Protecting and Managing California Valley Oak in the Face of Climate Change

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Collaborators

- **Genetic and GIS modeling**
  - Frank Davis (UCSB)
  - Delphine Grivet (UCLA/Spain)
  - Peter Smouse (Rutgers)
  - Bob Westfall (US Forest Service)
- **GIS climate modeling**
  - UCSB: Frank Davis, Lee Hannah, Lydia Ries, Changwan Seo
  - UC Davis: Jim Thorne

Contemporary distributions of major oak species in California:

- Blue oak
- Valley oak
- Coast live oak

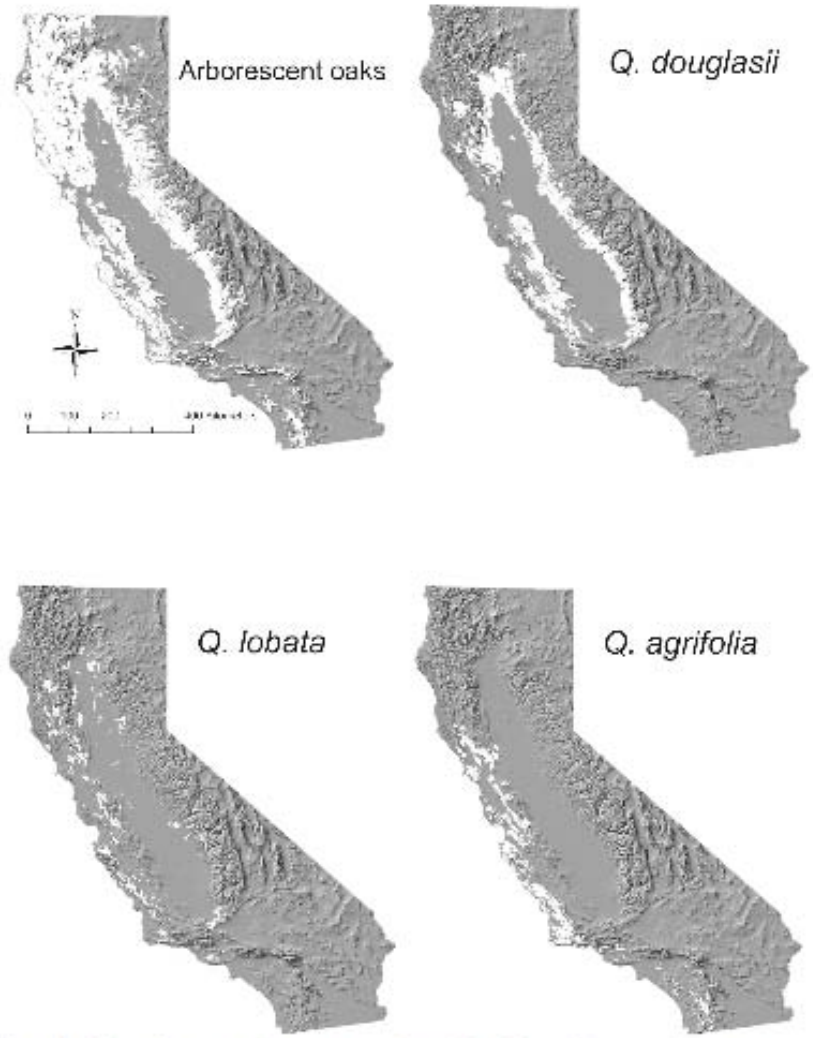
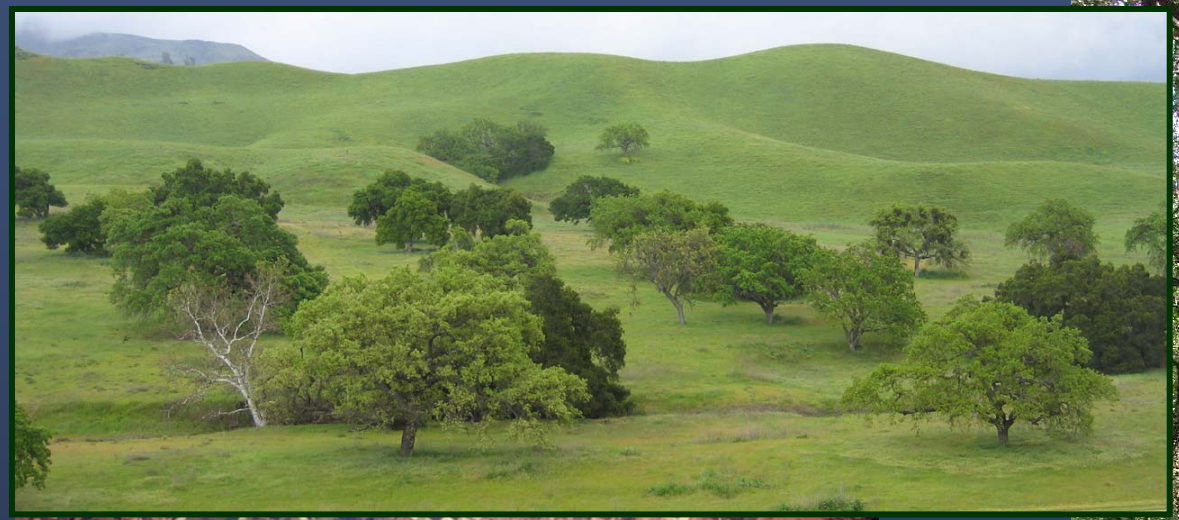


FIGURE 1. MODERN GEOGRAPHIC DISTRIBUTION OF CANOPY-SIZED OAKS IN CALIFORNIA (AREAS OF OCCURRENCE IN WHITE)

Data from Davis et al. 1988. A) All nine arborescent species combined; B) *Q. douglasii*, blue oak; C) *Q. lobata*, valley oak; D) *Q. agrifolia*, coast live oak.

Landscapes of valley oak



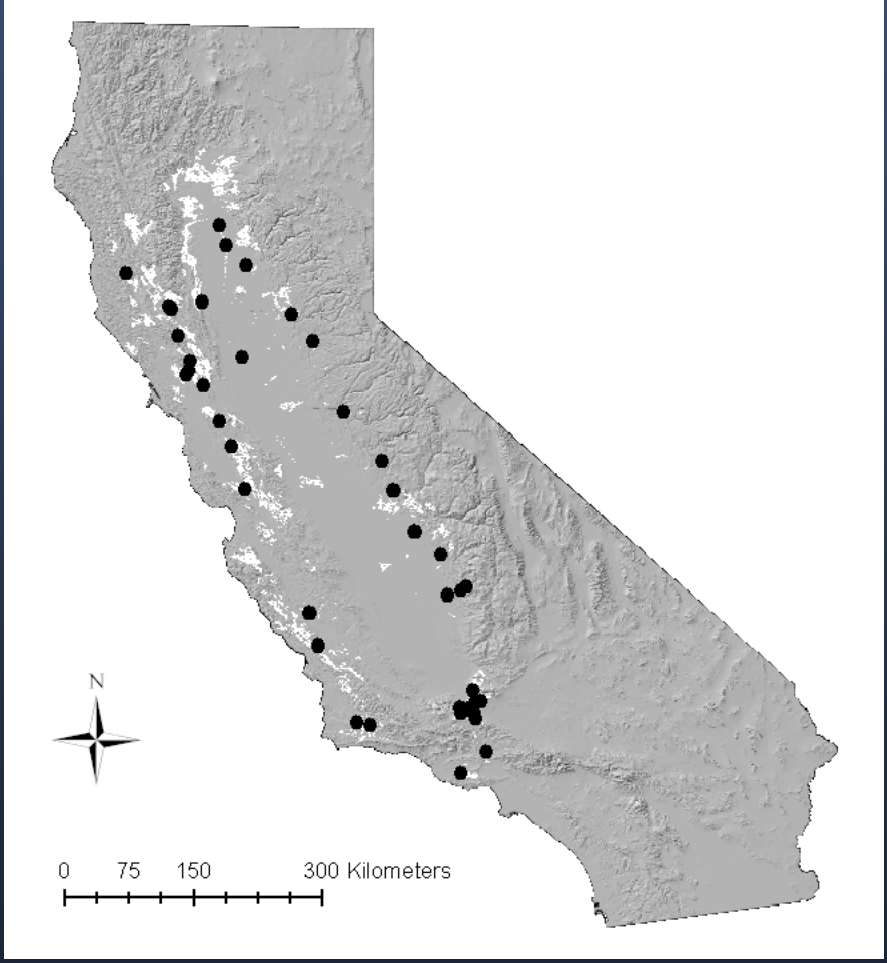
Distribution of California valley oak (*Quercus lobata*)

