Creating wild-flower meadows by strewing green hay

One of the source meadows, Eades Meadow NNR, with abundant Green-winged Orchids. Ian Trueman

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Habitat creation is not a universally esteemed activity. The introduction of uncommon species into new sites can cause confusion, and may even reduce our ability to use plants as indicators of the conditions where they normally occur. There is also the danger of 'officious' habitat creation on sites which already have unrecognised nature-conservation value. Furthermore, there is the concern that, if we can create 'replicas', this will reduce our ability to defend genuine sites against destruction.

We do not believe that these worries should totally rule out habitat creation. There is a clear need for proper documentation of attempts at habitat creation and for detailed survey of potential receiver sites. Furthermore, we know that we cannot replicate the context and history of a genuine wildlife site, or assemble the infinite biological complexity of a mature ecosystem.

Why, then, should we try to create habitats? Nature conservation is not necessarily a battle that we can win merely by preservation. Sites are still being lost and degraded every day. Perhaps we need to take steps to *expand* the biological capital whilst it still exists. The Dutch pioneers looked upon habitat creation as environmental education, placing their created habitats in parks and school centres so that everyone could appreciate them. However, it is their beauty that is probably the most compelling reason for trying to assemble

Top **The treatment plots on Bushbury Hill in 1984, with freshly cut hay ready to be strewn.** Ian Trueman
Above **The treatment plots on Bushbury Hill in 1987, dominated by Oxeye Daisy.** Ian Trueman

flower-rich communities.

For two decades, the University of Wolverhampton habitat-creation research group has worked with Wolverhampton City Council to create wild-flower meadows in Wolverhampton and beyond, using strewn hay as the seed source. It all started when one of the authors first observed an extremely species-rich wet meadow at the Zuiderpark School Garden complex in The Hague, in 1981. Hay from an existing meadow nature reserve had been strewn over a new site. Managing the result as a traditional hay meadow had led to the development of flower-rich vegetation. Intrigued by the beauty and simplicity of the idea, we made our first attempt at hay-strewing in Wolverhampton in 1983.

Donor meadows

Most of our work has utilised local hay meadows in which the vegetation is 'neutral' grassland, of the type now recognised as MG5 Crested Dog's-tail-Common Knapweed (*Cynosurus cristatus-Centaurea nigra*) grassland in the National Vegetation Classification (NVC) (Rodwell 1992). This is a widespread (though now rare) flower-rich type on neutral soils in the UK lowlands. It is particularly appropriate for habitat creation because it seems to depend mainly on the hay-meadow pattern of management, rather than requiring a very specific soil type or water regime.

Created meadows

Our first attempt, in late July 1983, used dried but unbaled hay freshly made at Pennerley Meadows, on the Stiperstones ridge in the Shropshire Hills, which after cultivation was spread on the edge of an old sandstone quarry at Windmill Hill Wood in Wolverhampton. Only modest success was achieved, and our conclusion was that the hay should be transferred from the source site to the receiver site as soon as possible after it has been cut, so that the hay would make and shed its seed on the receiver site.

Our second attempt was on an area of former gravel pit/landfill on Bushbury Hill, Wolverhampton. This had been capped with a sandy subsoil and sown with an amenity grass mix in the 1970s. In July 1984, freshly cut Pennerley hay from an area similar in size was strewn on strips variously cut short, killed with glyphosate, or rotavated. We found that, by 1986, all the plots where the original vegetation had been removed, whether by herbicide or by rotavation, were dominated by Oxeye Daisy *Leucanthemum vulgare* and included up to 30 of the 50 Pennerley species (Jones 1993).

