Relating Latent True Occupancy to Landscape Features in the Presence of Inter-Annual Swings in Apparent Occupancy

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BACKGROUND

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Occupancy Sampling

- Occupancy sampling is surveying and recording the detection or non-detection of a species
- Non-detection ≠ absent
- Occupancy sampling is an efficient way to sample and monitor populations, including desert tortoise (Zylstra et al. 2010)

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Mojave Desert Tortoise

- Spend up to 95% of their life underground
- Cryptic
- Home ranges vary but can be over 40 ha
- Long-lived species > 50 years in the wild
- **Above ground activity driven by past and current weather patterns**

Apparent occupancy ≠ True latent occupancy

OBJECTIVES

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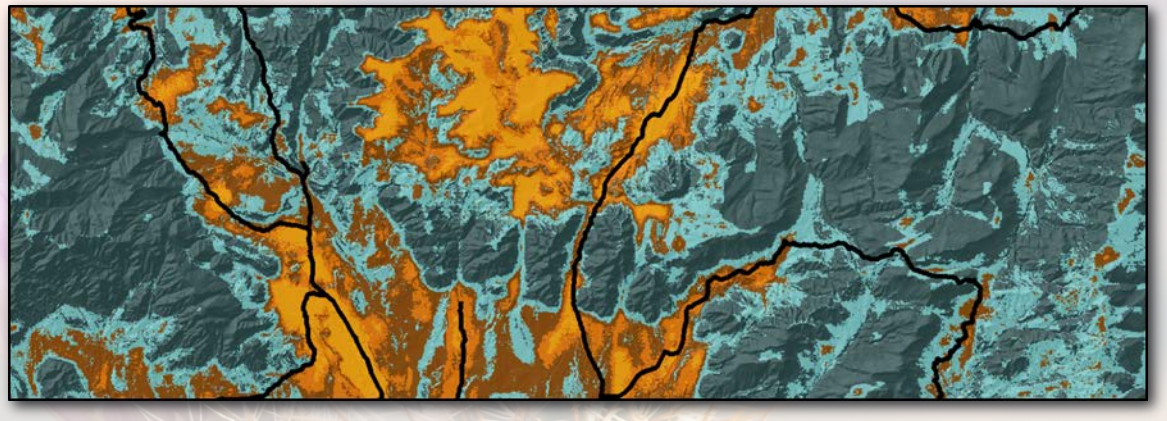
Need: Develop static predictive map of the relative probability of DT occurrence across the 86,000 ac Boulder City Conservation Easement (BCCE)



Existing options:

1) Series of single-year occupancy models

   Cons: inefficient; ignores non-independence within sites across years; give different estimates for each year

2) Dynamic multi-year occupancy model

   Cons: only use predictor variable estimate from the first year; can't include >1 method of detection

The goal: Develop multi-method occupancy model to estimate relationships with landscape variables that is robust to inter-annual swings in apparent occupancy when latent occupancy is constant

