



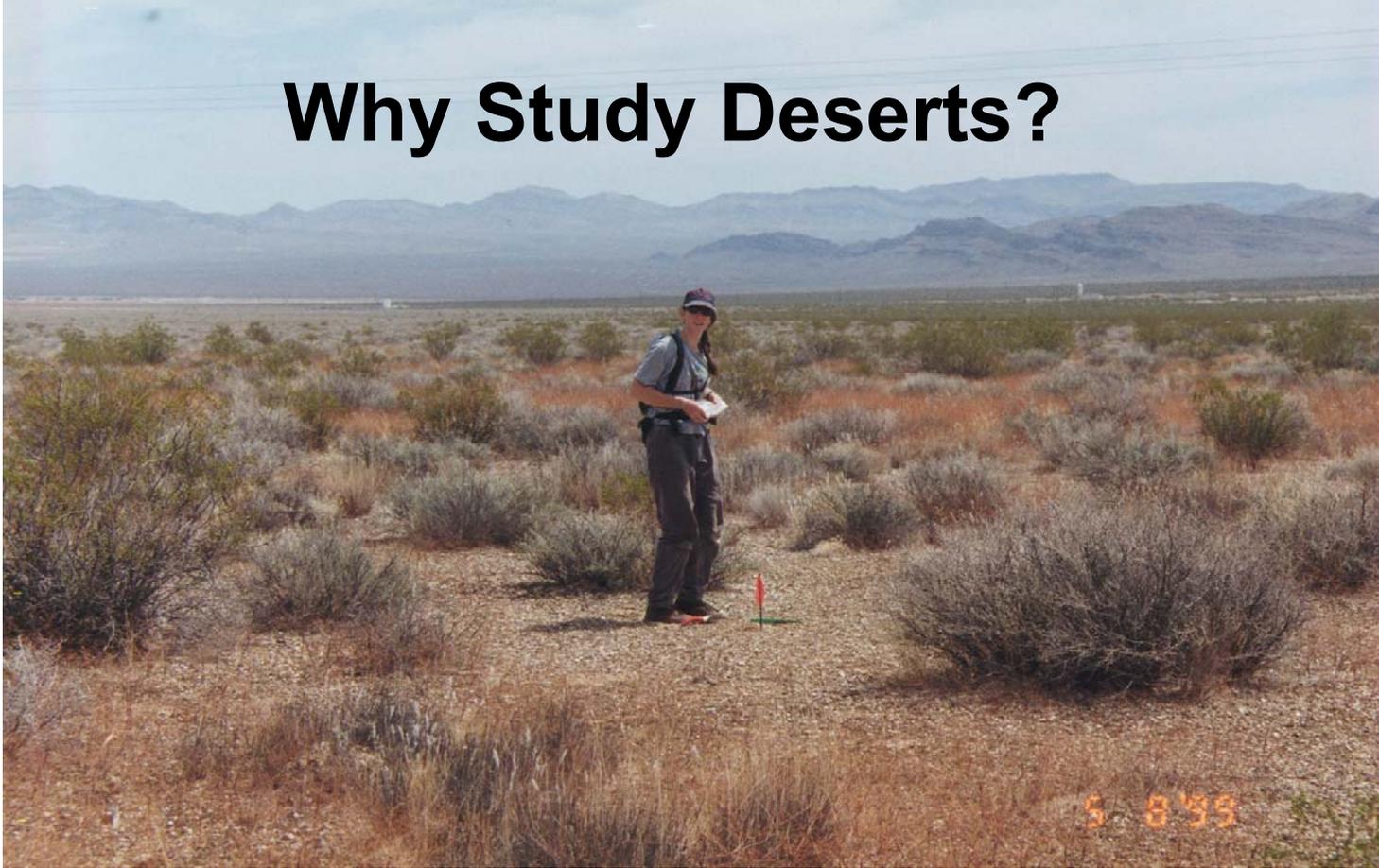
# Ecological Effects of Global Change in the Great Basin and Mojave Deserts

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Las Vegas**



# Why Study Deserts?



- Arid and semi-arid regions constitute ~40% of the earth's terrestrial surface
- Extreme environments, and particularly deserts, are predicted to show the greatest responses to rising atmospheric CO<sub>2</sub> and concomitant global change factors

# The Nevada Desert Research Center



**Elevated [CO<sub>2</sub>]**



**Added summer rain  
N deposition  
Crust removal**

# Nevada Desert FACE Facility

- Free-Air Carbon Dioxide Enrichment, operational since 1997
- Located 90 km north of Las Vegas on the Nevada Test Site
- Elevated  $[\text{CO}_2]$  rings maintained at 550 ppm ( $n = 3$ )
- Operates 365 days per year, 24 hours each day