Management at Bushbury Hill has been based on a single annual cut in the first week in August, with immediate removal of the vegetation. This is because hay, drying on this urban site, is likely to

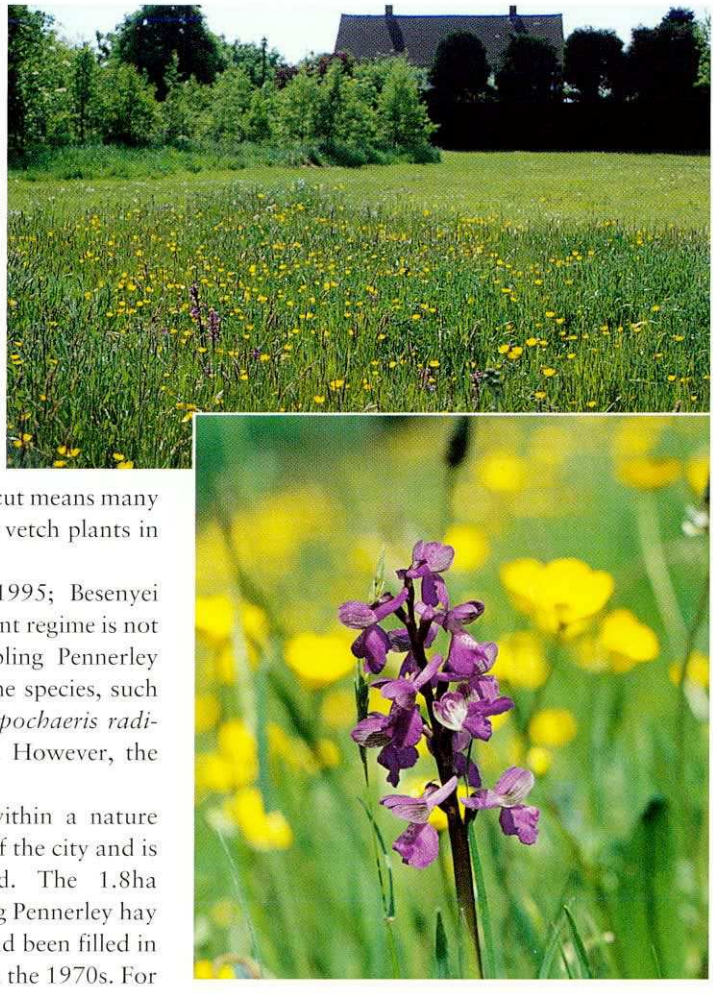
be set on fire, and the animals required for grazing the aftermath (the regrowth after the cut) would be impossible to contain and protect. With a 'cut-and-remove' regime, too early a cut means that the seed is not shed and is removed with the hay, not adding to the seed bank. However, too late a cut results in a build-up of Common Vetch *Vicia sativa*, which, unlike most hay-meadow species, continues to produce new flowers and fruits until the vegetation is cut. Therefore, a late cut means many more vetch seeds, and many more vetch plants in the following year.

Monitoring (Atkinson *et al.* 1995; Besenyei 2000) suggests that this management regime is not sufficient. Quadrats most resembling Pennerley have declined in number, and some species, such as Oxeye Daisy and Cat's-ear *Hypochaeris radicata*, have become less abundant. However, the plots are still quite species-rich.

Pendeford Mill meadow lies within a nature reserve on the northern outskirts of the city and is largely surrounded by farmland. The 1.8ha meadow was created in 1985, using Pennerley hay on the site of a mill pond which had been filled in with building rubble and levelled in the 1970s. For a variety of operational reasons, only a very poor transfer of species took place. It was, however, possible to make hay properly on this site, and from 1988 the aftermath growth was grazed each year by a dairy herd and, more recently, by sheep. As a result, the vegetation gradually became considerably more species-rich (Atkinson *et al.* 1995; Besenyei 2000).

The Kitchen Lane meadow is a 0.3ha rectangle within a large Wolverhampton landfill site capped with a poor subsoil and originally sown with an amenity grassland mix. In 1995, the existing vegetation was successfully killed with glyphosate and the land was strewn with hay from a similar area of Eades Meadow National Nature Reserve, the famous Green-winged Orchid *Orchis morio* meadow near Hanbury, in north Worcestershire.

A very species-rich sward developed, and by 1999 Green-winged Orchids had started to flower at the site. They are often picked by the locals, but



Green-winged Orchids at Kitchen Lane, Wolverhampton. This area was strewn with green hay from Eades Meadow NNR. Ian Trueman

numbers each year range from approximately 25 to 100 flowering stems. A smaller number of Common Spotted-orchids *Dactylorhiza fuchsii* and Twayblades *Listera ovata* also flower regularly on the site.

