Chequamegon-Nicolet National Forest Climate Change Response Framework

Forest Carbon Sequestration and Mitigation (Preliminary Mitigation Assessment)

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Entering Eastern Region National Forests U.S. Department of Agriculture

Forest Service U.S. Department of Agriculture

University of Wisconsin Forest Ecosystem Ecology

1885 – 2010 Michigan Tech

Princeton University

Why Mitigate?

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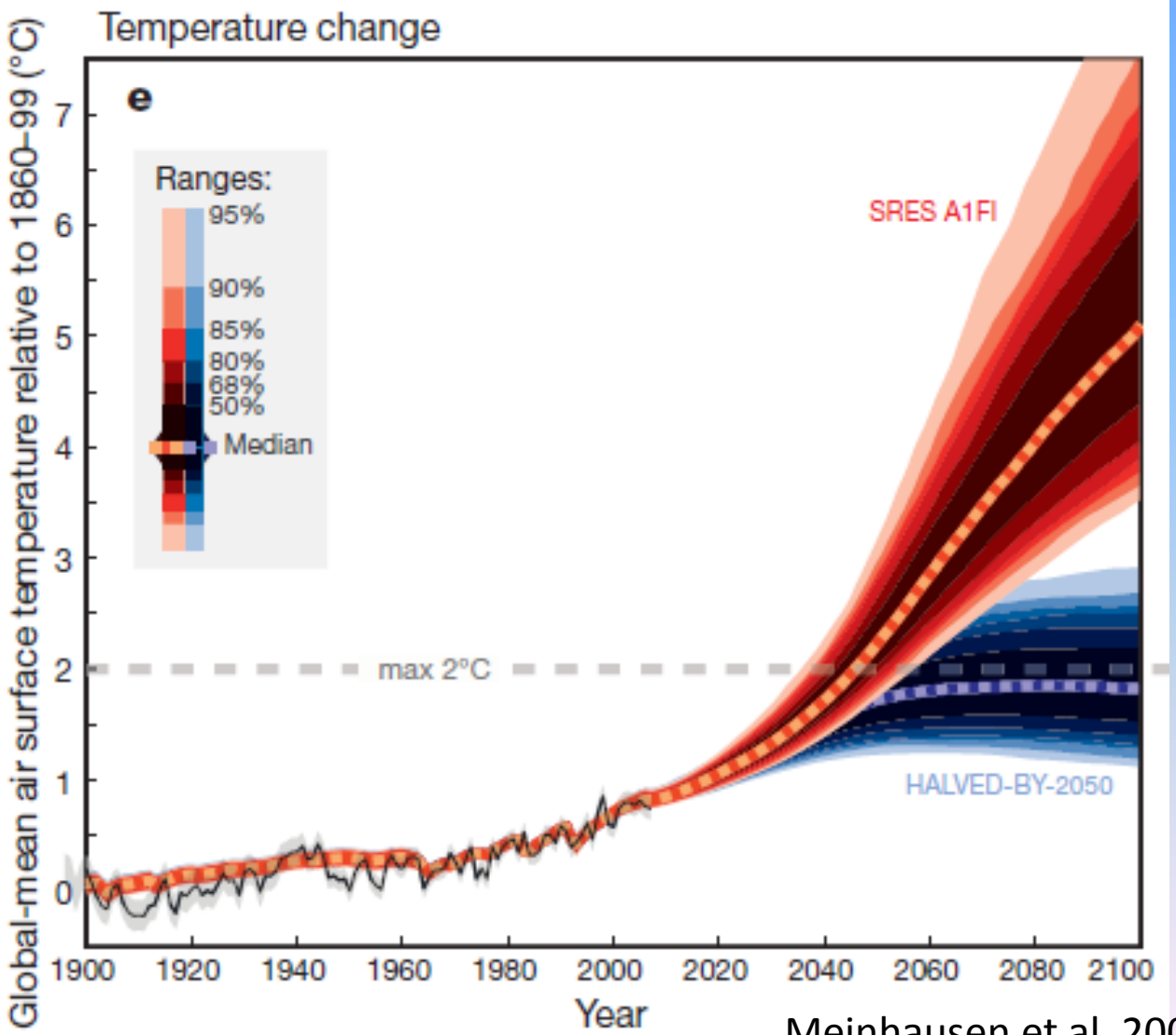


Past and projected average global temperature, with and without mitigation

Meinhausen et al. 2009 Nature 458

What is the Role of Public Lands in Mitigation?

What is the Role of Public Lands in Mitigation?

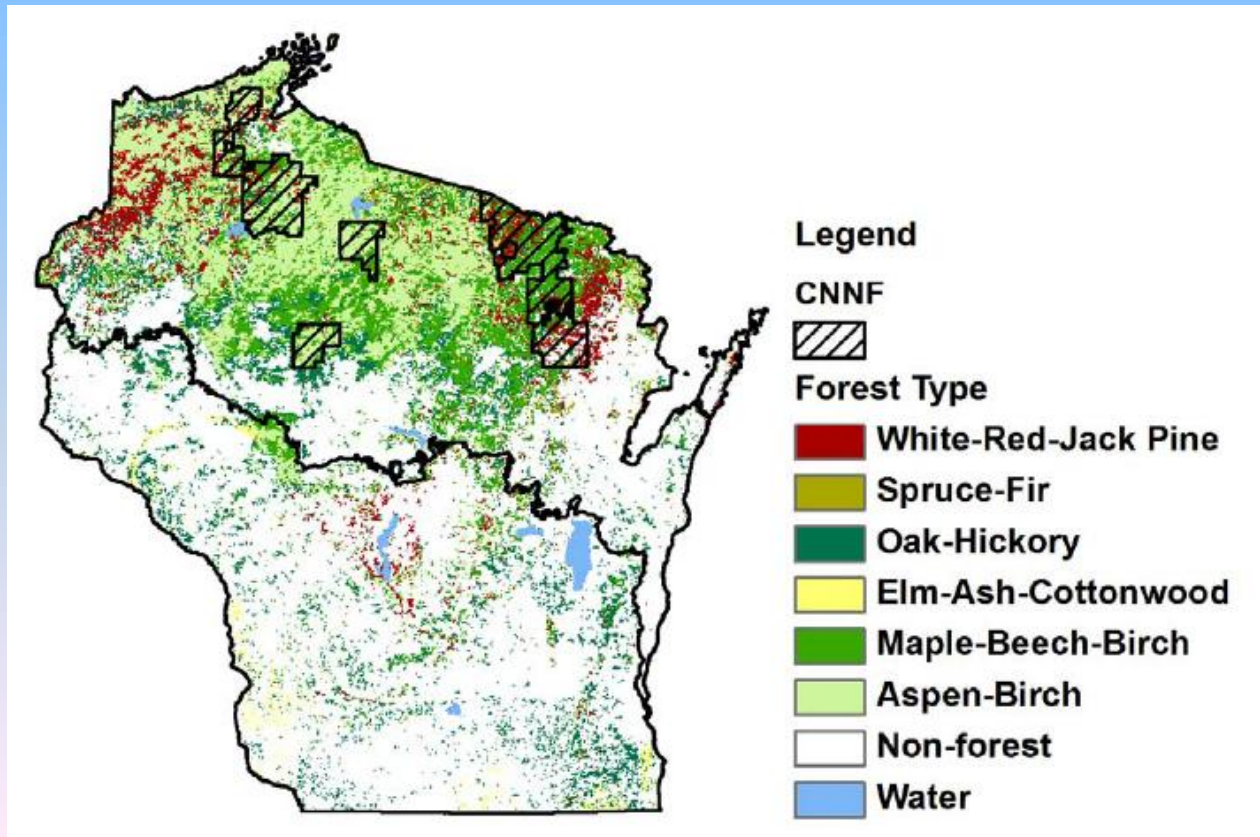
- U.S. forests and harvested wood products sequester 200 million tons C/yr from the atmosphere, offsetting 12% of fossil fuel emissions
  - 44% of U.S. forest land is public
  - 41% of total forest C stock is public
  - >60% of net C sequestration is public
- Public land policy is evolving -- public lands will surely be involved in mitigation
- Public and private lands may have different but complementary roles in mitigation across landscapes

CNNF Mitigation Assessment Objectives

- **Preliminary work:**
  - Describe current carbon stocks in forests and wood products of Northern Wisconsin, and recent trends
  - Develop several mitigation scenarios for future analysis
- **Future work:**
  - Assess impacts of several mitigation scenarios
  - Integrate analysis with vulnerability assessment
- **NOT** recommending any particular actions, just describing effects of scenarios based on analysis of data and models

Scope of Mitigation Assessment

- Ecoregion Province 212 (Northern Wisconsin)
- 3 major owner groups:
  - National Forest
  - Other Public
  - Private



General Categories of Mitigation Options

- Increase carbon stocks in forests and wood products
- Reduce the loss of forest land to other uses
- Increase the use of wood for bioenergy

➢ We also describe the opportunities and issues about engaging in greenhouse gas markets and registries

Estimating Land Mitigation Potential

- Biological factors
  - Net ecosystem productivity
- Economic factors
  - Supply as function of price
- Social factors
  - Barriers, rules, other owner objectives
- Uncertainties
  - Climate change, natural disturbances

Higher potential

Lower potential

Estimating Land Mitigation Potential

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Phase 1

Higher potential

Lower potential

Basic Accounting for Forest Carbon and Wood Products Management

- Ecosystem carbon
  - Biomass of trees and other vegetation
  - Woody debris and litter
  - Soil
- Carbon in wood products
  - In use and landfilled
  - Bioenergy
- Energy use
  - Growing and harvesting
  - Manufacturing
  - Transportation

