Long-term Plant Responses to Increasing Aridity in the Sonoran Desert and Southwestern U.S.

Seth Munson – Southwest Biological Science Center, US Geological Survey, Flagstaff, AZ

Jayne Belnap – US Geological Survey
Robert Webb – University of Arizona
Andy Hubbard – National Park Service

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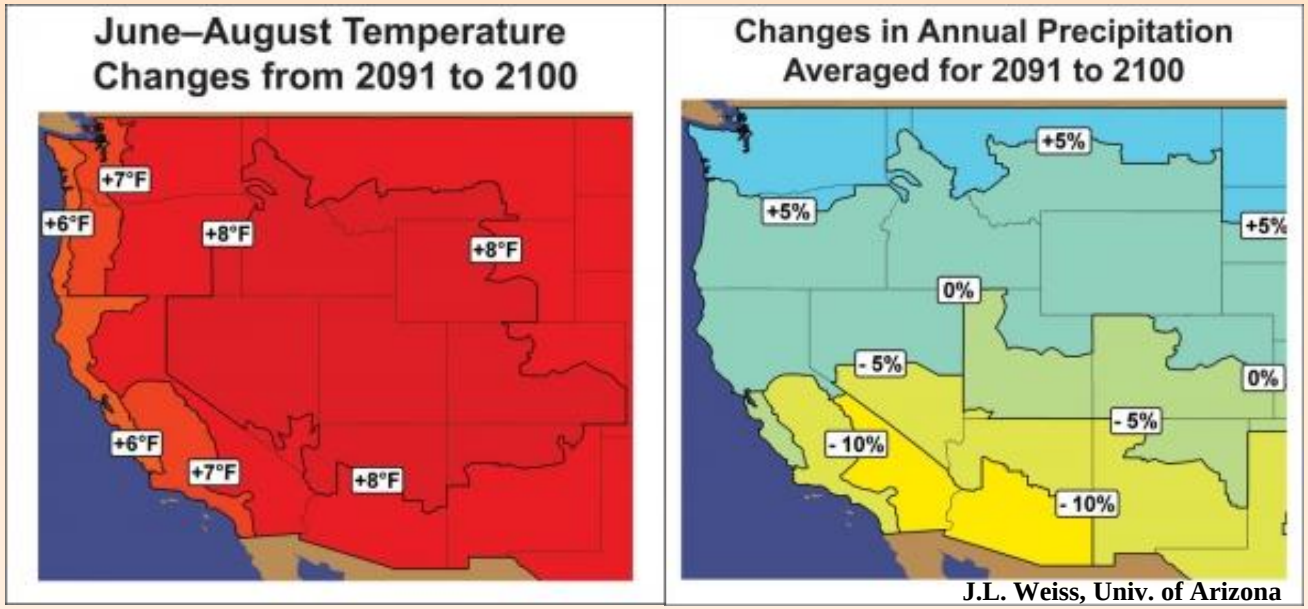
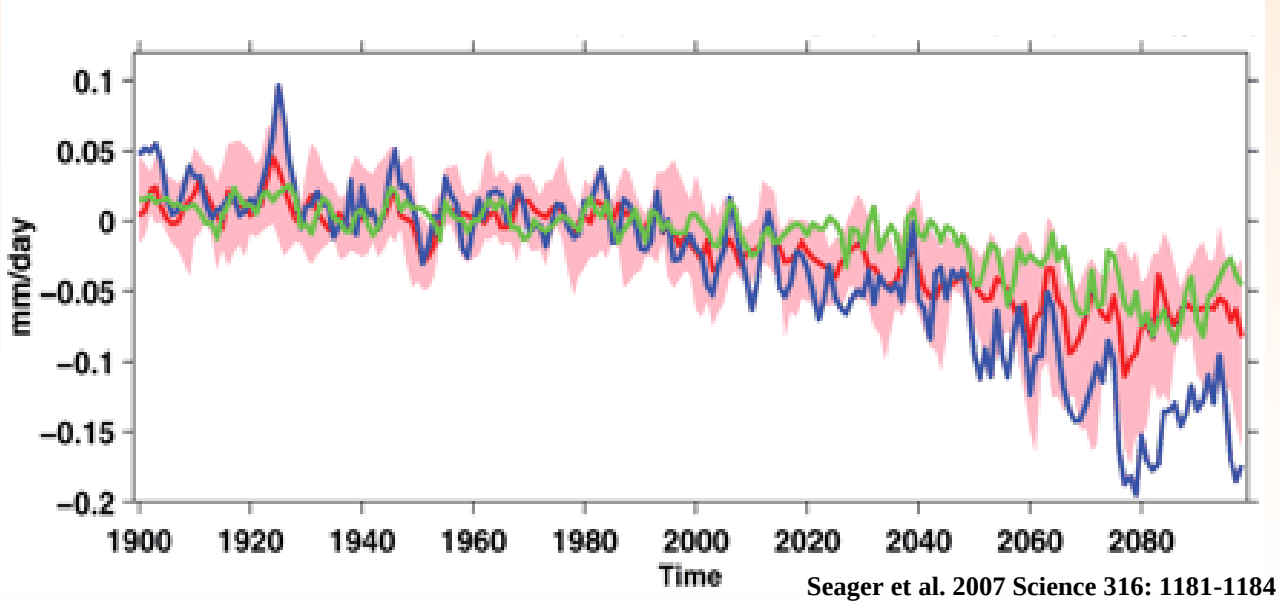
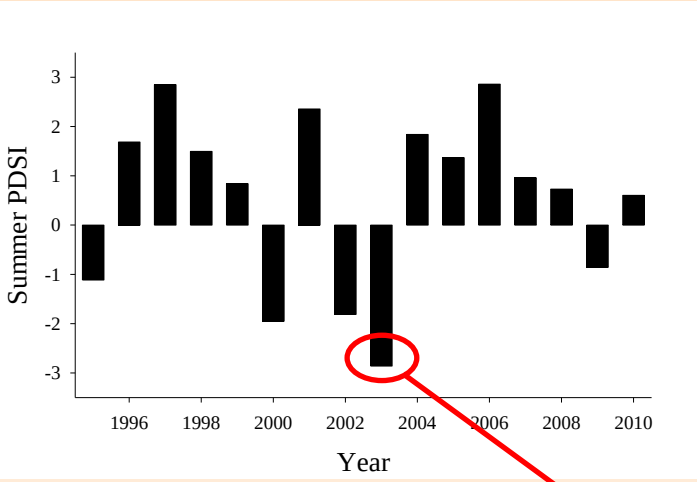
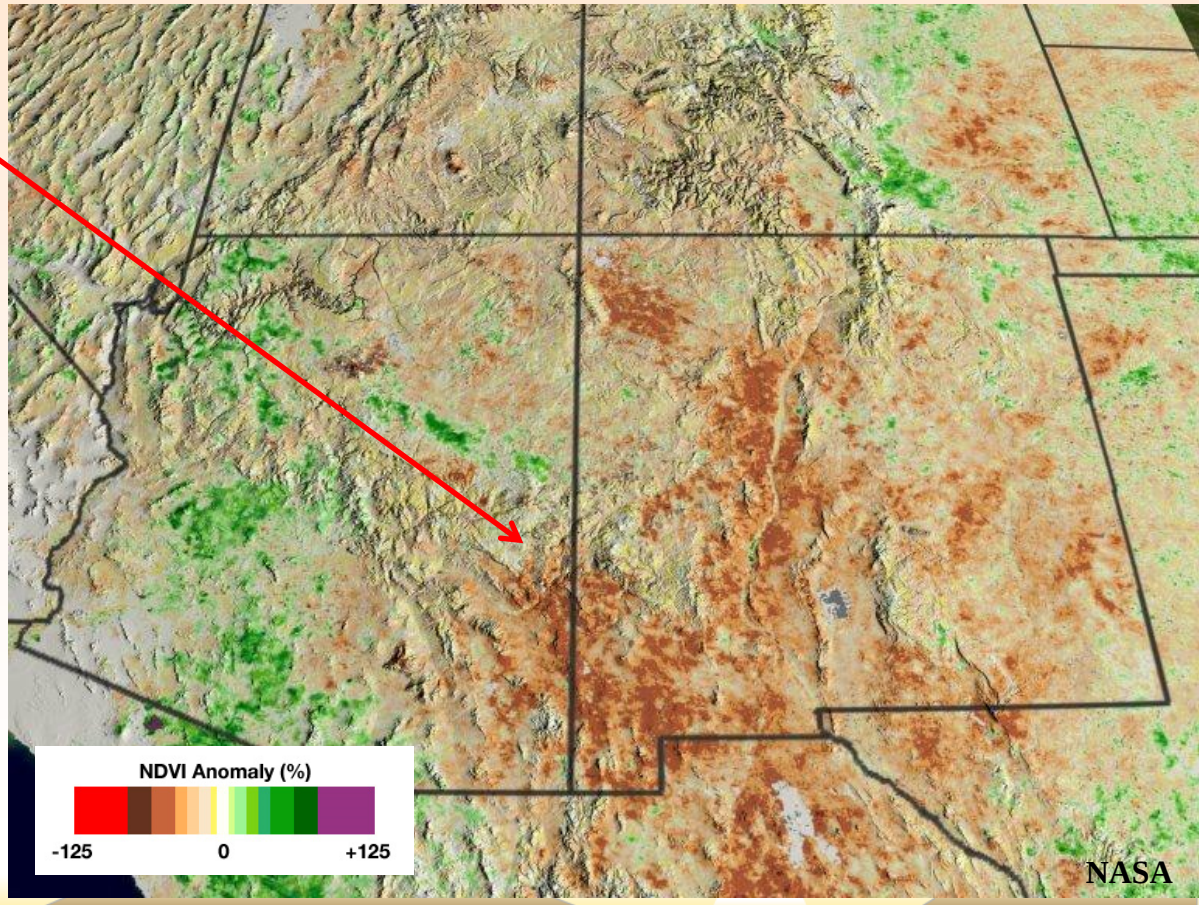


