# Occupancy analysis of the Mohave ground squirrel (*Xerospermophilus mohavensis)* throughout its range

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# Objective

Little Dixie Wash, March 2017

- Develop mathematical model from MGS surveys and environmental covariates to determine key site features for MGS presence
- (Eventually) use model to predict MGS presence on unsampled sites

# Hypotheses

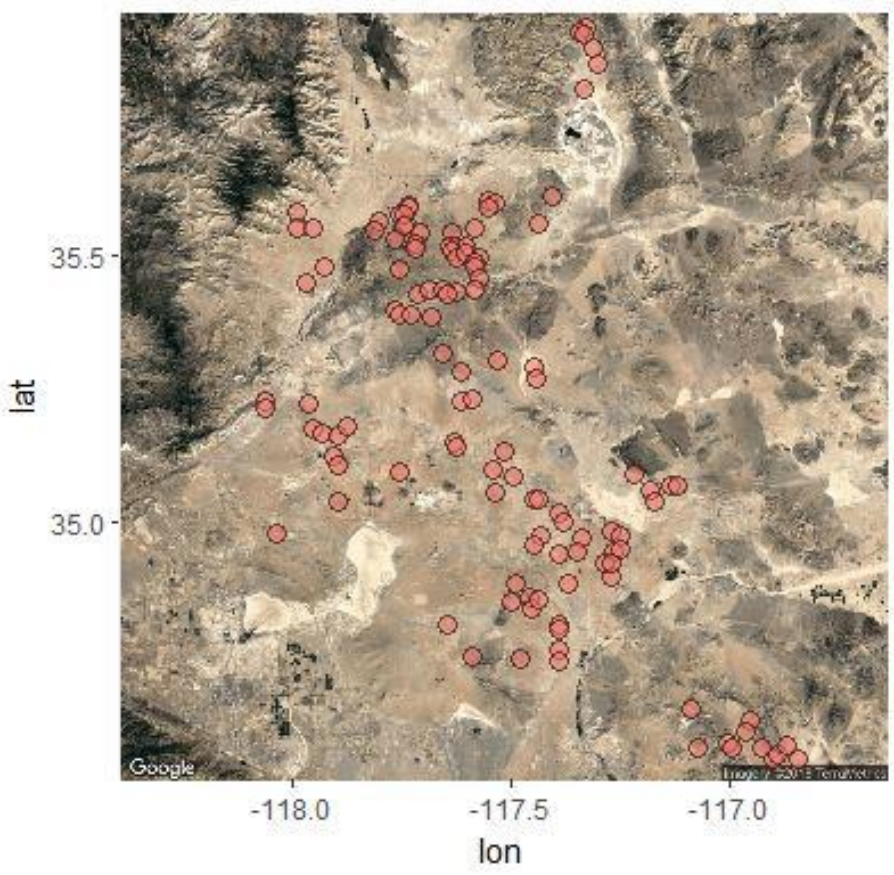
- Key MGS food resources determined by (Leitner and Leitner 2017) will be important for occupancy

Key Shrubs: Winterfat, Spiny Hopsage, Atriplex (specific species unknown)

