Projecting Effects of Climate Change on Boreal Bird Distribution and Abundance

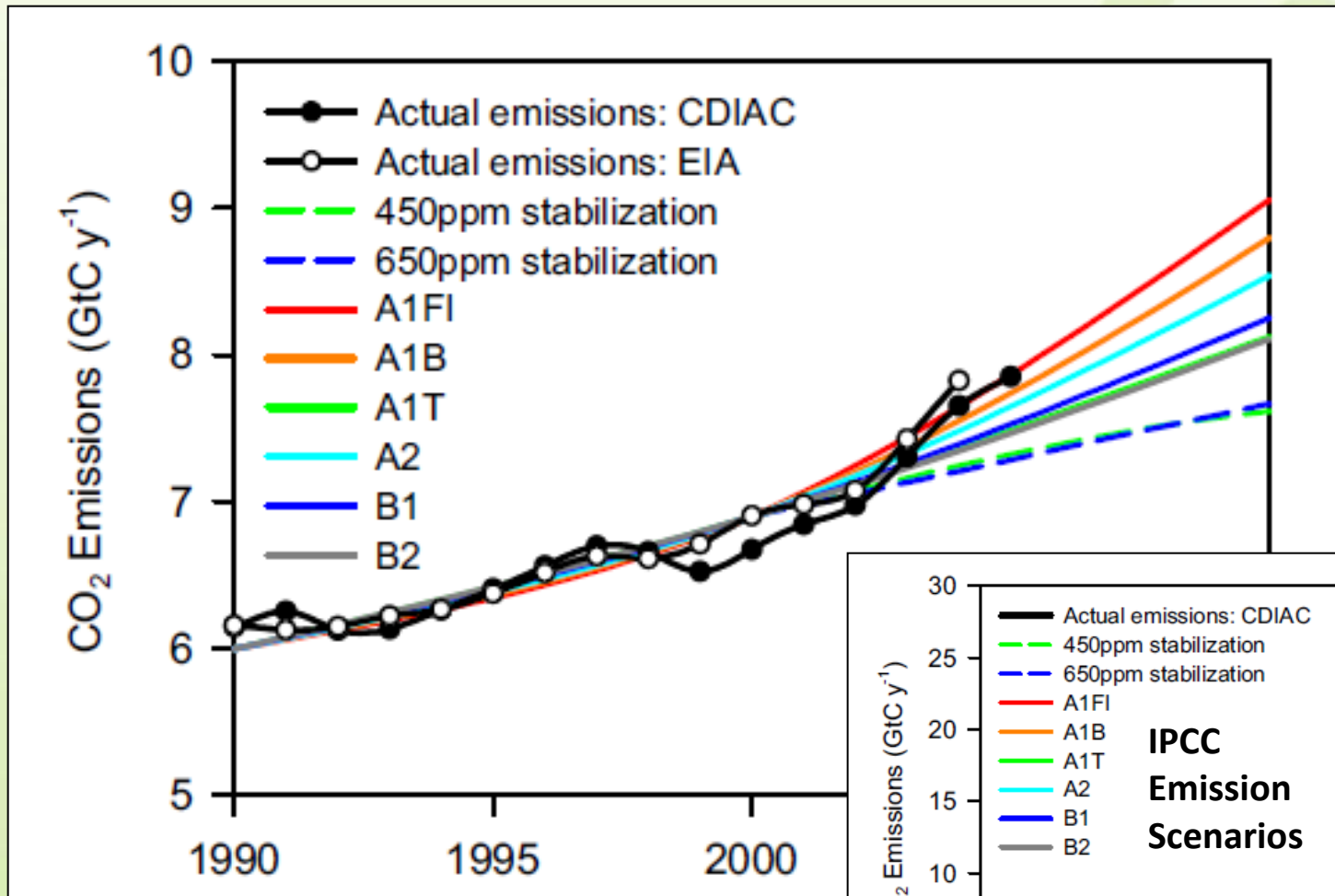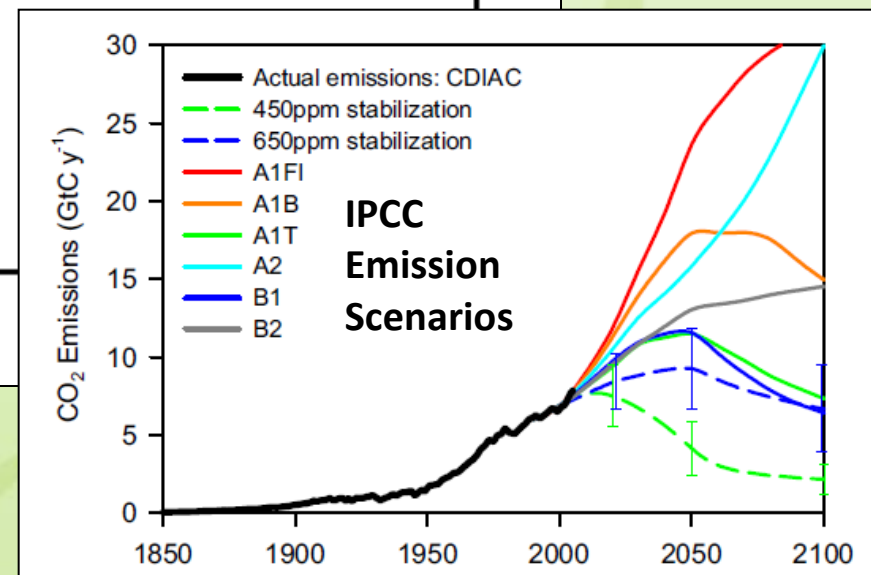## Diana Stralberg

Biological Sciences Department

University of Alberta GIS Day

13 Nov 2012

Climate Change is Happening

Raupach et al. 2009

Conservation Planning & Adaptation

How does climate change affect bird conservation priorities?

- Species vulnerability

- Climate "refugia"

- Diversity patterns

© Samantha Song, Canadian Wildlife Service
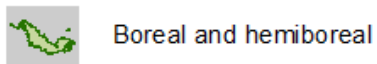
Steering Committee: Fiona Schmiegelow (U of Alberta), Samantha Song (Environment Canada), Steve Cumming (U de Laval), Erin Bayne (U of Alberta)

Bird Survey Data

Boreal Avian Modelling Project
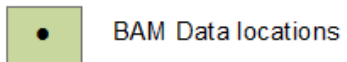
Projet de modélisation de l'avifaune boréale
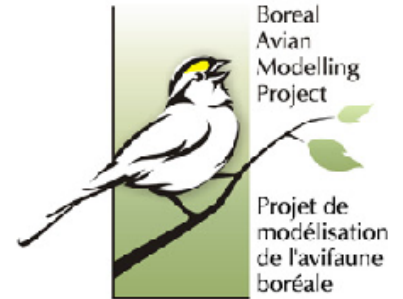
www.borealbirds.ca

Study area

Boreal and hemiboreal

Data Locations
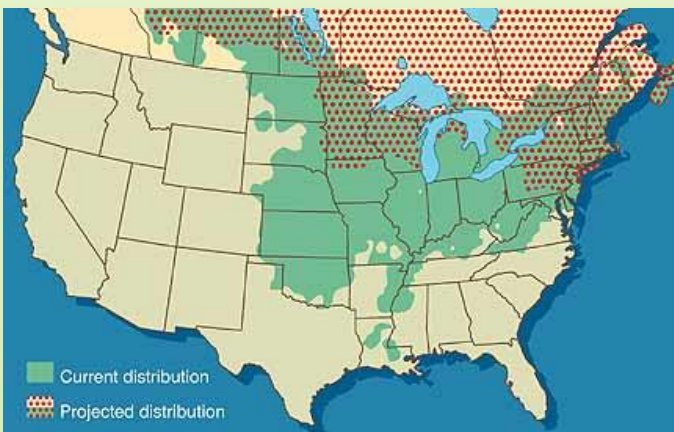
• BAM Data locations

BAM_NATIONAL_V3_2012 dataset
Lambert Conformal Conic
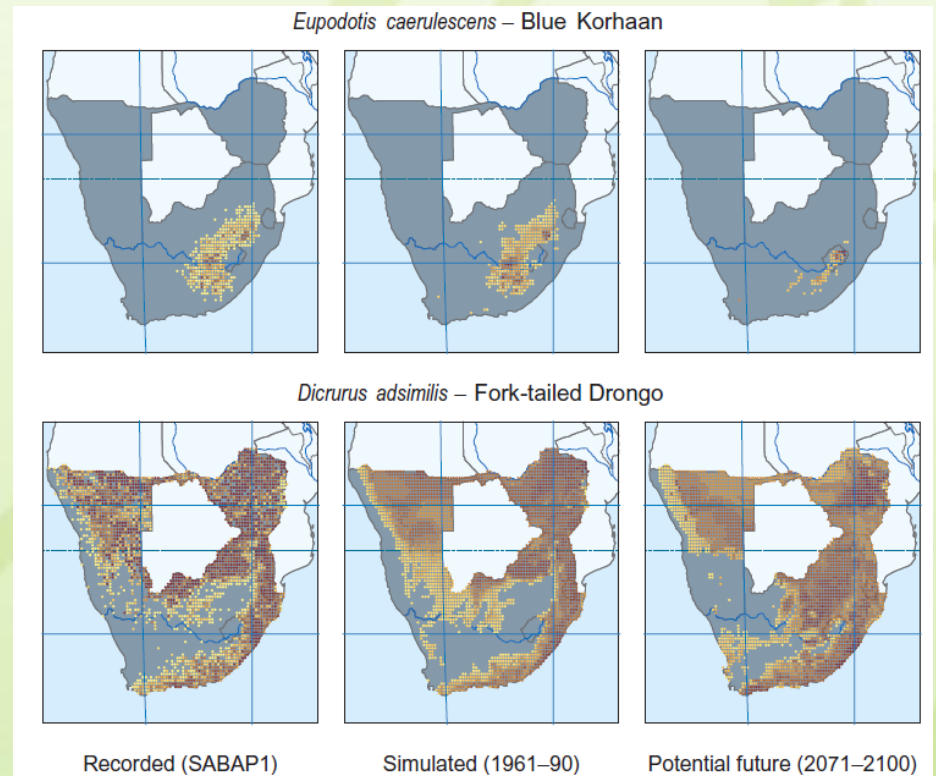Created: July 2012

Map by Trish Fontaine

5

Wildlife Responses to Climate Change

- Adapt in place

- Evolve rapidly

- Move
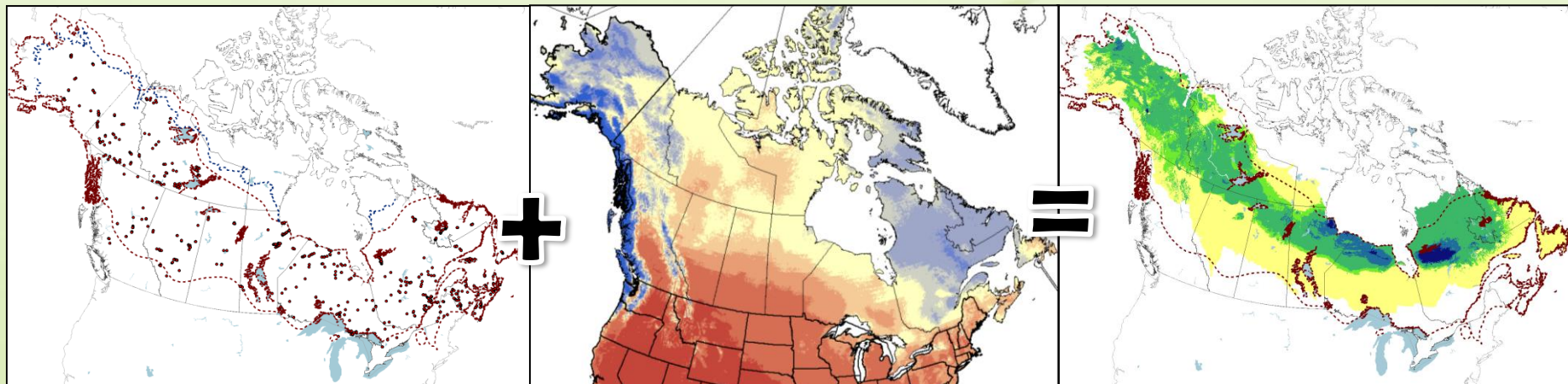
Baltimore Oriole (*Icterus galbula*)

Current distribution
Projected distribution

Price & Glick, National Wildlife Federation 2003

Eupodotis caerulescens – Blue Korhaan

Dicrurus adsimilis – Fork-tailed Drongo

Recorded (SABAP1)   Simulated (1961–90)   Potential future (2071–2100)

Huntley et al. 2010
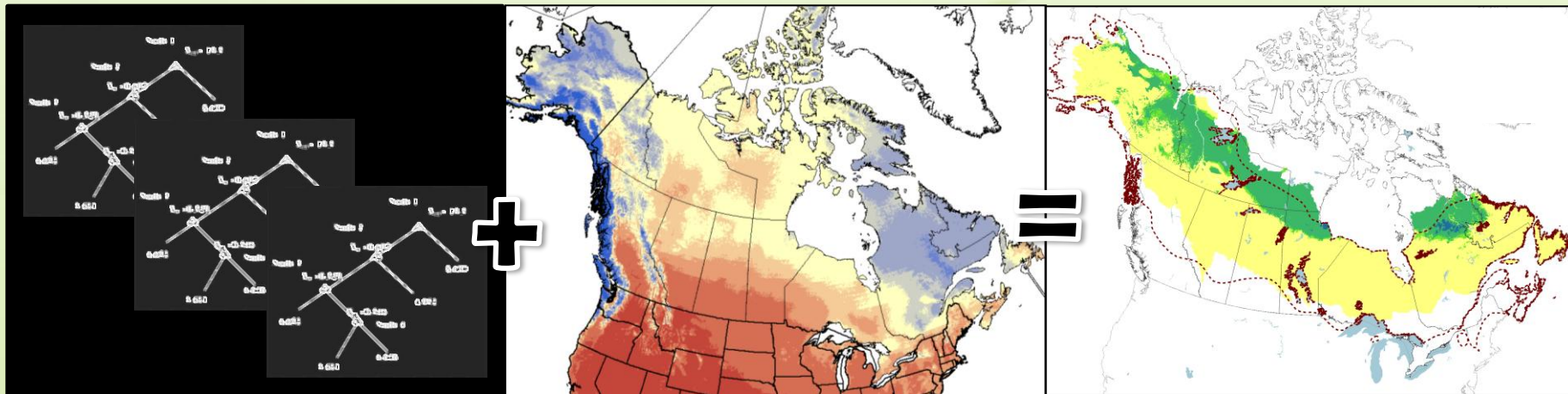
Bioclimatic Niche Models

