

Cumulative impact of climate change and forest management on bird community in mixed and boreal forests in Québec

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Boreal Avian
Modelling Project
Projet de modélisation
aviaire boréal

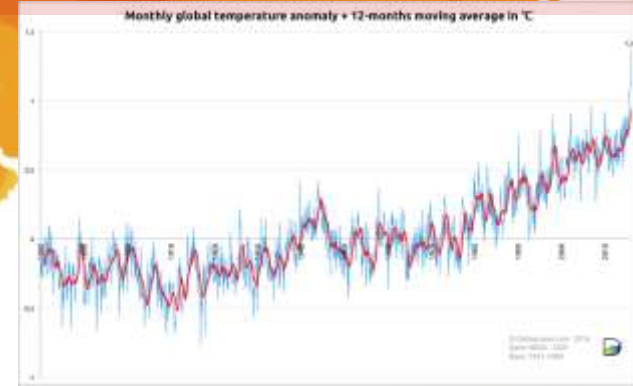


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Canada would see temperatures rise by 2-6°C, at the end of the century



KEY
Change in temperature from pre-industrial climate



Phenology

Net primary productivity

Behaviour

Resource availability

Trophic interactions

Invasive species

Habitat loss & fragmentation

Distribution shift

Density

→ Ecosystems

Climate changes

Natural disturbances

Wildfires

Insect outbreaks

Hurricane

Drought

Forest harvesting

Deforestation

Overexploitation



Minning

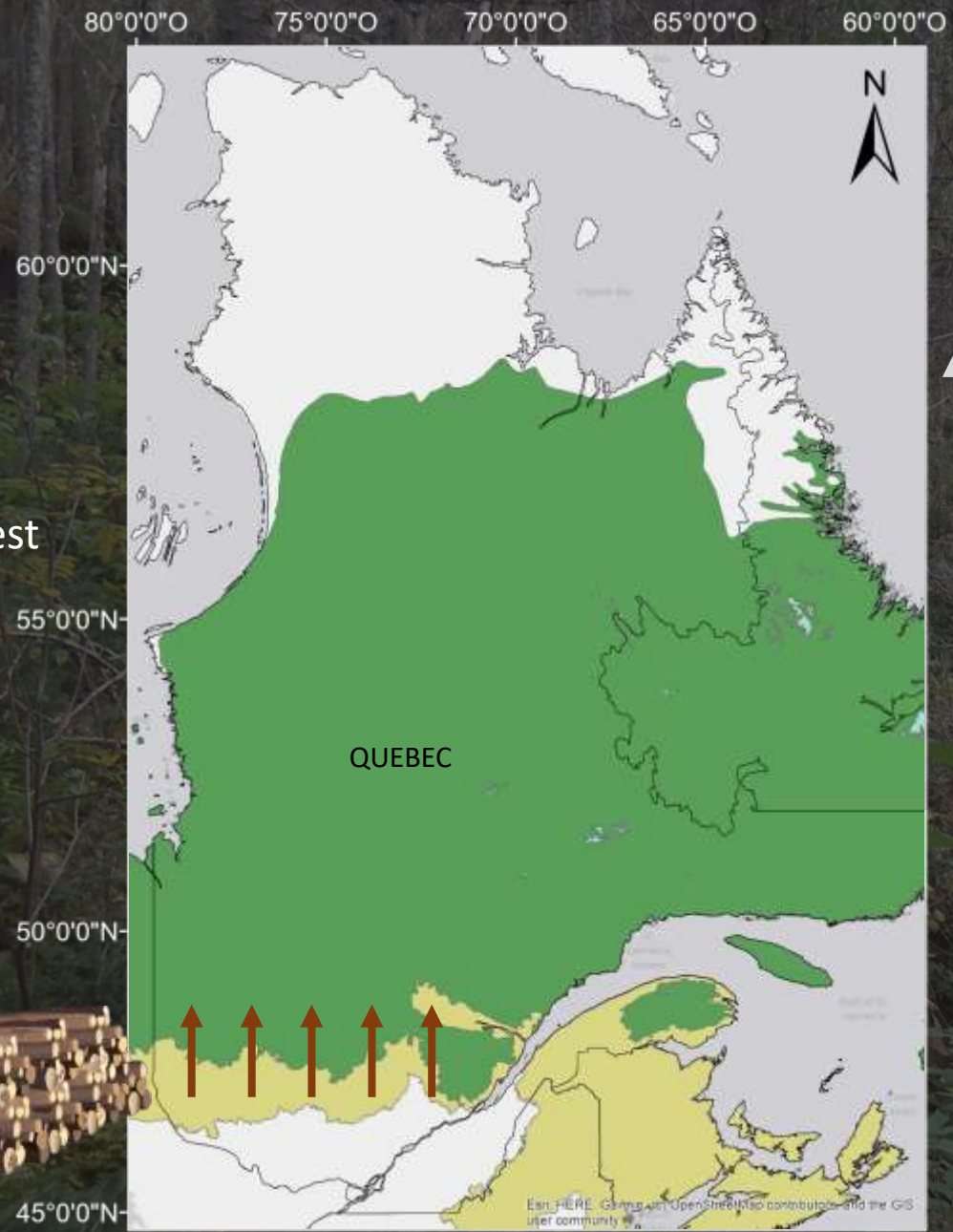
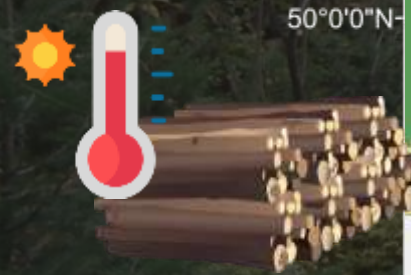
Fossil fuel

