Integrating assisted migration into adaptation strategies for northeastern forests

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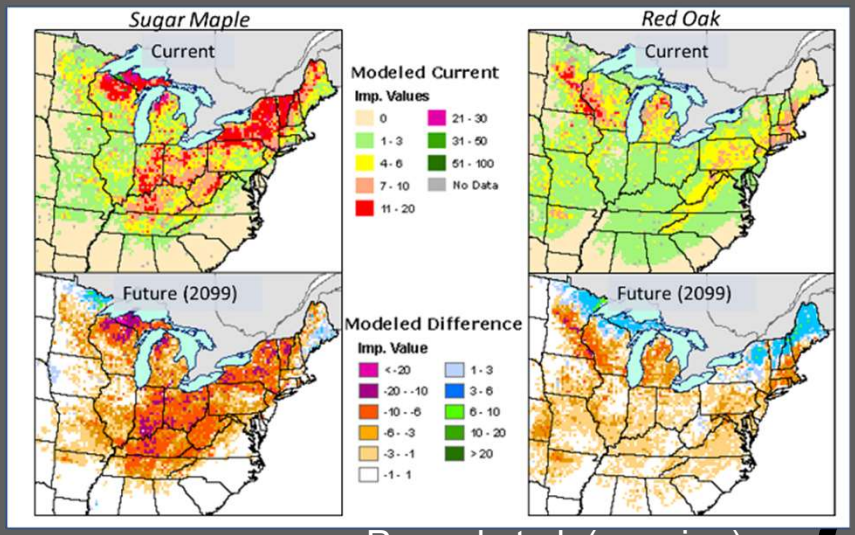
THE UNIVERSITY OF VERMONT FORESTRY

NE CASC Northeast Climate Adaptation Science Center

ASCC Adaptive Silviculture for Climate Change

Dartmouth

Context for Assisted Migration



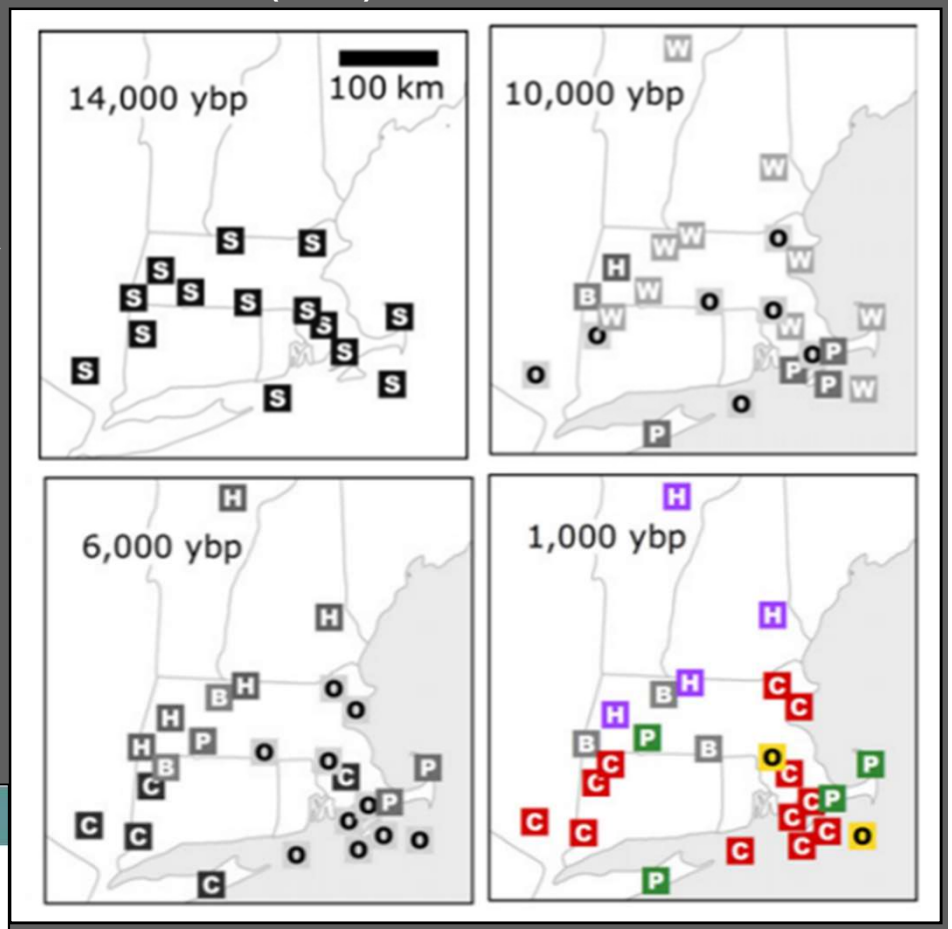
Prasad et al. (ongoing)

Context for Assisted Migration

Novel migration dynamics

- Dispersal of tree species during Holocene period estimated at 0.1-0.3 miles/year
- Climate regimes are currently shifting ~4-6 miles/year
- Inability for species to track climate will generate significant lags in natural migration

Oswald et al. (2017)



Global Change Biology

Global Change Biology (2012) **18**, 1042–1052, doi: 10.1111/j.1365-2486.2011.02571.x

Failure to migrate: lack of tree range expansion in response to climate change

KAI ZHU*, CHRISTOPHER W. WOODALL† and JAMES S. CLARK*‡

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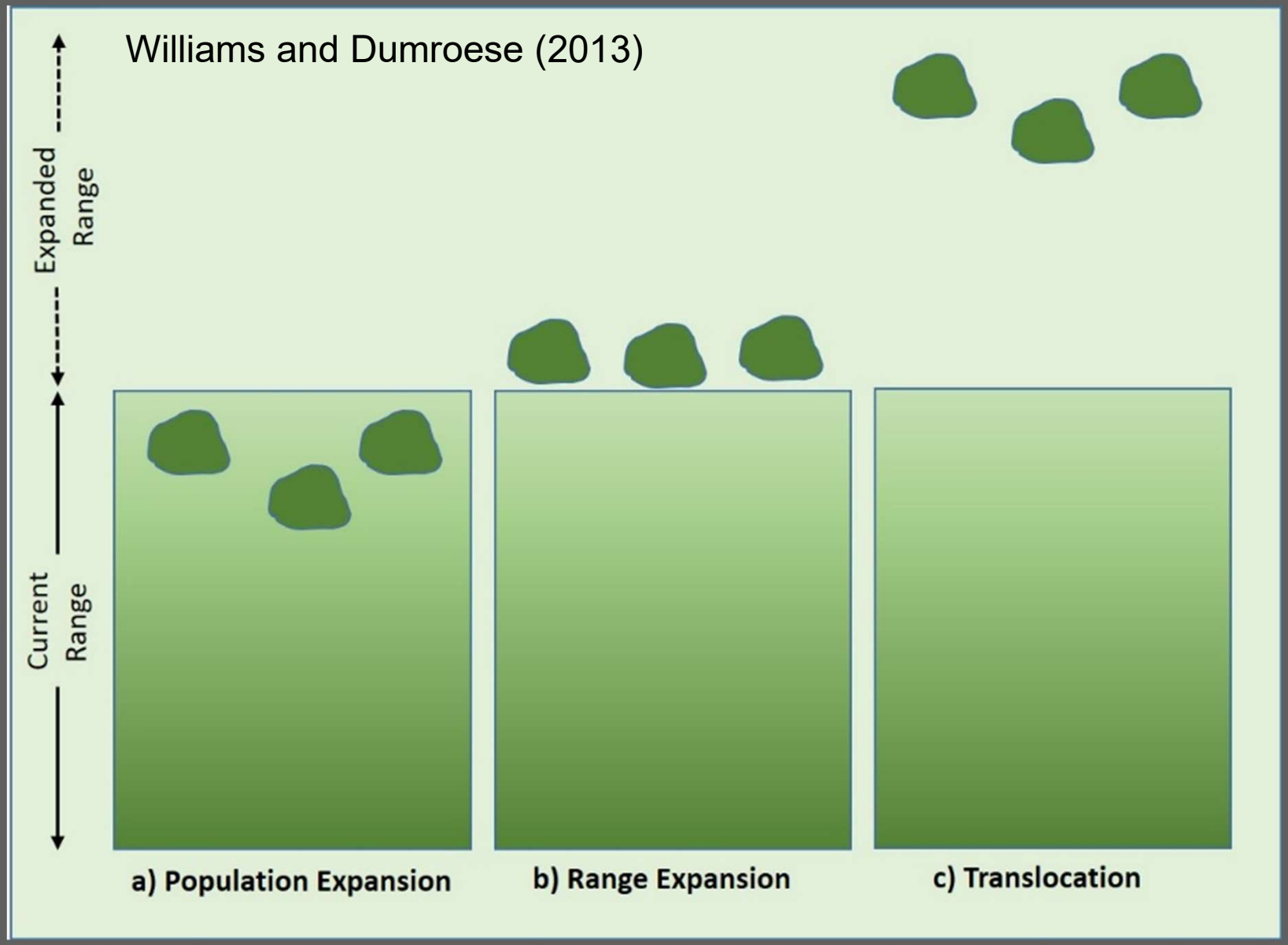
Types of Assisted Migration in Forestry

