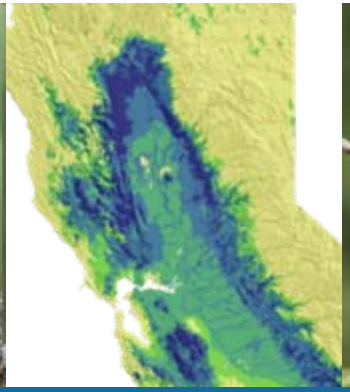
prbo

PRBO Conservation Science








Photos by Peter LaTourrette and PRBO

Predicting The Effects of Climate Change on California Bird Distributions

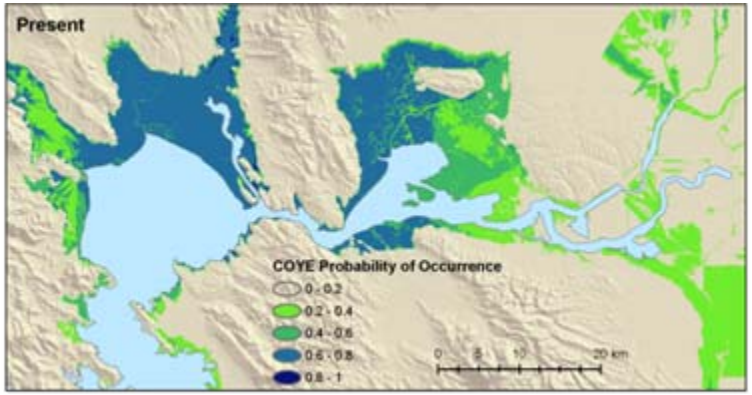
Diana Stralberg, Dennis Jongsomjit, Chrissy Howell, John Wiens, PRBO;

Mark Snyder, UCSC; Terry Root, Stanford University

Climate Change Modeling Outline

1. **California terrestrial breeding birds (ongoing)**

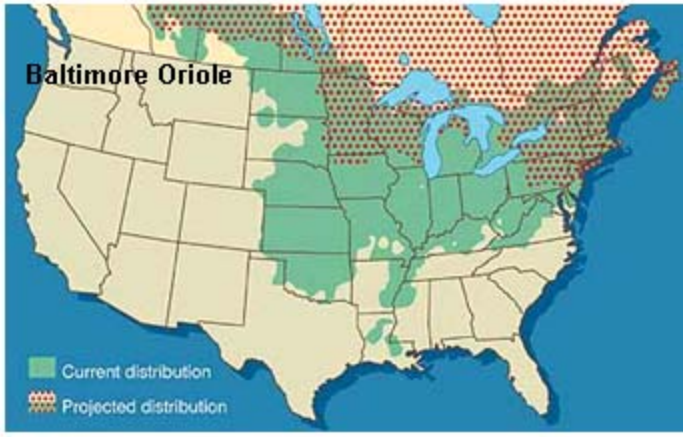
2. **San Francisco Bay marsh birds (preliminary)**



Conservation Background

- **Conservation planning challenges increase as climate changes**
  - **Increased conservation urgency**
  - **Moving conservation targets**

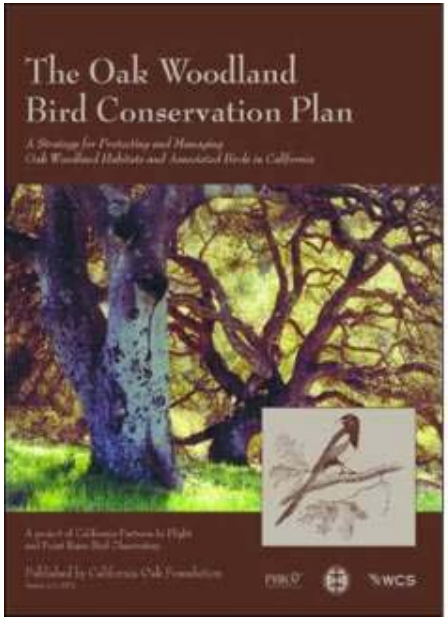
- **Distribution modeling can help fill information gaps (current and future)**



Source: Jeff Price, National Wildlife, Dec/Jan 2003

Project Goals

- **Inform bird conservation strategies**
  - **California Partners in Flight focal species**
- **Provide statewide picture of potential distribution shifts**
- **Identify local and regional change hotspots**
- **Suggest additional research**



Species Distribution Models

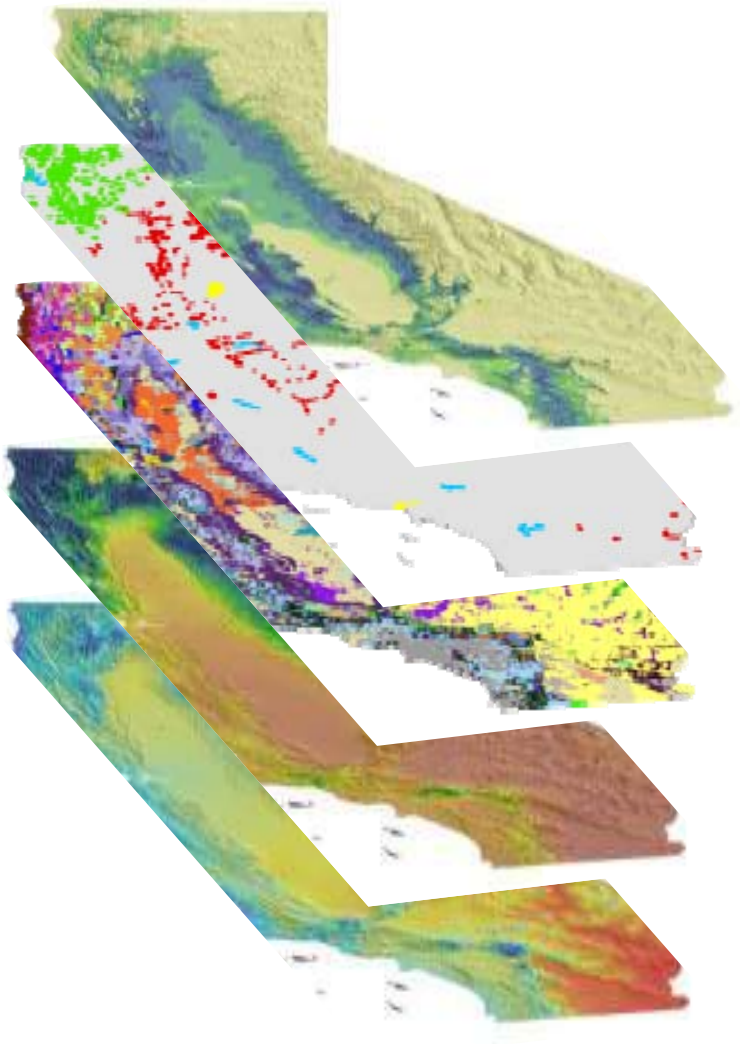
Spatial Predictions of Occurrence

↑ Maxent and GAMs

Observational Data

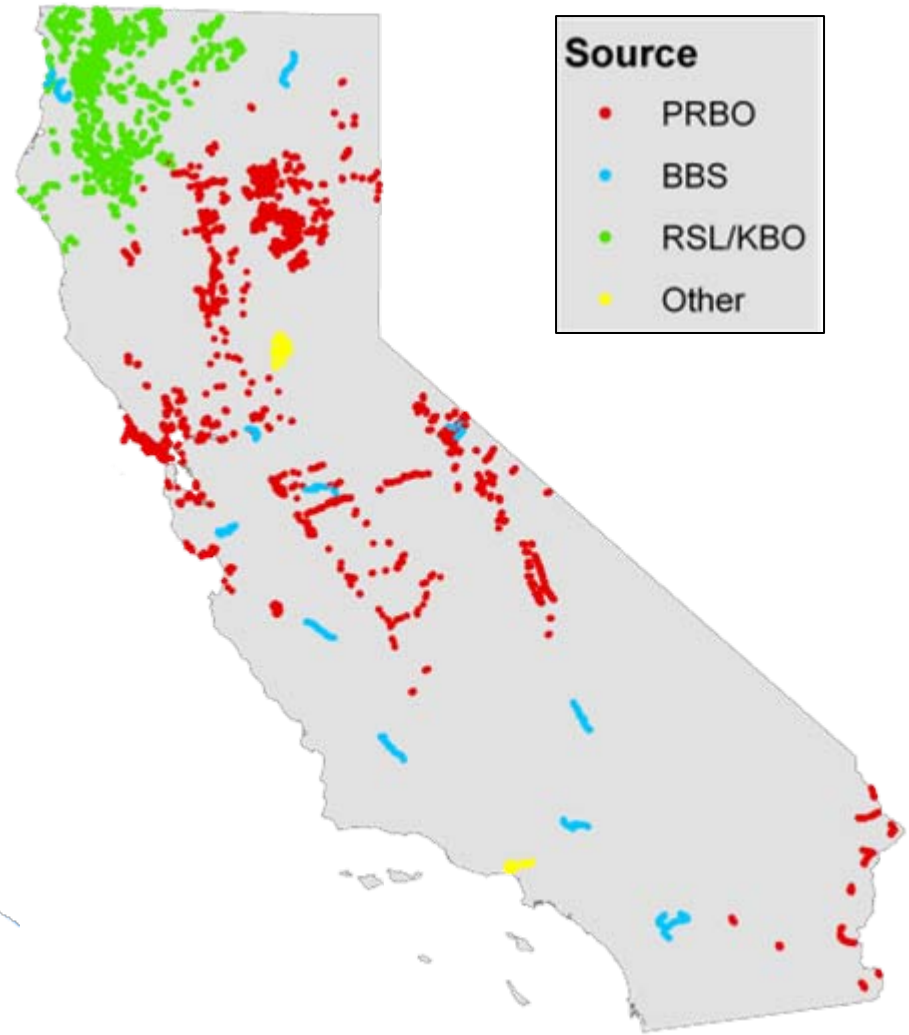
↑

Environmental Variables



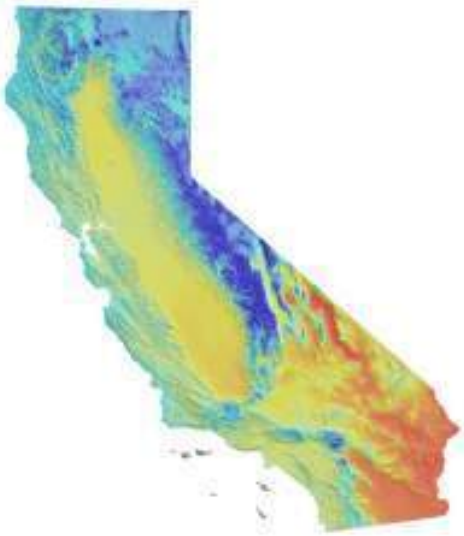
Bird Data

- **Terrestrial breeding birds**
  - **Point count data (presence/absence)**
- **60 CalPIF focal species**
  - **5 major habitat types**



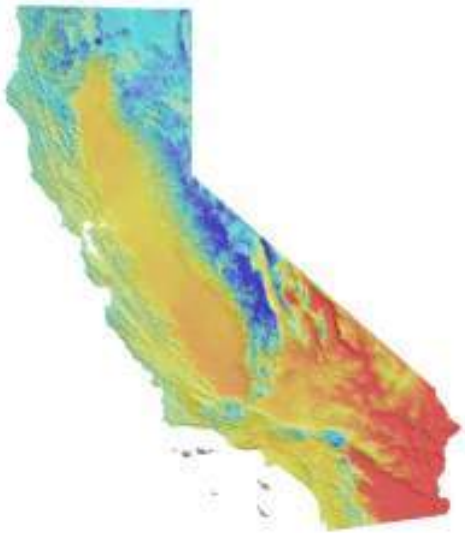
Climate Data

Current:
PRISM 800-m interpolated weather station data (1970-2000)



http://www.prism.oregonstate.edu/ (Daly and Phillips 1994, J. Appl. Meteor.)

