Adaptive Silviculture for Climate Change: Initial Structural and Compositional Outcomes in Northern Hardwood Forests

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Introduction

Global change, including climate change and increased prevalence of invasives, introduces a suite of unknowns into conditions affecting forest growth, development, and health. Forest managers are in need of strategies for retaining forest integrity in the face of climate change that are regionally relevant and can be incorporated into current silvicultural planning processes. The Adaptive Silviculture for Climate Change network (ASCC) is an international network designed to examine adaptation strategies to address these changes through operational-scale treatments based on local expertise in forest management. ASCC involves three treatments: resistance, resilience, and transition, as well as a no action option, representing a gradient of silvicultural approaches spanning single-tree selection to continuous cover irregular shelterwood methods. The northern hardwoods ASCC site is located at Dartmouth College's Second College Grant in northern NH and has been active since 2016.

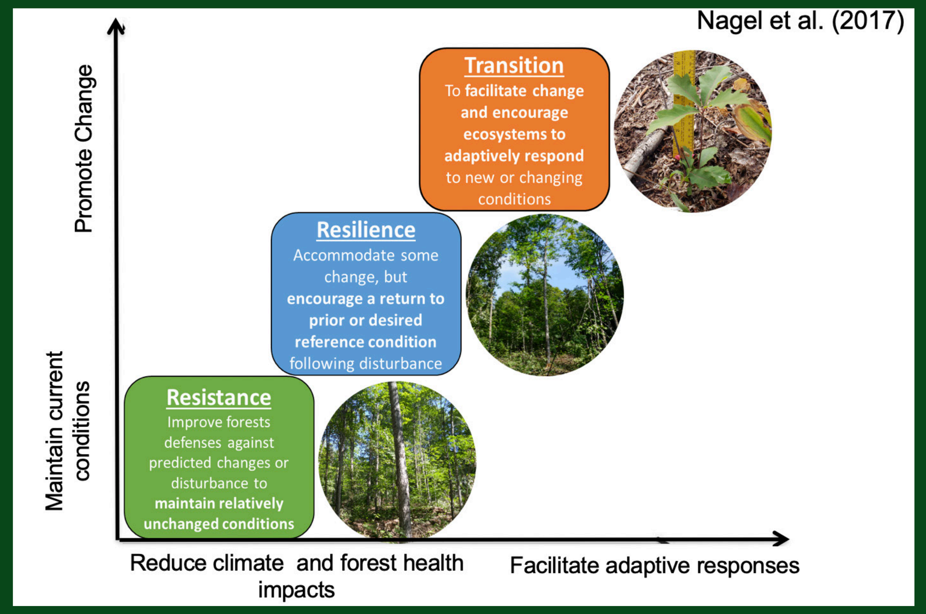
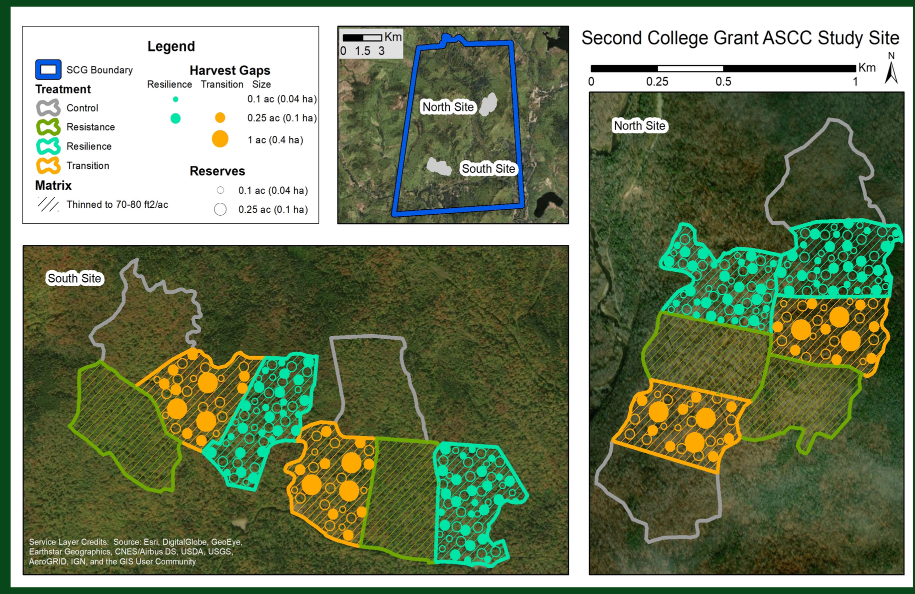


Figure 1. ASCC Treatments on a gradient of change and adaptation

Methods

Treatments were developed around a set of desired future conditions and associated silvicultural treatments, with the treatments representing a gradient of forest change and adaptation to change (Figure 1). Harvesting occurred in 2017 immediately following completion of pre-treatment measurements. Post-harvest measurements have been taken in 2018 and 2019. Forest vegetation and soil conditions were measured using 192 0.04 ha plots spread across all treatments.

