two of relatively unfavourable condition according to the English Nature guidelines on condition assessment. Standard trapping methods and quantitative habitat/environmental recording was used in each of these plots (see Section 2.1.5).

Data available

This is covered in section 2.1.5.

Results

Approximately 2500 specimens were identified from all trapping methods. This included 15 Noteable (Noteable "a" and "b") and two RDB (not assigned to a category) species. A full list of specimens identified not in the Carabidae or Araneae can be found in a report ("Porton Down Invertebrate Validation Monitoring – 2001" by J & P Whitehead Landscape Consultants).

Carabidae

This analysis was performed on total catches from pitfall traps, grouped for each plot. Two indices were calculated for each plot:

A Site Quality Score (SQS), following Foster (1987) and Eyre and Rushton (1989). This uses distributional data on each species where the proportion of total 10km squares each species occupies in Great Britain is transformed into a geometric progression as follows: >64% scores 1, 32-63.9% scores 2, 16-31.9% scores 3, 8-15.9% scores 4, 4-7.9% scores 5, 1-3.9% scores 6 and ,1% scores 7. Information on distribution was obtained from the BRC (P. Harding & H. Arnold, pers. comm.). Species' scores are totalled then averaged for each plot.

Shannon's (1948) Diversity Index, H', was calculated from total pitfall catches for each plot.

Species richness (total number caught per plot) is also calculated.

Table CS5.1 shows the results of these analyses.

Table CS5.1

Index	Roche Court Down ('Favourable')	The Breck ('Unfavourable')	Breck East ('Unfavourable')
SQS	3.833	2.667	2.667
H' Diversity	0.552	0.58	0.919
Species Richness	6	3	3

The 'favourable' plot clearly scores higher on the SQS, mainly due to the presence of two species, *Panageus bipustulatus* and *Licinus depressus*, both of which score 6 on the distributional index. No species on the other two plots scored higher than 3 on this index. The diversity index, conversely, is much higher in the Breck East 'unfavourable' plot due to the presence of three relatively common species at reasonably high numbers.

Araneae

The same analytical methodology was used for this group as with the Carabidae. Eight of the 22 species were not previously recorded in a comprehensive survey during the 1970s (Coleman, 1977-8). This period was one when Myxamatosis was rampant among the rabbit population at Porton and this resulted in large areas of tall, rank grassland (Bealey *et al* 1999; Wells *et al* 1976). This would in turn, have affected the available niches for spiders and other invertebrates. However, it is well known that spiders are particularly well adapted for rapid colonization of areas when conditions become suitable, often through the 'ballooning' behaviour of juveniles. The results of the 2001 survey are shown in Table CS5.2

Table CS5.2

Index	Roche Court Down ('Favourable')	The Breck ('Unfavourable')	Breck East ('Unfavourable')
SQS	3.5	4.071	3.667
H' Diversity	2.716	2.137	2.244
Species Richness	20	17	15

In this group, the SQS is more even across the plots, with the 'unfavourable' plot, The Breck, having a higher score than the other two plots. Three of the five rarest species (with distributional indices of 6 or 7), occurred in the Breck. The highest diversity index again does not coincide with the highest SQS and occurs on the 'favourable' Roche Court Down plot.

Habitat characteristics

The results of the habitat/environmental characterization of each plot are shown in Table CS5.3. Figures are means values of 36 samples per plot.

Table CS5.3

Index	Roche Court Down ('Favourable')	The Breck ('Unfavourable')	Breck East ('Unfavourable')
Vegetation ht (cm)	2.94 (± 2.0)	6.611 (± 2.76)	22.0 (± 12.08)
% Monocots	33.8	34.4	74.7
% Dicots	45.7	56.7	21.2
% Bryophytes	11.8	2.5	3.7
% Bare ground	8.9	5.5	0.1

The Table shows that Breck East is by far the 'grassiest' of the three plots with 75% monocotyledons per sample (although members of the Orchidaceae are included in this category). This is also reflected in the much higher vegetation height value for this plot. Roche Court Down is a heavily rabbit-grazed area and this is reflected in the combination of very short vegetation, high bryophyte cover and relatively high cover of bare ground.

Structurally, however, variation is greatest in the Breck where there is a medium sward height with plus or minus 30 per cent variation plus lots of gaps with bare ground.

Discussion and conclusions

Foster and Procter (1995) emphasized that individual species' habitat preferences in both wetland Carabidae and Araneae can considerably skew summary measures of diversity and 'quality'. Other previous studies have found that rarer Carabidae seem to prefer areas of low management intensity while rarer Araneae appear to be absent where management produces low structural variability (Foster and Procter, 1995).

The habitat/environmental data show that conditions in the 'favourable' plot are generally ideally suitable for ground-dwelling Carabid beetles, with patches where warm microclimates prevail among the short turf and bare ground (Thiele, 1977). Conversely, the Araneids as a group, require more diverse structure and conditions similar to the above site would provide good hunting areas for ground-dwelling species and groups such as *Atypus affinis* and the Lycosidae and areas of taller vegetation providing niches for groups such as the Thomisidae.

Unfortunately, data from this survey are too sparse for further analysis along the lines shown above, probably due to the relatively late dates when field sampling was carried out. Also, more detailed analysis linking habitat/environmental data with species and community composition is not possible as individual traps are not linked to specific habitat/environmental samples (thereby reducing overall sample size). However, there are some clear differences between both the two taxonomic groups and the community 'quality' indices and their link with habitat quality in this study. A more comprehensive study in 2002 will be able to look at these relationships in more detail.

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Appendix 1. Sites and habitats (NVC categories) covered by the Pilot Study

	NVC type								
Site	**CG4**	**CG2-7**	**M6**	**M23**	**M29**	**H4-8**	**H12-18**	**M17-19**	**U2-20**
Scratchy Bottom, South Dorset Coast SSSI, Dorset	✓								
Stiperstones NNR, Shropshire						✓	✓		
Studland Heath NNR, Dorset			✓	✓	✓				
Moorhouse & Upper Teesedale NNR, Cumbria & Northumberland								✓	✓
Porton Down SSSI, Wiltshire		✓							

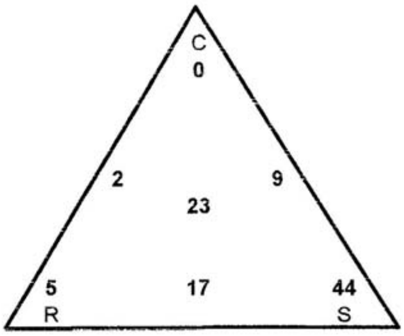
Appendix CS1.1 Scratchy Bottom FIBS analysis (all quadrats)

Scratchy Bottom, Dorset - All quadrats 2001

SITE NAME	Scr01all
Division	
Quadrat	0
Community	0
Date	

(Values for all attributes are expressed as a percentage)

PLANT STRATEGY



HABITAT	
Wetland	0
Skeletal	32
Arable	1
Pasture	54
Spoil	40
Wasteland	41
Woodland	0

