Where have all the flowers gone?

a management approach to save *Acanthomintha ilicifolia*

San Diego Management & Monitoring Program

CALIFORNIA DEPARTMENT OF FISH and WILDLIFE

Management Challenge

How do we enhance resilience of an annual, edaphic species that:

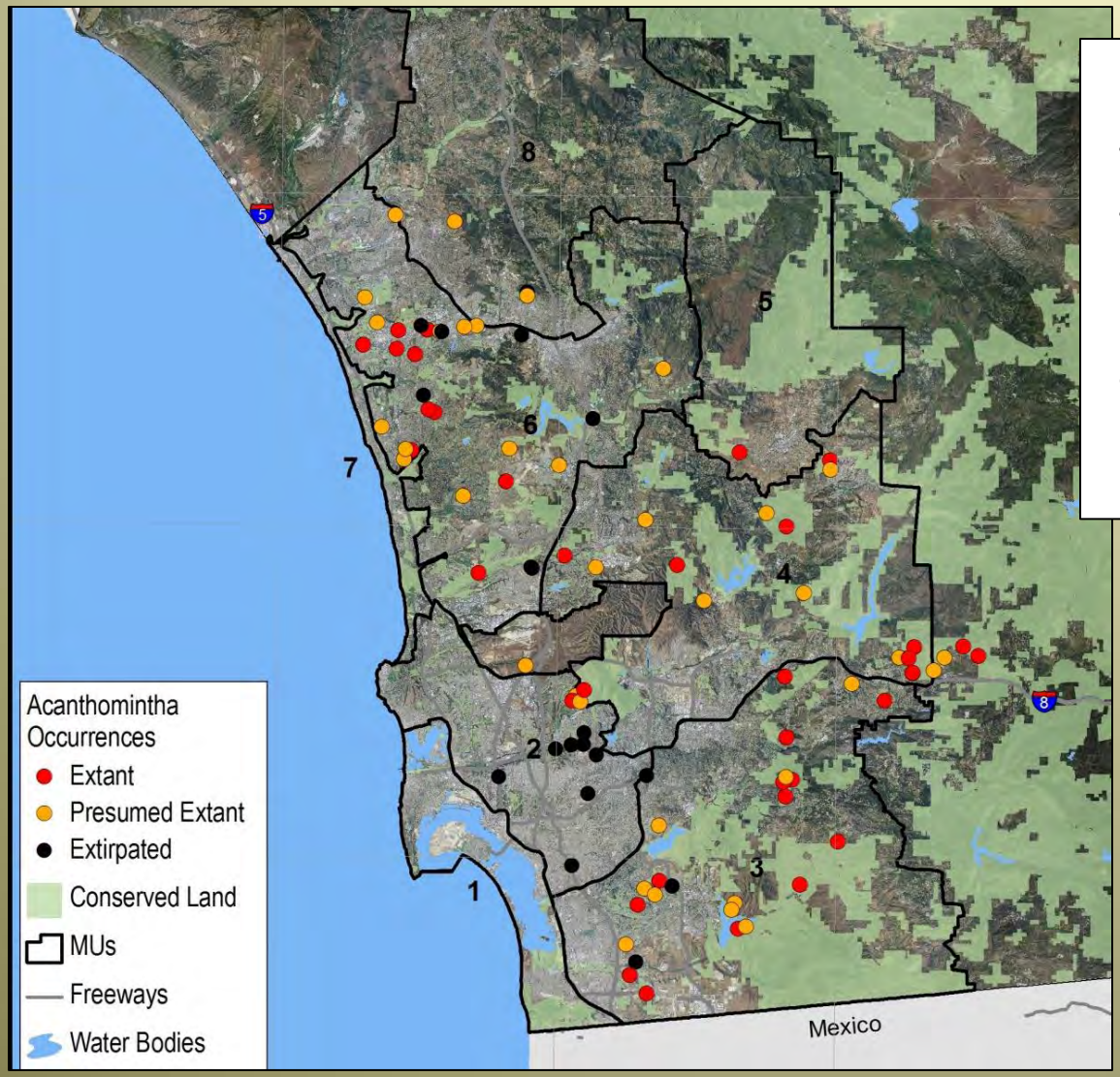
- Undergoes large population fluctuations
- Occurs across a fragmented landscape
- Is vulnerable to many threats and stressors
- May have low genetic diversity due to
  - reduced population sizes
  - geographic isolation
  - loss of pollinators

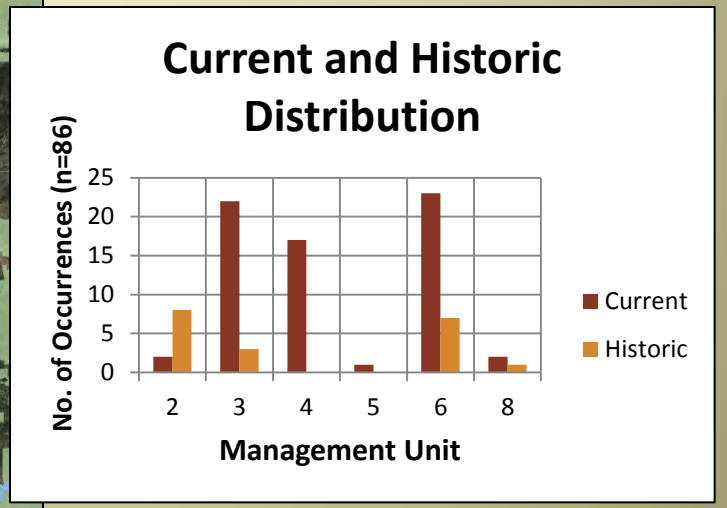
Approach to Prioritizing Management Actions

Assess opportunities for enhancement based on:

- Existing data, land managers, ACIL experts
- Conceptual model
- Modeled habitat suitability
- Modeled invasive species habitat
- Hypothesized regional population structure
- Potential habitat connectivity
- Future climate change

Acanthomintha Distribution





- 83% current occurrences on conserved lands
- 6 of 8 Management Units
- 5 occurrences outside MSPA

Acanthomintha Status

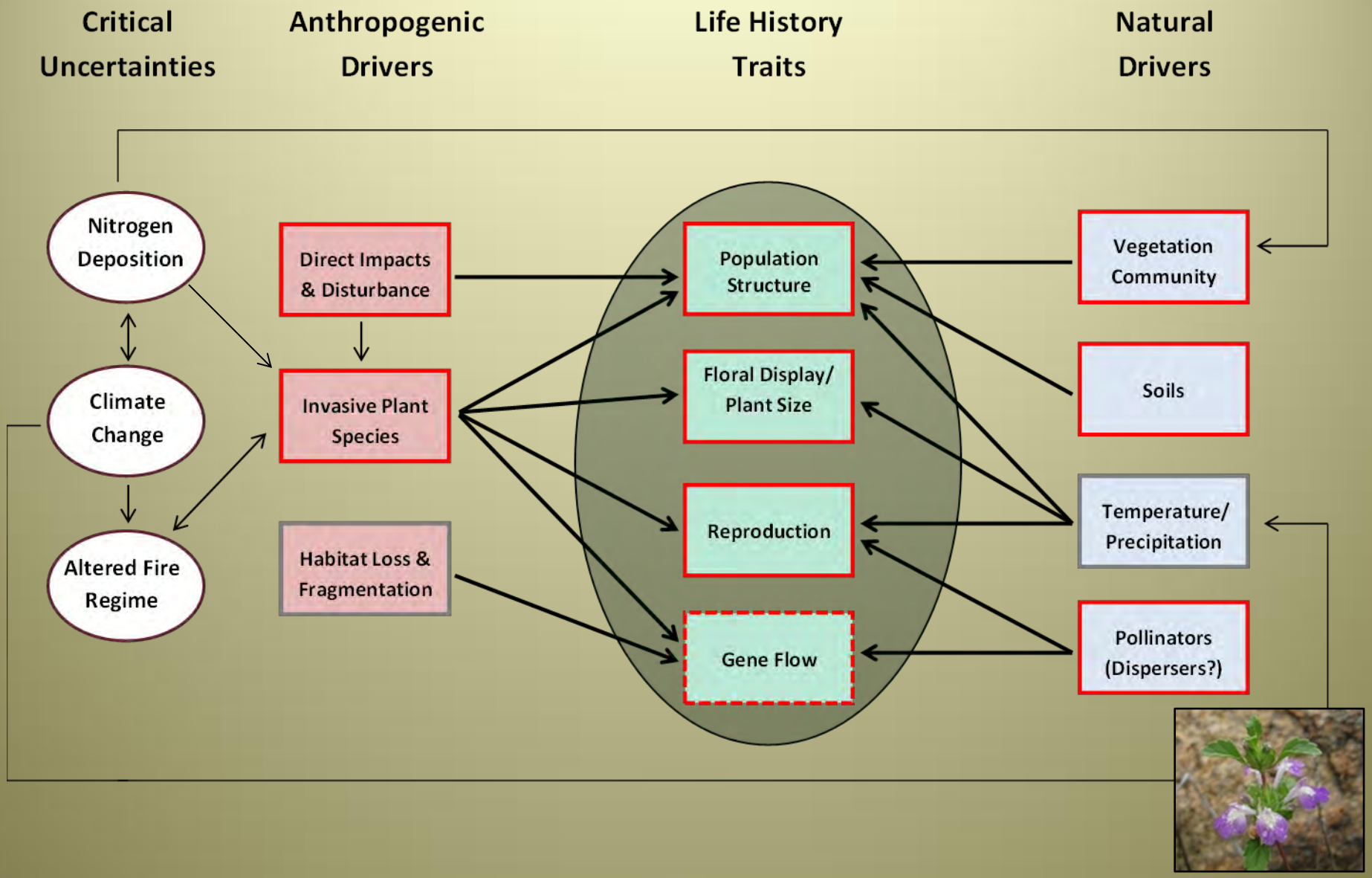
USFWS 5-year review (USFWS 2009)