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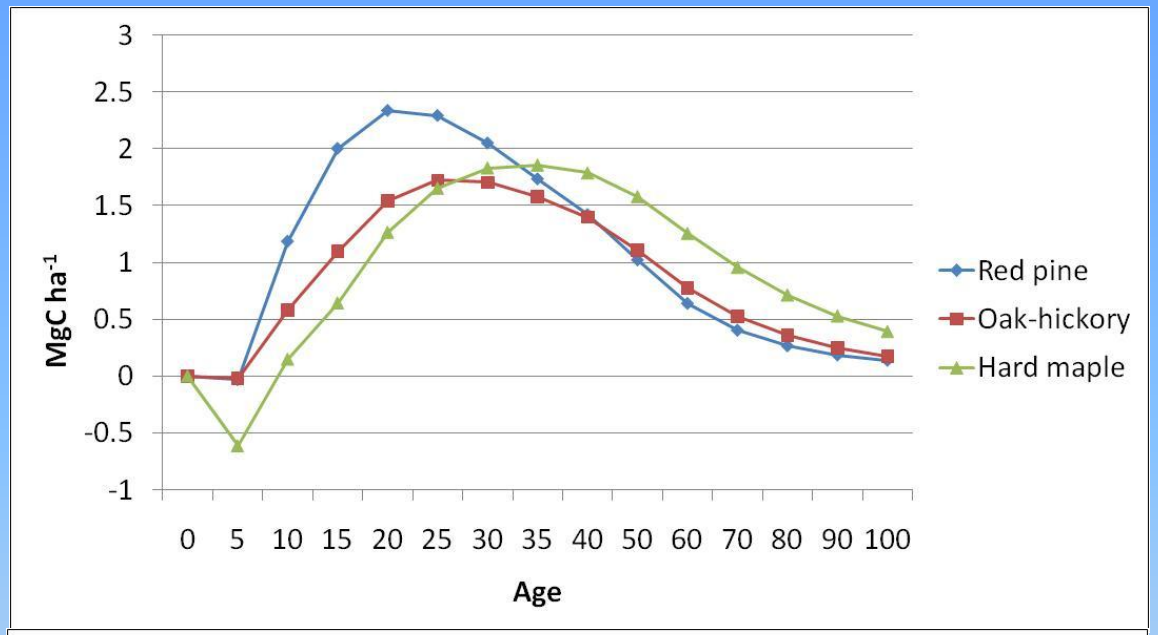
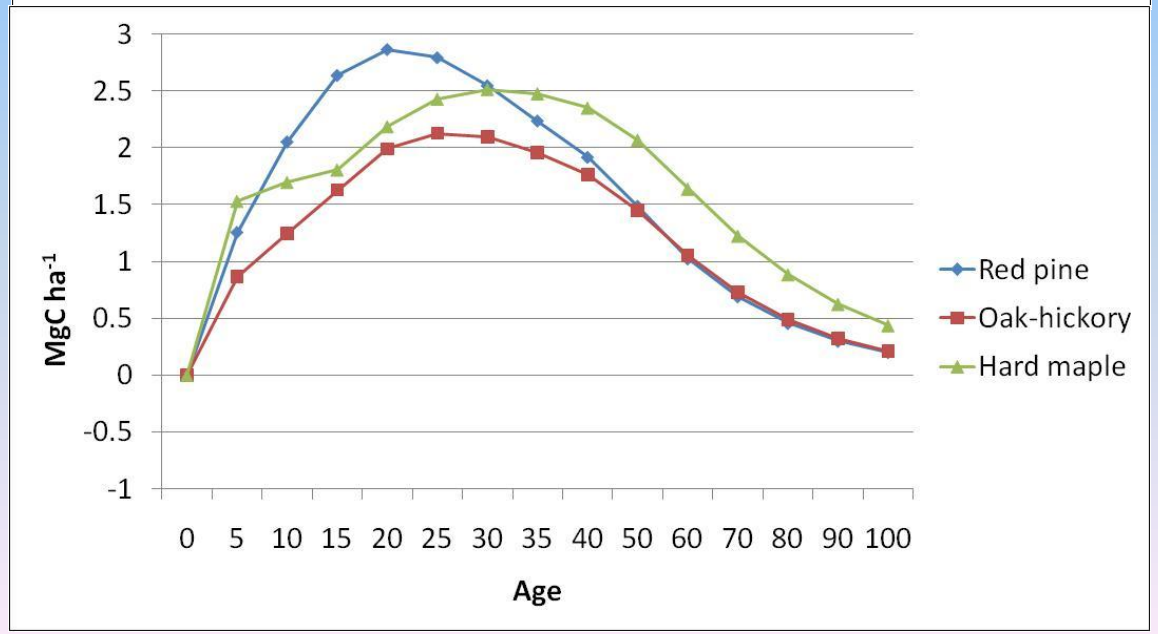
Phase 1

