Climate Change Mitigation Options in the BC Forest Sector

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- Thank you for the invitation and the opportunity to speak to you on behalf of the Pacific Institute for Climate Solutions.
- I will speak about climate change mitigation options in the BC Forest Sector, but our team has done similar analyses at the national scale in Canada, and internationally.

Climate change impacts affect mitigation options

- Impacts of environmental changes on forests will be **both positive and negative**: growth, mortality, disturbances.
- Understanding **where, when and how** these impacts will occur is necessary to design effective climate change mitigation and adaptation strategies for the forest sector.
- Research conducted by the PICS Forest Carbon Management Project, a collaboration of universities, the Canadian Forest Service and provincial agencies, will inform the design of regionally-differentiated mitigation strategies.

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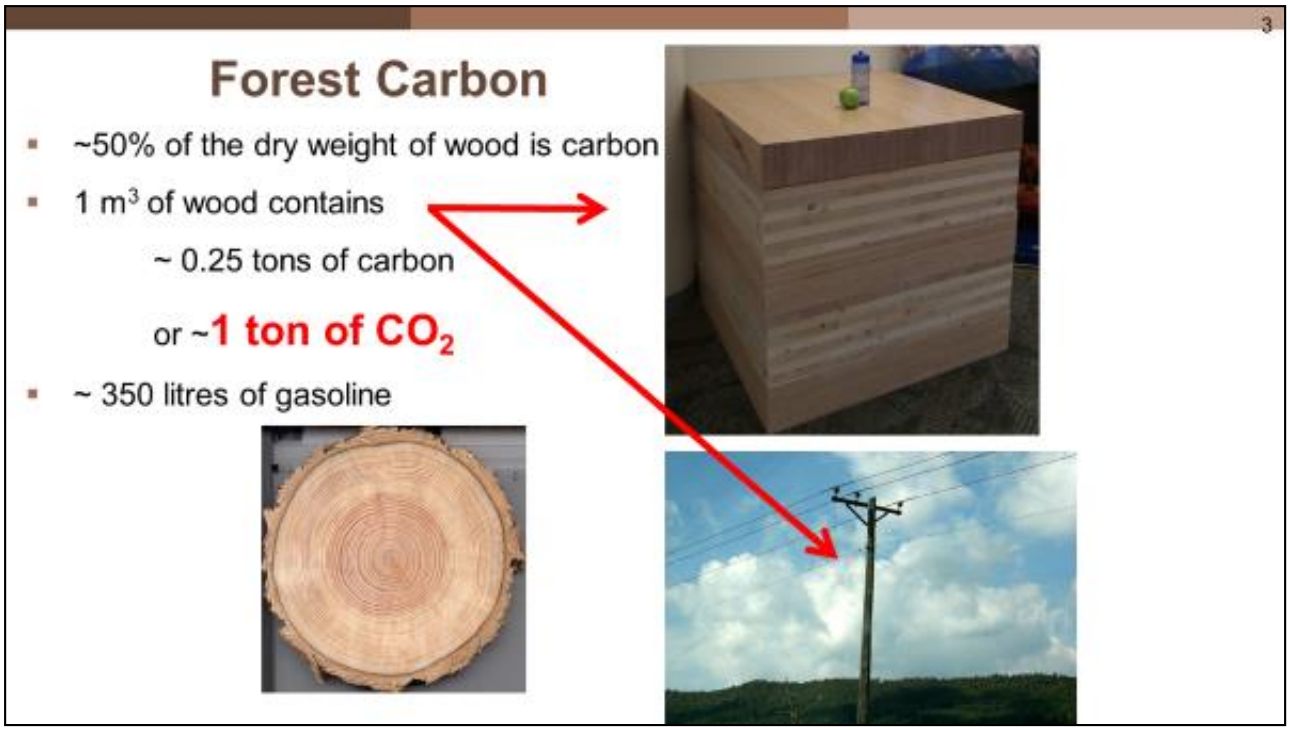
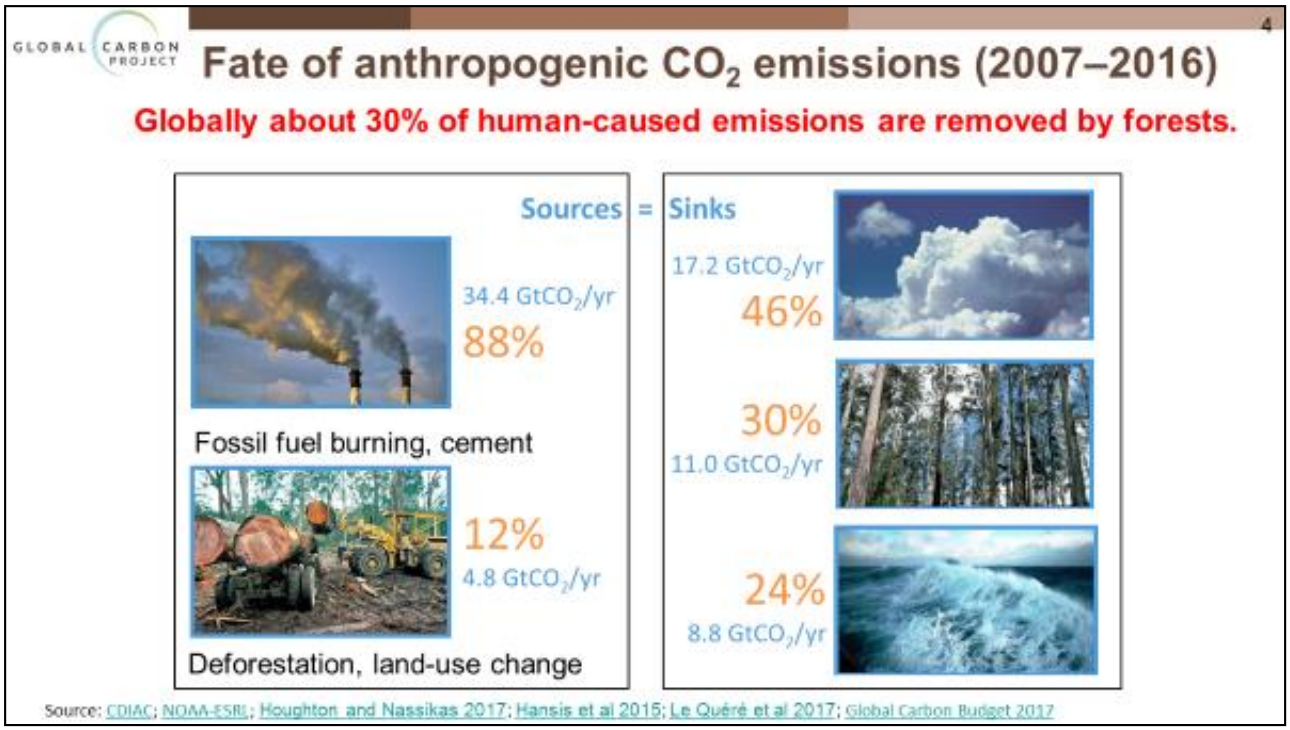
- PICS established in 2008, consortium of 4 BC universities.
- Five large projects (and other activities)
- I lead Forest Carbon Management Project, but I am also Senior Research Scientist at the Canadian Forest Service of Natural Resources Canada where I lead the team responsible for Canada's National Forest Carbon Monitoring, Reporting and Accounting System
- The tools we have developed over the past 30 years are used across Canada, and around the world by governments, academics, industry and NGOs.
- Refer to bullets on the slide