SOIL pH <5	0

SPECIES RICHNESS	
<10 spp m-2	0
10.1-14	3
14.1-18	9
18.1-22	64
>22	25

TOTAL COUNT	490

POLYCARPIC PERENNIALS	79
NUCLEAR DNA>10pg	3

PRESENT STATUS	
Decreasing	58
Uncertain	20
Increasing	23

FLOWERING TIME	
Jan-Feb	0
March	6
April	10
May	27
June	32
July	25
August	0
September	0
Oct-Dec	0

GEOGRAPHICAL RESTRICTION

(A) LATITUDINAL	
Northern	0
Slight northern	0
No lat.restriction	22
Slight southern	36
Southern	43

(B) LONGITUDINAL	
Western	0
Slight western	3
No long.restriction	97
Slight eastern	0
Eastern	0

CANOPY STRUCTURE	
Leafy	27
Semi-basal	44
Basal	29
Floating	0
Other	0

HEIGHT	
<100 mm	30
100-299	51
300-599	17
600-999	2
1000-3000	0
>3000	0

REGENERATIVE STRATEGY	
Persistent seed bank	79
Numerous widely dispersed seeds	29
Vegetative fragments importar	4

SEED WT	
Minute	0
<0.2mg	29
0.2-0.5	15
0.51-1.0	18
1.01-2.0	25
2.01-10.0	12
>10.0	2

VEG SPREAD	
Monocarpic	18
Patch >100mm	30
100-250	22
251-1000	18
>1000	12

Unit of Comparative Plant Ecology

Appendix CS1.2 Scratchy Bottom FIBS analysis (favourable plot)

Scratchy Bottom, Dorset - Favourable quadrats 2001

SITE NAME	ScrFav
Division	
Quadrat	0
Community	0
Date	

(Values for all attributes are expressed as a percentage)

HABITAT	
Wetland	0
Skeletal	30
Arable	0
Pasture	59
Spoil	29
Wasteland	41
Woodland	0

SOIL pH <5	0

SPECIES RICHNESS	
<10 spp m-2	0
10.1-14	7
14.1-18	12
18.1-22	51
>22	30

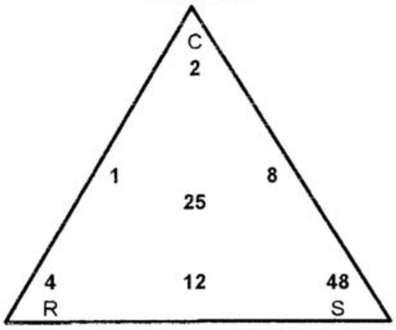
POLYCARPIC PERENNIALS	85
NUCLEAR DNA>10pg	12

PRESENT STATUS	
Decreasing	65
Uncertain	19
Increasing	17

CANOPY STRUCTURE	
Leafy	27
Semi-basal	51
Basal	22
Floating	0
Other	0

REGENERATIVE STRATEGY	
Persistent seed bank	54
Numerous widely dispersed seeds	22
Vegetative fragments importar	3

PLANT STRATEGY



TOTAL COUNT	521

FLOWERING TIME	
Jan-Feb	0
March	5
April	8
May	33
June	36
July	19
August	0
September	0
Oct-Dec	0

HEIGHT	
<100 mm	30
100-299	51
300-599	17
600-999	2
1000-3000	0
>3000	0

SEED WT	
Minute	0
<0.2mg	25
0.2-0.5	25
0.51-1.0	19
1.01-2.0	19
2.01-10.0	11
>10.0	1

GEOGRAPHICAL RESTRICTION

(A) LATITUDINAL	
Northern	0
Slight northern	0
No lat.restriction	27
Slight southern	33
Southern	40

(B) LONGITUDINAL	
Western	0
Slight western	2
No long.restriction	98
Slight eastern	0
Eastern	0

VEG SPREAD	
Monocarpic	13
Patch >100mm	28
100-250	35
251-1000	15
>1000	9

Unit of Comparative Plant Ecology

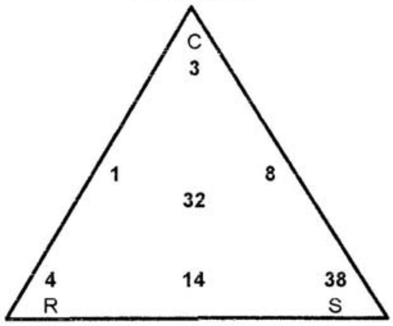
Appendix CS1.3 Scratchy Bottom FIBS analysis (unfavourable plot)

Scratchy Bottom, Dorset - Unfavourable quadrats 2001

SITE NAME	ScrUnf
Division	
Quadrat	0
Community	0
Date	

(Values for all attributes are expressed as a percentage)

PLANT STRATEGY



TOTAL COUNT 134

HABITAT	
Wetland	0
Skeletal	24
Arable	4
Pasture	55
Spoil	31
Wasteland	45
Woodland	0

SOIL pH <5	0

SPECIES RICHNESS	
<10 spp m-2	0
10.1-14	5
14.1-18	15
18.1-22	51
>22	28

POLYCARPIC PERENNIALS	81
NUCLEAR DNA>10pg	15

PRESENT STATUS	
Decreasing	59
Uncertain	22
Increasing	19

CANOPY STRUCTURE	
Leafy	27
Semi-basal	53
Basal	20
Floating	0
Other	0

REGENERATIVE STRATEGY	
Persistent seed bank	52
Numerous widely dispersed seeds	17
Vegetative fragments importar	2

FLOWERING TIME	
Jan-Feb	0
March	4
April	7
May	34
June	38
July	16
August	0
September	0
Oct-Dec	0

HEIGHT	
<100 mm	28
100-299	54
300-599	17
600-999	1
1000-3000	0
>3000	0

SEED WT	
Minute	0
<0.2mg	19
0.2-0.5	25
0.51-1.0	21
1.01-2.0	25
2.01-10.0	10
>10.0	1

GEOGRAPHICAL RESTRICTION

(A) LATITUDINAL	
Northern	0
Slight northern	0
No lat.restriction	27
Slight southern	35
Southern	38

(B) LONGITUDINAL	
Western	0
Slight western	1
No long.restriction	99
Slight eastern	0
Eastern	0

VEG SPREAD	
Monocarpic	16
Patch >100mm	22
100-250	34
251-1000	18
>1000	9

Unit of Comparative Plant Ecology

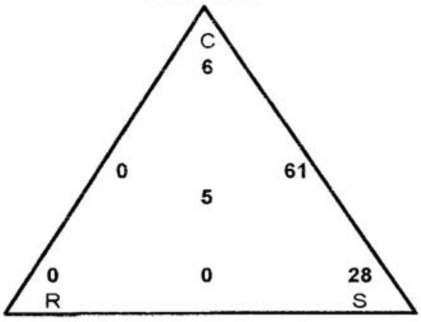
Appendix CS2.1 Stiperstones FIBS analysis (favourable plot)