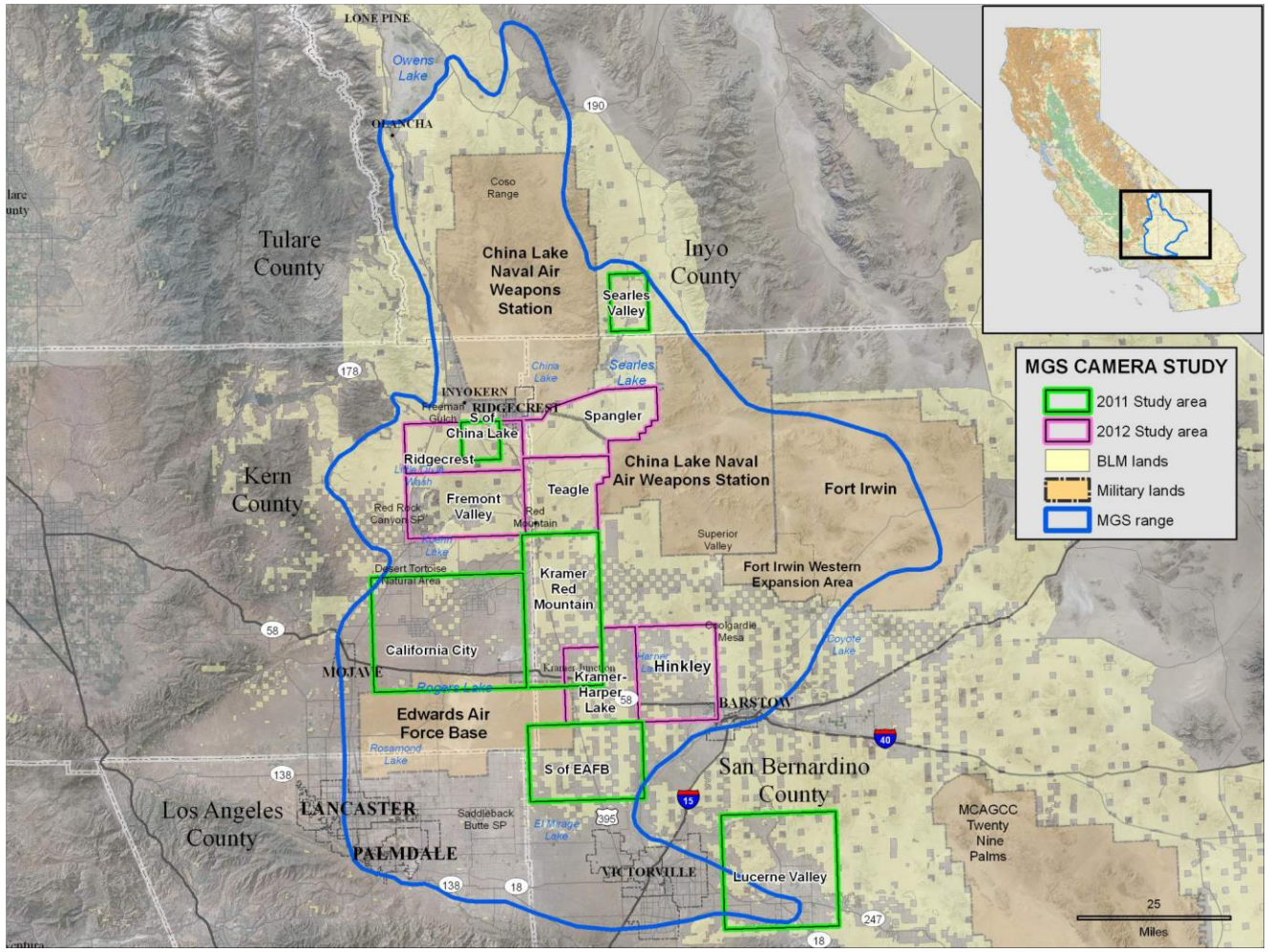
Key Herbs: Spotted milkvetch,  Mojave lupine, *Gilia* sp., *Linanthus* sp., *Eriogonum* sp., *Asteraceae*

- Since perennial shrubs are key during drought years, shrubs will be important for MGS occupancy

