CONSERVATION
SCIENCE PARTNERS

Implications for management: effects of hydroperiod on habitat suitability and occupancy of vernal pool species

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Implications for species management

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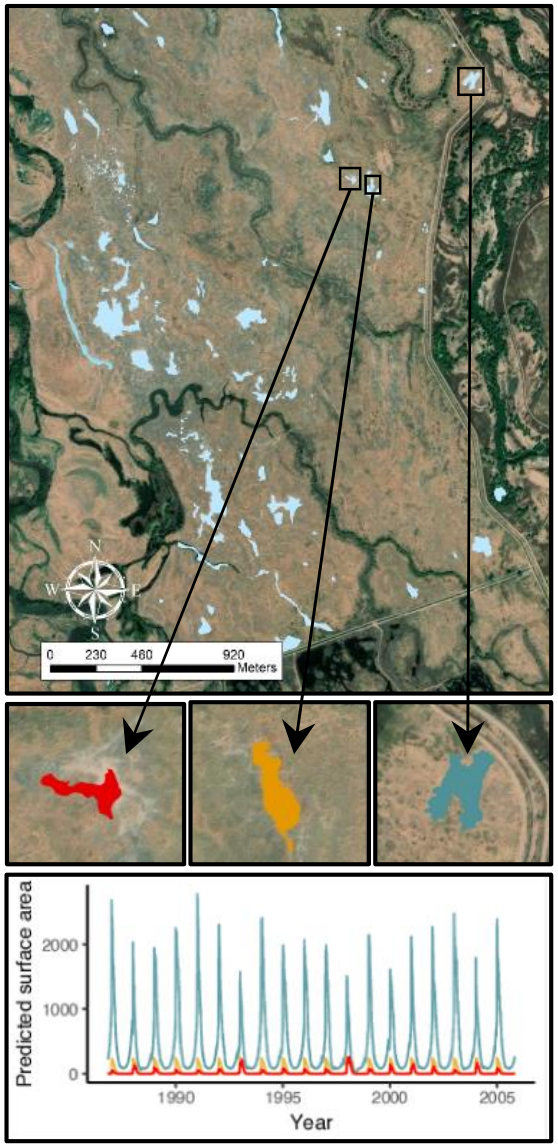
Implications for species management



- Mangers often lack data on spatial and temporal dynamics of wetland habitat at a scale relevant to making decisions

- Leveraging remotely sensed data to reconstruct wetland hydroperiods opens up opportunities to answer fundamental ecological questions and inform management decisions

- Offer a substantial improvement upon the severely limited and labor intensive data possible through field monitoring.

Implications for species management

Community dynamics

Year 1 Year 2

- Habitat suitability
- Species composition/interactions
- Stabilizing coexistence mechanisms

