

The wild Scots Pines (*Pinus sylvestris*) of Kielderhead

Adrian D. Manning^{1*}, Bill Burlton², Stephen Cavers³, Tom Dearnley⁴, Graham Gill⁵,
Graham Hollyoak⁶, Angus G. Lunn⁷

¹Fenner School of Environment and Society, Australian National University, Canberra, Australia; ²Hexham, Northumberland, UK; ³Centre for Ecology and Hydrology, Penicuik, Midlothian, UK; ⁴Forestry England, Hexham, Northumberland, UK; ⁵Thorngraston, Northumberland, UK; ⁶Northumberland Wildlife Trust, Gosforth, Newcastle upon Tyne, UK; ⁷Heddon-on-the-Wall, Northumberland, UK

*Corresponding author: adrian.manning@anu.edu.au

This pdf constitutes the Version of Record published on 12th June 2023

Abstract

In the British Isles, *Pinus sylvestris* L. (Scots Pine) is currently considered to be native only in the Scottish Highlands. Once widespread throughout the archipelago, the species is thought to have declined to extinction outside the Scottish Highlands c.4500 cal BP, and c.1550 cal BP in Ireland. However, there have been discussions about whether some naturally occurring populations may have persisted outside the Highlands into modern times, and potentially may still be alive today. One such population is the enigmatic “Kielderhead Pines” in a remote valley just on the English side of the Scottish border at the heart of the c.60,000 ha Kielder Forest in Northumberland. Debate about the origins of this small population of apparently wild living pines has been ongoing since the 1950s, which has inspired the creation of the “Kielderhead Wildwood” to support its conservation and restoration. We outline the status, significance and the state-of-play in 2023 of our understanding of the origin of these trees, summarising research on the age of the trees, bioclimatic studies, possible botanical evidence of flora and lichen species typical of the Scottish pinewoods and genetics. We conclude that the explanation for the occurrence of the Kielderhead Pines - that they are locally native - remains a possibility, but we recognise and recommend that further research is required. We summarise the conservation efforts that have taken place to secure the pines within a landscape of restored, wild native upland woodland and mires i.e. re-creation of a Northumbrian equivalent of the Caledonian Forest. We also reflect on how the Kielderhead Pines support the case for greater consideration of the restoration of W18 pine woodland vegetation in appropriate locations outside the Scottish Highlands. We conclude by reflecting that one day these few pines, discovered in an isolated valley in Kielder Forest in the 1950s, may be seen as the start of something much bigger in the uplands of northern England, southern Scotland and beyond.

Keywords: bioclimatic, genetics, Kielder, rewilding, wildwood

Introduction

"The restoration of a natural upland landscape on the Scotland-England border, comprising an extensive Scots pine and oak wildwood integrated with natural upland mire and scrub habitats." (Manning *et al.*, 2011)

Pinus sylvestris L. (Scots Pine) was once widespread throughout the British Isles. It re-colonised during the post-glacial period from glacial refugia from c.10,000 BP (Bennett, 1984; Birks, 1989). However, it declined and disappeared outside the Scottish Highlands after c.4500 cal BP (Bennett, 1984; Birks, 1989) and disappeared from Ireland in around c.1550 cal BP (McGeever & Mitchell, 2016; Roche, 2019). Today the species is "officially" considered to be native only in the Scottish Highlands (Carlisle & Brown, 1968; Rodwell, 1991; Hall *et al.*, 2004). Indeed, the tree species and the flora and fauna associated with it have become strongly associated with the Highlands, and the UK National Vegetation Classification "W18" is considered to be native only in that region (Manning *et al.*, 2010). There has been over the last 50 years, however, some discussion about whether naturally occurring populations actually may have persisted outside the Highlands into modern times, and potentially may still be extant today (Edlin, 1961; Turner & Hodgson, 1981; Ratcliffe, 2002; Lunn, 2004; Manning *et al.*, 2010; McGeever & Mitchell, 2016; Roche, 2019; Sassoon *et al.*, 2021).

