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

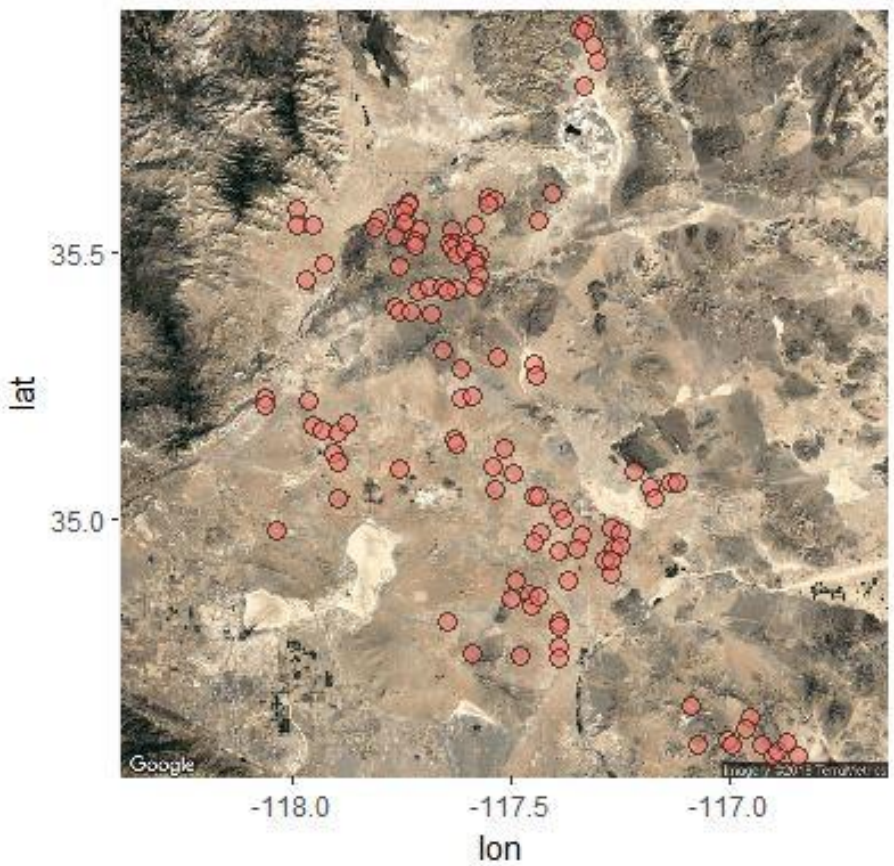
- Key MGS food resources determined by (Leitner and Leitner 2017) will be important for occupancy

