USING CLIMATE CHANGE VULNERABILITY ASSESSMENTS FOR RARE PLANT CONSERVATION IN THE WESTERN UNITED STATES

Shannon Still[1], Kay Havens[2], Pati Vitt[2]
[1]UC Davis Arboretum & Public Garden
[2]Chicago Botanic Garden

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Overview of research

- funded by Bureau of Land Management Plant Conservation Program
  - ~570 rare plants across 51 familes
    - ex. *Penstemon albomarginatus*
- Provide assessment for climate change effects on rare taxa
- Compare to other assessments
- Goal to provide data for rare plant management and seed collection strategies in part

Taxa included in the dataset:

Listed taxa

Listing	No. species	%
Listed Endangered	57	10.1
Listed Threatened	38	6.7
not listed	476	83.3

Taxa included in the dataset:

Global Ranks

Global Rank (rounded)	No. species	%	Ranks included	Designation
G1	134	23.7	G1, G1?, G1Q, G1?Q, G1G2, G1G2Q, G1G2T1, G1G2T1T2, G1G3, G1QT1Q, G1T1, G2G3T1, G2G3T1T2, G2T1, G3?T1Q, G3G4T1T3, G3T1, G3T1T2Q, G4?T1, G4G5T1, G4G5T1T2, G4T1, G5T1, G5T1Q	Critically Imperiled
G2	413	73.1	G2, G2?, G2Q, G2?Q, G2G3, G2G3Q, G2G3T2T3, G2T2, G3?T2, G3G4T2, G3T2, G4?T2, G4?T2Q, G4G5T2, G4T2, G5T2, G5T2?Q, G5T2Q, G5T2T3, G5T2T3Q	Imperiled
G3	17	3.0	G3, G3?	Vulnerable
G4	0	0.0		Apparently Secure
G5	0	0.0		Secure
GNA	1	0.2	GNA	N/A

Taxa included in the dataset:

species/state

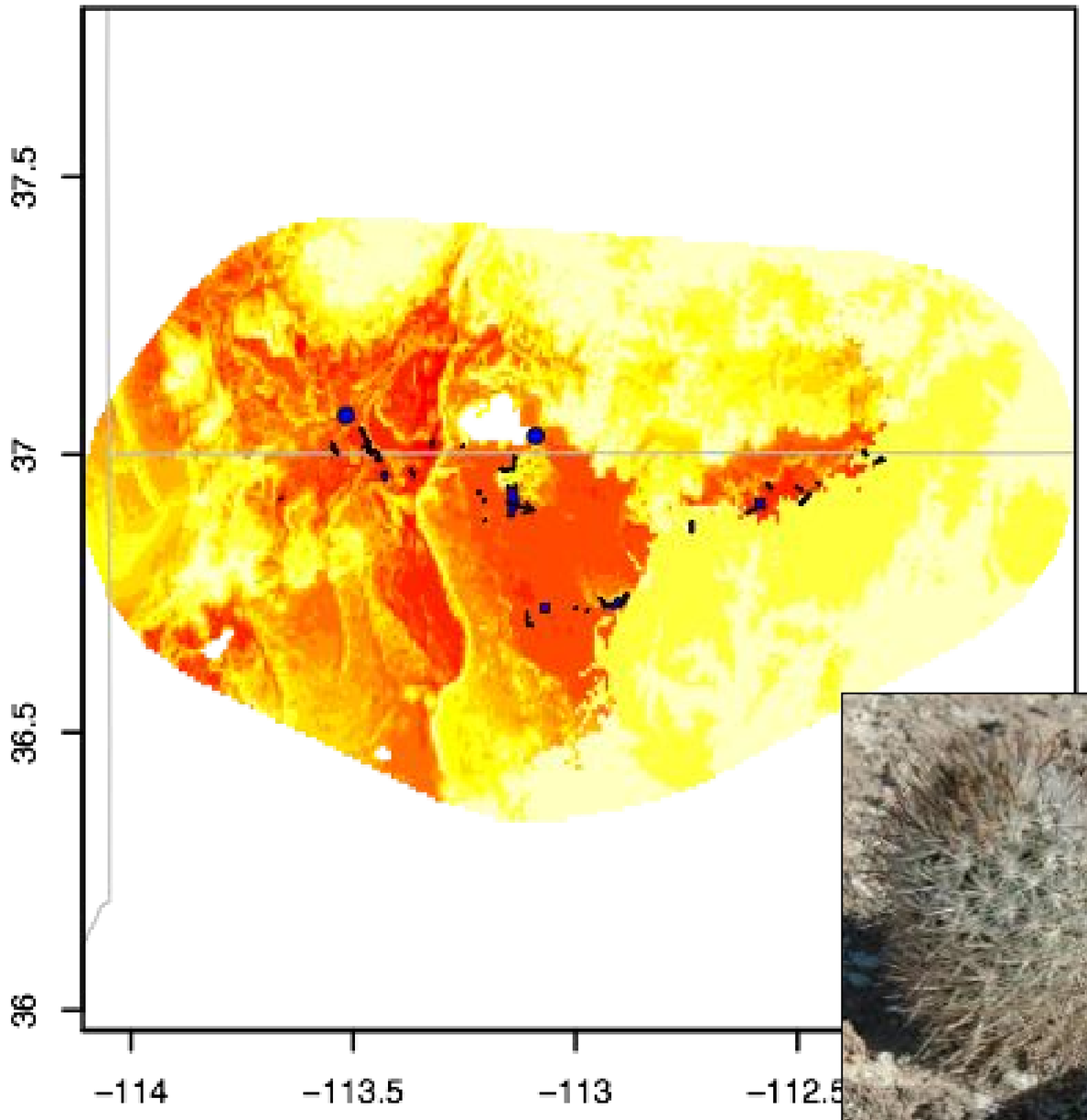
State/nation	No. species	Example taxa
Arizona	41	*Carex specuicola* [Navajo sedge] *Echinocereus triglochidiatus* var. *arizonicus* [Arizona Hedgehog Cactus]
California	314	*Penstemon albomarginatus* [white-edged beardtongue] *Prunus eremophila* [desert plum]
Colorado	12	*Sclerocactus mesa-verdae* [Mesa Verde cactus] *Astragalus osterhoutii* [Osterhout milkvetch]
Idaho	23	*Astragalus mulfordiae* [Mulford's milkvetch] *Rubus bartonianus* [Bartonberry]
Montana	11	*Lomatium attenuatum* [Taper-tip desert parsley] *Shoshonea pulvinata* [Shoshonea]
Nevada	79	*Enceliopsis argophylla* [silverleaf sunray] *Selaginella utahensis* [Utah spikemoss]
New Mexico	21	*Oenothera organensis* [Organ evening primrose] *Asclepias welshii* [Welsh's milkweed]
Oregon	64	*Trifolium owyhhense* [Owyhee clover] *Senecio ertterae* [Ertter's senecio]
Utah	98	*Pediocactus sileri* [Siler's pincushion] *Cryptantha jonesiana* [Jones' cateye]
Washington	23	*Allium constrictum* [Constricted Douglas' onion] *Howellia aquatilis* [Howellia]
Wyoming	27	*Penstemon acaulis* var. *acaulis* [stemless beardtongue] *Phlox pungens* [Beaver Rim phlox]
Navajo Nation	22	*Carex specuicola* [Navajo sedge] *Cryptantha atwoodii* [Atwwod's catseye]

Taxa included in the dataset: ***species/state***

		ESA Status		Rounded Global Rank			
State/nation	No. taxa	Total listed	Total not listed	G1	G2	G3	GNA
California	314	53	261	77	229	8	0
Utah	98	11	85	23	70	3	0
Nevada	79	6	73	9	68	2	0
Oregon	64	13	51	15	46	3	0
Arizona	41	8	31	9	27	2	1
Wyoming	27	0	27	1	24	2	0
Idaho	23	3	20	3	19	1	0
Washington	23	4	19	3	19	1	0
Navajo Nation	22	6	16	7	13	2	0
New Mexico	21	7	14	4	16	1	0
Colorado	12	7	5	6	5	1	0
Montana	11	1	10	0	7	4	0

Model parameters

- MaxEnt
- area is a convex hull of the occurrences buffered by 50 km or the entire west
- testing on 25% of occurrences
- projected to same extent as modeled
- up to 10,000 background points
- 10 model replicates for each species
- present, 2020s, 2050s, 2080s
- WorldClim, IPCC 4
- 13 Global Circulation Model and emission scenario combinations for each future prediction

