Temporal analysis of high resolution spatial datasets in the refinement of pesticide exposure risk assessments

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Katie Budreski, Lauren Padilla, Mike Winchell, Roger Brenton, and Paul Whatling

ACS, Philadelphia, PA

Presentation Outline

Overview

- Goal of Analysis
- Target Species
- Approach

Approach

- Developing probability distributions of 8 input characteristics specific to the target species
- Use of inputs for aquatic modeling

Conclusions

- Summary

Overview: Goal of Analysis

Develop spatially derived input parameters for aquatic exposure modeling that consider the various geographic, temporal, biological, and environmental conditions relevant to the target species

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Overview: Target Species

California Tiger Salamander (CTS)

Aquatic habitat consists of vernal pools for breeding

- During wet winter season
- 0.15 to 1 m in depth
- 0.003 to 58.71 ac (King et al.)

Vernal pools differ from the typical EPA standard farm pond

- 2 m in depth
- 1 ha (2.5 ac) surface area

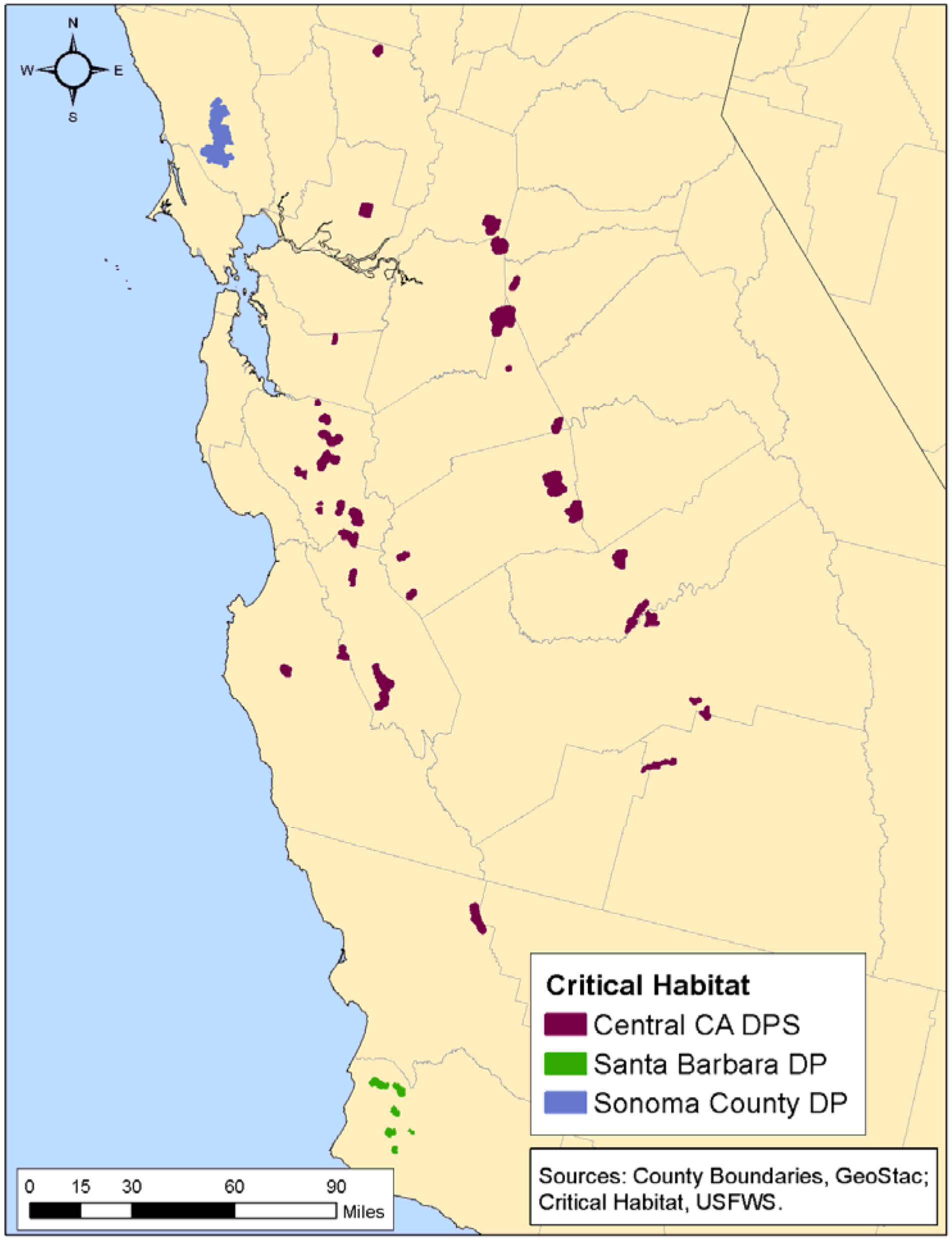
By Bill Stagnaro - http://calphotos.berkeley.edu/cgi/img_query?enlarge=0000+0000+0808+0019, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=26064062

King, J.L., M.A. Simovich and R.C. Brusca. 1996. Species richness, endemism, and ecology of crustacean assemblages in northern California vernal pools. Hydrobiologia 328:85-116.

Overview: Target Species

Distinct population segments (DPSs)

- Sonoma County
- Santa Barbara County
- Central California



Overview: Approach

Identify aquatic habitats (water bodies) specific to the CTS.

Determine water body characteristics

Delineate watersheds and driftsheds for each aquatic habitat

- Extract soils
- Calculate Percent Cropped Area (PCA)
- Extract weather (spatial / temporal)

Generate many model simulations by sampling from these input distributions using a robust method that ensures each distribution is sufficiently sampled

Construct an exposure distribution reflective of environmental conditions relevant to species habitat.

Approach: Identify Aquatic Habitats of Interest

Vernal pools are aquatic habitat for the CTS.

- High resolution (1:24,000 scale) National Hydrography Dataset (NHD)
- Evaluated NHD ponds using temporal historic aerial imagery
- Additional vernal pools were hand delineated based on review of aerial imagery over time.


Mounded Prairie/Vernal Pools, US Department of the Interior, Bureau of Land Management

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Approach: Identify Aquatic Habitats of Interest

Example of NHD pond that was confirmed to be a vernal pool

9/30/2009

4/22/2010

Approach: Identify Aquatic Habitats of Interest

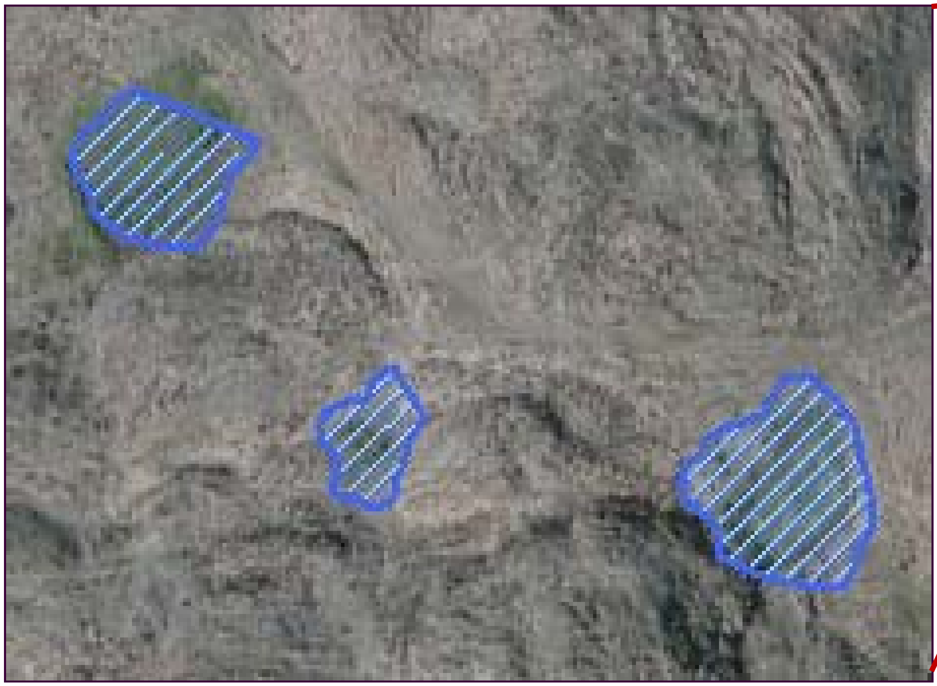
Example of NHD pond that was confirmed to be a perennial pond

