United States Department of Agriculture
Northern Forests Climate Hub

Strategies & approaches for managing forests for adaptation and mitigation




Todd Ontl

Climate Adaptation Specialist
Northern Institute of Applied Climate Science
Michigan Technological University
Houghton, MI

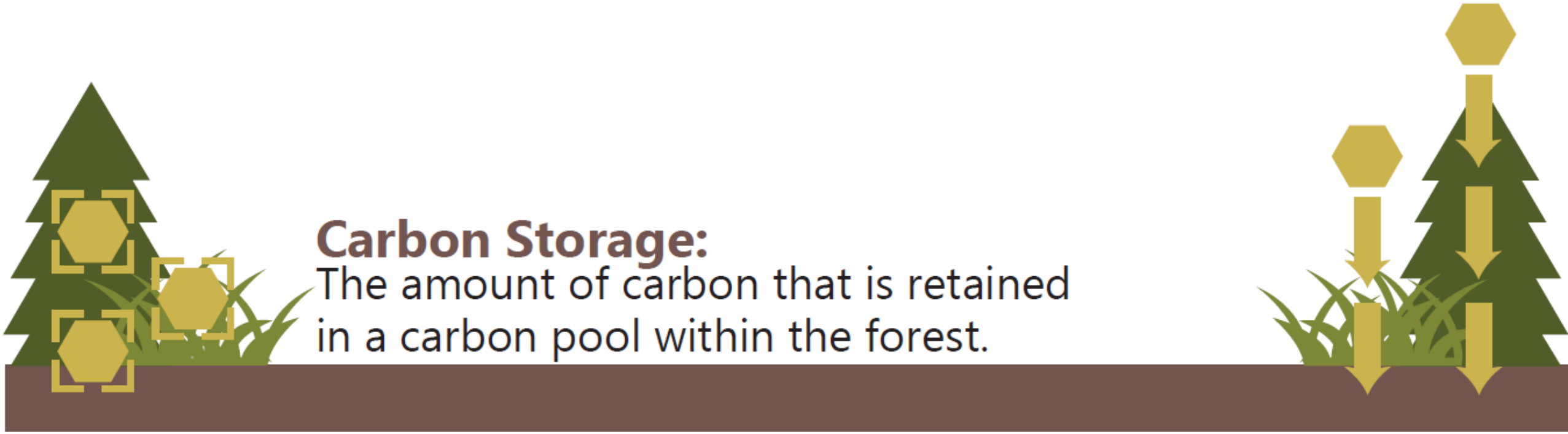
taontl@mtu.edu

US forests:

- Absorb **15%** of total CO_2 emissions
- Contain **68%** of terrestrial carbon stocks
- Are **90%** of the land sector sequestration capacity

A changing climate puts those forests
and the carbon they sequester and store
at risk

Carbon benefits include both carbon *storage* and carbon *sequestration*



Carbon Storage:
The amount of carbon that is retained in a carbon pool within the forest.

Carbon Sequestration:
The process of removing carbon from the atmosphere for use in photosynthesis, resulting in the maintenance and growth of plants and trees.

US forests:

- Absorb **15%** of total CO_2 emissions
- Contain **68%** of terrestrial carbon stocks
- Are **90%** of the land sector sequestration capacity

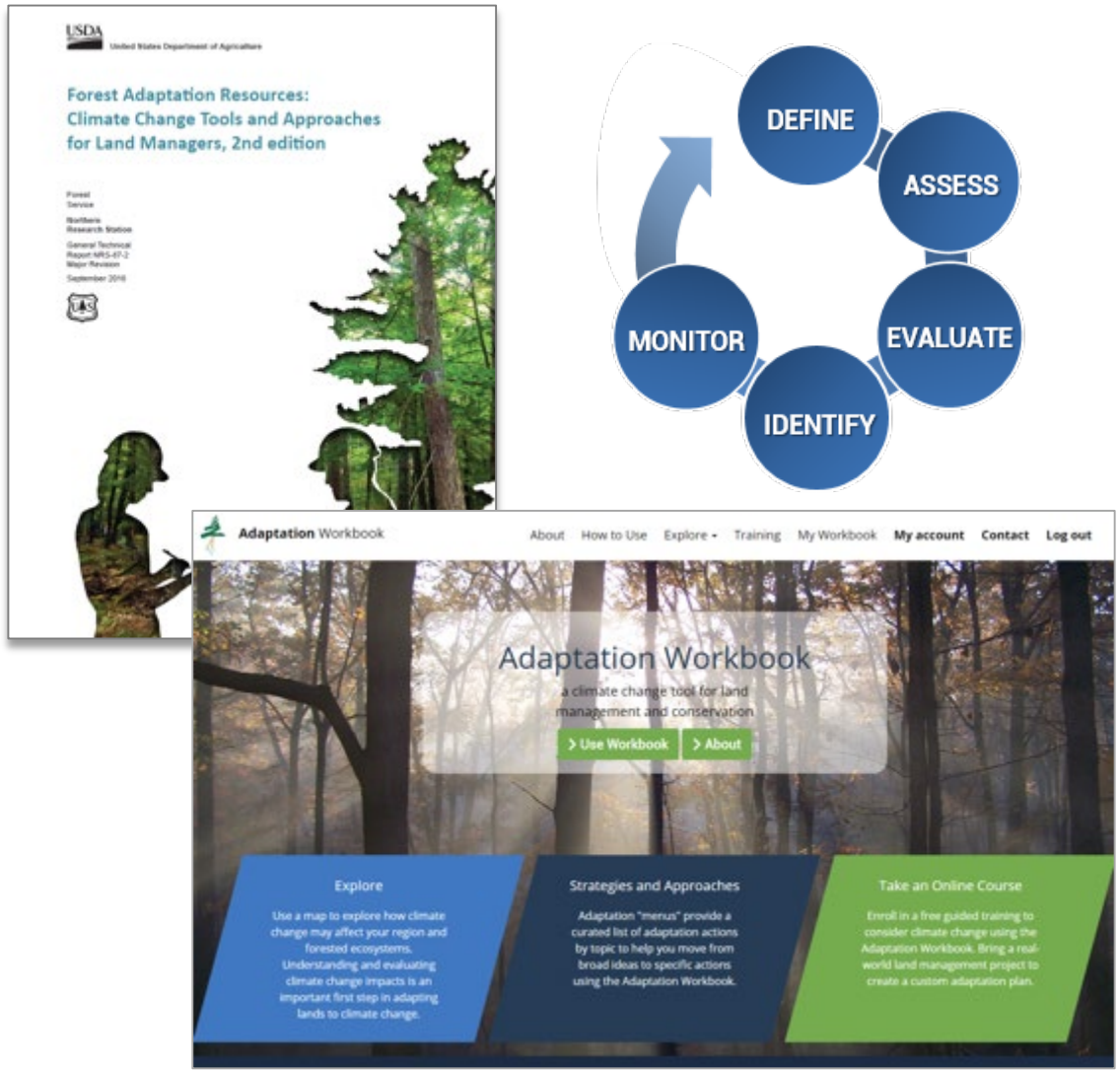
A changing climate puts those forests
and the carbon they sequester and store
at risk

Adaptation Resources

Adaptation actions intentionally address climate change risks to meet project goals and objectives

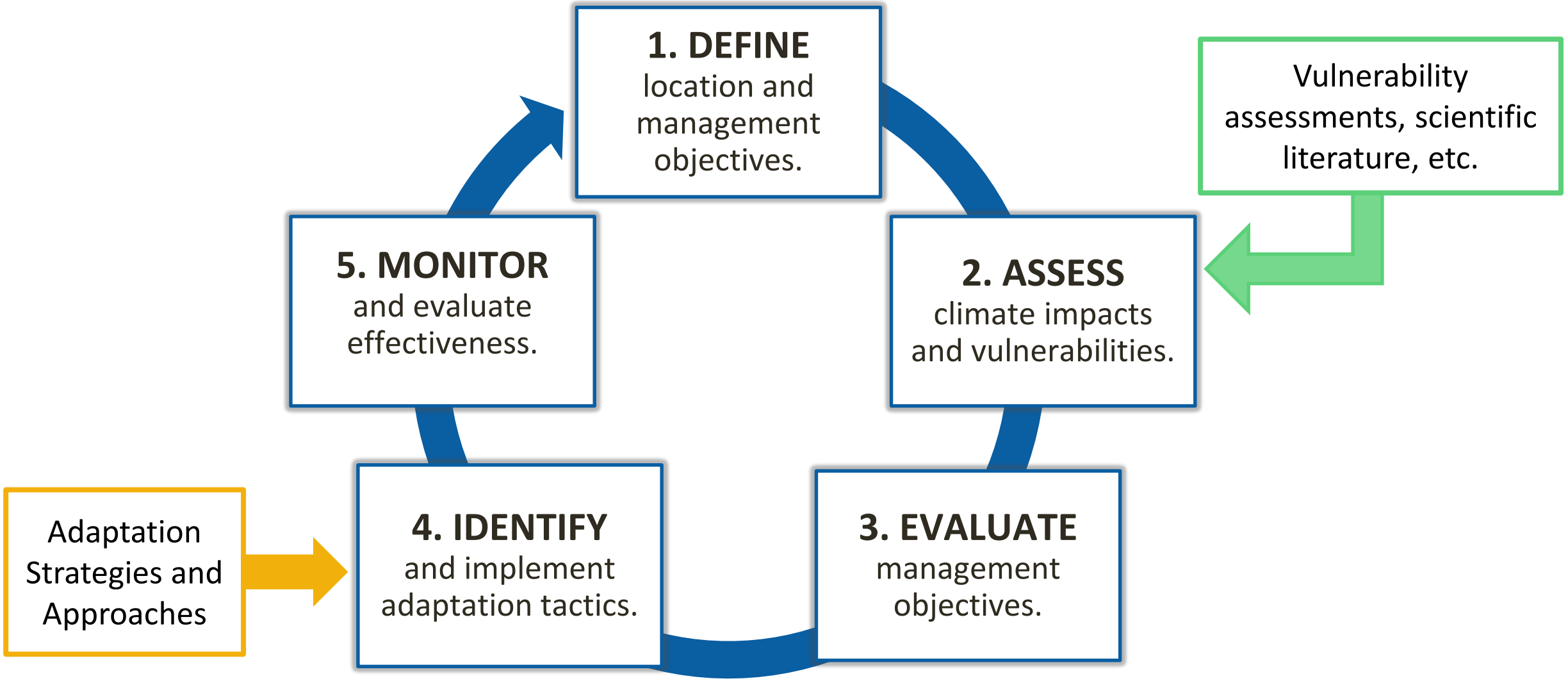
A flexible workbook and menu to address diverse needs of land managers

- Designed for a variety of land owners with diverse goals
- Does not make recommendations
- Includes:
  - Adaptation Workbook
  - Adaptation strategies for different resource areas (menus)



Swanston et al. 2016 (2nd edition); www.treesearch.fs.fed.us/pubs/52760; www.adaptationworkbook.org

