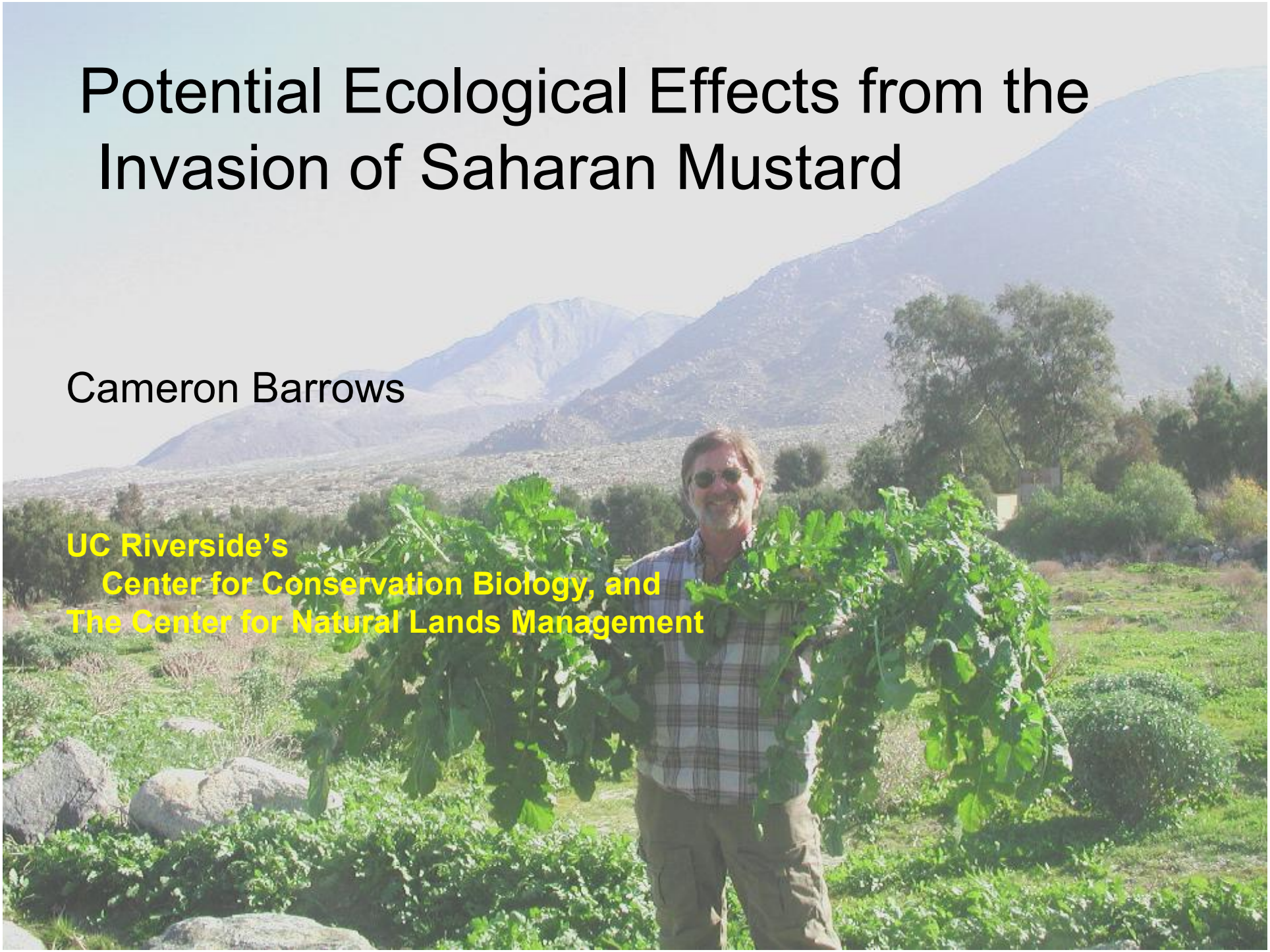
Potential Ecological Effects from the Invasion of Saharan Mustard

