



## Managing Scotland's pinewoods for their wild flowers

Back from the Brink Management Series



# Over the last two decades, there has been welcome enthusiasm for revitalising Scotland's Old Caledonian pinewoods.

**Management has focused on regenerating trees within the few remaining natural woods and establishing trees to create 'new native woodlands' but with relatively little attention to the wider plant community of these woods. This booklet provides land managers with advice on managing native and semi-natural pinewoods for their vascular plant communities, based on recent and ongoing management trials. It focuses especially on the characteristic pinewood herbs.**

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Where small, stunted Scots Pine trees invade a bog habitat, the resulting bog woodland forms an important community in its own right.

## Summary of management recommendations for pinewood vascular plants

More detail is provided on pages 23–25

- Maintain the extent and quality of existing pinewood habitat as the starting point for management.
- Produce a woodland management plan, which includes an inventory of the key pinewood species; this should be produced using Plantlife’s pinewood conservation framework, guided also by the associated leaflets on bryophytes, lichens and fungi.
- Diversify the structure and age of the forest, over an appropriate timescale, including forest clearings and open areas along tracks, watercourses and rocky areas.
- Use continuous cover restructuring to achieve a tree canopy of mixed densities across the wood.
- Plant regeneration areas ideally should have a mix of areas with tree densities varying between 60 and 150 stems per hectare; denser areas may be appropriate elsewhere for other management purposes.
- Ensure that the scale of habitat diversification is consistent with the distance over which pinewood herbs are able to disperse.
- In areas where an appropriate diversity of tree species is already present, use grazing, including by cattle, to diversify dwarf shrub height and ground vegetation diversity.
- Allow limited tree natural regeneration into boggy areas, without compromising the extent or quality of open bog habitat.
- Where possible, allow upper woodland edges to expand altitudinally towards the natural scrubline.
- Manage deer numbers to achieve grazing levels that enable natural regeneration but do not allow dwarf shrubs to take over the ground cover; monitor condition of the ground flora to refine deer management targets.
- Where regeneration exclosures are erected, ensure fencing is removed before trees reach the thicket stage.
- Consider using traditional methods of forest management to open up some areas within the forest.
- Review the woodland management plan on a regular basis to monitor management outcomes. Plantlife Scotland can supply some help in setting up surveillance schemes.
- Ensure that management lessons learnt are shared widely with other pinewood managers; Plantlife Scotland may be able to facilitate this process.

## What are pinewoods?

Native or Caledonian pinewoods are dominated by Scots Pine *Pinus sylvestris*. Their present structure and composition is the result of a long history of management and use. All pinewoods, including newer pine plantations, can be managed to encourage a diversity of flowering plants, but the history of each woodland will have implications for the management that is required.

## Native pinewoods

Native pinewoods are likely to be listed in Steven & Carlisle (ref 1) and in the Caledonian Pinewood Inventory (ref 2). They will normally fit the National Vegetation Classification *Pinus sylvestris* – *Hylocomium splendens* woodland (W18; see Rodwell, ref 3). This means that, as well as pine trees, they typically are characterised by leafy carpets of Glittering Wood-moss *Hylocomium splendens* (see ref 4). Non-flowering plants and fungi are an important component of this woodland, and advice on their management is available elsewhere (see [www.plantlife.org.uk](http://www.plantlife.org.uk)). Pinewoods are relatively poor in vascular plants, with only 31 species listed by Rodwell. Ling Heather *Calluna vulgaris* and other dwarf shrubs typically dominate the ground layer. The characteristic pinewood species are listed in table 1.



The best native pinewoods are likely to contain some trees over 200 years old.

Table 1: Characteristic flowering plants of pinewoods (after Rodwell, ref 3)

Regularly occurring species	
<i>Calluna vulgaris</i>	Ling (Heather)
<i>Deschampsia flexuosa</i>	Wavy Hair-grass
<i>Trientalis europaea</i>	Chickweed Wintergreen
<i>Vaccinium myrtillus</i>	Bilberry / Blaeberry (Sc)
<i>Vaccinium vitis-idaea</i>	Cowberry / Cranberry (Sc)
More restricted species	
<i>Arctostaphylos uva-ursi</i>	Bearberry (NM)
<i>Goodyera repens</i>	Creeping Lady's-tresses
<i>Neottia cordata</i>	Lesser Twayblade
<i>Orthilia secunda</i>	Serrated Wintergreen (C)
<i>Pyrola rotundifolia</i>	Round-leaved Wintergreen (C)
Rare species	
<i>Corallorhiza trifida</i>	Coralroot Orchid
<i>Linnaea borealis</i>	Twinflower (NM)
<i>Moneses uniflora</i>	One-flowered Wintergreen (C)
<i>Pyrola media</i>	Intermediate Wintergreen (C)

(Sc) = Name commonly used in Scotland

(NM) = Northern montane distribution.

(C) = Continental distribution.



Juniper *Juniperus communis* may occur as scattered bushes or small patches within pine woodland. As a UK Biodiversity Action Plan species, it should be a management priority, with denser stands managed specifically as juniper woods (see ref 5).

Native pine woodland is generally confined to the central and north-west Highlands, in areas where the mean annual maximum temperature is 23°C or less, the rainfall is relatively high, and the soil pH is typically 3.5–4.5. It occurs at altitudes from just above sea level to around 675m, where it grades into mountain woodland (ref 6). The density of Scots Pine is highly variable in such woods. In places, the canopy may be so open as to resemble a heath with trees, and these areas can be extremely valuable for flowering (and non-flowering) plants. Some trees may seed onto waterlogged areas, forming bog woodland (ref 7).