Adaptation Workbook

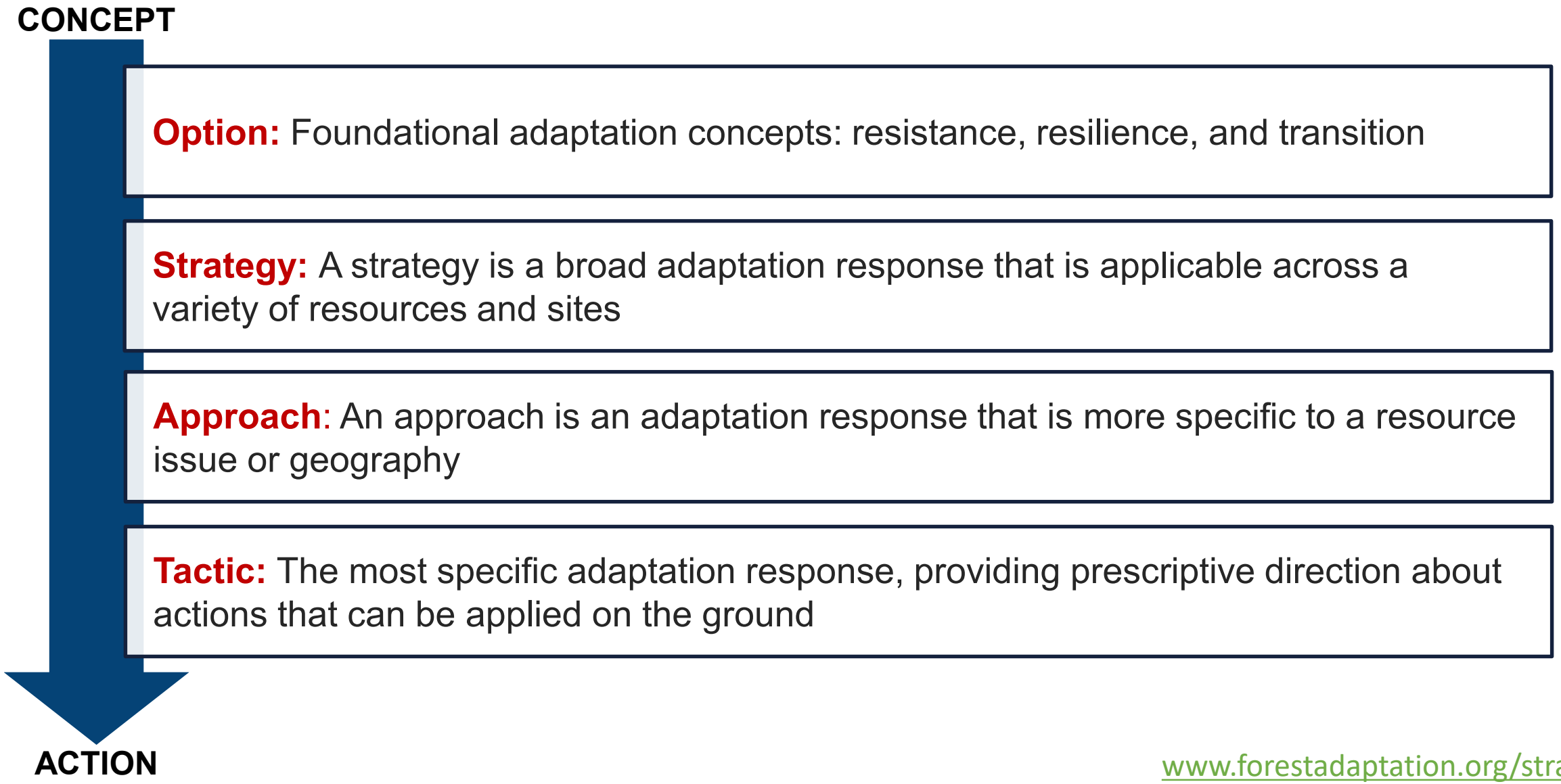


Swanston et al. 2016 (2nd edition) www.nrs.fs.fed.us/pubs/52760; **www.adaptationworkbook.org**

Menus of Adaptation Strategies and Approaches

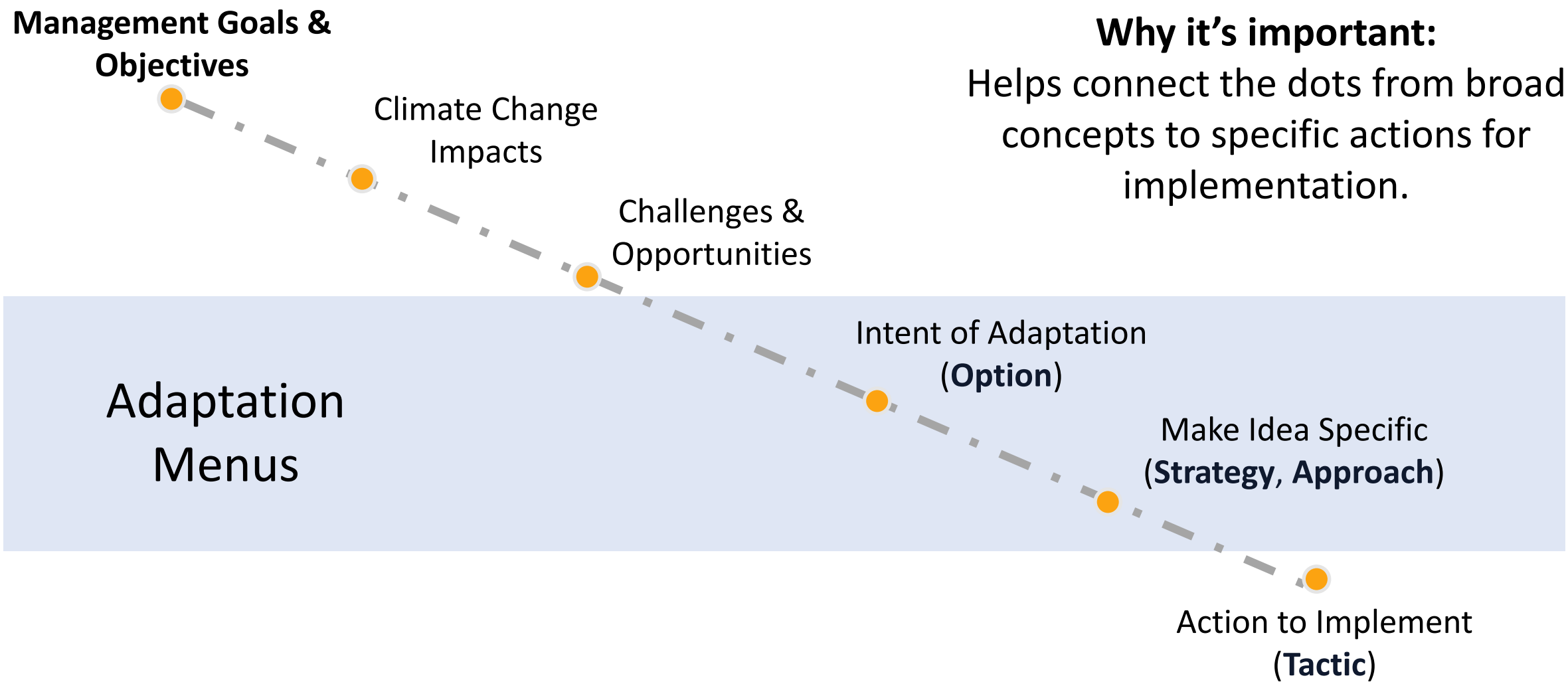
A “menu” of **possible actions** that allows you to decide what is ***most relevant for a particular location and set of conditions.***

Menus of Adaptation Strategies and Approaches



www.forestadaptation.org/strategies

Workbook + Menu



Why it's important:
Helps connect the dots from broad concepts to specific actions for implementation.

Adaptation Planning for Forest Carbon

What should I do here?

Forest carbon management

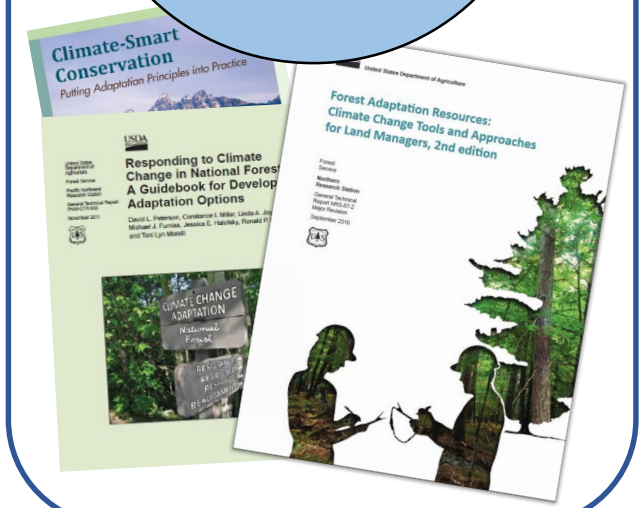
A synthesis of current knowledge on forests and carbon storage in the United States

Forest Carbon Management in the United States

Reforestation can sequester two petagrams of carbon in US topsoils in a century

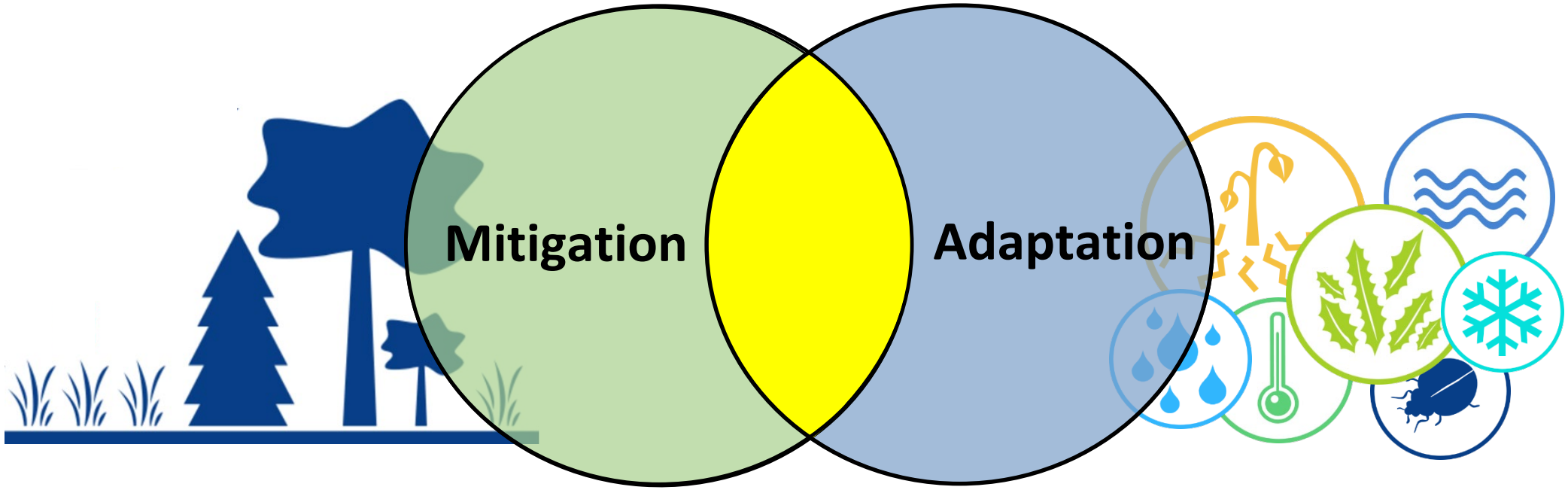
A Synthesis of the Science on Forests and Carbon for U.S. Forests