- **Assisted population expansion**- movement of species or genotypes relatively short distances, with the expansion occurring contiguously within the current distribution
- **Assisted range expansion**-movement of populations to locations adjacent to the species range; from areas where the current climate is similar to the projected climate of the new location.
- **Translocation of exotics**-interregional, transcontinental, or even intercontinental movement of a species well outside its current range

From: Leech et al. 2011; Williams and Dumroese 2013

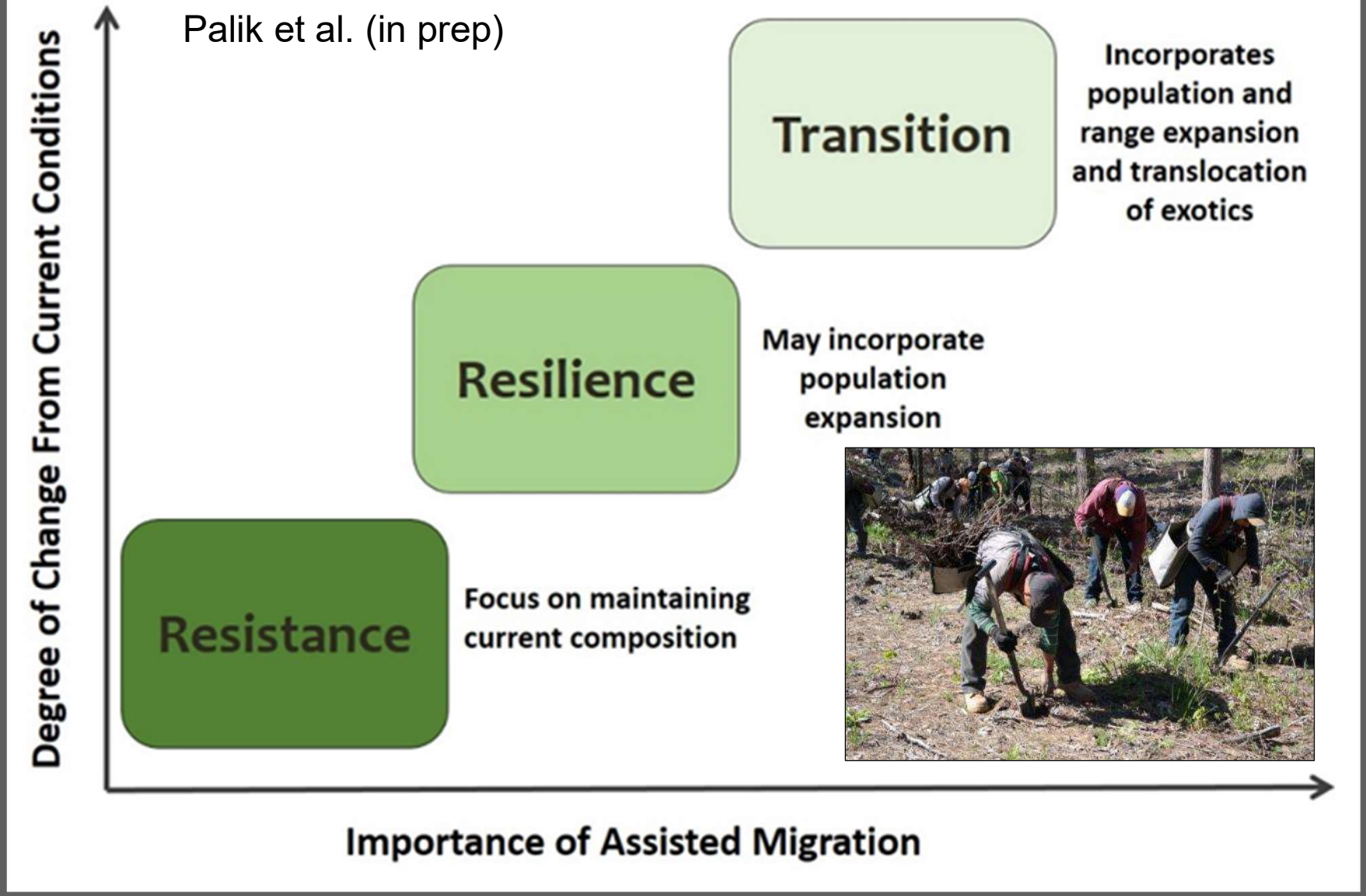
Types of Assisted Migration in Forestry



Types of Assisted Migration in Forestry

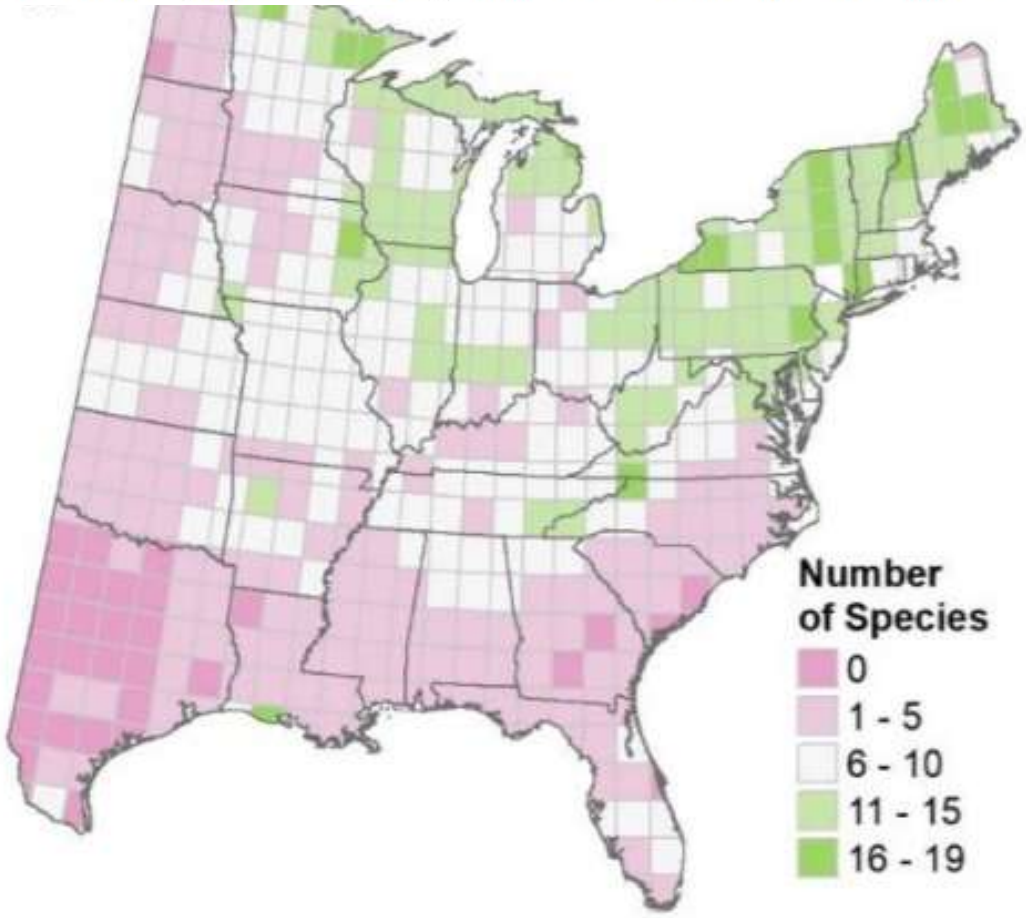
Assisted migration in the context of adaptation

