# Assessing Grassland Recovery following Scrub Clearance at Draycott Sleights – Interim Report 2016.

Reserve - Draycott Sleights
Code - R40
Size – 50.06 ha
Main habitat - Limestone grassland
Reserves Area – West Mendip
Reserve Manager – Neil Watson
Survey - Christopher Hancock – 28/10/2015
Report - Christopher Hancock – 30/01/2016

**Summary**
This baseline study was set up to investigate the restoration of species-rich limestone grassland following scrub clearance. This involved sampling species presence both in scrub cleared areas and in near-by target species –rich grassland with no scrub. Comparison of the two types showed a wide difference in their Jaccard percentage similarity indices, numbers of FEP indicator species, mean Ellenberg numbers for light and nitrogen and their mean competitive and stress-tolerance strategies. Initial conclusions suggest that vegetation developing on former limestone grassland cleared of scrub, initially has few of the characteristics of species-rich limestone grassland. There is a high risk that competitive species will take advantage of raised nutrient levels and either result in domination by ruderals and or scrub regeneration. Further scrub colonisation of limestone grassland should be avoided. It is suggested that if future resampling shows convergence of these parameters, this will indicate a good basis for assessment of grassland recovery.

**Introduction**
Draycott Sleights is a 40ha grassland nature reserve owned and managed by the Somerset Wildlife Trust. It lies on the south-western scarp of the Mendip Hills anticline. The geology of the upper part of the site is Carboniferous limestone and passes through Triassic dolomitic conglomerate to the south west. During the ice-age the Mendip Hills were not glaciated but were subjected to large depositions of loess (aeolian drift) blown from ice-sheets to the north. The thick depositions of relatively base-poor loess were subjected to further leaching due to vertical drainage. This has left much of the limestone plateau covered with soils that do not support limestone grassland except where outcrops reach the surface. On the scarp slopes the soils are thinner and so that those supporting limestone grassland are more extensive. The soils on the reserve still range from mildly acid (U4) to very thin (CG2) grassland that has a strong calcareous influence. However the majority are steep enough to show calcareous influences ranging from CG3 to MG5b.

Due to varying soil thicknesses and grazing requirements, parts of the reserve have a strong tendency to develop scrub. This is mainly relatively species poor bramble (*Rubus fruticosus agg.*), hawthorn (*Crataegus monogyna*) with more occasional gorse (*Ulex europaeus*) on the thinner soils, but the scrub is quickly colonised by ash (*Fraxinus excelsior*) and readily develops into secondary woodland. While grazing will control scrub if grazing is sufficiently intensive, once established it tends to spread unless grazing is intense and cutting back is carried out. On Draycott one fenced compartment, originally designated as a scrub grassland mosaic has posed a particular problem as grazing was far too light and coppicing scrub blocks largely discontinued. This led to about 80% of the compartment being covered by hawthorn and the intervening spaced filled by thick bramble patches (1.5 metres high). The remaining 20% was being kept open by rabbit grazing. The whole compartment was in danger of losing all remaining ground flora and developing into

secondary woodland. Efforts to clear the scrub began in 2010 with the removal of the fence and mechanical mulching of sections of the bramble and hawthorn, the latter to below ground level using a grinding head on the arm of a tracked 'digger'. This method had the effect of leaving a more or less deep litter layer of mulched hawthorn and bramble. Until recently the control of subsequent regrowth of hawthorn and bramble was intermittent. Original plans to spray regrowth with Round-up was not carried out and repeat clearance using clearing saws and then a power flail has been necessary. The current regime involves flailing twice yearly.
Once cleared, how quickly and how completely will grassland flora recover or recolonise in areas covered by scrub? Relevance to reserve management – how much resource is it worth putting into clearing scrub and restoring grassland once flora is lost? If resource needed is too high should priority be given to preventing further scrub development on existing species-rich grassland rather than removal of established scrub?

## Method

In October 2015 base line vegetation samples were taken from a 2 metre diameter circle at 19 locations. In addition species present within the general scrub cleared area were recorded. While this was late in the year, the weather had remained very mild, no significant die back had occurred and some seedlings were present. At the same time as the scrub samples, control samples were taken from nearby grassland unaffected by scrub growth to provide a reasonable comparison. As far as possible samples were taken from within areas where scrub cover had been complete. This reduced the risk of small patches of open grassland remaining between scrub patches and retaining grassland species richness. Appendix 1 shows the species recorded (presence or absence) at each of the 20 sample points. Appendix 2 shows the location of the samples.

