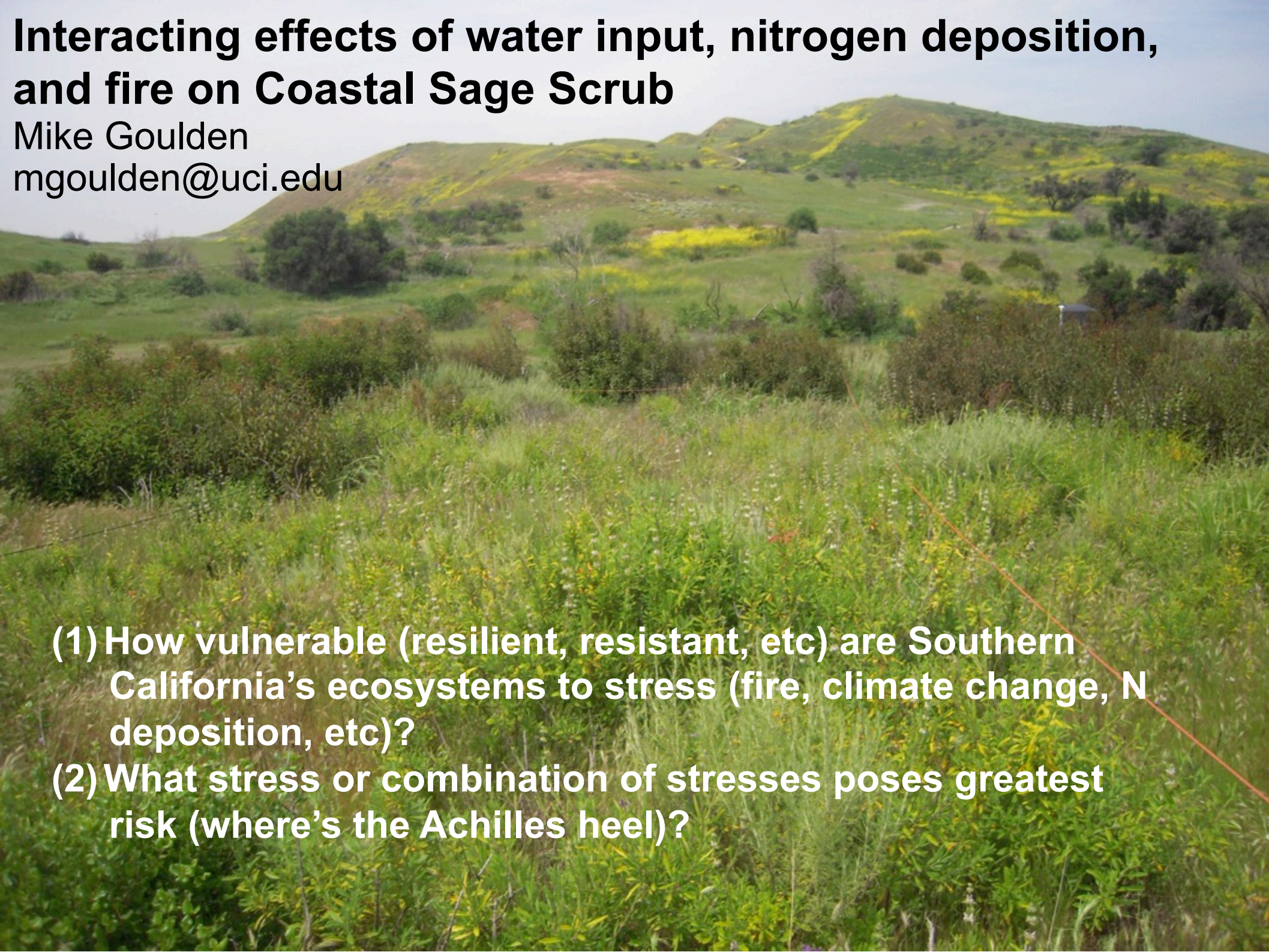
Interacting effects of water input, nitrogen deposition, and fire on Coastal Sage Scrub