Standardized Abundance Data + **Interpolated Climate Layers** = **Current Density Prediction**
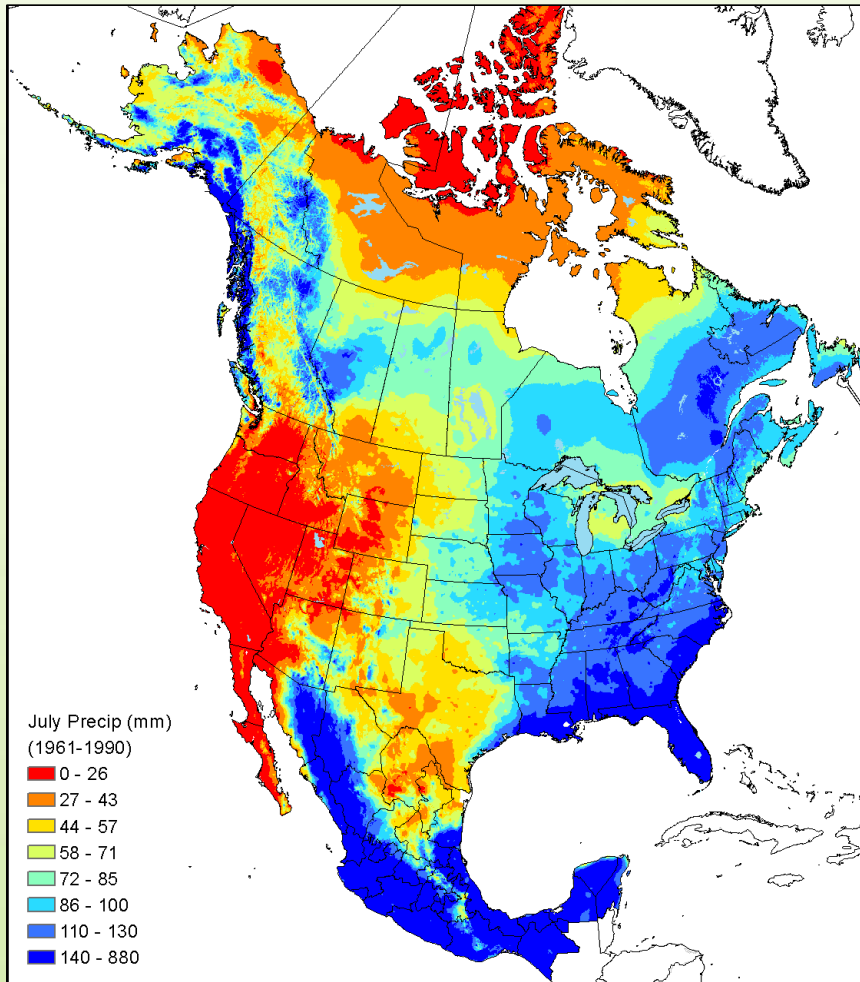
Bioclimatic Niche Models

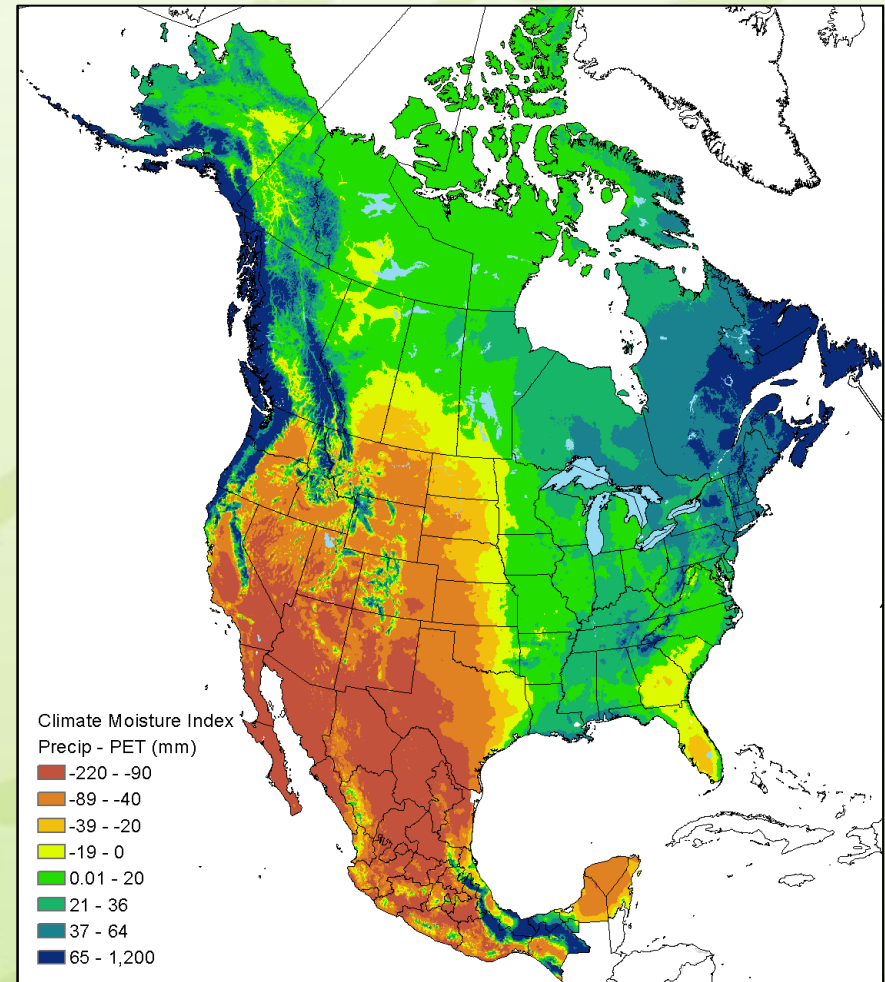**Boosted Regression Tree Model** + **Future Climate Projections** = **Future Density Projection**
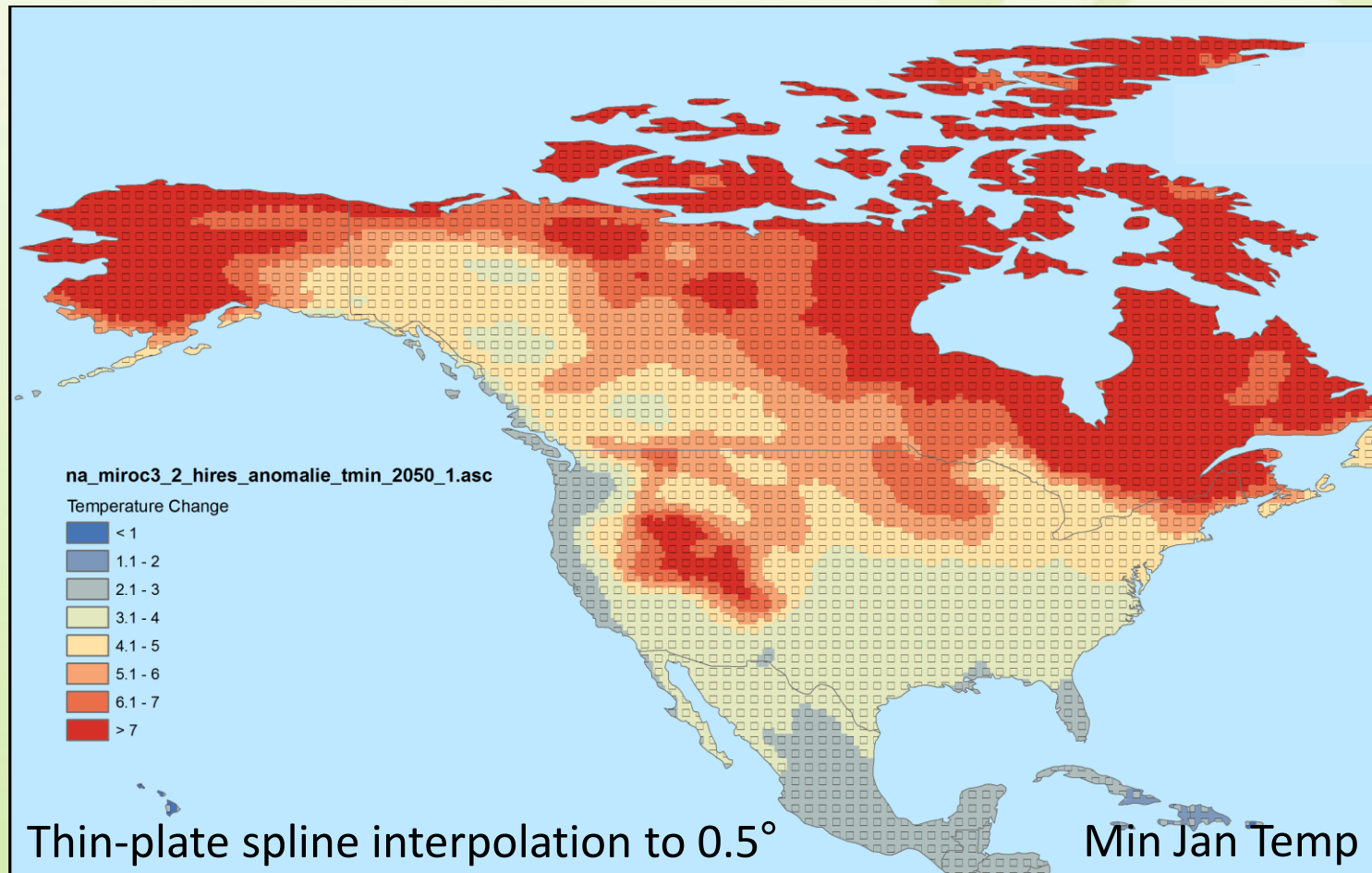
Current Climate Data

Monthly Temperature + Precip

Derived Climate Indices

July Precip (mm)
(1961-1990)
- 0 - 26
- 27 - 43
- 44 - 57
- 58 - 71
- 72 - 85
- 86 - 100
- 110 - 130
- 140 - 880

Climate Moisture Index
Precip - PET (mm)
- -220 - -90
- -89 - -40
- -39 - -20
- -19 - 0
- 0.01 - 20
- 21 - 36
- 37 - 64
- 65 - 1,200

4-km grids, Courtesy of A. Hamann and X. Wang (PRISM + ANUSPLIN sources)

Downscaled Climate Anomalies

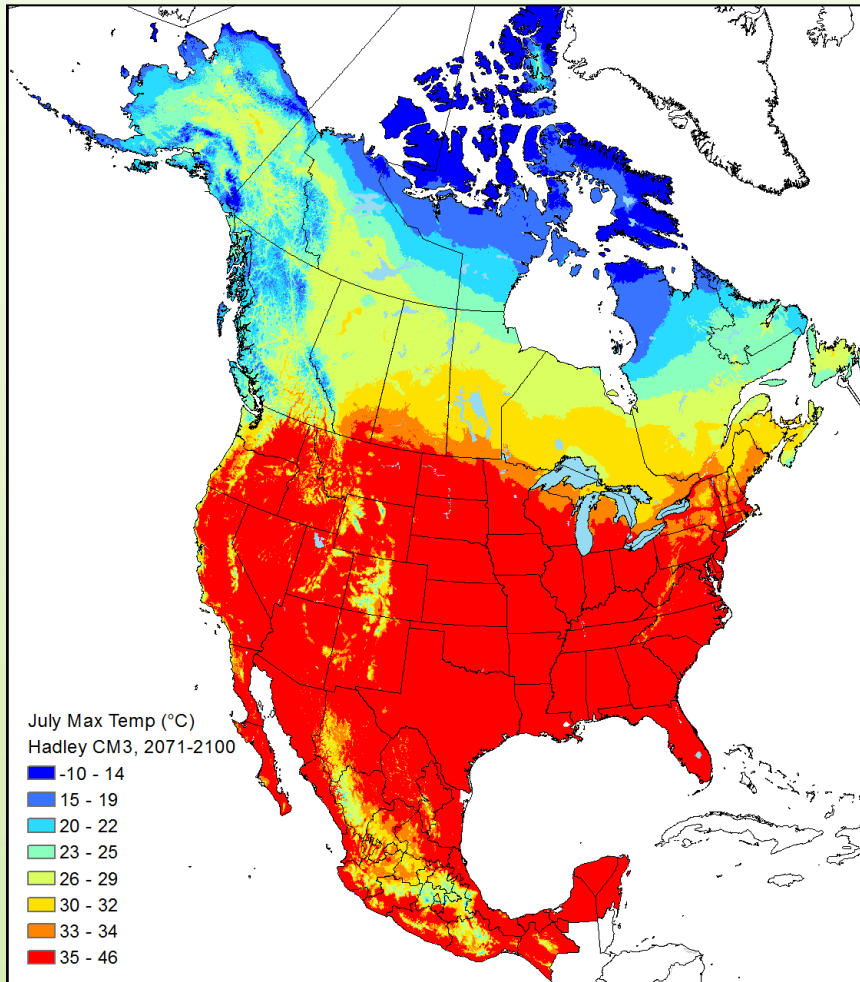GCM Anomaly = GCM Future (30-year mean) - GCM Current (30-year mean)

na_miroc3_2_hires_anomalie_tmin_2050_1.asc

Temperature Change
- < 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- 5.1 - 6
- 6.1 - 7
- > 7

Thin-plate spline interpolation to 0.5°   Min Jan Temp

IPCC 4th Assessment Report: 24 GCMs, 3 scenarios, 3 time periods

Future Climate Projections

Current mean (1961-1990) + GCM anomaly = Future 30-year mean (2071-2100)
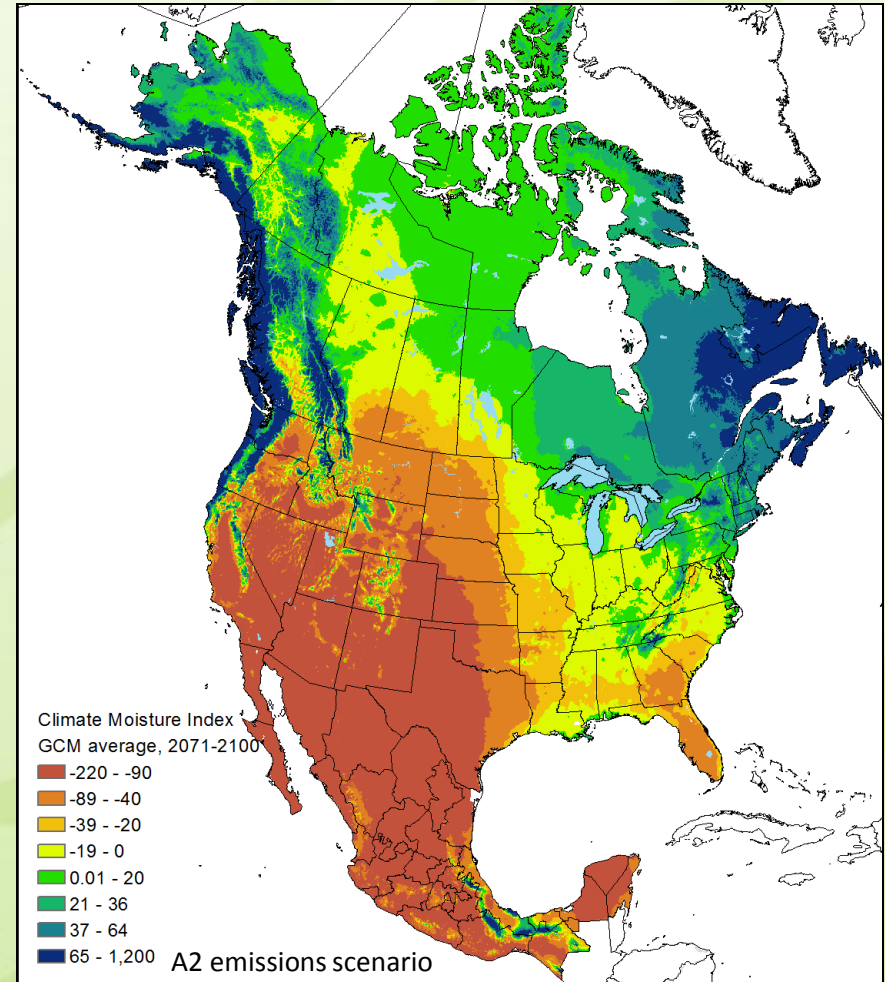

