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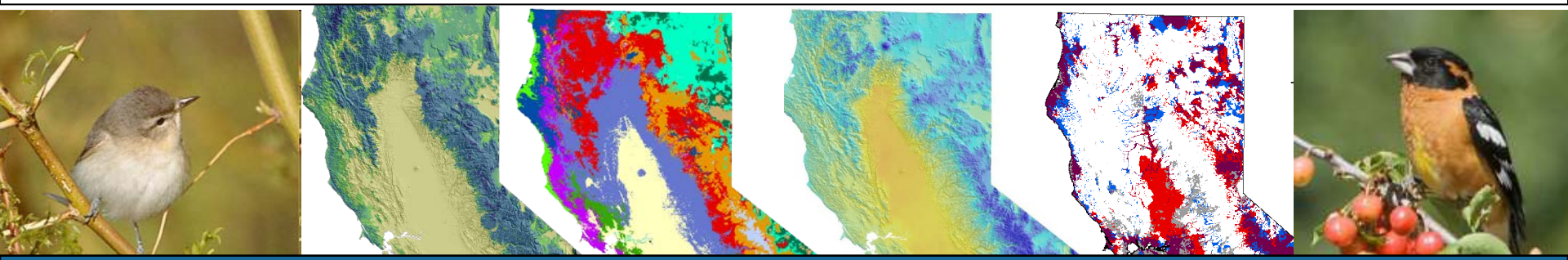


# Modeling climate change vulnerability of California breeding birds to inform conservation planning

Sam Veloz, Dennis Jongsomjit, Nathan Elliott, Grant Ballard

November 15, 2012

PRBO Conservation Science

# Applied Bird & Ecosystem Studies to Improve Conservation Outcomes- *using birds and other indicator species*

- Founded in 1965
- 140+ staff and seasonal biologists
- 2011 Budget: ~$9m

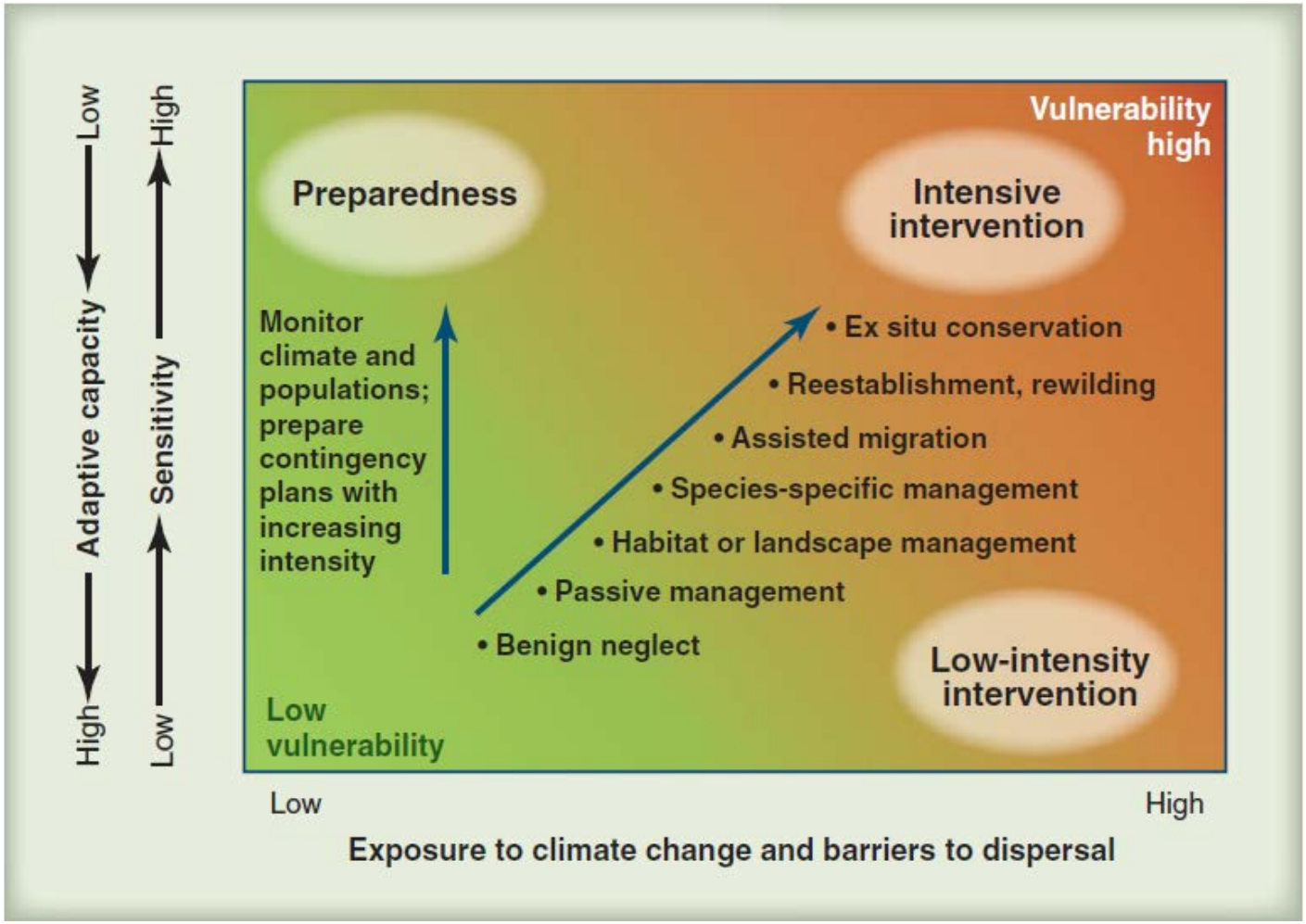
# Objectives

1. Project future shifts in California bird distributions and estimate species vulnerability

2. Inform conservation priorities for California avifauna in climate change context

3. Use birds as indicators of ecosystem quality to inform broader conservation outcomes

# Assessing species/system vulnerability and developing a response



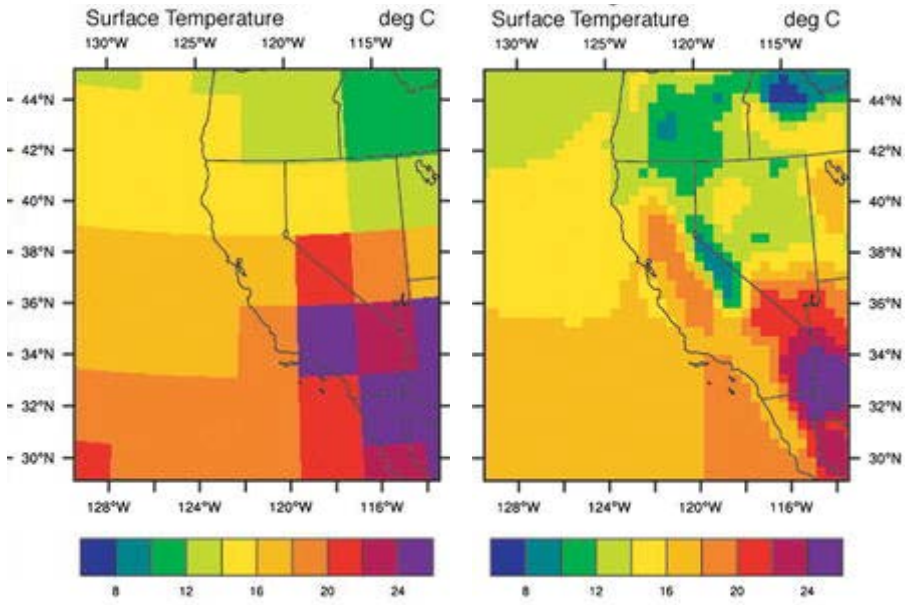

Dawson et al., 2011, Science

# ASSESSING EXPOSURE

# Regional Climate Models

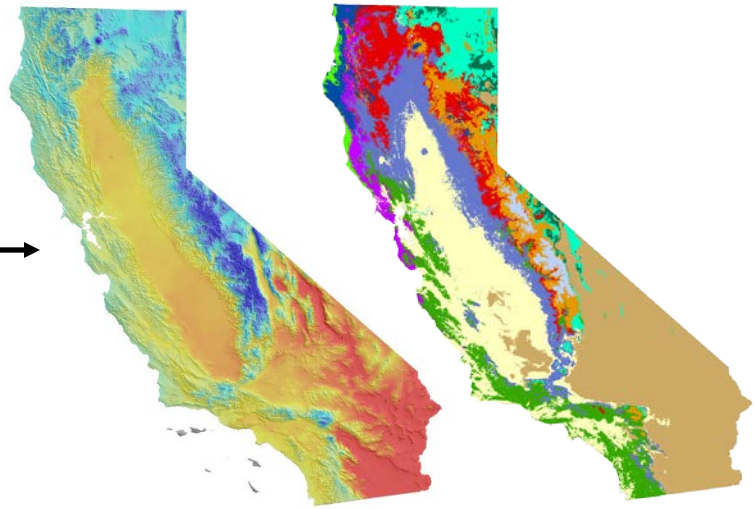
**General Circulation Model (GCM)**

**Regional Climate Model (RCM)**




From Snyder et al. 2005

Regional Climate Models from M. Snyder (UCSC)
RegCM3 (inputs from GFDL CM2.1, NCAR CCSM3.0)



