Forest sector contributions to climate change mitigation: opportunities from Canada to California

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Natural Resources Canada
Canadian Forest Service

Sacramento, CA Dec 8th, 2015

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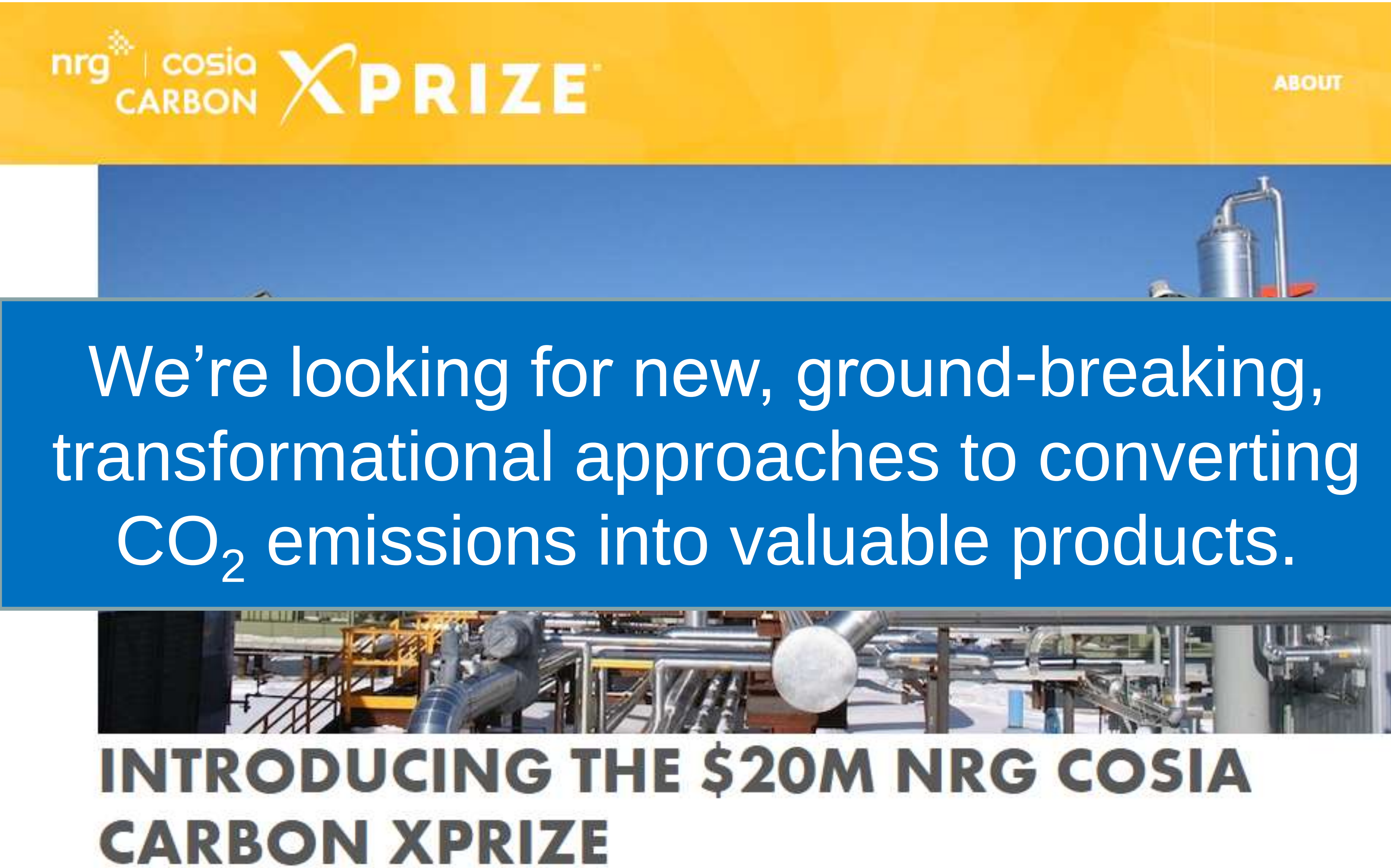
Canada



We're looking for new, ground-breaking, transformational approaches to converting CO_2 emissions into valuable products.

Source: http://carbon.xprize.org/news/introducing-20m-nrg-cosia-carbon-xprize

Tuesday Sept 29, 2015

We’re looking for … approaches to converting CO_2 emissions into valuable products.

Motivation

Global consensus is emerging that greenhouse gas emissions must be reduced to constrain climate change.

Can the forest sector make a substantial, cost-effective contribution to reducing GHG emissions?

The design of forest-sector based mitigation strategies requires scientifically-credible analyses to quantify and assess alternative options.

Outline

- Background
- Principles
- Analysis of mitigation potential in BC
- Challenges
- Conclusions

Terminology 101:
Estimation, Reporting, Accounting, Review

Estimate

- Calculate carbon (C) stock change and GHG emission and removal estimates using methodological guidance of the IPCC

Report

- Provide estimates and other information in national reports, using internationally agreed upon formats and guidelines

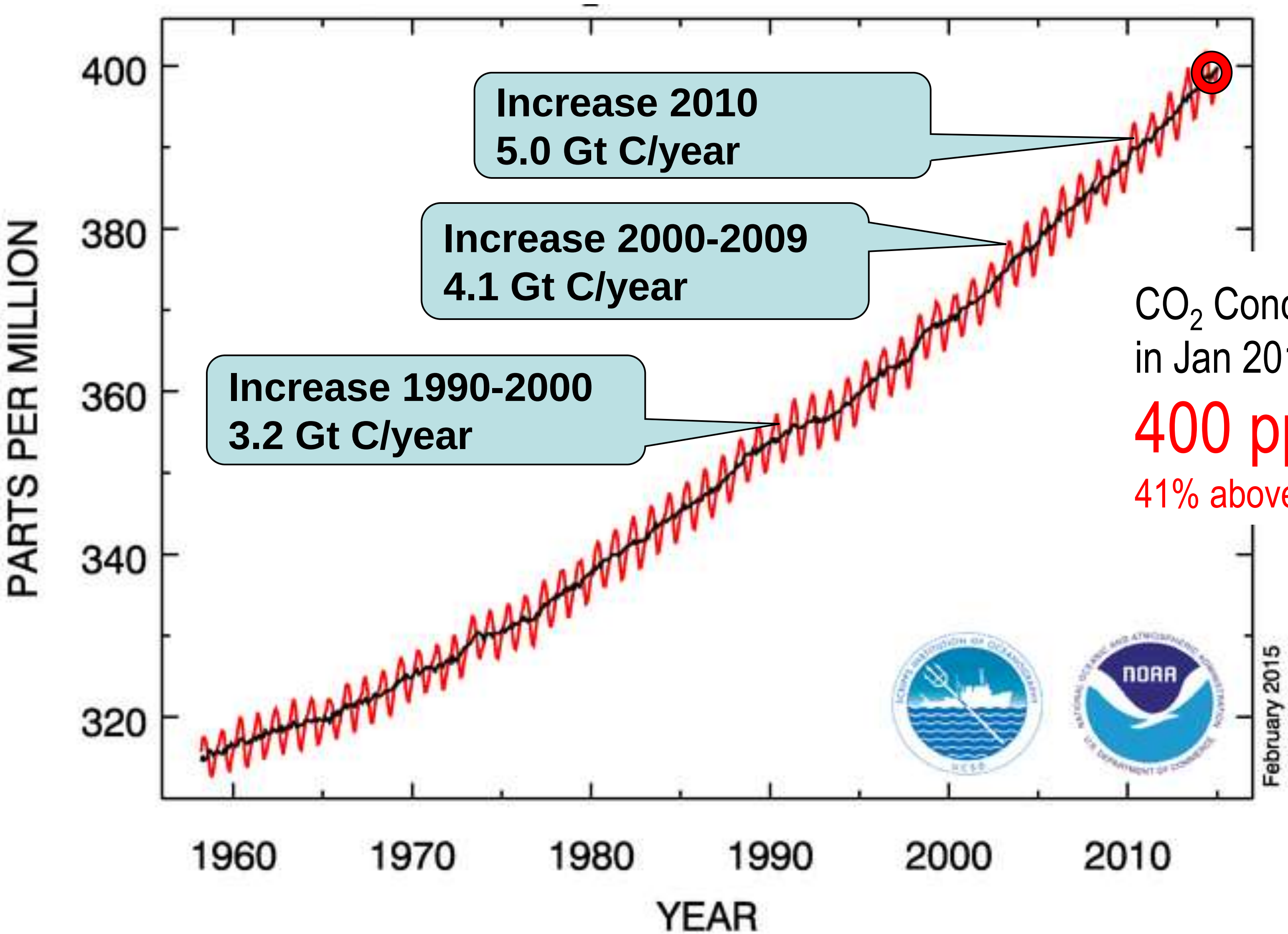
Account

- Use reported estimates and other information to show progress toward, or compliance with, a target

Review

- Process of examination (by others) of reported information in relation to an objective

Increase in Atmospheric CO_2 Concentration

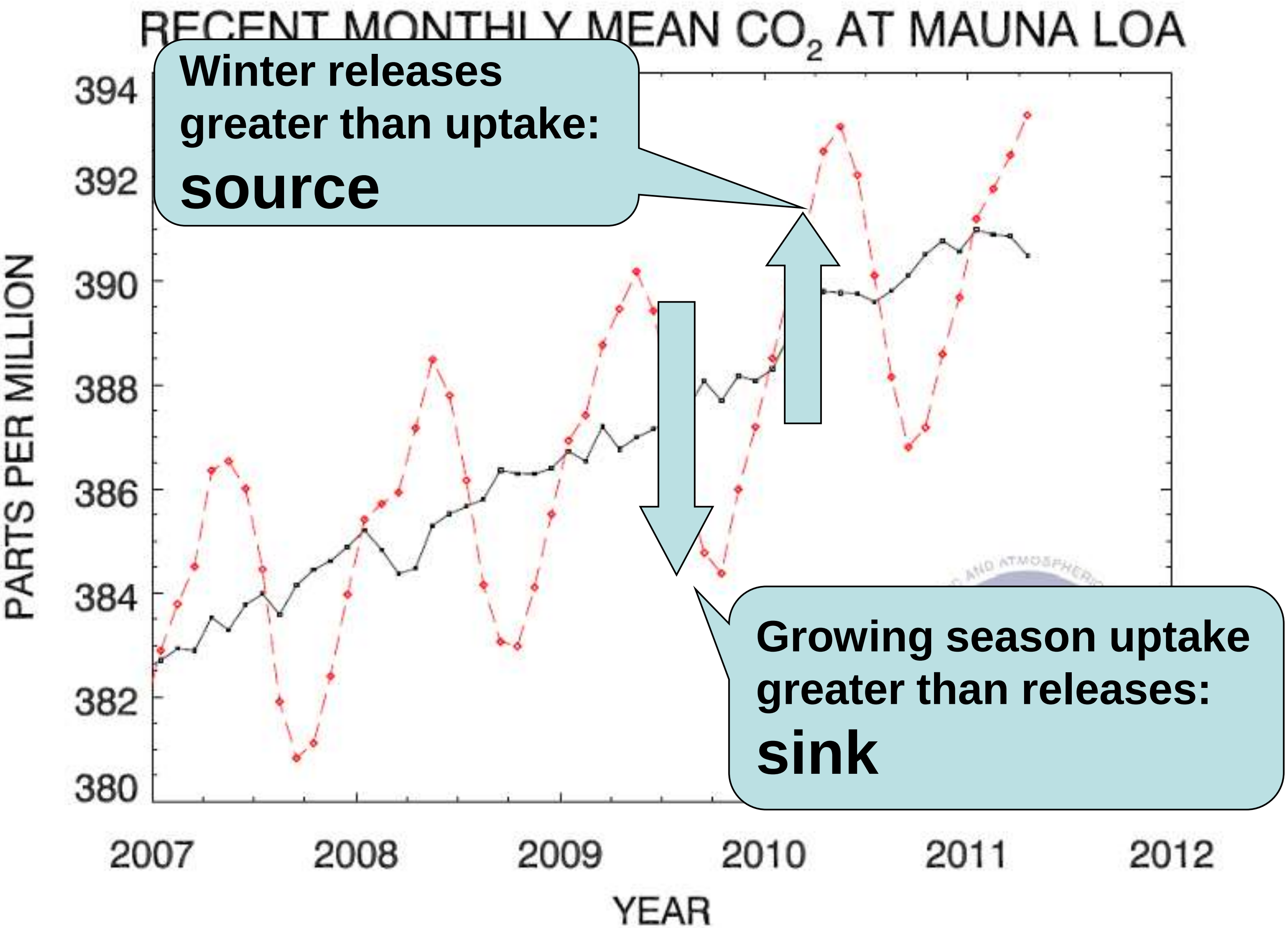


CO_2 Concentration
in Jan 2015

400 ppm

41% above pre-industrial

The Breathing Earth



Fate of Anthropogenic CO_2 Emissions (2004-2013 average)

