A photograph of a desert landscape in the Colorado Desert. The foreground is sandy with sparse, low-lying green and brown shrubs. In the middle ground, there are several white wind turbines. The background features a range of rugged, brown mountains under a clear blue sky. The text is overlaid on the upper half of the image.

**Evening the odds: evaluating the
combined effects of nitrogen
fertilization and exotic annual removal
on native annual forbs in the Colorado
Desert**

**Heather Schneider* & Edith Allen
University of California, Riverside**

Outline

- Introduction: invasives in the desert & nitrogen deposition
- Overview of the study:
 - Purpose
 - Study site
 - Methods
 - Results
- Conclusions
- Implications



Camissonia pallida

Welcome to the Desert

- Colorado Desert
 - Low elevation <1000 m
 - Sonoran Desert in southern California
 - Average precipitation: 2 - 6 inches (*US Forest Service*)
- Creosote Bush Scrub (CBS)
 - *Larrea tridentata* (creosote bush) is the dominant perennial shrub, often accompanied by *Ambrosia dumosa*
 - Patchy shrub distribution with bare soil between
 - Interspace filled in by winter annual forbs during the rainy season

Common Invaders

- *Schismus* spp.



- *Bromus rubens*



- *Erodium cicutarium*



- *Brassica tournefortii*





Schismus spp. grass invasion in a wet year.

