Forest Sector Mitigation Options to Reduce Climate Change

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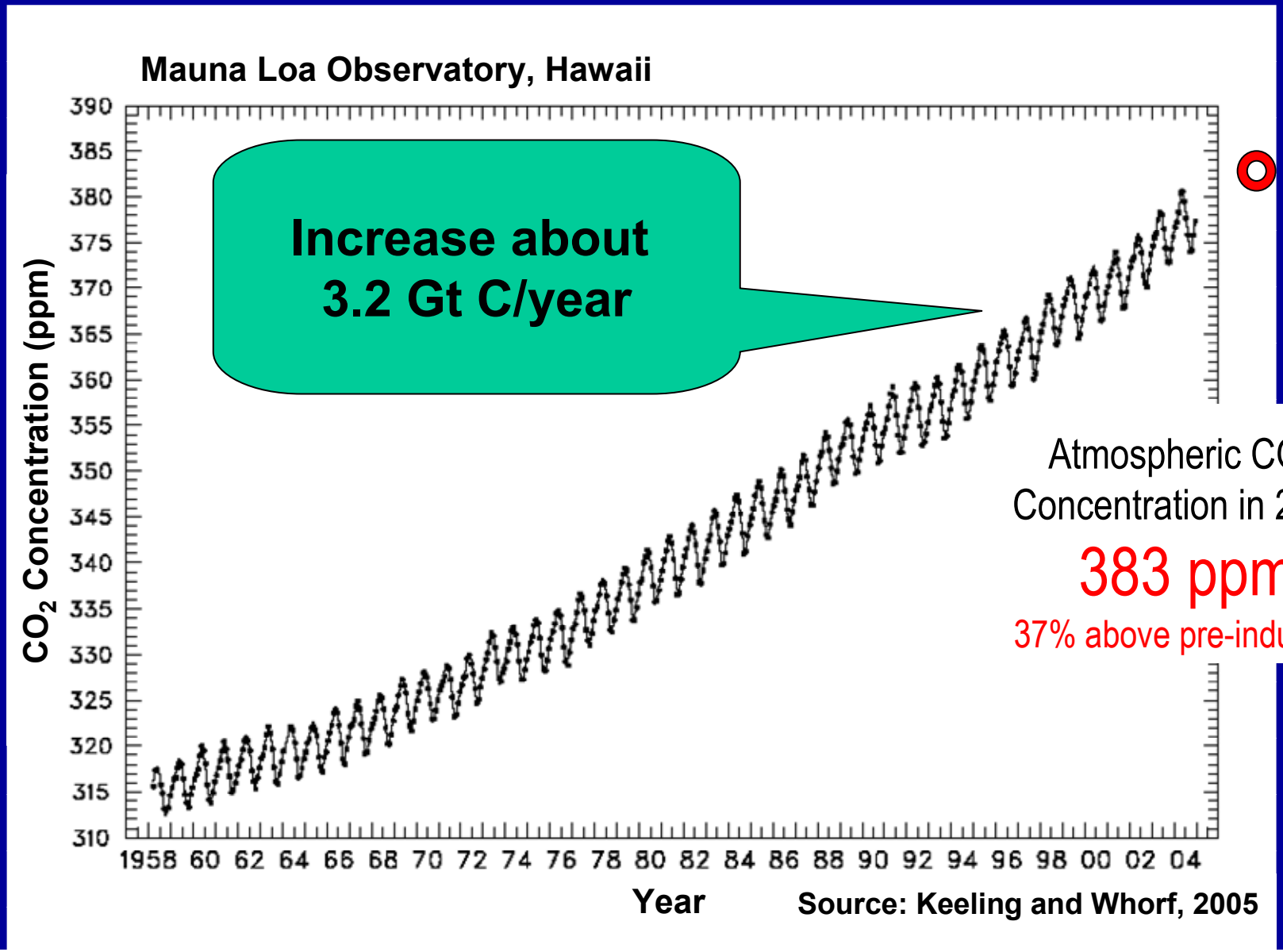
IEA Bioenergy Conference
Vancouver BC, August 26, 2009

