Silviculture through the lens of forest adaptation

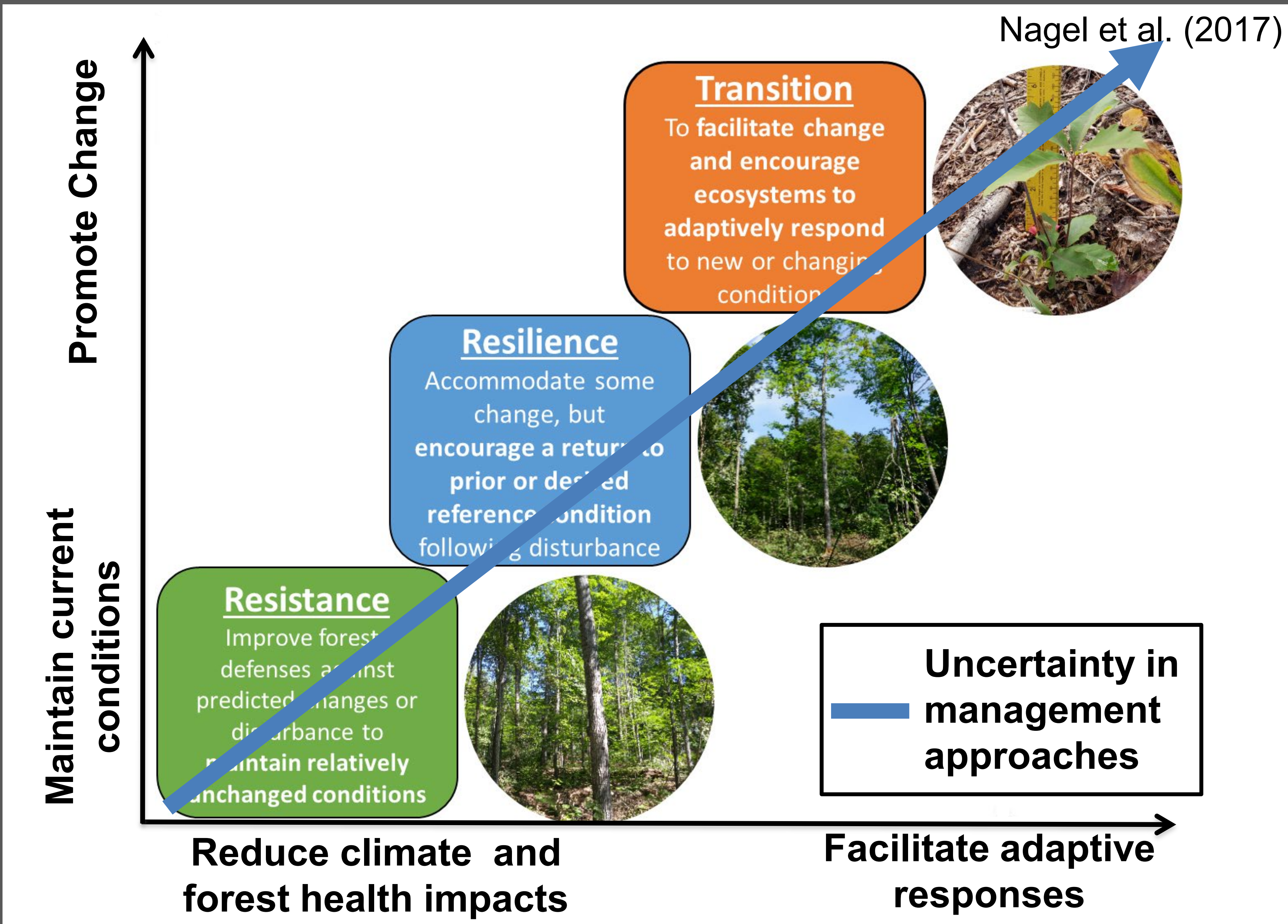
Tony D'Amato

Rubenstein School
University of Vermont

THE UNIVERSITY OF VERMONT FORESTRY

NE CASC Northeast Climate Adaptation Science Center

Forest Adaptation Spectrum



Repackaging silviculture

TOWARD A NEW FORESTRY

By DR. JERRY FRANKLIN

Brainchild of a group of scientists and rangers and driven by increasing resource conflict and decline, these concepts are a revolution in the making.

Forestry is at a crossroads. For decades we thought we knew all that we really needed to know about forests. But in fact our level of knowledge is remarkably superficial.

The more time I've spent studying forests, the more I've come to appreciate their richness. The traditional approach to the management of forestland has reflected a simplistic attitude that has homogenized these complex systems. The result has made them ef-

Logs create fish habitat in a stream.

