MONTANE SCRUB ACTION GROUP

Scrubbers' Bulletin 6

Scrubbers' Bulletin No. 6, May 2007.

The Bulletin of the Montane Scrub Action Group, a partnership of individuals supported by their organisations.

The current membership of the group is

Diana Gilbert, The Macaulay Institute
David Mardon, National Trust for Scotland
John Holland, Scottish Agricultural College
Phil Baarda, Scottish Natural Heritage
Rob Soutar, Forestry Commission Scotland
Billy Bodles, Highland Birchwoods
Adam Powell, Trees for Life
Hugh Chalmers/Philip Ashmole, Borders Forest Trust
Keith Miller, Mountaineering Council of Scotland
Deborah Long, Plantlife

We have welcomed Hugh Chalmers and Philip Ashmole as new members to the group since the last issue. They share representation for Borders Forest Trust and bring a wealth of practical experience from their work at Carrifran. Michael Scott is no longer an active member but we are grateful for his continuing support as Chair. Following his move from Highland Birchwoods to SNH we now welcome Phil Baarda as the SNH representative, while Billy Bodles replaces Phil for Highland Birchwoods.

Thanks and acknowledgement of their commitment and valuable participation over the last 10 years are due to Michael Scott, Alison Hester (The Macaulay Institute), both founder members of the group who are no longer able to commit to attending meetings, although both will remain in communication with the group. We would also like to thank Jenny Bryce and Ro Scott who both made useful contributions during their short-term membership representing SNH following Angus MacDonald's departure.

Welcome to issue number 6 of Scrubber's Bulletin.

If any readers are not on the circulation list but wish to be, or wish to be removed from it, please let us know and we can add your name to or delete it from the list.

Contributions for the Bulletin should be sent to: David Mardon, The National Trust for Scotland, Lynedoch, Main Street, Killin, FK21 8UW, **in MS Word** please, on CD, or by email to dmardon@nts.org.uk

If you have been sent a paper copy, but do have an email address, please email it to us.

We are most grateful to the contributors to this issue.

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Heritage Lottery Grant awarded to Action for Mountain Woodlands Project

Billy Bodles, Highland Birchwoods

Great news! The Action for Mountain Woodlands Project has been awarded a Heritage Lottery Grant against strong competition.

In February representatives from the HLF attended a meeting at Highland Birchwoods to discuss the project in detail and in the afternoon went on a site visit to Cairngorms Mountain; expertly led by Jim Cornfoot of Cairngorms Mountain Limited. Jim explained the importance of the mountain project and the work and activities the grant would help to fund within the Cairngorms.

The Action for Mountain Woodlands project is a big undertaking, helping to conserve and restore remnants of mountain woodlands on six sites throughout Scotland: Beinn Eighe, Cairngorms, Clyde Muirshiel, Fealar, Glenmore and the Merrick. Project activities will include survey work to assess the habitat condition, interpretation, education and promotional activities to raise people's awareness and appreciation of mountain woodlands.

Beinn Eighe is Britain's oldest National Nature Reserve encompassing a vast area stretching from loch-side to mountain summit. Activities planned as part of the Action for Mountain Woodlands project include:

- A 3-d interactive exhibit in the new visitor centre;
- 'Enhance interpretation at the site' through the design of a new mountain trail leaflet, interpretation markers and information panels specific to mountain woodlands.

The Cairngorms is the largest area of artic mountain landscape in Britain and is home to 25% of the UK's threatened bird, animal and plant species. In recent centuries extensive areas of mountain woodland have been lost due to unsympathetic land management practices and overgrazing. Project activities include:

- Enhancement of the existing Cairngorms wild mountain garden by improving the mountain plant collection, producing a new trail leaflet to strengthen people's understanding and appreciation of mountain woodlands and employing a seasonal gardener to act as an on-site interpreter.
- Education and interpretation facilities for visitors and school groups will be enhanced by the creation of a series of information panels and a mountain woodland exhibit illustrating the sub-artic mountain habitats of the Cairngorms.
- The project will also assist in the extension of the footpath network to improve public access to the Coire Cas.

