Forest Management During Climate Change

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Introduction …outline

Introduction

Forest management

1) Adaptation

2) Mitigation

Summary

Introduction

- **Change.**
  - Climate is changing. Forests are changing.
  - Forest management will need to adjust to cope with climate change.
- **Uncertainty.**
  - Working with uncertainty will be more effective than trying to guess the future.

Introduction

Adaptation.

- Actions to moderate the vulnerability of forests to climate change
- Positions forests to become more healthy, resistant, & resilient

Mitigation.

- Use of forests to sequester carbon, provide renewable energy from biomass, & avoid carbon losses from fire, mortality, conversion, etc.

These are not mutually exclusive.

Spittlehouse and Stewart 2003, Malmsheimer et al. 2008

Adaptation …rationale

- High level of uncertainty about future climate conditions
  - → Temperature, precipitation, extreme weather, etc.
- Different approaches for managing forests will be needed to *adapt* to new & changing conditions
  - → Current management:
    - Desired future condition
    - Pre-settlement conditions

Adaptation …options

Resistance – improve the defenses of the forest against effects of change

Resilience – accommodate gradual change, usually returning to a prior condition after disturbance

Response – intentionally accommodate change, enabling ecosystems to adaptively respond

Realignment – for severely changed or disturbed systems, allow for readjustment to new conditions

Reduce – mitigation of greenhouse gases through carbon sequestration and renewable energy use

Millar et al. 2007, 2008

Adaptation …options

Management for forest adaptation can focus on certain elements of disturbance:

- Increase resistance or resilience before a disturbance by altering forest structure or composition.
- Manage the opportunity for a disturbance to occur or reduce its impact.
- Manage for recovery after a disturbance by speeding recovery or reducing future vulnerability.

Monitor effects of disturbances and determine interactions between disturbances.

Dale et al. 2001

Adaptation …silvicultural strategies

‘Silvicultural Strategies for an Uncertain Climate Future’ workshop, 17-18 Sept. 2008

Part of a larger project “Forest Management for an Uncertain Climate Future” funded by USFS Global Change Program

- *USFS Northern Research Station*
  Chris Swanston, Brian Palik, Mark Twery, John Bradford
- *USFS Eastern Region*
  Linda Parker, Andrea Hille, Sheela Doshi
- *Michigan Technological University*
  Linda Nagel, Chris Webster
- *Northern Institute of Applied Carbon Science*
  Maria Janowiak

Adaptation …silvicultural strategies

Workshop activities:

- Provide information on climate change & impacts on forests
- Determine what considerations climate change will add to or alter in silvicultural decision-making
- Develop general strategies for managing climate change across the region
- Develop finer-scale approaches for the forest & stand levels

Results of the workshop will be synthesized with the help of workshop participants and then integrated into other components of this project.

Adaptation …silvicultural strategies

What silvicultural strategies may be helpful or necessary in sustaining our regional forests in the face of climate change?

Adaptation …silvicultural strategies

1) Location within a species range is valuable information
   - South end of species' range is likely more susceptible to decline than north end of range
   - Tools like the Climate Change Tree Atlas provide insight on whether potential suitable habitat is likely to change

Adaptation …silvicultural strategies

2) Maintain and increase diversity
   - Across all spatial scales (stand and landscape levels)
   - Diversity of tree species, genotypes, structure, age
   - Maintain components of forests for as long as possible
   - Provide a buffer against unexpected negative impacts

Adaptation …silvicultural strategies

3) Need for greater discussion on assisted migration
   - Shifting ranges may necessitate the planned movement of tree species in some situations
   - However, current uncertainty in climate and range projections requires a cautious approach to this tool in the near future

Adaptation …silvicultural strategies

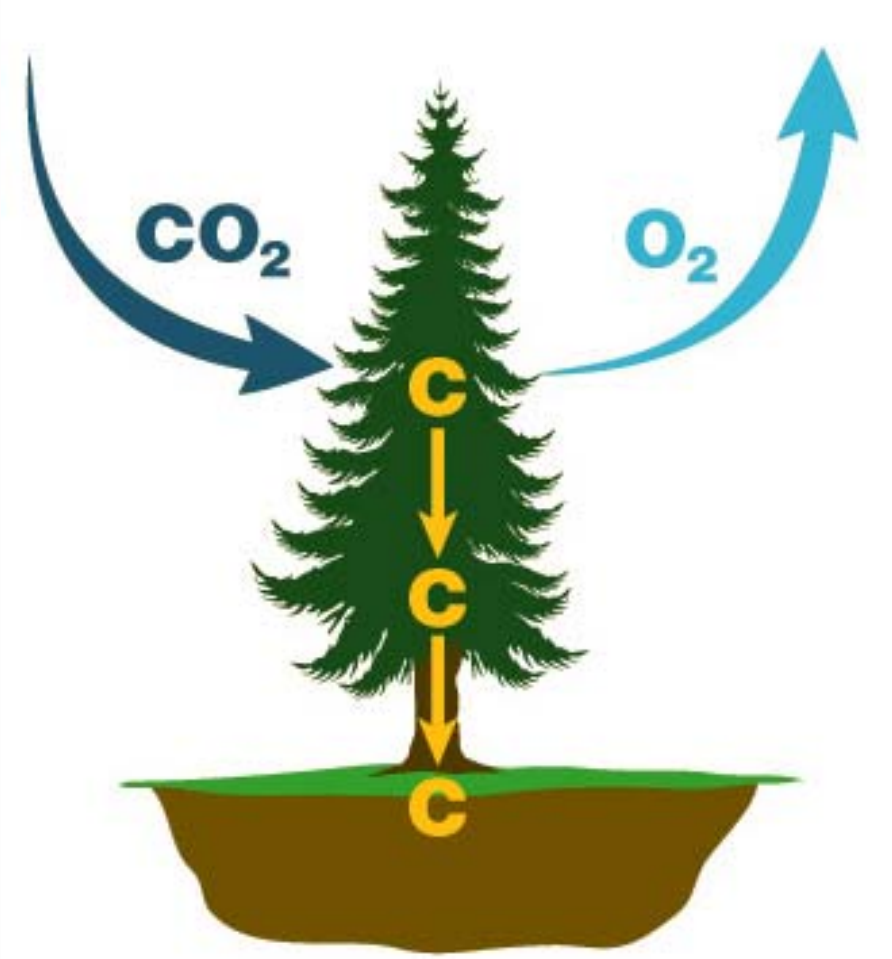
4) Emphasis on monitoring
   - Gather information on the effects of extreme weather events, increased pest incidence, and other factors related to forest health and productivity
   - Understand and forecast species and community response to changing conditions
   - Provide scientific basis for adaptive management

