Application of a Probabilistic Aquatic Exposure Modeling Approach for Use in Endangered Species Assessments

Presented by:

Michael Winchell[1], Lauren Padilla[1], Charlie Hofmann[1], Katie Budreski[1], Scott Teed[2], Paul Whatling[3]

1. Stone Environmental, 2. Intrinsik Environmental, 3. Cheminova

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Background

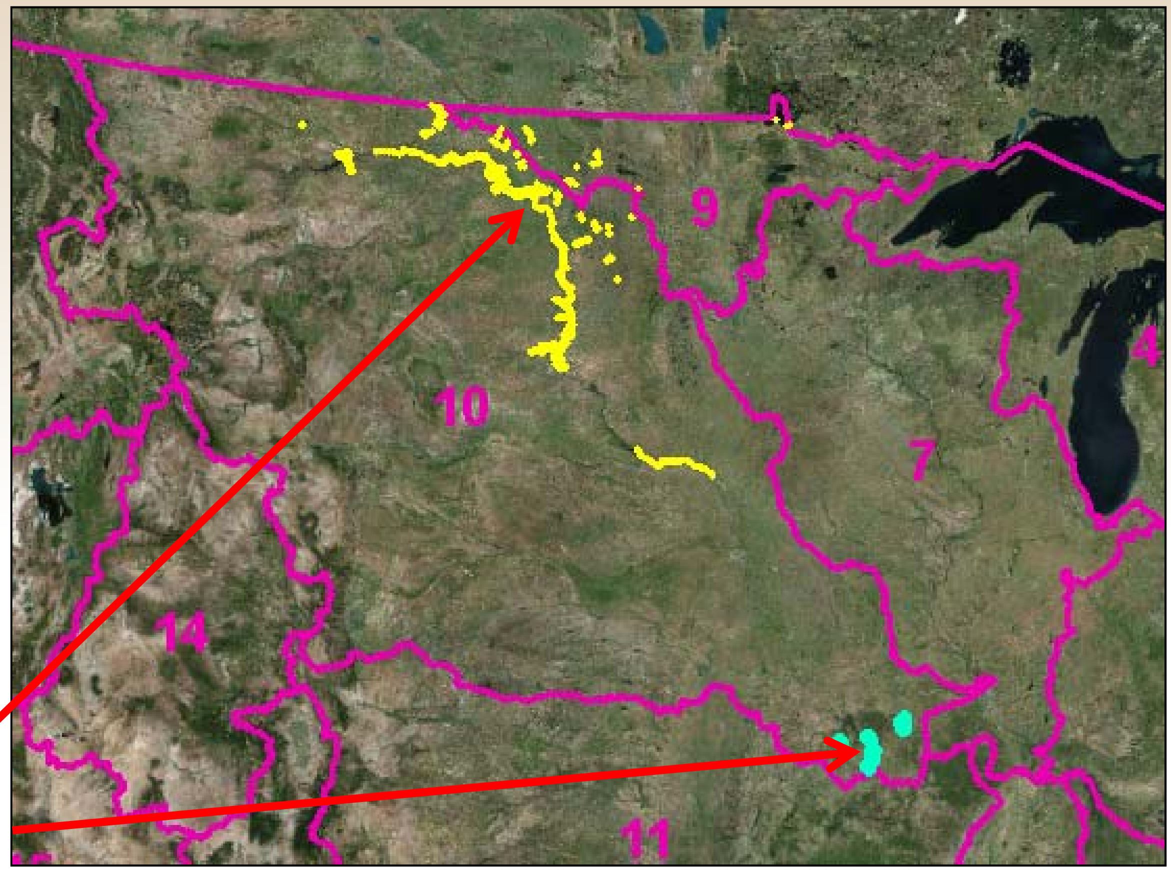
- Assessing pesticide exposure risk for endangered species will likely require that higher tier, probabilistic modeling approaches be applied in making likely to adversely affect (LAA)/not likely to adversely affect (NLAA) determinations (NAS, 2013).

- National geospatial datasets allow for exposure modeling that accounts for a broad range of environmental conditions which influence exposure potential.

- These environmental conditions can be quantified for specific species habitat ranges of interest, resulting in customized exposure predictions pertinent to a given species, group of species, or taxa.

Motivation: Why Might we Need to Refine Exposure Estimates?

- Existing SWCC crop scenarios vary in terms of a regional or national vulnerability.
- A single scenario does not account for the variability and frequency of important environmental factors.
- The use of a single scenario per crop for an entire HUC2 may result in inappropriate model assumptions for some species.



Piping Plover

Niangua Darter

Objectives

- Develop an approach for refining aquatic pesticide exposure estimates used in endangered species assessments that:

1. Accounts for the variability and uncertainty in environmental conditions relevant to species habitat.
2. Applies probabilistic approaches to account for this variability/uncertainty when parameterizing aquatic exposure models.
3. Produces a robust EEC probability distribution representing the likelihood of exceeding pesticide exposure concentrations that can be used directly in a refined risk assessment.