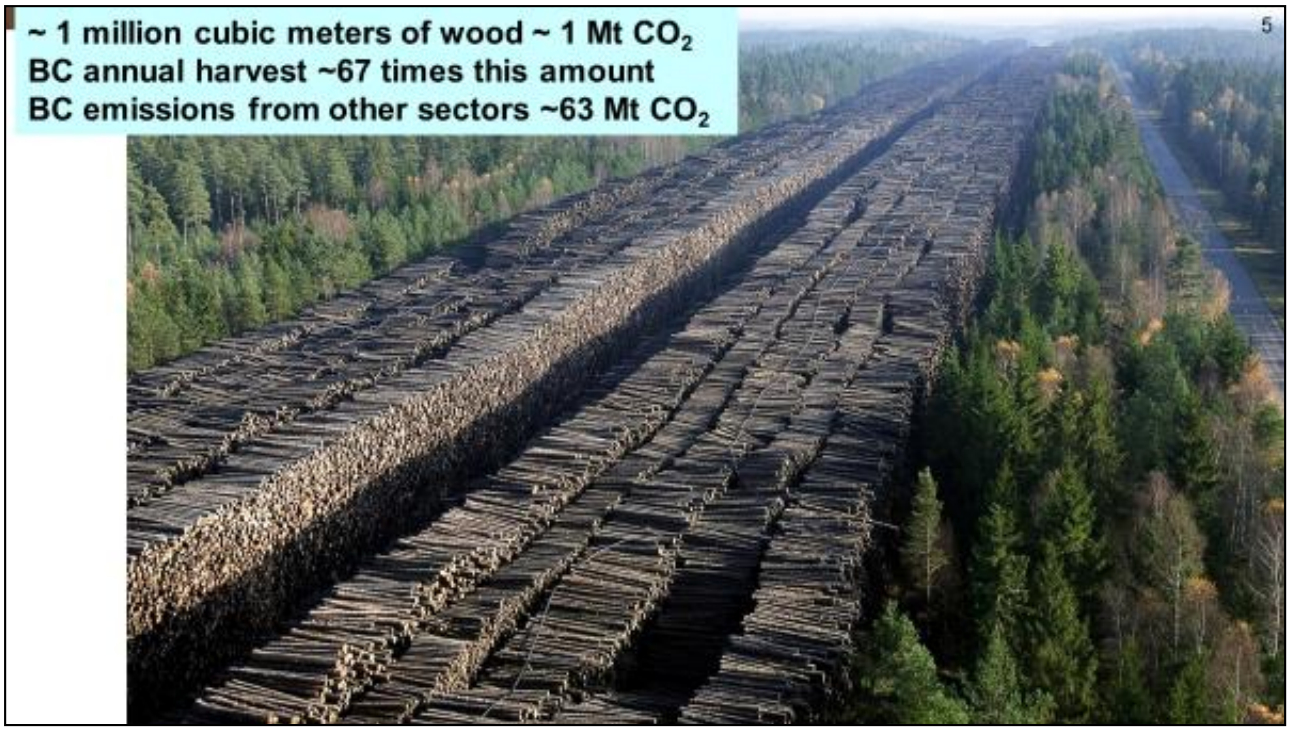


- ~50% of the dry weight of wood is carbon that was removed from the atmosphere as CO2.
- The carbon is converted into biomass, the oxygen released back into the atmosphere.
- 1 m3 of wood contains roughly the C from a ton of CO2 (differs by species).
- C in 1 m3 of wood similar amount as in ~350 litres of gasoline.



