Pine forest restoration.

This argument is about how best to regenerate a specific population of trees. These have become greatly diminished in a part of their original range, where they had spread widely during a mild climate after the last ice-age. These trees have been over-exploited for timber and the land they formerly occupied has been used for agriculture and field sports. They are Scots pines, *Pinus sylvestris*. This tree is one of the World's most vigorously successful to judge by its natural range: from Scotland to eastern Siberia, and Norway to the northern shore of the Mediterranean Sea (see Chapter: "How did this pine forest arrive here?"). In Scotland this is the only indigenous conifer tree, whilst juniper grows as a bush. Now there remain eighty four separate pine woods. Some of them cover no more than several hectares and others are far isolated from other populations of pines.

The largest pine woods grow on foothills of the Cairngorm massif of granite mountains and walking under these characterful trees is an emotional experience for many visitors. Within their range in Scotland there are also many commercial timber plantations of these trees. People have made plans for many decades now, to extend the distribution these pine woods onto land they formerly occupied.

How best to do this falls broadly into two methods. Natural regeneration, without any planting, is promoted because that will retain the high level of genetic diversity that is part of the vigour of this population of trees. But this is slow and could be difficult to practice in the context of widespread distribution of pollen and seed from both many plantations and natural stands of pines. The alternative is to use saplings grown in tree nurseries, then planted to grow alongside local natural stands. Both approaches require substantial work to control herbivores, from voles to deer, that eat seedlings or strip bark from young trees. Deer need to be controlled down to a level that provides sufficient browsing pressure to prevent fast growing populations of broad-leaf birch and rowan trees growing on ground formerly occupied by pine trees.

There is much enthusiasm for regenerating these pinewoods from individual volunteers, financed organisations, forestry enterprises, and many of the owners of the land on which these pines stand. One project is a collaboration between all landowners on wide arc of the western foothills of the Cairngorm mountain massif. This area already has many stands of pines, so the objective is to connect and expand them all. Other projects have plans to establish pinewoods on land that has not supported pinewoods for centuries. Nobody is making plans for regeneration extending onto land not formerly within the original, post-ice age, distribution in Scotland. However, plans vary, so what practical approach is likely to yield visible progress, within a forester's working life-time for example: a pine seedling through to its first full crop of seed, about thirty five years

Advocates of exclusively natural regeneration argue that natural habitats cannot be replicated by planting. Intervention by people on these natural habitats will make them, by definition, non-natural managed habitats resembling nature reserves. Where there is insufficient local source of pine seed then planting could be used, but only as a last resort. Scots pine seed used in nurseries is considered to genetically contaminate the high level of genetic diversity of the original natural pine forest of Scotland.

These pine trees, as they grow in Scotland, are known as *Caledonian* pines: a particular ecological and genetic component of the vast international spread of this species. Natural regeneration is considered best for its potential to spread out from core areas of vigorously growing, healthy pines. These areas are well defined, mapped and categorized as core areas, regeneration zones, and buffer zones. Such buffers are to isolate the stands of pines from competition by fast growing broad-leaf trees and the adverse effect on regeneration that non-native conifers have. These are predominantly commercial plantations of Sitka spruce, and several other species such as Lodgepole pine. From these plantations there is much production of seed that disperses on the wind. Sitka is an excellent tree for timber crops but in the broader context of pine wood regeneration it is a vigorous threat.

Within this Scottish area of natural distribution of Scots pines there are many actively managed plantations of this species, meeting the commercial demand for this type of timber. For the purpose of natural generation of Caledonian pine forests these plantations are an impediment. They occupy space and spread much pollen and seed which will have lower genetic diversity than any pines of fully natural provenance. Some advocates of natural regeneration advocate that once the trees in these plantations have been harvested there should be no replanting of that land as continuing plantations of pines. Alternatively, existing plantations could be restructured by selective felling so that they develop slowly into stands of natural character.

The geographic scale of contrasting proposals for regenerating pine woods, natural only or planted, must be considered. An inventory of these pine woods, done between 1994 and 1999, revealed that natural stands, of a minimum 30 trees, at 78 sites, the pines occupied approximately 16,000 hectares. In contrast, plantations of pines occupied 101,000 hectares. For the whole of Scotland the pine wood resource is approximately 1.4% of total forest resource. Furthermore, regulations for management of timber plantations specify that once the trees have been harvested the land must be replanted within two years, as commercial timber or of regeneration character.

