SOMERSET

Assessing Grassland Recovery Following Scrub Clearance at Green Down – Interim Report 2016

Reserve – Green Down
Code – R49
Size – 5.91 ha
Main habitat - Limestone grassland
Reserves Area – South & East Somerset
Reserve Manager – Mark Green
Survey – Christopher Hancock – October 2015
Report – Christopher Hancock – 12/01/2016

Summary

Limestone grassland communities on Green Down are readily colonised by scrub but cleared areas appear slow to recover. In 2012 scrub areas were cleared. In 2013 and 2015, the vegetation of 11 sites were sampled and resampled. In 2013, the vegetation present showed little similarity to species-rich limestone grassland. By 2015 some improvement was observed but key indices still showed poor similarity to species-rich limestone grassland. The main interim conclusions are that Species-rich limestone grassland recovery is slow and that surveillance of the vegetation should be continued to give a clearer picture of recovery time. Until there is greater clarity on the recovery time, no further spread of scrub should be allowed to develop or spread at the expense of existing species-rich limestone grassland.

Introduction

Green Down lies on the steep southern slopes of the Polden Hills (ST51752878). The underlying geology is Lias limestone and clay. Scrub is extensive and is spreading across the species-rich limestone grassland. The best limestone grassland is classified as CG2 by Natural England. In 1989 the centre of the site was bulldozed and a gallop made through the site. Areas of spoil were spread below the gallop and much of this has retained a ruderal flora or a grass dominated flora that is relatively species poor. Besides the intrinsic importance of the species-rich limestone flora, the site is nationally important for invertebrates associated with limestone flora; in particular the reintroduced and naturalised large blue butterfly. The denser part of the scrub area is one of the few Somerset sites to retain breeding Nightingales. The juxtaposition of scrub and grassland is important for shelter from wind and ensuring the grassland reaches sufficient temperatures to support key species. However, comparison of aerial photos has shown that scrub has spread at the expense of limestone grassland and so scrub clearance has been undertaken to maintain and increase the area of grassland. Following this management, the recolonization of cleared or disrupted areas of limestone grassland at Green Down was slower than expected. Consequently it was decided to obtain objective data.

Figure 1: Aerial Photo of Green Down showing scrub and grassland in 2001. © Google Earth

Figure 2: Aerial Photo of Green Down showing scrub, some areas of cleared scrub and grassland in 2011 (© Bing)

Figure 3: Aerial Photo of Green Down showing scrub, new areas of cleared scrub and grassland in 2013. © Google Earth

Following scrub clearance in 2012, In summer 2013, 12 vegetation samples were taken from the scrub cleared areas. 2001 Aerial photos showed that the areas had been continuously scrub covered for at least 11 years. The sample positions were recorded to one metre using a Garmin high resolution GPS. While this records at one metre accuracy the resolution is such that the position can only be realistically fixed to 5 metres.

Figure 4: Location of cleared scrub (red) and limestone grassland control (green) sample sites at Green Down

In 2015 11 of the sample sites were resampled. A direct comparison was carried out between the 11 data samples taken in each of 2013 & 2015 and were compared to 11 samples taken from good quality species-rich grassland nearby on Green Down in 2013, which can be regarded as the examples of ideal habitat condition.

The 11 samples of each group were combined for analysis. This allowed the three groups to be compared directly.