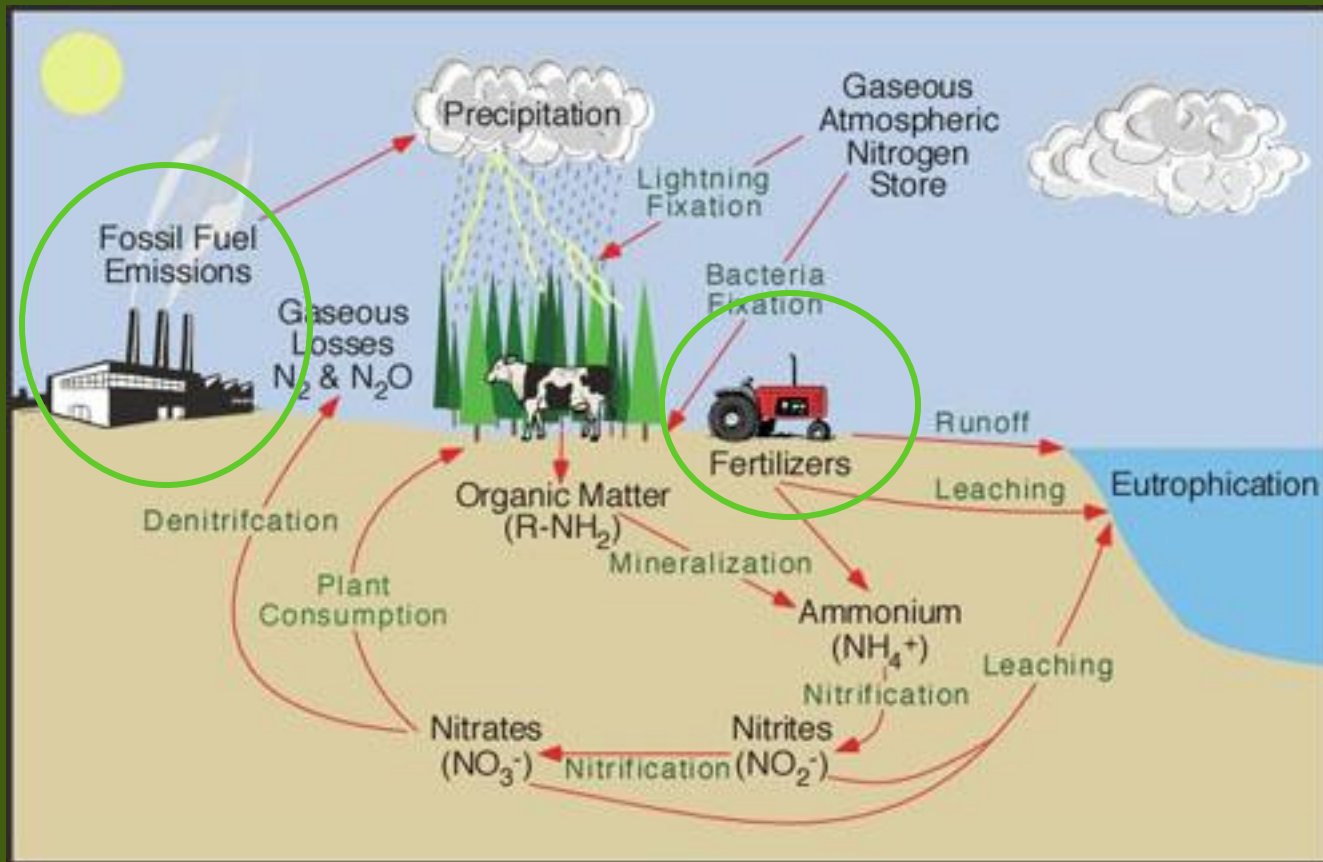
The Problem with Invasion

- Competition
 - Exotics can out-compete natives for resources
- Fire
 - Exotic annual grasses have been shown to be linked to increased fire frequency
- Ecosystem processes
 - Altered water and nutrient cycles



Robert Steers

Anthropogenic Nitrogen Deposition



Nitrogen Deposition



Air pollution in the Coachella Valley, California

The Study



Loeseliastrum schottii

- Objective:
 - To evaluate the combined effects of nitrogen fertilization and exotic removal on native annual forbs in the field
- Hypotheses:
 - There is a competitive effect of exotic annuals on native annual forbs
 - This competitive effect is altered by nitrogen deposition