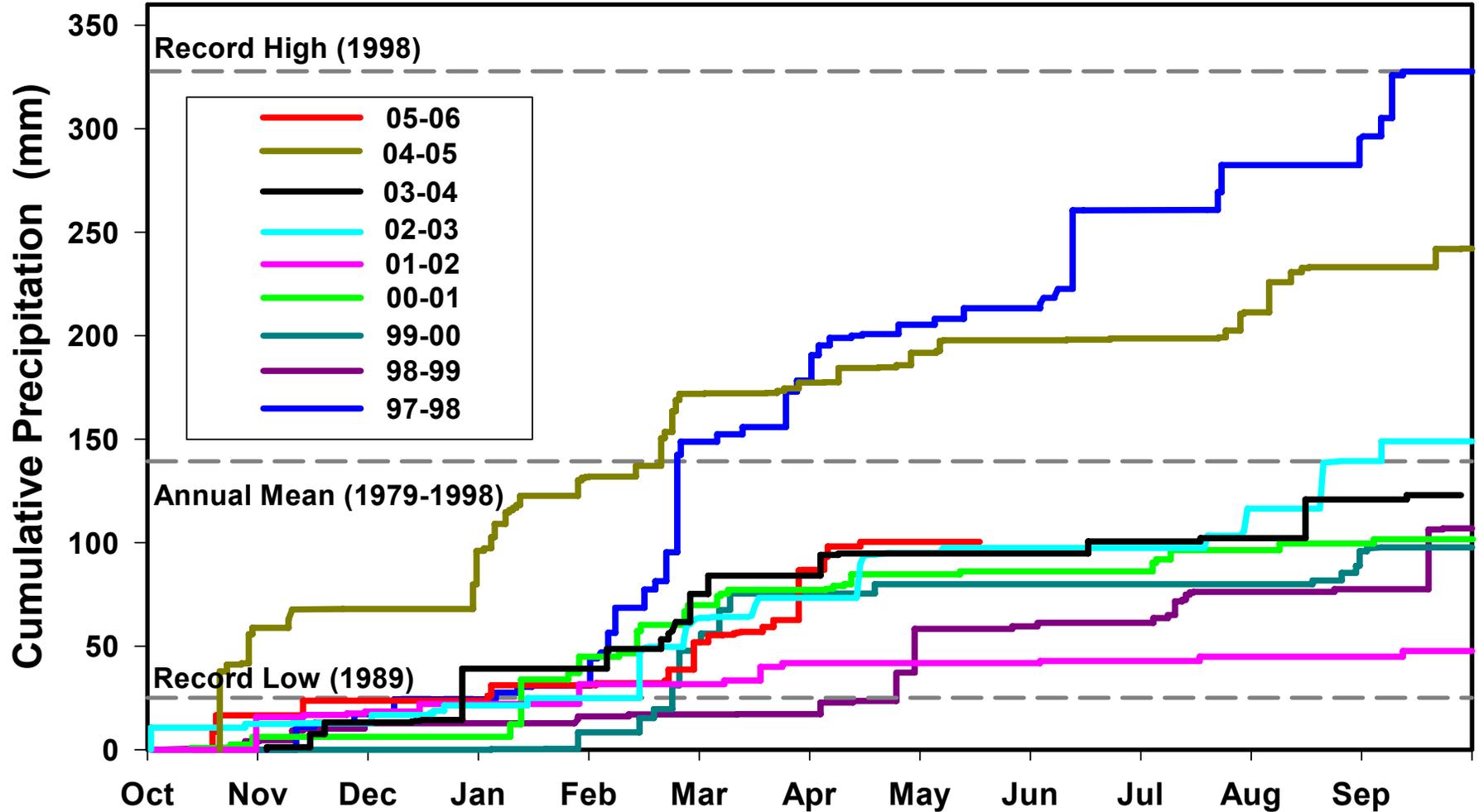


**Oblique aerial view of Ring 3; an elevated CO<sub>2</sub> treatment plot**

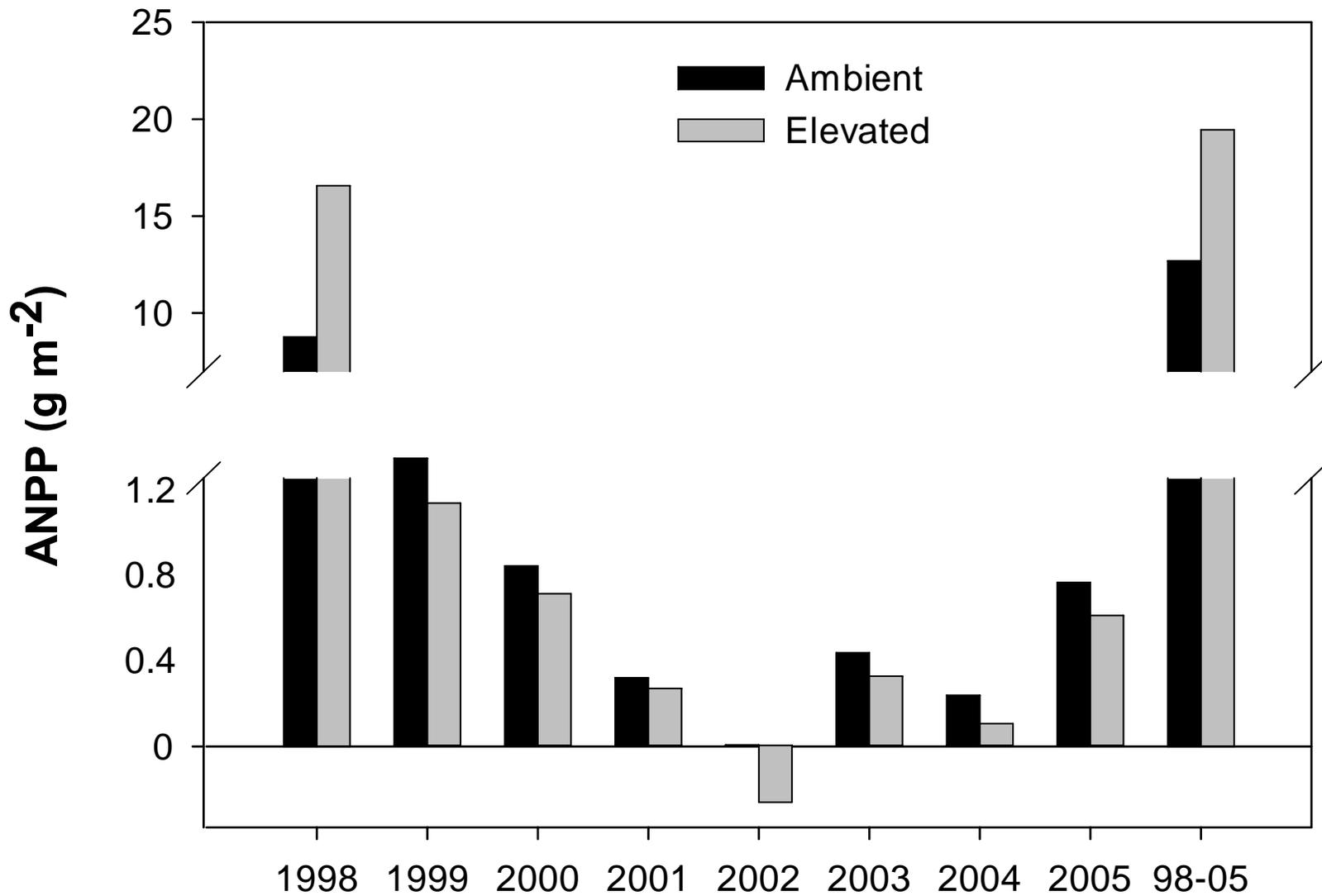


# Precipitation at the NDFE 1996-2006

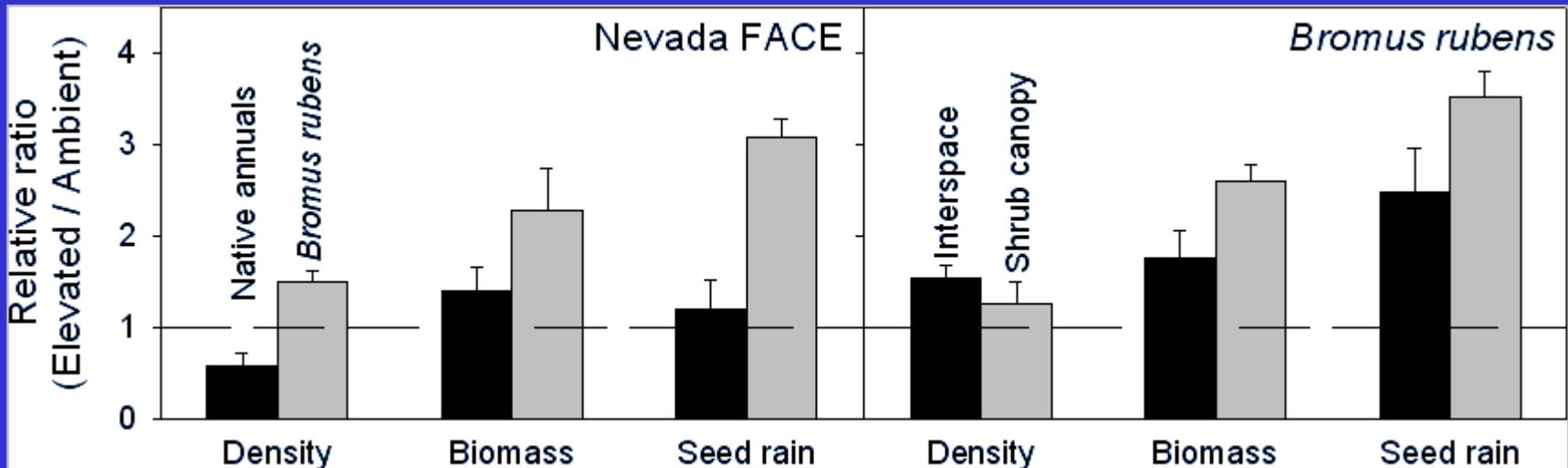
Hydrologic Year (Oct 1-Sept 30)



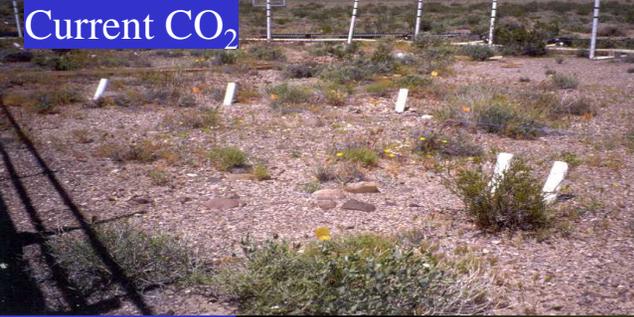
# Total Shrub ANPP from 1998-2005



# Productivity of Annuals: 1998



Smith et al. (2000) *Nature* 408:79-82.



