Preparing your woods for more frequent disturbance.

Gregg Sargis:
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Project Team

Project funded in part by the Wildlife Conservation Society Climate Adaptation Fund through the Doris Duke Charitable Foundation.

Project Team

- Cornell Cooperative Extension Onondaga County – emphasis on outreach and landowner scorecard
- SUNY ESF – with emphasis on the monitoring
- USFS – Northern Institute Applied Climate Science
- Cornell University – project design and outreach

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Tug Hill not just a lot of snow

- Snow
  - Upwards of 300” of snow a season (25ft)
- Not many people
  - Less than 50 people per sq mile.
- And lots of trees
  - Third largest forested area in NY, 75% of the four county area.
- Today the region supports 7,000 forest based jobs;

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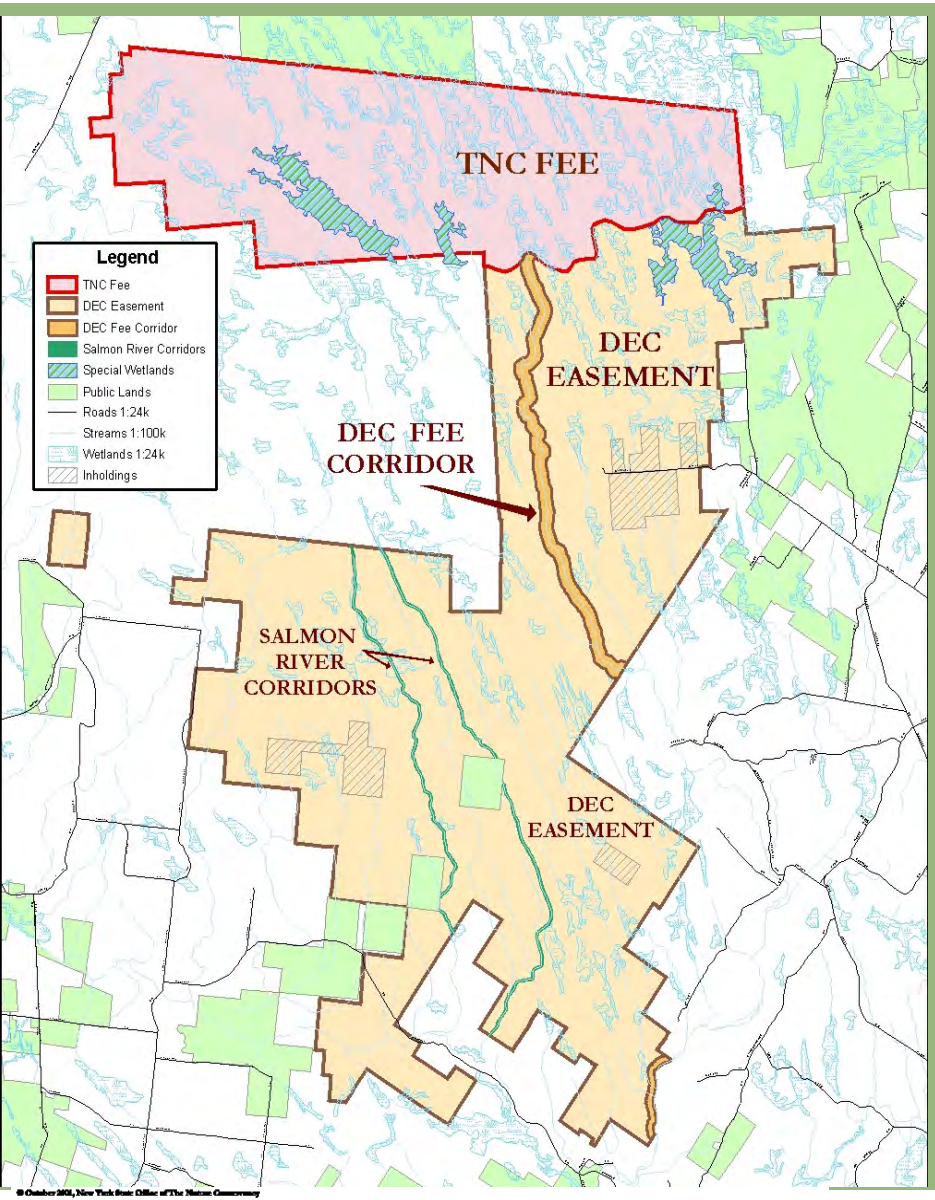
The Conservancy's history on “the Hill”



In 2002, purchased 45,000 acres.

TNC retained 15,000 acres and transferred the rest to DEC with a conservation easement.

Currently, we hold about 17,000 acres

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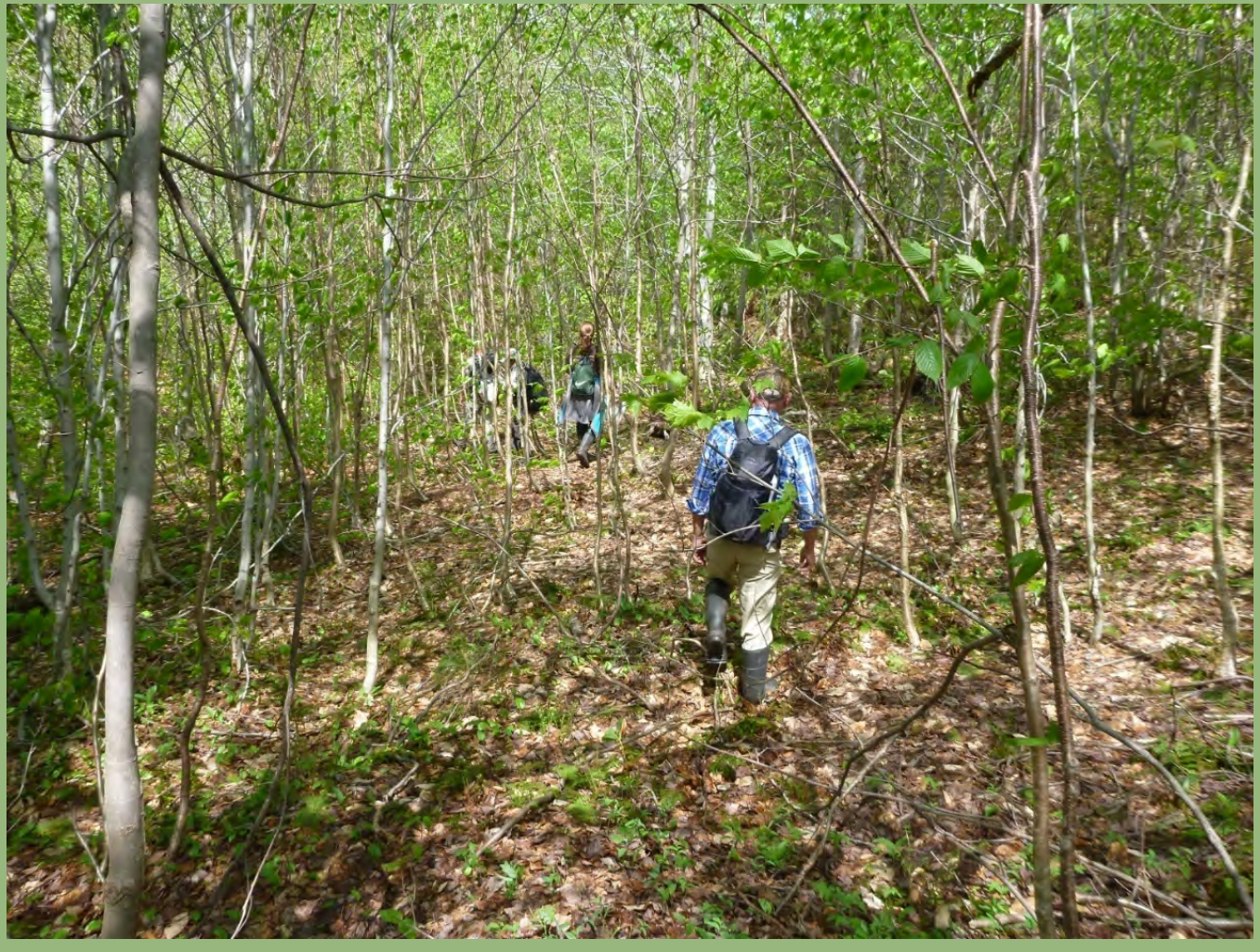
Strive for the past, or plan(t) for the future?



