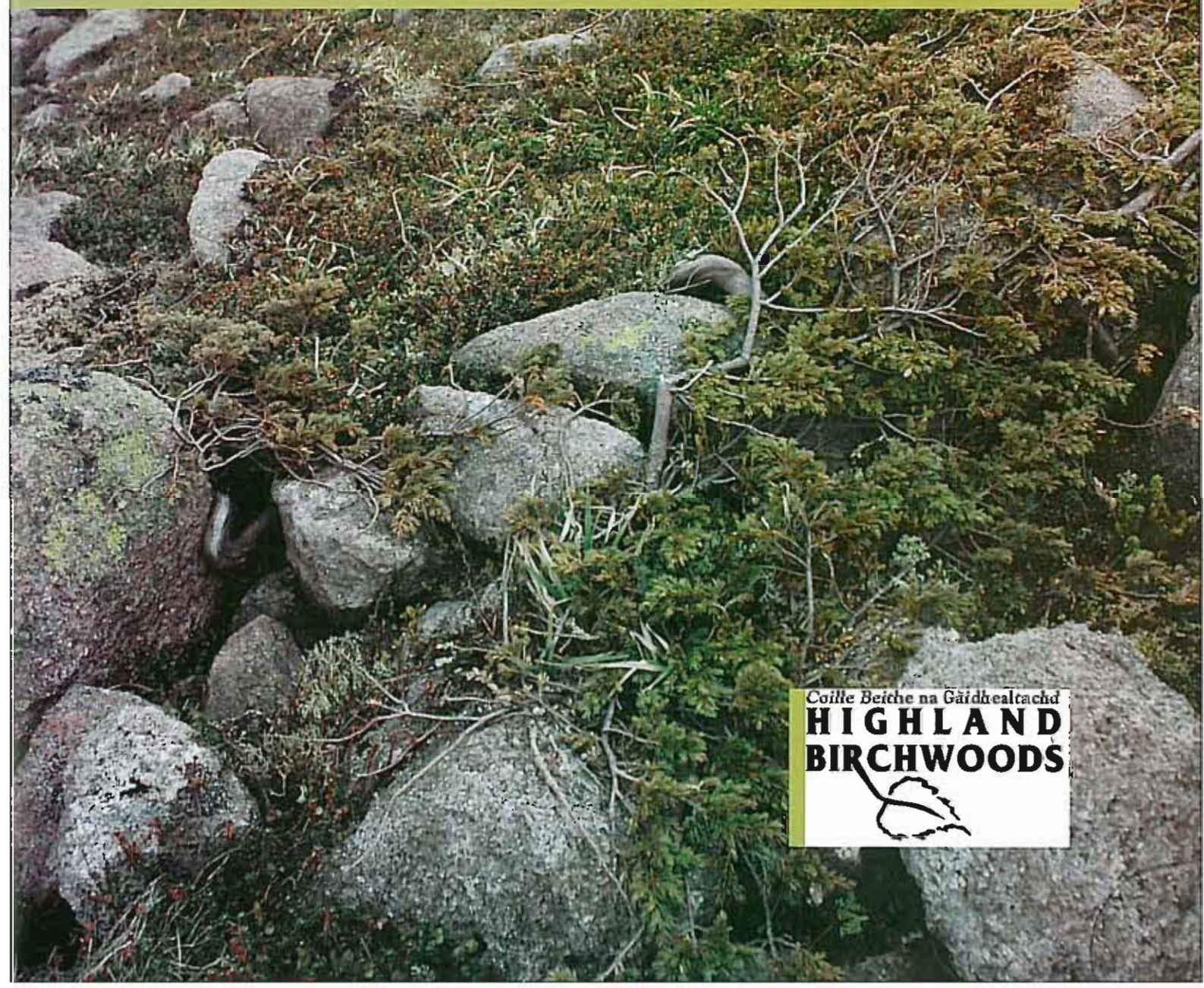


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MONTANE SCRUB: THE CHALLENGE ABOVE THE TREELINE



Coille Beithe na Gàidhealtachd
**HIGHLAND
BIRCHWOODS**



Published by Highland Birchwoods. Any enquiries should be addressed to Highland Birchwoods at:
Littleburn, Munloch, Ross & Cromarty IV8 8NN.

ISBN 0 9536447 4 X

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This report should be cited as follows:

Gilbert, D. (ed.) (2002) *Montane Scrub: The Challenge above the Treeline*. Highland Birchwoods, Munloch.

Photographs:

Front cover background; Dwarf juniper at Loch Etchachan; David Mardon

Front cover insets (left to right); *Betula nana*, *Salix reticulata* (male), *Salix myrsinitis* and *Salix lanata*; all David Mardon

Main document: Page 13: illustration by Claire Hewitt; page 14: all Neil MacKenzie; pages 23 & 24: all David Mardon

Acknowledgements:

This document is an output from the Montane Scrub Restoration project funded by Scottish Natural Heritage and the Millennium Commission through the Millennium Forest for Scotland.

The conference would not have been possible without the input and support of all the members of the Montane Scrub Action Group, past and present, over the last four years, from whom I have learned and to whom I owe much. In addition, I would like to thank Des Thompson, Scottish Natural Heritage, and colleagues at Highland Birchwoods for their assistance and invaluable comments, Millennium Forest for Scotland staff for their continuing support, and Sue Fenton for her patience in preparing the document for publication.



Highland Birchwoods is a charitable company (SC021146), limited by guarantee and registered in Scotland (no 142892).

Registered office: Redwood, 19 Culduthel Road, Inverness IV2 4AA

Montane Scrub: The challenge above the treeline

Editor: Diana Gilbert. Highland Birchwoods, Littleburn, Munloch, Ross-shire IV8 8NN



This document reports on a conference, of the same name, held at Battleby on 26 April 2001, and is part of a Millennium Forest for Scotland Project.

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Foreword

Barbara Kelly, CBE. Convenor, Millennium Forest for Scotland Trust

Montane Scrub is the rarest and most threatened of our native woodland formations, now confined largely to inaccessible mountain cliffs in Scotland. Very few people see these remote and tiny remnants, yet these habitats are a symbol of something precious and important, and they teeter on the brink of extinction.

As with so much of our former woodland cover, the history lesson on the mountain woods and treeline is one of loss and fragmentation. The Millennium Forest for Scotland project has raised awareness of native woodland, in all its guises and uses, and has generated a huge amount of action to restore some of the lost woodlands. Energy, imagination, the participation of many people, and of course the planting of over four million trees are the hallmarks of this grand project. As part of this, the Montane Scrub Restoration Project has endeavoured to recover the upper reaches of our mountain woods- the treeline. This has proved one of the most challenging of all the programmes of work, not least because until recently we knew so little about the original and present extent of the habitat, and its management needs.

The prospects for our mountain woods are about to change though. This booklet reports on the conference which closed the first phase of the Millennium Forest for Scotland Montane Scrub Restoration Project. Now we are on a much firmer footing for restoring the treeline through action on the hill, and through working with government agencies and others to make this happen. Resources still need to be found for much of this work, but at least there is now a huge commitment to get on with the tasks ahead.

Highland Birchwoods and the other members of the Montane Scrub Action Group are to be congratulated on their hard work over the last five years; they have put this habitat firmly on the map. I have to say the work involved has also stretched the scope of the Millennium Forest for Scotland — it has reached out into some of the most remote parts of Scotland, to generate interest and action far beyond what was originally envisaged. The well-attended, and very successful, conference in April 2001 demonstrated the increasing knowledge of mountain woodlands and the practical matters so important for their restoration.

Now, the challenge for us all is to build on this encouraging start and to take forward practical restoration on a significant scale. Our long-term ambition must be to bring back this missing part of Scotland's landscape; to help improve the face of Scotland.



Setting the scene

Diana Gilbert¹ & Michael Scott²

¹ Highland Birchwoods. Littleburn, Munloch, Ross & Cromarty IV8 8NN;

² Plantlife; deputy chair, Scottish Natural Heritage. Strome House, North Strome, Ross-shire IV54 8YJ

When an ecological history of the turn of the Millennium in Scotland is written, March 1996 will be recorded as a key date. That was the date of the first major conference on one of Scotland's most important 'Cinderella' habitats: montane scrub. The significance of the habitat had been recognised in an earlier paper by Alison Hester of the Macaulay Institute (Hester 1995), and this had partly stimulated the establishment that year of the Montane Scrub Restoration project (MSR) fronted by Highland Birchwoods and supported by the Millennium Commission through the Millennium Forest for Scotland Trust (MFST).

One of the first tasks of MSR was to organise the 1996 conference, held at the Scottish Natural Heritage (SNH) conference centre at Battleby near Perth. It was a hugely stimulating and well-attended event, at which many of the participants learnt for the first time about the significance of scrub in the Scottish uplands. A few 'lone voices' felt themselves vindicated, as the forgotten habitat, about which they had long preached, at last began to win widespread recognition in the conservation community of Scotland.

The conference strongly endorsed the vision of the ecological significance of montane scrub in Scotland, and it set a number of challenges for MSR. These are recorded in the proceedings of the conference, which were published as SNH Review No 83 (Gilbert, Horsfield & Thompson 1997). Five years on, many of the same participants — and a good number of new 'converts to the cause' — met again at Battleby in April 2001. Progress was reviewed and the way forward charted for work on montane scrub, as the culmination of MFST support for the project.

The present publication, also supported by MFST, marks the end of this phase of the work. It reproduces the main presentations at the 2001 conference, and records the key points from the far-reaching discussion at the end of the meeting. As the participants at the conference unanimously agreed, however, it

must not mark the end of the project, but rather the start of phase two. As the conference heard — and this document will show — much has been achieved since 1996, but much more remains to be done.

Definitions

Montane scrub can be defined as the habitat on mountains in which trees and shrubs grow at altitudes higher than the timberline (above which trees can no longer sustain an upright growth form, with good quality timber trunks), but beneath the tree line (above which tree species can no longer grow at all) and the shrub line (above which even the shrubs die out). It is characterised by a range of shrub and tree species, growing in a low, twisted, wind-pruned form, together with a variety of flowering plants, fungi, lichens, insects, birds and other wildlife particularly associated with this zone.

This montane scrub zone can also be characterised in continental phytosociological (*i.e.* plant community) terminology as consisting of the subalpine and low alpine zones. In Scotland, it is not exclusively high montane; similar communities can occur at relatively low altitudes in exposed situations, particularly in the northwest Highlands and islands. Professor Des Thompson, in his evocative paper with Angus MacDonald and David Horsfield later in this volume, gives a broader ecological overview of montane scrub and its importance, and more information is also available in an SNH publication in its Natural Heritage Management series (Scott 2000).

However, it is worth emphasising here that montane scrub is an important and fully-developed habitat in its own right. Some foresters, in particular, have a tendency to regard 'scrub' as a derogatory term, but in fact, even in the lowlands, scrub is an undervalued habitat of considerable importance for a wide range of wildlife. One of the lessons from the 2001 conference is that it is time to reconsider the use of the

phrase 'Montane Scrub' to describe our target habitats. It is time to rehabilitate these depleted habitats to Scotland's mountains, perhaps it is also time to rehabilitate the term 'scrub' with positive connotations in the minds of Scottish people.

Challenges and outcomes

MSR was set up with a twin purpose:

- ❖ to raise the profile of the habitat and its current condition in Scotland;
- ❖ to raise awareness of the issues facing restoration, mainly through a small pilot fencing project at two sites.

The 1996 conference added to this a range of new challenges, which the participants felt were essential if there was to be any progress in restoring this 'lost' habitat. Key to all of these was the establishment of an 'action group' to act as a champion for, and gather information on, the montane scrub habitat, within the overall remit of MSR. That action group was tasked with a range of other responsibilities that were essential to achieving the vision of restoring montane scrub to the Scottish uplands. In summary, these were to:

- ❖ engage a wide range of interest and user groups in considering the value and potential of the montane scrub habitat;
- ❖ raise the profile of the montane scrub habitat, and promote its wider benefits for soil conservation, water quality improvements *etc.*;
- ❖ gather information on the former and present distribution of montane scrub, and the ecological factors affecting its distribution;
- ❖ assess the impact of pressures on the habitat, including browsing by a range of herbivores and burning, and then develop 'best practice guidelines' on the restoration of the habitat;
- ❖ promote early action, rather than waiting for all the answers, through using active management as a tool for research.

The SNH report on the 1996 conference noted: "Another seminar will be held towards the end of the [Montane Scrub Restoration] project, to which a wider range of interests will be invited. It is intended that this later seminar will promote the benefits of restoring healthy scrub in appropriate areas of the montane zone. It is expected that a framework document will be the subject of discussion, and that it will attract support from a broad constituency of hill users."