4-km grids, developed by D. Stralberg, X. Wang, A. Hamman
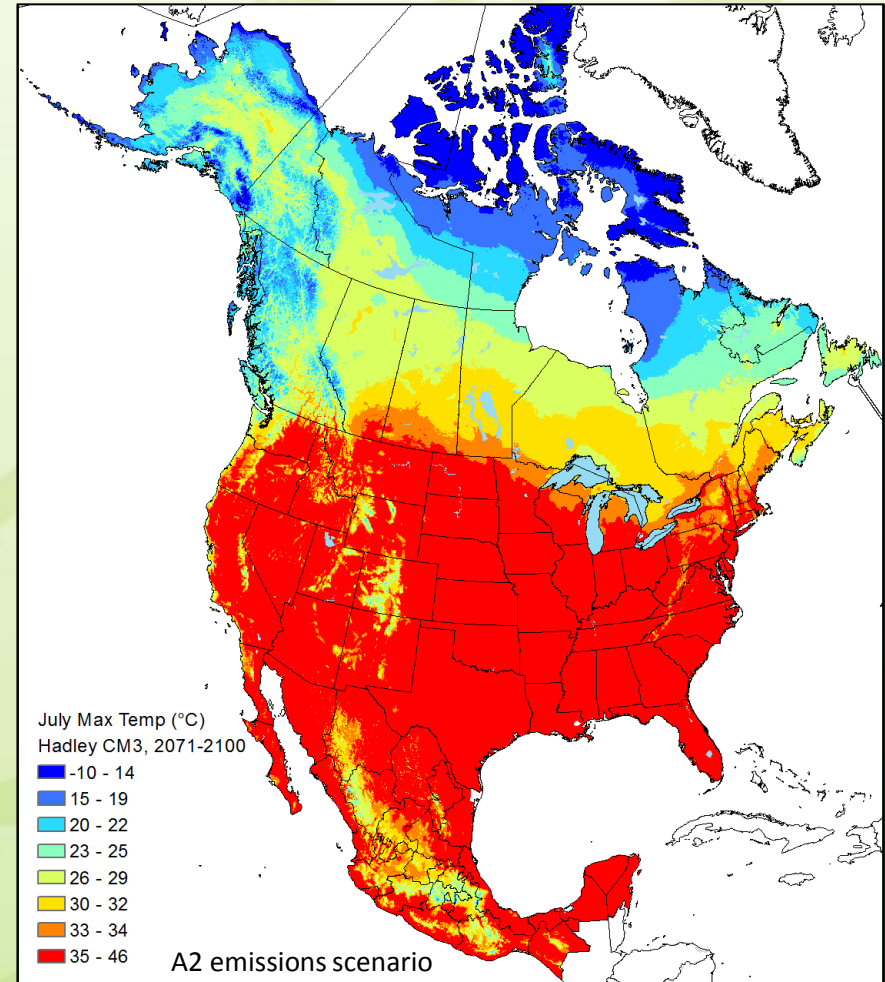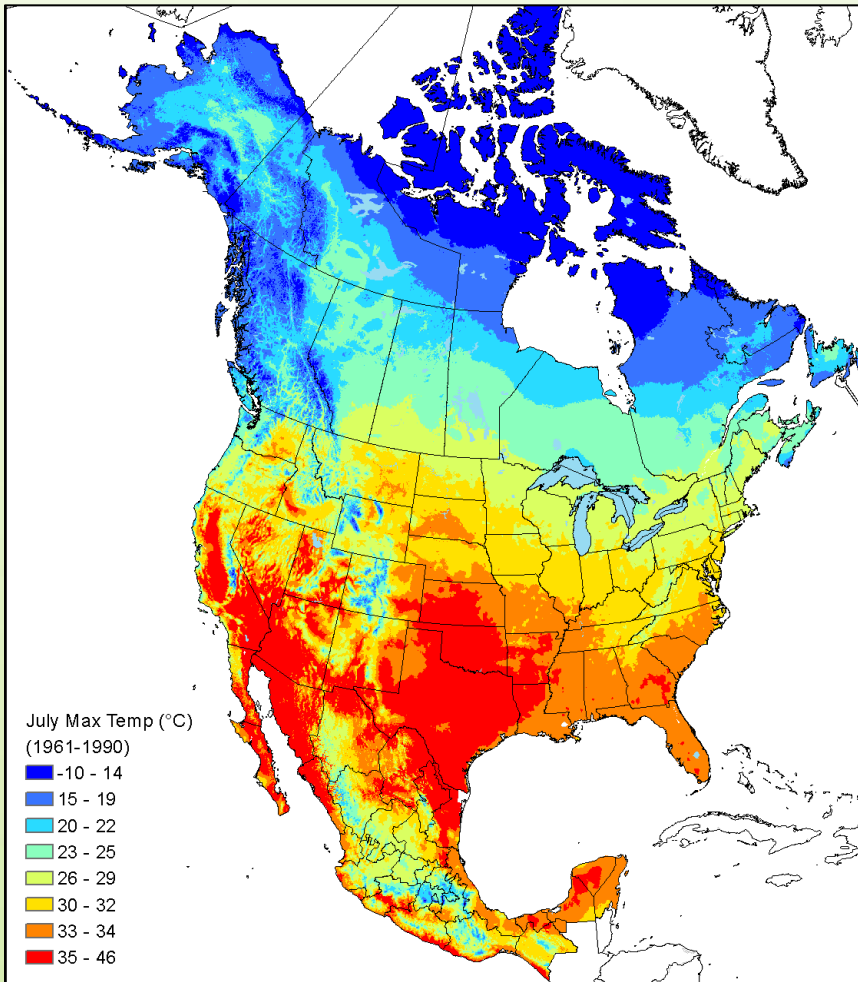
Future Climate Projections

Monthly Temperature + Precip

Derived Climate Indices

Left map legend:

July Max Temp (°C)
Hadley CM3, 2071-2100
- -10 – 14
- 15 – 19
- 20 – 22
- 23 – 25
- 26 – 29
- 30 – 32
- 33 – 34
- 35 – 46

Right map legend:

Climate Moisture Index
GCM average, 2071-2100
- -220 – -90
- -89 – -40
- -39 – -20
- -19 – 0
- 0.01 – 20
- 21 – 36
- 37 – 64
- 65 – 1,200

A2 emissions scenario

4-km grids, developed by D. Stralberg, X. Wang, A. Hamman

Current Climate Data

Monthly Temperature + Precip

Derived Climate Indices

July Max Temp (°C)
(1961-1990)
- -10 - 14
- 15 - 19
- 20 - 22
- 23 - 25
- 26 - 29
- 30 - 32
- 33 - 34
- 35 - 46

Climate Moisture Index
Precip - PET (mm)
- -220 - -90
- -89 - -40
- -39 - -20
- -19 - 0
- 0.01 - 20
- 21 - 36
- 37 - 64
- 65 - 1,200

4-km grids, Courtesy of A. Hamann and X. Wang (PRISM + ANUSPLIN sources)

Future boreal climate space

Current Mapped Ecoregions (Commission for Environmental Cooperation)

Southern Arctic
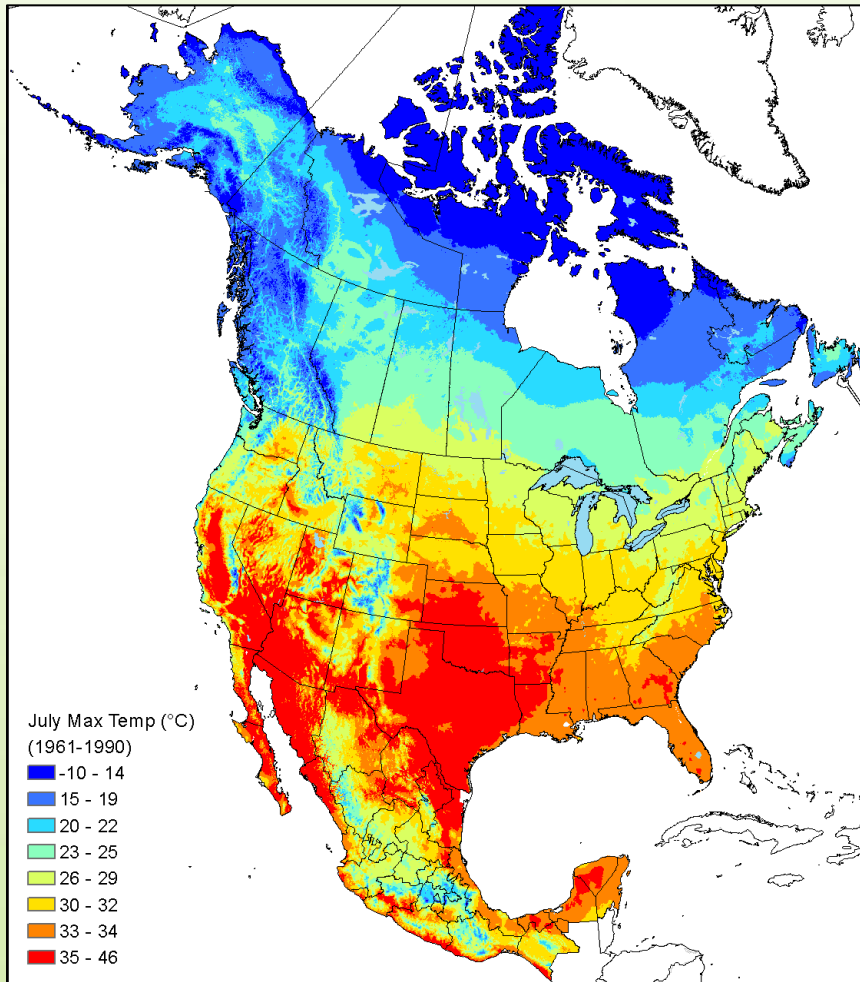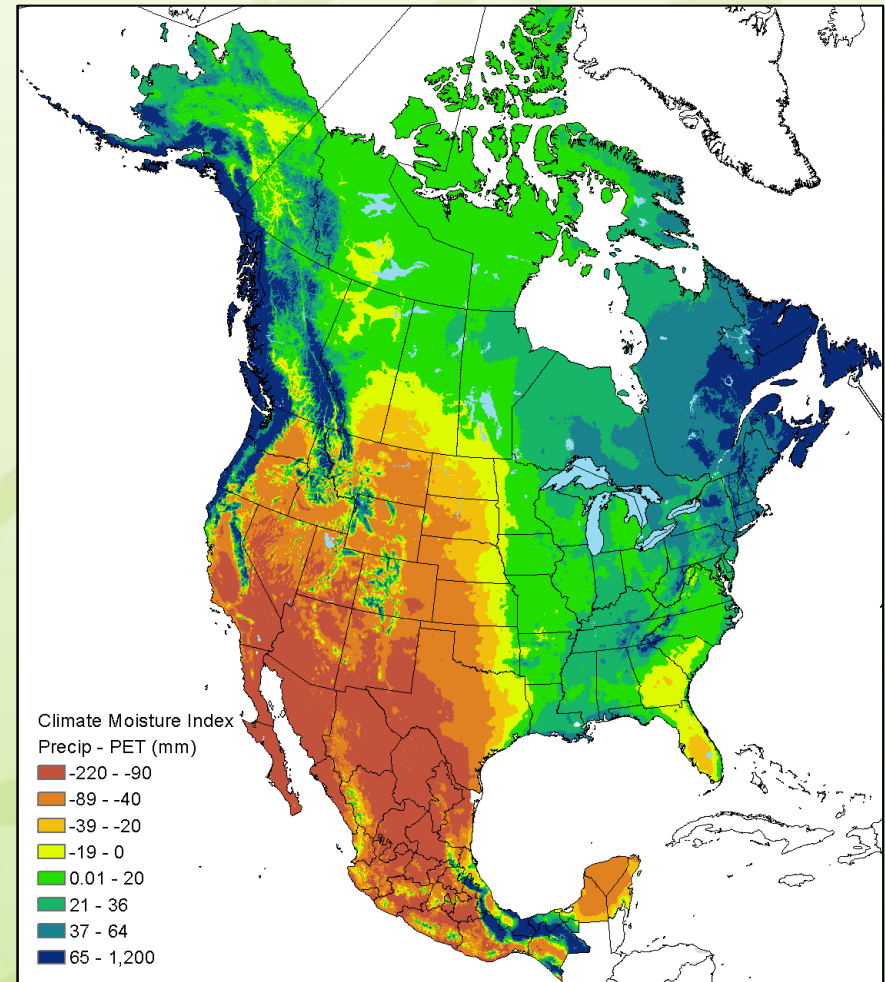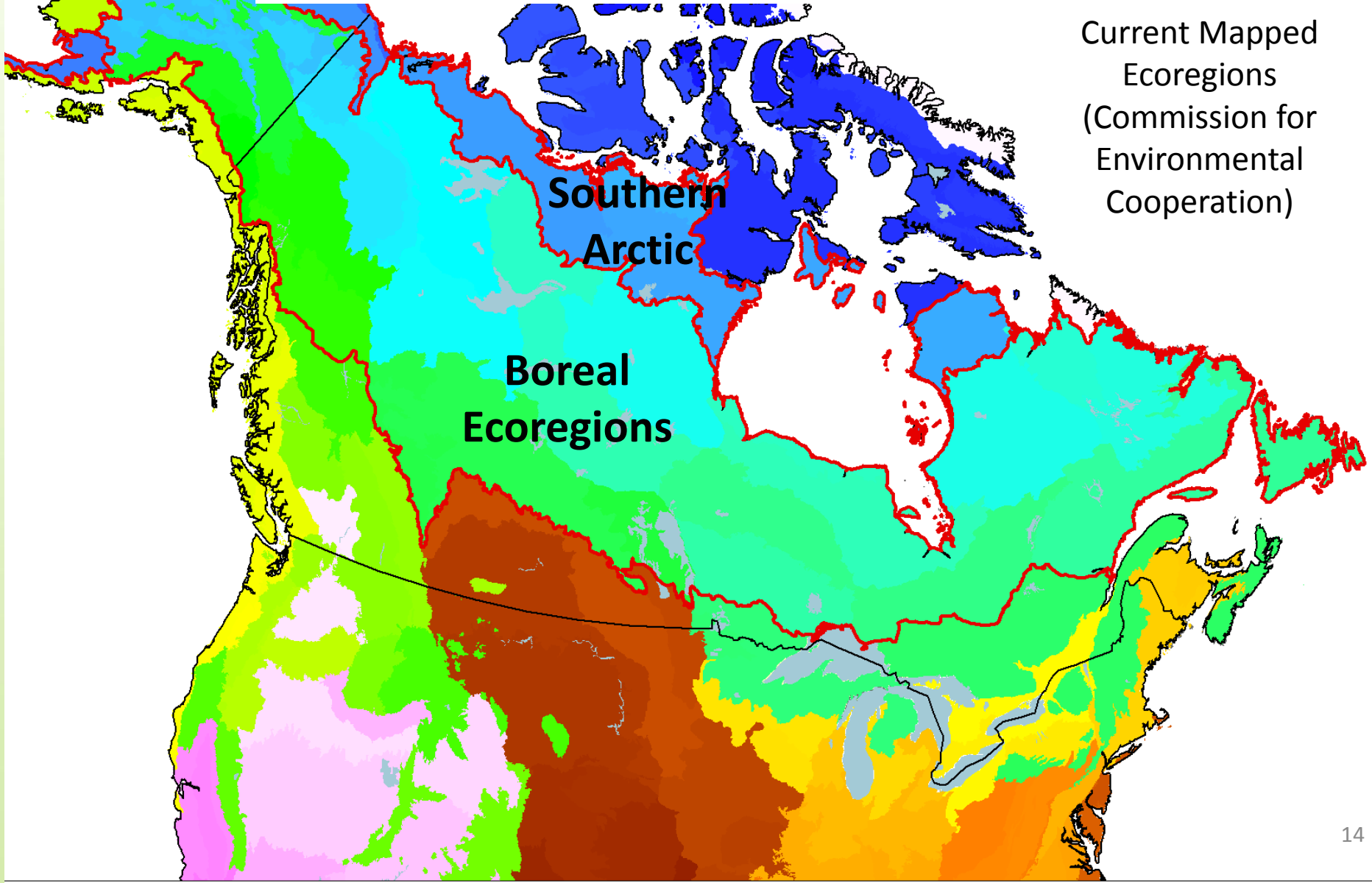
Boreal Ecoregions