Results

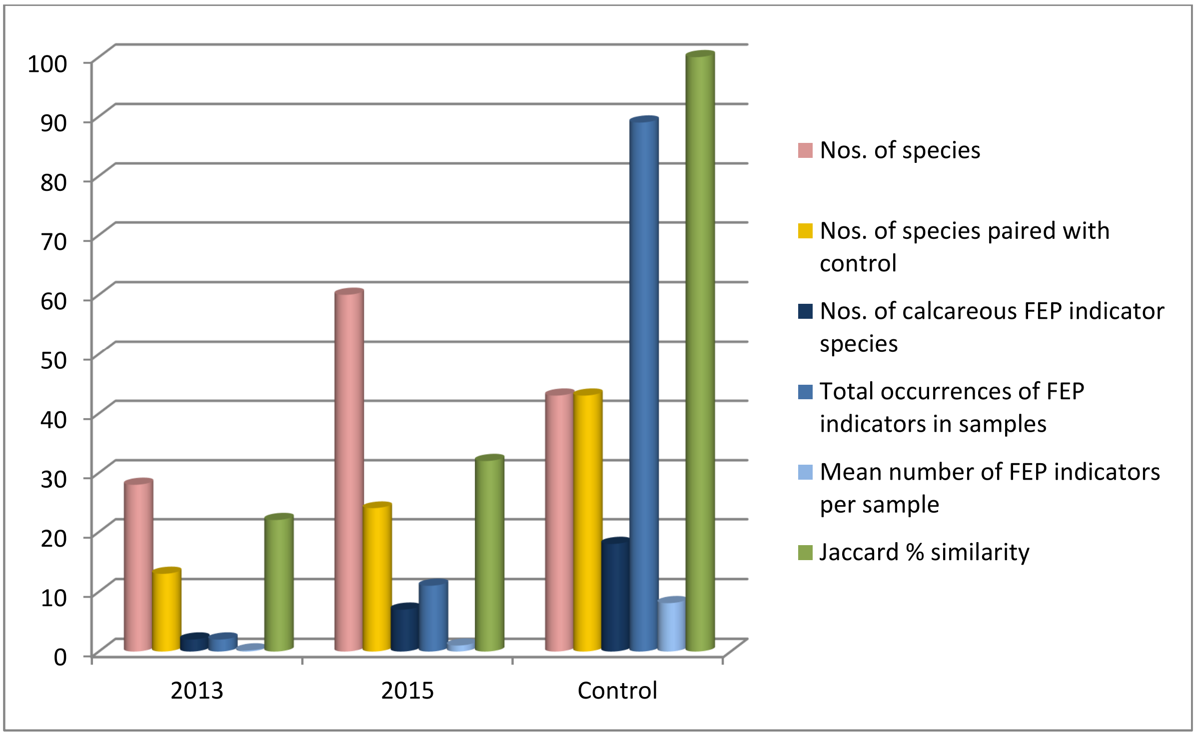
The list of species found and their occurrence at eleven sites sampled for each group are shown in Appendix 1.

Analysis and observations on results

Outputs from analysis (Table 1, Graph 1) show the number of species found in each of the three groups; the number of species on the cleared sites in 2013 and 2015 that were found in common with the control and with each other; the number of calcareous FEP (Farm Environment Plan) indicator species (Natural England 2010) in the three groups and finally the Jaccard % similarity index (Jaccard 1901 & 1912), with scrub-cleared groups compared to the control. In addition, the mean Ellenberg (Hill *et al* 1999) and CRS values (Grime *et al* 2007) were calculated from the species list recorded for each of the three groups using Vegetation Trend Analysis (VTA) (Hancock 2016) and also a set of means were calculated weighting the groups by the frequency of each species found in the 11 samples. Following this, VTA was repeated on the list of species common to, and individual to, compared samples. This was done to highlight the characteristics of the species in each group.

Sample Treatments	2013	2015	Control
No of species present	28	60	43
No of species present paired with control	13	24	43
No. of calcareous FEP indicator species	2	7	18
Total FEP indicator presence in all samples	2	11	89
Mean number of FEP indicators per sample	0.2	1.0	8.1
Jaccard % similarity index	22%	32%	100%

Table 1: Similarities in species composition between the sample and control sites in 2013 and 2015.



Graph 1: shows table 1 displayed graphically.

With the exception of total numbers of species, all outputs show a similar pattern with the control highest and the 2013 sample lowest. Indicating that the cleared areas have not yet reached a species composition similar to the species-rich limestone grassland found elsewhere on Green Down. The larger number of species in 2015 than the control is probably the result of opportunist germination into bare ground.

As well as total numbers of species, the commonality of the species found in the cleared areas with those in the control is also of interest. Taking the species found at the 11 samples in the control treatment as the desirable species, the cleared sites in 2013 have just under a quarter of those species as well as a further 15 other species. By 2015 this had risen to just over half the same species but had also gained a further 36 species. The Jaccard % similarity index takes these factors into account using a standard method (Appendix 4). Compared to itself, the control naturally shows a 100% similarity, the 2013 treatment a 21% similarity and while the 2015 has increased, it only reaches a 32% similarity due to the many additional species.

