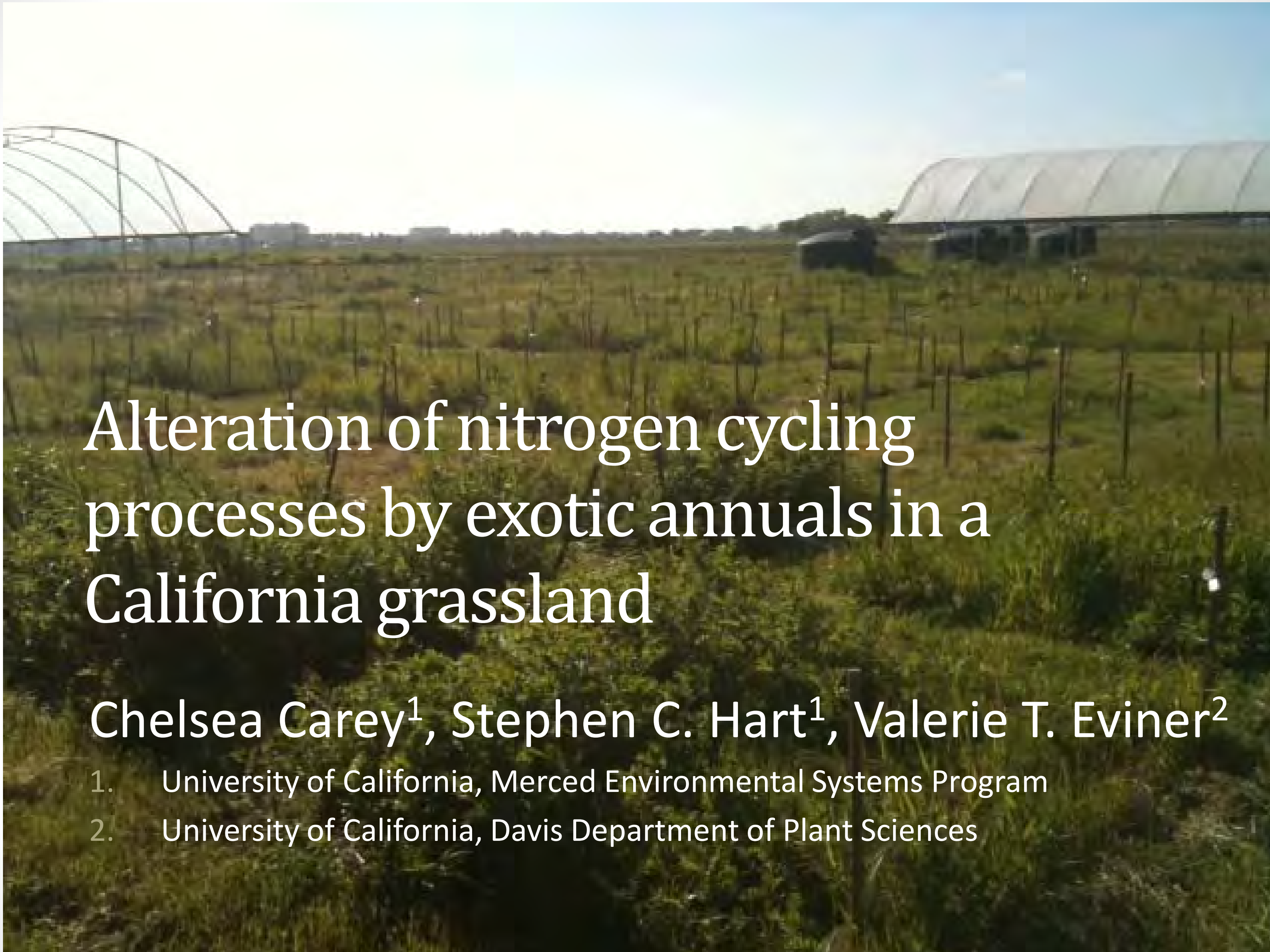

Alteration of nitrogen cycling processes by exotic annuals in a California grassland

