Vulnerability assessments for managing wildlife in a changing climate

Joshua J. Lawler, University of Washington

SCANNING THE CONSERVATION HORIZON

A Guide to Climate Change Vulnerability Assessment

NATIONAL WILDLIFE FEDERATION

Edited by
Patty Glick and Bruce A. Stein

What is vulnerability to climate change?



Why assess vulnerability?

Priority setting

Developing adaptation strategies

Fostering collaboration

Vulnerability = sensitivity + exposure - adaptability

Vulnerability =  +  - 

Climate Sensitivity Database

Physiological factors

Climate Sensitivity Database

Sensitive habitats

Climate Sensitivity Database

Dispersal abilities

Climate Sensitivity Database

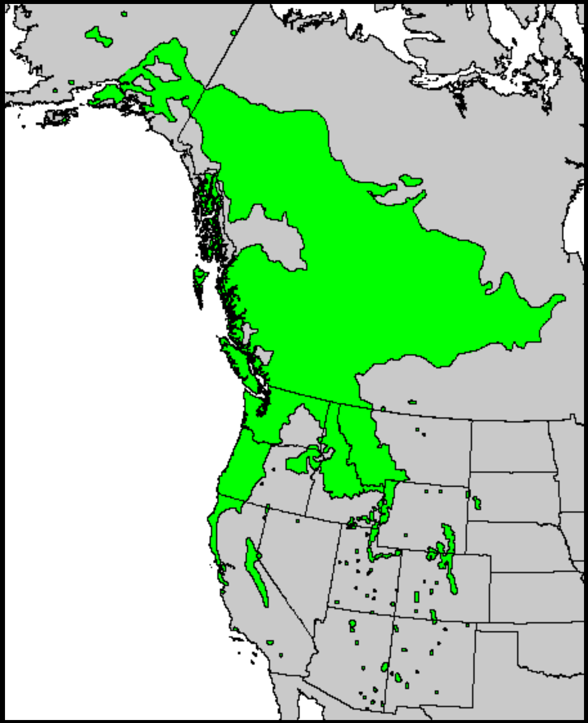
Population growth rates

Climate Sensitivity Database

Interspecific dependencies

Climate Sensitivity Database

Relative location

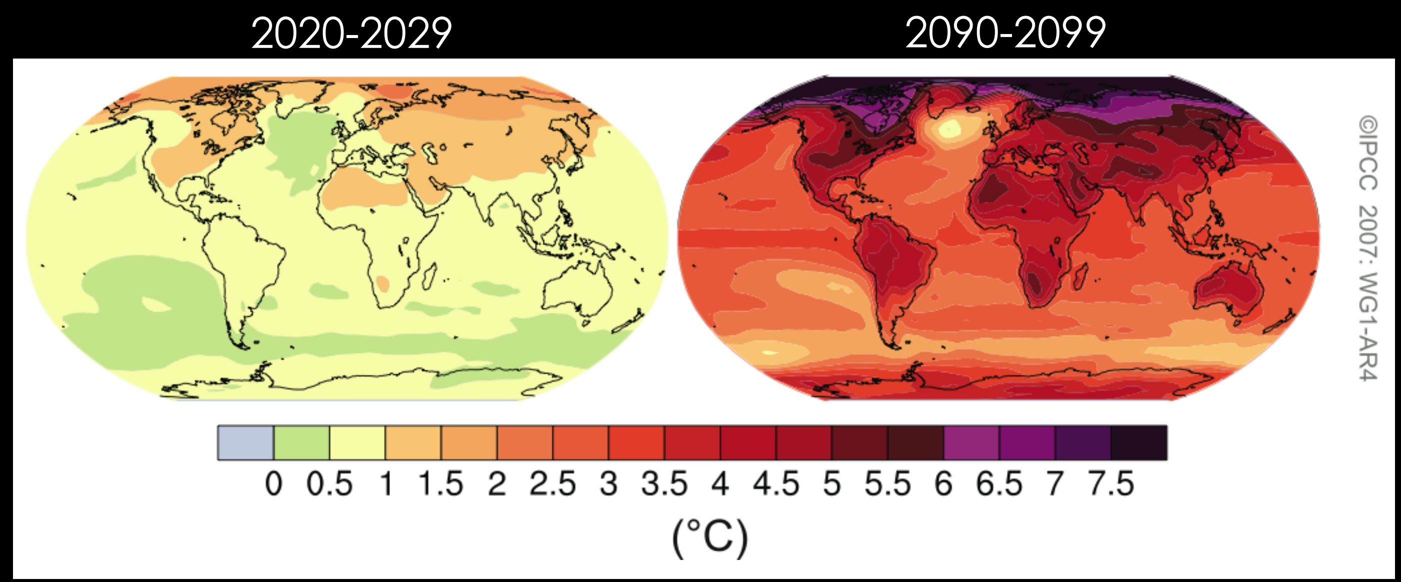


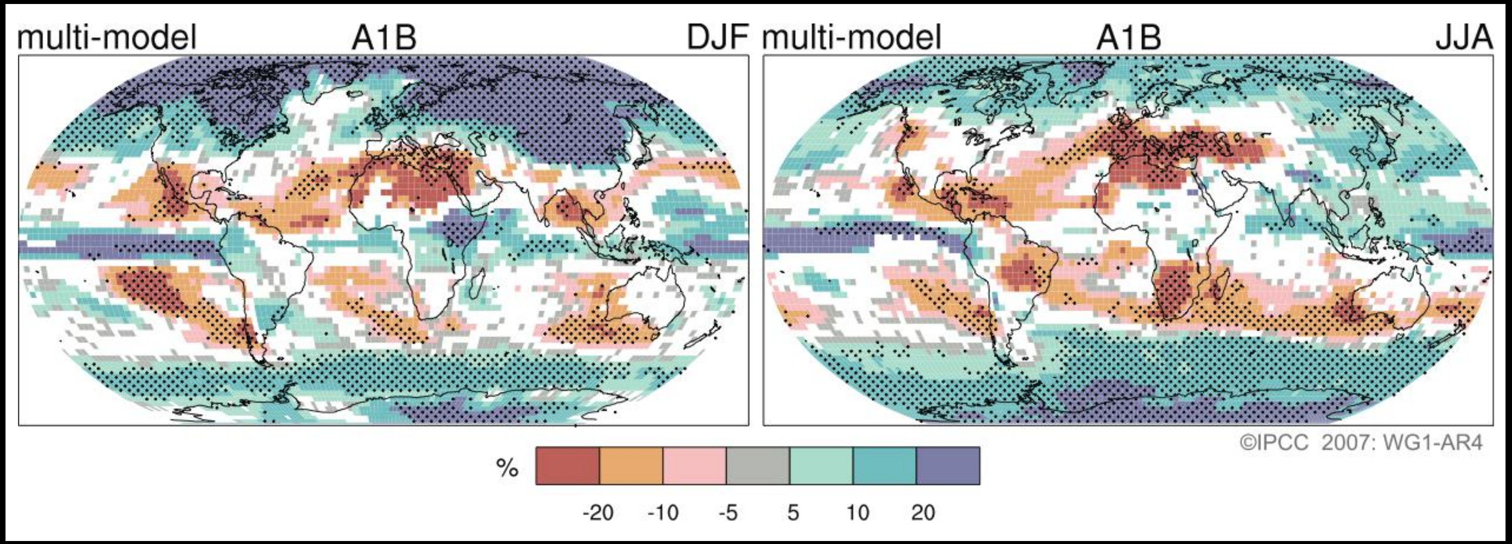
Salix scouleriana

Climate Sensitivity Database

Sensitive disturbance regimes

Exposure components





Other exposure components

Adaptive capacity

"the potential, capability, or ability of a system to adjust to climate change, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences" (IPCC 2007)

Adaptive capacity

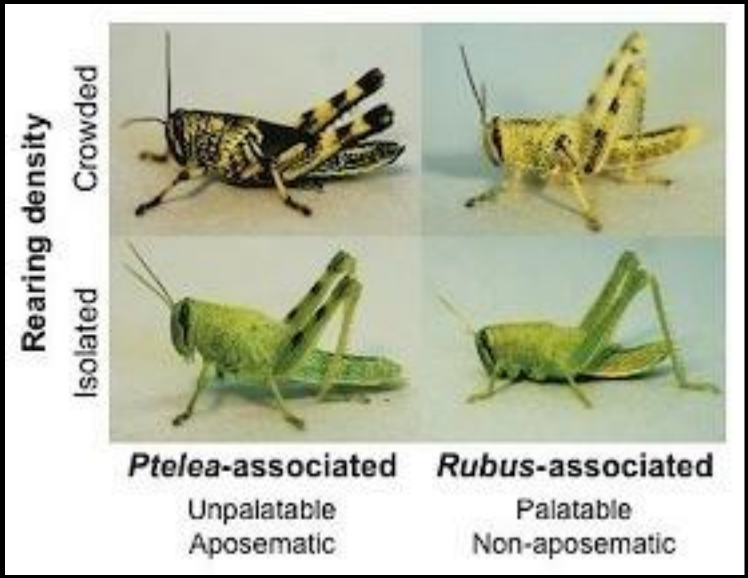
Population growth rates

Adaptive capacity

Genetic variability

Adaptive capacity

Phenotypic plasticity



Adaptive capacity

Behavioral plasticity

Adaptive capacity

Dispersal abilities

Adaptive capacity

Landscape permeability

Questions

Vulnerability assessments

Pacific Northwest U.S.

