TIMBER SUPPLY PROJECTIONS UNDER CLIMATE CHANGE IN CANADA:

Where are we at (in British Columbia)?

Modéliser l'approvisionnement en bois sous changement climatique au Canada: on en est où (à l'Ouest)?

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PAPER ANNOUCEMENT

Canadian Journal of Forest Research

OPEN ACCESS | Research Article

Combining thinning and diverse plantings to adapt to climate-change-induced timber supply shortage in British Columbia

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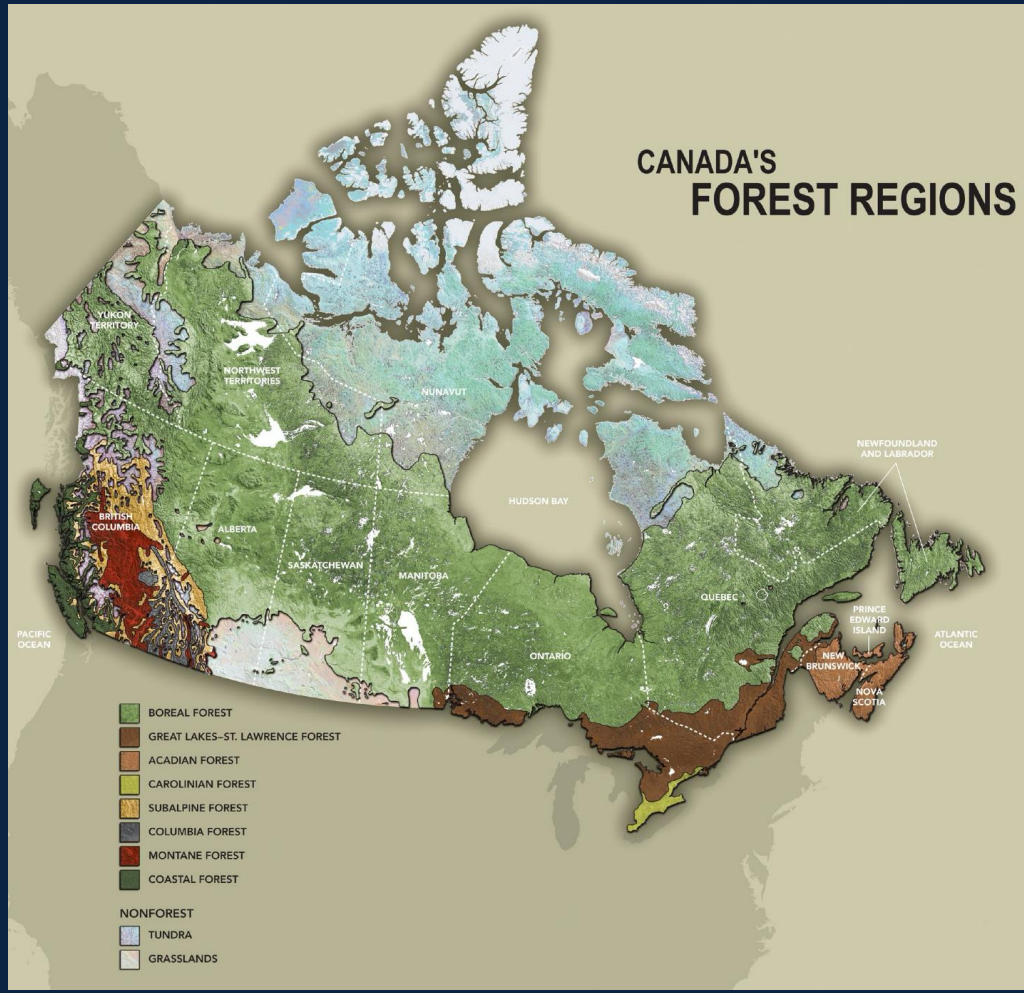
CONTEXT: CANADIAN FORESTS

CANADA

- 362 Mha of forested area
- CAD $35 billion GDP contribution from forests products sector

BRITISH COLUMBIA (BC)

- 60 Mha total BC forested area
- 95% public
- 40% of industrial roundwood harvested in Canada is from BC
- 75% of BC harvesting is from the interior (as opposed to the coast)



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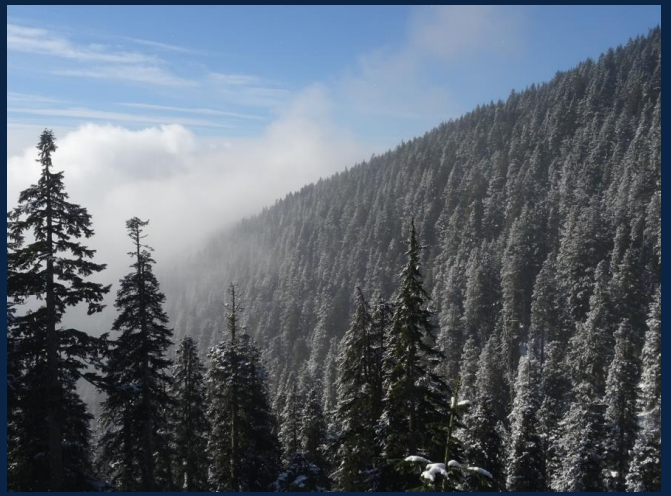
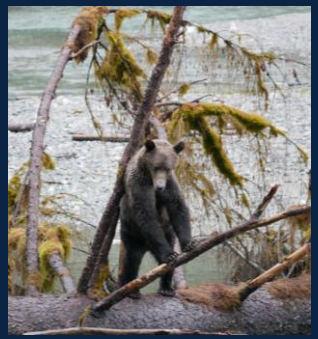
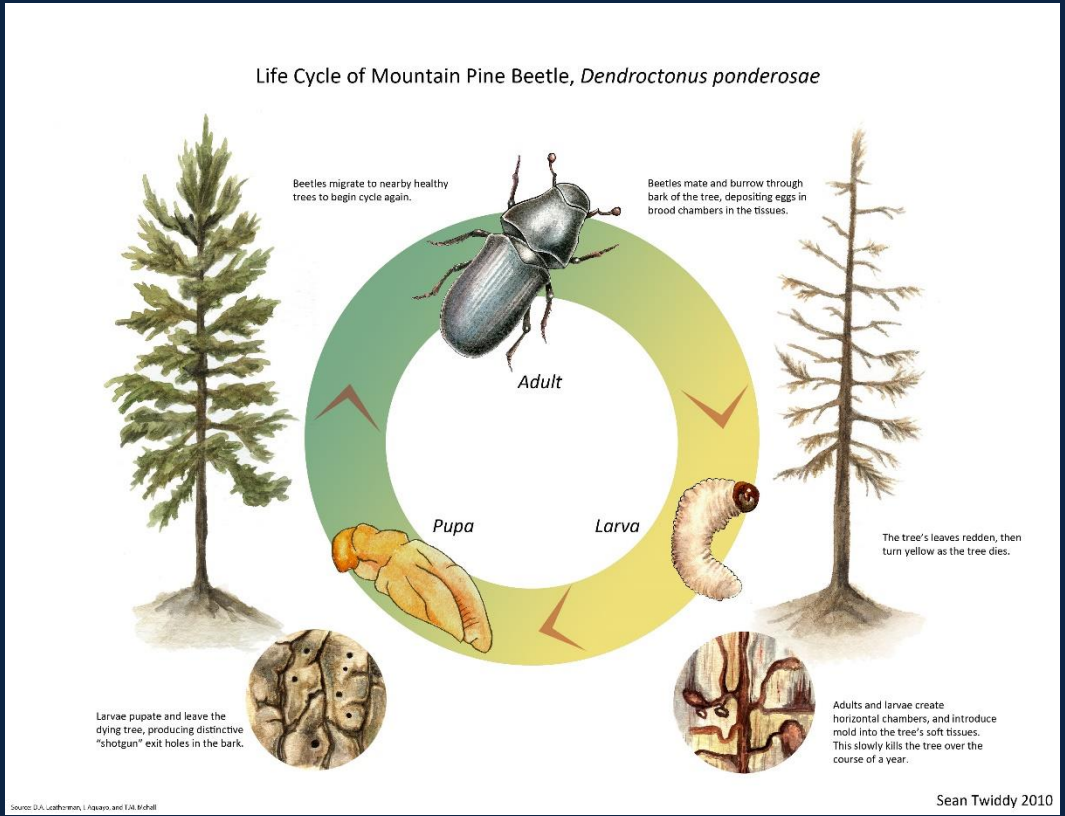




CONTEXT: MOUNTAIN PINE BEETLE OUTBREAK



Mountain Pine Beetle (MPB)
Dendroctone du pin ponderosa
Dendroctonus ponderosae

Alex Fraser Research Forest

CONTEXT: MOUNTAIN PINE BEETLE OUTBREAK

Mountain pine beetle outbreaks in BC 1920-2002 (Taylor and Caroll 2004)