32.4 ± 1.6 $GtCO_2/yr$ 91%

3.3 ± 1.8 $GtCO_2/yr$ 9%

+

15.8 ± 0.4 $GtCO_2/yr$

44%

10.6 ± 2.9 $GtCO_2/yr$

29%

Calculated as the residual of all other flux components

26%

9.4 ± 1.8 $GtCO_2/yr$

Source: CDIAC; NOAA-ESRL; Houghton et al 2012; Giglio et al 2013; Le Quéré et al 2014; Global Carbon Budget 2014

Inventory-based Estimates of Global Forest C Sink

Science
AAAS

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%

Mitigation in the Forest Sector

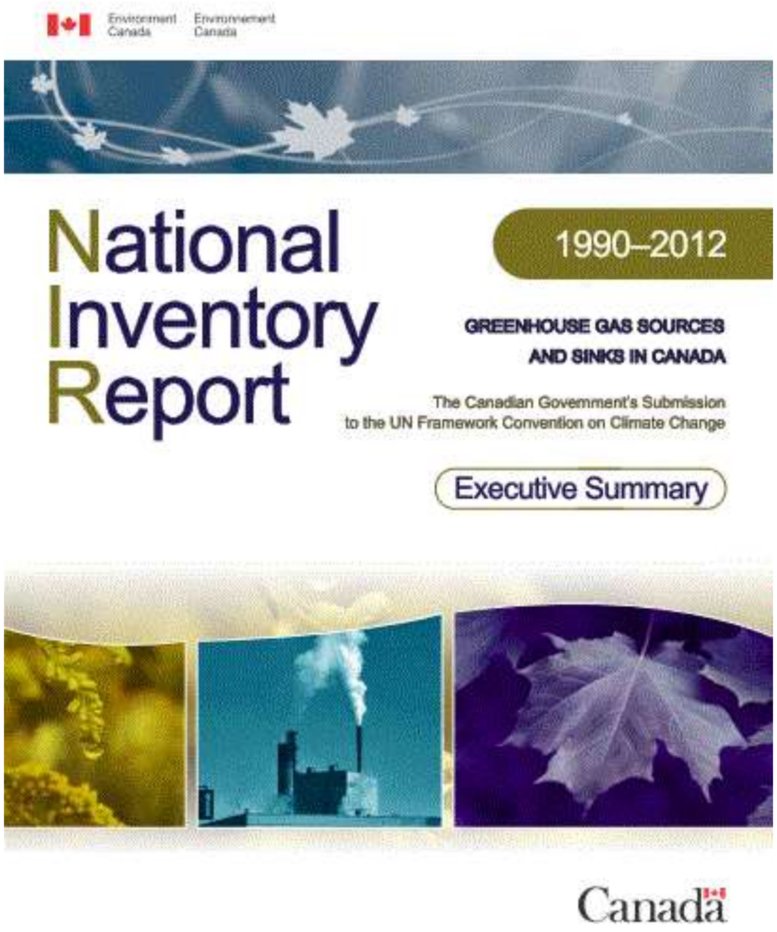
The observed global forest carbon sink is not the outcome of mitigation efforts and does not contribute to meeting mitigation targets.

Climate change mitigation is achieved when **changes in human behaviour or technology** contribute to reduction of GHG sources or enhancement of sinks, relative to a baseline.

National Forest Carbon Monitoring, Accounting and Reporting System

One national system, many uses:

- Reporting past C dynamics
  - National GHG Inventory
  - State of Canada's Forests
- Projecting future C dynamics
  - Scientific research
  - Policy development
  - International negotiations
- Develop climate mitigation and adaptation strategies



http://www.ec.gc.ca/ges-ghg/

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

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

CBM·CFS3

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

Natural Resources Canada | Ressources naturelles Canada

MODEL FOREST NETWORK
RÉSEAU DE FORÊTS MODÈLES

Canada

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

- CBM-CFS3 Toolbox includes
  - Software and databases
  - User's Guide and Tutorials
- Over 1,000 copies provided / 55 countries
- 21 Training Workshops

  540+ Trainees
  - from 17 countries

- Extension Forester for support: Stephen.Kull@nrcan.gc.ca

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

- Uses IPCC Gain-Loss Method to calculate annual GHG emissions and removals.
- Estimates based on forest inventory data, yield curves by forest type and activity data on forest management, natural disturbances and land-use change.
- By extending time series of past activities with scenarios of future activities, it is easy to generate seamless projections of alternative management scenarios.
- Also linked to Harvested Wood Products (HWP) model to account for fate of harvested material using IPCC Production Approach.

National-scale integration of forest C cycle data

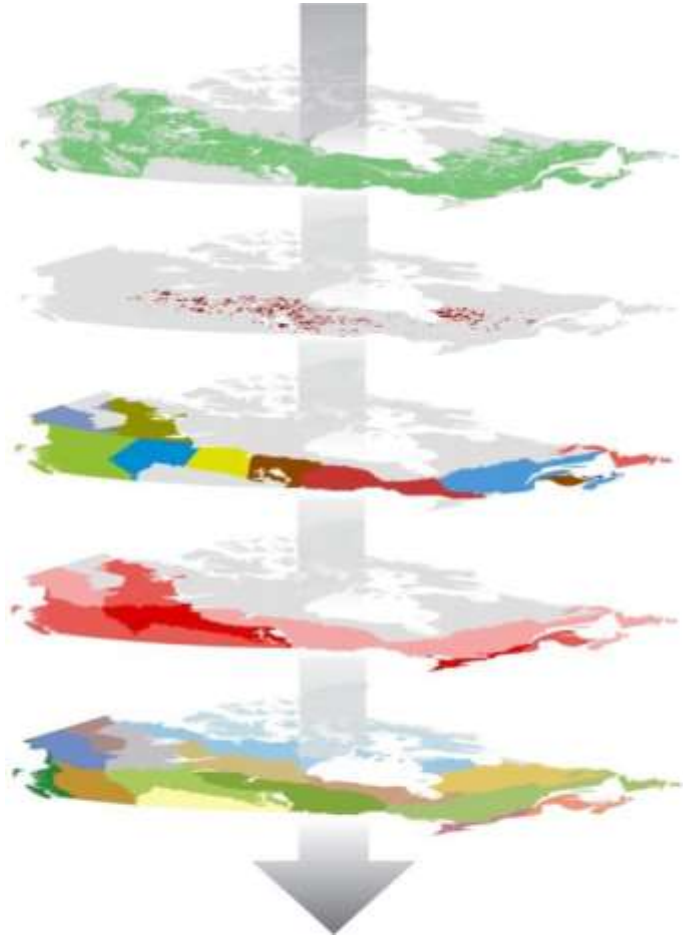
Forest inventory and growth & yield data