Palik et al. (in prep)



Facilitating Adaptive Forest Management under Climate Change: A Spatially Specific Synthesis of 125 Species for Habitat Changes and Assisted Migration over the Eastern United States

Louis R. Iverson [1,*], Anantha M. Prasad [1], Matthew P. Peters [1] and Stephen N. Matthews [1,2]



Iverson et al. 2019

Figure 7. (**A**) The number of species that may potentially migrate into each 1 × 1 degree cell (from elsewhere), within 100 years across the eastern US (Migrate+ plus Migrate++), under RCP 8.5.

Image: Ali Hall

https://www.fs.fed.us/nrs/atlas/combined/resources/summaries/

Integrating Assisted Migration

The problem…

- Current overstory trees in northeastern US are not going away anytime soon
  - Adaptation approaches, including assisted migration, need to focus on silvicultural treatments consistent with functioning of current forest systems and that build on prevailing management cultures

Integrating Assisted Migration

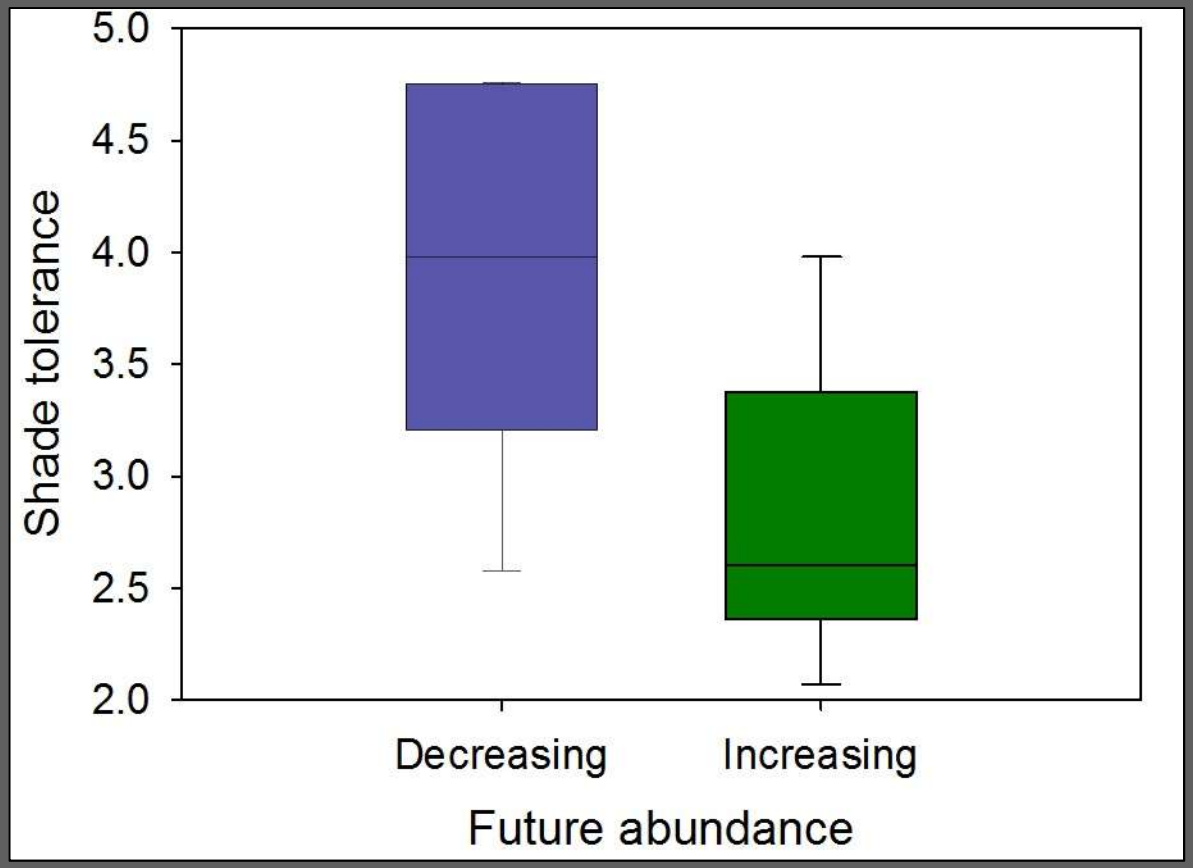
Projected changes in suitable habitat by 2100 (Tree Atlas New England-wide summary, Janowiak et al. 2018)

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

Integrating Assisted Migration

Shade tolerance: decreasing vs. increasing species



- Much of our silviculture in northern hardwoods has focused on favoring silvics of what is projected to decline (tolerants)
- Key question is how to work with current systems to encourage future adapted component through natural and artificial means?

Integrating Assisted Migration

How did species of lower shade tolerance recruit?



Translating meso-scale disturbance into irregular shelterwood systems (Raymond et al. 2009)

