High Weald AONB Unit Commissioned Report

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# Seed Sourcing for Grassland Restoration in the High Weald

## Informing a High Weald Nature Recovery Area proposal

Ted Chapman

March 2019

The High Weald: an outstanding medieval landscape

# Our research and advice programme

Futhering understanding of one of England's finest landscapes

**The High Weald Area of Outstanding Natural Beauty is one of the best surviving medieval landscapes in northern Europe**. The components of the High Weald's natural beauty that make it recognisably distinct are:

- **Geology, landform, water systems and climate:** deeply incised, ridged and faulted landform of clays and sandstone from which spring numerous gill streams.
- **Settlement:** dispersed historic settlements of farmsteads and hamlets and late medieval villages.
- **Routeways:** ancient routeways often narrow, deeply sunken, and edged with trees, hedges, wildflower-rich verges and boundary banks.
- **Woodland:** a great extent of ancient woods, gills, and shaws in small holdings
- **Field and heath:** small, irregularly shaped and productive fields often bounded by – and forming a mosaic with – hedgerows and small woodlands.

**The High Weald AONB Joint Advisory Committee (JAC)** is a partnership established in 1991 of 15 local authorities, Defra, Natural England and organisations representing farming, woodland, access and community interests. The JAC is responsible for publishing and monitoring the statutory **AONB Management Plan**.

The JAC is supported by a small, dedicated staff team, the **High Weald Unit,** which develops understanding of the High Weald's key components - their history, development, distribution, special qualities, management, deterioration, damage and loss - to provide an evidence base for the AONB Management Plan and related policy, guidance and action.

This report has been produced to further that understanding and aims to help everybody conserve and enhance **one of England's finest landscapes.**


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## Content

## 1. Background

This report has been commissioned as one of the outputs for the High Weald Nature Recovery Network Pilot Project.

The purpose of the report is to identify seed-related constraints to effective grassland restoration in the High Weald and make recommendations for how these could be addressed in a future Nature Recovery Network (NRN). Outcomes of this work will include:

- A summary of methods, results, conclusions and overall recommendations for responsible seed sourcing for grassland restoration and re-creation in the High Weald AONB.
- Improved coordination between local seed suppliers and service providers.
- Increased awareness of Weald Local Origin Seed (WNOS=local seed)

## 2. Summary of Recommendations

Increasing supplies of high-quality native seed will be essential to increasing the scale of grassland creation and restoration in the High Weald, as will building awareness, understanding and capacity to source, harvest and use native seed effectively. The High Weald has a long-established seed supply network, a history of grassland restoration and well-developed networks of land owners, managers and conservation practitioners. These place the High Weald in a unique position to expand the provision and use of native seed in the local landscape and provide an exemplar for landscape-scale projects elsewhere in the UK.

Objectives and activities that could be built into a future landscape scale initiative are summarised below. These are not exhaustive but provide the basis for future discussion with stakeholders in the High Weald.

| | |
|---|---|
| Increase the impact and financial sustainability of the Weald Native Origin Seed (WNOS) operation, increasing demand while reducing operating costs. | • Fund a replacement mini combine harvester.<br>• Provide marketing advice and assistance (Project Officer).<br>• Promote WNOS in printed guidance, training and via local land manager networks (Project Officer, training providers).<br>• Provide financial and technical support as necessary to increase WNOS harvesting, processing and storage capacity (Project Officer, RBG Kew) |
| Build capacity for the effective use of direct transfer techniques in grassland restoration. | • Develop a network of donor sites, machinery and contractors available to undertake direct transfer techniques, building on existing links between landowners (Project Officer, Weald Meadows Partnership (WMP).<br>• Provide user-friendly written guidance and training in direct transfer techniques (Project Officer, WMP, RBG Kew).<br>• Share results from the Coronation Meadow experiment at Wakehurst in written guidance, training and site visits (RBG Kew, Margaret Pilkington & WMP) |

| | |
|---|---|
| Raise awareness and demand for best practice in seed sourcing, harvesting and use | • Provide user-friendly written guidance and training in seed sourcing and use, including principles relating to seed origin, quality and responsible harvesting (Project Officer, RBG Kew). Material from an introductory training course piloted in 2018 is included in Appendix 1.<br>• Review the storage longevity and germination requirements of priority Weald species, filling knowledge gaps with new studies at the Millennium Seed Bank (MSB). Identify pre-treatments or site preparation techniques to enhance success (RBG Kew).<br>• Develop a local seed accreditation scheme including measures of seed origin and quality. This would help consumers make a more informed choice about the seed they buy and provide recognition and market advantage to suppliers of high quality, local-origin seed. |

## 3. Indicative Costs

Indicative costs for the seed-related work are outlined below, assuming a five-year project.

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Total |
|---|---|---|---|---|---|---|
| **Project Officer**<br>30% of a full-time post shared with other project outputs. | £10,000 | £10,000 | £10,000 | £10,000 | £10,000 | £50,000 |
| **WNOS Combine Harvester**<br>Figure provided by Agrifactors. | £100,000 | | | | | £100,000 |
| **External Trainers/Consultants**<br>10 days PA, at a day rate of £250. | £2,500 | £2,500 | £2,500 | £2,500 | £2,500 | £12,500 |
| **Training materials**<br>Printed guidance, training events etc. | £1,000 | £1,000 | £1,000 | £1,000 | £1,000 | £5,000 |
| **Seed longevity and germination study**<br>20 species over two years | £7,500 | £7,500 | | | | £15,000 |
| **Total** | £121,000 | £21,000 | £13,500 | £13,500 | £13,500 | **£182,500** |

## 4. Fundamental principles

### 4.1 The role of seed in grassland restoration

The restoration or re-creation of the High Weald's distinctive semi-natural grassland falls comfortably within the internationally-recognised definition of Ecological Restoration as "the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed" (McDonald, 2016).

Some valuable forms of habitat creation or enhancement may not meet this definition - the use of multi-species leys that increase nectar availability but do not seek to recreate native semi-natural habitat, for example - but nonetheless describe a range of deliberate actions carried out with purpose of enhancing the ecological and socio-economic value of the natural environment.

The introduction of native seed is a key restoration technique, undertaken to overcome a barrier to the recovery of a site imposed by the natural absence of appropriate seed or plants. It forms part of a wider restoration process, typically preceded by physical or biological modifications to the site (changes to the hydrology, soil conditions, existing vegetation etc.) and followed by management practices designed to drive the development of the habitat towards the desired target (Figure 1).

