Widespread forest recovery across the central Appalachian Mountains (U.S.) following reductions in pollutant emissions

Recent observations of enhanced tree growth in temperate forest ecosystems of the northern hemisphere have led to questions of why trees are currently growing faster than expected. Is this increased productivity a consequence of forest regrowth following disturbance, such as tree harvesting and farmland abandonment? Or, is tree growth being enhanced by anthropogenic environmental changes, such as CO$_2$ fertilization, climate change, and N deposition? These are important questions because forest ecosystems are a significant part of the terrestrial carbon sink that removes nearly 30% of anthropogenic carbon emissions each year, providing a negative feedback that moderates climate change, yet a large amount of uncertainty exists about the continued capacity of forests to sequester carbon emissions. State-of-the-art climate models require a mechanistic understanding of how simultaneous changes in key environmental variables affect carbon cycling across diverse forest ecosystems.

Temperate forests in the eastern U.S. have experienced decades of disturbance from high levels of acidic deposition from the atmosphere. In this seminar, I will show how my lab has used dendroisotopes to examine the effects of acid deposition on two tree species growing in the central Appalachian Mountains that differ in their sensitivity to acid deposition. Red cedar is a tree species with low sensitivity to acid deposition, whereas red spruce is highly sensitive to acid deposition. Despite these differences, tree growth estimated from tree cores indicates growth rates by both species increased after the Clean Air Act of 1970 compared to growth rates before this legislation. Basal area increment and carbon isotopes in tree rings confirm recovery of both species after decades of acid deposition, but provide strong evidence for differences in their sensitivities to acid deposition. Carbon isotopic discrimination in tree rings showed a nonlinear trend in both species that indicates a shift in gas exchange of both species before and after the Clean Air Act, but the critical year for this change was 7-10 years later for red spruce (1991) compared to red cedar (1982), indicating a more prolonged recovery time for red spruce.