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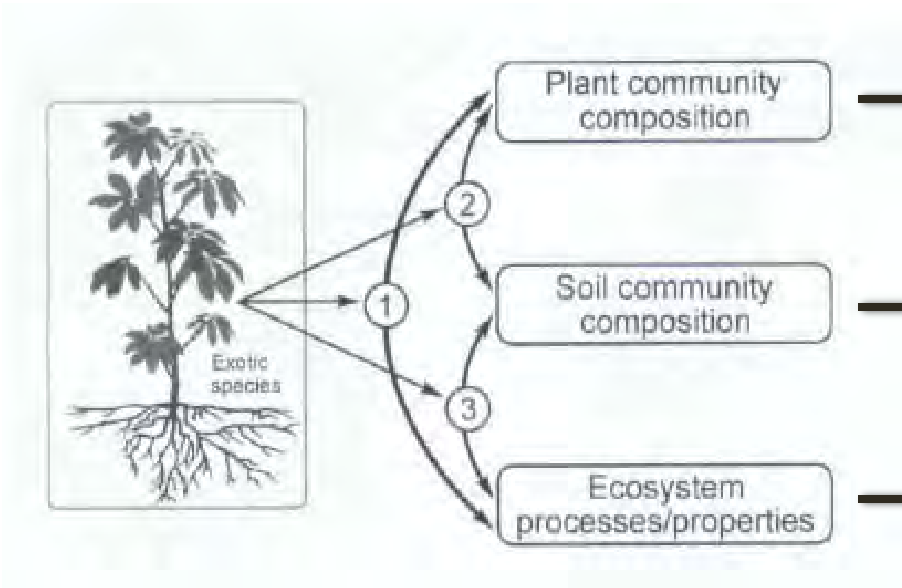
Outline

- Introduction
- Hypotheses
- Experimental design and methods
- Results
- Conclusions, implications, and further research

Plant-soil-microbe interactions may be altered by invasive species



Changes in litter quality or quantity, microclimate, phenology

Changes in direct and indirect interactions

Decomposition, N and C cycling, hydrology

Wolfe and Klironomos 2005

Soil flora and fauna are important to consider

Direct interactions | **Indirect interactions**

- Pathogens
- Mycorrhizae
- Root-feeding fauna

- Bacterial and fungal decomposers
- Nutrient-cycling microorganisms
- Protozoa and nematodes

Modified from Wardle et al. 2004

Shifts in nitrogen (N) cycling may have important implications for restoration

- Nitrogen is the limiting nutrient in most temperate ecosystems
  - Potential to control plant community composition
  - Plant-soil feedbacks one mechanism for invasion and reinvasion
- Soil legacies may interfere with restoration attempts
  - The success of restoration projects may depend on removal of invasive species + amendment to the soil