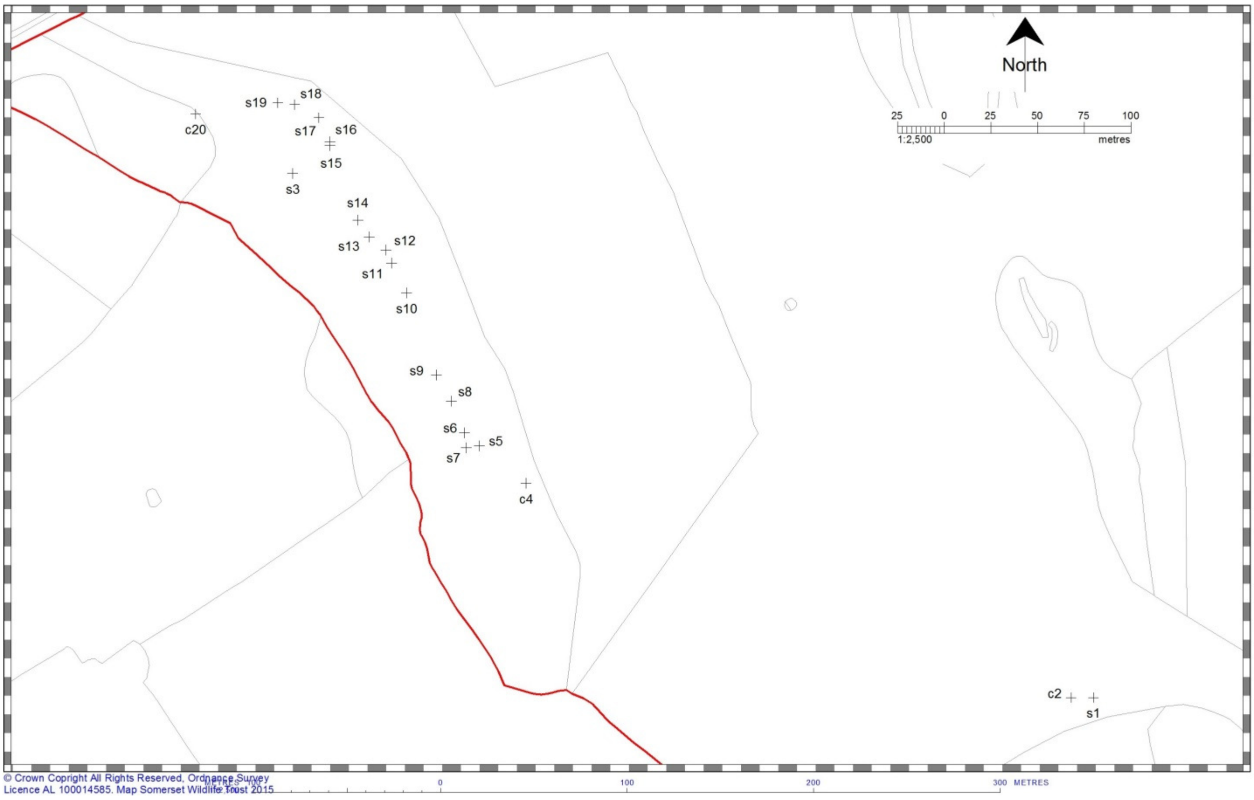


**Figure 2: Map showing location of sample points on Draycott Sleights Reserve.**

## Analysis

To simplify the analysis the results from 15 scrub cleared samples were amalgamated into one group and those in the 3 control samples into another. So that frequencies of occurrence were comparable between the two groups, the frequencies of species occurrences in the 3 control samples were multiplied by 5. Species presence lists for each sample was copied into 'Vegetation Trend Analysis' (Hancock 2016) to provide mean sample values for Ellenberg (Hill *et al* 1999) and Growth Strategy (Grimes *et al* 2004) and to identify FEP priority species (Natural England 2010) respectively. Jaccard (2001) % similarity values were calculated to show the similarity between the cleared samples and the controls. The formula used is shown in Appendix 4.

**Results**

The list of species found and their occurrence at eleven sites sampled for each group are shown in Appendix 1.

**Analysis and observations on results**

| Sample Treatments | Scrub cleared | Control |
|---|---|---|
| Nos. of species | 39 | 28 |
| Nos. of species paired with control | 13 | 15 |
| Nos. of calcareous FEP indicator species | 3 | 12 |
| Total occurrences of FEP indicators in samples | 15 | 130* |
| Mean number of FEP indicators per sample | 1 | 8.7* |
| Jaccard % similarity | 24 | 100 |

*Takes into account a 5 times multiplication factor to give equivalent sample frequency for control.

