Forest Sector Contributions to Climate Change Mitigation

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Carrefour Forêt Innovations
Quebec City, October 6, 2011

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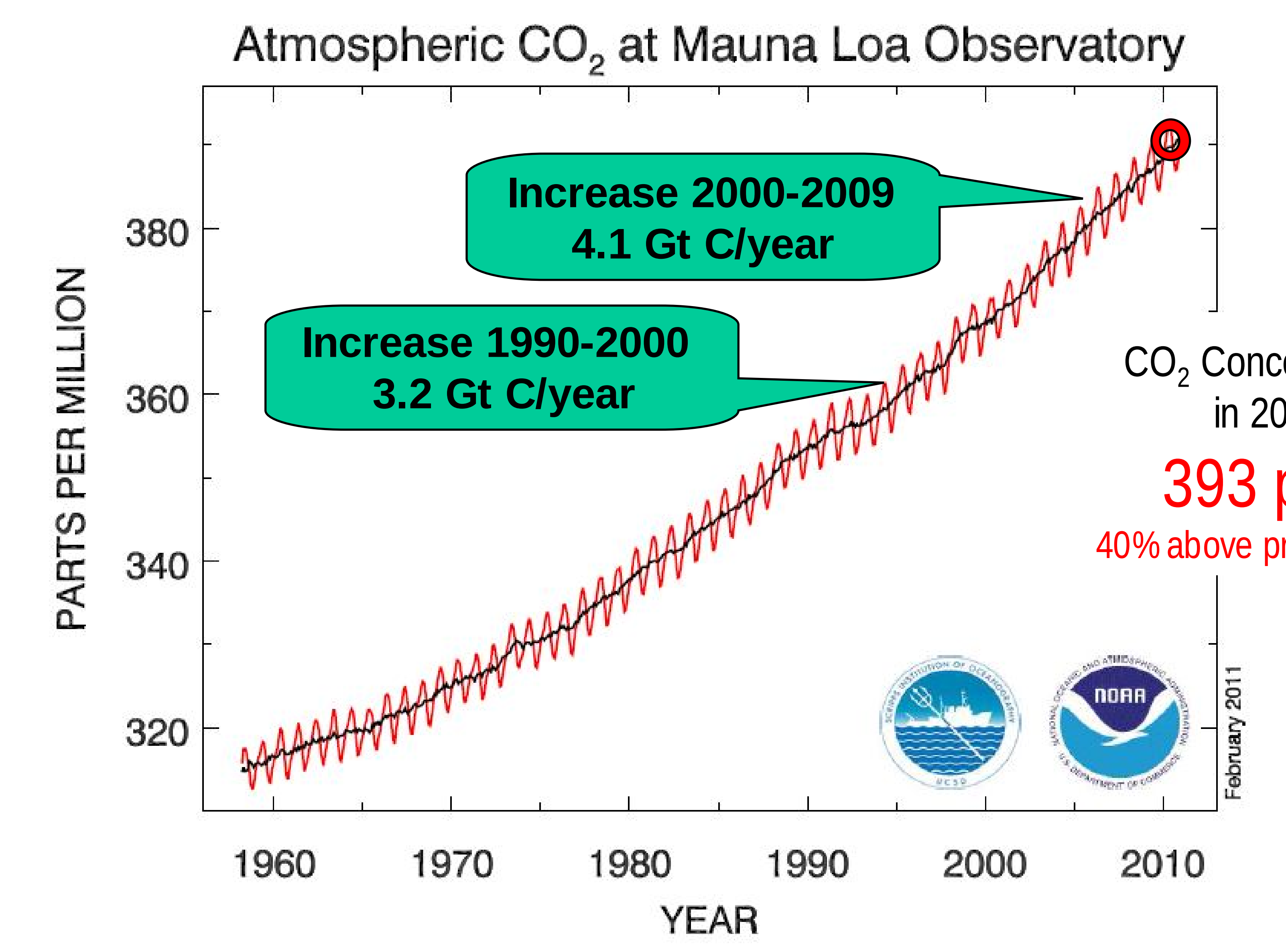
A Team Effort!

- CFS Carbon Accounting Team in Victoria and Edmonton in close cooperation with CFS policy community in Ottawa
- For national-scale analyses input from Resource Management Agencies in all Provinces and Territories
- Collaboration with scientists in CFS, universities in Canada and abroad, IPCC colleagues, and <u>many</u> others …

Outline

- Human perturbation to the global carbon cycle
- Climate change mitigation options in the forest sector
- Bioenergy and GHG emissions
- National-scale analyses of mitigation options
- Conclusions

Increase in Atmospheric CO_2 Concentration

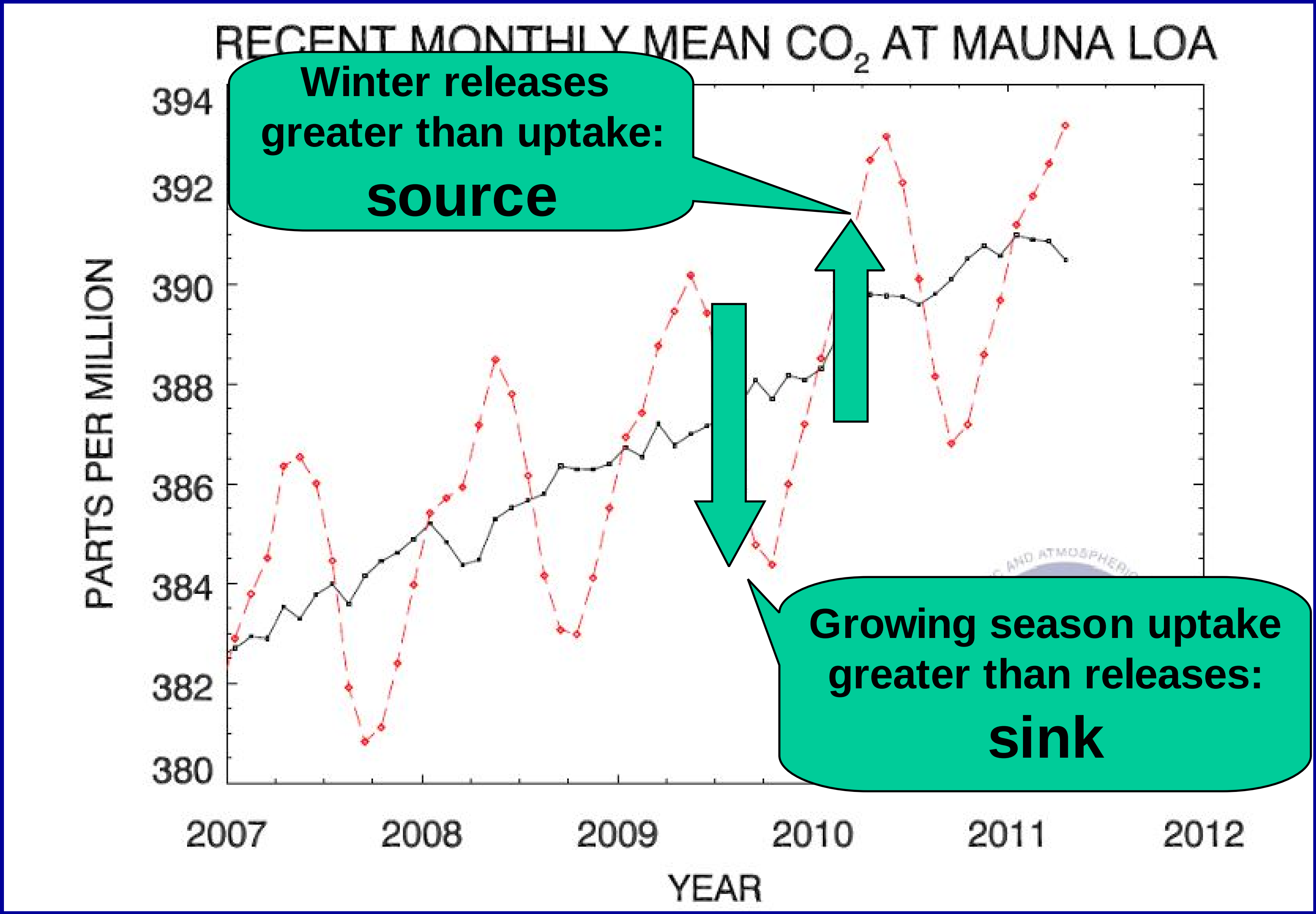


CO_2 Concentration in 2011

393 ppm

40% above pre-industrial

The Breathing Earth



Inventory-based Estimates of Global Forest C Sink

Science

Science (2011) **333:** 988-993;

A Large and Persistent Carbon Sink in the World's Forests

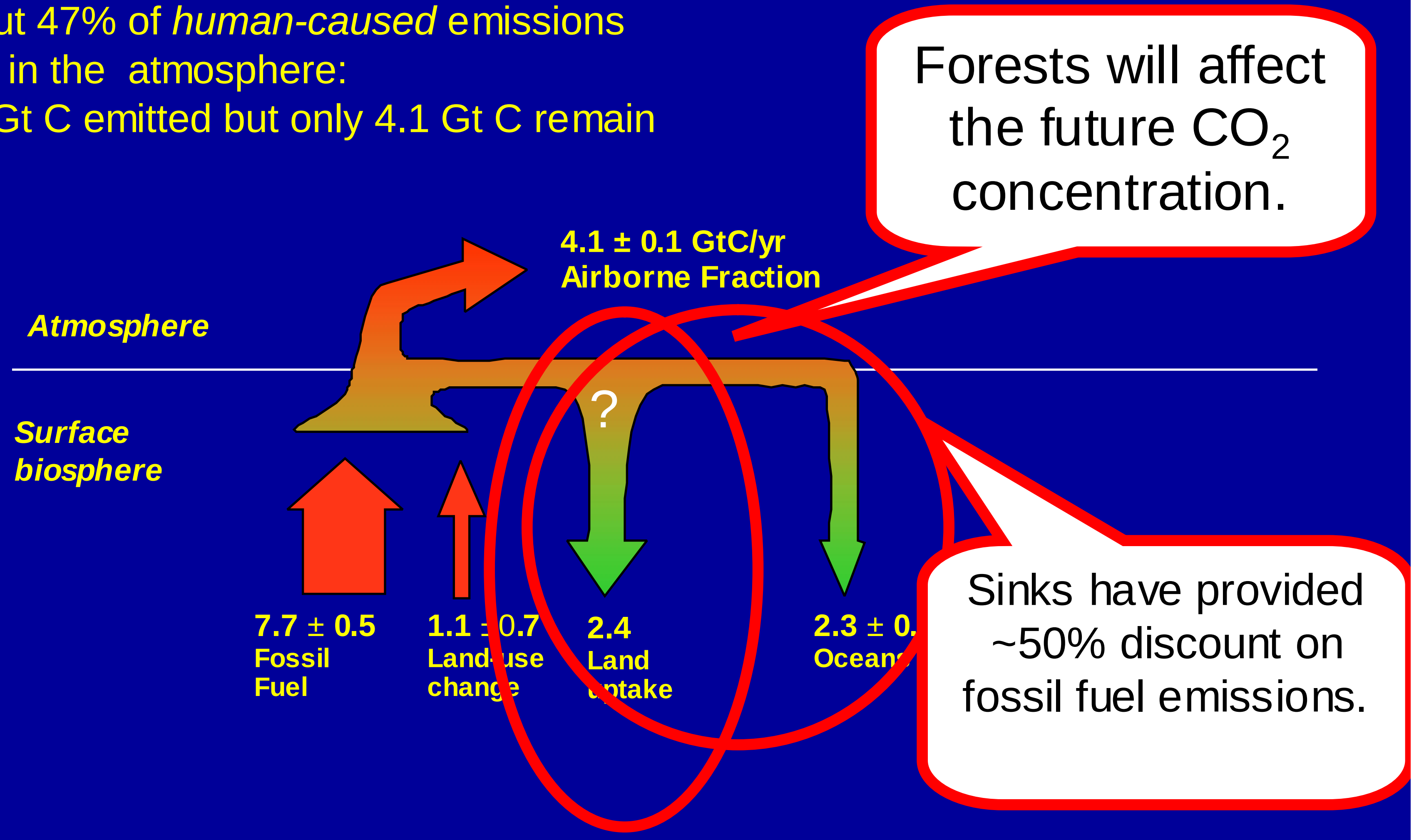
Yude Pan,[1*] Richard A. Birdsey,[1] Jingyun Fang,[2,3] Richard Houghton,[4] Pekka E. Kauppi,[5] Werner A. Kurz,[6] Oliver L. Phillips,[7] Anatoly Shvidenko,[8] Simon L. Lewis,[7] Josep G. Canadell,[9] Philippe Ciais,[10] Robert B. Jackson,[11] Stephen W. Pacala,[12] A. David McGuire,[13] Shilong Piao,[2] Aapo Rautiainen,[5] Stephen Sitch,[7] Daniel Hayes[14]

