Herbaria, their data, and data uses

Plant Diversity and specimen types

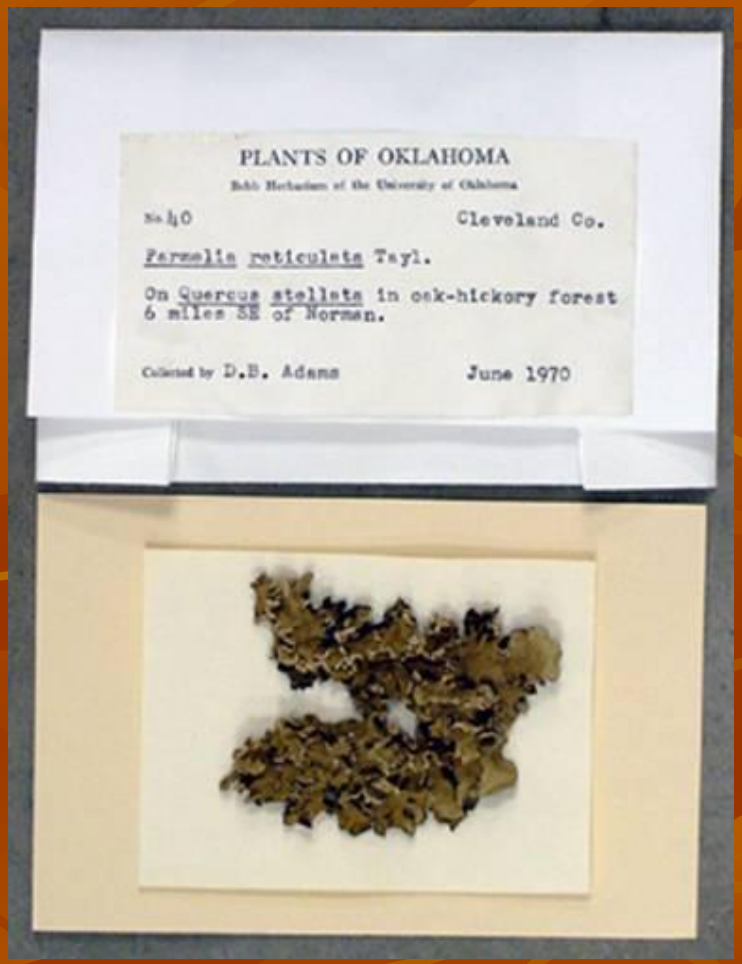
- Aquatic plants-marine and freshwater
- Terrestrial non-vascular plants

I. Bryophytes: Mosses and liverworts: Unmounted in packets

II. Vascular plants:

1. Mounted on paper sheets-labels
2. Pollen and spores: slides-data related to sheets
3. Wood: Unmounted: data related to sheets
4. Seeds: Unmounted in vials: data related to sheets
5. Pickled in jars: stems and flowers: related to sheets

Lichen specimen



Vascular plant specimen

Woody Angiosperm specimen

Herbarium collections

Species numbers- Described species

- Lichens: 17,000- fungi+algae
- Algae: Red and Green: ~10,000
- Bryophytes: ~16,000
- Vascular Plants: 311,000

Plant collecting

- Specimens collected in field, each taxon numbered and data recorded in field book.
- Specimen duplicates
- Pressed in Plant Press
- Dried, temp < 40^0 C
- Glued to special paper sheets, affix label with data from field notes
- Convert 3-dimensional organisms to 2-dimensional specimens as possible

Databasing

- Electronic capture of label data

  1. Manual entry: keystrokes

  2. Imaging of labels: Optical Character Recognition: Herbis, Salix etc.-not perfected
     Handwritten labels problematic

  3. Images of specimen

- Georeferencing of specimens

Data types

- Label data: Herbarium is a giant card file
  1. Locality
  2. Habitat
  3. Associated plants
  4. Pollinators
  5. Soil
  6. Date
  7. Collector and number