Adaptation …silvicultural strategies

Additional strategies worth mention:

- Consider managing at reduced stocking densities in moisture-limited areas
- Manage to favor naturally occurring drought resistant and heat-tolerant species
- When possible, maintain/increase forest connectivity at landscape level for migration corridors
- Look for and manage refugia for vulnerable species
- Look for and manage invasive species since systems may be more susceptible during transitions

Mitigation



Mitigation ...forest carbon sequestration

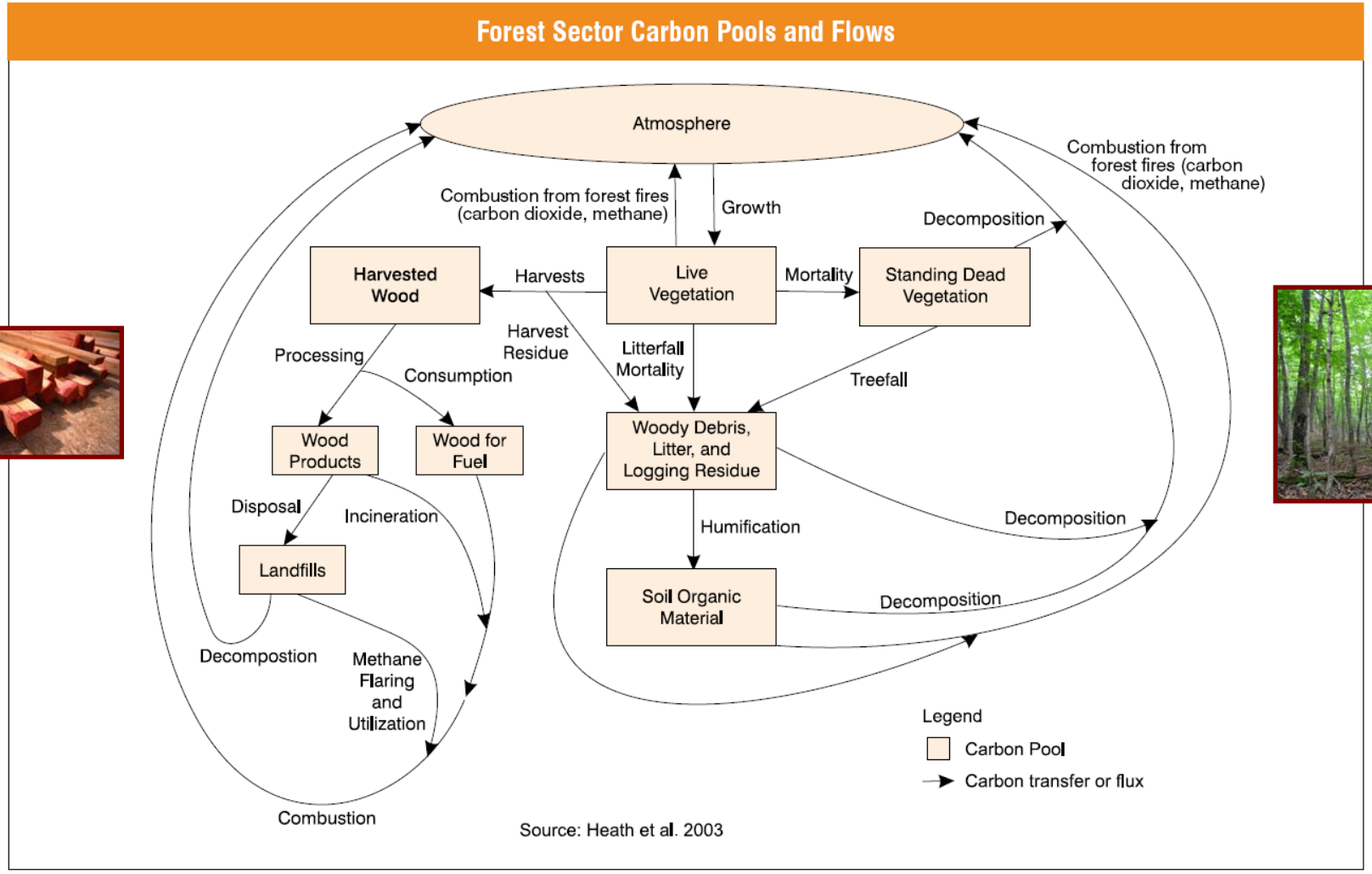


Figure: EPA 2007

Mitigation …forest carbon sequestration

Lake States Aspen-Birch:

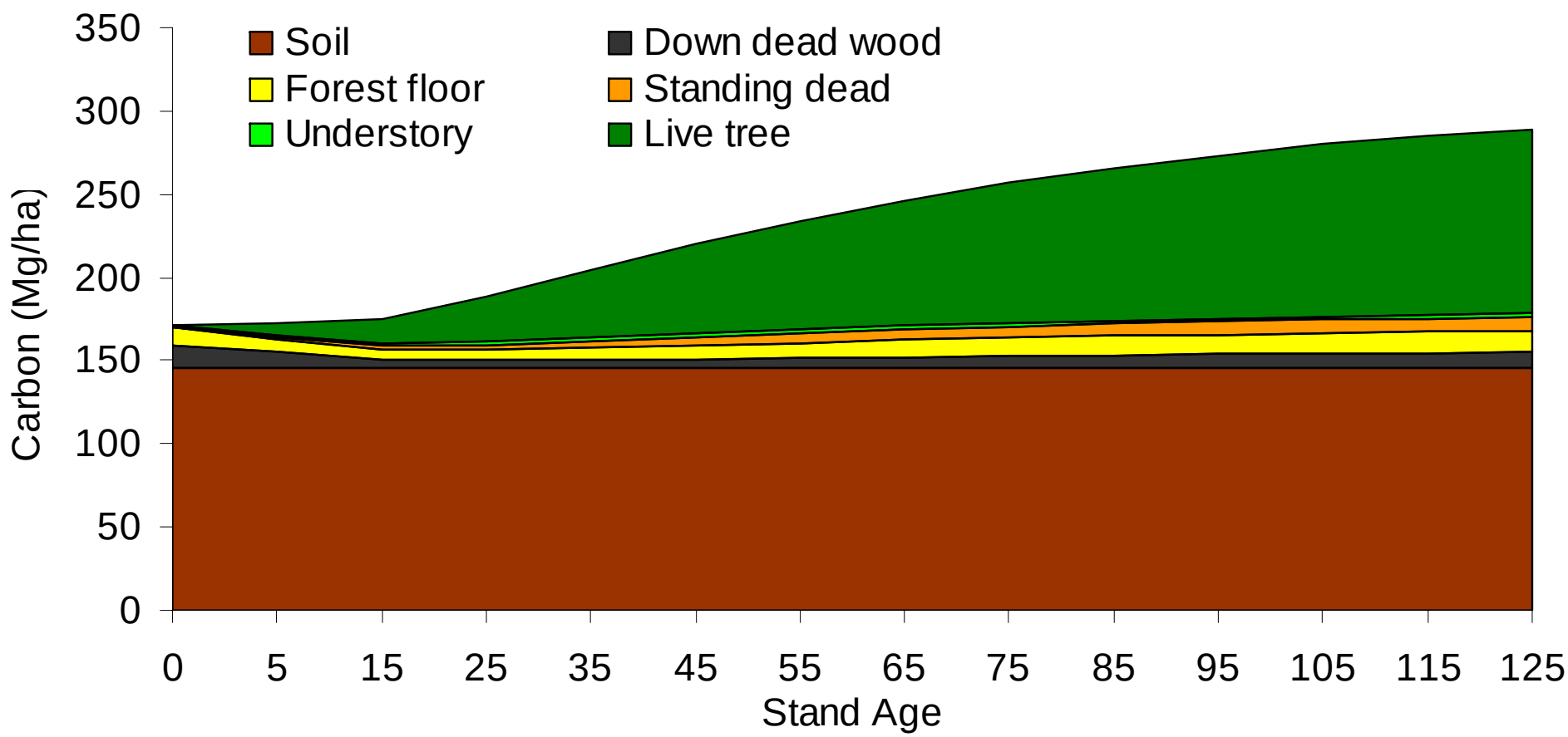
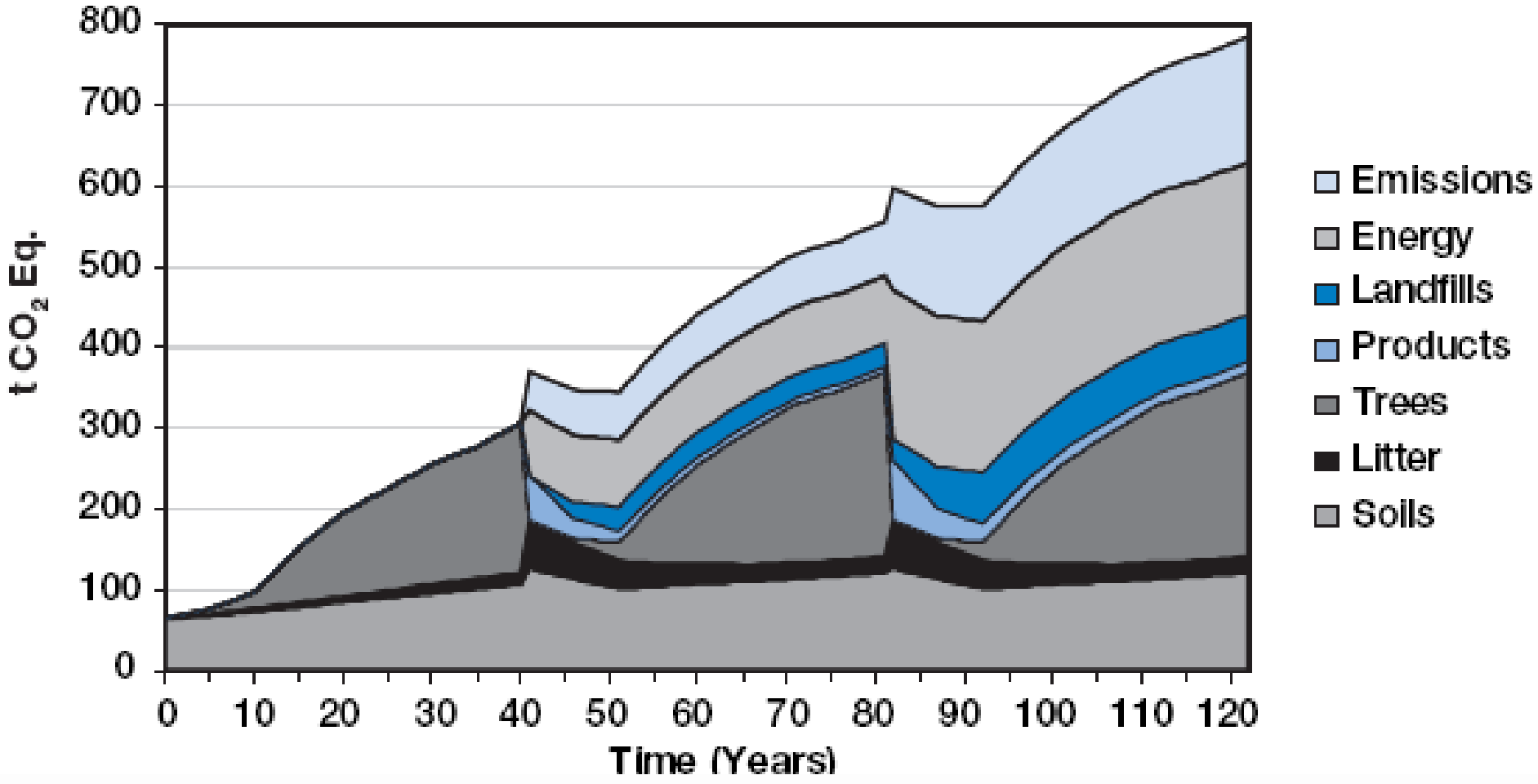