Sources and sinks	1990–1999	2000–2007
Sources (C emissions)		
Fossil fuel and cement*	6.5 ± 0.4	7.6 ± 0.4
Land-use change†	1.5 ± 0.7	1.1 ± 0.7
Total sources	8.0 ± 0.8	8.7 ± 0.8
Sinks (C uptake)		
Atmosphere†	3.2 ± 0.1	4.1 ± 0.1
Ocean‡	2.2 ± 0.4	2.3 ± 0.4
Terrestrial (established forests)§	2.5 ± 0.4	2.3 ± 0.5
Total sinks	7.9 ± 0.6	8.7 ± 0.7
Global residuals‖	0.1 ± 1.0	0.0 ± 1.0

34%

Human Perturbations to the Global C Cycle

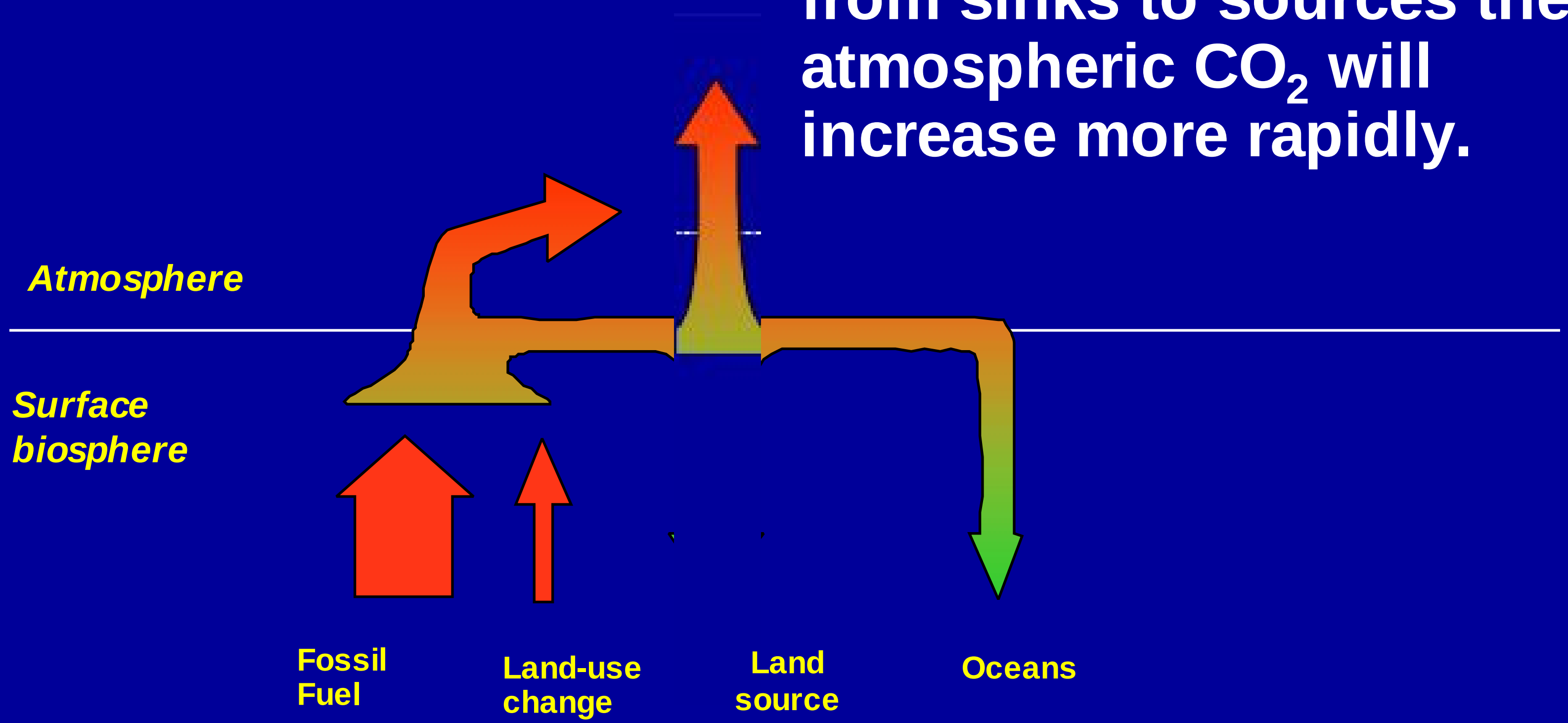
About 47% of *human-caused* emissions stay in the atmosphere:
8.8 Gt C emitted but only 4.1 Gt C remain



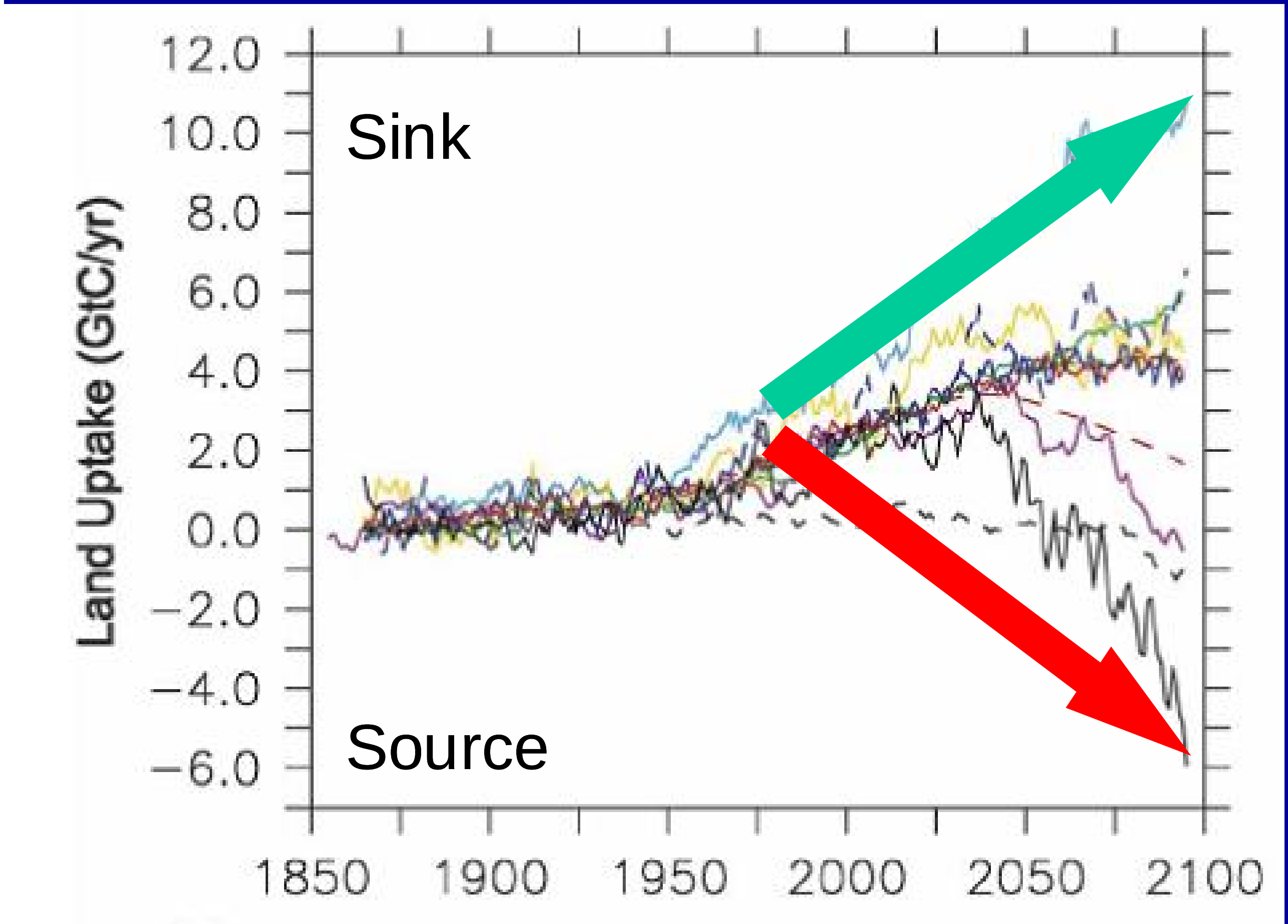
Data: annual averages for 2000- 2009 from Global Carbon Project

Human Perturbations to the Global C Cycle

If climate change impacts convert land ecosystems from sinks to sources then atmospheric CO_2 will increase more rapidly.



Climate Change impacts on forest carbon balance will affect the required level of mitigation efforts



Negative Feedback

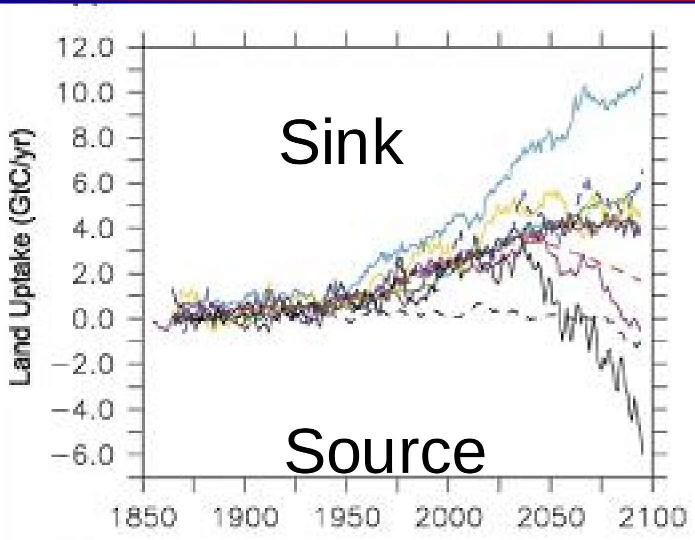
Sink increases with climate change

Positive Feedback

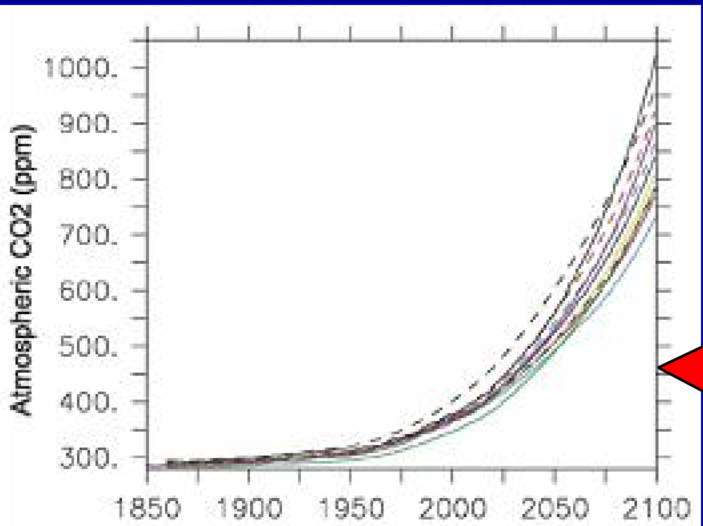
Sink decreases with climate change

Source: Friedlingstein et al., 2006

Climate Change impacts on forest carbon balance will affect the required level of mitigation efforts



Uncertainty among leading global models on future C balance of terrestrial ecosystems: ~16 Gt C yr^{-1}



Source: Friedlingstein et al., 2006

Contributes to uncertainties about future CO_2 concentration….