Stiperstones plot, Shropshire - Favourable quadrats 2001

SITE NAME	StipFa·
Division	
Quadrat	0
Community	0
Date	

(Values for all attributes are expressed as a percentage)

PLANT STRATEGY



HABITAT	
Wetland	9
Skeletal	0
Arable	0
Pasture	94
Spoil	0
Wasteland	4
Woodland	5

SOIL pH <5	97

SPECIES RICHNESS	
<10 spp m-2	79
10.1-14	18
14.1-18	3
18.1-22	0
>22	0

TOTAL COUNT	96

POLYCARPIC PERENNIALS	100
NUCLEAR DNA>10pg	27

PRESENT STATUS	
Decreasing	63
Uncertain	31
Increasing	6

FLOWERING TIME	
Jan-Feb	0
March	2
April	20
May	11
June	42
July	0
August	25
September	0
Oct-Dec	0

GEOGRAPHICAL RESTRICTION

(A) LATITUDINAL	
Northern	0
Slight northern	0
No lat.restriction	91
Slight southern	9
Southern	0

(B) LONGITUDINAL	
Western	3
Slight western	1
No long.restriction	96
Slight eastern	0
Eastern	0

CANOPY STRUCTURE	
Leafy	52
Semi-basal	42
Basal	5
Floating	0
Other	0

HEIGHT	
<100 mm	4
100-299	36
300-599	30
600-999	23
1000-3000	6
>3000	0

REGENERATIVE STRATEGY	
Persistent seed bank	74
Numerous widely dispersed seeds	5
Vegetative fragments importar	0

SEED WT	
Minute	5
<0.2mg	25
0.2-0.5	52
0.51-1.0	16
1.01-2.0	2
2.01-10.0	0
>10.0	0

VEG SPREAD	
Monocarpic	0
Patch >100mm	4
100-250	7
251-1000	64
>1000	25

Unit of Comparative Plant Ecology

Appendix CS2.2 Stiperstones FIBS analysis (unfavourable plot)

Stiperstones plot, Shropshire - Unfavourable quadrats 2001

SITE NAME	StipUn
Division	
Quadrat	0
Community	0
Date	

(Values for all attributes are expressed as a percentage)

HABITAT	
Wetland	3
Skeletal	0
Arable	0
Pasture	79
Spoil	0
Wasteland	0
Woodland	18

SOIL pH <5	97

SPECIES RICHNESS	
<10 spp m-2	92
10.1-14	5
14.1-18	3
18.1-22	0
>22	0

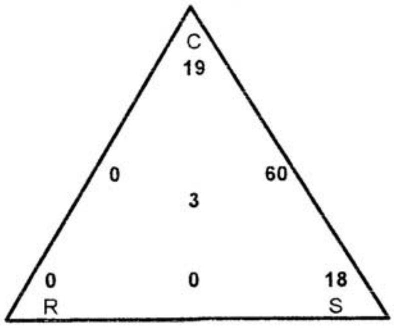
POLYCARPIC PERENNIALS	100
NUCLEAR DNA>10pg	44

PRESENT STATUS	
Decreasing	49
Uncertain	31
Increasing	21

CANOPY STRUCTURE	
Leafy	54
Semi-basal	26
Basal	18
Floating	0
Other	0

REGENERATIVE STRATEGY	
Persistent seed bank	77
Numerous widely dispersed seeds	18
Vegetative fragments importar	0

PLANT STRATEGY



TOTAL COUNT	39

FLOWERING TIME	
Jan-Feb	0
March	0
April	23
May	3
June	36
July	0
August	38
September	0
Oct-Dec	0

HEIGHT	
<100 mm	3
100-299	33
300-599	23
600-999	21
1000-3000	21
>3000	0

SEED WT	
Minute	18
<0.2mg	26
0.2-0.5	54
0.51-1.0	3
1.01-2.0	0
2.01-10.0	0
>10.0	0

GEOGRAPHICAL RESTRICTION

(A) LATITUDINAL	
Northern	0
Slight northern	0
No lat.restriction	96
Slight southern	4
Southern	0

(B) LONGITUDINAL	
Western	0
Slight western	0
No long.restriction	100
Slight eastern	0
Eastern	0

VEG SPREAD	
Monocarpic	0
Patch >100mm	0
100-250	3
251-1000	56
>1000	41

Unit of Comparative Plant Ecology

Appendix CS2.3 Stiperstones vegetation analysis: interset correlations of environmental variables

N	NAME	AX1	AX2	AX3	AX4
		0.0894	0.0533	0.1019	0.0284
1	Arc.Litt	-0.1672	-0.18	0.0565	0.0639
2	BareNat	-0.0635	-0.2386	0.5248	0.1865
3	BareDist	-0.0786	-0.1153	0.3042	0.12
4	Arc.Dcal	-0.173	-0.245	-0.1822	0.0721
5	Arc.Bare	-0.0951	-0.1371	0.3547	0.1415
6	Arc.CalA	-0.2538	-0.3456	0.3493	0.1884
7	Arc.CalA	0.124	-0.127	0.083	-0.028
8	Arc.CalA	0.8194	0.057	-0.1519	-0.2571
9	Arc.CalA	-0.3576	0.3516	-0.3929	-0.0367
10	Arc.CalG	-0.0803	-0.1258	0.3056	0.1438
11	Arc.Othe	-0.2791	0.4099	0.2225	-0.0152
12	Arc.OldB	-0.2769	0.1828	0.2723	-0.0013
13	Arc.RecB	-0.176	-0.1735	0.0786	0.0483
14	Arc.Cut	-0.2553	-0.1986	-0.0003	0.0912
15	Arc.Flow	0.5571	0.1438	-0.0087	-0.2629
16	Arc.Shoo	0.1749	-0.1315	-0.0535	-0.1094
17	Arc.Norm	0.0993	0.4411	-0.4823	-0.1924
18	Arc.Drum	0.2072	-0.1382	-0.0472	-0.1118
20	Arc.Carp	-0.1747	-0.3469	0.3928	0.1952
21	DDskHt	0.1748	-0.122	-0.6171	-0.425
22	MaxCalHt	0.4572	0.0353	-0.555	-0.1849

