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IRG begins this month with a feature photo essay from Alan Ayton of another Australian plant, *Hibbertia cuneiformis.*

Alan generously shares with us his photos of Australian plants - thanks, Alan!

Left: Alan at the recent AGSVictoria "bunfight" in Australia .

Next, there is a version of the talk given by Max Coleman at a recent SRGC-sponsored event at RBGE on Conservation Horticulture. Max Coleman kindly advised that he would share his recent article on '**Planting to assist recovery**' published in the British Wildlife journal (Home - British Wildlife). Max also has a series of RBGE blogs on translocations and conservation horticulture articles at Max Coleman – Botanics Stories should you wish to know more about the subject. Thanks to Frazer Henderson for his help with this and to Max for his generosity. Photo of Max Coleman, right: credit, copyright Gary Murison.

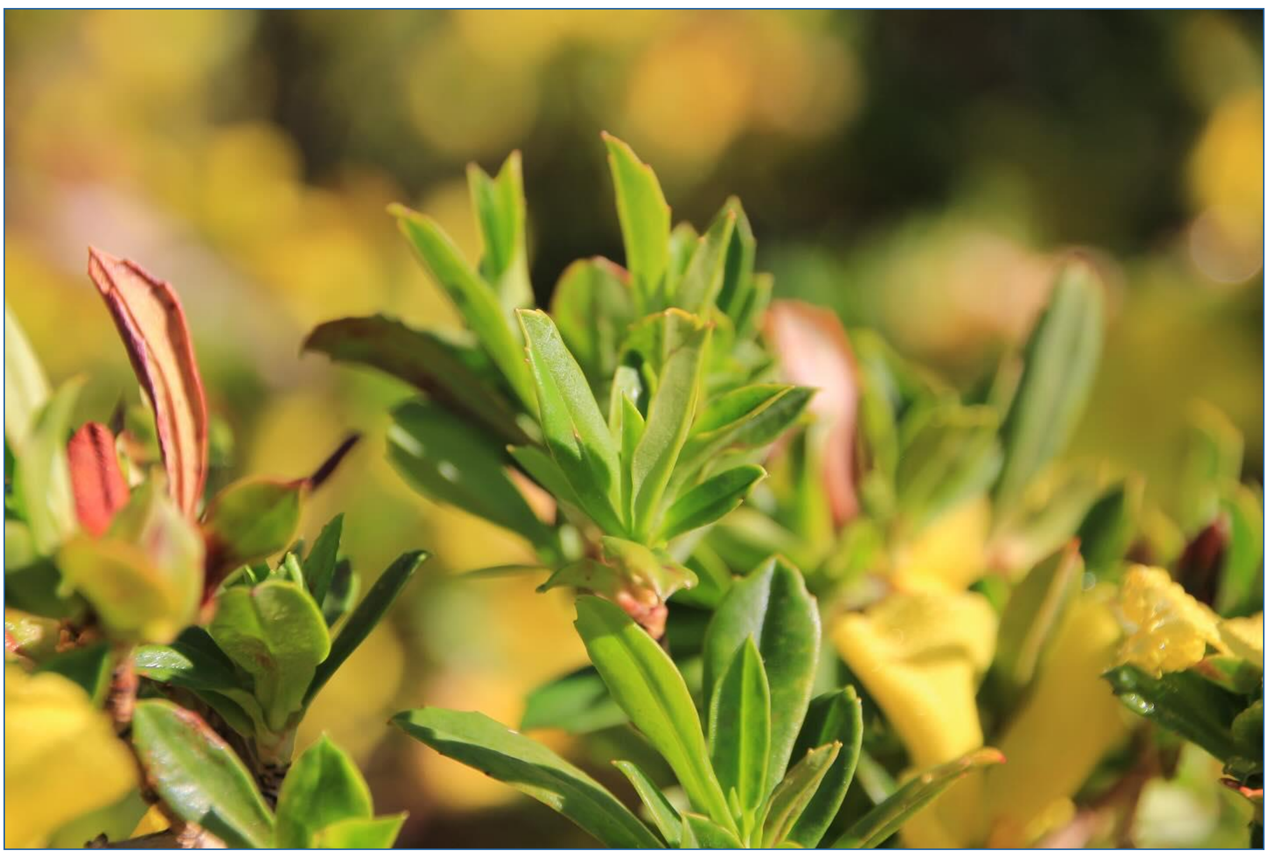
Cover image: Marsh Saxifrage (*Saxifraga hirculus)* Image: Francis Principe-Gillespie.