Forest climate adaptation



Forest Management for carbon sequestration & climate adaptation

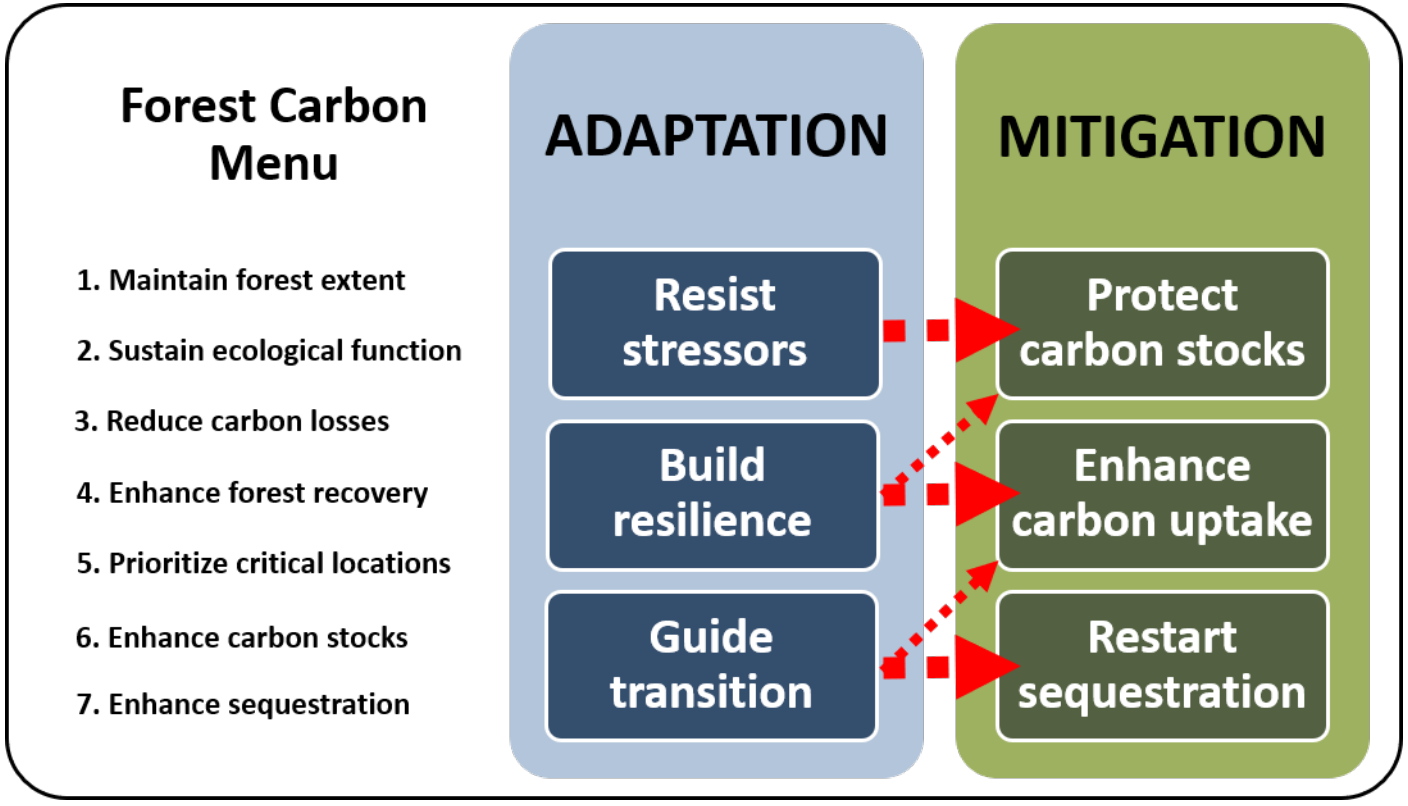
Integrate climate adaptation & mitigation practices for
robust & resilient carbon storage & sequestration



Practitioner's Menu of Strategies and Approaches for Forest Carbon Management

7 strategies, 31 approaches

Builds off of practices for sustainable forest management



Ontl et al. 2020: fs.usda.gov/treesearch/pubs/59214; **ForestAdaptation.org/carbon**

Added value of the Forest Carbon Management menu

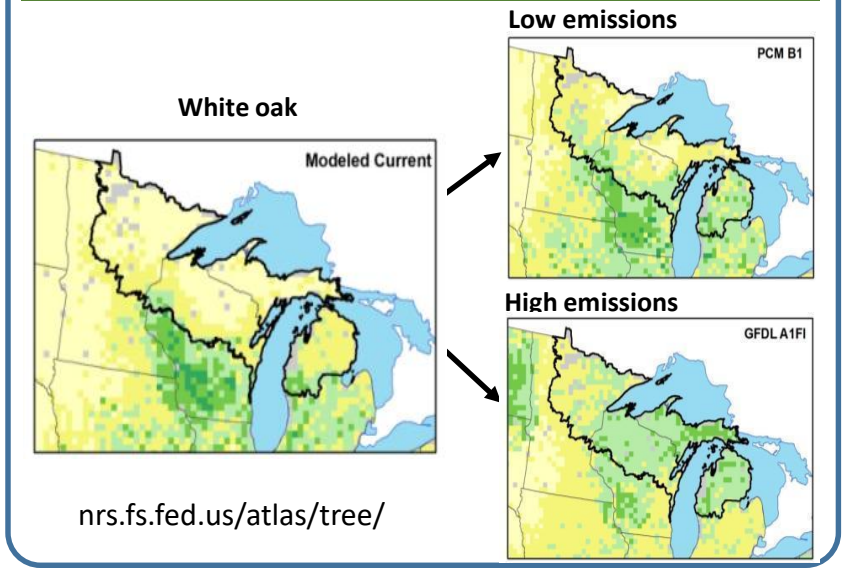
Considering vulnerability to climate and other stressors increases the effectiveness of management actions that enhance forest carbon

Vulnerability to large-scale tree loss from wind events

2019 derecho impacts on the CNNF

Risk of decreasing tree species habitat suitability

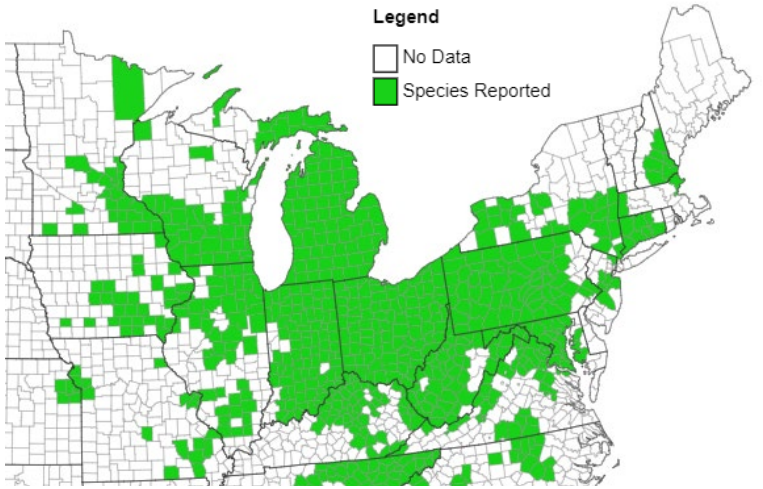
Climate Change Tree Atlas



nrs.fs.fed.us/atlas/tree/

Tree mortality risk from non-native insect pests

Emerald ash borer (*Agrilus planipennis*)



EDDMapS find · map · track

eddmaps.org/distribution

Added value of the Forest Carbon Management menu

Considering an array of options helps managers identify unseen opportunities to maintain or enhance desired outcomes

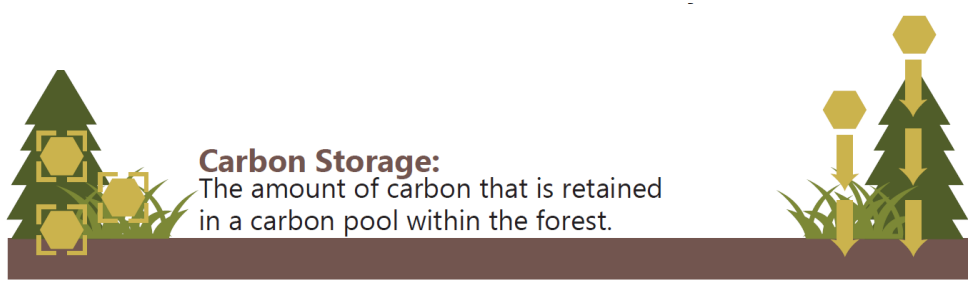
Existing carbon pools

Forest productivity & regeneration

Other desired co-benefits

Carbon FAQs: *Do forests accrue carbon forever?*

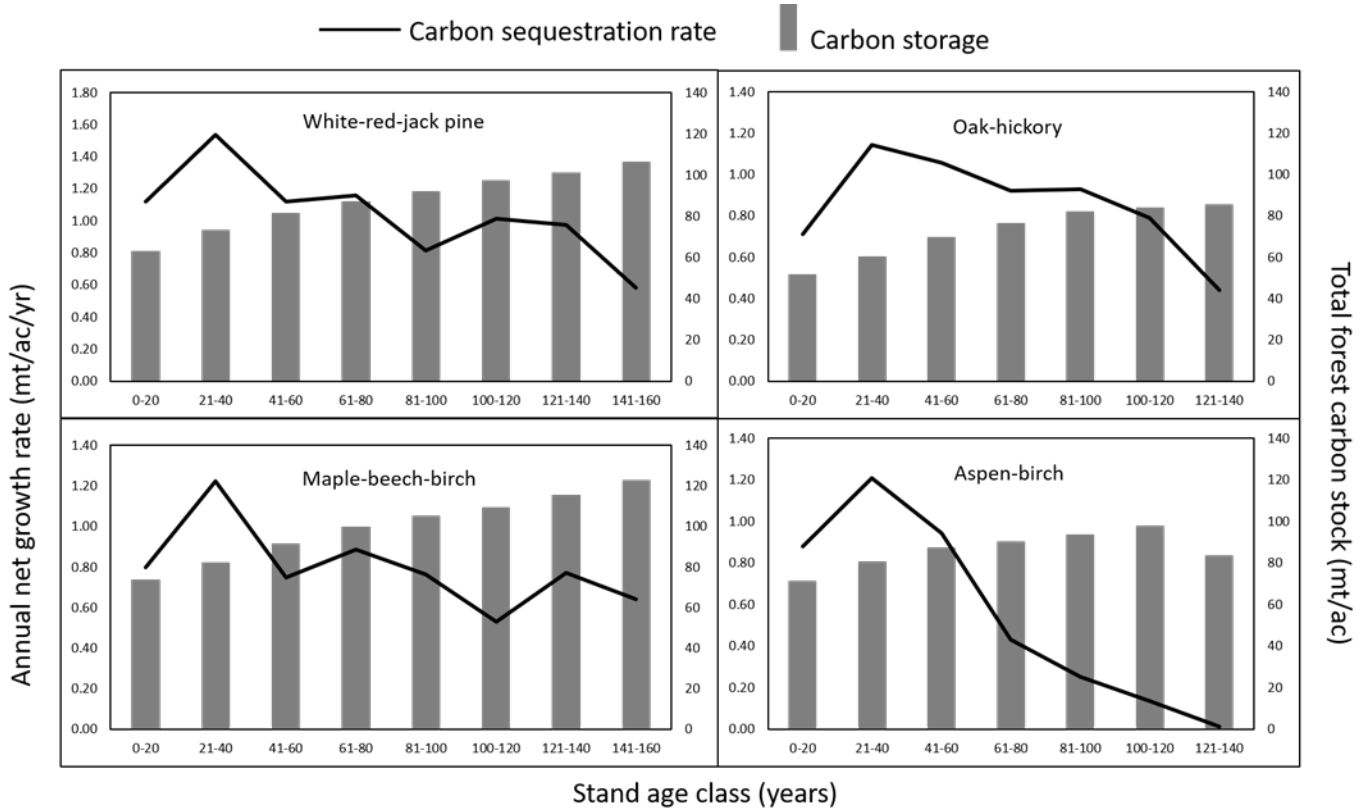
Carbon FAQs: *Do forests sequester carbon forever?*