- 80 populations
  - 50 extant/30 extirpated

Current study

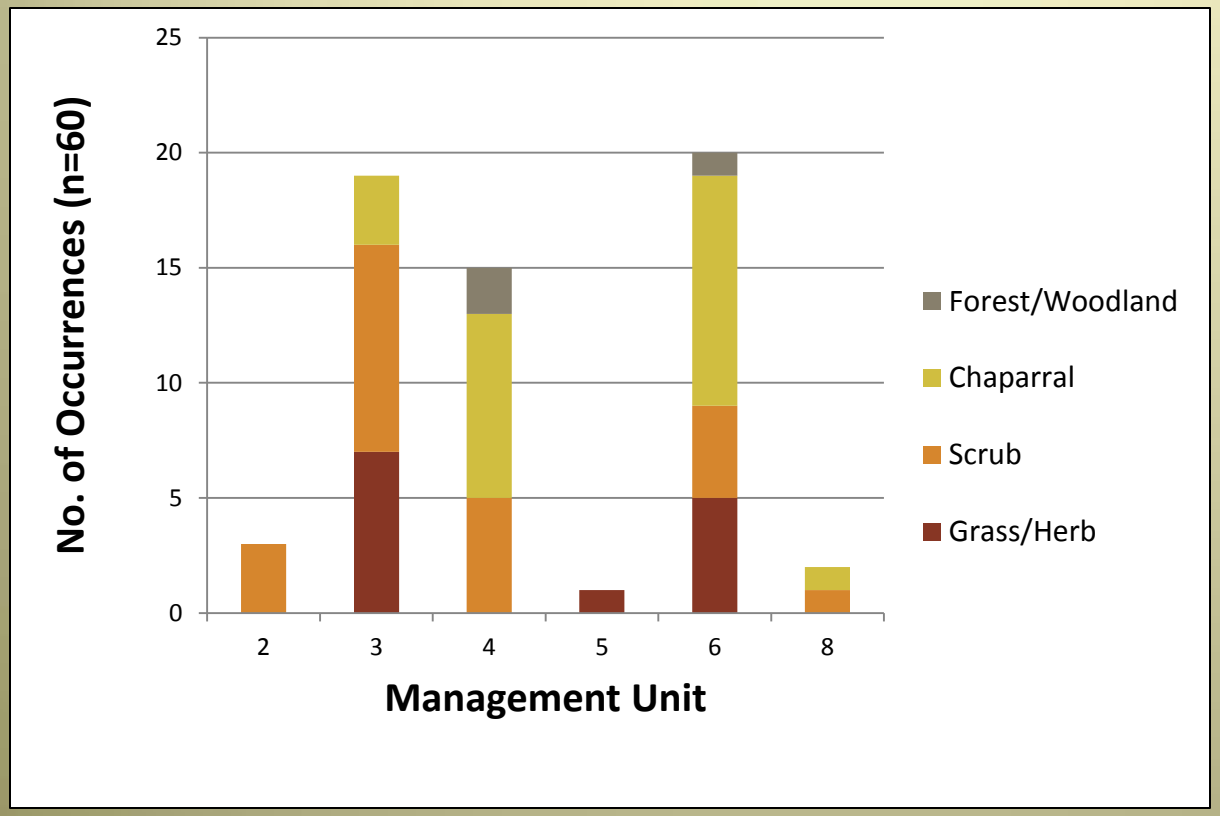
- 92 populations (12 new)
  - 73 current (36 extant, 37 presumed extant)
  - 19 historic (extirpated)
- 16 populations monitored
- 20 populations managed

Conceptual Model



Chaparral, Grassland, Coastal Sage Scrub

Vegetation Correlates

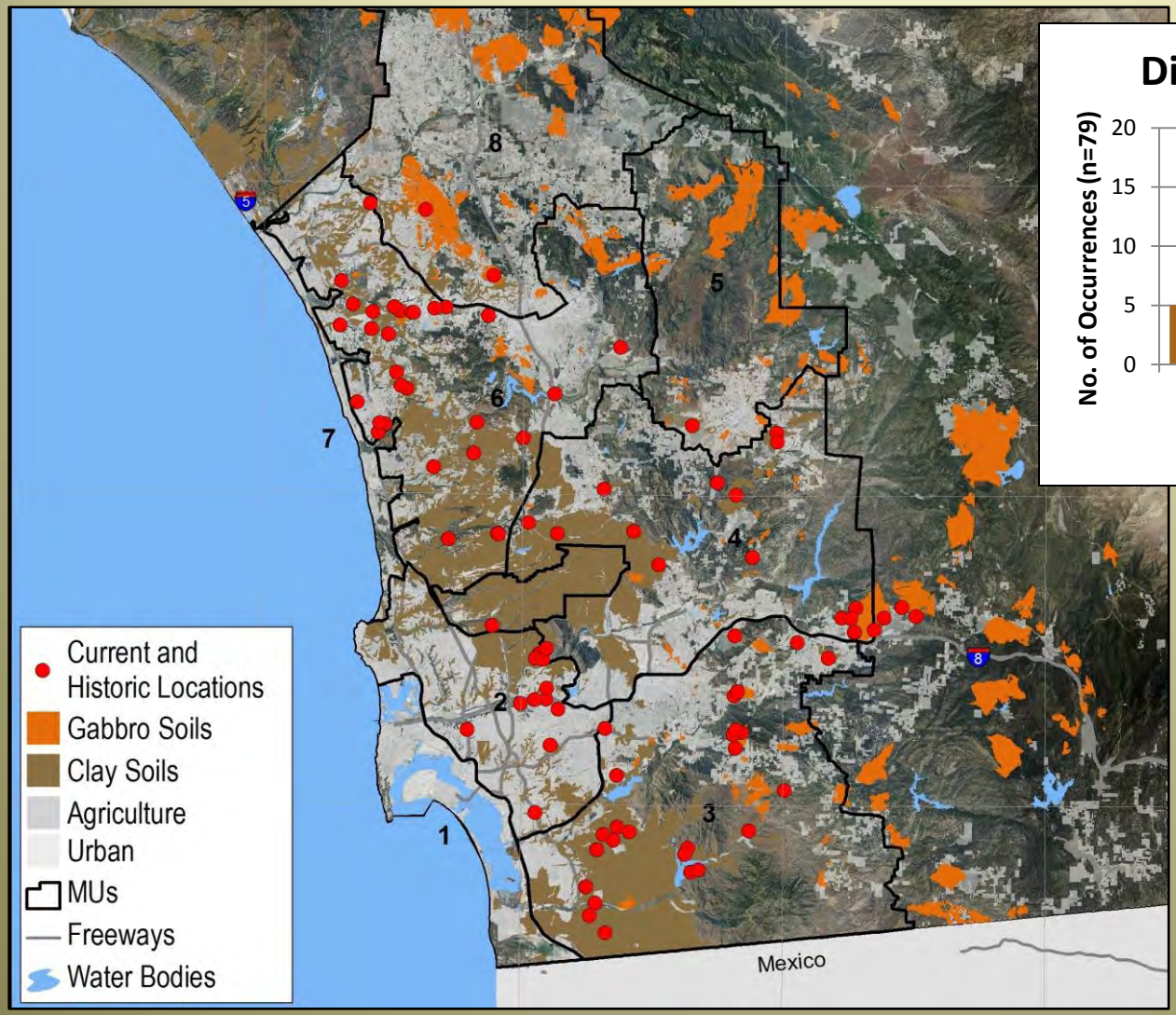


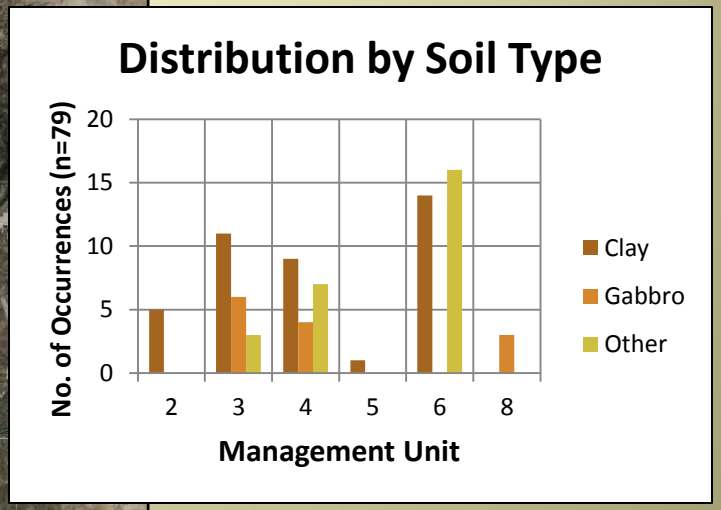
Group:

- 73% in Chaparral and Scrub
- 22% in Grass/Herb

- Chaparral Alliances (6):
  - 68%: *Adenostoma*-dominated/co-dominated vegetation
  - 27%: *Quercus*-dominated vegetation

Clay and Gabbro Soils





- 67% clay, gabbro; 33% 'other'
- Implications for future range shifts?