***Hibbertia cuneiformis*: text and photos Alan Ayton.**

The Cut leaf Hibbertia can be an erect or sprawling shrub and is endemic to the south west of Western Australia, it grows anywhere from .5 to 3 metres tall. The leaves are oblong to obovate or obtriangular in shape 15-50mm long by 5-30mm wide and glabrous. Flowers are 5 obovate shaped yellow petals 15-20mm in length making the flower 30-40mm in diameter. Flowering can be either January to March or June to November.

This can be found growing on white or grey sands, loamy soils, coastal dunes and swampy plains. I saw this in coastal habitat and also growing in the understory of the Karri Forests. Photos 3 and 4 are of plants in the Karri forests under *Eucalyptus diversicolor*, the rest of the photos are plants on white / grey sands on the coast.

Hibbertia cuneiformis on the white / grey sands on the coast.



Hibbertia is another amazing genus of plants containing about 120-150 species, with the majority being found in Australia. There are handful also in New Guinea, Madagascar and some pacific islands. This one is quite a spectacular species !

Planting to Assist Recovery : Max Coleman

Wych Elm seedling: this species has been devasted by Dutch Elm Disease. Image: Francis Principe-Gillespie.

This article makes a case for limited planting in wilding projects to assist the recovery of threatened species. It is also a commentary on what has become a polarised debate. The decision to plant is nuanced and often not an easy yes or no choice. Ron Summers, quite rightly, questioned the use of planting to recover Scotland's Caledonian pinewoods in a previous article in this series (*BW* 35: 338–346). The perception that planting is unnatural interference, more akin to gardening, is not uncommon. Peter Marren, in a discussion of his new book on rare plants (*BW* 36: 29–33), asks 'what wildness remains in a plant that owes its origin to pots in a greenhouse?' Yet this idealised view of the natural world as separate from humans does not reflect how many of us feel part of nature (Vining *et al*. 2008), or that Britain's natural environment is so widely modified that almost nowhere is without human influence. As wilding takes many forms, it is worth considering the opportunities that planting presents. Disagreements between those for and against planting have often revolved around whether to plant trees.

Richard Mabey, in his book *The Accidental Garden*, outlines the case against: ‘I’ve never understood those who believe that trees can’t prosper without human supervision, and how they imagine Britain became naturally forested before such intensive care strategies became fashionable’ (Mabey 2024). Oliver Rackham was unambiguous in his opposition: ‘Planting is not conservation, but an admission that conservation has failed’ (Rackham 2001). The view of tree planting as generally unnecessary is supported by the fact that habitat management often involves the removal of regenerating trees to maintain open heath, bog and grassland – an irony not lost on the critics of planting.

An increase in tree and shrub cover is often a desired outcome of wilding. Consequently, some wilding projects have opted to plant trees, sometimes on a grand scale. The decision to plant is likely to be influenced by the terms of government forestry grant schemes that require a certain density of trees and perhaps by a belief that it will speed up scrub and woodland development. In areas selected for natural regeneration, deer impacts need to be removed by fencing or reduced by culling to allow seedlings to establish.

Extensive natural regeneration has sometimes been achieved via this approach, such as at the Mar Lodge and Glenfeshie Estates in the Cairngorms National Park (Summers 2024).

The negative impacts of mass tree planting have also been highlighted. *The Scotsman* reported on an investigation by Scottish Forestry of the Muckrach woodland scheme, near Grantown-on- Spey (Hay 2024). Nearly one million trees have been planted here for climate and wildlife benefits, yet the investigation identified serious problems, such as planting on peat and over Black Grouse *Lyrurus tetrix* lek sites, leading some to describe the taxpayer-funded scheme as ‘de-wilding’. Ecologically damaging tree planting is nothing new. The scandal of tax breaks for planting on peatlands in the Flow Country of northern Scotland, now a UNESCO World Heritage Site, in the 1970s and 1980s is an infamous example.

Despite a history of the wrong trees being planted in the wrong places, tree planting is often presented as a panacea for both climate and wildlife. Because of this, there can be a potentially misplaced sense of doing ‘good’ associated with tree planting. Even when it does no obvious harm, the trees occupy space in the landscape and may act as a block to the colonisation of more ecologically appropriate species.

