Impacts of climate change on forest and forest sector in Québec

Yan Boulanger, research scientist in forest ecology

Canadian Forest Service

Natural Resources Canada

Climate change: "2011-2020 will be the warmest decade on record, with all 6 warmest years on record since 2015" - WMO, 2 December 2020

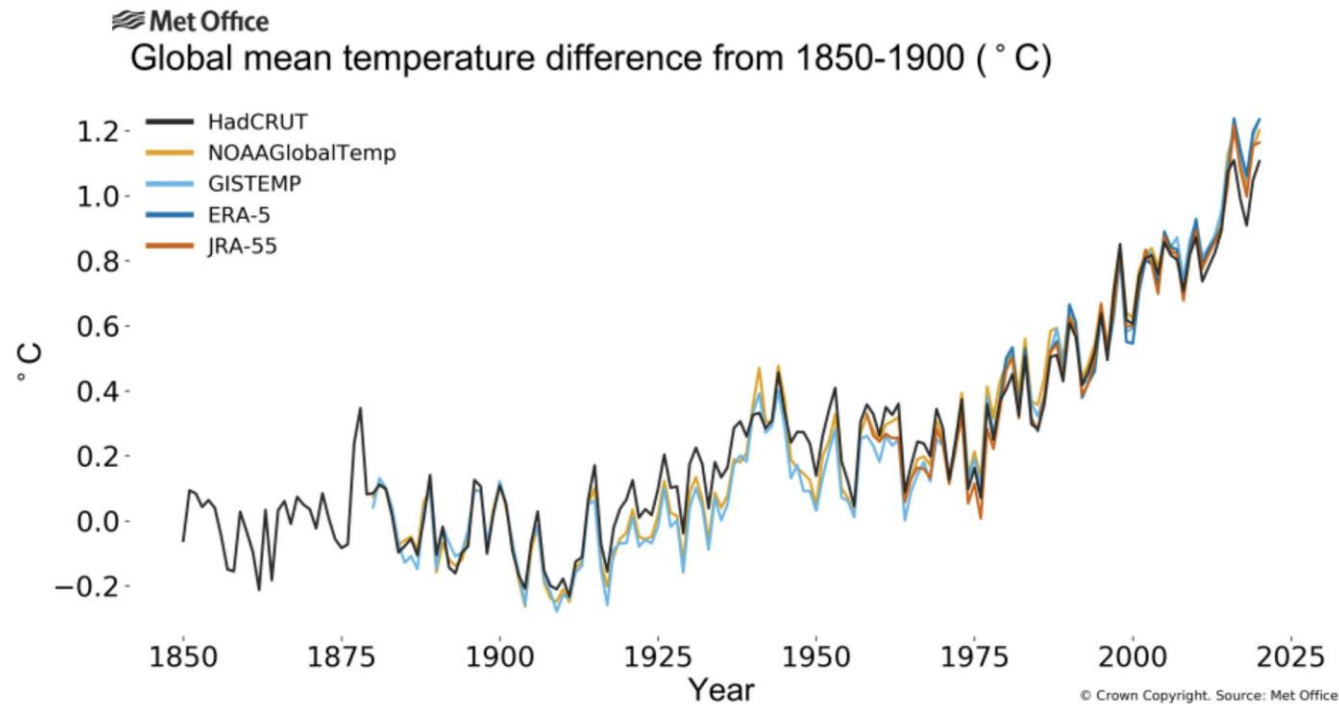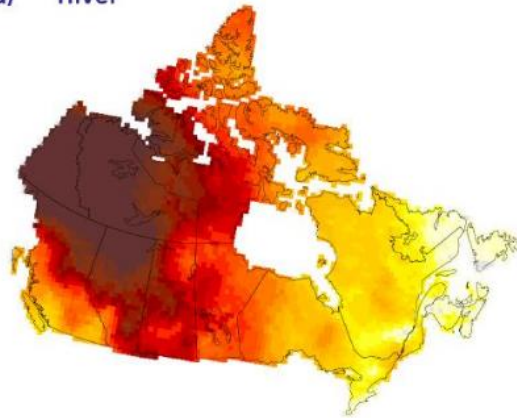Global mean temperature difference from 1850-1900 (°C)

Figure 1: Global annual mean temperature difference from preindustrial conditions (1850–1900). The two reanalyses (ERA5 and JRA-55) are aligned with the in situ datasets (HadCRUT, NOAAGlobalTemp and GISTEMP) over the period 1981–2010. Data for 2020 run from January to October.
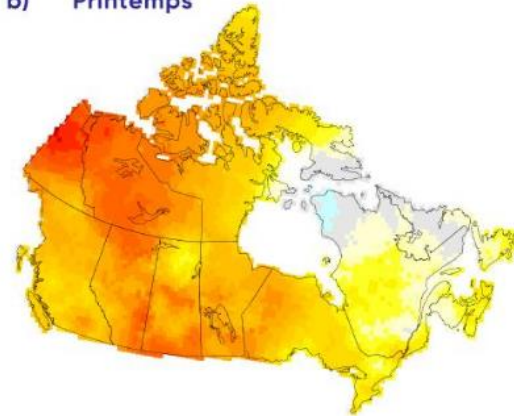
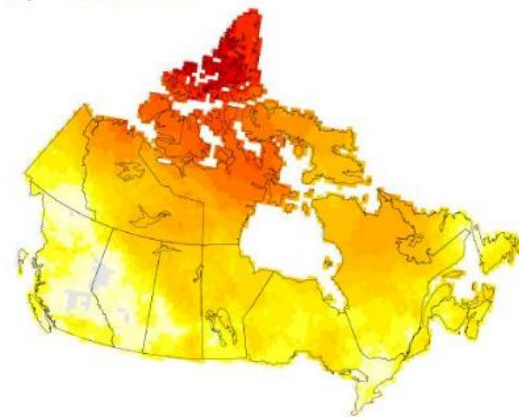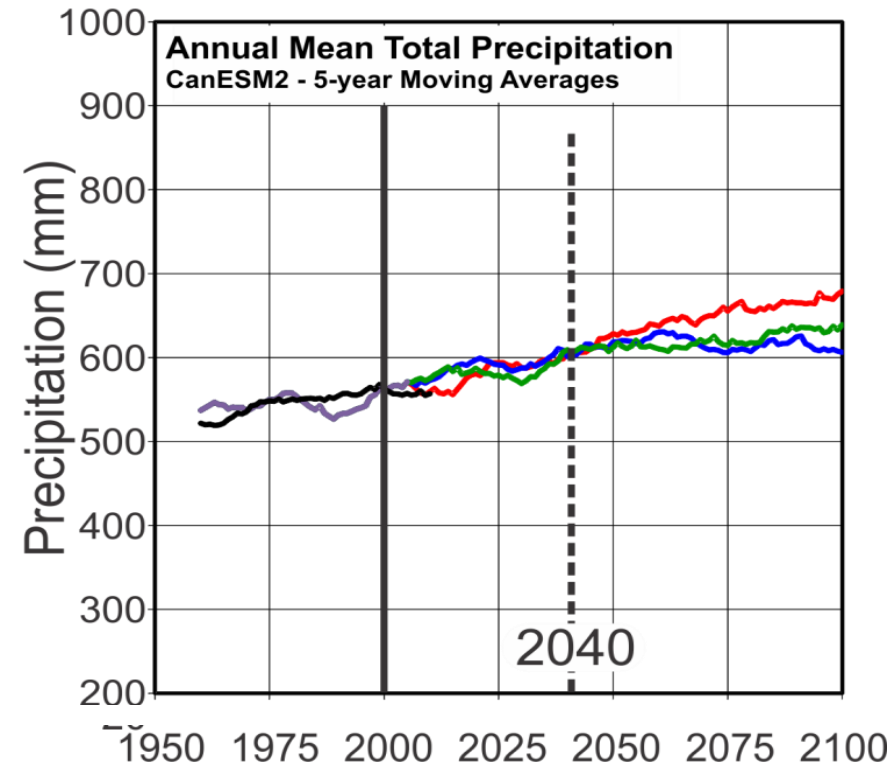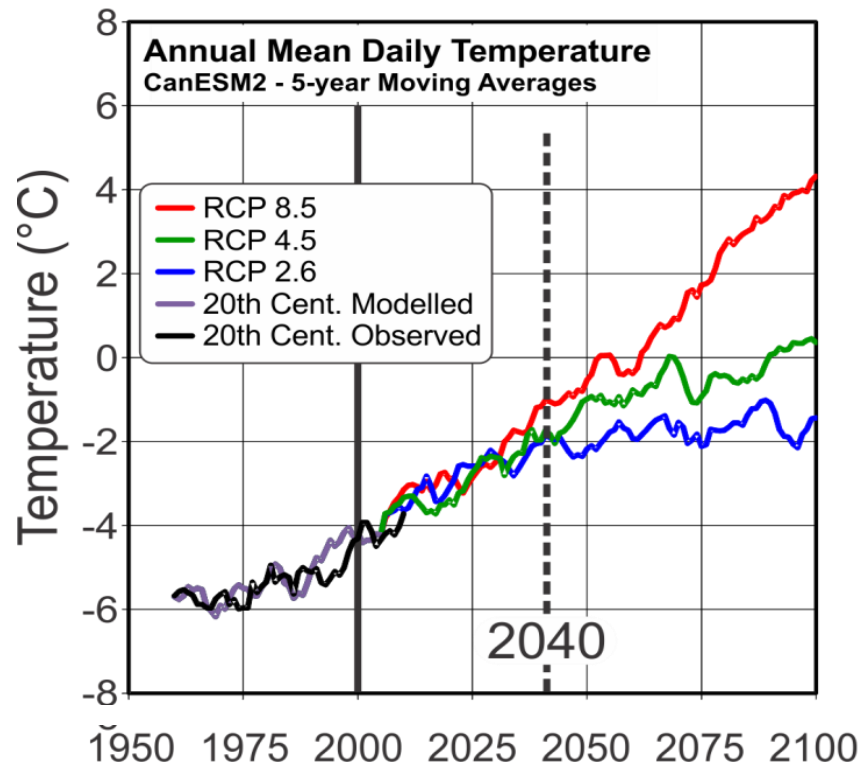# Temperatures in Canada are rising twice as fast as the rest of the globe