Data type

- Plant specimen

Data from non-destructive sampling

A. Phenotype

1. Morphology: micro and macro
2. Phenology: vegetative, flowering, fruiting

Data from Destructive Sampling

B. Genotype: DNA

C. Chemistry: chemical compds, stable isotopes

D. Anatomy-stomate density, C3 vs. C4

E. New data type

Future Collections

- Innovations in sampling- collection of “fragments”, pasted to 3X5 cards-DNA analysis for ID if necessary
- Collection of accessory material tied to vouchers for DNA, Stable Isotope Analysis

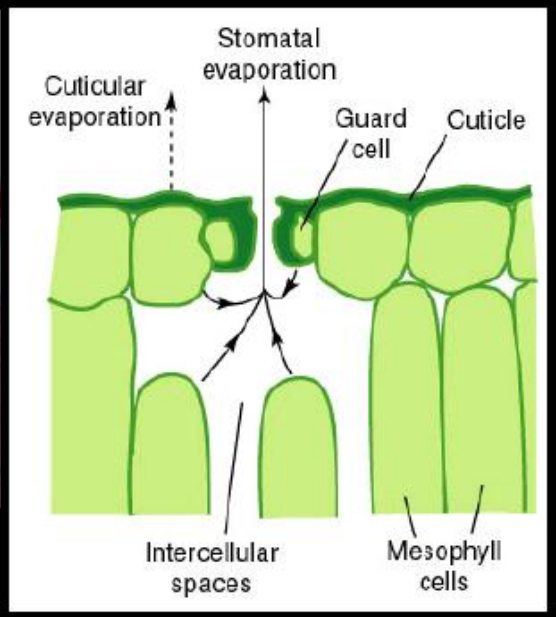
Future of Herbarium

- Image analysis: lessening need for loans but not eliminating
- Overlaying databased information of plant specimens with those of consumers (herbivores, pollinators, pathogens)
- Destructive sampling of specimens to analyze fungal, bacterial, and viral endophytes.
- Modeling
- Combining specimen databases with non-specimen databases

Non-traditional uses of herbarium specimens

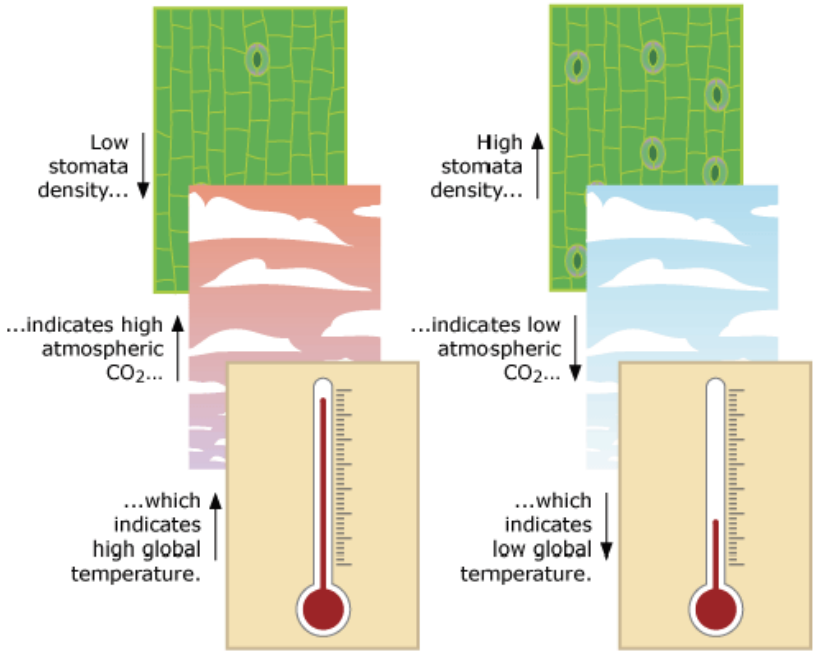
- functional Morphology(*Ephedra)*
- phenology and climate change (D. Ackerly - UC Berkeley)
- georeferencing and distribution modeling (D. Ackerly - UC Berkeley)
- connecting specimen and non-specimen databases