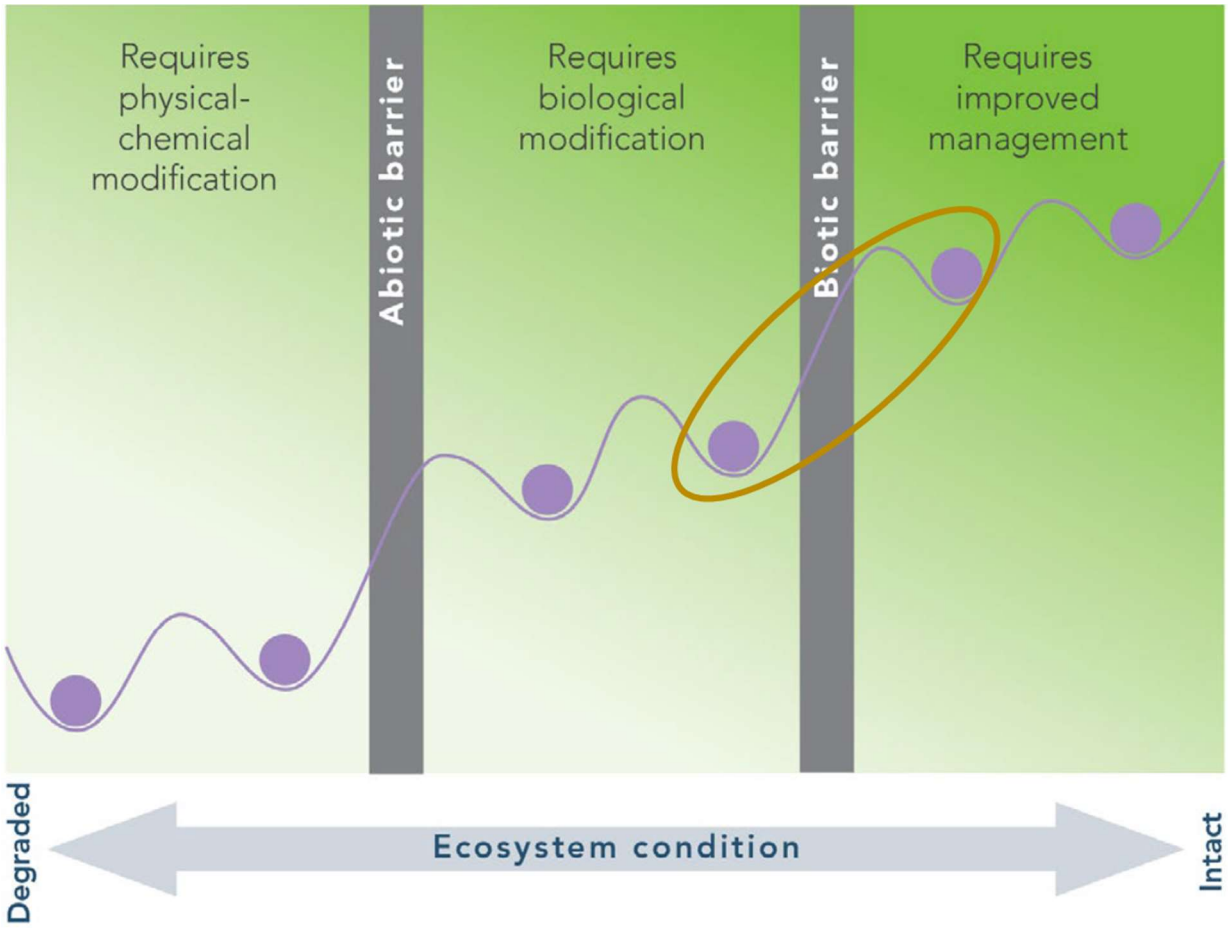


**Figure 1.** Conceptual model of habitat degradation and restoration. Troughs represent a 'steady state' where an ecosystem will remain without an intervention to degrade or restore it further. Seed addition is intended to remove a biotic barrier (the natural absence of seed or plants) and enable the continued recovery of the ecosystem. Adapted from McDonald et al, 2016.

In some cases, it may not be necessary to introduce seed - where plants are able to colonise naturally, management practices that provide suitable germination niches and allow flowering and seed dispersal may be enough to promote the recovery of the target habitat. In many cases, however, opportunities for natural colonisation and regeneration are likely to be limited or take an unacceptably long period of time to yield results. In these cases, the introduction of seed is likely to be justified.

Where growing conditions are already well suited to the target, seed sowing may take place early in the restoration process – at other sites, longer-term efforts to reduce soil fertility or the vigour of existing vegetation may be necessary before seed sowing is likely to succeed. In all cases, the timing, methodology, sourcing strategy and species composition should be guided by individual site conditions and the target community.

### 4.2 Seed origin

There is considerable debate about the importance of seed origin to restoration success, the implications of transferring non-local seed and plants across large geographic areas and the extent to which this should be avoided or controlled (Miller et al., 2016; Jones, 2013)

Local-origin material is typically preferred in conservation projects and is broadly regarded as the gold standard approach to seed sourcing (Jones, 2013; Mijnsbrugge et al., 2010; Broadhurst et al., 2008). Locally-sourced seed is assumed to confer a 'home-site advantage' when used nearby, and several studies suggest local material performs better overall, although the frequency and scale of this response may be site, population and/or species-specific (Bucharova et al., 2016; Hereford, 2009; Leimu & Fischer, 2008). Perhaps more significantly, the use of local seed avoids potential risks associated with the introduction of non-local material, including outbreeding depression, hybridisation and phenotypic changes (leaf burst, flowering time etc.) that could disrupt interactions with invertebrates and other organisms (Bucharova et al., 2016 Bischoff, 2014; Frankham et al, 2011).

The assumption that 'local is best' is subject to challenge, however, particularly as environmental change accelerates. Two large meta-analyses suggest local adaptation is evident in under half of cases (Leimu and Fischer, 2008; Hereford, 2009), less frequently than commonly assumed, although none of the studies included relate specifically to grassland communities typical of the High Weald. Several authors argue that the use of genetically-diverse non-local material may mitigate inbreeding depression and other detrimental effects associated with small local populations (Broadhurst et al., 2008; Leimu and Fischer, 2008; Weeks at al., 2011), or enhance adaptability and resilience where growing conditions have been radically altered (Broadhurst et al, 2016; Breed et al, 2013). Non-local materials may also offer a more practicable or cost-effective option where the supply of local-origin material is limited (Broadhurst et al, 2016; Jones, et al., 2013; Weeks et al. 2011).

A number of models have been developed to guide seed sourcing based on environmental and genetic variation between sites and populations (Breed et al., 2013) or species distribution, taxonomy, life-history and genetic factors (Weeks et al., 2014; Byrne et al., 2011; Frankham et al., 2011; Walker et al., 2004). Such models provide a flexible and informed approach to seed sourcing but are difficult to apply and inevitably dependant on the availability of relevant data and the expertise and attitude to risk of those making the assessment. A general and highly simplified approach is provided in Figure 2, but wherever data or confidence is lacking a precautionary local sourcing strategy is recommended.