Grman and Suding 2010

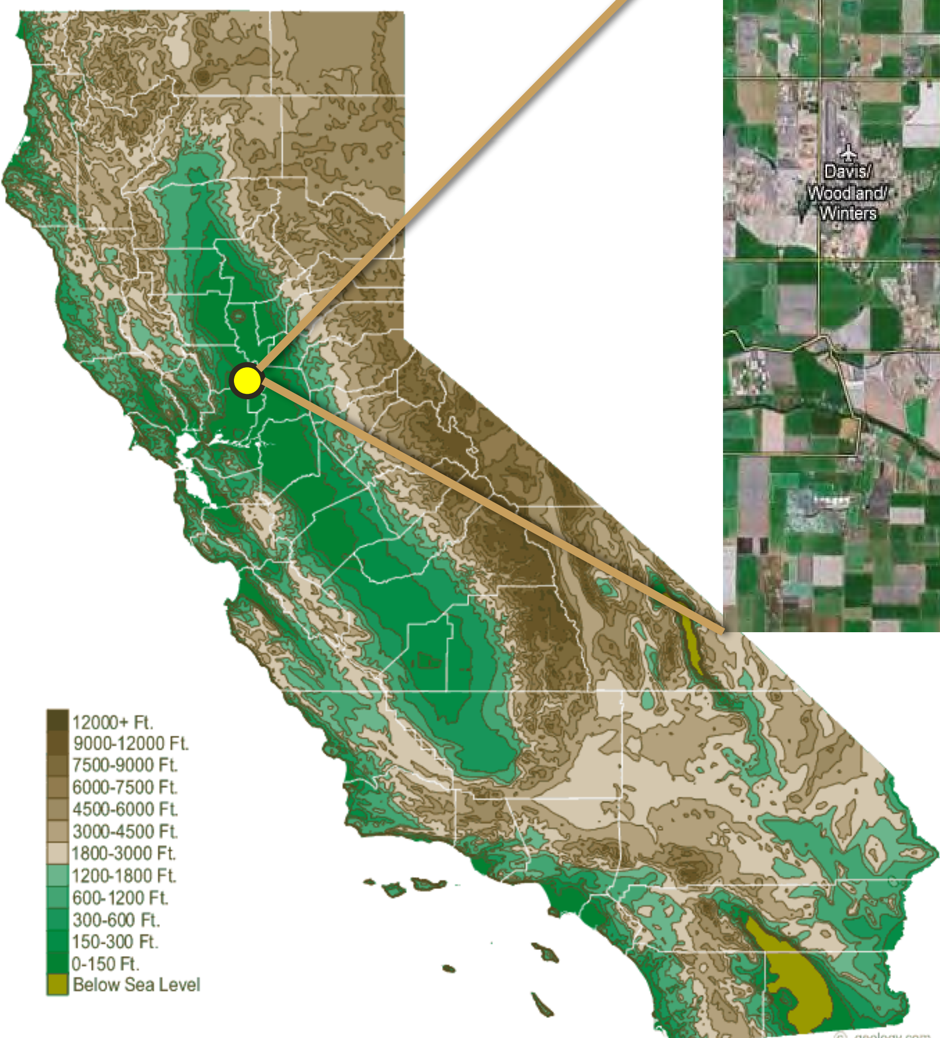
Hypotheses

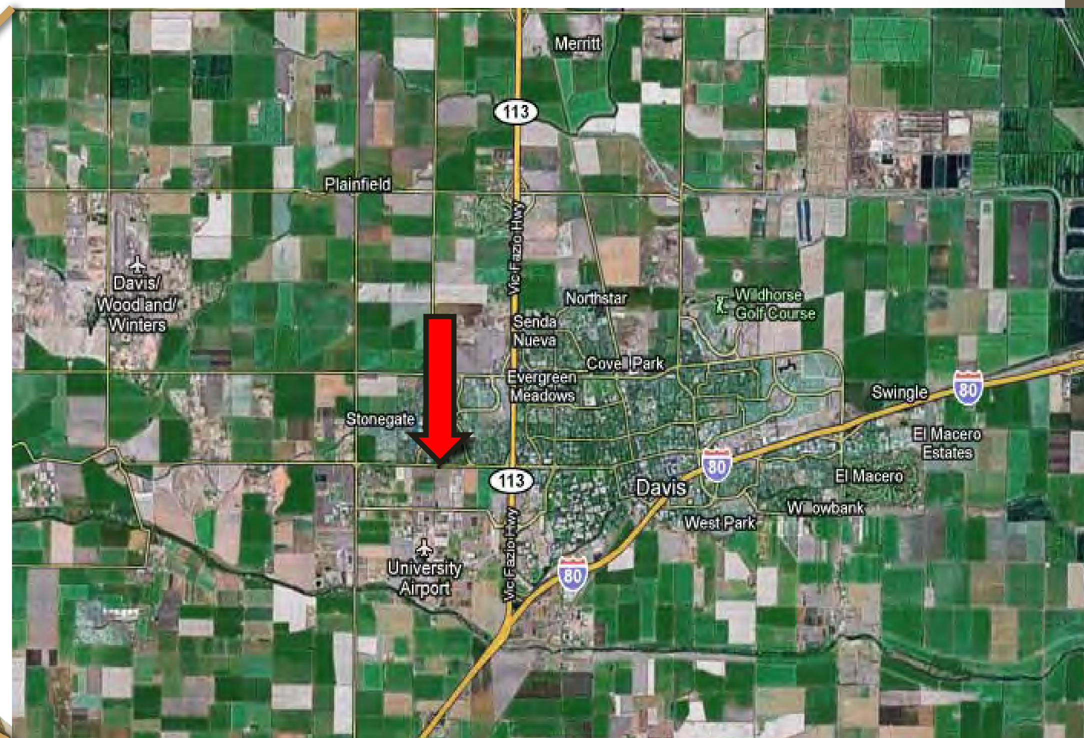
- Nitrogen cycling associated with invaded communities would differ from native communities

- “Old” invasive species would have intermediate values between “new” invasive species and native species

- Shifts in microbial communities and soil fauna would accompany shifts in nitrogen cycling

Study site: Davis, CA





Experimental design

- Established 2006
- Randomized complete block design
- Factorially replicated treatments
- 1.5 x 1.5 m plots