**8 bioclimatic variables (based on monthly temperature and precipitation)**

**Vegetation type (modeled from climate, soil, topography)**

2-3˚

30 km

800 m

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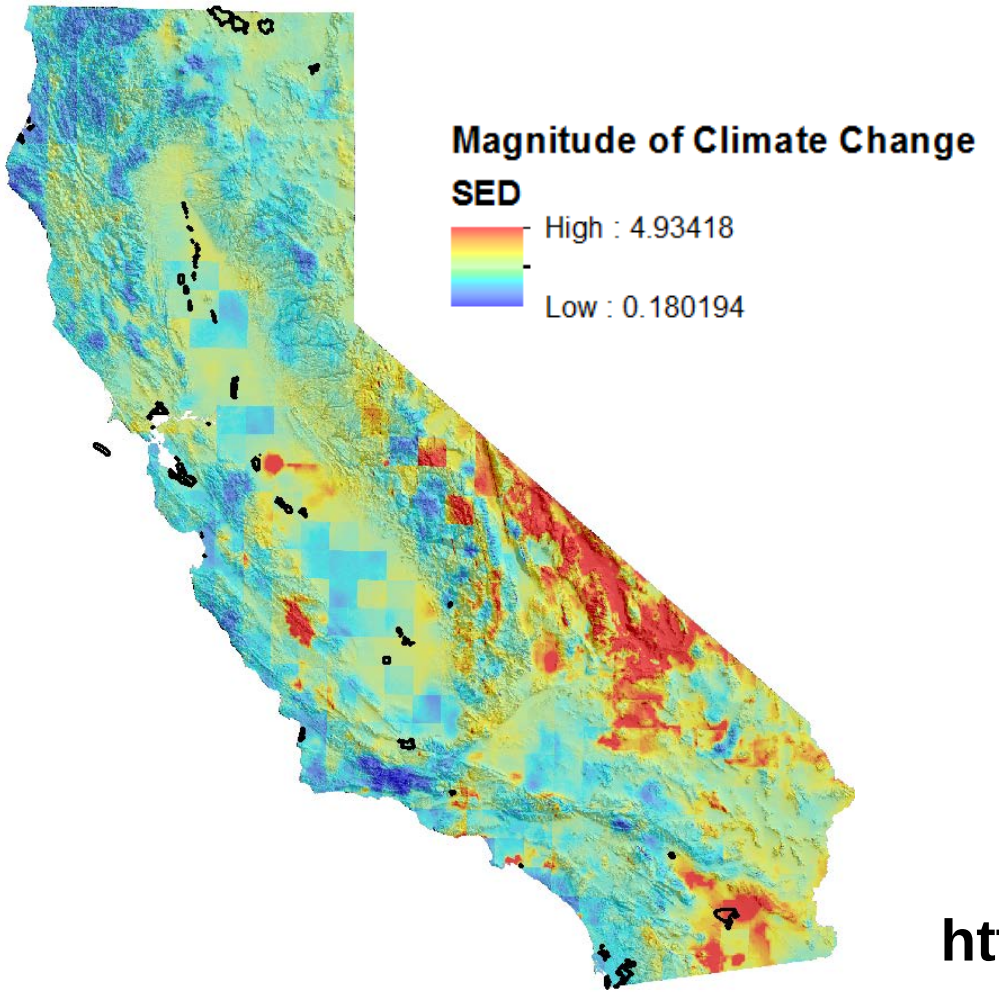
# Exposure To Climate Change (Accounting for inter-annual variability)

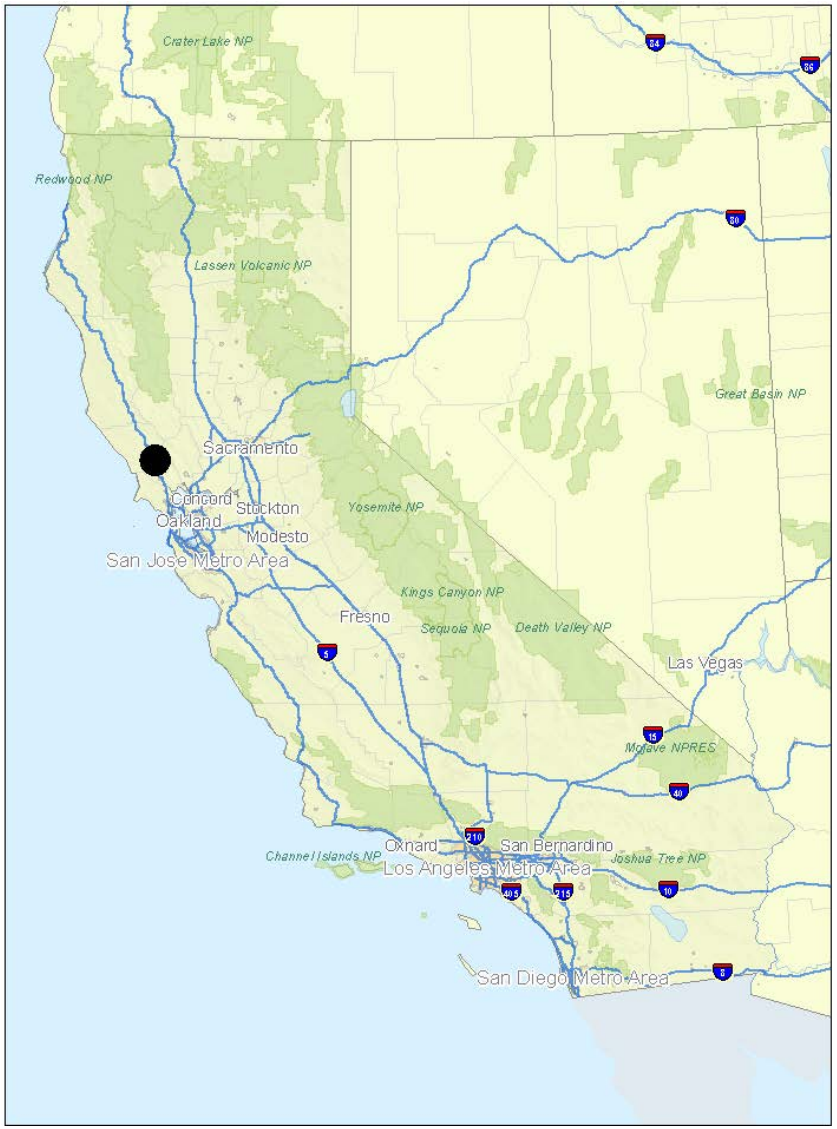



- Annual mean temperature
- Mean diurnal temp range
- Isothermality
- Temperature seasonality
- Mean summer temperature
- Annual precipitation
- Precipitation seasonality
- Summer precipitation

**http://data.prbo.org/apps/ecn/**

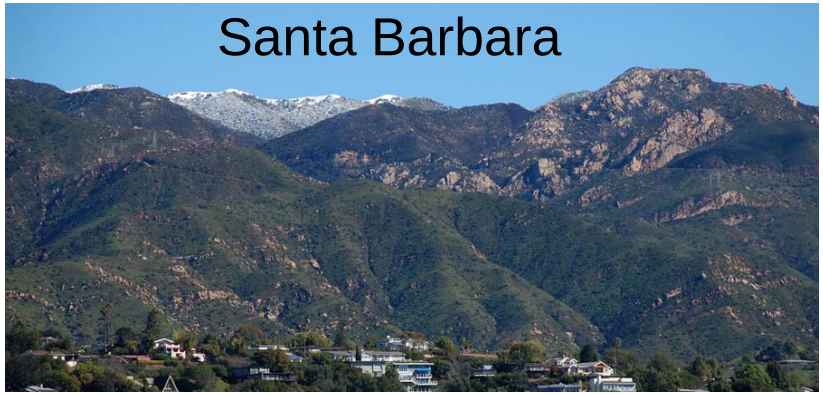
# Alternative ways to express climate change exposure

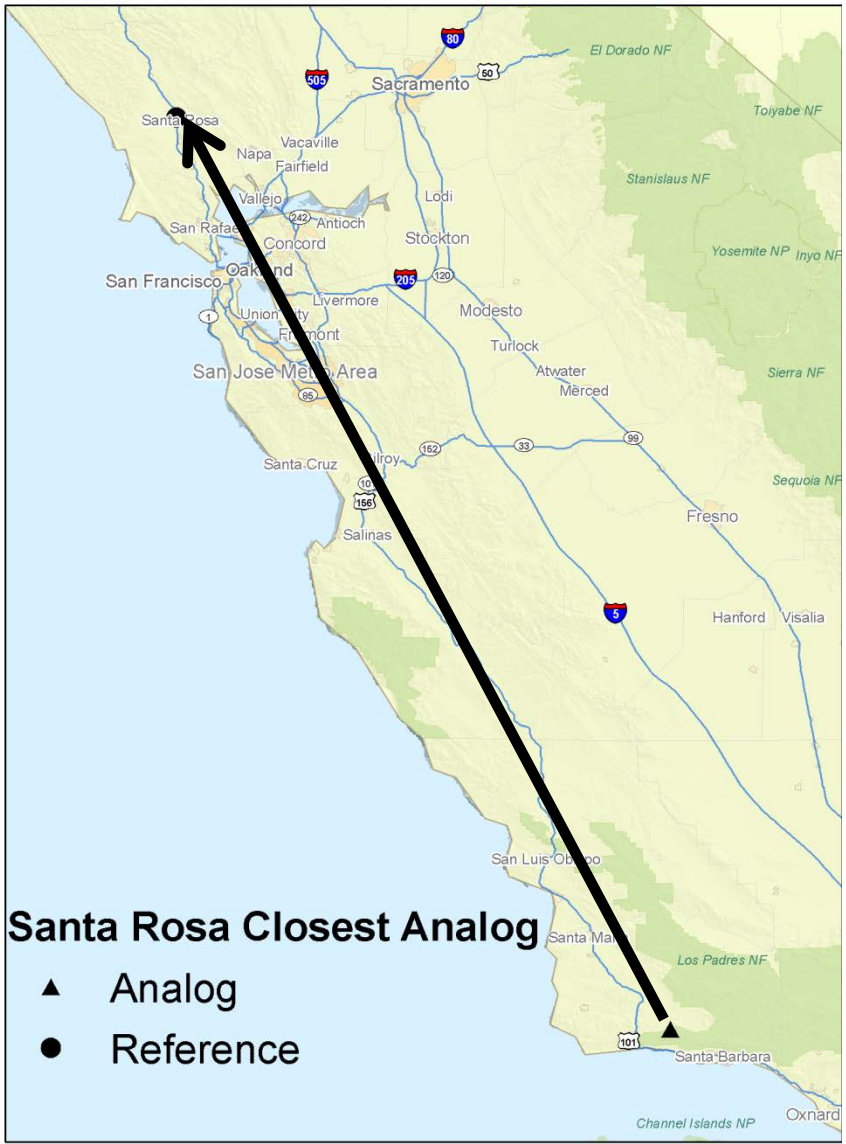
What is the best current match for Santa Rosa's future climate at the end of the 21st century?