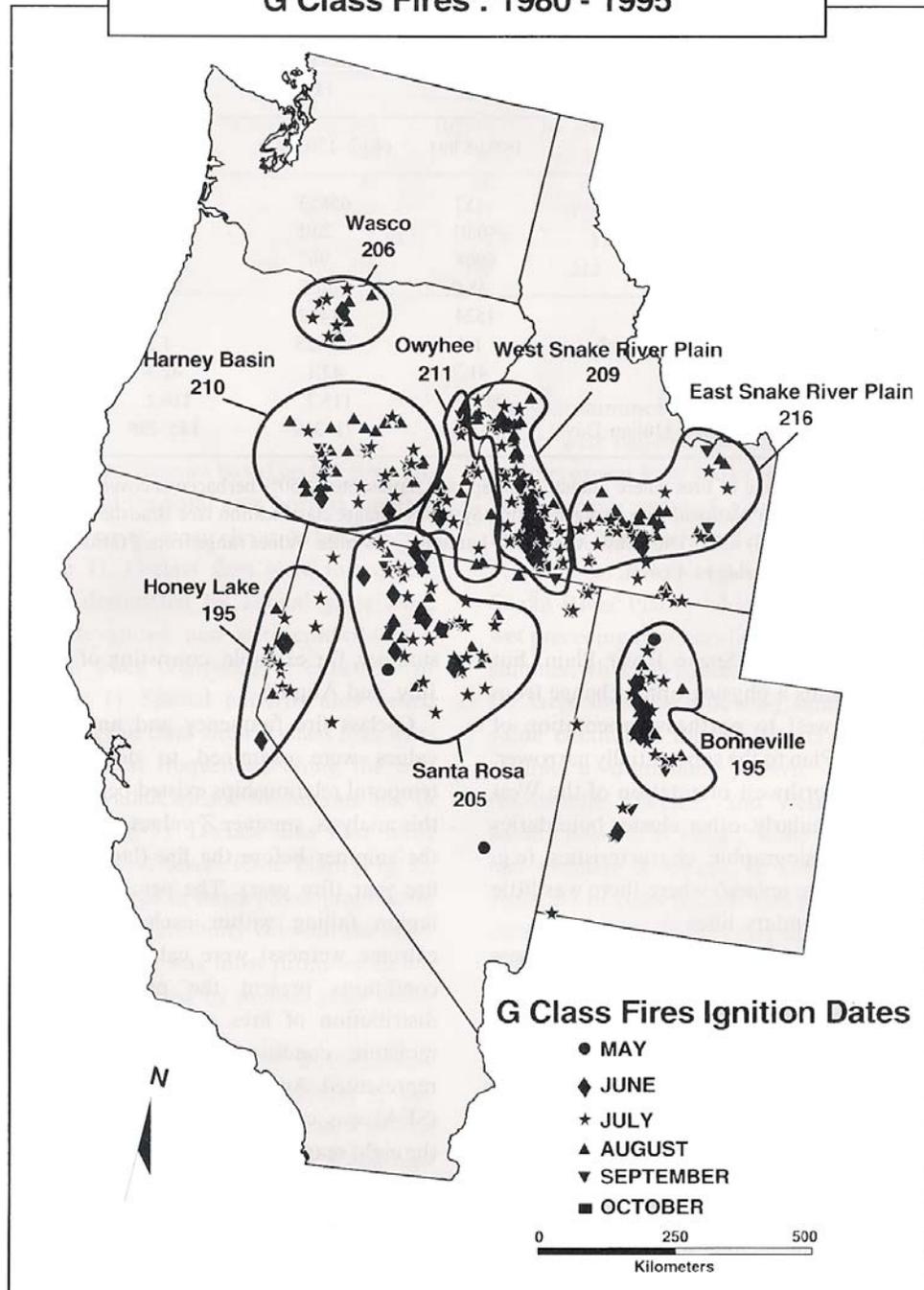


Community change



## G Class Fires : 1980 - 1995

**Class G Fires:  
> 2,000 ha in Area**

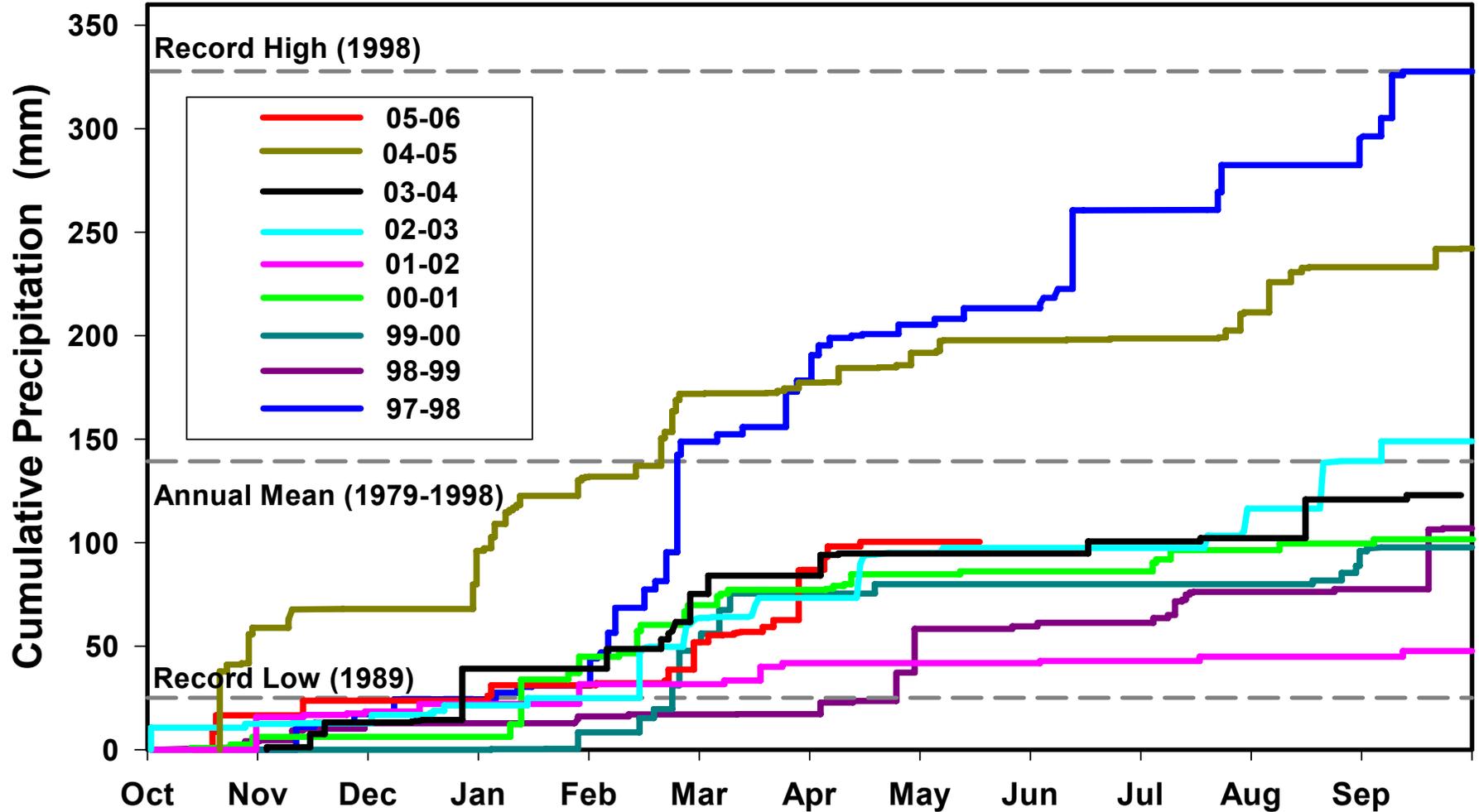


**From P. Knapp**

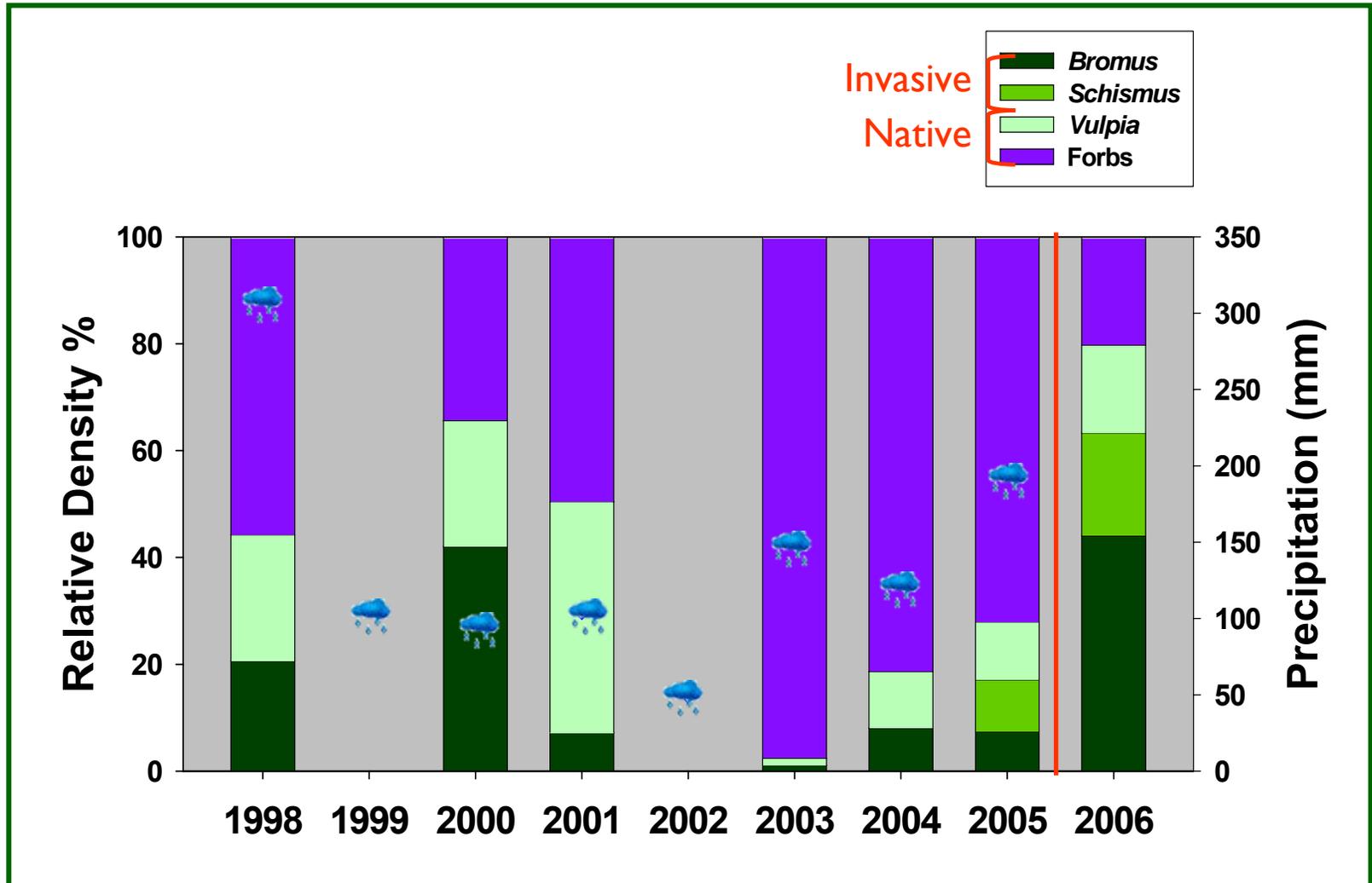


# Precipitation at the NDFE 1996-2006

Hydrologic Year (Oct 1-Sept 30)



# Native v. Invasive Annuals



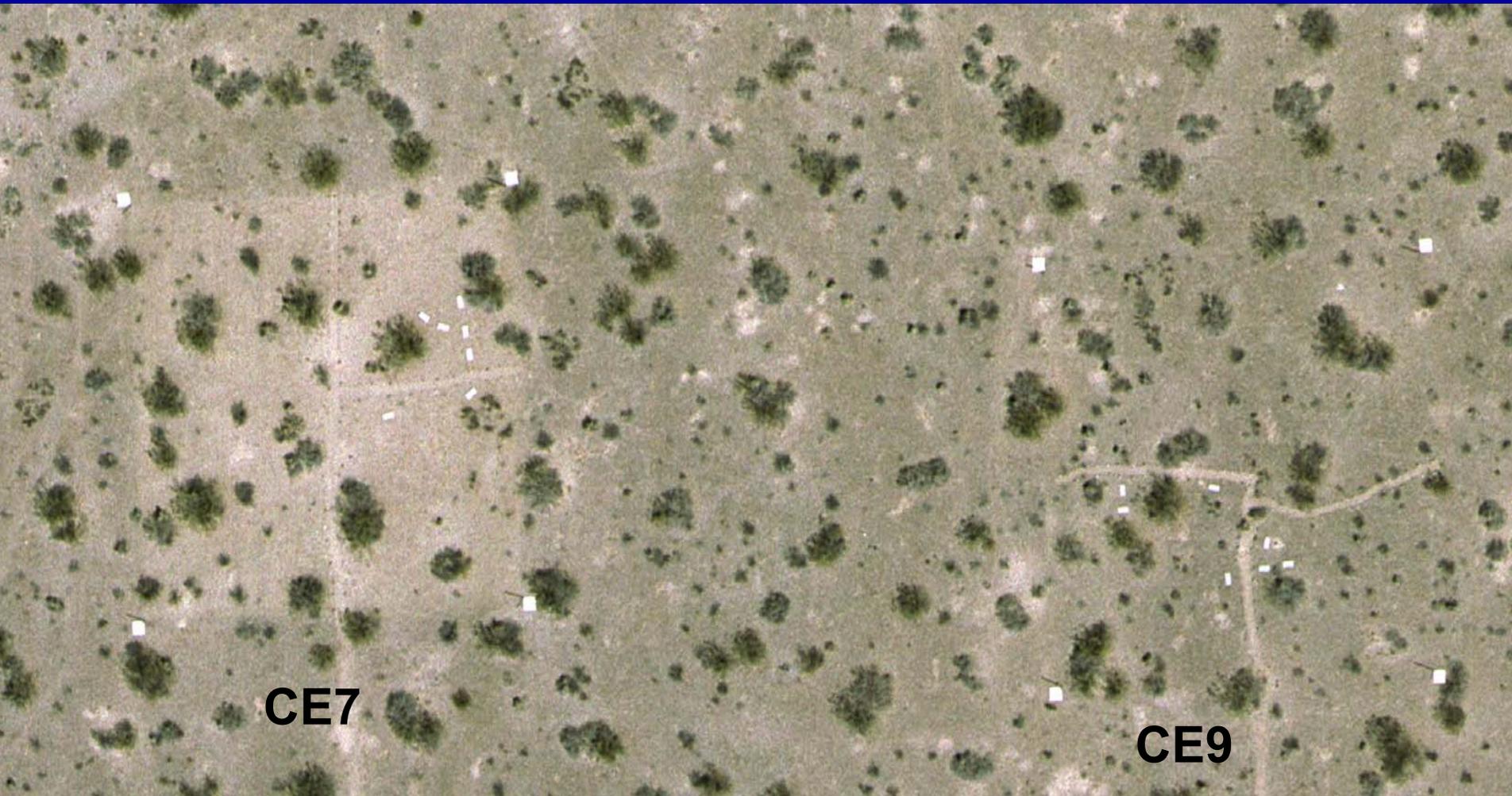
