



United States Department of Agriculture
Northern Forests Climate Hub

Climate Change Effects on Forest Carbon

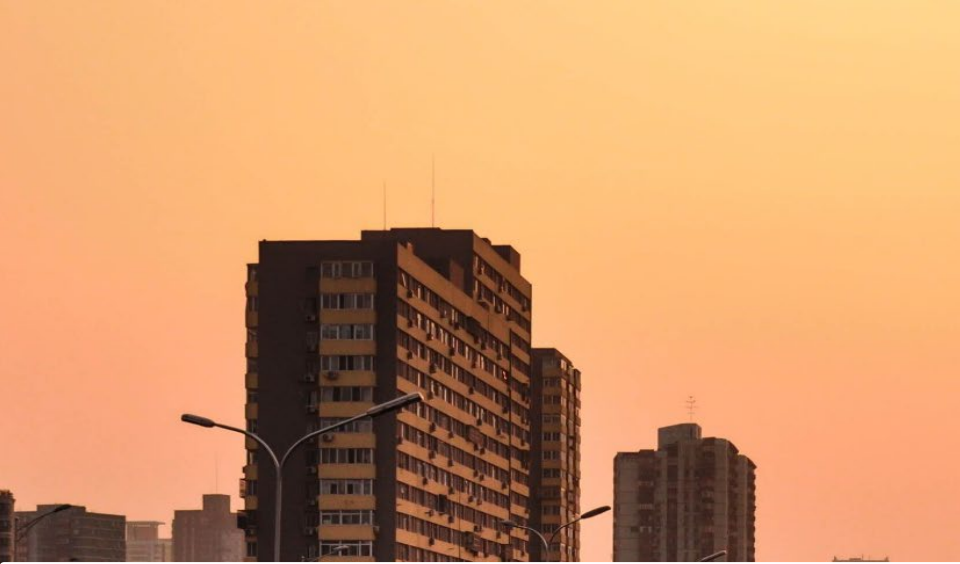


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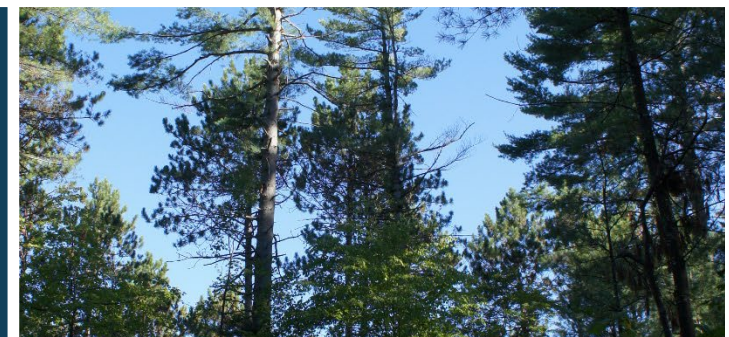


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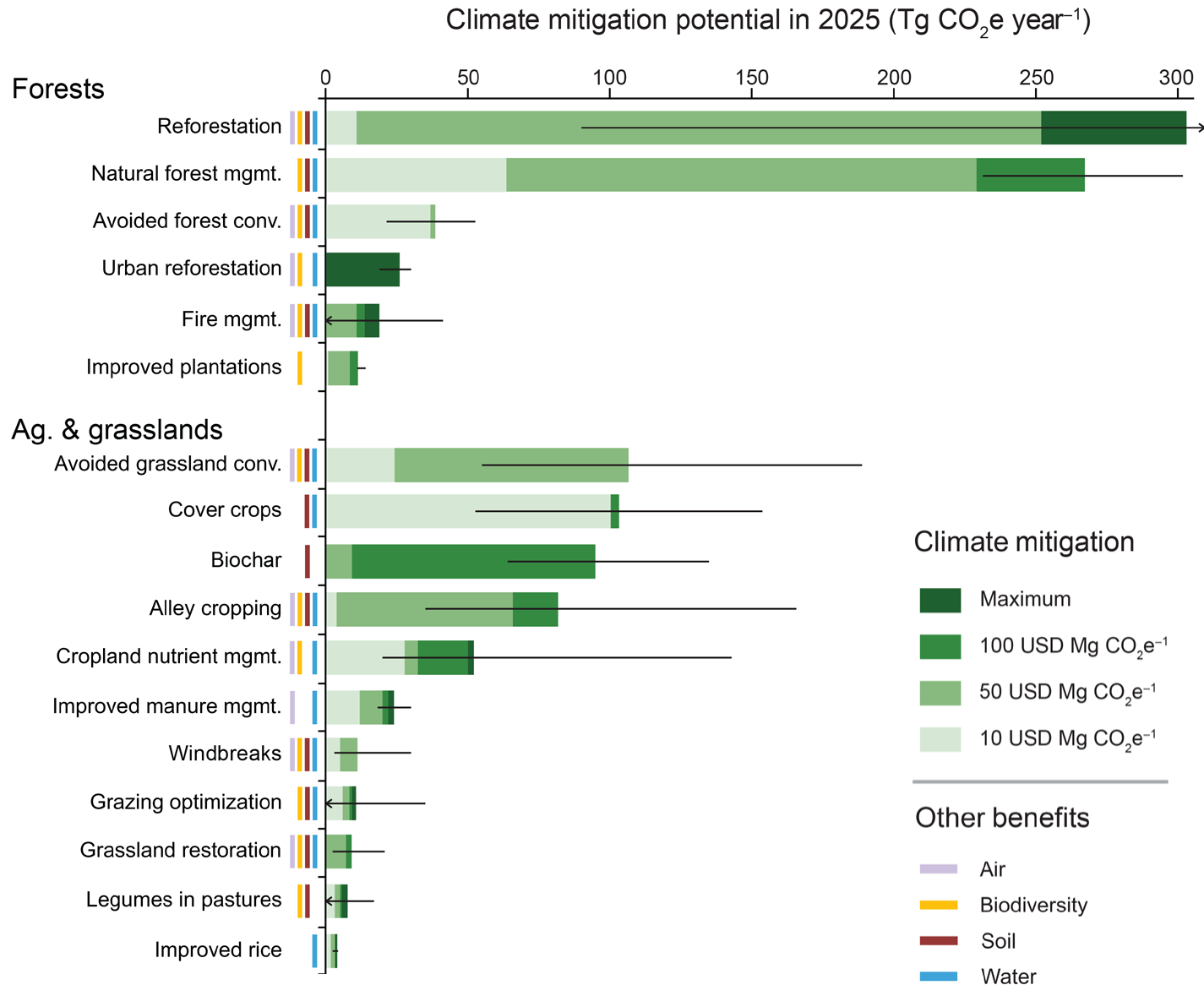


