# Investigating the Role of Mycorrhizal Fungi in New England Forest Management

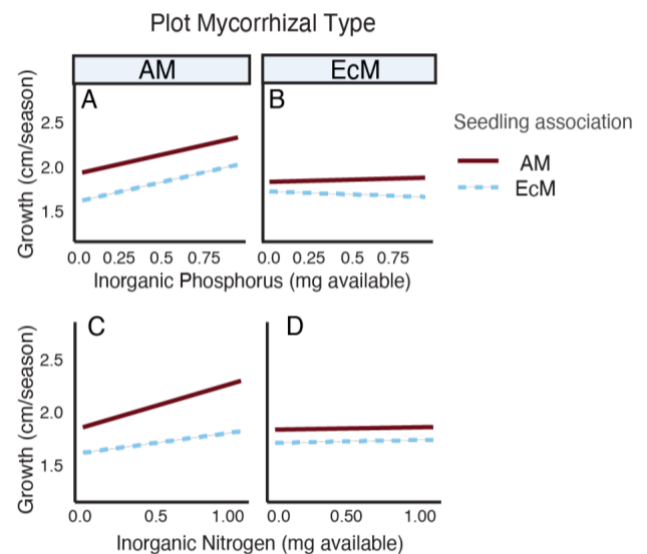**PI Caitlin Hicks Pries, Dartmouth College**

## Project Abstract

Mycorrhizae—fungi that live on plant roots—are essential to tree growth and provide nutrients and water in exchange for sugars. Mycorrhizal fungi enhance soil carbon storage and tree pathogen resistance. New England forests are dominated by arbuscular mycorrhizae (AM) and ectomycorrhizae (EcM), depending on tree species present. Forests dominated by EcM or AM differ in seedling survival, nutrient availability, and how soil stores carbon. As climate change and invasive pests shift tree species in New England forests, mycorrhizae will also change. With loss of ash trees from emerald ash borer and decline of sugar maple, the Northern Forest will lose two AM-associated trees, and the Northern Forest may become more dominated by EcM, with cascading effects on the ecosystem services New England forests provide.

Researchers will examine how the legacy of dominant mycorrhizal associations affects how forests regenerate, cycle nutrients, and sequester carbon following timber harvesting. In this field experiment, researchers will investigate how changes in soil fungal communities and nutrient availability affect planted and naturally regenerated seedling survival and growth in AM- and EcM-dominated forest stands after logging. They will investigate how timber harvesting differently affects long-term soil carbon storage in EcM- vs AM-dominated forest stands.

This project will establish a site for long-term monitoring of forest regeneration and carbon storage, and data will be publicly available through the Northeastern Forest Regeneration Network. Outcomes will help guide foresters and land managers as they consider how tree mycorrhizal associations could impact forest regeneration, nutrient retention, and long-term carbon storage in their management planning.

Panels show seedling growth measured as height accumulated over the 2021 growing season in response to inorganic phosphorus (A, B) and nitrogen availability (C, D) in arbuscular (AM) legacy plots (A, C) and ectomycorrhizal (EcM) legacy plots (B, D). Legacy means that these plots had >80% of their basal area in AM- or EcM-associating trees prior to logging.

## Progress in 2022

The 8 species of seedlings (4 arbuscular mycorrhizal (AM) and 4 ectomycorrhizal (EcM)) were planted in 8 split plots (4 AM legacy and 4 EcM legacy) in the spring of 2021. We measured their survival and growth at the end of the 2021 and 2022 growing seasons. We sequenced the soil microbial communities for fungal ITS markers (to identify the relative abundances of fungal amplicon sequence variants (ASV's) that are akin to species) for our fall 2020 pretreatment soils (prior to logging), as well as the summer 2021 and fall 2021 Year 1 treatment soils. We are currently processing those data. We also collected soils from our

plots in the summer and fall for nutrient, microbial biomass, and fungal community analyses. Those lab analyses are ongoing.

For outreach, we wrote an article (starts on page 8) for the New England Society of American Foresters quarterly, which includes our most recent data analysis. We presented this project and our current results at the Ecological Society of America Meeting in August 2022 and the Society of American Foresters meeting in September 2022. We presented our study design and latest results at the Corinth Conservation Commission's December 2022 meeting. (Corinth is the town where the experiment is taking place.) Lastly, we sent a survey informed by our results to the Forest Ecosystems Monitoring Cooperative meeting in December 2022.

## Problems or Changes

We have had no problems. One change is that we added to our experiment, based on the work of Dartmouth College undergraduate Eva Legge, who is carrying out her senior thesis in the Hicks Pries lab. Based on our preliminary data showing AM seedlings have a "home field" advantage by growing more in AM legacy than in EcM legacy plots, Eva designed an experiment to test how the presence of AM roots from other trees might affect seedling survival, growth, and nutrient status.

## Plans for 2023

Our plans for 2023 resemble those of 2022. We will finish the lab analyses of the samples collected in 2022. We will analyze the soil community data. We will again evaluate seedling growth and survival at the end of the 2023 growing season. We will again collect soils in the summer and fall to analyze nutrients, microbial biomass, and fungal communities. Additionally, we will measure seedling survival and growth in the new AM-only subplots described above. We also will begin to analyze our pretreatment soil samples for soil carbon abundance, including the amount of carbon in particulate and mineral-associated fractions. We will work with UVM's Tony D'Amato and Ali Kosiba to facilitate a spring 2023 workshop with forest managers to discuss our results and elicit feedback on which results are most useful and how best to communicate those results. We plan to present our research at the New England Society of American Foresters Meeting in March 2023 and present our research at a special "Corinth Town Hall" in spring 2023 with collaborators on the larger Corinth project (including Tony D'Amato and Dartmouth Forester Kevin Evans). We will also collaborate with JP Gannon at Virginia Tech, who teaches a data science course. Students in this course will create an interactive output using our seedling survival data beginning in January 2023. We hope this might make our data more accessible. Proposed 2023 activities include:
- Winter and spring: Soil fungal community analysis
- Spring: Seedling survival 2020-22 data analysis
- Spring: Forest manager workshop
- Summer and fall: 2023 seedling and soil data collection.
- Fall: Pre-treatment soil carbon analysis

## Collaboration

We worked with Tony D'Amato and Ali Kosiba to create a mycorrhizal research survey that was included in a poster at the 2022 Forest Ecosystem Monitoring Cooperative conference. This survey will also be distributed to attendees after the meeting and to the NE SAF chapter. We presented study design and preliminary results at Corinth Conservation Commission's meeting in December 2022.