Forest Management and Carbon Sequestration

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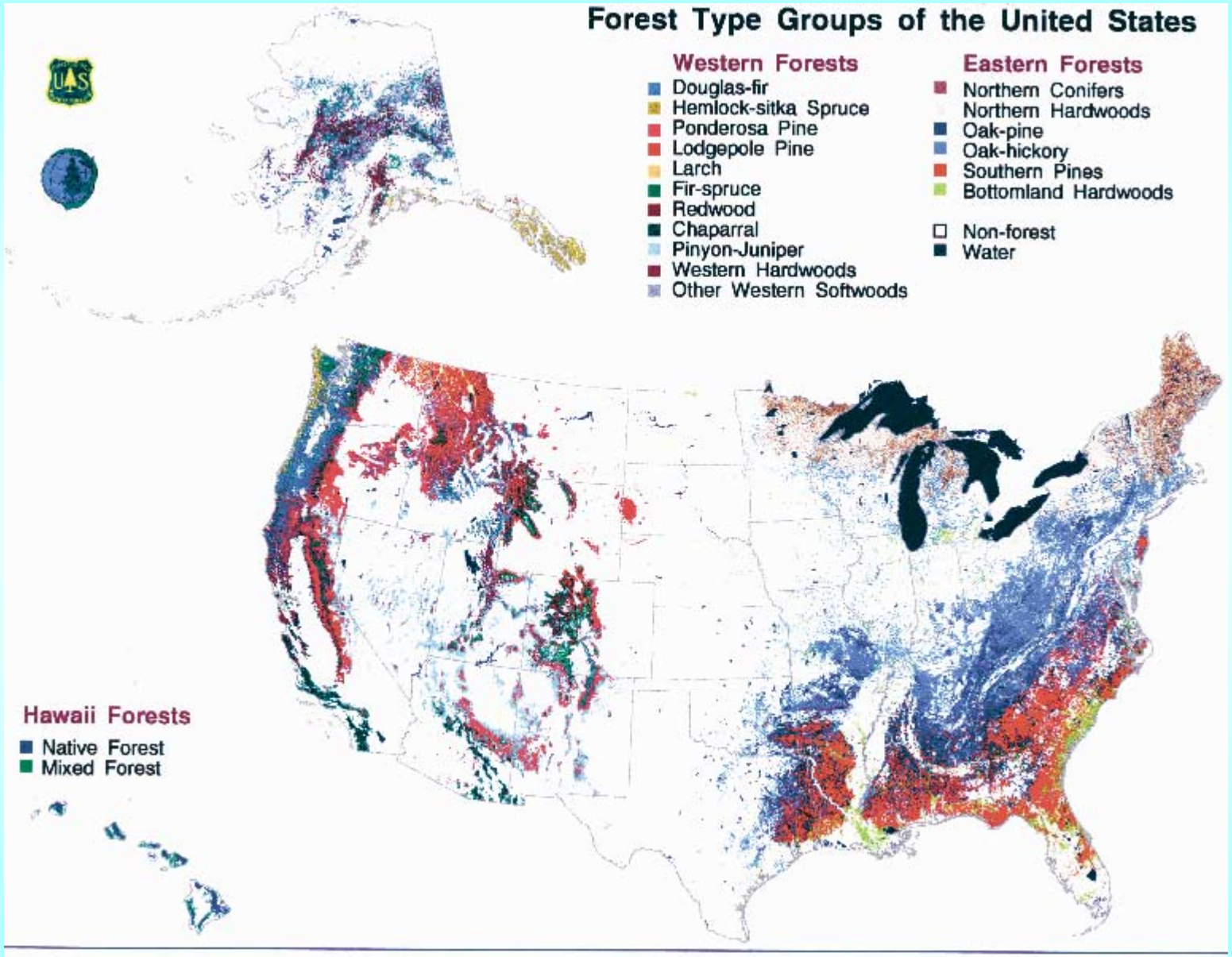
USDA Forest Service

Global Change Research Program

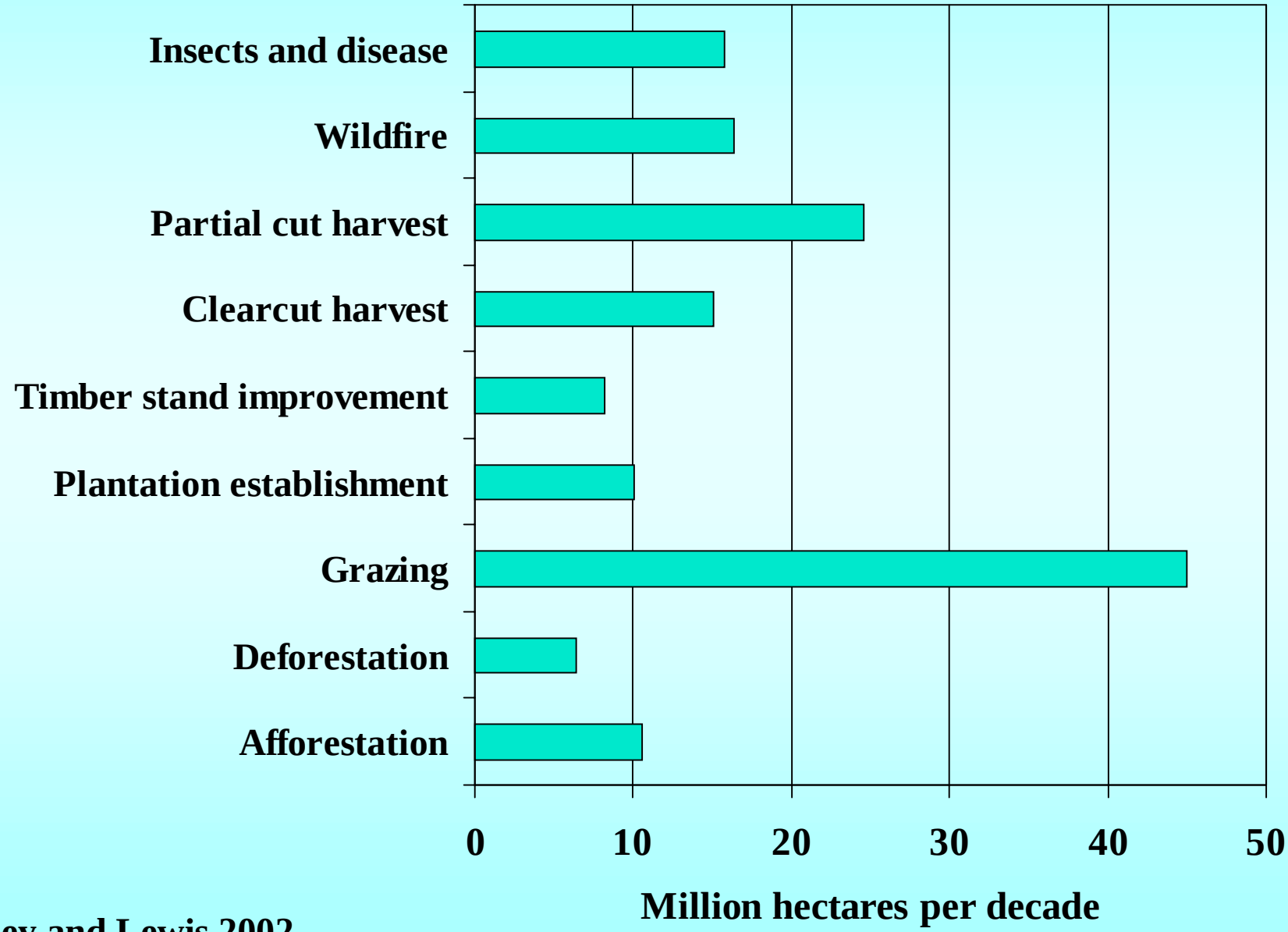
Regional Partnerships in Terrestrial Carbon Sequestration