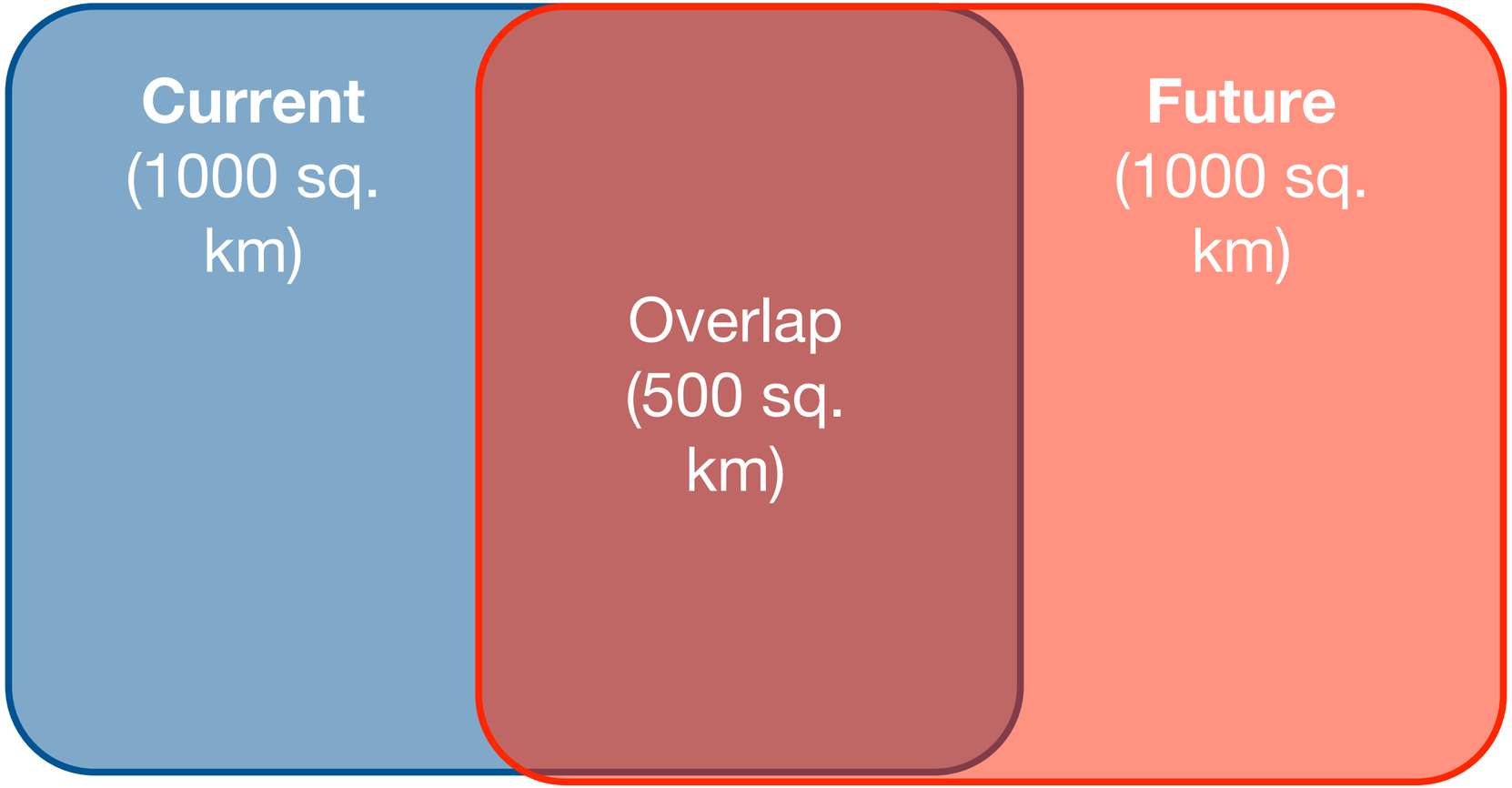


What I will discuss

- change of suitable habitat area
- change in suitable habitat range
- change of *in situ* habitat
- create SDM Score for vulnerability using species distribution models

