Three Hagges Woodmeadow

From arable field to a functioning ecosystem

Why Woodmeadow?

Three Hagges Woodmeadow was not originally created with that habitat in mind: the main aim in 2012 was to restore the biodiversity of an area that had historically been a bleak arable field by creating a woodland habitat in association with a species-rich lowland meadow (Hawthorne 2015a,b). The work began in earnest in May 2013 with sowing of seed mixes that are characteristic of wet (MG4) and dry (MG5) meadows. After the first hay cut at Lamas time (late summer), 10,000 tree saplings were introduced in copses (Fig. 1). It wasn't until George Peterkin commented on our plans that the Trust realised they' had created one of the rarest habitats in the UK, and one which is fast disappearing across mainland Europe - a woodmeadow.

Figure 1. Three Hagges Woodmeadow, south of York (Google Image). The woodmeadow proper is the area bounded by the mature trees to the north, west and east and by the road to the south. The dotted white line represents the boundary between dry meadow (to the north) and wet meadow (to the south) communities. The lighter patches are copses of mixtures of different tree species: 1, small-leaved lime, oak and hazel; 2, English oak, field maple and hazel; 3, sessile oak; 4, small-leaved lime, English oak, hazel and Wych elm; 5, oak hazel, blackthorn, hawthorn, rowan, cherry, crab apple; 6, English oak, small-leaved lime and Wych elm; 7, lime, oak and hornbeam; 8, oak hazel, blackthorn, hawthorn, rowan, cherry, crab apple; 9, Jubilee copse of downy birch, alder, grey willow, goat willow.

Mosaics of woodland and meadows create high biodiversity and can be seen across the UK (Peterken 2019), whilst 'wooded meadow' is formally recognised as an important habitat in itself across Europe and has been given Red List status. The habitat can be seen in the Mediterranean wooded meadows and pastures typical of Spain, Portugal, Greece, South-Italy and South-France (European Red List of Habitats E7.3) and those in the cooler areas of Northern and Eastern Europe (E7.1). Given the huge climate range across Europe, plant composition of these habitats varies considerably and the habitat is best described as *one which is a mixture of established trees and large open areas of species-rich grassland which is managed in some way.* In the UK, we might expect woodmeadow to more closely resemble those described for the Baltic (*Natura 2000 Habitat Type 6530, Fennoscandian wooded meadows),* characterised by small copses of deciduous trees and shrubs and patches of open meadows, with ash, birch, oak, lime and alder as common species, and, importantly, the habitat is actively managed.

In fact, active management is one of the defining feature of woodmeadows. In the Baltic, they have been described as "cultural systems with social organisation focused around a natural resource that drives people's interactions with the natural world." Management may take a variety of forms, depending on local traditions, and includes coppicing and pollarding of the trees and using the meadow for hay-making or for grazing pasture. The distinction between woodmeadow and wood pasture therefore becomes blurred, and the habitat should be recognised as 'a broad church', much like that suggested by George Peterken (2019).

Modern practices associated with more intensive production agriculture are unsympathetic to woodmeadow biodiversity, and are the main reason for the habitat's decline across Europe. For instance, wooded meadows covered a third of Estonia until the middle of the 20th century but since then have virtually disappeared, so that only 700 ha of the original 850,000 ha remain today, mainly due to the cessation of hand-mowing and horse-mowing (Sammul et al 2008). The remaining Estonian wooded meadows demonstrate the high biodiversity value of this habitat: typically, more than 60 species/m^2, 25 species/100cm^2, 225 vascular plants per site, together with a high species diversity of butterflies and moths, spiders and other invertebrates, as well as mosses and fungi (Sammul et al 2008). Much of this biodiversity derives from the active management of these habitats, as done at Three Hagges Woodmeadow: when management stops species decline, along with soil organic carbon, and the ecosystem services that they provide similarly diminish (Villoslada Peciña et al 2019).

The aim of Woodmeadow Trust is to recreate the wooded meadow habitat across the UK for its extraordinary plant and invertebrate biodiversity and to promote its recognition and value in conservation policy. To make that case, the Trust has embarked on several assessments at its flagship site at Three Hagges Woodmeadow to document the evolution of its biodiversity and the wider benefits of woodmeadow.

This report is a summary of those assessments for the first seven years of the project, all of which can be found on the Woodmeadow Trust website (https://www.woodmeadowtrust.org.uk/learn/research).