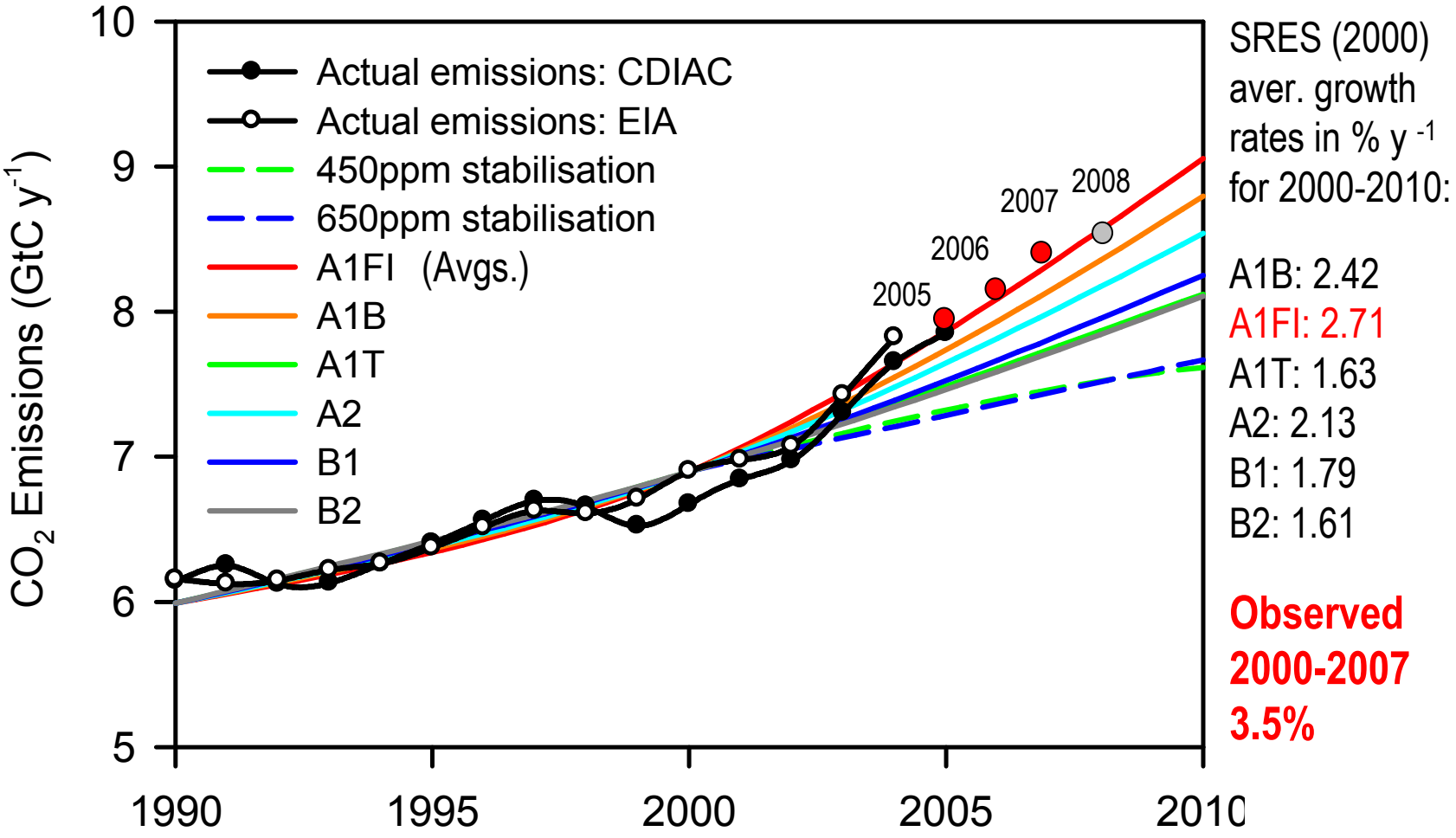
Outline

- Forest Mitigation Options
- C Implications of Salvage Logging for Bioenergy
- Conclusions

Increase in Atmospheric CO_2 Concentration



2000-2007 CO_2 emissions growth rate exceeds all IPCC scenarios



Raupach et al 2007, PNAS, Global Carbon Project, 2009 update

Does the Forest Sector have a Role in a Mitigation Portfolio?

- Mitigation objectives are achieved when changes in human activities result in
  - a reduction of emissions or
  - an increase in removals of GHG from the atmosphere relative to a projected business-as-usual baseline.
- Climate change will increase the area annually affected by fires, drought, and insects and could have negative impacts on forest carbon stocks.
- Nevertheless, forest management options are available to improve the net GHG balance of the forest sector relative to a baseline.

Mitigation Options in the Forest Sector

1. Increase (or maintain) forest area
   - Reduce deforestation, Afforestation
2. Increase stand-level carbon density
   - Silviculture, harvest systems with partial cover, avoid slashburning, reduced regeneration delays, species selection, fertilization, tree improvement programs
3. Increase landscape-level carbon density
   - Longer rotations, conservation areas, protection against fire and insects

- Forest management technologies for mitigation portfolios exist and are implemented operationally.

