

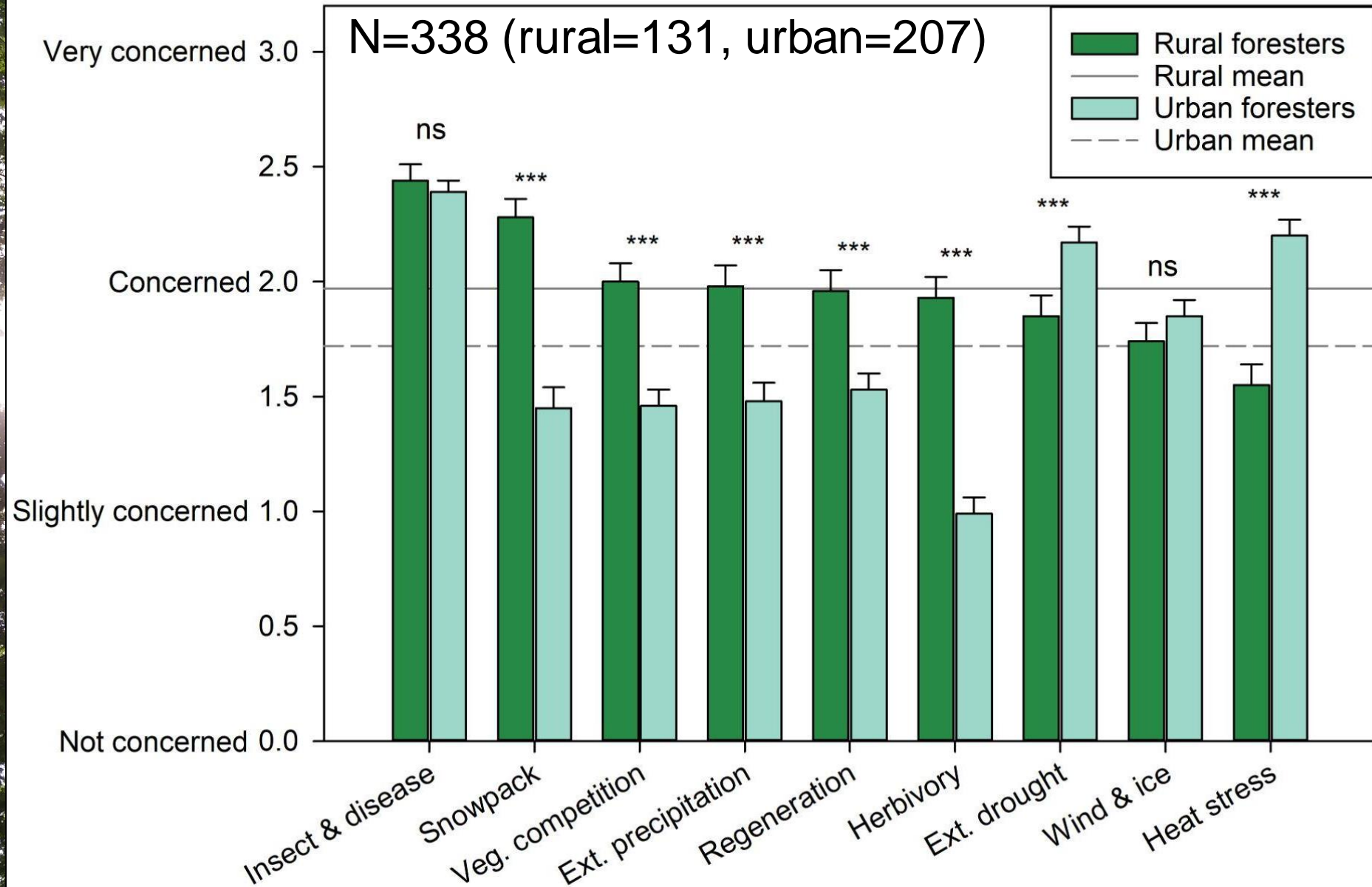
Implementing forest adaptation options for Northern Forest ecosystems



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NE US forester's concerns about global change



Schattman et al. (in review)

Project Goals and Objectives



- **Goal:** Increase application of adaptation strategies that confer resilience to climate change and associated invasive pest and disease impacts.
- **Objectives:**
 - 1) Evaluate outcomes and effectiveness of already implemented adaptation strategies
 - 2) Co-produce, site-tailored best adaptation practices with resource managers for addressing climate change and invasive species impacts



