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Restoring diverse grassland: What can be achieved where, and what will it do for us?

"Going for gold (purple and pink) in 2012" Results from five years of hay meadow restoration in Cumbria

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Summary

Cumbria Wildlife Trust, in partnership with the Farming and Wildlife Advisory Group, has been working with Natural England Advisors and Cumbrian farmers to deliver BAP targets for upland hay meadows. In the five years of the Hay-day project to date 135 meadows have been surveyed and restoration undertaken at 35 sites, encompassing 71 hectares of upland meadow. None of this would have been possible without the active cooperation of the farmers, who have also benefited from the project. Restoration was by hay strewing and seeding from local, species-rich donor meadows, with some supplementary plug planting on earlier sites. Floristic surveys before and after restoration have shown significant increase in species richness in the restored meadows and early indications that the species assemblages are moving towards traditional upland hay meadow communities.

Key words: Upland hay meadows, restoration, Cumbria Wildlife Trust

Introduction

Northern hay meadows

Flower rich hay meadows in the UK have been in steep decline since the 1940's. 97% of herb rich traditional meadows have been lost, largely to agricultural intensification, since the 2nd World War. In Britain, upland hay meadows, NVC type MG3 (Rodwell *et al*., 1992) a specifically northern meadow variant supporting Northern Montane species is confined to Cumbria, Northumberland, parts of Scotland and North Yorkshire. Broadly similar vegetation is found in Belgium, Germany, Austria, Czech Republic and Hungary, and further north Norway, Greenland and Sweden. The UK supports *c*. 1100 ha (3% of the current global resource (JNCC, 2007)).

Although it is the use of nitrogen fertiliser more than any other factor which has contributed to the impoverishment to the flora of flower rich meadows (Rodwell *et al*., 1992), in the northern counties many hay meadows are still managed with relatively low inputs, providing early sheltered grazing for lambing ewes, autumn grazing for cattle and winter fodder for stock. The scarcity of fertile land[1] means that many meadows are on marginal hill land, where fertiliser use is expensive and inappropriate. Though the Environmentally Sensitive Area (ESA) scheme sought to safeguard meadows with any floristic interest through restrictions on inputs and cutting dates, many became more impoverished under higher tiers, due to shut up dates that were too late and early cutting dates, and the application of too much muck (Critchley *et al*., 2004). The environmental stresses on moderately productive fields in the region (mostly the cold, wet, windy and cloudy climate),

[1]Over 70% of Cumbria is in a 'Disadvantaged' or 'Severely Disadvantaged' Area.

mean that sites with medium to high potential for restoration or enhancement may be found, if changes in management could be implemented.

Upland or northern hay meadows are characterised by a dense growth of grasses and herbaceous dicotyledons to 60–80 cm high. No grass species is predominant; in fact grasses typically only make up a small proportion of the herbage which is dominated by bulky broad leaved plants including wood crane's-bill, great burnet, pignut and lady's mantle species (Rodwell *et al*., 1992). Some locally rare species may be represented – spignel (*Meum athamanticum*), bitter wood vetch (*Vicia orobus*) and a lady's mantle (*Alchemilla glomerulans*) have all been found in hay meadows. The community is also found in churchyards, woodland clearings, and in Cumbria particularly, along road verges.

Within the meadows, surface flushing and seasonal waterlogging can lead to areas supporting frequent meadowsweet (*Filipendula ulmaria*), bistort (*Persicaria bistorta*), and small sedges (*Carex panicea*, *C. nigra*). In gunnels and shallow drains marsh marigold (*Caltha palustris*) can often be abundant. Damp field corners and lower lying areas typically support rushes, usually sharp flowered rush, with small wetland herbs, and sometimes marsh or bog mosses. Where hay meadows are adjacent to rivers the vegetation often merges into tall herb mixtures where cutting and grazing is infrequent. This is not dissimilar to vegetation found along the River Tay and some Scottish lochs. Conversely rock outcrops may also be common, where soils are thinning over bedrock and prone to draining quickly. Eyebrights, harebells and betony typically feature here often with bird's foot trefoil and sometimes common cat's ear.