All of this land, the entire area of Scotland, is owned as legal entities, nearly all private. The Cairngorms National Park is a managerial organisation that promotes public access and good practice of land management. Whether or not a pine wood is to be left to flourish exclusively by natural regeneration is with the consent, tacit or explicit, of the owner. Land here that is devoid of any stands of trees is likely to be moorland vegetated by heathers and similar low shrubs. Pine seed naturally dispersed onto such terrain often struggle to establish and grow up into the light. Scots pine trees flourish on well drained, sandy, soils. They struggle to survive on bog-land, of which there are many large areas in Scotland.

The largest pine woods of most natural character skirt around the margins of the Cairngorms massif. Here is active a group of landowners and managers: the *Cairngorms Connect* partnership for the restoration and expansion of pine woods over 60,000 hectares. Management styles have varied but this project has relied mostly on natural regeneration. Collaborative management of deer is crucial for this regeneration project. Professional stalkers cull the deer; this method is more effective than fencing for exclusion of deer. The expansion of new woodland, has over this time, been approximately 164 hectares each year of the project. This restoration project was started with a plan for the next two hundred years. Here Scots pine is the most conspicuous species but the broad-leaf trees of this region also thrive.

Regeneration of pinewoods is also done as various projects by people, with emphasis on work on ground preparation, planting saplings of pines and some broad-leaf trees, removal of competing species of trees such as spruces, and deer control. This approach, this human intervention imposed on the natural environment, needs clear definition. Here the term rewilding is a problem. If the long-term objective is to produce larger pine woods of character that resemble those of thousands of years ago then a more managerial term is needed. Restoration, for example: unequivocal and similar to what people might do to their own house or neglected garden. To restore a decrepit house requires money, skilled labour, and compliance with professional and legal requirements. Restoration of pine woods comes within the norms of commercial forestry. Thus it is open to financial subsidy for expansion of woodlands and forests in general, for purposes of removing carbon from the atmosphere and increasing biodiversity of natural environments. However, the land on which this pine wood restoration is being done has a long history of human ownership, exploitation, management, and emotional engagement. The influence of these social components of woodland regeneration are powerful. Avoiding the term rewilding will probably be more effective than promoting it.

The scale of what is proposed, geographic and over time, is dauntingly large. Furthermore, it must be done at a pace to show progress that will continue to encourage engagement by people working on site and those providing financial support. The widest range of organisations working at woodland restoration will be needed to maintain momentum long-term. So the promotional material of the Cairngorms Connect project is instructive here. This partnership, as described above, also includes land managers for Wildland Ltd, NatureScot (a Scottish Government agency), Forestry and Land Scotland, and the Royal Society for Protection of Birds who own and manage reforestation in a large landholding. Sixty people are engaged by this partnership. This land comes within the remit of the Cairngorms National Park, with their long-term objectives that require cooperation from all partner land-owners in the restoration region. Private donors toward this restoration work are invaluable and some of the estate owners work specifically for woodland restoration over most of their land-holding; with or without planting the trees. Often the most important contribution is by sustained control of deer, which is usually done by collectives of estates – the deer move widely wherever they find best graze and browse.

Focus on the most dense populations of Scots pines around the Cairngorm massif is unbalanced. There are many areas further north and west where woodland restoration is active. Organisations such as Trees for Life, together with the Woodland Trust are typical, with active fund-raising, broad range of methods including running tree nurseries or purchasing seedlings from them. Professional ecologists are employed to make large-scale surveys of where best to do restoration work. Similar, often private, projects are also active here. Conferences held at national scale, active websites, paid-for teaching and engagement courses, opportunities for volunteer tree-planters are the modus operandi here. An example is the *Caledonian Pinewood Partnership* (see their website for information).

Professional foresters, mostly concerned with how best to run commercial plantations of spruce and pine trees, have contributions to make

for restoration projects. Also there are independent surveys of opinion made by organisations such at the Royal Society of Edinburgh. They report that forestry replanting for maintaining production conifers should include areas of broad-leaf trees and Scots pines. This should include removal of invasive non-native trees, such as Sitka, spreading naturally from plantations near to pine-woods.