Future:
Regional Climate Models
NCAR and GFDL projections (A1b, 2080-2099; A2, 2050-2070)



Scenario A1b, NCAR CSM1.2 40-km RegCM2.5 (Snyder and Sloan 2005, Earth Interactions)

Derived bioclimatic variables:
Mean annual temperature
Mean diurnal range
Isothermality
Temperature seasonality
Mean temp. of warmest quarter
Annual precipitation
Precipitation seasonality
Precipitation of driest quarter

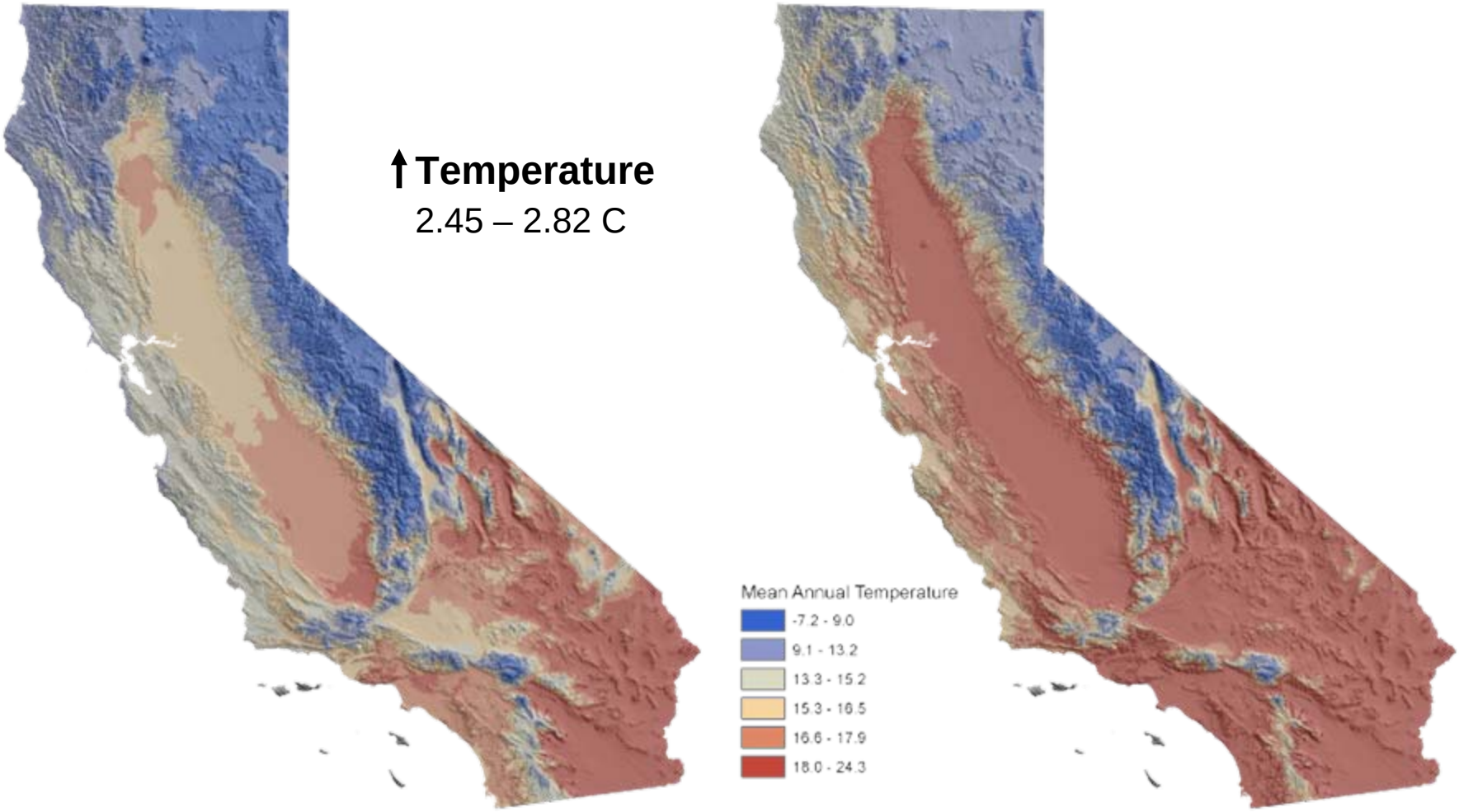
California Climate Change Projections

Current (1970-2000)

Future (2080-2099, IPCC Scenario A1b, NCAR GCM)

Temperature

2.45 – 2.82 C



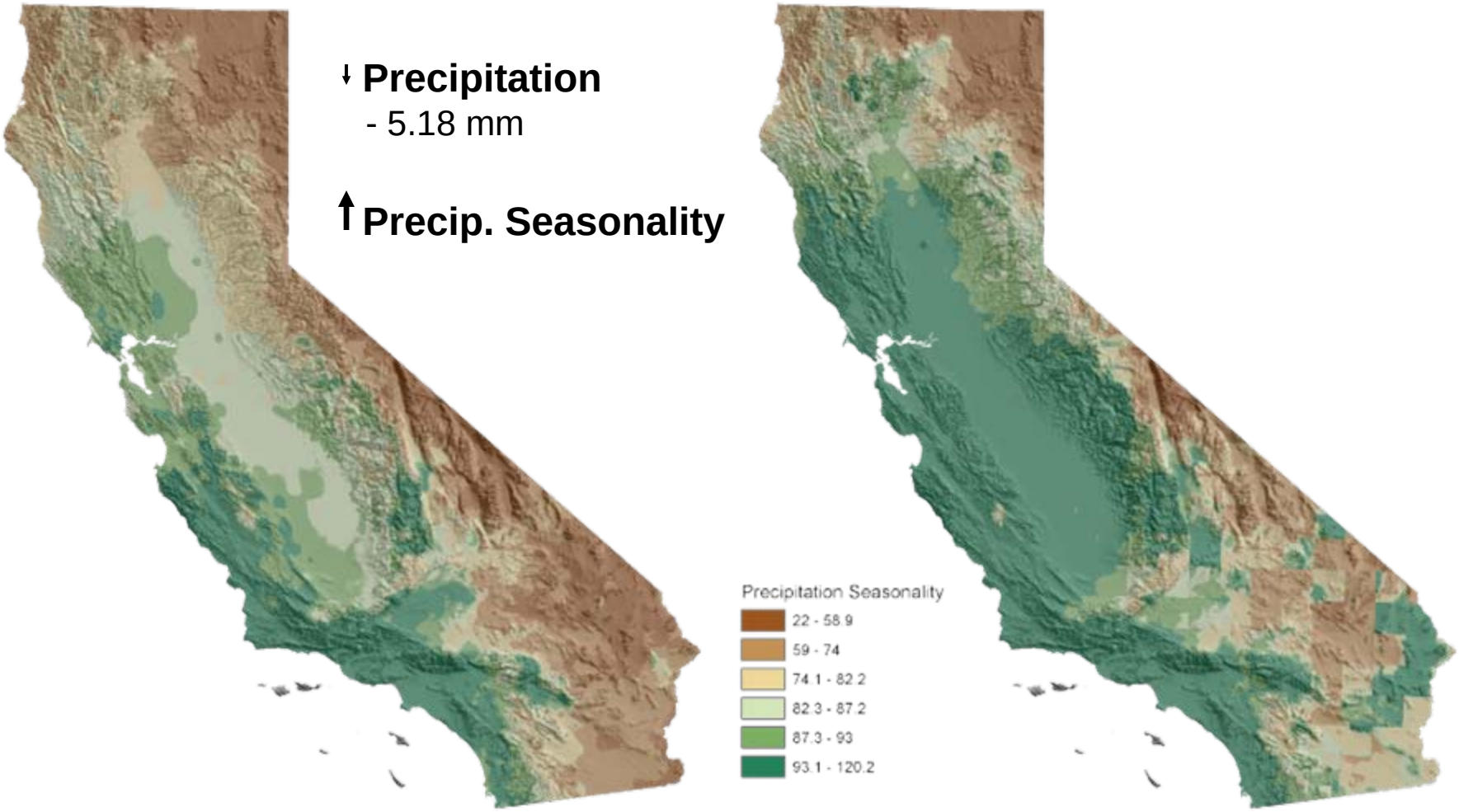
California Climate Change Projections

Current (1970-2000)

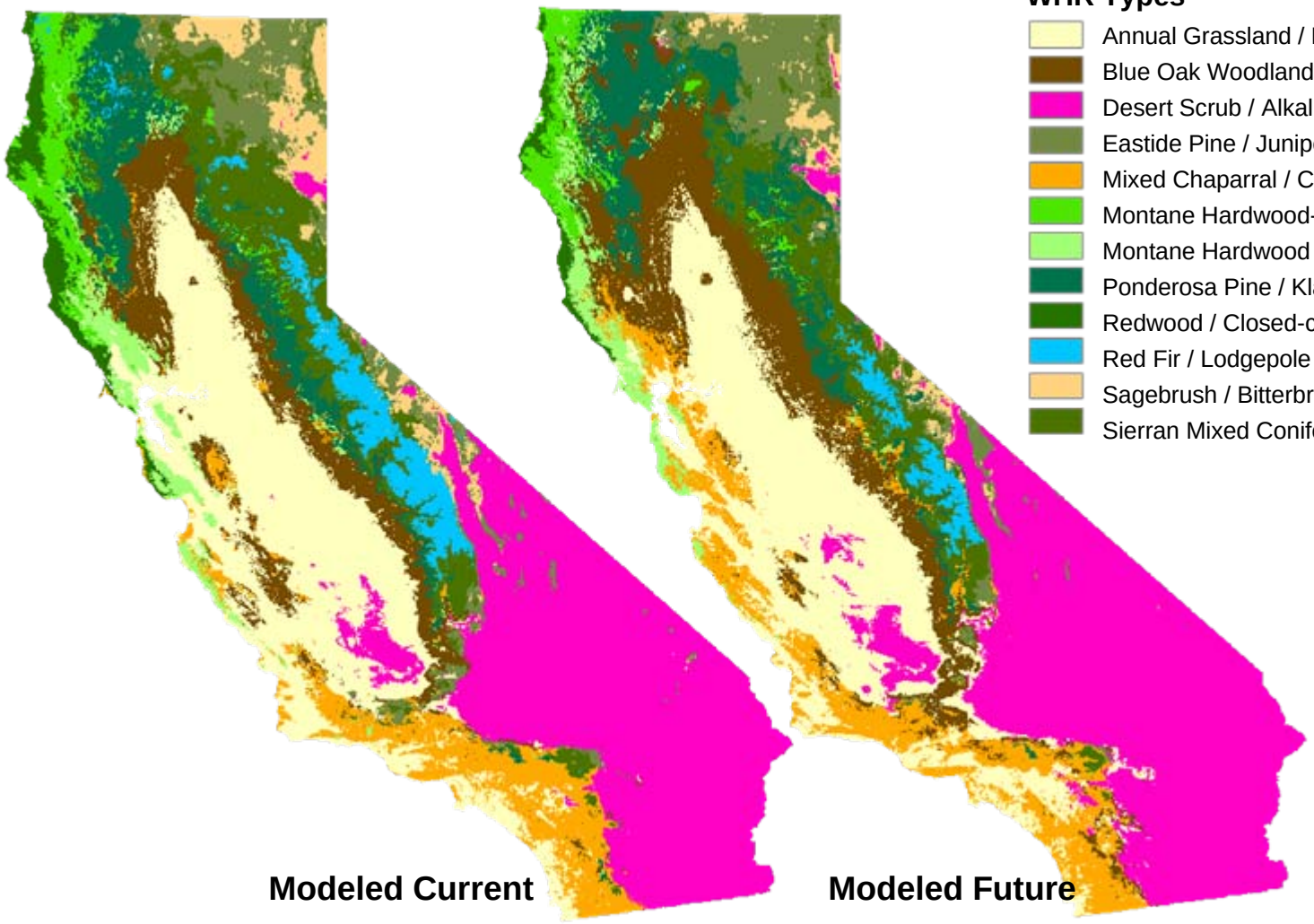
Future (2080-2099, IPCC Scenario A1b, NCAR GCM)

