Monitoring Golden Eagle Occupancy and Reproduction in Variable Environments

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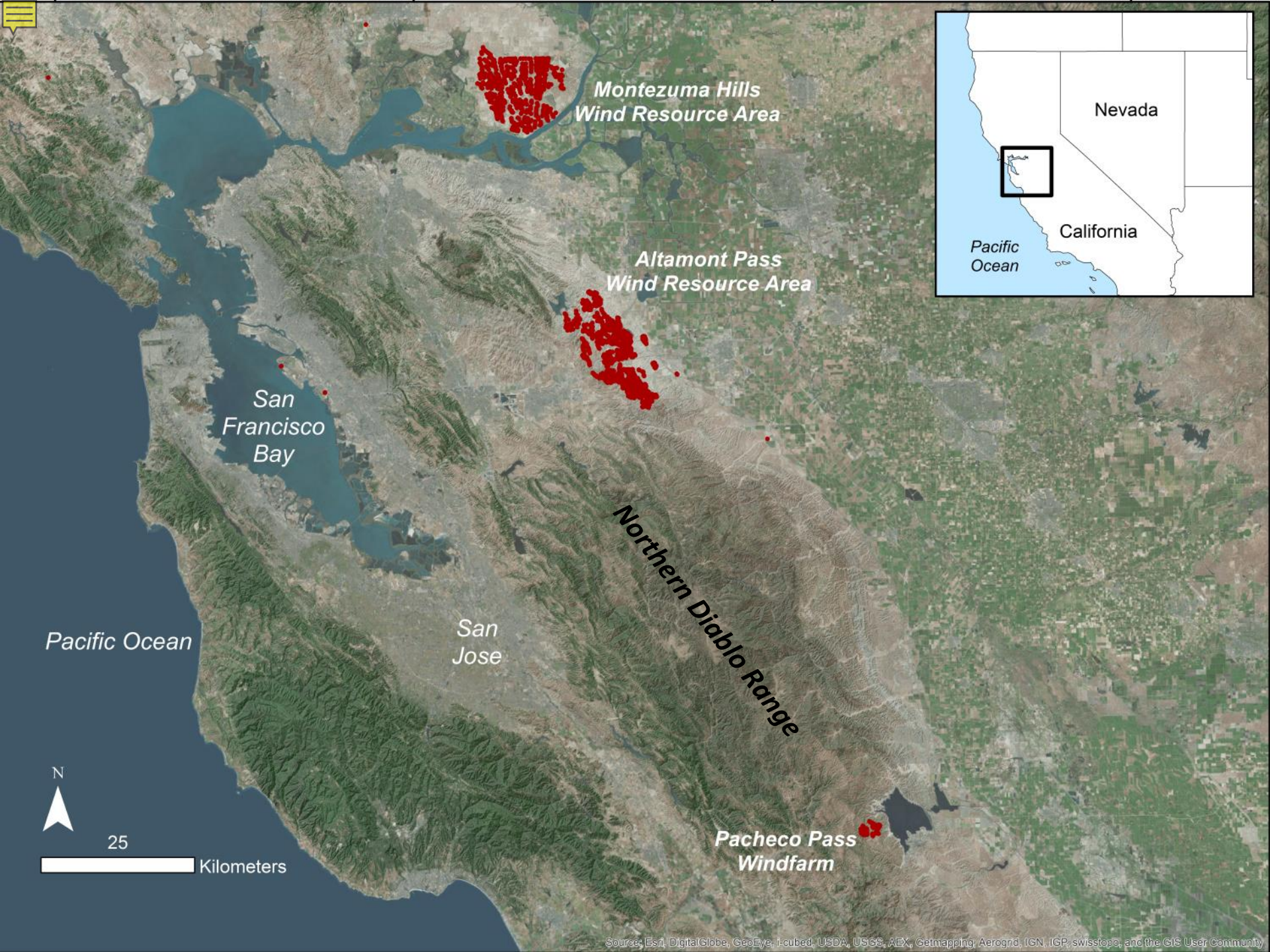
U.S. Fish & Wildlife Service

East Bay Regional Park District

NEXTera ENERGY

The Peregrine Fund


Altamont Pass/
Northern Diablo Range
Western San Diego County
Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors,


Montezuma Hills
Wind Resource Area
Altamont Pass
Wind Resource Area
San
Francisco
Bay
Pacific Ocean
San
Jose
Northern Diablo Range
Pacheco Pass
Windfarm
N
25
Kilometers
Nevada
California
Pacific
Ocean
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

25 – 110 Golden Eagles killed by collisions with wind turbines in APWRA each year, 1998 – 2002
(Smallwood and Thelander 2008)

Photo by P. Kolar

What are the cumulative, population-level consequences of turbine blade-strike fatalities?

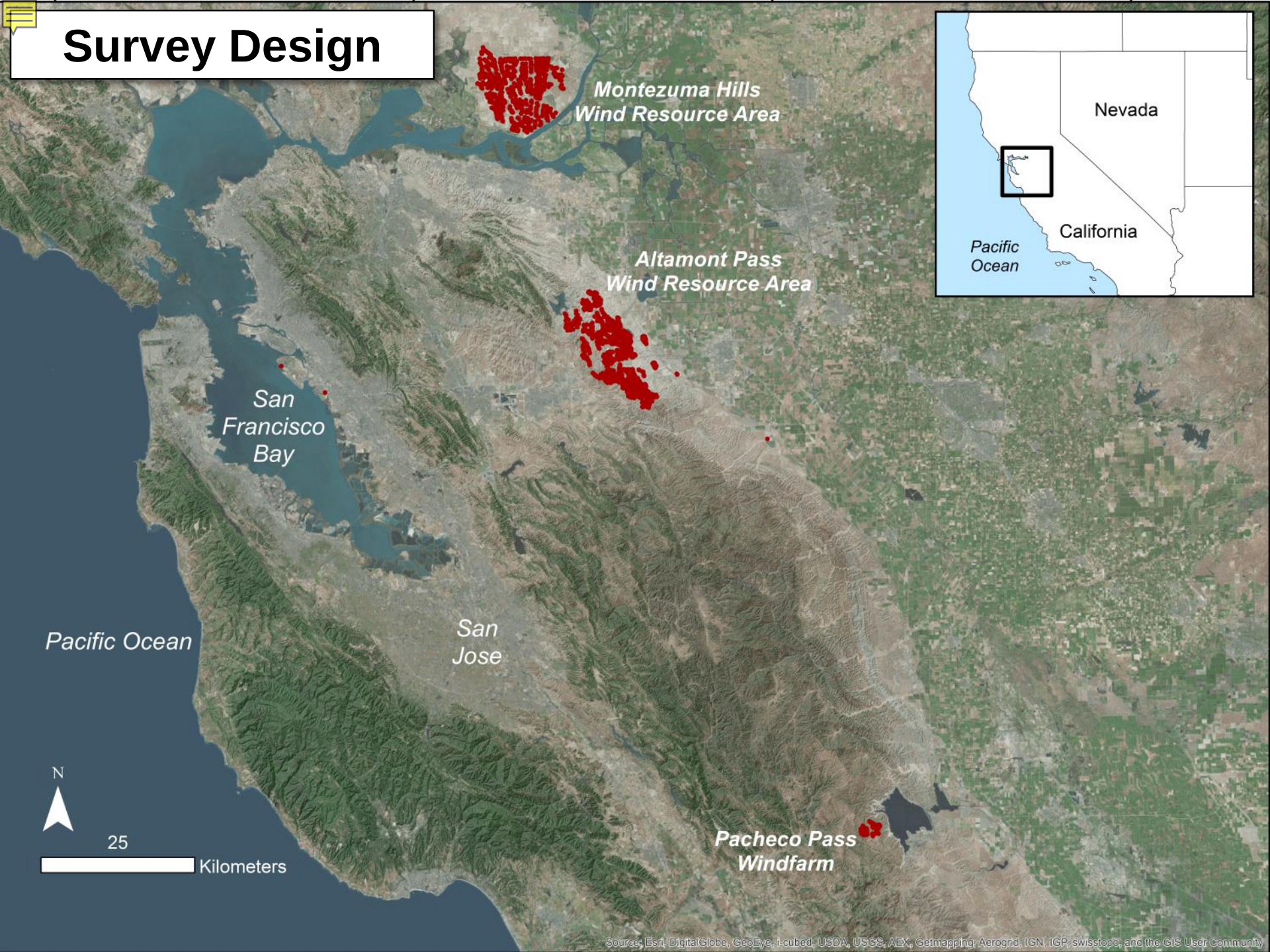
Research Objectives

1. Characterize spatial variation in quality of breeding sites, as measured by site occupancy and reproduction of territorial pairs