Habitat Suitability Model

Variables

- Climatic, topographic, and edaphic variables
- Presence-only modeling

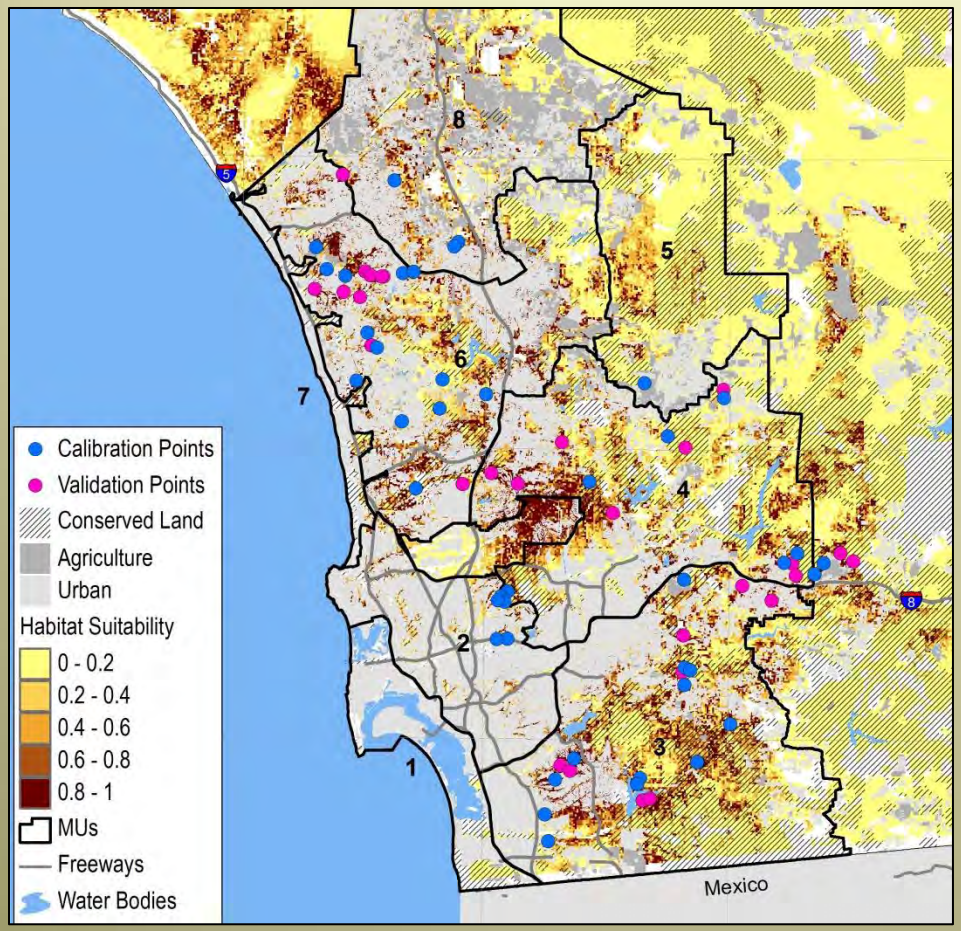
Design

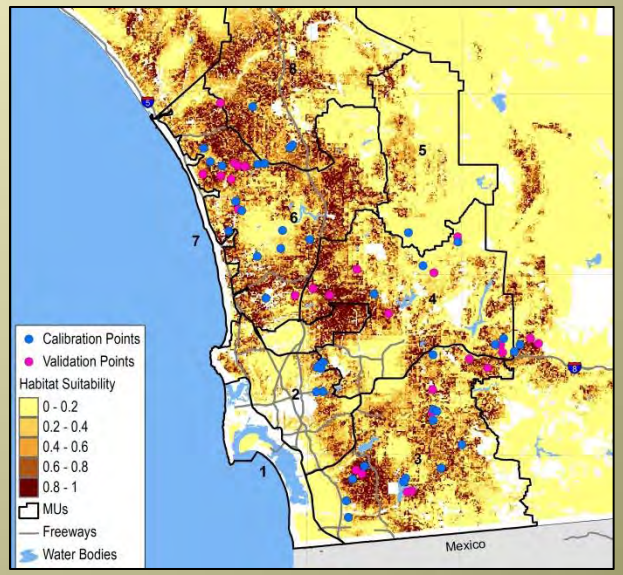
- Grid of points spaced 200 m apart with GIS-calculated environmental variables
- Calibration = 45 locations; validation = 30 locations

Models

- Constructed alternative models and evaluated performance
- Calculated Habitat Similarity Index (HSI) (0-1.0)
  - 1.0 = most similar to multivariate mean

Habitat Suitability Model Results





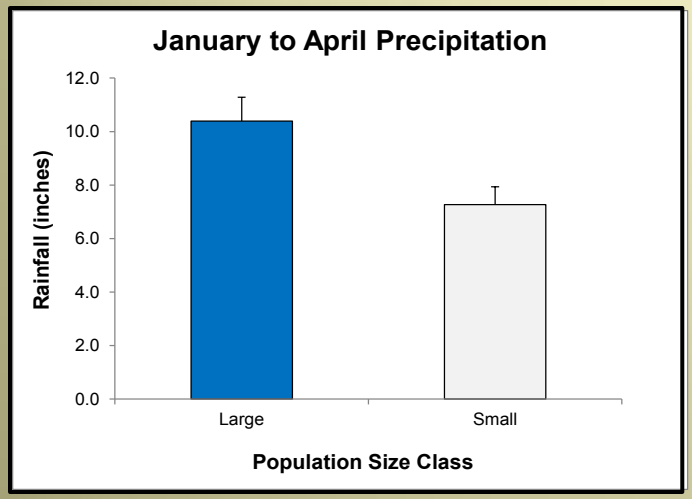
- Top-performing model; median HSI = 0.7
- Tool for predicting potential habitat

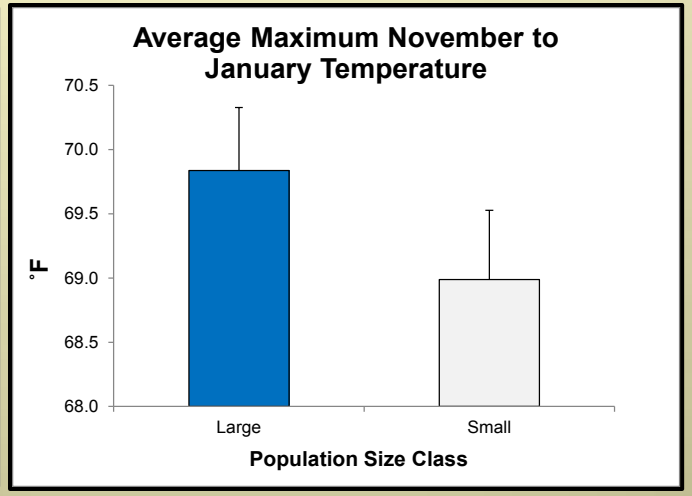
Modeling Climate Influences

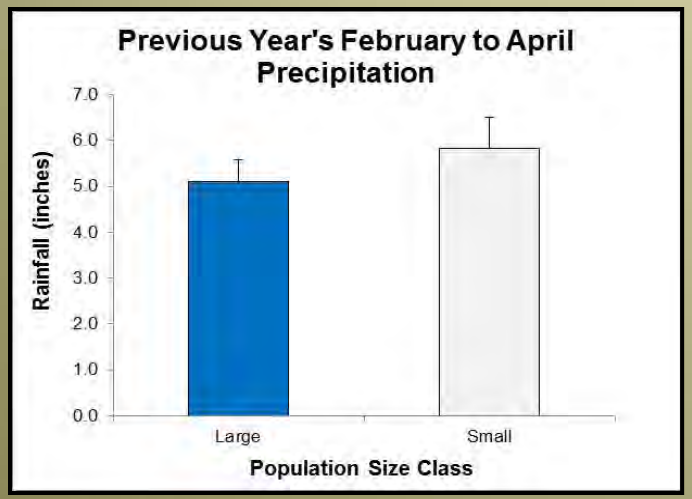
Objective: predict population boom vs bust years

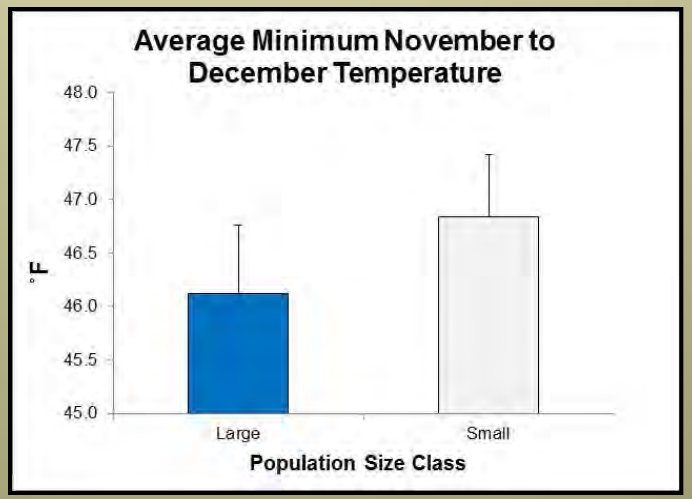
- Climatic variables
  - Precipitation (growing season/previous growing season)
  - Temperature (growing season)
- Design
  - 37 paired populations representing boom/bust population abundance years (Mean ± 2SE)
- Models
  - Exploratory: 45 single climate variable models
  - Final: 25 single variable, *a priori* multivariate models