The April 2001 conference was that end-of-project seminar, and this document reflects its outcomes. The number and range of attendees showed that huge progress has been made, in the interim, in raising the profile of the habitat, and they heard what has been achieved to date through the restoration project:

- ❖ A highly influential Montane Scrub Action Group (MSAG) has been established, drawing from a wide range of Scottish countryside bodies (see the back cover for full membership).
- ❖ To promote the habitat, the group developed and compiled a booklet on montane scrub, published in the SNH Natural Heritage Management series (Scott 2000).
- ❖ To disseminate knowledge and share experience amongst countryside management practitioners, the MSAG has published an annual newsletter originally entitled *Scrubbers Bulletin* (although this tongue-in-cheek title is now likely to change, following comments at the conference).

As part of MSR, Neil MacKenzie was contracted to gather information on the extent of the montane scrub habitat. His results were published in a report entitled *Low alpine, subalpine & coastal scrub communities in Scotland*, and this information is summarised in his paper later in this volume. The data from his surveys is being prepared for inclusion in a Geographical Information System which will be maintained by Highland Birchwoods. Once this resource is more accessible, it will provide a powerful base on which to develop project work.

A range of pilot and demonstration restoration schemes have been established. Under MSR, two trial enclosures were established around browsed willow plants on high altitude north-facing coire walls. The aim was to test the use of low impact, small-scale electric fencing to allow the restoration of existing plants in areas where there was the potential for regeneration, if sufficient quantities of seed could be produced. Although fencing should always be considered a last resort, there is still a lot to learn about different fencing systems, designed for different situations. This trial showed that electric fencing is effective in keeping hinds out of small areas within their hefted coire. However, it also demonstrated that fencing in such areas is very difficult,

primarily in terms of the high level of resources required to maintain the fences, which are prone to considerable winter damage. In areas where shrub plants are subject to both browsing and the extremes of winter weather, sustaining damage on an annual basis, the trial was of great value in emphasising the message that while browsing remains at current levels, vulnerable elements of our natural vegetation are going backwards.

On a much larger scale — and to its huge credit — the National Trust for Scotland has begun a major montane scrub restoration project on the slopes of Meall nan Tarmachan, adjacent to its Ben Lawers property in Perthshire, drawing on earlier experience from a smaller-scale enclosure experiment on the slopes of Beinn Ghlas. Although it is much too soon to assess the success of this innovative and important project, a great deal of practical experience has already been gained on propagation techniques and project planning. David Mardon, who has masterminded the Ben Lawers project, draws on this project and the experience from the other pilot schemes in his paper later in this volume.

From the inception of the group, the Forestry Commission (both Forest Enterprise and the former Forestry Authority) have been active partners in the work, and their commitment to the montane scrub habitat was amply proved by the production of *Treeline Woodlands and the Woodland Grant Scheme* (Forestry Commission 1998), which outlined how the restoration of treeline woodland could be eligible within the woodland grant scheme as part of overall forestry projects in the uplands. This is a major commitment which for the first time makes wide-scale restoration of treeline woodland a viable prospect.

Having stimulated considerable interest in the habitat, and with grant-aid now possible, it became urgent to develop practical guidance on how to restore montane shrub. Accordingly, a set of five draft Guidance Notes were published for consultation at the 2001 conference, as a key output from the restoration project (Gilbert 2001). These are now being revised in the light of comments received, and will be available on the website: www.highlandbirchwoods.co.uk

A great deal has been achieved, therefore: information has been gathered, practical experience has been gained, promotional and guidance materials have been produced and

distributed. All the elements are in place for a major resurgence in montane scrub on Scotland's hills, but that resurgence is not yet begun.

Hence the need for the April 2001 conference. Its purpose was to provide a critical appraisal of what had been achieved, as a 'quality check' on the materials and ideas that were now in place. The conference sought the endorsement of a 'broad church' for what was being proposed, and it sought input of other land use interests, to ensure that the action proposed would not have unexpected impacts and would secure the overall long-term benefits envisaged. The conference was asked to consider a practical target for montane scrub restoration: given the critically small extent of the resource at present, it was asked to consider whether a doubling of the area might be out of the question. The outcomes of that final plenary are summarised in the last section of this booklet.

This report includes the key presentations delivered at the conference. One, about the need for appropriate action planning, by Andrew McBride, has not been included as the text of the presentation closely followed his guidance note on the same subject.

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Montane scrub — Towards the Restoration of Scotland's Treeline

D. B. A. Thompson, Angus MacDonald and David Horsfield

Scottish Natural Heritage, 2 Anderson Place, Edinburgh EH6 5NP

"After the hillmen had grazed the upper slopes to the stage when forest cover vanished, and cleared their small fields down in the dales, there yet remained the steep-sided bluffs and the rocky craigs or escarpments, together with the deep cloughs, cwms, denes, and glens, wherein the native trees clung tenaciously to their rugged foothold....Neither the irregular character of the terrain, nor the individualist character of the hillman, are conducive to the harvesting of neat, geometrically-shaped, crops of standard-sized poles, at set intervals. He was apt to cut when, where, and what he wanted, with little thought for replacement; and although nature was usually kind and provided oft-repeated crops of poles, by and large he eventually made a mess of his woods.

Today foresters call this mess scrub — an unsatisfactory term because it is also applied to coarse young regrowth that has nothing to do with coppicing."

From: *Trees, woods and man*, by H. L. Edlin (1956)

Introduction

In the 32nd Collins New Naturalist volume, we find an interesting account of the history and management of Britain's woods and forests, by the redoubtable forester and former rubber planter in Malaya, Mr H. L. Edlin. We open this paper with a quote from that book because it says as much about perceptions of the history of upland woodland cover as it does about the low regard foresters, at least, have had for 'scrub'. The Collins Dictionary of the English Language (Hanks 1979) does not bode well either. 'Scrub' is defined as 'vegetation consisting of stunted trees, bushes and other plants growing in an arid area.' Fair enough; but it goes on to define scrub also as: an animal of inferior breeding or condition; a small or insignificant person; anything stunted or inferior; a player not fit for the first team (US);

and a remote place, especially where contact with people can be avoided (Australia). At the outset, we suggest we have a problem — scrub *per se* is not a term one associates with a habitat in need of conservation and management, and seems a long way from a habitat which will attract public endearment!

Montane scrub is the habitat that we find within the ecotone marking the upper reaches of natural woodland in the mountains — the treeline. Manley (1952) was one of the first to point out that this occurs throughout the northern hemisphere, approximately where the mean summer temperature of 10°C occurs in the two warmest months. The treeline typically appears as stunted patches of downy birch (*Betula pubescens*), Scots pine (*Pinus sylvestris*), and sometimes hazel (*Corylus avellana*), with several species of willow (*Salix spp*), aspen (*Populus tremula*) and rowan (*Sorbus aucuparia*) often present and interspersed within heaths of ericaceous dwarf-shrubs and tall herbs. Juniper (*Juniperus communis*) and dwarf birch (*Betula nana*) may also be present, with the latter showing a particular affinity for blanket bog in Britain (*e.g.* Horsfield & Thompson 1997; Mackenzie 2000; Lusby & Wright 2001). Krummholz woods, consisting of small, multi-stemmed trees with crooked and creeping stems and branches, can form at the treeline, and in their upper reaches the few remnants of scrub may appear as finger-like formations or tiny fragments in rather sheltered locations.

Looking across the uplands, montane scrub occurs along the border of the subalpine and low alpine zones (Horsfield & Thompson 1997). The approximate altitudinal ranges are 600 to 900 metres above sea level in the central and eastern uplands, but at much lower altitudes, from around 300 to 750 metres, in the north and west Highlands (in extremely exposed oceanic areas scrub may

occur below that: Pearsall 1971; Ratcliffe 1977; Ratcliffe & Thompson 1988). All of this is well above the 'timberline', in the zone where trees cease to be upright and have limited timber value. At Creag Fhiaclach in the west Cairngorms, for instance, the timberline lies at around 500 to 550 metres, up to 150 metres below the treeline. The distinction between the treeline, with its montane scrub, and the timberline below this is important. The latter is obvious in many parts of Scotland where woods and forests reach up into the mountains; the treeline is largely absent, however, having given way to heaths or grasslands, with barely any scrub remaining.

Indeed, a whole ecosystem appears to be absent in Britain, as is evident to those of us who have wandered in the upper reaches of natural woodland in arctic-alpine parts of the world. In southwest and parts of west Norway, with a comparable climate to ours, one can move upwards through vegetation belts in the mountains, leaving commercial forests, and then natural woods, before entering the stunted canopies of woods which quickly give way to treeline scrub, to alpine scrub and then open heaths above this. This is not our experience in Britain, where the treeline is evidently absent. Instead, we find ourselves looking for the missing link between the former natural woods and the more open mountain plains.

Fortunately, the Montane Scrub Restoration Project has taught us a great deal about the history and restoration needs of this habitat (Gilbert & Scott, this volume). In this introductory paper we explore some of the facets of the habitat, and pose some questions and challenges for further work.

Montane Scrub — the missing link

The treeline in Britain is so scattered and rare that some researchers have questioned its actual existence. It is present in no more than a few hundred localities (MacKenzie 2000 and this volume), and is most evident as scattered trees on cliff faces (well above any woodland on the open hill) showing the upper limits of tree-growth but not forming a continuous treeline. The best example of a more continuous treeline in Britain is at Creag Fhiaclach where a complex of Scots pine and juniper scrub is developed at 550 to 650 metres (Ratcliffe 1977; McConnell & Legg 1995; McConnell 1997). Such scattered fragments offer a tantalising glimpse of what once must have been much more

widespread. We are not aware of any evidence which indicates that montane scrub was absent from much of the uplands in the earlier part of the Holocene, before human influences resulted in cutting, burning and grazing impacts of the sort which Edlin (1956) refers to. Much of the upland woodland cover has indeed been removed by human influence, and it would appear that this is especially the case around those parts of the mountains which include the treeline.

Mounting evidence points to similarities between the climate of the treeline region of Britain and other parts of Europe. Working with ecologists in the Alpine Biodiversity Network (ALPNET, Nagy *et al.*, in press), Christian Körner (in press) has amassed some brilliant observations on the ground temperature of the alpine terrain. Using tiny temperature sensors placed in the soil at the treeline of 18 sites in Europe (ranging from the Sierra Nevada in Spain and Mount Etna in Sicily, to Kilpisjarvi and Tornetrask in the Scandinavian high arctic), Körner has reported daily, weekly and monthly comparative observations on soil temperature (and on the basis of this, the growing period). His observations show that, roughly, soil temperature declines at the same rate over an ascent of 1000 metres and 12° latitude north. Hence, the alpine soil conditions in the Scottish mountains are similar to those of north Scandinavia, and those of the Tatra mountains of the Carpathians are similar to those of central Norway.

There is a gradual decline in alpine growing period with distance north, so that at 36° N the range lies between approximately 145 and 200 days, tailing off to between 110 and 130 days at 68° N. Interestingly, Körner's two study sites in Scotland had growing periods slightly in excess of what was expected on this basis (by around some ten to 15 days), but other than that there was no difference between the growing conditions between the treeline ecotones of Scotland and other parts of Europe. This adds to the view that Scotland is not so different, in terms of alpine growing conditions, from much of the rest of Europe. It is cooler, wetter and windier than much of the European mainland, with the steep increases in oceanicity northwards and westwards resulting in marked descents in life zones in these directions (Ratcliffe & Thompson 1988). However, this does not account for any major discrepancy in the occurrence of the treeline in Britain compared with much of the rest of Europe. It is plain to

see that some factors other than natural forces have accounted for the removal of much of Britain's treeline, and these are probably due to human influence.

Conservation status

Consciousness-raising is still required, even within professional conservation bodies, to improve the standing of montane scrub. As a habitat it tends to fall between specialisms, being neither moorland nor woodland. Yet it is distinctive in growth form, and to some extent in species composition, and occurs in well-defined situations. It was recognised in the Site of Special Scientific Interest (SSSI) guidelines (Nature Conservancy Council 1989) only as a willow scrub component of 'Ungrazed ledge vegetation', a rare habitat for which all good examples should be selected (W20 *Salix lapponum-Luzula sylvatica* scrub is the only type of willow scrub listed). There are eight SSSIs in Scotland specifically notified for montane willow scrub, all in the Highlands, but many more examples are represented on SSSIs. No other upland scrub habitat is specifically mentioned in the SSSI guidelines, though other, usually widespread habitats may be

notified where at least the best example is selected for each area of search (Nature Conservancy Council 1989). *Juniperus communis* scrub is a notified habitat on three SSSIs, which have high-altitude examples of juniper scrub. Two SSSIs are notified for blanket bog with *Betula nana*. Only one SSSI is notified for sub-montane birch woodland (Morrone Birkwood), though it does occur on other SSSIs. There is no continuous treeline birch scrub on any SSSI.

