Restoring biodiversity in the native pinewoods of the Caledonian Forest

No native woodland habitat in Scotland is quite as symbolic of a lost wilderness as the remnant Caledonian pinewoods. Their rich biodiversity includes charismatic creatures such as capercaillie and pine marten, but also many rare lower plants and insects. Executive Director of Trees for Life, ***Alan Watson Featherstone****, charts efforts to restore the pinewoods and all its inhabitants.*

Left: The rare mining bee (*Andrena marginata*) found on Trees for Life's Dundreggan Estate in 2007. This species was though to have been extinct in Scotland since 1949, although a solitary individual was recorded in Strathspey in 2002.
Top right: Scots pines and birches reflected in Loch Benevean in Glen Affric.
Bottom right: David Barbour and volunteers checking a light trap for moths at Dundreggan, in one of the biodiversity surveys carried out there. To date 196 species of moths have been identified there, but undoubtedly there are other species still to be found.
All photos courtesy of Alan Watson Featherstone.

The native pinewoods of the Caledonian Forest are a priority habitat under both the EU Habitats and Species Directive and the UK's Biodiversity Action Plan (BAP). Relatively little-known as recently as three decades ago, they have since become the focus of much conservation action and numerous restoration projects, involving government agencies, conservation groups and private landowners.

The declaration of 2010 as International Year of Biodiversity by the UN therefore provides a useful opportunity to reflect on how those projects, and the increased awareness of the pinewoods they have engendered, have affected the pinewoods themselves, and the rich biodiversity of species they sustain.

At the maximum extent of their range, about 4,000 years ago, it is

estimated that the native pinewoods covered approximately 1.5 million hectares in the Highlands of Scotland. In the centuries and millennia since then, the Caledonian Forest shrank in area, due to both climatic factors and the impact of humans, so that by the second half of the last century a mere 17,000 hectares survived.

Remnants with depleted biodiversity

Scattered in different parts of the forest's original range, these remnants were isolated from each other and consisted mostly of old trees, with many of them moribund and in terminal decay – what we have termed the 'geriatric forest'. In the absence of natural predators, and with a greatly increased population of large herbivores (both deer and sheep), all the naturally regenerating tree seedlings were being eaten, so there was a huge generation gap, with the forest remnants containing lots of old trees, but virtually none younger than 150 years of age in most cases.

The natural biodiversity of the Caledonian Forest had been seriously impacted too, with most of the large mammals (beaver, wild boar, lynx, brown bear and wolf) extirpated, and many other species, from red squirrels to plants such as twinflower, substantially reduced in numbers. It is possible, in fact, that less obvious or charismatic species which formerly occurred here (for example various fungi and invertebrates) were lost as the forest disappeared, and are now not considered to be native to Scotland, because biological recording began in earnest after they had disappeared.

One potential example of this is the calypso orchid (*Calypso bulbosa*), which is circumboreal, occurring in forests throughout northern hemisphere – perhaps it also grew in Scotland, before the near total disappearance of the Caledonian Forest took place?

Thus, the situation which prevailed in the latter part of the 20th century was one of substantial depletion of Scotland's native forests, paralleled by a reduction in biodiversity, both through the outright loss of some species and a dramatic reduction in population of other forest-dependent species. Halting further losses has always been a primary goal of conservation, and from the 1980s in particular onwards, reversing the depletion has been the stated aim of many of the native woodland schemes and projects that have been launched since then.

As the westernmost outpost of the boreal forest in Europe, the native pinewoods are the primary habitat in Scotland for a number of important and even iconic species, including capercaillie (*Tetrao urogallus*), Scottish crossbill (*Loxia scotica*) and twinflower (*Linnea borealis*). Early projects to protect and restore the pinewoods were focused either on protecting the old pines themselves and/or on securing the habitat for some of these key species, for example the RSPB's purchase of the Abernethy Reserve in 1988.

Since then, a range of other projects have been launched for the pinewoods, including significant initiatives by Forestry Commission Scotland (who manage some of the best remnants, for example Glen Affric, Glen More, Black Wood of Rannoch), Scottish Natural Heritage (particularly at Beinne Eighe) and various private landowners.

Linking the remnants, returning species

Trees for Life began practical work in 1989, concentrating initially in the Glen Affric area, and is unique in being the only organisation exclusively dedicated to the restoration of the Caledonian Forest and all its constituent species. Our long-term aim is to link up some of the isolated native woodland remnants and restore the forest to a large contiguous area of about 600 square miles in the north central Highlands, centred around the glens immediately west of Inverness.

We see this as being a 250-year project, as it will take that long for mature pinewood to develop on sites that have no trees left on them today. In the long term, we also advocate the reintroduction of all the forest's missing mammal species, including the top predators, as there will not be truly self-sustaining forest ecosystems

This page:
Rust fungus (*Gymnosporangium clavariiforme*) growing on juniper on Dundreggan. This spectacular fungus fruits in the spring, and the spores it releases then infect hawthorn, where the fungus fruits in a different form on the leaves, before infecting juniper again in an unusual two host-dependent life cycle.
Opposite page:
Phaeocalicium praecedens. These tiny pinhead lichens, about 1mm in size, occur on the twigs of mature aspen trees. Because of the inaccessibility of this habitat, this species is seldom recorded, but it has been found in both Glen Affric and at Dundreggan.