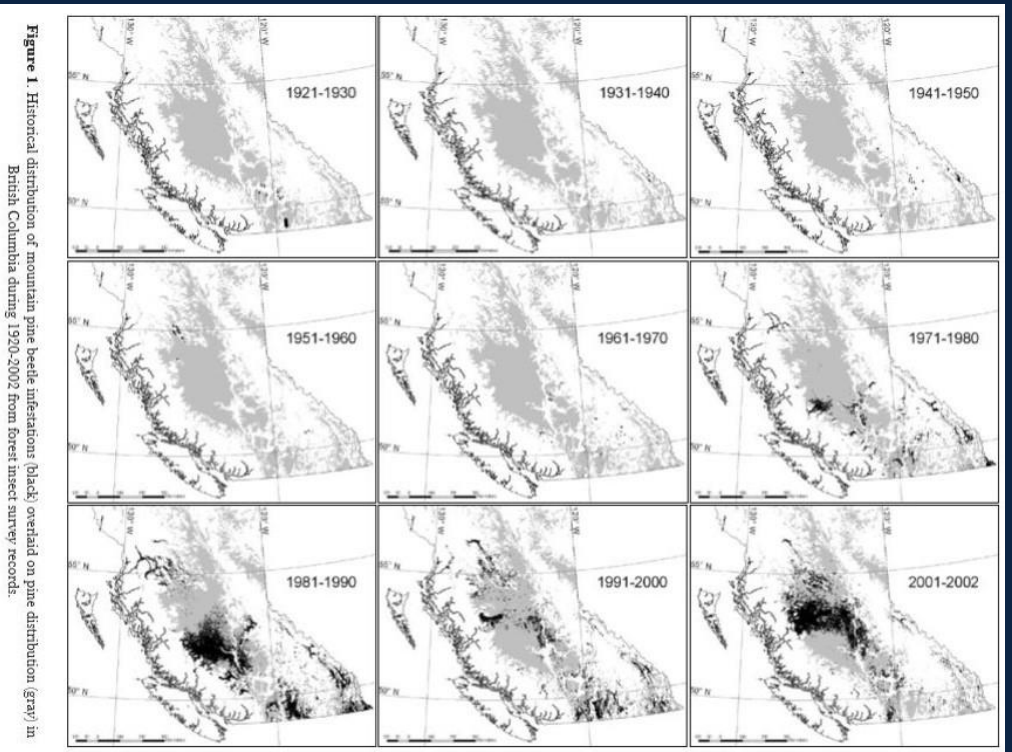
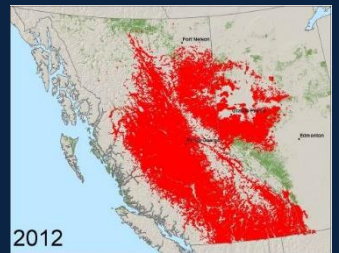


Figure 1. Historical distribution of mountain pine beetle infestations (black) overlaid on pine distribution (gray) in British Columbia during 1920-2002 from forest insect survey records.

Mountain Pine Beetle (MPB)
Dendroctone du pin ponderosa
Dendroctonus ponderosae

- Endemic to BC forests, but …
- Major outbreak in BC (2000 – 2015)
  - Impacted > 18 Mha (~30% BC forests)
  - Killed >750 Mm3 = 50% of BC lodgepole pine growing stock (Walton, 2013)

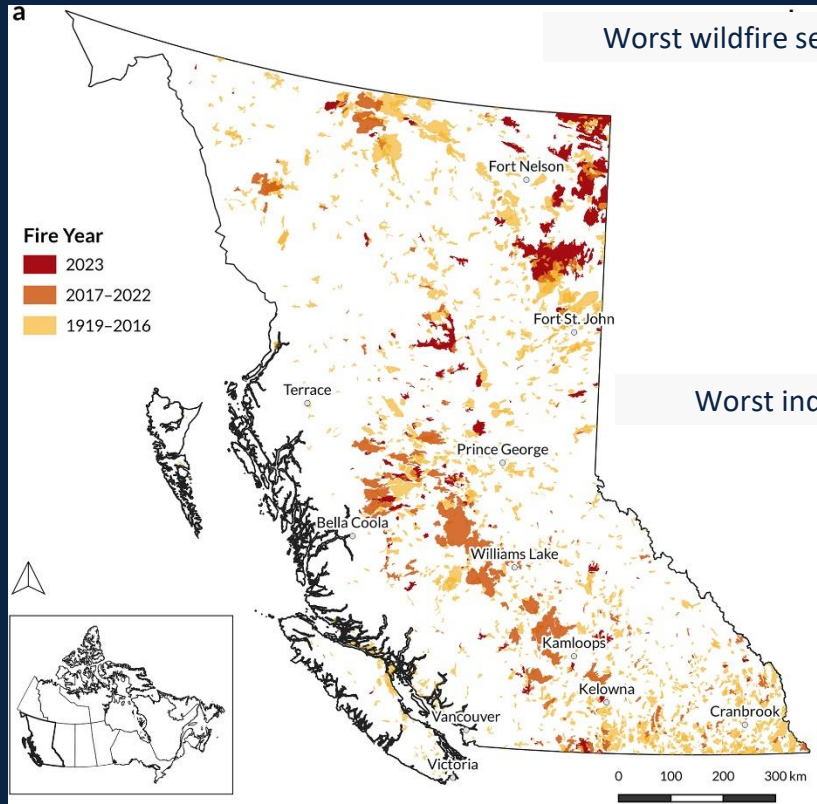


CONTEXT: MOUNTAIN PINE BEETLE OUTBREAK … AND WILDFIRES !

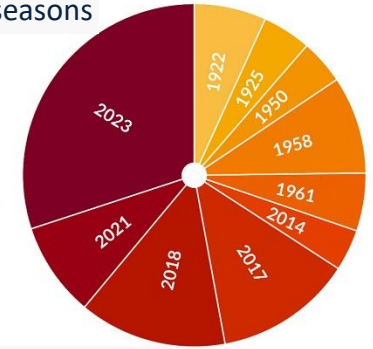
BC wildfires (Daniel et al., 2024)


BC fire, 2023

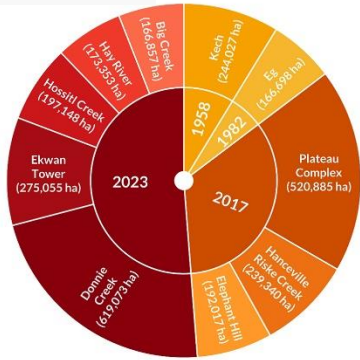

BC fires, 2017



Worst wildfire seasons



Worst indiv. wildfires



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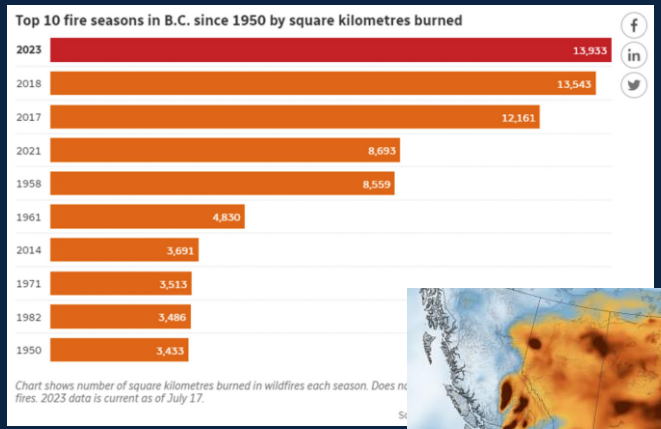
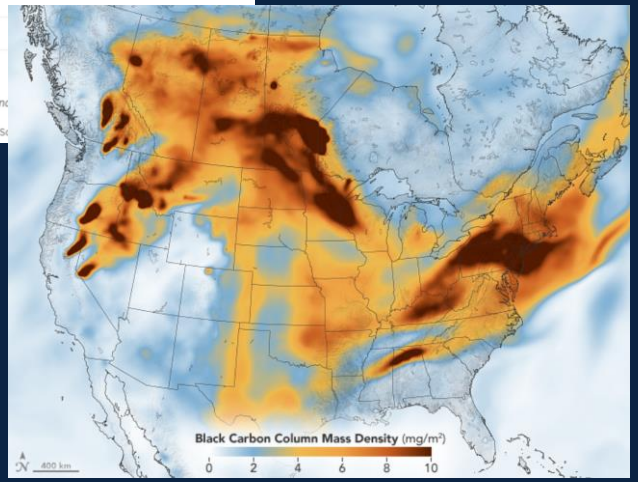


Worst BC wildfires seasons (BC wildfire service)