Project Team



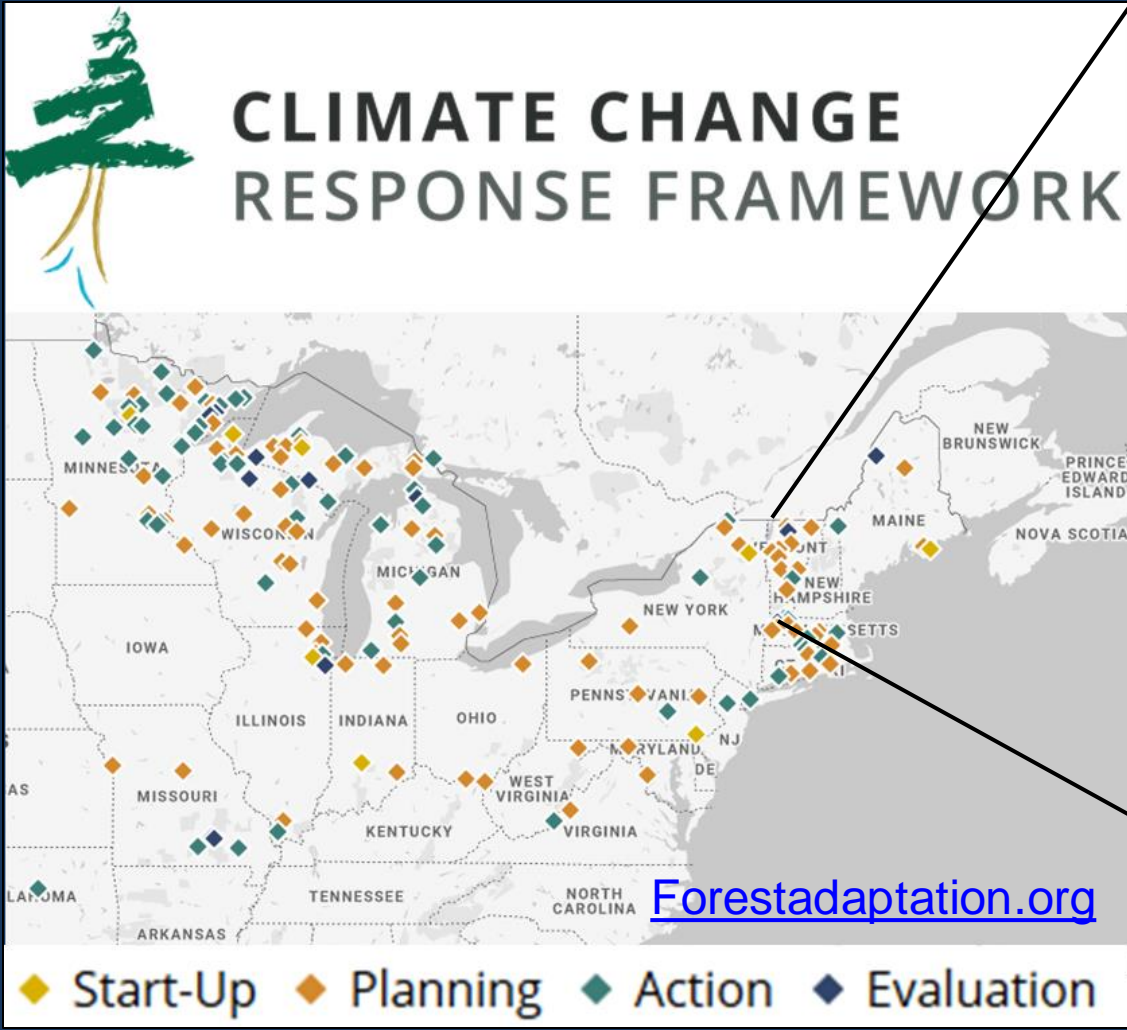
- **Maria Janowiak, Danielle Shannon**, USDA Forest Service Northern Research Station Northern Institute of Applied Climate Science
- **Sam Myers, Ali Kosiba, Tripp Whiting, Peter Clark, Grace Smith**, University of Vermont
- **Amanda Mahaffey, Erika Rowland**, Forest Stewards Guild
- **Kevin Evans**, Dartmouth College Woodlands
- **Sean Ross**, Lyme Timber
- **Ethan Crumley**, Vermont Forests, Parks and Recreation
- **Jeremy Goetz**, US Fish and Wildlife Service
- **Chris Zimmerman**, The Nature Conservancy-New York