The origins of the enigmatic "wild" *P. sylvestris* at Williams Cleugh, Kielderhead (v.c.67) (Fig. 1) have been debated since the 1950s (Edlin, 1961; Lunn, 2004; Manning *et al.*, 2010; Gill, 2019). This is because they could potentially be a remnant of the once vast post-glacial pinewoods of the British Isles. To date, no plausible evidence has been found to disprove that they are locally native remnants, and more has been accumulated to support the hypothesis that they are. Consequently, this small number of trees in a remote valley in Kielder Forest has sparked some big thinking about the future of *P. sylvestris* in upland restoration, and initiated the ambitious Kielderhead Wildwood project.

In this paper, we will discuss in more detail the significance of *P. sylvestris* at William's Cleugh/Kielderhead and the state-of-play regarding the evidence supporting their origin. We will then summarise the efforts to date to conserve and expand the population as part of the Kielderhead Wildwood. We will conclude with some thoughts on the long-term future of *P. sylvestris* at Kielderhead.

Why are the Kielderhead Scots Pines significant?

In 1955, Valdemars Blankenburgs, a Second World War refugee from Latvia, employed as a civil engineer with the Forestry Commission (Gill, 2019), reported on and photographed a group of wild-type *P. sylvestris* at William's Cleugh in Kielder Forest (Walton, 1958). In 1961, Herbert Edlin wrote a paper on the potential local nativeness of *P. sylvestris* (Edlin, 1961), and included notes from Blankenburgs, Scots pine experts Dr Alan Carlisle and Professor Henry Steven (authors of the seminal "The native pinewoods of Scotland" (Steven & Carlisle, 1959)) and the then Kielder Forestry Commission district officer Keith Wilson. A key discussion point was how seed of *P. sylvestris* could have got to the valley (given the remoteness from plantations) and where it may have come from. It was a lively discussion, but inconclusive either way about the origin of the trees – but local nativeness could not be discounted. Native status would have major conservation implications, since the trees would probably have been isolated from those in the Scottish Highlands for

8000 years (Birks, 1989), and therefore would be unique and of high national significance. Native status would also indicate that a vegetation type currently associated only with the Scottish Highlands (W18 in the National Vegetation Classification (Rodwell, 1991; Hall *et al.*, 2004)) may have persisted in pockets in upland northern England, Southern Scotland and indeed elsewhere. This would open-up the possibilities for the re-creation of a W18 community in the uplands of northern England and southern Scotland.



Figure 1. The main cluster of wild *Pinus sylvestris* at Williams Cleugh. Original trees can be seen in the centre, and 1990s planted trees derived from seed collected from the mature trees can be seen in the top left. Photo: Adrian Manning

How many original pines are there?

The number of original *P. sylvestris* trees at Kielderhead is very small. In total there were eight original, mature trees (though two are now dead – see below), plus planted saplings derived from the original trees. Five were in a cluster mid-way up Williams Cleugh (a right-bank tributary of the Scaup Burn), one was towards the bottom of the cleugh, one on the main Scaup Burn and one on the Carry Burn (a tributary higher up the Scaup Burn). Though generally referred to as the “Williams Cleugh Pines” – because this cleugh is where the first and largest group were found by Blankenburgs, two additional trees were located respectively on the Scaup Burn and Carry Burn (Edlin, and probably Blankenburgs, knew of these trees as well). The pines could, therefore, perhaps more accurately be termed the “Kielderhead Pines”

(the term we will use henceforth here). The small number of original pines emphasises their vulnerability, and the need for their conservation.

Evidence of native status: the state of play in 2023

In addition to the original discussion in Edlin (1961), further evidence has since been gathered regarding the nativeness of the Kielderhead Pines.

Aging of the trees – how old are they?