Net Ecosystem Production of Selected Forest Types

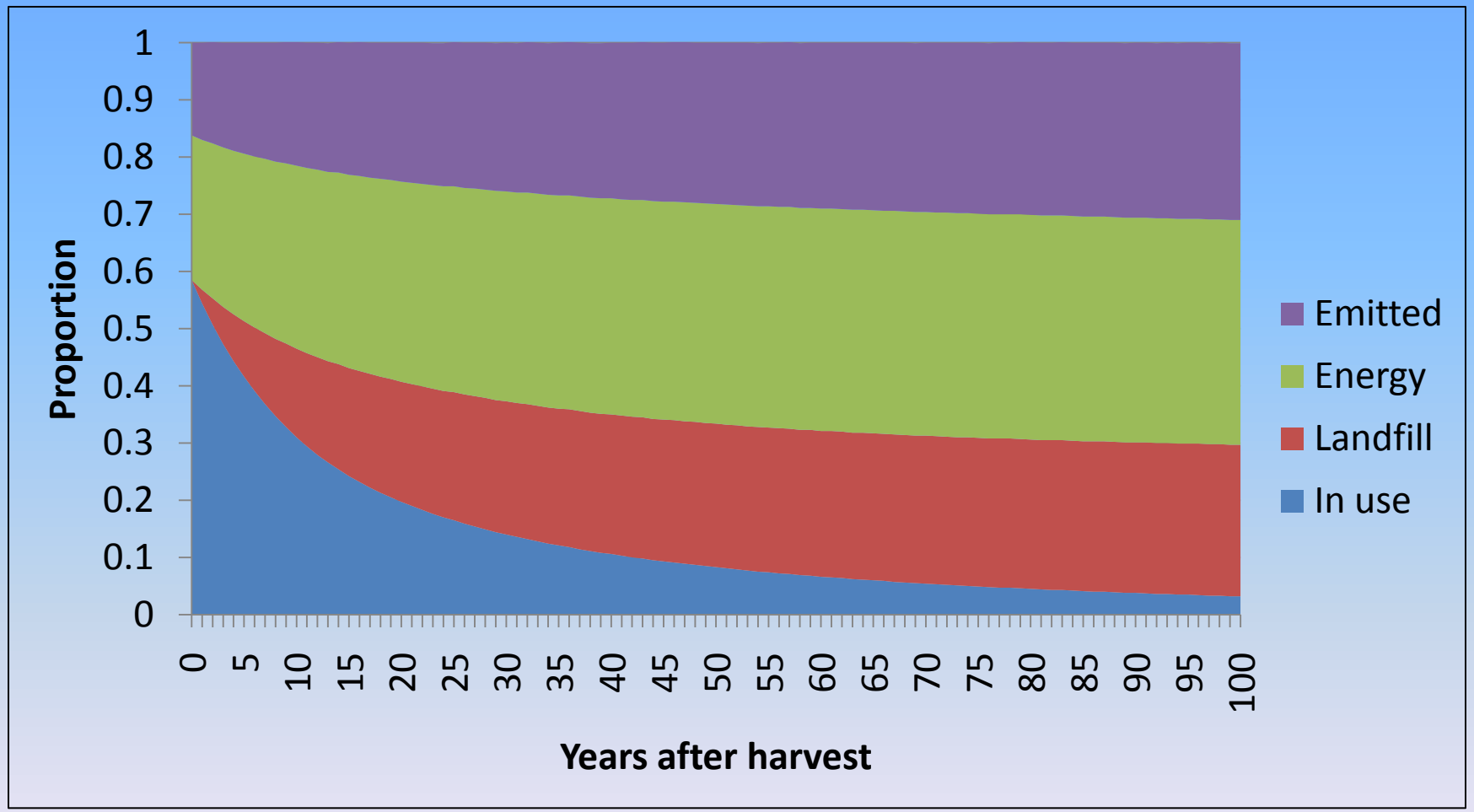


Clearcut/regeneration



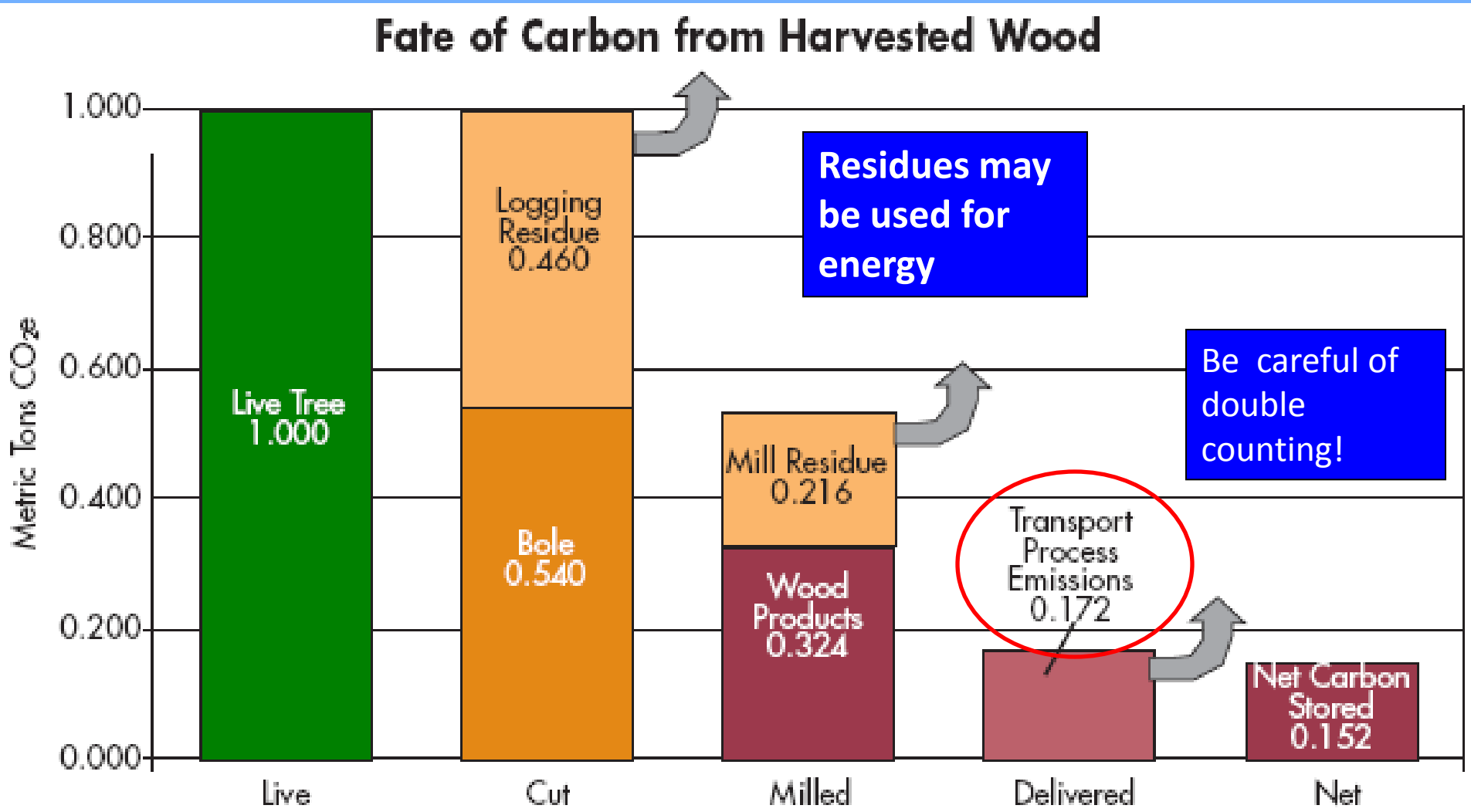
Afforestation

Transfer and Disposition of Harvested C



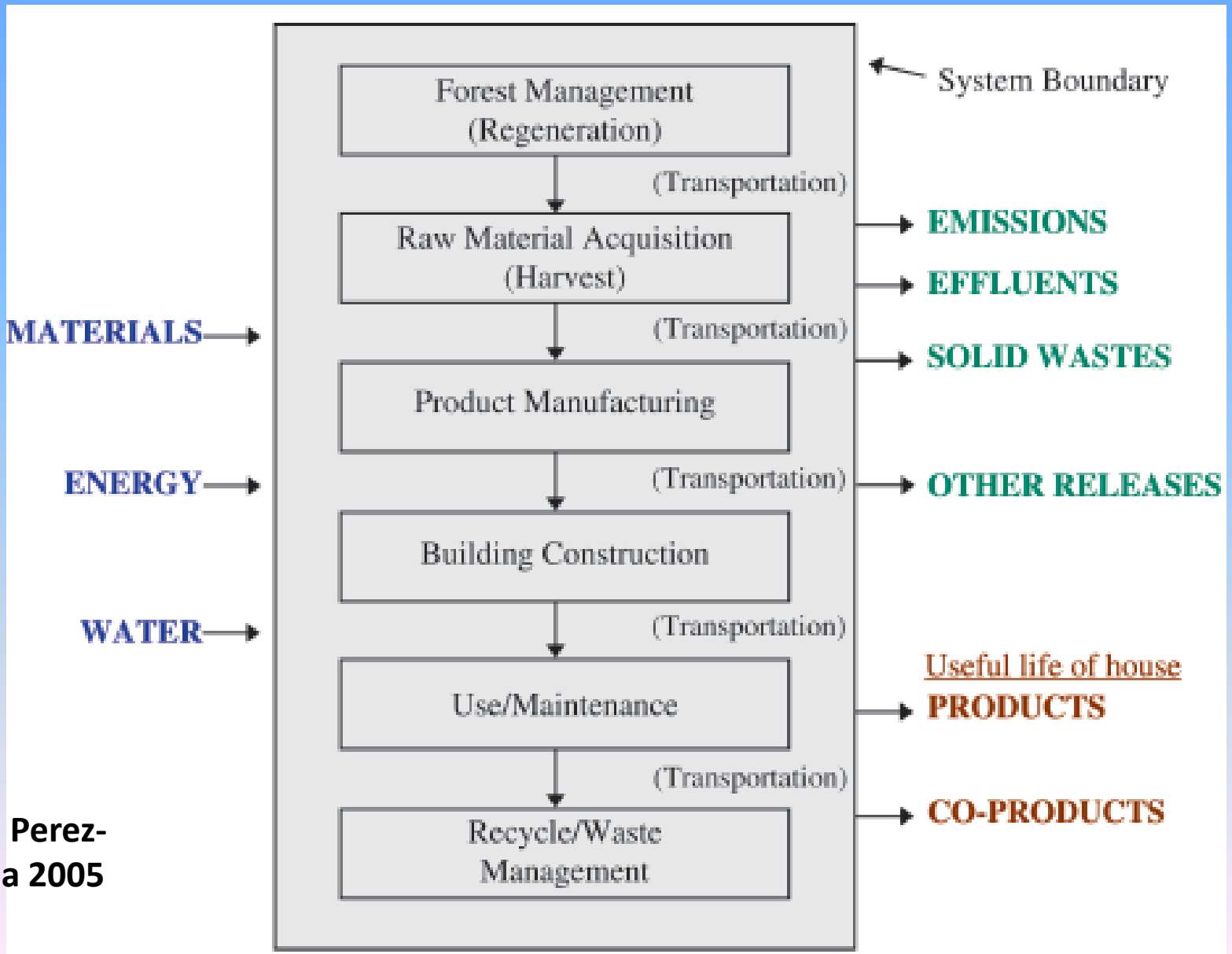
Greenhouse Gas Balance of Wood Production

(adapted from Ingerson 2007)



Data from Smith et al. 2006 and Gower et al. 2006.

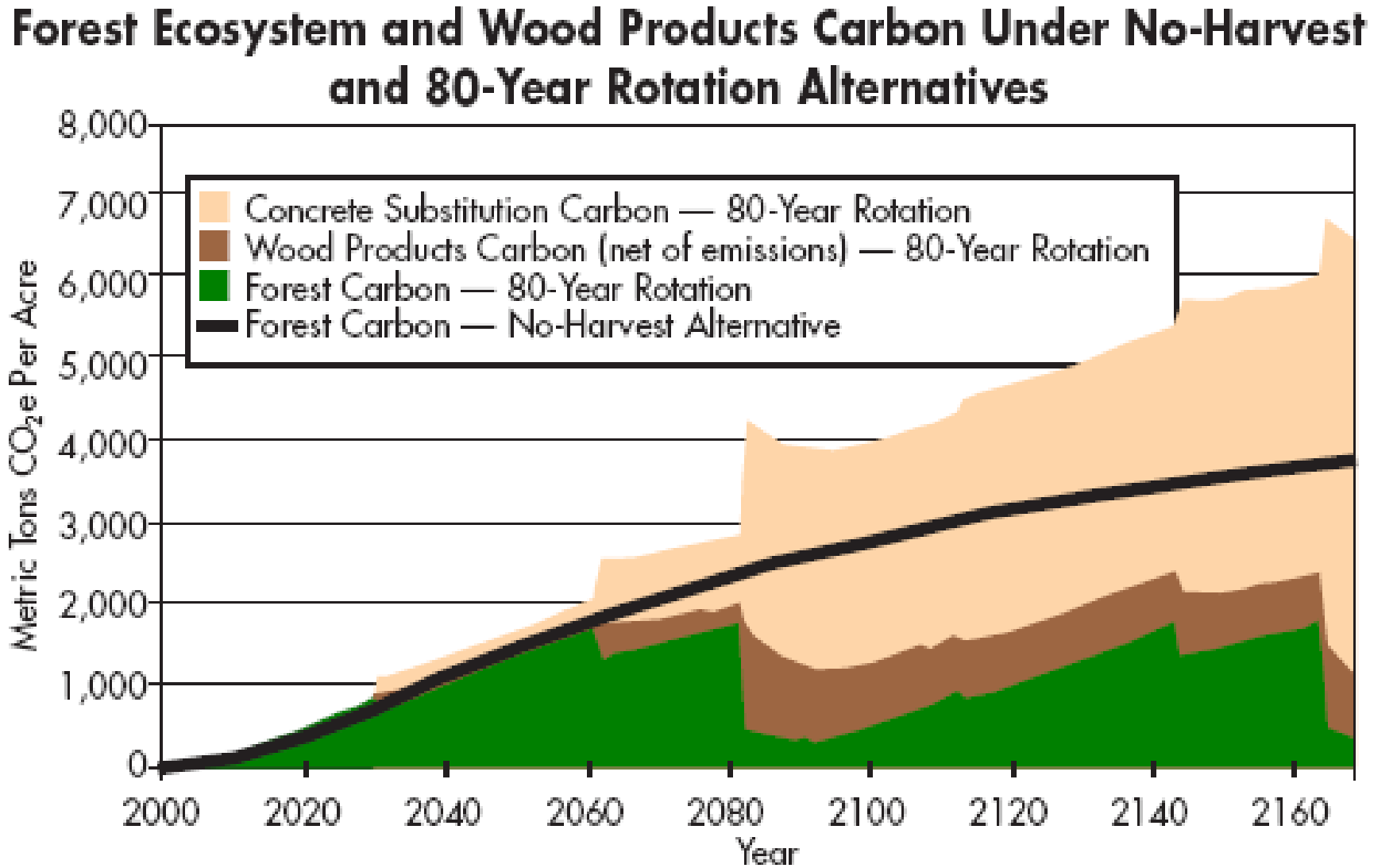
Life Cycle Inventory and Analysis



From Perez-Garcia 2005

Comparison of Management Alternatives

(from Ingerson 2007)