Pollution



Introduction

 Boreal Forest
 Hemiboreal Forest



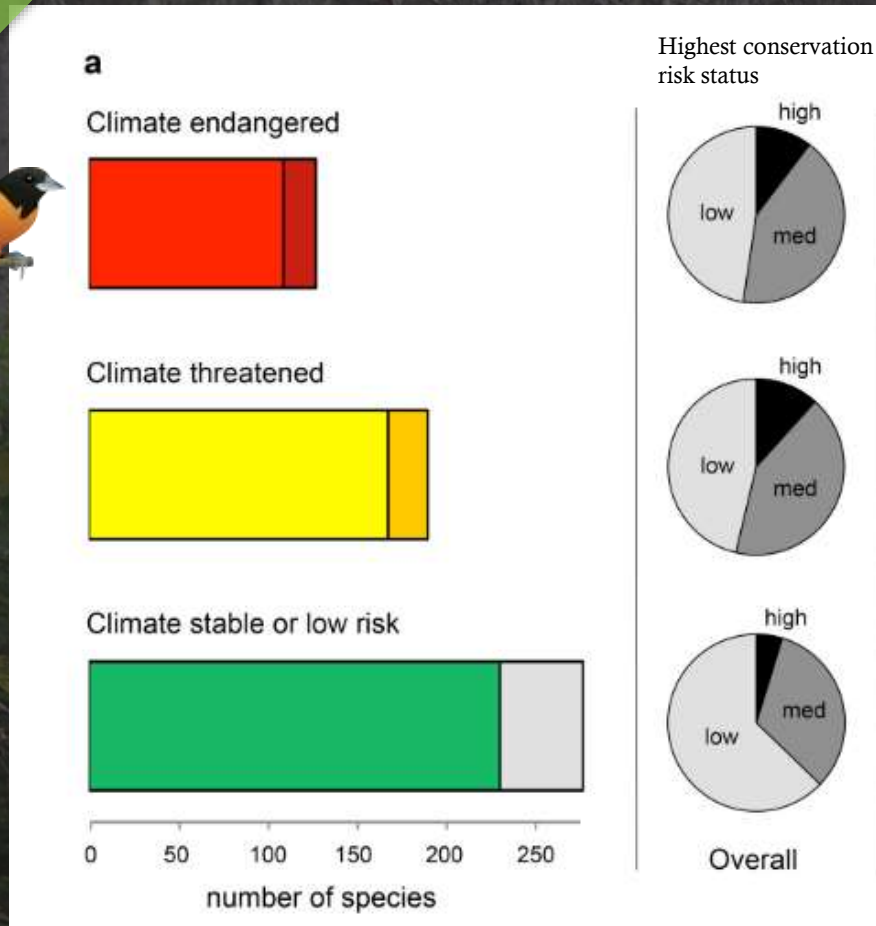
Latitudinal Gradient



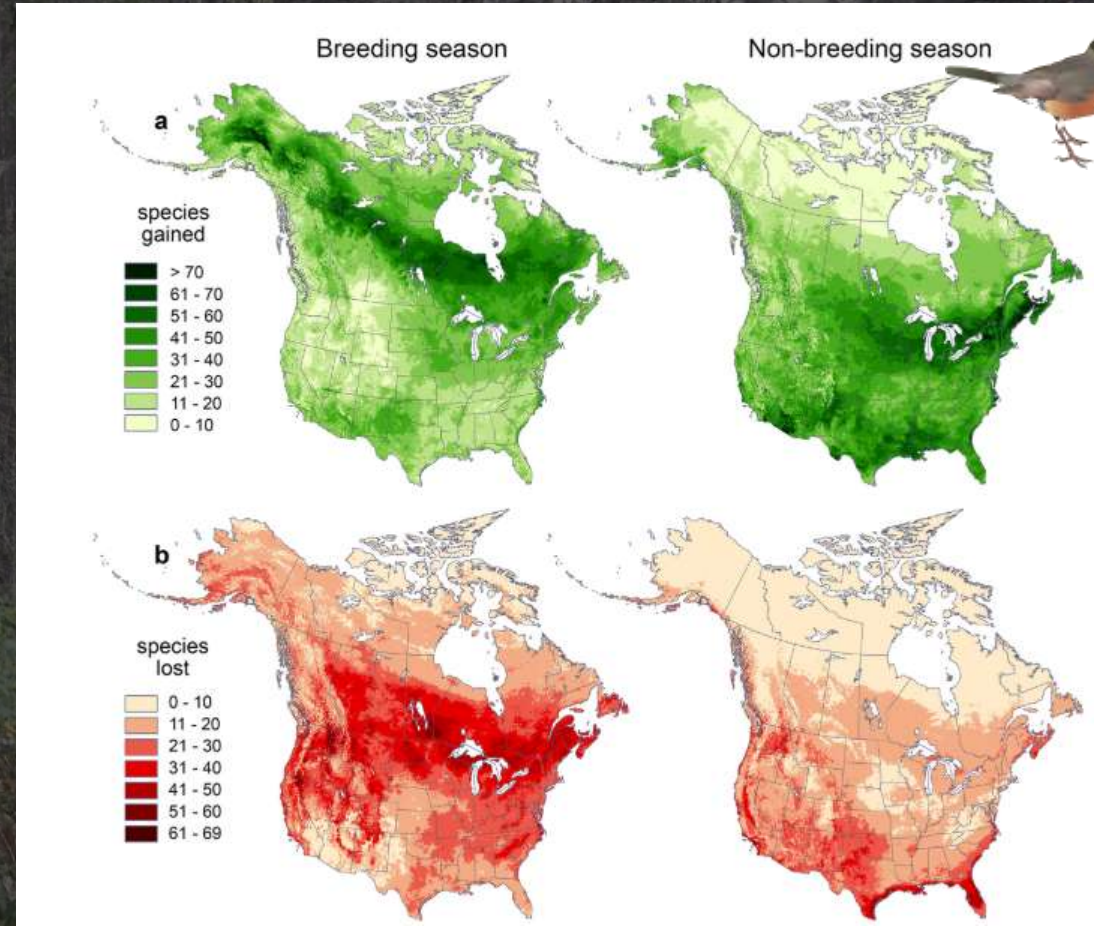


- ◇ Forest age
- ◇ Canopy structure
- ◇ Tree species composition

→ lead to higher extinction rates, community reorganization, homogenization, and ecological novelty.



Climate risk from future climate change across North American bird species (n = 588) in relation to existing conservation assessments.



Impacts of future climate change on geographic ranges of North American bird species (n = 588) by 2080 during the breeding and non-breeding season under SRES A2 scenario.

→ 53% are projected to lose more than half of their current geographic range across scenarios of climate change through the end of the century.