The first key piece of evidence needed was to know how old the trees were because this might help pinpoint when source seed from a plantation would have had to have arrived in the valley. In 2004, Russell Anderson of Forestry Research cored the trees in Williams Cleugh, and in 2010 the two trees in Scaup Burn and Carry Burn, to determine their age (Anderson, 2004, 2010). He found (dates corrected here to 2023) the oldest tree in the main cluster on William's Cleugh was between 172-179 years old (germinated between 1844 and 1851), a single tree further down the cleugh was 143-151 years old at death (1871 and 1879), the single 'Scaup Burn pine' (the iconic emblem of the wildwood, Fig. 4c) was around 110 years old (c.1912), and the 'Carry Burn Pine' was c.155 years old (c.1868). All these ages pre-date the earliest plantings for the modern Kielder Forest in 1926 (Lunn, 2004). Although there were some earlier plantings around Kielder Castle and other sites, these were a significant distance from the pines over difficult/high elevation terrain (Edlin, 1961) which might be expected to impede wind-blown seed. It also seems unlikely the Kielderhead pines were directly planted, given their age (before the large-scale Kielder Forest established) and that they have an uneven age structure more typical of natural woodlands (noting that while some of the Williams Cleugh trees may be derived from the oldest tree, the tree further down the cleugh, and the Scaup Burn and Carry Burn trees are increasing distances away).

Bioclimatic studies

Bioclimatic (and edaphic) conditions, such as temperature, rainfall and soils, are key determinants of where plants and animals might naturally occur (Nix, 1986; Nix & Switzer, 1991), and thus could potentially provide insights into the local nativeness of the Kielderhead Pines. In 2010, some of the present authors published a paper exploring the bioclimatic plausibility of the Kielderhead Pines being locally native (Manning *et al.*, 2010). We found that the environment where the Kielderhead Pines occur is bioclimatically indistinguishable from that in the Scottish Highlands where *P. sylvestris* naturally occurs. Thus we concluded it was bioclimatically and edaphically plausible that the pines could be locally native.

Flora and lichens of the Scottish Highlands

Flora and lichens associated with the Scottish pinewoods have been found near the Kielderhead Pines (Lunn, 2004). One ground flora species associated with the Williams Cleugh pines is *Lysimachia europaea* (Chickweed-wintergreen) that is also associated with Caledonian pinewoods (Pickering & Luff, 1995; Lunn, 2004). Another species, *Diphasiastrum x issleri* (Issler's Clubmoss), also a pine forest associate was identified near the Kielderhead Pines (Lunn, 2004), but has recently been re-examined and found to be the more widespread *Diphasiastrum alpinum* (Alpine Clubmoss) (Rumsey *et al.*, 2021).

Gilbert (1980) noted the presence of the lichen *Alectoria sarmentosa* subsp. *sarmentosa* (witch's hair) which almost exclusively occurs in the Scottish Highlands (Gilbert, 1980). Gilbert considered that its presence on the Kielderstone (only 1 km from the Williams Cleugh pines) supported the cases that the trees were native. The findings of Manning *et al.* (2010) that show the bioclimatic and edaphic conditions are the same as in the Scottish Highlands supports the hypothesis that *Lysimachia europaea* and *Alectoria sarmentosa* could be remnants of the post-glacial pinewoods (though noting that their presence alone, of itself, does not prove continuous pinewood persistence).

Genetic analysis

In 2017, Dr Stephen Cavers of The Centre for Ecology & Hydrology undertook a genetic analysis of samples from all of the Kielderhead Pines (Cavers, 2017). The aim was to address two questions (1) to evaluate their genetic diversity and compare this to the diversity found in accepted Scottish native *P. sylvestris* populations, and (2) to assess the level of inbreeding in the small population to assess whether the trees could form sources for an expanded naturalistic *P. sylvestris* forest as part of the Kielderhead Wildwood. In response to question (1), the results revealed that every tree analysed had a different chloroplast haplotype. Some of the chloroplast haplotypes found were distinct, not having been found in a previously extensive survey of trees (N=540) from native populations of *P. sylvestris* in Scottish Highlands. Regarding question (2), the genetic diversity levels of the pines were comparable to those in native pinewoods in Scottish Highlands, and there was no evidence of inbreeding.