- Global emissions from burning of fossil fuels and cement manufacturing are about 34 billion tons of CO2 per year
- An additional 5 billion tons are released from the conversion of forests to other land uses, mostly in developing countries
- Less than half of the human-caused emissions remain in the atmosphere, as 30% are removed by forests and 24% by oceans.
- Climate change impacts may affect the future CO2 uptake by forests

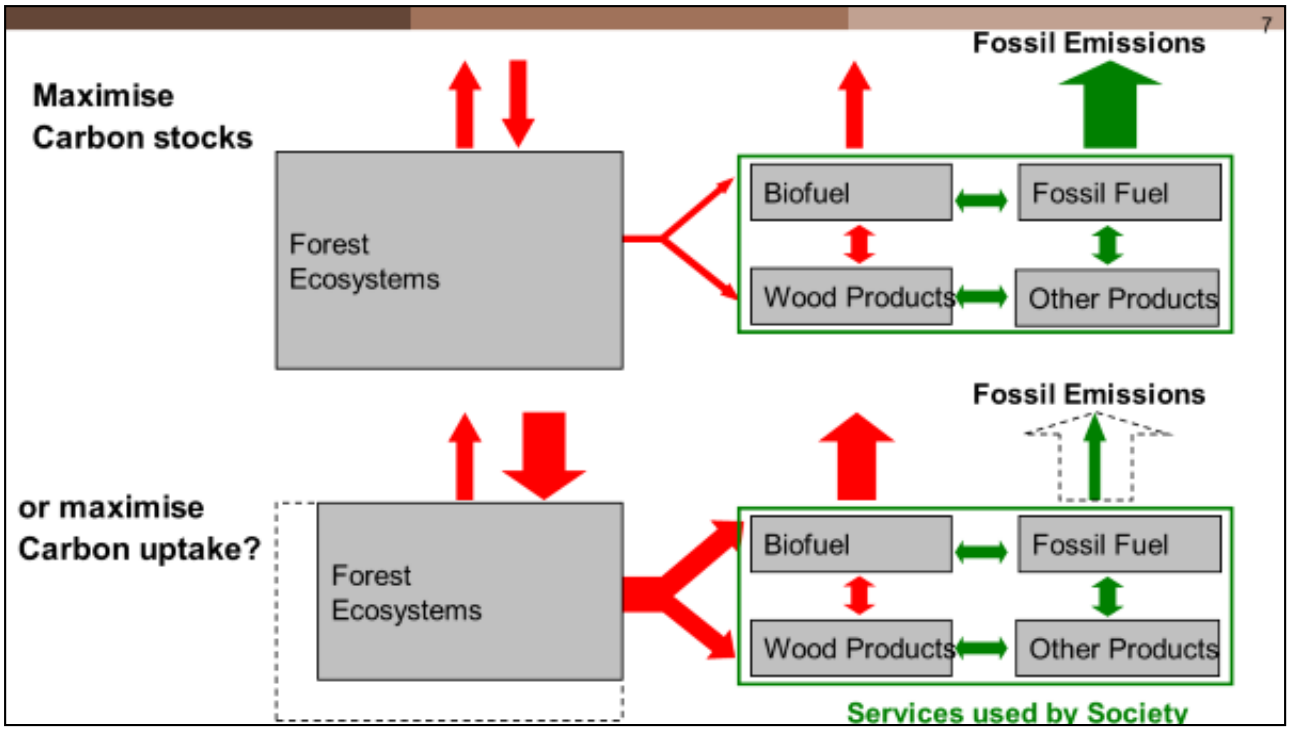
Footnote: there is a 2.2 Gt (6%) imbalance in the budget estimates of global sources and sinks