Let's look in the future…

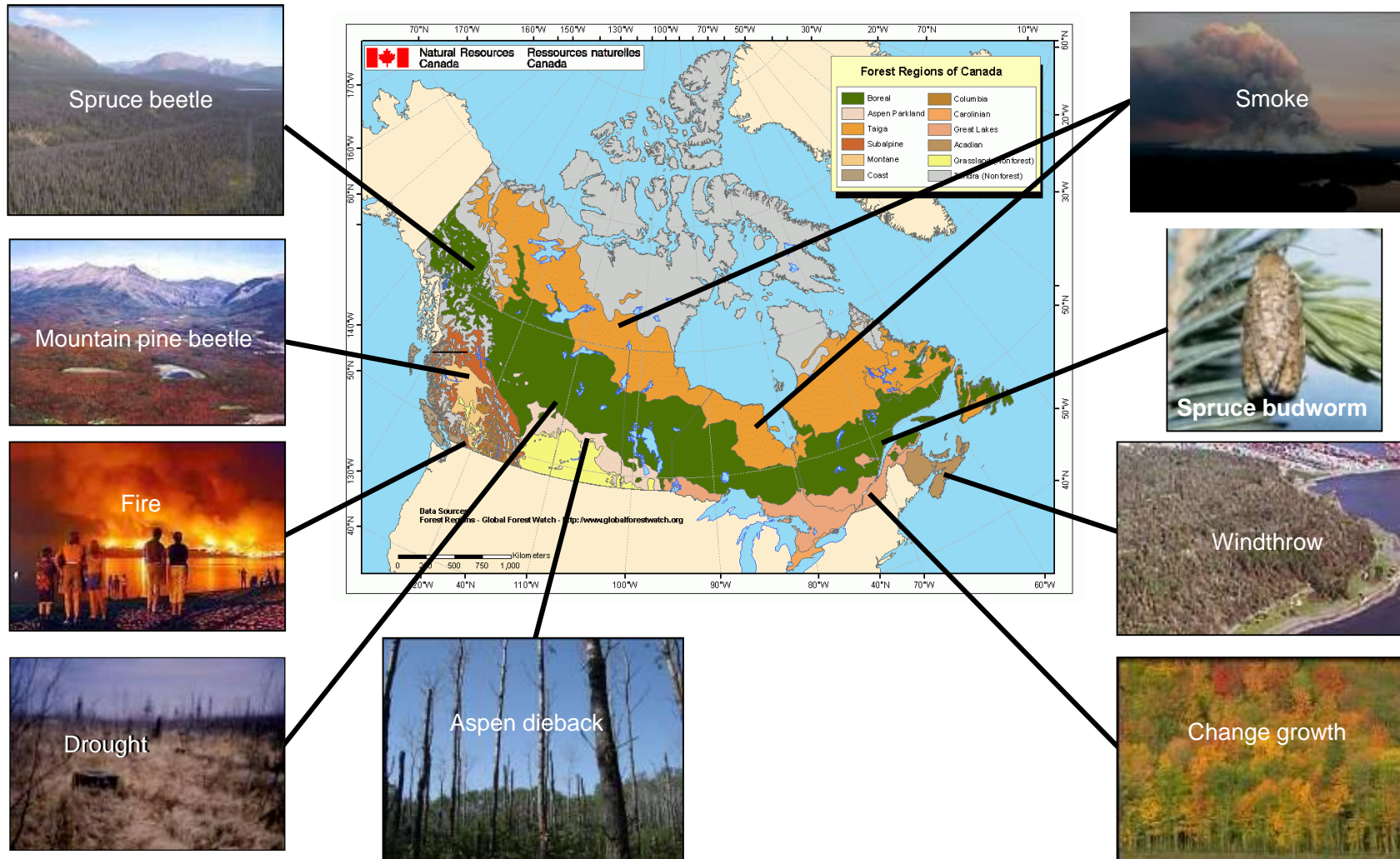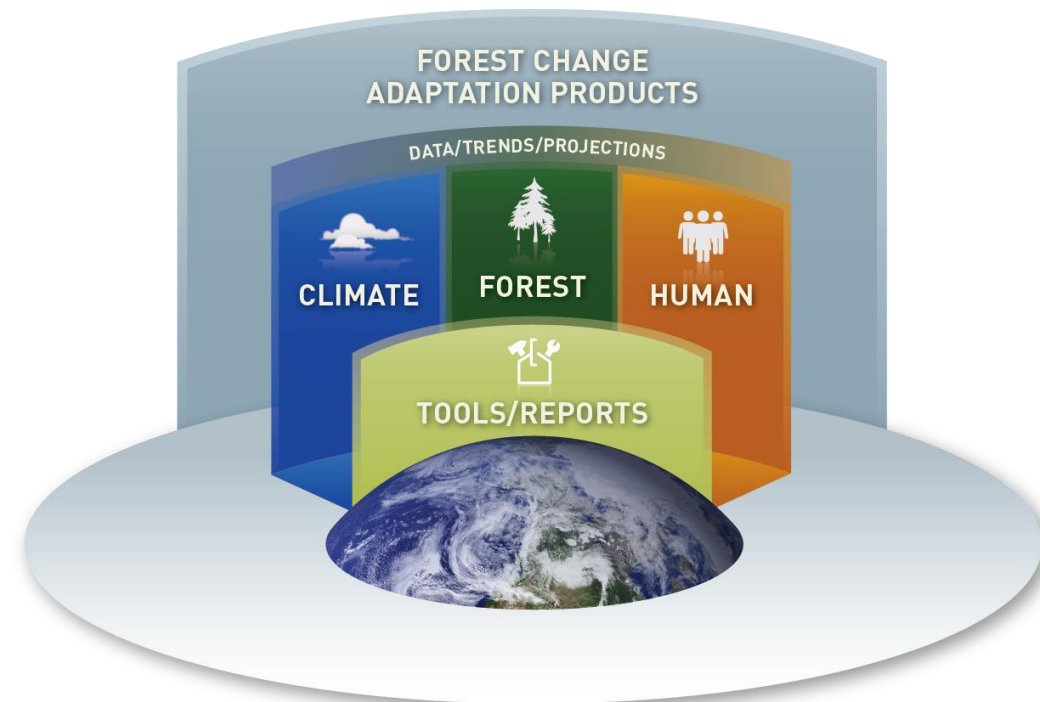## RCP : Representative Concentration Pathways (W.m-2)
Canada (land-based)

Source : Price et al.

Projected environmental changes of unprecedented speed and amplitude pose a substantial threat to boreal forest health

Spruce beetle

Mountain pine beetle

Fire

Drought

Aspen dieback

Smoke

Spruce budworm

Windthrow

Change growth

Forest Regions of Canada

Boreal
Aspen Parkland
Taiga
Subalpine
Montane
Coast
Columbia
Carolinian
Great Lakes
Acadian
Grassland (nonforest)
Tundra (Nonforest)

Data Sources:
Forest Regions - Global Forest Watch - http://www.globalforestwatch.org

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Forest Climate Change Adaptation:

- Forest Change 1.0 (2011-2016)
- Forest Change 2.0 (2016-2021)

FOREST CHANGE ADAPTATION PRODUCTS
DATA/TRENDS/PROJECTIONS
CLIMATE   FOREST   HUMAN
TOOLS/REPORTS

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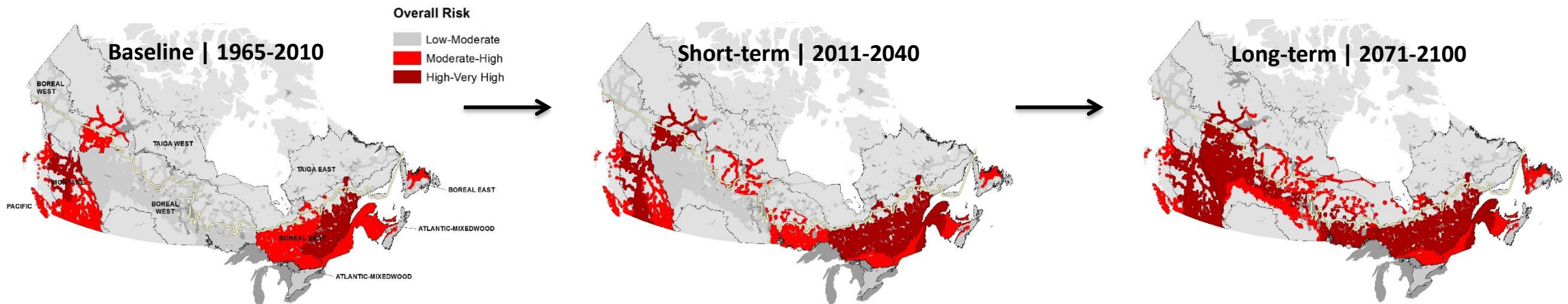
Canada

Forest Change 1.0

National Integrated Assessment

- Future projections of climate change impacts on Canada's forests
- End-to-end modeling, from biophysical to socioeconomic impacts

CLIMATE CHANGE RISK TO FOREST DEPENDENT COMMUNITIES

Baseline | 1965-2010

Overall Risk
- Low-Moderate
- Moderate-High
- High-Very High

Short-term | 2011-2040

Long-term | 2071-2100

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Forest Change 2.0

Why Regional Integrated Assessments?

- Climate change adaptation requires action at local and regional scales
  - Regional areas differ in risks, opportunities, and capacity
 - Regional solutions require collaboration and partnerships

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Forest Change 2.0

Our Approach to RIAs

- Integration of varied expertise and perspectives is key to informing decision-making
- Projects must be useful to end users
  - → Bottom up approach:
    - Issues identified by local and regional partners
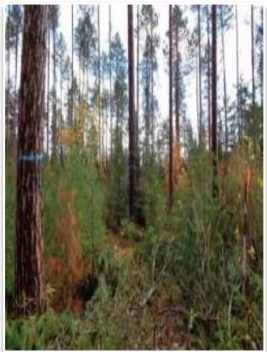   - Early and continuous engagement and collaborations

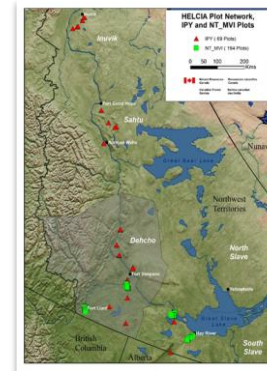# Examples of collaborative RIA work in progress
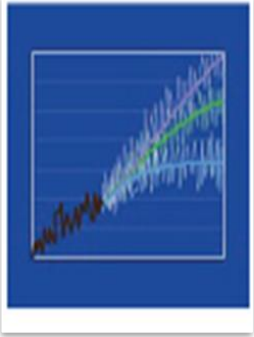
New models to inform provincial forest management planning

Indigenous-led community climate change monitoring

Economic impacts of fire-induced regeneration failure

Establishment of baseline forest conditions in changing northern forests

New visualization tools for decision-makers considering multiple values

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Work at the national level suggested that vulnerabilities would be specific to certain regions of the eastern part of the country.

In particular, fires are expected to increase in northwestern Quebec
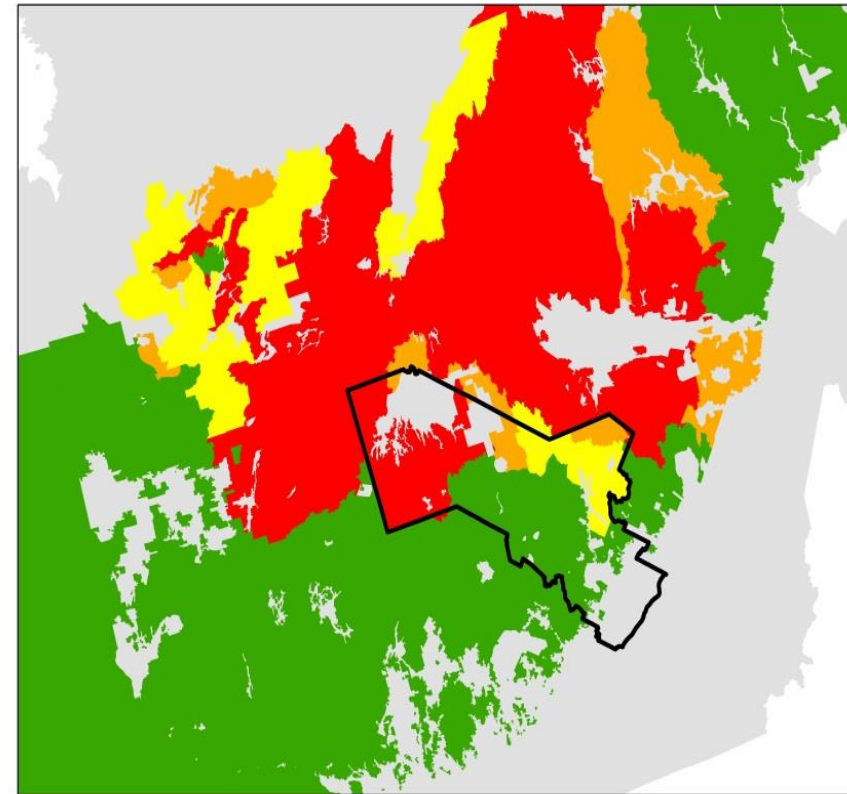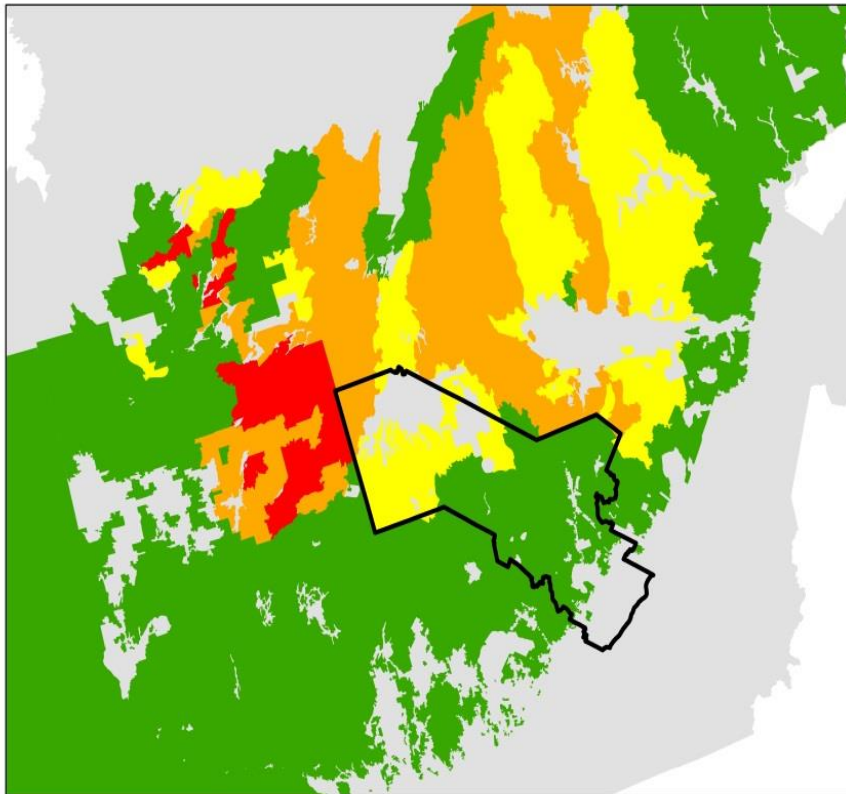