Natural history of California valley oak

Dispersal agents of valley oak

Part I.
Geographical genetic patterns & areas of evolutionary interest

Methods: sampling and markers



Chloroplast data set

- 32 sites
- 97 individuals
- 6 cp microsatellite primers

Nuclear dataset

- 37 sites
- 113 individuals
- 7 nuclear microsatellite primers

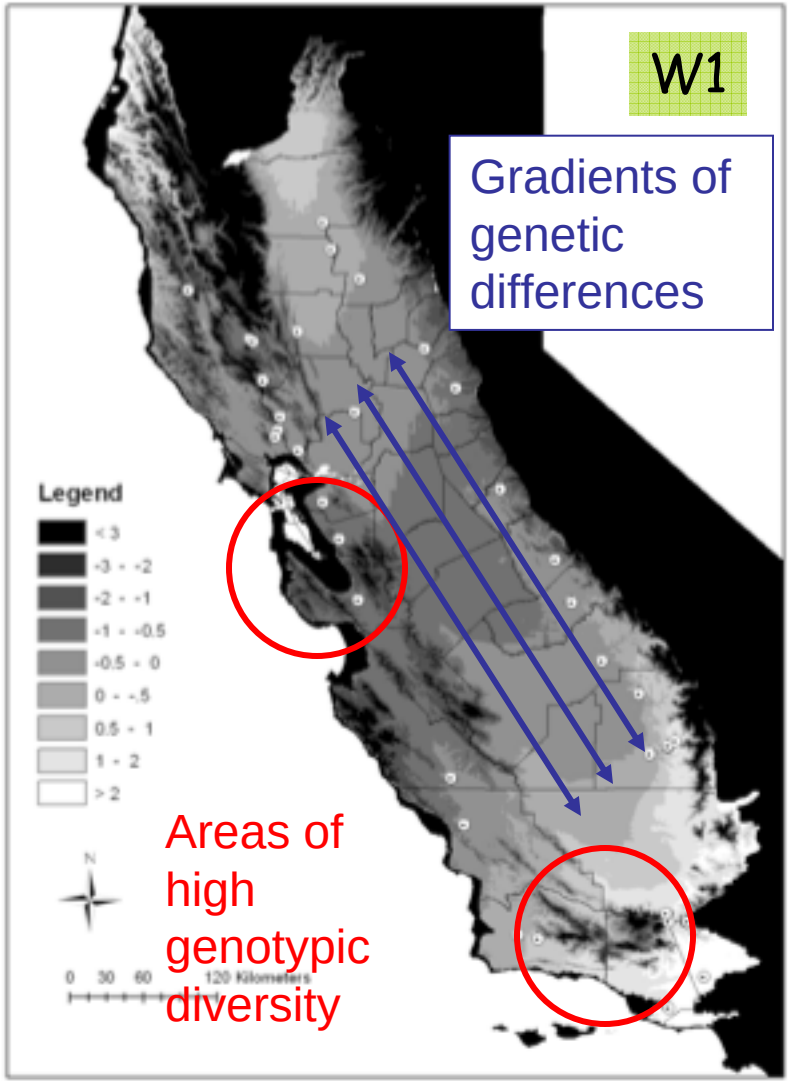
Statistical methods

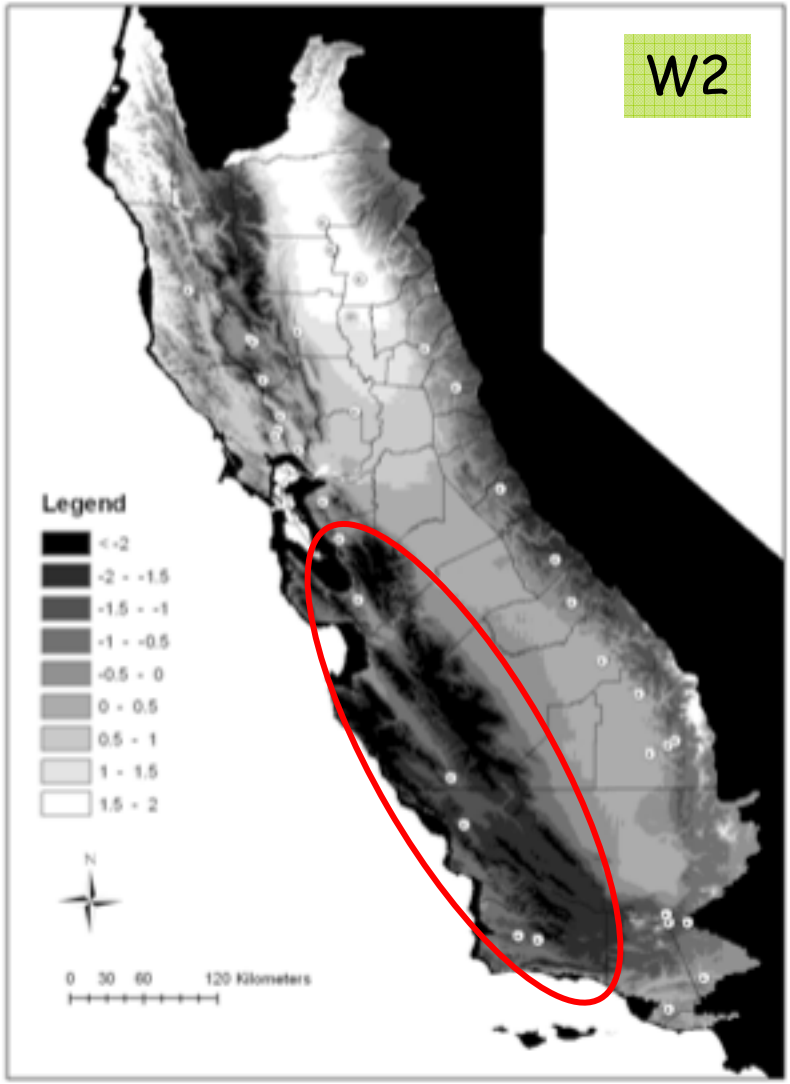
Canonical Correlation and Trend Analysis

Step 1: Correlate genotypic variables with spatial variables

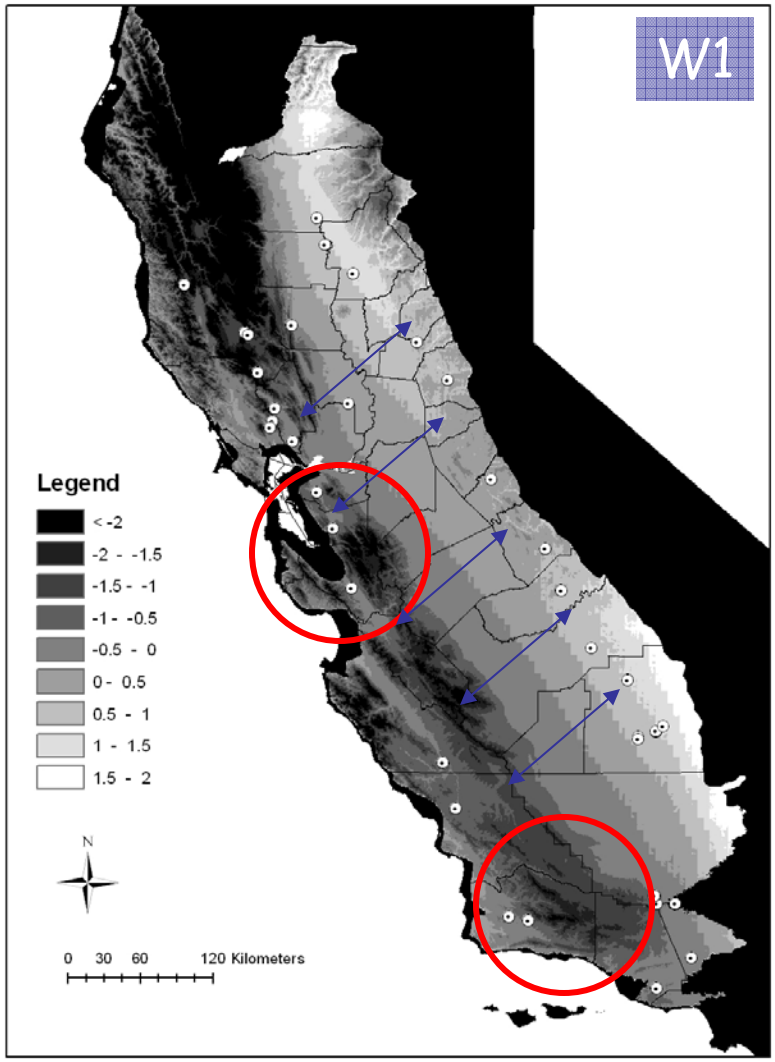
Step 2: Create a model with all parameters that is projected on a map

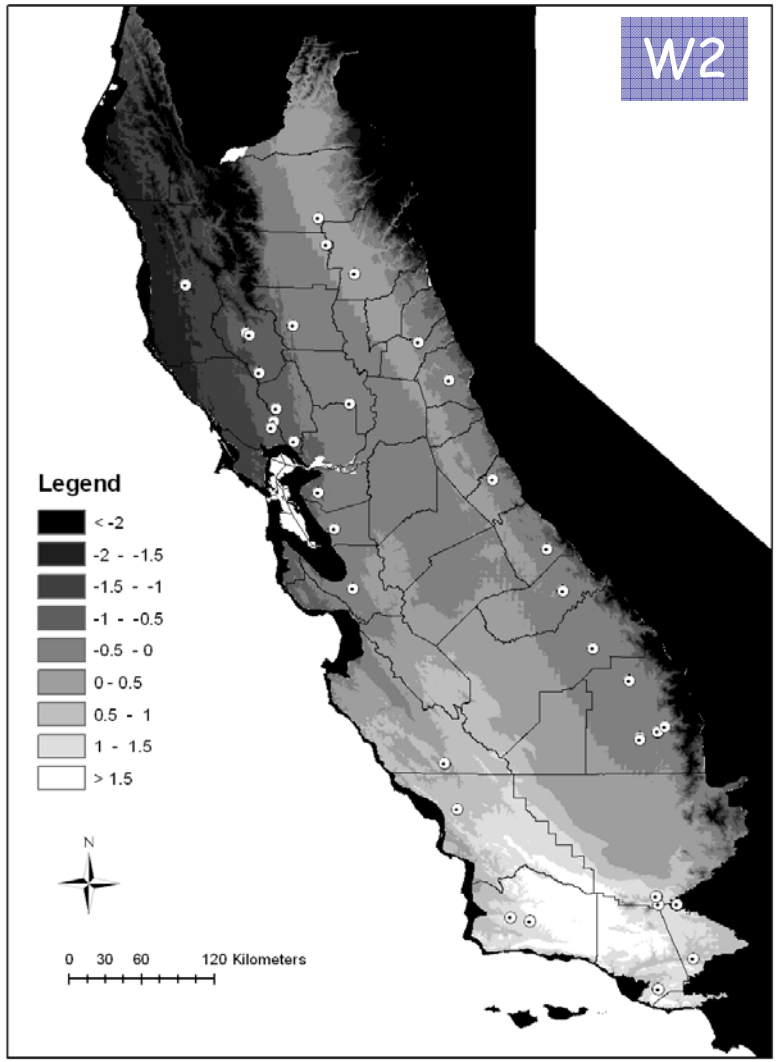
Canonical trend of chloroplast genotypes overlaid on valley oak distribution





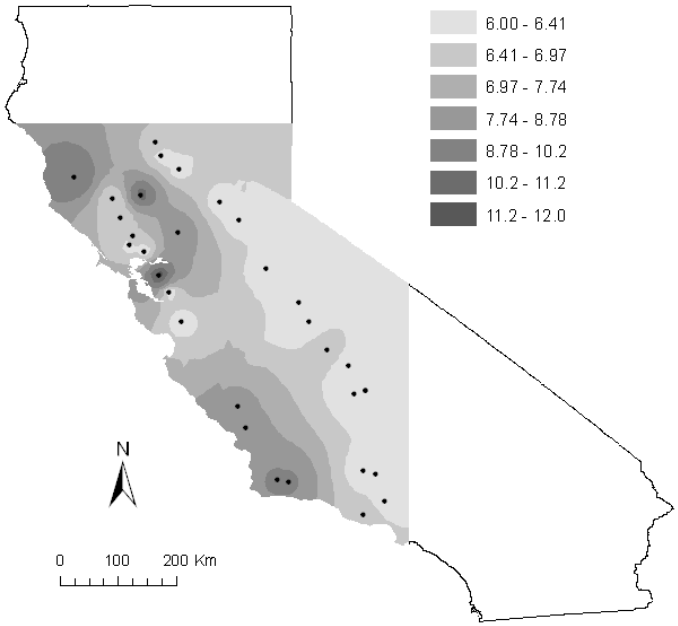
Canonical trend of nuclear genotypes overlaid on valley oak distribution



