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Woodland restoration in Scotland: Ecology, history, culture, economics, politics and change

Richard Hobbs^{a,*}

^aSchool of Environmental Science, Murdoch University, Murdoch, Western Australia 6150, Australia
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Abstract

In the latter half of the 20th century, native pine woodlands in Scotland were restricted to small remnant areas within which there was little regeneration. These woodlands are important from a conservation perspective and are habitat for numerous species of conservation concern. Recent developments have seen a large increase in interest in woodland restoration and a dramatic increase in regeneration and woodland spread. The proximate factor enabling this regeneration is a reduction in grazing pressure from sheep and, particularly, deer. However, this has only been possible as a result of a complex interplay between ecological, political and socio-economic factors. We are currently seeing the decline of land management practices instituted 150–200 years ago, changes in land ownership patterns, cultural revival, and changes in societal perceptions of the Scottish landscape. These all feed into the current move to return large areas of the Scottish Highlands to tree cover. I emphasize the need to consider restoration in a multidisciplinary framework which accounts not just for the ecology involved but also the historical and cultural context.

Keywords: Scots Pine; *Pinus sylvestris*; Woodland restoration; Interdisciplinarity; Grazing management; Land ownership; Restoration goals

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1. Introduction

What should the goal of land management, conservation and restoration be in any particular place? How do we decide what an appropriate goal, or set of goals, is? Are decisions to be driven primarily by pragmatic land use issues such as the provision of food and fibre or the fulfilment of clearly stated narrow conservation goals, or are they to be guided more by consideration of what was there in the past as a guide to what “should be” there now? How can change – in both environmental conditions and in human perceptions, knowledge and expectations – be built into these decisions? Deciding on goals for land management in general, and ecological restoration in particular, is not a straightforward task ([Ehrenfeld, 2000], [Hobbs, 2003] and [Hilderbrand et al., 2005]). Often, it is not done effectively or well, not done involving all parties with a stake in the decision, or sometimes not done at all. Decisions are often made on the basis of the viewpoints of a few powerful stakeholders, on the basis of incomplete information and understanding of the ecological and socioeconomic settings in place, and/or on the basis of a set of beliefs concerning the “correct” ecosystem which should be present in an area (from a particular geographic or historic perspective). Or sometimes decisions are made in a more or less ad hoc manner – either based on the assumption that doing something is bound to be better than doing nothing, or based on the particular biases and preconceptions of the people involved at the time.

I suggest that the influences on ecological restoration are manifold and involve not just the ecological and other biophysical aspects of the environment, but also a wide range of social and historical issues. In Fig. 1, I highlight the range of disciplines likely to be involved in developing a useful understanding of how restoration decisions are made and goals are set.

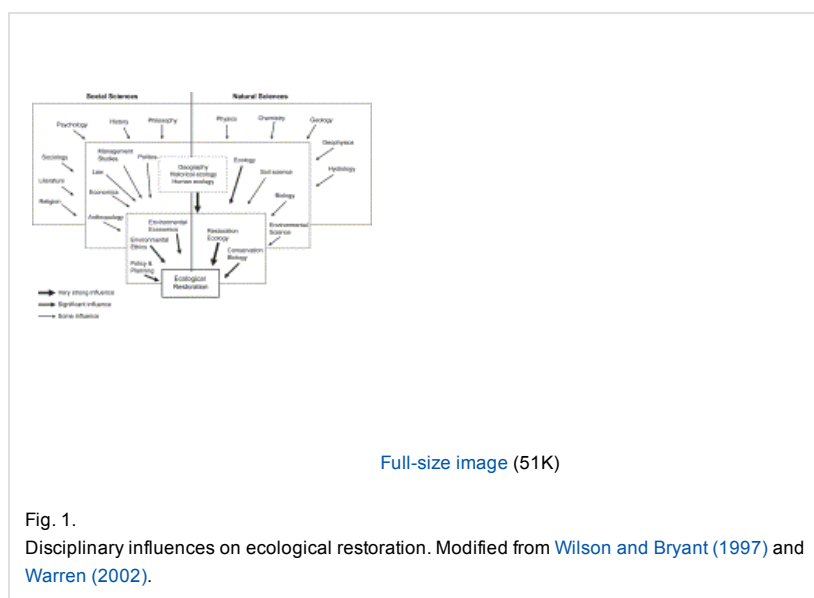


Fig. 1. Disciplinary influences on ecological restoration. Modified from Wilson and Bryant (1997) and Warren (2002).