Foresters also have opinions on use of the word *natural* in this context. An operational definition is needed, but difficult. Seed production by existing pine woods is very variable over time for any specific stand and the distribution of stands regularly producing ample seed is highly variable. Most pine seeds fall to the ground within one hundred metres of their parent tree, although storm winds may carry pollen and the small, winged, seeds by the kilometre Another problem is the poor ecological state of the smaller pine woods in Scotland. These might be foci from which widespread natural regeneration will spread as larger woods that combine to resemble a coherent woodland. So planting is recommended, using saplings from nurseries. These are for planting at about half the density used for a commercial plantation of pines; that is 1500 tree stems per hectare with average spacing 2.5 metres between trees.

Another approach to pine wood restoration from foresters is to restructure some of the plantations of Scots pines. These are large and comprise many healthy trees at or close to full reproductive, seed producing, capacity. Such plantations cannot be re-created as anything resembling the ancient Scots pine forest here. Instead they can be changed using ordinary silvicultural methods to allow a collective behaviour of the woodland that is more natural in character. Plantations of mature pines are often within seed-dispersal range of areas now managed for pine wood restoration. This source of new growth should be included as part of the restoration plan. This is all complex to manage, specially with a complex patch-work of land-ownerships. As always in this region, priority is needed for collective control of deer as a direct benefit to woodland restoration.

References (in order of presentation).

Summers, R.W., 2023. The effect of planted trees and self-seeding non-native conifers on the expansion and integrity of Caledonian pinewoods. Scottish Forestry, 77: 3, 34-43.

Dunlop, *et al*., 2025. Caledonian pinewoods: a conservation framework. Scottish Forestry, 79: 3, 32-36.

Wachowiak, M.J., *et al*., 2011. High genetic diversity at the extreme range edge: nucleotide variation at nuclear loci in Scots pine (Pinus sylvestris L.) in Scotland. Heredity, 106: 775–787.

Bunce, R.G.H. & Jeffers, J.N.R., 1977. *Native Pinewoods of Scotland*. Institute of Terrestrial Ecology. ISBN: 0904282082. [See pg 96. Faulkner, R., The gene pool of Caledonian Scots pine.]

Mason, W.L. *et al*., 2004 *Managing the Pinewoods of Scotland*. (Forestry Commission) Chapter 3, Pinewood Ecology, 63-111. ISBN: 0855386371.

Bunce, R.G.H & Jeffers, J.N.R., 1977. *Native Pinewoods of Scotland* (Institute Terrestrial Ecology) [See 1: Gimmingham, C.H., "Status of pinewoods in British Ecosystems". See 2: Bunce, R.G.H. "The range of variation within the pinewoods". See 3: O'Sullivan, P.E., "Vegetation history of pinewoods." See 4: Goodier, R. & Bunce R.G.H. "Current state of pinewood resource."

Scottish Biodiversity Strategy to 2045: Tackling the Nature Emergency in Scotland. [Includes: 3.1 Scotland's Strategic Framework for Biodiversity]

Painting, A. 2021. *Regeneration: the rescue of a wild land*. Birlin, Edinburgh, ISBN: 9781780277141. [See pages 37-52; Scots pine. Describes major restoration of pine woods of Mar Lodge estate in southern Cairngorms by natural regeneration with vigorous control of deer.]

Clements, V., 2025. Rewilding, restoring or renovating? Scottish Forestry, 79: 3, 38.

Cameron, A.D. & MacMillan, D.C., 2025. Large scale rewilding in Scotland: deconstructing the narrative. Scottish Forestry, 79: 3, 38.

Cairngorms Connect. [See their website: a partnership of neighbouring land-managers covering 600 square Km of Cairngorm area. Land-managers for: Wildland Ltd.; Nature Scot; Forestry and Land Scotland; RSPB Scotland; and with Cairngorms National Park as a supporting partner.]

Gullett P., *et al*. 2025. Assisted regeneration to restore lost forests. [In: Lapin, K. et al. Conectivity of Forest Ecosystems. [The assistance includes ground preparation using machines to reduce competition from moorland bushes. See Google Scholar for a pdf.]

Caledonian Pinewood Partnership. [See their website material about Trees for Life company.]

Royal Society of Edinburgh, 2023. Inquiry into public support for tree planting and forestry. [See their website. Chapter 10: Biodiversity.]

Mason, W.L., *et al*., 2004. *Managing the Pinewoods of Scotland* (as above) Chapter 5: Pinewood management. 145-203.

Forster, J.A. & Morris, D., In: Bunce, R.G.H. & Jeffers, J.N.R., 1977. Native Pinewoods of Scotland. Institute of Terrestrial Ecology. ISBN: 0904282082.