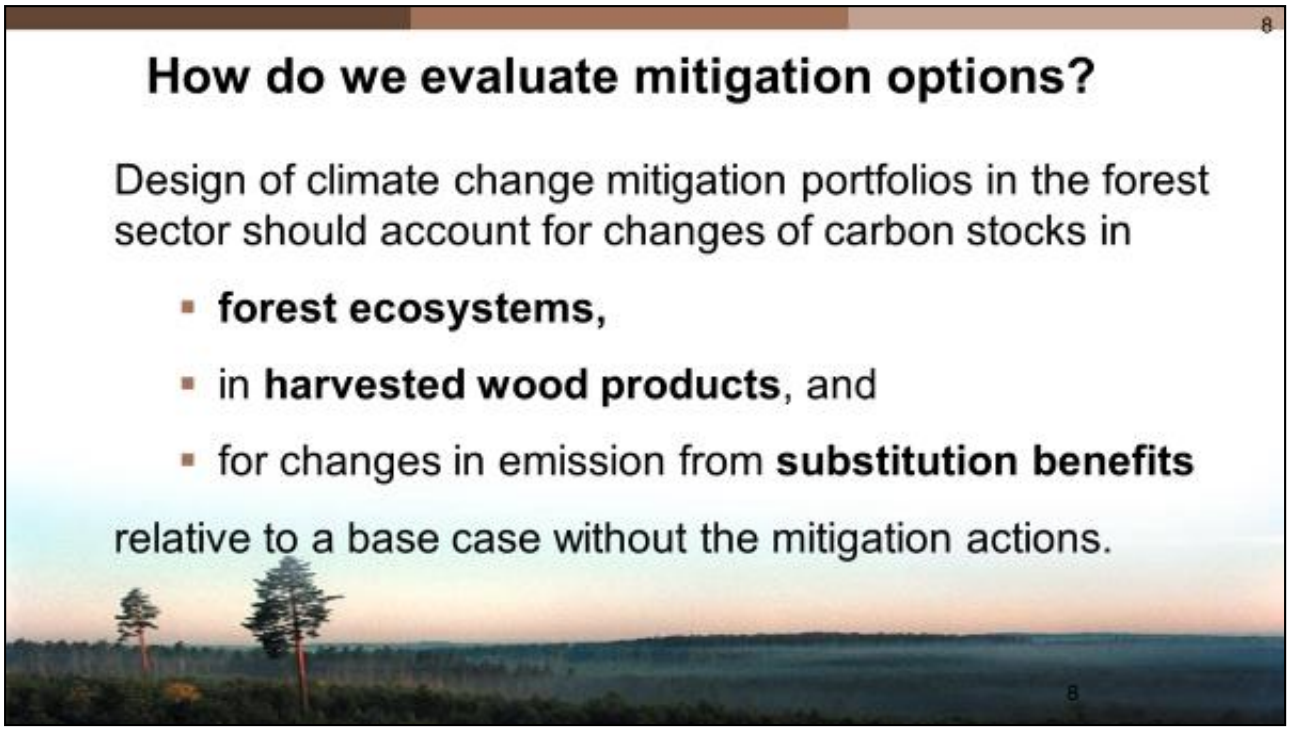
Mt = megatonnes (million tonnes), CO2 = carbon dioxide

- This is a photo of 1 million cubic meters of wood, salvaged in Sweden after a very large windstorm.
- In BC, the carbon contained in the wood that we harvest annually is about 67 times this amount, more than the carbon contained in the emissions from all other sectors in BC.
- All of this harvested carbon has previously been removed from the atmosphere and will be removed again as forests regrow.
- How forest products are used will determine how much and how fast the harvested carbon is released back into the atmosphere.

The forest sector is removing CO_2 emissions from the atmosphere and turns them into valuable products.



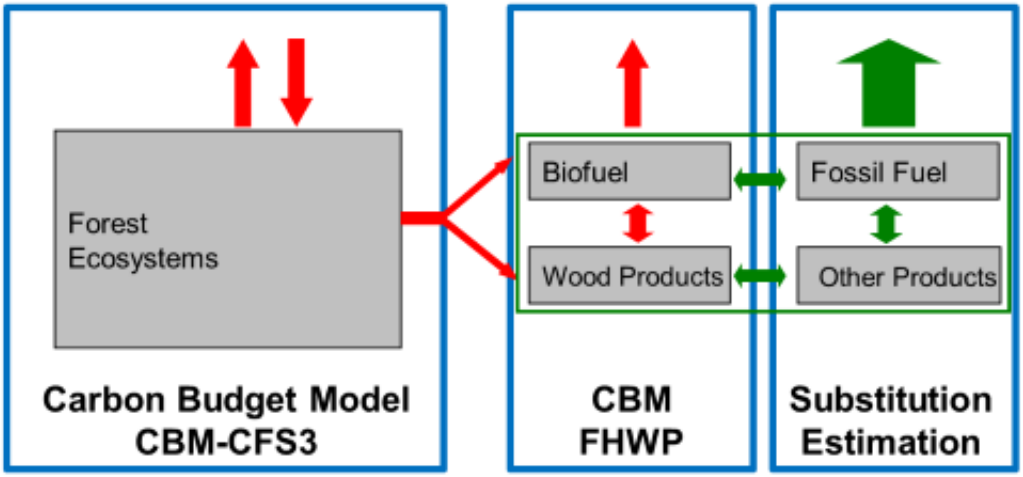
- There is considerable debate about approaches to forest management that focus on conservation and maximizing carbon stocks in forests or
- Managing forests in such a way that they remove large amounts of CO2 from the atmosphere and provide materials such as timber, biomass and fibre to meet societies needs.
- As scientist, we seek to contribute to this often emotional debate by quantifying alternative management strategies and their impacts on the atmosphere.



- How do we evaluate mitigation options?
- Based on work that we have published with the Intergovernmental Panel on Climate Change in 2007, we take a systems perspective.
- We do not focus on forests alone but we also evaluate a changes in carbon storage and emissions in harvested wood products and through the use of HWP.
- And we always compare the results against a base case in which no mitigation actions have been taken.

- A wide range of mitigation options is available to focus of forests management and wood product uses on carbon and GHG objectives
- To produce longer-lived wood products and to use these to replace other emissions intensive materials.
- We have analysed some of these options

Mitigation analyses: analytical framework



CBM-CFS3 and CBM-FHWP used for Canada's National GHG inventory reporting.

- For our analyses we use the same data and computing infrastructure that our team also uses to report on the GHG emissions and removals in Canada's managed forests and harvested wood products sectors.
- In addition, we estimate the marginal impacts on the atmosphere of changes in available wood products on emissions in other sectors, such as concrete and steel but also from burning of fossil fuels.

Mitigation Analysis for BC

Climate change mitigation strategies in the forest sector: biophysical impacts and economic implications in British Columbia, Canada

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Zhen Xu[1] · Carolyn E. Smyth[2] · Tony C. Lemprière[3] · Greg J. Rampley[4] · Werner A. Kurz[2]

Mitigation and Adaptation Strategies for Global Change: 2017

By 2050,18.2 MtCO_2e/yr or **35% of BC's emission reduction target can be contributed by the forest sector** at less than $100/tonne of CO_2e with additional socio-economic benefits.