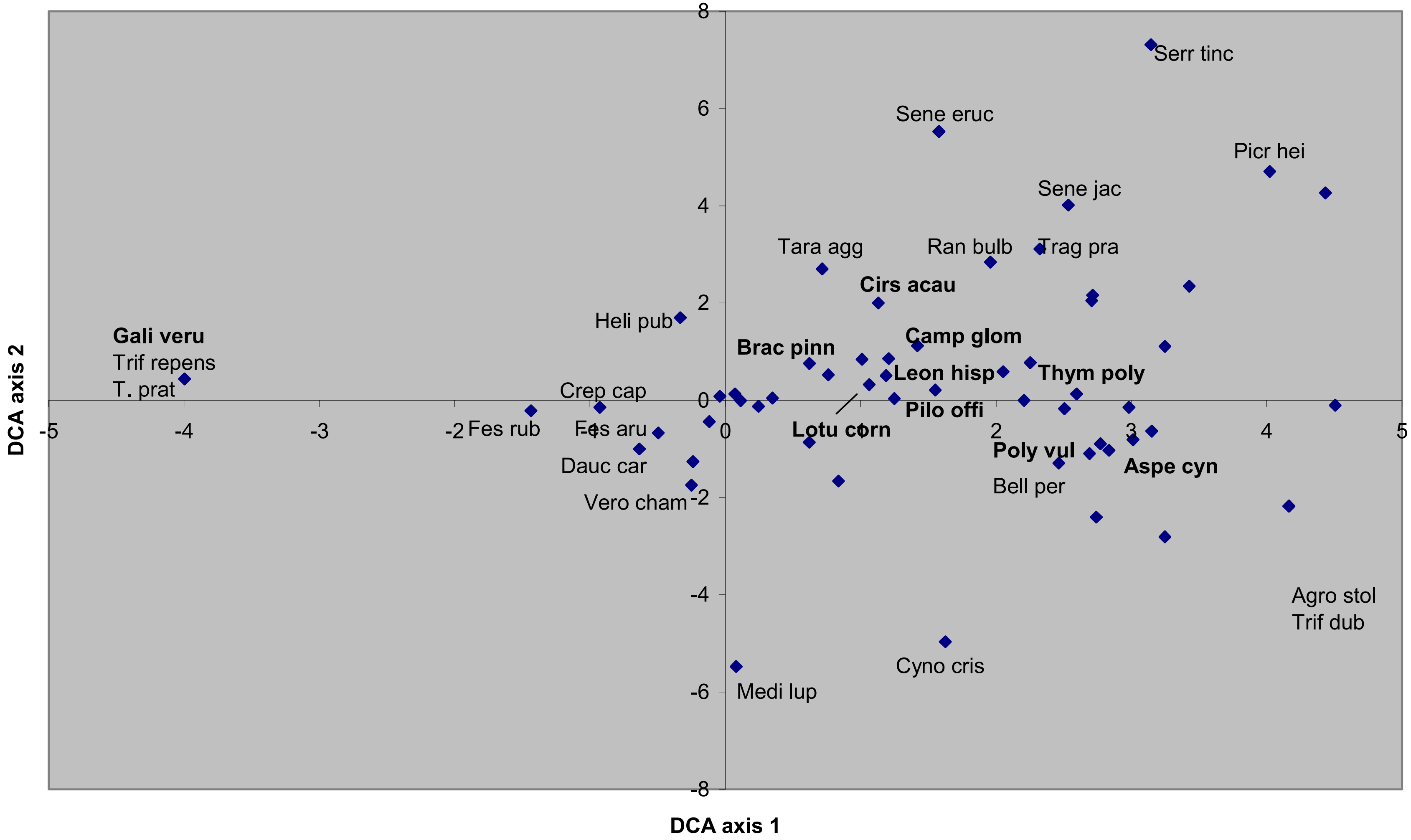


Figure CS1.1 Scratchy Bottom 2001: species scores

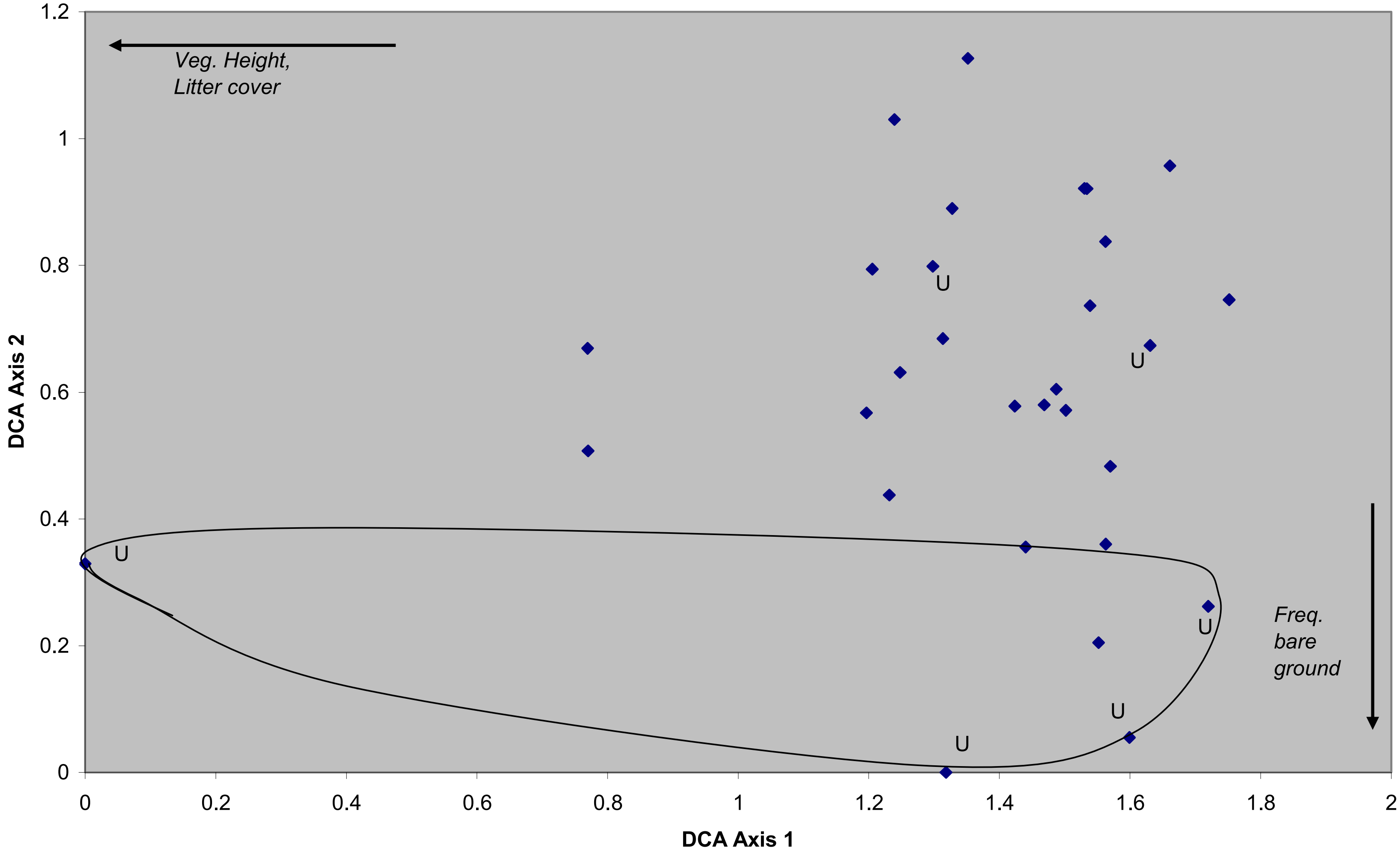


Figure CS1.2 Scratchy Bottom 2001 site scores