Stabilization Target ~ 450 ppm

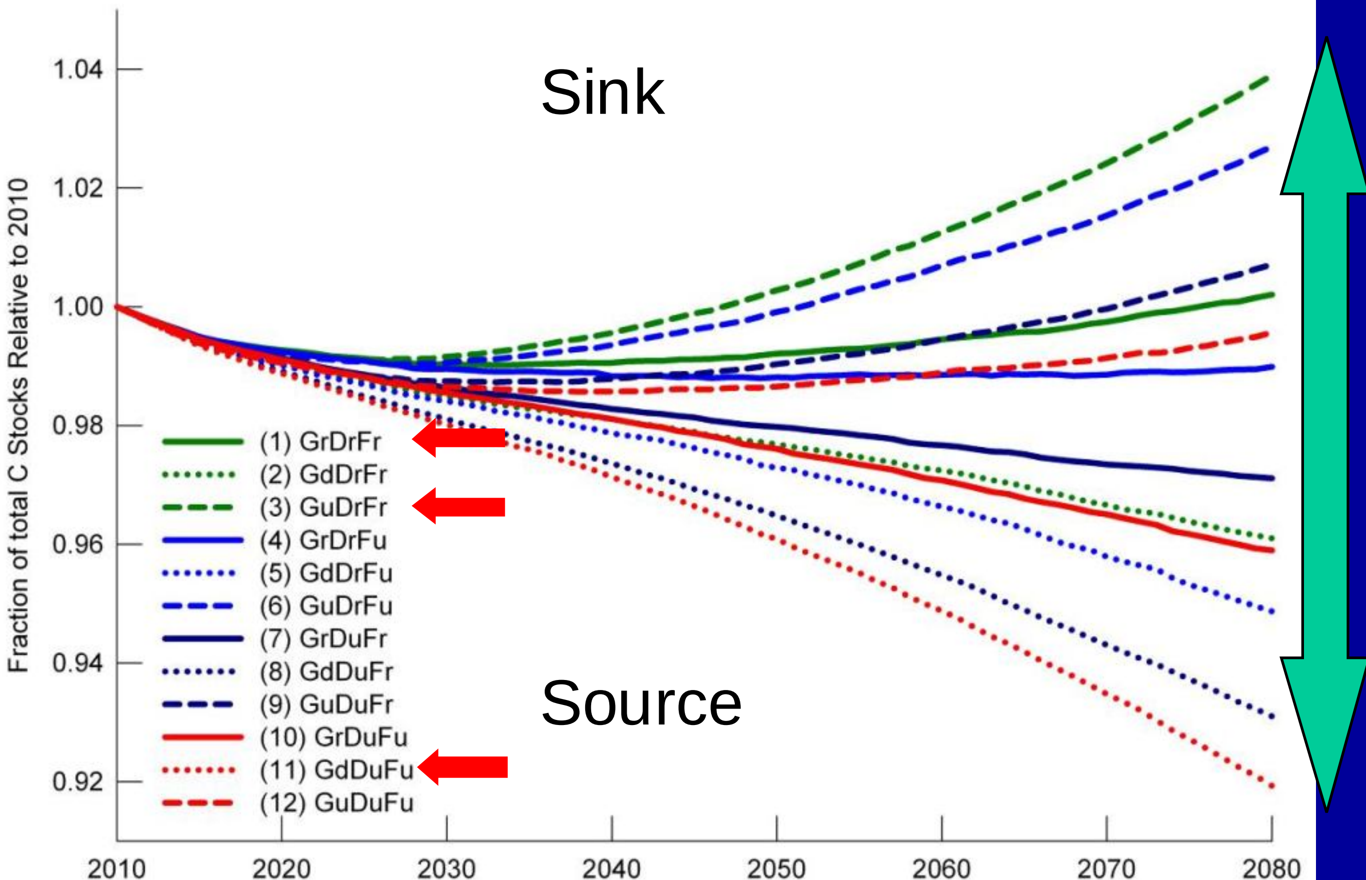
… and uncertainties about required level of mitigation efforts.

Contents lists available at ScienceDirect

Forest Ecology and Management
262 (2011): 827-837
journal homepage: www.elsevier.com/locate/foreco

Uncertainty of 21st century growing stocks and GHG balance of forests in British Columbia, Canada resulting from potential climate change impacts on ecosystem processes

Juha M. Metsaranta[a,*], Caren C. Dymond[b], Werner A. Kurz[c], David L. Spittlehouse[b]



Difference between endpoints of 12 realistic scenarios:

2.4 Pg C or
126 Mt CO_2e yr^{-1}
over 70-yr period

British Columbia emissions in 2007:
~65 Mt CO_2e yr^{-1}

Direction and Magnitude of Feedback?

- Climate changes will affect many processes (growth, decay, disturbances) with large differences between ecosystems and regions.
- Currently not able to predict net impacts, but …
- **Asymmetry of risks:** unlikely that productivity increases can off-set increased disturbance losses (Kurz et al. 2008).
- **Monitoring and modelling** required to quantify direction and magnitude of feedback.

Feedback to Climate Change

- Forests' response to climate change has the potential to provide positive feedback to future climate change through increased emissions that **could completely negate the benefits of mitigation efforts in all other sectors.**

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

- Despite potential impacts of climate change, human activities in forest sector can contribute to mitigation objectives by reducing sources & increasing sinks, relative to a baseline.
- Future forest C budgets are affected by many processes: age-class legacy, recovery from past land-use, climate change impacts, etc.
- Need to evaluate mitigation benefits relative to a **“forward looking baseline’’** and seek to improve C balance relative to this baseline through directed mitigation efforts.
- Merely claiming credit for existing sinks does not contribute any mitigation benefits.
- Reducing a source does contribute to mitigation objectives.

Mitigation Options in the Forest Sector

1. Increase (or maintain) forest area
   - Reduce deforestation (REDD), increase afforestation
2. Increase stand-level carbon density
   - Silviculture, avoid slashburning, reduced regeneration delays, species selection, fertilization, tree improvement programs
3. Increase landscape-level carbon density
   - Longer rotations, conservation areas, protection against fire
4. Increase C stored in products, reduce fossil emissions through product substitution and through bioenergy use

Source: Nabuurs et al. 2007, IPCC AR4

Canada's National Forest Carbon Monitoring, Accounting and Reporting System (NFCMARS)

- Reporting of GHG balance to EC for National GHG Inventory Reporting.
- Analyses in support of policy development and negotiations.

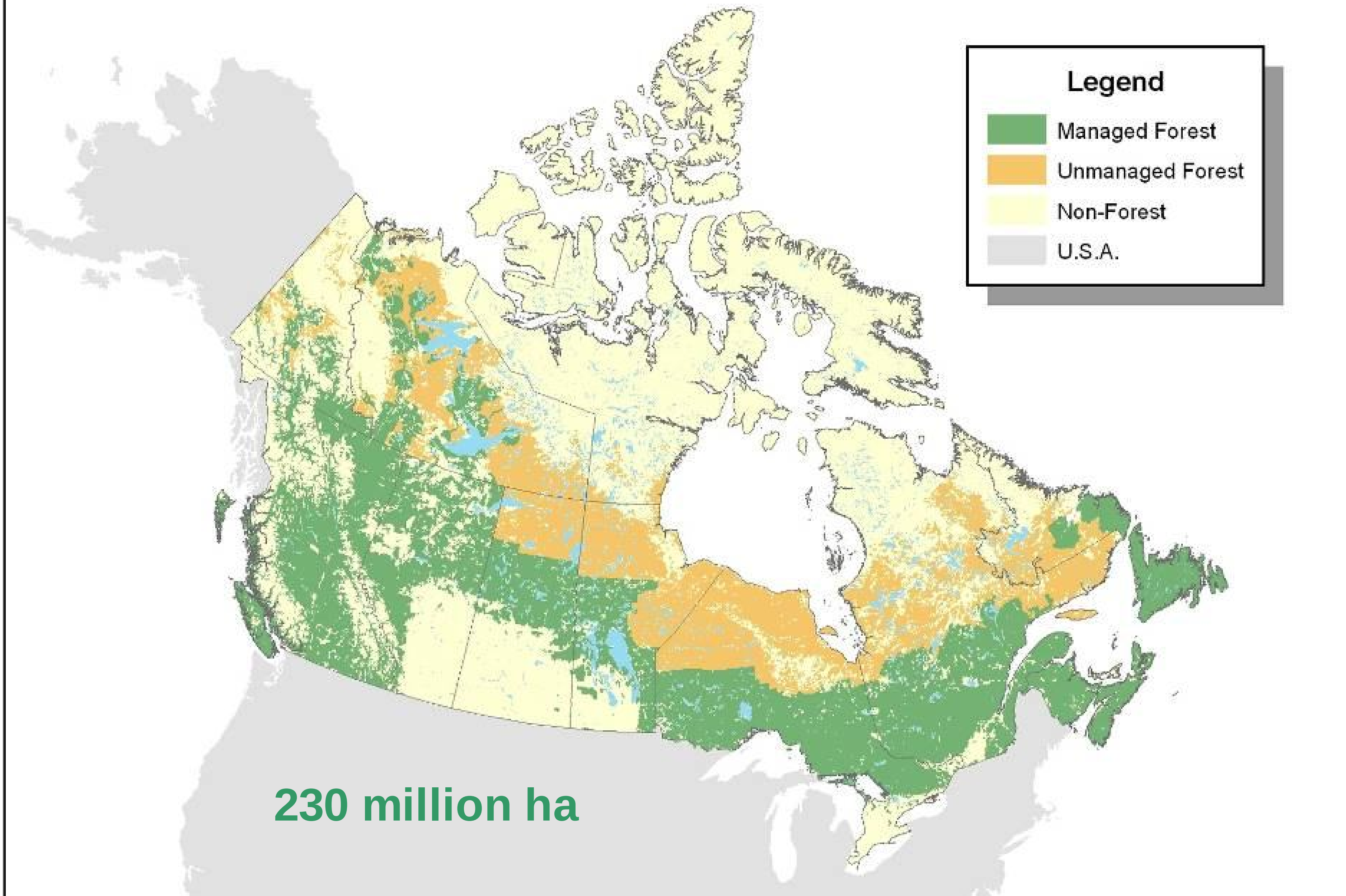
Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3)

- 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



Legend
Managed Forest
Unmanaged Forest
Non-Forest
U.S.A.
230 million ha

Carbon Budget Model of Canadian Forest Sector CBM-CFS3

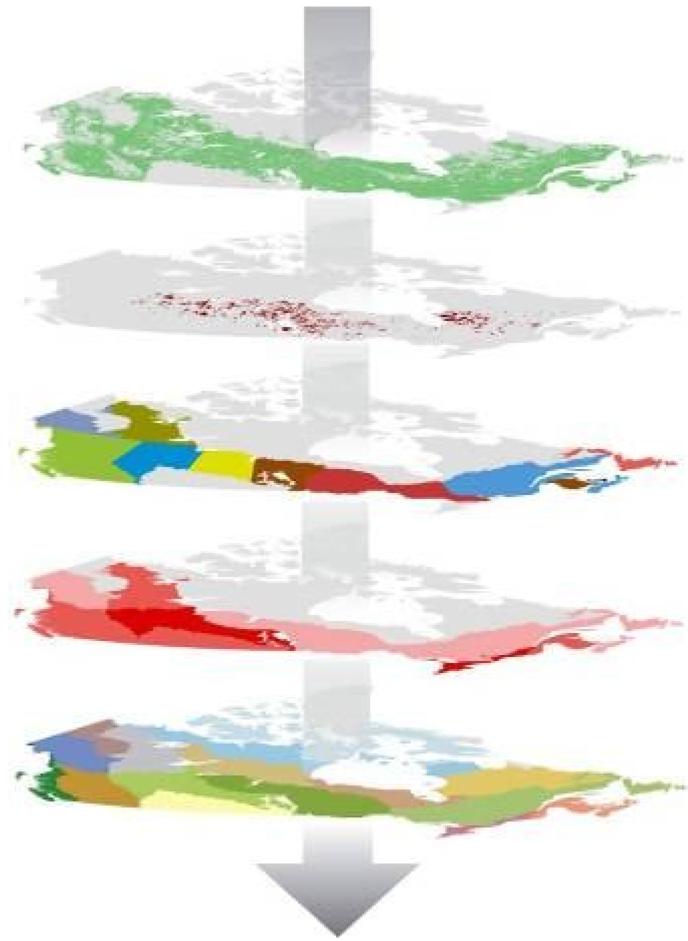
Forest inventory and growth & yield data

