Estimation of Site Occupancy and Nesting Success of Golden Eagles in the Diablo Mountains, California

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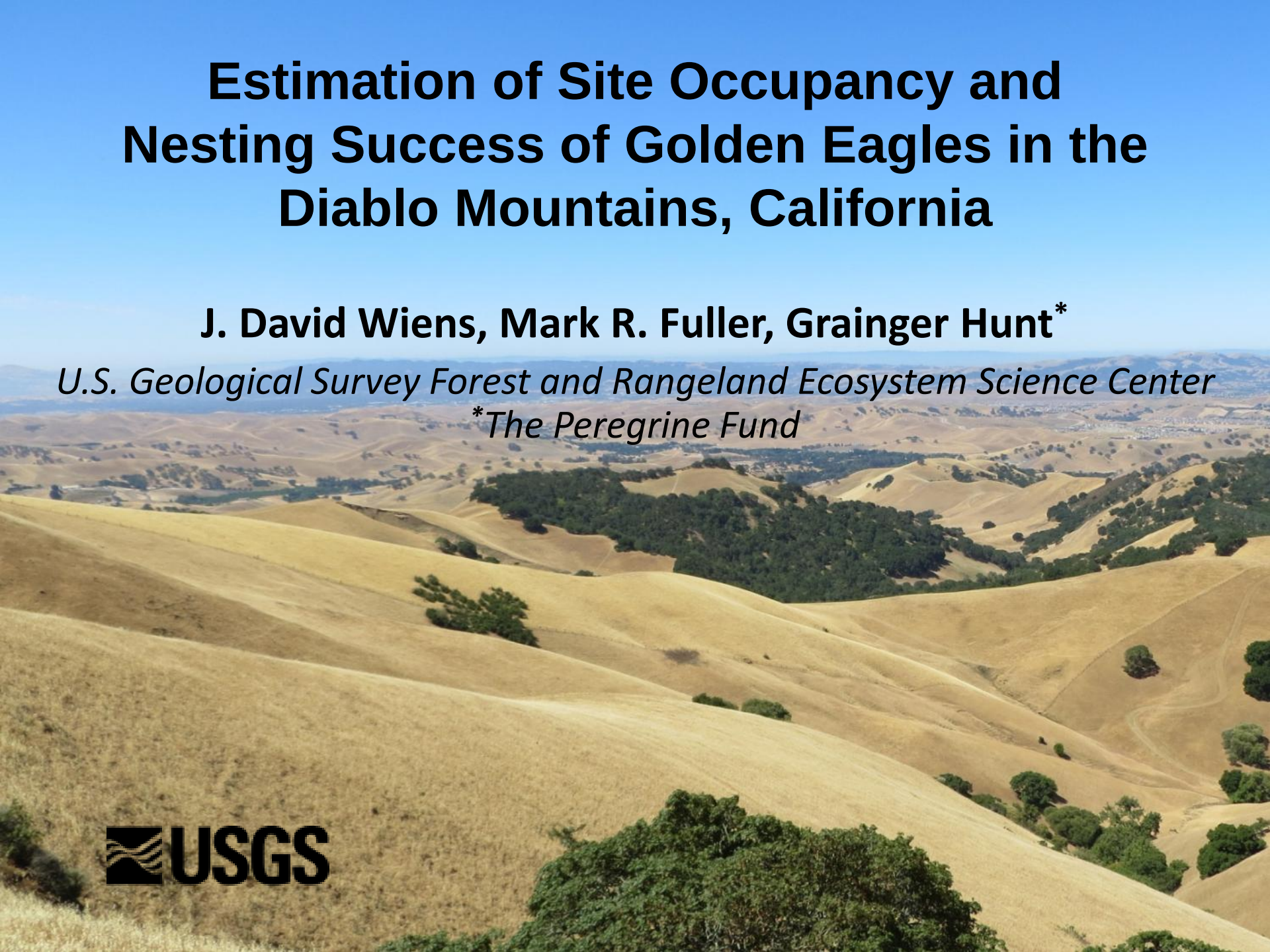
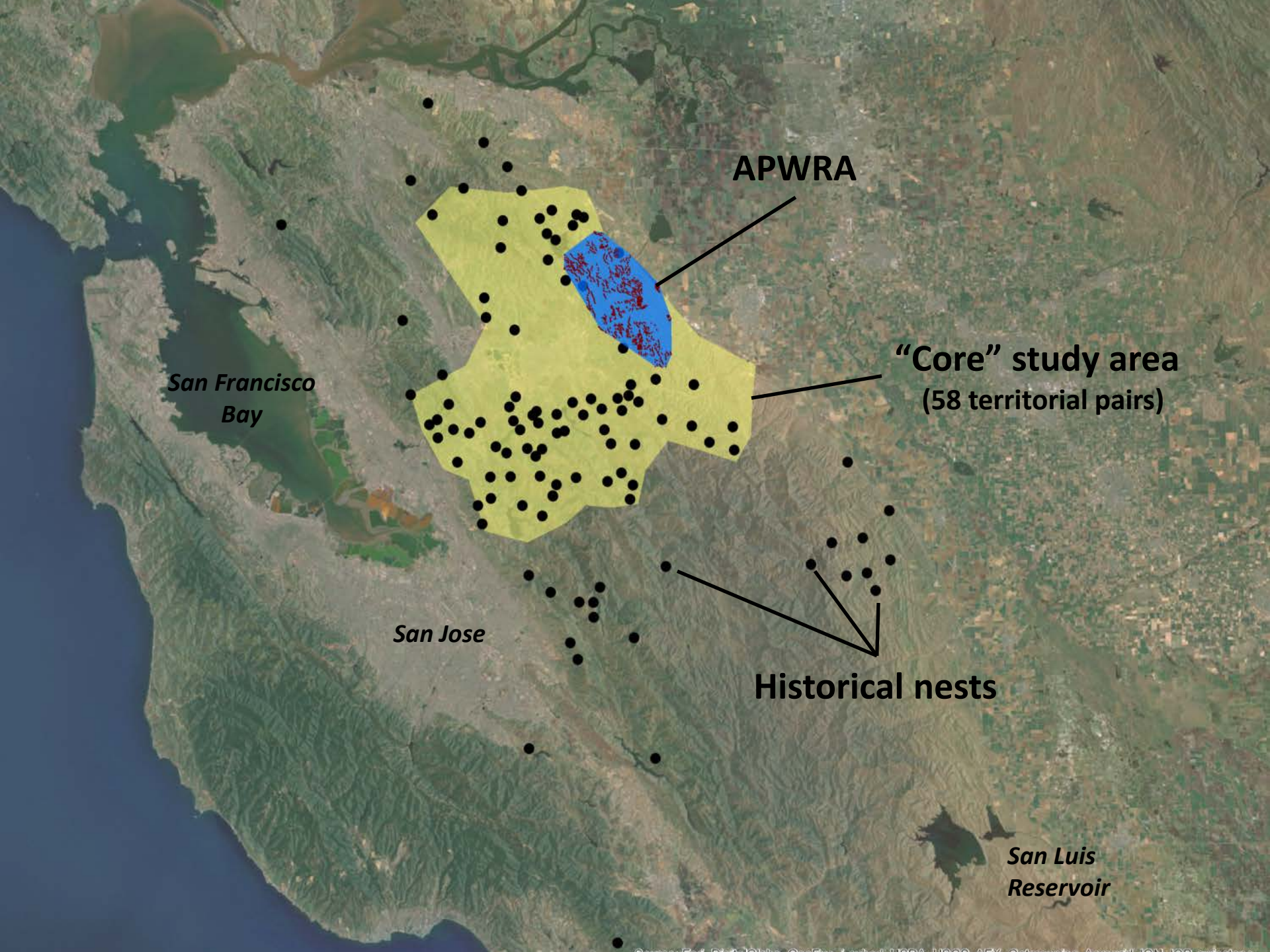
**The Peregrine Fund*