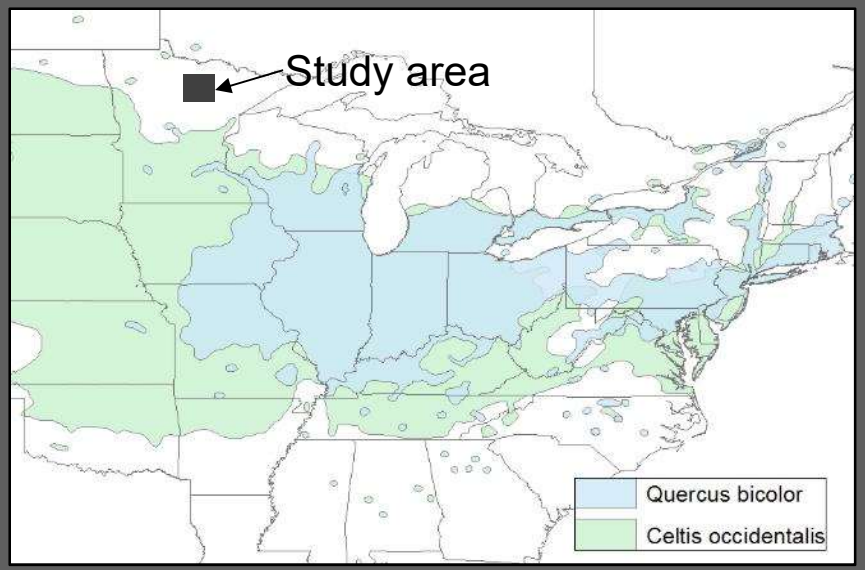

Matching Dynamics with Assisted Migration

Matching Dynamics with Assisted Migration

Evaluating non-host regeneration options

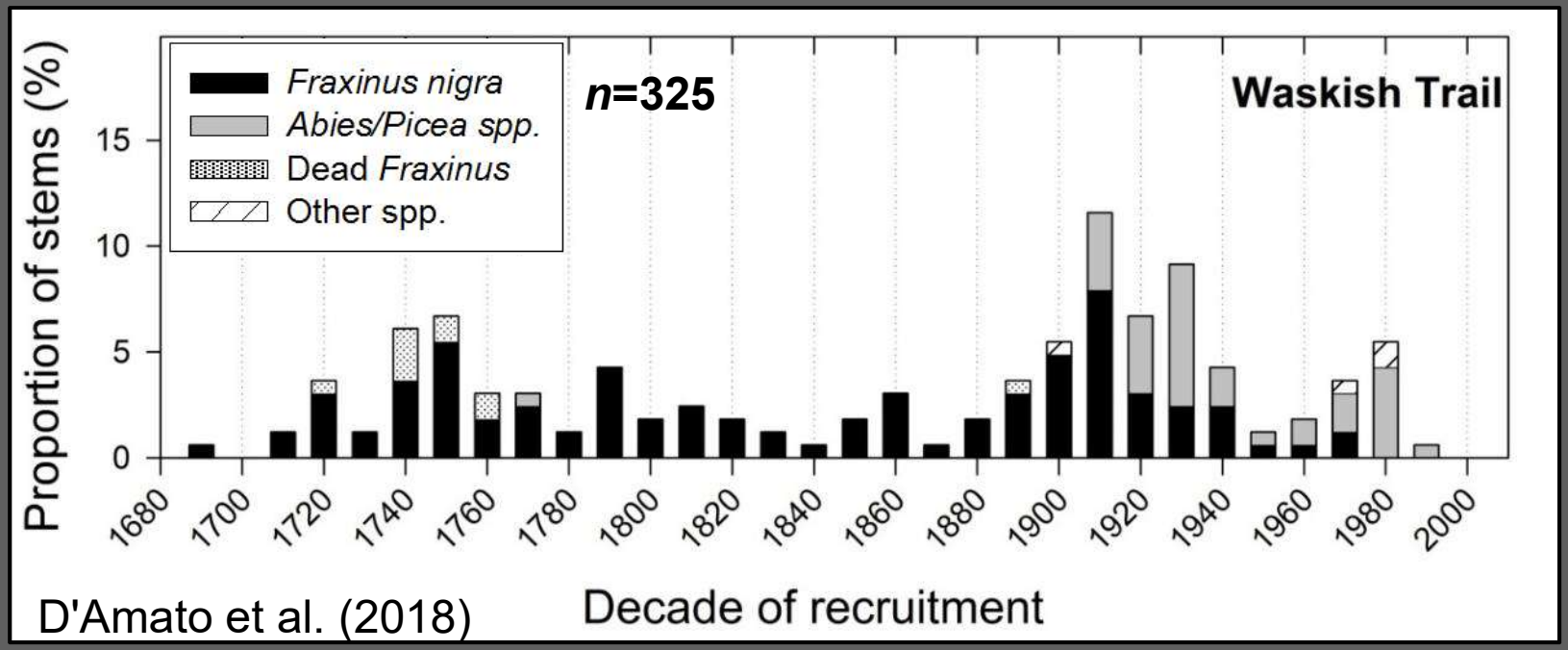
- **Most present in regional ecosystem:**
  - **Red Maple*, Yellow Birch*, Eastern Larch, Eastern Cottonwood*, Black Spruce, Balsam Poplar, Quaking Aspen, White Cedar, American Elm***
- **Two from the next southern climate zone:**
  - **Hackberry*, Swamp White Oak***
- **One exotic:**
  - **Manchurian Ash***
  - **Northeast Asia & Japan, EAB-resistant, potential basket material**

** **Future adapted: climate and EAB***



Matching Dynamics with Assisted Migration

- **Natural recruitment dynamics of old-growth black ash**



D'Amato et al. (2018)

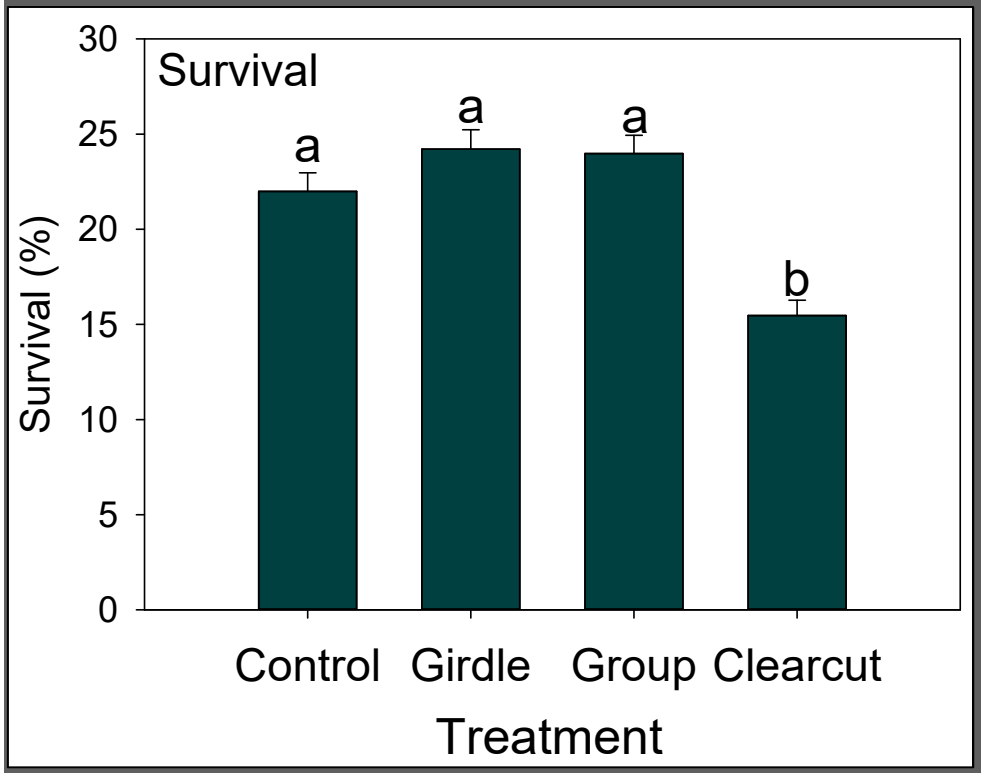
- Strongly uneven-aged systems with recruitment peaks reflective of drought periods and canopy disturbance
  - Overstory **present** during regeneration events




Matching Dynamics with Assisted Migration

Matching Dynamics with Assisted Migration

Survival of planted seedlings (six years)