Lexington, Kentucky

November 6-7, 2001

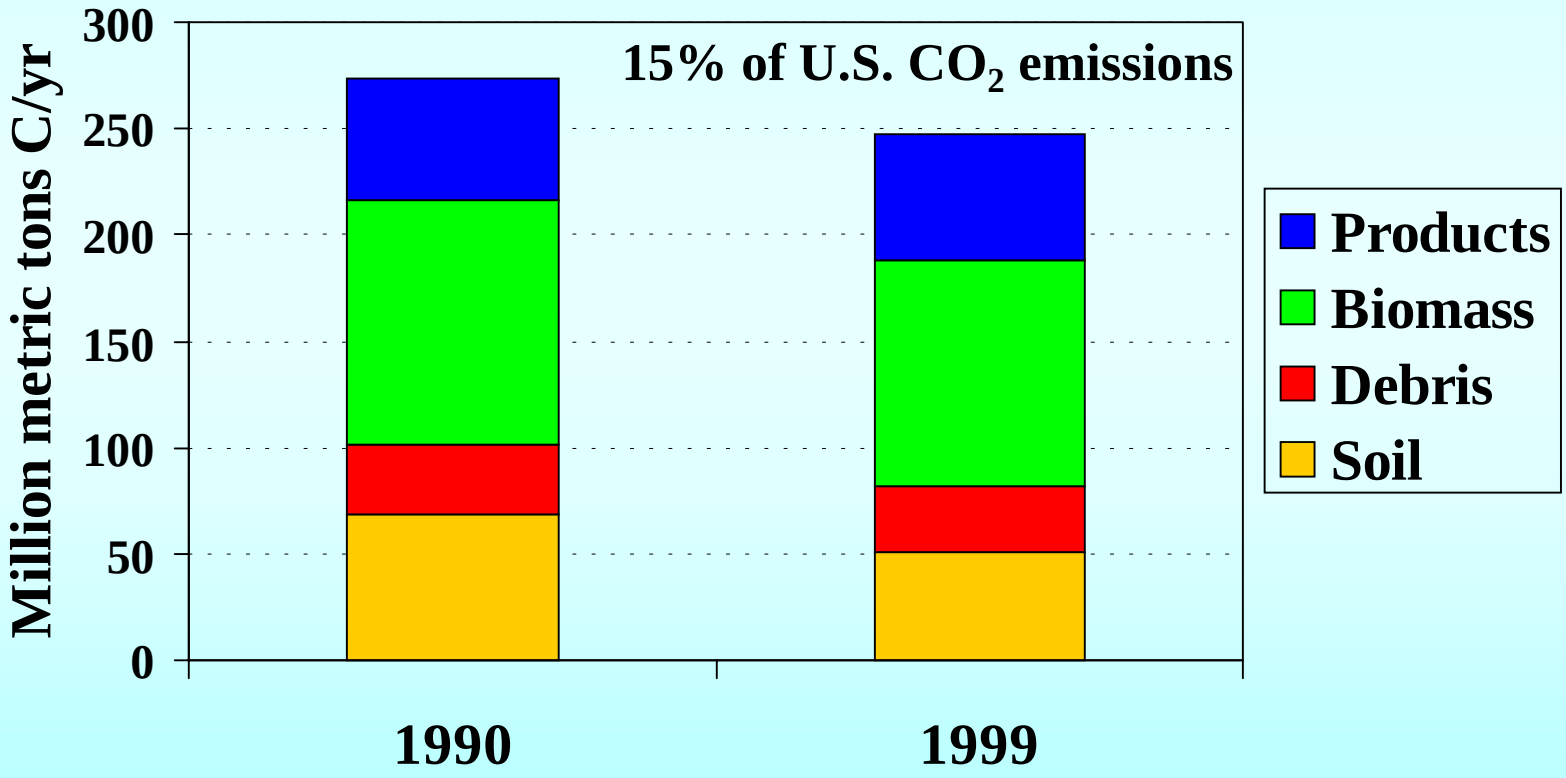

Forest Type Groups of the United States
Western Forests
Douglas-fir
Hemlock-sitka Spruce
Ponderosa Pine
Lodgepole Pine
Larch
Fir-spruce
Redwood
Chaparral
Pinyon-Juniper
Western Hardwoods
Other Western Softwoods
Eastern Forests
Northern Conifers
Northern Hardwoods
Oak-pine
Oak-hickory
Southern Pines
Bottomland Hardwoods
Non-forest
Water
Hawaii Forests
Native Forest
Mixed Forest

Selected Disturbances Affecting U.S. Forests



Birdsey and Lewis 2002

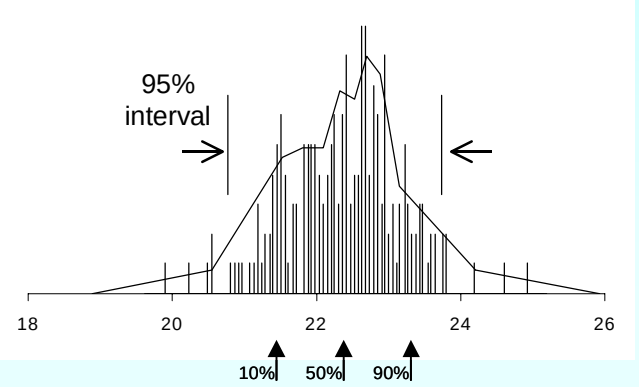
The Baseline: Carbon Sequestration by the U.S. Forest Sector



