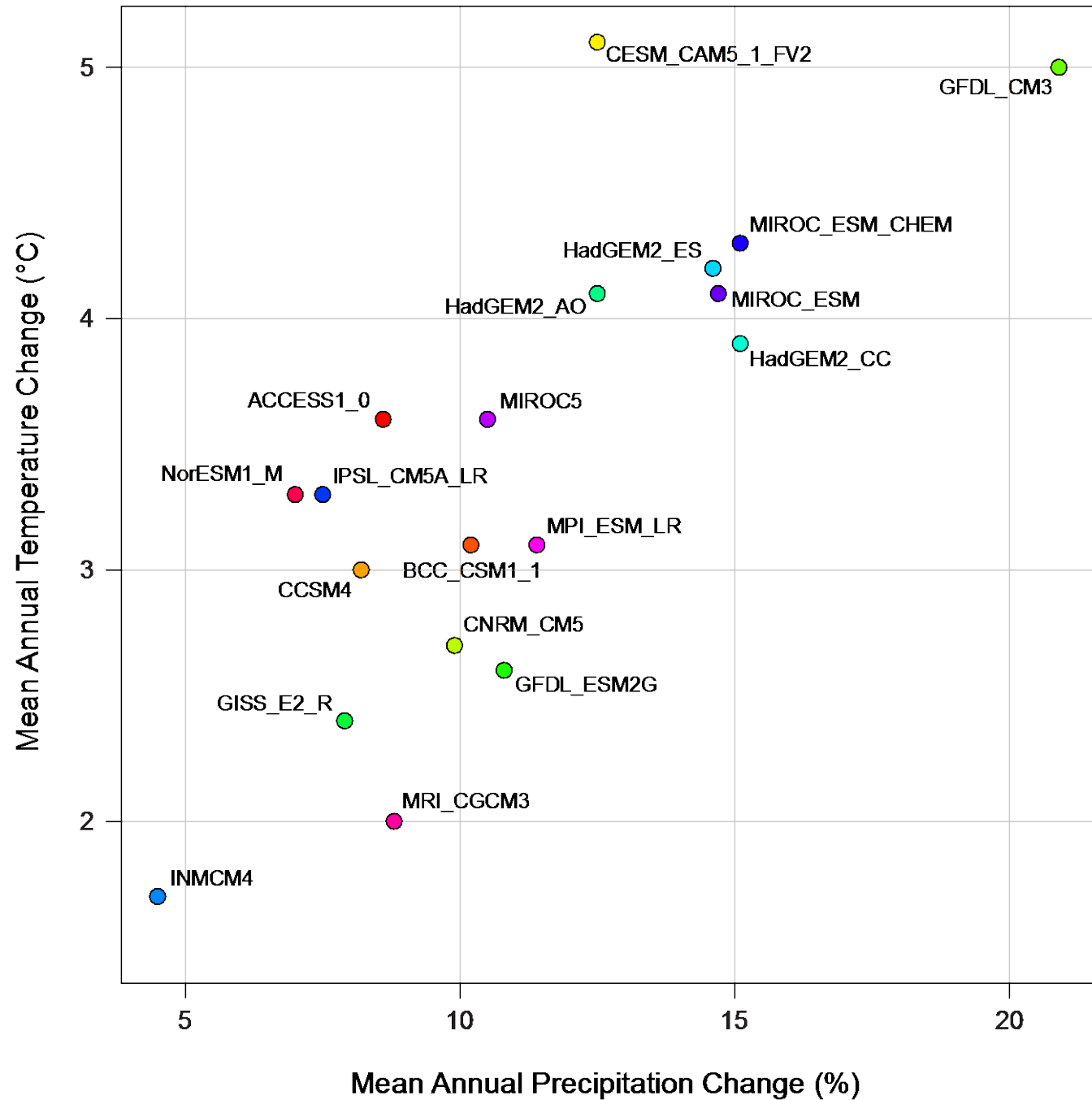# Projected climate-change impacts on snow, vegetation, and lynx populations in the western U.S.

