

Evaluating the progress of habitat restoration at Prees Heath, Shropshire.

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As reported in previous Society Newsletters (Lockton , 2013, Lewis, 2013) Butterfly Conservation bought 60ha of Prees Heath Common in 2006, including the area designated as a Site of Special Scientific Interest, with the intention of reverting the approximately 29ha of adjacent arable land to heath and acid grassland to increase the area of habitat suitable for Silver-studded blue (Davis, *et al.*, 2011).

In 2007, at the start of the restoration process, the existing semi-natural vegetation communities at Prees Heath Common reserve were surveyed, using the National Vegetation Classification (NVC) (Rodwell, 2006). Much of the site was bare sand, following deep ploughing, so the focus was on existing vegetation, south of the A41, primarily SSSI. The main vegetation types recorded along the runways were U1 *Festuca ovina-Agrostis capillaris-Rumex acetosella* acid grassland often in a mosaic with H8 *Calluna vulgaris-Ulex gallii* heathland with some W10 woodland (Whild Associates, 2007).

Butterfly Conservation have been working to restore grass and heath communities since then using various combinations of deep ploughing, sulphur applications and repeated seeding and plug planting (Lewis, 2015). The management between 2007 and 2014 is summarised in table 1 below. This shows that repeated treatments to add seed have been added to the various areas. Recent research has shown that repeated applications of seed improve the chances of establishing target species in meadow restoration (Baasch, *et al.*, 2016). There were early concerns about the mobility of bare sand and obviously the ongoing impact of agricultural weed species including – Ragwort *Senecio jacobea*, Rose-bay Willowherb *Chamaenerion angustifolium*, docks and thistles. All the areas have had regular spot spraying or weed wiping with glyphosate to treat weeds, although area 4 did not require this until after the deep ploughing. There has been ongoing work to control invasive weeds and scrub and to plant plug plants since then.

Obviously, this is not an experiment with replicated trials, this is an example of restoration where you keep trying until it works. However it is still important to evaluate the restoration periodically and identify if tweaks in management are needed. Evaluation of success is still a growing science, using a variety of measures like indicator or keystone species but it is also important to use a reference site for comparison (Miller, 2007, Wortley, *et al.*, 2013).

When should the restoration be considered a success at this site? Is it when Heather *Calluna vulgaris* is established? When the Silver-studded blue butterfly colonises? Or when the habitats start to resemble the reference vegetation? Arguably the answer to all these questions should be yes, at least as steps along the way.

In early summer 2017 a vegetation survey was undertaken to describe the existing semi-natural habitats present across the common, both SSSI and non-designated land, (the reference habitats) and to compare these to the restoration areas. This information can be used to look at the National Vegetation Classification for the areas, to look at condition assessment e.g. frequency of positive and negative indicators and also the host and nectar plants for Silver-studded blue butterfly.

Table 1: Summary of management treatments by area at Prees Heath common reserve. (Source: Lewis, 2015)