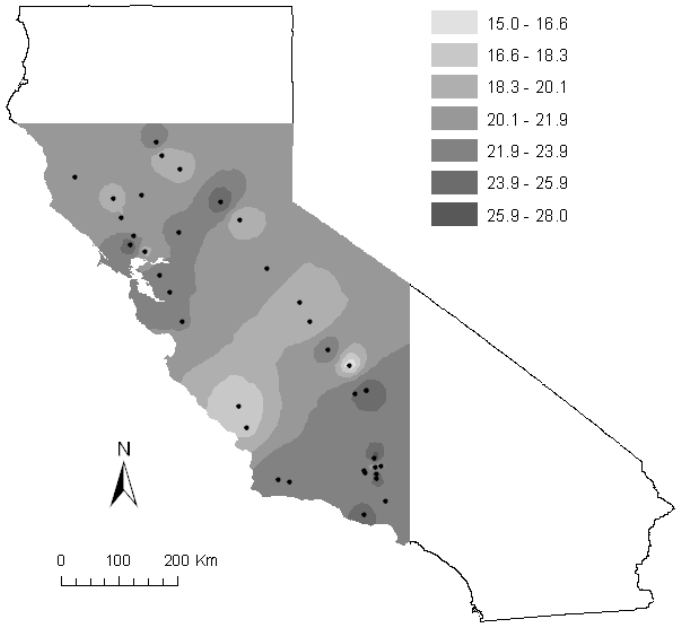


Geographic trends in allelic richness

Cp alleles per site



Nuclear alleles per site



Evolutionary Considerations

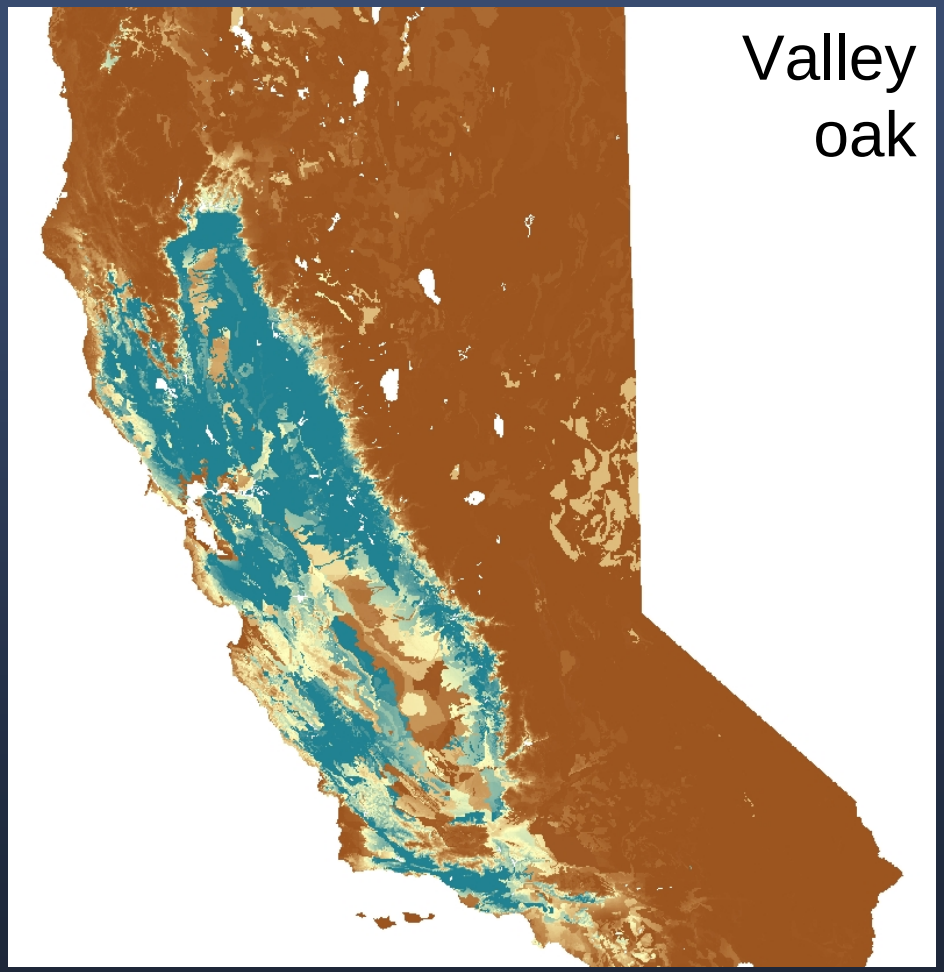
- Areas of high diversity
  - Bay area
  - Southern California
- Areas of genetic differentiation
  - East v West
  - North v South

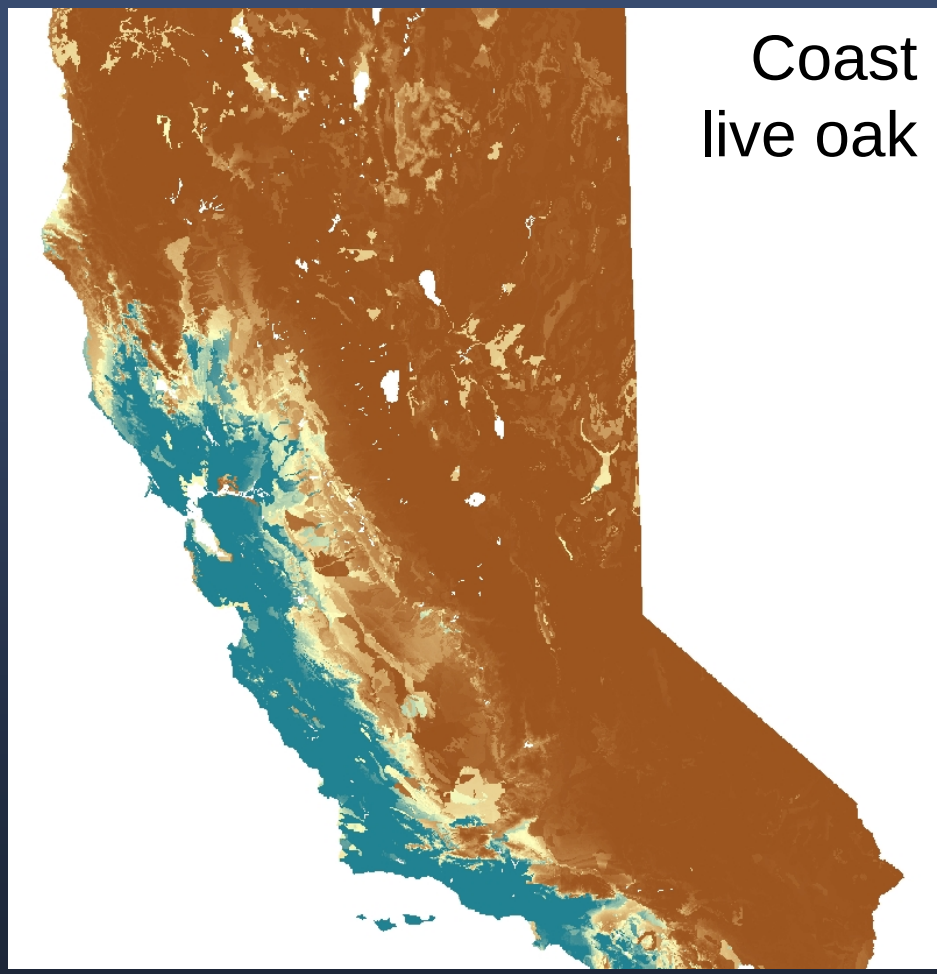
Part II.
California oak reserve design in the face of climate change

Strategies for reserve network design of California valley oak

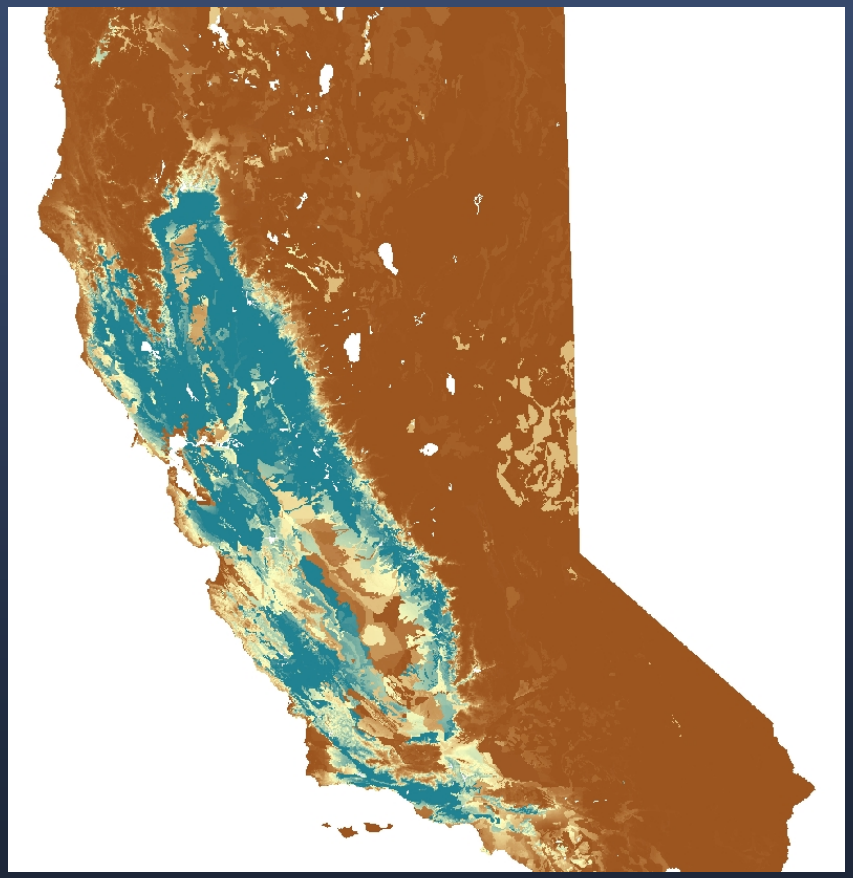
- Ecological criteria
- Geographical criteria
- Areas of threat
- Opportunity and cost
- **Evolutionary history and potential**
- **Climate change**