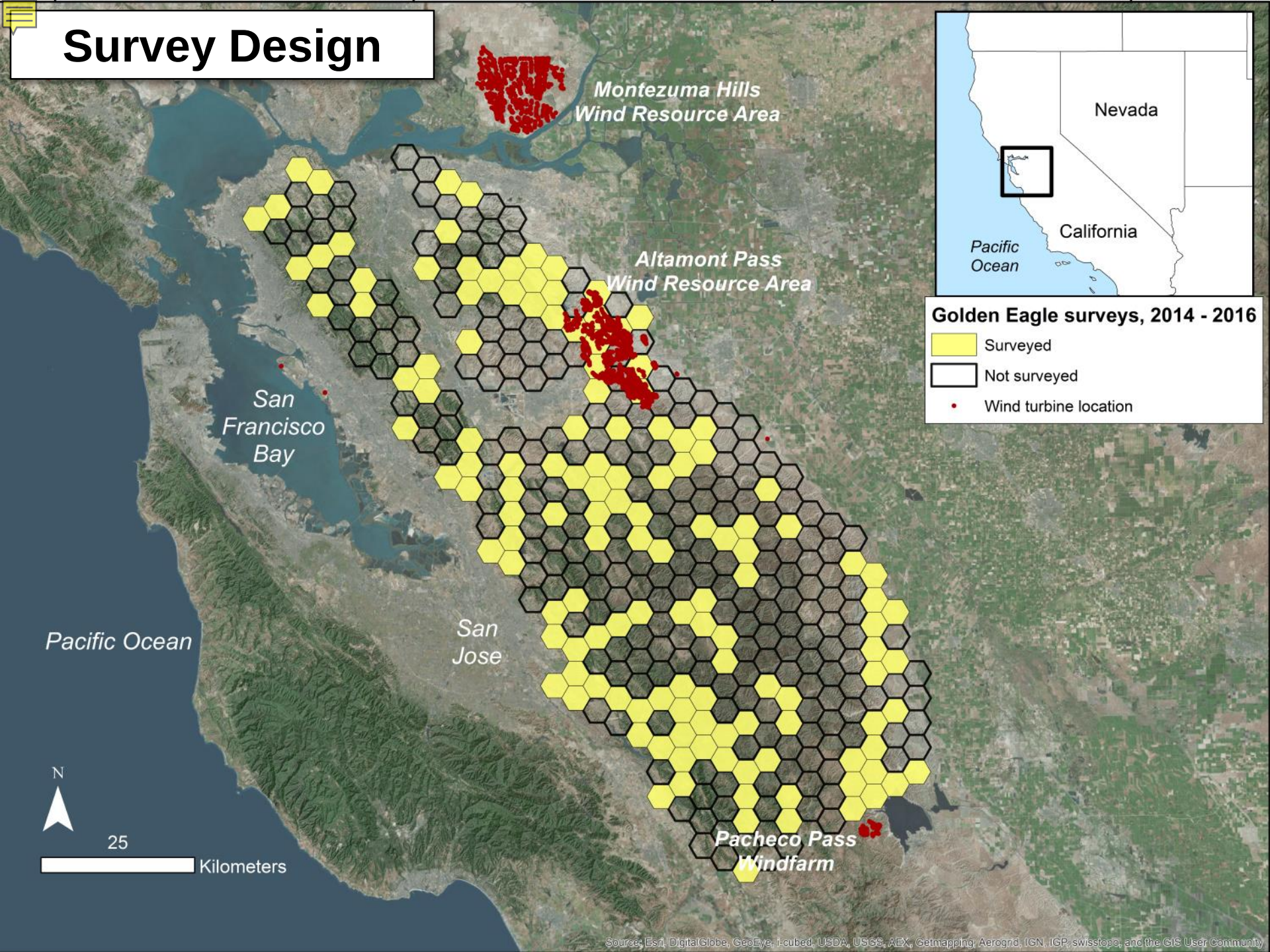
2. Develop predictive spatial models of site usage by breeding and nonbreeding Golden Eagles