J.L. Weiss, Univ. of Arizona

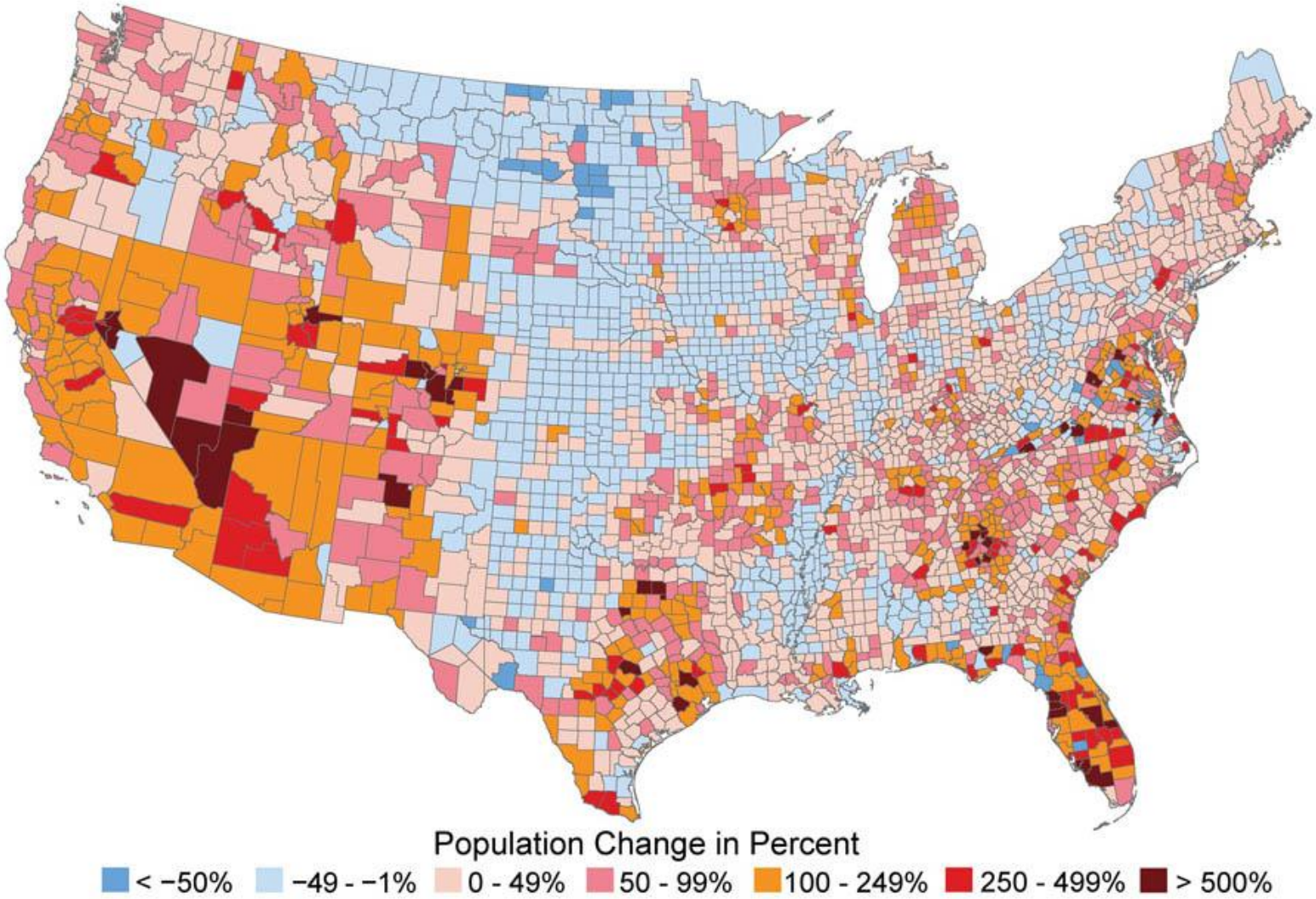


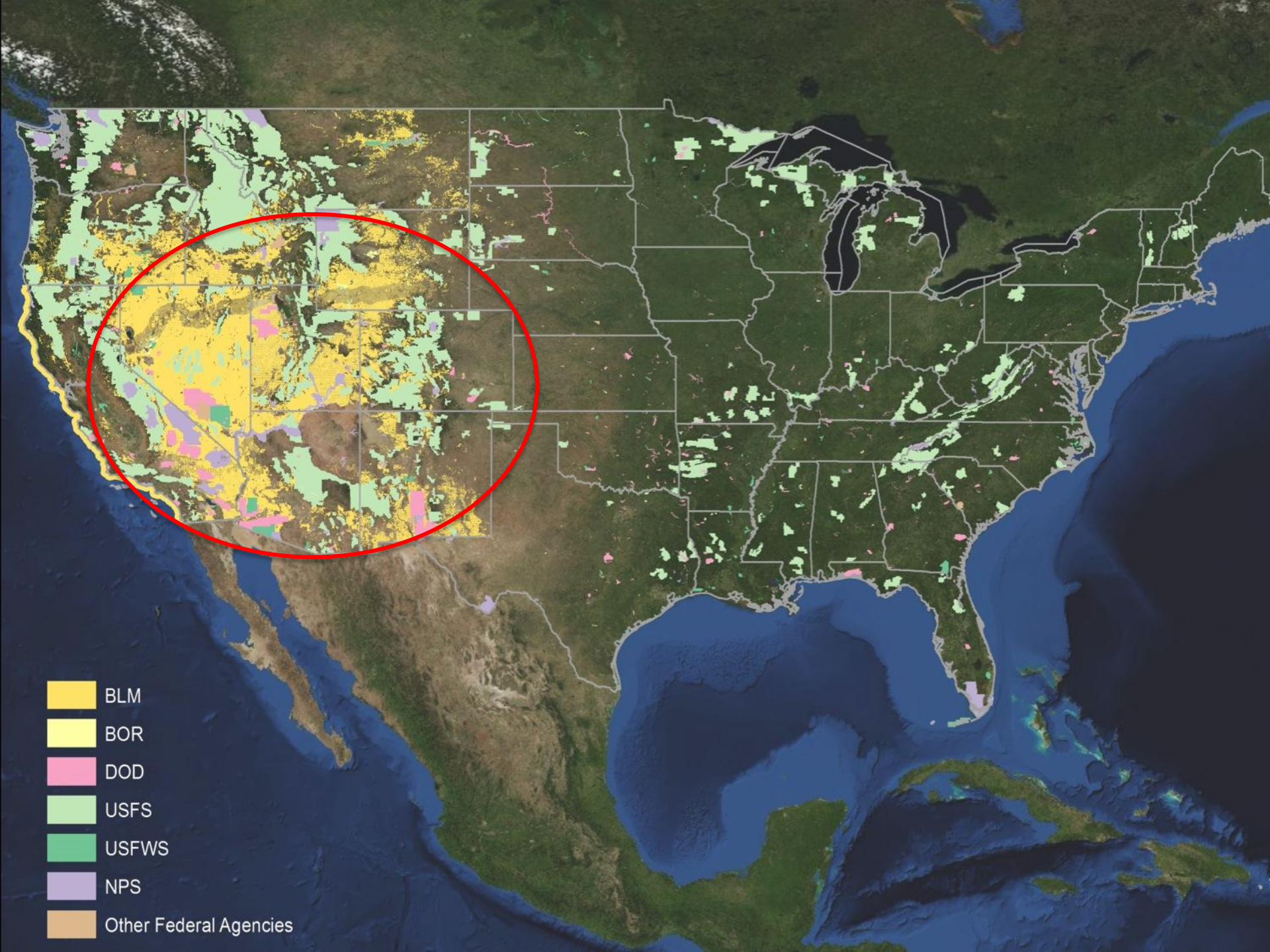
Seager et al. 2007 Science 316: 1181-1184


Summer PDSI
3
2
1
0
-1
-2
-3
1996
1998
2000
2002
2004
2006
2008
2010
Year


NDVI Anomaly (%)
-125
0
+125
NASA

1970 – 2008

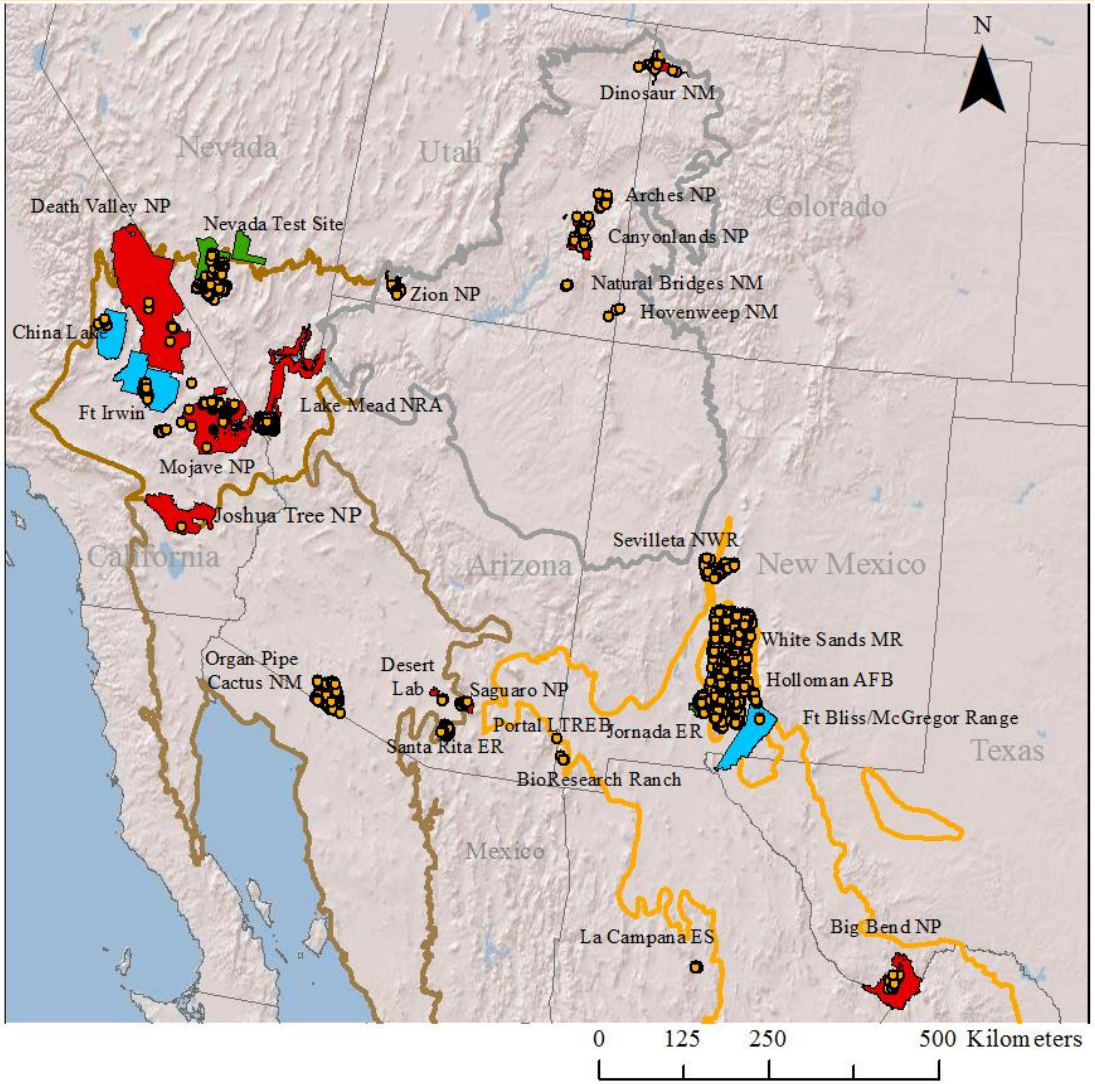

Population Change in Percent
< −50%
−49 - −1%
0 - 49%
50 - 99%
100 - 249%
250 - 499%
> 500%


BLM
BOR
DOD
USFS
USFWS
NPS
Other Federal Agencies

Long-term Vegetation Monitoring Sites

1500+ study plots that have been repeatedly measured

Over a century of monitoring from 1906 – 2014



Legend

- Colorado Plateau
- Chihuahuan
- Mojave
- Sonoran
- Department of Interior
- Department of Defense
- Other Federal Land
- Private Land
- Long-Term Monitoring Site