In this paper, I consider the background to radical changes in conservation and restoration objectives in Scotland which have occurred over the last few decades of the 20th century. In particular, I examine the shift in emphasis from maintaining open upland, predominantly heathland, habitats to the large-scale re-establishment of woodlands, with particular reference to Scots Pine (*Pinus sylvestris*) woodlands. I trace the history of woodland degradation in Scotland and its socio-economic drivers through to the latter part of the 20th century and then examine the factors which have led to the current resurgence in interest and activity in woodland restoration. I then consider current issues in woodland restoration from the broader perspective of setting restoration goals and lessons for ecological restoration in general. I do this from the perspective of someone who worked on a PhD on heathland ecology in the Scottish Highlands in the late 1970s and early 1980s, departed for a prolonged stay overseas in North America and then Australia, and returned regularly to Scotland for holidays and for a study visit in 2006. The differences in perceptions, expectations and activity surrounding woodland restoration between when I left in 1982 and when I returned in 2006 are what inspired this paper. This paper represents an attempt to produce a synthetic overview covering some of the main influences on restoration illustrated in Fig. 1, using a review of primary literature sources and field observations conducted during 2006/2007.

2. Woodlands in Scotland

Woodlands of a variety of types are found in Scotland (e.g., McVean, 1964), and the distribution, history and use of Scottish woodlands has received increasing attention over recent years (e.g., [Fowler, 2002], [Smout, 2002] and [Smout, 2003]). In particular, focusing on woodlands dominated

by Scots Pine (*Pinus sylvestris*), their distribution and extent has varied through time since the last glaciation in response to climatic and other environmental change and, increasingly, through human activities (Bennett, 1995). Palaeoecological evidence, including subfossil pine stump remains, clearly indicates that pine occurred throughout northern Scotland (Fig. 2; [Birks, 1989], [Gear and Huntley, 1991], [Bennett, 1995] and [Froyd and Bennett, 2006]). However, this did not necessarily mean complete forest cover all at one time period. Indeed, there is debate over woodland extent in historic times, with some accounts suggesting a large, almost unbroken forest covering much of the northern part of Scotland, but others suggesting that this is more myth than reality and that woodland was less widespread and more patchily distributed across the landscape (see, e.g., [Smout, 2000], [Breeze, 2002], [Hanson, 2003] and [Muir, 2005]).



Full-size image (78K)

Fig. 2.

Map showing approximate extent of Caledonian pine woodlands in Scotland 6000 years ago, as derived from paleoecological studies (dotted line), current distribution of woodlands (black), major towns, and major locations mentioned in the text. Collated from (Aldhous, 199) and Royal Society for the Protection of Birds (RSPB), 2002 and Warren (2002). Note that the estimated former area of pine woodlands presented here is only one of a number of suggested distributions: for instance Edwards and Whittington (2003) present a map of woodland in Scotland at 5000 years BP which differs in detail from that presented here, and Bennett (1995) presents evidence for pine extending further than indicated, including up to the north coast of Scotland and on some of the western islands.

It is clear, however, that pine woodlands have undergone a history of exploitation and reduction in extent from at least the 18th century onwards – as, for instance, was recognised in the ecological literature as early as 1935: “The woodlands such as now survive in the Spey Valley are chiefly Scots Pine (*Pinus sylvestris*) During the period 1914–1918 much of the woodland was cut, and for the most part there has been no extensive planting to replace the heavy losses” (Fenton, 1935). In the classic study of native pinewoods in Scotland, Steven and Carlisle (1959) surveyed all the remaining stands and suggested that, not only were there only relatively few, mostly small stands left, but that most of these stands were not regenerating. For instance, they state that, “The natural regeneration of the native pinewoods is clearly full of difficulties” (p. 90), and, “Most of the pine are old, the principal age class being from 140 to 190 years. There are relatively few trees under 100 years old, and current natural regeneration is both exceptional and on a small scale” (p. 298). Their conclusion is that, “If no positive action is taken for the preservation and perpetuation of the native pinewoods, it is not difficult to foresee their future, because their past history provides the answer. The smaller remnants will gradually disappear, and the larger woodlands shrink in area as heather burning on adjacent grazings bites into their margins” (p. 299). Despite these warnings, little heed was taken of the apparent plight of the native pinewoods until a conference held in 1975 (Bunce and Jeffers, 1977), and even as late as 1983, Watson (1983) concluded that, “The dying native woods in this area (Braemar) and other parts of the Highlands now pose one of the chief problems for nature conservation in Scotland.”

Hence it is clear that by the second half of the 20th century, the woodlands were restricted in area (Fig. 2), covering far less than their potential range ([Rodwell and Cooper, 1995] and [Jones, 1999]), and not regenerating. How had this come about?