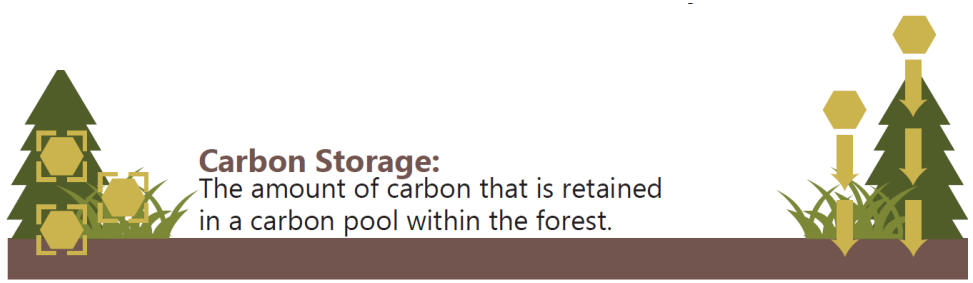
Carbon Storage:
The amount of carbon that is retained in a carbon pool within the forest.

Carbon Sequestration:
The process of removing carbon from the atmosphere for use in photosynthesis, resulting in the maintenance and growth of plants and trees.

FIA data for four forest type groups in MI, MN, and WI



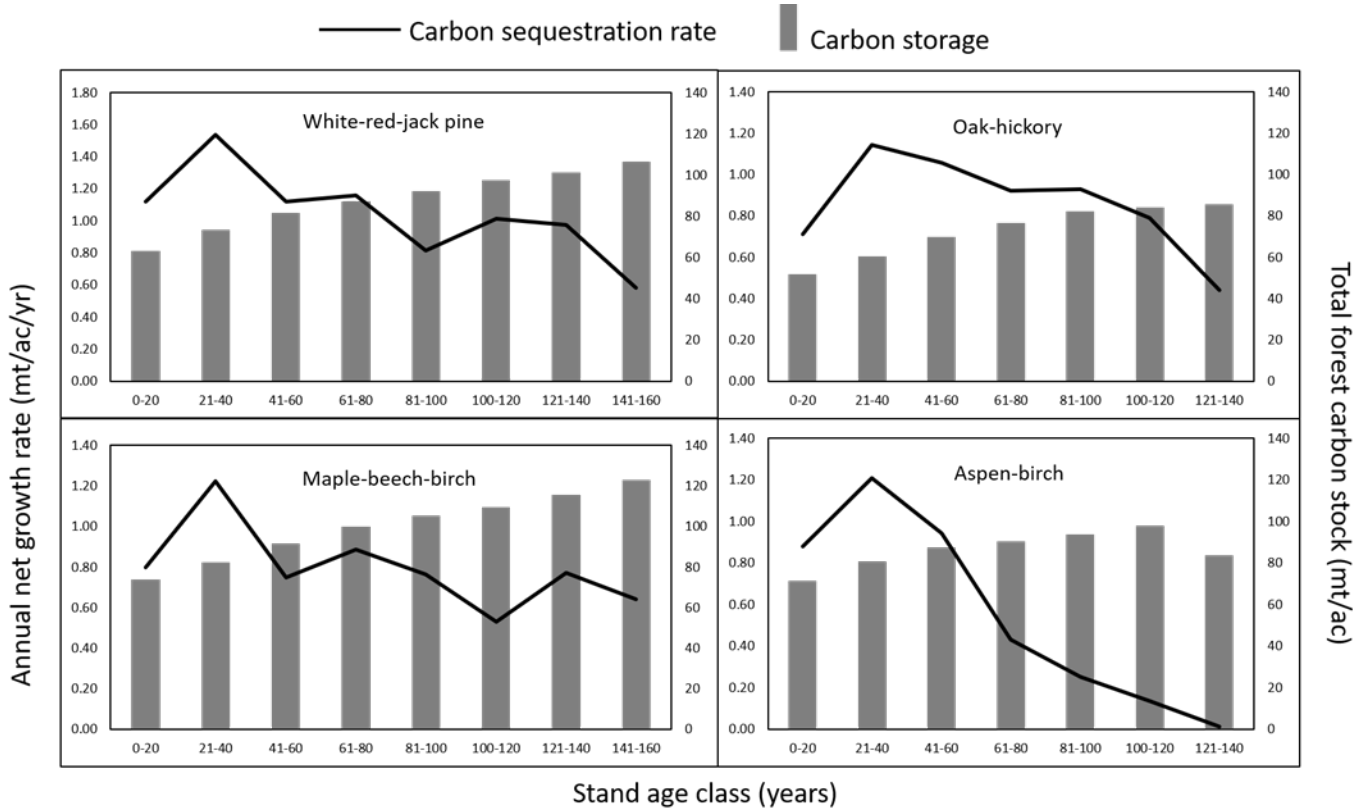
Carbon FAQs: *Do forests accrue carbon forever?*



Carbon Storage:
The amount of carbon that is retained in a carbon pool within the forest.

Carbon Sequestration:
The process of removing carbon from the atmosphere for use in photosynthesis, resulting in the maintenance and growth of plants and trees.

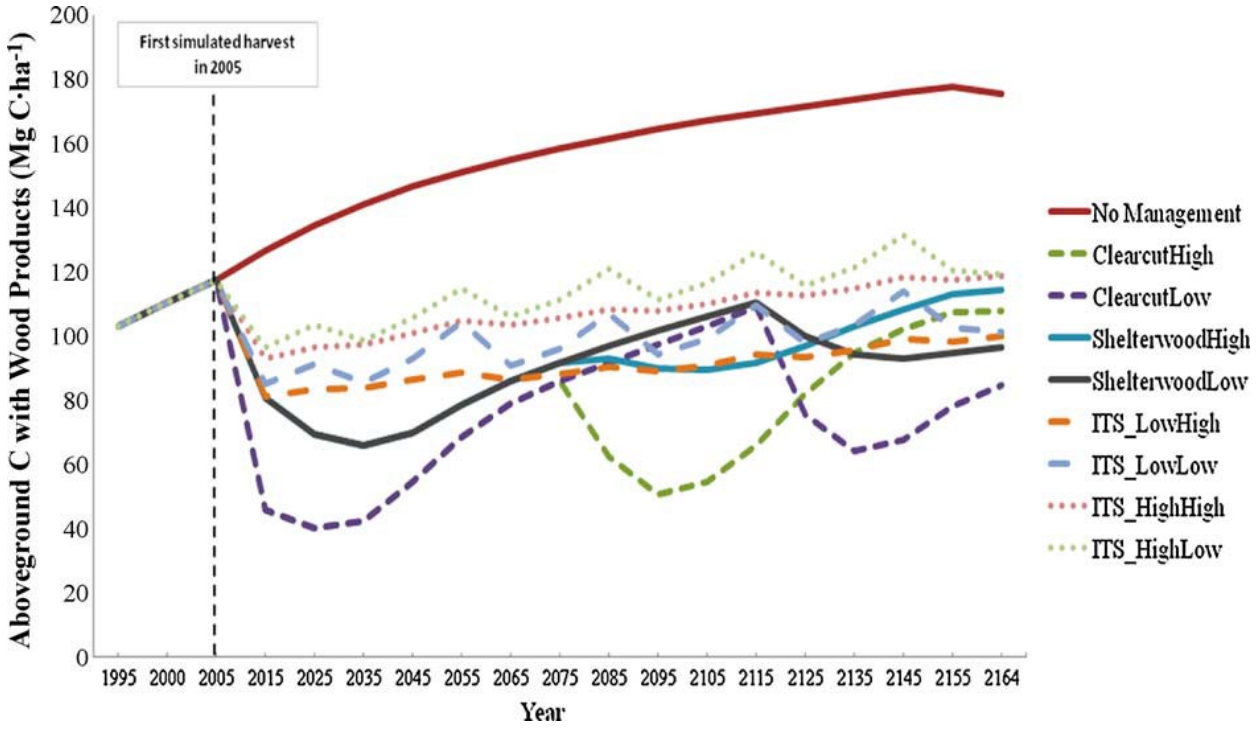
FIA data for four forest type groups in MI, MN, and WI



"Moderate-severity disturbance may sustain [carbon sequestration] at higher than expected rates in aging forests by the introduction of physical & biological complexity as the leaf area recovers. Canopies made more complex and physiologically efficient through periodic moderate disturbance may sustain [carbon sequestration] later into ecosystem development" (Curtis and Gough 2018).

Carbon FAQs: *Isn’t stopping all forest harvests the best thing for carbon?*

Carbon FAQs: *Isn't stopping all forest harvests the best thing for carbon?*



Nunery and Keeton 2010

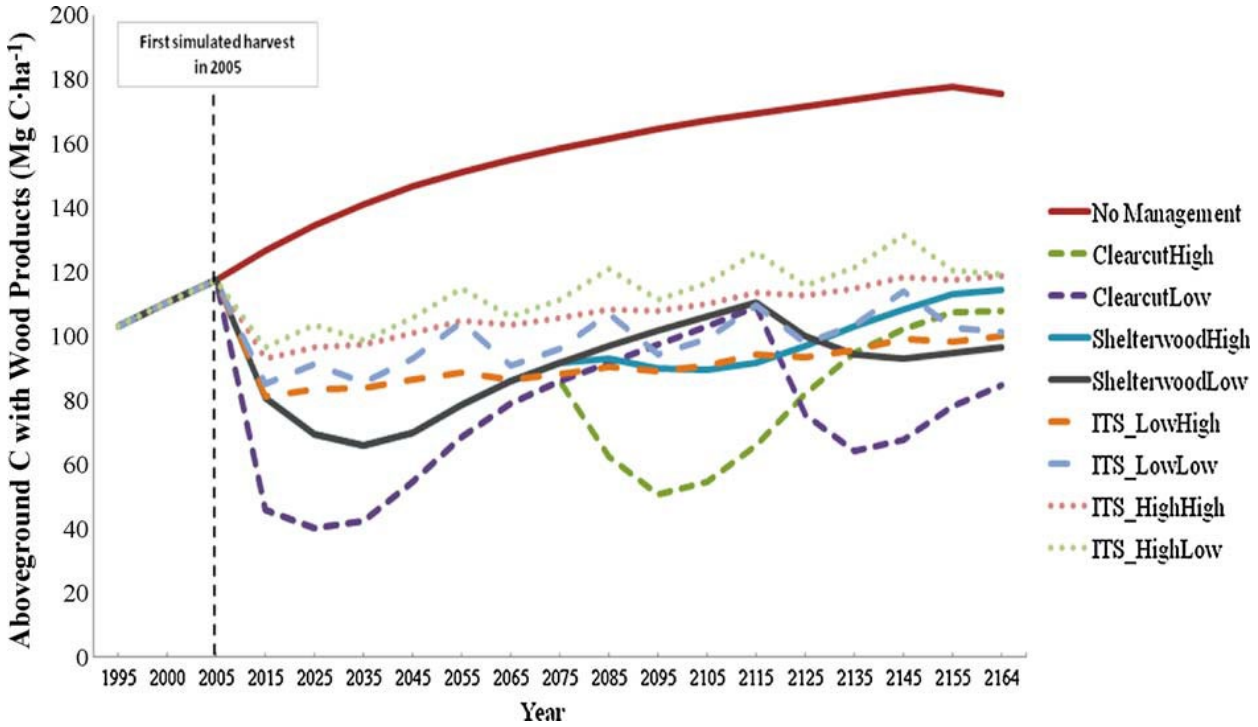
Modeling studies often <u>assume climate stationarity.</u>