U.S. Forest Service

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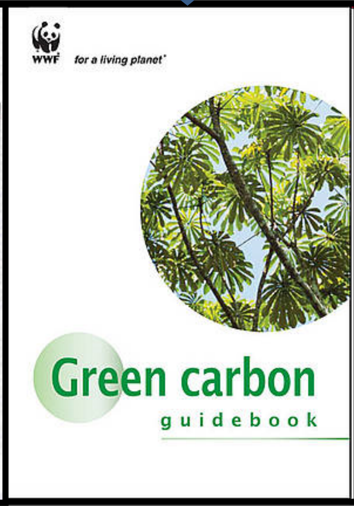
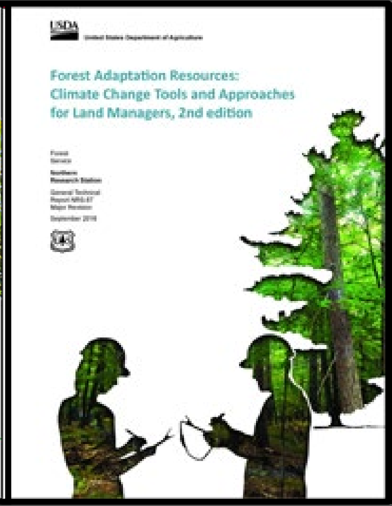
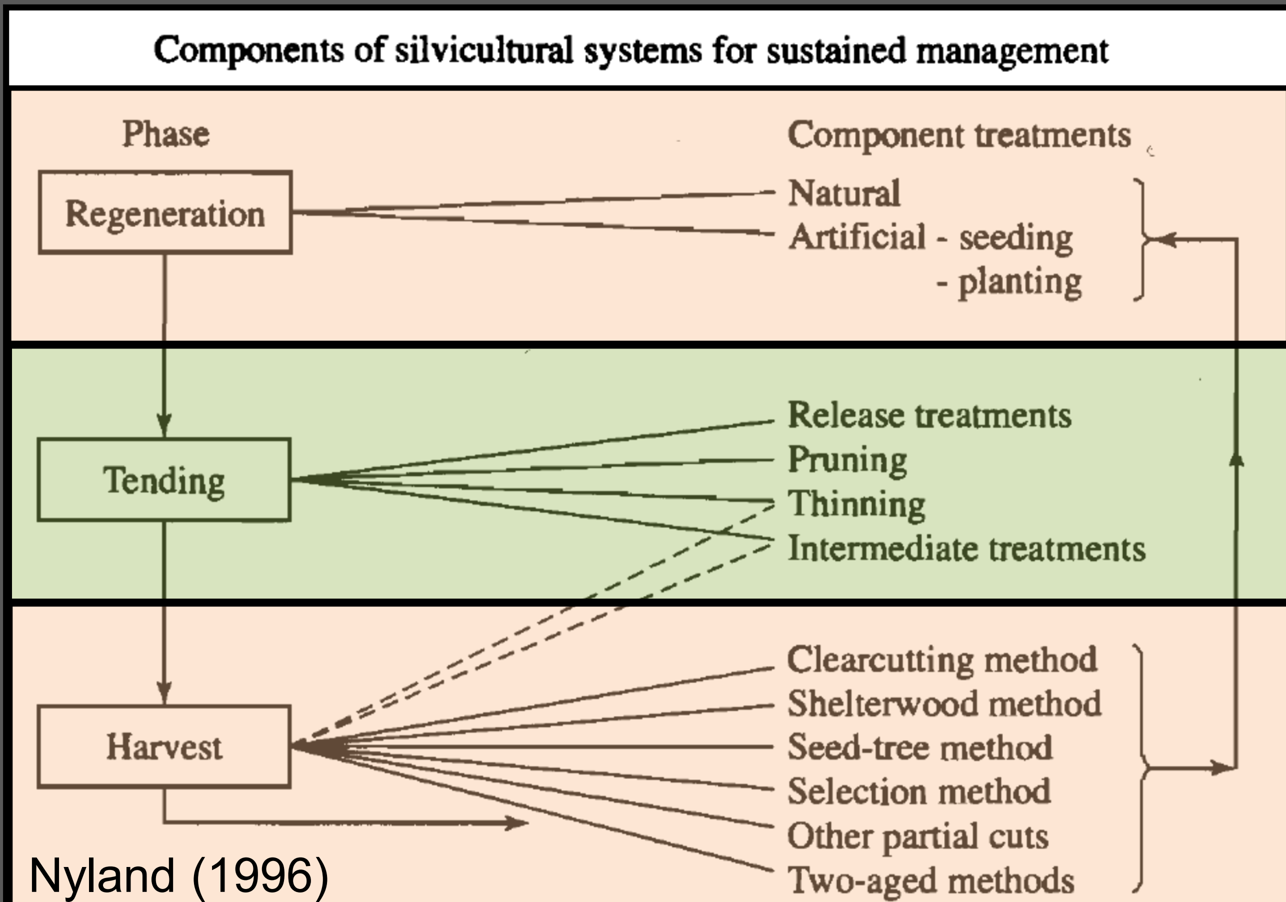




Repackaging silviculture

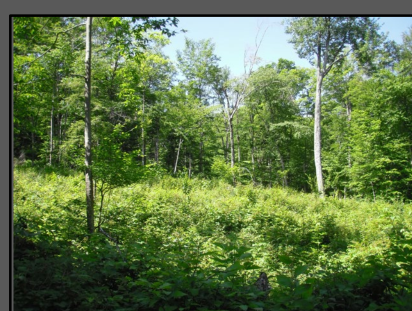


Nyland (1996)

Resilience & Transition Strategies

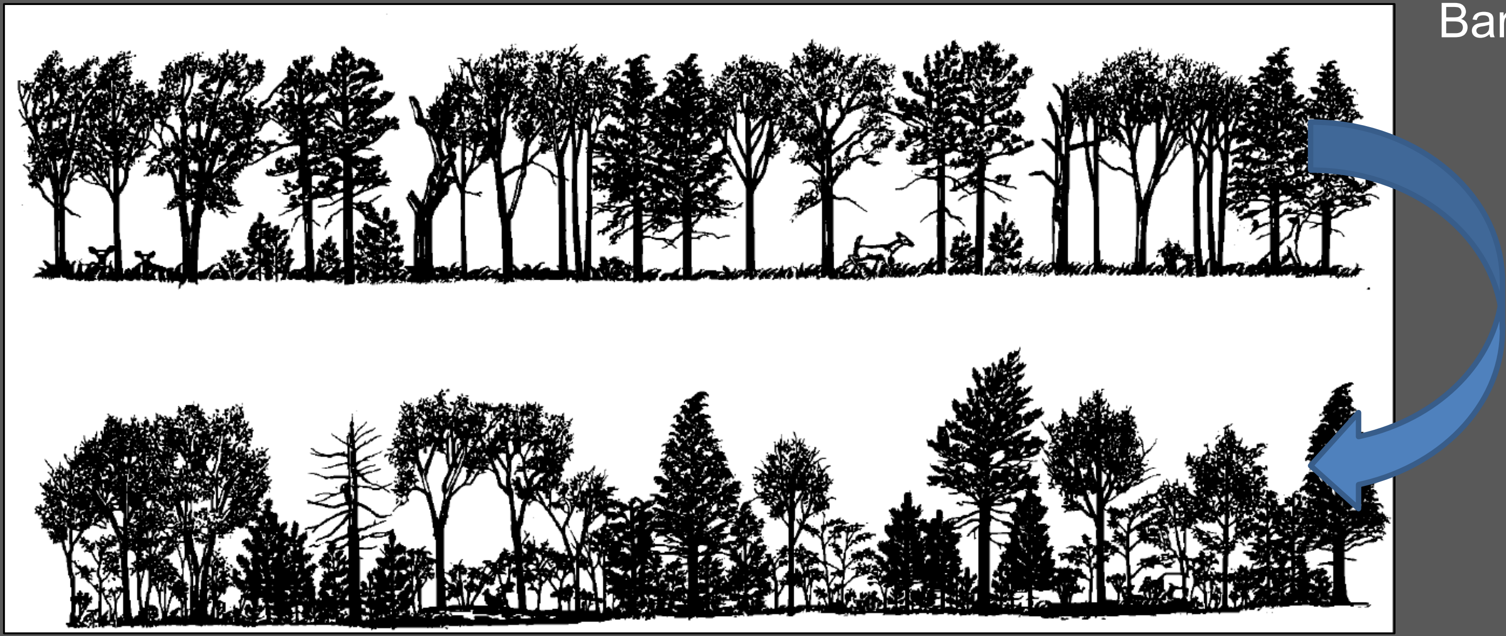
Resistance Strategies

Resilience & Transition Strategies



Repackaging silviculture

Barten et al. (1998)



