

WILDFLOWER MEADOW

Creation and management in land regeneration

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BPG

NOTE 15

Best Practice Guidance
for Land Regeneration

Introduction

While pasture is grazed by animals without allowing a grass crop to be harvested, meadows are fields grown specifically to produce a hay crop; any livestock is moved off in late spring to allow the vegetation to grow and flower (Figure 1). If such fields are floristically rich, they are described as wildflower meadows, and this term may be applied to a range of priority grassland types including lowland acid, neutral and calcareous grasslands. This floral richness is both aesthetically pleasing and ecologically important. Natural England (2011) estimated that between 1930 and 1983, 97% of wildflower-rich grasslands were lost in England and Wales and that as little as 7500 ha remained by 2010. Loss was largely through intensification of agriculture and the spread of built development. The conservation of existing and creation of new wildflower meadows is of national importance (Natural England, 2010).

While wildflower meadows are generally seen as species rich (the Hay Time Project in the Yorkshire Dales found 45 plant species in 1 m²), they vary in type principally as a consequence of geology, climate, soil fertility and management regime. For example, meadows rich in perennial non-woody species require nutrient-poor soils where there is less grass competition. Habitats rich in annuals are also nutrient poor, limiting competition by robust and rank perennial species; they also experience frequent ground disturbance. The species of wildflowers found in a meadow will vary greatly depending on underlying geology (e.g. chalk or granite) and soil type (e.g. sandy loam or heavy clay).

Wildflower meadows are popular in gardens, as demonstrated at the RHS Chelsea Flower Show 2012, and large public projects in urban areas (such as the 10 ha of annual and perennial meadows created in the Olympic Park for London 2012), as well as being features in their own right within the wider landscape. This interest is reinforced by the UK Government's biodiversity objectives, which encourage the creation of 'wild' areas (JNCC, 2004). Wildflower meadows that are appropriately placed and managed in the long term are important to the conservation of threatened species such as the Barn Owl (*Tyto alba*), Greater Horseshoe Bat (*Rhinolophus ferrumequinum*), Adonis Blue Butterfly (*Polyommatus bellargus*) and Short-haired Bumblebee (*Bombus subterraneus*).

Wildflower-rich meadows can develop in areas disturbed by human activities, including disused mineral extraction and post-industrial sites, and their establishment on reclaimed land can contribute to national priority grassland habitat targets. This guidance note reviews the essential considerations and practices for establishing wildflower-rich grasslands on reclaimed land.



Figure 1 An example of a wildflower meadow
(Photo: © Natural England/Paul Glendell)

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Project planning

Before commencing any work on a site, it is essential to establish key facts. These will help you to characterise your site and determine the site's objectives, including whether wildflower habitat is suitable for your reclaimed site. The information will also inform site preparation techniques, seed mix selection and development of a management regime appropriate to your site. The checklist provided in the Annex (see page 7) will help. With the objectives for your site established, you can move on to the preparation of the site prior to seeding.

Ground conditions

For the establishment of perennial wildflowers it is often necessary to have a soil or planting medium low in nutrients; this applies particularly to calcareous grassland. Mesotrophic (neutral) grassland can tolerate higher nutrient levels. Soil fertility can be reduced by removing the topsoil (approximately the upper 20 cm) to reveal the subsoil. Alternatively you may mix subsoils, overburdens, building or quarry waste materials with the topsoil to reduce its fertility. Ensure that the source of such material is known and documented and that it has been tested to avoid the introduction of contamination (see BPG Note 2). The final upper surface should be broken up to a firm, fine tilth using a rake.

While it is possible to adjust soil pH and fertility, you should aim to create a habitat that is most suited to the quality and conditions of the planting medium on your site. Creation of a habitat that is in keeping with the local character and landscape is a more sustainable practice.

If your soils are deficient in nutrients or organic content, or have poor structure, it may be necessary to add materials. While applying chemical fertilisers is an unsustainable technique, the incorporation of compost or rotting organic matter is a valuable use of recycled material. It is important to know the source of such material to avoid the introduction of invasive plant species or contamination (see above).

Grass and weeds should be removed by ploughing or rotovation prior to seeding. Such methods can bring the native seed bank to the surface, encouraging it to germinate. Rank and pernicious species such as Common Nettle (*Urtica dioica*),¹ Spear Thistle (*Cirsium vulgare*), Creeping Thistle (*Cirsium arvense*), Broad-leaved Dock (*Rumex obtusifolius*), Curled Dock (*Rumex crispus*) and Common Ragwort (*Senecio jacobaea*) should be controlled if they begin to dominate. This can be achieved by cutting or mowing, spot-spraying with glyphosate or, where this is not possible, over-sowing may provide an alternative.