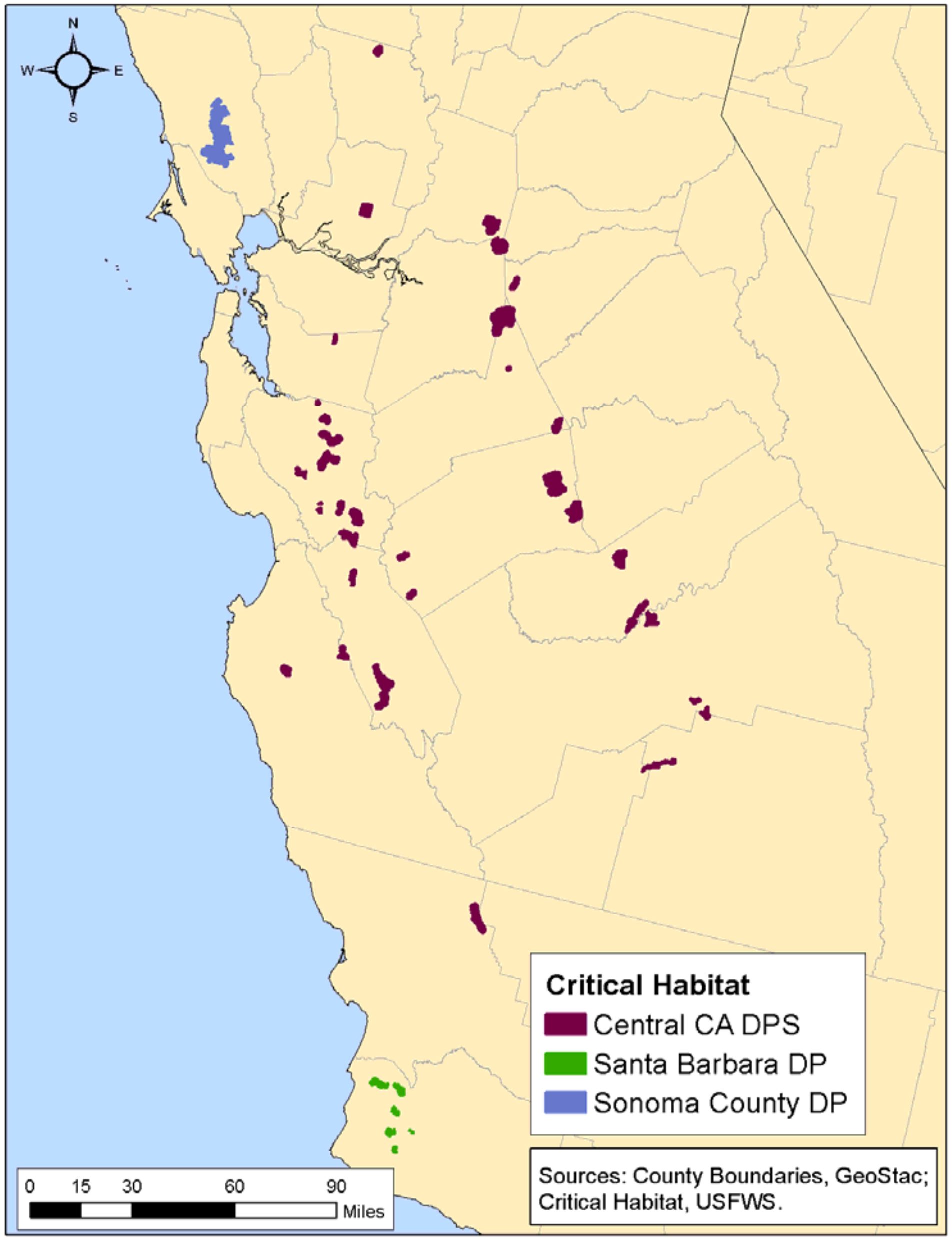
Topics for Discussion

- Description of case study
- Modeling approach
- Modeling results
- Implications for National Endangered Species Assessments
- Summary and conclusions

Description of Case Study

- Species: California Tiger Salamander (CTS)

- Species habitat location: 3 distinct population segments (DPSs):
  - Central California
  - Santa Barbara County
  - Sonoma County

