Assessing Post-Fire Salvage Harvest Supply Chains for Wood Product and Bioenergy Production: A Case Study in BC

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Natural Resources Canada
Ressources naturelles Canada

Canada

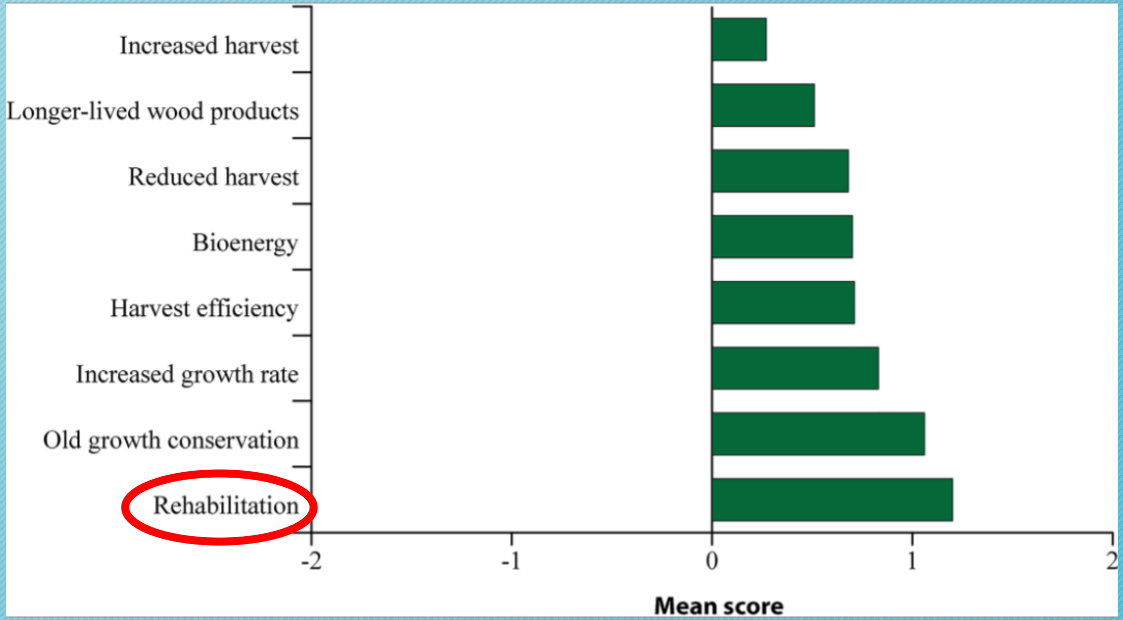
Background

- Earlier national analysis of GHG reduction scenarios included post-fire restoration, but it wasn't impactful.

- BC analyses of climate change mitigation activities focused on changing harvest levels, longer-lived wood products, bioenergy, and greater harvest utilization.

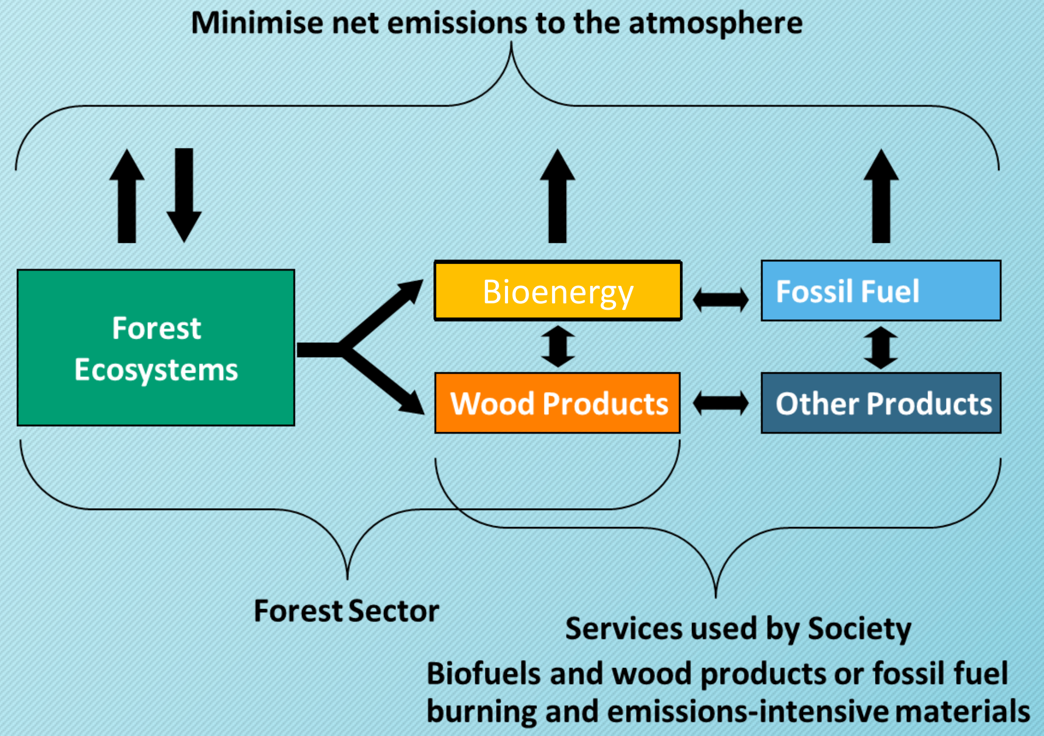
- Public perception of mitigation activities

- Large fires in BC in 2017/2018 led to questions on availability of fire-killed biomass and GHG benefit of post-fire restoration



System approach for post-fire restoration

Systems Perspective in Climate Change Mitigation Analyses



System approach

Examine mitigation options for forest management, wood use and substitution benefits from avoided fossil fuel burning or emissions-intensive materials

Baseline Scenario

- After wildfire occurs, stands regrow pre-existing species and growth rate

Rehabilitation Scenario

- For suitable, accessible stands, salvage harvest fire-killed stands, slashburn and replant timber species with managed yield curves

Reduced emissions in the forest ecosystem (less decay or slashpile burning).

Increased biogenic emissions from bioenergy, biofuel burning, wood products. Fewer fossil emissions.

Spatially explicit workflow

Forest ecosystem

Forest ecosystem modeling @ 1 ha (Generic Carbon Budget Model)

Baseline: do-nothing

Rehabilitation: post-fire salvage harvest and replant (accessible and suitable stands)

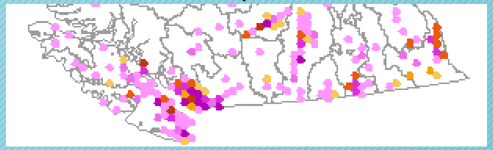
50-year stack of 100 wild fire futures

Buffered road layer

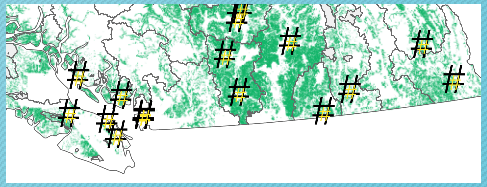
OR

Wood products and bioenergy

Use salvage harvest for bioenergy in 10 communities (electricity and/or heat) or biofuels, and estimate haul costs. Optimize for lowest GHGs.