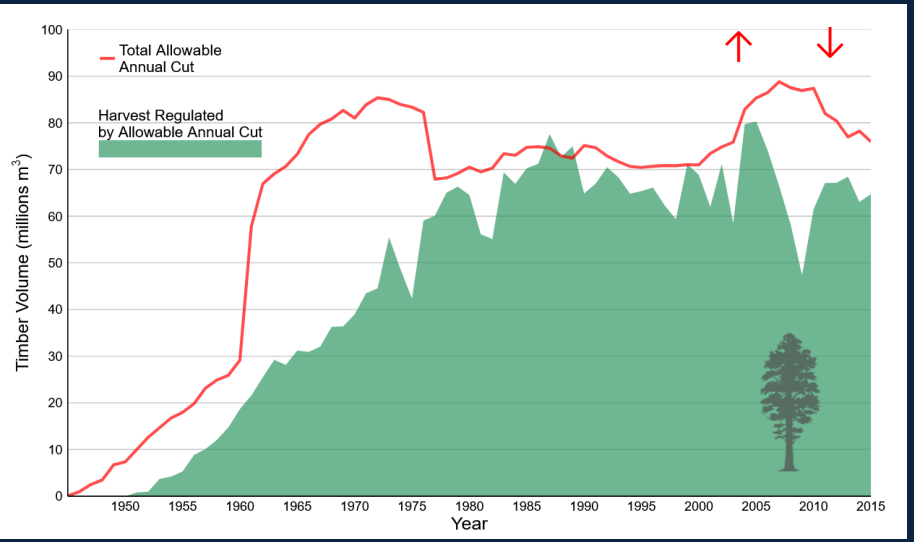


Smoke over North-America, June 2021 (NASA)

Vancouver, August 2018 (V Lafond)

CONTEXT: MOUNTAIN PINE BEETLE OUTBREAK … AND TIMBER PRODUCTION

- Impact on Allowable Annual Cut (AAC) [= long-term sustained yield, LSY]?
  - MPB 2000-2015: temporary ↑AAC to accommodate MPB salvage logging (then AAC ↓)
  - Future? MPB x climate change … Stable or ↓ ? **<u>And by how much?</u>**



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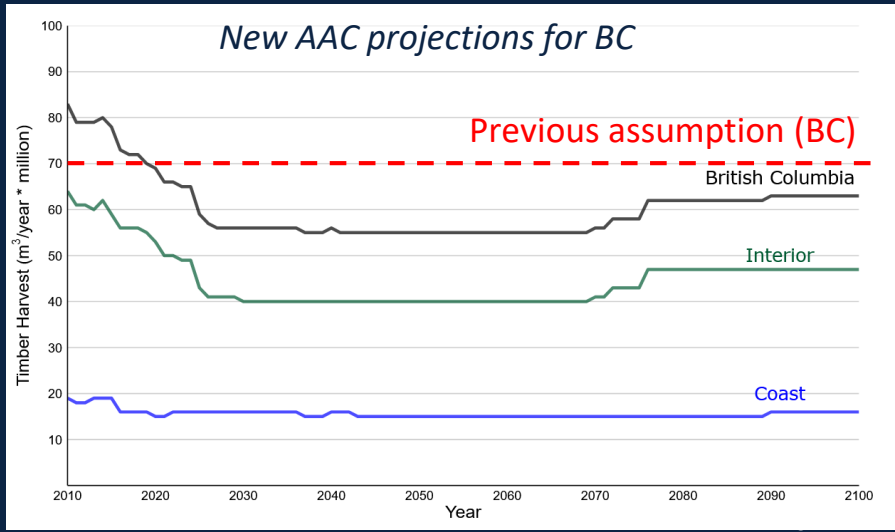

Source: BC government, 2018

CONTEXT: MOUNTAIN PINE BEETLE OUTBREAK … AND TIMBER PRODUCTION … UNDER CLIMATE CHANGE !

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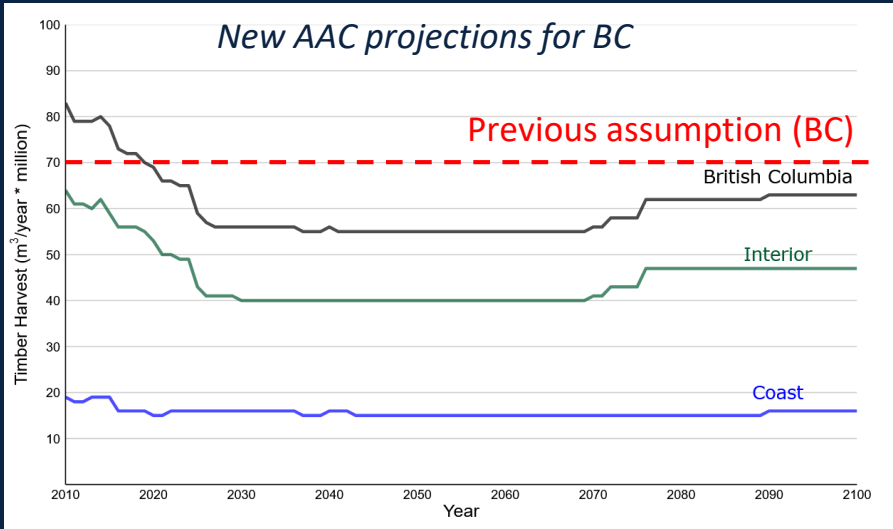
  - Future? MPB x climate change … Stable or ↓ ? **<u>And by how much?</u>**

Challenge: considering impacts of climate change & natural disturbances in AAC projections to modulate the delivery of cutting licenses !



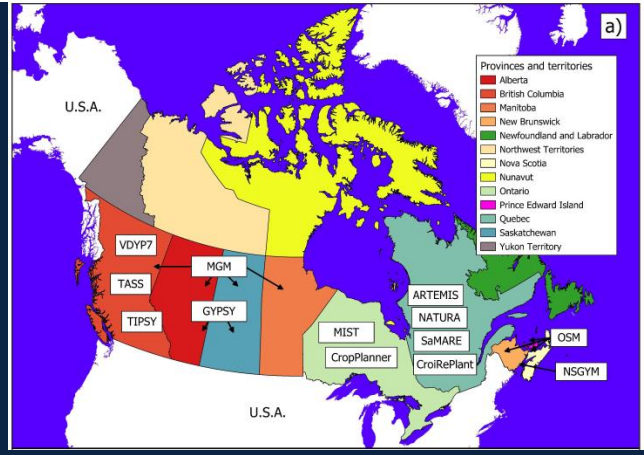
Source: BC government, 2018

RESEARCH (& DEVELOPMENT) GAPS

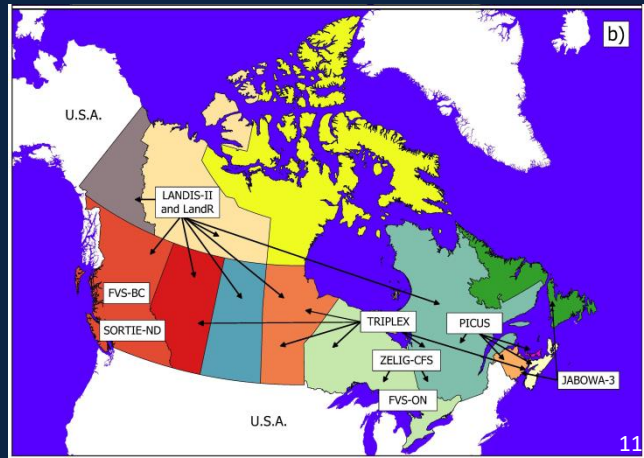
❖ ***What impact of climate change on AAC ?***

- Currently government- approved models used to determine AAC levels are typically not climate-sensitive (at least in BC)
- Multiple barriers to :
  - the development of climate sensitive growth and yield models for Canadian forests
  - their transition from research to operational tools
- Preliminary studies use existing tools => multiple limits!