Figure data: Smith et al. 2005

Mitigation …forest carbon sequestration



EPA 2005

Mitigation …forest carbon sequestration

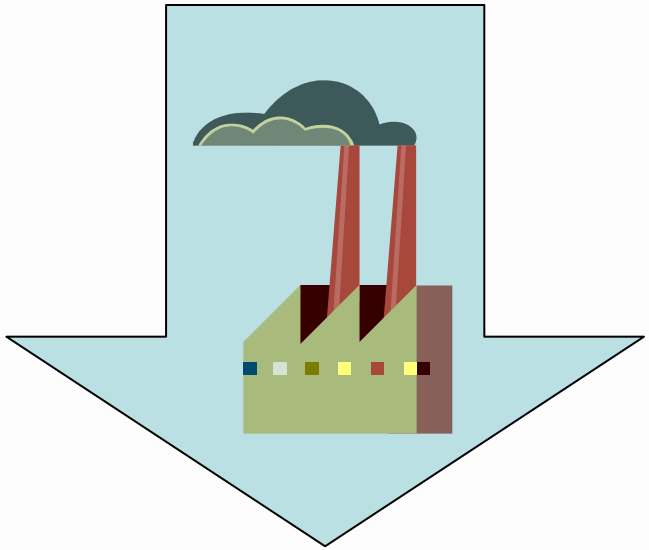
Life of Wood and Paper Products:

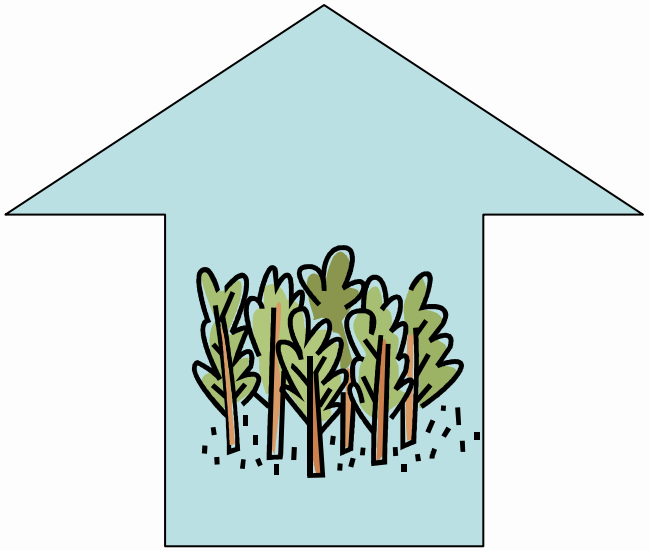
End use	Half-life of carbon (years)
Single-family homes (pre-1980)	80
Single-family homes (post-1980)	100
Multifamily homes	70
Mobile homes	20
Nonresidential construction	67
Pallets	6
Manufacturing	12
Furniture	30
Railroad ties	30
Paper (free sheet)	6
Paper (all other)	1

Skog and Nicholson 2000

Mitigation ...forestry options

Emissions Reduction





Sink Enhancement

Mitigation ...forestry options

Emissions Reduction.