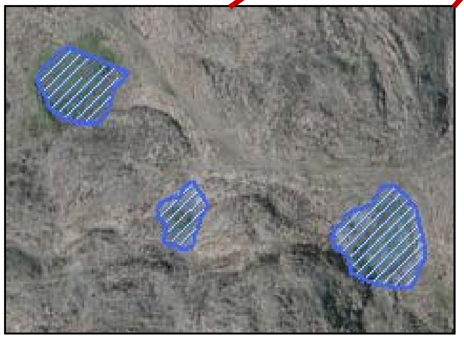


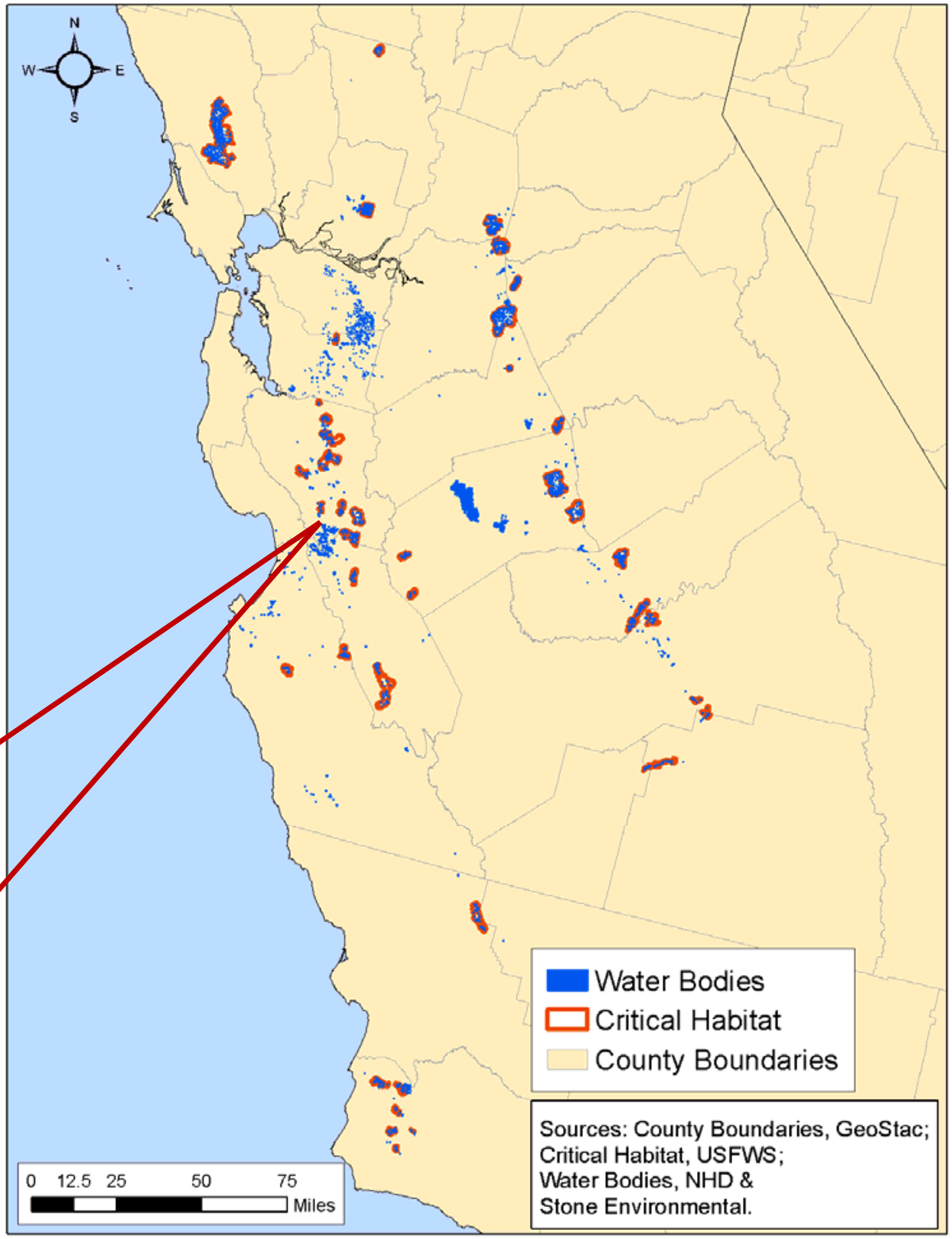
Modeling Approach: Overview

- Identify aquatic habitats (water bodies) specific to the CTS.
- Develop probability distributions of critical environmental and agronomic factors to provide a more comprehensive estimate of exposure likelihood:
  - Pesticide application date
  - Weather (spatial/temporal)
  - Soils and slope
  - Percent cropped area (PCA)
  - Use site proximity to water bodies (drift fraction)
  - Water body (habitat) characteristics (drainage area, surface area, volume)
- Generate many model simulations by sampling from these input distributions using a robust sampling method that ensures each distribution is sufficiently sampled
- Construct an exposure distribution reflective of environmental conditions relevant to species habitat.

Modeling Approach: Identify Aquatic Habitats of Interest

- Vernal pools are aquatic habitat for the CTS.
- High resolution (1:24,000 scale) National Hydrography Dataset (NHD) identified many of these water bodies.
- Additional vernal pools were hand delineated based on review of aerial imagery over time.
- In total, 4,297 vernal pools in CTS habitat were assessed.



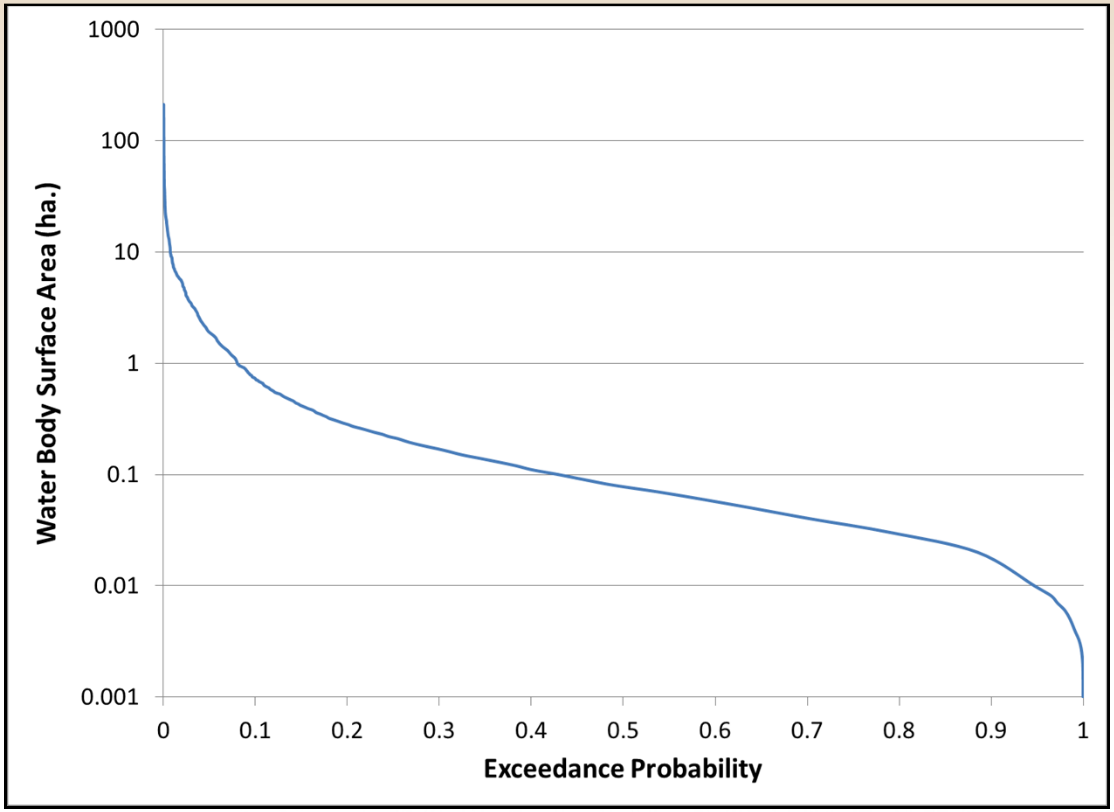


Modeling Approach: Application Date

- Screening level EECs are often based on a single simulation and the assumption of a single application date.
- Application dates for some pesticide uses can span a broad window, and are often driven by pest pressure.
- Probability distributions of application dates can be developed from local or regional agronomic datasets and/or pesticide label restrictions.
- The CTS example assumed a uniform probability distribution of application dates based on the timing allowed on the pesticide label.

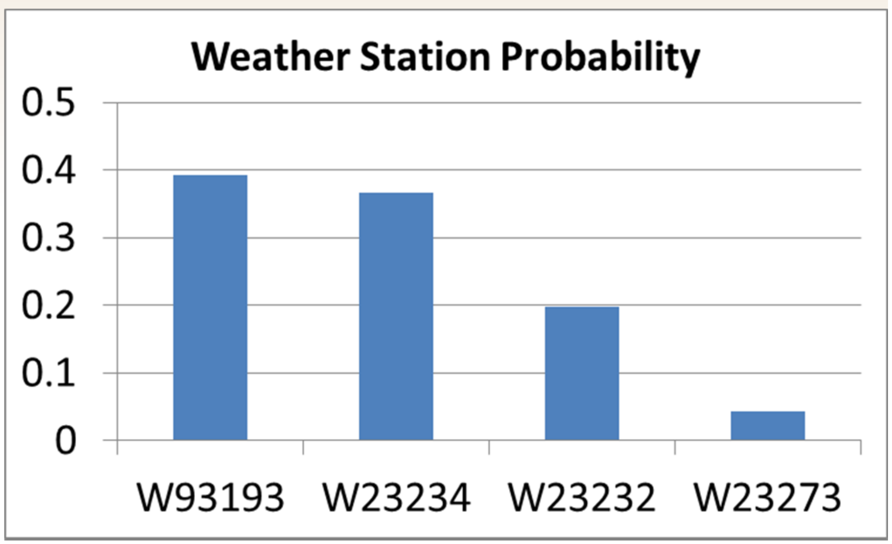
Modeling Approach: Water Body Size and Depth