(Metsaranta et al., 2024)



Government-approved models ↑
& potential candidate models ↓
(Metsaranta et al., 2024)



RESEARCH QUESTIONS

❖ ***What management options to reduce climate change-related risks to timber supply in BC?***

- Currently considered options
  - ❑ Assisted migration
  - ❑ Species diversification
  - ❑ Commercial thinning

No studies on combined effectiveness

(Spittlehouse and Stewart, 2003; Devisscher et al., 2021)

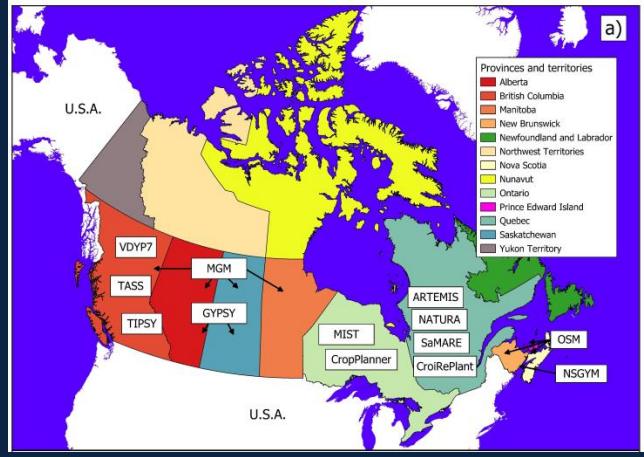
Source: BC Government

FPInnovation

OBJECTIVES & METHODOLOGICAL APPROACH

- Aimed to assess potential benefits of:
  - ❑ Commercial thinning => mitigate AAC fall-down
  - ❑ Alternative planting regimes (assisted migration, mixed species) => mitigate future climate change impacts
  - ➢ Combined effects of both options

- Applied a toolkit framework combining different models
  - ❑ Gov-approved G&Y models (VDYP, TASS, TIPSY)
  - ❑ Climate-sensitive landscape model (Landis-II)



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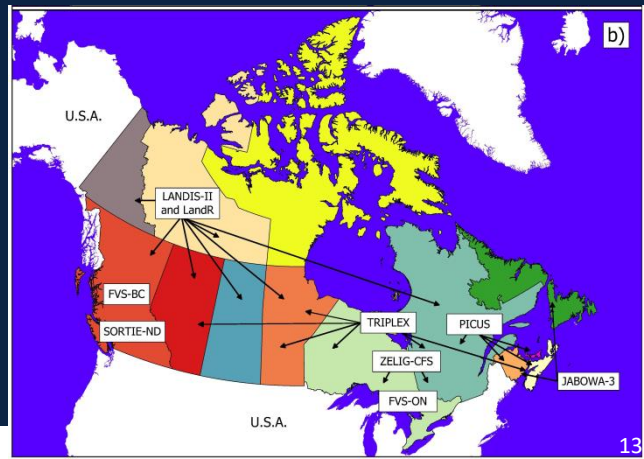
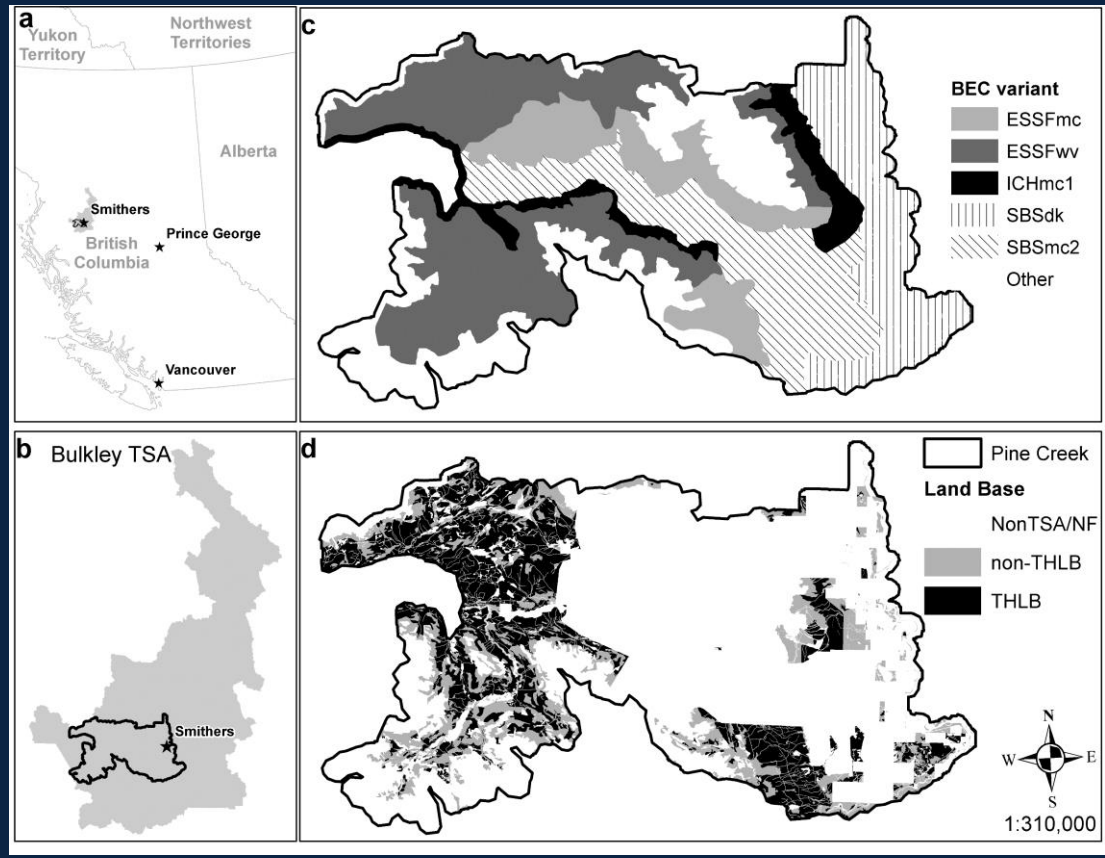


MATERIAL AND METHODS

CASE STUDY AREA

- Copper Pine Creek area (~ 100 Kha)
- Part of Bulkley Timber Supply Area (TSA)
- Timber Harvesting Landbase (THLB): 18,270 ha

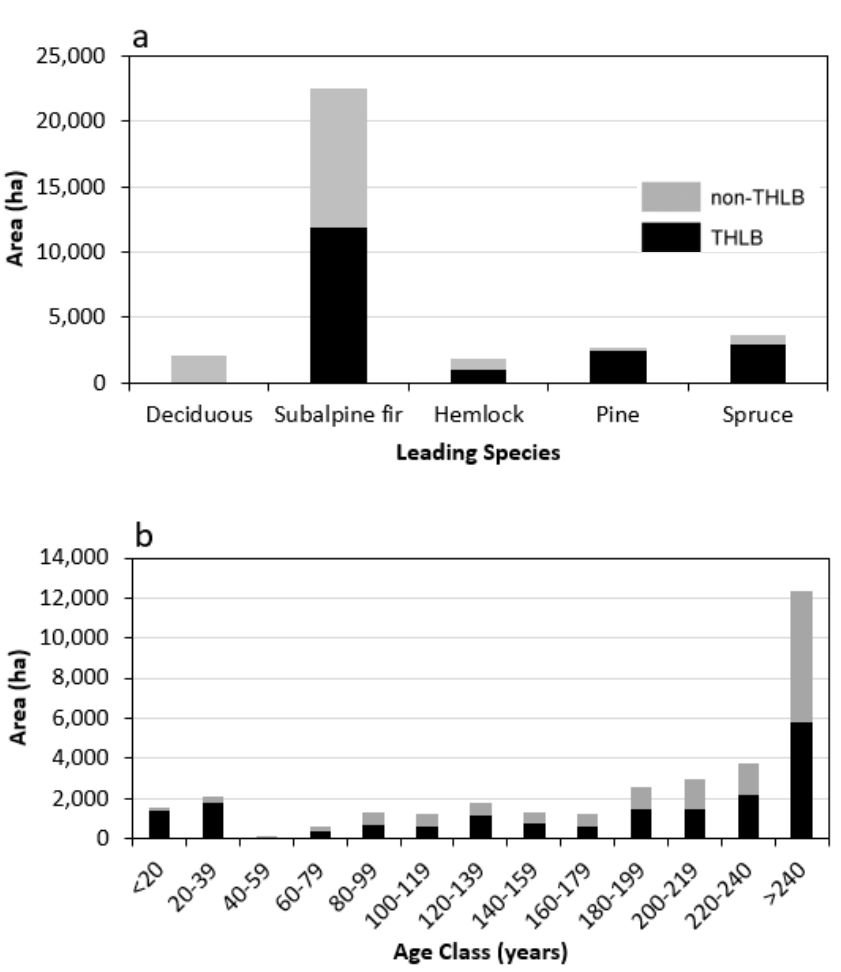
- Elevation 460m to 2500m a.s.l
- 3 main Biogeoclimatic Ecosystem Classification (BEC) zones (5 variants)
  - ESSF = Engleman Spruce – Subalpine Fir)
  - ICH = Interior Douglas Fir
  - SBS = Sub-boreal Spruce