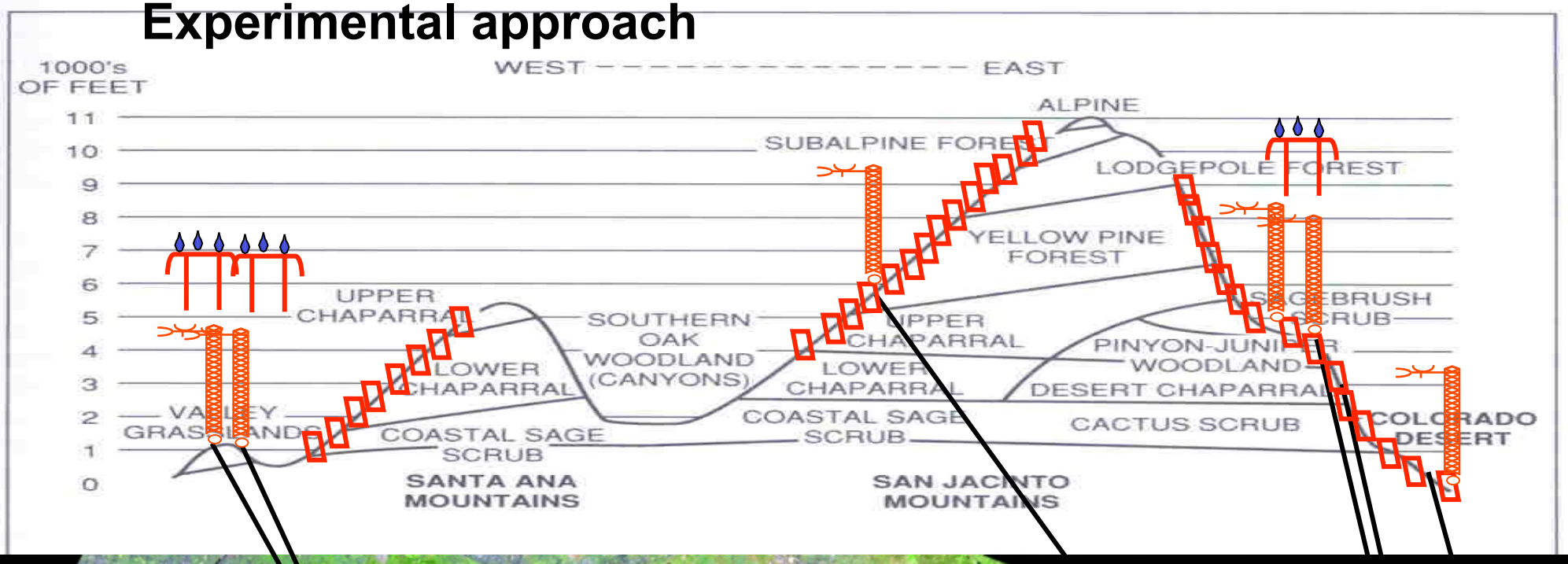
Mike Goulden
mgoulden@uci.edu

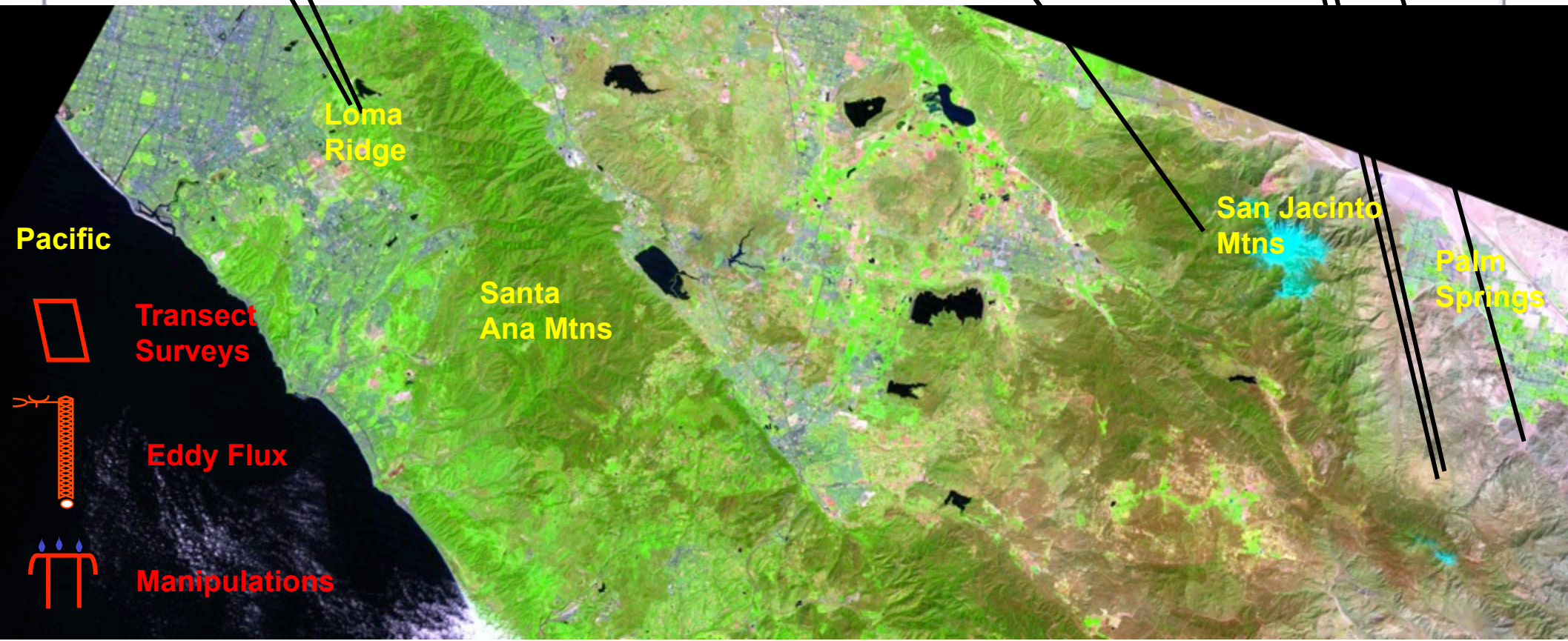


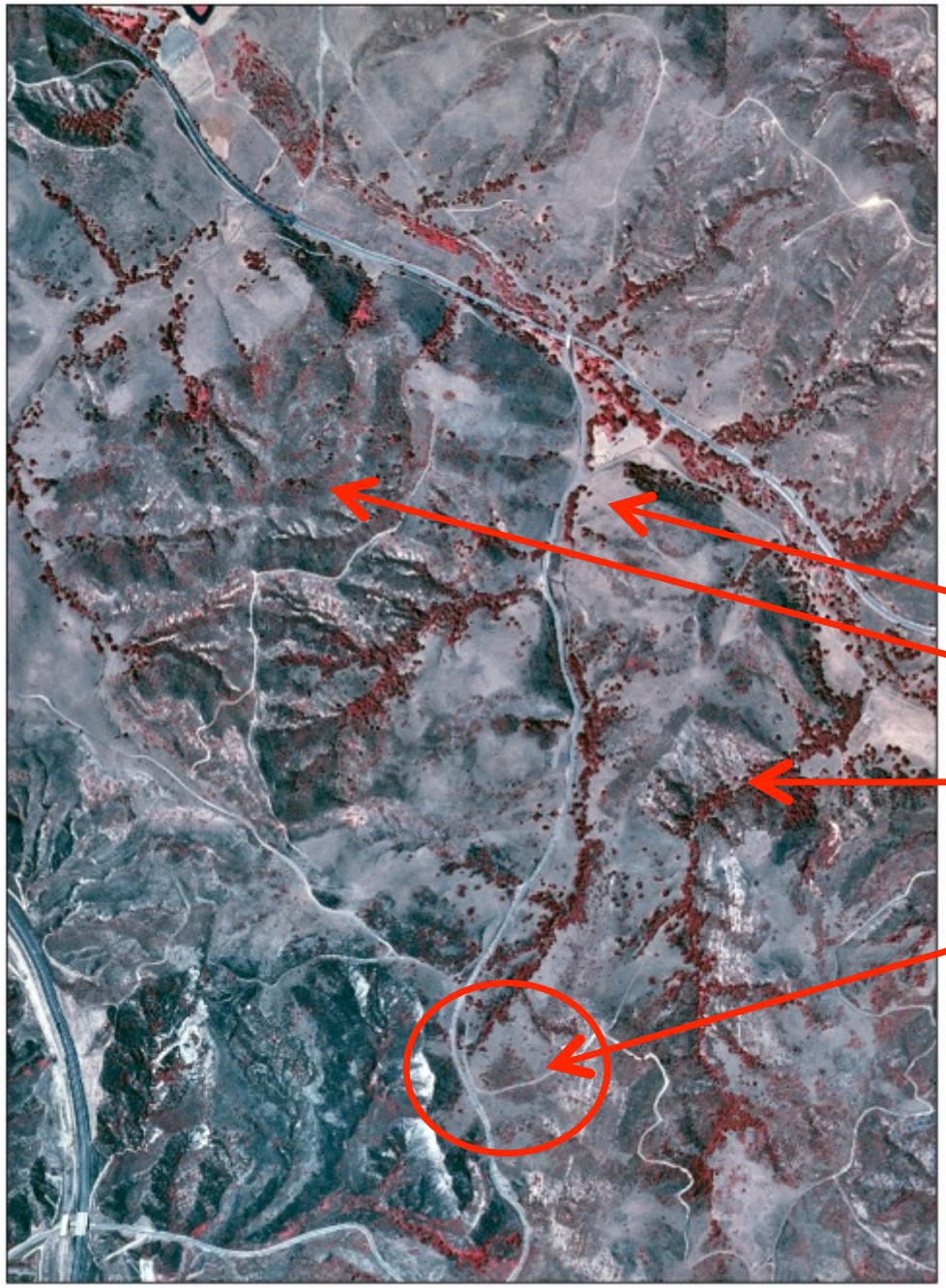
(1) How vulnerable (resilient, resistant, etc) are Southern California's ecosystems to stress (fire, climate change, N deposition, etc)?

(2) What stress or combination of stresses poses greatest risk (where's the Achilles heel)?