Josh Lawler, University of Washington
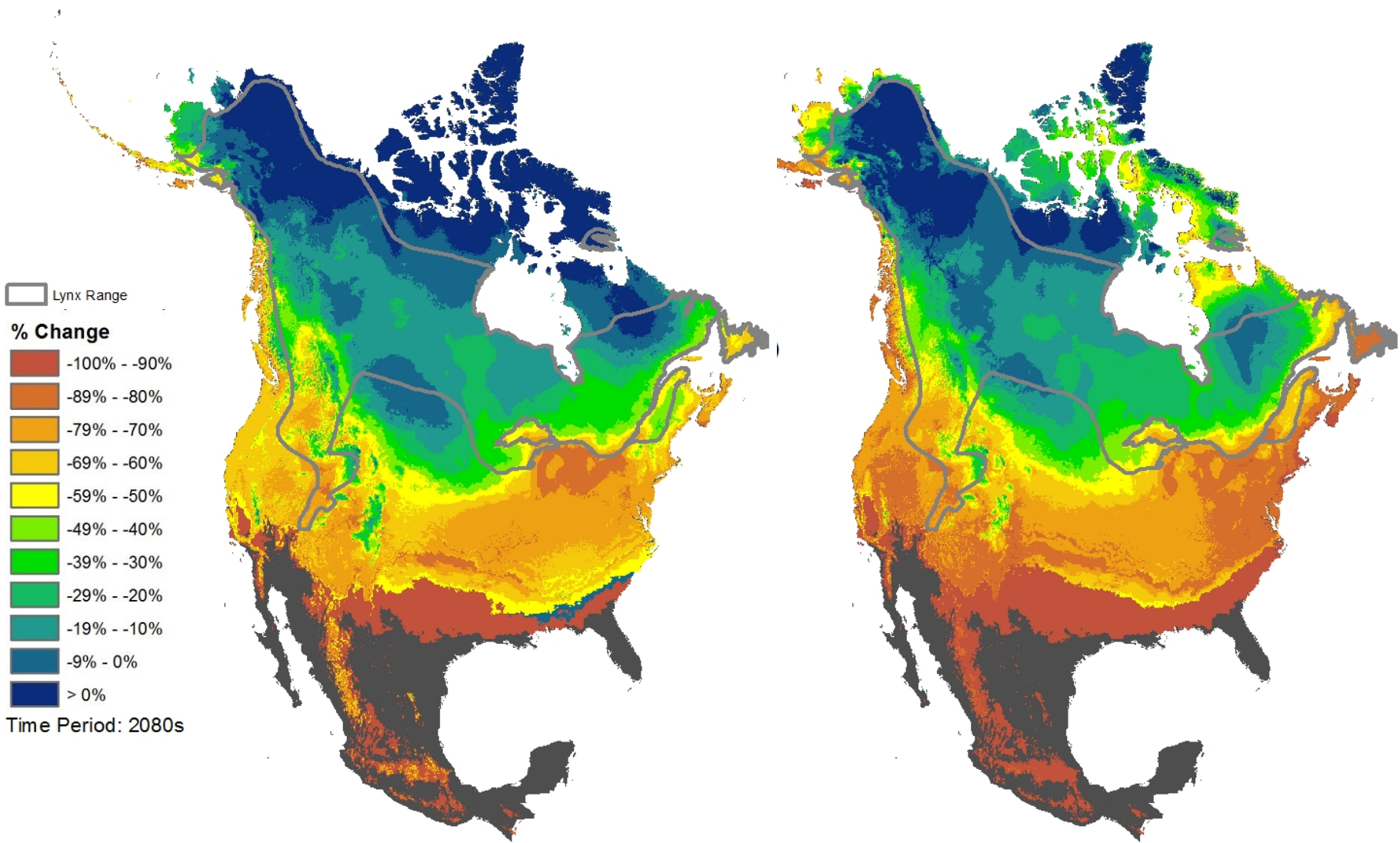Chad Wilsey, National Audubon Society

N. America Projected Climate Anomalies (CMIP5 RCP45 - 2050s)
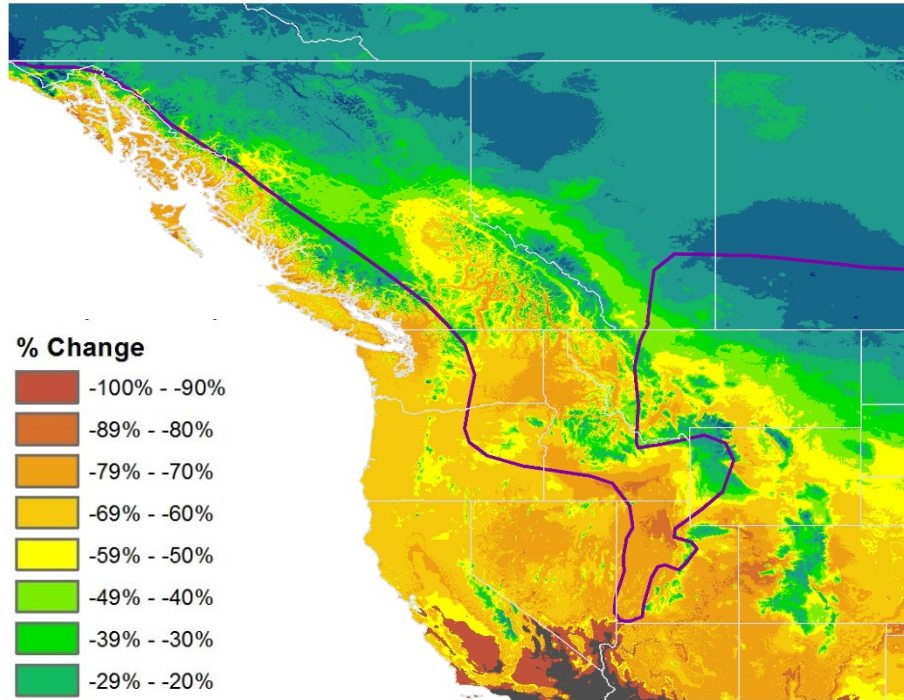
Precipitation falling as snow

INM CM4 (Mild Change)

GFDL CM3 (Extreme Change)

Lynx Range

% Change

- -100% - -90%
- -89% - -80%
- -79% - -70%
- -69% - -60%
- -59% - -50%
- -49% - -40%
- -39% - -30%
- -29% - -20%
- -19% - -10%
- -9% - 0%
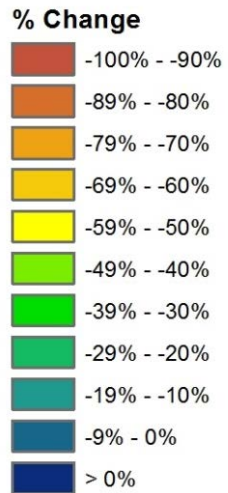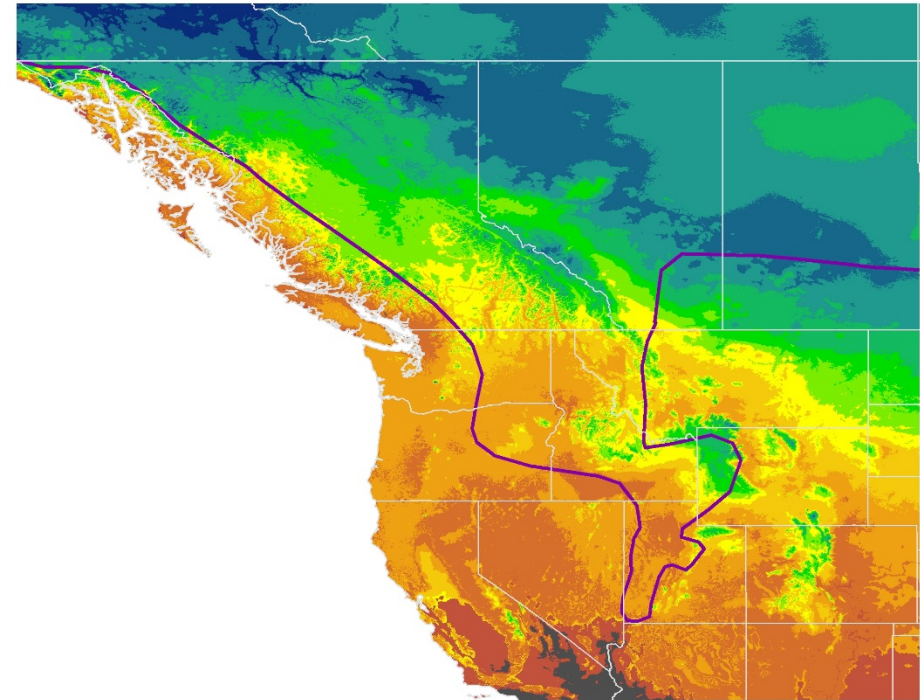- > 0%