3. Socio-political background to land use

The decline of Scottish woodlands, including pine and other types, was part of a broader pattern of dramatic changes in land use and human population distribution that characterized the Scottish Highlands. Although such changes had been evident earlier, Fraser Darling (1955) used 1745 as the starting point for his analysis of what he termed the “Highland Problem”. While focussed on the west Highlands, Fraser Darling's report is relevant to the Highlands as a whole and was an impressive attempt, well ahead of its time, at an interdisciplinary approach to land use and management issues. Fraser Darling used 1745 as the starting point of his analysis because it marked the Jacobite Rebellion which ended in defeat at the Battle of Culloden, near Inverness, in

1746 (e.g., [Devine, 1994] and [Lenman, 2004]).

Many are largely ignorant of the history of Scotland following the battle of Culloden. As Devine (1994) and others chronicle, the defeat at Culloden ushered in a sad period of Scottish history in which the victors set about ensuring that no further rebellions would occur by vicious reprisals and the subsequent systematic break up of the social framework of the Highlands. The clan, or family, system was the main social system within which the clan owned lands and the clan chief, a hereditary position, was responsible for the welfare of clan members who farmed smallholdings and tended cattle, in return for military service when required by the chief. After Culloden, many of clan lands fell into the hands of non-hereditary chiefs and at the same time the clan chiefs grew more attracted to more sophisticated ways of life which were expensive to maintain. The clan members who had previously been secure within the clan system now found themselves without any security of tenure. Numbers on the land were also increasing because of the advent of the potato as a reliable staple food.

The need to pay for expensive lifestyles led to an expansion of the few industries which were capable of making reasonable profits from the highland landscape. These were kelp, or seaweed, harvesting at the coast and extensive sheep grazing inland. Extensive sheep grazing increasingly replaced the more intensive cattle husbandry previously practiced and was incompatible with the continued presence of large numbers of small farm holdings. The fact that the farmers had no security of tenure allowed landowners to remove the farming communities from their lands, at first from the inland areas to the coast and then increasingly away from Scotland altogether. A long period of systematic depopulation of the Highlands began in the 1750s and continued into the late 1800s, hurried along by other factors such as the potato famine which occurred in the mid-1800s. This process, known as the Highland Clearances, resulted in the forced eviction and emigration of thousands of people, many of whom were transported to the United States, Canada and elsewhere ([McIntosh et al., 1994a] and [Richards, 2002]). The message from landowners was clear. Buchanan (1996) quotes from Lady Matheson, speaking in Lewis in 1888, well towards the end of the clearance period, to tenant farmers: "The land under sheep and deer is my property and I can do with it what I like." In an account of the process of clearance on the island of Rhum, the site of what may be the earliest human habitation in Scotland (Finlayson and Edwards, 2003), Hugh Miller, writing in 1845, wrote, "The island ... had been divested of its inhabitants, amounting at the time to rather more than four hundred souls, to make way for one sheep-farmer and eight thousand sheep ..." (cited in Love, 2001).

While extensive sheep grazing was the initial choice of land use on the highland estates, the demand for wool declined after the end of the Napoleonic wars in 1815. Later in the century, imported lamb from New Zealand also began to supplant home-grown meat. In addition, the Highlands became increasingly accessible from the south as road, rail and steamer links improved. This, together with the relatively cheap land to be had in large quantities, led to a further shift in land use towards recreation for wealthy landowners from the south. This recreation centred on fishing and hunting, particularly of red deer (*Cervus elaphus*). The process was further enhanced by the increased popularity of the Highlands through Queen Victoria's setting up of Balmoral as a Highland retreat, which coincided with the Romantic era in which the Highlands were portrayed in art and literature as a wild and empty place (e.g., Marshall, 2005). The "Balmoralisation" and "romanticisation" of the Highlands contributed further to the decline in rural human populations, but also led to increasing deer numbers and management to promote these and other game species such as red grouse (*Lagopus lagopus scoticus*). This affected not only farming communities but also those involved with forestry—for instance Smout (2006) recounts how 104 people working in the forests of Abernethy in the Spey Valley were cleared in 1879 to make way for a deer reserve employing 7 people.

While there was eventual resistance to clearances in places such as Lewis (Buchanan, 1996) and clearances ceased towards the end of the 19th century, Scotland's Highland landscape was by then owned by a very small number of people, who supported far fewer tenant farmers than previously. The mix of extensive sheep grazing and management of estates predominantly for hunting and recreation has persisted virtually unchanged to the present day.