# Mojave Global Change Facility (MGCF)

## Treatments

- + Monsoon = 25 mm H<sub>2</sub>O in June, July, and August
- 10 N = 10 kg N ha<sup>-1</sup> yr<sup>-1</sup>  
40 N = 40 kg N ha<sup>-1</sup> yr<sup>-1</sup>
- Disturbance = trampling biological soil crust
  - 12 treatments in complete factorial design (n=8)
  - 96 plots (14m x 14m)



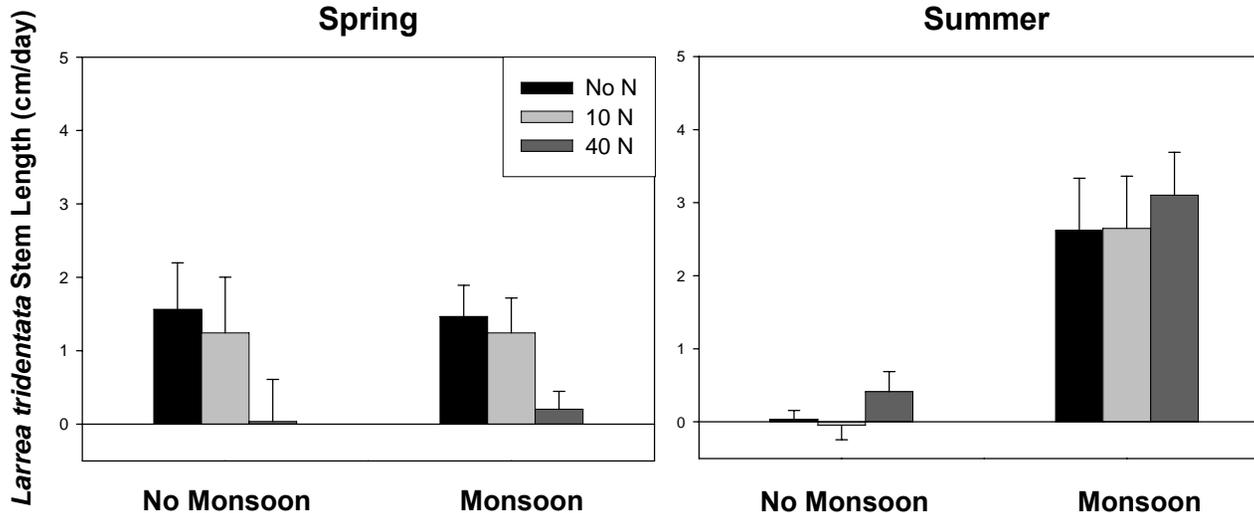
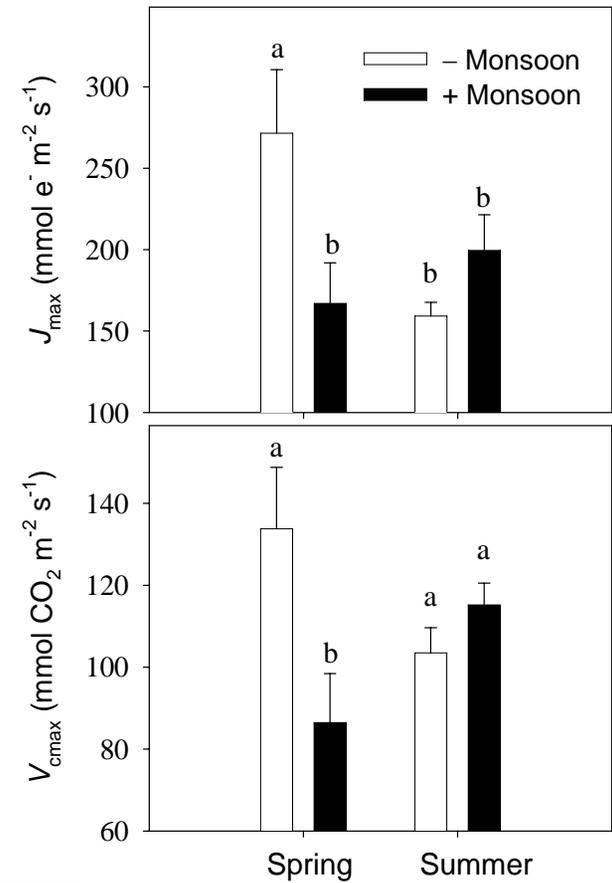
Established 2001