University of Washington, TNC, WDFW, ODFW, IDFW, NPS

United States

Linda Joyce, Curtis Flather, and Marni Koopman
USFS and National Center for Conservation Science and Policy

Massachusetts

Hector Galbraith, Manomet Center for Conservation Sciences

Southwestern U.S.

Carolyn Enquist, The Nature Conservancy

Multi-region

Bruce Young, NatureServe

Climate Change Vulnerability Assessment for the Pacific Northwest

University of Washington, TNC, WDFW, ODFW, IDFW, NPS, NWF

Study Objectives

Assess inherent sensitivity to climate-change of species and systems

Project potential impacts

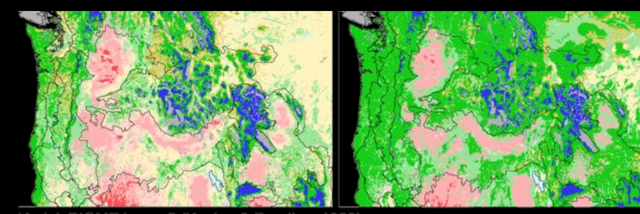
Facilitate adaptation-strategy development and modification of SWAPs

Study Area

Methods

- Build a database of climate change sensitivities

- Downscale and summarize climate projections



- Project vegetation and animal responses

- Assess impacts on protected areas

- Modify SWAPS
  (WA, OR, and ID FWDs)

Part I:

Climate Sensitivity Database

Climate Change Sensitivity Database

Home | Browse Species | Browse Systems | Reports | Your Profile

Home Page

Welcome!

Welcome to the Sensitivity Database.

Climate changes poses a daunting challenge to natural resource managers and in response the University of Washington has partnered with key collaborators to conduct a climate change sensitivity assessment. This assessment is designed to evaluate the sensitivity of the species and ecological systems of the Pacific Northwest to climate change.

This digital database summarizes the inherent climate-change sensitivities for species and habitats of concern throughout the Pacific Northwest and will provide resource managers and decision makers with some of the most basic and most important information about how species and systems will likely respond to climate change.

Please come take a look!

Recent Science Updates

- Climate change will substantially decrease the duration and thickness of wintertime ice cover on many North American lakes.
  Seasonal or year-round ice cover is crucial for the health of lakes located in cold environs, but looks set

Recent Updates

Ursus americanus
Updated: *1 week 1 day* ago
Vulpes macrotis
Updated: *1 week 1 day* ago
Ursus arctos
Updated: *1 week 1 day* ago
Ursus americanus - Olympics
Updated: *1 week 1 day* ago
Thomomys mazama yelmensis
Updated: *1 week 1 day* ago
Taxidea taxus
Updated: *1 week 1 day* ago
Thomomys mazama - Olympics
Updated: *1 week 1 day* ago
Spermophilus washingtoni
Updated: *1 week 1 day* ago
Spermophilus brunneus brunneus
Updated: *1 week 1 day* ago
Spermophilus brunneus brunneus
Updated: *1 week 1 day* ago

1 of 70 ››

Browse all species

User login

Username: *

Password: *

Log in

Log in using OpenID

- Create new account
- Request new password

http://courses.washington.edu/ccdb/drupal/

Climate Sensitivity Database

▸ **Taxonomy**

▸ **Dispersal Ability**

▾ **Disturbance Regimes**

How dependent is this species on one or more disturbance regimes:

- ☐ 1 not dependent on the nature of any disturbance regime
- ☐ 2 slightly dependent
- ☑ 3 somewhat dependent
- ☐ 4 moderately dependent
- ☐ 5 more dependent
- ☐ 6 definitely dependent
- ☐ 7 highly dependent on the nature of one or more disturbance regimes

Confidence in how dependent is this species on one or more disturbance regimes:

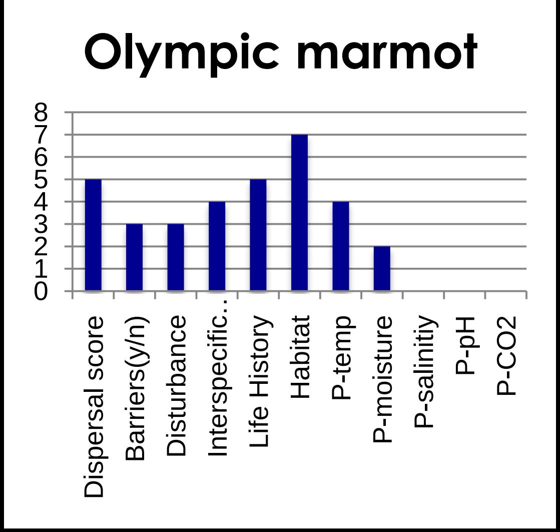
– None –

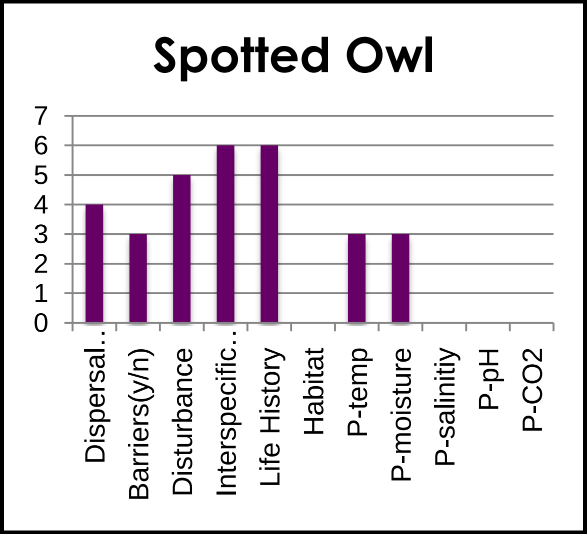
Please check all disturbance regimes upon which the species is dependent:

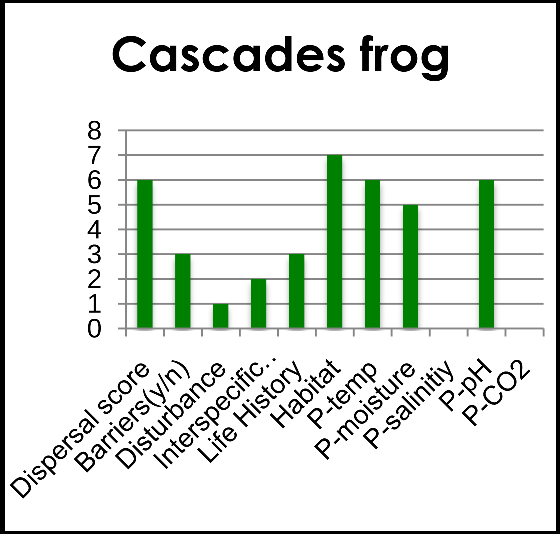
- ☐ Fire
- ☐ Flooding
- ☐ Wind
- ☐ Drought
- ☐ Other (please specify in comments section)