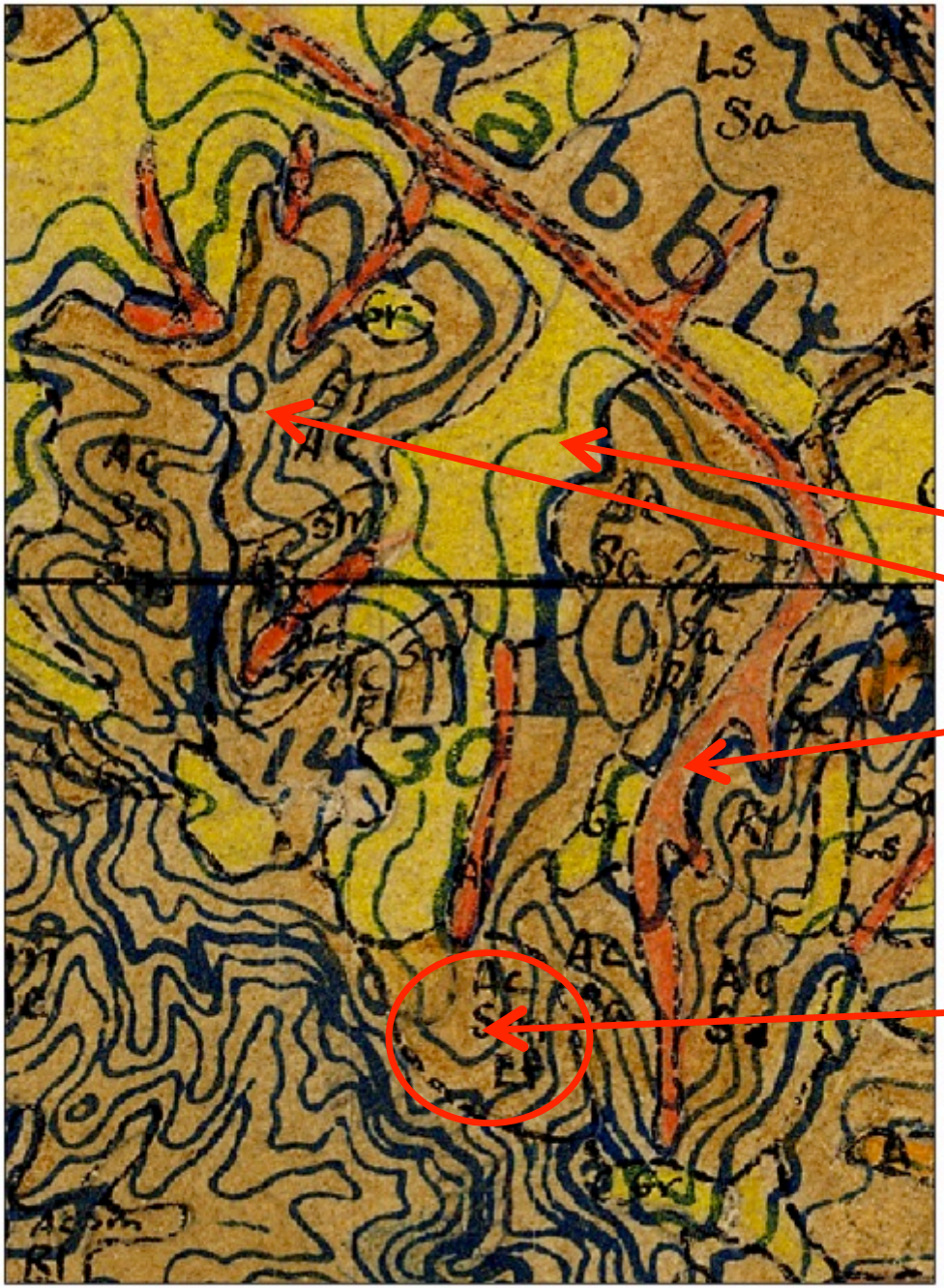
Experimental approach



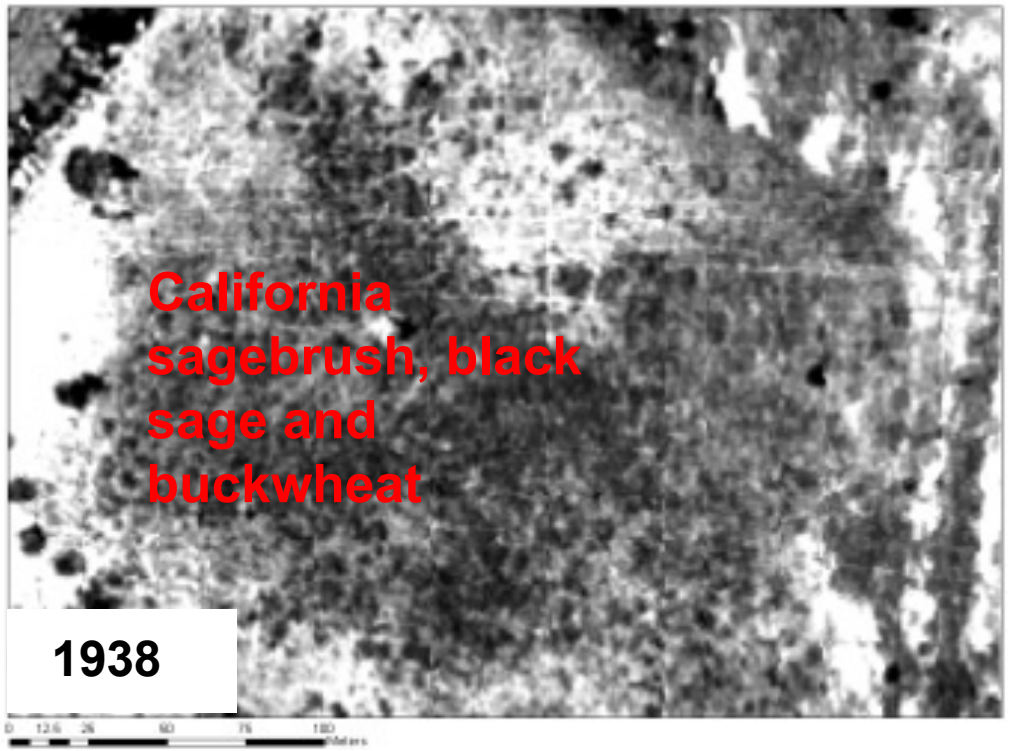


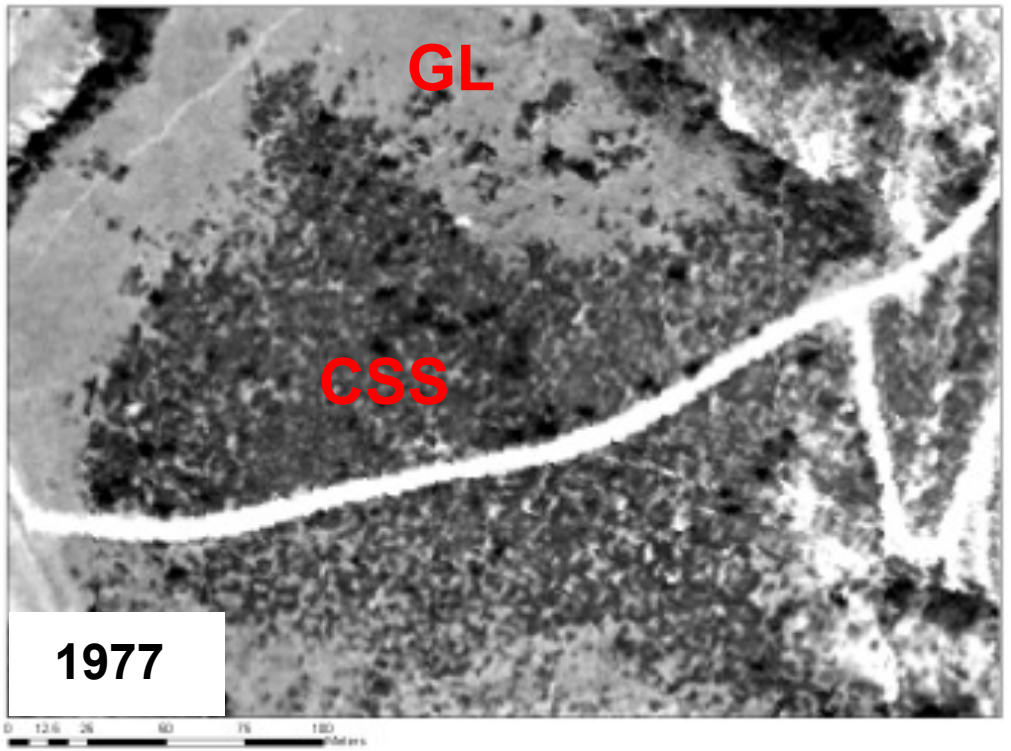


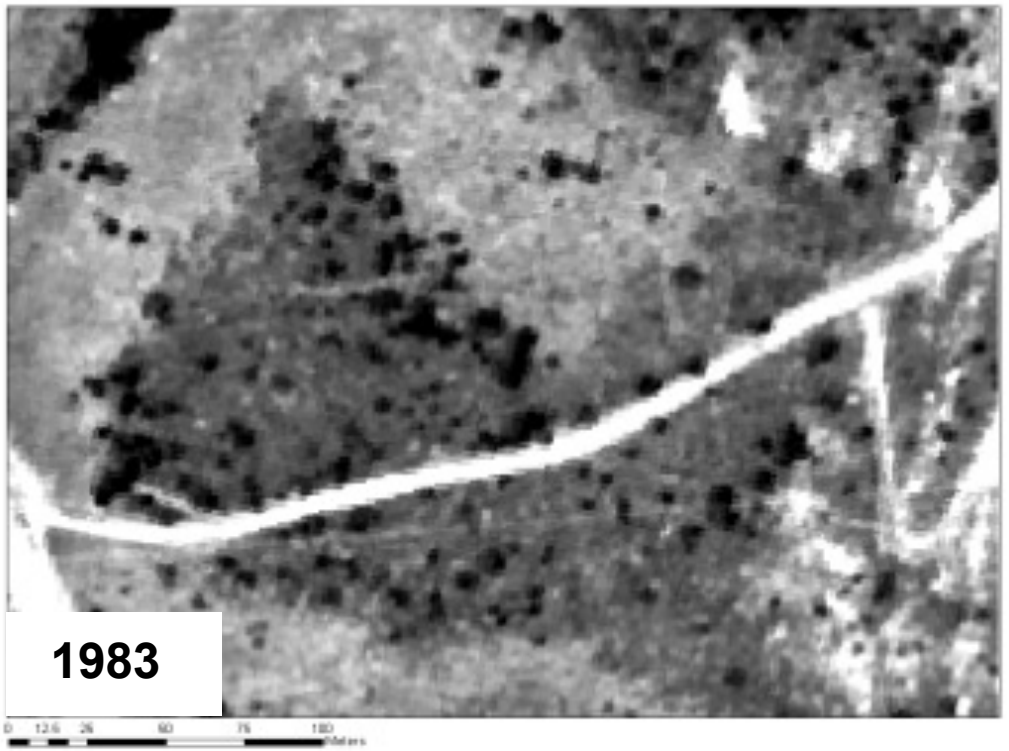
- Loma Ridge section of historic Irvine Ranch (~75 km southeast of here)
- Currently managed by Irvine Ranch Conservancy
- Mosaic of
  exotic annual grassland
  coastal sage
  evergreen oaks
- Experiment site
- What did this area look like 80 years ago?



- VTM (Vegetation Type Map) survey in ~1930
