Forest Carbon and Silviculture

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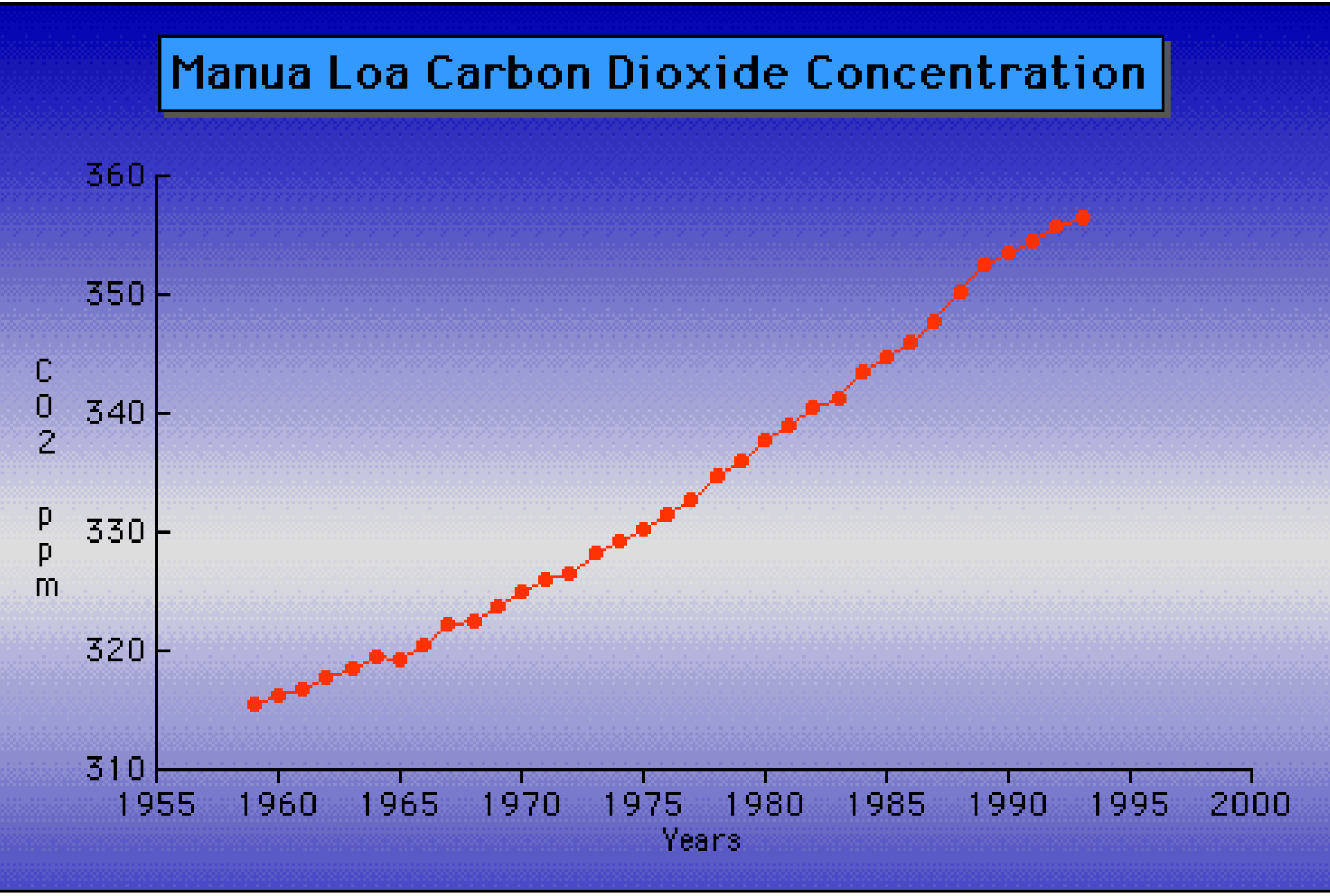
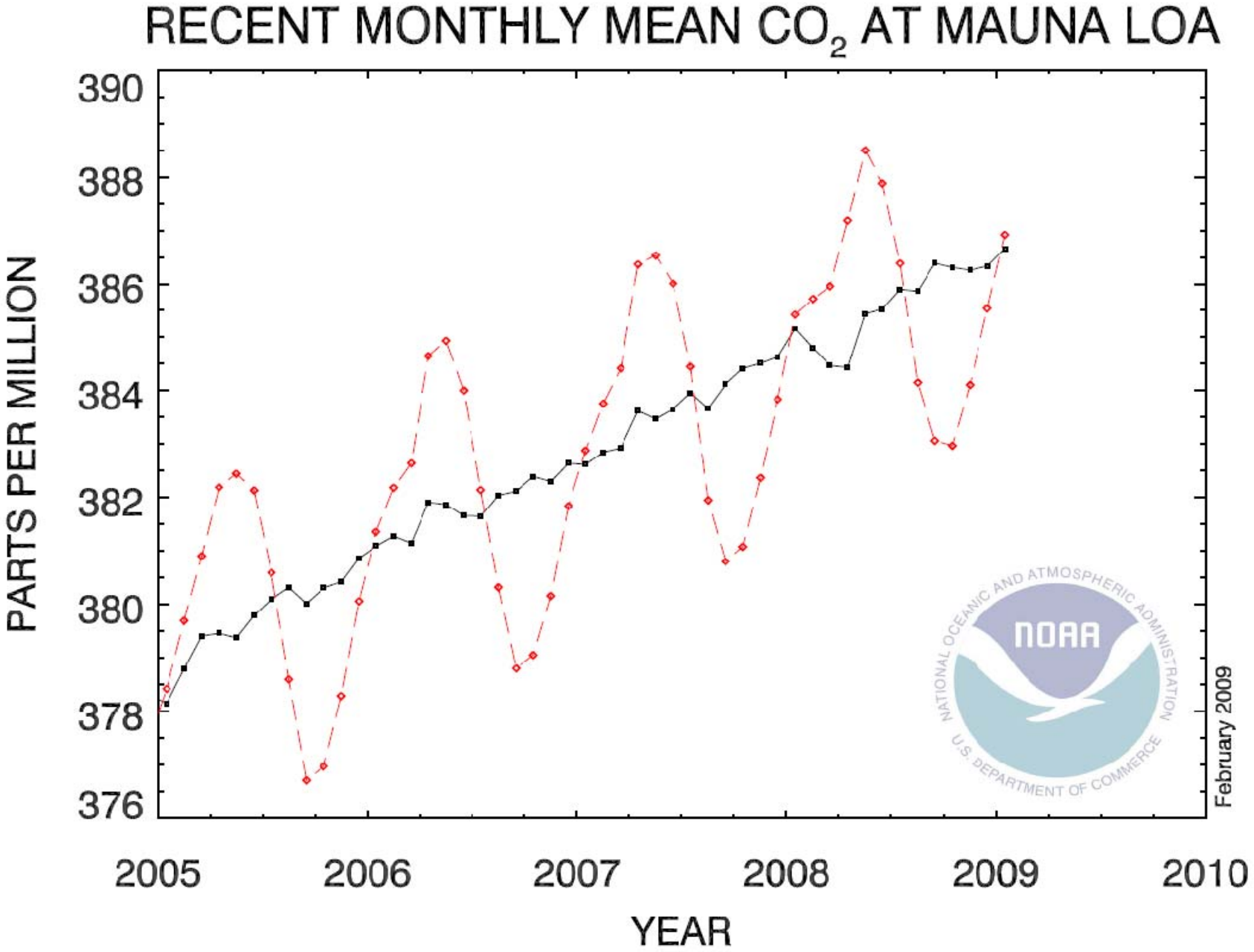
Outline

- Introduction
- The role of forests in sequestering CO_2
- Quantification of forest carbon
- Some Coastal Silviculture Examples
- Protocols
- Key Messages