Predicting species distributions for conservation decisions



Species at risk



Multi-approach criteria



Species conservation

+



Climate change mitigation

+

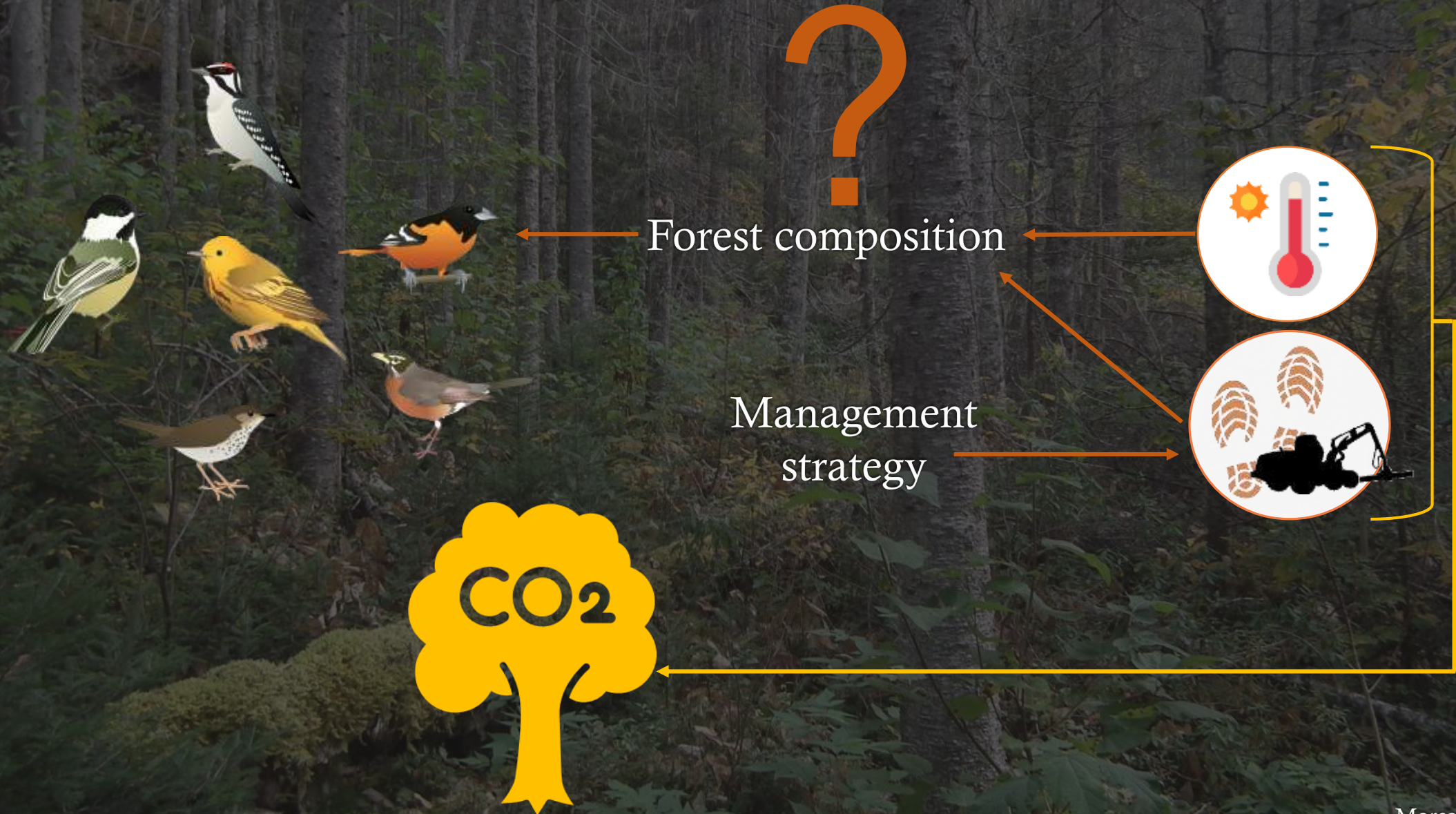


Wood products

Cumulative effects of climate change and forest management on bird communities






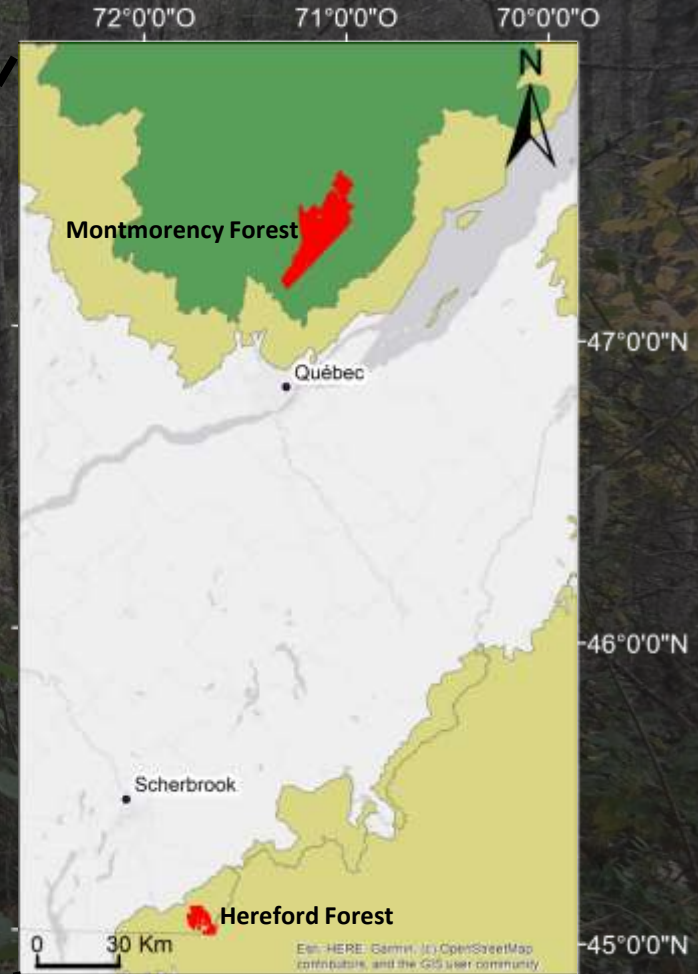
Multi-approach criteria



Study sites

Legend

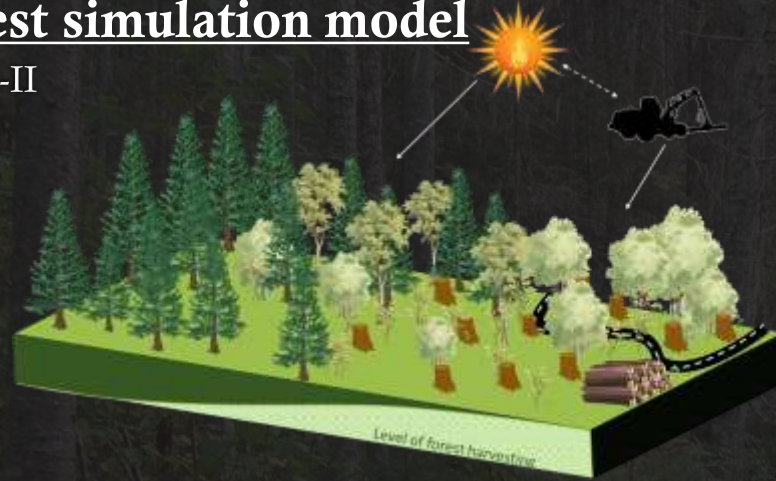
-  Boreal Forest
-  Hemiboreal Forest
-  Study areas



Forest simulation model

1. Forest simulation model

LANDIS-II



Reference : Baseline - BaU

Baseline

No harvest : No human intervention

RCP 4.5

Conservation : ↘ forest harvesting or ↗ rotation time / BaU

RCP 8.5

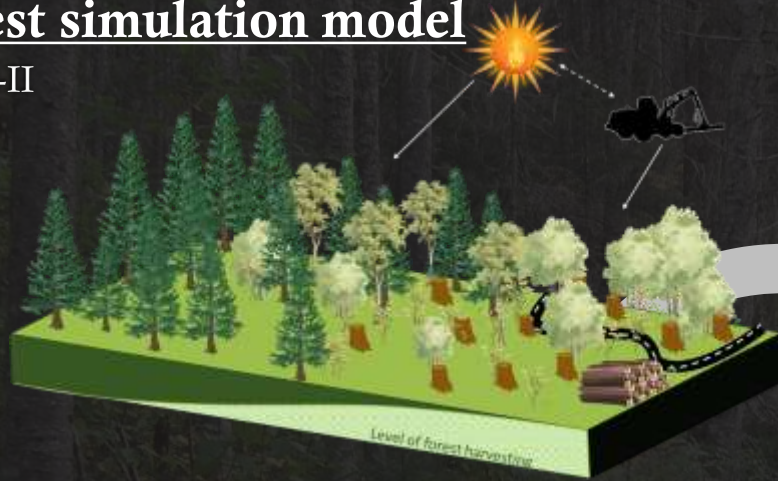
Business-as-usual (BaU) : Current forest management

Intensive : Intensification of forest harvesting / BaU

Forest simulation model with empirical models of bird species distribution

1. Forest simulation model

LANDIS-II



2. Empirical bird data

Boreal Avian Modeling Project

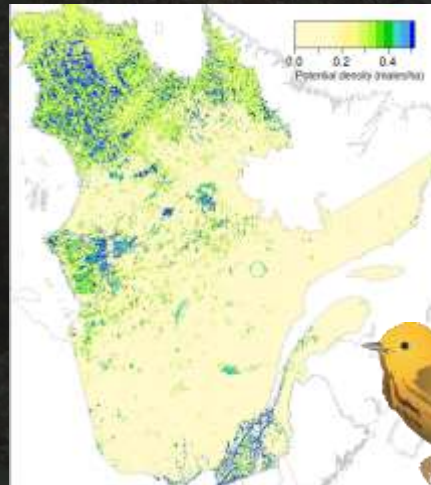


Hereford
45 species

Montmorency
51 species

3. Bird species distribution

Boosted Regression
Trees (BRT)



Yellow warbler (*Setophaga petechia*)

Covariates	Relative importance (%)
Pice.Mar_750m	15.91
Biomass	14.22
Biomass_750m	7.70

Impacts of climate change and forest management on bird communities

$$\text{Percentage of change} = \left(\left(\text{ProjAbund}_t / \text{RefAbund}_t \right) - 1 \right) \times 100$$

Scenario x

Baseline - BaU

Forest cover types	Age class		
	Generalist		
Young deciduous	Closed deciduous	Mature deciduous	
Young mixedwood	Closed mixedwood	Mature mixedwood	
Young coniferous	Closed coniferous	Mature coniferous	