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Current Forest Condition (issues extend across northeast)

- Years of high grade logging ("cutting the best and leaving the rest") have:
  - Created young even aged forest stands with poor regeneration
  - Altered stand complexity (vertical structure)
  - Reduced tree species diversity
  - Eliminated mature forest characteristics (snags, coarse woody debris)
  - Generally have maximized short term gains for long-term losses.

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Current condition compounded by altered weather patterns.

Decreased snow pack:

- increasing deer pressure on regeneration

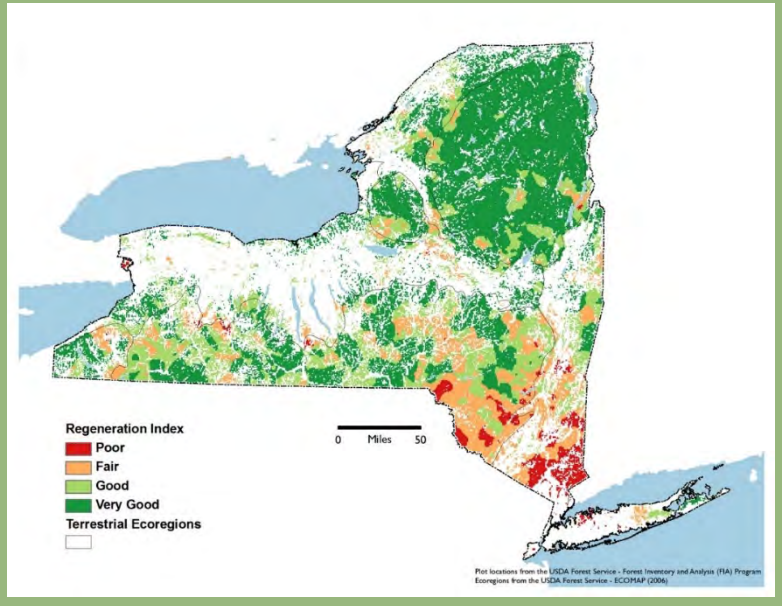
More frequent storms:

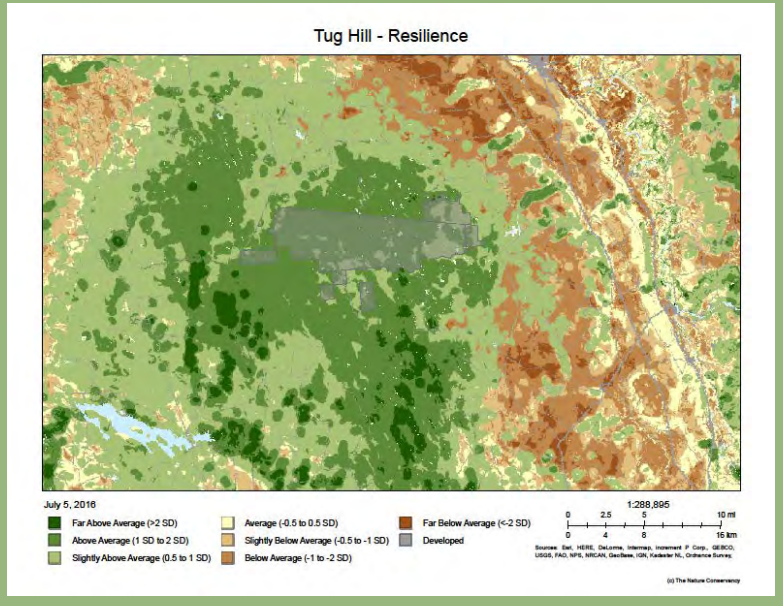
- Lack of diversity in species reduces resilience

Vulnerable to pests and pathogens

- Already present beech bark disease; with emerald ash borer, hemlock wooly adelgid on the way.

Compacted soils criss-cross the stands from years of harvesting.





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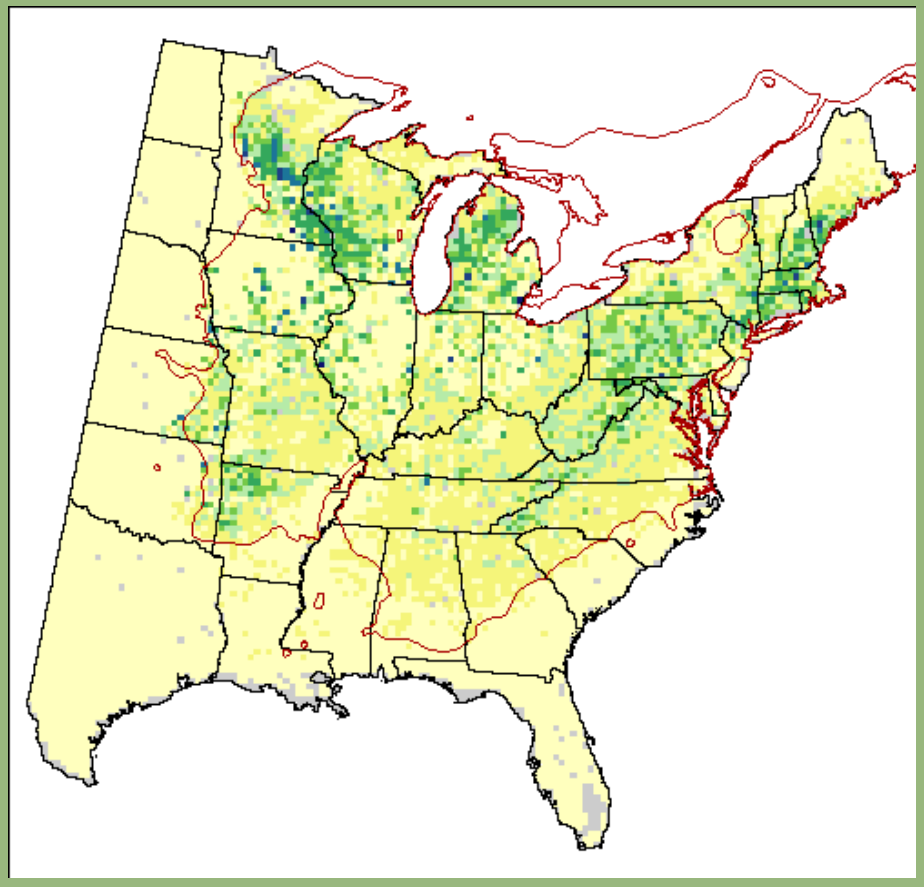
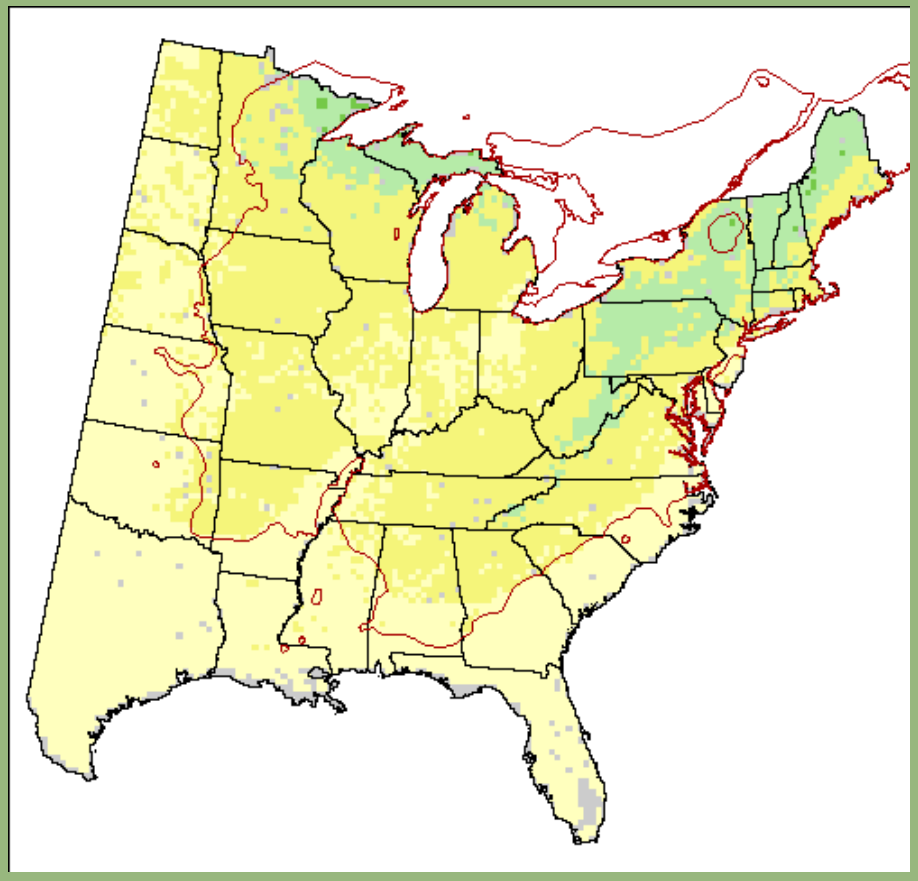
Warming temperature and changing precipitation…

…shifting species ranges.