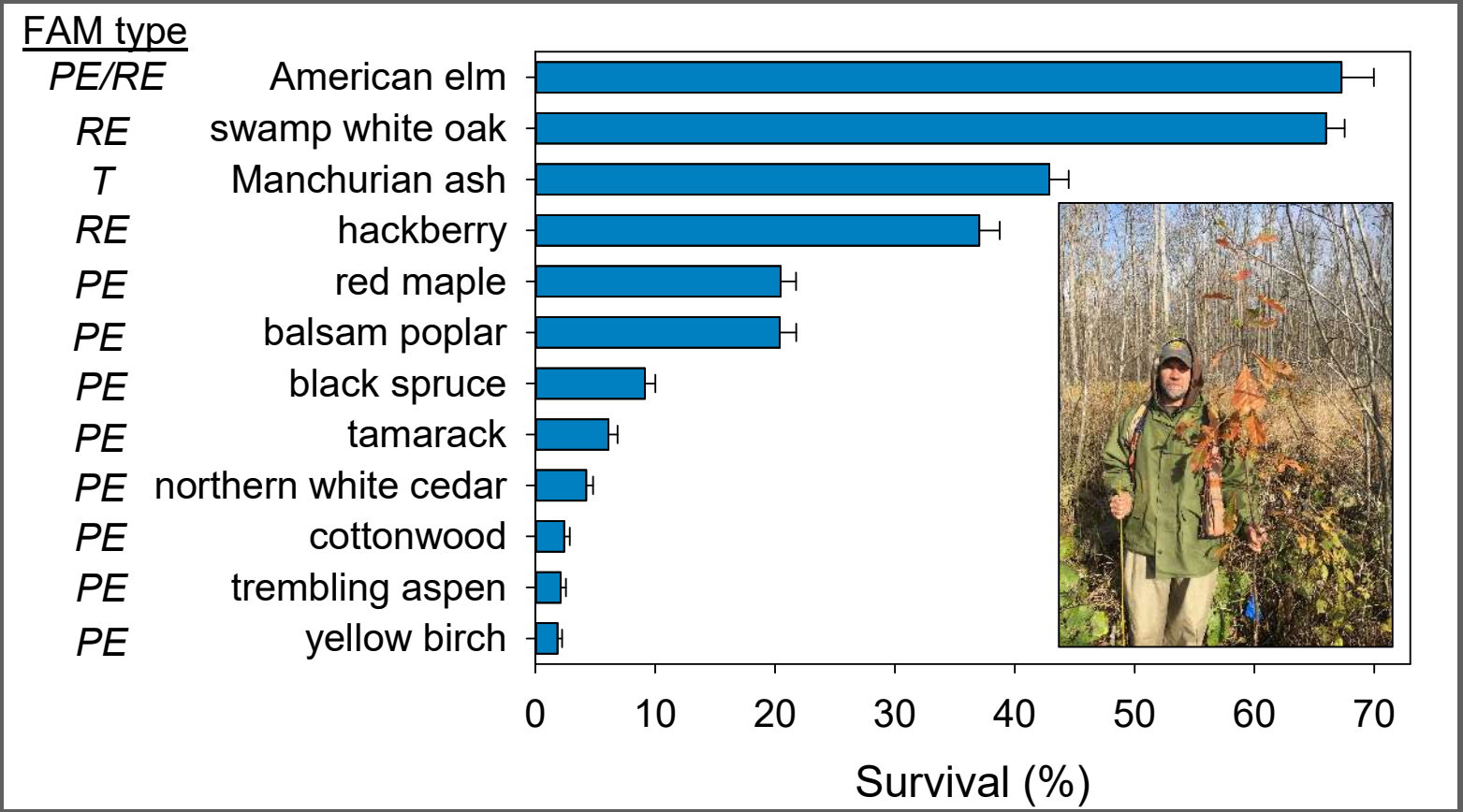


- Survival lowest in clearcut vs other treatments regardless of planting season
  - No natural analog
- Survival similar for planting in control, group selection, and girdle

➢ Despite novel, emerging threat, current ecosystem dynamics still matter for designing adaptation silviculture

Matching Dynamics with Assisted Migration

Survival of planted seedlings (six years)



- Survival highest for non-native, pathologically-limited, or out-of-range species
- Survival lowest for commonly occurring, native species
  - ➢ Integrating assisted migration is providing promising adaptation options not historically considered

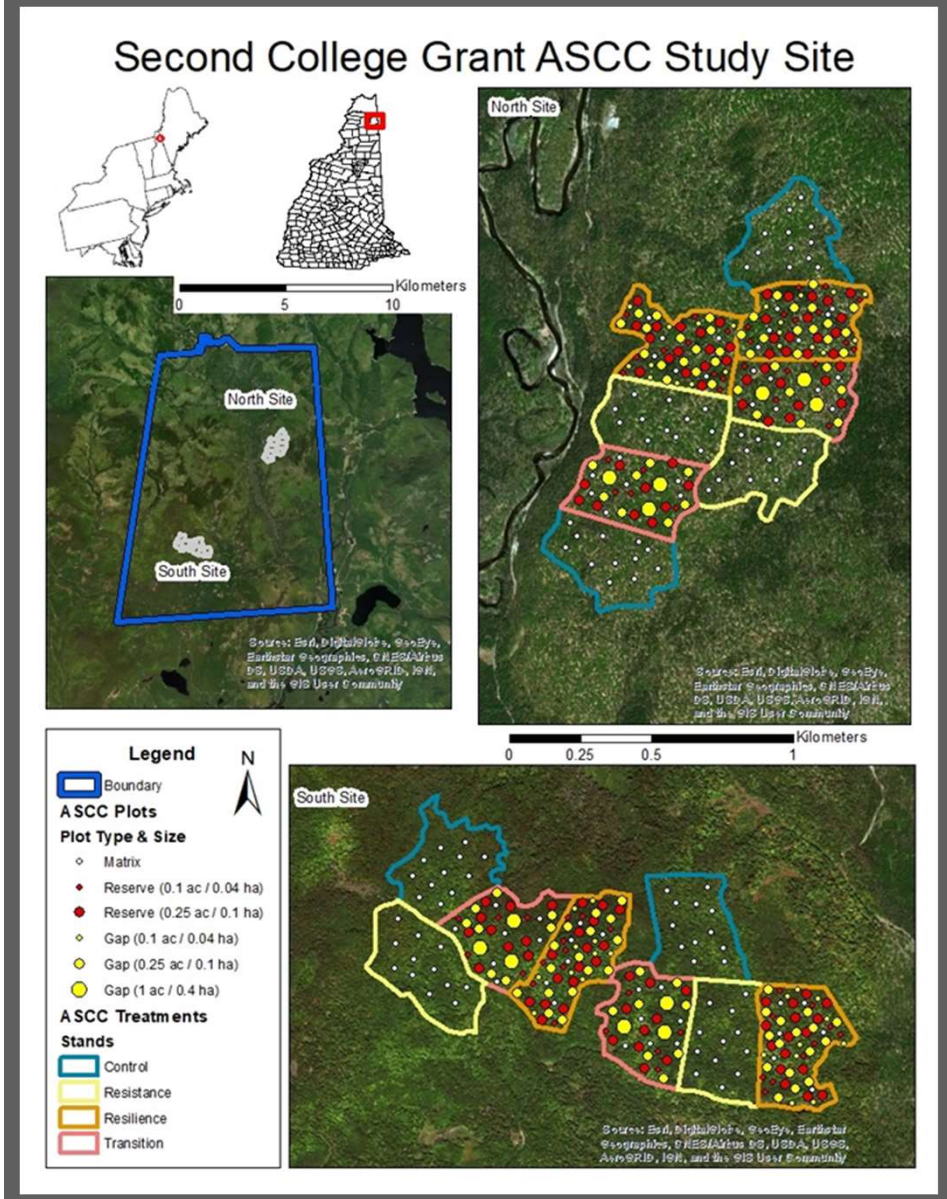
Operationalizing assisted migration

Adaptive Silviculture for Climate Change

Co-produced, multi-region study of adaptation designed using input from local managers and regional scientists

- Replicated, operational examples of integration of climate adaptation into on-the-ground actions that can foster resilience and enable adaptation to uncertain futures

New England ASCC Installation



Dartmouth College Second College Grant, NH

Second College Grant

- 27,000 ac property owned and managed by Dartmouth College since 1807
- Dominated by northern hardwoods and mixedwoods
- ASCC study codeveloped in 2016
- Largest, replicated forestry experiment in northeast US

Adaptation Treatments

Treatments (including c

Resistance

Single-tree selection
70-80 ft^2/ac
Multi-cohort structure
↑ <u>downed dead wood</u>
Favor beech bark disease and ice resistant residual stems

-Increased resource availability to residual trees
-Maintenance of multi-cohort condition, with SM dominance

-Increase downed logs to minimize impacts of hydrologic extremes (downpours/drought)

-Marking priority to favor disease resistant individuals
-Crown forms & species (yellow birch) resistant to ice damage

Adaptation Treatments

Treatments (including controls) replicated 4 time

Resistance	Resilience
Single-tree selection 70-80 ft^2/ac Multi-cohort structure ↑ downed dead wood Favor beech bark disease and ice resistant residual stems	Group selection and single-tree selection 20% gaps 0.1-0.25 ac / **20% reserves** / matrix of 70-80 ft^2/ac Multiple pathways ↑ downed dead wood ↑ wind and ice resistant species

-Increased heterogeneity in resources & structure via canopy gaps, reserve patches, & single-tree removals
-Multiple response pathways

-Increase representation of ice, drought, & wind resistant spp. (yellow birch, red maple, red spruce) in harvest gaps