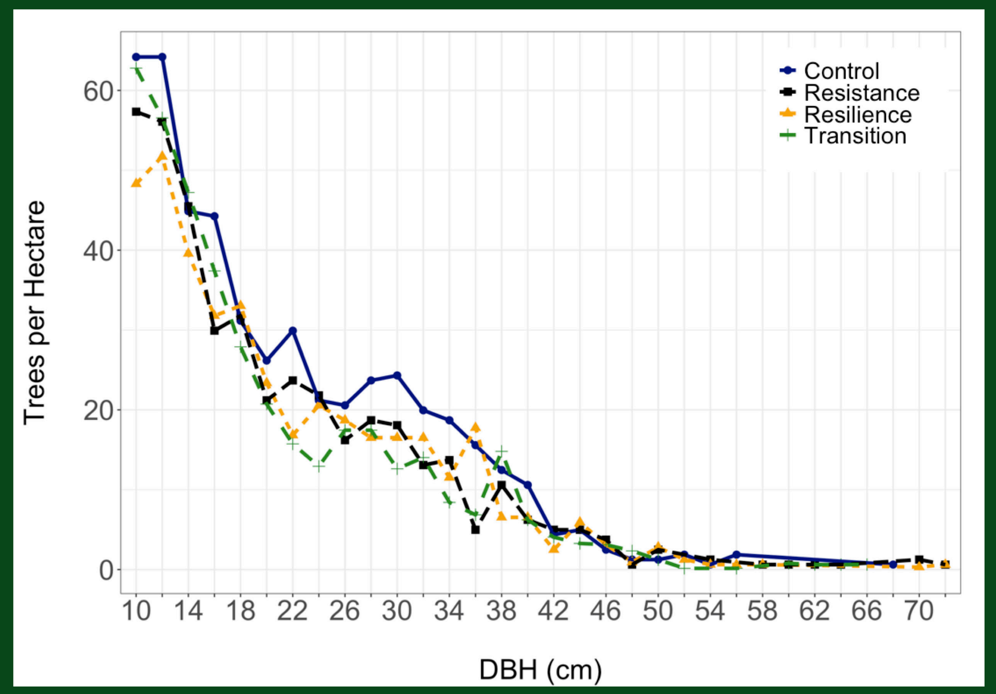


Treatment	Resistance	Resilience	Transition
Objectives	Maintain existing structure, composition, and productivity, increased downed dead wood	Diverse structure and composition, high species diversity, uneven-aged stand, increased downed dead wood	Dominance of species adapted to future change currently on site, uneven aged stand, increased dead wood
Prescription	Single tree selection	Group/single-tree selection with gaps 0.1 – 0.25 acres	Continuous cover irregular shelterwood with gaps 0.25 – 1 acre

Figure 2. Treatment layouts at New England ASCC Site, Dartmouth Second College Grant, New Hampshire. Each treatment is 25 acres and is replicated four times in two blocks.

Results - Overstory Structure

Two years after harvest, moderate differences were found between treatments in terms of forest structure. Notably, the Control plots showed a higher number of stems in the mid-diameter ranges (20 – 40 cm dbh), while all three treatments showed a reduction in this size class, most markedly, the Transition treatment. This is indicative of the level of disturbance created by each treatment. Resilience and Transition, with gaps ranging from 0.1 - 1 acre, had the most trees removed in the mid-diameter range, whereas Resistance had a more uniform removal across all size classes with marking conforming to an Arborgast-like structure.



	Treatment	Trees per hectare	Basal area (m2/ha)
Pre-Harvest	Control	499	23.8
Post-Harvest		491	23.7
Pre-Harvest	Resistance	513	25
Post-Harvest		411	19
Pre-Harvest	Resilience	490	24.7
Post-Harvest		395	19.5
Pre-Harvest	Transition	548	25.2
Post-Harvest		397	17.7

Figure 3. Diameter distribution of each treatment in 2019 (two years post-harvest)

Results - Coarse Woody Material

Volume of coarse woody material increased with intensity of treatment, although the Control and Resistance treatments showed very similar levels of coarse woody material. Prescriptions for both Resilience and Transition included intentional creation of coarse woody material, as a strategy for adapting to future extreme precipitation events and maintaining saproxylic species and ecosystem processes associated with deadwood.