Population dynamics

Occupancy

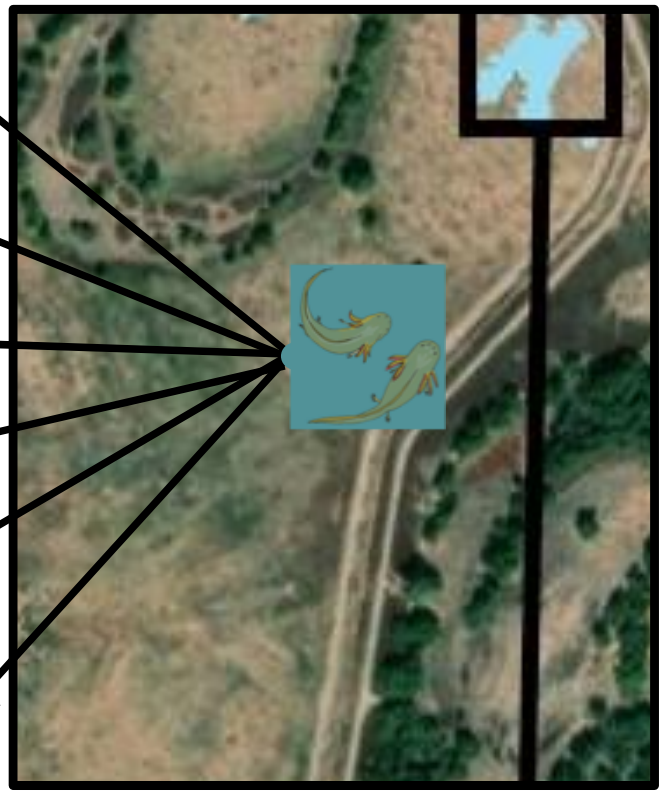
Population fitness

Birth rates

Death rates

Dispersal

Selection pressures



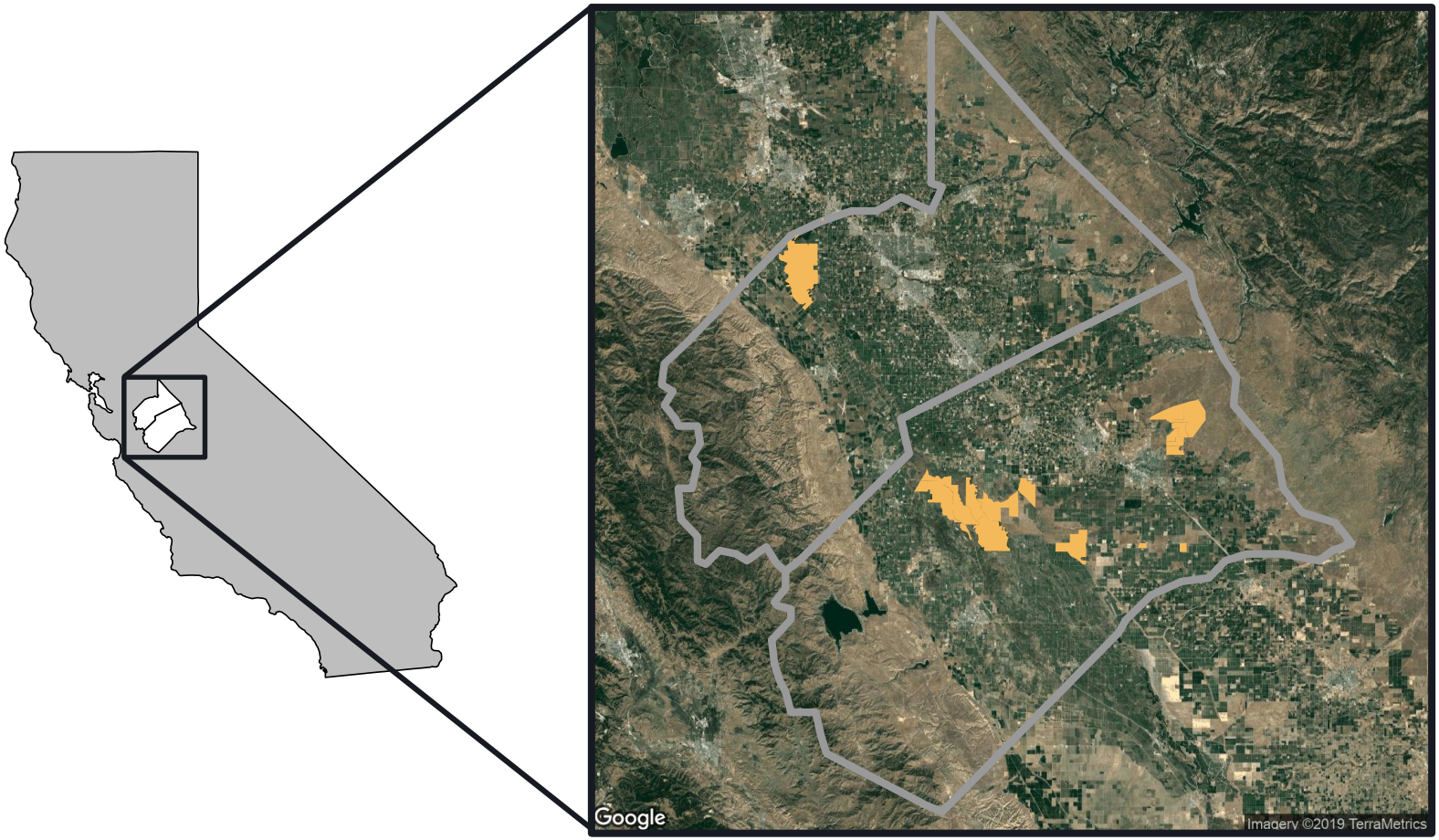
Goals and objectives

1. Demonstrate novel methods for reconstructing daily surface area estimates of wetlands
    - Combination of Spectral mixture analysis and Bayesian mixed-effects models
    - Case study: vernal pools in the Central Valley of California

2. Demonstrate application to species management
    - Occupancy of California tiger salamanders

Study area

Sampled vernal pools on wildlife refuges, conservation areas, and mitigation banks in CA Central Valley



Study area

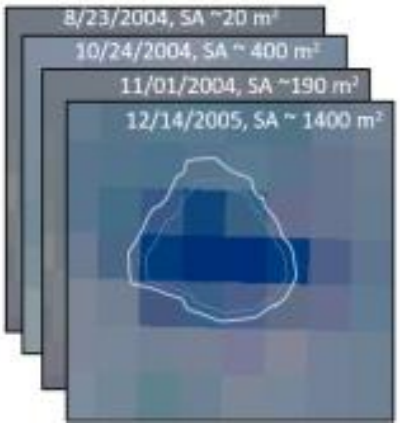
- Sampled 149 vernal pools
- Multiple visits between January 17th and May 8th 2017
  - Each pool surveyed 2-4 times
  - Walked perimeter of pool recording GPS track
- Collected data on a number of species ranging in conservation status

Species	Mean aquatic development time (days)	Conservation status (CA)
Invertebrate spp. 	29-48	Threatened/ Endangered
Western toad 	48	Stable
Spadefoot 	56	Species of special concern
Pacific tree frog 	81	Stable
California tiger salamander 	154	Threatened