### Scots pine plantations

The range of *Pinus-Hylocomium* woodland has been extended by planting into areas where Oak and Birch was the dominant natural woodland, especially around the Moray Firth (ref 3). These woods are unlikely to support northern montane vascular plants, but may support the continental species listed in Table 1. Culbin Forest supports especially important communities of pinewood herbs, propagules of which are thought to have been introduced with brash brought in to stabilise sand dunes.

The species richness of these woods will generally increase with age and decrease with intensity of management. Where a rich bryophyte flora suggests reasonably natural conditions, management to encourage vascular plants should be considered.

**Chickweed Wintergreen *Trientalis europaea* is a localised inhabitant of open pinewoods and birchwoods. It rarely sets seed, so is unlikely to colonise new areas.**





▶ **Long-established pine plantations can provide valuable habitats for pinewood herbs, particularly if there is a continuous woodland record, as here at Balblair Wood in East Sutherland.**

The origin of plantation woods is critical to their importance for vascular plants. In the 19th century, some native woods were felled, then the area was left for trees to regenerate from the seed bed. This often resulted in rapid regeneration of closely-spaced trees in a plantation-like form, but some characteristic ground flora may have survived from the original woodland. At other sites, plantations were created around remaining stands of native trees. These acted as refugia for the pinewood flora, which could then spread into the plantation more rapidly than into plantations isolated from natural seed sources. Where possible, these sites should be managed as if they were native woodlands.

### **New native woodlands**

Many new 'native' pinewoods have been created by government agencies, conservation bodies and private landowners since the early 1990s. This continues to the present day, with many supported through the Scottish Rural Development Programme (SRDP). Within the SRDP, specific prescriptions relate primarily to woodland creation, native woodland management and woodland restoration. These are largely concerned with the management of tree and shrub layers, and some modification to the current prescriptions is required for vascular plants, bryophytes, lichens and fungi. Suitable options are shown in Table 2.

Table 2: Options which may support pinewood management under the Scottish Rural Development Programme (SRDP)

<b>Feature supported</b>	<b>Rural Priority</b>
	<b>Highland</b>
Native woodland biodiversity	HIG08
PAWS (plantations on ancient woodland sites) restoration	HIG08
Management of nature sites, favourable condition	HIG09
Endangered species	HIG10
Control of non-natives	HIG11
Landscape scale restoration	HIG12
Low intensity grazing	HIG 12

◀ **Curr Wood near Grantown-on-Spey has plantation-like form but was established by rapid regeneration from seed after earlier felling.**





### **Scots Pine *Pinus sylvestris***

Biodiversity includes the variation within species as well as between species.

In managing pinewoods for conservation, therefore, it is important to consider, and maintain, the natural variability of Scots Pine.

The name 'Scots Pine' is a misnomer, as it is the most widely distributed conifer in the world, extending from Finnmark in Norway south to the Sierra Nevada in Spain and as far east as the Sea of Okhotsk. However our native trees generally retain a pyramidal shape until late in life and have short leaves and cones. They are sometimes distinguished as variety *scotica*.

Within Scotland, genetic differences between pine populations have been identified through studies of chemicals called monoterpenes in the resin of shoot cortices. These indicate a very high degree of genetic variation within all populations, but identify distinctive regional populations above this general level of variability (ref 8). On this basis, the Forestry Commission identified seven distinct biochemical regions (see map opposite).

Scots Pine reaches its highest elevation at Creag Fhiaclach within the Cairngorms National Park.



The seven biochemical zones for Scots Pine recognised by the Forestry Commission in Scotland (see ref 8).



It is good practice in pinewood management schemes to plant only trees derived from the same biochemical region. This is a specific requirement for schemes within two 'exclusion zones' where the trees are most distinctive biochemically. These are the North West Biochemical Region, near Kinlochewe in Wester Ross, and the South West Biochemical Region, around Fort William. The distinctiveness of these populations may reflect different post-glacial origins (ref 2).

Within populations, Scots Pine shows a natural variability. Steven & Carlisle (ref 1) note that the conditions under which pine trees grow, and in particular the degree of competition between trees (as a result of their spacing), can influence the form of their crown. Nevertheless, they suggested that at least eight 'habit types' of Scots Pine were present in Scotland (ref 1). In practice, browsing and burning will have far more impact on the appearance of trees in a pinewood. Nevertheless, where thinning is required, it is important to recognise this natural variability and harvest proportionately across habit types.

**This fine old 'granny' pine was probably spared felling in earlier times because its many-branched form reduced its value for timber.**



## Factors affecting species richness in pinewoods

### Geographical variation

Not all the characteristic vascular plant species are found across the range of native pinewoods. Creeping Lady's-tresses and Chickweed Wintergreen are found more frequently in eastern pinewoods, Twinflower is largely confined to Deeside and Speyside, and Lesser Twayblade is more common in central and western pinewoods. The distribution of key species is shown in the *New Atlas of the British and Irish Flora* (ref 9).

### Tree cover

Broadly speaking, most of the characteristic vascular plants of pinewoods are found in small clearings or open areas, where there is at least dappled shade. Typically Ling, Bilberry and Cowberry will dominate these areas, perhaps with some Bracken *Pteridium aquilinum*, and the less common species will be found amongst these.