What has all this to do with woodlands? The answer is that a direct link can be drawn between the observations of woodland decline discussed earlier and the history of land ownership and land use presented above. Timber provided another source of revenue to Highland estates, and large amounts of timber were cut and exported for a number of uses, including shipbuilding and fuel, especially during wartime periods ([Grant, 1994] and [Dunlop, 2002]). In addition, increased emphasis on extensive grazing by sheep and deer significantly altered the amount and extent of herbivory experienced by native plant communities. It is well established in Scotland and elsewhere that increasing deer numbers leads to significant browsing pressure on native tree species, often completely preventing any effective regeneration (e.g. [Miller et al., 1998] and [Côté et al., 2004]). In addition, management for red grouse is focused on frequent small-scale burning which maintains open heathland vegetation in a mosaic of different ages (e.g., Hobbs and Gimingham, 1987). The combination of intense herbivore pressure and fire management ensured that tree species would be restricted to existing remnant areas and could only rarely regenerate within these areas nor spread out into the surrounding areas.

4. Woodland regeneration

The combination of historical events, socio-economic and political factors discussed above led to the archetypal Scottish landscape as it has been depicted in paintings, literature, pictorial calendars and tourist material – open, mostly treeless, wild and empty (Fig. 3). This landscape has long been regarded as “normal” and “natural” for most Scots and visitors to Scotland. It is only recently that the relatively recent origins of the landscape in its present form have been made more apparent. It is in this setting that the problem of woodland decline must be discussed.



[Full-size image \(29K\)](#)

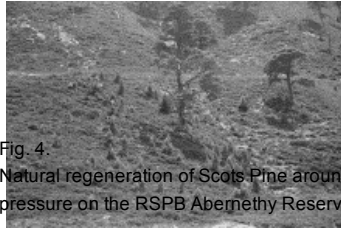
Fig. 3.

A classical Scottish landscape with open hillsides covered in heather moorland and/or grassland, and virtually no trees (photo by R.J. Hobbs).

When I left Scotland in 1982, although there was recognition of the problem of woodland decline and lack of regeneration, there was little discussion of the possibility of a rapid solution to this problem. There was some thought being given to how existing stands might be conserved and regenerated, but virtually no discussion of broad-scale regeneration, replanting and conversion of currently unwooded areas back to woodland cover. While the need for increased forest cover to increase the supply of domestically-grown timber and timber products was recognised, the strategy at that stage was to plant extensive industrial-style plantations of species such as lodgepole pine (*Pinus contorta*) and sitka spruce (*Picea sitchensis*), often using highly mechanised ground preparation methods and venturing onto lands which were often marginal at best for commercial forestry. When I returned in 2006, the situation had changed entirely. It seemed as if many places I visited showed signs of extensive native woodland restoration – either by natural regeneration of pine and other species, or by active planting and assisted restoration. Existing woodland areas showed clear signs of vigorous regeneration and extensive areas of former open heath were now undergoing conversion to woodland or forest.

What precipitated these changes? Here I outline both the proximate ecological factors resulting in extensive woodland regeneration and the underlying socio-economic and political drivers which encouraged and/or facilitated this.

The factors preventing woodland regeneration were identified early: Fraser Darling (1947) reported observations of mature and regenerating woodlands on islands in freshwater and sea lochs despite a complete lack of woodland in surrounding areas, and such observations are still possible in many areas today (e.g., Warren, 2002). Islands were essentially free from herbivory, and hence the inference was that herbivory played a major role in limiting tree regeneration elsewhere. Watson (1983) made a very clear link between deer numbers and tree regeneration, and numerous other studies since then have done the same (e.g., Miller et al., 1998). Similarly, exclosure fencing has been shown to allow regeneration and forest re-establishment near to seed sources (Scott et al., 2000). There is clear evidence that deer populations in Scotland have been increasing greatly since the first systematic counts started in the 1950s, from about 155,000 then to about 350,000 in the early 1990s and continued increase thereafter ([Clutton-Brock and Albon, 1992], [Deer Commission for Scotland, 2000] and [Warren, 2002]). Hence the problem has been clear for some time, and its solution relatively obvious: exclude or reduce the numbers of grazing animals, particularly sheep and deer, in an area. Cessation of frequent patch burning for grouse moors may also be necessary. Where seed sources are available nearby, regeneration of pine and other tree species occurs (Fig. 4), and can be further encouraged by soil scarification ([Low, 1988], [Karlsson and Orlander, 2000] and [Edwards and Mason, 2006]). Where no seed is available, planting of trees is possible and can achieve high success rates.



[Full-size image \(56K\)](#)

Fig. 4.
Natural regeneration of Scots Pine around an adult tree following the reduction of grazing pressure on the RSPB Abernethy Reserve (photo by R.J. Hobbs).