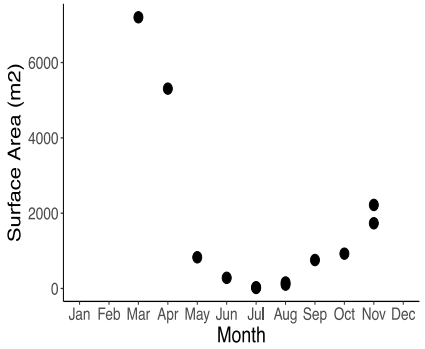
Hindcasting hydroperiod

Spectral Mixture Analysis

- Total of 385 images
- 31 years (1986-2017)
- Monthly to bi-monthly estimates

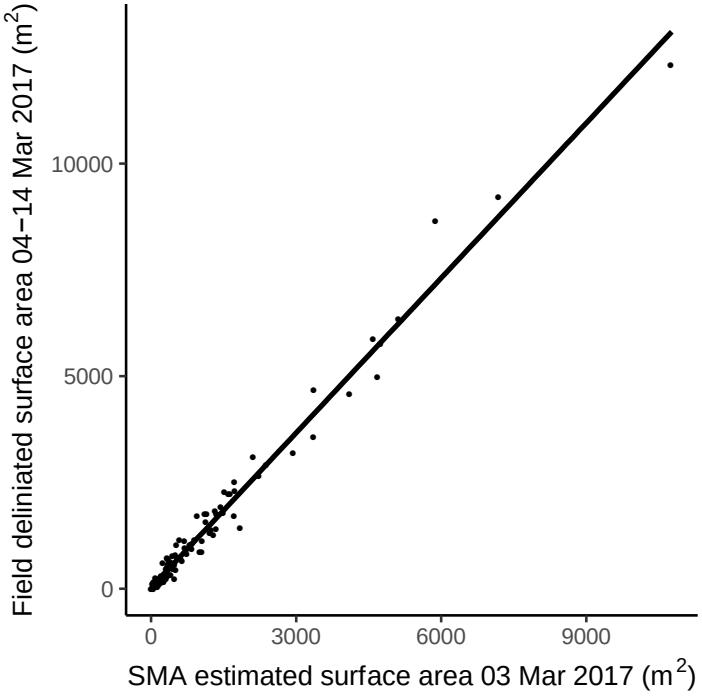


Landsat images for one pool



Surface area estimates

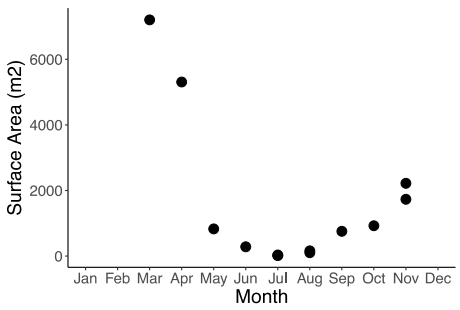
Strong correlation with field estimates!



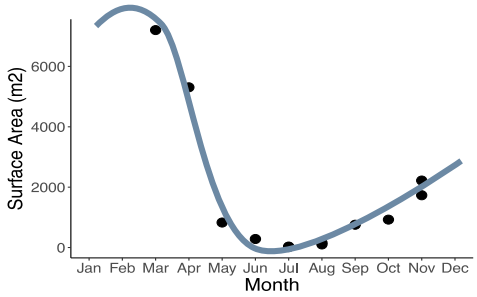
Hindcasting hydroperiod

Estimating daily hydroperiod using Bayesian hurdle models

Surface Area estimates from SMA



Predict daily surface area estimates



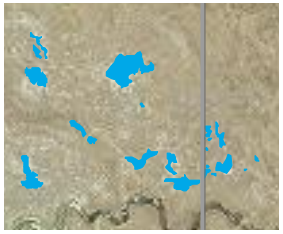
Surface Area ~

Soil moisture *

+

Month

+



Maximum pool size

+

Pool 1
Pool 2
Pool 3….