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

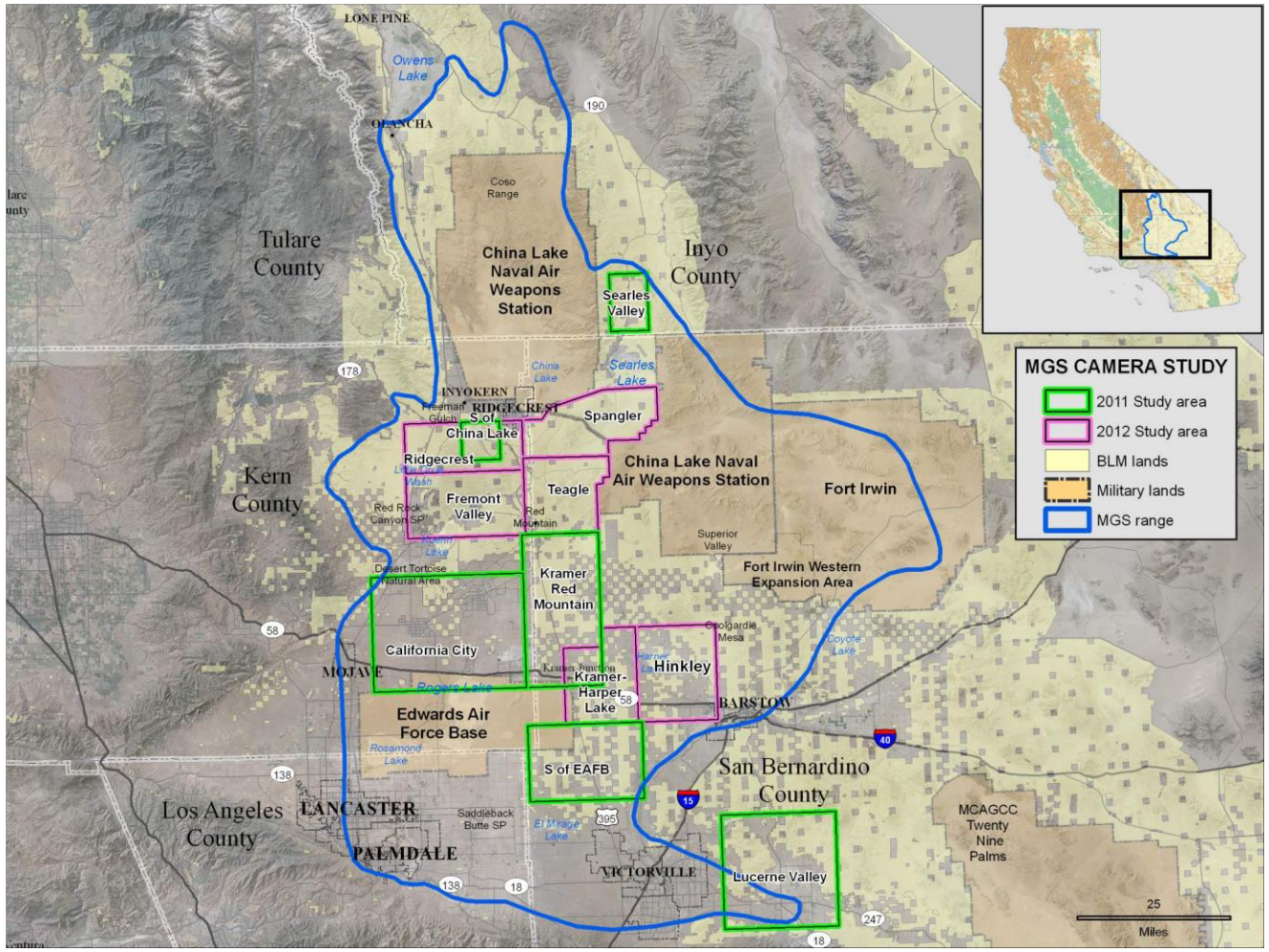
Key Herbs: Spotted milkvetch, Mojave lupine, *Gilia* sp., *Linanthus* sp., *Eriogonum* sp., *Asteraceae*

