

# Red List of Ecosystem assessment series

Produced by JNCC and NatureScot, supported by Natural Resources Wales, Natural England, and Northern Ireland Environment Agency.

This resource is one in a series/number of Ecosystem Red List assessments developed to accompany the UK Biodiversity Indicator '[Red List of Ecosystems](#)'. The assessments are available at: <https://jncc.gov.uk/resources/7b922dfc-708b-4c8c-9e6a-e2040447fb39>.

Resilient ecosystems are crucial for preventing biodiversity loss and species extinction. Maintaining healthy ecosystems safeguards the essential services they provide, which are fundamental to human well-being and a thriving economy. However, pressures and threats such as deforestation, overfishing, or climate change, can disturb the balance of ecosystems and threaten their health and functioning. Assessing the level of threat facing ecosystems is important in helping us understand the current status of the environment, and on a practical level, assessments can be used to help prioritise conservation funding decisions and where to take conservation management action on the ground.

The 'Red List of Ecosystems' (RLE) is a global assessment approach set out by the International Union on Conservation of Nature (IUCN). The approach includes consideration of a series of criteria, including change in geographic distribution through time; whether the ecosystem distribution is geographically restricted; evidence for any environmental degradation; and disruption to biotic processes or interactions. We have not carried out the quantitative analyses of the probability of ecosystem collapse necessary to assess criterion E as we do not have the data needed to carry out such analyses consistently. The IUCN methodology is widely used as a robust approach to assessing the status of ecosystems. Further details of the criteria used in these assessments are available on the [IUCN portal](#).

This assessment series sets out the RLE assessment conclusions for ecosystems found in the UK, alongside the details of how the assessment was made, including for each IUCN component criterion. The assessments have been peer-reviewed, and source data is referenced. Once complete, the series will cover the full range of natural and seminatural habitats that occur in the UK, throughout marine, terrestrial and freshwater environments.

Assessments are conducted according to the [Global Ecosystem Typology Level 3](#) (Ecosystem Functional Groups). This enables the assessments to feed into the Kunming-Montreal [Global Biodiversity Framework](#) (GBF) headline indicator A.1 Red List of Ecosystems. This indicator, which has been incorporated into the UK Biodiversity Indicator suite, is designed to measure progress against [Goal A](#) ('Protect and restore') and [Target 1](#) ('Plan and manage all areas to reduce biodiversity loss') of the GBF.

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## T2.1 Boreal and temperate high montane forests and woodlands

### 1. Key facts

**Ecosystem description:** In boreal and mountainous cold, seasonally snow-prone climates, acid soils support structurally simple forests made up of Scots pine, and associated birch *Betula* spp. and juniper. Large forest trees provide habitat for fungi, mosses and liverworts. Seasonal understorey growth sustains high densities of herbivores such as deer, and a variety of insects, with predators such as pine marten and raptors. In the UK, this type of woodland is noted for several rare northern plants including creeping lady's-tresses *Goodyera repens*, twinflower *Linnaea borealis* and the ostrich-plume feathermoss *Ptilium crista-castrensis*



Image credit: Beinn Eighe National Nature Reserve, Highland. ©Lorne Gill/NatureScot.

**Overall assessment conclusion:** Vulnerable (VU), based on criteria A1, A2a, B1b, C2a, D1, D2a and D3

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#### **Corresponding habitat classifications:**

The following habitats were considered in the production of this assessment:

**EUNIS codes:** [G3.41](#) G3.41 Caledonian forest

**UK BAP Priority Habitats:** Native pinewoods

**Habitats Directive Annex I habitats:** [H91C0](#) Caledonian forest

### 2. Assessment against IUCN criteria

#### **Criterion A: Reduction in geographic distribution**

Criterion A considers reduction in geographic distribution over ANY of the defined time periods for criteria A1, A2a, A2b or A3. For details of time periods and criteria see [IUCN Red List of Ecosystems Criteria Summary Sheet 2.2 EN.pdf](#)

This ecosystem occurs in the central and north-eastern Grampian mountains and in the northern and western Highlands of Scotland. Ancient pinewoods believed to be truly native, descended from one generation to another by natural seeding, are included in the

Caledonian Pinewood Inventory (Scottish Government, 2024), and cover nearly 180km<sup>2</sup>. The total area of native pinewood, including planted and more recently regenerated pinewood, is 638km<sup>2</sup>. This is based on coverage of native pinewood from the Native Woodland Survey of Scotland (Patterson et al, 2014) outside of the 'hyper-oceanic' rainforest zone of west Scotland (which is included within the T2.3 Oceanic cool temperate rainforests ecosystem type). This figure includes recently planted Scots pine and, for such areas, management is not generally in place to allow progression to natural forest habitat, principally because of chronically high grazing impacts.

