NSRC Progress Report 2022

Assisted Migration: A Viable Silvicultural Technique for Facilitating Adaptation of Northern Forest Tree Species to a Warmer and Drier Future World?

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Project Abstract

NSRC researchers and local stakeholders in the four-state region will evaluate the capacity of ten assisted migration tree species to acclimate to new environments and drought in a periodically drier, warmer future Northern Forest. Researchers will conduct a drought experiment to assess seedling acclimation potential and trait plasticity. Measurements will be collected at six other sites to evaluate seedling responses across broader temperature and precipitation gradients at the landscape scale. The results will inform guidelines for selecting suitable assisted migration species as part of climate change adaptation strategies to promote future resilient forests.

Progress in 2022

In 2022, we established a common garden experiment to test how ecotype, severe drought, and their interaction may influence the physiology and growth of assisted migration candidate species in the Northeastern U.S. Bareroot seedlings from local (NH), warmer (VA), and drier (MI) ecotypes were planted into 2-gallon pots at the UNH MacFarlane greenhouse. Seedlings were randomly assigned into drought or control treatment groups with controls irrigated to field capacity and droughted plants withheld water for 21 days during mid-summer. After this drought, plants were rewatered and maintained at field capacity for the duration of the growing season.

Seedlings in this common garden experiment were grown under a semi-enclosed greenhouse at the UNH MacFarlane Greenhouses.

The researchers measured greenhouse temperature and humidity, soil volumetric water content, photosynthetic rate, stomatal conductance, water potential, seedling growth, and additional stomatal conductance measurements. We observed several notable differences in growth and physiology across species and ecotype. In terms of growth, the drought treatment significantly limited growth in black cherry, northern red oak, and southern red oak. In white oak, Michigan seedlings grew more in height and diameter compared to Virginia seedlings in the drought group, but not in the control group. Black cherry had the highest water demand and, subsequently, the largest physiological and growth responses to the drought.

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Problems or Changes

After the acclimation period, black walnut from Michigan did not have a high enough survival rate to include in our experiment. Black walnut from the New Hampshire ecotype was kept in the study to determine how this species acclimates to drought. To avoid negative impacts to the seedlings and to provide abundant leaf material for the 2023 growing season, we limited how many leaves were destructively sampled for data collection in 2022. This will allow us to create more robust measurements of variables including predawn and midday water potentials for the final year of the study when treatment effects will be more pronounced. Pathogen presence in sugar maple—and other species to some extent—was a minor issue during the 2022 growing season. We cultured tissue samples and are in the process of identifying these pathogens to determine potential prevention or treatment measures for the 2023 growing season.

Plans for 2023

The seedlings over-wintered in the greenhouse where they have been tightly packed and insulated with straw. Their soil temperature is monitored hourly. As seedlings break dormancy in the spring, phenology will be tracked, and the greenhouse will be prepared for a second year of experimentation. Preparations for the growing season include fertilization, installing drip irrigation, and mounting the greenhouse plastic.

In the summer of 2023, we will subdivide our drought treatment to include two levels of drought intensity. The more intense drought treatment will allow us to determine the duration and intensity of water deficit eliciting the various physiological responses leading up to mortality. We will remeasure the growth and physiology variables from the first year of the experiment, intensify our measurements of predawn and midday water potential, and expand our sampling protocol to include phenology. Seedlings will be harvested at the end of the growing season to measure wood and leaf anatomical traits including specific leaf area, leaf thickness, and xylem vessel diameter.

Collaboration

The USFS has increasing interest in planting trees as a climate change adaptation strategy. We are collaborating with two USFS personnel who have experience with precipitation manipulation experiments and tree planting. We are collaborating with the Adaptive Silviculture for Climate Change (ASCC) program, which is funded by the USFS and shares the similar goal of assessing the potential for assisted migration in the Northeast. UVM scientist Anthony D'Amato is the site lead at the Second College Grant ASCC field site and an investigator in this experiment.

Publications

PhD student Sam Zuckerman presented posters on the original field-based design of this experiment and on the preliminary findings from the common garden experiment.

Zuckerman S, Asbjornsen H, D'Amato A, Vadeboncoeur M, McIntire C, Wason J, Frost T. Assisted Migration and Drought in New England: Lessons Learned and Future Directions. Poster presented at: New England Society of American Foresters Annual Meeting; South Portland, ME. March 2022.

Zuckerman S, Asbjornsen H, Vadeboncoeur M, McIntire C, Wason J, D'Amato A, Ehmett J. Identifying species and ecotypes suitable for assisted migration in the Northeast U.S. Poster presented at: Forest Ecosystem Monitoring Cooperative; Burlington, VT. December 2022.

Also, see a New Hampshire Bulletin article about the project.