METHODS

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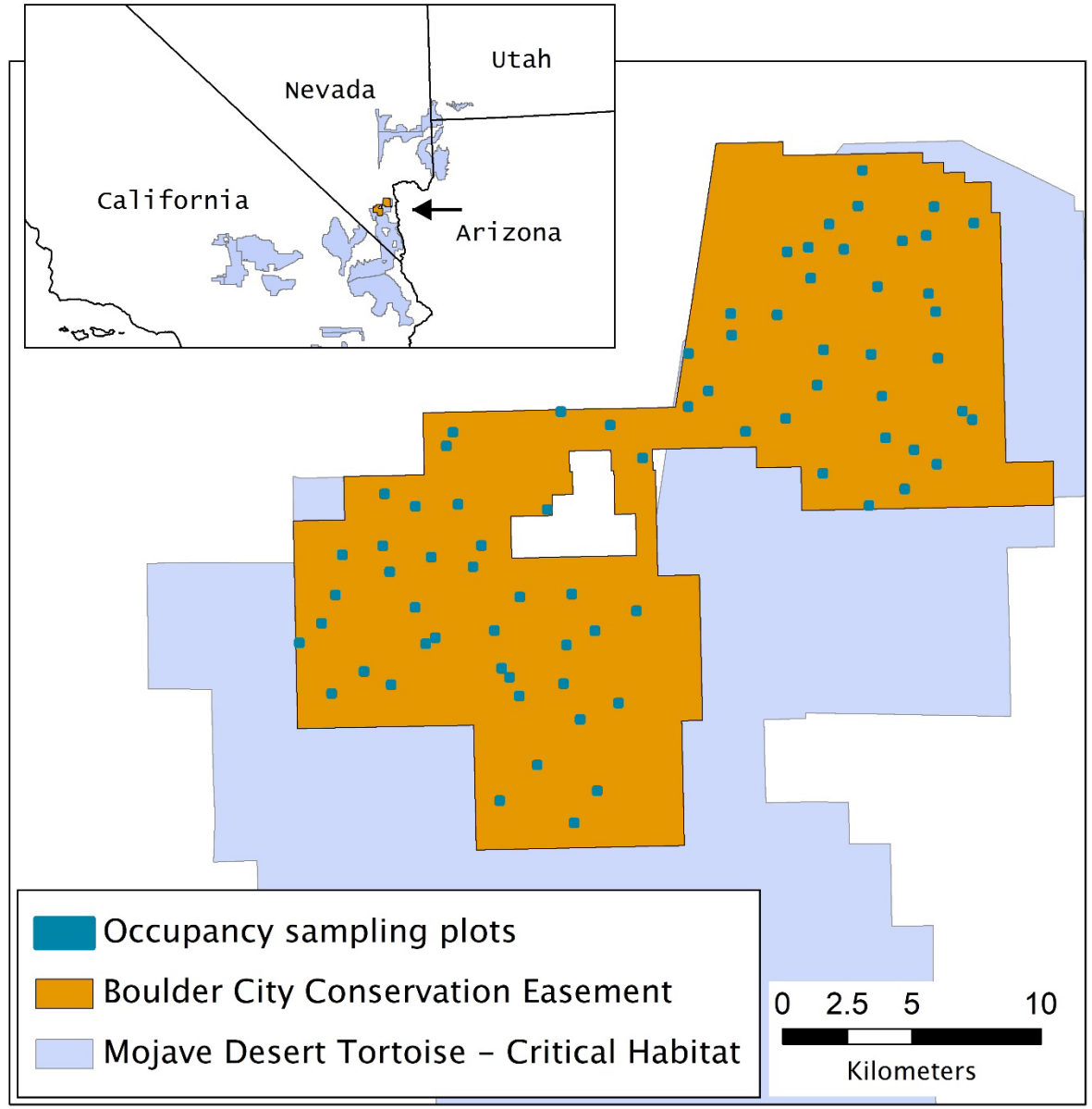
- 75 plots surveyed 3 times each in 2013 and 2014
- 60 plots surveyed 7 times each from 2015 – 2017
- Total of 1710 plots surveyed over 5 years
- Live tortoises and active burrows were recorded separately
- Plots were occupied with either/both a live tortoise or active burrow observed



CONCEPTUAL ISSUES

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- Two data types that were indicators of occupancy
  - Separate detection probabilities
  - Can be detected independently
- Sampling in multiple years
  - Not yet interested in temporal occupancy dynamics, need singular landscape relationship estimates
- Bayesian state-space model
  - New class of multi-method latent occupancy model for occupancy analysis when apparent occupancy is confounded with primary sampling period