Natural disturbance monitoring data

Forest management activity data

Land-use change data

Ecological modelling parameters

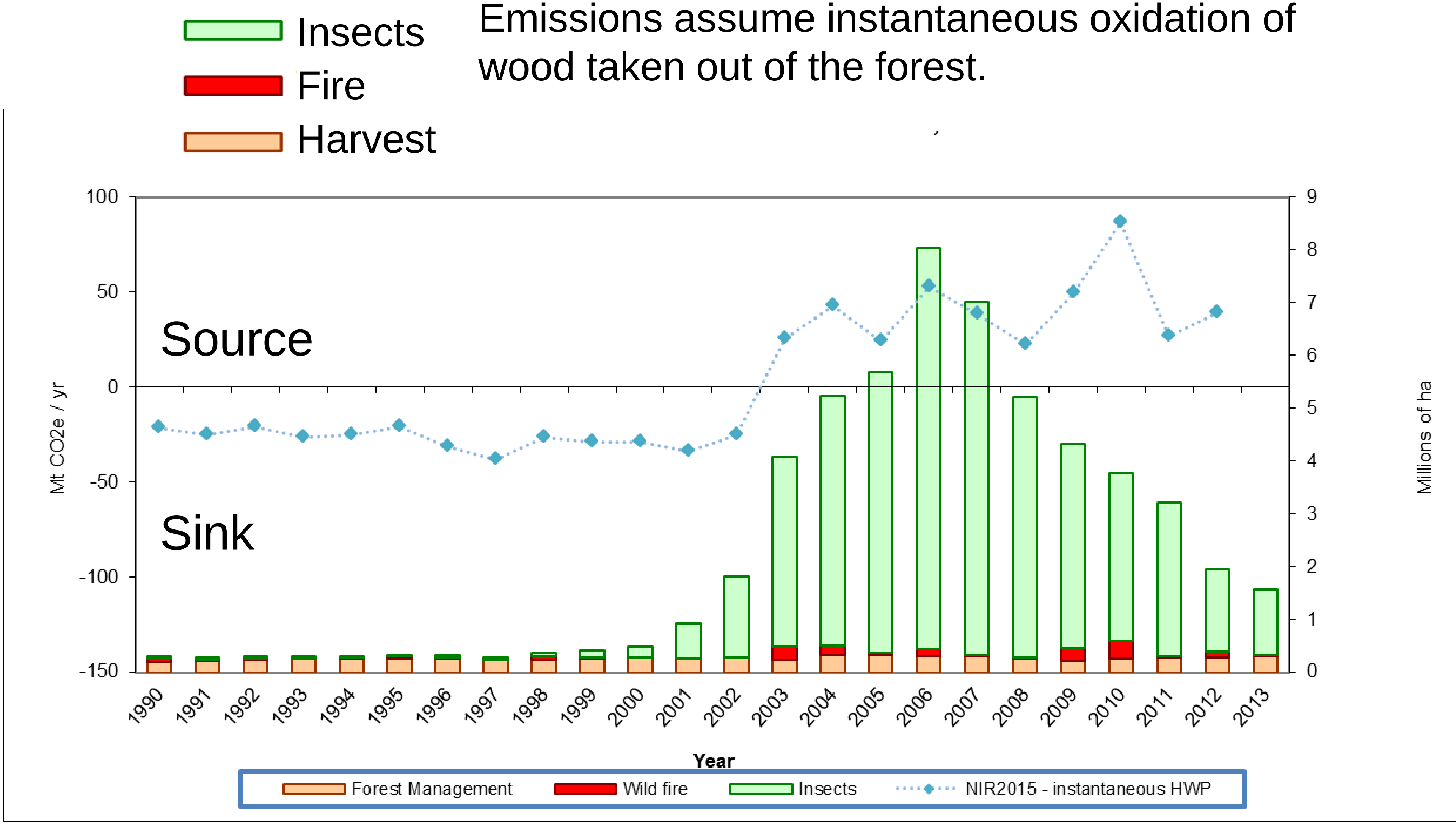


CBM-CFS3

Source: Kurz and Apps, 2006, Kurz et al. 2009

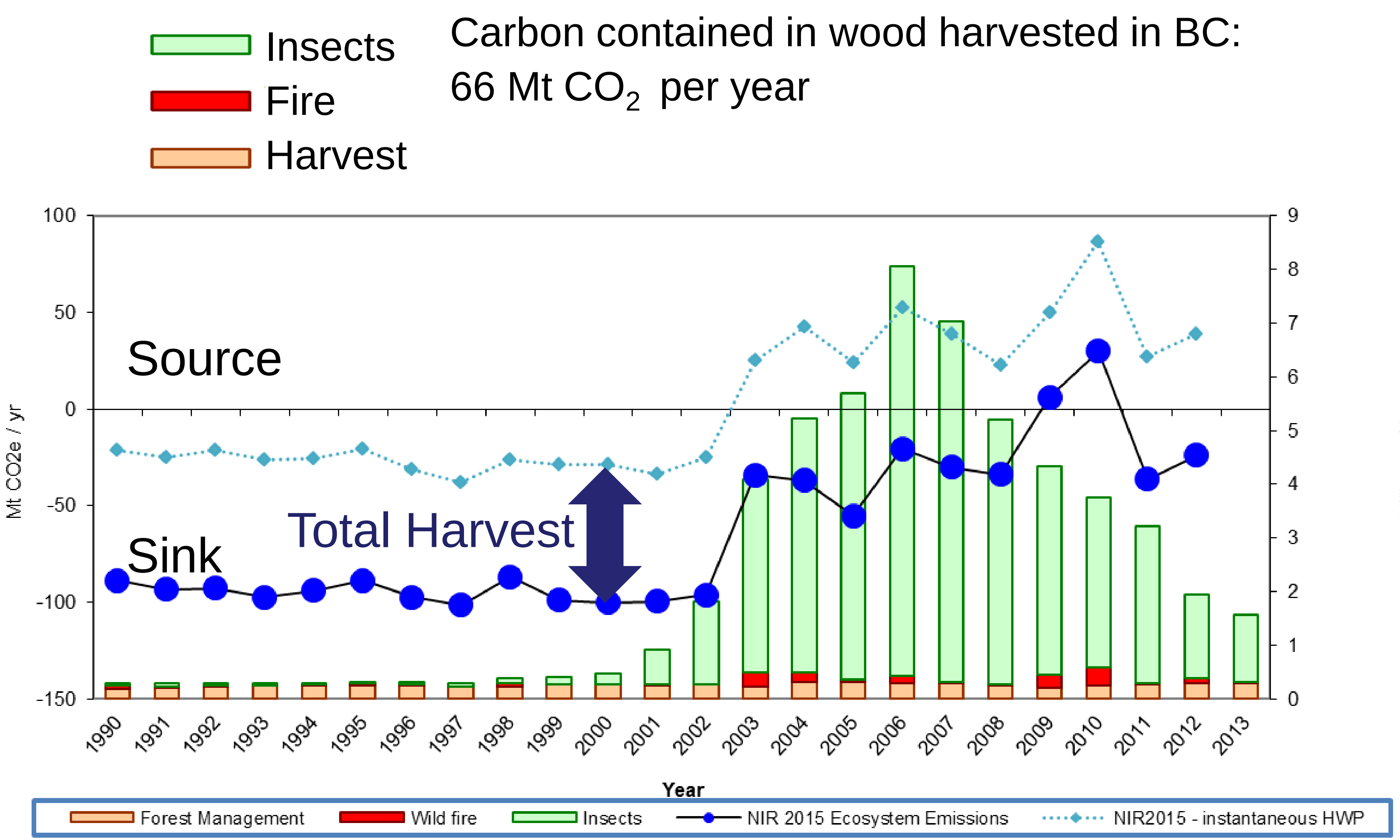
BC managed forest greenhouse gas balance (FLFL)

Emissions assume instantaneous oxidation of wood taken out of the forest.



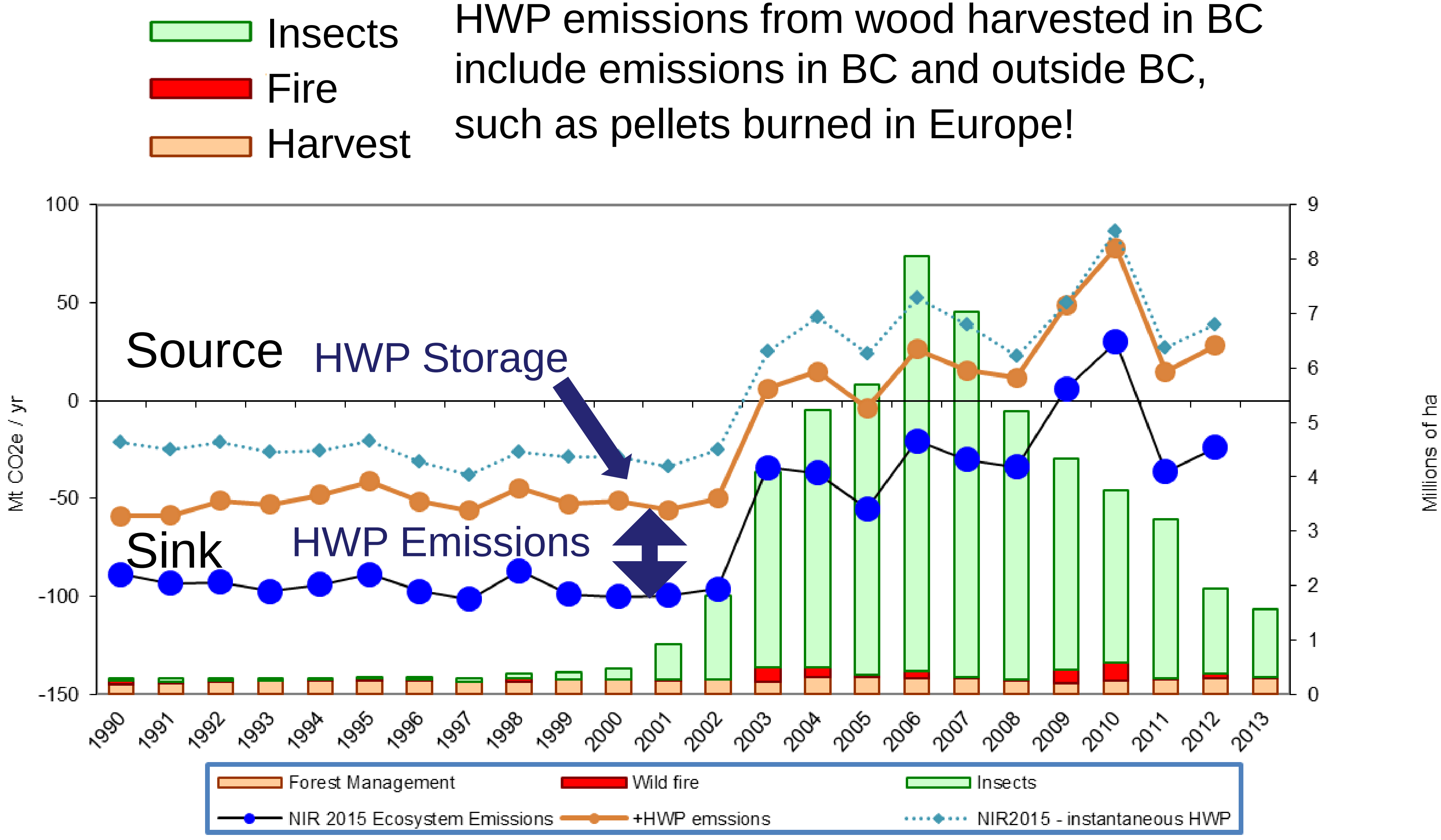
BC managed forest greenhouse gas balance (FLFL)

Carbon contained in wood harvested in BC:
66 Mt CO_2 per year



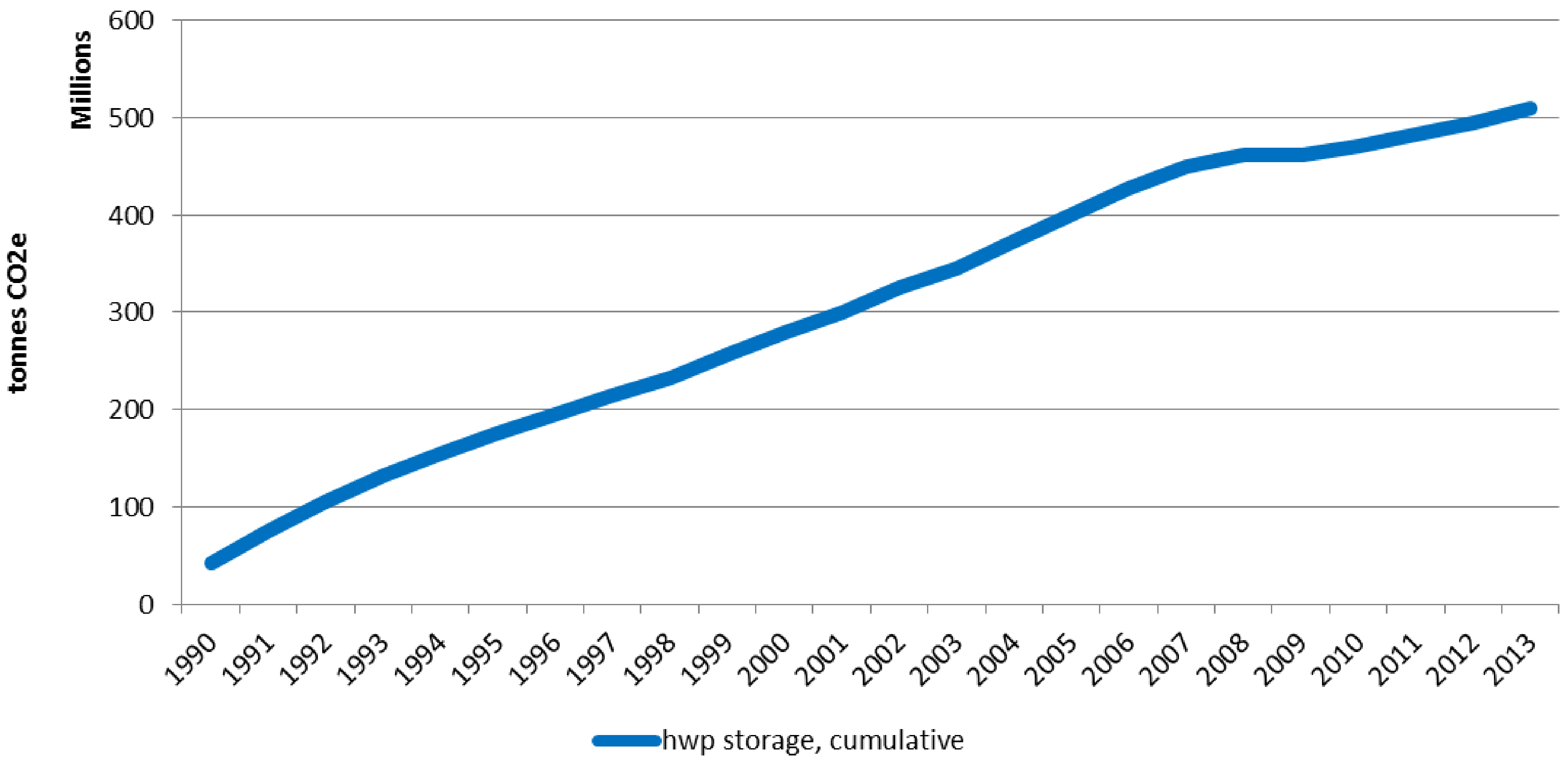
BC managed forest greenhouse gas balance (FLFL)

HWP emissions from wood harvested in BC include emissions in BC and outside BC, such as pellets burned in Europe!



C Stored in Wood Products Harvested in BC since 1990

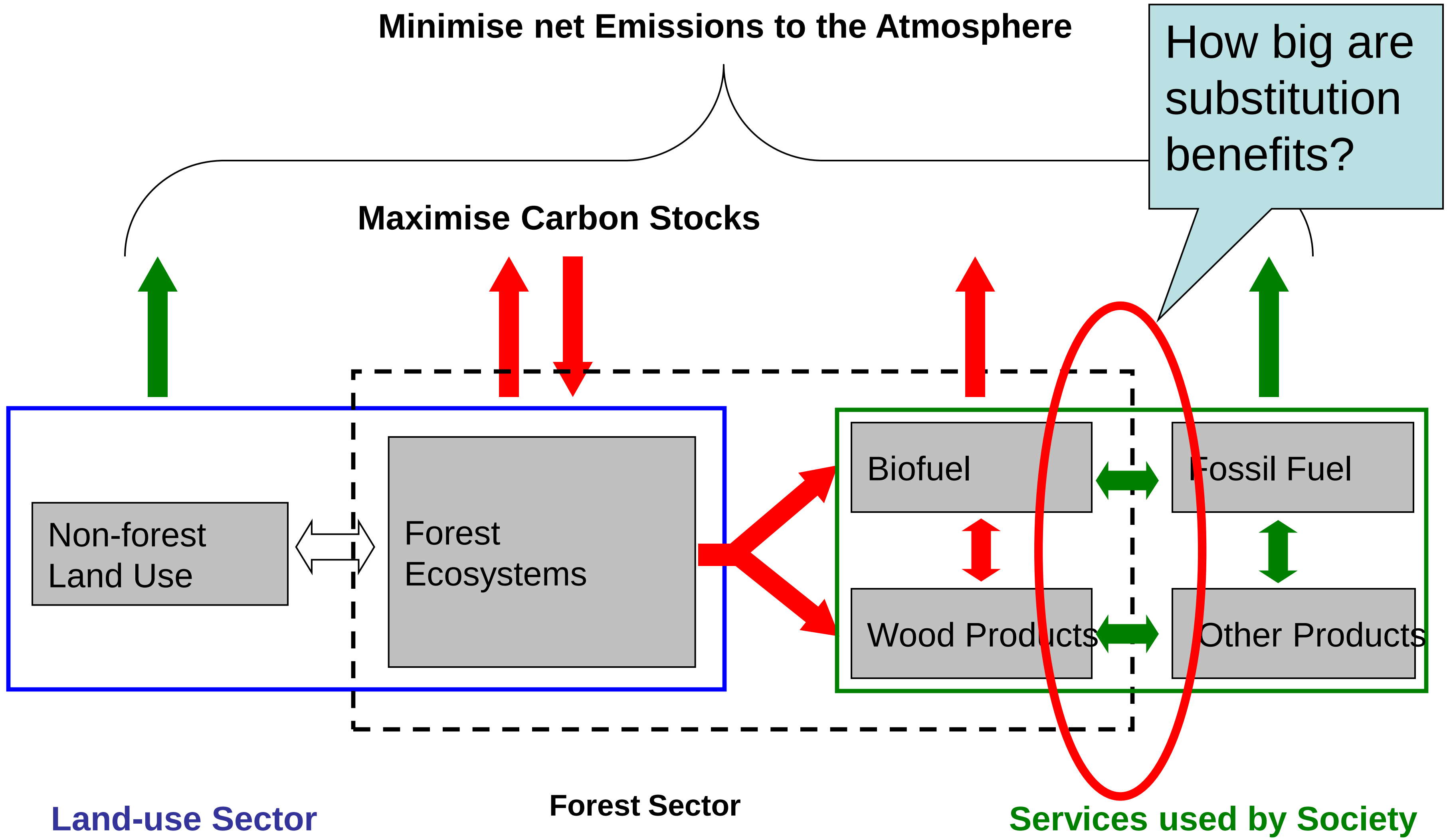
Excluding C stored in Landfills and pre-1990 harvests