There is no Habitat Action Plan (HAP) specifically for montane scrub, although *Salix lanata* and juniper have their own Species Action Plans (SAPs). The Upland Birchwood HAP will, however, provide an opportunity to raise awareness about birch treelines.

The EC Habitats Directive (European Communities Directive 92/43/EEC) recognises two scrub habitats which include montane scrub: Subarctic *Salix sp.* scrub, and *Juniperus communis* formations on heaths or calcareous grasslands. Broadly, there are four habitats with montane scrub species, which are given formal nature conservation status directly, or indirectly (see Table 1).

Table 1: Types of sub-alpine and alpine scrub currently described by the NVC with corresponding Annex I habitats under the EC Habitats Directive (where appropriate)

Scrub habitat	NVC community	Annex I habitat
Krummholz Scots pine scrub	W18 <i>Pinus sylvestris-Hylocomium splendens</i> woodland	H91C0 Caledonian Forest
Subalpine birch scrub or woodland	W11 <i>Quercus-Betula-Oxalis</i> woodland W17 <i>Quercus-Betula-Dicranum</i> woodland	
Subalpine/alpine willow <i>sylvatica</i> scrub	W20 <i>Salix lapponum-Luzula Salix sp.</i> scrub	H4080 Sub-arctic scrub (also covers other forms of scrub other than W20)
Juniper (<i>Juniperus ssp. communis</i> scrub)	W19 <i>Juniperus communis-Oxalis acetosella</i> woodland	H5130 <i>Juniperus ssp. communis</i> formations on heaths or calcareous grassland
<i>Betula nana</i> scrub	Usually occurs in peaty heaths or mires such as M15 <i>Trichophorum cespitosum-Erica tetralix</i> wet heath or M19 <i>Calluna vulgaris-Eriophorum vaginatum</i> blanket mire (denser scrub not covered by the NVC)	Covered by a range of Annex I heath and mire habitats

i. Krummholz Scots pine scrub

This is included in NVC type W18 *Pinus sylvestris-Hylocomium splendens* woodland (*sensu* Rodwell 1991) and Annex I habitat H91C0 Caledonian Forest (*sensu* European Commission Directive 92/43/EFC), although krummholz woods are not specifically mentioned. Krummholz Scots pine scrub forms the upper boundary of the treeline, and above it there is the largely tree-less alpine zone where only scattered tree species occur up to the extreme upper limit of tree-growth. The krummholz is a form of 'subalpine' wood of which the only example in Britain is on Creag Fhiaclach in the Cairngorms.

ii. Alpine/Subalpine or montane willow scrub

Included in NVC type W20 *Salix lapponum-Luzula sylvatica* scrub and Annex I habitat H4080 Subarctic *Salix sp.* scrub, this habitat occurs in the lower part of the alpine zone. It occasionally occurs with scattered trees such as birch and rowan suggesting it also belongs to the upper part of the subalpine zone. In Scandinavia, it occurs patchily in open areas within subalpine woods and extensively as scrub plains in the alpine zone. This habitat in Britain has other forms of subalpine/alpine willow scrub not included within NVC type W20 *Salix lapponum-Luzula sylvatica* scrub. These include *Salix mysinites* scrub on limestone found at Inchnadamph, and *Salix lapponum* growing with *Luzula sylvatica* and *Vaccinium myrtillus* on acid soils.

iii. High altitude *Juniperus communis ssp. communis* scrub

This attractive habitat is included in NVC type W19 *Juniperus communis ssp. communis-Oxalis acetosella* woodland and Annex I habitat H5130 *Juniperus communis* formations on heaths or calcareous grasslands. At Creag Fhiaclach, *Juniperus-Oxalis* scrub occurs in open areas within the krummholz Scots pinewood and also extends above the woodland into the alpine zone, running up shallow but more sheltered gullies.

iv. *Betula nana* scrub

Betula nana occurs chiefly on wet peaty soils in blanket bogs and wet heaths from 120 to 860 metres above sea level. (Stewart, Pearman & Preston, 1994) in Britain. Around Lochnagar in the eastern Highlands *B. nana* also occurs locally in heathland on better-drained soils with shallower organic layers. Throughout its circumpolar range *B. nana* is typically found on moist, acidic and nutrient-

poor organic sites with a wide range of soil temperatures and organic matter depths, and which are usually well-drained (de Groot, Thomas & Wein 1997). Stands tend to be scattered or patchy in Britain, but in Scandinavia and the arctic region the species is a dominant over large areas.

Juniperus communis ssp. nana occurs in a range of alpine heaths growing with *Calluna* and other dwarf-shrubs, most abundantly in NVC type H15 *Calluna vulgaris-Juniperus communis ssp. nana* heath. The corresponding Annex I habitat is H4060 Alpine and Boreal heaths. *J. communis ssp. nana* grows as a low growing, prostrate shrub generally less than ten centimetres tall — we tend to treat it not as scrub but as a component of alpine dwarf-shrub heath.

Treeline (in the strict sense) woods are not specifically included in either the Habitats Directive or the SSSI guidelines. The lack of their inclusion in the Habitats Directive may be because they are frequently developed on the continent, although virtually non-existent in Britain.

Clearly, we have to do a great deal to raise the profile of montane scrub in the statutory sense. Whilst it is tempting to lament the exclusion of some variants of the habitat from the EC Habitats Directive and from the SSSI guidelines, this in itself is a minor consideration. What matters more is to find a way to conserve and manage the totality of the variants which comprise montane scrub.

Research Issues

Montane scrub is a prime candidate for ecosystem-level, plant physiological, phytosociological, genetic and conservation management studies!

The impacts of grazing animals are clear. However, new forms of herbivore exclusion may need to be investigated (e.g. Mardon, this volume). These may include new forms of fences (which survive snow accumulation), or the application of new technologies to enable 'fenceless' herbivore control (e.g. development of a GIS collar which gives animals an electric shock when they approach a forbidden area — though we need to catch the animals first!) We may need to control damage from mountain hares (*Lepus timidus*) and voles (*Microtus spp.*). The use of fences needs special care. Recent work is pointing to the alarming impacts of deer fences on black game. But in any case, fences are a poor, last resort option for

managing deer — they displace deer to neighbouring areas where grazing and trampling impacts will be higher and impede human access.

We need to consider scrub restoration in a larger scale context. Restoration is perhaps most easily achieved, and with most complimentary landscape effects, if carried out in conjunction with forestry or woodland schemes at lower altitudes. If whole topographic units are involved then this can add to some of the herbivore control problems. Herbivores are controlled within the larger forest area by removal, shooting or use of fences at lower altitudes (where snow is not a problem), and landscape impacts are less marked. But such control is needed over all estates within the topographic unit. Work at Creag Meagaidh and Abernethy Forest has borne out the importance of trans-estate management in achieving woodland restoration.

At the broader scale, there is still much scope for undertaking challenging, pure research in order to provide a basic understanding of the past history and future potential of montane scrub. Let us look at three areas:

i. Conservation value and management

We still do not have a clear picture of what is associated with montane scrub as a habitat. How restricted to it are the species concerned? Because there is so little of this it is difficult to investigate this aspect! But comparisons with the Scandinavian treeline are important. We should like to see these comparisons being made, and to see treeline restoration trials involving different species complexes. It strikes us that we are missing a trick in not using landscape modelling methods to produce scenarios of landscape change under different management regimes — at increasingly large scales. Let's take a particular mountain range, assemble information in land-use and management, and then model the impacts of changes in management on one, two, three and more estates to see how the treeline landscape may change.

ii. Reproductive ecology

If we think of montane willows we can pose several questions:

How important is wind pollination relative to insect pollination? Over what distances do the pollinators forage, and what effect does this have on seed set and the prevention of inbreeding depression? Are bumblebees the

main pollinators or are other species involved such as ichneumon flies (said to be largely responsible for pollination of *Salix herbacea*) or various true flies?

Are the fragments of montane willow scrub already suffering from inbreeding depression, and how might we best alleviate this?

Some stands of willows e.g. at Creag Meagaidh in the central Highlands, are known to produce abundant, viable seed yet seedlings are rare or non-existent — why? Do we need to investigate more about vole grazing or, more overlooked but possibly more important, grazing by slugs (*Pulmonata*: notably *Arion spp.*) which can be very abundant in the damp conditions at higher altitudes? How important are severe winter conditions and snow-lie for creating bare seedbeds and for protecting the seedlings and bushes from browsing?

How closely adapted to local conditions are the remaining fragments and populations of treeline scrub? This has consequences for choice of provenance for restoration work (e.g. Mardon, in this volume).

iii. Past history and present potential

As we have already indicated, questions have been raised about the history of montane scrub. Palaeocological work by Tipping *et al.* (1993) on Ben Lawers is relevant to montane willow scrub in clarifying the history of human impacts. It is difficult to get good information from traditional palaeocological approaches. Often, little pollen is deposited, and what is present may be of distant origin (e.g. McConnell 1997). Species such as the montane willows may be largely entomophilous.

Perhaps some different approaches might yield new insights. For example, genetic analysis of the remaining fragments, coupled with a better understanding of the reproductive behaviour of these species, might prove informative. Many of the remaining fragments of montane scrub are very small and isolated. If they have been like this for a long time then there should, in theory, be a loss of genetic diversity within stands, inbreeding depression (unless deleterious alleles have been purged over time), and divergence in the genetic composition between stands. Alternatively the degree of specialisation of associated fauna may tell us something about the past history of montane scrub. If, for instance, species strongly specialising on montane willows are

still present this would tend to indicate that the willows were much commoner in the fairly recent past (since such species will have small populations and small populations tend to go extinct quite readily).

What is compelling is the need for more team-based research founded on the skills of a range of specialists. K rner's work with ALPNET colleagues shows the value of genuine trans-European sampling. Let us see more of such work at the actual and potential treeline on a number of sites in Britain. Maybe we will find much more variability in treeline conditions in more oceanic parts of Britain than in the continent — and that could have implications for restoration measures.

Challenges for the future

We are left musing over three principal challenges. First, we need to find additional ways of raising the consciousness of this remarkable habitat. Second, we need to galvanise research which is innovative. Third, there is the challenge of scale — just what are we trying to achieve over the next few years?

We feel it is reasonable to seek to double the extent of montane scrub in ten years. This will make a huge difference to the visibility of treeline and montane scrub while being unlikely to cause problems for any other land-use interests. Indeed, it may add some unexpected benefits. In order to do this we need, in particular, to latch onto other schemes, notably Woodland Grant Schemes (WGS), administered by the Forestry Commission.

Given the importance of further research, but also the stark simplicity of some of the questions raised, we need to form interdisciplinary teams to combine research, technical, advisory, promotional and policy skills. Funding is crucial of course. We see no reason why EU LIFE funds should not be secured to underpin action on Special Areas of Conservation, especially if comparative actions are to be undertaken across Sweden, Finland and other parts of Europe where montane scrub poses special challenges.

But most of all we need to recognise the huge amount of work needed to restore this amazing asset. We are close to re-introducing the 'harmless wolf': this is the wolf-equivalent of habitats — in some ways the habitat which people fear without foundation for traditional reasons associated with its definition and affinities. This should change; indeed it has to.

Think about it: you have the chance to hike high into the hill through the forest lands resonating to the sound of the wind and the scent of pine. And then, as you rise up into the higher plains where the forest gives way to heath and (if you are lucky) that gradual transition to scrub, you will snatch a glimpse of raw nature — of a landscape which our ancestors must have witnessed many times — the sights, sounds and aroma of a land opening up — embracing the upper reaches of our senses. Here we are at that special place where one is propelled into something spiritual — the threshold between where the woods give out and the high, open plains begin. This is the mark of change — when we gather speed as we stride on and catch our second breath.

But just imagine it — that purposeful step out from the stunted wood into the petering scrub, and then finally, higher still above the corries and onto the plateau where we look below on the jigsaw pieces of woodland, mountain scrub and heath. What an inspiration for us all: to help improve the face of Scotland to ensure a more complete sense of being — that is the real challenge of restoring our treeline.