Despite the early recognition of the issue, until recently large-scale woodland restoration has only occurred in a relatively few areas such as Beinn Eighe, where attempts to restore woodland cover have been ongoing for some time ([[Johnston and Balharry, 2001](#)] and [[Clifford and Forster, 2002](#)]). In the last two decades of the 20th century, on the other hand, interest and activity in woodland restoration increased markedly, both in terms of restoring and regenerating existing woodlands (e.g. [[Cameron, 1995](#)] and [[Taylor, 1995](#)]), and planting new areas (e.g., [[Rollinson, 2003](#)] and [[Wormell, 2003](#)]).

Reduction of pressure from herbivory has been increasingly seen as an important element of woodland restoration ([[Beaumont et al., 1995](#)], [[Warren, 2002](#)] and [[Thompson et al., 2006](#)]). Sheep numbers can be reduced by reducing stocking rates or increased enclosure on lower land, but the reduction of deer herbivory is viewed as more of a priority and is more problematic. The two main methods available for doing this are fencing and culling, and there has been considerable debate over both methods. At first glance, one would assume that the most benign method would be fencing to exclude deer from areas to allow trees to regenerate and grow to a suitable size. However, fencing has been shown to have a number of important disadvantages, including expense to erect and maintain, visual impact and restriction of human access ([Warren, 2002](#)). Perhaps more importantly, however, fences do not solve the problem of overabundance of deer, but simply move it elsewhere, and they also have severe negative impacts on other species. Of particular concern is their impact on woodland grouse species, particularly capercaillie (*Tetrao urogallus*). This bird, a large game bird about the size of a turkey (its Gaelic name, *Capall coille* means "horse of the woods") was driven extinct in Scotland in 1771 through habitat loss and hunting, was reintroduced successfully in 1837 ([Fraser Darling, 1947](#)), and in a survey in 1948 was widespread throughout the Scottish Highlands. It is now considered an iconic woodland species, but its numbers have been declining markedly over the past few decades ([[Moss et al., 2001](#)], [[Baines et al., 2004](#)] and [[Shaw et al., 2006](#)]). While there are numerous hypotheses on the cause of these declines, including predation, habitat and climate change ([[Moss et al., 2001](#)], [[Baines et al., 2004](#)] and [[Summers et al., 2004](#)]), collisions with deer fences have been documented as a significant contributor to mortality of capercaillie and other woodland grouse ([Catt et al., 1994](#)). While redesign of deer fence construction can decrease this impact ([[Summers and Dugan, 2001](#)] and [[Baines and Andrew, 2003](#)]), this in turn significantly increases the visual impact of the fences.

The problems with fencing have led to some managers removing deer fences and relying instead on culling ([[Beaumont et al., 1995](#)] and [[Taylor, 1995](#)]), and reduction of deer numbers by culling has been carried out in several other locations, for instance at Creag Meagaidh National Nature Reserve ([[Ramsay, 1996](#)] and [[Deer Commission for Scotland, 2006](#)]). These efforts have resulted in increased tree regeneration and calls have been made to reduce deer numbers over broader areas. However, deer culling is controversial and certainly not universally accepted, either by landowners and gamekeepers who see culling as a potential threat to their income, or by the general public who do not necessarily understand the broader picture within which culling should be placed ([Wigan, 1993](#)). Adverse publicity, such as following culling operations in Glen Feshie in 2004 (e.g., *The Scotsman* newspaper, 30 March 2004, "Gamekeepers protest against red deer cull"), portrays culling as cruel, unnecessary or bad management, without explaining the reasons why culling was initiated. Adverse sentiment also extends to the membership of NGOs such as the Royal Society for the Protection of Birds (RSPB), and their culling operations have resulted in a loss of some urban members who do not want to be associated with an organisation that kills deer regardless of the reasons that this is being undertaken (R. Thaxton, personal communication). In addition, recent work has indicated that successful regeneration cannot readily be predicted on the basis of simple deer density estimates, but may instead be related to the spatial and temporal patterns of deer foraging in combination with other factors such as the incidence of severe weather and pine growth rates ([Palmer and Truscott, 2003](#)).

The impacts of deer on vegetation in Scotland are mirrored in many places elsewhere in the world ([[Bradshaw et al., 2003](#)], [[Rooney and Waller, 2003](#)], [[Weisberg and Bugmann, 2003](#)], [[Côté et al., 2004](#)] and [[Oyen et al., 2006](#)]). Reduction in deer numbers following the extinction and recent reintroduction of wolves into parts of the United States had significant impacts on the regeneration of tree species ([Ripple and Larsen, 2000](#); [[Ripple and Beschta, 2004](#)], [[Beschta, 2005](#)] and [[White and Garrott, 2005](#)]). While there are ongoing discussions concerning the possibility of reintroducing wolves into parts of Scotland, it seems an unlikely prospect, at least in the near

future. Hence some other form of controlling deer seems essential if woodland regeneration is to continue.