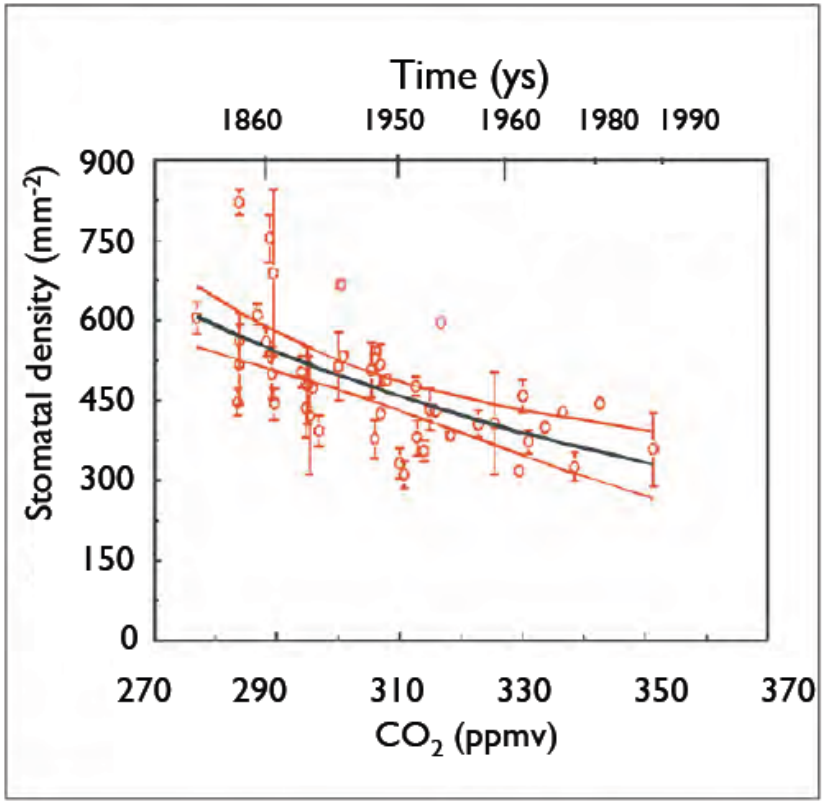
Stem anatomy



Climate Change

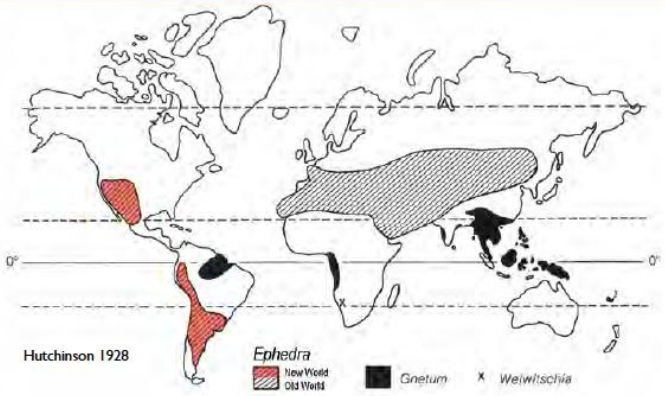
Stomatal Density and CO_2 / Climate

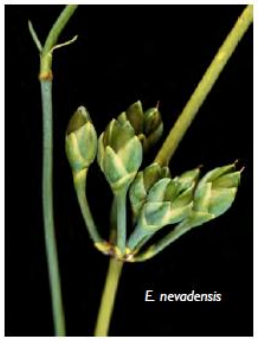


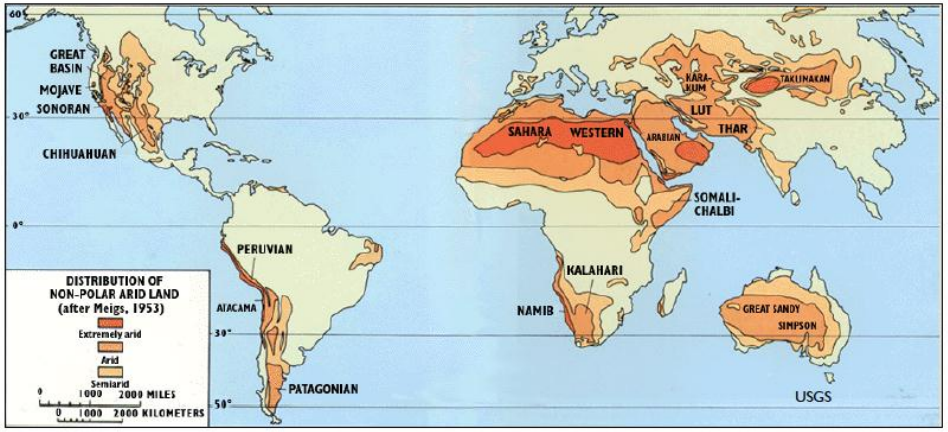


