Using herbarium records to make climate niche comparisons among co-occurring sub-dominant forbs of the sagebrush steppe

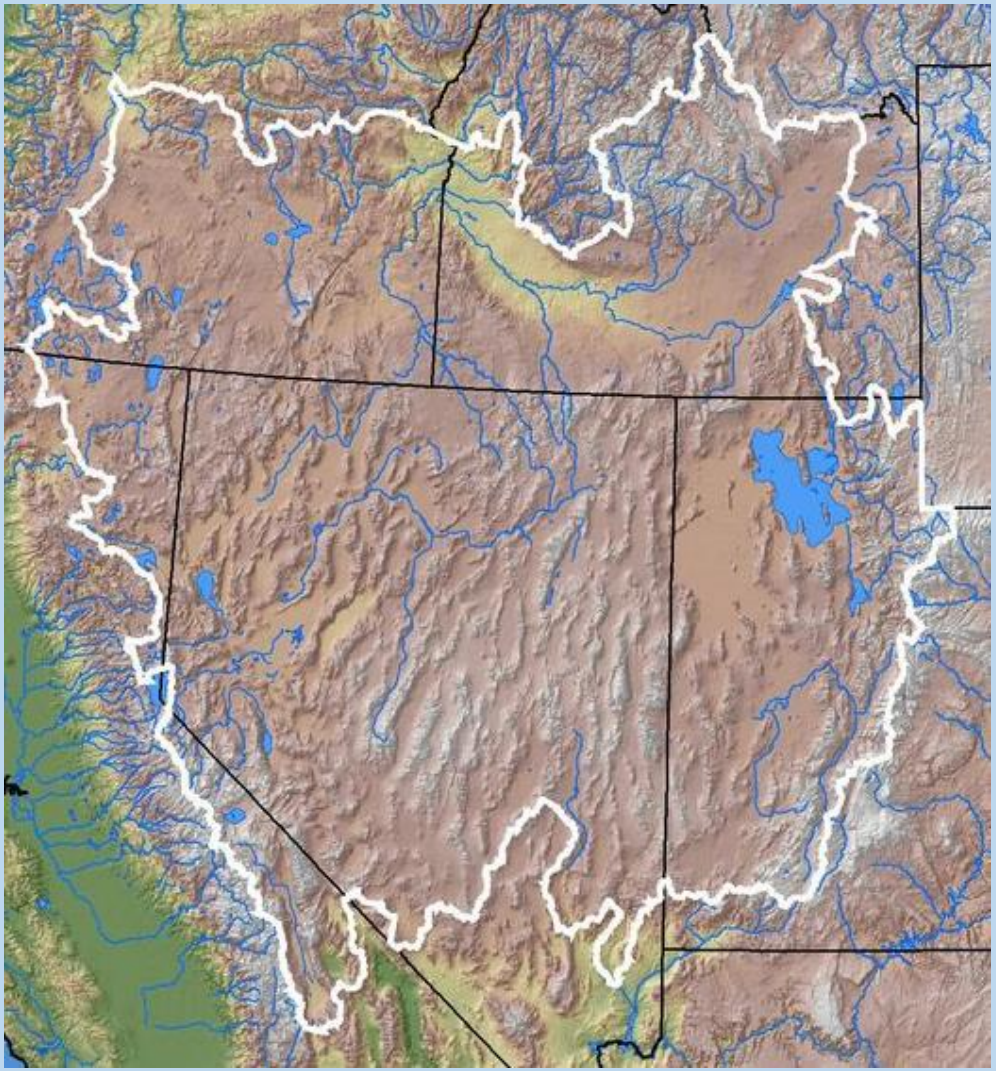
Sarah Barga, PhD
Tom Dilts, MS
Elizabeth Leger, PhD
University of Nevada, Reno

Dept. of Natural Resources & Environmental Science

A focus on the Great Basin

Climate variability in the Great Basin

- Topographic influence
- Precipitation
  - Quantity
  - Timing
- Temperature
  - Onset of seasons
  - Temperature range



Plants are sensitive to climate cues

- Seed dormancy and germination
- Timing of reproduction
- May be a signal of:
  - resource availability
  - competitive pressure

But, are all plants responding to the same environmental cues?

How do species respond to climate?

- Are species responding to similar environmental variables?
  - e.g. is precipitation always predictive of climatic suitability, or do some species cue in to other things?
- Do our species possess unique climate niches?
- Do they differ in their tolerance for climate variability?

Where do they live?
What is the climate there?

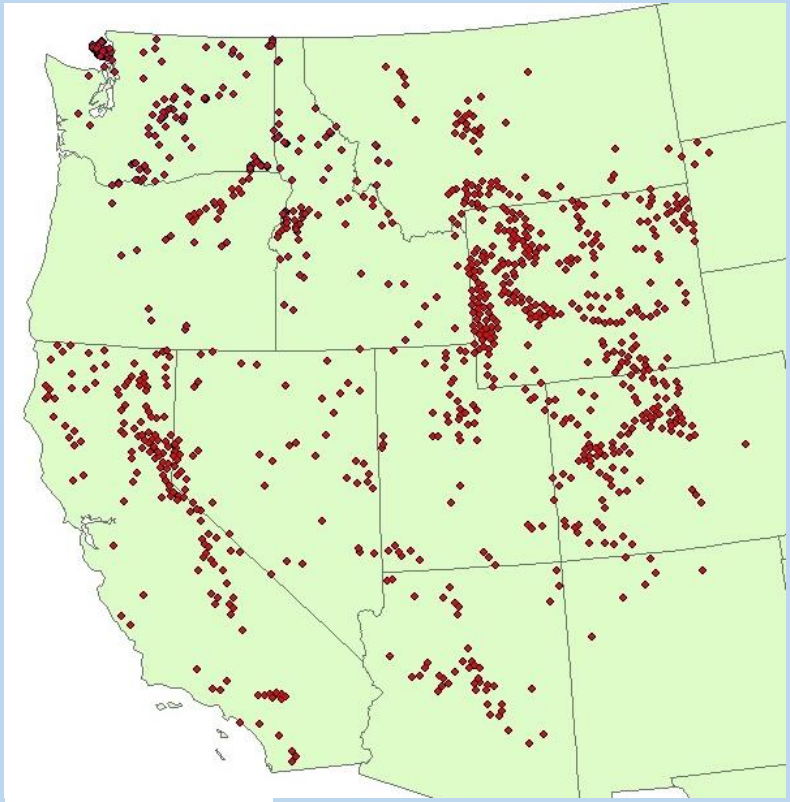
An in-depth look at co-occurring Great Basin forbs