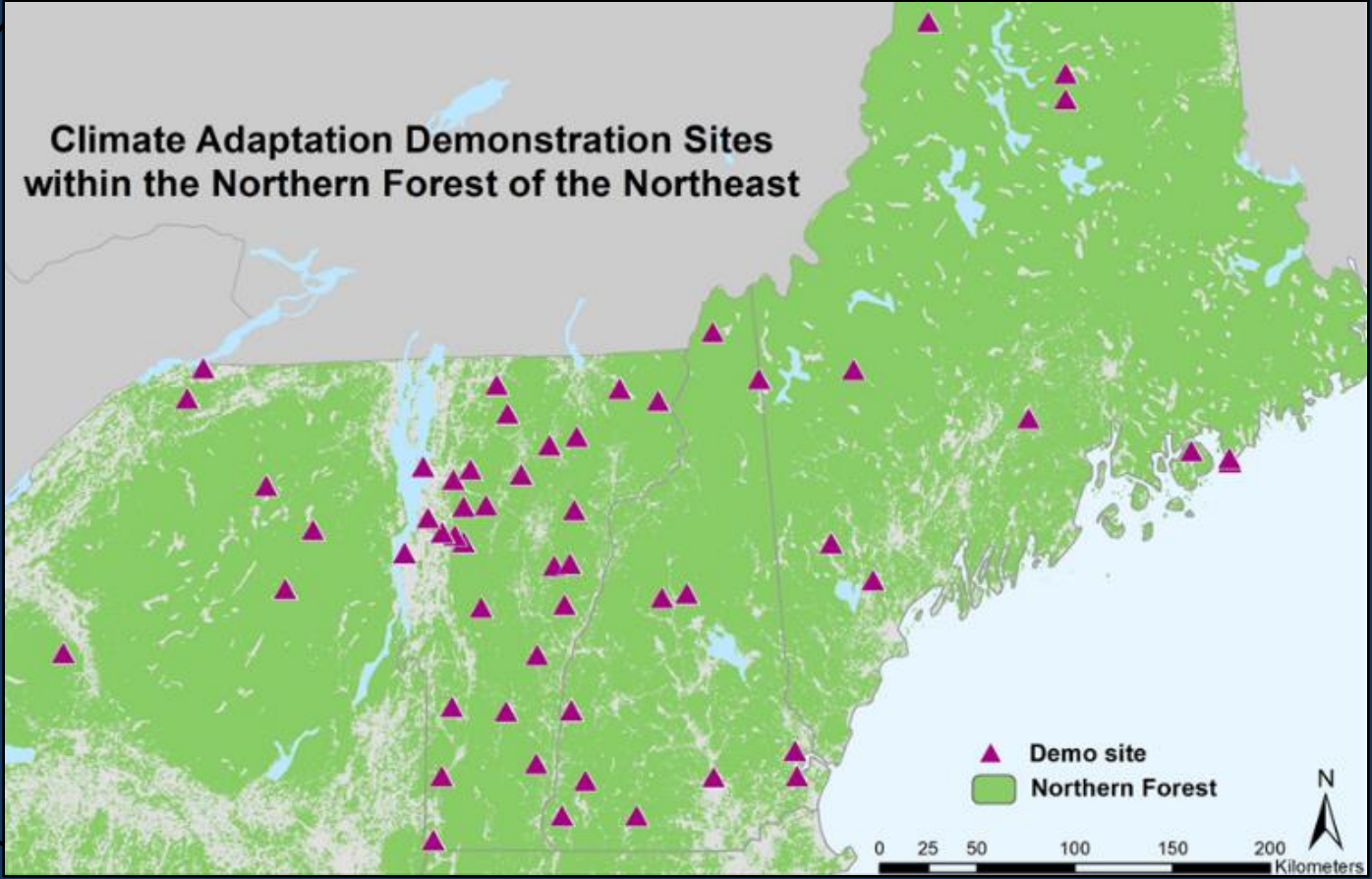
Outcomes of Adaptation in Practice



Outcomes of Adaptation in Practice

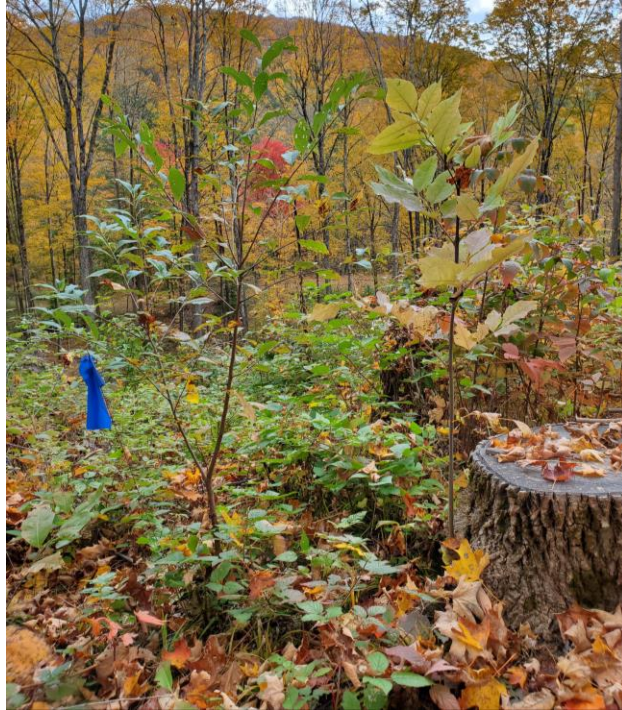


Forestadaptation.org



30 Adaptation Demonstration Sites in northern hardwood, mixedwood, and spruce-fir forests across the Northern Forest region

200+ adaptation demonstrations co-developed by NIACS



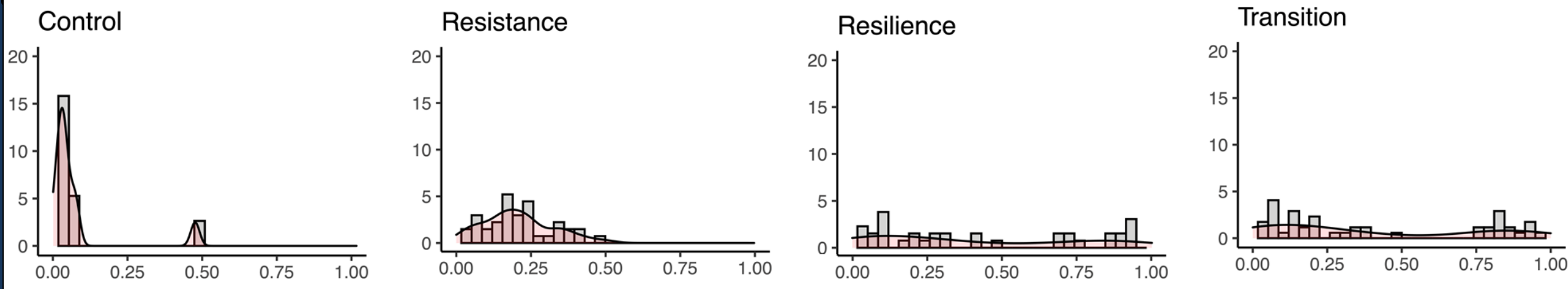
Measuring outcomes

- Forest structure, composition, and function
- Aboveground carbon
- Regeneration conditions, including growth and survival of planted trees
- *Document approaches that confer greatest adaptation potential*