- *Substitute Wood Products for More Energy-Intensive Products*
- *Reduce Demand for Energy through Forest Operations Efficiency*
- *Reduce Biomass Burning (Wildfires)*

Sink Enhancement.

- *Afforest Marginal Cropland and Pasture*
- *Reduce Conversion of Forestland to Nonforest Use*
- *Improve Forest Management*
- *Reduce Harvest*
- *Increase Agroforestry*

Emissions Reduction & Sink Enhancement.

- *Substitute Renewable Biomass for Fossil Fuel Energy*
- *Increase Proportion and Retention of C in Durable Wood Products*
- *Increase Paper and Wood Recycling*
- *Plant Trees in Urban and Suburban Areas*

Birdsey et al. 2000

Mitigation ...forestry options

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Mitigation …emissions reduction

Reduce Catastrophic Wildfires

- Annual carbon emissions in US from fire ranges from 9 to 59 Mt C *(CCSP 2007)*

  → 4-25% of annual sequestration in US forest ecosystems *(CCSP 2007)*

Mitigation ...sink enhancement

Afforest Marginal Cropland and Pasture

- Afforestation increases sequestration by 1.5 to 6.4 Mg C/ha/yr for 120 yrs *(Birdsey 1996, CBO 2007)*

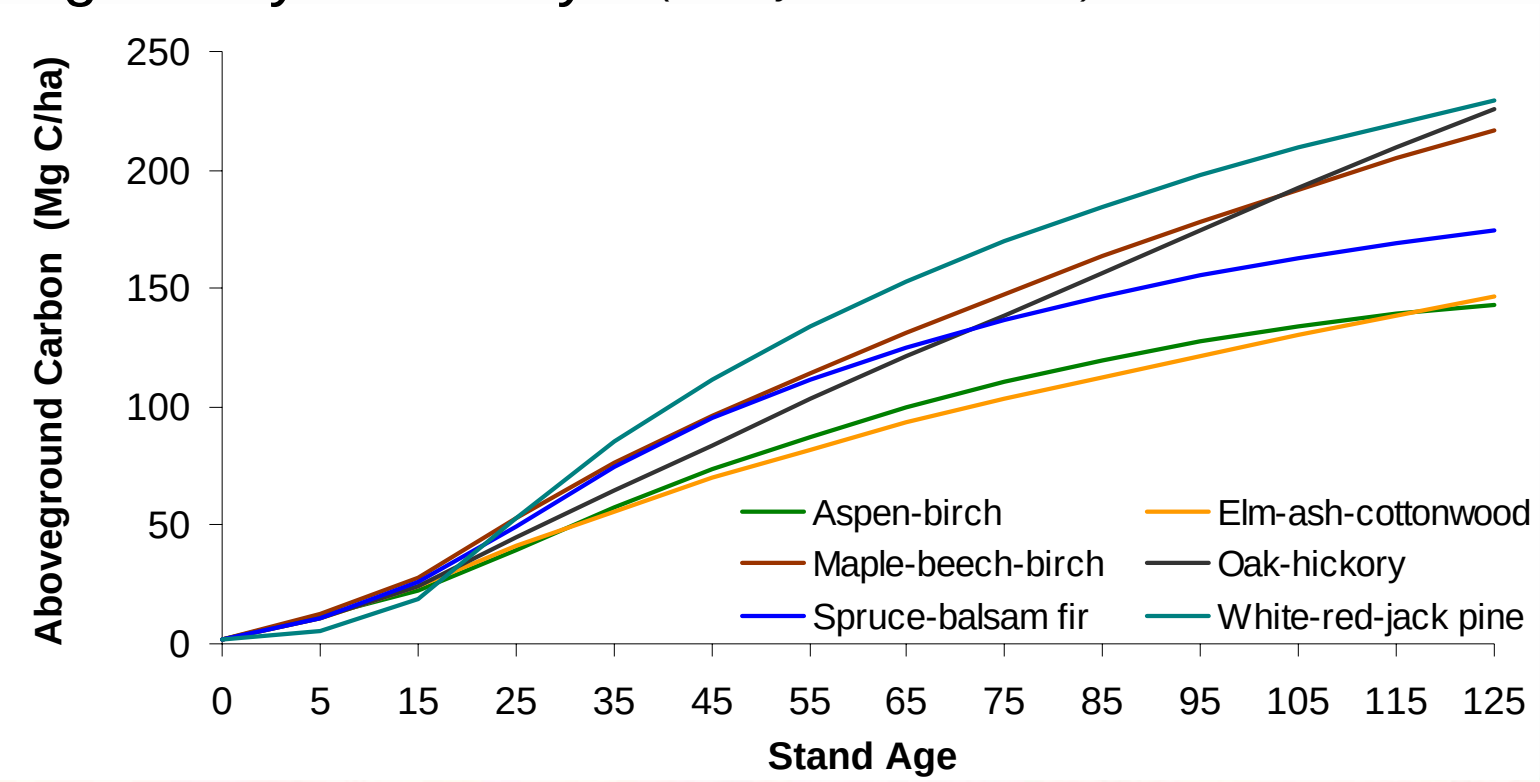


Figure data: Smith et al. 2005

Mitigation ...sink enhancement

Reduce Conversion of Forest to Nonforest

- Globally, deforestation releases 18-25% of human-caused greenhouse gas emissions *(Stern 2006)*