Area	Treatment
Area 1, Control tower field (CT) Ex-arable, approx. 4.5 ha.	2007 - Deep ploughing to 60cm. 2cm depth bracken compost. Approx. 13kg/ha local meadow seed (including Molverley Meadows SSSI).
Area 2, Hangars field (HF) Ex-arable, approximately 6.5ha	2007 - Deep ploughing to 90cm, Sulphur approx. 1.2 tonnes/ha. 0.8kg of <i>D. flexuosa</i> (sourced on reserve) sown on western 0.5ha. <i>C. vulgaris</i> brash spread and compressed onto soil. 2008 – <i>E. cinerea</i> and <i>D. flexuosa</i> seed, harvested on site, in two applications. 2009 – 10,000 <i>E. cinerea</i> plug plants (grown from seed harvested on site), plus broadcast <i>E. cinerea</i> seed. 2012 – brush harvested <i>C. vulgaris</i> seed added 2013 - brush harvested <i>C. vulgaris</i> seed added 2014 - 2ha of tall heather cut with disc harvester
Area 3, east of runway (ER) field, meadow creation (approx. 8ha)	2007 - Deep ploughing to 90cm. 10kg of <i>A. capillaris</i> (Shropshire sourced) 2008 – mix of local and seed merchant meadow seed at ~ 20kg/ha to prevent sand erosion. 2009 – 40m diameter pond dug. 2010 – Local meadow seed approx. 2kg/ha. 2012 –pond spoil area – boom sprayed 2.5ha around pond. Harrowed, seeded and rolled with local meadow mix plus additional grass seed.
Area 3, east of runway (ER) field, heath creation (approx. 6.5ha)	2007 - Deep ploughing to 90cm. 10kg of <i>A. capillaris</i> (Shropshire sourced) Approx 1.2 tonnes/ha sulphur and <i>C. vulgaris</i> brash applied 2009 - 6.5 ha cut, collected and disposed of vegetation. Power harrow to root out mat of dead grass where needed. <i>C. vulgaris</i> brash applied. 2010 - <i>C. vulgaris</i> brash applied. 2012 – brush harvested <i>C. vulgaris</i> seed added 2013 – brush harvested <i>D. flexuosa</i> seed broadcast
Area 4, Corner field (CF) approx. 2.5 ha (a further 1 ha of this field, nearest the wood has not been treated).	2010 Boom sprayed. Deep ploughed to 90cm. 1.75 tonnes/ha sulphur. <i>C. vulgaris</i> brash applied. 2012 – wildflower & grass seed mix from seed merchant 9.5kg/ha. 2012 – brush harvested <i>C. vulgaris</i> seed added 2013 – wildflower & grass seed mix from seed merchant 9.5kg/ha. <i>C. vulgaris</i> , and some <i>E. cinerea</i> seed broadcast 2014 – <i>C. vulgaris</i> brash (from Hangars field) plus <i>E. cinerea</i> seed.

National Vegetation Classification

Looking at the National Vegetation Classification for Prees Heath raises some interesting questions (table 2). Using MAVIS (CEH, 2015) to analyse the quadrat data showed that none of the communities, reference or created are a good fit for national vegetation types, with a wide range of affinities suggested including sand dune. The paper keys (Rodwell 1991 *et seq.*) have been used to finalise an NVC community based on likelihood in the county and the amount of dominant species e.g. *Calluna vulgaris*. Created heath and reference grass are very obviously different habitats, although they might be best 'labelled' as U1 grassland. In fact all the habitats whether grass, 'heath', reference or created, could have been classified as grassland habitats. Any of the reference 'heath' is in very small patches with lots of grassland indicators present, so grassland communities could validly have been selected, even though the cover of dwarf shrubs was over 25%. The best match is for the created grass (using a meadow seed mix). However the created grassland is still species poor, whether it is considered as neutral grass or lowland acid grass (see condition assessment below).

Table 2: Top 3 results from MAVIS for habitat groups at Prees Heath

Habitat Group	Top 3 results from MAVIS	Best fit NVC community using keys
Reference Heath	U4a 47.10 SD12a 44.03 U1d 43.85	U1/H8
Created Heath	U1 46.19 U1b 40.82 U1d 38.44	U1/H12
Reference grassland	U1 45.49 U4b 45.42 U1d 44.92	U1
Created grassland	MG5 56.48 MG5a 56.05 MG6b 55.76	MG5

Positive indicators

Another way of comparing habitats is to look at the frequency of axiophytes and positive indicators. Common standards monitoring includes a list of positive indicator species for habitats (JNCC, 2004, JNCC, 2009), not all of which would be considered as axiophytes, as they are not rare, but are still important components of those habitat types. In general reference habitat types had both more species and more combined indicator species than created habitat types, as shown in table 3. As a measure of the evaluation of the progress of restoration at Prees Heath, this shows that created habitats have not yet achieved similarity based on the numbers of indicators found.

Created heath had eleven indicators at lower frequencies than the reference heath including lower frequency of both Bird's-foot-trefoil *Lotus corniculatus* and Bell heather *Erica cinerea*, the nectar species for Silver-studded blue. Only three indicators are present at higher frequencies in created habitats and one of those is Wavy Hair-grass *Deschampsia flexuosa*, one of the specifically sown species.