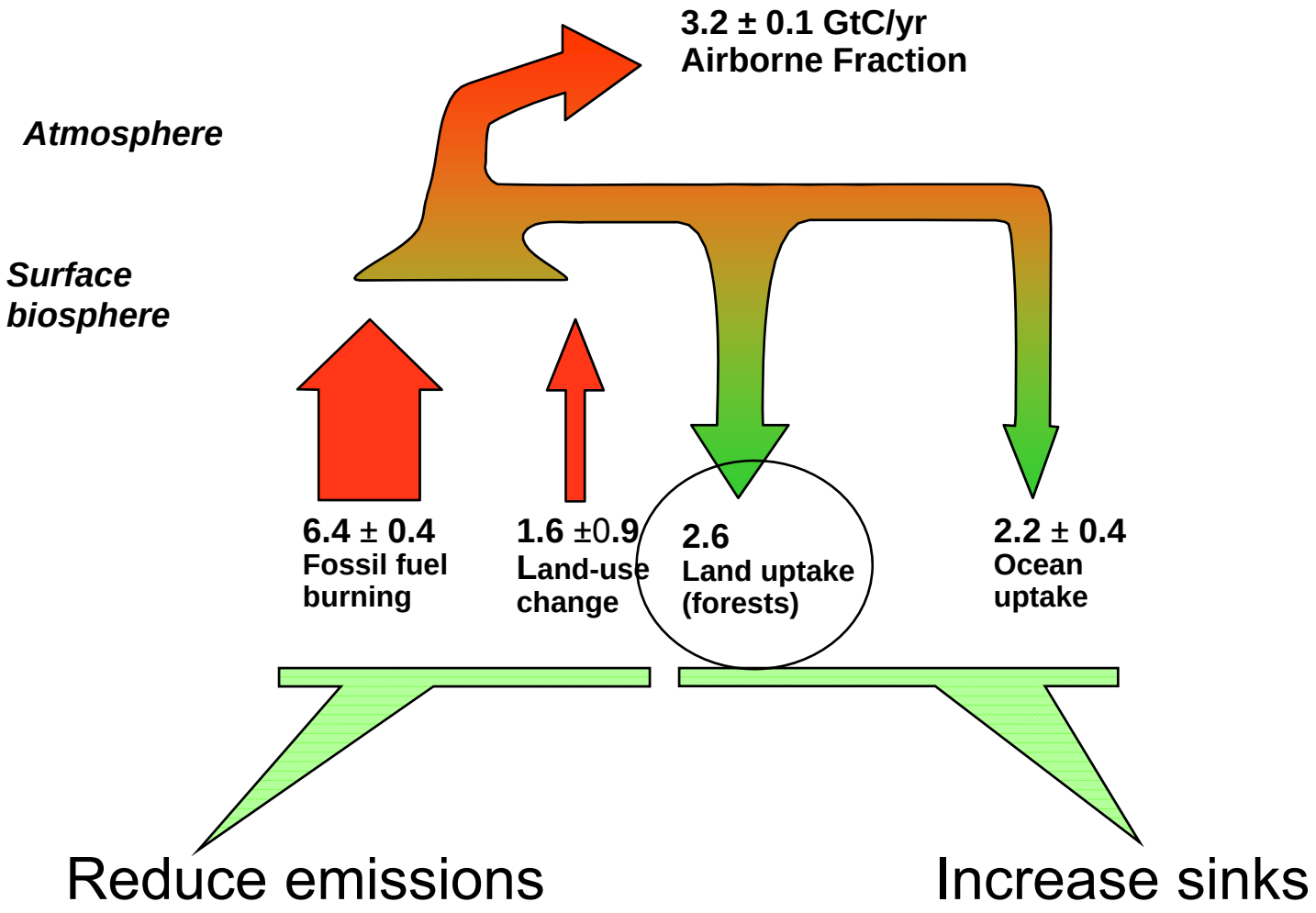
Introduction

- Atmospheric CO_2 from 280 to 385 ppm
- Carbon emissions:
  - 8 Gt/y (6.4 fossil fuel, 1.6 land use change)
    - 3.2 atmosphere
    - 2.2 oceans
    - 2.6 forests ***
- Reduction targets
- Stabilization wedges


Manua Loa Carbon Dioxide Concentration
360
350
340
330
320
310
CO2 ppm
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
Years

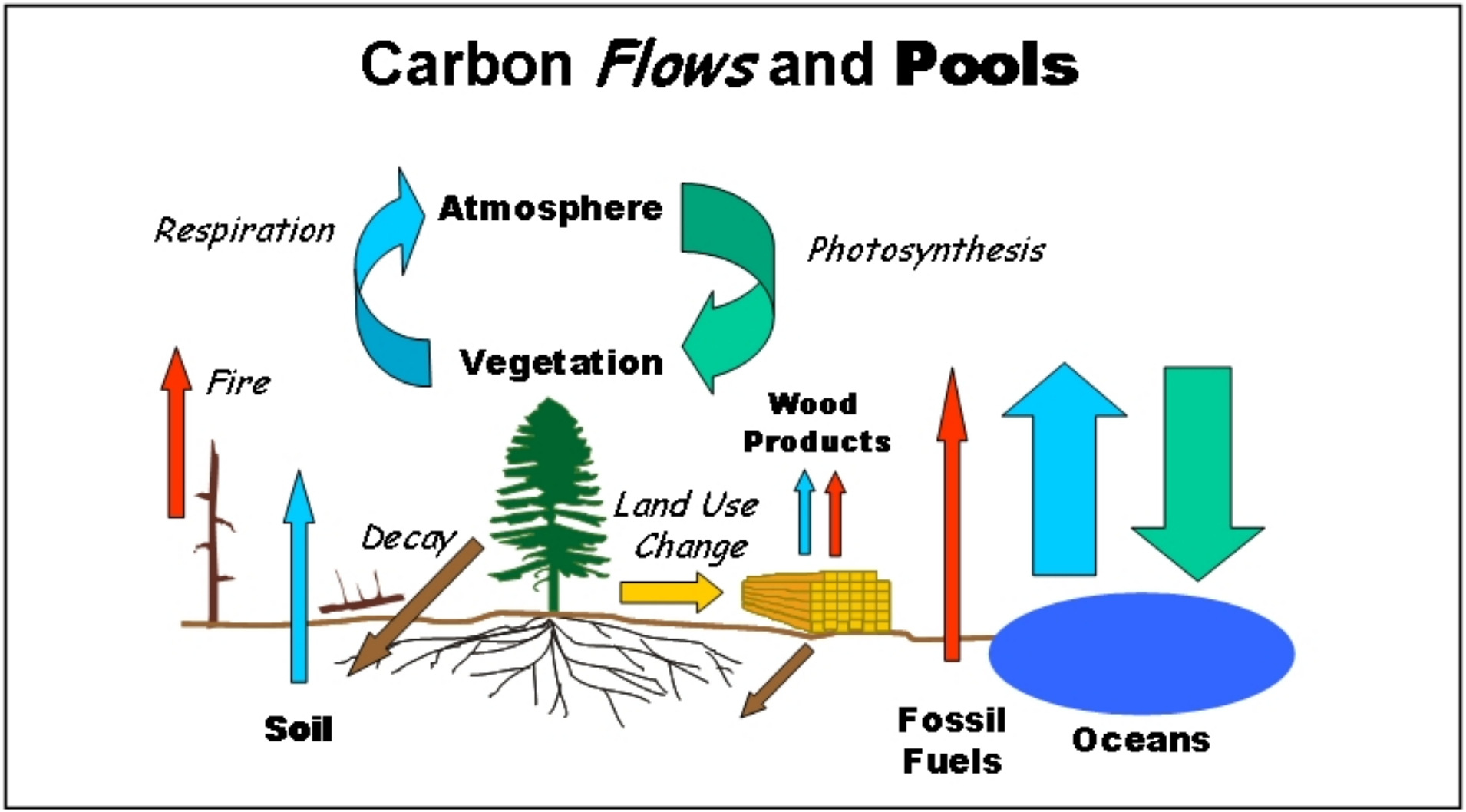

RECENT MONTHLY MEAN CO2 AT MAUNA LOA
PARTS PER MILLION
390
388
386
384
382
380
378
376
2005
2006
2007
2008
2009
2010
YEAR
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE
February 2009