Clyde Muirshiel Regional Park in west central Scotland is an area of spectacular scenery which is home for rare wildlife such as hen harriers and peregrine falcons. There has been a dramatic decline in areas of juniper scrub; the increasing isolation of the surviving plants decreases the likelihood of any natural regeneration. The

Action for Mountain Woodlands project aims to improve the condition of mountain woodlands by:

- Protecting and restocking the remnant areas of juniper scrub.
- Organising volunteer days to collect, propagate and plant new juniper plants.
- Producing a leaflet to raise the awareness of the importance of juniper woodland in the Clyde Muirshiel Regional Park area.

Fealar Estate lies in the Grampian Mountains and its mountain woodlands comprise a wide range of species. A species of particular importance is the dwarf birch (*Betula nana*) which is threatened by grazing. In order to secure the future of the species on the site a deer fence will be erected to protect the dwarf birch from grazing pressure. The impact of this work will be monitored and used to guide upland management practices throughout Scotland.

Glenmore Forest Park in the Cairngorms comprises some of the best remnants of Caledonian Pinewood in Scotland and provides excellent habitat for many internationally rare species. Mountain woodland in the park includes sub-artic willow, juniper scrub and a naturally regenerating Scots pine treeline. Activities designed to improve the condition of the existing mountain woodlands include:

- Removal of non-native conifer seedlings and establishing protected enclosures for mountain scrub species enabling them to act as a seed source for future expansion.
- An inventory of mountain woodland.
- Installation of an interactive mountain woodland exhibit at the Glenmore visitor centre and interpretation panels on the footpaths will raise the level of public awareness and appreciation of mountain woodlands.

The Merrick is the highest mountain range within Galloway Forest Park. It is recognised for its sub-artic willow and juniper scrub and it is one of only three sites south of the Highlands on which downy willow (*Salix lapponum*) can be found. The aim is to restore 1000 Ha of mountain woodlands in the Galloway Hills and to assist the recovery of montane scrub species. Activities planned as part of the project include:

- Volunteer surveys to establish the condition of mountain woodland species in the Galloway Hills.
- Establishment of a 10 Ha area of new woodland in partnership with local volunteers.
- Creation of a mountain woodland garden to enhance on-site interpretation at the Glentrool visitor centre.

The official launch of the project will be in summer 2007 and we will be providing regular site updates.

Highland Birchwoods would like to thank everyone for their contributions to the project and for helping to safeguard and restore Scotland's mountain woodlands.

Restoring the natural treeline at Carrifran

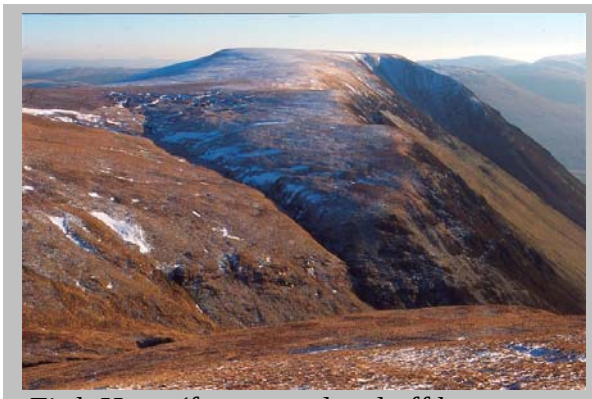
Hugh Chalmers and Philip Ashmole
(Borders Forest Trust)

The Carrifran Wildwood project of Borders Forest Trust entered a new phase when the main scheduled planting in the valley was completed at the end of 2006. Although beating up and tree maintenance in the planted area will be needed for several years, the main focus can move uphill. Members of the Wildwood Group have always been aware that the great altitudinal range of the Carrifran site (165-821 m) provides a unique opportunity to re-create the full range of habitats that would have been natural to the Southern Uplands before humans began to have a major impact. Restoration of low-ground habitats is relatively straightforward (although past and future changes in climate have to be borne in mind), but treeline woodland and scrub habitats present a greater challenge. There are ecological and practical difficulties, and also the problem that we lack knowledge of the natural high-altitude habitats that we aim to recreate.