US forests:

- Absorb **15%** of CO₂ emissions from fossil fuels
- Contain **68%** of terrestrial carbon stocks
- Are **90%** of the land sector sequestration capacity



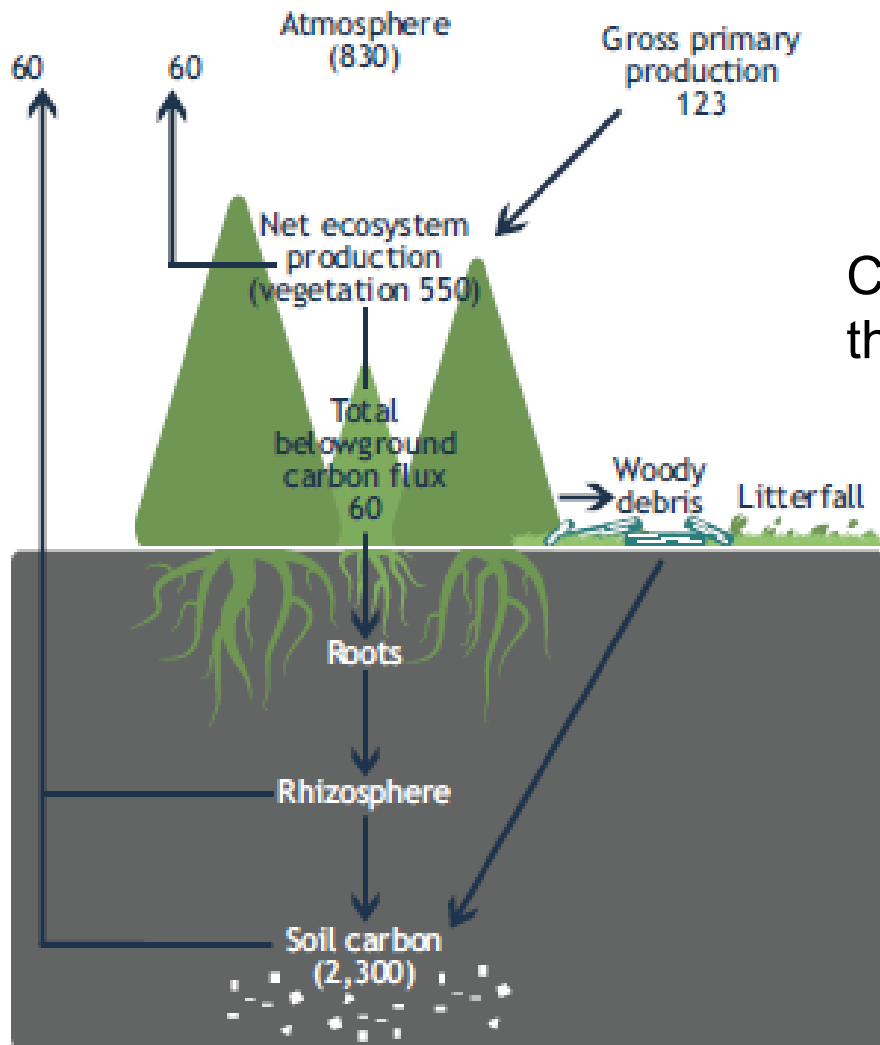
Natural Climate Solutions



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



Effects on Forest Carbon



Climate change impacts forest carbon through affects on:

- Carbon sequestration (forest productivity)
- Carbon storage (biomass in trees, roots, soil)

Effects on Forest Carbon

SHIFTING SEASONS | SHIFTING SPECIES | SHIFTING STRESSORS

THE GOOD:

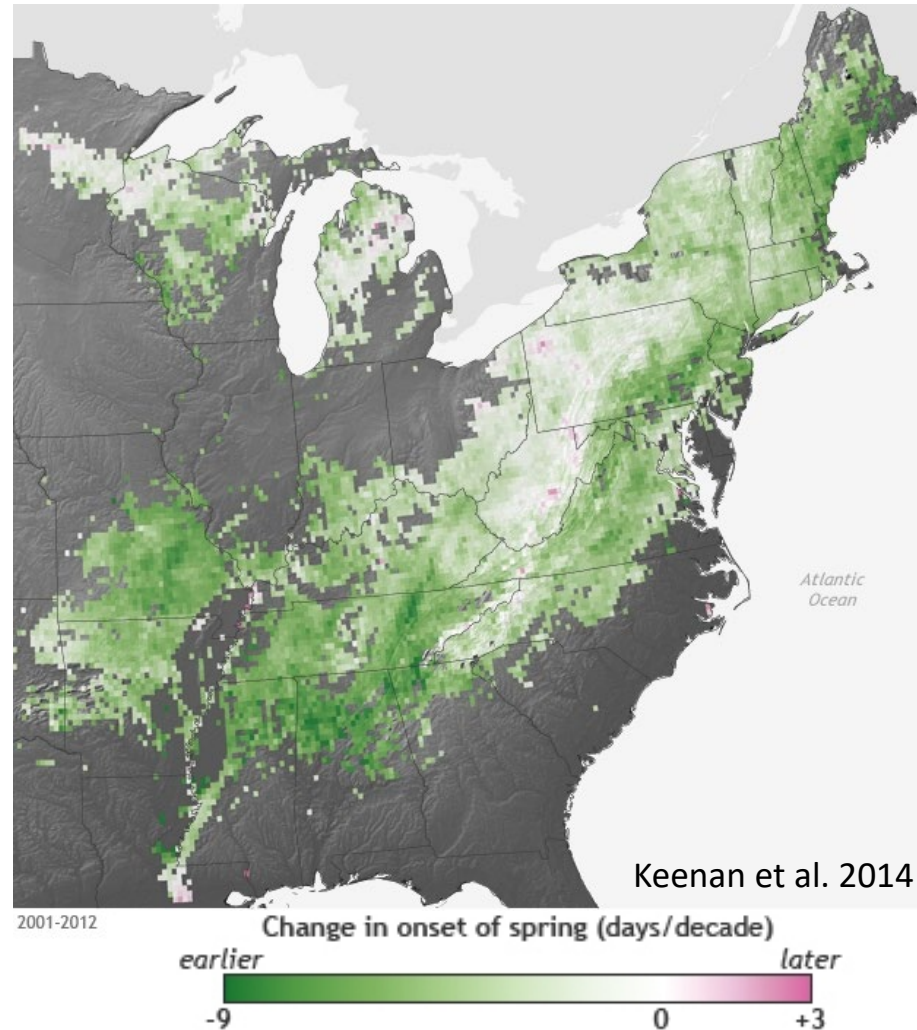
Longer growing
seasons.