Heath 2001, reported in EPA GHG Inventory

Confidence in Carbon Estimates at Regional Scale

Live biomass	Good
Woody debris and litter	Fair
Soil organic matter	Poor
Wood and Ag Products	Fair

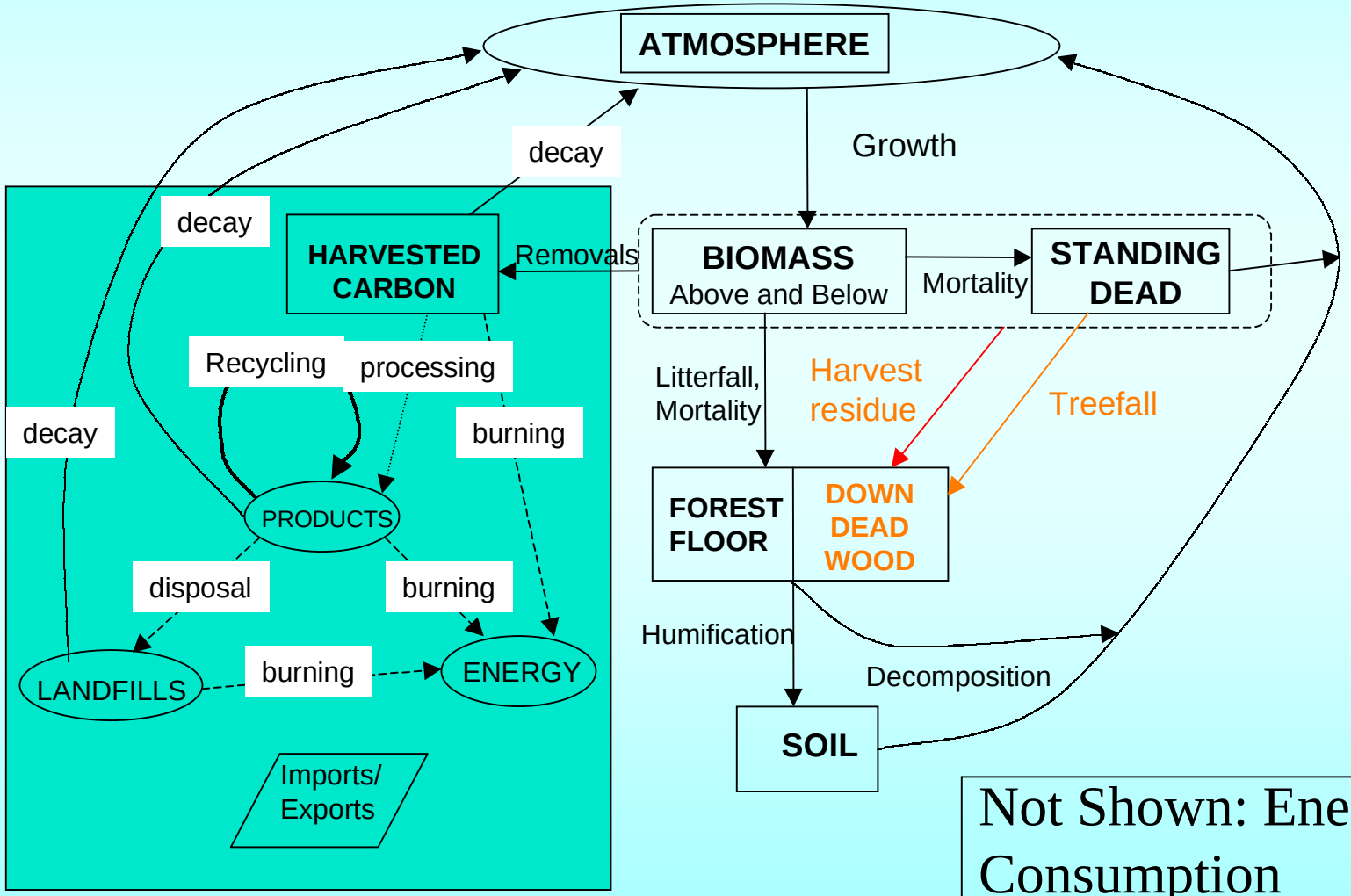


(Heath and Smith 2000)

- ***Research needs***: efficient protocols for extensive monitoring; enhanced network of long-term intensive study sites; improved models and analysis

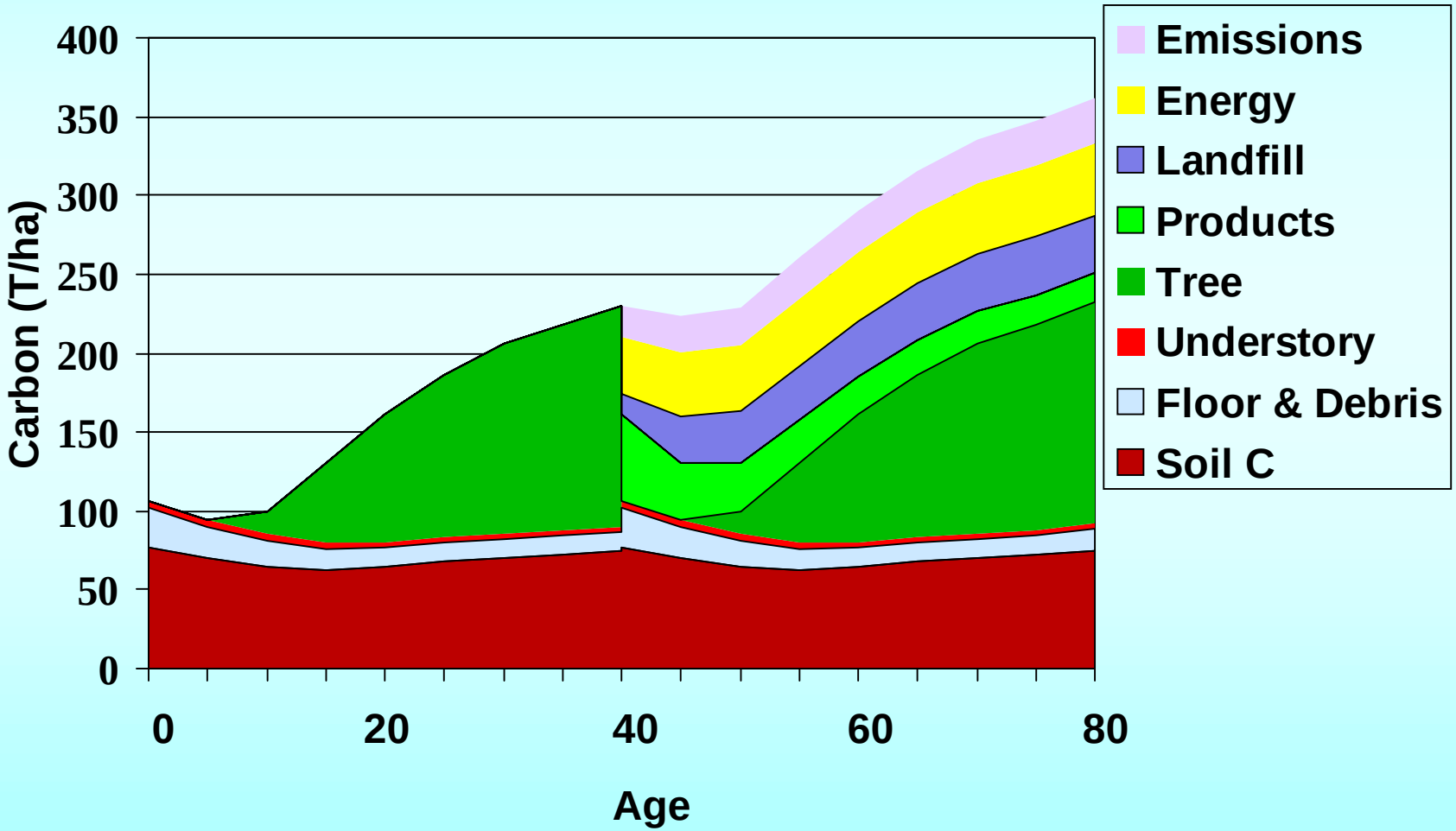
- ***Implementation need***: not all lands are monitored effectively for changes in ecosystem C