We have taught the principles of hay-strewing widely since the late 1980s. The Manx Wildlife Trust used our methods with success at Close Sartfield in the Isle of Man in the early 1990s, and the Staffordshire village of Derrington created a large and quite diverse lottery-funded Millennium Meadow by using our techniques and hay from the wetter Mottey Meadows National Nature Reserve, in Staffordshire. A significant recent development is the use of Mottey Meadows hay at Wall Farm, in Shropshire, to create a series of

A protocol for hay-meadow creation by strewing green hay

1. Identifying a possible receiver site

- The prospective site should be subjected to a detailed ecological survey and evaluation. Even moderate nature-conservation value should militate against habitat creation. Consider also the impact on neighbouring habitats of the species introductions involved.
- Meadow creation should be long-term: discuss the mechanics and finance of management with those likely to be concerned. The purposes and rationale of the project need to be agreed and accepted by all the interested parties, including local residents.
- Consider access for management: preferably there should be access for mechanised equipment. Is grazing feasible? If so, consider husbandry issues including fencing, provision of water, use of pesticides, etc.
- Undertake a chemical soil analysis of the site and reject it if it falls outside the guidelines for NPK and pH recommended in the literature. Make yourself aware of the texture and drainage of the soil across the site. If the site is damp, try to ascertain the reason: impeded drainage can be easily disrupted or generated in site preparation.

2. Identifying a possible source site

- A suitable source site should be notably species-rich. Unless you are creating a site just for 'deep botanists', it should include a range of attractive flowers at high frequencies, and preferably species which have been shown previously to transfer by hay-strewing. It will be necessary to view the prospective donor site through the season – usually a pleasure!
- A suitable source site will almost certainly be a Site of Special Scientific Interest, which means that you will need to negotiate well in advance with English Nature or its equivalent, and possibly the county Wildlife Trust, as well as the site's owners and/or managers.
- The site will probably conform to the National Vegetation Classification type MG5. If another type is selected, a careful study of the required conditions will be needed in order to determine the extent to which they can be replicated. Even for an MG5 meadow, you should examine its soil texture and water relations, since the receiver site should have some resemblance to the source.
- The previous management of the source site should be investigated in order to ascertain the extent to which it can be replicated at the receiver site. Choose a hay meadow in preference to a site managed by grazing throughout. The latter will be more difficult to manage for a good display of wild flowers at the receiver site and it will be more difficult to select the best time to take a cut for seed at the source site.
- The source site should have about half the area of the receiver site so that the hay is spread quite thinly. If it is much smaller, the transfer may be poor. If it is much larger, the hay may be set on fire by vandals and, in any case, it will need to be raked off the receiver site after a few weeks.
- Pay a good price for the hay: we suggest double its value as animal fodder. This will still be much cheaper than all but the cheapest seed mixes, and you may help to increase the monetary value of the genuine sites, thus encouraging their preservation.

3. Preparing the receiver site

- It is necessary to remove the existing vegetation at the receiver site. We advise achieving this by using glyphosate weedkiller.
- Prior to this, minimise the amount of dead material present when the hay is strewn (it is a fire risk and it may impede seedling establishment) by keeping the existing vegetation mown short through the spring and summer. In particular, do not allow a weed problem to build up through poor husbandry.
- If you wish to retain some of the existing vegetation, apply the weedkiller in patches or wide strips.
- On a light, open-textured soil it does not seem to be necessary to raise a tilth. Note that ANY cultivation will release fertility and will encourage the germination of seeds in the existing soil seed bank. A gentle chain-harrowing one way, just prior to strewing, should suffice. On heavier soils it may be necessary to do more, e.g. several passes with a disc harrow. Do not rotavate unless the soil is reliably infertile.
- If you are not willing to use weedkillers, you will have to destroy the existing vegetation by cultivation. Keep this to a minimum, as described above.
- Inform local inhabitants and interested parties before you start work.