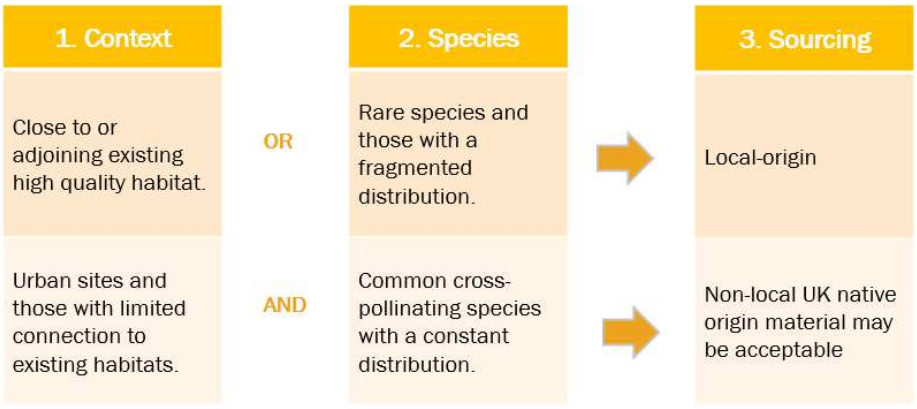


**Figure 2.** A simplified model to guide seed sourcing decisions, considering the context of the reintroduction site and species involved. There is no standard definition of 'local-origin' although seed originating from the Weald is likely to be acceptable in most cases. In some cases – rare species reintroductions, for example – seed from individual populations may be preferred. Where data or confidence is lacking, a precautionary local origin sourcing strategy is recommended.

### 4.3 Seed quality

The effectiveness of seed sowing is determined by many factors – site preparation, sowing methodology, weather, aftercare and, fundamentally, the viability of the seed when it is sown and its ability to germinate under conditions at the restoration site.

A viable seed is one able to germinate under suitable conditions. Viability is influenced by factors including environmental conditions during flowering and seed development, the maturity of the seed at the point of harvesting, post-harvest handling and storage. Good harvesting and processing practices aim to optimise viability - by harvesting at the correct time, for example - and to retain this by the careful drying and storage of seed, typically in cold and/or humidity-controlled stores. Whilst all seeds lose viability as they age, the rate of aging is strongly linked to the initial maturity of the seed, storage conditions and the species involved – yellow rattle (Rhinanthus minor), for example, ages much more quickly than common knapweed (Centaurea nigra) or meadow buttercup (Ranunculus acris) (Byrne, Chapman & Probert, 2014).

The viability of commercially-available native seed has been shown to be variable (Marin et al., 2017; Ryan et al., 2008), reflecting the inherent variability of native species and a spectrum of production and storage practice across the native seed industry. Several techniques have been developed to assess viability, the simplest being a germination test (Davies, Di Sacco & Newton, 2015), but these are not carried out in all cases and there are currently no standards or regulations governing the quality of native seed. High quality native seed is available, and buyers are strongly recommended to make enquiries about production, storage and testing practices when sourcing seed, or to conduct viability tests before seed is sown.

Where high quality seed is available, success may still be limited by poorly understood dormancy mechanisms (Miller et al., 2016) or site preparation, reintroduction and management practices that do not provide appropriate germination and establishment niches (Wagner et al., 2011). Many species typical of High Weald grassland have evolved dormancy mechanisms which delay germination until conditions for seedling establishment are right – yellow rattle requires cold stratification, for example, whilst germination of dyer's green weed (Genista tinctoria) is promoted by breaking down the hard seed coat. Understanding the dormancy alleviation and germination requirements of species in a restoration seed mix can help plan site preparation, sowing and management methodologies and identify simple pre-treatments – scarification of hard-seeded legumes, for example – likely to increase germination and establishment success.

### 4.4 Protecting wild plant populations

For many plant species, seed is the primary – in some cases only – form of reproduction. Over-exploitation of wild seed resources can cause long-term damage to plant populations and change community composition, with annuals and other short-lived plants most likely to be affected (Bucharova, 2017).

A voluntary code for seed collectors was developed by the charity Flora locale in 2012 – although Flora locale ceased to operate in 2018, the code remains accepted best practice for UK native seed collectors and producers. Standard practice within RBG Kew's Millennium Seed Bank Partnership is to harvest no

more than 20% of mature seed available on the day of collection (Way & Gold, 2014), unless there is evidence that higher harvesting rates will not compromise the long-term survival of the source population. Accurately assessing harvesting rates for green hay, brush or combine harvested seed mixes is very difficult, and ongoing monitoring of harvesting sites is required to ensure community composition is not affected, particularly where harvesting is repeated.

Seed may not be collected from protected species listed in Schedule 8 of the Wildlife and Countryside Act (1981) or Sites of Special Scientific Interest (SSSIs) without the consent of Natural England. Seed of non-protected species may be collected from non-SSSI sites with the landowner's permission.

**Recommendations for future success:**

- A Grassland Restoration Officer or other post facilitating seed supply in the High Weald should have an in-depth knowledge of issues around seed origin, quality, germination and responsible harvesting.
- Fundamental principles should be incorporated in user-friendly guidelines for seed sourcing for use in printed literature and training courses.
- The seed longevity and germination requirements of species typical of High Weald grasslands should be reviewed and, where necessary, supplemented by new studies at the Millennium Seed Bank (MSB). This should include recommendations for seed pre-treatments – scarification, after-ripening – or site preparation techniques able to enhance restoration success.
- Develop a local seed accreditation scheme including measures of seed origin and quality. This would help consumers make a more informed choice about the seed they buy and provide recognition and market advantage to suppliers of high quality, local-origin seed.

## 5. Evaluation of Options for Native Seed Supply

### 5.1 Natural regeneration

Vegetation can regenerate naturally in two ways – from plants, seed or other propagules (rooted fragments, bulbs etc.) already present at the site or the arrival of seed rain from elsewhere, driven by wind, water or the movement of animals. Less degraded sites are likely to provide the best opportunities for regeneration from the existing vegetation or soil seed bank, although studies suggest opportunities for regeneration from the soil seed bank decline with the length of time under intensive agricultural management or abandonment (for example, Smith et al., 2002; Willems et al., 1998). Natural regeneration from seed rain has been shown to be effective in sites immediately adjacent to species-rich donor habitat, particularly where colonisation is facilitated by the movement of machinery or animals (Winder, 2013; Magnificent Meadows, no date). In many cases, however, the natural dispersal of seed is likely to be severely limited by the degradation and fragmentation of high-quality habitat (Bullock, 2002).

| Strengths | Weaknesses |
|---|---|
| • Low cost.<br>• Maximises opportunities for local adaptation.<br>• Eliminates potential risks of introducing non-local material.<br>• Places emphasis on site preparation and long-term management.<br>• No negative impacts on donor sites. | • Sources of seed must already be present at the site or very nearby.<br>• Regeneration may be slow.<br>• Likely to require initial and ongoing disturbance to create germination niches. |
| **Opportunities** | **Threats** |
| • Can be effective in recently or less severely degraded sites, or those with species-rich donor habitat immediately adjacent.<br>• Naturally regenerated grassland may be supplemented at a later stage with targeted introductions using seed or plug plants. | • Soil seed banks are not necessarily representative of the target vegetation, declining with time under intensive management or abandonment.<br>• Habitat fragmentation limits opportunities for natural colonisation. |
| **Most suitable for:** | |
| • Less degraded sites and those with good connections to existing species-rich grassland. | |
| **Least suitable for:** | |
| • Highly degraded or fragmented sites, or where a more rapid change in species composition is required. | |
| **Recommendations for future success:** | |
| • The potential for natural regeneration is considered when developing restoration plans and is included as an option in printed advice and training for practitioners and land managers.. | |