3. Provide recommendations to identify and monitor site quality of Golden Eagles at multiple spatial scales

Survey Design

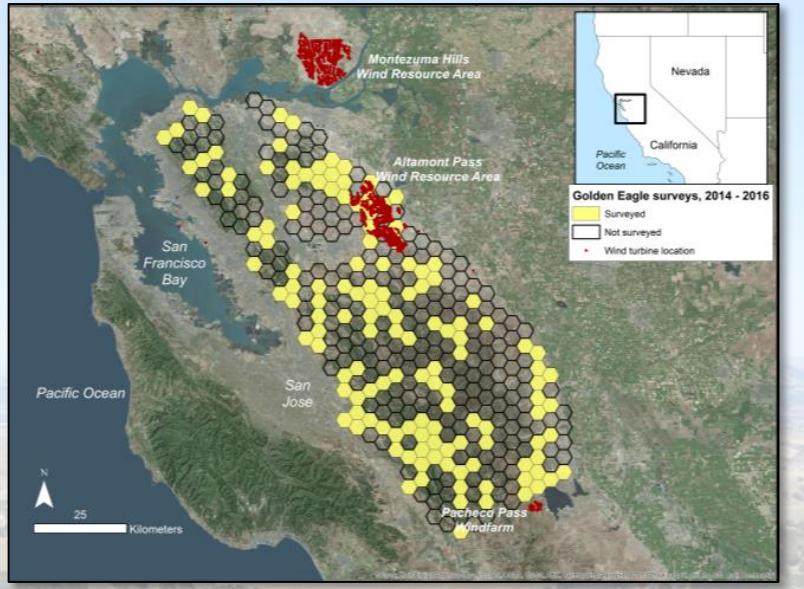


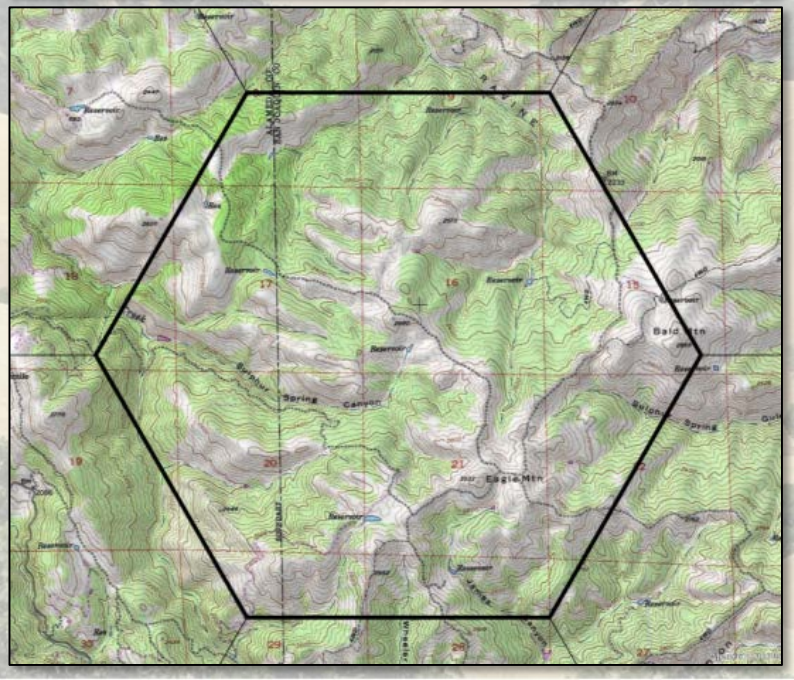
Survey Design



Survey Design

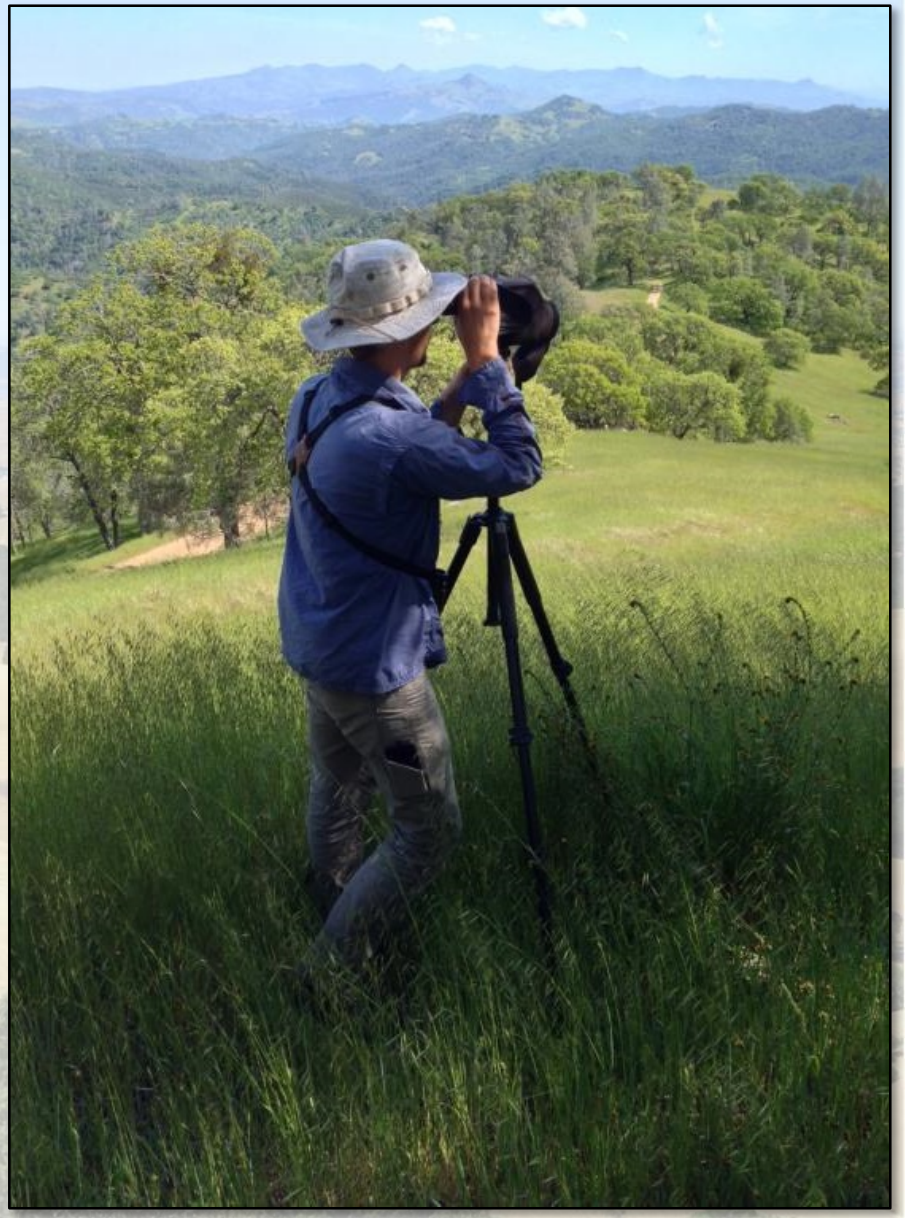
- Randomly selected 138 of 373 sites
- Survey ‘site’ = **1,385 ha hexagon**
  - based on mean territory size
- Each site searched on **4** repeated visits during the breeding season (15 Dec – 31 July)
- On each visit, site is classified as:
  - no pair detected
  - occupied by pair with no young
  - occupied by pair with young





Eagle Survey Protocol

- 4-hr observation period each visit
- Record location, behavior, age, and pair status of all Golden Eagles
  - surveys also included *BAEA*
- Estimate “activity center” of pairs
  - used nest location
  - observations of adults with young
  - territorial displays
- Record number of GOEA detected (territorial adults, subadults)



Key Sources of Variation: Landscape Conditions

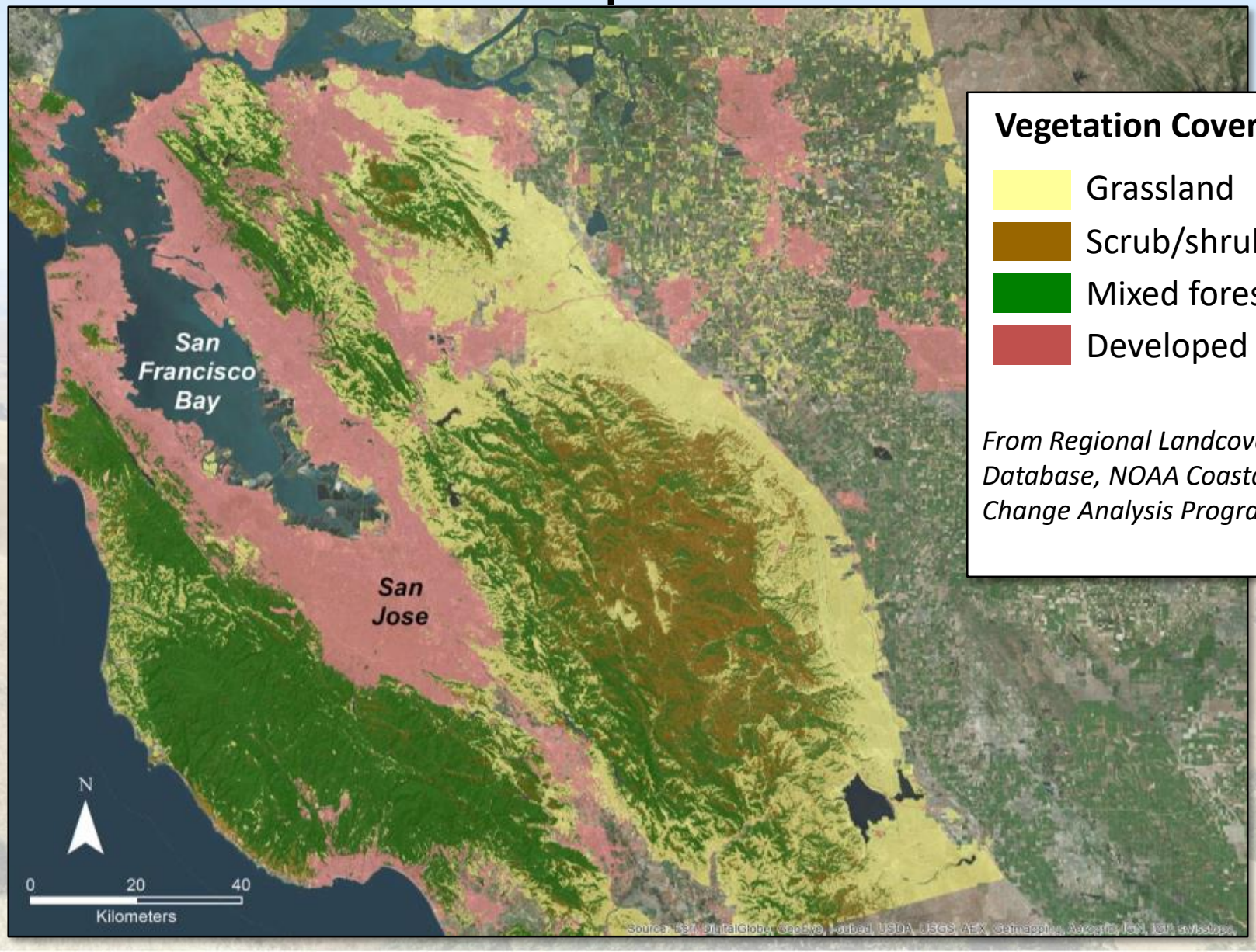



Photo by P. Kolar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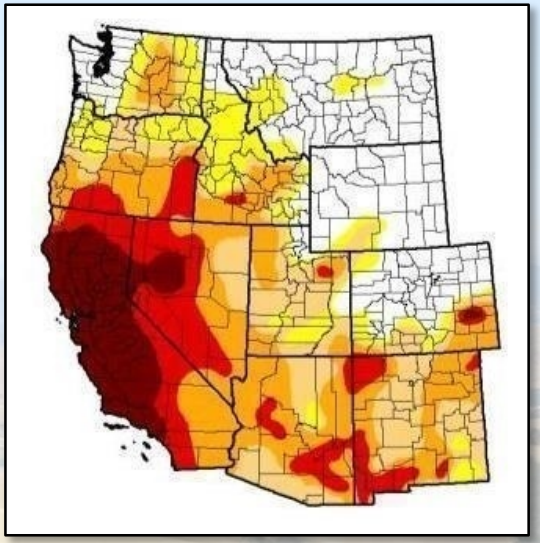
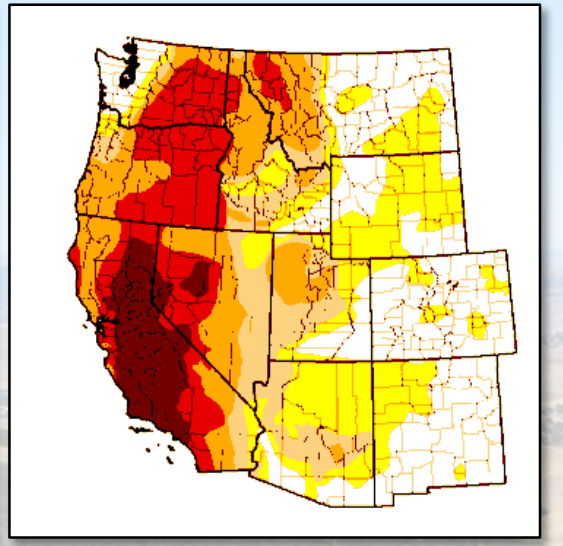
Weather and Drought Severity