Interestingly the undesignated grassland north of the A41, was of equal quality to the grassland found in the SSSI area.

Table 3: Differences between reference and created heath habitats

Species name	% quads reference heath	% quads created heath	Diff. between reference and created heath	Indicator type
<i>Pilosella officinarum</i>	90	0	90	Indicator
<i>Carex pilulifera</i>	70	0	70	Axiophyte
<i>Lotus corniculatus</i>	80	33	47	Indicator
<i>Erica cinerea</i>	100	58	42	Axiophyte/CSM indicator
<i>Cladonia [spp]</i>	90	58	32	Indicator
<i>Danthonia decumbens</i>	30	0	30	Axiophyte
<i>Veronica officinalis</i>	30	0	30	Axiophyte
<i>Aphanes arvensis</i> agg.	40	17	23	Indicator
<i>Carex flacca</i>	20	0	20	Indicator
<i>Leontodon hispidus</i>	20	0	20	Indicator
<i>Leucanthemum vulgare</i>	20	0	20	Indicator
<i>Myosotis discolor</i>	20	42	-22	Axiophyte
<i>Molinia caerulea</i>	0	42	-42	Axiophyte
<i>Deschampsia flexuosa</i>	50	100	-50	Axiophyte

For grassland, fourteen indicators are found at higher frequencies in reference grass (see table 4). Notably the host plant and one of the two main nectar species for Silver-studded blue are absent from created grass areas. Compared to the reference grass, the created areas have much less Mouse-ear-hawkweed *Pilosella officinarum*, Common Centaury *Centaurea erythraea*, *Calluna vulgaris*, Sheep's Sorrel *Rumex acetosalla* and Silver Hair-grass *Aira caryophyllea*. However the created areas have a higher frequency of Eyebright *Euphrasia officinalis* agg. and Common Knapweed *Centaurea nigra*.

Table 4: Differences between relative amounts of combined indicator species for reference and created grassland.

Species name	% quads reference grass	% quads created grass	Difference	Indicator type
<i>Pilosella officinarum</i>	67	0	67	indicator
<i>Centaureum erythraea</i>	58	0	58	indicator
<i>Calluna vulgaris</i>	50	0	50	Axiophyte/CSM indicator
<i>Rumex acetosella</i>	58	10	48	indicator
<i>Aira caryophyllea</i>	42	0	42	Axiophyte/CSM indicator
<i>Cladonia [spp]</i>	58	20	38	indicator
<i>Filago minima</i>	33	0	33	axiophyte
<i>Spergularia rubra</i>	33	0	33	axiophyte
<i>Leucanthemum vulgare</i>	33	0	33	indicator
<i>Aphanes arvensis agg.</i>	58	30	28	indicator
<i>Trifolium campestre</i>	25	0	25	axiophyte
<i>Erica cinerea</i>	25	0	25	Axiophyte/CSM indicator
<i>Ornithopus perpusillus</i>	33	10	23	Axiophyte/CSM indicator
<i>Aira praecox</i>	42	20	22	Axiophyte/CSM indicator
<i>Euphrasia officinalis agg.</i>	0	30	-30	Axiophyte/CSM indicator
<i>Centaurea nigra</i>	8	60	-52	indicator

Common Standards Monitoring

Common standards monitoring (CSM) will look at numbers of positive indicators, but also looks at negative indicators to flag up management issues along with structural elements like bare ground for the benefit of species using those habitats. The created heathland is lacking the nectar plants for Silver-studded blue butterfly *Erica cinerea* and/or *Lotus corniculatus*, and there are still frequent negative indicators mainly agricultural weeds and birch seedlings. The created grass areas do not meet the CSM target for the frequency of positive indicator species. Most grassland types need at least 2 frequent and 4 occasional positive indicators. Prees Heath reference grassland has 5 frequent and 2 occasional positive indicators for lowland acid grassland. The created grassland has just 2 frequent positive indicators (*Lotus corniculatus* and *Euphrasia officinalis agg.*) for MG5 grassland type, and this is based on larger quadrats. They lack *Calluna vulgaris* and *Erica cinerea* host and nectar plant for Silver-studded blue and again the frequency of agricultural weeds is too high. On the plus side there is a good frequency of the alternative nectar plant *Lotus corniculatus*.