Comprehensive Accounting for Forest Sector Carbon Pools and Flows



Heath 2001 (Personal Communication)

Two rotations of pine on a high site in SE Forest C and disposition of C in harvested wood



NOTE: Energy and emissions are releases of C to the atmosphere

Heath 2001 (Personal Communication)

How Forest Sector Carbon Stocks Change Over Time

- Carbon in managed forests has a repeatable pattern
- Including wood products may produce a long-term increase

Birdsey et al 2000

Forestry Activities to Increase C Sequestration

- **Increase Sequestration**
  - Afforest marginal cropland, pasture, degraded lands
  - Reduce conversion of forestland to nonforest use
  - Improve forest management
  - Reduce harvest
  - Increase agroforestry
- **Increase Sequestration Plus Reduce Emissions**
  - Substitute renewable biomass for fossil fuel energy
  - More efficient use of raw material
  - Increase paper and wood recycling
  - Plant trees in urban and suburban areas
- **Reduce Emissions**
  - wildfire management
  - energy efficiency in wood production
  - product substitution

Birdsey et al. 2000

Some Effective and Cost Efficient Activities to Increase Carbon Sequestration

(selected from a larger list)

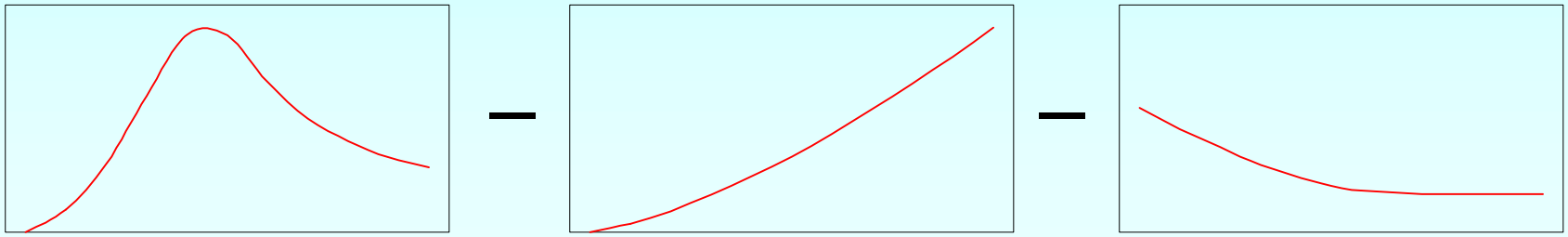
- Increase productivity of forest land
- Increase area of forest land
- Increase agroforestry
- Increase carbon in durable wood products through efficient utilization of raw material

Birdsey et al. 2000

Increase Productivity of Forest Land

Carbon Storage After Disturbance is Determined By:

Carbon Uptake (Photosynthesis) – **Carbon Release (Respiration)** – **Carbon Release (Decomposition)**