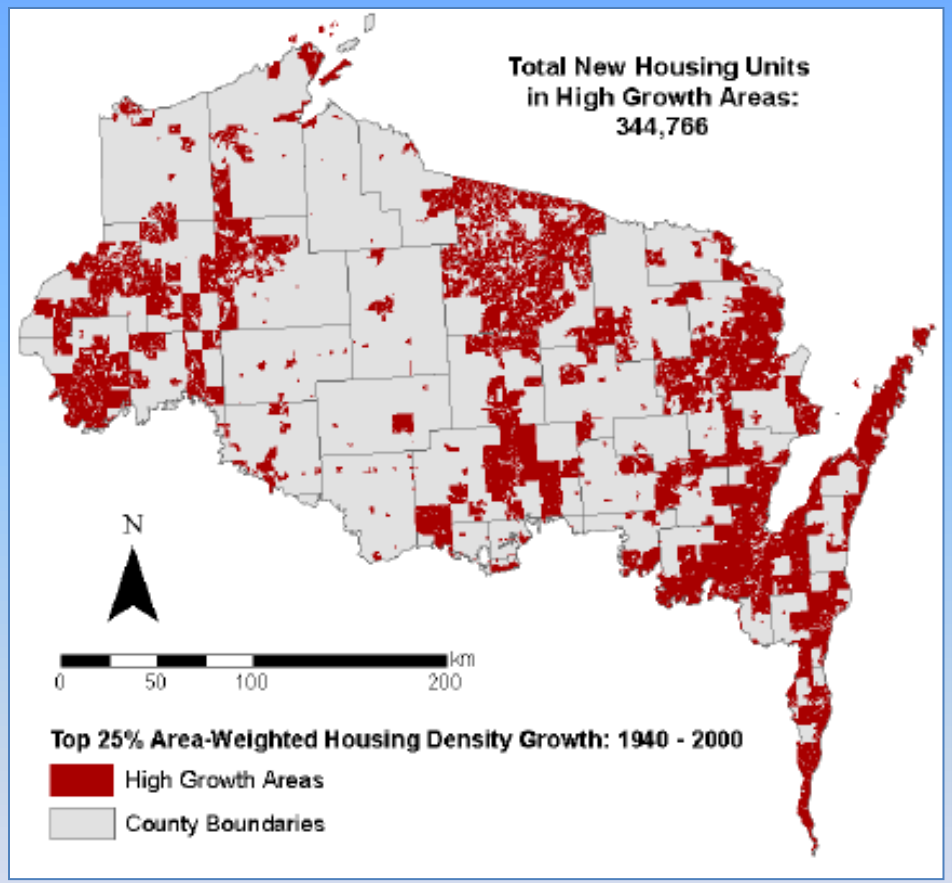


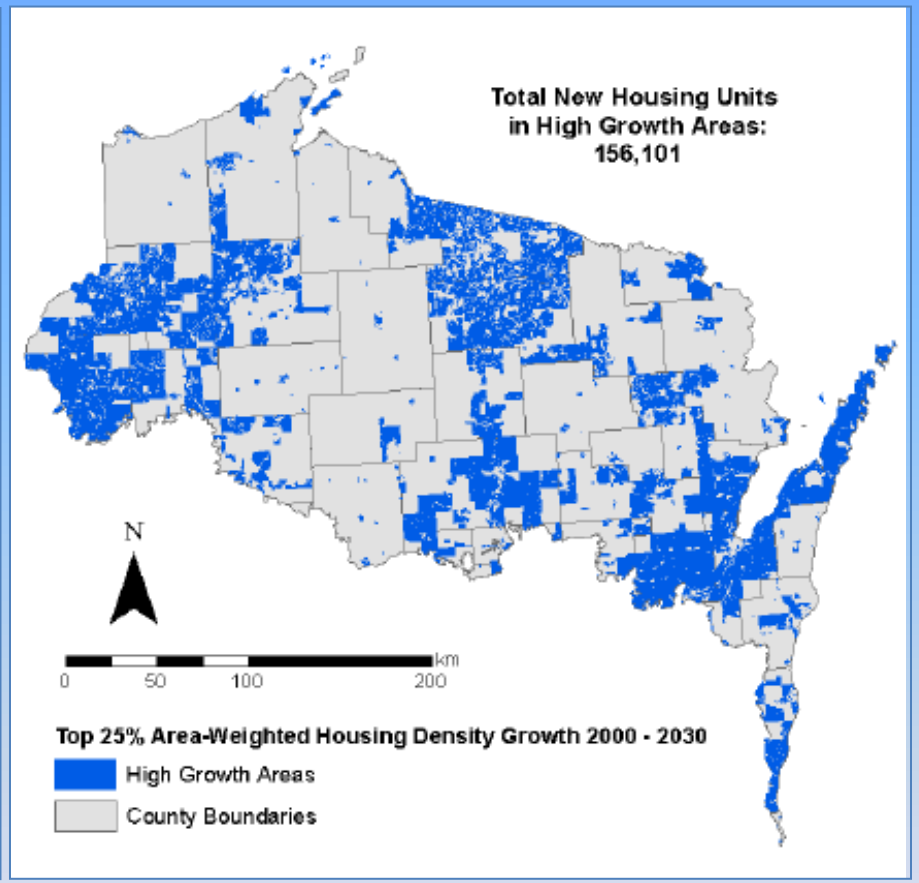
Adapted from Wilson 2006, data from Perez-Garcia et al. 2005.

Does the U.S. Have a Deforestation Problem?

The U.S. Loses about 500,000 hectares per year to development and other land uses – approximately offset by afforestation (mostly from rangeland)

Avoiding Deforestation





345,000 new housing units between 1940 and 2000

156,000 new housing units between 2000 and 2030

Afforestation

- Potential depends on:
  - Land productivity
  - Price of carbon

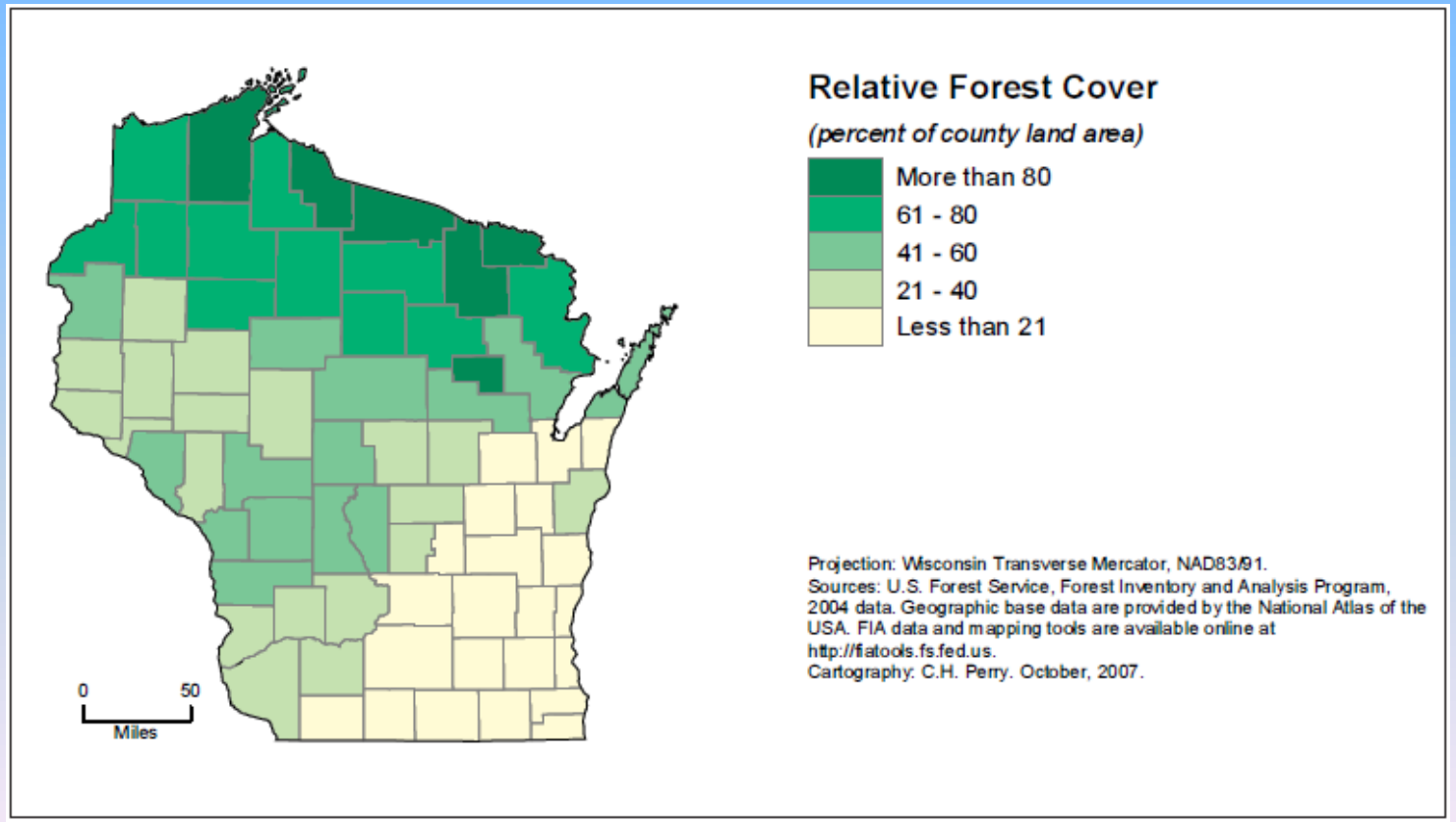


Figure 5. Area of forest land by county, Wisconsin, 2004 (from Perry et al. 2008).

Increasing Use of Wood for Bioenergy

- Wood and wood waste makes up 4.6% of Wisconsin's energy consumption
- National and state policies encourage more use of bioenergy
- There may be 1.5 million tons of biomass available per year – 3 times current consumption
- Accounting rules for estimating carbon credit is not yet clear

Markets and Registries: Forest C Accounting Issues

- Additionality
- Baselines
- Leakage
- Permanence
- Analysis boundary issues*

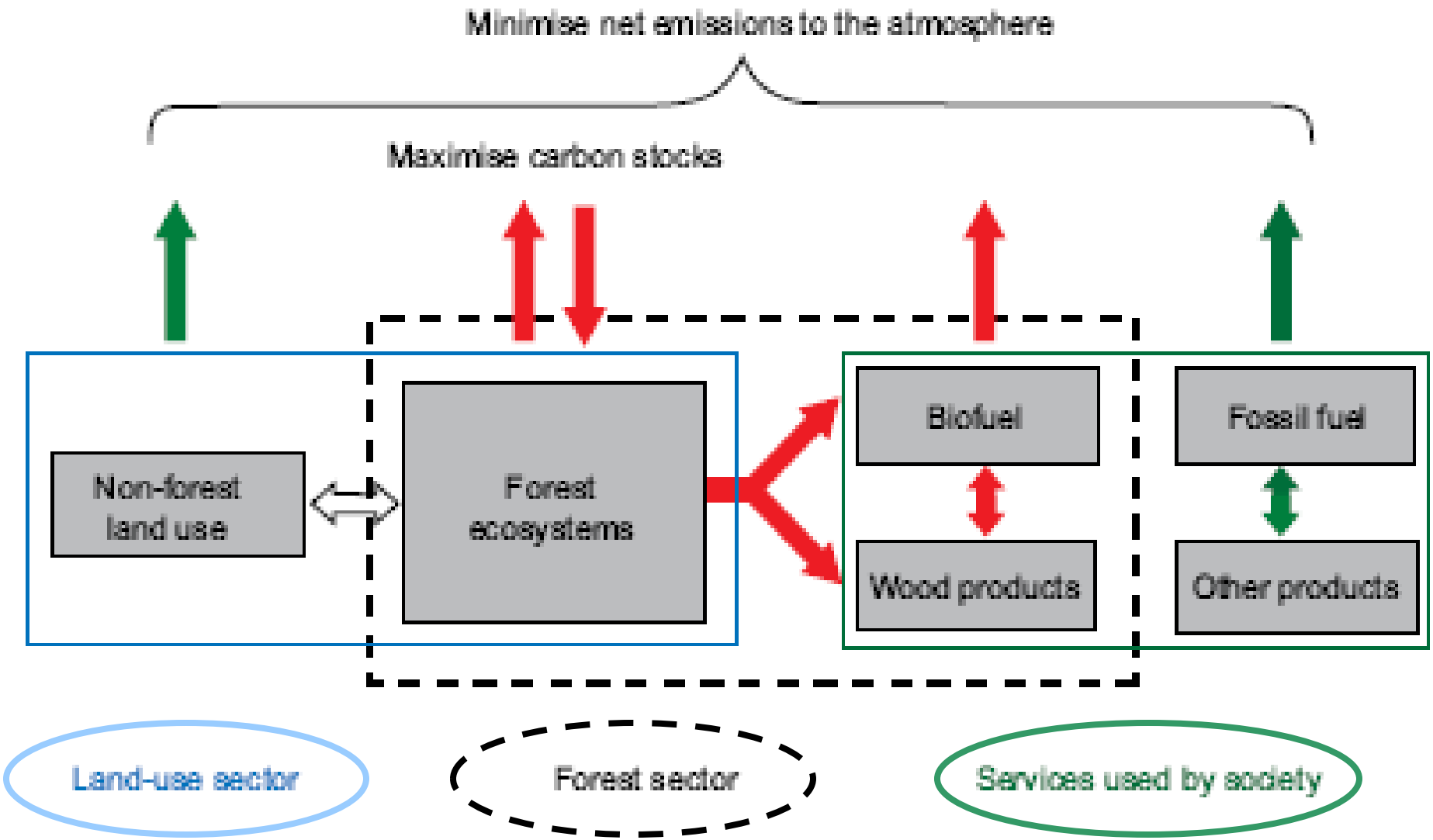


Figure 9.3: *Forest sector mitigation strategies need to be assessed with regard to their impacts on carbon storage in forest ecosystems on sustainable harvest rates and on net GHG emissions across all sectors.*