# Climate is moving across the landscape. Will species follow?

The best match for Santa Rosa's future climate (2100) is like 20th century climate inland from Santa Barbara



# ASSESSING SENSITIVITY

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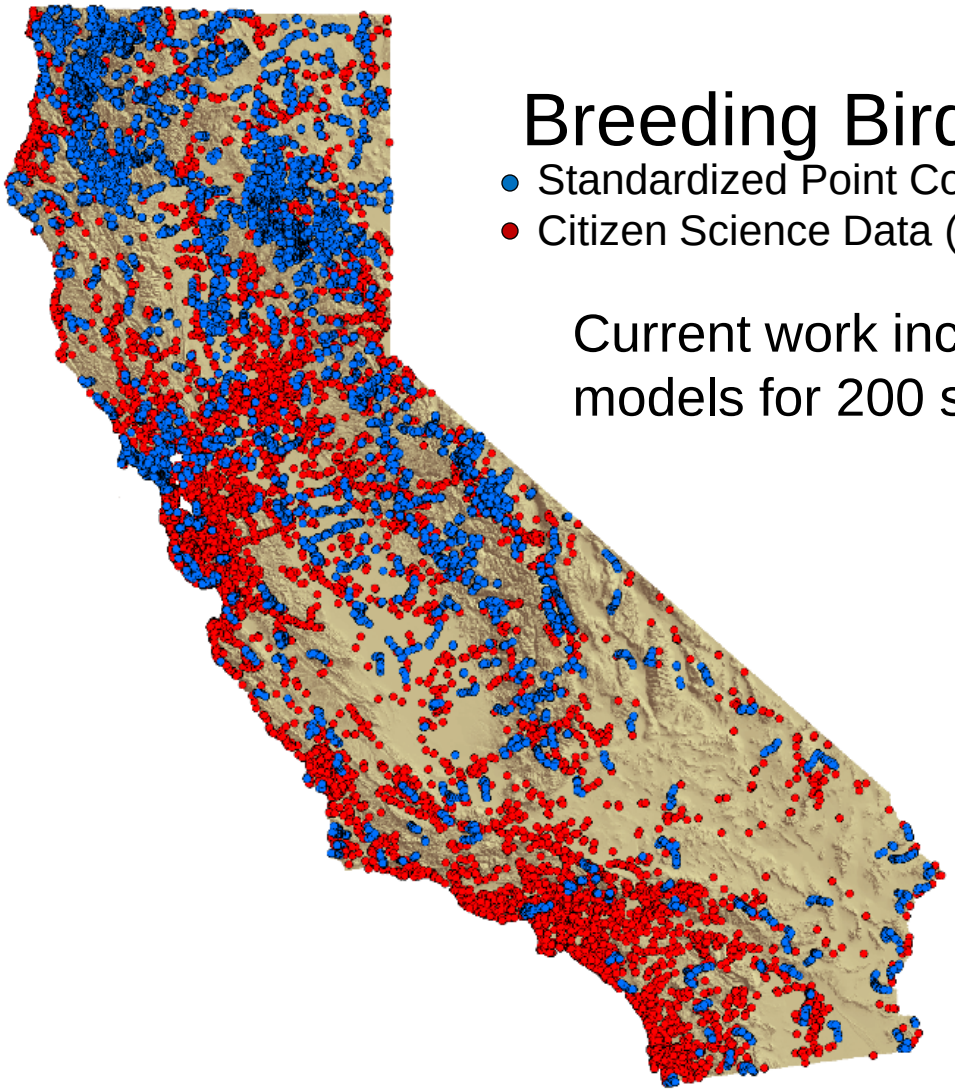
# Data-rich California (http://data.prbo.org/cadc/tools/multimap)



## Breeding Bird Records

- Standardized Point Counts
- Citizen Science Data (eBird)

Current work includes models for 200 species

Audubon

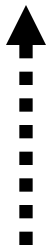
The Cornell Lab of Ornithology

North American Breeding Bird Survey

# Breeding Bird Distributions

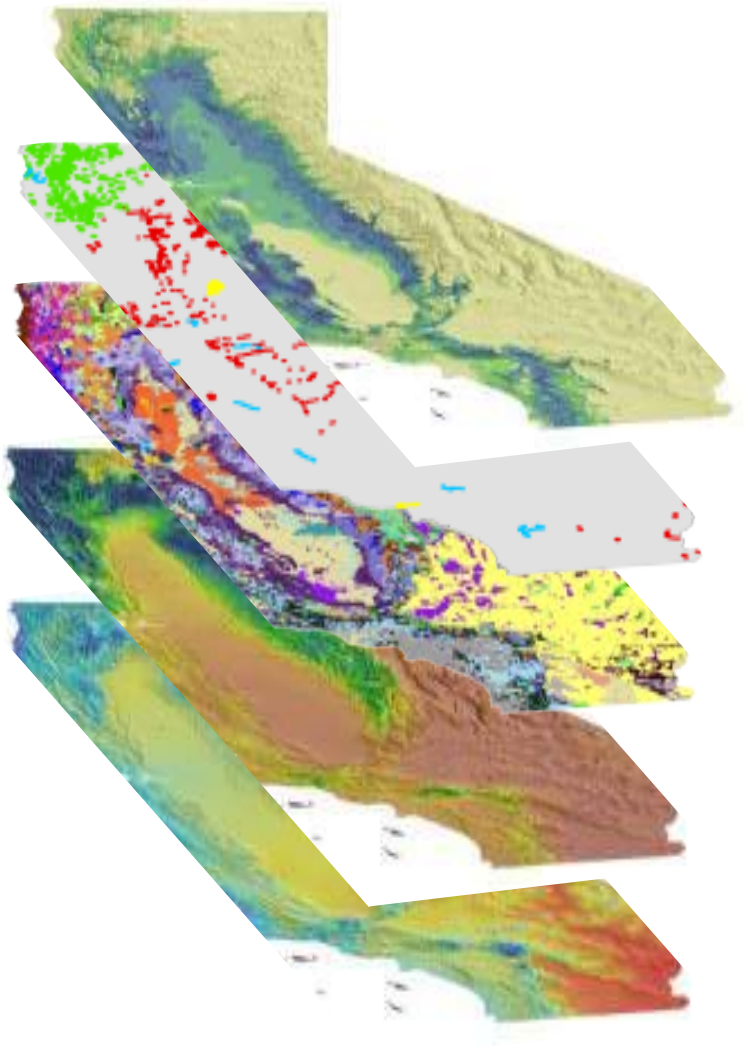
www.prbo.org/cadc

Spatial Predictions of Occurrence



Observational Data

Environmental Variables



# In some locations we project large changes in vegetation community composition

**Modeling Bird Distribution Responses to Climate Change:**
*A mapping tool to assist land managers and scientists in California*

About the Maps & Data | Download Model Data

**Vegetation** | Start Over

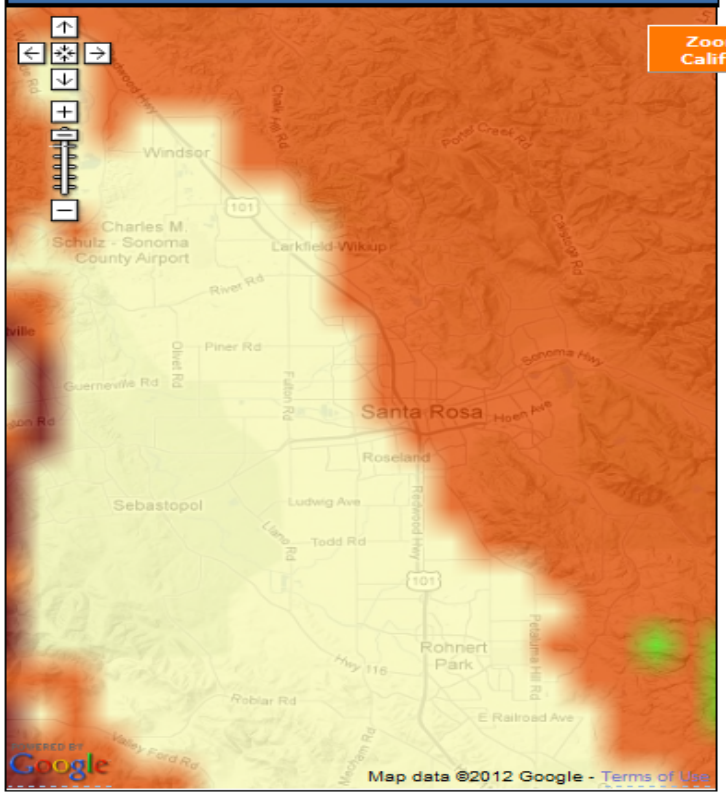
**Select climate model:** GFDL CM2.1

**Select other data:** Show study locations

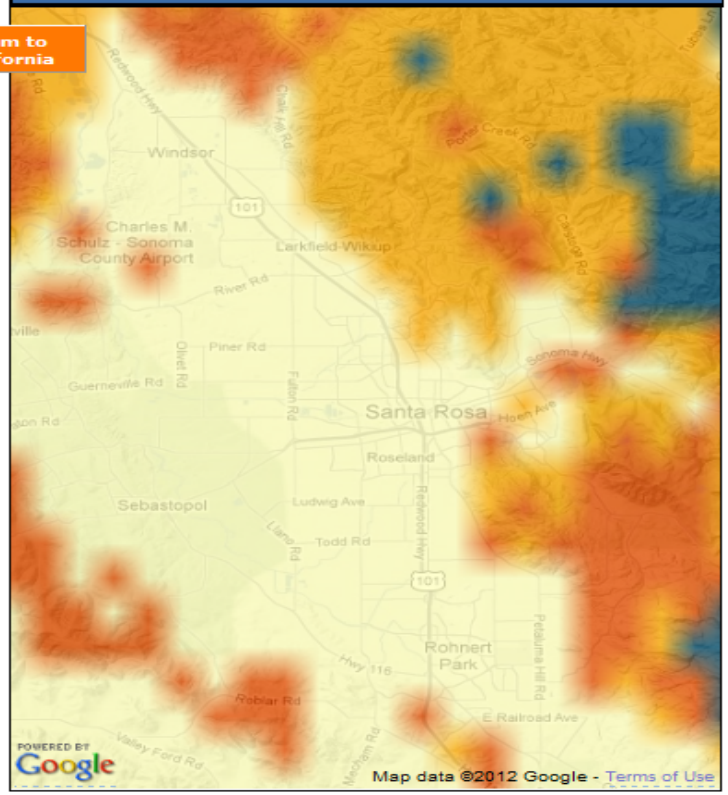
http://data.prbo.org/apps/ecn/

**Vegetation**

**Actual Current Vegetation**




**Projected Future Vegetation**




### *Vegetation legend*

- Annual Grassland (AGS), Perennial Grassland (PGS)
- Blue Oak Woodland (BOW), Blue Oak-Foothill Pine (BOP)
- Desert Scrub (DSC), Alkali Desert Scrub (ASC), Desert Succulent Shrub (DSS)
- Eastside Pine (EPN), Juniper (JUN), Pinyon-Juniper (PJN)
- Mixed Chaparral (MCH), Chamise-Redshank Chaparral (CRC), Coastal Scrub (CSC)
- Montane Hardwood-Conifer (MHC), Douglas Fir (DFR)
- Montane Hardwood (MHW), Coastal Oak Woodland (COW)
- Ponderosa Pine (PPN), Klamath Mixed Conifer (KMC)
- Redwood (RWD), Closed-Cone Pine Cypress (CPC)
- Red Fir (RFR), Lodgepole Pine (LPN), Subalpine Conifer (SCN)
- Sagebrush (SGB), Bitterbrush (BBR), Low Sage (LSG)
- Sierran Mixed Conifer (SMC), White Fir (WFR), Jeffrey Pine (JPN)