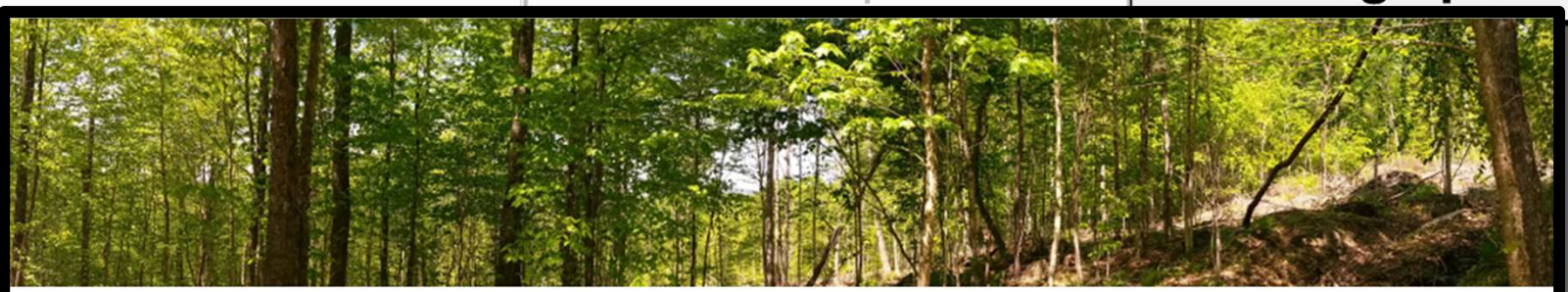
Adaptation Treatments

Trea[illegible] 4 times in 10-ha replicates

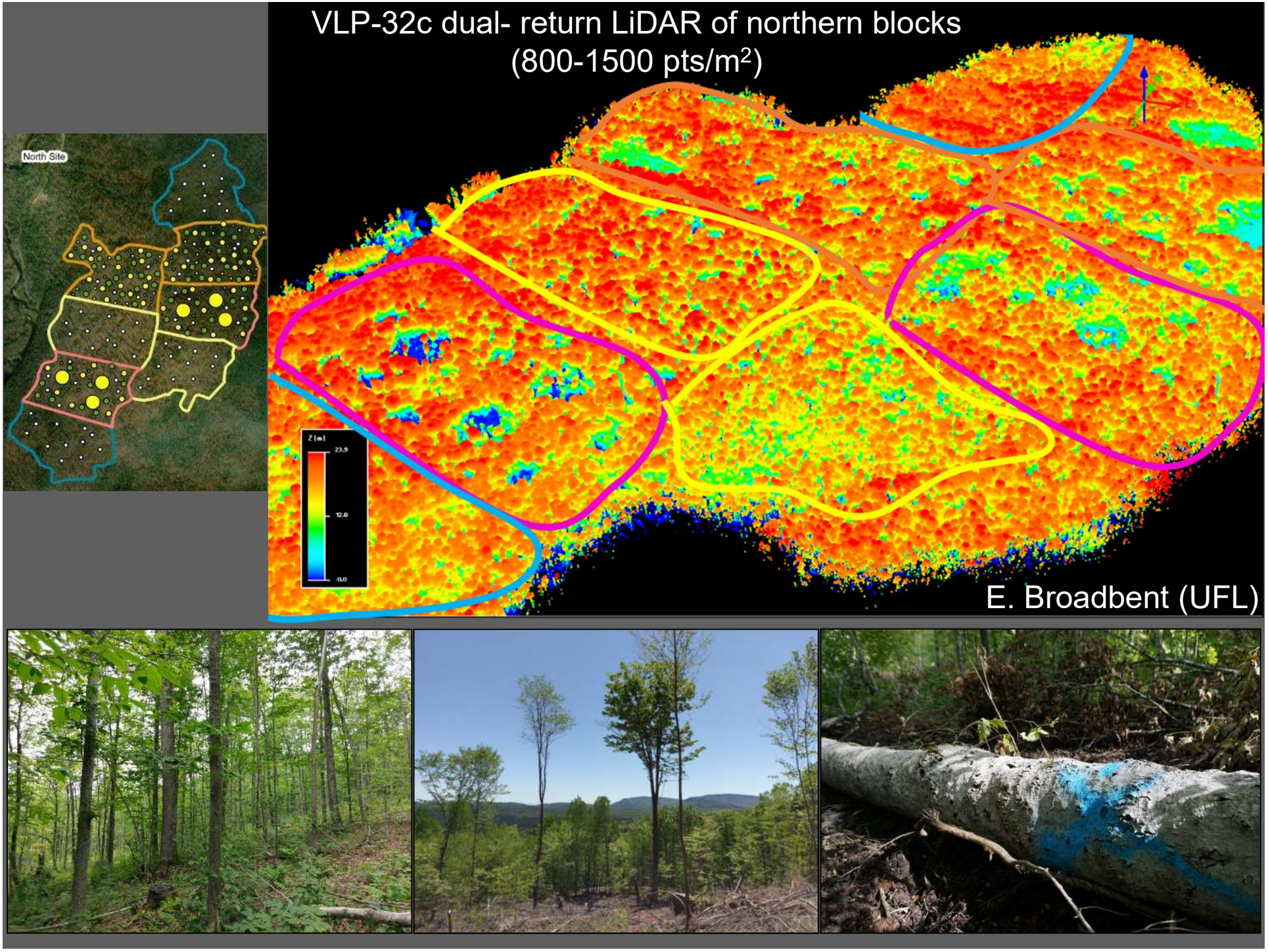
-Increase representation of future-adapted species via planting in large gaps
-Within-gap retention of reserves representing key ecological & adaptation functions (beech, red maple, yellow birch, red spruce)

Transition

Continuous cover irregular shelterwood
20% gaps 0.25-1.0 ac
10-20% reserves / matrix 70-80 ft^2/ac
↑ **future-adapted component through planting**

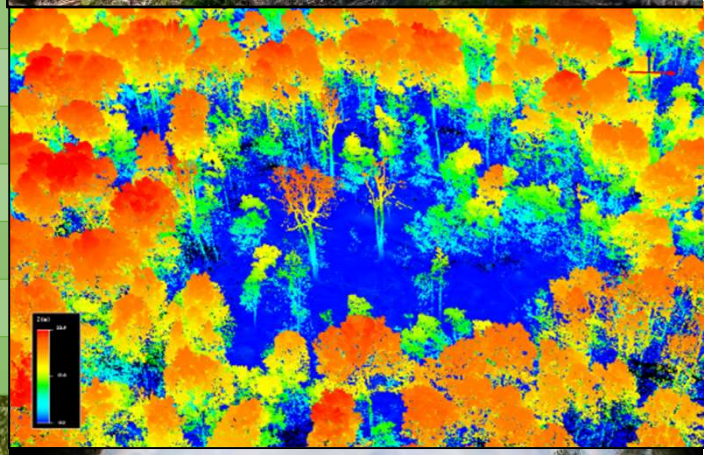


-Continuous cover irregular shelterwood (variable density thinning) to create heterogeneity, maintain multicohort structure, & provide recruitment opportunity for less tolerant species