Nabuurs et al. 2007 (IPCC WG3)

Markets and Registries: Participation Options (examples)

- Chicago Climate Exchange
- Voluntary Carbon Standard
- Climate Action Reserve

Many similarities, but there can be significant differences in requirements such as what kinds of projects can be registered and how calculations are made.

Pending Legislation and Administrative Direction in the U.S.

ROLES OF PUBLIC AND PRIVATE LANDS: A number of voluntary and mandatory carbon markets and initiatives have arisen in the absence of national legislation, and the landscape of these programs has been changing quickly and dramatically in recent years.

Pending Legislation and Administrative Direction in the U.S.

DOMESTIC LEGISLATION. Climate change legislation failed to pass in 2009 but may remain on the agenda of Congress in 2010. Provisions for including forestry "offsets" were included in the main legislative drafts from 2009. Future of offsets is very uncertain.

A less controversial, near-term approach for domestic forestry lies in supplementary incentives for mitigation and/or adaptation.

Pending Legislation and Administrative Direction in the U.S.

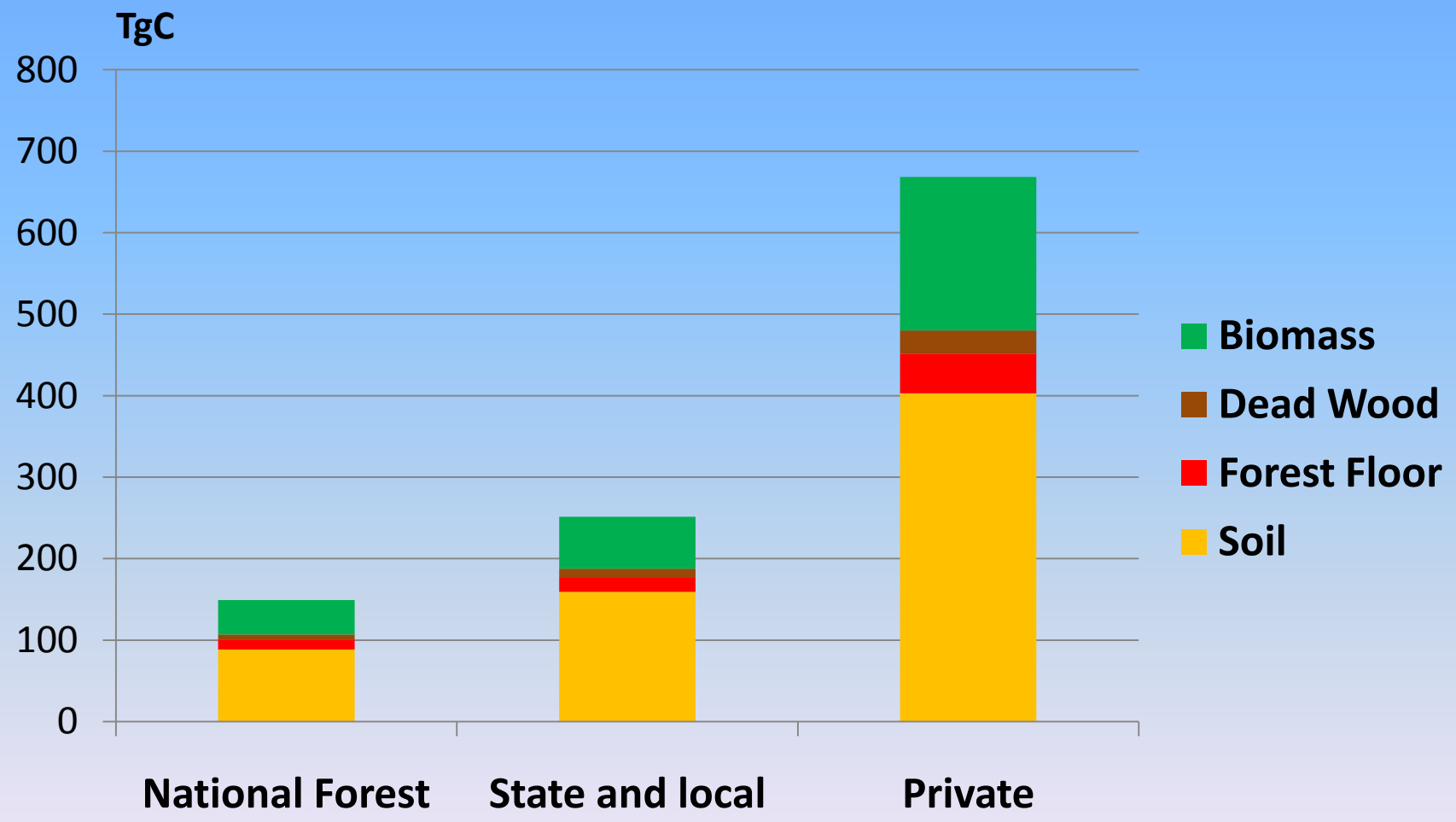
Executive Order 13514 (Federal Leadership in Environmental, Energy, and Economic Performance) requires Agencies to increase energy efficiency; and to measure, report, and reduce their greenhouse gas emissions from direct and indirect activities <u>including Federal land management practices</u>.

The Administration is also considering expanding the scope of the National Environmental Policy Act (NEPA) to determine how projects would contribute to and be affected by climate change.

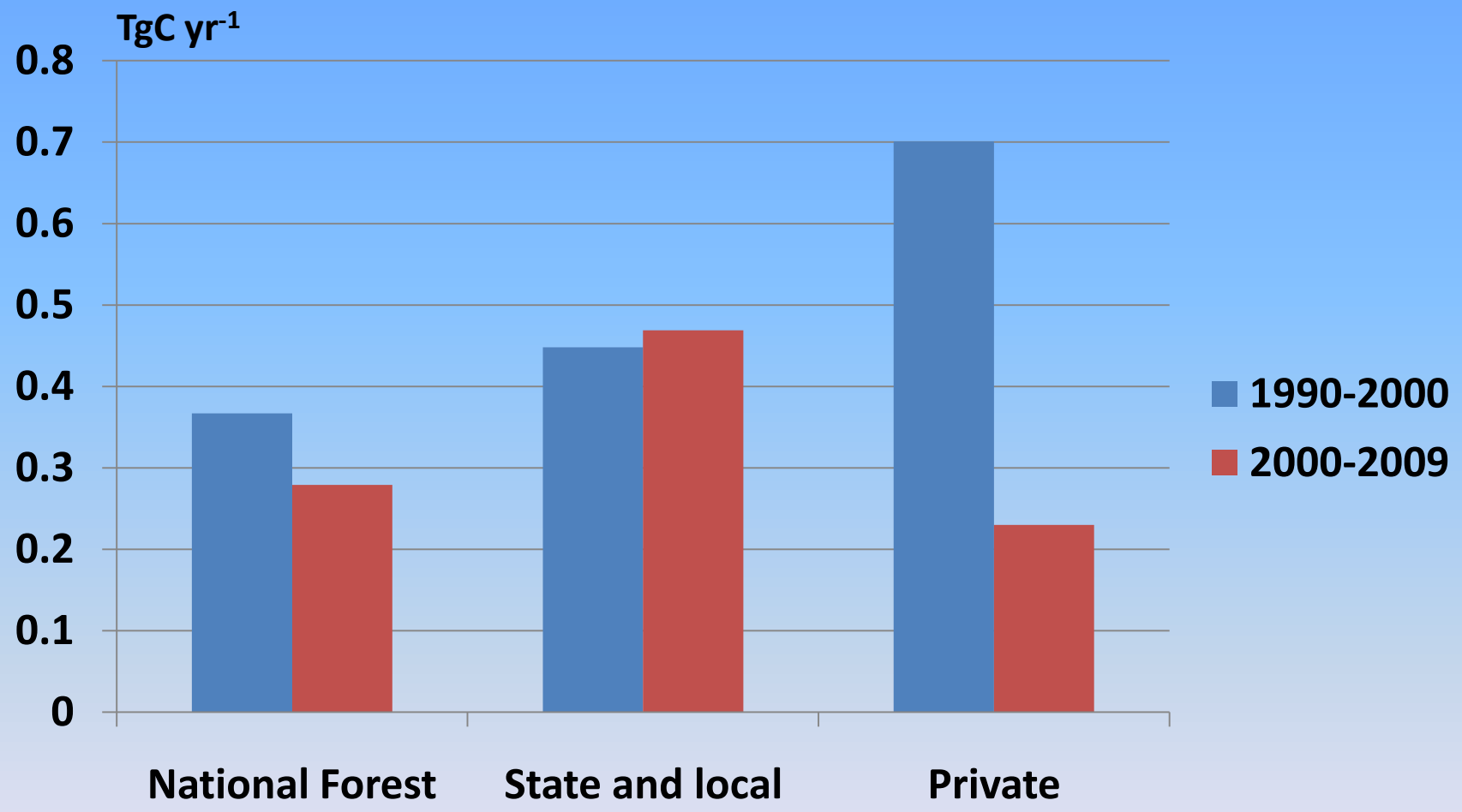
Estimates of Forest Carbon Stocks and Recent Changes in Northern Wisconsin