CONCEPTUAL ISSUES

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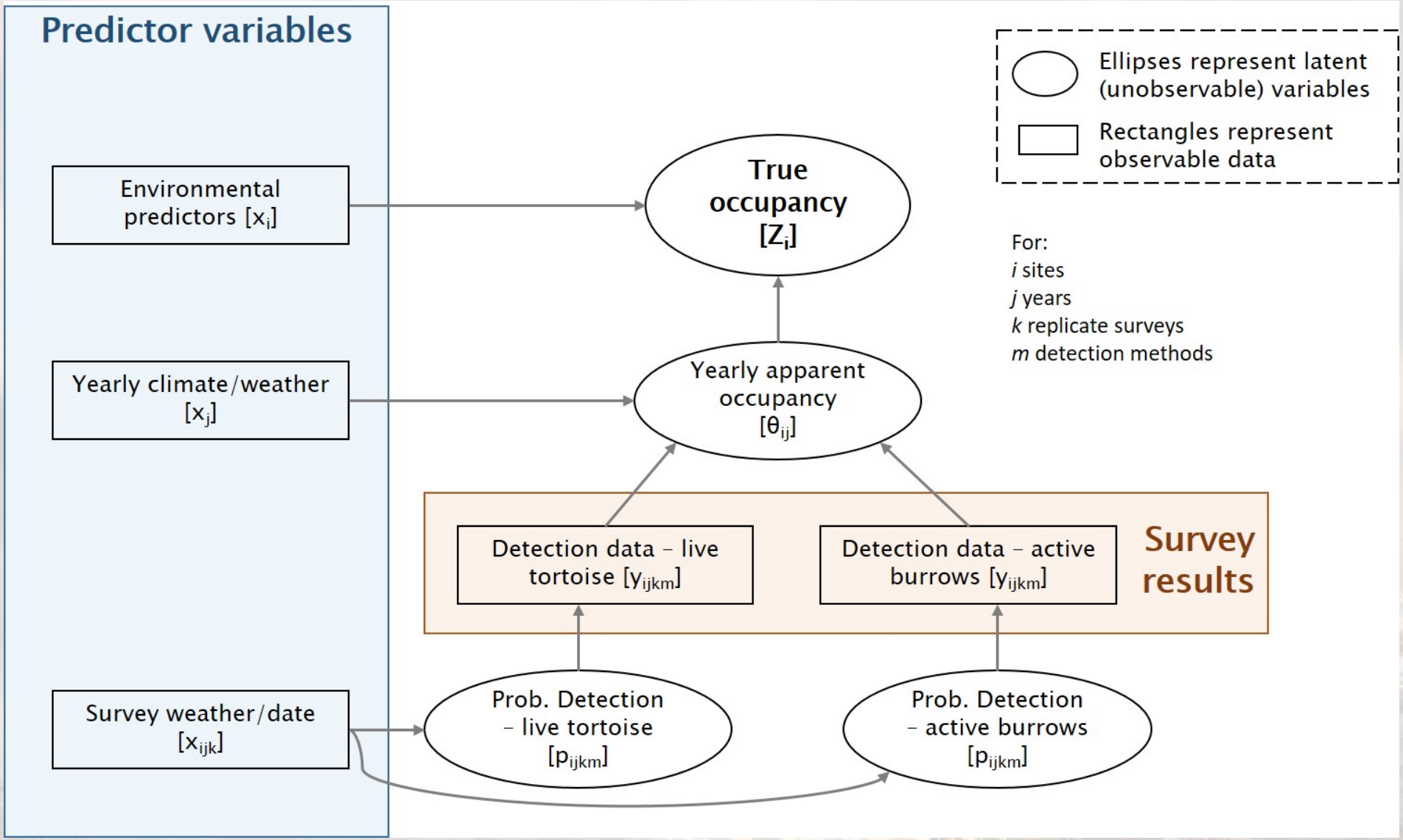

PREDICTOR VARIABLES

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Type of predictor	Predictor variable
Topographic	Distance to road
	Roughness
	Slope
	Wetness
	Washes
Edaphic	Dominant soil
Vegetative	Creosote cover
	Bursage cover

RESULTS

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Raw data: detections

Year	Plot surveys	No. live tortoise	No. active burrow
2013	225	10	12
2014	225	6	5
2015	420	22	8
2016	420	22	9
2017	420	36	29
Total	**1,710**	**96**	**63**