4 perennial and 6 annual plants

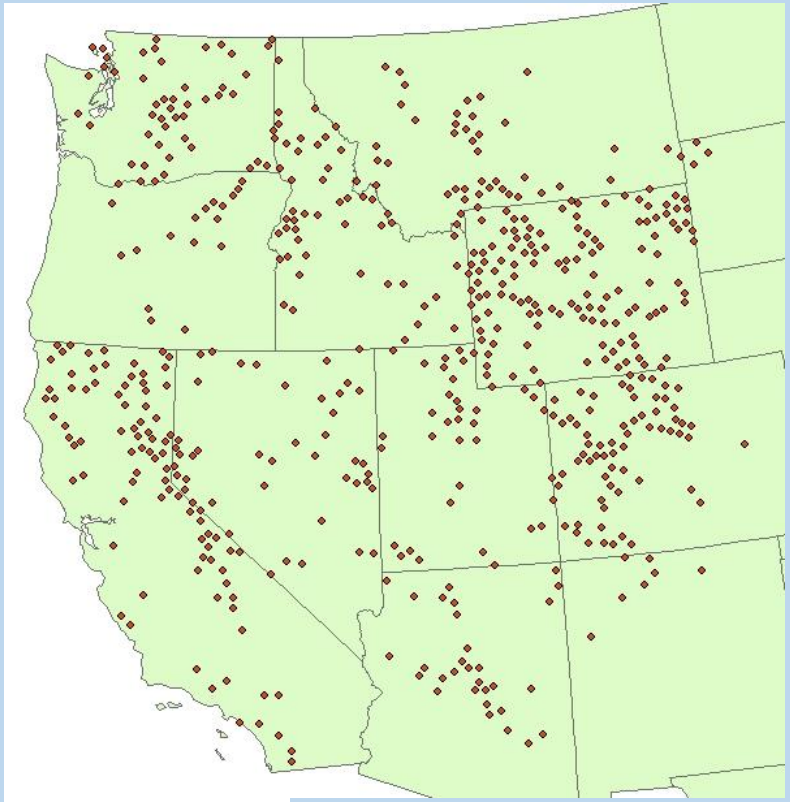
Asteraceae | Asteraceae | Asteraceae | Boraginaceae

Asteraceae | Plantaginaceae | Loasaceae | Boraginaceae | Polemoniaceae | Polemoniaceae

Estimating range-wide occupancy and climate



Pre-thinning



Post-thinning

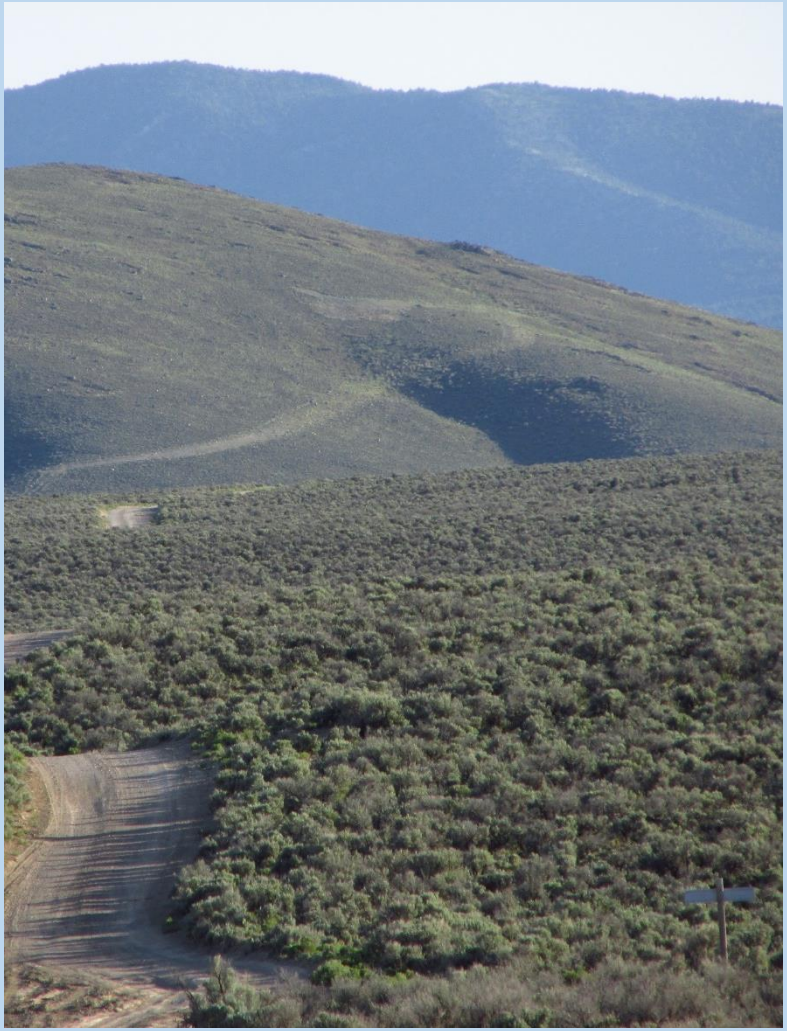
The Data: herbarium records, PRISM climate data (past 64 yrs), point thinning