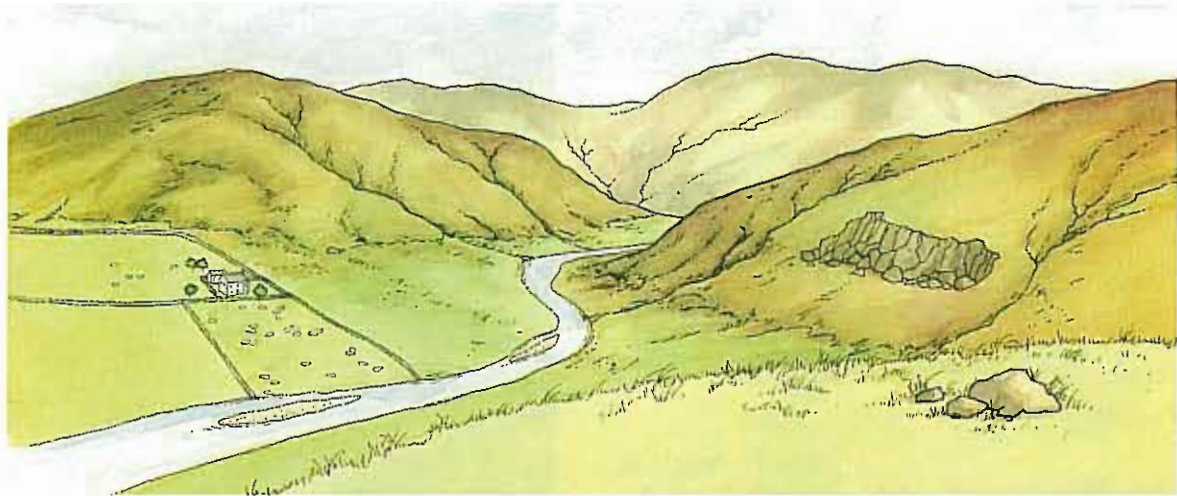
Acknowledgements

We thank colleagues and friends who have helped us form views of montane scrub: Dick Balharry; John Birks; the late Morton Boyd; Charles Gimingham; Paul Haworth; Alison Hester; John Atle K l s; Dave Mardon; the late Jennifer McConnell; the late John Miles; Derek Ratcliffe; Alex Scott; Michael Scott; Graham Sullivan; Adam Watson; Sarah Woodin and Marcus Yeo. We are especially grateful to ALPNET colleagues, Georg Grabher, Christian K rner and Laszlo Nagy, and to Diana Gilbert for encouraging us to complete this manuscript.

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A heavily grazed and uniform landscape (top) can be diversified by well-designed forestry (middle), but the addition of a montane scrub zone (bottom) softens the visual impact of the forest and creates a more natural 'feel' to the landscape.



1 & 2. Creag Fhiaclach, Cairngorms
3 & 4. *Salix lapponum* at Drumochter Pass

5. Juniper at Ceag Fhiaclach
6. *Salix lapponum*

The changing policy context

Andrew Raven

25 Dean Street, Edinburgh, Lothian. EH4 1LN

I once met a man who changed his name by deed poll from 'Wood' to 'Forest' because he thought it more assertive. In these more enlightened days, if I met him again, I guess I'd have to try and persuade him to change his name to 'Scrub'!

We've heard quite a lot about the effort that is going on and some of the opportunities for future work on montane scrub. I hope I can help to identify some more opportunities. I'm going to specifically address land use policy as it applies to montane scrub, and I'm going to concentrate upon the changes since the previous conference in 1996.

Political context

The most obvious change with consequences for land use policy is devolution, with all land use issues effectively devolved. The result is more time for Scottish issues than Westminster could ever have afforded. Some argue that the absence of jurisdiction of the House of Lords is potentially relevant.

Devolution has unleashed a policy ferment, for example the number of land use strategies that are currently being developed. The different agencies and the Rural Affairs Department (in relation to agriculture) are all working over longer time horizons than they ever have before, and in a more cohesive fashion than previously.

The other aspect that I would particularly highlight is the focus on land reform. Specifically, the code of good practice on rural land use that has been promised as part of the Land Reform Action Plan. A consensus group is developing this code, which will then be put before a Scottish Executive Environment and Rural Affairs Department (SEERAD) consultative forum. The debate is at a fairly early stage and presents an important opportunity to promote the place of montane scrub within the wider land use arena.

Natural Heritage

National Parks, the proposed top tier natural heritage designation in Scotland, will be focused on mountain areas, which must present some opportunities, reinforced by the 'Sandford principle' whereby National Parks have a variety of different objectives but with conservation primacy. This should be helped by the development of National Park Plans. The experience in the Cairngorms is relevant, where the management strategy explicitly refers to montane scrub for the first time, and provides a forum where the management of montane scrub can be more carefully considered.

Des Thompson touched on Natura 2000 and Special Areas of Conservation, which bring in enhanced environmental regulation and make a wider variety of public bodies competent authorities in relation to appropriate habitats. It also brings in the possibility of LIFE funding and so the rolling out of Natura 2000 since 1996 seems to be a significant change.

The coming change resulting from the Sites of Special Scientific Interest (SSSI) reform, encompassed in *The Nature of Scotland* (Scottish Executive, 2001), currently subject to consultation, is focused on the promotion of the development of management statements. SNH was developing these anyway, and such statements must give an opportunity for montane scrub issues to be highlighted. Another emerging emphasis is on positive management, rather than paying people not to do things. Such incentive lead natural heritage policy and nature conservation management must also open up opportunities. This would be further supported by the back stop powers of land management orders currently being discussed, so if existing land uses are not sustainable there may be more bits in the natural heritage tool kit with which to address the situation.

Biodiversity

The Biodiversity Action Planning process (Habitat Action Plans, Species Action Plans, Local Biodiversity Action Plans) introduces a more systematic approach for addressing all of these issues. That again provides an opportunity for montane scrub to be considered more seriously. However, montane scrub is a transition habitat and so can drop through the network, unless it is particularly considered.

Forestry policy

At the international/national level there has been a serious push over the last five years towards sustainable forest management, starting really in Rio and then Helsinki and through UK strategies for sustainable development. Forestry examples include the UK Forestry Standard, which is further reinforced by the UK Woodland Assurance Scheme. The whole prominence of sustainable forest management must give enhanced opportunities for consideration of treeline woodland.

This thrust is further developed in the Scottish Forestry Strategy (Scottish Executive, 2000), which cascades these higher policy directions into a Scottish Context. There is a whole section on conserving the natural heritage and improving the environment, describing forest habitat networks where it specifically says "there is also an important role for treeline or montane woodland providing a link between forest and mountain habitats." That is cascaded through into the action sections where there are 23 priorities for action in five groupings. One grouping, to do with positive contributions to the environment, specifically refers to extending and enhancing native woodland by developing forest habitat networks and highlights benefits that include 'the development of montane woodland.'

The institutional context has moved on and for the better in relation to the management of montane scrub. The Scottish Forestry Strategy was pre-dated by the development of the FC guidance note *Treeline woodland and the woodland grant scheme* (Forestry Commission Scotland, 1998). Woodland Grant Scheme (WGS) funding is now potentially available for treeline woodland, it is discretionary but applications are likely to succeed, especially where they recognise biodiversity and visual benefits from treeline woodland. So there is a stream of funding

potentially available.

For the future there is the WGS and Farm Woodland Premium Scheme (FWPS) review, a consultation paper being due shortly. There will be the opportunity to argue the case for funding for management and restoration of treeline woodland.

Agricultural policy

Agenda 2000 has been the main European policy development. Many were disappointed with the modest scale of change, but it did introduce the Rural Development Regulation (RDR), the so-called second pillar of the Common Agricultural Policy, which offers the potential of putting what was previously production support into a more diverse basket of land management options. That has been taken forward in individual countries, including Scotland, by the whole idea of 'modulation' or top slicing production support and using that as funding for RDR measures, including agri-environment schemes, FWPS etc. A further implication was the change from Hill Livestock Compensatory Allowance to the Less Favoured Area Support Scheme, involving a move from headage to area based payment systems in Less Favoured Areas. This was not without political contention because of winners and losers, but it also introduces more conditionality or the potential of cross compliance into upland grazing subsidies.

The above will help to provide the context for the development of a forward strategy for Scottish agriculture. I would argue that previous agriculture policy has staggered from short-term crisis to short-term crisis, so I welcome the fact that there is a longer-term strategy under development. The indications are that it should recognise the role of agriculture within the economy, but also that it should be part of rural development rather than something stand-alone. Agriculture should be a component of rural development, rather than vice versa. The strategy should also recognise that Scottish agriculture must have a key role in, and a key objective of protecting and enhancing the environment, so I am quietly optimistic about some of the progress that is being made in terms of long-term agriculture strategy.

In the meantime, there is enhanced funding for agri-environment schemes. The Countryside Premium Scheme is being replaced by the Rural Stewardship Scheme (RSS), with a priority for the management of

scrub on grazed land and a raft of prescriptions that back that up. These include the exclusion of grazing and incentives of both annual and capital payments. So, there are opportunities for montane scrub in the RSS.

Deer policy

There has been a lot of change over the last five years in relation to deer policy. The Deer Commission (DCS) for Scotland has produced *Wild Deer in Scotland — a long term vision* (DCS 2000), which followed on from a full public consultation about the long-term objectives of deer management. For today's context, the key point I'd reflect on in the DCS' statement is the emphasis placed on locally based deer management that is integrated and sustainable. This does move on and develop the policy context, and means that in practice the DCS is putting a lot of emphasis on an unfolding programme of habitat assessment, and now rapid habitat assessment.

The techniques for getting a handle, not only on deer data, but on habitat condition and the interaction between deer and their habitat have moved on hugely. In effect, affordable and reliable techniques are now available, at a simple level, for environmental audit of deer range. All deer, habitat and other socio-economic data can be put together and DCS are actively promoting deer management planning, based on this data, as a key technique. Gathering all the relevant data to audit the resource within a Deer Management Group's (DMG) boundaries (*i.e.* between those who share a common resource); and then where possible, agreeing objectives, prescriptions and actions, then periodically reviewing them, all move the debate forward and provide opportunities for consideration of treeline woodland issues.

In conclusion, the policy context alone will not safeguard montane scrub, even though it has changed radically in the last five years. This change has been for the better. There is a need to continue to champion montane scrub if these benefits in policy are to be translated into practical action on the ground. The challenge is to find out how those who advocate restoration and further development and management of montane scrub can continue to participate in this debate and make the best of these emerging opportunities.

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Current status

Neil MacKenzie

Norbu, Lochgarthside, by Inverness, IV1 2YP

This section summarises current knowledge of the state of the montane scrub resource in Scotland. More specifically, it covers the scrub communities which are found in the low alpine, subalpine (including treelines) and exposed coastal zones.

Subalpine scrub and treeline woodlands are a natural part of the upland vegetation communities of Scotland. They are regarded as a kind of transition zone between the forest and the alpine heath and, perhaps because of this, they are frequently overlooked in many vegetation surveys. Over the past fifteen years I have reviewed native woodland statistics three times and much has changed (Mackenzie 1987; Mackenzie & Callander 1995; Mackenzie 1999).

Restoration programmes are in place, Habitat Action Plans prepared and native woodlands are now part of the Scottish Forestry Strategy — the future for native woodlands certainly looks better than it did twenty years ago (UK Biodiversity Steering Group 1995; Scottish Executive 2000). Scrub, however, and montane scrub in particular, has largely been omitted from most national surveys and only recently has it been recognised that treelines and subalpine communities should play a part in the forest habitat network. In addition to site specific protection, Species Action Plans have been published for Woolly willow and for juniper, whilst dwarf birch is a priority species in the European Community's Habitats Directive for blanket bog. At present, there are no other action plans for montane scrub (Horsfield & Thompson 1996).

The data on montane scrub have been collated nationally for the first time from all available survey information including reports, databases, file notes and verbal sources to compile a provisional dataset which is now held by Highland Birchwoods (MacKenzie 2000). I should acknowledge here the invaluable contributions of botanical recorders over many years; the dataset would be all the poorer without these, largely voluntary, efforts. Although the information in the dataset is rather sparse, it has revealed that the resource is very scarce and

fragmented, and is frequently in poor condition. Most of the montane willow communities are so small and patchy that boundaries cannot be measured on a map.

Despite the optimism implied earlier, Scotland's native woodland resource is still impoverished in its condition and in its biodiversity. Treelines themselves have largely disappeared from the uplands. The best developed community is Creag Fhiaclach in the western Cairngorms but other treelines are regenerating well, particularly in the northern Cairngorms and on Meall a'Bhuachaille, and there are several high altitude birchwoods scattered throughout the country. Another example is the small area of treeline Scots pine above oak woodland at Loch Maree. This was first noted by McVean (1962) because of the interesting edaphic zonation between the oak on the fertile low ground and the pine on the upper slopes. Virtually every native woodland with suitable higher ground above it has the potential to develop a treeline zone — given time and a balanced grazing regime. The dataset also includes coastal, wind-pruned scrub which has affinities in respect of form, stature and slow growth rates with the treeline. There remain some good examples of this on the fringes of woodland of normal stature in the exposed northwest of Scotland, and on the islands, where it may be the only woodland. The stunted and often dwarf trees of exposed coastlines are not rare as individuals but well developed communities are uncommon. Coastal parts of Mull have some very fine specimens with a variety of wind-shaped forms. Most of Scotland's native trees and shrubs have been recorded in such exposed coastal locations; while the species associated with treelines are principally Scots pine, downy birch, juniper, rowan, aspen and willow although other species may also be present (see Appendix 1).