The solution commonly advocated is to allow treeline habitats to develop by the gradual upward spread – through natural regeneration – of native woodland already present at lower altitudes nearby. There are several problems with this approach. First, the low input of seeds, coupled with scarcity of microsites suitable for germination and low growth rates of seedlings at high altitude, must lead to slow establishment. Second, it is hard to maintain continuity of herbivore control and the commitment of managers and funders over the required long periods (Mardon 2003). Third, because most surviving native woodlands are impoverished, there is a danger of eventually producing treeline woodland and scrub of unnaturally low diversity (Watson 1977, Ashmole 2006). Planting of small groups of shrubs and trees to provide seed sources at high altitude could ensure presence of a full range of species, but there seem to be no examples demonstrating that this can produce extensive areas of treeline habitats on a reasonable timescale.

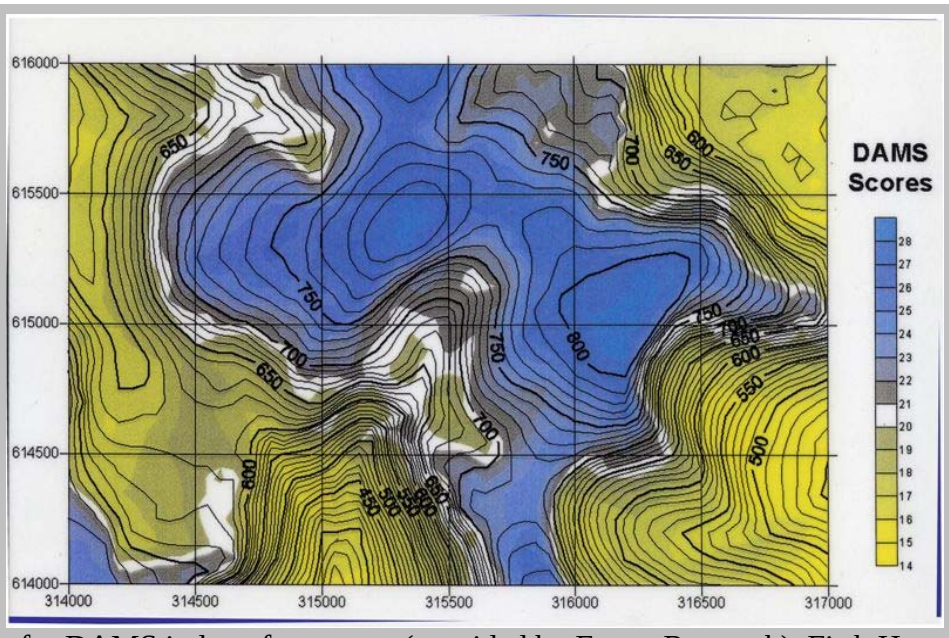
The Montane Scrub Action Group (MSAG) has repeatedly pointed out the 'Cinderella' nature of montane scrub, and how it has been neglected as a habitat which has almost disappeared, and is often remote and so “out of sight, out of mind” (Scott 2000, Gilbert & di Cosmo 2003). However, there is a growing awareness of this issue among people who spend time on the hills, typified by volunteers at Carrifran, many of whom have experience of walking through montane scrub habitats in places such as the Alps, the High Tatras and Scandinavia. They are conscious that there is something missing on our hills, and with that awareness comes the feeling of walking in Scotland through a 'wounded landscape'. The recent Scottish Mountaineering Trust publication (Kempe & Wrightham 2006) is an expression of this, and is specifically written for hillwalkers to increase their knowledge of upland habitats. We hope that this new awareness of our substantial and widespread natural habitat loss will eventually result in better funding. Perhaps the changes in agricultural support will mean that more landowners will be willing to remove domestic grazing and 'farm' montane scrub for its wildlife and landscape (and be paid for the operation).

In the meantime, there are some opportunities for grass-roots initiatives. Members of the Wildwood Group believe that public enthusiasm for ecological restoration is fuelled mainly by demonstrations that it can dramatically enhance the biological diversity, interest and beauty of the countryside. At Carrifran, therefore, the plan is to proceed boldly by planting, creating around 40 hectares of semi-natural treeline habitat – including extensive areas of open ground – in two parts of the site, linking the restored native woodland within the valley to the open heathland of the summits. The current work is in the hanging valley of Firth Hope, between 600 and 750 m. This initiative is pushing the limits of native woodland establishment to heights where it has rarely been attempted in Britain, although ambitious schemes are being undertaken by the National Trust for Scotland on the Tarmachan range in Perthshire and by Trees for Life in the northwest Highlands.