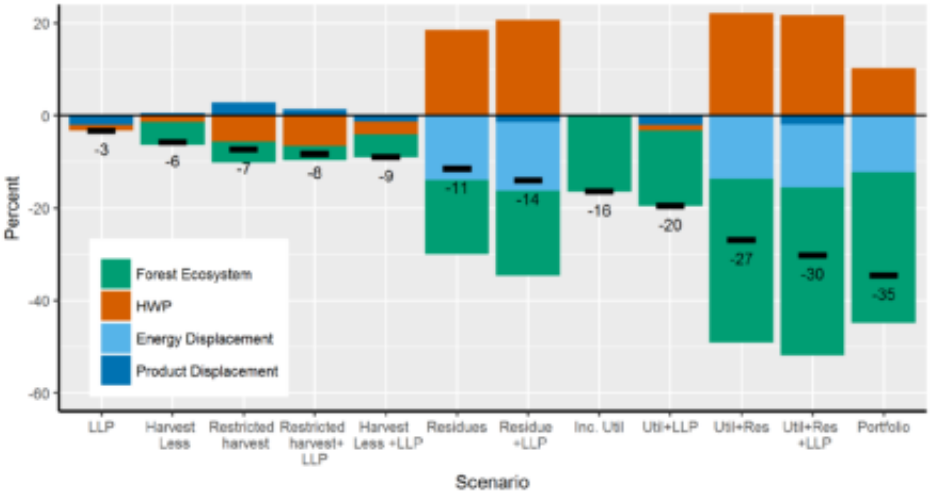
Greater contributions are possible with more ambitious actions.

Open Access at http://link.springer.com/article/10.1007/s11027-016-9735-7.

- Our team published several peer-reviewed papers and I will focus on only one study here.
- We evaluated a series of options to change forest management or the use of wood products in BC.
- BC GHG reduction targets are 30% by 2020 and 80% by 2050 (relative to 2007)
- We estimated that it is possible to achieve 35% of the 2050 target with a regionally-differentiated portfolio of mitigation actions (18 Mt CO2e/yr in 2050)
- The costs of achieving this are less than $100/tonne of CO2e – which is very competitive compared to other options but the cumulative costs are still very high.

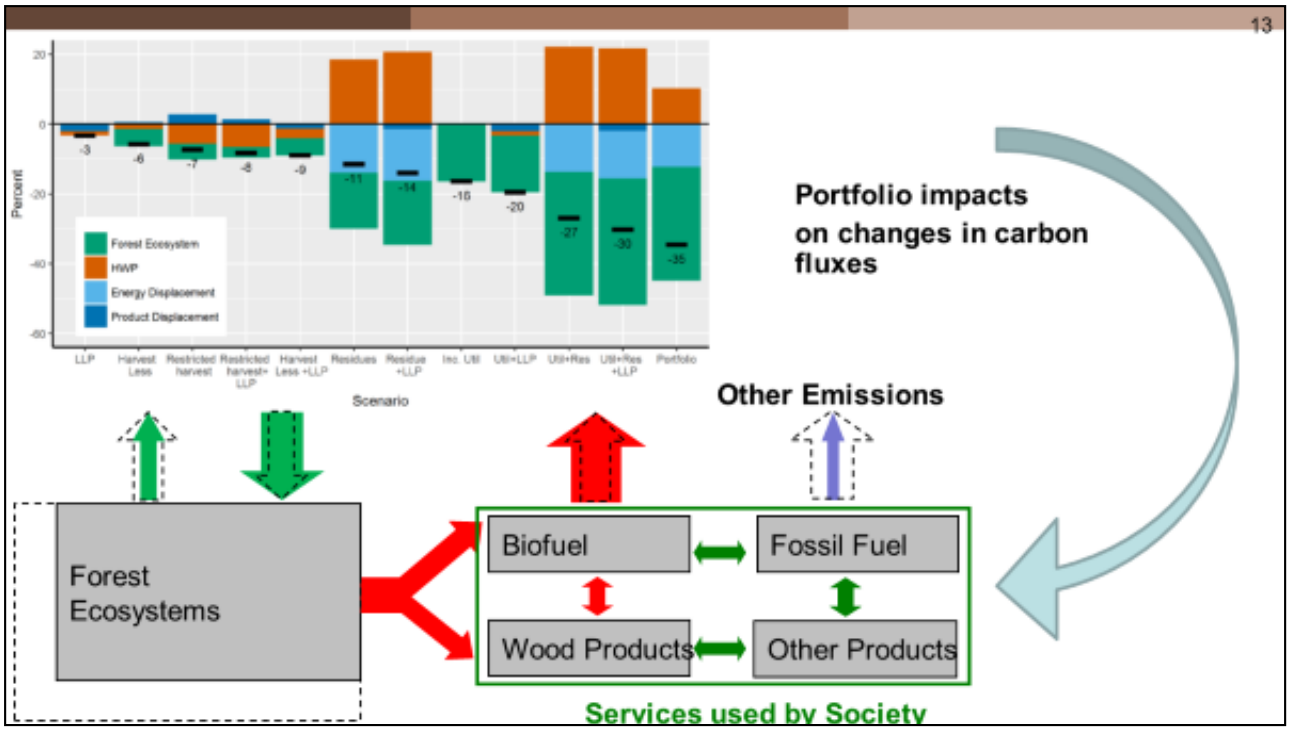
Results (Xu et al. 2017)

Best mitigation activities vary by region in BC: a portfolio of regionally-differentiated forest management and wood-use strategies can achieve 35% of emission reductions in BC by 2050.