Nevertheless, many people have positive experiences of tree planting, and the point of connection with nature that planting can provide has value in terms of public engagement and winning wider support. The arguments against planting risk creating a false dichotomy and a failure to appreciate potential opportunities and benefits.

This article focuses on conservation translocation of threatened plants and draws on the experience of native species recovery work at the Royal Botanic Garden Edinburgh (RBGE).

The term conservation translocation has been widely adopted in recent years. It refers to the movement of species for conservation purposes and involves the release, or planting, of animals and plants into appropriate habitats. Guidance informed by the science has been published to share best practice (Soorae 2021; Gaywood *et al.* 2023) and Scotland was first to establish national guidelines (National Species Reintroduction Forum 2014). There have also been many high-profile recoveries of species on the brink of extinction and reintroductions of those already lost. Activity has mainly centred on larger, charismatic animals. This area of conservation was recently reviewed in *British Wildlife* (Gaywood *et al*. 2023) and is considered by some as a form of wilding.

Planting to initiate natural regeneration

The long-term goal of planting must be the natural spread of a species. If there is no recruitment then little has been achieved, even if the translocated plants survive. It is what happens post-planting that matters. The recovery of a species can only be regarded as sustainable if further human intervention is unnecessary. To answer the question posed earlier, regarding the doubted 'wildness' of translocated plants, it must be stressed that the hoped-for recovery will be achieved by plants that are 'wild' in the sense that they have arisen via natural regeneration. Intervention is simply a necessary step.

Viewed in this way, planting and natural regeneration are no longer contrary alternatives and can be seen as complementary. Planting is the precursor to natural regeneration, and natural processes embed recovery. This combination of the two approaches represents an overlooked middle way that has been called dynamic restoration (Collin & Bozzano 2015), a term in which the word 'dynamic' refers to the role of natural processes. But dynamic restoration has failed to make an impression, probably because it satisfies neither of the opposing camps in the debate. It is seen as too slow by advocates of planting and too unnatural by wilding purists.

Place is paramount

An aspect of botanical translocations that needs to be highlighted is that plants are rooted to the spot. This is so obvious that its consequences are easily overlooked. Unlike mobile animals, plants must find what they need in the places where they are planted. An obvious problem is that suitable sites may contain large areas of unsuitable habitat. Such spatial variability must be considered along with habitat and environmental preferences, including altitude, aspect, soil chemistry, microclimate, interactions with other organisms (such as pollinators and seed-dispersal vectors), other beneficial partnerships, disturbance to create regeneration niches and pathogens (Maschinski & Albrecht 2023).

Fully understanding the needs of a plant species can be extremely difficult, making the selection of appropriate planting sites hit and miss. Attempting to do this for what might be regarded as a ‘fussy’ threatened species can simply highlight knowledge gaps. Poor planning and limited understanding easily result in planting into unsuitable habitat. In contrast, animals are often able to move from a release site to find what they need. This means that research and planning are key and more plant-specific guidance on translocation is needed (Silcock *et al*. 2019).

Conservation horticulture

The RBGE’s Scottish plant conservation work has involved translocating threatened plants to wild sites since the early 2000s. Through this work, a new discipline – conservation horticulture – has emerged. Species are brought into cultivation and studied, including in terms of their genetic diversity, while at the same time they are propagated with the goal of returning plants to suitable habitats. This involves either reinforcement of numbers in existing populations or introduction to create new populations within the native range, sometimes at sites with no historical records of a species. Particular attention is paid to biosecurity, as the unintended release of pests and diseases could be disastrous for already-threatened plants. The RBGE’s expertise in this area has fed into the first published guidance on biosecurity for conservation translocation of plants (Mitchell *et al*. 2023).

Assessment of genetic diversity is carried out, because threatened species can experience problems due to low levels of diversity – for example, limited seed production due to self-incompatibility and negative effects caused by inbreeding.

Oblong Woodsia is one of the focal species in RBGE’s conservation horticulture programme. Image: Francis Principe-Gillespie.