Future boreal climate space

Projected Future Ecoregions based on Random Forest Model
(most frequent across 19 GCMs)

A2 emissions scenario

Future boreal climate space

Projected Future Ecoregions based on Random Forest Model (most frequent across 19 GCMs)

Southern Arctic

Boreal Ecoregions

Hemi-Boreal + Adjacent Ecoregions
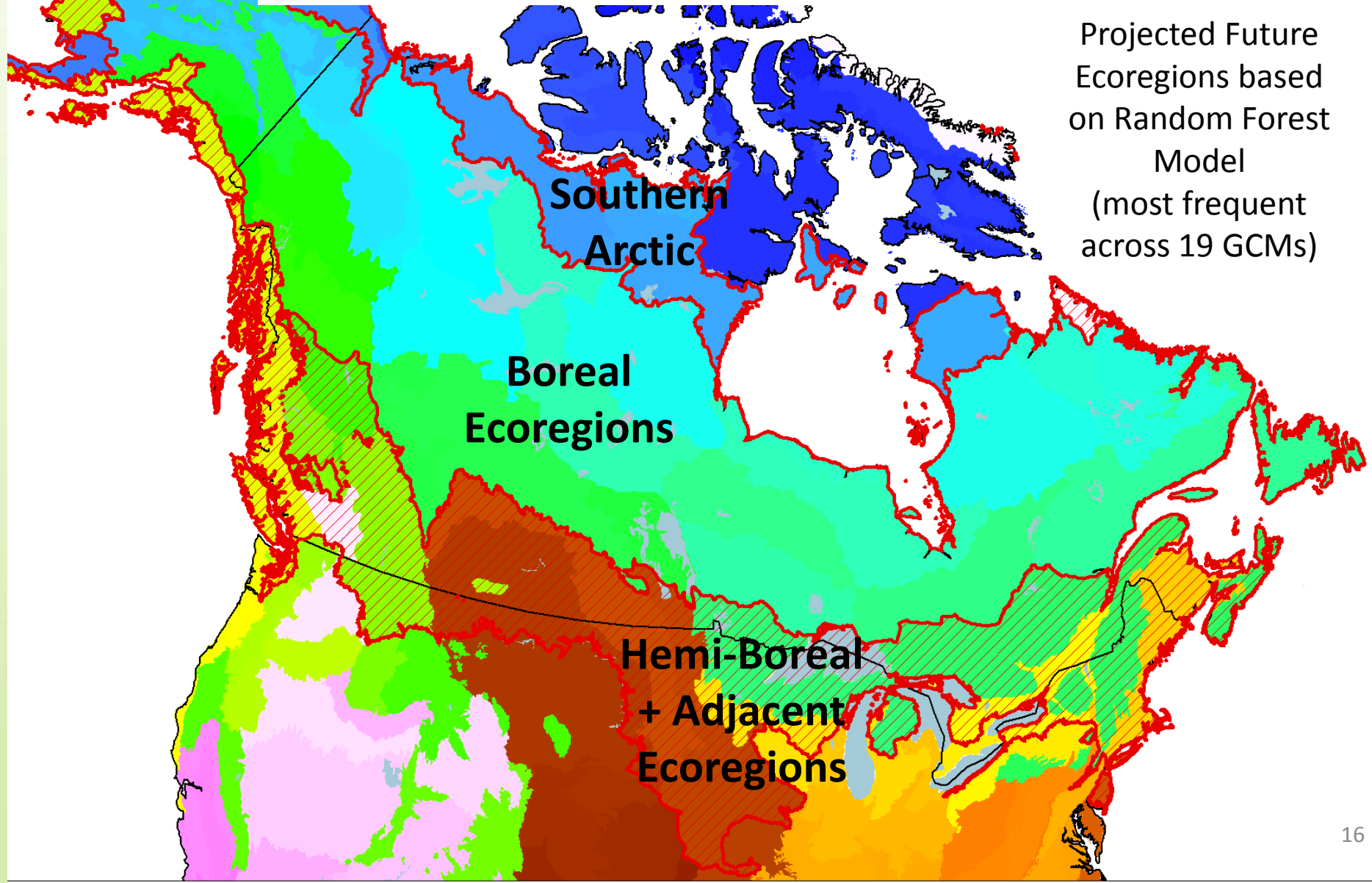
Data & Study Area

- BBS (57,961)
- Atlas (42,290) + other BAM (82,478)

~550,000 surveys subsampled for analysis (1992-2012)
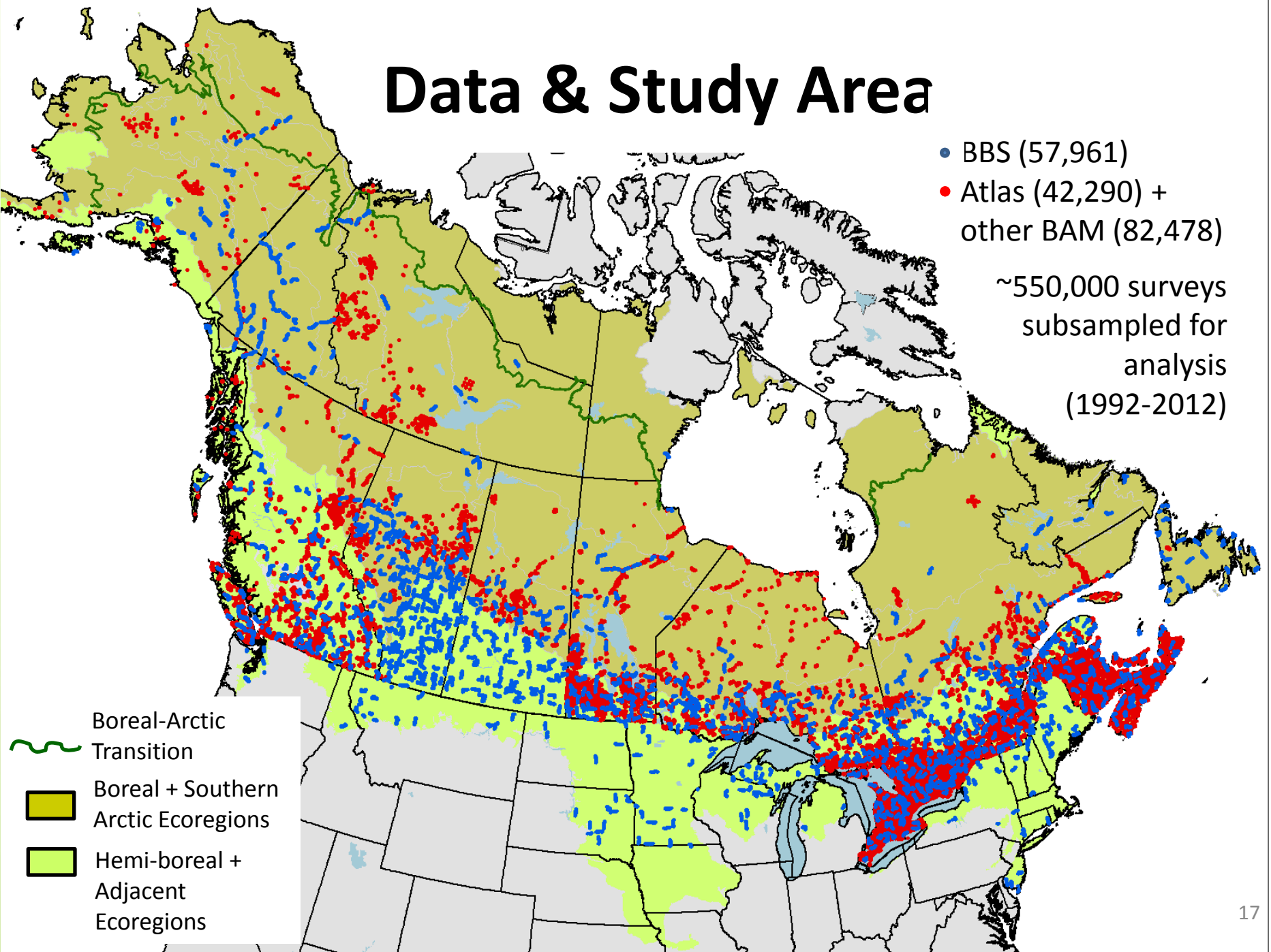
Boreal-Arctic Transition

Boreal + Southern Arctic Ecoregions

Hemi-boreal + Adjacent Ecoregions

17

Boreal Chickadee

:

Current
Predicted
Density
(1961-1990)

Boreal Chickadee

© Benoît Audet

:
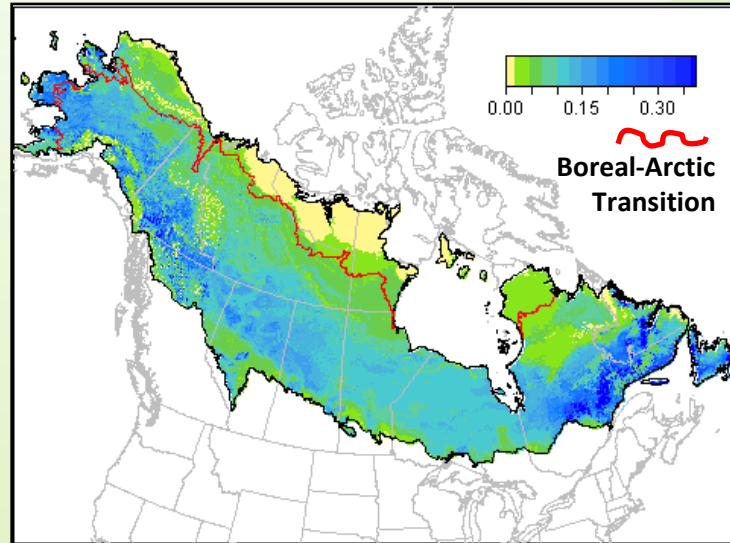
Projected
future density
(2011-2040)
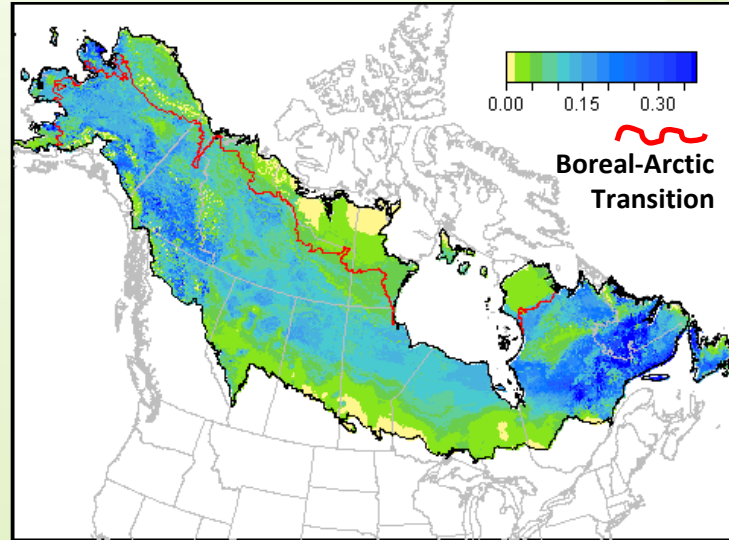
3% gain
70% of core
remaining