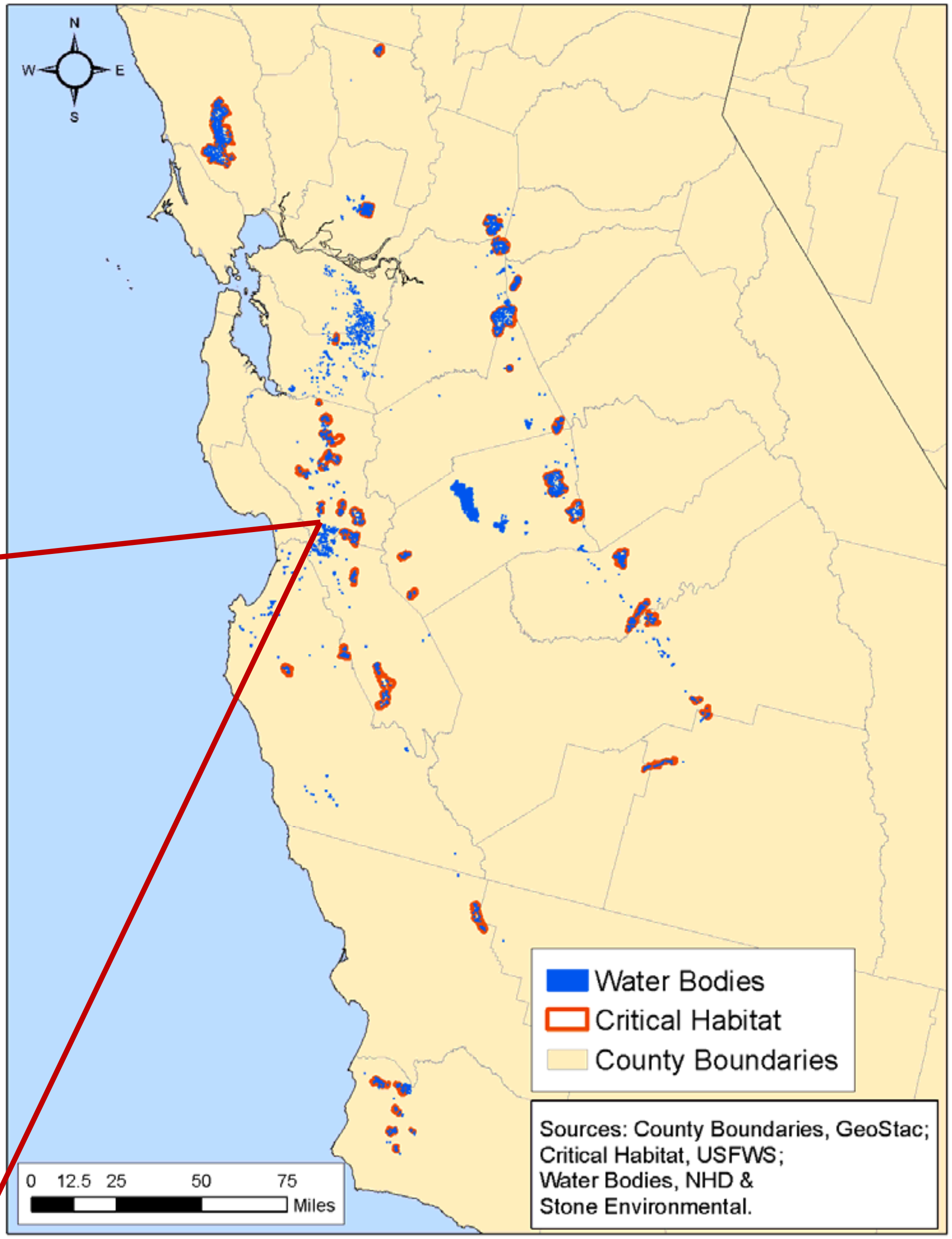
9/4/2006

6/6/2012

Approach: Identify Aquatic Habitats of Interest

In total, 4,297 vernal pools within CTS habitat range were identified





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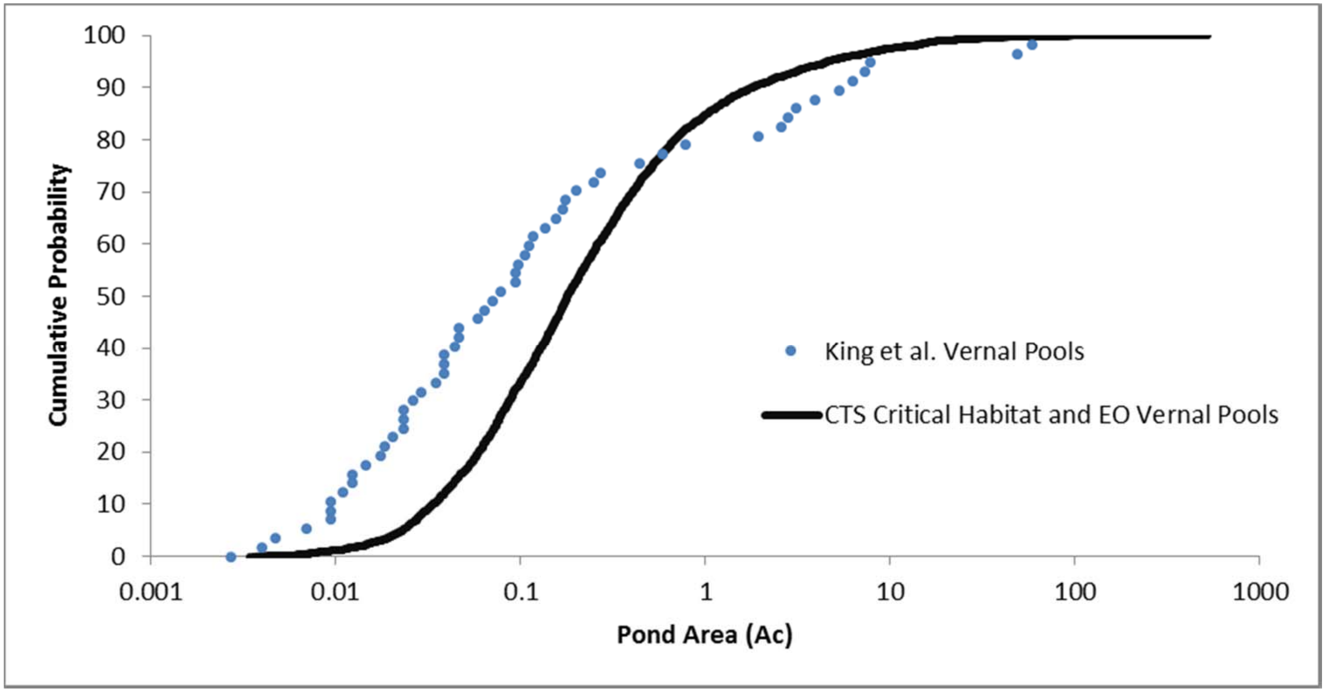
Approach: Characterize Water Body Size and Depth

Water body surface area and depth were represented as probability distributions. These factors influence:

- Volume
- Integrated drift fraction

A discrete distribution of surface area was developed from the spatial layer.