### *Variables in order of Importance*

1. Annual precipitation
2. Annual mean temperature
3. Temperature seasonality
4. Soil available water capacity (AWC)
5. Mean temperature of the warmest quarter
6. Precipitation seasonality
7. Slope
8. Precipitation of driest quarter
9. Solar radiation
10. Isothermality
11. Soil permeability
12. Soil pH

variable definitions

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# Acorn Woodpecker: negative response

http://data.prbo.org/apps/ecn/

http://data.prbo.o...hange-distribution

**Modeling Bird Distribution Responses to Climate Change:**
*A mapping tool to assist land managers and scientists in California*

About the Maps & Data

prbo

Species Distributions

Start Over

**Select a habitat type:** Oak Woodland

**Select a species:** Acorn Woodpecker

Results from GFDL CM2.1 climate model

and Maxent algorithm

**Select other data:**

Current range maps (more info)

Show locations for this species

Probability of occurrence 0-20% 20-40% 40-60% 60-80% 80-100%

**Projected Current Distribution**

**Projected Future Distribution**

Zoom to California

Larkfield-Wikiup
Santa Rosa
Roseland
Sebastopol
Annadel State Park
Taylor Mountain
Diamond Mountain
101

## *Acorn Woodpecker*

Photo (c) Peter LaTourrette

Learn more about the **Acorn Woodpecker** at All About Birds or read the Partners In Flight species account

## *Variables in order of Importance*

1. Annual precipitation

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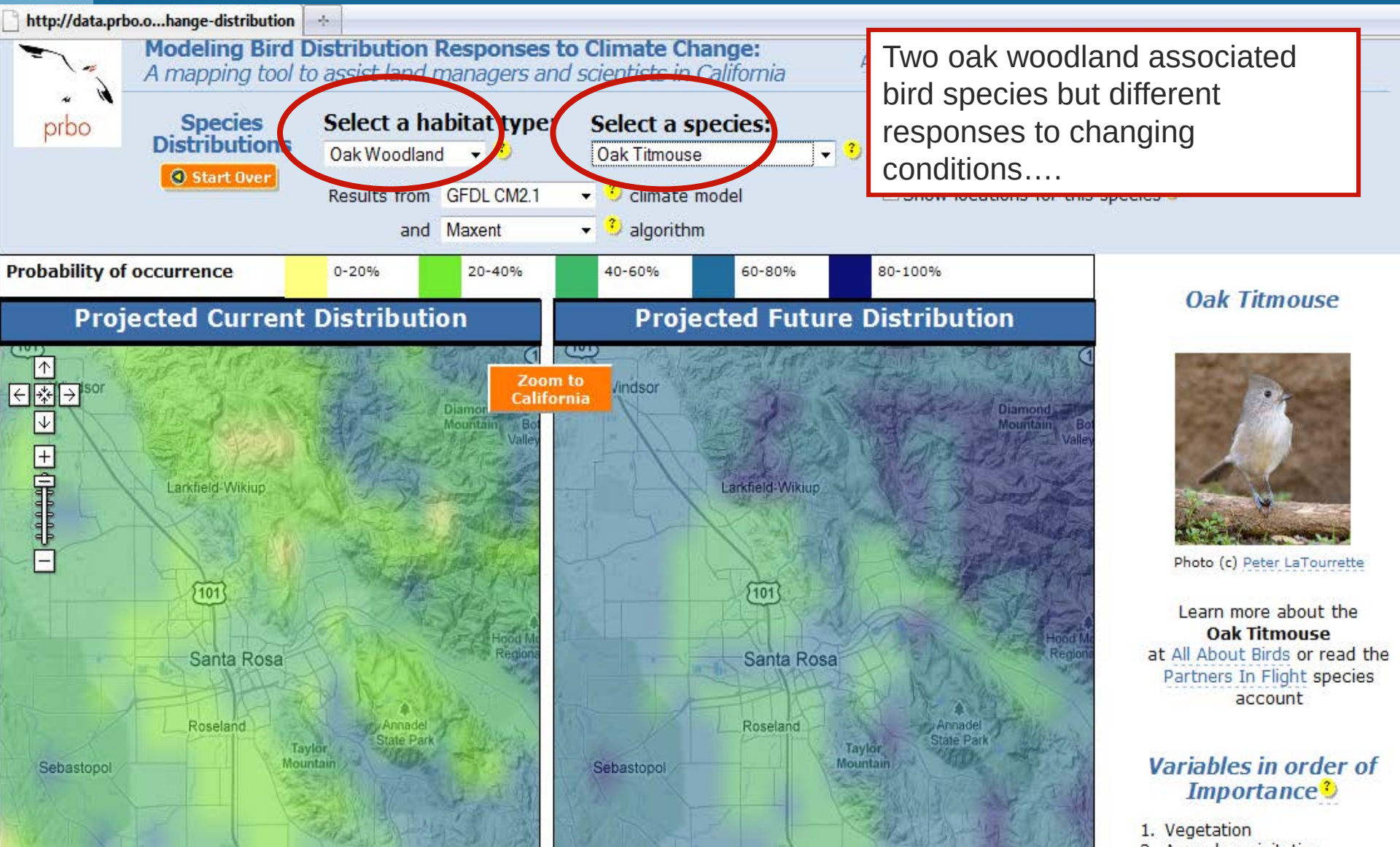
# Oak Titmouse: positive response

http://data.prbo.org/apps/ecn/




Two oak woodland associated bird species but different responses to changing conditions….

## Oak Titmouse



Photo (c) Peter LaTourrette

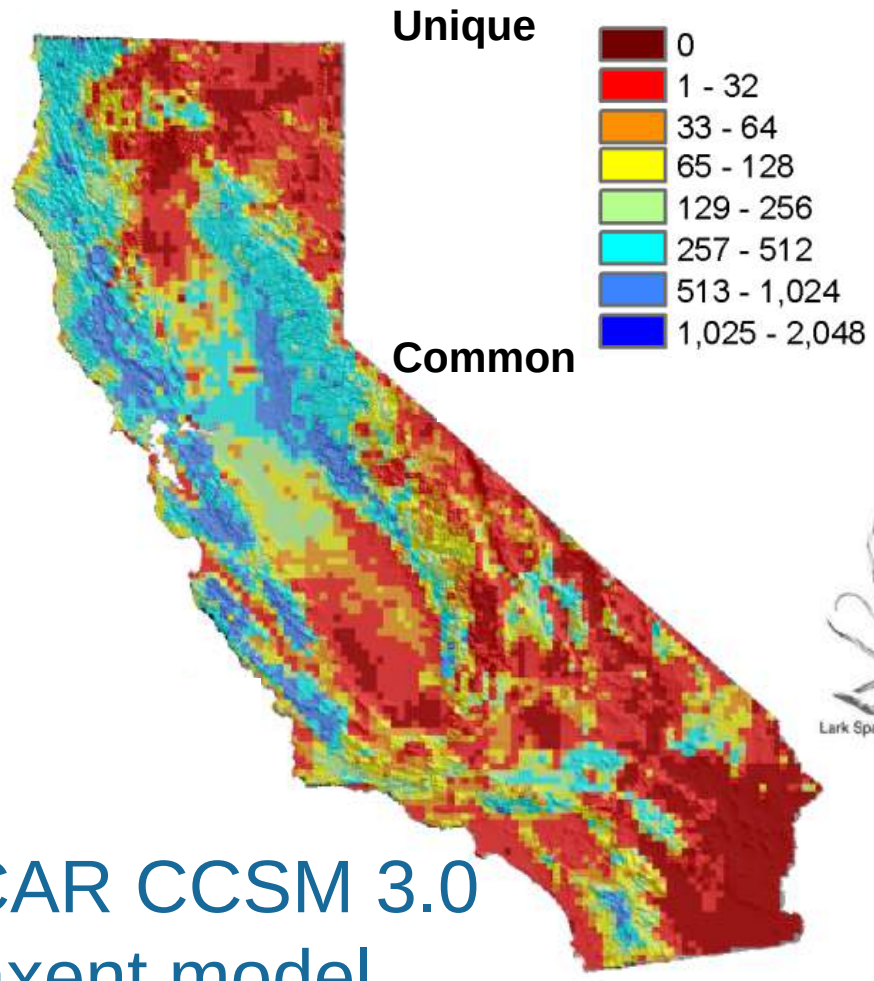
Learn more about the **Oak Titmouse** at All About Birds or read the Partners In Flight species account