0.00   0.15   0.30

**Boreal-Arctic
Transition**

Average across 19 GCMs, A2 emissions scenario

-0.3   0.0   0.3
Density Change

**Boreal-Arctic
Transition**

Core loss
Core gain
Refugia

**Boreal-Arctic
Transition**

Boreal Chickadee

© Benoît Audet
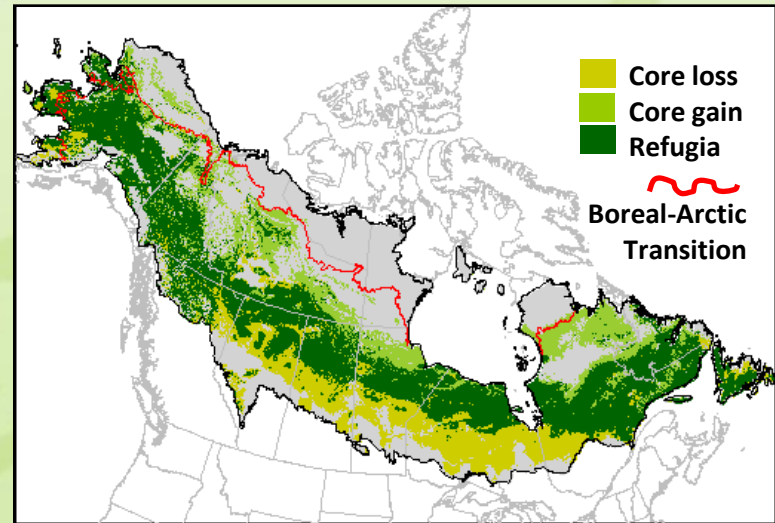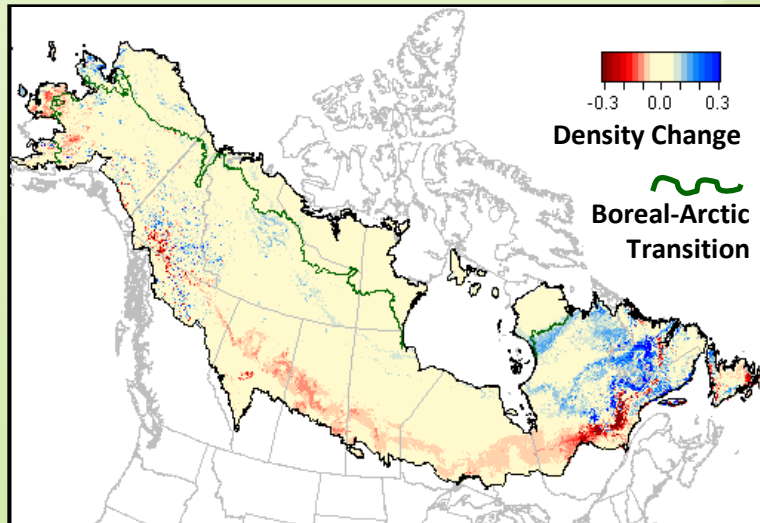
Projected future density (2041-2070)

2% gain
48% of core remaining

Average across 19 GCMs, A2 emissions scenario

Boreal Chickadee

© Benoît Audet

:
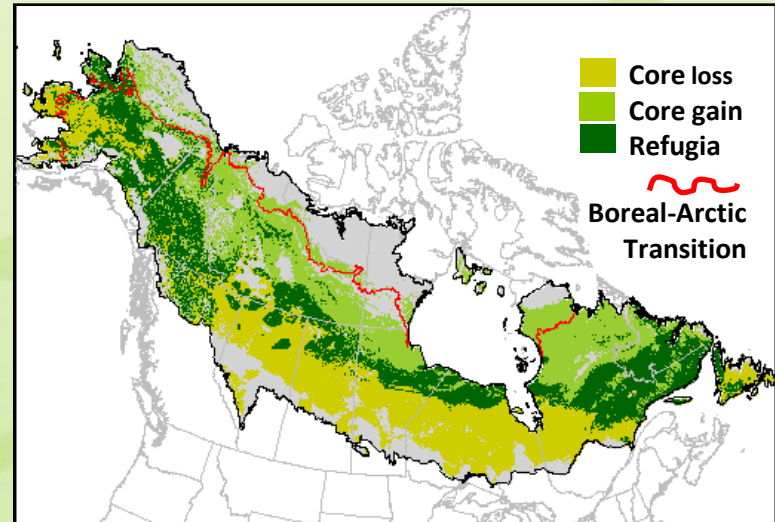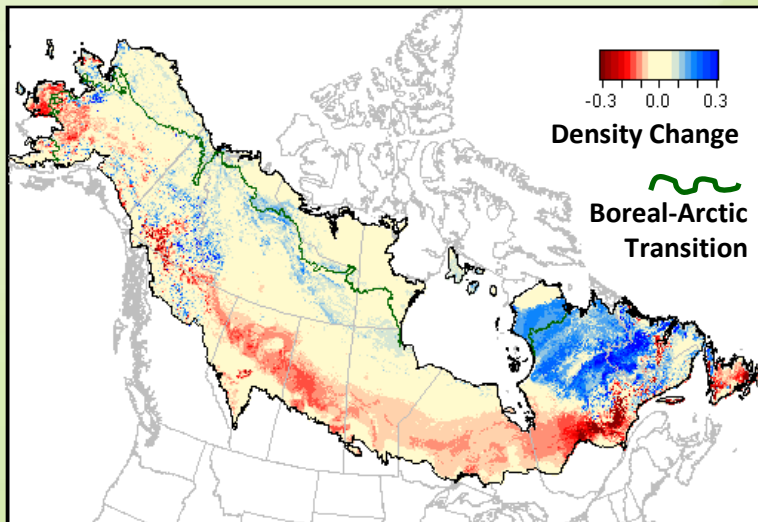
Projected future density (2071-2100)
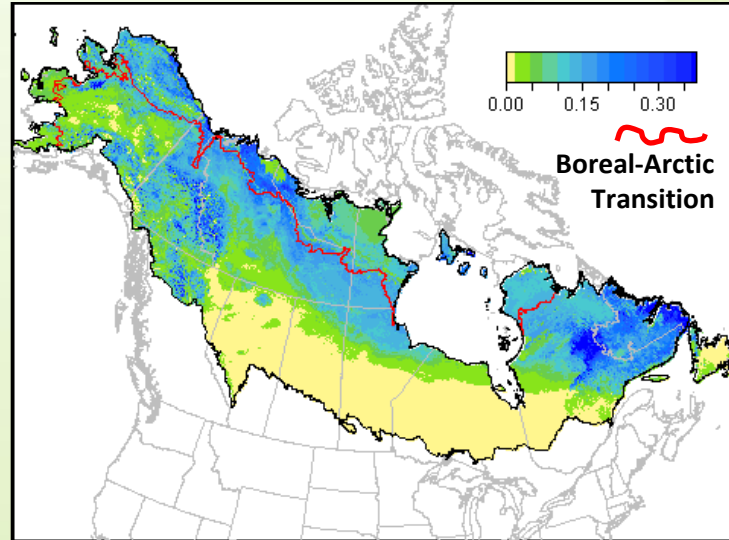
13% loss
21% of core remaining

Average across 19 GCMs, A2 emissions scenario
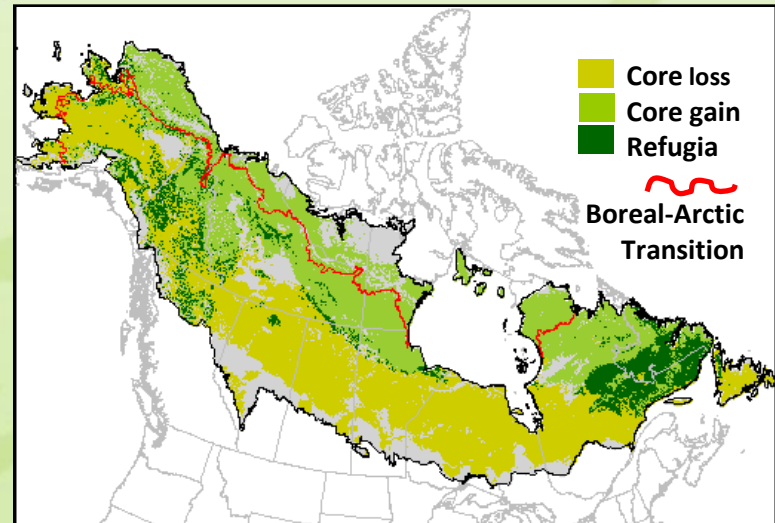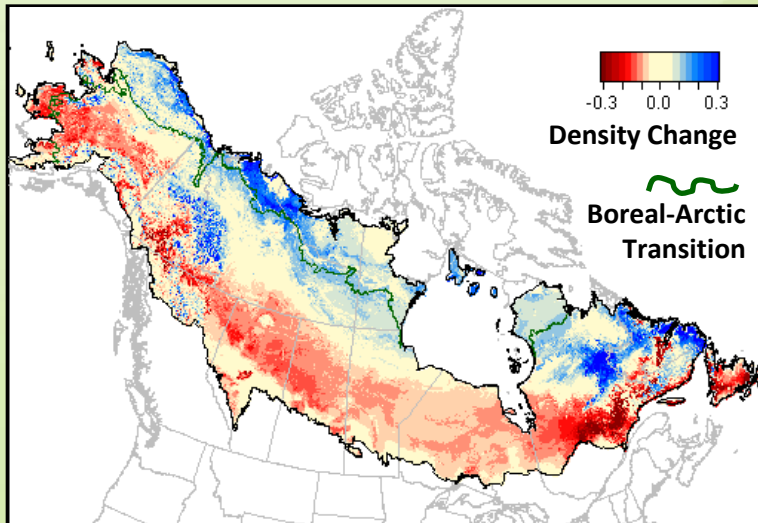
Blackpoll Warbler

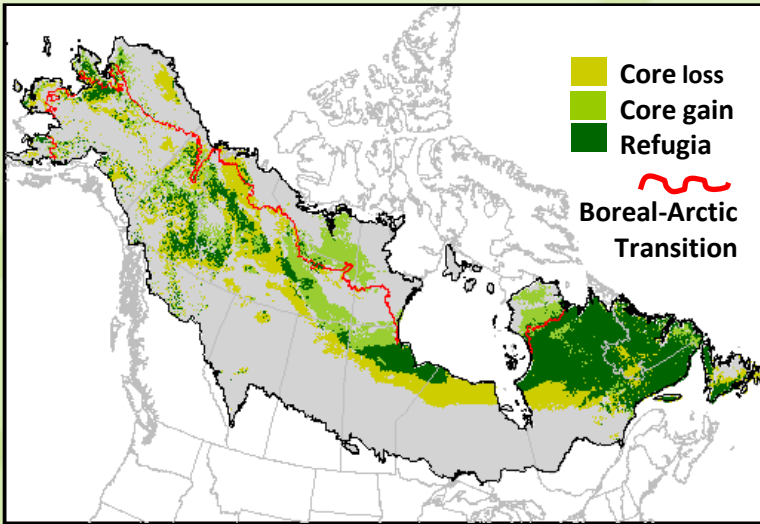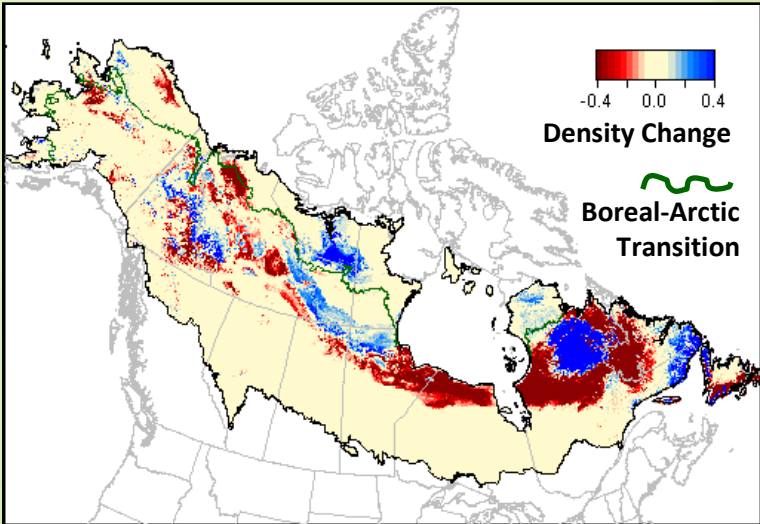

:

Current
Predicted
Density
(1961-1990)

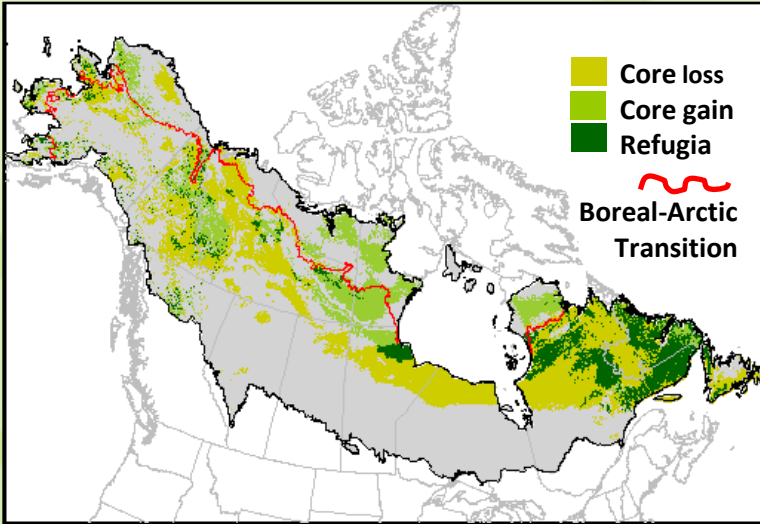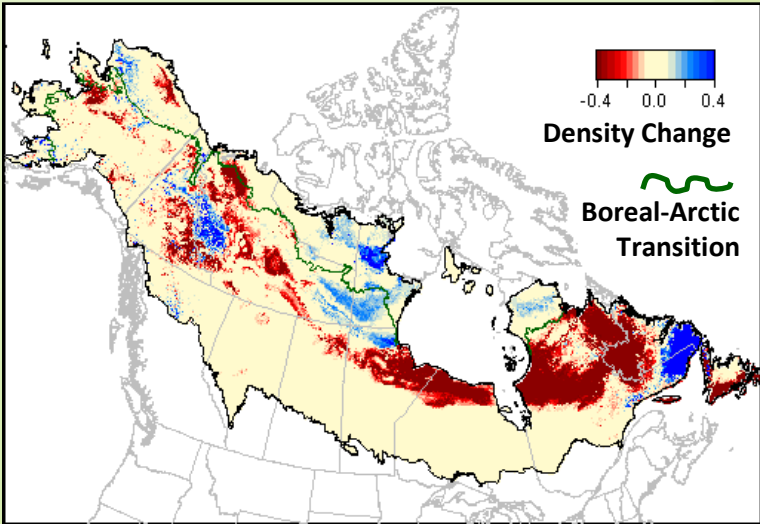# Blackpoll Warbler