King, J.L., M.A. Simovich and R.C. Brusca. 1996. Species richness, endemism, and ecology of crustacean assemblages in northern California vernal pools. Hydrobiologia 328:85-116.

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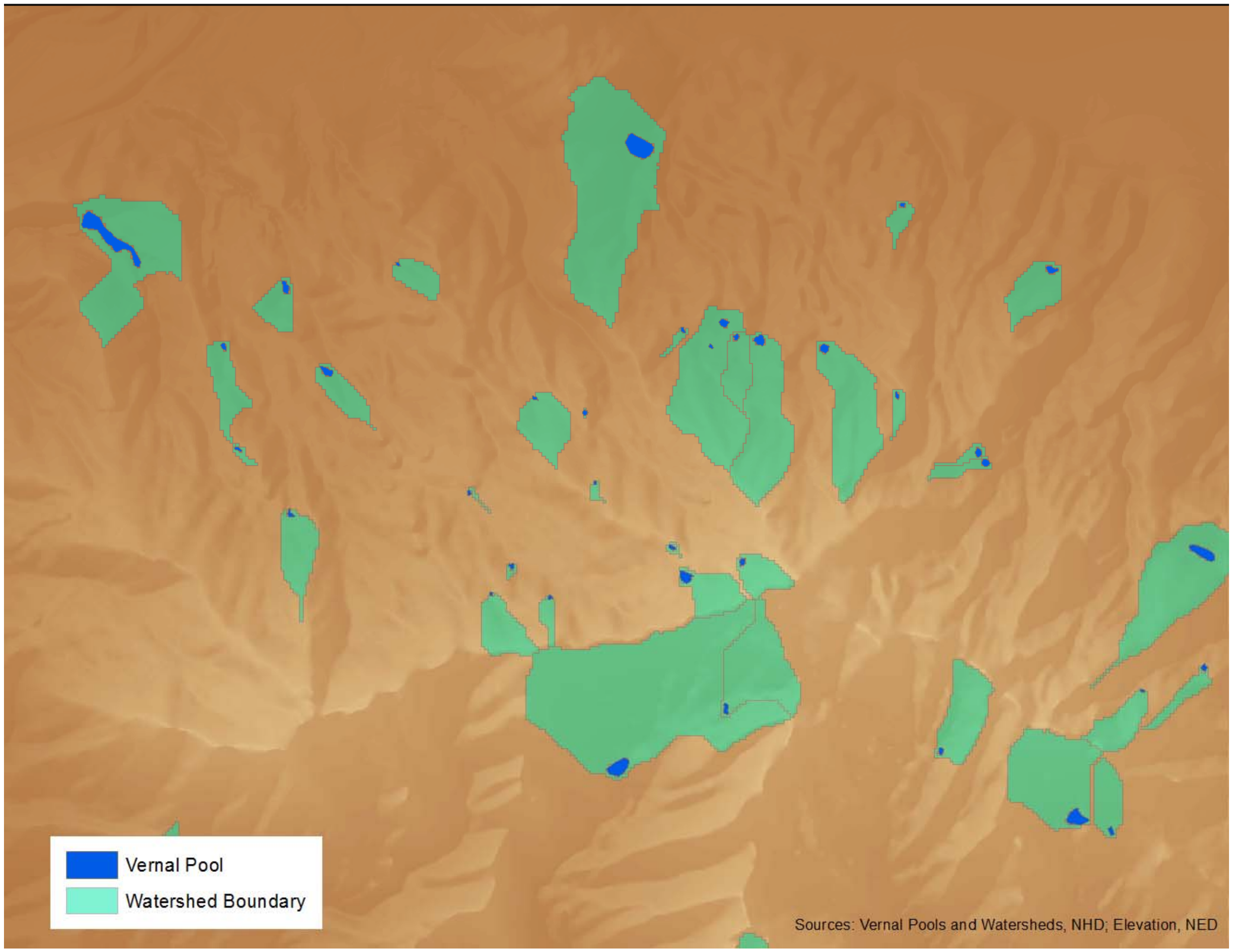
Approach: Watershed Delineation MW4

Watersheds boundaries were estimated from a DEM-based delineation using 10-meter National Elevation Dataset (NED) data.

Vernal pools were burned into the DEM

These watersheds were then used to identify relevant soils and PCAs



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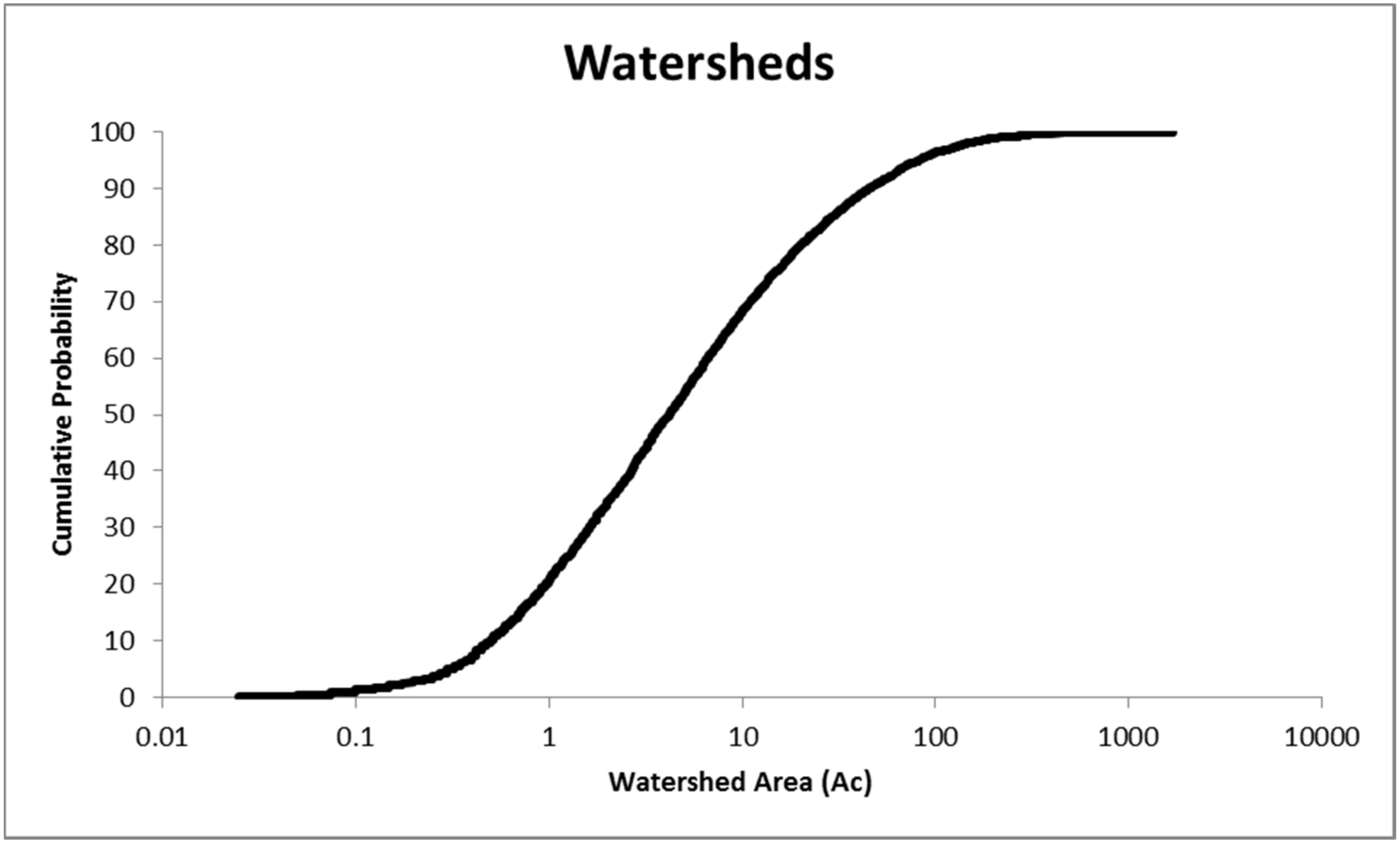
Slide 12