Managing Global Carbon Flows



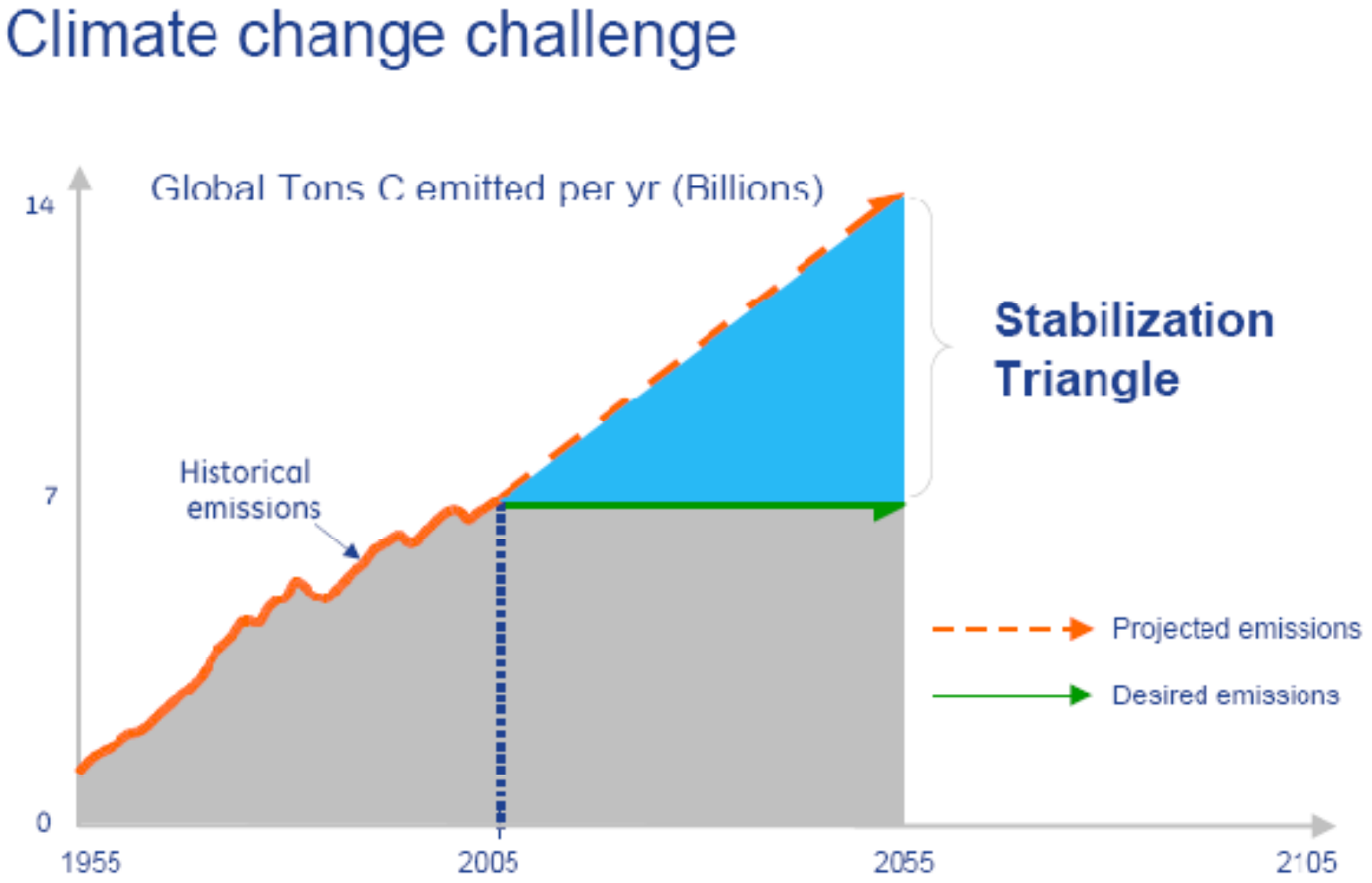
Adapted from: W. Kurz, CFS, 2007

Forest Carbon Flows



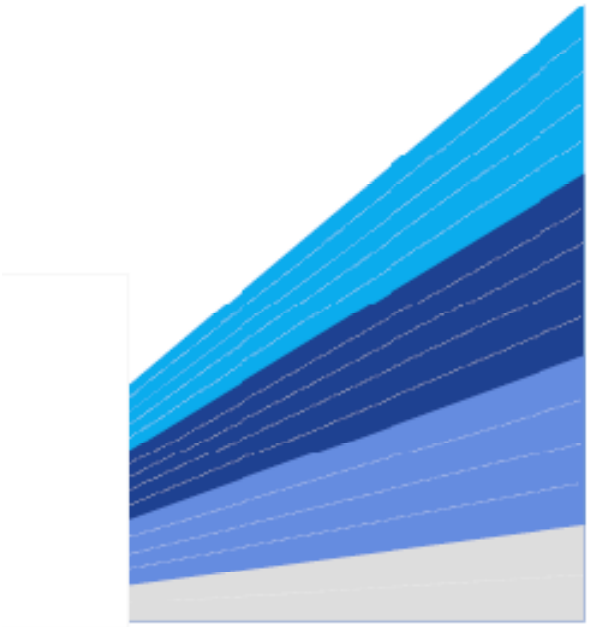
State of Forest report 2006 MFR

Stabilization Wedges



http://unfccc.int/files/meetings/dialogue/application/pdf/ann_condon_-_ge.pdf

Stabilization wedges…7 required



Wedge=emissions reduction of 1 Gt C/yr by 2055

16 potential wedges

(5) Efficiency

(5) Decarbonization of Power

(4) Decarbonization of Fuels

(2) Forests & Agriculture

http://unfccc.int/files/meetings/dialogue/application/pdf/ann_condon_-_ge.pdf

Reductions targets

- GGRTA: 33% by 2020

Strategies

- Reduce Sources
- Increase Sinks

Looking for the perfect carbon sink

The Perfect Sink

What is

- Solar powered?
- Capable of working in low light at low temperatures?
- Low maintenance?
- Inexpensive?
- Self cleaning and repairing?
- Produces other benefits such as habitat, water storage, building materials, etc

- Answer

Carbon Quantification in the Forest

- Approximately 50% of the oven dried weight of a tree is carbon
- Many of the tree species in British Columbia have a density of 0.4 - 0.5 g/cm^3

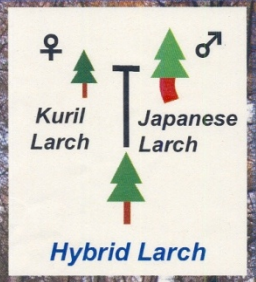
Larch .55	Birch .51
Coastal D Fir .51	Red Alder .37
W. Hemlock .42	Aspen .35
Lodgepole pine .41	Red Oak .56
White Spruce .36	** 12% M.C.

**http://www.bcforestinformation.com/wood-products/tree-species/

Clean Larch

new variety of the hybrid larch with high carbon-fixing potential

What is "the hybrid larch" and "Clean Larch" developed in Hokkaido ?



The hybrid larch is first generation of inter-specific hybrid between 2 Larches.

Clean larch is the hybrid progeny of particular Kuril larch named "Nakashibetsu 5 "

Natural ranges of its parent species.

Superior carbon storage capacity of the Clean Larch

Fig. Carbon storage capacity of stems in 30-year-old stands

Fig. Comparison of total carbon fixation until harvest between Clean Larch( ) and Japanese larch ( )at various site productivities.

Other excellent characteristics

High resistance to vole gnawing, high wood density, and high wood strength.

Future perspectives

1. *Low cost forestry with lower planting density and fewer interventions.*
2. *Contribution to prevent global warming by low cost plantations of the Hybrid Larch with high carbon-fixing potential and high timber quality.*

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Phone: +81-126-63-4164 Fax: +81-126-63-4166 URL: http://www.hfri.pref.hokkaido.jp

- Superior carbon storage
- High carbon fixing and high wood strength
- High wood density
- And more

Quantification

- A m^3 of Fdc is approximately 250 kg of Carbon
- A m^3 of Fdc has the same Carbon content as 100 litres of gasoline (approximate)
- A m^3 of Fdc is roughly equivalent to one tonne of CO_2

Questions and Answers

http://carbon.cfs.nrcan.gc.ca/FAQ_e.html#1a

The Largest Sustained Mitigation Benefit

"In the long term, a sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual sustained yield of timber, fibre or energy from the forest, will generate the largest sustained mitigation benefit." [1]

•[1] IPCC Fourth Assessment Report, Working Group III Report "Mitigation of Climate Change" http://www.ipcc.ch/ipccreports/ar4-wg3.htm , Accessed July 17th, 2008 page 543

Carbon content/value in wood

- Oven-dry density of blue-stained lodgepole pine: 422.68 kg/m3
- Carbon content of lodgepole pine: 51.2 %
- 1 metric ton carbon = 3.667 (44/12) metric tonnes CO_2 equivalent
- Price of carbon ECX = 11.90 Euros per tonne CO_2e
- 1.00 Euro = $1.60 Canadian
- 1 m3 of oven-dry MPB-killed Lodgepole pine = 422.68 kg oven-dry biomass = 216.41 kg C = 0.216 tonnes C = 0.792 tonnes CO_2e
- worth approximately 9.42 Euros, or $15.08 CND
- 8 bfm ≈ $1.60 lumber value on the C market ≈ $0.12

http://swst.metapress.com/content/f62662558j23p182/ - Liping and Oliveira, 2008, avg of values in Table 1
http://www.sampsongroup.com/Papers/Monitoring%20and%20Measuring%20Wood%20Carbon.pdf
http://www.iuep.org/RFP2006/commonconversionfactors.php
http://www.pointcarbon.com/

Strategies

- Worldwide terrestrial carbon storage is a significant quantity of carbon
- Forests are a significant component of the terrestrial carbon
- There are strategies that can be implemented that will increase the total carbon stored
- **Who** will pay for increasing carbon storage?