Some existing managed lawns/grassland may be transformed into wildflower meadows by allowing the grassland to flower so that meadow flowers already present may seed and reproduce (Figure 2). In addition, it may be necessary to forage harvest the grass in the autumn to prevent nutrient build up, and to create bare patches by raking or machine. Wildflower seed mix can then be applied to the patches or generally over-seeded. Perennial Rye-grass (*Lolium perenne*) is a common species in agriculturally improved swards. Where a dominant grass species such as Rye-grass is already widespread, there is a specific technique by which a hemi-parasitic plant – Yellow-rattle (*Rhinanthus minor*) – that lives on the Rye-grass is introduced to reduce its vitality. Some bodies, including The Grasslands Trust, are keen advocates of using Yellow-rattle, which should be introduced to bare patches in the autumn. It is an annual and needs to set seed each year. This technique should be used in combination with general over-seeding with wildflower species.

All site/ground preparation works should be undertaken in dry (preferably still) weather conditions so as not to damage the soil structure or to lose soils as windblown dust.



Figure 2 Self-sown poppies in the first year of wildflower meadow establishment
(Photo: © David Jarvis)

¹ Nomenclature follows Stace (2010) throughout.

Plant selection and sources

There is a seemingly infinite combination of grass and wildflower species so it is important to define your requirements having answered the questions listed in the Annex at the project planning stage. If you are trying to re-create known local vegetation communities, it is best to consult the National Vegetation Classification (NVC) handbook produced originally by the Nature Conservancy Council (Rodwell, 1992). This will help you in identifying which species and associations are appropriate to your site/area. If you are trying to extend local habitats, these should be characterised according to the NVC handbook by a competent botanist or similarly skilled professional.

Seeds may be bought, and a reputable seed house will be able to supply mixtures suited to the climate and principal soil conditions of your site. Seed should be used that is of local provenance, where available. Alternatively, seeds may be collected by hand from local sources for your own use subject to obtaining the permission of the landowner or tenant.

Biosecurity (the objective of reducing the transmission of pests and diseases) is important, and good working practice should be observed to minimise the risk of transporting harmful organisms between sites; for example, clean and disinfect tools and boots before leaving donor and regeneration sites. Seeds should be collected from June to September when ripe, dried carefully and stored in airtight containers in a cool dark place between 2 and 5°C. Prepared seed mixes range typically in combination from 4 to 8 grass species and 10 to 20 wildflower species. Typical seed mixes for general use, acid (low pH) conditions, alkaline (high pH) conditions, extremely heavy/wet conditions and cornfield annuals are shown in Tables 1 to 5.

Sowing

A wildflower meadow seed mix should be in the ratio 4:1 (grass seed:wildflower seed). It should be sown in September/October in calm, dry weather, by machine or hand at a rate of 2–5 g m⁻². Agricultural machinery such as slot seeders and seed drills maximise the area sown for the amount of seed used (Crofts and Jefferson, 1999). On land prone to waterlogging, sowing should take place during a dry period in April/May. If sowing by hand, mixing the seed with damp sand or sawdust helps to ensure it is evenly distributed, and allows the sower to see where they have already sown. After sowing it can be helpful to lightly roll or tread the soil surface. Raking should be avoided as it can concentrate seed distribution or bury the seed too deep. If there is a prolonged dry period, the seeded area may be lightly watered. Birds and other seed predators should be kept off the land as much as possible.

Management and aftercare

Wildflower meadows require continuing annual maintenance; this can be achieved using machinery, grazing or a combination of both. Livestock grazing has a more random effect on the growth and distribution of plant species. Use a low stocking rate to prevent over-grazing. Exact requirements will be site specific, though a rule of thumb is to use 0.5 cattle or 2.5 sheep ha⁻¹ yr⁻¹ (Department of Transport, 1993). Remove livestock during prolonged wet conditions and during late spring and summer to let the plants grow and flower. Unproductive sites may only be suitable for winter grazing, though this must be monitored for poaching – the compaction or physical breakdown of soil structure under the feet of heavy animals.

Where mowing is the selected maintenance method, the emerging meadow needs to be cut in the first year in order to maintain a vegetation height of 100–150 mm. Do not mow the vegetation to a height below 50 mm. Where a low nutrient status soil is required the cuttings will need to be removed (e.g. cut with a forage harvester).