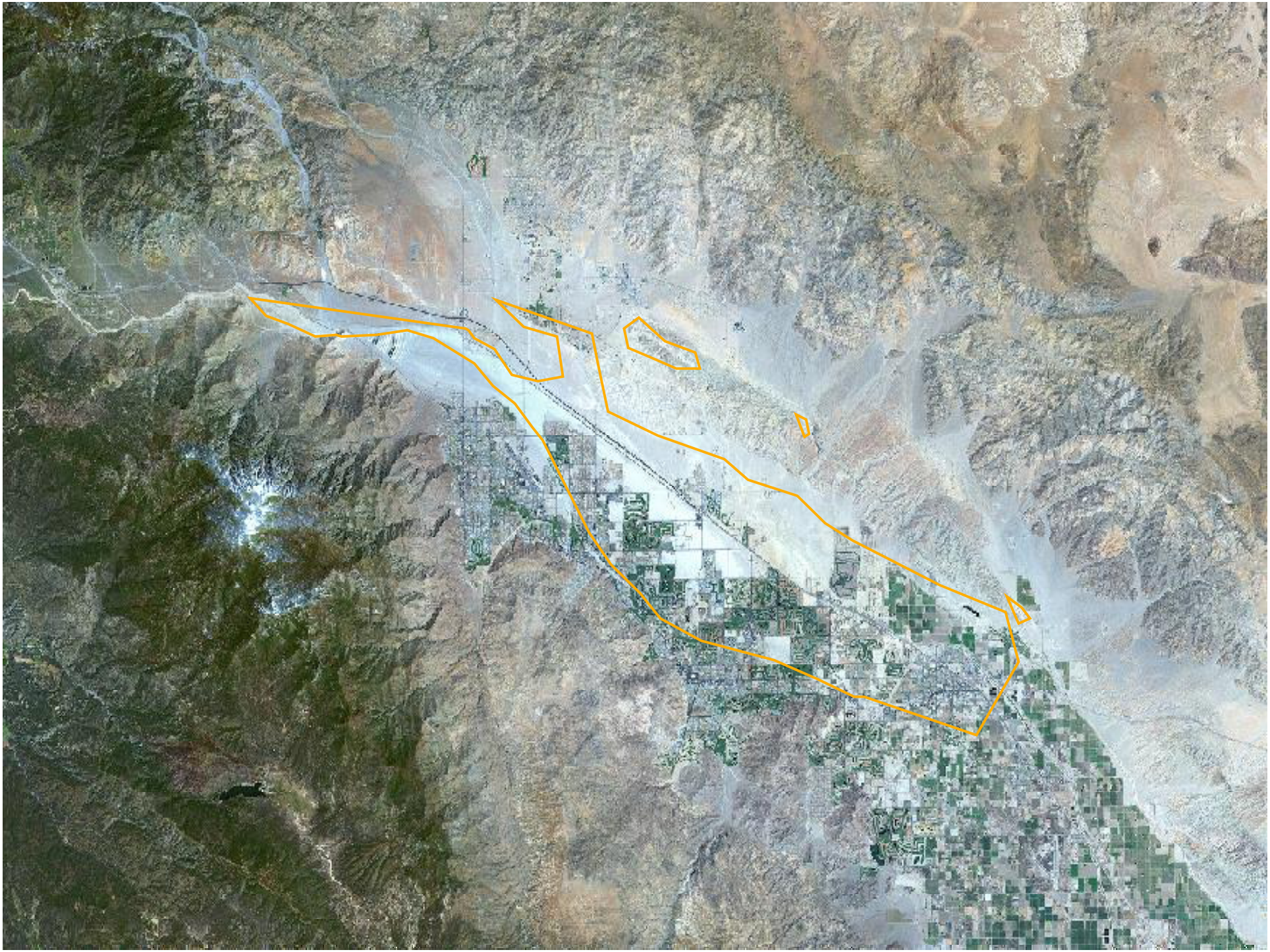
Cameron Barrows

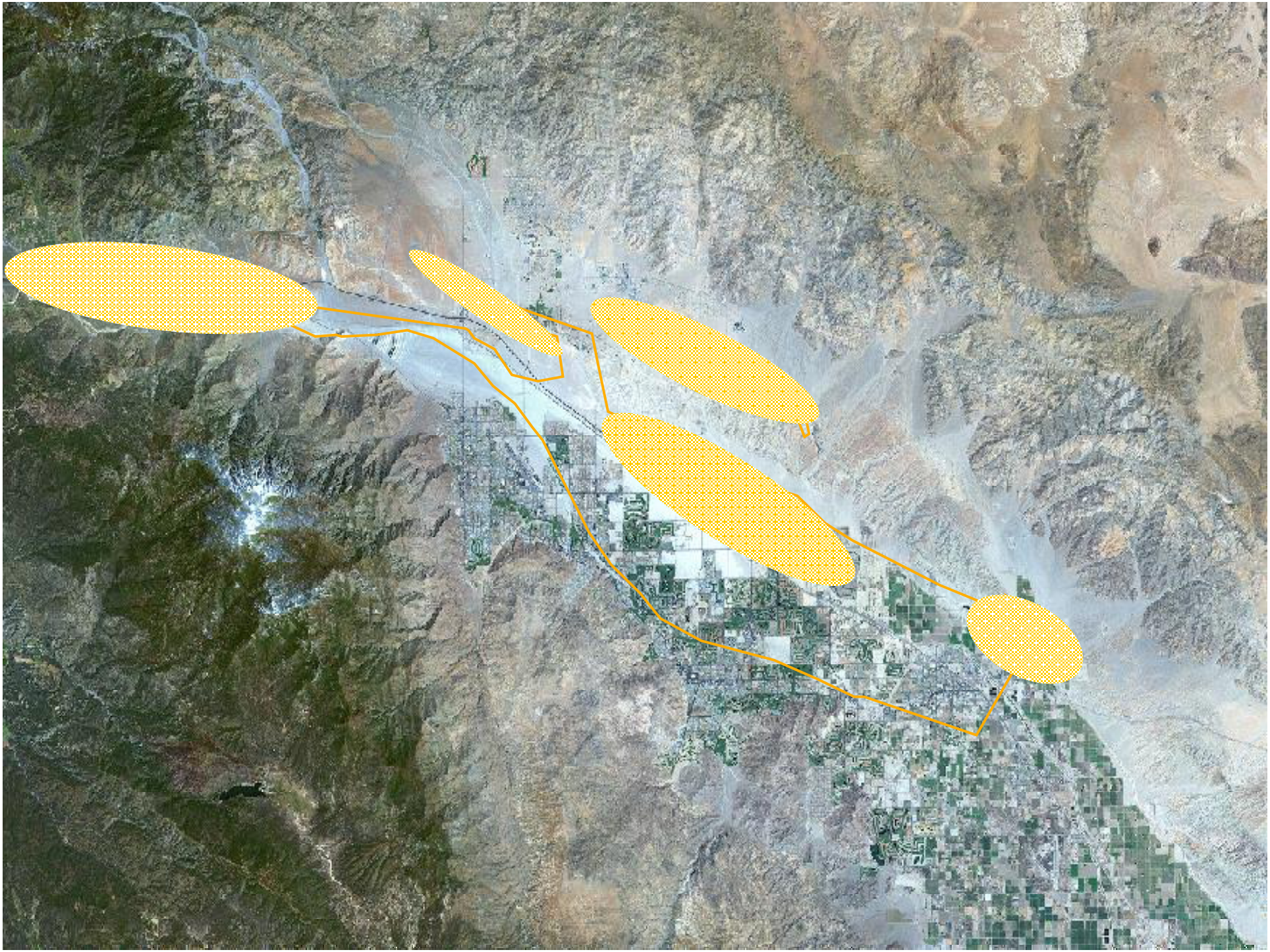
UC Riverside's
Center for Conservation Biology, and
The Center for Natural Lands Management