If genetic problems are identified, steps to achieve ‘genetic rescue’, involving mixing of, or crossbreeding between, individuals from different populations, can be employed. Cases of low diversity across the entire British range can be addressed through the inclusion of plants from other countries where they are growing under similar conditions. The aim is to return genetically diverse, adaptable populations to the wild. Current species recovery work at RBGE, supported by the Scottish Government's Nature Restoration Fund, focuses on five trees: Wych Elm *Ulmus glabra*, Crab Apple *Malus sylvestris* and three hybrid whitebeam *Hedlundia* microspecies restricted to the island of Arran. In addition, the work includes five non-woody plants: Oblong Woodsia *Woodsia ilvensis*, Marsh Saxifrage *Saxifraga hirculus*, Small Cow-wheat *Melampyrum sylvaticum*, Alpine Blue-sow-thistle *Cicerbita alpina* and Whorled Solomon's-seal *Polygonatum verticillatum*. Each species is being planted across multiple sites involving many different landowners. Many of the partners' landholdings are effectively wilding projects.

Mobility and isolation

Rarer species that exist as isolated individuals, or as discrete populations that are not in reproductive contact with each other, can be viewed as priorities for planting because they are more likely to suffer the negative consequences of isolation and less likely to expand their range by colonisation of new sites. The mobile phases of a plant's lifecycle – pollen and seed – disperse through the landscape, sometimes over considerable distances. These movements can be sufficient to bridge gaps between populations. As habitat destruction and degradation increase the area of inhospitable land, however, the likelihood of this happening is reduced. Population declines and local extinctions can be caused by, and exacerbate the problems of, isolation. Crab Apple is a species with problems arising from isolation. This small tree is generally unable to self-pollinate and often grows as isolated individuals. Such trees produce limited seed, due to the absence of a pollination partner, or will be pollinated by nearby cultivated Apples *Malus domestica* and produce hybrid offspring. Genetic research has shown that apple hybrids are widespread and could cause ongoing erosion of the genetic integrity of native Crab Apple (Ruhsam *et al*. 2019; Worrell *et al*. 2021).

Cross pollination by species such as Common Carder-bee *Bombus pascuorum* may be crucial to the persistence of Small Cow-wheat populations.
Image: Francis Principe-Gillespie.

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Small Cow-wheat exists as small, isolated populations and in mainland Britain is now restricted to the Scottish Highlands, having been lost from England. Two plant–animal interactions may be key to its survival and mobility, both of which are poorly understood at present. The tubular flower structure is typical of species that rely on pollination by insects with probing mouthparts, and bees have been suggested as likely pollinators (Dalrymple 2007). During fieldwork by RBGE staff in Norway, to learn about the ecology of several species in the current recovery programme, the Banded Thintail hoverfly *Meliscaeva cinctella* was observed visiting Small Cow-wheat flowers. Wild Scottish populations of the plant are genetically distinct from one another, indicating little or no gene flow. In cultivation these differences are lost, showing that insect-mediated cross-pollination is mixing genes. Knowing which species act as pollinators and where they occur could help in the search for suitable translocation sites.

The second interaction that may be important for Small Cow-wheat involves wood ants *Formica* species acting as seed dispersers. Being an annual, Small Cow-wheat regenerates from seed each year, so effective dispersal of seeds is potentially of even greater importance than in perennial plants. The large seeds have a structure called an elaiosome at one end that is attractive to the ants as a food source. It has been observed that ants will carry the seeds to their nests, although this behaviour has not been seen in Scotland (Dalrymple 2007) and, oddly, wood ants do not appear to coexist with Small Cow-wheat in Scotland.

Translocation of Small Cow-wheat would ideally involve a better understanding of such interactions in Scotland. Planting at sites that lack potentially important dispersal vectors may be less likely to result in spread. Work with the James Hutton Institute is exploring the feasibility of dual translocation of both Small Cow-wheat and wood ants. Based on habitat preferences, Hairy Wood Ant *Formica lugubris* may be the most likely *Formica* species to act as a dispersal vector in Britain, but further work is needed to establish whether these species do have a mutualistic relationship. Intriguingly, observations by RBGE staff in Norway found that wood ants consistently coexist with Small Cow-wheat, although the ant in question appears to be a species not found in Britain – *Formica polyctena*.

Small Cow-wheat seeds have a fleshy structure (seen here on the right) which is attractive to species of wood ant.
Image: Francis Principe-Gillespie.

While interactions with ants are unknown in Britain, the Hairy Wood Ant *Formica lugubris* could be a potential vector for seed. Image: Francis Principe-Gillespie.