MW4 I think elaborating a little more about the delineation would be good. A couple thoughts:
1.) Show an exagerated DEM with the watershed bounds
2.) Mentiond that the NHD ponds were burned into the DEM to enforce drainage to theponds.
Michael Winchell, 8/19/2016

Approach: Watershed Delineation

Watersheds ranged in size from 0.001 ha to 688 ha (mean of ~ 7.6 ha)

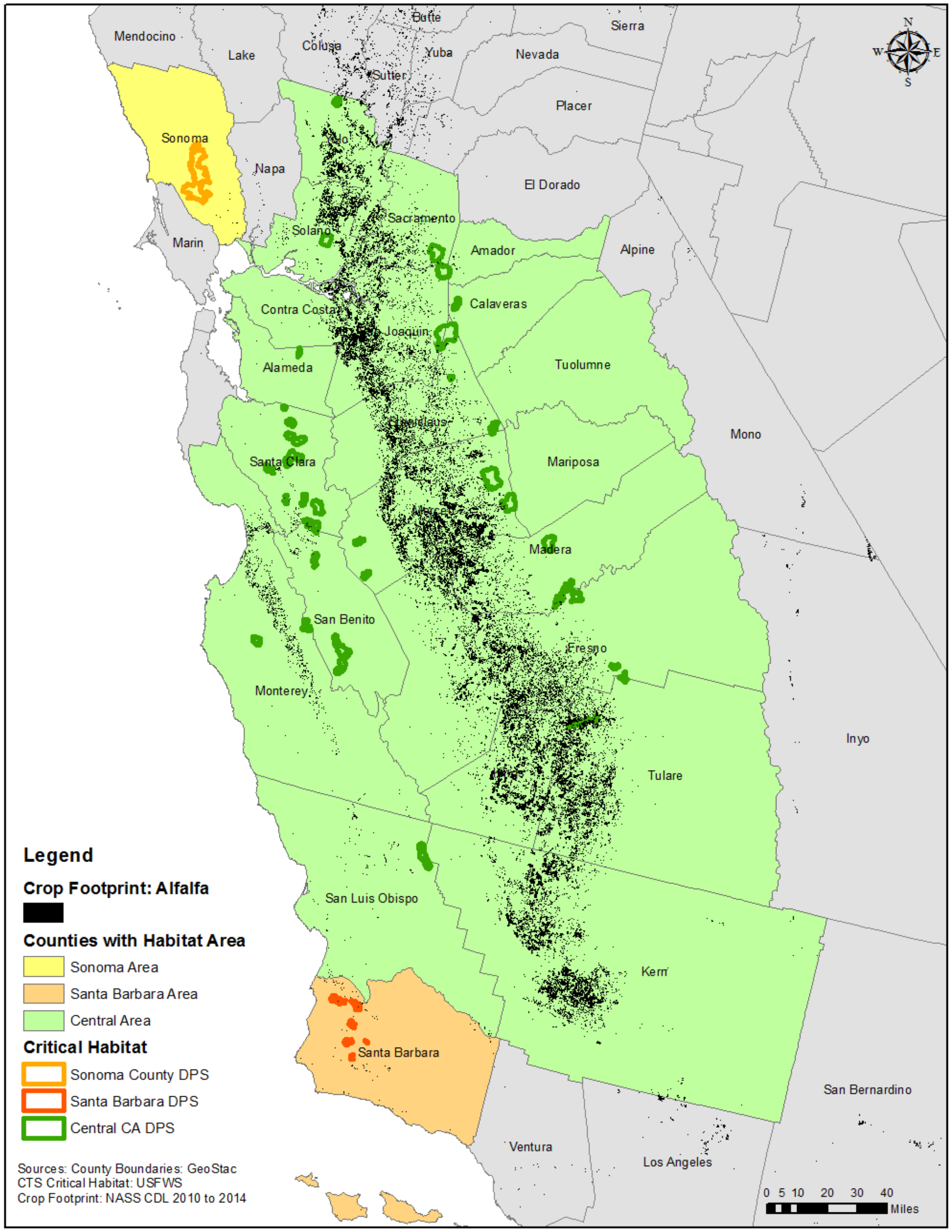


Approach: Crop Footprint

For a broad use pesticide, a conservative “All Ag” crop footprint was developed

For a refined analysis, crop specific footprints were developed using 5 years of NASS Cropland Data Layer (CDL, 2010-2014).

- If crop presence in any one year, crop footprint was labeled as crop of interest.



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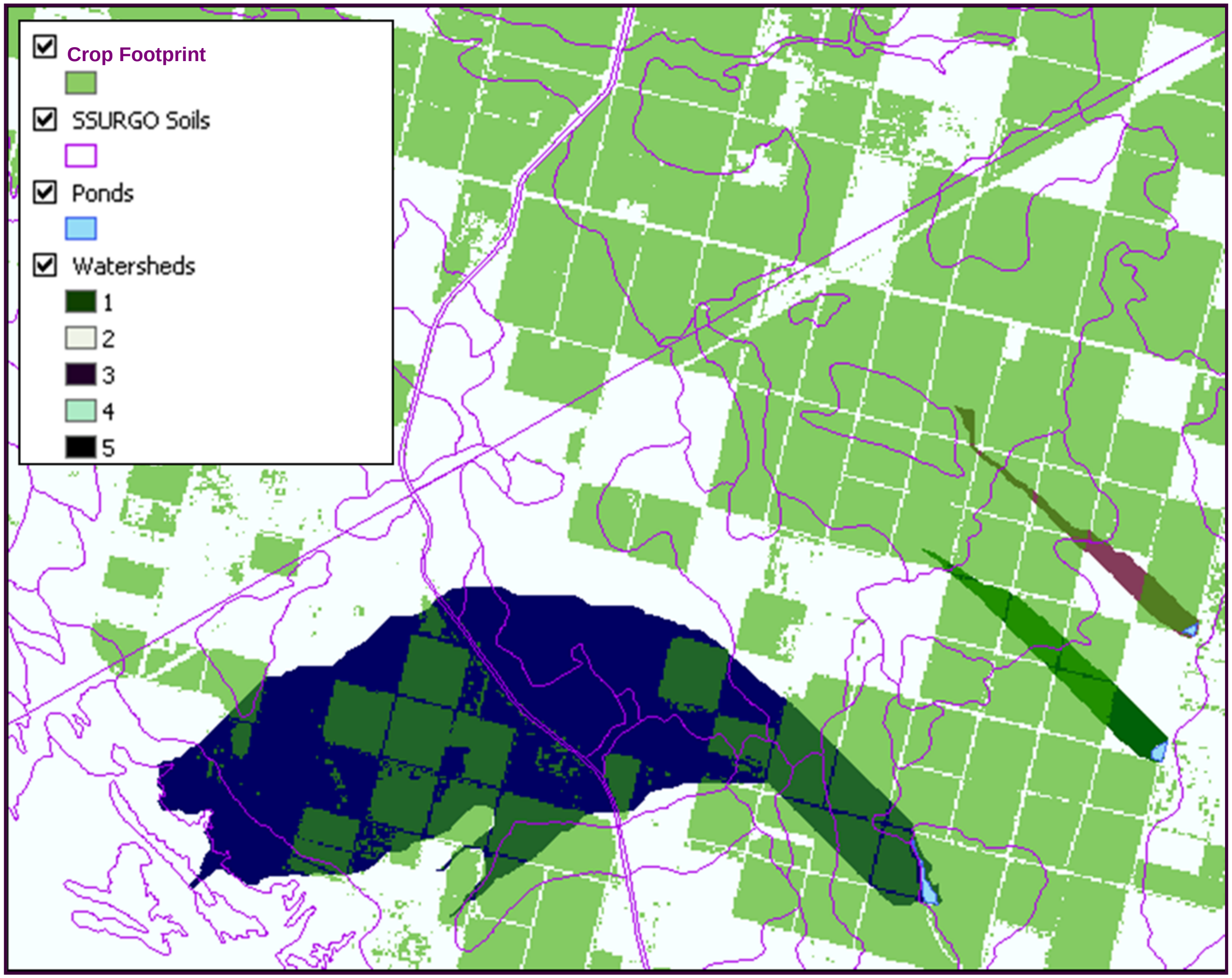
Approach: Soils Analysis