Location

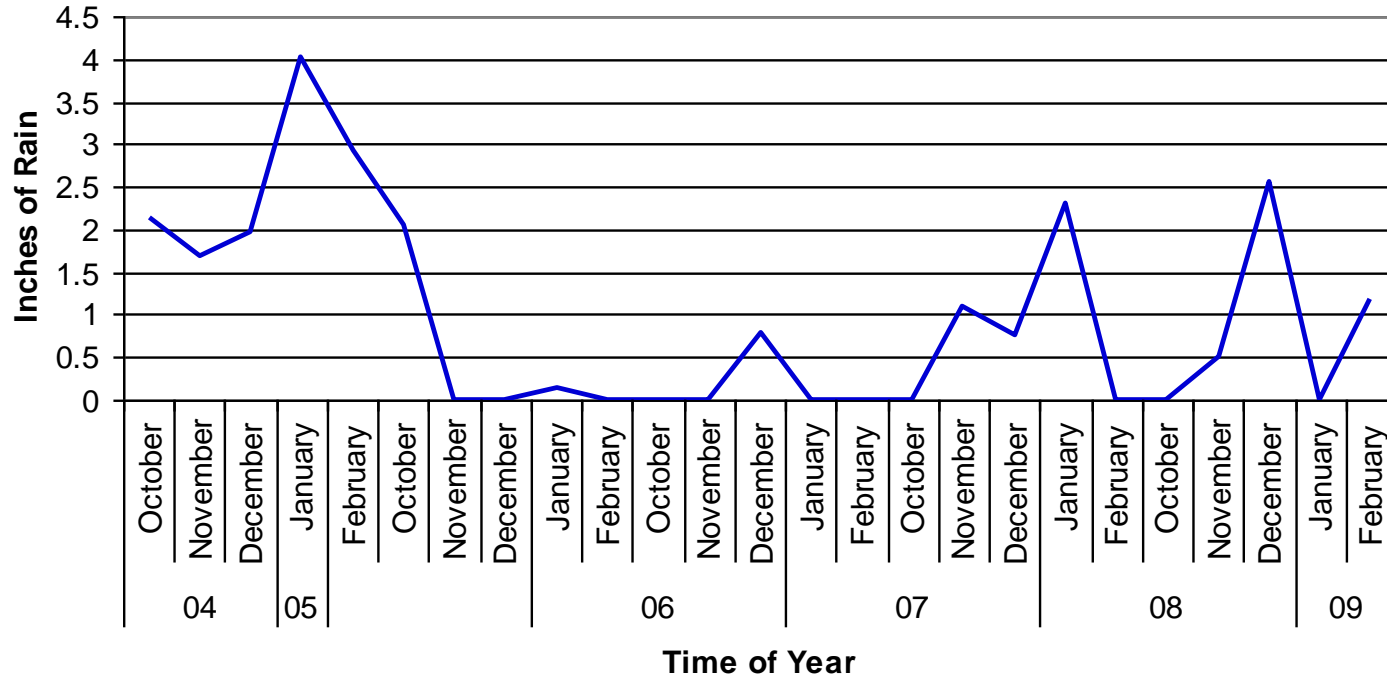


Study sites

- Coachella Valley, southern California
- CBS vegetation
- Approx. 8 kgN/ha/yr deposition
- Willow Hole (2008 & 2009)
- Varner Road (2009)



2004 - 2009 Precipitation*



- 2004 - 2005: 12.77"
- 2005 - 2006: 0.15"
- 2006 - 2007: 0.8"

- 2007 - 2008: 4.171"
- 2008 - 2009: 4.25"

*Data from NOAA

Methods

- 2008:
 - Willow Hole
 - 12 blocks, 4 plots each = 48 plots
 - Treatments:
 - Nitrogen : control (no N added)
fertilized (25 kg/ha N added)
 - Exotic grass removal : control (no herbicide)
removal (Fusilade II:
Fluazifop-P-butyl)



Methods

- 2009:
 - Willow Hole & Varner Road
 - Treatments
 - Nitrogen: control (no N added)
fertilized (25 ppm N added)
 - Exotic removal: control
Fusilade II + hand-weeding