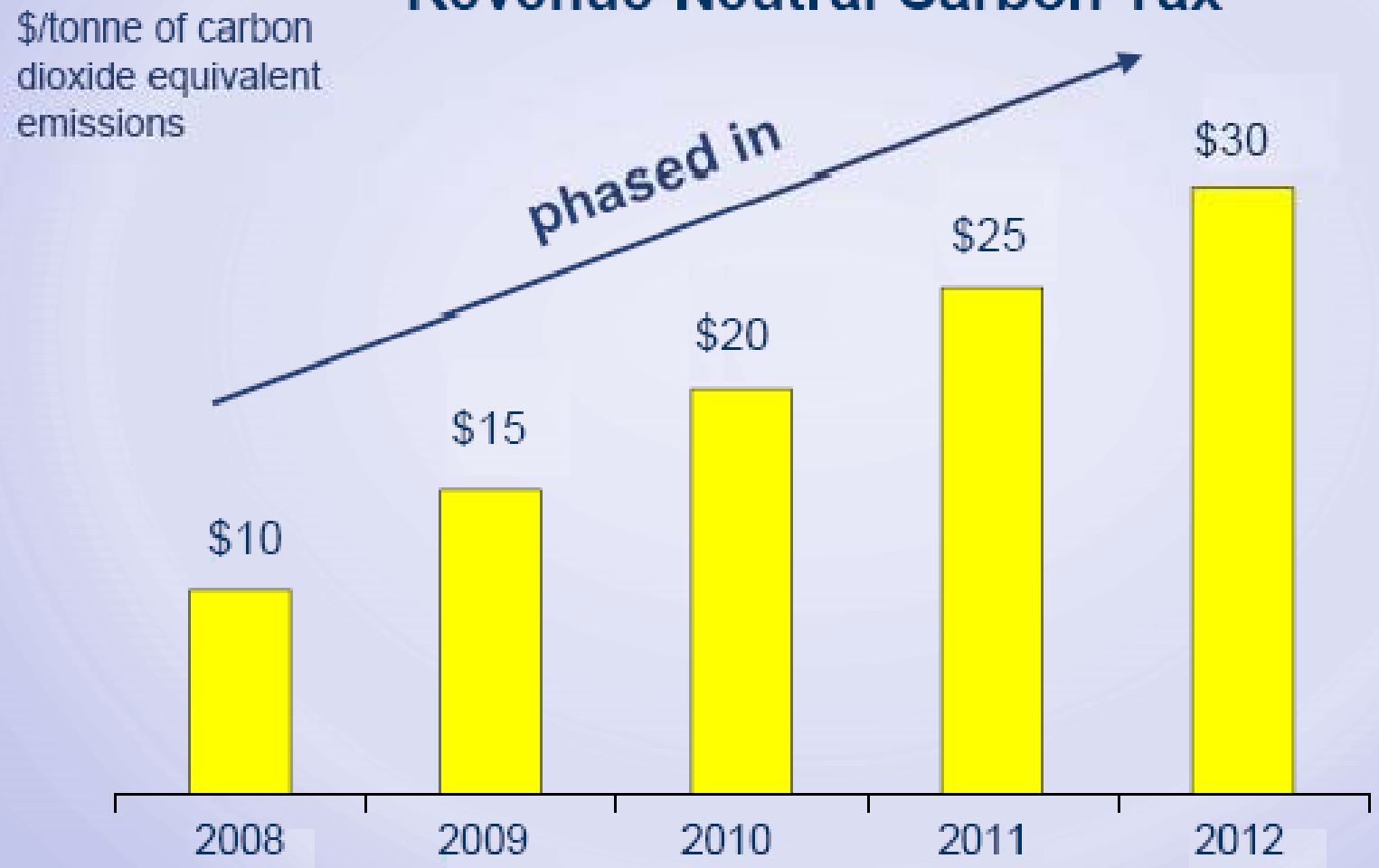
$ for Offsetting

- Pacific Carbon Trust
- Western Climate Initiative
- Voluntary markets
- Other markets
- You and me

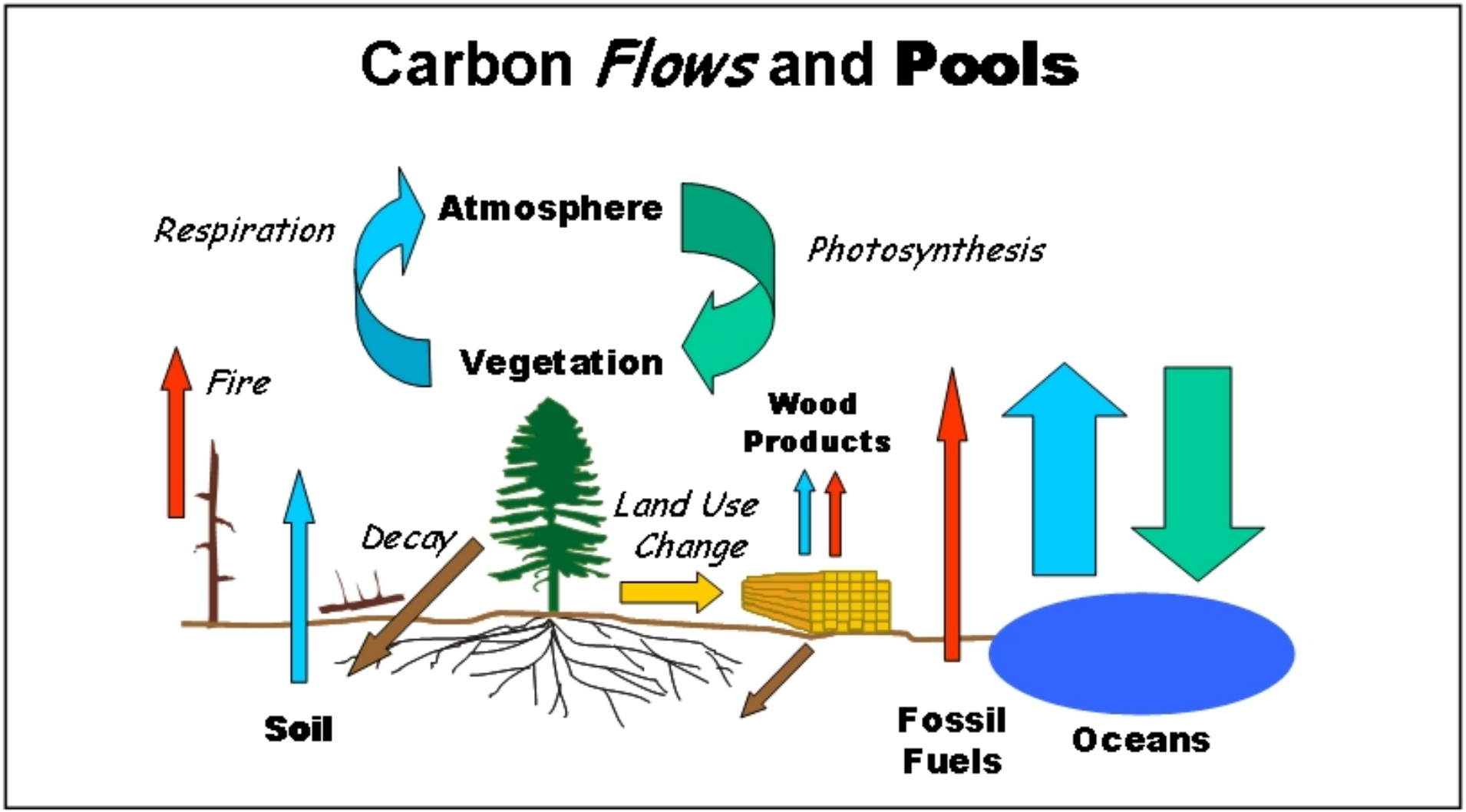
Government carbon-neutral by 2010

- Includes Crown agencies
- All public sector organizations, including school boards and health authorities, will have to report on progress.
- Pacific Carbon Trust - $25 per tonne ($CO_2$) related to travel