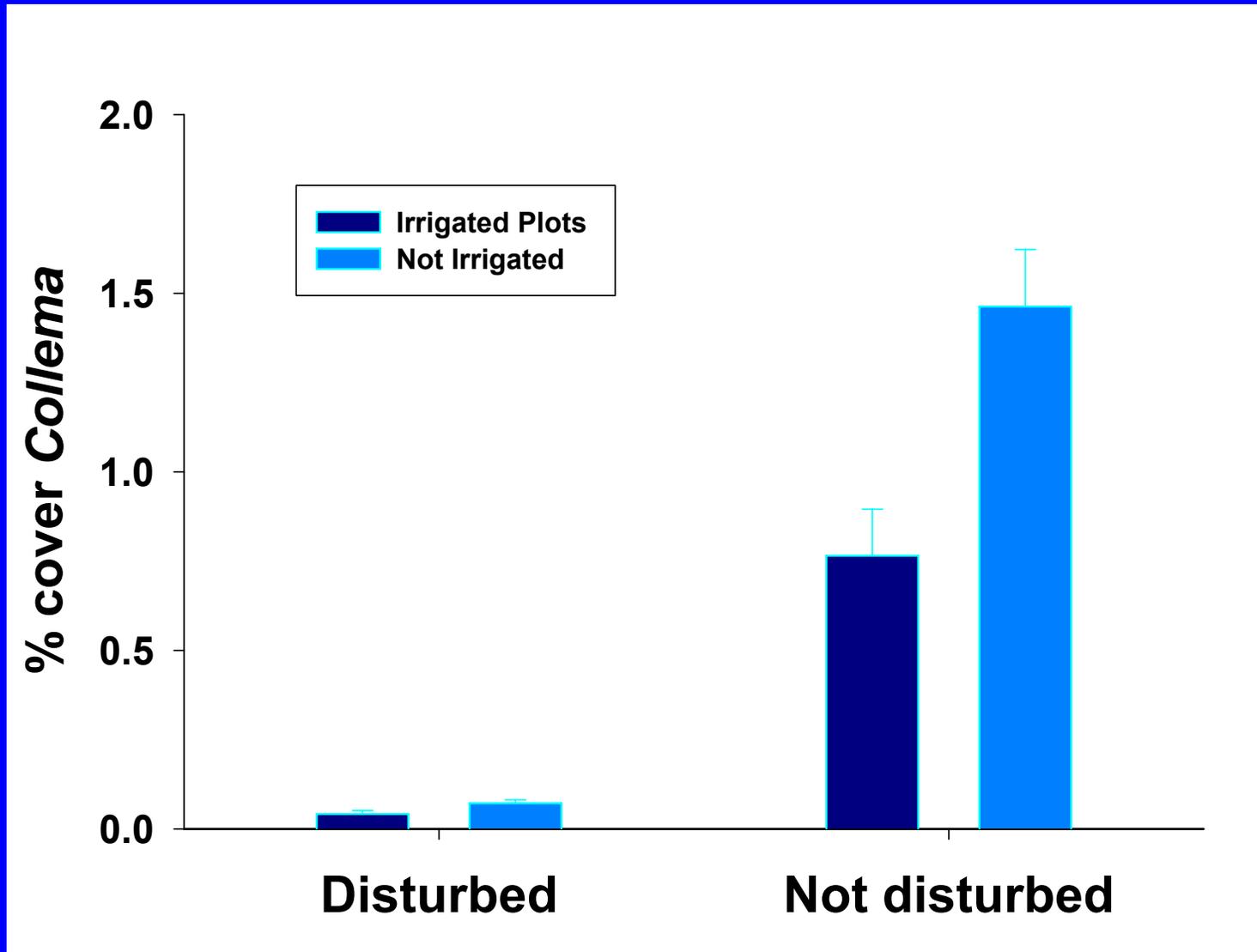
Close-up view of two plots, CE7 (crust disturbed) and CE9 (crust undisturbed).

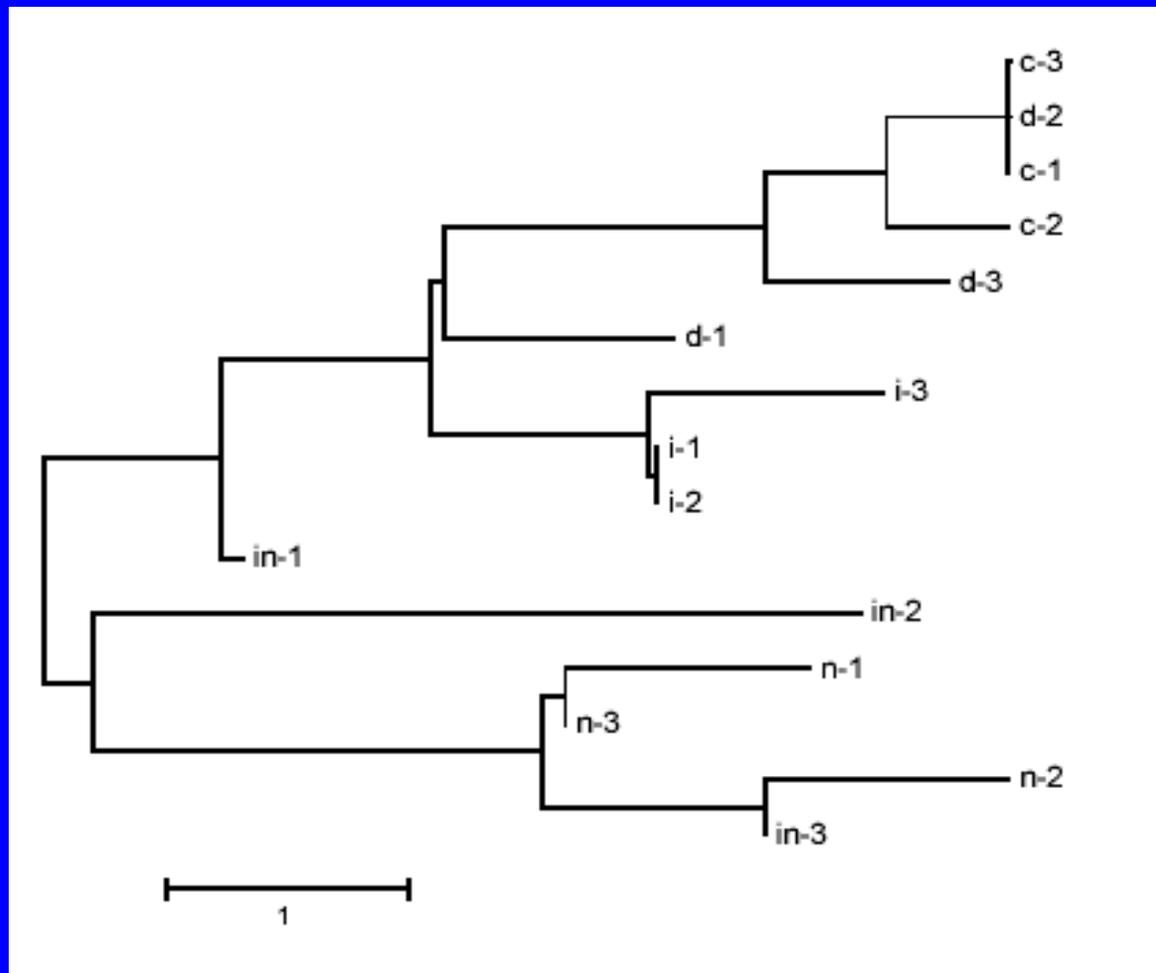
# Aboveground Production

	LATR	LYPA	PLRI
+H <sub>2</sub> O	↑↑		↑↑
+10N			
+40N		↑	
+H <sub>2</sub> O + 10N	↑↑		↑↑
+H <sub>2</sub> O + 40N	↑↑		↑↑
Disturbance			