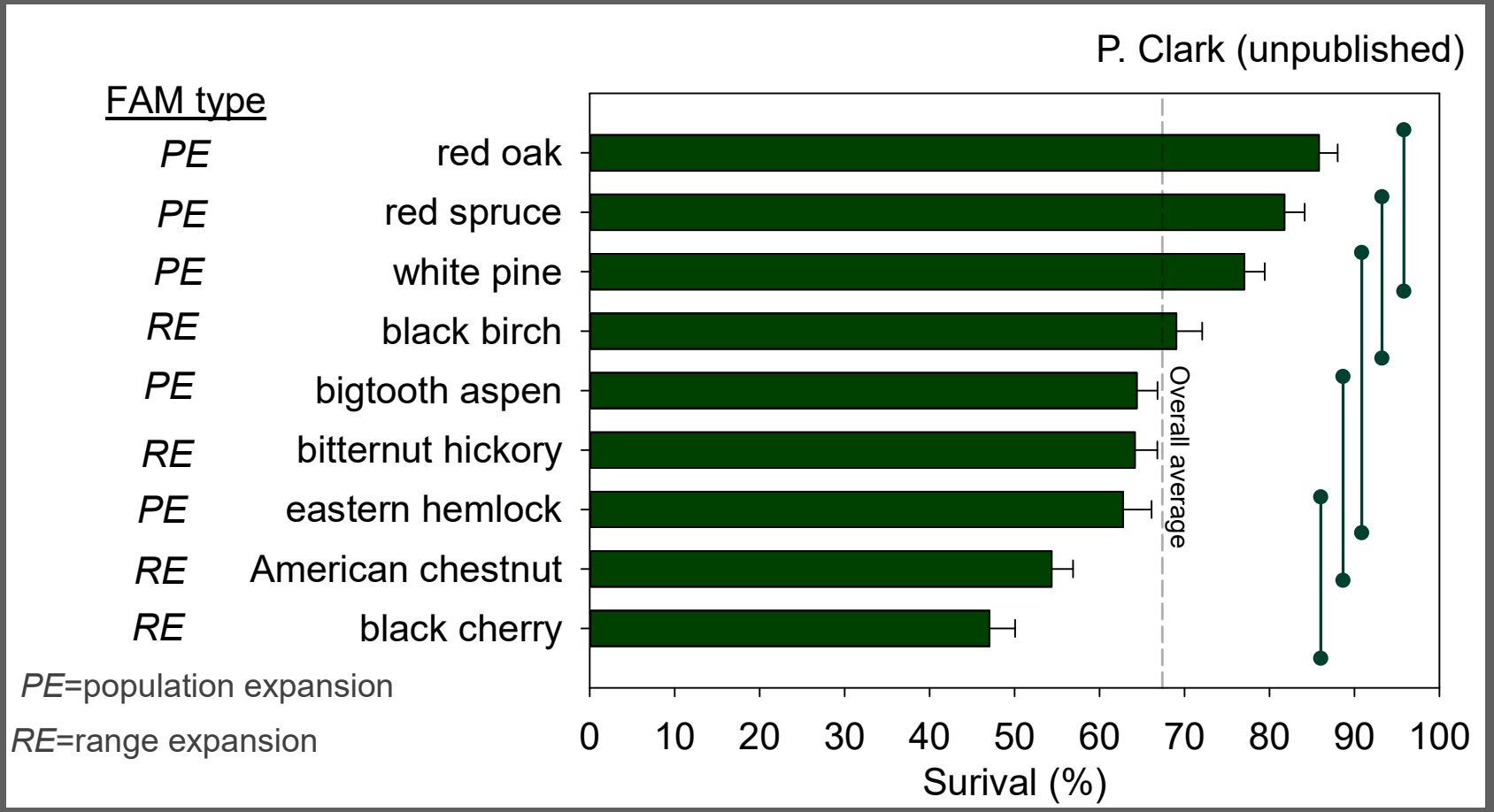

VLP-32c dual- return LiDAR of northern blocks
(800-1500 pts/m2)
North Site
Z (m)
23.9
12.0
0.0
E. Broadbent (UFL)

- 6500 bare-root seedlings planted at ASCC
- Planted *only in gaps* within Transition
- Species selected for functional redundancy
- Operational context, not provenance trial

SPECIES	FUTURE HABITAT
Red spruce	*Decrease
Eastern hemlock	*Decrease
Eastern white pine	No Change
Big-tooth aspen	No Change
B3F3 American chestnut (seed)	No Change
Bitternut hickory	**Increase**
Black birch	**Increase**
Black cherry	**Increase**
Red oak	**Increase**



Planted seedling survival



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

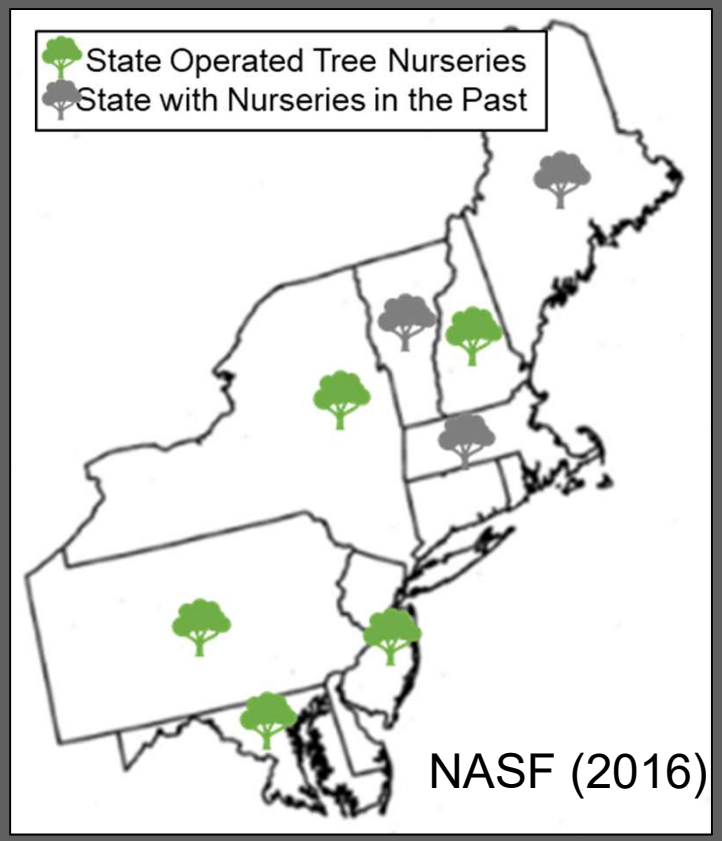
Challenges to operationalizing AM

- Ideal approach would match future seed zones within species using tools like the Seedlot Selection Tool: https://seedlotselectiontool.org/sst/

Example for selecting seedlots that would match climate in 2055 and 2085 on Green Mountain National Forest, VT

Challenges to operationalizing AM

- The Challenge:
  - Very limited capacity for growing seedlings for assisted migration in northeastern US (north of border is different story)
  - Limited opportunity for matching future seed zones



Species and seed sources for NH ASCC site

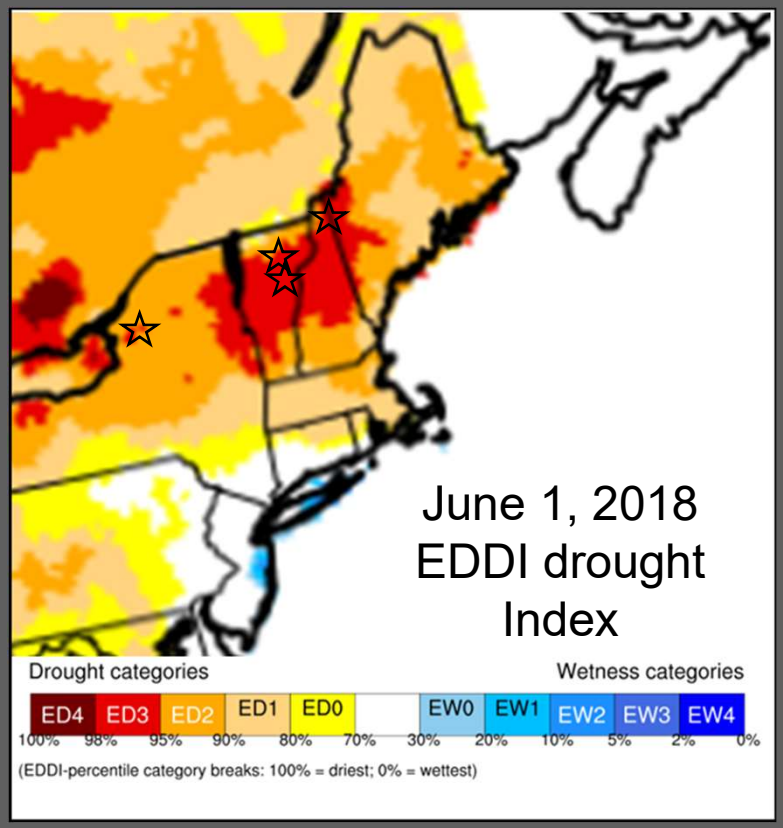
Species	Nursery	Seed Source
aspen	Alpha (MI)	Michigan
bitternut hickory	Alpha (MI)	Illinois
black birch	Alpha (MI)	commercial source
black cherry	Alpha (MI)	Pennsylvania
Chestnut	Amer. Chest. Fdn	B3F3 (Graves/Clapper)
hemlock	Alpha (MI)	Michigan
red oak	NH State	New Hampshire
red spruce	Alpha (MI)	NE US / Nova Scotia
white pine	NH State	New Hampshire