Effects on Forest Carbon

SHIFTING SEASONS | SHIFTING SPECIES | SHIFTING STRESSORS

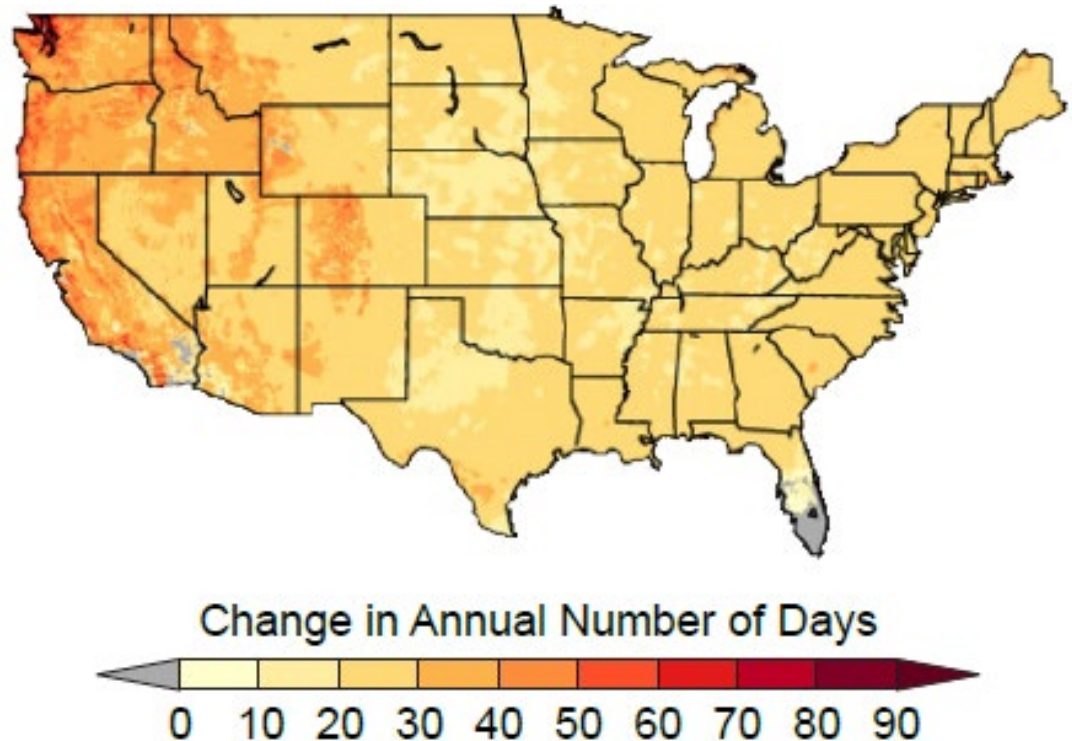
THE GOOD:
Longer growing seasons.



Effects on Forest Carbon

SHIFTING SEASONS | SHIFTING SPECIES | SHIFTING STRESSORS

THE GOOD:
Longer growing seasons.



Effects on Forest Carbon

SHIFTING SEASONS | SHIFTING SPECIES | SHIFTING STRESSORS

THE GOOD:
Longer growing
seasons
means
more carbon
uptake in
forests.