Predicted present distribution

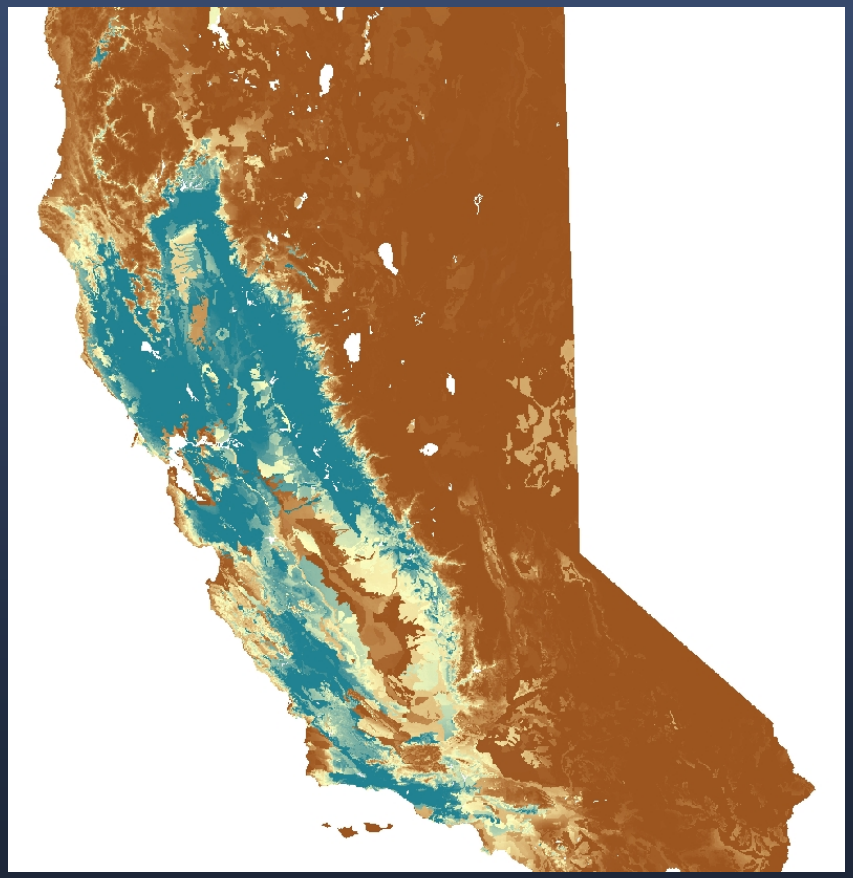




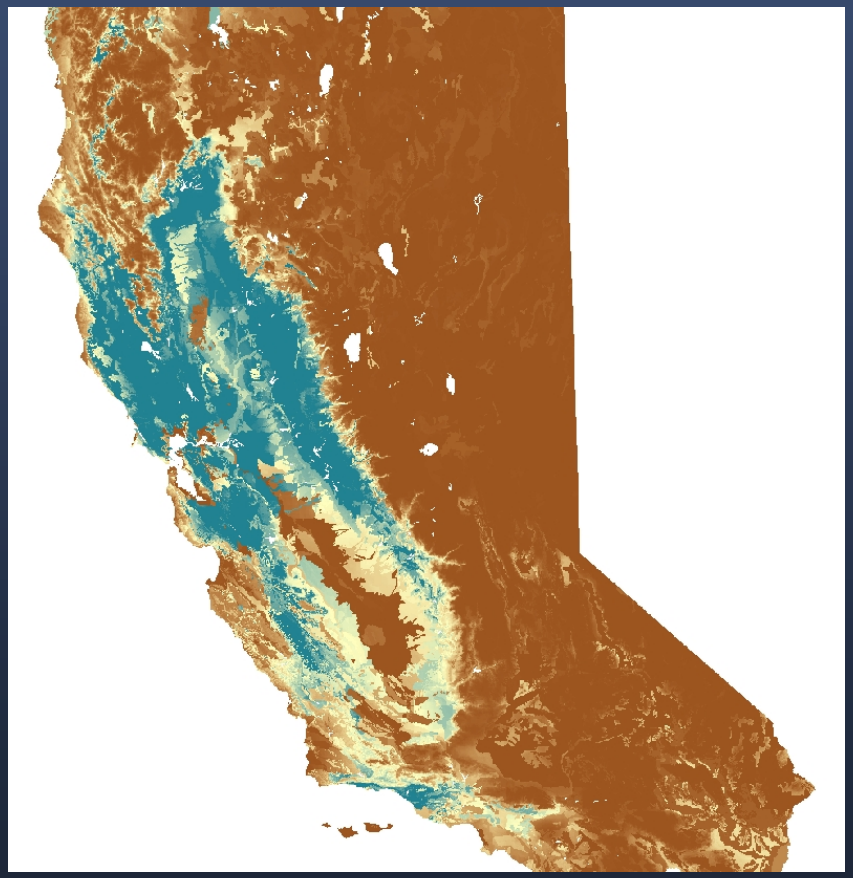
California valley oak: current



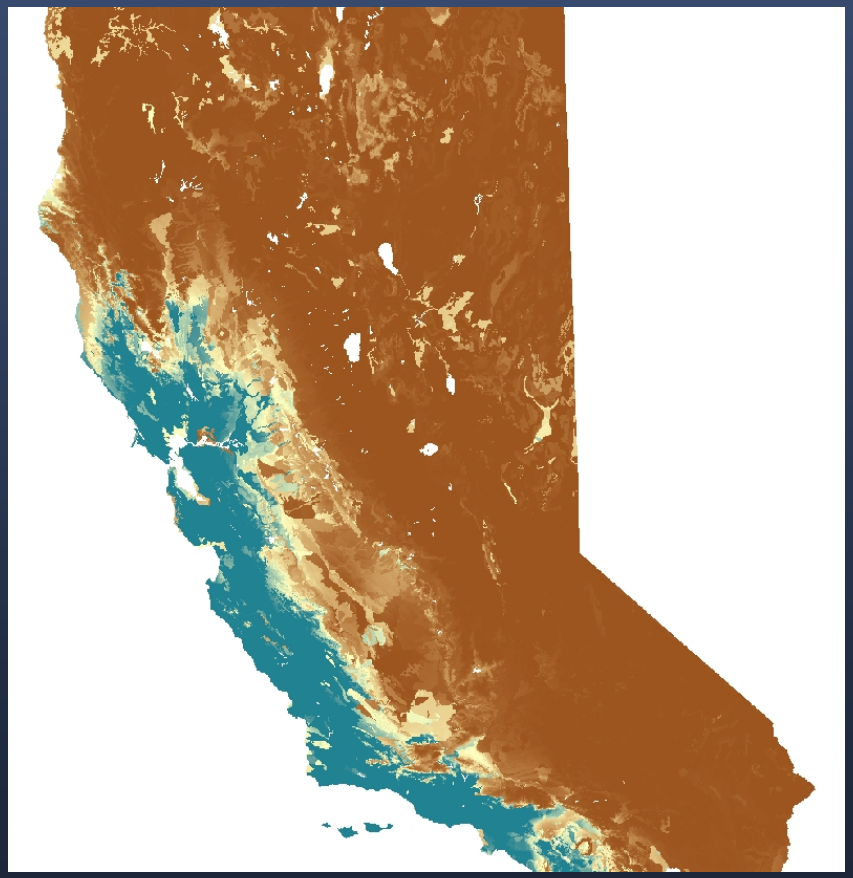
California valley oak: 2050



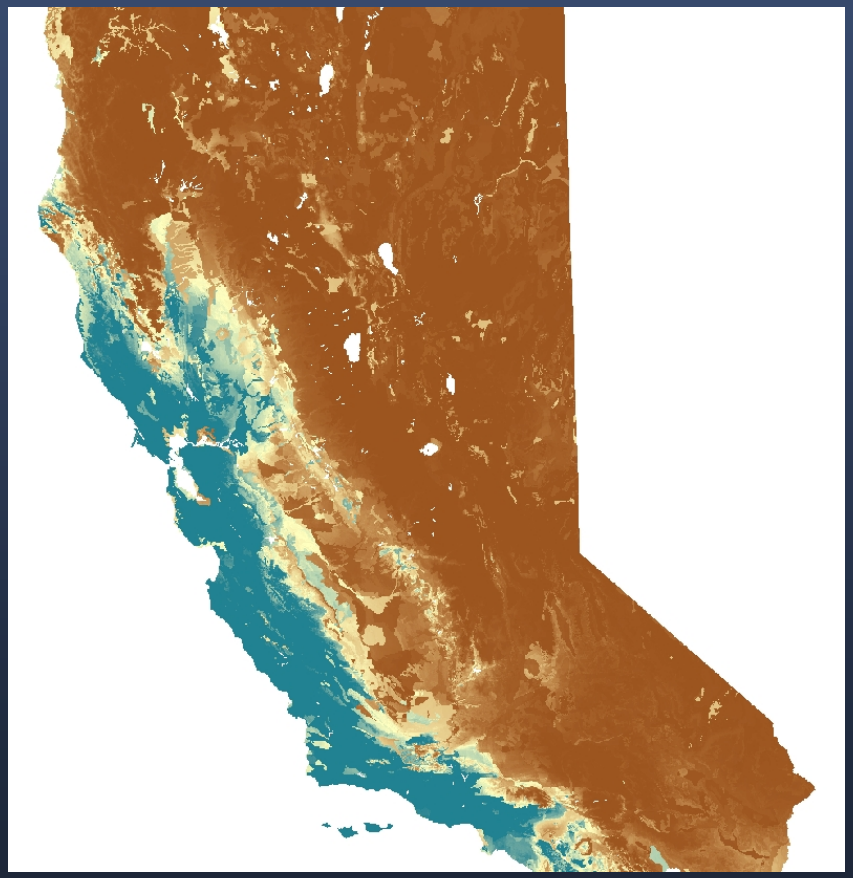
California valley oak: 2080



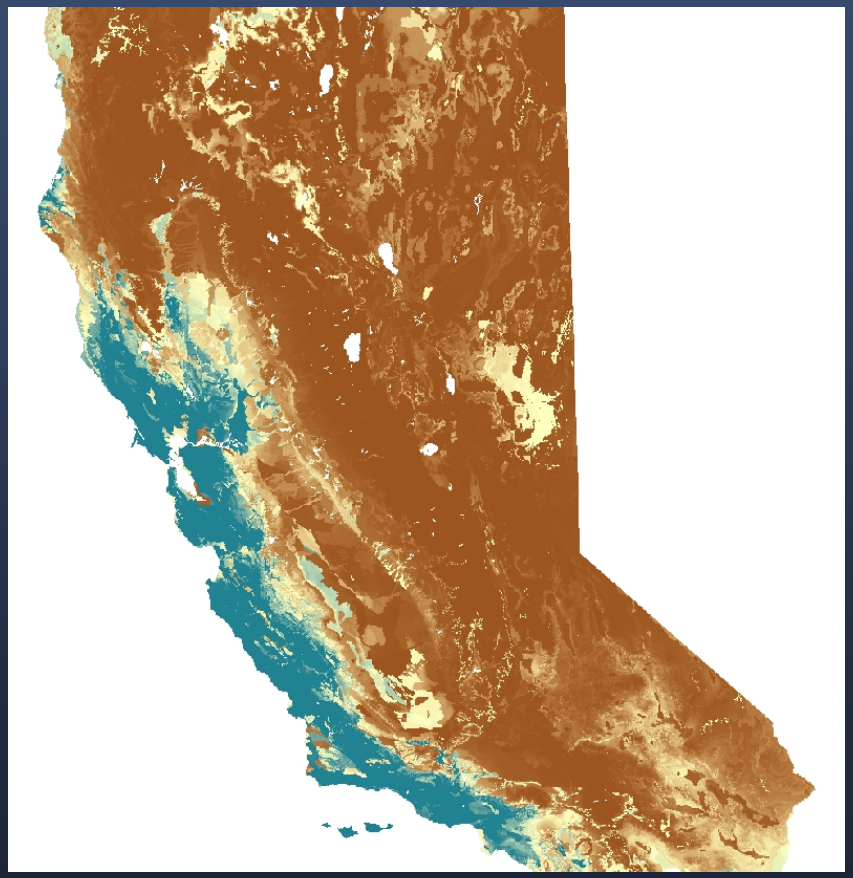
Coast live oak: current



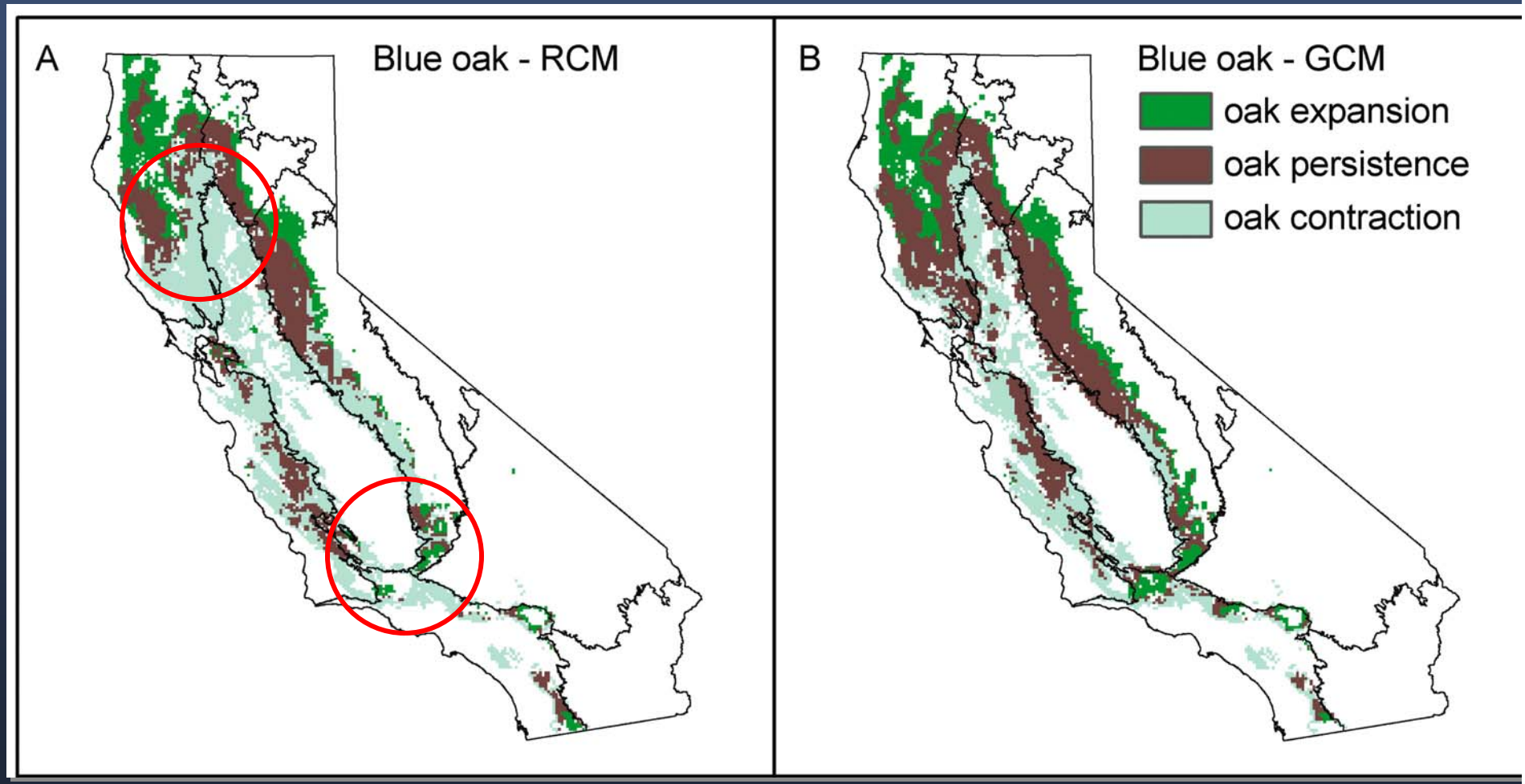
Coast live oak: 2050



Coast live oak: 2080

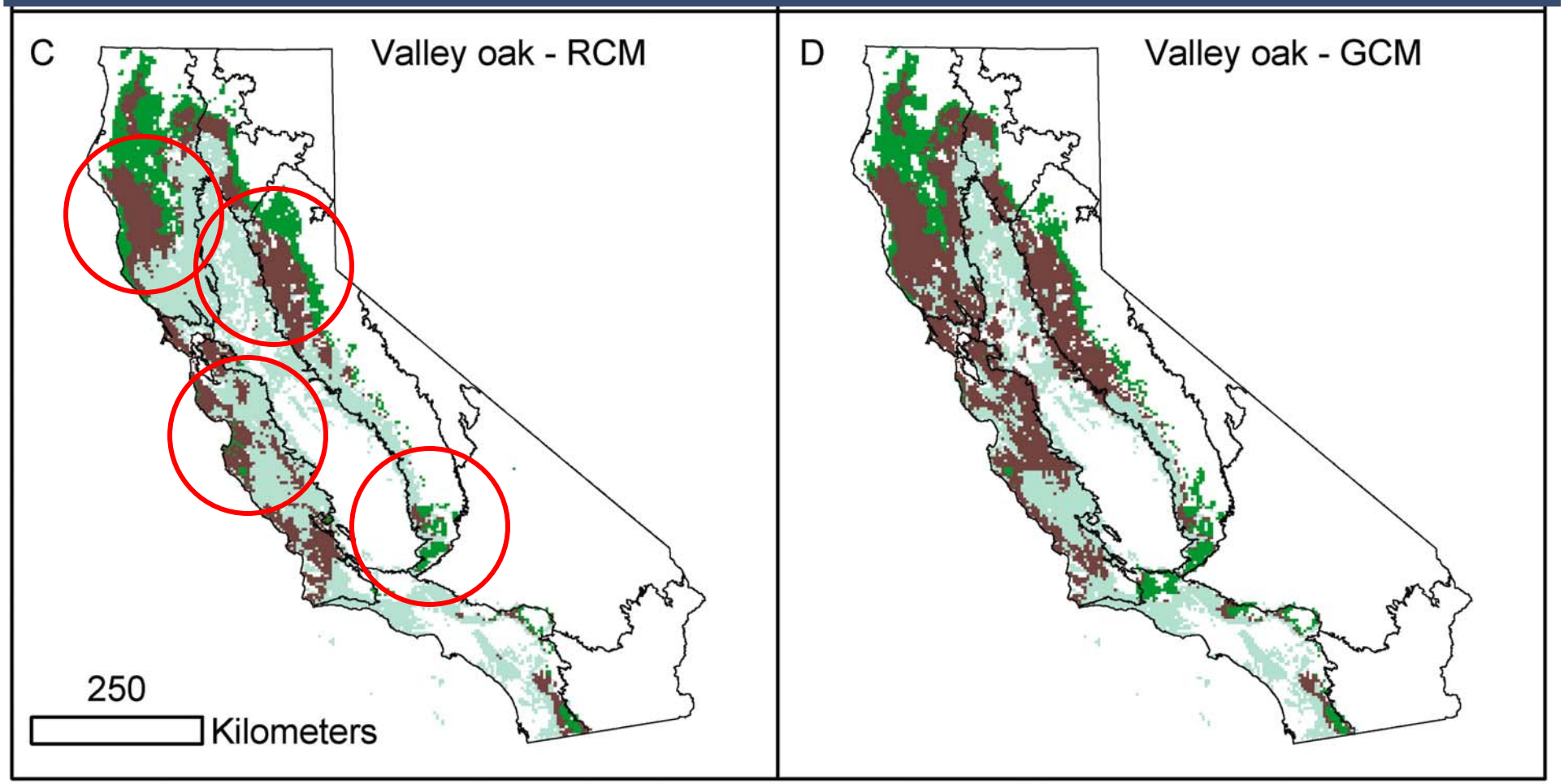


Blue oak: abundance change models