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

Study Locations



Trapping site locations by latitude/longitude

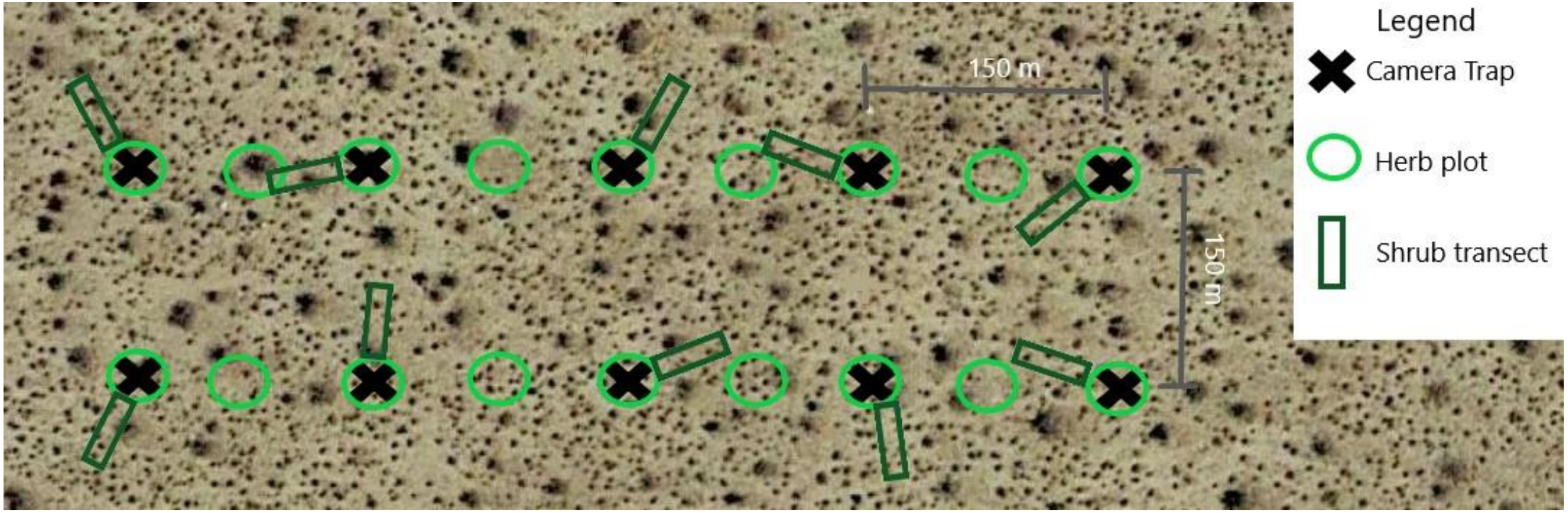


Map of regional trapping locations. From Leitner and Delaney (2014)

Site and Detection Covariates

	2011	2012	Data Type	Data Source
Site Covariates				
Herbaceous plant sampling	Surveys completed	Surveys not done	- Density (plants/plot) - Cover (percentage of plot covered by vegetation, plant cover/plot) - 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) - 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 θ_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