Diablo Mountains Study Area
(2,640 mi^2)


APWRA
"Core" study area
(58 territorial pairs)
San Francisco Bay
San Jose
Historical nests
San Luis Reservoir

Golden Eagles in the Vicinity of the Altamont Pass Wind Resource Area

58 territories monitored within 30-km of APWRA

- Monitored for occupancy in 2000, 2002, 2005, 2013
- <3.6% of breeders identified as subadults

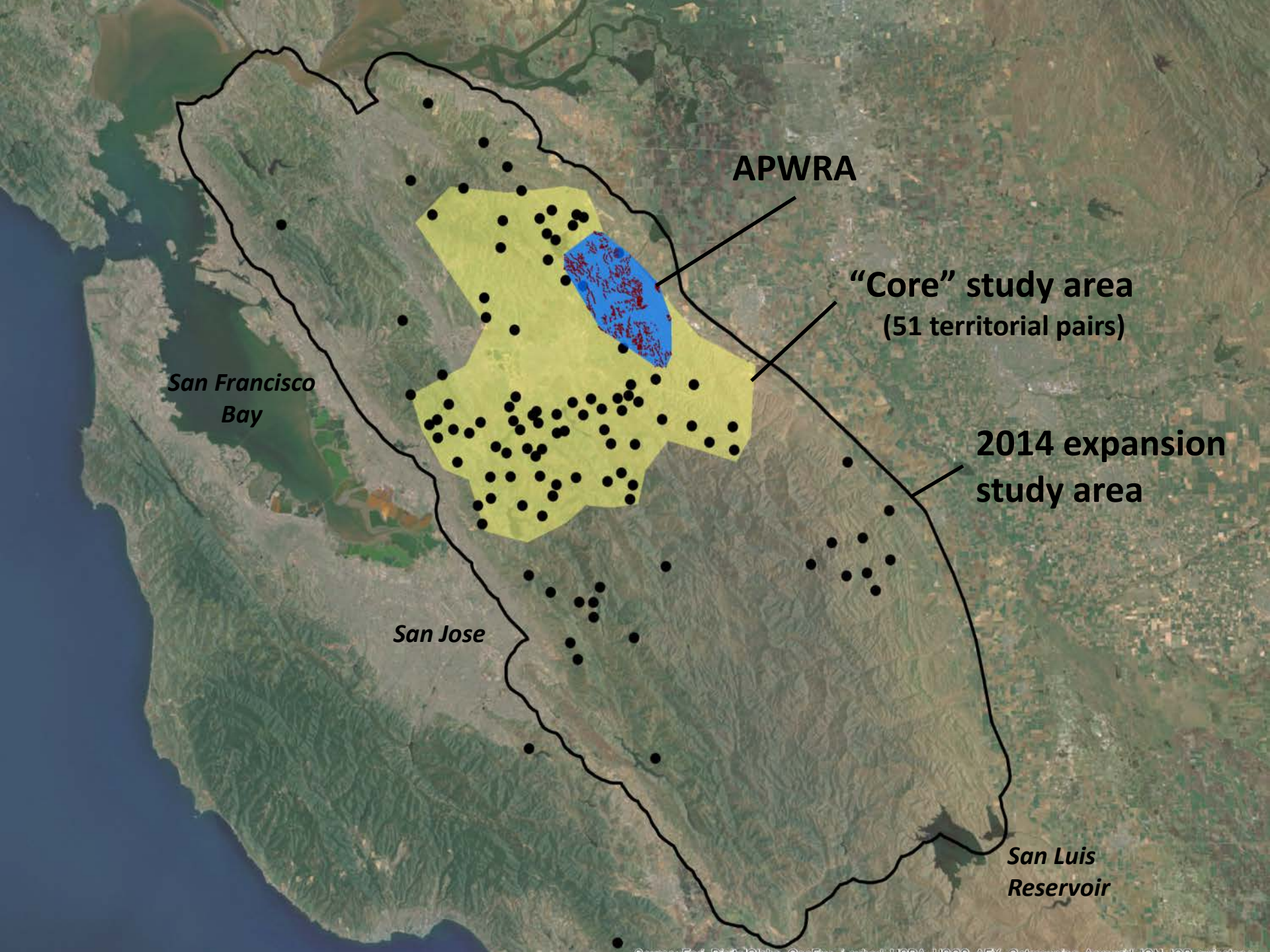
Reproduction

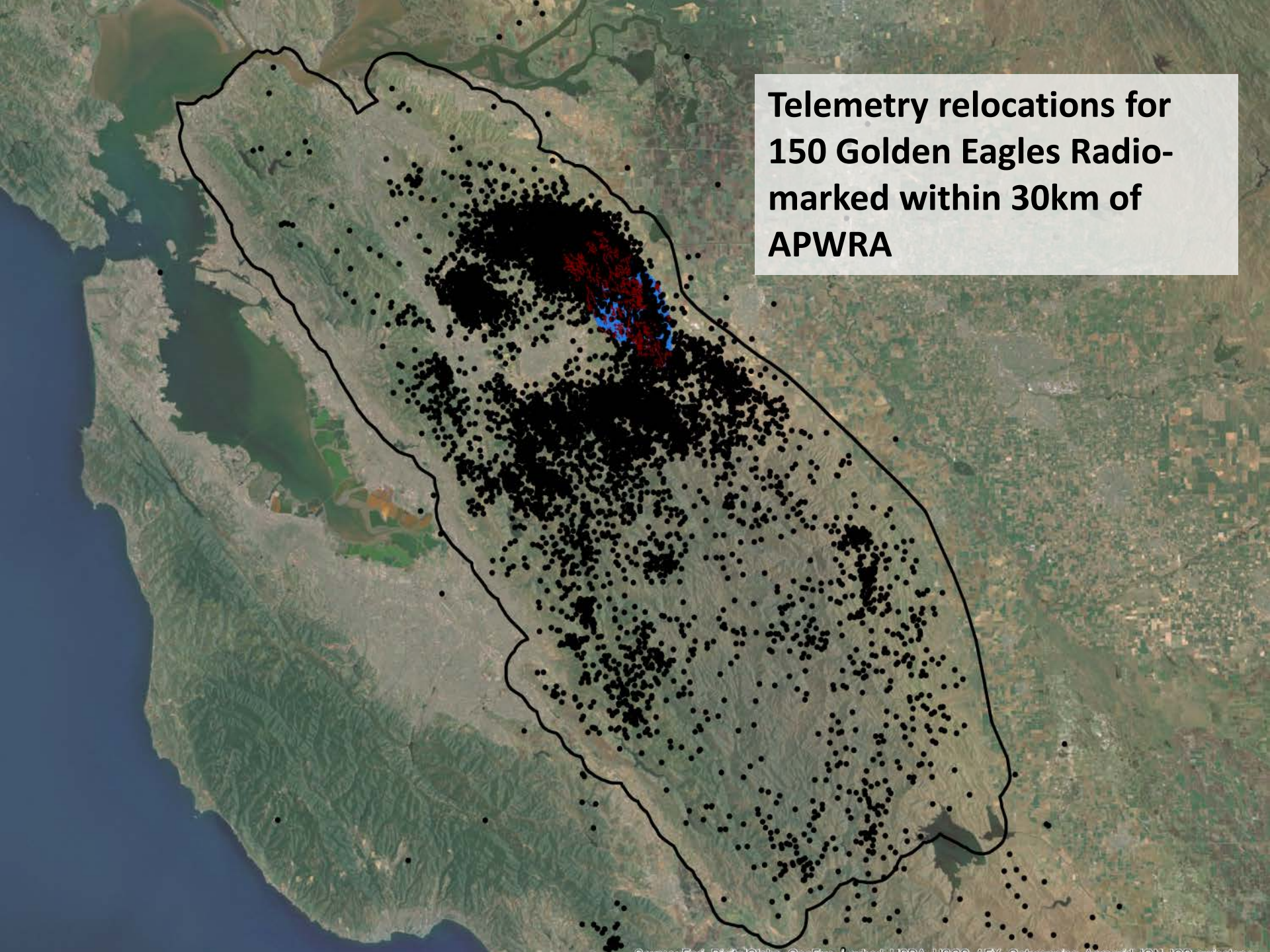
- Highly variable among years (20 – 84% pairs nesting/yr)