Northern Red Oak

Adaptation forestry actions

- Increase species diversity (redundancy)
  - Planting some potential climate winners.
- Shift towards multiple age classes
  - creating small gaps, favoring large trees to help them to grow faster
- Improve Regeneration (Future canopy)
  - removing interfering vegetation
- Increase Coarse Woody Debris
  - removing and girdling large beech

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Understory Management Goals:

- Begin shifting to multi-age class
- Diversify forest structure/species composition
- Release advance regeneration (sugar maples, red spruce
- Reduce understory competition

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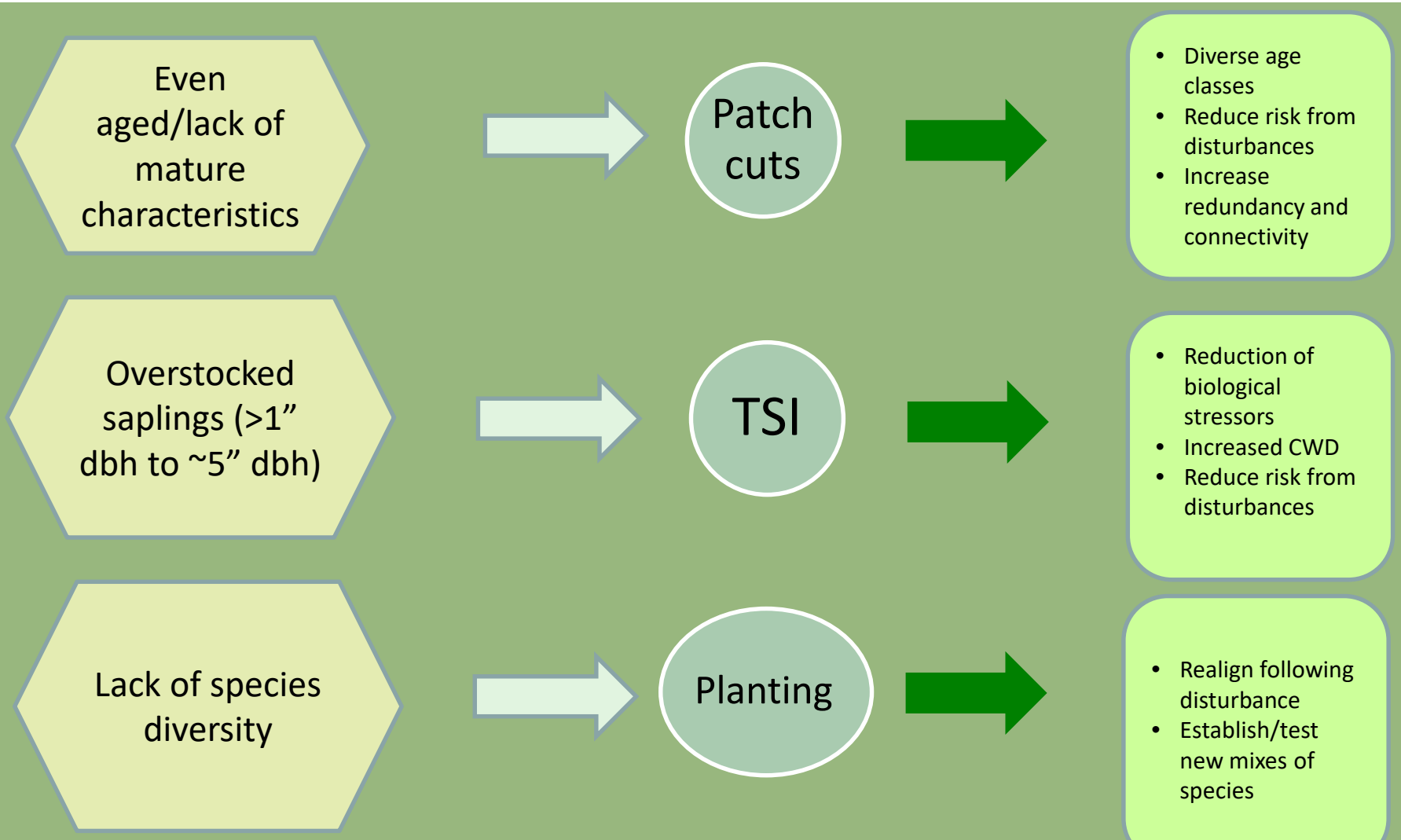
Forest Management:



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In 2015 we purchased a “clean slate”

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Climate adaption planting

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Photo Mon 12 - Brushcut

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PhotoMon10

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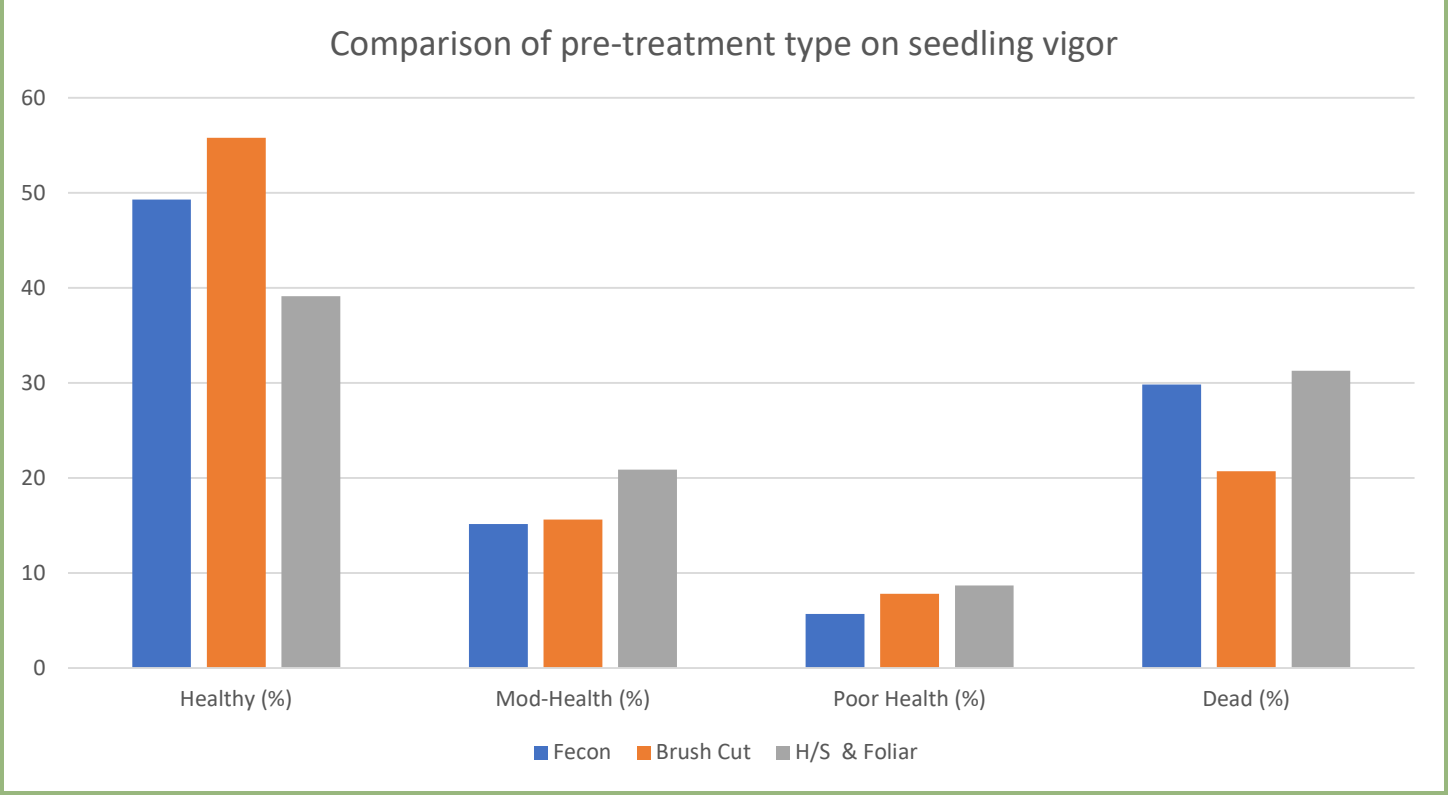
Pre-treatment type



	No Tree Tube		Tree Tube	
Tree Species	**Thriving (%)**	**Dead (%)**	**Thriving (%)**	**Dead (%)**
Black Cherry	76	0	86	4
Maple	66	11	86	6
Oak	69	7	71	6
White Pine	41	26	23	49
White Spruce	32	31	22	41

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Enhance Species and Structural Diversity (even-aged, beech bark disease)

- Patch Cut & Understory "TSI"
  - Various size gaps and "thinning" in size up to 1¼ ac.
  - Across 1/3 of the stand
  - Where possible:
    - Remove all beech (will pretreat/post treat with herbicides when applicable).
    - Leave standing dead and downed trees; large limbs
    - Push over trees
- "Timber Stand Improvement"
  - Removal of small diameter beech and red maple
- Prompt vegetation establishment
  - Will plant some tree seedlings in various treatments.