True absences are difficult to find…

Challenges:

- Many species are small and/or cryptic
- Seeds may remain dormant in the soil for long periods

	Species	n
A)	*Agoseris grandiflora*	141
	Chaenactis douglasii	456
	Crepis intermedia	173
	Phacelia hastata	468
B)	*Blepharipappus scaber*	80
	Collinsia parviflora	554
	Cryptantha pterocarya	401
	Gilia inconspicua	214
	Mentzelia albicaulis	568
	Microsteris gracilis	515



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Modeling approach:

- MaxEnt modeling approach
- 29 bioclimatic variables
- Thornthwaite water balance approach

Model details:

- Used a bias file for unequal sampling
- Buffer distance for optimal background selection
- Model tuning
  - feature types
  - regularization parameters
- Model selection – AIC

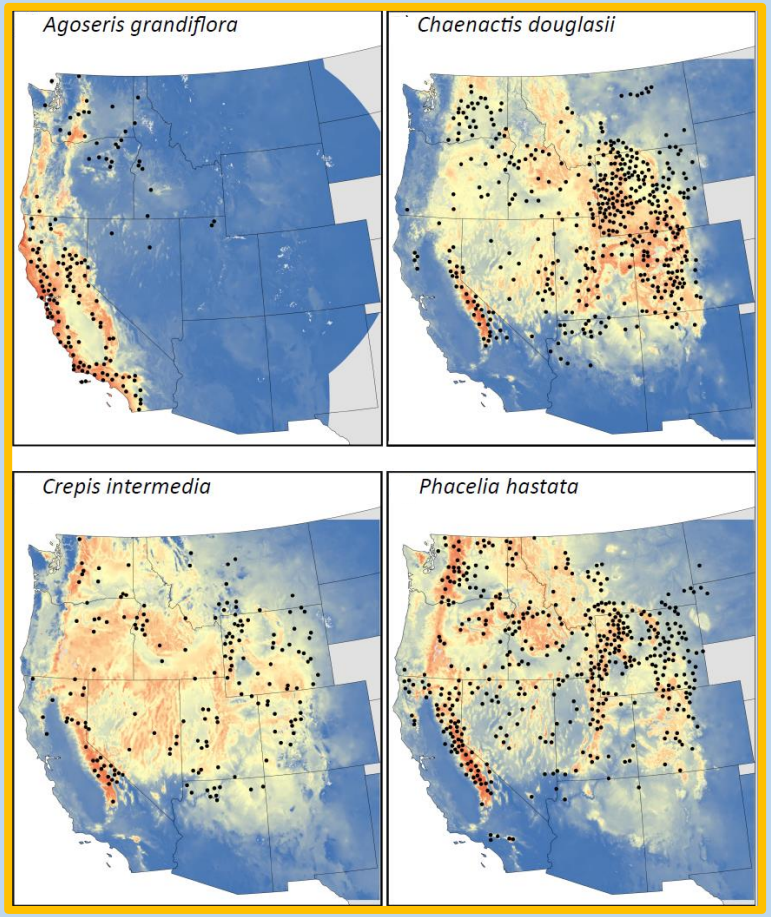
We used a suite of uncorrelated environmental variables

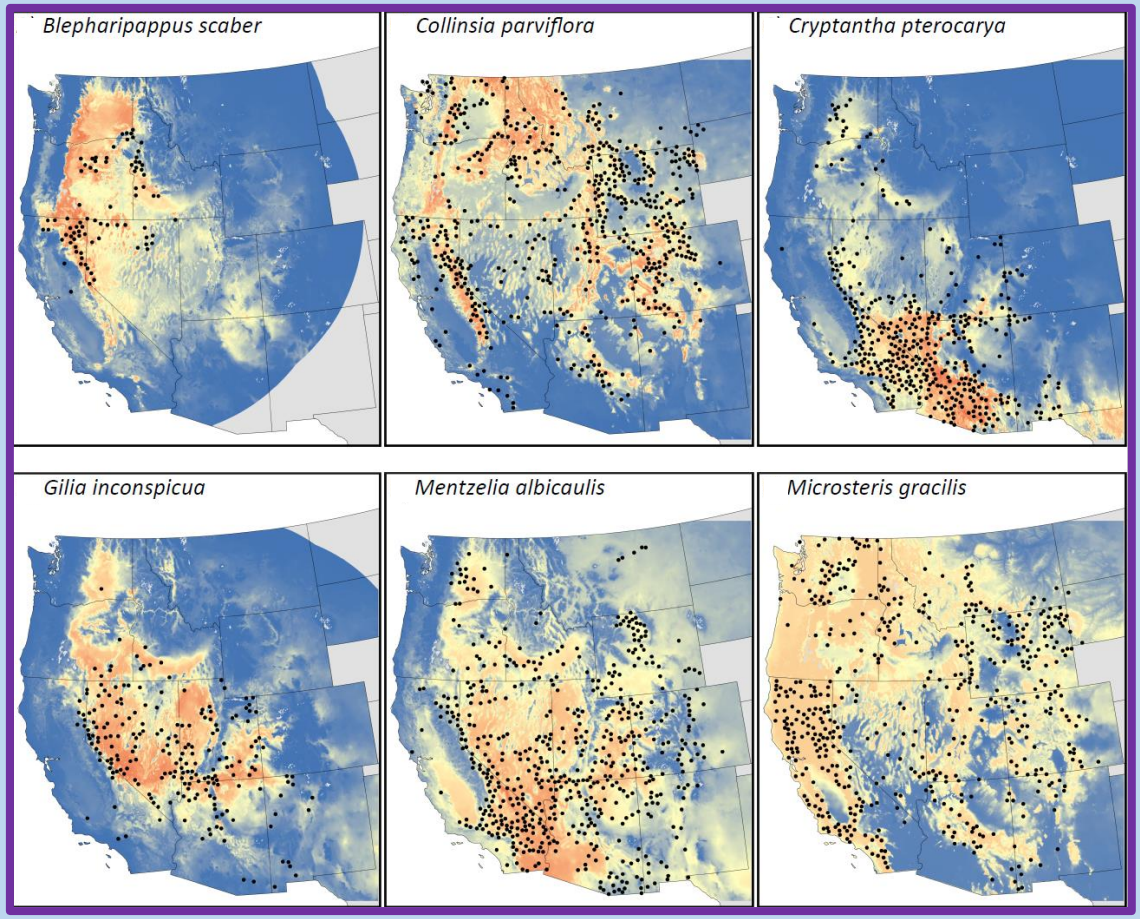
Our ten variables include:

- maximum temperature
- minimum temperature
- temperature range
- annual precipitation
- summer precipitation
- precipitation seasonality
- fraction of AET from precipitation
- soil water balance
- relative aridity
- spring water availability

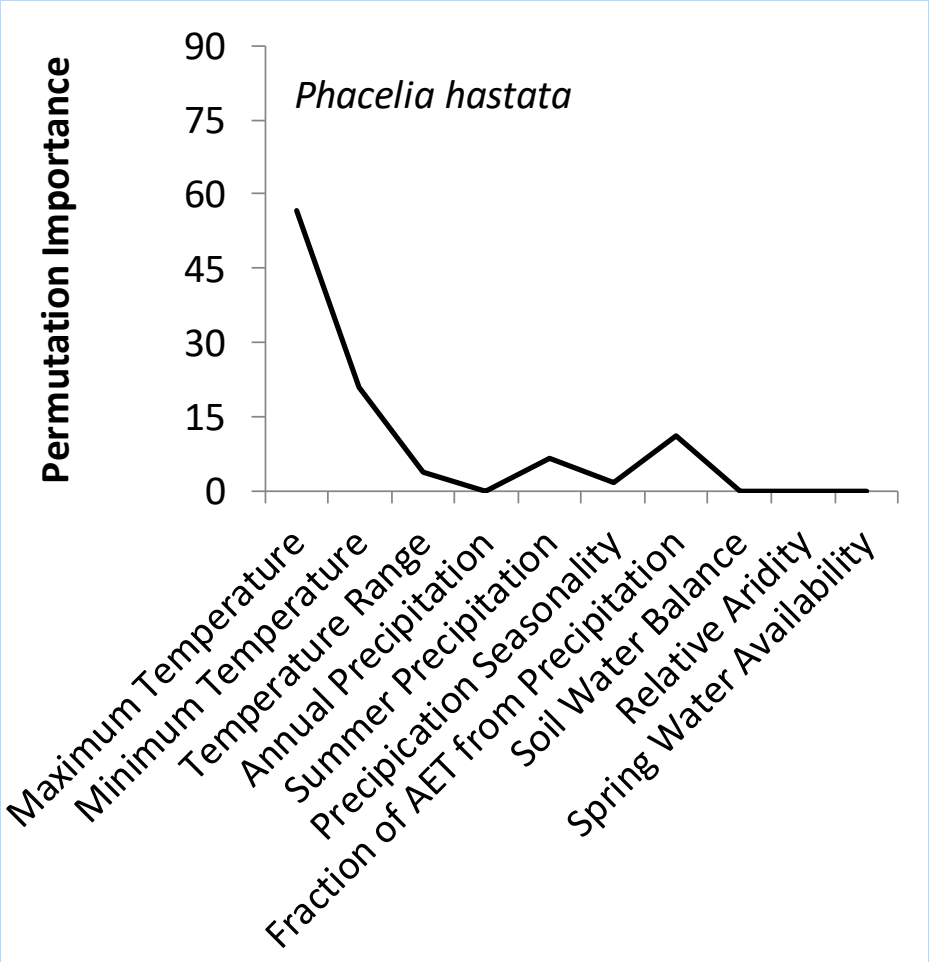
AET (Actual Evapotranspiration):
the simultaneous availability of water and sunlight, proxy for productivity

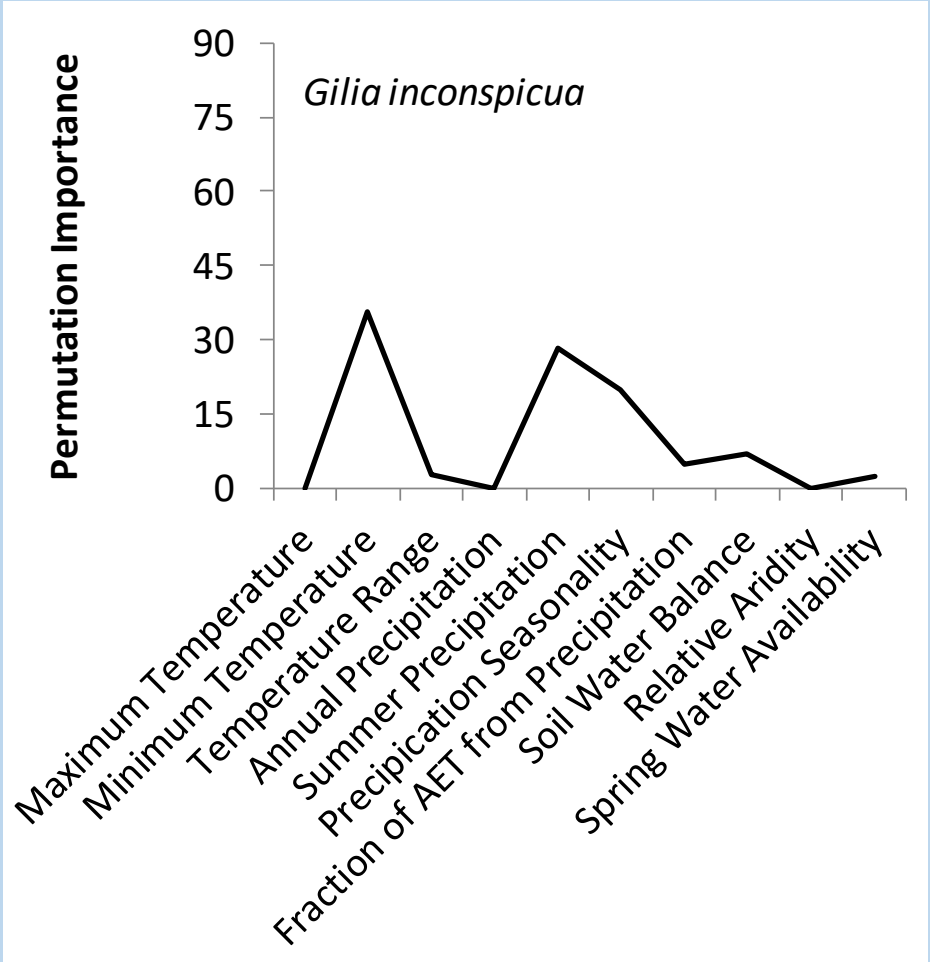
Species overlap in some areas, but not in others