Change in suitable habitat area

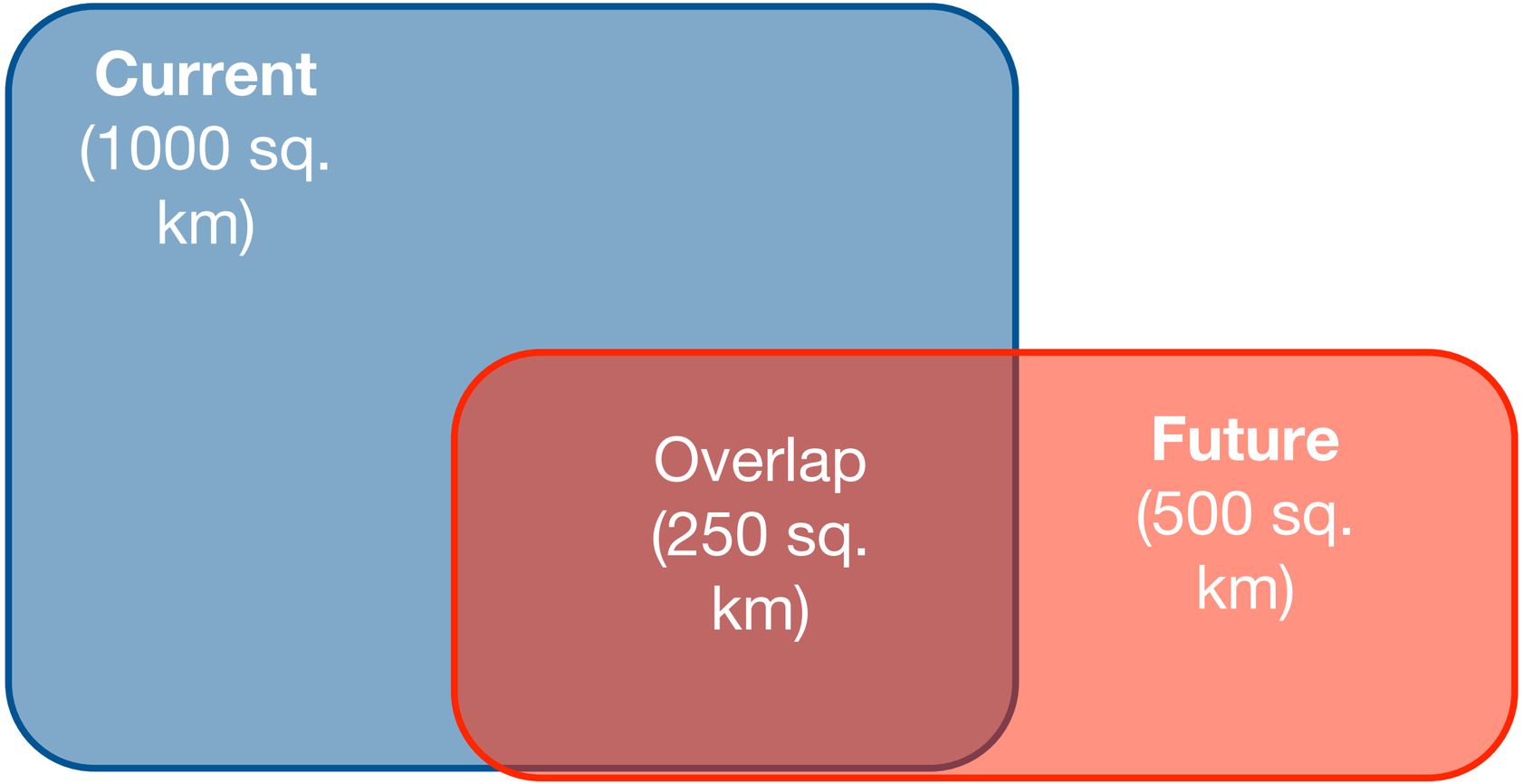
Change in Suitable Habitat Area



Change in Suitable Habitat Area = 0%

Overlap = 50%

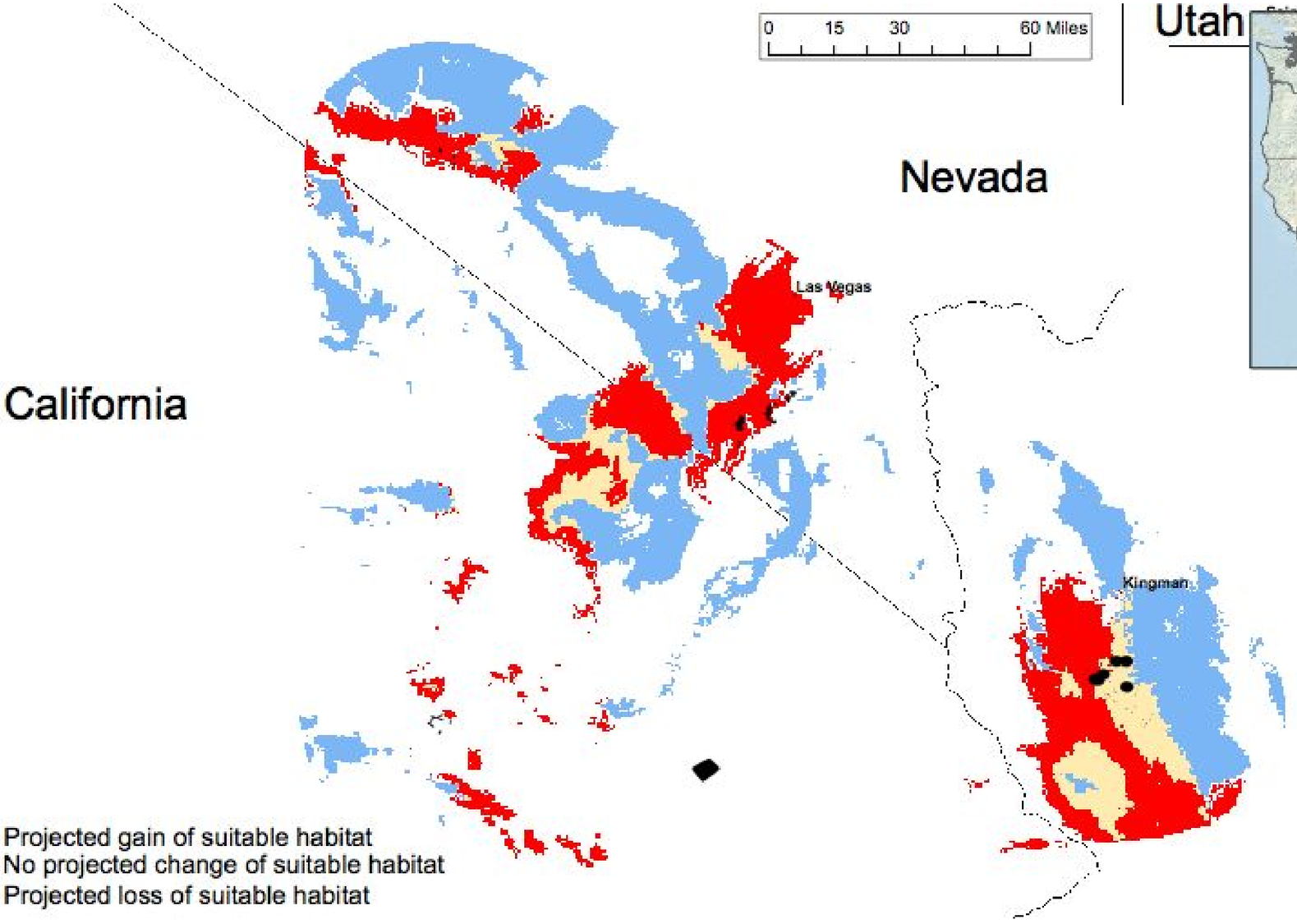
Change in Suitable Habitat Area



Change in Suitable Habitat Area = -50%

Overlap = 25%

Predicting change in suitable habitat area



Predicting change in suitable habitat area

How can you use this?

✓ Predict suitable areas for the future

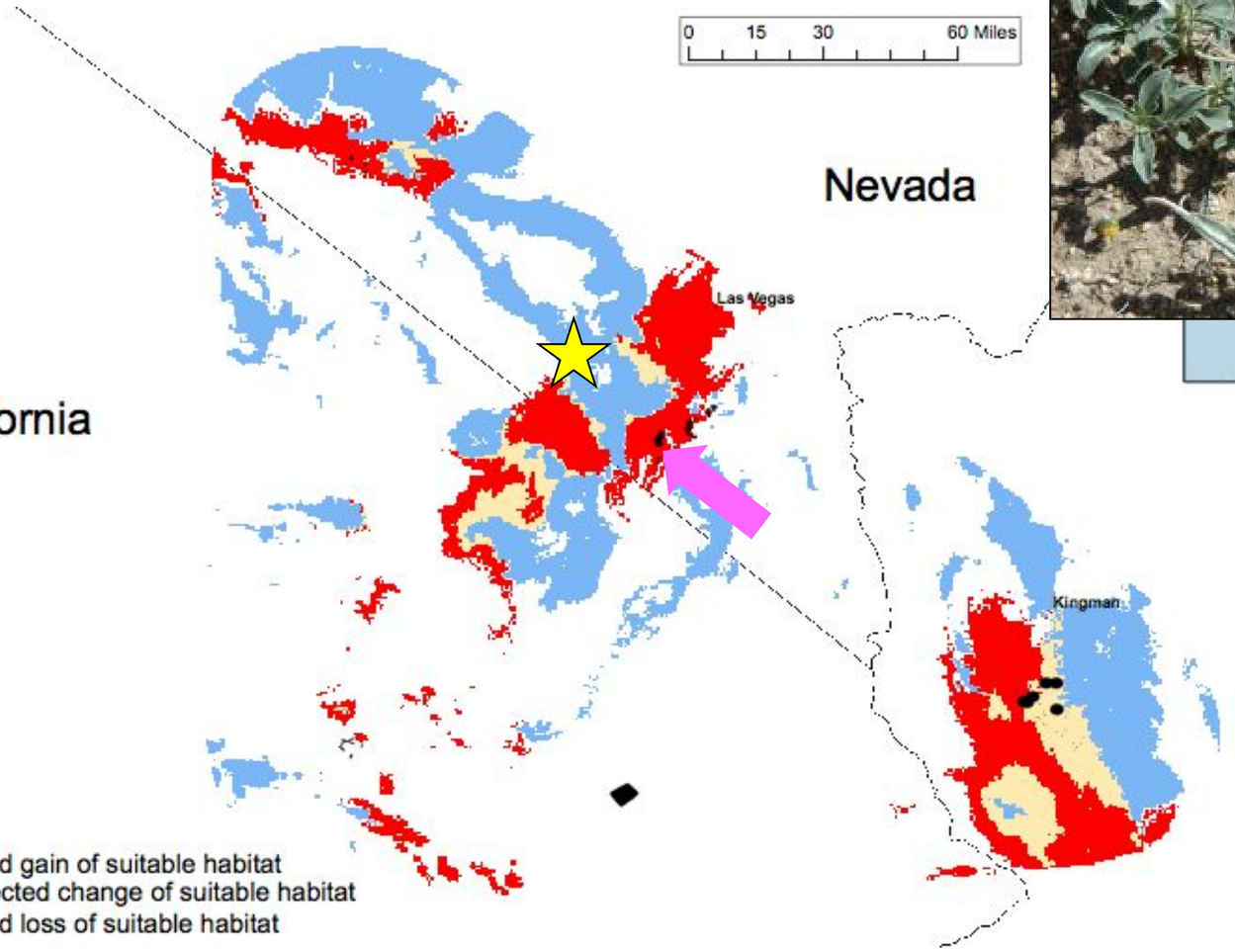
- prioritize species for conservation
    - which taxa more imperiled
- prioritize areas for conservation
    - which areas more imperiled