### 5.2 Hand Harvesting

There are a range of techniques for harvesting seed by hand – in grasslands, the mostly commonly used are plucking individual fruit or stripping entire seed heads (Way & Gold, 2014). Seed is collected into breathable paper or cloth bags, dried, cleaned and stored for sowing at the optimum time. Although an apparently basic technique, making high quality hand harvests requires some skill in plant and seed identification, the ability to assess and evenly sample a donor population and an understanding of how to process and store seed correctly.

| Strengths | Weaknesses |
|---|---|
| • Species-specific<br>• Known, local origin material. Can capture distinctive species and ecotypes.<br>• Collect from sites inaccessible to machinery.<br>• Hay making and grazing is possible once collections are made.<br>• Single-species collections are ideal for species reintroduction projects, to increase the diversity of direct-harvested mixes, to establish field production or to propagate plug plants.<br>• With proper training and supervision, large numbers of volunteers can be involved.<br>• Does not require specialist equipment to make collections. | • Labour intensive.<br>• Collections are likely to be small.<br>• Requires good plant/seed ID skills and the ability to assess ripening and dispersal.<br>• Must be carried out responsibly to avoid depleting wild populations.<br>• Very small local populations may exhibit inbreeding depression, reducing genetic diversity and the ability of restored populations to adapt and survive. |
| **Opportunities** | **Threats** |
| • RBG Kew's Millennium Seed Bank is a world-leading authority on wild seed collecting and has experience in training and low-tech field approaches. | • Ongoing habitat degradation and species decline may reduce the number and size of donor populations in the future. This may compound concerns about genetic diversity within small populations. |
| **Most suitable for:** | |
| • Species reintroduction projects, to supplement bulk mixes, to establish seed production beds or propagate plug plants.. | |
| **Least suitable for:** | |
| • Habitat creation or restoration on larger scales. | |
| **Recommendations for future success:** | |
| • Hand harvesting is included within a general seed collecting training led by the MSB, including seed processing and storage techniques. | |

### 5.3 Commercial Seed

Several UK-based companies grow native seed as an agricultural crop, typically in large single-species rows or blocks. The process begins with a small founder stock sourced from the wild, existing stocks held by the producer or material from another supplier. This founder stock may be grown on a small scale for bulking up or placed directly into large-scale production. Seed is harvested, cleaned and sold directly by the producer or indirectly via a network of seed merchants and retail outlets, either as individual species or combined to form mixes. Some companies also supply direct-harvested seed mixes and offer bespoke direct harvesting services. A list of UK native seed suppliers is provided in Appendix 2.

Some imported non-UK origin material is also marketed as 'native' or 'wildflower' seed. This material is not recommended for use in habitat creation or restoration projects, and practitioners should satisfy themselves that the seed they use is of UK native origin, sourced from populations growing in the wild in the UK.

| **Strengths** | **Weaknesses** |
|---|---|
| • Relatively low cost.<br>• Available in quantity, on-demand.<br>• Available as single species and a range of mixes including or excluding grasses.<br>• High quality, UK-origin material is available.<br>• Seed is typically clean and suitable for use with some spreading or drilling equipment.<br>• No requirement,for– or collecting pressure on – donor sites.<br>• Some producers are able to offer expert advice on site preparation, species choice and management. | • Limited availability of less common, locally-distinctive species.<br>• Unlikely to be of local origin. Some (but not all) suppliers state the wild origin of their seed.<br>• Some poor-quality material is available.<br>• Limited regulation and the absence of recognised industry standards place an onus on the buyer to find a reputable supplier.<br>• Mixes may include cultivated varieties of grasses and fodder species (for example, birds foot trefoil, *Lotus corniculatus*).<br>• Production processes place selective pressures on seed and may reduce genetic diversity and adaptability (Miller et al. 2016; Nevill et al., 2016; Schröder & Prasse, 2013). |
| **Opportunities** | **Threats** |
| • UK-native seed production is expanding in quantity and diversity.<br>• Growing national and international awareness and interest in issues around seed origin, quality, testing and accreditation/certification schemes. | • Non-native imported seed may be marketed in 'native' or 'wildflower' mixes. |

| Most suitable for: |
|---|
| • Amenity and semi-improved sites with limited connection to existing high-quality grassland, particularly where the objective is to provide a general (i.e. not locally-distinctive) wildflower habitat. Common, widespread, cross-pollinating species. |
| **Least suitable for:** |
| • Sites on or close to existing high-quality grassland. Rare species and those with a fragmented distribution. |
| **Recommendations for future success:** |
| • Advice to help practitioners identify reputable native seed suppliers and source high quality seed is included in written guidance and training. |

### 5.4 Direct transfer techniques

Several techniques have been developed to transfer seed directly from one site to another (Blakesley & Buckley, 2016; Scotton, Kirmer & Krautzner, 2012). Three of these - green hay transfer, brush harvesting and combine harvesting – have been trialled extensively in the High Weald and are of particular relevance to grassland restoration.

Direct transfer techniques share a number of advantages and disadvantages, explored in the SWOT analysis below. The strengths and weaknesses of the individual techniques are also considered.

| **Strengths** | **Weaknesses** |
|---|---|
| • Wild seed of known local origin.<br>• Ecological and management conditions at the donor and receptor sites can be carefully matched.<br>• Locally-distinctive species and communities can be preserved.<br>• Payments to landowners add value to high quality donor sites and encourage appropriate long-term management. | • Requires appropriate high-quality donor habitat.<br>• Specialist expertise is required to survey and monitor donor sites, coordinate and undertake harvesting and process seed.<br>• Potential negative impacts on donor sites must be carefully monitored. Harvesting should not be repeated more frequently than once every three years or should be undertaken with carefully planned and recorded strip operations to avoid harvesting from the same area. |
| **Opportunities** | **Threats** |
| • Relevant experience, equipment and access to a network of high-quality donor sites is held within the WMP and Weald Native | • Habitat loss and degradation may reduce the quantity of high-quality donor sites in the future. |

| | |
|---|---|
| Origin Seed (WNOS) operation (see below).<br>• Existing links between landowners/managers provide the basis for collaboration in identifying donor sites, sharing machinery etc.<br>• Trials in the Coronation Meadow at Wakehurst will provide an evidence base and demonstration site in the High Weald. | |
| **Most suitable for:** | |
| • Larger projects with a focus on creating high-quality, locally distinctive grassland. | |
| **Least suitable for:** | |
| • Smaller projects are less likely to justify the coordinating effort and costs of a bespoke approach. | |
| **Recommendations for future success:** | |
| • A Grassland Restoration Officer or similar post should build on existing links between landowners/managers – the local farm cluster, for example – to develop a network of potential donor sites, machinery and contractors.<br>• Training, printed guidance and one to one support should build awareness and capacity to undertake green hay, combine and brush harvesting.<br>• Results from the Coronation Meadow experiment at Wakehurst Place should be made available in the scientific literature, non-technical guidance and via training and site visits. | |

