REDUCING ATMOSPHERIC GREENHOUSE GASES THROUGH SEQUESTRATION

Wisconsin SAF
12 November 2008
Stevens Point, WI

Northern Institute of Applied Carbon Science

Introduction …outline

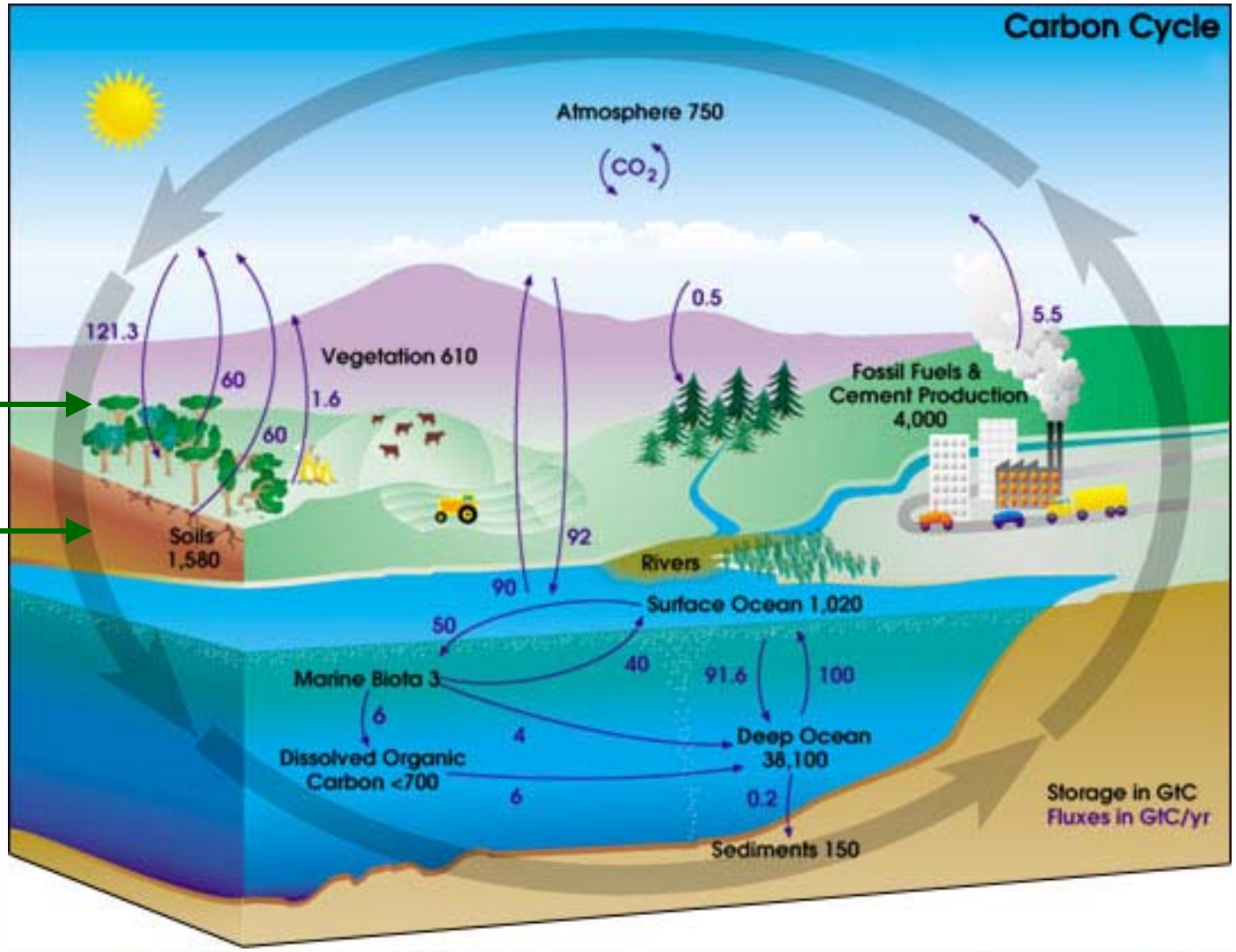
1) Forest carbon cycle
   (Global & Regional)
2) Forest carbon management
   (Adaptation & Mitigation)
3) Summary

Forest Carbon …global cycle

FORESTS CONTAIN:

Up to 80% of aboveground carbon

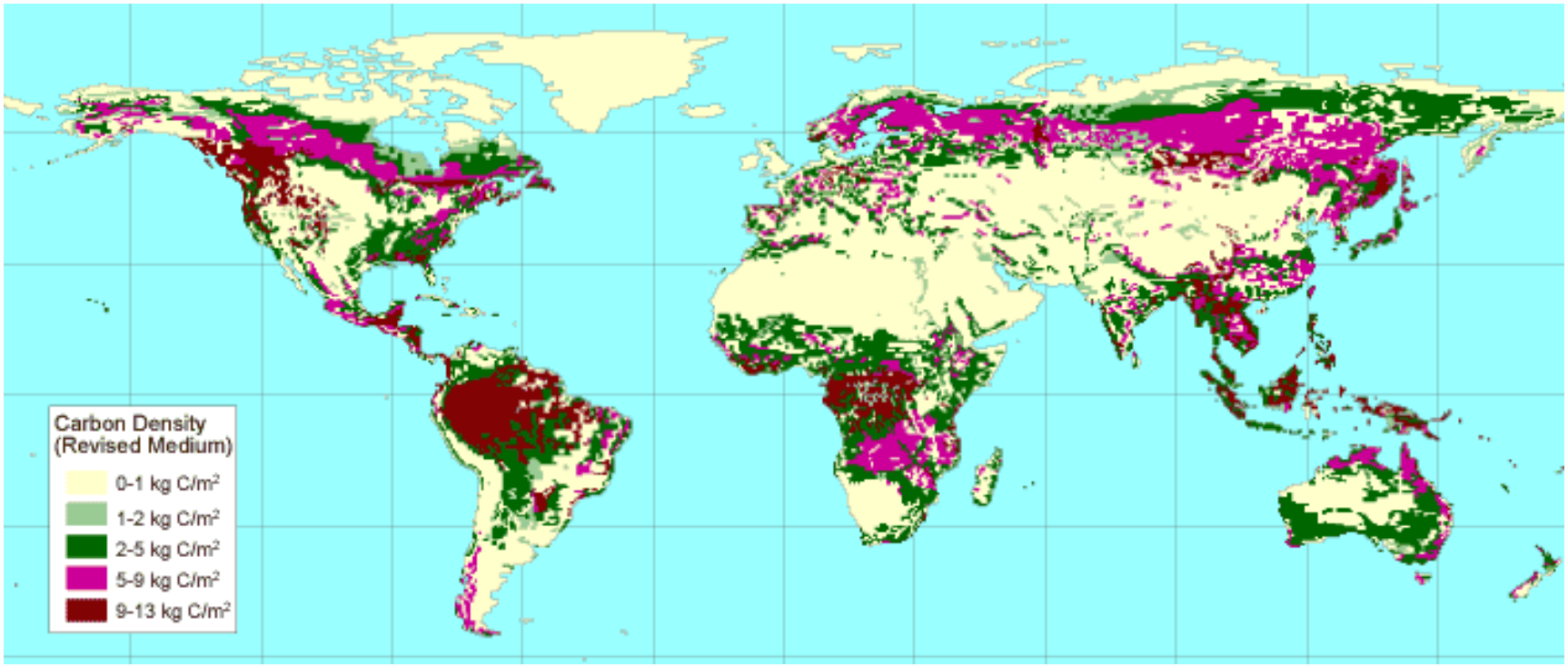
~40% of belowground carbon



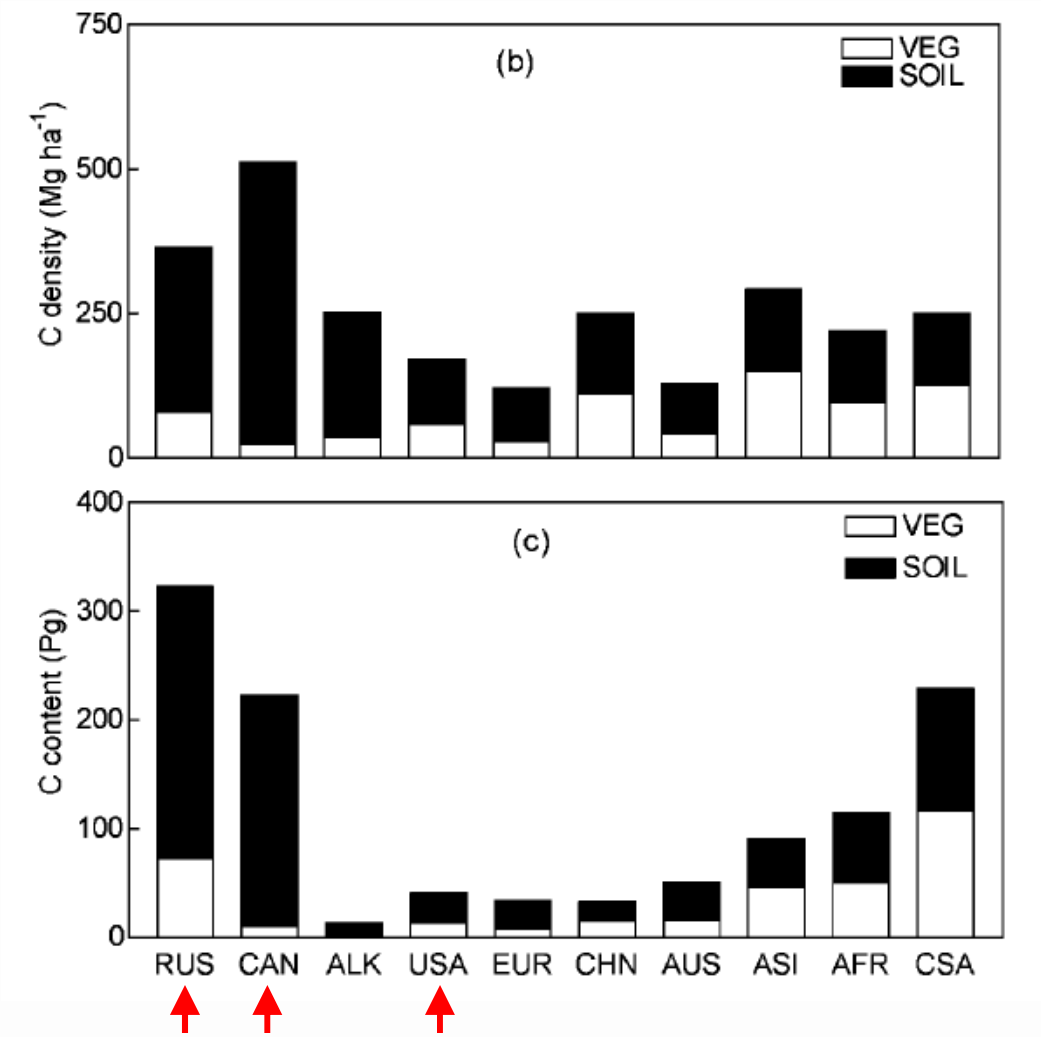
Dixon 2004, Figure: NASA Earth Observatory