RESULTS

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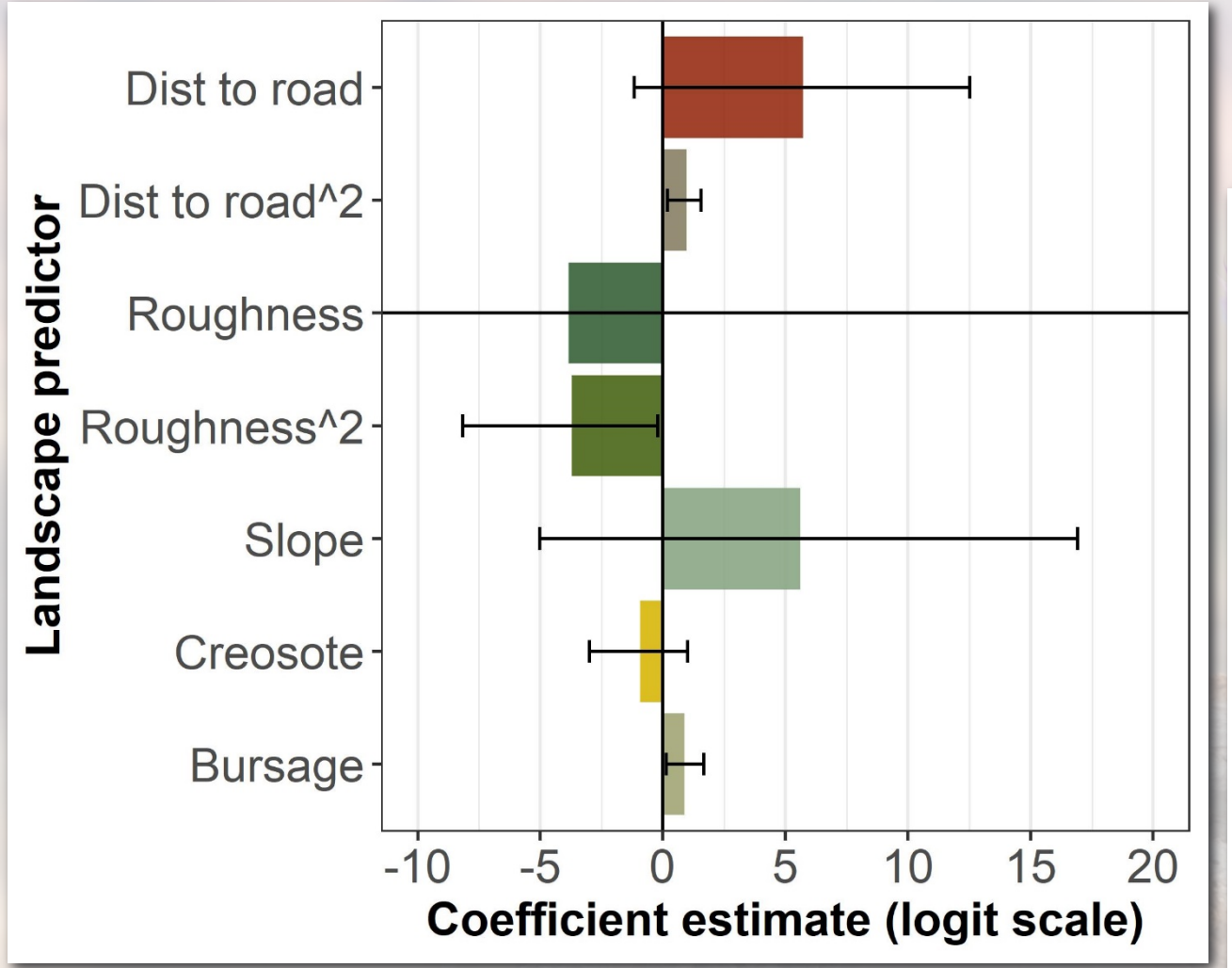