Projected
future density
(2011-2040)
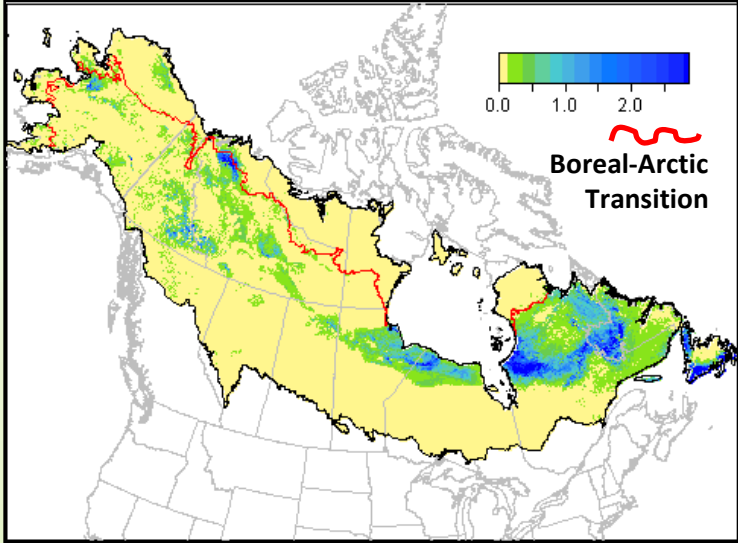
Average across 19 GCMs, A2 emissions scenario
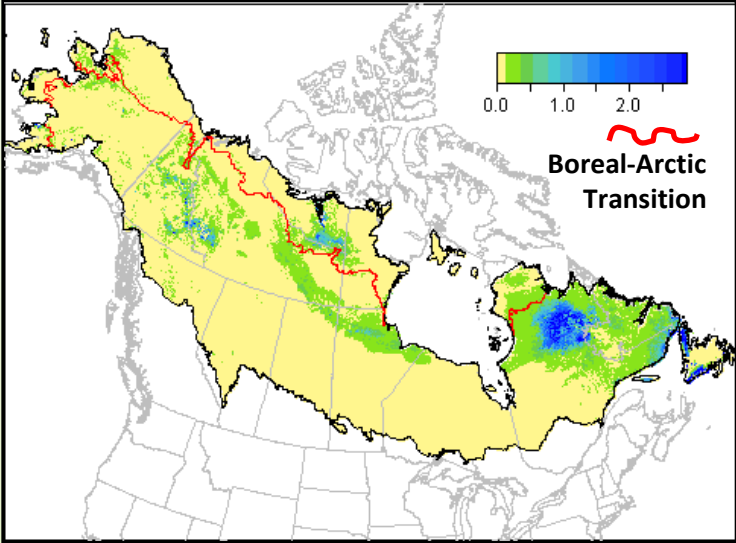
35% loss
56% of core
remaining

Blackpoll Warbler

Projected future density (2041-2070)
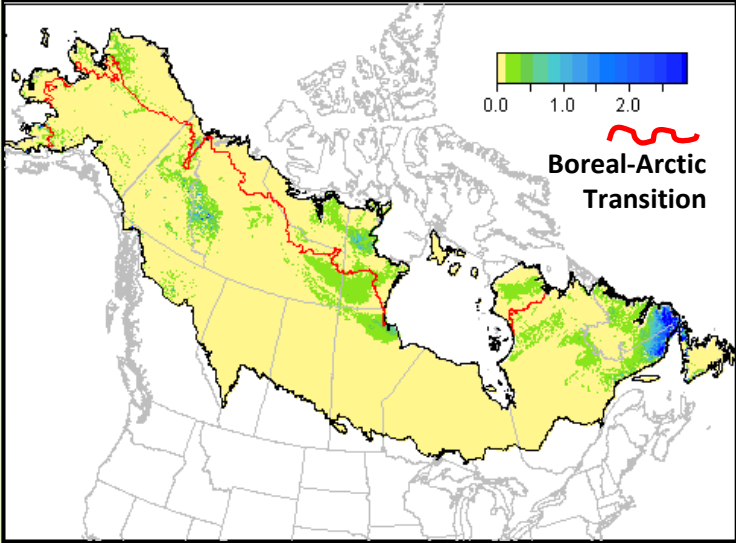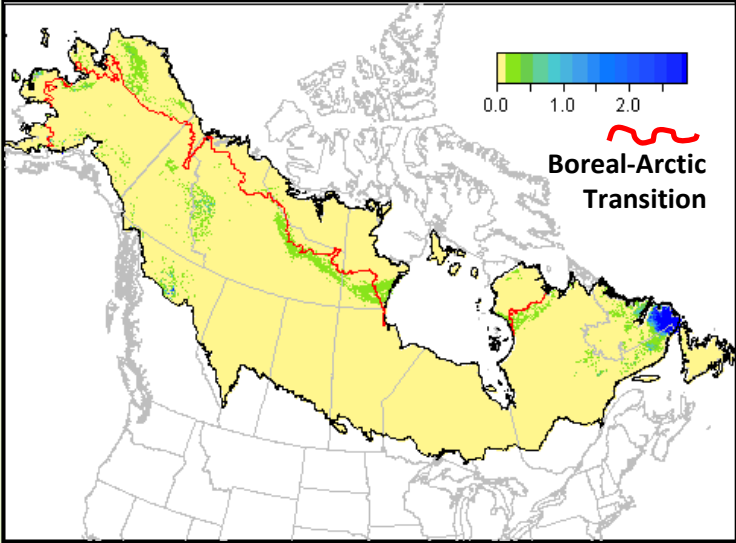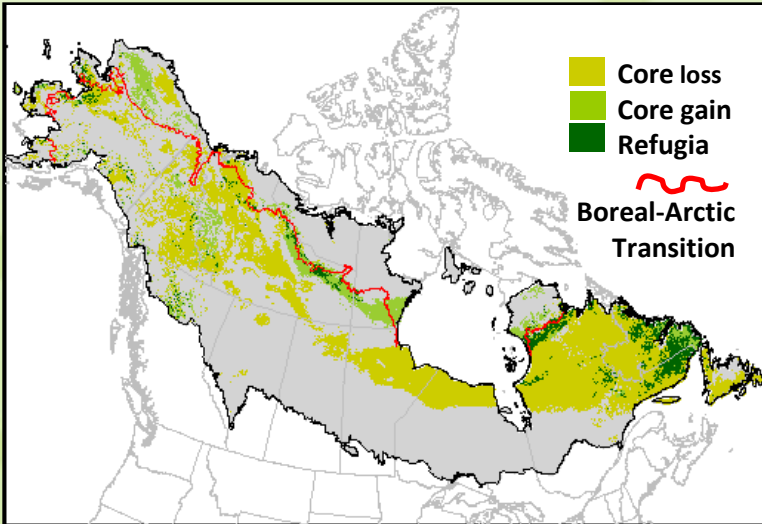
70% loss
26% of core remaining

Average across 19 GCMs, A2 emissions scenario
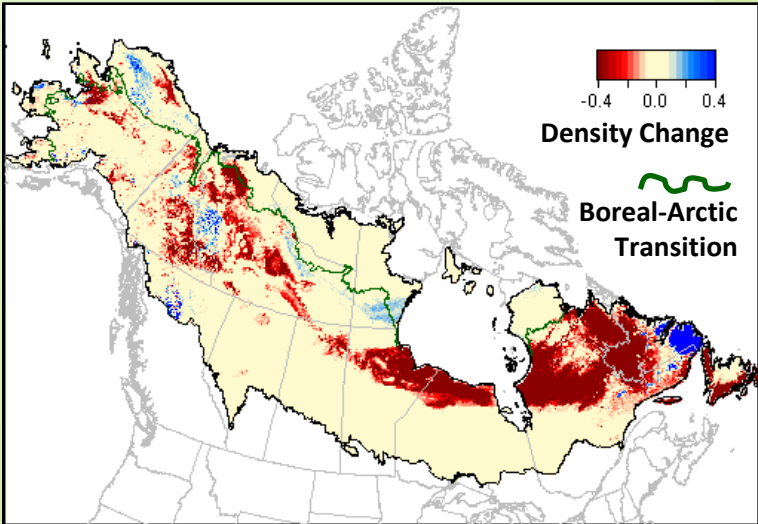
Blackpoll Warbler
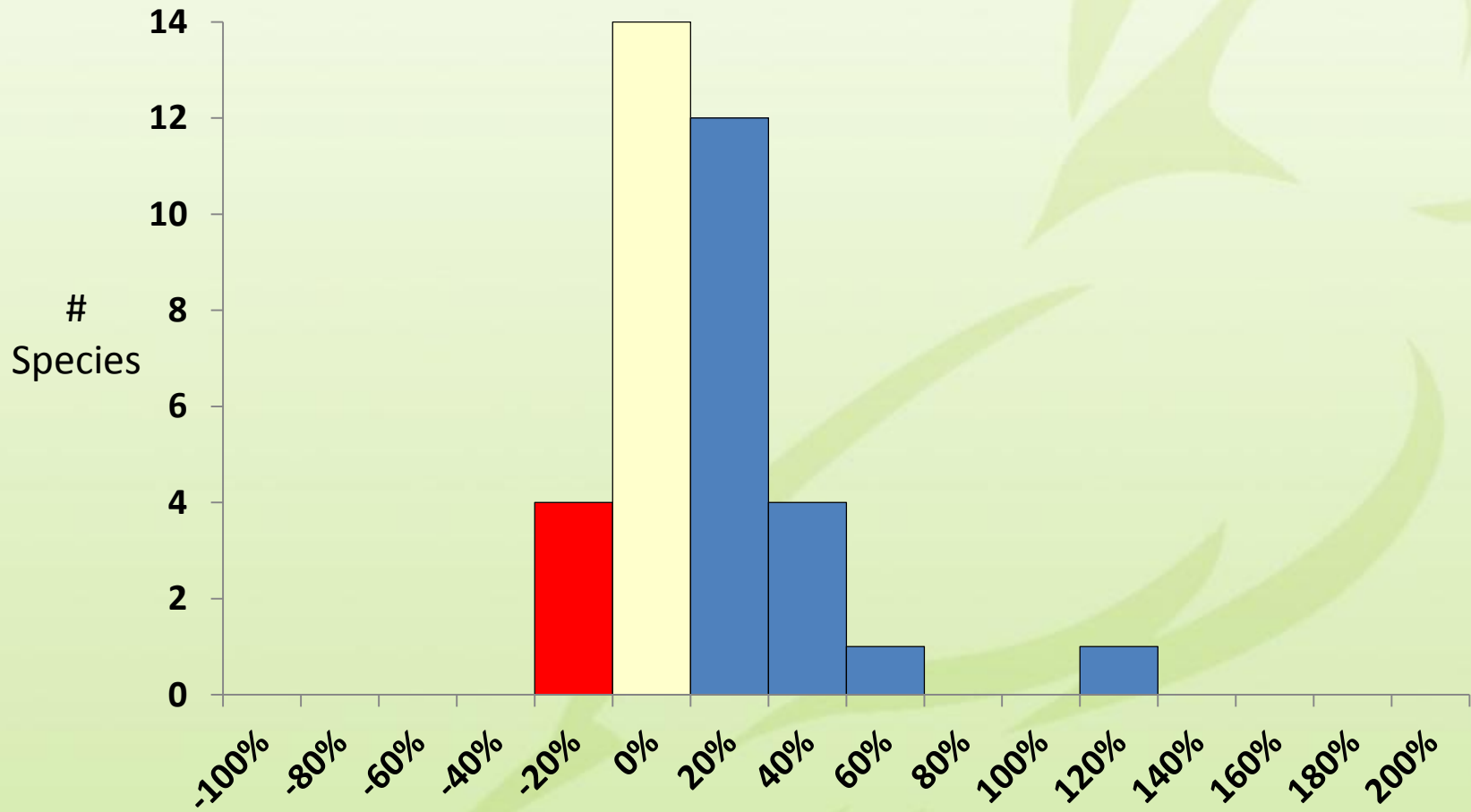

Projected
future density
(2071-2100)

71% loss
11% of core
remaining
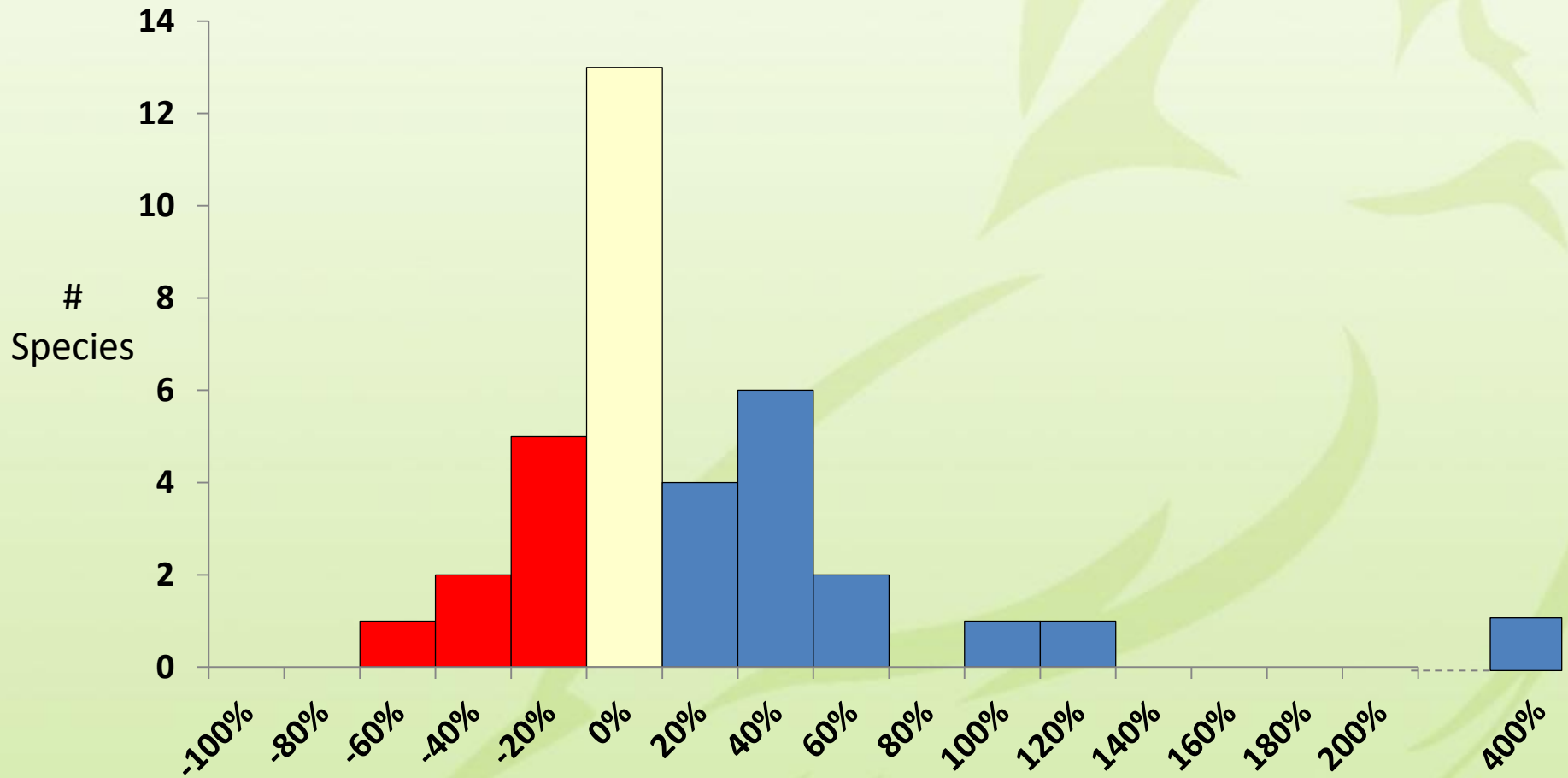
Average across 19 GCMs, A2 emissions scenario