- Hand drawn – working off ~1895 topographic maps – lots of uncertainty
- Mosaic of
  exotic annual grassland
  coastal sage
  evergreen oaks
- Similar to what we see today
- Experiment site - dominated by California sagebrush, black sage and buckwheat


California sagebrush, black sage and buckwheat
1938

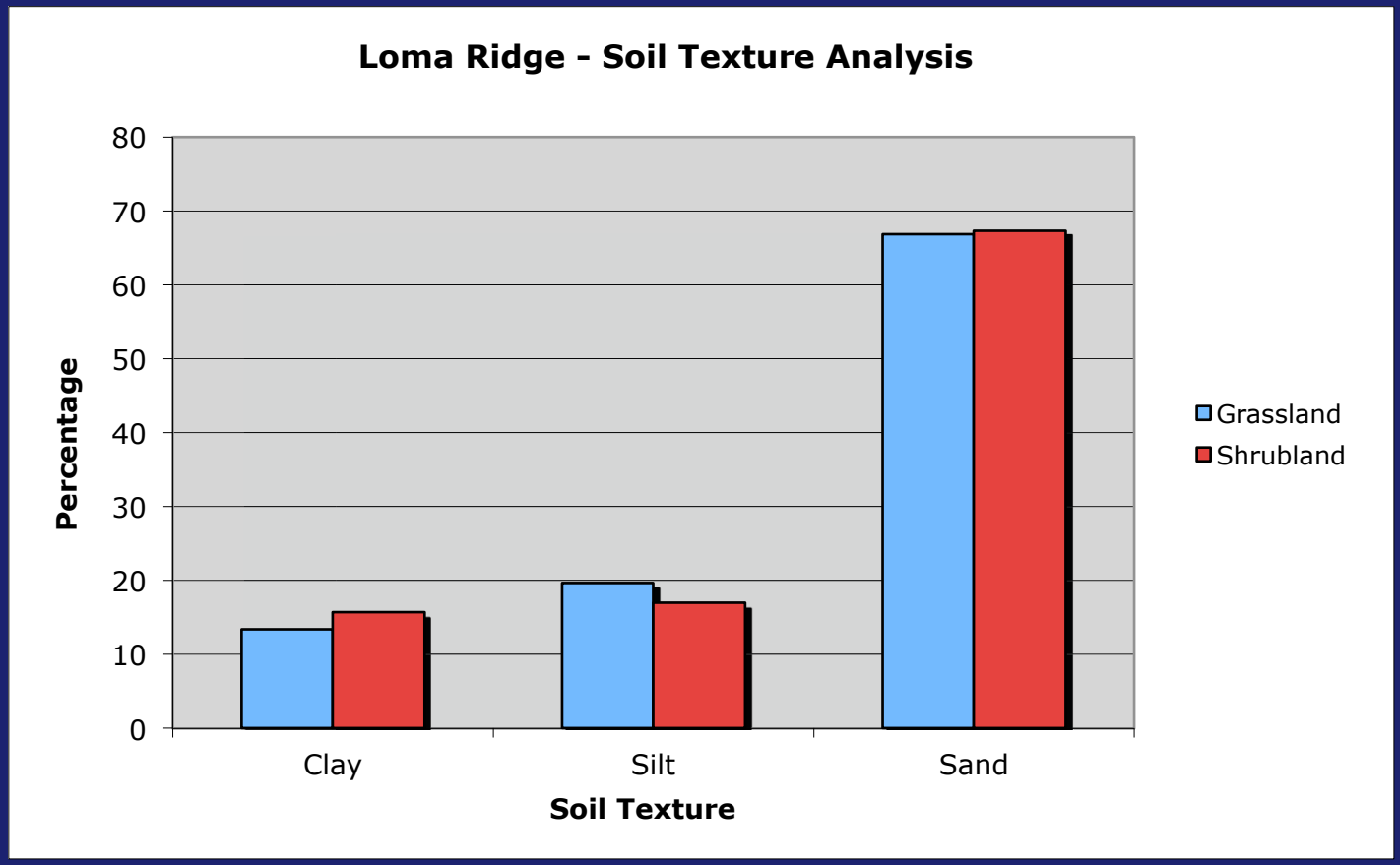

GL
CSS
1977


1983


California sagebrush, black sage still dominate; Rhus/Malosma have increased
2002