Forest Carbon …global density

Carbon density in live vegetation



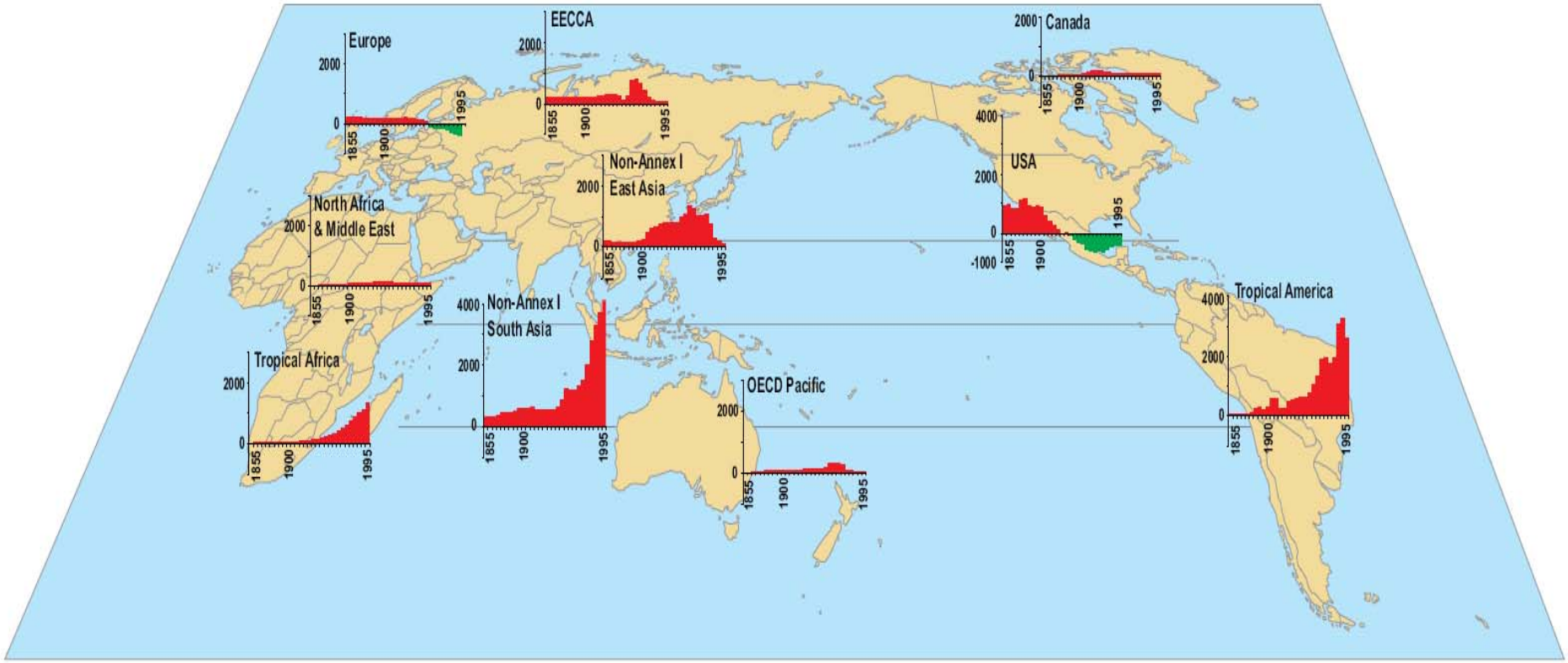
Forest Carbon …global density



Gower 2003

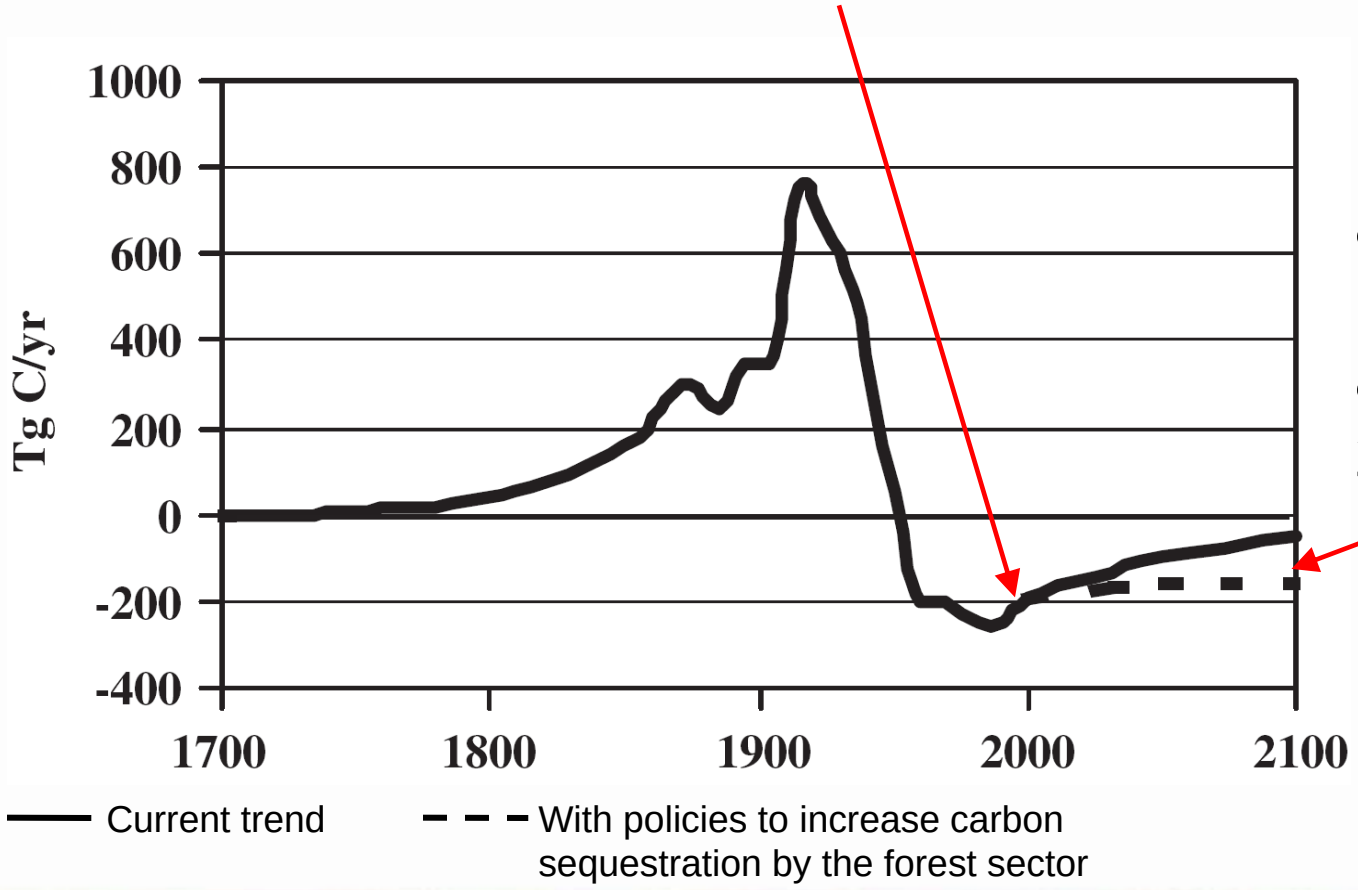
Forest Carbon …global trends

Regional carbon balance ($MtCO_2$), 1855-2000.



Forest Carbon …US pools

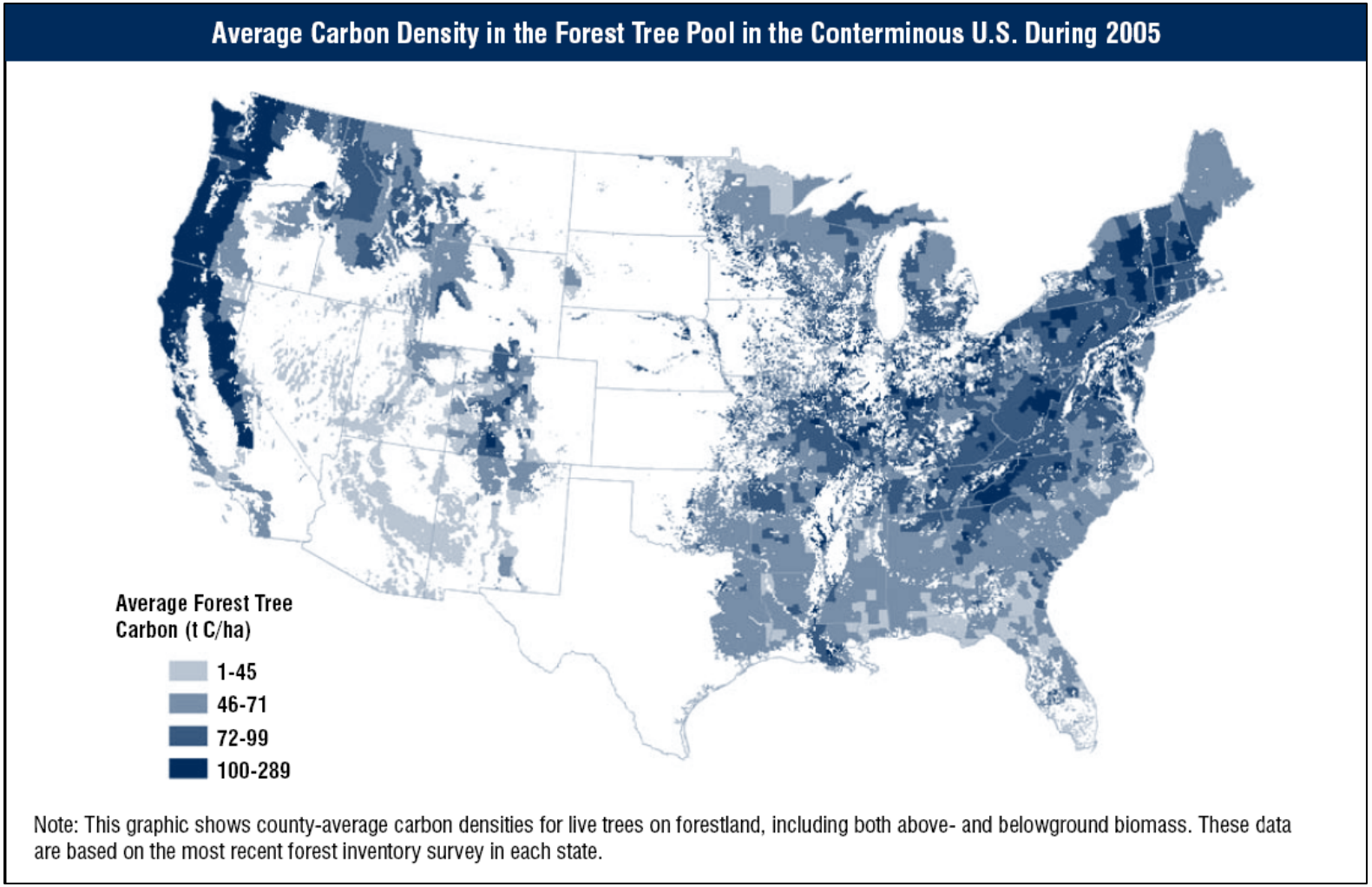
US forests annually sequester the equivalent of 10% of US carbon dioxide emissions from burning fossil fuels