The soils co-occurring with crops within the habitat watersheds were identified.



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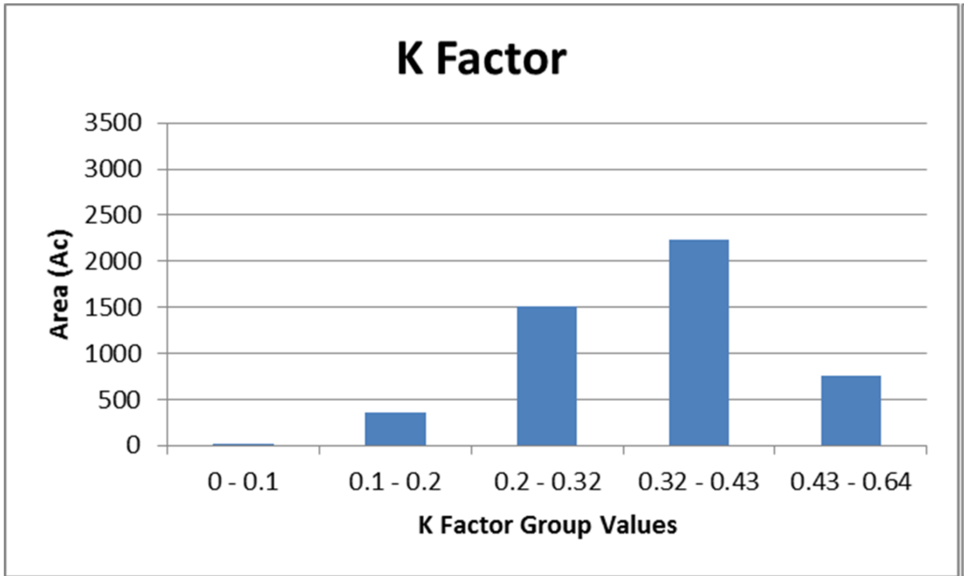
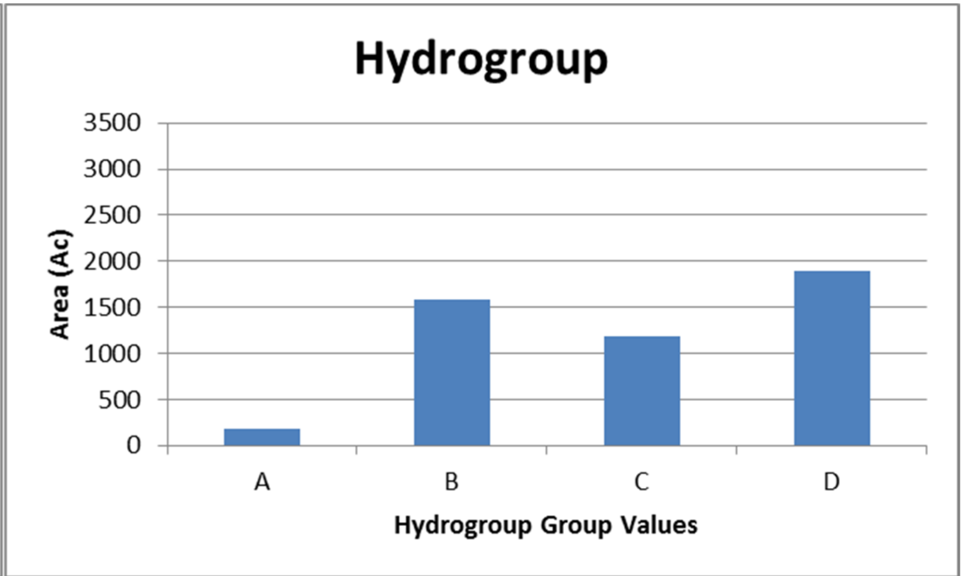
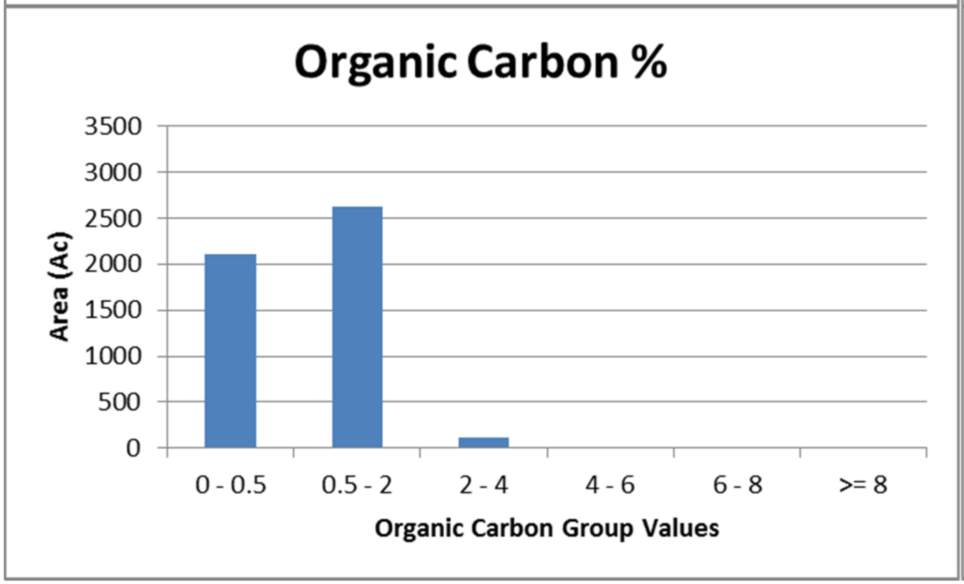
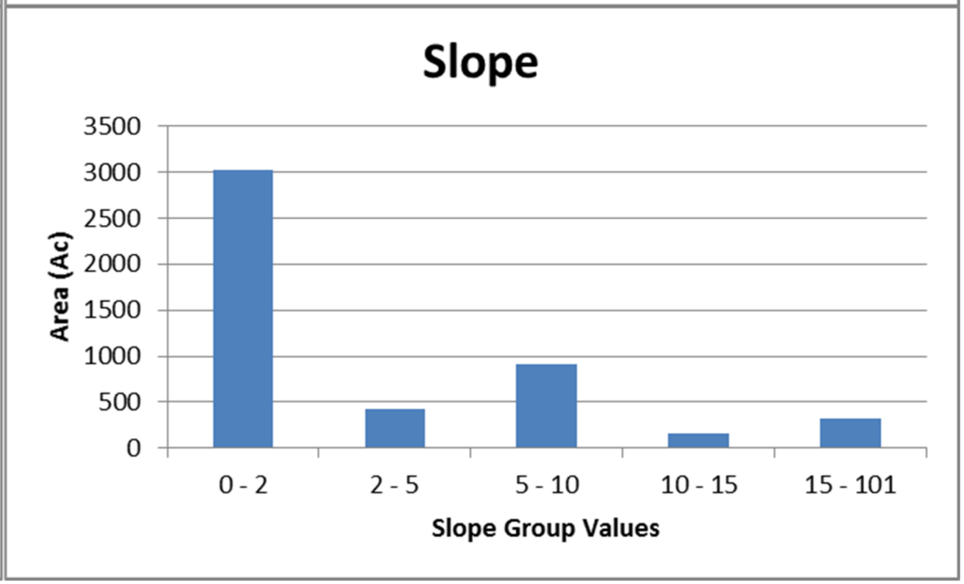
Approach: Soils Analysis