Few flowering plants will grow under a dense canopy, other than occasional Wood Sorrel *Oxalis acetosella*. On the other hand, characteristic woodland species will not grow in very open areas, where the soil is likely to dry out, although some, such as Lesser Twayblade and Chickweed Wintergreen, may find shelter under Ling. Chickweed

Wintergreen also seems to flourish in recently felled areas. The upheaval of soil when large trees are blown over in gales is probably an important factor, opening new niches in natural forests and encouraging pine regeneration. Standing and dying dead wood should be left *in situ* where possible, to maintain this habitat and encourage fungi and non-flowering plants.

The precise shade requirement of key vascular plant species is being investigated in several current studies, the preliminary conclusions of which are difficult to assess. Worrell & Ross (ref 10) recommend an optimum tree density of 60–80 stems per hectare for the successful regeneration of Scots Pine itself, using shelterwood systems. However, the associated ground flora may have different shade requirements. Ongoing trials in Speyside indicate that stem densities of 145–155 stems per hectare are optimal for flowering species such as Twinflower (Broome & Long, ref 11). Even more dramatically, Humphrey *et al* (quoted in ref 12) suggest that the best growing condition for Bilberry is under a tree density of 300 to 600 stems per hectare, although this refers to a young, growing plantation.

**Management is encouraging pine regeneration at Coille na Glas Leitre within the Beinn Eighe National Nature Reserve in Wester Ross.**



The further development of these trials may lead to better guidance, but, in the meantime, the best approach is to use continuous cover techniques to provide, over time, a variety of different mature canopy densities within the range of 80–150 stems per hectare, perhaps with some denser as well as open areas. This should create a range of potential niches for flowering plants, and also allow managers to provide appropriate habitat for other species, including Capercaillie and rare bryophytes.

### Ground conditions

Evidence suggests that natural pinewoods were never a continuous expanse of pine. Areas of forest cover are interspersed naturally with rocky areas where the soil is too thin for tree roots, and boggy areas where seedling trees struggle to survive. These areas have their own characteristic ground flora, adding to the overall plant diversity. Along riverbanks and loch shores, occasional flooding constrains pine growth but allows broadleaved trees such as Alder *Alnus glutinosa*, Rowan *Sorbus aucuparia*, willows *Salix* spp and Aspen *Populus tremula* to establish instead. Where herbivores gather to feed, tree regeneration is suppressed, creating clearings, although scuffing of the ground by herbivores may encourage vascular plants.

Areas of basic rocks create soils with a higher pH in which willows and other broadleaved trees flourish, rather than conifers. Tree species diversity is greater in western pinewoods, and oak/hazelwoods can grow in mosaic with Scots Pine on richer micro-sites.

### Grazing and browsing

The impact of grazing and browsing is complex. Heavy grazing can lead to a marked reduction of Bilberry and Ling, encouraging

some vascular plants such as Twinflower but not others, such as Lesser Twayblade, which benefit from the shade of these woody species. Heavy grazing can switch the vegetation from Bilberry towards the less palatable Cowberry which, being evergreen, might repress other herbaceous seedlings. Bilberry is especially vulnerable to decline where herbivore densities are even moderately high (e.g. more than five roe deer per hectare).

### Fire

Occasional fires open up areas of forest, creating a seedbed in which tree seedlings and other vascular plants quickly establish. Fires occur naturally after lightning strikes, but are more likely to arise these days from human carelessness. Subsequent regeneration will depend on the heat of the fire (determined by such factors as wind speed and the accumulation and dryness of leaf litter). Ling can regenerate quickly from root stock after relatively cool, fast-moving fires, and its dense mass may then inhibit other species. Hotter, slower fires kill Ling's roots, so it and other species must regenerate from seed. These fires release nutrients from the ash, and can burn through the tough mat at the surface-humus interface, producing good conditions for the regeneration of Scots Pine and perhaps other vascular plants.

**Twinflower is one of the characteristic pinewood herbs that benefits from opening up of areas within the forest and limited disturbance along track sides or routes used for timber extraction.**



## Pinewood priority species

### Juniper *Juniperus communis*

#### **Ecological requirements**

Juniper is the most important of the large shrubs that grow in pinewoods. It grows in columnar, bushy and procumbent forms. It is a particular feature of Speyside pinewoods, but is more localised in western pinewoods, perhaps partly as a result of grazing.

Trials in establishing Juniper in the Millbuie Forest pine plantation (ref 12) suggest that its survival is not affected by either tree thinning, fencing or planting positions. However, they showed that Juniper grows and spreads faster in fenced areas. This concurs with other experience suggesting that Juniper is highly susceptible to deer grazing. Juniper is relatively slow growing and its growth rate is more than halved when bushes are grazed (ref 13). A study in Glen Feshie showed a 31% mortality of Juniper saplings unprotected from deer grazing, compared to 4% in plots from which Red Deer were excluded (ref 14). Deer can debark and kill Juniper by rubbing their antlers against the trunk to remove velvet. Seedlings are also attacked by slugs, mice and other small rodents, rabbits, mountain hares and sheep.

#### **Management requirements**

Juniper regeneration requires some form of disturbance to open up dense ground vegetation. Preliminary results from plot trials at five Scottish sites suggest that regeneration may occur best at a sward height of 4.5–8cm, with 3–6.5% bare ground. These conditions are best facilitated by light summer cattle grazing. Management of deer numbers is therefore critical to successful Juniper regeneration.