Hidden isolation

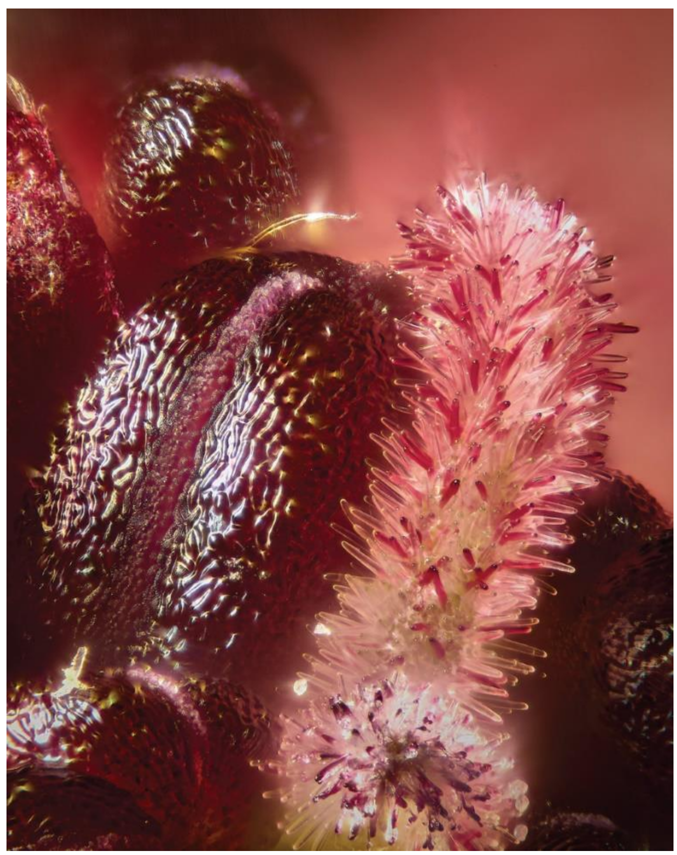
Sometimes isolation is not obvious. Wych Elm, like other elms, has been devastated by an aggressive form of Dutch Elm Disease *Ophiostoma novo-ulmi* since the late 1960s, with an estimated 100 million trees lost across Britain so far. Surprisingly, Wych Elm has not been identified as being of conservation concern. In Britain, the species is classified as Least Concern (LC), while in Norway and Sweden it is Endangered (EN) and Critically Endangered (CR) respectively. What the British conservation assessment fails to consider is that the flush of seedling regeneration, into gaps left by dead elms, is lost on a roughly 20-year cycle to subsequent waves of disease. The result is that the habitat provided by mature elms, with a characteristic community of associated species, is lost as well. Ecologists would describe the species as being functionally extinct across large parts of its range. The impact of this is seen in species that rely on elm. For instance, the lichen *Cerothallia luteoalba* declined rapidly in response to Dutch Elm Disease and is now Endangered.

Elms that have survived disease are so rare – possibly just 1% of the original population – that reproduction between them is highly unlikely. Survivors are ‘islands’ of adaptation in a ‘sea’ of susceptible individuals. Recovery work at RBGE is assisting the return of Wych Elm by managing pollination between survivors that have been exposed to disease for decades to create plants that have two promising parents. The first saplings produced in this way were planted in spring 2024. This is an experimental approach, and time will tell if the observed resilience to disease has a genetic basis and has been inherited.

Other cases of isolation that are not obvious are seen in Marsh Saxifrage and Alpine Blue-sow-thistle. In both species, populations with reasonable numbers of flowering spikes have turned out to be composed of just a few genetic individuals (clones) that have spread vegetatively (Finger *et al*. 2024).

Genetic studies have demonstrated low diversity at some sites (Finger *et al*. 2023). One population of Marsh Saxifrage in the Pentland Hills near Edinburgh appears to be reduced to a single clone. Low clonal diversity is likely to be responsible in turn for low levels of seed production.

Genetic rescue of Alpine Blue-sow-thistle, involving crossing Scottish plants with individuals from Norway and the Alps, has been trialled successfully at the Mar Lodge Estate in the Cairngorms National Park



Close-up of the anthers prior to pollen release (left) and stigma (right) of Wych Elm. Experiments by RBGE are aiming to propagate disease-resistant individuals of this species.
Image: Francis Principe-Gillespie.

Restricted ecological niches

Oblong Woodsia is a small mountain fern that suffered from intense collecting in the second half of the 19th century. This period of the Victorian era experienced a fern craze – pterid-omania – and entire populations were collected to extinction in the Moffat Hills within a few years of their discovery (Mitchell 1980). One reason for these rapid local extinctions is likely to be that the fern was never common. It is an example of a plant with very particular requirements, including unusual rock chemistry (Aguraiuja 2011). Unfortunately, the loss of so many populations, with very limited information recorded at the time, has made it hard to build up a picture of the typical habitat of this species.