### *5.4.1 Green Hay Transfer*

A hay crop is taken from the donor site at or just before the point of maximum seed dispersal. Cut material is collected and transferred immediately to the prepared receptor site, where seed disperses naturally.

| **Strengths** | **Weaknesses** |
|---|---|
| • Relatively low cost.<br>• Employs standard agricultural equipment and techniques.<br>• Captures species growing at the base and top of the sward (depending on cutting height).<br>• Hay mulch can stabilise soils and promote germination and establishment on some sites. | • Cut material deteriorates rapidly and must be spread within an hour or two of cutting, limiting travelling distance.<br>• Cut material is bulky to transport and spread.<br>• Captures a single 'snapshot' of the donor – early or later flowering species may be missed.<br>• Significant short-term impact on donor site and potential hay crop is lost. |

### *5.4.2 Combine Harvested 'Green Seed'*

Seed is harvested and threshed at or just before the point of maximum seed dispersal using a combine harvester. The threshed seed-rich material is transferred immediately to the prepared receptor site. This technique shares the strengths and weaknesses associated with green hay transfer, with the additional advantage of maximising seed quantity and minimising volume (an advantage for transport).

### *5.5.3 Brush Harvesting*

A mechanised brush harvester is towed over the sward, stripping seed with a rotating nylon brush. Most of the sward remains intact and a hay harvest can be taken. Seed is dried, cleaned and can be stored for future sowing. The same site can be harvested more than once in a year to increase the quantity of seed and number of species captured.

| **Strengths** | **Weaknesses** |
|---|---|
| • Repeated harvests capture earlier and later flowering species, although at increased cost.<br>• Reduced short-term impact on site.<br>• Hay crop can still be taken, although late-season hay may be of limited fodder value.<br>• Brush harvesters can be towed by a range of vehicles, increasing access to more challenging sites.<br>• Seed can be stored until the optimum time for sowing. Under good conditions, seed may be stored for many years.<br>• Suitable machinery is operated within the High Weald by WMP/Agrifactors and RBG Kew. | • Requires specialist machinery and expertise, increasing cost.<br>• Favours taller species with more easily dispersed seed. Low-growing species may be missed.<br>• Viability of seed may be undermined by poor drying, cleaning and storage techniques.<br>• Brush-harvested mixes contain a high proportion of chaff – this must be accounted for when calculating seeding rates and makes seed unsuitable for drilling equipment. |

## 5.5 Weald Native Origin Seed

The Weald is fortunate in having a long-established seed supply chain providing a range of 'off the peg' direct-harvested seed mixes from local, high quality donor sites. Weald Native Origin Seed (WNOS) combines many of the benefits of direct-harvesting approaches with the convenience and cost-efficiency of commercially-produced seed.

Donor sites are identified and surveyed by Dawn Brickwood, , Weald Meadow Partnership and Services, who monitors seed maturation and schedules harvesting. Harvesting is undertaken by Weald Meadows partner Agrifactors Southern using a mini-flower combine or brush harvester where the landowner wishes to take a hay crop. Seed is dried, cleaned, stored and co-marketed by Agrifactors. Seed mixes representing a range of Wealden grassland types are available on demand, with Dawn matching receptor

sites to the most suitable harvested mixes. Payments for seed are shared between the landowner, Agrifactors and Dawn. Between 1996 and 2018, 5,700kg of WNOS has been supplied, enhancing 1,307 ha of grassland on 830 sites.

| **Strengths** | **Weaknesses** |
|---|---|
| • Moderate cost – approximately 40% higher than a commercial seed mix.<br>• Local origin seed, containing locally-appropriate species (for example, pepper saxifrage, *Silaum silaus,* meadow rue, *Thalictrum flavum* and dyer's greenweed, *Genista tinctoria*).<br>• Established network of donor sites and landowner relationships.<br>• Involves and supports specialist local expertise and facilities.<br>• Payments to landowners promote continued access and add economic value to high quality donor sites.<br>• Locally-native grasses from grazed sites are more palatable than amenity grasses found in most stewardship mixes.<br>• Regular monitoring of donor sites. | • Commercial viability is marginal – seed sales cover basic costs, but machinery and other overhead costs are met within the wider Agrifactors business.<br>• Marketing has not fully exploited existing demand.<br>• Existing second-hand combine harvesters are unreliable and expensive to maintain. Replacement machinery will require grant funding.<br>• Seed availability fluctuates seasonally.<br>• Surveying, monitoring and harvesting work must be done up-front, with no payment until the seed is sold |
| **Opportunities** | **Threats** |
| • Latent donor site, harvesting and processing capacity – more seed could be harvested if demand justified. Agrifactors estimate annual production could be doubled, increasing revenue through increased sales and economies of scale.<br>• Latent demand – could increase share of existing market by effective marketing and increased awareness.<br>• WNOS is well-integrated in local planning and Natural England guidance.<br>• Very high demand for certain species – *Rhinanthus minor* and *Leucanthemum vulgare*. Increasing provision of these could help financial sustainability of WNOS | • Problems with stewardship payments and uncertainty about future schemes have reduced demand from farmers.<br>• WNOS is heavily reliant on the expertise and ongoing commitment of two individuals. |

| Most suitable for: |
|---|
| • All sites requiring a mix of locally native grasses and wildflowers. |
| **Least suitable for:** |
| • Larger projects or those with a very specific species focus may justify bespoke direct transfer or hand harvesting approaches. These may be carried out within the WMP/WNOS operation, but require sufficient lead in times. |
| **Recommendations for future success:** |
| • Efforts to increase the impact and long-term sustainability of WNOS should focus on increasing demand and reducing operating costs through new machinery and economies of scale.<br>• Secure funding for a replacement mini-combine harvester.<br>• Raise awareness and build demand for WNOS - provide marketing advice and assistance, promote WNOS in printed guidance, training and via local land manager networks.<br>• Develop a local seed accreditation scheme to provide recognition and market advantage for high quality, local-origin seed.<br>• Provide financial and technical support as necessary to increase WNOS harvesting, processing and storage capacity. |

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## Appendix 1: Sample training materials

Materials for an introductory 'principles and practice of grassland creation and restoration' one-day training course, piloted with High Weald landowners and managers at Wakehurst in 2018 are provided. This course included a focus on seed sourcing and pollinators, with the formal taught component followed by visits to various restored grasslands at Wakehurst.

**The principles and practice of grassland creation and restoration**

This one-day course introduces the basic principles and practical techniques involved in planning and delivering successful grassland creation or restoration projects. We will discuss the ecological and management factors considered during the planning phase, and how these can help identify opportunities, frame objectives and inform which restoration techniques to use.