Forestry activities could remove another 100 to 200 Tg C/yr

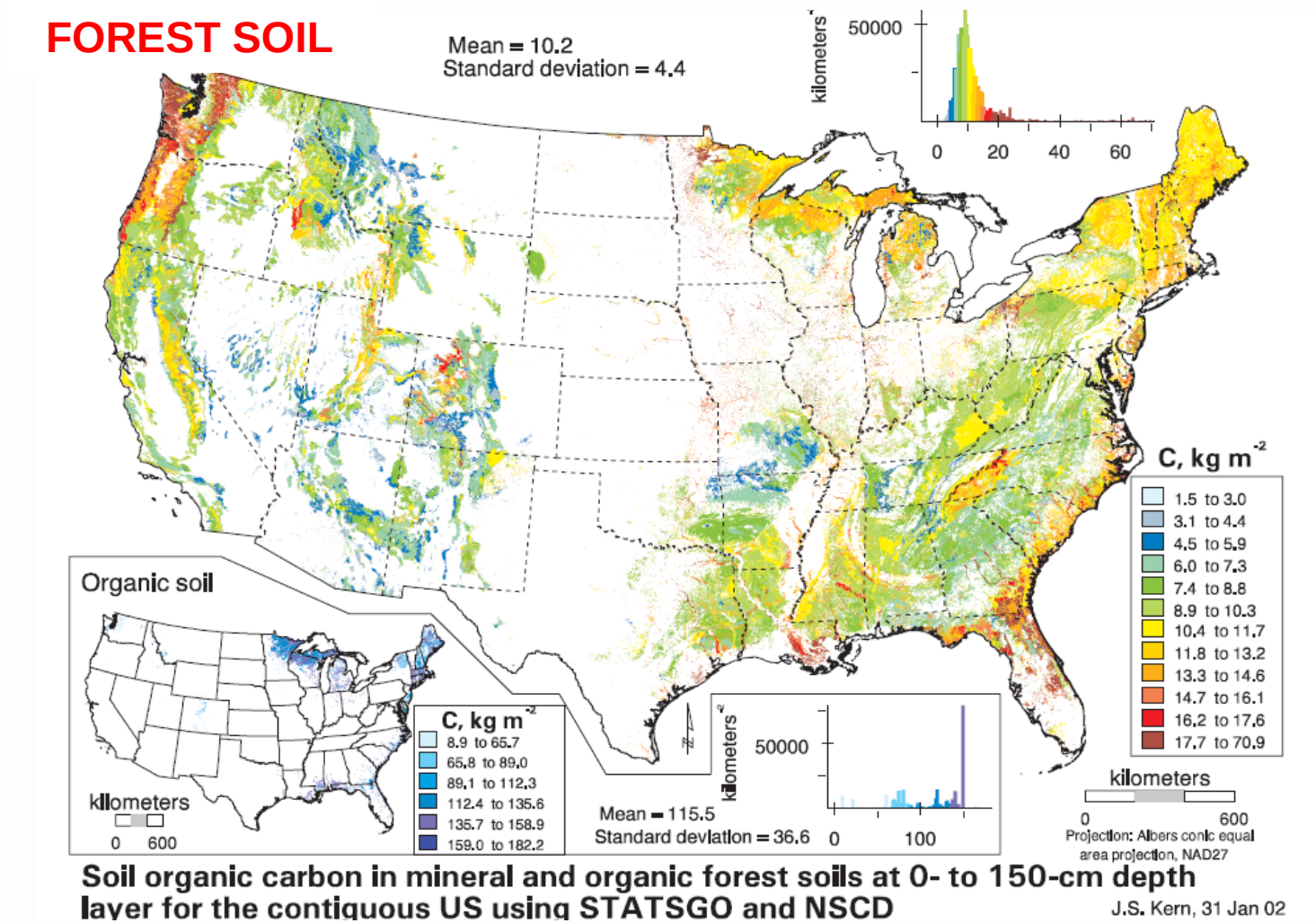
Heath and Smith 2004, EPA 2005, Figure: Birdsey et al. 2006

Forest Carbon …US pools



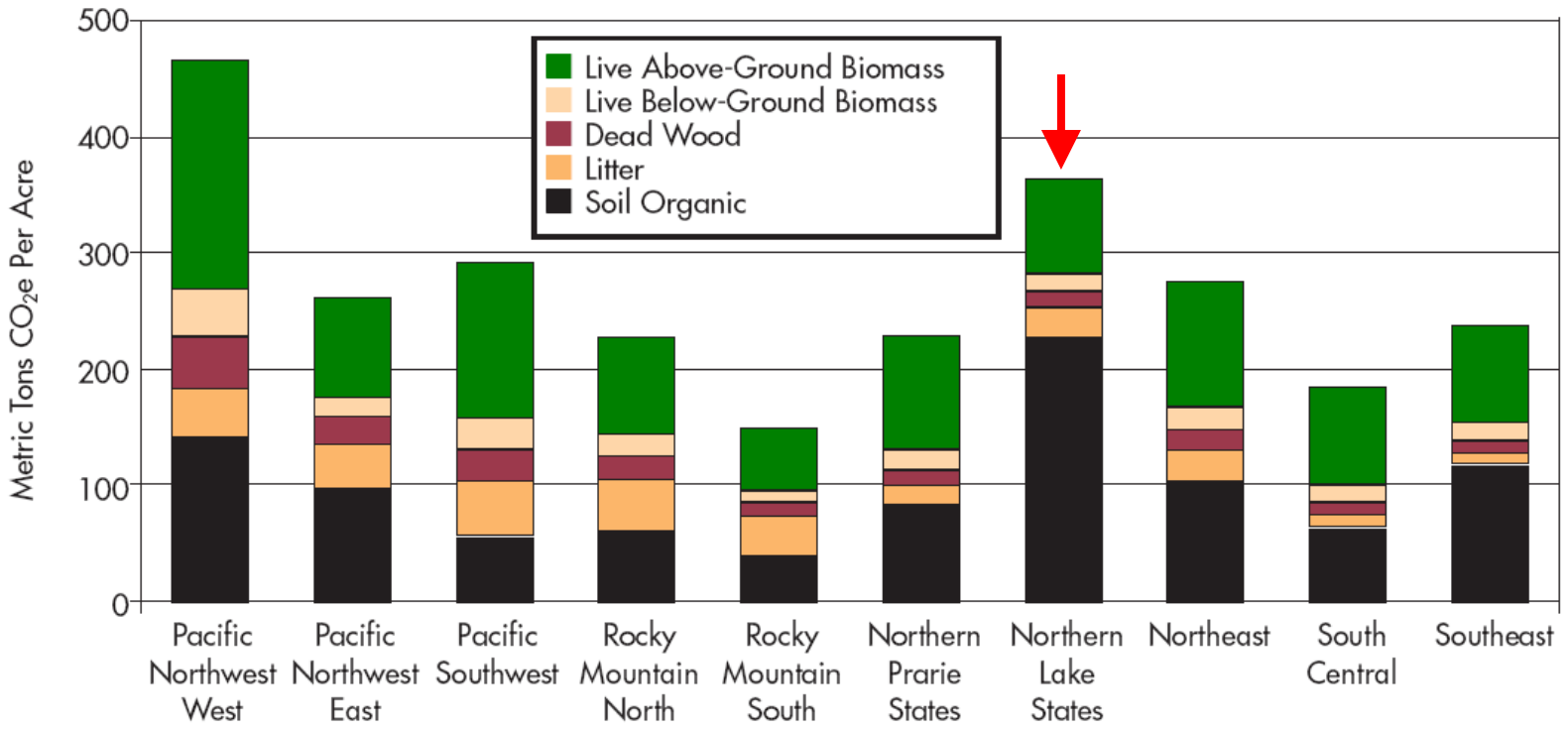
EPA 2006

Forest Carbon …US pools



Forest Carbon …US pools

FIGURE 6.