Functional outcomes of adaptive silviculture



- Spatial variability in harvest severity and adaptation pathways



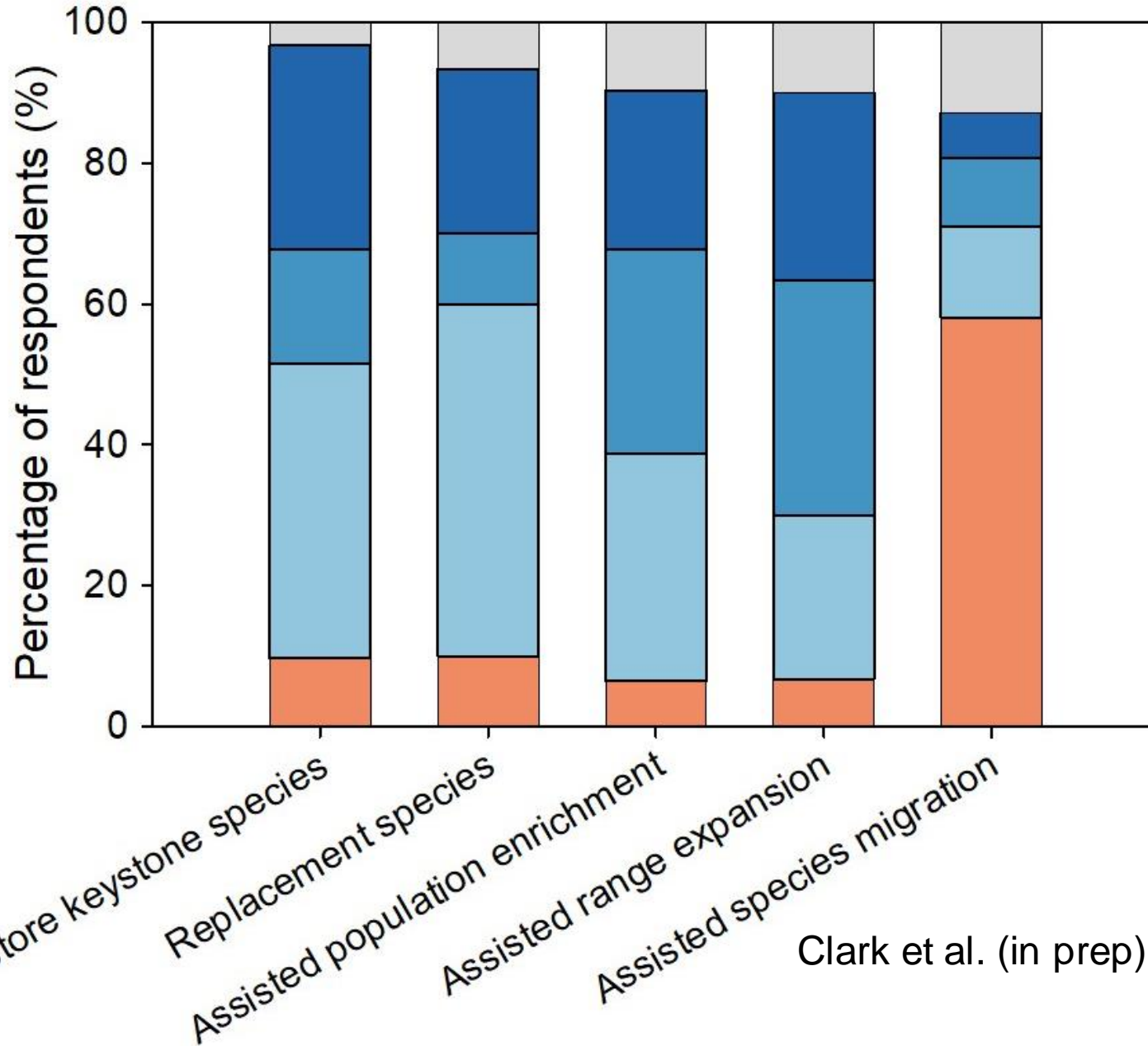
Disturbance severity of harvest at 0.1 acre scale

Wikle et al. (in prep)

Outcomes of Forest Adaptation Planting



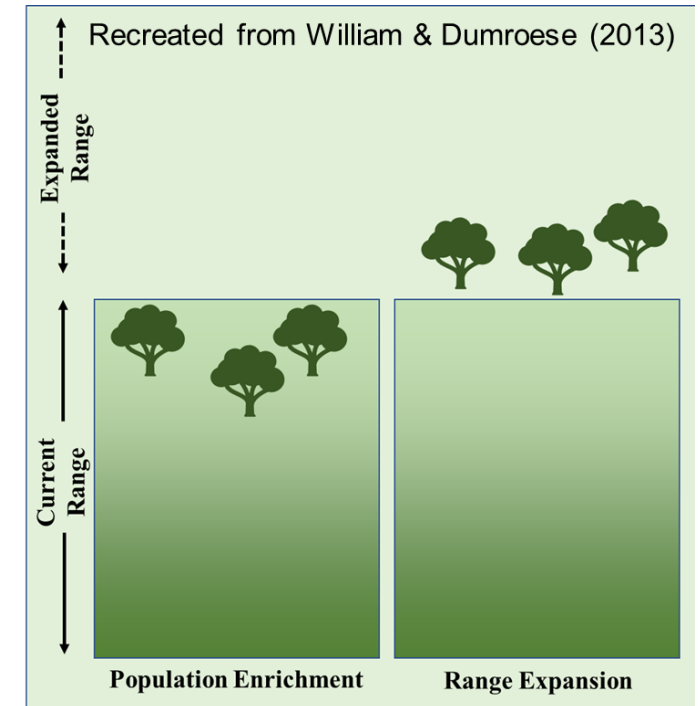
Interest & applications of planting in Northern Forest



Survey of managers from demos (n=42)

- Don't plan to implement
- Interested in implementing
- Plan to implement
- Implemented
- Unsure/Prefer not to answer

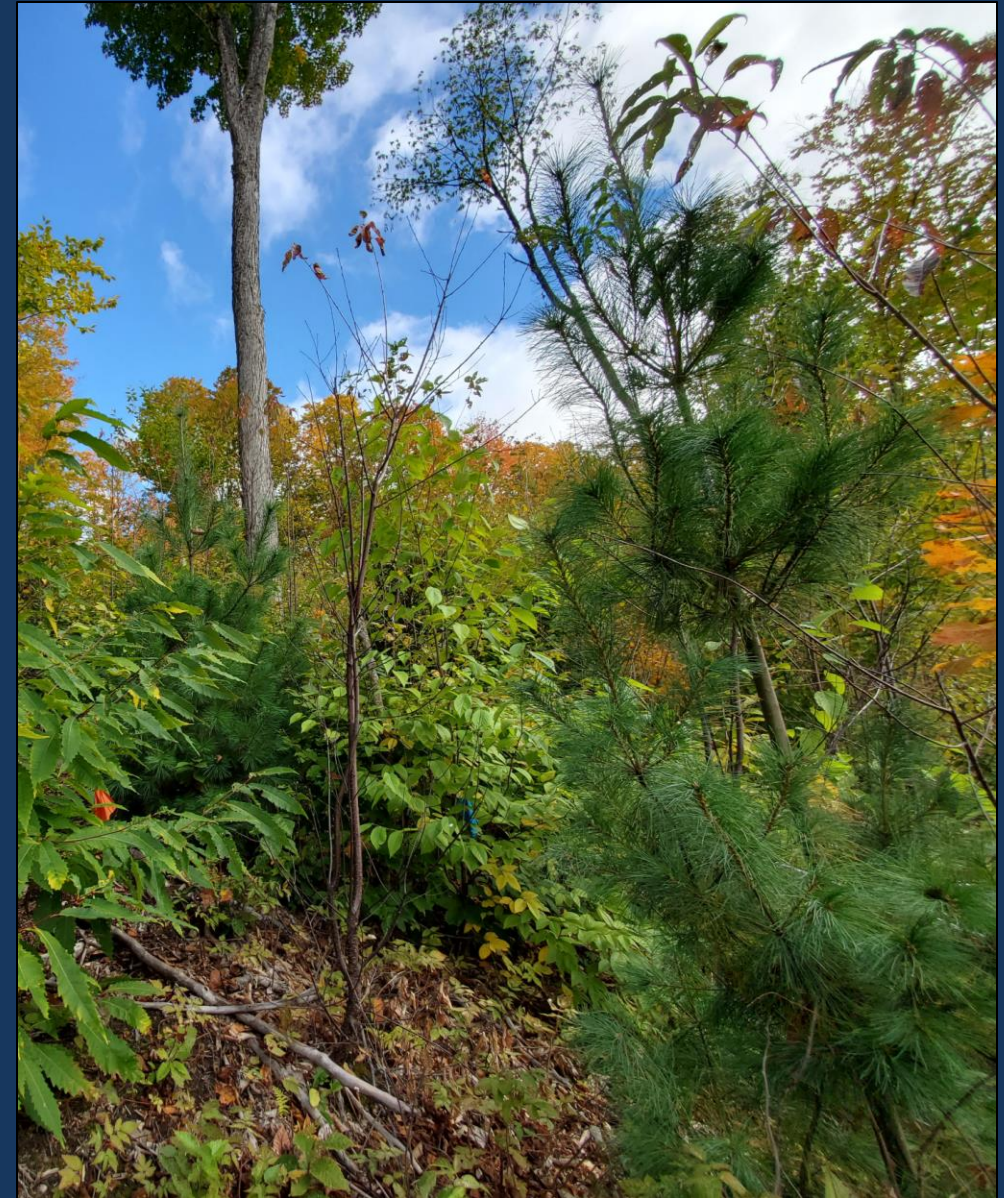
Clark et al. (in prep)