Most models do not incorporate:

- Projected changes in temperature, precipitation
- Increased disturbance frequencies
- Enhanced mortality from drought, insect pest outbreaks or new pathogens, etc

~~Carbon FAQs:~~ ~~*Isn't stopping all forest harvests the best thing for carbon?*~~

*What management practices can we implement to reduce our climate risk and **increase** carbon compared to BAU management*



Nunery and Keeton 2010

Modeling studies often assume climate stationarity.

Most models do not incorporate:

- Projected changes in temperature, precipitation
- Increased disturbance frequencies
- Enhanced mortality from drought, insect pest outbreaks or new pathogens, etc

Carbon FAQs: *Does the type of tree matter when it comes to carbon, or can I plant anything?*

Carbon FAQs: *Does the type of tree matter when it comes to carbon, or can I plant anything?*

Fast growing trees sequester carbon quickly, but can produce weak wood that is prone to storm damage, or have short life-spans

- Silver maple
- Box elder

Slow growing trees often have strong carbon-dense wood and have long life-spans, but very slow sequestration rates

- Bur/ white oaks
- Shagbark/ shellbark hickories

Carbon FAQs: *Does the type of tree matter when it comes to carbon, or can I plant anything?*

Fast growing trees sequester carbon quickly, but can produce weak wood that is prone to storm damage, or have short life-spans

- Silver maple
- Box elder

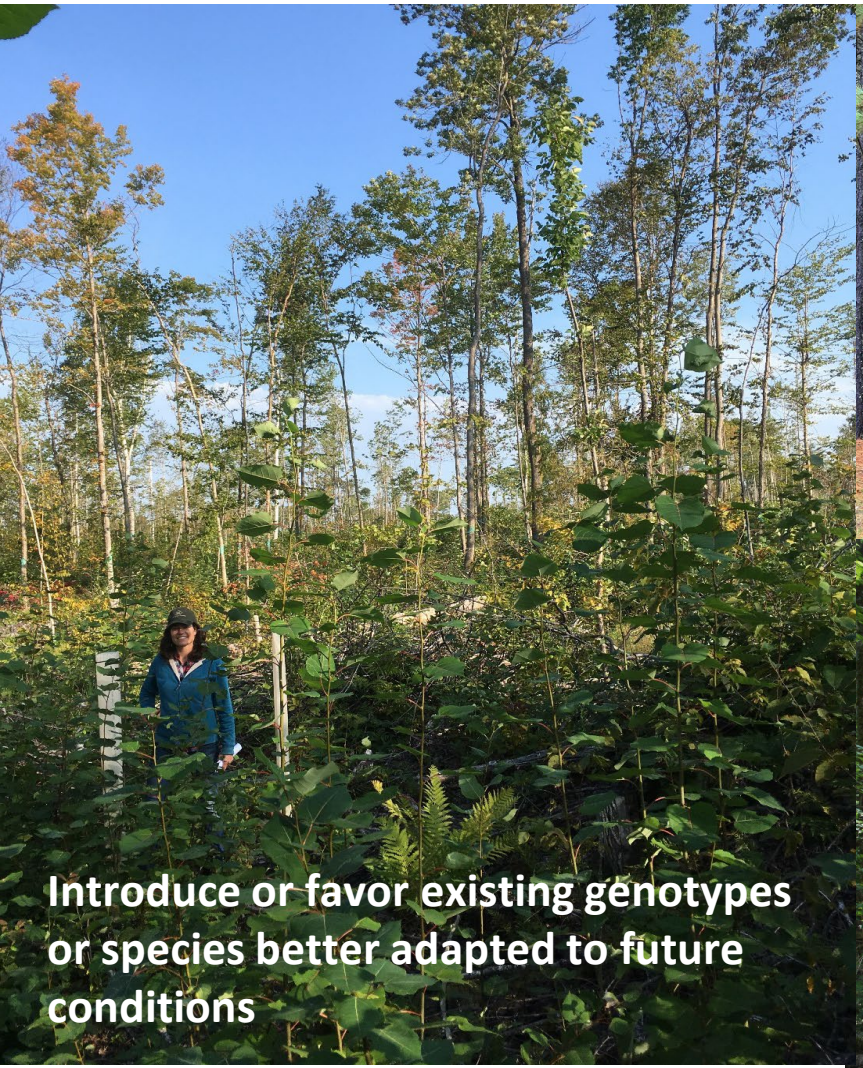
Slow growing trees often have strong carbon-dense wood and have long life-spans, but very slow sequestration rates

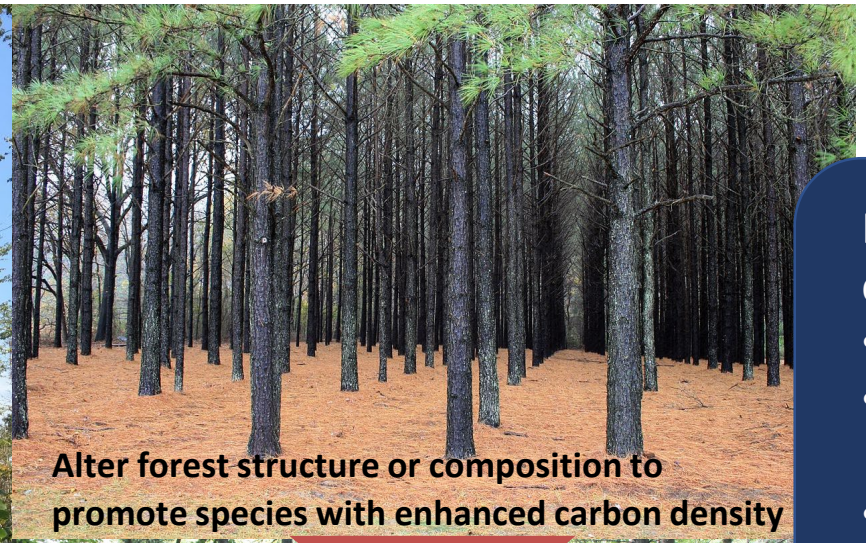
- Bur/ white oaks
- Shagbark/ shellbark hickories

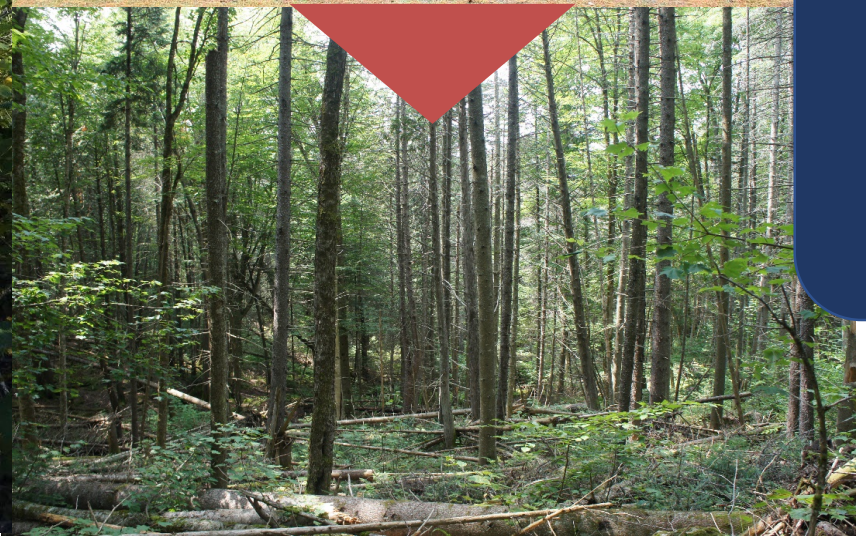
Look for the carbon rock stars!! Large, fast-growing & long-lived tree species:

- Pin/ northern red oaks
- Sycamore
- Tulip tree
- Black walnut

Carbon FAQs: *Does the type of tree matter when it comes to carbon, or can I plant anything?*







Management plays a key role for forest carbon:

- Species and structural diversity
- Retaining existing legacy trees, snags, CWD
- Match tree species to site conditions:
  - Sandy, dry soils
  - Cool, moist sites: draws, N-facing slopes
  - Frequently flooded areas

CLIMATE CHANGE
RESPONSE FRAMEWORK

Who we are | Assess | Adapt | Learn | Focus | Contact

There's no single answer for responding to climate change

Our team will work with you to find solutions that fit your individual needs.

> Learn More

Understanding risk

Climate change introduces uncertainty about future conditions and increases challenges for natural resource managers interested in sustaining

Adaptation in action

Responding to climate change requires an approach that tailors actions to the unique needs of a particular project.

forestadaptation.org/adapt/demonstration-projects
forestadaptation.org/focus/forest-carbon-management

Case Study: Minnesota DNR

Split Rock Lighthouse State Park

The Nature Conservancy – MN DNR partnership.