FEP calcareous indicator species are those identified by Defra as species used to indicate calcareous grassland. Their presence with sufficient number and frequency can be used to justify applications to agri-environment schemes. There is clear difference between the three groups when the total numbers of FEP indicator species present in the 11 matched samples are compared. However the difference is much greater if the total number of occurrences in all of the 11 samples is compared. The FEP indicators are much more common in the control and show an average of 8.1 FEP species per sample as opposed to only 1.0 in 2015 and 0.2 in 2013. This shows that there has been a 5 fold increase in numbers of indicators found between 2013 and 2015 but this is still well short of the control.

Values for all species in each treatment									
	Light	Moisture	pH - acidity	Nitrogen	Salinity		Compe titive	Ruderal	Stress tolerant
Control	7.28	4.53	6.58	3.74	0.14		1.22	1.03	1.75
2015	6.93	4.95	6.77	4.97	0.05		1.64	1.23	1.12
2013	6.75	5.07	6.96	5.29	0.07		1.98	1.11	0.91
Values for species in each treatment taking into number of occurrences in each treatment									
	Light	Moisture	pH - acidity	Nitrogen	Salinity		Compe titive	Ruderal	Stress tolerant
Control	7.31	4.58	6.52	3.65	0.25		1.11	1.01	1.88
2015	6.85	5.01	6.83	5.12	0.12		1.68	1.21	1.11
2013	6.69	5.13	6.88	5.51	0.07		2.07	0.99	0.94

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 these 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. Table 2a shows that the control species have the highest mean light demand, the lowest nitrogen demand, and the lowest competitive, ruderal and stress tolerance values. When this is adjusted for frequency of the species present these trends are increased (Table 2b). In contrast to this, the cleared area in 2013 is less light and more nitrogen demanding, having greater competitive and lower stress tolerant values. By 2015 the cleared area is intermediate but with values closer to those found for the 2013 community. The exception is the ruderal value, this corresponds with the greater number of species found at 2015. Perhaps more surprising is the pH index consistently showing the highest (more alkaline) value in the earliest cleared area (2013) and the lowest for the limestone grassland control (pH Ellenberg value 6.5). Meanwhile in the cleared areas the majority of the more competitive; nutrient loving, shade tolerant and ruderal species still have a preference for lime rich conditions. The moisture index is also lower in the control. This is likely to reflect the greater stress tolerance of the plants present.

Values for all species in each treatment								
	Light	Moisture	pH - acidity	Nitrogen	Salinity	Compe titive	Ruderal	Stress tolerant
C only	7.3	4.5	6.5	3.5	0.1	1.1	1.0	1.9
13 only	6.5	5.4	6.9	5.6	0,0	2.3	1.1	0.6
C all	7.1	4.8	6.7	4.6	0.2	1.6	1.1	1.3
13 all	7.1	4.8	6.7	4.6	0.2	1.6	1.1	1.3
Values for species in each treatment taking into number of occurrences in each treatment								
	Light	Moisture	pH - acidity	Nitrogen	Salinity	Compe titive	Ruderal	Stress tolerant
C only	7.4	4.6	6.4	3.4	0.2	1.0	1.0	2.0
13 only	6.4	5.3	7.0	6.1	0.0	2.3	1.2	0.5
C all	7.1	4.7	6.7	4.3	0.3	1.4	1.0	1.6
13 all	6.9	5.0	6.7	5.1	0.1	1.9	0.9	1.2

Table 3a (top) & Table 3b (bottom): shows the results of VTA for split data from the control (C) and the 2013 cleared area. Results are shown for the values for species and separately for the frequency of those species.

While the characteristics of the vegetation types seem fairly clear, further detail can be identified by testing the shared species against those that are individual to the sites. Table 3 above compares the split lists for the control and scrub-cleared areas for 2013. The mean characteristics of the species found only in either the cleared or the control areas have similar but more extreme characteristics than the full species lists. These extremes are stretched further when the frequency of the species is taken into account. While the species in the common lists are naturally the same, when the frequency of the species in those common lists are taken into account, the cleared area has a higher frequency of species showing higher nitrogen higher competitive and lower stress tolerance characteristics (red text). The characteristics are similar but less extreme when the control is compared with 2015 treatment (see table 4 below).