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Understory TSI

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Understory TSI – Beech treatment

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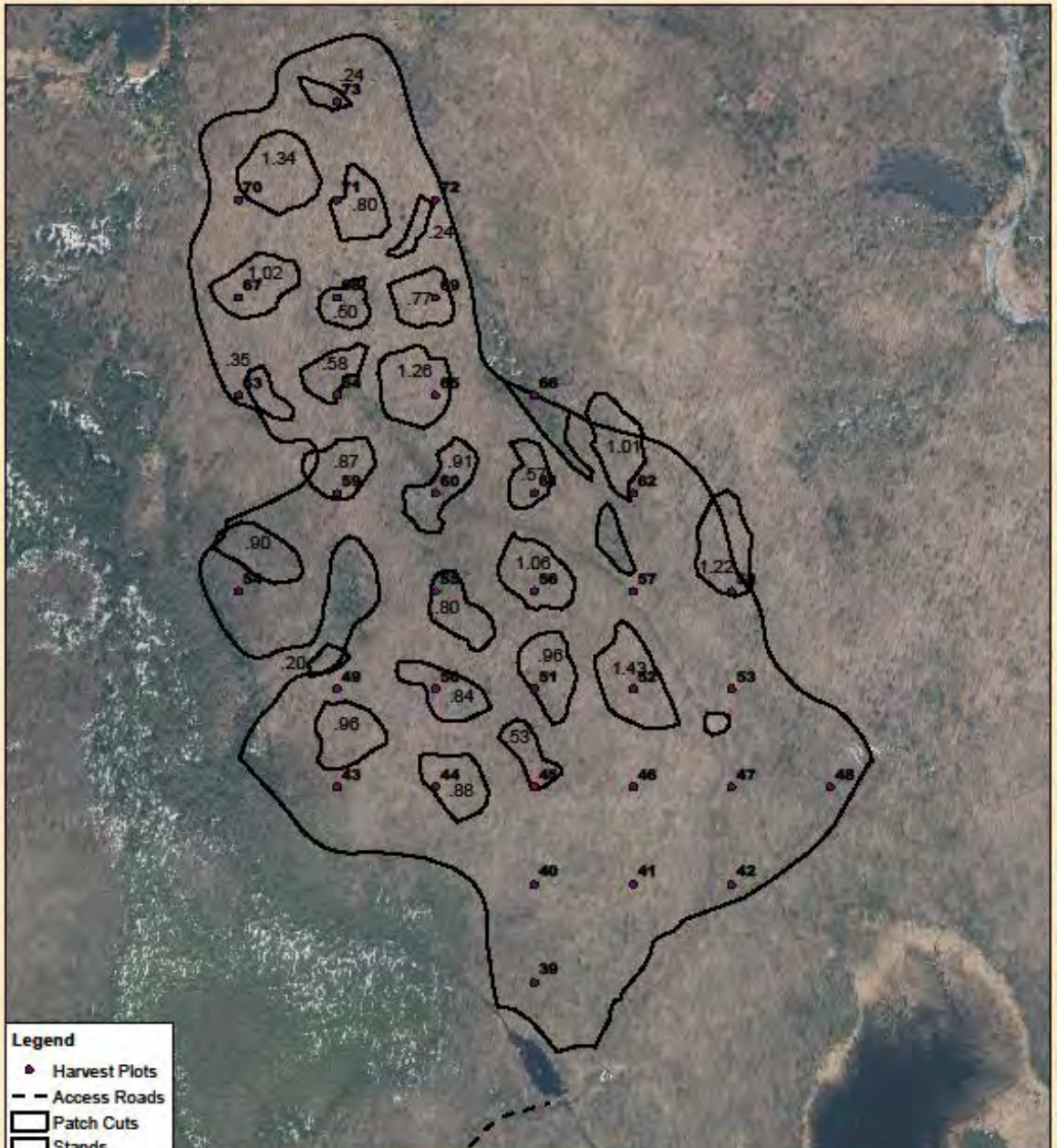
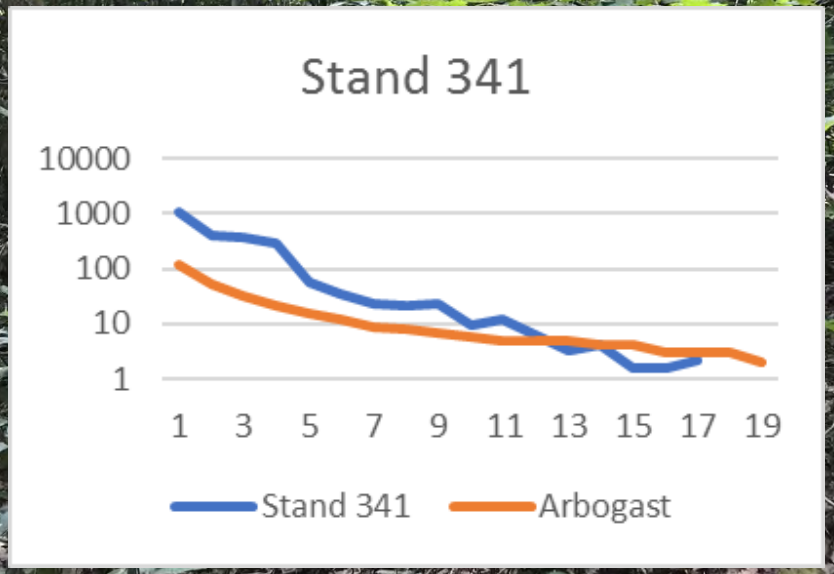
Harvest Orthoimage NW
Tug Hill Region
West Turin, Lewis County, NY
Owned by: The Nature Conservancy
93+/- Acres



Overstocked Understory:

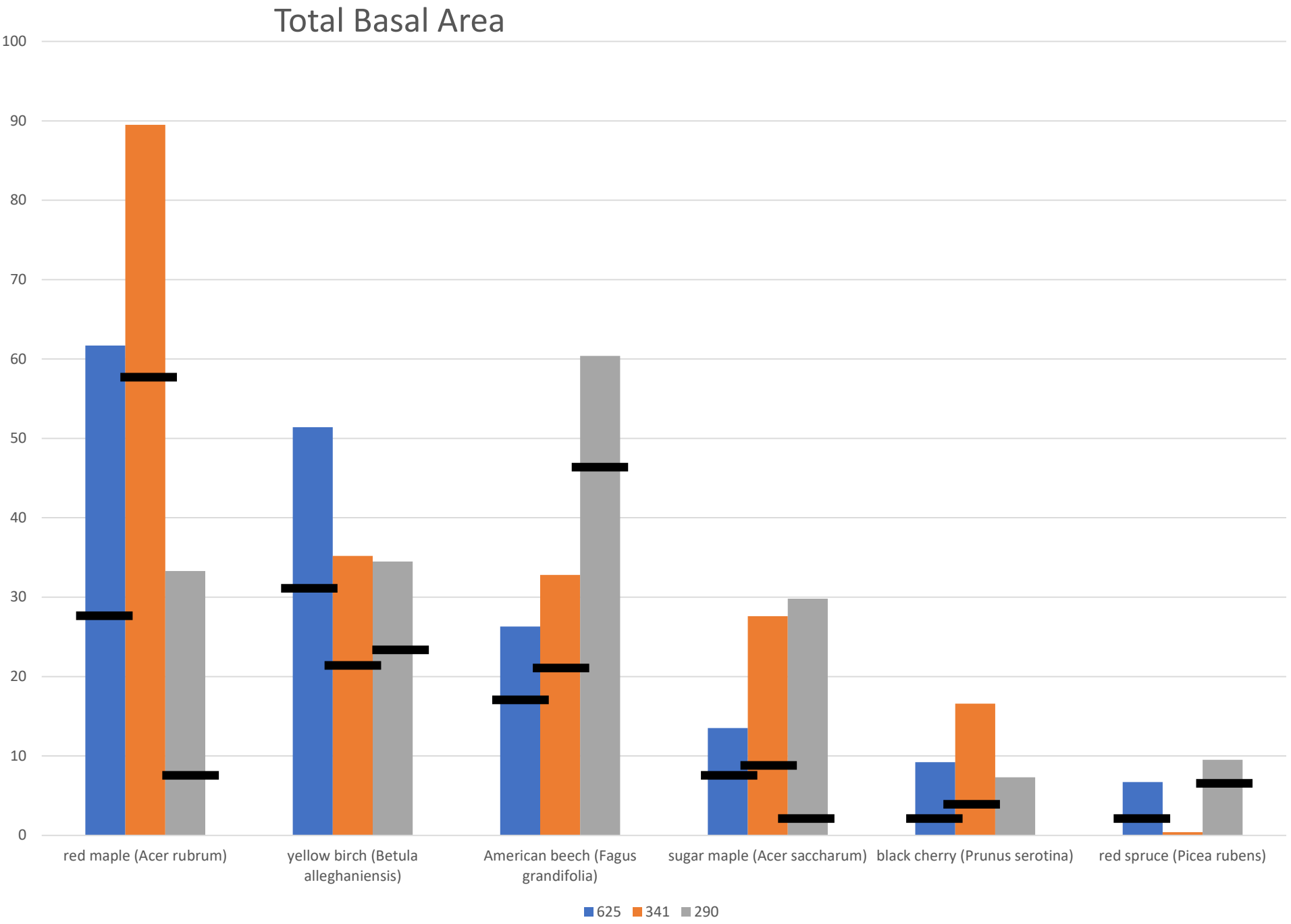
- Using current stand data and reference data of mature uneven-aged northern hardwood stand determined small size classes way over stocked.
  - Strategy to remove on average a couple hundred stems/ac in small size classes of beech and red maple.
  - Using brush saw/basal treatment and hack/squirt.



Monitoring Long-term Trends

- Seedling survival; seedling height growth
- Forest condition
  - Tree growth
  - Structure
  - Natural regen
- Cost/time/ROI
  - Cost to implement work
  - Amount that could be sold
- Carbon projections

Thank you!


Total Basal Area
100
90
80
70
60
50
40
30
20
10
0
red maple (Acer rubrum)
yellow birch (Betula alleghaniensis)
American beech (Fagus grandifolia)
sugar maple (Acer saccharum)
black cherry (Prunus serotina)
red spruce (Picea rubens)
625
341
290

Planted over 35,000 trees:

- Refugia Trees:
  - Maples
  - Cherry
- Transitional:
  - Oaks (Red/White)
  - Hickory (Mockernut, bitternut)

* No apple trees were planted.

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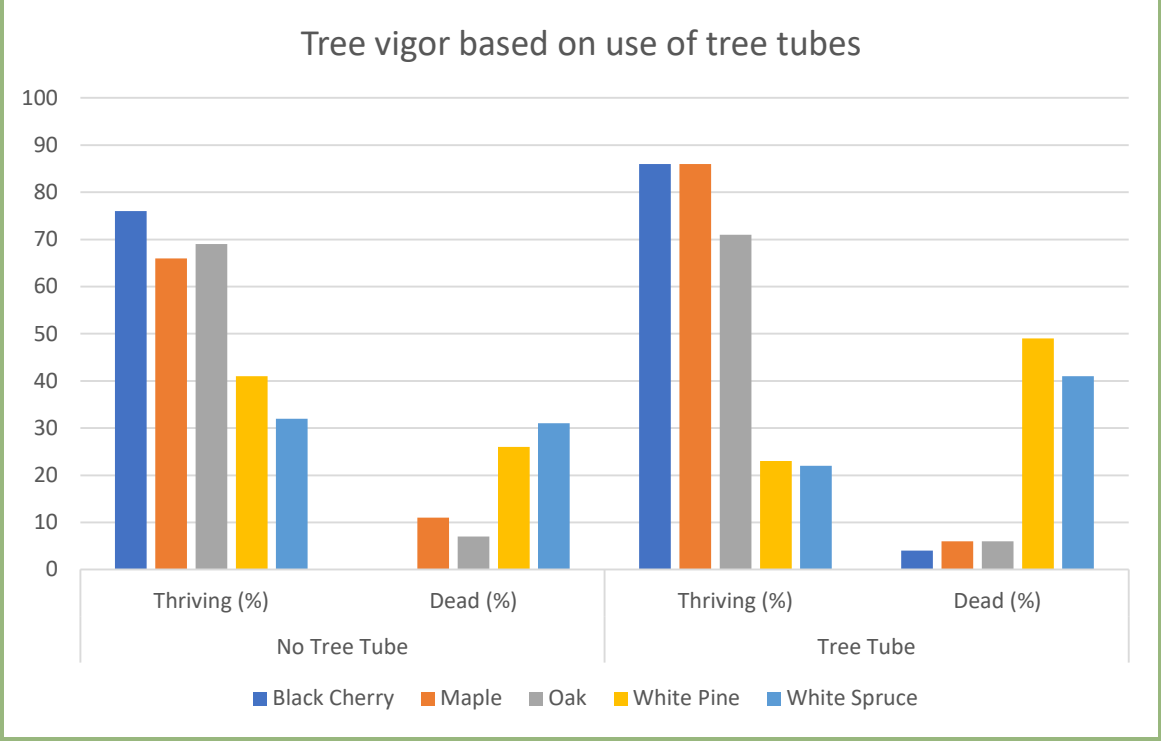
Seedling Monitoring Plots – 44 total (16 with tree tubes)



Treatment	Healthy (%)	Mod-Health (%)	Poor Health (%)	Dead (%)
Fecon	49	15	6	30
Brush Cut	56	16	8	21
H/S & Foliar	39	21	9	31

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- Was all planting done in treated areas.
- How much per acre?

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Lessons Learned: (will know more in a year or two)

- Plant as soon after harvesting as possible.
- Pre-treatment may be effective at reducing vegetative competition in first year.
- Late treatment may be difficult to prevent damage to tree especially if not tubed.
- Vegetation may have helped shade some seedlings during early season drought.
- Tree tubes don't appear to be all that effective for needle leaved trees.
- Raspberry difficult to control… found that …. Was effective….

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Timber Stand Improvement –

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Some of the numbers

- How much per gallon of herbicide?
  - 5gal = 104
  - .87 gal = $18-20 acre.
- 2 hours – per plot or 20 hours per acre
  - 13.50 x20 -= $270 acre
  - (Brian and Gregg pace)

13 hr X $13.5 = $180 acre

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1. Define goals and objectives
2. Assess climate impacts and vulnerabilities
3. Evaluate objectives considering climate impacts
4. Identify adaptation approaches and tactics for implementation
5. Monitor effectiveness of implemented actions

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Influence the influencers –

With focus on Master Forest Owners and NYFOA

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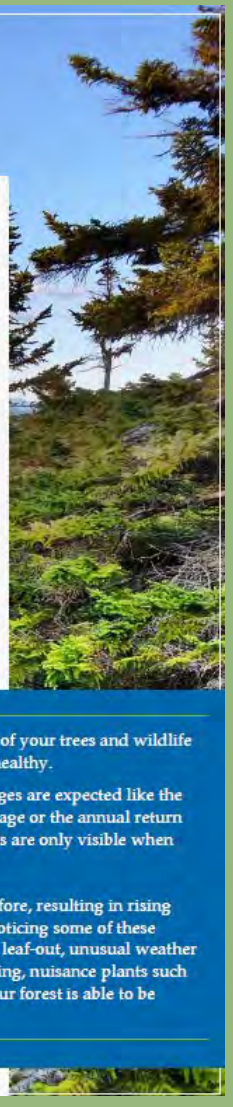
Forest Resilience Scorecard



Keeping Your Woods Healthy in a Changing World:

A Tool to Assess Forest Resilience, Health, and Productivity

Whether you spend time outside in your woods, or just enjoy the beauty of your trees and wildlife from your window, you likely love your woods and want to keep them healthy.

Forests are always changing and adapting to new conditions. Some changes are expected like the progression of green summer leaves to the bright red and gold of fall foliage or the annual return of brightly-colored migratory songbirds. Other changes in our woodlands are only visible when comparing differences across many years or decades.