- Historic logging followed by fire
- Lack of regeneration
- <25% stocked stands

Goal to reforest areas of degraded aspen-birch forest on state lands in the north shore highlands region for:

- Carbon sequestration
- Aesthetic value for park visitors
- Stabilizing soils

forestadaptation.org/adapt/demonstration-projects/minnesota-department-natural-resources-split-rock-lighthouse-state

Case Study: Minnesota DNR

Challenges

Warming winters:

- Intensify deer herbivory
- Tree pests and pathogens

Increased drought frequency + drought-prone soils

Rising temperatures

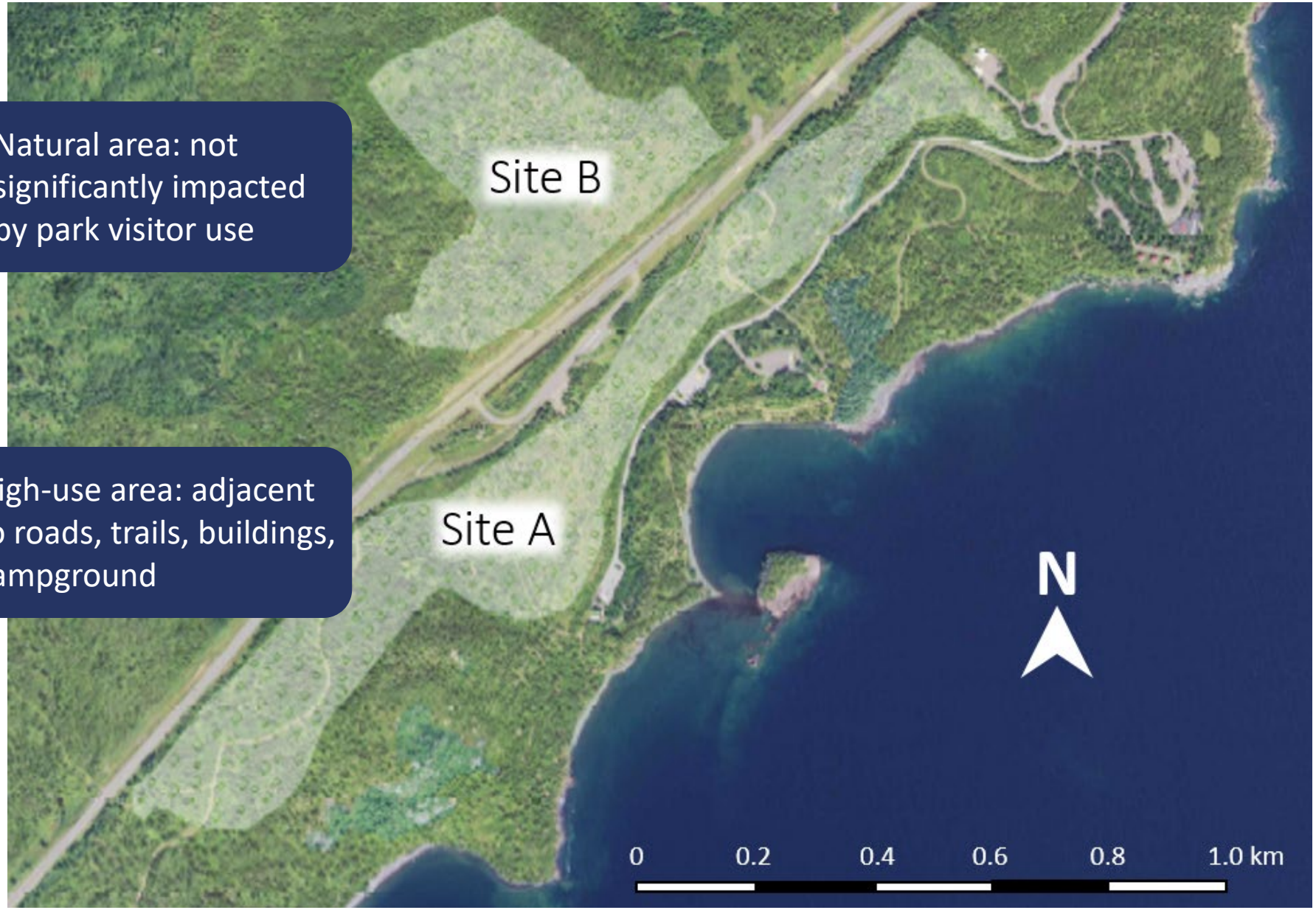
Extreme storms causing soil erosion

Photo courtesy of Chel Anderson/ Minnesota Conservation Volunteer

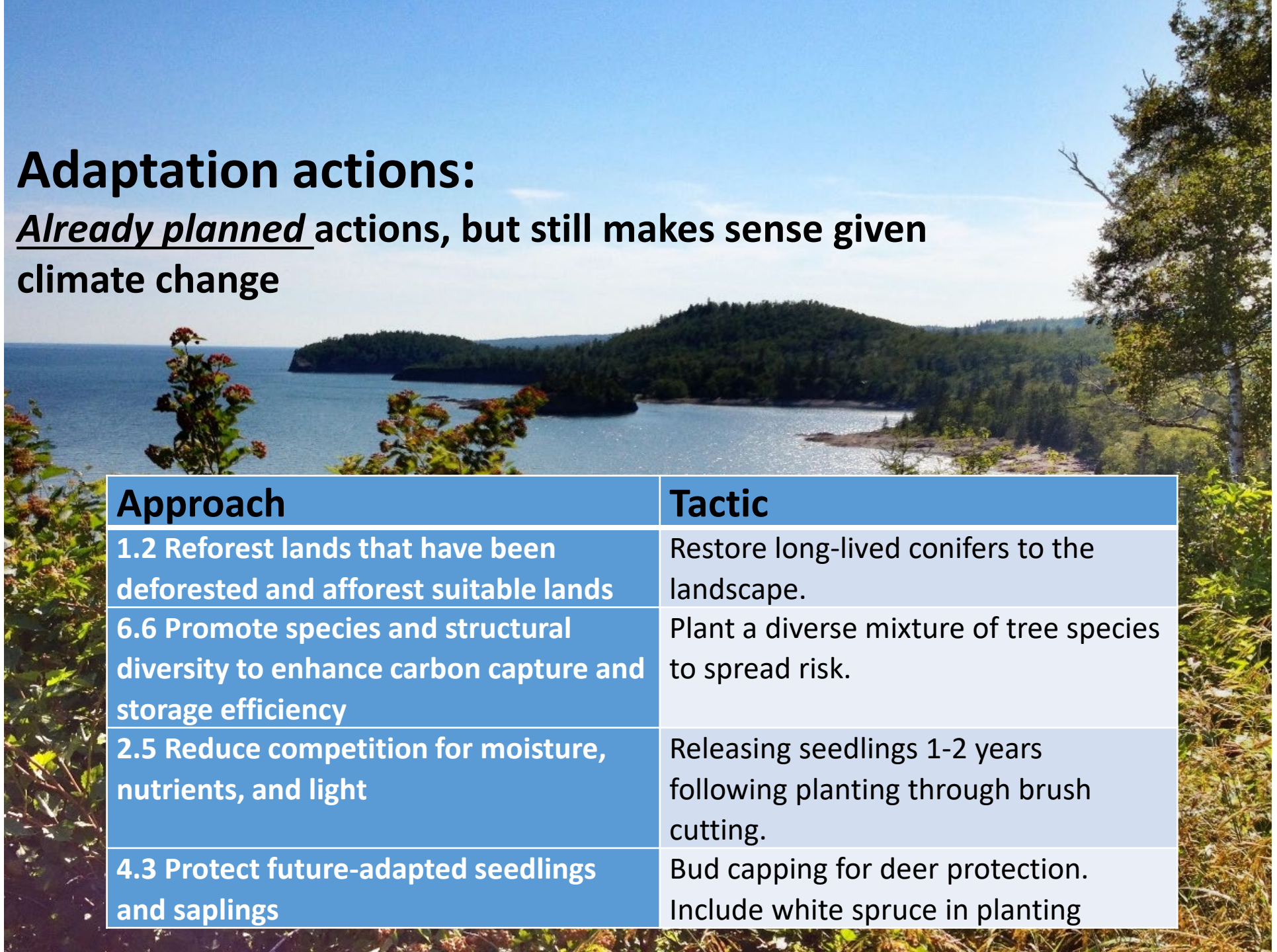
Case Study: Minnesota DNR

Natural area: not significantly impacted by park visitor use

High-use area: adjacent to roads, trails, buildings, campground



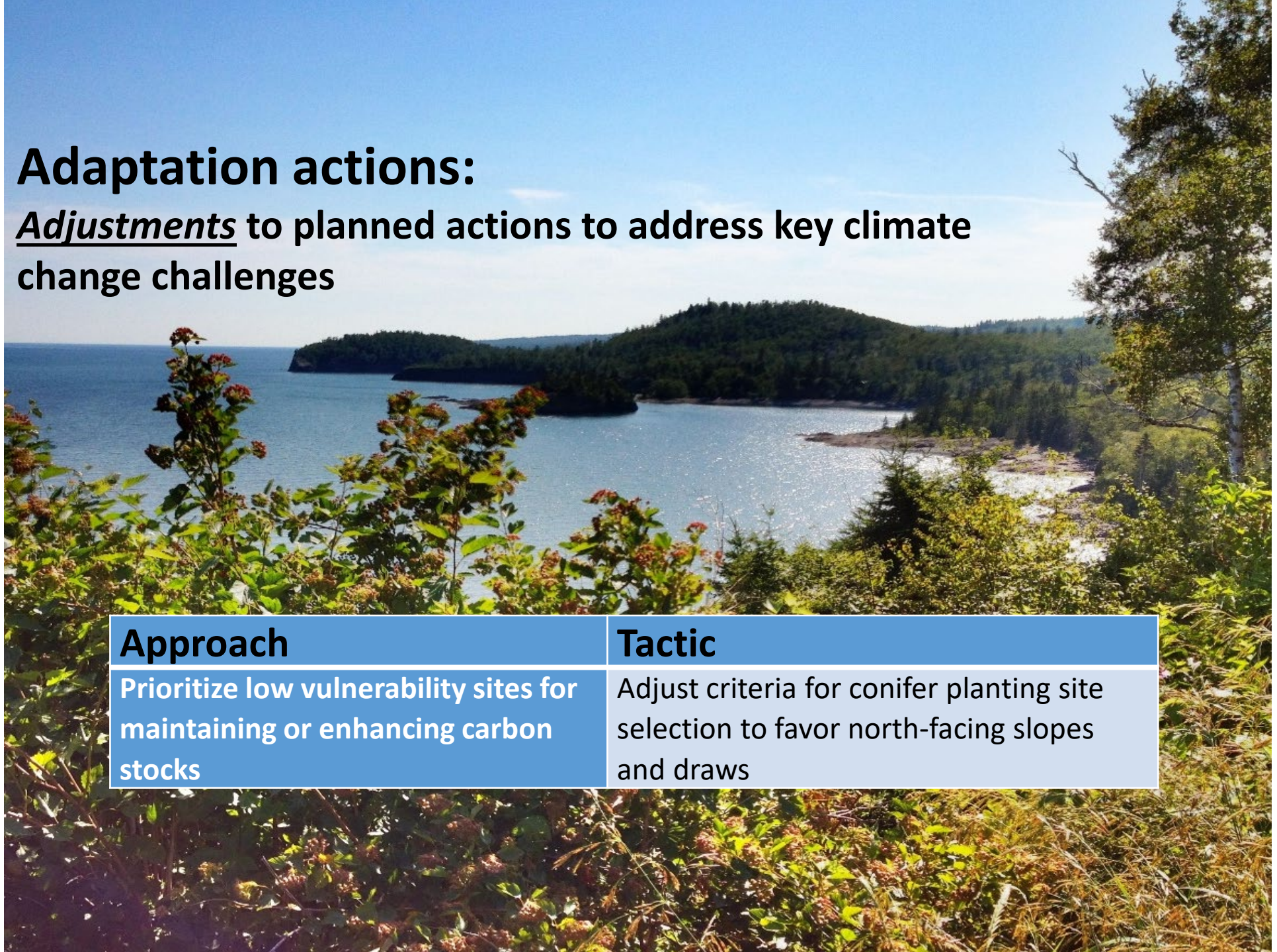
Map courtesy of Samuel Reed, University of Minnesota