Values for all species in each treatment								
	Light	Moisture	pH - acidity	Nitrogen	Salinity	Compe titive	Ruderal	Stress tolerant
C only	7.5	4.3	6.5	3.1	0.2	0.9	1.0	2.1
15 only	6.8	5.1	6.9	5.6	0.0	1.8	1.4	0.8
C both	7.1	4.7	6.7	4.2	0.1	1.4	1.0	1.5
15 both	7.1	4.7	6.7	4.2	0.1	1.4	1.0	1.5
Values for species in each treatment taking into number of occurrences in each treatment								
	Light	Moisture	pH - acidity	Nitrogen	Salinity	Compe titive	Ruderal	Stress tolerant
C only	7.6	4.4	6.4	3.0	0.4	0.9	1.0	2.1
15 only	6.8	5.3	6.9	5.7	0.0	1.7	1.5	0.8
C both	7.1	4.7	6.6	4.1	0.2	1.3	1.0	1.7
15 both	6.9	4.7	6.8	4.5	0.2	1.6	0.9	1.5

Table 4a (top) and 4b (bottom) shows the results of VTA for split data from the control (C) and the 2015 cleared area. As in tables 2a & 2b and 3a &3b, results are shown for the values for species and separately for the frequency of those species.

Discussion

There is a clear difference between the suites of species found on limestone grassland and in the scrub cleared areas demonstrated by their low 'Jaccard' percentage similarity values. The mean environmental preferences (Ellenberg numbers) their growth character (CRS indices) of the species and the numbers of FEP indicators differ substantially between the initial scrub cleared areas (2013) and the controls and reflect the different growth conditions in scrub and open grassland.

The controls show strong characteristics of open aspect, nutrient poor grassland and indicate stress tolerance needed to survive well in heavily grazed conditions. They also have much higher numbers of FEP indicators. Conversely the 2013 scrub cleared areas support a more nutrient demanding, competitive suite of species and a low number and variety of FEP indicators. High nutrient conditions are likely to result from a build-up of organic matter resulting from leaf fall and made available from soil disruption during clearance, coupled with the sudden removal of the main users of the available nutrients. By 2015, the vegetation community demands fewer nutrients, is more stress tolerant and less competitive suggesting nutrient depletion. However considerable further change is needed in the vegetation community before it achieves the characteristics of the control group.

The ruderal characteristics of a community reflect its potential proclivity to take advantage of bare ground. Steep limestone grassland is subject to damage by grazing animals and so would be expected to contain some species readily able to take advantage of bare ground. However following scrub clearance, bare ground would be expected to attract an enhanced population of ruderal species. In 2013 this is higher than the control but not as high as 2015, which suggests that further time was need for the population to build up.

The lower (more acid tolerant) Ellenberg value for the control (table 2b) seems perhaps counter intuitive. This is especially surprising bearing in mind that the majority of FEP limestone indicators typically show Ellenberg values of 7 and 8. However there are a lot of other species present in the control that are equally at home in neutral grassland that have a value of 6 as well as three species with yet lower values, dodder (2) , sheep's fescue (4) and eyebright (5). These combine to reduce the mean sufficiently.

Newly cleared areas are colonised by vegetation that indicates a need or tolerance for enhanced nutrient levels (nitrogen). To further investigate this, it would be useful to take soil samples for nutrient analysis. To give the best opportunity to demonstrate this, samples should be taken from newly cleared areas, the currently investigated cleared sample areas and undamaged species rich grassland communities to see if gross changes in available soil nutrients are reflected in the observed vegetation communities.

Conclusions

1. The vegetation developing on former limestone grassland cleared of scrub, initially has few of the characteristics of species-rich limestone grassland.
2. 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
3. After 2 years the vegetation shows signs of moving towards the control (species-rich limestone grassland) character. However the speed of movement suggests many further years before the vegetation will be indistinguishable from the control.
4. Prevent further loss of limestone grassland. Due to the time taken for the recovery of limestone grassland. 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.

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.

Reference

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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.

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Acknowledgement – Thanks to Eleanor Higginson for commenting on the script.

Appendix 1.

Results of surveys showing the frequency of species found at each site for each treatment
(Species marked yellow are FEP limestone grassland indicators).