5. Links to cultural renewal, politics and land ownership

Recent trends of woodland regeneration were undoubtedly initiated by the increased recognition of the conservation and cultural value of woodlands, arising from increased awareness and recognition of the threatened status of these woodlands (McIntosh, 2006). However, this, in itself was not enough to make things happen. While there was concern over the conservation status of woodlands in Scotland from at least the 1950s, little actually happened (apart from a few isolated examples) until towards the end of the 20th century. This can be explained in part by the prevailing land use and land ownership patterns and the underlying assumption that little could be done to change either.

Scotland, even today, remains the country with the most concentrated private land ownership in the world ([Cramb, 1996], [Wightman, 1996], [Wightman, 1999] and [Warren, 2002]), with relatively few individuals owning large tracts of land. Most of these private estates are run primarily to provide sport shooting and fishing, and these activities provide many estates with an important source of income. Land use practices on estates are thus geared heavily towards maintaining the land in the state which allows deer and grouse shooting to be maximised. Burning heather moorlands for grouse and maintaining high numbers of deer are both incompatible with large-scale woodland regeneration, and hence, until the late 20th century, there seemed little hope that such regeneration could be achieved. In addition, management of many large estates has been assessed as being poor and causing a number of land degradation issues (e.g., Cramb, 1996). Even with appropriate management for grouse habitat, red grouse populations declined dramatically in the 1970s (e.g., Budiansky, 1995).

In the last part of the 20th century, however, a number of important trends in land ownership picked up speed. Firstly, NGOs such as RSPB began to purchase key conservation land such as Abernethy Forest, and large estates such as Mar Lodge Estate were taken over by the National Trust for Scotland ([Johnston, 2000] and [Warren, 2002]), in some cases with native woodland restoration as a key management goal. Secondly, in a selection of high profile cases, private estates were purchased by local community groups: for instance the North Assynt estate in Sutherland (MacAskill, 1999) and the Isle of Eigg ([McIntosh, 1997] and [Dressler, 1998]).

MacAskill (1999) tells the story of the Assynt crofters and their purchase of the North Assynt estate which was originally owned by Lord Vestey, an English businessman who had made a fortune from meat trading. Cramb (1996) suggests that it was “the view of the locals that Vestey has been a regressive landowner who may love the place, but only as an oil painting, hunting ground, and salmon reservoir. Not as a place where people live and work, and may have aspirations for new development and opportunity.” One of the main activities undertaken since purchase has been the extensive fencing and planting of trees in areas of the purchased land (personal observations). Magnusson (1995), in his keynote address to a 1994 conference on pine woodlands, observed: “Last week, on a visit to North Assynt estate, I saw and felt for myself the passionate importance which the crofters of Assynt, newly come into ownership of their ancient lands, attached to the concept of woodlands: of letting trees grow where they belong, of letting trees once again become part of their lives, for firewood, for shelter, for buildings, for nourishment, for fencing, for creels, for a hundred necessities of life – and for spiritual refreshment. And I found myself mentally adapting that celebrated sentence from Steven and Carlisle: ‘To stand in them is to feel the future’.” (Steven and Carlisle wrote about native pinewoods: “To stand in them is to feel the past”).

These community land purchases, although still relatively small in number, form part of a broader push within Scotland for land reform. While the idea of land reform has been around for a long time, there was little scope for changing the situation since the small number of private landholders were exceptionally powerful and were very resistant to change of any kind. However, with the advent of the devolution of government to a new Scottish Parliament at the end of the 20th century, land reform has been placed squarely on the political agenda ([Wightman, 1999] and [Warren, 2002]). While some commentators suggest that a parliament in Edinburgh may serve the needs of communities in the Highlands no better than one in London (Hunter, 1995) and the Scottish Parliament may be viewed as simply another layer of red tape, there are also grounds to be hopeful, and the Land Reform (Scotland) Act 2003 (<http://www.opsi.gov.uk/legislation/scotland/>) brought the community right to purchase land into the legislative framework. Recent legislation passed by the Scottish Parliament (the Nature Conservation (Scotland) Act 2004) and relevant policy documents, such as the Scottish Biodiversity Strategy and Scottish Forestry Strategy ([Forestry Commission Scotland, 2006] and [McIntosh, 2006]), also feature progressive, forward-looking strategies which target woodland management and restoration. However, it also must be recognised that this legislation sits within the broader framework of policy from the European Union (such as the Habitats Directive, Natura 2000 and Land Management Contracts under Common Agricultural Policy reforms; see, e.g.,

http://ec.europa.eu/environment/nature_biodiversity/index_en.htm) and the UK parliament (including the UK Biodiversity Action Plan and Habitat Action Plans; <http://www.ukbap.org.uk/>) and, at the more local level, local biodiversity action plans. The policy landscape is a constantly evolving one, and other considerations, particularly climate change, will undoubtedly lead to

further development.