Time Period: 2080s

Precipitation falling as snow

INM CM4 (Mild Change)

GFDL CM3 (Extreme Change)

% Change
- -100% - -90%
- -89% - -80%
- -79% - -70%
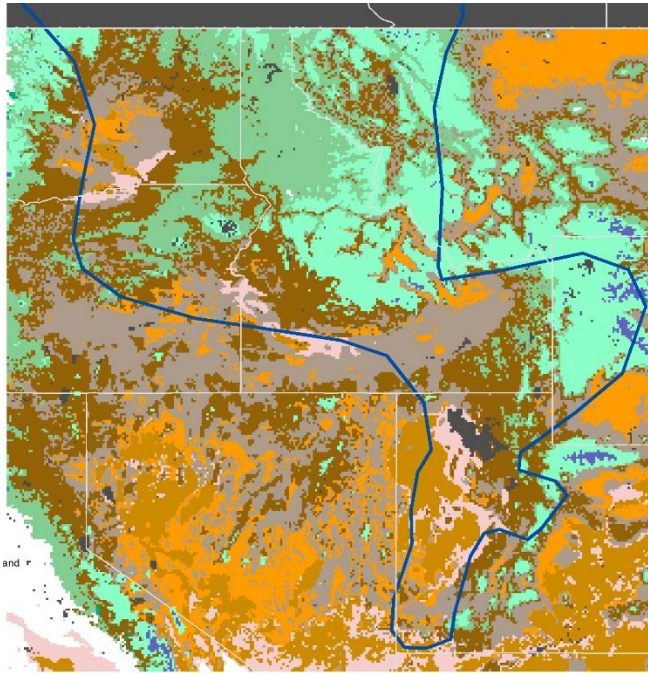- -69% - -60%
- -59% - -50%
- -49% - -40%
- -39% - -30%
- -29% - -20%
- -19% - -10%
- -9% - 0%
- > 0%