Species name	Common name	C	13	15
Achillea millefolium	Yarrow	6		
Agrimonia eupatoria	Agrimony	5		5
Anagallis arvensis	Scarlet Pimpernel			2
Arctium minus	Lesser Burdock		4	3
Arrhenatherum elatius	False Oat-grass		1	2
Blackstonia perfoliata	Yellow-wort		1	
Brachypodium sylvaticum	False-brome	11	5	11
Bromus hordeaceus	Soft-brome			4
Briza media	Quaking-grass	8		
Carex flacca	Glaucous Sedge	7		
Carlina vulgaris	Carline Thistle	8		
Centaurea nigra	Common Knapweed	7		2
Centaurea scabiosa	Greater Knapweed	1		
Centaurium erythraea	Common Centaury	2	5	4
Cerastium fontanum	Common Mouse-ear			1
Cirsium acaule	Dwarf Thistle	7		
Cirsium arvense	Creeping Thistle	4	7	6
Cirsium eriophorum	Woolly Thistle	7	1	5
Cirsium palustre	Marsh Thistle			1
Cirsium vulgare	Spear Thistle	1	1	2
Clematis vitalba	Traveller's Joy	3	8	11
Clinopodium vulgare	Wild Basil	2		3
Crataegus monogyna	Hawthorn	6		3
Crepis capillaris	Smooth Hawk's-beard			9
Cuscuta epithymum	Dodder	3		1
Dactylis glomerata	Cock's-foot			6
Daucus carota	Wild Carrot	10	3	11
Dipsacus fullonum	Wild Teasel	1		1
Epilobium hirsutum	Great Willowherb		1	6
Euphrasia officinalis agg.	Eyebright	7		
Festuca ovina	Sheep's Fescue	1		
Festuca rubra	Red Fescue	10		
Fraxinus excelsior	Ash			2
Galium mollugo	Hedge Bedstraw			1
Galium verum	Lady's Bedstraw	11		
Glechoma hederacea	Ground-ivy		3	10
Heracleum sphondylium	Hogweed			1
Holcus lanatus	Yorkshire-fog			5
Hypericum hirsutum	Hairy St. John's-wort			1
Inula conyzae	Ploughman's-spikenard		1	1

Species name	Common name	C	13	15
Iris foetidissima	Stinking Iris	1		3
Leontodon hispidus	Rough Hawkbit	1		1
Ligustrum vulgare	Wild Privet		4	2
Linum catharticum	Fairy Flax	5		1
Lotus corniculatus	Common Bird's-foot-trefoil	8		
Medicago lupulina	Black Medick			5
Odontites vernus	Red Bartsia			5
Ononis repens	Common Restharrow	4		
Origanum vulgare	Wild Marjoram	1		
Pastinaca sativa	Wild Parsnip	1		7
Phleum bertolonii	Smaller Cat's-tail			2
Picris echioides	Bristly Oxtongue	1	9	7
Pilosella officinarum	Mouse-ear-hawkweed	1		1
Pimpinella saxifraga	Burnet-saxifrage			3
Plantago lanceolata	Ribwort Plantain	11	1	7
Plantago major	Greater Plantain			3
Plantago media	Hoary Plantain	3		
Prunella vulgaris	Selfheal	9	3	8
Rosa canina agg.	Dog Rose			4
Rubia peregrina	Wild Madder		2	2
Rubus fruticosus agg.	Bramble	5	9	10
Rumex conglomeratus	Clustered Dock			1
Rumex obtusifolius	Broad-leaved Dock			1
Sambucus nigra	Elder		5	1
Sanguisorba minor	Salad Burnet	10	1	1
Scabiosa columbaria	Small Scabious	2		
Scrophularia nodosa	Common Figwort		1	
Senecio jacobaea	Common Ragwort	3	1	1
Sherardia arvensis	Field Madder	3		
Solanum dulcamara	Bittersweet		3	8
Sonchus asper	Prickly Sow-thistle		2	1
Sonchus oleraceus	Smooth Sow-thistle		6	
Tamus communis	Black Bryony		1	
Taraxacum officinale	Dandelion			5
Torilis japonica	Upright Hedge-parsley			4
Thymus polytrichus	Wild Thyme	7		1
Trifolium pratense	Red Clover	10		3
Urtica dioica	Common Nettle		2	4
Viburnum lantana	Wayfaring-tree			1
Viola hirta	Hairy Violet	2		3

Appendix 2.

Ellenberg values and competitive, ruderal & stress tolerance values (derived from J.P.Grime et al, Comparative Plant Ecology 2nd edition 2007) used in Vegetation Trent Analysis (VTA) programme.