Projected Change, 2011-2040

for 35 western species

Projected Change, 2041-2070

for 35 western species

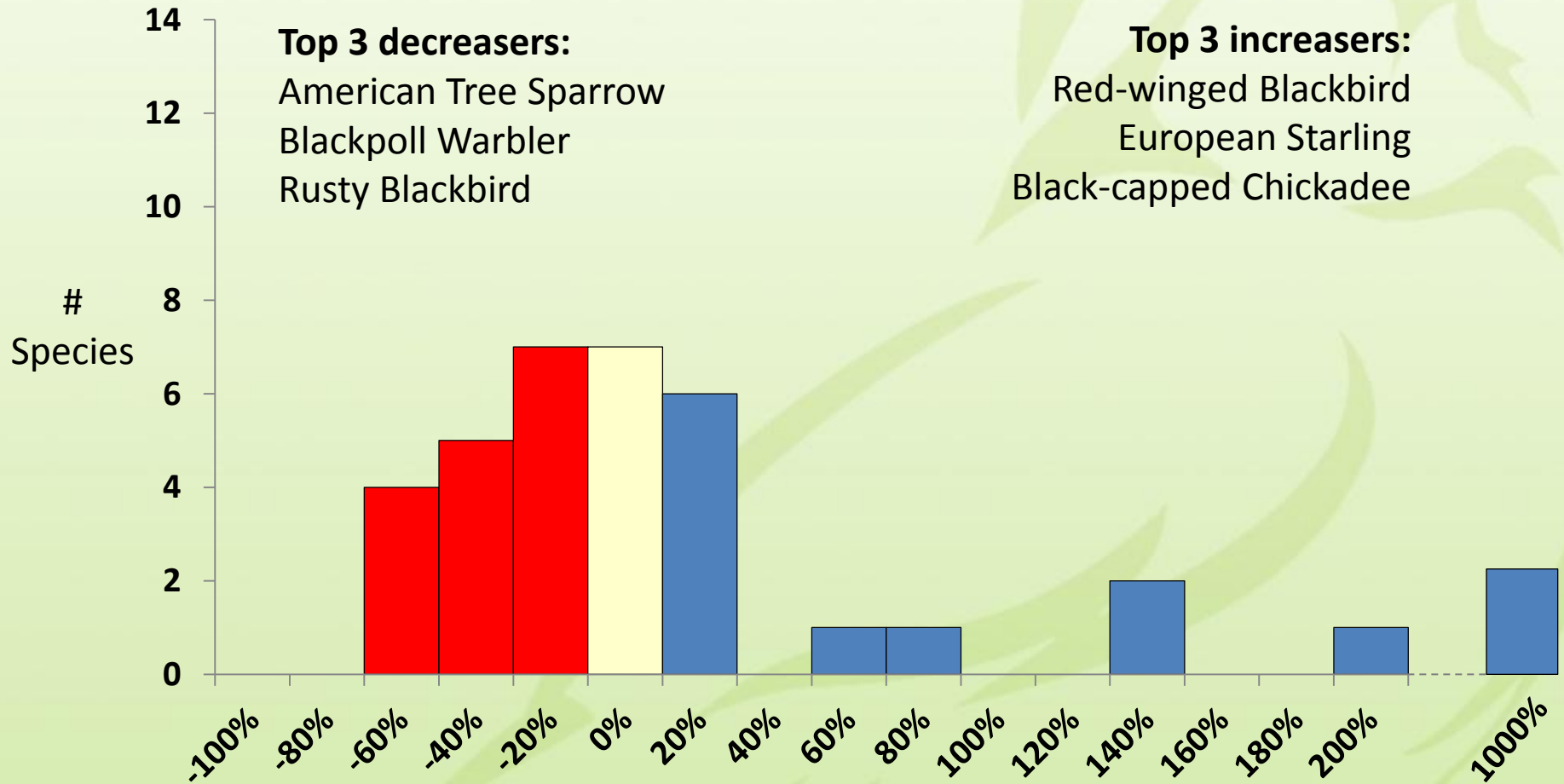# Projected Change, 2071-2100

for 35 western species

Top 3 decreasers:
American Tree Sparrow
Blackpoll Warbler
Rusty Blackbird

Top 3 increasers:
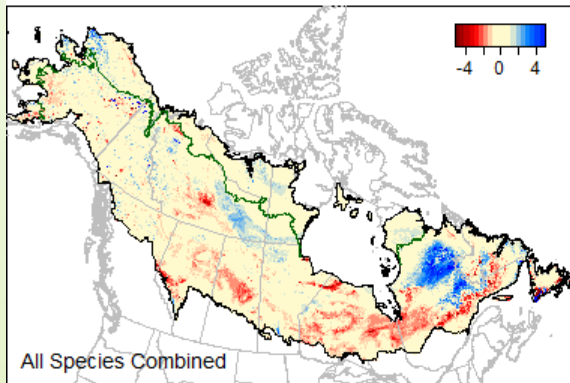Red-winged Blackbird
European Starling
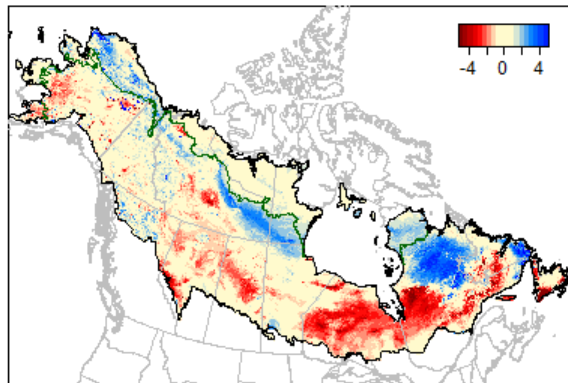Black-capped Chickadee

Multi-Species Patterns

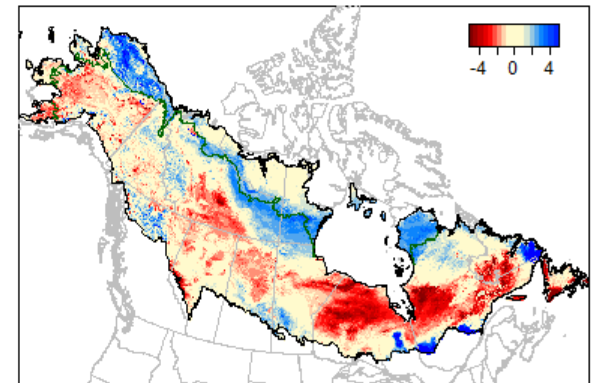**Combined Density Change:**   **for 35 western species**

Frequency of Refugia:

Scaling Down

Multi-species Projected Density Change, 2071-2100
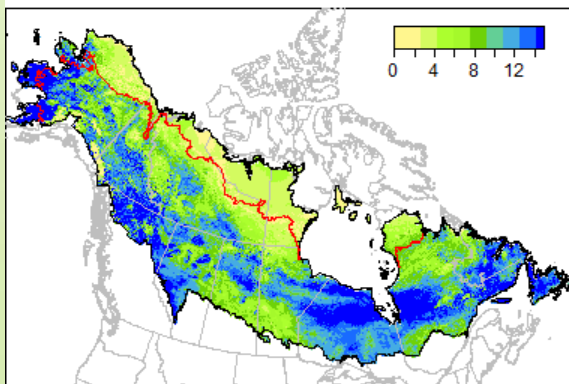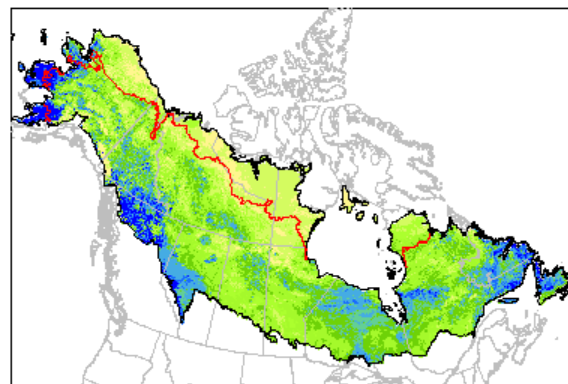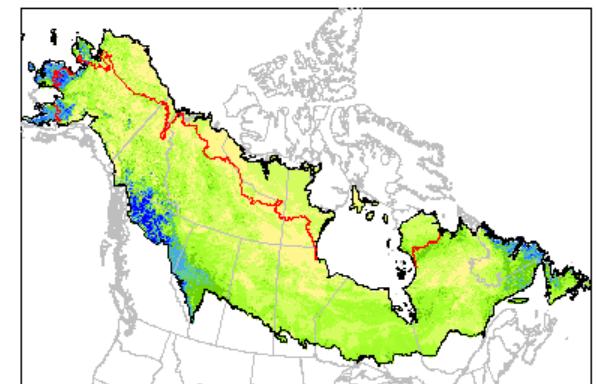
Landscape Heterogeneity

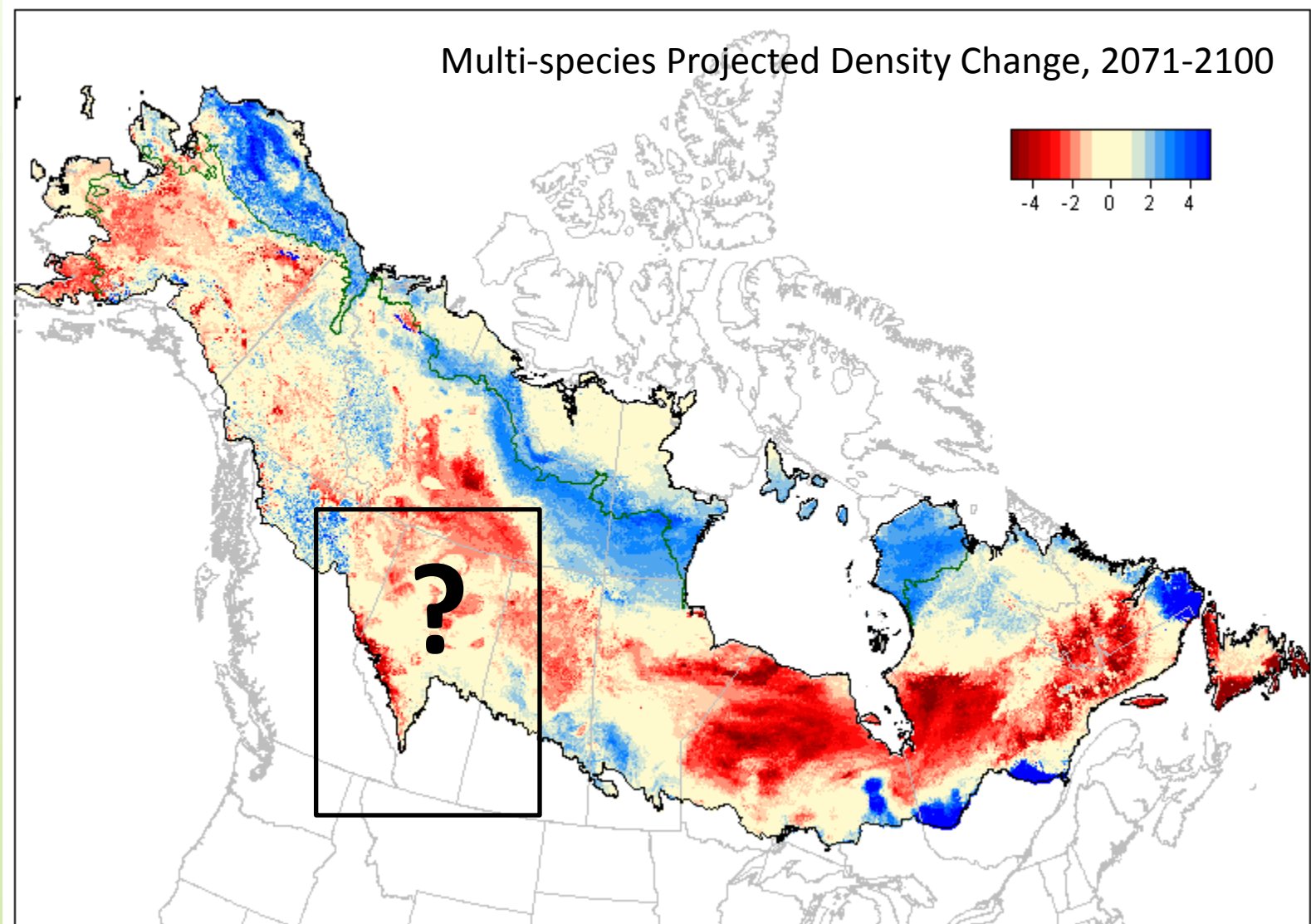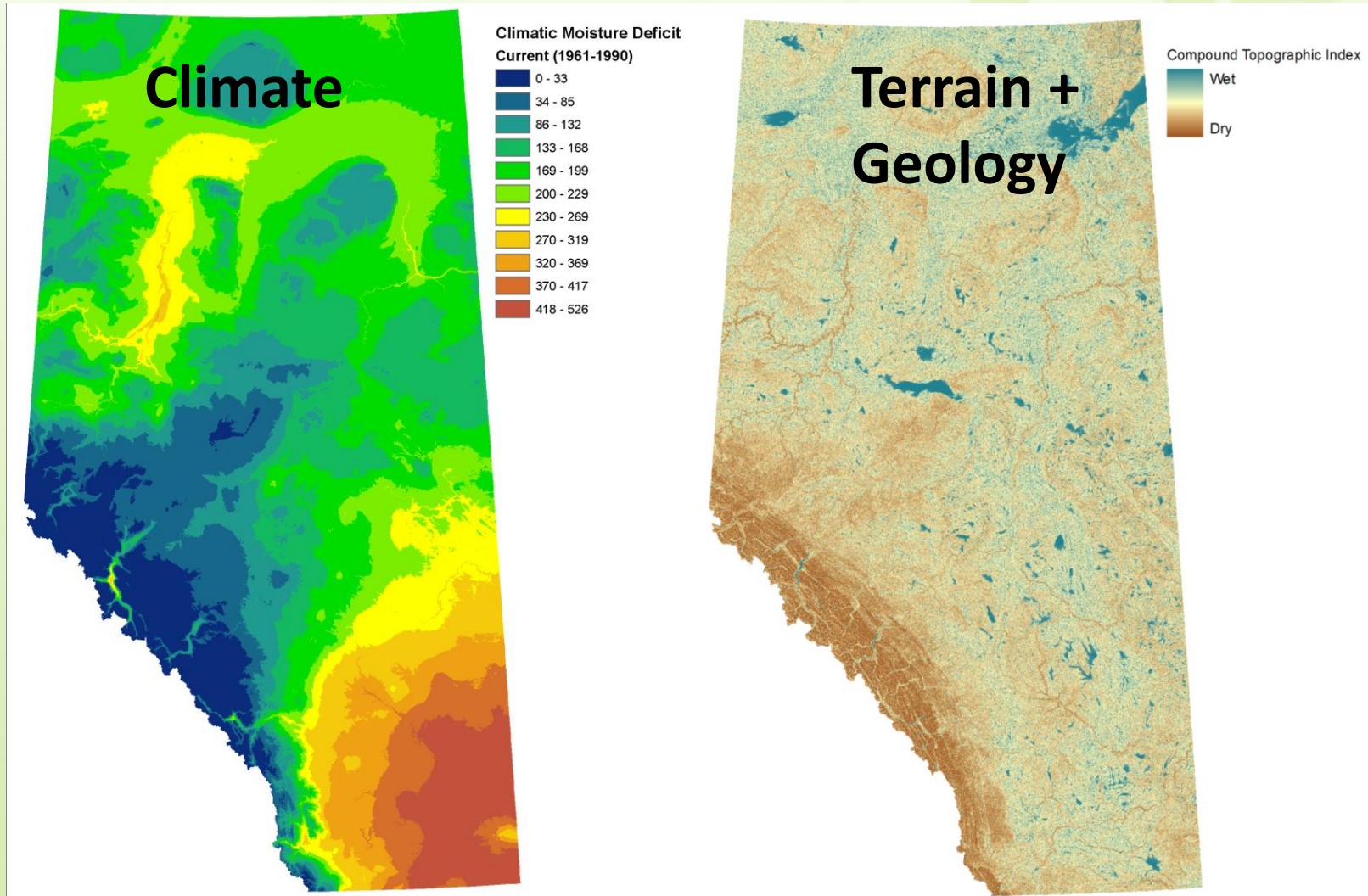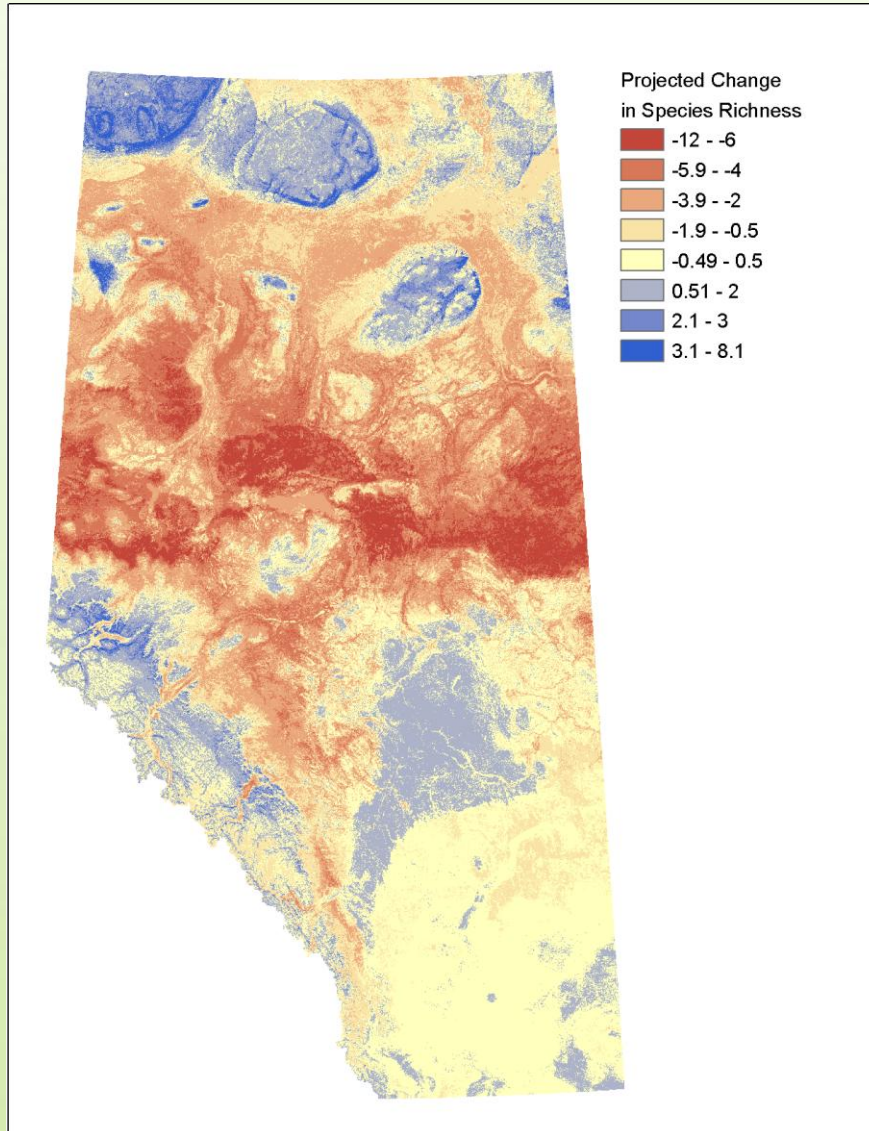500-m grids, climate data from ClimateWNA tool, terrain metrics courtesy of S. Nielsen