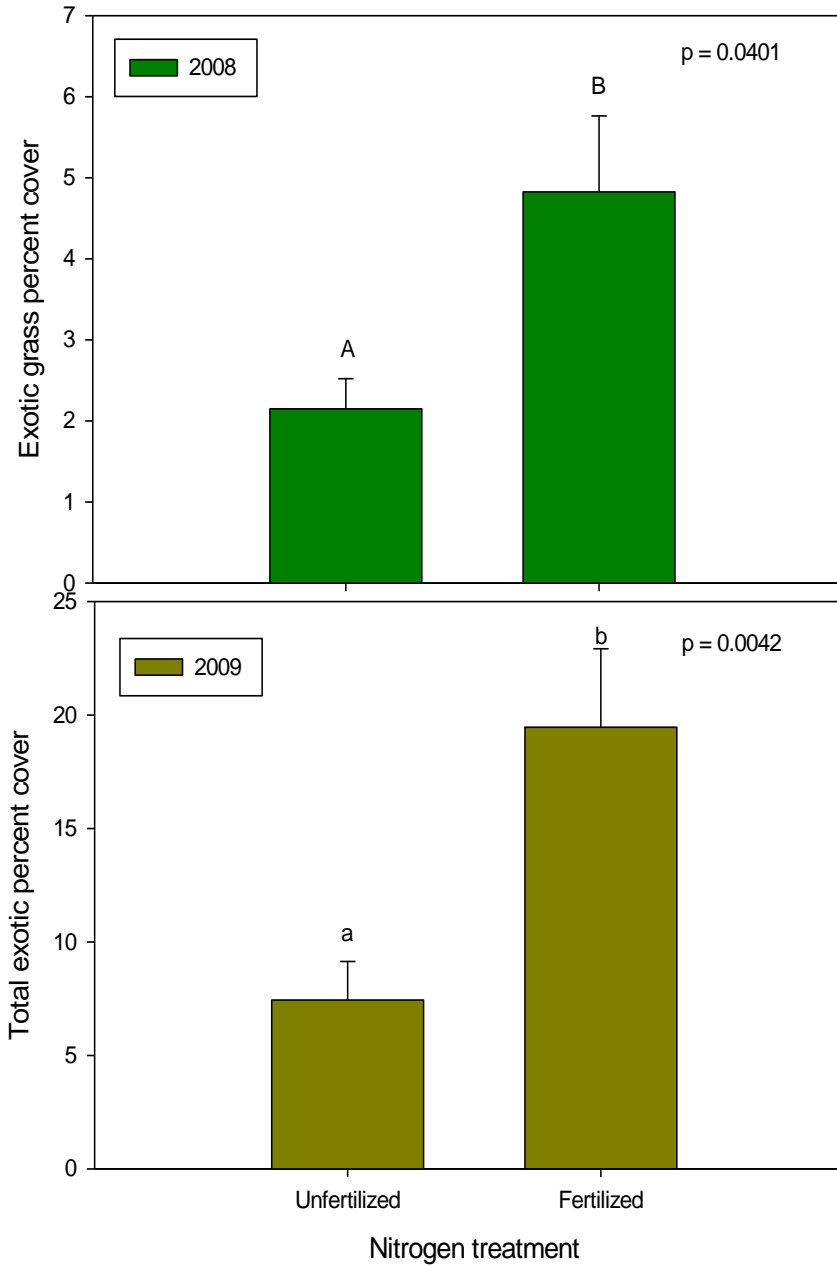


Methods

- Vegetation sampling
 - Percent cover
 - Density
 - Species richness
- Analysis
 - Data shown was analyzed using the Wilcoxon Rank Sum test for nonparametric data in JMP



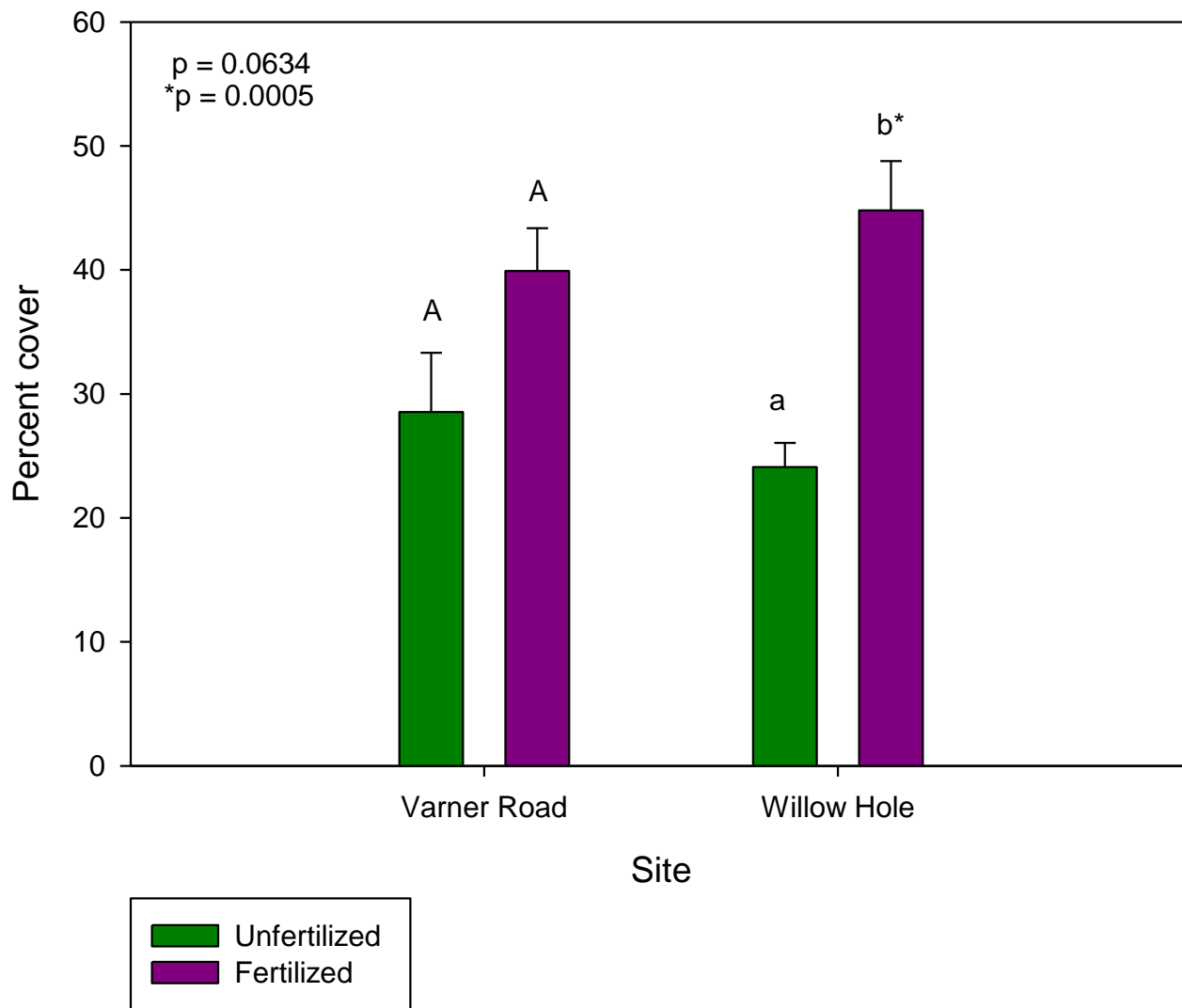
Willow Hole Exotic Cover x Nitrogen without Exotic Removal