Acanthomintha Boom vs Bust Years, Paired Populations



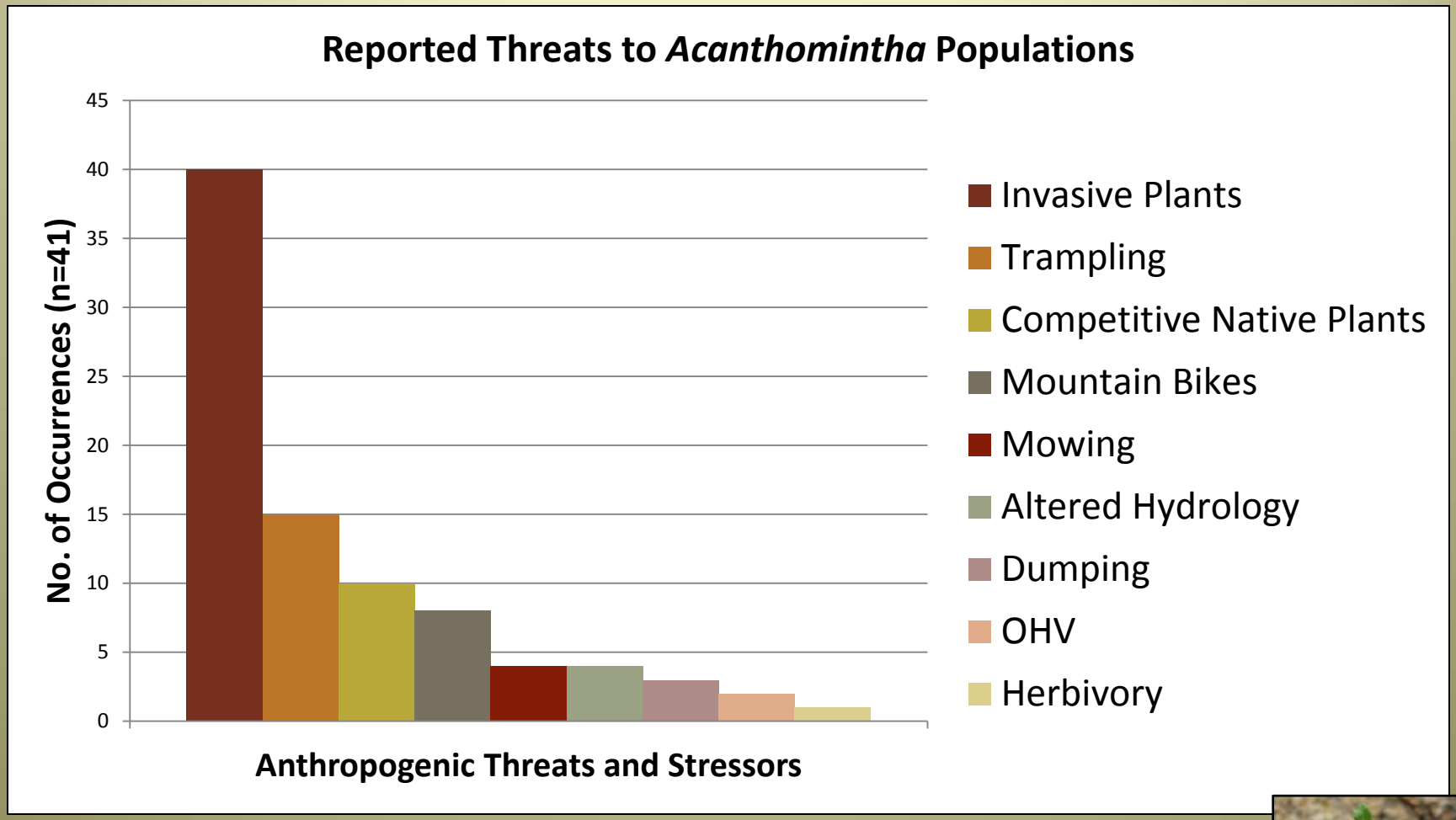






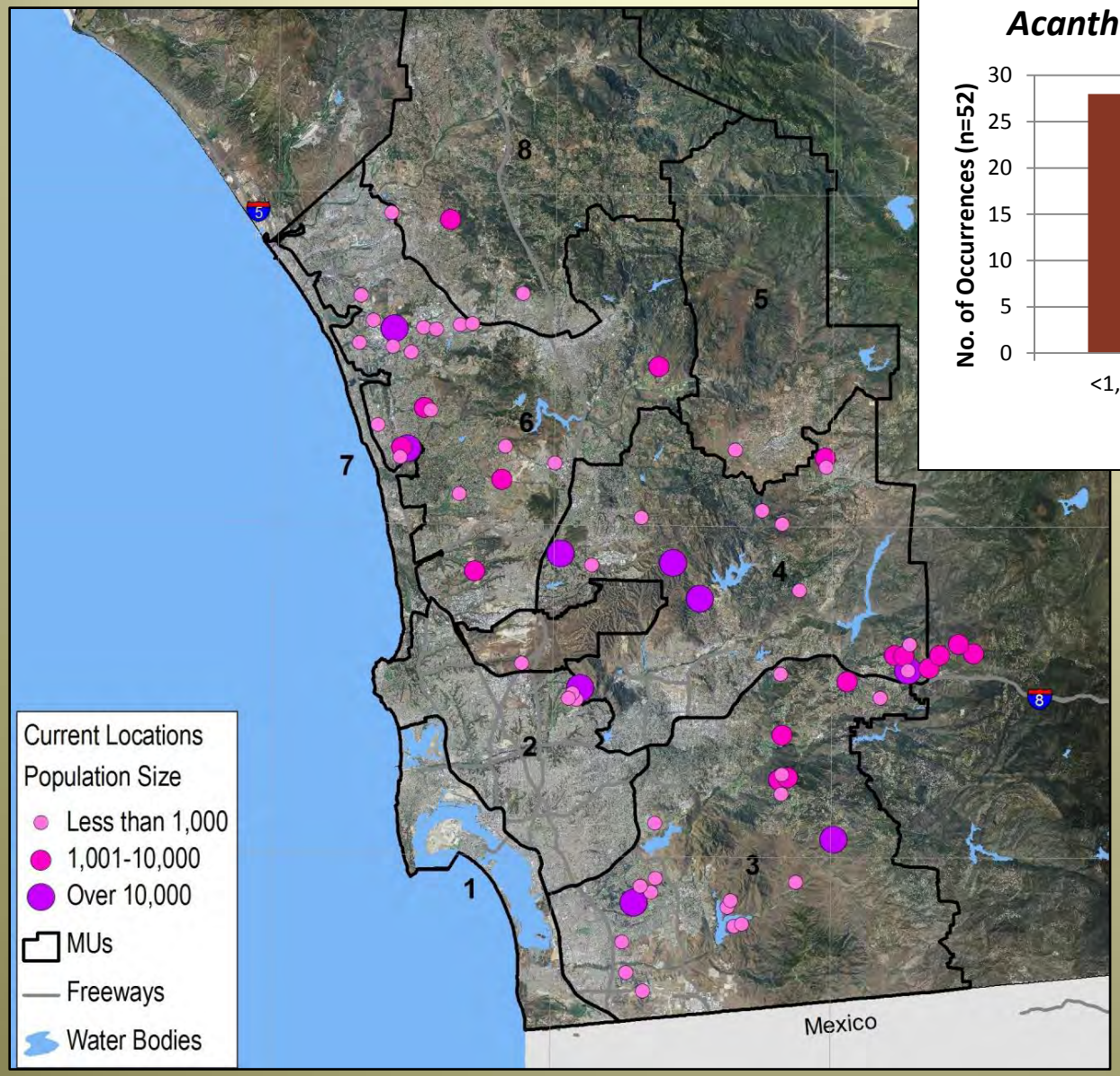
- Most important predictor of boom years = warm fall + wet spring
- Previous Feb-Apr ppt = ambiguous trend
- Boom years of 1980s-1990s often preceded by low Feb-Apr ppt in previous growing season