Different variables were predictive of the climate niche of each species





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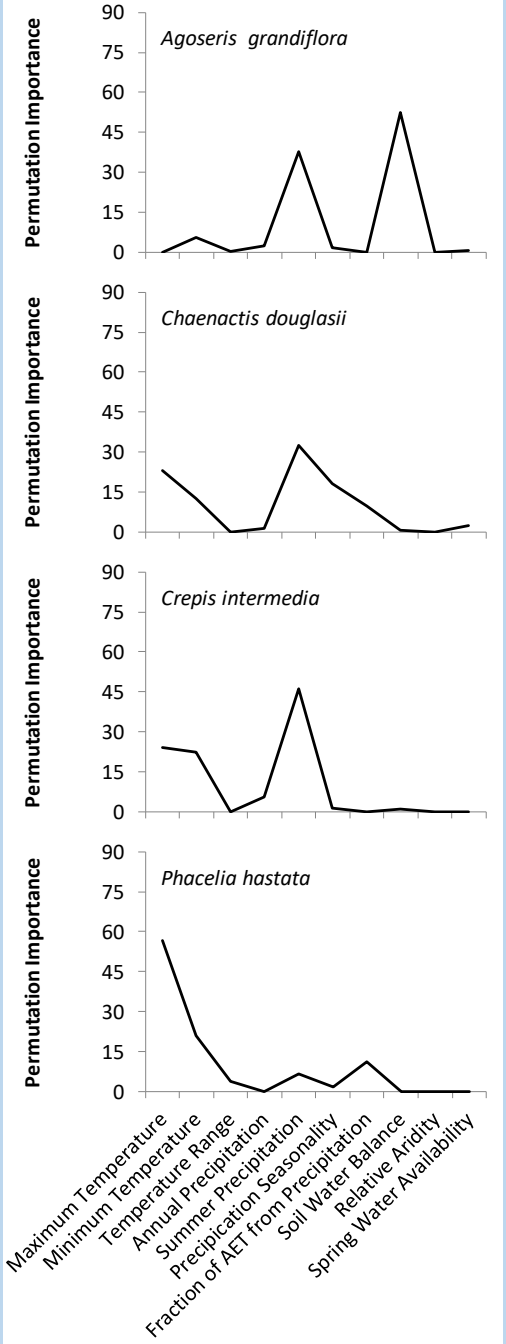
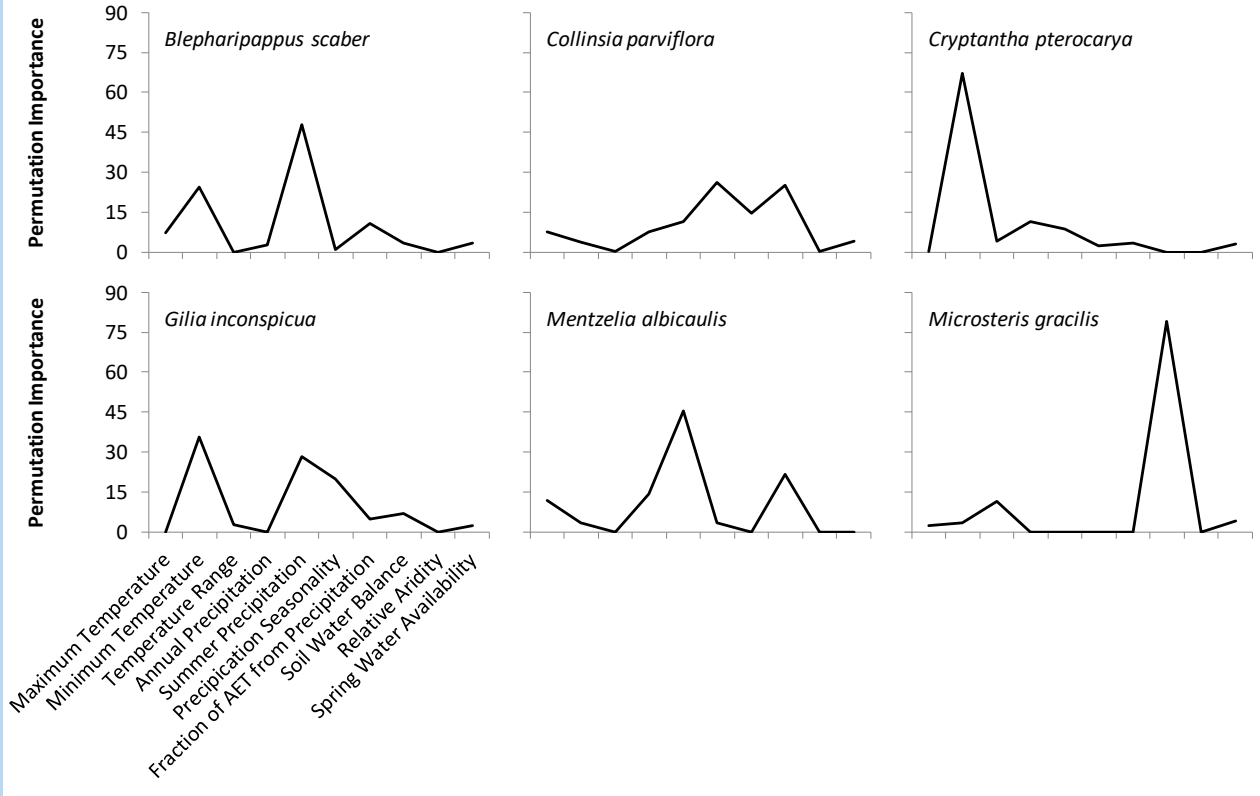
Perennial Species