**Table 1: Similarities in species composition between the mean sample and control sites.**

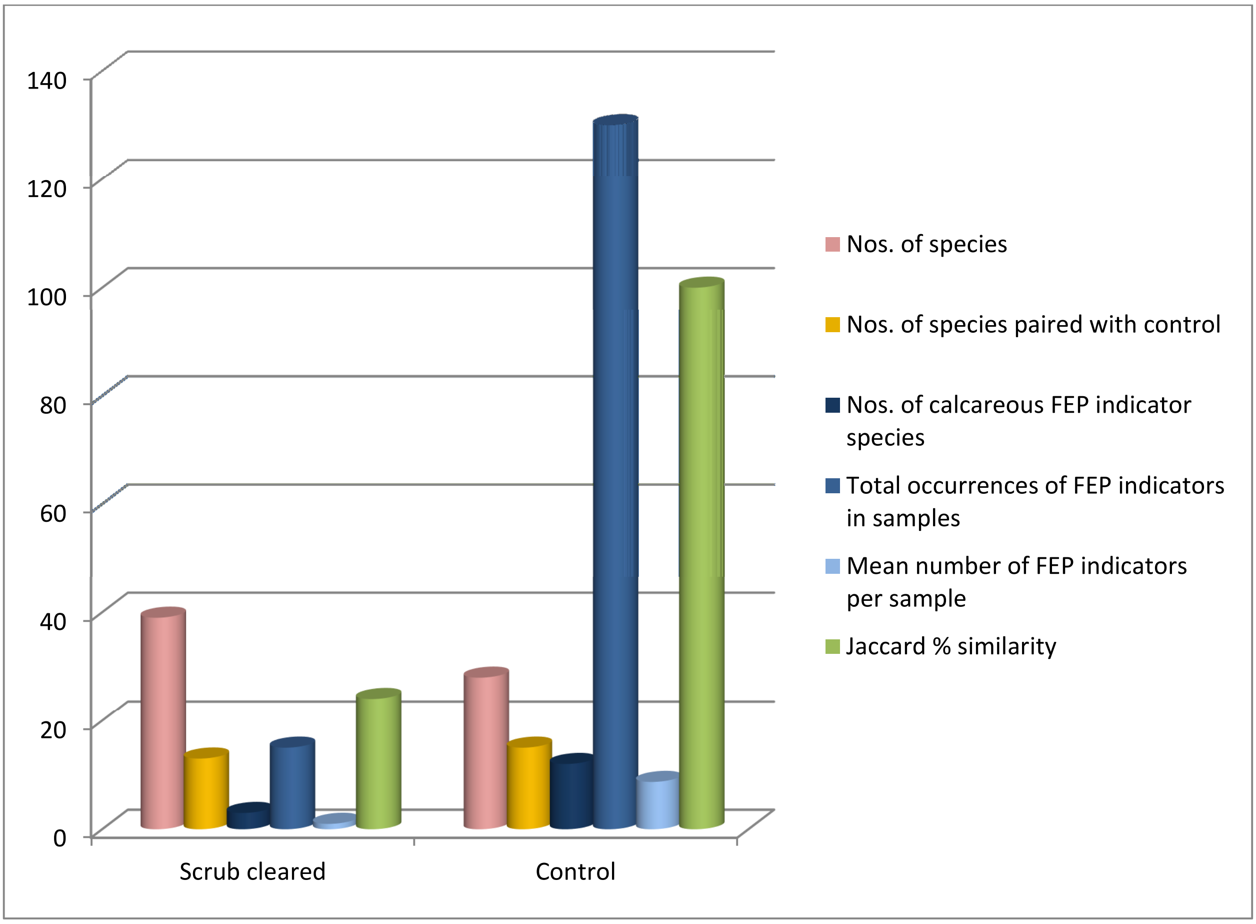


**Figure 2: Shows table 1 displayed graphically.**

Table 1 & Figure 2 show values for total numbers of species recorded, species numbers common with their control sample, numbers of FEP calcareous indicators, their total frequency in all samples (control adjusted) and their mean number per sample as well as their Jaccard percentage similarity.

A number of inferences can be drawn from the results.