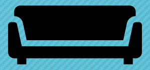
Use salvage harvest for products. Haul costs and delivered fibre for 28 mills.



Substitution benefits

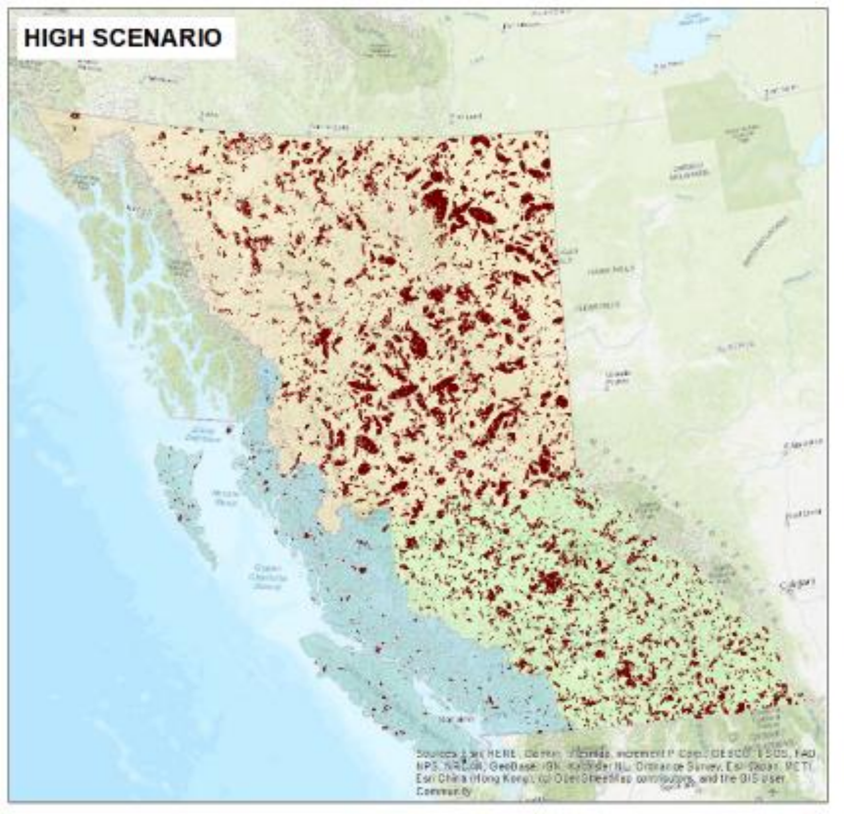
Optimized bioenergy/fuel facility selection (maximize avoided fossil fuel emissions) with future decarbonization.

Avoided emissions-intensive materials (general use).



Future wildfires: Statistical projections

Draw 1, 2020 to 2070



Fit log-normal distributions of historical annual area burned and the number of fires.

Three regions (north, south, and coast) fitted separately, based on 1950 to 2018 area burned.

Assumed annual area burned increased linearly to double over 50 years.

100 draws of 50-year future fires. (Draw 1 shown on left).

Simple ellipsoidal fires placed randomly on forest.

Delivered biomass and haul costs

Salvage harvest softwood stands, within 500 m of road, moderate to high site index, eligible for harvest.

Haul costs were estimated using a provincial road, rail and barge network assuming fixed costs

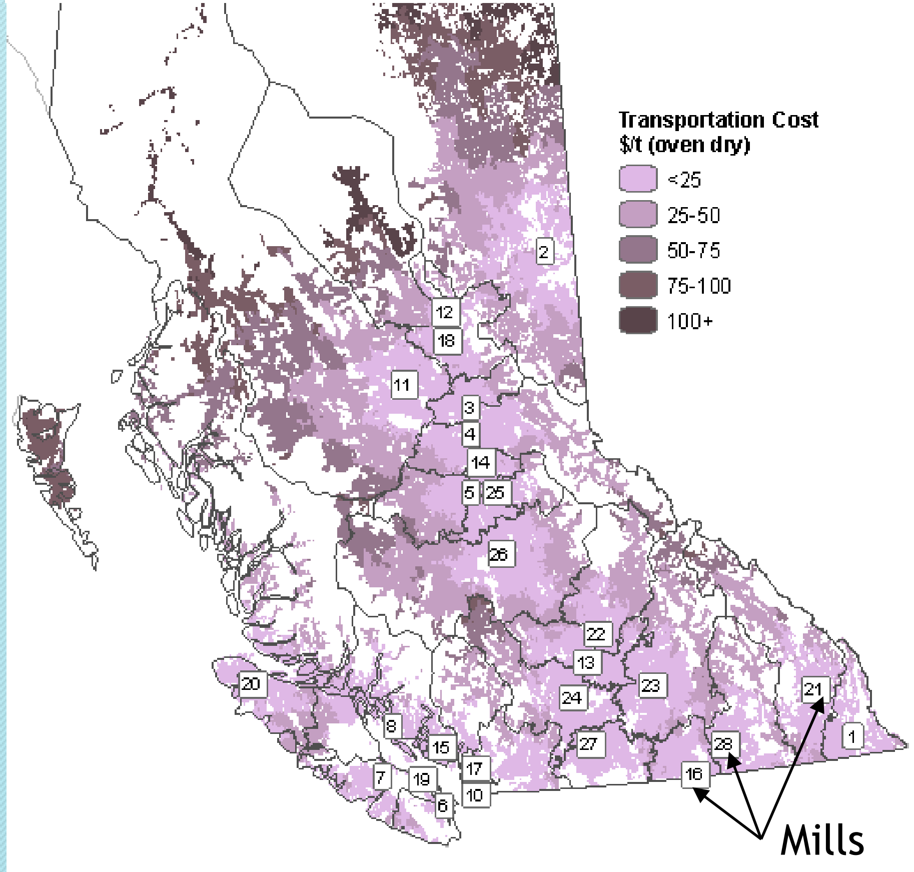
- paved road 0.16$/km/odt
- unpaved road 0.31$/km/odt
- rail 0.23$/km/odt + $2 transhipment
- barge 0.1$/km/odt + $2 transhipment