An estimated 25% of the Caledonian pinewood mapped by Steven and Carlisle (1959) was lost by the mid-1980s, primarily due to underplanting with commercial conifers and felling (Bain 1987). Given the limits of mapping, especially for small sites, and further losses since the 1980s (as old trees senesce and are not replaced), it is considered that >30% loss of area of ancient Caledonian pinewood over a 50-year period (1959-2009) is plausible. Such a loss would be outweighed by areas of Scots pine planted since the 1990s, but this recent planting has not yet acquired the equivalent habitat value. Furthermore, the Caledonian Pinewood Recovery project found that significant areas of this ecosystem are still declining, and 23% of what remains is critically threatened (Rainey & Holmes 2023).

**Assessment: Vulnerable (VU) A1, A2b**

### **Criterion B: Restricted geographic distribution**

Criterion B considers restricted geographic distribution indicated by ANY of the time periods for criteria B1, B2 or B3. For details of time periods and criteria see [IUCN Red List of Ecosystems Criteria Summary Sheet 2.2 EN.pdf](#).

This ecosystem has a limited range across Scotland, with a range surface area of approximately 36,000 km<sup>2</sup> (JNCC 2019) and an estimated extent of 638km<sup>2</sup> (Mountford et al., 2025). The Caledonian Pinewood Recovery project found that significant areas of Caledonian Pinewood are still declining, and 23% of what remains is critically threatened. While chronic over-browsing by deer is the main threat to continuity, some areas are threatened by competing non-native conifers from 20th century plantations. In some places, especially the northern Cairngorms, condition and extent have recently improved, but 34% of Caledonian Pinewood in the South-West region remains critically threatened (Rainey & Holmes 2023).

**Assessment: Vulnerable (VU) B1b**

### **Criterion C: Environmental degradation**

Criterion C considers environmental degradation over ANY of the time periods for criteria C1, C2a, C2b or C3. For details of time periods and criteria see [IUCN Red List of Ecosystems Criteria Summary Sheet 2.2 EN.pdf](#).

Climate change and extreme weather events have the potential to cause significant and perhaps catastrophic damage to Caledonian pinewoods. In particular, drought (Kirkpatrick-Baird et al, 2023) and wildfire risk are predicted to significantly increase in the next 50 years (Gagkas et. al. 2023). These can clearly cause direct damage, especially wildfire, but they are also enablers of indirect damage where biotic agents can attack damaged or weakened trees.

**Assessment: Vulnerable (VU) C2a**

## **Criterion D. Disruption of biotic processes or interactions**

Criterion D considers Disruption of biotic processes or interactions over ANY of the time periods for criteria D1, D2a, D2b or D3. For details of time periods and criteria see [IUCN Red List of Ecosystems Criteria Summary Sheet 2.2 EN.pdf](#)

The tree species diversity of pinewoods has declined markedly since the 18<sup>th</sup> century. Smout et al (2005, p74-75) quote Joseph Avery (between 1725 and 1730) and James Robertson (1771) describing a much more mixed canopy than is now present, in Glens Affric, Cannich, Moriston and Garry as well as in Rothiemurchus. They particularly noted birch, oak and alder in the glens, and birch, aspen and hazel in Rothiemurchus. This historic depletion of tree species diversity has reduced the resilience of the woods today.

Over the last 50 years most of the Caledonian Pinewood area has suffered from high herbivore impact, especially by deer, preventing tree regeneration and simplifying ground vegetation (Rainey & Holmes 2023). The widespread use of deer fences has given temporary relief at times, but the benefits are not sustained because deer gain entry through fences over time. While this does not kill mature trees, it prevents regeneration, natural understorey development and skews tree species mixtures towards less vulnerable species (Rainey & Holmes 2023). Invasive species are an increasing problem, especially Sitka spruce (Summers 2023), as well as Rhododendron and Gaultheria, especially in the west. Air pollution is also regarded as problematic due to the nutrient N critical load for the habitat being exceeded across >25% of the habitat area (JNCC, 2019).

For the next 50 years, there seems significant potential for the biotic damage described above to continue as the underlying causes are not resolved. Furthermore, the historical depletion of tree diversity has increased the risk of catastrophic ecosystem loss if Scots pine suffers disease or pest damage. Given relevant examples of novel biotic impacts - e.g. on native pine populations in North America – such an impact cannot be discounted. It is possible that improving growth conditions would benefit associated non-pine species, such as oak (Huntley et.al. 2018), provided browsing impacts reduce sufficiently to allow successful regeneration. Over a 50-year period this has the potential to increase tree species diversity within the pinewoods, although it would take longer than this to substantially alter their character.

**Assessment: Vulnerable (VU) D1, D2a, D3**

## **Conservation measures in place**

This woodland type is a designated feature on 44 SSSIs (as Native pinewood) and 12 SACs (as Caledonian Forest). However, only 16 SSSIs (36%) and two SACs (17%) are in favourable condition, with a further seven SSSIs (16%) and two SACs (17%) recovering. Note that several SACs comprise more than one SSSI. An SAC can only be assessed as favourable if all component SSSIs are favourable, and thus a higher proportion of SACs than SSSIs are unfavourable.