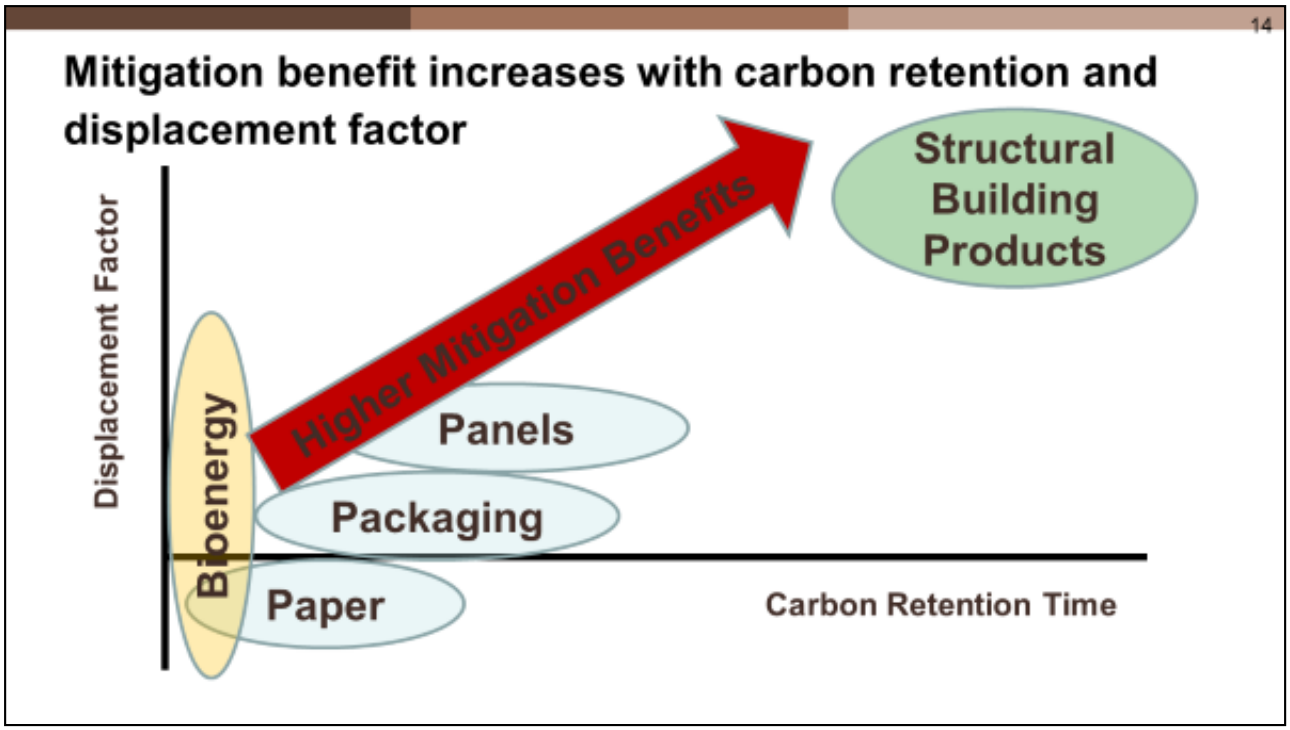


Increased wood product emissions, but these reduced emissions from non-wood sources, and reduced emissions or enhanced sink in the forest.

- Without going into details, this graph summarizes the results for 12 of the scenarios that have been analysed.
- A bar below the zero line indicates that this component contributed to an emission reduction, above the line to an increase.
- The horizontal black line in each bar indicates the sum of the positive and negative contributions.
- The portfolio (right most bar) includes a variety of regionally-differentiated actions.
- In this portfolio the forest sink strength is increased and higher emissions from harvested wood products are the consequence of reducing emissions from other products, in particular fossil fuels.
- The net impact in 2050 is a reduction by about 18 Mt CO2e per year about 35% of BC's GHG reduction target