Firth Hope (foreground and off bottom left), Carrifran Gangs (757 m) and the Little Firthhope Burn (centre) with the exclosure (not visible) just below its main fork. Photo: Philip Ashmole.

Forest Research has collected data on accumulated temperature (AT: degree-days above 5^{o}C) and relative windiness (DAMS: Detailed Aspect Method of Scoring for exposure, based on tatter flags) in different parts of Scotland. Analysis of the limits of existing woods suggest that land in the Highlands with AT below 500 or DAMS scores exceeding 24 does not support woodland or scrub (Hale, Quine & Suárez 1998). Land with AT 500-690 and DAMS 19-24 is considered capable of supporting non-commercial forestry, and it is suggested that establishment of treeline woodland in the less extreme parts of the latter zone might lead to extension by natural regeneration into colder and more exposed areas close to the biological limits of tree growth.



Scores for DAMS index of exposure (provided by Forest Research). Firth Hope is the hanging valley in the centre, north of the main Carrifran valley and flanked to the northwest by Firthhope Rig (800 m) and to the east by White Coomb (821 m).

In Firth Hope at Carrifran, the DAMS exposure index gives scores of 19-23 and the AT figures are in the range 500-650, suggesting that some woody species could grow there. The underlying geology comprises heavily folded Lower Silurian greywackes, shales, siltstones and mudstones. Talus deposits and exposed scree are common on the slopes of Firthhope Rig and in the channel of the burn. Some of the shales and mudstones are calcareous in nature and their outcrops can support calcicolous vegetation. The soils vary from thin, free-draining brown earths on the steeper slopes through peaty mineral soil on sloping ground to pure peat on the higher plateaus and in the wetter mires; some gleyed mineral soils are also present (Adair 2005).

Tipping (1999) studied pollen and macrofossils in the peat from the site at 620 m at Carrifran where the 6000-year-old Rotten Bottom bow was found. Remains of wood identified as *Salix* show that willows once grew on the plateau. The pollen record cannot prove what other trees and shrubs grew immediately around the site because pollen can travel upwards in the wind. However, Tipping's sophisticated analysis strongly suggests that hazel grew on the plateau between about 7000 and 4000 years ago. Birch and alder may also have been present during some of this time, with oak and elm at least common nearby; data are not available for rowan. At about 5600 BP there was a massive increase in *Calluna* (also shown in many other areas) which is poorly understood but possibly reflects a situation with more open woodland and low intensity grazing by domestic stock. However, tree pollen declined only gradually until the last two millennia, during which human influence increased.

Constructing the 40 m x 40 m trial exclosure at 690 m on the Little Firthhope Burn, May 2002. Photo: Philip Ashmole.

Experience in a trial exclosure established in spring 2002 showed that a variety of trees and shrubs including Scots pine, juniper, downy birch, rowan and downy willow can survive and grow slowly as high as 690 m under current conditions. Other species likely to be viable in parts of Firth Hope include hazel, aspen, bird cherry, hawthorn, montane goat willow, grey willow and eared willow, while holly and alder might also survive. Provenance of planting stock is clearly an issue in these severe conditions. As with the planting elsewhere on the site, nearly all of the seed is collected by Wildwood volunteers in relict woods as close as possible to Carrifran. For planting of the treeline woodland, special attempts are made to use high collecting sites, though none are comparable in altitude to Firth Hope. Some birch and rowan seeds come from relict trees high up in Carrifran valley.