↓ Precipitation
- 5.18 mm

↑ Precip. Seasonality



Vegetation Change



Modeled Current **Modeled Future**

(Random Forest classification algorithm, 72% accuracy)

WHR Types

- Annual Grassland / Perennial Grassland
- Blue Oak Woodland / Blue Oak-Foothill Pine
- Desert Scrub / Alkali Desert Scrub
- Eastide Pine / Juniper / Pinyon-Juniper
- Mixed Chaparral / Coastal Scrub
- Montane Hardwood-Conifer / Douglas-fir
- Montane Hardwood / Coastal Oak Woodland
- Ponderosa Pine / Klamath Mixed Conifer
- Redwood / Closed-cone Pine
- Red Fir / Lodgepole Pine / Subalpine Conifer
- Sagebrush / Bitterbrush / Low Sage
- Sierran Mixed Conifer / White Fir / Jeffrey Pine

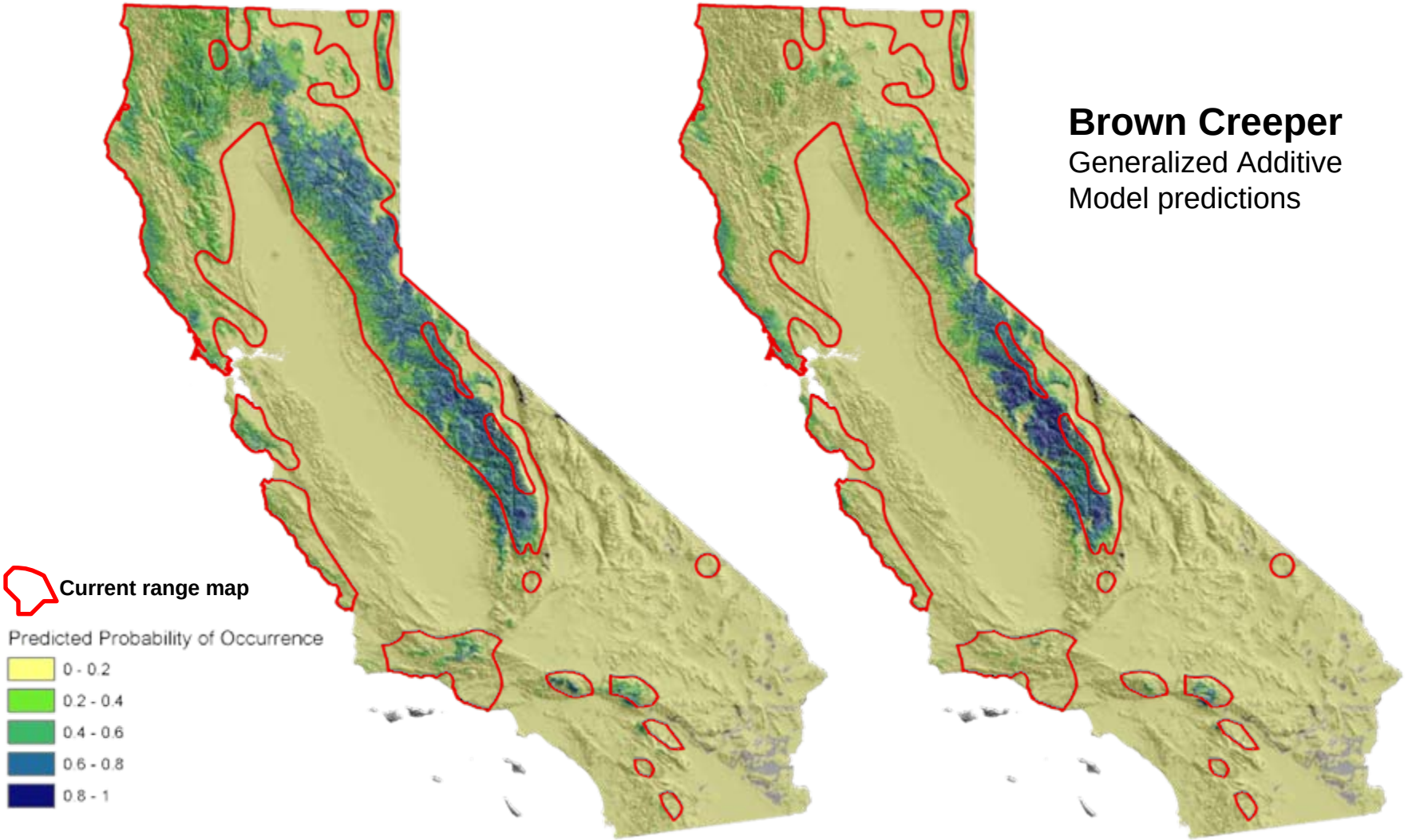
Vegetation Data Source:
California Gap Analysis Project

Model Inputs:
- Bioclimatic Variables
- Solar Radiation
- Slope
- Soil pH
- Soil permeability
- Soil available water capacity

Individual Species Predictions

Current (1970-2000)

Future (2080-2099, IPCC Scenario A1b, NCAR GCM)