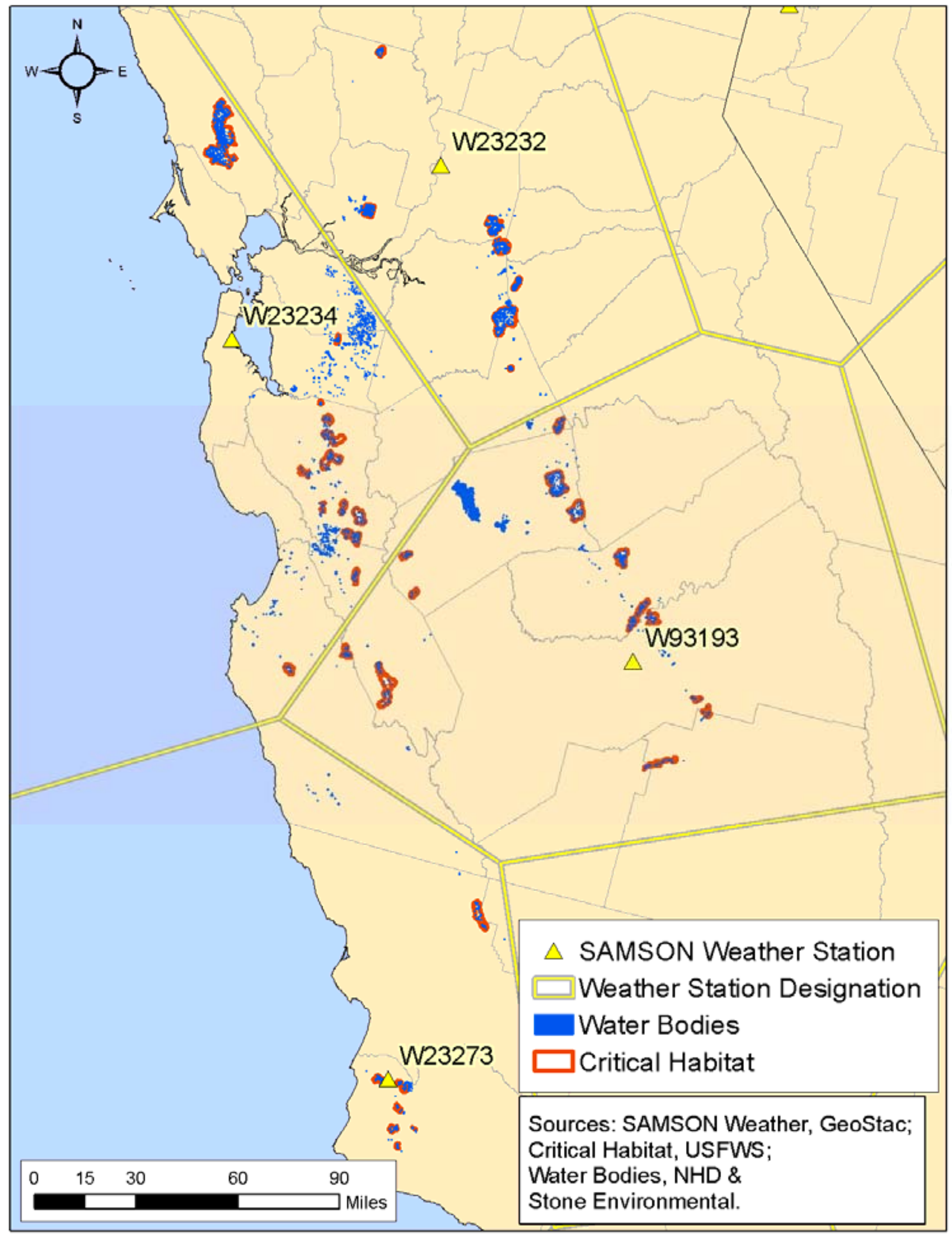
- Water body surface area and depth were represented as probability distributions. These factors influenced:
  - Volume
  - Integrated drift fraction
- A discrete distribution of surface area was developed from the spatial layer.
- A depth range of 0.15 - 1.0 m., represented by a uniform distribution, was used based on preferred CTS habitat characteristics.



Modeling Approach: Weather Station Distribution

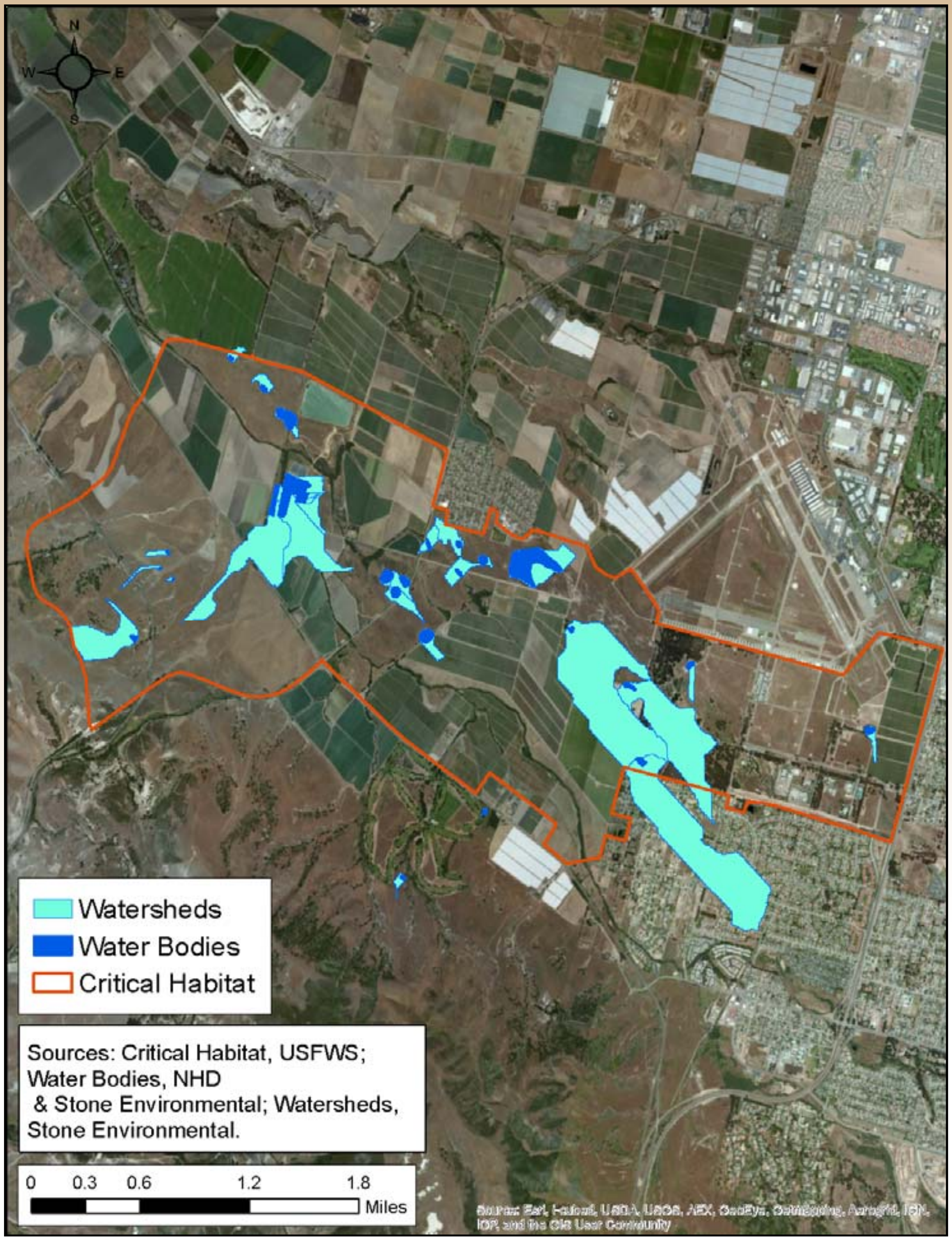
- The CTS habitat extends from Santa Barbara County in the South to Sonoma County in the North.
- Weather station polygons were intersected with the water bodies to determine weather station probability.