Revenue-Neutral Carbon Tax

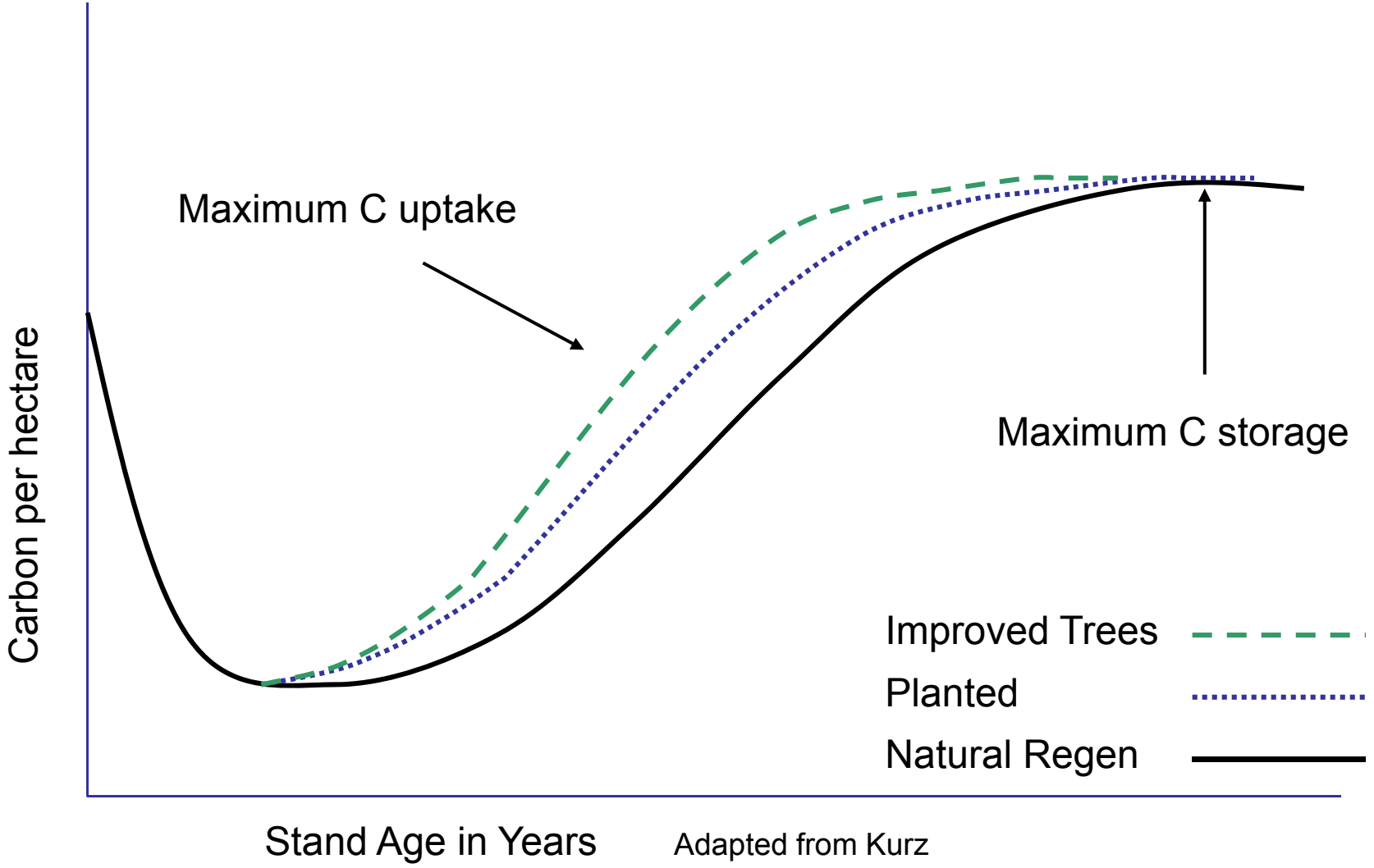


Forest Carbon Flows



State of Forest report 2006 MFR

Stand Level Carbon Dynamics after disturbance

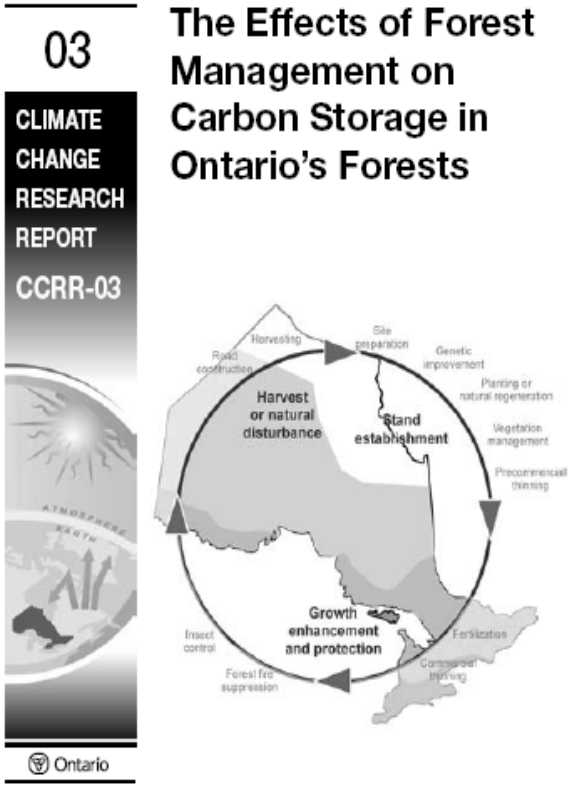


More numbers

What does this mean for forest management?

- $15/tonne CO_2 roughly equals $15/$m^3$
- MAI of 4 – 10 m^3/ha/yr are common (above ground biomass)
- Needs to be compared to the baseline
- The carbon needs to be additional to qualify
  - If the baseline is 3 m^3/ha/yr using improved seed (GW20) then additional volume is 0.6 m^3/ha/yr ($9/ha/yr)
- Quantification of gains from forest management are complex
  - Protocols are being developed

Forest Management Options for BC



- Forest management opportunities to increase carbon storage are being developed for British Columbia
- These opportunities are expected to help guide the development of strategies