Source: Nabuurs et al. 2007, IPCC AR4

Mitigation Options in the Forest Sector

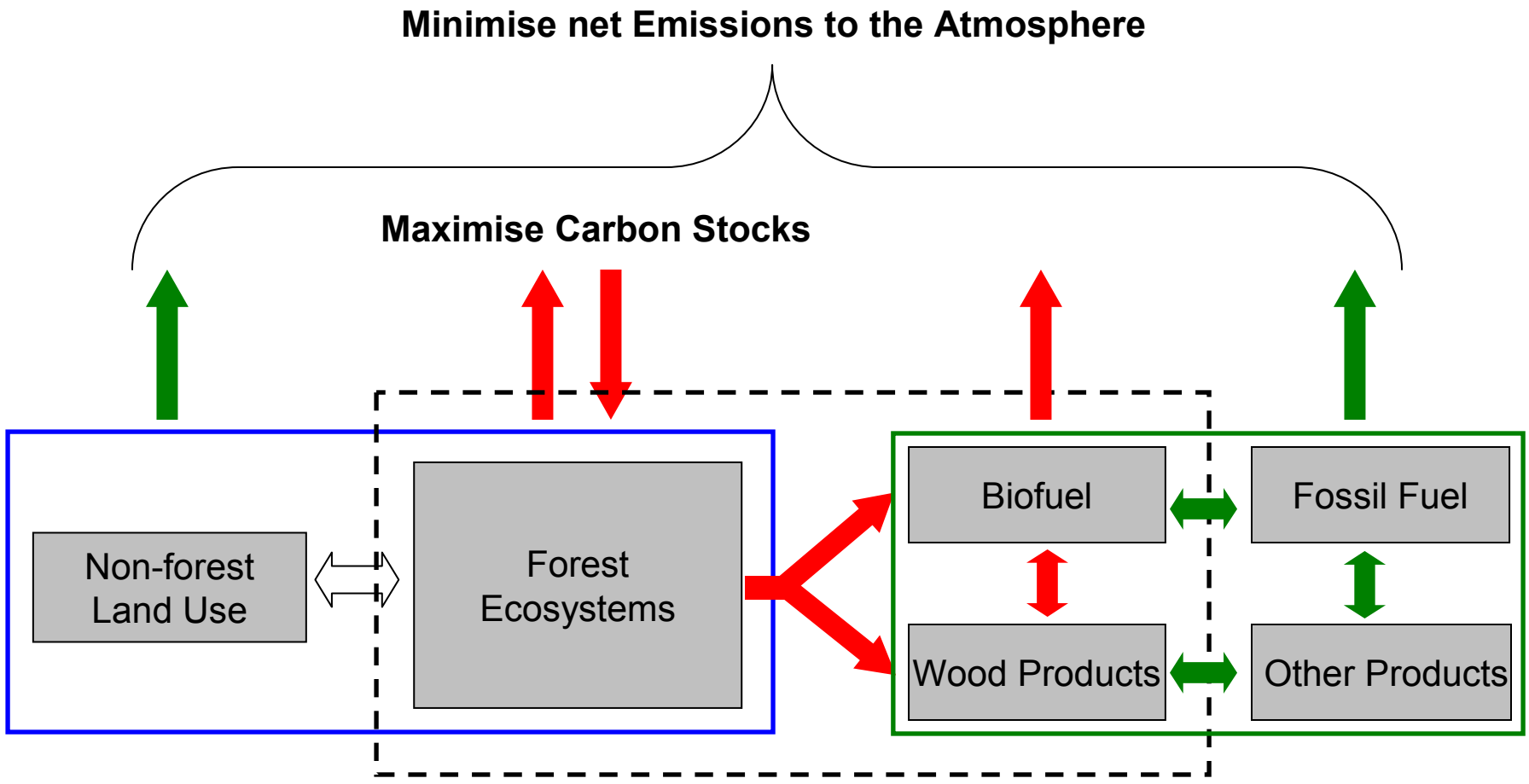
1. Increase (or maintain) forest area
2. Increase stand-level carbon density
3. Increase landscape-level carbon density
4. **Increase C stored in products, reduce fossil emissions through product substitution and through bioenergy use**

Source: Nabuurs et al. 2007, IPCC AR4

C Mitigation in Forest Sector

- Forest Carbon stocks will eventually saturate or release C through disturbances.
- Harvested wood products – unless accumulating in anaerobic landfills, will also saturate.
- Substitution effects through product use or bioenergy use will accumulate indefinitely.
- Analyses very sensitive to:
  - assumptions about HWP storage (e.g. landfills)
  - magnitude of substitution effects (displacement factors)
  - time horizon of analysis , and
  - system boundaries.

Forest Mitigation Strategies: What to Optimise?