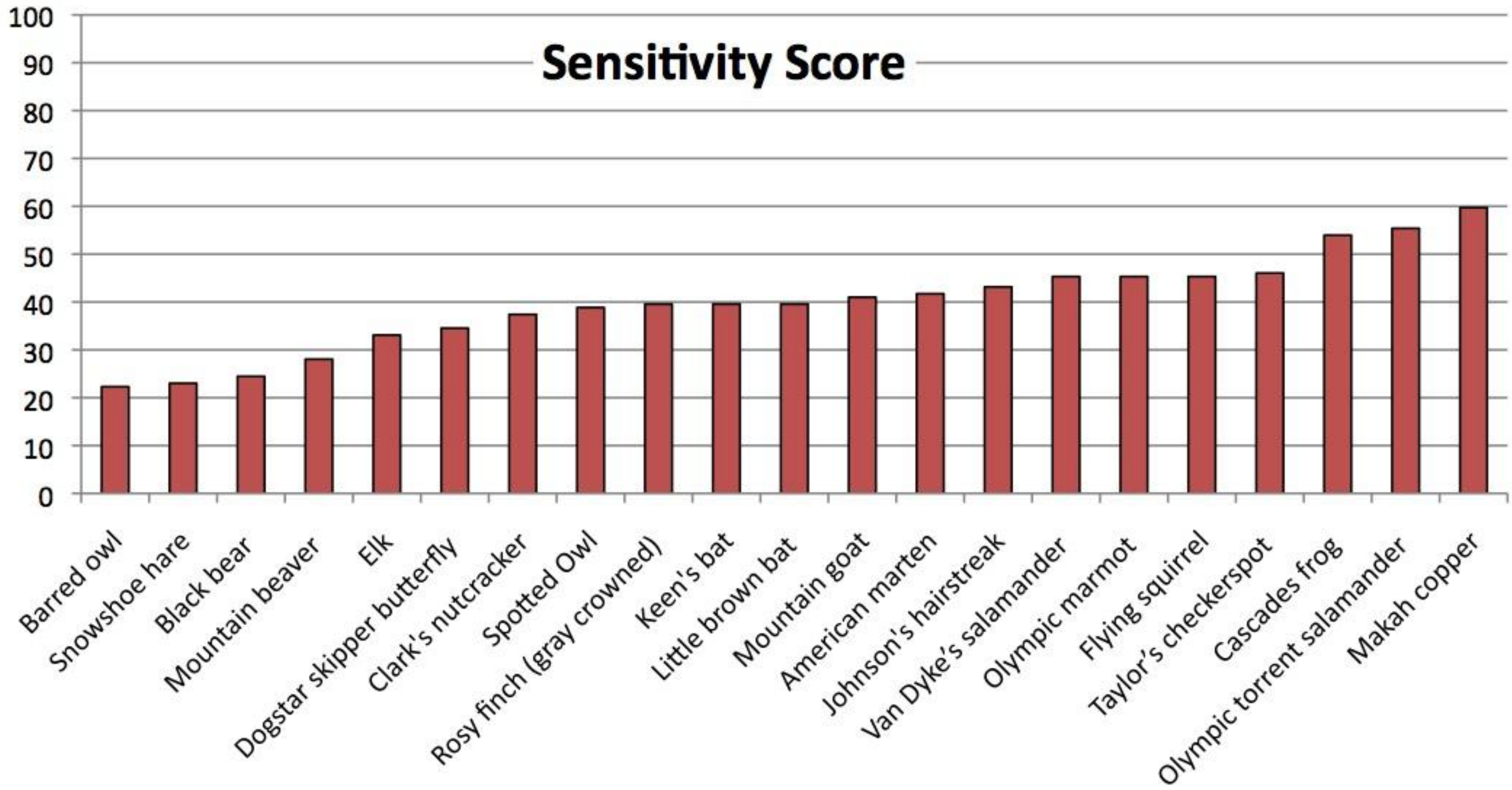
Please describe the disturbance regimes upon which the species is dependent (frequency, timing, severity, duration):

Sensitivity scores









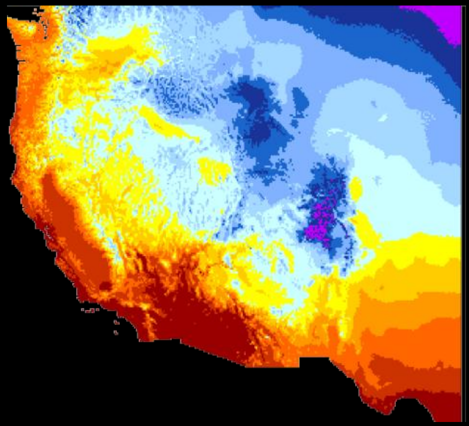
Sensitivity Score
100
90
80
70
60
50
40
30
20
10
0
Barred owl
Snowshoe hare
Black bear
Mountain beaver
Elk
Dogstar skipper butterfly
Clark's nutcracker
Spotted Owl
Rosy finch (gray crowned)
Keen's bat
Little brown bat
Mountain goat
American marten
Johnson's hairstreak
Van Dyke's salamander
Olympic marmot
Flying squirrel
Taylor's checkerspot
Cascades frog
Olympic torrent salamander
Makah copper

Part II:

Future Climate Projections

Exposure and impacts

Downscaled climate and bioclimate projections



Simulated changes in vegetation

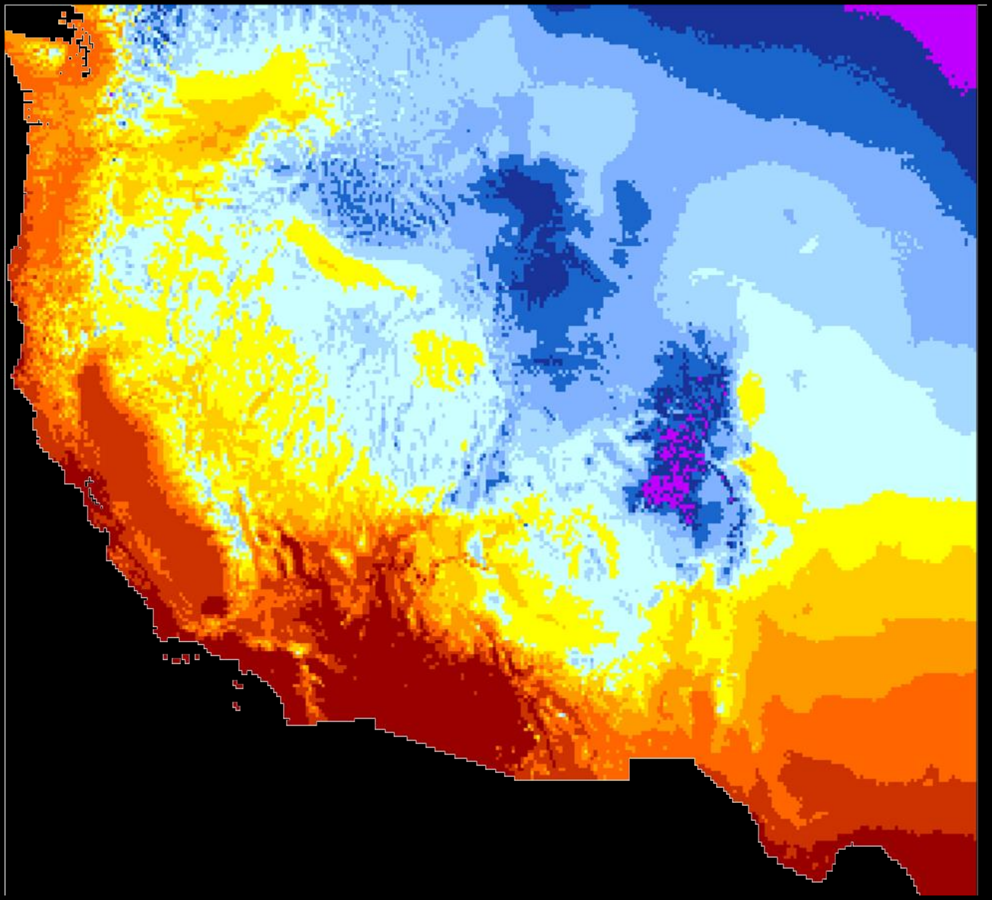
Projected shifts in focal species distributions

Climate Data

General circulation model (GCM) simulations

At least 6 GCMs

2 emissions scenarios
(A2, A1B)