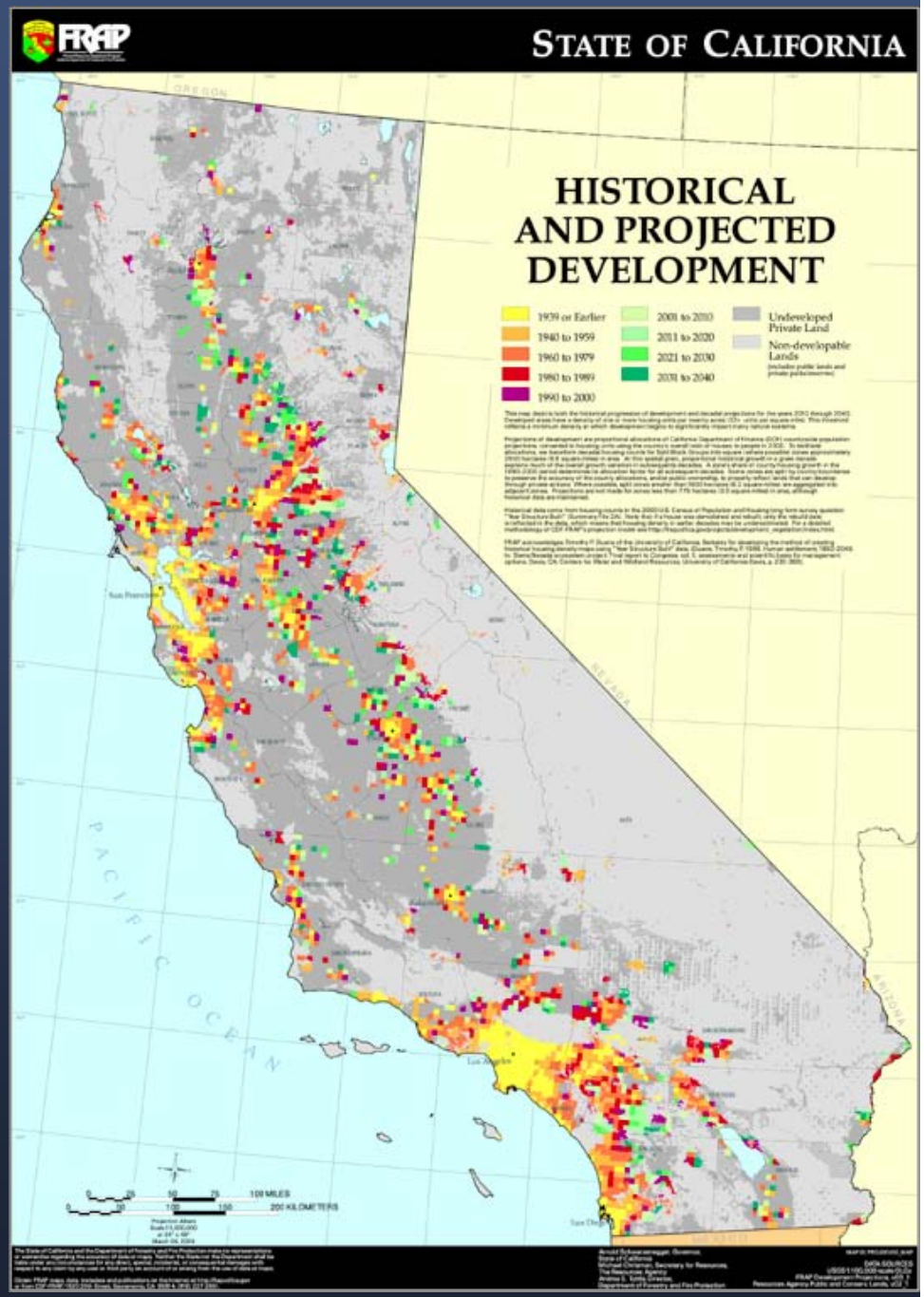
Source: (Kueppers et al. 2005)

Valley oak: abundance change models

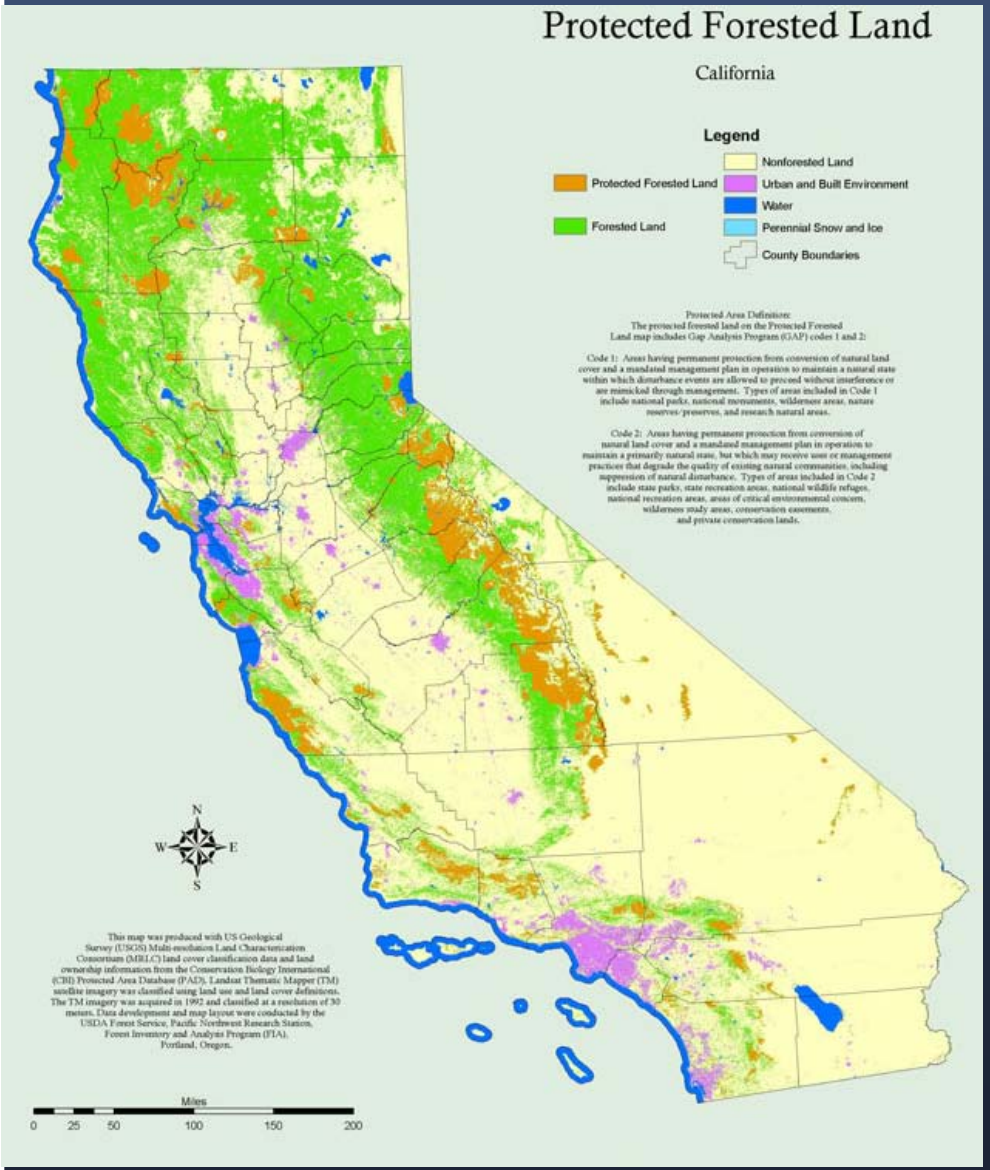


Source: (Kueppers et al. 2005)

Areas of evolutionary interest versus current threat



Protected areas versus Valley oak distribution



Recommendations about regions of high priority

1. Regions of high evolutionary interest that are under threat of development
2. Stands in southern California with connectivity into Tehachapis