Natural disturbance monitoring data

Forest management activity data

Land-use change data

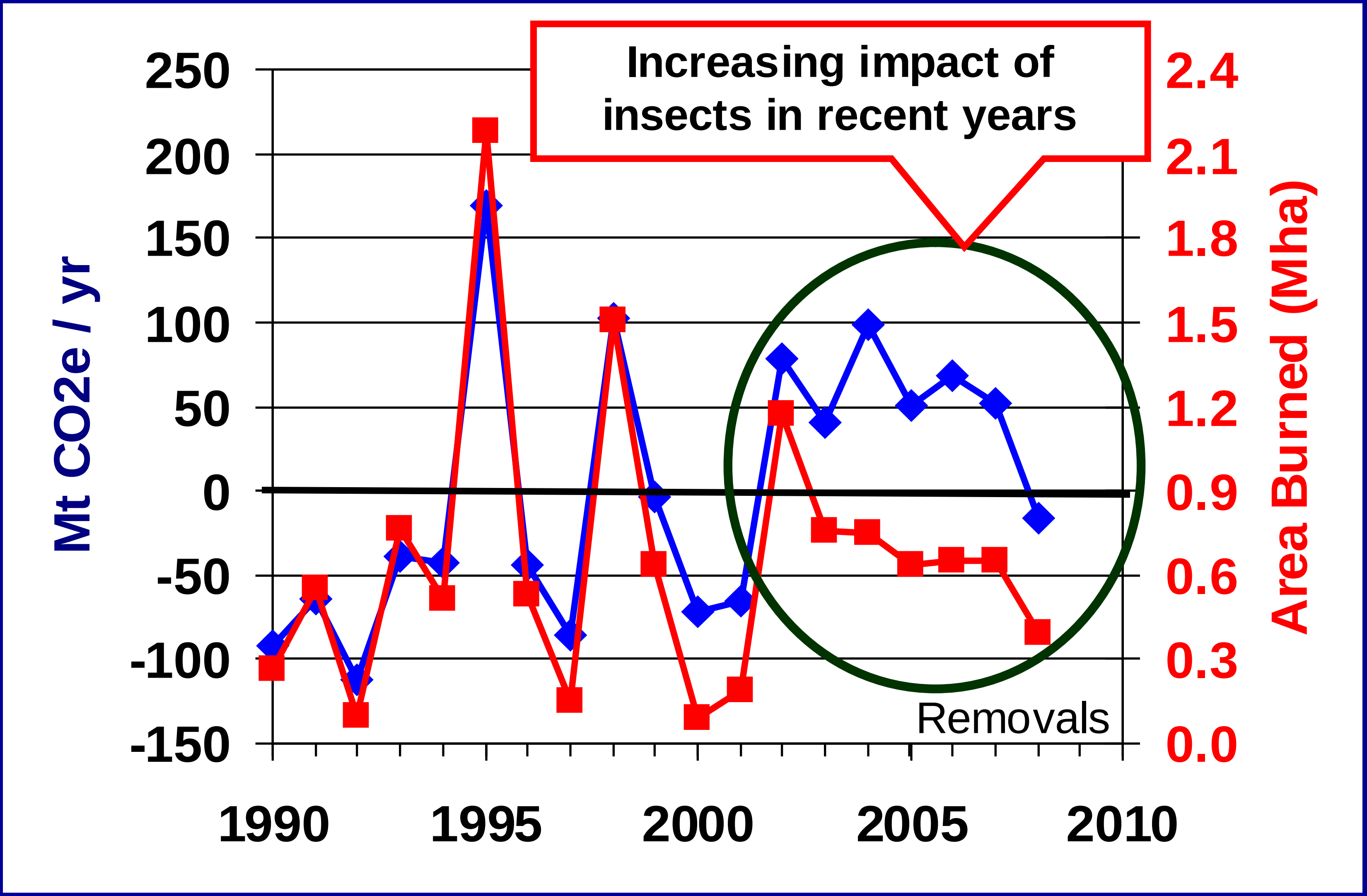
Ecological modelling parameters



Kurz et al. 2009, Ecol. Modelling

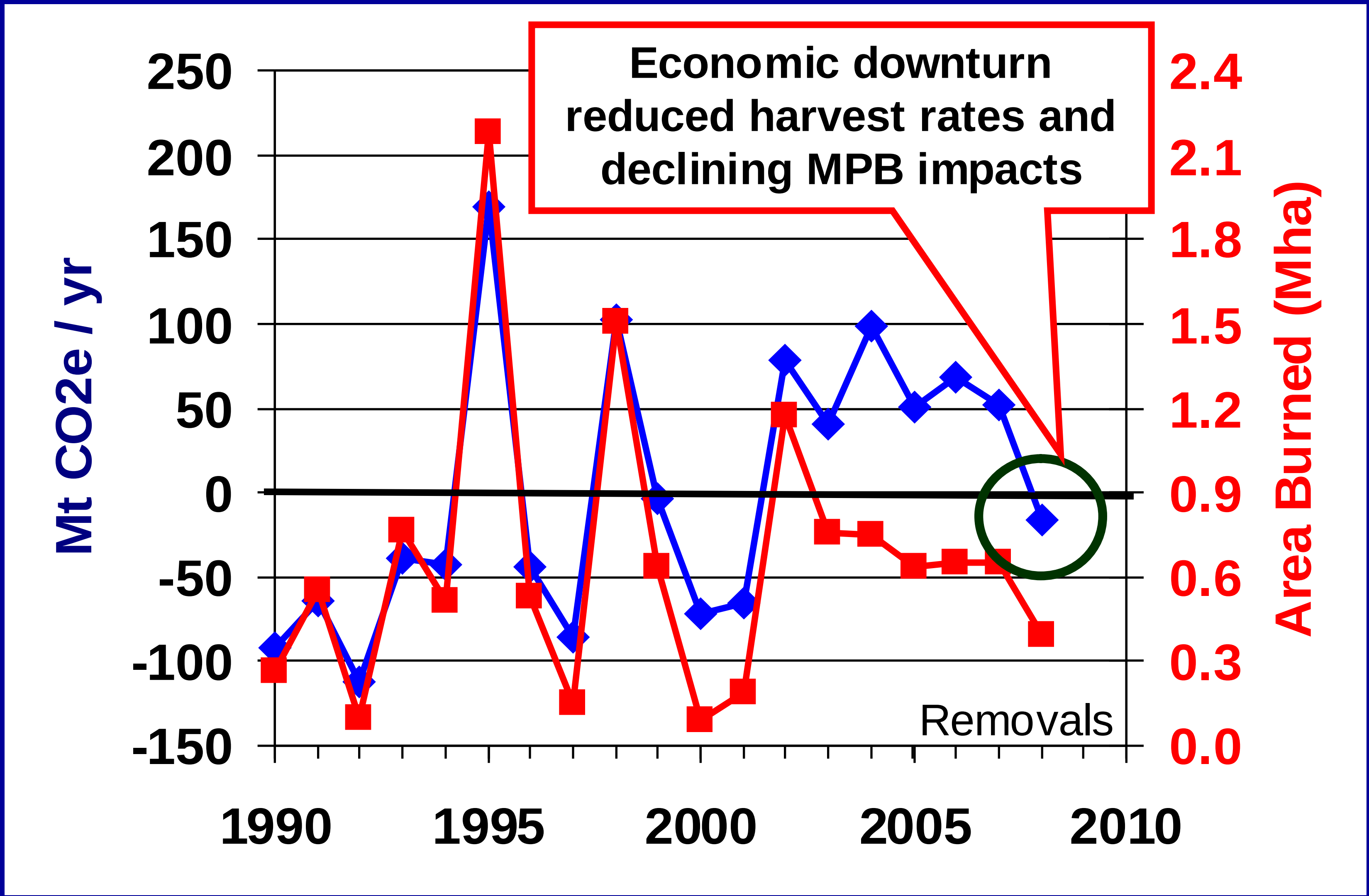
CBM-CFS3

Large interannual variation in GHG balance resulting from wildfires



Source: Stinson et al., 2011

Large interannual variation in GHG balance resulting from wildfires

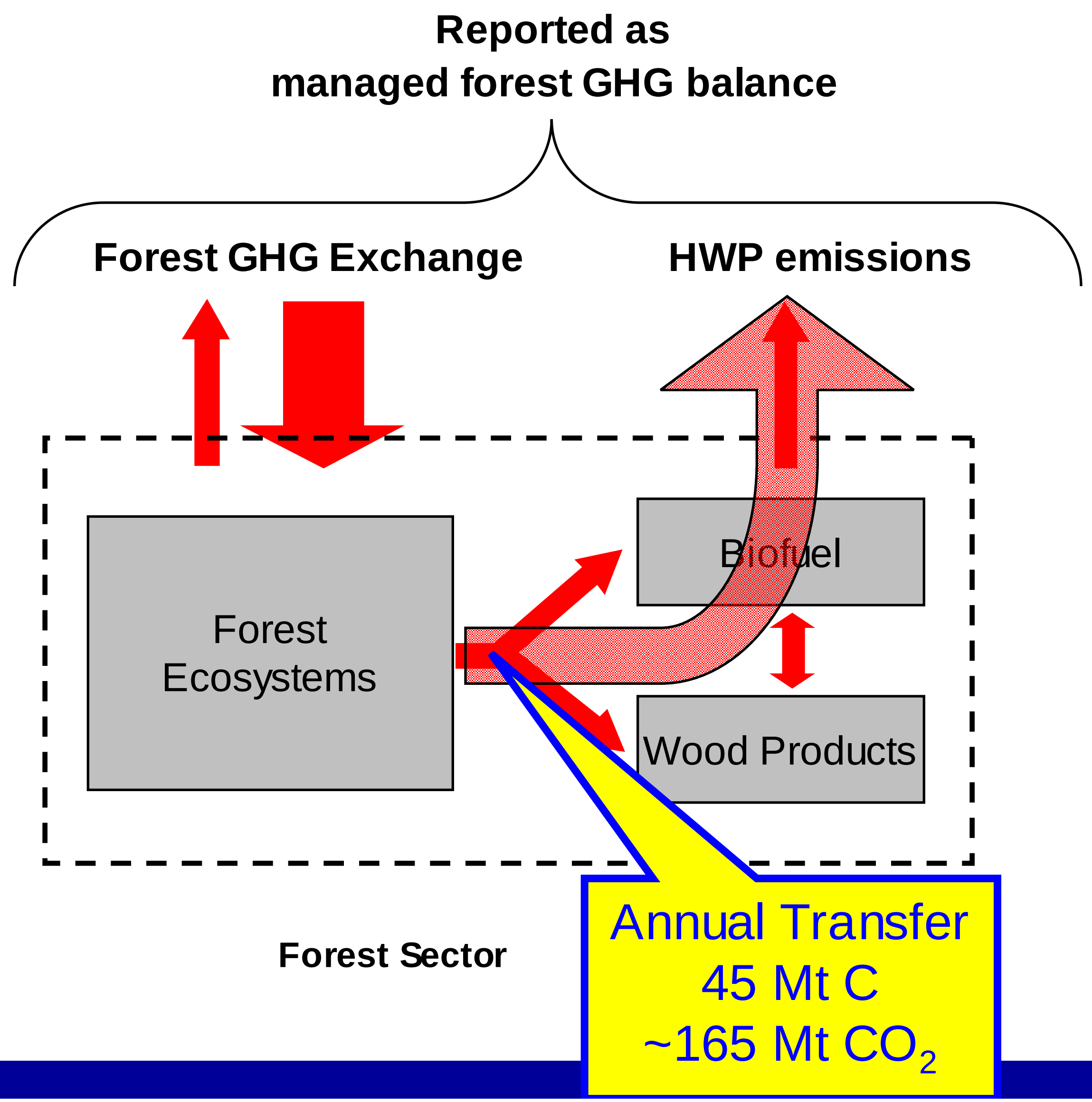


Source: Stinson et al., 2011

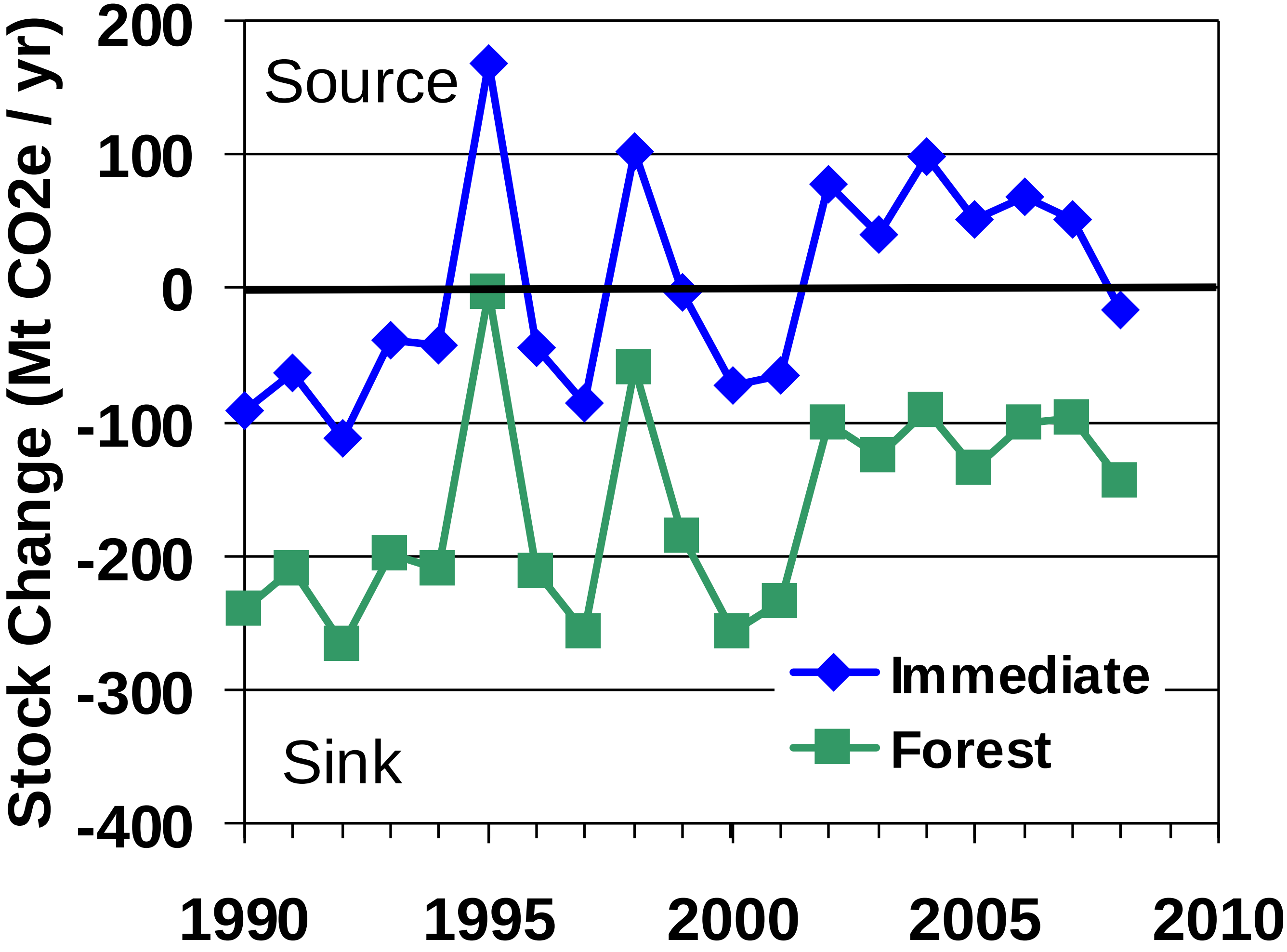
Accounting of Harvested Wood Products

- Default assumption of the 1996 IPCC reporting guidelines is that amount of wood added to stocks of HWP from this year's harvest merely replaces C lost through decay and burning of C harvested in prior years.
- HWP C stocks are assumed constant
- Because inputs are assumed = outputs, the simplified assumption is that all material transferred from forest through harvest is immediately emitted to the atmosphere.
- But data indicate that HWP in use and in landfills are increasing (e.g. Apps et al. 1999).