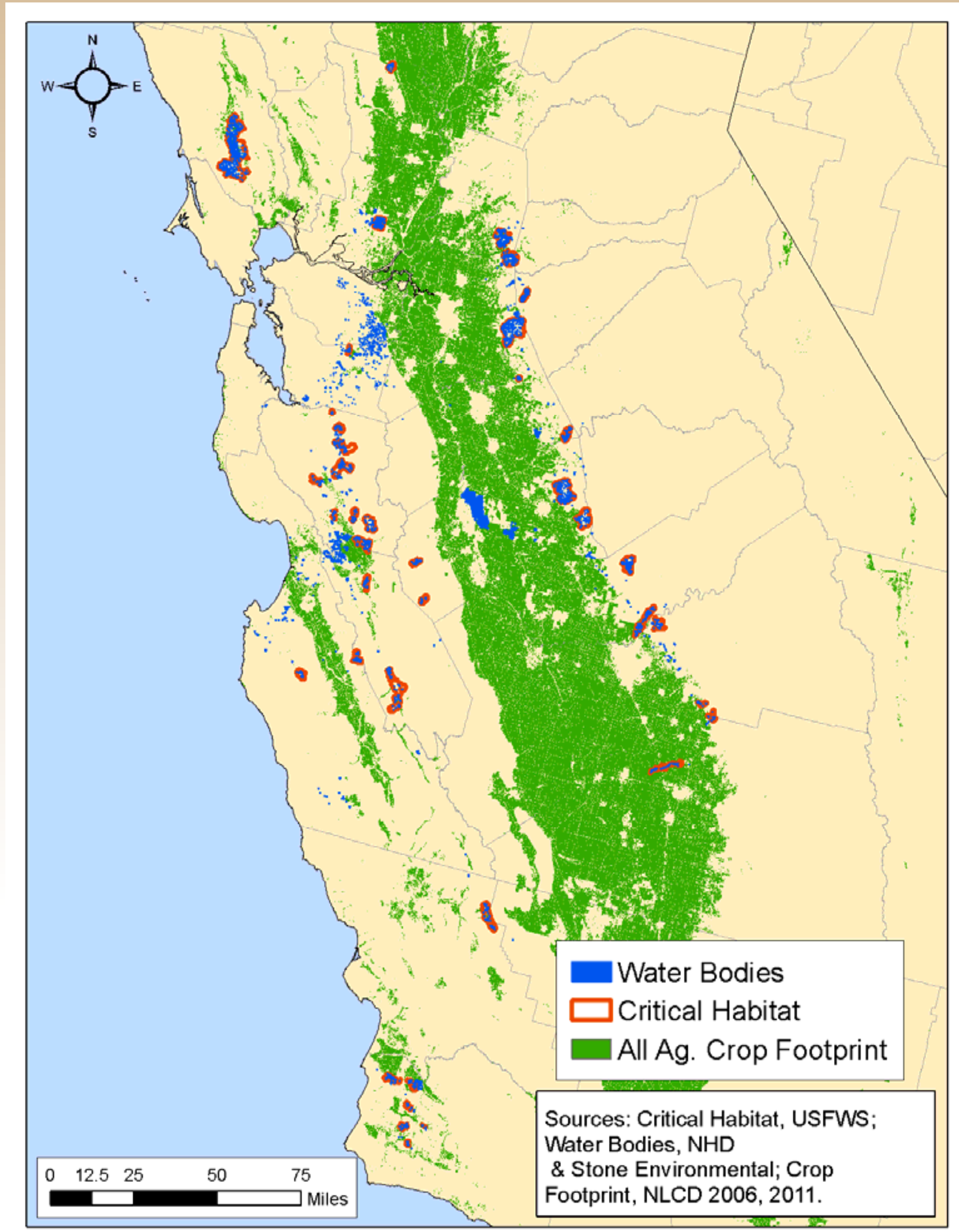
Modeling Approach: Watershed Delineation

- Watersheds boundaries were estimated from a DEM-based delineation using 10-meter National Elevation Dataset (NED) data.
- Watersheds ranged in size from 0.001 ha to 688 ha (mean of ~ 7.6 ha)
- These watersheds were then used to identify relevant soils and percent cropped areas.