✓ Identify leading and trailing edges of suitable habitat

- collect germplasm for those areas on trailing edge

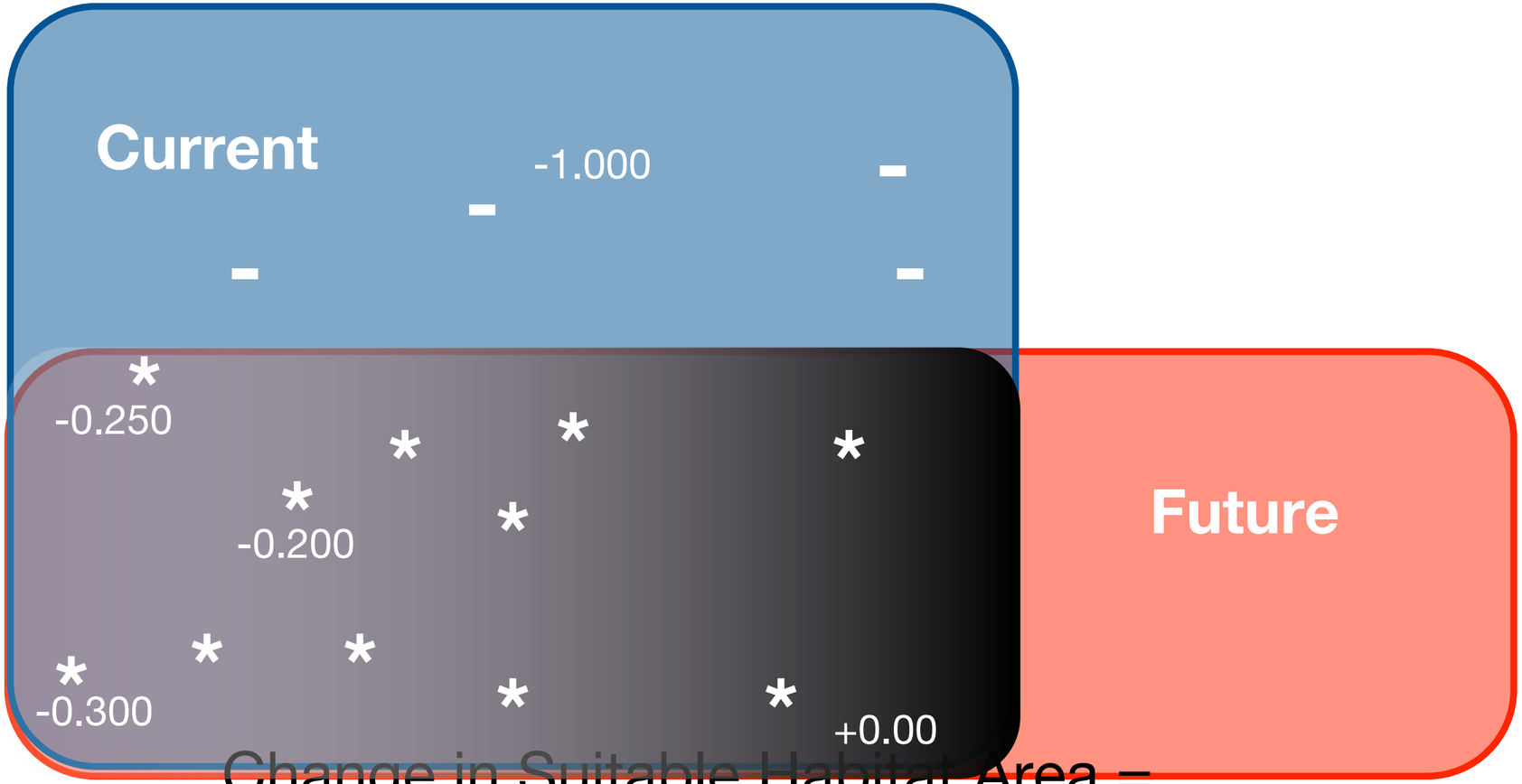
Predicting change in suitable habitat area

areas classified (thresholded) as suitable/not suitable




Change of in situ habitat
(areas where species presently located)

Suitability Score (*in situ* change)