**The course also introduces the insects that play a role in pollination, helping you to identify them, understand how they interact with plants, and explaining how you can help to conserve them.**

The content of the training course is relevant to professionals, site managers and advisors who are involved in restoring, creating and managing species-rich grassland.

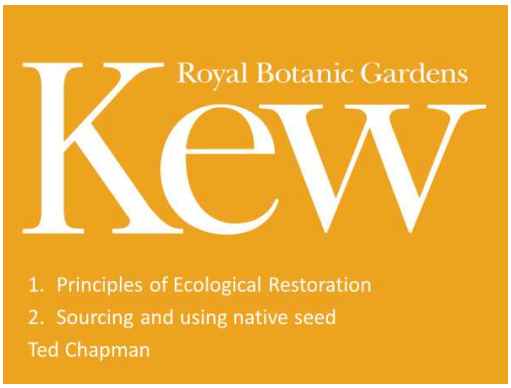
**Venue:** Wakehurst Royal Botanic Gardens Kew, Ardingly, West Sussex, RH17 6TN.

**Date:** Wednesday 20th June 2018

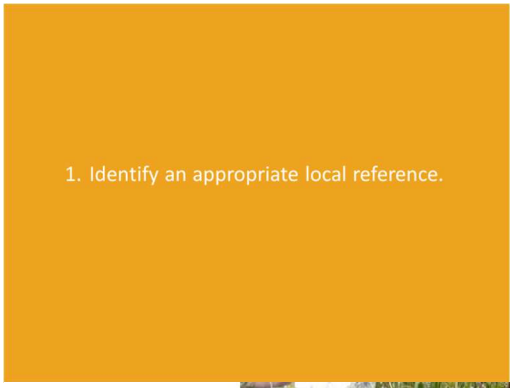
**Course tutors:** Iain Parkinson (High Weald, Land Management Advisor))
Ted Chapman (UK Native Seed Hub Project Co-ordinator)
Laurie Jackson (Farm Pollinator and Wildlife Advisor)

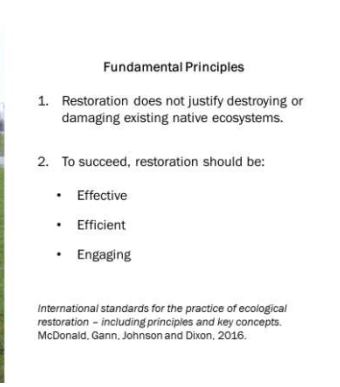
| | | |
|---|---|---|
| 9.30 | Arrivals, registration and coffee | Wakehurst Visitor Centre |
| 10.00 | **Sourcing and using native seed and plants.**<br>**Points for discussion include:**<br>• Principles of ecological restoration<br>• Species selection and seed origin.<br>• Sourcing: commercial seed hand and mechanised harvesting. | Ted Chapman (UKNSHP Coordinator) MSB Seminar Room |
| 11.00am | **Wild pollinator conservation** –<br>• ecology - life cycle, nutrition needs, mobility, foraging preferences, nesting requirements;<br>• habitat - what they use, how, when, why;<br>• pollinator decline – assessing and managing habitat, how to plan a pollinator network;<br>• identifying pollinators - introduction to different pollinator groups, information on how to get started in survey and identification | Laurie Jackson (Farm Pollinator and Wildlife Advisor, Buglife) |
| 12.30-13.15 | Lunch | Picnic Site |

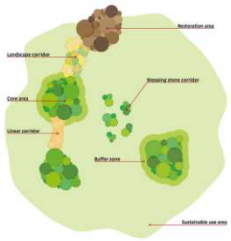
| | | |
|---|---|---|
| 13.15-15.15 | Site visit to include Wakehurst's Coronation Meadow and Bloomers Valley Grassland Restoration Project. Points for discussion include:<br>• Site preparation and enhancement techniques: green hay spreading, plug planting, seed sowing.<br>• Management programme: weed control, mowing regime, conservation grazing.<br>• Integrating habitat restoration and management in a historic landscape and visitor attraction.<br>• Monitoring and evaluating success | Coronation Meadow and Bloomers Valley |
| 15.30 | Depart | Wakehurst Visitor Centre |





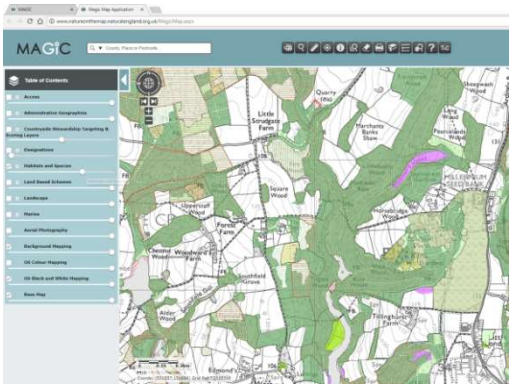



## Understand the landscape

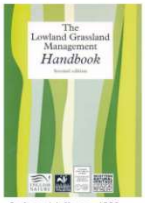
- Characteristic habitats, species and patterns of vegetation.
- Opportunities to buffer, enlarge or connect existing habitats.
- Traditional land-uses and cultural practices.
- Foreseeable environmental change.

## 2. Develop objectives based on the key attributes of the reference.




| Attributes | Goal |
|---|---|
| Threats | Brambles are removed. |
| Soil | Soil nutrients are at reference levels for MG5 grassland (Critchley et al, 2002). |
| Species | Characteristic MG5 species (Rodwell et al, 1992) are present. |
| Structure | Hay meadow predominates, with areas of uncut tussock grassland. |


| Attribute | Goal | Objective |
|---|---|---|
| Threats | Brambles are removed. | Brambles are reduced to <5% cover by 2025. |
| Soil | Soil nutrients are at reference levels for MG5 grassland (Critchley et al, 2002). | Nutrient status declining towards reference by 2025. |
| Species | Characteristic MG5 species (Rodwell et al, 1992) are present. | Increased number of MG5 species recorded by 2025. |
| Structure | Hay meadow predominates, with some taller tussock grassland. | Annual hay cut and grazing of 80% of site from 2020. 20% of site maintained as tussock grassland. (Crofts and Jefferson, 1999). |




Crofts and Jefferson, 1999

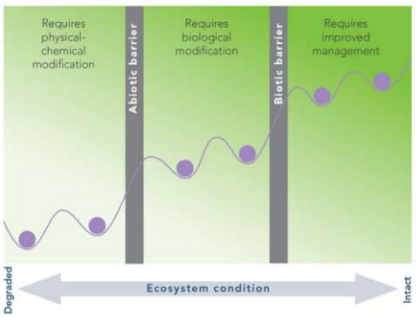
## Understand your own resources

- Time and resources for initial planning and treatments.
- Time and resources for ongoing management and monitoring.
- Identify gaps in knowledge and resources.
- Identify local partners, training, research needs etc.
- Consider competing organisational demands.