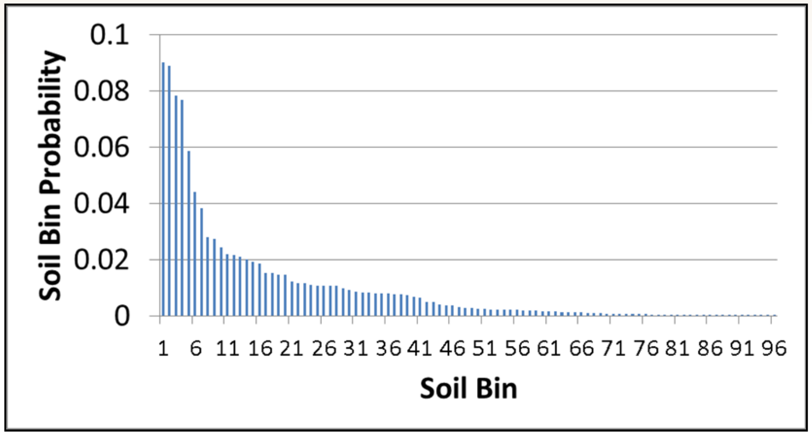
Modeling Approach: Crop Footprint Development

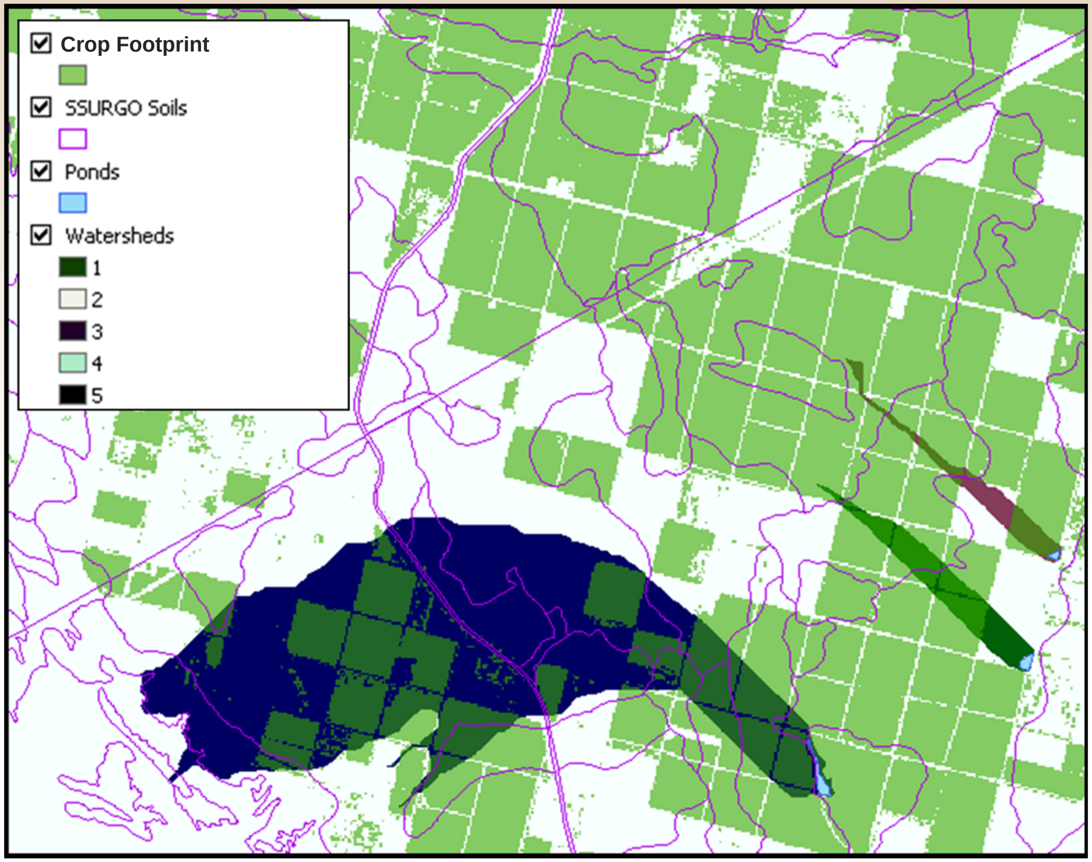
- For a broad use pesticide, a conservative "All Ag" crop footprint was developed from 2 years of NLCD (2006 and 2011).
- The crop footprint was intersected with watersheds to identify the extent of potential use sites within the drainage areas of CTS aquatic habitat.
- A CDL-based All Ag footprint would be very similar, and crop group-based refinements could be applied as needed.



Modeling Approach: Soils Analysis

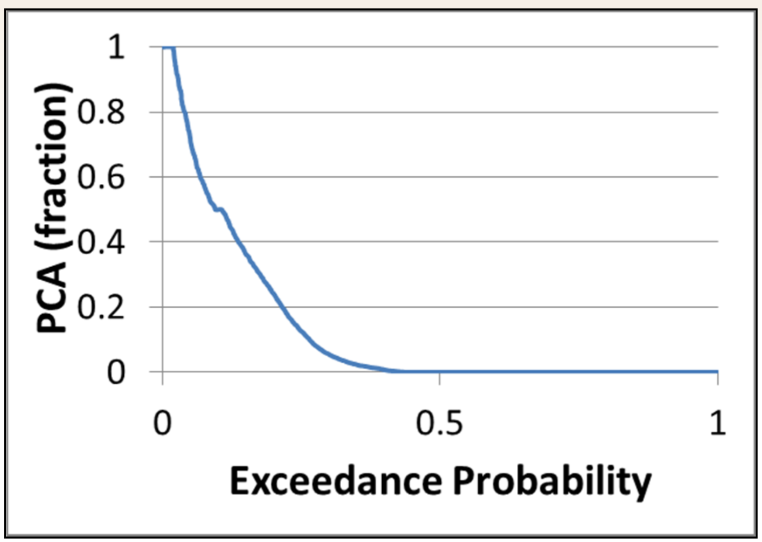
- The soils co-occurring with crops within the habitat watersheds were identified and grouped into "bins".
- The soil binning approach was adopted from the Spatial Aquatic Model's method which groups soils by:
  - Hydrologic group
  - USLE K-factor
  - Organic carbon in surface layer
  - Slope
- 96 soil bins were represented in CTS habitat