Species being planted in ME, NH, NY, VT



Species	Migration type
red oak***	Enrichment
white pine***	Enrichment
red spruce*	Enrichment
black cherry	Enrichment
bigtooth aspen	Enrichment
sugar maple	Enrichment
basswood	Enrichment
white oak	Range expansion
bitternut hickory	Range expansion
black birch	Range expansion
American chestnut	Range expansion



Outcomes of Forest Adaptation Planting



Tug Hill Plateau, NY (Nature Conservancy)



Photo: C. Zimmerman

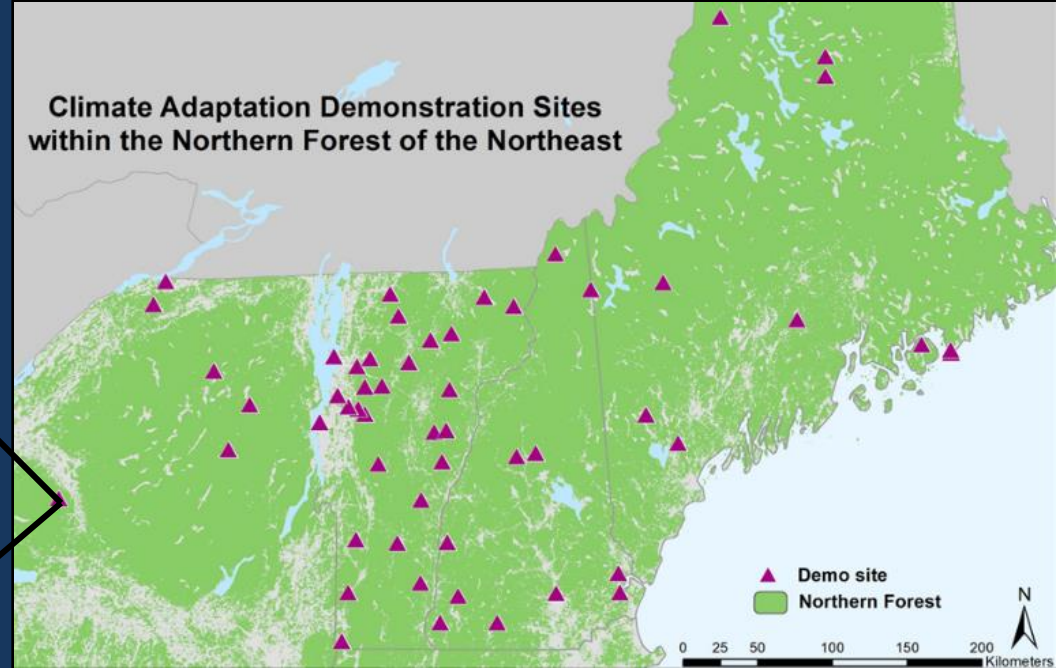


Photo: P. Clark

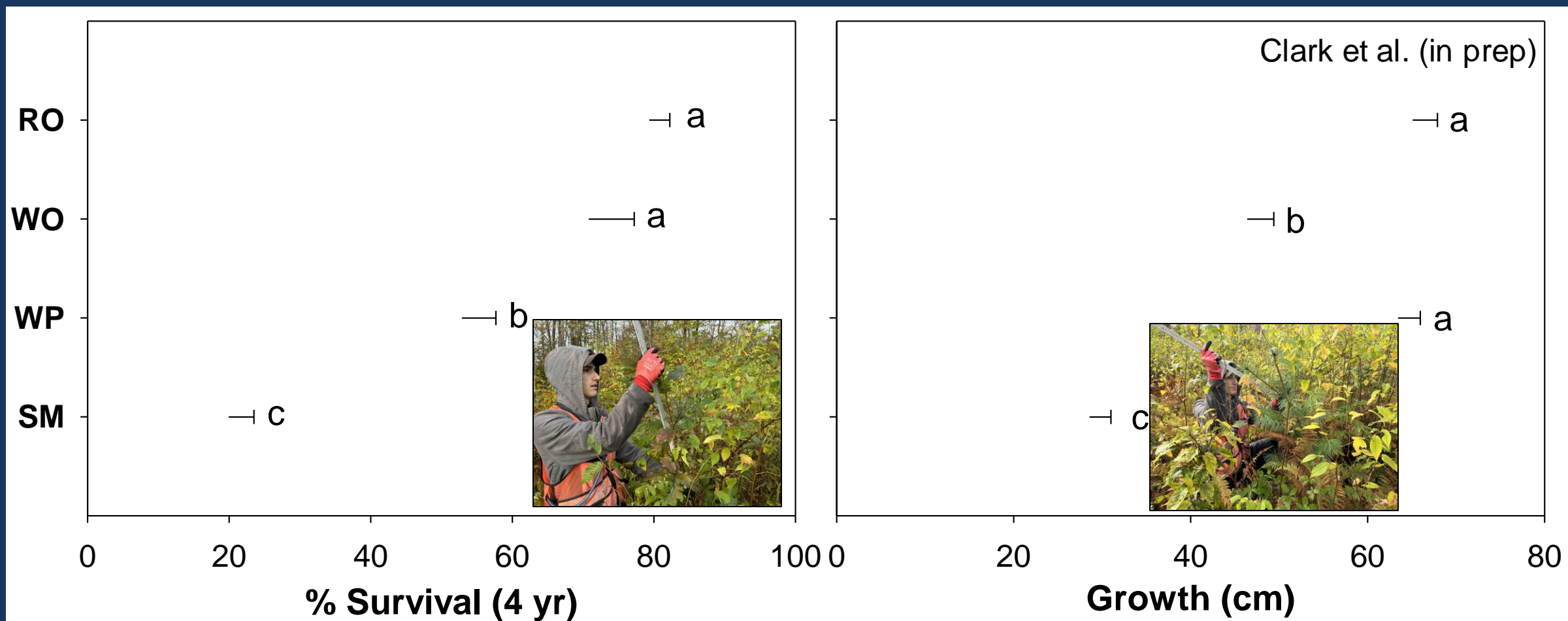
Tug Hill Adaptation Demonstration

Established in 2018-2020 at TNC Tug Hill Conservation Area
Patch selection with reserves across ~36 acres
Planted with 8,500 seedlings projected to gain habitat (red oak, white oak, white pine, sugar maple (southern))