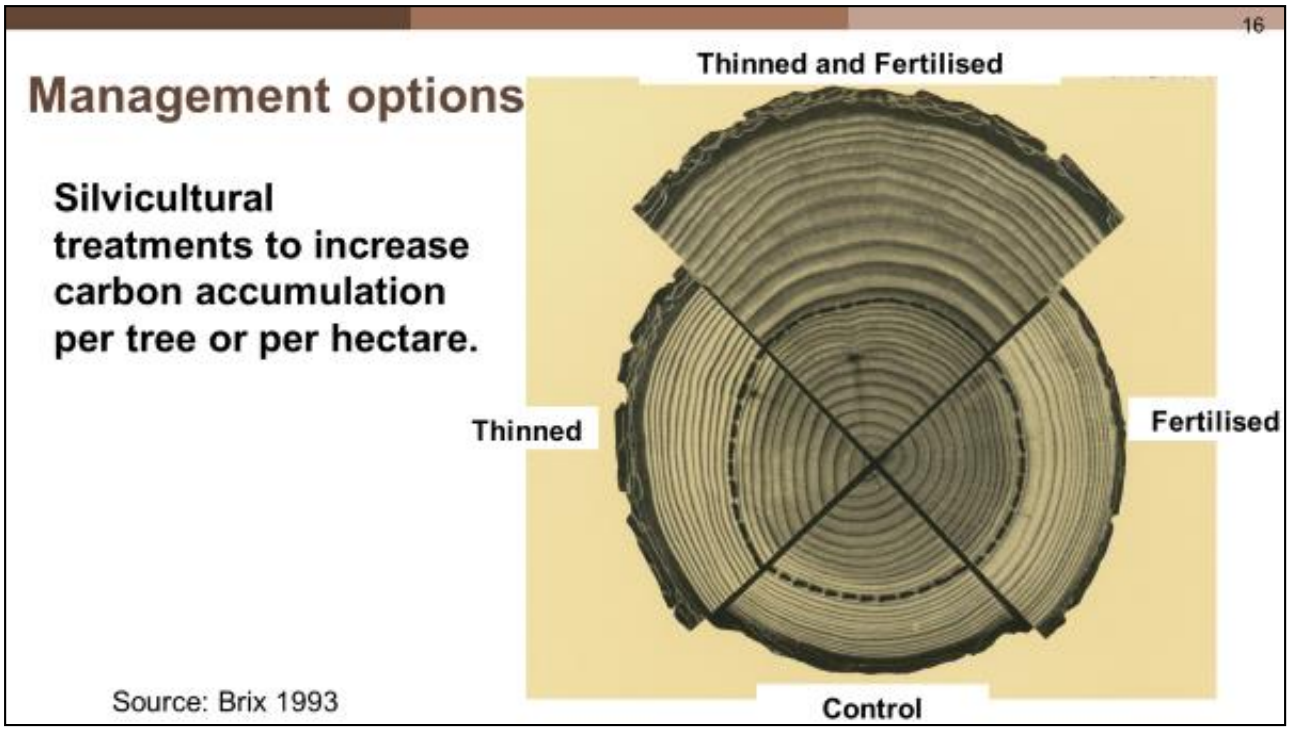


- This graph summarizes the changes in fluxes resulting from the mitigation scenario:
- Sources in forests ecosystems are reduced and sinks are increased,
- Emissions from forest products (in particular through the use of bioenergy have increased)
- Emissions from other sectors – both from products and fossil fuels have decreased.
- Note that in the case of the portfolio the emissions from other non-fossil fuel products have both increased and decreased in different regions of BC with a net effect of near zero.
- The bars in the upper graph are to scale – the width of the arrows in the lower graph is not proportional to the fluxes.



- To increase the mitigation benefit of wood uses is achieved by converting wood into long-lived products that substitute for other emissions intensive materials.
- This also generates biomass and residues that can be used for bioenergy to replace, for example, long-range transportation fuels.
- Innovative wood products can produce other materials such as textiles, plastics, and carbon fibre but while this is technically possible, it is costly and no operational facilities exist in BC.
- Note that this is a conceptual diagram with approximate X/Y values only

- These are examples of buildings using modern mass timber construction methods.
- They not only store large amounts of carbon, but they can also be esthetically pleasing.



- Increasing the use of wood is only possible if forests are managed sustainably
- Many opportunities exist to increase forest carbon sinks and to reduce sources.
- Enhanced forest management can be financially viable if carbon removals from the atmosphere can be paid for as ecosystem service.

Opportunities to reduce emissions from post-harvest burning of residues

BC emissions about 5 Mt CO_2e/year

Alternate uses of biomass?

At what cost?

- The burning of harvest residues in BC releases about 5 million tons of CO2 per year
- Research is ongoing to explore strategies to reduce emissions from slash pile burning. For example, some of the wood could be converted into products or bioenergy.
- Barriers to change include costs for transportation and processing of the biomass materials, long-term supply and demand for products.

2017 BC wildfire emissions estimated at ~3 times the emissions from all other sectors in BC

- While mitigation options exist, climate change will also bring risks to carbon losses from forests.
- In 2017, wildfires in BC released about 180 million tons (± 25% - this is a very preliminary estimate!)
- This is about 3 times the emissions from all other sectors combined in BC.
- GHG impacts over the Mountain Pine Beetle were even larger but over a much longer period.

Conclusions

- GHG emission reduction goals cannot be reached without
  - reduction in burning of fossil fuels and
  - the forest sector contributing strong sinks (net negative emissions).
- PICS team's research therefore focuses on:
  - how the forest sector can mitigate climate change,
  - how forests will be affected by the changing environment, and
  - what policies can help achieve mitigation objectives, cost-effectively and with the support of the public.
- BC's forest sector can make a significant contribution to mitigation but is also very vulnerable to climate change impacts.
- Effective mitigation strategies involve sustainable forest management, use of long-lived products for C storage and substitution, and bioenergy.

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PICS Forest Carbon Management Project: here

Publications at CFS Bookstore

Recent Publications

Kurz et al. 2016. **Climate change mitigation through forest sector activities: principles, potential and priorities**. Unasylva 246 (67): 61-67. www.fao.org/3/a-i6419e.pdf

Lemprière et al. 2017. **Cost of climate change mitigation involving's Canada's forest sector.** Canadian Journal of Forest Research. DOI: 10.1139/cjfr-2016-0348 http://www.nrcresearchpress.com/doi/pdfplus/10.1139/cjfr-2016-0348

Smyth et al. 2016. **Climate change mitigation potential of local use of harvest residues for bioenergy in Canada**. Glob. Chg. Biol. Bioenergy. DOI: 10.1111/gcbb.12387 http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12387/abstract

Smyth et al. 2016. **Estimating product and energy substitution benefits in national-scale mitigation analyses for Canada**. Glob. Chg. Biol. Bioenergy. DOI: 10.1111/gcbb.12389 http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12389/abstract

Xu et al. 2017. **Climate change mitigation strategies in the forest sector: biophysical impacts and economic implications in British Columbia, Canada**. Mitigation and Adaptation Strategies for Global Change. DOI: 10.1007/s11027-016-9730-z http://link.springer.com/article/10.1007/s11027-016-9735-7.