Overlapping with, and beyond the treeline, are the subalpine and low alpine zones, where Scotland's seven species of montane willow survive as relict populations, as single sex groups or even individual plants on their, usually base rich, steep sided gullies and

craggs. Single sex populations and individual willows at remote and isolated sites can now be regarded as ecologically extinct in such areas. The willows are concentrated in mountain areas in the Scottish Highlands but there are small populations in the Southern Uplands and a single plant exists on the Shetland Isles. There are no longer any links with the treeline or forest zone at virtually all willow sites and most populations tend to be isolated on their respective crags.

Also in this zone is juniper which is quite widespread in the Highlands, from seacoasts and islands to the highest mountains, and with remnants also in the Scottish Lowlands. It is usually the prostrate form that is found on islands, coastlines and on upland heaths. Upright and semi-erect juniper is more commonly associated with woodland and with seral scrub although erect, prostrate and intermediate forms can occur together at some locations. Juniper is found as far north as Shetland and Fair Isle and as far south as the coast of Galloway. Some populations are doing quite well, especially in some woodland and seral habitats, but most juniper communities in remote and upland areas are simply holding their own or are declining. As it is quite a long lived species, and many individuals can be 150 to 200 years of age, populations are maintained by their longevity, at least for a while, without replacement. However, many communities are in poor condition, and are rarely able to regenerate or expand. Losses have been recorded over the past one hundred years in some areas, such as the upper Findhorn straths, by comparing the first edition Ordnance Survey maps of 1870 with the present distribution (MacKenzie 1997). Juniper, however, has the best connectivity with the forest zone and has the advantage of being able to exist as a woodland understorey shrub, as a seral scrub and as a component of the subalpine and low alpine zone.

The final subalpine scrub species considered here is dwarf birch which is quite widespread in blanket bog, wet heath and, occasionally, dry heath throughout the north, east and central parts of the Highlands. There are no records at present from the Scottish lowlands. Dwarf birch never attains its full potential as a community and its growth form is suppressed by grazing and burning except in a few rare exclosures and these only recently. It would be very interesting to see how this species develops under a changed land use policy and in some of the protected sites. There are

no links at present with the forest zone but some examples in Glen Muick and Glen Derry are in close proximity to Downy birch and Scots pine woodland and have great potential to create extensive treeline scrub in these areas. Another example is on the slopes of Ben Loyal where there are hybrid Downy birch/Dwarf birch seedlings. Presently all seedlings are browsed and suppressed but it would be of great botanical interest to see how such a treeline community would develop should grazing levels be reduced.

Montane scrub can be used as an example in miniature of what human activities have done to the planet. In the recent BBC television series on the *State of the Planet*, David Attenborough identified five human activities as the causes behind the most losses in biodiversity and in species. All five of these activities have also affected montane scrub in Scotland:

Overharvesting

The exploitation of native woodlands and hence montane scrub has occurred over many centuries, perhaps thousands of years. Although climate change has also had an impact clearance of the forest has caused a reduction in tree cover, loss of the treeline and impoverished woodland ecosystems;

Alien introductions

Sheep, goats, sika deer (*Cervus nippon*), rabbits, exotic conifers and rhododendron (*Rhododendron ponticum*) are examples of the types of introduced species which have prevented the regeneration of montane scrub;

Habitat destruction

Land-use activities, particularly sport and agriculture, but also forestry, settlement etc., have caused the loss of montane scrub, prevented regeneration and reduced biodiversity;

Pollution

An increase in greenhouse gases and a change in the world's climate are already taking place. Climate change has occurred in the past and the vegetation has adapted but the rapid progress of climate change today is likely to have a significant impact on marginal habitats such as montane scrub. Treelines may simply ascend in altitude but the relict populations of montane willows may be vulnerable if, for example, spring snow lie is diminished;

Islandisation

Small pockets of scrub in large areas of disturbed habitat have led to piecemeal

destruction of habitat and local extinction. The montane willows are a classic example of population fragmentation. Their connection with the forest zone has been lost and many communities are ecologically extinct.

All of these activities tend to occur in combination; we have one because of the other — a matter of cause and effect. However, the principal contemporary human activities affecting montane scrub relate to sport and agriculture — overgrazing by large numbers of deer and sheep, muirburn and grouse moor management are preventing regeneration and leading to decline, fragmentation and the eventual loss of montane scrub and treelines.

The montane scrub database itself and the information within it is far from comprehensive. Inevitably, records will vary in content depending on the objectives, or indeed the interests, of the surveyor. Many of the records simply note the presence of a particular species, some of the willow sites have numbers of plants but area data, sex ratios and age range are often lacking. The best information tends to be available for designated sites, well known mountains such as Beinn Eighe and Ben Lawers and the notable willow sites such as Coire Sharroch. Such variable data are not so useful as baseline material for the assessment of future trends in the population but are a useful starting point for highlighting key areas and communities that offer the best potential for restoration and expansion. The database also helps us to perhaps understand the former distribution of montane scrub. Juniper, tolerant of a wide range of soils, was probably more widespread than the mountain willows for example. The latter are largely restricted to base rich mountain areas, though Downy willow may have once been more common along upland burns and rivers as it can tolerate slightly more acid conditions. Today, all the montane willows are relict populations, there are only a few healthy communities, there is limited scope for expansion under present grazing policies, there are single sex populations, and there is this loss of connectivity with the treeline and forest zone.

A particularly important function of the database is that it can be used to locate the best sites with the potential to link with existing native woodlands, perhaps helping to restore a woodland continuum from sealevel to the alpine zone. The usefulness of the database could be extended by expanding and updating the detail of many of the

records, in particular the montane willows. It is also important to keep records up to date and to correct changes. Such data collection should have clear and specific objectives, should be consistent and include quantitative information on condition, health and population structure.

There are some key recommendations which may assist in the restoration of treelines and subalpine scrub in the future:

- ❖ Wider recognition is needed that treelines and subalpine scrub form part of the native woodland resource and could readily form part of a regeneration scheme in suitable upland sites. There would certainly be an important biodiversity benefit. The Forestry Commission (1998) now encourages the creation of treeline woodlands as part of its Woodland Grant Scheme.
 - ❖ Fast, reliable methods for the assessment and monitoring of population trends where the communities are small and inaccessible need to be found — perhaps based on fixed point photography and the counting of individual clumps or plants. Brief and *ad hoc* surveys were very useful initially but now specific information is needed on how populations are surviving and whether they are able to expand should grazing levels be reduced.
 - ❖ Marginal habitats, such as montane willows, dwarf birch and juniper, should be incorporated into the vegetation surveys used for Environmental Impact Assessments, Woodland Grant Scheme surveys *etc.* Many surveys only record at National Vegetation Classification (NVC) community level, sometimes simply as an NVC map with no target notes, which will rarely pick up scrub species. Scrub often falls between woodland and heath classifications, neither one nor the other; either because the density is low and the scrub species are masked by the dominant classification or because they are not in the list of indicator plants (Rodwell 1991a, 1991b & 1992).
 - ❖ The present system of grant aid and subsidy must be reviewed. Any change in policy will have implications for the future of montane scrub restoration. Promoting sustainable management over all upland habitats is therefore a key prerequisite.
- Should montane scrub be restored in the Scottish uplands? There are many landscape and biodiversity benefits associated with scrub just as there are with dwarf heath and

heather moorland. In the past there would probably have been a natural mosaic of open moor and patchy scrub. Montane scrub will not replace moorland in the subalpine and low alpine zones. However, it will complement it and add to its diversity in the relatively few areas it can expand. This diversity must be restored and a more impoverished environment should not be left as a legacy for future generations.

Appendix 1: The main tree and shrub species associated with treeline, sub-alpine, low alpine and coastal scrub communities

Ash*	<i>Fraxinus excelsior</i>
Aspen	<i>Populus tremula</i>
Birch, Downy	<i>Betula pubescens</i>
Birch, Dwarf	<i>Betula nana</i>
Blackthorn*	<i>Prunus spinosa</i>
Hawthorn*	<i>Crataegus monogyna</i>
Hazel	<i>Corylus avellana</i>
Holly	<i>Ilex aquifolium</i>
Juniper, Upright/Prostrate	<i>Juniperis communis ssp. communis</i>
Juniper, Prostrate	<i>Juniperis communis ssp. nana</i>
Oak, Sessile*	<i>Quercus petraea</i>
Pine, Scots	<i>Pinus sylvestris</i>
Rose, Dog	<i>Rosa canina</i>
Rose, Guelder	<i>Viburnum opulus</i>
Rowan	<i>Sorbus aucuparia</i>
Whitebeam	<i>Sorbus rupicola</i>
	<i>Sorbus arranensis</i>
	<i>Sorbus pseudofennica</i>
Willow, Eared	<i>Salix aurita</i>
Willow, Goat	<i>Salix caprea</i>
Montane willows:	
Willow, Dark-leaved	<i>Salix myrsinifolia</i>
Willow, Downy	<i>Salix lapponum</i>
Willow, Mountain	<i>Salix arbuscula</i>
Willow, Net-leaved	<i>Salix reticulata</i>
Willow, Tea-leaved	<i>Salix phylicifolia</i>
Willow, Whortle-leaved	<i>Salix myrsinites</i>
Willow, Woolly	<i>Salix lanata</i>
Yew*	<i>Taxus baccata</i>

All species can be found at subalpine, low alpine and exposed coastal locations except for those marked * which rarely occur above the treeline, and the montane willows, which are largely restricted to upland sites.

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Practical considerations for Montane Scrub restoration

David Mardon

The National Trust for Scotland, Lydenoch, Main Street, Killin FK21 8UW

This section is largely based on practical experience at Ben Lawers National Nature Reserve (NNR) over a 15-year period, from the perspective of a site-based project manager for the National Trust for Scotland (NTS). The background and details of Ben Lawers are described by Mardon (1990 & 1997) and a more detailed report on the management of the montane scrub in Mardon (2000). The range of species covered, (montane willows, juniper, and mountain birch, *Betula pubescens ssp. tortuosa*), is therefore not exhaustive, and other species may involve additional considerations. The issues discussed are, however, of general relevance and are not site-specific, although some sections reflect the emphasis on montane willow scrub, rather than other scrub types, in the NTS's experience at Ben Lawers.

Rationale & objectives

It is assumed that the origin of any scrub conservation project will be clear, with explicit objectives. These may be site-based objectives as in a reserve management plan, or regional or national objectives for species or habitats. The principal relevant objectives at Ben Lawers NNR are the maintenance of the population size of rare species, the maintenance of the area of important plant communities, and the maintenance of the diversity of both species and communities. These require a detailed knowledge of the species and communities in question. Once this level of knowledge was acquired at Ben Lawers, it was clear that the objectives were not being met, and that prescriptive action was required to ensure they would be. Given that projects may involve considerable costs and commitment, and indeed may be in conflict with other objectives or be controversial for various reasons, the rationale on which they are based must be agreed by all parties concerned.

Once prescriptions are made, additional benefits may become apparent. For example, work at Ben Lawers to enhance montane

willow scrub is also enhancing tall herb vegetation, with no additional effort or cost (beyond monitoring). Furthermore, NTS staff believe that there are also educational benefits, such that demonstration of results on such a popular site can only enhance the realisation of and support for such conservation generally. Recognition of such additional objectives for a project can surely enhance its value for funding applications.

Guidance on integration with other land uses is discussed by Wood-Gee (2001a).

Condition of surviving scrub

As a general rule, with some exceptions, the condition of montane scrub in Scotland is impoverished and imperilled. However, a much more detailed, site-based assessment is required to answer questions crucial to prescribing the most appropriate action. What is the area of montane scrub within the site? What is its species composition? Are there any clues to a different, former range or species composition? What is the population size and structure of the constituent species? What is the sex ratio in dioecious species and is the dispersion favourable to pollination? Is there evidence of seedling production and establishment? Are there naturally created areas of bare soil to permit seedling establishment? What is the rate of seed production? What are the factors constraining the recovery of the community or its species? Can these be controlled effectively?

