

Meadow management increased plant species diversity in a species-poor, neutral grassland in Herefordshire, UK

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SUMMARY

The effect of meadow management on plant species diversity was examined in a meadow in the west of England. In 2002 the meadow was assessed as species-poor. From 2002 to 2013 the meadow, along with 11 surrounding fields, was managed as a hay meadow, with grass being mown for hay in late July or early August each year and the aftermath then grazed by cattle. Vegetation surveys from 2002 and 2013 showed that the diversity of the meadow was significantly enhanced over the period of management, with ten additional meadow herb species becoming established by unaided colonisation. In consequence, a colourful, nectar-rich meadow has been created within the space of 11 years. However, a number of species present on the farm that are more closely associated with old meadows have not yet colonised the field.

BACKGROUND

Joan's Hill Farm occupies an area of 19 ha within the parish of Mordiford, to the southeast of Hereford (Ordnance Survey grid reference SO 591 376). It is owned by the charity Plantlife and managed as a nature reserve. The area is within a 5,000 ha geological feature known as the Woolhope Dome. This comprises strata of Silurian limestone and shales that have been folded into an anticline and subsequently eroded to form a series of hills. The reserve lies on a north-facing slope near the centre of the dome.

The main area of the reserve comprises a block of small, neutral, hay meadows, surrounded by woodland. There are 12 meadows in total, separated by internal hedgerows. These fields have a varied management history, with some fields having had periods under arable cultivation, whereas others appear to have remained as permanent grassland for at least 170 years. These different histories were reflected in the flora of each meadow, with some fields containing species-rich MG5a *Cynosurus cristatus* - *Centaurea nigra* grassland *Lathyrus pratensis* subcommunity vegetation, whilst other fields contained the MG6b *Lolium perenne* - *Cynosurus cristatus* grassland *Anthoxanthum odoratum* subcommunity (Rodwell 1992), that was relatively species-poor.

Between 2002 and 2013 one of the species-poor fields was managed with the aim of increasing species diversity and evolving towards MG5 vegetation. Sward enhancement by spreading species-rich, green hay from donor fields elsewhere on the reserve was considered. However, it was decided that the sward should be allowed to diversify simply by unaided colonisation of species from neighbouring areas. The latter option was chosen because it is a more natural process, even though a species-rich sward might take longer to achieve. The site was surveyed in 2002 and again in 2013 after 11 years of meadow management, in order to assess the effect on species diversity.

ACTION

During the period from 2002-2013, all 12 fields on the farm were managed as hay meadows. The grass was mown for hay in late July or early August each year. The aftermath was then grazed by continental breed suckler cattle in September and October. The entire 15 ha area of the 12 meadows was grazed as one unit, with up to 15 cattle free to move between all the meadows on the farm via gateways in the hedgerows.

In 2002, a baseline survey for the long-term surveillance of the grassland habitat was carried out on one of the species-poor MG6b fields. The field is 1.6 ha in area, its altitude is 135 m, and it is gently sloping (3°), with a northerly aspect. The soil has a pH of 5.6, a Phosphate Index of zero, and a fine, silty texture, prone to slight waterlogging. It is believed to have had a period of arable cultivation between 1930 and 1950 but, according to the former owner, it has been grassland since the 1950s. Cattle were free to move between the study field and neighbouring fields of similar MG6b vegetation, and also a field of MG5a *Cynosurus cristatus* - *Centaurea nigra* grassland *Lathyrus pratensis* subcommunity 160 m to the west and another area of MG5b vegetation 150 m to the east. Similarly, during hay making operations each year, farm machinery moved from field to field. Therefore, both livestock and farm machinery were potential vectors for seed dispersal into the study field from the rest of the nature reserve.

For the initial baseline survey, using the method detailed below, all grasses and broad-leaved herbs were recorded. However, while all broad-leaved herbs were again recorded in 2013, the only grasses to be recorded were cocksfoot *Dactylis glomerata*, Yorkshire fog *Holcus lanatus* and perennial ryegrass *Lolium perenne*, so the full range of grasses present in 2013 is not known.