Regions: PNWW (Western OR and WA); PNWE (Eastern OR and WA); PSW (CA); RMN (ID, MT); RMS (AZ, CO, NM, NV, UT, WY); NPS (IA, IL, IN, KS, MO, ND, NE, SD); NLS (MI, MN, WI); NE (CT, DE, MA, MD, ME, NH, NJ, NY, OH, PA, RI, VT, WV); SC (AL, AR, KY, LA, MS, OK, TN, TX); SE (FL, GA, NC, SC, VA).

Data from Smith and Heath 2006.

Forest Carbon …Wisconsin

- Wisconsin forests are a carbon sink, sequestering ~8.5 Mt CO_2/year during 1992-2001 *(Brown et al. 2008)*
- Statewide emissions: 123 Mt CO_2e in 2003 *(GTFGW 2008)*

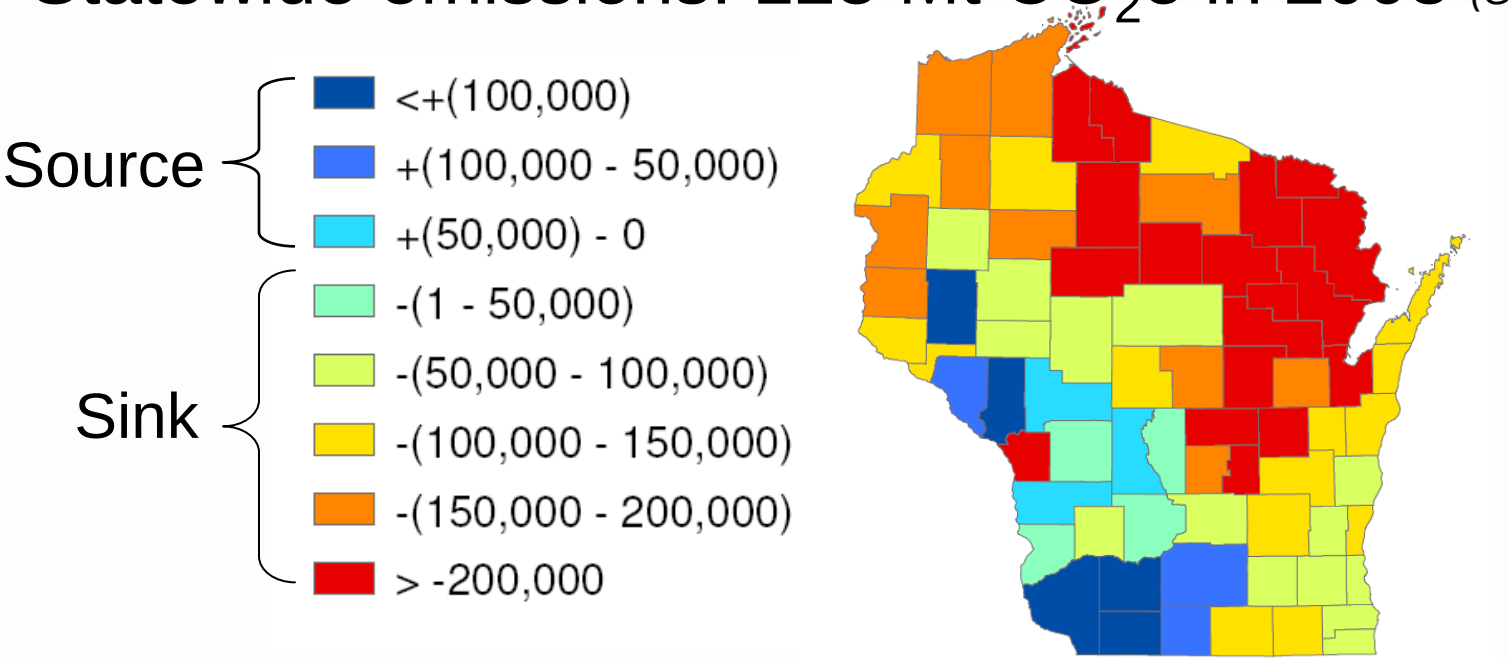


Figure 14. The net change in total tons of CO_2 in Wisconsin counties. Negative sign indicates a removal from the atmosphere and positive sign is an emission.

Figure: Brown et al. 2008

Forest Carbon …managed forests

Lake States Aspen-Birch:

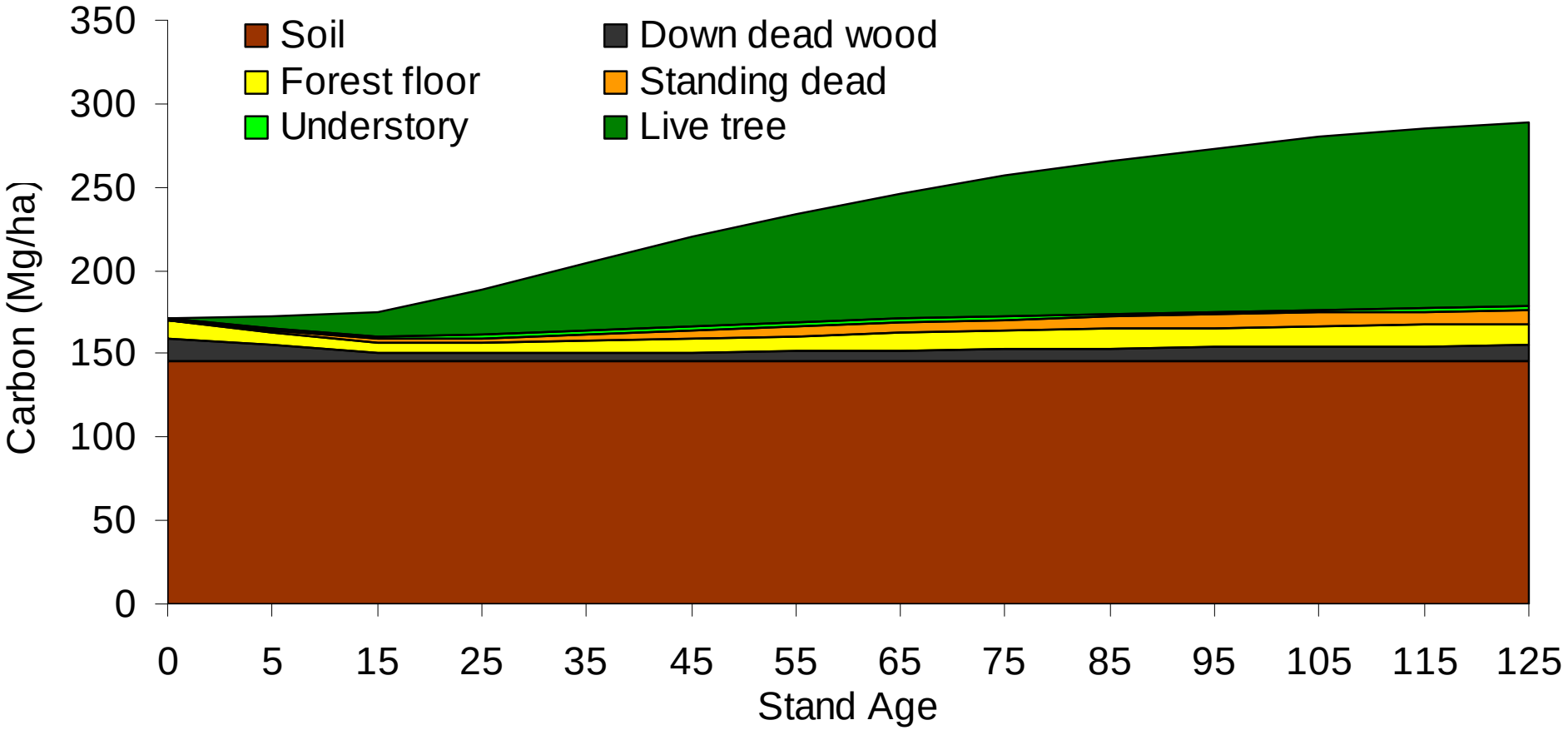
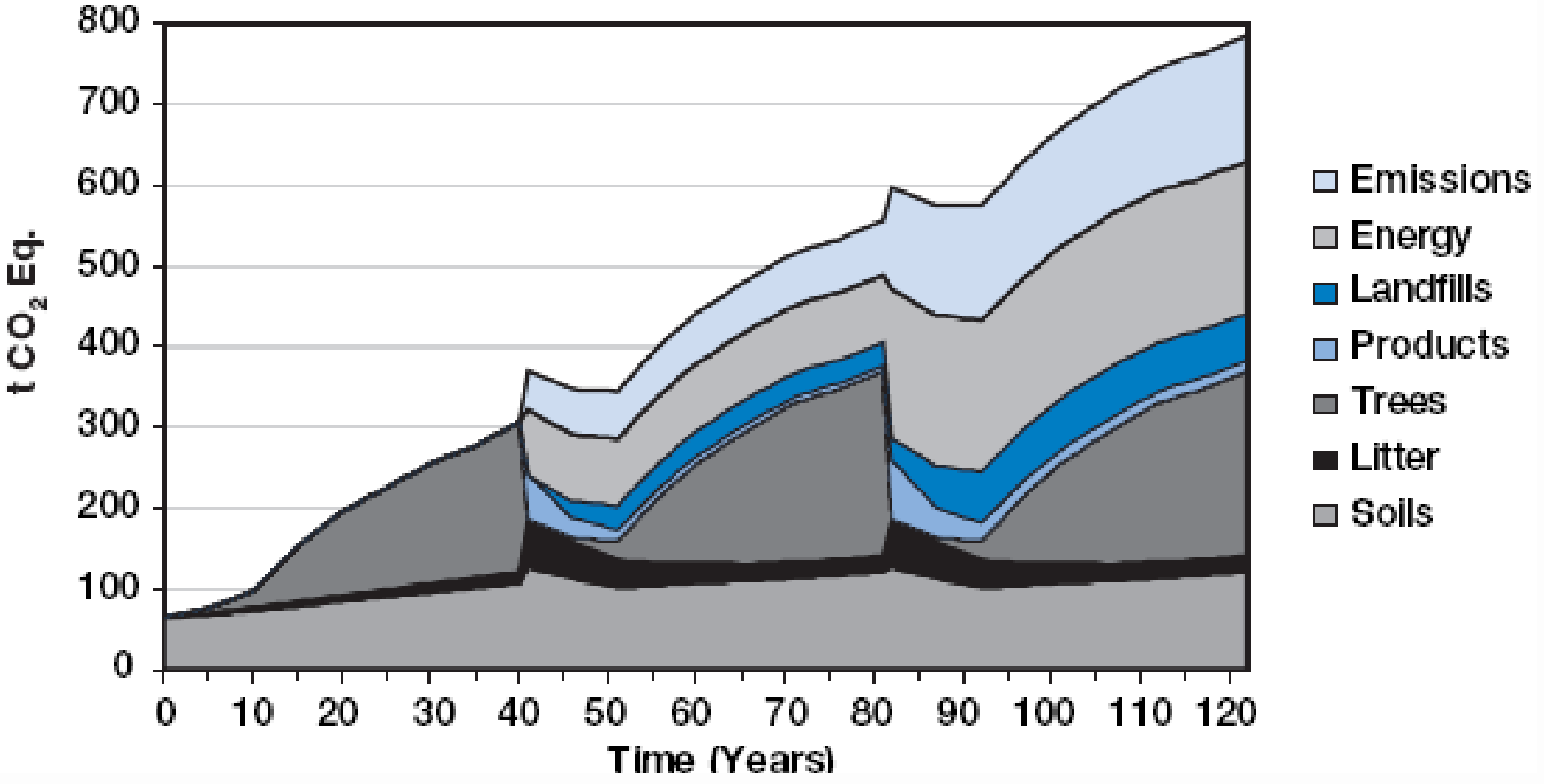


Figure data: Smith et al. 2005

Mitigation …forest carbon sequestration



EPA 2005

Forest Carbon …managed forests

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

- Framework for adaptation (5 R's)

Adaptation …options

1) **Resistance** – improve the defenses of the forest against effects of change
   - High value, high risk, or urgent situations, such as:
     - → Endangered species
     - → Extreme fire risk
     - → Invasive species epidemics
   - Likely short term

Millar et al. 2007, 2008

Adaptation …options

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

- Preventative treatments encouraging health, such as:
  - → Thinning overstocked forest
  - → Prescribed fire
  - → Augmenting endangered species populations
- Likely short term

Millar et al. 2007, 2008

Adaptation …options

3) **Respond** – intentionally accommodate change, enabling ecosystems to adaptively respond

- Accept inevitability of change
- Proactive approach, having multiple tools:
  - → Assist transitions, range shifts, and other adjustments
  - → Anticipate and plan for associated risks
  - → Promote connected landscapes
  - → Increase biodiversity
  - → Include experimentation/creativity in management

Millar et al. 2007, 2008

Adaptation …options

4) **Realign** – for severely changed or disturbed systems, allow for readjustment to new conditions

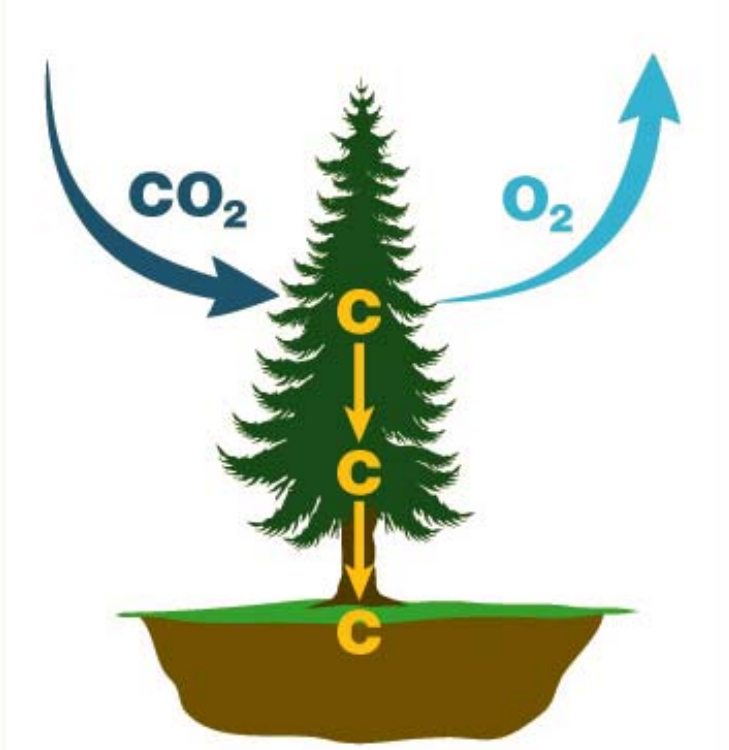
- Recognize that managing for pre-settlement conditions or natural range of variability may not be appropriate