- FIA periodic and recent annual inventories (1983, 1996, 2004, annual 2006-2009)
- Calculations done with the FS “Carbon Calculation Tool”
- Needed some special data compilation to work at sub-state level

Carbon Stocks by Ownership Class and Carbon Pool, Northern Wisconsin Forests, 2009



Average Annual Change in Carbon Stock by Ownership, Northern Wisconsin Forests, 1990-2010



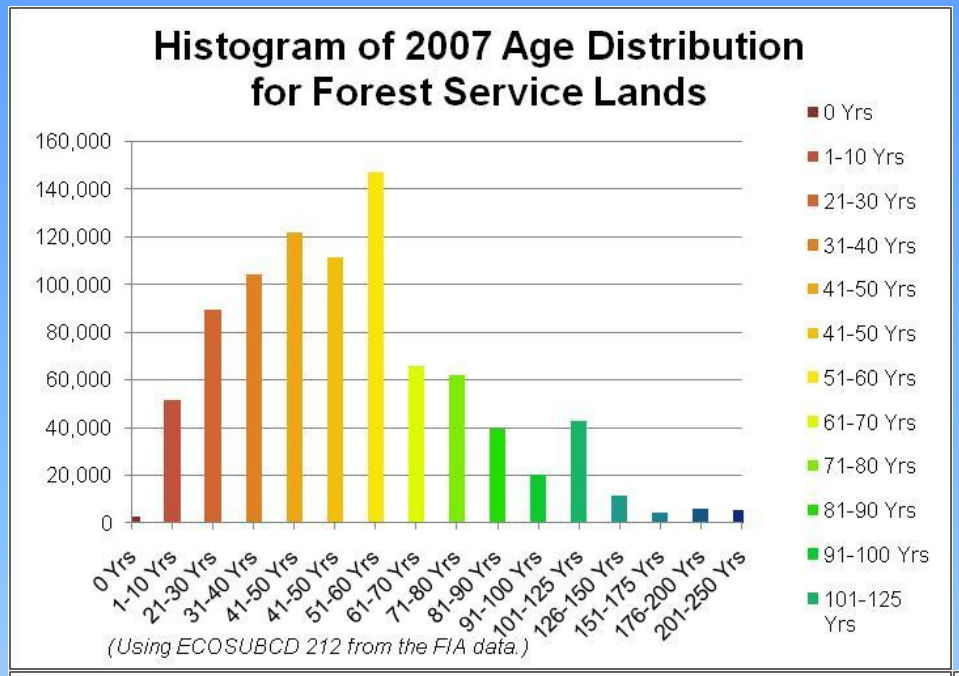
Possible causes of declining rate of sequestration: increased harvesting, aging forests, and increasing disturbances

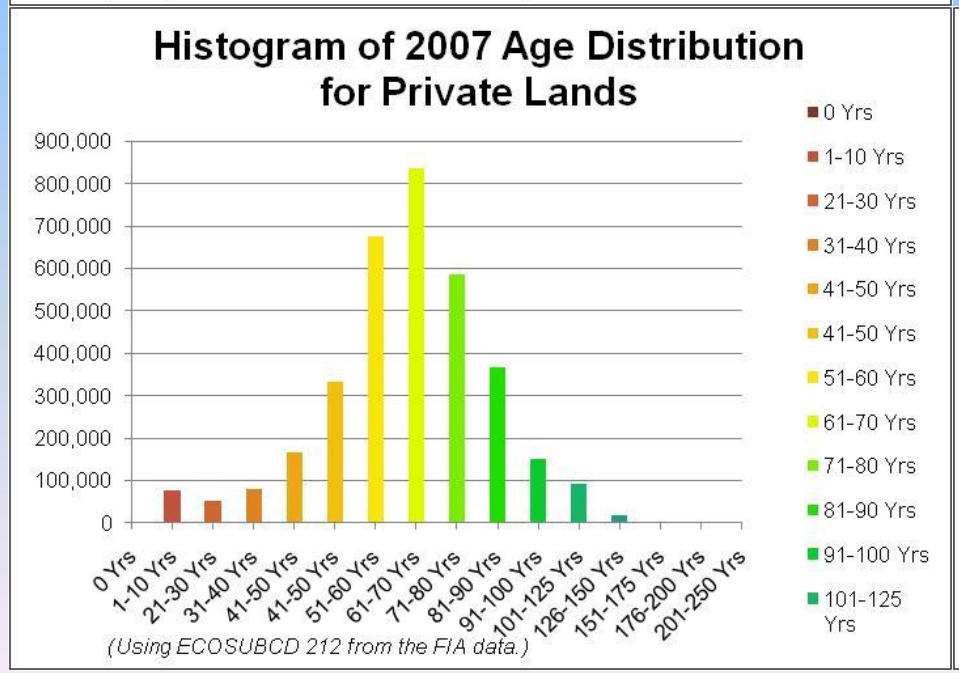
Carbon Budget of Northern Wisconsin Forests and Wood products, 2000-2009

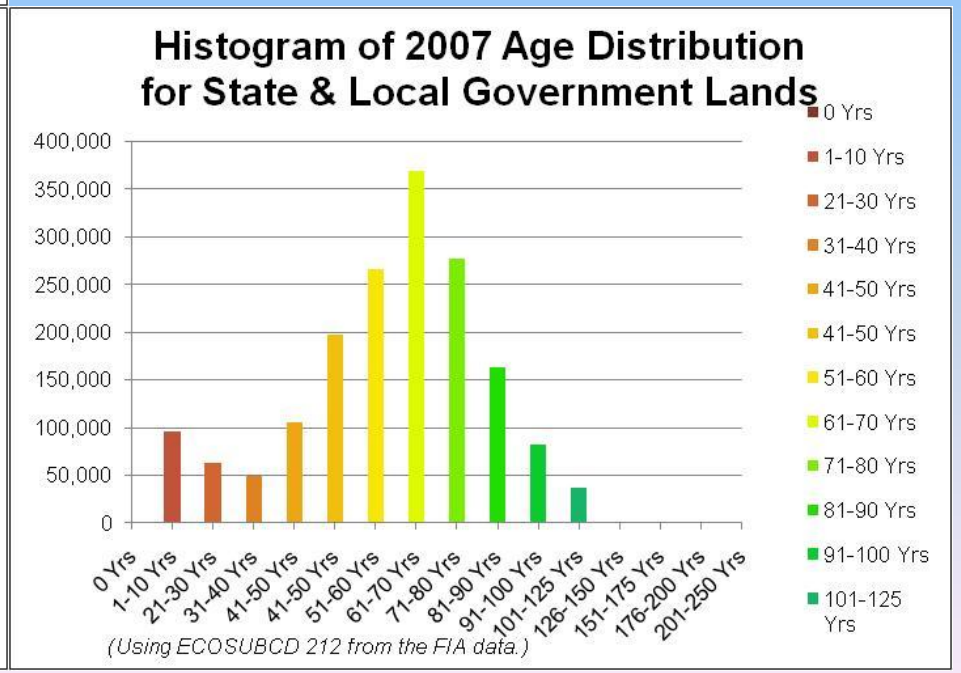
	TgC yr^{-1}
Forest Ecosystem	**1.0**
Transfer to Harvested Wood Products	0.5
Total	1.5

Energy use and substitution effects not included

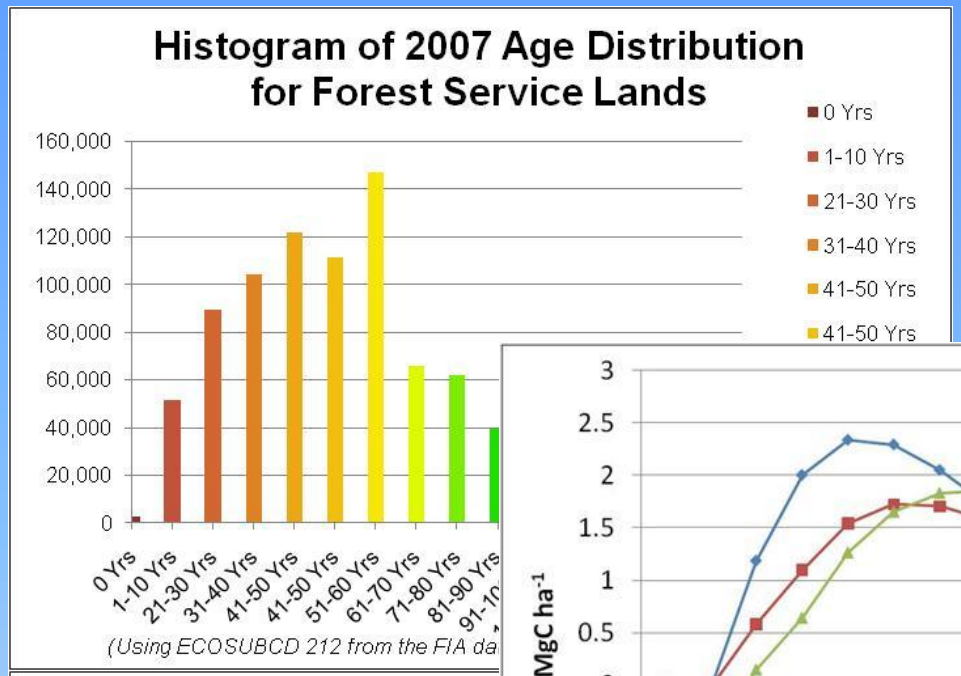
Age-class Distributions of N. Wisconsin Forests by Ownership Group