The study field was surveyed in 2002 and again in 2013 using a random sampling methodology as follows (Hodgson *et al.* 1995):

1. The entire field, which had relatively uniform vegetation, was divided into five fixed sub-plots of equal size (approximately 0.3 ha). A 3 m boundary around the perimeter of the field was excluded from the survey plots.

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2. Within each sub-plot, eight randomly-positioned 1 x 1 m quadrats were surveyed.
3. For each 1 m² quadrat, the species present in one corner 10 x 10 cm cell were noted. Subsequently, records were made of the additional species present when the cell size was increased successively to 20 x 20 cm, 30 x 30 cm, 40 x 40 cm, 50 x 50 cm and 100 x 100 cm.

Change in abundance between 2002 and 2013 was then calculated for each species as follows (Hodgson *et al.* 1995):

Σ (no of occurrences in 2013 – no of occurrences in 2002) for all cell sizes.

CONSEQUENCES

Twenty-four species of vascular plant were recorded in the study field before management started in 2002 (Table 1a). In 2013, after 11 years of meadow management, the number of species recorded had increased by ten to 34 (Table 1b). The change in abundance of key species recorded is shown in Figure 1.

The diversity of the sward was significantly enhanced over the period 2002-2013 when the meadow was managed as a hay meadow. An additional 10 species colonised the field, and there was a dramatic increase in the abundance of desirable herb species including yellow rattle *Rhinanthus minor*, common knapweed *Centaurea nigra*, red clover *Trifolium pratense* and self-heal *Prunella vulgaris*. Yorkshire fog, white clover *Trifolium repens* and perennial ryegrass, which are indicative of eutrophication, all decreased in abundance, the last showing a particularly pronounced decrease.

The surveys show that the field had been colonised by a range of meadow herbs that are relatively widespread within semi-natural neutral grasslands. However, a number of species that are closely associated with old meadows were found

Table 1a. Species recorded in the study field in 2002.

<i>Agrostis capillaris</i>	<i>Phleum pratense</i>
<i>Alopecurus pratensis</i>	<i>Plantago major</i>
<i>Anthoxanthum odoratum</i>	<i>Poa pratensis</i>
<i>Bellis perennis</i>	<i>Potentilla reptans</i>
<i>Bromus hordeaceus</i>	<i>Ranunculus acris</i>
<i>Cerastium fontanum</i>	<i>Ranunculus repens</i>
<i>Convolvulus arvensis</i>	<i>Rumex acetosa</i>
<i>Cynosurus cristatus</i>	<i>Rumex crispus</i>
<i>Festuca rubra</i>	<i>Taraxacum officinale</i>
<i>Holcus lanatus</i>	<i>Trifolium dubium</i>
<i>Leucanthemum vulgare</i>	<i>Trifolium pratense</i>
<i>Lolium perenne</i>	<i>Trifolium repens</i>

Table 1b. Additional species recorded in the study field in 2013 only.

<i>Centaurea nigra</i>	<i>Plantago lanceolata</i>
<i>Dactylorhiza fuchsii</i>	<i>Prunella vulgaris</i>
<i>Hypochaeris radicata</i>	<i>Ranunculus bulbosus</i>
<i>Linum catharticum</i>	<i>Rhinanthus minor</i>
<i>Lotus corniculatus</i>	<i>Rumex acetosa</i>

within 200 m of the field and within the same grazing unit but had not yet colonised the field. These include green-winged orchid *Anacamptis morio*, common milkwort *Polygala vulgaris*, pepper-saxifrage *Silaum silaus*, cowslip *Primula veris*, betony *Stachys officinalis*, lady's bedstraw *Galium verum* and dyer's greenweed *Genista tinctoria*. Pepper-saxifrage, common milkwort and betony are mainly confined to those fields on the farm where evidence suggests they have been grassland for at least 88 years. Similarly, established colonies of green-winged orchid and dyer's greenweed are confined to those fields on the farm that we believe could have been grassland for at least 170 years.