1. While there is a tendency for the Individual control samples (species-rich grassland) to have a higher number of species than the individual scrub cleared samples, the total number of individuals recorded in all samples is higher in scrub cleared areas.
2. The controls have four times number of FEP limestone grassland indicator species than the scrub-cleared areas and nearly nine times the numbers of individuals per sample.
3. Even where the scrub cleared samples have relatively high numbers of species, those that are common between the control and the scrub cleared sample is low.
4. The mean (Jaccard) percentage similarity (this compares species found in the control and the scrub cleared samples, Appendix 4) was only 24%.

| Values for All Treatments | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Light | Moisture | pH - acidity | Nitrogen | Salinity | | Compet itive | Ruderal | Stress tolerance |
| Control All | 7.15 | 4.56 | 6.52 | 3.59 | 0.19 | | 0.98 | 0.97 | 2.04 |
| Scrub Cleared All | 6.37 | 5.21 | 6.47 | 5.16 | 0.08 | | 1.74 | 0.90 | 1.35 |

| Values for species taking into account number of occurences in each treatment | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Light | Moisture | pH - acidity | Nitrogen | Salinity | | Compet itive | Ruderal | Stress tolerance |
| Control All | 7.23 | 4.51 | 6.53 | 3.23 | 0.23 | | 0.89 | 0.96 | 2.15 |
| Scrub Cleared All | 6.38 | 5.20 | 6.40 | 5.23 | 0.06 | | 1.75 | 0.85 | 1.40 |

**Table 2a (top) & Table 2b (bottom): shows the mean values of Ellenberg and CRS values for all the species in each treatment and weighted for the number of occurrences* in each treatment.** (Green labels show the index values most closely associated with limestone grassland and red labels the values least closely associated.)

To get a further insight into what is happening in the scrub cleared areas, the species for each of the three groups were run through VTA and the Ellenberg and CRS values from this analysis are shown in Table 2a and 2b. VTA analyses species composition in two ways, giving the mean values for all of the species occurring in each treatment no matter how frequently it occurs (Table 2a) but also by weighting the mean values by taking into account the frequency that each species occurs (Table 2b). This means that the more common species will give greater weight to the mean value and minimise the weight of the rare species. The Ellenberg and CRS values for individual species found in this report are shown in Appendix 2. The results from the Vegetation Trend Analysis (VTA) shows that the mean species values for the control are consistently higher for light demand, lower for nitrogen demand indicate a low competitive tolerance and a high stress tolerance. These are the conditions more closely associated with species-rich grassland - highlighted green in table 2a. Moisture demand is lower and pH preference more alkaline for species in the control samples while the ruderal abilities are similar between the 2 groups of species. When this is adjusted for frequency of the species found, these trends are similar (Table 2b). In contrast to this, the cleared areas are less light and more nitrogen demanding, are more competitive and show lower stress tolerant values. These are highlighted in red in table 2b. They also tolerate less alkaline as well as damper conditions (less extreme highlighted pink).

| Values for All Treatments | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Light | Moisture | pH - acidity | Nitrogen | Salinity | | Competitive | Ruderal | Stress tolerance |
| Single Control | 7.57 | 4.29 | 6.71 | 2.79 | 0.29 | | 0.77 | 0.97 | 2.26 |
| Paired Control | 6.69 | 4.85 | 6.31 | 4.46 | 0.08 | | 1.22 | 0.97 | 1.81 |
| Paired Scrub | 6.69 | 4.85 | 6.31 | 4.46 | 0.08 | | 1.22 | 0.97 | 1.81 |
| Single Scrub | 6.20 | 5.40 | 6.56 | 5.52 | 0.08 | | 2.03 | 0.86 | 1.11 |

| Values for species taking into account number of occurences in each treatment | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Light | Moisture | pH - acidity | Nitrogen | Salinity | | Competitive | Ruderal | Stress tolerance |
| Single Control | 7.56 | 4.33 | 6.63 | 2.74 | 0.37 | | 0.75 | 0.99 | 2.26 |
| Paired Control | 6.80 | 4.75 | 6.40 | 3.90 | 0.05 | | 1.08 | 0.92 | 2.00 |
| Paired Scrub | 6.56 | 5.05 | 6.33 | 4.67 | 0.11 | | 1.27 | 0.72 | 2.01 |
| Single Scrub | 6.24 | 5.32 | 6.46 | 5.67 | 0.02 | | 2.13 | 0.94 | 0.93 |

**Table 3a & Table 3b: shows the results of VTA for split data from the control and the scrub cleared area. Results are shown for the values for species and separately for the frequency* of those species.** (Green labels show the index values most closely associated with limestone grassland and red labels the values least closely associated.)

