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Risks of converting coniferous forests to broadleaved species

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Non-native coniferous plantations in the UK have long been associated with potentially negative impacts on surface water and groundwater quality due to high levels of nitrogen accumulation in their soils. Recent changes in UK forestry policy and targets and in attitudes towards biodiversity triggered a shift towards restocking conifer forests with broadleaved species. Broadleaved species are typically associated with lower rates of nitrogen deposition, scavenging and nitrate leaching, so it is often assumed that this change in management will enhance water quality. However, the conversion of coniferous woodland to broadleaved woodland typically stimulates the breakdown of organic matter, leading to a pulse release of nutrients which cannot be taken up rapidly enough by the nascent broadleaved forest.

To assess the significance of this process we conducted a study at Thetford Forest, Norfolk, a forest exposed to elevated levels of nitrogen deposition. We measured throughfall and soil solution chemistry, soil C/N ratios, pH and net nitrification in a chronosequence of stands (0-72 years old) in the conversion process. Observed changes in organic soil C/N ratios indicate the potential for elevated nitrate leaching fluxes within the first decade post-conversion. Results also show an increase in net nitrification in the summer five to eight years post-conversion, followed by an accumulation of nitrogen in the deep mineral soils (30-90 cm depth) ten years post-conversion. Our ongoing analysis of deep soil solution and throughfall chemistry will confirm whether these observations are linked to elevated leaching fluxes in the first decade after conversion. Mature broadleaf stands were unexpectedly associated with greater concentrations of throughfall nitrate from August-October, and lower rates of soil nitrification in the summer than coniferous stands. Further analyses from winter-spring 2022 will explore seasonal variations in throughfall chemistry between broadleaf and coniferous stands in the context of elevated nitrogen deposition.

Our observations highlight the need to consider interactions between the effect of land management, seasonality and elevated deposition on nitrogen cycling processes to understand the impact of intensive nitrogen use on terrestrial nitrogen fluxes.