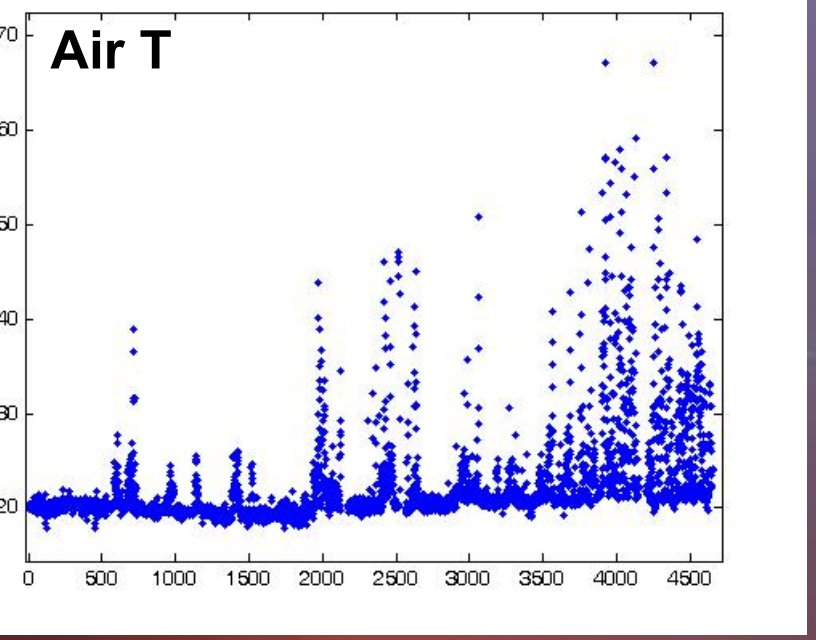
Why so stable?

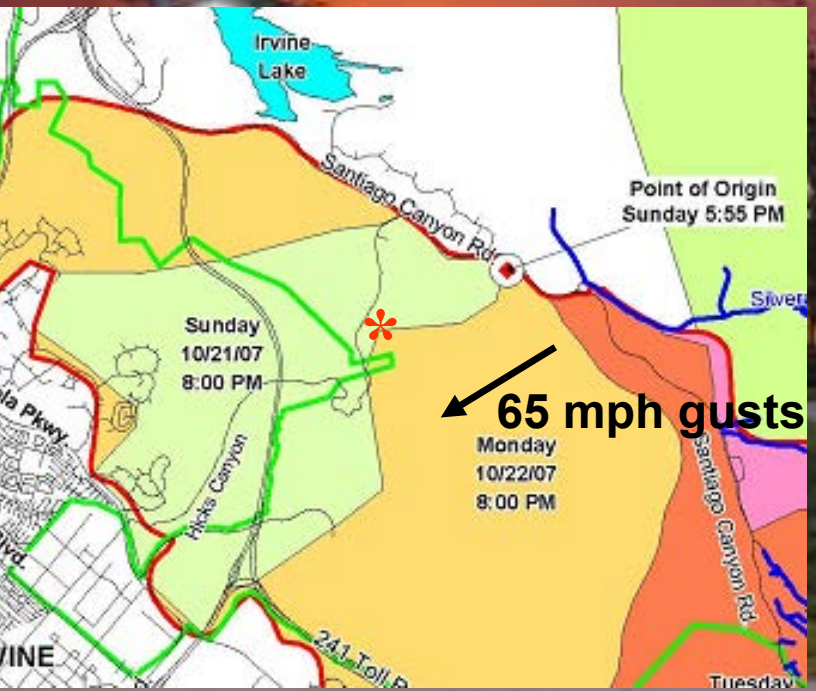
- Differences in soil? Nope – same texture across border – same texture to 2-m depth

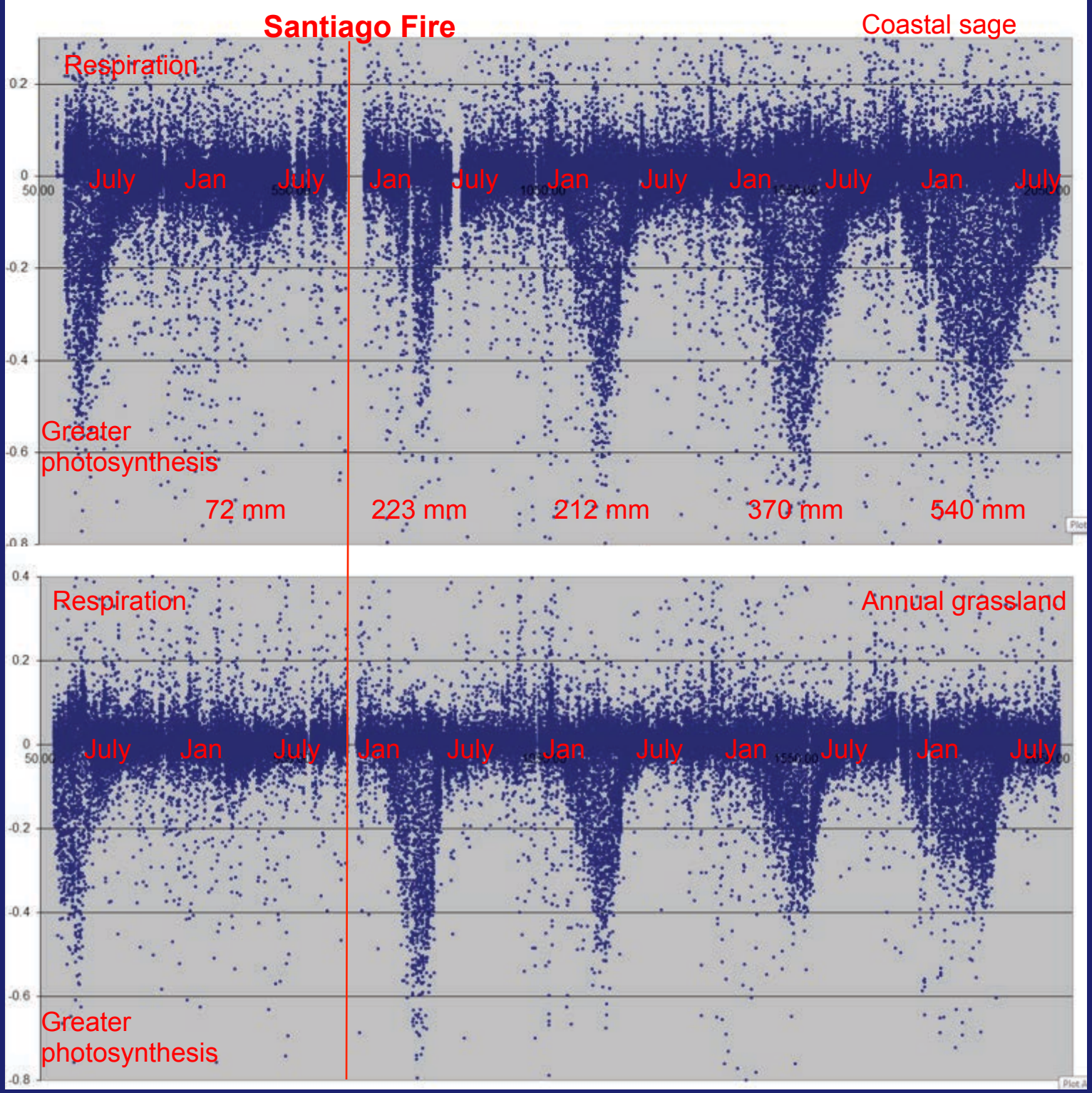


- Constant environment? Nope – at least 4 wildfires (1948, 67, 98, 07), an order of magnitude interannual precip variation
- Lots of ecological resiliency (at least to normal fire and precip patterns of management since 1930)