1961 - 1990

2011 – 2040 RCP 8.5

2041 – 2070 RCP 8.5

2071 – 2100 RCP 8.5
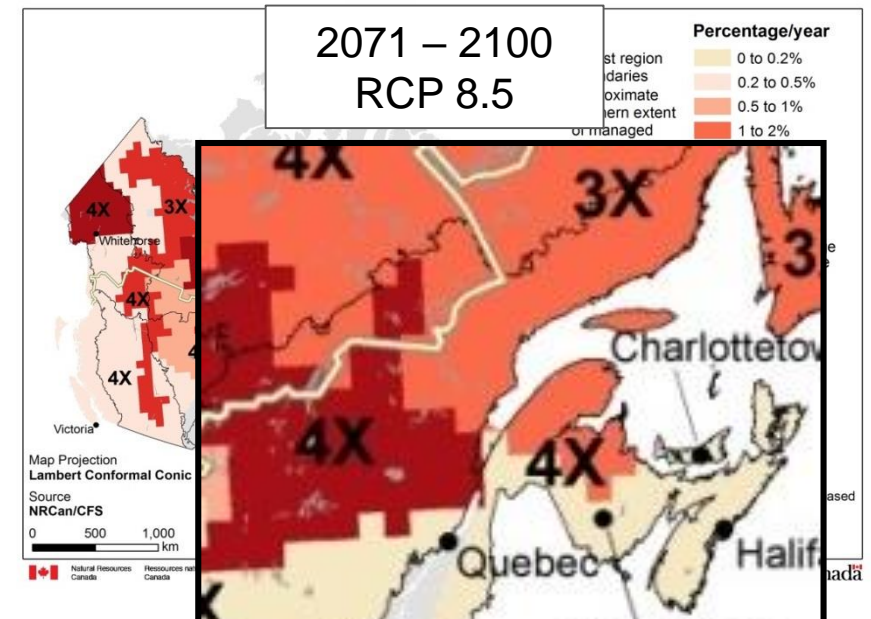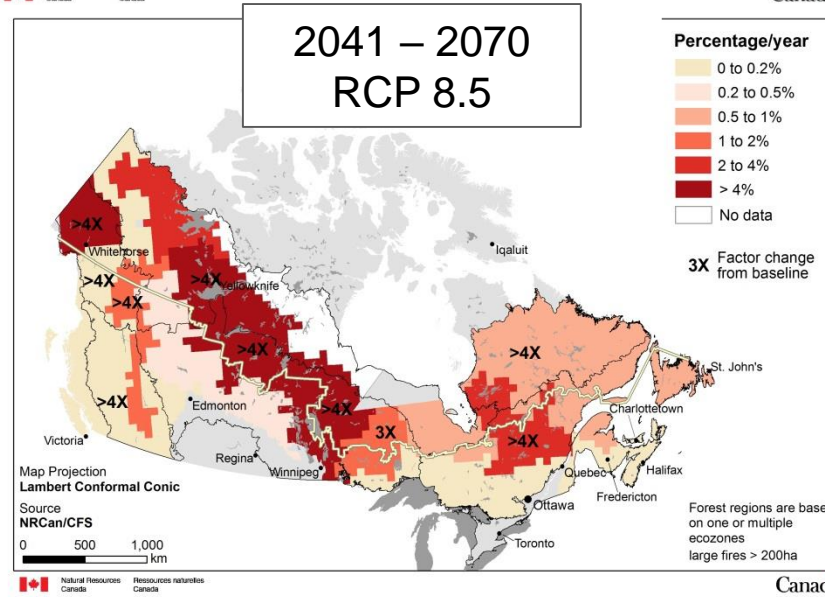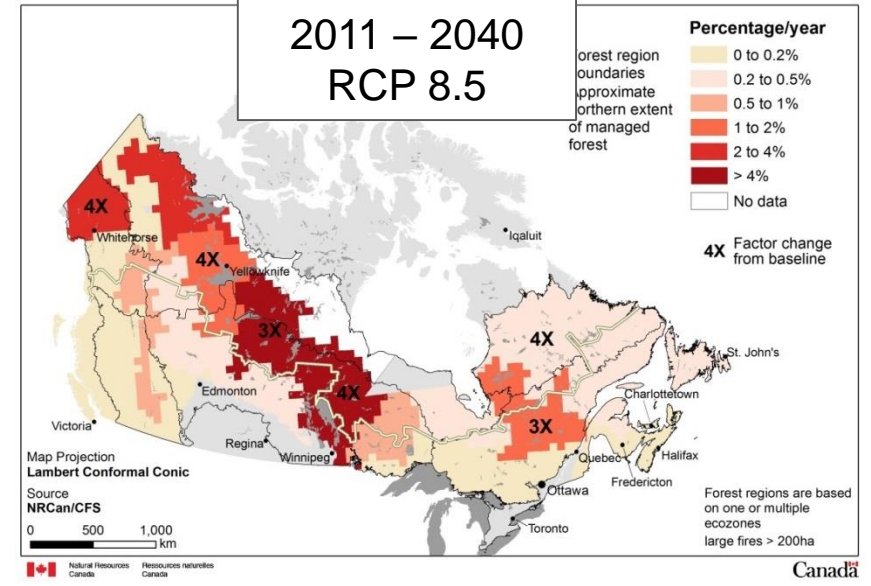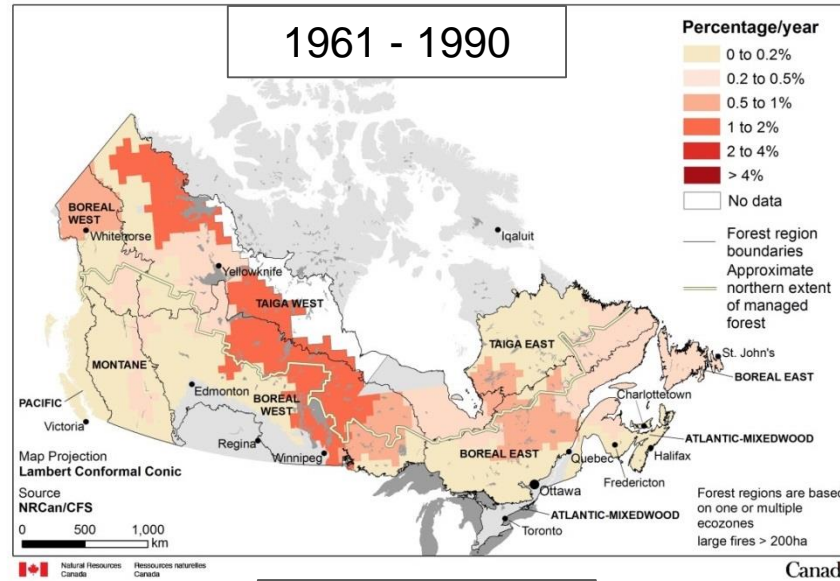
If harvesting rates remain the same, some areas will become much more vulnerable due to an increase in fires

RCP 8.5

2025

2085

Vulnerability
- Low (green)
- Moderate (yellow)
- High (orange)
- Extreme (red)

Gauthier et al. 2015

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SBW outbreaks should be shorter

Baseline | 1965-1998

Short term| 2011-2040

RCP 8.5

Medium term | 2041-2070

Long term | 2071-2100

Number of years with severe defoliation on a 30-year basis

- 0.5 to 1
- 1 to 2
- 2 to 4
- 4 to 6
- >6

By: Yan Boulanger, Barry Cooke, Sylvie Gauthier, David Price

Natural Resource Canada

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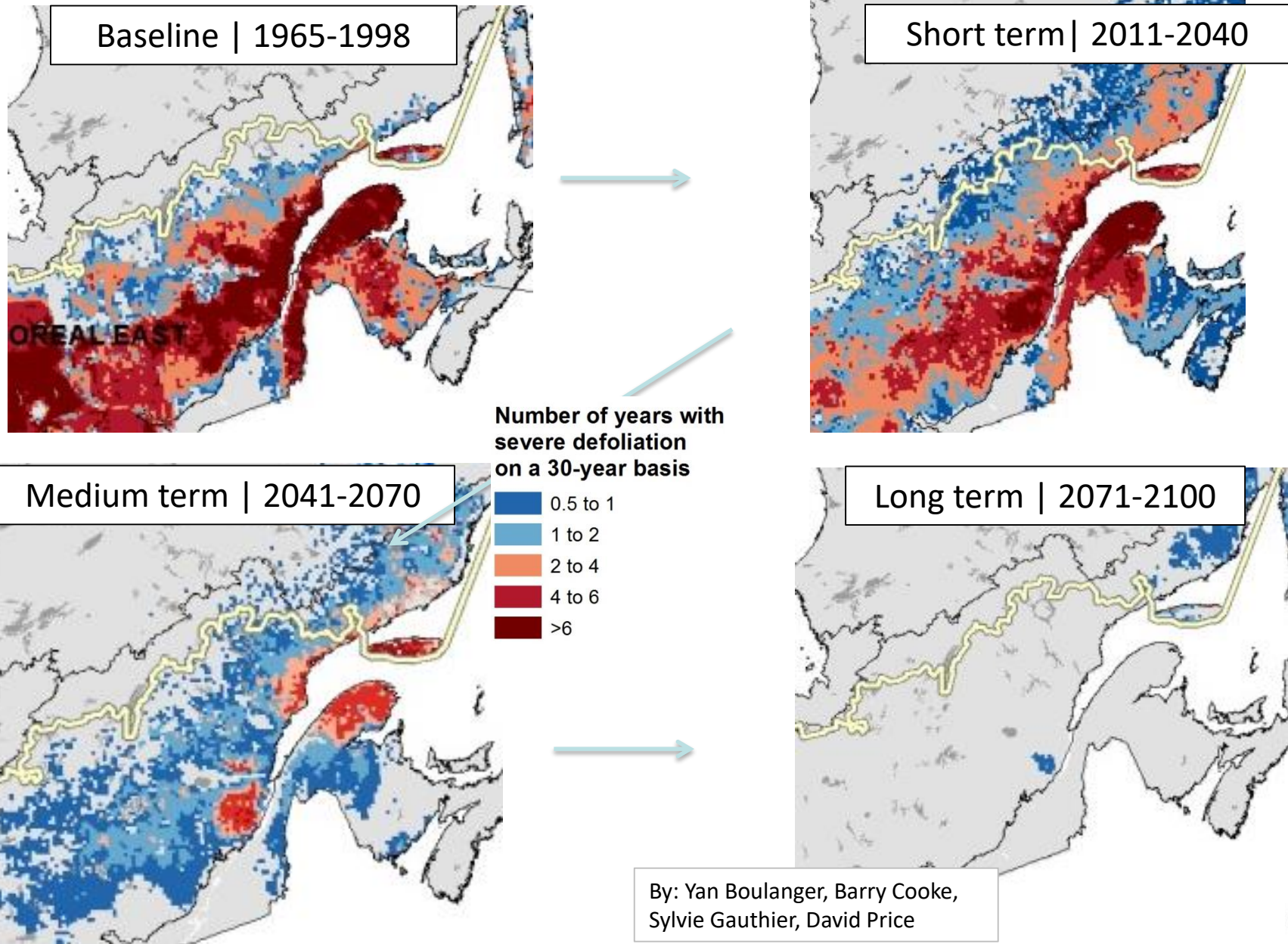
More volumes will be exposed to drought