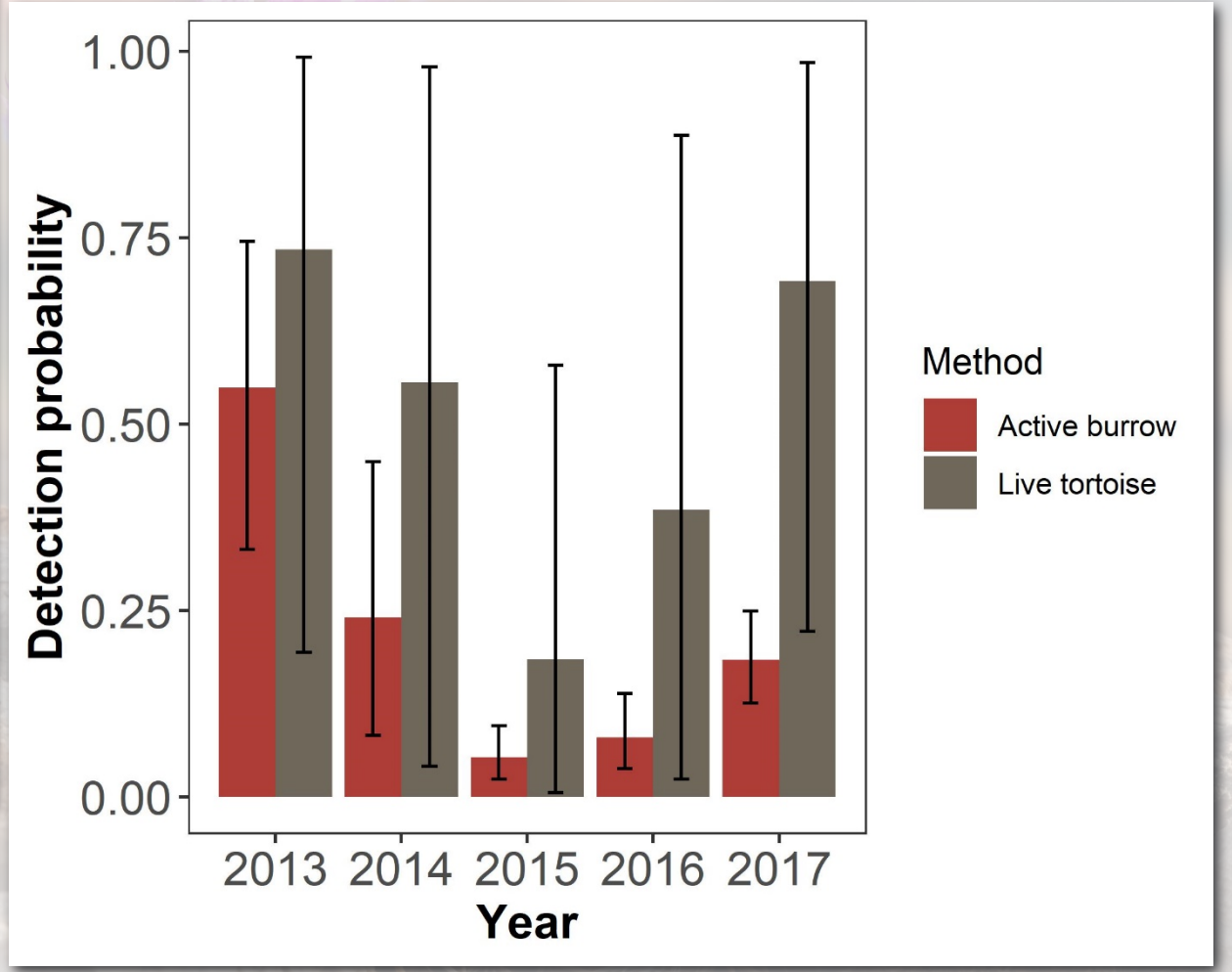

RESULTS

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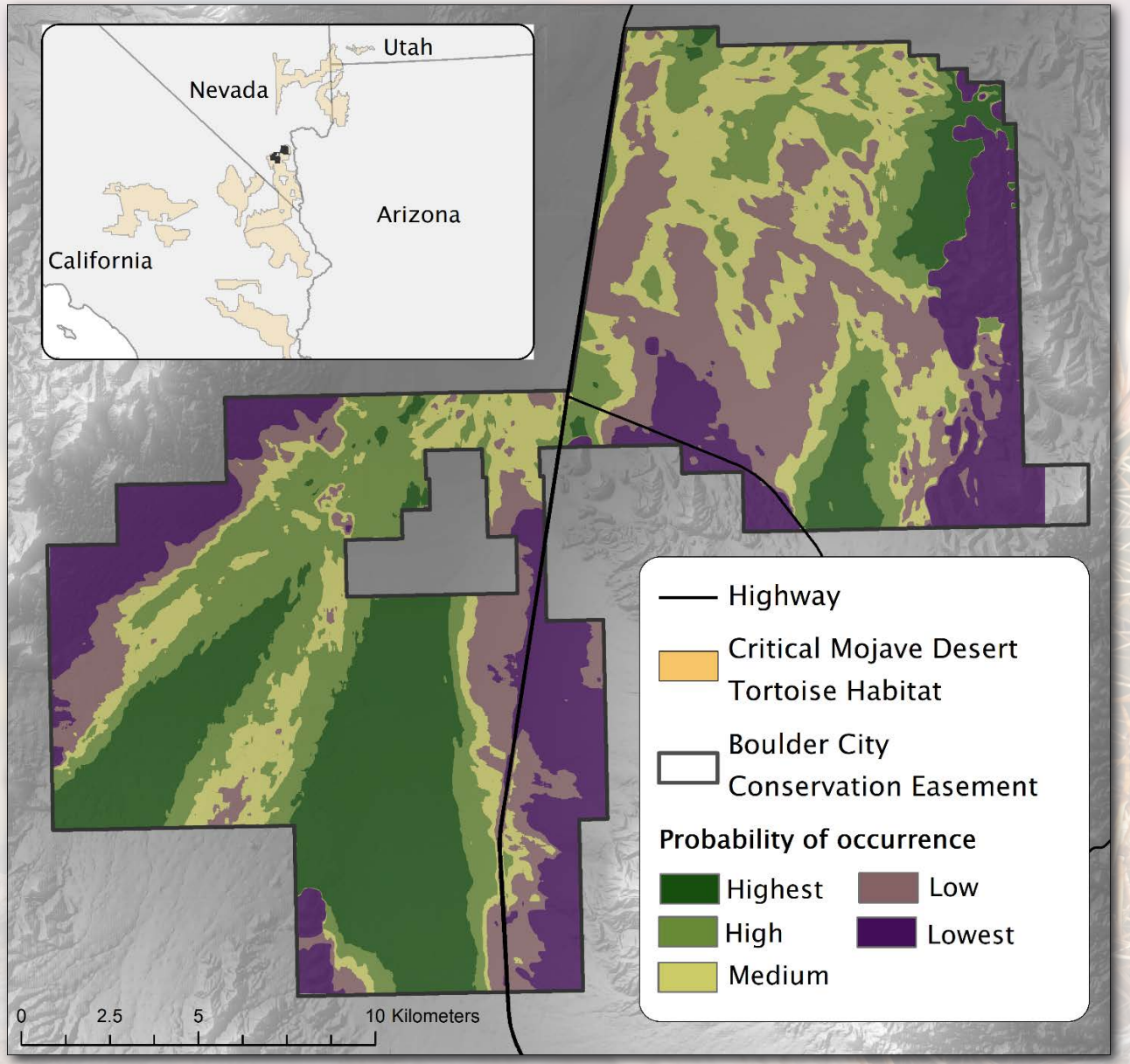