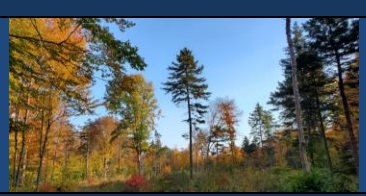
Outcomes of Forest Adaptation Planting



Four-year survival and height growth

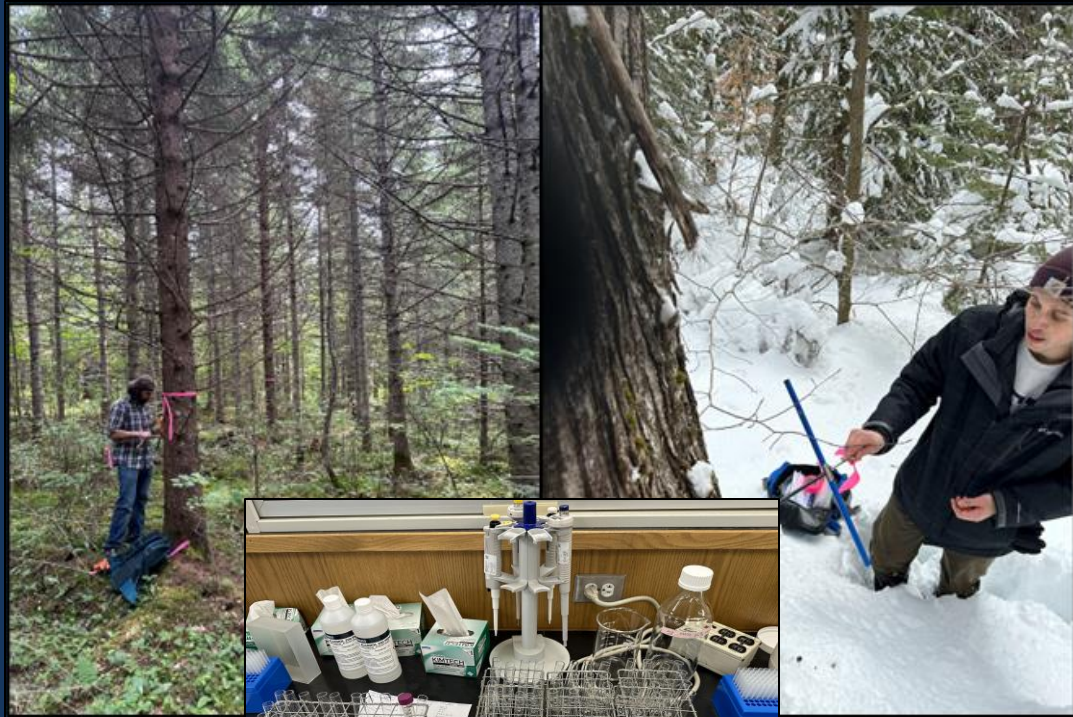


Effectiveness of Forest Adaptation