Patch, irregular shelterwoods, and selection cuts to guide development of structurally diverse stands

"Optimal" watershed protection forest consists of three patch characteristics:

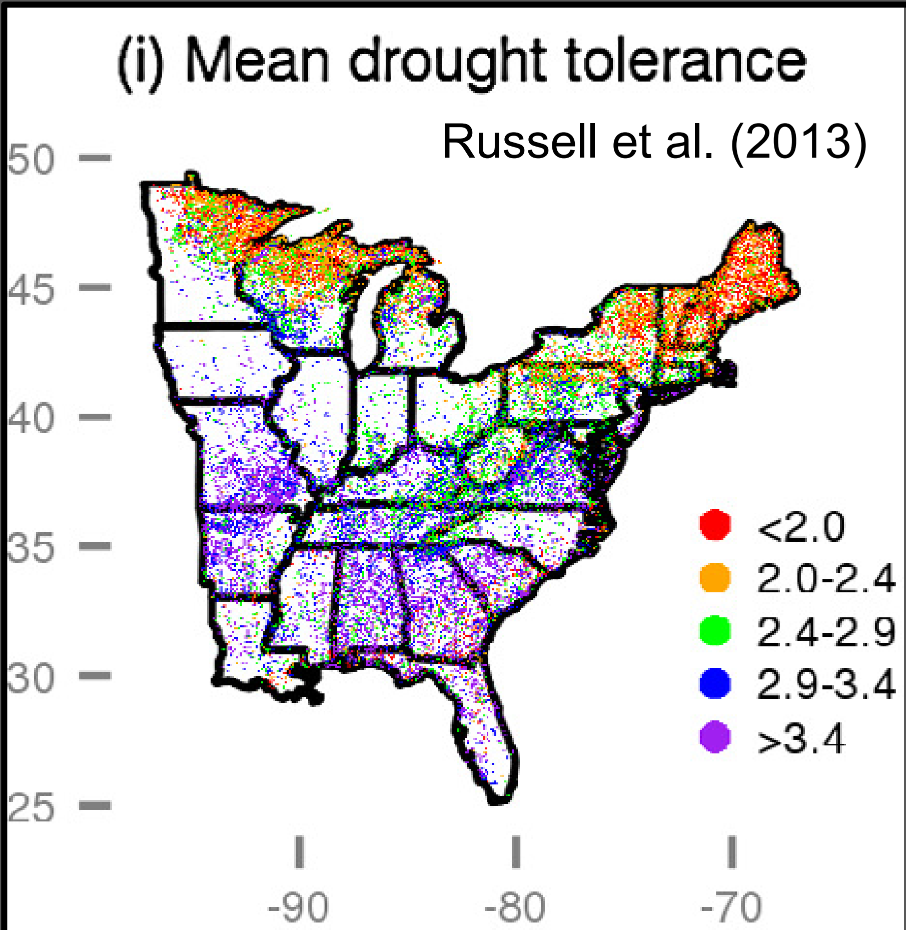
1. Regeneration for recovery following disturbance
2. Vigorous middle-aged trees and stands for nutrient uptake and biomass accumulation
3. Mature trees and stands for seed sources and amelioration of temp and moisture conditions

Applying the adaptation lens

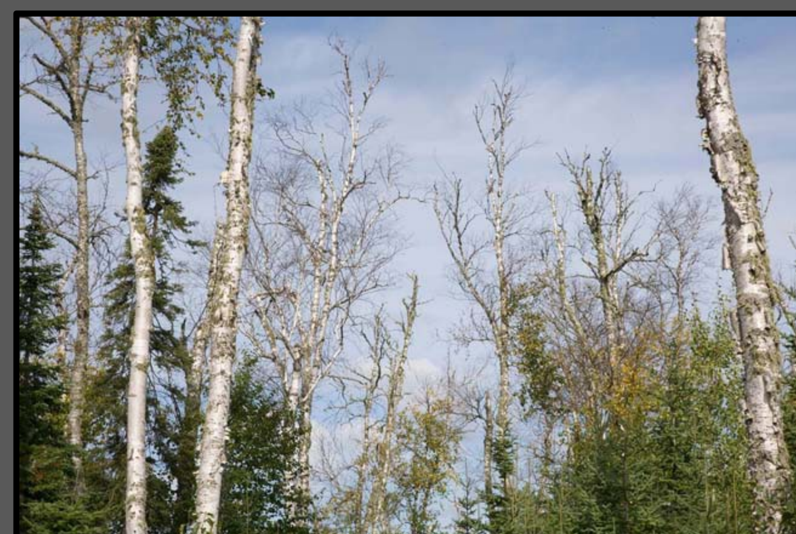
Silvicultural outcomes and adaptation

1. Forest composition
   - Functional characteristics of species (drought tolerance, regeneration strategies, disturbance response)
2. Forest structural conditions
   - Resource levels and heterogeneity, size and cohort structures (disturbance and drought response)
3. Site conditions
   - Is adaptation a priority based on edaphic factors and disturbance vulnerability?