Excess manure, long periods of spring grazing by ewes and lambs and early cutting dates have led to losses in these meadows. Annuals such as yellow rattle and eyebright and perennials like wood crane's-bill and lady's mantle are grazed out in spring, while slower growing perennials great burnet and black knapweed do not get a chance to flower and set seed due to early cut dates, so populations slowly diminish.

The Hay-day project

Hay-day, a partnership project between Cumbria Wildlife Trust and the Farming and Wildlife Advisory Group sought to deliver BAP targets for upland hay meadows on farms entering Higher Level Stewardship (HLS) schemes through appropriate management prescriptions and at suitable sites, by restoring meadows. Project staff worked closely with Natural England advisors to select sites suitable for restoration, wrote site specific prescriptions to be included in new HLS agreements and then coordinated contractors and/or supervised farmers to undertake ground preparation and harvest and spread seed or green hay.

By reviewing known species rich meadow sites in Cumbria outwith statutory designations (County Wildlife Sites CWS) and assessing their condition, the Hay-day project hoped to provide an indication of the status of meadows since the early 1980's. The project also sought to increase the area of species rich meadows by working with Natural England and farm businesses in Cumbria to floristically enhance sites. Suitable fields were inoculated with local wildflower seed mixes and this, coupled with management prescriptions designed to lower fertility (where necessary) and provide optimum growth requirements for the herbs typical of northern hay meadows, was the basis of the project's restoration programme.

The advantages of working within the farming community were several: the relatively large number of sites already managed as hay meadows, access to appropriate machinery and stock by the land manager if not already managed as hay meadows, the understanding of the agreement holder of how traditional meadows are managed, the number of potential sites made accessible to the project from Natural England, the comparatively high hectarage of sites assessed by the project, the securing of a decade of positive management post restoration and not least the money generated through HLS agreements which funded most of the restoration and ongoing management.

Materials and Methods

Surveys and restoration

This paper reports on the results from surveys of 135 upland grassland fields in Cumbria. Sites fall into several different categories. The majority (119 sites) were surveyed just once to contribute to the inventory of upland grasslands in Cumbria (County Wildlife Sites). Some sites were found to be very good examples of upland hay meadow type (MG3) and seven became donor sites for subsequent seed collection. Five sites were part of the Wealth of Wildlife project, an earlier Cumbria Biodiversity Project that started in 2006 and restored five meadows. These were surveyed, followed by seeding and plug planting. These were then surveyed again at two-yearly intervals. A further 11 sites have been restored by Hay-day since 2009, with annual surveys (five resurveyed twice and six once to date).

The restoration sites were selected using guidance from DEFRA which focuses on soil nutrient status, especially available phosphorous levels, and the species composition of the existing sward. In addition, sites needed to be in long-term low input management for at least 10 years following the restoration, on sites managed by agreement holders or smallholders who were enthusiastic about traditional hay meadows. Sites were prioritised where they formed links with or enlarged other areas of semi-natural habitat. Many sites formed part of a Higher Level Scheme agreement as this fulfilled the 10 year low input management requirement.

Brush harvesting was used to collect seeds, leaving the majority of the hay crop behind to be taken by the farmer at a later date. This was an efficient if expensive method as specialist contractors had to be used. Seeds were spread using a modified muck spreader or lime spreader after fields had been sufficiently harrowed to create up to 40% bare patches of soil. The fields were then rolled to ensure that the seeds made contact with the soil, and grazing commenced once the sward began to regrow. The Wealth of Wildlife sites also has selected plug plants added in the restoration year. Ongoing management prescriptions included no inputs for the first 3 years and low inputs thereafter (six tonnes ha^{-1} $annum^{-1}$ max), early shut up dates (early May), late cuts (mid July or later) and the introduction of cattle grazing if possible. As part of the preparation for restoration, fields were limed or weed wiped where necessary.

With limited time and surveyors, the sites were surveyed by stopping at a minimum of nine places at random intervals in a "W" shaped walk through the field and recording all of the forb and grass species observed in a 1 m radius at that position. The frequencies with which species were recorded across the site were used as input data for analysis.