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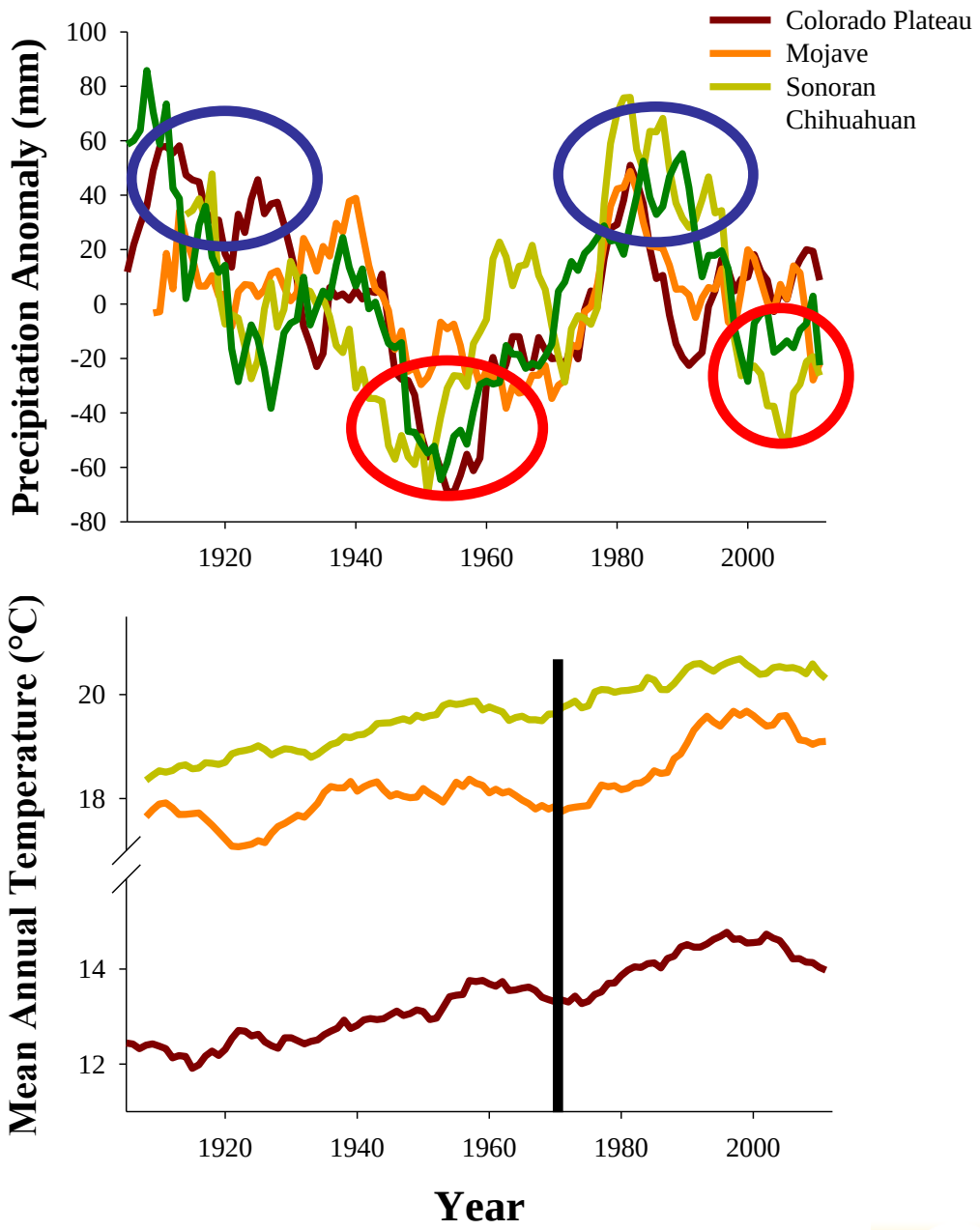
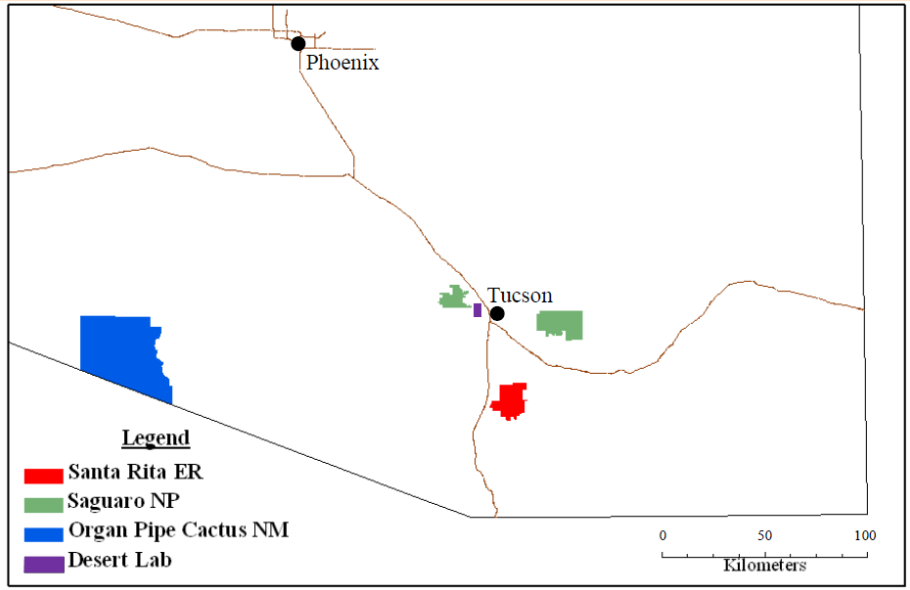
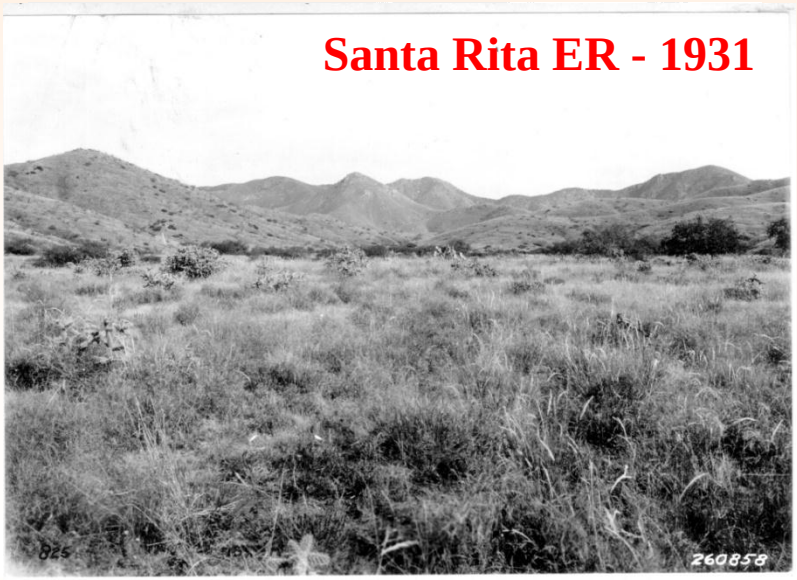
Historical Climate (1900-2013)



Sonoran Desert





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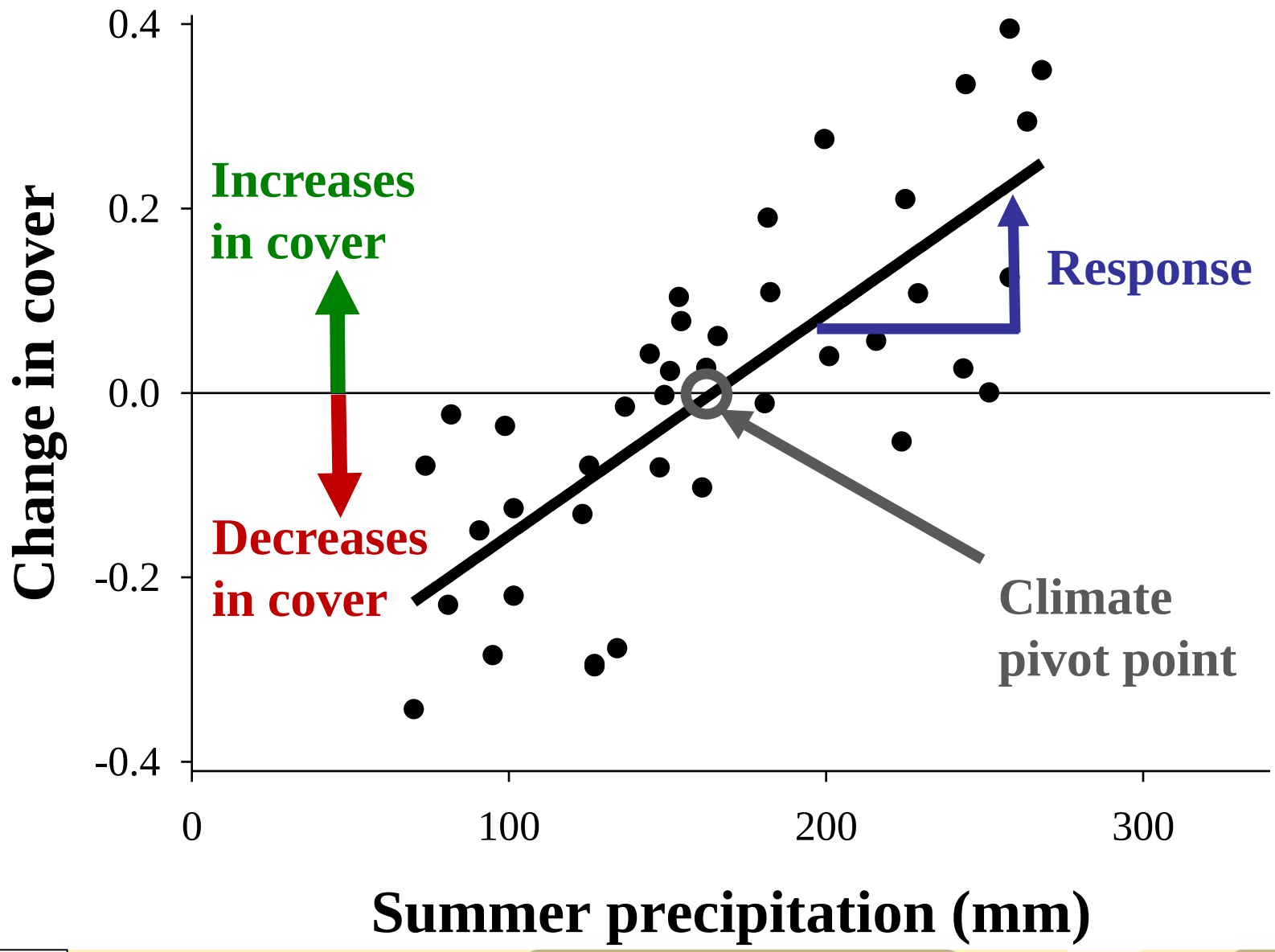
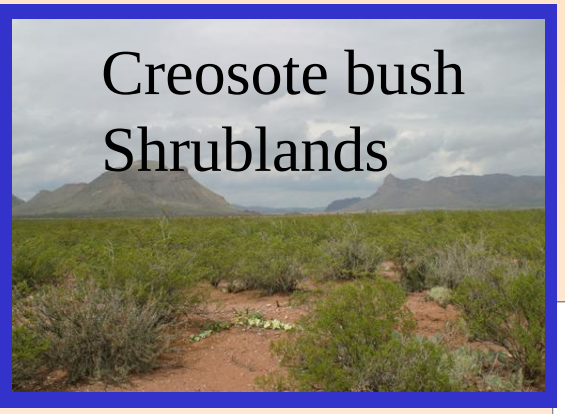
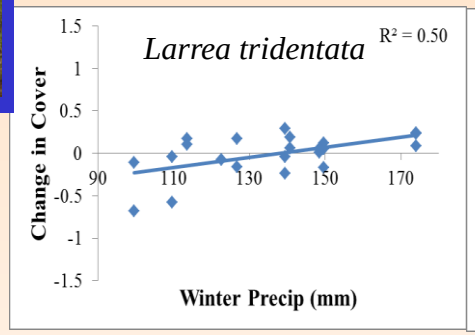
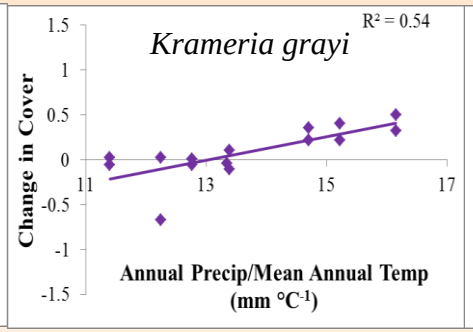
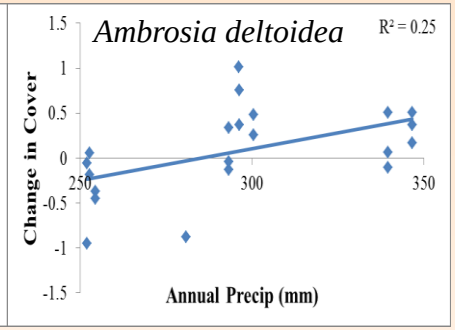
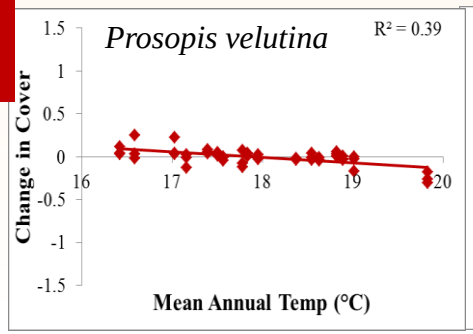

0.4
0.2
0.0
-0.2
-0.4
Change in cover
Increases
in cover
Decreases
in cover
Response
Climate
pivot point
0
100
200
300
Summer precipitation (mm)