N. America Projected Climate Anomalies (CMIP5 RCP45 - 2050s)
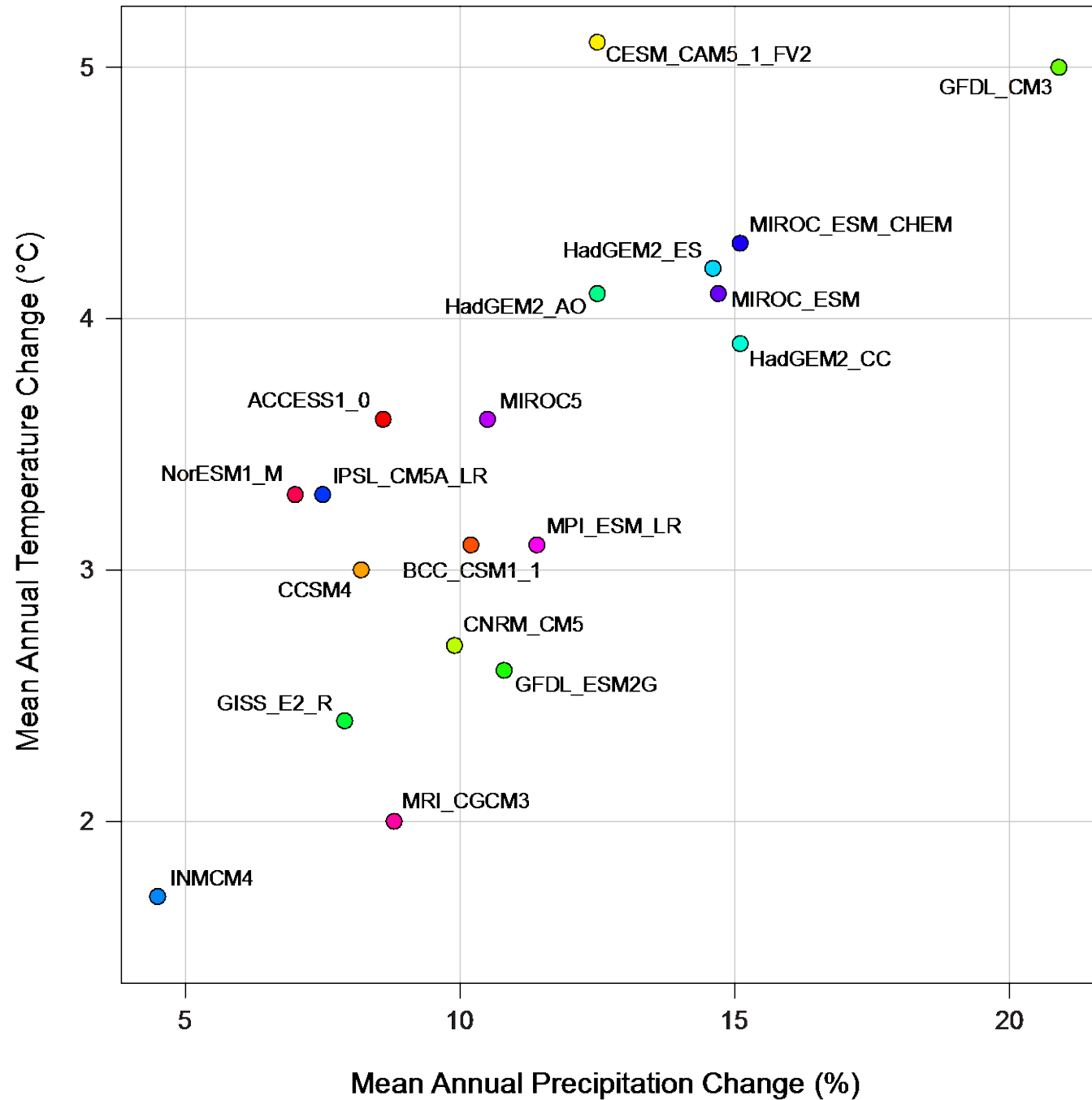
MC2, 2080s, RCP8.5

Modeled
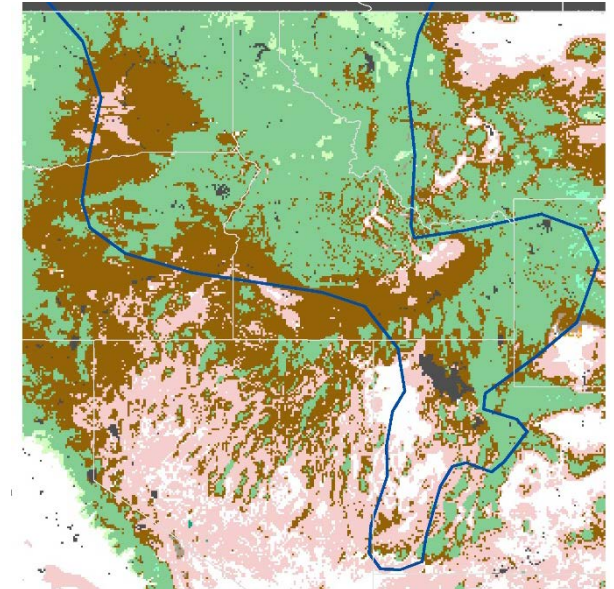Historical

INM CM4
(Mild Change)
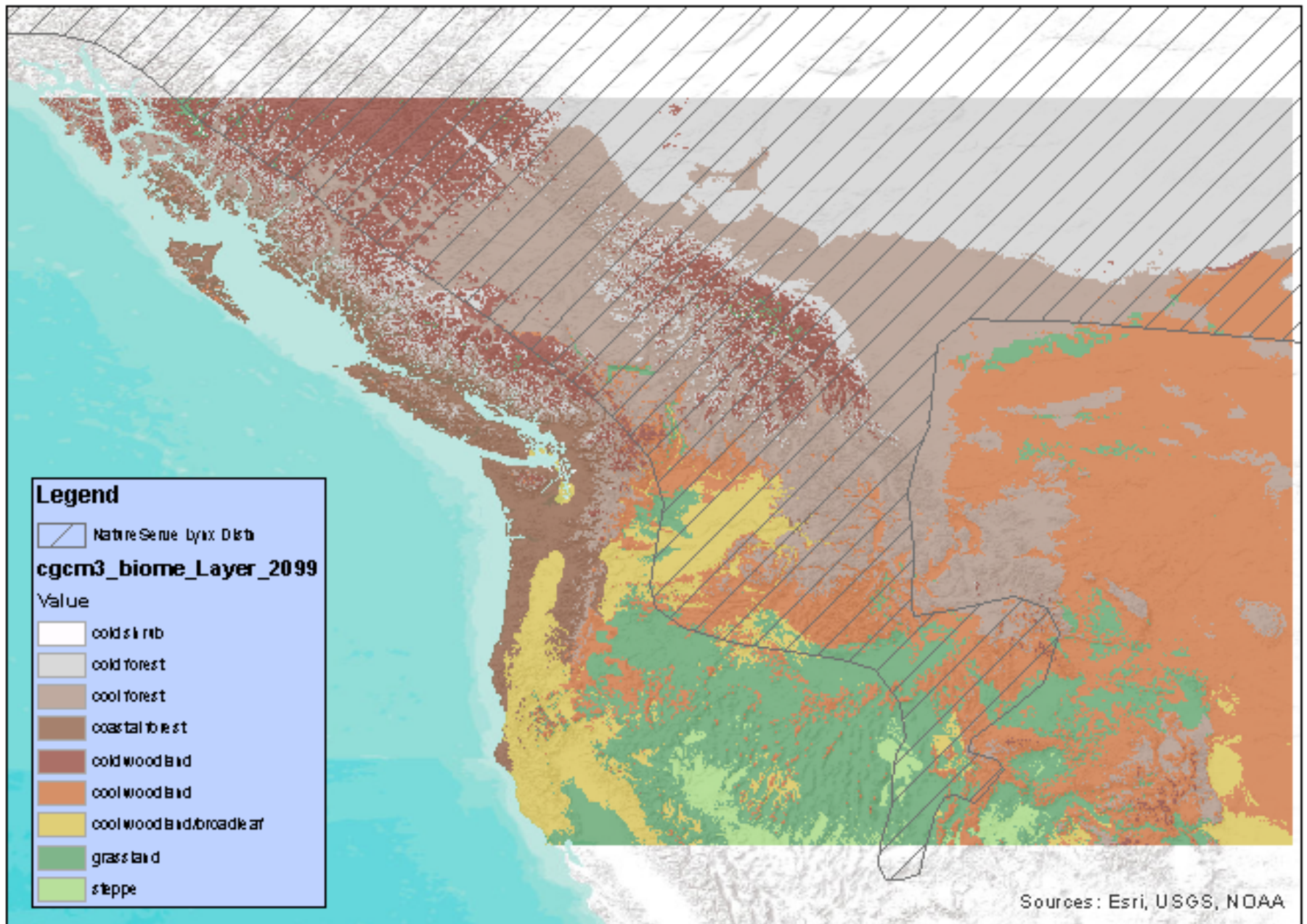

MIROC ESM
(High Change)