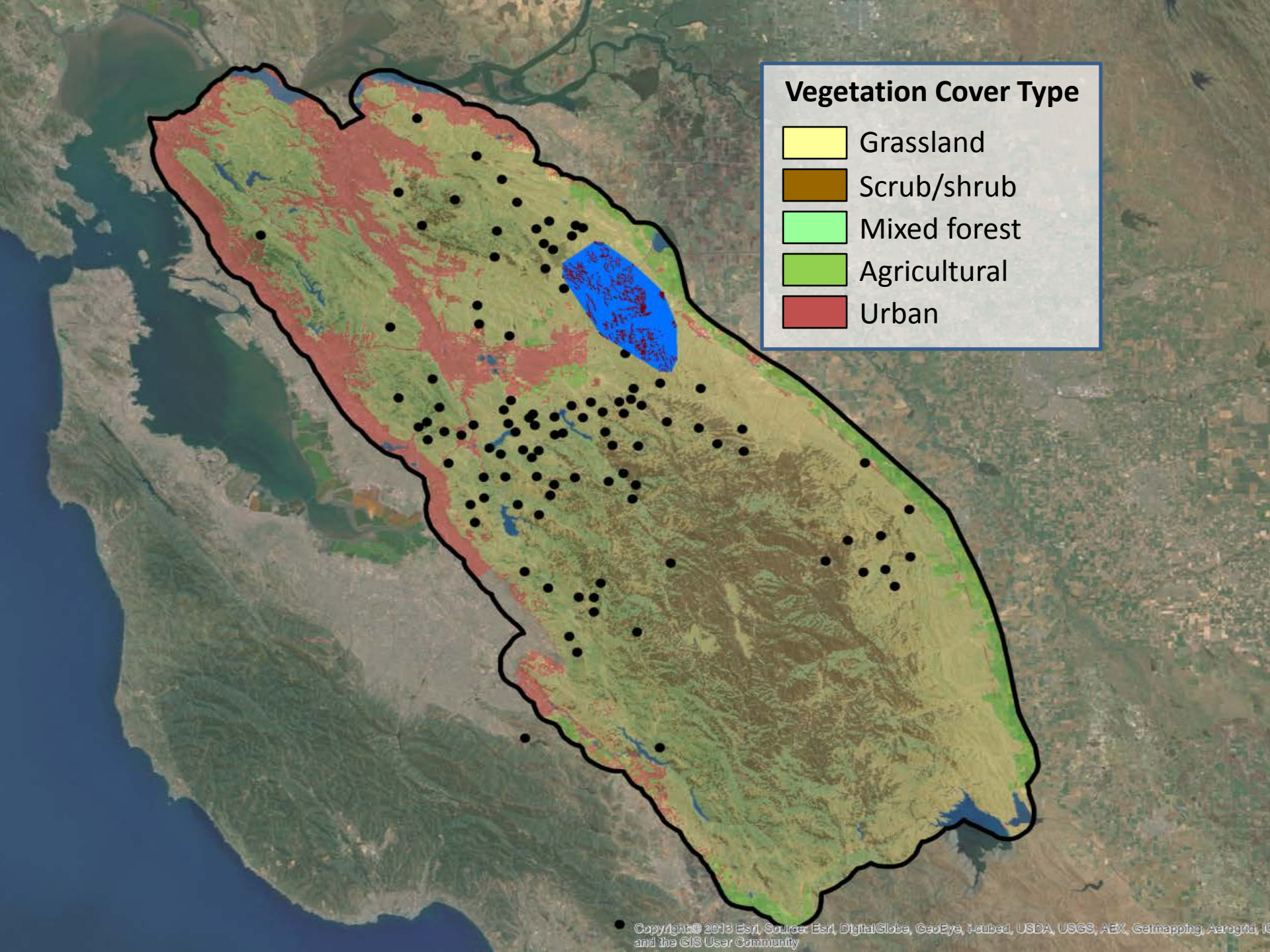
Survival, Movements, and Habitat Use

- Based on 257 individuals radio-marked near APWRA
- Collisions with wind turbines was leading COD
- Productivity from ~160 breeding pairs required to compensate for annual mortality observed in APWRA

[1]**Hunt, G., and T. Hunt**. 2013. *Golden Eagle Territory Occupancy and Reproduction in the Vicinity of the Altamont Pass Wind Resource Area: 2013 Survey Results.* Research report to East Bat Regional Parks District


APWRA
"Core" study area
(51 territorial pairs)
2014 expansion
study area
San Francisco
Bay
San Jose
San Luis
Reservoir


Telemetry relocations for 150 Golden Eagles Radio-marked within 30km of APWRA


Vegetation Cover Type
Grassland
Scrub/shrub
Mixed forest
Agricultural
Urban