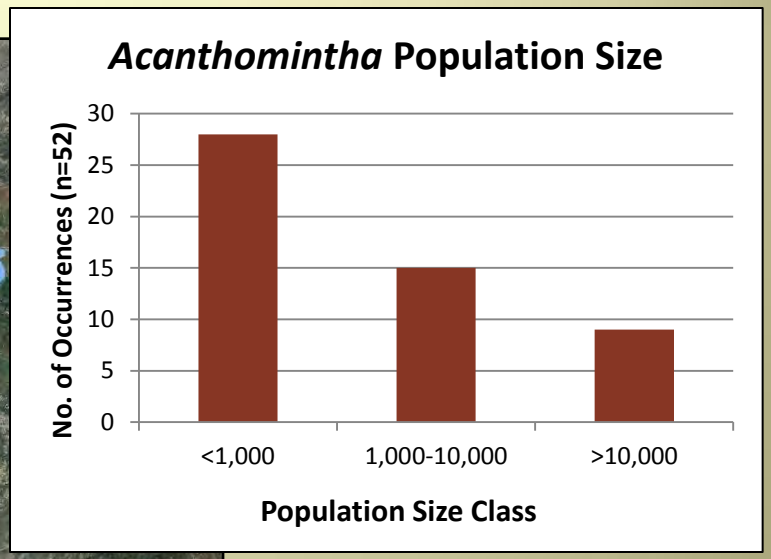
Preserve-level Threats and Stressors



- Invasives reported as a threat at 98% of managed/monitored occurrences

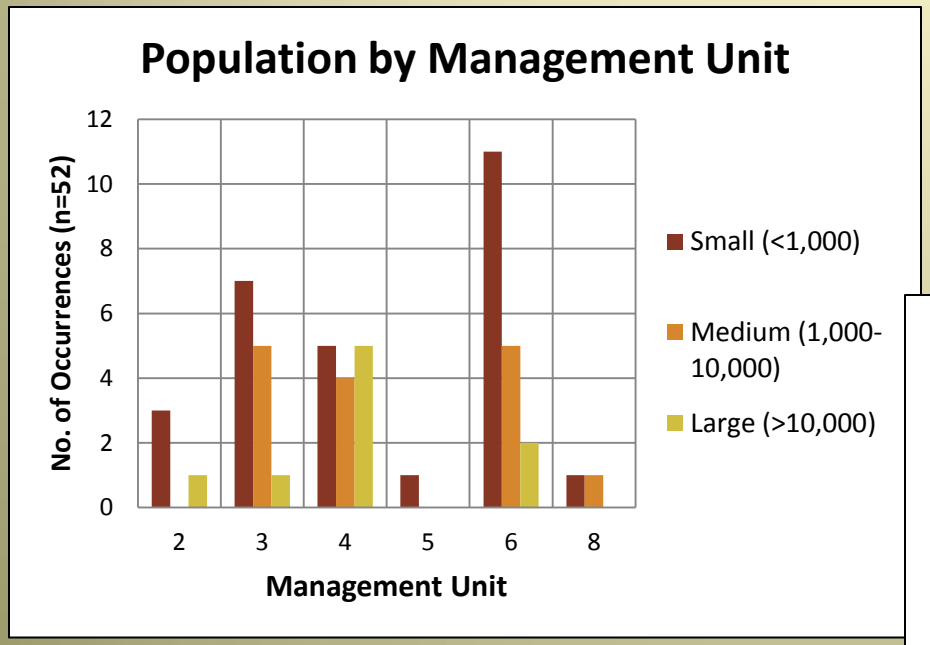
Population Size



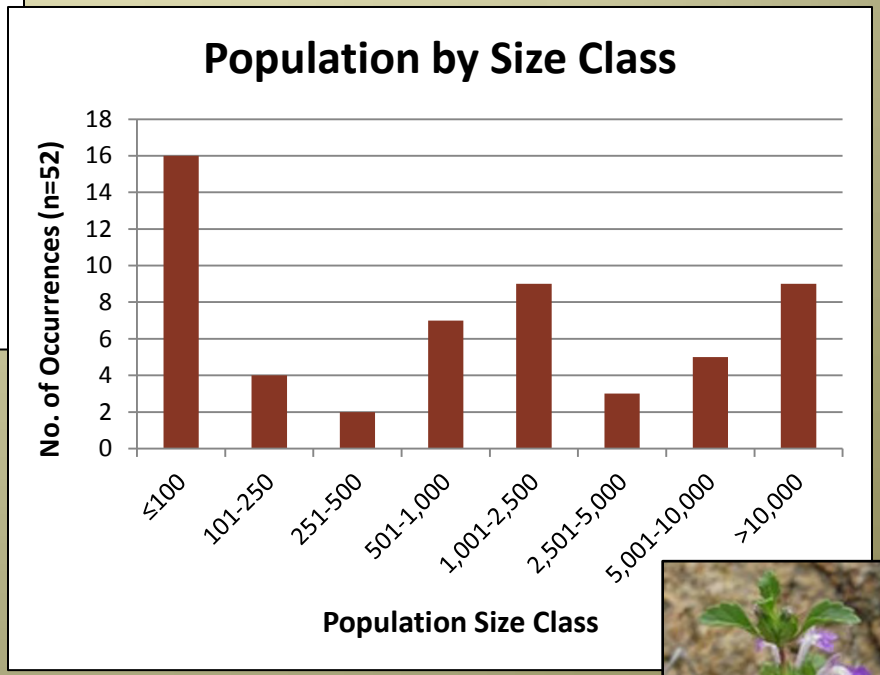


- Long-term resilience vs short-term persistence
- Larger populations buffer against environmental stochasticity (e.g.,10^3-10^6; Shaffer 1987 and others)

Population Size (based on above-ground census)

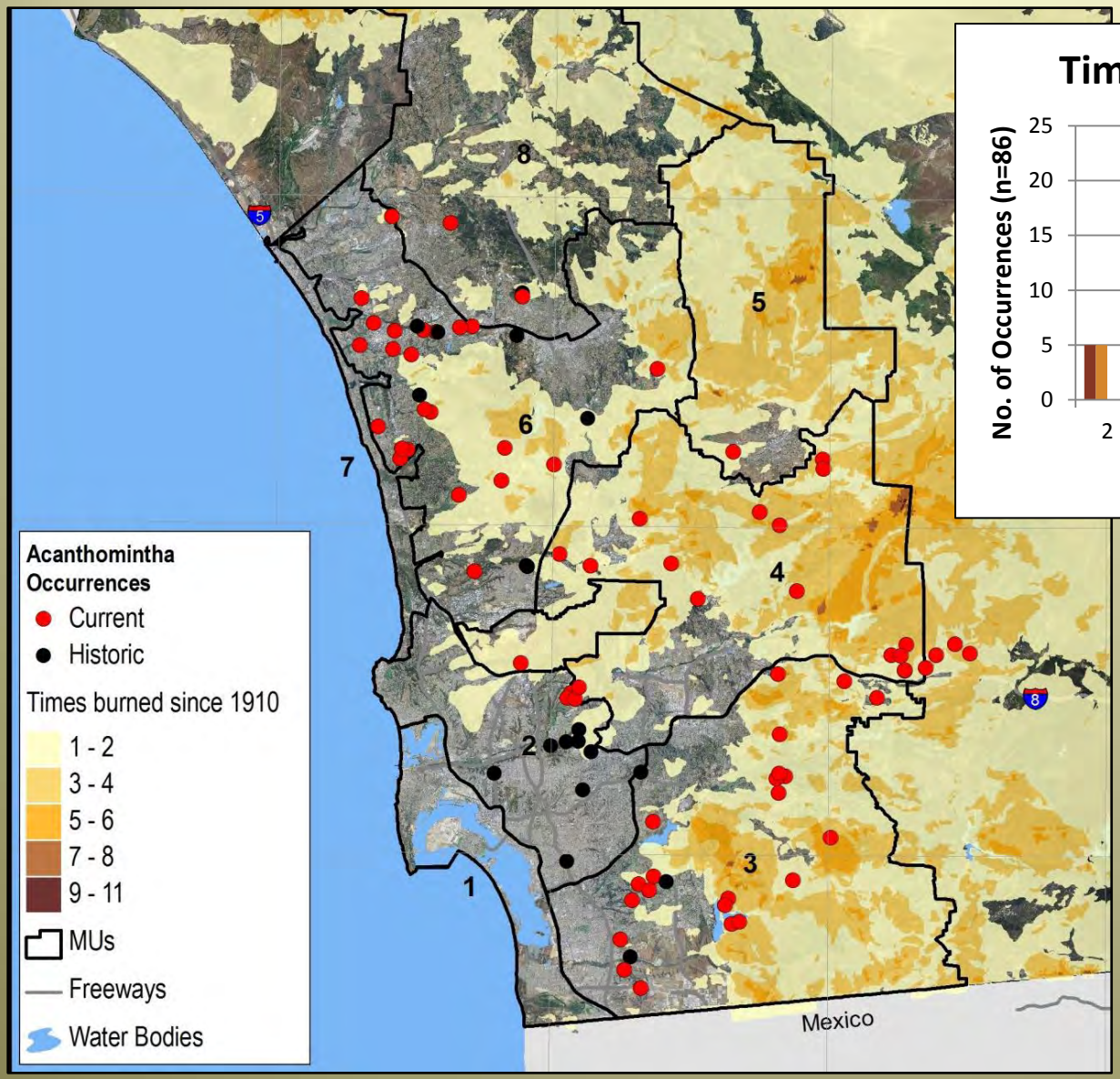


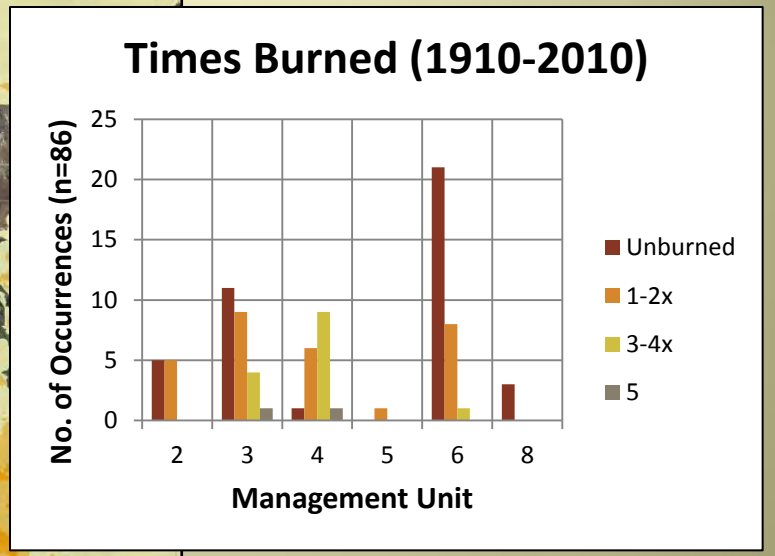
- Smallest populations most at risk due to genetic factors (e.g., Lacy 1987, Barrett and Kohn 1991, Menges 1991)