3. Areas with elevational gradients in coastal and Sierran ranges.

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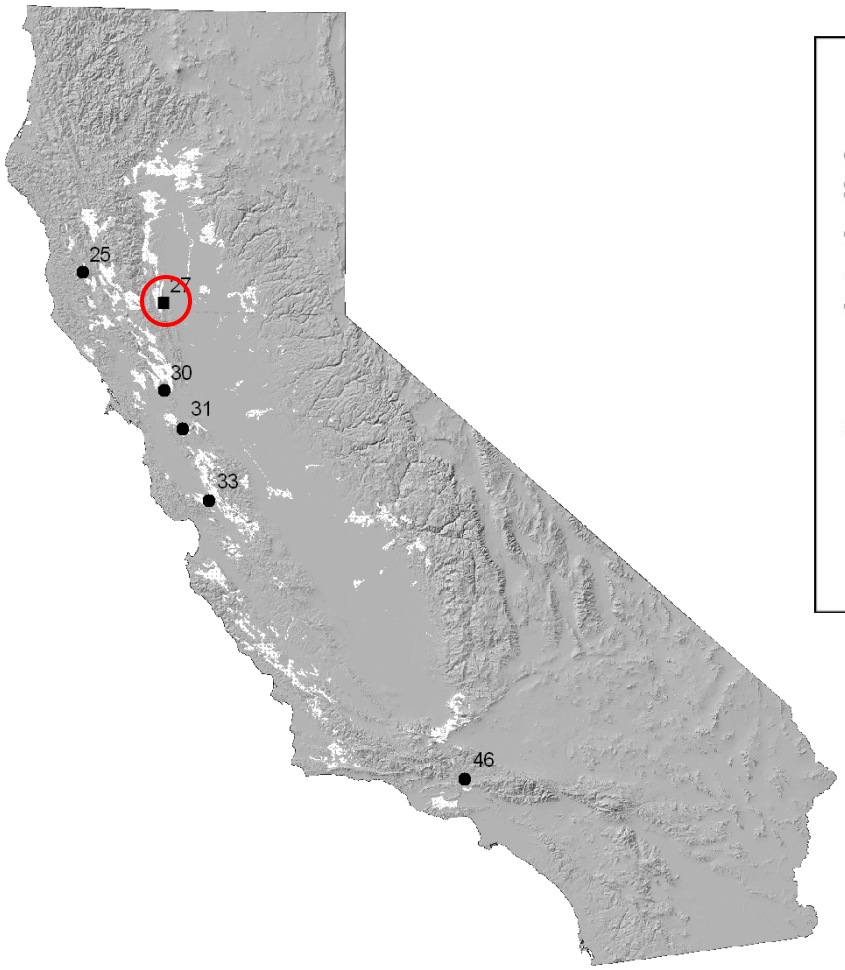
Reserve Design Example: Using valley oak genetic diversity

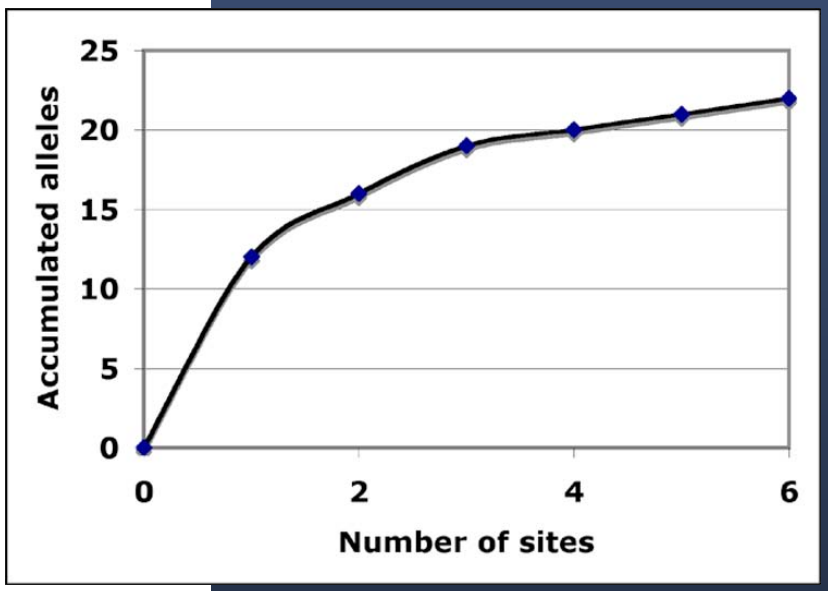
Maximum coverage approach

- MARXAN 1.8 reserve design software
- Minimum number of sites and
  maximum number of "alleles"
- Chloroplast haplotypes
- Nuclear alleles
- Combined model
- Analyses are based on simple model and no additional weightings (e.g. threat, cost, opportunity)