The Woodmeadow's Soils

When creating the woodmeadow at Three Hagges, the Trust faced a major challenge. Prior to 2012, the site had been in continuous agricultural use, with a general rotation of spring barley/winter barley/beans, although sugar beet may also have been cropped in the past. These crops had been fed with inorganic fertilisers and regularly tilled with heavy machinery, so that the soil into which meadow plants were to be introduced was compacted, high in potash, magnesium, and phosphorus and it had also been limed at some point. 120 units of nitrogen would have been applied each year and Lin Hawthorne (2015a,b) reported phosphorus levels of 72 ppm, Index 5, far in excess of the levels recommended for meadow establishment (26-45 ppm, Index 3). These high phosphorus levels might have put many people off the prospect of establishing meadow plants, but the Trust persevered and, despite what seemed to be unpromising soil conditions, meadow establishment has been incredibly successful (see below).

Unfortunately, no comprehensive soil survey was carried out prior to planting the woodmeadow, but several University of York Biology students undertook soil projects between 2015 and 2018 on a range of soil physical and chemical properties, and these should be considered the 'baseline' (https://www.woodmeadowtrust.org.uk/learn/research). Those properties included 'bulk density' (a measure of soil compaction), which approached the threshold at which there are adverse effects on plant growth. Bulk density will reduce over time, especially in the upper layers due to plant root movement and the activity of the soil fauna.

Soil moisture is, not surprisingly, different between the designated 'dry' and 'wet' areas of the woodmeadow and the 'wet' area has a slightly lower pH (more acidic). Levels of nitrogen and carbon appear quite variable, probably because they are both closely related with bulk density and soil moisture, but on average the % carbon is 1-1.5%, 'wet' unmown areas being slightly higher. Phosphorus ranged between 7ug/g and 10ug/g, similar to those found in MG4 (5-15) meadows elsewhere, but much less than in the adjacent agricultural fields and somewhat lower those levels originally reported by Hawthorne (2015a,b) prior to woodmeadow establishment.

Soil nutrient management at Three Hagges Woodmeadow now consists of annual biomass (hay) removal. The first hay cut was in late July 2013 (89 bales weighing 400kg) and a second crop was taken that October, and this continues every year. Spot sampling for phosphorus in 2020 gave an index of 4.7 for Jubilee Copse, 2.9 for the MG5 area, 3.4 for the MG4 area and 3.7 for all copses. Soils will continue to be monitored over time as and when time and resources become available.

Plant Communities

The woodmeadow habitat was created on a 'blank sheet' of a 10 ha arable site with a far from ideal soil chemistry. In 2013, wet and dry grassland seed mixes (fine meadow grasses) along with cornfield annuals were sown following glyphosate treatment to establish a stale seed bed (Hawthorne 2015 a,b). The seed mixes were loosely based on MG5 ('dry' meadow) and MG4 ('wet' meadow) NVC communities, reflecting the soil conditions in the southern and northern sections (Fig. 1). Species were selected on the matched vigour principle: the most competitive grasses were excluded and the most robust of perennials favoured (Hawthorne, 2015a,b).

In the autumn of 2013, 10,000 saplings were planted in the established meadow comprising 24 species of native tree and 7 shrub species in twelve mixed-species compartments, creating open areas and rides with a lot of woodland edge. About 40% of the area is open meadow (Fig. 1). A full description of the planting procedure is given in Hawthorne (2015a,b) and the pros-and-cons of different strategies are rehearsed by Ros Forbes Adam (2022, in prep).

The trees have now become established and are regularly mapped. Species composition is in line with wooded meadows elsewhere in Europe (see above). Management of the trees has only recently started with pruning and some coppicing.

The meadow plant community has been censused since 2017 by measuring the abundance of species within $1m^2$ quadrats in late June, prior to a hay cut followed by grazing of the aftermath by Skipwith Common's herd of Hebridean sheep. Analysis of the plant data using ordination methods confirms that the communities as originally sown remain more-or-less intact with only minor variation in changes of dominant species between years (Table 1).