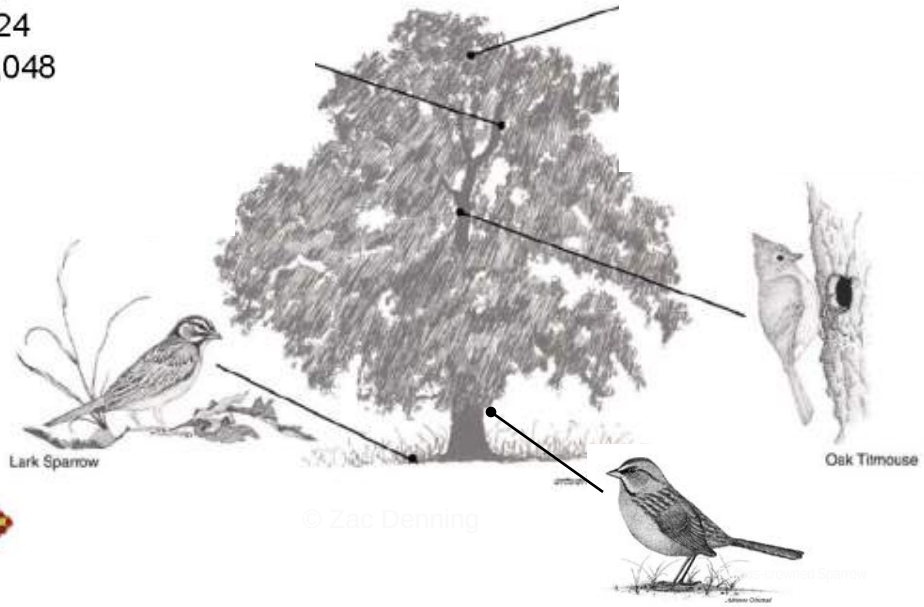
## Variables in order of Importance

1. Vegetation

# Climate change will likely lead to ecological surprises

**Future Bird Communities: Number of Modern Analogs**

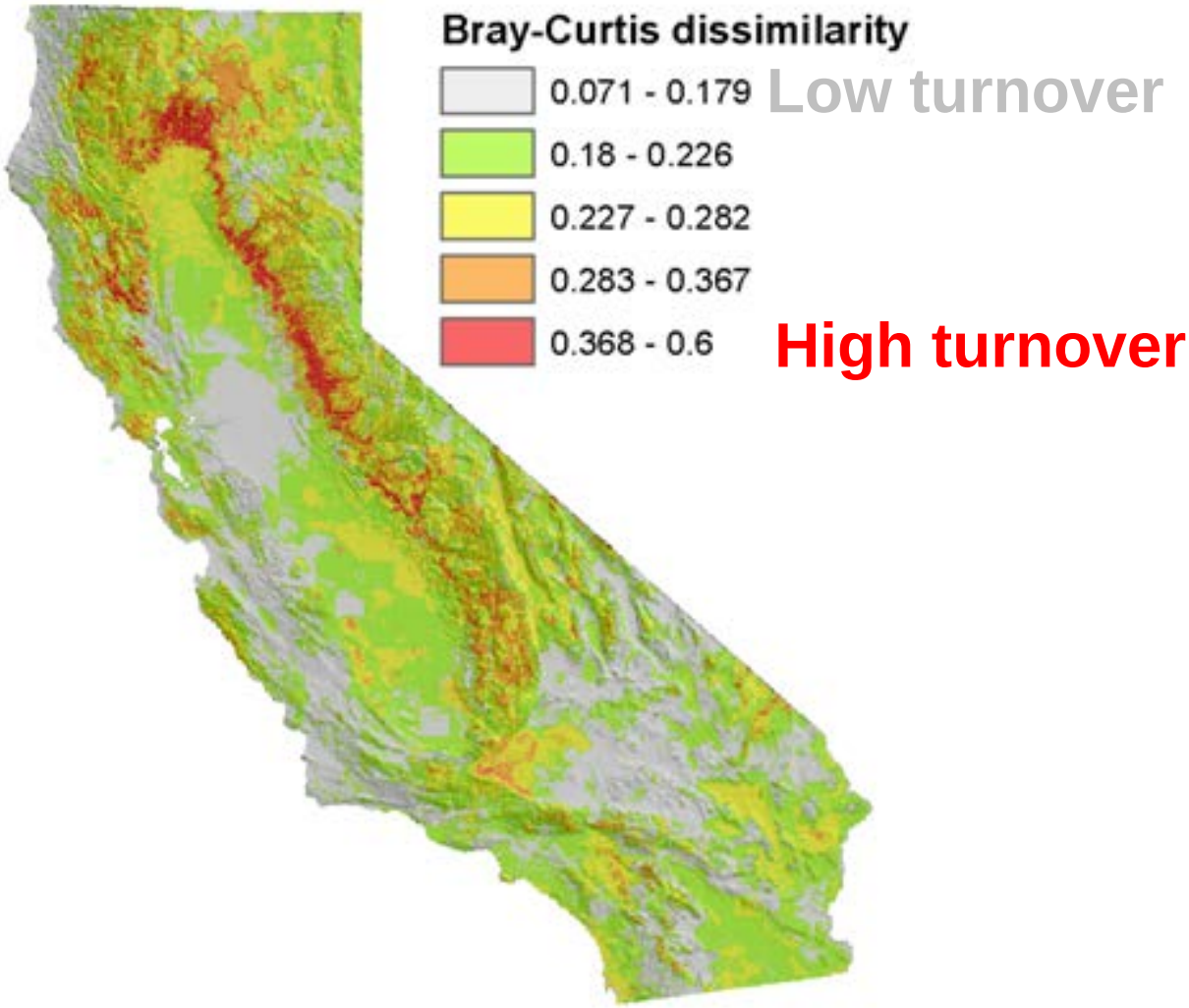


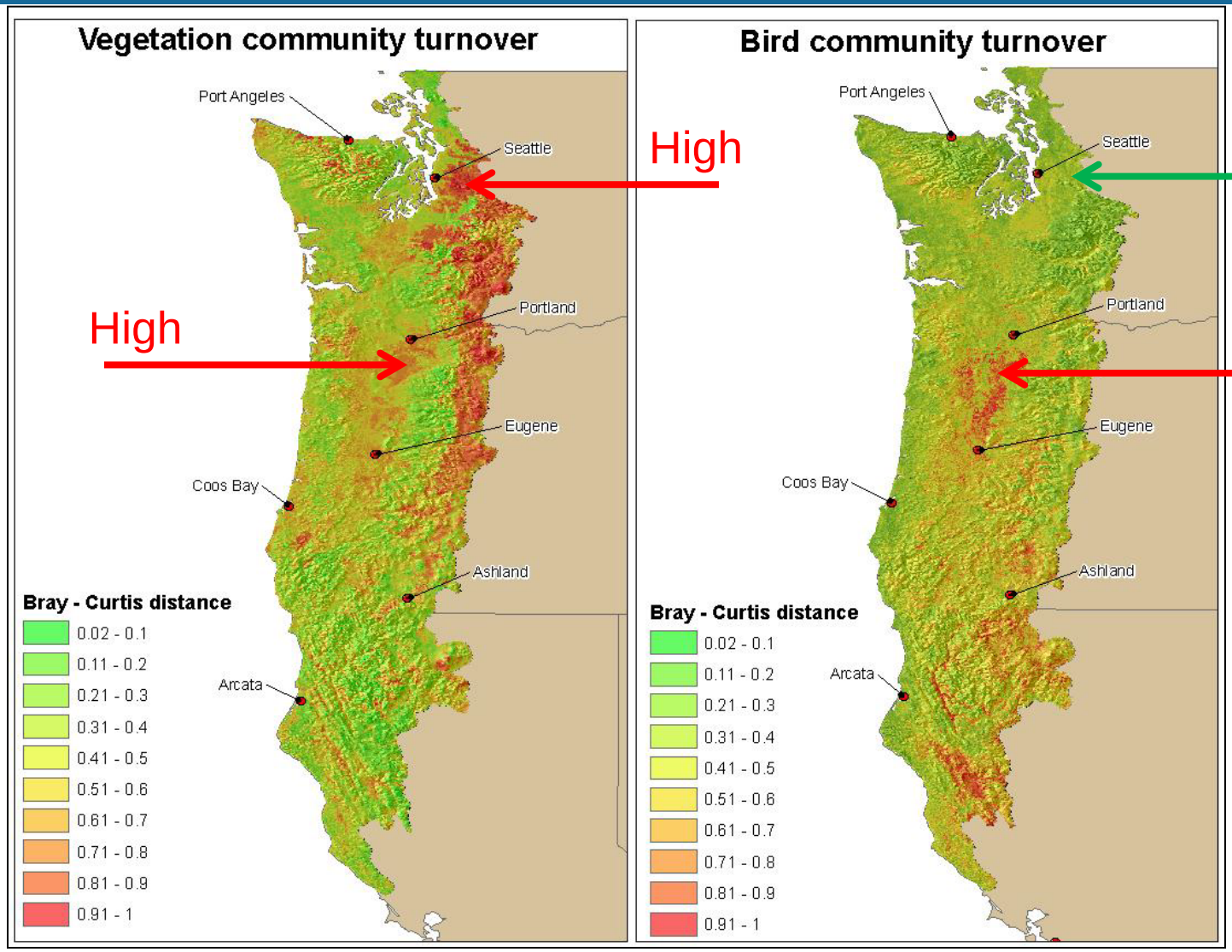

NCAR CCSM 3.0
Maxent model

Stralberg et al. 2009, PLoS ONE

# Community turnover: Changes in bird community composition (200 species)

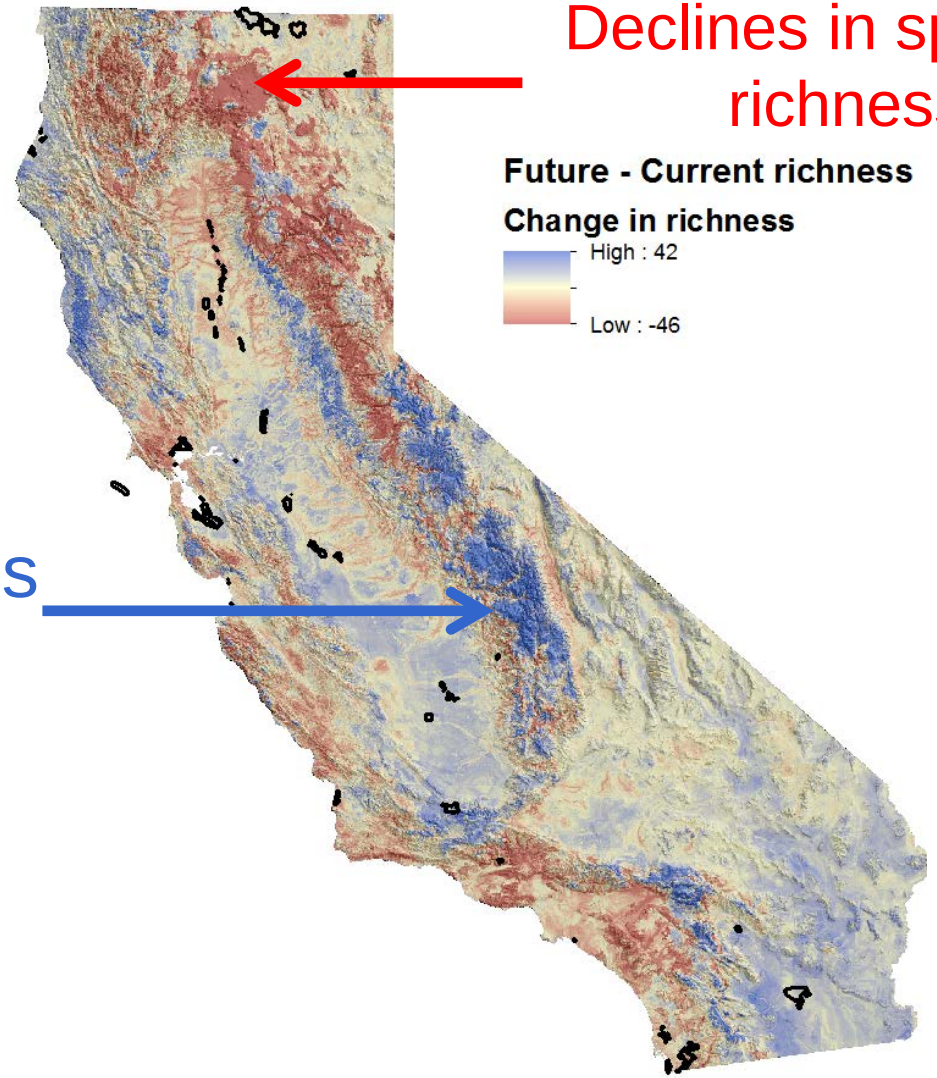


# Vegetation community turnover vs. bird community turnover (North Pacific Landscape Conservation Cooperative)



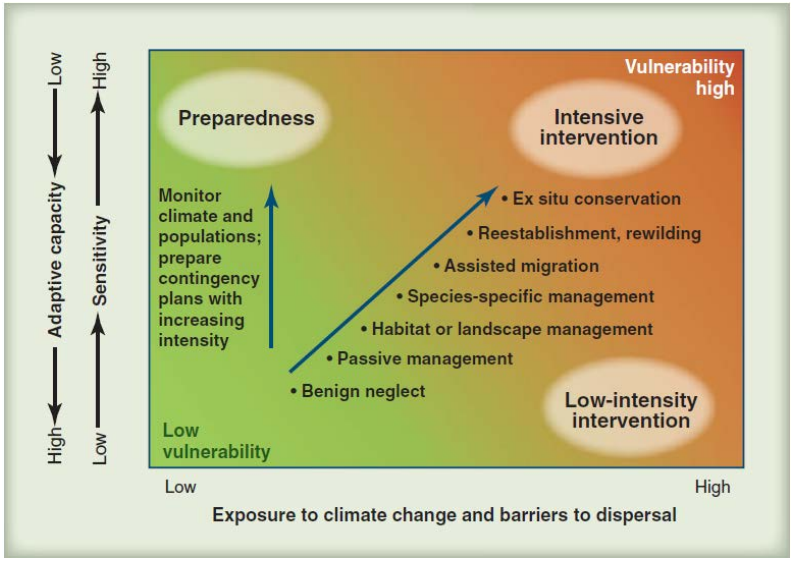
# Changes in Species Richness (number of species/ pixel)

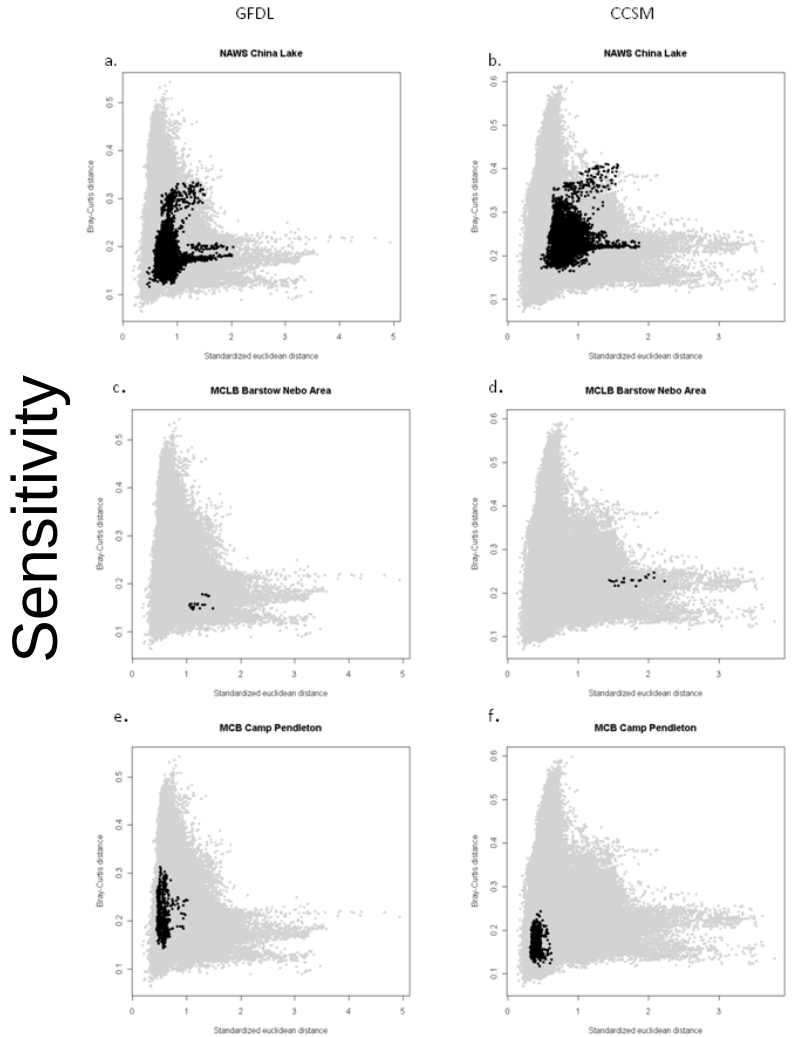
Declines in species richness




Increase in species richness