~ 1 million cubic meters of wood
~ 0.25 Mt C

BC annual Harvest ~72 times this:
Provides timber, fibre and energy

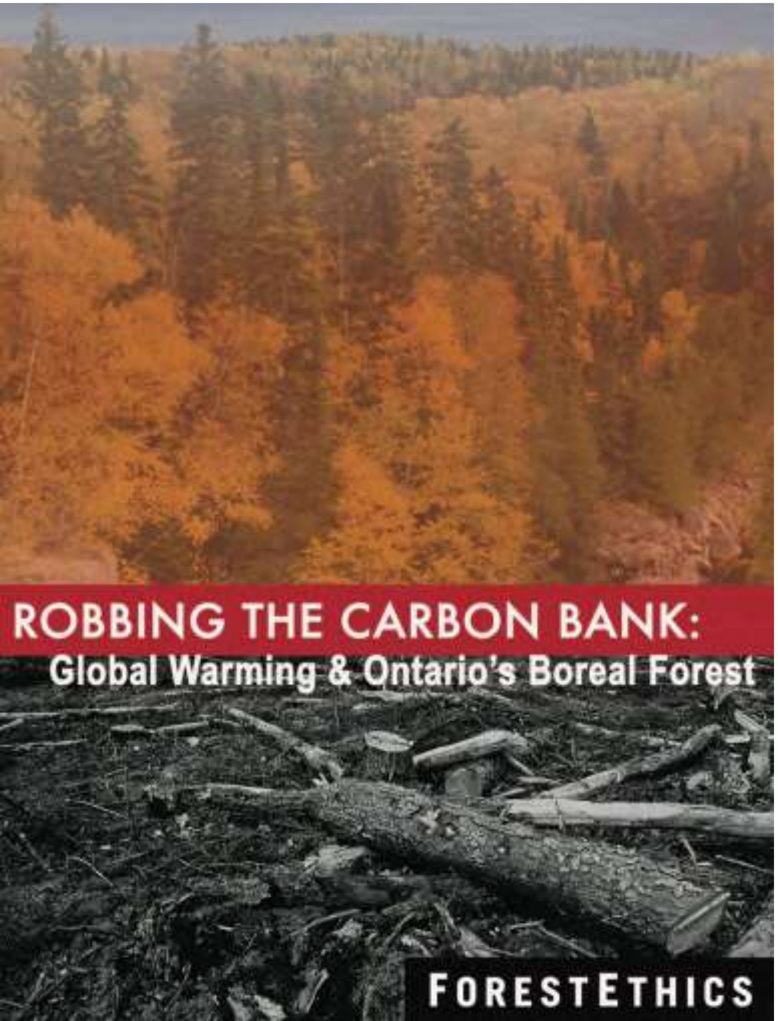
Mitigation Strategies: Need for Systems Perspective



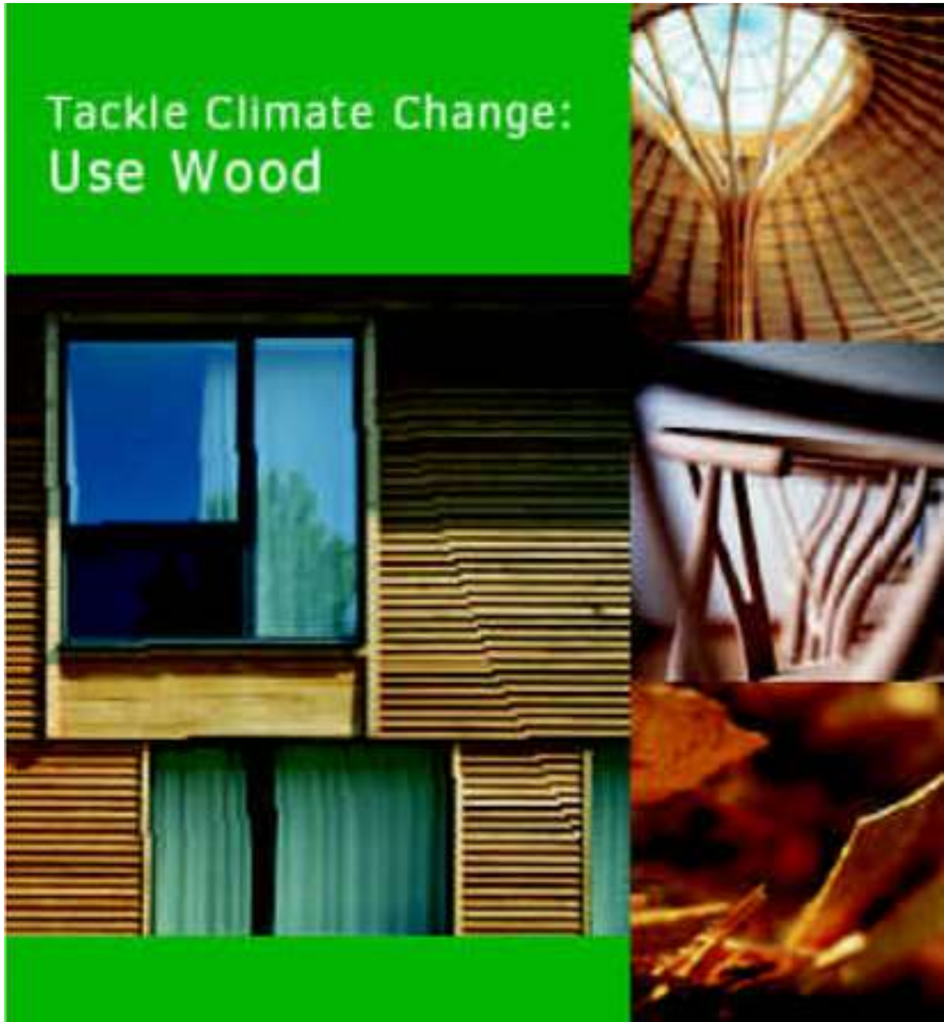
Source: IPCC 2007, AR4 WG III, Forestry

Forest Mitigation Strategies: Two competing positions

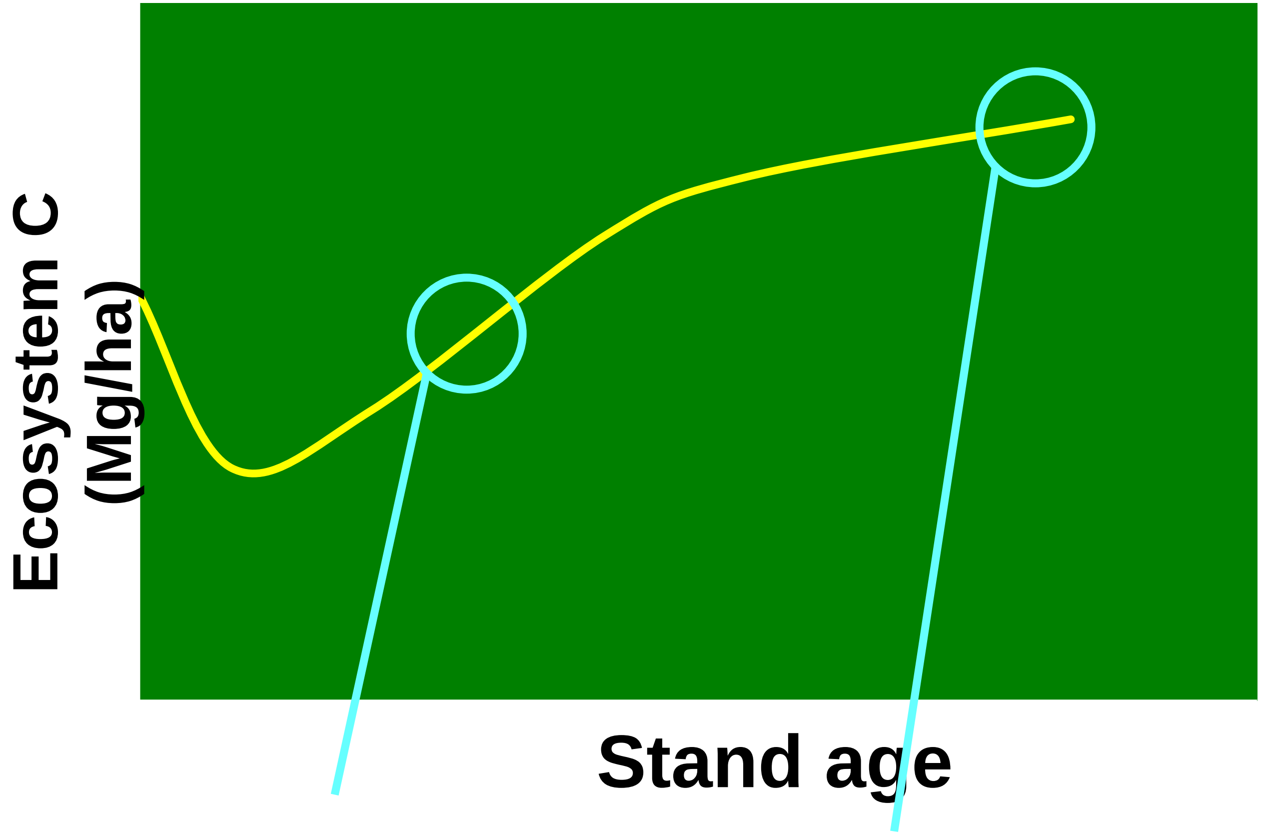
Stop logging …..



… or use wood?