Compositional considerations

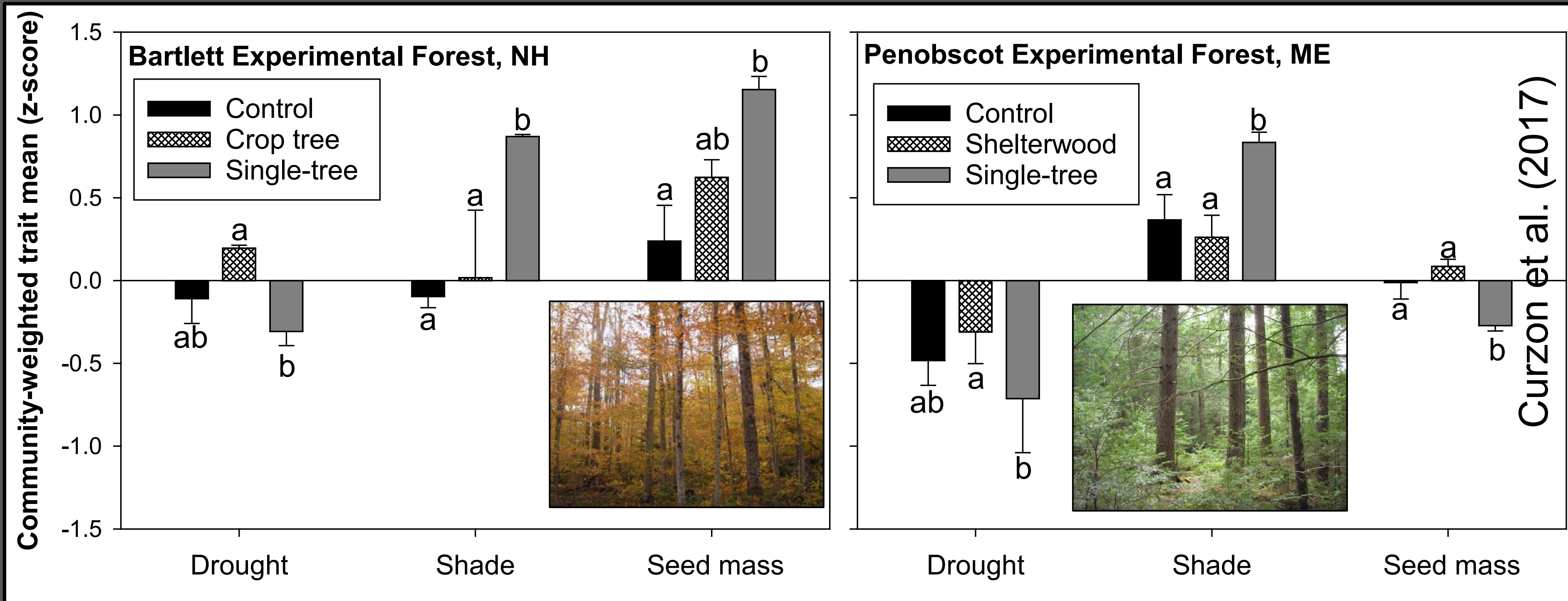


Shade tolerance is common lens we use to evaluate stands
-general inverse relationship with drought tolerance



Compositional considerations

Long-term silvicultural impacts on stand drought tolerance

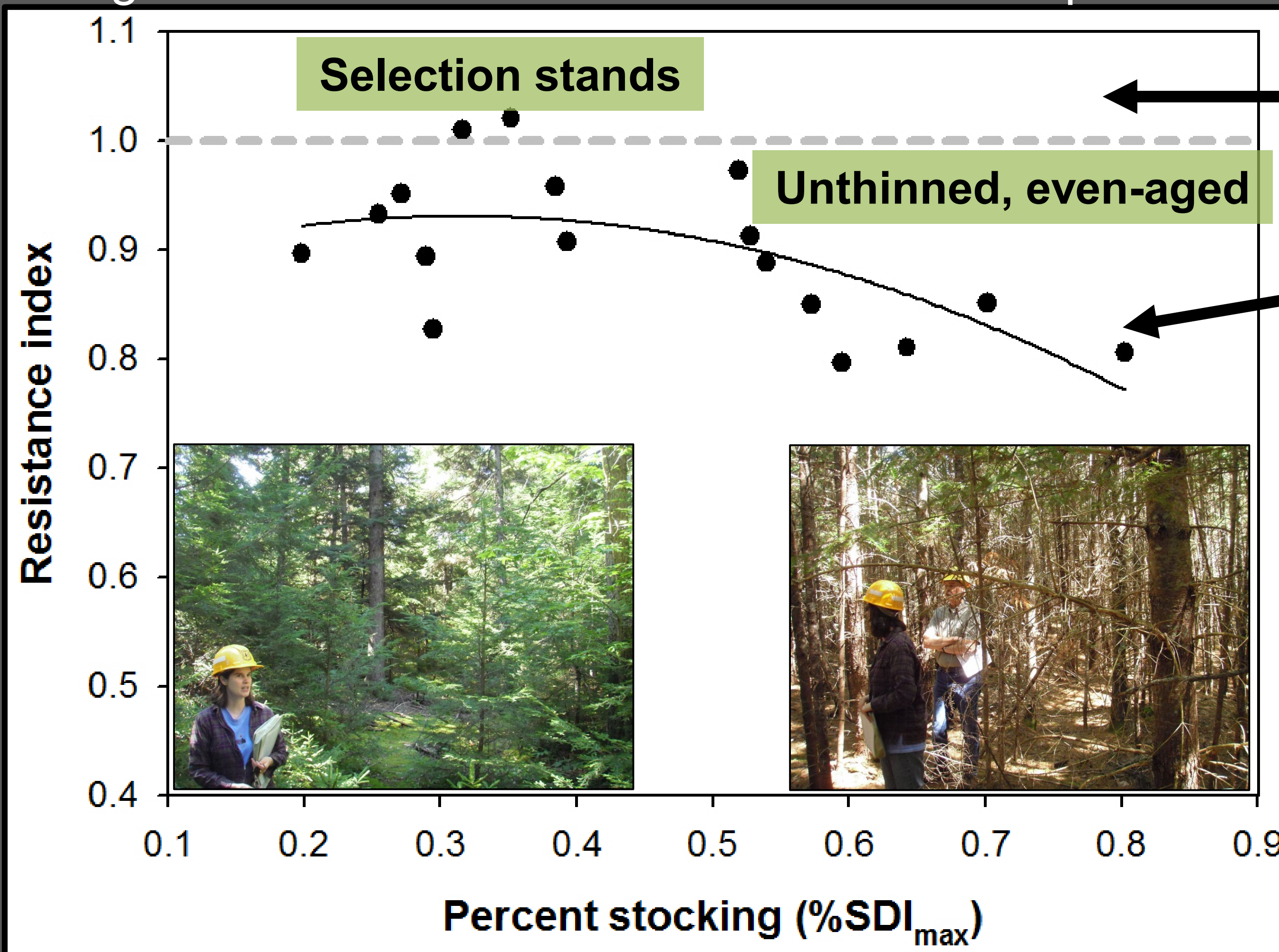


- Reduced drought tolerance under single-tree selection (opposite shade tolerance)
- Greater seed mass reflective of beech dominance in selection plots at BEF; decline at PEF due to increasing hemlock
- Homogenization towards vulnerable condition relative to projected changes in climate

Structural considerations

- Past vulnerability of managed and unthinned stands to known drought events (e.g., 2001)