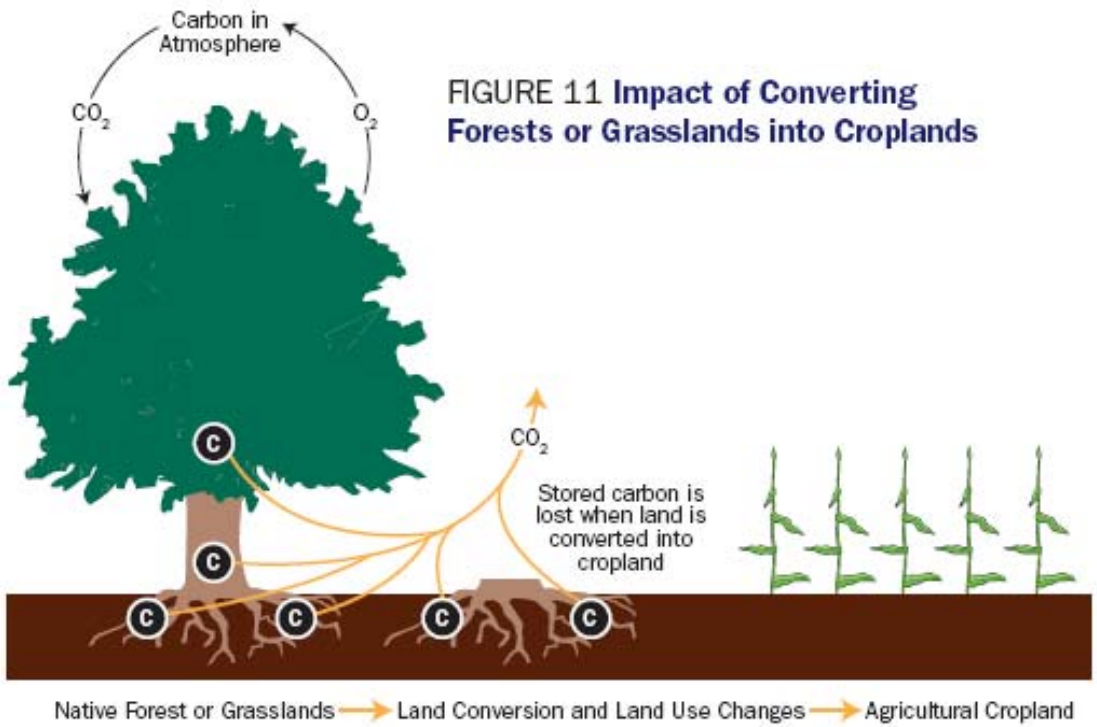


Figure: UCS 2007

Mitigation ...sink enhancement

Reduce Harvest

- Short-term strategy to increase carbon stocks
- However, managed forests can sequester more carbon over longer time periods because of:
  - →Contributions to wood product and landfill pools
  - →Maintenance of forest health and productivity

Birdsey et al. 2000, Malmsheimer et al. 2008

Mitigation …sink enhancement

Improve Forest Management

- Even-aged or uneven-aged management:
  - → Influence depends on time horizon
  - → Important to match site conditions to the appropriate silvicultural system for that stand
- Species selection:
  - → Fast growing intolerants have higher rates of sequestration, however…
  - → Shade tolerant species usually support higher stand densities and can accumulate more carbon over time

Malmsheimer et al. 2008

Mitigation …sink enhancement

Improve Forest Management *(cont'd)*

- Minimize soil disturbance during harvest and site preparation to limit loss of soil carbon
- Slash disposal:
  - → Decomposition and burning are comparable
  - → Could be used for bioenergy, depending on site

Malmsheimer et al. 2008

Mitigation ...sink enhancement

Improve Forest Management *(cont'd)*

- Site should be regenerated as soon as possible after harvest
- Reforestation increases sequestration by 0.7 to 5.2 Mg C/ha/yr for 120 yrs *(Birdsey 1996, CBO 2007)*

Birdsey et al. 2000, Malmsheimer et al. 2008

Mitigation …managing for carbon

Improve Forest Management *(cont'd)*

- Silvicultural treatments to improve growing-stock volume on poorly stocked or stagnated stands will increase carbon sequestration (*Birdsey et al. 2000)*

- 'Structural complexity enhancement' *(Keeton 2006)*
  - → Enhance late-successional characteristics in managed northern hardwoods
  - → Retain greater amounts of live & dead biomass on site