4. Extracting the hay

- The ideal time to extract the hay is when the owner would normally make hay on the site. This is in late July at Pennerley, for example, but it may be earlier in the lowlands, or later where spring grazing has taken place. Be advised by the site manager, but make sure that the later-flowering species such as Common Knapweed are going to seed. On the other hand, do not wait until the Yellow-rattle has shed all its seed. You will have a little more latitude than in normal hay-making in that you have less need of a long drying period of weather following the cut, although hay-strewing in the rain is not a lot of fun!
- Remove the hay from the source site immediately after cutting, or at least within 24 hours. Small areas can be raked up by hand; larger areas should be baled. Round big-bales seem to be ideal, although the older smaller bales seem fine. Alternatively, load the hay into a trailer by using a forage harvester, provided that you are satisfied that seed loss is at a minimum.
- Organise transport well in advance, get the hay to the receiver site as rapidly as possible, and in any event spread the hay on the SAME DAY as baling to prevent heating-up in the bale.
- To eliminate worries about depleting the seed bank at the source site, limit extraction to once every five

years. Alternatively, bale only every fifth windrow in the field and leave the rest to be made into conventional hay in the normal way.

5. Strewing the hay

- Hand-strew the hay by dropping the bales at intervals, unrolling them if they are big-bales, and spreading the hay with a pitchfork, silage fork or garden fork or by hand.
- Material gathered by using a forage harvester, and possibly even big-bales, if their nets are removed, might be spread with a muck-spreader.
- If the material is spread over twice the area of the source, it should not be necessary to remove it. We do not recommend higher rates, which may require raking up and removal after three weeks.

6. Initial management

- Keep a close eye on the developing vegetation throughout autumn and spring. Vegetation establishment should be slow, with plenty of bare places, but some recognisable meadow plant species should be visible in the autumn.
- Do not cut the developing sward until normal hay-meadow management starts in the following summer, unless there is an overwhelming annual-weed problem.
- If there is an extensive problem with non-target perennial species such as docks *Rumex*, consider spot or patch weed-killing with glyphosate during the autumn or spring growing season.
- Monitor the site with a quadrat survey in early summer.
- Make hay on the site when the Yellow-rattle has shed most of its seed, around late July in the Midlands. If this is impossible because of potential vandalism, cut and remove the vegetation when most of the species are in seed, around early August.
- A light chain-harrowing at this stage may encourage re-establishment from seed.
- If possible, graze the regrowth from August until the site starts to show signs of poaching. On some sites it might be possible to graze through the winter. In any case, stock should be removed from the site by March. However, stock may lose condition rapidly in autumn as the quality of the vegetation declines. Store cattle are probably the best grazers, but dairy cattle, horses or sheep can be used.
- If grazing is impossible, the single hay cut might be sufficient. In general, the poorer the soil, the less perfect the management needs to be. If there is a significant regrowth in the autumn, consider a second cut in October. Alternatively, try gang-mowing through the autumn.

7. Long-term management

- Have an agreed management plan with the site managers, and insist that they stick to it. Be consistent, but also be flexible. Emulate traditional management, but be imaginative, inventing substitutes using basic agricultural principles.
- Monitor progress on your meadow by quantitative surveys, and respond to changes by modifying the management.
- Assess and influence local opinion: celebrate your meadow! Create leaflets and education packs, and involve butterfly and bird groups in the management.
- Manage your meadow for 1,000 years.

Top **Hay-strewing at Venus Pool, Shropshire, in July 2001.**
Above **Venus Pool in June 2003.** Ian Trueman

Table 1 Success of individual plant species in hay-strewing experiments

Key to degree of success:
0 = no success
1 = species recorded rarely and sporadically
2 = species recorded regularly, but at much lower frequency than at source site
3 = species recorded regularly, generally less frequent than at source site
4 = species recorded regularly, at similar frequencies to those at source site
S = species slow to establish, not normally appearing in first two years