Table 3a and 3b show VTA carried out on the species only found in the control or the scrub cleared areas (single) and also those found in both (paired). The results for those found only in the control or scrub cleared areas are broadly similar to those found in table 2 but more extreme. Species found only in the control samples are even more light demanding, have an even lower nitrogen tolerance, a greater alkaline affinity, a lower competitive tolerance and a higher stress tolerance (green highlight). Conversely those species found only in the cleared scrub samples are least light demanding, more nitrogen tolerant, more competitive and substantially less stress tolerant (red highlight). The paired species, those found both in the control and in scrub cleared areas naturally have the same value. However when the frequencies of the paired species are taken into account, those found in the cleared scrub (pink highlight) result in mean species values that are less light demanding, have a higher nitrogen demand and more competitive than their paired control counterparts.

**Discussion**
This study shows that scrub-cleared grassland has a greater total number of species than the control (species rich calcareous grassland). This suggests that a straight species count should not be considered a useful indicator of recovery. Straight species counts fail to differentiate between shade tolerant, ruderal and competitive species that are not normally present on good condition species rich grassland but may remain or colonise adventitiously where scrub has been cleared. Using the number of species in the cleared area found in common with the control gives a better indication. Jaccard's similarity index appears to provide a better measure of the similarity between two vegetation samples as it takes the total number of species into account, including those found in the cleared area that are not found in the control. Calcareous FEP indicators again provided a very useful indicator of grassland quality, especially when the frequency of their occurrence was taken into account. Straight presence or absence gave an optimistic impression of recovery but the frequency when expressed either as a total or as mean numbers per sample highlighted the difference.

A clearer indication of the characteristics of the control species and additional species in the scrub-cleared areas can be obtained by comparing their Ellenberg and CRS values with the control. Almost all of the limestone grassland species were light index 7 or above. However within the scrub, and initially remaining in the sample following clearance, were those species likely to be shade tolerant and more closely associated with wood edge or woodland (see appendix 3). Given continued scrub suppression these may decline and the most shade adapted disappear, but until this happens their presence will continue to indicate a shade legacy. Considering nitrogen demand, the index values were reversed with limestone grassland species that were generally heavily grazed and stress tolerant were adapted to the lowest levels while the competitive species such as creeping thistle (*Cirsium arvense*), nettle (*Urtica dioica*), elder (*Sambucus nigra*), bramble, herb bennet (*Geum urbanum*), ground ivy (*Glechoma hederacea)* and many of the tree species responded well. The reasons why scrub has established here were uncertain; this was possibly due to localised dunging by livestock or lack of locally sourced drinking water resulting in under-grazing. However once scrub was established, nitrogen would have increased due to animals dunging under shade and by the scrub intercepting aerial nitrogen. Scrub removal, depending upon how it was carried out may have a long term effect on restoration. In this location, until recently, the scrub was mulched to ground level, leaving a thick coating of bramble as well as hawthorn chippings. This would have had two effects. Firstly the mulch layer prevented germination by herbs; but is usually unable to prevent coppiced bramble from growing back through the mulch layer. Secondly the mulch layer while initially having a nitrogen demand, following breakdown would have released available nitrogen which was not conducive to establishment of nitrogen intolerant species-rich limestone grassland. This strongly suggested that the removal of mulched material should be a priority. Similarly if instead cut scrub is burnt, this should involve the smallest possible number of sites, avoidance of thin soiled areas and the subsequent removal of wood ash.

**Conclusions**

1. Prevent further loss of limestone grassland. As a precautionary measure, management priority should be given to ensuring no further loss. Where a scrub mosaic is required, the structure should be maintained by rejuvenating existing scrub blocks and not by clearing blocks and allowing new scrub patches to generate on species rich grassland.
2. The vegetation developing on former limestone grassland cleared of scrub, initially has few of the characteristics of species-rich limestone grassland.
3. Unless management over and above grazing is continued there is a high risk that competitive species will take advantage of raised nutrient levels and either result in domination by ruderals and or scrub regeneration.

**Recommendations**

1. Management – it is vital that the cleared areas continue to be topped of ruderals and any developing scrub as needed; the topped material removed to help reduce nutrient levels and that standard site grazing continues.
2. Surveillance – return to resample the vegetation every second year 2017, 2019 etc. until the cleared area is indistinguishable from the control.
3. Surveillance – sample soil for nutrient analysis on newly cleared, the current cleared sample areas and undamaged species rich grassland communities.