Brown Creeper

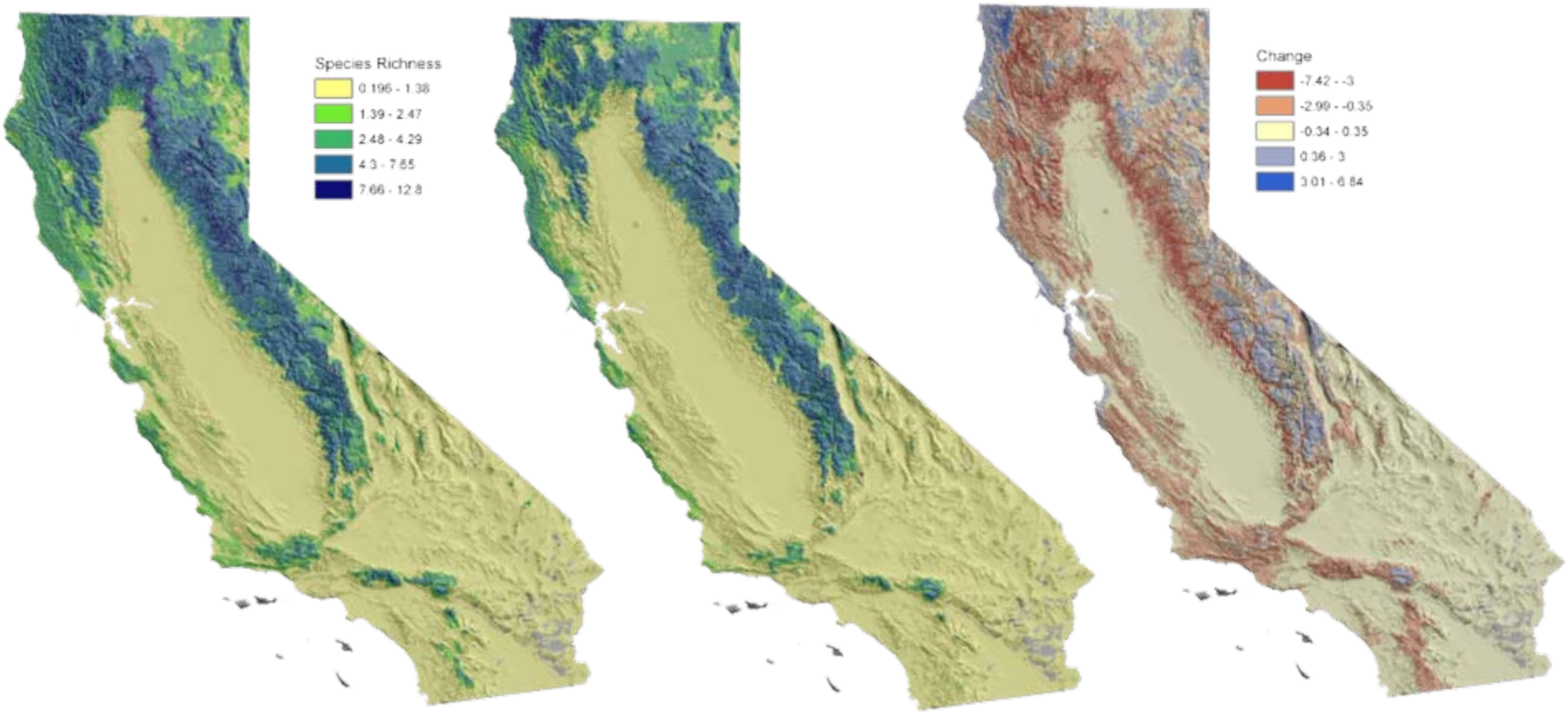
Generalized Additive Model predictions

Habitat Groups – Conifer Species

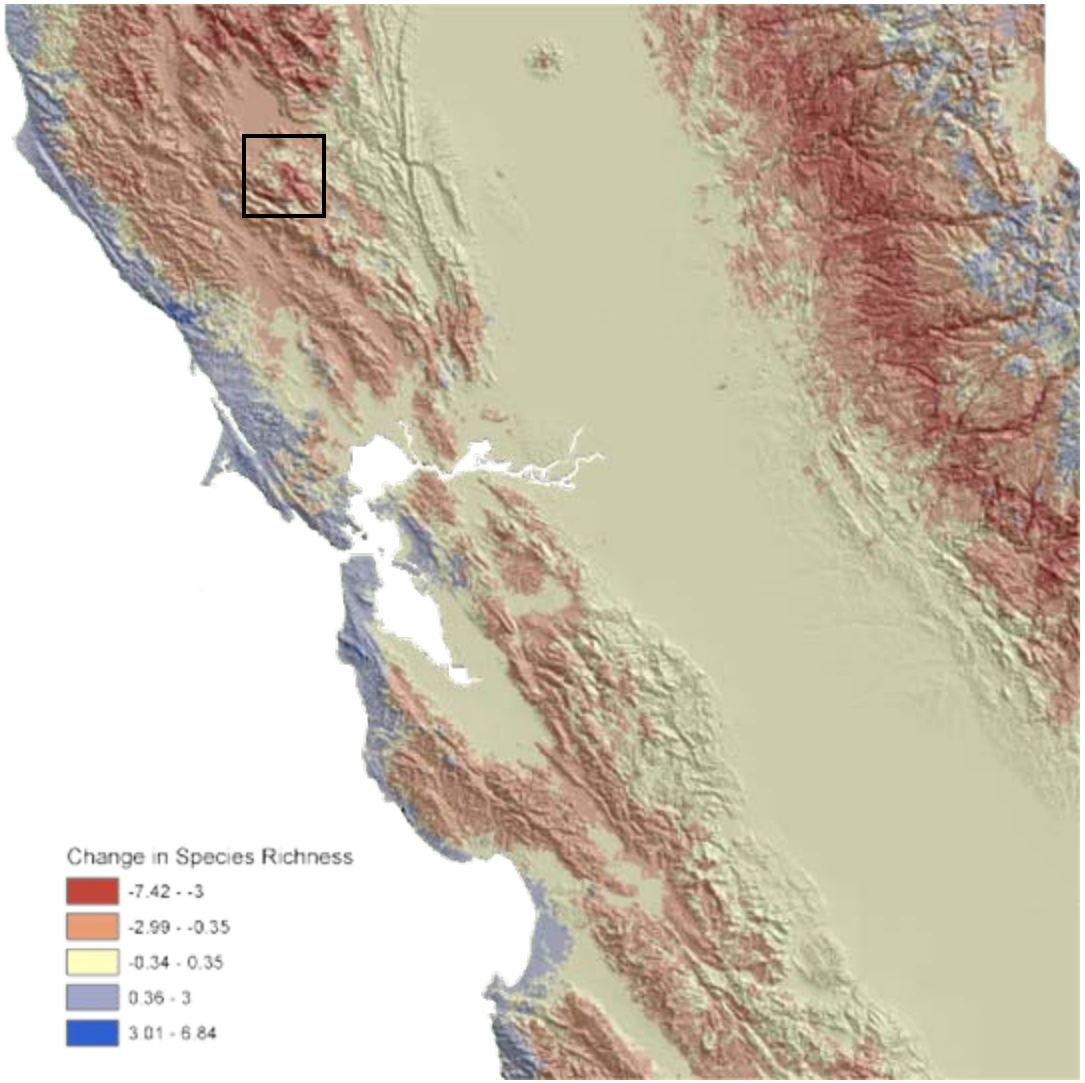
Current # Species

Future # Species

Projected Change

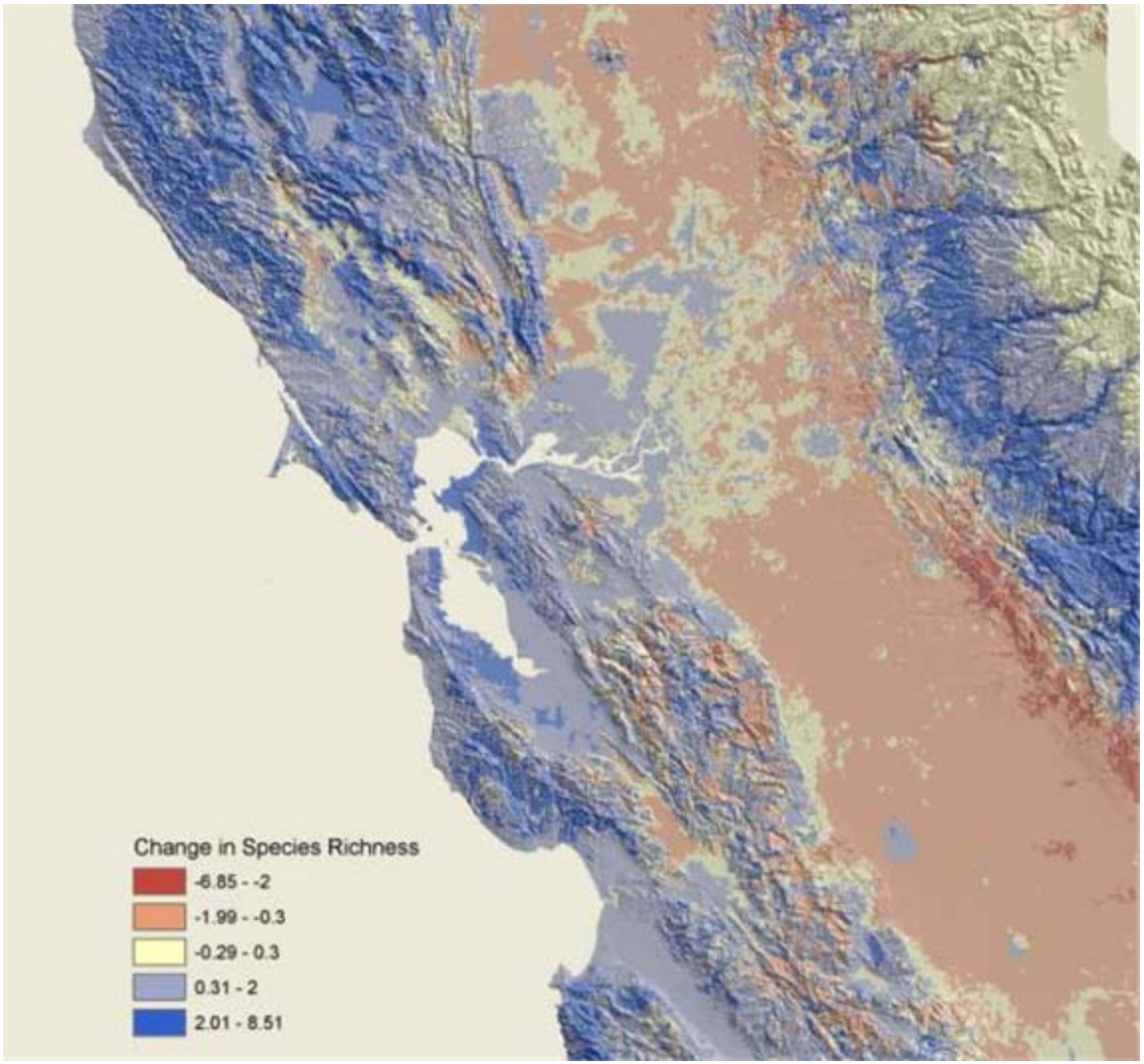


Conifer Species Change – SF Bay Area

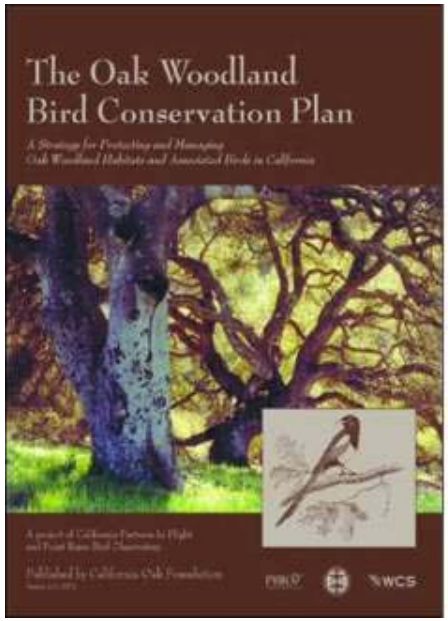


Conifer-Associated Focal Species

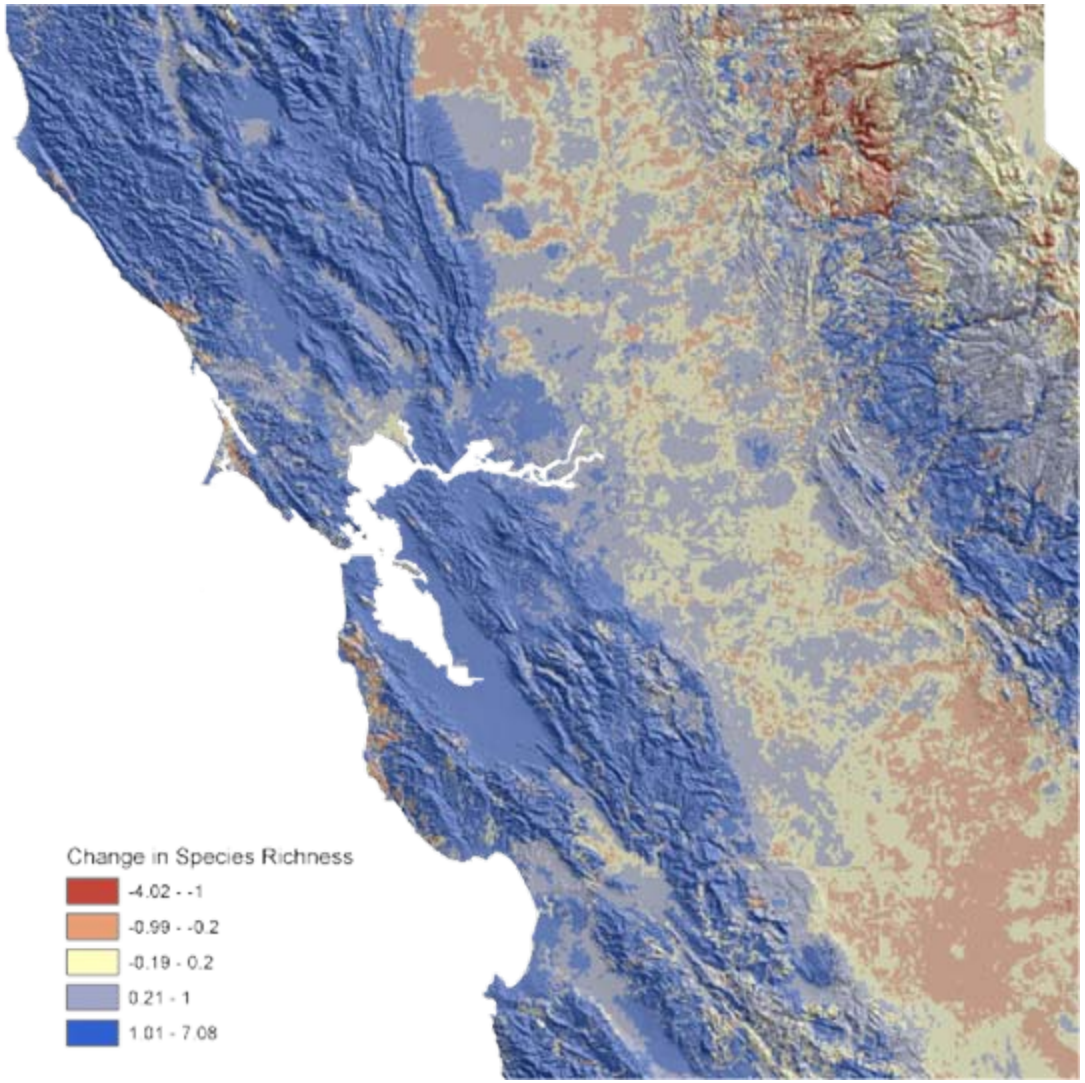
Oak Woodland Species Change