# Assessing vulnerability



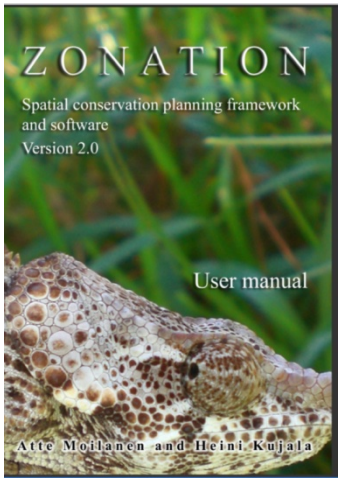



# Vulnerability is helpful for developing adaptation plans, but what conservation priorities?

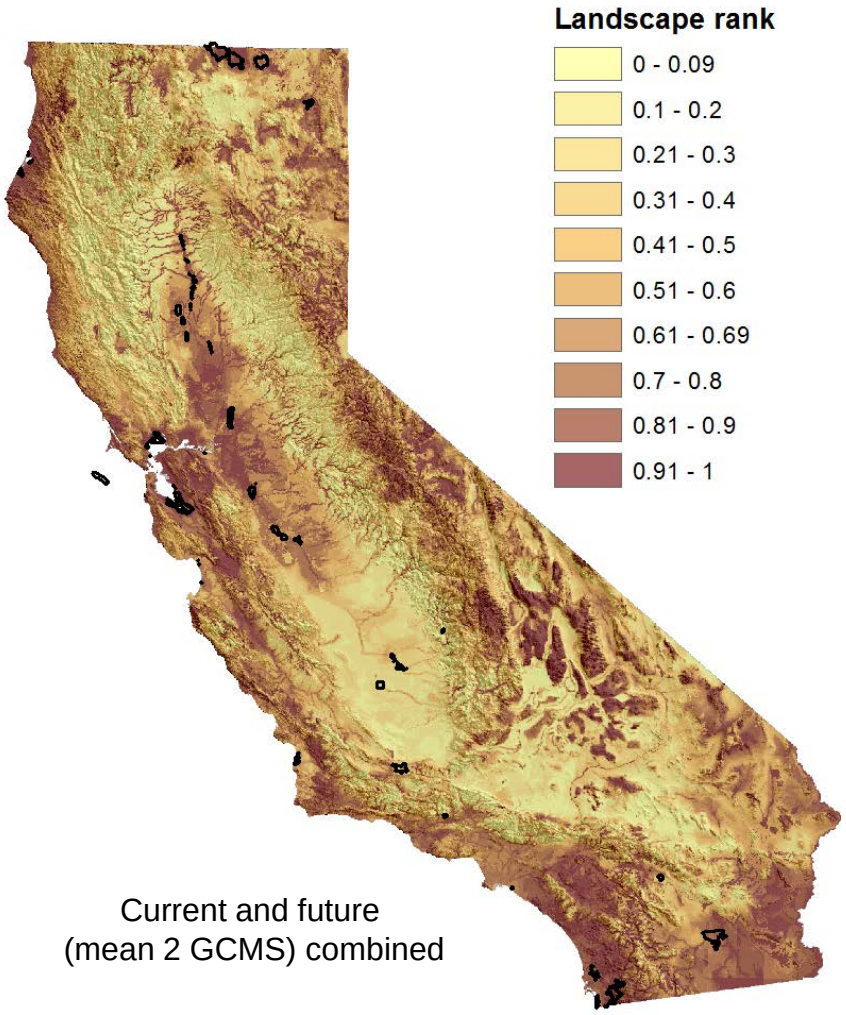
- An increase in richness doesn't tell us anything about rare or common species (you could be losing T&E species even with an increase in richness)
- Is high community turnover good/bad? How do you use it to prioritize?
- Species lost in one area may simply move to another (no net loss of species)

# Systematic Conservation Prioritization

- Zonation (Moilanen and Kujala)
  - Multi-species spatial conservation planning software
  - Hierarchical prioritization of landscape (vs. targets)
  - Species “core area” algorithm retains high value areas for each species
  - Can incorporate uncertainty
  - Can weight species by conservation status