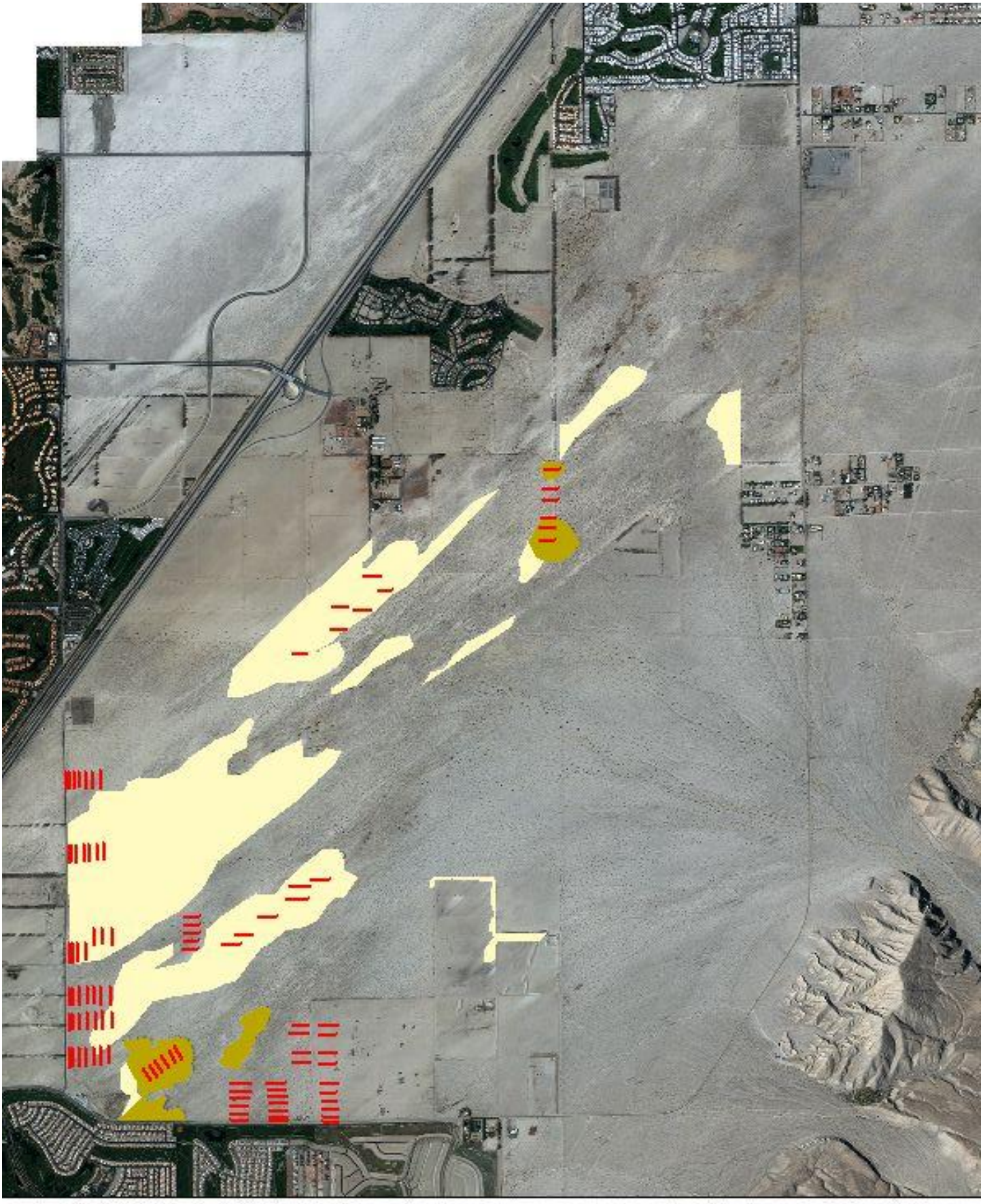


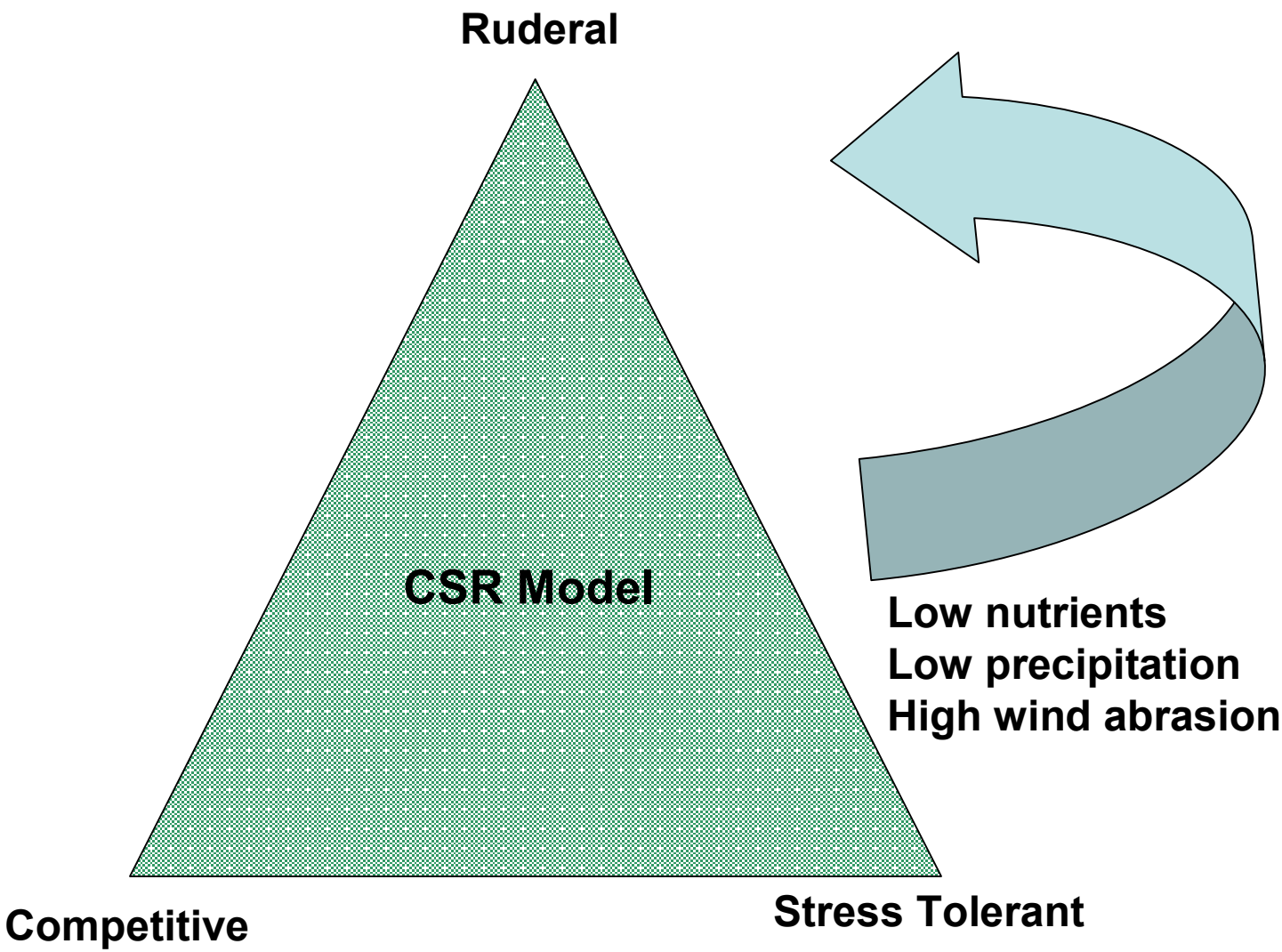
How Damaging are Invasive Species to Natural Ecosystems?

- Second only to habitat destruction as a cause for the loss of biodiversity, but…
- 10% “rule”
- In Hawaii there are over 4600 exotic species; 800 have become invasive; 86 are causing ecological damage.
- Managers must employ a triage approach to addressing invasive species.
- To have broad impacts, invasive species must alter ecological processes.