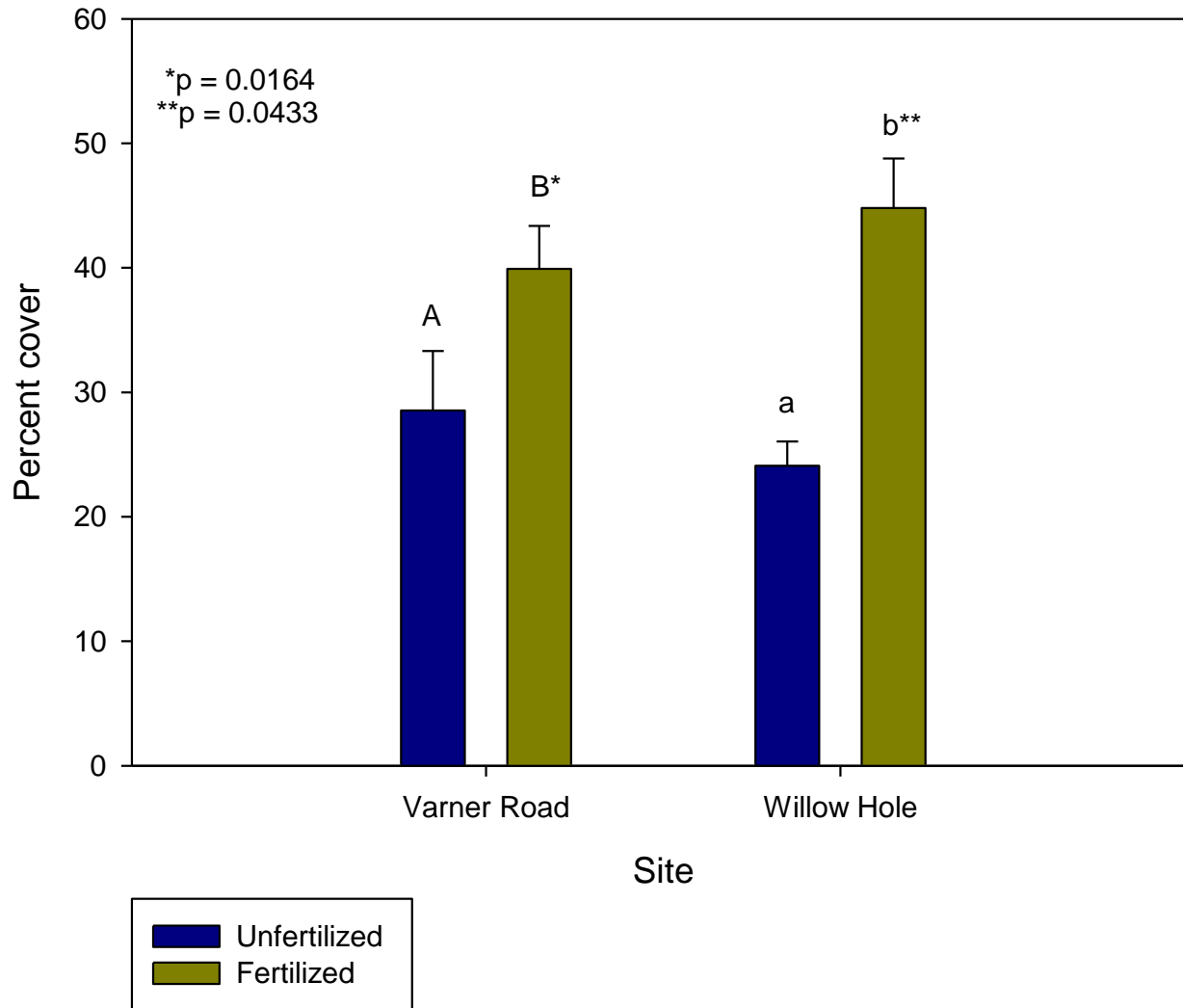
2008: exotic grass percent cover

2009: total exotic percent cover