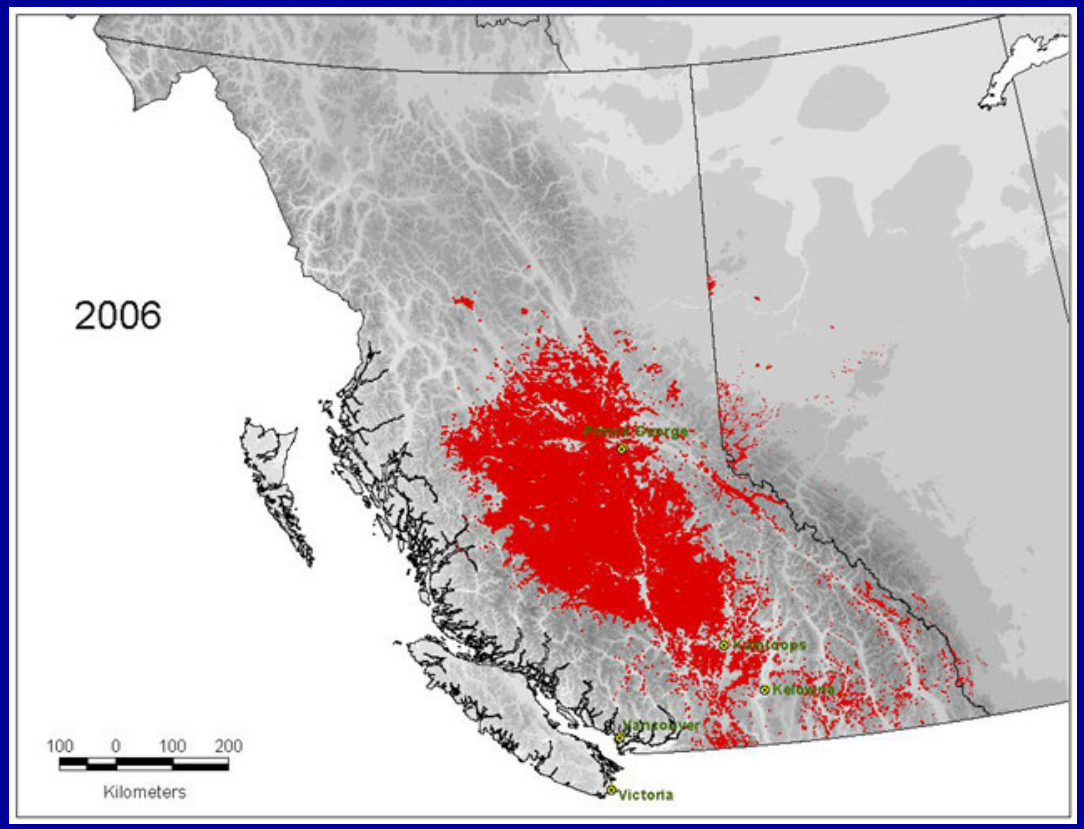


Source: IPCC 2007, AR4 WG III, Forestry

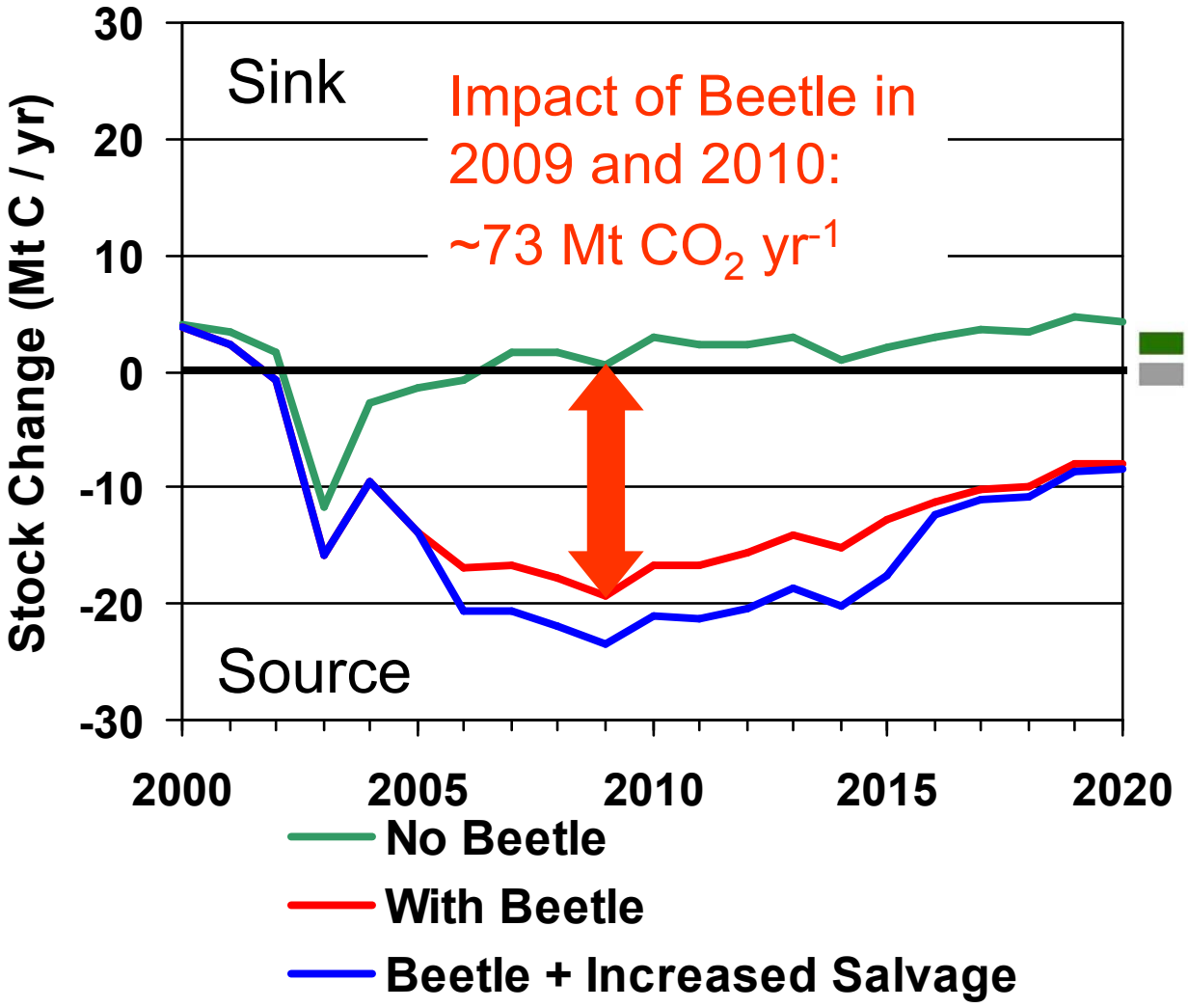
Forest Mitigation Strategies: Climate Change Impacts?

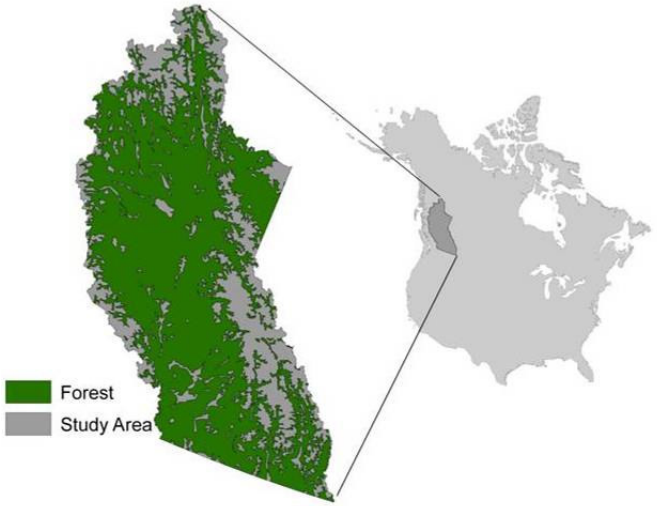
- Climate change is likely to affect the forest sector's mitigation potential
  - Changes in forest growth rates
  - Increased natural disturbances
  - Species maladapted to shifting climate zones
  - Changes in ecological processes (drought, decomposition, permafrost melting)
  - May create opportunities in some regions
- Increased natural disturbances (fire, insects, windthrow), drought and climate-induced species mortality will create millions of cubic meters of dead wood.
- Need discussion before these events about the appropriate forest management response(s).