Accounting of Harvested Wood Products



GHG Fluxes with and without immediate emissions of harvested carbon



Cumulative Sink:

With immediate emissions: 24 Mt CO_2e

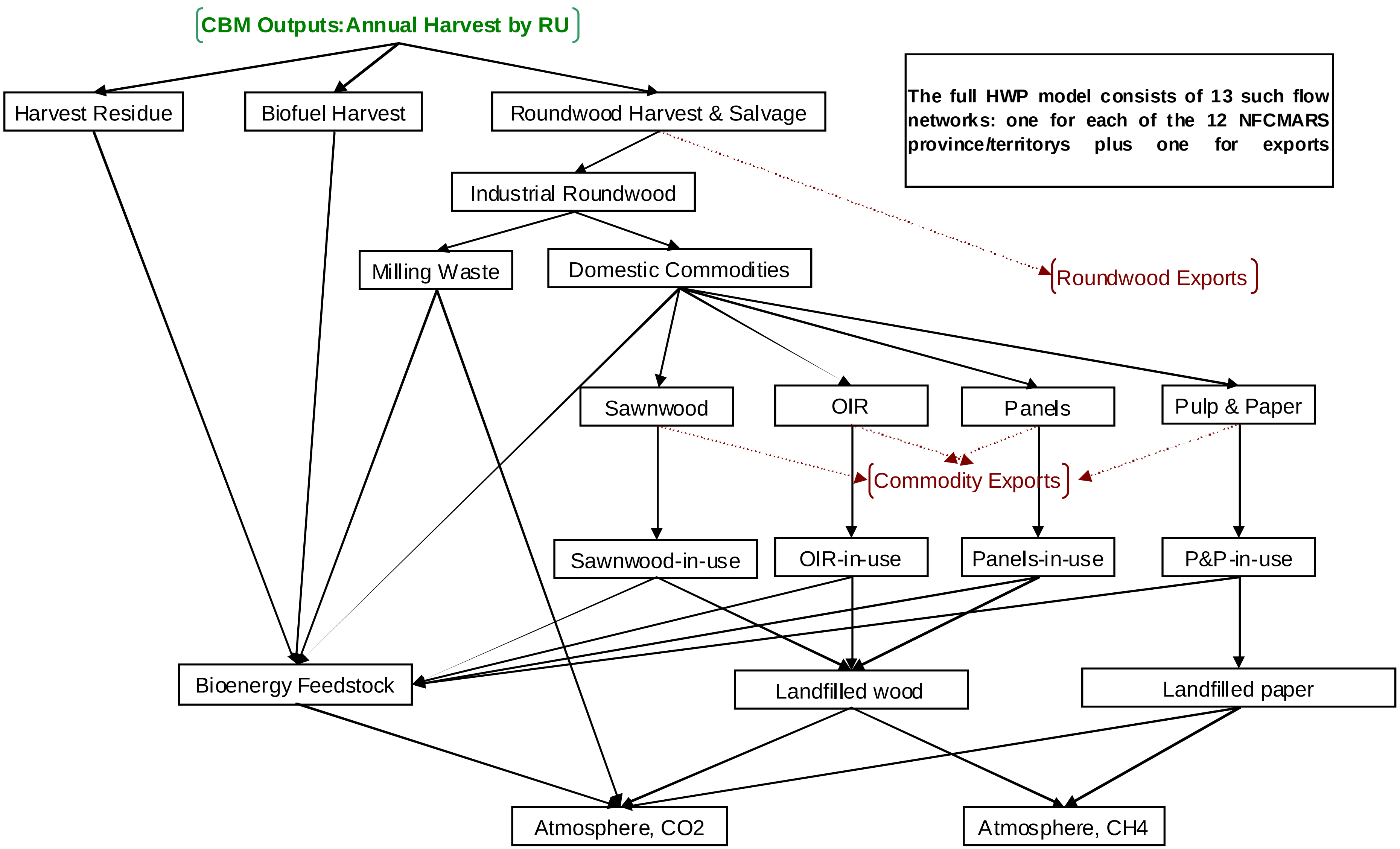
Forest only 3125 Mt CO_2e

Exported to HWP 3149 Mt CO_2e

How much C is retained in HWP and landfills?

Source: Stinson et al., 2011

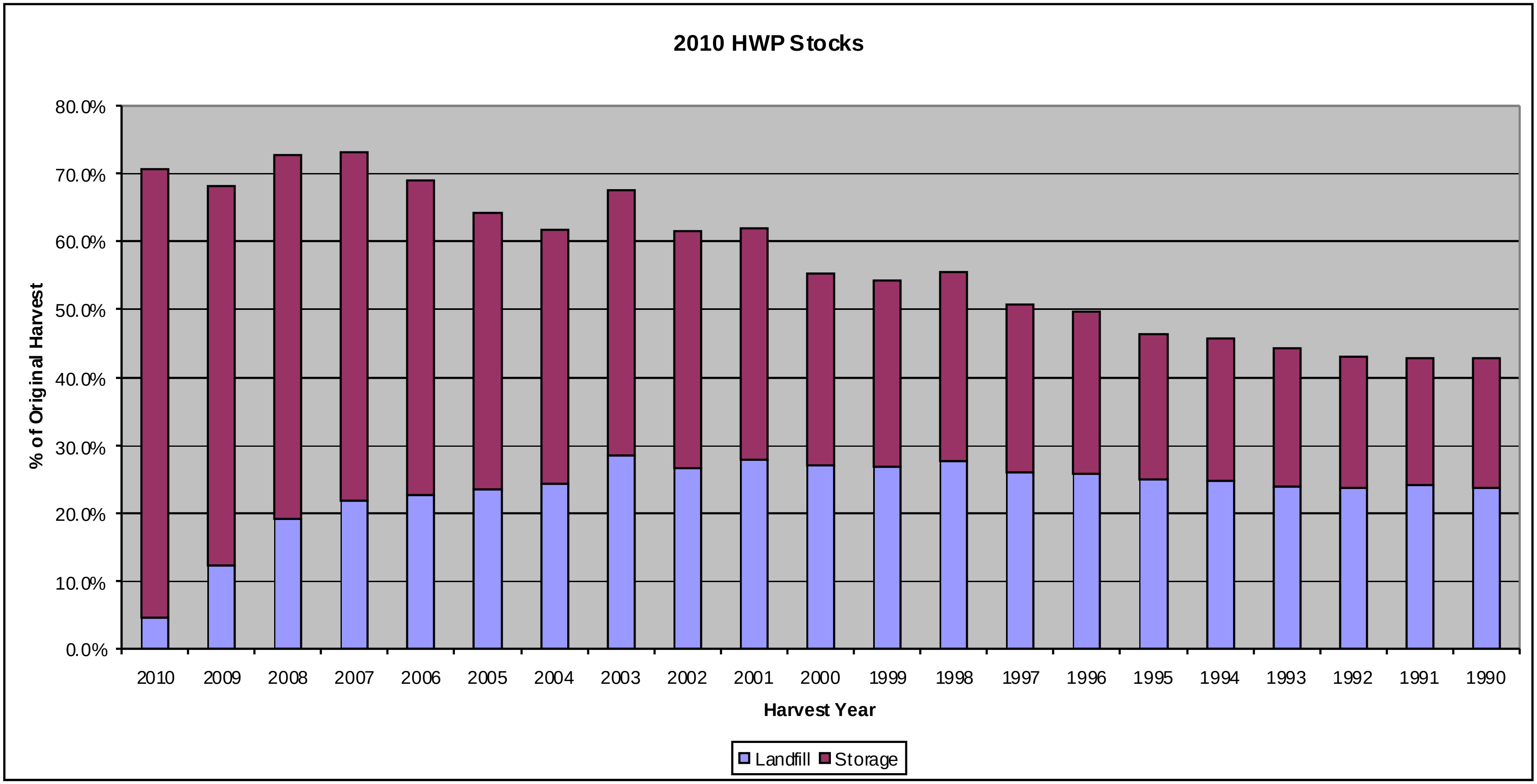
New HWP C tracking model developed by CFS CAT



The full HWP model consists of 13 such flow networks: one for each of the 12 NFCMARS province/territorys plus one for exports

C retention in HWP and Landfills – preliminary data

(harvest since 1990, Canada and export regions combined)



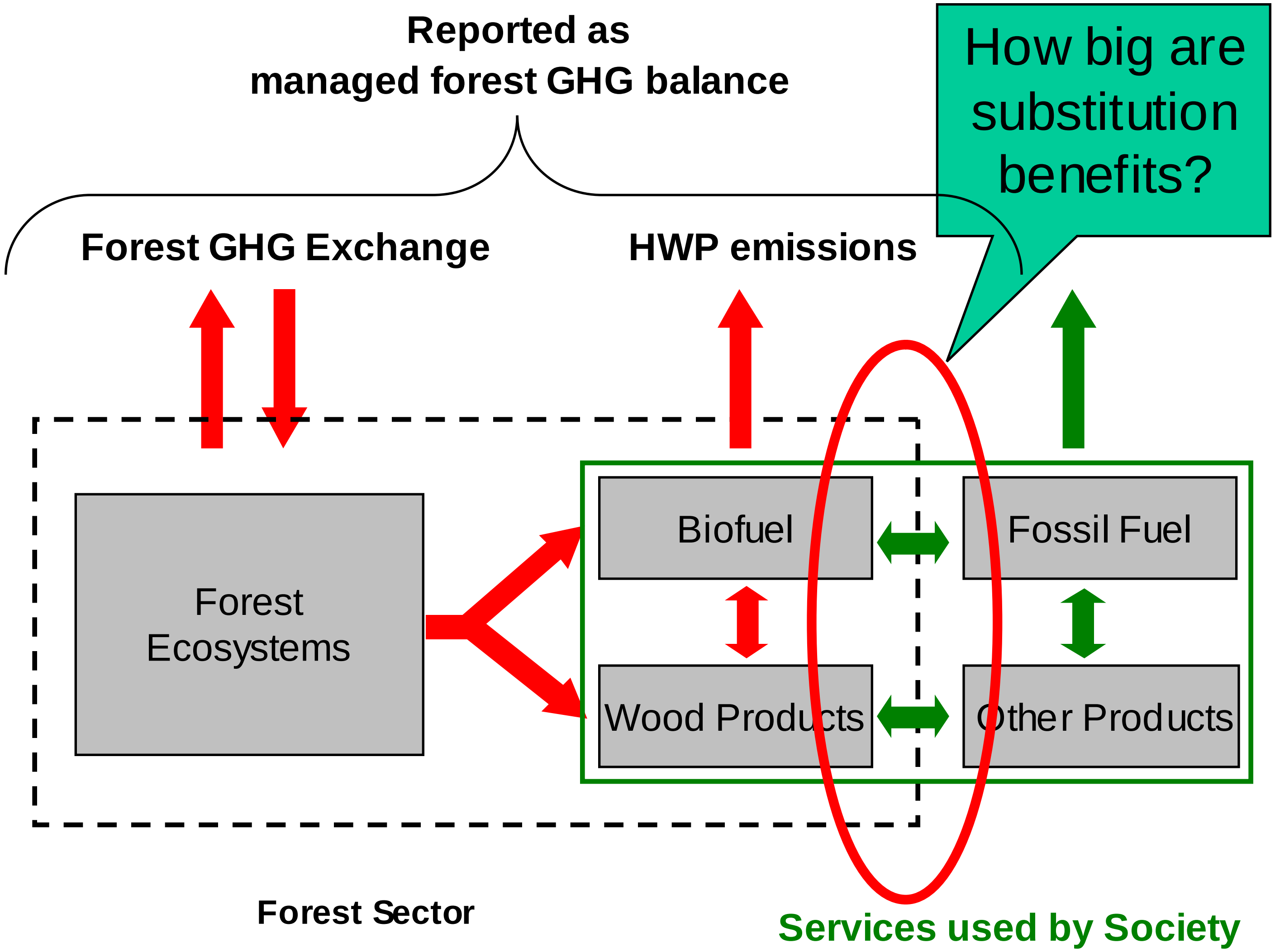
Impact of UNFCCC reporting guidelines

- Default assumption of immediate emissions captures neither the timing nor the location of actual emissions.
- In Canada (1990 – 2008) ~3,150 Mt CO_2e are reported as emitted – but over 50% of this remains stored in HWP and landfills (in Canada and abroad).
- Many of the emissions occur outside Canada.
- Same issue for all (net) wood exporting countries.
- International convention to not report C stocks retained in HWP creates **public misunderstanding** of forest management contribution to C cycle.
- It also decreases incentives to manage C in HWP.