With such information to hand, one can identify proximate or interim objectives to work to. For example, at Ben Lawers, most species are confined to cliff ledges, and sparsely dispersed. Seed production on most of the dioecious species was negligible, with many female plants well isolated from males, and there was virtually no evidence of seedling establishment. The potential for scrub development is strongly constrained by sheep and deer. The NTS has therefore sought to establish seed-producing



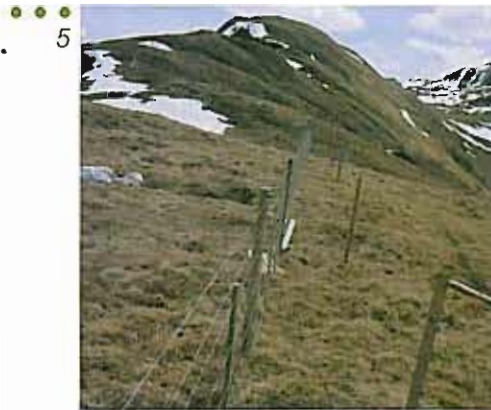
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1. Juniper scrub, up to knee-high, at 700 metres. Coire Etchachan, Cairngorms
2. Collecting seed from *Salix lapponum* & *Salix myrsinifolia* in the Breadalbane hills
3. Planting *Salix lapponum*, from cell-grown stock. (Exclosure in Ben Lawers National Nature Reserve)
4. Conventional deer fence around exclosure broken by snow at 800 metres
5. Electric exclosure fence built in 2000; there is a reduced risk to birds and it is also easier to mend
6. Seed collecting using a Marriott long-reach catkin collector for safety. Breadalbane hills

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1. Dwarf shrub heath, low-alpine scrub and tree-line birchwood. Junkerdal, Norway
2. Low-alpine scrub and tree-line birchwood. Stoldalén, Norway
3. *Salix lanata* (foreground) and *Salix lapponum* scrub, with *Luzula sylvatica*. Coire Sharroch

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populations within areas protected from large browsing herbivores, as the proximate objective. When this is achieved, it must be determined whether the process of regeneration takes place without further intervention. Progress over the first ten years suggests that this may take decades rather than years.

To fence or not to fence?

Throughout Scotland, montane scrub is likely to be affected by sheep or deer, perhaps both, and possibly other large domestic browsers. The ideal solution would be the control of these browsers to a level compatible with scrub regeneration, but this is often not possible in practice (Sydes 1997). Within very large estates in which the owner has full control of grazing, *e.g.* Creag Meagaidh NNR, the RSPB Abernethy & Cairngorms reserve and NTS's Mar Lodge estate, this might be achieved. In smaller management units such as Ben Lawers, deer may enter from a neighbouring estate and gain access to scrub sites in a few minutes. Within an area where sheep farming is also a major land use, sheep will quickly occupy any vacant areas. This situation explains the current distribution of most montane shrub species at Ben Lawers on inaccessible cliff ledges only. Any attempt to enhance the status of such species will be dependent on fencing.

Once the need for fencing is accepted, we are faced with many dilemmas regarding the scale of the operation, and the siting and type of fence. As a general rule, the cliff ledge refuges of most of the montane willow sites are probably among the worst sites one can find for building and maintaining fences. The risks and hazards must be identified and assessed at the planning stage, to estimate both installation costs and long-term maintenance commitment and cost. In general, the solution to risk reduction is often likely to be increasing the scale of the enclosure, to enclose a whole cliff or cluster of outcrops rather than only a part of such a complex, with obvious implications for cost. Factors such as additional time needed for planning, particularly in winter surveys, remoteness of the site, frequent zigzagging to avoid snow beds, and the need for unusually high numbers of metal posts with rock drilling, will also increase fencing costs significantly. The cost per metre may be up to twice that expected at lower altitudes.

Snow is usually a major hazard to fencing in montane sites. In traditional Scottish winters a significant accumulation of snow would have been the norm at many montane scrub sites. This may be to a depth well in excess of the height of any fence, conditions that are bound to cause damage. Engineering alone is unlikely to solve the problem, although a high specification will doubtless be more durable overall. Route planning is the best way to minimise this risk, requiring snow surveys to be carried out prior to montane fence construction. Ideally, these should be done for several years to overcome the problem of our variable winters, although the time scale of project planning and funding usually militates against this. Fence damage will be minimised by using ridges and hummocks that are blown clear of snow. Where an unavoidable snow bed is identified, damage limitation can be achieved by tying off the fence on separate strainers either side of the damage area, to limit the length to be repaired. Remember that, as montane willows especially are likely to be on sites with some accumulation of snow, a winter survey is an essential part of the planning process. Snow probes should be used to measure depth rather than a visual estimate. Even on very familiar ground such estimation is likely to be unreliable.

All mountain cliffs are subject to rockfall to some extent. This destructive force must be assessed when planning a fence, and again routing the fence along the line of least hazard is an obvious precaution. However, the crucial issue to be assessed is the probable frequency of destructive rockfalls and the size of rocks to be expected. An examination of the site, including the scree and boulder fields around the cliff, will give many clues. What proportion of rocks around are bare and unvegetated? Are there troughs of bare ground gouged out by large, fast-moving boulders? Are there many bare patches of cliff indicating a recent rockfall? How far do most of the rocks travel below the cliff? Are most of the fallen rocks large enough to cause extensive rather than localised damage?

The beginning of the enclosure programme at Ben Lawers, with two small enclosures below Creag an Lochain, included a prediction that rock damage would occur. However, it was predicted that the repairs necessary could be handled in-house. The first serious damage occurred precisely two weeks after construction, and it was repaired within a few

days. Similar, serious damage occurred once more on that fence within its 13-year life, a rate that was manageable. The other fence had more frequent but more minor breakages due to rockfall, usually repaired promptly. Such repairs on remote or high altitude sites present logistical problems of management. As they are largely unpredictable, a planned work programme needs to include frequent monitoring and be flexible enough to react quickly to destructive events. This is inherently difficult on remote, unmanned sites. It is normally cost effective to transport the materials to the site by helicopter to install the fence, but less so for ongoing maintenance. It is worth stockpiling materials on site to some extent, taking steps to prevent wood rot, to facilitate quick repairs with minimal transport costs.

Instability of fences may also arise from other natural processes, such as solifluction on steep slopes, ice deposition *etc.* In the case of electric fences, regenerating vegetation may need to be controlled alongside the fence to limit shorting to earth, which reduces power and effectiveness. In total, all these factors create a considerable maintenance commitment. Success depends on the project manager's ability to both monitor the condition of the fence frequently, and to deal promptly with any problems that arise. This commitment can easily be underestimated in establishing a project. It needs to be borne in mind that the duration of such projects is likely to be long, perhaps decades rather than years.

Secondary considerations that should be borne in mind in designing a fence are its impact on the landscape, the potential for fatal bird strikes, and perhaps public expectations of access. For best practice, the impact on landscape and birds should be minimised, while it is in the interest of the project to facilitate access rather than risk damage by people climbing over the fence. Selecting the specification of the fence, then, is likely to be a complex decision, taking into account the species to be excluded, the hazards and therefore the likely maintenance requirements, the availability of staff and the budget to meet this commitment, and the relative importance of potentially conflicting considerations. Bearing in mind that roe deer have the reputation for being especially adept at passing through fences, their proximity to a project site should be considered.

Fence failures, *e.g.* resulting from snow

damage, may result in an invasion of herbivores. Depending on the number of animals and vulnerability of the shrubs, action may be needed urgently. The possibility of herding invaders out should be considered at the design stage, to incorporate appropriate gates, ramps, or sections of fence designed for temporary removal or lowering. If resident staff do not have sheepdogs, a cooperative local shepherd may be the answer. Deer are difficult to herd and may need to be culled. Timeous action will often require a control agreement or licence for out-of-season culling.

A general discussion of protection issues is given by Wood-Gee (2001b).

To plant or not to plant?

The dioecious species such as willows and juniper will generally fail to produce seed when sparsely distributed. Many relict populations are in this condition, and their viability for long-term survival may depend on increasing the number and density of plants to promote pollination. Plants on cliff ledges are subjected to many additional stresses and threats (Mardon 1990), and in effect have no secure future. However, the dynamic processes that contribute to these threats, *e.g.* frost heave, rockfall & landslips, also create bare soil niches for seedling establishment. The proximate aim may be to change the balance of probability in favour of reproduction by both seedling establishment and by vegetative spread. This will often require planting on areas of greater stability, perhaps immediately adjacent to cliffs, where plants are not likely to slough off and where spreading branches may encounter vegetation rather than airspace. If clustered closely, with both male and female plants, seed production will follow. A substantial annual seed rain, rather than a moderate one, will give the best probability of success. However, no restoration project yet exists in Scotland where success with montane willow regeneration by seed has been demonstrated.

Evidence of some regeneration can be found at natural relict sites, in the form of an apparent age structure including very small plants that are probably seedlings. In spite of this, the population is normally constrained by browsing such that those seedlings away from the protected ledges can never grow to maturity. When such evidence is found it is logical to test the possibility of regeneration without planting. Such an approach, based on

the guiding principle of minimum intervention and favouring natural processes (e.g. Clifford 1997), would be more acceptable to many people. However, the presence of sheep or deer may be a significant factor in the creation of bare soil niches, and unless landslips continue to create these, as is possible on steep slopes at high altitude, then the subsequent closure of the sward may inhibit further regeneration. In such a case a controlled grazing regime compatible with survival of shrubs may be sought, or manual creation of bare areas tried. As also pointed out by Clifford (1997), natural regeneration is sporadic and may involve long time scales. The struggle to obtain funds for such conservation projects is a compelling reason to accelerate the process so that by the time a fence reaches its expiry date, demonstrable success can support a request for further funding for a rebuild.

Propagation of plants for restoration projects

It is often assumed that the best method of propagating willows is from cuttings. While it is true that many species will root readily as cuttings, there are both advantages and problems with this method. With relict populations, it allows the local gene pool to be maintained without 'pollution' from outside. Some may consider this important. It thus ensures that hybrids that are not already present on the site are not introduced. It avoids the commitment to intensive care needed for seedlings. However, the need to conserve relict populations by planting implies that relatively few plants are left. In such cases the population is unlikely to yield an adequate amount of material, at least not without sustaining significant damage. If only a small number of plants are required, and the source plants are large, then use of cuttings may be the best method. In such a case it is possible to know the sex of planted saplings to ensure an adequate ratio (see below). One solution to the problem of damage to surviving plants is the use of intermediate cultivation from cuttings, grown on as parent or donor plants in nursery conditions, providing bigger and more accessible plants from which further cuttings provide the saplings for planting. This 'bulking up' would be a slower and more costly process.

Propagation from seed can allow production of larger numbers of plants. Collection of

seed (or cuttings) from crag-bound plants may however be an adventure, sometimes involving danger of death. Use of climbing rope-work may be necessary to provide safety, but is not advisable for those without the necessary training, experience and equipment. Also, a rope is only as good as the belay to which it is attached, and many willow scrub sites are on cliffs built of the most friable rocks which are mostly not to be trusted. Turf may provide a better anchorage but requires specialised tools and a very fine judgement. The development of bespoke extension-arm gadgets for reaching awkwardly sited plants may be worthwhile (Marriott, personal communication).

However, even at populations that are mostly inaccessible, a few plants bearing seed may be within reach for collecting. Experience suggests that the accessible proportion of such relict plants is inversely correlated with the age of the collector, or in other words, the hazards seem more fearsome as you get older. 'Bulking up' in cultivation is also possible to overcome the limits to potential seed collection, but may incur genetic risks, so material planted in the wild should ideally be grown from wild propagules (Fleming & Sydes 1997).

The timing of willow seed collection is critical. The ripe capsules dehisce to release the minute, wind-borne seeds, each of which is equipped with a plume of silky hairs. Collecting too early results in failed germination while arriving too late means the seeds have gone with the wind. With geographical, seasonal and altitudinal variation in timing of up to a few weeks, predicting the optimum date is difficult. To avoid failure some early visits to monitor ripening of fruit are advisable. Warm sunshine ripens more rapidly than cool wet conditions. Catkins are best collected when just a few capsules are beginning to dehisce. The unopened capsules thus retain all their seed, and can easily be opened by rubbing. The full opening of capsules and expansion of the fluff follows rapidly under indoor drying conditions. Separating seed from the fluff is necessary to ensure that individual seeds make contact with the compost for germination. This can be done quickly and mechanically by whisking with a bent wire in an electric drill, contained within a large sweetie jar. This also has the advantage of spinning the fluff together, thus reducing its tendency to float on the air throughout your premises. In spite of such efforts, fruiting may

simply fail at some sites in some years, potentially preventing the achievement of short-term deadlines.

