Climate change and mixed forests

Can mixing species improve resilience?

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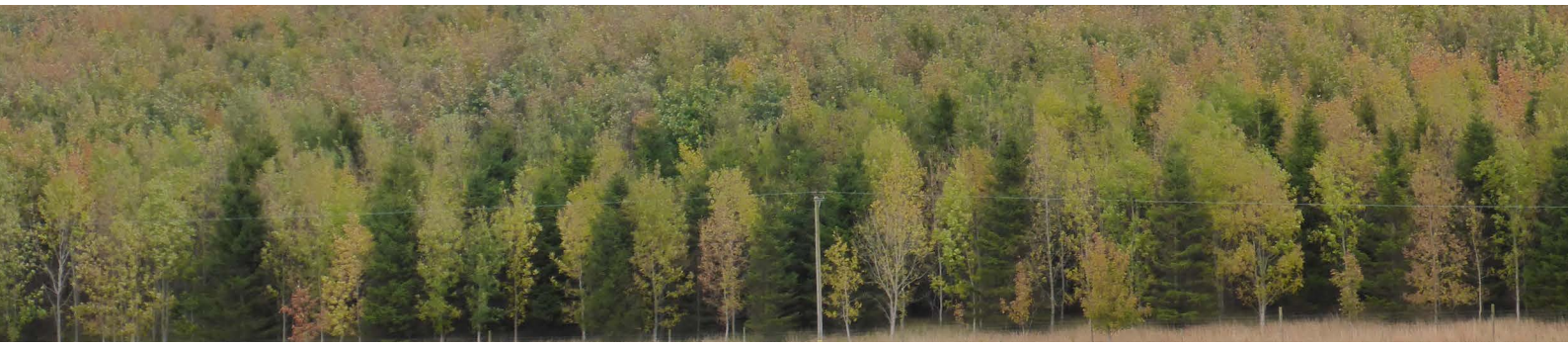

Compared to stands with just one species, mixed-species forest stands may be more resilient to the direct and indirect effects of the changing climate. The use of mixed stands may also increase carbon sequestration by boosting biological productivity.

Types of mixed-species stands

There are many types of mixed-species stands (Box 1). For example, semi-natural woodlands in Great Britain are usually a mixture of different native tree species, many of which have evolved to grow in association with other tree species. In contrast, most stands in British commercial, production forests are managed as even-aged monocultures (single-species stands).

Box 1 Types of mixed-species stands

Mixed stands can:

- be permanent or temporary;
- be even or uneven aged;
- be intimate mixes or mixes using distinct rows or blocks of each species;
- have a single canopy or several canopy layers;
- comprise just conifers, just broadleaved species, or a mix of conifers and broadleaved species.

Mixed-species stands in Great Britain

Mixed stands in Great Britain can be divided into two broad categories: semi-natural woodland (predominantly native species mixtures) and productive mixtures (predominantly non-native species, but can include native species). Semi-natural woodlands are often relatively diverse, and their composition can be described by one of the National Vegetation Classification woodland types. Productive mixtures that are primarily for timber production have a simpler composition (normally two or three species of a single age). In Great Britain, they are most commonly composed of Sitka spruce and lodgepole pine, where the pine improves nutrition for the spruce. Oak with birch is a common combination of broadleaved species grown for timber production.

There has been a long history of using mixed stands in forest management. For example, 'coppice with standards' was an ancient system for producing both large timber and small roundwood, in which two species were managed on different rotations. Oak was commonly used for the large single stems, with an understorey of hazel coppice for small roundwood in this system. Another approach to using mixed stands is the use of a combination of conifers and broadleaved species. In this approach, the conifer is harvested earlier, leaving a single-species broadleaved stand.

Mixed-species stands should be chosen when they meet management objectives more effectively than monocultures. Like monocultures, the species used in mixed-species stands must be well adapted to current and future site conditions.

Benefits and drawbacks

The benefits and drawbacks that arise from mixed species stands are dependent on the tree species used.

- **Resilience to biotic damage:** reduced contact between trees of the same species and lower apparency to insect pests can result in mixtures being less damaged by pests and diseases. Using more than one species also acts as an insurance

policy: if one is killed then the other is likely to remain. However, mixed stands can also increase damage depending on the species used. For example, poplar and larch are both hosts of *Melampsora larici-populina* (a rust fungus).

- **Resilience to abiotic damage:** some species can ameliorate climatic or soil conditions for a more sensitive species, in effect acting as a nurse species. For example, they may provide sensitive species with shelter from frost and exposure. Mixing broadleaved species with conifers can also improve the wind stability of the conifer, and some combinations of species can improve drought tolerance.
- **Overall use of site resources, for example light and rooting space:** some species can thrive in the shade while others need higher light levels, and the roots of some species are concentrated towards the top of the soil while others are much deeper rooted. Combining species with different traits can result in better use of site resources and increase stand growth overall compared with the same species when grown in monoculture.
- **Nutrient availability.** Using nitrogen-fixing species mixed with others can increase available soil nitrogen. On some sites which are dominated by heather, pine in mixture with spruce improves the nitrogen availability for the spruce, preventing spruce growth being slowed by the antagonistic effect of the heather. Mixed stands, such as those incorporating birch, can improve nutrient cycling and other species can increase nutrient uptake through stimulating mycorrhizal activity.
- **Biodiversity:** stands of mixed tree species are likely to have greater structural and chemical diversity, supporting a wider range of other species. However, the level of biodiversity is also linked to that supported by each tree species. For example, birch stands support more species than spruce stands and a mix of the two has intermediate levels of biodiversity.
- **Aesthetics:** the varied crown architecture, texture, and colours of intimate mixtures of species, such as in semi-natural woodland, are visually attractive. However, care should be taken in planning as mixtures with blocks or rows of different species can have a negative visual impact, particularly on visible slopes.
- **Timber quality:** a species that casts deep shade on stems and branches of another neighbouring species can improve the latter's stem form and also reduce branching – and the resulting knots – in timber.
- **Financial return:** growing a short rotation species with a longer rotation one allows both an intermediate and final harvest. This improves the financial return compared with growing the longer rotation species alone. For example, growing a conifer and a broadleaved species, with the conifer being removed earlier. Up to 50% of the stand can be conifers and still provide a good quality broadleaved stand.
- **Stand transformation:** underplanting a stand with a different species can gradually allow the transition from one species to another and/or move towards a continuous cover canopy system.
- **Cost and complexity:** managing mixed-species stands will generally require more input of time and resources.

Oak and western hemlock at Micheldever Forest

More information:

Further details of our work on mixed-species stands are available on our website and include:

- **Establishing robust species mixtures**
- **Managing mixed stands of conifers and broadleaves in upland forests in Britain**
- **Creating new native woodlands**
- **Forest Development Types**
- **Adaptation measures: creating mixed-species stands**

To discuss any aspect of Forest Research's work on mixed-species stands, please contact: **andrew.leslie@forestresearch.gov.uk**

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