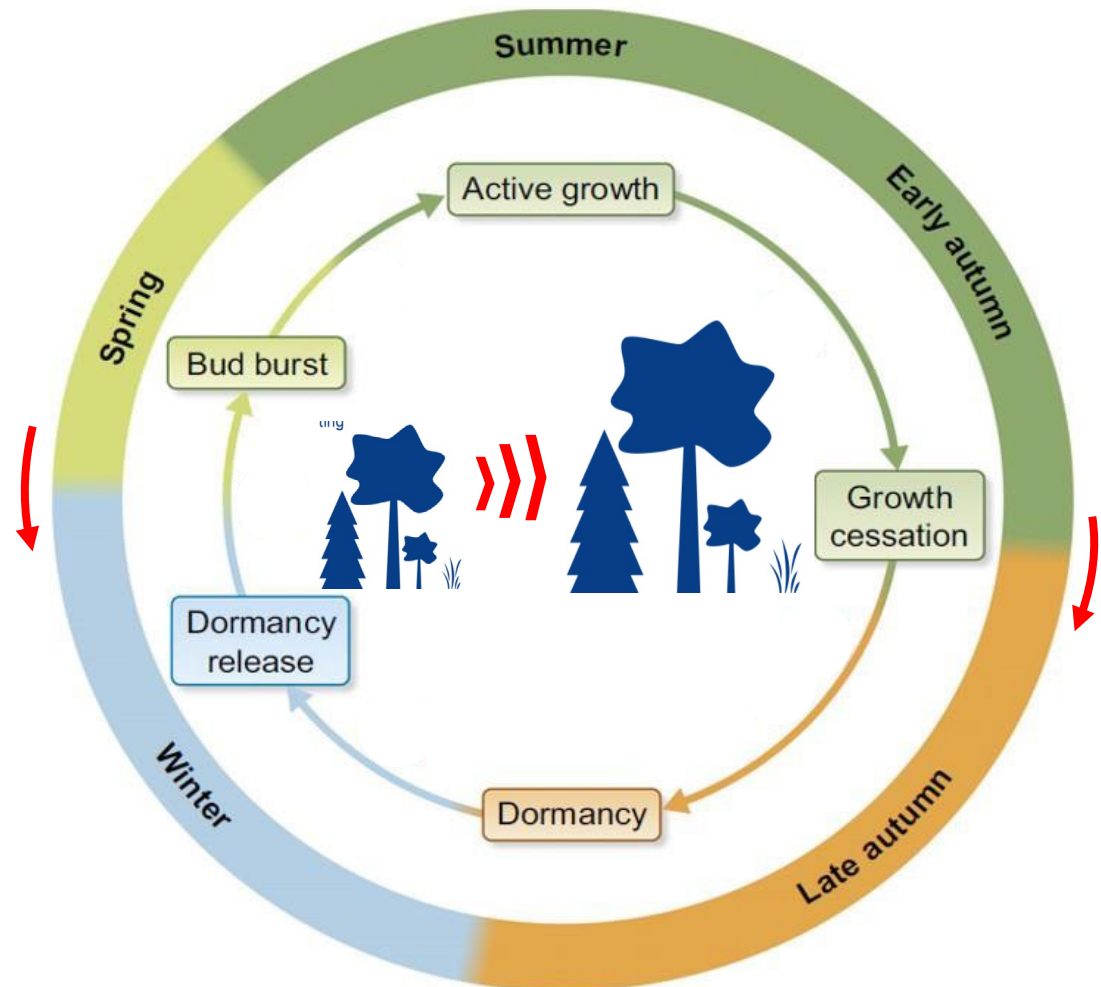


Figure from Singh et al. 2017

Effects on Forest Carbon

SHIFTING SEASONS | SHIFTING SPECIES | SHIFTING STRESSORS

THE GOOD:

Longer growing seasons.



THE BAD:

Shorter, warmer winters.



Effects on Forest Carbon

SHIFTING SEASONS | SHIFTING SPECIES | SHIFTING STRESSORS

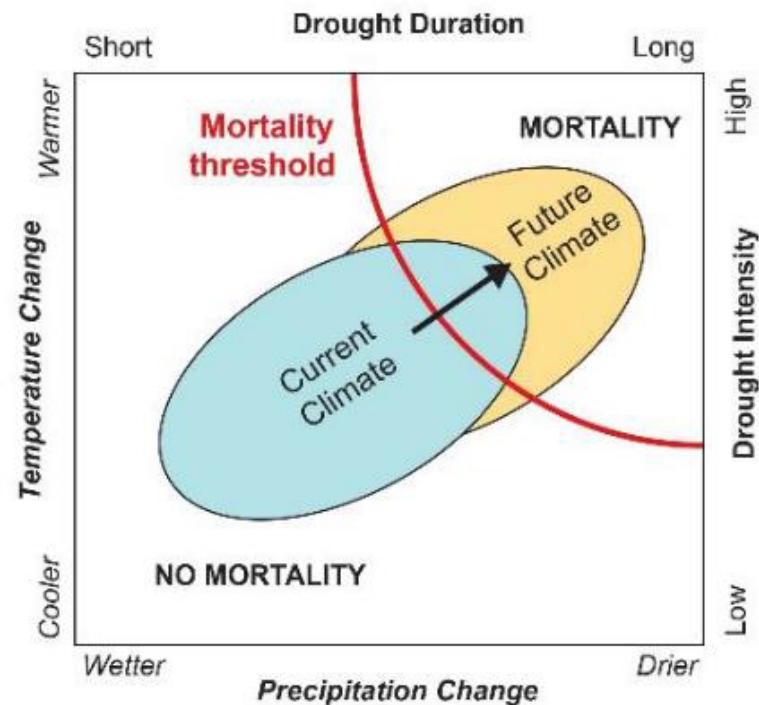
THE BAD:

Shorter,
warmer
winters.



Drier conditions & drought

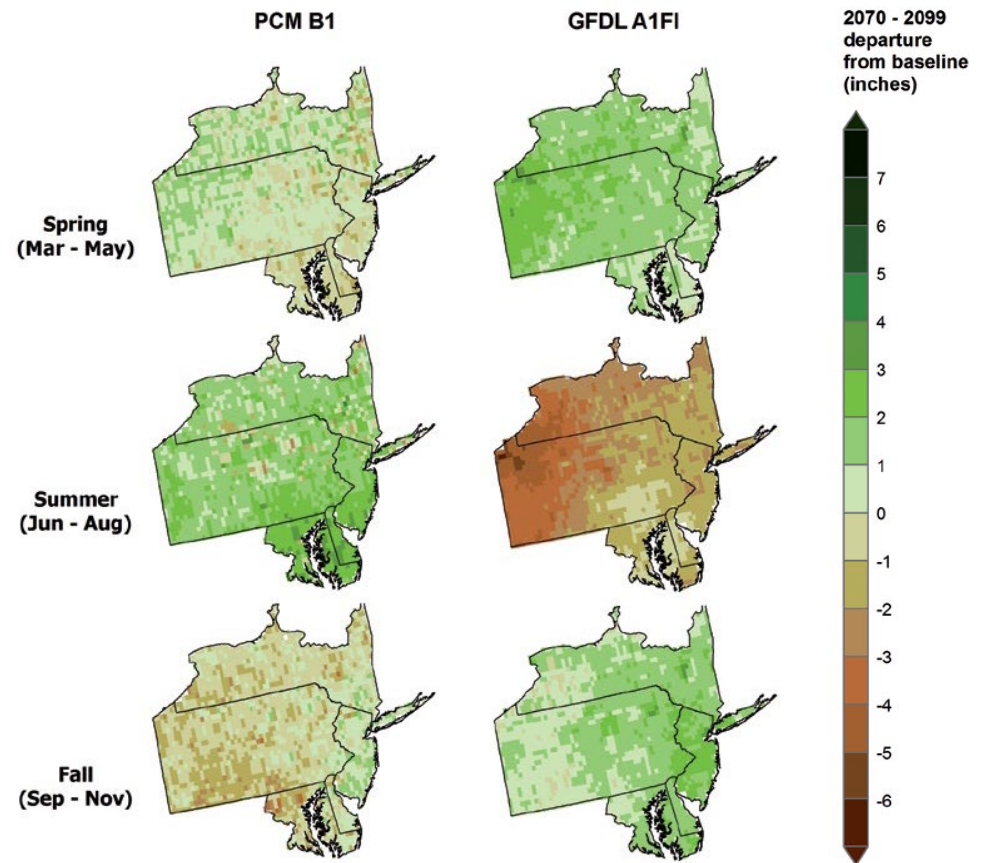
Warmer temperatures
drive moisture deficits