- Haul to closest mill: 28 Mills selected from BC's 2015 GHG inventory

- Haul to communities within $100 haul cost: 10 communities

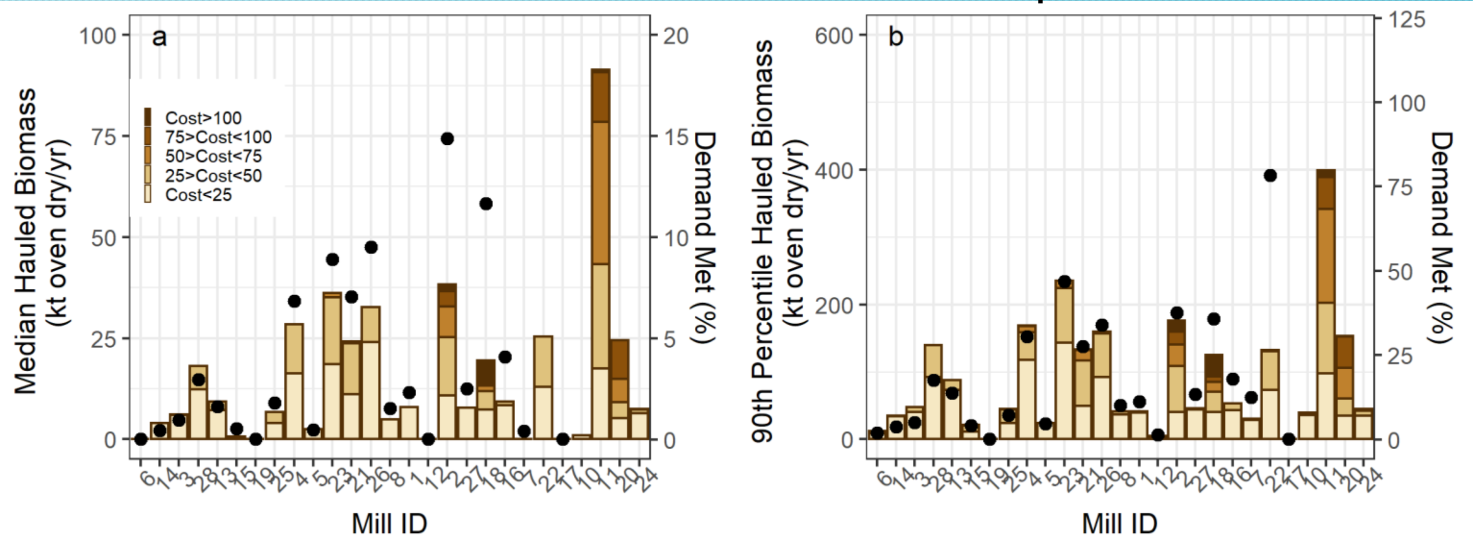
Distribution of biomass delivered to mills

Fibresheds of selected mills by cost threshold, median over all years



Median

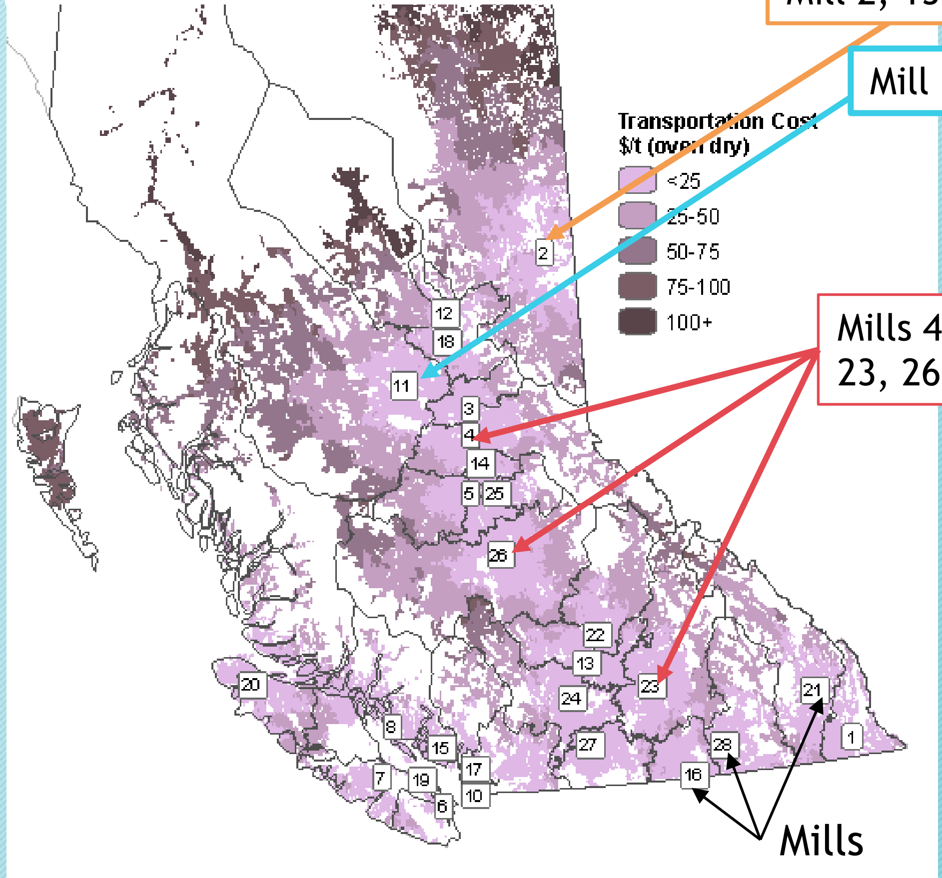
90th percentile

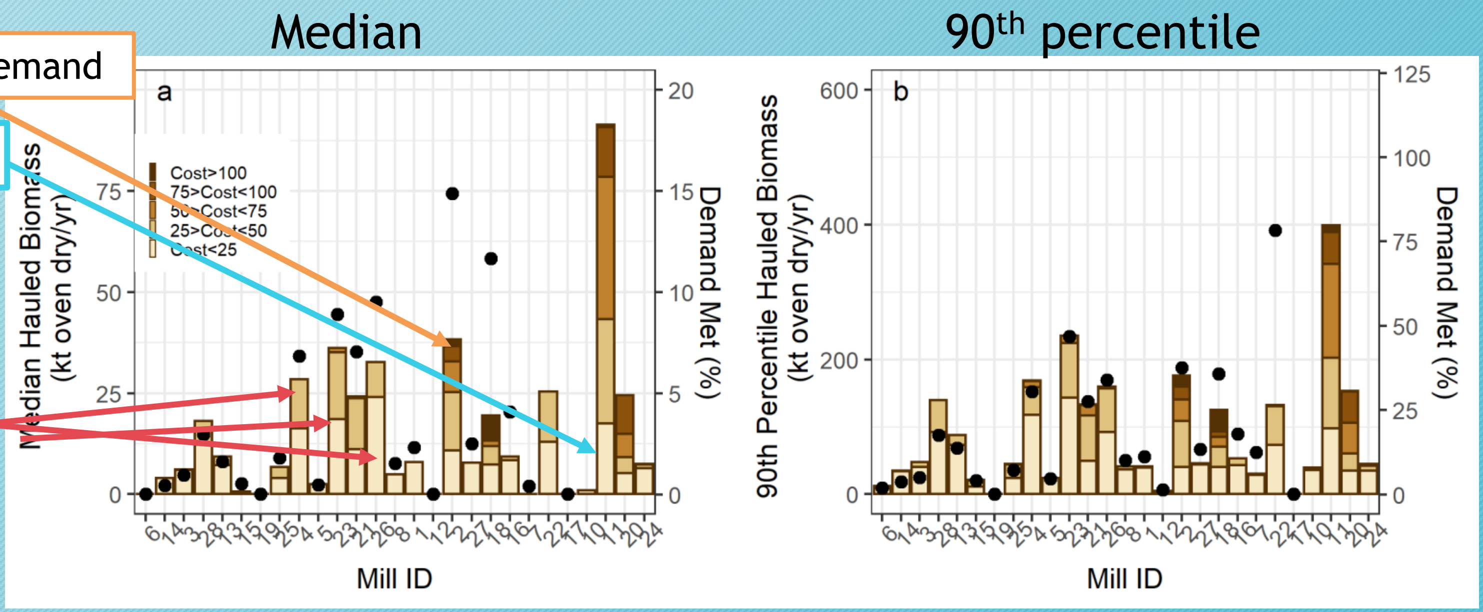


Much of the biomass can be hauled to the mill at < $25/ODT.
High variability in delivered biomass.