Stand-level C dynamics



Time of maximum C uptake rates

Time of maximum C stocks

Forest Sector C with Sustainable Forest Management (SFM)

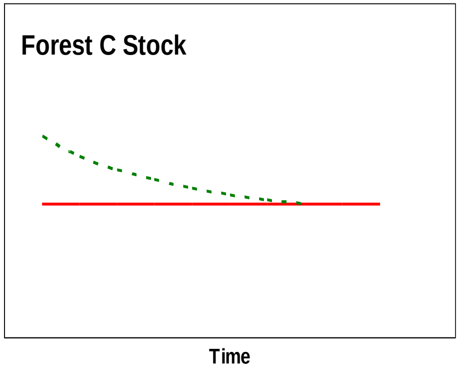
- With SFM C stocks can be maintained

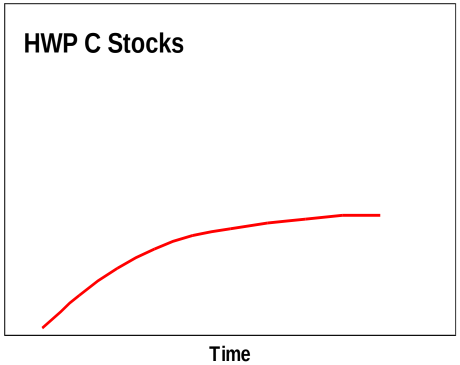
  (once transition from natural to managed landscape completed)

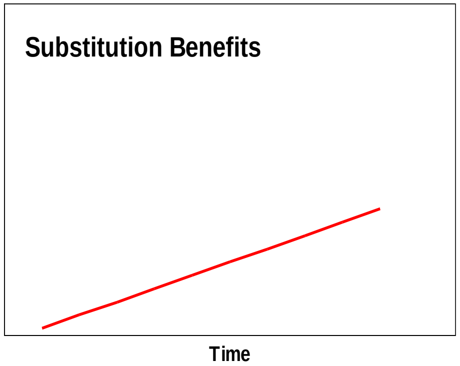
- Harvested Wood Product (HWP) C stocks will saturate

  continuous increases in landfills possible – but because of CH_4 emissions not desirable

- Substitution benefits accumulate over time
  - through replacement of emission-intensive products

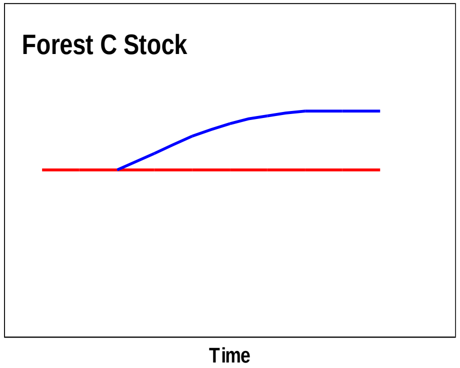


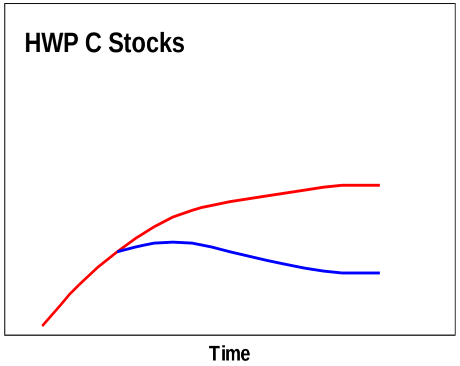


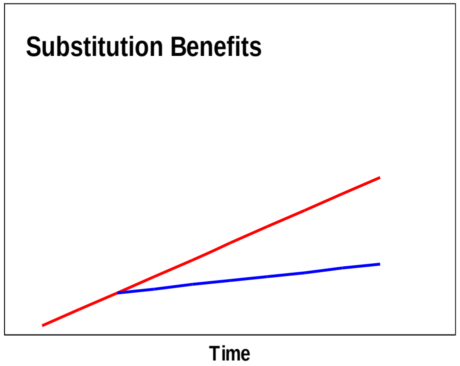


Forest Sector Carbon with Conservation Strategy

- With conservation strategy forest C stocks can increase
- Harvested Wood Product C stocks decrease to lower level
- Substitution benefits accumulate at slower rate.
- **Relative advantage of SFM vs conservation strategy depends on MANY factors and is not decided by carbon criteria alone.**

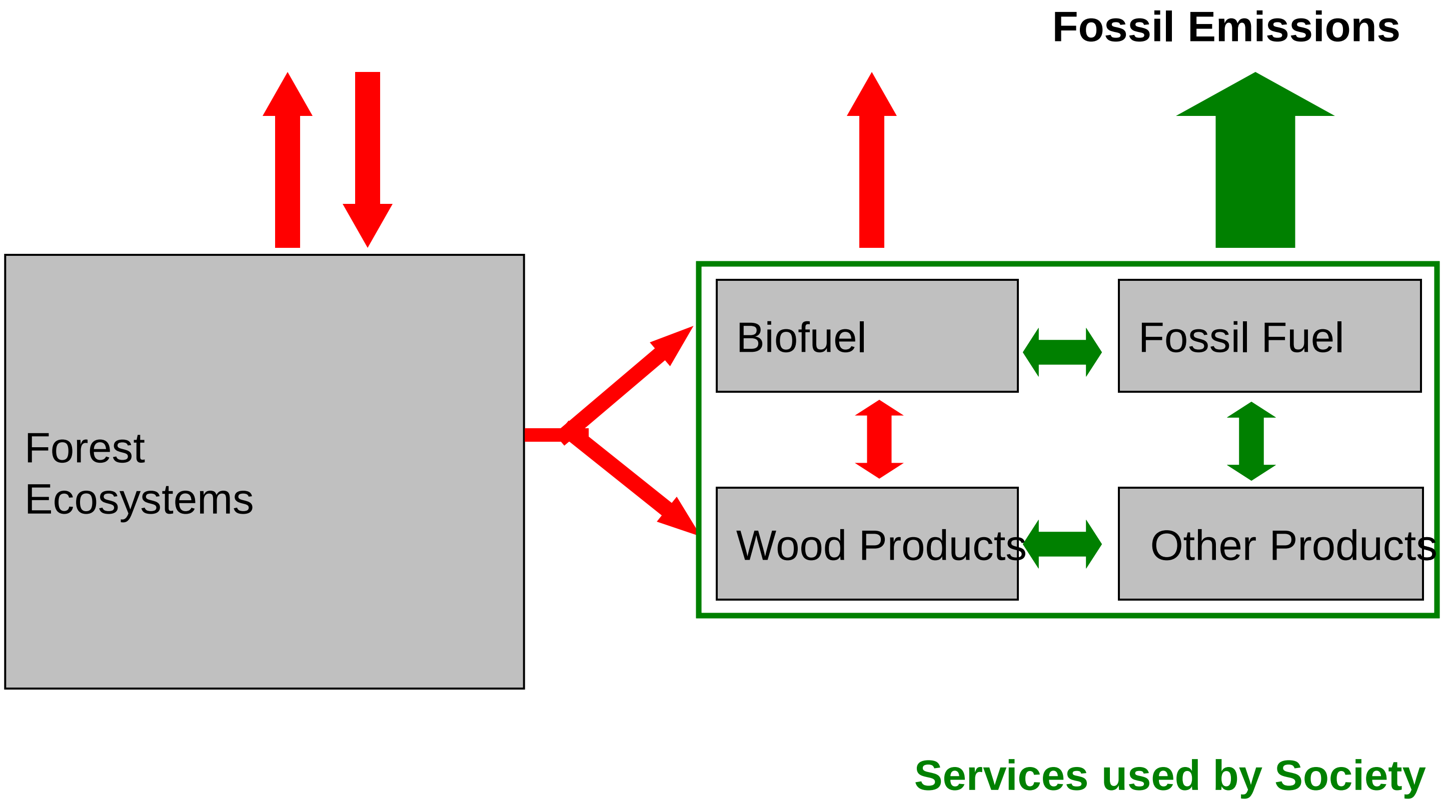






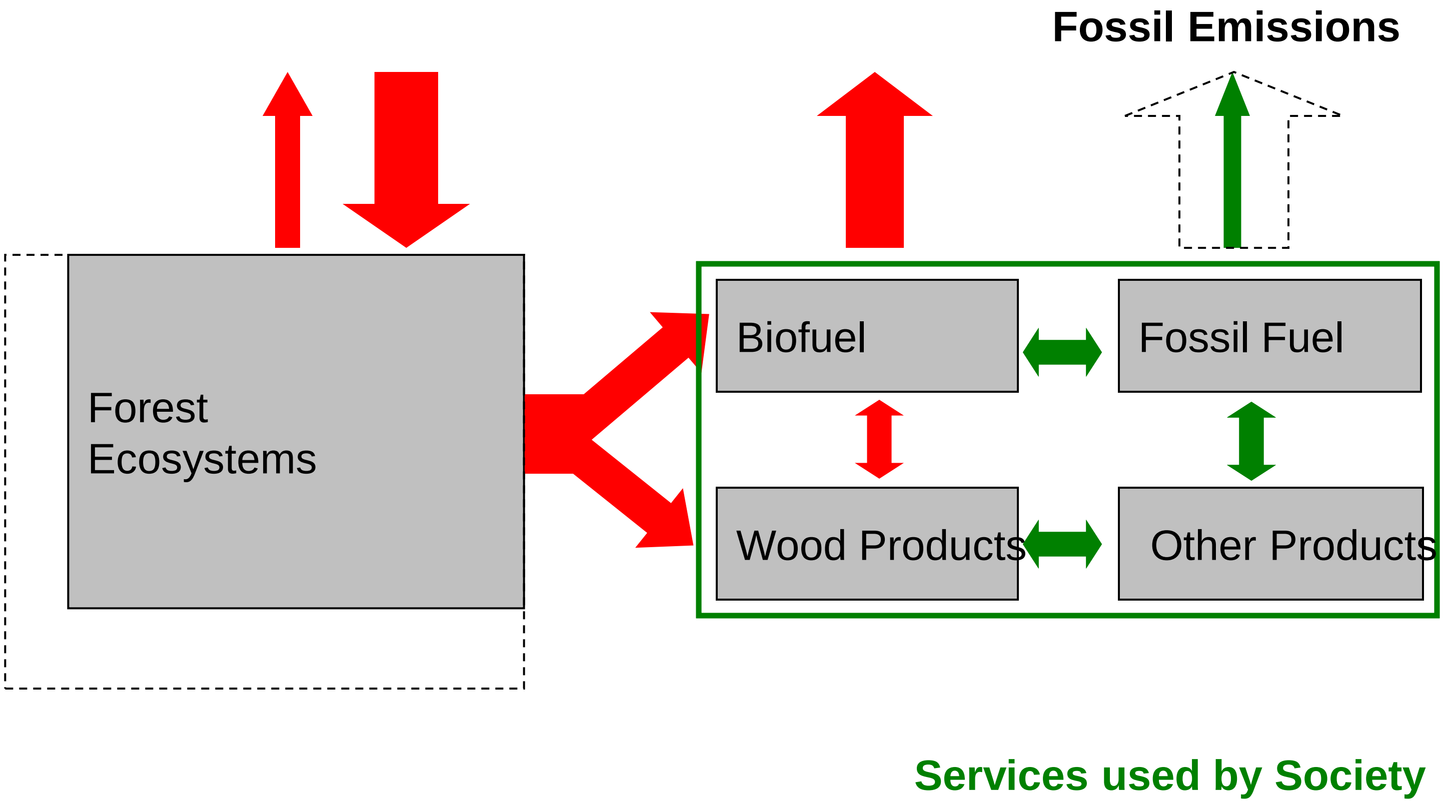
Forest Mitigation Strategies: Two competing positions

Maximise Carbon stocks ….



Forest Mitigation Strategies:
Two competing positions

… or maximise Carbon uptake?



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

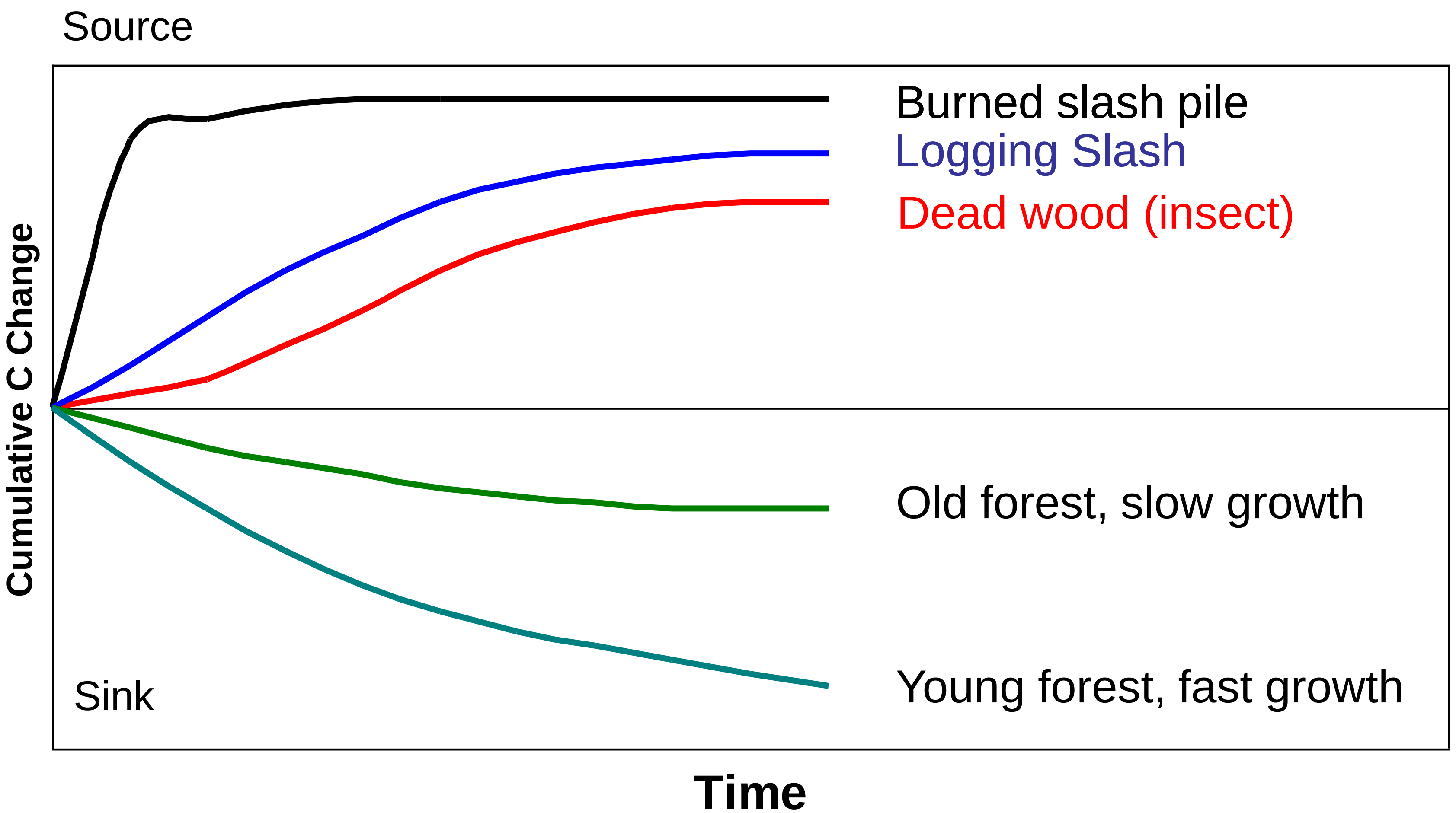
Photo: BC MoF

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 the 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.