Spare slides

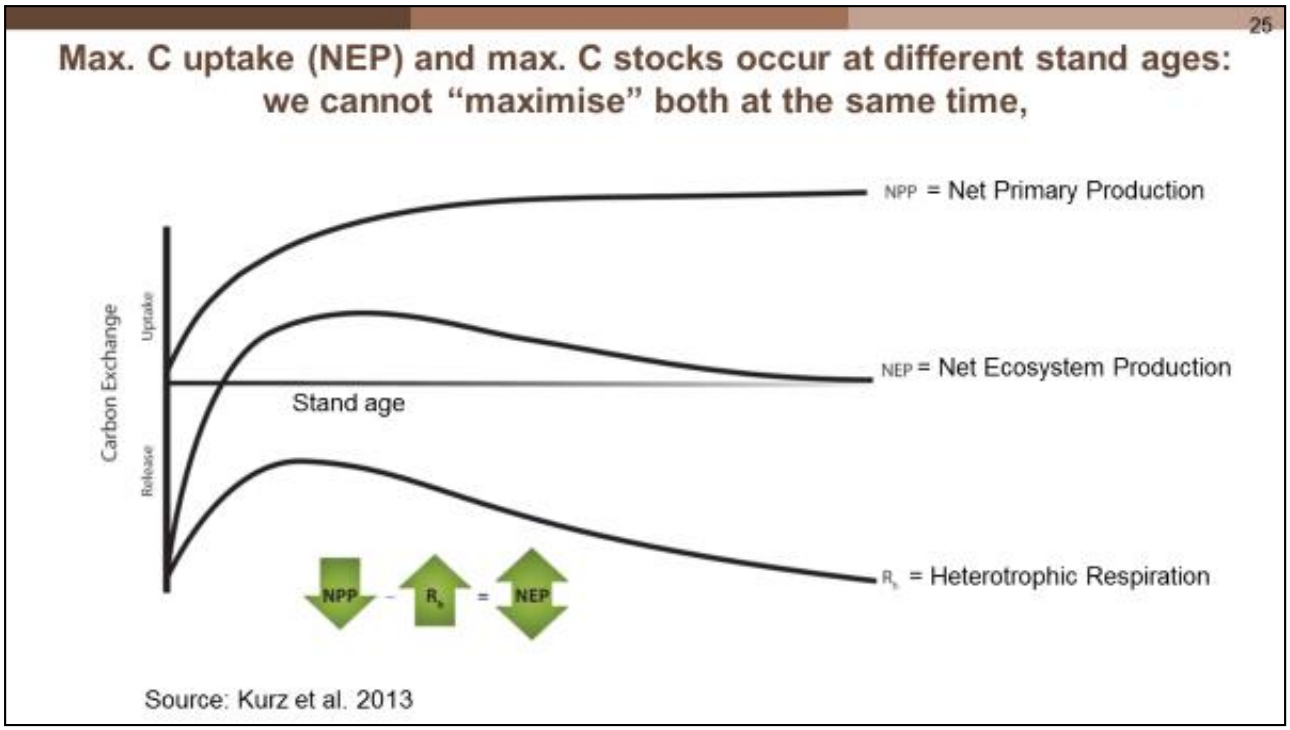
The future of forest carbon management?

- Placing a price on carbon could enable protection, planting and other silvicultural activities that in the past have been considered “uneconomical”.
- Climate change impacts (fire, insects, drought) will create many dead trees: shifting from green tree to salvage logging, site rehabilitation, assisted tree migration and enhanced silviculture can help increase C sinks relative to the “no action” scenario.
- Government investments to enhance forest carbon sinks can contribute to climate-effective, cost-effective mitigation portfolios.
- **Forest carbon management demonstration areas** can help improve public understanding and acceptance of carbon-focused management.
- Monitoring of carbon dynamics required to demonstrate value of mitigation investments.

Analyses and monitoring required for C mitigation programs

Forest C mitigation and reporting its outcome in national GHG inventories requires tools and data to establish:

1. Business-as-usual **baseline** of C dynamics without mitigation action.
2. **Projection** of C dynamics to evaluate alternatives and design climate and cost-effective mitigation portfolios.
3. **Monitoring** actual C dynamics following implementation of actions.
4. GHG inventories **report** actual emissions, difference between baseline and actual required to demonstrate effectiveness of investments.
5. Investing into mitigation actions without monitoring will undermine the **credibility** and sustainability of mitigation financing.



- The forest carbon balance is a small difference between two large fluxes – the production of organic matter (measured as net primary production) and the loss of organic matter from decomposition (measured as heterotrophic respiration).
- The magnitude of these two fluxes changes with stand age.
- Old forests have the largest carbon stocks, but young and middle-aged forests remove carbon from the atmosphere at the highest rates.
- It is not possible to maximize both carbon stocks and carbon sinks in the same stand or landscape.