The chronic high grazing impact has been addressed over the last 30 years by the erection of deer fences around 30-44% of the forest (Rainey & Holmes 2023). This has provided temporary improvement, but fences are often quickly breached by deer, resulting in widespread impairment or reversal of any recovery. Much more successful has been the landscape-scale deer management reducing deer numbers to natural levels and allowing natural woodland development processes to occur – especially seen in the northern Cairngorms (Gullett et al 2023). There is however too little of this landscape-scale

management at present, and given the failure of fencing approaches, the grazing issue remains largely unresolved. The establishment of Gene Conservation Units (GCU) for Scots pine also has a role in the resilience of the keystone species through adapting to changing conditions, whether caused by climate change, novel pests and pathogens or other pressures (Cavers et al. 2022).

With a few exceptions, little has been done to prepare pinewoods for key abiotic threats, especially wildfire.

Some efforts have been made to secure biosecurity for pinewoods, especially the removal of nearby lodgepole pine plantations and a prohibition on new Scots pine planting adjacent to pinewoods – all to limit the potential damage from the rust fungus responsible for *Dothistroma* needle blight (Forestry Commission Scotland 2017).

### Overall assessment conclusion

**Boreal and temperate high montane forests and woodland in the UK is assessed as Vulnerable (VU) based on criteria A1, A2a, B1b, C2a, D1, D2a and D3.**

### 3. Literature references

Bain, C. (1987). *Native pinewoods in Scotland: A review 1957-1987*. Royal Society for the Protection of Birds, Edinburgh.

Cavers, S., Lobo-Guerrero, J.P. and Perry, A. (2022). *Pilot study to find potential new sites for genetic conservation units for native trees in Scotland*. NatureScot Research Report 1306.

Forestry Commission Scotland (2017). *Planting in Caledonian pinewoods: reducing risks from Dothistroma Needle Blight*. Policy guidance note.

Gagkas Z., Rivington M., Glendell, M., Gimona, A., and Martino, S. (2023). [Fire danger assessment of Scottish habitat types. Deliverable 2.3b for the Project D5-2 Climate Change Impacts on Natural Capital. The James Hutton Institute, Aberdeen. Scotland](#)

Gullett, P.R., Leslie, C., Mason, R., Ratcliffe, P., Sargent, I., Beck, A., Cameron, T., Cowie, N.R., Hetherington, D., MacDonell, T. and Moat, T., (2023). [Woodland expansion in the presence of deer: 30 years of evidence from the Cairngorms Connect landscape restoration partnership](#). *Journal of Applied Ecology*, 60(11), pp.2298-2308.

Huntley, B., Allen, J.R.M., Bennie, J., Collingham, Y.C., Miller, P.A. and Suggitt, A.J. (2018). Climatic Disequilibrium Threatens Conservation Priority Forests. *Conservation Letters*, 11: e12349. Available at: <https://doi.org/10.1111/conl.12349>

JNCC (2019). *Conservation status assessment for the habitat: H91C0 - Caledonian forest. Fourth Report by the United Kingdom under Article 17 on the implementation of the Habitats Directive from January 2013 to December 2018*. JNCC, Peterborough. Available at: <https://jncc.gov.uk/jncc-assets/Art17/H91C0-UK-Habitats-Directive-Art17-2019.pdf>

JNCC (2025). *91C0 Caledonian forest*. Available at: <https://sac.jncc.gov.uk/habitat/H91C0/>

Kirkpatrick Baird, F., Spray, D., Hall, J. and Stubbs Partridge, J., (2023). Projected increases in extreme drought frequency and duration by 2040 affect specialist habitats and species in Scotland. *Ecological Solutions and Evidence*, 4(3), p.e12256.

Mountford, E., Baulch, V. & Hill, E. (2025). Technical Documentation for the UK Biodiversity Indicator on the Extent of Natural Ecosystems: 2025 version. *JNCC Report 809*. JNCC, Peterborough, ISSN 0963-8091. <https://jncc.gov.uk/resources/ee44fbd1-81de-4c5b-8210-83a24e799555>.

Patterson, G., Nelson, D., Robertson, P. and Tullis, J. (2014). *Scotland's Native Woodlands - results from the Native Woodland Survey of Scotland*. Forestry Commission Scotland, Edinburgh

Rainey, J. and Holmes, F. (2023). *Caledonian Pinewoods: Findings from the Caledonian Pinewood Recovery Project*. Trees for Life.

Scottish Government (2024). *Caledonian Pinewood Inventory*. Available at: <https://www.data.gov.uk/dataset/9fe00904-da11-44f7-97c3-f4e617e34ec7/caledonian-pinewood-inventory>

Smout, T.C, MacDonald, A.R. and Watson, F. (2005). *A History of the Native Woodlands of Scotland, 1500–1920*, Edinburgh, Edinburgh University Press.

Steven, H.M. and Carlisle, A., (1959). *The native pinewoods of Scotland*. Edinburgh: Oliver and Boyd.

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), 35–43.