- Prioritization will consider landscape context, disturbance history, management history

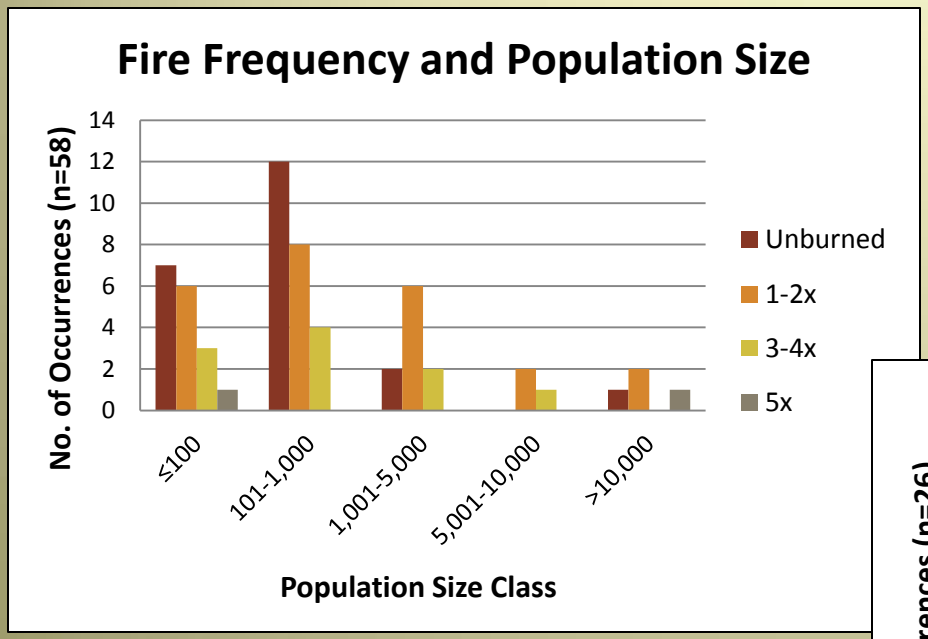
Number of Fires Since 1910



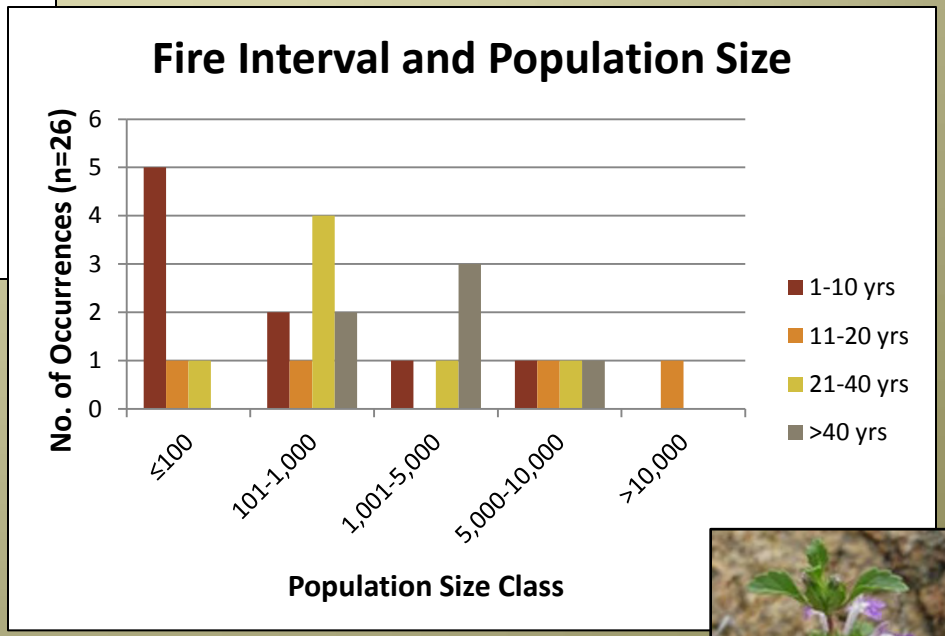


- 0-5 fires per population (1910-2010)
- 48% of current (46% all) populations unburned
- 2003: 1st burn for 6 populations
- Fire threat differs among MUs

Fire History and Population Size

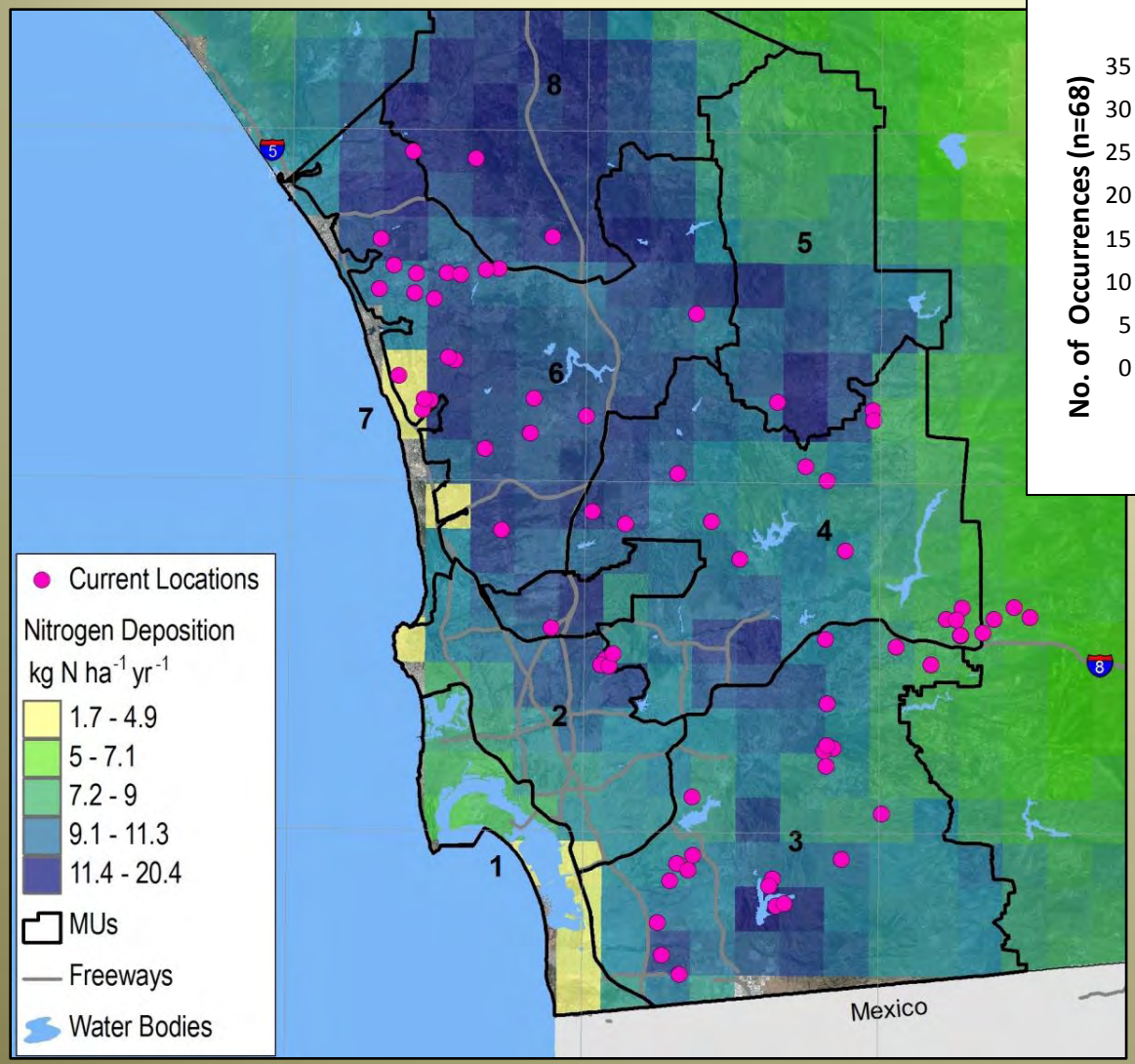


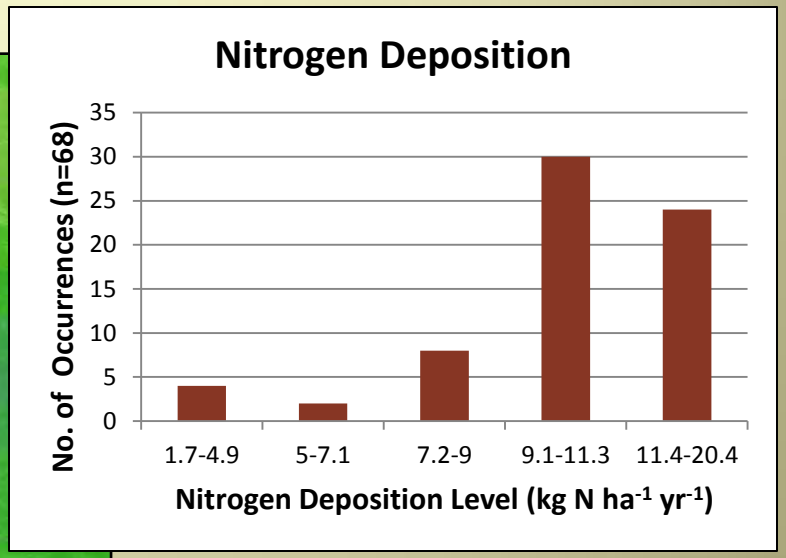
- Small and large populations experience range of fire frequencies
- No clear relationship between population size and fire history