Biogeogaphic Analysis

Biogeographic Distribution and Deserts





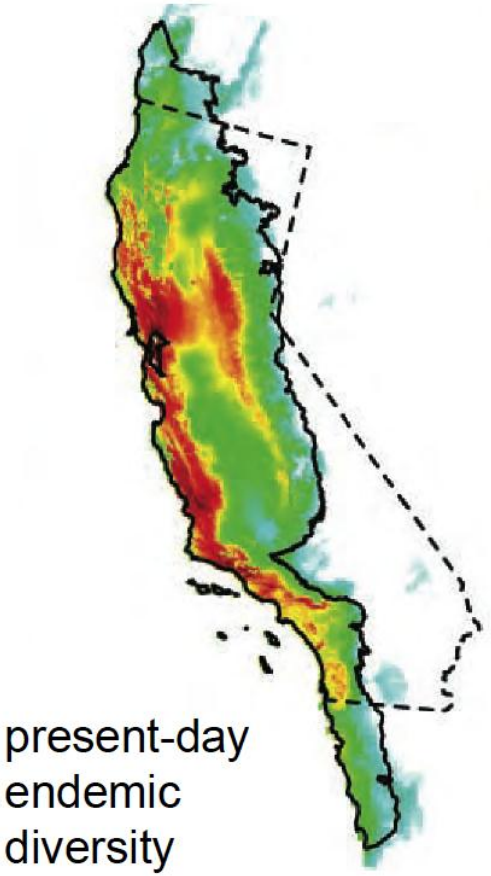


***Hyperarid**
(P/PET < 0.03)

***Arid**
(P/PET ranges from 0.03 - 0.2)