| Attribute | Goal | Objective | Monitoring |
|---|---|---|---|
| Threats | Brambles are removed. | Brambles are reduced to <5% cover by 2025. | Annual random quadrat surveys. |
| Soil | Soil nutrients are at reference levels for MG5 grassland (Critchley et al, 2002). | Nutrient status declining towards reference by 2025. | Soil sampling in 2021, 2023 and 2025. |
| Species | Characteristic MG5 species (Rodwell et al, 1992) are present. | Increased number of MG5 species recorded by 2025. | Annual random quadrat surveys. |
| Structure | Hay meadow predominates, with some taller tussock grassland. | Annual hay cut and grazing of 80% of site from 2020. 20% of site maintained as tussock grassland. (Crofts and Jefferson, 1999). | Management records. Fixed point photography. |

| Attribute | Goal | Objective | Monitoring | Action |
|---|---|---|---|---|
| Threats | Brambles are removed. | Brambles are reduced to <5% cover by 2025. | Annual random quadrat surveys. | Flail dense patches in autumn 2020. |
| Soil | Soil nutrients are at reference levels for MG5 grassland (Critchley et al, 2002). | Nutrient status declining towards reference by 2025. | Soil sampling in 2021, 2023 and 2025. | Eliminate fertiliser inputs. Instigate cut and collect mowing with aftermath grazing regime (Crofts and Jefferson, 1999). |
| Species | Characteristic MG5 species (Rodwell et al, 1992) are present. | Increased number of MG5 species recorded by 2025. | Annual random quadrat surveys. | Allow light annual poaching. Plant locally-sourced plugs in autumn 2020. |
| Structure | Hay meadow predominates, with some taller tussock grassland. | Annual hay cut and grazing of 80% of site from 2020. 20% of site maintained as tussock grassland. (Crofts and Jefferson, 1999). | Management records. Fixed point photography. | Instigate cut and collect mowing with aftermath grazing regime (Crofts and Jefferson, 1999). |

## 3. Assist natural recovery processes wherever possible.




| Attribute | Goal | Objective | Monitoring | Action |
|---|---|---|---|---|
| Threats | Brambles are removed. | Brambles are reduced to <5% cover by 2025. | Annual random quadrat surveys. | Flail dense patches in autumn 2020. |
| Soil | Soil nutrients are at reference levels for MG5 grassland (Critchley et al, 2002). | Nutrient status declining towards reference by 2025. | Soil sampling in 2021, 2023 and 2025. | Eliminate fertiliser inputs. Instigate cut and collect mowing with aftermath grazing regime (Crofts and Jefferson, 1999). |
| Species | Characteristic MG5 species (Rodwell et al, 1992) are present. | Increased number of MG5 species recorded by 2025. | Annual random quadrat surveys. | Allow light annual poaching. Plant locally-sourced plugs in autumn 2020. |
| Structure | Hay meadow predominates, with some taller tussock grassland. | Annual hay cut and grazing of 80% of site from 2020. 20% of site maintained as tussock grassland. (Crofts and Jefferson, 1999). | Management records. Fixed point photography. | Instigate cut and collect mowing with aftermath grazing regime (Crofts and Jefferson, 1999). |

## 4. Aim for the best possible recovery.

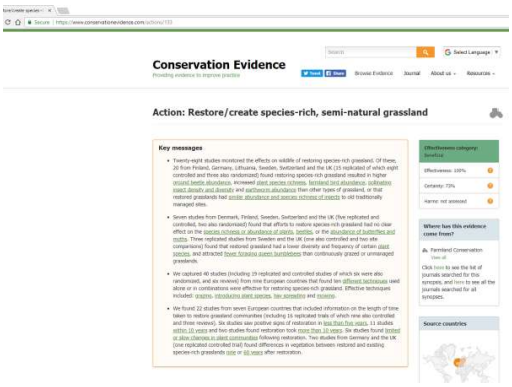

| Attribute | Goal | Objective | Monitoring | Action |
|---|---|---|---|---|
| Threats | Brambles are removed. ***** | Brambles are reduced to <5% cover by 2025. *** | Annual random quadrat surveys. | Flail dense patches in autumn 2020. |
| Soil | Soil nutrients are at reference levels for MG5 grassland (Critchley et al, 2002). ***** | Nutrient status declining towards reference by 2025. ** | Soil sampling in 2021, 2023 and 2025. | Eliminate fertiliser inputs. Instigate cut and collect mowing with aftermath grazing regime (Crofts and Jefferson, 1999). |
| Species | Characteristic MG5 species (Rodwell et al, 1992) are present. **** | Increased number of MG5 species recorded by 2025. ** | Annual random quadrat surveys. | Allow light annual poaching. Plant locally-sourced plugs in autumn 2020. |
| Structure | Hay meadow predominates, with some taller tussock grassland. ***** | Annual hay cut and grazing of 80% of site from 2020. 20% of site maintained as tussock grassland. (Crofts and Jefferson, 1999). **** | Management records. Fixed point photography. | Instigate cut and collect mowing with aftermath grazing regime (Crofts and Jefferson, 1999). |

5. Draw on all available knowledge.

6. Engage all those with stake in managing, accessing or benefiting from the site.

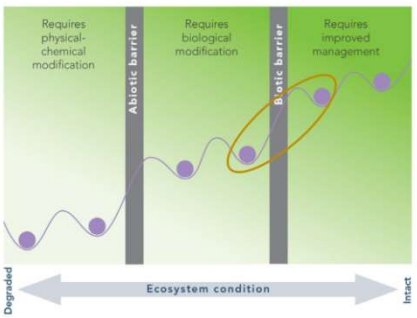

www.magnificentmeadows.org.uk

www.floralocale.org



# Sourcing and using native seed



## Natural Regeneration

+ Low cost
+ Maximises potential for local adaptation
+ Eliminates risks associated with non-local seed
- May be slow
- May require disturbance to create germination niches
- Soil seed banks not necessarily representative of target vegetation
- Fragmentation limits opportunities for natural colonisation

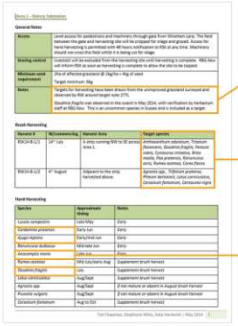
## Commercial Seed

+ Cost effective
+ Available in quantity, on-demand
+ Mixes and single species collections
+ Some high quality, UK-origin material is available
+ No requirement for – or collecting pressure on – donor sites
- Unlikely to be of local High Weald origin
- Limited availability of less common species
- Quality may be variable

# Species Selection

## Green Hay

+ Transfer large quantities of seed
+ Cheap, simple technique using conventional machinery
+ Hay mulch can promote germination and establishment
- Captures a single 'snapshot' of species
- Donor and recipient sites must be close together



## Species Selection

1. Species drawn from reference system
2. Framework species
   - Fast coverage
   - Promote future natural or assisted regeneration
3. Rare and distinctive species
   - Consider specialist establishment needs