Carbon Impacts of Current Mountain Pine Beetle Outbreak in British Columbia



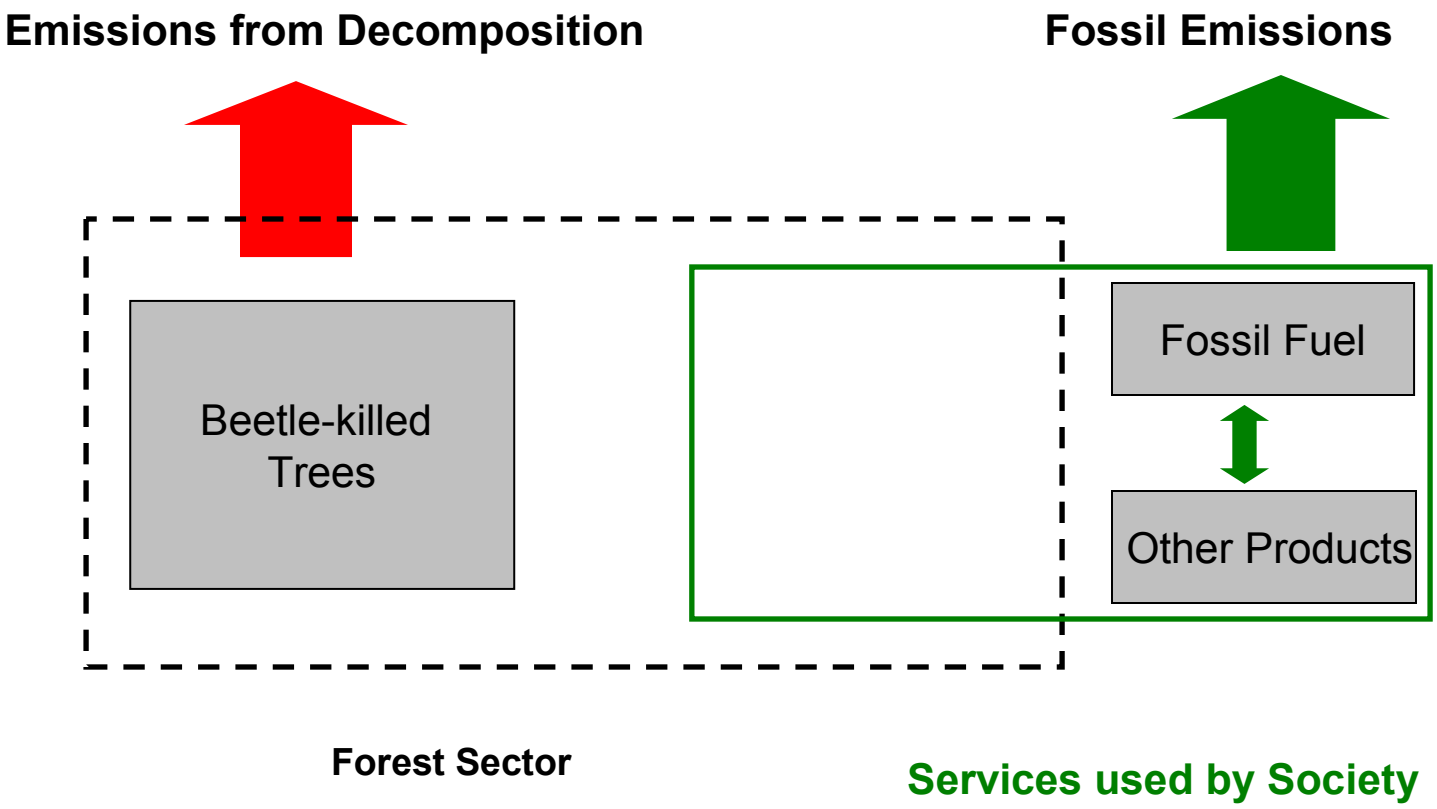
Carbon Impacts of MPB in Western Canada



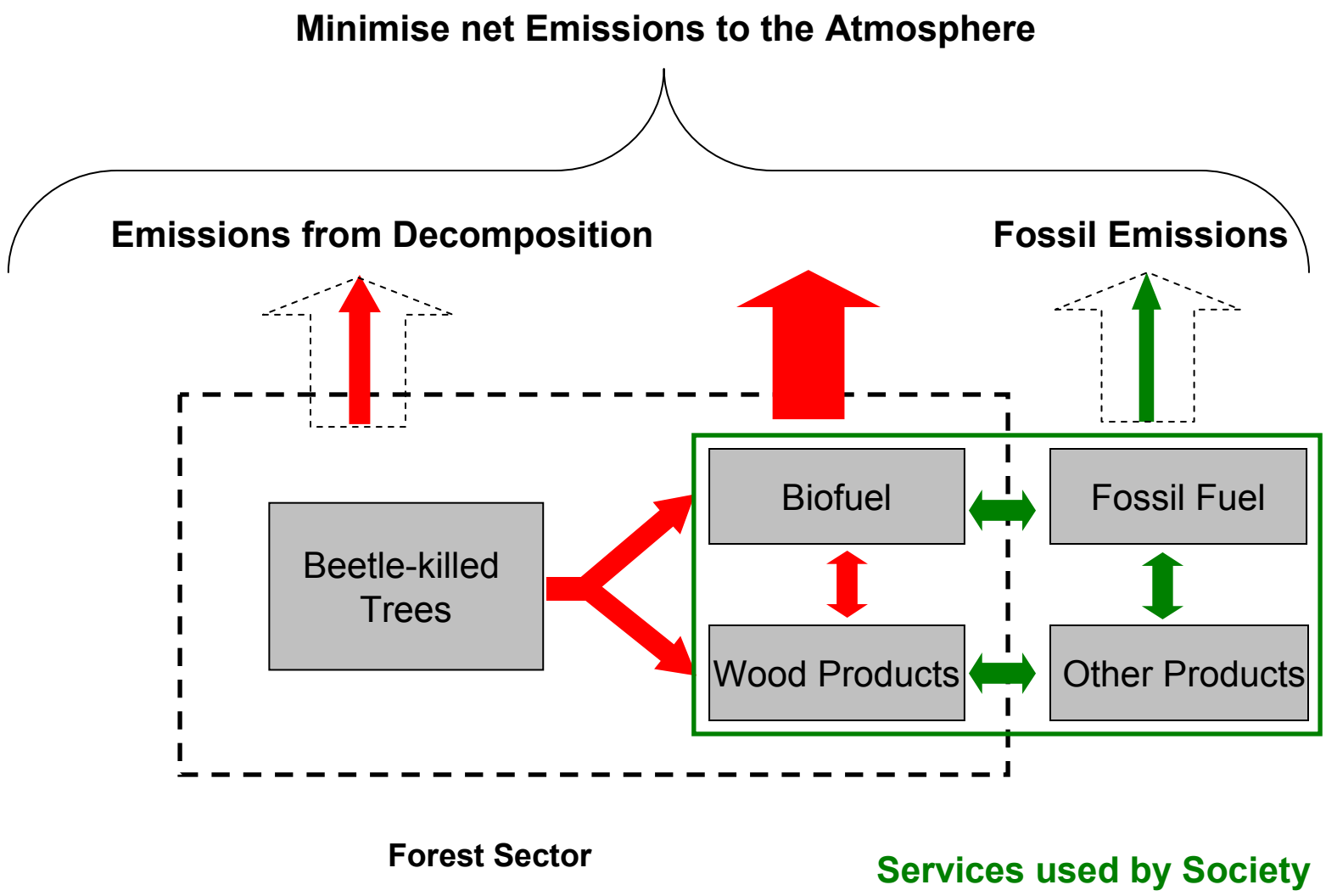


Source: Kurz et al. 2008, Nature

Beetle-killed trees: No salvage



Beetle-killed trees: Salvage and Biofuels



Carbon Neutral Bioenergy from Forests?

- Two reasons why bioenergy is considered C neutral:

1. Current accounting rules consider emission to occur when biomass is transferred out of forest
   - Emissions already accounted at time of harvest
   - Rules could change in future agreements

2. Regrowth removes emitted C from atmosphere
   - But over what time frame does this removal occur?

Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3)

- An operational-scale model of stand and landscape-level forest C dynamics.
- Allows forest managers to assess carbon implications of forest management: increase sinks, reduce sources

- Builds on 20 years of CFS Science

- Freely available at: carbon.cfs.nrcan.gc.ca

Kurz et al. 2009, Ecol. Modelling

CBM·CFS3

Operational Scale Carbon Budget Model of the Canadian Forest Sector Release 1.0

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Simulation Experiment with CBM-CFS3