While point (1) is notable, it does not exclude the possibility that the distinctive types found at Kielderhead originated from non-local sources because *P. sylvestris* pollen can disperse over long distances, and therefore may have arrived from substantial distances away (i.e. plantations in the region, or plantations or native populations in the Scottish Highlands or even mainland Europe). The genetic analysis carried out was a very limited study, and much more powerful, genome-wide methods are now available. In addition, a collection of reference genetic material allowing comparison with mainland European pine populations (the other potential source of plantation pines that might have seeded the Kielderhead Pines) is now in place. There are very good prospects now to thoroughly evaluate the origins of the Kielderhead Pines, and other putative native pines in Northumberland, to attempt to put in place a clear picture of their origins.

Pulling together the evidence in 2023

There has been a significant development in our understanding of the Kielderhead Pines since debates back in the 1960s (Edlin, 1961). Although the discussants disagreed then on whether or not pine seed could blow from potential source plantations to Kielderhead over such distances and difficult terrain, an obvious source has yet to be identified. Without a verified source or sources, the 'plantation source' hypothesis cannot currently be supported. What we now know, that they did not then, is the specific different ages of the pines (Anderson, 2004, 2010) and the genetic diversity (Cavers, 2017) of the main trees. Also, we now know that the bioclimatic and edaphic conditions are essentially identical to the Scottish Highlands, so optimal growing conditions for naturally grown Scots pines exist at the site

(Manning *et al.*, 2010), and the ground flora and lichen associated with Caledonian forest beneath the Williams Cleugh pines or nearby in the Scaup Burn valley are present (Gilbert, 1980; Pickering & Luff, 1995; Lunn, 2004). While further investigation will continue, based on the evidence that we have, the explanation for the occurrence of the Kielderhead pines that they are locally native remains a possibility.

Conservation in the context of the Kielderhead Wildwood

The enigmatic origins of the Kielderhead Pines, and the small and vulnerable status of the population, led to the development of a proposal to create a “Kielderhead Wildwood” in 2011 (Manning *et al.*, 2011; Manning, 2020; Northumberland Wildlife Trust, 2023). The original proposal was written by Dr Angus Lunn of Northumberland Wildlife Trust, Dr Philip Ashmole of the Carrifran Wildwood (Borders Forest Trust) and Professor Adrian Manning (The Australian National University), and was developed by the inaugural Project Coordinator, Heinz Traut and Northumberland Wildlife Trust into a successful National Lottery Heritage Fund Bid for £354,000 (Manning, 2020). The concept for the wildwood was to conserve the pines within the context of a landscape of restored, wild native upland woodland and mires i.e. re-create a Northumbrian equivalent of the Caledonian Forest.

Upscaling the Kielderhead pinewoods

It was recognised in the early to mid-1990s that the Williams Cleugh pines needed protection and regeneration. A deer-proof fence was constructed by the Forestry Commission (Jim Potts) around the main cluster of pines on the cleugh (Gill, 2019). Seed was collected by the Forestry Commission (Gordon Riley and Marie Clay) and grown by Northumberland Wildlife Trust (Anne Pickering) and Marie Clay and her mother, and planted within the enclosure – with many of those trees being now well established (Gill, 2019). In 2008, Philip Ashmole, Michael Matthews (Borders Forest Trust) and colleagues, with the support of Northumberland Wildlife Trust and the Forestry Commission, began collecting seed from all the trees over the following years (Fig. 2), and arranged drying and propagation (Philip Ashmole, Personal Communication). Germination was generally low, and a very modest number of saplings of plantable quality (*c.*200) was produced over the years (Heinz Traut, personal communication). Around 94 of these were planted at the Kielderhead Wildwood (on the Scaup Burn), *c.*4 at Kielder Castle and, as insurance, *c.*102 at Carrifran Wildwood (Heinz Traut, personal communication). The lack of large numbers of saplings was a matter of serious concern in terms of conserving the Kielderhead Pines in the long-term, and having sufficient stock to create the expansive wild Northumbrian pinewood envisaged in the original wildwood proposal. In 2013 it was observed that the single pine tree in the lower part of Williams Cleugh was in terminal decline (Fig. 4b), and Graham Gill of the Forestry Commission initiated some pollination experiments by collecting pollen from the tree and using it to pollinate female flowers on pines within the main enclosure (Gill, 2019). Sixteen cross-pollinated conelets across five trees were successfully matured, and ultimately 48 cross pollinated plants from three mother trees were successfully grown, and in April 2018 were planted in the main William’s Cleugh enclosure (Gill, 2019).