Our climate is changing in ways that humans have never experienced before, resulting in rising temperatures and shifts in seasonal precipitation patterns. You may be noticing some of these changes in your woods – such as earlier dates for the first signs of spring leaf-out, unusual weather patterns, longer dry periods in summer, or even an increase in fast-growing, nuisance plants such as poison ivy. There are many actions that you can take to ensure that your forest is able to be resilient, healthy, and productive in the face of future changes.

Forest Diversity and Composition

Every woodlot is different, and will contain a different mix of tree and plant species due to the conditions unique to that particular place and to the history of the land. In general, a forest that contains a variety of tree species that are well-suited to current local conditions and future climate conditions without many interfering plant species will be better able to tolerate changes in climate and others stressors.

	Higher Risk	↔	Lower Risk	
Species diversity: The forest has low species diversity, either in the canopy or throughout the forest. One or a few tree species are dominant.	☐	☐	☐	Many tree species are present, without a single species being overly dominant.
Species suitability: The dominant tree species are near the southern extent of their species range or are adapted to cold conditions.	☐	☐	☐	The dominant tree species can tolerate warmer, drier, or more variable conditions, and they are generally found farther south.
General tree health: Trees have poor growth form or have been damaged by insect pests or forest diseases.	☐	☐	☐	Trees are healthy and free of disease. The trees generally have good growth and form.
Insects and Diseases: The forest is currently affected by insects or diseases. There are looming threats, such as nearby outbreaks.	☐	☐	☐	There are no current or looming forest insect or disease issues and there is a diversity of non-host species.

Forest Structure

When it comes to forest structure, more complexity is often better. Forest structure includes having a diversity of tree sizes and species, varying the number of trees per acre, and ensuring the presence of dead wood – both standing and down. These conditions make your woods more likely to attract wildlife and recover quickly from disturbance.

	Higher Risk	↔	Lower Risk	
Structural diversity: The forest contains trees that are primarily a single age or size, creating a simple canopy.	☐	☐	☐	The forest includes trees of different sizes, and the forest contains multiple vertical layers (overstory, understory, etc.)
Standing dead trees: No or few large standing dead trees are present.	☐	☐	☐	There are noticeable numbers of standing dead trees (several per acre) and some are large.
Down dead wood Woody material, especially large pieces, are rare or absent.	☐	☐	☐	There are noticeable amounts of dead wood, especially large pieces, on the forest floor.
Tree crowns and spacing: Trees are too crowded and competing for growing space, or (less common) trees are inadequately stocked and too widely spaced.	☐	☐	☐	Trees have adequate growing space that leads to them having large, healthy crowns.

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Regional Outcomes

Response to disturbances:

* Resilient response

Climate refugia:

* Healthy diverse landscape promote new species assemblages

Landscape connectivity:

* Allow for shifting species across landscapes

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Thank you!

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Questions for you!

- Does this any of this make sense to you?
- What questions or concerns do you have?
- What resonates most with you?
- What do you think could help to scale this up: examples of working with partners, landowners, etc.

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Forest Health and Resilience Report Card: Forest Health & Diversity

	Higher Risk	←→	Lower Risk	
Species diversity: Forest has low species diversity. One or a few tree species are dominant.	X			Many tree species are present, without a single species being overly dominant.
Species suitability: The current tree species are near the southern extent of their species range or are adapted to cold conditions.	X			The current tree species can tolerate warmer, drier, or more variable conditions, and they are generally found farther south.
General tree health: Trees have poor form reflecting more challenging site conditions or are damaged from insect pests or forest diseases.	X			Trees are healthy and free of disease. The trees generally have good growth and form.
Insects and Diseases: The forest is currently affected by insects or diseases. There are looming threats (such as nearby outbreaks) or host species dominate composition.		X		There are no current or looming forest insect or disease issues and there is a diversity of non-host species.
Invasive plants: Plants such as buckthorn, multiflora rose, autumn olive, and garlic mustard are common in the forest.			X	Invasive plants are absent on the property, or invasives are deliberately confined to small areas.

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Forest Structure

	Higher Risk	←→	Lower Risk	
Structural diversity: The forest contains trees that are primarily a single age or size, creating a simple canopy.	X			The forest includes trees of different sizes, and the forest contains multiple vertical layers (overstory, understory, etc.)
Standing dead trees: No or few large standing dead trees are present.	X			There are noticeable numbers of standing dead trees (several per acre) and some are large.
Down dead wood Woody material, especially large pieces, are rare or absent.	X			There are noticeable amounts of dead wood, especially large pieces, on the forest floor.
Tree crowns and spacing: Trees are inadequately stocked and too widely spaced, or trees are too crowded and competing for growing space	X			Trees have adequate growing space that leads to them having large, healthy crowns.

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Regeneration:

	Higher Risk	←→	Lower Risk	
Desirable regeneration Tree seedlings and saplings are absent in the understory or are dominated by undesirable species.	X			Tree seedlings or saplings of are present in the understory; the species mix is desirable for achieving management goals.
Species suitability: Regeneration includes species that are near the southern extent of their species range or are adapted to cold conditions.		X		Regeneration includes tree species that can tolerate warmer, drier, or more variable conditions, and they are generally found farther south.
Challenges to regeneration: Stressors such as invasive species or deer browse create substantial challenges for tree regeneration and recruitment.			X	There are no substantial challenges to tree regeneration that need to be addressed.

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Geographic Site Level Risks

	Higher Risk	←→	Lower Risk	
Moisture stress or drought: The forest would be negatively affected by drought because the trees are susceptible or because the soils are sandy or drought-prone.		X		Moisture stress or drought would not cause particular problems at this location.
Extreme rainfall: Forest is located in an area that would be heavily affected by extreme rainfall, such as a floodplain or steep, highly-erodible slope.		X		Extreme rainfall would not cause particular problems at this location.
Other extreme weather: The forest is at-risk from other extreme weather events, such as windstorms or hurricanes.		X		Extreme weather events would not be expected to cause particular problems at this location.
Shorter and milder winters: Warmer winter conditions would negatively affect the forest (increase deer) or create challenges to forest management or timber harvest (snowpack).	X			Warmer winter conditions may be beneficial to forests or may increase opportunities for forest management or timber harvest.

Strategies

To address:	Consider this:
Species diversity: Forest has low species diversity. One or a few tree species are dominant.	➢ Promote regeneration or plant a variety of native species expected to do well under future conditions ➢ Use site scarification, planting, or other techniques to support adequate regeneration
Species suitability: The current tree species are near the southern extent of their species range or are adapted to cold conditions.	Promote species with a wide range of moisture and temperature tolerances if they are present, or plant if needed Promote a variety of native species expected to do well under future conditions if they are present, or plant if needed
General tree health: Trees have poor form reflecting more challenging site conditions or have damaged from insect pests or forest diseases.	Thin forest stands to remove crowded, damaged, or stressed trees in order to reduce competition for light, nutrients, and water
Insects and Diseases: The forest is currently affected by insects or diseases, or there are looming threats (such as nearby insects).	➢ Retain survivors of pest or disease outbreaks, droughts, windthrow events, or other disturbances during salvage or sanitation operations Create a diverse mix of forest or community types, age classes, and stand structures to reduce the availability of host species for pests and pathogens ➢ Thin to reduce the density of a pest's host species in order to discourage infestation, knowing that species are especially susceptible to pests and pathogens at particular stocking levels
Invasive plants: Plants such as buckthorn, multiflora rose, autumn olive, and garlic mustard are common in the forest.	➢ Eradicate existing populations or seed sources of invasive plants through physical or chemical treatments ➢ Prevent and remove undesirable species, including invasive nonnative or aggressive native species, in order to reduce competition for resources ➢ Control competition from undesirable tree species and invasive species to enhance regeneration of desired tree species

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To address:	Consider this:
Structural diversity: The forest contains trees that are primarily a single age or size, creating a simple canopy.	Use forest management to emulate aspects of natural disturbance to support the establishment of different age classes
Standing dead trees: No or few standing dead trees are present.	Leave or create standing dead trees during forest management activities where they do not create a hazard ➢ Leave standing dead trees during salvage operations where they do not create a hazard. ➢ Allow some trees to grow to larger sizes so that they can provide value to wildlife and serve as future dead wood
Down dead wood Woody material, especially large pieces, are rare or absent.	Leave large pieces of woody material on the ground after disturbances and forest management activities. ➢ Allow some trees to grow to larger sizes so that they can provide value to wildlife and serve as future dead wood
Tree crowns and spacing: Trees are inadequately stocked and too widely spaced, or trees are too crowded and competing for growing space	➢ Perform timber stand improvement to favor and promote the growth of desirable growing stock Thin stands by identifying crop trees, creating room to grow for desirable species of good form