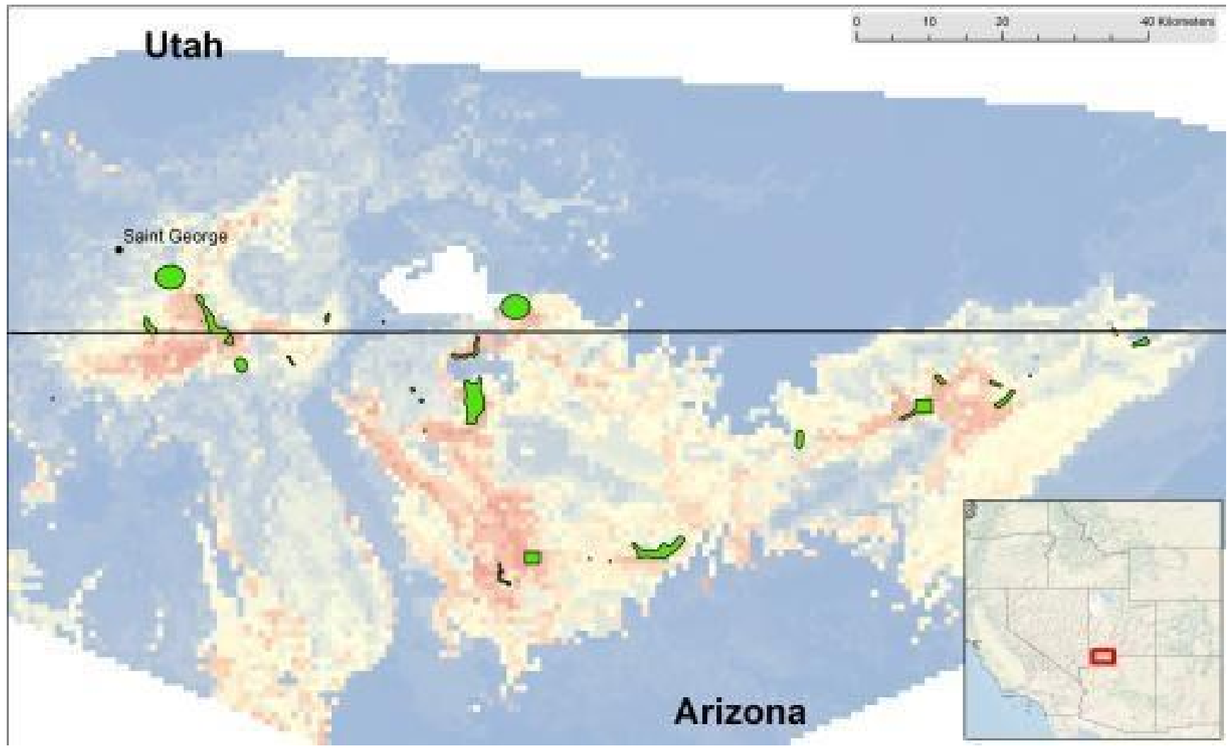
Change in Suitable Habitat Area = -20%

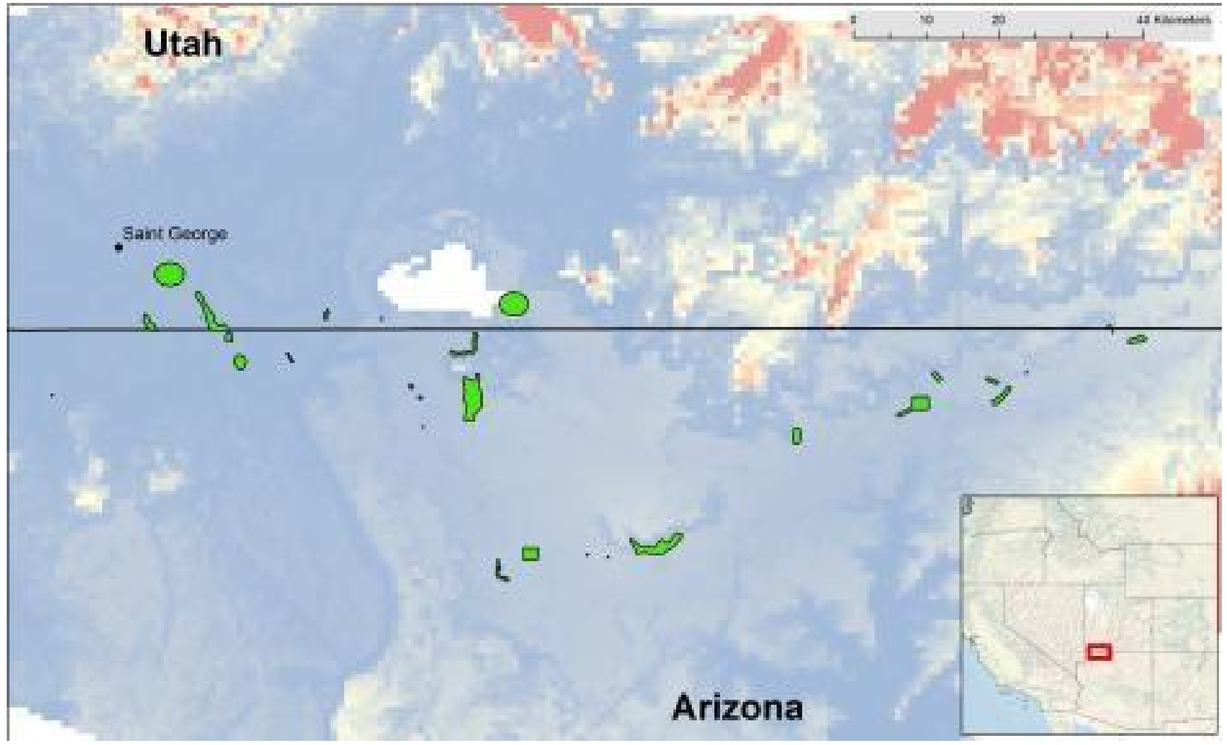
Overlap = 50%

Suitability Score = -0.350

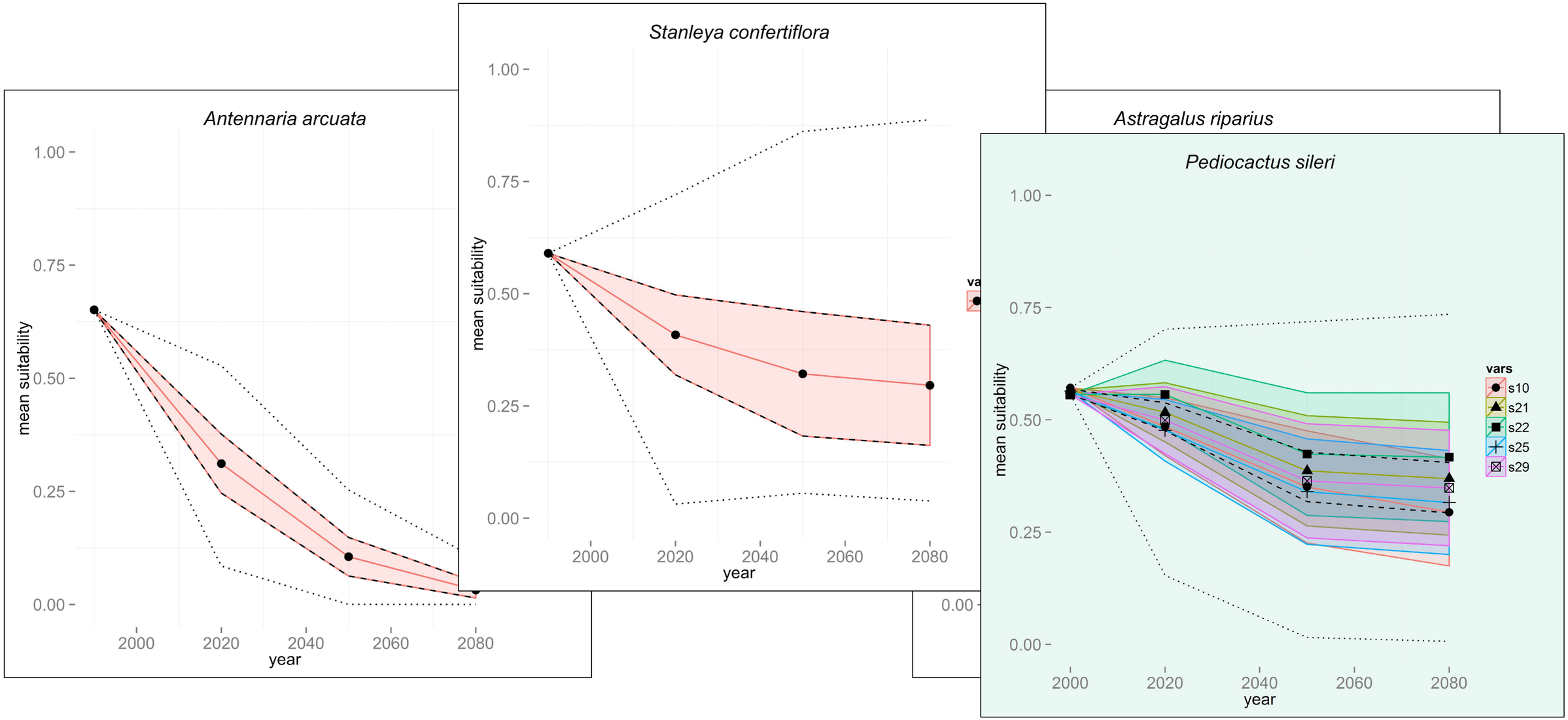
Quantify change for known occurrences (*in situ*)

- Compare suitability between present and future for all occurrences
  - for each location…is suitability changing?