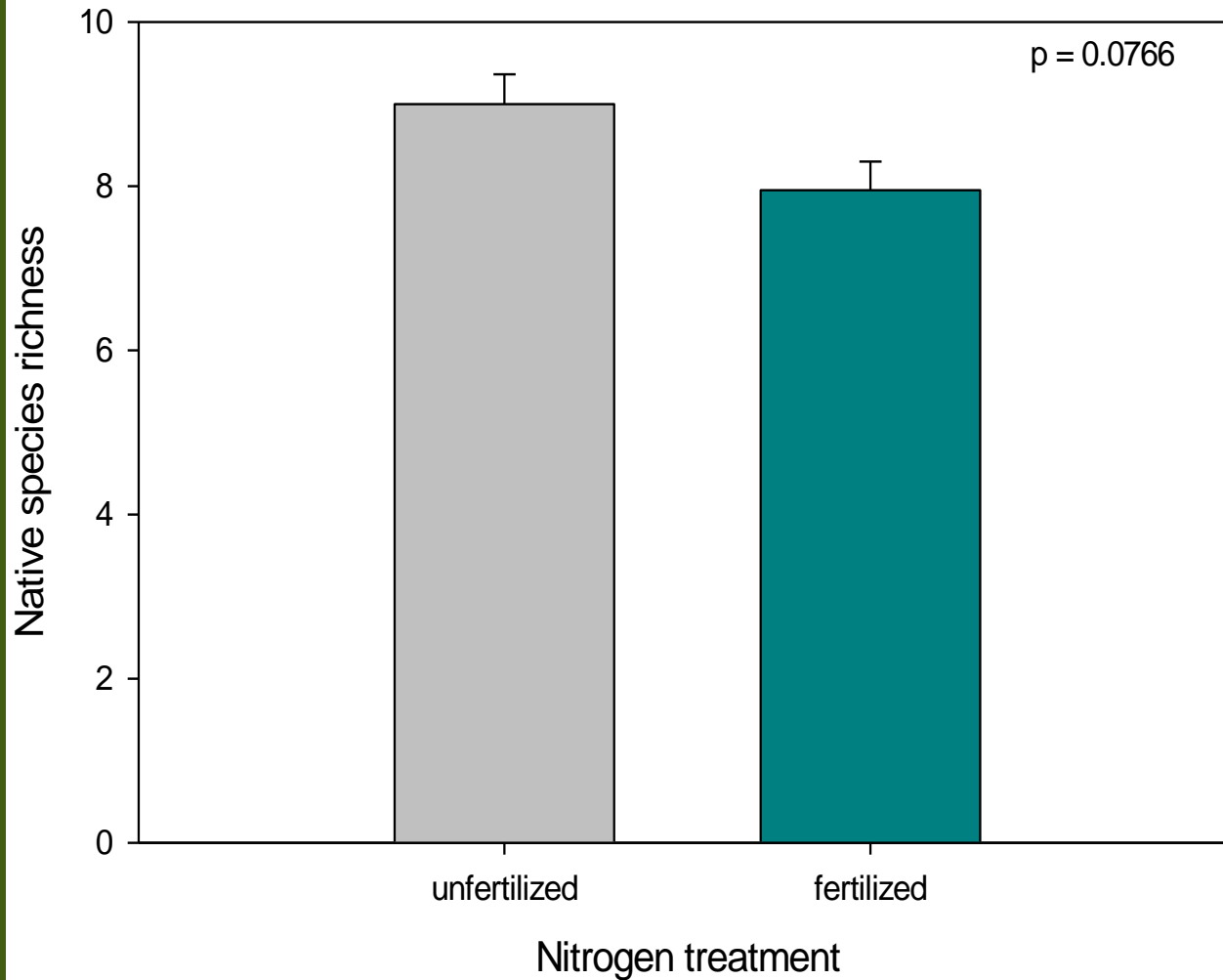
Native Annual Forb Percent Cover x Nitrogen with Exotic Removal 2009