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

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

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

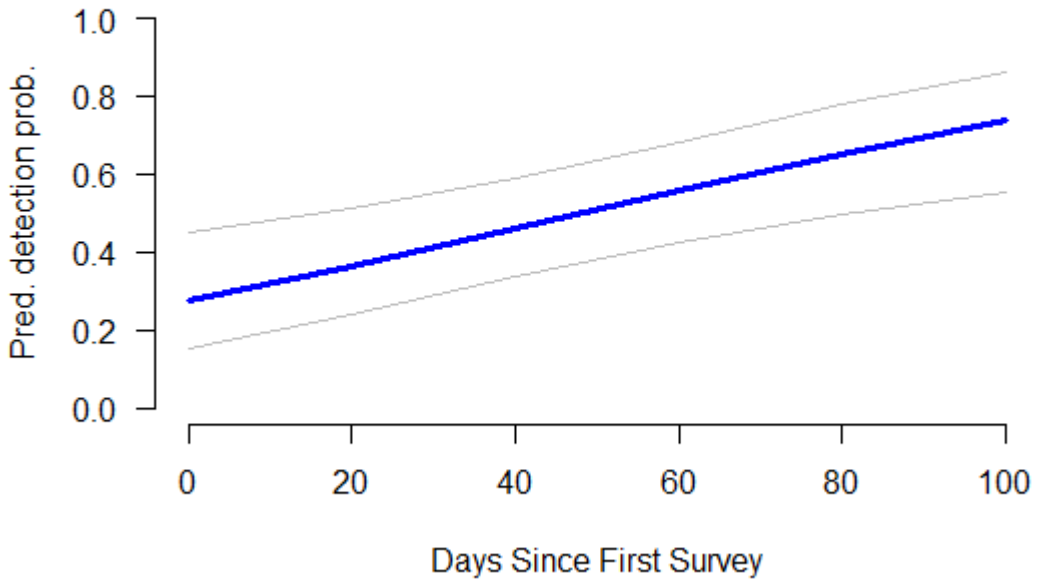
Model Evaluation – AIC

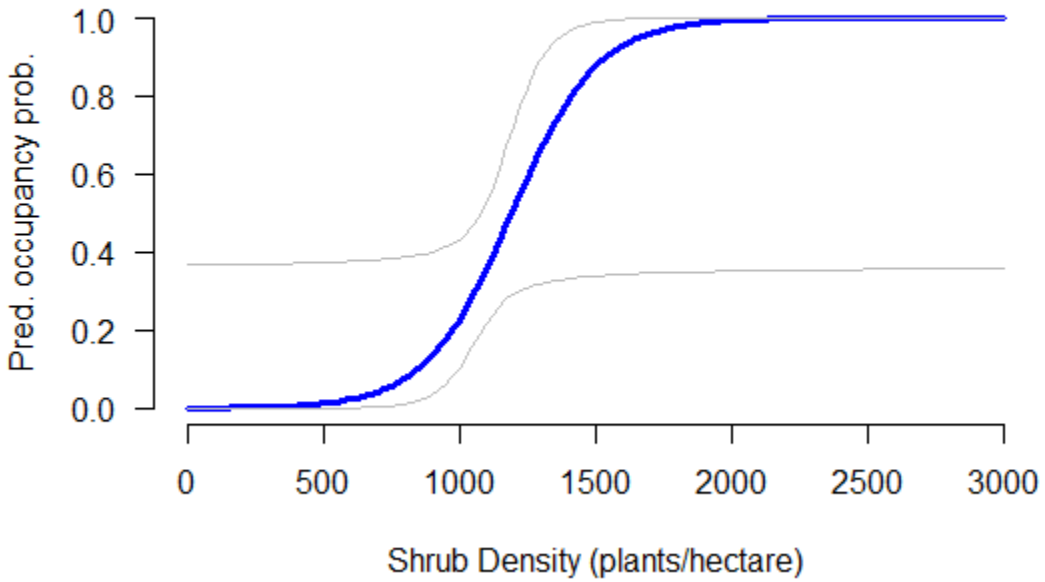
2011 and 2012 Shrub Models

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

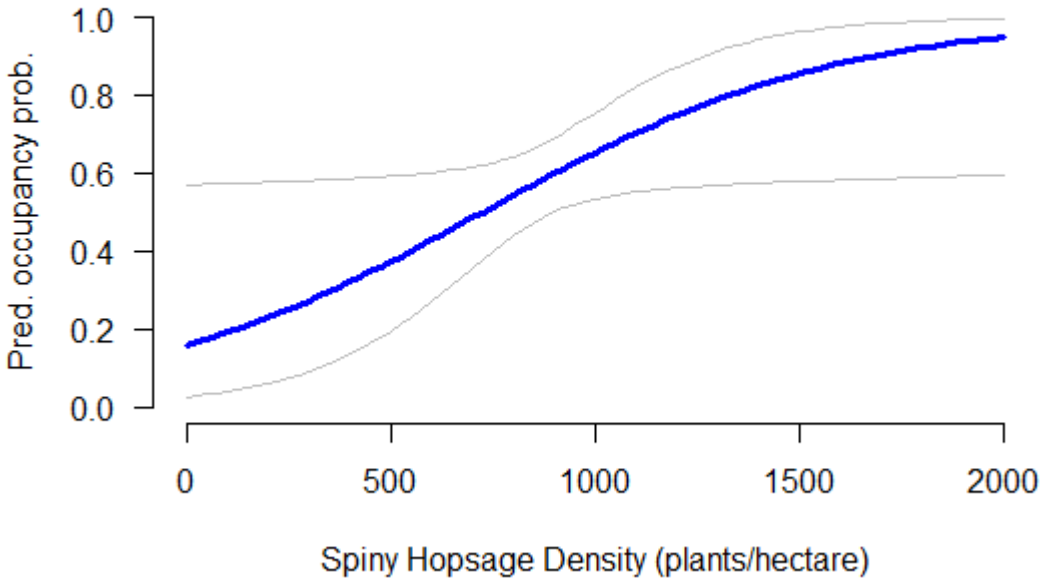
- Detection probability is influenced by timing of surveys
- Hypothesis of the importance of MGS shrub food resources seems to be supported for occupancy probability