Mitigation …sink enhancement

Improve Forest Management *(cont'd)*

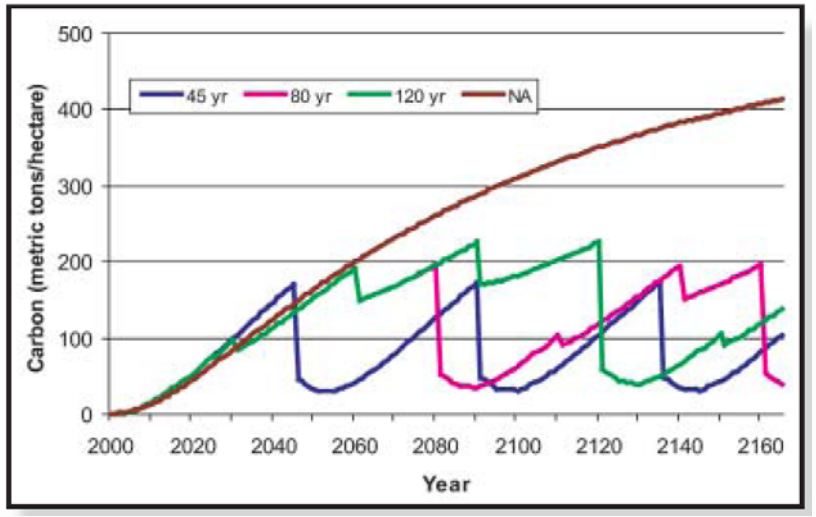
- Rather than being at a steady-state, old growth forests are very often C sinks *(Luyssaert et al 2008)*
- Preservation of old-growth may have a greater impact than favoring younger forests *(Schulze et al. 2000)*

Mitigation

…emissions reduction
& sink enhancement

Increase Carbon in Durable Wood Products

- Longer rotations increase carbon sequestered on-site and increase production of long-lived wood products. *(Wilson 2006)*



- Net carbon benefit of shorter rotations can be greater if accounting includes wood products, product substitution, and bioenergy *(Liski et al. 2001, Perez-Garcia et al. 2005)*

Figure: Wilson 2006

Mitigation

…emissions reduction
& sink enhancement

Increase Carbon in Durable Wood Products

- Thinning to reduce fire risk in ponderosa pine released 3.1 Mg C/ha. Emissions could have been reduced if wood was used in long-lived products *(Finkral and Evans 2008)*