Pool ID

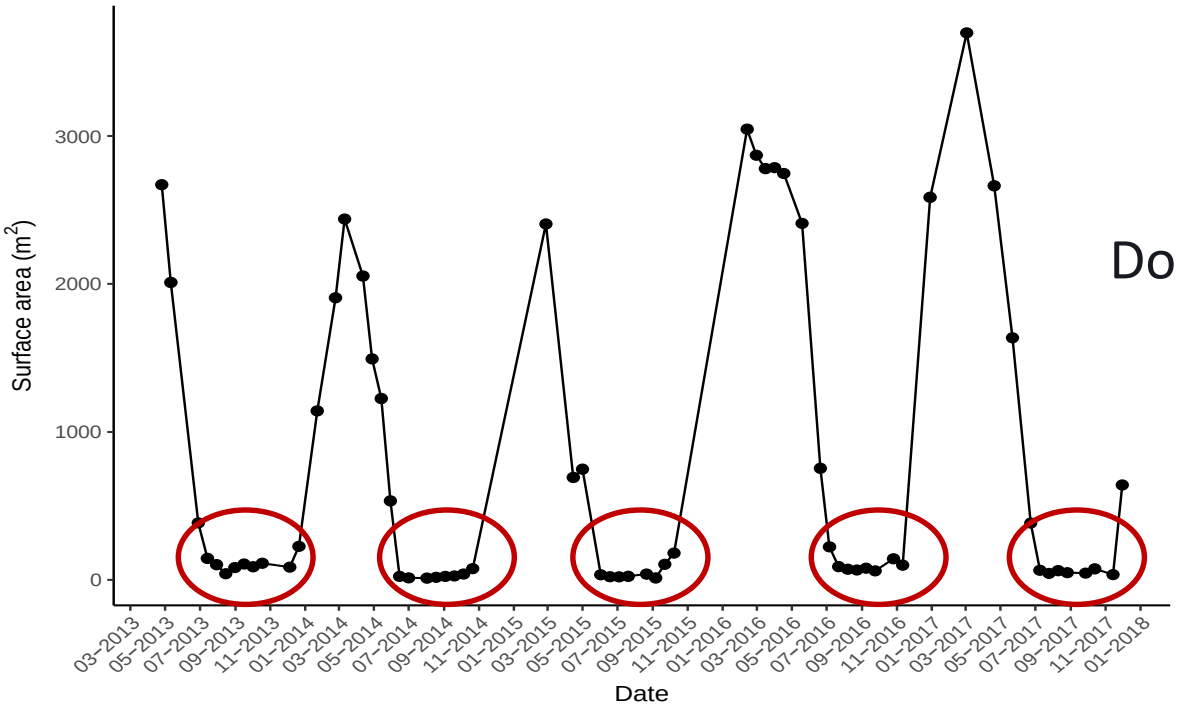
Random effect

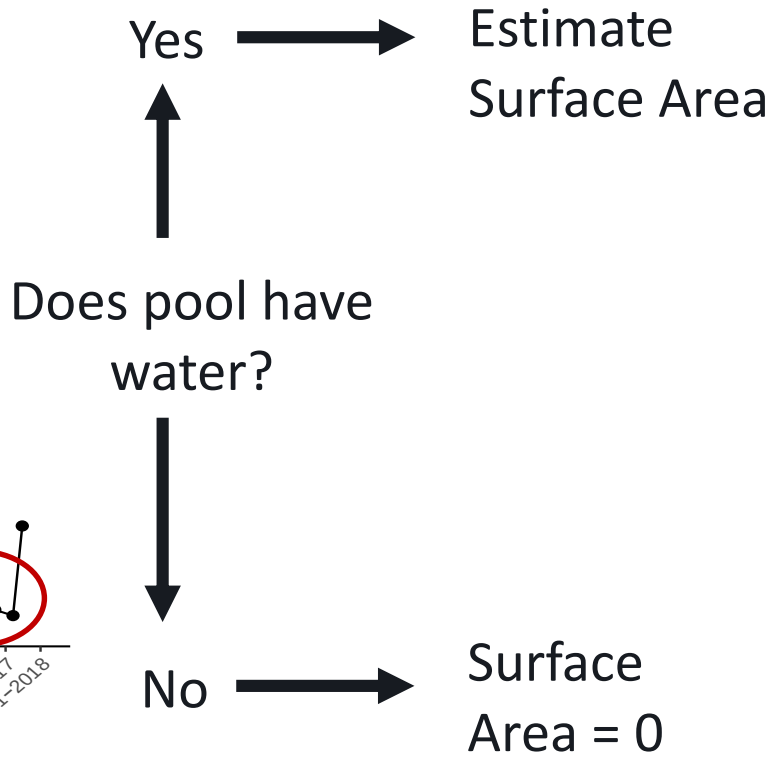
*https://climate.northwestknowledge.net/IntegratedScenarios/index.php

Hindcasting hydroperiod

Estimating daily hydroperiod using Bayesian hurdle models

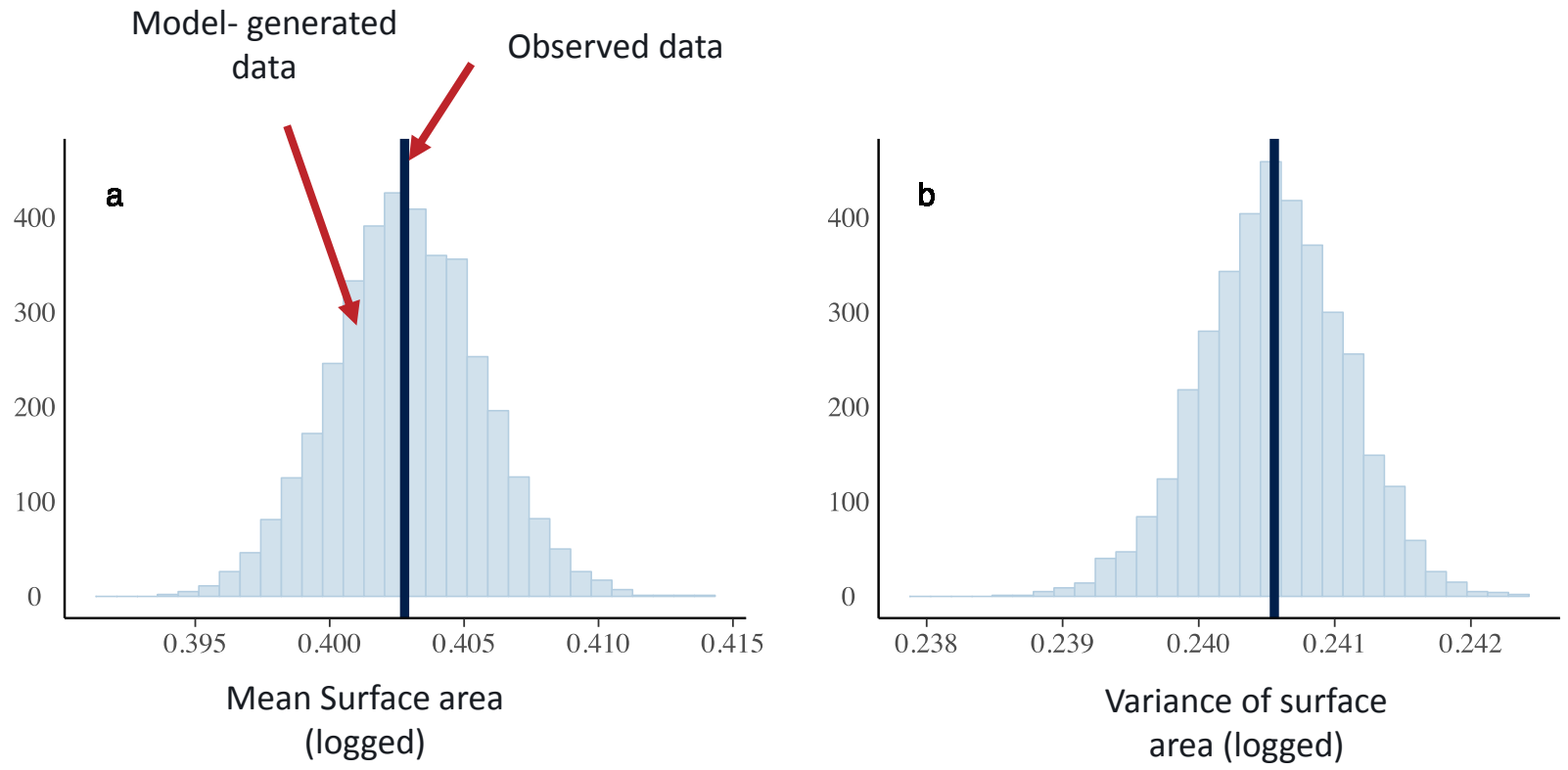
- Lots of 0's in the data- but we know they are real (i.e. pool is dry)
- Hurdle model- 2 parts:



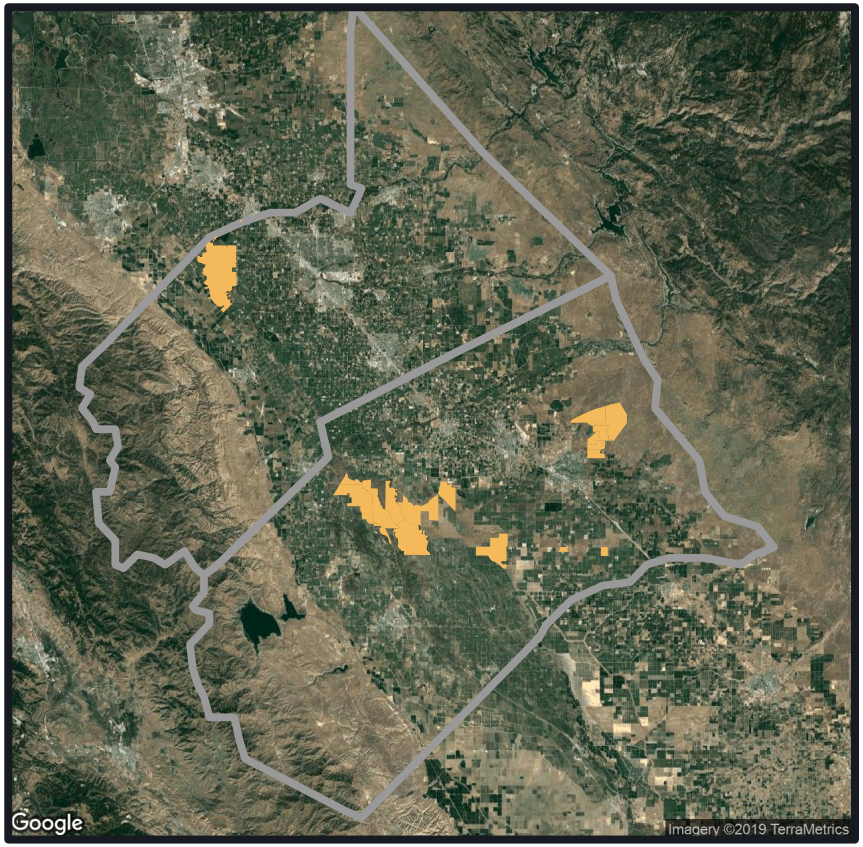


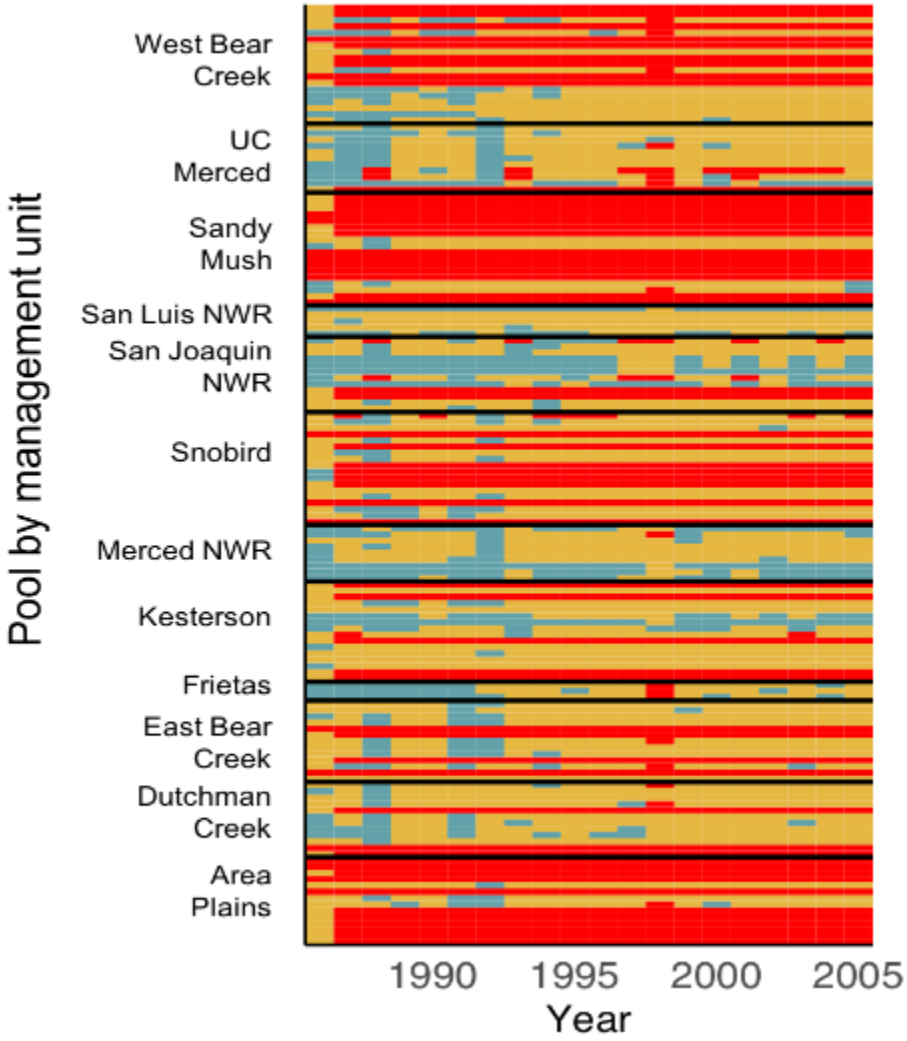
Hydroperiod results

Model captured the mean and variance of observed data



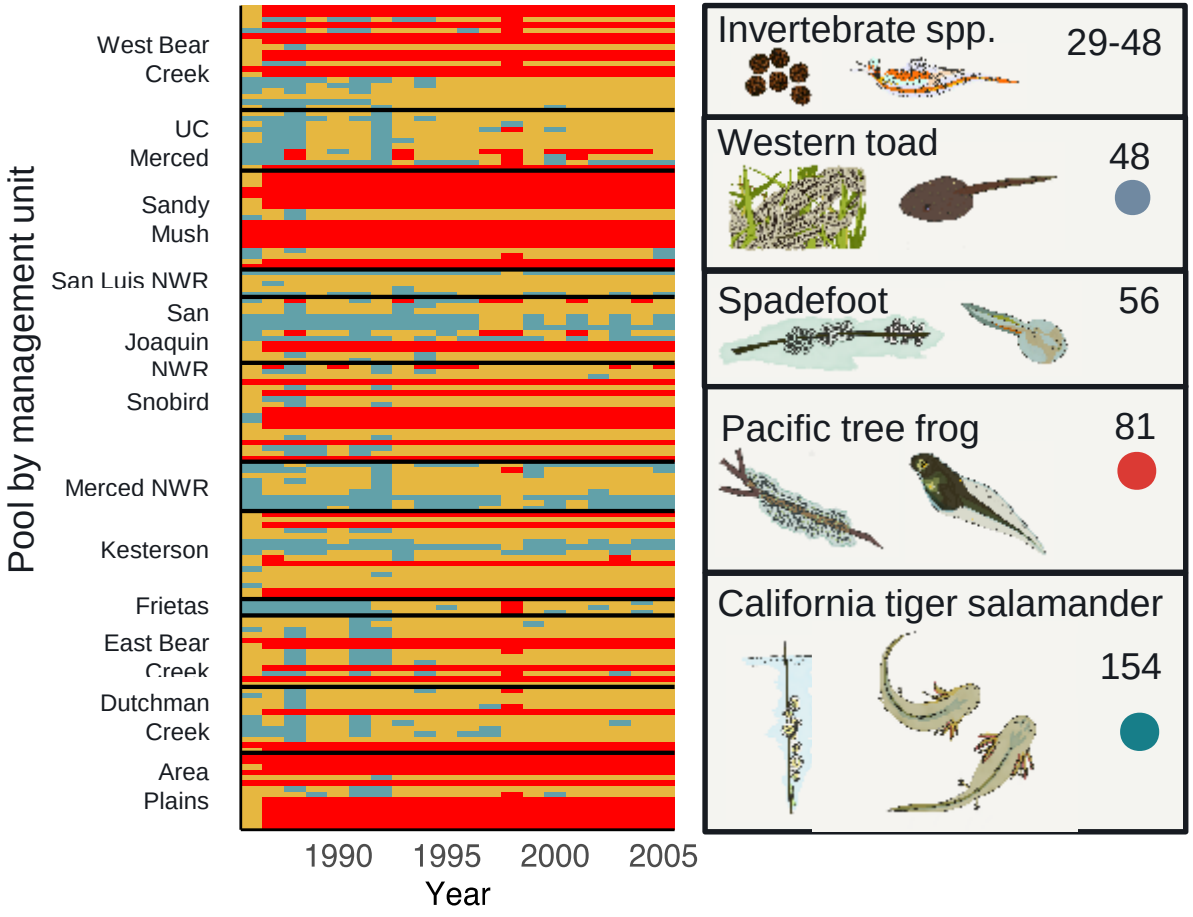
Hydroperiod results

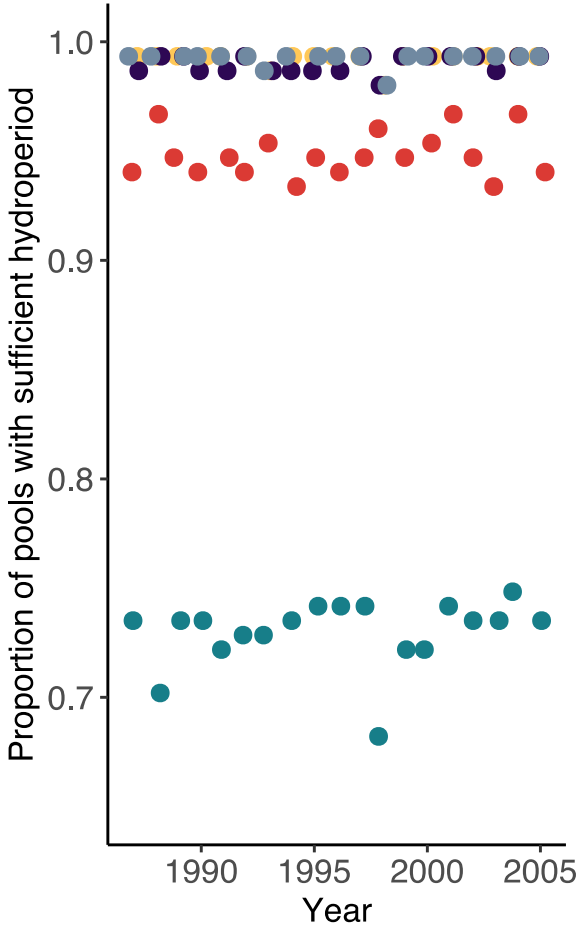




Wetland dried Wetland <20% of maximum > 20% of maximum

Implications for species management





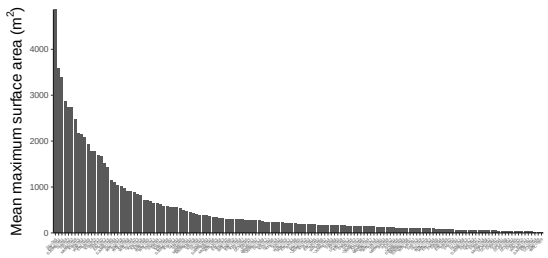
Implications for species management