Legend
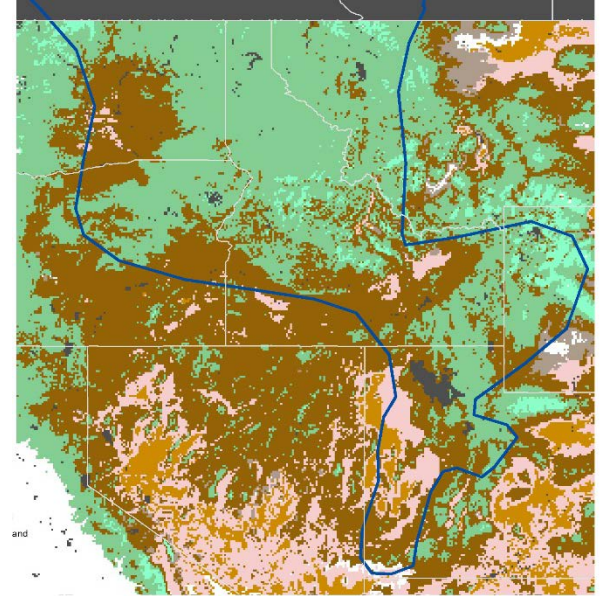
- Cool Needleleaf Forest
- Other
- Subalpine Forest
- Temperate Evergreen Needleleaf Forest
- Temperate Deciduous Broadleaf Forest
- Temperate Cool Mixed Forest
- Temperate Evergreen Needleleaf Woodland
- Temperate Shrubland
- Temperate Grassland
- Subtropical Shrubland
- Subtropical Grassland

LPJ, 2080s, A2 (CMIP3 data)

Legend

/// NatureServe lynx Distr

cgcm3_biome_Layer_2099

Value

□	cold shrub
□	cold forest
□	cool forest
■	coastal forest
■	cold woodland
■	cool woodland
■	cool woodland/broadleaf
■	grassland
■	steppe

Sources: Esri, USGS, NOAA

Climatic Niche Projections
A2 Emissions Scenario
Time Period: 2080s
GCMs: CGCM3.1 and HadCM2

State Boundaries

Lynx Range

Value

No Presence
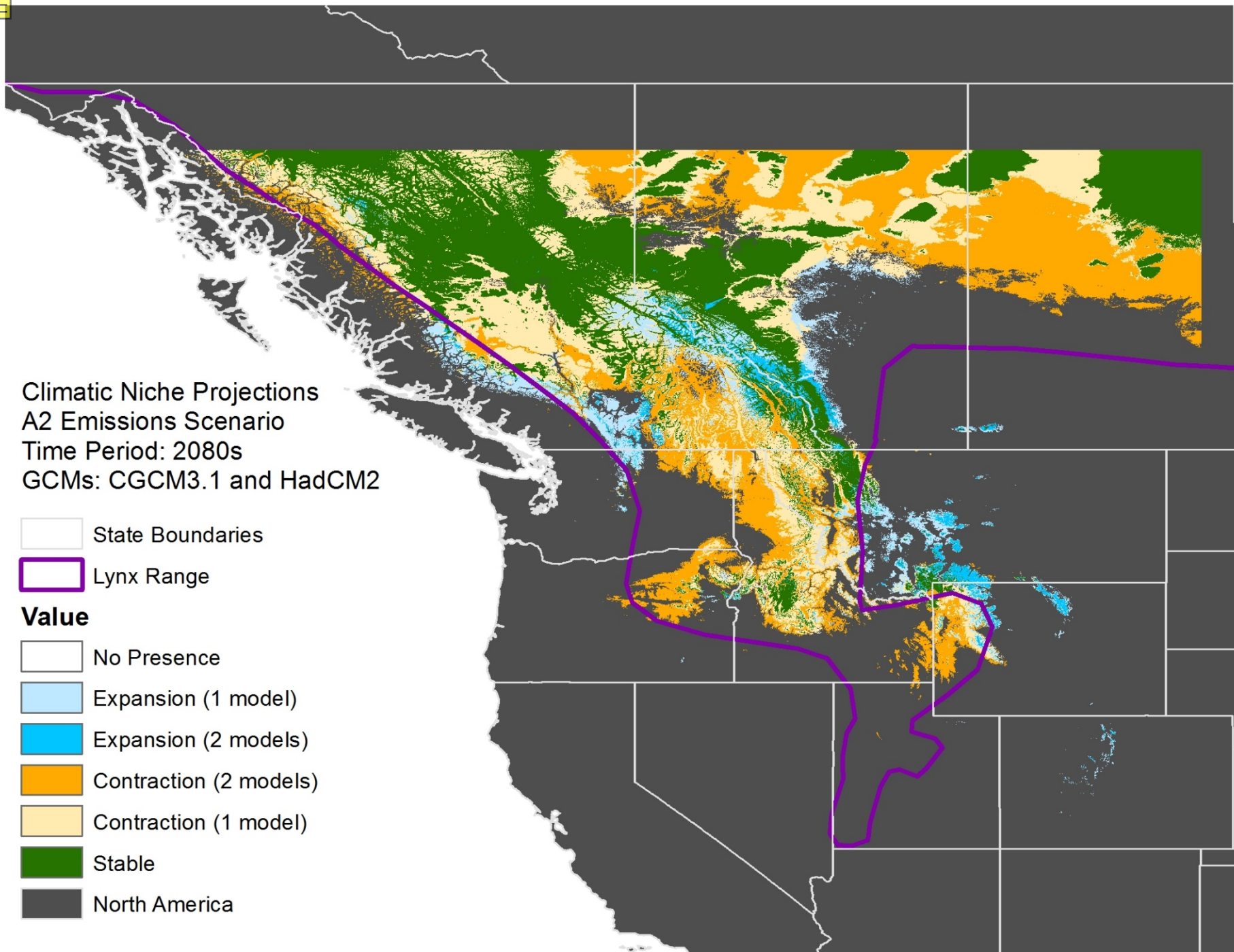
Expansion (1 model)