Effects on Forest Carbon

SHIFTING SEASONS | SHIFTING SPECIES | SHIFTING STRESSORS

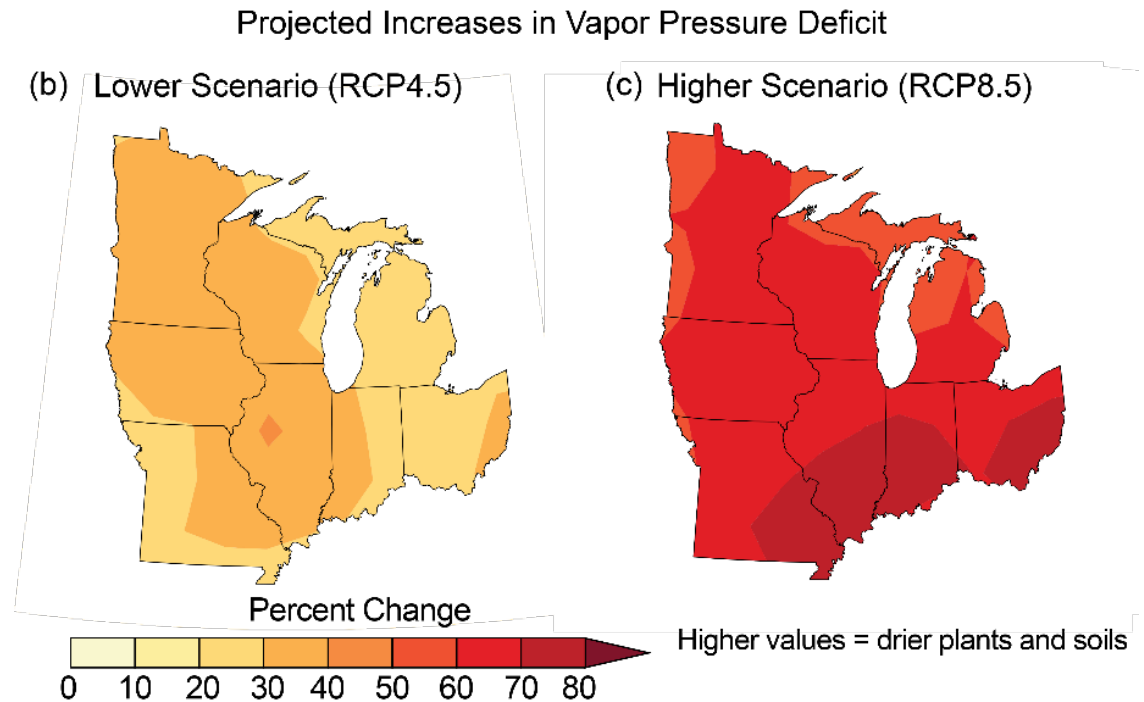
THE BAD: Shifting precipitation patterns



Effects on Forest Carbon

SHIFTING SEASONS | SHIFTING SPECIES | SHIFTING STRESSORS

THE BAD:
Soil moisture stress



Impacts on tree health, forest regeneration, productivity,...

Effects on Forest Carbon

SHIFTING SEASONS | SHIFTING SPECIES | SHIFTING STRESSORS

THE GOOD:

Longer growing seasons.



THE BAD:

Shorter winters, drier conditions.



THE UGLY:

More extreme events.



Effects on Forest Carbon

SHIFTING SEASONS | **SHIFTING SPECIES** | SHIFTING STRESSORS

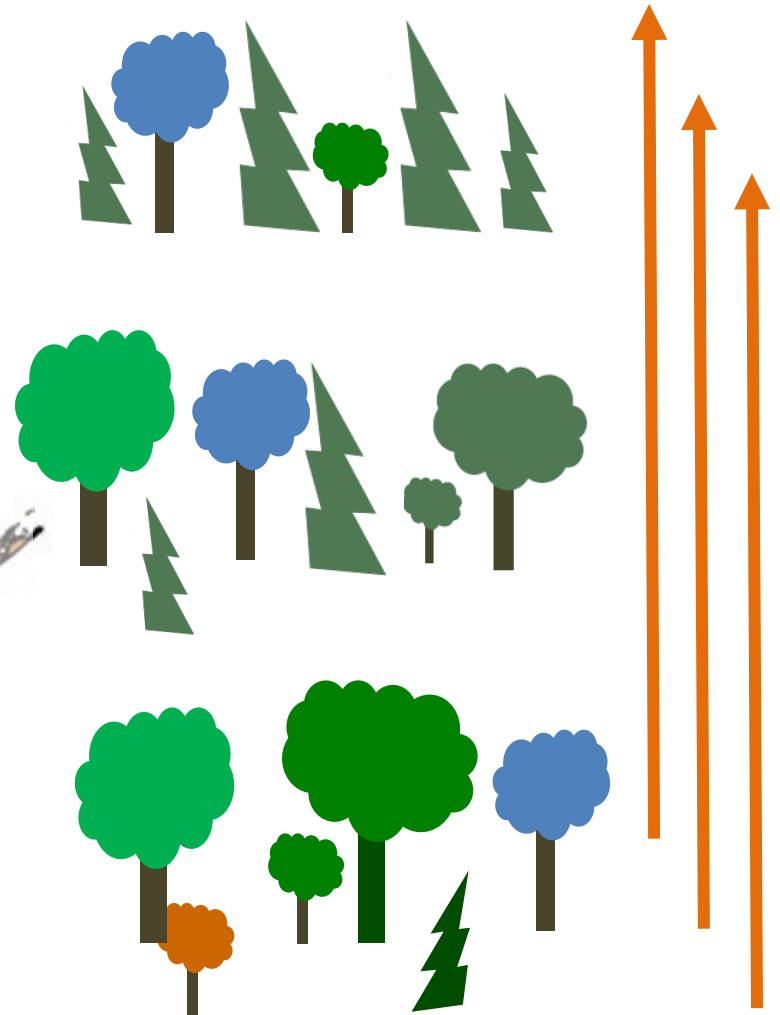
Effects on Forest Carbon

SHIFTING SEASONS | **SHIFTING SPECIES** | SHIFTING STRESSORS

Many northern species are projected to decline in the region

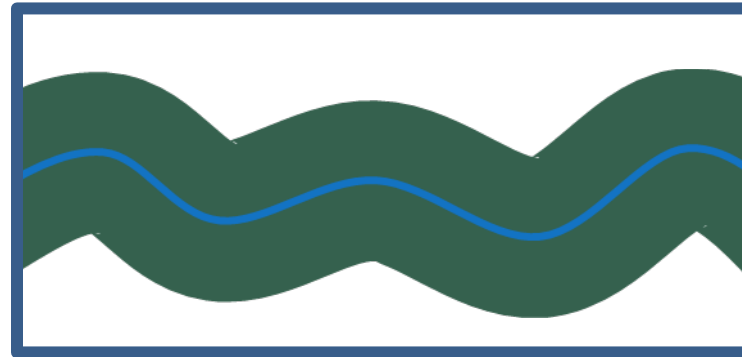


Many species common farther south are expected to see increased or new habitat.