Baseline | 1981-2010

Short term | 2011-2040

Medium term | 2041-2070

Long term | 2071-2100

Tree volume (m³/ha)
High : 100
Low : 0

By: Yan Boulanger, David Price, Isabelle Aubin

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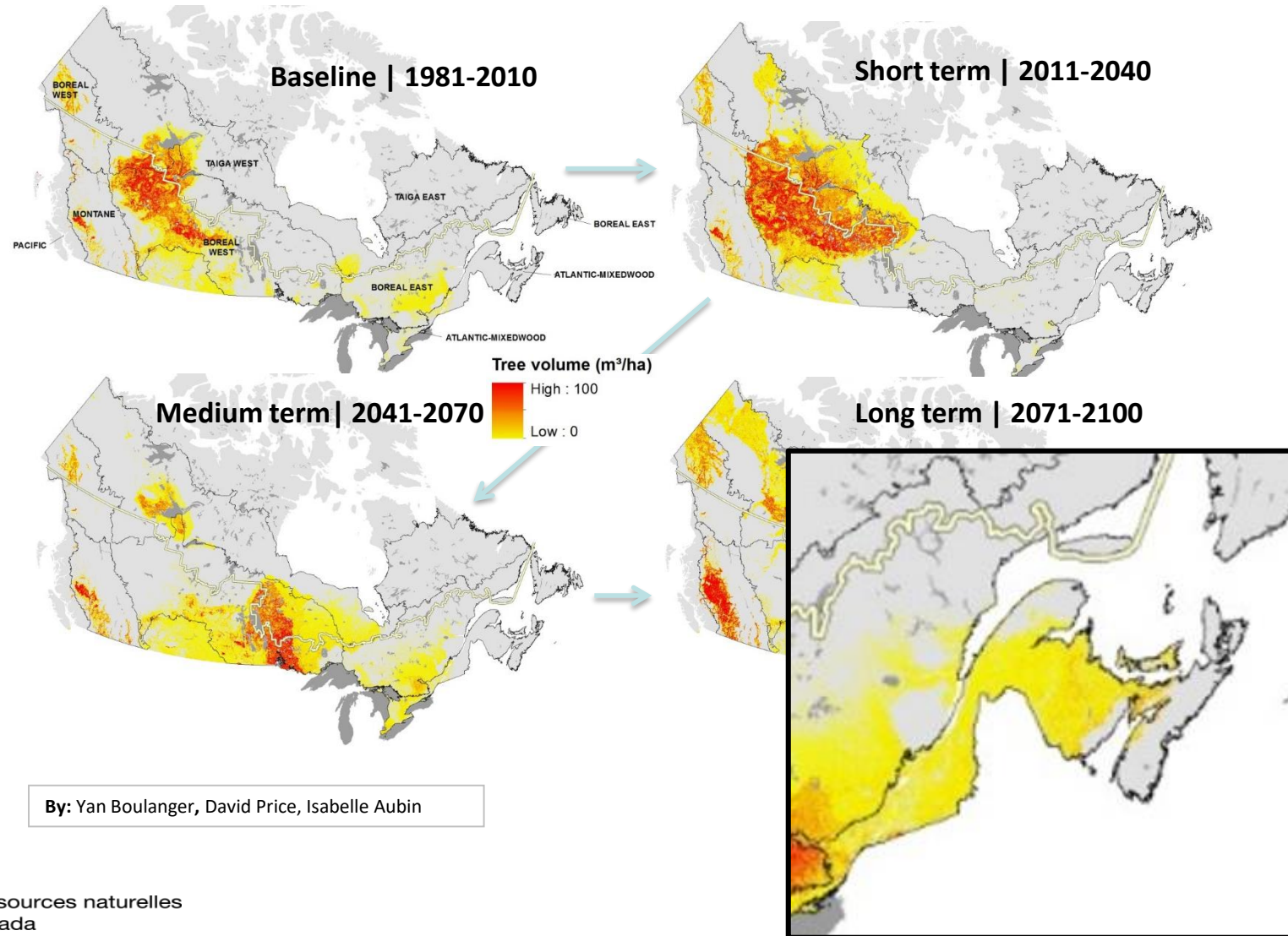
Future Challenges in Eastern Forests

- Vulnerabilities must be identified
- Challenges will be specific to certain regions
- Regions vulnerable to a particular element must be delineated in order to establish effective adaptation and mitigation measures.

An Integrated Analysis of the Impact of Climate Change on the Eastern Boreal Forest

- 12 sub-projects
- Vulnerability analyses and adaptation strategies
- In collaboration with MFFP, BFEC, private prop.
- 2017-2021

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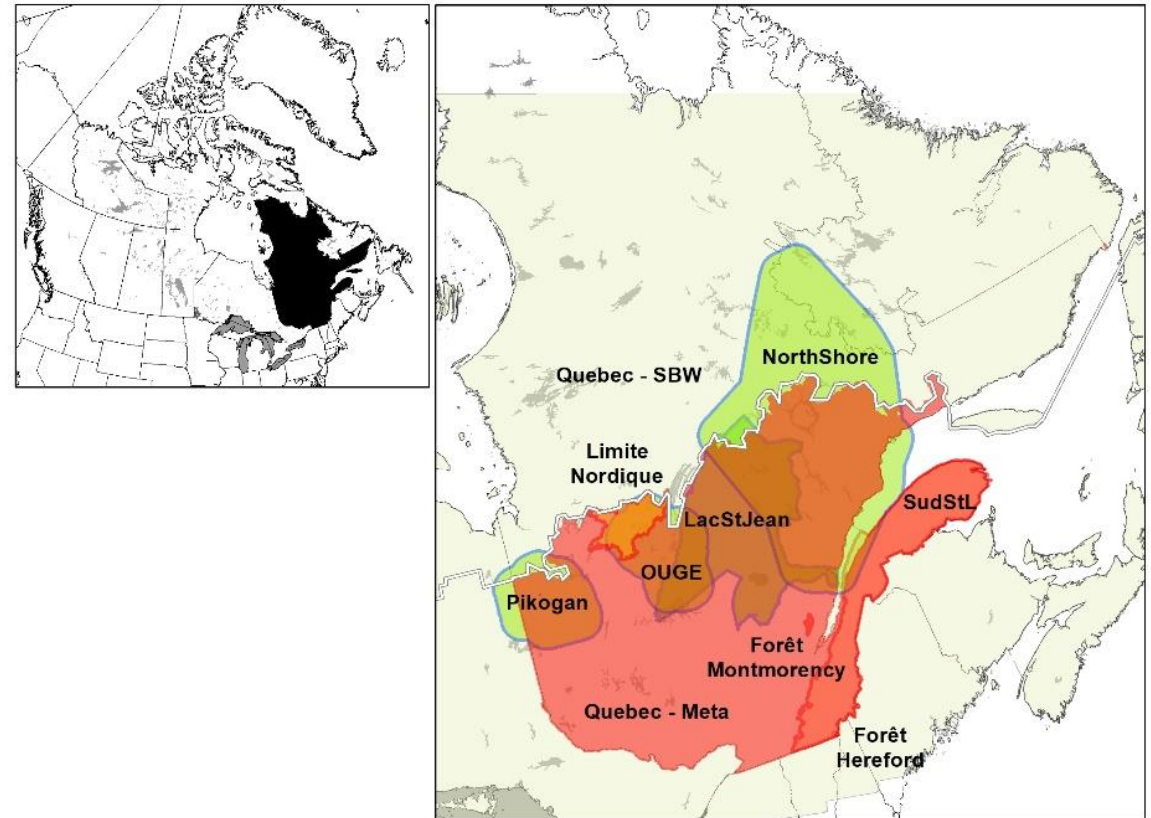
An Integrated Analysis of the Impact of Climate Change on the Eastern Boreal Forest

- January 20, 2021

Impacts of climate change on Québec forest landscapes - *Yan Boulanger, Canadian Forest Service*

A multi-model analysis of the impacts of climate change on Quebec forests - *Jesus Pascual Puigdevall, CFS*

- January 27, 2021

Regeneration accident; importance for maintaining forest productivity and strategies to mitigate their impacts - Sylvie Gauthier, CFS

Climate change, spruce budworm and potential impacts on the composition of Quebec's boreal forest - Louis De Grandpré, CFS

- February 3, 2021

On the road to adaptation: co-constructing an approach to take climate change into account in forest planning - Marie-Andrée Vaillancourt and Catherine Périé, MFFP

- February 10, 2021

Combining Forest Modeling and Aboriginal Knowledge to Assess the Sustainability of Changing Boreal Landscapes - *Annie-Claude Belisle, UQAT*

- February 17, 2021

Integrating Climate Change and Developing Adaptive Capacity in Determining Harvest Levels in Quebec - *Stephen Yamasaki, Jean Girard, Bruno Forest, BFEC*
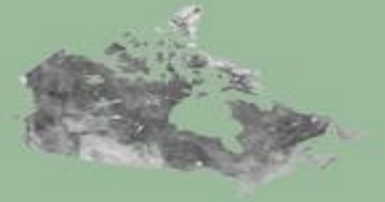
- February 24, 2021

Forest management and conservation of the biodiversité in a context of climate change: two case studies in Quebec - *Évelyne Thiffault, Université Laval and Junior Tremblay, ECCC*

Presentations were recorded and should be available soon.
Stay tuned!

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Impacts of climate change on Quebec's forest landscapes

Yan Boulanger, research scientist in forest ecology, CFS
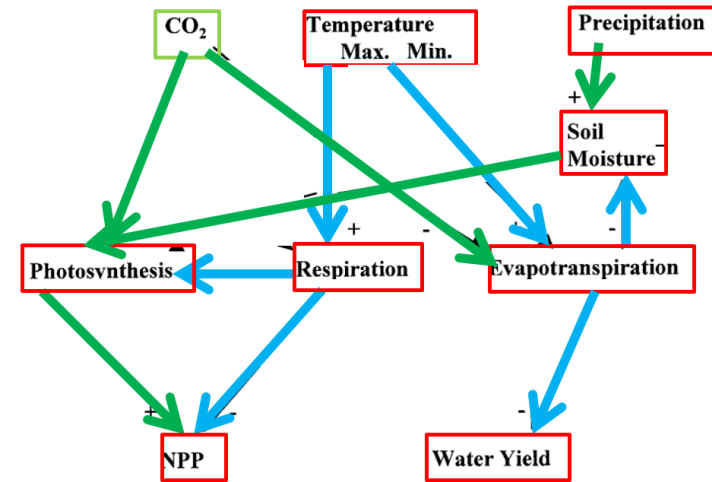
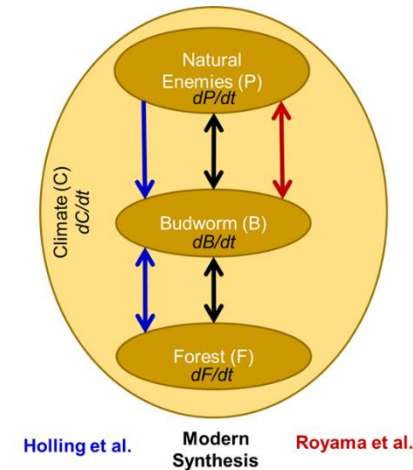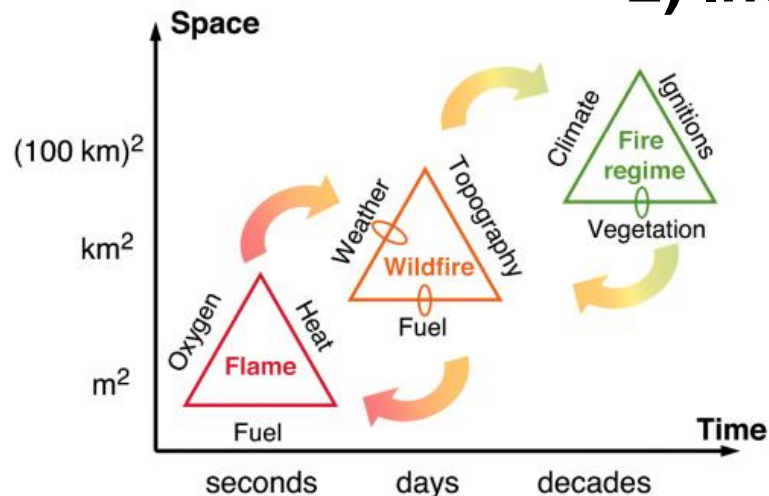Jesus Pascual Puigdevall, research associate, CFS

What will be the impacts on forest landscapes ?