Willow seed once collected must be germinated immediately, as its viability is limited to a few days. This phenomenon was measured on small samples of *Salix lapponum* seed by Sullivan (1997), and observed but not quantified by the NTS with many large samples propagated at Ben Lawers. Once placed on damp compost, germination begins within hours, and is usually completed within a day or two. They should be sprinkled carefully and evenly onto the surface, to avoid overcrowding. This is the most critical stage, when seedlings need careful nurturing. They must be protected from heavy rain and from drying out. They are subject to damping off and other fungal infections, and predation by slugs. It is wise to assume that there will be losses during the early weeks. Project managers taking on this task should expect to spend a significant amount of time on the collection and propagation of seed. If seed is sent to a nursery for growing, ensure that there are no undue delays at the stage of germination.

Selection of source material may pose problems, assuming the precautionary principle indicates using sources as near to the planting site as possible (Sydes 1997). If this is not possible, then what is the most acceptable source? This dilemma exists at Ben Lawers for juniper, although not for the willows planted so far. Herbert, Samuel & Patterson (1999) is assumed to be best guidance in this case. Within the guideline for selecting a source population, it is assumed that genetic variation should be maximized. Seed or cuttings should therefore be taken from as many individual plants as possible, given the constraints of safety and accessibility. A method of random selection would be the ideal, (Sydes 1997), but in practice accessibility and safety may be the overriding considerations.

Translocation of genotypes from one population to reinstate another does present some dilemmas. Some plant geneticists may argue that potentially unique features of local plant populations should be conserved, and that translocation and population reinforcement should only be carried out after careful genetic screening of existing populations. Such work is time-consuming and costly and in many cases will not be possible as a precursor to a restoration project. With willows, there is also the risk of

translocating a hybrid to a location where it has never existed naturally. Even if the parent female plant shows no hybrid characters, there is no guarantee that the pollen involved was from a similar plant. Screening for obvious hybrids can be done at the nursery stage, but requires the retention of plants in the nursery for longer than normal, thus adding to costs. However, nursery-grown plants may have artificial characters not resembling those of wild plants, confounding identification, and hybridisation in willows may involve multiple origins, (Meikle 1984). The recognition of all such hybrids therefore demands considerable skill.

Differential growth rates among species need to be taken into account at the nursery stage. For example, *Salix arbuscula* grows very slowly, and *Salix lanata* and *Salix lapponum* slowly, such that these species may be best kept in the nursery for two seasons. After over-wintering the growth is much more similar to that in the wild, rather than the lush, highly palatable growth of first year nursery-grown plants. *Salix myrsinifolia* and *Salix aurita* grow significantly faster, and can achieve a better size for planting within one year, although hardened growth-form may still be an advantage from over-wintering.

Propagation of juniper may also be from either seed or cuttings. However, in this case the seeds do not germinate quickly but instead may require over a year to do so (Beckett & Beckett 1979). In either case, initial growth is slower than with willows. As with willows, the dioecious habit will lead to lack of fruiting on isolated plants. Fruiting is also limited at higher altitude sites, even with clustered populations. At Ben Lawers, a lack of local seed requires us to propagate from distant seed sources, or from cuttings. With only seven plants left on the Reserve, of which five are reasonably accessible with climbing or abseiling, propagation of only small numbers of plants will be possible from this source. McBride (1998) reports that propagation by cuttings is easier than from seeds, and gives useful information on this process.

General guidance on propagation and planting is given by Sullivan (2001).

Planting

Assuming the proximate objective is to establish a seed-producing population, then the pattern of planting should optimise the rate of pollination. Observations of willows at

Ben Lawers indicate that a female within five metres of a male will normally be very fruitful, but a female some 50 metres from the nearest male will hardly ever produce seed. However, Sullivan (1997) recorded seed production on *Salix lapponum* females some 40 metres from males. A formula to fully represent the pattern of correlation between dispersion and pollination is not known, but would be a useful area of study. NTS practice has been to cluster a high proportion of plants to well within an average interval of five metres, but to use a random and irregular pattern to avoid an obviously planted appearance, and some plants are scattered more sparsely to mimic a natural dispersion pattern. Seed production has been achieved, but only on plants with over six years of development after planting.

It is assumed that seeds will provide a sex ratio of about 50:50. Female predominant sex ratios of flowering willows of about 60:40 have been reported in nature, (e.g. Crawford & Balfour 1983), as has differentiation in mortality and physiological attributes of sexes. Such a sex ratio may be optimal for seed production. However, while all these factors are of considerable academic interest, they appear to represent unmanageable complications for implementing a practical planting programme.

Planting at Ben Lawers has all been done with cell-grown stock. This enables planting to be carried out in summer, with seasonal contract staff and conservation volunteers. Given that the planting sites for willows are continually moist, desiccation has never been a problem. At the altitude of montane scrub communities, working in summer has obvious advantages but planting is unlikely to be feasible in the period November to April. Ground preparation has not been used much at Ben Lawers, considered as one level of intervention too far, and for reasons of aesthetics and time economy, although many foresters would strongly recommend it. It may be that the period of slow initial development would have been reduced with ground preparation.

The manner in which projects are funded may result in planting over a very short time scale, resulting in a population of one age class. Natural populations would be expected to include a range of age classes. Ideally such attributes should be reflected in the planting, and may be so if a long time scale can be adopted. However, if the project successfully establishes regeneration processes, then

variation in age class should develop in time, but in any case differential rates of growth and development will often result from variation in habitat from place to place.

Aftercare & monitoring

Aftercare such as watering, weeding or fertilising is unlikely to be necessary or perhaps even feasible for montane scrub sites. To avoid the risk of increasing the artificial selection it is best avoided, even though some losses may be expected (Fleming & Sydes 1997). The question of protecting individual plants against the smaller herbivores often arises. There is no doubt that hares and voles may have an affect on montane shrubs. A high proportion of willows planted at Ben Lawers has had apical shoots bitten off by hares. There is no evidence that this is not sustainable as many plants thrive in spite of this, and simply become more branched and bushy, but the cause of the demise of some of the plants is not known. However, in the area where birches have also been planted, they too can sustain the apical shoot hare predation, but voles biting through the base of the stem have killed significant numbers. Once the plants have grown to achieve an increased stem diameter, to above at least five millimetres, their survival prospects are much enhanced. This threat may also apply to willows, but their overall success rate has been more satisfactory. Planting when such growth has already been achieved may give better success rates, but will incur increased nursery costs. Vole populations fluctuate on a three to four-year cycle, and are known to damage young trees at population peaks (Southern 1964). It would probably be advantageous to synchronise planting with the troughs in the vole cycle, but administrative deadlines rather than biological phenomena may determine the timing. Protection of the individual montane willows planted has not been applied at Ben Lawers, so we cannot evaluate its cost-effectiveness. Trials to determine whether success could be enhanced enough to justify the additional time and costs, and the negative aesthetic aspects of vole guards, could be useful.

Most projects will need to have their success measured in some way. An early attempt to do this at Ben Lawers used a sample of tagged plants to monitor survival and growth after planting. This did demonstrate a high survival rate for the first year, but the rapid, progressive dislodgement of tags rendered

the project incapable of measuring the ongoing survival and growth. These and subsequent observations indicated that upward growth only becomes measurable after about three years. This could be a period of root establishment and, as stated, of apical shoot predation. The onset of flowering was gradual, but was significant after six years of growth and development.

The method of monitoring now employed at Ben Lawers depends on the survey of the principal areas planted, to record the plants that are well established. Plants too small to be easily noticed are not fully established and thus not recorded. Each plant recorded is described in terms of size and degree of branching, thus recording the overall growth and development of individual plants, and the area of scrub. The number of plants counted is compared to the number planted. The rate of flowering can also be measured, perhaps as a catkin count, although a precise measure of seed production may not be possible in practice. In the longer term, evidence of regeneration will be sought. Data were recorded in 1998 for two main species of willow, *Salix lapponum* and *Salix myrsinifolia*, planted on two sites at different altitudes from 1991 to 1993. Thus, five to seven years after planting, success in becoming established varied from 31% to 77%, between the four species/site categories (Griffith 1998). The success rate on the lower site (500 to 630 metres) was nearly twice that on the higher site (700 to 810 metres), and *Salix myrsinifolia* was more successful than *Salix lapponum* on each site. The variation might be the result of altitudinal climatic effects, and of specific differential growth rates that have also been observed in the nursery. It is assumed that growth and development will continue to progress over many years.

Much still needs to be learned about the dynamics of the communities and the potential for achieving the ultimate objective of restoring viable montane scrub. Regarding projects as trials to test ideas or working hypotheses will enhance progress. Thus a programme of monitoring after planting should aim to enhance guidance for future projects. Restoration projects also provide an opportunity to extend our knowledge of the fauna associated with scrub, and investigation of the invertebrate associations, as yet incompletely known (Bland, Entwistle & Horsfield 1997), would be particularly interesting.

Long-term commitment

The measurably slower growth rate at the altitude range of most montane scrub communities indicates that even the proximate objectives may require decades to achieve. Beyond that, it is assumed that the process of regeneration by seed will also be slow, largely dependent on the coincidence of variable factors such as seed rain and niche creation. Achieving even the reduced stature of montane shrubs at high altitude may take as long as the growth of larger trees at moderate altitude. There can be little doubt, however, that such projects will require a life span of decades (Maunder 1992). Project planners should assume that they are in for the long haul. Ensuring this type of long term commitment from corporate agencies and ensuring the succession of staff to continue a project are among the many challenges inherent in conserving montane scrub.

Conclusions

The restoration of montane scrub in Scotland is beset with many practical difficulties. Progress on a large scale depends on radical, widespread changes in land management which seem improbable for the foreseeable future (Sydes 1997). At present, success is most likely to be achieved on designated sites owned by conservation agencies and with resident staff. Projects will currently require intensive local management of large herbivores, often in the form of enclosure fencing. Most of us would regard such measures as 'temporary' and agree that their permanence is highly undesirable. Yet without an indication that radical, large-scale management changes will actually occur, establishing a project under present conditions must involve an uncertain future, representing something of a gamble. Once the additional uncertain consequences of climate change are added, and given the long time scale required, one might wonder if the effort is worthwhile. In spite of the difficulties and uncertainties, it is important that we do establish a significant number of projects in order to progress up the learning curve. Projects should be fully exploited to test practical methods and hypotheses about the ecology and dynamics of montane scrub. This may require the co-operative participation of both academics and reserve managers. Long time scales are inevitably involved, such that it is often helpful to recognise both proximate objectives and ultimate objectives against which success can be measured.

Acknowledgements

I am grateful to Helen Cole and Andrew Warwick for comments on the manuscript.

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Discussion

Chaired by Michael Scott

Plantlife; deputy chair, Scottish National Heritage.
Strome House, North Strome, Ross-shire IV54 8YJ

The conference included afternoon workshops which aimed to identify some of the key issues facing montane scrub restoration. This paper begins with a summary of the workshop outcomes, which was delivered on the day by Tim Clifford, Highland Birchwoods, and concludes with a report of the key elements of the plenary and discussion sessions.

Workshops — report back

There were four different workshops, split across land-use interests: hill farming & sporting; cultural & natural heritage; landscape & recreation and forestry. Each one was asked to identify the key positive and negative issues that restoration of montane scrub would have on their interests, and then to spend time identifying solutions for two or three of the negative issues.

It was immediately clear in pulling together the outcomes that there were a number of common threads running through each workshop. There was consensus that the restoration and expansion of montane scrub is generally something to be desired. The time is right, and the policy framework is very different from that of the time of the first conference (March 1996; see Gilbert *et al.*, 1997).

Three other major issues were identified by each group:

- ❖ the name 'montane scrub' was considered a handicap in promoting restoration beyond those 'already converted', particularly in the agricultural sector where it is associated with abandoned land.
- ❖ the scale of restoration is going to need to be large, spanning the interests of different land use agencies. Cross-sectoral compliance between incentive schemes was considered a key need.
- ❖ there are real issues in terms of the long term sustainability of management because of fund-raising shortfalls. Grant schemes tend to be short-term although changes on the ground are not going to happen quickly. Even when outside funding is brought in to partner

grant schemes, funding is still an issue over the longer term. If seed corn funding is brought in, there must be also be funding for long-term maintenance.

In addition, each group identified specific key issues, and a few suggested solutions, associated with their land use interests. These are summarised as:

Hill Farming & Sporting

Key issues identified:

- ❖ lack of adequate incentives, where they do exist they are not adequate or realistic;
- ❖ need for cross-sectoral compliance both in management schemes and incentives which function at the whole farm scale;
- ❖ need for education and promotion regarding montane scrub which is sensitive to the association between scrub and abandoned farm land.