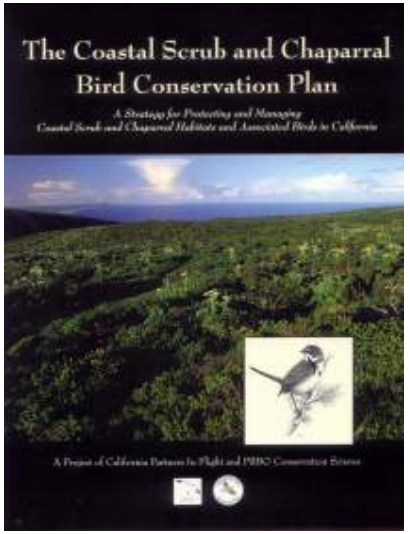
Oak Woodland-Associated Focal Species



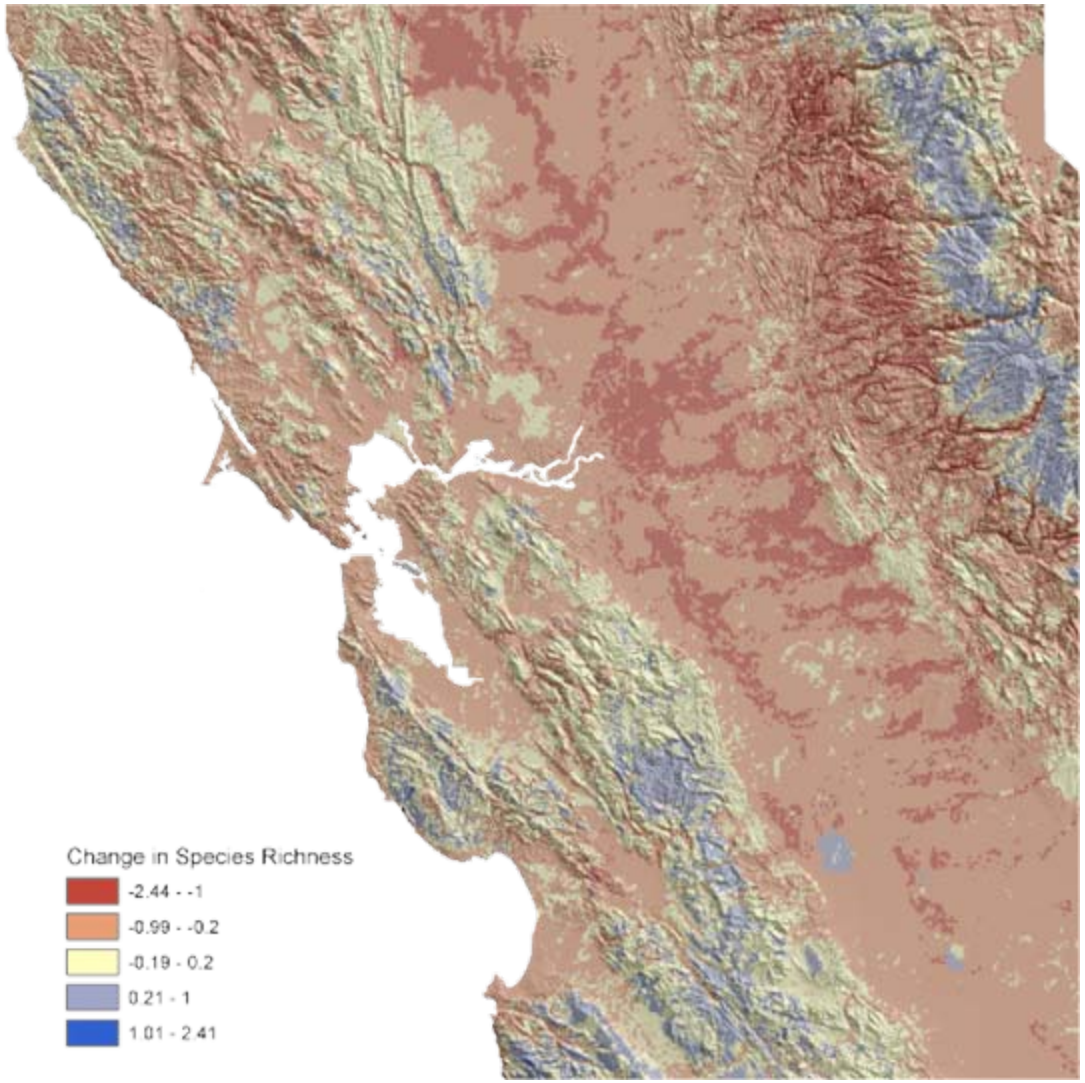
Scrub Species Change



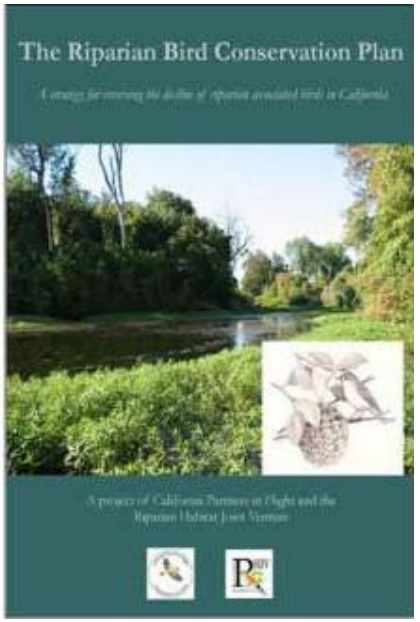
Scrub-Associated Focal Species



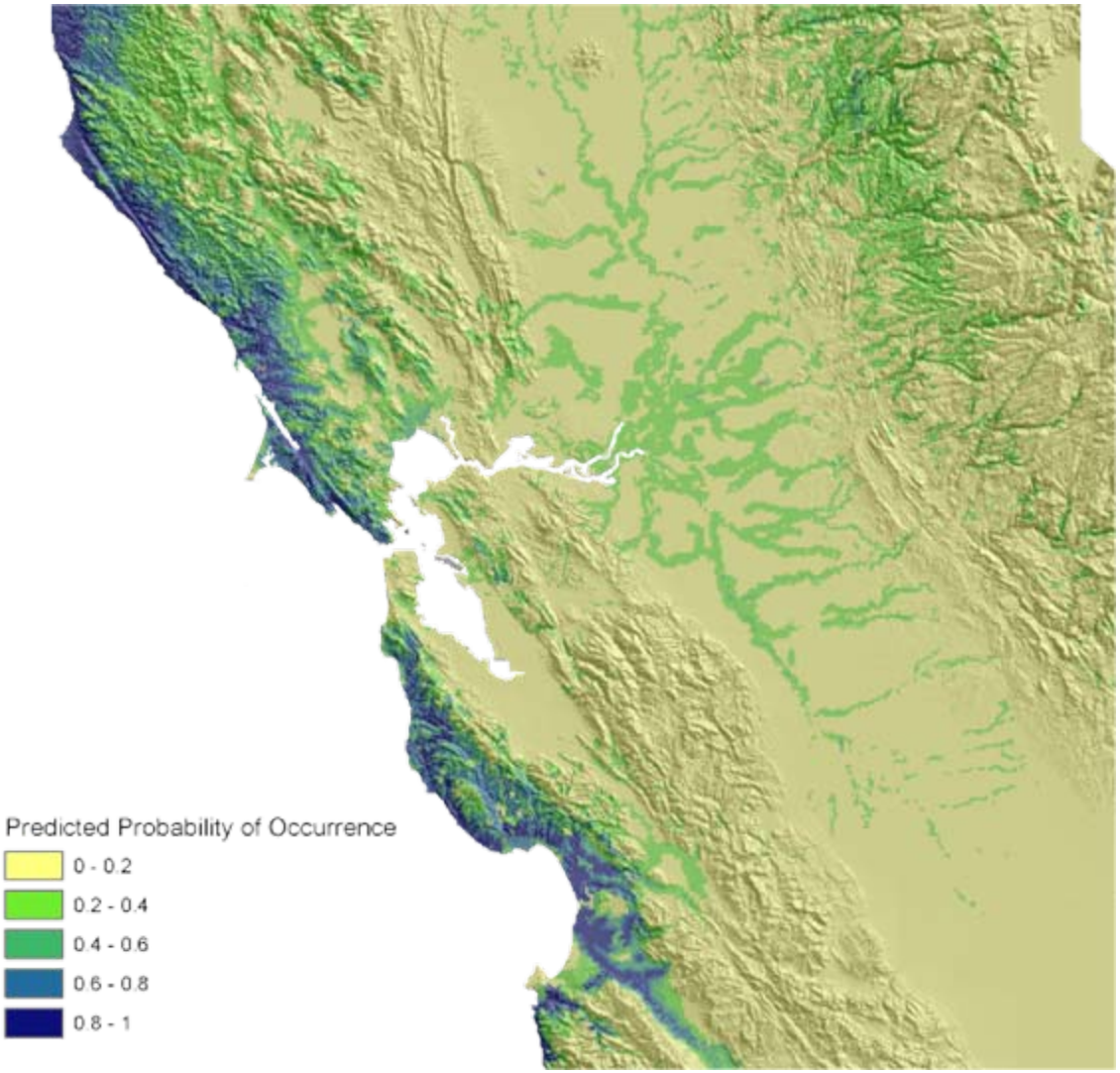
Riparian Species Change



Riparian-Associated Focal Species



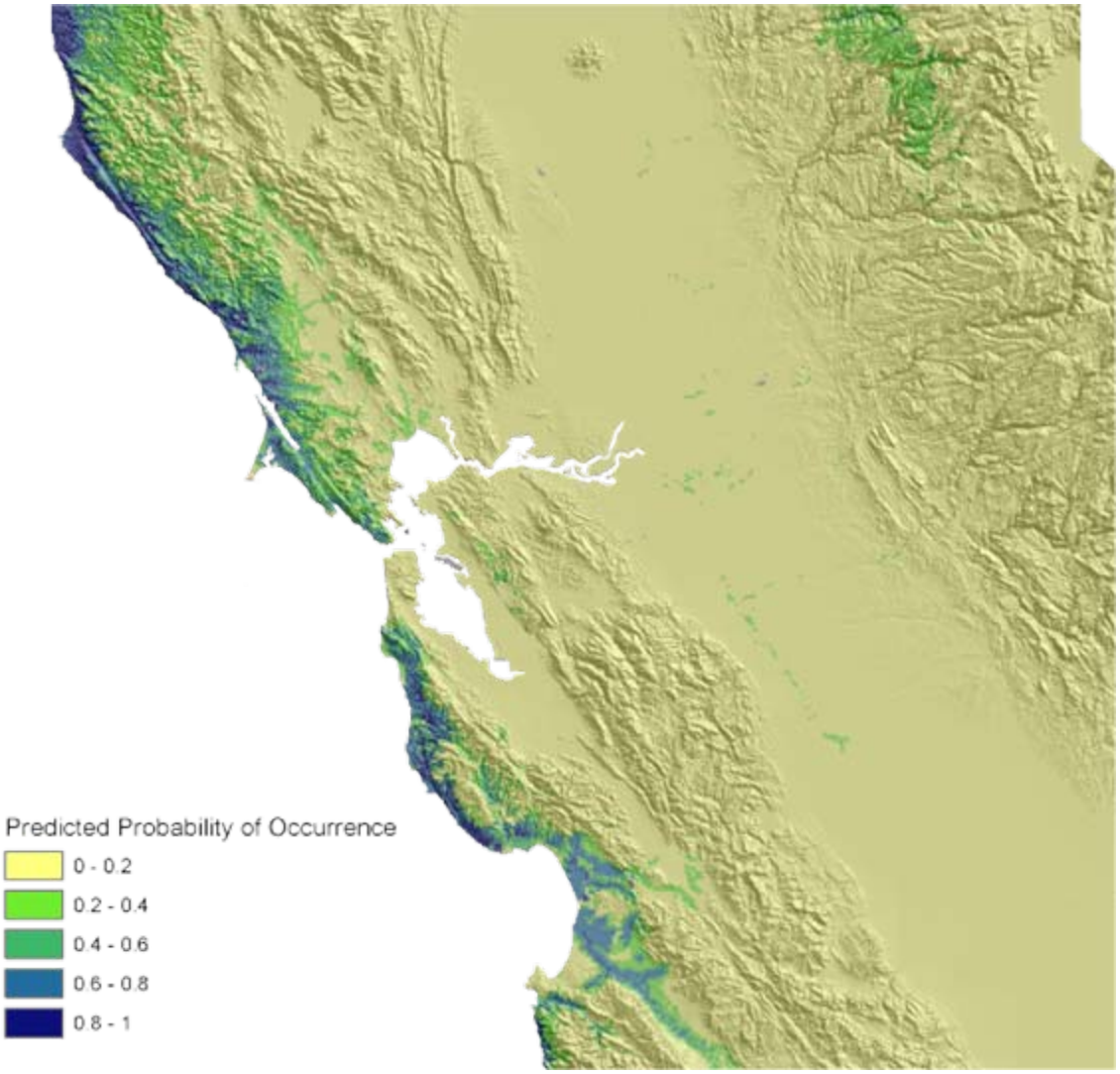
Individual Species Variation



Wilson's Warbler (Riparian Focal Species)