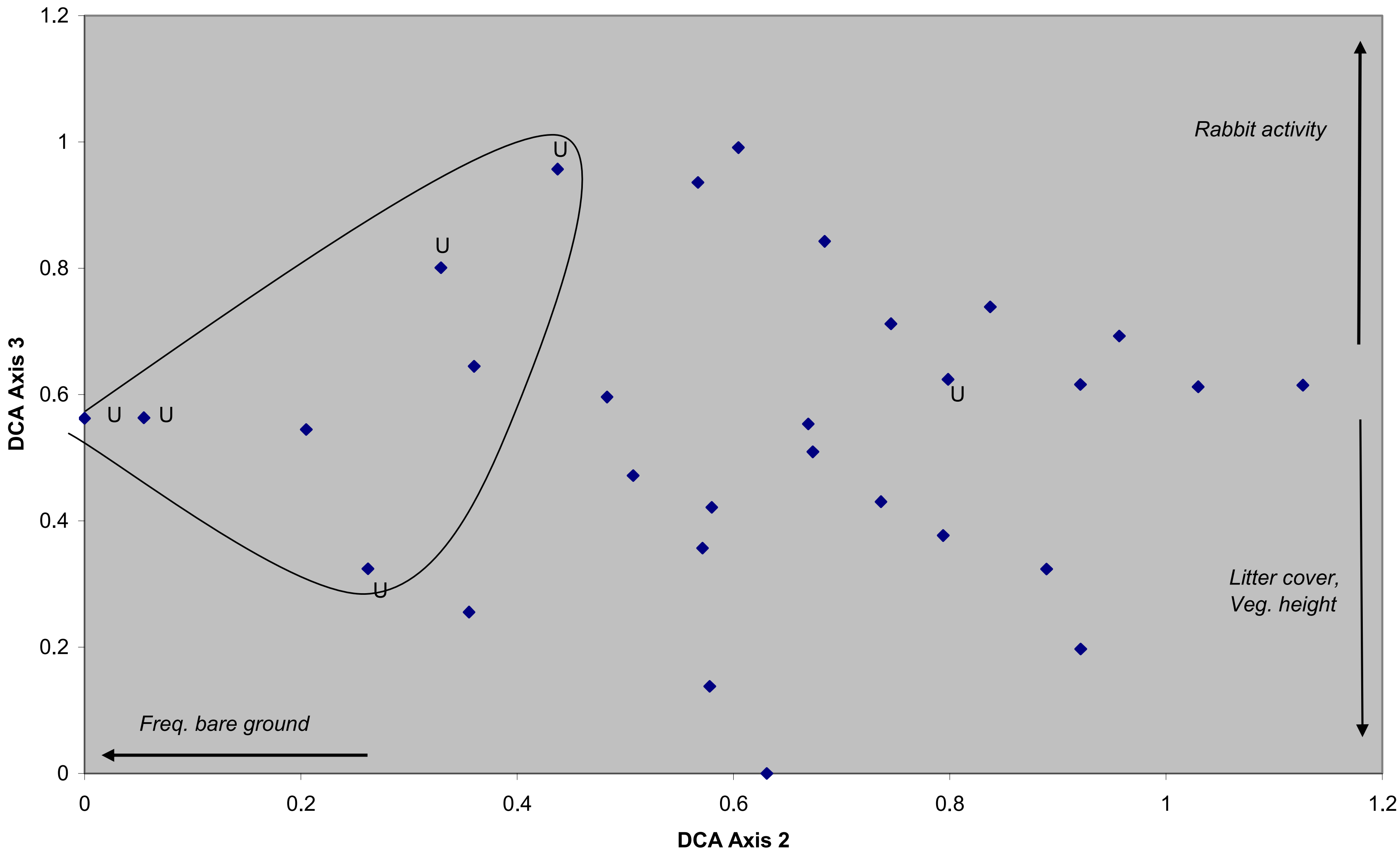


Figure CS1.3 Scratchy Bottom 2001 site scores

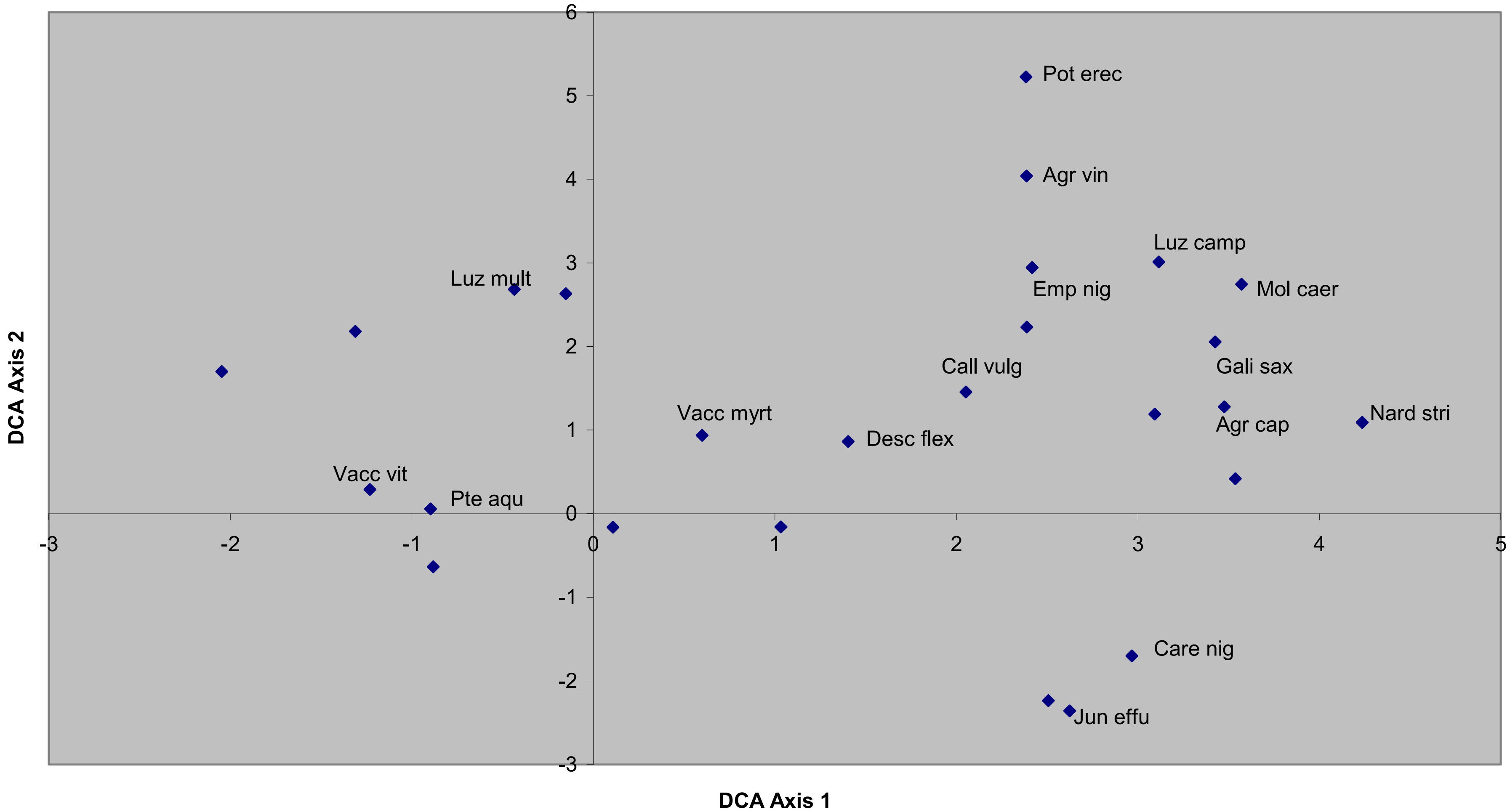


Figure CS2.1 Stiperstones species scores