Outline

- Background
- Principles
- **Analysis of mitigation potential in BC**
- Challenges
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Mitigation Analysis

Biogeosciences, 11, 3515–3529, 2014
www.biogeosciences.net/11/3515/2014/
doi:10.5194/bg-11-3515-2014

Biogeosciences Open Access

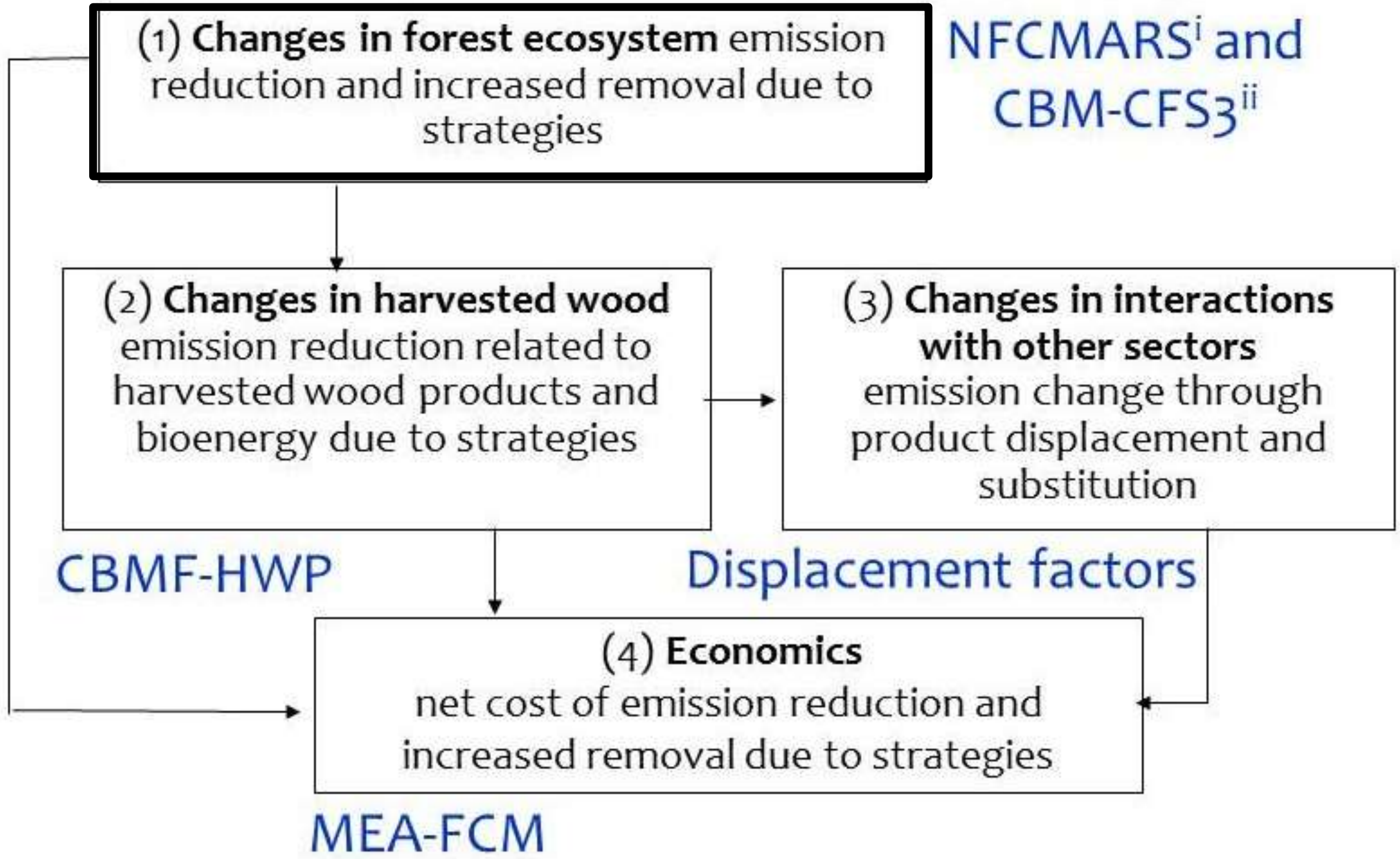
Quantifying the biophysical climate change mitigation potential of Canada's forest sector

C. E. Smyth[1], G. Stinson[1], E. Neilson[1], T. C. Lemprière[2], M. Hafer[1], G. J. Rampley[3], and W. A. Kurz[1]

- Base Case
- 7 Forest management scenarios
- 2 Harvested Wood Product use scenarios

http://www.biogeosciences.net/11/3515/2014/bg-11-3515-2014.pdf

Mitigation analyses: Analytical framework



[i] Stinson et al. (2011) *Global Change Biology* 17, 2227-2244

[ii] Kurz et al. (2009) *Ecological Modelling* 220, 480-504

National-scale integration of forest C cycle data

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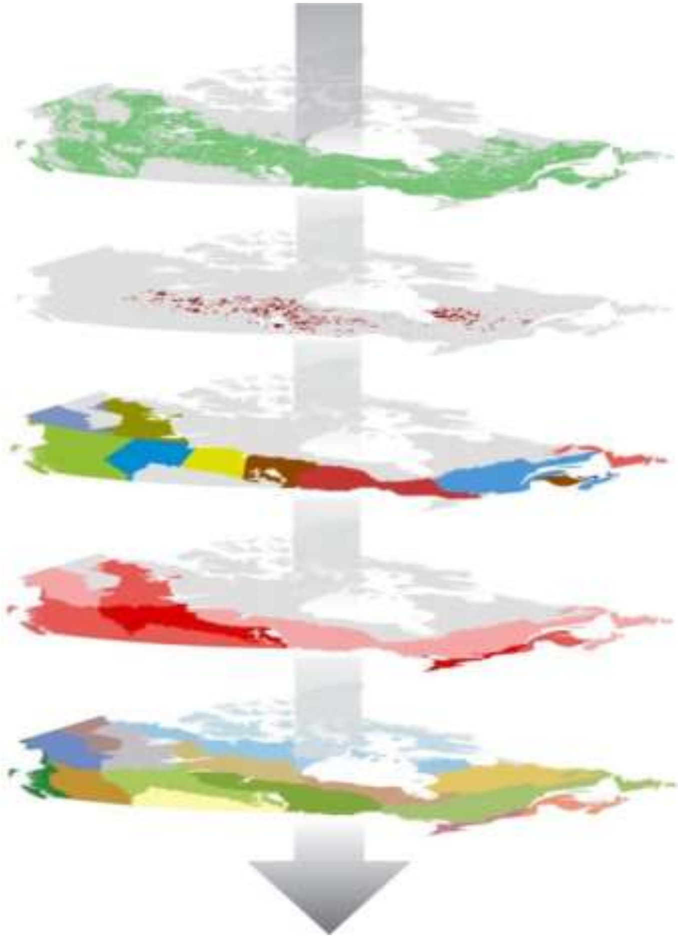
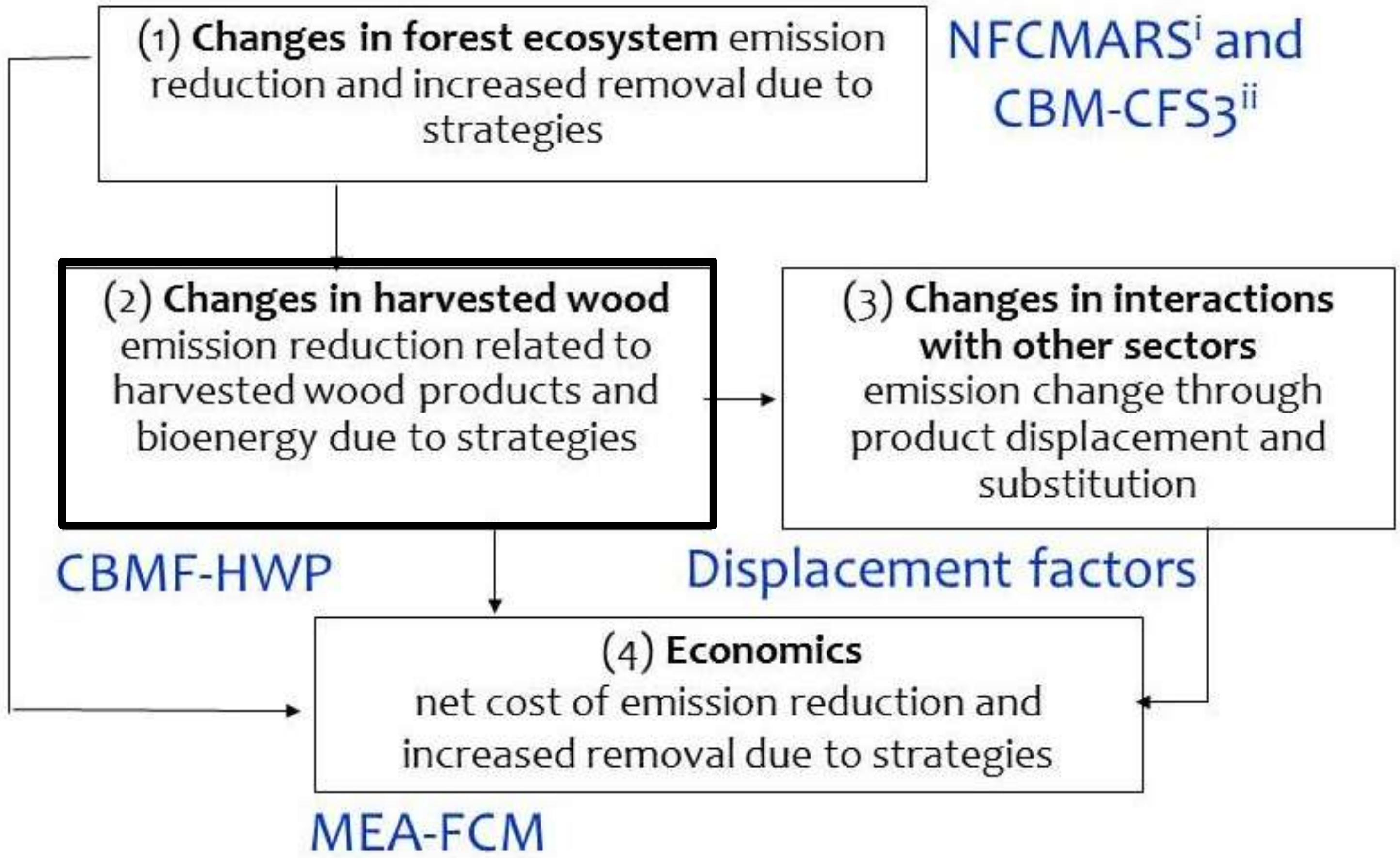