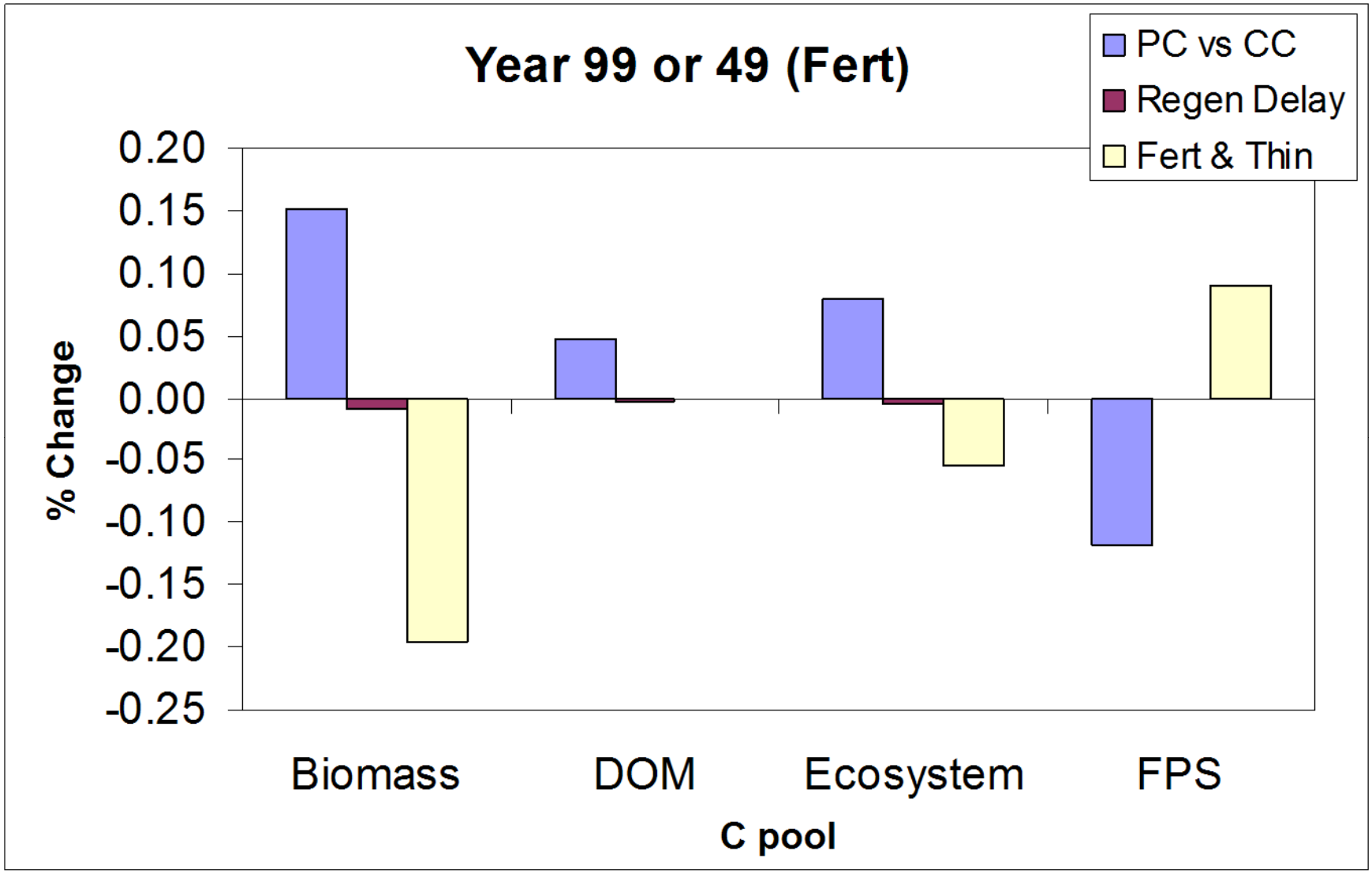
Coastal Silviculture Scenarios

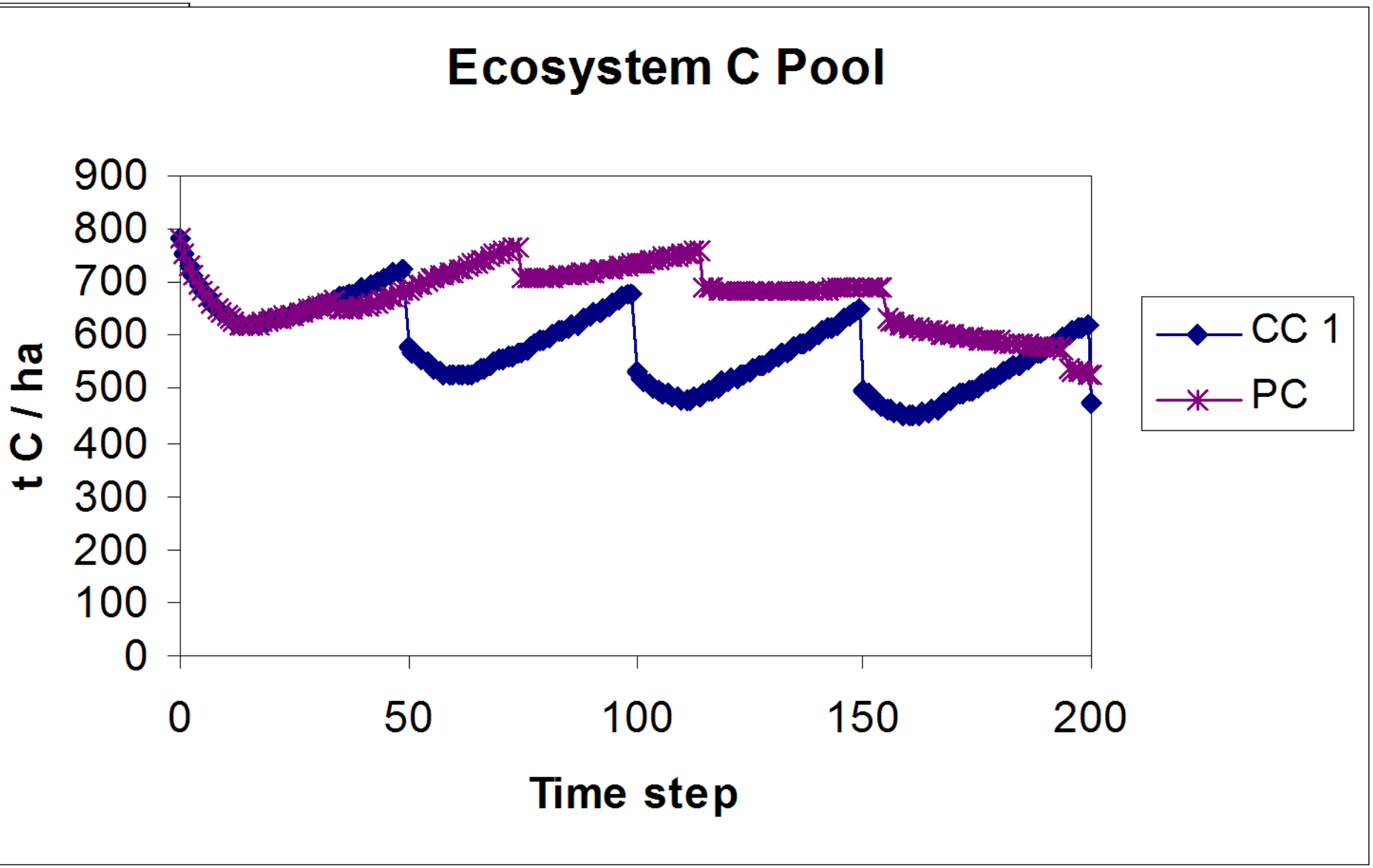
Activity/Activities	**Stand Type**	**BAU**	**Scenario**
Commercial Thinning with Rotation Length "PC vs CC"	Fd SI30	50 year rotation for 200 years.	200-year rotation with multiple thins starting at age 35, removing 35% of biomass, and repeating every 40 years. *(removing 30-35% of dominant and co-dominant)*
CC with retention, regen delay, tree improvement, landing burn "Regen Delay"	FD SI30 CWH	CC with burn at age 50, then re grow with 1 year regen delay using a Typsy curve that assumed 1600 stems/ha. *1 yr regen delay, 800 stems/ha planted with 1000-2000 additional coming in naturally* *10% tree improvement* *With landing burn*	CC with burn at age 50, then re grow with a 4 year delay using the same Typsy curve. *4-yr delay, 1200-1800 stems/ha natural regen (not planted)* *0% tree improvement* *With landing burn* *No tree improvement (because natural regen)*
Fertilization "Fert & Thin"	Fd SI30 CWH	CC at age 50 *No management*	Fertilization at age 20, commercial thin 35% biomass at age 35 and CC at age 50.