Analyses

The analysis used was a Detrended Correspondence Analysis (DCA) (Legendre & Legendre, 1998), using the CANOCO package (Ter Braak & Smilauer, 1997). All vascular plant and grass species recorded by surveyors were used in the analyses. Bryophytes, which had only been recorded sporadically, were left out. Where fields were surveyed using DAFOR scores these were interpreted like this: D=100, A=60, F & LF = 40, O=2, R & P=1.

Results

Fig. 1 shows the mean species number for the different categories of sites. It can be seen that the sites selected for restoration (recorded before restoration (baseline) and at least once since restoration) are initially impoverished in terms of species richness, with a mean number of species of just 28 compared with the relatively species-rich donor sites and with the mean of 32 for the rest of the inventory sites. The mean for the first survey of the restoration sites shows a significant increase in recorded species and a further significant increase by the second survey.

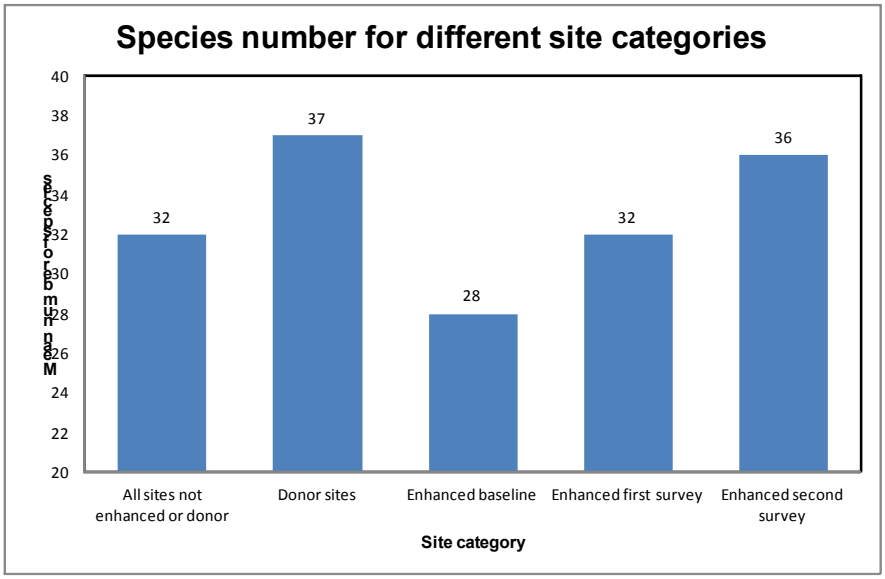

Fig 1. The chart shows the mean count of species for surveyed fields of different types. One tailed *t*-tests show the increases between enhanced baseline and first survey, first survey and second survey and baseline and second survey are all significant ($P = 0.03$, $P = 0.08$, $P = 0.0004$).