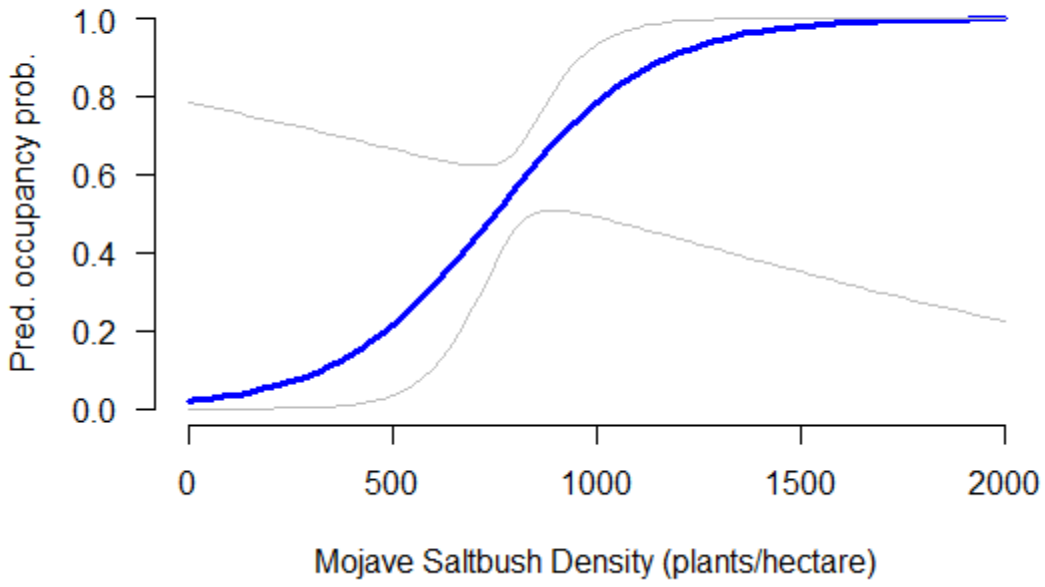




Results & Interpretation

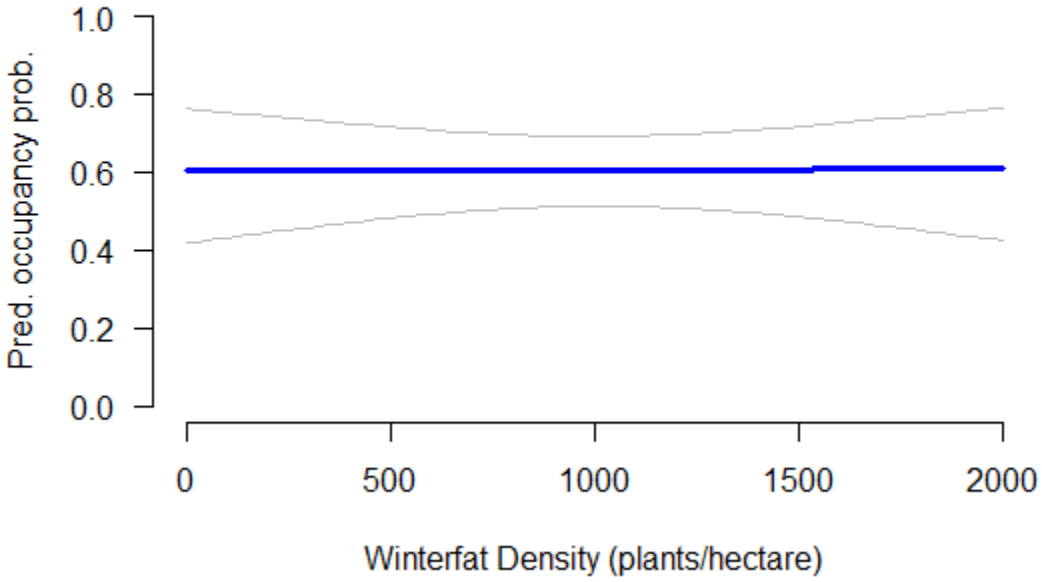
- Spiny Hopsage appears important for MGS occupancy
- Mojave Saltbush appears important but confidence intervals are not good





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?)