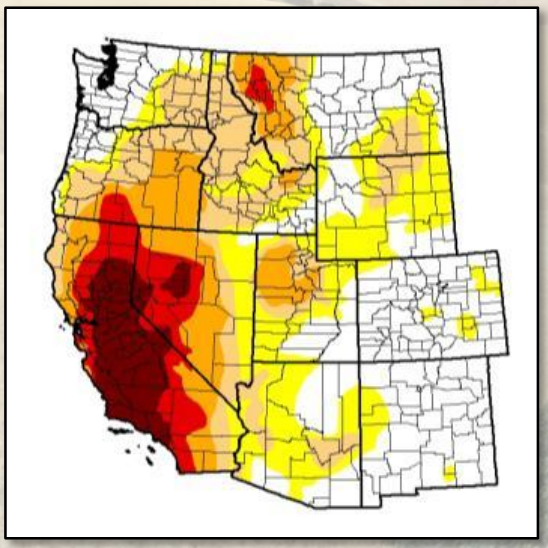
2014



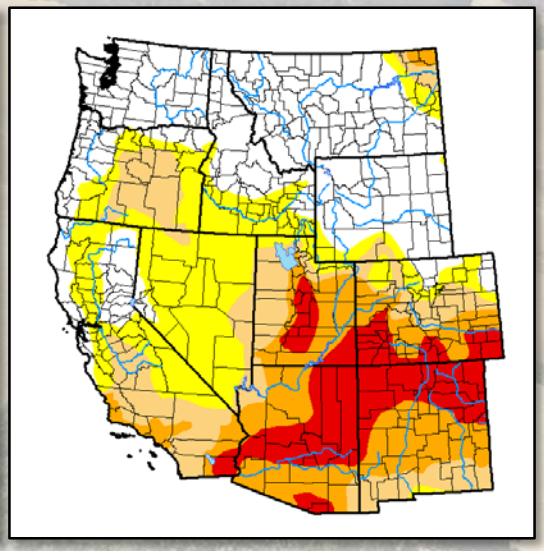
2015



2016



2018

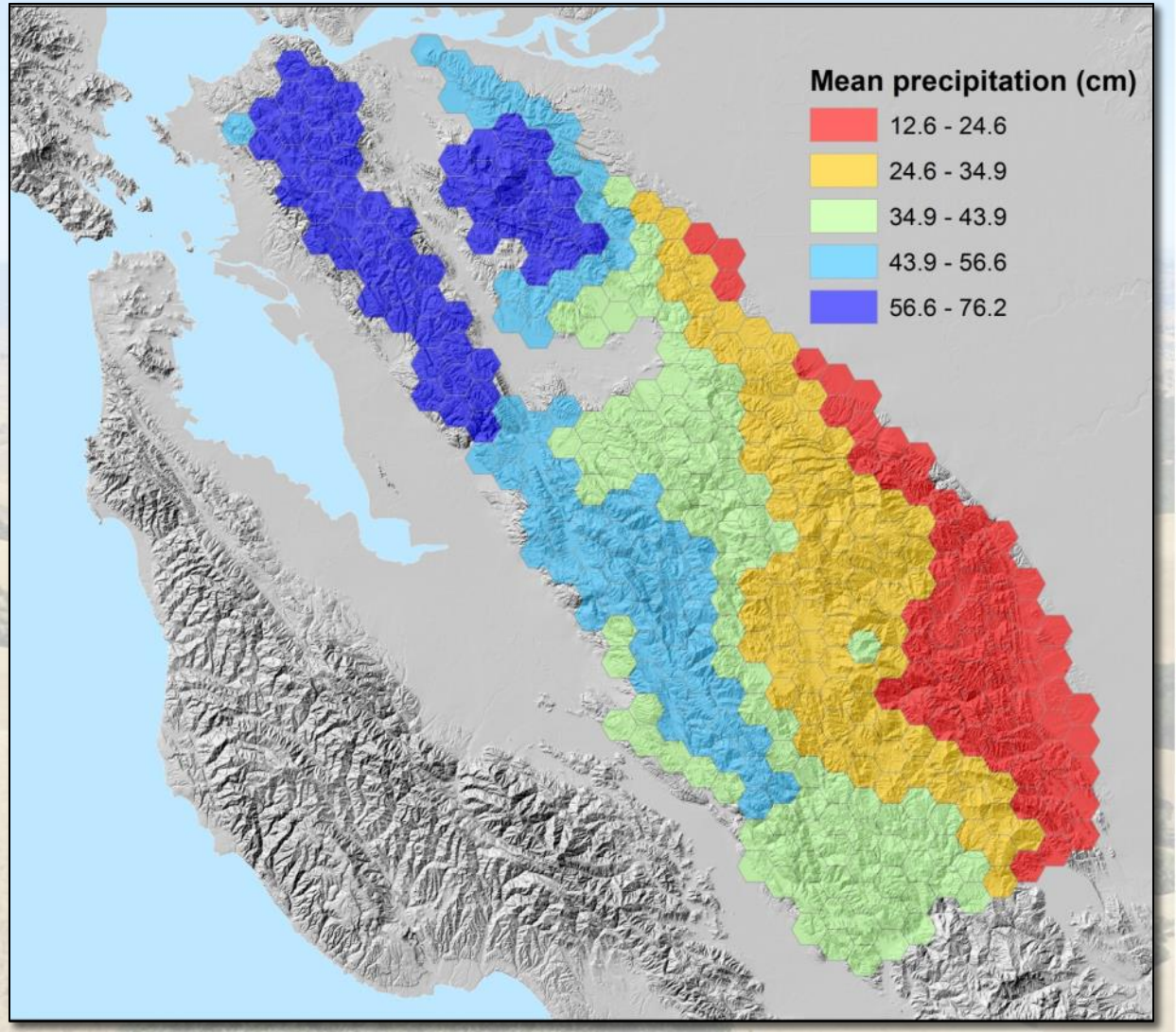


PRISM Spatial Climate Data

(Parameter elevation Regression on Independent Slopes Model)

http://www.prism.oregonstate.edu/

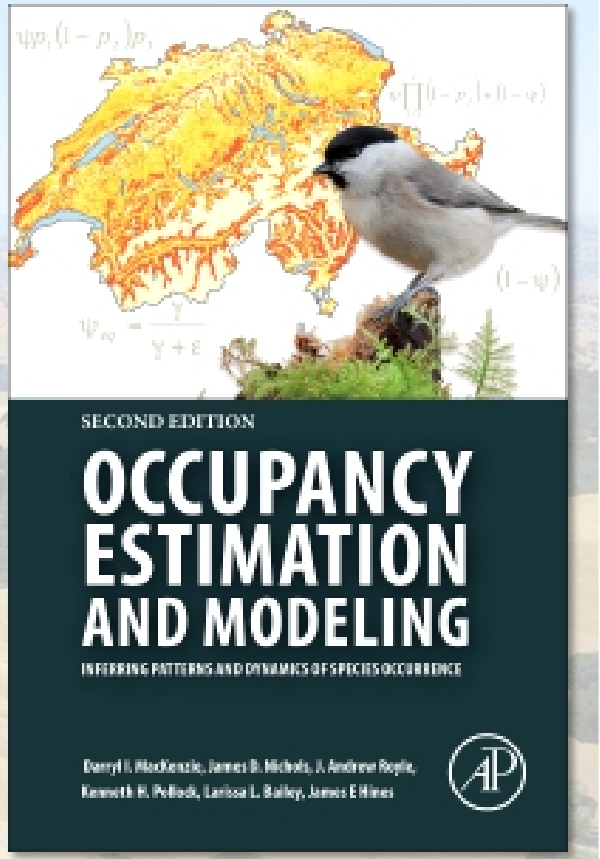
- High-resolution (4-km) spatial climate data
- Mean precipitation and max temperature:
  - pre-nesting
  - brood-rearing
  - prior year (lag effect)