Cultural & Natural Heritage

Key issues identified:

- ❖ lack of information about the impact of possible scrub expansion on archaeological features. There is also a lack of information about the way that scrub develops, reacts and functions generally;
- ❖ need for education, particularly to sell the story of montane scrub to the general public in a way which will be relevant to the urban dweller;
- ❖ danger of dealing with montane scrub in isolation from adjacent habitats, both woodland and open ground;
- ❖ need for integration of research and long-term planning across traditional policy making and management divides.

Landscape & Recreation

Key issues identified:

- ❖ need to see the habitat in the context of the hill landscape, as part of a vertical continuum, rather than an isolated band;
- ❖ although the need for interactive restoration techniques, such as planting,

were accepted, the use of fencing was considered negative, both visually and ecologically. Further research should be undertaken to confirm whether it should remain as one of the measures to conserve existing remnants;

- ❖ need for long-term targets (20 years at least) for restoration. A strategic action plan could deliver recreational aspirations, such as increased biodiversity and the better harvesting and management of game species;

- ❖ presence of sheep on the hills was considered the major impediment to restoration;

- ❖ education was proposed as a key to raise awareness. In particular, it was felt that all policy makers from the different sectors would benefit from a trip to Scandinavia to experience the habitat for themselves, with the prospect of beneficial changes in policy on their return.

Forestry

Key issues identified:

- ❖ multiple benefits associated with montane scrub restoration such as increased biodiversity, improved landscape, soil and water quality, tourism, forestry, greater integration of different land uses and benefits in general to education;

- ❖ need for policy to drive restoration at the landscape scale which would require a strategic approach;

- ❖ strategic approach required to grazing control which would in turn require cross-sectoral compliance;

- ❖ further policy development is required with regard to the use of native and non-native species;

- ❖ gap in technical information available on species ecology, genetic variation within populations, propagation, monitoring, protection and demonstration/advice;

- ❖ innovative funding for restoration is needed such as; a multi-agency approach with research into ways of adding value to government funding; voluntary management agreement schemes or promoting the adoption of treelines or scrub communities by climbers as areas to scatter their ashes;

- ❖ general education was seen as extremely important.

Plenary and discussion

Many of the issues raised in the workshops came back to the fact that there are no clear targets for delivering the future montane scrub resource which could be promoted and the plenary confirmed that this was a requirement. It was agreed that it is not necessarily possible to define realistic targets for restoration in the conventional terms normally used for woodland, such as an increase in area, because the present area is very small (except possibly juniper and dwarf birch); there are also no accurate figures available on which to base a total. This restriction did not necessarily apply to relict high altitude woodlands or woods approaching the treeline that could be encouraged to spread up the hill. The need to include quality of the resource, as well as quantity, in target setting was emphasised. Nonetheless, the meeting agreed that some sort of vision was necessary.

Another issue that generated discussion was the question of a name for the habitat, given that 'scrub' had such pejorative definitions and negative connotations for farmers and crofters. The Forestry Commission tend to use 'treeline woodland', which excludes the higher altitude scrub communities. Other names suggested are: 'montane woodland', 'woodland at the edge', 'from sea to summit', 'mountain woodland', and 'dwarf mountain woodland'. There was some debate as to whether high altitude scrub (willows, dwarf birch, juniper) should in fact be included with the upper margins of forests given that they have quite distinct ecologies, but strategically both have a low public profile and their cause would be disadvantaged by being split. Given that the main, particularly short-term, benefits to be gained from restoration will be natural heritage ones, it was considered important to link promotion for restoration to other hill habitats and land use interests and capitalise on existing incentive schemes, such as the Woodland Grant Scheme (WGS). It was recognised that there are, and will be, initial negative consequences of restoration which must be acknowledged and accepted in the light of longer-term benefits.

The need for strategic action plans was raised by a number of the workshops. There is the existing UK-wide Biodiversity Action Planning (BAP) process that covers many woodland and grassland habitats. The current complement of these plans has recently been reviewed for gaps and a new plan covering

'montane heaths' has been proposed, which will embrace the treeline. This new plan is seen as an opportunity to integrate some of the mosaic and transition habitats that occur in the subalpine and low alpine zones with each other and their lower altitude woodland and heath neighbours. It was recognised that one of the weaknesses of the Biodiversity Action Plan process was the lack of interaction between teams developing the different action plans, limiting the consideration of transitions and intergrades between different habitats. It was suggested that a remedy for this might be the inclusion of a high-altitude Montane Heath HAP representative on the woodland HAP team and vice versa. Habitat networks are increasingly being recognised as of crucial importance, not just for woodlands, or moors or mountain tops, and this is requiring greater communication between specialist of different habitat types.

The final area of discussion related to the future of the Montane Scrub Action Group and how the conference saw its role following the conclusion of the Millennium Forest Montane Scrub Restoration Project. The review of the Woodland Grant Scheme (WGS) had already been highlighted as a key opportunity to build provision into the forestry incentives, although it was felt that greater impact would be made if all the organisations present were able to

include treeline woodland and montane scrub in their submissions. Particularly, the experience in areas like Carrifran would be invaluable for consideration of useful changes to the current system. There was recognition of the need for integration between different funding schemes, specifically the relationship between the Rural Stewardship Scheme and the new WGS would be important. The question of a WGS mountain woodland supplement was raised, with the suggestion of enhanced management payments. Another suggestion was to kick-start action through a bid for European Union funding, through LIFE -Environment for research and integrated management or through LIFE-Nature for restoration work associated with Special Areas of Conservation. There are a number of other minority habitats that are equally rare and threatened and there would be benefit in promoting all these habitats together, whilst retaining their ecological distinctions. Two initiatives for 2002 might be used to bring forward much earlier results; Treefest — for trees, woods and forests and the Mountain Forum for the International Year of the Mountain.

The chairman concluded the discussion by observing that the perspective of a 'little belt along the hillside' had been widened during the course of the day to put it into the full context of the mountain landscape.

Conclusions

Sir Peter Hutchison

Chairman, Forestry Commission (until November 2001), 231 Corstorphine Road, Edinburgh EH12 7AT

It really has been a mind stir to hear some extremely interesting talks and opinions and views. I don't know whether you can look backwards at a foreword but before I came along today I had a look at what I'd written at the start of the Montane Scrub booklet published by Scottish Natural Heritage and I was pleasantly surprised to see I strongly agreed with everything that I'd said! Which was reassuring and it reminded me that it was an extremely well written booklet; I think Michael Scott is largely to thank for that.

Michael started the proceedings talking about his enthusiasm for montane scrub, I think he got it in Mount Washington. Then Des Thompson, against photographs of Norway, said how he'd acquired much enthusiasm there. My affection for montane scrub came from the mountains of West China where there are, surprisingly enough, quite a lot of similar genera; birches are there, the willows, the junipers; they are different species but the same genera keep cropping up. But there are also *Rhododendron* which form a dense scrub with a waist-high canopy made up of ten to 15 species. Windswept almost to a table, it is often easier to walk on top of them, but when you bend down and look underneath you see that the individuals, although only about a metre high, might be two to three across and two to 300 years old. That is where I got my enthusiasm.

Montane scrub is an orphan, wandering between designations, a few SAPs (Species Action Plans), very short on HAPS (Habitat Action Plans), and BAP-less (Biodiversity Action Plan); lost among all these classifications and categories, largely ignored by the National Vegetation Classification. I think it really needs a champion.

Des Thompson reminded us of how much valuable work has been going on over the last few years, and still is, to try and establish something of a sound scientific base for our understanding of what we're trying to do. Some of the information about growing conditions across Europe was particularly fascinating, demonstrating the importance of ground temperature, and how this was a

critical factor. Also the very unusual position of Scotland, which is most interesting as it started coming out of the graphs.

But his final words will stay with me, when having amplified what a lot there is still to do, he remarked that "we had an opportunity to significantly alter the natural face of Scotland" and that seemed to me quite an inspiring thought for all.

I mentioned that montane scrub needed a champion and it has certainly has one in Diana Gilbert. She reminded us of the basic work that needed to be done when all this was embarked on. We needed to establish a vision and to promote that vision to get people on board. We needed to improve our understanding of the resource that we were working with, this fragmented and frail scattering of plants, and guidance as to how we could restore it, what in practical terms we could do.

Neil Mackenzie gave us a fascinating review of our knowledge of this resource, which really has to be the bedrock from which we start. There were some wonderful pictures of these communities, fragile as I said. 'Clinging on to life' took on a new kind of meaning when you see the willows huddled on a cliff face just out of reach of browsing. So his booklet, (Mackenzie 2000), is a fundamental database without which we couldn't really proceed on any sensible basis. And I am aware there is a lot of work still to be done.

Talking of restoration projects we then had two very practical and very well informed talks from Andrew McBride and David Mardon. Andrew emphasised the need for a methodical and planned approach to our projects with SMART (Specific, Measurable, Achievable, Relevant, Time-limited) objectives. He is absolutely right, it is an area that can get a bit fuzzy and where aspirations are always good, but hard delivery is a good deal more difficult to achieve. He also raised some very interesting issues in relation to how much intervention is allowable. It is obviously desirable to start with less and if that is not successful to move onto a more interventionist phase, but do we have the

time? There were one or two references to global warming; it is generally agreed that warming is happening but there is much less consensus on the outcome, or what the results are going to be and how it will manifest itself. But there does seem to be general agreement that there is likely to be some migration of plant communities if those communities are going to survive. But *Salix lanata* (Woolly willow) ain't migrating nowhere, uphill or anywhere else unless it has a healthy breeding stock and population to start with. There is an element of urgency in some parts of the problem, as ably demonstrated by David Mardon; we were lucky to have David with us given the hazards of collecting willow seed! He gave the benefit of a tremendous wealth of practical experience and I found it very entertaining and informative, the results of his 14 years at Ben Lawers. He also raised a lot of questions; do you fence and if so what sort of fencing? I will certainly go away with a mental image of the twisted and bent Sgurr na Lapaich fencing. Do you plant and if so how do you maintain genetic diversity? I'd never thought that even voles could be a problem.

A very sound foundation has been established for stage one. There are also a number of factors running in our favour. There is a benign climate of thinking and an increased awareness of a neglected corner of our natural heritage. I think that one sign might be that I'm here. It really is a bit improbable that ten or 20 years ago the chairman of the Forestry Commission would have been standing in front of a group like this, advocating strongly that we should restore little scrubby things all over the hillsides without a single stick of decent timber coming out of it! However, I am here and I do think it's an extremely well founded project.

Andrew Raven set the scene very well for this improved climate and he gave a very good review of some of these favourable factors which are working on our side — the political context, of course, devolution, changes in natural heritage policy, and changes in farming as well, perhaps not enough yet but agricultural policy surely must, and will,

change. And forestry is not least amongst these. I now urge you to make full use of the Woodland Grant Scheme consultation process that is about to happen; these opportunities don't arise that often — please make full use of it. The Scottish Forestry Strategy is a step in this process and out of it change will come. We're very keen that Scotland and the Scottish Executive owns its strategy; one of the benefits from devolution is that there will be quite a different character in the three countries in the way that forestry is operated and managed.

A very good foundation has been laid, and we're ready for stage two. Many of the things for that second stage and which needed discussing have been dealt with in the workshops and subsequent plenary, as summarised ably by Tim Clifford, pulling together a great many opinions. But one or two things did come forward: the need for targets; the need is very real for specific, visible, observable projects that can have a time scale which we work to and which enable us to demonstrate to people that something is happening. Of course there is a need for funding and there is both a short term funding need and a long term need. The Forestry Commission are anxious to be helpful and supportive and to give it a fair wind. That may include some money from time to time but a government body, an agency like us, can not lead such a movement. It needs to be a cooperative effort between a number of bodies, and it helps the Forestry Commission if there are a number of funding partners such as Scottish Natural Heritage and the Scottish Agricultural College, to do that as well.

Montane Scrub needs a champion and the Montane Scrub Action Group (MSAG) have done a tremendous job; I hope that it goes on to champion this cause and to give some leadership and co-ordination. Several people have talked about the need for cross-sectoral work and coordination of projects, and they are right. I hope that MSAG will accept the challenge to continue to co-ordinate and lead this project. If we work together we will have an opportunity of 'significantly altering the natural face of Scotland.'

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Sullivan, G. *Note No.5. Propagation of Species*.



This is part of the Montane Scrub Restoration Project, steered by the Montane Scrub Action Group, a partnership of the following individuals, supported by the above organisations.

Brian Staines
David Mardon
Alison Hester

Rob Soutar
Angus MacDonald
Diana Gilbert

Michael Scott
John Holland
Timothy Clifford



This project is part of the Millennium Forest for Scotland



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