**References**

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Hancock C. G. (2016), Vegetation Trend Analysis an Introduction, Somerset Wildlife Trust unpublished report. To download follow http://www.somersetwildlife.org/Reports.html then click on 'Vegetation Trend Analysis an Introduction'.

Hill, M.O., Mountford, J.O., Roy, D.B. & Bunce, R.G.H. (1999) Ellenberg's Indicator Values for British Plants. Institute of Terrestrial Ecology, Huntingdon, UK.

Jaccard, Paul (1901), Étude comparative de la distribution florale dans une portion des Alpes et des Jura, Bulletin de la Société Vaudoise des Sciences Naturelles 37: 547–579.

Jaccard, Paul (1912), The distribution of the flora in the alpine zone, New Phytologist 11: 37–50.

Natural England, Higher Level Stewardship Farm Environment Plan (FEP) Manual Technical guidance on the completion of the FEP and identification, condition assessment and recording of HLS FEP features Third Edition – March 2010.

**Acknowledgements**

My thanks to Matthew Marshall, Ann Fells and Eleanor Higginson for making comments on the report.

**Appendix 1** - Sample species data shown as presence of absence

| Sample No | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Acer campestre | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Achillea millefolium | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Agrimonia eupatoria | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Anagallis arvensis | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Aphanes arvensis agg. | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Asplenium scolopendrium | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Brachypodium sylvaticum | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Bromopsis erecta | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Carex flacca | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Centaurium erythraea | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Cerastium fontanum | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| Circaea lutetiana | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cirsium arvense | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| Cirsium vulgare | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| Clematis vitalba | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Crataegus monogyna | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dryopteris filix-mas | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Epilobium hirsutum | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Festuca rubra agg. | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Fragaria vesca | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fraxinus excelsior | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Galium aparine | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Galium mollugo | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Galium verum | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Geum urbanum | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Glechoma hederacea | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hypericum perforatum | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| Leontodon hispidus | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Linum catharticum | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Lotus corniculatus | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Myosotis caespitosa | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Origanum vulgare | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pilosella officinarum | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Plantago lanceolata | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Polygala vulgaris | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Potentilla reptans | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Potentilla sterilis | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| Primula veris | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Prunella vulgaris | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |
| Rosa canina agg. | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rubus fruticosus agg. | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Rumex crispus | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sambucus nigra | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Sanguisorba minor | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Scabiosa columbaria | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Senecio jacobaea | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| Solanum nigrum | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| Taraxacum officinale | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| Thymus polytrichus | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Trifolium repens | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Ulex europaeus | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Urtica dioica | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| Veronica chamaedrys | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| Veronica serpyllifolia | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| Viburnum lantana | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Viola hirta | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| Viola riviniana | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |

| | |
|---|---|
| (dark green) | FEP priority calcareous grassland species |
| (light green) | Fep priority neutral grassland species |

**Appendix 2** - showing location and type of vegetation samples.

| Sample No. | | grid ref |
|---|---|---|
| 1 | s | ST4842951419 |
| 2 | c | ST4841751419 |
| 3 | w | ST4800051700 |
| 4 | c | ST4812551534 |
| 5 | s | ST4810051554 |
| 6 | s | ST4809251561 |
| 7 | s | ST4809351753 |
| 8 | s | ST4808551578 |
| 9 | s | ST4807751592 |
| 10 | s | ST4806151636 |
| 11 | s | ST4805351652 |
| 12 | s | ST4805051659 |
| 13 | s | ST4804151666 |
| 14 | s | ST4803551675 |
| 15 | s | ST4802051715 |
| 16 | s | ST4802051717 |
| 17 | s | ST4801451730 |
| 18 | s | ST4800151737 |
| 19 | s | ST4799251738 |
| 20 | c | ST4794851732 |
| | | |
| c = control (species-rich grassland) | | |
| s = sample from scrub-cleared area | | |
| w = all species recorded in yellow / green scrub cleared area | | |

**Appendix 3** – Species values for Ellenberg Numbers and Grimes Growth Strategies, derived from Vegetation Trend Analysis software.