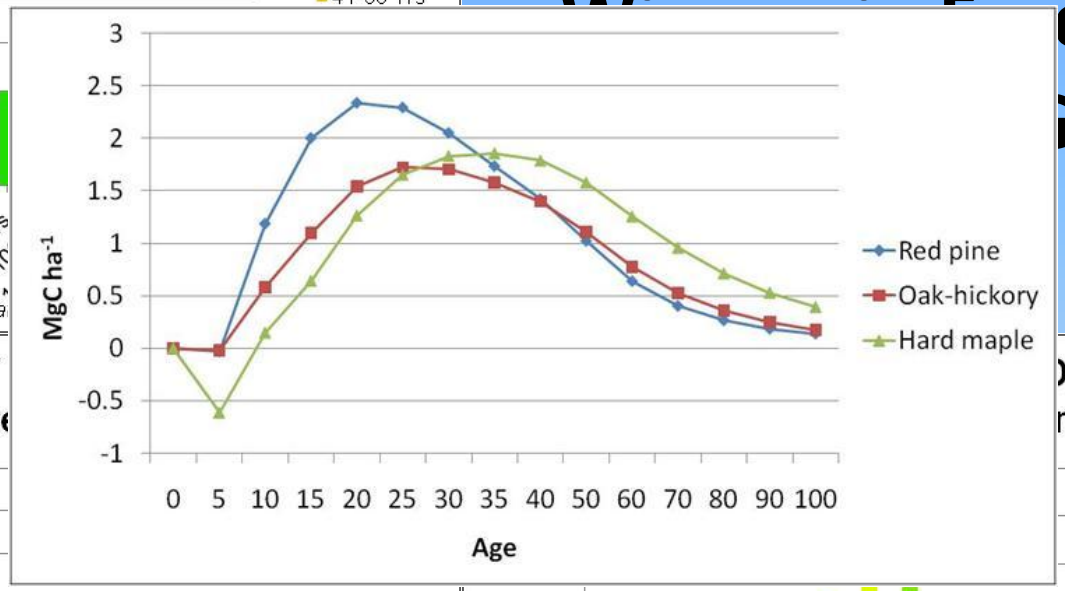


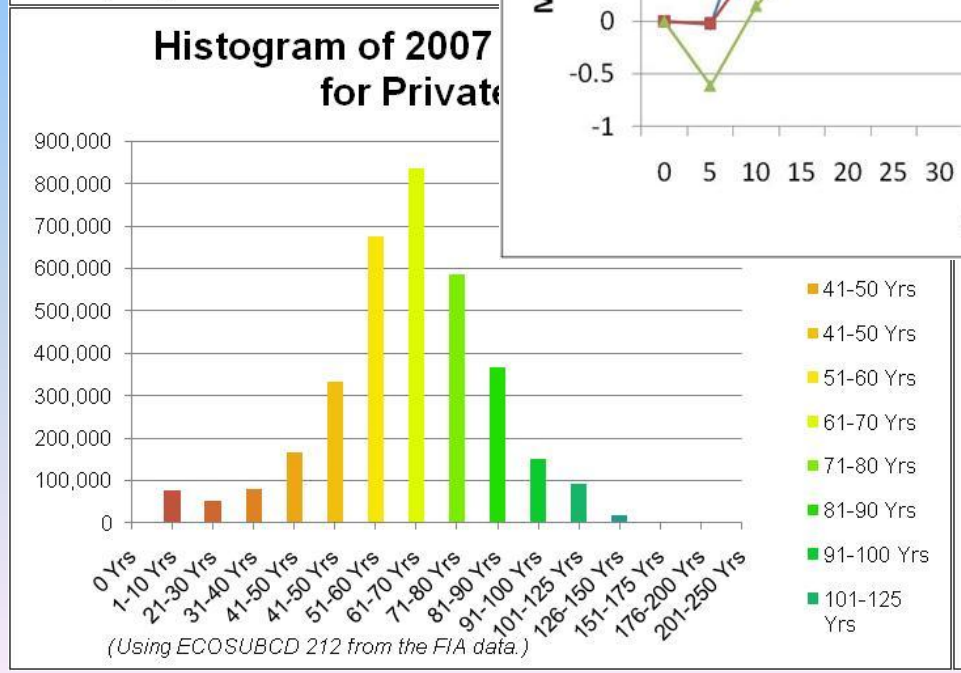


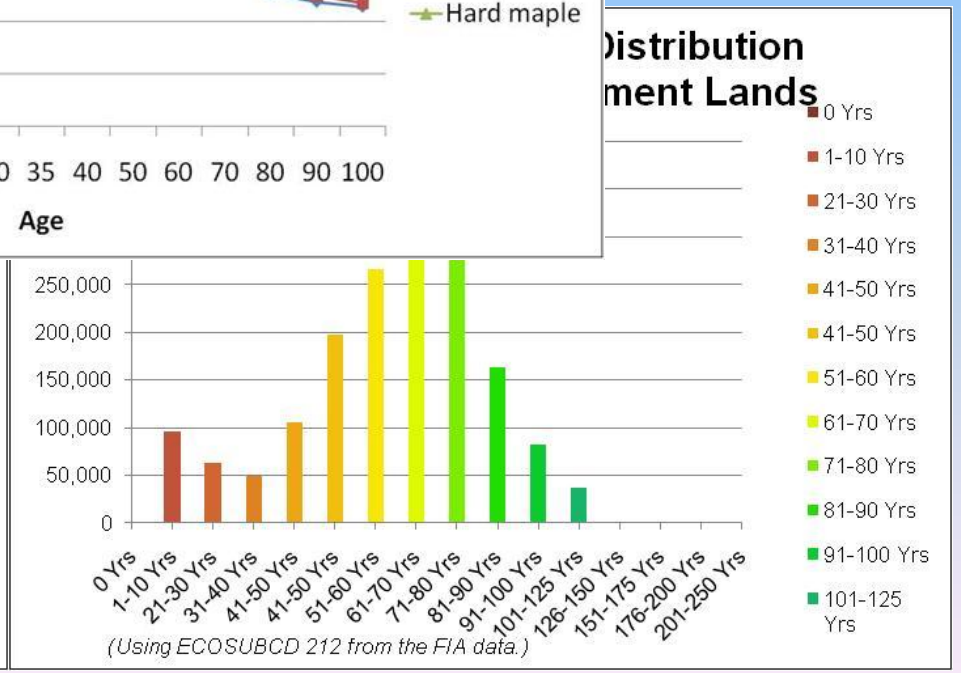


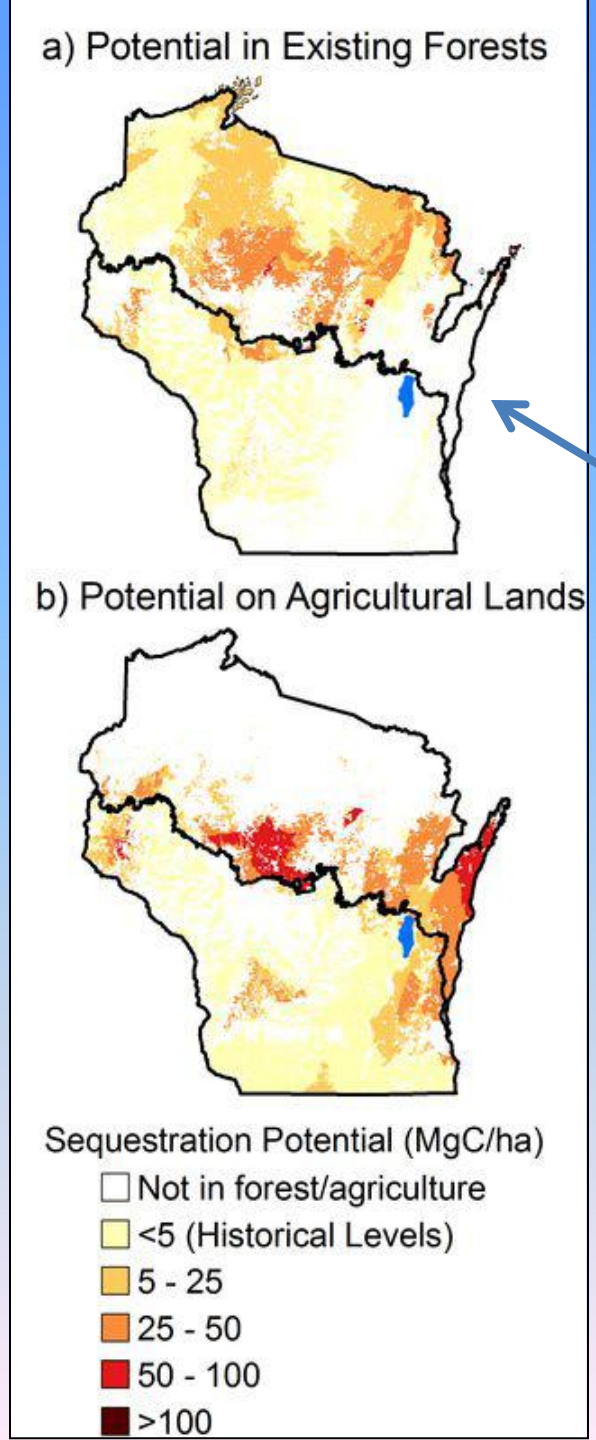
Age-class Distributions of N. Wisconsin Forests by Group











Biological Mitigation Potential Under Historical Climate and Disturbance

If all existing forests were allowed to grow to maturity, average annual change in C stocks (ecosystem plus wood products) would increase from 1.5 to about 4.0 Tg C yr-1 for a few decades, until carbon stocks became typical of old-aged forests.

Rhemtella et al. (2009)

Suggested Approach to Analysis of Mitigation Potential

- Calculate baseline under “business as usual”
- Calculate effects of different management scenarios
- Consider effects of risk factors
- Consider economic and social factors
- Integrate with adaptation response options

There are many issues to be considered in a mitigation assessment, such as:

- What are the boundaries of the analysis -- geographic, temporal, ownership, accounting, etc?
- What are some likely strategies to increase carbon sequestration and avoid? What may be an optimum mix of mitigation options?
- What tradeoffs need to be considered between carbon management and management for other ecosystem services?
- How can this information be integrated into forest planning?