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Lake Mountain


04/


San Antonio Valley

Golden Eagle Occupancy Surveys: Objectives for Year 1 (2014)

1. Estimate:
   - total number of territorial pairs in the Diablo Mountains study area
   - spatial variation in occurrence and nesting success of territorial pairs

2. Identify factors associated with the probability of detecting breeding and non-breeding golden eagles during ground based surveys (e.g., time of season, duration of survey, % forest cover).

3. Assess the utility of a multistate occupancy survey design for monitoring trends in occurrence and nesting success at broad spatial scales.

Multistate Occupancy Survey Design

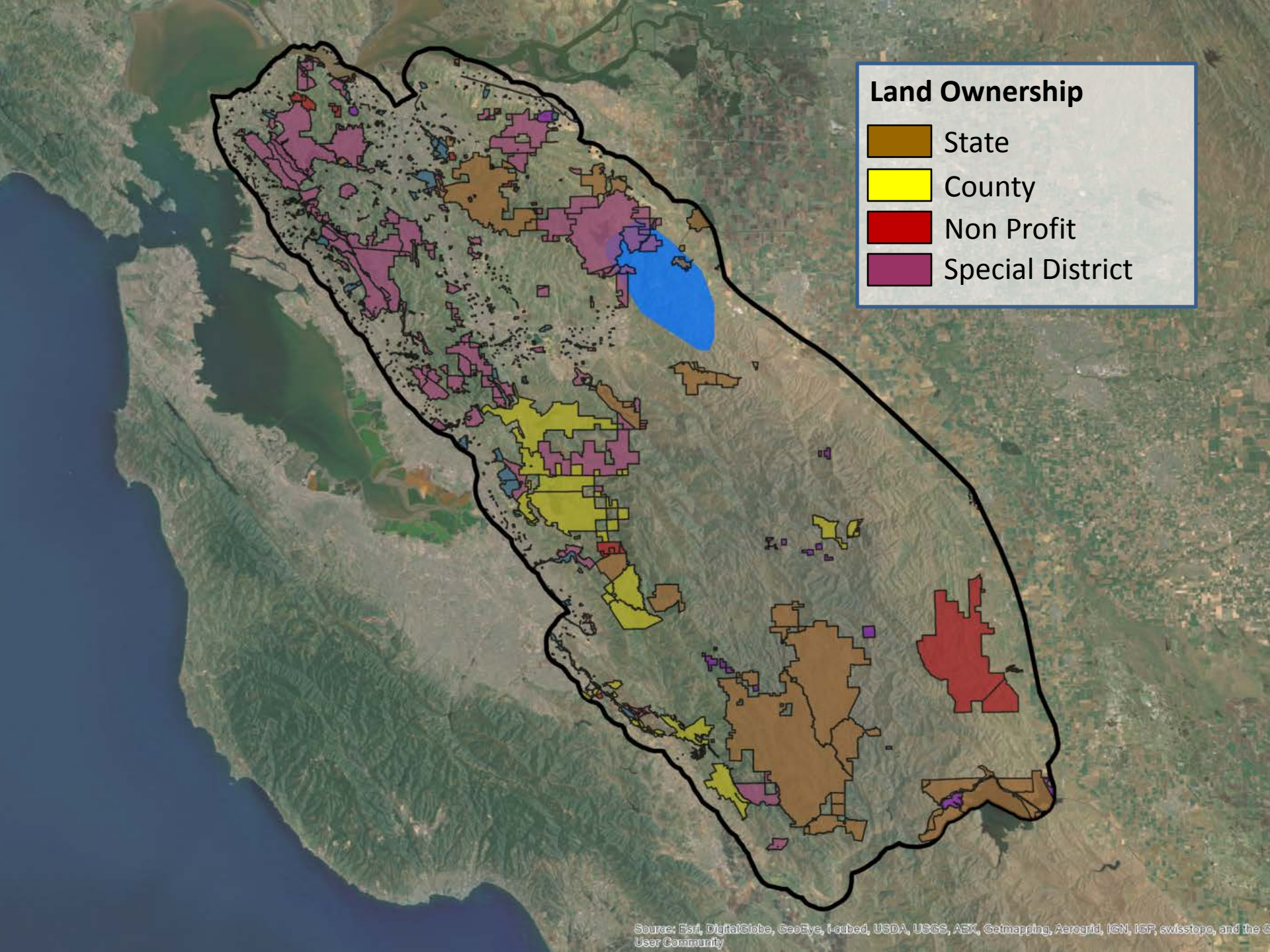
- Standard multistate occupancy model (Nichols et al. 2007, MacKenzie et al 2009).