Species at risk and sensitive species

Species at risk

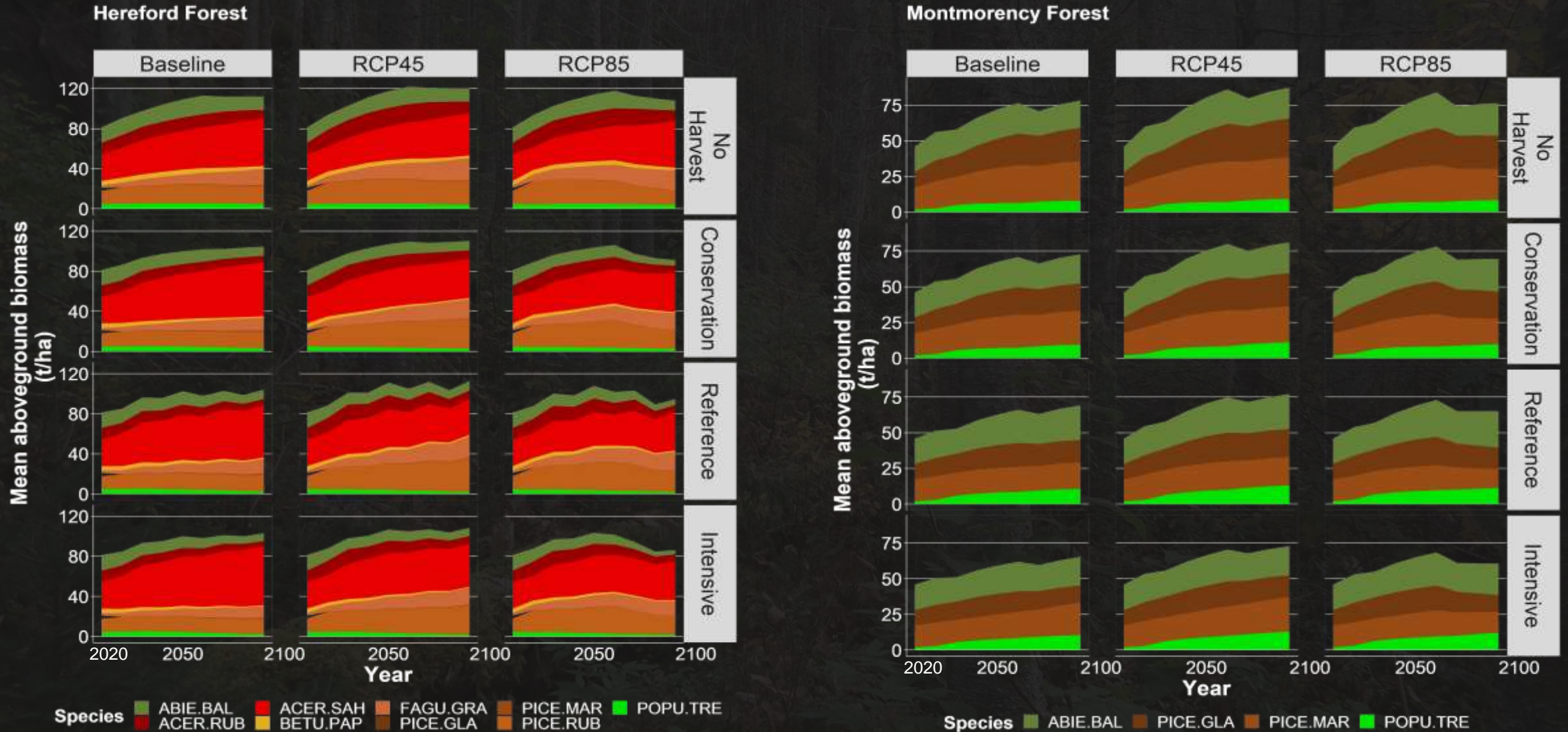
- ◇ Canada Warbler (CAWA, *Cardellina canadensis*)
- ◇ Rusty Blackbird (RUBL, *Euphagus carolinus*)
- ◇ Eastern Wood-pewee (EAWP, *Contopus virens*)



Sensitive species | Percentage of change | $> 25\%$

Sensitive communities | Percentage of change | $> 10\%$

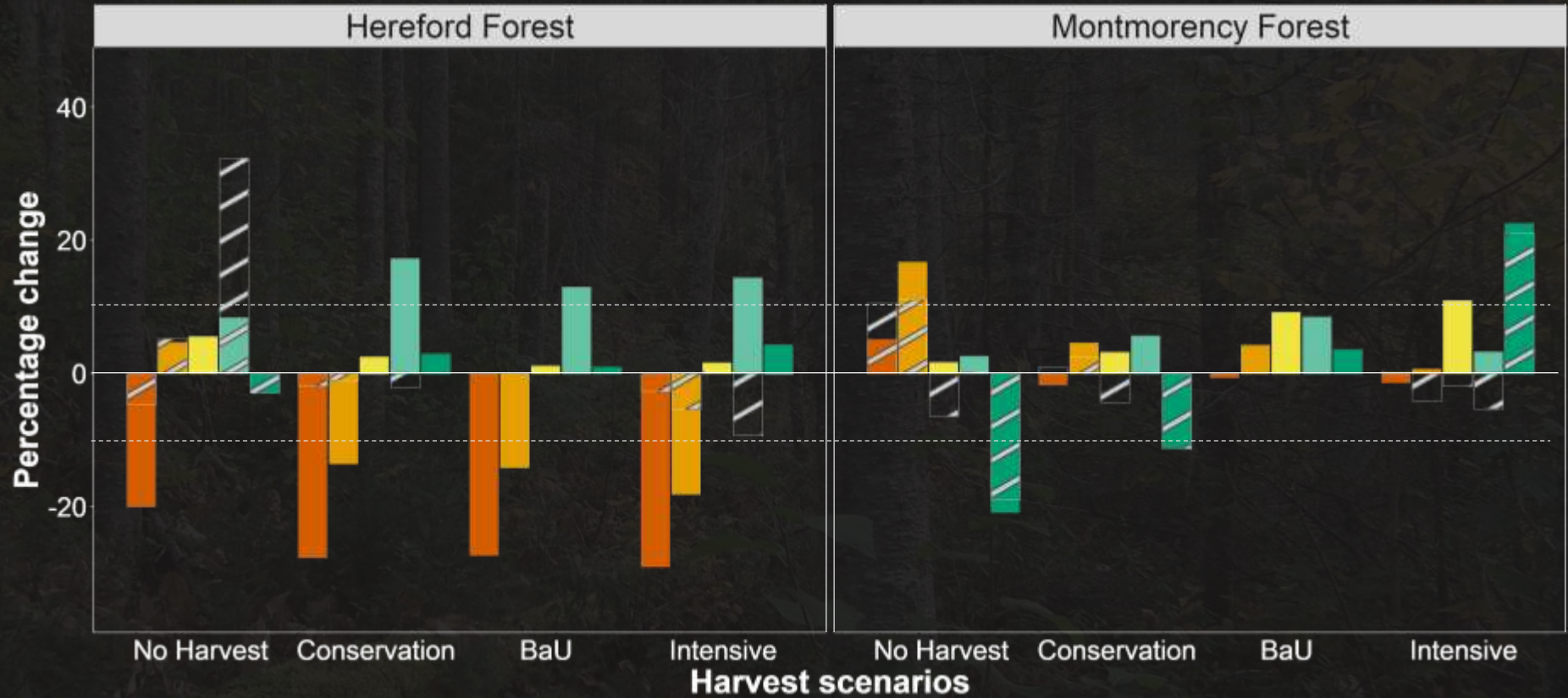
Cumulative impacts of climate change and forest management on the tree species biomass



Projected changes in bird communities



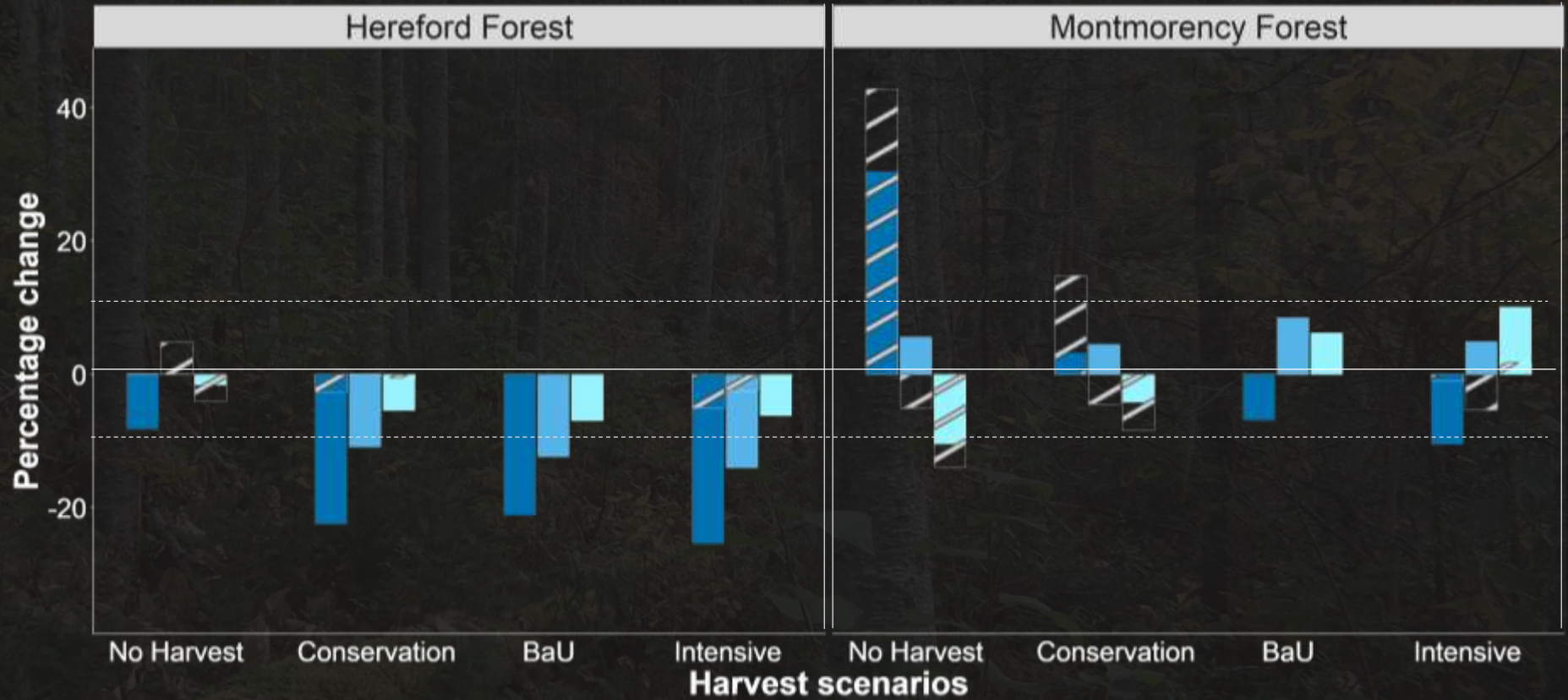
- Cover**
- Coniferous
 - Mixedwood
 - Deciduous
 - Generalist
 - Wetland
- Climate scenarios**
- Baseline
 - RCP 8.5