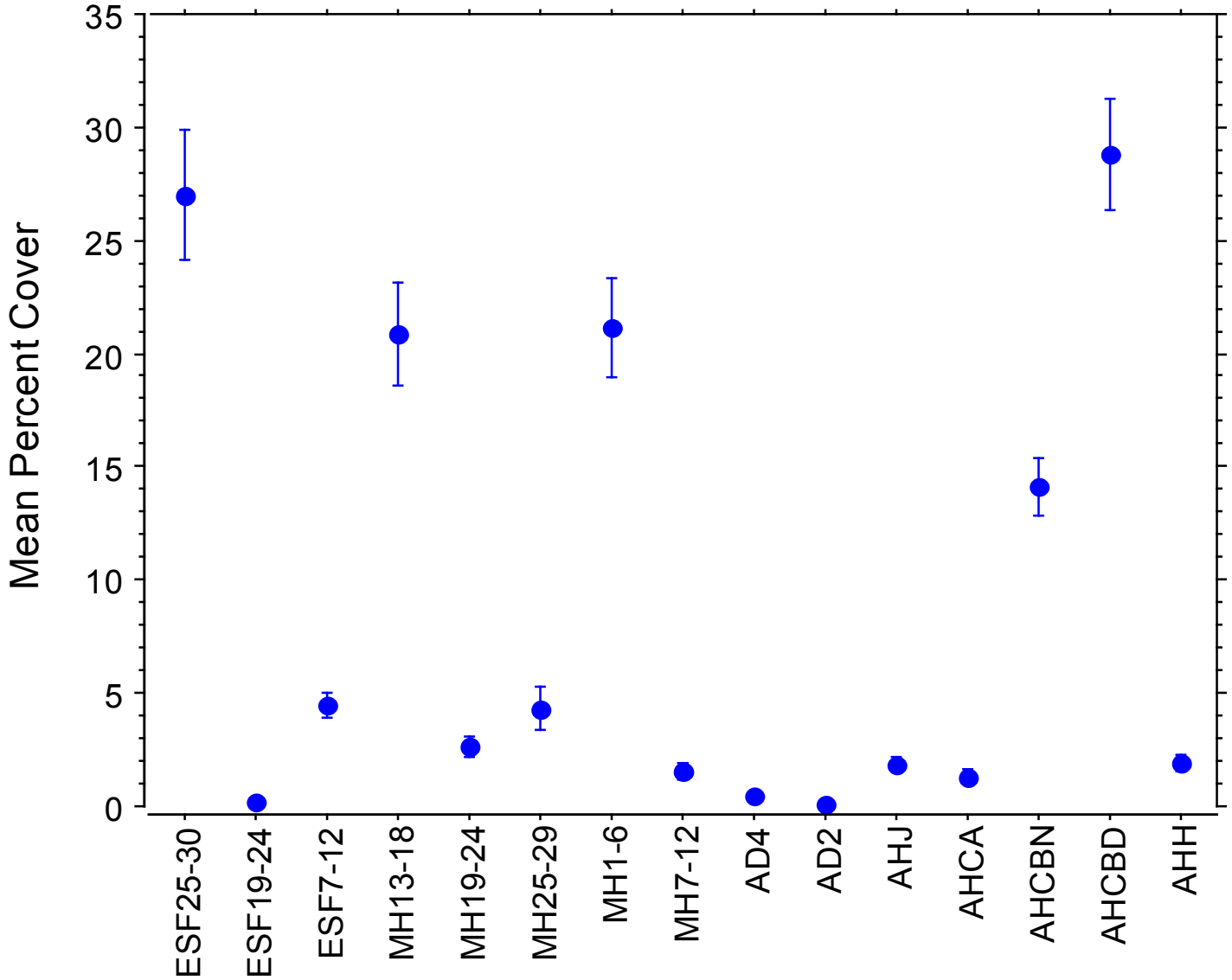




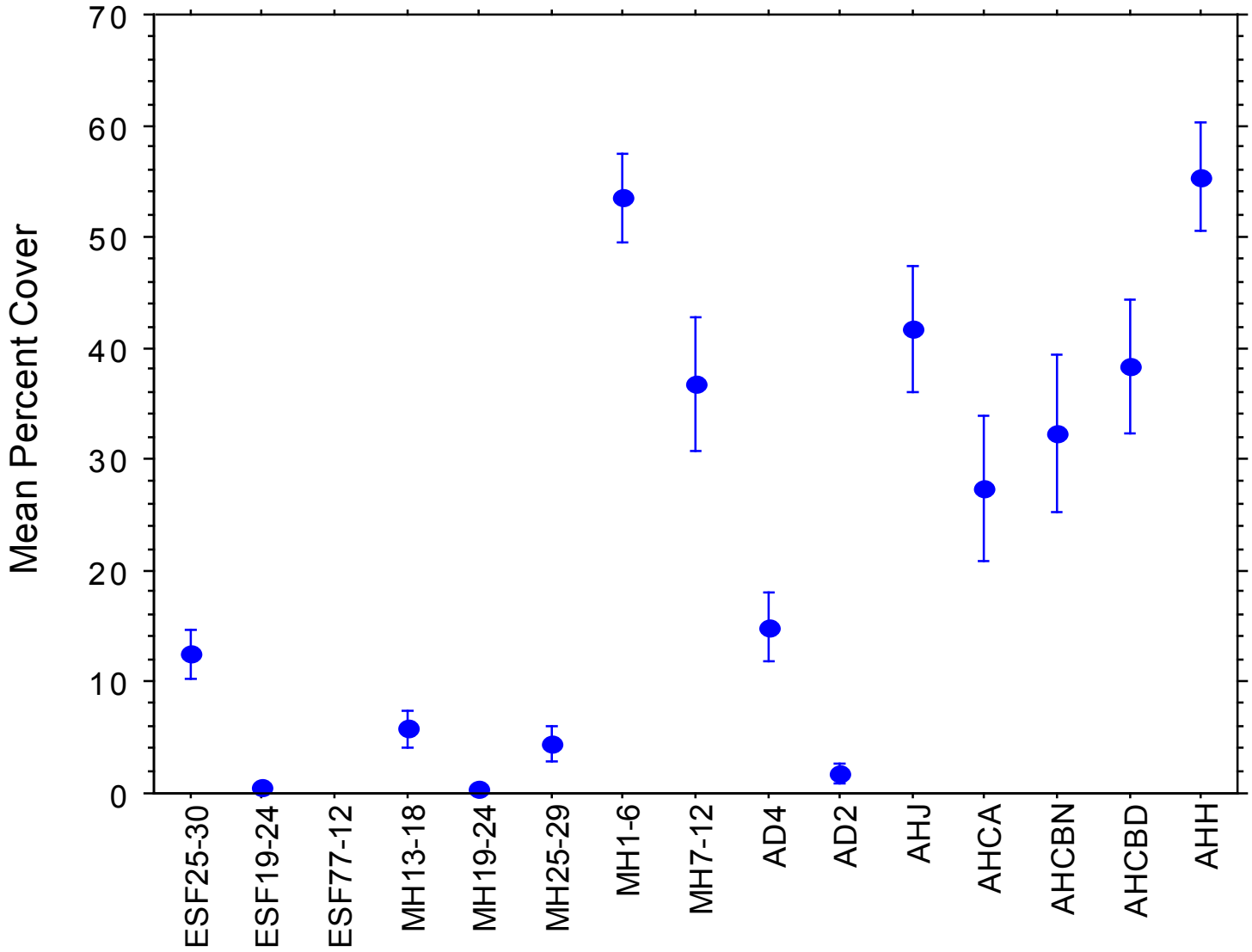


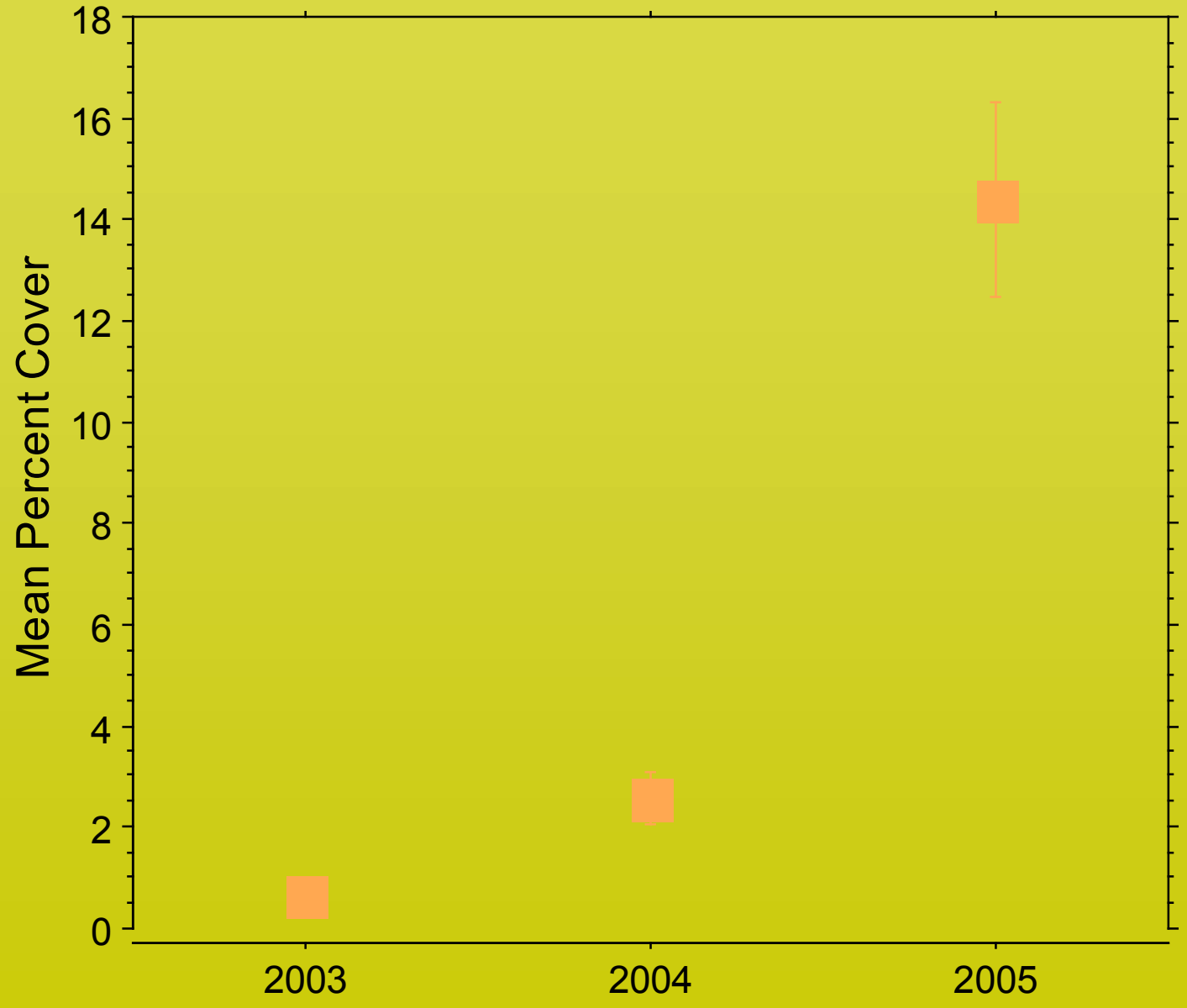

Ruderal
CSR Model
Competitive
Stress Tolerant
Low nutrients
Low precipitation
High wind abrasion

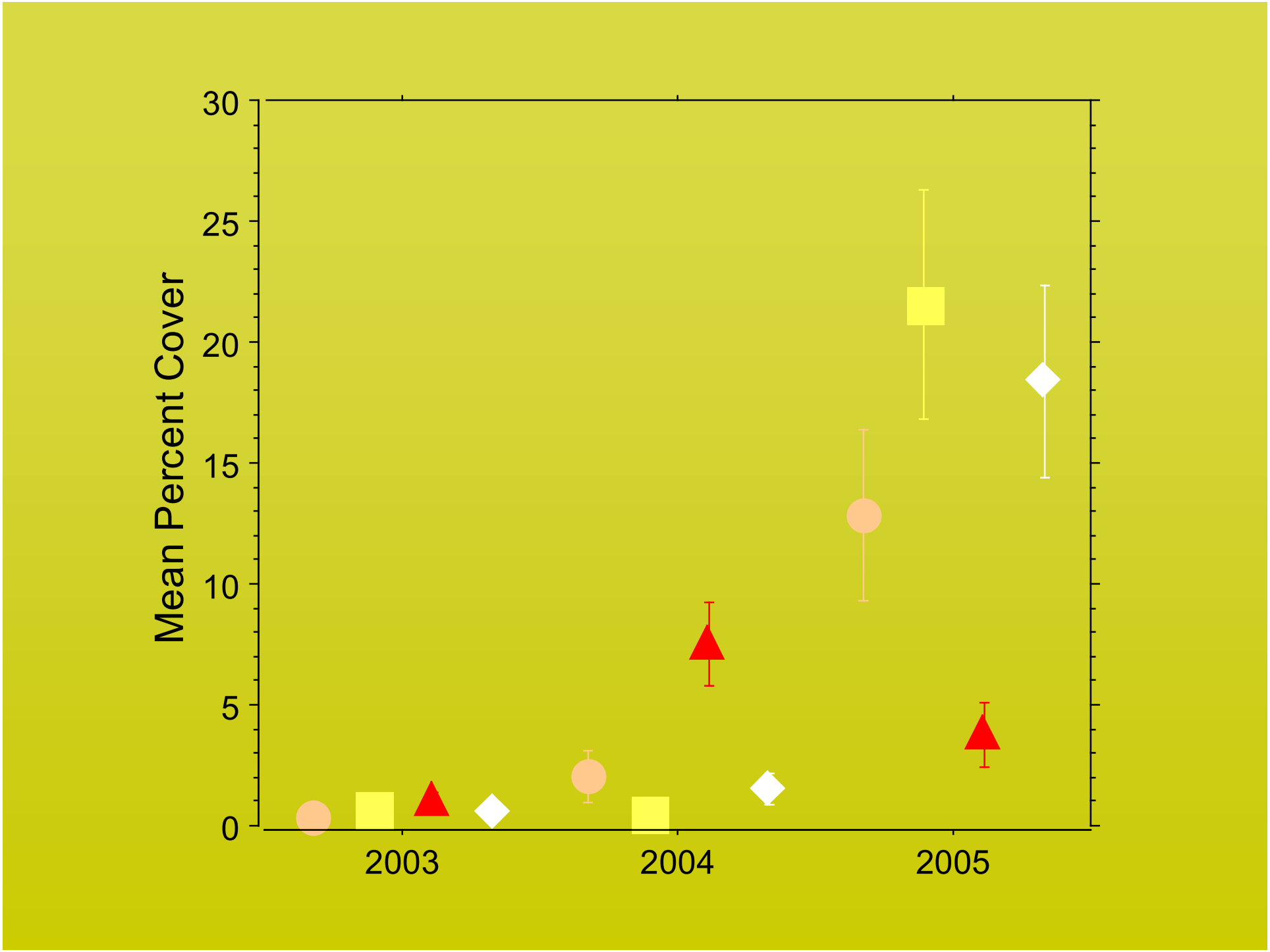
Coachella Valley *Schismus barbatus* Distribution