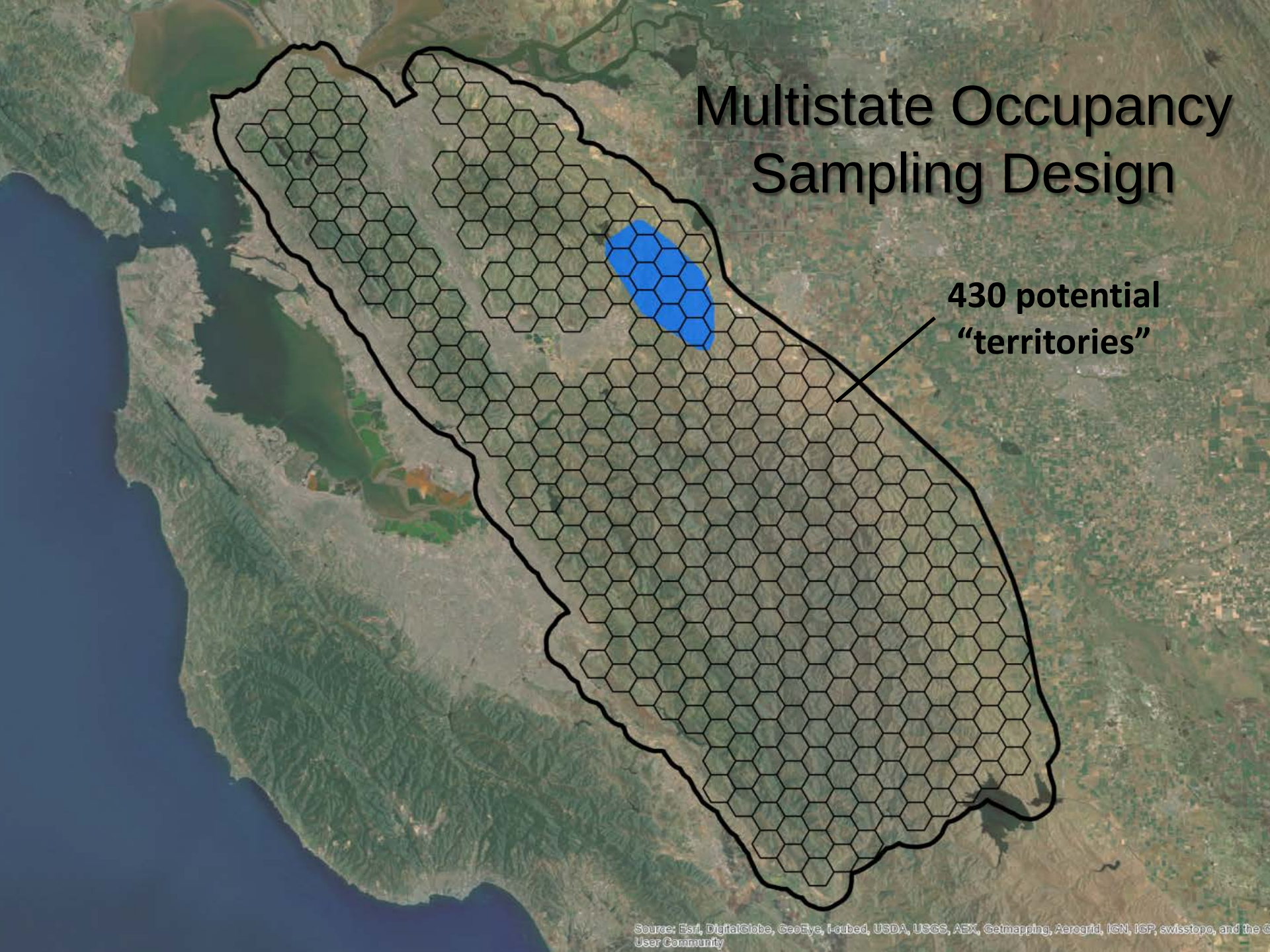
- Randomly placed sample units visited over repeated survey occasions

- Sampling units classified as:
  - unknown/unoccupied (state 0)
  - occupied with no young (state 1)
  - occupied with young (state 2)

- Sample unit size based on mean size of adult core-use areas (~1,500 ha for golden eagles in the Diablos; *Wiens, Hunt, & Fuller in prep*).