Sensitive communities | Percentage of change | > 10%

→ Hereford Forest > Montmorency Forest

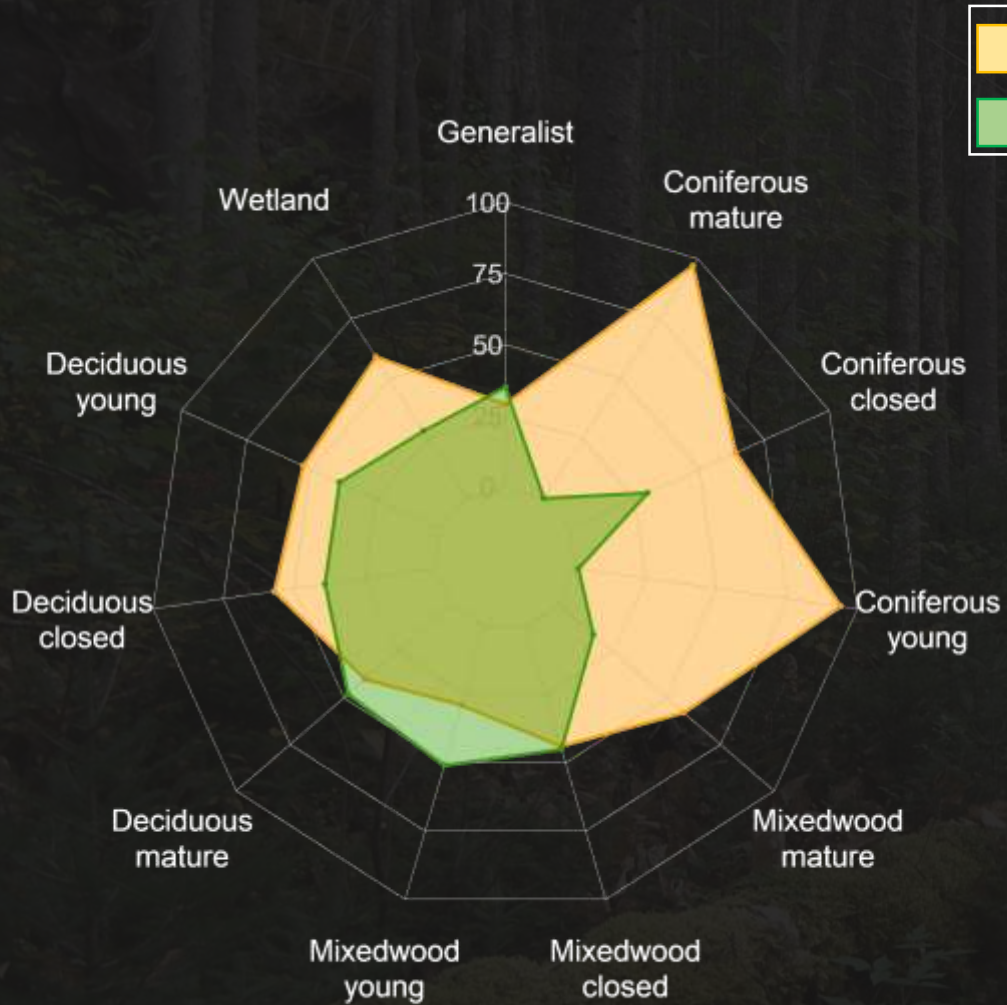
Projected changes in bird communities



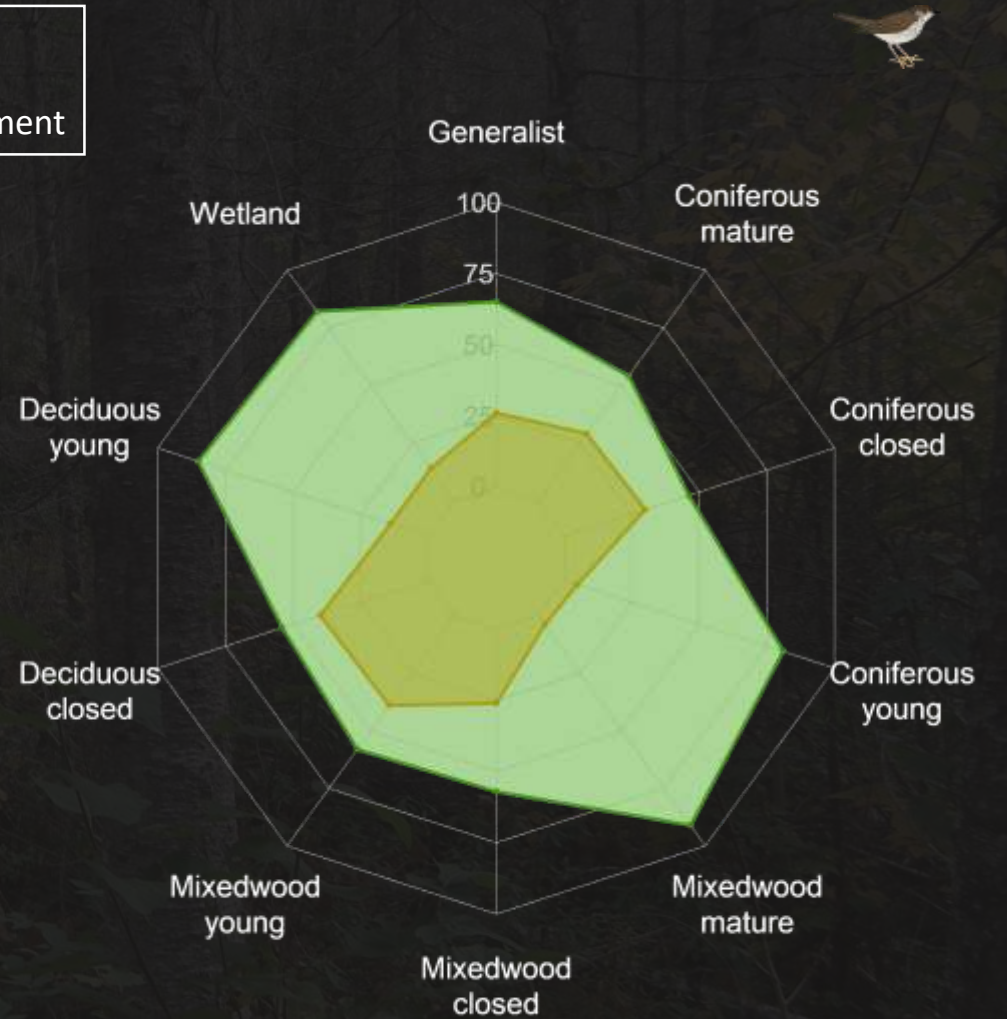
Sensitive communities | Percentage of change | > 10%

→ Hereford Forest > Montmorency Forest

Specific impacts of climate change and forest management scenarios on bird communities