MATERIAL AND METHODS

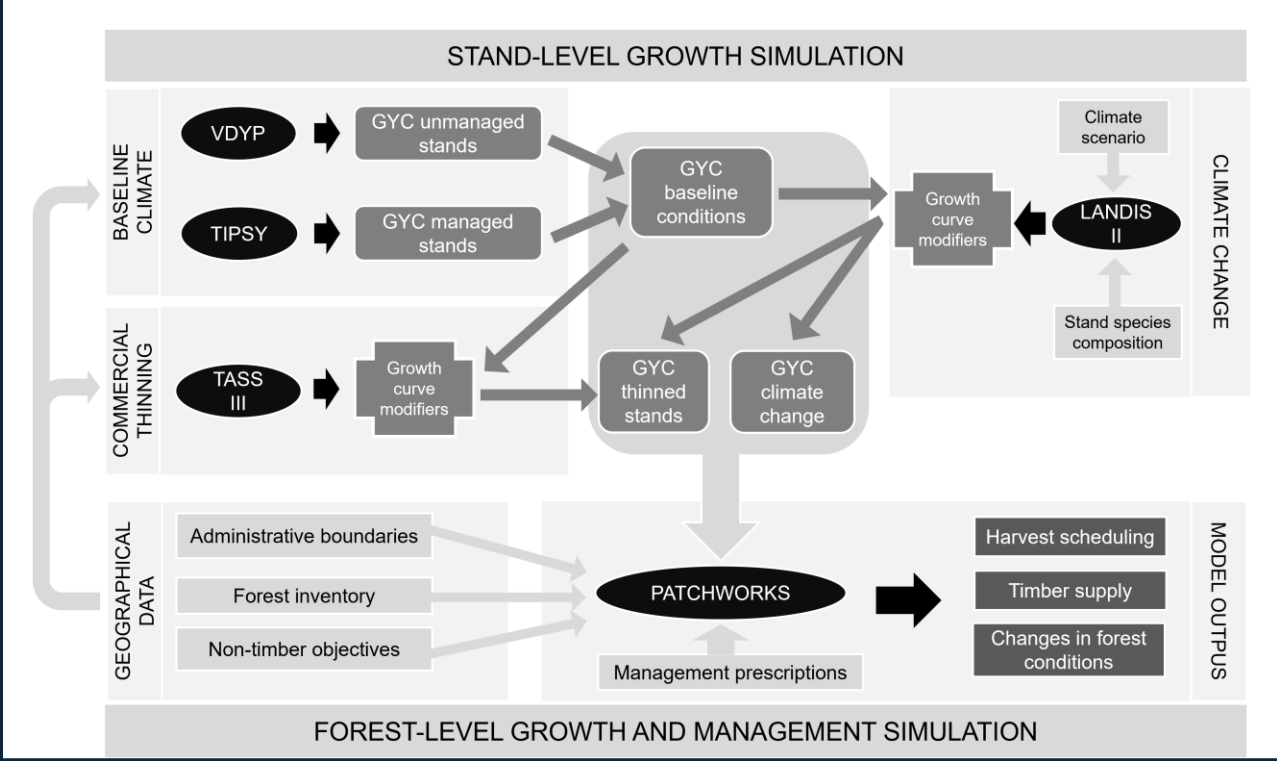
CASE STUDY AREA

- Tree species
  - Mostly Subalpine fir (69%) and Spruce (11%)
  - Lodgepole pine (8%) and Hemlock (5%) at lower elevation
  - Few deciduous-dominated stands (6%)
- Age class distribution inherited from:
  - Past natural disturbance regimes
  - Low harvesting intensity



MATERIAL AND METHODS

TOOLKIT MODELLING FRAMEWORK



MATERIAL AND METHODS

TOOLKIT MODELLING FRAMEWORK

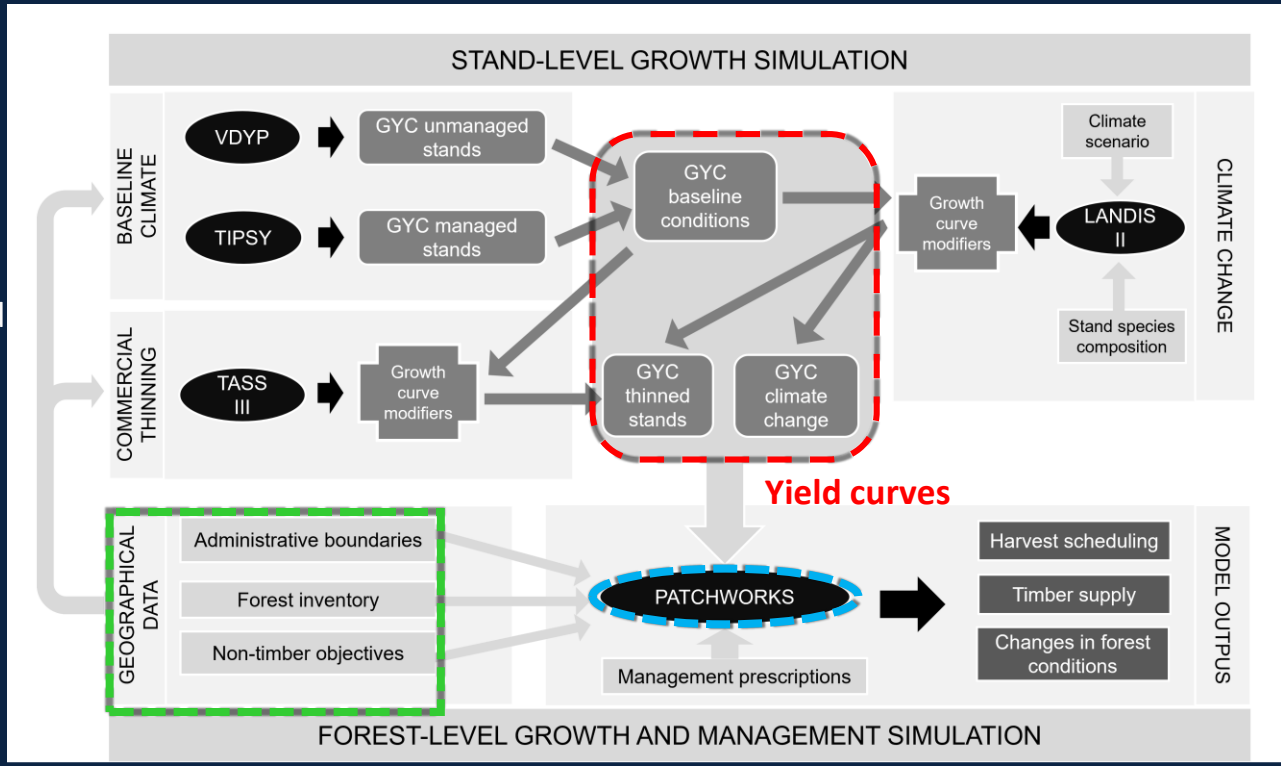
❑ **« Classic » components**

Input Data

- ✓ Admin. Boundaries (parks, reserve, private land etc.)
- ✓ Forest inventory
- ✓ Non-timber objectives (e.g., % old forest to preserve per BEC zone)

Forest management planning model (« forest estate model»)

- ✓ Optimization forest operations
- ✓ Max. timber harvest under constraints (e.g., biodiv. targets)
- ✓ Model: Patchworks ™ [1]



[1] Spatial Planning Systems (2020)

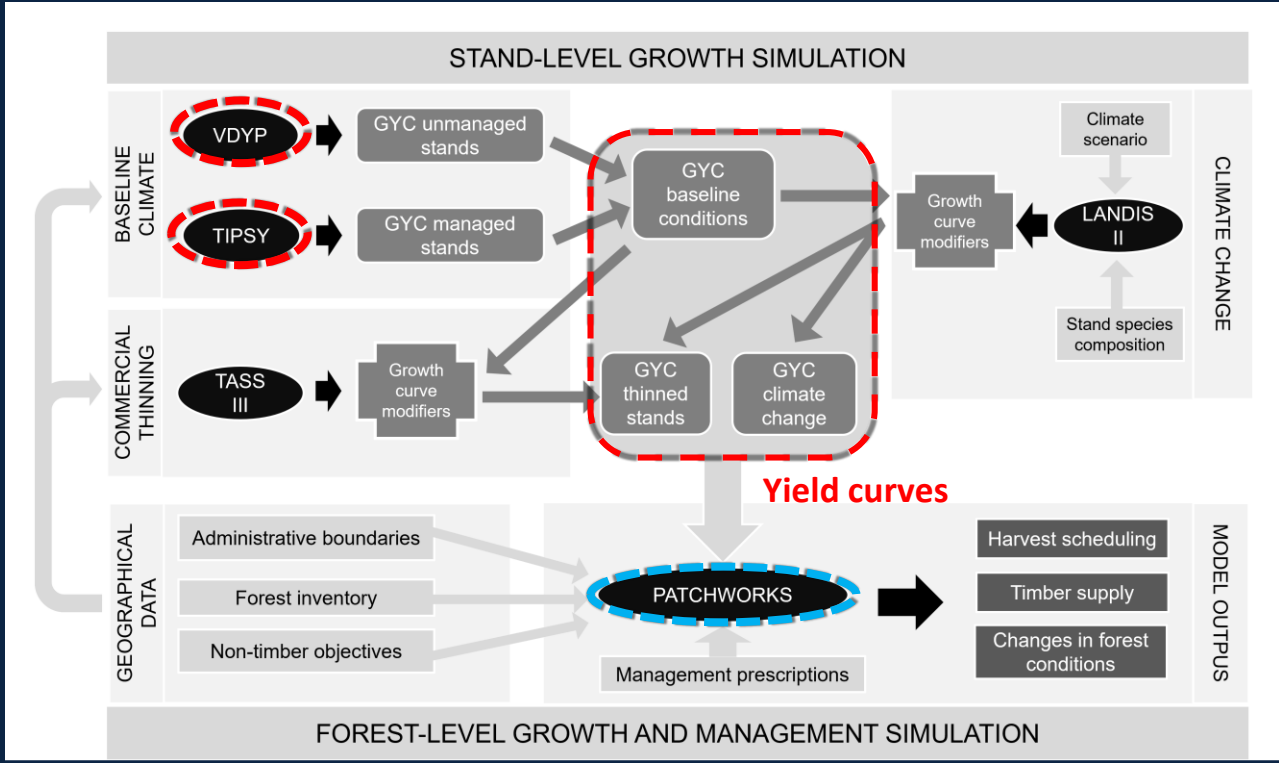
MATERIAL AND METHODS

TOOLKIT MODELLING FRAMEWORK

- ❑ **« Classic » components**

Growth and yield models

- ✓ **VDYP :** Variable Density Yield Projection [1]
- ✓ **TIPSY :** Table Interpolation Program for Stand Yield [2]