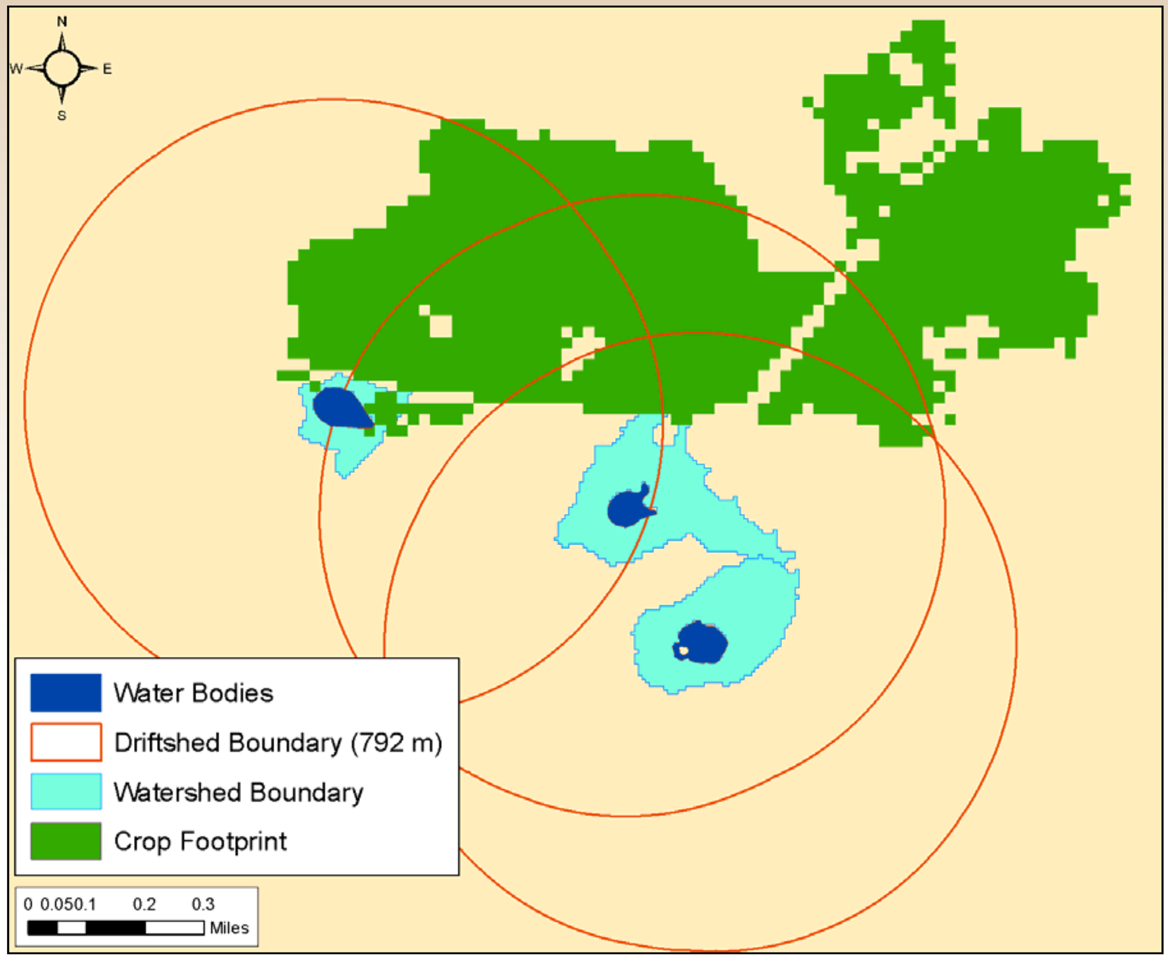




Modeling Approach: PCA Calculation

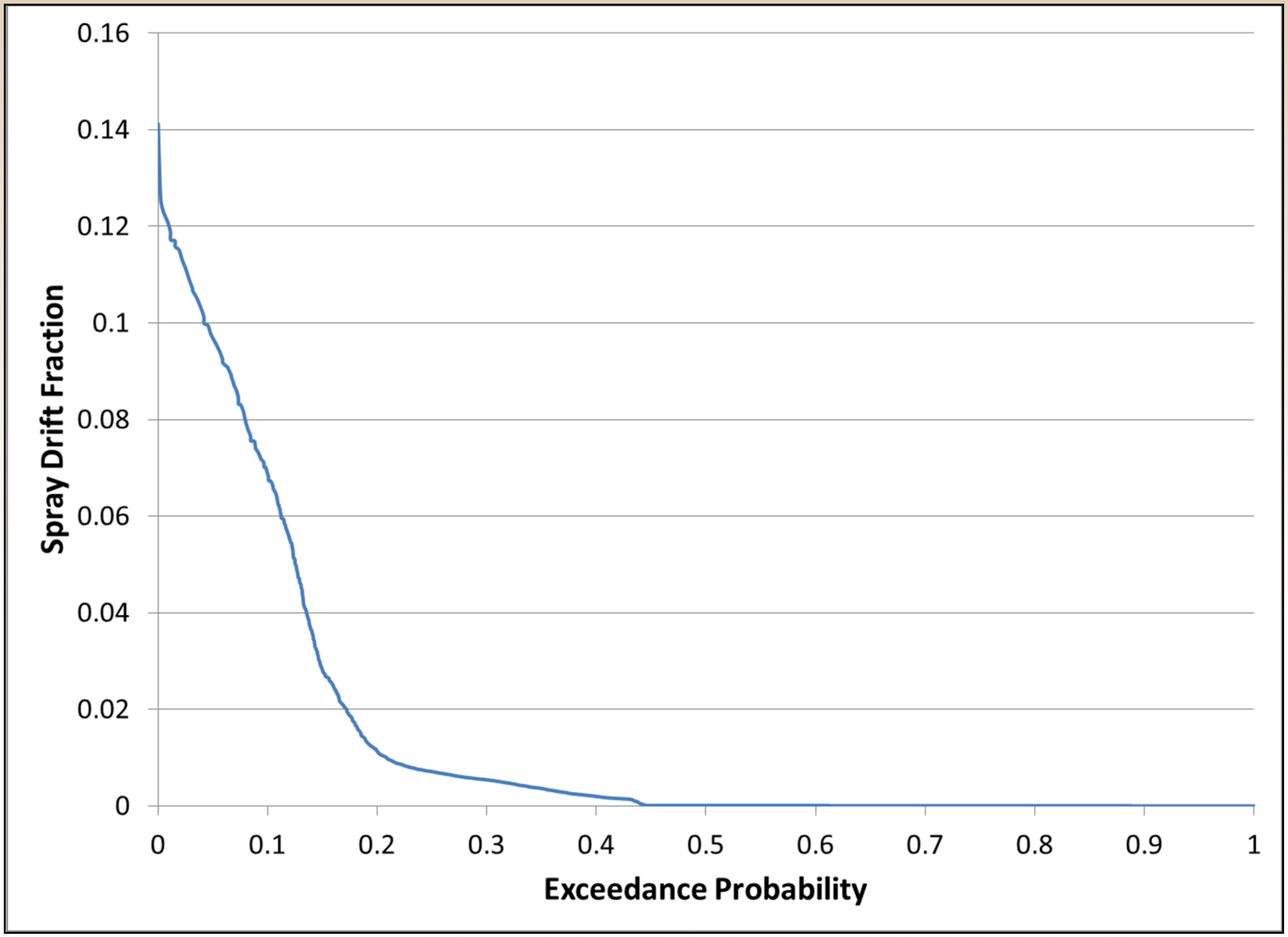
- Percent Cropped Areas (PCAs) are calculated based on both watersheds and a 792-meter buffer "drift-shed" (AgDRIFT limit).
- The maximum of the watershed and "drift-shed" PCA is used in developing the PCA distribution based on 4,297 water bodies.