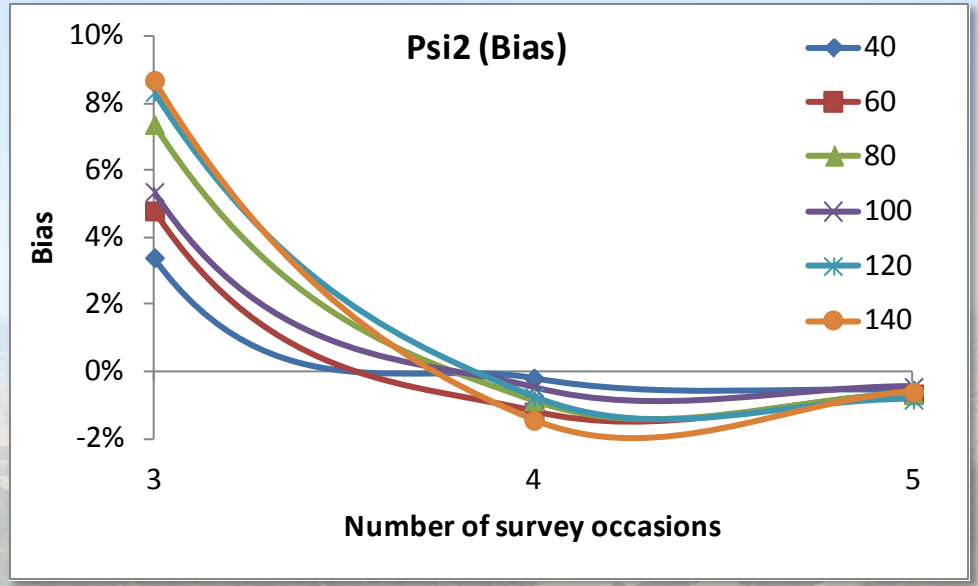
[1]**Nichols, J.D. et al.** 2007. *Occupancy estimation and modeling with multiple states and state uncertainty*. Ecology 88:1395–1400.

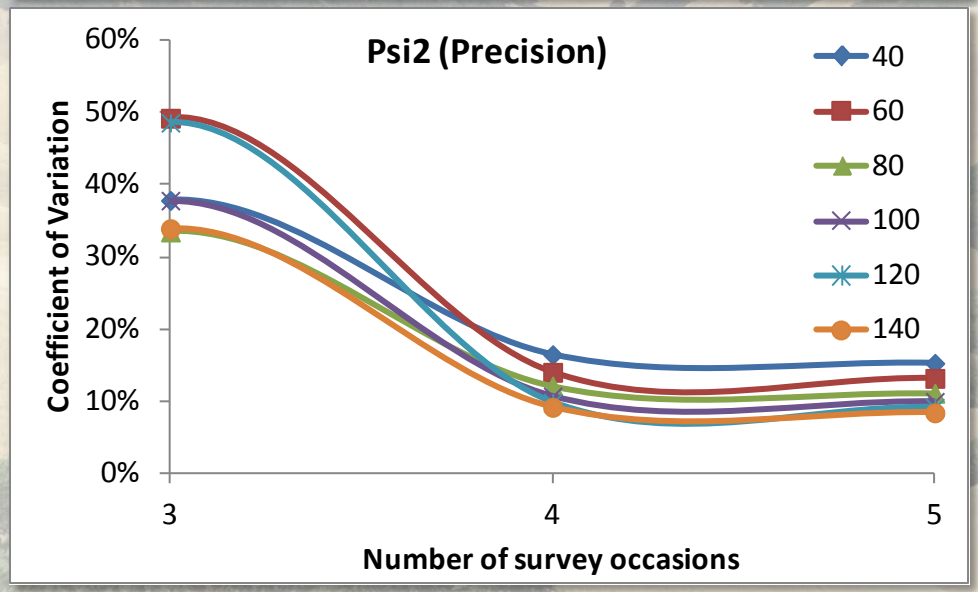

Land Ownership
State
County
Non Profit
Special District
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Multistate Occupancy
Sampling Design
430 potential
“territories”
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