In 2018/2019, some seed was collected from trees at William's Cleugh, the Scaup Burn Tree and Carry Burn Tree to trial micropropagation. Seeds were sent to Forest Research, Alba Trees and Gentech, but the trial was unsuccessful and no saplings were produced (Heinz Traut, Personal Communication).



Figure 2. Philip Ashmole of the Carrifran Wildwood (Borders Forest Trust) collecting pine cones at Williams Cleugh. Philip (a co-author of the original Kielderhead Wildwood proposal), worked with colleagues over multiple years to propagate samplings. Photo: Adrian Manning

An alternative, though labour-intensive approach, to growing large numbers of saplings is that of grafting. In this process, vegetative material is grafted onto the generic rootstock of the same species. The resulting saplings are clones of the original tree and, when they set seed, can be a seed source for conventional propagation or natural regeneration. It was decided to proceed with producing grafted saplings of the Kielderhead pines. The concept is to establish dispersed "seed orchards" of grafted Scots pines across the wildwood site so that seed can naturally disperse and grow, and also be collected and propagated to produce "normal" saplings for planting. Northumberland Wildlife Trust has engaged Forestart (www.forestart.co.uk/) to produce grafted saplings. This represents a significant (if unconventional for a conservation project) way to amplify the size of the Scot pine population. In winter 2022-2023, Graham Holyoak and volunteers planted out 20

seed orchards or 'woodland islets' as centres of pine regeneration (*sensu* Benayas *et al.*, 2008) across Scaup Burn valley and tributaries. Each islet of Scots pines consists of approximately 24 saplings planted with a stake and wire shelter in a circular shape, with saplings approximately six metres apart. An additional 120 grafted saplings will be available for planting in autumn 2024. Further, at the time of writing, 107 seed-derived saplings will be ready for planting in autumn 2023, and a further 1250 in autumn 2024 (Figure 3).



Figure 3. Grafted saplings (clones) of the Williams Cleugh Scots pines being propagated ready for planting in autumn 2023 and 2024. Though unconventional, this approach is currently the most effective way to secure the Kielderhead Pine population and upscale to a pine forest as part of the Kielderhead Wildwood. Photo: Neil Bebbington

Risks to the original pines

Since the inception of the Wildwood project, two of the original trees have died (Fig. 4). This illustrates the urgency of the need to amplify the population and capture the genetics of the trees in the next generation of trees. The single tree in the lower part of Williams Cleugh that was 143-151 years old was the first to die (Fig. 4a and b) sometime after 2013 (Gill, 2019). Some of its seeds from cones collected in the 1990s, plus those derived from the cross pollination experiments were planted in the main enclosure on Williams Cleugh (Gill, 2019). The second tree to die was the iconic Wildwood Scaup Burn pine – which was blown over in Storm Arwen in November 2021 (Fig. 4c and d). A small number of saplings derived from this tree were produced and have been planted in the valley (Heinz Traut, personal communication). After discovering it had been blown over, Graham Holyoak and

colleagues from the Forestry Commission urgently went to collect vegetative material for grafts and cones while the tree was still alive. They also explored the possibility of winching the tree upright, but it was determined not to be possible. We hope that the grafts will take, in which case we will have clones of that tree. These tree deaths highlight the risks to the remaining trees, and capturing genetics via seeds and grafts will be a key priority in coming years so we can grow the pinewood based on the broadest input of the founding trees.