Native Annual Forb Percent Cover x Nitrogen Without Exotic Removal 2009



Willow Hole Native Species Richness 2009



Varner Road Native Species Richness 2009

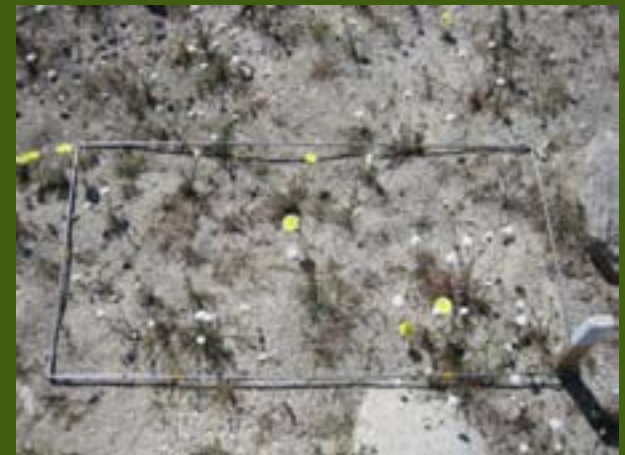


Results

- Exotic cover and density were significantly reduced by Fusilade and hand-weeding
- Exotic removal significantly increased native forb density at Varner Road ($p = 0.0026$)
- Both exotic and native percent cover responded positively to nitrogen fertilization, although native forbs responded better when exotics were removed

Results

- Native forb species richness tended to be higher in unfertilized plots at Willow Hole, although not significantly ($p = .0766$)
- At Varner Road, native forb species richness was significantly higher in plots where exotics were removed ($p = 0.0256$)



Conclusions

- Nitrogen fertilization can affect percent cover of both exotic and native annual species
- Native forb percent cover responds more strongly to N when exotics are removed
- Species richness may be affected by N, although the relationship is somewhat unclear

Conclusions

- There was some competitive effect of exotics on native annuals, but the interaction with nitrogen was not significant
- The relatively low exotic cover at these sites may not be enough to elicit a strong competition by nitrogen interaction
- Very dry conditions at these sites likely prevent a level of productivity at which fire danger would increase, whereas wetter areas of the desert can see large increases in exotic cover and biomass that can approach fire thresholds

Implications

- N deposition can alter species interactions in the desert
- While fire danger may not be an issue at these sites, conservation of native habitat is
- As urbanization continues to increase in the desert, N deposition may also increase
- This work can be used to inform legislators about the impacts of N emissions on wild lands

Acknowledgments

Dr. Edith Allen

Chris True

Allen lab

UCR Botany & Plant Sciences

UCR Ag Ops

The Community Foundation

Coachella Valley Mountains Conservancy

National Science Foundation



*Enhancing the quality of life
in the communities we serve*



Lotus strigosus var. *tomentellus*



Camissonia claviformis



Loeflingia squarrosa



Cryptantha angustifolia



Calyptridium monandrum



Pectocarya recurvata