Figure 3 A Five-spot Burnet Moth (*Zygaena trifolii*) in a floristically rich meadow
(Photo: © David Jarvis)

Mowing must be timed to not conflict with ground-nesting birds. It is possible to leave field margins unmown for 1 year to further aid wildlife.

In the second year and thereafter, the meadow requires cutting at least once, preferably in late summer/early autumn, to a height of 50 mm after the plants have flowered. A spring cut, as necessary, will keep rank species in check; cuttings will contain seed from these plants and so should be removed. Some species take several years for their seed to germinate (this includes both sown and self-seeded). Over-seeding naturally occurring or created bare patches in subsequent years with an appropriate seed mix may increase the floral diversity.

Cornfield annuals require a different management regime as they grow and flower in the same year. After the annuals have set seed in August or September, the meadow can be cut to 50 mm. The field then needs to be rotovated or ploughed in the spring to encourage seed germination. This annual surface preparation allows the opportunity for over-sowing with seed; this is especially necessary in the early years and is often required on an ongoing basis to maintain a flourishing cornfield-annual-rich wildflower meadow. Cornfield annuals can thrive on poor and fertile soils. In the case of nutrient-rich soils, rank and pernicious weed species will need to be controlled where they start to dominate the meadow.

Table 1 Seed mix – general use.

Common name	Scientific name	Common name	Scientific name
Yarrow	<i>Achillea millefolium</i>	Ribwort Plantain	<i>Plantago lanceolata</i>
Common Bent	<i>Agrostis capillaris</i>	Hoary Plantain	<i>Plantago media</i>
Sweet Vernal-grass	<i>Anthoxanthum odoratum</i>	Smooth Meadow-grass	<i>Poa pratensis</i>
Betony	<i>Betonica officinalis</i>	Tormentil	<i>Potentilla erecta</i>
Common Knapweed	<i>Centaurea nigra</i>	Salad Burnet	<i>Poterium sanguisorba</i> ssp. <i>sanguisorba</i>
Greater Knapweed	<i>Centaurea scabiosa</i>		
Wild Carrot	<i>Daucus carota</i>	Cowslip	<i>Primula veris</i>
Foxglove	<i>Digitalis purpurea</i>	Selfheal	<i>Prunella vulgaris</i>
Red Fescue	<i>Festuca rubra</i>	Bulbous Buttercup	<i>Ranunculus bulbosus</i>
Lady's Bedstraw	<i>Galium verum</i>	Common Sorrel	<i>Rumex acetosa</i>
Perforate St John's-wort	<i>Hypericum perforatum</i>	Wild Clary	<i>Salvia verbenaca</i>
Oxeye Daisy	<i>Leucanthemum vulgare</i>	Red Champion	<i>Silene dioica</i>
Common Bird's-foot-trefoil	<i>Lotus corniculatus</i>	White Champion	<i>Silene latifolia</i>
Musk-mallow	<i>Malva moschata</i>	Night-flowering Catchfly	<i>Silene noctiflora</i>
Black Medick	<i>Medicago lupulina</i>	Devil's-bit Scabious	<i>Succisa pratensis</i>
Field Forget-me-not	<i>Myosotis arvensis</i>	Goat's-beard	<i>Tragopogon pratensis</i>

Table 2 Seed mix for acid conditions.

Common name	Scientific name	Common name	Scientific name
Yarrow	<i>Achillea millefolium</i>	Common Cat's-ear	<i>Hypochaeris radicata</i>
Sneezewort	<i>Achillea ptarmica</i>	Oxeye Daisy	<i>Leucanthemum vulgare</i>
Fragrant Agrimony	<i>Agrimonia procera</i>	Common Bird's-foot-trefoil	<i>Lotus corniculatus</i>
Common Bent	<i>Agrostis capillaris</i>	Greater Bird's-foot-trefoil	<i>Lotus pedunculatus</i>
Sweet Vernal-grass	<i>Anthoxanthum odoratum</i>	Smooth Meadow-grass	<i>Poa pratensis</i>
Betony	<i>Betonica officinalis</i>	Meadow Buttercup	<i>Ranunculus acris</i>
Harebell	<i>Campanula rotundifolia</i>	Yellow-rattle	<i>Rhinanthus minor</i>
Cornflower	<i>Centaurea cyanus</i>	Common Sorrel	<i>Rumex acetosa</i>
Common Knapweed	<i>Centaurea nigra</i>	Sheep's Sorrel	<i>Rumex acetosella</i>
Pignut	<i>Conopodium majus</i>	Ragged-Robin	<i>Silene flos-cuculi</i>
Foxglove	<i>Digitalis purpurea</i>	Lesser Stitchwort	<i>Stellaria graminea</i>
Sheep's-fescue	<i>Festuca ovina</i>	Devil's-bit Scabious	<i>Succisa pratensis</i>
Lady's Bedstraw	<i>Galium verum</i>	Wood Sage	<i>Teucrium scorodonia</i>
Meadow Crane's-bill	<i>Geranium pratense</i>	Wild Thyme	<i>Thymus polytrichus</i>
Perforate St John's-wort	<i>Hypericum perforatum</i>	Tufted Vetch	<i>Vicia cracca</i>