Coachella Valley *Brassica tourneforti* Distribution

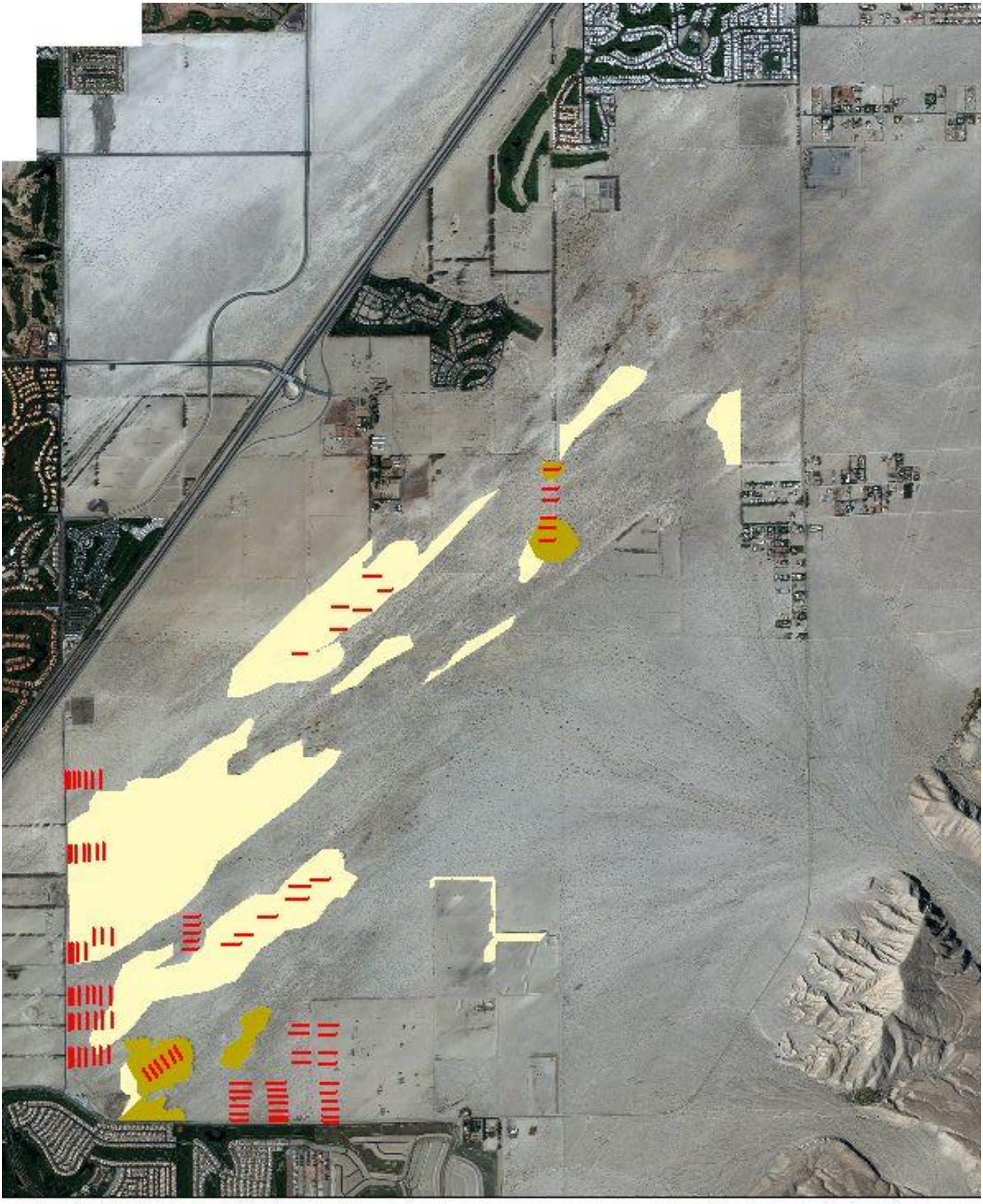


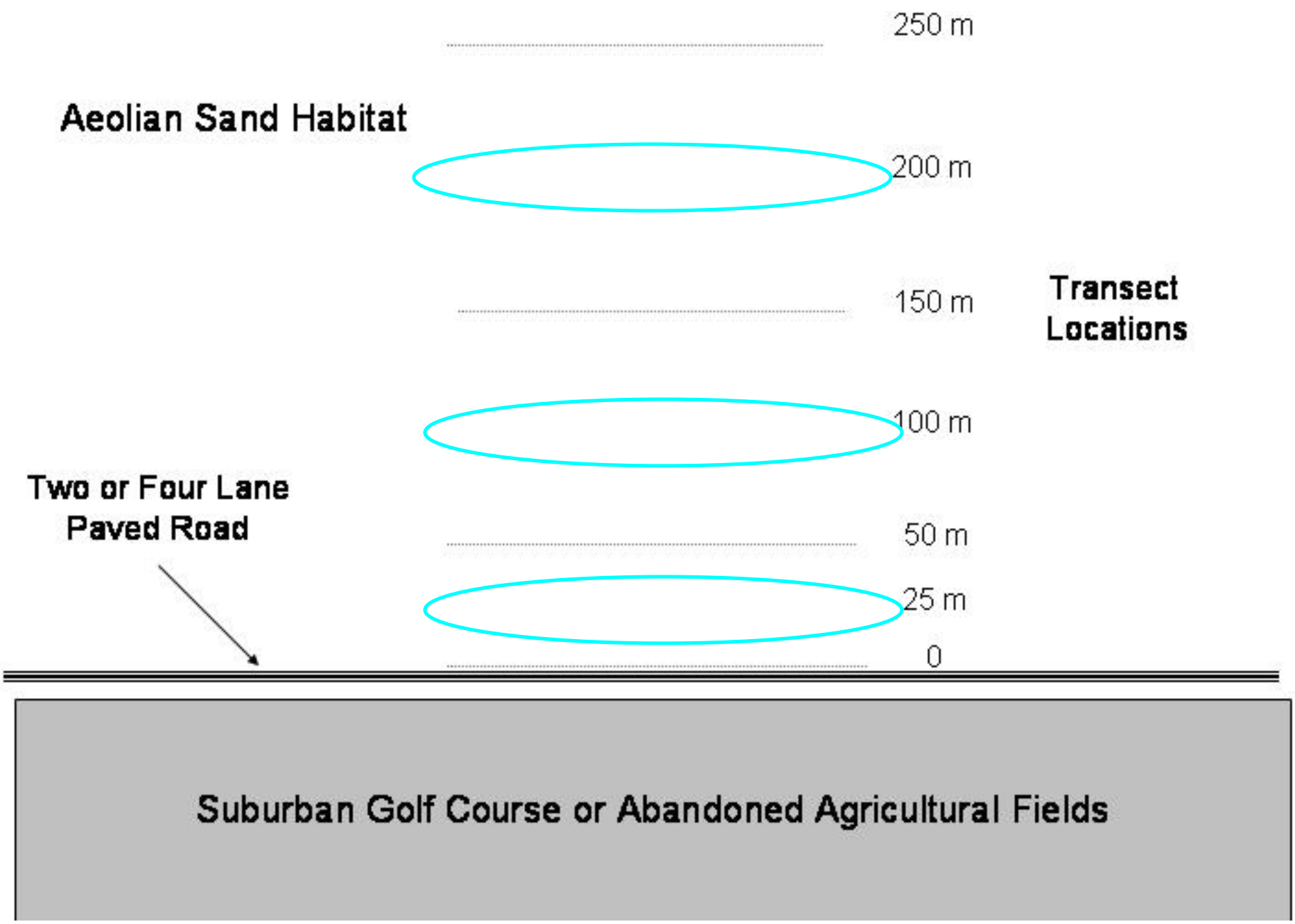

Mean Percent Cover
18
16
14
12
10
8
6
4
2
0
2003
2004
2005

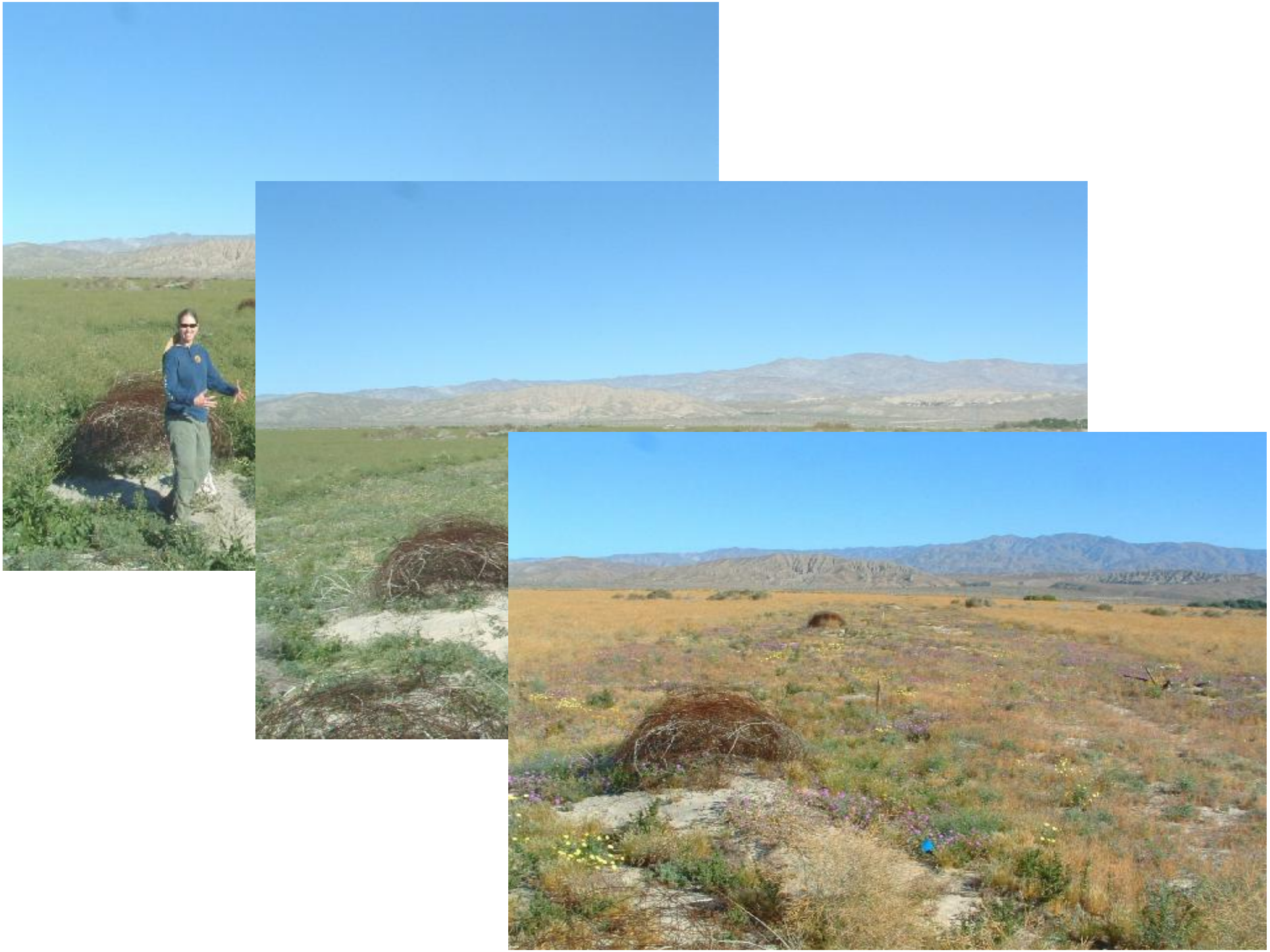

Mean Percent Cover
30
25
20
15
10
5
0
2003
2004
2005

Distributional Data for the Coachella Valley

- Saharan Mustard has been present in the Coachella Valley since at least 1927.