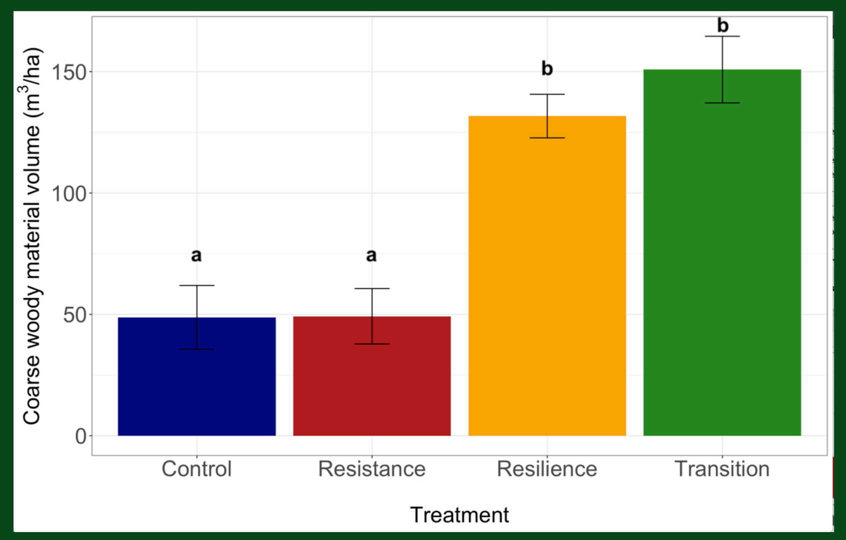


Figure 4. Volume of coarse woody material found across ASCC treatments

Results - Natural Regeneration

A key aspect of the adaptation treatments is creating a range of resource environments for regeneration and native biota via canopy gaps and legacy retention. We examined regeneration across the elements created by each treatment (i.e. gaps, thinned matrix, uncut reserve patches, and controls). Sugar maple and beech were most common across all size classes and treatment types, although more intensive harvesting included a reduction in beech abundance. In addition to these species, pin cherry and aspen increased in large gaps. Large saplings increased in abundance with decreasing severity of treatment, with uncut plots containing the highest sapling abundance.

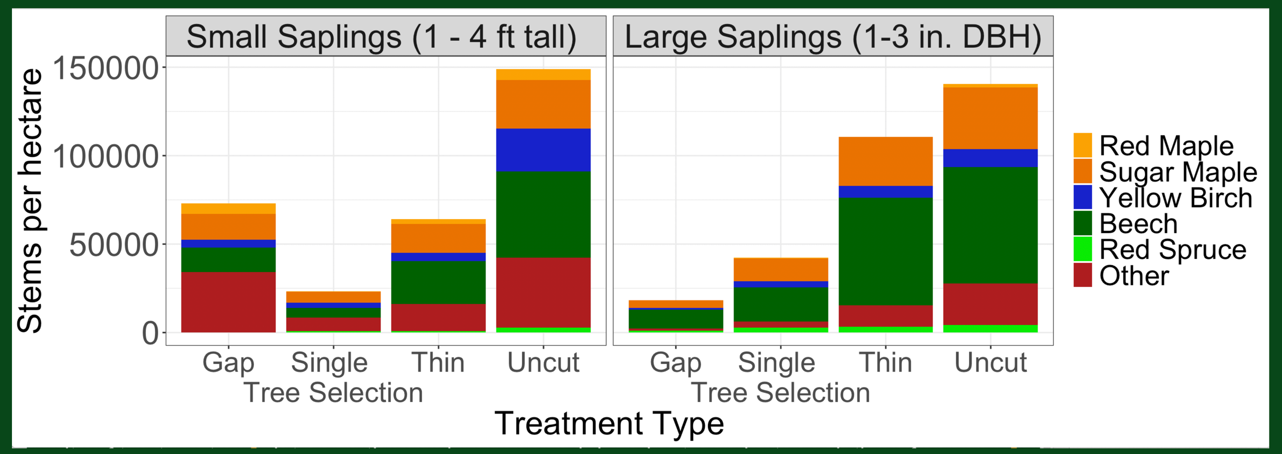


Figure 4. Natural regeneration in 2019. broken down by treatment location of each plot

Future Directions

This experiment represents a new generation of long-term silvicultural studies in the region and we will continue measurements on these plots over the coming years and decades to evaluate evolution of stand structure and regeneration conditions. Additionally, we intend to examine stand structure in more depth to better understand the outcomes of each treatment. Other research at this study site includes projects focused on future-adapted planted seedlings, wood and litter decomposition, small mammals, mycorrhizal fungi, breeding birds, insects, pollinators, and quantification of forest structural dynamics using high resolution LiDAR.

Acknowledgments

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