Can Underplanting Help Us Diversify Conifer Forests?

Ian Willoughby summarises recent research on utilising the technique of underplanting to extend the range of conifer species that could potentially be used for future commercial timber production.

Commercial forestry in the United Kingdom relies heavily on just nine conifer species: Sitka spruce, Scots pine, Corsican pine, Norway spruce, hybrid larch, European larch, Japanese larch, Douglas-fir and lodgepole pine. Together, these 'Principal' species account for more than 90% of all of the timber that is harvested. Their widespread use over the last century has been instrumental in driving an expansion of tree cover in the UK, particularly on sites that are relatively marginal for agricultural production, and in the development of thriving forest and timber processing industries.

Risks of low species diversity

But there's a problem. Relying on such a narrow species base is risky. Climate change is bringing hotter, drier summers and more extreme weather, while highly damaging pests and diseases such as *Phytophthora ramorum* and Dothistroma needle blight have already had big impacts on where we can safely plant species like larch and Corsican pine. More recently, to reduce the risk of *Ips typographus* spreading should it become established in the UK, a moratorium on new planting of spruce has been imposed in parts of southeast England.

Planting a broader range of species that can better cope with future conditions is one way to reduce the risks to our forests. Recognising the challenge, since 2015 Forest Research has been working with Forestry England and Forestry and Land Scotland to establish a new series of large-scale trials across the UK, with the aim of testing the suitability of seventeen 'emerging' conifer species as potential future alternatives for commercial timber production (Willoughby et al., 2025). However, whilst this work has already allowed us to identify a number of species that look promising, it was clear early on that other species under test can struggle to cope with the conditions found on clearfell sites, especially in warm, dry areas in the lowlands. So that led us to wonder, could underplanting – establishing trees beneath a retained canopy of trees – be part of the solution?

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Can underplanting help?

Although underplanting has been used historically in the UK to restore native and derelict woodlands, recent experience is more limited, and the suitability of this technique for the emerging conifer species that are currently of most interest for diversifying our productive forests is not well understood. However, for some time Forestry England have being trialling underplanting Corsican pine stands in Thetford Forest that are infected with Dothistroma needle blight and that have, as a consequence, been suffering from severe growth check. Building on this work, in 2018 we took the opportunity to set up an experiment to test the performance of seventeen emerging species planted on two identical, adjacent areas of the forest (Table 1). The only differences between the areas were that one site was a conventional

clearfell coupe, and the other utilised a retained overstory of 30-year-old Corsican pine. The experiment was designed so that all establishment and maintenance operations could continue to be carried out as normal by local operational teams, using the same methods as would have been followed by them if the sites were being restocked with standard Principal species, with the exception that the plots were fenced to keep out rabbits and deer. The soil in the experimental area was a calcareous brown earth, and the site was relatively hot, dry and drought prone. On similar clearfell sites, the main commercial timber producing species now being planted is Scots pine, and it is generally assumed that the opportunities for further diversification in the range of productive conifers used are very limited.

Table 1. List of species used in the experiments, and their relative shade tolerance.

Species	Relative shade tolerance
Atlas cedar	Very intolerant
Coast redwood	Tolerant
Douglas-fir	Intermediate
European silver fir	Very tolerant
Grand fir	Tolerant
Japanese red-cedar	Intermediate
Leyland cypress	Intermediate
Macedonian pine	Intermediate
Maritime pine	Very intolerant
Noble fir	Intolerant
Norway spruce	Tolerant
Oriental spruce	Intermediate
Pacific silver fir	Tolerant
Scots pine	Intolerant
Serbian spruce	Very tolerant
Wellingtonia	Intermediate
Western hemlock	Very tolerant
Western red-cedar	Very tolerant
Weymouth pine	Intermediate

Results

The first few months after our experimental planting were particularly challenging for tree establishment, and there was a severe drought in the summer of 2018. It is perhaps unsurprising, therefore, that most species on the clearfell site struggled. After five years, apart from Scots pine, we found that, as expected, few other species had established (Figure 1). However, Maritime pine did grow very well, and would seem to have some potential in our future climate as a fast growing, robust species choice for suitable freely draining, sheltered clearfell sites, particularly in the south of the UK. Further testing of this species is therefore recommended.

However, under the retained canopy of trees, things looked very different. A much wider range of species appeared to be thriving, with Douglas-fir, grand fir, European silver fir, western red-cedar, coast redwood and Leyland cypress all growing strongly (Figures 2 and 3). We found that during periods of very warm and very cold weather, the temperatures under the canopy were less extreme than on the clearfell site, and consequently, even though light levels were lower, those species adapted to tolerate some shade coped well.

Species trials are a long-term business, and before we draw any firm conclusions, we need to continue to

Figure 1. Overview of the clearfell experiment site at Thetford Forest in September 2023, six years after planting. Few young trees can be seen, reflecting the generally poor performance of most species, but a plot of well established Maritime pine is visible in the mid-ground. The retained overstorey of the underplanting experiment is in the far background.

Figure 2. Douglas-fir at the Thetford Forest experiment site in September 2023, six years after being underplanted beneath an overstorey of Corsican pine with relatively sparse foliage due to infection by Dothistroma needle blight, 110 cm walking pole in the foreground.

Figure 3. Western red-cedar at the Thetford Forest experiment site in September 2023, six years after being underplanted beneath an overstorey of Corsican pine with relatively sparse foliage due to infection by Dothistroma needle blight, 110 cm walking pole in the foreground.

monitor these and other sites to see how the trees get on with our changing climate, how resilient they are to pest and disease attack, and how their yield and timber quality stacks up. However, our early results do suggest that underplanting is a potentially useful technique, worthy of further study, for establishing shade tolerant emerging species that might otherwise be unsuitable for deployment on clearfell sites, as long as the locations chosen are sufficiently windfirm for an overstory of trees to be retained.

If you would like to read more about this research, full details are given in a recently published scientific paper (Willoughby et al., 2026), which is freely available at https://doi.org/10.1016/j.foreco.2025.123346.

A Forest Research publication is also available, which gives practical guidance on the technique of underplanting and is available to download from the Forest Research website (Kerr and Haufe, 2016).

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References

Kerr, G. & Haufe, J. (2016) Successful underplanting. Forestry Commission Silvicultural Guide. https://cdn.forestresearch.gov.uk/2022/02/underplantingguideversion10_11october2016-1.pdf.

Willoughby, I.H., Dhanda, R., Clarke, T. & Reynolds, C. (2025) Seventeen coniferous tree species show early promise for future commercial timber production in the UK. *Forestry: An International Journal of Forest Research*. cpaf048. https://doi.org/10.1093/forestry/cpaf048.

Willoughby, I.H., Clarke, T., Stokes, V.J. & Dhanda, R. (2026) Underplanting extends the range of coniferous tree species that could potentially be used to diversify future commercial timber production in the United Kingdom. *Forest Ecology and Management* **601**:123346. https://doi.org/10.1016/j.foreco.2025.123346.

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