Distribution of biomass delivered to mills

Fibresheds of selected mills by cost threshold, median over all years



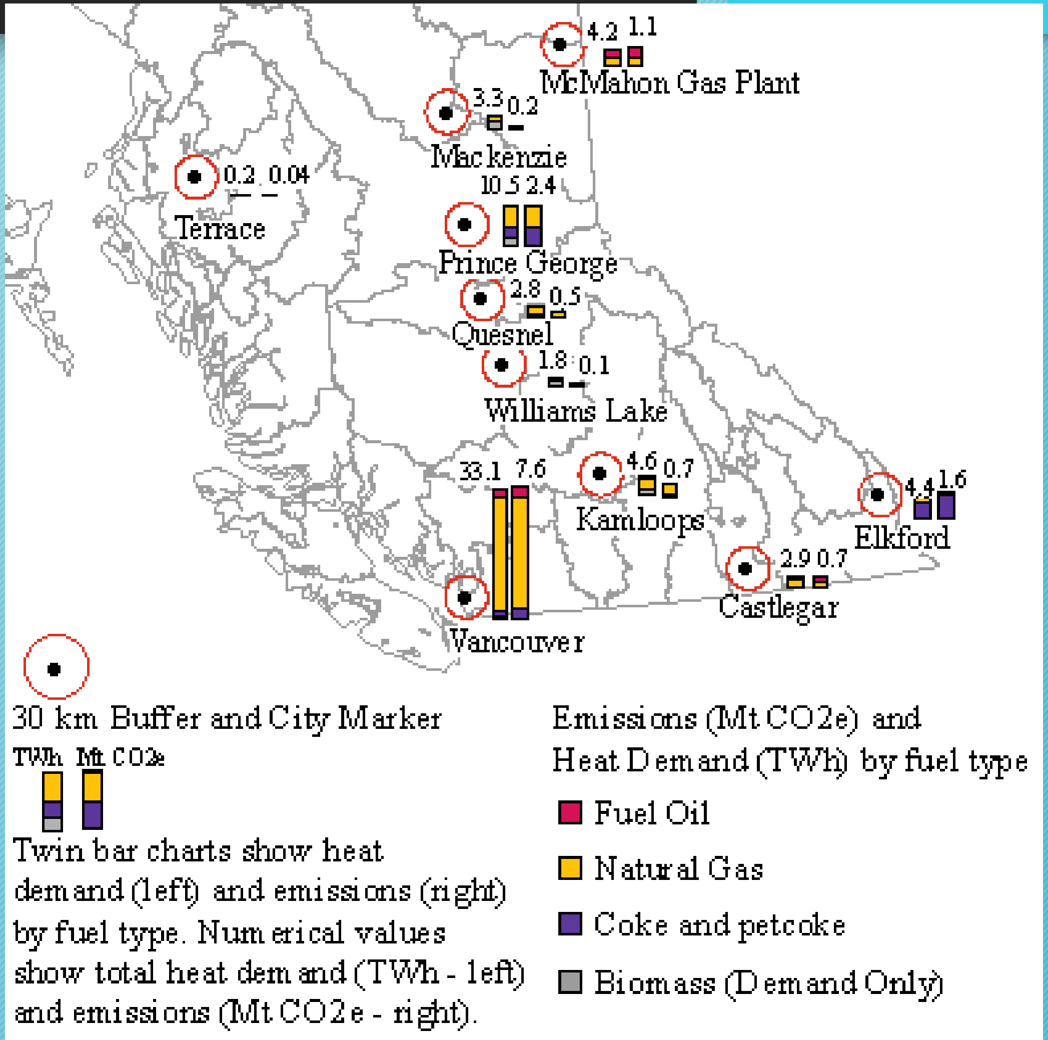


Much of the biomass can be hauled to the mill at < $25/ODT.
High variability in available biomass.
Could meet up to 15% of input demand (median).

Bioenergy and biofuels pathways

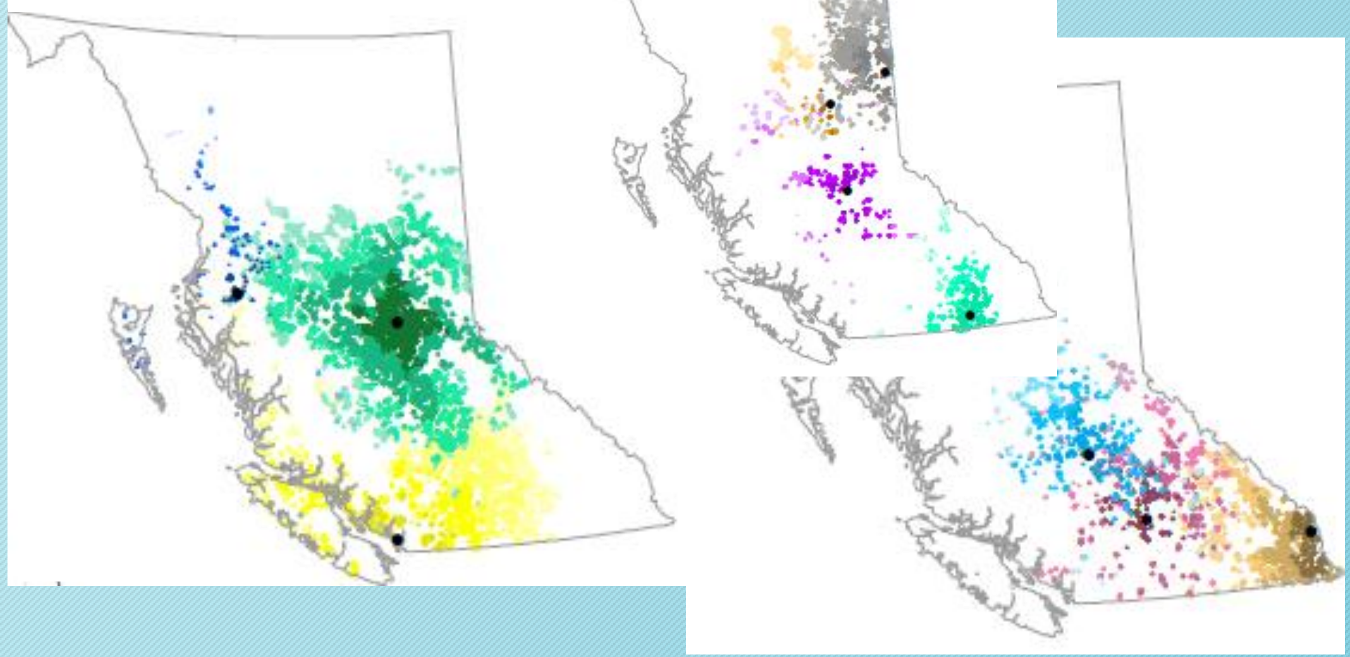
Estimate the net change in GHG emissions from salvage harvest for bioenergy and liquid transportation fuels (HTL)