RESULTS - VALIDATION

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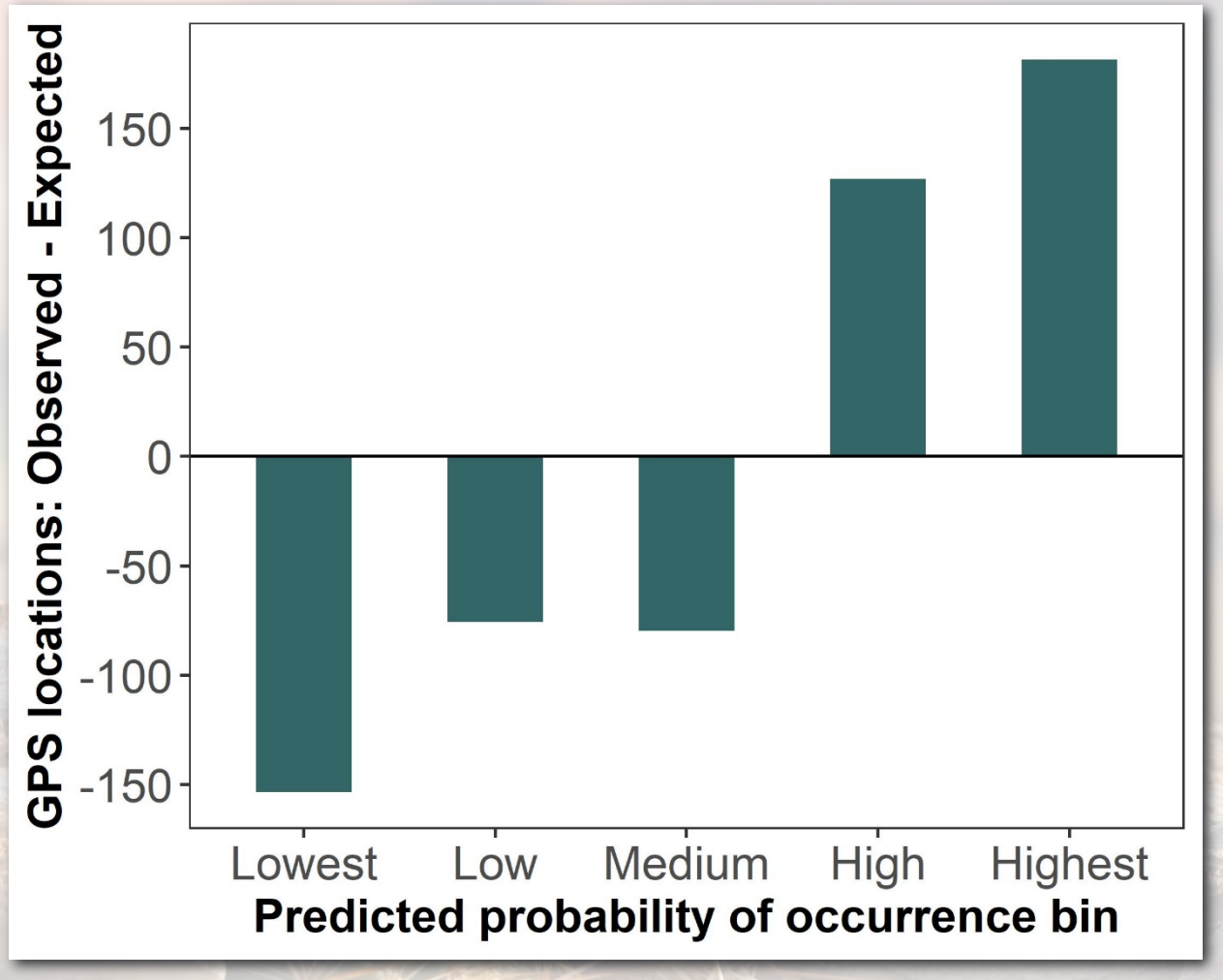
- MCMC internal diagnostics
  - 97.1% of internal R-hats were well below 1.05
- Model goodness-of-fit for input data
  - Logistical regression:
    - Odds Ratio = 1.68 (95% Cr.I. 1.14 – 2.48)
    - P-value = 0.09
- Independent Validation using independent telemetry data
  - Correlation:
    - Pearson's r = 0.948
    - P-value = 0.014