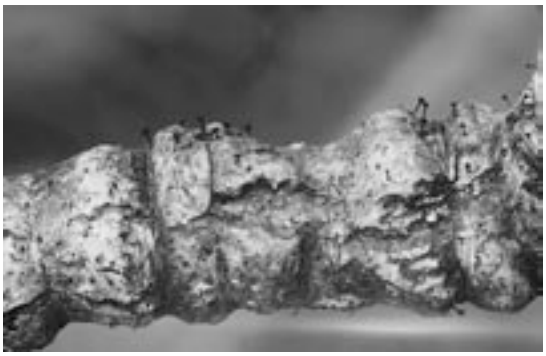
in the Highlands again until all the key components are back in place, fulfilling their essential ecological functions.

We work in partnership with Forestry Commission Scotland (FCS), the National Trust for Scotland, the RSPB and a number of private landowners, and now carry out forest restoration projects in Glens Affric, Cannich, Moriston, at Corrimony, at Achnashellach and at other sites throughout our target area. In 2008 we took ownership of the 10,000 acre Dundreggan Estate in Glen Moriston, which now provides a significant opportunity to expand and further develop our work.

In the first couple of years that we were active, our work was concentrated primarily on the Scots pine (*Pinus sylvestris*), in recognition of its role as the backbone or framework in the pinewood ecosystem upon which many other species depend. We funded the fencing of several areas for natural regeneration, and also planted Scots pines in areas where regeneration was unlikely to occur because of the distance from the nearest seed source.

This emphasis on Scots pine also reflected the management aims of the Forestry Commission for Glen Affric, where all our initial work was carried out. As the largest and longest-lived tree in the pinewoods, Scots pine provides a habitat for species as varied as red squirrel, Scottish crossbill, pine marten, various species of pinewood tooth fungi, wood ants, capercaillie and numerous invertebrates, including a couple of rare hoverflies – *Callicera rufa* and Blera fallax. The latter species is only known in Scotland from a few sites in Strathspey, as is the narrow-headed wood ant (*Formica exsecta*).

Other rare or unusual species associated with the pinewoods include the Caledonian sac spider (*Clubiona subsultans*), one-flowered wintergreen (*Moneses uniflora*) and a Red Data Book-listed spider (*Dipoena torva*) which preys on wood ants. It is likely, though, that there are still some undiscovered species of invertebrates waiting to be found in the pinewoods. Fogging experiments a few years ago in the canopy of Scots pine forests of western Norway – those which are the most similar ecologically to our pinewoods – resulted in the discovery of nine invertebrate species that were new to science. With the canopy of the Caledonian Forest not having been studied in similar detail, there could be unrecorded species living there.



Aspen, the pioneer

Recognising that a natural forest is an interconnected ecological community of many species, from soil micro-organisms, fungi and insects to mammals and birds, we soon diversified our work from Scots pine to include other species as well. For example, in 1991 we launched a project to regenerate and expand the stands of aspen (*Populus tremula*) in the forest, because of the inability of that tree to produce seed on more than a very occasional basis. Our aspen work includes mapping the areas where the tree still occurs, collecting root sections for propagating new trees and protection of existing stands so that young suckers, or ramets, growing off the roots of a parent tree can grow successfully without being overgrazed – aspen is one of the most palatable of all trees.

As a species, aspen is under-represented in the native pinewoods, because it has been preferentially removed by browsing pressure over a long period, and, once gone, it will rarely if ever return of its own accord. In similar forests with Scots pine in Scandinavia and Russia, aspen is much more abundant, where it fulfils a crucial role as a pioneer species, colonising areas rapidly after natural disturbance such as a forest fire.

Aspen is also a very important tree in terms of its associated biodiversity, and there is a whole range of rare and unusual species associated with it, including mosses, lichens, fungi and insects, particularly saproxylic, or dead wood dependent, ones. A number of these are priority species under the UK's Biodiversity Action Plan, and have very limited distribution in Scotland. The aspen hoverfly (*Hammerschmidtia ferruginea*), for example, needs a minimum of 4.5 hectares of aspen wood to survive, and only occurs at 12 sites in the Highlands.

Therefore, an important element of our work with aspen, and also that of the Highland Aspen Group (which Trees for Life is a member of), is to enlarge and link up existing aspen stands that are close to each other, to provide adequate habitat for this species. With aspen also being a favoured winter food for the European beaver, we are targeting some of our work towards expanding the presence of aspen in riparian areas, so that there will be an improved habitat for the future wider reintroduction of beavers that will follow the current trial project at Knapdale in Argyll.