What is the probability that larval CTS occupy a pool?

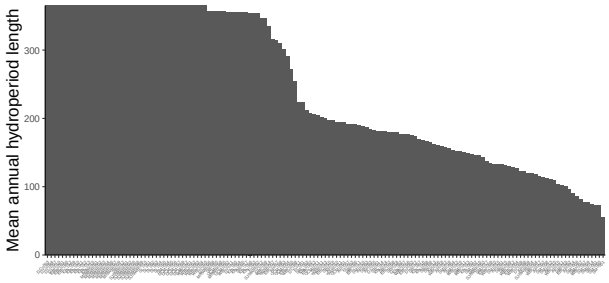
- Ran a suite of 30 occupancy models with combinations of covariates
- Used Akaike's Information Criterion (AIC) to rank models
- Considered those that held 95% of AIC weight to have support (n= 11 models).

Developed three hydroperiod metrics to include in occupancy model:

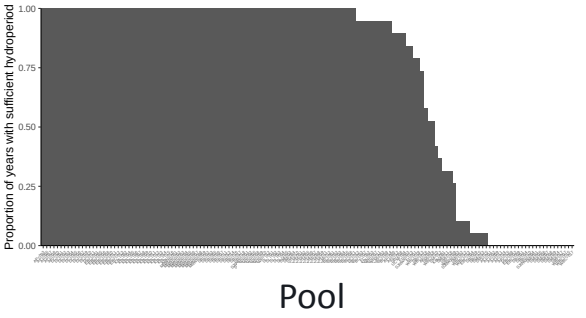
Mean maximum surface area



Mean annual hydroperiod length