MANAGEMENT

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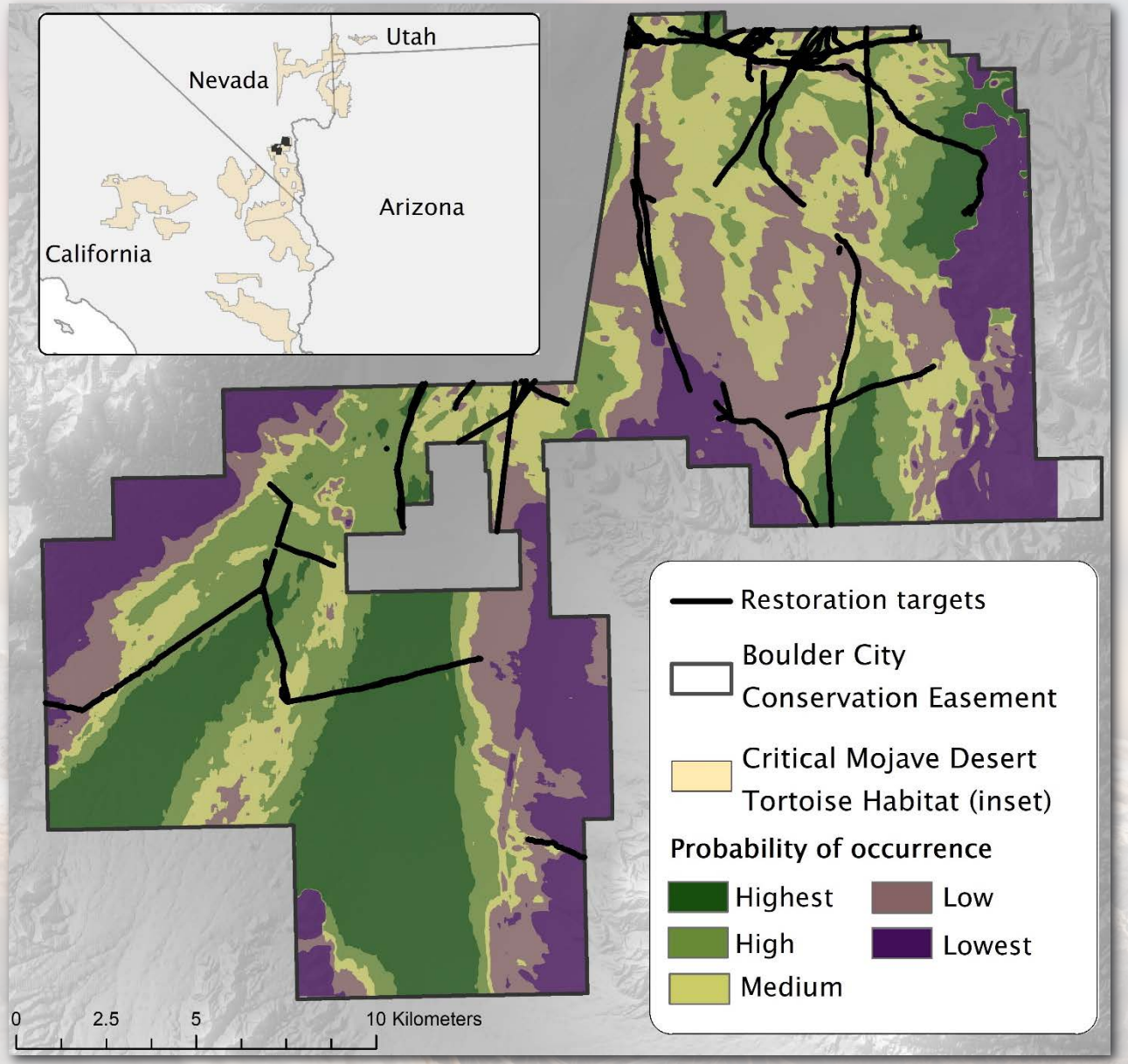
Management Implications