# Considering important areas both currently and in the future highlights conservation priorities



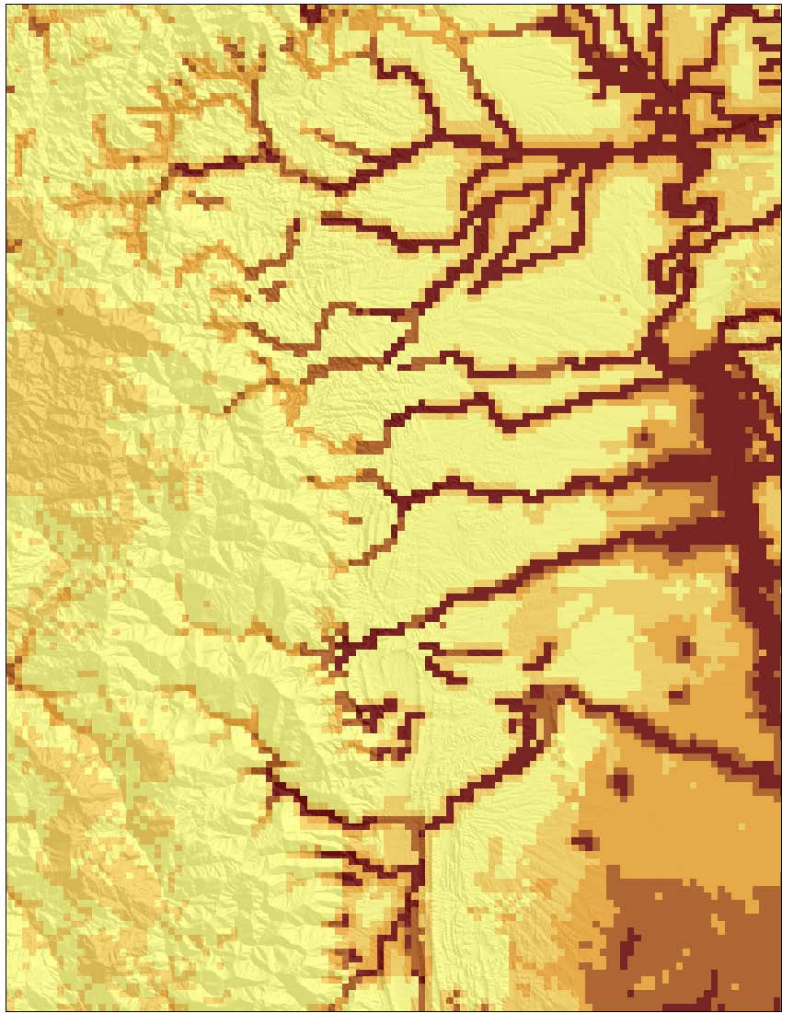

Current and future
(mean 2 GCMS) combined

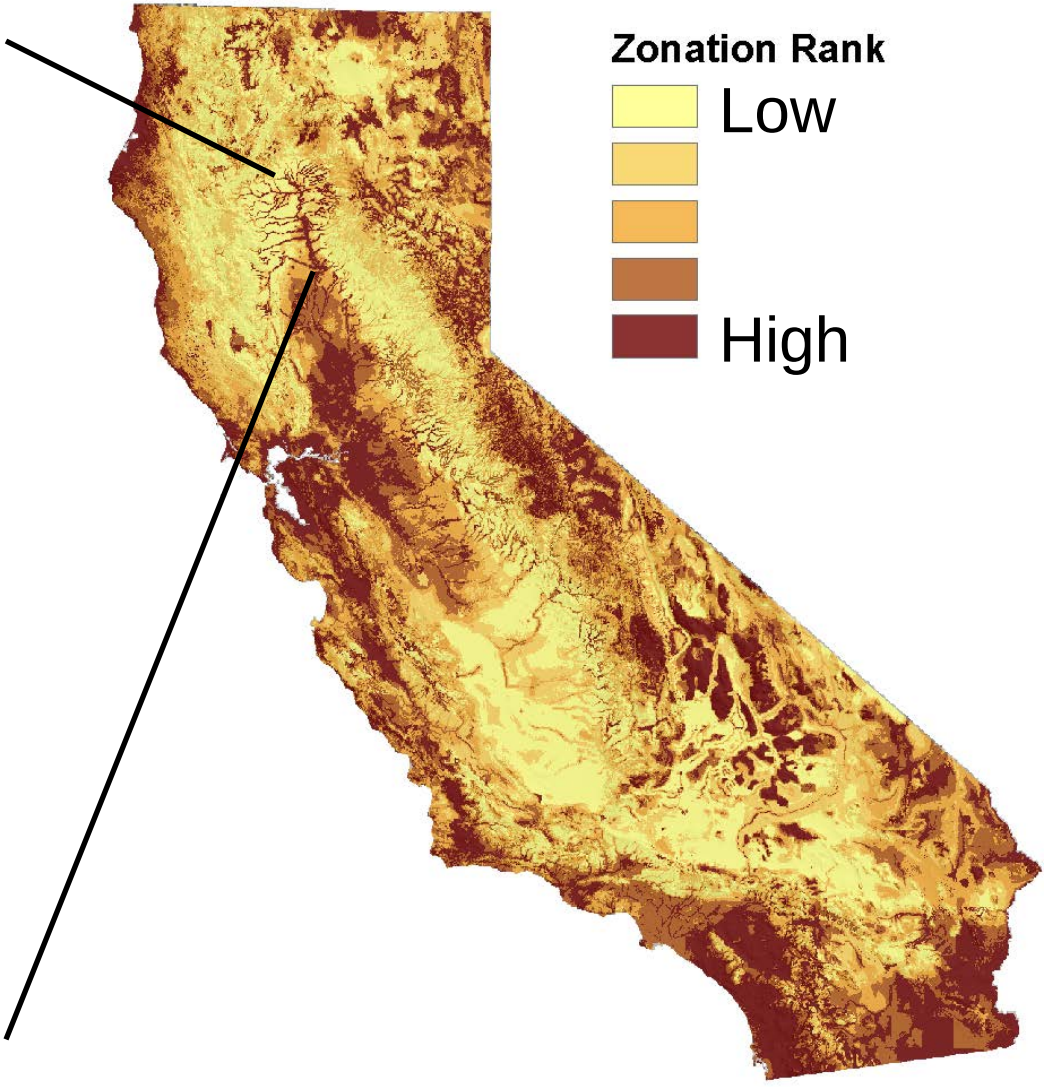
**http://data.prbo.org/apps/ecn/**

200 bird species (current and future distributions, 2 GCMs 600 *species*)

- Attempts to conserve all *species* included
- Species ranked by conservation status
- Future models discounted by uncertainty

# Prioritizing watersheds for working lands
# Some restoration required





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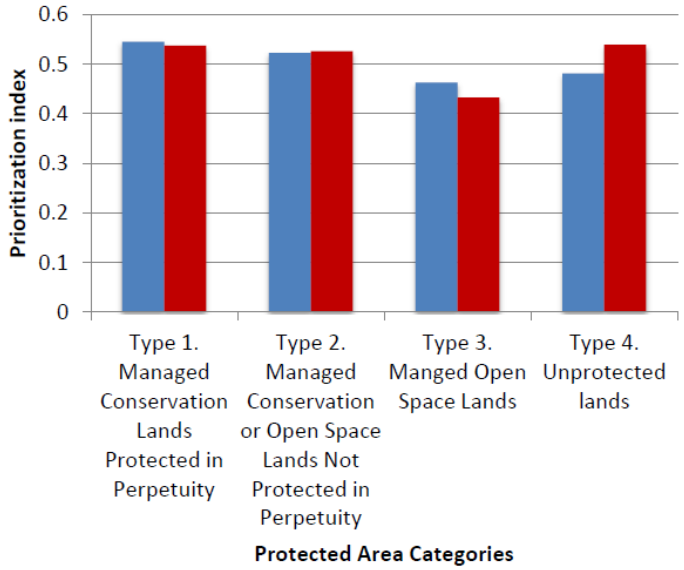
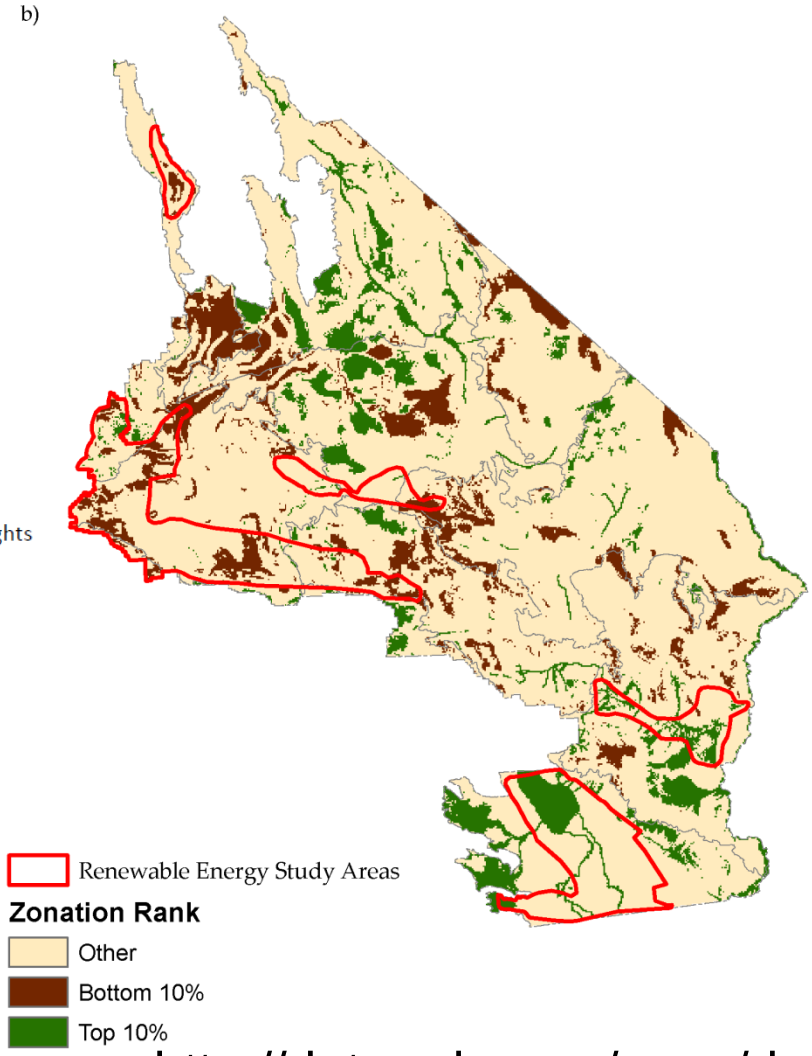
# Overlap between conservation priorities and renewable energy development (DRECP)