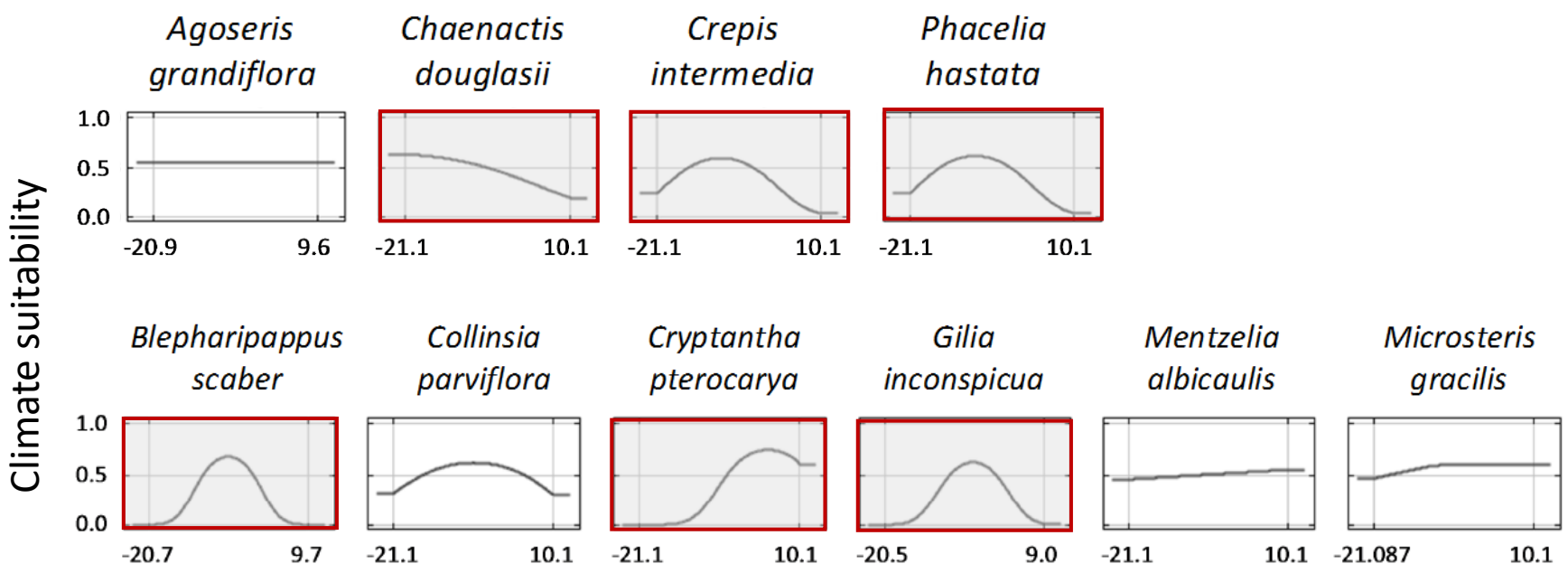


Annual Species



Relationships to variables are different too!

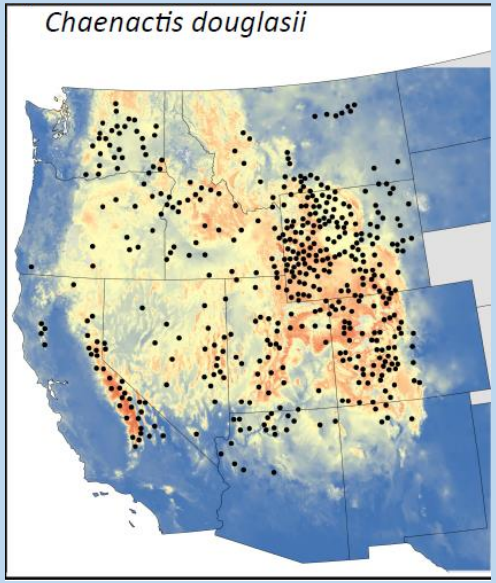
Annual Minimum Temperature (C)