[1] Government of British Columbia (1993)
[2] Government of British Columbia (2018a)
[3] Government of British Columbia (2018b)

MATERIAL AND METHODS

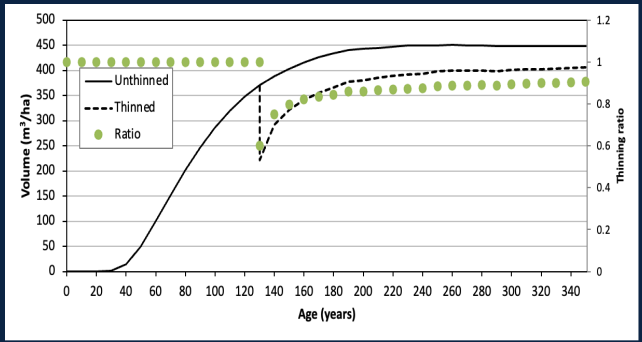
TOOLKIT MODELLING FRAMEWORK

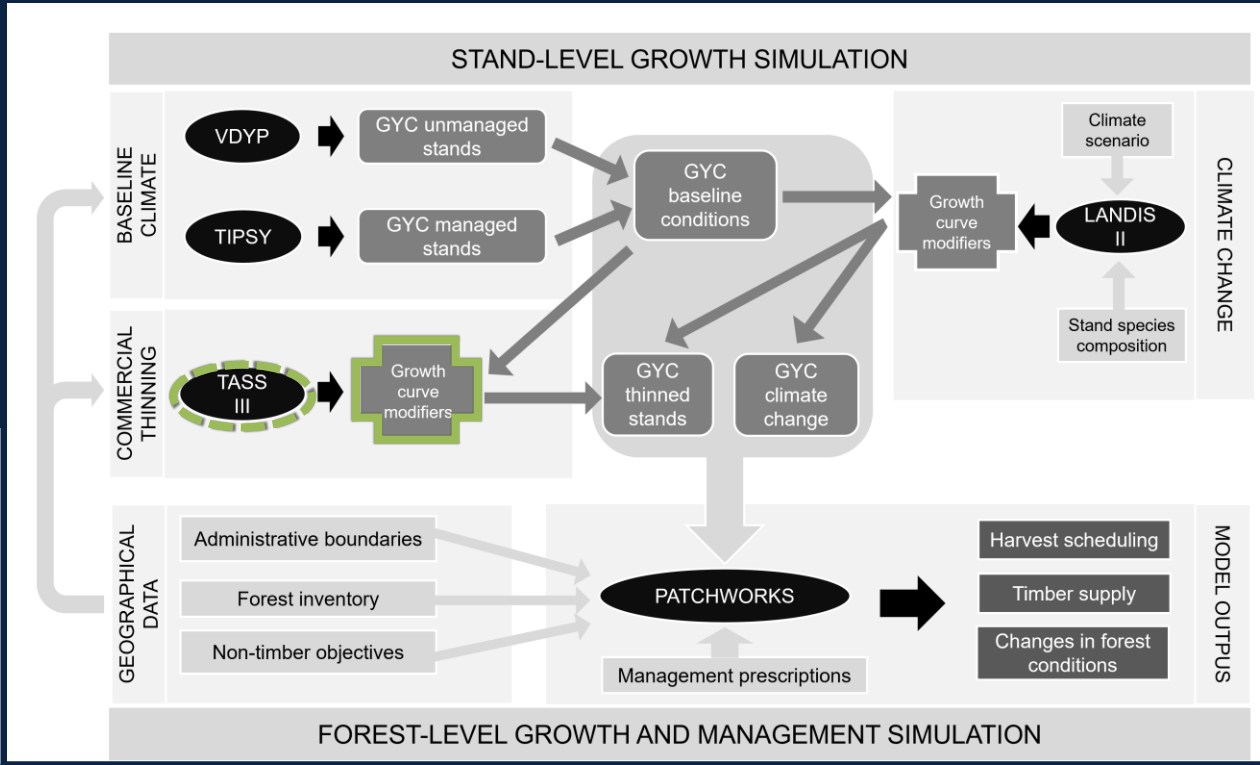
- ❑ « Classic » components
- ❑ + model thinning impact

Growth curve modifiers for thinning impact derived from

- ✓ **TASS III** : Tree And Stand Simulator [3]

Based on Griess et al. (2019)





MATERIAL AND METHODS

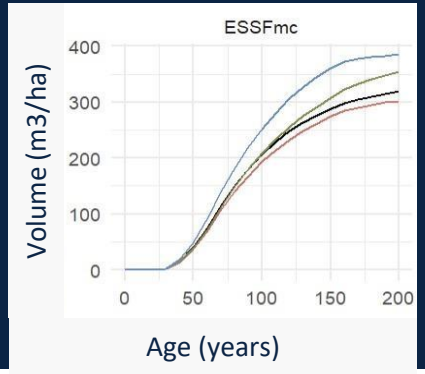
TOOLKIT MODELLING FRAMEWORK

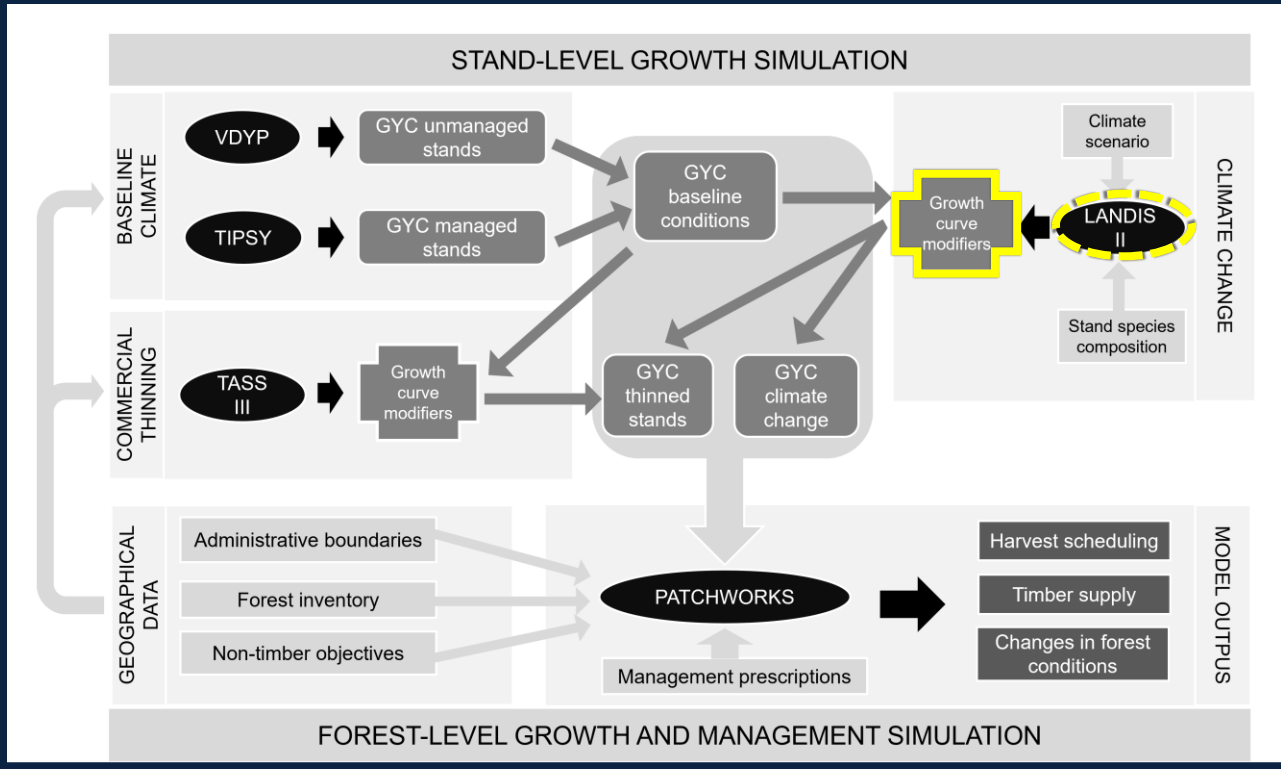
- ❑ « Classic » components
- ❑ + model thinning impact
- ❑ + model CC impact