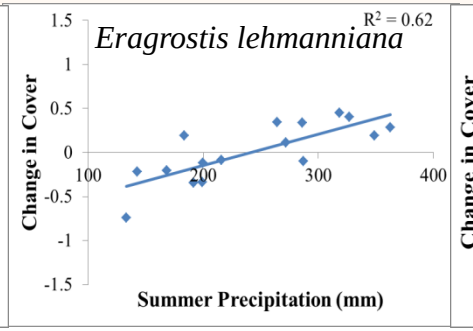


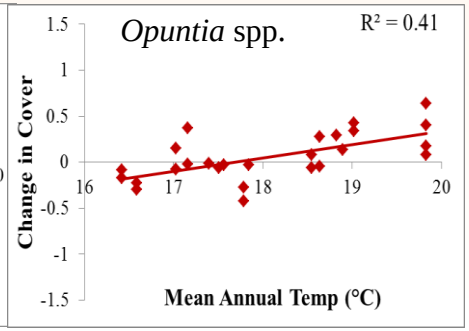












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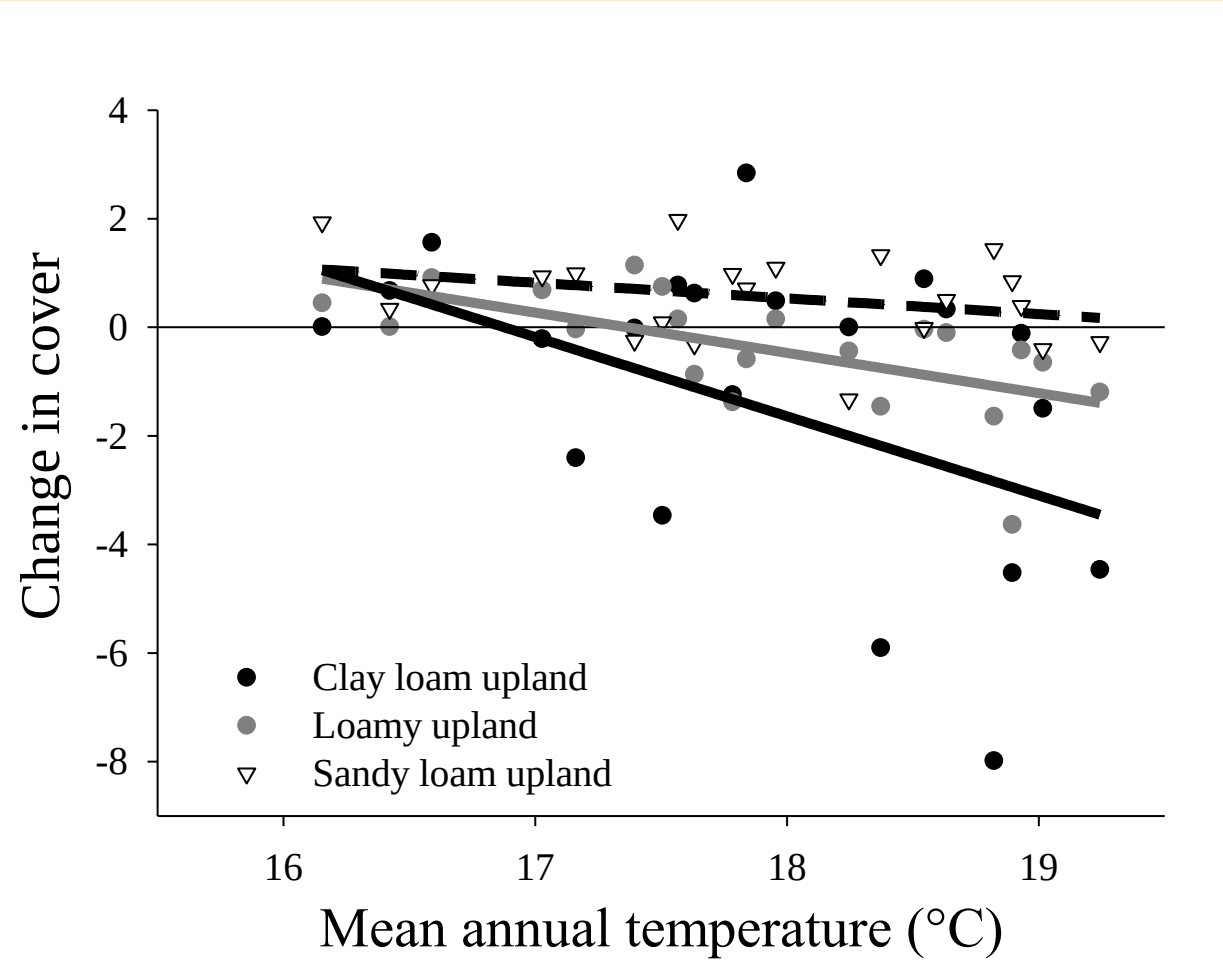
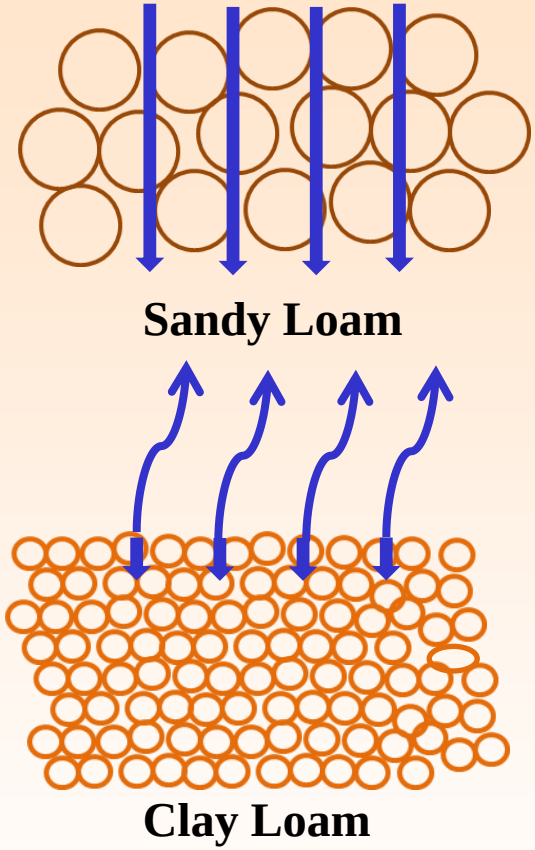
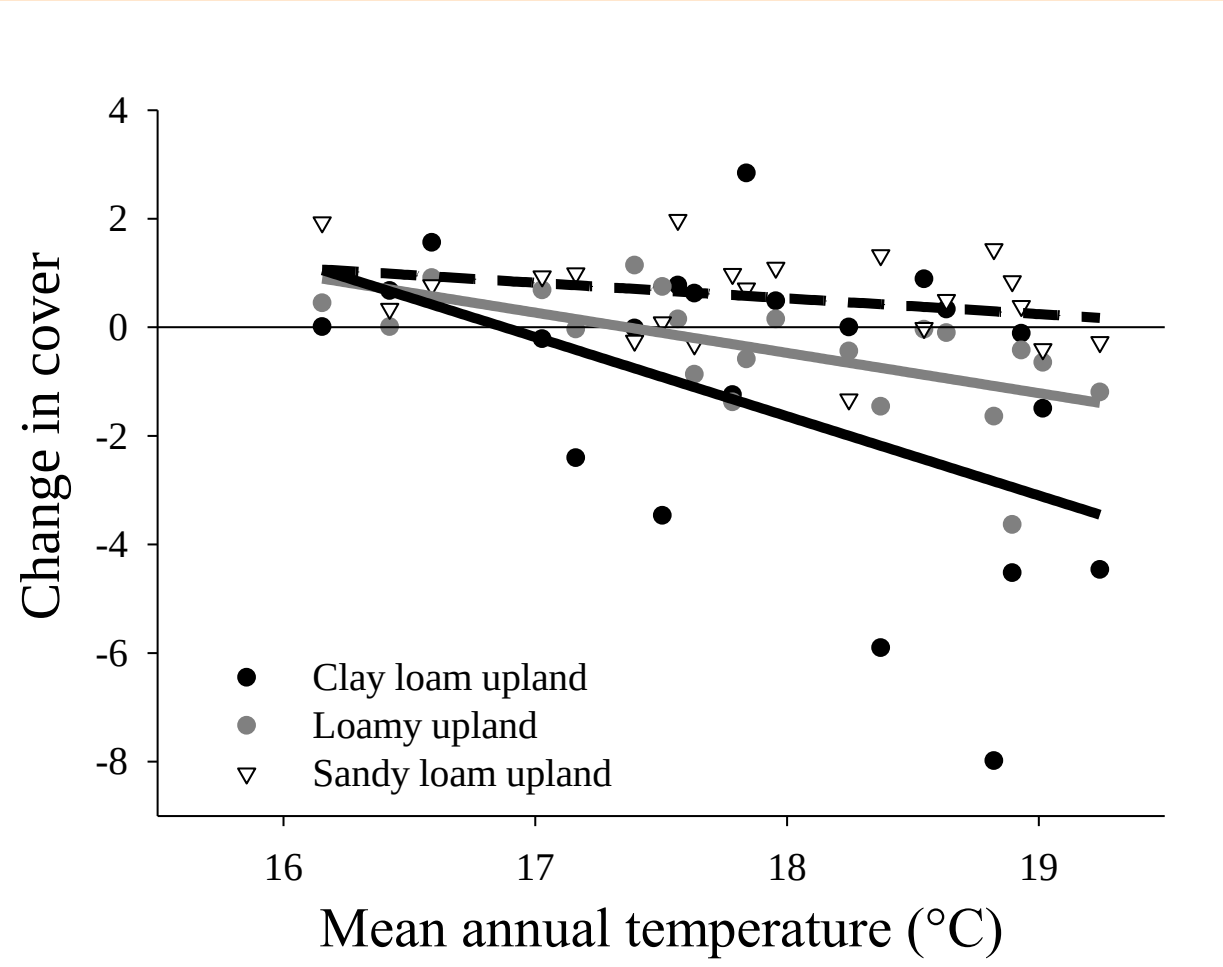
Prosopis velutina