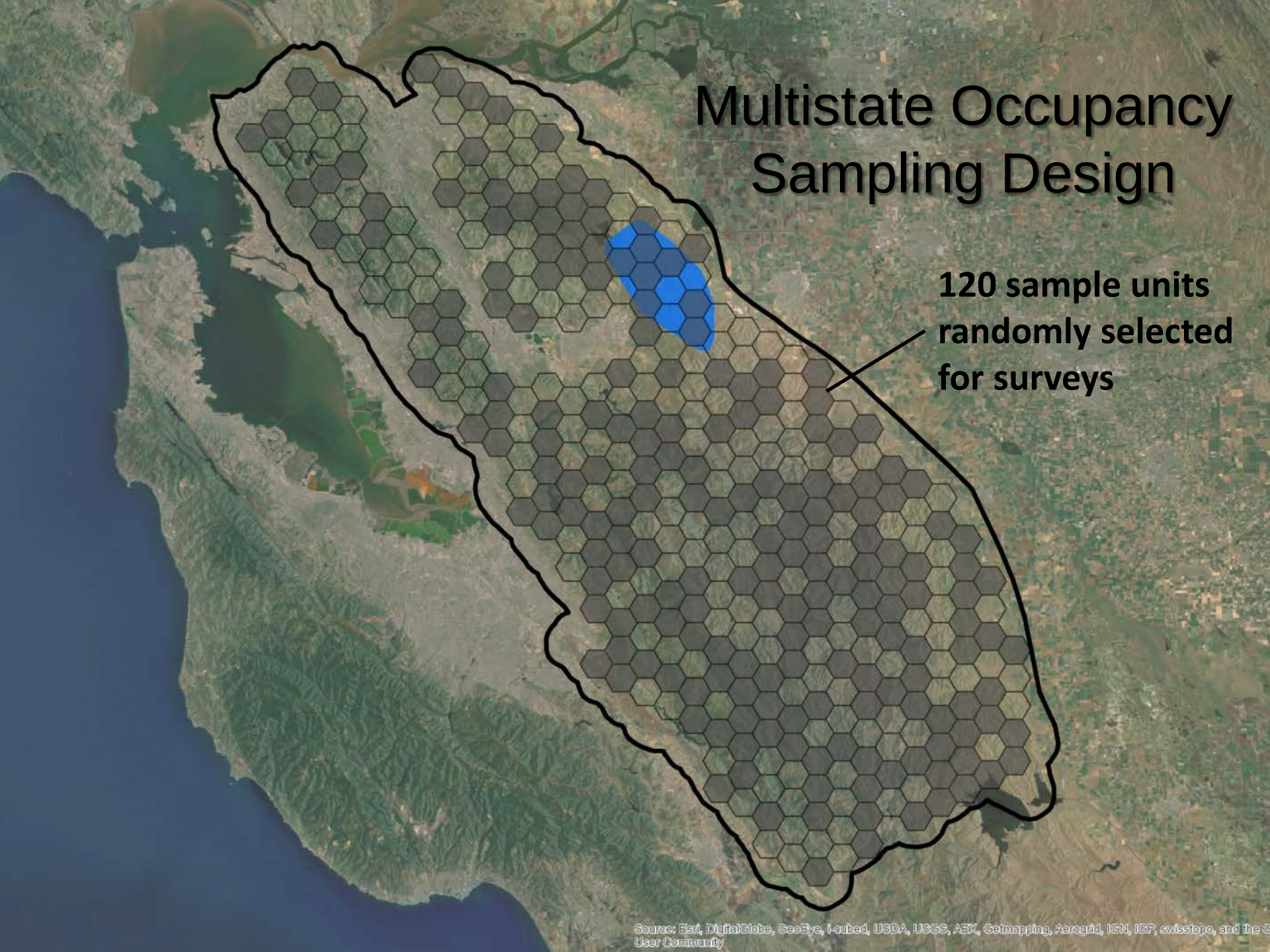
Optimizing the Survey Design

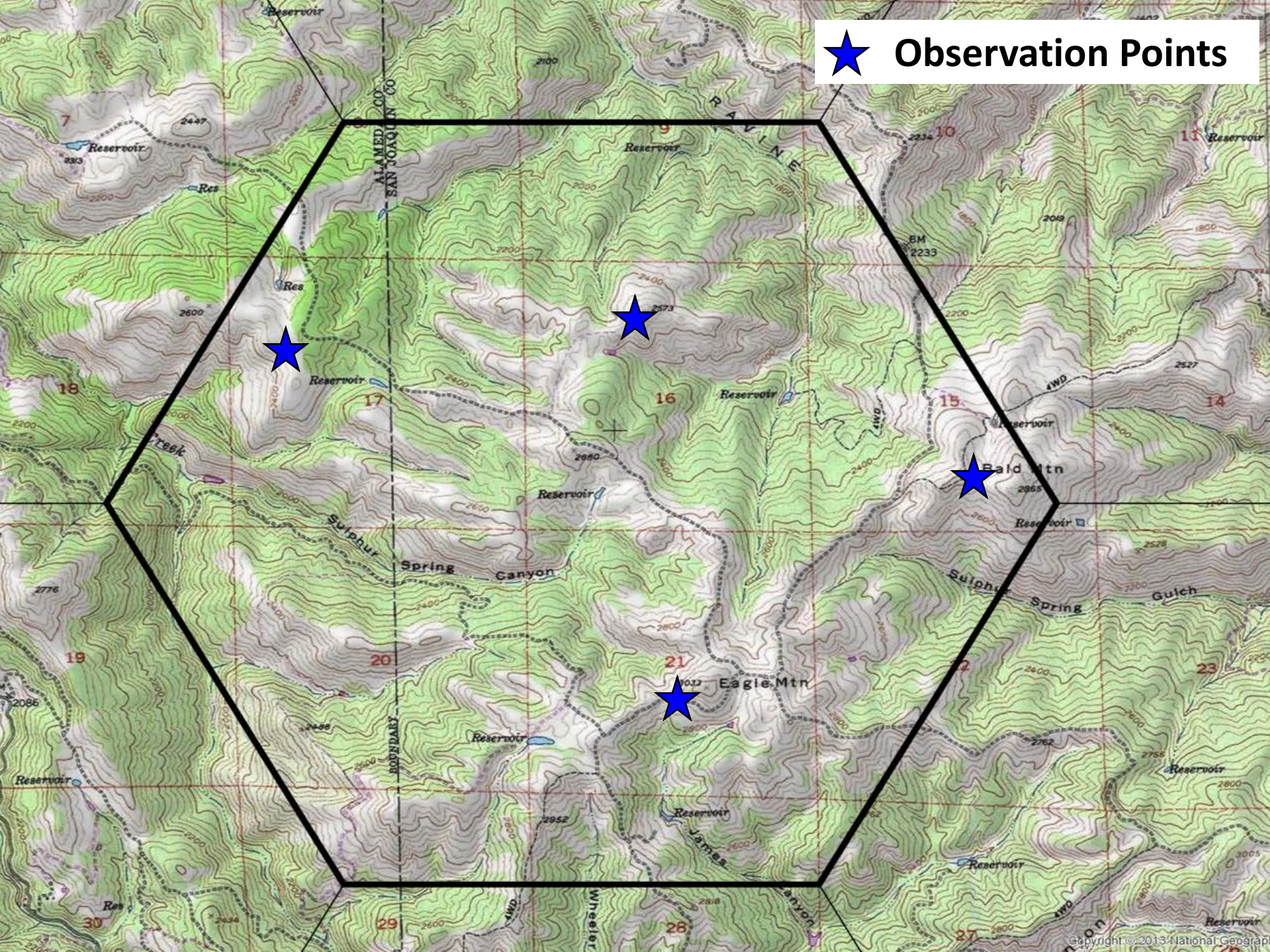
- **Number of sites and visits required?**
- **Simulated occupancy data in program GENPRES (Bailey et al. 2007).**
- **"True" values based on previous studies**
- **Survey designs with ≥120 sites and ≥4 replicate visits provided relatively unbiased and precise estimates of occupancy and nesting success**