- Fire over the last few decades?
- Need post-fire monitoring data
  - 1 year post-fire (2 populations)
  - 2 years post-fire (4 populations)

Nitrogen Deposition





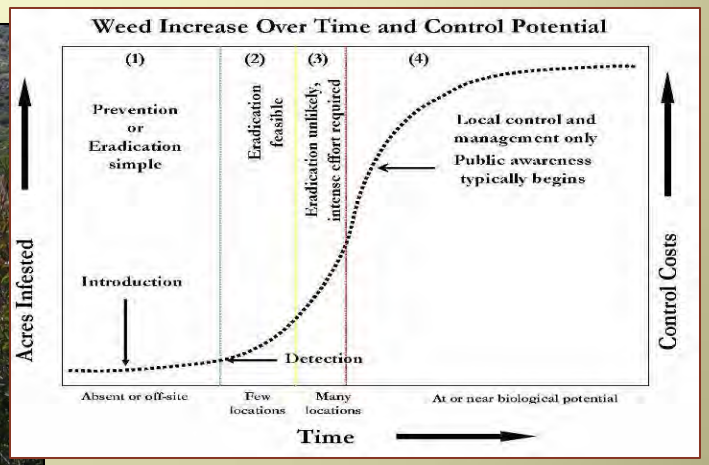
- Exceeds thresholds for CHP, CSS, GL (Fenn et al. 2010) at >90% of occurrences
- Elevated N levels may promote invasive species, vegetation type-conversion

Source: U.C. Riverside. Bourns College of Engineering's Center for Environmental Research and Technology

Invasive Plant Species

- Identified as a threat by multiple sources
- Enhanced by other threats (e.g., disturbance, fire, nitrogen deposition)
- Nonnative grasses and forbs (e.g., *Avena* spp., *Bromus madritensis, Centaurea melitensis*)
  - Impact biomass and fecundity, but not survivorship (e.g., Bauder and Sakrison 1997, 1999, Bauder et al. 1994)
- *Brachypodium distachyon* – game changer?

Brachypodium as a Threat

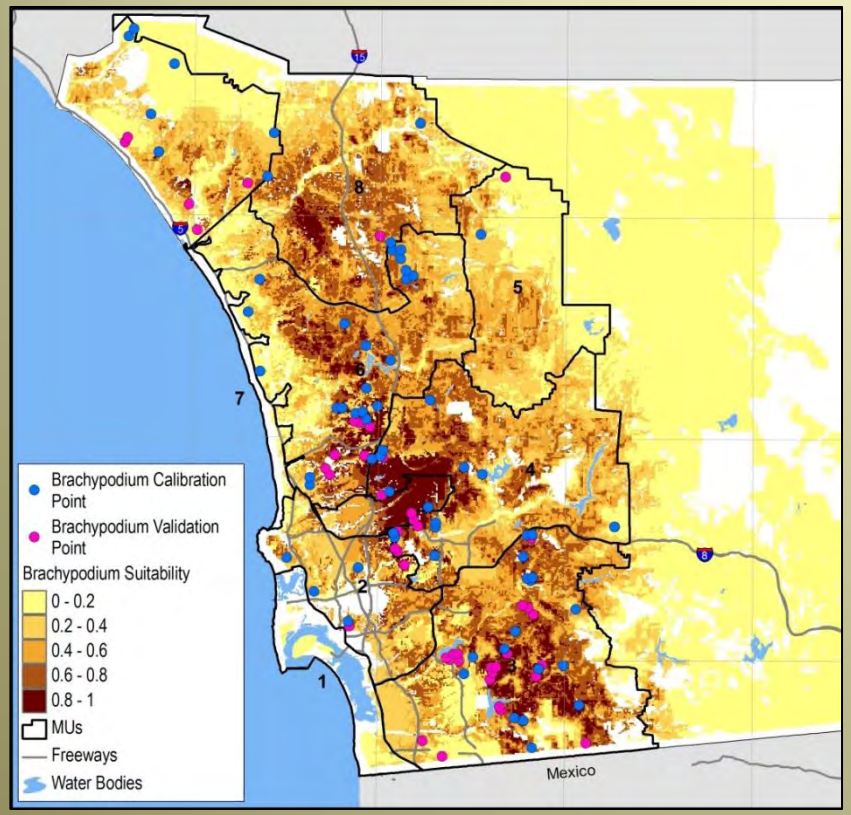


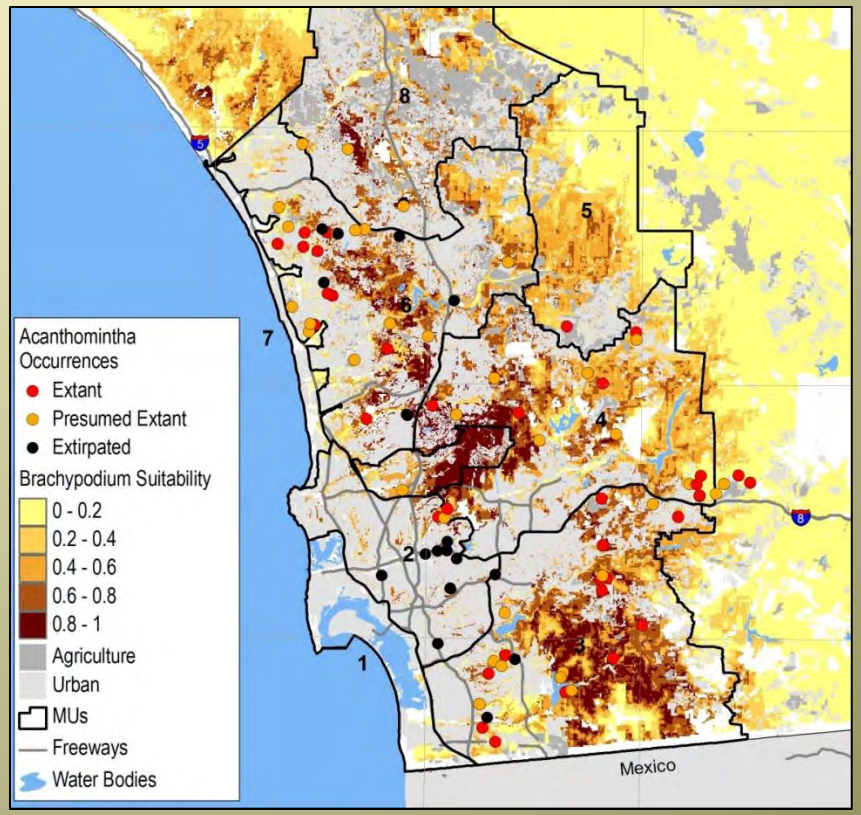
Siemens and Tu 2007

- Affinity for clay soils?
- Short-lived seed bank?
- Killed by fire?

- High seed production, little to no seed dormancy
- Rapid germination, short life cycle
- Outcompetes other nonnative species
- Dense thatch layer
- High germination in dark

Brachypodium distachyon Habitat Suitability Model Results





- Model calibration = 66 locations, validation = 46 locations
- 5 top-performing models; model average median HSI = 0.7

Adaptive Management Framework

- Review population data and management and monitoring history.
- Identify potential vegetation and soil correlates and landscape context.
- Identify natural drivers and threats.
- Prioritize populations for enhancement or connectivity.
- Identify areas that need to be surveyed.
- Identify priority research questions to be incorporated into a monitoring strategy.