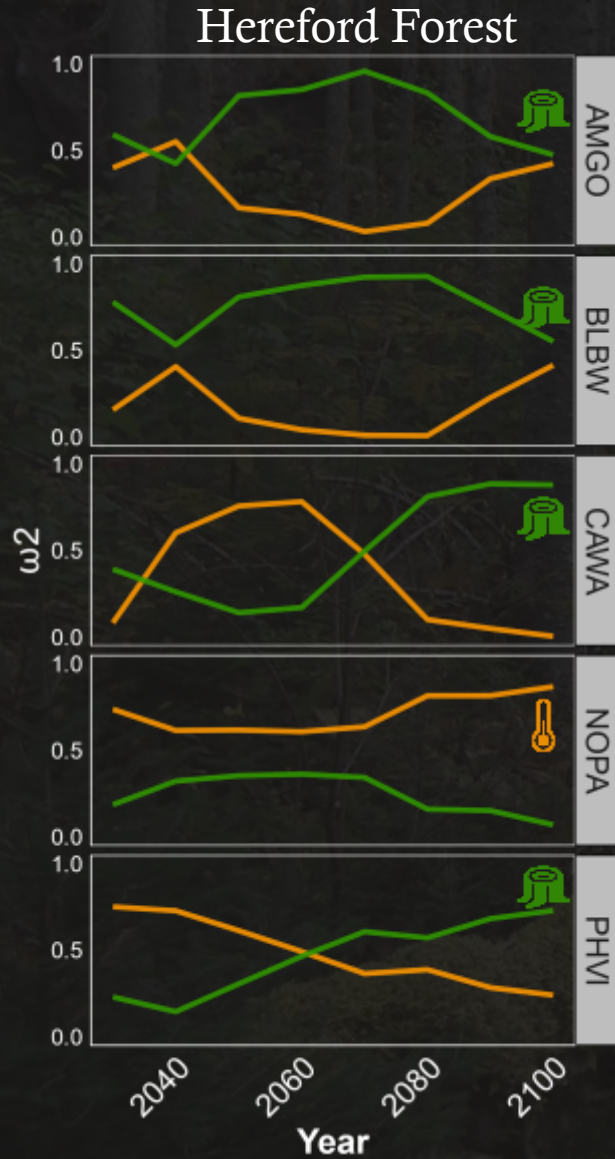
Hereford Forest 2100 – RCP8.5



Montmorency Forest 2100 – RCP8.5

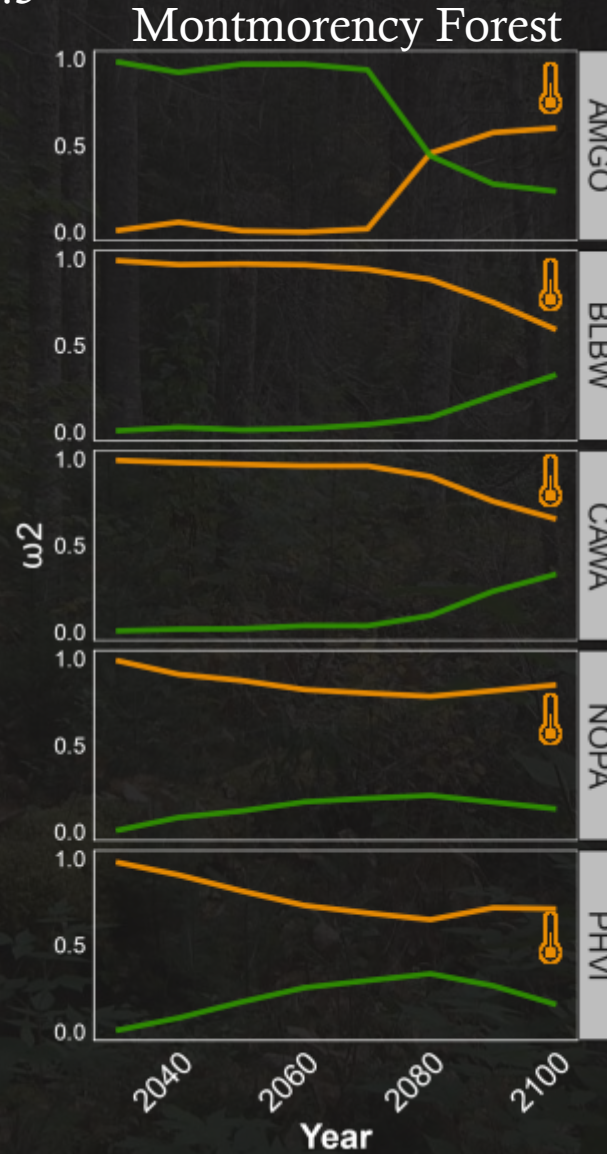
Specific impacts of climate change and forest management scenarios on bird species

RCP 8.5



≠

≈



American goldfinch



Blackburnian Warbler



Canada Warbler



Northern Parula



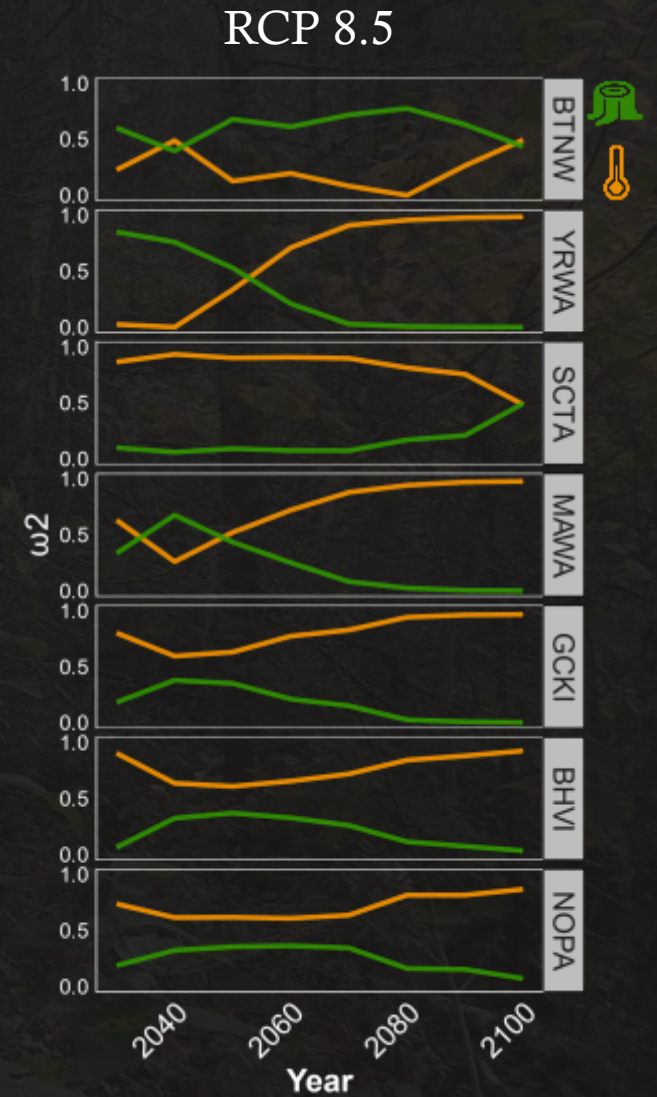
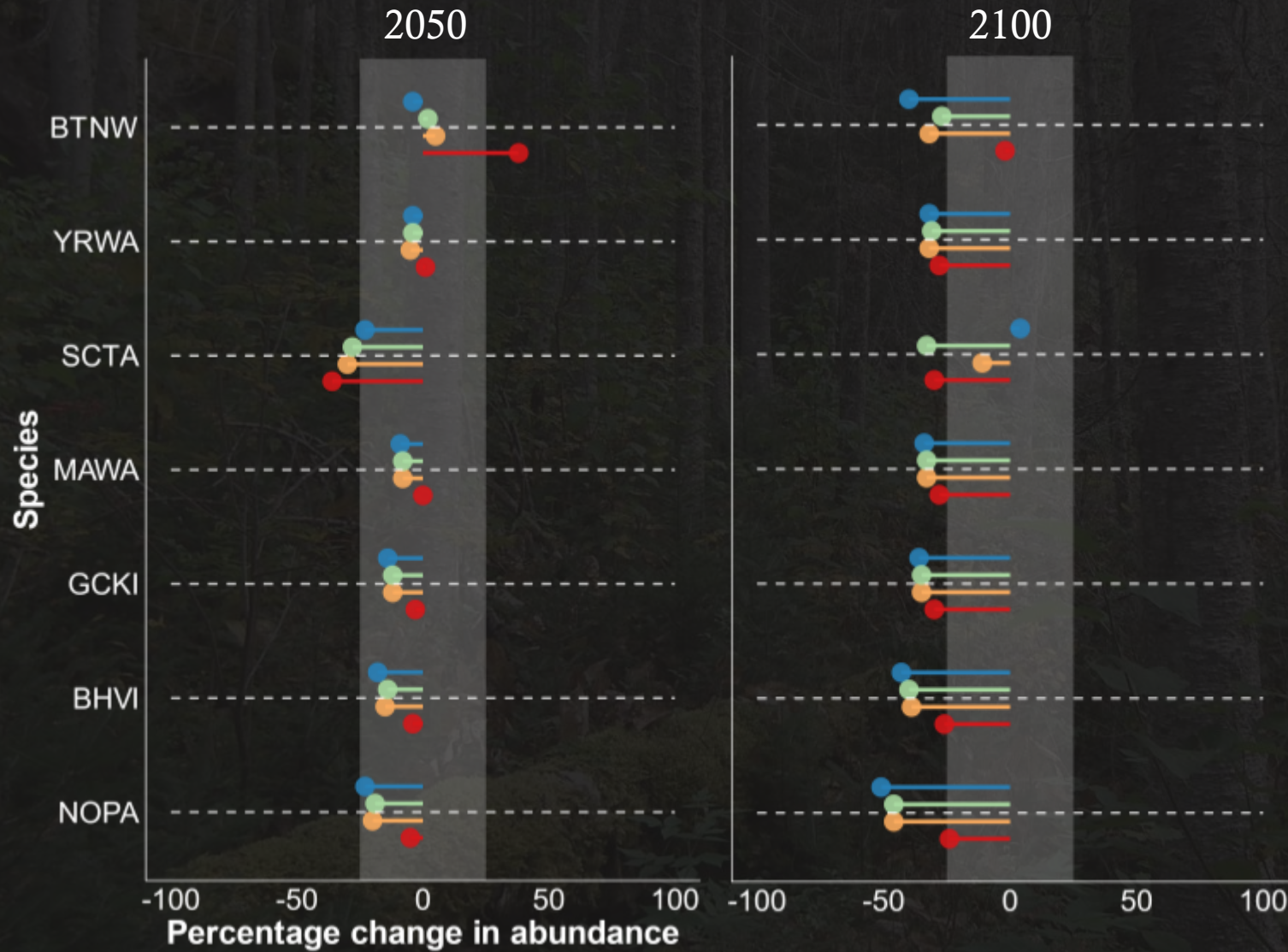
Philadelphia Vireo