In other news

In 2016, Butterfly Conservation did a full count for Silver-studded blue across Prees Heath Common, including areas outside of regular transects e.g. restored areas and land north of A41. As a result a total of 2954 butterflies were counted with most of the population found on the main SSSI runway, but there are also good numbers north of A41 and smaller numbers appearing in the created habitats particularly the older areas (Lewis, 2017). Evidence of breeding (egg and caterpillar) have been found in the first two of the three heathland creation areas (Lewis pers com.). Four Silver-studded blue were also recorded in July 2017 in the land newly acquired by Shropshire Wildlife Trust, the furthest north part of Prees Heath Common (Lewis, 2017).

Freshwater Habitats Trust looked at the pond created within the Prees Heath restoration area (Williams, 2017). They found 28 plant species, making it richer than most ponds in the countryside. It has a combination of both acidic bank-side wetland plants including Sharp-flowered Rush *Juncus acutiflorus*, Bog Pimpernell *Anagallis tenella*, growing alongside more calcareous Blunt-flowered Rush *Juncus subnodulosus* and Bristly Stonewort *Chara hispida*, which suggests that the groundwater water feeding the pond must be calcium rich.

Prees Heath's pond flora included a number important species:

- Lesser Spearwort *Ranunculus flammula* has recently been included on the England Red List because of an estimated occupancy decline of 32% in England in last 10 years (<http://bit.ly/2wYzpfq>).
- Ragged-robin (*Silene flos-cuculi*) is now designated as Near Threatened in England because of a marked decline.
- Orange Foxtail (*Alopecurus aequalis*) borders on being red-listed with a worrying 42% decline in England (<http://bit.ly/2wYzpfq>).
- Bristly Stonewort (*Chara hispida*) although not red listed, is an uncommon stonewort. There are exceptionally few modern records of this species in Shropshire, making this an important county record.

Discussion

So what can we learn from a study like this? The NVC can be a bit of a blunt tool when looking in this level of detail at a specific site, or indeed for setting targets for restoration. Comparing the frequency of positive indicators is a good way to see whether the restoration is approaching surrounding reference vegetation. It may also help to suggest next steps in terms of restoration.

The requirements of Silver-studded blue butterfly are relatively well understood compared to many species. The key requirement is the presence of abundant black ants along with the larval food plants, adult nectar sources, bare ground, short vegetation for egg-laying and taller vegetation for shelter and communal roosting (Lewis pers com.). It probably doesn't mind whether we label the habitat as a heathy grassland or a grassy heathland.

In order to create heath in favourable condition, for CSM, there would need to be 25-90% cover of ericoid species. The upper target would not be desirable for the Silver-studded blue, which needs lots of pioneer heather and bare ground. In many respects the restoration at Prees Heath is still in the very early stages, but the fact that the butterfly is using the restored areas has to be a very positive sign. There will be an ongoing requirement to manage agricultural weeds and tree seedlings, and management needs to make sure that neither *Calluna vulgaris* or *Deschampsia flexuosa* become over-dominant. This is clearly undesirable both in terms of re-creating the desirable vegetation, or to deliver the needs of the Silver-studded blue butterfly. Positive indicators will move around the site over time, but there may be things that can be done to help speed this up, including considering using larger grazing animals, and possibly considering moving small turves into the restored areas.

The pond survey is also thought provoking. Brown Moss SSSI/SAC is less than 1km away from the most northern part of Prees Heath Common. It would be helpful to think of these sites as part of a complex and aim to create more ponds and wetlands between Prees Heath SSSI and Brown Moss, but also look at the heathland areas at Brown Moss with a view to enhancing them.