1) Direct impacts

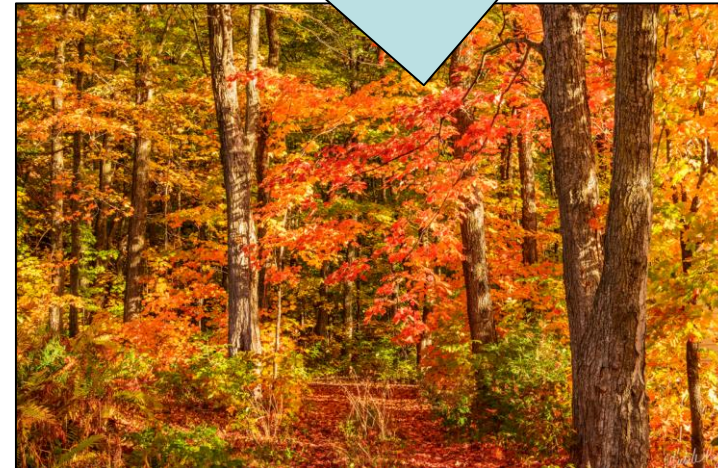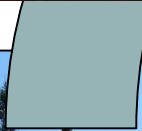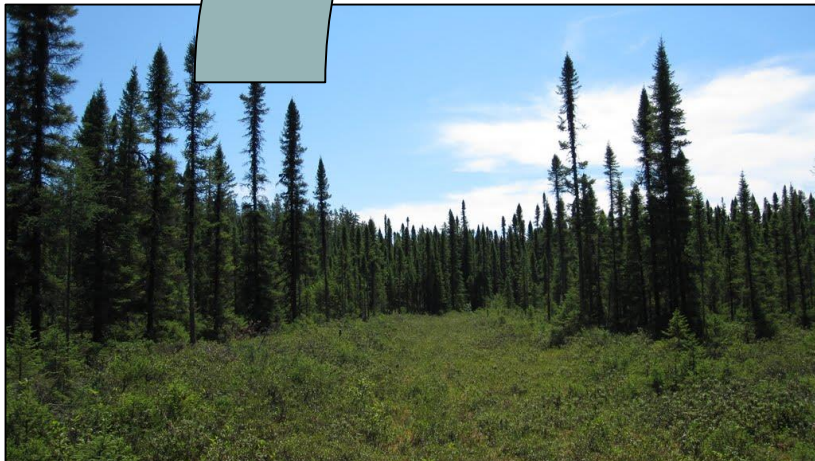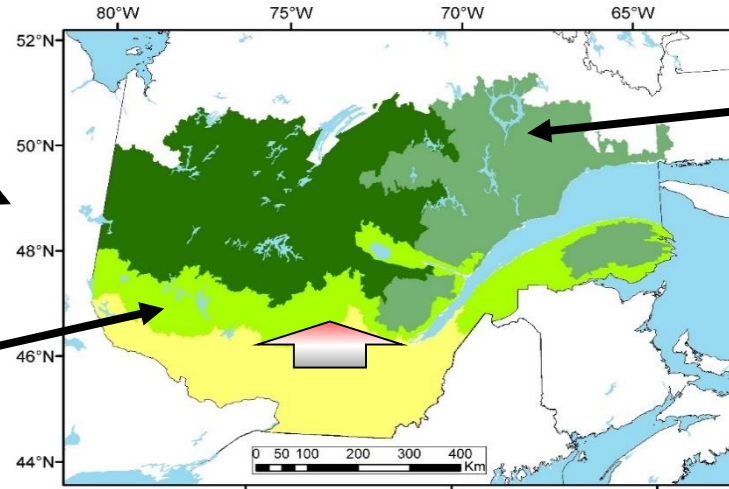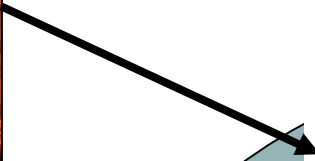- Forest landscapes will be influenced by the direct and indirect effects of climate change.

2) Indirect impacts

Moritz M A et al. PNAS 2005;102:17912-17917

Holling et al.   Modern Synthesis   Royama et al.

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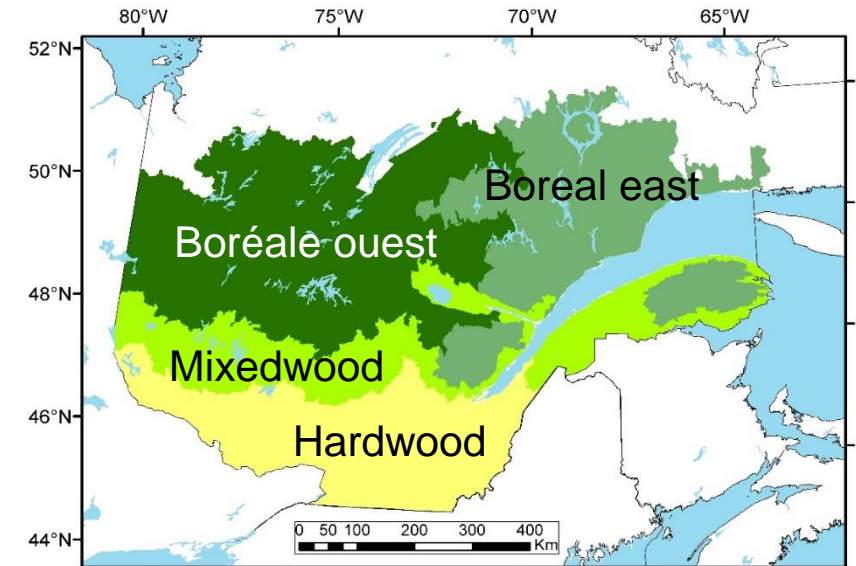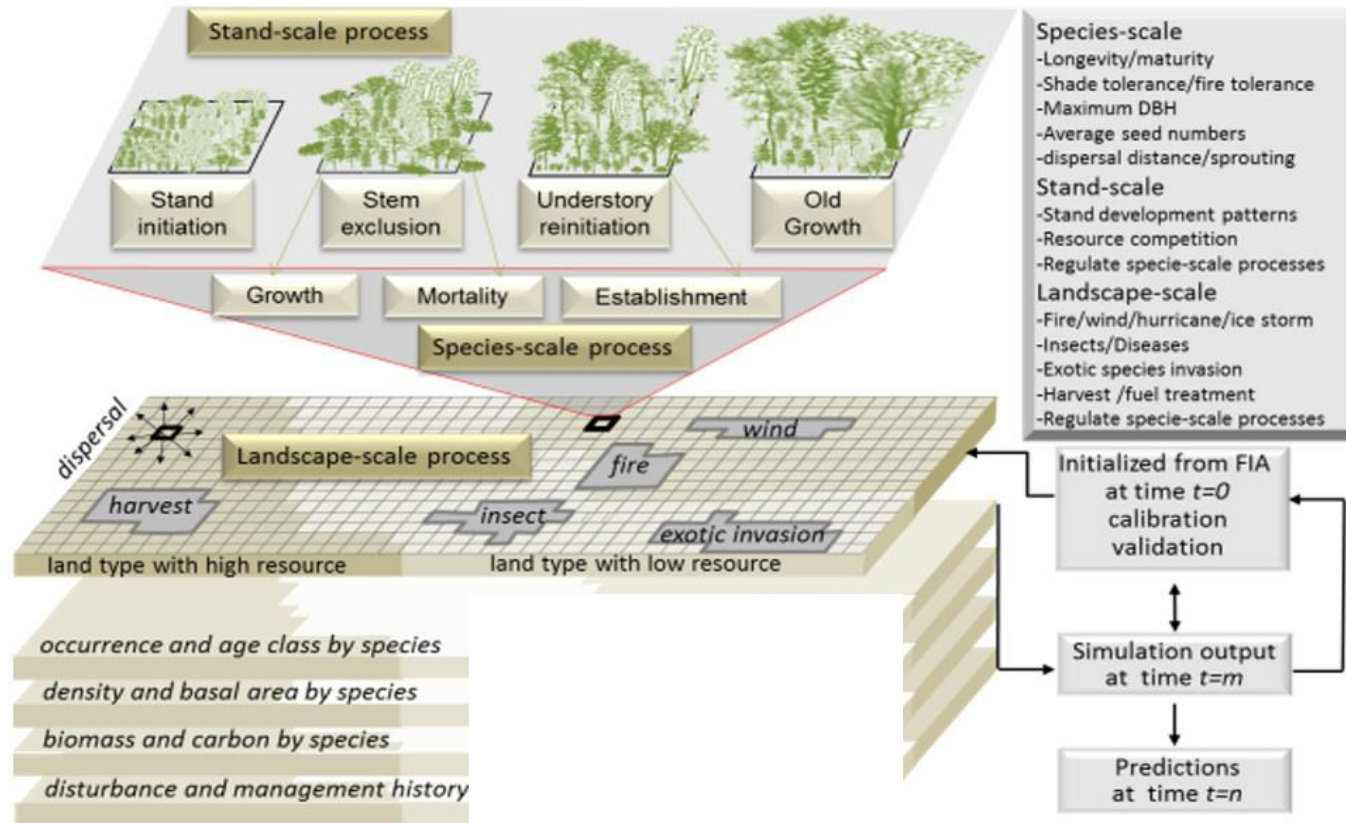# What will be the cumulative impacts on forest landscapes ?
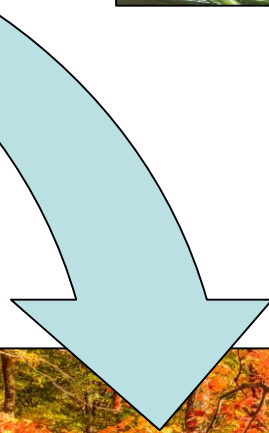
Will current forest management practices affect the resilience of forest landscapes in a changing climate?
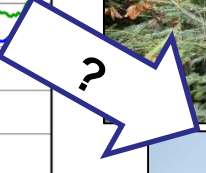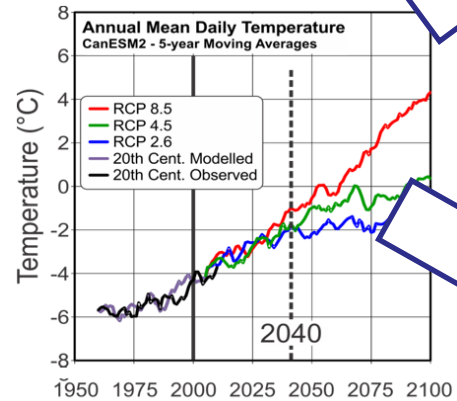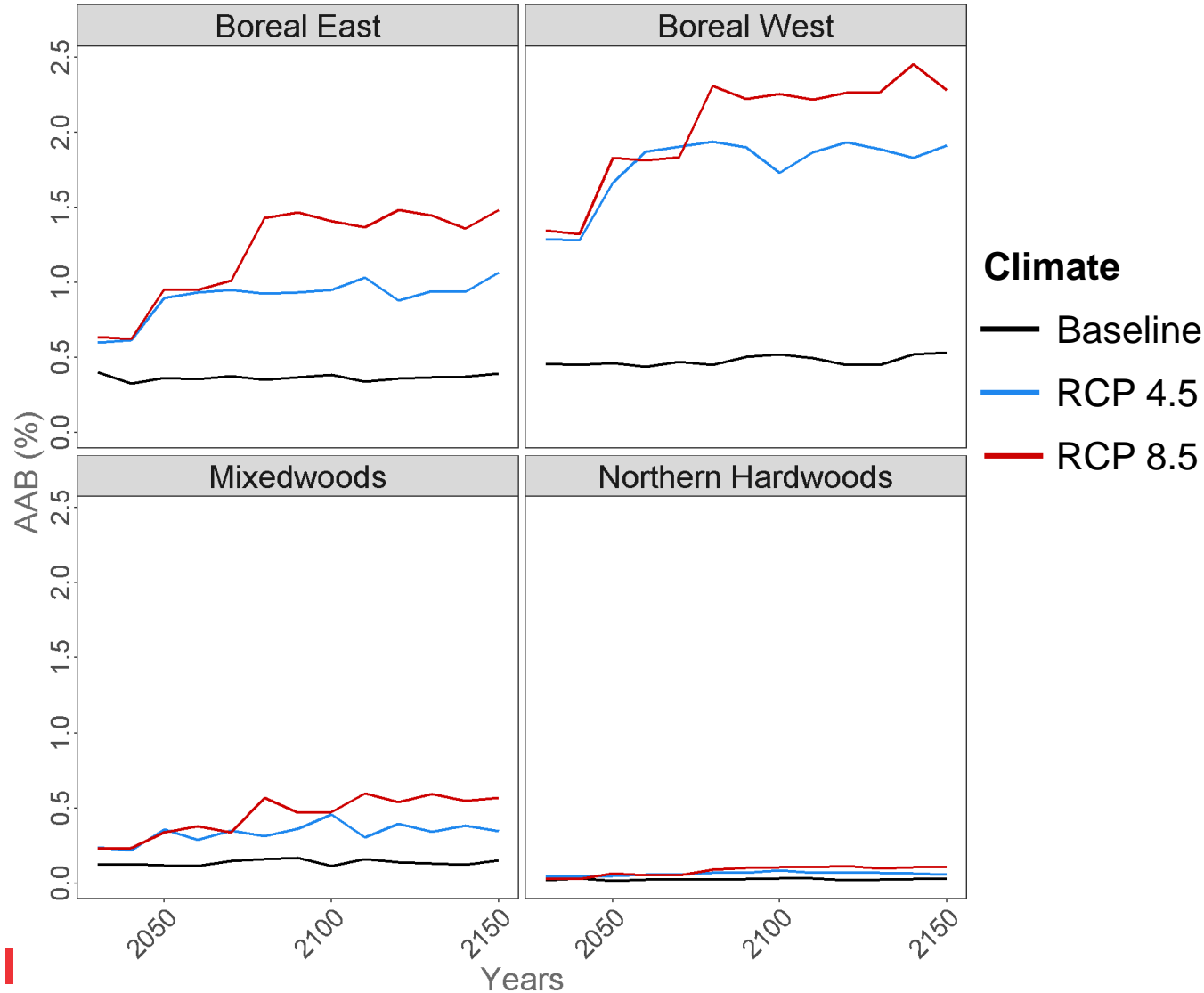
LANDIS-II: a forest landscape model