Two-way factorial ANOVA

$$\omega^2 = (SS_{\text{effect}} - (df_{\text{effect}} \times MS_{\text{error}})) / (MS_{\text{error}} + SS_{\text{tot}})$$

Impacts of climate change and forest management scenarios on sensitive species

Hereford Forest



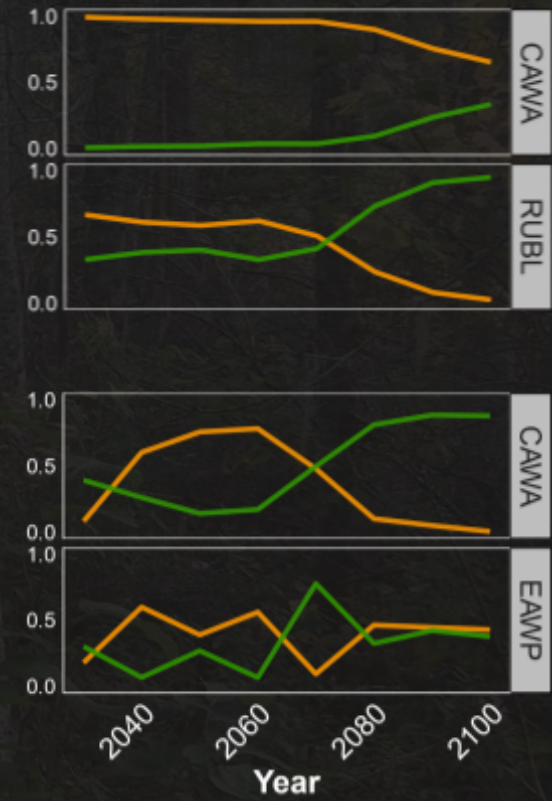
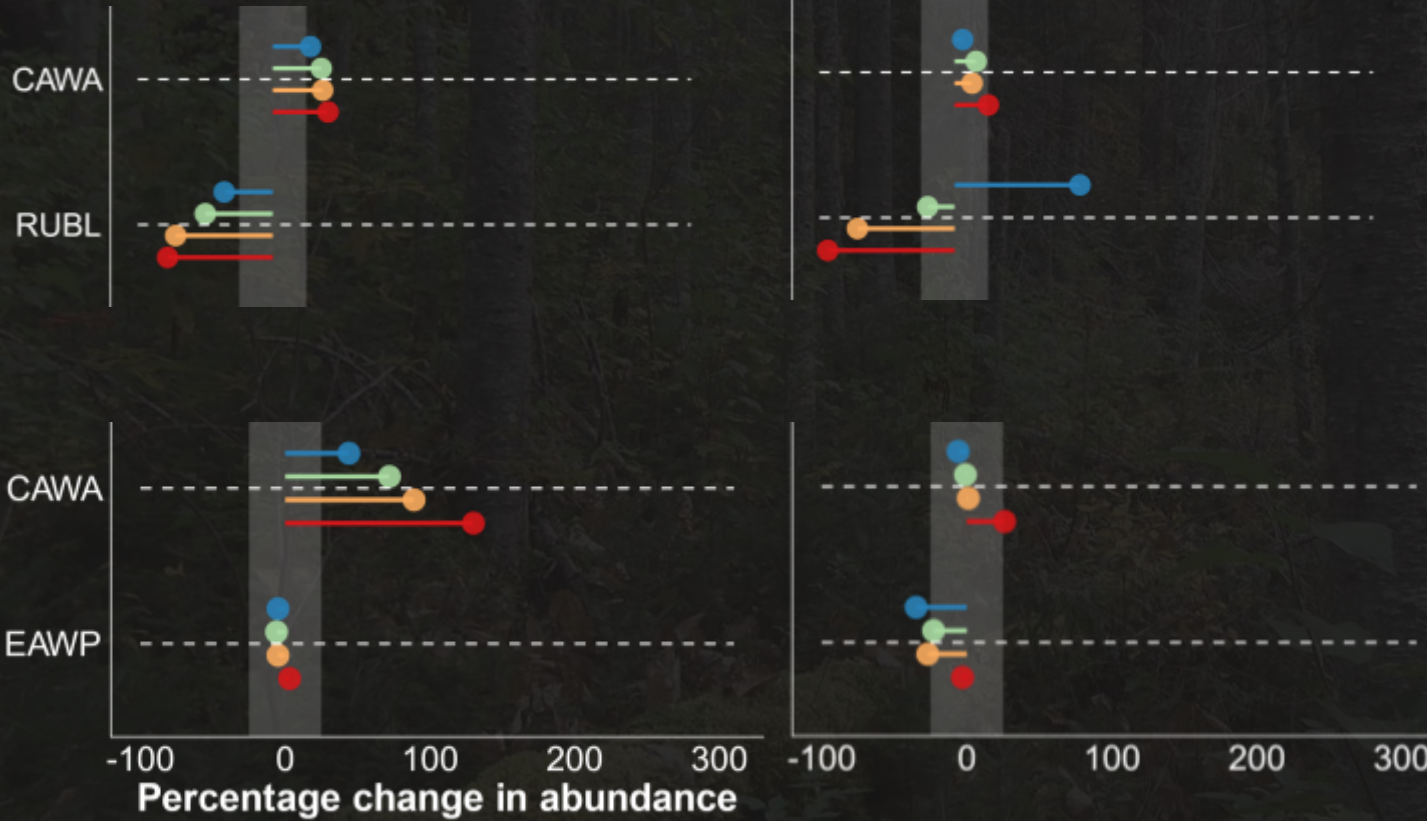
Impacts of climate change and forest management scenarios on species at risk