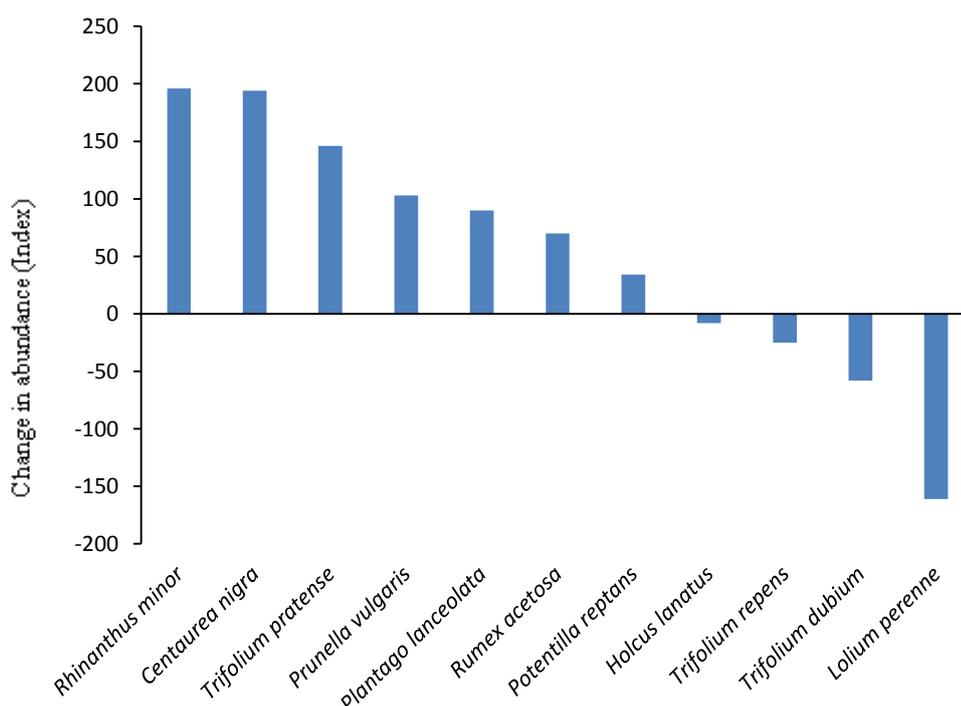


Figure 1. Change in abundance of flowering plant species abundance between 2002 and 2013.

DISCUSSION

The example of Joan's Hill Farm suggests that a species-poor meadow, with only 24 species of grasses and herbs, could be enhanced within 11 years to a colourful, nectar-rich meadow containing 34 species, including 20 species of common meadow herbs, once appropriate hay meadow management was implemented. This was achieved purely by unaided colonisation of species from neighbouring areas of species-rich grassland.

The dispersal mechanisms that enabled these species to colonise the field are not known, but it is noted that livestock grazing the aftermath were free to move between the receptor field and donor fields of species-rich MG5 grassland, and similarly, that farm machinery moved from field to field during hay making operations each year. This evidence suggests that, where the aim is to enhance the botanical diversity of meadows that are within the same management unit as species-rich meadows, then there appears to be little justification for using imported seed. Even spreading green hay from species-rich fields elsewhere within the site may be unnecessary given that, in this example, a moderately diverse meadow was established without such methods over a relatively short time scale. However, a number of herbs that are closely associated with old meadows have not yet colonised the field, and may take much longer to do so. By correlating the histories of other fields on the farm with their respective flora, it is noted that that pepper-saxifrage, common milkwort and betony are absent from fields less than 88 years old, while green-winged orchid and dyer's greenweed are absent from fields less than 170 years old.

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