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To address:	Consider this:
Species diversity: Forest has low species diversity. One or a few tree species are dominant.	Use forest management to encourage regeneration by creating canopy openings Plant or seed sufficient stocks of desired species before undesirable species have the chance to establish or compete
Desirable regeneration Tree seedlings and saplings are absent in the understory or are dominated by undesirable species.	➢ Retain or promote trees of desirable species in the overstory to serve as a seed source Control competition from undesirable tree species, including beech suckers and sprouts, and invasive species to enhance regeneration of desired tree species ➢ Restrict recreation or management activities that may have the potential to damage desirable regeneration
Species suitability: Regeneration includes species that are near the southern extent of their species range or are adapted to cold conditions.	➢ Favor species that are currently present that have wide ecological amplitude and can persist under a wide variety of climate and site conditions ➢ Identify and promote species that currently occupy a variety of site conditions and landscape positions
Challenges to regeneration: Issues such as invasive species or deer browse create substantial challenges for tree regeneration and recruitment.	➢ Apply repellant, install fences, bud caps, and other physical barriers to prevent herbivory ➢ Promote abundant regeneration of multiple species to supply more browse than herbivores are expected to consume ➢ Use tree tops from forest harvest or plantings of nonpalatable tree species as locations for “hiding” desirable species from herbivores to reduce browse pressure ➢ Partner with state wildlife agencies to monitor herbivore populations or reduce populations to appropriate levels

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To address:	Consider this:
Species diversity: Forest has low species diversity. One or a few tree species are dominant.	➢ Create conditions that will be favorable for regeneration of desired species, for example by removing the duff layer to allow germination and sprouting of shortleaf pine ➢ Use site scarification, planting, or other techniques to support adequate regeneration
Moisture stress or drought: The forest would be negatively affected by drought because the trees are susceptible or because the soils are drought-prone.	➢ Seed or plant drought-resistant genotypes of commercial species Plant oaks, pines, and other drought-tolerant native species that are expected to become drier
Extreme rainfall: Forest is located in an area that would be heavily affected by extreme rainfall, such as a floodplain or steep, highly-erodible slope.	➢ Plant species that can cope with periodic inundation and flooding, such as swamp white oak and silver maple, on sites that are in low landscape positions or prone to flooding
Other extreme weather: The forest is at-risk from other extreme weather events, such as windstorms or hurricanes.	➢ Thin stands to increase tree growing space and increase the windfirmness of the residual stand, favoring the healthiest trees ➢ Design canopy gaps and harvest edges with an orientation and shape informed by the prevailing winds in order to reduce the risk of wind throw.
Shorter and milder winters: Warmer winter conditions would negatively affect the forest or create challenges to forest management or timber harvest.	Promote long-lived conifers with wide ecological tolerances, such as eastern white pine ➢ Time the season of harvest operations to match site conditions and minimize risk to stands ➢ Limit harvest or management-related disturbance in areas that may be buffered from climate change (e.g., spring-fed stands sheltered in swales or valleys)

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Improving the health and resilience of our forests – Gregg Sargis

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Stand 341

Overstory only

	All species	red maple (Acer rubrum)	sugar maple (Acer saccharum)	yellow birch (Betula alleghaniensis)	black cherry (Prunus serotina)	American beech (Fagus grandifolia)	red spruce (Picea rubens)
Basal area (sq.ft./ac.)	89	31.7	19.5	14.5	11.9	10.9	0.4
Percent of stand basal area (%)	100	35.6	22	16.3	13.3	12.3	0.5
Stems/area (stems/ac.)	197.4	78.4	36.3	27.4	26.8	27.4	1.1

Understory only

	All species	red maple (Acer rubrum)	American beech (Fagus grandifolia)	yellow birch (Betula alleghaniensis)	sugar maple (Acer saccharum)	black cherry (Prunus serotina)
Basal area (sq.ft./ac.)	113.3	57.8	21.9	20.7	8.1	4.7
Percent of stand basal area (%)	100	51	19.4	18.3	7.2	4.1
Stems/area (stems/ac.)	3,263.20	1,026.30	1,157.90	868.4	157.9	52.6

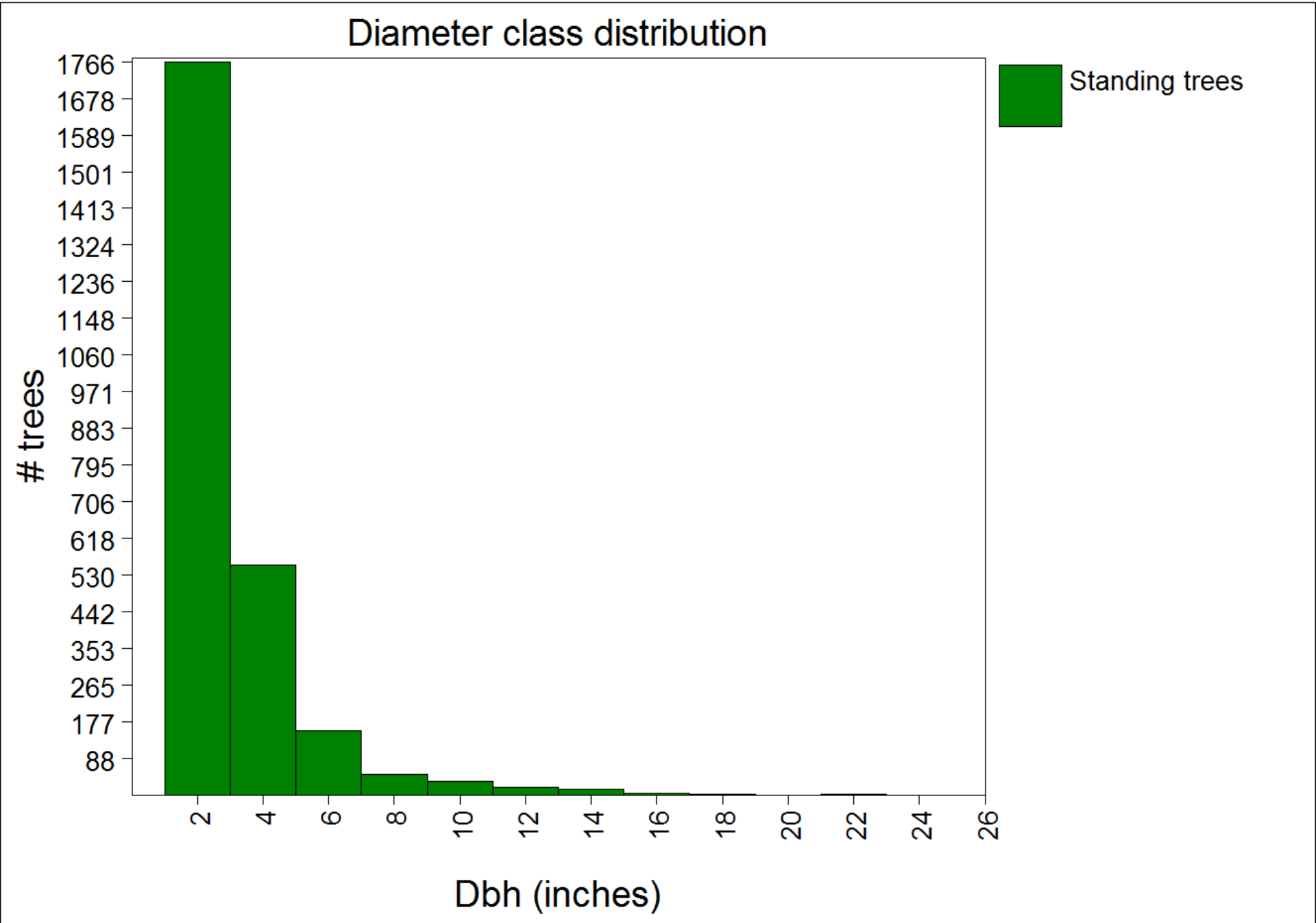
Overstory only

	All species	red maple (Acer rubrum)	sugar maple (Acer saccharum)	yellow birch (Betula alleghaniensis)	black cherry (Prunus serotina)	American beech (Fagus grandifolia)	red spruce (Picea rubens)
Mean DBH (in.)	8.6	8.2	9.5	9.1	8.6	8.2	8.4

Understory only

	All species	red maple (Acer rubrum)	American beech (Fagus grandifolia)	yellow birch (Betula alleghaniensis)	sugar maple (Acer saccharum)	black cherry (Prunus serotina)
Mean DBH (in.)	2.2	2.9	1.7	1.9	2.7	4

Stand 625, Inventory, 2017



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Row Labels	Count of DBH	Average of DBH2	Max of DBH3	Min of DBH4
ABBA	7	7.785714286	9.3	5.6
ACPE	1	6.1	6.1	6.1
ACRU	121	9.819008264	30.8	5.5
ACSA	31	9.203225806	17.6	5.7
BEAL	42	9.84047619	24.1	5.5
FAGR	34	9.144117647	15	6.1
N/A*	1	#DIV/0!	0	0
PIRU	9	9.1	16.3	5.7
PRPE	2	7.3	8.3	6.3
PRSE	16	9.45	15.7	6.1
Grand Total	264	9.529770992	30.8	

Row Labels	Count of DBH	Max of DBH
-	1	0
ACRU	145	18.4
ACSA	68	18.4
BEAL	44	23.7
FAGR	50	15.2
PIRU	2	9.6
PRPE	2	5.7
PRSE	49	15.3

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Strive for the past, or plan for the future?