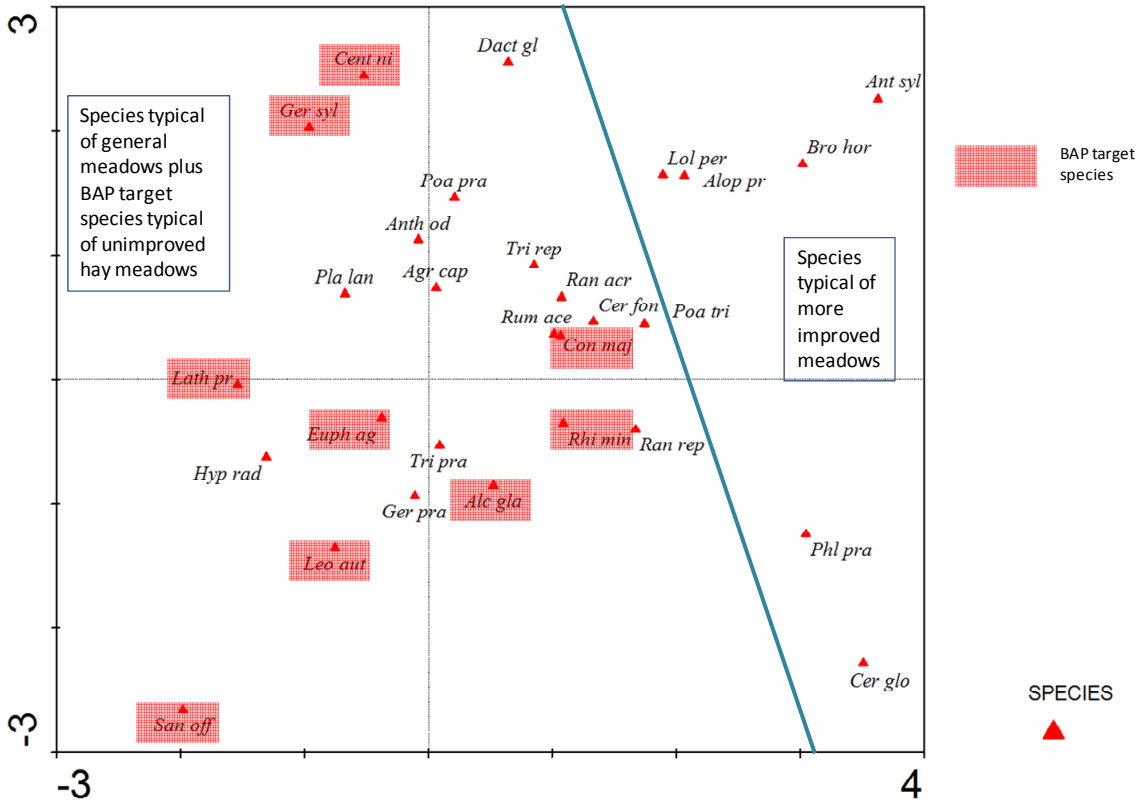

Fig 2. DCA of all surveyed sites. The species ordination is shown. Highlighted species contribute most to the ordination or are indicator species for target BAP grassland types. (*Agrostis capillaris*-Agr cap, *Alchemilla glabra*-Alc gla, *Alopecurus pratensis*-Alop pr, *Anthoxanum odoratum*-Anth od, *Anthriscus sylvestris*-Ant syl, *Bromus hordeaceus*- Bro hor, *Centaurea nigra*- Cent nig, *Cerastium fontanum*-Cer fon, *C. glomeratum*-Cer glo, *Conopodium majus*-Con maj *Dactylis glomerata*-Dact gl, *Euphrasia agg.*-Euph ag, *Geranium sylvaticum*-Ger syl, *Hypochaeris radicata*-Hyp rad, *Lathyrus pratensis*-Lath pra, *Leontodon autumnalis*-Leo aut, *Lolium perenne*-Lol per, *Phleum pratense*-Phl pra, *Plantago lanceolata*-Pla lan, *Poa pratensis*-Poa pra, *P. trivialis*-Poa tri, *Ranunculus acris*-Ran acr, *R. repens*-Ran Rep, *Rhinanthus minor*-Rhi min, *Rumex acetosa*-Rum ace, *Sanguisorba officinalis*-San off, *Trifolium pratense*-Tri pra.).

The ordination clearly shows the distribution of species with those typical of more agriculturally improved fields on the right and those more typical of less improved fields on the left.