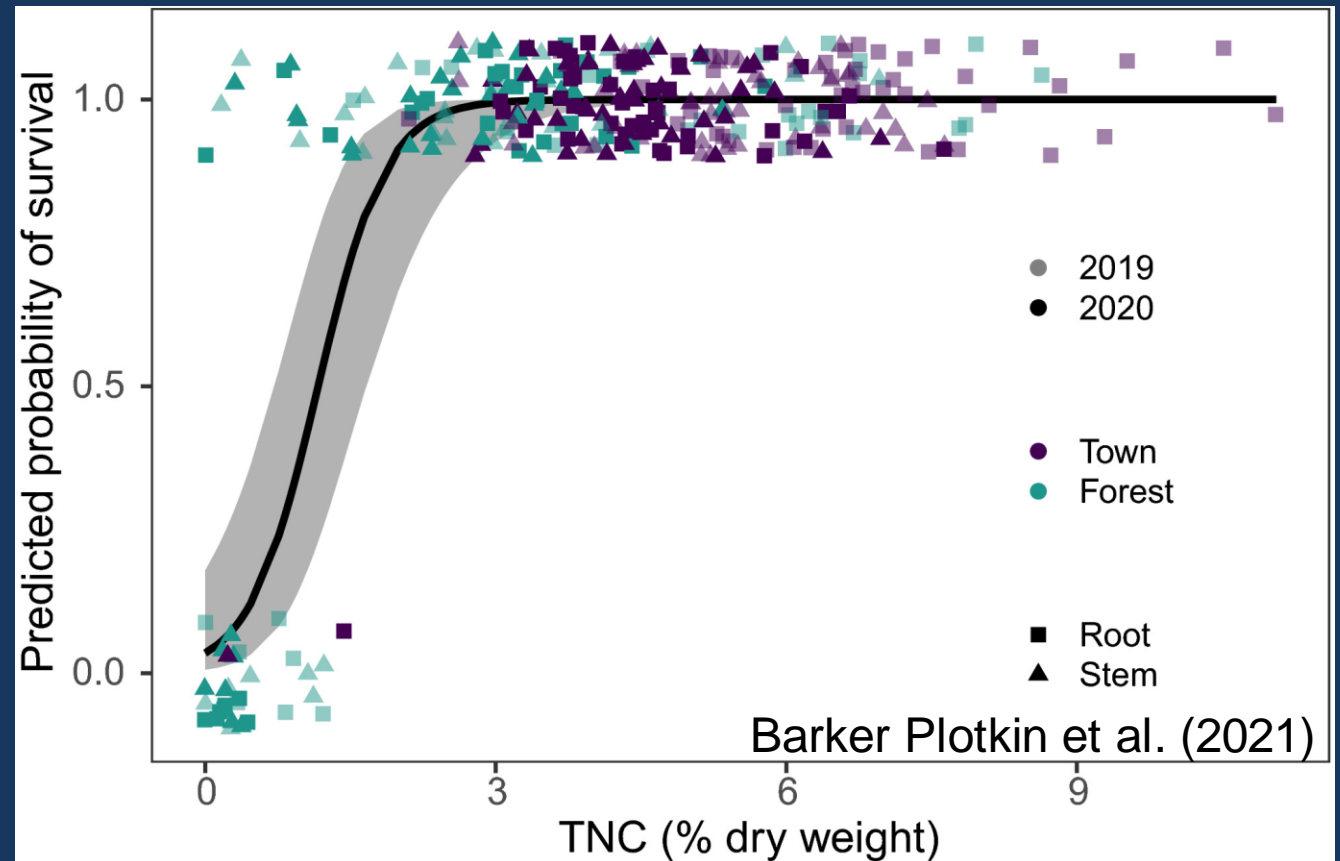


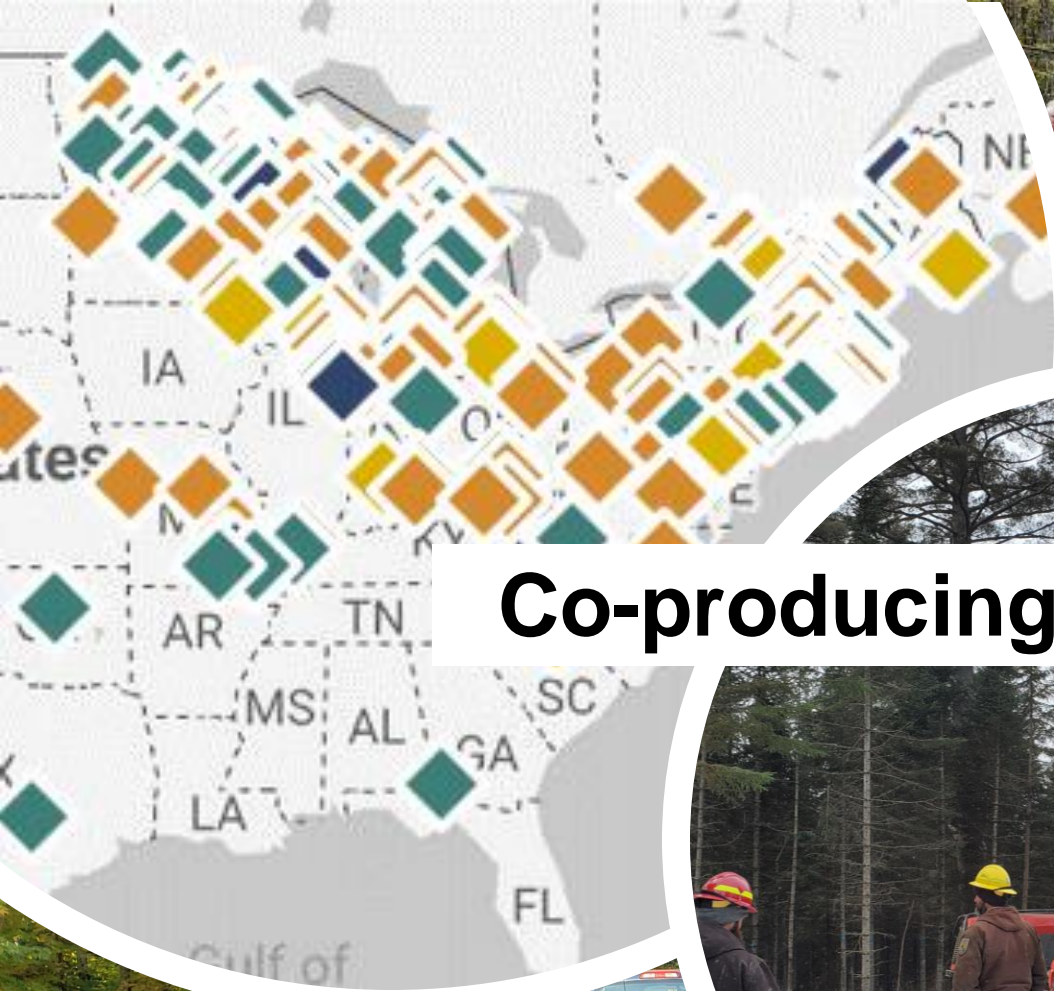
Potential resilience of red spruce and sugar maple under different adaptive management strategies