Adaptation actions:

Already planned actions, but still makes sense given climate change

Approach	Tactic
1.2 Reforest lands that have been deforested and afforest suitable lands	Restore long-lived conifers to the landscape.
6.6 Promote species and structural diversity to enhance carbon capture and storage efficiency	Plant a diverse mixture of tree species to spread risk.
2.5 Reduce competition for moisture, nutrients, and light	Releasing seedlings 1-2 years following planting through brush cutting.
4.3 Protect future-adapted seedlings and saplings	Bud capping for deer protection. Include white spruce in planting



Adaptation actions:

Adjustments **to planned actions to address key climate change challenges**

Approach	Tactic
Prioritize low vulnerability sites for maintaining or enhancing carbon stocks	Adjust criteria for conifer planting site selection to favor north-facing slopes and draws

Adaptation actions:

New actions identified using the Forest Carbon Management Menu

Approach	Tactic
6.1 Increase structural complexity through retention of biological legacies in living and dead wood	Retaining healthy individuals of birch and aspen
7.1 Favor existing species or genotypes that are better adapted to future conditions	Planting existing species expected to be better adapted to future conditions
6.7 Use seeds, germplasm, and other genetic material from across a greater geographic range	**SITE A ONLY:** Planting southern genotypes of red oak & other future-adapted species regionally present

Integrating climate vulnerability case study:

Community Forests International

Whaelghinbran Hemlock stand

Integrating climate vulnerability case study:

Community Forests International

Whaelghinbran Hemlock stand

- Whaelghinbran Forest is a 693-acre property located in New Brunswick, Canada
- Forest carbon offsets project since 2012
- Property has a 20-acre pure hemlock stand storing lots of (sold) carbon
- *Can we proactively mitigate the probable effects of Hemlock Woolly Adelgid?*

Integrating climate vulnerability case study: Whaelghinbran Hemlock stand

Management goals

- Improve the resistance of a portion of mature hemlock to HWA
- Increase species diversity within the stand
- Maintain carbon stocks

Climate impacts

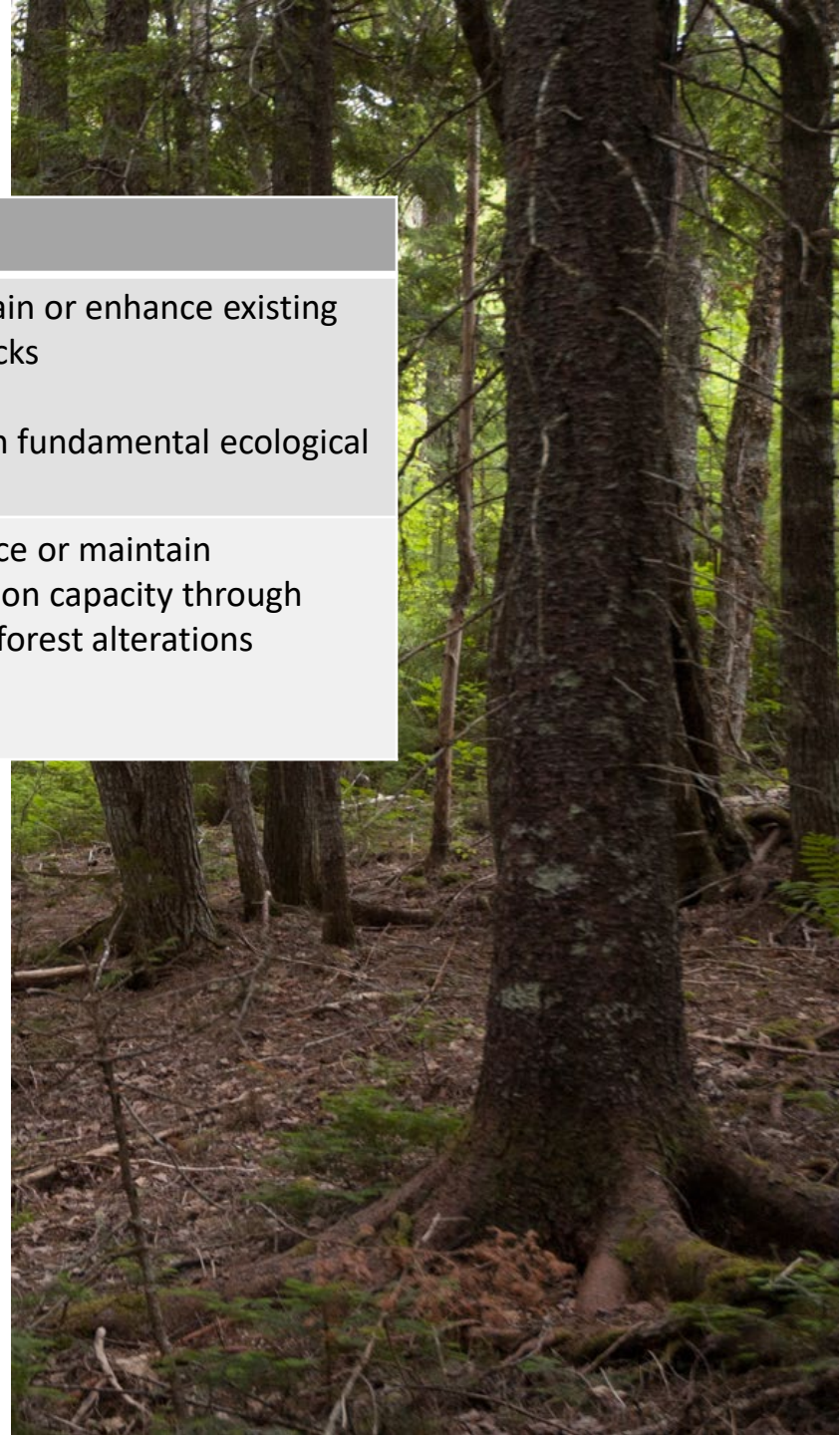
Warming winters:

- Longer growing season
- Increased growing degree days
- Increased insect pests from northward expansion (HWA impacts anticipated in <10 years)

Increased frequency and intensity of precipitation

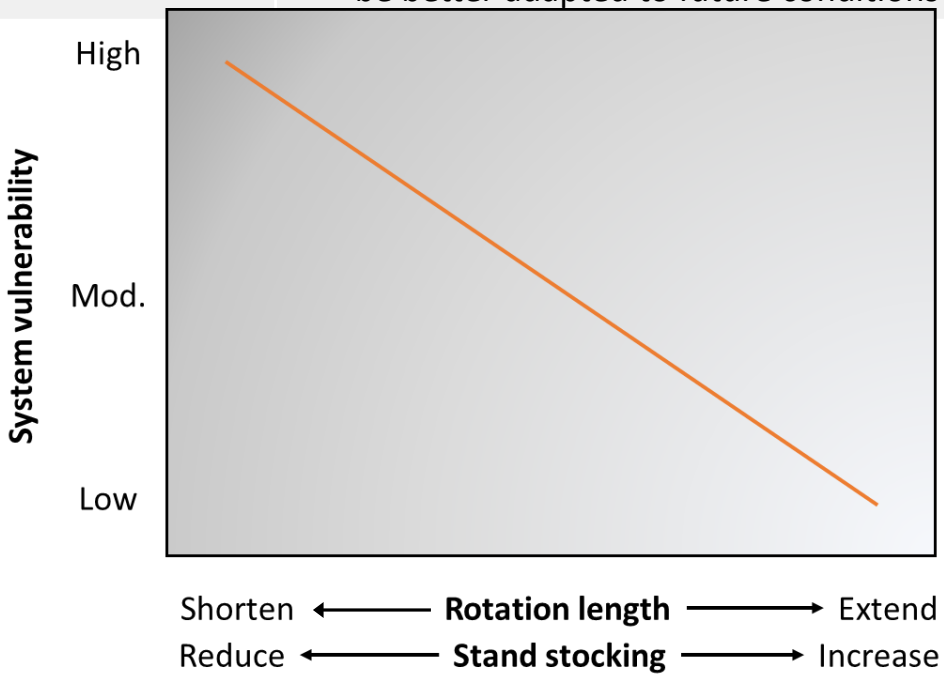
Integrating climate vulnerability case study: Whaelghinbran Hemlock stand

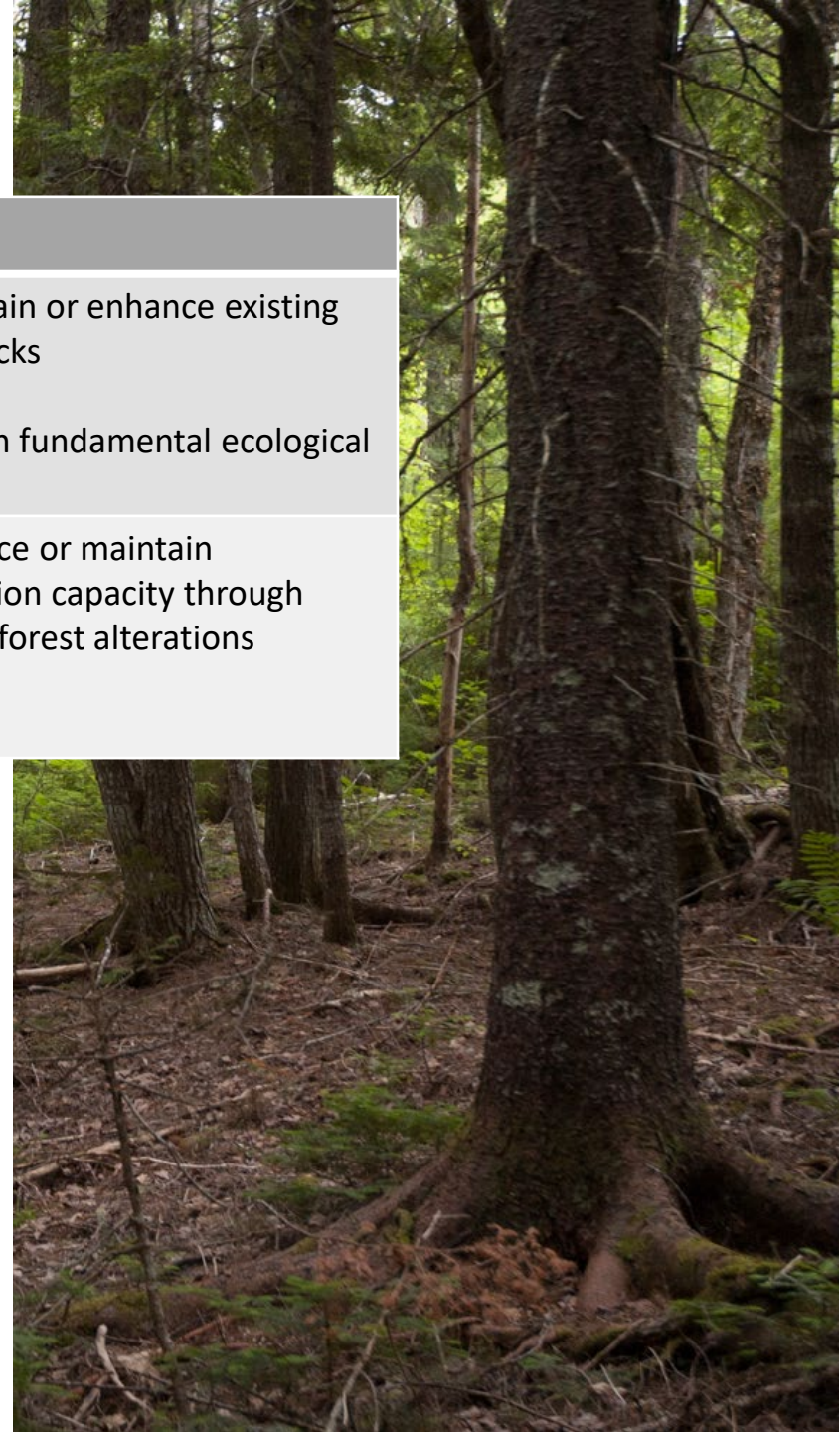
Tactic	Approach	Strategy
Harvest ~30% of the overstory hemlock, uniformly distributed through the stand, to open the canopy	• [6.3] Increase harvest frequency or intensity because of greater risk of tree mortality • [2.4] Maintain or improve the ability of forests to resist pests and pathogens	• [S6] Maintain or enhance existing carbon stocks • [S2] Sustain fundamental ecological functions
Encourage climate-adapted species by planting to augment natural regeneration.	• [7.1] Favor existing species that are better adapted to future conditions • [7.4] Introduce species that are expected to be better adapted to future conditions	• [S7] Enhance or maintain sequestration capacity through significant forest alterations



