Adaptive Silviculture for Climate Change at Green Hills, NH

Project overview: Climate change and the increasing prevalence of non-native insects and pathogens represent significant threats to the ecology and functioning of forests in the northeastern US. Compounding these impacts is the relatively homogenous condition of present-day forests, which increases vulnerabilities to these stressors and limit opportunities for adaptation, as well as many other ecological benefits.

To address these concerns, a network of large-scale, experiments was established in VT, NH, and NY beginning in 2016 through a diversity of partnerships with the University of Vermont and Northern Institute of Applied Climate Science (Figure 1). One of these sites, Green Hills Preserve in Conway, NH, was co-produced with ecologists, biologists, and foresters from The Nature Conservancy, NH Fish and Game, and Forest Land Improvement in 2023 with experimental harvests implemented in fall 2023 (Figure 1). Treatments focus on accelerating structural and compositional conditions found in older forests, while integrating considerations for adaptation to future change, including increasing representation of future adapted tree species (Table 1). Experimental areas are representative of two common forest types on the preserve, including transitional hardwood forests dominated by American beech and red oak, and softwood forests dominated by eastern hemlock and red spruce. Spongy moth impacts were prevalent throughout transitional hardwood forests at the time of study establishment providing a unique opportunity to examine adaptation in the context of ongoing novel stressors.

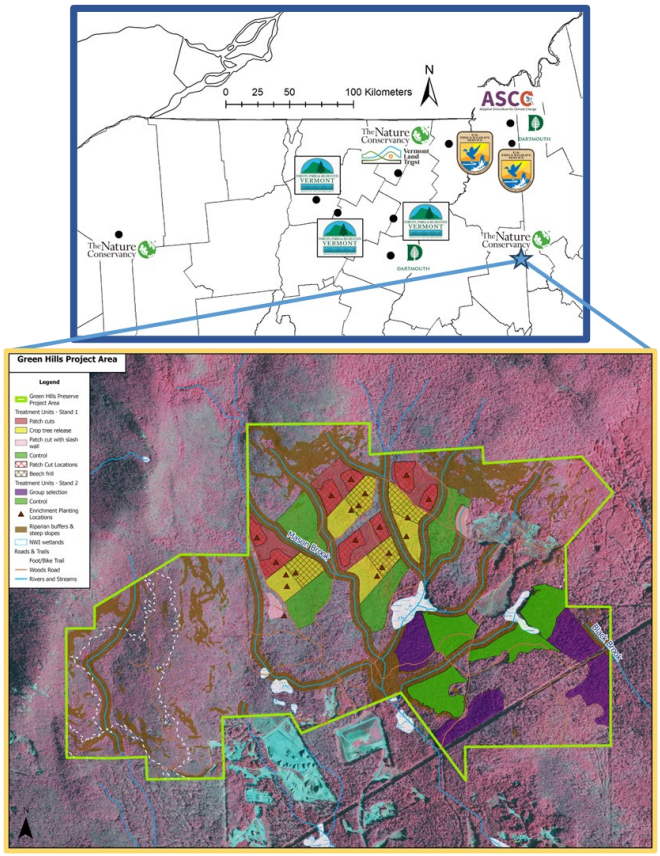

Figure 1. (Upper panel) Locations of co-produced adaptation experiments across Vermont, New Hampshire, and New York. Each site contains large-scale, replicated experiments co-produced by managers, scientists, and other natural resource professionals to test local strategies to restore ecosystem complexity and increase adaptation options in response to climate change and other stressors. Location of Green Hills Preserve indicated with star. (Bottom panel) Experimental treatment units at Green Hills Preserve. Green areas are unharvested controls, yellow areas received crop-tree release treatments, red areas received patch cuts, and purple areas were treated with group selection. Triangles indicate location of where future-adapted seedlings were planted.

Table 1. Management goals and forest adaptation strategies co-produced with ecologists, biologists, foresters, and scientists from The Nature Conservancy, NH Fish and Game, Forest Land Improvement, Northern Institute of Applied Climate Science, and UVM for the Green Hills Preserve.