Magnusson (1995) concluded, in relation to woodland regeneration: "We have the opportunity to recreate something we have lost, to reclothe the land with something of which we can be proud." The regeneration of woodlands coincides with a broader political revival, as outlined above, but also a cultural revival, with increased interest in the music, art and language of the Scottish Highlands. Hutchinson (2005) discussed the demise of Gaelic, the native language of the Highlands of Scotland, in the period since 1745 and its recent renaissance in popular music, literature and drama. Interestingly, one of the earliest proponents of the revival of Gaelic music was a band called Capercaillie, after the woodland bird discussed above. The interplay between ecological, cultural and political rejuvenation marks a new era in Scottish life in which recognition of the problems of the past is matched with new hope for the future (e.g., [McIntosh et al., 1994b], [Hunter, 1995] and [McIntosh, 2000]).

6. Current issues in woodland restoration

While I have discussed what I perceive as a dramatic increase in woodland restoration currently underway in Scotland, there remain significant issues to be considered in relation to the goals and extent of woodland restoration – what is appropriate, where, and how should it be achieved? As outlined in Section 1, the process of setting goals for restoration is often unclear or ineffective, and this also appears to be the case in Scottish woodlands. Fenton and York (2003) suggest that: "The rationale behind woodland restoration projects is sometimes fragile, and is rarely clearly articulated." If increasing the extent of native woodlands is a goal, how much is appropriate and what should it consist of?

As indicated above, the original extent of woodland cover in Scotland is unknown and actively debated. If the "Great wood of Caledon" is portrayed by some as a myth, one could debate the growing assumption that much of the Highlands of Scotland were once wooded. Are we simply replacing one paradigm (i.e., that the Scottish Highlands are open and largely treeless) with another (that trees were everywhere). The first has been shown to be based on a situation created over the past 250 years by changing patterns of population, land ownership and land use. But the second, although it has some basis in evidence from paleoecological literature, hides a wealth of complexity relating to how continuous the woodland cover was and what its structure and dynamics were. Growing interest in woodland restoration creates a tension on private estates between extending woodland and maintaining open heathland for sporting purposes (e.g., [Wigan, 1993] and [Ratcliffe, 1999]), and, indeed, heathland is important as a habitat in its own right. This mirrors the situation in other parts of Europe, where valuable habitats and cultural landscapes previously maintained by traditional management are now under threat following abandonment and encroachment by woody species, including Scots Pine (e.g., [Molinillo et al., 1997] and [Hobbs and Cramer, 2007]). In addition, recreation in the Highlands includes large numbers of hill walkers and climbers who come to the region to experience the open landscape. Clearly there is a middle ground which allows for expansion of woodland while at the same time maintaining adequate areas of open country (Hope et al., 2006). There are attempts currently to base the siting of woodland regeneration sites on bioclimatic modelling approaches ([Hester et al., 2003] and [Towers et al., 2004]), and such approaches can also be used to ensure that an appropriate mix of vegetation is maintained in any given area: assuming that there are transparent and acceptable means of deciding what is "appropriate".

The other set of decisions to be considered is the desired woodland structure within restored areas. Ratcliffe (1999) highlights the importance of the "desired future condition" but does not attempt to define what this is. Edwards and Mason (2006) point to uncertainty concerning past structure, composition and regrowth dynamics in pine woodlands. Should restoration aim to reintroduce tree species other than pine, as suggested by Ogilvy et al. (2006)? Should restored areas be targeted at the development of a closed canopy characteristic of dense young pine regrowth, or should they be modelled more on the majority of mature woodlands which are more open, with open-grown individuals in a park-like structure (Fig. 5)? There is some evidence to suggest that at least some woodlands were historically managed as "wood-pasture", or a savannah-like system based on scattered trees and livestock grazing ([Quelch, 2001], [Holl and Smith, 2002] and [Smout, 2006]). While Vera (2000) has emphasized the importance of wood pasture as a vegetation type present in northern Europe even before extensive human management, Svenning (2002) concluded that both closed forest and more open wood pasture were likely to have been present, a conclusion also reached in the Scottish context by Smout (2006). Further, Shaw and Tipping (2006) suggest that paleoecological evidence indicates that sudden changes in forest structure and composition have occurred in some places in the past, and hence we should also expect these in the future. Periodic changes in stand structure over time have also been documented in Scandinavia both in relation to fire dynamics and climate variation ([Zackrisson et al., 1995], [Pennanen, 2002] and [Oyen et al., 2006]). Indeed, Smout (2006) concludes that careful consideration is required of the potential impacts of climate change on the success or otherwise of current regeneration and planting schemes. Hence, on what do you base the desired future condition: paleoecological evidence; historic management; an arbitrarily selected time period in the past to reconstruct; societal desires; recognition of a rapidly changing climate and a "no-analogue" future (Fox, 2007); a combination of these?