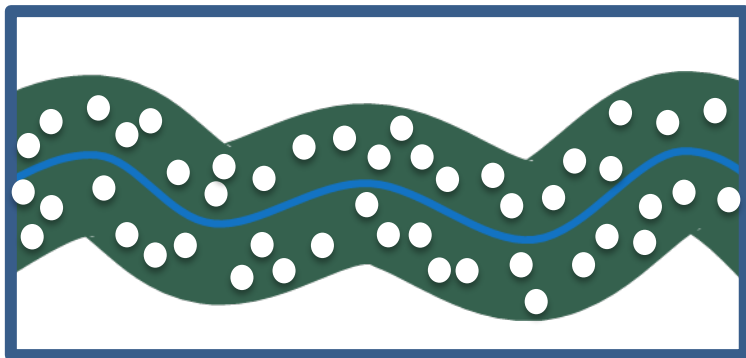
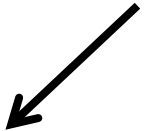
Effects on Forest Carbon

SHIFTING SEASONS | **SHIFTING SPECIES** | SHIFTING STRESSORS

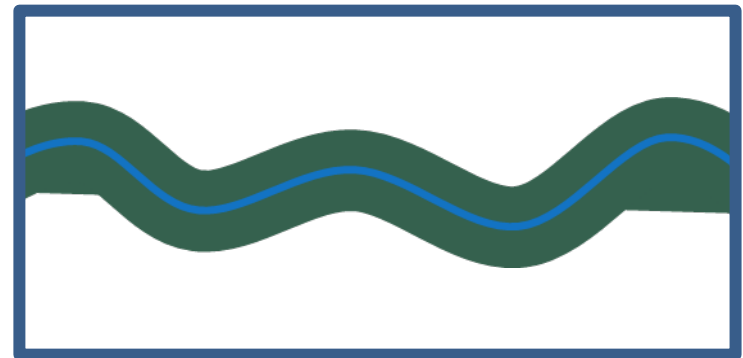


 = suitable habitat

50% Reduction in Habitat:



Habitat reduced equally



Best habitats remain

Effects on Forest Carbon

SHIFTING SEASONS | SHIFTING SPECIES | **SHIFTING STRESSORS**

Effects on Forest Carbon

SHIFTING SEASONS | SHIFTING SPECIES | **SHIFTING STRESSORS**

Climate change is a “threat multiplier”

- Chronic stress
- Disturbances
- Insect pests
- Forest diseases
- Invasive species

Interactions make all the difference.

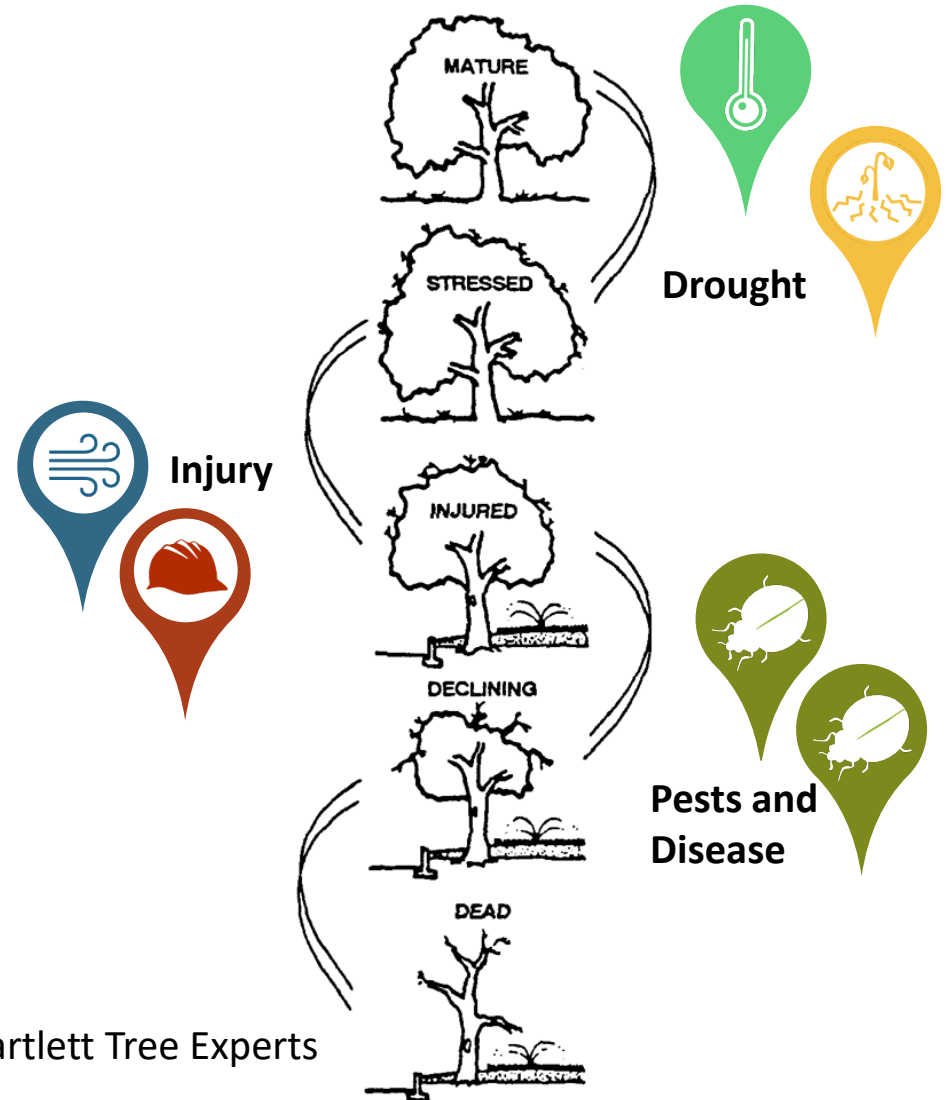


Image: Bartlett Tree Experts

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



AMERICAN FORESTS

www.forestadaptation.org/carbon

Ontl et al. 2019. Forest management for
carbon sequestration and climate adaptation.
Journal of Forestry, *in press*.