Characterization of soils within CTS pond watersheds.









Approach: PCA Calculation

Percent Cropped Areas (PCAs) are calculated based on both watersheds and a 792-meter buffer “drift-shed” (AgDRIFT limit).

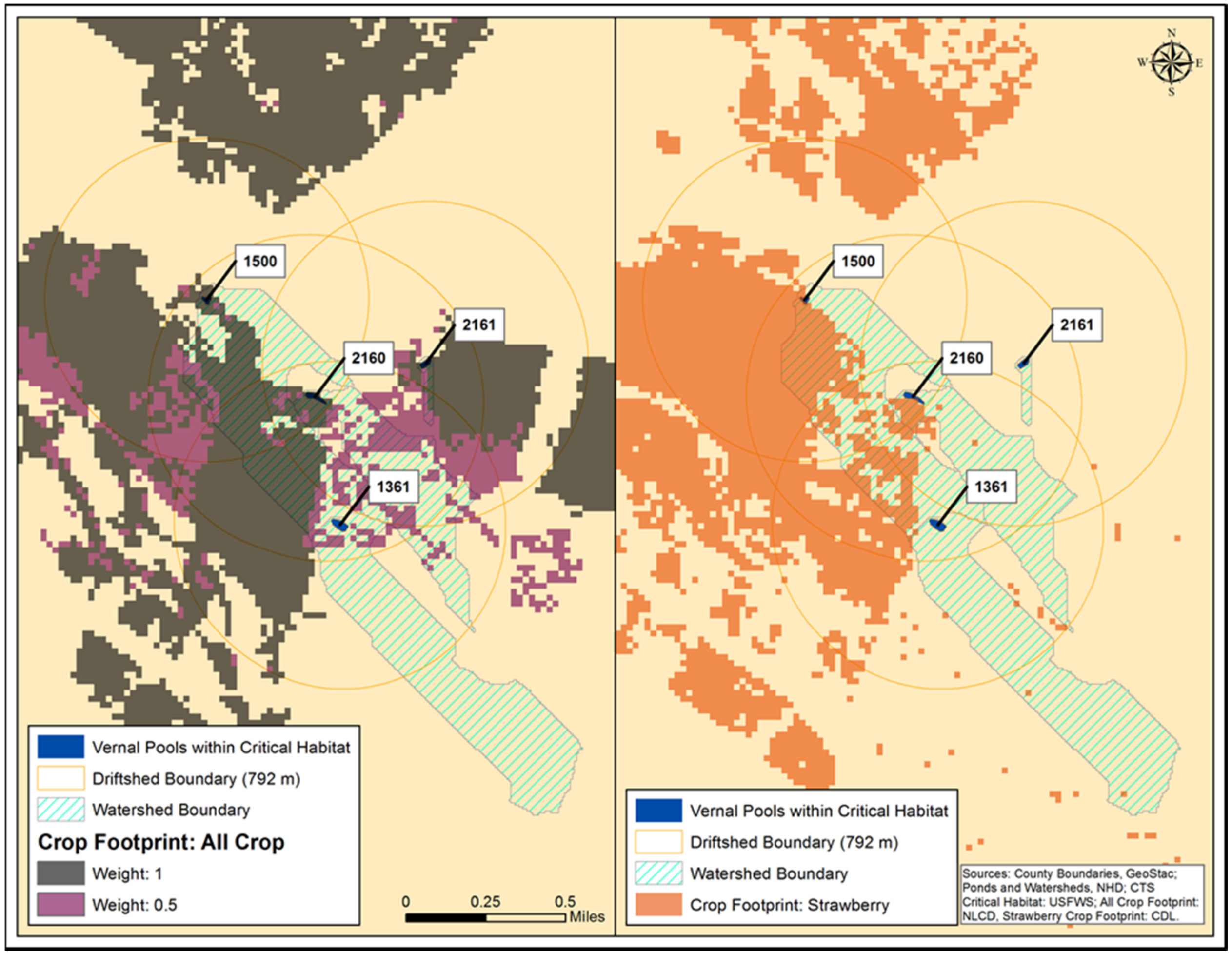


Table 4-6 Percent cropped area for pools.

Vernal Pool	All Crop Watershed PCA	All Crop Driftshed PCA	PCA Assumed for Screening Level Modeling	PCA Assumed for Refined Modeling (Strawberry)
1361	1%	40%	40%	21%
1500	58%	45%	58%	49%
2160	20%	44%	44%	28%
2161	75%	26%	75%	3%

