Impact & Insights Note
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Analysing the trajectory of ancient woodlands to ensure resilience and carbon sink capacity

Authors: Bruno Barçante Ladvocat Cintra, Rodrigo Scarton Bergamin, Rachel Mailes and Adriane Esquivel-Muelbert

Ancient woodlands are important carbon stocks and carbon sinks. In the last few years, reports of increases in tree mortality have raised concerns about the future of these valuable natural ecosystems.



Photo credit: Adriane Esquivel-Muelbert

Headlines

The carbon sink capacity of ancient woodlands is declining. There is a decline in sink capacity via an increased loss of biomass through tree mortality – specifically, a rise in mortality rates within the largest trees.

Ancient woodlands are failing to regenerate. There has been a sharp decline in the number of saplings and small trees in the last decade.

Ash dieback is expected to pose a significant threat to ancient woodlands, impacting both tree survival and carbon storage.

Background

The MEMBRA team re-surveyed ten ancient woodlands in Great Britain adding to over 40 years of long-term ecological data. Understanding the trajectory of ancient woodlands and how these forests respond to changes in the environment allows us to design practices to protect these systems.

Through multiple years of observation, we can also learn from these natural systems on how to create future forests across the country.

Findings

Ancient woodlands of Great Britain are operating as a carbon sink, but in some regions their carbon sink capacity is declining. Above-ground biomass stocks are increasing across the sites analysed. This is likely driven by the increasing temperature and humidity. However, the decline in sink capacity via an increased loss of biomass through tree mortality is due to a **rise in mortality rates within the largest trees**.



Together these results show the UK's ancient woodlands have some resilience to global change pressures and can bring a valuable contribution to net-zero strategies. However, this resilience **might be time-limited due to increased losses of the longest-lived trees.**



Photo credit: Rachel Mailes

Findings

Ancient woodlands are failing to regenerate. We have observed a sharp decline in the number of saplings and small trees in the last decade. This was caused by a 90% increase in the mortality of saplings and a 46% decrease in the recruitment of small trees. These changes are associated with **canopy closure**, but there is also evidence of the effect of **warming temperatures** on the observed regeneration decline.

Ash mortality has not increased in the woodlands analysed since the introduction of Ash Dieback, but up to a third of ash-based carbon stocks in the ancient woodlands assessed are vulnerable to loss due to severe infection.

27.4% of carbon stocks are found in trees with >75% canopy loss from ash dieback and are thus unlikely to recover, creating a 'carbon debt'. **Size, neighbours, and access to light determines the likelihood of mortality and susceptibility to ash dieback.**

Implications & Recommendations

To maintain mature woodlands as effective carbon sinks, forest practitioners should **implement measures to protect and enhance their resilience** through:

- Controlling pathogens and grazing pressure
- Continued monitoring of these woodlands to understand their trajectories and allow for fast implementation of new strategies.
- Reduce grazing from deer and squirrels to support woodland regeneration.

Promoting seed or seedling spread while introducing seeds from climate-adapted populations can improve tree tolerance to droughts and heatwaves. **Increasing genetic diversity** by sourcing seeds from varied sites will further strengthen woodland resilience.

Net-zero calculations and carbon budgets should consider the 'carbon debt' (diseased trees that will die soon) when calculating how woodlands offset human emissions for the UK.



Mixed, open-canopy stands are more beneficial to individual ash trees. In existing young ash stands already infected by ash dieback, thinning the most severely affected trees may reduce competition and light suppression and reduce the symptom severity in the remaining trees.

Authors contact details: https://membra.info/

This note is based on Cintra et al. (in prep) Regeneration failure in mature forests of Great Britain, Bergamin et al. (in prep) Long-term dynamics of mature woodland remnants in Great Britain, Mailes et al. (in prep) Ash Dieback effects on Great Britain's natural Ash populations.

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