Substitution Benefits

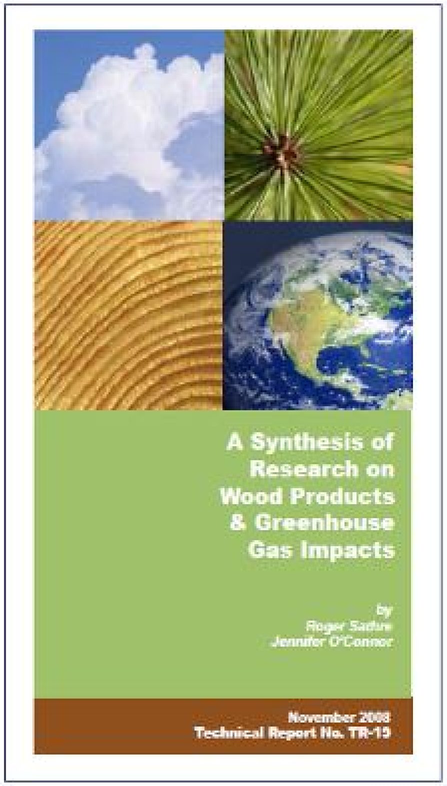
- In addition to C stored in HWP, their use also contributes to meeting societal demands that would otherwise be met with steel, concrete or plastics – all of which are energy-intensive to produce.
- Although substitution benefits – where they do occur – cannot be accounted for in the forest sector – they do result in real emission reductions observed in energy or production sectors.
- Therefore substitution benefits should be considered when developing mitigation policies in the forest sector.

Accounting of Harvested Wood Products



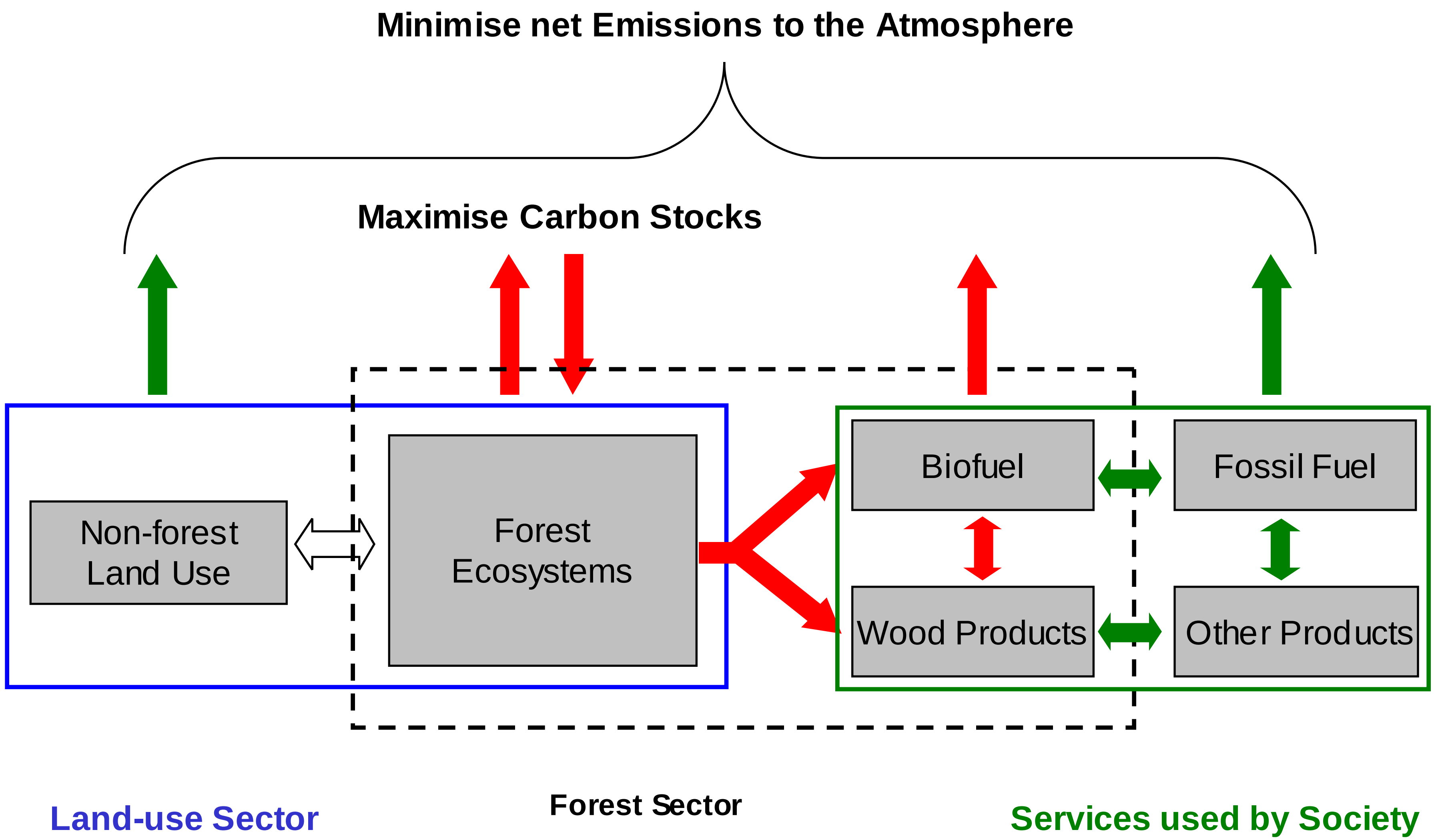
Substitution Benefits from Wood Use

- Displacement factor (DF) quantifies the amount of emission reduction achieved per unit of wood <u>used</u> in products (i.e. substitution)
- On average, we avoid 2 tons of C emissions for every 1 ton of C used in wood products.
- Substitution benefits of wood use for bioenergy typically < 1.
- How do we achieve greatest substitution benefits and where do they occur?



Source: Sathre, R. and J. O'Connor 2008 and 2010

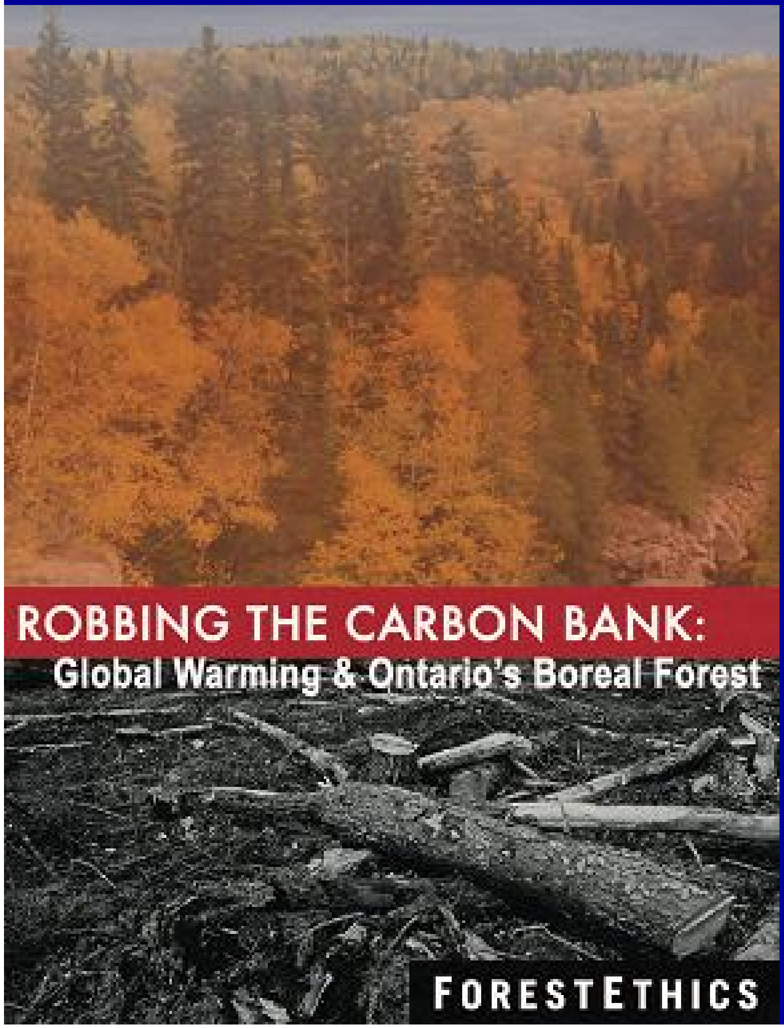
Mitigation Strategies: Need for Systems Perspective