| Species found in samples | | Ellenberg Numbers for species | | | | | Growth Stategies for species | | |
|---|---|---|---|---|---|---|---|---|---|
| Scientific name | Common name | Light | Moisture | pH - acidity | Nitrogen need | Salinity | Competitive | Ruderal | Stress tolerant |
| Acer campestre | Field Maple | 5 | 5 | 7 | 6 | 0 | 2.00 | 0.00 | 2.00 |
| Achillea millefolium | Yarrow | 7 | 5 | 6 | 4 | 1 | 1.33 | 1.33 | 1.33 |
| Agrimonia eupatoria | Agrimony | 7 | 4 | 7 | 4 | 0 | 1.33 | 1.33 | 1.33 |
| Anagallis arvensis | Scarlet Pimpernel | 7 | 4 | 6 | 5 | 0 | 0.00 | 3.00 | 1.00 |
| Aphanes arvensis agg. | Parsley Piert | 7 | 4 | 6 | 4 | 0 | 0.00 | 3.00 | 1.00 |
| Asplenium scolopendrium | Hart's-tongue | 4 | 5 | 7 | 5 | 0 | 2.00 | 0.00 | 2.00 |
| Brachypodium sylvaticum | False-brome | 6 | 5 | 6 | 5 | 0 | 1.70 | 0.60 | 1.70 |
| Bromopsis erecta | Upright Brome | 7 | 4 | 8 | 3 | 0 | 1.70 | 0.60 | 1.70 |
| Carex flacca | Glaucous Sedge | 7 | 5 | 6 | 2 | 0 | 0.00 | 0.00 | 4.00 |
| Centaurium erythraea | Common Centaury | 8 | 5 | 6 | 3 | 0 | 0.00 | 2.00 | 2.00 |
| Cerastium fontanum | Common Mouse-ear | 7 | 5 | 5 | 4 | 0 | 0.68 | 2.65 | 0.68 |
| Circaea lutetiana | Enchanter's-nightshade | 4 | 6 | 7 | 6 | 0 | 2.00 | 2.00 | 0.00 |
| Cirsium arvense | Creeping Thistle | 8 | 6 | 7 | 6 | 0 | 4.00 | 0.00 | 0.00 |
| Cirsium vulgare | Spear Thistle | 7 | 5 | 6 | 6 | 0 | 2.00 | 2.00 | 0.00 |
| Clematis vitalba | Traveller's Joy | 6 | 4 | 8 | 5 | 0 | 2.00 | 0.00 | 2.00 |
| Crataegus monogyna | Hawthorn | 6 | 5 | 7 | 6 | 0 | 2.00 | 0.00 | 2.00 |
| Dryopteris filix-mas | Common Male Fern | 5 | 6 | 5 | 5 | 0 | 2.00 | 0.00 | 2.00 |
| Epilobium hirsutum | Great Willowherb | 7 | 8 | 7 | 7 | 0 | 4.00 | 0.00 | 0.00 |
| Festuca rubra agg. | Red Fescue | 8 | 5 | 6 | 5 | 2 | 1.33 | 1.33 | 1.33 |
| Fragaria vesca | Wild Strawberry | 6 | 5 | 6 | 4 | 0 | 1.33 | 1.33 | 1.33 |
| Fraxinus excelsior | Ash | 5 | 6 | 7 | 6 | 0 | 3.00 | 0.00 | 1.00 |
| Galium aparine | Cleavers | 6 | 6 | 7 | 8 | 0 | 2.00 | 2.00 | 0.00 |
| Galium mollugo | Hedge Bedstraw | 7 | 4 | 7 | 4 | 0 | 2.65 | 0.68 | 0.68 |
| Galium verum | Lady's Bedstraw | 7 | 4 | 6 | 2 | 0 | 1.70 | 0.60 | 1.70 |
| Geum urbanum | Herb Bennet | 4 | 6 | 7 | 7 | 0 | 1.70 | 1.70 | 0.60 |
| Glechoma hederacea | Ground-ivy | 6 | 6 | 7 | 7 | 0 | 1.70 | 1.70 | 0.60 |
| Hypericum perforatum | Perforate St. John's-wort | 7 | 4 | 7 | 5 | 0 | 1.70 | 1.70 | 0.60 |
| Leontodon hispidus | Rough Hawkbit | 8 | 4 | 7 | 3 | 0 | 1.33 | 1.33 | 1.33 |
| Linum catharticum | Fairy Flax | 8 | 5 | 7 | 2 | 0 | 0.00 | 2.00 | 2.00 |
| Lotus corniculatus | Common Bird's-foot-trefoil | 7 | 4 | 6 | 2 | 1 | 0.68 | 0.68 | 2.65 |
| Myosotis caespitosa | Tufted Forget-me-not | 7 | 9 | 6 | 5 | 0 | 0.00 | 1.00 | 3.00 |
