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# Living the DREAM:
## Implementing the Desired REgeneration through Assisted Migration (DREAM) Framework for Climate-adaptive Silviculture

Climate change is outpacing the natural migration rates of many tree species in eastern North America. The local climates in which many tree species are naturally found may become unsuitable in the future. This mismatch could reduce forests' ability to provide ecosystem services such as carbon sequestration, wildlife habitat, and forest products.

One proactive solution to these challenges is forest assisted migration, the process by which land managers deliberately move trees from native seed sources to other locations within, or even slightly beyond, their current ranges. The process is complex, and the science available to guide management decisions is incomplete. For forest assisted migration to be successful, managers need to know how to source planting stock (e.g., seeds) appropriate for their region and the range of conditions that new, migrating plants can tolerate. Managers also need to be able to implement silvicultural strategies that promote the success of the trees and forecast the effectiveness of assisted migration decades into the future.

Researchers with the U.S. Department of Agriculture, Forest Service, Northern Research Station are leading an international effort to develop an integrated and comprehensive research program that thoroughly investigates many aspects of forest assisted migration. The program, Desired REgeneration through Assisted Migration (DREAM), aims to fill knowledge gaps and enable managers to practice forest assisted migration in a scientifically sound way.

### KEY MANAGEMENT CONSIDERATIONS

- Climate change is outpacing natural migration rates of many tree species in eastern North America. Forest assisted migration, in which planting stock from one location is transferred to another location, is a solution, but the science on the topic is complex and the guidance for managers incomplete.
- The Desired REgeneration through Assisted Migration (DREAM) framework aims to provide comprehensive knowledge to inform forest assisted migration practices.
- The DREAM framework involves sourcing planting stock from appropriate climate analogues, evaluating seedling tolerances to a range of conditions, investigating silvicultural outcomes, and using models to forecast long-term effects.

## DREAM Framework

The DREAM framework leverages expertise from three research disciplines with applications to climate adaptation science, modeling, physiology, and silviculture, and it integrates insights from all three in a structured and self-strengthening manner to ensure success in assisted migration plantings (Fig. 1).

### *Sourcing Stock*

The first step in forest assisted migration is identifying the source of planting stock for the migrating plants. It is important that the current climate conditions of the migrating planting stock match the anticipated future climate conditions of the new planting location. If the predicted future climate at the intended planting destination is similar to climate currently occurring in a different geographic location today, the two areas are "climate analogues."

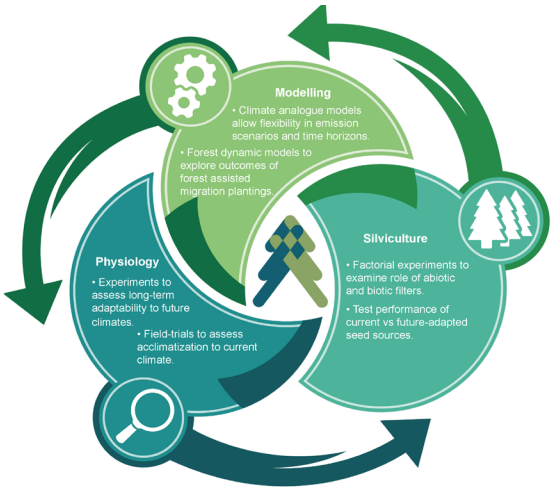


**Figure 1.**—The DREAM framework involves an iterative process in plant physiological test results and outcomes of silvicultural scenarios that are fed into forecasting models. Source: Royo et al. 2023.

The climate analogue can serve as a location to source planting stock for forest assisted migration projects.

In DREAM, Northern Research Station researchers use computer models to identify climate analogues for forest assisted migration planting sites. The models use multiple climate variables, including mean minimum and maximum temperature and total precipitation among the four climatological seasons, climate change predictions, and maps to delineate the climate analogue areas. Model output enables researchers to target specific regions for sourcing planting stock that may grow well in the future.

### *Testing Tolerances*

After identifying where the stock can be sourced, managers need to determine whether migrating plants will survive as seedlings in new planting locations under both current and expected future climate conditions. Controlled experiments that expose the planting stock in growth chambers and greenhouses to a range of climate conditions can provide this information.

In DREAM experiments, seedlings are tested for their responses to climatic stressors, such as summer heat and drought and cold tolerance, and biotic factors, such as simulated browsing or positive and negative soil microbial associations. Testing the tolerance of planting stock ahead of time, in a controlled environment, can help land managers know whether assisted migration plantings might grow well on their land without needing to wait many years to measure outcomes.

### *Silvicultural Scenarios*

Even though tolerance tests reveal the range of conditions under which the migrating seedlings can acclimate, these experiments do not account for the complexity of interactions that occur after seedlings are planted in the field. For this reason, the DREAM framework also includes silvicultural field experiments that provide an operational perspective on the feasibility of assisted migration (Fig. 2).