Current Prediction

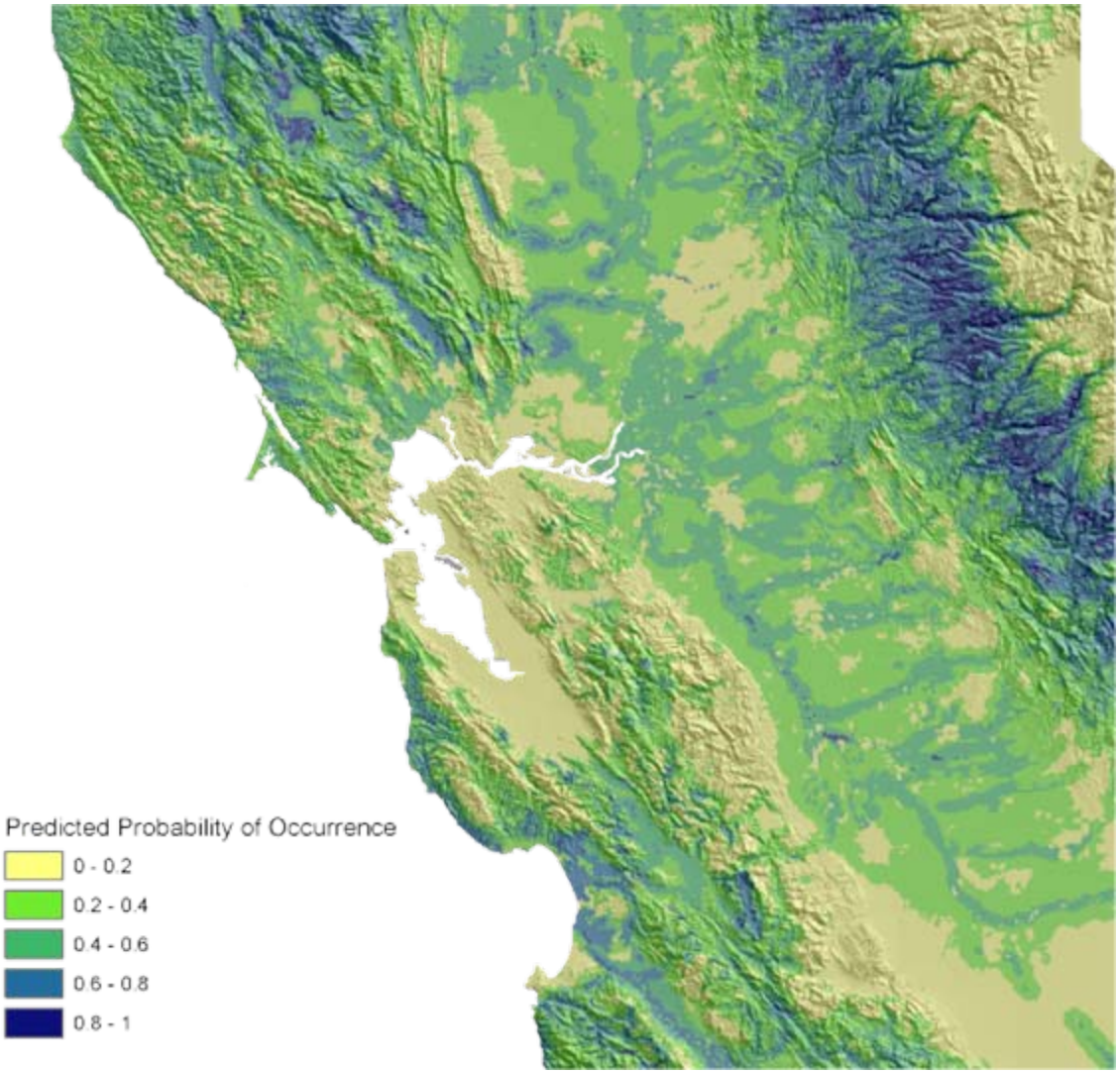
Individual Species Variation



Wilson's Warbler (Riparian Focal Species)

Future Prediction

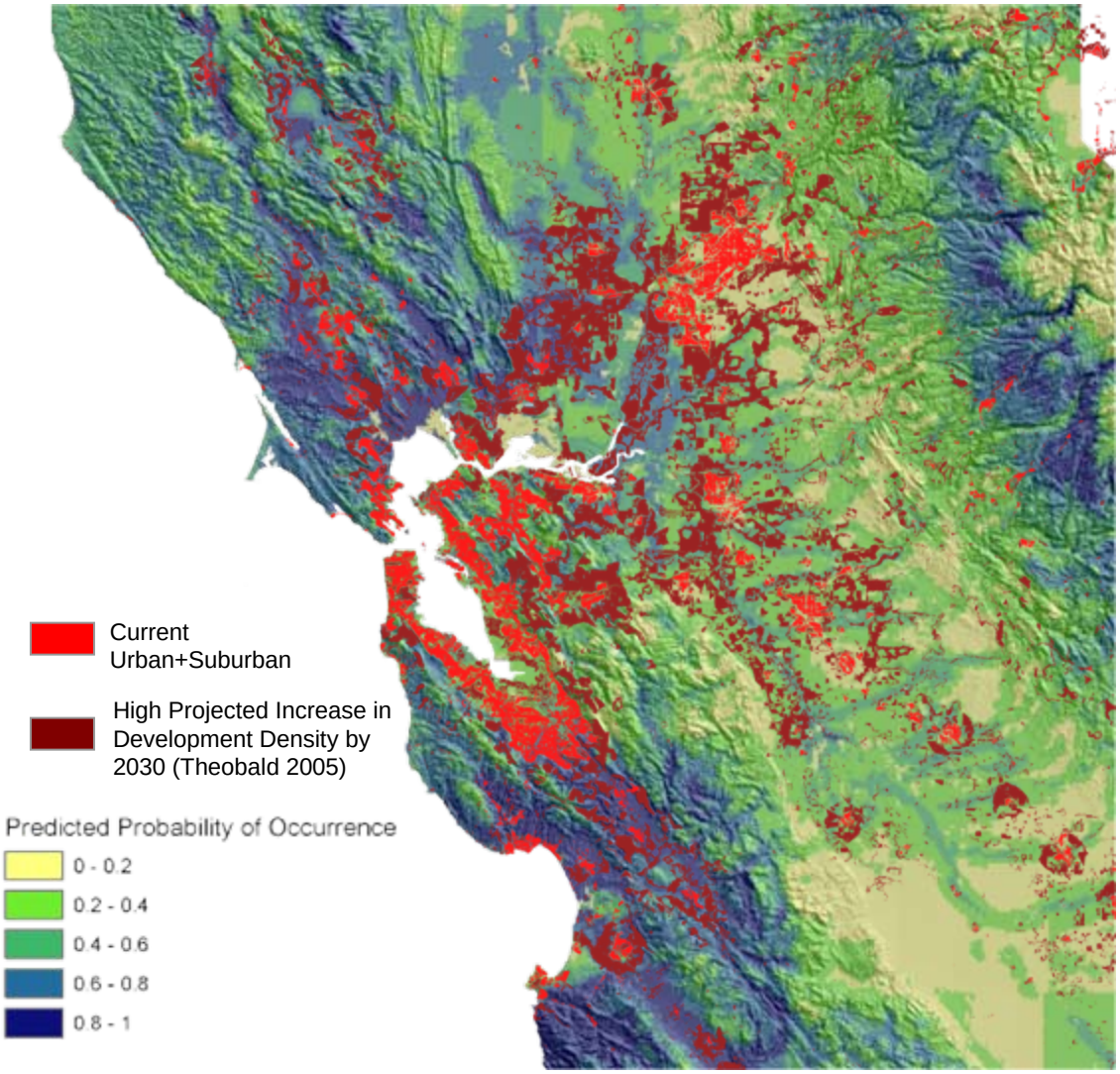
Individual Species Variation



Black-headed Grosbeak (Riparian Focal Species)

Current Prediction

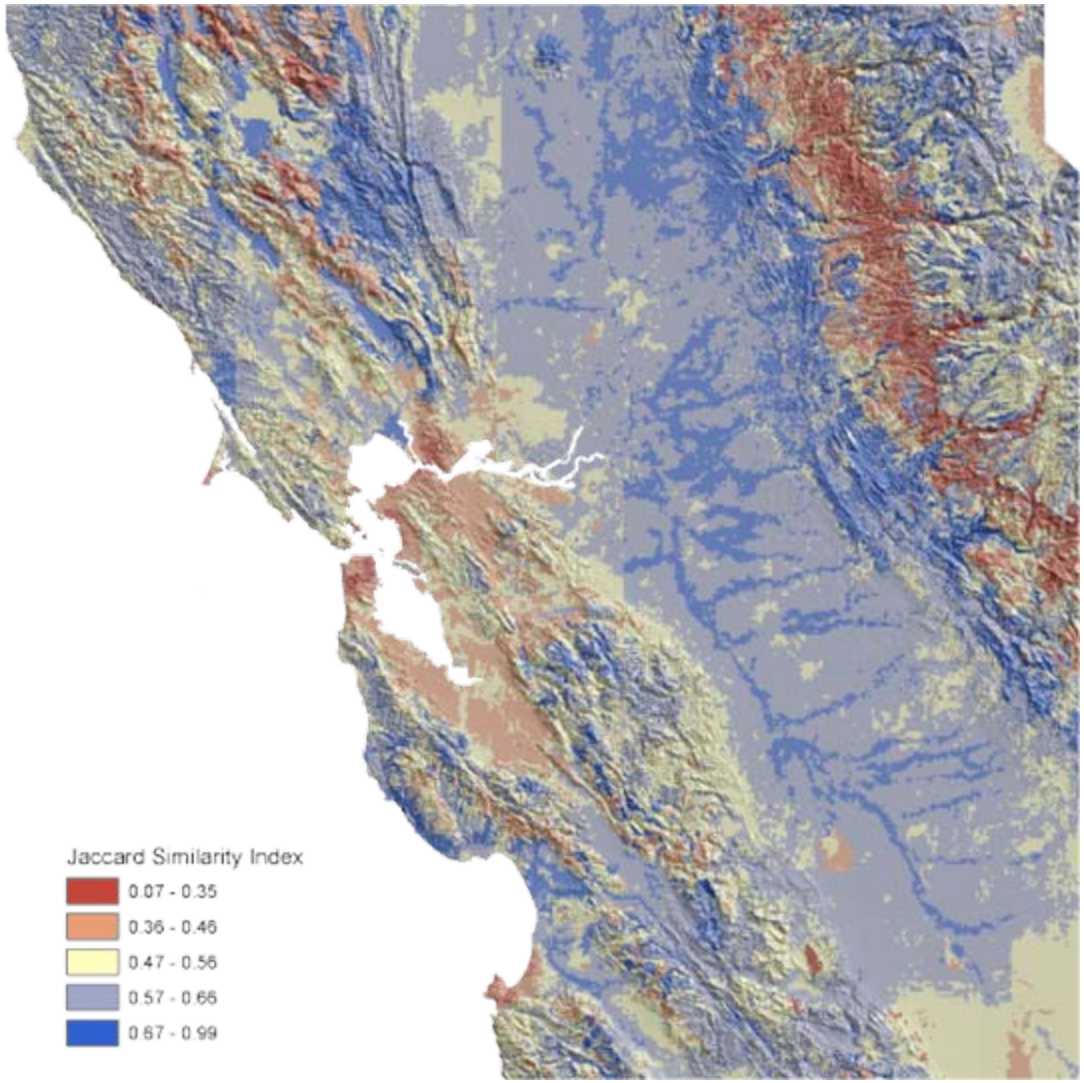
Individual Species Variation



Black-headed Grosbeak (Riparian Focal Species)