***Semiarid**
(P/PET ranges from 0.2-0.5)

Climate change modeling



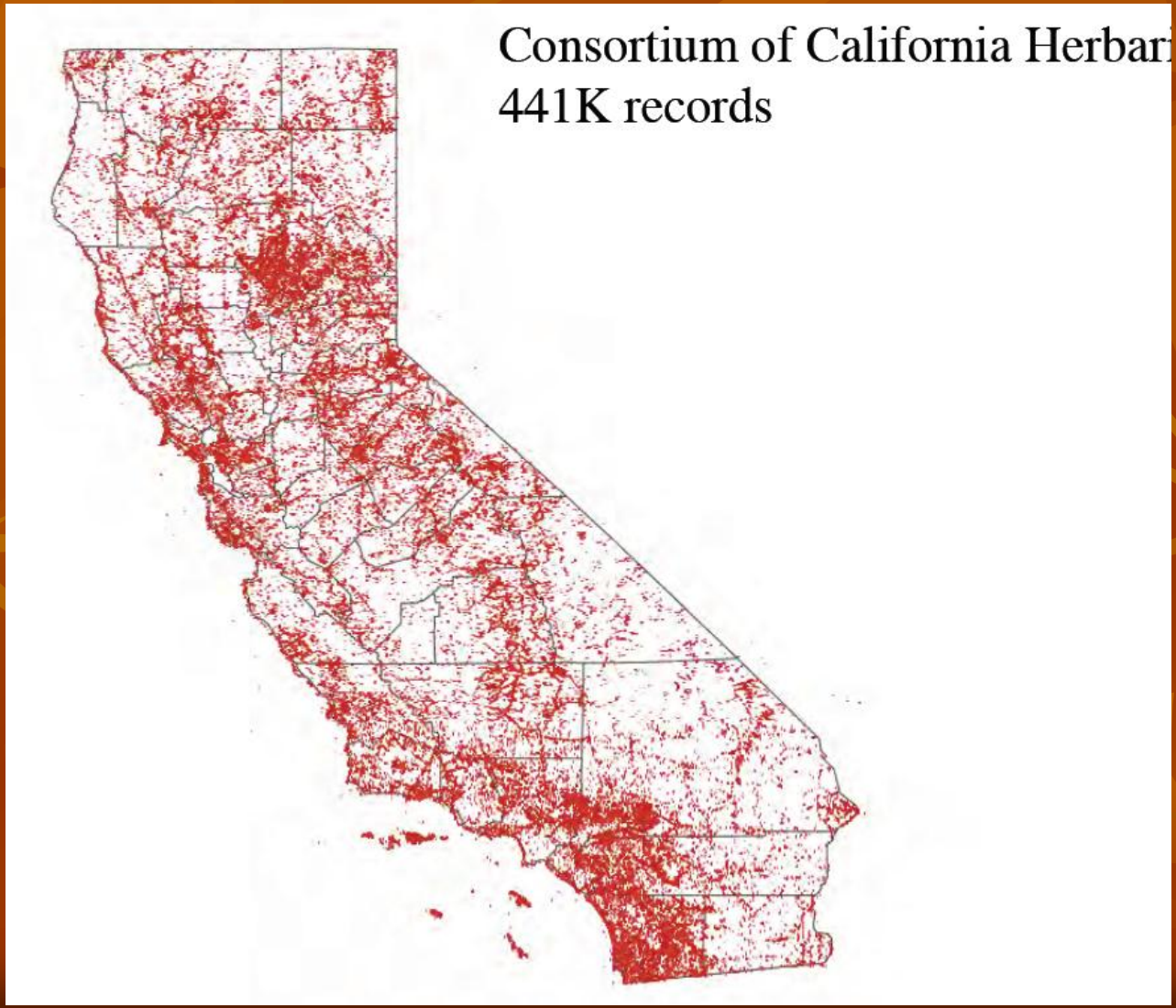
present-day
endemic
diversity

Climate change and the future of California's endemic flora

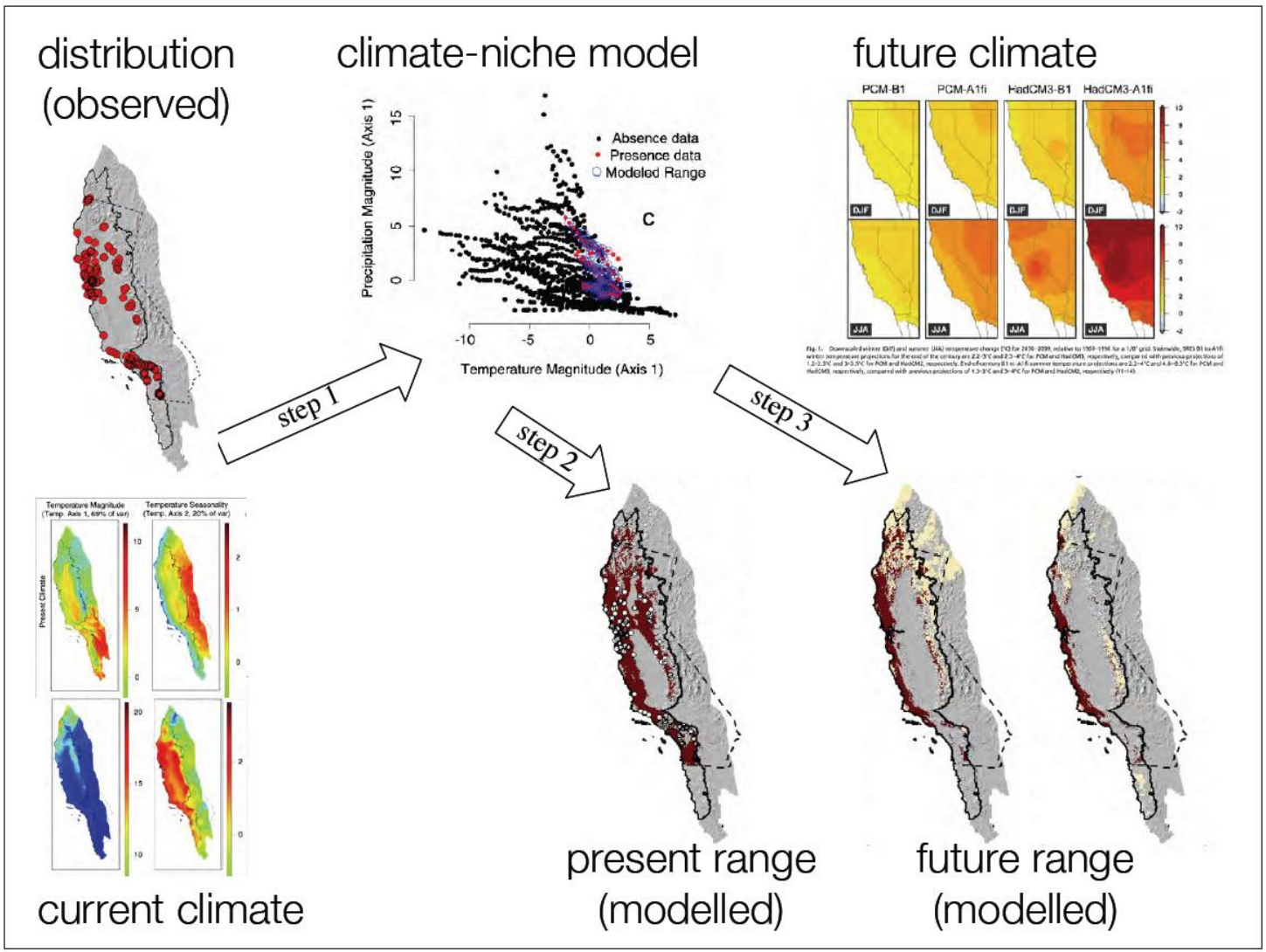
Collaborators:
Scott R. Loarie (Duke)
Ben Carter (UCB, Cal Poly SLO)
Sean McMahon (Duke)
Katherine Hayhoe (Texas Tech)
Richard Moe (Jepson Herbarium, UCB)
Charles Knight (Cal Poly SLO)
David Ackerly (UCB)