The field experiments test the independent and combined effects of multiple factors that are known to influence the growth and survival of tree seedlings in the following ways:

- Using different harvesting strategies, such as clearcuts and shelterwood harvests, to assess how seedlings respond to variation in light availability.
- Manipulating the presence or absence of browsers, such as deer, which can strongly influence which species survive and thrive.
- Assessing the role of competing vegetation surrounding each species, both by manipulating the species composition within each experiment and implementing vegetation removal in some plots but not others.

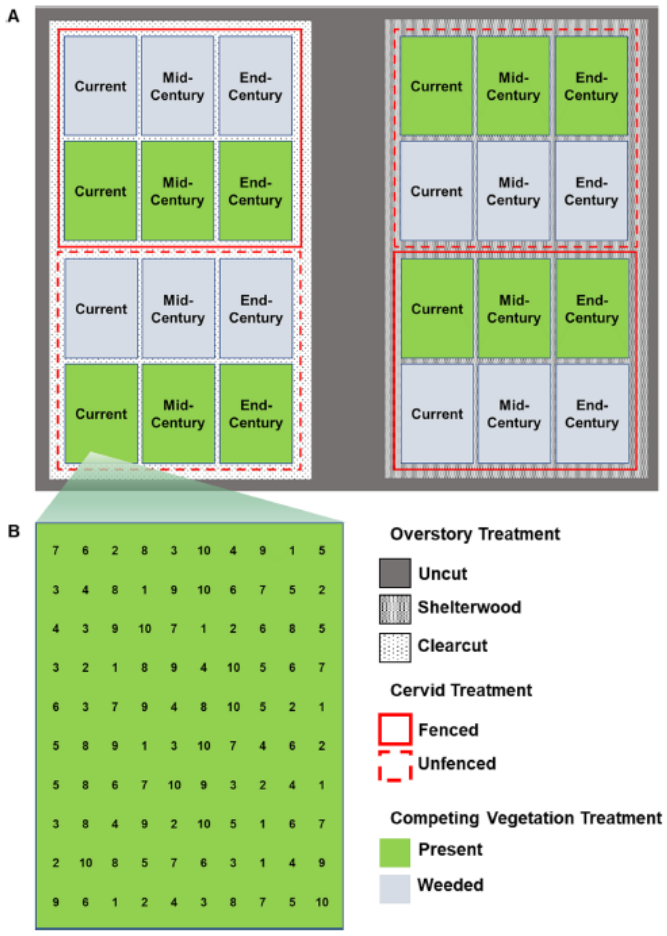


**Figure 2.**—Plot layout for the silvicultural experiment component of the DREAM framework. The experiments simultaneously test climate analogue mixtures, test the effects of browsing, and compare clearcut and shelterwood conditions. Source: Royo et al. 2023.

Through field experiments, the DREAM framework can improve understanding of how multiple factors influence seedling survival and provide insights into strategies that managers can use to enhance the success of assisted migration efforts.

### *Forest Forecasting*

The three components of the DREAM framework described in the preceding paragraphs describe the ways the researchers approach sourcing planting stock and testing the range of conditions that migrating plants can sustain as well as the performance of the transplanted trees in real-world, silvicultural scenarios. Understanding whether these approaches are successful and increase forest resilience could take years, even decades, to yield usable insights because trees grow slowly. This timeframe is longer than ideal for managers to wait, particularly in light of the urgency of a changing climate. In the meantime, resource managers can leverage the power of forest forecasting models to explore the extent to which forest assisted migration will succeed in sustaining a full range of ecosystem services.

Northern Research Station scientists are already using the LANDIS-II model to explore different forest assisted migration scenarios (see Gustafson et al. 2023). As they gather results from the other three components of DREAM, they will enter data into forest forecasting models, incorporate new knowledge into the project, and provide land managers with more reliable information on forest assisted migration.

## Developing DREAM

DREAM projects are currently underway and in different stages of development. Two early studies, the Pine Popple installation in Wisconsin (Fig. 3) and the Lac des Amanites installation in Quebec, Canada (Fig. 4) involve close collaboration between forest land managers and Write out Northern Research Station scientists, which has been key to the success of the installations. Local managers have aided in selecting sites, defining relevant silvicultural scenarios, and considering the feasibility of local seedling production.

DREAM can guide the implementation of forest assisted migration, particularly in eastern North America, which may serve as a critical solution for adapting tree species to anticipated range shifts. The framework can be adopted across a variety of forest types and provide comprehensive answers to questions about the challenges of climate change.

**Figure 3.—**Scientists plant seeds sourced from climate analogues in the Wisconsin State Nursery for the Pine Popple DREAM installation in Wisconsin. Courtesy photo by Amanda McGraw/ Wisconsin Department of Natural Resources.

**Figure 4.—**Scientists Emilie Champagne (standing) and Patricia Raymond (kneeling) revisit seedlings planted in the Lac des Amanites DREAM installation in Quebec. Courtesy photo by Daniel Dumais/Government of Quebec.

## PROJECT LEADS


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## FURTHER READING


Gustafson, Eric J.; Kern, Christel C.; Kabrick, John M. 2023. Can assisted tree migration today sustain forest ecosystem goods and services for the future . Forest Ecology and Management. 529(12): 120723. 18 p. https://www.fs.usda.gov/research/treesearch/65605.

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