## Brush Harvesting

+ Harvest large quantities of seed
+ Multiple harvests capture a broad range of framework species
+ Limited damage to sward
+ Seed can be stored until needed
- Access and safe operation may be limited
- Some species missed – growth characteristics, phenology etc.
- Requires careful post-harvest drying, cleaning and storage of seed

# Seed Sourcing

**AREA 1: BOLNEY SUBSTATION**

| | Sample Weight (g) | % occurrence in sample | Germination% |
|---|---|---|---|
| Total Sample Weight | 3.7659 | 100.00% | |
| *Lotus corniculatus* | 0.0103 | 0.27% | not tested |
| *Festuca rubra* | 1.0081 | 26.77% | 96 |
| *Holcus lanatus* | 0.1325 | 3.53% | 57 |
| *Gaudinia fragilis* | 0.1915 | 5.10% | 100 |
| *Ranunculus acris* | 0.1401 | 3.72% | 58 |
| *Dactylis glomerata* | 1.0453 | 27.76% | 96 |
| *Anthoxanthum odoratum* | 0.0079 | 0.21% | not tested |
| *Cerastium fontanum* | 0.0029 | 0.08% | not tested |
| *Alopecurus pratensis* | 0.0039 | 0.10% | not tested |
| *Trifolium pratense* | 0.2048 | 5.44% | 85 |
| *Trifolium dubium* | 0.0007 | 0.02% | not tested |
| *Prunella vulgaris* | 0.0222 | 0.59% | 92 |
| *Poa sp.* | 0.0009 | 0.02% | not tested |
| Other species | 0.0162 | 0.43% | not tested |
| Debris | 0.9778 | 25.96% | |

| | |
|---|---|
| Total BH Weight (g) | 17500 |
| Minus Debris (g) | 12956 |

## Hand Harvesting

+ Species specific
+ Collect from sites inaccessible to machinery
+ Supplement species missing from brush harvests

- Labour intensive
- Requires good plant/seed ID skills and the ability to assess ripening and dispersal
- Must be carried out responsibly to avoid depleting wild populations

## Seed Origin

| Serial No | Collection No | Date Collected | Note | Site | Genus | Species | Adj Seed Quantity | Germination Test Result % |
|---|---|---|---|---|---|---|---|---|
| 793263 | RSK14-H1-1 | 10/06/2014 | | Bolney | Luzula | campestris | 28770 | 100 |
| 793274 | RSK14-H1-2 | 10/06/2014 | | Bolney | Cerastium | fontanum | 36059 | 100 |
| 793285 | RSK14-H1-3 | 10/06/2014 | Orchid | Bolney | Anacamptis | morio | 67614 | not tested |
| 793296 | RSK14-H1-4 | 19/06/2014 | | Bolney | Ajuga | reptans | 911 | 96 |
| 793300 | RSK14-H1-5 | 19/06/2014 | | Bolney | Rumex | acetosa | 8056 | 100 |
| 793311 | RSK14-H1-6 | 30/06/2014 | | Bolney | Briza | media | 9620 | 100 |
| 793327 | RSK14-H1-7 | 30/06/2014 | | Bolney | Gaudinia | fragilis | 22337 | 100 |
| 793768 | RSK14-H1-8 | 10/07/2014 | | Bolney | Anthoxanthum | odoratum | 11351 | 96 |
| 795094 | RSK14-H1-9 | 19/08/2014 | | Bolney | Hordeum | secalinum | 3786 | 100 |
| 795108 | RSK14-H1-10 | 19/08/2014 | | Bolney | Lotus | corniculatus | 20948 | 100 |
| 795119 | RSK14-H1-11 | 19/08/2014 | | Bolney | Leontodon | saxatilis | 3829 | 83 |
| 795120 | RSK14-H1-12 | 19/08/2014 | | Bolney | Vicia | cracca | 2921 | 100 |

Local is best – a sensible but increasingly 'testable hypothesis' (Jones, 2013).

| | |
|---|---|
| Local material may be better adapted to local conditions | Consider the diversity of the donor population and likely environmental change |
| Non-local material may undermine local adaptation and damage populations | Risks are contested, and likely to be highly species specific |
| Local material better supports local plant-animal interactions | Much more research needed! |

Jones, 2013. When local isn't best. *Evolutionary Applications*, 6(7), pp 1109–1118.

| | Brush Harvests | Weight of Seed |
|---|---|---|
| **Bolney (MG5)** | 2 | 13 kg |
| **Tottington Mount (CG3)** | 2 | 8.6 kg |
| **Lambleys (CG2, CG3)** | 1 | 1.26 kg |

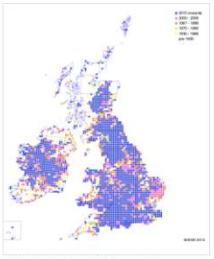
| | Harvesting Days | Species |
|---|---|---|
| **Bolney (MG5)** | 5 | 12 |
| **Tottington Mount (CG3)** | 4 | 13 |
| **Lambleys (CG2, CG3)** | 5 | 17 |

| 1. Context | 2. Species | | 3. Sourcing |
|---|---|---|---|
| Close to or adjoining existing high quality habitat. | Rare species and those with a fragmented distribution. | → | Local |
| Urban sites and those with limited connection to existing habitats. | Common outcrossing species with a constant distribution. | → | Non-local material may be acceptable |


## Plug Planting

+ Overcome complex germination requirements
+ Introduce plants to competitive, established habitats
+ Efficient use of small seed collections
+ Public engagement opportunities

- Expensive and time consuming
- Vulnerable to drought and uprooting



UK distribution of *Briza media* (quaking grass). www.brc.ac.uk.

UK distribution of *Anemone pulsatilla* (pasque flower). www.brc.ac.uk.

## Appendix 2: Commercial Native Seed Suppliers

A list of companies marketing wildflower seed in Great Britain is provided. The list is not exhaustive, and inclusion does not imply RBG Kew endorsement of the supplier, the quality of their products or their suitability for use in the High Weald.

**Local-origin suppliers**

Agrifactors (WNOS)

Weald Meadows Partnership and Services (WNOS)

**Other suppliers**

Boston Seeds (UK wide)

British Flora (UK wide)

British Wild Flower Plants (UK wide)

Charles Flower Wildflowers (UK wide)

Cumbria Wildflowers (UK wide)

Emorsgate Seeds (UK wide)

Farm Seeds (UK Wide)

Flowerscapes (UK wide, based in High Weald)

Habitat Aid (UK wide)

Heritage Seeds (UK wide)

Idealseed (UK Wide)

John Chambers Wildflower Seed (UK wide)

LG Seeds (UK wide)

Meadowmania (UK wide)

Naturescape (UK wide)

Phoenix Amenity

PlantWild (UK wide)

Really Wild Flowers (UK wide)

Scotia Seeds (Scotland)

Watson Seeds (Scotland)

Wild Flower Lawns and Meadows (UK wide, based in the Weald)

Wild Flower Shop (UK wide)

Wynnstay Agriculture (UK wide)