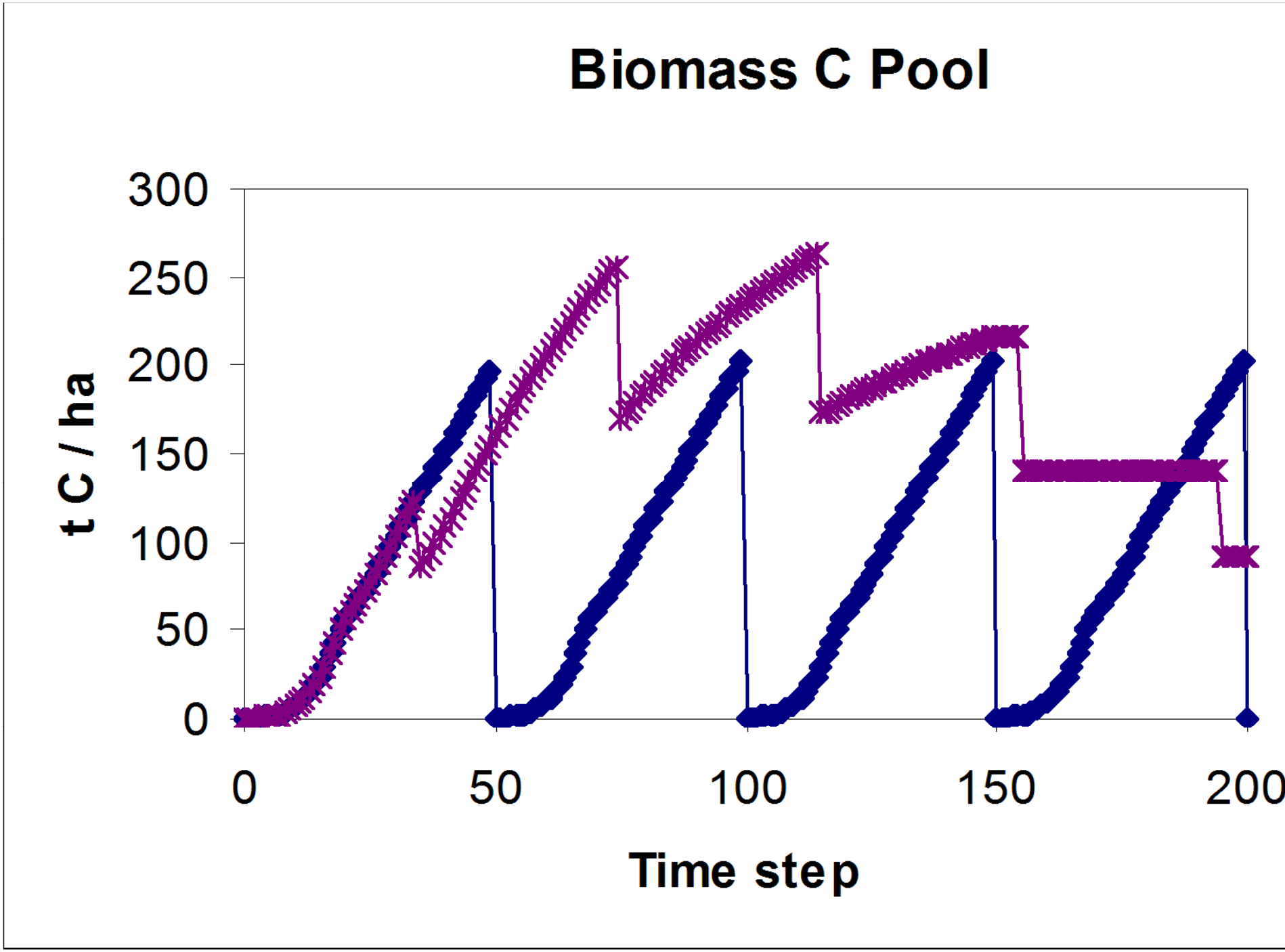
Key Terms

- **Biomass Carbon:** The total Carbon mass of living organisms in a given area or volume
- **Dead organic carbon:** A generic term for all dead organic compounds in the ecosystem, including standing dead trees, downed trees, coarse and fine woody debris, litter, soil carbon, and peat.
- **Forest Product Sector Carbon:** Carbon removed by the Forest Sector for lumber, fibre, etc

Percent change in C Pool




Ecosystem C Pool
900
800
700
600
500
400
300
200
100
0
t C / ha
0
50
100
150
200
Time step
CC 1
PC

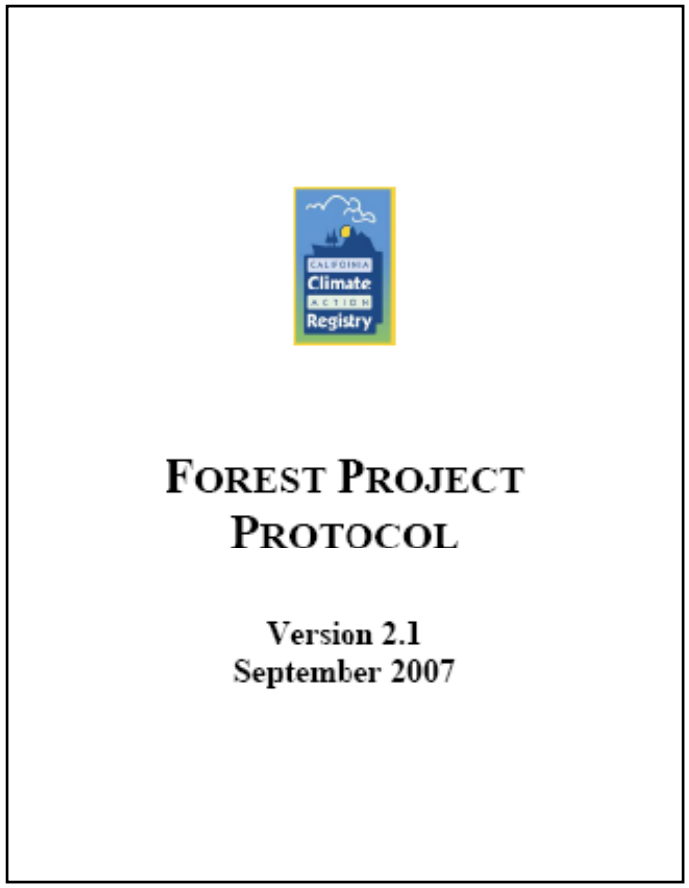

Biomass C Pool
300
250
200
150
100
50
0
t C / ha
0
50
100
150
200
Time step

Protocols

Protocols will be developed to ensure the carbon sequestration is:

- Real
- Measurable
- Additional
- Verifiable
- Counted once
- Clear ownership
- Conservativeness

www.climateregistry.org



- A number of protocols are being developed
- There is current interest in BC to develop protocols that "work" for us
- Anyone interested in getting involved?

California Forest Project Protocol

- Forest Project Protocol (FPP) is the Registry's guide for the design, implementation and registration of forest projects.

Forest Project Types (California)

- ***Conservation-based Forest Management***: Forest projects that are based on the commercial or noncommercial harvest and regeneration of native trees and employs natural forest management practices

- ***Reforestation***: Forest projects that are based on the restoration of native tree cover on lands that were previously forested, but have been out of tree cover for a minimum of ten years

- ***Conservation***: Forest projects that are based on specific actions to prevent the conversion of native forests to a non-forest use, such as agriculture or other commercial development

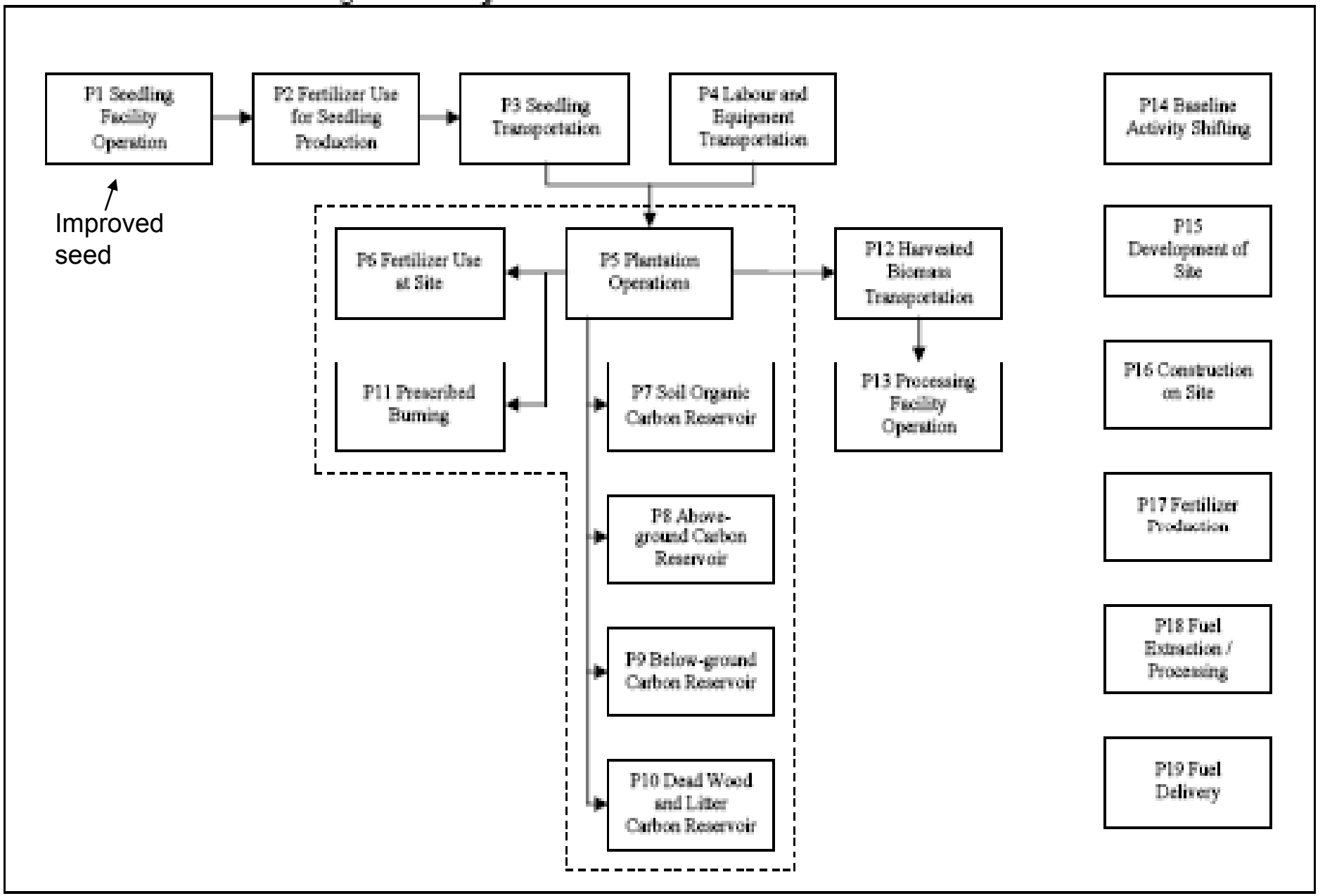
Protocols

Afforestation protocols serve as a generic ‘recipe’ for proponents to follow in order to meet the measurement, monitoring and GHG quantification requirements.