		No. of attempts	No. of successes	Degree of success
Achillea millefolium	Yarrow	6	2	3
Agrostis capillaris	Common Bent	7	7	2-4
Agrostis stolonifera	Creeping Bent	2	2	4
Ajuga reptans	Bugle	1	0	0
Alchemilla filicaulis	Hairy Lady's-mantle	2	0	0
Alopecurus pratensis	Meadow Foxtail	2	2	2-4
Anacamptis pyramidalis	Pyramidal Orchid	1	1	3
Anemone nemorosa	Wood Anemone	1	0	0
Anthoxanthum odoratum	Sweet Vernal-grass	6	6	4
Aquilegia vulgaris	Columbine	1	1	4
Arrhenatherum elatius	False Oat-grass	3	2	3-4
Bellis perennis	Daisy	5	3	2-4
Botrychium lunaria	Moonwort	5	0	0
Brachypodium sylvaticum	False Brome	1	1	4
Briza media	Quaking-grass	6	5	2-3 S
Bromus hordeaceus	Soft-brome	1	1	4
Campanula rotundifolia	Harebell	6	0	0
Caltha palustris	Marsh-marigold	1	0	0
Cardamine pratensis	Cuckooflower	2	2	2 S
Carex caryophyllea	Spring-sedge	1	0	0
Carex flacca	Glaucous Sedge	1	1	1 S
Carex hirta	Hairy Sedge	2	0	0
Carex nigra	Common Sedge	1	0	0
Carex pallescens	Pale Sedge	2	0	0
Centaurea nigra	Common Knapweed	7	7	3-4
Cerastium fontanum	Common Mouse-ear	6	6	3-4
Cirsium palustre	Marsh Thistle	1	1	4
Clinopodium vulgare	Wild Basil	1	1	3
Conopodium majus	Pignut	6	4	1-2 S
Cynosurus cristatus	Crested Dog's-tail	6	6	2-4
Dactylis glomerata	Cock's-foot	6	5	3-4
Dactylorhiza fuchsii	Common Spotted-orchid	7	1	3 S
Dactylorhiza maculata	Heath Spotted-orchid	1	1	1 S
Dactylorhiza praetermissa	Southern Marsh-orchid	1	0	1 S
Deschampsia cespitosa	Tufted hair-grass	1	1	3
Eleocharis palustris	Common Spike-rush	1	1	3
Equisetum arvense	Field Horsetail	1	0	0
Euphrasia officinalis	Eyebright	5	3	1-2
Festuca pratensis	Meadow Fescue	2	2	3
Festuca rubra	Red Fescue	6	5	4
Filipendula ulmaria	Meadowsweet	1	1	2
Galium palustre	Common Marsh-bedstraw	1	1	4
Galium verum	Lady's Bedstraw	4	0	0
Glechoma hederacea	Ground-ivy	1	0	0
Glyceria fluitans	Floating Sweet-grass	1	1	3
Heracleum sphondylium	Hogweed	7	4	3-4 S
Holcus lanatus	Yorkshire-fog	7	7	4
Hyacinthoides non-scripta	Bluebell	1	0	0
Hypochoeris radicata	Cat's-ear	6	6	3-4
Isolepis setacea	Bristle Club-rush	1	1	3
Juncus acutiflorus	Sharp-flowered Rush	1	1	4
Juncus articulatus	Jointed Rush	1	1	2
Juncus bufonius	Toad Rush	1	0	0
Juncus bulbosus	Bulbous Rush	1	1	3
Juncus conglomeratus	Compact Rush	2	1	4
Juncus effusus	Soft-rush	1	1	4
Juncus inflexus	Hard Rush	1	1	4
Knautia arvensis	Field Scabious	1	1	2
Lathyrus linifolius	Bitter-vetch	5	0	0
Lathyrus pratensis	Meadow Vetchling	6	3	2-3 S
Leontodon autumnalis	Autumn Hawkbit	2	2	3-4
Leontodon hispidus	Rough Hawkbit	5	5	2-4
Leucanthemum vulgare	Oxeye Daisy	5	5	3-4
Linum catharticum	Fairy Flax	4	1	1
Lolium perenne	Perennial Rye-grass	7	6	3-4
Lotus corniculatus	C'mm'n Bird's-foot-trefoil	6	5	1-3 S
Lotus uliginosus	Gr'ter Bird's-foot-trefoil	2	2	1-3 S
Luzula campestris	Field Wood-rush	6	6	2-3 S
Lychnis flos-cuculi	Ragged-Robin	1	1	3
Lysimachia nummularia	Creeping-Jenny	1	1	3
Lysimachia nemorum	Yellow Pimpernel	1	0	0
Mentha aquatica	Water Mint	1	1	3
Mentha arvensis	Corn Mint	1	0	0
Myosotis laxa	Tufted Forget-me-not	1	0	0
Ophioglossum vulgatum	Adder's-tongue	5	0	0
Origanum vulgare	Marjoram	1	1	4
Pedicularis sylvatica	Lousewort	2	1	3
Phalaris arundinacea	Reed Canary-grass	1	0	0
Pilosella officinalis	Mouse-ear Hawkweed	5	1	1
Plantago lanceolata	Ribwort Plantain	6	6	3-4
Platanthera chlorantha	Greater Butterfly-orchid	4	0	0
Poa trivialis	Rough Meadow-grass	2	2	2-4
Polygala vulgaris	Common Milkwort	1	0	0
Potentilla erecta	Tormentil	6	3	2-3
Potentilla reptans	Creeping Cinquefoil	2	1	2
Primula veris	Cowslip	6	4	2-4 S
Prunella vulgaris	Selfheal	6	3	2-3 S
Ranunculus acris	Meadow Buttercup	6	5	2-4
Ranunculus bulbosus	Bulbous Buttercup	5	5	2-4
Ranunculus repens	Creeping Buttercup	2	2	3-4
Rhinanthus minor	Yellow-rattle	5	5	3-4
Rumex acetosa	Common Sorrel	6	5	2-4
Stachys officinalis	Betony	2	0	0
Stellaria graminea	Lesser Stitchwort	1	1	4
Succisa pratensis	Devil's-bit Scabious	2	1	2
Taraxacum spp.	dandelions	6	5	4
Trifolium dubium	Lesser Trefoil	4	3	4
Trifolium pratense	Red Clover	6	6	2-4
Trifolium repens	White Clover	6	5	3-4
Trisetum flavescens	Yellow Oat-grass	6	5	3-4
Vaccinium myrtillus	Bilberry	3	0	0
Veronica chamaedrys	Germander Speedwell	6	4	2-3 S
Veronica officinalis	Heath Speedwell	1	0	0
Veronica serpyllifolia	Thyme-leaved Speedwell	1	1	4
Vicia cracca	Tufted Vetch	6	4	2-4
Vicia sepium	Bush Vetch	1	1	3 S
Viola lutea	Mountain Pansy	4	0	0
Viola riviniana	Common Dog-violet	5	0	0