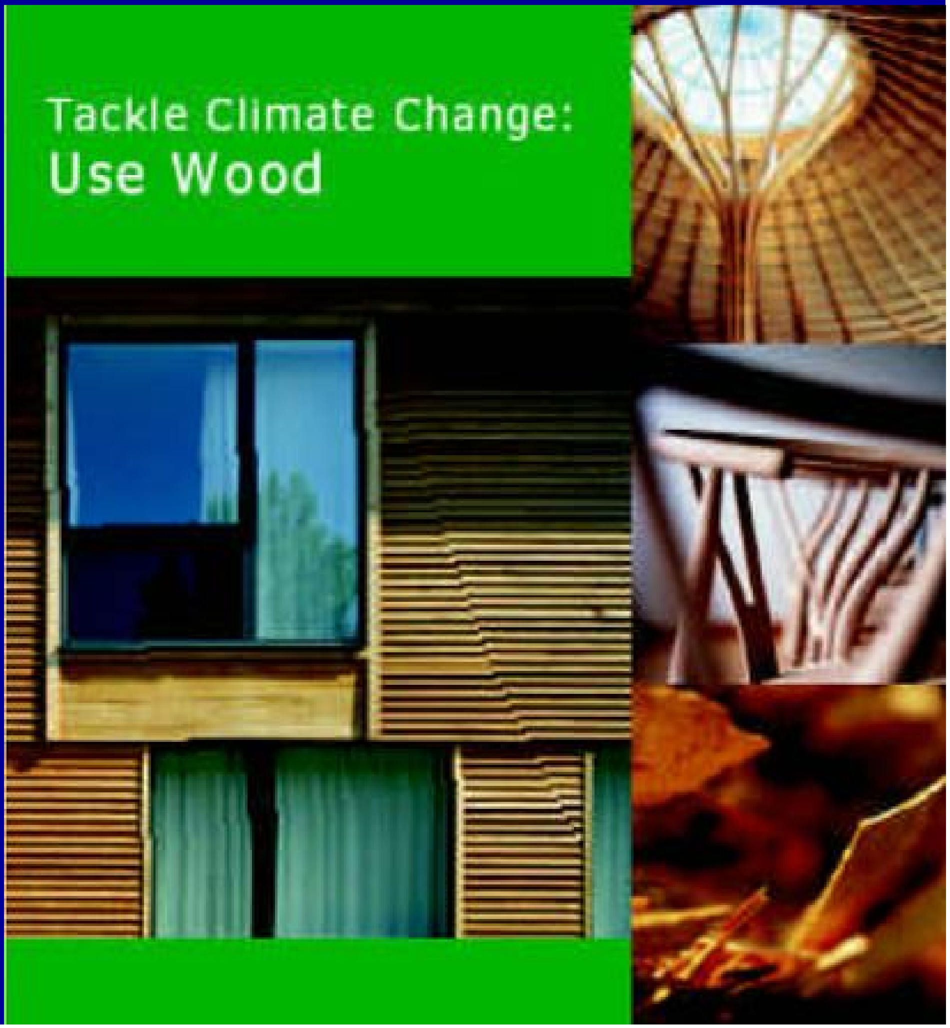


Source: IPCC 2007, AR4 WG III, Forestry

Forest Mitigation Strategies: Two competing positions

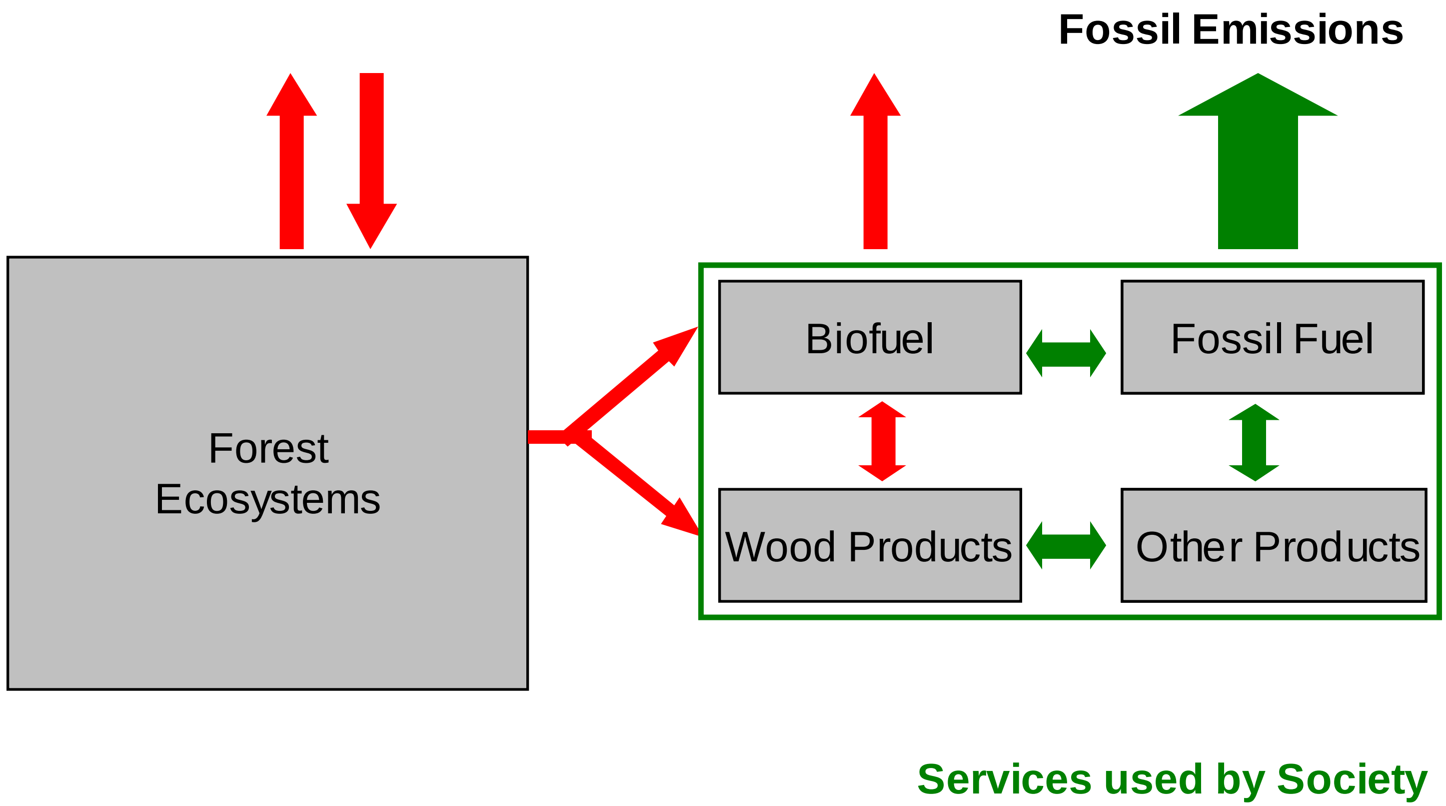
Stop logging ….. … or use wood?





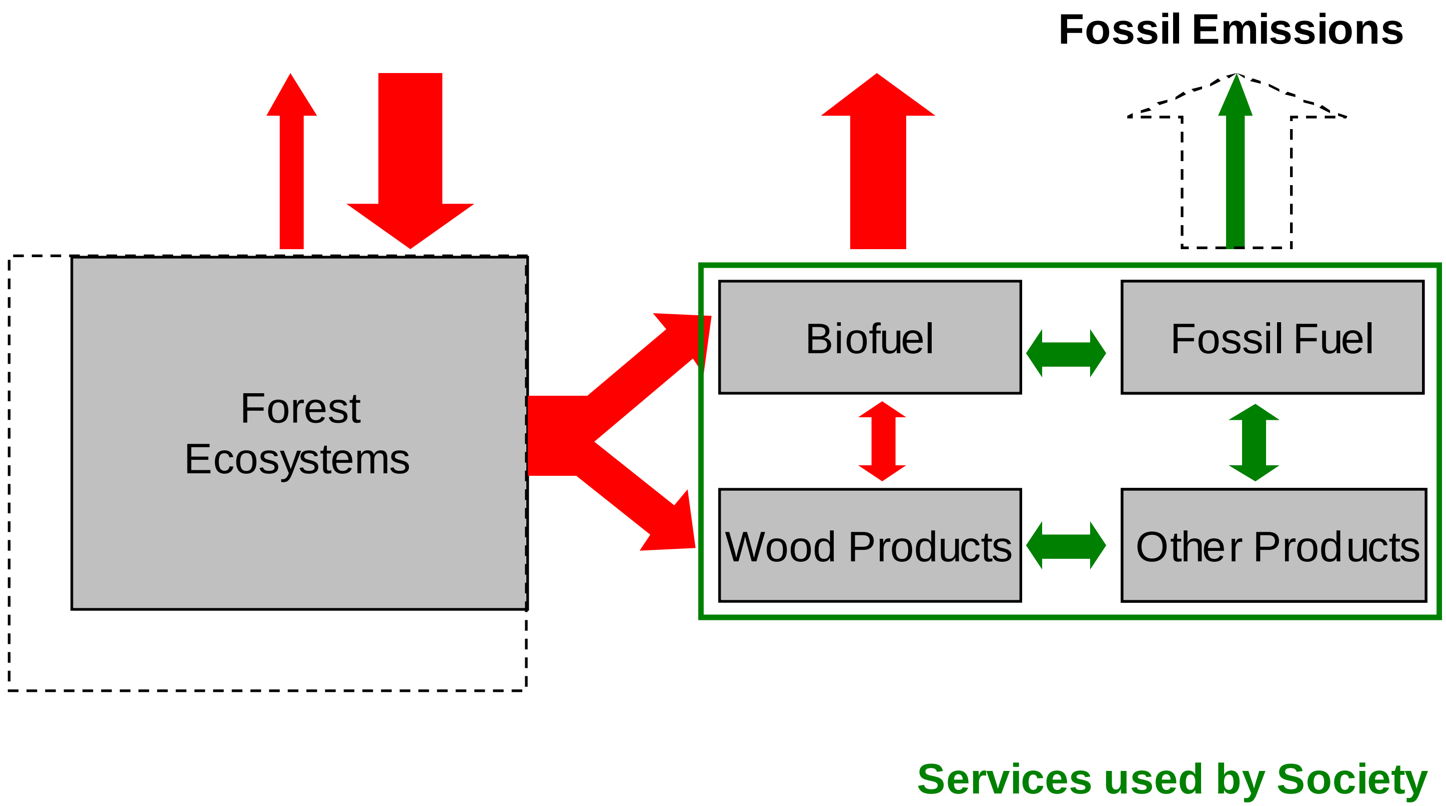
Forest Mitigation Strategies: Two competing positions

Maximise Carbon stocks ….



Forest Mitigation Strategies: Two competing positions

… or maximise Carbon uptake?



Forest Sector C Mitigation Strategies

- Relative advantage of each strategy depends on MANY factors and is not decided by C criteria alone.
- The assessment of mitigation options should include
  1. carbon in forests,
  2. carbon in harvested wood products, and
  3. avoided emissions from wood use.
- Any policy aimed at increasing C in forests, harvested wood products or the substitution benefits (e.g. bioenergy) typically reduces C in the other pools.
- Quantifying these trade-offs and relationships can identify mitigation opportunities.
- Assessment should also include the time dynamics of when C costs and benefits occur.

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. (Re) Growth removes emitted C from atmosphere
   - But over what time frame does this removal occur?
   - For agricultural residues – in single year.
   - For short-rotation energy crops – in 3 - 5 years
   - For forests – over decades

Carbon Neutral Bioenergy from Forests?

- Bioenergy does not have to be C neutral – it has to better than the alternatives to contribute to climate mitigation – i.e. have lower net emissions within a specified time.
- Several recent studies have demonstrated that using wood for bioenergy incurs an initial C debt to the atmosphere, followed by a net benefit, but the break-even point can be decades into the future
- The assumption of carbon neutrality removes incentives to assess mitigation benefits for different biomass feedstock sources – but what biomass we use for bioenergy has big implications for the atmosphere.

Slash burning still a management practice

Alternate uses?

Photo: T. Sullivan

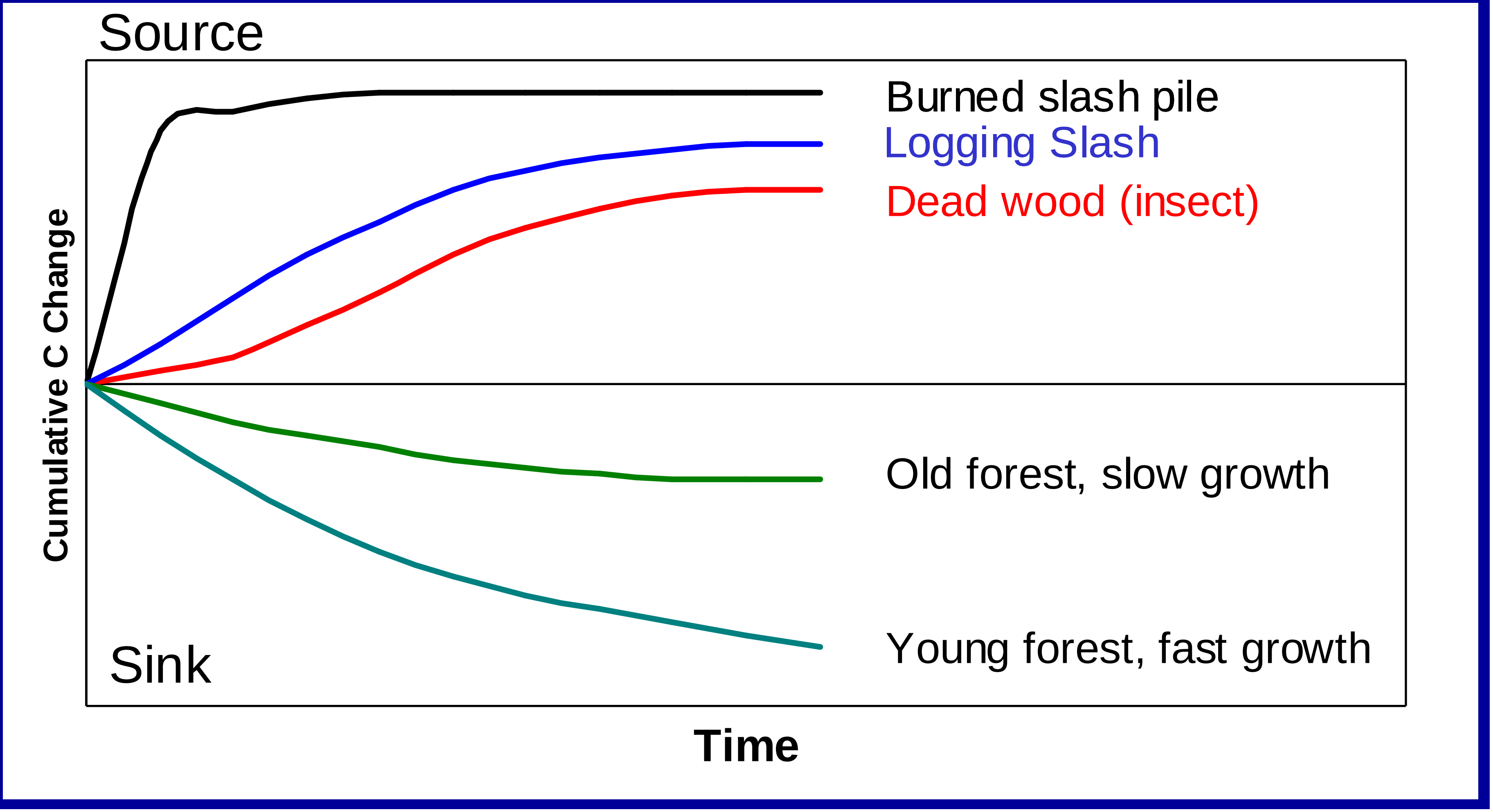
Photo: BC MoF

Can we capture energy and reduce non CO_2 emissions

Photos: T. Sullivan

Origin of Biomass and C dynamics

- C dynamics of biomass sources affects net emissions
- Chose biomass with short expected C retention



Simplifying Accounting Assumptions can lead to Bad Policy Decisions

Immediate C emission at time of harvest

C neutral biomass emissions

- Assumption of immediate emissions at time of harvest fails to recognise importance of C storage in HWP and eliminates incentives for mitigation options in forest product sector.
- Assumption of C neutrality of biomass emissions fails to recognise importance of the type of biomass used and the time required to remove C from atmosphere.