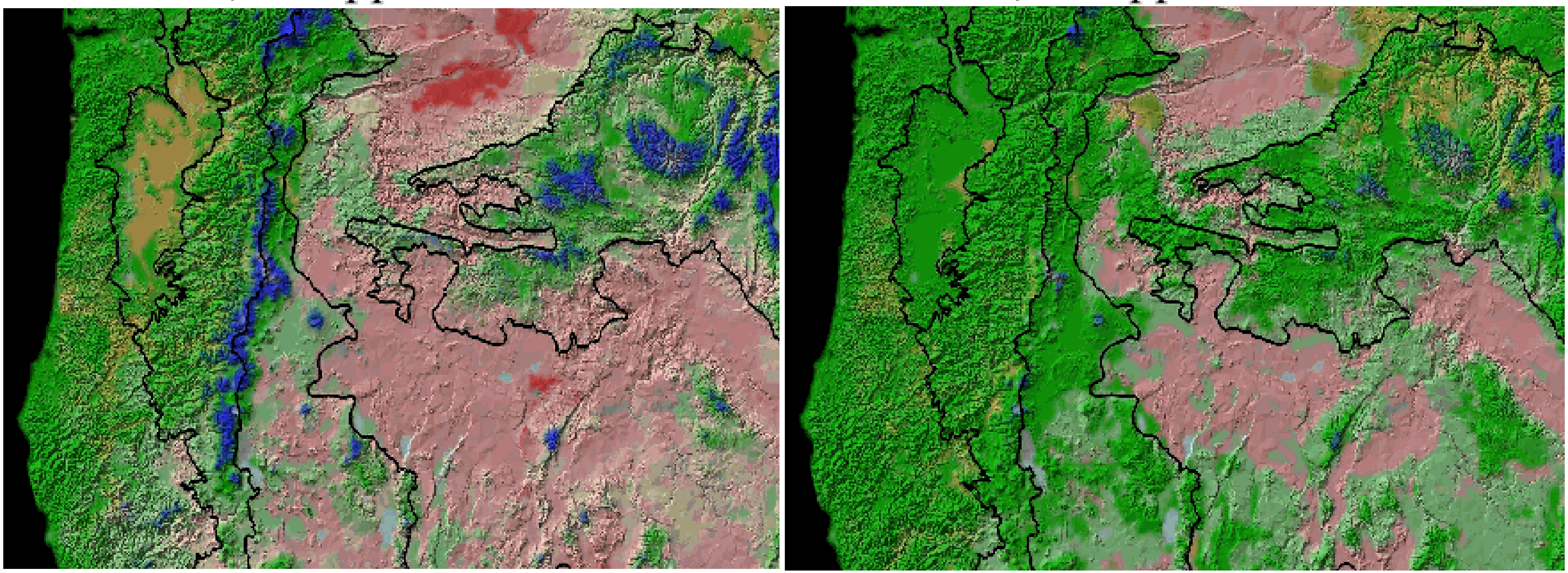


Part III:

Future Vegetation Projections

Simulated Biomes

1951-1980, 340 ppm CO_2 | 2050-2059, 554 ppm CO_2



Environmental Change Research Group, Dept. of Geography, Univ. of Oregon. Model: BIOME4, ver. 2 (J. O. Kaplan and I. C. Prentice)

- Subalpine forest and tundra
- Closed forest
- Open forest/woodland
- Prairie woodland
- Grassland
- Steppe
- Shrubland
- Desert/semi-desert shrubland
- Water
- Areas with no soil data

USGS

Environmental Change Research Group, Dept. of Geography, Univ. of Oregon. Climate data: CRU C 1.0 (New et al. 1999); CRU data interpolation: P. J. Bartlein (Univ. of Oregon); HadCM2 (Mitchell and Johns 1997). Soil data: CONUS-SOIL (Miller and White 1998); Vegetation model: BIOME4 (Kaplan 2001) modified by S. Shafer (USGS).

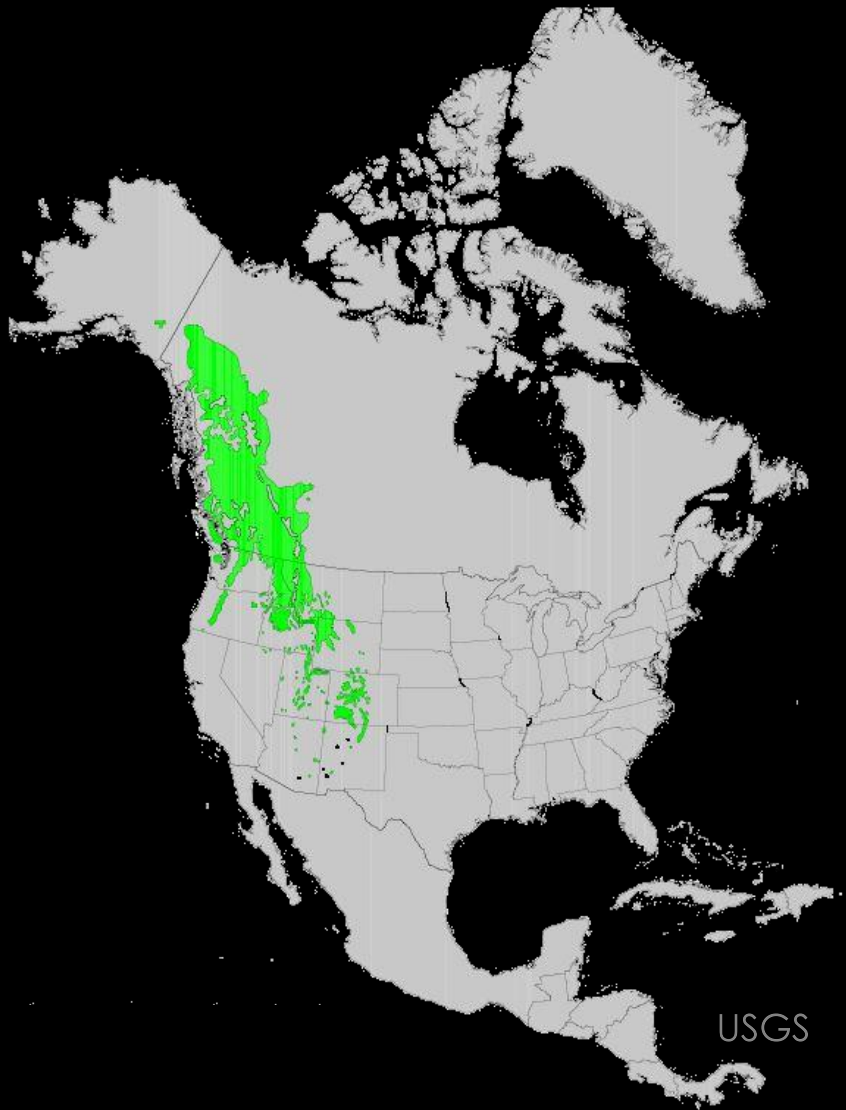
Part IV:

Animal Range Shift Projections

Modeling potential range shifts

Current ranges -- modeled as functions of current climate & vegetation

Future ranges – modeled using projected future climate & vegetation

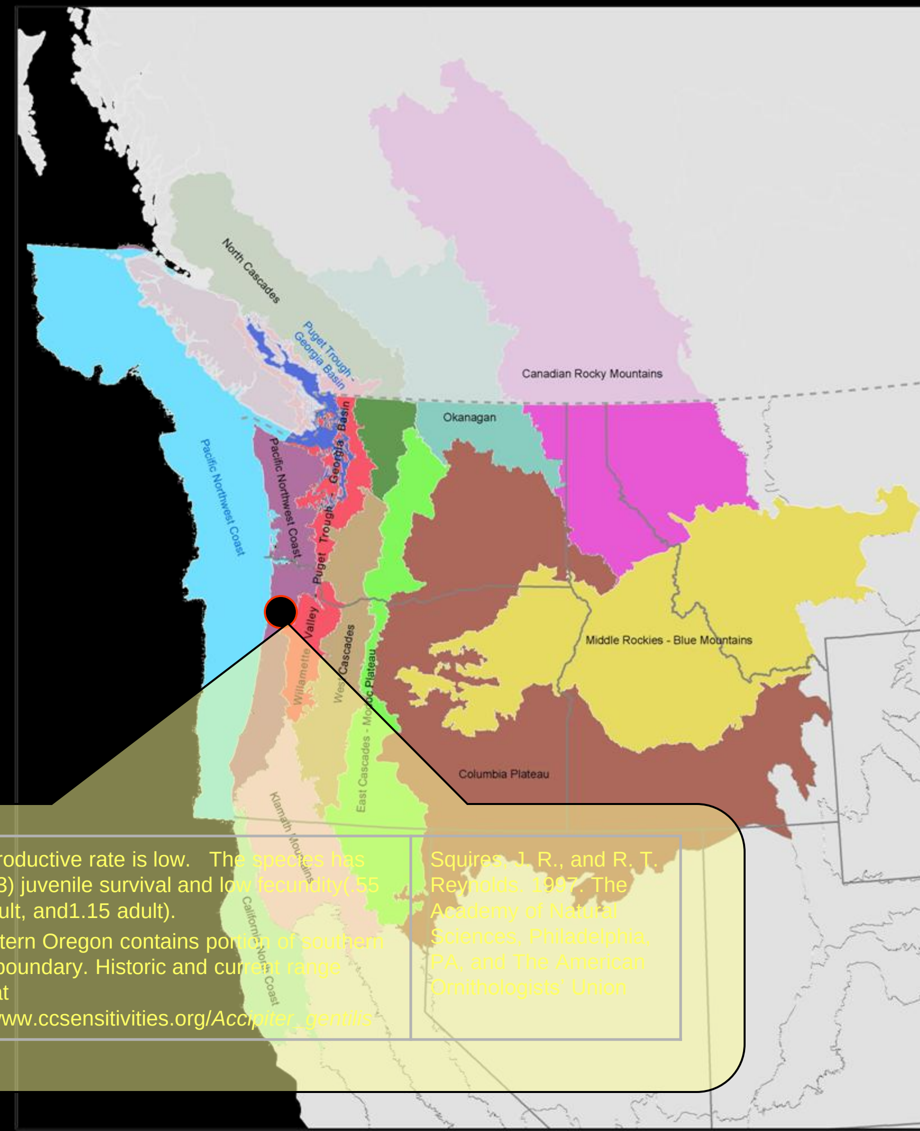


Douglas Squirrel (HADCM3 A1B)

stable
expansion
contraction

Products will include

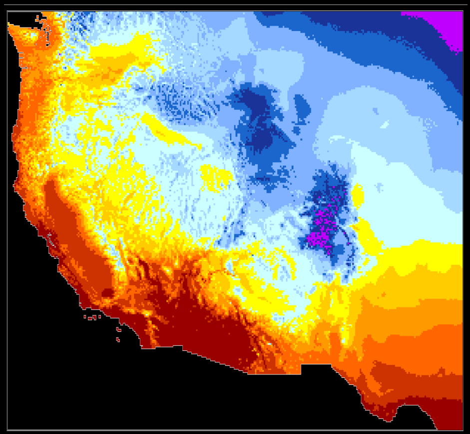
- Searchable, spatially referenced climate change sensitivity database

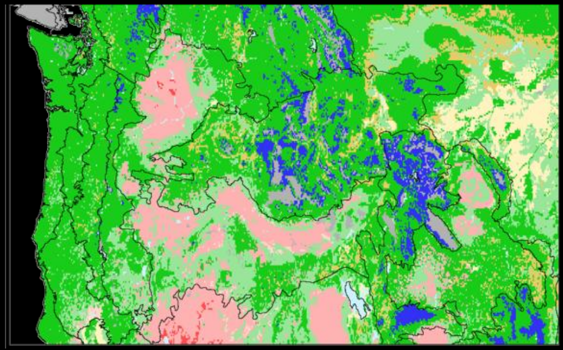


Northern Goshawk *Accipiter gentilis*				1		2		1. Reproductive rate is low. The species has low (.33) juvenile survival and low fecundity(.55 sub-adult, and1.15 adult). 2. Western Oregon contains portion of southern range boundary. Historic and current range maps at http://www.ccsensitivities.org/*Accipiter_gentilis*	Squires, J. R., and R. T. Reynolds. 1997. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union