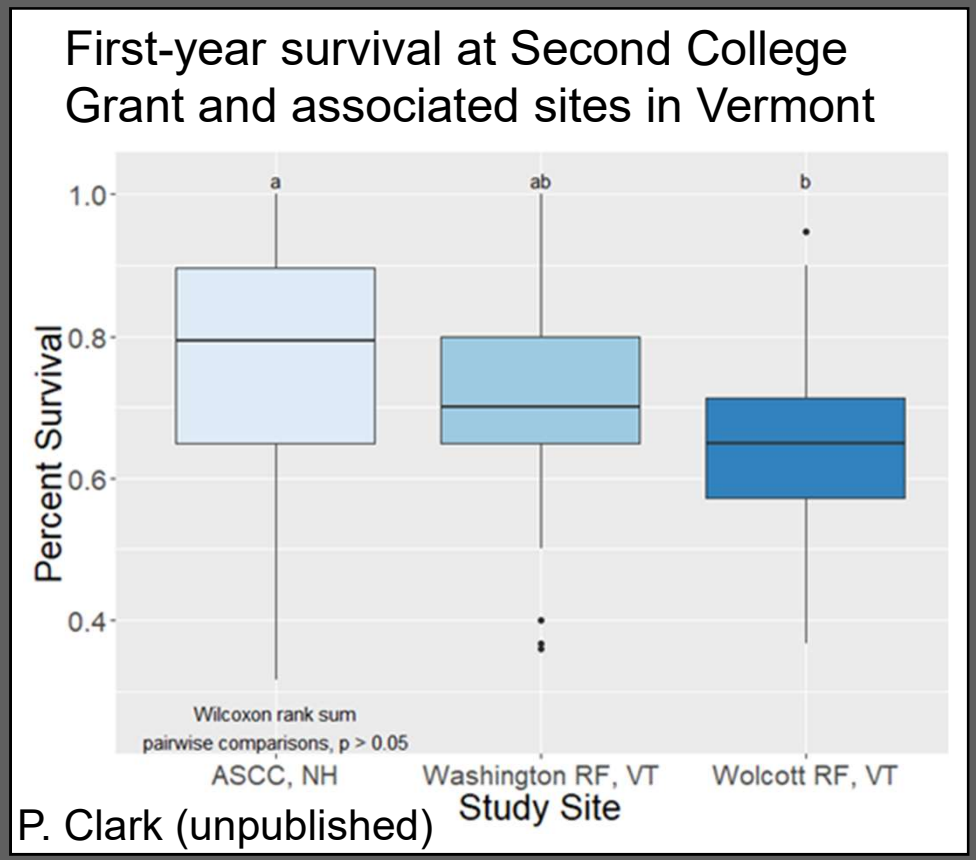
Challenges to operationalizing AM

- Planting is extremely minor component of current silvicultural activities
  - Lack of infrastructure, funds, and expertise

Challenges to operationalizing AM

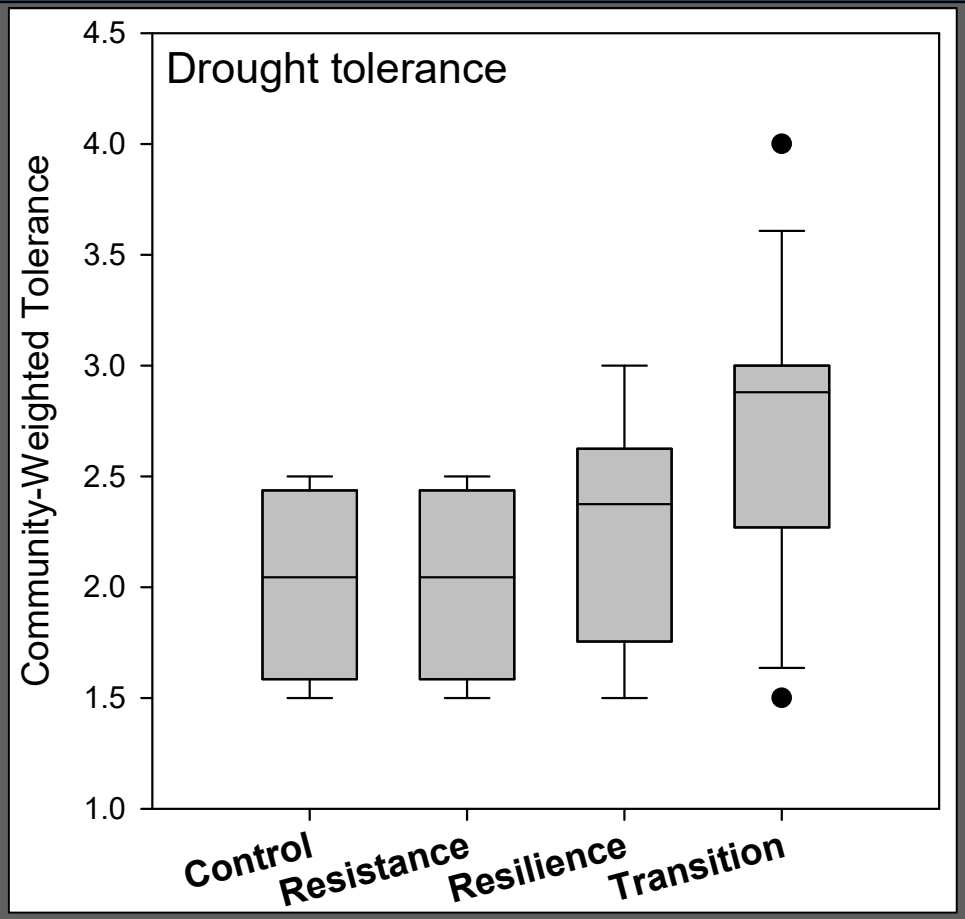
- Unpredictability of climate change complicates planning for assisted migration (e.g., spring 2018)





- ASCC site received measurable rainfall 1-5 days post planting, VT sites did not receive rain for up to 15 days post planting
- Similar low survival on TNC Tug Hill, NY adaptation planting in 2018

Challenges to operationalizing AM

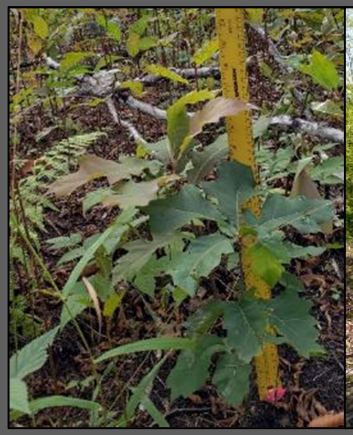


- Future-adapted planting provides functional response not represented in natural regeneration on site

The risks could be worth it, but maintaining all options is critical!

Conclusions

- Assisted migration represents important tool in collection of tactics for addressing global change impacts
- Despite future focus, strategies need to build from and account for underlying dynamics and silviculture for a given system
- Northeast currently lacks capacity and expertise for wide scale operationalization of assisted migration, but localized integration with other tactics may be critical risk worth taking
- Opportunity for visiting the NH ASCC site: 30th Annual Coos Foresters Mud Season Breakfast, May 15



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Northern Research Station
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NE CASC
Northeast Climate Adaptation Science Center

USDA NIFA
United States Department of Agriculture
National Institute of Food and Agriculture

The University of Vermont

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