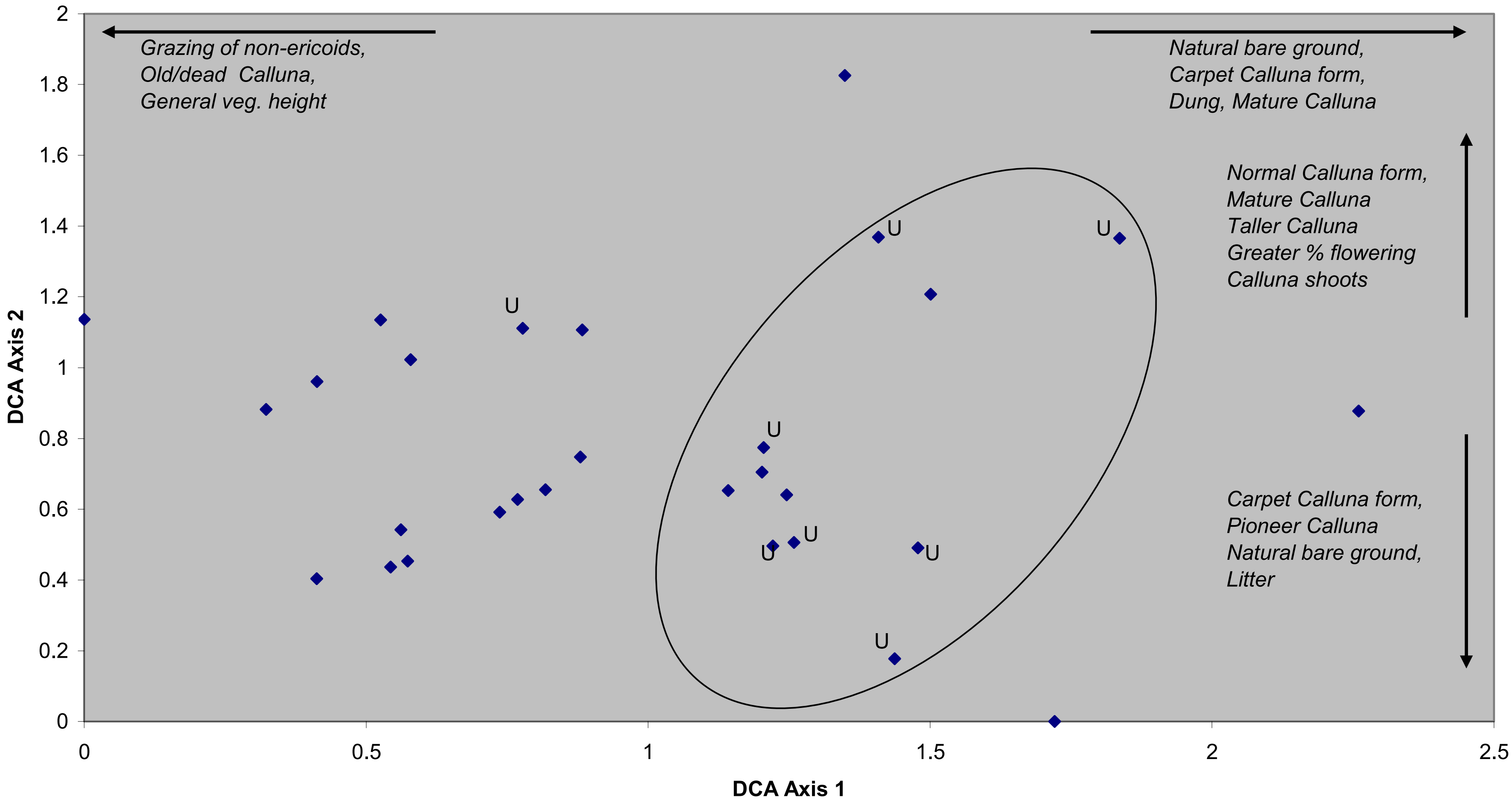


Figure CS2.2 Stiperstones site scores

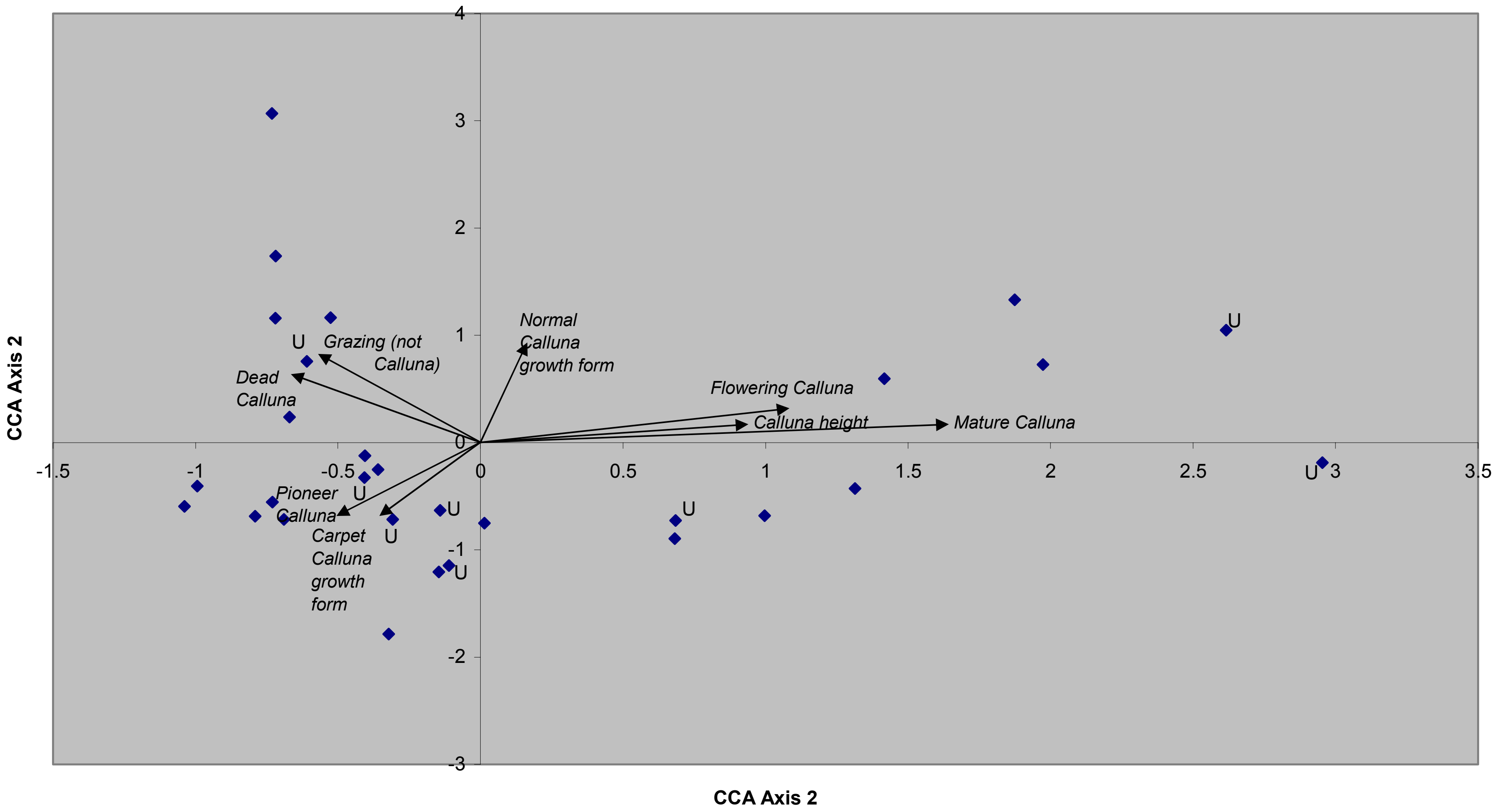


Figure CS2.3 Stiperstones 2001 Canoco analysis (Environmental vectors x2)