Table 3 Seed mix for alkaline conditions.

Common name	Scientific name	Common name	Scientific name
Yarrow	<i>Achillea millefolium</i>	Common Rock-rose	<i>Helianthemum nummularium</i>
Agrimony	<i>Agrimonia eupatoria</i>	Field Scabious	<i>Knautia arvensis</i>
Common Bent	<i>Agrostis capillaris</i>	Oxeye Daisy	<i>Leucanthemum vulgare</i>
Kidney Vetch	<i>Anthyllis vulneraria</i>	Common Toadflax	<i>Linaria vulgaris</i>
Betony	<i>Betonica officinalis</i>	Common Bird's-foot-trefoil	<i>Lotus corniculatus</i>
Quaking-grass	<i>Briza media</i>	Black Medick	<i>Medicago lupulina</i>
Upright Brome	<i>Bromopsis erecta</i>	Wild Marjoram	<i>Origanum vulgare</i>
Common Knapweed	<i>Centaurea nigra</i>	Mouse-ear-hawkweed	<i>Pilosella officinarum</i>
Greater Knapweed	<i>Centaurea scabiosa</i>	Hoary Plantain	<i>Plantago media</i>
Crested Dog's-tail	<i>Cynosurus cristatus</i>	Smooth Meadow-grass	<i>Poa pratensis</i>
Wild Carrot	<i>Daucus carota</i>	Salad Burnet	<i>Poterium sanguisorba</i> ssp. <i>sanguisorba</i>
Sheep's-fescue	<i>Festuca ovina</i>	Cowslip	<i>Primula veris</i>
Meadowsweet	<i>Filipendula ulmaria</i>	Selfheal	<i>Prunella vulgaris</i>
Dropwort	<i>Filipendula vulgaris</i>	Small Scabious	<i>Scabiosa columbaria</i>
Hedge Bedstraw	<i>Galium album</i>	Goat's-beard	<i>Tragopogon pratensis</i>
Lady's Bedstraw	<i>Galium verum</i>	Common Vetch	<i>Vicia sativa</i>

Table 4 Seed mix for heavy/wet conditions.

Common name	Scientific name	Common name	Scientific name
Yarrow	<i>Achillea millefolium</i>	Field Scabious	<i>Knautia arvensis</i>
Agrimony	<i>Agrimonia eupatoria</i>	Oxeye Daisy	<i>Leucanthemum vulgare</i>
Common Bent	<i>Agrostis capillaris</i>	Common Bird's-foot-trefoil	<i>Lotus corniculatus</i>
Wild Angelica	<i>Angelica sylvestris</i>	Black Medick	<i>Medicago lupulina</i>
False Oat-grass	<i>Arrhenatherum elatius</i>	Common Poppy	<i>Papaver rhoeas</i>
Betony	<i>Betonica officinalis</i>	Ribwort Plantain	<i>Plantago lanceolata</i>
Common Knapweed	<i>Centaurea nigra</i>	Hoary Plantain	<i>Plantago media</i>
Greater Knapweed	<i>Centaurea scabiosa</i>	Salad Burnet	<i>Poterium sanguisorba</i> ssp. <i>sanguisorba</i>
Crested Dog's-tail	<i>Cynosurus cristatus</i>	Cowslip	<i>Primula veris</i>
Cock's-foot	<i>Dactylis glomerata</i>	Selfheal	<i>Prunella vulgaris</i>
Wild Carrot	<i>Daucus carota</i>	Meadow Buttercup	<i>Ranunculus acris</i>
Tufted Hair-grass	<i>Deschampsia cespitosa</i>	Yellow-rattle	<i>Rhinanthus minor</i>
Wild Teasel	<i>Dipsacus fullonum</i>	Common Sorrel	<i>Rumex acetosa</i>
Meadowsweet	<i>Filipendula ulmaria</i>	Wild Clary	<i>Salvia verbenaca</i>
Lady's Bedstraw	<i>Galium verum</i>	White Champion	<i>Silene latifolia</i>
Water Avens	<i>Geum rivale</i>		

Table 5 Cornfield annuals seed mix.