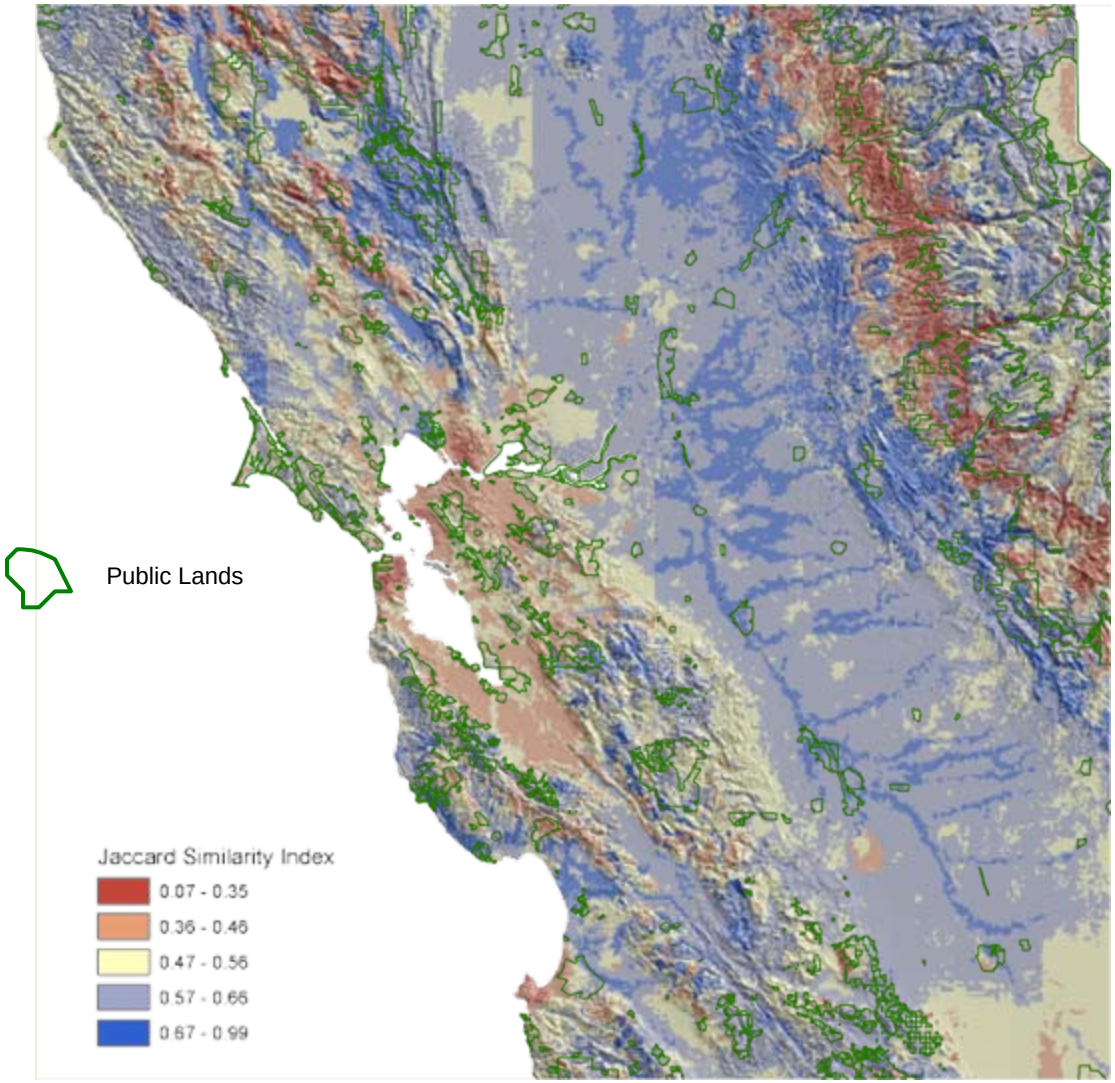
Future Prediction

Avian Community Change



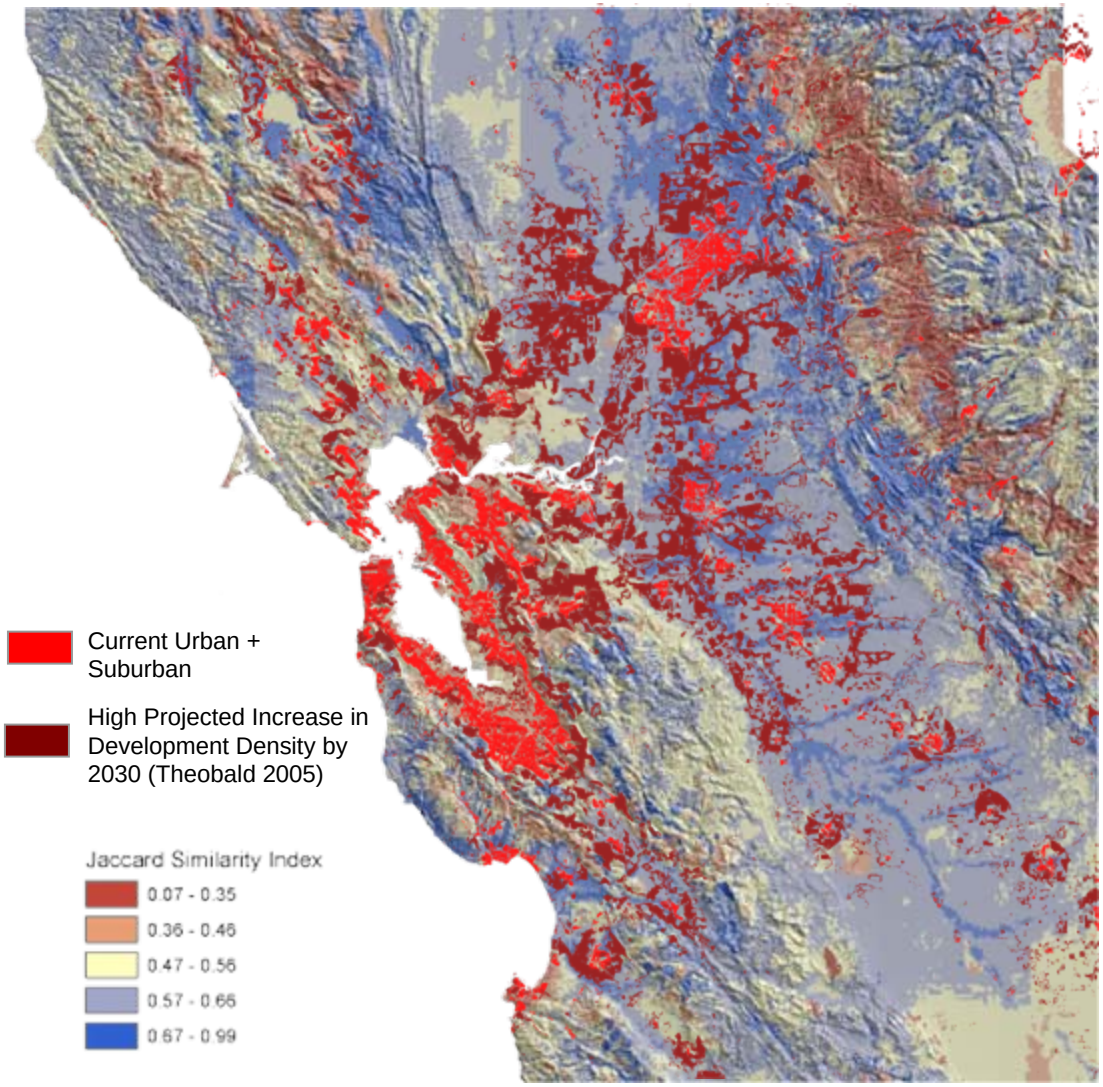
Community Similarity (Current vs. Future)

Avian Community Change



Community Similarity (Current vs. Future)

Avian Community Change



Community Similarity (Current vs. Future)

Preliminary Conclusions

- **Climate change will result in winners and losers**
- **Large geographic variability within species**
- **Large individual species variability within habitats**
- **Small shifts in individual species can result in large community changes**
- **Hotspots of climate AND land use change important**
- **Future species' distributions should be considered in conservation planning**

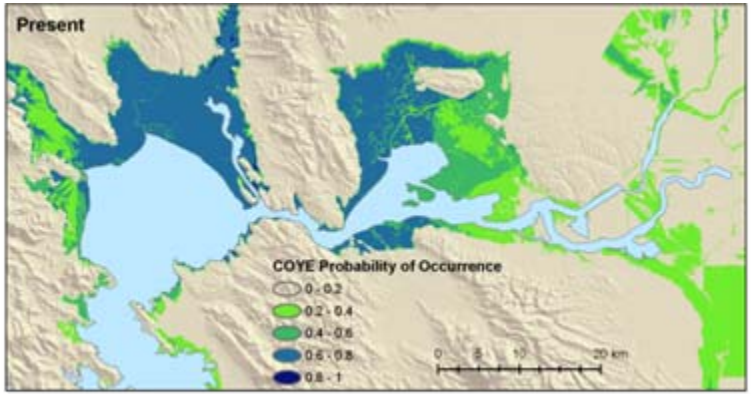
Future Directions

- **Synthesize community-level impacts**
- **Quantify combined effects of climate and land-use change**
- **Identify species and regions of future concern**
- **Future gap analysis / conservation priorities**
- **“Downscale” and refine predictions at regional scale**

Regional Scale Models

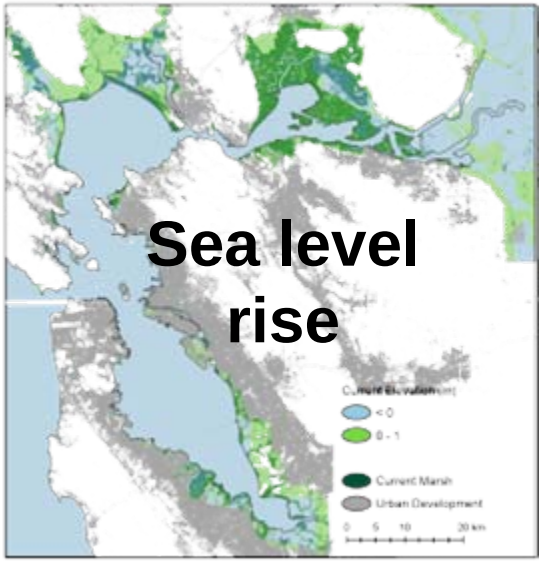
1. California terrestrial breeding birds (ongoing)

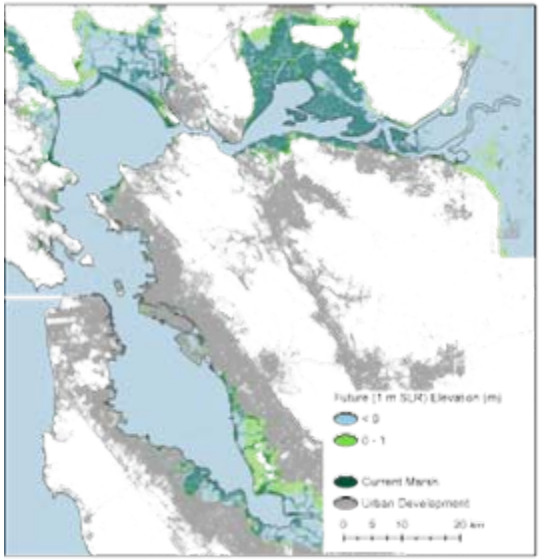
2. San Francisco Bay marsh birds (preliminary)



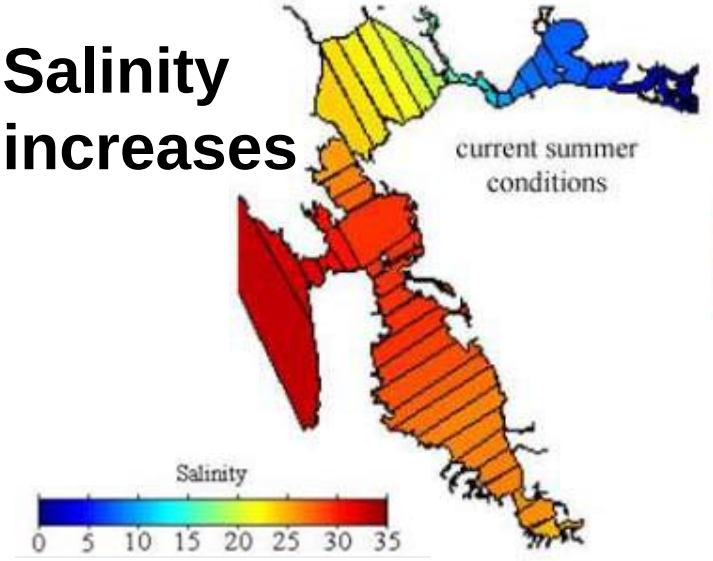
San Francisco Bay Tidal Marsh

Main drivers:

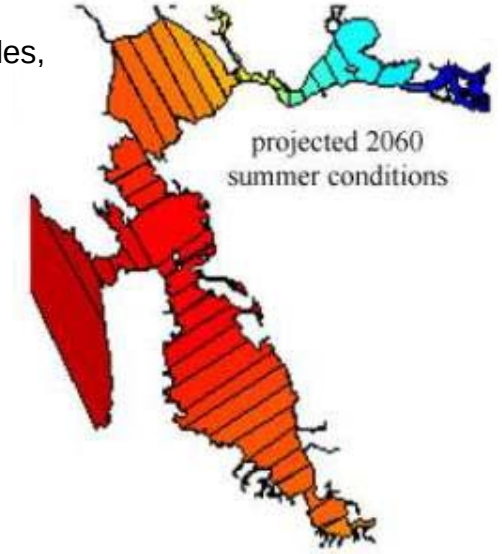




Salinity increases



From N. Knowles, USGS

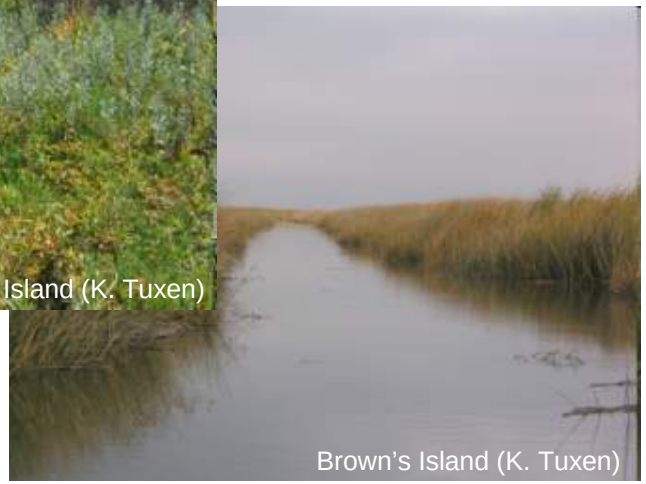


Species Distribution Modeling Approach

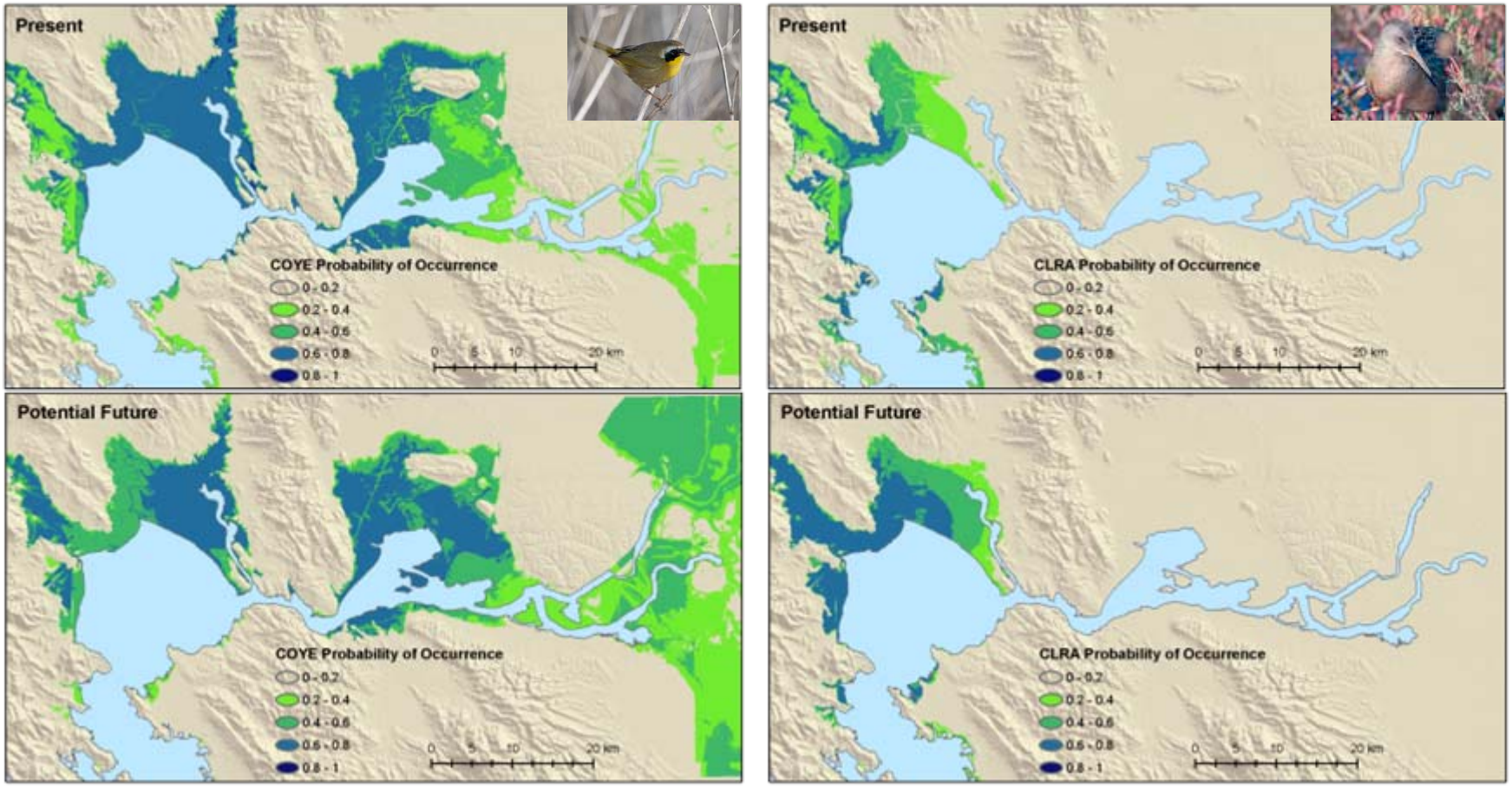
- Preliminary models based on inundation and salinity
- Direct effects (flooding, predator exposure) + indirect effects (vegetation change)
- Data inputs:
  - PRBO point count data
  - 10-m elevation data (NED)
  - salinity projections


Newark Slough


Coon Island (K. Tuxen)

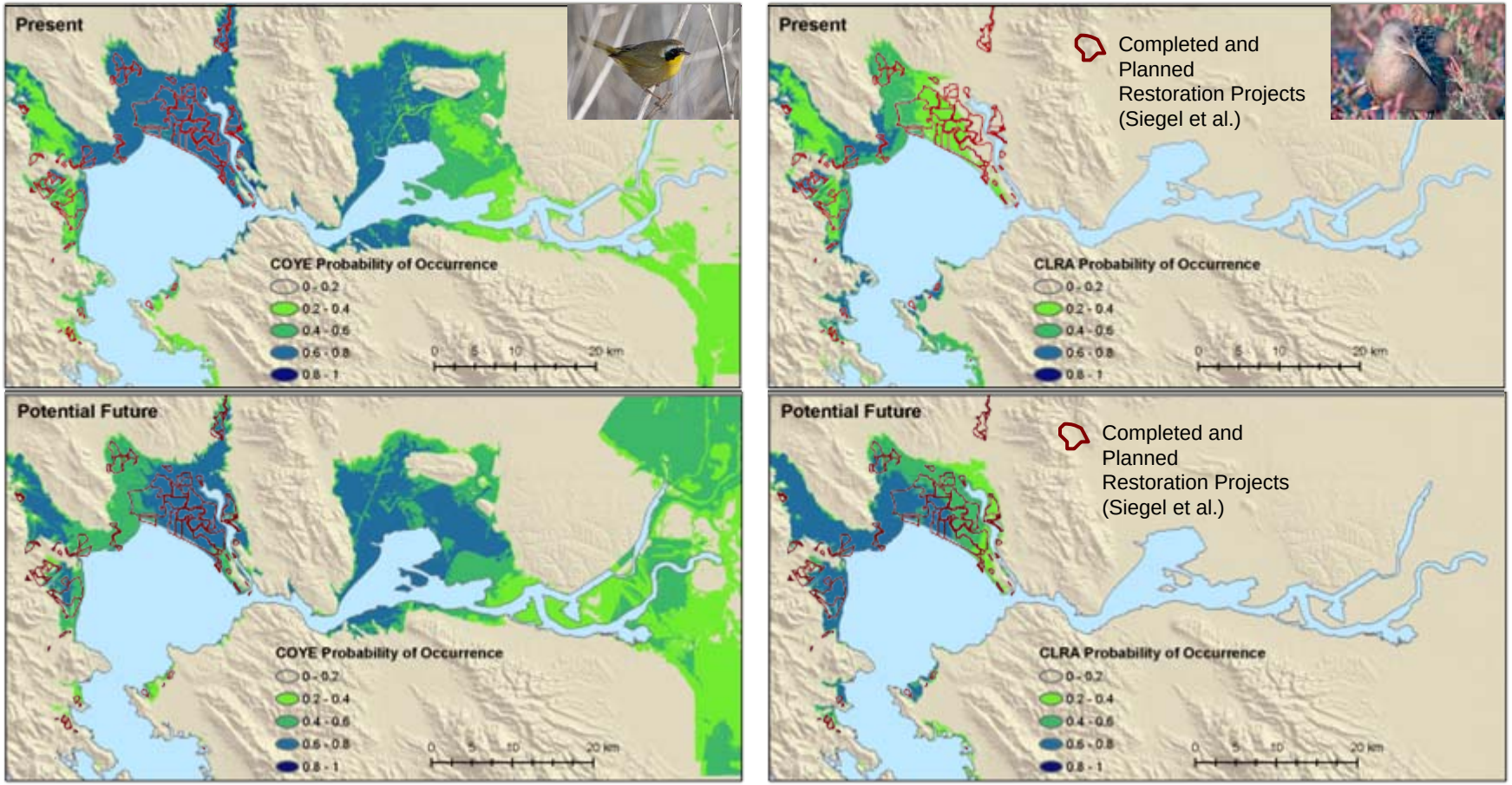

Brown's Island (K. Tuxen)

Preliminary spatial predictions (examples)



Models based on 1-m SLR and increased salinity (projections from N. Knowles)
Maxent distribution modeling algorithm (Phillips et al. 2006)

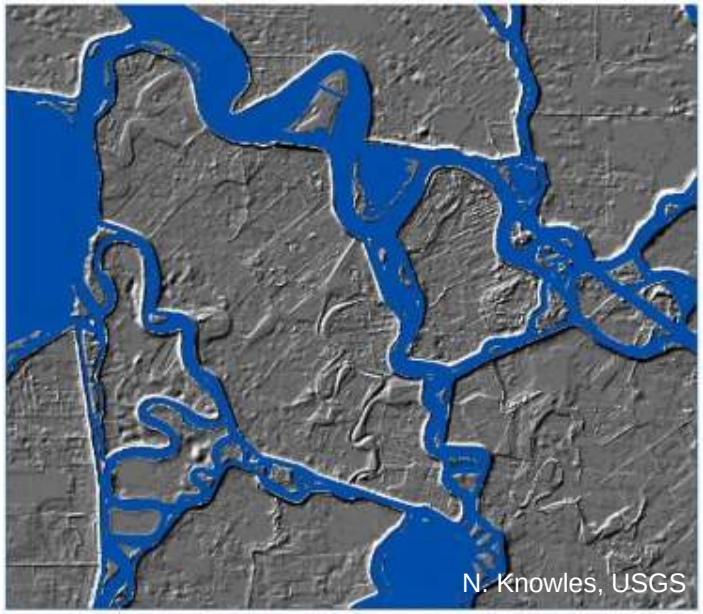
Preliminary spatial predictions (examples)



Models based on 1-m SLR and increased salinity (projections from N. Knowles)
Maxent distribution modeling algorithm (Phillips et al. 2006)

Next steps

- Obtain best available inundation and salinity projections for the Bay
- Include range of realistic marsh accretion estimates
- Model dominant plant species distributions + avian responses
- Evaluate influence of levee infrastructure
- Analyze community change, current/future conservation and restoration priorities


N. Knowles, USGS


K. Tuxen, IRWM Project

Conclusions

- Distribution models useful tools for assessing potential ecological responses to climate change
- Appropriate scale and data inputs are key
- Conservation planning should incorporate effects of climate and land use change

Acknowledgments

California modeling

- **Bird Data:** Klamath Bird Observatory, Redwood Sciences Laboratory (USFS), Breeding Bird Survey (USGS), PRBO terrestrial division staff and interns
- **Environmental Data:** PRISM Climate Group, California Gap Analysis Project, Dave Theobald
- **Funding:** Anonymous, Fawcett Family Foundation

San Francisco Bay modeling

- **Bird Data:** PRBO wetland division staff and interns
- **Environmental Data:** Noah Knowles, USGS
- **Collaborators:** T. Parker, J. Callaway, M. Kelly, L. Schile
- **Funding:** San Francisco Foundation