Resiliency to wildfire – an unfortunate dataset

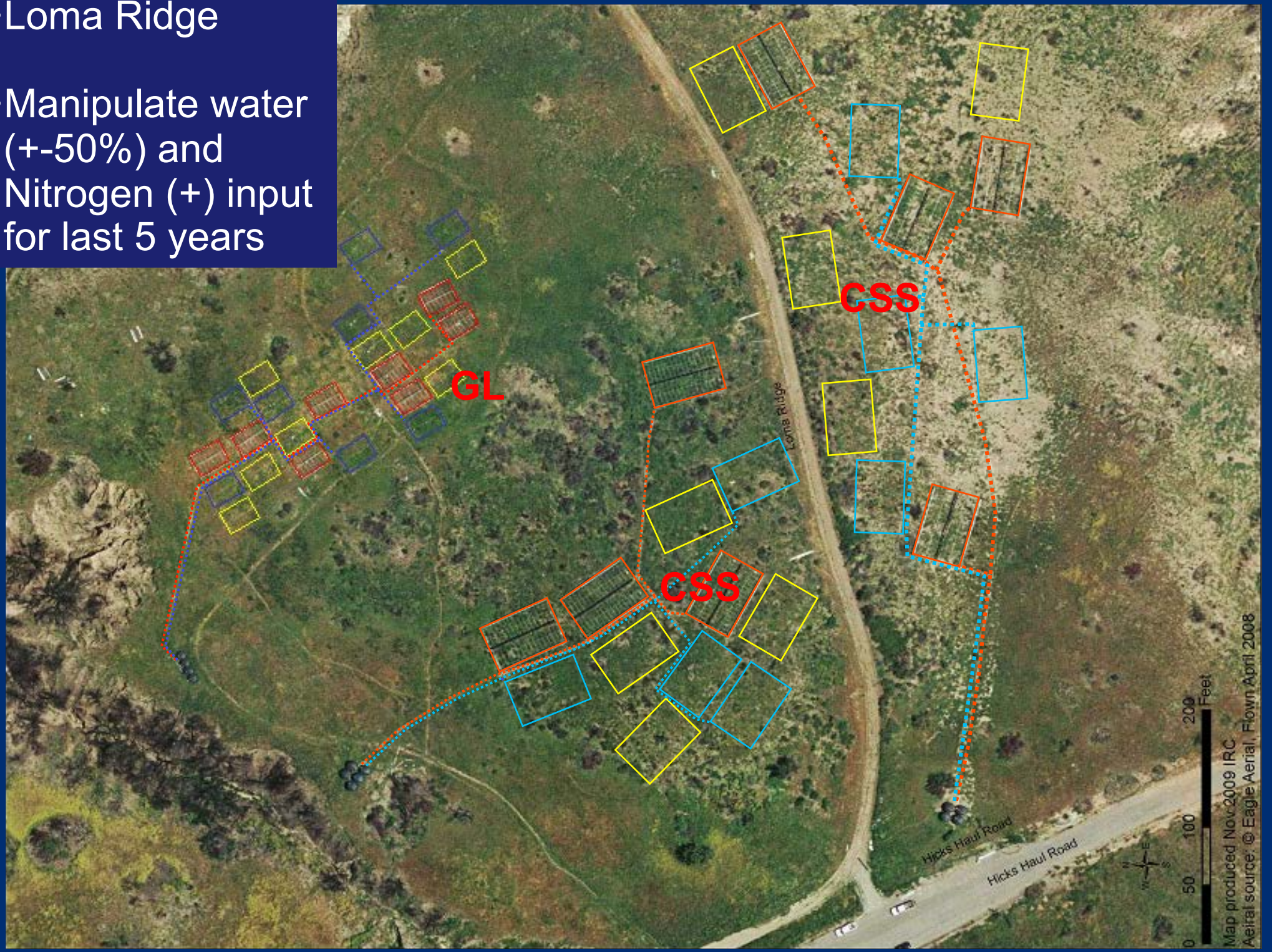


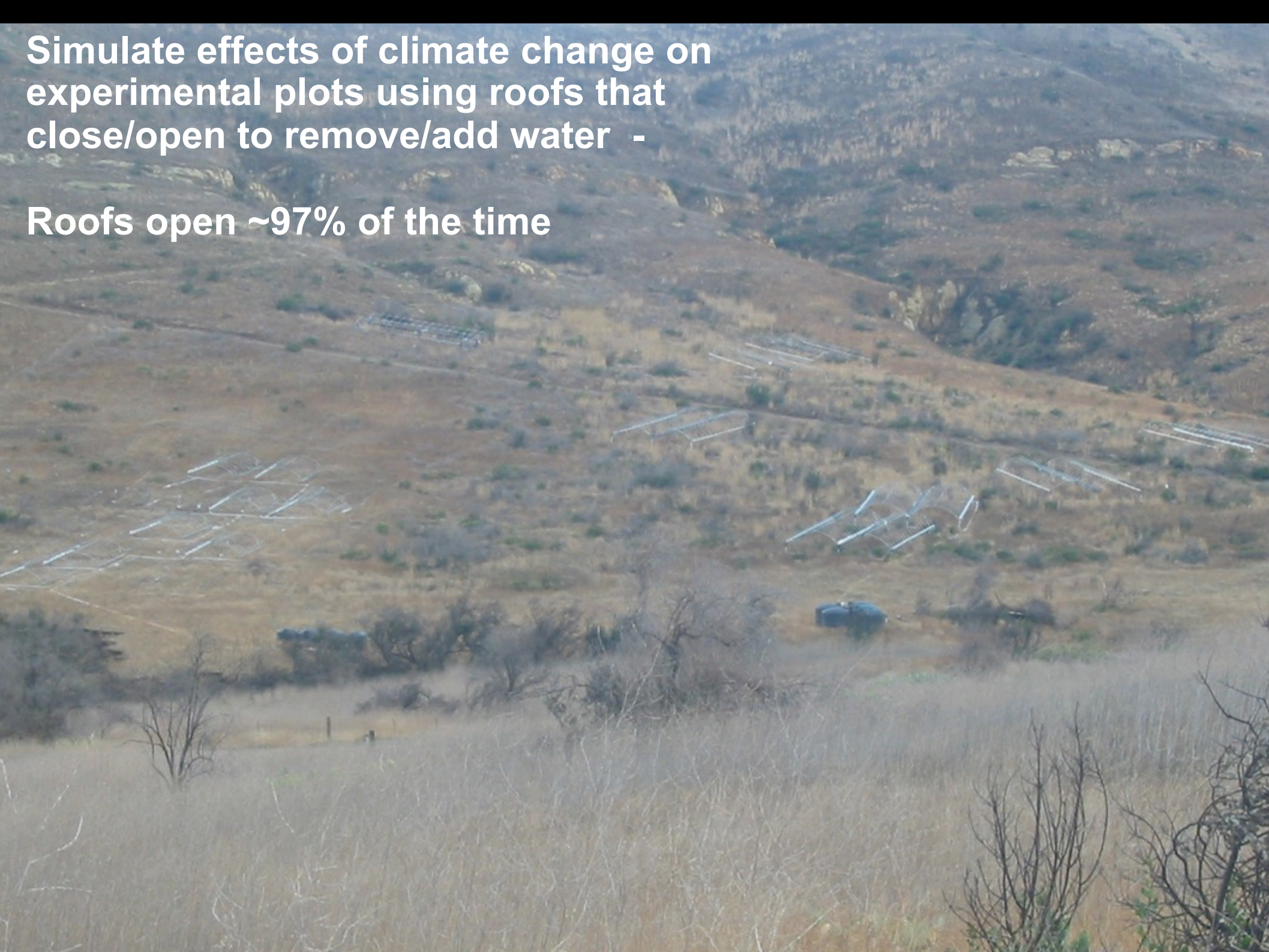




- Eddy covariance – measures whole ecosystem exchanges, such as photosynthesis
- Two sites ~300 m apart on similar soil
- Both burned in Oct 2007 Santiago wildfire
- Fire had no (or positive) effect on grass production
- CSS production recovered rapidly – rates of exchange 3-4 years after fire appear higher than before fire