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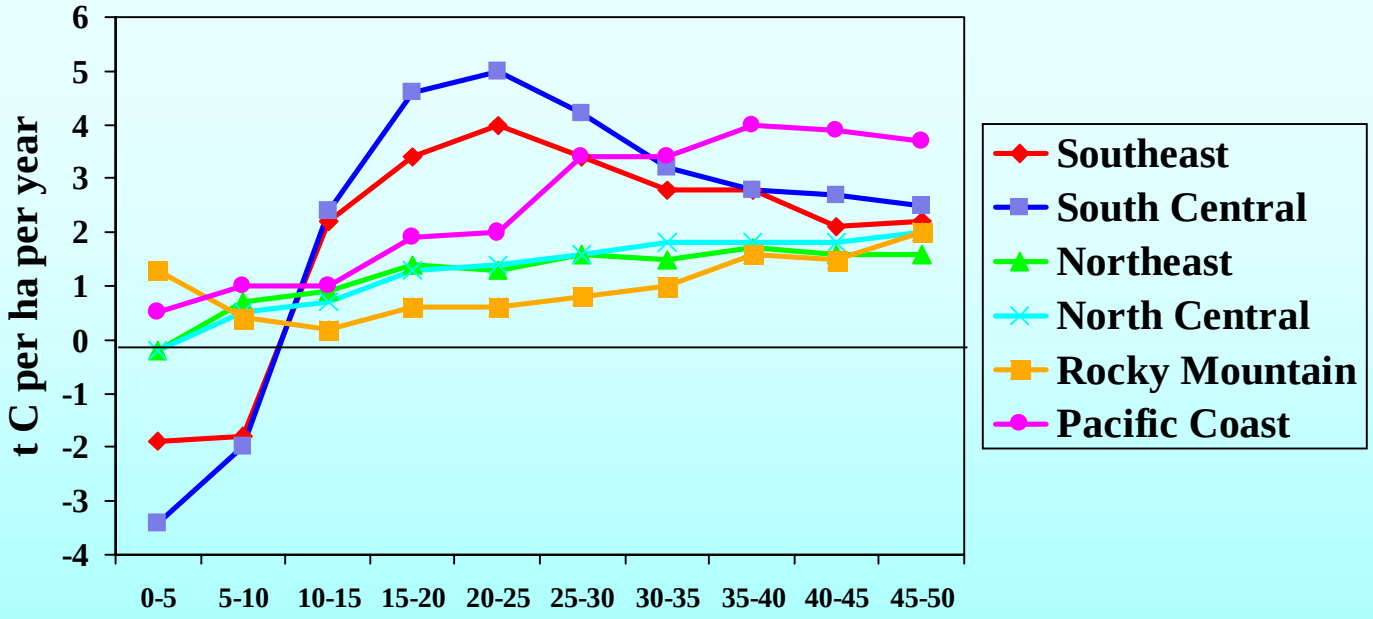
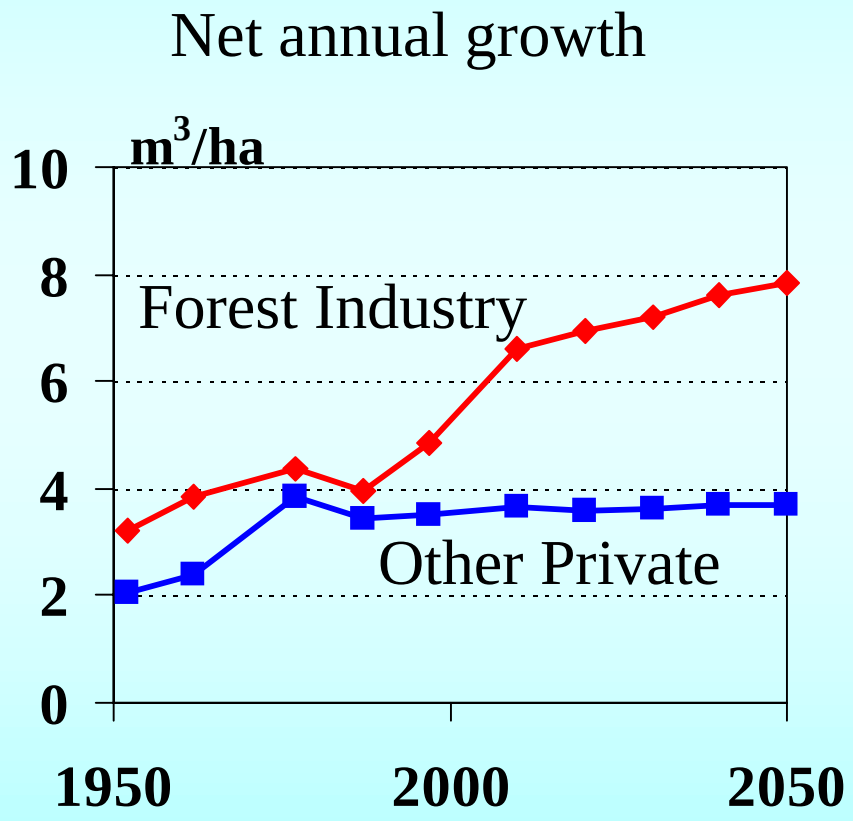


Heath and Birdsey 2000

Increase Productivity of Forest Land

Management Intensification in the South

- Forest industry lands are managed more intensively
- Average site quality better on forest industry lands
- Long-term trend toward more intensive management
- Opportunity to increase productivity on other private lands
- Implications for carbon sequestration are not completely understood