# Study Locations




Trapping site locations by latitude/longitude

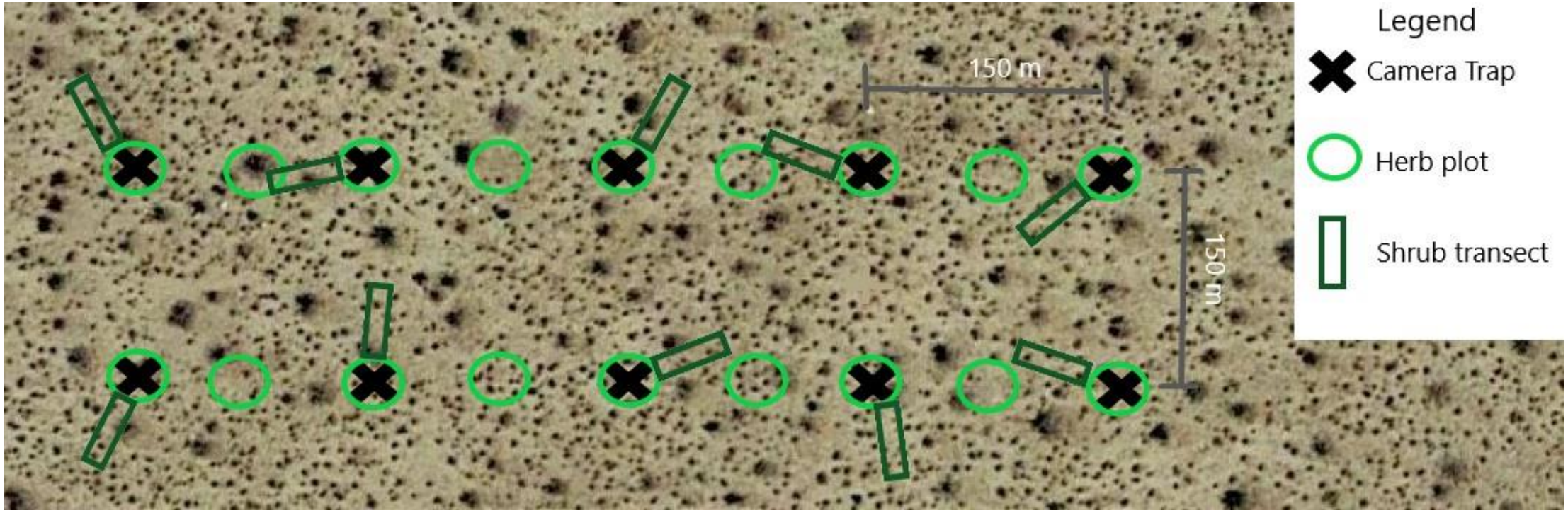



Map of regional trapping locations. From Leitner and Delaney (2014)

# Site and Detection Covariates

| | 2011 | 2012 | Data Type | Data Source |
|---|---|---|---|---|
| **Site Covariates** | | | | |
| **Herbaceous plant sampling** | Surveys completed | Surveys not done | - Density (plants/plot)<br>- Cover (percentage of plot covered by vegetation, plant cover/plot)<br>- Special plants of interest (counted if seen anywhere on the site) | 20 circular plots, (2 m radius) every camera site and midpoint between camera sites. |
| **Shrub plant sampling** | Surveys completed | Surveys completed | - Density (plants/transect)<br>- Cover (percentage of transect covered by vegetation, plant cover/transect) | 10 25 x 2 m transects, every camera site, random compass direction selected |
| **Precipitation** | Data collected | Data collected | - 10-year winter precipitation means for each site | PRISM climate center |
| **Detection Covariates** | | | | |
| **Sampling time** | 3 Surveys | 2 Surveys | Days since first survey | Survey dates |

# Example Study Site



# Model Selection: Occupancy Analysis

- Species detection in surveys is not always perfect (p < 1)
- Use observed proportion of sampled sites occupied to estimate parameter ψ for occupancy probability
- Estimate occupancy and detection probabilities from detection history

Logit Link Function (transform to log scale for binomial response variable) derives parameters $\theta_i$

$$\text{logit}(\theta_i) = \beta_0 + \beta_1 x_{i1} + \ldots + \beta_U x_{iU}$$

Maximum Likelihood function is then used to estimate ψ and p

$$L(\theta \mid x) = \binom{s}{x} \psi^x (1 - \psi)^{s-x}$$

$$\text{Where } \binom{s}{x} = \frac{s!}{x!(s-x)!}$$

# Model Evaluation – AIC

$$AIC = 2k - 2\ln(\hat{L})$$

k = # of parameters estimated by model
$\hat{L}$ = max value of likelihood function

2011 Models

| Model | npar | AIC | ΔAIC | culm-wt |
|---|---|---|---|---|
| ψ(Shrub Foods)p(date) | 4 | 165.39 | 0.00 | 0.92 |
| ψ(.)p(date) | 3 | 170.84 | 5.45 | 0.98 |
| ψ(Shrub Foods)p(.) | 3 | 175.25 | 9.86 | 0.99 |
| ψ(MGS Foods)p(.) | 3 | 175.25 | 9.86 | 0.99 |
| ψ(MGS Foods + Precip)p(.) | 4 | 175.88 | 10.49 | 1 |
| ψ(.)p(.) | 2 | 182.01 | 16.62 | 1 |
| ψ(Shrub Cov)p(.) | 3 | 182.42 | 17.02 | 1 |