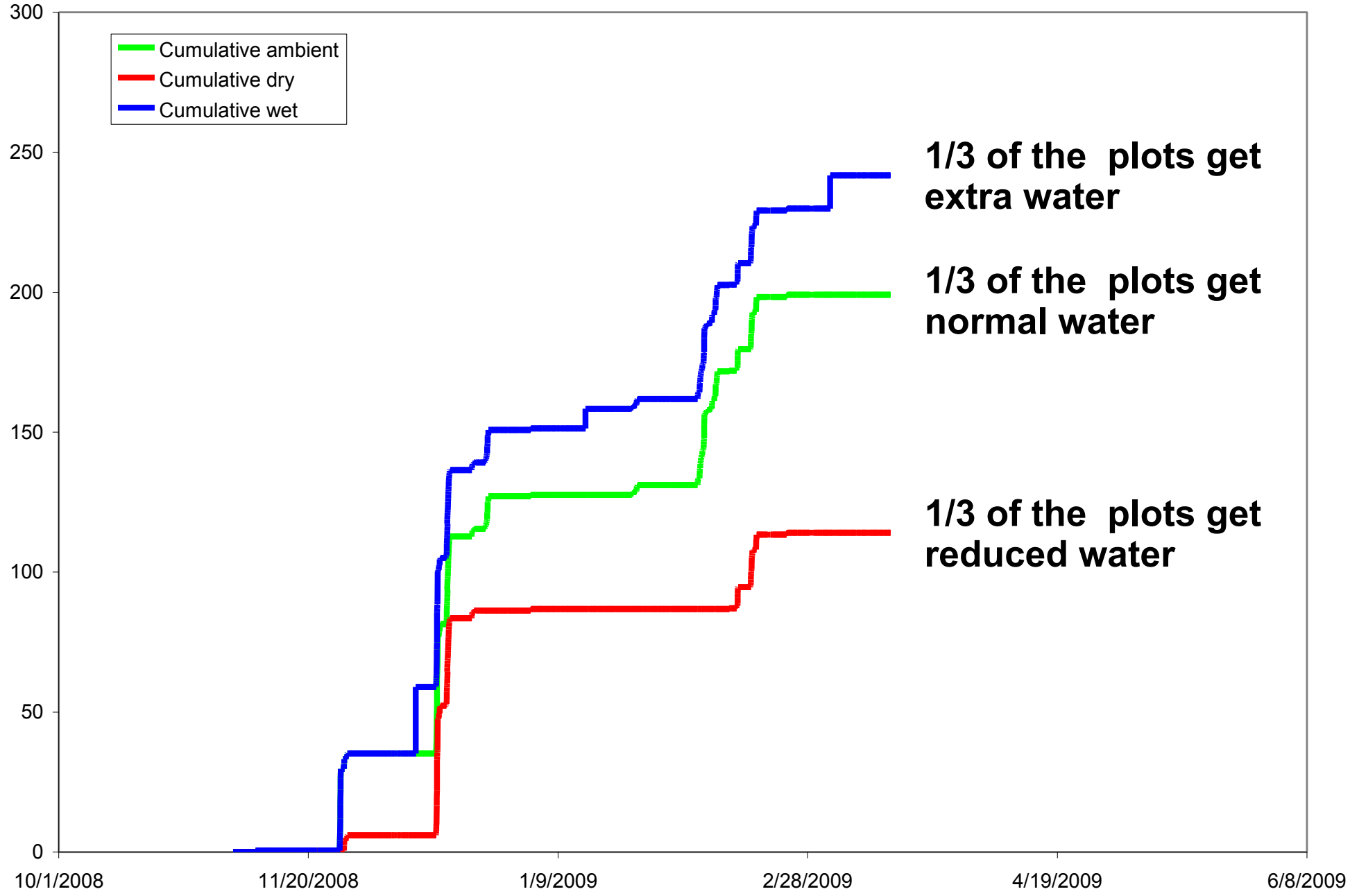
- Loma Ridge
- Manipulate water (+-50%) and Nitrogen (+) input for last 5 years