Suggested Mitigation Options
(may be different for public and private lands)

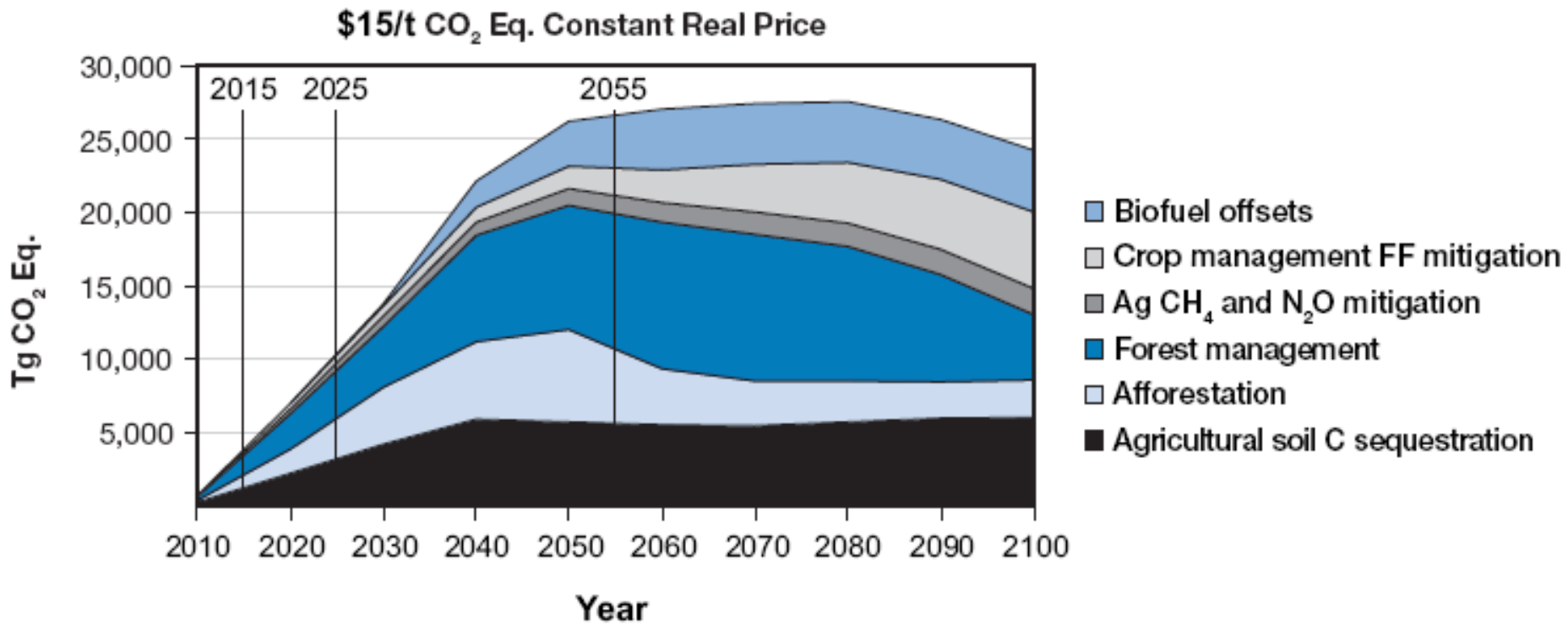
- Afforestation and restoration
- Conserve existing forests
- Forest management
  - Changing rotation ages
  - Changing harvest strategies
  - Changing forest density
  - Changing harvest intensity
- Forest soil management
- Managing the industrial forest carbon cycle
  - Carbon storage in wood products
  - Substituting wood products for other materials
  - More efficient use of raw material
- Bioenergy options
- Minimizing impacts of natural disturbances

Possible Approach to Analysis of Mitigation Options – Phase 2

- Scenario analysis (historical climate and disturbance)
  - FIA analysis approach used in phase 1
  - FVS driven by FIA data
- Scenario analysis (historical climate and disturbance)
  - Biome-BGC
  - LANDIS-II
  - PneT-CN
  - Land model (LM3V) from GFDL Earth System model
- Results compared with life cycle analysis approach
- Economic analysis
- Consider social factors
- Tradeoffs with other ecosystem services

The Cumulative Effects of Greenhouse Gas Mitigation

Figure 4-6: Cumulative GHG Mitigation over Time
Quantities are Tg CO_2 Eq. cumulative net emissions reduction below baseline.

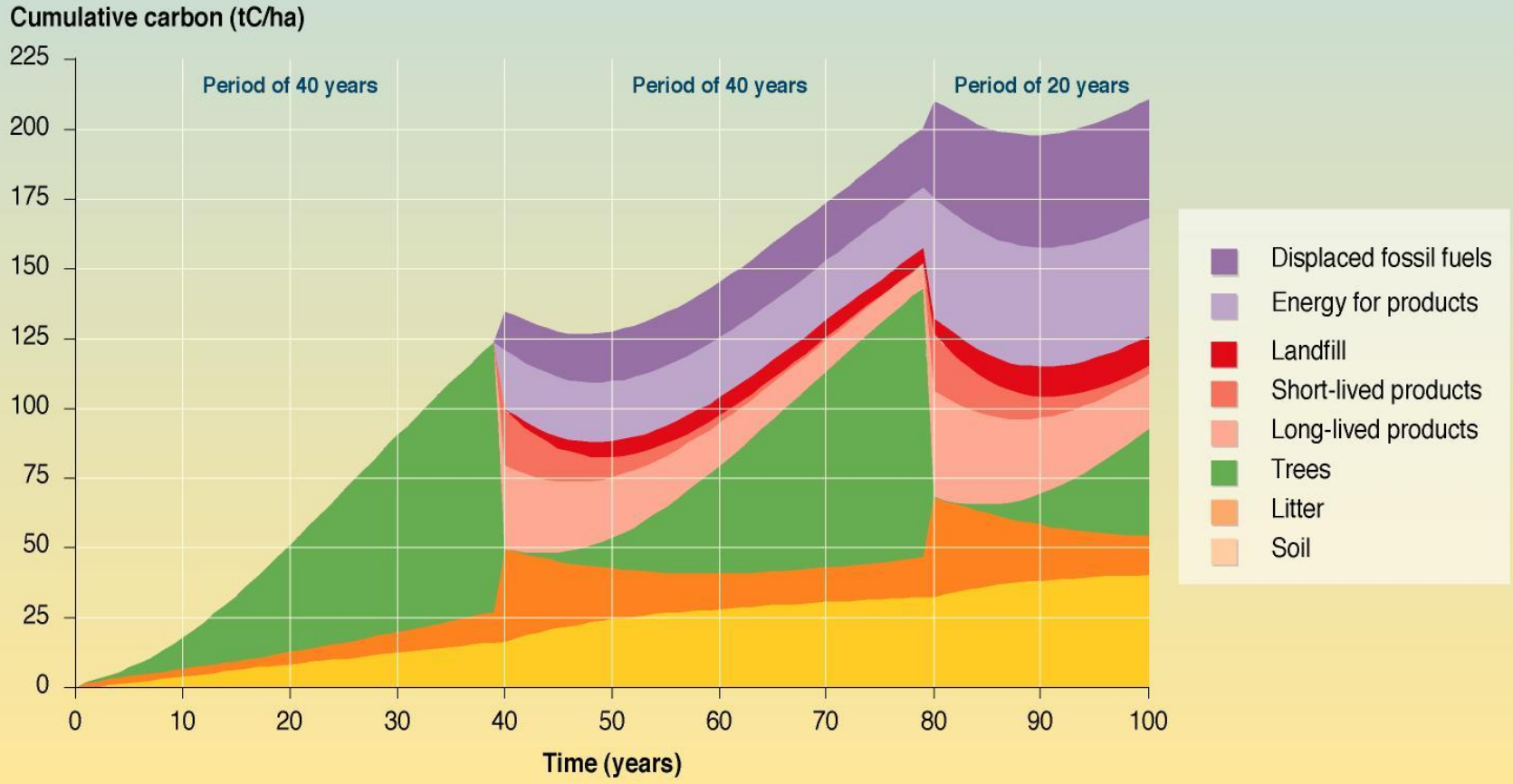


From IPCC 2007

Thank You!

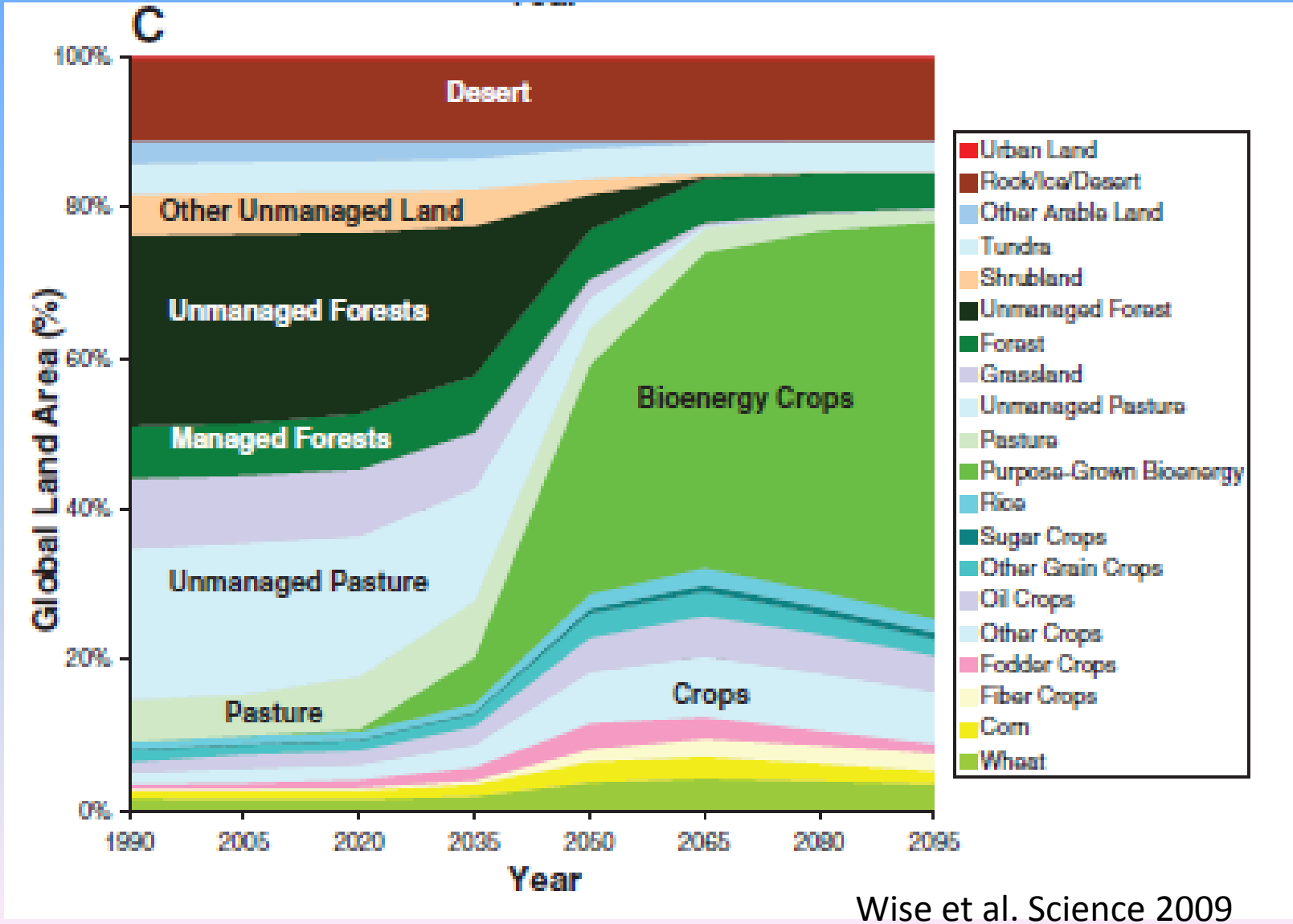
Managing the atmosphere by managing emissions and ecosystems.

Carbon balance from a hypothetical forest management project



WG3 - FIGURE TS-6

How Global Land Use Might Change with Aggressive use of Bioenergy



Wise et al. Science 2009