Management Goals for Adaptive Treatments

- Enhance compositional and structural diversity of forested habitats
- Manage for pockets of old forest characteristics to develop biological legacies
- Promote diverse regeneration, favoring species adapted to future climate, to provide multiple adaptation pathways.
- Increase potential for carbon sequestration and storage by improving forest health.
- Mitigate the negative impacts of forest pests and pathogens.
- Provide diverse habitat for State Wildlife Action Plan species.
- Demonstrate best practices and techniques for climate adaptive management.

Forest Adaptation Strategies Being Tested

No management. Eight areas (four in each forest type) have been designated as "no harvest" experimental controls where we are monitoring how the current forests at Green Hills respond to changing climate and disturbance conditions with limited human intervention. These controls are monitored to understand how wildlife communities and forest conditions change without the aid of active adaptation strategies. Monitoring in controls and in actively treated areas focuses on vegetation and breeding bird communities and forest structural, compositional, and carbon dynamics.

Crop-tree release. This strategy is designed to accelerate growth of large trees that may be better able to resist and recover from forest pests, and to enhance carbon sequestration and storage. Target residual basal area was 85-90 ft^2/ac with 50 crop trees/acre selected for release (at least two sides of crown). Recent spongy moth outbreaks resulted in fewer oaks available to use as crop trees. Beech was chemically controlled on half of each crop-tree release treatment area and portions were underplanted with enrichment plantings of future-adapted species (see Tables 2 and 3 below).

Patch clearcuts with reserves. This strategy is designed to recruit and retain diverse, future-adapted tree species and focused on degraded areas with heavy dominance of beech in all canopy layers. A 3-acre and a 5-acre patch were established in each unit with retention of softwoods larger than 6" DBH when present. A central 1-acre portion of each patch was planted with future-adapted species (see Tables 2 and 3 below). Two additional 3-acre patches were created to test the capability of "slash walls" to protect the regeneration from herbivory.

Table 2. Seedlings planted in subset of patch cuts and crop-tree release units, including geographic origin of seed source, and cost per seedling. Species shaded in green are not currently present in the study area, but are expected to gain new habitat over the next 100 years, those shaded in blue are currently present and expected to gain more habitat over this period, and those shaded red are currently present and projected to lose habitat over this period. Flag colors used for marking planting location in gap are also indicated.

Species	Origin	Cost (per seedling)	# planted	Flag Color
red oak	New York/New Hampshire	$0.80	709	purple
white pine	New Hampshire	$0.50	709	dark blue
eastern hemlock	Michigan	$1.25	709	yellow
red spruce	Southern NH/northern MA	$35	709	green
shagbark hickory	Illinois	$0.83	709	silver
chestnut oak	Wisconsin	$0.81	709	white
American chestnut	B3F3 (Graves/Clapper)	$250	240	orange
white oak	Michigan	$0.81	709	magenta
black birch	Pennsylvania	$1.99	709	light blue
		Total	5868	

Table 3. Red oak and red spruce seed sources being evaluated, including geographic origin of seed source. Goal is to determine best options for oak and spruce seed sources for increasing representation of species in this portion of NH.

Species	Origin	Species	Origin
red oak	Newport, VT	red spruce	Piseco, NY
red oak	Goshen, VT	red spruce	Monadnock, NH
red oak	Brattleboro, VT	red spruce	Harvard Forest, MA
red oak	Rumney, NH	red spruce	Cranseville Swamp, MD/WV
red oak	Pepperell, MA	red spruce	Kumbrabow, WV
red oak	State College, PA	red spruce	Pocono, PA
red oak	Crawford County, PA	red spruce	Dolly Sods, WV
red oak	Altoona, PA	red spruce	White Top, VA
red oak	Lake County, OH	red spruce	Roan Mt., NC
red oak	Delaware, OH	red spruce	Black MT, NC
red oak	Bates County, MO		
red oak	Pearisburg, VT		
red oak	Candler, NC		

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