Integrating climate vulnerability case study: Whaelghinbran Hemlock stand

Tactic	Approach	Strategy
Harvest ~30% of the overstory hemlock, uniformly distributed through the stand, to open the canopy	• [6.3] Increase harvest frequency or intensity because of greater risk of tree mortality • [2.4] Maintain or improve the ability of forests to resist pests and pathogens	• [S6] Maintain or enhance existing carbon stocks • [S2] Sustain fundamental ecological functions
Encourage climate-adapted species by planting to augment natural regeneration.	• [7.1] Favor existing species that are better adapted to future conditions • [7.4] Introduce species that are expected to be better adapted to future conditions	• [S7] Enhance or maintain sequestration capacity through significant forest alterations

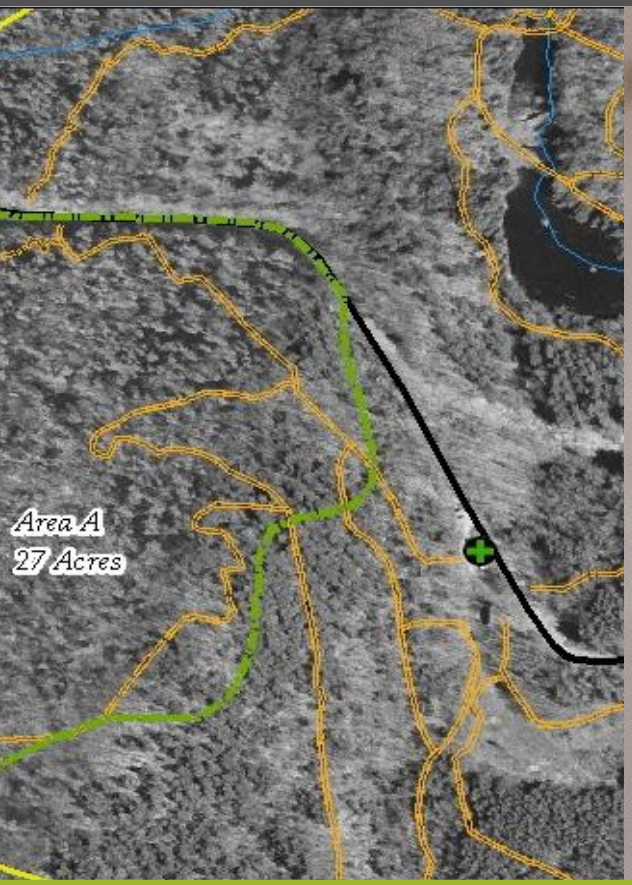




Identifying climate co-benefits case study:

Audubon Vermont

Green Mountain Audubon Center



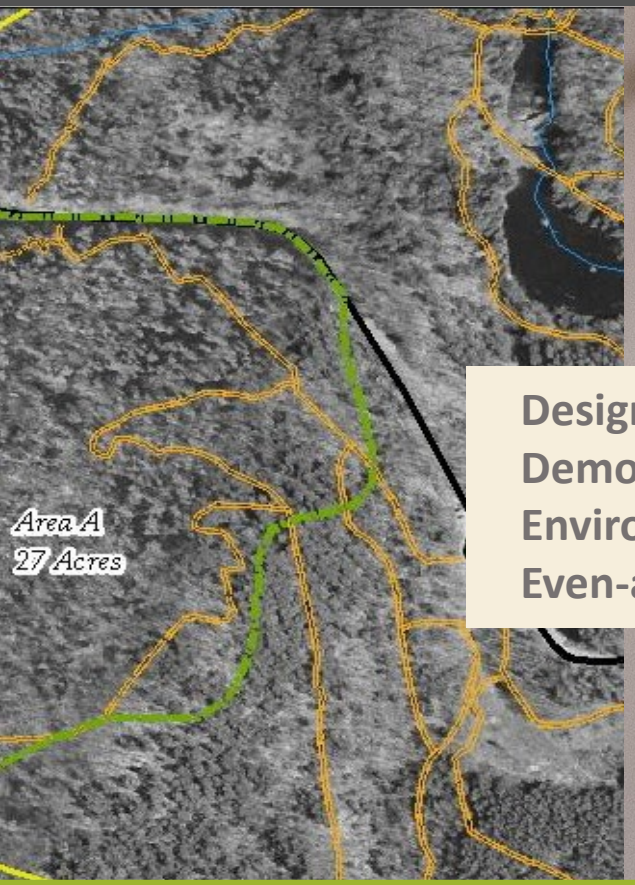
https://forestadaptation.org/GMAC

Audubon Vermont/ Alberto Lopez

Identifying climate co-benefits case study:

Audubon Vermont

Green Mountain Audubon Center



Designated Important Bird Area
Demonstration site for Foresters for the Birds
Environmental education, scientific research, and outdoor recreation
Even-aged, multi-strata northern hardwood stands

GREEN MOUNTAIN Audubon CENTER

https://forestadaptation.org/GMAC

Audubon Vermont/ Alberto Lopez

Integrating climate co-benefits case study: Green Mountain Audubon Center

Management goals

- Neotropical songbird breeding habitat
- Increase sawtimber quantity & quality
- Increase understory development
- Increase regeneration through controlling beech
- Control invasive plant species

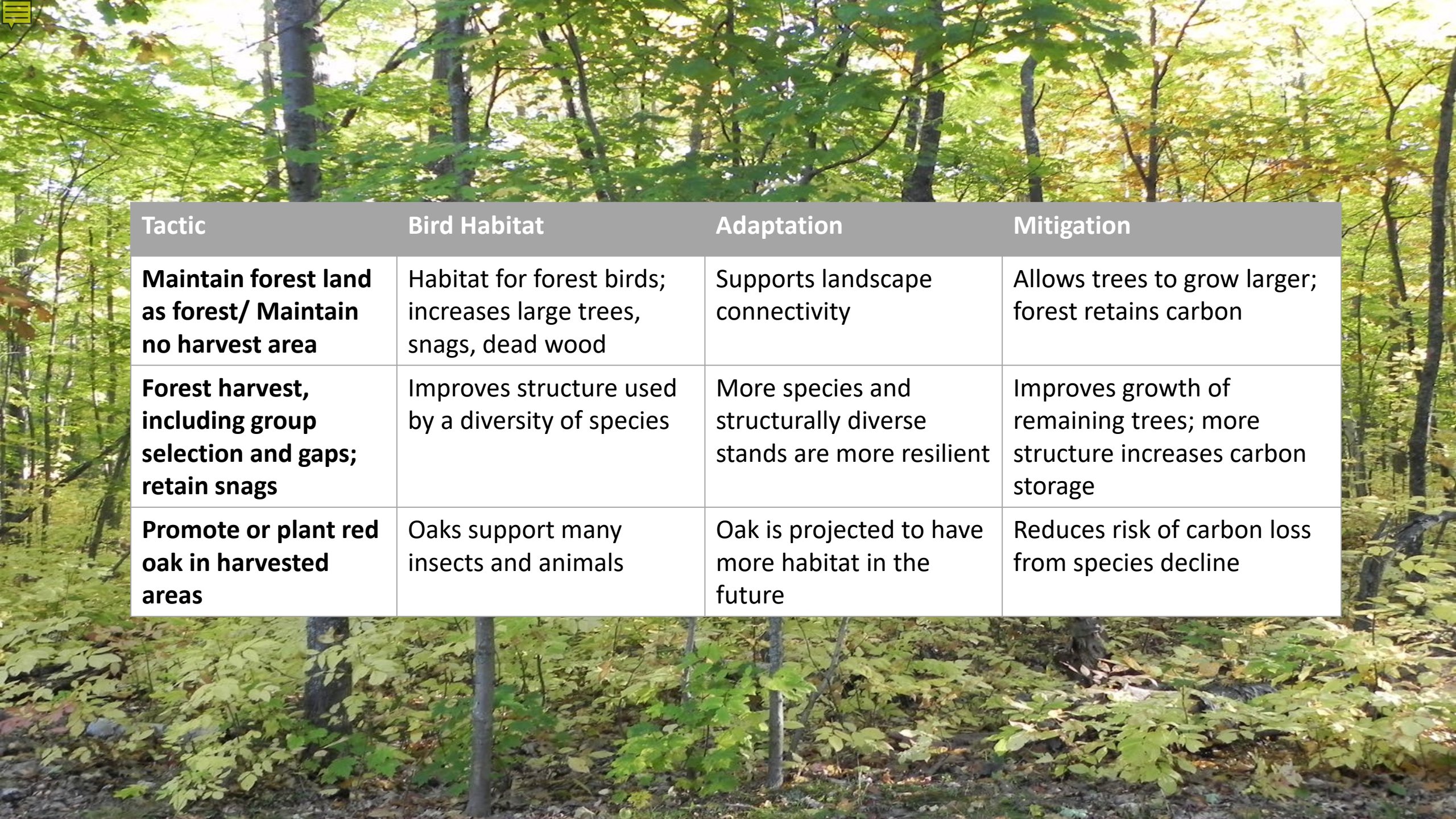
Climate impacts

Warming winters:

- reduce snowpack
- increase pests

Increased frequency and intensity of extreme weather:

- non-native invasive plant species
- soil erosion



Tactic	Bird Habitat	Adaptation	Mitigation
Maintain forest land as forest/ Maintain no harvest area	Habitat for forest birds; increases large trees, snags, dead wood	Supports landscape connectivity	Allows trees to grow larger; forest retains carbon
Forest harvest, including group selection and gaps; retain snags	Improves structure used by a diversity of species	More species and structurally diverse stands are more resilient	Improves growth of remaining trees; more structure increases carbon storage
Promote or plant red oak in harvested areas	Oaks support many insects and animals	Oak is projected to have more habitat in the future	Reduces risk of carbon loss from species decline