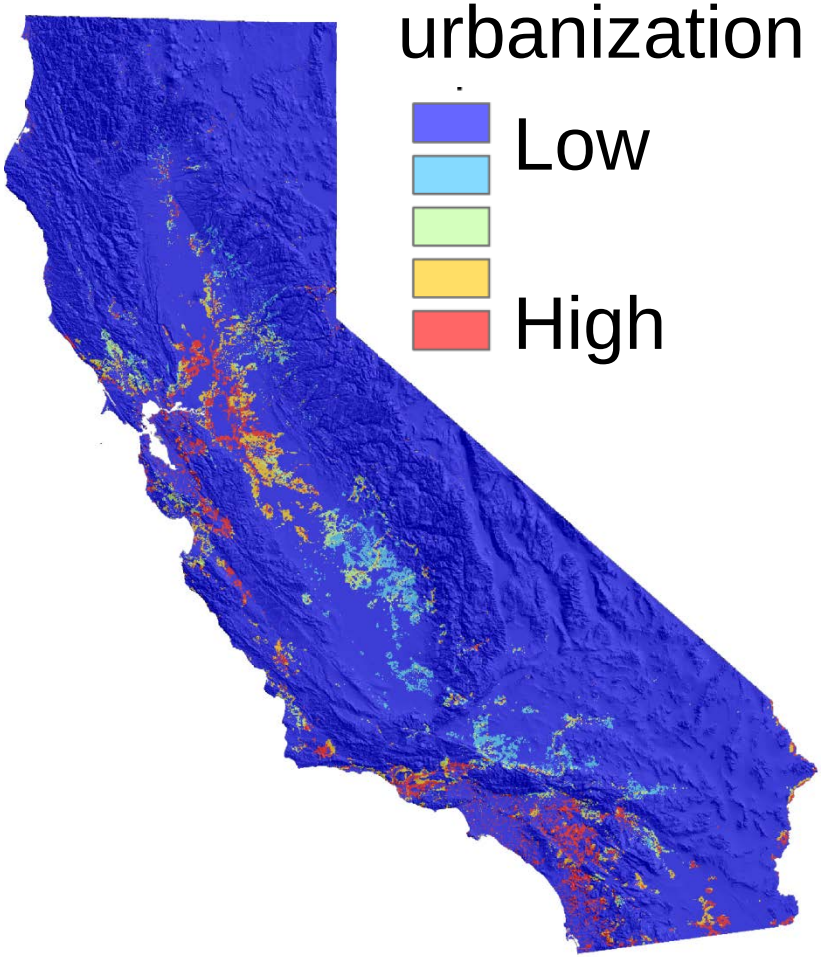


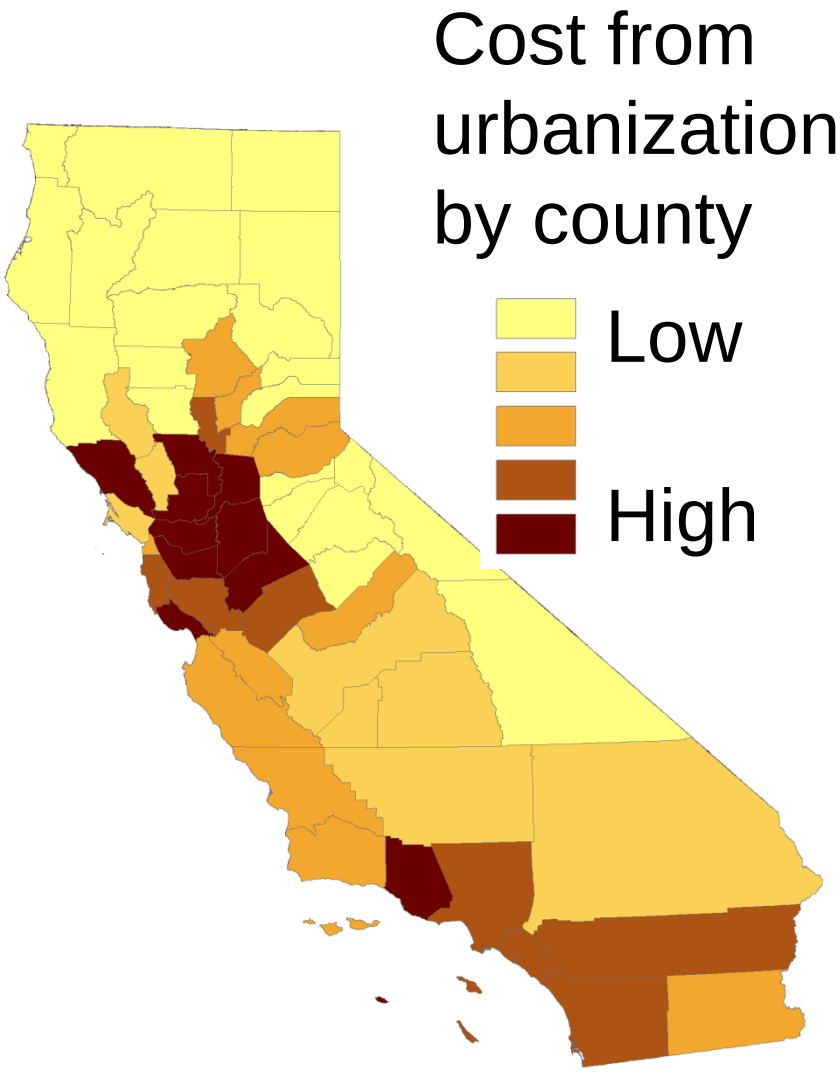




http://www.prbo.org/cms/574

http://data.prbo.org/apps/drecp/

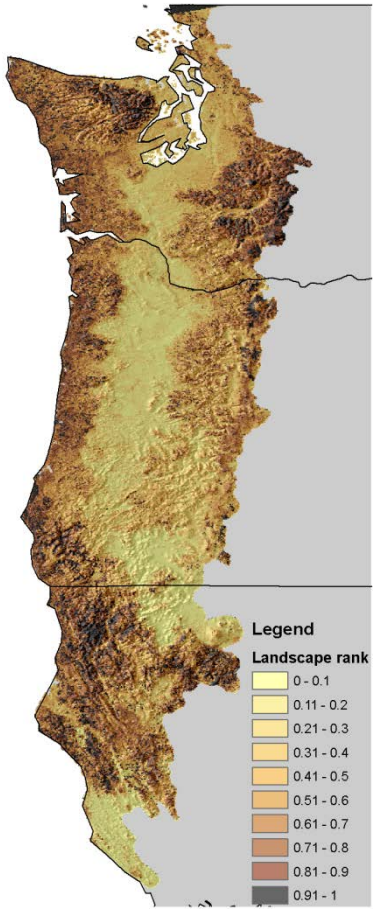
# Threats from urbanization



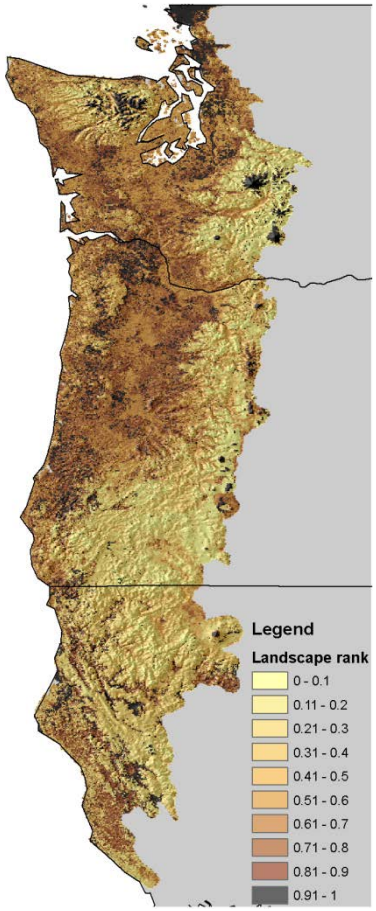



# Prioritization of bird distributions representing different habitat types

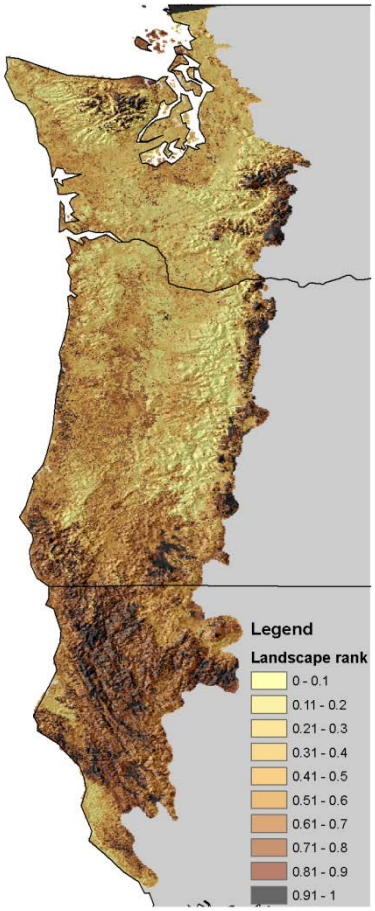
## Conifer species



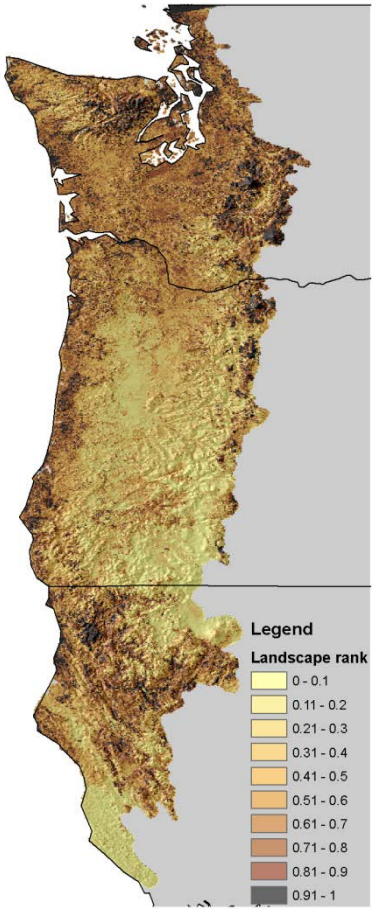

## Grassland species




## Oak woodland species




## Riparian species



# Conclusions

- High climate change exposure will lead to changes in the distribution of species and the composition of biological communities
- Different sensitivities of species in response to climate change is likely to lead to ecological surprises
- Models can be useful for identifying high priority conservation areas and threats to conservation

# Acknowledgments

www.prbo.org/cadc


- **Bird Data:** PRBO terrestrial division staff and interns, Klamath Bird Observatory, Redwood Sciences Laboratory (USFS), Breeding Bird Survey (USGS), Cornell Lab of Ornithology,
- **California Avian Data Center Website:** M. Fitzgibbon, D. Jongsomjit, D. Moody, PRBO
- **Environmental Data:** PRISM Climate Group, California Gap Analysis Project
- **Funding:** Anonymous donors to PRBO, Faucett Family Foundation, National Science Foundation, California Landscape Conservation Cooperative

Contact: sveloz@prbo.org

http://data.prbo.org/apps/ecn/

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