LANDIS : Forest succession and disturbance model

- Three climate scenarios:
  - Baseline
  - RCP 4.5
  - RCP 8.5
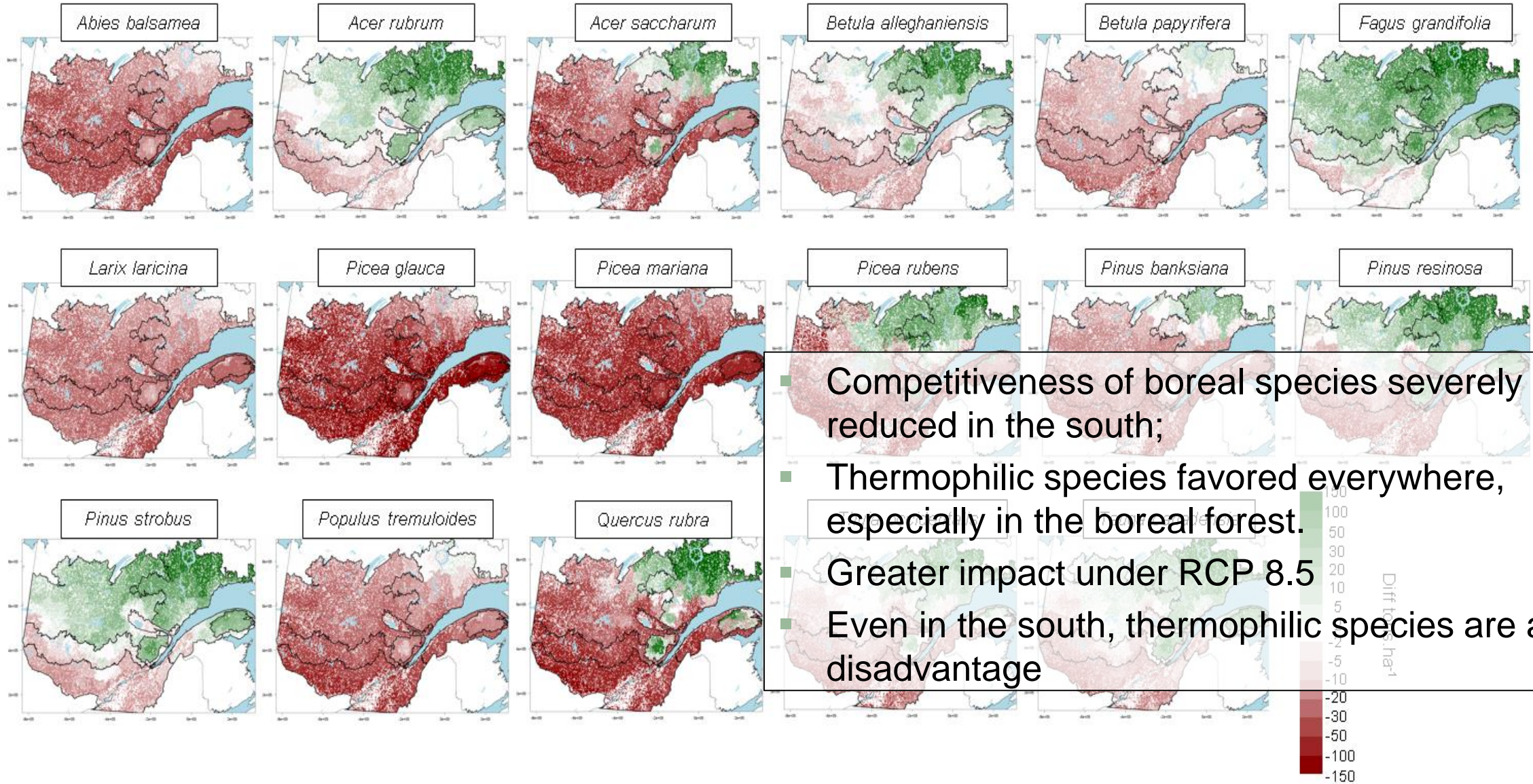- Two Harvesting Scenarios
  - Current (EBFM)
  - No cut

Annual area burned will increase, especially in the western boreal forest

- Landscape "rejuvenation"
- Regeneration accidents
- Favour pioneer / pyrophilous species

Growth potential 2100 vs 2000 – RCP 8.5

- Competitiveness of boreal species severely reduced in the south;
- Thermophilic species favored everywhere, especially in the boreal forest.
- Greater impact under RCP 8.5
- Even in the south, thermophilic species are at a disadvantage

These changes will result in reductions in biomass everywhere and a more pronounced species shift in hardwood and mixedwood forests
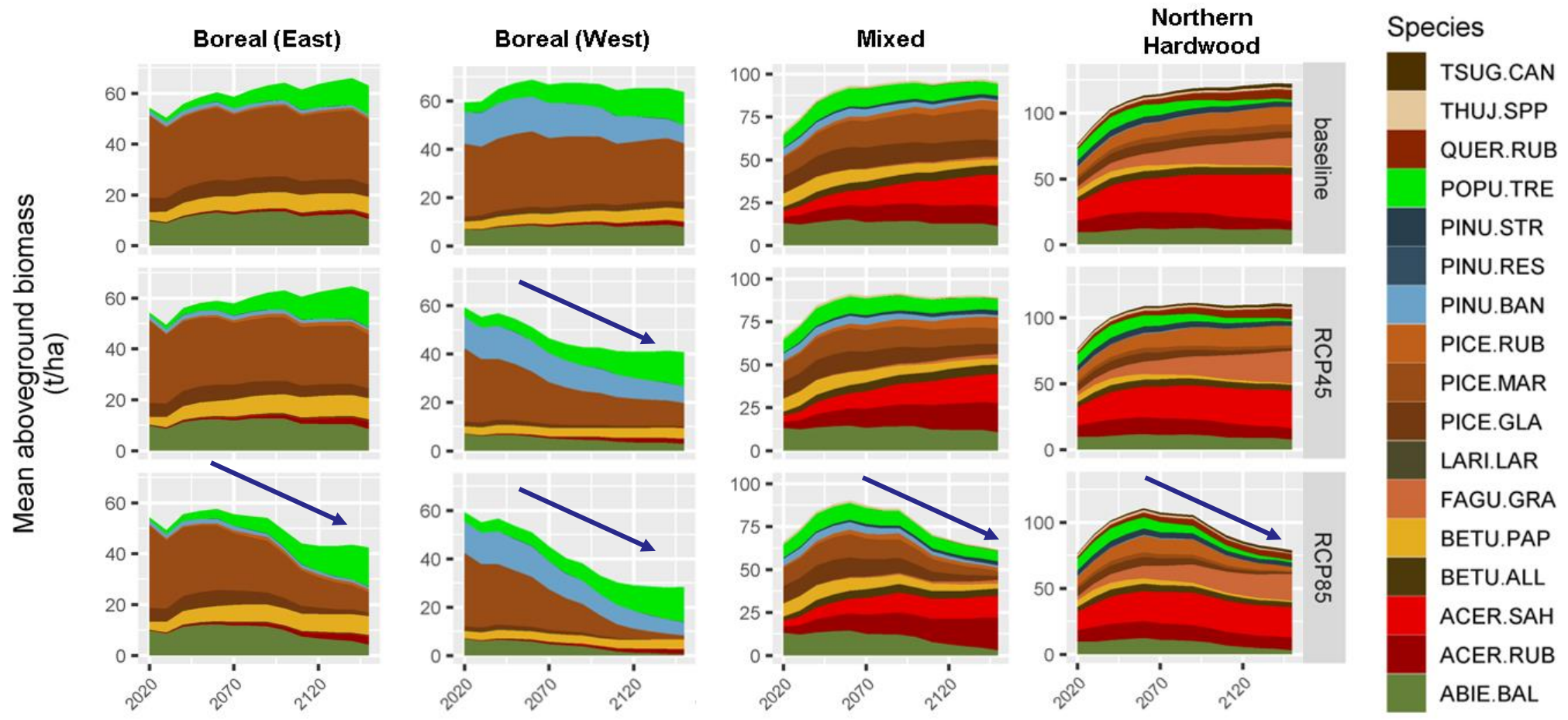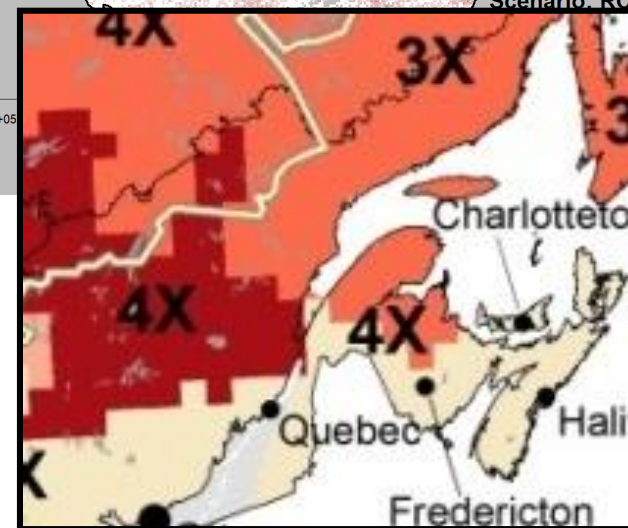
The northward migration of temperate species will be very low
The increase of fires will have a very important impact on boreal species, even leading to their local extirpation
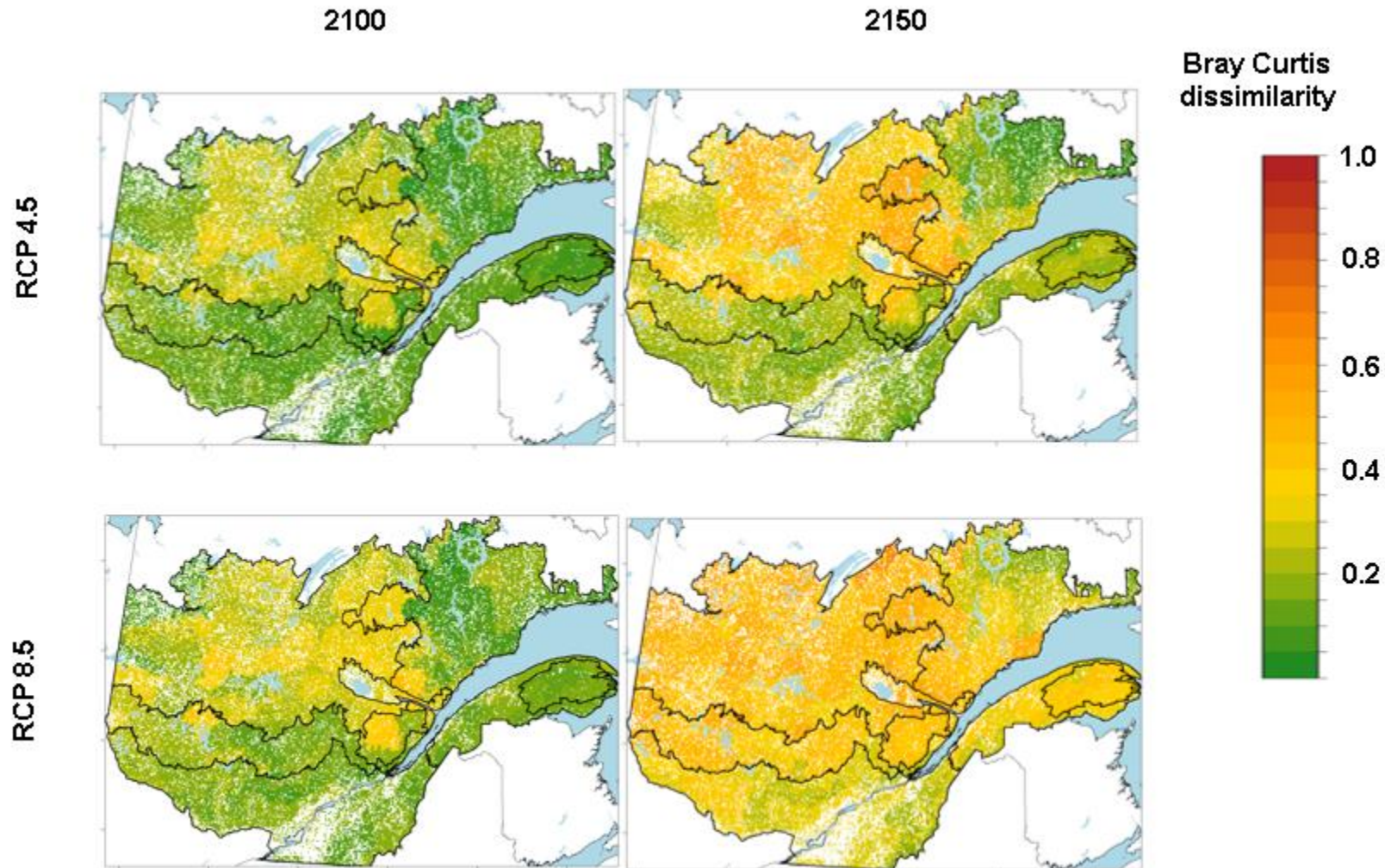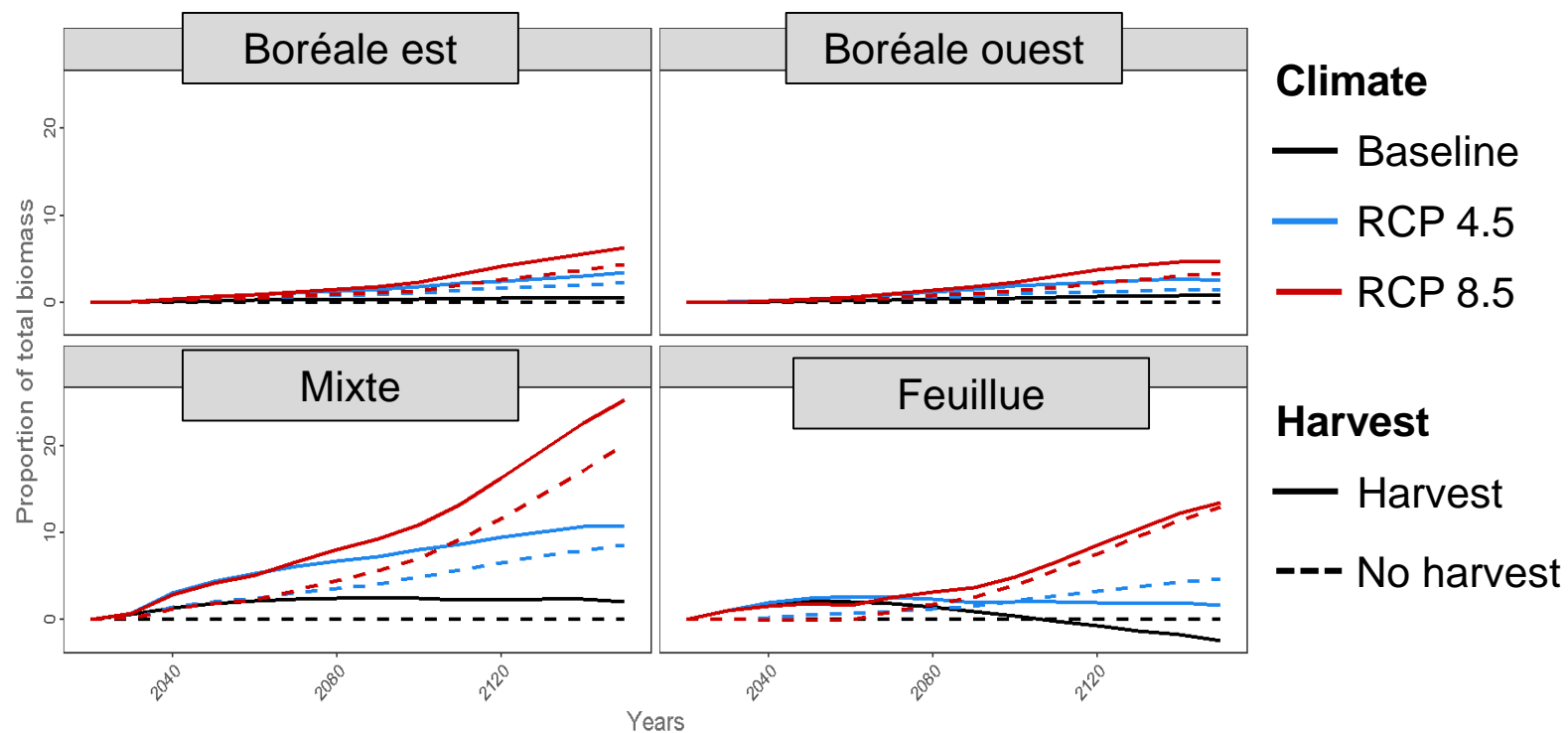
A) Red maple