Two other elements of our aspen work highlight the remarkable nature of the biodiversity of woodlands, and the positive improvements that simple, basic conservation action can make. Firstly, lichen surveys that we have been involved with in both Glen Affric and Dundreggan have included the discovery on both sites of a tiny pinhead lichen (*Phaeocalicium praecedens*) that is classified as Nationally Scarce.

Growing to about 1mm in size, this lichen apparently only occurs on the twigs of mature aspen trees. It may actually be more common than anyone realises, as its habitat, at the outermost tips of branches high in the air, is very hard to access

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and search! Planting young aspens, or enabling the suckers of existing aspens to grow without being grazed, is therefore creating a future habitat for this lichen (and the many other species that aspen supports) when the trees reach maturity.

However, the biodiversity benefits of forest restoration can be much more immediate in some cases. In the early summer of 2009, we protected a number of suckers growing off the root systems of mature aspens on Dundreggan. This was done by putting Netlon tree guards around the suckers, which were a few inches tall in early June, to protect them from being eaten by deer.

Ten weeks later, in late August, the suckers had grown over a metre, and their leader shoots were protruding above the top of the tree guards. More significantly, though, aphids were feeding on the stems of these vigorous young aspens, and they, in turn, were being tended by wood ants (*Formica lugubris*), which feed on the sugary liquid secreted by the aphids. Remarkably, this simple action of enabling young aspens to grow for less than three months had already provided the habitat for two invertebrate species to thrive in.

Biodiversity surveys find 'extinct' insects

Since purchasing the Dundreggan Estate in 2008, we have been carrying out a series of biodiversity surveys to identify the range of species present there, and to date we have found 56 species that are on the UK BAP list, including black grouse, pine marten, 19 species of moths, six species of tooth fungi, a lichen (*Fuscopannaria ignobilis*) which occurs on one of only two mature wych elms on the estate, and the lichen running spider (*Philodromus margaritatus*).

Two other species that are not even on the BAP list, because they were thought to be extinct in Scotland, have also been discovered at Dundreggan. One of these is a mining bee (*Andrena marginata*) that was last recorded in Scotland in 1949 (although a solitary individual was seen in Strathspey in 2002) and the other is the golden horsefly (*Atylotus fulvus*), which had only been seen once since 1923.

At the time of writing we're developing a Forest Plan for the estate, which will guide the work of forest restoration there, taking account of the habitat needs of these species. Expanding the native woodland there will also hopefully enable us to attract red squirrels to Dundreggan in future. Squirrels are present in native pinewood remnants on nearby Forestry Commission land in Glen Moriston, but have not been recorded on Dundreggan, so we're hoping that our work will facilitate the expansion and dispersal of that population in the years ahead.

We've also initiated an ongoing series of biodiversity surveys in the Glen Affric NNR, with the support of funding from FCS and Scottish Natural Heritage, that to date have focused on moths, beetles, bryophytes, aquatic invertebrates and *Diptera* (two-winged flies), substantially increasing the number of species recorded in each of those groups in the glen.

Other aspects of our work that have particular relevance for biodiversity are our woodland ground flora and montane scrub projects. In the former, we're mapping sites where rare flowering plants such as twinflower, one-flowered wintergreen and creeping ladies tresses occur, and are beginning work to propagate these and other pinewood flowering plant species. The plants which we grow will then be used to establish new populations at suitable sites in the pinewoods.

This is particularly relevant for twinflower, a circumboreal species that thrives in considerable abundance in conifer forests in Scandinavia and western Canada, for example, but, for reasons unknown, is very rare in our forests. Montane scrub is the community of woody plants that grows at the treeline, and is a habitat with very few healthy examples occurring in Scotland today. Trees for Life is part of the Montane Scrub Action Group, which seeks to foster the regeneration and recovery of the habitat, and we've been concentrating particularly on dwarf birch (*Betula nana*), which in turn is the host plant for a rare moth (*Swammerdamia passerella*) that features on the Scottish Biodiversity list.

In conclusion, the initial wave of concern 20 years or more ago about the native pinewoods has resulted in practical action at many of the surviving remnants of the original Caledonian Forest. From an initial focus on the trees, and especially Scots pine, many projects and various conservation groups are now looking at the much broader suite of species that make up the pinewood ecosystem. From dragonflies and moths to badgers and the Scottish wildcat, special projects, or even in some cases single species-focused charities, are working to protect Scotland's biodiversity as never before.

The trial reintroduction of European beavers at Knapdale in Argyll represents a new high point for concern about lost species, and in the years and decades ahead, it is possible other mammals will also be reintroduced. Indeed, if we want to have truly healthy forest ecosystems in Scotland again, all the component species, from micro-organisms in the soil and invertebrates to the predators at the top of the food webs, need to be present.

A measure of the progress that's been made therefore is the increasing public discussion given to the possible return of the lynx and even the wolf. Whatever the outcome of those discussions, the future of our native pinewoods, and all the biodiversity they support, is looking brighter now than at any time probably in the last thousand years.

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