- Major “outbreaks” have occurred in 1977-1983, 1994-1995, and in 2005, coinciding with high rainfall.
- In outbreak years it dominates on sandy soils, but not where wind velocities are high and the sands are extremely dynamic.
- Many Coachella Valley endemics prefer the more dynamic sand dune habitats.

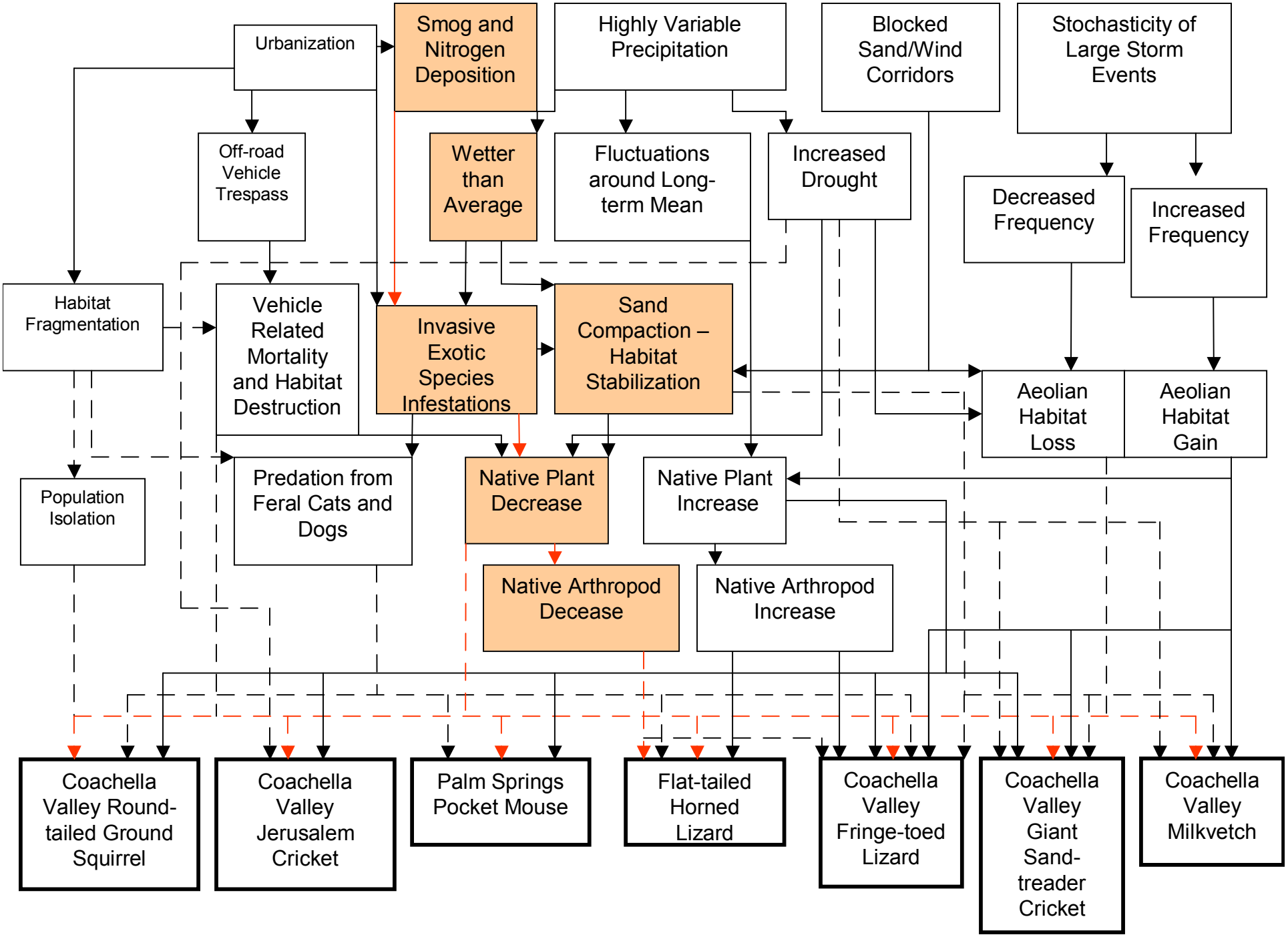



250 m
Aeolian Sand Habitat
200 m
150 m
Transect Locations
100 m
Two or Four Lane Paved Road
50 m
25 m
0
Suburban Golf Course or Abandoned Agricultural Fields