It is important to control competing vegetation around young plants (up to 20 cm in height), since competing plants shade their growth and may shelter destructive voles. This control can be achieved through appropriate grazing regimes or through targeted control. Juniper is generally intolerant of deep shade (less than 1.6% daylight) but has been shown to establish and grow successfully in 20% daylight (ref 14) — around the light levels in a typical 40-year-old, thinned Scots Pine forest.

**In some situations, isolated mature Juniper bushes survive in open habitats, akin to 'Juniper savannah'.**



▲ Juniper will grow readily from its fruits, but the treatment needed to propagate from seed is complex and demanding.

▼ A stand of Juniper isolated from the main pine forest in the Cairngorms National Park.

### *Sourcing Juniper for planting*

Where Juniper is not present at a site and (re) introduction is considered, the production of stock from seed is preferable, to maximise genetic diversity. However, this process is extremely time-consuming (ref 15). The seeds need first to be cleaned from the ‘berries’, then soaked and rehydrated, before sowing outdoors or pre-treating over 15 months in a variable temperature regime, described fully in ref 13. Direct sowing of Juniper seed is unlikely to be successful.

Cuttings are a more reliable and faster method of propagation. Plantable stock can be produced in two years, compared to at least four years from seed. Vegetative propagation may be the only available option when trying to regenerate a Juniper population from remnant or isolated bushes, since these may not produce viable seed.



## Twinflower *Linnaea borealis*

### Identification<sup>1</sup>

From June to August, Twinflower's *white/pink, bell-shaped flowers* are unmistakable but easily overlooked. They hang in *pairs* from forked flower stalks up to 8cm tall. Its delicate, branching, reddish stems are woody at the base and *root at the nodes*. They creep widely in all directions, *forming an open mat*, sometimes covering several square metres. The *opposite, paired, oval leaves* are 4–16mm long, with *1-3 short teeth on each side*.

### Ecological requirements

Twinflower grows in native pinewoods and old plantations of mature pines, usually as a loose mat over mosses, in slight to moderate shade. While it may persist without flowering under denser canopies, it is frequently associated with track sides, clearings and extraction routes in plantations and occasionally in very open woodland / heath at much lower densities. It is pollinated mainly by small flies and bees, and its sticky fruits are animal dispersed. Seed set is rare in Scotland, because most populations consist of self-sterile clones, isolated at distances too great for cross-pollination by insects. Seedling establishment seems to require disturbed ground.

### Management requirements

Twinflower is a fairly robust survivor, but poor coloniser because of its restricted seed production. Clear felling may exterminate it at a site. Otherwise, under-management is the biggest threat, allowing dwarf shrubs to overwhelm it. Twinflower is destroyed by fire because it has no underground rhizomes from which to regenerate and limited ability to recolonise burnt areas from seed. It is also susceptible to drought.



Track sides, extraction routes, clearings and stands of old pine trees provide refuges for Twinflower amidst the heavy shade of a young developing pine plantation or thicket stage of natural regeneration. When light levels rise after thinning (or as the stand matures), Twinflower may then spread, especially if Ling does not become too rampant. Preliminary results of work commissioned by Plantlife suggest that dragging logs from a site after thinning may open up bare mineral soil and disperse stem fragments which can then root and spread (ref 11). However, such intervention should only be attempted in healthy populations.

Reintroduction into a site from which Twinflower has been lost requires careful planning to address genetic bottlenecks; Plantlife Scotland should be consulted for the latest guidance.

## One-flowered Wintergreen

### *Moneses uniflora*

#### Identification

The *solitary, nodding, wide-open* white flower, topping a stem up to 15cm tall in July and August, distinguishes this from other pinewood wintergreens (see overleaf). The *soft, oval, evergreen* leaves are *finely-toothed* and light green in colour. *Dark brown scales* on the short stem between the roots and the *loose basal leaf rosette* are distinctive.

#### Ecological requirements

This is the rarest pinewood herb. Typically it is found, partially hidden, beneath Ling or other dwarf shrubs in old pine plantations, in north-east Scotland. It is rare in native pinewoods, perhaps due to past overgrazing. Its fine, branching roots spread through the bryophyte carpet, which protects the leaf rosettes from dehydration and root buds from frost. It is mycorrhizal, allowing it to survive in nutrient-poor, shaded conditions on the forest floor. It relies on its fungal associate for nutrients, and has no food-storing rhizomes, unlike the true wintergreens.

**Although distinctive in close-up, One-flowered Wintergreen is easily overlooked, partially hidden beneath Ling, especially when not in flower.**

The solitary flower is pollinated by bumble bees, which must beat their wings at a particular frequency to shake pollen from the anther appendages. Its dust-like, wind-blown seeds require the appropriate fungal partner to germinate, and rarely produce new plants. Most propagation is from root buds, resulting in localised clones of genetically similar plants.

#### Management requirements

To protect *Moneses*, pinewoods must be managed to maintain a moist bryophyte layer, and to encourage the right fungal partners and pollinating bees. This complex challenge is probably best met by ensuring a diverse canopy structure, from dense to completely open. Limited disturbance may help its vegetative spread, but excessive canopy thinning is thought to be damaging. Given its rarity, identifying colonies before planned operations and safeguarding them during operations is currently the main way to safeguard the species.