Journal of
FORESTRY

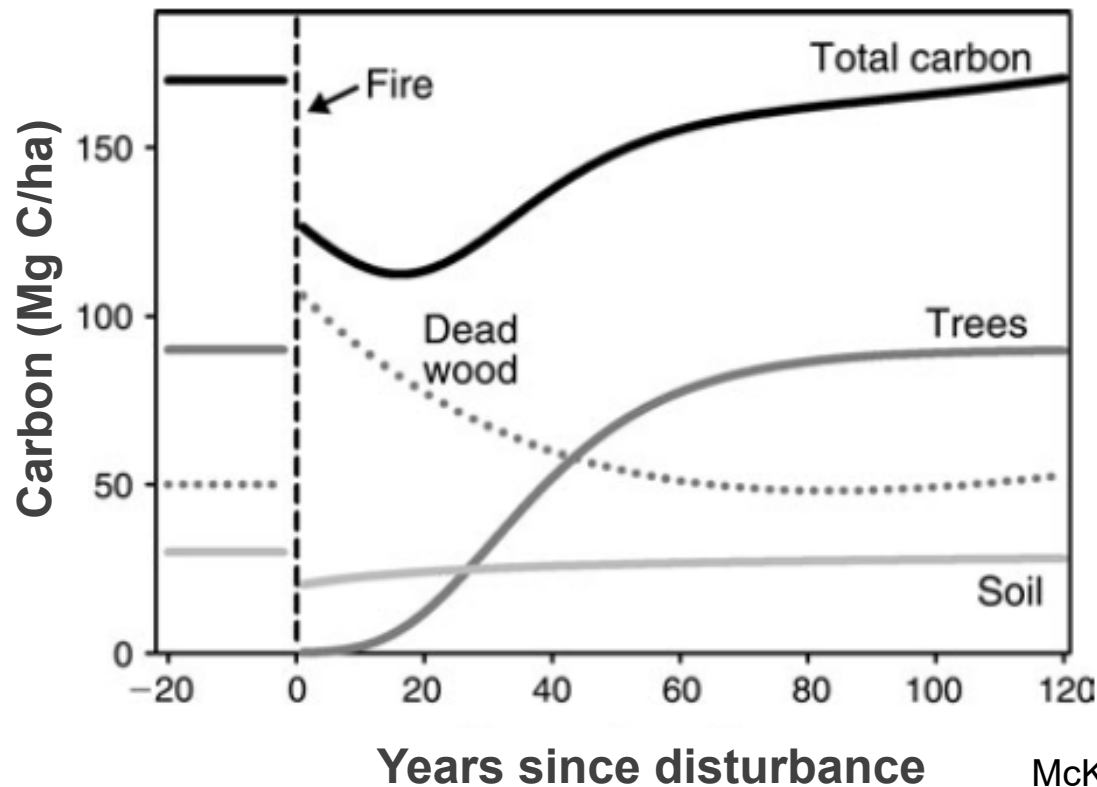


Synergies between Mitigation & Adaptation



Synergies between Mitigation & Adaptation

“Considering extended time-scales can reveal synergies between adaptation and mitigation”



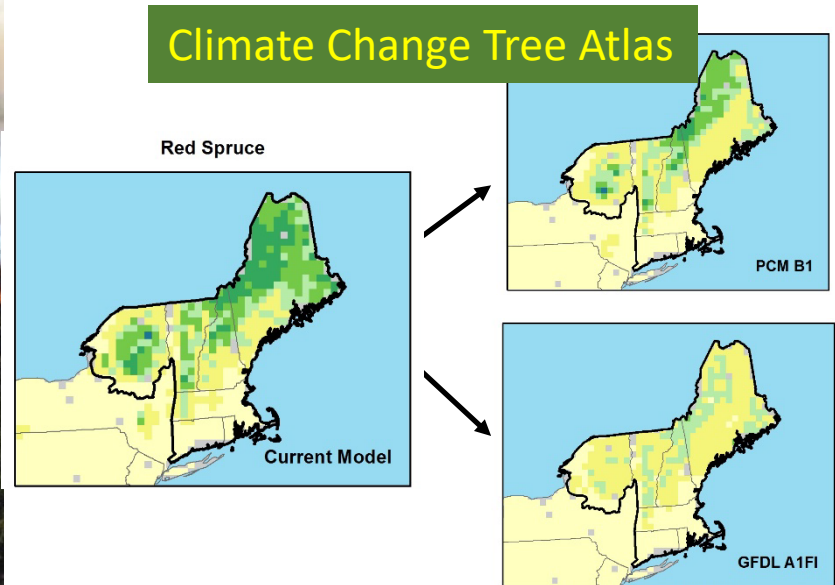
McKinley et al. 2011

Synergies between Mitigation & Adaptation

“Consideration of climate vulnerability may increase the effectiveness of management actions on enhancing forest carbon”



Adler Fire, Yellowstone NP (NPS)



Synergies between Mitigation & Adaptation

“Carbon is often one of many desired forest benefits”



Forest Carbon Management Menu

Strategies

1. Maintain or increase extent of forest ecosystems.
2. Sustain fundamental ecological functions.
3. Reduce carbon losses from natural disturbance, including wildfire.
4. Enhance forest recovery following disturbance.
5. Prioritize management of locations that provide high carbon value across the landscape.
6. Maintain or enhance existing carbon stocks while retaining forest character.
7. Enhance or maintain sequestration capacity through significant forest alterations.