large species-rich meadows in an agricultural context. Also interesting is an experiment at the Shropshire Ornithological Society site at Venus Pool, near Shrewsbury, where 8ha of ex-arable land was strewn with hay from five different sites in 2001. Already, in 2003, the results are spectacular, and positive effects on insect populations and such birds as Tree Sparrows *Passer montanus* and Lapwings *Vanellus vanellus* have been reported.

General points about hay-strewing

One of the disadvantages of using freshly cut 'green' hay is that it must be transported and spread on the same day. It will rapidly heat up if left even overnight in heaps or bales, and the high temperature will reduce seed viability. Hay-strewing requires much thought and careful planning.

It is frequently asked whether a single sample

taken at the normal hay-making time is sufficient to provide a representative range of species at the new site. Most species present in significant amounts in the donor vegetation transfer successfully, although some may take several years to appear. The success of a range of species for which we have significant data is summarised in Table 1.

Strewing green hay requires the seed to be 'sown' at the end of July, when the hay is made. The result of this unusual sowing date seems to be that many species have developed beyond the seedling stage into quite large plants before winter, which appears to make them much less vulnerable to frosts and other winter hardships. We are sure that late-autumn sowing causes more meadow failures than does early sowing.

Bushbury Hill in 2001, 17 years after strewing, showing Oxeye Daisy, Red Clover, Yellow-rattle, Bulbous Buttercup, Lesser Trefoil and Quaking-grass. Ian Trueman

Almost all manuals on the creating of meadows recommend frequent cutting in the first growing season. Logically, this must be unwise since it favours the grasses, which are adapted to withstand grazing and cutting, over the forbs, which often are not so adapted. Yellow-rattle *Rhinanthus minor* suffers particularly badly if cut soon after germination, and may not recover. Many grasses will respond to frequent cutting by spreading laterally and occupying the ground permanently. If the vegetation is allowed to grow up without cutting, lateral spread of grasses is suppressed and bare areas, which are available for further colonisation, are revealed after hay-making. Possibly bad infestations can occur with annual arable weeds such as Charlock *Sinapis arvensis*, and these should be prevented from fruiting with an early cut, but annual weeds not adapted to hay-meadow management rarely persist after the first year. Perennial weeds are unlikely to be deterred by frequent cutting and may require spot killing.