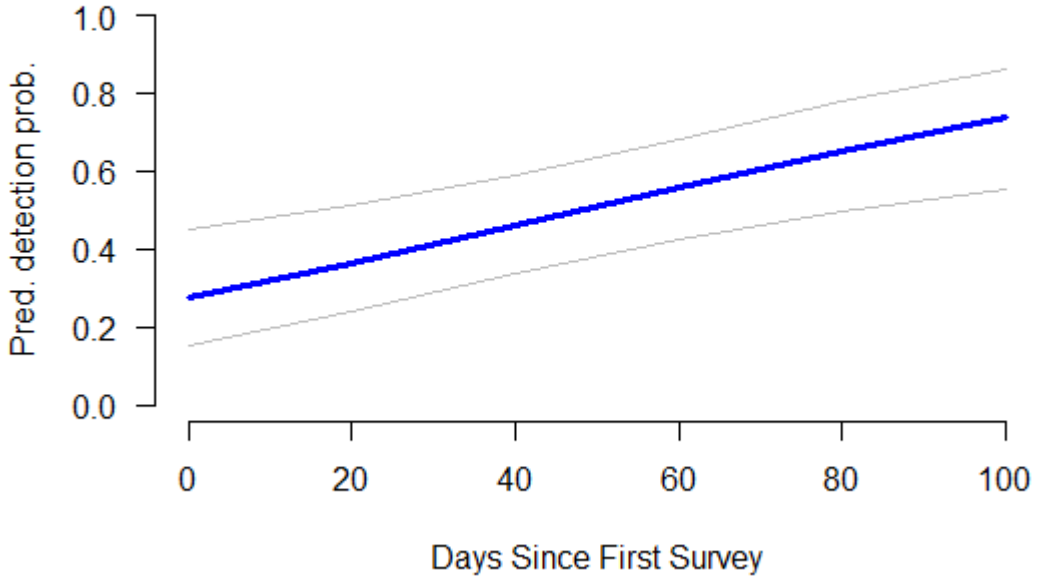
# Model Evaluation – AIC

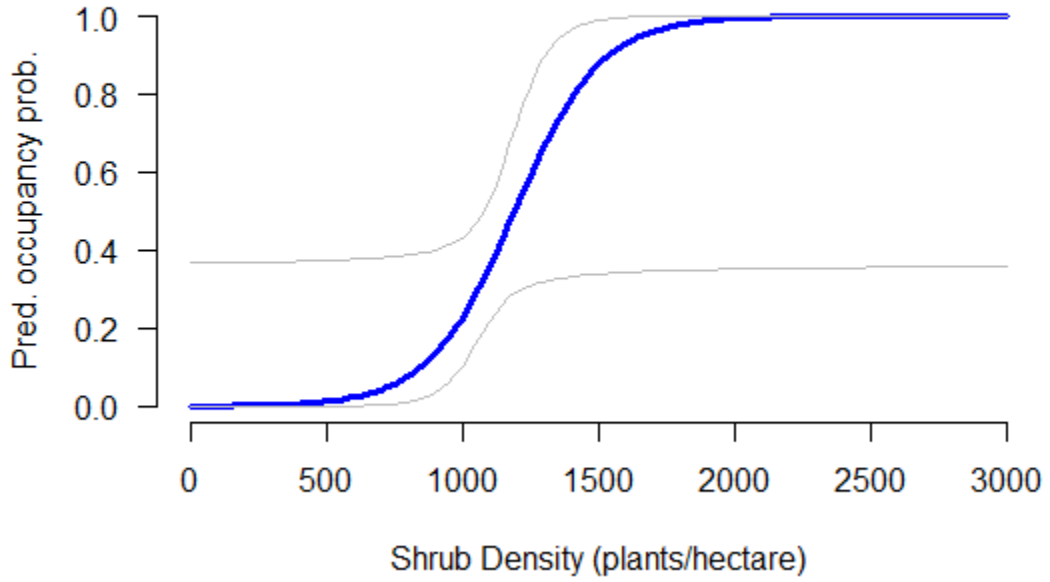
2011 and 2012 Shrub Models

| Model | npar | AIC | ΔAIC | culm-wt |
|---|---|---|---|---|
| ψ(Spiny Hopsage)p(.) | 3 | 336.30 | 0.00 | 0.67 |
| ψ(Mojave Saltbush)p(.) | 3 | 338.60 | 2.30 | 0.88 |
| ψ(Fourwing Saltbush)p(.) | 3 | 341.22 | 4.92 | 0.94 |
| ψ(.)p(.) | 2 | 343.31 | 7.00 | 0.96 |