Data Analysis:
Site Occupancy and Intensity of Use

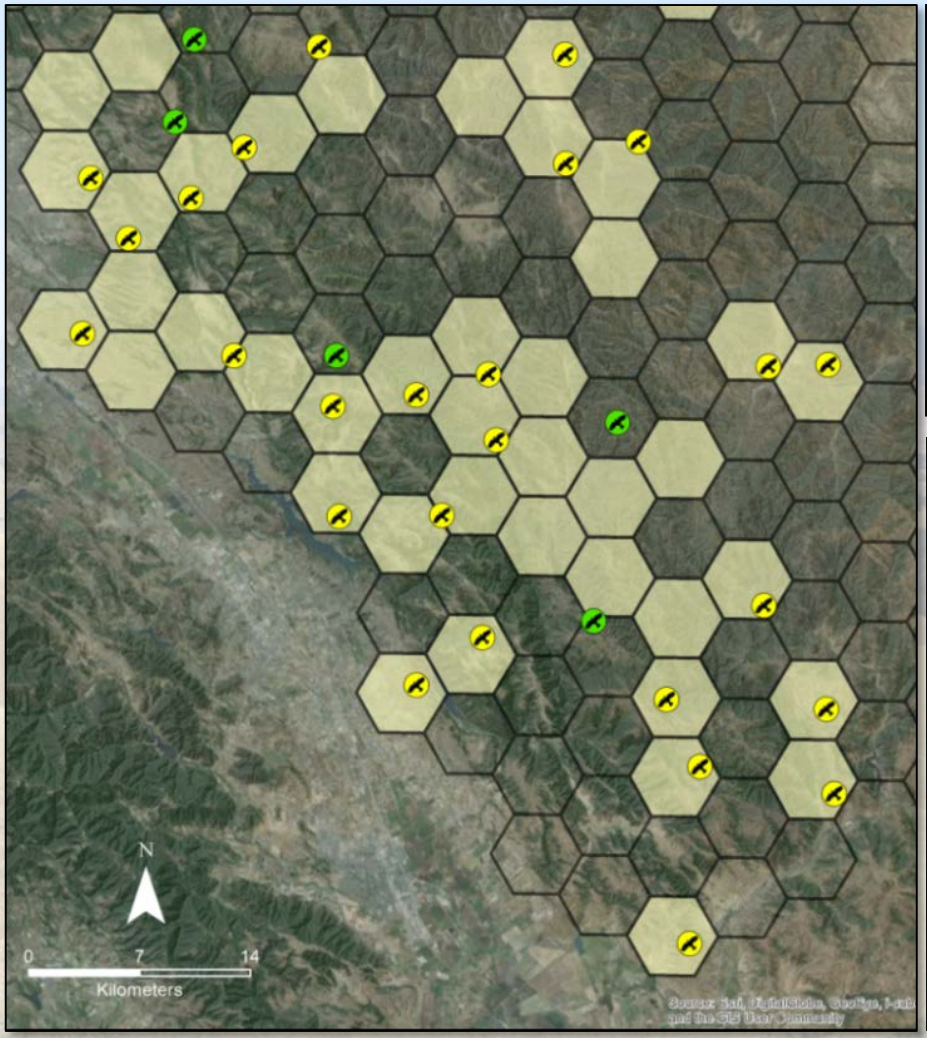
- **Multistate site-occupancy models**
  - site-specific occupancy and reproduction
  - account for imperfect detection

- **N-mixture models**
  - counts of GOEA detections (pairs, subadults)
  - intensity of use of survey plots
  - account for imperfect detection



MacKenzie et al. 2017

Survey Results, 2014 – 2018



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RESEARCH ARTICLE

Spatial patterns in occupancy and reproduction of Golden Eagles during drought: Prospects for conservation in changing environments

J. David Wiens,[1]* Patrick S. Kolar,[1] W. Grainger Hunt,[2] Teresa Hunt,[2] Mark R. Fuller,[1] and Douglas A. Bell[3]

[1] U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Corvallis, Oregon, USA
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[3] East Bay Regional Park District, Oakland, California, USA
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- **138 sample sites surveyed on 1,238 occasions**
- **102 territorial pairs identified at 89 focal sites (mean = 1.1 pairs/site)**
- **99 additional pairs identified in adjacent, non-focal sites**
- **Total territorial pairs detected = 201**