Growth curve modifiers for CC impact, derived from:

- ✓ **LANDIS II:** landscape ecology

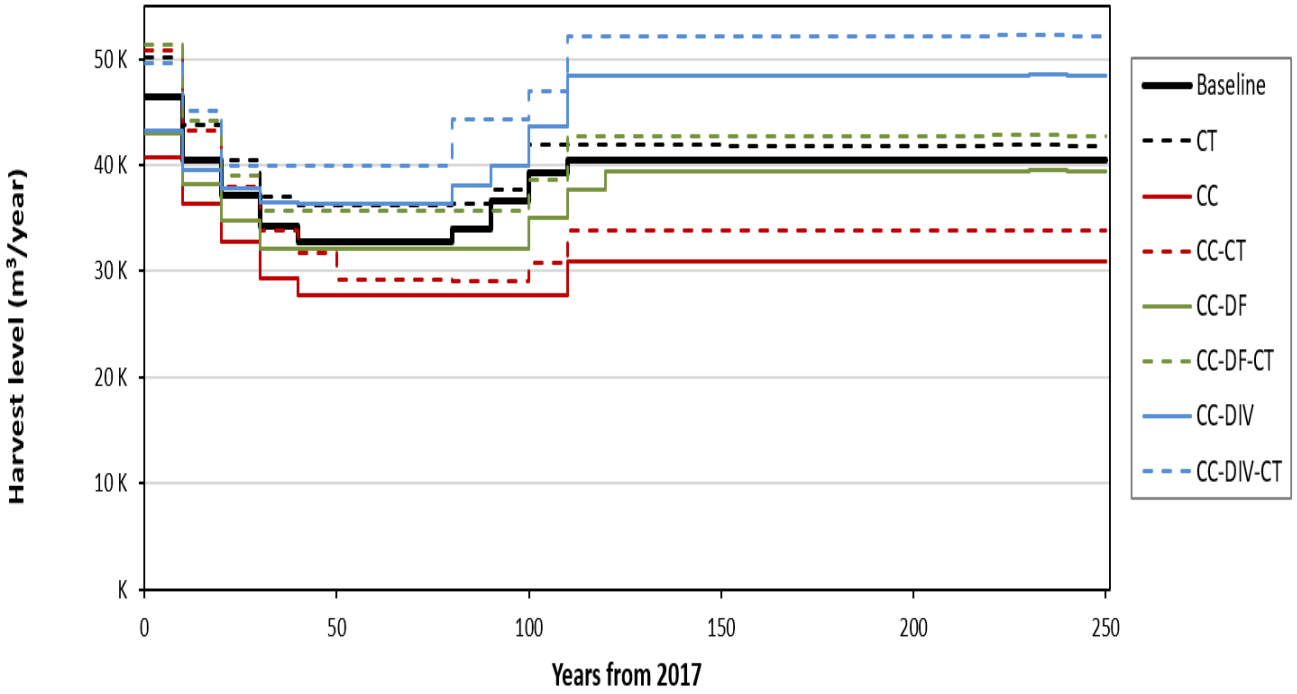
Based on Hof et al. (2017)





RESULTS

Harvest levels under different scenarios

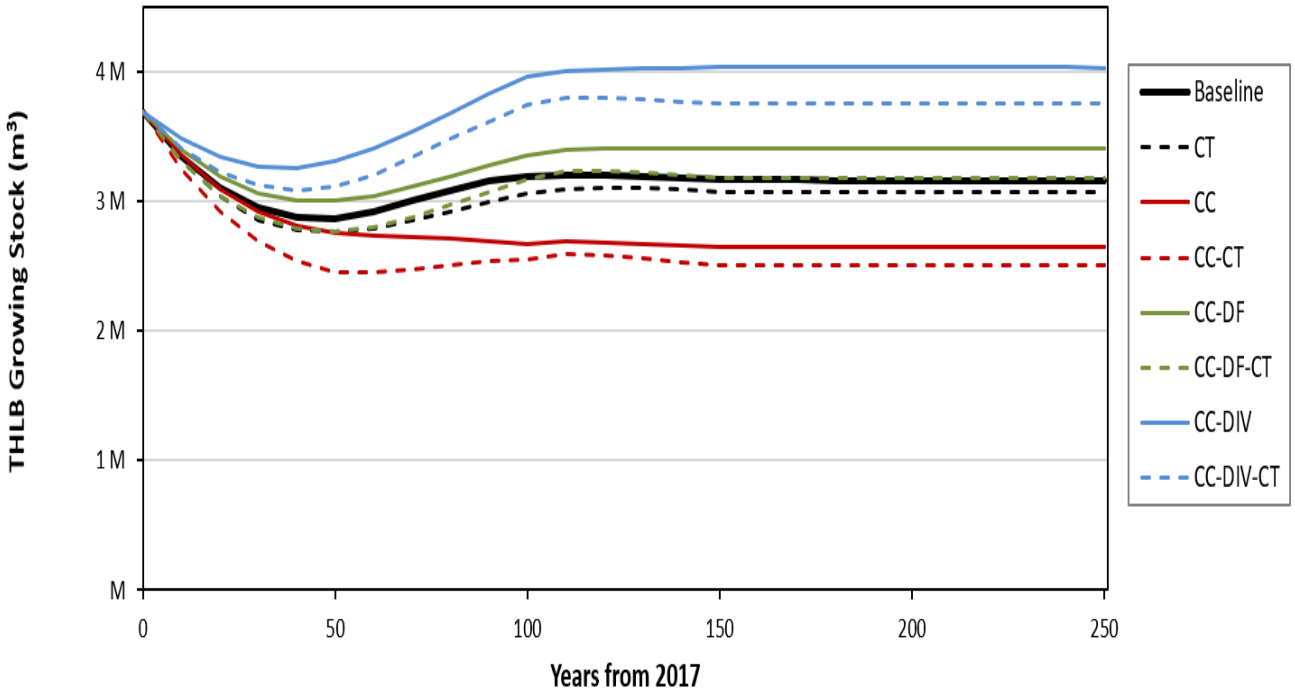


Legend and scenario description

CLIMATE	THINNING	SPECIES
Baseline	NO	Base
Baseline	YES	Base
CC	NO	Base
CC	YES	Base
CC	NO	+ DF
CC	YES	+ DF
CC	NO	Diversif.
CC	YES	Diversif.

RESULTS

Growing stocks



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Baseline	NO	Base
Baseline	YES	Base
CC	NO	Base
CC	YES	Base
CC	NO	+ DF
CC	YES	+ DF
CC	NO	Diversif.
CC	YES	Diversif.

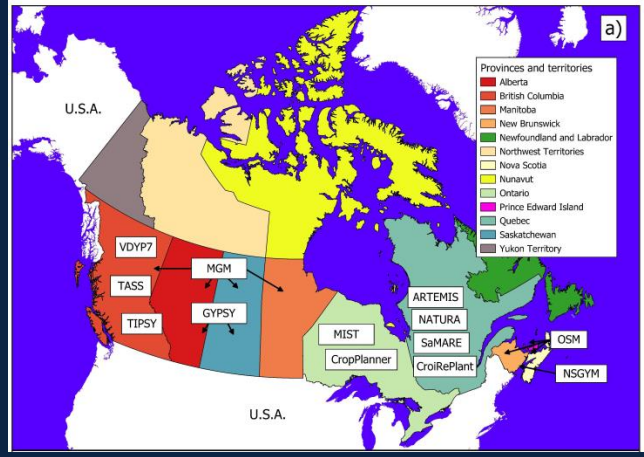
Discussion: impact of alternative scenarios

- ❑ Commercial thinning
  - ✓ Opportunity to access timber earlier => some mitigation of mid-term timber supply fall-down
  - ✓ But same total timber supply (i.e., CT does not increase productivity)
  - x Pot. effects on resistance / resilience to drought or pest (Morneau et al., 2022) => not considered
- ❑ Assisted migration and species diversification
  - ➢ Assisted migration
    - x Only modelled here for Douglas fir (other species maybe relevant)
  - ➢ Species diversification
    - ✓ Hedging bets with respect to climate change (probably OK)
    - x Over yielding effect from LANDIS II yield curves (overestimated?)
- ❑ Combined effects?
    - x Mostly additive, do not consider potential interactions