The silvicultural approach of the Wildwood project in the treeline work is minimalist. Apart from the trial exclosure, no fencing of the treeline woodland is being used, although the whole Carrifran site has a perimeter stock fence to exclude sheep and feral goats. Roe deer are rigorously culled. No herbicide or mounding is being used, but an area of about one square metre is screefed and the substrate broken up with a spade or mattock, after which 100 g of a P-K fertiliser is applied. Protection from herbivores (mainly mountain hares and field voles) varies with the species but

involves 20 cm voleguards and chicken wire or plastic mesh guards (<50 cm high) supported by canes. The fine-grained patchiness of the substrate precludes the use of a detailed planting plan: instead, planters are given general guidance and then asked to judge the appropriateness of each microsite for planting only after investigating the substrate. Planting is avoided where peat is deeper than about 20 cm and species are matched to microsites.

One constraint is imposed by the designation of the whole of Carrifran as an SSSI and Special Area of Conservation (SAC), which requires the maintenance of specified habitat types. Much of the vegetation is anthropogenic grassland, but at the highest levels there are montane moss-heaths of prostrate heather with blaeberry and crowberry. Fragments of this habitat survive in only a few places in the Southern Uplands and deserve preservation, although those in the Moffat Hills are impoverished (Ratcliffe 2007), now apparently lacking bearberry and with woolly fringe moss (*Racomitrium lanuginosum*) largely confined to scree patches. There is also a need to preserve enriched flushes with special montane flora including the alpine fox-tail grass (*Alopecurus alpinus*).

In Firth Hope there will be no planting above the transition to prostrate moss-heath, which typically occurs around 750 m. The sensitive flushed areas have been mapped (and marked on the ground) with support from Scottish Natural Heritage, so that wide unplanted zones can be left around them. Elsewhere, the species mix is adjusted to suit local conditions. The most widespread community, on peaty podzols and patches of well-drained mineral soil, will have dominant juniper (prostrate at the highest levels) along with downy birch, rowan, goat willow and aspen. Soligenous mires in the wet central part of Firth Hope will eventually have a patchy low canopy dominated by eared and grey willow, with occasional downy birch, bird cherry, aspen and goat willow in drier spots. Protected dry and sunny areas may also carry hawthorn, hazel and holly, while flushed crags and shelves within the channels of the burns will be suitable for downy willow.

The second site at Carrifran where there are plans for establishment of treeline woodland by planting is Rispie Lairs, an open corrie between 500 and 650 m below Saddle Yoke near the western boundary of the site. It is suitable for establishment of juniper woodland with downy birch, rowan and perhaps Scots pine.

Saddle Yoke and Rispie Lairs (centre); the slopes up to the crags have recently been planted. Photo Philip Ashmole.

A fundamental aspect of the Wildwood project is that it comes from the grass roots, with continued participation of volunteers in all aspects of the project, as well as professional management input (Ashmole & Chalmers 2004). For the treeline work, it was decided to try to plant at least half of the trees with volunteers, starting in early spring each year, but to use contractors to complete the planting as necessary. A good start has been made in 2007. A helicopter lift, needed to get 3000 trees and planting materials up to this remote site at 650 m in Firth Hope, was finally successful

Volunteers planting trees in wire-netting cages in Firth Hope, February 2007.
Photo: Mike Baker.

on 6th February after many postponements caused by bad weather. Planting was started on the weekend of 17-18th February, when five hardy people camped overnight in subzero temperatures but fine weather; they were joined by other volunteers on both days. A similar event on 14-15th April and small-scale work on other days gave a total of 1500 trees planted by volunteers; 300 more are scheduled for planting on 19-20th May, and the remaining 1200 have been planted by two of our regular contractors.

It is important to emphasise that there is no intention of establishing a continuous blanket of trees over the summits of the Moffat Hills. The aim is to create natural looking montane scrub and treeline woodland habitats in a mosaic including large open areas, with patches of bent and wind-clipped dwarf trees, ribbons of woodland along watercourses and clumps of bushes hugging the ground in damp hollows. The woody species will gradually start to provide cover for several kinds of birds, along with resources for a whole array of insects and other animals.