B) Black spruce
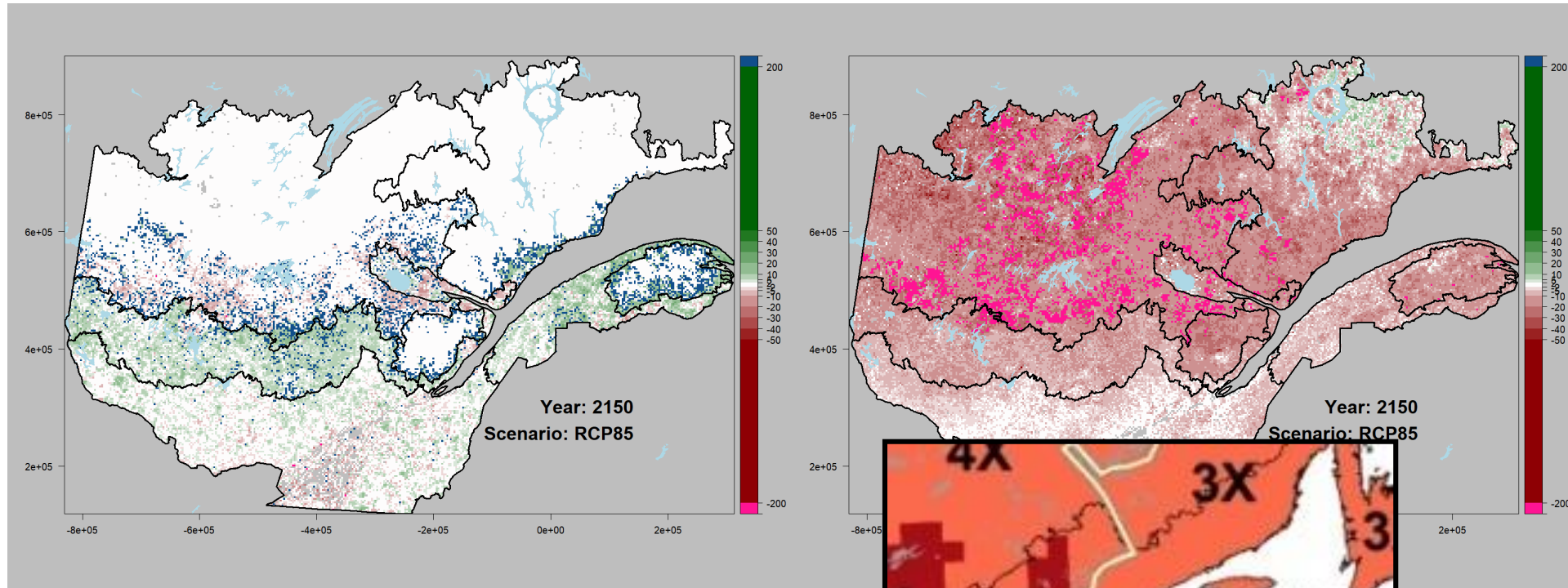
Colonization

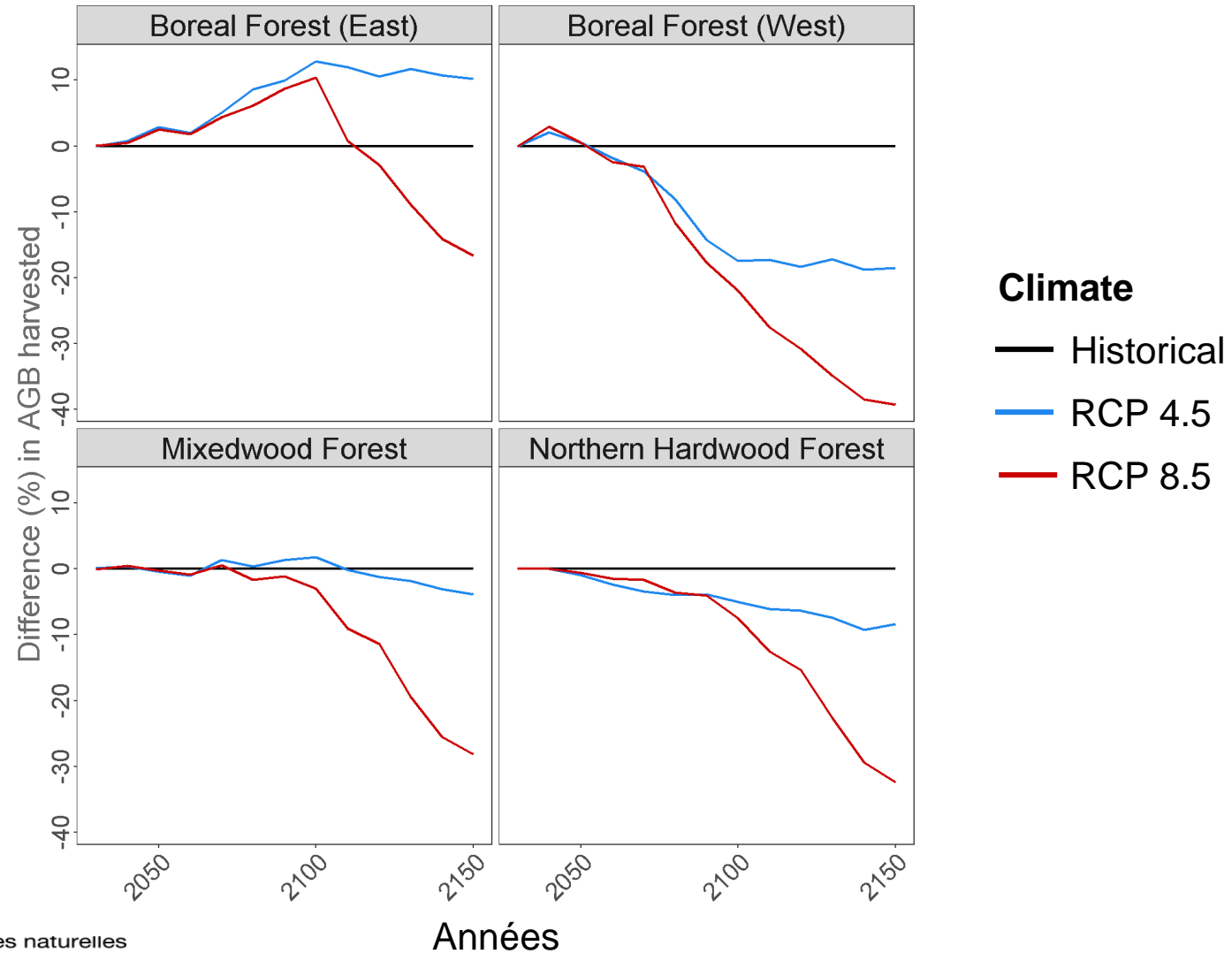Extirpation

Cumulative impacts will be much greater in the boreal forest than in mixed or hardwood forests

Harvest favored thermophilic species especially in the mixedwood

These changes will lead to significant reductions in harvested volumes

In summary…

- Tipping point under RCP 8.5, after ~2080
- The boreal forest appears to be less resilient than mixed and temperate forests.
  - Natural disturbances at a higher rate than natural variability
  - Fires lead to a certain change in composition but above all a significant drop in biomass
  - No adapted temperate species can take the place
- In mixed and deciduous forests, the species composition changes strongly towards thermophilic species, which are better adapted than the boreal species present