Multiple past translocations in the Moffat Hills have failed, suggesting that planting sites may have been unsuitable.

Woodsia ilvensis. Image from SRGC Forum by Kristl Walek.

Observations made of Oblong Woodsia in other countries, including recently in Norway, are helping to guide the Scottish plant recovery work. One possibility is that this species needs more shelter and higher humidity levels than previously thought. The only British locality where the fern is expanding is in Cumbria, in a more humid, oceanic climate.

A lack of ecological understanding in the case of Oblong Woodsia could be used as an argument against planting. An experimental approach to translocation, however, could extend our knowledge. For example, translocation to the north side of a stone wall in Estonia has resulted in natural regeneration (Aguraiuja 2011).

Fortunately, the propagation of this species from spores is relatively straightforward, making it suitable for experimentation.

Scottish populations of Marsh Saxifrage suffer from low genetic diversity. Image: Francis Principe-Gillespie.

As well as exhibiting low genetic diversity, Marsh Saxifrage is a plant with very exacting requirements that are rare and hard to find. The species has declined because of agricultural improvement and former lowland sites have now been lost. The remaining populations are associated with small patches of vegetation around base-rich springs that produce flowing, oxygenated water. These conditions, and the vegetation community that they support, are quite different to the surrounding large expanses of more typical oxygen-poor, acidic bog.

Other species interactions

Pollen and seed dispersal have already been discussed as they often involve interactions with animal vectors. But it is also necessary to bear in mind any other significant species interactions that plants may have. Pathogens are an obvious consideration, and the overlooked impact of Dutch Elm Disease has been mentioned. Another critical interaction in nearly all plants is their root partnerships with mycorrhizal fungi. These trading partnerships, located at root tips, enable plants to gain access to water and nutrients in return for ‘payment’ to the fungal partner in the form of sugars. These mutualistic relationships are critical to nearly all plants and yet there are huge gaps in our knowledge. Relatively few studies have examined this mutualism, but there is evidence of the benefits of using fungal root partners during plant translocations (Maschinski & Albrecht 2023).

It has proved difficult to keep Whorled Solomon’s-seal healthy in cultivation as the foliage tends to yellow, giving the appearance of nutrient deficiencies. These symptoms could be the result of a virus, but another plausible explanation is that fungal root partners are absent. Maintaining the soil microbiome in cultivation is extremely challenging, given the strict need for biosecurity and the fact that plants are being grown in small containers.

Return of the alpine blue sow-thistle

Four small, isolated natural populations of Alpine Blue sow-thistle on inaccessible ledges in the Cairngorms have become critically inbred and produce little viable seed. Genetic studies confirm that interbreeding between these populations is not occurring (Finger *et al* 2023). At Mar Lodge Estate, in the Cairngorms National Park, the sustained culling of deer to allow tree regeneration has created opportunities for the introduction of Alpine Blue-sow-thistle, a species that is highly palatable to grazers and has been pushed to the brink of extinction by grazing pressure that do not replicate natural conditions. Nonetheless, plants translocated to wild sites without their root partners may become colonised by wild fungi as appropriate species could be widespread. The acquisition of fungal partners has been observed in translocated tropical orchids (Downing *et al*. 2017), but much more research in this area is needed.

A programme of crossbreeding at RBGE, including plants from Scandinavia and the Alps, has reversed the negative consequences of a restricted gene pool. Trial translocations at Mar Lodge have demonstrated the value of this ‘genetic rescue’ and that this species can thrive in upland woodland when deer numbers are reduced. Three years of monitoring have shown over 80% survival of the original plants. One thousand plants have been translocated in autumn 2024 to another four sites – Balmoral Estate, Mar Lodge Estate (two locations) and Loch Arkaig owned by the Woodland Trust.

Cross-breeding of Alpine Blue-sow-thistle has helped to increase the viability of the isolated and inbred Cairngorms population of this species.
Image: Francis Principe-Gillespie

Unusual biology

Any unusual biological characteristics should also be considered. The Arran whitebeams, all formerly in the genus *Sorbus* but now placed in *Hedlundia*, are a complex of three microspecies only found on the island of Arran, off the west coast of Scotland. The reproductive biology of these trees is unusual and involves the creation of seedlings that are genetically identical to the mother tree by an asexual seed-production process called agamospermy. The origin of these microspecies is through a series of hybridisation steps involving Rowan *Sorbus aucuparia* and Rock Whitebeam *Aria rupicola*. It seems that part, or all, of the sequence has been repeated more than once, as similar-looking clones have been identified by genetic fingerprinting. Consequently, conservation of the Arran whitebeams is as much about enabling the process of ongoing change as it is about any of the recognised microspecies (Ennos *et al*. 2012).