Expansion (2 models)

Contraction (2 models)

Contraction (1 model)

Stable

North America

Canada lynx

- Long-distance dispersal
- Mid and high elevation forests
- Avoid humans
- Snowshoe hare specialists

A mechanistic approach

- Statistically downscaled GCM output

Applying anomalies to observed climate (DELTA method)
30 arc second, ~1km grid
5 GCMs, CMIP 3
A2 emission scenario
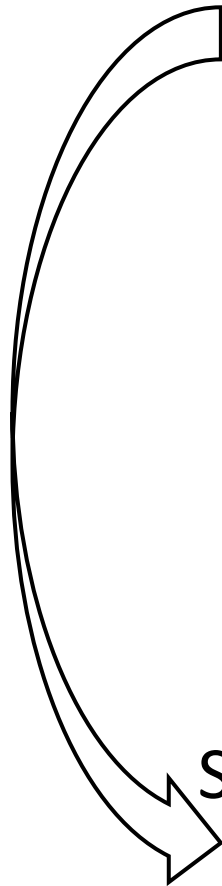
Dynamic vegetation simulations

LPJ DGVM (Sitch 2003)
8 plant function types
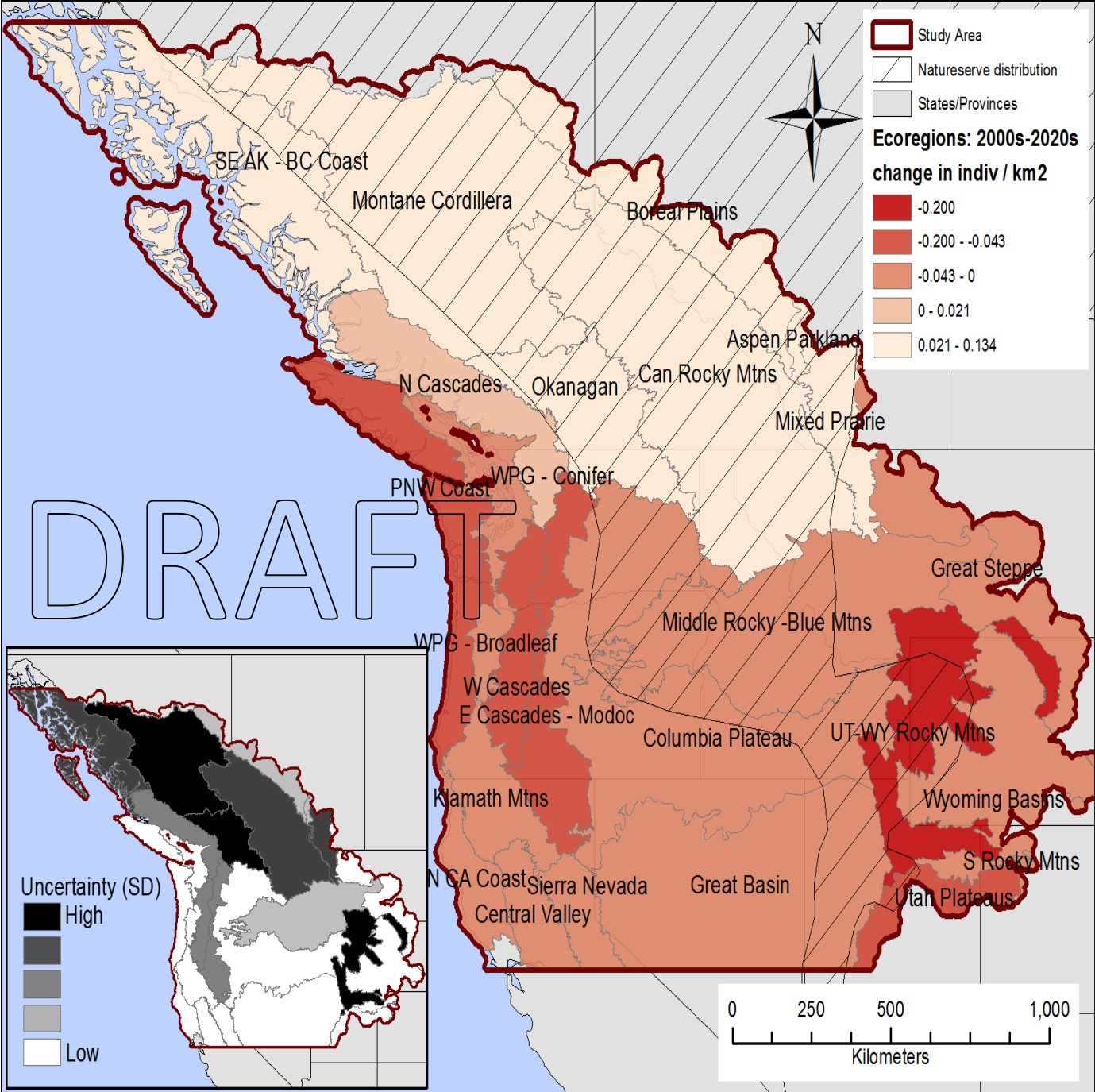Processes...
   CO_2 fertilization, fire, competition