In summary…

- Harvesting favors thermophilic species in mixed forests.
  - Faster northward migration of hardwood forest
- Frequent silvicultural interventions would encourage a more rapid proliferation of these species.
  - More frequent partial cuts over a larger area (moderate disturbance hypothesis)

In summary…

- Significant reduction in cutting volumes:
  - Potentially significant economic losses
  - Softwood timber expected to decrease
- Important adaptations required
  - AAC reductions to address fire increases?
  - Transition strategies in mixed and hardwood forests?
- Adaptations will need to be regionally specific

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Adaptation: some insights from central Quebec
## Stephen Yamasaki et al. 2021
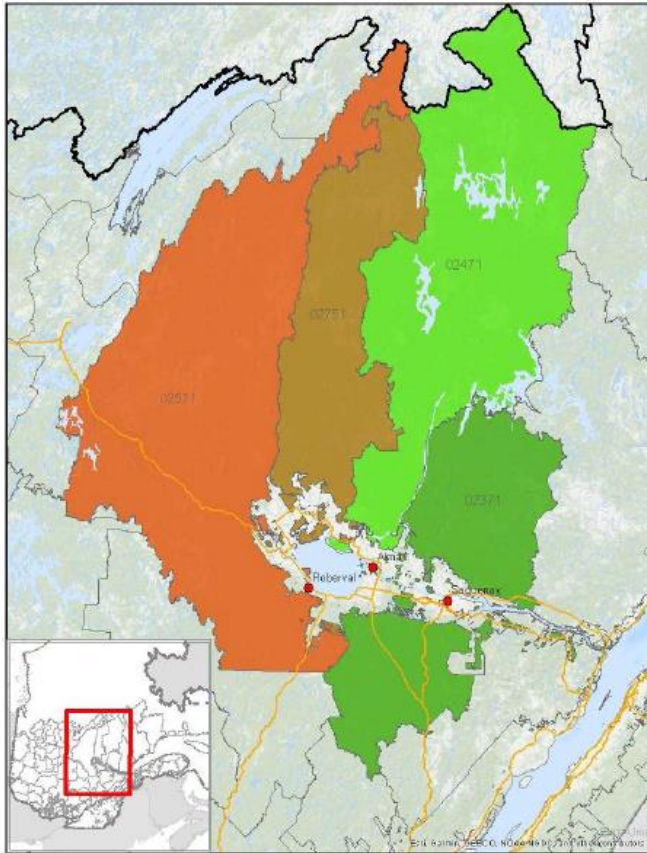
- Very important timber production region
- Fire is currently and will be even more frequent in the future
- Regeneration accidents more frequent
- What should we do?

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Much more regeneration failures, less volume harvested (sustainable), more salvage
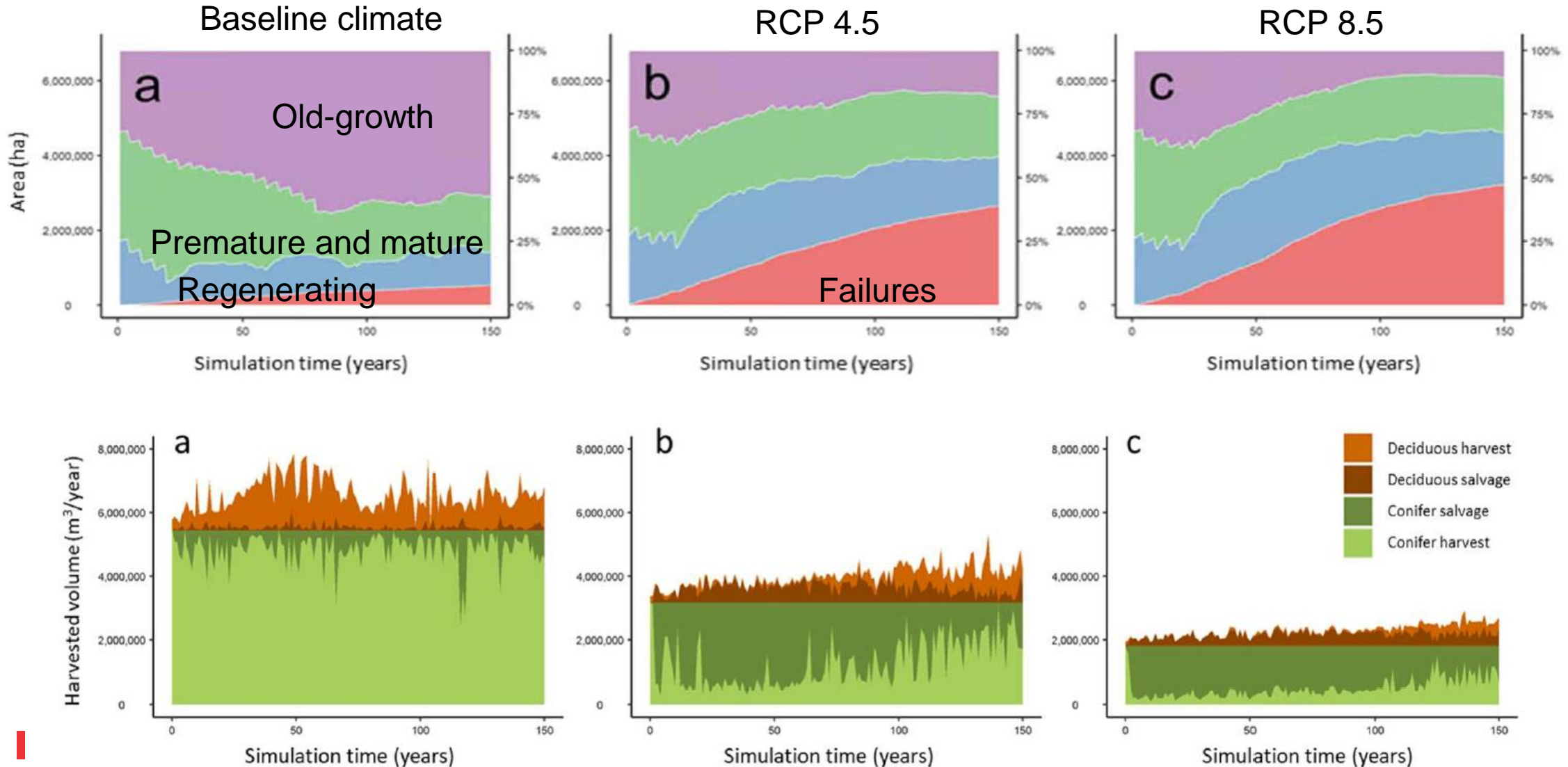
Planting conifers AND deciduous help maintain more volume harvested (also less fires!)
Harvest rates still have to be adjusted to prevent shortfalls

RCP 8.5, Intensive_F50_Plant2
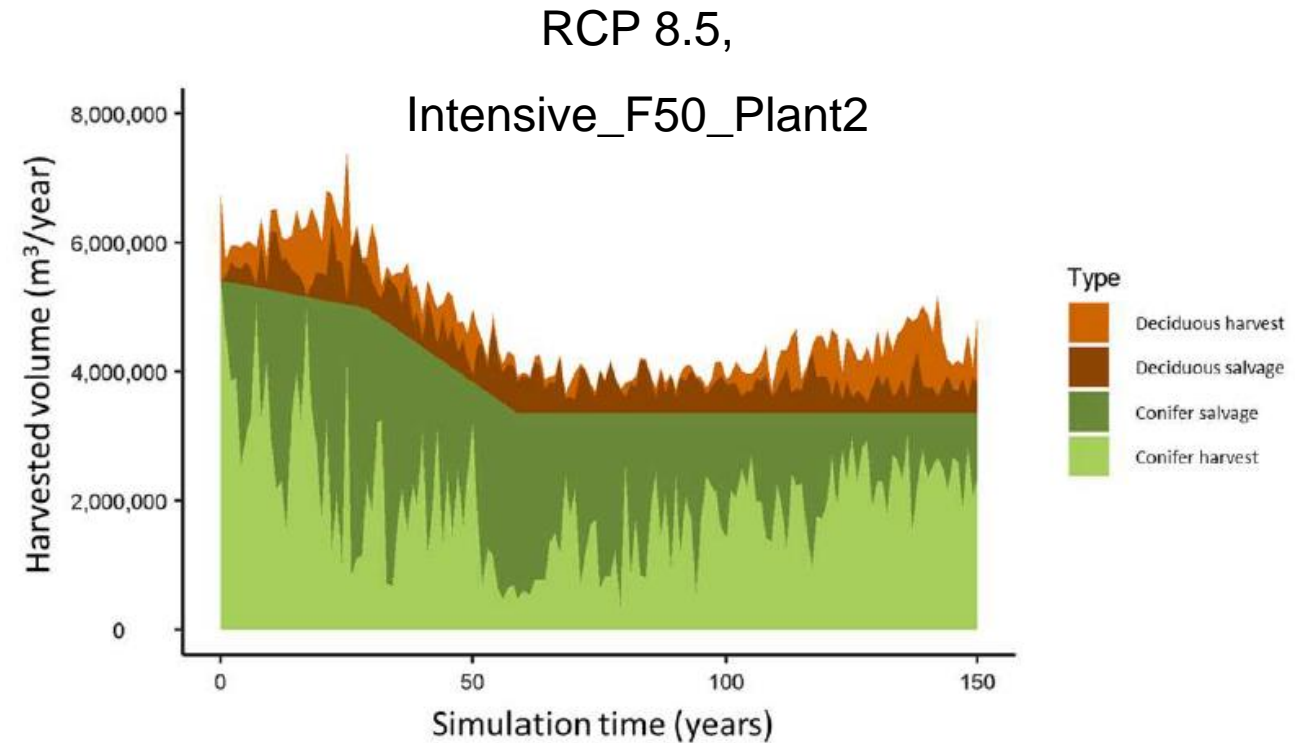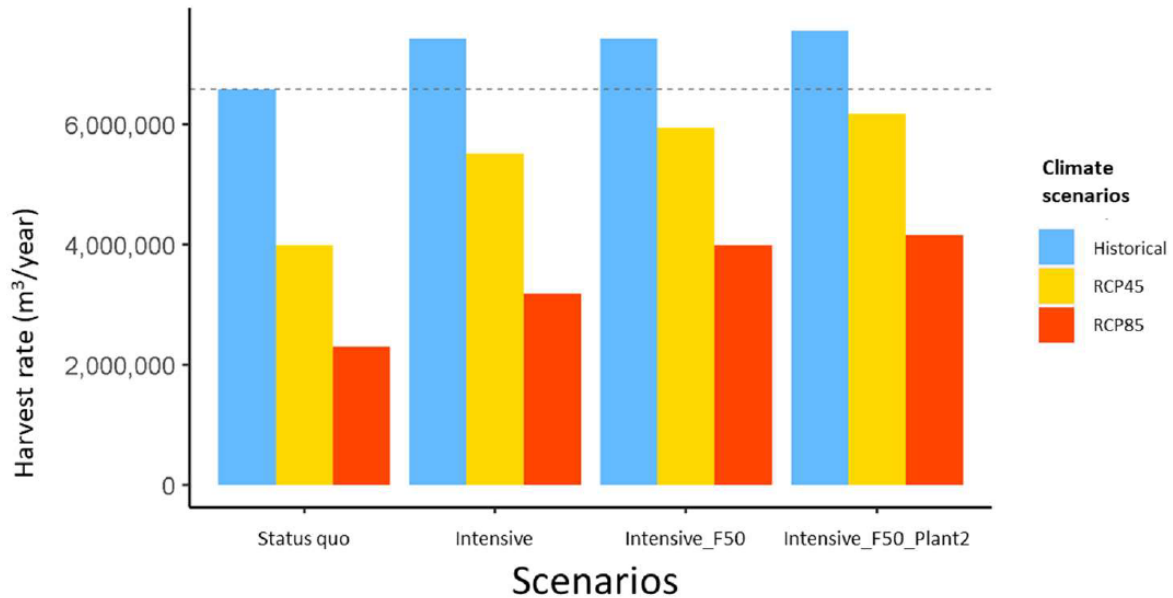
What's next?

- Any trade-offs among adaptation scenarios?
- How about carbon, biodiversity, other values?
- More deciduous: which forest product?
- Uncertainty must be included in management: big paradigm shift

For full presentation, connect tomorrow to webex!

https://canada.webex.com/canada-fr/j.php?MTID=m7839a32edc99d1bb44984dc9d8d1d232

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■ Questions?

Help shape the future of the FACoP
by filling out this short online survey.

www.ccadaptation.ca/en/facop

The FACoP is made possible with support from the Canadian Council of Forest Ministers (CCFM)

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