- Use optimization for 10 communities (3 bioenergy facilities versus 1-stage or 2-stage biofuels)
- Community-level information on fossil fuel use
- Assume decarbonization: stationary combustion emissions reduced to 0 in 2070



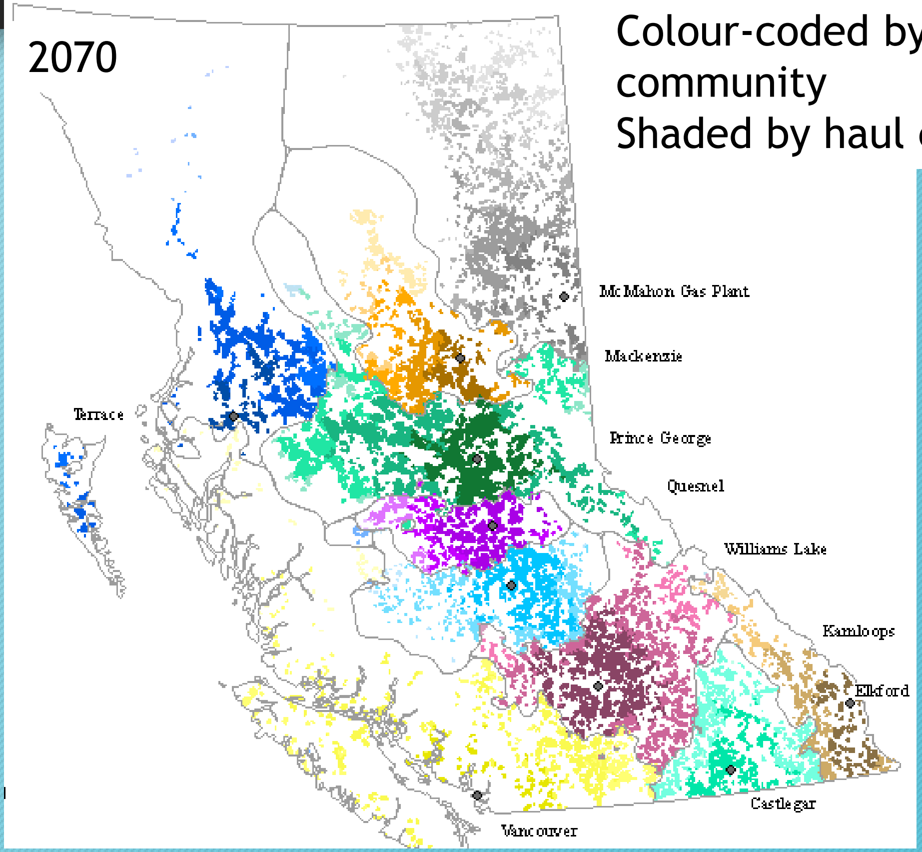
Spatial allocation of biomass

2050



Allocation by community for heat and electricity (shown split into 3 maps) shows large allocation of bioenergy in Vancouver and Prince George. In PG, can satisfy 10% of heat demand).

2070



Colour-coded by community
Shaded by haul cost

Biofuel production was 0.32 Bl yr^{-1} (median), and up to 1.3 Bl yr^{-1}. Displacement factors were between 0.21 to 0.29 for all communities.

Summary

Restoration of fire-killed stands on *suitable and accessible regions* ~ 14% of burned area, but variable supply

Delayed climate change mitigation benefit
- Carbon sink enhancement from regrowth takes time
- Harvesting generates residues that must be managed to abate wildfire risk (often burned)
- Net GHG reduction
  - Products: -44 $MtCO_2e$ (range -32 to −79 $MtCO_2e$) after ~ 2050
  - Bioenergy: -7 $MtCO_2e$ (range -39 to 37 $MtCO_2e$) after ~ 2065

Fire-killed biomass supply chains
  - Products: Lower-cost supply chains in the southern interior, with competition between mills.
  - Bioenergy: Biomass is directed towards bioenergy until ~2055 (mostly to Prince George and Vancouver), and then towards biofuels as energy systems are decarbonized.

Next steps: national post-fire restoration

- Long history of modeling forest sector GHG mitigation opportunities

Climate change mitigation in British Columbia's forest sector: GHG reductions, costs, and environmental impacts

C. E. Smyth, Z. Xu, T. C. Lemprière & W. A. Kurz

Carbon Balance and Management **15**, Article number: 21 (2020)

- Improve future fire modeling. Future biomass, restoration

Forest Ecology and Management
Volume 529, 1 February 2023, 120729

Future fire risk and the greenhouse gas mitigation potential of forest rehabilitation in British Columbia, Canada

J.M. Metsaranta [a b], B. Hudson
W.A. Kurz [a c]

- Use biomass for bioenergy/biofuel

Contents lists available at ScienceDirect

Biomass and Bioenergy

journal homepage: www.elsevier.com/locate/biombioe

Fire-killed forest biomass for mills and communities and bioenergy GHG impacts

C.E. Smyth [a,*], B. Hudson [a], J. Metsaranta [b], C. Howard [c], M. Fellows [a], W.A. Kurz [a]

- Prototype: manage for wildfire

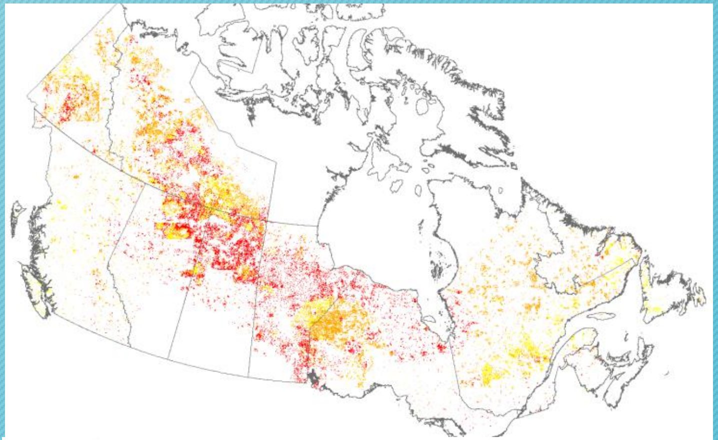
MethodsX
Volume 10, 2023, 101985

Method Article

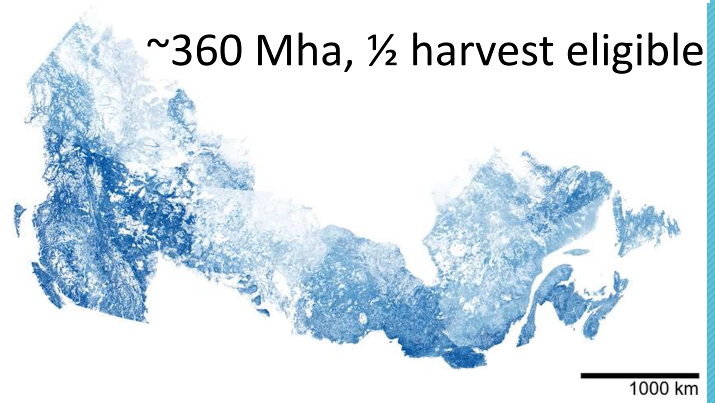
Development of a prototype modeling system to estimate the GHG mitigation potential of forest and wildfire management