## Pinewood wintergreens

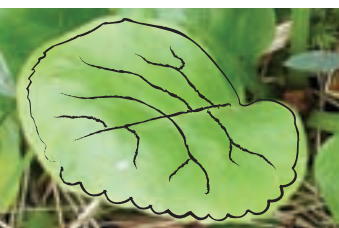
### Serrated Wintergreen *Orthilia secunda*

This is the easiest of the three species to distinguish. It flowers, rather erratically, in July and August. Its flower stem, up to 12cm tall, often droops near the tip, with a loose cluster of *greenish-white* flowers, 4–5mm across. All the flowers *turn to one side of the inflorescence*. Unlike other wintergreens, it has leaves up its stem and these have a *strong network of veins over their surface*. The leaves are 2–4cm long, ovate and pointed at the tip. They have 11–15 fine teeth on each side (see photos left) and a petiole (leaf stalk) *shorter than the leaf*.



### Common Wintergreen *Pyrola minor*

From June to August, this develops a leafless flowering stem up to 30cm tall, with a tight cluster of white flowers near the top, arranged round the stem. Its *closed, globe-shaped, white* flowers are *c6mm* across, with a straight style 1–2mm long, *enclosed within the petal tube*. Its light-green, oval leaves all grow in basal rosettes, sometimes with 2 or 3 rosettes in a cluster. The leaves usually have *more than 16 slight teeth down each side*<sup>2</sup>, with a gently pointed tip and a *petiole slightly shorter than the leaf*.



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### Intermediate Wintergreen *Pyrola media*

This species originated as a hybrid between Common and Rounded-leaved Wintergreen *P. rotundifolia*, but subsequent chromosome doubling produced a fertile species. As a result, its appearance often grades into Common Wintergreen, and identification can be tricky especially when not in flower or when old flower spikes are not present. However, its white flowers, which appear from June to August, are *c10mm* across, more open than Common Wintergreen, and in a looser *inflorescence*. The straight style is 4–6mm long, *projects slightly beyond the petal tube (this can still be seen on old flower spikes long after flowering, see photo left)*, and is thickened immediately below the stigma lobes into a distinct ring. Its dark green leaves are rather rounded at the tip, usually with *less than 16 slight teeth down each side*<sup>2</sup>. The petioles are *as long as or slightly longer than the blade*, and leaf rosettes are solitary.



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<sup>2</sup>The leaf tooth count is one of the surest ways to distinguish *P. minor* and *P. media* out of flower; it is best to take the average count from 5 to 10 leaves, from different plants in a population if possible. The number of teeth should be counted from tip to base down one side of the leaf only. A hand-lens is required to view these teeth with ease. See Poland & Clement (2009) *The Vegetative Key to the British Flora* for more details.





**The leathery leaves of *Pyrola* species remain evergreen well into winter, but the inflorescences are relatively short-lived.**

### ***Ecological requirements***

All three species have evergreen leaves, conspicuous in winter. They are mainly found in the dwarf shrub cover of heathery pinewood clearings. Although Intermediate Wintergreen is the only one of the three species listed as a Scottish Biodiversity List priority, Stevens & Carlisle record it as “by far the commonest” in pinewoods, particularly in the east. It grows in the mossy, dwarf shrub layer of open woodland clearings, often under Bilberry or Cowberry, most typically along tracksides. Common Wintergreen is more local in its distribution, sometimes in mixed populations with Intermediate Wintergreen, although it can cope with rather damper conditions. Serrated Wintergreen is scarce, and mainly confined to the mossy floor of upland woods. All three have food-storing rhizomes, and form associations with a wide range of mycorrhizal fungi.

### ***Management requirements***

The most important action is to protect colonies during forest management work. Although there is little practical expertise, all three species benefit from management that maintains open areas in the forest and prevents heather becoming too tall and dense. They cannot survive under a dense canopy, but may cope with clear felling around them, provided the heathery area in which they grow is not excessively damaged. All three species, but especially Serrated Wintergreen, are damaged by high intensity burning, although Intermediate Wintergreen has been noted as regenerating after low intensity burns. Heavy grazing is detrimental to all three species but the presence of some grazing will help to maintain an open shrub layer. Historically, fire, grazing animals and windthrow played an important role in creating open habitats for wintergreens in natural pinewoods. Cattle grazing or brush cutting have value in opening up ground vegetation and promoting seedling establishment, but experimentation is still needed on the best approach to this. Disturbance from thinning operations may be beneficial around the edge of colonies.

**The flowers of Serrated Wintergreen are short-lived, but the head of fruits characteristically hangs to one side.**



## Other key pinewood species

### Creeping Lady's-tresses

*Goodyera repens*

#### Identification

This orchid spreads by creeping rhizomes. A series of *leaf rosettes*, typically of 5 or 6 leaves, appear along the rhizomes. The leaves are oval to tongue-shaped, evergreen, untoothed and *slightly inrolled at the base* where they narrow into a *winged stalk*. They have a *conspicuous network of veins* over their surface. The stiff flower stem, which appears in July and August, is enclosed by a *leafy sheath at its base*, with small scales and a fuzz of *glandular hairs* above. The slender spike of *greenish white, sweet-scented* flowers is often *twisted into a slight spiral*.

#### Ecological requirements

Creeping lady's-tresses grows in mature semi-natural or plantation pinewoods, mostly in north and east Scotland. It has been lost from forests that have been clear-felled then replanted, and is susceptible to encroachment by developing scrub or dwarf-shrub heath. Its rhizomes spread just below the surface of the moist carpet of mosses and needles. They enable rapid vegetative spread, sometimes forming a cluster of colonies in an area. However, the species rarely colonises new areas through its fine, wind-blown seeds. Once germinated, the tiny seedlings cannot absorb nutrients from the soil, and probably require invasion of their roots by the orchid's known mycorrhizal associates (*Rhizoctonia spp.*).