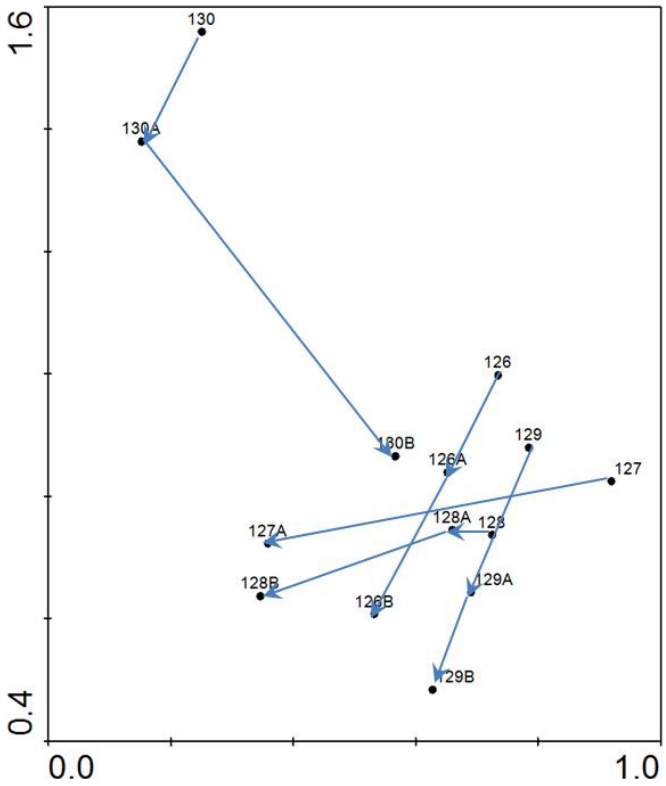

Fig. 3. Wealth of Wildlife sites, surveyed at two year intervals and shown - 126 = baseline survey of site in 2006, 126A = resurvey in 2008, 126B = resurvey in 2010. The arrows generally show a strong trend from right to left corresponding to a change from species typical of improved meadows to species associated with traditional hay meadows.

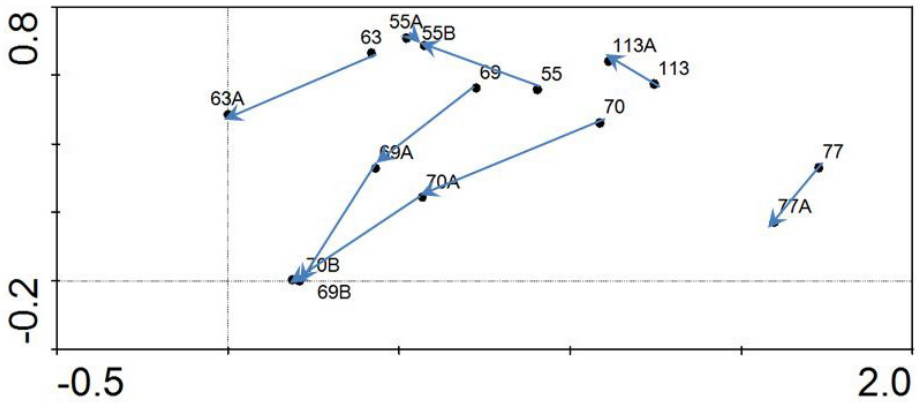

Fig. 4. Other sites (restored by Hay-day) surveyed at one year intervals (2009, 2010 and 2011). These sites also show a strong trend towards species typical of less improved meadows.

Figs 2 to 5 show the results of the DCA. Fig. 2 is the species ordination for all of the 135 surveyed sites. The species shown are those with the highest contribution to the ordination plus a few species typical of target BAP grasslands. Axis 1 appears to differentiate between species rich, less agriculturally improved meadows and species poor, improved meadows. Species to the left of the marked diagonal line are general meadow species, including the desirable BAP target indicator species. To the right are species more typically associated with species-poor, more agriculturally improved grasslands. The sample ordination is shown on several different graphs for clarity. Just the restored sites are shown although all sites were used in the ordination.

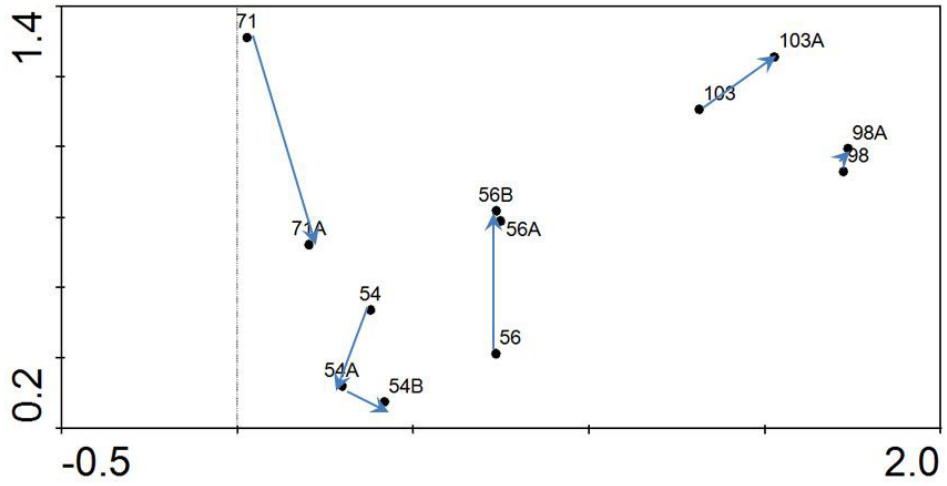

Fig 5. Other sites surveyed at one year intervals (2009, 2010, 2011). The restoration at these sites does not appear to be as successful so far.