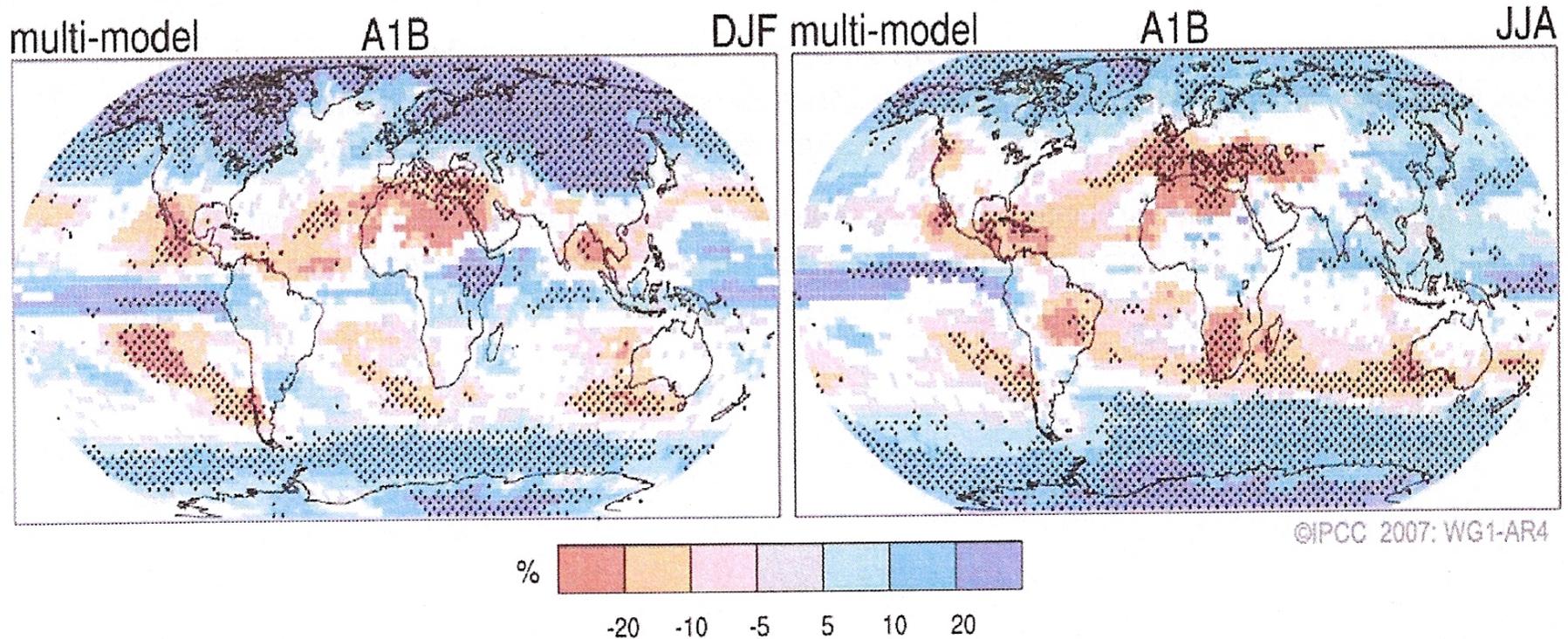
# *Collema* % Cover: Irrigation & Disturbance





Phylogenetic tree of changes in bacterial community composition resulting from irrigation (i), disturbance (d), added nitrogen (n) and irrigation and nitrogen (in), based on 16S rDNA T-RFLP results. The forward primer was fluorescently labeled and the PCR products digested with a restriction enzyme that recognizes a four base sequence. This tree is derived from distance matrices (presence or absence of specific taxa) using the neighbor-joining method.

# Projected Patterns of Precipitation Changes



**FIGURE SPM-7.** Relative changes in precipitation (in percent) for the period 2090–2099, relative to 1980–1999. Values are multi-model averages based on the SRES A1B scenario for December to February (left) and June to August (right). White areas are where less than 66% of the models agree in the sign of the change and stippled areas are where more than 90% of the models agree in the sign of the change. {Figure 10.9}

# Sierra Nevada Snowpack Projections Based on Different Emissions/Warming Scenarios

2020-2049

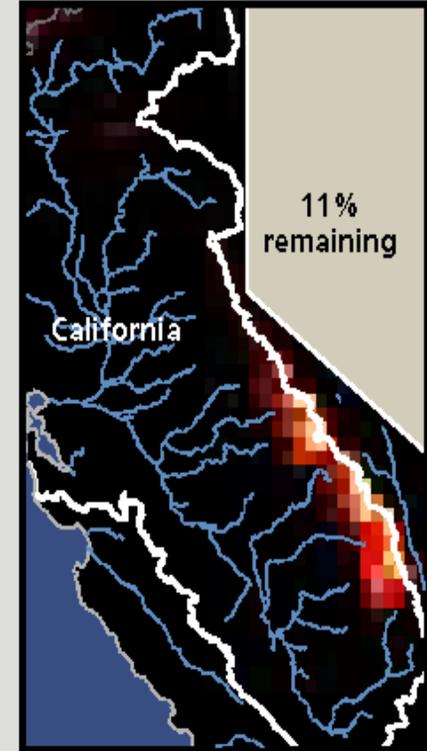
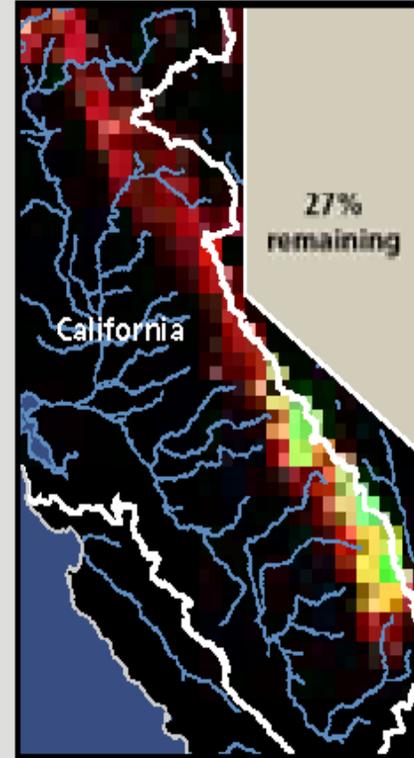
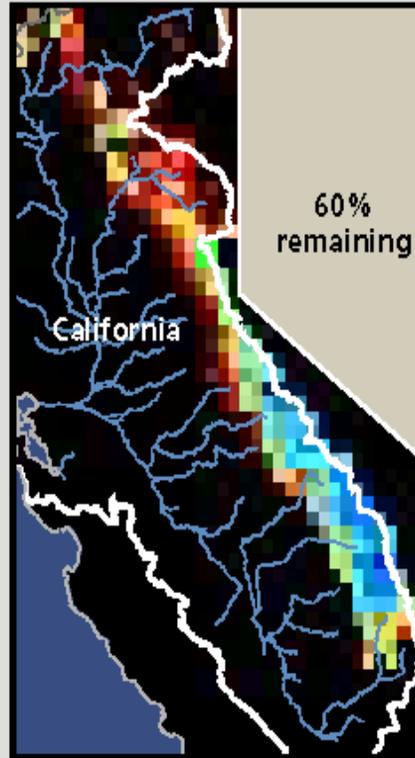
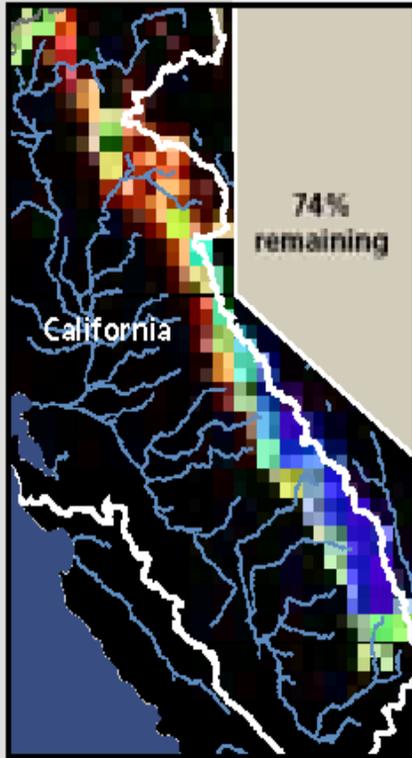
2070-2099