**The spirally-twisted inflorescence of Creeping Lady's-tresses in the mossy carpet of a Speyside pinewood. ►**

#### Management requirements

The limited available management experience suggests that this species grows best under relatively dense canopy shade, typically beneath pine or occasionally birch, with about 10% daylight at ground level. Exclusion of deer is beneficial (ref 12), although limited grazing might help constrain competing vegetation. However, if a small localised enclave survives, it can spread from there into new forest as this becomes established.





## Lesser Twayblade *Neottia cordata*<sup>3</sup>

### Identification

Habitat is one key to this small, inconspicuous orchid: it typically grows hidden at the edge of a dense Ling clump or occasionally on open bog moss. It spreads by a *thread-like creeping rhizome* from which arise solitary, slender, pale green, shortly hairy flower stems, 6–10cm tall. These have a *single pair* of leaves about *halfway up the stem*. The spreading leaves are 1–2cm long, shining green, *wavy edged*, and have *three strong veins along their length* and a *hard, rounded tip*. The spike of 6–12 *tiny, reddish* flowers appears from June to September.

### Ecological requirements

Lesser Twayblade is recorded in all the main geographical groups of native pinewoods, and in mature pine plantations. It is almost always found under Ling or with a sheltering stand of Ling nearby, and it is perhaps better regarded as an inhabitant of the *Calluna*

Lesser Twayblade is rarely found far from the shelter of Ling heather, and is often completely obscured beneath the dwarf shrub's branches.

dwarf shrub heath within the pinewood, rather than a true pinewood species. It forms a mycorrhizal association with fungi in the genus *Rhizoctonia*, which live in its long, slender roots.

### Management requirements

Lesser Twayblade is most typically found under Ling which is in the mature phase of its lifecycle, but disappears when Ling slumps into its degenerate phase. It is therefore likely to benefit from management to maintain a mixed age within the dwarf shrub community, through grazing by deer or cattle or even limited brush cutting. On open grouse moors, it seems to survive well-managed burning, but this may not be practicable in the forest. While limited grazing is desirable, it will suffer from overgrazing by deer and sheep.

<sup>3</sup>Formerly *Listera cordata*

## Coralroot orchid *Corallorhiza trifida*

### Identification

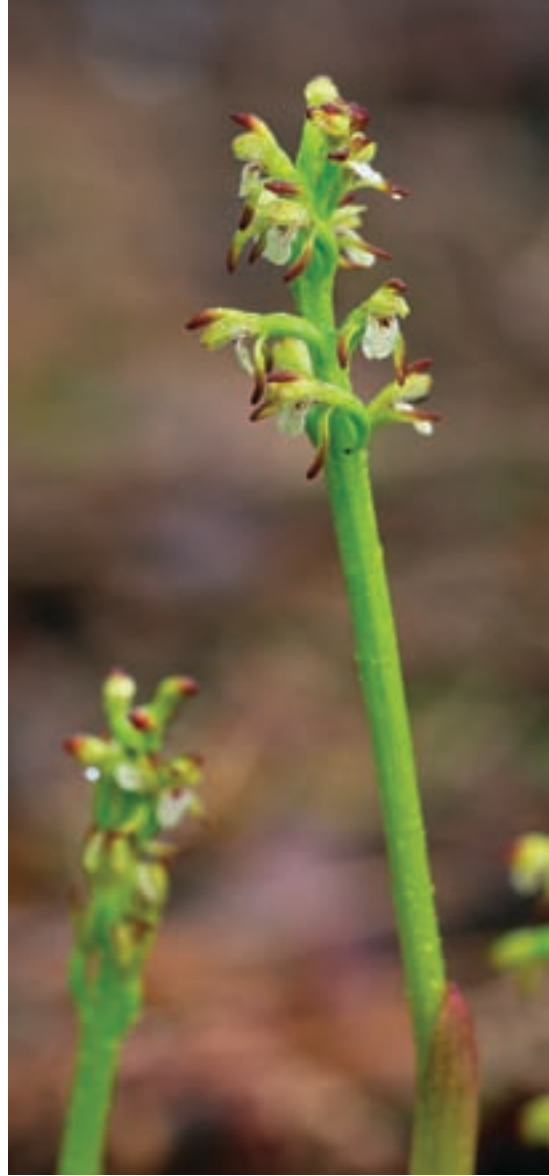
This orchid lacks roots, but has a rather coral-like underground rhizome of stubby, cream-coloured branches, ending in tufts of hairs. All its above-ground parts are yellowish-green, due to the limited presence of chlorophyll. Flower stems appear from April and wither by August, but remain as dry husks into the winter. They have 2–4 long, brown-veined scale leaves reaching halfway up the stem, and are topped by an open spike of 4–12 inconspicuous flowers.

### Ecological requirements

Coralroot orchid grows in damp peaty or mossy areas in pine plantations and semi-natural pinewoods, mostly in eastern Scotland, although in recent years it has been recorded increasingly in western Scotland. It occurs from quite deep shade through to open conditions, sometimes with Creeping Lady's-tresses. Flowering at any site is sporadic, with populations apparently vanishing in some years. It gets food mainly by parasitising fungi in its rhizome hairs. These, in turn, feed saprophytically on leaf litter or as a mycorrhizal associate with neighbouring willow and birch (but rarely pine) trees. As a result, this species is often found in small pockets of wet birch and willow trees within pinewoods.