National-scale Analysis of Mitigation Options

Assessing the Climate Change Mitigation Potential of Canada's Forest Sector

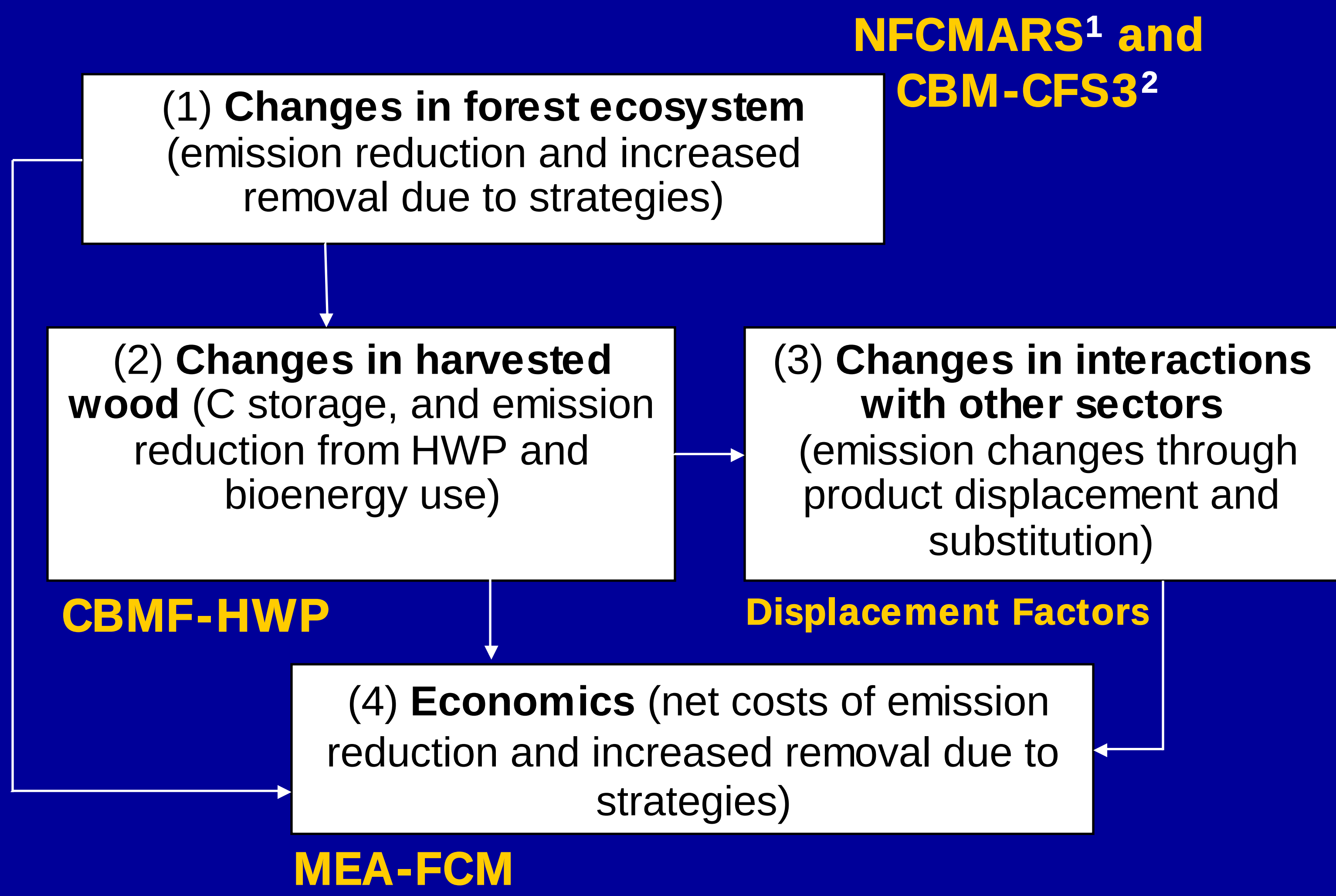
CFS CAT: Graham Stinson, Mark Hafer, Carolyn Smyth, Eric Neilson, Gary Zhang, Max Fellows, Michael Magnan, and Werner Kurz

CFS EAD: Emina Krcmar, Alison Beatch, Greg Rampley, and Tony Lemprière

National Forest Sinks Committee

Natural Resources Canada Ressources naturelles Canada

Analytical Framework



[1] Stinson et al. (2011) *Global Change Biology* 17, 2227-2244
[2] Kurz et al. (2009) *Ecological Modelling* 220, 480-504

Mitigation Strategies

National-scale analyses with regionally differentiated mitigation scenario implementation (developed in consultation with forest management agencies from across Canada).

Scenarios combine changes in forest management with changes in use of harvested wood products and bioenergy. (Changes in land use, reduced deforestation and increased afforestation not included).

Analyses of costs per ton of CO_2 emission reduction.

Lessons learned from Mitigation Options Analyses

- Mitigation benefits differ between sector, nation and globe: spatial scope of analysis defines which substitution benefits can be considered.
- Bioenergy-related mitigation options often contribute net emissions with break-even points years or decades into the future – depending largely on alternate fate of feedstock.
- Sector-level displacement factors lower than project-level DF
- Development of mitigation portfolio requires understanding of time lines of costs and benefits of mitigation activities.
- Ranking of mitigation portfolios changes over time.
- Assessment of costs per ton required to compare with options in other sectors.

Conclusions

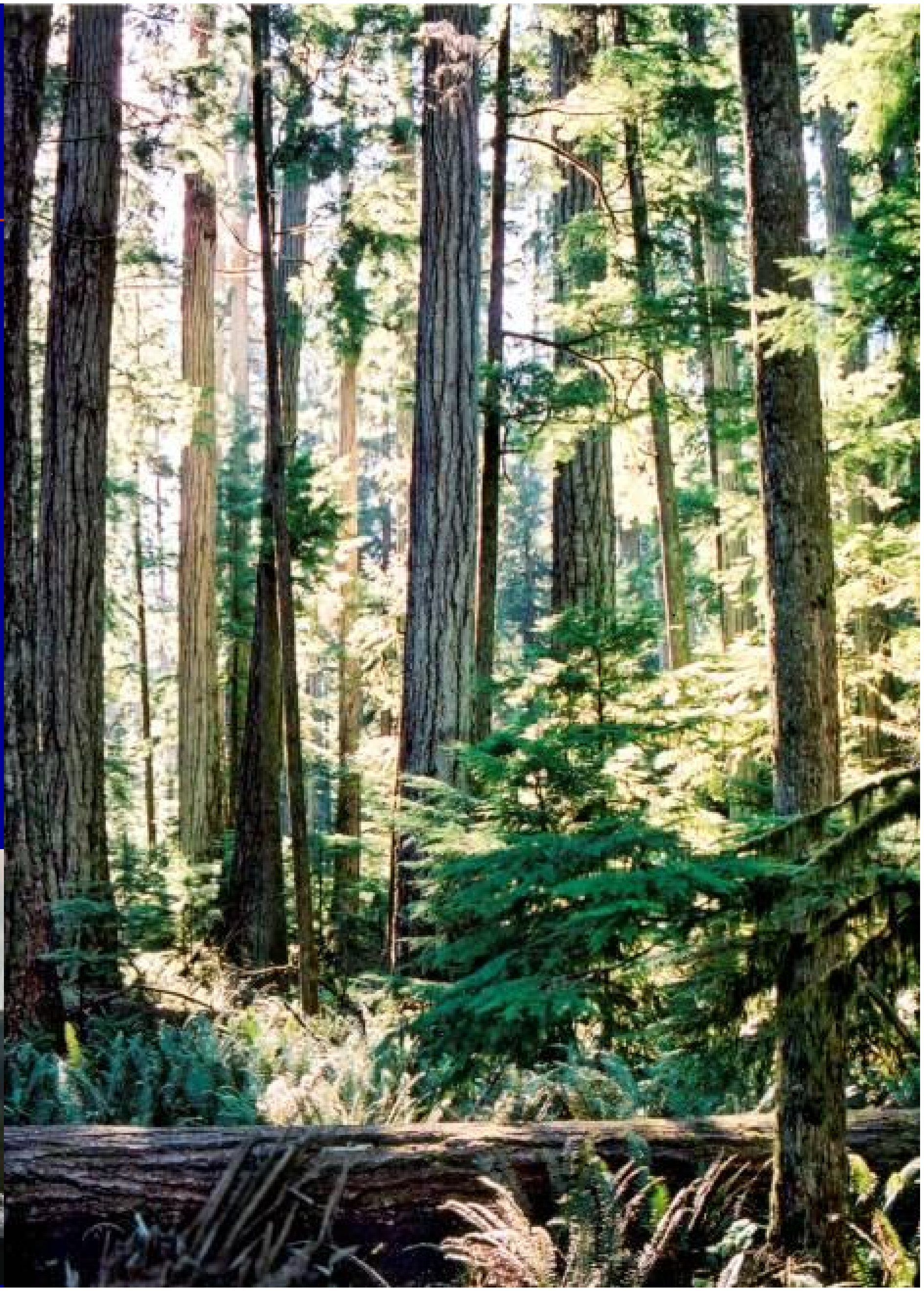
- Globally forests have been absorbing one third of annual fossil fuel emissions.
- Climate change impacts on forests could increase net emissions and these could completely negate mitigation efforts in all other sectors.
- Limiting climate change impacts is the first important step towards maintaining the forest sink.
- Sustainable forest management and use of wood to substitute more emissions-intensive materials such as concrete and steel can contribute to climate change mitigation efforts.

Conclusions

- Design of climate change mitigation portfolios in the forest sector should be based on systems approach that accounts for C in forest ecosystems, C in HWP, and substitution benefits.
- Analyses should also account for all emissions and removals relative to a baseline, when and where they occur.
- Forest managers do not control use of wood – effective mitigation portfolios need to integrate forest management with wood use strategies.
- Mitigation incentives – and the resulting economic values of carbon and energy contained in wood – may create new opportunities for forest sector, communities and economy.

Conclusions

- Forests and forestry cannot solve the problem of fossil C emissions, but they can contribute to the solution.



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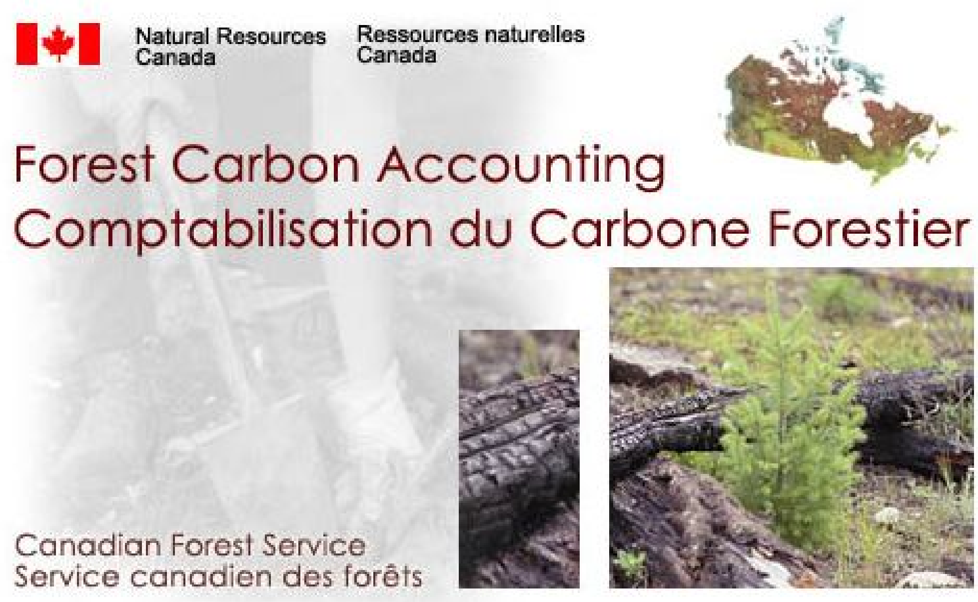
Thank you very much!



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