Spatially explicit population modeling

HexSim modeling framework
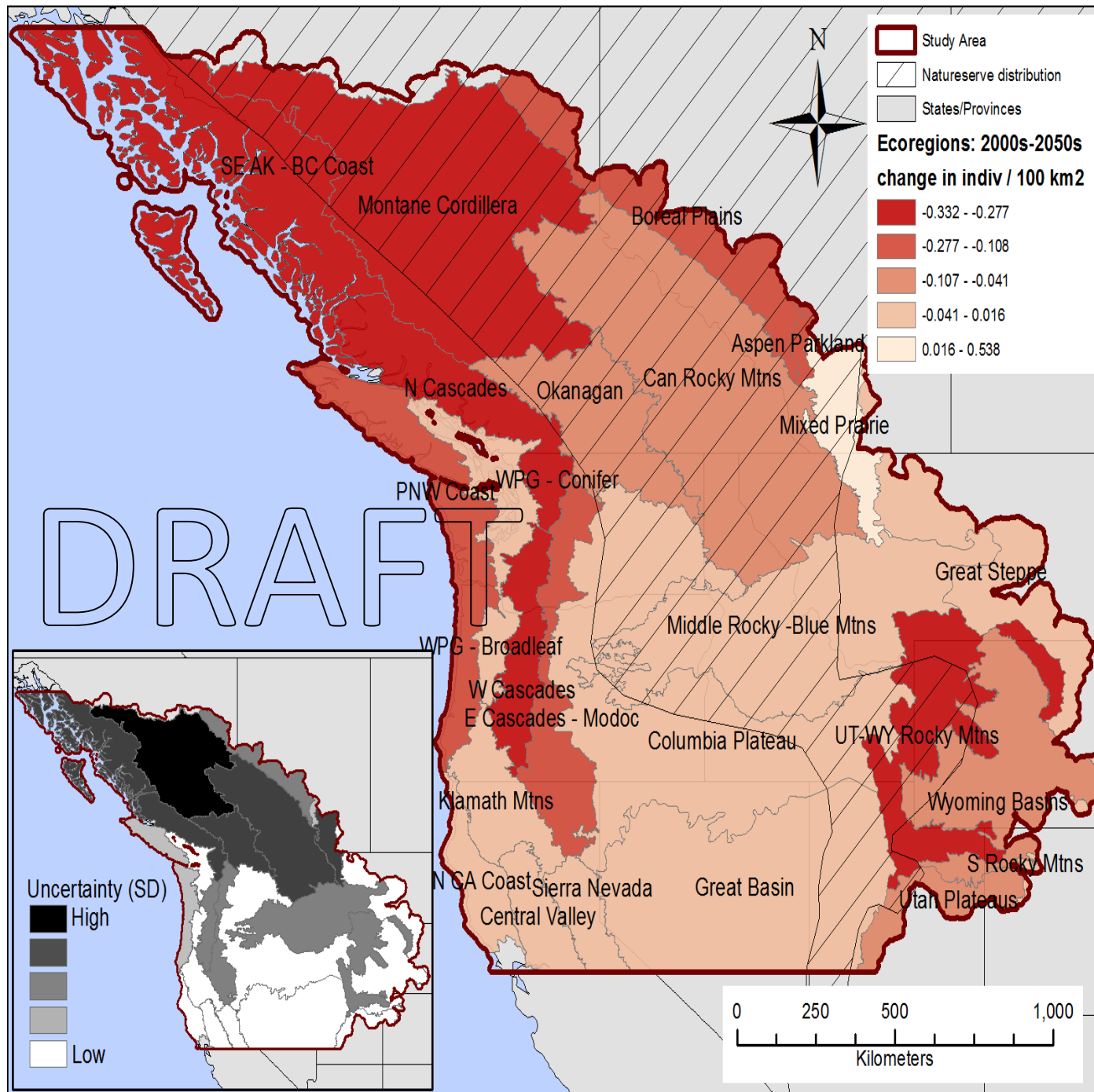Individual-based model
Processes...
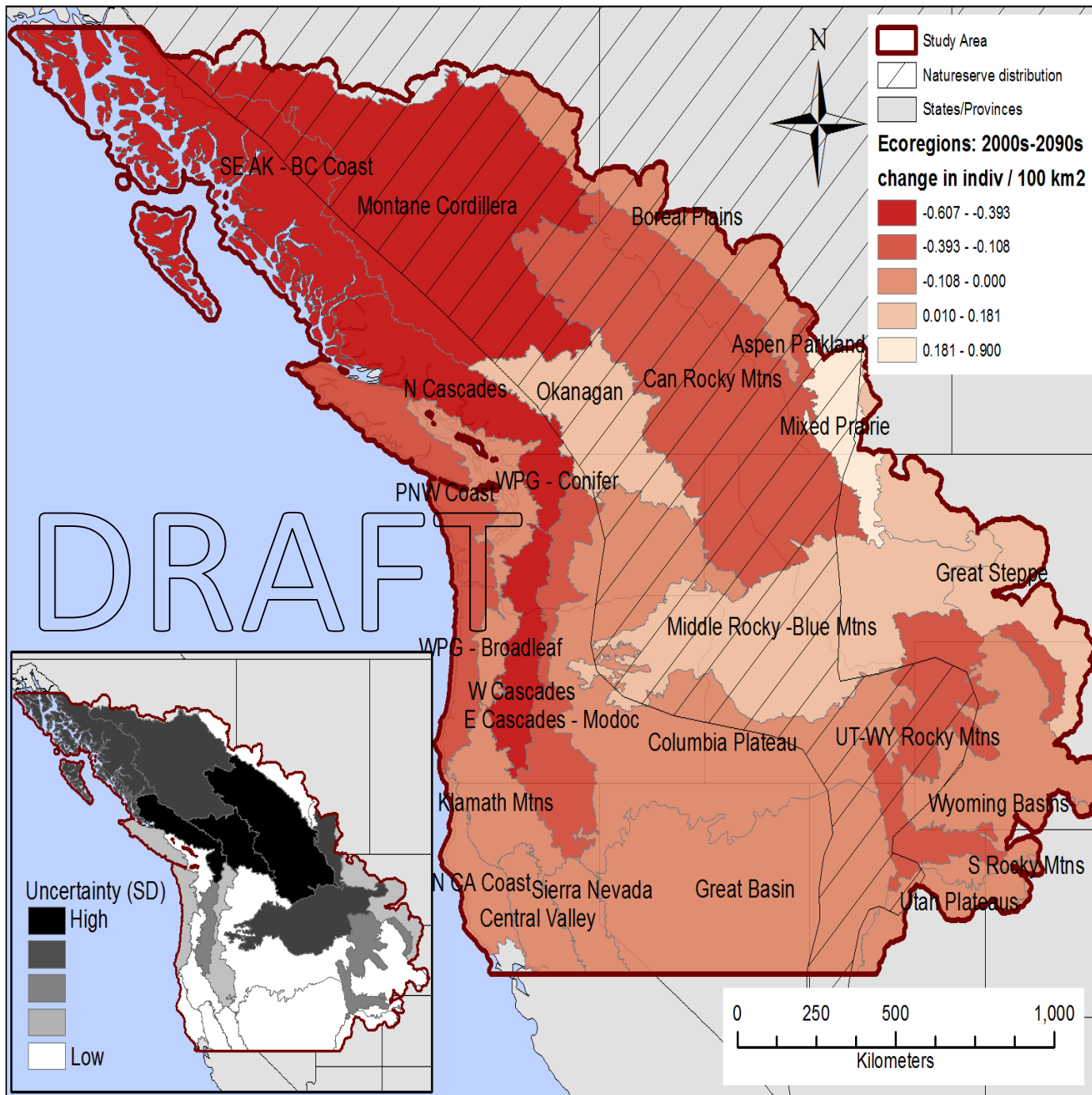   Survival, reproduction, dispersal