Long-term silviculture studies at Penobscot Experimental Forest, ME

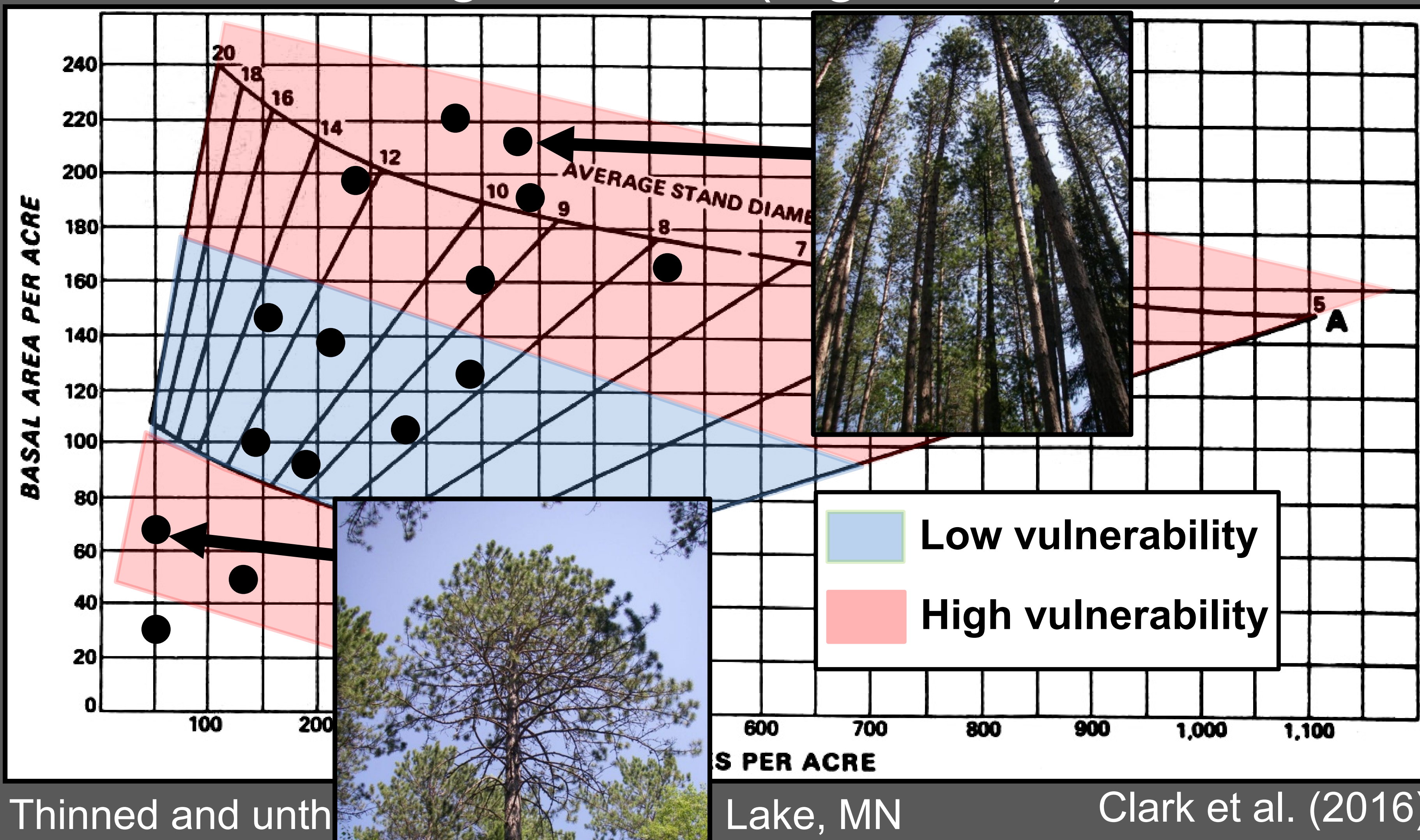


No effect of drought on stand-level growth

Stand-level growth reduced during drought

Structural considerations

- Past vulnerability of thinned and unthinned stands to known drought events (e.g., 1988)



Thinned and unth Lake, MN

Clark et al. (2016)

Varying within stand densities to
of adap

<u>Single trees (thinned matrix)</u>

- Distributed mature habitat
- Lower drought sensitivity
- Lower fire vulnerability
- Higher vulnerability to wind

<u>Clumps</u>

- Potential refugia
- Greater drought sensitivity
- Lower wind vulnerability
- Greater selection pressure

<u>Openings</u>

- Increased vegetation cover
- Adaptation opportunities via natural and artificial regen

Regeneration considerations

Regeneration considerations

Projected changes in suitable habitat by 2100 (Tree Atlas New England-wide summary, Janowiak et al. 2018)

Decreasing	Increasing	New
American beech	black cherry	cherrybark oak
balsam fir	black oak	persimmon
balsam poplar	black walnut	loblolly pine
black ash	chestnut oak	pond pine
black spruce	e. cottonwood	sand pine
n. white cedar	e. red cedar	southern red oak
paper birch	mockernut hickory	sweet gum
red spruce	northern red oak	Virginia pine
sugar maple	pignut hickory	
white spruce	yellow poplar	