[Full-size image \(40K\)](#)

Fig. 5.
Mature open pine woodland on RSPB's Abernethy Reserve (photo by R.J. Hobbs).

Other decisions involve the choice between purely native species and the possible inclusion of non-native species. While there is a growing push to use only native species currently, there is also the point of view that some non-native species are valuable both for production and aesthetics (Warren, 2002). Indeed, current management by some organizations which involves removing existing non-native species has been regarded as of questionable value by some observers (Cross, 2006).

Peterken (1996) has discussed the question of woodland restoration from the perspective of naturalness. He recognized a number of different "states" of naturalness, including:

original-naturalness (the state which *existed* before people became a significant ecological factor),

present-naturalness (the state which *would prevail now* if people had not become a significant ecological factor),

past-naturalness (the quality attached to woods whose components have been inherited directly from the original-natural forests,

potential-naturalness (the state which *would develop* if people's influence were completely removed and the resulting succession were finished in a single instant), and

future-naturalness (the state which *would eventually develop* if people's influence were completely and permanently removed, which accounts for species gains and losses, climate change, etc.).

He suggests that useful restoration options include original-natural woodland, present-natural woodland, and future-natural woodland, involving either restoring original landform (including removing artefacts) or accepting the present condition and configuration of the site. How useful are these definitions and targets in a practical sense? Do we know what woods were like prior to human influence? Is it meaningful to consider what would happen if humans were completely removed from the successional process? Are these concepts appropriate in situations such as Scotland where humans have been present almost from the time ice retreated at the end of the last glaciation and have had such an intimate relationship with ecosystems? Bradshaw et al. (2003) concluded: "There is ... no single set of 'base-line' conditions, just a trajectory of periods with short-term stability in response to shifting driving forces" – because of changing ungulate communities, climate change and its effect on vegetation, and increasing interaction with human activities.

This taps into a broader question of the place of humans in nature. Should the goal in the Scottish highlands be to maintain the current emptiness of the landscape in terms of human habitations, even although this emptiness is an artefact of two centuries of depopulation? Should the large estates be retained in their current or similar form since they maintain the "wild" nature of the Highlands? What will happen to this "wildness" if community groups purchase the land and want to develop new local industries or reinhabit areas once populated but cleared of humans? There is an apparent paradox of an archaic land ownership system maintaining a set of landscape characteristics which have come to be valued, especially by visitors to the region, which may be threatened if the current trend of bottom-up community-driven activity continues.

Such bottom-up approaches may also be at odds with more strategic conservation initiatives, and certainly have the danger of clashing with the raft of regulations discussed above arising from the hierarchy of government from the European Union through the UK parliament, the Scottish parliament and finally local authorities.

Clearly there are many challenges ahead both in the setting and achieving of restoration and conservation goals for woodlands in Scotland, and for broader land use and land ownership issues. I have raised many questions above and could be criticised for not attempting to provide potential solutions. However, I believe that arriving at solutions will be an iterative approach and of necessity needs to involve a wide range of people. Many activities are already underway, and a useful way forward is to critically observe these and assess whether the outcomes are useful and "desirable", or at least looking as if things are heading in a generally acceptable direction. Rather than attempting to develop a common approach practiced everywhere, use can be made of the

diversity of approaches currently underway: indeed, if rapid environmental change is to become the norm, having an array of different approaches may be the best way of building resilience into both our management and the ecosystems themselves.



7. Conclusion

Achieving sensible and broadly acceptable outcomes in woodland restoration in Scotland depends on an understanding not only of the ecology of the woodland systems but also the social, economic and historical (recent and longer term) settings. This Scottish case study is likely to be representative of many situations worldwide. While the details will differ, the broad need to think about more than just the ecology is likely to be increasingly essential: however, this realisation has not often been built into planning and carrying out restoration programs. I have explored only some of the influences on what is currently happening with woodland restoration in Scotland that are indicated in Fig. 1, and a fuller analysis would undoubtedly uncover many more interrelationships. We are currently in a highly dynamic and changeable period both in terms of climate and environmental change and in the socio-political environment. This can be a period of great opportunity with the potential to do things differently and aim for a future where decisions result in useful outcomes for both woodland and other ecosystems and for the human population. I argue that deciding on restoration goals has to be placed in this broader context: doing so not only enriches the debate but might ensure that we learn from history rather than repeating the mistakes of the past.

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