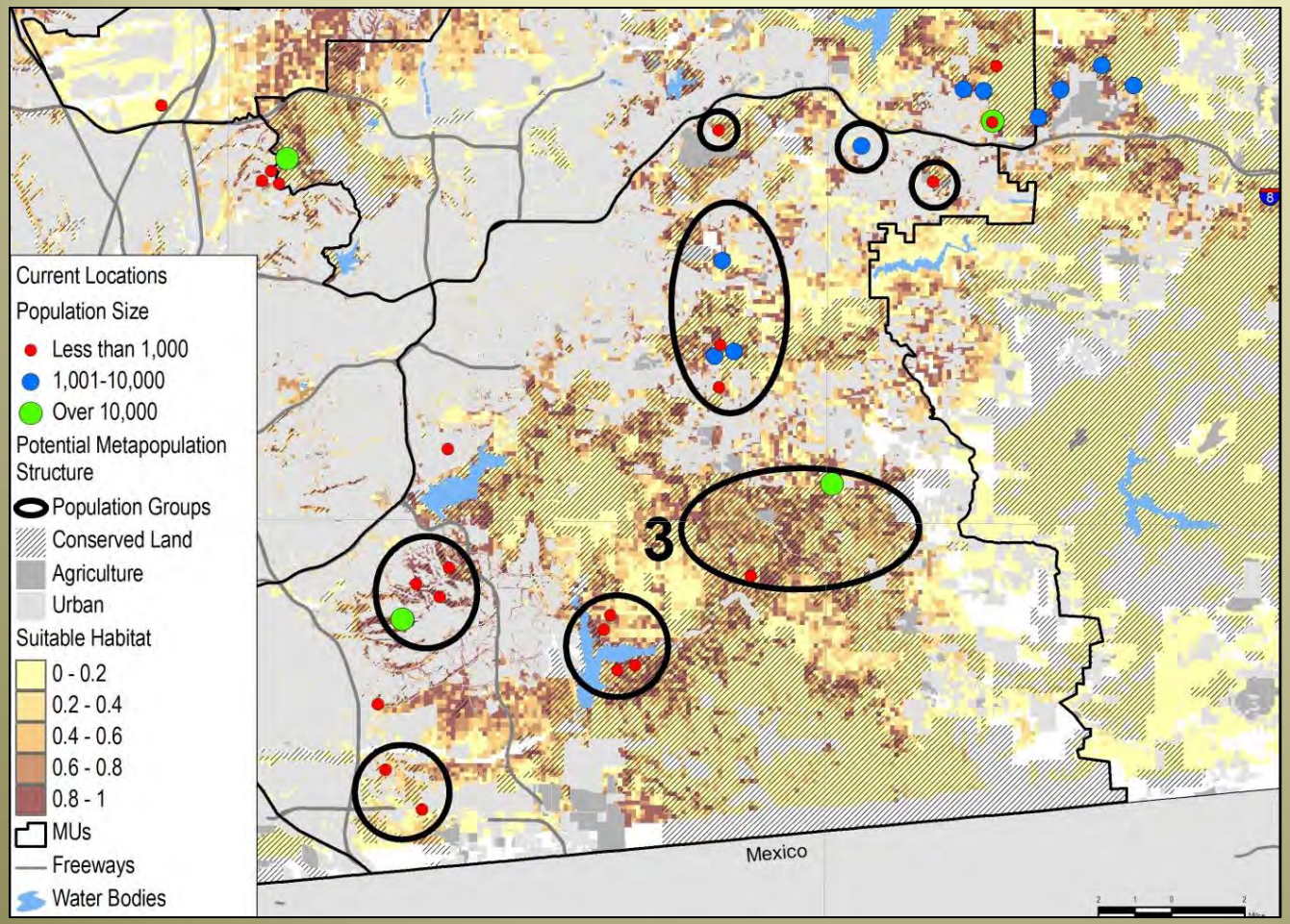
Regional Population Structure

Goal: Enhance resilience of ACIL within and among MUs

- Assumptions
  - Small populations more susceptible to extirpation, esp. those with recent reductions in population size.
  - Relatively low levels of gene flow may be sufficient to offset effects of genetic drift in small populations.
  - Small populations more likely to receive gene flow from large populations than from other small ones, even if latter are closer.
  - Gene flow should be maintained at ± historic levels.

    (e.g., Menges 1991, Ellstrand & Elam 1993)

Potential Population Structure



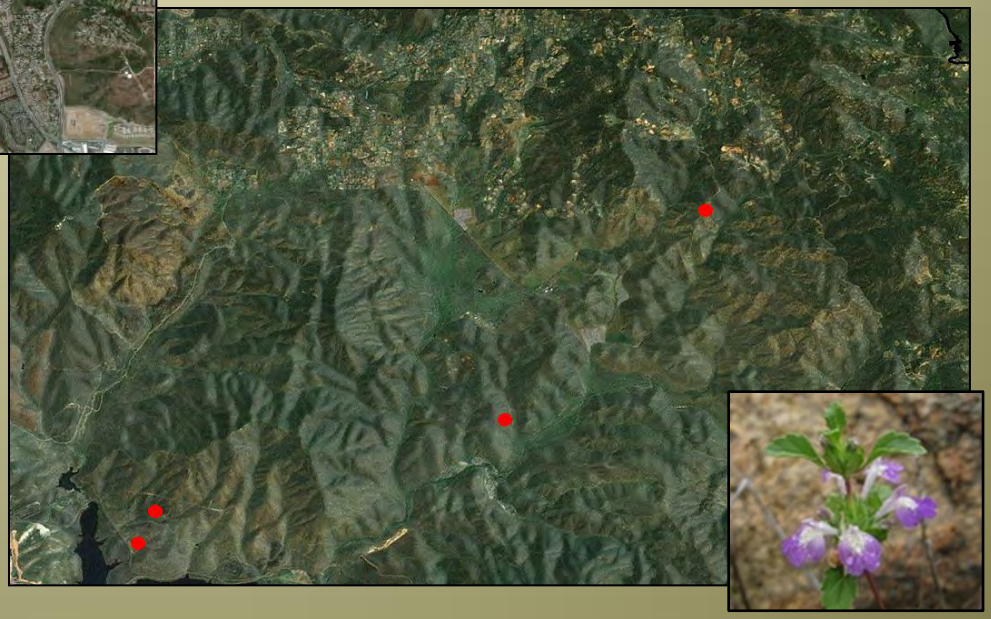
- Assess population size, threats, and degree of connectivity within population groups.

- Genetic studies will help refine hypothesized population structure.

Potential Habitat Connectivity

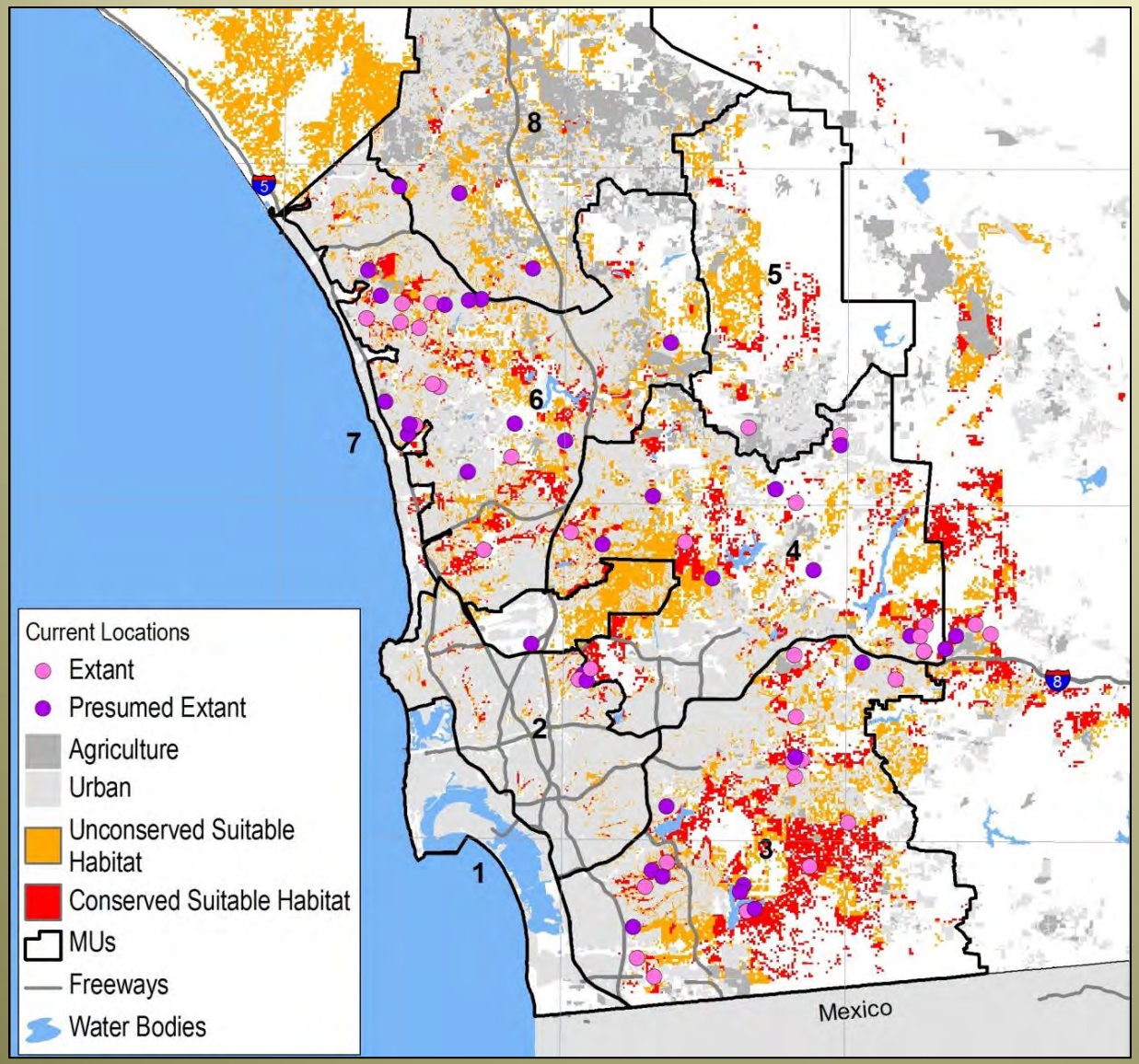
Fragmented Landscape

Large Distance between Populations



- Identify gaps within/between population groups
- Use habitat suitability model to id potentially suitable habitat (ACIL, pollinators)

Opportunity Areas



- Focused surveys
- Habitat connectivity
- Population expansion
- Acquisition?

Next Steps – Regional Level

- Identify areas of potential habitat on conserved lands that are priorities for survey, including "presumed extant" populations.
- Test soils of all populations to examine soil affinities.
- Determine if there are other annual endemic plants that could function within a similar conceptual model as ACIL.
- Develop standardized monitoring protocol.
- Conduct research on effective pollinators, seed bank dynamics, and fire response.
- Refine regional population structure hypotheses based on genetic studies.
- Identify potential climate change impacts (e.g., Conlisk et al. 2012).
- Identify:
  - Populations to monitor regularly as "sentinels."
  - Isolated populations that may serve as refugia.
  - Isolated populations not prioritized for management.
  - Enhancement areas, by Management Unit.

Next Steps – Preserve Level

- Identify invasive species and other threats and assess their impacts.
- Validate vegetation alliances and associations.
- Survey potentially suitable habitat.
- Test soils underlying ACIL populations.
- Monitor germination and population size.

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