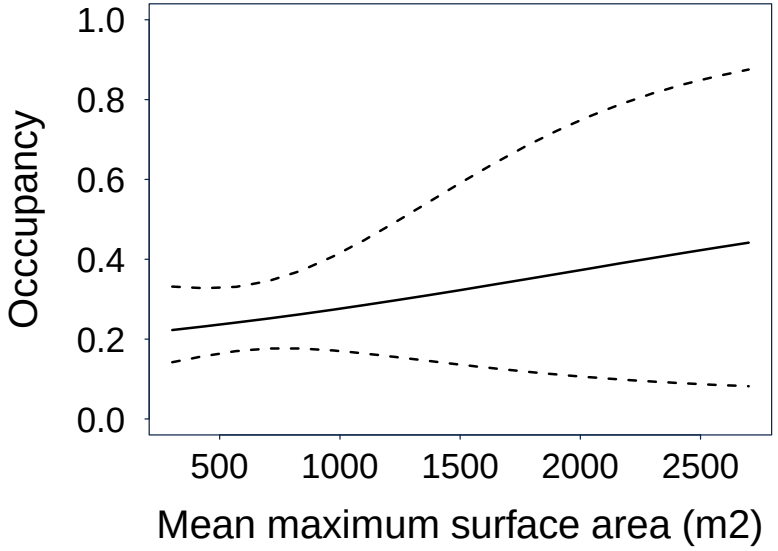
Proportion of years with sufficient hydroperiod for CTS development

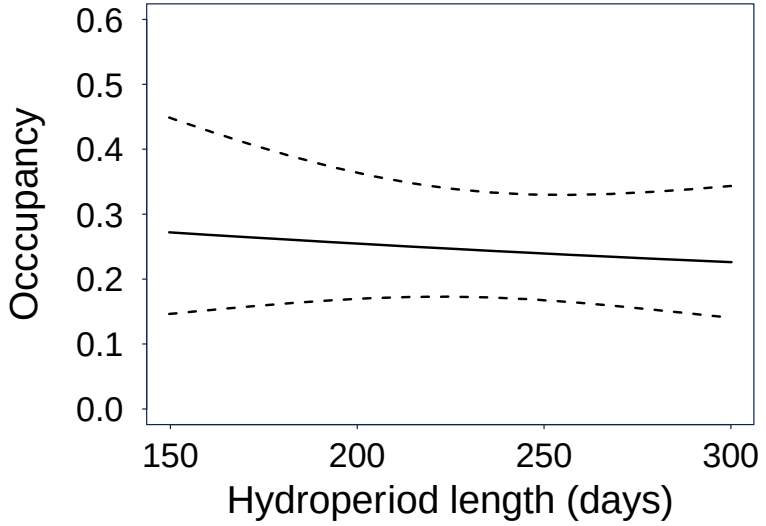


Implications for species management

Covariate	Number of Models
Maximum surface area of the pool	6/11
Mean hydroperiod length	4/11
Proportion of years with sufficient hydroperiod length for CTS development	3/11
Maximum number of burrows along a 20 meter transect	11/11
Turbidity	0/11