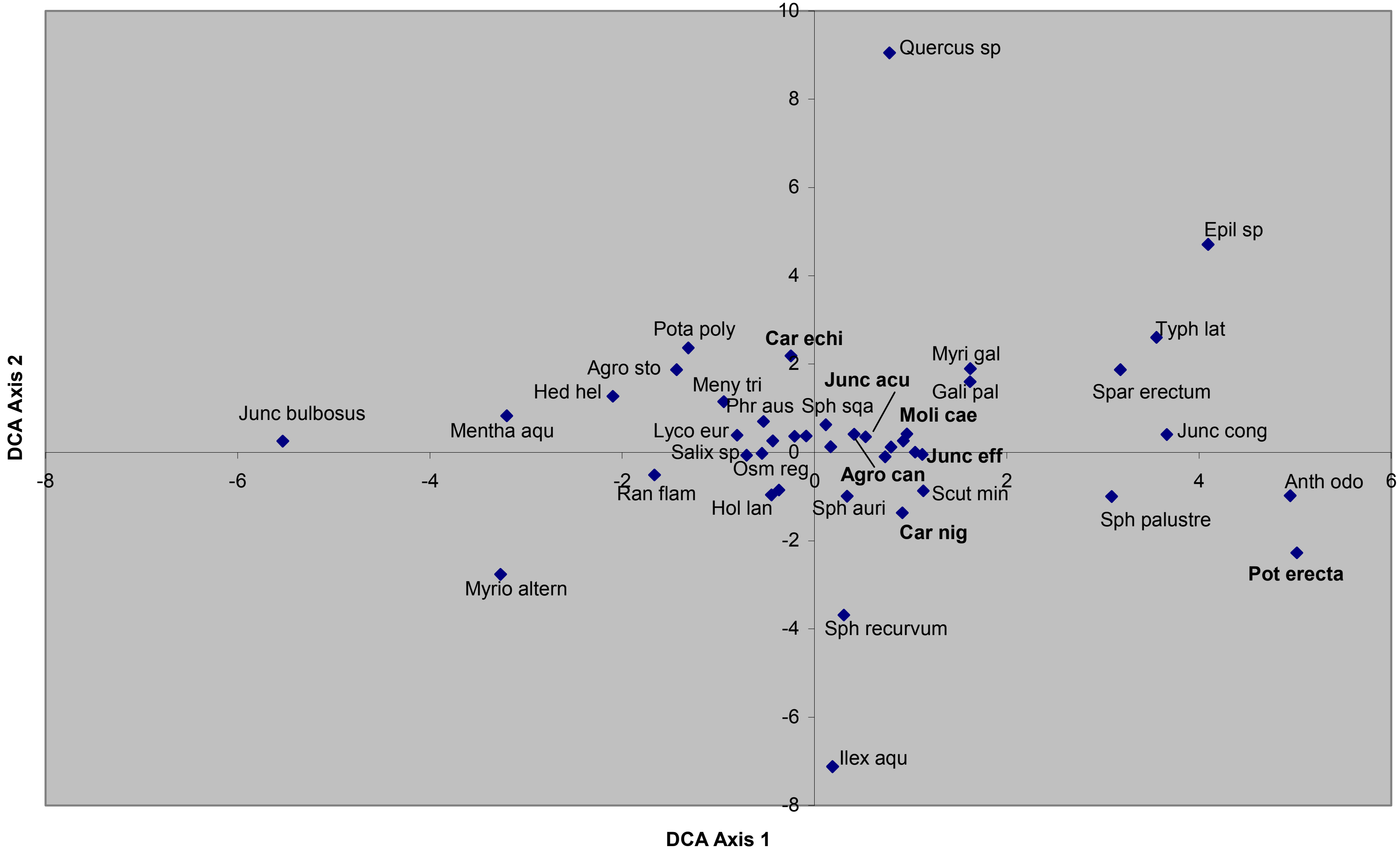


Figure CS3.1 Studland Clearing species scores

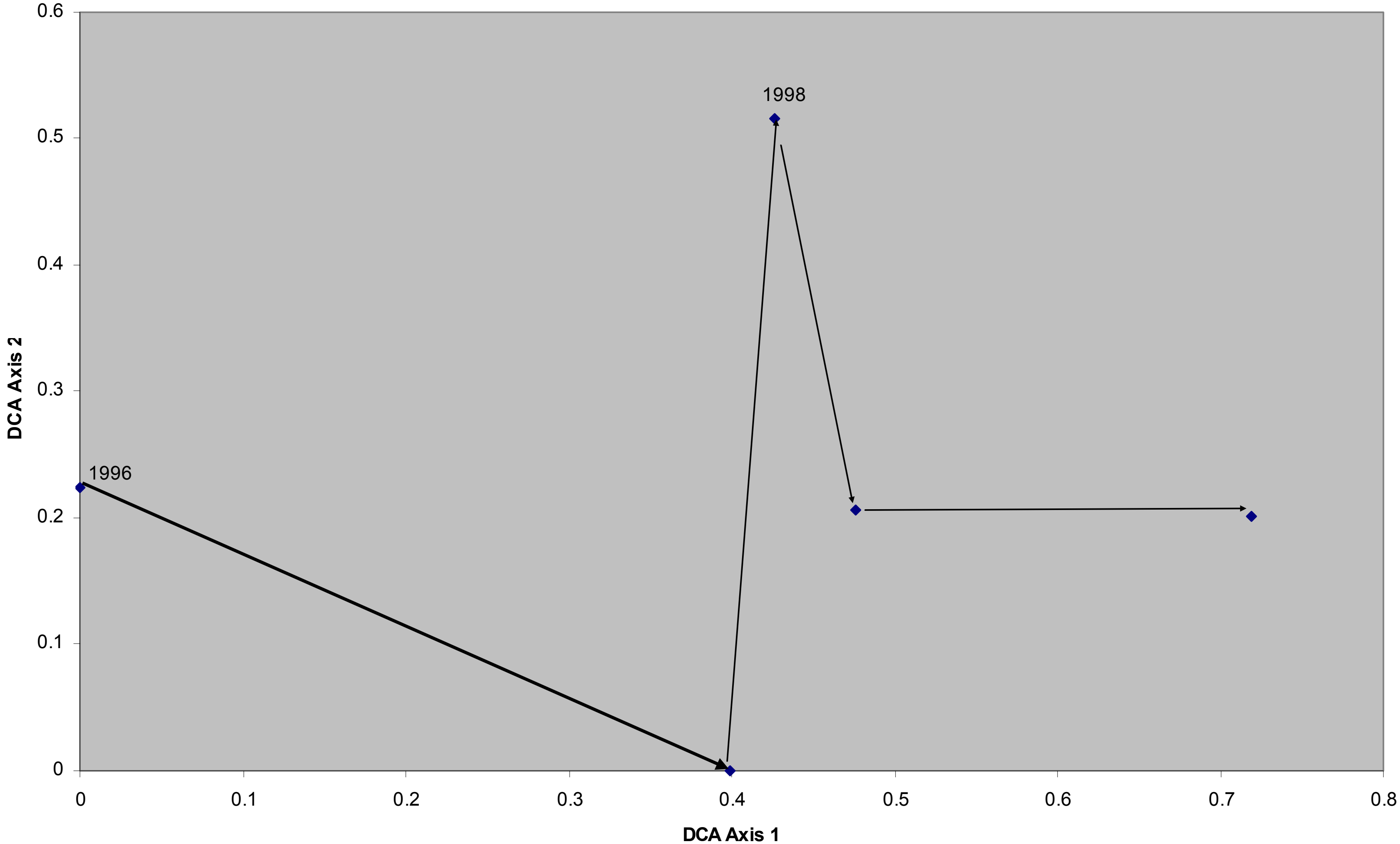


Figure CS3.2 Studland Clearing 1996-2001 site scores

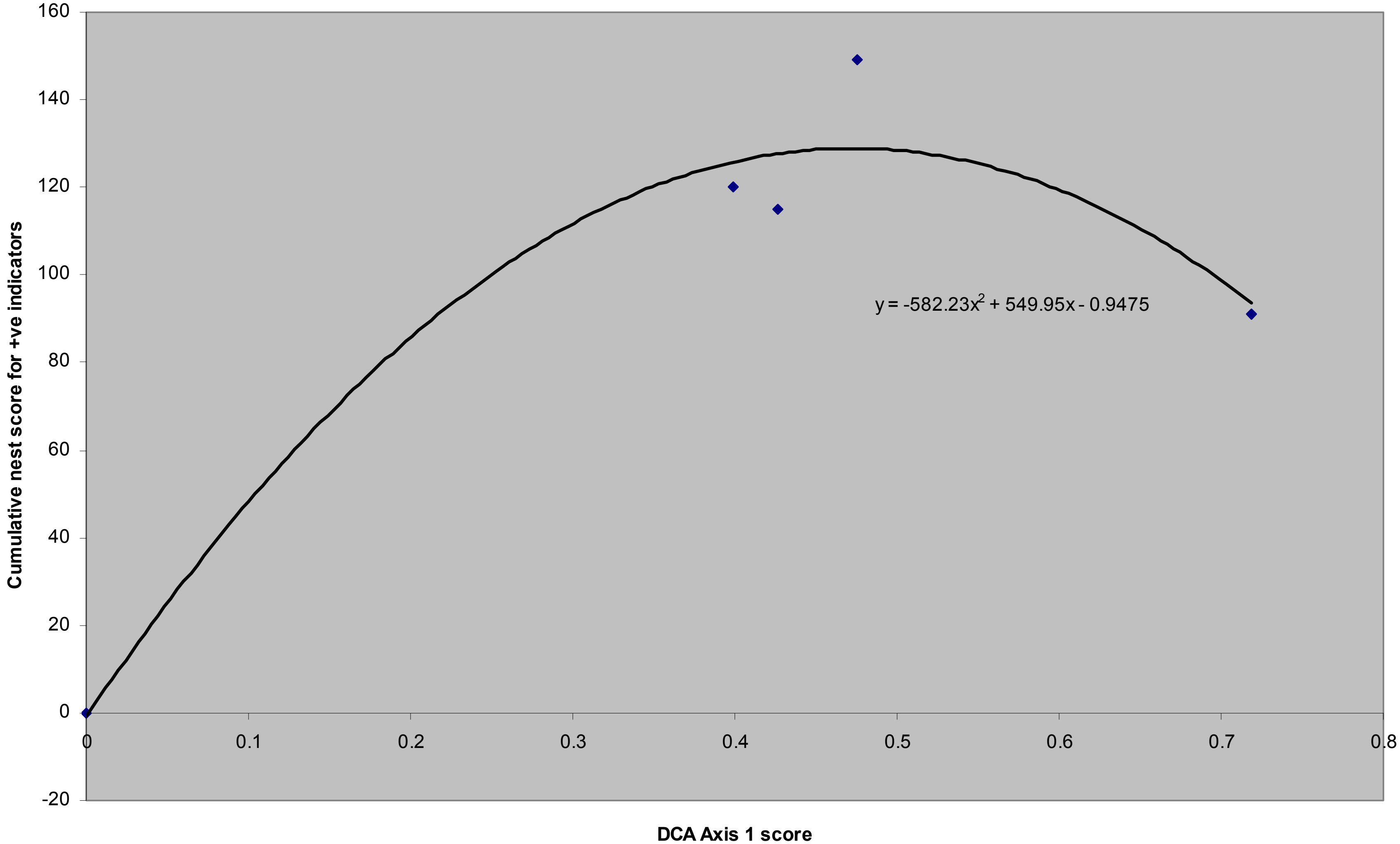


Figure CS3.3 Studland Clearing 1996-2001 site scores versus cumulative nest scores

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Top left: Using a home-made moth trap.
Peter Wakely/English Nature 17,396
Middle left: Co_2 experiment at Roudsea Wood and Mosses NNR, Lancashire.
Peter Wakely/English Nature 21,792
Bottom left: Radio tracking a hare on Pawlett Hams, Somerset.
Paul Glendell/English Nature 23,020
Main: Identifying moths caught in a moth trap at Ham Wall NNR, Somerset.
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