	Ellenberg Values					CRS Values (derived from J.P.Grime *et al*. 2007)		
Species name	Light	Moisture	pH - acidity	Nitrogen need	Salinity	Competit -ive	Ruderal	Stress tolerance
Achillea millefolium	7	5	6	4	1	1.3	1.3	1.3
Agrimonia eupatoria	7	4	7	4	0	1.3	1.3	1.3
Anagallis arvensis	7	4	6	5	0	0.0	3.0	1.0
Arctium minus	6	4	7	5	0	3.0	1.0	0.0
Arrhenatherum elatius	7	5	7	7	0	2.7	0.7	0.7
Blackstonia perfoliata	8	5	8	2	0	0.0	2.0	2.0
Brachypodium sylvaticum	6	5	6	5	0	1.7	0.6	1.7
Bromus hordeaceus	8	4	7	4	0	1.0	3.0	0.0
Briza media	8	5	7	3	0	0.7	0.7	2.7
Carex flacca	7	5	6	2	0	0.0	0.0	4.0
Carlina vulgaris	8	4	7	2	0	0.0	2.0	2.0
Centaurea nigra	7	5	6	5	0	1.3	1.3	1.3
Centaurea scabiosa	8	3	8	3	0	1.7	0.6	1.7
Centaurium erythraea	8	5	6	3	0	0.0	2.0	2.0
Cerastium fontanum	7	5	5	4	0	0.7	2.7	0.7
Cirsium acaule	9	4	8	3	0	1.7	0.6	1.7
Cirsium arvense	8	6	7	6	0	4.0	0.0	0.0
Cirsium eriophorum	8	4	8	5	0	Species not evaluated		
Cirsium palustre	7	8	5	4	0	1.7	1.7	0.6
Cirsium vulgare	7	5	6	6	0	2.0	2.0	0.0
Clematis vitalba	6	4	8	5	0	2.0	0.0	2.0
Clinopodium vulgare	7	4	7	4	0	1.7	0.6	1.7
Crataegus monogyna	6	5	7	6	0	2.0	0.0	2.0
Crepis capillaris	7	4	7	4	0	0.0	3.0	1.0
Cuscuta epithymum	7	6	2	2	0	Species not evaluated		
Dactylis glomerata	7	5	7	6	0	2.7	0.7	0.7
Daucus carota	8	4	7	3	2	0.6	1.7	1.7
Dipsacus fullonum	8	7	7	7	0	2.0	2.0	0.0
Epilobium hirsutum	7	8	7	7	0	4.0	0.0	0.0
Euphrasia officinalis agg.	8	5	5	3	0	0.0	2.0	2.0
Festuca ovina	7	5	4	2	0	0.0	0.0	4.0
Festuca rubra	8	5	6	5	2	1.3	1.3	1.3
Fraxinus excelsior	5	6	7	6	0	3.0	0.0	1.0
Galium mollugo	7	4	7	4	0	2.7	0.7	0.7
Galium verum	7	4	6	2	0	1.7	0.6	1.7
Glechoma hederacea	6	6	7	7	0	1.7	1.7	0.6
Heracleum sphondylium	7	5	7	7	0	2.7	0.7	0.7
Holcus lanatus	7	6	6	5	0	1.3	1.3	1.3