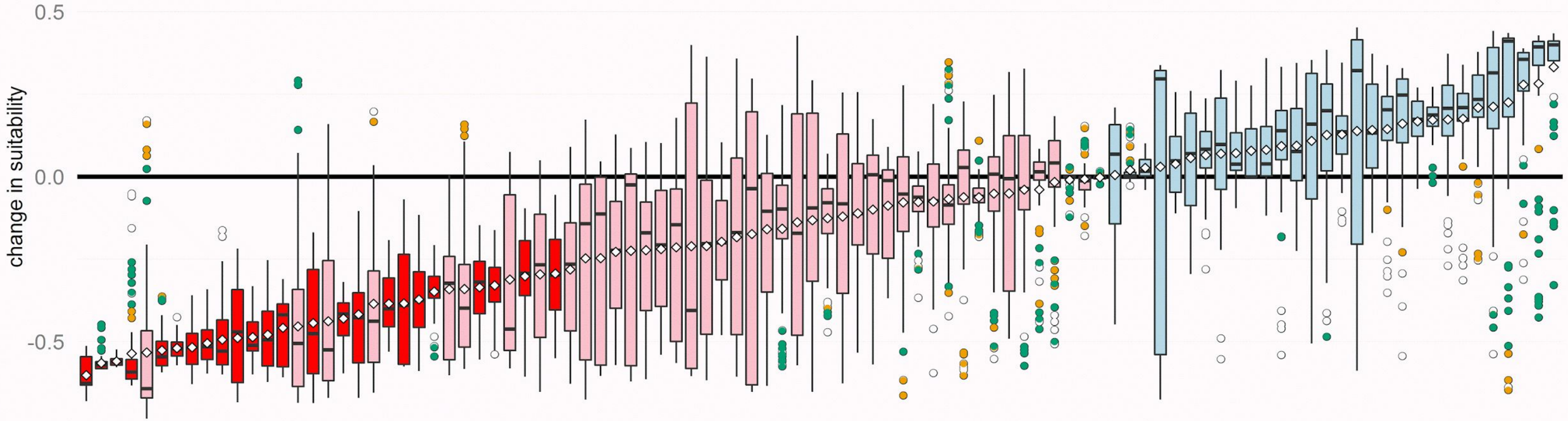




Model variation



Federally listed: 95 taxa

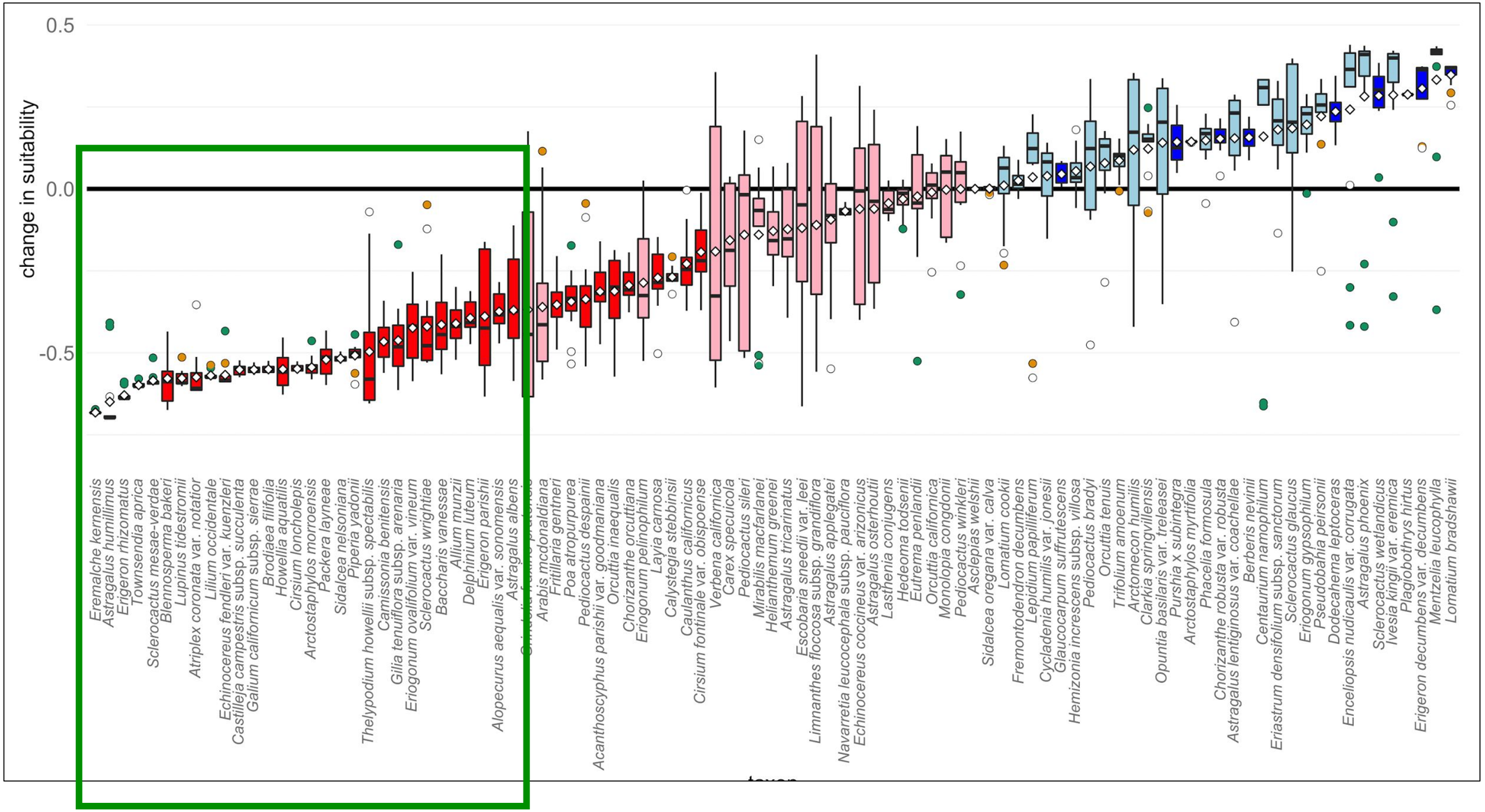


2080s

suitability
28 increase (0 all gain)
67 decrease (24 all loss)

Conservation planning:

focus on species using *in situ* score



Change of habitat where presently located

How can you use this?

- ✓ Identify species most at risk
- ✓ Identify populations most at risk
    - collect germplasm from imperiled populations

Using the results:

Conservation planning & prioritization

Conservation planning:

focus on overall patterns

Suitable habitat range	Overlap of Suitable Habitat Area	Suitability Score	n (%)
Contracting (n=308)	< 50%	decreasing	277 (49.0%)
		increasing	0 (0%)
	> 50%	decreasing	22 (3.9%)
		increasing	3 (0.5%)
Expanding (n=263)	< 50%	decreasing	72 (12.7%)
		increasing	4 (0.7%)
	> 50%	decreasing	44 (7.8%)
		increasing	143 (25.3%)

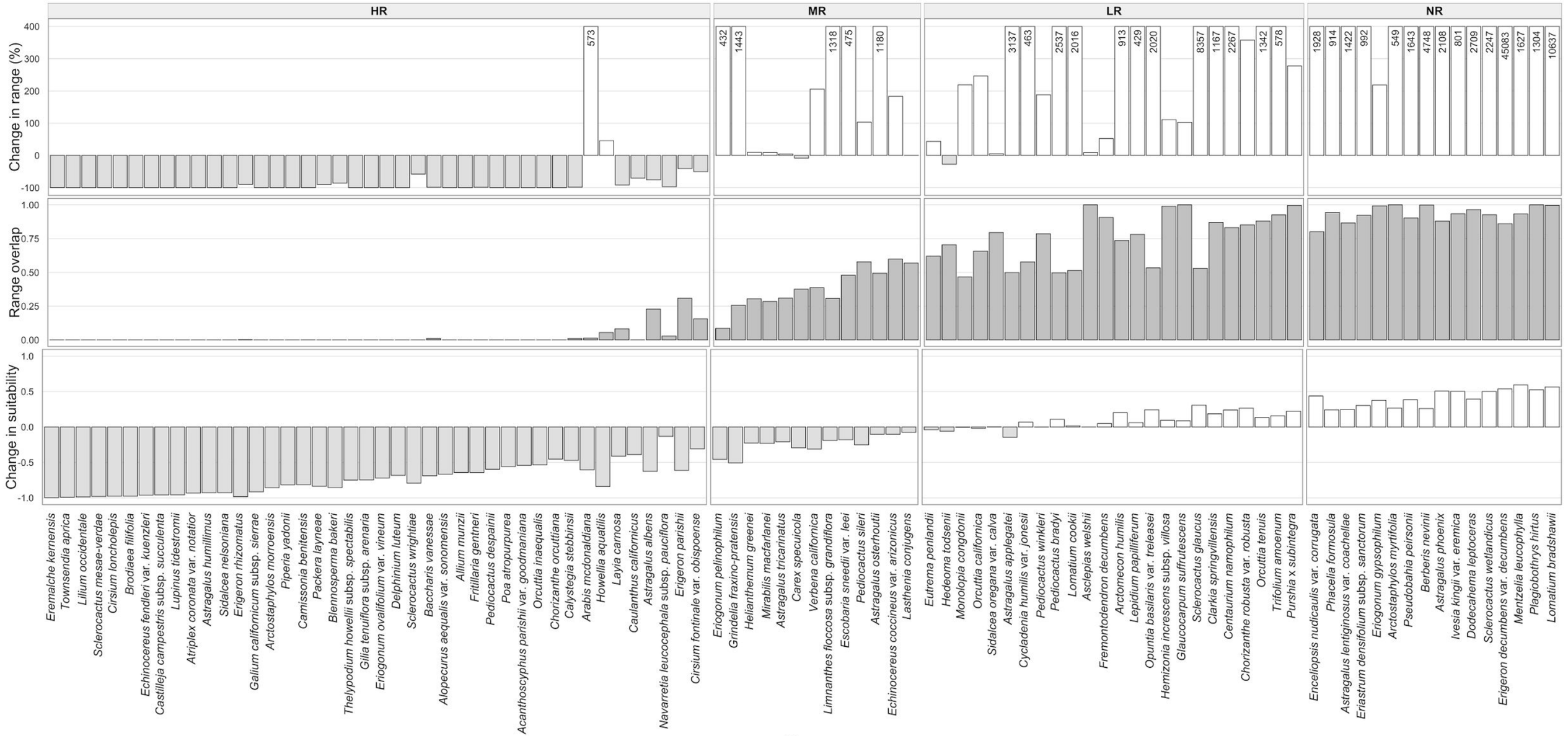
Overall results

			2020s		2050s		2080s	
			count	%	count	%	count	%
Change in range size		increasing	277	48.5	267	46.7	263	46.1
		decreasing	294	51.5	304	53.3	308	53.9
Range overlap		> 50%	286	50.1	237	41.5	218	38.2
		< 50%	285	49.9	334	58.5	353	61.8
Suitability score		increasing	176	30.8	163	28.5	149	26.1
		decreasing	395	69.2	408	71.5	422	73.9
SDM Score	highest risk	0.75-1.00					254	44.5
	moderate risk	0.50-0.75					114	20.0
	lower risk	0.25-0.50					149	26.1
	presumed not at risk	0.00–0.25					54	9.5

SDM Score (risk categories)

		2080s	
		count	%
highest risk	0.75-1.00	254	45.0
moderate risk	0.50-0.75	114	20.2
lower risk	0.25-0.50	143	25.3
presumed not at risk	0.00–0.25	54	9.6

SDM Score (risk categories)



Conservation planning:

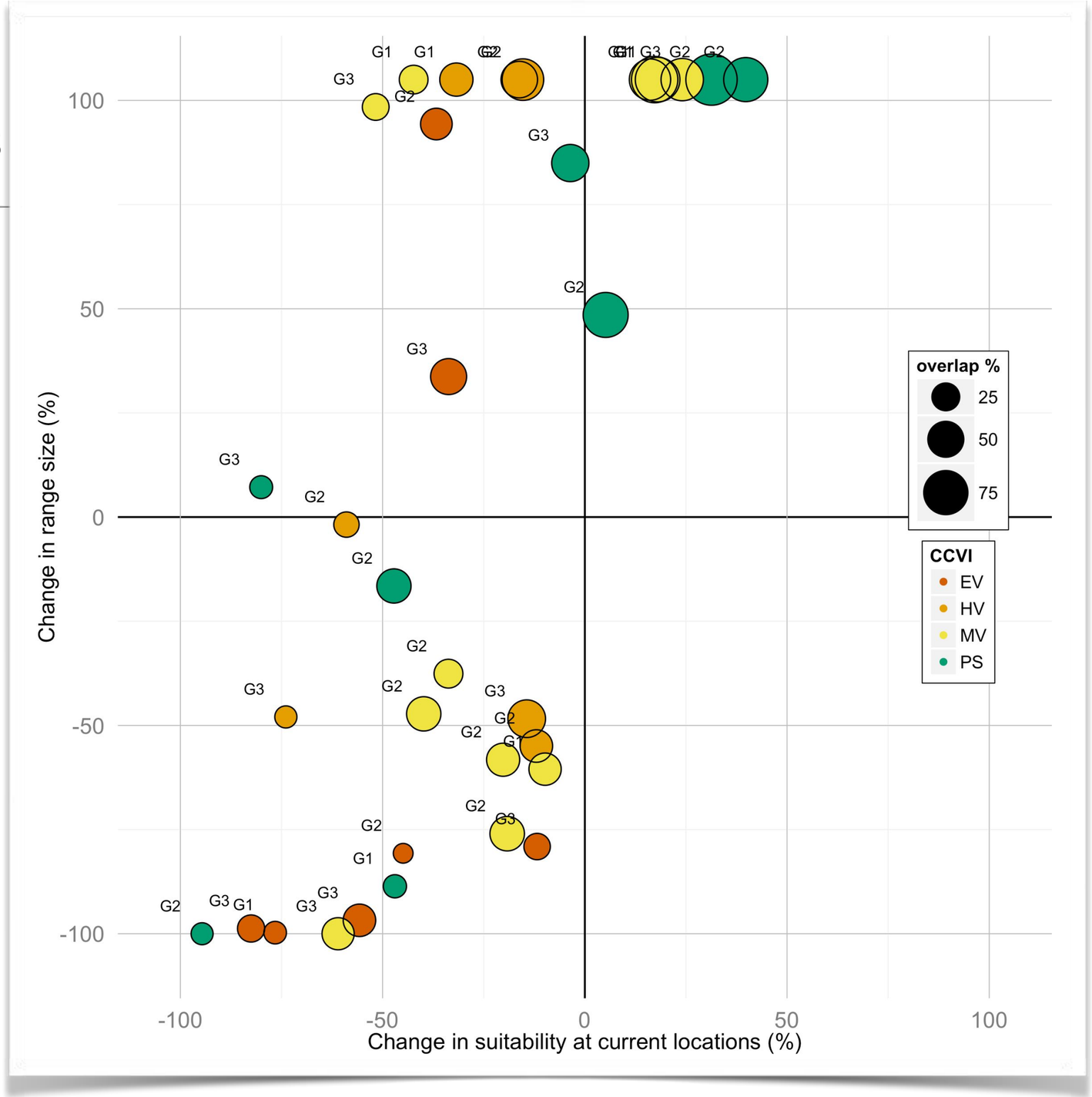
focus on species using SDM Score (overall patterns)

Lowest and highest risk taxa (by SDM Score)

2080s	
Top 10 lowest risk	**Top 10 highest risk**
Astragalus lentiformis	*Sphaeralcea janeae*
Dudleya brevifolia	*Lomatium bradshawii*
Monardella frutescens	*Penstemon barrettiae*
Townsendia aprica	*Tracyina rostrata*
Eriophyllum mohavense	*Sullivantia oregana*
Lyonothamnus floribundus subsp. *aspleniifolius*	*Plagiobothrys hirtus*
Stylocline citroleum	*Agrostis howellii*
Eremalche kernensis	*Mentzelia leucophylla*
Monardella crispa	*Erigeron decumbens* var. *decumbens*
Callitropsis pygmaea	*Eriogonum viscidulum*

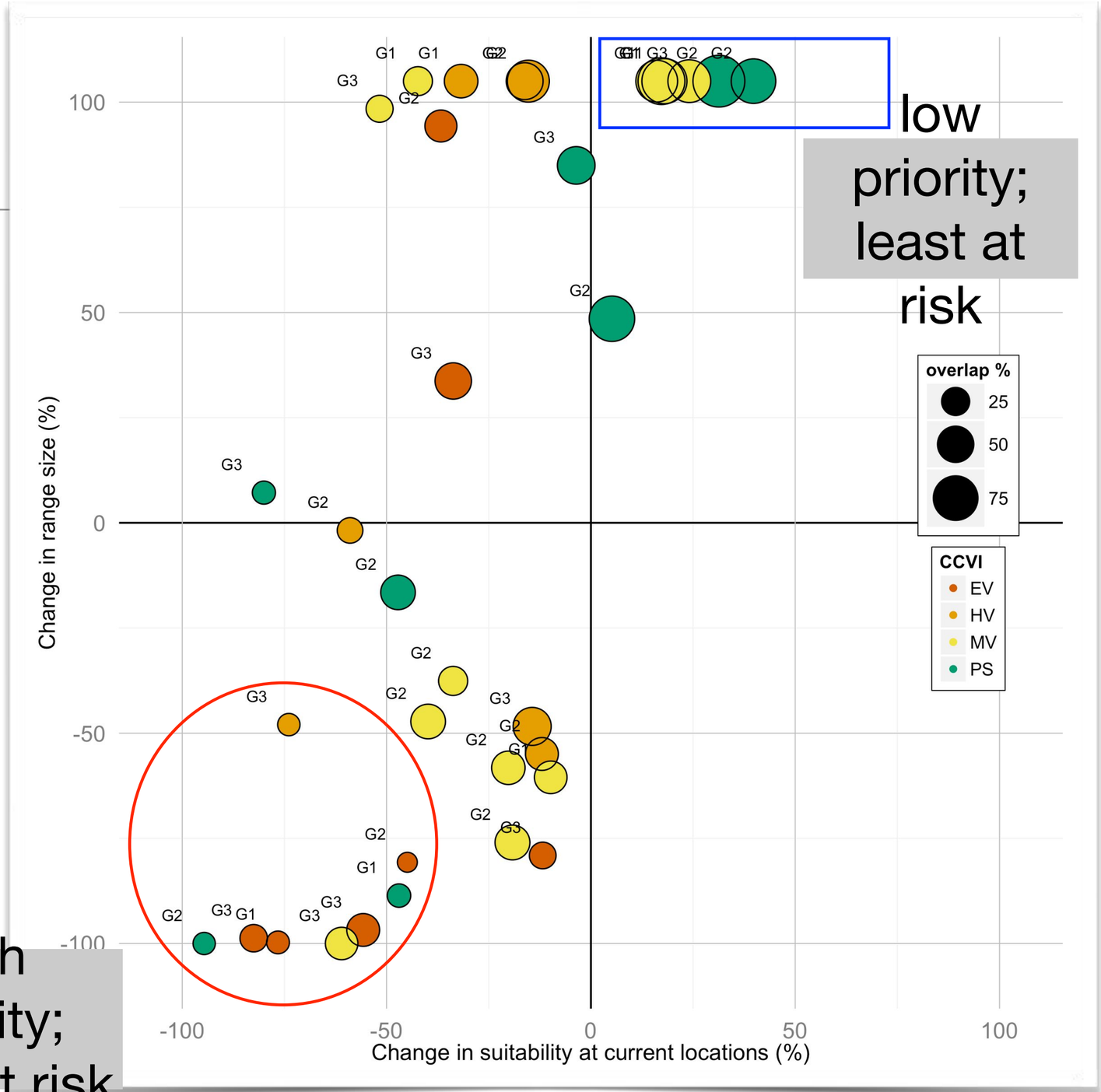
Global Ranks

- Do Global Ranks indicate future vulnerability?