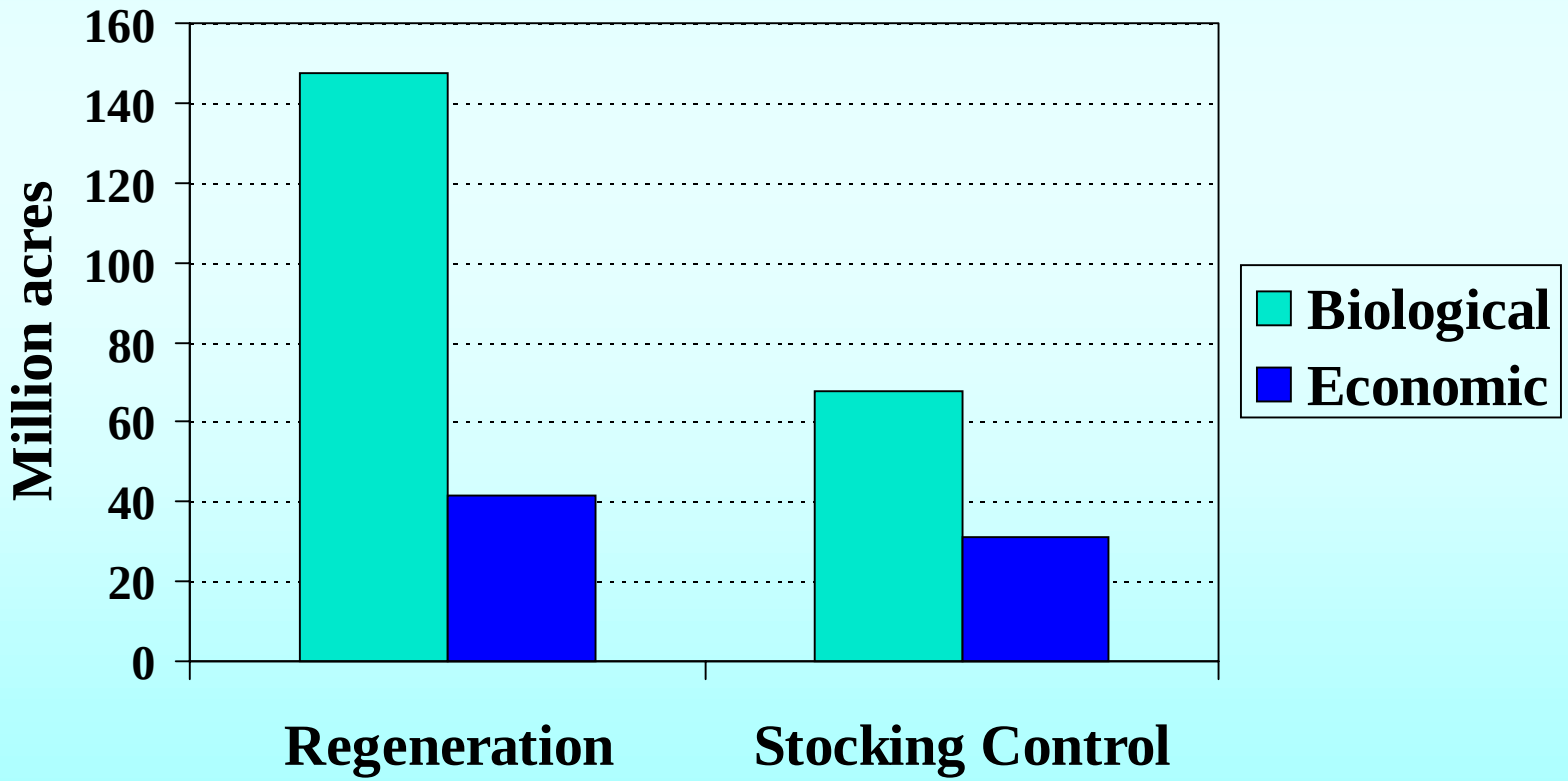


Smith et al. 2002

Increase Productivity of Forest Land

Biological and Economic Opportunities for Increasing Growth on Timberland

(NOTE: increased growth ≠ increased C Sequestration)



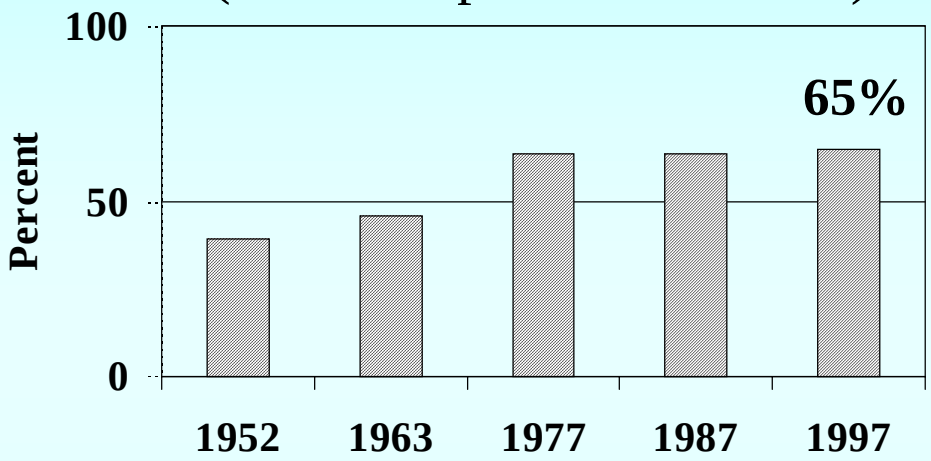
(Vasievich and Alig 1996)

Increase Productivity of Forest Land

- Growth of many forest stands is below biological potential
- Theoretically possible to double productivity of existing forest land by increasing biological potential

Actual Net Growth Relative to Potential Net Growth, 1952-1997

(Assumes potential is fixed)



Poorly stocked

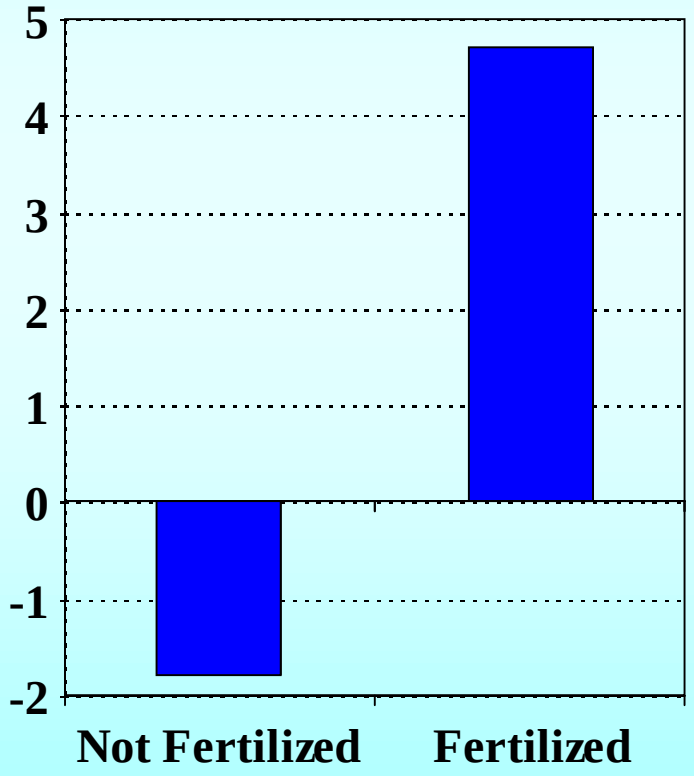
Fully stocked

Increase Productivity of Forest Land

Forestry Practices to Increase Productivity

- Regeneration
- Weed control
- Fertilization →
- Genetic improvement
- Site management
- Stocking control
- Harvest methods
- Utilization of logging debris
- Low-impact harvesting