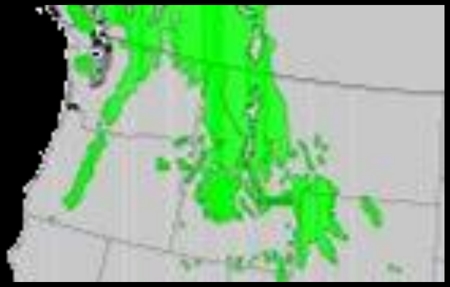
Products will include

- Projected change maps
  - Climate
  - Vegetation
  - Birds and mammals





- Protected area analyses

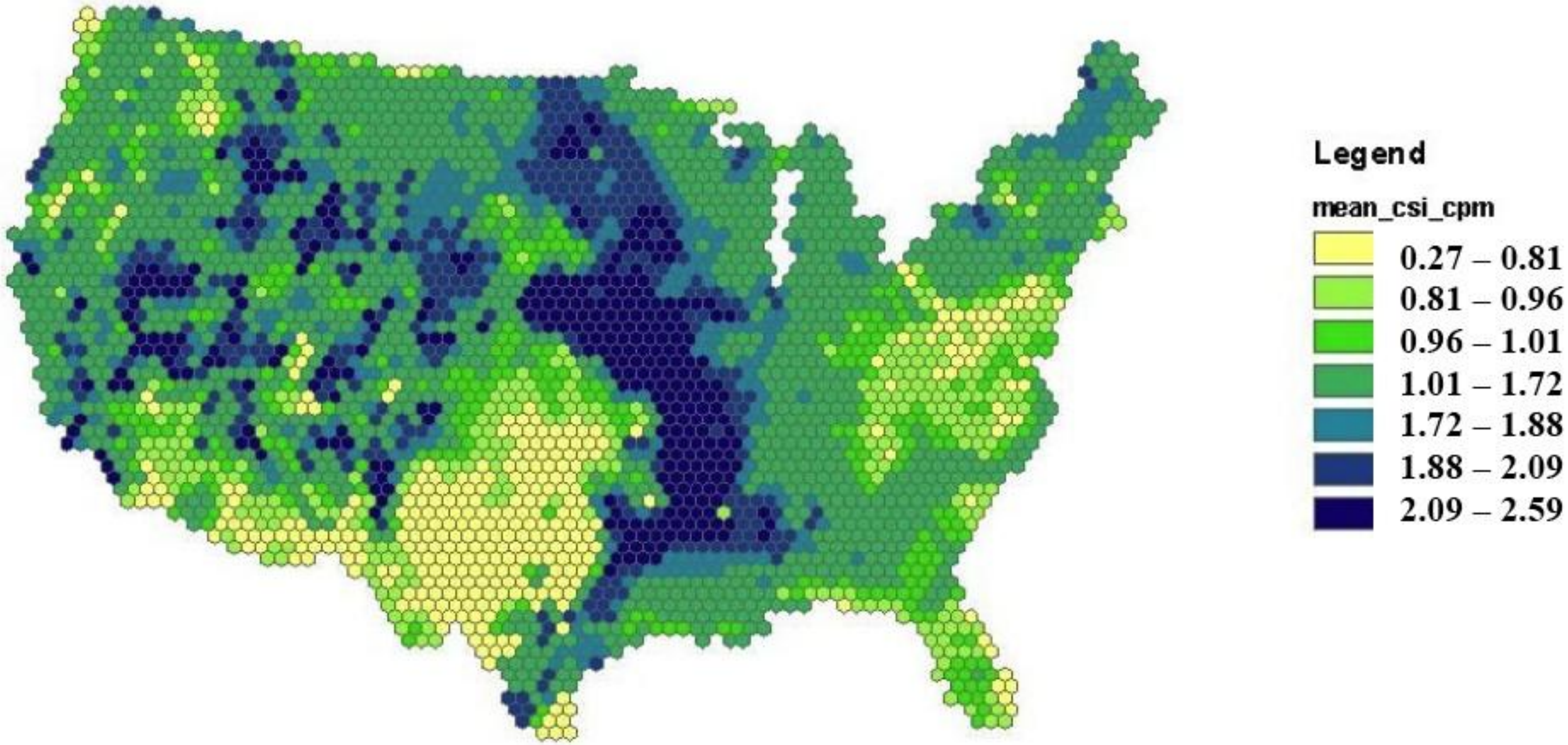


- Modified SWAPS

Questions

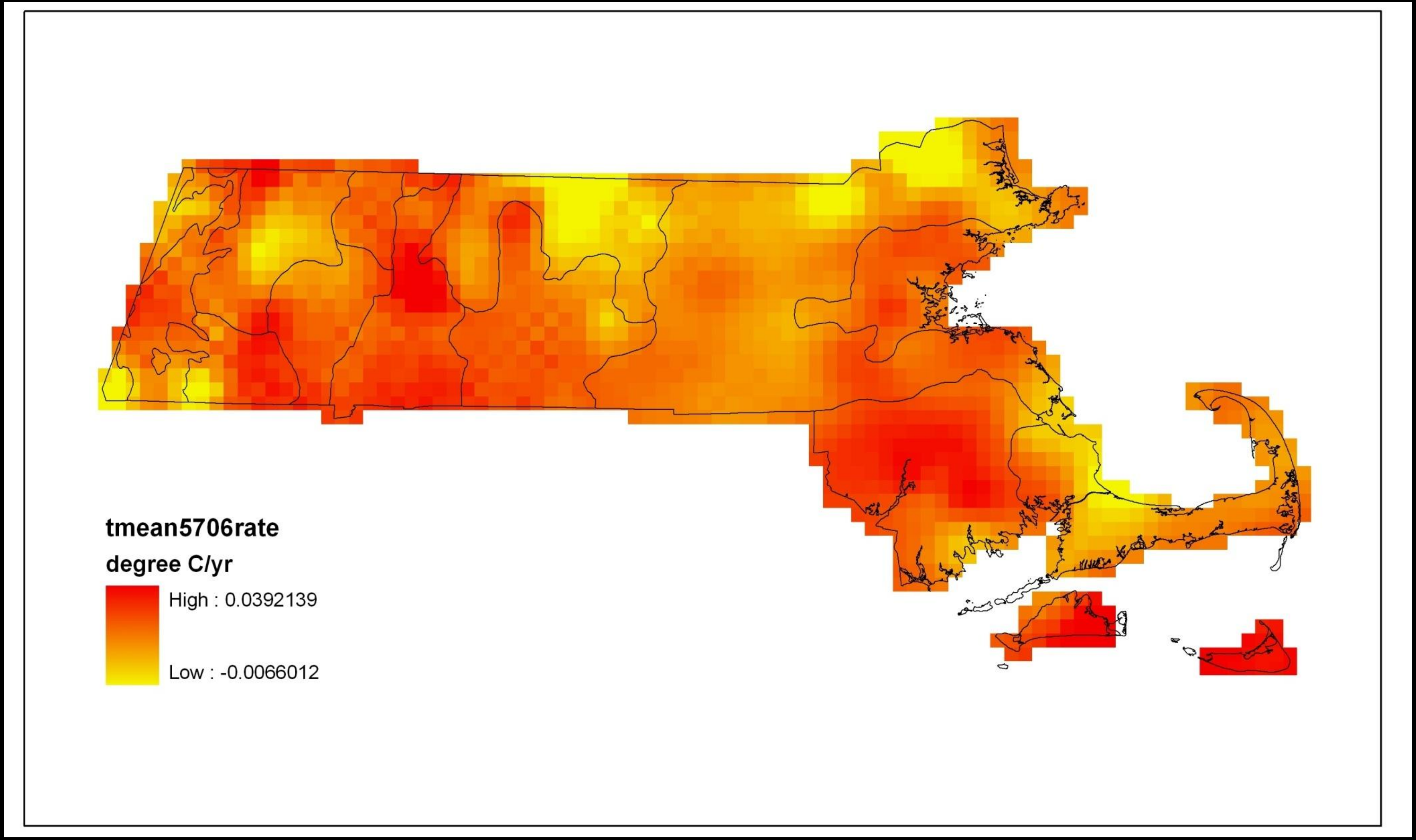
U.S. terrestrial climate stress index

Linda Joyce, Curtis Flather, and Marni Koopman



Massachusetts vulnerability assessment

Hector Galbraith and John O'Leary



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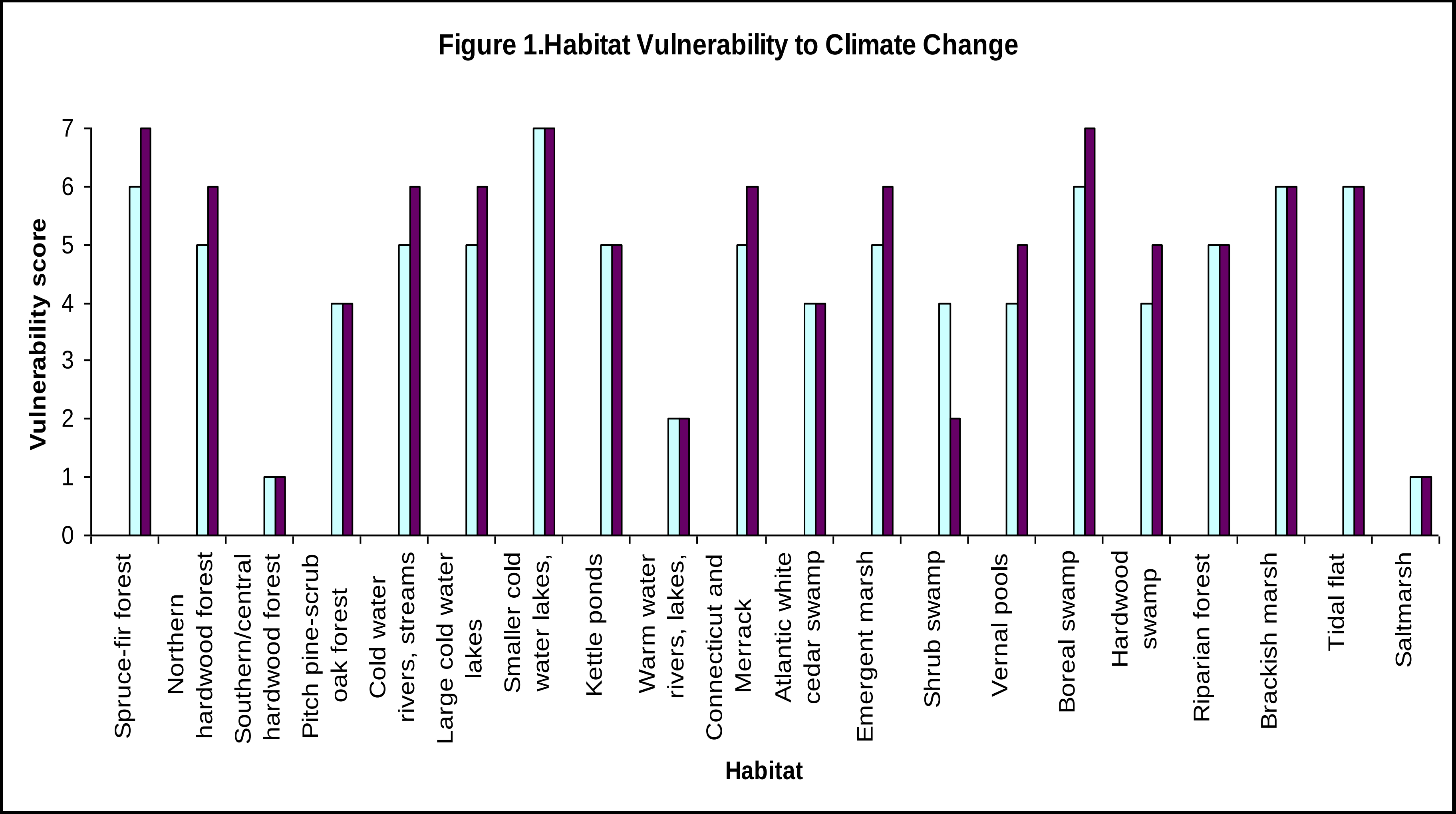


Note: the leftmost bar in each pair represents a doubling of CO_2, while the right bar is a tripling.

Southwestern U.S.

Carolyn Enquist

New Mexico

Study Finds Evidence of Significant Climate Change

By Darci Palmquist

A groundbreaking new study from The Nature Conservancy reveals that **95 percent of New Mexico has experienced significant temperature increases over the last three decades due to climate change**.

And the study warns that specific habitats — such as high-elevation forests and woodlands — are particularly vulnerable to this warming trend, which is being echoed across much of the western United States.

The study is the **first of its kind to assess actual change across an entire state at a very explicit scale** of 4 kilometers. According to the study's authors — Conservancy scientists **Carolyn Enquist and David Gori** — the findings will help resource managers as they develop climate-change adaption strategies.

Nature.org spoke with Enquist about the study and what it means for conservation in a world facing dramatic climate change.