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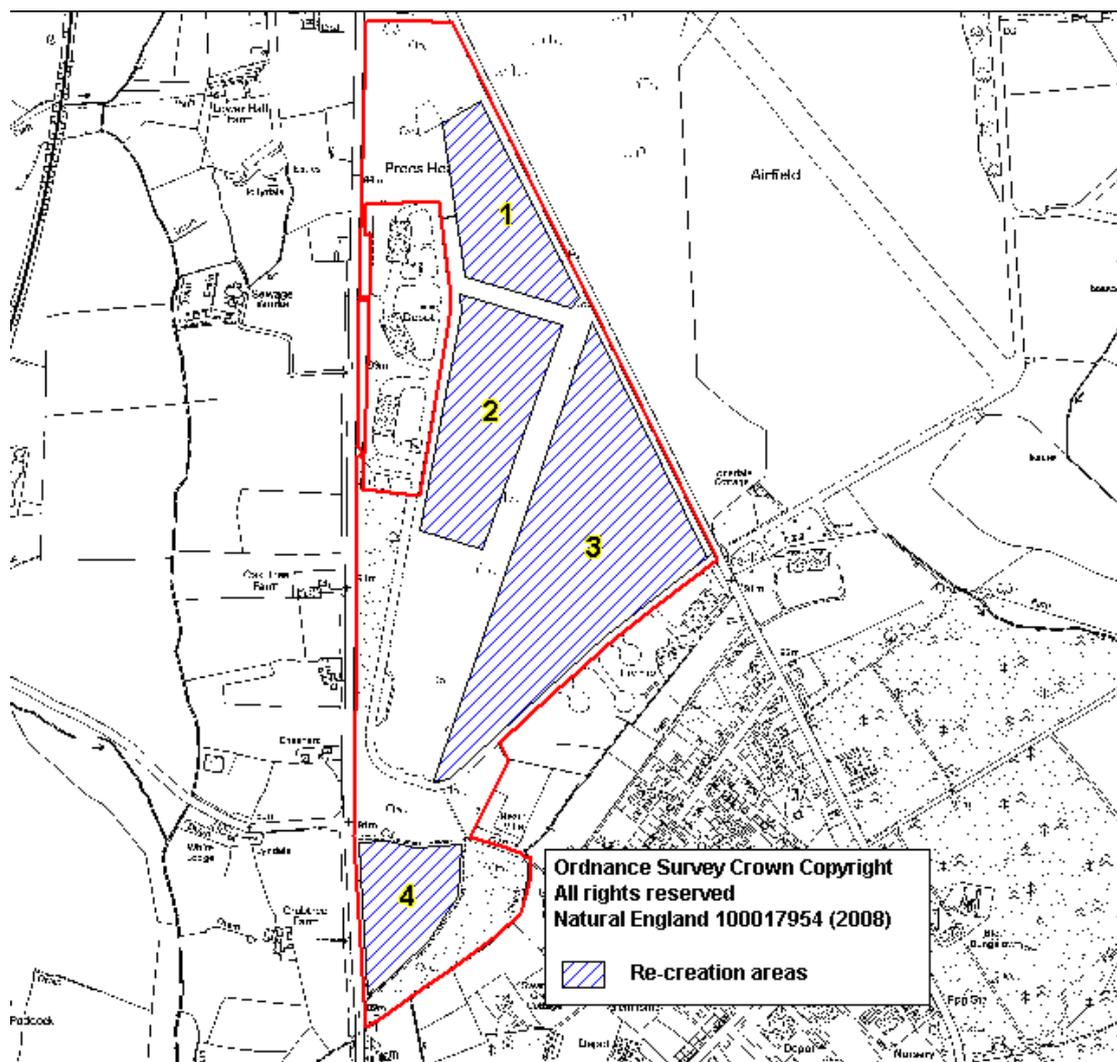


Figure 1: Habitat creation management compartments at Prees Heath Common Reserve. (Source: Lewis, 2015).



Figure 2: Reference heath at Prees Heath Common.