Species name	Ellenberg Values					CRS Values (derived from J.P.Grime *et al*. 2007)		
	Light	Moisture	pH - acidity	Nitrogen need	Salinity	Competit -ive	Ruderal	Stress tolerance
Hypericum hirsutum	6	5	7	5	0	1.7	0.6	1.7
Inula conyzae	7	3	8	3	0	0.6	1.7	1.7
Iris foetidissima	5	4	8	5	0	3.0	0.0	1.0
Leontodon hispidus	8	4	7	3	0	1.3	1.3	1.3
Ligustrum vulgare	6	5	7	5	0	2.0	0.0	2.0
Linum catharticum	8	5	7	2	0	0.0	2.0	2.0
Lotus corniculatus	7	4	6	2	1	0.7	0.7	2.7
Medicago lupulina	7	4	8	4	0	0.7	2.7	0.7
Odontites vernus	7	5	6	5	0	1.0	3.0	0.0
Ononis repens	8	4	6	3	0	1.7	0.6	1.7
Origanum vulgare	6	4	7	4	0	1.7	0.6	1.7
Pastinaca sativa	7	4	7	5	0	2.0	2.0	0.0
Phleum bertolonii	8	4	7	4	0	0.6	1.7	1.7
Picris echioides	7	5	7	6	0	2.0	2.0	0.0
Pilosella officinarum	8	4	7	2	0	0.7	0.7	2.7
Pimpinella saxifraga	7	4	7	3	0	0.6	1.7	1.7
Plantago lanceolata	7	5	6	4	0	1.3	1.3	1.3
Plantago major	7	5	6	7	0	0.7	2.7	0.7
Plantago media	8	4	7	3	0	0.7	0.7	2.7
Prunella vulgaris	7	5	6	4	0	1.3	1.3	1.3
Rosa canina agg.	6	5	7	6	0	2.0	0.0	2.0
Rubia peregrina	6	4	8	5	0	Species not evaluated		
Rubus fruticosus agg.	6	6	6	6	0	2.0	0.0	2.0
Rumex conglomeratus	8	8	7	7	0	1.7	1.7	0.6
Rumex obtusifolius	7	5	7	9	0	2.7	0.7	0.7
Sambucus nigra	6	5	7	7	0	4.0	0.0	0.0
Sanguisorba minor	7	4	8	3	0	0.7	0.7	2.7
Scabiosa columbaria	8	3	8	2	0	0.0	1.0	3.0
Scrophularia nodosa	5	6	7	6	0	3.0	1.0	0.0
Senecio jacobaea	7	4	6	4	0	1.7	1.7	0.6
Sherardia arvensis	7	4	6	4	0	0.0	3.0	1.0
Solanum dulcamara	7	8	7	7	0	2.7	0.7	0.7
Sonchus asper	7	5	7	6	0	1.0	3.0	0.0
Sonchus oleraceus	7	5	7	7	0	1.0	3.0	0.0
Tamus communis	6	5	7	6	0	2.7	0.7	0.7
Taraxacum officinale	7	5	7	6	1	0.7	0.7	2.7
Torilis japonica	7	5	7	7	0	1.7	1.7	0.6
Thymus polytrichus	8	4	6	2	0	0.0	0.0	4.0
Trifolium pratense	7	5	7	5	0	1.3	1.3	1.3
Urtica dioica	6	6	7	8	0	4.0	0.0	0.0
Viburnum lantana	7	5	7	5	0	Species not evaluated		
Viola hirta	7	4	8	2	0	0.7	0.7	2.7

Appendix 3: Sample Location Data

Year	Grassland		Easting	Northing
2013	Control 2013	1	351771	128797
2013	Control 2013	2	351758	128797
2013	Control 2013	3	351743	128805
2013	Control 2013	4	351731	128816
2013	Control 2013	5	351713	128828
2013	Control 2013	6	351695	128829
2013	Control 2013	7	351675	128830
2013	Control 2013	8	351657	128831
2013	Control 2013	9	351598	128831
2013	Control 2013	10	351594	128821
2013	Control 2013	11	351600	128819

Year	Scrub	2013	Easting	Northing
2013	Cleared 2012	1	351872	128759
2013	Cleared 2012	2	351876	128753
2013	Cleared 2012	3	351882	128756
2013	Cleared 2012	4	351827	128774
2013	Cleared 2012	5	351844	128767
2013	Cleared 2012	6	351658	128815
2013	Cleared 2012	7	351642	128815
2013	Cleared 2012	8	351628	128829
2013	Cleared 2012	10	351636	128831
2013	Cleared 2012	11	351933	128769
2013	Cleared 2012	12	351904	128778

Year	Scrub	2015	Easting	Northing
2015	Cleared 2012	1	351871	128758
2015	Cleared 2012	2	351876	128754
2015	Cleared 2012	3	351882	128756
2015	Cleared 2012	4	351827	128774
2015	Cleared 2012	5	351844	128767
2015	Cleared 2012	6	351658	128815
2015	Cleared 2012	7	351642	128815
2015	Cleared 2012	8	351618	128822
2015	Cleared 2012	10	351636	128831
2015	Cleared 2012	11	351933	128768
2015	Cleared 2012	12	351904	128778

Appendix 4

Jaccard P. (1901, 1912) 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.

$\%S J = SJ*100$