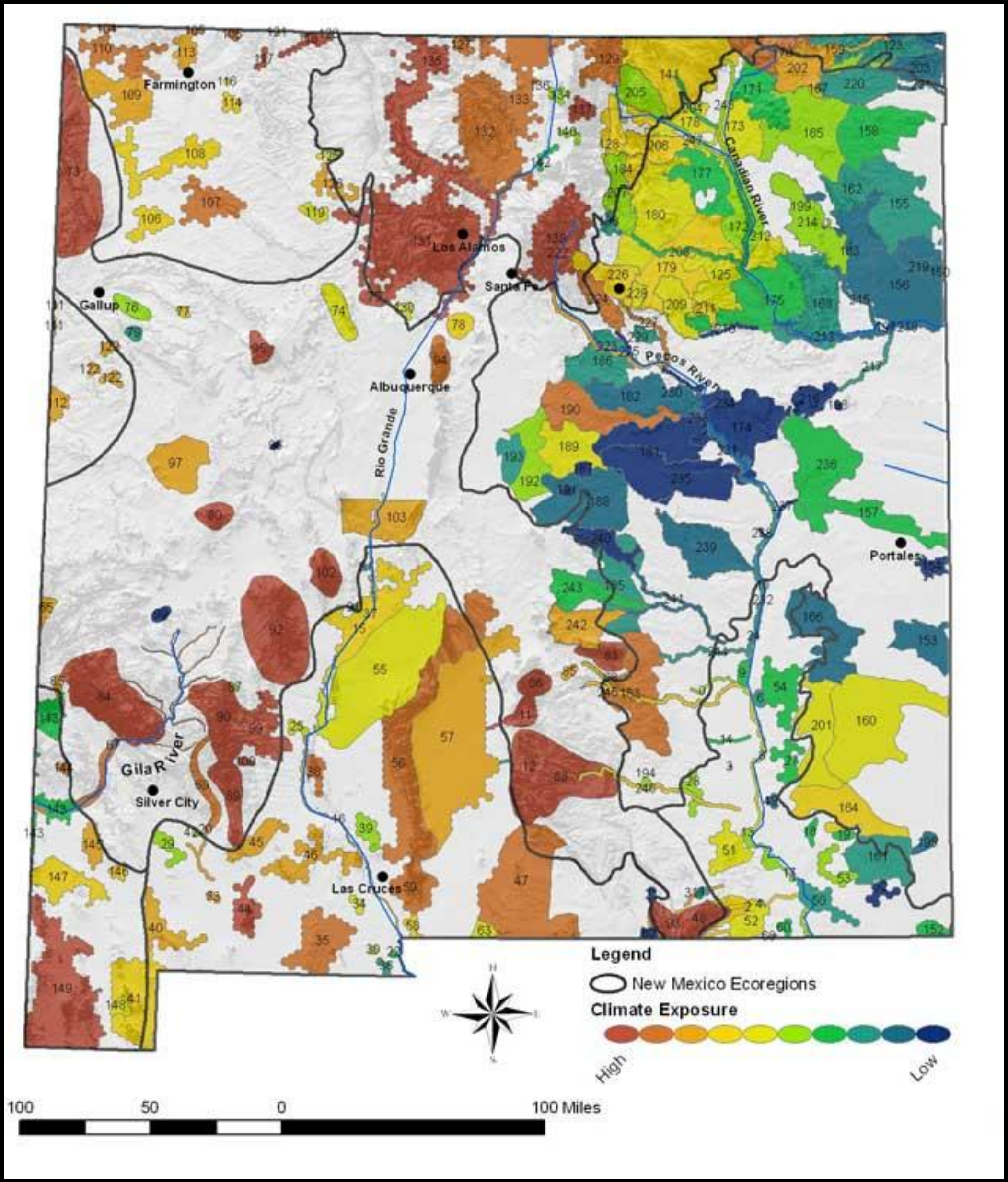
Nature.org: *A typical reaction to this study might be — OK, but this is just one state. What are the wider implications of*

Carolyn Enquist is The Nature Conservancy's first statewide ecologist focusing on climate change. She specializes in assessing the vulnerability of species and ecosystems to climate change, and planning for adaptation to future climate change. She holds a Ph.D. and M.S. in biology from the University of New Mexico.

Dave Gori, senior ecologist for the Conservancy in New Mexico, has contributed to the scientific expertise of The Nature Conservancy for 17 years. He holds a Ph.D. in ecology and evolutionary biology from the University of Arizona.

Southwestern U.S.

Carolyn Enquist

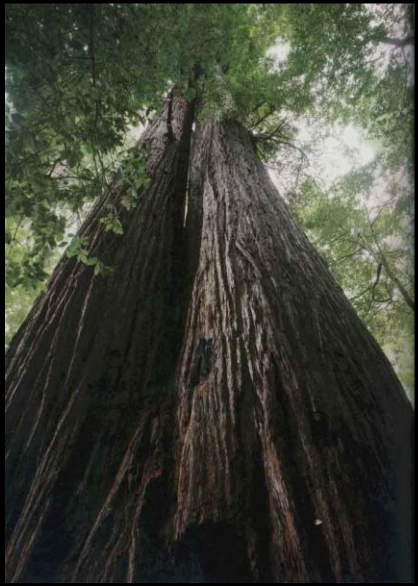


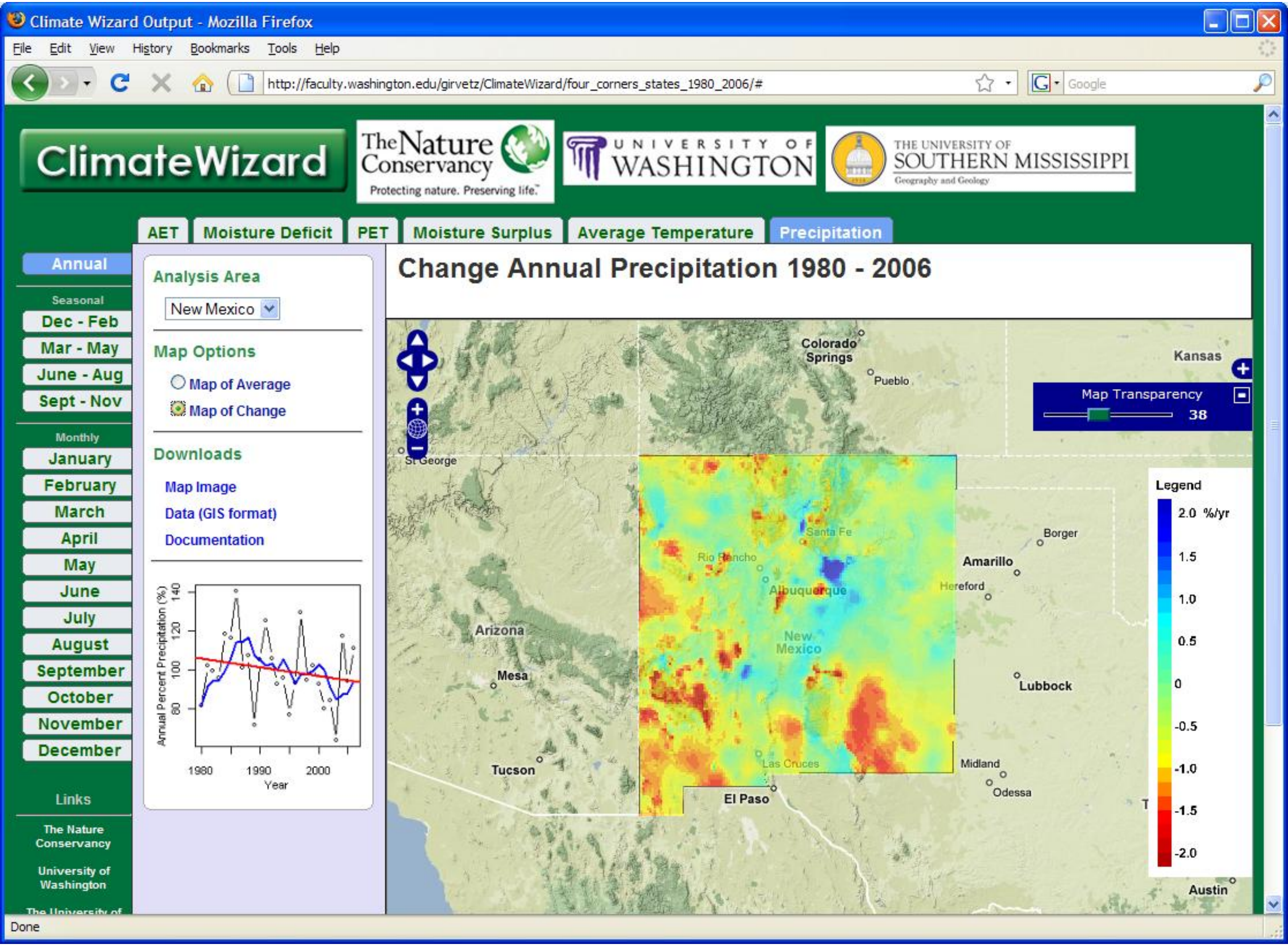
Climate susceptibility index

NatureServe

- Combines species sensitivity with projected temperature and precipitation change