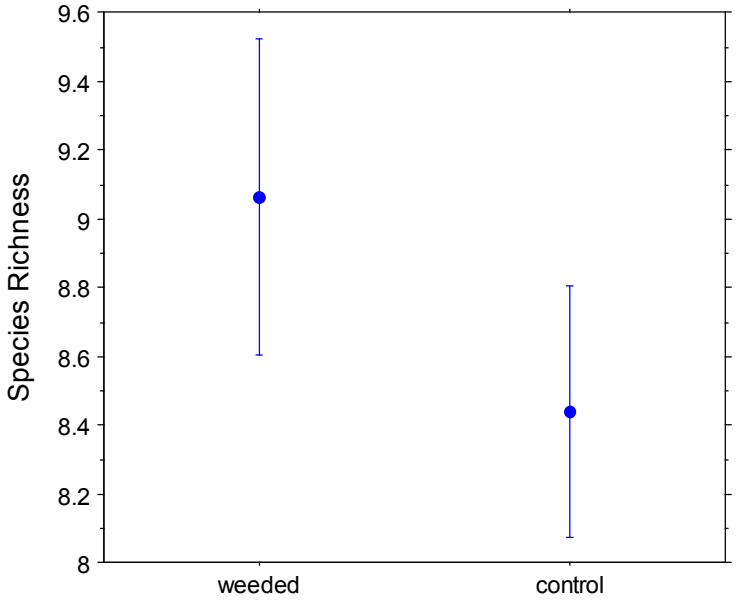
Questions:

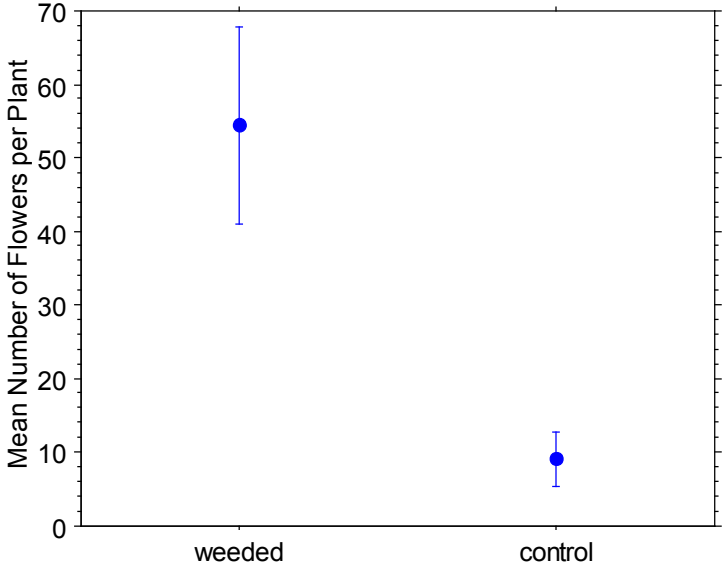
- Does the mustard have a negative impact on native annual plant species richness?
- Does the mustard have a negative impact on the reproductive success of the native annual plants?
- Is there an impact on native arthropod species richness and abundance?
- Is there an impact on native vertebrate species richness, abundance, and reproductive success?
- Does the mustard affect sand compaction?

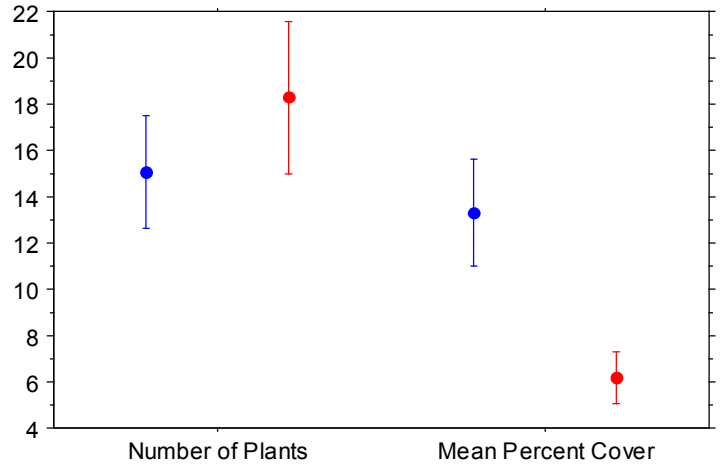

Urbanization
Smog and Nitrogen Deposition
Highly Variable Precipitation
Blocked Sand/Wind Corridors
Stochasticity of Large Storm Events
Off-road Vehicle Trespass
Wetter than Average
Fluctuations around Long-term Mean
Increased Drought
Decreased Frequency
Increased Frequency
Habitat Fragmentation
Vehicle Related Mortality and Habitat Destruction
Invasive Exotic Species Infestations
Sand Compaction – Habitat Stabilization
Aeolian Habitat Loss
Aeolian Habitat Gain
Population Isolation
Predation from Feral Cats and Dogs
Native Plant Decrease
Native Plant Increase
Native Arthropod Decease
Native Arthropod Increase
Coachella Valley Round-tailed Ground Squirrel
Coachella Valley Jerusalem Cricket
Palm Springs Pocket Mouse
Flat-tailed Horned Lizard
Coachella Valley Fringe-toed Lizard
Coachella Valley Giant Sand-treader Cricket
Coachella Valley Milkvetch

Impacts on Native Annual Plant Species

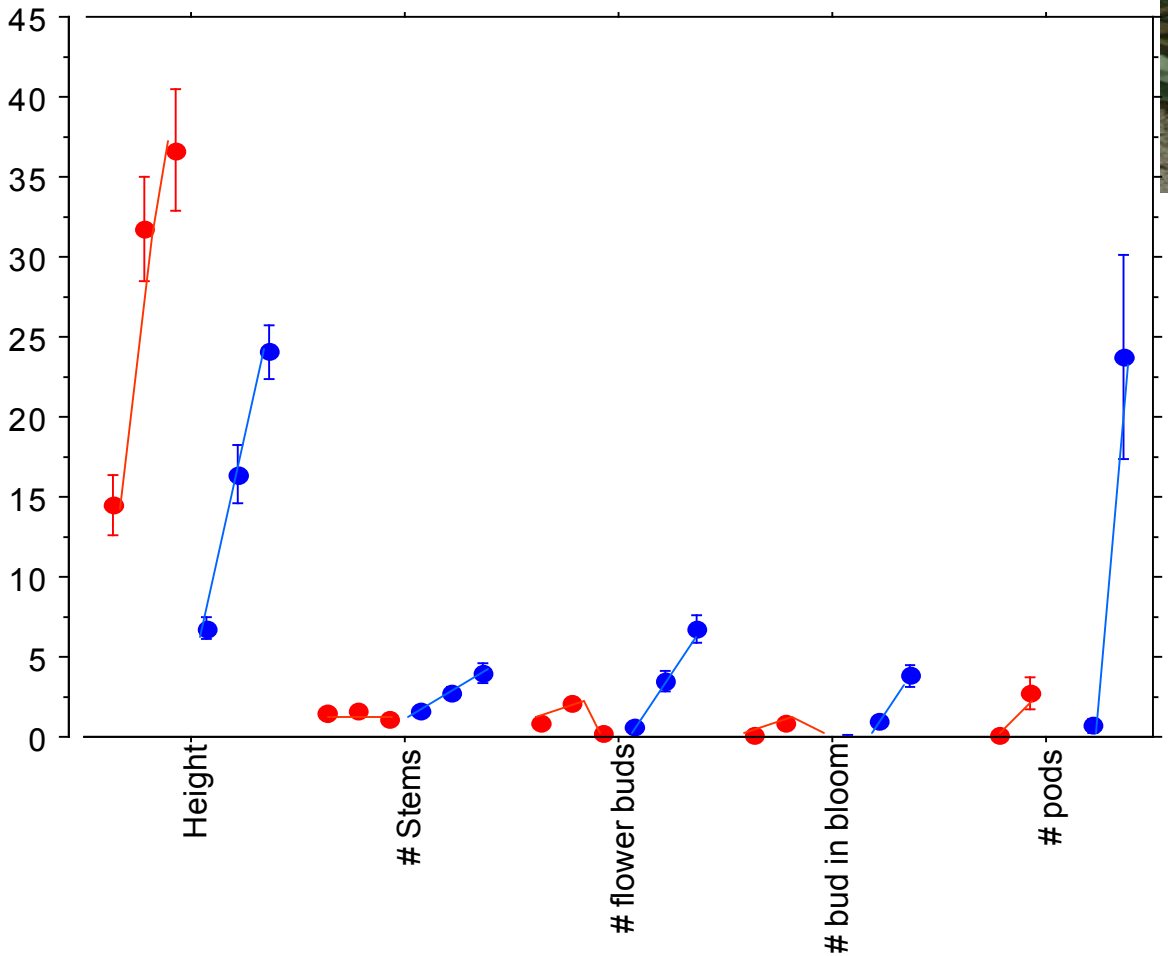
	Weeded	Control
Annual Species Richness		
Mean	**9.4**	**8.4**
	p = 0.105	
Annual Species Density		
Mean	**14.063**	**10.030**
	p = 0.020	
Annual Percent Cover		
Mean	**41.232**	**23.343**
	p = 0.007	