Common name	Scientific name
Corncockle	<i>Agrostem magithago</i>
Corn Chamomile	<i>Anthemis arvensis</i>
Cornflower	<i>Centaurea cyanus</i>
Corn Marigold	<i>Glebionis segetum</i>
Common Poppy	<i>Papaver rhoeas</i>

Annex

1. **What is the nature of the soil/growing media/substrate? Limestone? Sand? Clay?** The answers will identify the sustainable meadow options. Acid-loving plant species will not grow on limestone, for example, and any attempt to do this would be expensive and time consuming.
2. **What are the characteristics of the soil(s)? Nutrient-rich? Waterlogged? Lime-based? Organic material deficient? Thin?** These answers will show you what is possible immediately or the preparation and management techniques needed to change the soil characteristics and, consequently, the meadow type.
3. **Is the site likely to be water stressed?** Steep slopes (>25°, 46% or 1-in-2), shallow soils (<100 mm deep) or extremely stony soils (>70% stones weight for weight) will contribute to high stress. These factors will contribute to the likely biomass production (important if the site is to be grazed) and reduce the likelihood of domination by competitive species.
4. **Are there risks to human health and the environment remaining from previous use of the land?** Thorough site surveys are required to identify potential risks. Risks identified will need to be quantified and may need remedial action. Planned carefully, such actions can be linked to site preparation for seeding.
5. **Is the site vegetated? Is it bare soil? Is it currently grassland/pasture? Does it have pernicious weeds?** This information informs the site preparation, sowing and management options.
6. **Do you have specific biodiversity objectives? Are you trying to attract specific animals?** These answers will help you to choose the plant species and/or the management regime.
7. **Do you have specific aesthetic objectives? Do you require individual species? Do you want spring and/or summer flowering?** These answers will help to define the plant species used, and the choice between annuals and perennials.
8. **Do you intend to have livestock on the site for some of the year?** Livestock have a fundamental impact on the management regime and the species that survive long term.
9. **How often, when and with what technique will you cut the meadow?** The intended cutting regime helps to determine which species can be planted. Cut timing determines which plant species can seed, disperse and survive.

References

- Crofts, A. and Jefferson, R.G. (eds) (1999). *The lowland grassland management handbook*, 2nd edition. English Nature/The Wildlife Trusts, Peterborough. Available from: <http://publications.naturalengland.org.uk/publication/35034>.
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- Natural England (2010). *List of habitats and species of principal importance in England under Section 41 of the Natural Environment and Rural Communities (NERC) Act (2006)*. Available from: www.naturalengland.org.uk/ourwork/conservation/biodiversity/protectandmanage/habsandspeciesimportance.aspx.
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- Rodwell, J. (1992). *British plant communities, volume 3: grassland and montane vegetation*. Cambridge University Press, Cambridge.
- Stace, C. (2010). *New flora of the British Isles*, 3rd edition. Cambridge University Press, Cambridge.

Further information and useful links

- Ecoscope Applied Ecologists (2000). *Wildlife management and habitat creation on landfill sites – a best practice manual*. Ecoscope Applied Ecologists, Cambridge.
- More information on biosecurity and plant health can be found at www.forestry.gov.uk/biosecurity.
- Additional information may be found from the following organisations:
- Bumblebee Conservation Trust
www.bumblebeeconservation.org
- Butterfly Conservation
www.butterfly-conservation.org
- Flora Locale
www.floralocale.org
- Joint Nature Conservation Committee
www.jncc.defra.co.uk
- Landlife National Wildflower Centre
www.wildflower.co.uk
- Natural England
www.naturalengland.org.uk
- Nature after Minerals
www.afterminerals.com
- Plantlife
www.plantlife.org.uk
- Royal Horticultural Society
www.rhs.org.uk
- Royal Society of Wildlife Trusts
www.wildlifetrusts.org
- RSPB
www.rspb.org.uk
- The Grasslands Trust
www.grasslands-trust.org