Climate Wizard Output - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://faculty.washington.edu/girvetz/ClimateWizard/four_corners_states_1980_2006/#
Google
ClimateWizard
The Nature Conservancy
Protecting nature. Preserving life.
UNIVERSITY OF WASHINGTON
THE UNIVERSITY OF SOUTHERN MISSISSIPPI
Geography and Geology
AET
Moisture Deficit
PET
Moisture Surplus
Average Temperature
Precipitation
Annual
Seasonal
Dec - Feb
Mar - May
June - Aug
Sept - Nov
Monthly
January
February
March
April
May
June
July
August
September
October
November
December
Links
The Nature Conservancy
University of Washington
Analysis Area
New Mexico
Map Options
Map of Average
Map of Change
Downloads
Map Image
Data (GIS format)
Documentation
Annual Percent Precipitation (%)
80
100
120
140
1980
1990
2000
Year
Change Annual Precipitation 1980 - 2006
Colorado Springs
Pueblo
Kansas
Map Transparency
38
St George
Santa Fe
Rio Rancho
Albuquerque
Borger
Amarillo
Hereford
Arizona
New Mexico
Mesa
Lubbock
Tucson
Las Cruces
El Paso
Midland
Odessa
Austin
Legend
2.0 %/yr
1.5
1.0
0.5
0
-0.5
-1.0
-1.5
-2.0
Done

Species	Natural barriers	Anthropogenic barriers	Dispersal ability	Macro temp requirements	Micro temp requirements	Macro precip requirements	Micro precip requirements	Dependence on ice/snow	Physical habitat requirement	Diet specialization	Migrations - movements	Genetic variation	Index Score
Aplodontia rufa	Inc	N	Inc	SI	SI	Inc-SI	N	N	N	N	SI	U	EV
Rhinichthys osculus oligoporus	N	N	Inc	N	N	GI-Inc	GI	N	N	N	SI	U	HV
Limenitis archippus lahontani	N	N	Inc	N	SI	SI	GI	N	N	Inc	SI	U	HV
Ochotona princeps	GI-Inc	N	SI	SI-N	N	SI-N	N	N	Inc	N	SI	U	HV
Sorex palustris	Inc	N	Inc	N	SI	SI-N	GI-Inc	N	N	N	SI	U	HV
Oncorhynchus clarkii henshawi	N	N	N	N	Inc-SI	SI	Inc-SI	N	N	N	Inc	U	HV
Rana pipiens	N	N	N	N	SI	SI	GI-Inc	N	N	N	SI	U	MV
Draba cusickii var. *pedicellata*	N	N	Inc	N	SI-N	SI	N	N	SI	N/A	U	U	MV
Leucosticte atrata	GI	N	Dec	SI	U	SI	N	SI	Inc-SI	N	SD	U	MV
Populus tremuloides	N	N	GI	N-SD	Inc	SI-N	SI	N	N	N/A	U	SD	MV
Asclepias eastwoodiana	N	N	SI	N	N	SI	Inc	N	N	N/A	U	U	PS
Phrynosoma platyrhinos	N	N	N	N	SD	Inc-SI	N	N	N	SI	SI	U	PS
Quiscalus mexicanus	N	SD	Dec	N	N	N	N	N	N	SD	U	U	IL

Which species, communities & systems are most sensitive?

Keith Lazelle

Which places will likely see the most change?

Keith Lazelle

Which species and systems will be able to “adapt”?

Keith Lazelle

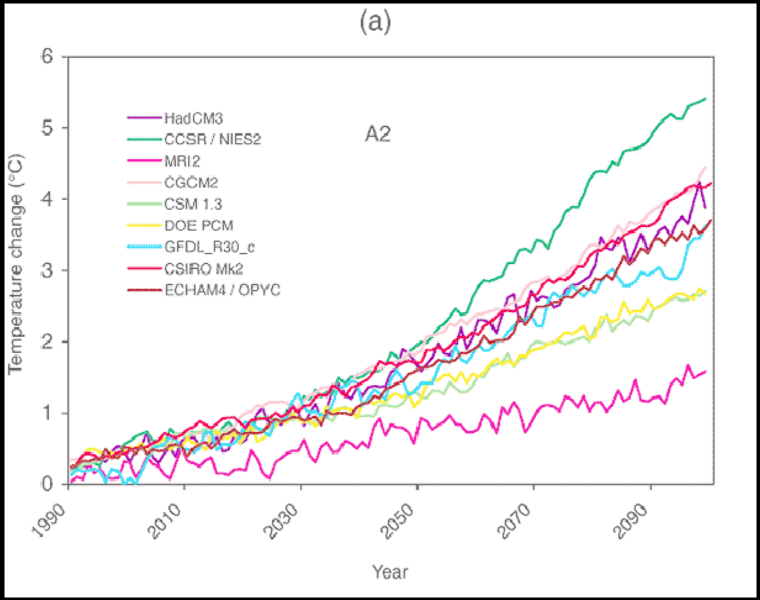
Which species and systems will be most vulnerable?

Keith Lazelle

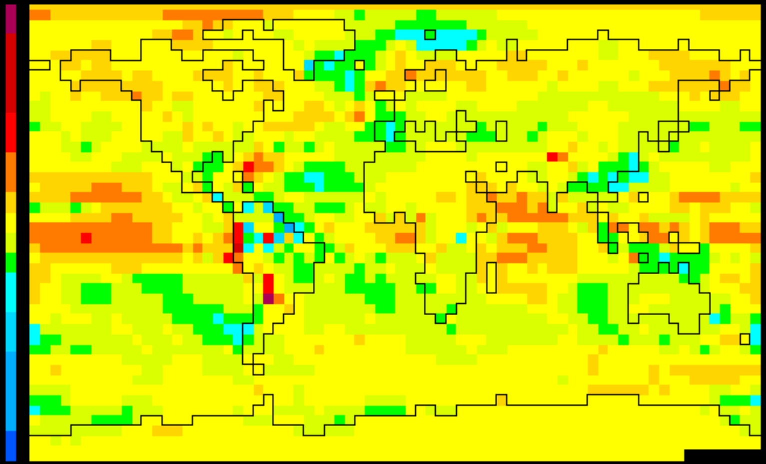
Craig Bienz

Common challenges of using climate change studies

- Uncertainty – different models produce different results
- Spatial resolution is too coarse
- Results not applicable to practitioners



From Cubasch et al. 2001

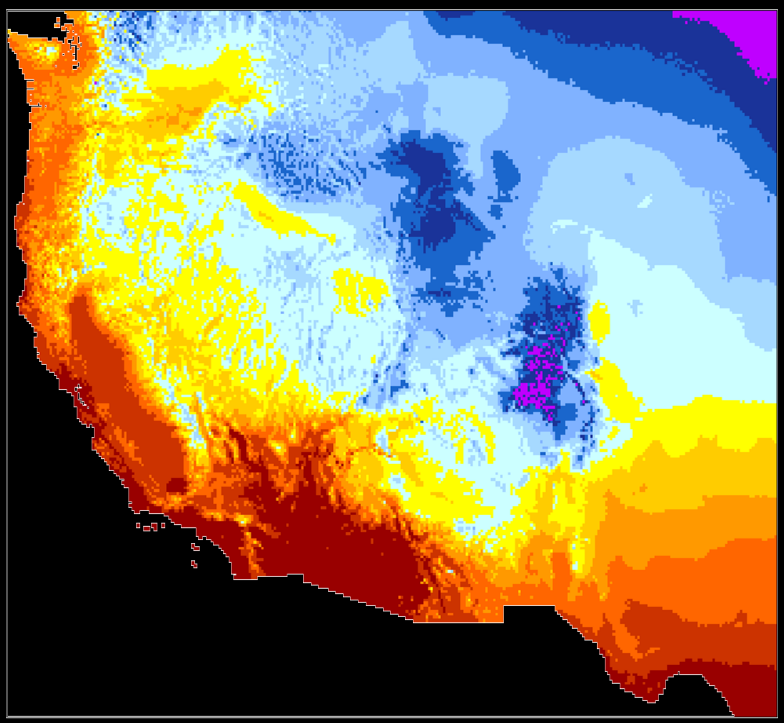


Proposed solutions

- Incorporate uncertainty into results

- High spatial resolution

- Temporal analyses (e.g., animations)



Part V: Application of Results

- Synthesize impacts on species and systems
- Identify refugia
- Assess impacts on protected areas
- Modify SWAPS (WDFW)