Establishment of trees and shrubs in such high and exposed situations is slow and difficult, making it unsuited for support by a conventional grant system. Public funding for the actual planting of treeline woodland at Carrifran has not been obtained. However, Scottish Natural Heritage has supported surveys required for planning the initiative and is funding work done by the Project Officer with volunteers, while Forestry Commission Scotland has provided valuable advice. Contributions towards direct costs have been made by the Konrad Zweig Trust, Scottish Mountaineering Trust and HBOS, and many private individuals and charitable trusts contribute through their donations to the Carrifran Wildwood project as a whole. Although dependence on independent funding sometimes leads to difficulty, it has advantages in this high-altitude work, where the risk of setbacks is high and adaptive management is necessary, since it allows greater flexibility in both procedures and timescales, and is likely to lead to a better final result.

The Wildwood Group, comprising all the current supporters of the Carrifran project, is confident that this pioneering initiative will in due course lead to a natural looking treeline zone in one part of the Southern Uplands, greatly enhancing the landscape and increasing diversity of both fauna and flora.

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"Biodiversity: taxonomy, genetics and ecology of sub-arctic willow scrub" (SEERAD Commission No. RBG/837/01) - Scottish Montane Willow Research Group

Introduction

Willow scrub has been in decline in Scotland for some years and efforts at halting or reversing this decline have been hampered by a lack of data about the biology of sub-arctic willows. Willows in general have always had a somewhat fearsome reputation for taxonomic complexity due to a propensity to hybridize with one another and there was a need to find out whether in fact the entities that we call sub-arctic willows are clearly defined taxonomic units or whether the species barriers have broken down so comprehensively as to render sub-arctic willows indefinable as species. The existing fragmentation of sub-arctic willow populations into mostly small remnants on ledges and other localities inaccessible to grazing animals also led to concerns that these populations may have suffered losses of genetic diversity due to reduced gene flow and that the smaller populations may be susceptible to inbreeding depression. Our lack of knowledge also extended to the ecology of these willow species in that we did not know what the main requirements for successful recruitment of new generations of willows were, what ways in which they might be affected by grazing or how they interact with other taxonomic groups such as fungi.

In the last Scrubbers Bulletin (No. 5, May 2003), we introduced a large multidisciplinary, SEERAD funded project that aimed to address these questions and knowledge gaps. Here we present some of the key findings from the project.

Key findings

Although the project finished in 2005, full assessment of the data is still ongoing. However, there are several key findings that can be highlighted for their conservation implications for the willows.

- Genetic analyses of reference populations showed that all examined species were distinct except *S. myrsinifolia* and *S. phylicifolia* which we were unable to distinguish. Thus for the vast majority of taxa, hybridisation has not led to major blurring of species limits over broad geographical scales, and hence species-based conservation programmes are appropriate.
- There were some instances where hybridization was more prevalent among other species. For example, at some sites *S. lapponum* and *S. arbuscula* appeared to hybridize freely. It is not currently clear what the factors driving this are. However there is some evidence to suggest that, in accordance with prevailing hybridization theory, it is more likely to occur where there are serious imbalances in relative species abundances.
- Despite field observations suggesting that current levels of seed production in *S. lanata* and *S. lapponum* at one of the largest sites at Corrie Sharroch are very low, molecular analysis showed that the vast majority of individuals there have been derived sexually.
- There appeared to be no difference between *S. lanata*, *S. lapponum* and *S. herbacea* in diversity levels within populations in spite of their different abundance. We also found that all three of these species showed some evidence of low but significant genetic differentiation between populations. Thus the rarity of *S. lanata* is not apparently associated with high population

differentiation. This suggests either high levels of gene flow between populations or limited divergence since fragmentation. It is not possible to distinguish between the two at present, but the latter seems most likely. The longevity of willows may have led to limited generations since the populations have been fragmented and hence limited opportunities for differentiation via genetic drift.

- *Salix herbacea,* and probably also other sub-arctic willows, support a rich diversity of ectomycorrhizal fungi. Many of these are arctic-alpine specialists that are probably restricted to this habitat. As an example of the richness, we recorded 33 species of ectomycorrhizal fungi with *S. herbacea* at a single site.
- Ectomycorrhizal inoculum available to willows planted in upland sites appears to be low in abundance and diversity.
- *S. lanata* is less susceptible to rust infection than other sub-arctic willow species. Although there is a lot of variation, some willow individuals of species other that *S. lanata* can be very heavily infected. It is unclear what the implications of heavy infection are for reproductive fitness.
- We recorded significant year-to-year variation in seed production of *S. arbuscula* which may be related to the weather. In addition, very little seed was dispersed away from parent plants over the course of two years. Inadequate drying of seed hairs to facilitate wind dispersal may have resulted in most of the seed being washed down directly beneath parent plants.
- Browsing reduced seed production of *S. arbuscula* and also possibly had a negative impact on reproductive success due to the removal of catkins resulting in reduced attractiveness to pollinating insects.
- Ground disturbance favoured germination and survival of both *S. arbuscula* and *S. lapponum* and slugs were identified as a significant cause of early seedling mortality. Voles caused significant damage to year-old seedlings though this did not usually result in mortality.