Velvet Mesquite Response by Soil Texture

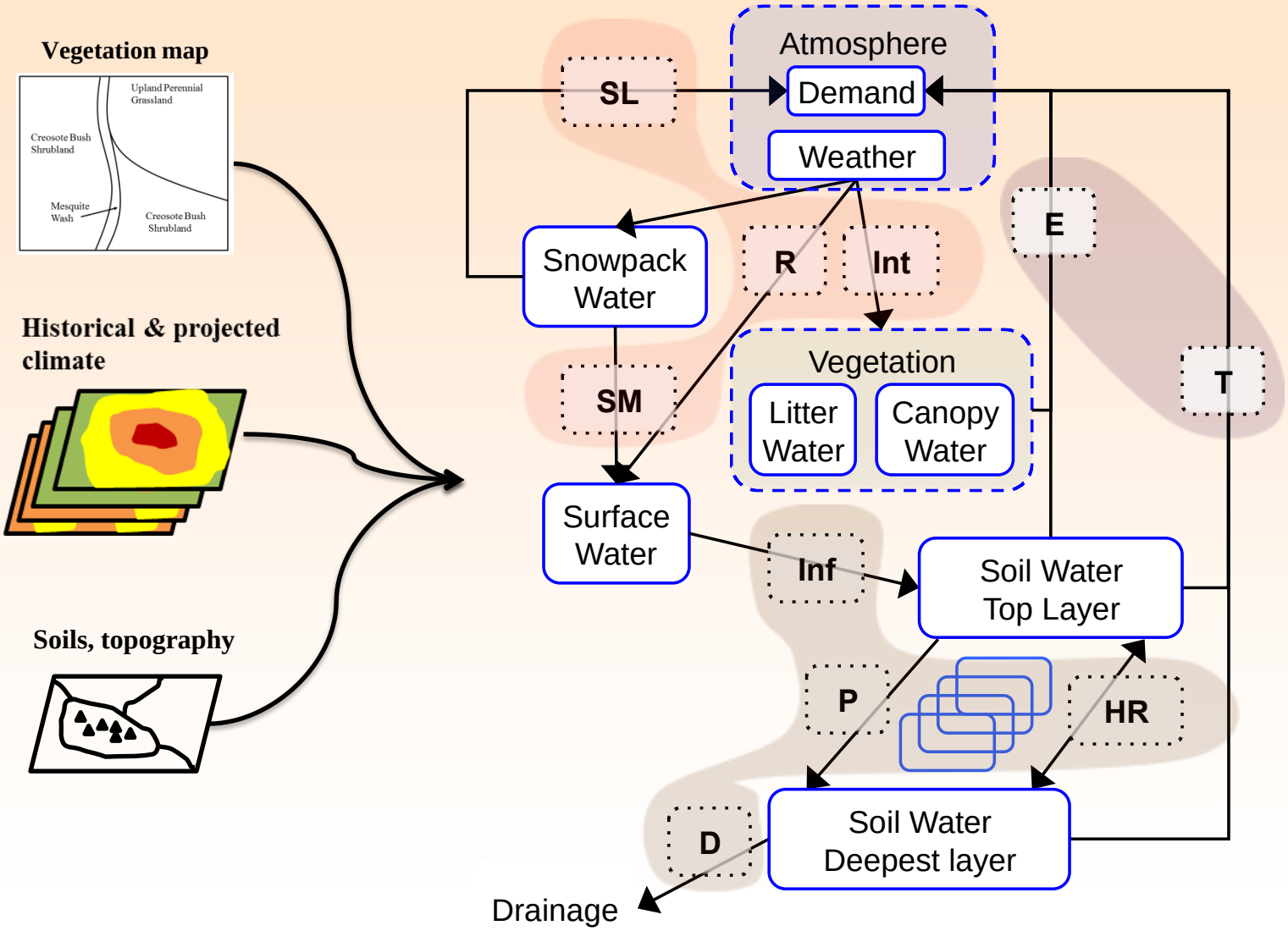


Velvet Mesquite Response by Soil Texture

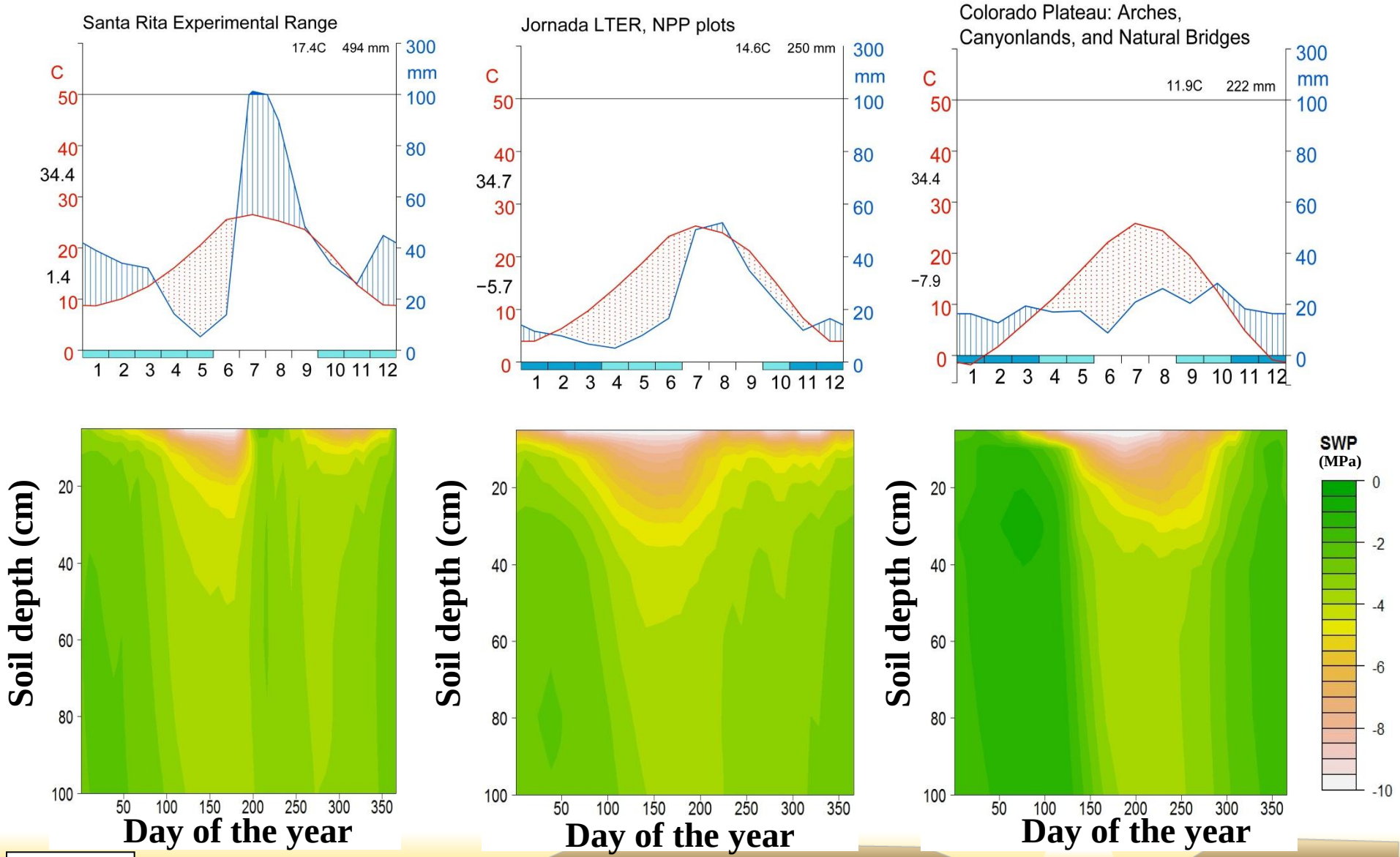




Soil Water Model



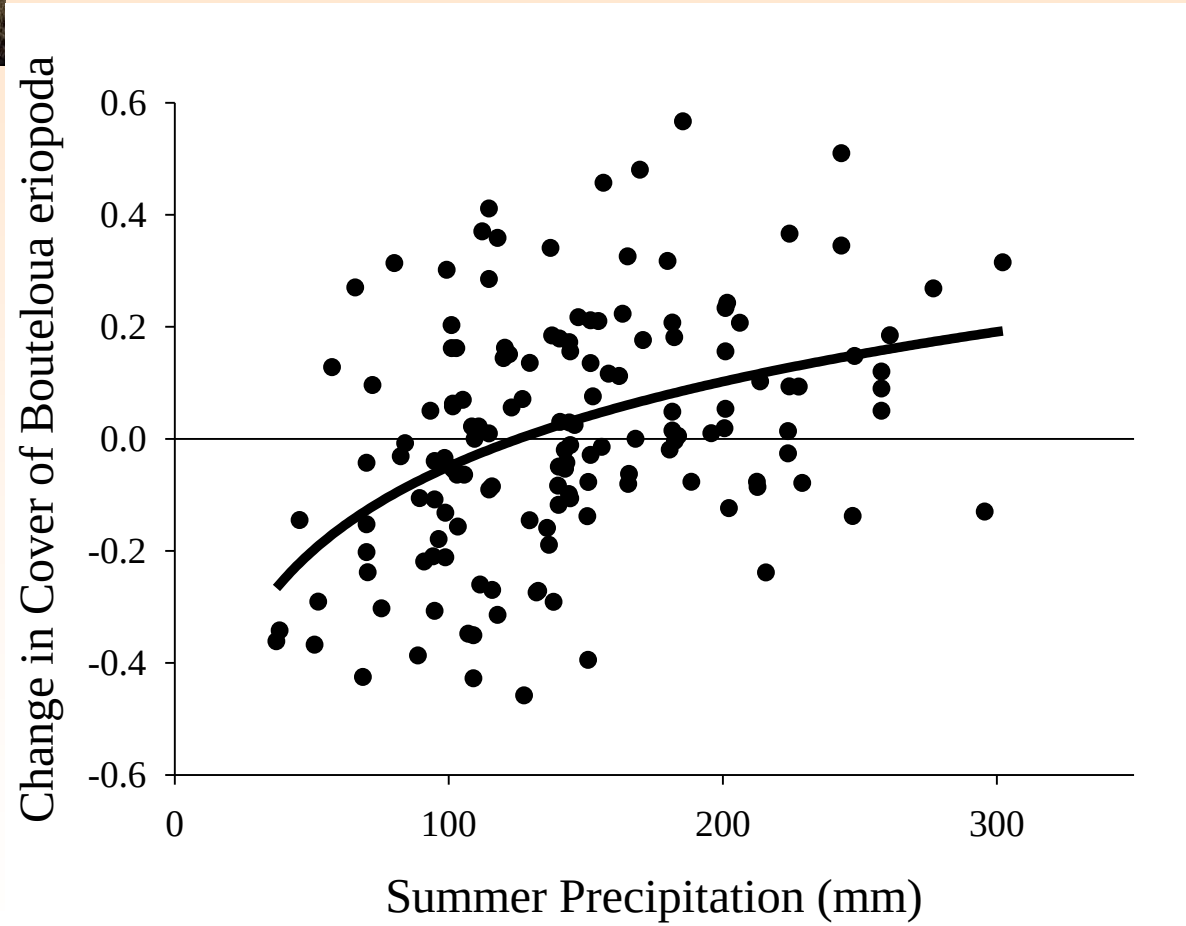
Sites differ in climate and soil water dynamics