### Management requirements

The habitat of known colonies should be protected. The species may benefit from slight disturbance, which fragments and spreads its rhizomes, but not from heavy disturbance, especially if this dries the habitat. It relies on powdery seeds for wider dispersal. Seedlings require mycorrhizal associates to establish,



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**Coralroot Orchid is not easy to spot on mossy areas beneath pine plantations.**

and these, in turn, need soil invertebrates for spore dispersal. Maintenance of damp, shaded woodland habitat seems key to this complex interrelationship. Trampling by humans is a threat at some sites. Grazing seems less of a threat, although it is attacked by slugs.

## Threats to the special vascular plants of Scottish pinewoods

### *In insensitive woodland management*

- Historically, clear felling of native or semi-natural pine woodland, and replacement by dense plantations, has had the greatest impact on pinewood vascular plants, since none of the key species can survive the dense shade of the thicket stage in woodland development.
- Typically, tree establishment in commercial plantations is encouraged by drainage and other soil preparation; this removes the damp conditions on which several key species depend.
- The heavy machinery used to establish plantations can damage habitats for pinewood species, even beyond the plantation.
- Fences are often constructed around plantations to exclude deer, and cattle and sheep are rarely grazed in commercial plantations. This leads to dense development of dwarf shrub heath or scrub in the understorey and clearings, which can swamp pinewood herbs.



**Serrated Wintergreen is mainly confined to the mossy floor of upland woods, and amongst higher-altitude rocks above the woods.**

- Even where woodland is being established or managed primarily for conservation or amenity, there is a perceived priority to establish tree cover quickly and extensively, sometimes to meet grant requirements and sometimes because of the limited perspective of human timescales. This management is unlikely to encourage a diverse ground flora.
- Even where trees are established through 'natural' regeneration, the initial site preparation and curtailment of grazing promotes rapid sapling establishment, leading to a thicket stage of regeneration inimical to many pinewood herbs.

**Pinewoods that are heavily grazed by Red Deer or sheep support few pinewood herbs.**



### Grazing pressures

- Historically, some open pine stands were regarded by shooting estates as valuable cover for Red Deer. Concentrated, heavy grazing by deer then discouraged most pinewood herbs. Prolonged heavy grazing by deer and subsequent suppression of tree regeneration has completely changed the composition and structure of the ground layer vegetation in many of these former 'deer forests' leaving the habitat in an unsuitable condition for pinewood herbs.
- In the past, cattle were grazed in some pinewood areas for part of the year. Where stock levels were relatively low, grazing and trampling by these beasts opened up and diversified the shrub layer, creating a variety of habitat niches for pinewood herbs. The virtual disappearance of the cattle economy from Highland Scotland has ended these benefits.

### Other impacts

- In the past, lightning sparked occasional local or extensive pinewood fires. Ling responds well to burning, so fire

**This twisted 'krummholz' tree at high elevation in the Cairngorms National Park shows the ecological variability of Scots Pine due to exposure and other environmental factors.**



encouraged pockets of dwarf shrub heath within the forest, in which several pinewood herbs flourished. Today, however, fire plans are in place to stop the spread of fires in most pinewoods, because of damage to the timber crop or surrounding property. The lack of fire, and other management practices, has increased flammable materials in many forests, making the controlled use of fire too risky as a management tool.

- To date, there have been few problems with invasive non-native species in pinewoods, with only localised occurrences of Snowberry *Symphoricarpos albus* and Salmonberry *Rubus spectabilis*.
- There is no evidence that climate depresses the range of the key pinewood herbs, so there appears no short-term threat from climate change. However, the prediction of drier summers in east Scotland could reduce habitat for Coralroot Orchid and perhaps other species. Damper summers in the north and west might encourage Heather Beetle *Lochmaea suturalis*, with an impact on the dwarf shrub heath habitat on which pinewood herbs depend.

**Twinflower is a fairly robust survivor but poor coloniser because it rarely sets seed in Scotland.**





**This well-established pinewood, with a rich ground cover of Juniper and Ling, is situated in the RSPB's Abernethy Forest Reserve within the Cairngorms National Park.**

## **Management recommendations for Scotland's pinewood herbs**

There is very little practical experience of managing for the key pinewood herbs. A number of trials are underway by Plantlife Scotland, the Forestry Commission and Forest Research, the Cairngorms Rare Plants Project, the RSPB and Trees for Life. Given the slow timescale of change in woodland communities, these need to be long-term trials, and it would be unwise to make preliminary judgements on experience so far. However some general management approaches are suggested below.

The diversity of management required to open up habitat niches for pinewood herbs will almost certainly benefit pinewood fungi, lichens, bryophytes, invertebrates and other wildlife. Leaflets on management for fungi, lichens and bryophytes are available from Plantlife (refs 4, 17 and 18).

### ***Landscape scale considerations***

The ecological condition of woodlands is best considered at the landscape scale, and a key management aim for woodland remnants should be to join them up through Forest Habitat Networks. This network approach is the best way to encourage the spread of pinewood herbs over an extended period of time, and to secure the management of Important Plant Areas (ref 16).

### ***Managing for diversity***

Recommendations on how to prepare a management plan for pinewood herbs is described by Worrell & Long (ref 16). Stage 1 is to identify key habitat niches in the wood, using indicator species. Stage 2 assesses the management needs of species within these habitat niches and produces a plan to manage for their ecological needs.