The future

The intriguing story of the Kielderhead Pines and their instrumental role in driving the vision for the Kielderhead Wildwood, the uniqueness of the location and the trees themselves places their national significance beyond doubt. In coming years there will be further insights that will emerge. We know the local specimens of *P. sylvestris* are not inbred and contain sufficient genetic diversity to provide a sound basis for creating a Northumbrian version of the Caledonian Forest. The future of the unique Kielderhead Pines will depend on rapidly growing the extent of the pinewood within the context of the Wildwood. It will also be important to establish populations at other sites to guard against natural attrition and disasters that are inevitable, and also grow the area of “wild” pinewood ecosystems beyond the Scottish Highlands. The Kielderhead Pines also support the case for greater consideration of the use of W18 pine woodland vegetation in appropriate locations outside the Scottish Highlands. It is important to think of the pines within the context of their place and role in the regenerating upland wildwood ecosystems, and the increasingly important ‘rewilding’ land management principles (Carver *et al.*, 2021). One day these few pines discovered in an isolated valley in Kielder Forest in the 1950s may be seen as the start of something much bigger in the uplands of northern England and southern Scotland.

Acknowledgements

Thanks to Forestry England, Northumberland Wildlife Trust, the Borders Forest Trust and the Kielderhead Committee for their support for the Scots Pine research and conservation at Kielderhead. Thanks to Alba Trees, Forest Research, Forestart, Gentech for assistance with Scots Pine propagation. The conservation of the Kielderhead Pines would not have been possible without the efforts of many people over many years including Philip Ashmole, Russell Anderson, Katy Barke, Stephen Cavers, Marie Clay and her mother, Marjorie Davey, Neville Geddes, Duncan Hutt, Steven Lipscombe, Michael Matthews, Kevin May, Jimmy Potts, Anne Pickering, Mike Pratt, Gordon Riley, Heinz Traut and many more. An abridged and significantly modified version of this paper appears as a chapter titled “The wild Scots Pines of Kielderhead– an icon and catalyst for landscape-scale conservation” in the book “Reseeding – Restoring Wildness at Kielderhead Wildwood” (2023), published by Northumberland Wildlife Trust. Thanks to Philip Ashmole for information on the seed collection, and Heinz Traut for information and for feedback on an earlier draft of this manuscript.



(a)



(b)



(c)



(d)

Figure 4. While considerable efforts are being taken to secure the Kielderhead Pines, natural processes and disasters mean the pines are not 'out of the woods' yet. Since the start of the Kielderhead Wildwood project, the single tree on Williams Cleugh has died (a) and (b), and in November 2021, the iconic Scaup Burn pine was blown over in Storm Arwen (c) and (d). Photo (a-c): Adrian Manning, and (d): Graham Holyoak

References

- Anderson, R. 2004. Ages of the William's Cleugh pines. Forest Research, Unpublished report.
- Anderson, R. 2010. Ages of the William's Cleugh pines: Addendum - Diary of visit to additional outlying pines - 22 June 2010. Forest Research, Unpublished report.
- Benayas, J.M.R., Bullock, J.M. & Newton, A.C. 2008. Creating woodland islets to reconcile ecological restoration, conservation, and agricultural land use. *Frontiers in Ecology and the Environment* 6: 329-336.
- Bennett, K.D. 1984. The Post-Glacial History of *Pinus sylvestris* in the British-Isles. *Quaternary Science Reviews* 3: 133-155.