- Examining non-structural carbohydrates as proxy for resilience



Photos: T. Whiting

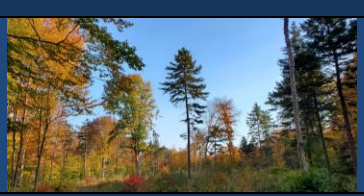




Co-producing best adaptation practices



Guide to best adaptation practices



- Development of Managers Guide to Adaptation
 - Integration of adaptation demonstrations, discussions with managers, outcomes of experiments and demos (objective 1)

A Manager's Guide to Climate Change Adaptation in the Northern Forest Region



Baxter State Park: Frost Pond Late Successional Forest

Home > Adapt > Demonstrations > Baxter State Park: Frost Pond Late Successional Forest

Map Satellite

CLIMATE CHANGE RESPONSE FRAMEWORK

Who we are Assess Adapt Learn Focus Contact

Start-up Planning Action Evaluation

Adaptation Actions

Project participants used the Adaptation Workbook to develop several adaptation actions for this project, including:

Area/Topic	Approach	Tactics
Mixed northern conifer forest	5.1. Promote diverse age classes.	■ Continue forest management activities that promote late-successional characteristics and a healthy, diverse forest as a way to enhance the forest's capacity to adapt to change.
	5.2. Maintain and restore diversity of native species.	
	5.3. Retain biological legacies.	
	5.4. Establish reserves to maintain ecosystem diversity.	
	1.4. Reduce competition for moisture, nutrients, and light.	■ Employ thinning operations to allocate growing space and resources to specific groups (based on size and species) to maintain current composition and size class distribution.
	3.3. Alter forest structure to reduce severity or extent of wind and ice damage.	■ Design operations to perform like natural (and historical) disturbances to resist impact from novel ones, including gap size, dispersal of retention within gaps, species of retention, and skid trail layout.
	1.3. Maintain or restore riparian areas.	■ Maintain late-successional conditions and minimize/avoid harvesting in riparian areas near Frost Pond above and beyond state regulatory requirements.
	2.1. Maintain or improve the ability of forests to resist pests and pathogens.	■ Maintain or reduce eastern hemlock component of the forest. ■ Enforce and continually develop Park regulations on the prohibition of bringing in outside firewood into the park.
	8.2. Favor existing genotypes that are better adapted to future conditions.	■ Consider underplanting genetically-adapted stock if managers experience regeneration failure/difficulties.



A Manager's Guide to Climate Adaptation Northern Forest



Overall vulner...
Will this comm...
declining healt...
extent, or iden...
2100?



Moderate

Climate



• Drought



• Increased wind



• Reduced snow



• Forest stress



• Deer winter

Northern Hardwoods

Northern Hardwoods: Site-level Considerations

Site-level fact...
more or less v...
factors to con...

Factors that increase climate risk

High barriers...
regeneration on...
(e.g., deer brow...
invasive plant...
earthworms, and n...
limitations).

Site is dominated...
few species that...
vulnerable to cli...
change impacts a...
invasive pests

Invasive or nuis...
species (beech,...
scented fern,) c...
compete native sp...



Northern Hardwoods: Adaptation Actions

Here are some exam...
high-risk conditions...
Use this list as a sta...
and review the Fore...
more ideas.

High-Risk Condition (Strategy)

Hydrology & Infrastructure

- R...
- U...
- R...

Insects & diseases

- R...
- U...
- P...

Northern Hardwoods

Increasing Opportunity for Harvest

Adaptation actions (RS= Resistance, RL=Resilience)

- Increase species diversity
- Increase patch size in structural diversity.
- Retain more large co...
- Reduce site impacts b...
- Minimize disturbance...
- Prioritize most likely a...



A stream crossing in winter using a portable bridge

To read more about the <https://forestadaptation.org>

Northern Forest Change

POOR CAPABILITY

- Balsam fir
- Balsam poplar
- Black ash
- Black willow
- Bur oak

FAIR CAPABILITY

- American elm
- Bitternut hickory
- Black spruce
- Boxelder
- Jack pine

GOOD CAPABILITY

- American basswood
- Bigtooth aspen
- Black cherry
- Black locust
- Black oak
- Blackgum
- Chestnut oak

- Eastern redcedar
- Eastern white pine
- Hackberry
- Ironwood

MIXED RESULTS

- American beech
- Eastern hemlock
- Flowering dogwood
- Green ash

NEW HABITAT WITH A...

- Chinkapin oak
- Common persimmon
- Cucumbertree
- Eastern redbud
- Osage-orange

Species planted as assisted migration in northern hardwood forests

Given a historic reliance on natural regeneration in northern hardwood forests, there is little experience with planting in these ecosystems. The species listed below are some that have recently been tested as assisted migration species in these forests and the functions they may sustain under change climate and disturbance regimes.

Species	Type of assisted migration	Functions
Basswood	Assisted population migration	Nutrient-rich foliage, pollinator habitat
Black birch	Assisted range expansion	Similar functions to yellow birch
Bitternut hickory	Assisted range expansion	Hard mast production
Bigtooth aspen	Assisted population migration	Similar functions to quaking aspen
Black cherry	Assisted population migration	Soft mast production
Northern red oak	Assisted population migration	Hard mast production
American chestnut	Assisted range expansion	Hard mast production
White pine	Assisted population migration	Long-lived conifer

Next steps



- Finish synthesizing outcomes of adaptation demos and experiments and their effectiveness (completion summer 2024)
- Release final adaptation guide (March 2024 at NESAF)
 - Please come to working session at 3 PM to provide feedback



Acknowledgements



- **Project partners:** USDA Forest Service Northern Institute of Applied Climate Science, Vermont FPR, Green and White Mountain NFs, USFWS, Dartmouth College Woodlands, Forest Stewards Guild, NH Fish and Game, Vermont Land Trust, The Nature Conservancy, American Chestnut Foundation, Redstart Forestry, NH Forests and Lands, Lyme Timber Company, Vermont Fish and Wildlife