C. Smyth [a], S.H. Xie [a, b], T. Zaborniak [a], M. Fellows [a], C. Phillips [c], W.A. Kurz [a]

National runs with forest and fire management



~360 Mha, ½ harvest eligible



Thank you

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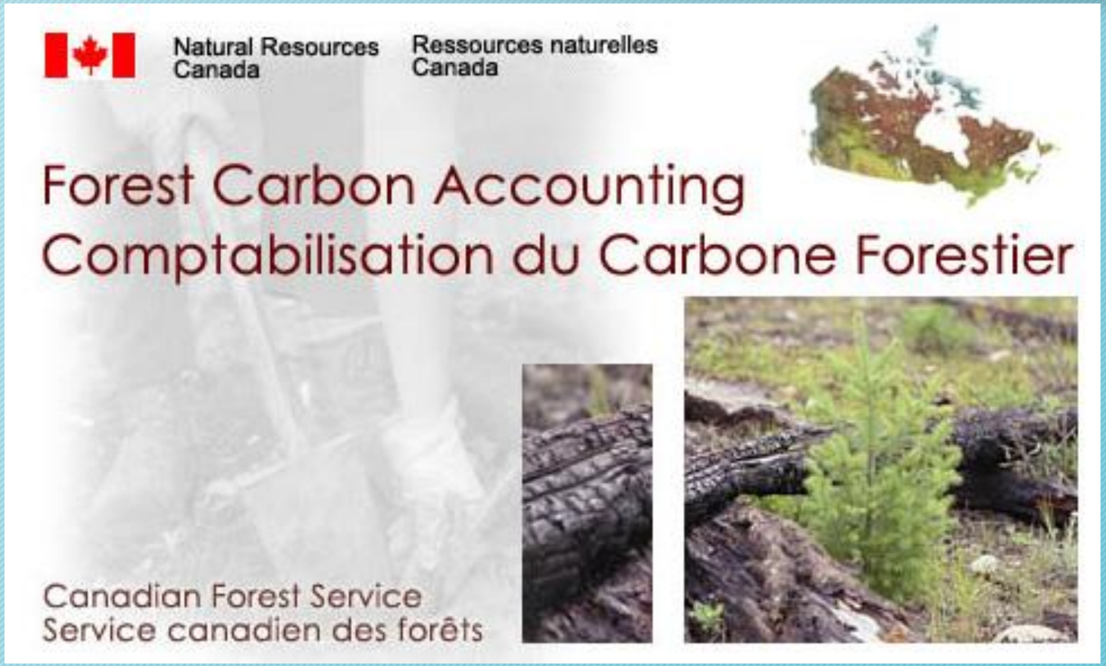


Reporting Canada’s forest greenhouse gas emissions and removals

Support from: Natural Resources Canada (Canadian Forest Service) Forest Innovation Program
Data provided by BC’s Ministry of Forests, Lands, Natural Resource Operations and Rural Development and BC’s Ministry of Environment and Climate Change Strategy
Thanks to: CFS Carbon accounting Team, Students/staff (Christina Howard, Amy Badger, Finnerty Cunliffe, Paulina Marczak, and Jenn Richards), and Consultants (Nick Walsworth and Simon Norris).

Publications

2020: Climate change mitigation in British Columbia's forest sector: GHG reductions, costs, and environmental impacts. Smyth et al. *Carbon Balance Manag.* https://doi.org/10.1186/s13021-020-00155-2 Biomass at 1 ha resolution, optimized facility selection, regional fossil fuel demand and costs.

2020: Bioenergy and biofuels in British Columbia, UBC M Sc. Thesis, C. Howard. Include transportation costs and emissions, add transportation fuels to optimization.

2020: Greenhouse Gas Mitigation Potential of Forest Rehabilitation after Severe Disturbance Events in British Columbia, SFU MRM thesis, B. Hudson

2018: Bioenergy Mitigation Potential: Refining Displaced Emissions from British Columbia's Heat and Electricity Production, Howard and Smyth. BC-X 442, https://cfs.nrcan.gc.ca/publications?id=39189 Regional fossil fuel demand, optimization to select facility for stationary combustion

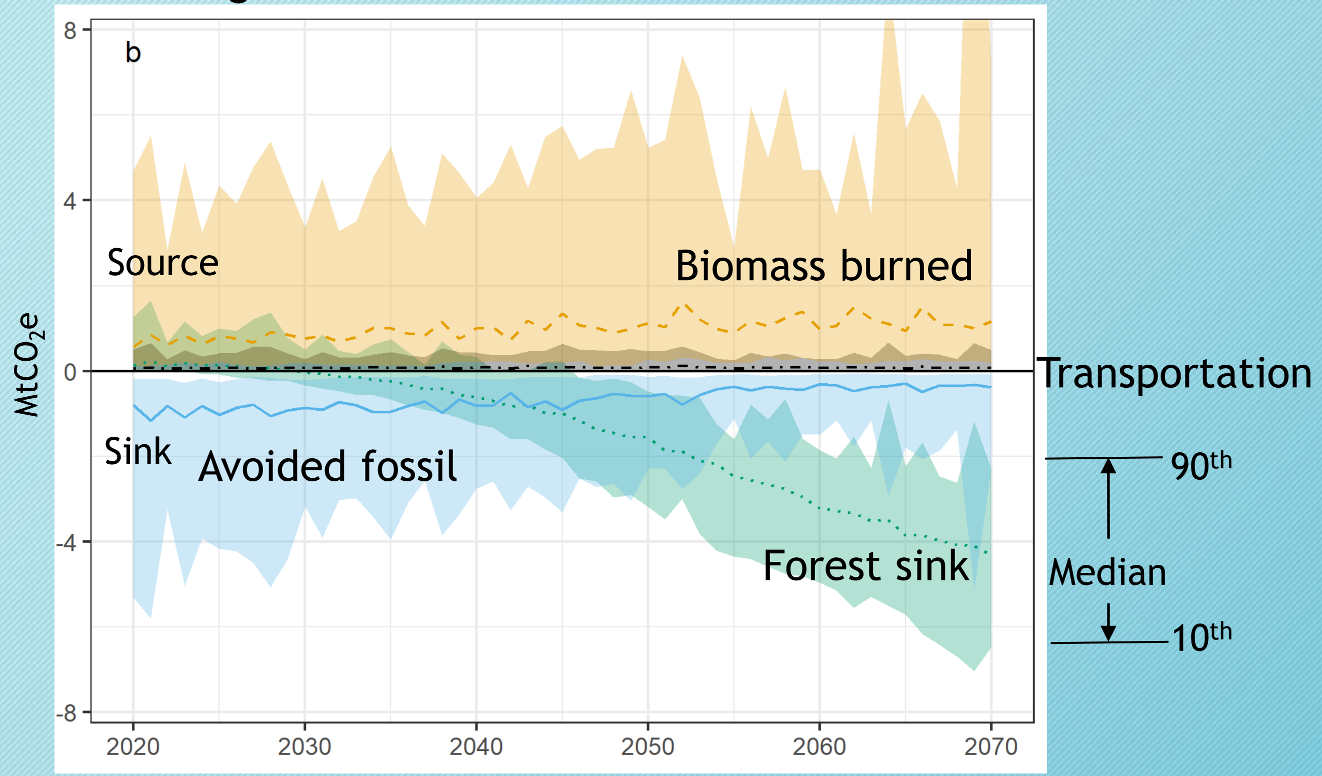
2018: Climate change mitigation in Canada's forest sector: a spatially explicit case study for two regions, Smyth et al. CBM https://cbmjournal.biomedcentral.com/articles/10.1186/s13021-018-0099-z Case study transportation distances.