Species Richness
9.6
9.4
9.2
9
8.8
8.6
8.4
8.2
8
weeded
control


Mean Number of Flowers per Plant
70
60
50
40
30
20
10
0
weeded
control


22
20
18
16
14
12
10
8
6
4
Number of Plants
Mean Percent Cover

Data collected on:
2/12/2005
3/6/2005
4/1/2005



Impacts on Arthropods

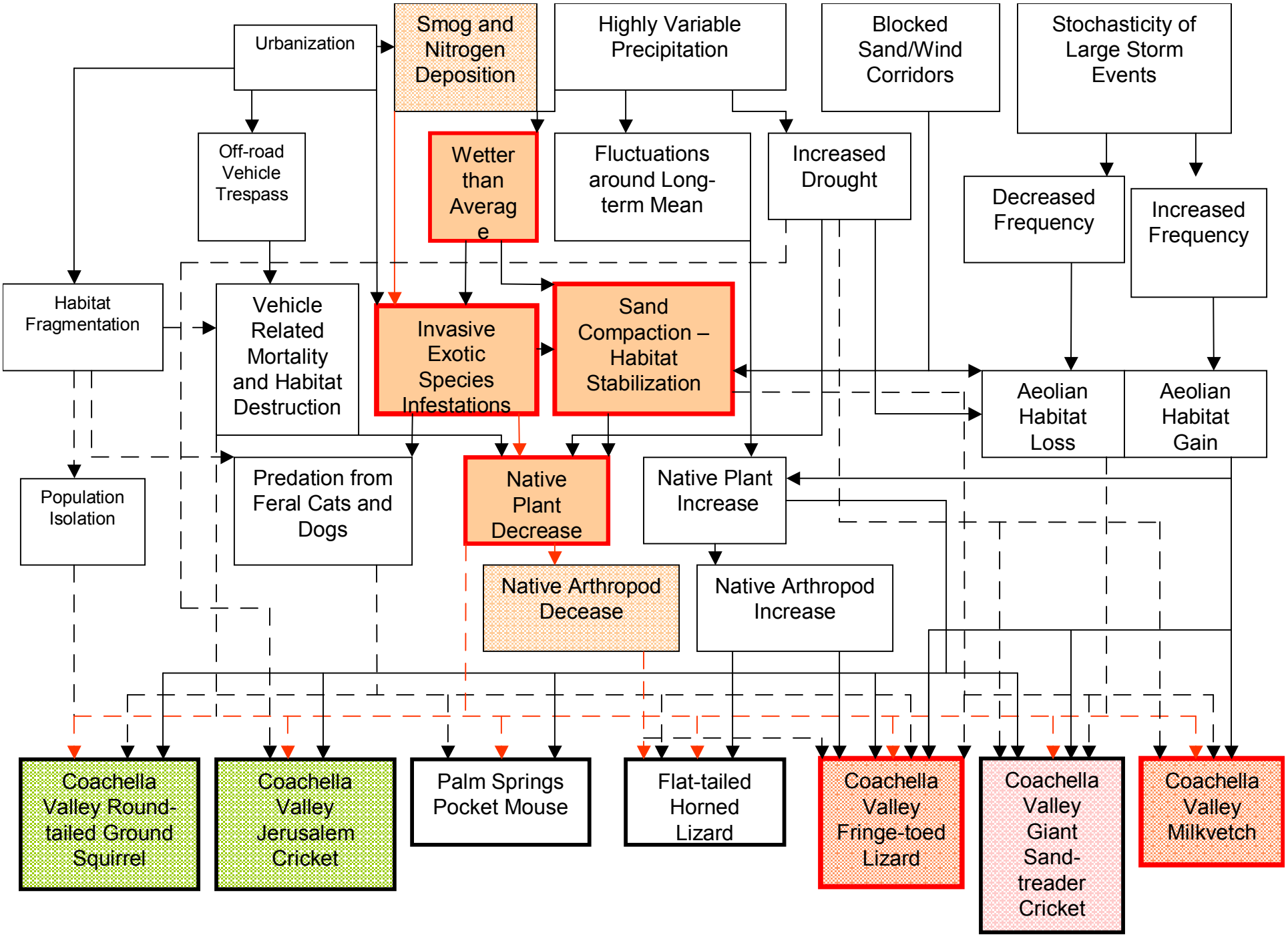
	Weeded		Control
Total Arthropod Abundance			
Mean	33.537		36.067
		p = 0.765	
% Change	- 45 %		- 32 %
Giant Sand-treader Crickets			
Mean	21.000		17.800
		p = 0.339	
% Change	+ 55 %		+ 34 %
Harvester Ants			
Mean	2.867		4.667
		p = 0.110	
% Change	- 85 %		- 64 %
Coleoptera			
Mean	16.600		11.953
		p = 0.027	
% Change	- 40 %		- 52 %

Impacts on Vertebrates

	Weeded		Control
Coachella Valley Fringe-toed Lizard			
Mean	**2.505**		**1.629**
		p = 0.009	
% Change	**+ 37 %**		**- 17 %**
Flat-tailed Horned Lizard			
Mean	**0.138**		**0.111**
		p = 0.736	
% Change	**- 49 %**		**- 55 %**
Round-tailed Ground Squirrel			
Mean	**0.915**		**1.004**
		p = 0.604	
% Change	**+ 44 %**		**+ 59 %**
Desert Kangaroo Rat			
Mean	**6.125**		**5.287**
		p = 0.001	
% Change	**+ 46 %**		**+ 33 %**
Merriam's Kangaroo Rat			
Mean	**3.287**		**3.695**
		p = 0.250	
% Change	**+ 78 %**		**+ 81 %**

Impacts on Soil Compaction

Weeded	Control
0.202 kg / cm^2	0.228 kg / cm^2
p = 0.003	
- 0.17 kg / cm^2	+ 0.032 kg / cm^2


Urbanization
Smog and Nitrogen Deposition
Highly Variable Precipitation
Blocked Sand/Wind Corridors
Stochasticity of Large Storm Events
Off-road Vehicle Trespass
Wetter than Averag e
Fluctuations around Long-term Mean
Increased Drought
Decreased Frequency
Increased Frequency
Habitat Fragmentation
Vehicle Related Mortality and Habitat Destruction
Invasive Exotic Species Infestations
Sand Compaction – Habitat Stabilization
Aeolian Habitat Loss
Aeolian Habitat Gain
Population Isolation
Predation from Feral Cats and Dogs
Native Plant Decrease
Native Plant Increase
Native Arthropod Decease
Native Arthropod Increase
Coachella Valley Round-tailed Ground Squirrel
Coachella Valley Jerusalem Cricket
Palm Springs Pocket Mouse
Flat-tailed Horned Lizard
Coachella Valley Fringe-toed Lizard
Coachella Valley Giant Sand-treader Cricket
Coachella Valley Milkvetch

Conclusions

- Saharan mustard abundance, and therefore its impact, in the Coachella Valley is dynamic, mediated by stochastic inputs (rain) and local site conditions, including wind velocity, sand movement, and soil type.
- Short-term impacts to biodiversity are uneven, with negative impacts predominantly on those species associated with loose aeolian sands, and on native annual plant reproduction.
- The larger size and resistance to wind of this mustard compared to native annual plants alters a key process shaping the character and quality of aeolian sand habitats.
- Even modest control efforts yield measurable results.

Other Potential Impacts

- Fire Frequency
- Tortoises

Additional Questions

- While Saharan mustard has been present here since 1927, and there have been multiple “outbreak” years, with each successive outbreak does the mustard expand its dominance and extent of its impact?
- Is there an incremental trajectory of dune stabilization associated with the mustard?
- What role does nitrogen deposition play in mustard occurrence?
- Does the sand stabilization caused by the mustard facilitate nitrogen deposition and/or *Schismus barbatus* invasion?
- Are there lingering impacts to biodiversity after mustard abundance declines in drought years?
- What are long-term impacts to native annual plant seed banks ?
- What are long-term impacts to harvester ants?

ACKNOWLEDGMENTS

Funding for this research
was provided by the Coachella Valley Association of Governments, and the California Department of Fish and Game.

We particularly thank
James Sullivan, Kim Nicol, Brenda Johnson and Eric Loft.

Monica Swartz, Donna Thomas, Marisa Sripracha, Thomas Prentice, Brandon Mutrux, Darrell Hutchinson, Glenn Jones and K.D. Fleming provided essential support in collecting and summarizing data.