## Back from the Brink Management Series

It is important to recognise that if a significant population of any of the key pinewood herbs is present, then that population must have survived many decades of forest management and the status quo should therefore be the starting point for future management. If only a residual, seriously declining population remains, then more proactive management will be needed. In extreme circumstances, targeted management of the ground layer vegetation may be required to maintain small, isolated flowering herb populations until such time as forest management plans ensure suitable woodland conditions more widely. This may be particularly important for species such as Twinflower that have very limited potential to recolonise former sites.

**Where small, stunted Scots Pine trees invade a bog habitat, the resulting bog woodland forms an important community in its own right.**



Generally, the aim should be to manage for a diverse, multi-aged forest community, as part of a long term management plan. This diversification should take account of topography and local conditions, with glades in the forest and open areas, and with some scrub and broadleaves along tracks, watercourses and natural rocky areas. However, pinewood herbs are unlikely to benefit from habitat variation over a large area, because their vegetative spread and the majority of their seed dispersal is highly localised. The scale of diversification should therefore be determined by the potential range of these species' dispersal.

Where Ling or other dwarf shrubs dominate open areas, they should be managed to achieve a diverse pattern of vegetation height, by grazing, brush cutting or possibly tightly controlled fire. One further approach might be to plant a small stand of willows and other broadleaves as grazing inducement for deer, which will then graze and trample the surrounding area.

Recent RSPB research at Abernethy suggests that controlled burning in pinewood clearings can lead to a short term increase in Bilberry and a reduction in Ling, which could be beneficial for other vascular plants. Further experimentation on this approach would be valuable.

Some tree invasion into bogs should be accepted, provided there are no species of particular interest in the bogs. In upland areas, every effort should be made to grade the woodland altitudinally towards the natural scrubline, because mountain woodland is a particularly valuable habitat for priority pinewood plants, including Juniper.





◀ The creeping stems of Twinflower form an open mat, sometimes several square metres in extent, particularly where management maintains a fairly open habitat. These mats are often formed of single or very few clones.

### **Ground management**

It seems clear that some species, such as Twinflower and Coralroot Orchid, benefit from ground disturbance at a level which breaks up and disperses their stolon or rhizome fragments. This may also help open up sites for seedling recruitment for the wintergreens and for Creeping Lady's-tresses which seem unable to recruit into sites with a dense shrub layer. 'Traditional' forest management – felling individual trees then dragging them from the site – might therefore be an appropriate management tool, and merits further measured experimentation.

### **Grazing management**

Grazing at the right level is a key management tool. The Forestry Commission's interactive *Woodland Grazing Toolbox*<sup>4</sup> allows managers to plan appropriate types and levels of grazing. Where grazing is primarily by deer, the ideal approach is to define woodland condition objectives, then manage deer numbers progressively towards achieving these objectives. Trials of cattle grazing within the forest should be considered, with careful monitoring to guide future grazing intensity and duration.

If short-term fencing is required for woodland regeneration (appropriately highlighted to protect woodland birds), then limited grazing within the fence should be considered, either by domesticated stock or by temporarily allowing access to a few wild herbivores. There is a strong case for removing the fencing earlier than would be desirable purely for tree establishment, to allow grazing to diversify the stand before it reaches the thicket stage, provided deer grazing can be managed sufficiently to ensure tree establishment.

### **Genetic diversification**

One major problem is that Twinflower, and probably other pinewood herbs, are clonal in nature. At many sites, only a single clone persists, isolated from other populations. This depresses sexual reproduction and seed set in Twinflower, and probably also in One-flowered Wintergreen at most sites, and may impact on isolated populations of other pinewood herbs. The obvious approach is to transfer groups of plants between sites to diversify the genetic populations. However it is important that this is done in an integrated way, rather than piecemeal by individual site managers. It should be taken forward as part of an action plan for the species concerned, with full outcome monitoring. Management plans for sites should include flexibility to participate in experimental management of this kind. Any proposals to introduce clones of Twinflower or One-flowered Wintergreen should be discussed with Plantlife.

<sup>4</sup> Available at [www.forestry.gov.uk/woodlandgrazingtoolbox](http://www.forestry.gov.uk/woodlandgrazingtoolbox)

## References

Titles marked \* below are especially recommended reading for pinewood managers.

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(18) Acton, A. (2010) *Lichens of Scottish Pinewoods: Guide 1 Leafy and shrubby lichens on pine, birch, alder and deadwood. Guide 2 Crustose and scaly lichens on pine, birch and alder, and lichens on trees with less acidic bark.* Plantlife Scotland, Stirling.

### Contacts for advice and further information

Plantlife Scotland [www.plantlife.org.uk](http://www.plantlife.org.uk)

Forestry Commission  
[www.forestry.gsi.gov.uk](http://www.forestry.gsi.gov.uk)

Scottish Rural Development Programme  
[www.scotland.gov.uk/Topics/farmingrural/SRD](http://www.scotland.gov.uk/Topics/farmingrural/SRD) (for information on the Land Managers Options scheme and Rural Development Contracts – Rural Priorities)

Botanical Society of the British Isles  
[www.bsbi.org.uk](http://www.bsbi.org.uk)

Scottish Natural Heritage [www.snh.org.uk](http://www.snh.org.uk)

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\* (13) Broome, A. (2003) *Growing Juniper: Propagation and Establishment Practices* FC Information Note, September 2003. Forestry Commission, Edinburgh.

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**Curr Wood near  
Grantown-on-Spey,  
established from seed  
after felling between  
1750 – 1860 retains  
diverse pinewood  
herb populations.**



**Scottish Natural Heritage**  
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