| ψ(Allscale)p(.) | 3 | 344.20 | 7.90 | 0.97 |
| ψ(Desert Holly)p(.) | 3 | 344.30 | 8.00 | 0.98 |
| ψ(Shadscale)p(.) | 3 | 344.85 | 8.55 | 0.99 |
| ψ(Winterfat)p(.) | 3 | 345.30 | 9.00 | 1.00 |

# Results & Interpretation

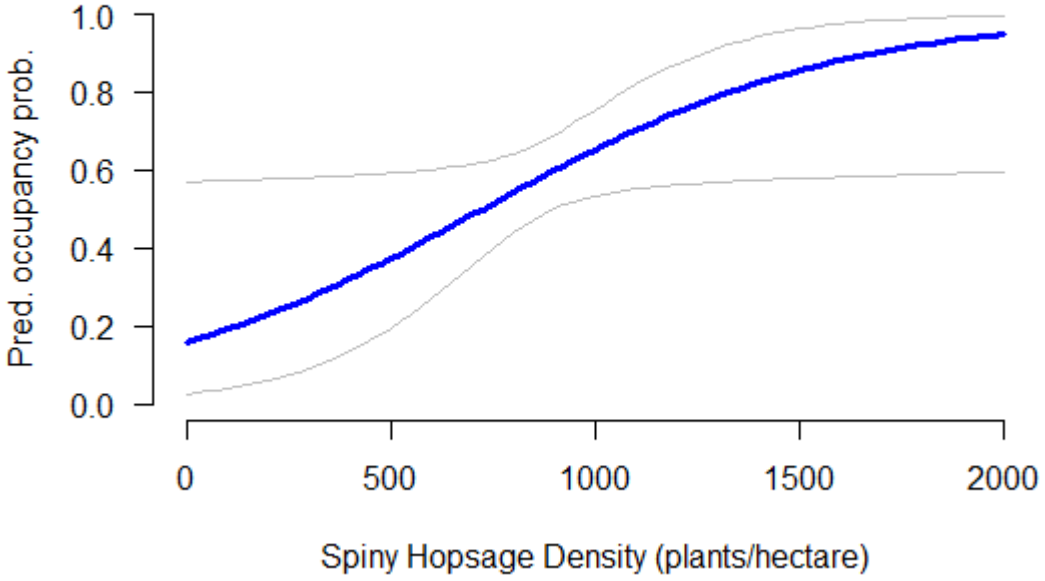
- Detection probability is influenced by timing of surveys
- Hypothesis of the importance of MGS shrub food resources seems to be supported for occupancy probability