Montmorency Forest

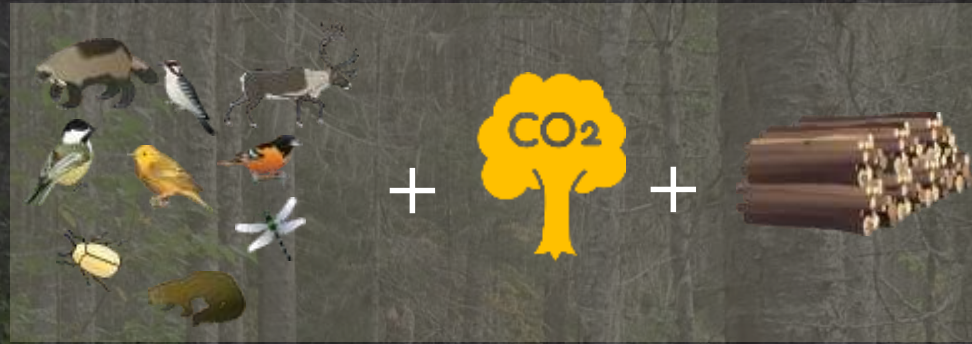
2050

2100

RCP 8.5



Best possible management measures in a multi-criteria approach



Hereford Forest

Montmorency Forest

Birds

Strategies that reduce forest harvesting levels

Birds

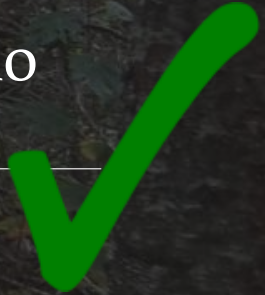
Conservation scenario

Climate change mitigation

Strategies that increase forest harvesting levels

Climate change mitigation

Strategies that reduce forest harvesting levels



Take home message

- ◆ Hereford forest : highly impacted by **climate change** by 2100
- ◆ Montmorency forest : highly impacted by **forest management** by 2100
- ◆ Forest management & climate change are expected to differently influence the integrity of regional bird biodiversity communities :
Hereford forest >> Montmorency forest
Mature & coniferous species vs young & deciduous species
- ◆ The simulated areas are not impacted by wildfires, which represent a major agent of change in the boreal forest

→ Understanding how global changes affect multiple species is critical for anticipating shifts in ecological communities and the ecosystem services they provide.



Thank you !



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ABMI

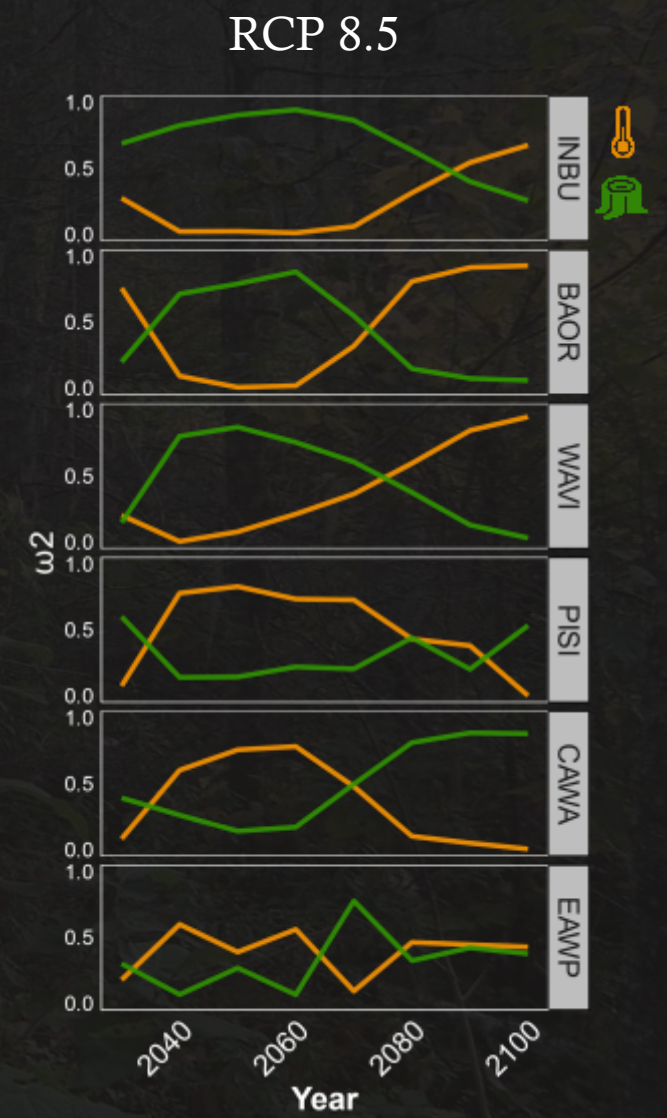
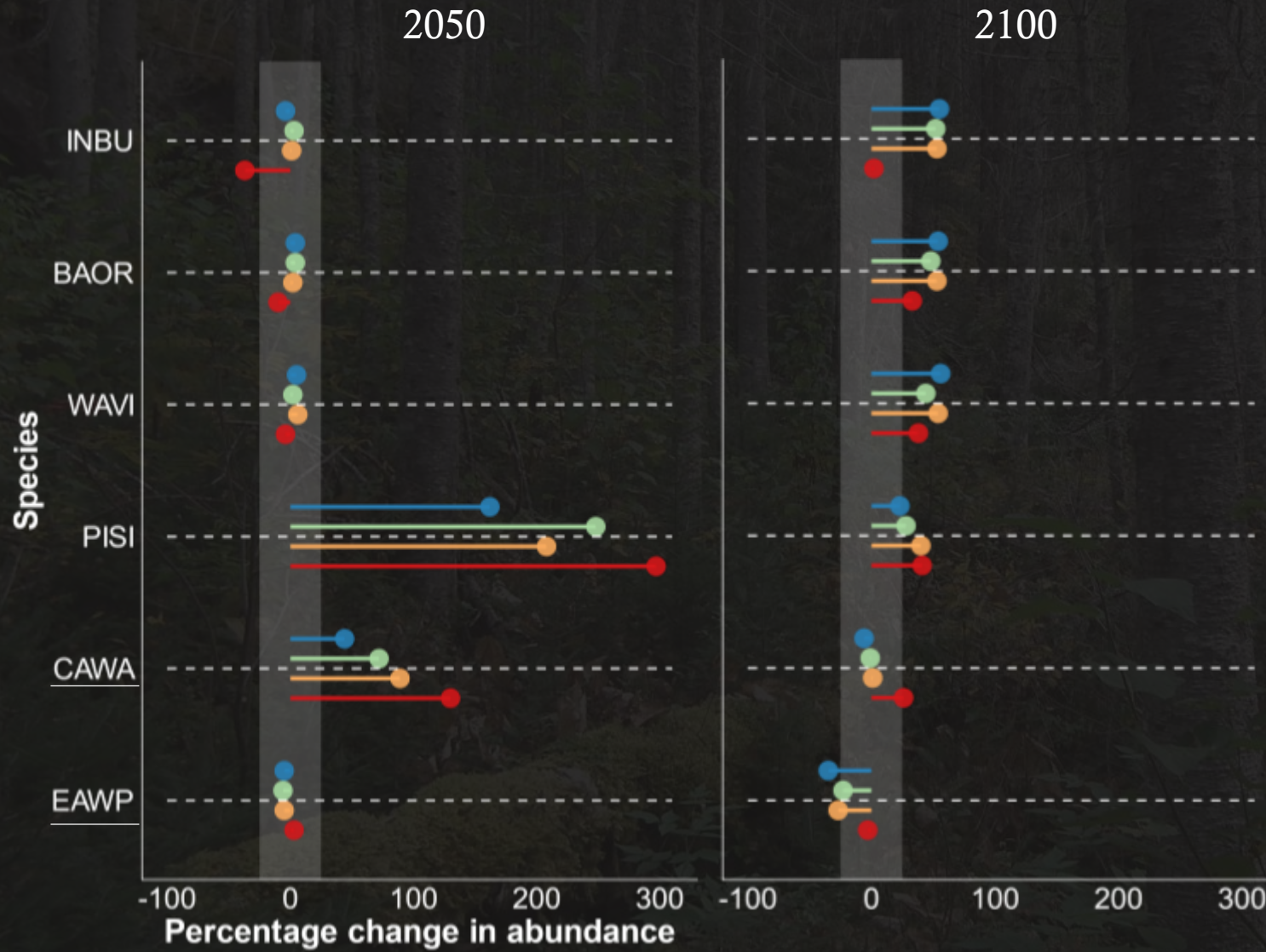


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Impacts of climate change and forest management scenarios on species at risk & sensitive species

Hereford Forest



Impacts of climate change and forest management scenarios on species at risk & sensitive species

Montmorency Forest