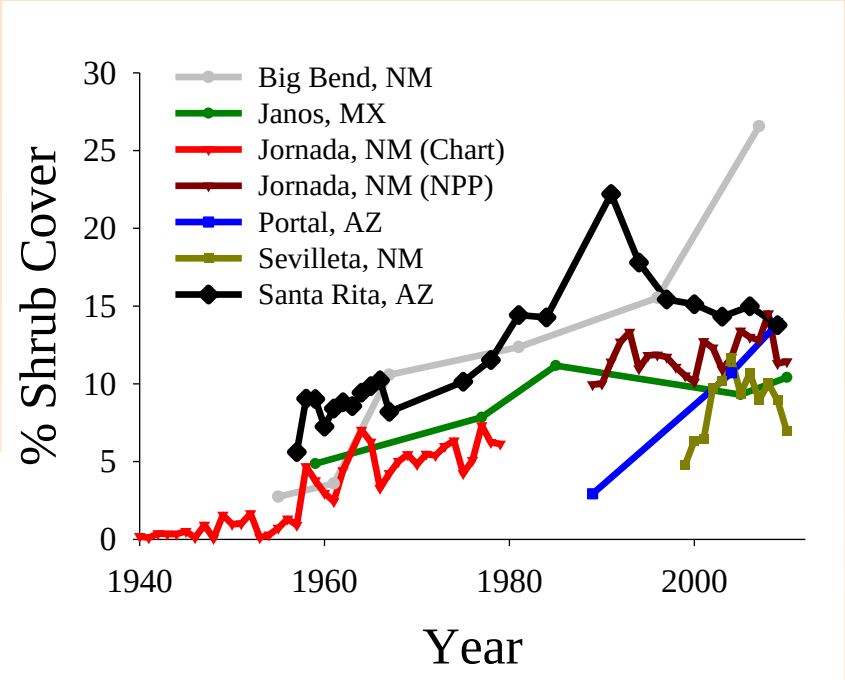
J. Gremer, unpublished data

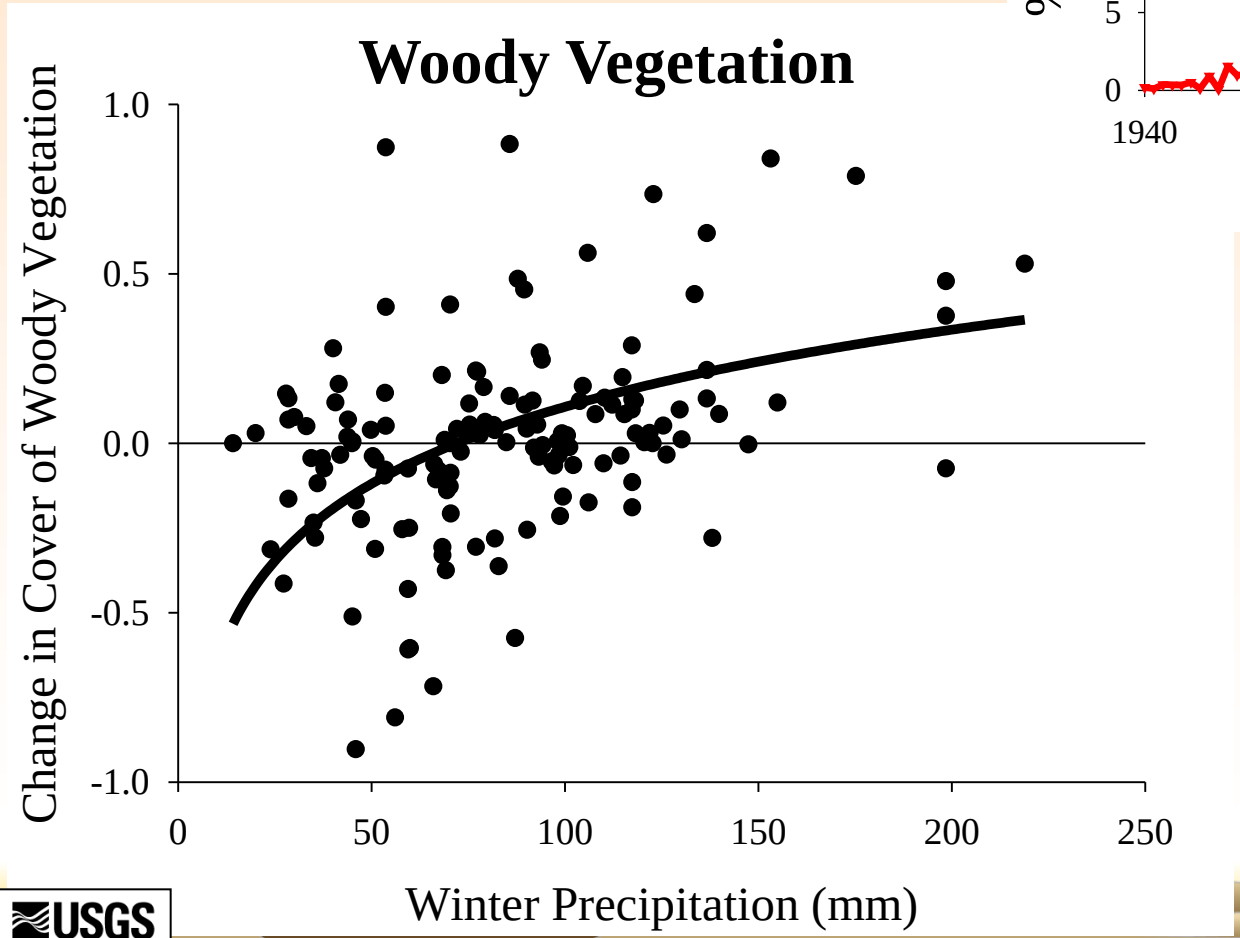
Chihuahuan Desert

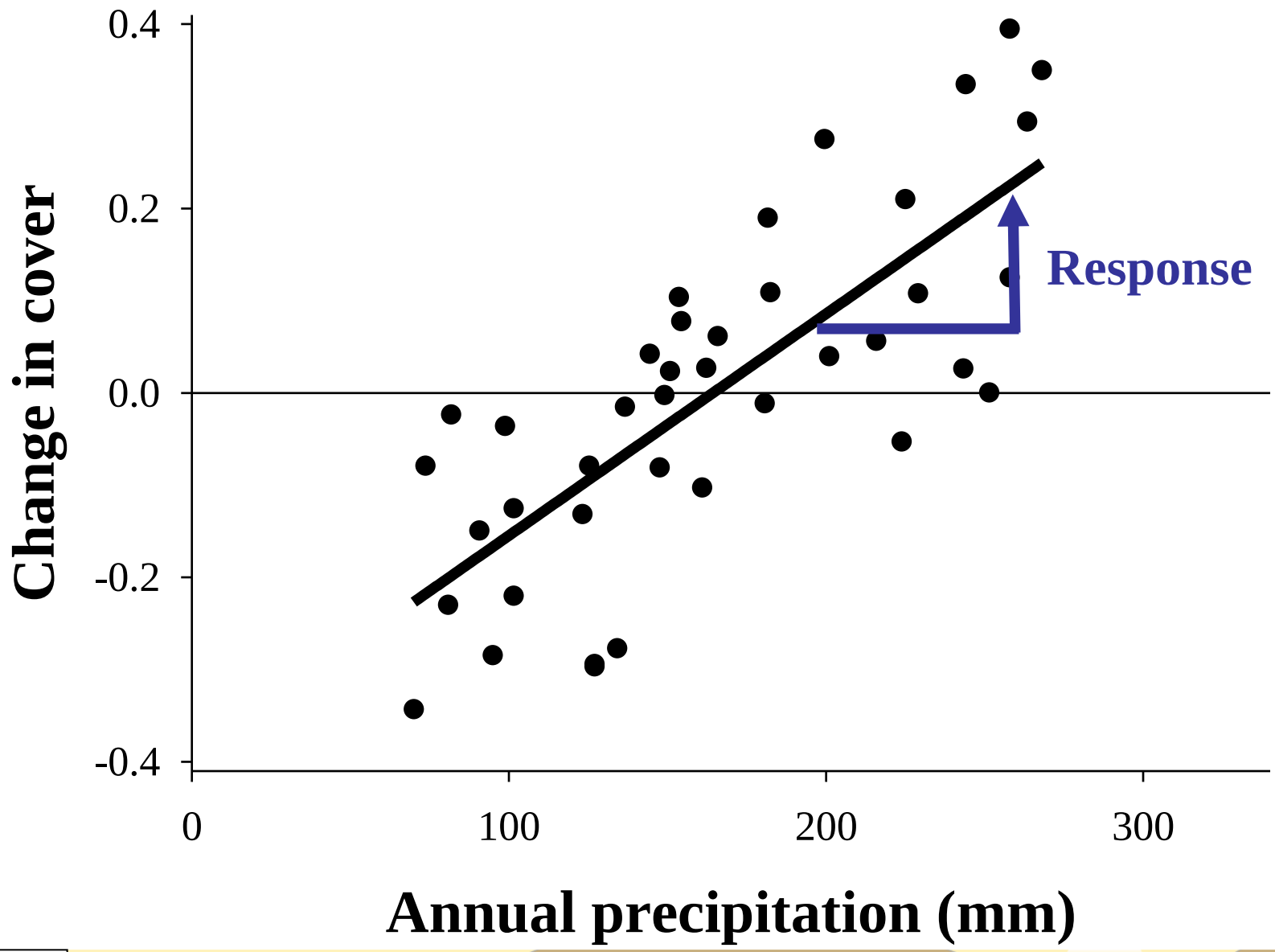
Bouteloua eriopoda



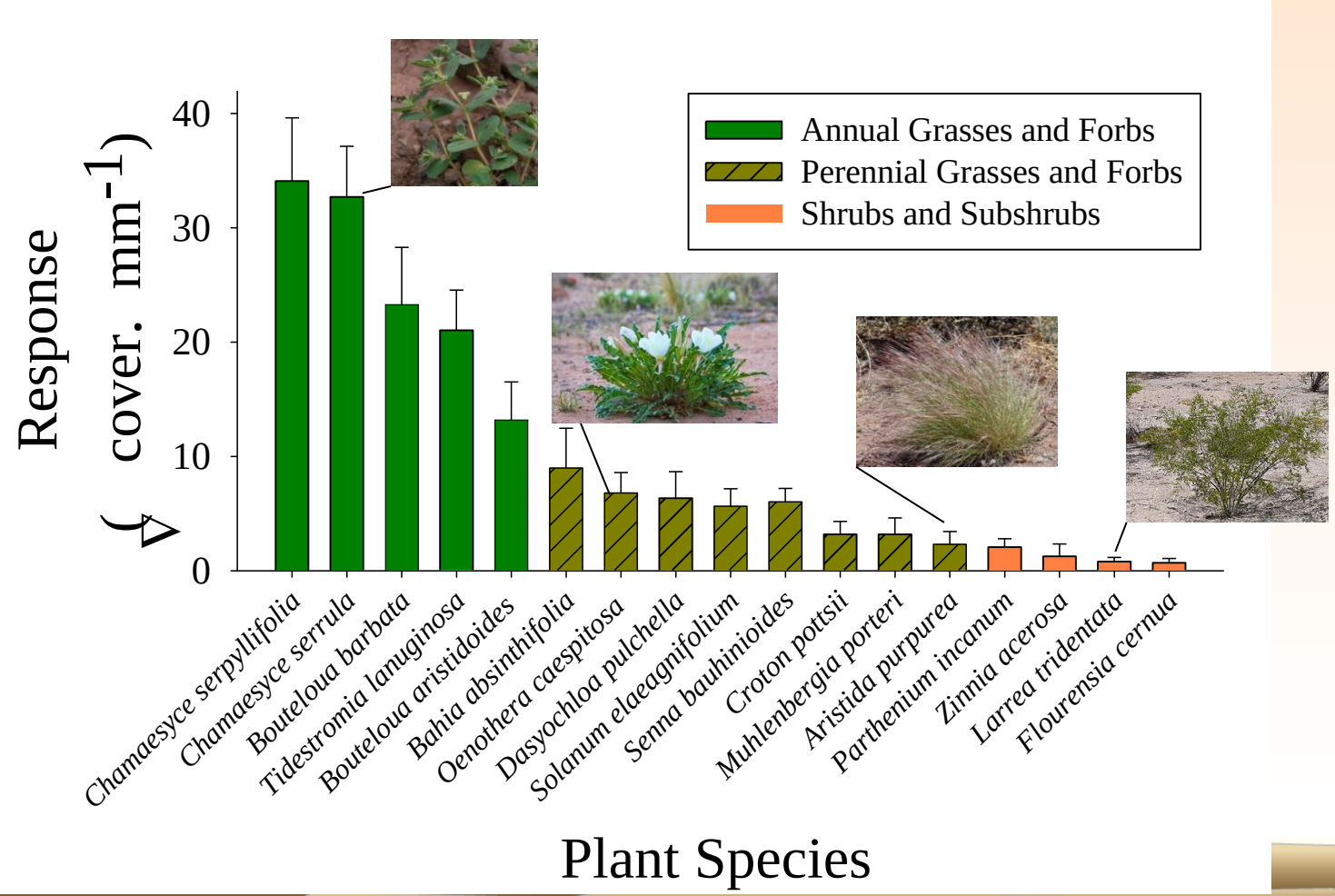
Black Grama Grassland

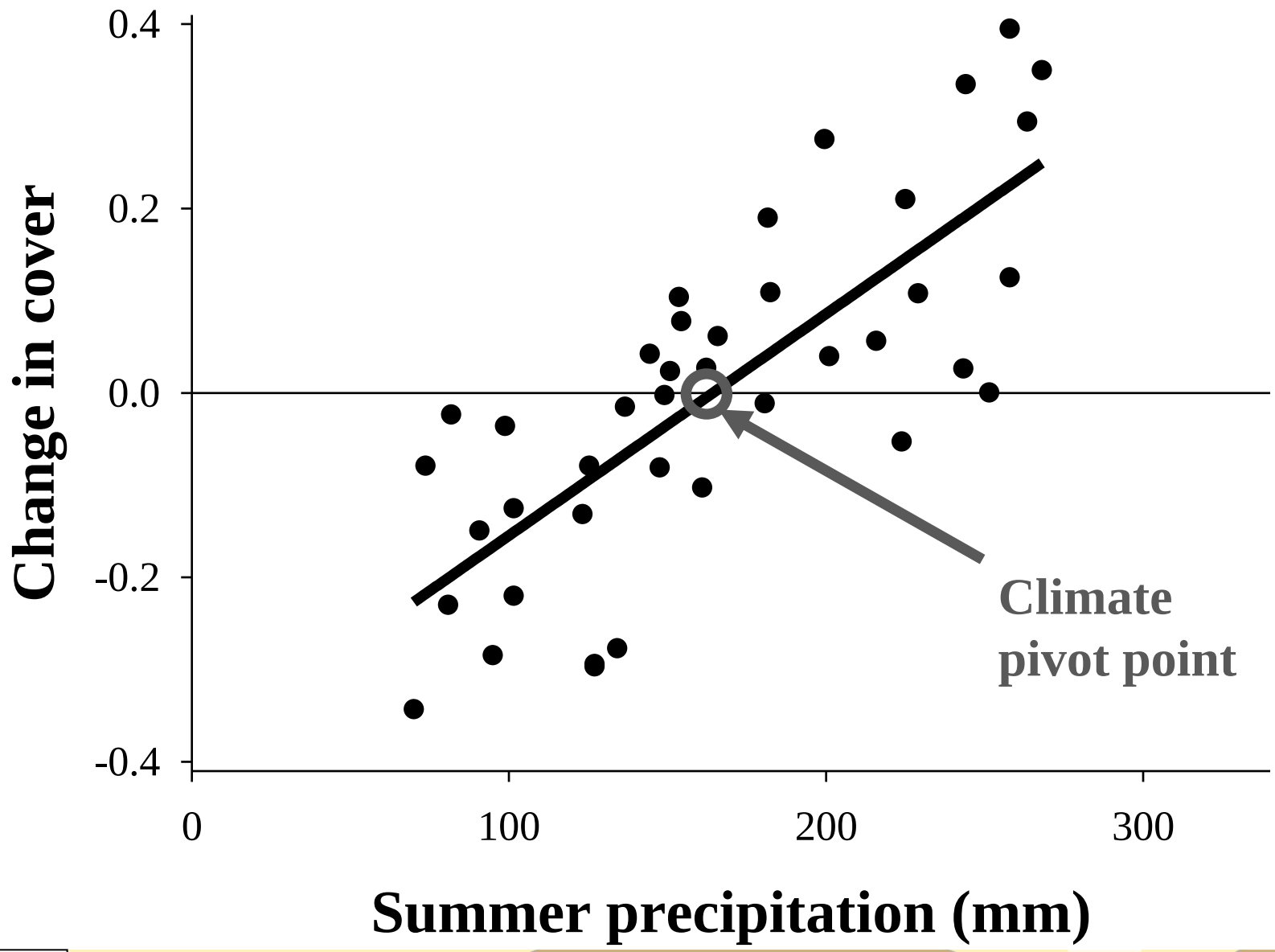

% Shrub Cover
30
25
20
15
10
5
0
1940
1960
1980
2000
Year
Big Bend, NM
Janos, MX
Jornada, NM (Chart)
Jornada, NM (NPP)
Portal, AZ
Sevilleta, NM
Santa Rita, AZ