Modeling Approach: Spray Drift Fraction

- The actual proximity of an edge of field to a water body in CTS habitat is highly variable.
- A probability distribution of the closest distance from an edge of field to CTS aquatic habitat can be readily constructed.



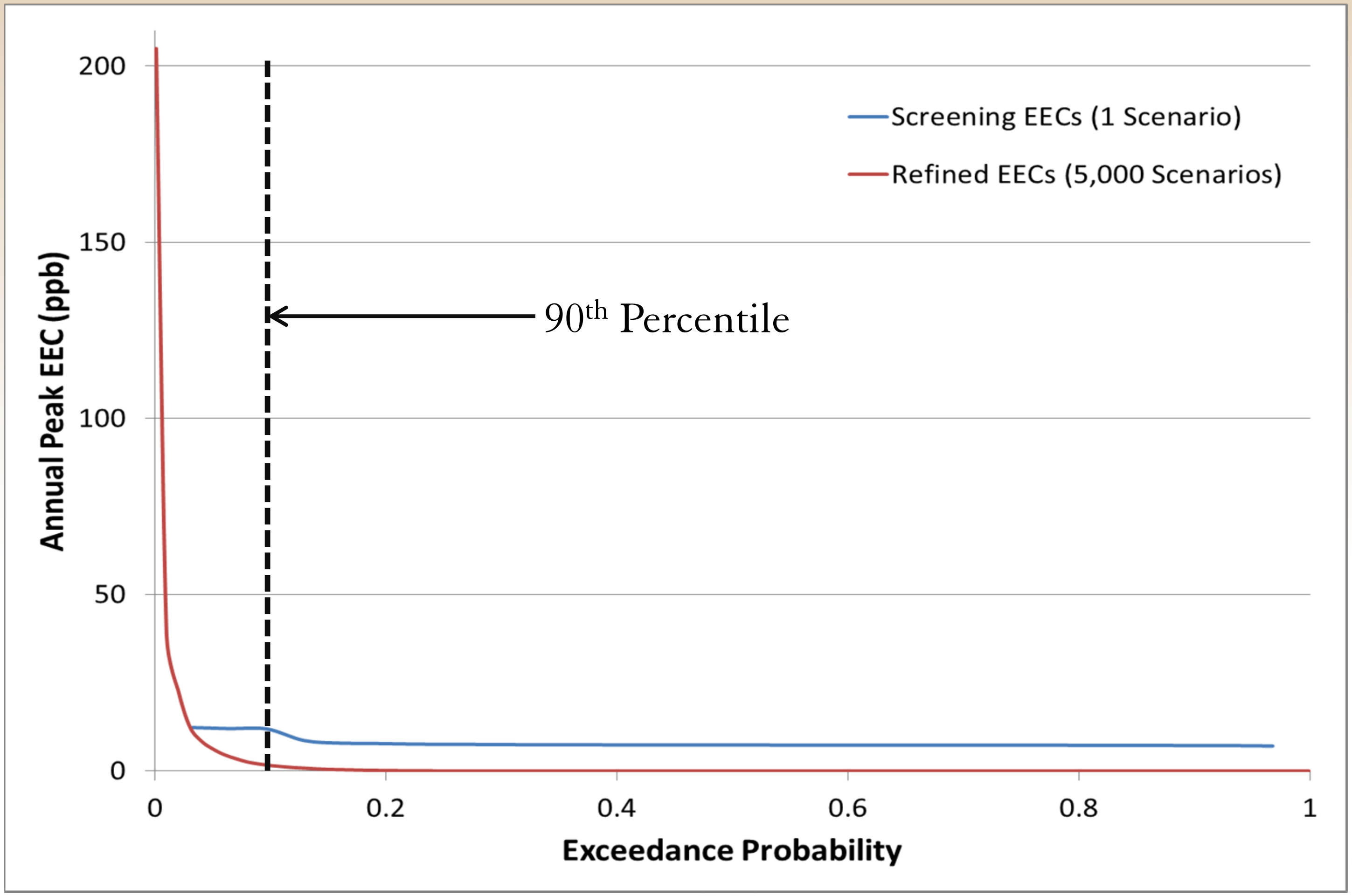
- AgDRIFT was used to calculate resulting drift.
- Existing label buffers were accounted for.

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 SWCC simulations.

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

- Screening EECs: 1 30-year CA strawberry scenario simulation.
- Refined EECs: 5,000 30-year CA strawberry scenario simulations, based on sampling 8 probability distributions of habitat specific inputs.



Implications for National Endangered Species Assessments

- The current proposed aquatic exposure modeling approach for early in Step 2 will consider 1 crop scenario per crop group, per HUC2, applied to appropriate habitat bins.
- While this is a an appropriate screening level approach, refinements may be needed if there is a desire to forego progression to Step 3 and consultation with the Services.
- The datasets and processing techniques required to characterize the variability of key environmental factors that drive aquatic exposure, as demonstrated in this example, are currently available.
- Methods can be developed to efficiently characterize aquatic exposure model inputs for taxa, species, or region-specific habitat areas for use in national assessments.

Summary and Conclusions

- A probabilistic approach for refining aquatic EECs for use 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.
- A Latin Hypercube sampling method was use to generate the inputs to 5,000 SWCC scenarios and simulations.
- The refined EEC distribution, specifically representative of CTS habitat conditions, showed a wider range of annual peak EECs, and a 90th percentile that was a factor of 7.6 times lower than the screening level.
- Many aspects of this approach can be adopted for refined exposure modeling at Step 2 of the national ESA process, and can be used to identify conditions to target for mitigation.