In a healthy state, the whitebeam populations on Arran would continue to generate new microspecies. The main threat to these trees is that deer numbers are too high to allow natural regeneration. This problem is exacerbated by intrinsically low seed viability. In this case, other vegetative methods of propagation are biologically equivalent to seedling regeneration. Hence, rooting cuttings and the production of plants through micropropagation (a sterile technique using cell cultures to create clones) are options and both approaches are being explored.
Another example of the need to understand the complex biology of a species is seen in Small Cow-wheat. This annual is also a hemiparasite – a plant capable of photosynthesis but needing the resources of a host plant. Not only must it regenerate from seed each year, as mentioned earlier, but it also needs to locate and connect to the roots of a host, such as Rowan or Norway Spruce *Picea abies*. There is uncertainty about the host plants being used in Britain. Work is also being done to trial the use of seed, planted directly into suitable habitat where potential hosts are common, versus translocation in pots of a selected host already connected to Small Cow-wheat plants. Results indicate that direct sowing can be successful and this both simplifies the task and reduces the biosecurity risk of translocating soil.

The dilemma of translocation

For plants with highly specific requirements that may not be fully understood, there is an obvious dilemma. By translocating to sites with existing populations (or to historical sites where a species may cling on unnoticed) we might improve the chances of returning plants to the right habitat. However, this irreversibly alters the genetic makeup of the population. For some people this represents an undesirable outcome that could negatively influence local adaptation and reduce evolutionary fitness. Alternatively, translocations that avoid such sites, while they seek to preserve the native genetic makeup, may have a higher failure rate, owing to sites not meeting the preferences of the species concerned.
Clearly, a case-by-case approach is necessary, following scientific guidance. In reaching decisions it is worth remembering that very little habitat can now be regarded as entirely natural, and human influence has pushed many species to the brink of extinction. It can be argued that we have a moral responsibility to restore species where we have intentionally or accidentally removed them from ecosystems. The more connections we can restore in the intricate web of life, the better ecosystems are likely to function. The introduction of non-native stock to an existing native population does not necessarily compromise the hard-to-define concepts of nativeness and wildness. A population that is critically inbred and isolated may have no future unless genetic diversity can be increased. It could be contended that a decision

against translocation compounds the negative effects of past habitat degradation and loss. The issue of translocation to aid species recovery is undoubtedly complex, and debate about whether it is the right thing to do will continue.

Conclusion

Planting ought to be seen as a last resort in wilding projects and should be carried out with great care and attention to the ecological requirements of the species concerned. There is a need to follow best practice and inform interested parties, particularly those involved in biological recording. But a case can be made for limited planting of threatened species. In some instances, this may be the only way of initiating recovery in species that are unlikely to colonise and recover by themselves.

Much positive publicity for nature conservation has been generated from animal reintroductions. The animals involved are often presented as flagship species or ecologically important ‘ecosystem engineers’ that can create a step-change in the restoration of nature. Plant translocations, guided by the science, can feed into the developing view of nature as resilient and able to recover when given the chance (Tree & Burrell 2023). That half the species in the RBGE’s current plant recovery project are trees is no coincidence. Trees are unrivalled among plants in terms of their power to engage. Trees also create habitat for diverse communities of associated organisms. In some instances, they can be so important for the structure and dynamics of forest ecosystems that they are regarded as ‘foundation species’ (Ellison *et al*. 2005). In this respect they are comparable to the animals described as ecosystem engineers. There is no inherent incompatibility between wilding and planting, and it is hoped that the number of projects that have successfully translocated threatened plants to appropriate sites will continue to grow.

Apart from being examples of recovery that engender hope for the future, initiatives of this kind are also opportunities to learn about the ecology of the plants involved. Conservation horticulture, and the associated science, is at the forefront of improving our understanding of some of Britain’s most threatened plant species.

*This piece forms part of the Wilding for Conservation series – see the February 2021 issue (*BW *32.4) for an introduction to the series, along with its first two articles.*

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