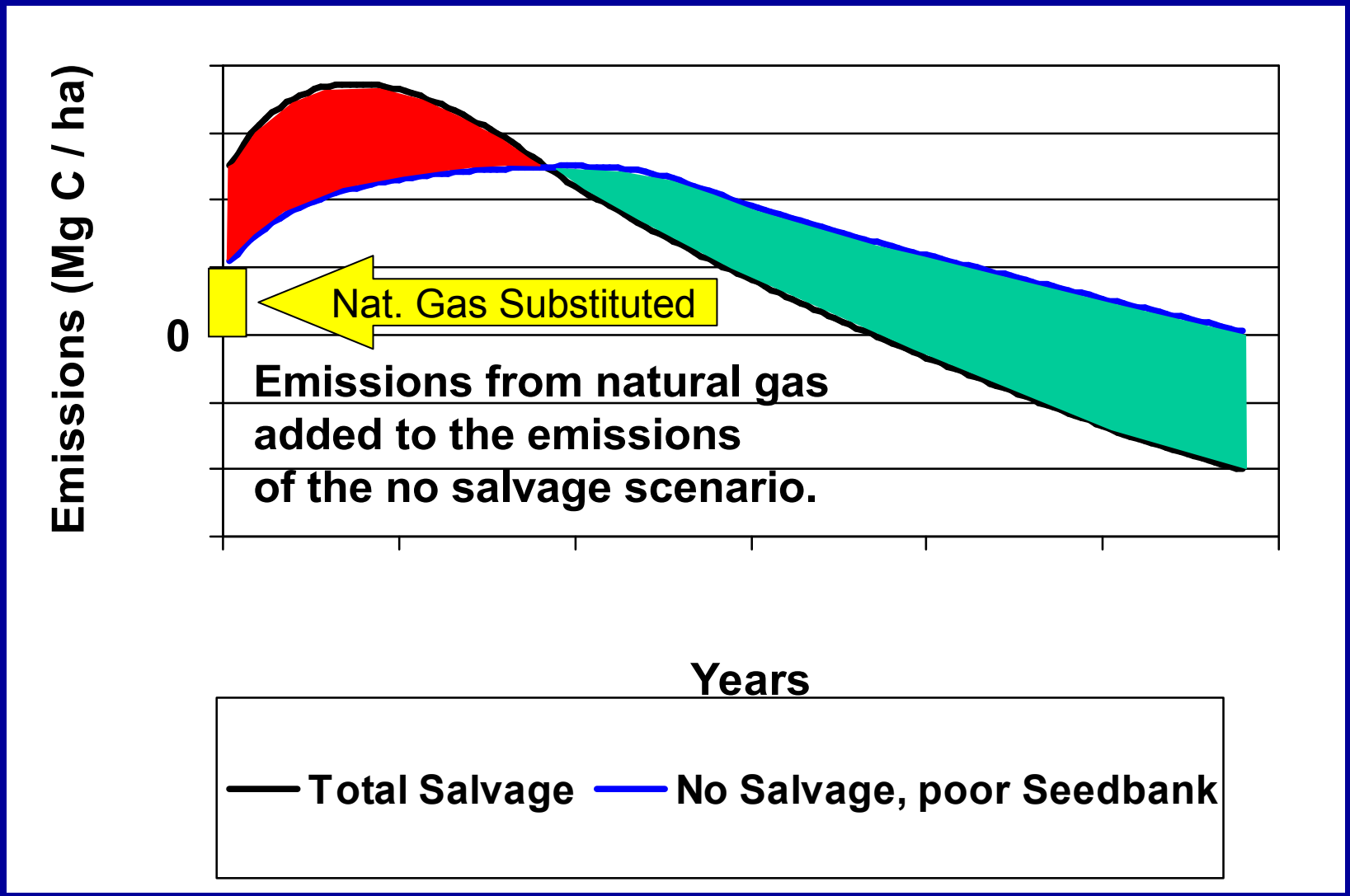
- Analyses of net GHG emissions from MPB salvage with CBM-CFS3
- Assumed a range of stand conditions and varied
  - Species composition (MPB host, non-host)
  - Stand age
  - Percent canopy mortality
  - Salvage impact (total versus partial removal)
  - Status of advanced regeneration in understory
- Used biomass to substitute natural gas (0.42) or coal (0.75)
- Did not account for energy use associated with production or transportation of either biomass or fossil fuels.

Results

- Per unit of electricity produced, emissions from salvaged wood are higher than those using natural gas or coal.
- Cumulative net emissions from salvage logging (see next graph) are higher for the initial years.
- As the stand re-grows cumulative net emissions in the salvage scenario will eventually break even with those in the no-salvage scenario.
- From the break-even point onwards, the salvage scenario will have smaller cumulative net emissions.

Cumulative Emissions – Natural Gas Substituted

Young Pine Example, 75% mortality from MPB



Source: Wolinetz and Kurz, in review

Results

- Scenario analyses are being used to identify the time to break-even point and the impacts of various factors (stand age, MPB mortality, type of salvage, status of regeneration, etc.) on management strategies with greater climate mitigation potential.
- Analyses are currently under review and will be submitted for peer-review and publication.

Conclusions

- Climate change (drought) and natural disturbances (fire, insects) will cause large-scale mortality: salvage logging can contribute to climate mitigation, but net benefits may not be achieved for decades.
- Criteria for stand selection needed.
- Even if net emissions are higher in the short term, bioenergy keeps fossil C below ground.
- Forest managers do not control end-use of products but that has a large impact on mitigation benefits.

Conclusions

- Mitigation opportunities – i.e. reducing sources and increasing sinks relative to a baseline – exist in both forest management and the forest product sector.
- Design of mitigation portfolio requires understanding of carbon dynamics of mitigation actions.
- 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 (IPCC AR4, Nabuurs et al. 2007).

Acknowledgements

- Partial funding from Panel on Energy Research and Development (PERD) administered by Natural Resources Canada.

Thank you very much!

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