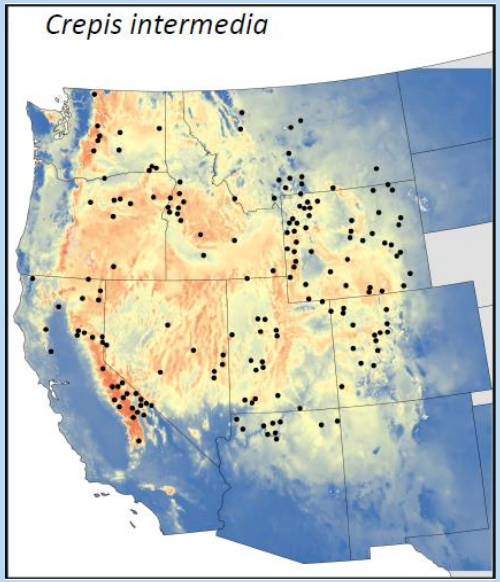


Range of values across study area

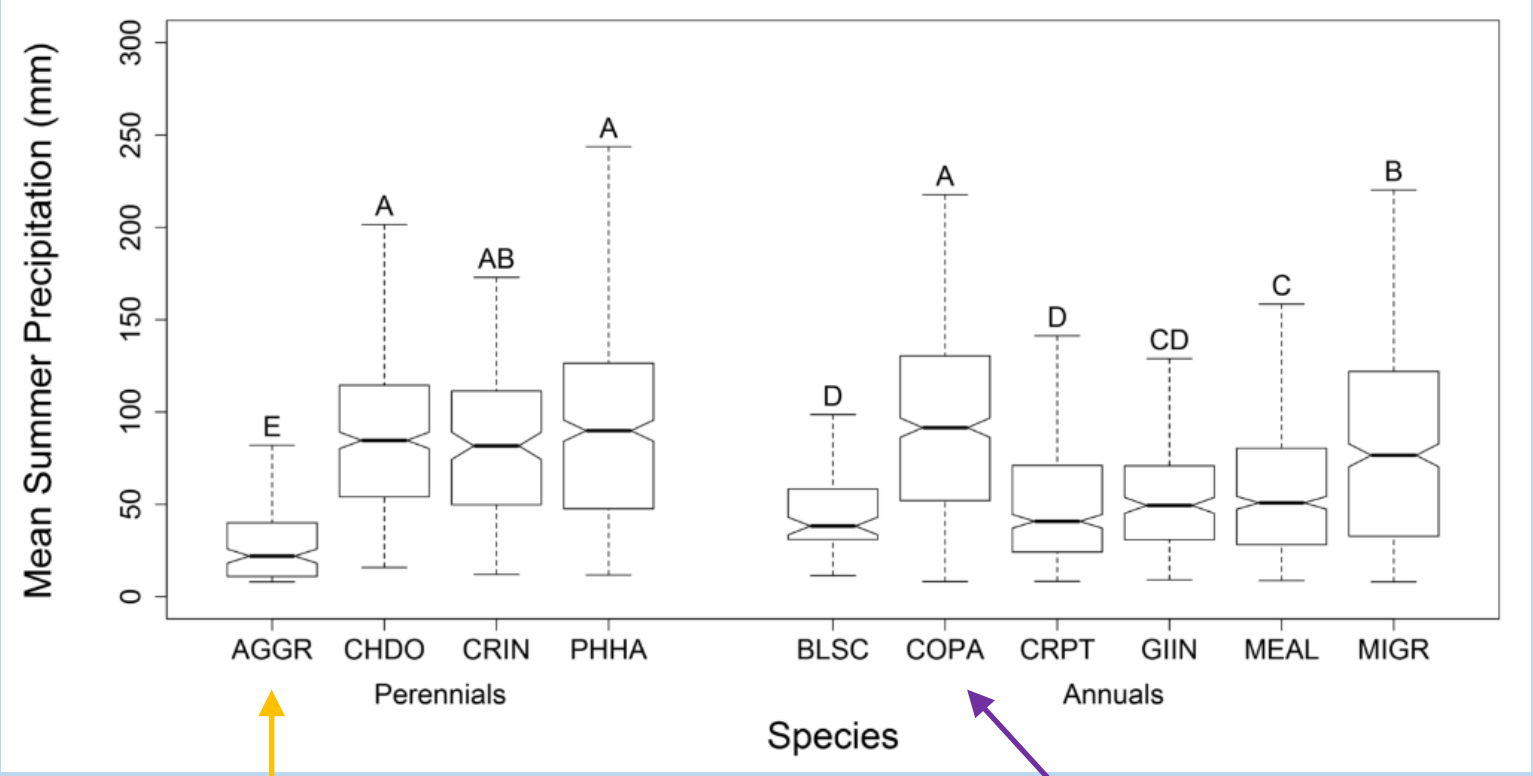
Climate niches were considered distinct for all but <u>one</u> species comparison

These two species are in the same family and are both perennials, so that could lend to their similarity?