Multistate Occupancy Sampling Design




Observation Points
Reservoir
Res
RAVINE
ALAMEDA CO
SAN JOAQUIN CO
BM 2233
Bald Mtn
Eagle Mtn
Sulphur Spring Canyon
Sulphur Spring Gulch
James
Wheeler
BOUNDARY
4WD
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Field Protocols

- 4 visits per sample unit during the breeding season (1 Jan – 31 Jul)
- 4 hr observation period each visit
- Record location, behavior, age, and breeding status of all Golden Eagles

Territorial pairs detected in 26 (79%) of 33 sample units surveyed since Jan 10, 2014…

Benefits of a Multisate Occupancy Approach

1. Deals with uncertainty in sampling reproductive status of golden eagles via the incorporation of detection probabilities.

2. Provides a standardized modeling framework to evaluate hypotheses relevant to conservation of golden eagles (e.g., Martin et al. 2009[1]).

3. Can incorporate multiple years of survey data to investigate how site-specific environmental conditions influence annual transition probabilities between breeding and non-breeding states.

[1]Martin et al. 2009. Dynamic multistate occupancy models to evaluate hypotheses relevant to conservation of golden eagles in Denali National Park, Alasks. Biological Conservation 12:2726-2731

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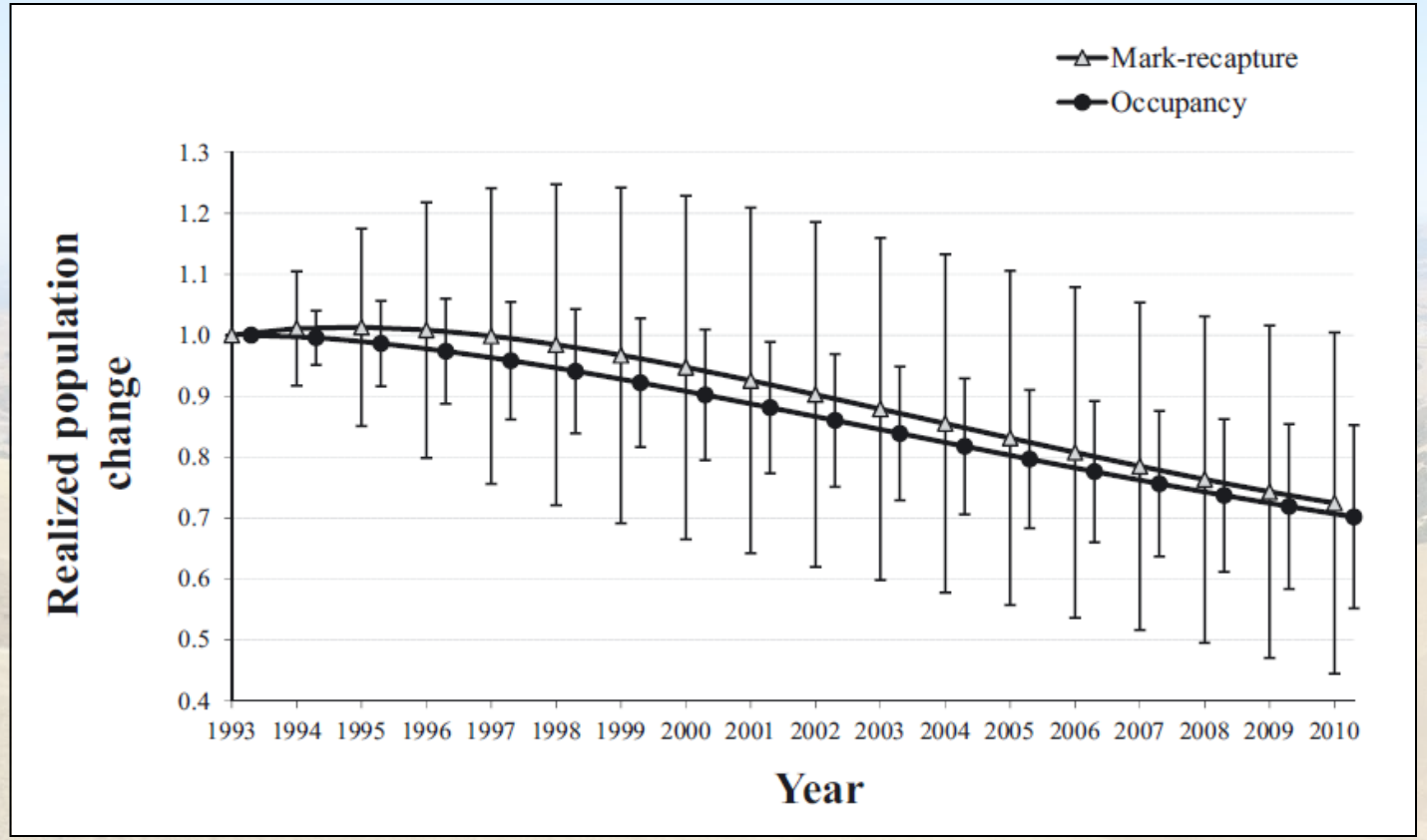
Mark-recapture vs. Occupancy Modeling for Estimating Rate of Population Change



FROM: *Tempel and Gutiérrez 2013.* Relationship between occupancy and abundance for territorial species. *Conservation Biology 0:1–9*

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