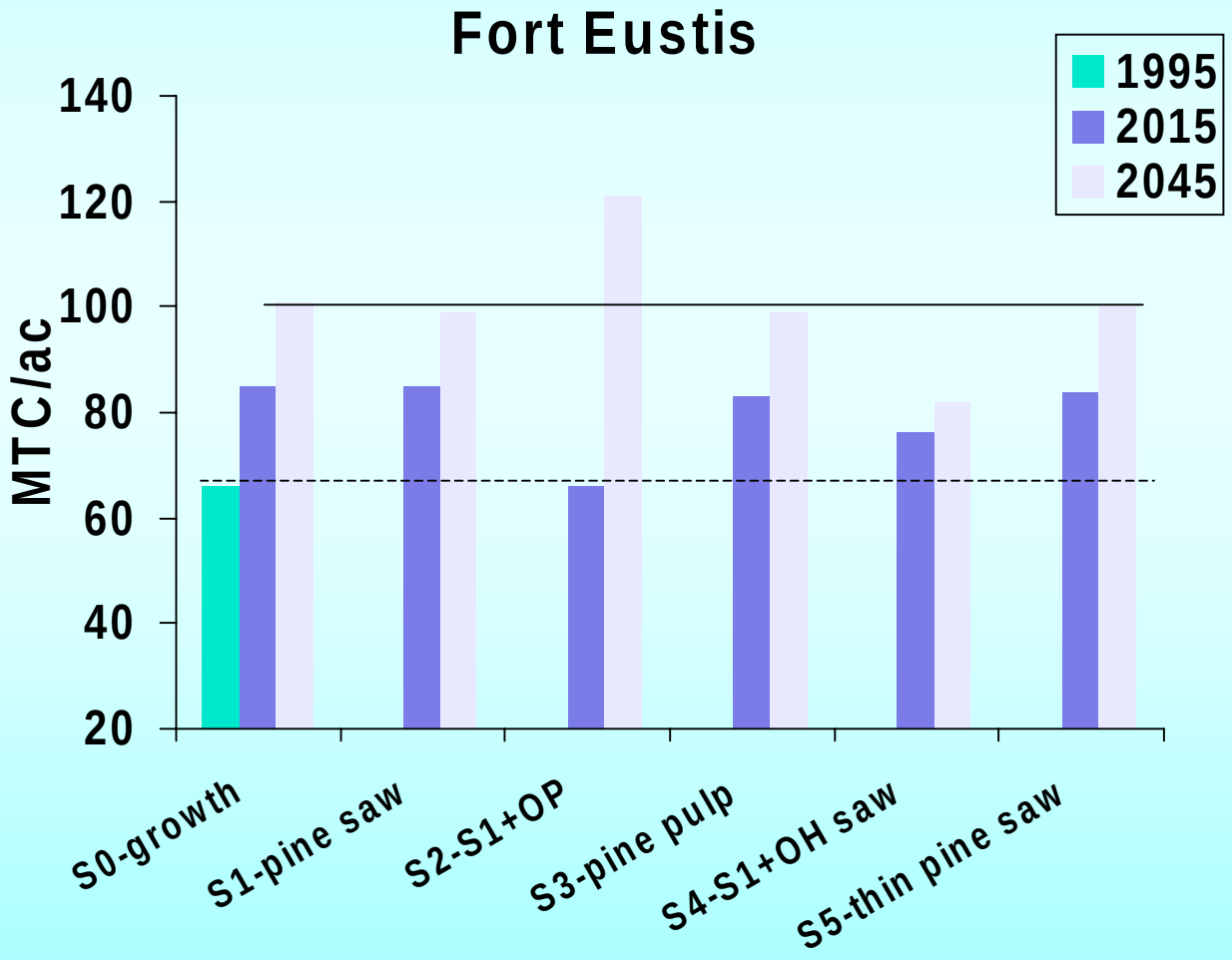
Net ecosystem production (tC/ha/yr) – 11 year old loblolly pine plantation



Sampson and Hair 1996

Johnson et al. 2001

Case Studies: Management Alternatives for DoD Installations



Hoover 2000

Increase Area of Forest Land

- Afforestation for carbon sequestration has been studied extensively
- Between 23 and 45 million acres of marginal cropland and pasture may be available for conversion to forest, mostly in the East
- Reclamation of degraded lands may be effective
- Not all available land can be converted to forest economically
- Landowner incentives are needed to enroll acres in programs
- Significant gains in sequestered carbon will take 20-30 years
- Potential gains are approximately 50 MMTC/yr

Increase Agroforestry

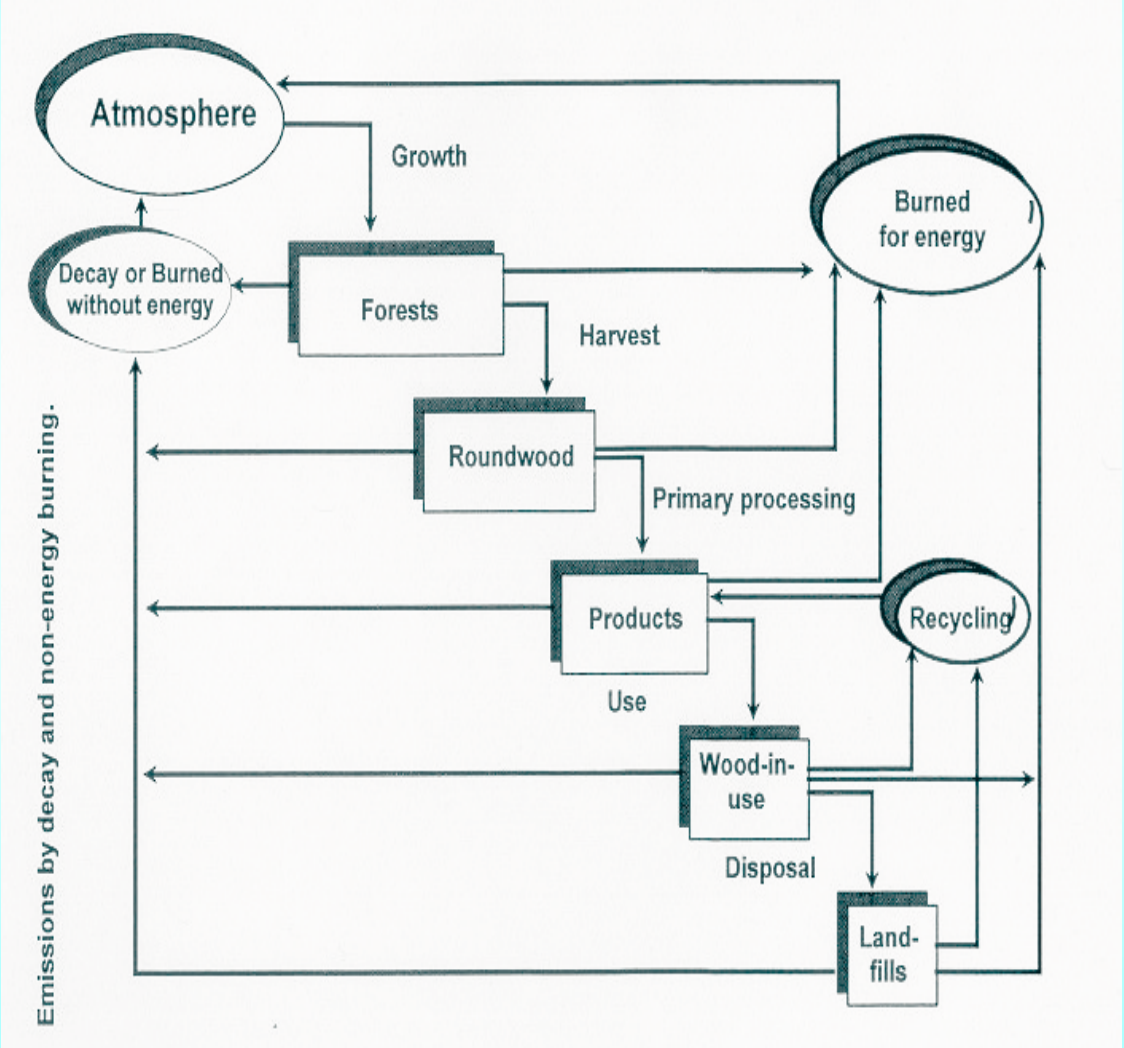
Designed Forests in Agricultural Landscapes