Rank	2017	2018	2019	2020
1	*Cynosurus cristatus*	*Medicago lupulina*	*Lotus corniculatus*	*Holcus lanatus*
2	*Festuca rubra*	*Cynosurus cristatus*	*Rhinanthus minor*	*Centaurea nigra*
3	*Holcus lanatus*	*Lotus corniculatus*	*Trifoilum hybridum*	*Festuca rubra*
4	*Lotus uliginosus*	*Trifolium repens*	*Holcus lanatus*	*Rhinanthus minor*
5	*Centaurea nigra*	*Centaurea nigra*	*Centaurea nigra*	*Agrostis capillaris*
6	*Plantago lanceolata*	*Holcus lanatus*	*Festuca rubra*	*Trifolium pratense*
7	*Agrostis capillaris*	*Rhinanthus minor*	*Trifolium pratense*	*Agrostis stolonifera*
8	*Agrostis stolonifera*	*Festuca rubra*	*Cynosurus cristatus*	*Trifolium repens*
9	*Vicia cracca*	*Trifolium pratense*	*Vicia hirsuta*	*Plantago lanceolata*
10	*Trifolium pratense*	*Plantago lanceolata*	*Plantago lanceolata*	*Trifoilum hybridum*
11	*Phleum pratense*	*Agrostis capillaris*	*Medicago lupulina*	*Cynosurus cristatus*
12	*Trifolium repens*	*Agrostis stolonifera*	*Agrostis capillaris*	*Phleum pratense*
13	*Trifoilum hybridum*	*Poa trivialis*	*Trifolium dubium*	*Rumex acetosa*
14	*Rumex acetosa*	*Phleum pratense*	*Agrostis stolonifera*	*Leucanthemum vulgare*
15	*Poa trivialis*	*Trifoilum hybridum*	*Ranunculus acris*	*Lotus corniculatus*
16	*Medicago lupulina*	*Ranunculus acris*	*Phleum pratense*	*Ranunculus acris*
17	*Leucanthemum vulgare*	*Rumex acetosa*	*Rumex acetosa*	*Achillea millefolium*
18	*Achillea millefolium*	*Lolium perenne*	*Achillea millefolium*	*Hypochaeris radicata*
19	*Calliergon cuspidatum*	*Achillea millefolium*	*Trifolium repens*	*Ranunculus bulbosus*
20	*Ranunculus acris*	*Prunella vulgaris*	*Lolium perenne*	*Lotus uliginosus*

Table 1. The Top-20 species recorded by Kat Wotherspoon in 1m² plots within the MG5 area in rank order of abundance, 2017-2020. Note that the rank order changes slightly from year-to-year, but the community remains a high match with recognised MG5 grassland. The results for the MG4 area are similar.

A high diversity of species has been maintained and the communities remain a good match with recognised NVC MG4 and MG5 communities. Furthermore, ordination and classification analyses shows that the original MG4 and MG5 plantings remain floristically distinct. Typically, 14-22 species are recorded in the 1m² quadrats but total number of species identified throughout the woodmeadow is over 160. These figures are less than those for established Scandinavian woodmeadows (see above), but Three Hagges Woodmeadow is still relatively young.

Invertebrates

Annual surveys of the invertebrates of Three Hagges Woodmeadow have been carried out since 2014, principally by Andy Grayson. Andy's surveys have been supplemented by occasional moth trapping, a Bioblitz, by visits from specialists and more recently by focussed butterfly and bumble bee recording along transects which feed into national monitoring schemes. Andy's surveys are extremely detailed and cover the spring to autumn period. The woodmeadow has seen a dramatic increase in invertebrate species, from 361 in 2014 to 872 in 2018 and to and over a thousand in 2020 (Fig. 2).

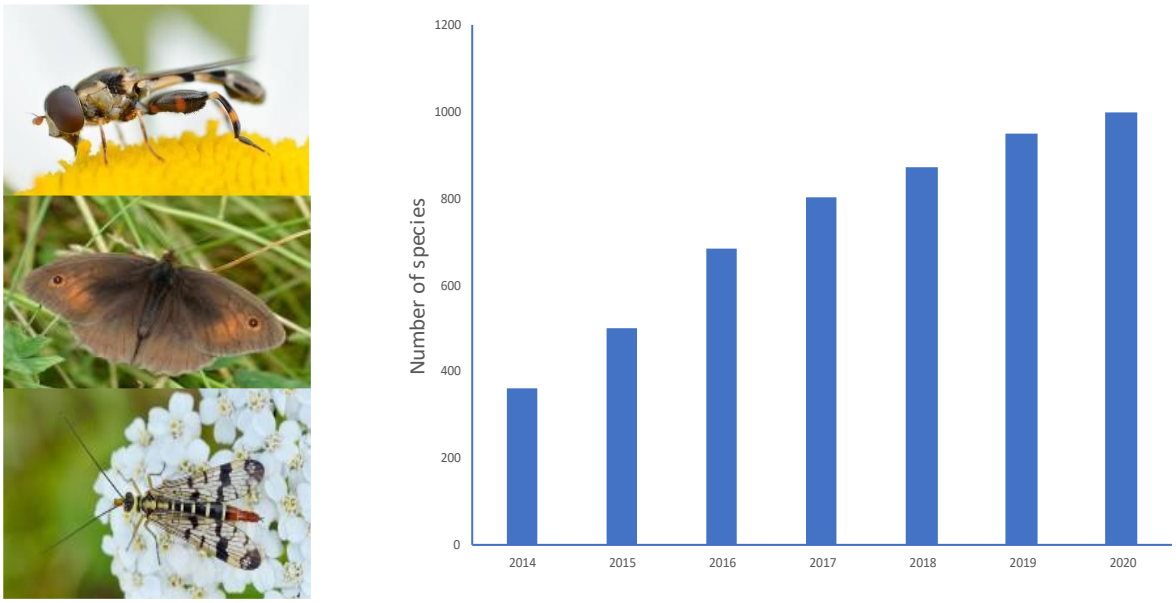

Figure 2. Number of invertebrate species recorded at Three Hagges Woodmeadow. Note the steady increase year-on-year.