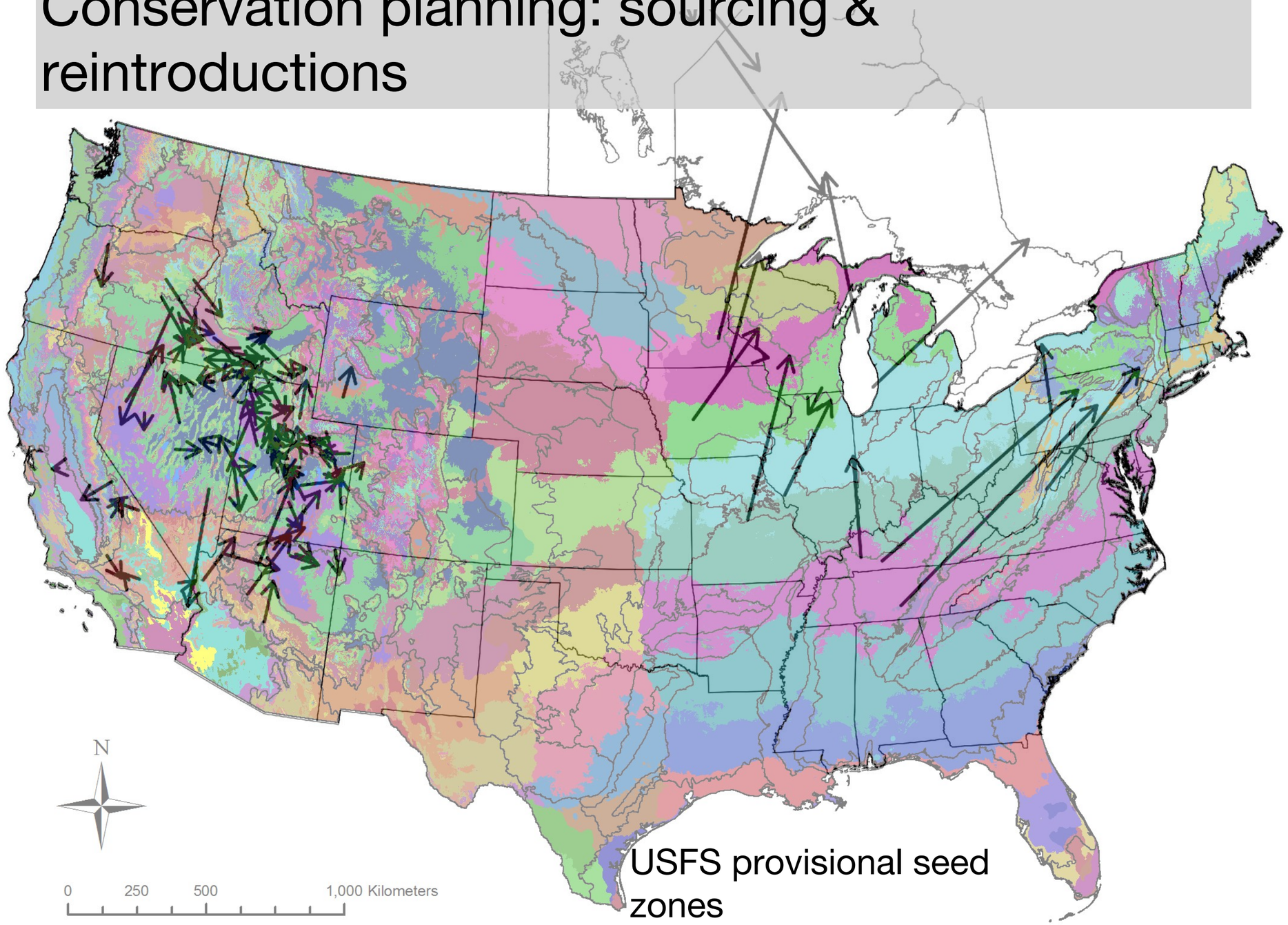


Prioritization

- Which species for conservation focus?



Conservation planning: sourcing & reintroductions



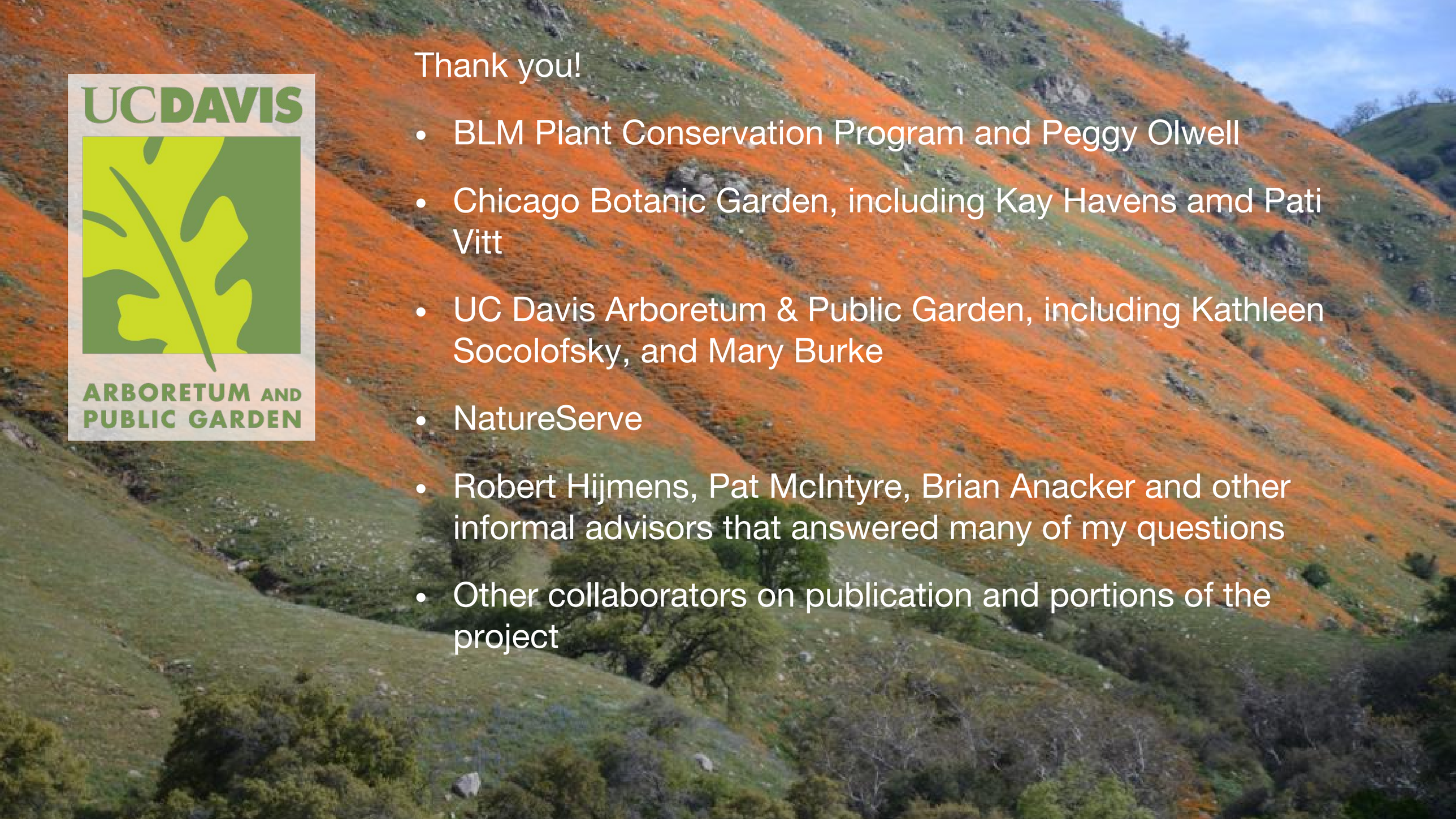
USFS provisional seed zones

Overall results

- Seeing loss of suitable habitat for ~75% of rare taxa and 75% for federally listed species
- Contraction for half of species
- Range overlap less than 50% for half of species
- Fairly consistent with CCVI but there are notable exceptions

Issues

- SDMs do not account for plasticity of plants
- May have not included factors important to the distribution (such as soils)
- Rare plants more difficult to model due to lower number of populations/occurrences
    - Doesn’t mean models are bad but we are unable to effectively test them
- Vegetation models and common plants have more locations and may develop a better climatic envelope
- Absence data can help increase the quality of models and may allow for other modeling algorithms (such as Random Forests)



Thank you!

- BLM Plant Conservation Program and Peggy Olwell
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- UC Davis Arboretum & Public Garden, including Kathleen Socolofsky, and Mary Burke
- NatureServe
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- Other collaborators on publication and portions of the project

The preceding presentation was delivered at the

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This and additional presentations available at http://nativeseed.info

NATIVE SEED NETWORK

Institute for Applied Ecology