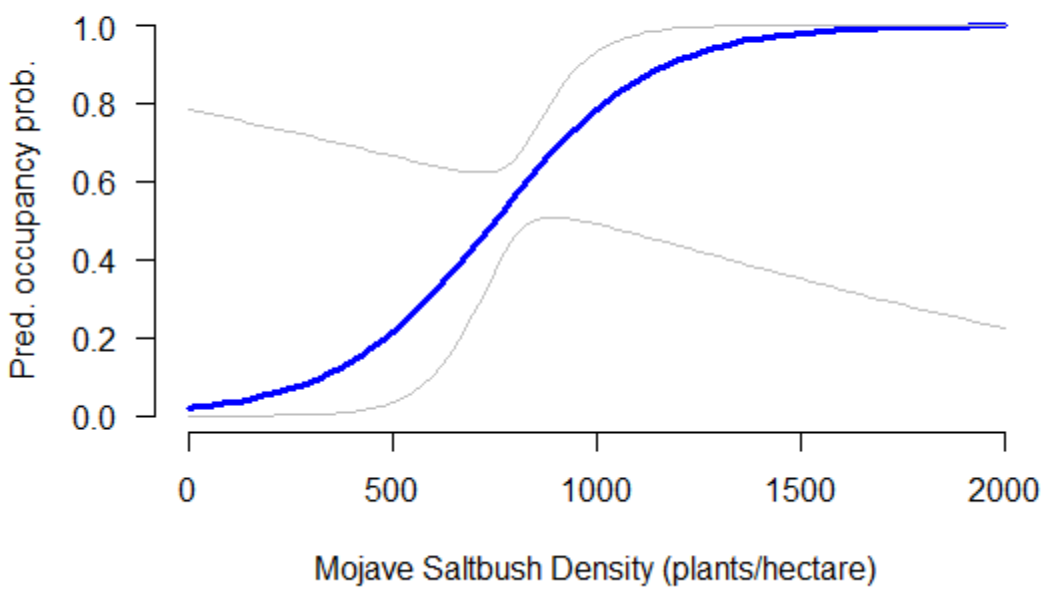


# Results & Interpretation

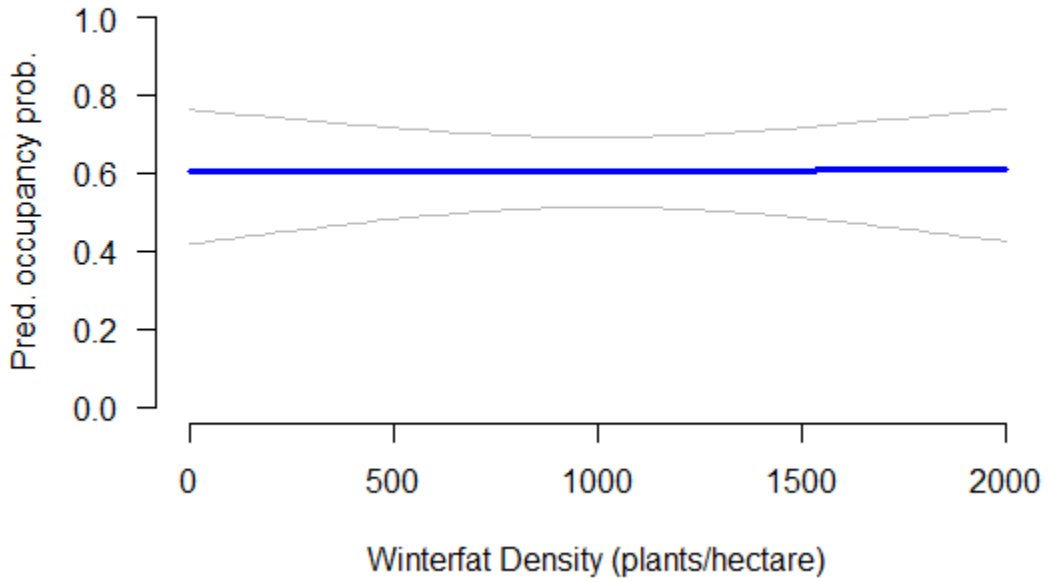
- Spiny Hopsage appears important for MGS occupancy
- Mojave Saltbush appears important but confidence intervals are not good



# Results and Interpretation

- KRLA density is uninformative for MGS occupancy



# Further Steps

- Test additional variables (e.g. alien herbaceous species vs. native herbaceous species, influence of other non-food shrubs)
- Look more closely at Winterfat sites and Mojave Saltbush sites to get a clearer idea of what's going on
- Build occupancy probability maps across MGS range (and hopefully ground truth this and compare with live-trapping records)
- Analyze the fecal data we've collected over MGS range to verify what they're eating – this would help tease apart the differences between Coso diet analysis and range-wide occupancy analysis (what are they actually eating?)