Millar et al. 2007, 2008

Adaptation …options

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

- Closely tied with our ability to adapt to change



Millar et al. 2007, 2008

Mitigation …managing for carbon

Silvicultural Treatments

- Even-aged or uneven-aged management:

  → Likely has little effect on aboveground stores over long time periods

- Species selection:

  → Fast growing intolerants have higher rates of sequestration (short term), however…

  → Shade tolerant species usually support higher stand densities and can accumulate more carbon over time

Malmsheimer et al. 2008

Mitigation …managing for carbon

Silvicultural Treatments

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

Malmsheimer et al. 2008

Mitigation …managing for carbon

Silvicultural Treatments

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

Birdsey et al. 2000, Malmsheimer et al. 2008

Mitigation …managing for carbon

Silvicultural Treatments

- 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 …managing for carbon

Harvest Reduction

- 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 …managing for carbon

Role of Old-growth

- Old growth forests are usually C sinks *(Luyssaert et al 2008)*
- Conversion to young managed forest results in significant reduction in carbon stocks *(Harmon et al. 1990)*
- Preservation of old-growth may have a greater impact than favoring younger forests *(Schulze et al. 2000)*

Forest Carbon …management

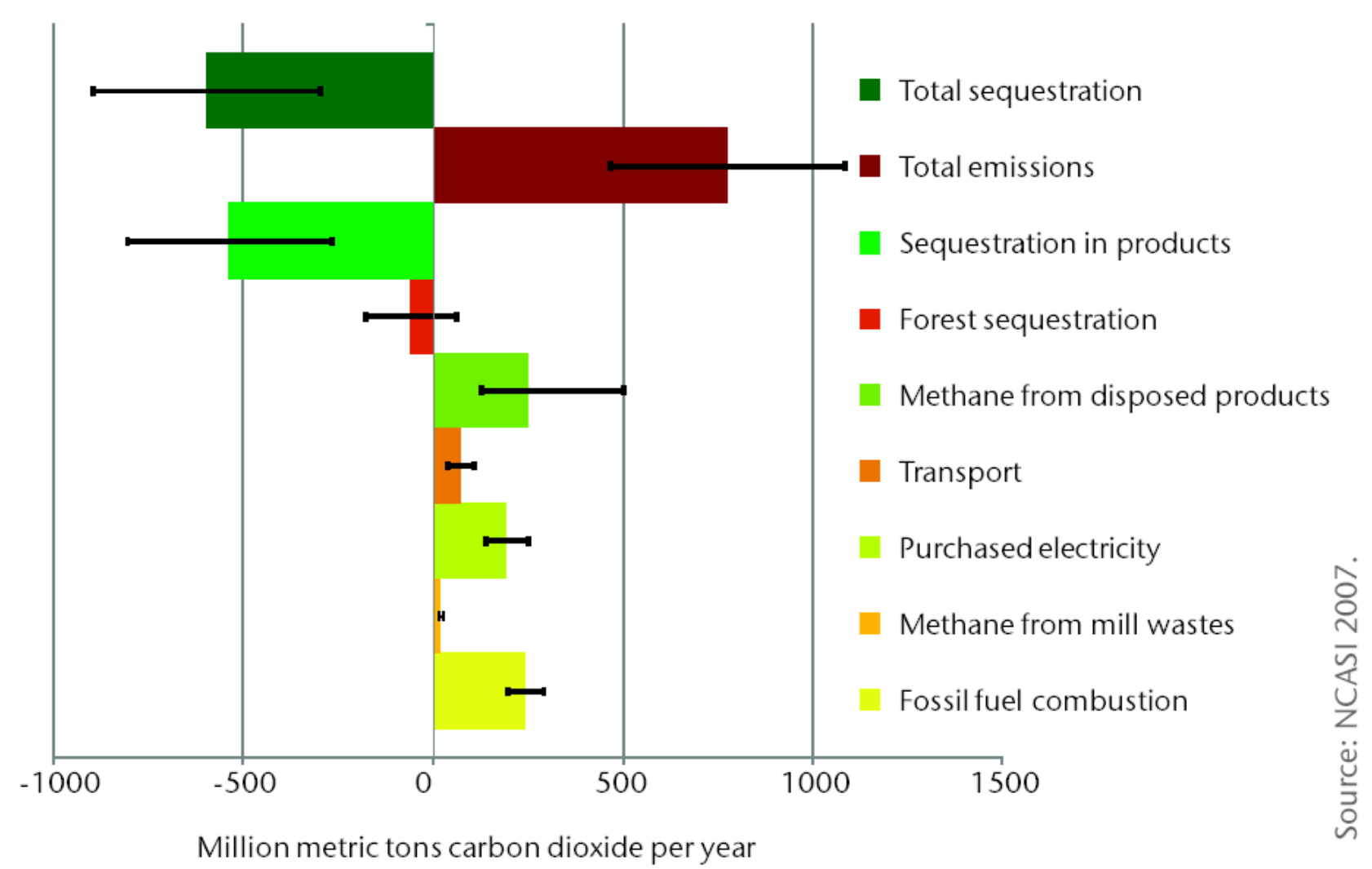


Figure: WBCSD 2007

Mitigation …wood products

Wood product categories

- Waste wood
- Wood used for energy
- Solid wood (lumber)
- Composite products
- Paper products
- Nonstructural Panels