2017: Climate change mitigation strategies in the forest sector: biophysical impacts and economic implications in British Columbia, Canada. Xu et al. Mitig. Adapt. Strateg. Glob. Chg. Cost estimates and impacts on jobs (Z. Xu & T. Lemprière)

2016: Climate change mitigation potential of local use of harvest residues for bioenergy in Canada. Smyth et al. Glob. Chg. Biol. Bioenergy. http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12387/abstract Regional biomass estimates, optimization to maximize avoided fossil fuels by selecting best type of bioenergy facility.

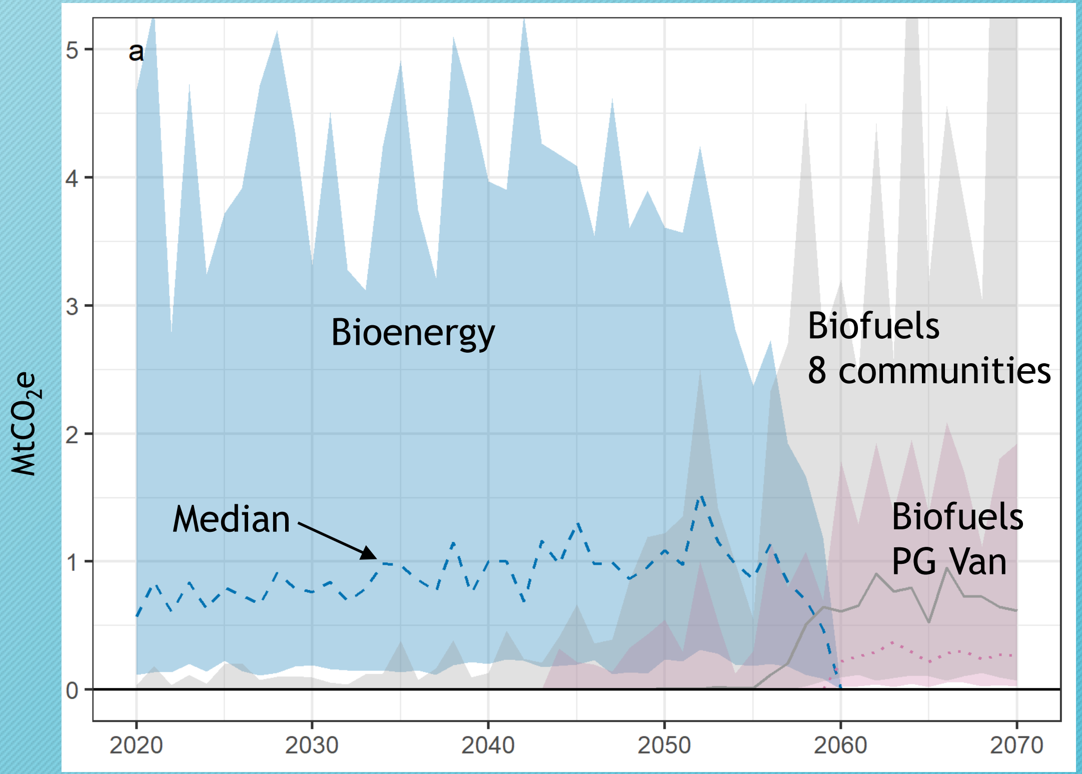
GHG results: lowest GHG pathway (annual)

Annual net change in GHG emissions



Bioenergy and biofuel emissions are mostly offset by avoided fossil fuels and enhanced forest sink. Small net reduction in GHG emissions after 2065 of -7 $MtCO_2e$ (range -39 to 37 $MtCO_2e$).

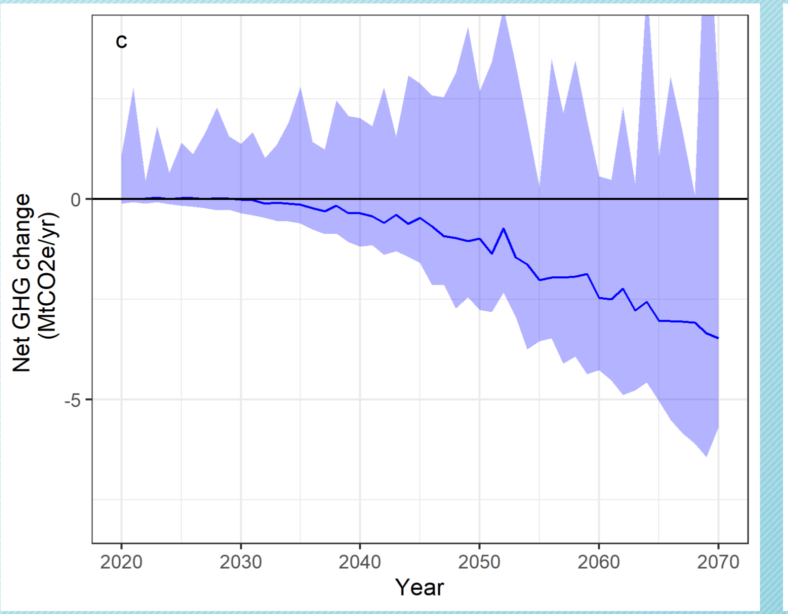
Annual biomass burned



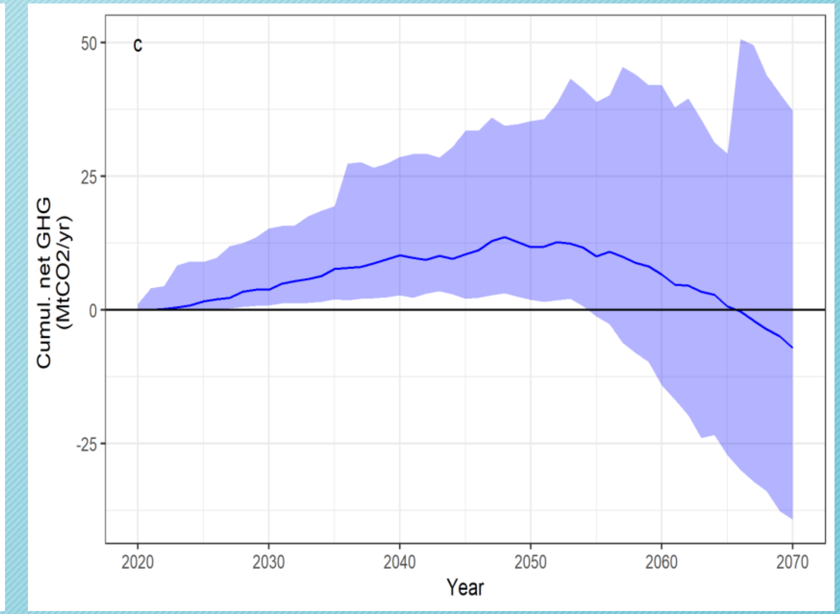
Biomass is directed towards bioenergy until ~2055, and then biofuels as energy systems are decarbonized.