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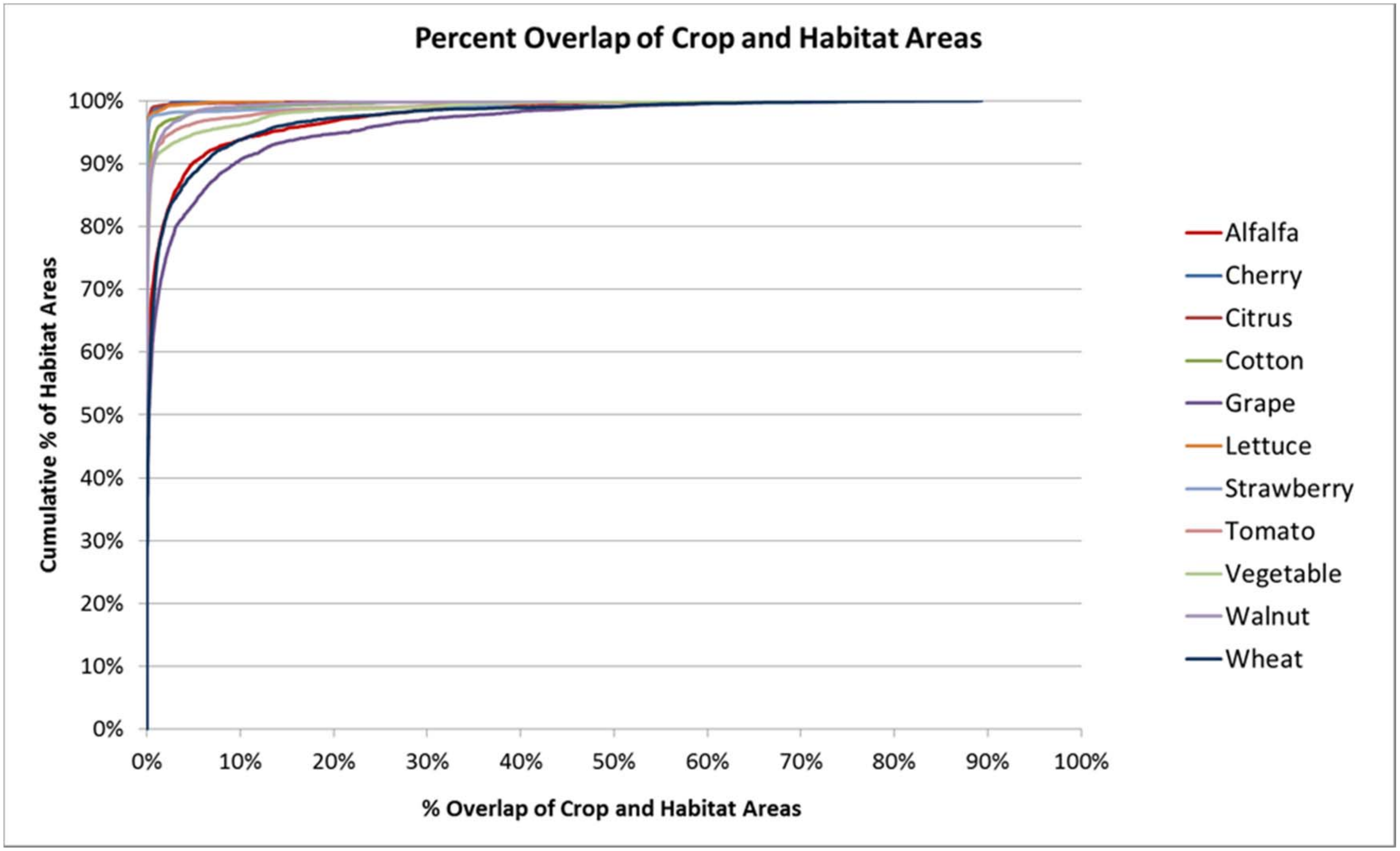
Approach: PCA Calculation

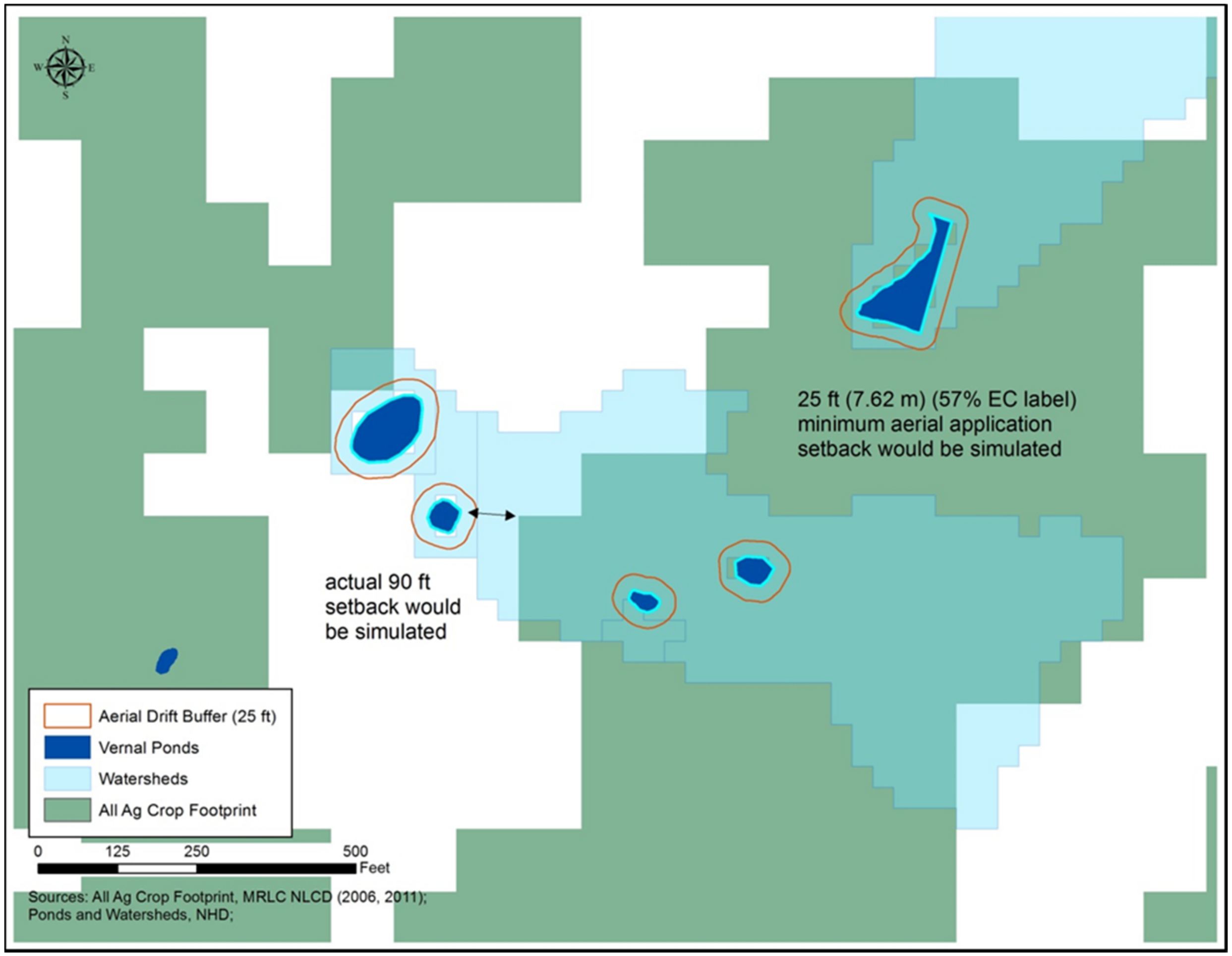
The maximum of the watershed and "drift-shed" PCA was used in developing the PCA distributions for all crops and individual crops based on 4,297 water bodies.



Modeling Approach: Spray Drift Fraction

The actual proximity of an edge of field to a water body in CTS habitat is highly variable.

- Distances of closest crop to every CTS aquatic habitat water body was determined.
- AgDRIFT was used to calculate resulting drift fraction.
- Existing label buffers were accounted for in determining a minimum distance.



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Modeling Approach : Latin Hypercube Sampling of Distributions

Latin Hypercube Sampling (LHS) is an alternative to Monte Carlo (random) sampling.

In LHS, each input distribution is divided into the same number of equally probable intervals.

The approach allows a multi-dimensional parameter space to be more fully sampled with a smaller number of points.

For the CTS exposure modeling, 8 input distributions were sampled 5,000 times to generate input data sets for Soil Water Concentration Calculator (SWCC) simulations.