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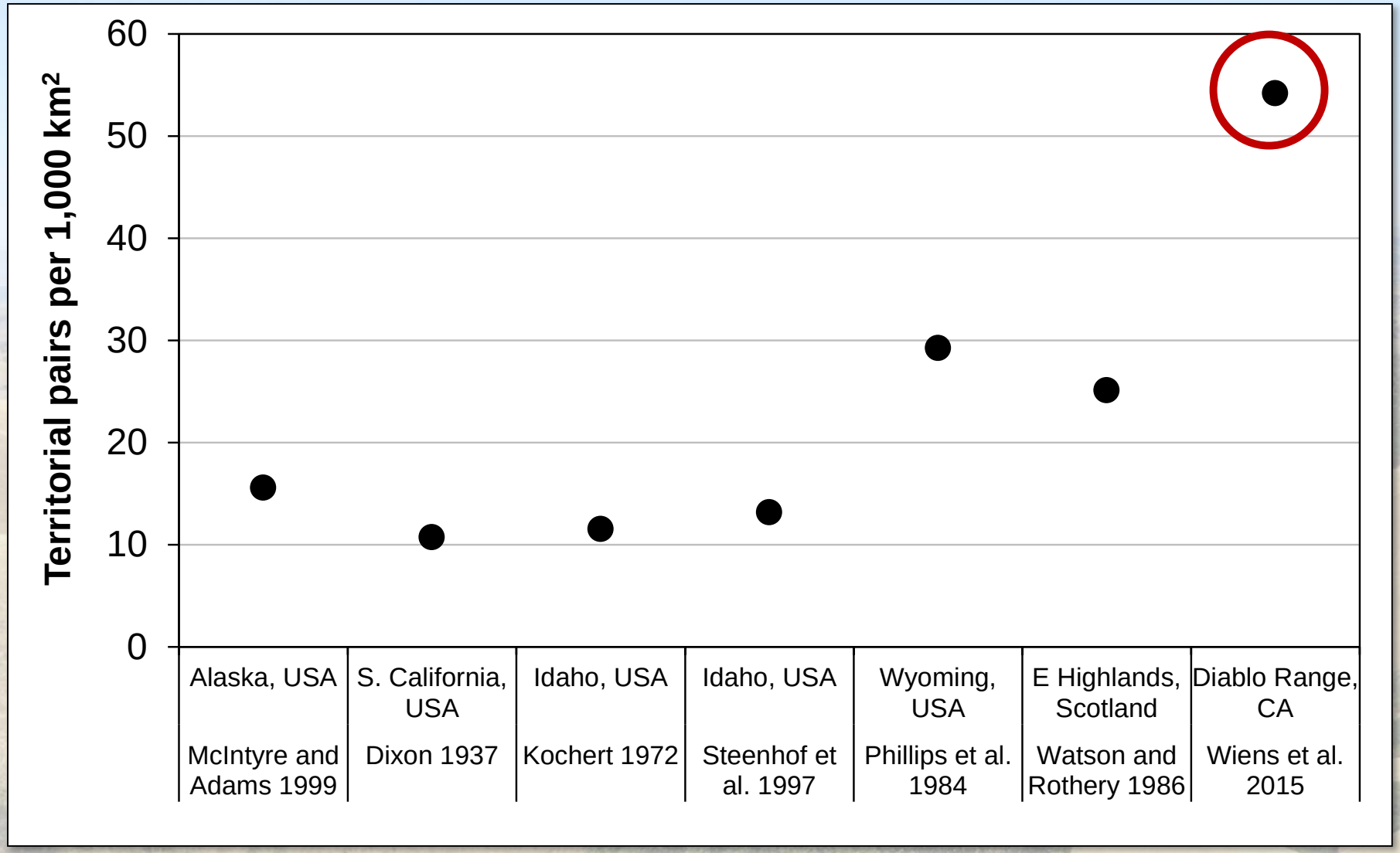
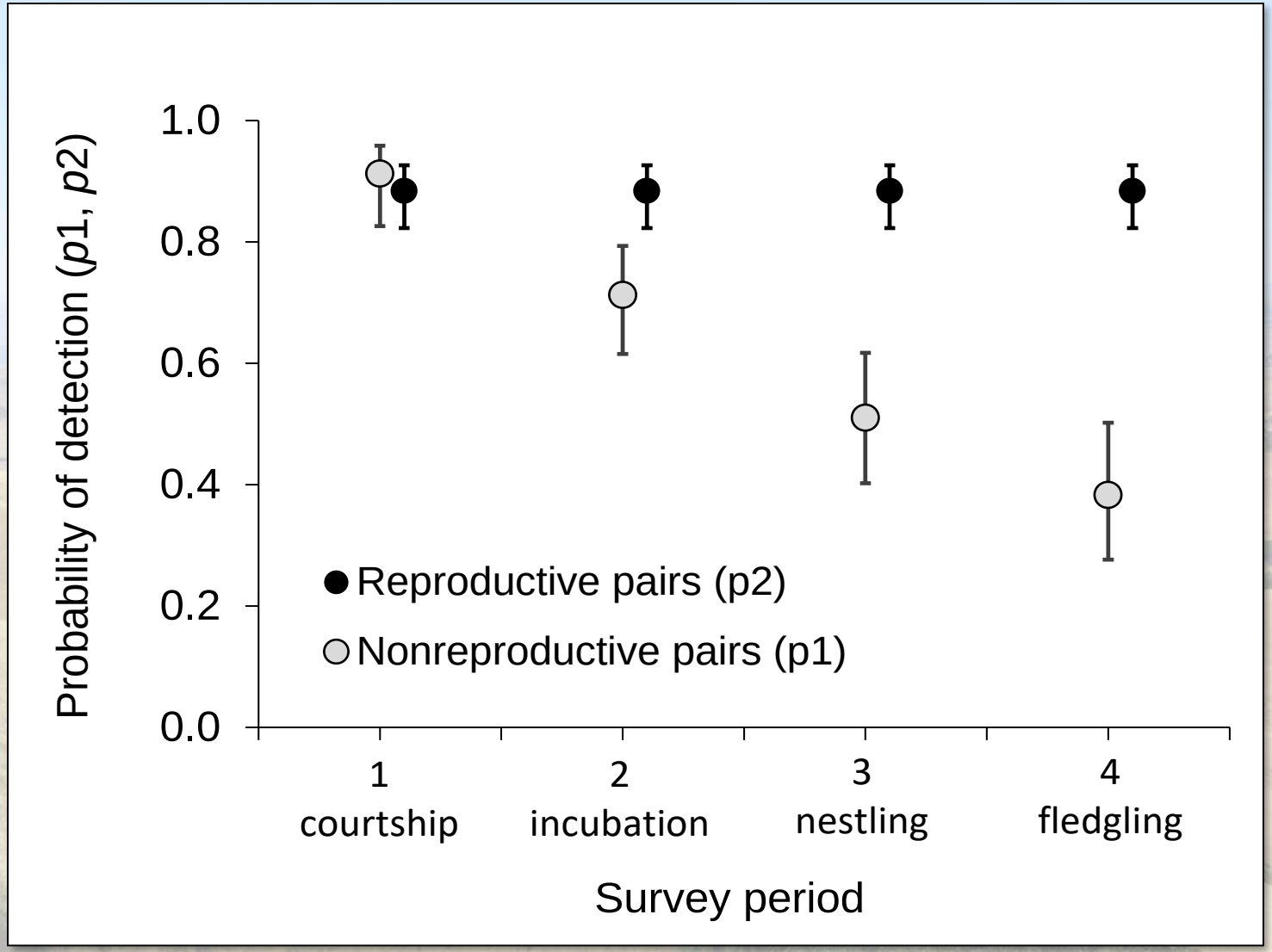
Density of Territorial Pairs (*naïve, uncorrected estimates*)



Detection of Territorial Pairs



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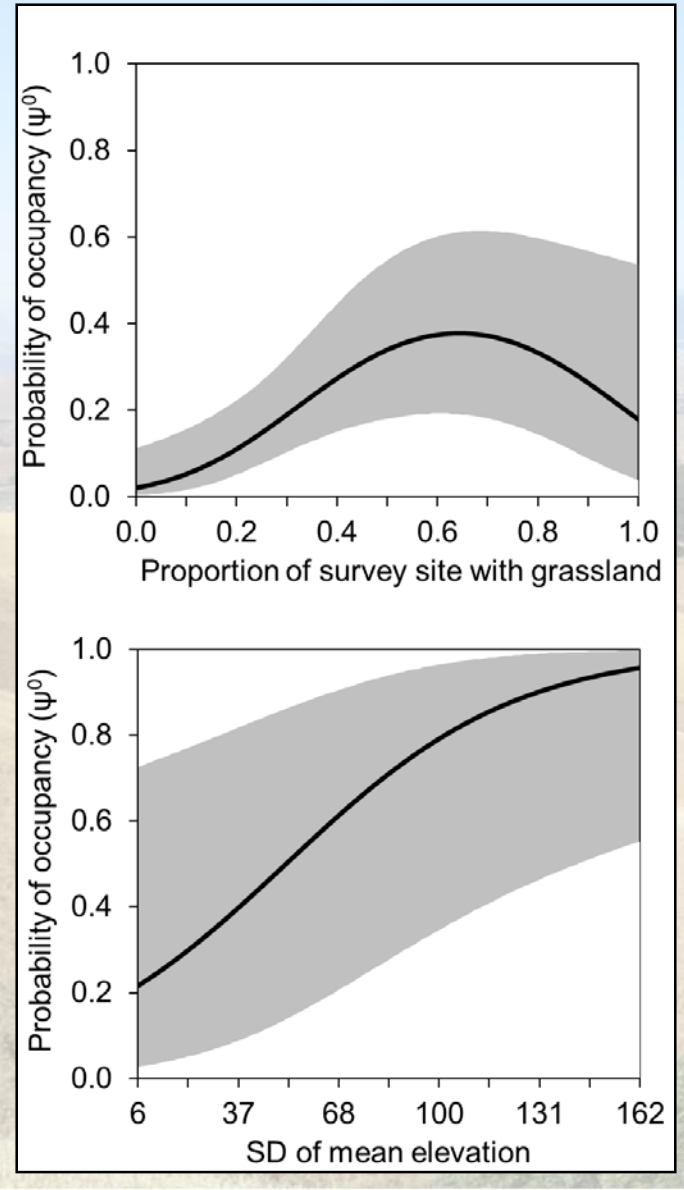
Influence of Landscape Conditions on Site Occupancy