Primarily intolerant and midtolerant species

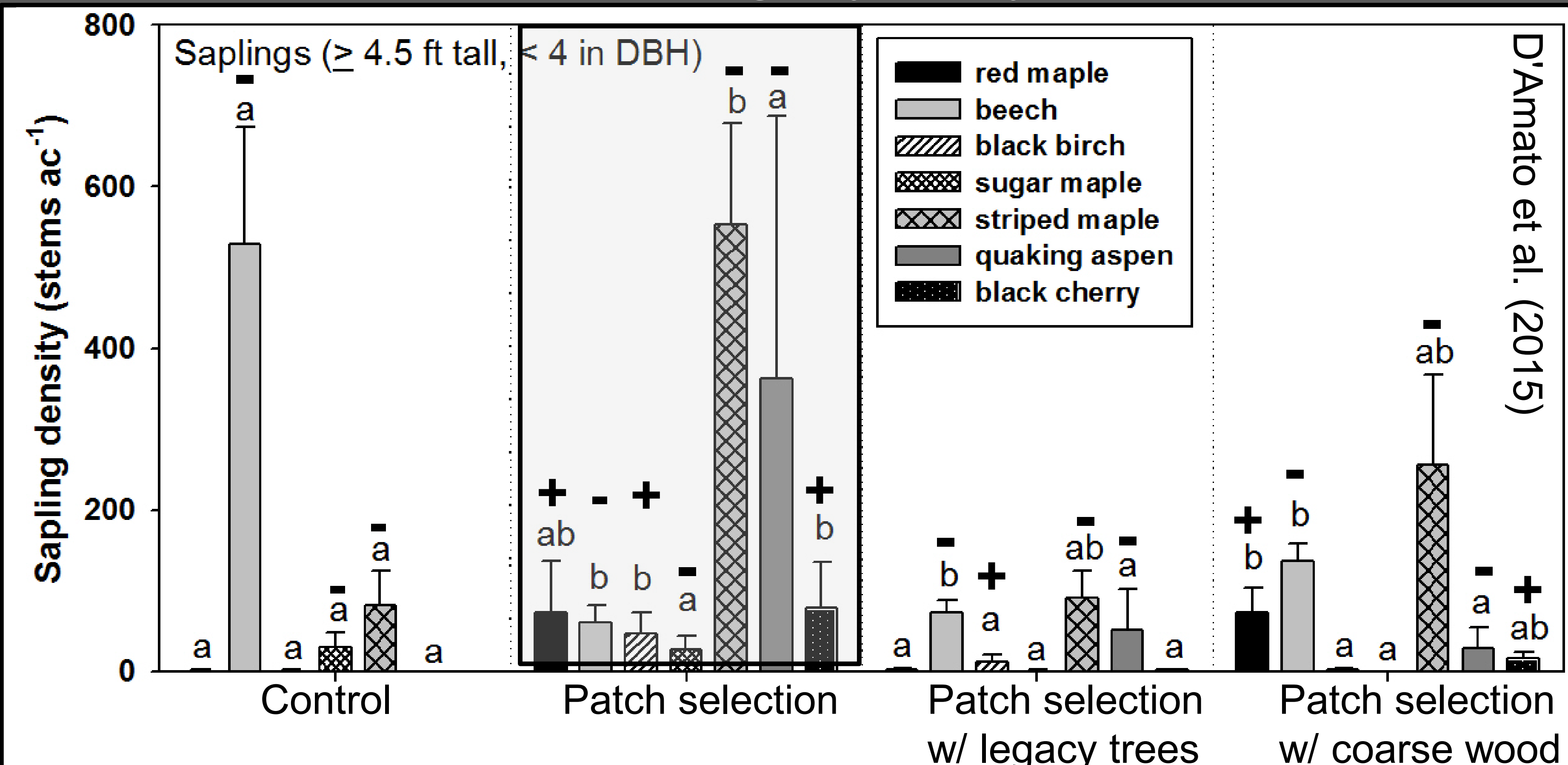
Future-adapted regeneration

Patch selection harvests in western MA (1/3 acre gaps)

Patch selection openings (all preexisting beech felled) with various levels of w/in gap structural retention

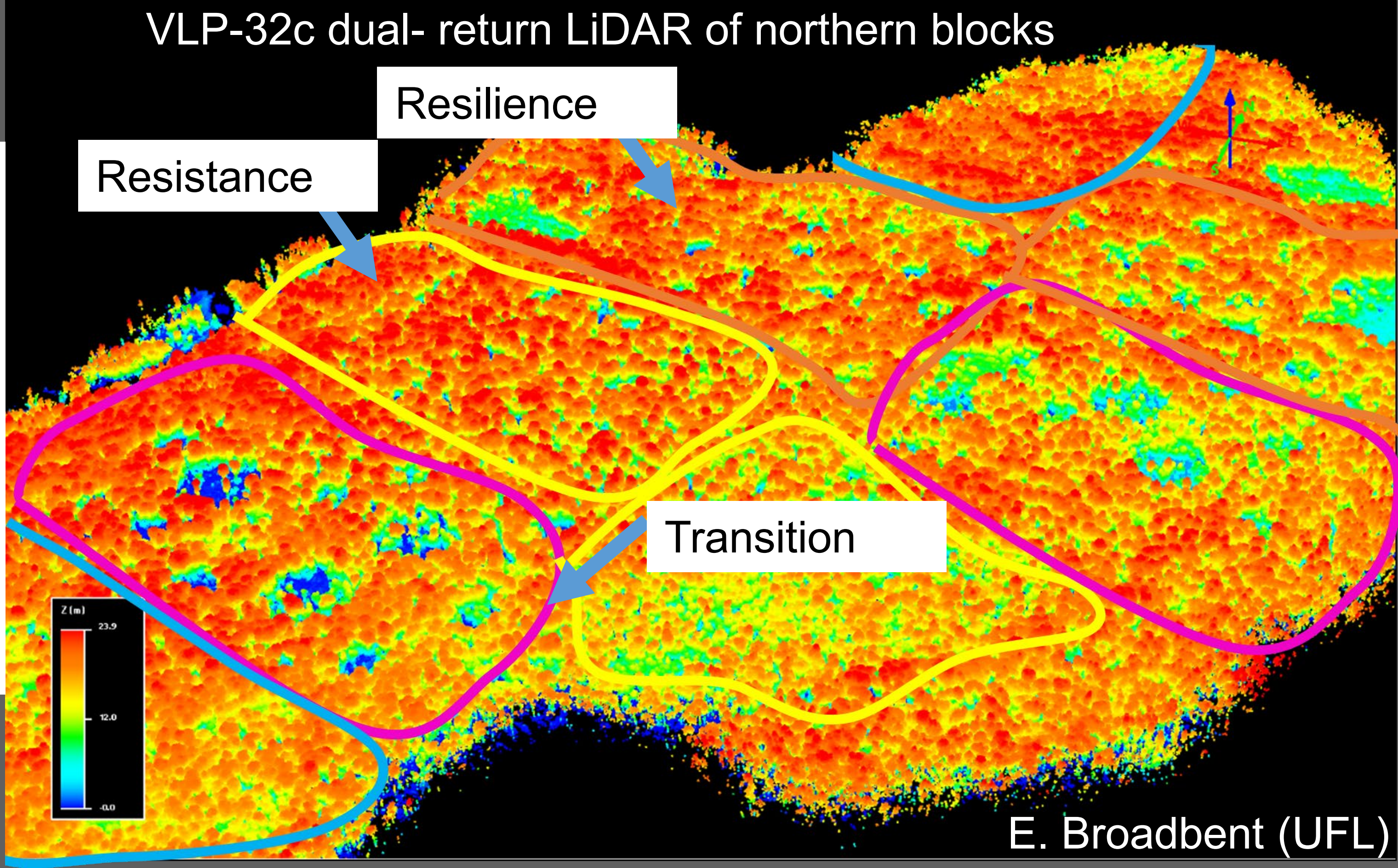
Future-adapted regeneration

Resilience profile of sapling layer 3 years post-treatment



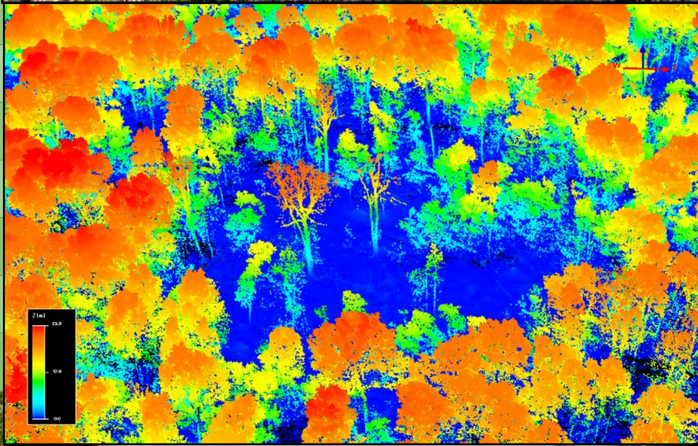
- Addressing beech competition and providing adequate light environment central to increasing future-adapted component (i.e., silviculture 101)