CBM-CFS3

Mitigation analyses: Analytical framework



[i] Stinson et al. (2011) *Global Change Biology* 17, 2227-2244

[ii] Kurz et al. (2009) *Ecological Modelling* 220, 480-504

Harvested Wood Products

Production approach

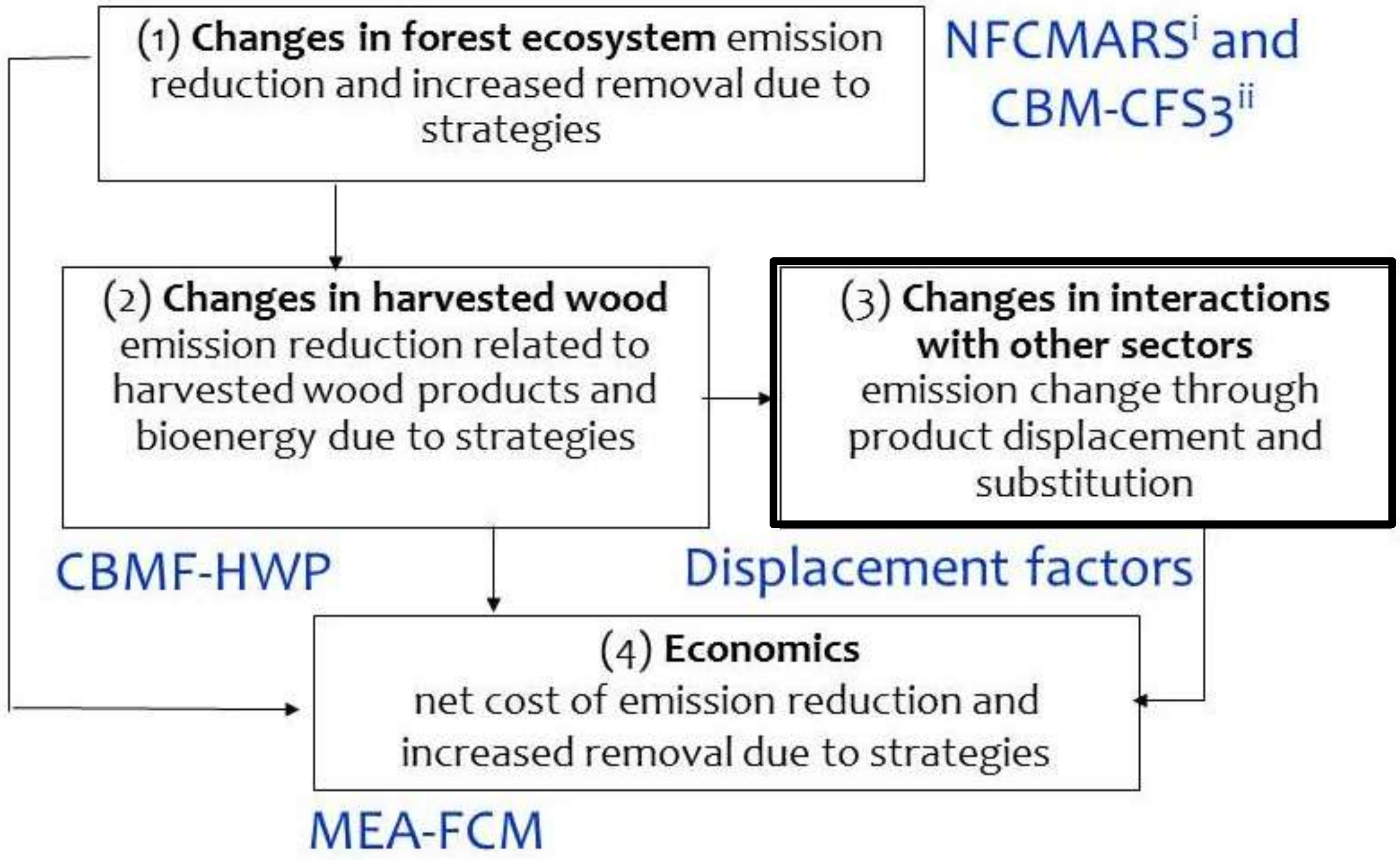
Commodities based on national statistics reported in FAO:

Sawnwood (35 years)
Other solid wood (35 years)
Panels (25 years)
Pulp and paper (2 years)
Bioenergy (instant oxidation)

End-of-life (bioenergy, landfill)

Landfill (CO_2/CH_4 emissions)

Mitigation analyses: Analytical framework

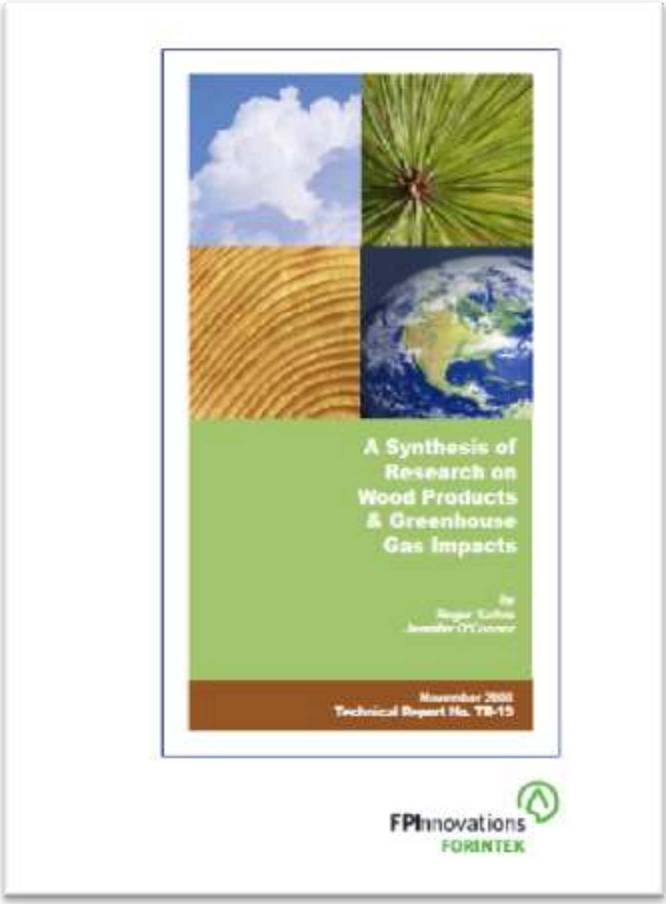


[i] Stinson et al. (2011) *Global Change Biology* 17, 2227-2244

[ii] Kurz et al. (2009) *Ecological Modelling* 220, 480-504

Substitution Benefits from Wood Use

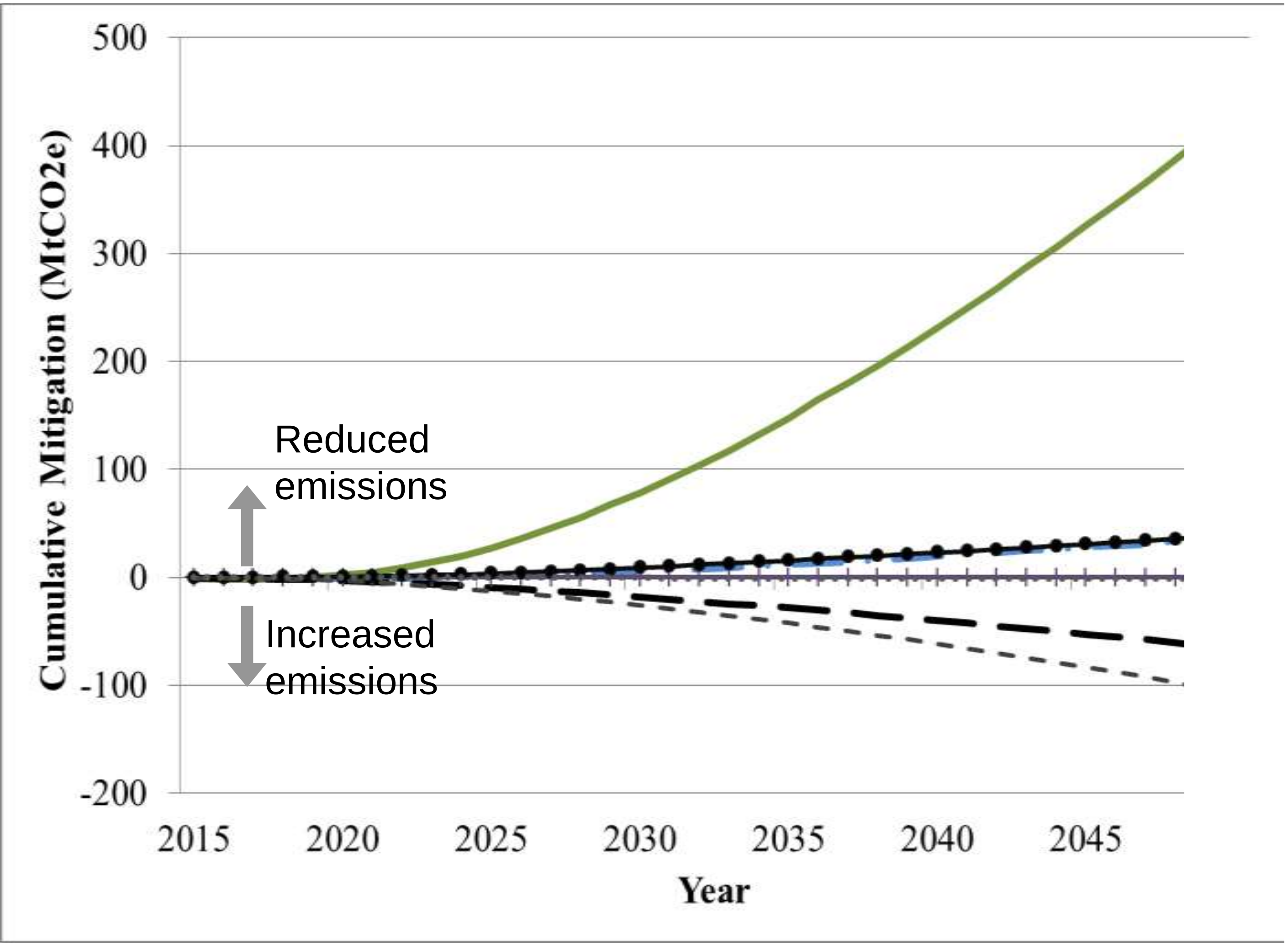
- Displacement factor (DF) quantifies the amount of emission reduction achieved per unit of wood used in products (i.e. substitution)
  - On average, we avoid 2 tons of C emissions for every 1 ton of C used in wood products.
  - Substitution benefits of wood use for bioenergy typically < 1.
- Calculated own DF for product categories used in this study



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

Changes in forest management in BC

Cumulative mitigation relative to base case



Better Utilization

Better Growth, Conservation

Bioenergy (PCT)