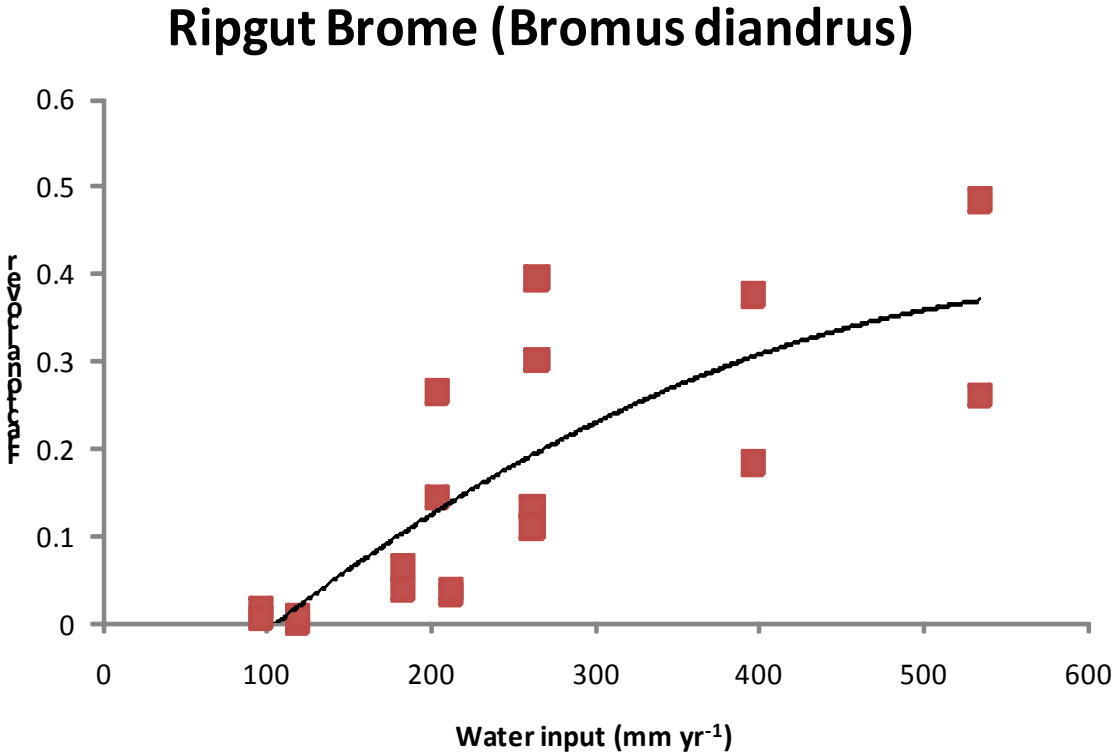


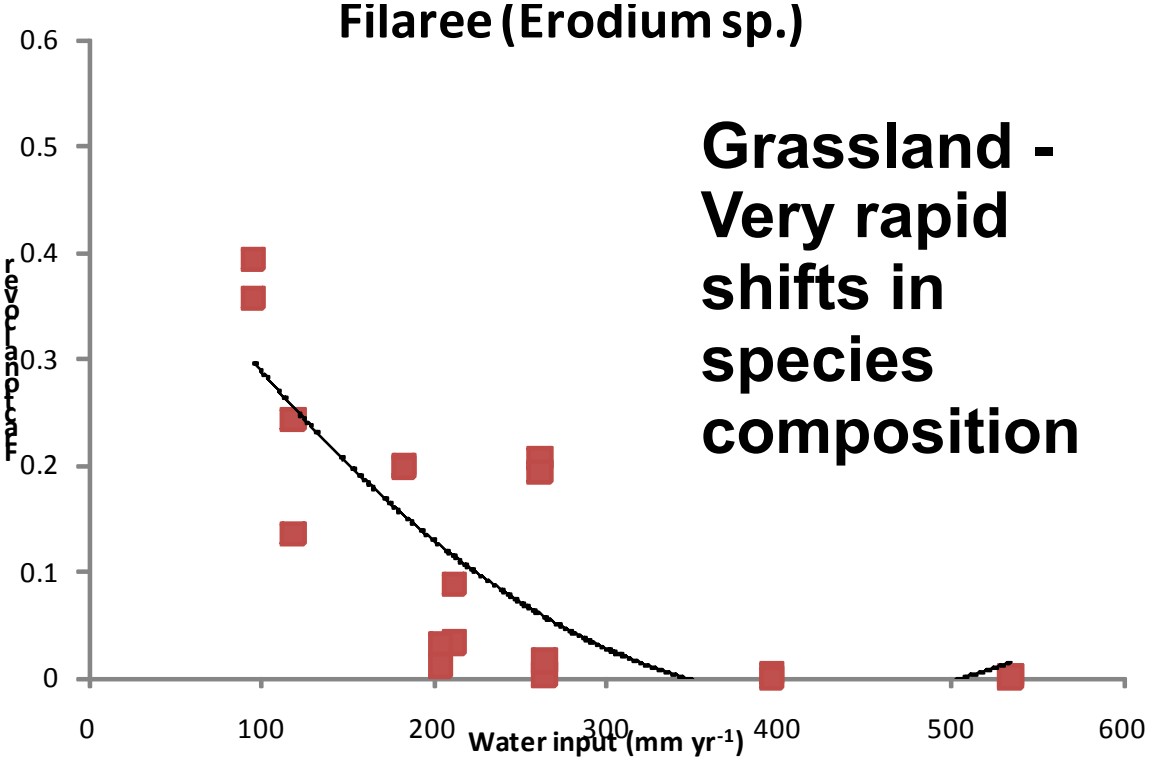

Simulate effects of climate change on experimental plots using roofs that close/open to remove/add water -
Roofs open ~97% of the time


Roofs closed 3% of the time (for big storms)

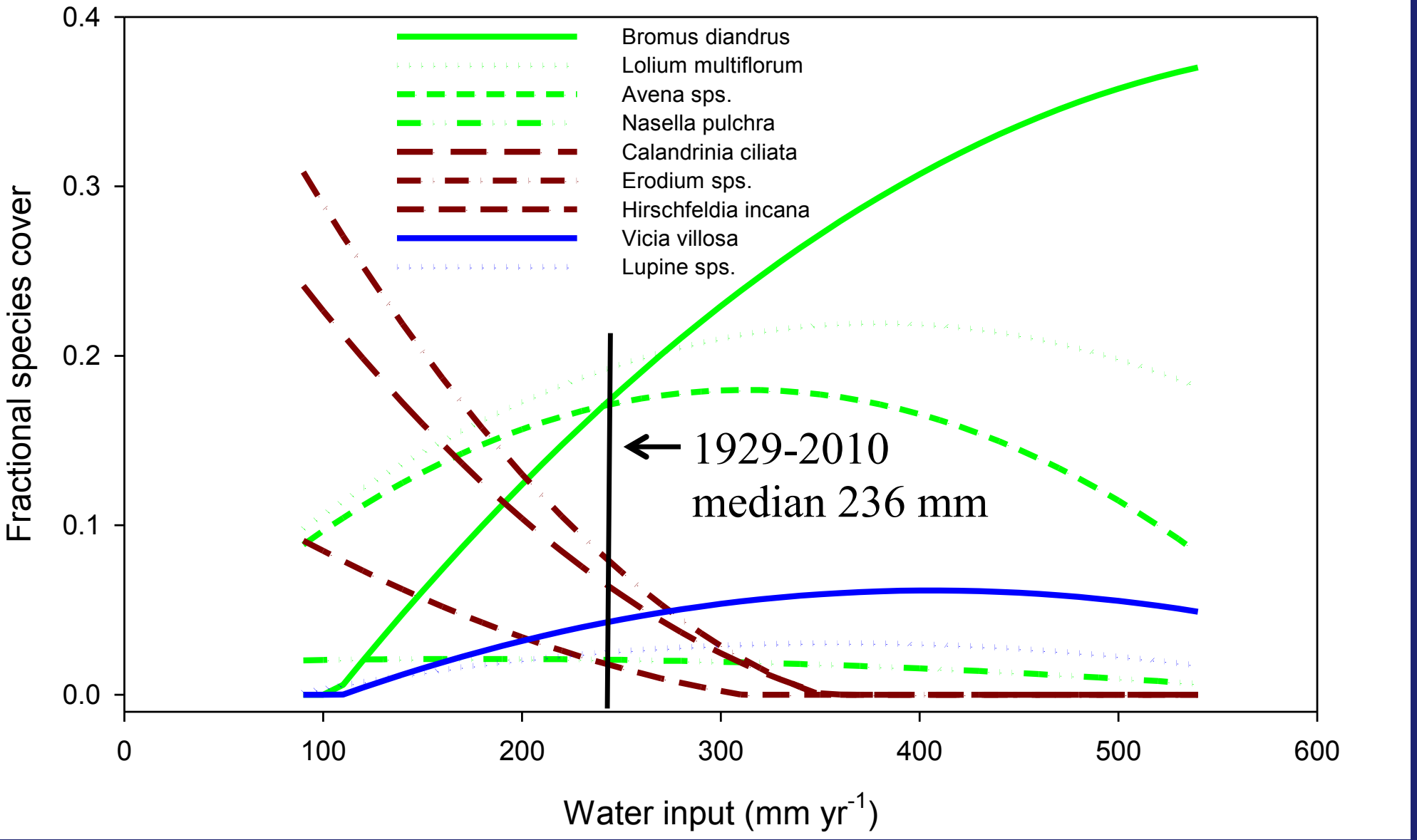
Water input for the various treatments




Ripgut Brome (Bromus diandrus)
0.6
0.5
0.4
0.3
0.2
0.1
0
0
100
200
300
400
500
600
Water input (mm yr-1)


Filaree (Erodium sp.)
0.6
0.5
0.4
0.3
0.2
0.1
0
0
100
200
300
400
500
600
Water input (mm yr-1)
Grassland - Very rapid shifts in species composition

- Rapid changes in relative abundance – Species reordering
- Species coexist at climatological precipitation (median 236 mm /yr)
- Species reordering tied to traits
- Favored with drought - Forbs and shorter time to flowering
- Favored in wet treatments - Grasses and N fixers



CSS' Achilles heel? The combination of:

- **Fire (knocks shrubs back 2-3 years; no or positive effect on grasses)**
- **Several dry years (soil below 0.5-1 m remains dry; hurts shrubs, not grasses)**
- **Added N (accelerates grasses; only small effect on shrubs)**

	Normal Nitrogen	**Added Nitrogen**
Reduced precipitation	Moderate risk of change to red brome grassland	Large risk of change to red brome grassland
Normal precipitation	Stable	Moderate risk of change to brome grassland
Added precipitation	Stable	Stable