Net change in GHG emissions

Annual

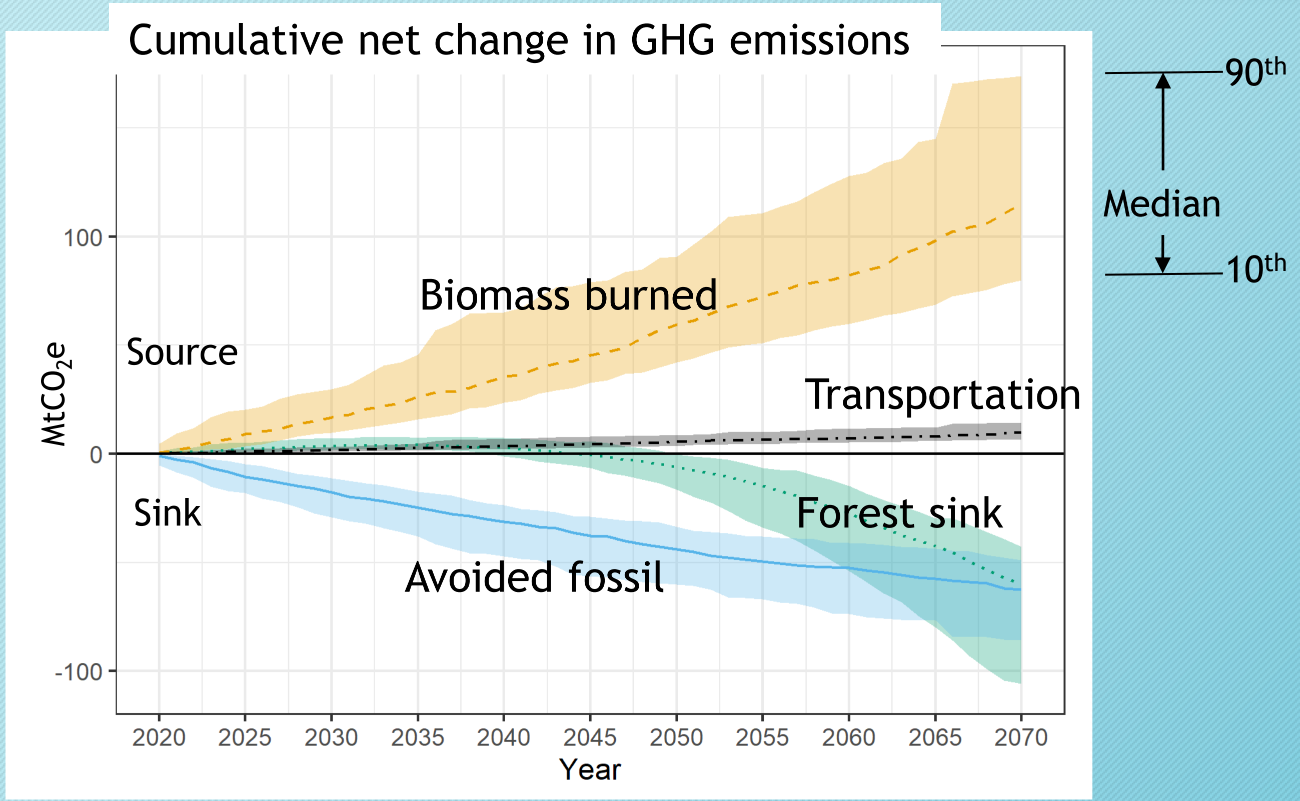


Cumulative



The cumulative net change in GHG emissions in 2070 was a reduction of 7 $MtCO_2e$ (median) with a range from -39 $MtCO_2e$ to 37 $MtCO_2e$. There was a 65% chance in 2070 that the use of salvage biomass for bioenergy and biofuels would have a net reduction in GHG emission, relative to a ‘do nothing’ baseline.

GHG results: lowest GHG pathway



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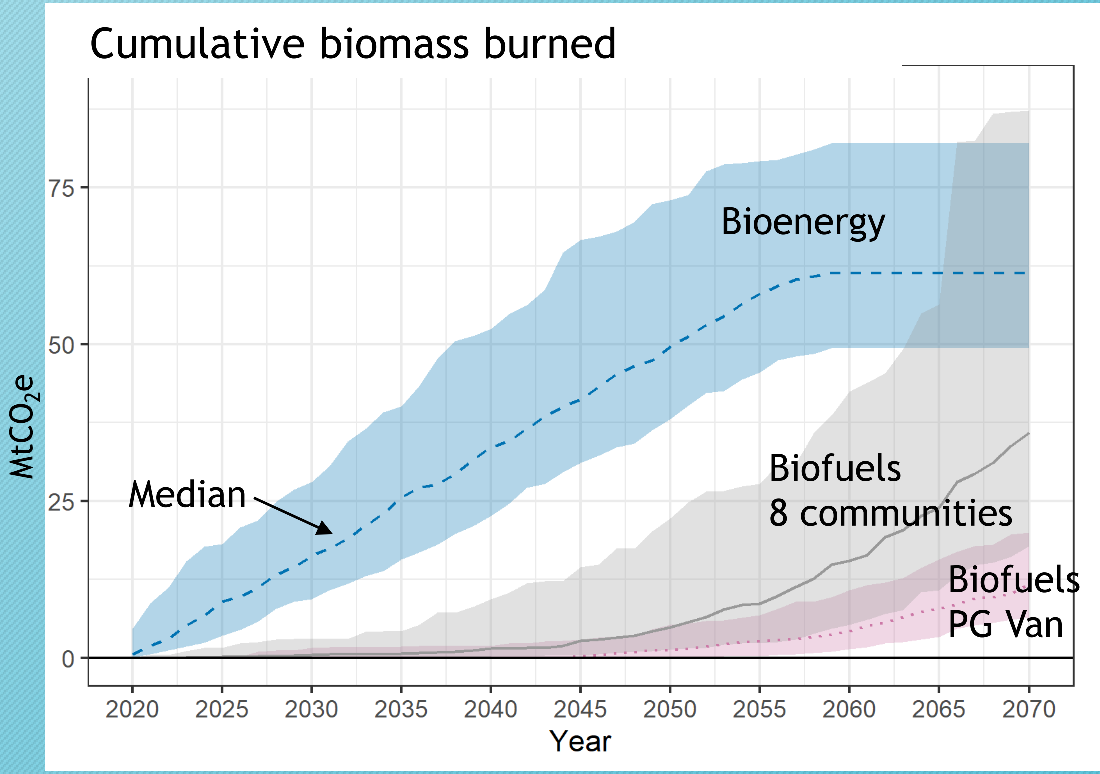

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