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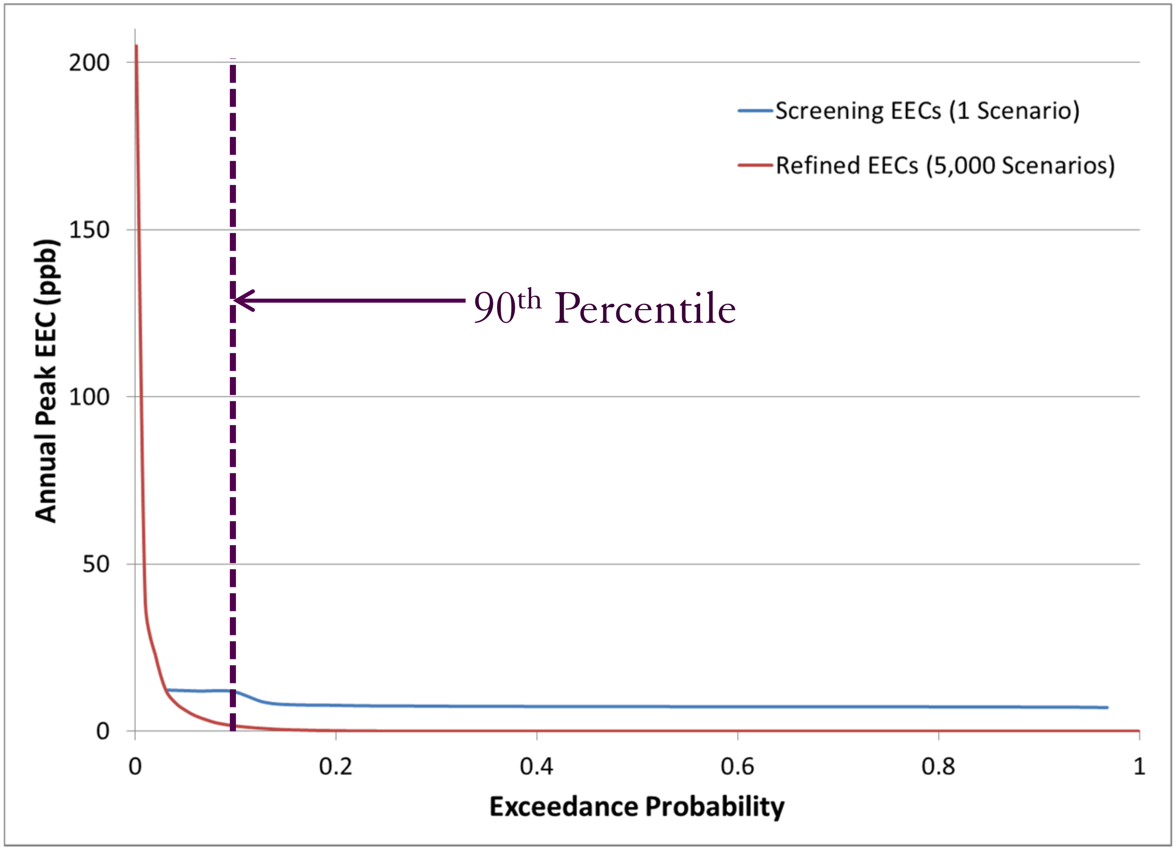
Modeling Results: Comparison of Screening Level EECs with Refined EEC Distribution

Screening EECs:

- 1 30-year CA strawberry scenario simulation.

Refined All Crop PCA EECs:

- 5,000 30-year CA strawberry scenario simulations, based on sampling 8 probability distributions of habitat specific inputs.



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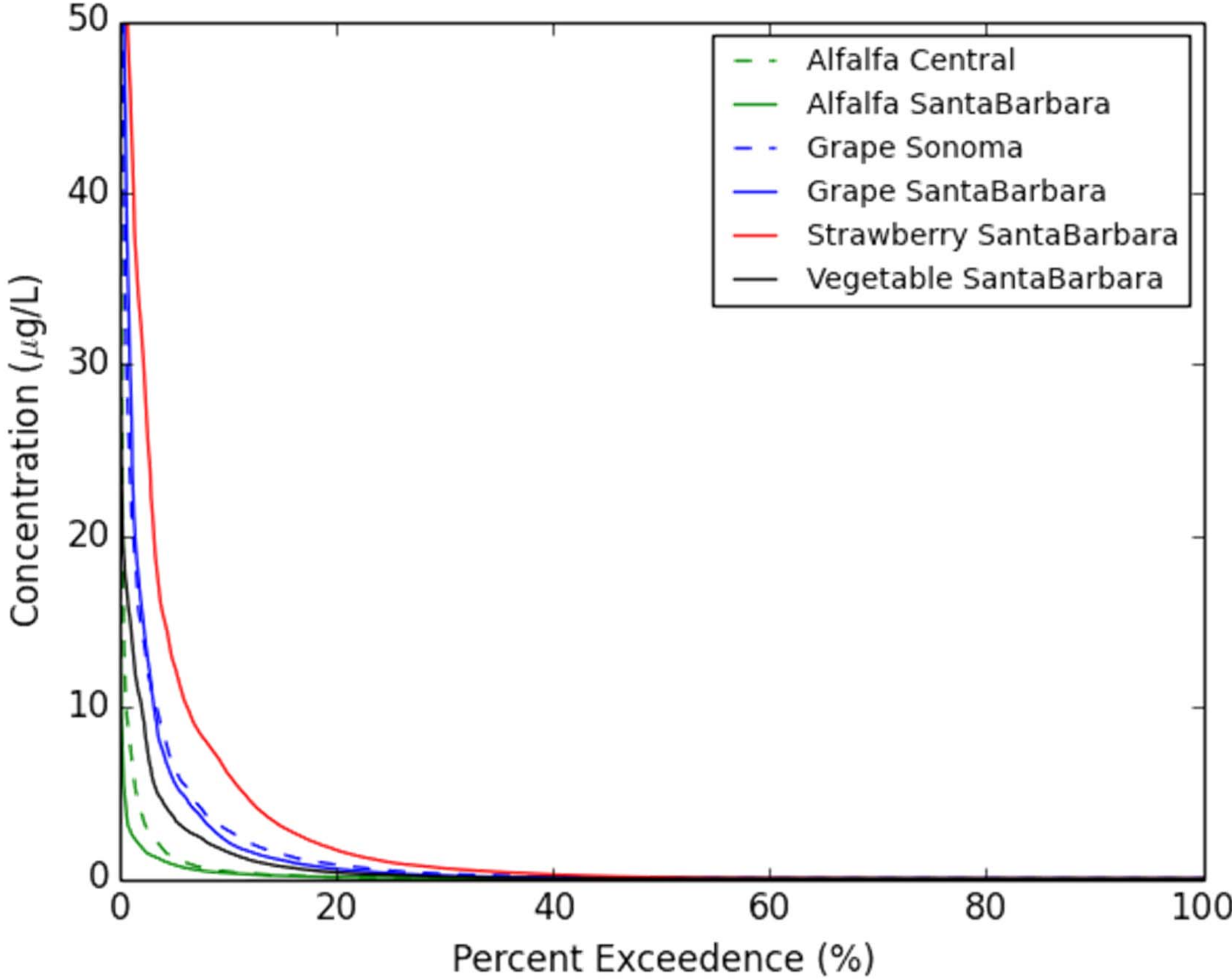
Modeling Results: Refined EEC Distributions Based Upon Individual Use Patterns and Distinct Population Segments

Exposure likelihood shows spatial variability across different DPSs

Individual crop patterns have significant impact on exposure likelihood



Summary and Conclusions

A **probabilistic approach** for **refining aquatic EECs** in Endangered Species Assessments was developed for use in assessing the **California Tiger Salamander**.

Probability distributions of **8 input characteristics** specific to CTS aquatic habitat, 6 based **on spatial data**, were developed for **parameterizing the SWCC model**.

The spatial and temporal analysis of landscape characteristics explicitly associated with CTS aquatic habitat allowed for **significant refinement in the exposure predictions**.

The approaches presented can be applied for detailed assessments of **individual species** as well as for **national** aquatic exposure assessments.

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Thank you.

For more information / www.stone-env.com

Contact / kbudreski@stone-env.com, mwinchell@stone-env.com
lpadilla@stone-env.com