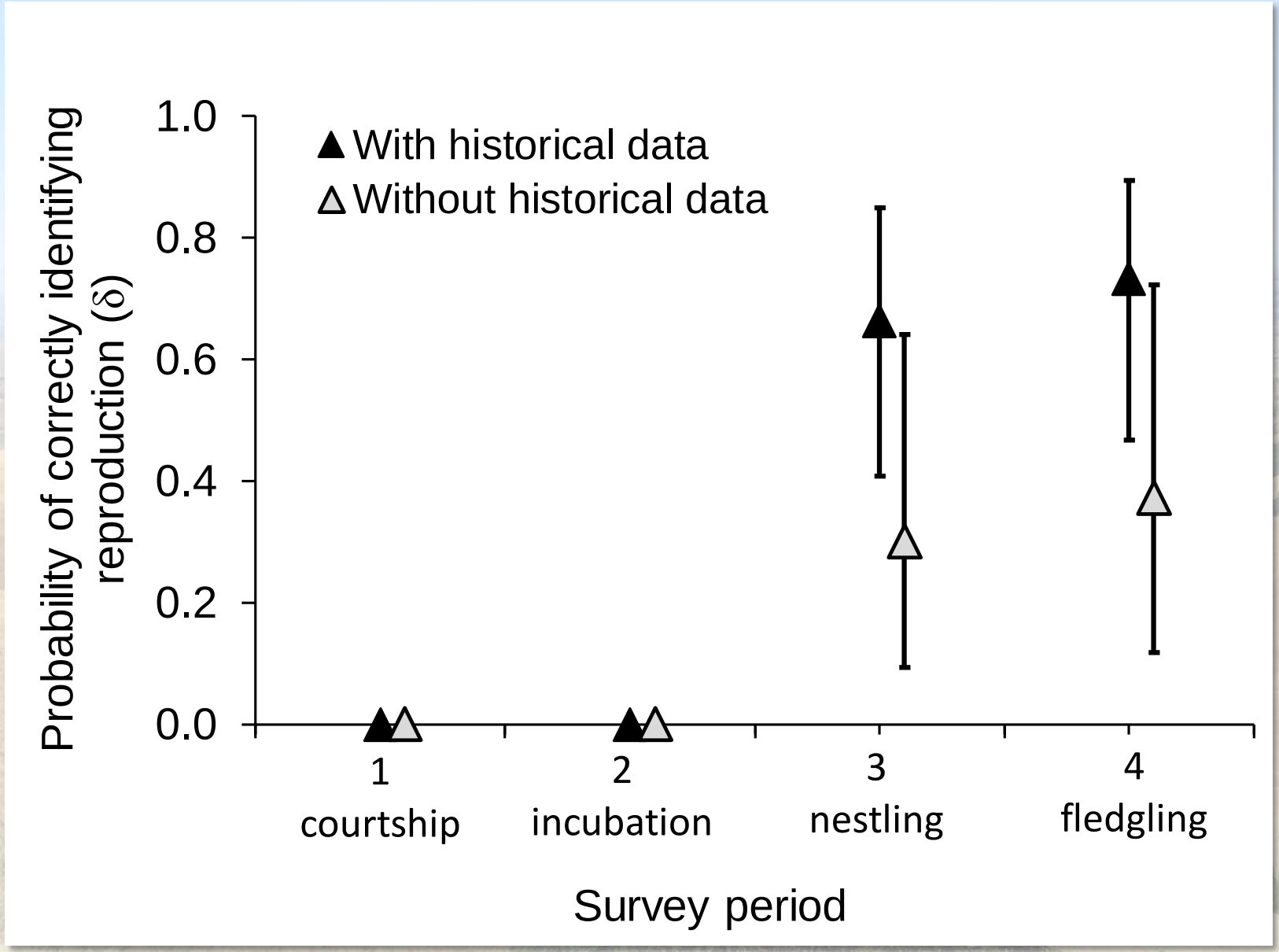


Intermediate amounts of grassland with patches of mixed-oak woodlands

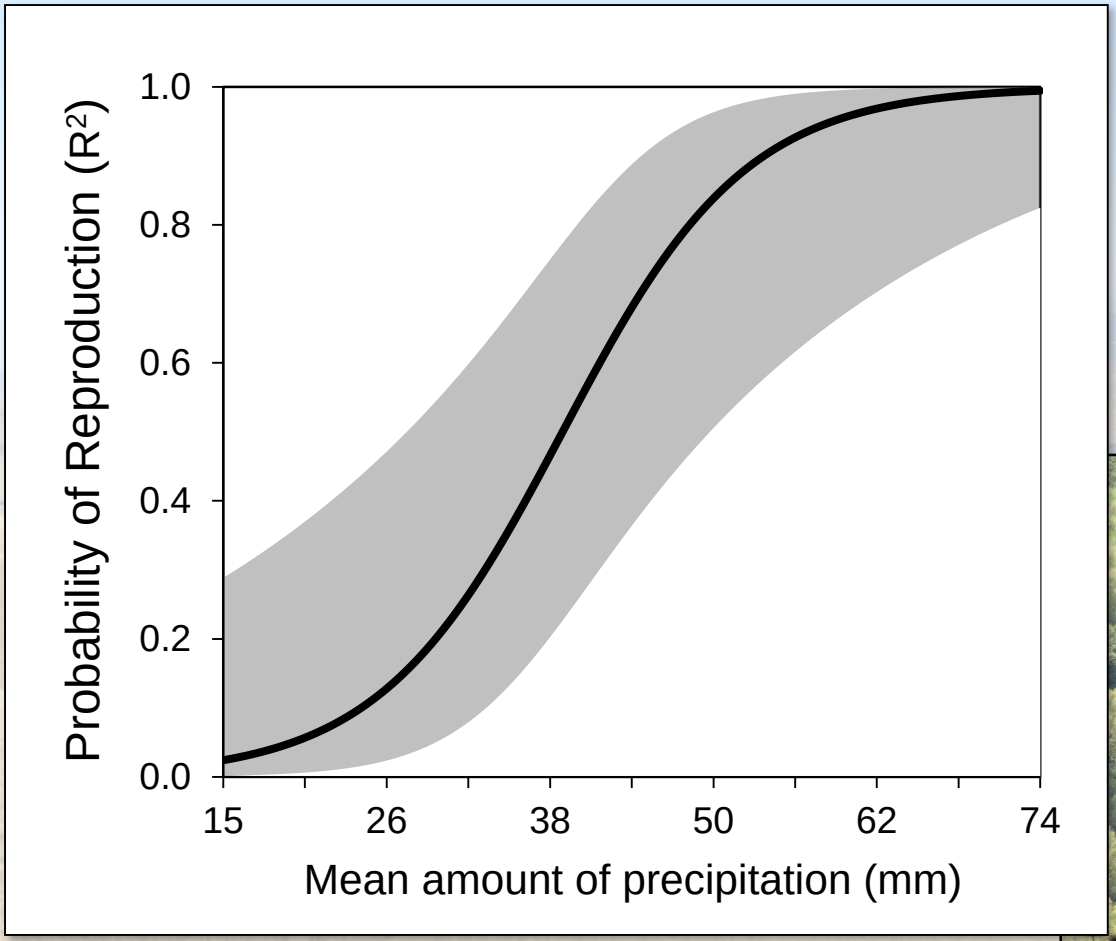
Rugged terrain conditions


Photo by P. Kolar

Detecting Nests and Young



Nesting success was greatest at sites with more rainfall in drought years (2014 – 2016)