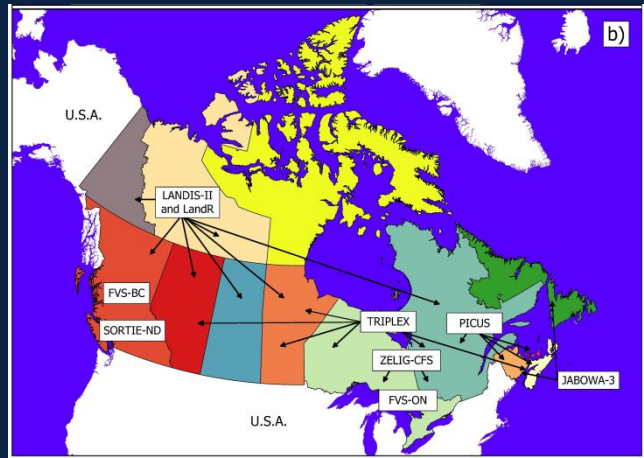
Discussion: perspectives

- Reconciling forestry and ecology modelling tools
  - National-scale and multi-partner initiative led by the Canadian Forest Service aiming at fostering the development of **climate sensitive growth and yield models** (Metsaranta et al., 2024)

- Ongoing work in the UBC FRESH lab
  - Developing an open innovation hub for forest ecosystem management modelling
  - Link stochastic simulation models (e.g., SpaDES) with deterministic optimization models (e.g., ws3)



Government-approved models ↑ & potential candidate models ↓ (Metsaranta et al., 2024)



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Questions?

MATERIAL AND METHODS

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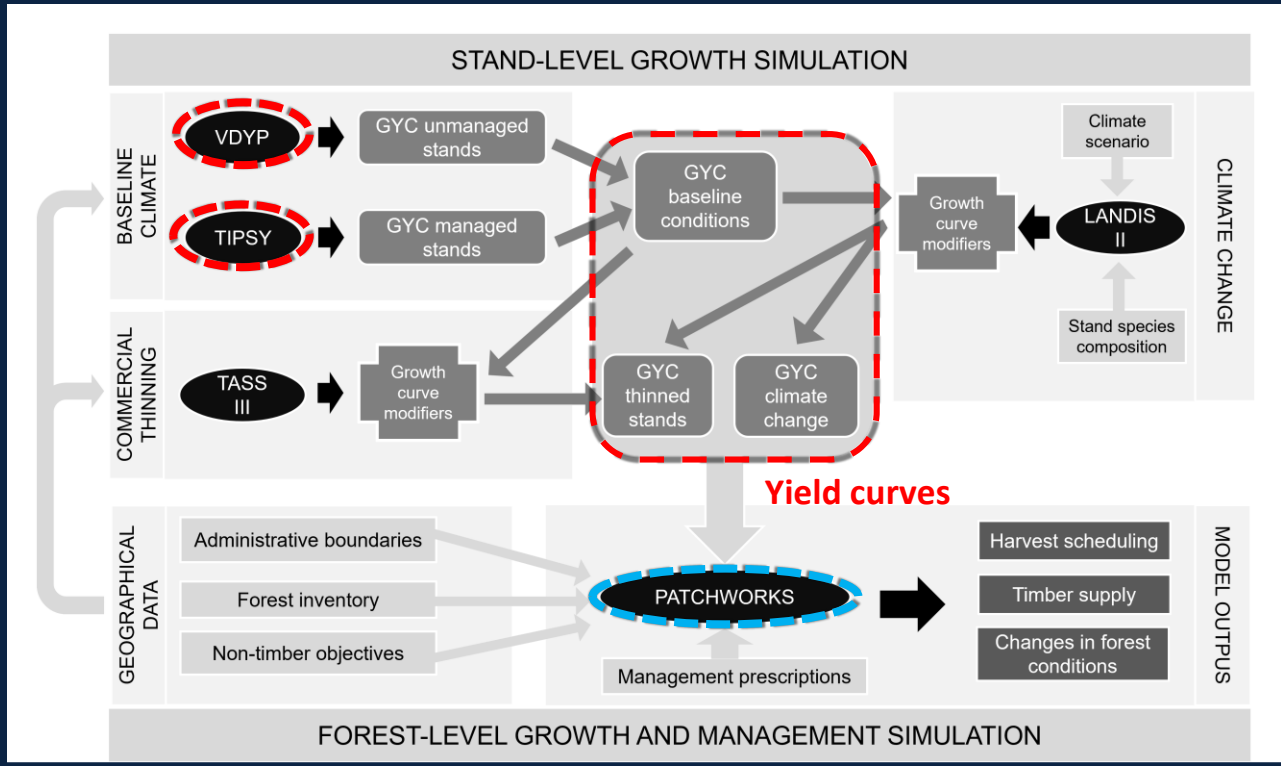
Forest management planning model (« forest estate model»)

- ✓ Patchworks ™ [4]



[1] Government of British Columbia (1993)
[2] Government of British Columbia (2018a)
[3] Government of British Columbia (2018b)
[4] Spatial Planning Systems (2020)

MATERIAL AND METHODS

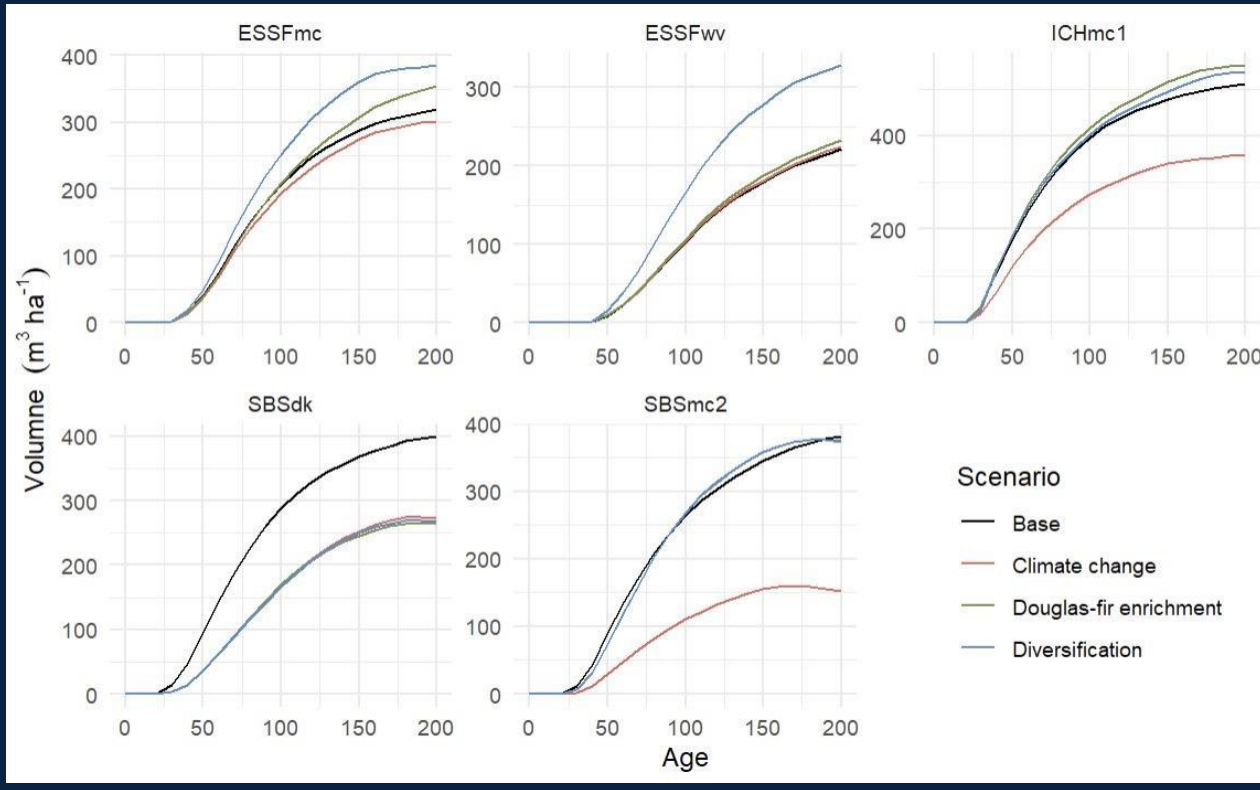
TOOLKIT MODELLING FRAMEWORK

- ❑ « Classic » components
- ❑ + model thinning impact
- ❑ + model CC impact

Growth curve modifiers for CC impact, derived from:

- ✓ **LANDIS II:** landscape ecology

Based on Hof et al. (2017)



MATERIAL AND METHODS

TOOLKIT MODELLING FRAMEWORK

- ❑ « Classic » components
- ❑ + model thinning impact

Growth curve modifiers for thinning impact derived from

- ✓ **TASS III** : Tree And Stand Simulator [3]

Based on Griess et al. (2019)