Our observations on grazing the aftermath suggest that this practice plays an important role in creating bare sites where seedlings can establish themselves. It is difficult to devise a substitute for aftermath grazing, although sometimes unauthorised motor-cycling plays a part! We have advocated second cuts, or keeping the vegetation open by frequent gang-mowing into the autumn.

Most manuals specify that soils for wild-flower meadows should be poor in the major plant mineral nutrients (Gilbert & Anderson 1998). This is undoubtedly true, and all of our successful meadows have been created on soils (McCrea 1999; McCrea *et al.* 2001) which show extractable-phosphate levels within the 'infertile' to 'intermediate' range recommended by Ash *et al.* (1992). Available nitrogen is also important, but is difficult to assess satisfactorily. Consideration of the status and past history of the site may be sufficient to characterise its nitrogen status. Sites having received recent fertiliser applications or showing nitrogen-indicating species should be avoided. Old pastures should also be avoided, since these, as well as probably having more nature-conservation value than a created habitat, will release much nitrogen fertility when cultivated. In addition, recent work (McCrea *et al.* 2001; Vaz 2001) is suggesting that levels of available potassium may also be limiting. Soil pH also shows a correlation with local variation in the flora (McCrea 1999), but we have been able to generate successful 'neutral' meadows on sites with soil pH ranging from 5.3 to 7.9.

One of the advantages of hay-strewing over other methods seems to be its ability to promote colonisation by orchids. The dust-like seed of orchids is very difficult to collect and incorporate in seed mixtures, and the necessary mycorrhizal

Pyramidal Orchid growing in a meadow created in Wolverhampton by using hay from a limestone grassland. Ian Trueman

symbiont is even more difficult to include. Orchid capsules dehisce and spread the seed easily in strewn hay, and it is possible that the cut vegetation carries an innoculum of the relevant mycorrhiza to the new site. We have observed Common Spotted-orchid at three hay-strewn sites in Wolverhampton, Green-winged Orchid at three sites, and Heath Spotted-orchid *Dactylorhiza maculata*, Pyramidal Orchid *Anacamptis pyramidalis* and Twayblade at single sites. Curiously, orchids not known from the source site sometimes appear on our created meadows: Southern Marsh-orchid *Dactylorhiza praetermissa*, in cultivation nearby, spread on to a small area of dry hay meadow sourced from Pennerley at the University Experimental Gardens. Even more bizarre is the appearance of about 80 flowering spikes of Bee Orchid *Ophrys apifera* at Kitchen Lane in 2001. Neither species is known at the hay source sites. The invasion of landfill by Bee Orchids is not unknown (Shaw 1992), but it is interesting to observe that the creation of a fairly closed hay-meadow community has not prevented this invasion.

The advantages of hay-strewing include a known provenance, guaranteed fresh seed and a moderate cost. The Shropshire Ornithological Society conducted an analysis of the costs of hay-strewing, and concluded that, having paid twice the normal value for the hay, and paid for the transport of the baled hay across Shropshire, the hay-strewing methodology is comparable in cost to a normal commercial agricultural reseeding with Perennial Rye-grass *Lolium perenne*. The only imponderable item is the strewing itself. Clearly, the manual spreading of hay is potentially a significant extra expense. The managers of one area of Mottey Meadows have mechanised this aspect by cutting with a double-chop forage harvester into a trailer and subsequently spreading the green hay in a muck-spreader, a practice used successfully at Derrington. The extent to which this forage-harvester method results in the loss of seed remains to be assessed. Possibly, the collection of hay in big-bales could be followed by spreading in a particularly robust muck-spreader. The mechanisation of hay-strewing needs further research.

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