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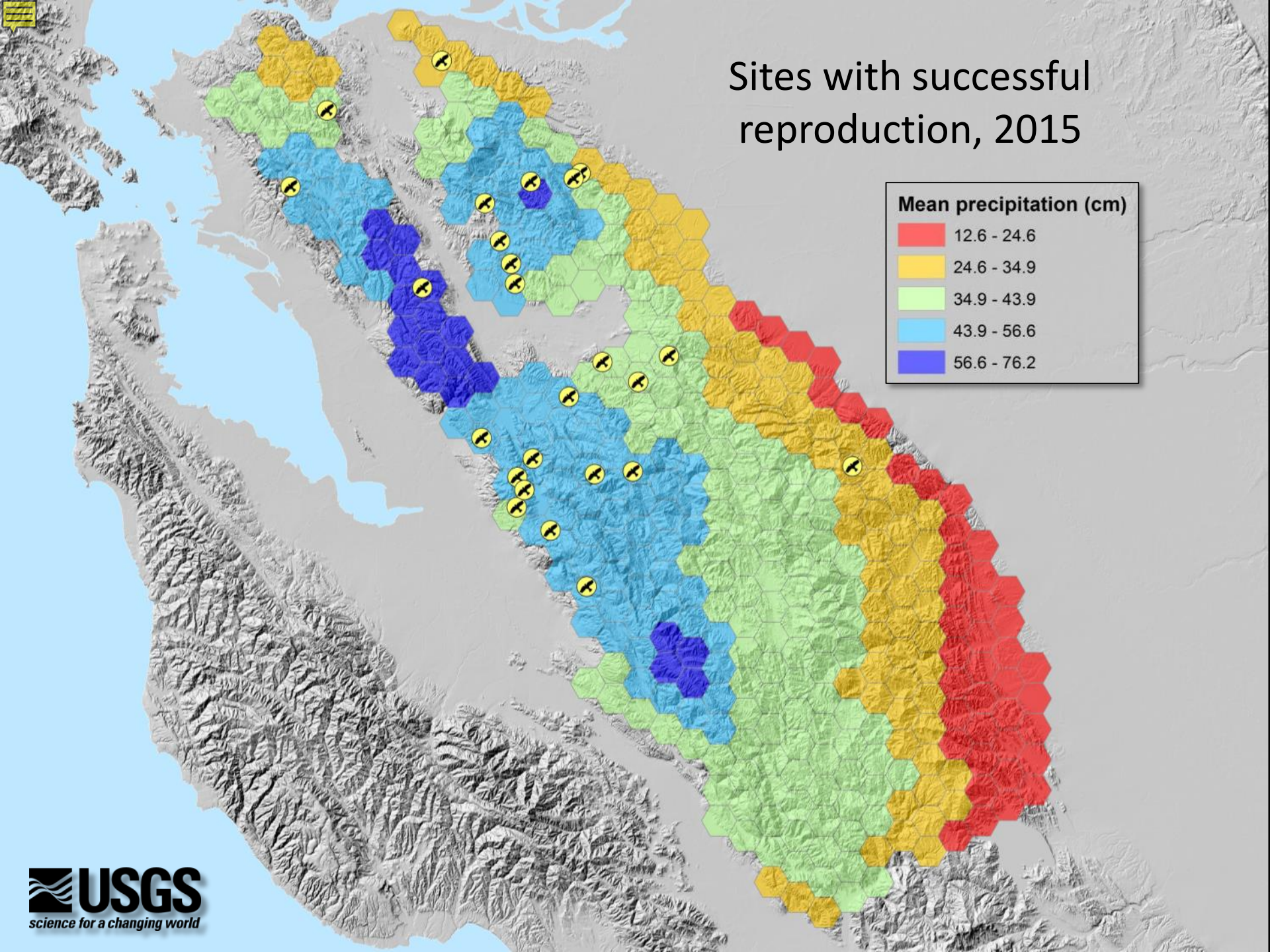
Sites with successful reproduction, 2015
Mean precipitation (cm)
12.6 - 24.6
24.6 - 34.9
34.9 - 43.9
43.9 - 56.6
56.6 - 76.2
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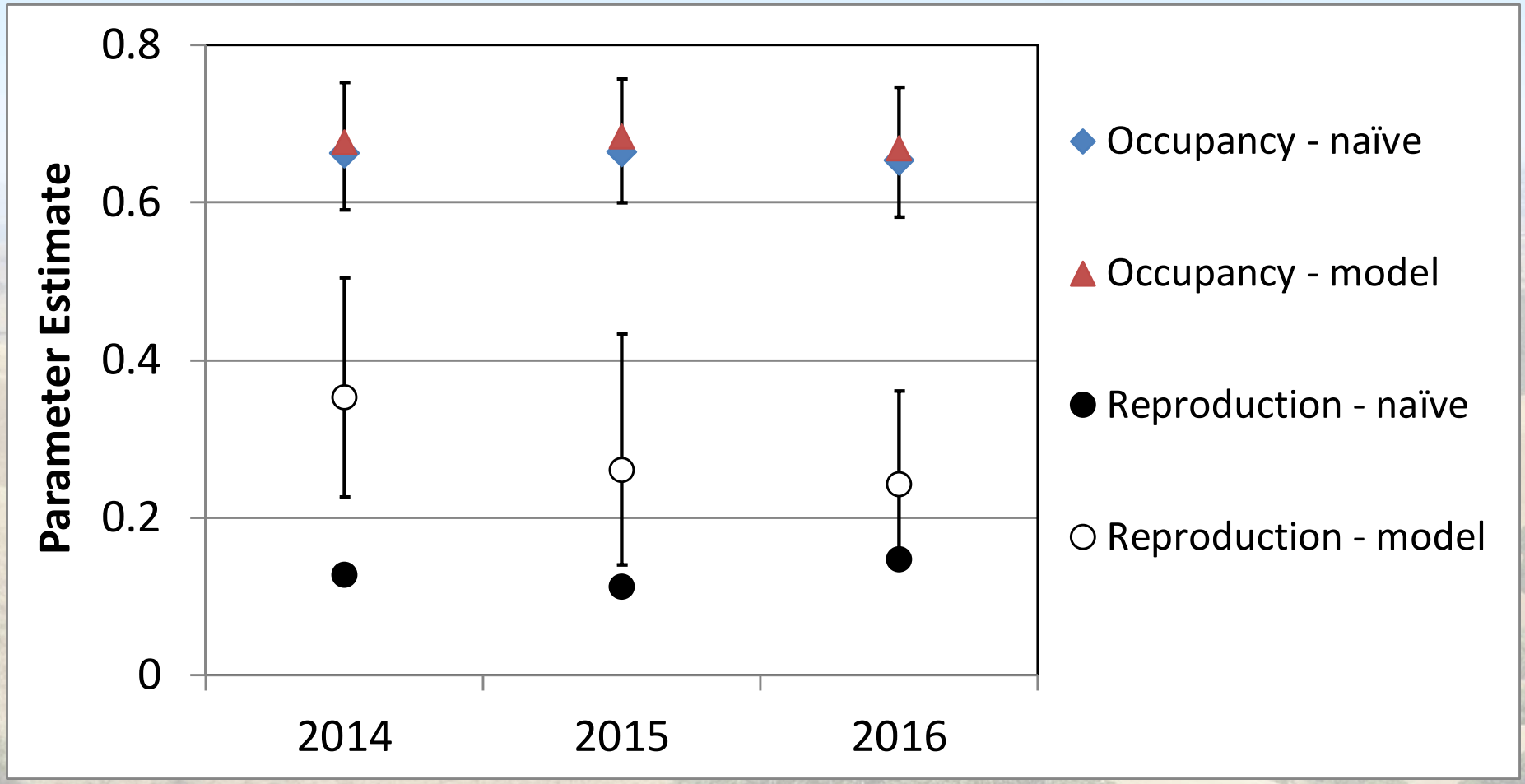
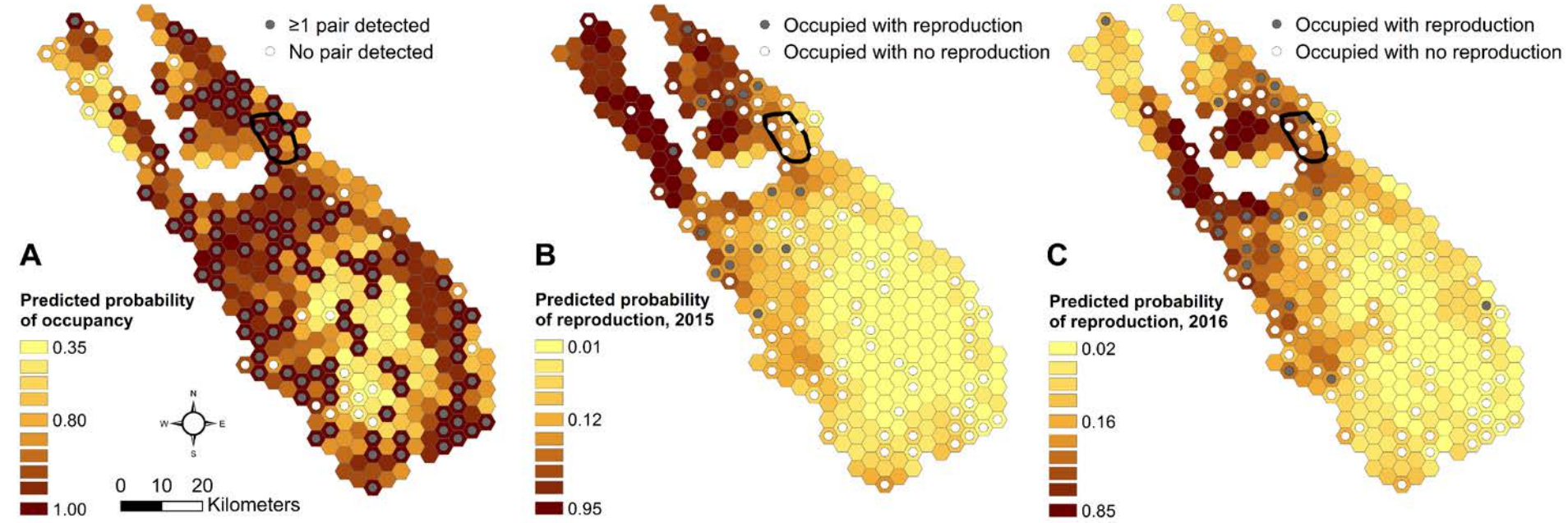
Naïve vs. Corrected Estimates



Spatial Patterns in Landscape Occupancy and Reproduction



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Conclusions and Benefits of the Study Design

- Provided a means for using monitoring data to quantify changes in site-occupancy/use and factors driving changes over time.
- Strong evidence of non-random spatial distribution of landscape occupancy and reproduction
- Survey design effective for identifying and monitoring “hotspots” of occupancy, reproduction, and site-usage at broad spatial scales
- Identified and mapped specific areas where conservation and mitigation actions can be most effectively placed