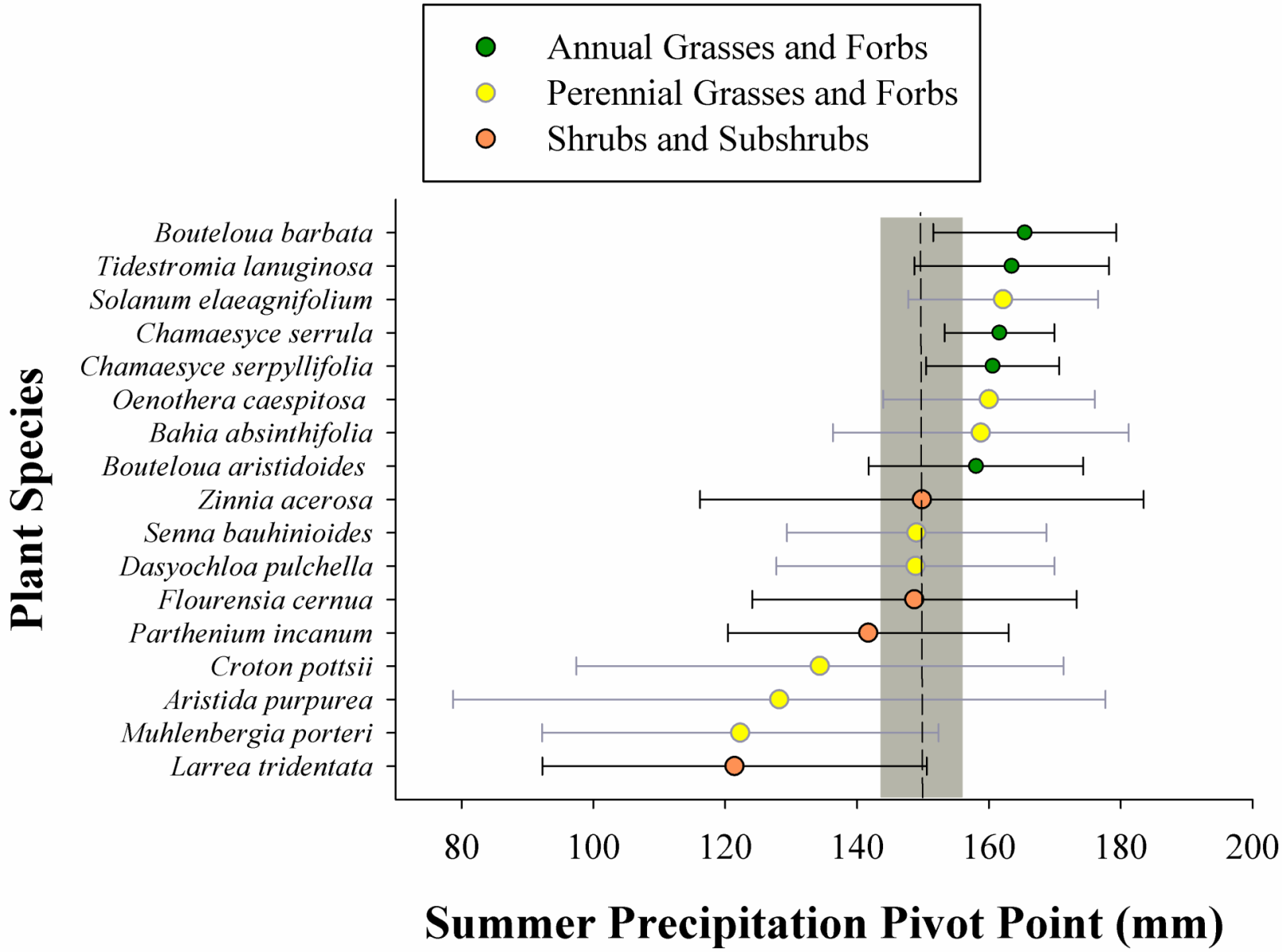

Woody Vegetation
Change in Cover of Woody Vegetation
1.0
0.5
0.0
-0.5
-1.0
0
50
100
150
200
250
Winter Precipitation (mm)


0.4
0.2
0.0
-0.2
-0.4
Change in cover
Response
0
100
200
300
Annual precipitation (mm)

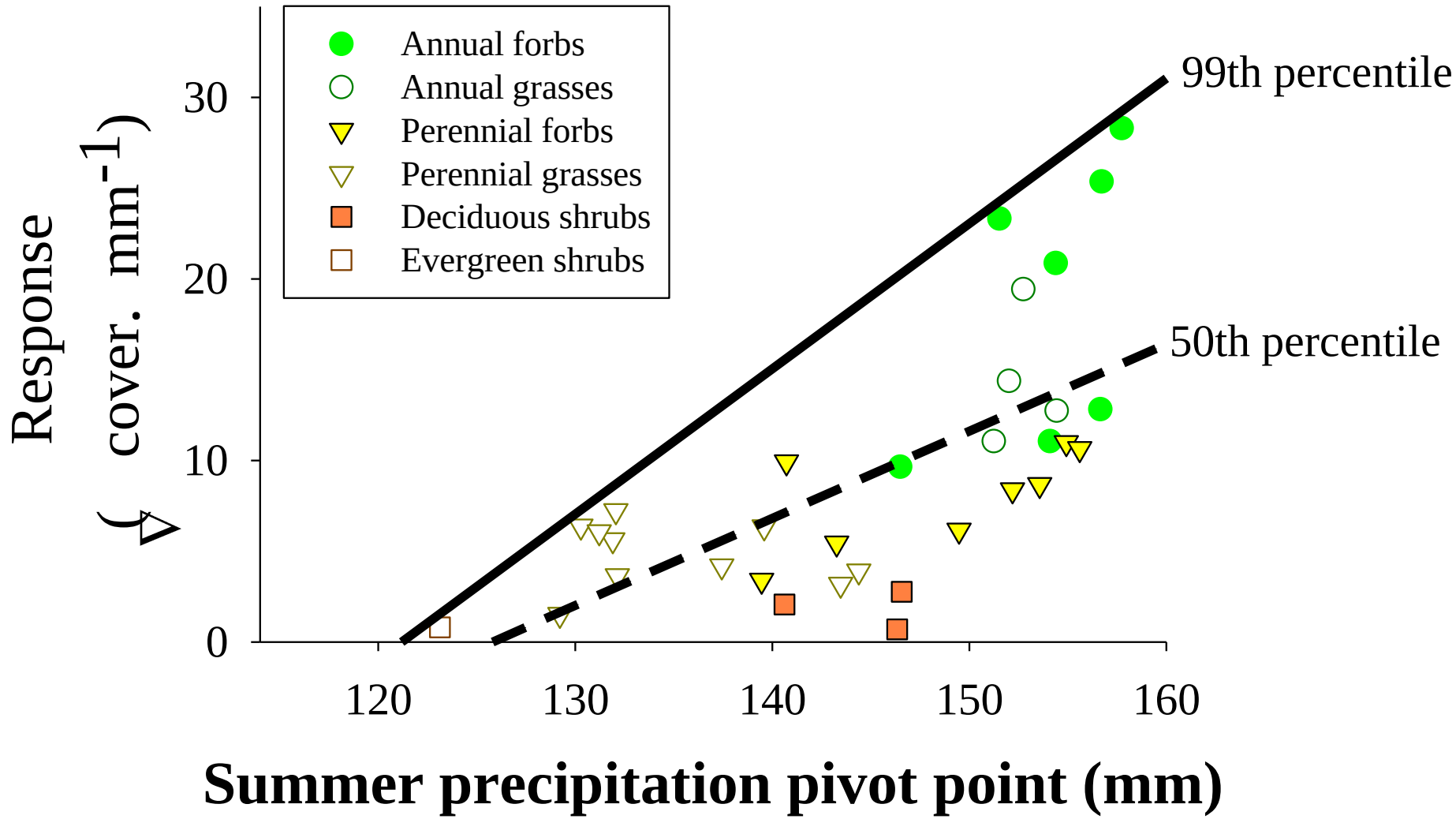
Response of Chihauhuan Desert Plant Species to Summer Precipitation

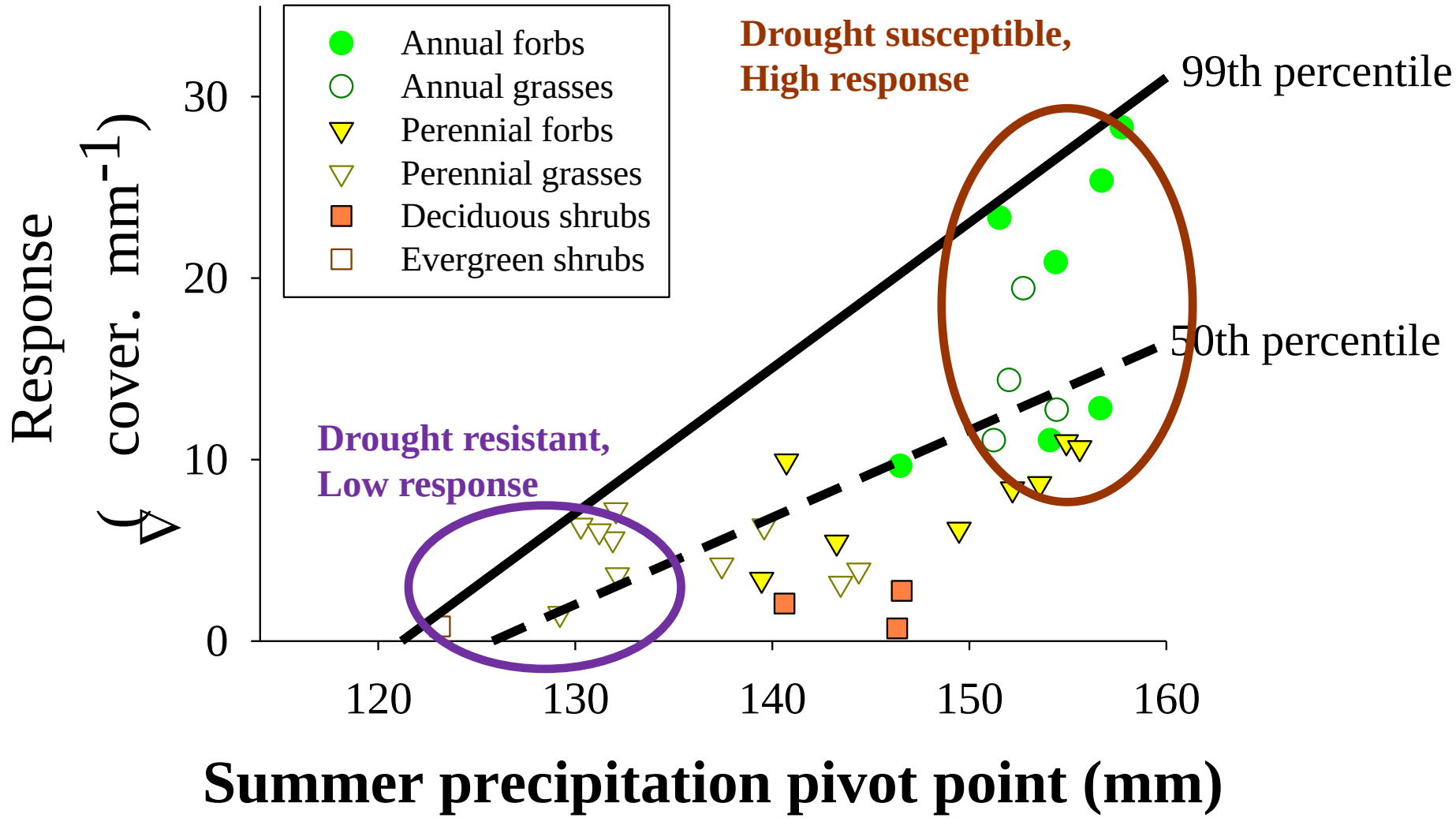



0.4
0.2
0.0
-0.2
-0.4
Change in cover
0
100
200
300
Summer precipitation (mm)
Climate
pivot point