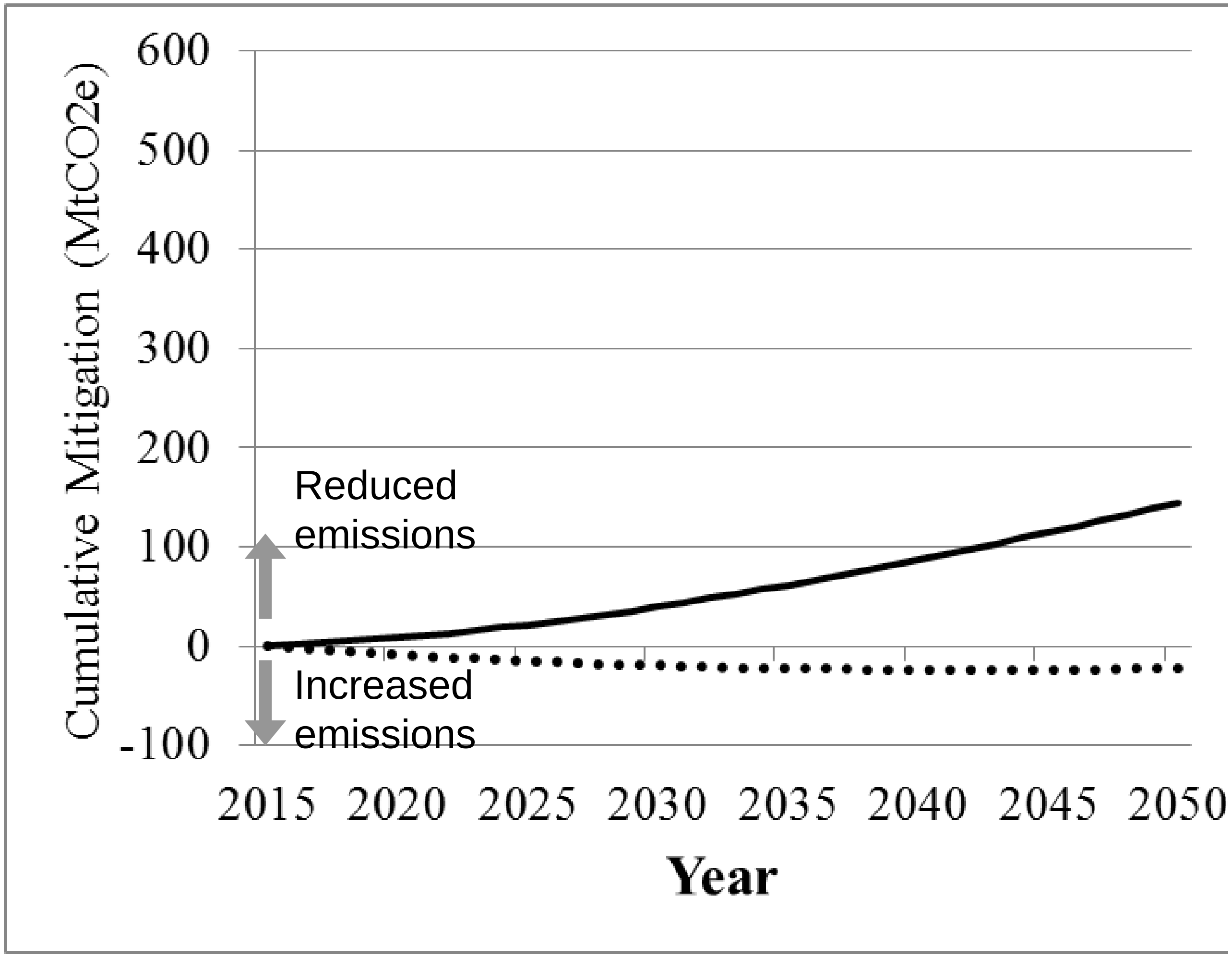
Bioenergy clearcut Harvest

Bioenergy Comm. Thinning

Source: Smyth et al. 2014, Biogeosciences

Mitigation through HWP use in BC

Cumulative mitigation relative to base case



← Longer-lived Products (LLP)

← Bioenergy feedstock

Source: Smyth et al. 2014, Biogeosciences

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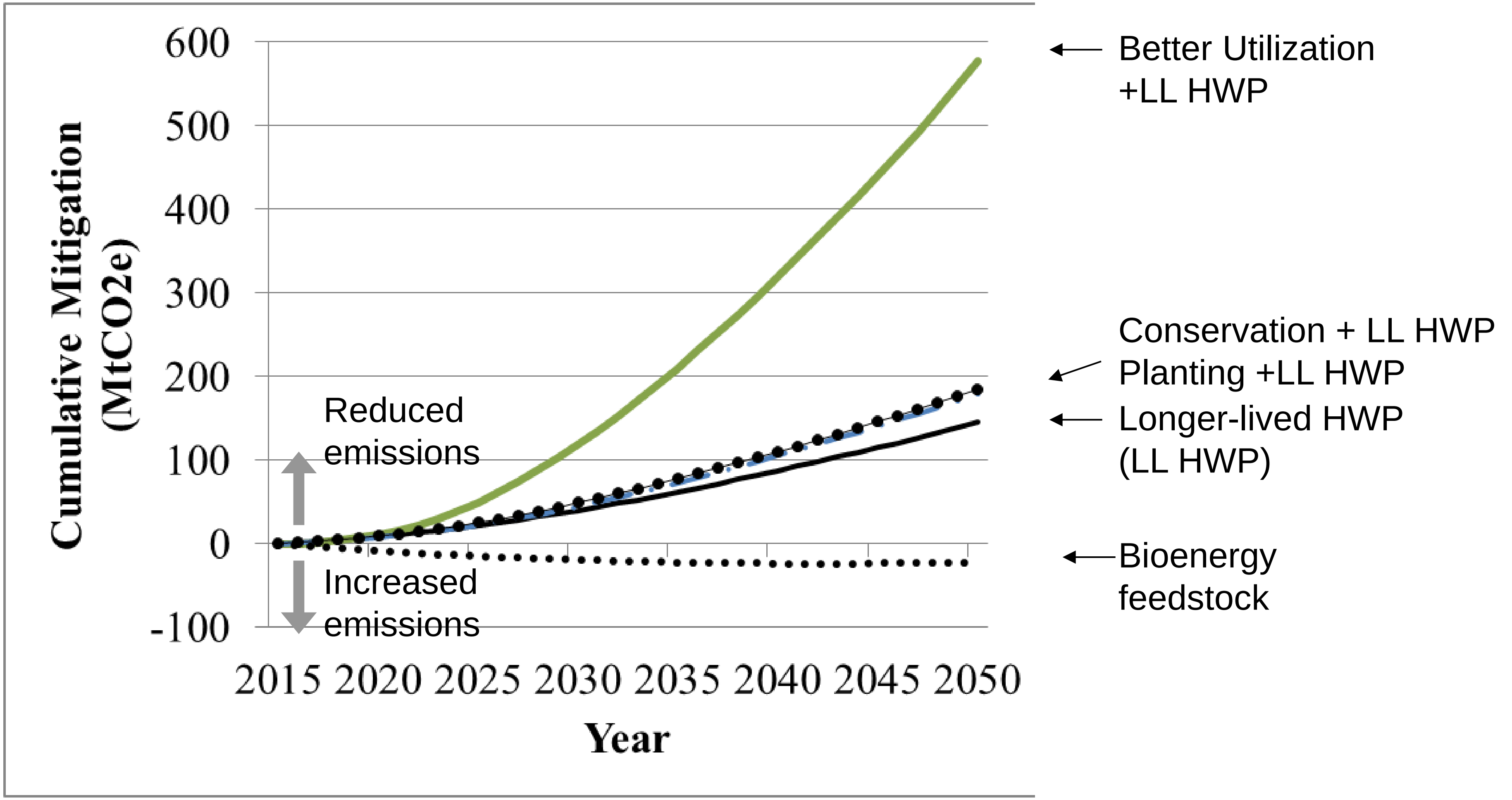
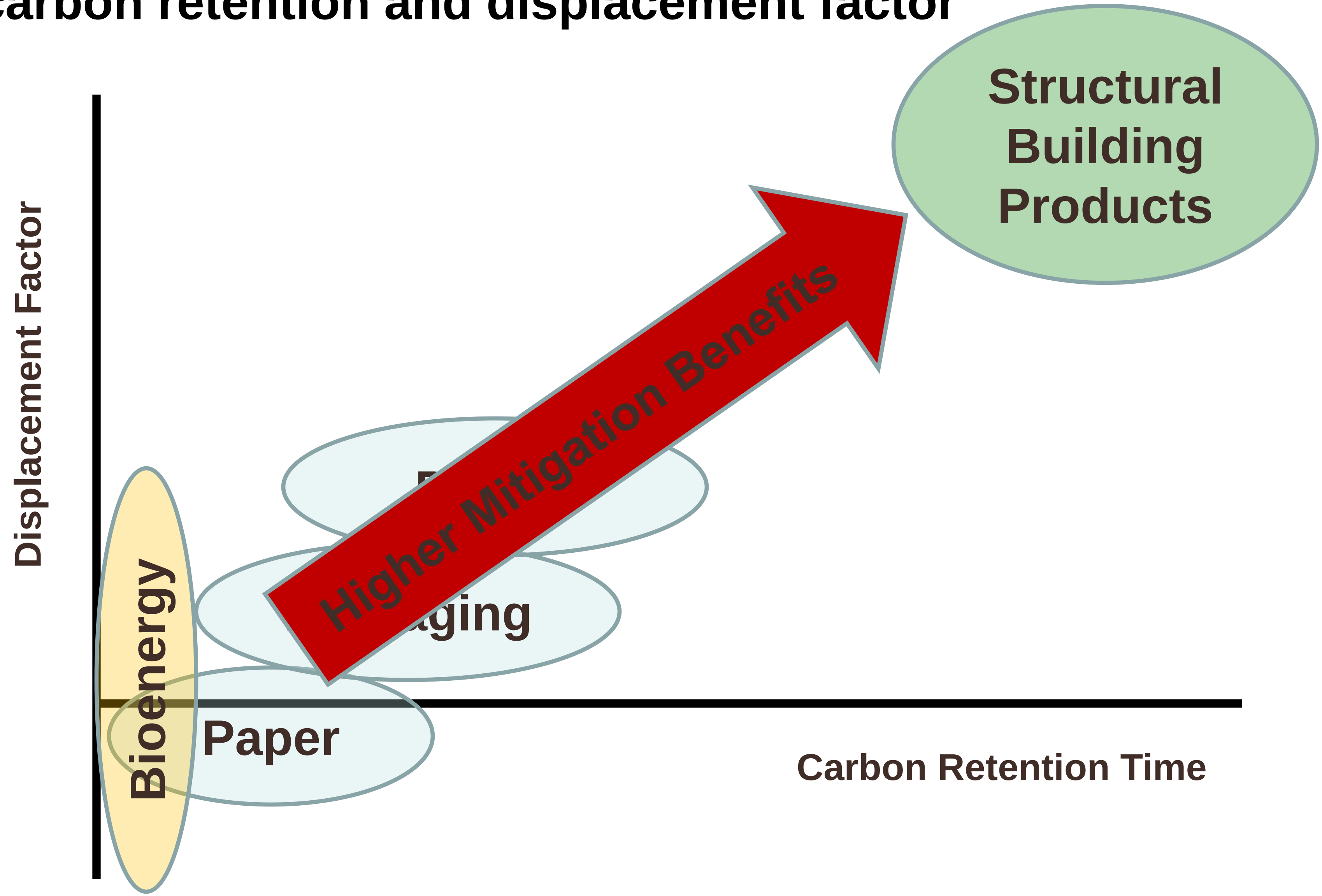
FM and HWP mitigation in BC

Cumulative mitigation relative to base case



Source: Smyth et al. 2014, Biogeosciences

Mitigation benefit increases with carbon retention and displacement factor



Mitigation benefit increases with carbon retention time and displacement factor

18-story
wood building
at UBC,
Vancouver

Tallest Wooden Building in N. America
Wood Innovation Design Centre
Prince George, BC

Outline

- Background
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- **Challenges**
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Potential Challenges: Domestic use

- Need to demonstrate that increased production of long-lived structural wood products results in emission reductions in other sectors.
  - Wood exporting countries can work with importing countries to increase C retention in HWP, reduce wood waste and maximise substitution benefits through building technology
- Increased domestic use of wood products for bioeconomy & GHG reduction could affect global forest product trade.

Potential Challenges: Social License

- Forest sector-based climate change mitigation activities require ongoing “social license” for forest management.
  - Monitor and document sustainability of ecological services
  - Requires strong adherence to principles of sustainable forest management
- Need to demonstrate that climate change mitigation actions do not increase vulnerability of ecosystems to climate change.
- Need to learn how forest management can increase forest ecosystem resilience to climate change.

Potential Challenges: Climate Change

- Climate change impacts on BC forests are predicted to be large – both positive and negative.
- Estimates for net carbon balance remain highly uncertain.
- If net impacts of climate change adversely affect forest sustainability and forest management is perceived to contribute to the problem, then social license for mitigation actions may be in question.

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Conclusions (1/2)

- Design of climate change mitigation portfolios in the forest sector should account for changes in C in **forest ecosystems,** in **harvested wood products**, and for **substitution benefits**, relative to a base case.
- Efficiency of mitigation activities varies among activities and by region, and no single strategy is best everywhere.
- Best strategies focus on substitution and HWP C storage.
- Forest managers do not control use of wood – effective mitigation activities need to integrate forest management with wood use strategies aimed at increasing life span of HWP and substitution of steel, concrete, plastics & fuels.

Conclusions (2/2)

- Substantial mitigation potential by 2050 if the implementation of strategies starts soon.
- Regional differences (disturbances, ecology, response to climate change, management intensity) likely to affect choice of most efficient mitigation options.
- Design of mitigation strategies needs to anticipate climate change impacts and consider contributions to adaptation.
- As societies seek to reduce GHG emissions, the forest sector can make a meaningful and sustained contribution if social license to do so can be established & maintained.

Thank-you

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Publications at:

http://cfs.nrcan.gc.ca/publications/search?query=Kurz

References

• *Model Description and Related Publictions*

Kurz, W.A., Dymond, C.C., White, T.M., Stinson, G. , Shaw, C.H., Rampley, G.J., Smyth, C., Simpson, B.N., Neilson, E.T., Trofymow, J.A., Metsaranta, J., Apps, M.J., 2009. CBM-CFS3: a model of carbon-dynamics in forestry and land-use change implementing IPCC standards, Ecol. Mod. 220: 480-504, http://dx.doi.org/10.1016/j.ecolmodel.2008.10.018

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