Many of these species are pollinators attracted by the diversity of wildflowers on the woodmeadow, including 34 bee species, 25 butterfly species, and 43 hoverfly species – few of which would have been found on the site when it was an arable field. Butterflies include the Dingy Skipper, a species usually found on chalky soil, and - unexpected at this site - Marbled White, and Purple Hairstreak. Bees include the Red Mason bee and Leafcutter bees which makes good use of the insect hotel, whilst seven true bumble bee and all six of the UK's cuckoo bumblebee species have been recorded. Unusual sightings include the Yellow-legged Clearwing – an insect rarely documented since records began in 1883, and the third-ever recent British record of the ruby-tailed wasp *Chrysis corusca*.

In 2021, the Trust started recording earthworm abundance to assess the health of soil community, using the AHDB earthworm recording scheme (Stroud 2019). Surveys in May and June indicated an overall healthy soil in both the 'wet' and 'dry' sections with all three of the main earthworm functional groups present in good numbers, in contrast to what the site would have supported when a regularly tilled arable field. An abundance of earthworms had been apparent for several years before the AHDB survey, reflected in high mole activity across the site.

Amphibians and Reptiles

The woodmeadow boasts good populations of great-crested newts, smooth newts, common frogs and toads, all of which are prey for one on the site's iconic species, the grass snake, which regular surveys by Nick Atherton show thrives in the habitat. More recently, common lizard has been frequently recorded.

Birds

Birds of prey (buzzard, red kite, kestrel, sparrowhawk, barn owl) are regularly seen over the woodmeadow, often foraging on field voles and, in the case of sparrowhawk, wood pigeons. Corvids (crows, jackdaws and magpies) are regularly recorded, and like the birds of prey, they do not breed in the woodmeadow. Pheasant and red-legged partridge occasionally nest, and this year (2021) a pair of greylag geese showed serious interest in the wet meadow area but they did not stay. Reed bunting and common whitethroat may have nested in some of the copses in previous years. As the trees develop, we expect more species to use the woodmeadow for breeding.

Mammals

The woodmeadow is fenced to exclude rabbits and deer to protect the young saplings, but roe deer are frequently seen around the perimeter. Of course, the fence also excludes badgers and foxes. Small mammals, are abundant in the woodmeadow, particularly Field voles. The high vole abundance at the time of tree planting necessitated the installation of tree guards. Common shrew, pygmy shrew, water shrew, wood mouse, bank vole and mole have all been recorded to date and bats fly nightly over the meadow, enjoying the rich insect abundance.

Wider benefits

Given the high biodiversity of its plants and invertebrates, it is no surprise that the site provides a range of associated public benefits and ecosystem services. These include recreation, reflected in the large numbers of visiting public who simply enjoy walking around a beautiful landscape or taking advantage of the mindfulness opportunities created by the judiciously placed benches off the paths. Education is provided for all ages, including regular school visits and safari days as well as specialist courses ranging from plant identification to biological illustration. The site is now an important resource for pollinating insects that can spill over into the surrounding farmland to pollinate crops. The trees and the meadow plants sequester carbon and although there are no data yet for Three Hagges Woodmeadow, species-rich grasslands can potentially draw down several tonnes of carbon per hectare annually and mature woodland in excess of that. The value of these diverse benefits are hard to capture – how does one estimate the transformational experience seen in a child's face seeing a grass snake for the first time or the bequest value to adults who want their children and grandchildren to be able to walk in the woodmeadow? Eftec have had a stab at calculating values for Three Hagges Woodmeadow and suggest that "*over a 100 year period, the monetary value of the benefits of carbon sequestration, recreation and education alone were over £600,000, more than ten times the original creation costs. By 2020 the number of educational visits have more than doubled, significantly increasing the return on the original investment"* (Duncan Royle, eftec).

Summary

Despite the not-ideal soil conditions of an arable field, the woodmeadow has clearly established well and has maintained a high plant diversity over the 7 years since its creation. The trees are established and growing, with few mortalities and without the Trust having to resort to herbicide spraying around their bases. Coppicing is anticipated in the coming years. The meadow plants are a blaze of colour and structure in the summer which attract many visitors, as well as the diverse invertebrate community that has arrived. As the trees grow and provide more habitat structure, we expect to see a breeding bird community established, adding another dimension to the woodmeadow ecosystem. Surveys of soils, plants, invertebrates and vertebrates will continue into the future so that we can document how these all change and mesh together as the habitat develops.

References

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