The overall picture is of scattered populations of taxonomically discrete sub-arctic willow species representing fragments of a once more widespread habitat. Due to the relatively long generation times of willows, fragmentation may still be too recent to have resulted in significant losses of genetic diversity. Current reproduction is uncertain and appears to require a coalition of factors to include a good seeding year coinciding with good drying conditions at the critical period and available areas of disturbed ground. It may be that sufficient amounts of seed required to exploit available disturbed microsites and survive slug predation can only be produced once the reproductively mature population reaches a critical mass.

Conservation implications of the data

Planting material derived from hybridizing populations should be avoided where known. The safest sites for seed collection in this respect are where parent species are growing alone or with few other willow species. Sites where willow species co-occur in seriously imbalanced proportions should also be avoided. Balanced populations should be promoted in areas of new planting through symmetrical planting ratios.

Our data suggest that even the smallest fragments represent a useful genetic resource. These patches should not be considered ‘dead-ends’ beyond hope. They represent both potentially useful sources as donors for new populations/ex situ

collections, as well as reservoirs of diversity for the expansion of existing sites. In this respect, it is not too late to restore and expand populations of these species.

Since montane willow species like *S. lanata* and *S. lapponum* reproduce predominantly by sexual reproduction, restoration programmes should focus on large numbers of different genotypes if they are to match natural populations (rather than multiple replicates of vegetatively propagated individuals). Ensuring genetic diversity within new and expanded willow populations may also be important in order to minimise the risk of catastrophic pathogen epidemics.

The ultimate aim must be to restore naturally regenerating populations of willows. Therefore management to facilitate sexual reproduction by avoiding excessive large mammal grazing is a necessary component of willow conservation as willow populations are unlikely to expand via vegetative growth and dispersal. However, care will need to be taken to ensure that sufficient areas of bare ground are available for seed germination and establishment. In many cases this will be achieved through the natural dynamics of the mountain terrain. In other cases though, some level of grazing and ground poaching by large herbivores may also be necessary. Small populations will initially need to be boosted through a programme of planting in order to reach a regeneratively sustainable size. Our data show that slug predation is a significant cause of mortality among early stage seedlings and therefore planting one-year old stock is advisable though these should be protected from voles.

It is not possible to state the minimum viable population size for sub-arctic willows but we suggest that fragments with population sizes of less than 50 are of conservation concern as it would take few generations or environmental catastrophes to lose diversity or whole plants.

Being restricted to a particular altitudinal zone, sub-arctic willows have the potential to host other taxa that are of considerable conservation interest and should be valued for this role in upland biodiversity. *S. herbacea* supports a high diversity of ectomycorrhizal fungi, many of which are arctic/alpine specialists found only in this habitat. Given the widely understood functional significance of ectomycorrhizal associations, it is advisable to carry out trials to assess the benefits of inoculum enhancement for willow establishment.

Conclusion

This project has shown that populations of sub-arctic willows in Scotland are taxonomically coherent and genetically diverse. They support and interact with a wide diversity of associated species and reflect an important component of montane biodiversity. The ecological and climatic conditions required for successful reproduction and establishment of willow populations are relatively uncommon. It is uncertain what the implications of climate change for this pattern of required conditions will be. However, it is clear that intervention is required in the short-term to increase the size of existing populations and begin the expansion of these species by establishing new populations in order for them to have any chance of meeting future challenges.

For more information visit the project website at http://rbg-web2.rbge.org.uk/willow/ from which the project Final Report and also a summary of the results can be downloaded.