Forest Carbon Management Menu

EQIP PRACTICE: PRESCRIBED BURNING 338

Strategy 3: Reduce carbon losses from natural disturbance, including wildfire

Approach 3.1 Restore or maintain fire in fire-adapted ecosystems

Approach 3.2 Establish natural or artificial fuelbreaks to slow the spread of catastrophic fire

Approach 3.3 Alter forest structure or composition to reduce the risk, severity, or extent of wildfire

Approach 3.4 Reduce the risk of tree mortality from biological or climatic stressors in fire-prone systems

Approach 3.5 Alter forest structure to reduce the risk, severity, or extent of wind & ice damage

Forest Carbon Management Menu

EQIP PRACTICE: WOODY RESIDUE TREATMENT 384

Strategy 3: Reduce carbon losses from natural disturbance, including wildfire

Approach 3.1 Restore or maintain fire in fire-adapted ecosystems

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Approach 3.3 *Alter forest structure or composition to reduce the risk, severity, or extent of wildfire*

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Approach 3.5 Alter forest structure to reduce the risk, severity, or extent of wind & ice damage

Increase on-site carbon storage

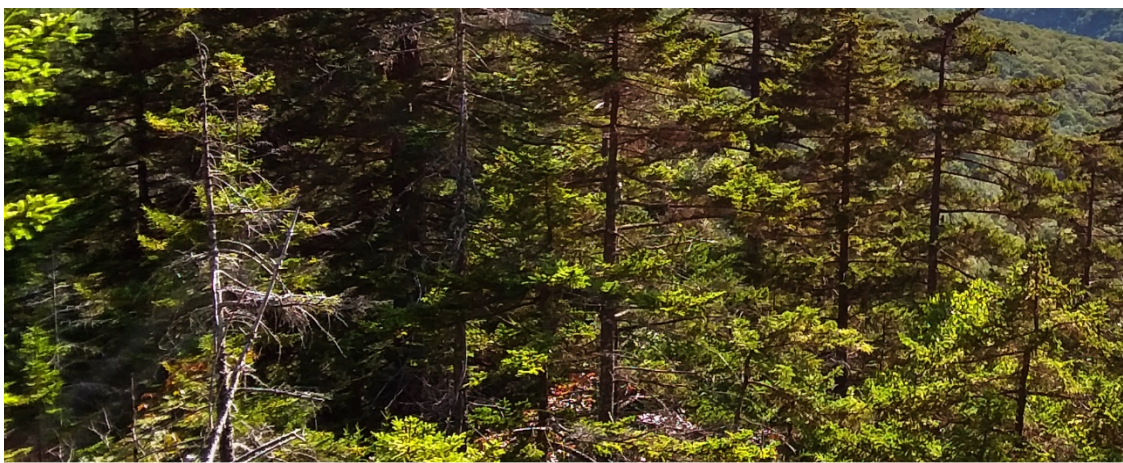
Conservation Practice 666: Forest Stand Improvement

Strategy	Approach	Tactic (from CSP)
Strategy 2: Sustain fundamental ecological functions	2.1 Reduce impacts to soils and nutrient cycling	Close unneeded roads and limit off-road vehicular traffic to avoid displacing the forest litter layer.
Strategy 2: Sustain fundamental ecological functions	2.1 Reduce impacts to soils and nutrient cycling	Adopt techniques for maintaining and/or improving soil quality, specifically retention of organic carbon.
Strategy 6: Maintain or enhance existing carbon stocks while retaining forest character	6.1 Increase structural complexity through retention of biological legacies in living and dead wood	Retain all snags and downed woody debris of 6" diameter or larger at the base.
Strategy 6: Maintain or enhance existing carbon stocks while retaining forest character	6.1 Increase structural complexity through retention of biological legacies in living and dead wood	Identify leave-trees or clumps of trees that will be retained on site throughout their life span.
Strategy 7: Enhance or maintain sequestration capacity through significant forest alterations	7.2 Alter forest composition or structure to maximize carbon	Transition from even-aged to unevenaged management.

Planting for high carbon sequestration rate

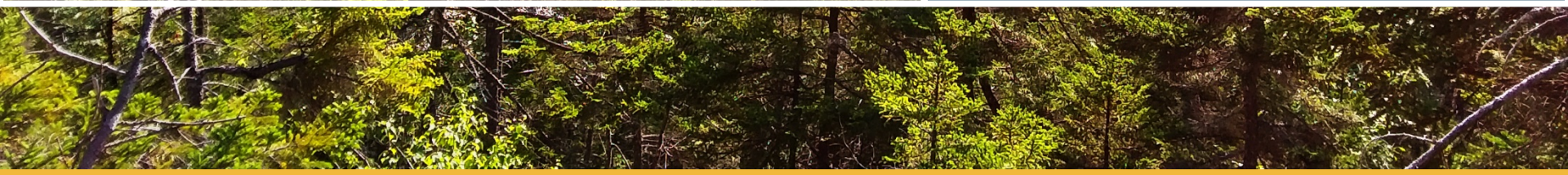
Conservation Practice 612: Tree/Shrub Establishment

Strategy	Approach	Tactic (from CSP)
Strategy 1: Maintain or increase extent of forest ecosystems	1.2 Reforest lands that have been deforested and afforest suitable lands	Trees and shrubs will be planted on selected areas within any land use.
Strategy 2: Sustain fundamental ecological functions	2.5 Reduce competition for moisture, nutrients, and light	Trees and shrubs will be planted in areas with adequate sunlight.
Strategy 4: Enhance forest recovery following disturbance	4.2 Restore sites with a diversity of species that are adapted to future conditions	Trees will be selected for their rate of growth and suitability for use in durable manufactured products <u>as well as their adaptability to site conditions.</u>
Strategy 6: Maintain or enhance existing carbon stocks while retaining forest character	6.2 Increase stocking on well-stocked or understocked forest lands	Increase stocking levels in forests that are not fully stocked.



Thank you!

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Forest Carbon Management Menu

EQIP PRACTICE: TREE/SHRUB ESTABLISHMENT 612

Strategy 6: Maintain or enhance existing carbon stocks while retaining forest character

6.1 Increase structural complexity through retention of biological legacies in living and dead wood

6.2 Increase stocking on well-stocked or understocked forest lands

6.3 Increase harvest frequency or intensity due to greater risk of tree mortality

6.4 Disfavor species that are distinctly maladapted

6.5 Manage for existing species and genotypes with wide moisture and temperature tolerances

6.6 Promote species and structural diversity to enhance carbon capture and storage efficiency

6.7 Use seeds, germplasm, and other genetic material from across a greater geographic range