New England Adaptive Silviculture for Climate Change Dartmouth Second College Grant, NH

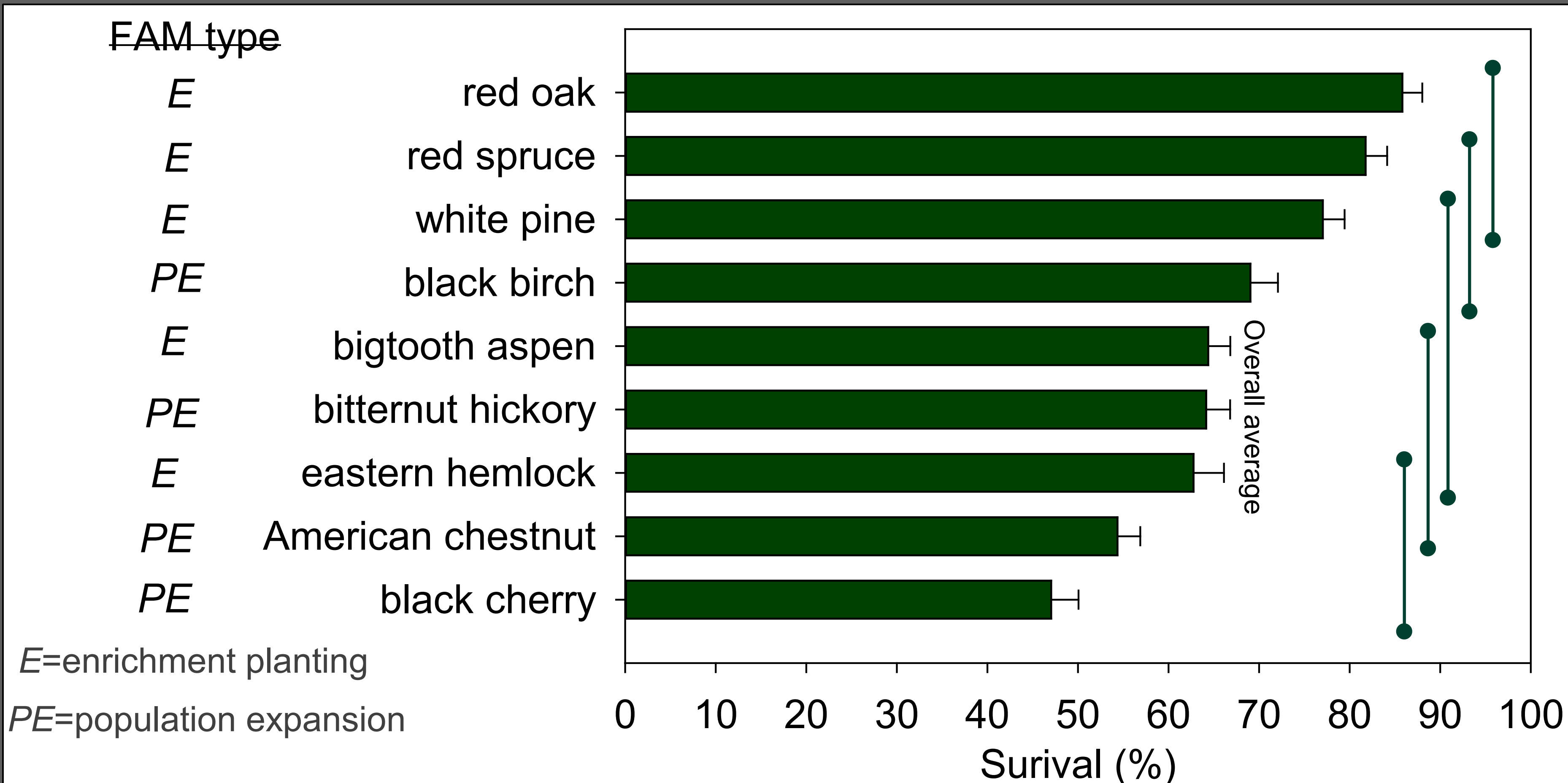


- 6500 bare-root seedlings planted at ASCC
- Planted *only in 1-acre gaps* as part *of* continuous cover irregular shelterwoods
- Species selected for functional redundancy

SPECIES	FUTURE HABITAT
Picea rubens	*Decrease
Tsuga canadensis	*Decrease
Pinus strobus	No Change
Populus grandidentata	No Change
B3F3 *Castanea dentata* (seed)	No Change
Carya cordiformis	**Increase**
Betula lenta	**Increase**
Prunus serotina	**Increase**
Quercus rubra	**Increase**

Planted seedling survival

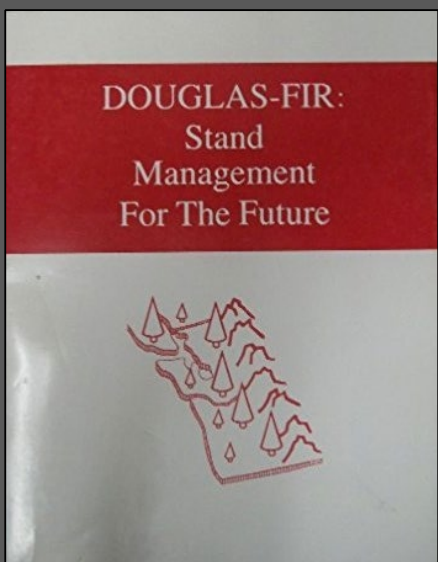


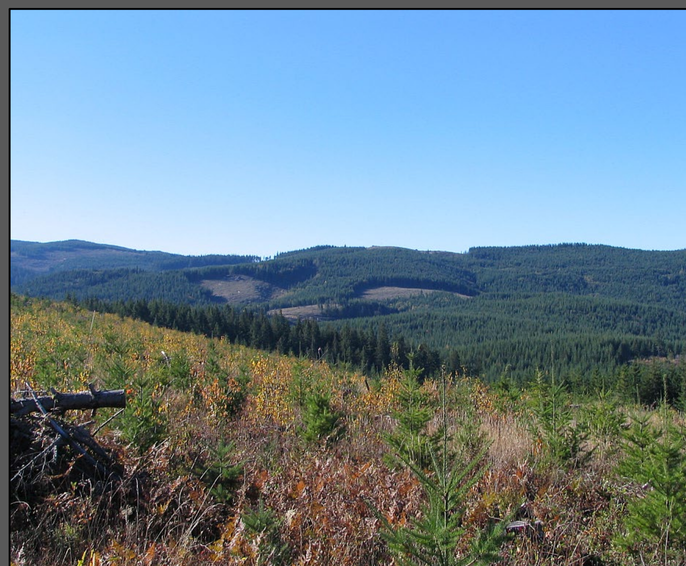
- Lower survival for seedlings representing assisted population expansion versus enrichment
- Lagged response may pose potential risk to planting today based on 100-year projections