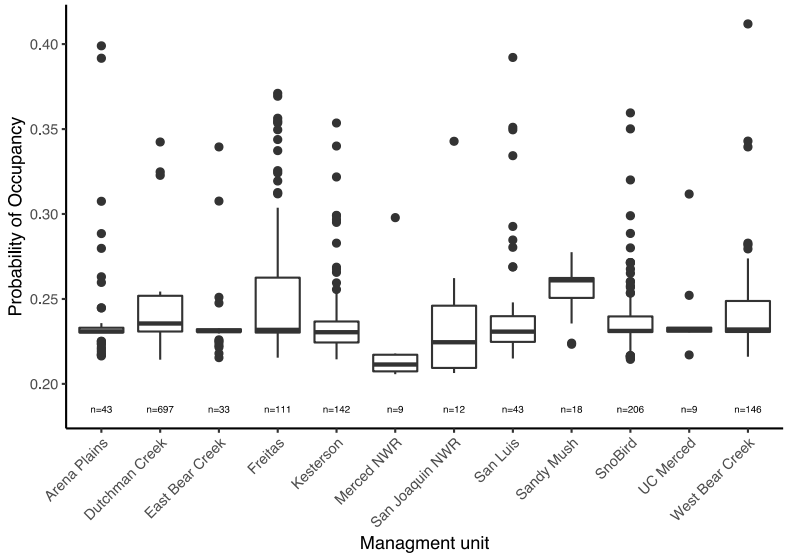
General support for hydroperiod metrics

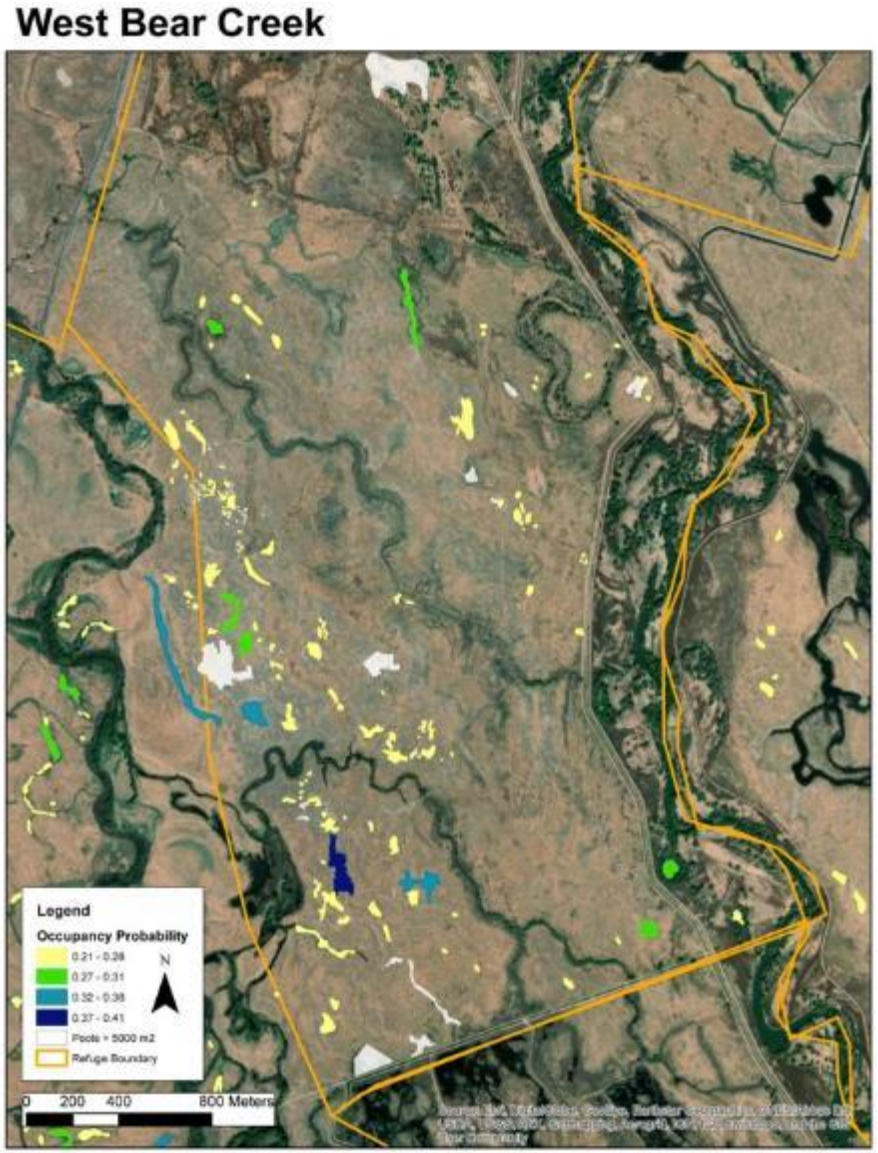




Mapping occupancy

- Used models to predict occupancy for 1,469 pools on management unit
- Allowed us to generate maps of occupancy for each management unit
- Identify areas with high concentrations of vernal pools with high probabilities of occupancy.





Conclusions

- Example of how integrated multi-disciplinary methods can advance our understanding of freshwater hydrologic and ecosystem dynamics.
  - Occupancy of aquatic obligate species may be linked to hydroperiod dynamics

- Methods for reconstructing historical hydroregimes can be extended to other regions and systems, and vary by ecoregion and season.

Acknowledgements

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