Loarie et al. (2008) PLoS-One
google: plos california flora

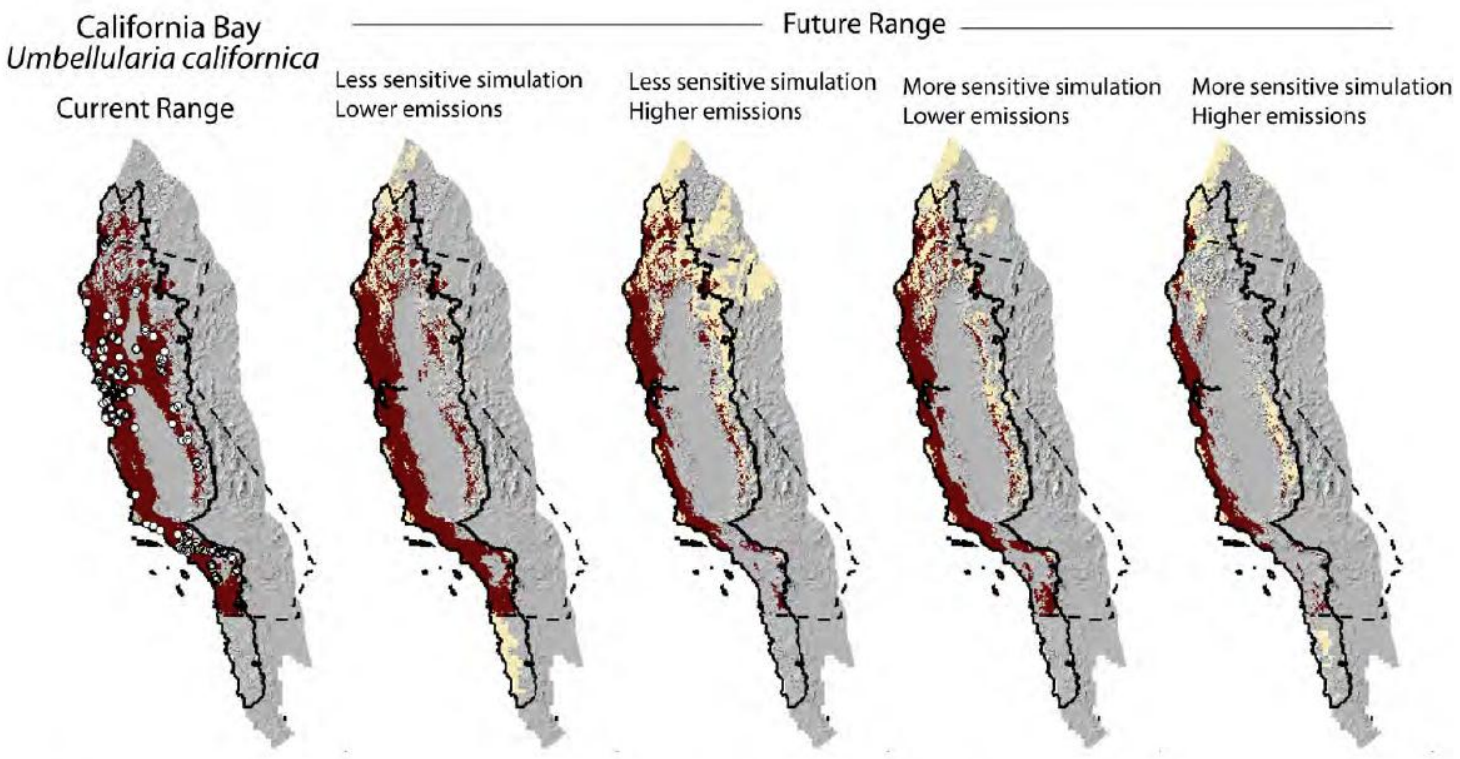
Plant specimen coverage of Calif. Herbaria