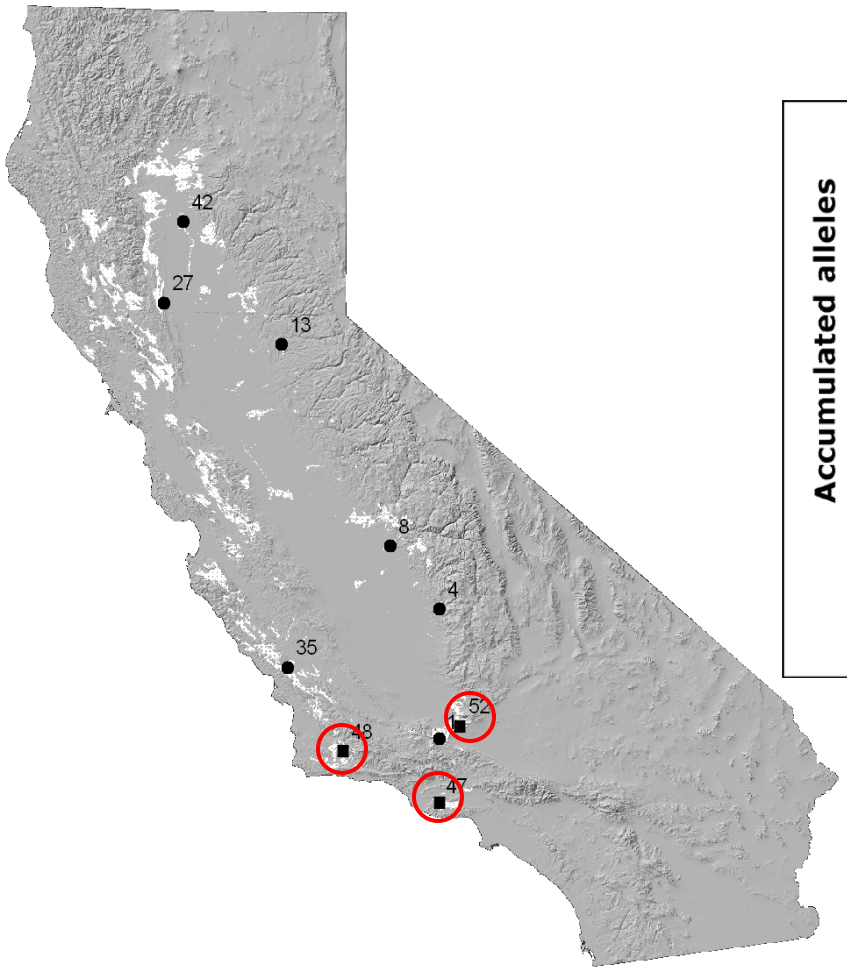
Sork, Grivet, Davis, In press

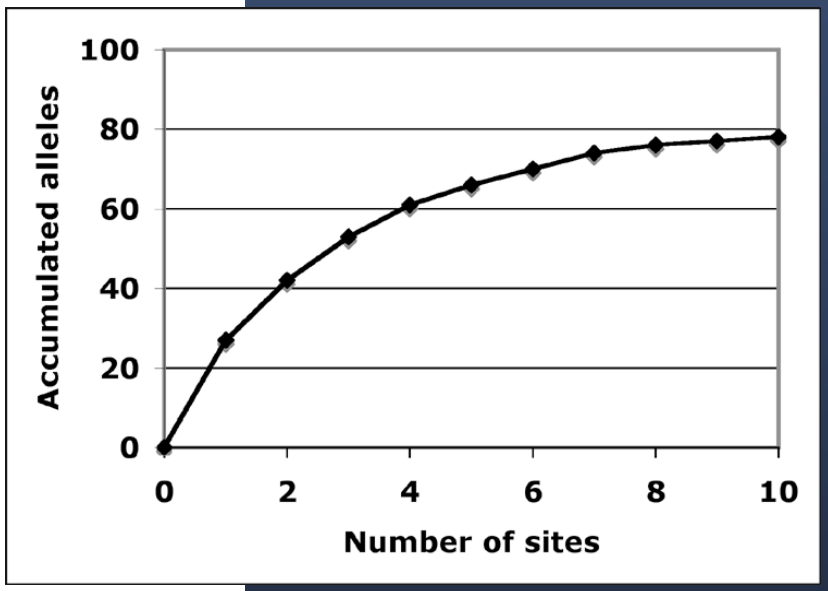
Results: chloroplast haplotypes



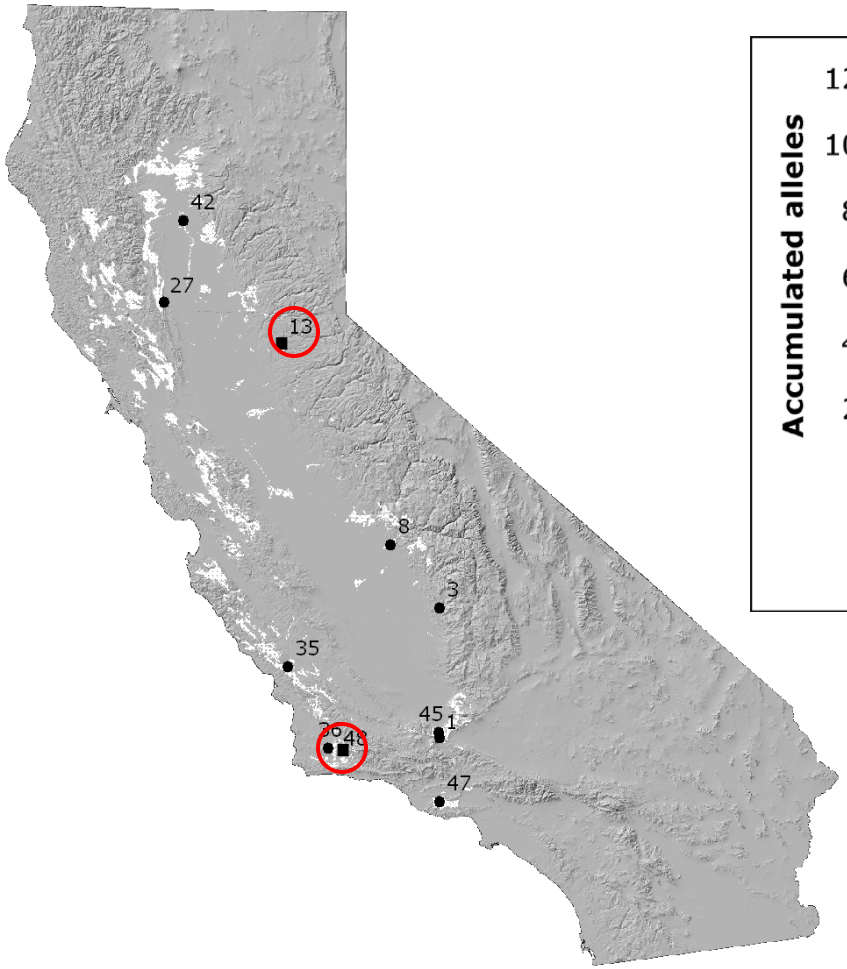


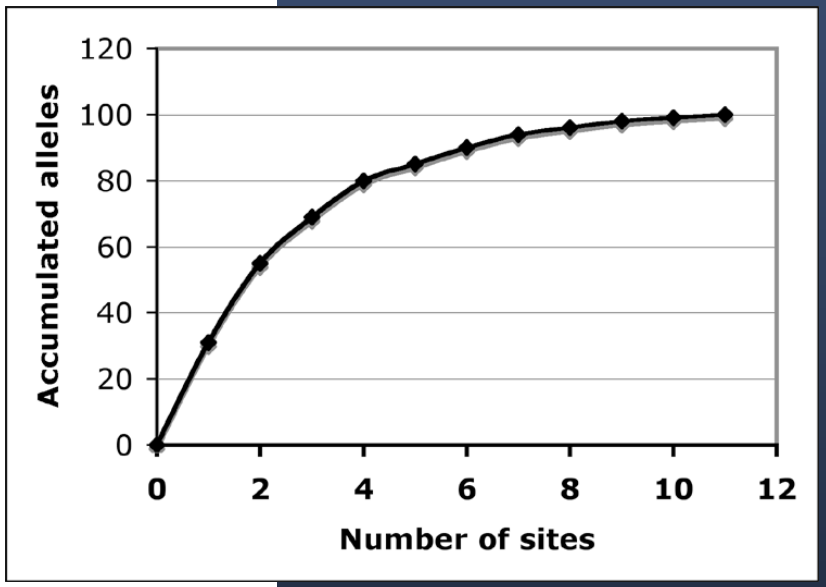
Results: nuclear alleles



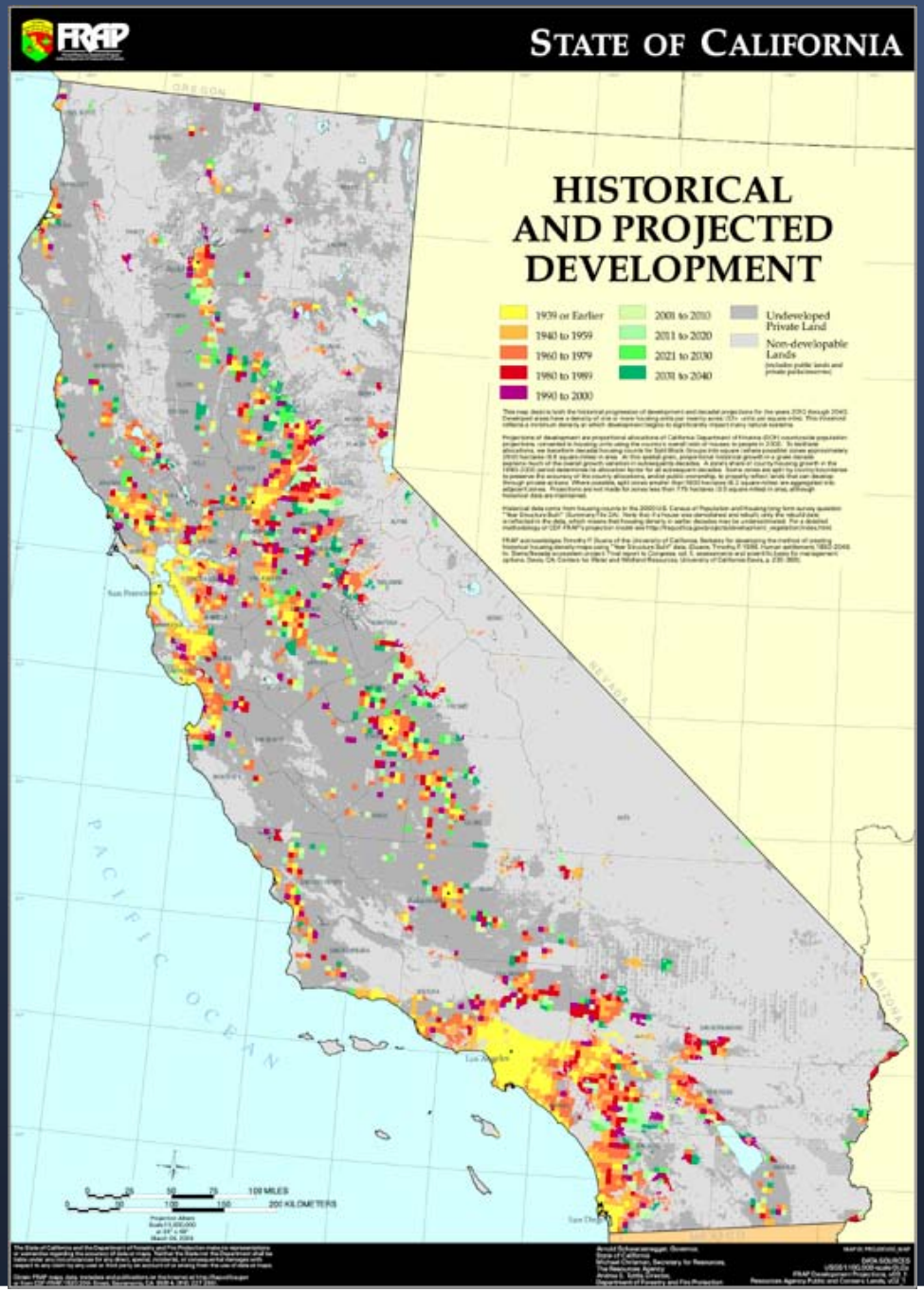


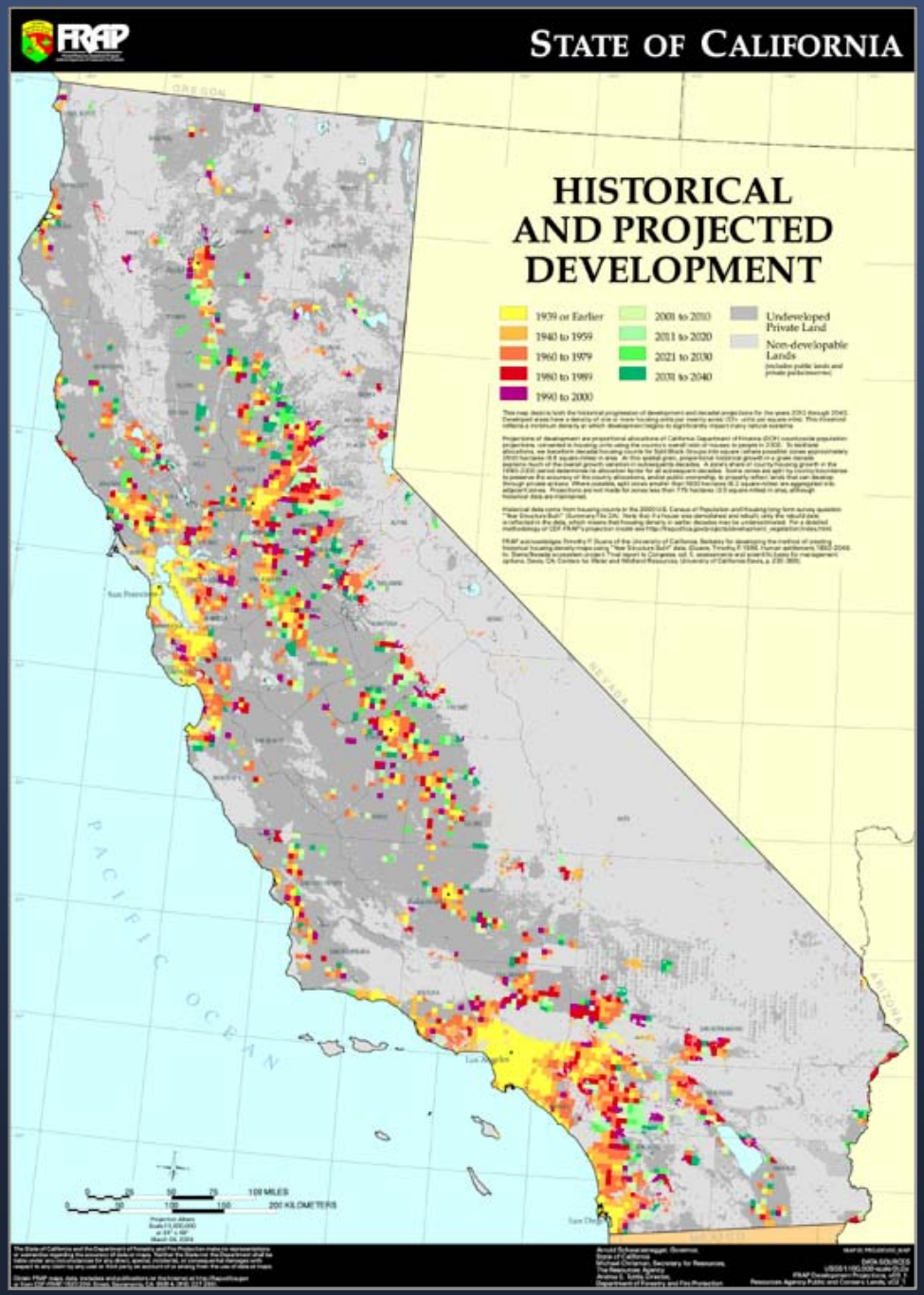
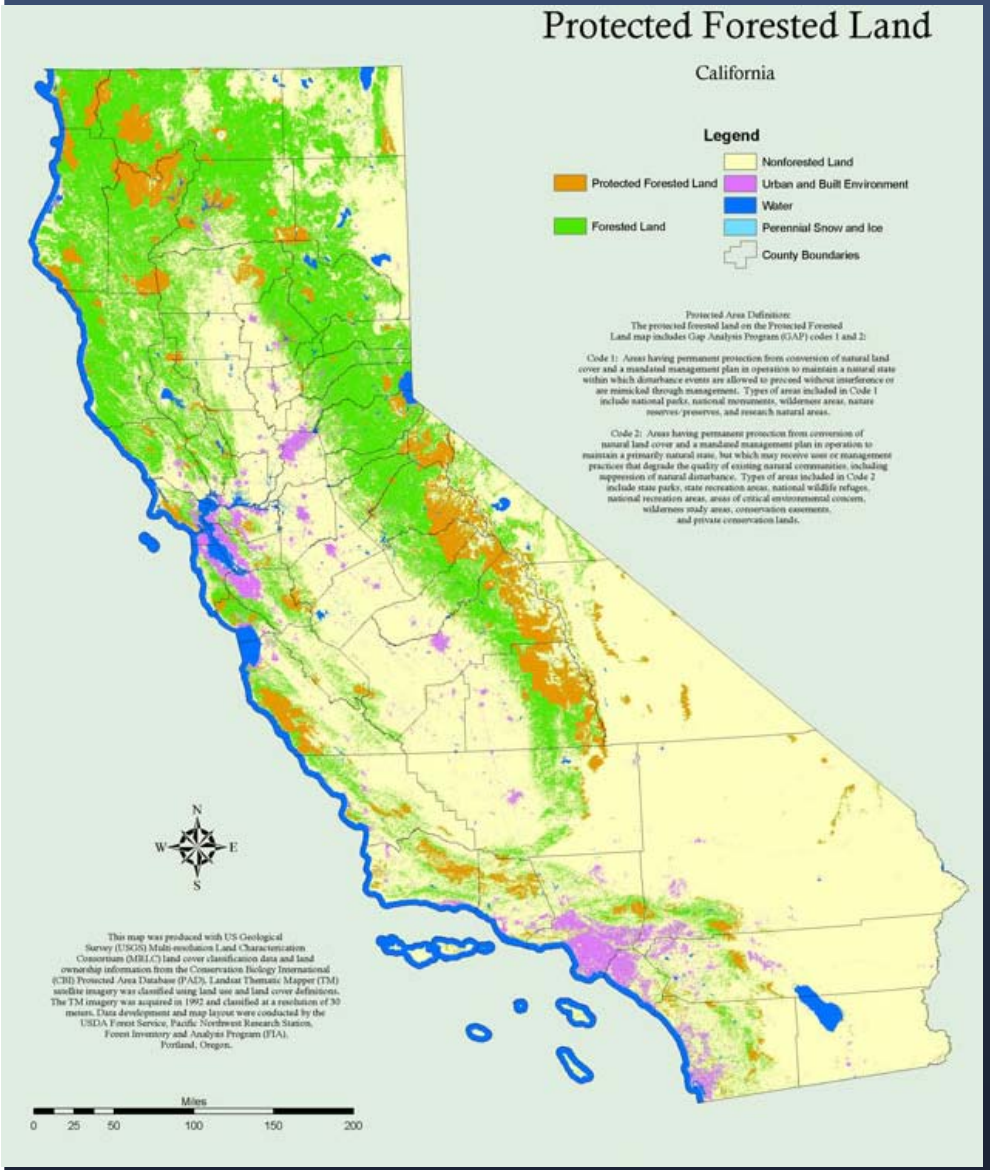
Combined marker model





The threat to California ecosystems




FRAP
STATE OF CALIFORNIA
HISTORICAL AND PROJECTED DEVELOPMENT
1939 or Earlier
1940 to 1959
1960 to 1979
1980 to 1989
1990 to 2000
2001 to 2010
2011 to 2020
2021 to 2030
2031 to 2040
Undeveloped Private Land
Non-developable Lands
OREGON
NEVADA
ARIZONA
PACIFIC OCEAN
100 MILES
200 KILOMETERS

Is Valley oak currently in protected areas?