Supporting resilient forests through tree species diversity, genetic diversity & epigenetics

Authors: The Tree of Knowledge Team

To identify the core qualities of species diversity, within-species genetic diversity and within individual epigenetic effects, their interactions, and how forest managers might make the best use of this knowledge to support resilient woodlands and forests.

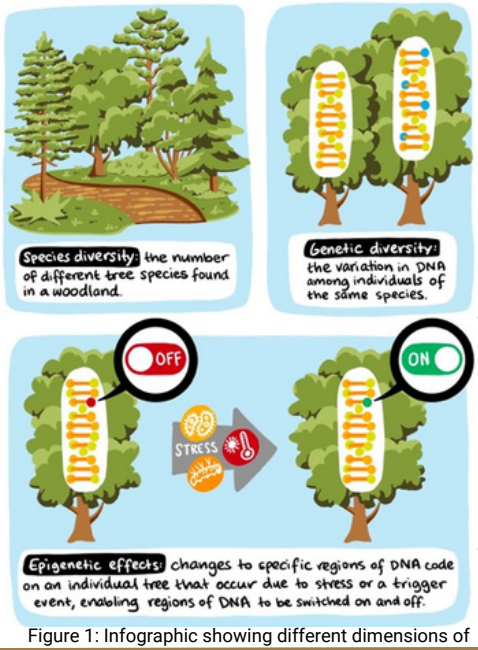


Figure 1: Infographic showing different dimensions of diversity found in UK woodlands and forests.

Headlines

Tree diversity has **multiple dimensions** including species diversity, genetic diversity and epigenetic effects.

Diversifying UK forests will generally **increase resilience to threats**, but there are **exceptions** where diversification does not equate to greater resilience.

When integrating multiple dimensions of diversity, forestry management should consider **spatial scale, natural colonisation and regeneration, and the nursery environment.**



Background

As part of the Tree of Knowledge project, we explored three dimensions of tree diversity – species diversity, within-species genetic diversity and within individual epigenetic effects (Figure 1). Forest management strategies and policies have tended to focus on building species diversity but rarely consider how different dimensions of diversity interact and how they can be integrated to enhance resilience. We collated knowledge via a project leader workshop, conferences, and practitioner and policymaker workshops to synthesise knowledge on how different dimensions of diversity interact.

Findings ~ Interactions

Different dimensions of diversity can interact **positively** – where outcomes are favourable or dimensions of diversity complement one another in achieving forest resilience, or **negatively** – where outcomes are unfavourable, or dimensions of diversity are not complementary and/or management decisions need to prioritise one source of diversity over another.

Examples of positive and negative interactions are shown in Figure 2 and in our research note (link below). These collectively formed the basis of our management and policy recommendations.



Figure 2. Infographic of positive and negative interactions between species diversity, genetic diversity and epigenetic effects.



Findings ~ Forestry Management

Species and genetic diversity can be considered at different spatial scales. At the stand scale there are two contrasting approaches to increase species or genetic diversity: (1) a **mixture of two or more species** in close proximity, or (2) **separate blocks of different single species** also result in diversification at a larger spatial scale.

Forest management that **supports natural colonisation and natural regeneration** has the potential to increase species diversity, genetic diversity and epigenetic effects.

The **nursery environment can have large and lasting impacts on growth** and survival even after the trees are planted out. For example, epigenetic changes can be induced by exposing seedlings to stress or chemical treatments, a process known as priming that may increase seedling resilience to these stresses when planted out.

Implications & Recommendations

There is **no 'one right answer'** to the question of how to diversify and management objectives are key. Given the range and uncertainty of unknown future threats, a **combination of diversification approaches across sites** may provide optimise resilience at the landscape scale.

Whatever management approach is taken, a principle should be to **maintain within-species genetic diversity**, to allow a range of responses to current and future environmental conditions.

This includes:

- Where appropriate, make use of **natural colonisation and regeneration**.
- At the stand scale, a **mixture of two or more species** in close proximity, or **separate blocks,** can result in diversification at a larger spatial scale.
- Trialling **the priming of seedlings** for resistance to particular stressors (Source: Membra).

Diversification will involve **making challenging decisions**, as well as **accepting and learning from failures**; for example, higher mortality of ill-adapted species or genotypes, and potential trade-offs between ecological resilience and performance/productivity.

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