Simulated change in density 2020s

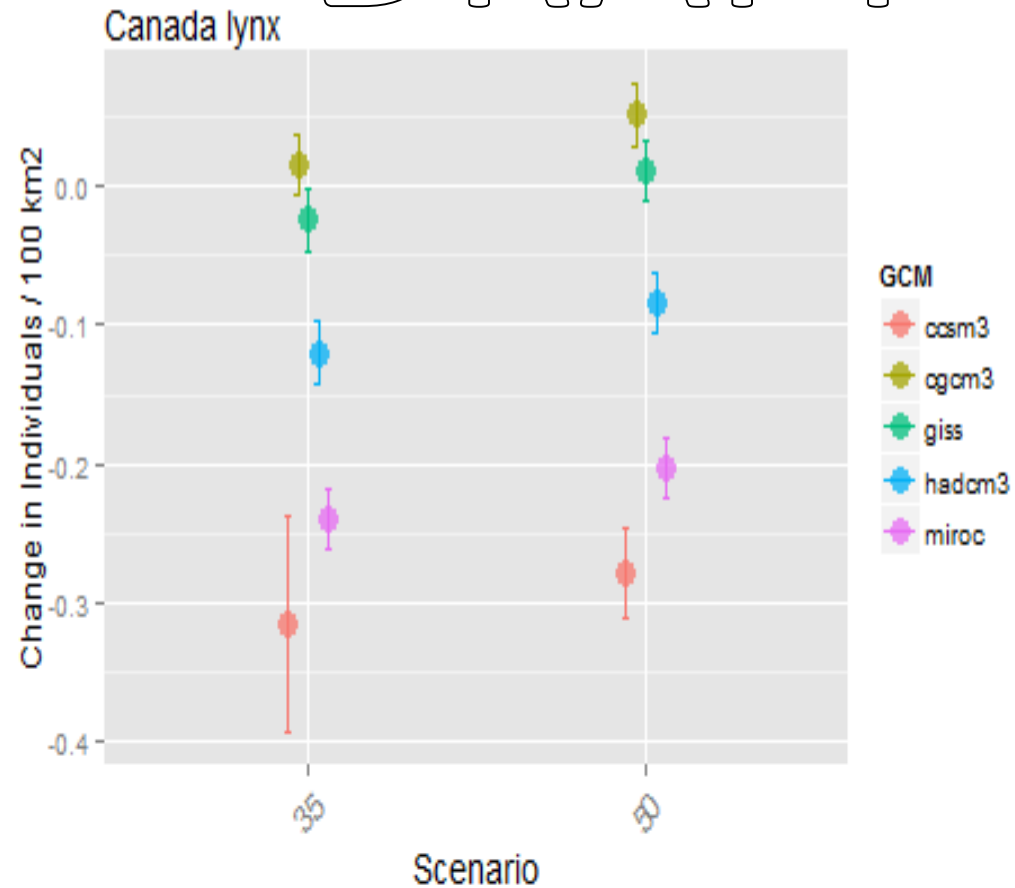Simulated change in density 2050s

Simulated change in density 2090s

Effect of population cycling

- Simulated declines differed more due to GCM model used than due to population cycling

- Differences among GCMs generated more variability in predictions

DRAFT

Conclusions

- On average simulated moderate declines in Canada lynx
  - Growing populations: Fescue-Mixed Grass Prairie, Middle Rocky-Blue Mountains, and Great Steppe
  - Declines occurred in: West Cascades, PNW Coast, N Cascades, East Cascades – Modoc, and Aspen Parkland
- Results robust to assumptions of population cycling