- Focus restoration activities
- Focused law enforcement
- Targeted habitat enhancement



NEXT STEPS

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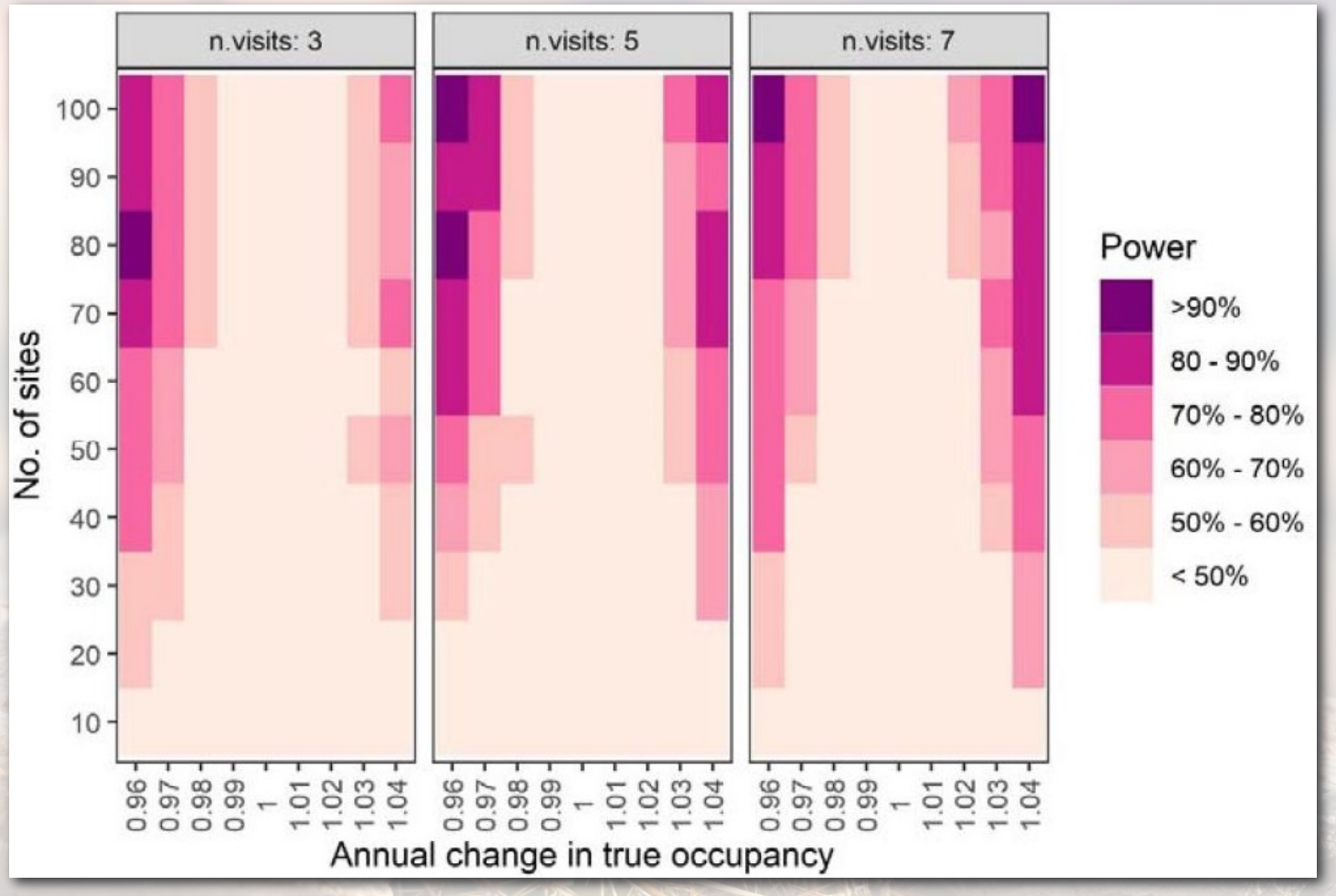
- Continue to monitor occupancy for changes over time
  - Use occupancy decreases to indicate the need for management actions
  - Use occupancy changes within adaptive management to determine how management actions affect tortoises
- Examine fine-scale vegetation data in the plots to see if they correlate with apparent occupancy among years



Questions?