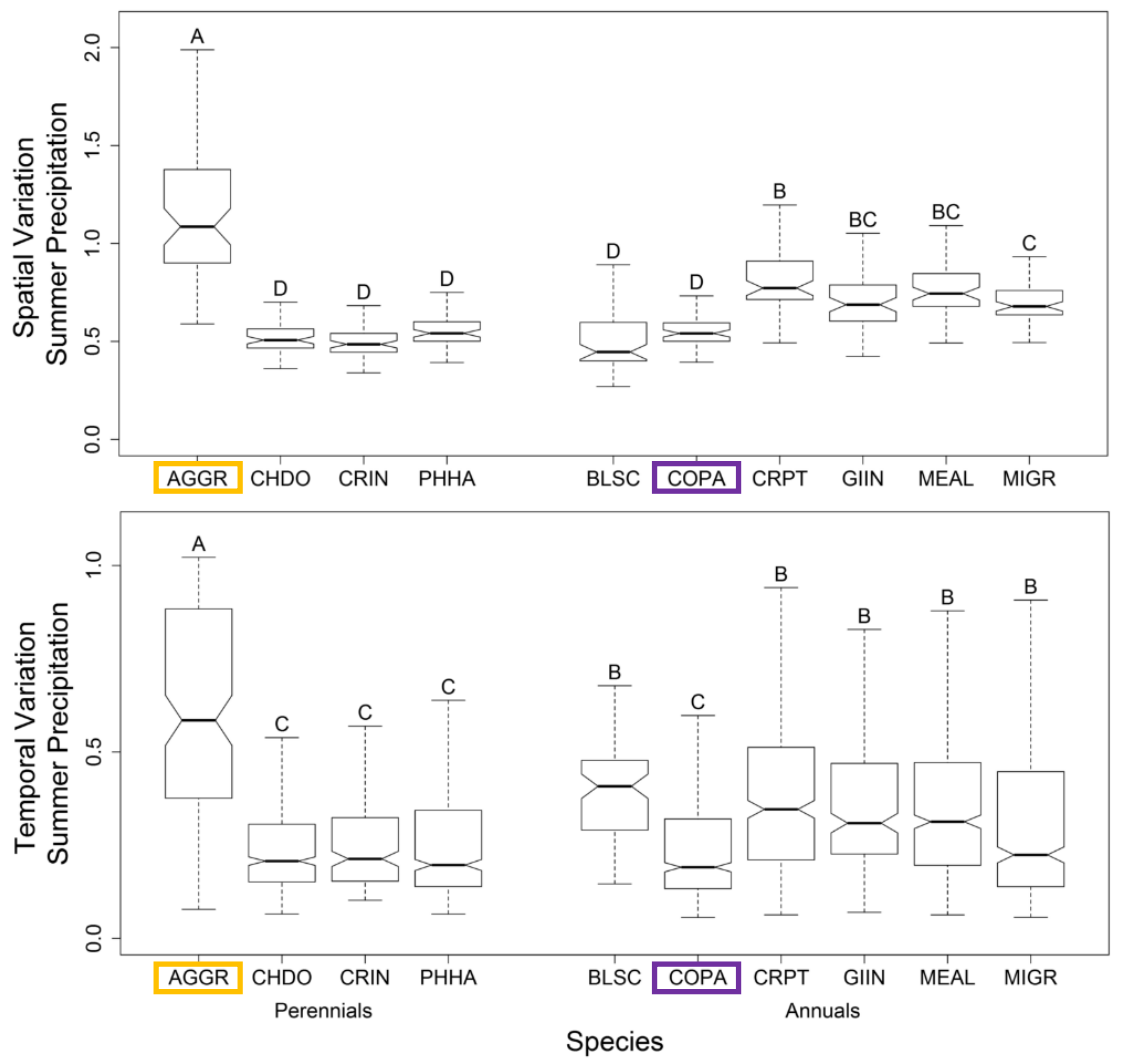
Species have different moisture preferences and…



A. grandiflora grows in areas with relatively low levels of summer precipitation

C. parviflora grows in areas with relatively high levels of summer precipitation

Species have different moisture preferences and tolerances for variability



A. grandiflora grows in areas with relatively low levels of summer precipitation, with a high level of spatial and temporal variability

C. parviflora grows in areas with relatively high levels of summer precipitation, with a low level of spatial and temporal variability

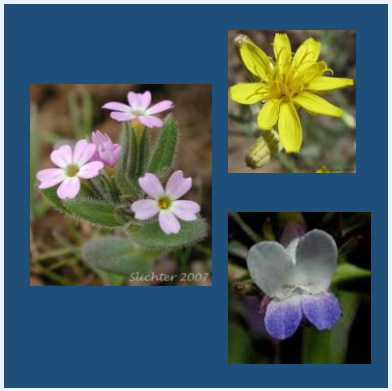
How do species respond to climate?

- Are species responding to similar environmental variables?
  Species were predicted by unique relationships with the climate variables that describe their suitable climate

- Do our species possess unique climate niches?
  Yes, only one pair of species occupied a similar climate niche

- Do they differ in their tolerance for climate variability?
  Yes, we found species-level differences in climate variability across known locations

Support for the existence of temporal partitioning of resources, where species co-occur



Year 1

Moderate

Year 2

Cool Temperatures
Wet Summer

Year 3

Dry Year

We also found…

- Niche differences among plant families
  - *Asteraceae, Boraginaceae, Polemoniaceae*
- Niche differences among growth forms
  - Annuals vs. Perennials
- No relationship between phylogenetic distance and niche overlap for our species

Citation: Barga SC, Dilts TE, Leger EA. 2018. Contrasting climate niches among co-occurring subdominant forbs of the sagebrush steppe. *Divers Distrib*. 00:1–17. https://doi.org/10.1111/ddi.12764

Restoration practitioners can benefit from the huge amount of collector effort found in herbaria

My post-doctoral work includes making maps for the Bureau of Land Management

- Seed for native species can be…
  - very expensive
  - difficult to procure
- We need to be discriminating about where these seed resources are placed on the landscape

Thank you!

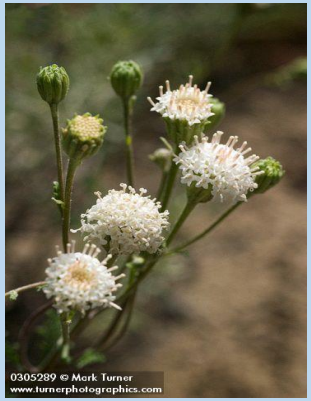
Intermountain Region Herbarium Network

- Great Basin Native Plant Project
- University of Nevada, Reno
- Bureau of Land Management
- Many online resources for herbarium and environmental data

Questions?



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Email: sarahcatherinebarga@gmail.com

Note: Herbarium records are an important resource!

From an ecological perspective:

- Insight into ecology of cryptic and non-dominant species
- Predict potential vulnerability to climate change
- Inform testable hypotheses related to species coexistence

From a land management perspective:

- Guide selection of restoration species
- Locate appropriate populations for seed increase

Note: Herbarium records are an important resource!

From an ecological perspective:

- Insight i… a…
- Pr… to…
- Info… rela…

Fr… …ment

…toration

…crease

BUT, users must also carefully consider:

- Uneven spatial sampling
- Impact of collector bias
- Inaccurate location information

…