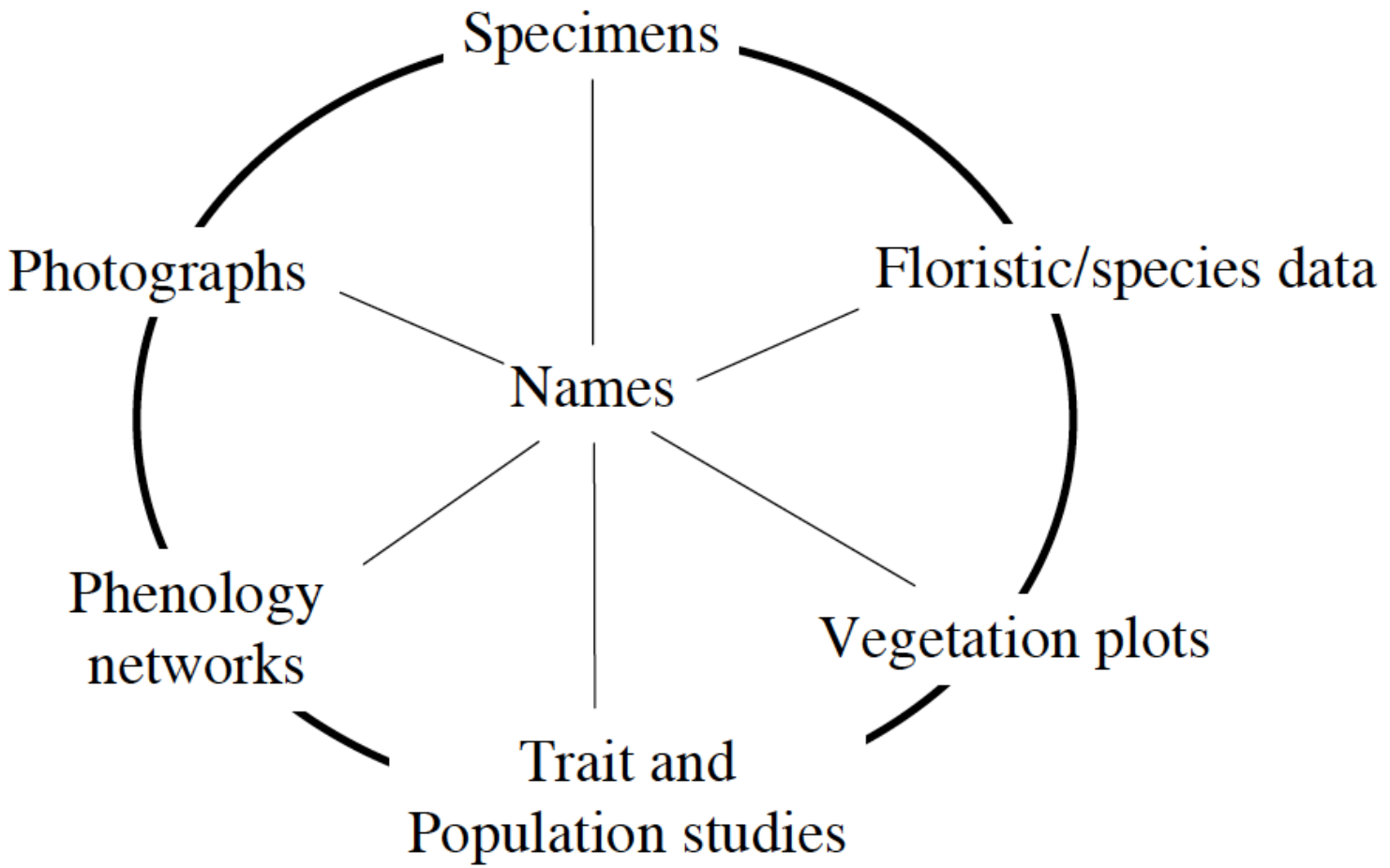
Modeling Procedure



Species Modeling



Connecting specimen and non-specimen data (bases)



Non-specimen database

Ecological trait databases

UCJEPS: Ecological Flora Means Data

Ecological Flora Pilot

***Rhamnus* mean values**

Rhamnus alnifolia	Low elevation	1700 m	(N=1)
Rhamnus alnifolia	High elevation	1900 m	(N=1)
Rhamnus californica	Annual seed production per plant (c)	516000 -	(N=1)
Rhamnus californica	Low elevation	0 m	(N=1)
Rhamnus californica	High elevation	2300 m	(N=1)
Rhamnus californica ssp. californica	Blade area (c)	10.7 cm^2	(N=10)
Rhamnus californica ssp. californica	Specific leaf area	11.7 mm^2 mg^{-1}	(N=10)
Rhamnus californica ssp. californica	Blade length (c)	5.56 cm	(N=9)
Rhamnus californica ssp. californica	Blade width (c)	2.21 cm	(N=9)
Rhamnus californica ssp. californica	Leaf thickness	221 micron	(N=1)
Rhamnus californica ssp. californica	Leaf type	simple	(N=9)
Rhamnus californica ssp. californica	Seed mass	95.3 mg	(N=1)
Rhamnus californica ssp. californica	Wood density	0.496 g cm^{-3}	(N=1)

Ecological Flora of California: ucjeps.berkeley.edu/efc

Vegetation plots

(important source of absence data)