Mitigation …wood 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

Figure: Wilson 2006

Mitigation …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)*

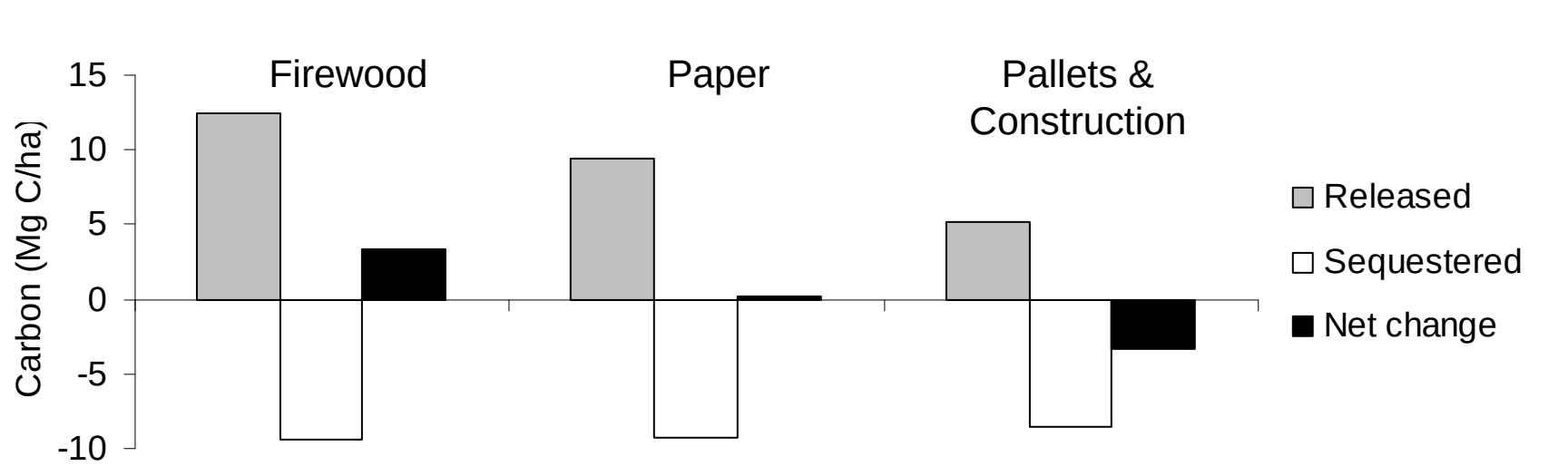


Figure data: Finkral and Evans 2008

Mitigation …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

Rotation length

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

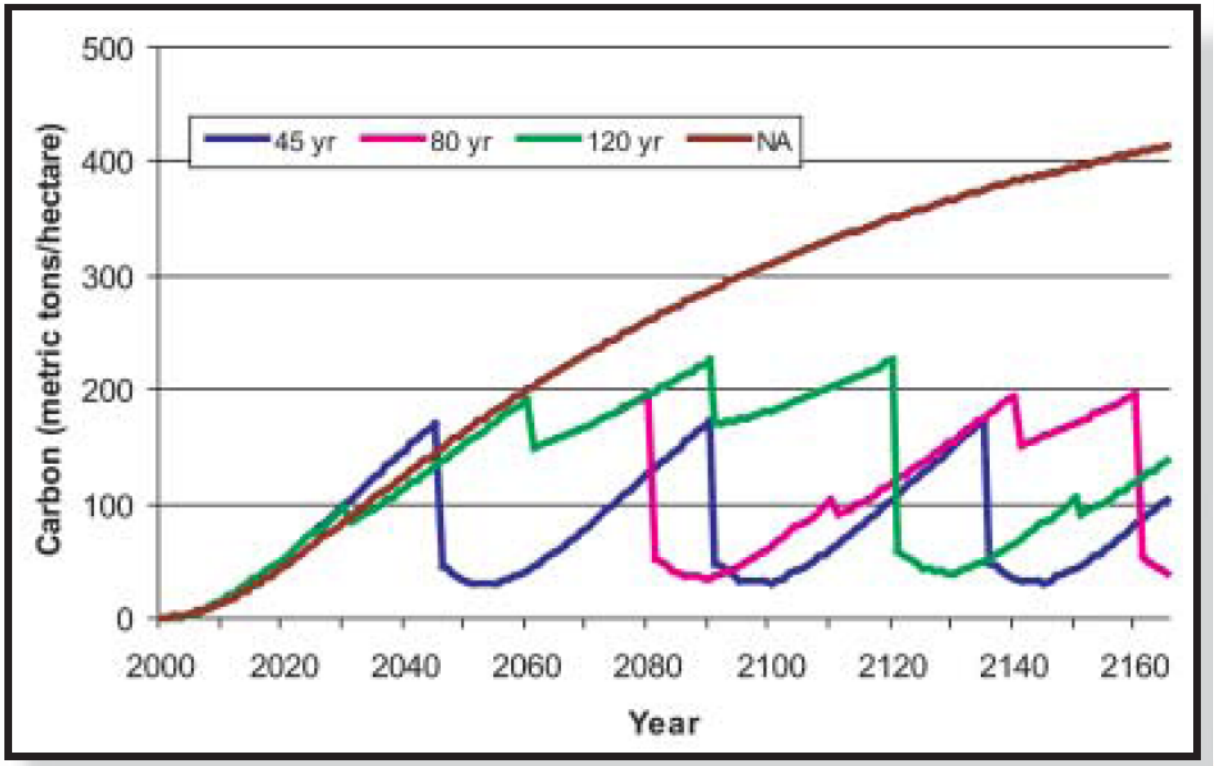
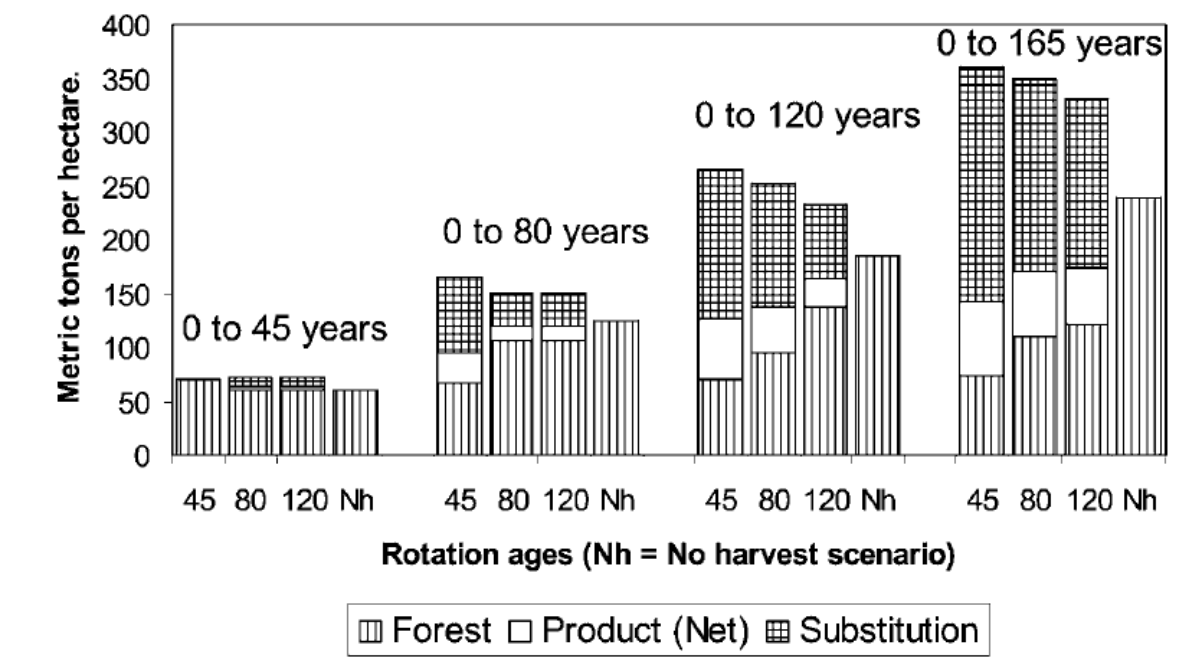


Figure: Wilson 2006

Mitigation …wood products

Rotation length

- …However, 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, Hennigar et al. 2008)*



→ Don't forget management objectives other than carbon.

Figure: Perez-Garcia et al. 2005

Summary

- 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 that needs to be balanced with all of the others.

QUESTIONS?

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Global Carbon …soil factoids

- "Worldwide, SOC in the top 1 meter of soil comprises about 3/4 of the earth's terrestrial carbon…"
  - →Indirect sequestration through decomposition from plant biomass into soil organic matter
  - →Direct sequestration from chemical reactions that convert CO_2 into inorganic compounds