The Conservancy evaluated if we should focus on restoration, or adaptation/resilience for the future.

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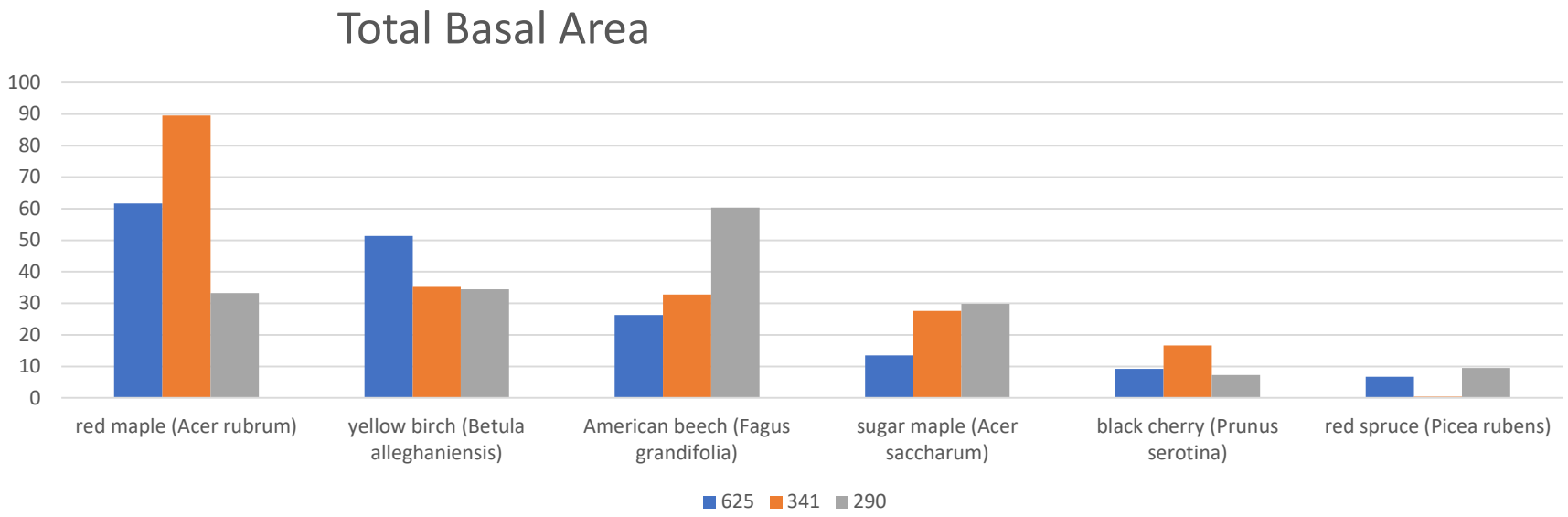
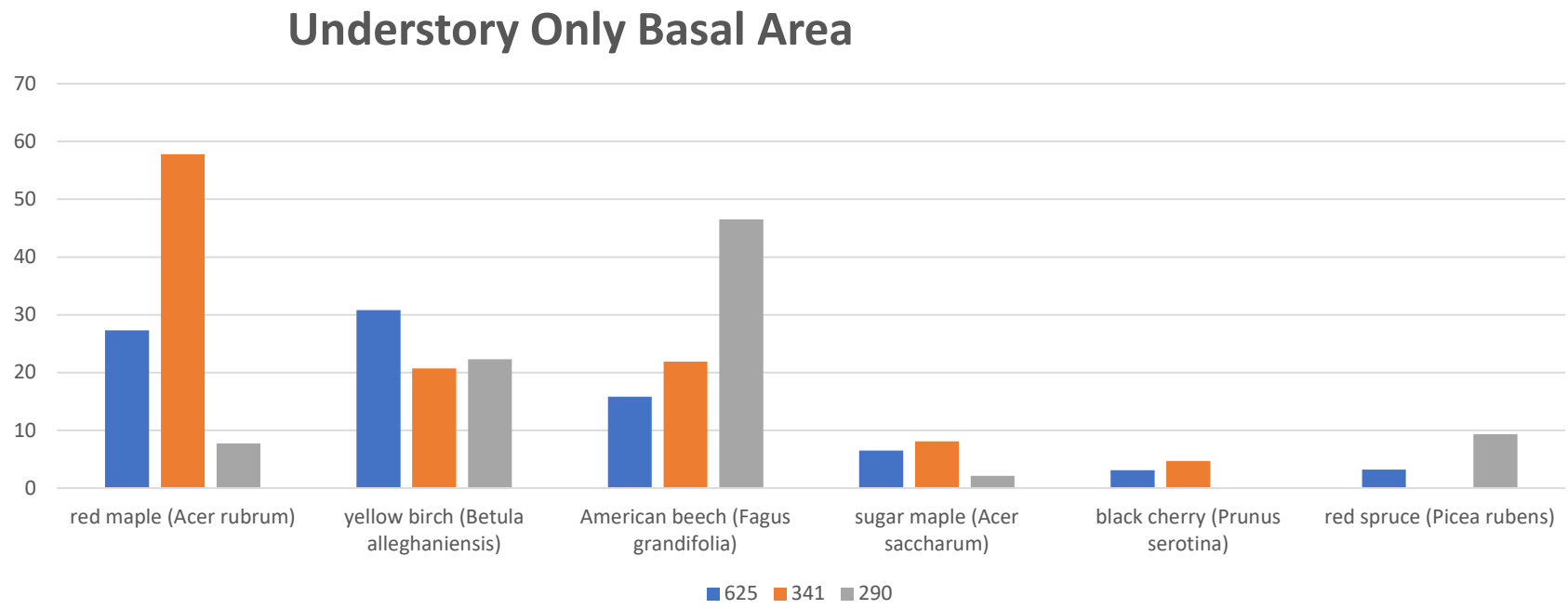
PROJECT II. Release and Small Gap Outcomes

- Reduce density and volume of smaller size classes
- Reduce competition of resources for larger trees
- Release advanced regeneration, especially sugar maple and red spruce.
- Monitor long-term trends.
  - Seedling survival; seedling height growth
  - Forest condition
    - Tree growth
    - Structure
    - Natural regen
  - Cost/time/ROI
  - Carbon projections

Long Term Forest Outcomes

- Across 700 acres in Tug Hill
  - Diversified age class structure
  - Large live trees
  - Greater and more diverse tree regeneration
  - Understory diversity
  - Snags and cavity trees
  - Dead downed wood
- Across the region and northeast;
  - Incorporate some of these resilience and adaption lessons/techniques into forest management plans.


Total Basal Area
100
90
80
70
60
50
40
30
20
10
0
red maple (Acer rubrum)
yellow birch (Betula alleghaniensis)
American beech (Fagus grandifolia)
sugar maple (Acer saccharum)
black cherry (Prunus serotina)
red spruce (Picea rubens)
625
341
290


Understory Only Basal Area
70
60
50
40
30
20
10
0
red maple (Acer rubrum)
yellow birch (Betula alleghaniensis)
American beech (Fagus grandifolia)
sugar maple (Acer saccharum)
black cherry (Prunus serotina)
red spruce (Picea rubens)
625
341
290

Stand 341, Inventory, 2017

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Overstocked Understory

- Using current stand data and reference data of mature uneven-aged northern hardwood stand determined small size classes way over stocked.
  - Strategy to remove on average a couple hundred stems/ac in small size classes of beech and red maple.
  - Using brush saw/basal treatment and hack/squirt.