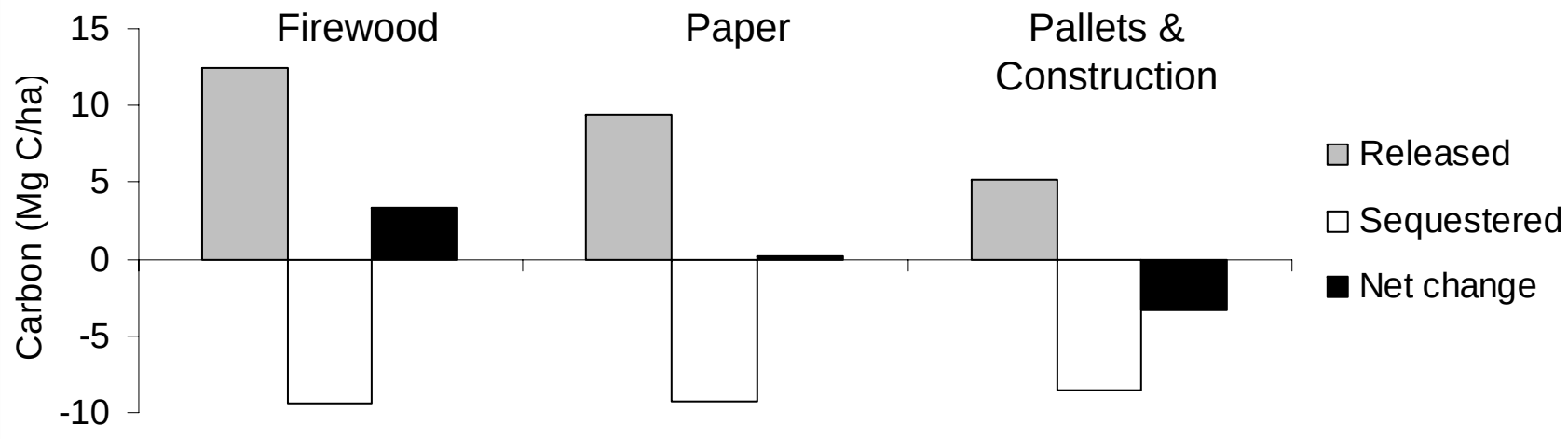


Figure data: Finkral and Evans 2008

Mitigation

…emissions reduction
& sink enhancement

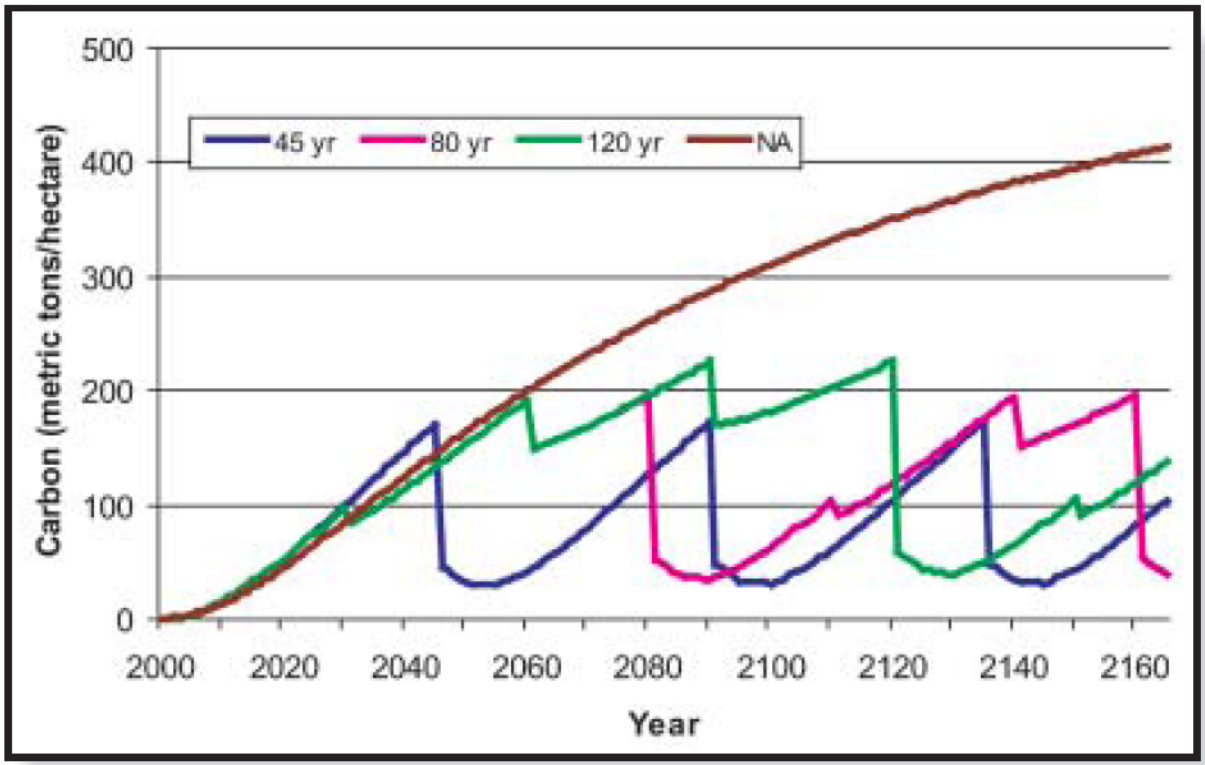
Increase Carbon in Durable Wood Products

- Carbon emissions from fertilization and site preparation in intensively managed southern pine was balanced by increased sequestration in forest soils or paper products. Production of sawlogs could increase net sequestration. *(Markewitz 2006)*

Mitigation …wood products

Increase Carbon in Durable Wood Products

- Longer rotations increase carbon sequestered on-site and increase production of long-lived wood products…



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Mitigation …wood products

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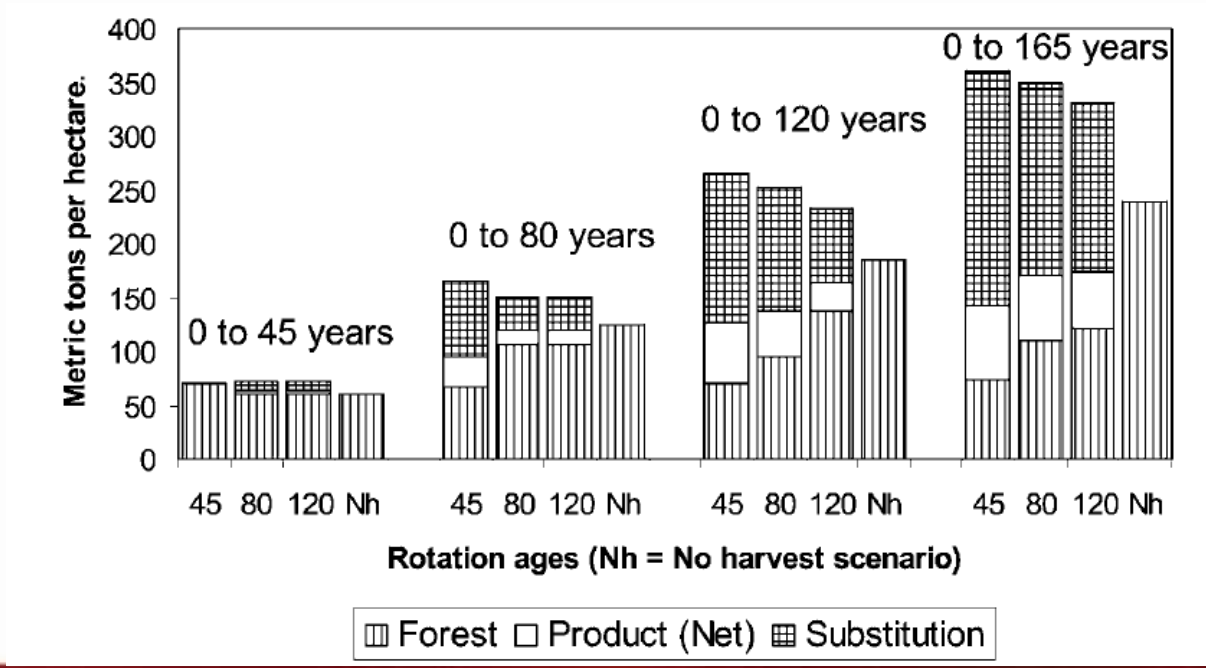

→ Don't forget management objectives other than carbon.

Figure: Perez-Garcia et al. 2005

Summary

- Climate change introduces a high degree of uncertainty about future conditions.
- Managing forests will almost certainly be more successful than taking a hands-off approach.
- Adaptation and mitigation: not mutually exclusive. Look for win-wins.
- Carbon is another management objective.

QUESTIONS?

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