Scaling Down

Projected Change in Species Richness
- ■ -12 - -6
- ■ -5.9 - -4
- ■ -3.9 - -2
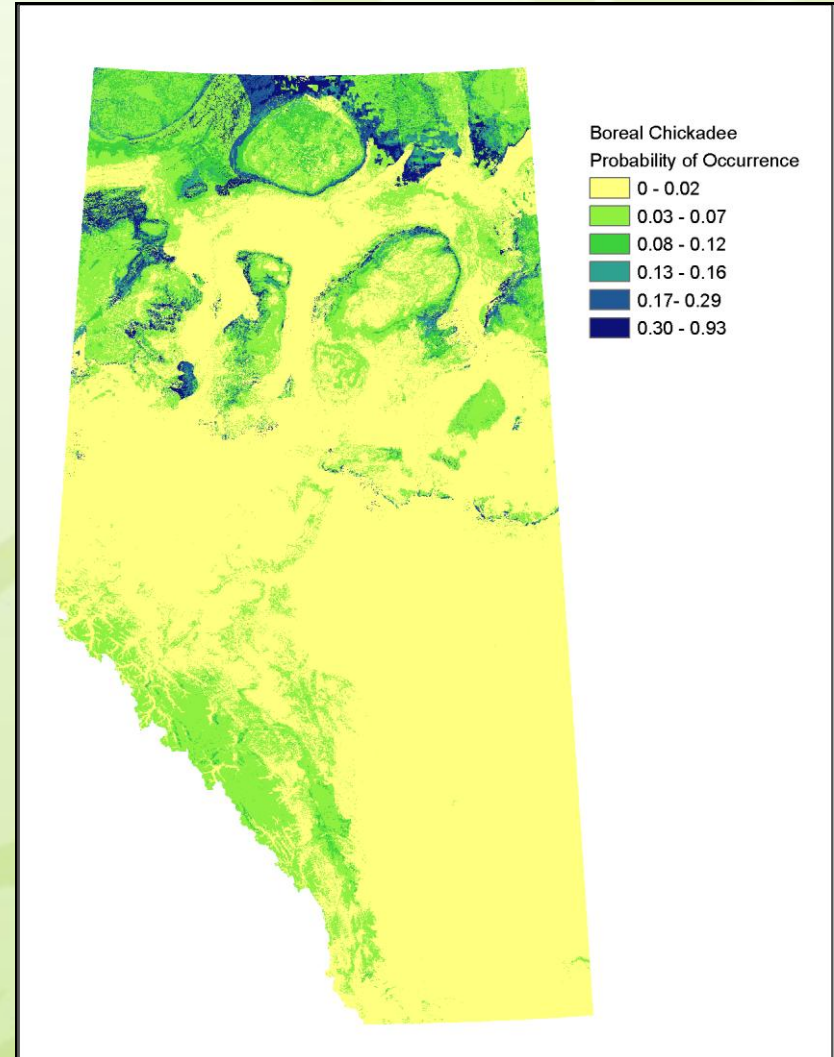- □ -1.9 - -0.5
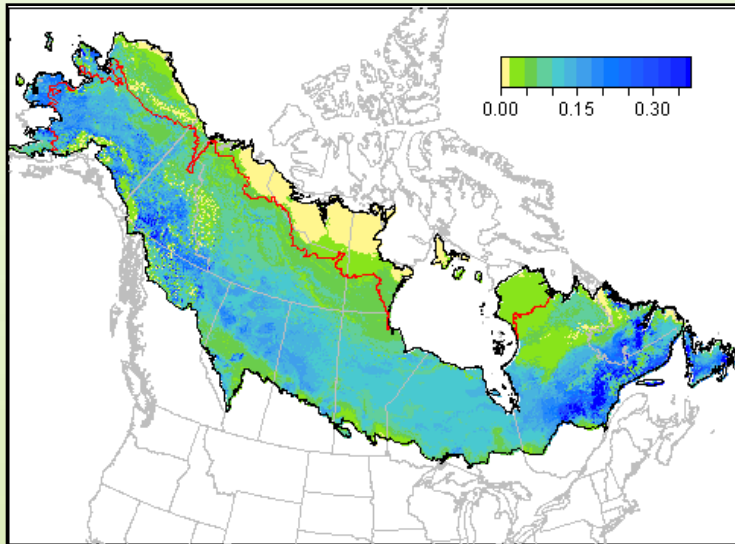- □ -0.49 - 0.5
- □ 0.51 - 2
- ■ 2.1 - 3
- ■ 3.1 - 8.1

Projected change in bird species richness by 2071-2100 (Canadian Climate Model, 58 passerine species)
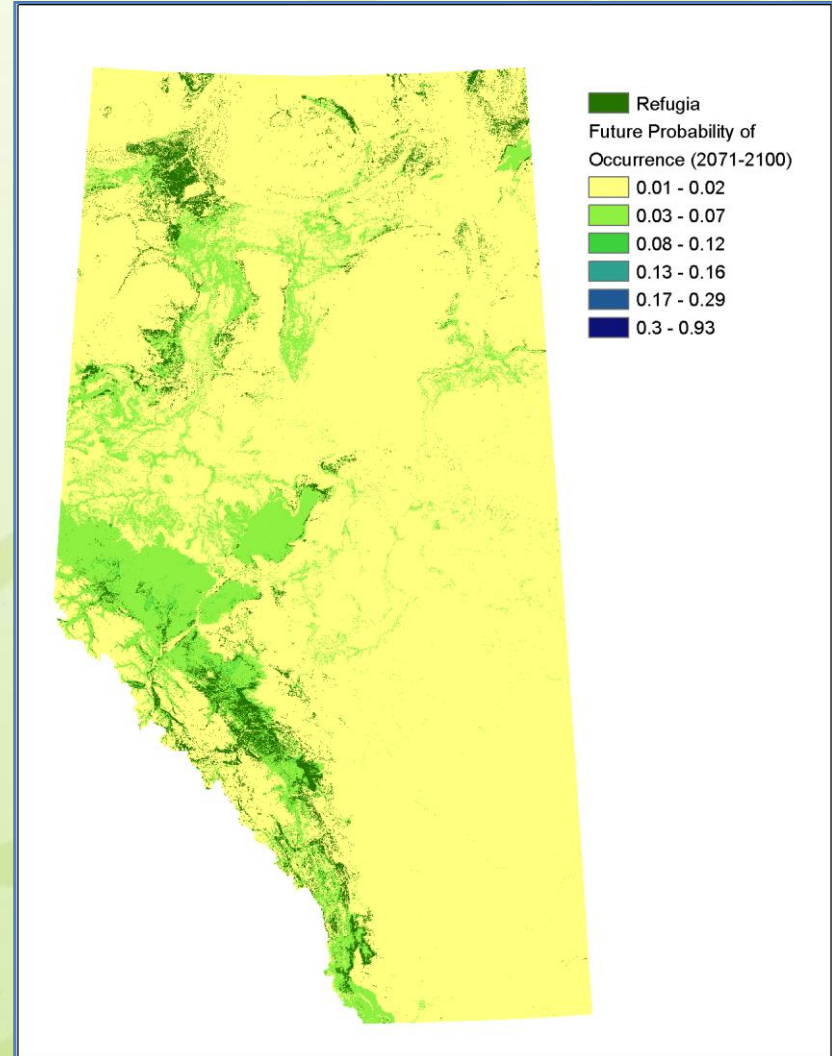

© Alberta SRD

Boreal Chickadee

Current Distribution

Boreal Chickadee

Future Distribution (2071-2100)

Core loss
Core gain
Refugia

Refugia
Future Probability of Occurrence (2071-2100)
0.01 - 0.02
0.03 - 0.07
0.08 - 0.12
0.13 - 0.16
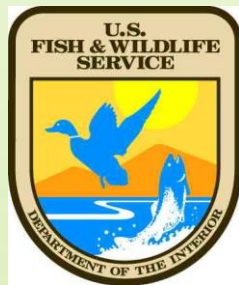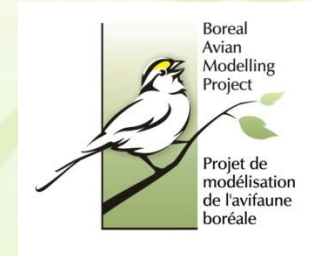0.17 - 0.29
0.3 - 0.93

© Benoît Audet
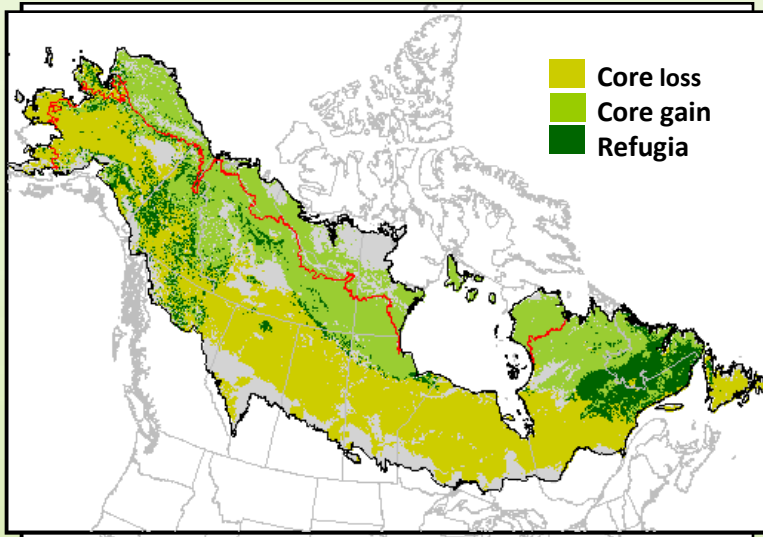
Conclusions

- Disparate survey data combined with downscaled climate data are valuable for quantifying and projecting climatic niches

- Multi-scale climate refugia important to identify in light of uncertainties

- Shifting conservation priorities → more collaboration and monitoring

Funding

People

Co-supervisors: Erin Bayne, Fiona Schmigelow

BAM Team: Steve Matsuoka, Peter Solymos, Trish Fontaine, Steve Cumming, Samantha Song, Lisa Mahon, Nicole Barker, Catherine Rostron

GIS Data Collaborators: Andreas Hamann, Xianli Wang, Scott Nielsen