Protocol Statements

- An afforestation project will achieve GHG reductions/removals through the increase in carbon stocks (above and/or below ground and possibly soil carbon) on the project site as a result of the growth of trees.
- Initial carbon stocks vary, but in all cases are lower than future expected carbon stocks, both above and below ground.
- Emissions from the project are expected during establishment due to site preparation and planting.
- Other emissions following establishment will occur as a result of the maintenance required by the plantation design.
- These emissions are expected to be small compared to the carbon sequestered by the project.

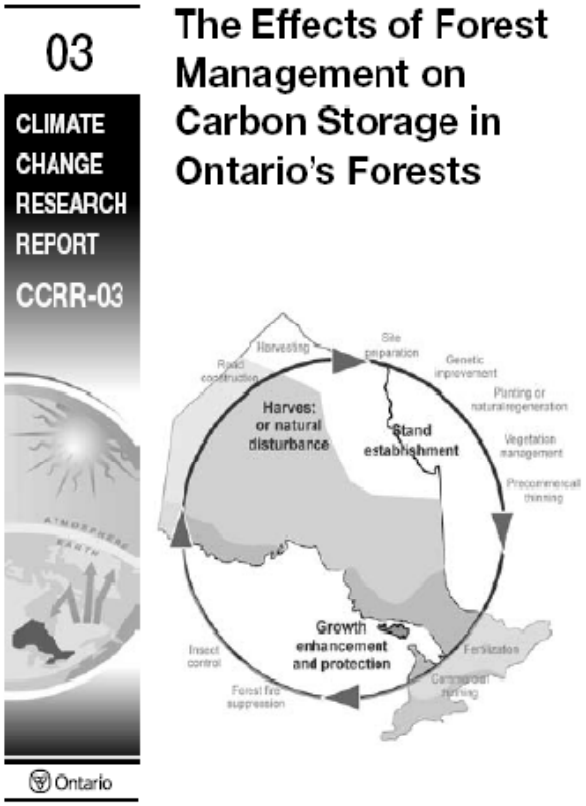
FIGURE 1.1: Process Flow Diagram for Project Condition



Forest Carbon Projects

- Enhance C sinks
  - Afforestation, Reforestation, Deforestation (LUC)
  - Reduce AAC, Longer rotations, Fertilizing
- Reduce C emissions
  - Forest health
  - Fire management
  - Fuel switching (biofuels, bioenergy, cogen)
- Forest products as C storage
- Forest products as substitutes for high-C materials and fuels

Forest Management Opportunities



- Forest management opportunities to increase carbon storage are being developed for British Columbia
- These opportunities are expected to help guide the development of strategies

Other information

http://www.for.gov.bc.ca/hre/topics/climate/

- **Common Misconceptions about Forest Carbon**
- **Misconceptions:**
- **1. "Young stands take up carbon quickly, therefore we should convert old-growth and harvest at max MAI."**
  2. "It's best to maximize carbon storage in the ecosystem therefore we should stop harvesting."
  3. "Bioenergy is always good/clean/C-neutral."
  4. "Short rotation managed stands are better at carbon storage than unmanaged stands".
  5. "All harvested carbon is stored for a long time."
  6. "Converting riparian hardwoods to conifers is a good idea for carbon storage."

1. "Young stands take up carbon quickly, therefore we should convert old-growth and harvest at max MAI."

- **Harvesting an old stand with a low or zero yield increment and replacing it with a young vigorous stand seems to make sense for mitigating climate change since the growth of the tree is a sign of carbon uptake. While that statement is true from a "flux" or "annual uptake" point of view, it's less certain when you think about carbon stocks. What are you doing with the harvested carbon? Is it being burned in slash piles, turned into paper or solid-wood furniture? The amount of carbon stored in a 300 yr old stand is huge. It's going to take maybe 250 yrs or more to get back to the same carbon density per hectare.**
- **From a carbon storage point of view, longer rotations result in more carbon stored per hectare. The carbon benefit of longer rotations is not only due to the rate of uptake (which slows after 80-100 years). The benefit is due to the storage in the biomass and relative balance of the annual turnover (litterfall & mortality) with the decomposition of dead wood and soil carbon. If a stand that's historically been disturbed every 350 years starts to be part of a 30-yr rotation plan there will be a lot of CO2 released from the soil. There just isn't as much carbon being transferred from the living biomass to the dead wood and soil to maintain the carbon stocks on the site. On the other hand, if a site has already been harvested and is part of a short-rotation system, it might be better to maintain the short-rotation and have the carbon stored as forest products.**

Key Messages

- Wood is good
- Current silvicultural practices tend to increase carbon. We already are sequestering more carbon than less intensive forest management
- Biological systems have the capacity to sequester large amounts of carbon
- Biological systems are very complex and highly variable

Questions?

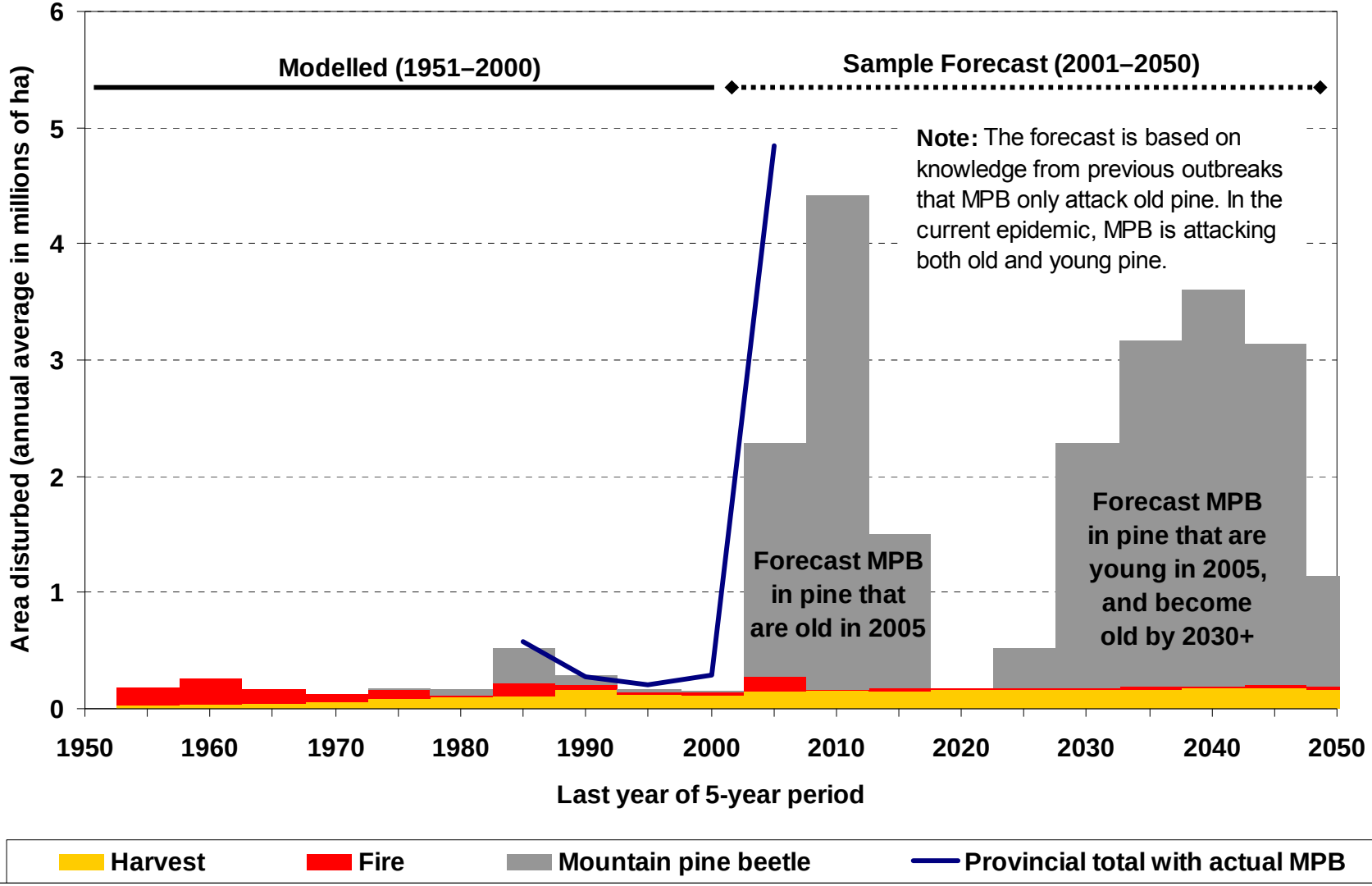
Thanks to

Sarah Beukema

Tom Niemann

Caren Dymond

Disturbance Causing Tree Mortality, 1951–2050



Disturbances and Reforestation, 1970–2005/06

Public land