Moving forward with adaptation

Building on the Era of Complexity

"There are even fewer absolutes in ecology than in forestry, but an emerging operating maxim is *Simplification is rarely beneficial*." (Franklin et al. 1986)





MODIFYING DOUGLAS-FIR MANAGEMENT REGIMES FOR NONTIMBER OBJECTIVES

Jerry F. Franklin, Thomas Spies, David Perry, Mark Harmon, and Arthur McKee

Building on the Era of Complexity

Revisiting two of several principles guiding our previous silvicultural "revolution"

1. **<u>Continuity</u>** - provision for continuity in forest structure, function, and biota between pre- and post-harvest (legacies, system "memory")
2. **<u>Complexity</u>** - create and maintain structural and compositional complexity and biological diversity through silvicultural treatments



(From Seymour and Hunter 1999, Franklin et al. 2007)

Building on the Era of Complexity

Ecological silviculture principles

Principle	Linkages with Uncertainty and Adaptation

Continuity	• Long-term options for regeneration and structure in face of uncertainty
	• Amelioration of harsh environmental conditions
	    • Regeneration safe sites (shaded understory, well-decomposed dead wood)
	    • Micro-refugia for sensitive taxa
	• Conservation of genetic diversity
	Palik et al. (in press)




Building on the Era of Complexity

Ecological silviculture principles

Principle	Linkages with Uncertainty and Adaptation

Complexity	• Reduced vulnerability to disturbance
	  • Spatial variability in fuels
	  • Heterogeneity in: 1) wind risk, 2) potential host species abundance, 3) within-species stress tolerance (tree size/age), 4) resource availability
	• Multiple recovery/developmental pathways
	  • Diversity of seed sources and reproductive mechanisms
	  • Heterogeneity in microsites for new species

Conclusions

- In many circumstances, adaptation will entail repackaging of silvicultural strategies with an eye towards increasing and maintain ecosystem heterogeneity
- Despite future change, understanding of past drivers and dynamics can still inform transition methods
  - Use of regeneration methods that maintain overstory trees during regeneration phase to keep options on site and ameliorate extremes
  - Build on decades of experience managing these systems, particularly with recent ecological approaches

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Northern RESEARCH STATION USDA Forest Service

NE CASC Northeast Climate Adaptation Science Center

NIACS Northern Institute of Applied Climate Science

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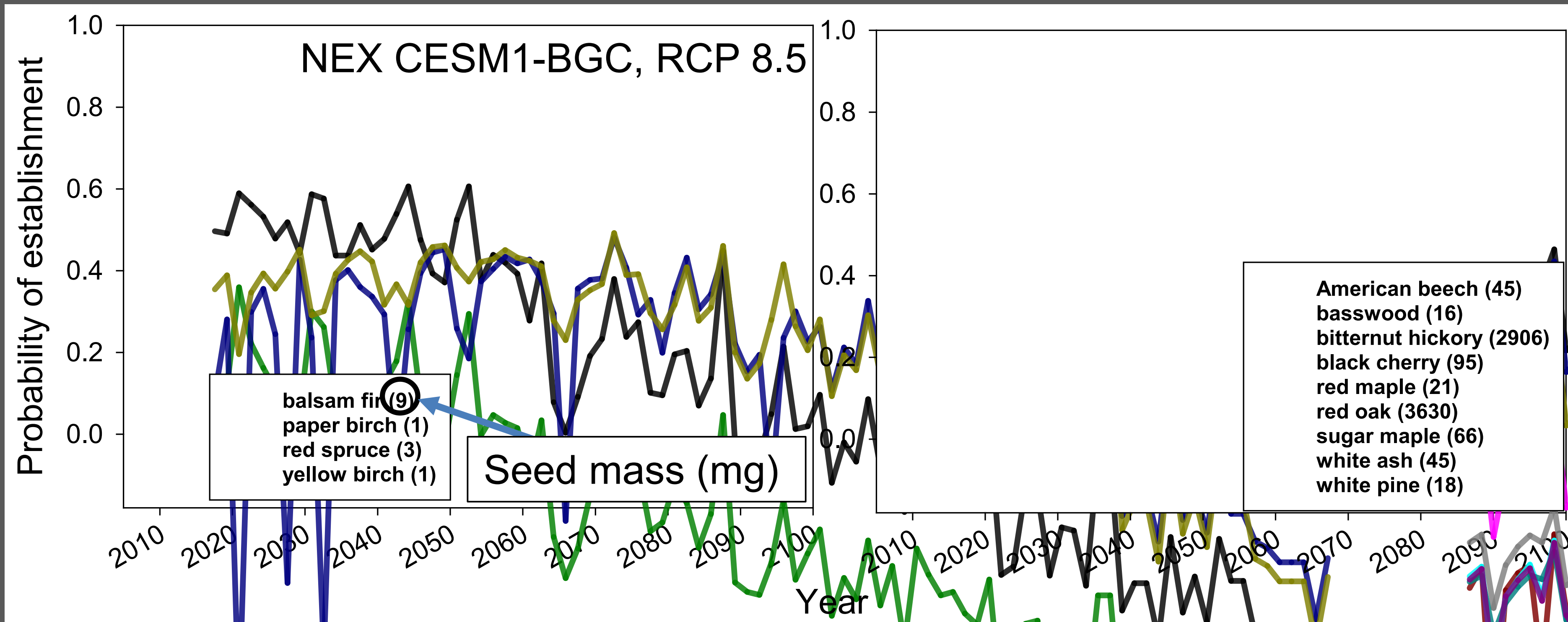
Compositional considerations

Future establishment of major tree species on the Green Mountain NF



Probability of seedling establishment predicted to:

- ***Decline*** for smaller-seeded species (paper birch, balsam fir, red spruce, and yellow birch)
- ***Increase*** for larger-seeded species (oak, hickory, beech, cherry)