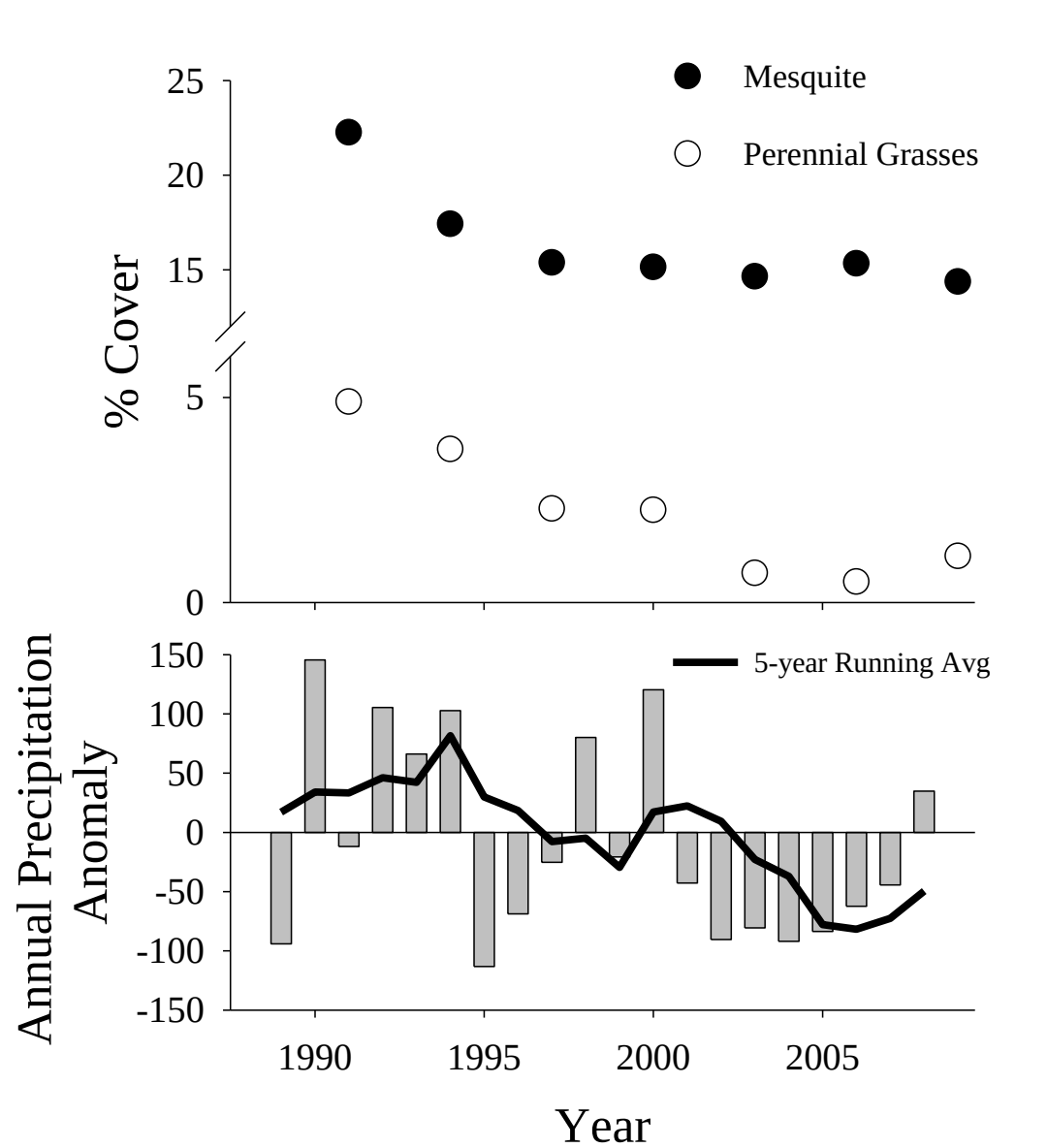


Increasing Drought Resistance


Annual forbs
Annual grasses
Perennial forbs
Perennial grasses
Deciduous shrubs
Evergreen shrubs
99th percentile
50th percentile
Response
(cover. mm-1)
0
10
20
30
120
130
140
150
160
Summer precipitation pivot point (mm)

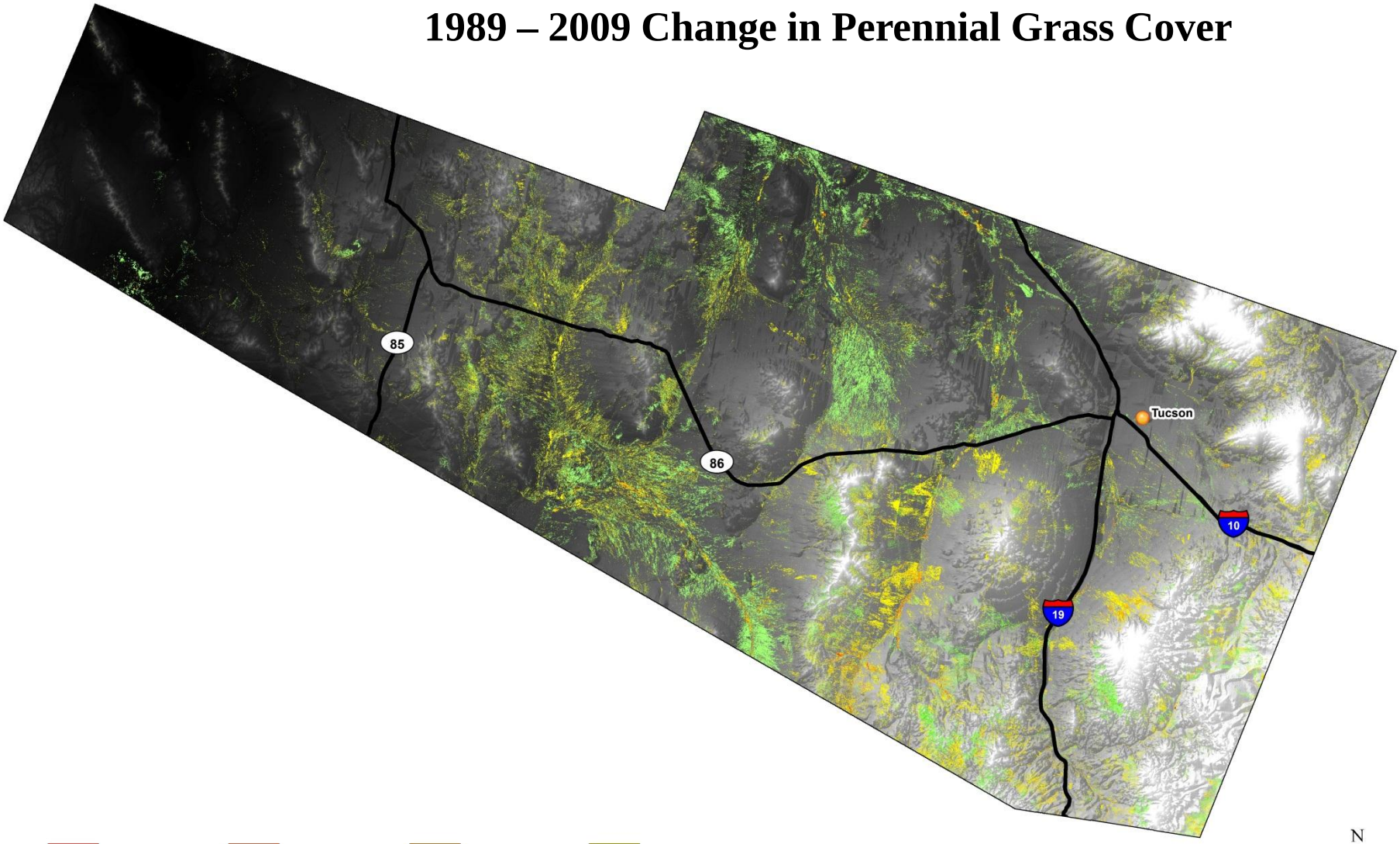

Annual forbs
Annual grasses
Perennial forbs
Perennial grasses
Deciduous shrubs
Evergreen shrubs
Drought susceptible,
High response
99th percentile
50th percentile
Drought resistant,
Low response
Response
(cover. mm-1)
0
10
20
30
120
130
140
150
160
Summer precipitation pivot point (mm)

Santa Rita Experimental Range – Permanent Transects



Region?

1989 – 2009 Change in Perennial Grass Cover



Loss: -40 to -30% | -30 to -20% | -20 to -10% | -10 to 0%

Gain: 0 to 10 % | 10 to 20% | 20 to 30% | 30 to 40%

0 12.5 25 50 75 100 Kilometers

N

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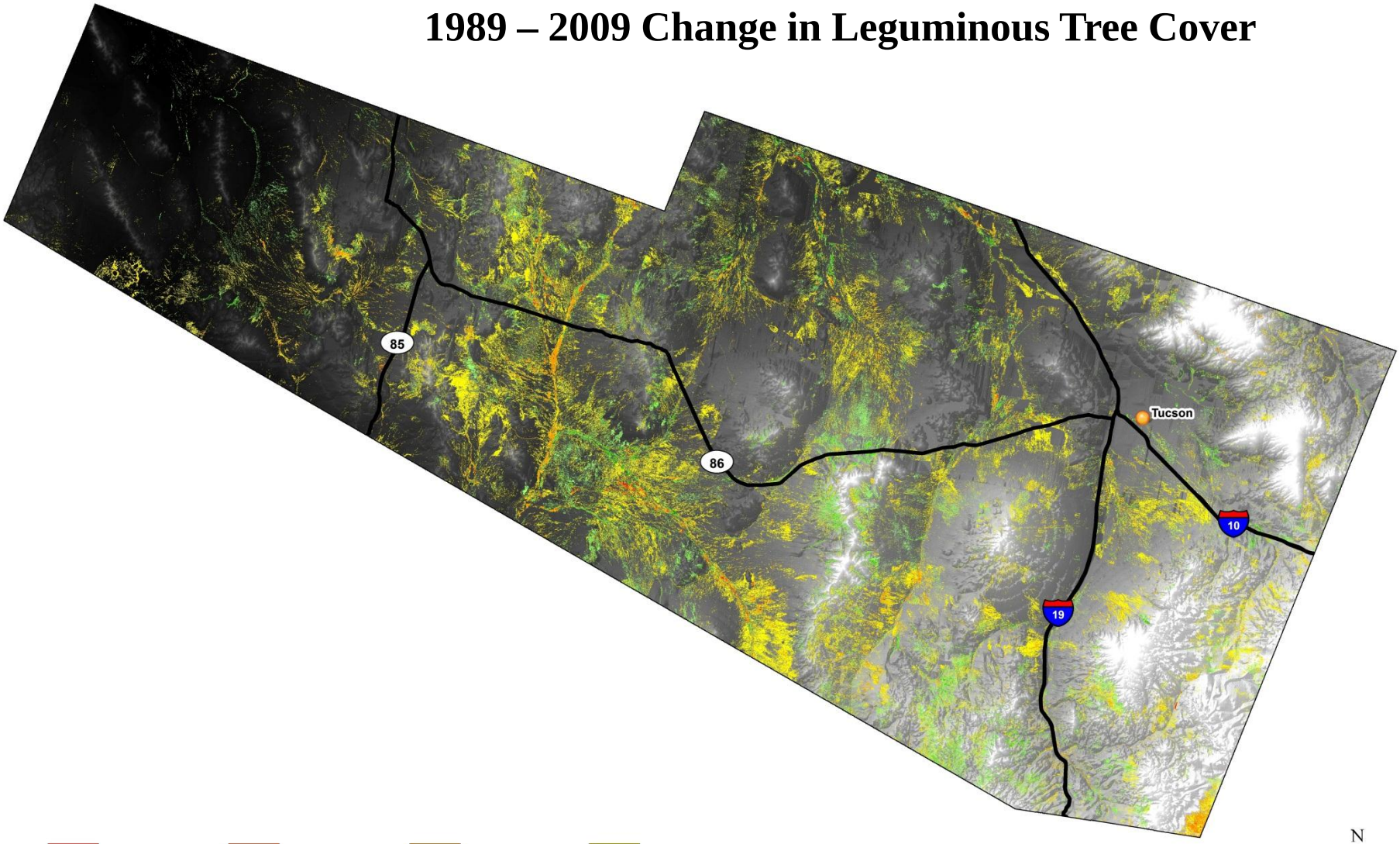
1989 – 2009 Change in Leguminous Tree Cover



Loss: -40 to -30% | -30 to -20% | -20 to -10% | -10 to 0%

Gain: 0 to 10 % | 10 to 20% | 20 to 30% | 30 to 40%

0 12.5 25 50 75 100 Kilometers

N

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Acknowledgements

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Website: https://profile.usgs.gov/smunson

Email: smunson@usgs.gov

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National Park Service

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