- **Windbreaks** store carbon while protecting farmsteads, livestock, roads, people, soils, and crops
- **Riparian forest buffers** store carbon while protecting water quality
- **Silvopasture** stores carbon while producing livestock benefits if both trees and grass are properly managed
- **Short-rotation woody crops** store carbon while providing income from wood products or biofuel

Increase Carbon Sequestration Through Wood Production

There are many opportunities in the ***life cycle*** of wood production to

- Improve the utilization of harvested biomass
- Increase the useful life of wood products



Skog and Nicholson 2000

Considerations for Implementing a Forest Carbon Sequestration Program

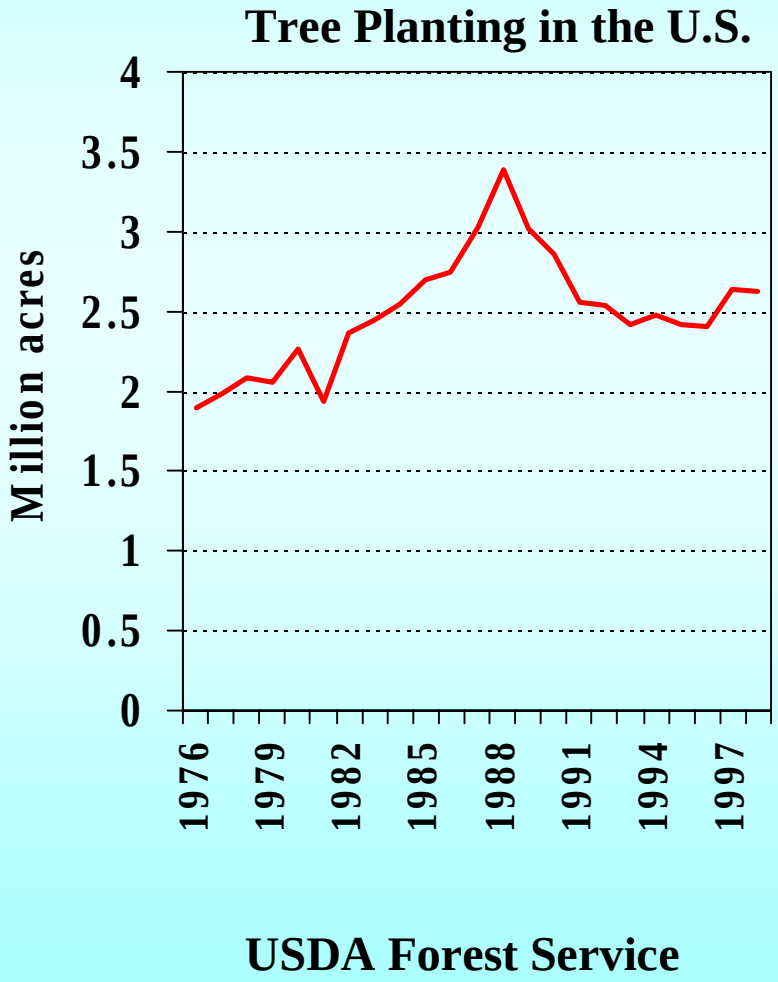
- Landowner objectives – is increased carbon sequestration compatible? (e.g. DoD)
- A *suite* of practices may be effective
- Practices must be tailored to specific forest ecosystems which are highly diverse
- Knowledge of specific practices to apply in different situations is lacking
- Experience with programs suggests that incentives are required to engage landowners

Why Increasing Forest Carbon Sequestration is Feasible

- Increasing carbon sequestration and increasing forest productivity are compatible landowner objectives
- Strong role for private sector to participate
- Administrative infrastructure is in place to deliver program results

Barriers to Increasing Forest Carbon Sequestration

- Infrastructure may be lacking (e.g. nurseries to produce tree seedlings)
- Lack complete knowledge of how forest practices affect ecosystem carbon pools
- Landowner assistance programs specific to carbon sequestration must be developed
- May be incompatible with other policy goals



Monitoring Considerations

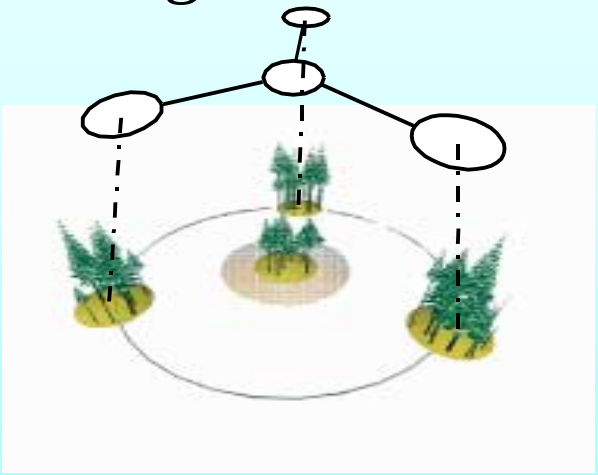
- Existing national programs (FIA and FHM) are speeding up and expanding coverage
  - Goal is 5-year cycle nationwide
  - “Wall-to-wall” sampling is envisioned
  - Gaps in ecosystem carbon pools filled by FHM
- Project-level monitoring feasible but not as part of National strategic monitoring
- International context regarding C accounting:
  - Accounting components and methods not yet defined
  - Methods must be transparent and verifiable
  - Possible need to separate direct from indirect causes
- Techniques research is ongoing
  - Part of mission of FIA, FHM, and GC programs
  - Interagency cooperation (USDA, USGS, NASA, etc.)

Separating Direct from Indirect Causes of Carbon Stock Changes

- **How to attribute effect …**
  - Change in carbon stocks
- **…to causes**
  - Natural (indirect): CO_2, N deposition, climate
  - Human (direct): land use, land management

Face Experiment

Flux Tower



Inventory Plot

Summary: The Current and Potential Role of Forests in Sequestering Carbon

- Currently, U.S. forests sequester carbon at a rate that is 15% of U.S. emissions
- It is technically feasible to double the current rate of sequestration in forests and wood products for a finite period of time
  - (+200 MMTC/yr from 4 activities described, plus others not discussed)
- Increasing forest carbon sequestration has other positive benefits
- Research, new infrastructure, and landowner assistance would be required to double the rate of sequestration