VGL - MAMMALIAN ECOLOGY AND CONSERVATION UNIT

# Occupancy estimation as a tool to test and refine a predictive species distribution model for the Sacramento Valley red fox (*V.v.patwin*)

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## Introduction

The Sacramento Valley red fox (SVRF, *Vulpes vulpes patwin*) is endemic to the northern Central Valley of California. It was only recently (2007) identified as native and distinct from the more widely distributed nonnative population of red foxes that currently occupies large portions of California's lowlands (Sacks 2010, Statham 2012; Sacks et al. 2016). Recently, the California Department of Fish and Wildlife (CDFW) listed the SVRF as a Species of Special Concern (SSC) due to the apparent decline in abundance from historic levels, the recognition of its low genetic effective population size (n = 50) as well as its restricted and sparse distribution, and the limited amount of information on its current ecological status. Presently, habitat loss and hybridization with non-native red foxes present the most significant threats to the persistence of the SVRF. A preliminary distribution model was generated (using presence only data) in order to guide future survey efforts. This study sought to build upon the original model using systematic camera surveys and occupancy modeling, which incorporates presence and absence data.

## Objectives

Use Occupancy Modeling to:

1. Test utility of a presence only (MAXENT) modeling tool
2. Determine availability of suitable red fox habitat throughout the Sacramento Valley
3. Estimate abundance of Sacramento Valley red fox throughout its range.

**Acknowledgements**

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## Methods Flowchart

**STEP 1** Generated two preliminary range-wide red fox distribution models using presence only data (MAXENT modeling) from 42 den sites and 28 roadkill sites collected between 2007-2009 across the Sacramento Valley

**MODEL 1: HABITAT ONLY**
- Developed Land
- Dryland Agriculture
- Flooded Agriculture
- Grassland
- Wetland
- Woodland
- Proximity to Grasslands

**MODEL 2: HABITAT + HUMAN DEVELOPMENT**
- Identical to MODEL1
  +
- Proximity to Human Development



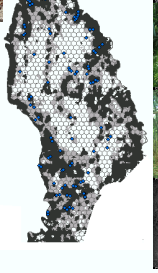

Overlaid the two models

**STEP 2** Dichotomized the Sacramento Valley into high, moderate and low suitability habitat.

Overlaid CDFW hexagonal survey grids

**STEP 3** Set baited cameras at 107 unique sites (presence and absence)

Rebait every two weeks for a 90 day survey period



## Results

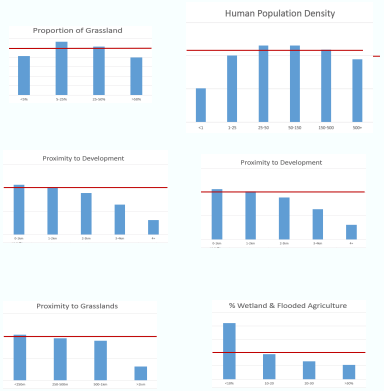
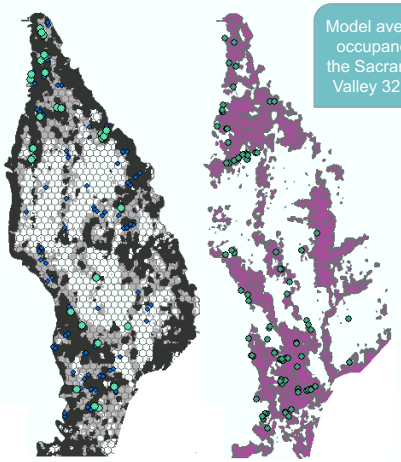



Figure 1. Selection Indices… Still need to writ eout this caption. Basically explain relationships between the 6 predictive covariates. NOTE - Need to update these selection indices to reflect the 6 covariates in the table below.

Red fox detected at 30 of 107 sites

Naïve Occupancy 28%

Based on the MAXENT model classifications we detected red fox at :
- 26 (35.6%) high probability sites
- 30 (32.3%) moderate probability sites models
- 0 (0%) low probability sites



MAXENT MODEL



OCCUPANCY MODEL

Figure 2. Showing final dichotomized predictive surface based on a modeled average probability of occurrence. The green dots show independent data not used in the generation of this model that further show the relative accuracy of this updated model.

| | Woodland | Dry Agriculture | Development | Human Population Density | Distance to Grassland | Distance To Development |
|---|---|---|---|---|---|---|
| Model 1 | | * | | | * | |
| Model 2 | | * | * | | * | |
| Model 3 | | * | | | * | |
| Model 4 | | * | | | * | |
| Model 5 | | * | | | | |
| Model 6 | | * | * | | | |
| NULL | | | | | | |

Table 1. Model selection table for top (ΔQAICc < 4) models, with null model shown for reference. QAICc is Akaike's Information Criterion corrected for overdispersion (ĉ=1.2044) and small sample size (n=100), ΔQAICc is the relative difference in QAIcc compared to the top ranked model . Covariates shown in blue indicate a negative response variable, while covariates shown in red indicate a positive response variable, and those in grey indicate the covariate was not included in that model. Covariates denoted with an (*) indicate that the 95% confidence intervals of the beta coefficients did not overlap zero (i.e. significant directional relationship)

## Model Performance

Model averaged occupancy of the Sacramento Valley 32.76%

The Sacramento Valley is ~12,000km$^2$

There is ~4,000km$^2$ of suitable red fox habitat

Average territory size of SVRF breeding pair 4km$^2$ - 10km$^2$

ESTIMATED 400-1,000 breeding pairs of SVRF

## Conclusions

1. Our detection results during the occupancy survey in each of the three MAXENT classifications (high (35.6%), moderate (32.3%), low (0%) probability of detection) support the utility of the original model.
2. Using the model averaged results from our occupancy survey we were able to determine that ~33% of the Sacramento Valley is occupied by the SVRF. This number likely corresponds to the availability of suitable habitat.
3. Though we do not yet have home range estimates for the SVRF, using predicted home range sizes from other red fox subspecies, we estimate the abundance of SVRF to be between 400-1,000 breeding pairs.

## References

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