Figs 3, 4 and 5 show the sample ordination for different categories of site on the same axes as Fig. 2, so site samples to the right have more of the species typical of more improved grassland, while those to the left are more typical of less improved sites. Figs 3 and 4 show sites where restoration has led to a species mix trending, with increasing time after restoration, away from improved towards the target of less improved hay meadows with BAP target indicator species. Fig. 5 shows the results for some sites where the restoration does not, so far, appear to be so successful, with site 103 in particular appearing to move towards even more dominance by grasses typical of agricultural improvement. It is striking that the sites that appear initially to have done least well are those to the far right of the graphs with a species assemblage typical of the least species-rich, more improved grasslands.

Discussion

The analyses show that the restoration has moved the species composition of two-thirds of the restored fields towards that of less improved hay meadows. Overall species richness has increased in most cases, with the majority of meadows getting better with time. Over the whole suite of samples, annual species eyebright *Euphrasia* and yellow rattle *Rhinanthus minor* were successfully introduced into 88% of sites. Red clover *Trifolium pratense* and ribwort plantain *Plantago lanceolata* increased in cover on sites which were originally good candidates for restoration and those which were the earliest sites to have been restored (WoW sites). Common cat's ear *Hypochaeris radicata* was also relatively easy to introduce to suitable sites. Sites which were more agriculturally improved to begin with had an increase in common mouse ear *Cerastium fontanum* and often Yorkshire fog *Holcus lanatus* after restoration. Early restoration (WoW) sites saw a reduction in rough meadow grass *Poa trivialis*, Yorkshire fog *Holcus lanatus* and perennial rye grass *Lolium perenne* after 5 years. Sites considered to have high potential for restoration saw a relatively fast decline in common bent *Agrostis capillaris*, daisy *Bellis perennis*, rough meadow grass *Poa trivialis* and dandelion *Taraxacum officinale*.

Field observations after restoration record common meadow species ribwort plantain, meadow buttercup, red clover and common sorrel often having germinated within weeks of being sown as freshly harvested seed. Black knapweed has also germinated the autumn after being sown.

The introduction of target BAP species was variable. Yellow rattle and eyebright have been relatively easy to introduce. Lady's mantles *Alchemilla* species have proved difficult to introduce, and existing populations slightly decreased after restoration. Black knapweed *Centaurea nigra* and great burnet *Sanguisorba officinalis* appear to germinate well if there is adequate ground

preparation though the WoW project successfully introduced knapweed through plug planting. Wood cranes'-bill has not been introduced through brush harvested seeding or green hay spreading so far, though plug planting has proved successful on WoW sites. Autumn hawkbit, like common cat's ear appears to be relatively easy to introduce to new swards, while meadow vetchling Lathyrus pratensis is variable.

The few meadows that have not been so successful are particularly interesting. Some had low potential for restoration but were chosen because they are adjacent to SSSI grasslands; some were insufficiently cultivated, some were dry sites and one was atypical. The poor candidates for restoration were dominated by perennial rye grass with frequent white clover, rough meadow grass, Yorkshire fog and soft brome. Even though nutrient levels were low, introduced species may have found it difficult to compete in the lush grass dominated swards, only yellow rattle was successful in this situation. Some sites were insufficiently cultivated prior to sowing. These were often drier fields, where germination was so low that one had to be restored a second time. Another drier field was accidentally grazed late into spring; it is assumed that stock ate the emerging seedlings, especially the early germinating yellow rattle. These results will inform further restoration undertaken by the project.

All but one of the sites surveyed for this project are in private ownership, and are managed for grazing and winter fodder, including all of the donor sites and the sites selected for restoration. The enthusiastic co-operation of the farming community has been essential to the success of the project and ongoing sympathetic management of the fields will be required for the meadows to increase in species richness. For the farmers involved there are also benefits, including access to higher agri-environment scheme payments and improved quality hay.

Acknowledgements

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