| Origanum vulgare | Wild Marjoram | 6 | 4 | 7 | 4 | 0 | 1.70 | 0.60 | 1.70 |
| Pilosella officinarum | Mouse-ear-hawkweed | 8 | 4 | 7 | 2 | 0 | 0.68 | 0.68 | 2.65 |
| Plantago lanceolata | Ribwort Plantain | 7 | 5 | 6 | 4 | 0 | 1.33 | 1.33 | 1.33 |
| Polygala vulgaris | Common Milkwort | 8 | 5 | 6 | 3 | 0 | 0.68 | 0.68 | 2.65 |
| Potentilla reptans | Creeping Cinquefoil | 7 | 5 | 7 | 5 | 0 | 1.70 | 1.70 | 0.60 |
| Potentilla sterilis | Barren Strawberry | 5 | 5 | 5 | 5 | 0 | 0.60 | 1.70 | 1.70 |
| Primula veris | Cowslip | 7 | 4 | 7 | 3 | 0 | 0.68 | 0.68 | 2.65 |
| Prunella vulgaris | Selfheal | 7 | 5 | 6 | 4 | 0 | 1.33 | 1.33 | 1.33 |
| Rosa canina agg. | Dog Rose | 6 | 5 | 7 | 6 | 0 | 2.00 | 0.00 | 2.00 |
| Rubus fruticosus agg. | Bramble | 6 | 6 | 6 | 6 | 0 | 2.00 | 0.00 | 2.00 |
| Rumex crispus | Curled Dock | 8 | 6 | 7 | 6 | 2 | 1.70 | 1.70 | 0.60 |
| Sambucus nigra | Elder | 6 | 5 | 7 | 7 | 0 | 4.00 | 0.00 | 0.00 |
| Sanguisorba minor | Salad Burnet | 7 | 4 | 8 | 3 | 0 | 0.68 | 0.68 | 2.65 |
| Scabiosa columbaria | Small Scabious | 8 | 3 | 8 | 2 | 0 | 0.00 | 1.00 | 3.00 |
| Senecio jacobaea | Common Ragwort | 7 | 4 | 6 | 4 | 0 | 1.70 | 1.70 | 0.60 |
| Solanum nigrum | Black Nightshade | 7 | 5 | 7 | 8 | 0 | 1.00 | 3.00 | 0.00 |
| Taraxacum officinale | Dandelion | 7 | 5 | 7 | 6 | 1 | 0.68 | 0.68 | 2.65 |
| Thymus polytrichus | Wild Thyme | 8 | 4 | 6 | 2 | 0 | 0.00 | 0.00 | 4.00 |
| Trifolium repens | White Clover | 7 | 5 | 6 | 6 | 0 | 1.70 | 1.70 | 0.60 |
| Ulex europaeus | Gorse | 7 | 5 | 5 | 3 | 0 | 2.00 | 0.00 | 2.00 |
| Urtica dioica | Common Nettle | 6 | 6 | 7 | 8 | 0 | 4.00 | 0.00 | 0.00 |
| Veronica chamaedrys | Germander Speedwell | 6 | 5 | 6 | 5 | 0 | 0.68 | 0.68 | 2.65 |
| Veronica serpyllifolia | Thyme-leaved Speedwell | 7 | 5 | 6 | 5 | 0 | 0.68 | 2.65 | 0.68 |
| Viburnum lantana | Wayfaring-tree | 7 | 5 | 7 | 5 | 0 | | | |
| Viola hirta | Hairy Violet | 7 | 4 | 8 | 2 | 0 | 0.68 | 0.68 | 2.65 |
| Viola riviniana | Common Dog-violet | 6 | 5 | 5 | 4 | 0 | 0.68 | 0.68 | 2.65 |
| | | | | | | | | | |
| | FEP priority calcareous grassland species | | | | | | | | |
| | Fep priority neutral grassland species | | | | | | | | |

**Appendix 4**

Jaccard (1901, 1912, and 1928) developed a very simple mathematical expression, which although originally used to compare the general floras of larger areas, has subsequently been shown to be suitable for assessing the similarity of quadrat samples in terms of species composition. The formula is:

$$S J = a / (a + b + c)$$

Where 'a' is the number of species common to both quadrats/samples, 'b' is the number of species in quadrat/sample 1 only, and 'c' is the number of species in quadrat/sample 2 only. Often the coefficient is multiplied by 100 to give a percentage similarity figure.

$$\%S J = SJ*100$$