- Birks, H.J.B. 1989. Holocene isochrone maps and patterns of tree-spreading in the British Isles. *Journal of Biogeography* 16: 503-540
- Carlisle, A. & Brown, A.H.F. 1968. Biological Flora of the British Isles. No. 109. *Pinus sylvestris* L. *Journal of Ecology* 56: 269–307.
- Carver, S., Convery, I., Hawkins, S., Beyers, R., Eagle, A., Kun Z., Van Maanen, E., Cao, Y., Fisher, M. & Edwards S.R. 2021. Guiding principles for rewilding. *Conservation Biology*. <https://doi.org/10.1111/cobi.13730>
- Cavers, S. 2017. Genetic variation in Scots pines at William's Cleugh. Centre for Ecology & Hydrology, Unpublished report.
- Edlin, H.L. 1961. The wild pines of Kielder Forest - are they truly native? *Journal of the Forestry Commission* 30: 38-44.
- Gilbert, O.L. 1980. A lichen flora of Northumberland. *The Lichenologist* 12: 325-395.
- Gill, G. 2019. William's Cleugh Pine Pollinations 2013. *Native Woodland Discussion Group: Newsletter Spring 2019* 44: 15-19.
- Hall, J.E., Kirby K.J., & Whitbread, A.M. 2004. National Vegetation Classification: Field Guide to woodland. Peterborough: Joint Nature Conservation Committee.
- Lunn, A.G. 2004. *Northumberland* (New Naturalist). London: HarperCollins.
- Manning, A. 2020. Kielderhead Wildwood and the Carrifran Connection. In: Ashmole, P. & Ashmole, M., eds. *A Journey in Landscape Restoration: Carrifran Wildwood and Beyond*, 191-192. Dunbeath, Scotland:Whittles Publishing.
- Manning, A., Kesteven, J., Stein, J., Lunn, A., Xu, T. & Rayner, B. 2010. Could native Scots pines (*Pinus sylvestris*) still persist in northern England and southern Scotland? *Plant Ecology & Diversity* 3: 187-201.
- Manning, A.D., Lunn, A.G. & Ashmole, P. 2011. Kielderhead Wildwood: A proposed wildwood restoration project within the Scaup Burn catchment in Kielder Forest, on the Scotland-England border. Northumberland Wildlife Trust and Borders Forest Trust.
- McGeever, A.H.& Mitchell, F.J. 2016. Re-defining the natural range of Scots Pine (*Pinus sylvestris* L.): a newly discovered microrefugium in western Ireland. *Journal of Biogeography* 43: 2199-2208.
- Nix, H.A. 1986. A biogeographic analysis of the Australian elapid snakes. In: Longmore, R., ed. *Atlas of Elapid snakes of Australia*, 4-15. Canberra: Australian Government Publishing Service.
- Nix, H.A. & Switzer, M.A. (eds.) 1991. *Rainforest animals: atlas of vertebrates endemic to Australia's wet tropics*. Canberra: Australian National Parks and Wildlife Service.
- Northumberland Wildlife Trust (2023) Reseeding – Restoring Wildness at Kielderhead Wildwood, Northumberland Wildlife Trust.
- Pickering, A. & Luff, M.L. 1995. Surface-active beetles from Scots Pine (*Pinus sylvestris* L.) woodland sites in the Border Forest Park. *The Vasculum* 80: 44-49.
- Ratcliffe, D. 2002. Lakeland (New Naturalist). London: HarperCollins.
- Roche, J.R. 2019. Recent findings on the native status and vegetation ecology of Scots pine in Ireland and their implications for forestry policy and management. *Irish Forestry* 76: 29-54.
- Rodwell, J.S. (ed.) 1991. *British Plant Communities: Volume 1: Woodlands and Scrub*. Cambridge: Cambridge University Press.

- Rumsey, F., Metherell, C. & Metherell, H. 2021. *Diphasiastrum* × *issleri* (Lycopodiaceae) in England and Wales. *British & Irish Botany* 3: 33-51. <https://doi.org/10.33928/bib.2021.03.033>
- Sassoon, D., Fletcher, W.J., Hotchkiss, A., Owen, F. & Feng, L. 2021. Scots pine (*Pinus sylvestris*) dynamics in the Welsh Marches during the mid to late-Holocene. *The Holocene* 31 :1033-1046.
- Steven, H.M. & Carlisle, A. 1959. *The native pinewoods of Scotland*. Edinburgh: Oliver & Boyd.
- Turner, J. & Hodgson, J. 1981. Studies in the vegetational history of the Northern Pennines. 2. an atypical pollen diagram from Pow Hill, Co Durham. *Journal of Ecology* 69: 171-188.
- Walton, J. 1958. *The Border: National Forest Park Guide*.

Copyright retained by author(s). Published by BSBI under the terms of the [Creative Commons Attribution 4.0 International Public License](https://creativecommons.org/licenses/by/4.0/).

ISSN: 2632-4970

<https://doi.org/10.33928/bib.2023.05.209>