Lower Emissions

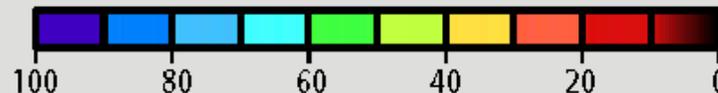
Higher Emissions

Lower Emissions

Higher Emissions



Remaining Snowpack (%)



# Great Basin Biodiversity and Global Change

**(with help from Brett Riddle, SoLS, UNLV)**



# *Dipodomys*: kangaroo rats

*D. deserti*



*D. merriami*



*D. microps*



*D. ordii*





# *D. deserti*

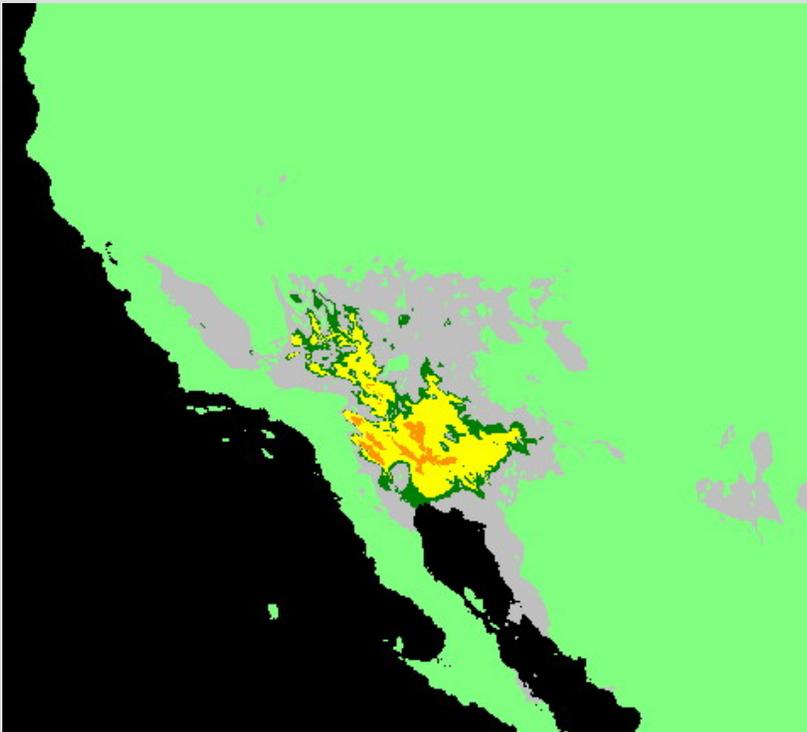
genetic diversity:

high in warm deserts

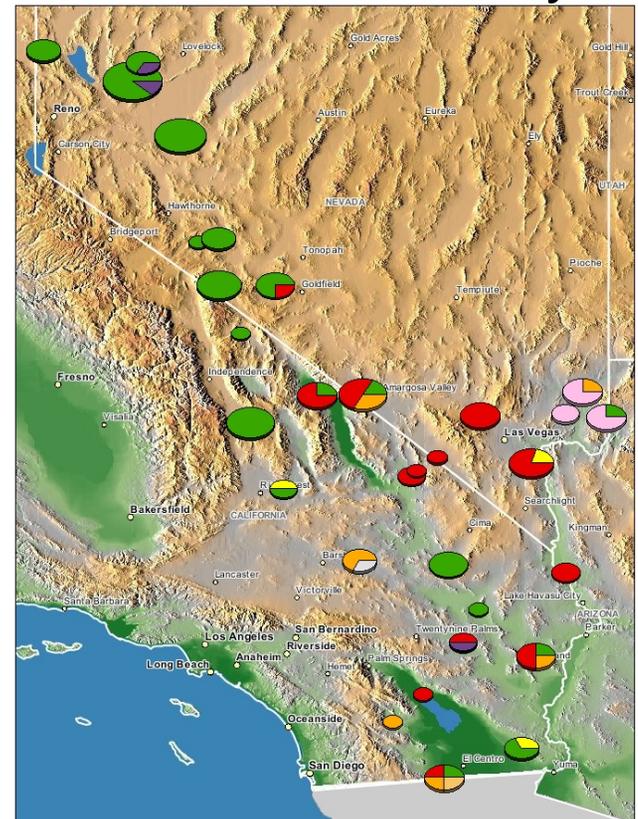
low in Great Basin

consistent with post-glacial range expansion

ecological niche model: 18,000 ybp



## mtDNA diversity

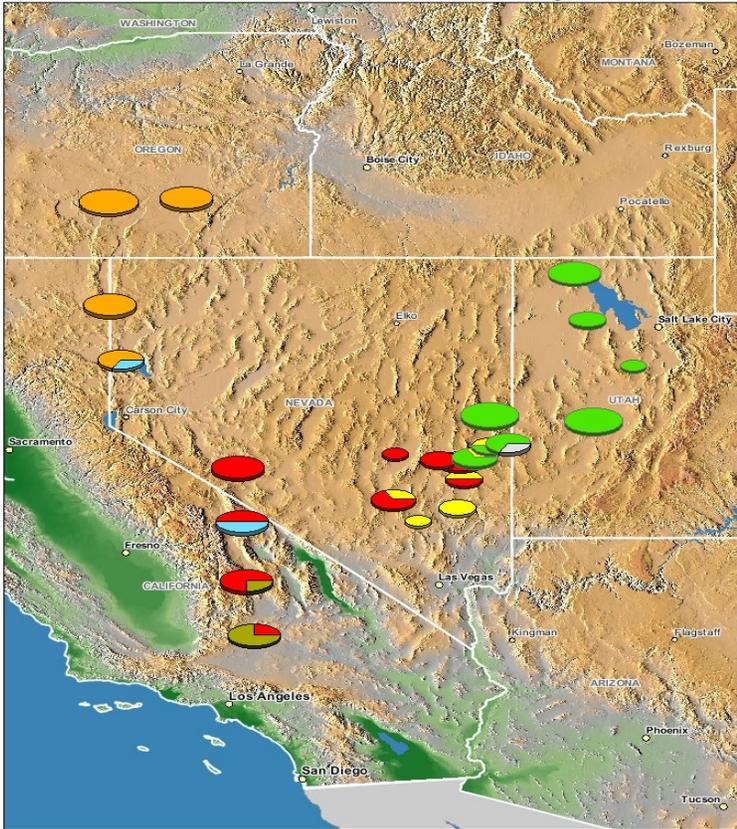




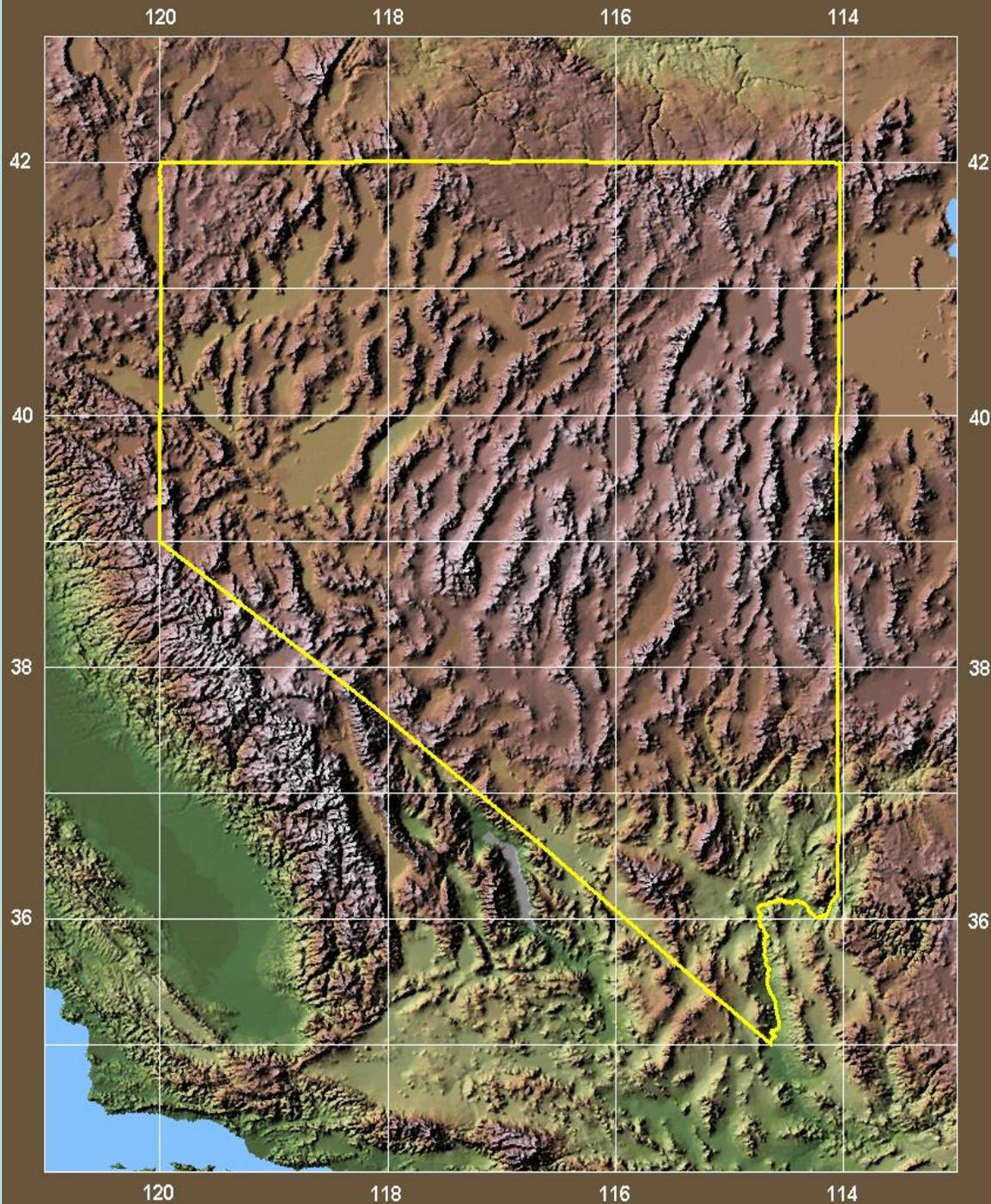
# *D. microps*

genetic diversity high  
geographically highly structured  
several glacial-age refugia

## mtDNA diversity



**Nevada's  
Montane  
"Sky Islands"**



# Death Valley

# Pupfish

S. Lema

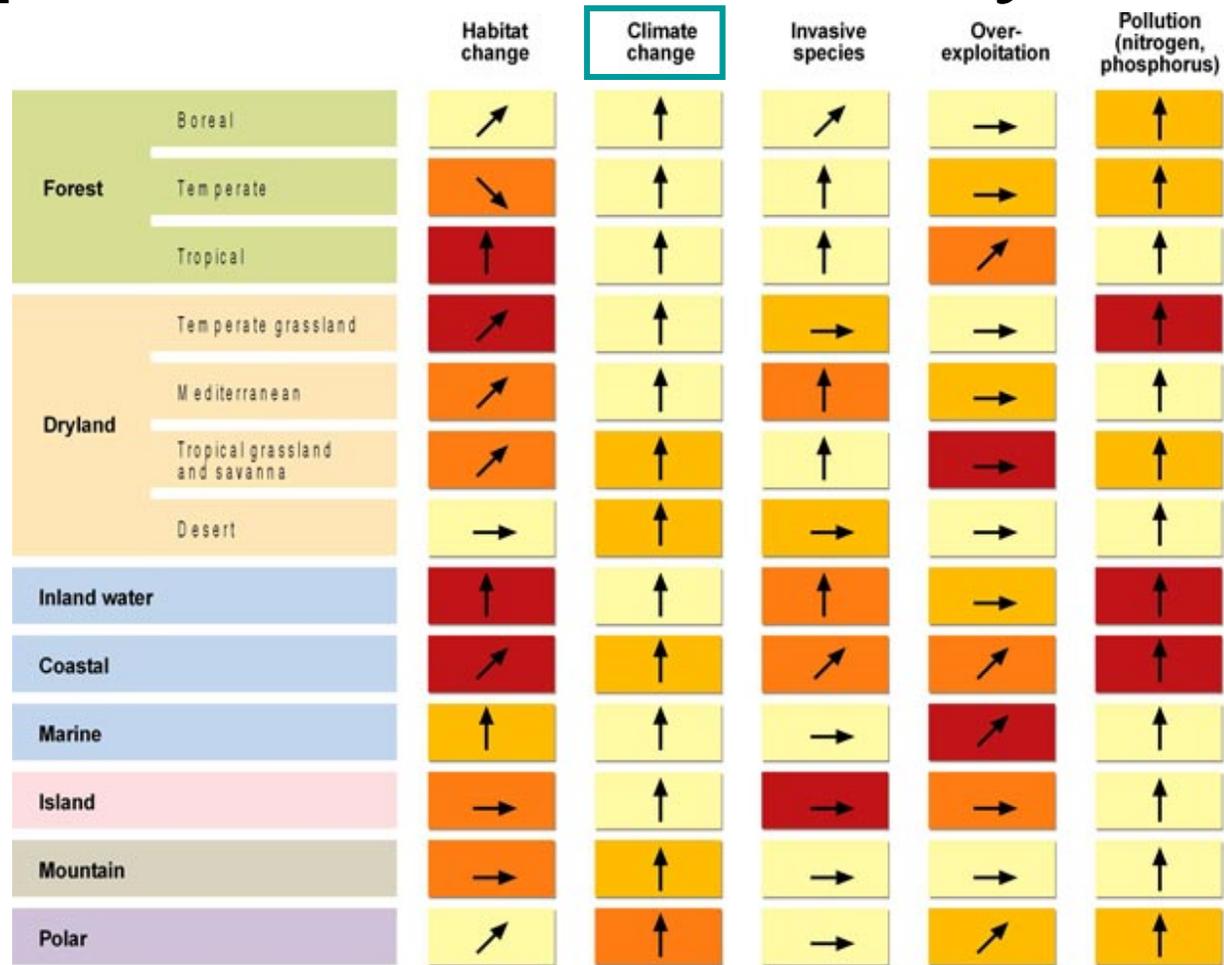
(2008)

Am. Sci.



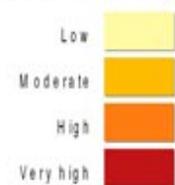
Figure 3. Permanent bodies of water are few and far between in Death Valley, and the pupfish that live here are scattered in these remote springs, marshes and streams. Two salt-tolerant species, the Cottonball Marsh pupfish (*Cyprinodon salinus milleri*) and the Salt Creek pupfish (*Cyprinodon salinus salinus*) make their homes in Cottonball Marsh and Salt Creek in the northern reaches of Death Valley (a and b). Devils Hole pupfish (*Cyprinodon diabolis*) are among the rarest of the remaining seven species, with fewer than a hundred individuals remaining (c). Big Spring (d) hosts the Ash Meadow pupfish (*Cyprinodon nevadensis mionectes*). The Amargosa River pupfish (*Cyprinodon nevadensis amargosae*) lives at two locations along the Amargosa River (e), whereas Saratoga Springs and Marsh provide habitat for the Saratoga pupfish (*Cyprinodon nevadensis nevadensis*) (f). The Warm Spring pupfish (*Cyprinodon nevadensis pectoralis*) is found near Devil's Hole. Two other species, *Cyprinodon nevadensis calidae* and *Cyprinodon nevadensis shoshone*, are extinct.

# Driver impacts on biodiversity



Millennium  
Ecosystem  
Assessment

Driver's impact on biodiversity over the last century



Driver's current trends



Source: Millennium Ecosystem Assessment