Experimental design

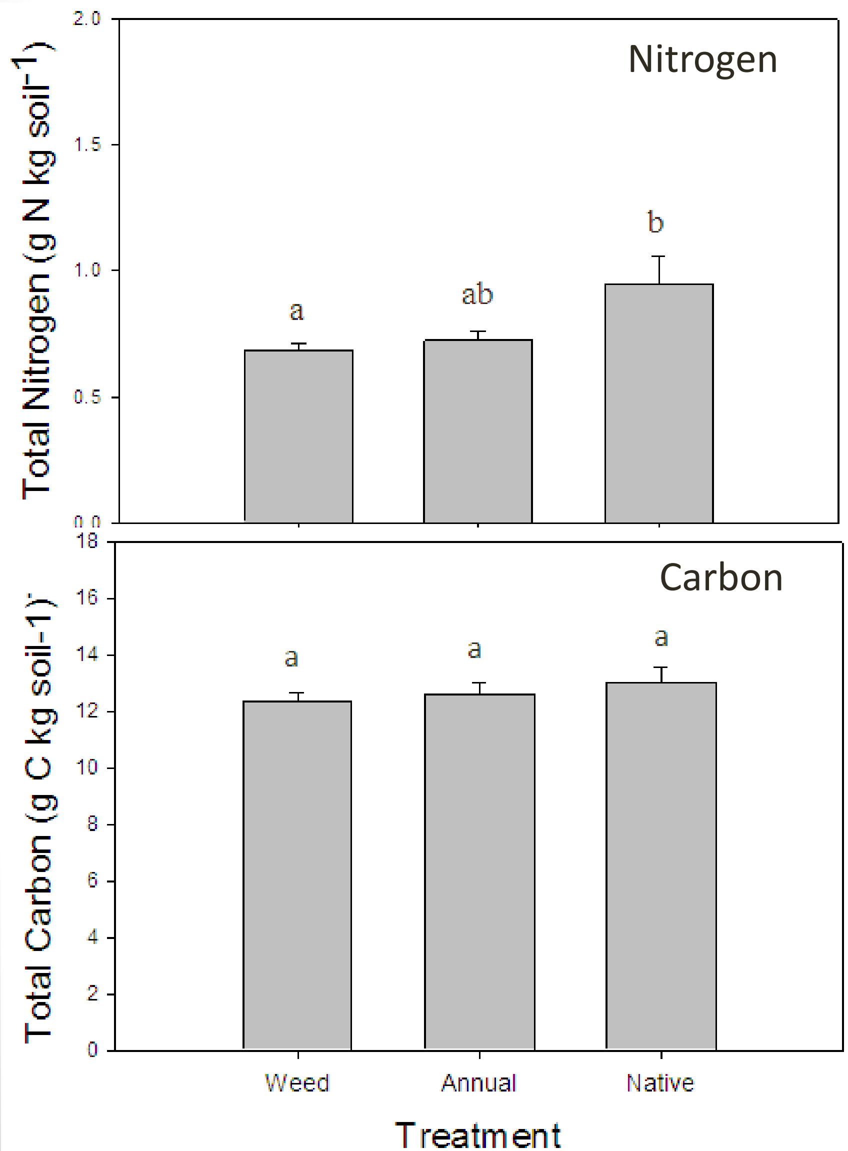
- Three treatments:
  - **“New” invasive species (“weeds”)** – *Aegilops triuncialis* and *Taeniatherum caput-medusae*
  - **“Old” invasive species (exotic forage annuals; “annuals”)** – *Avena fatau, Bromus hordeaceus, Lolium multiflorum,* and *Trifolium subteranneum°*
  - **Native species (“natives”)** – *Bromus carinatus, Elymus glaucus*, Leymus triticoides*, Lotus purshianus°, Lupinus bicolor°, Nassella pulchra*, Poa secunda,* and *Vulpia microstachys*

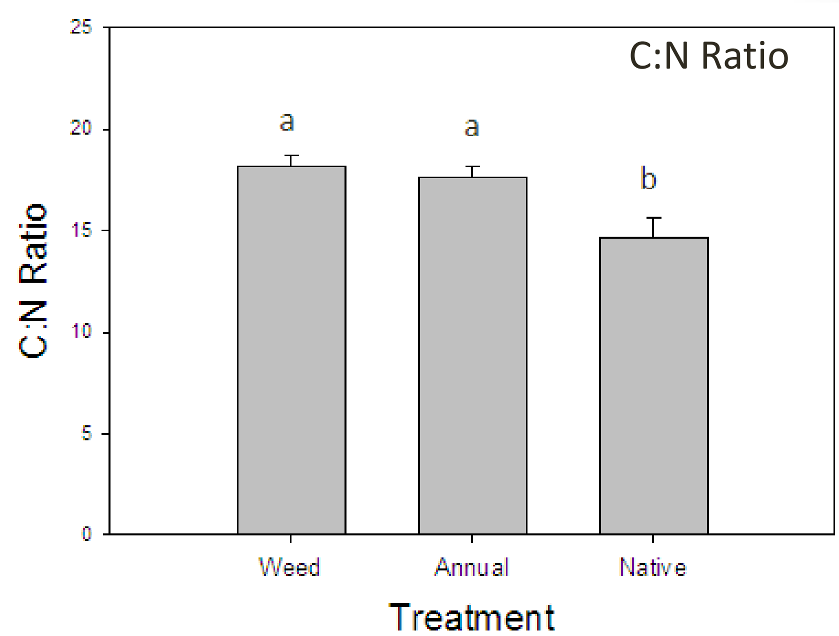
°Nitrogen fixers
*Perennials

Data collection

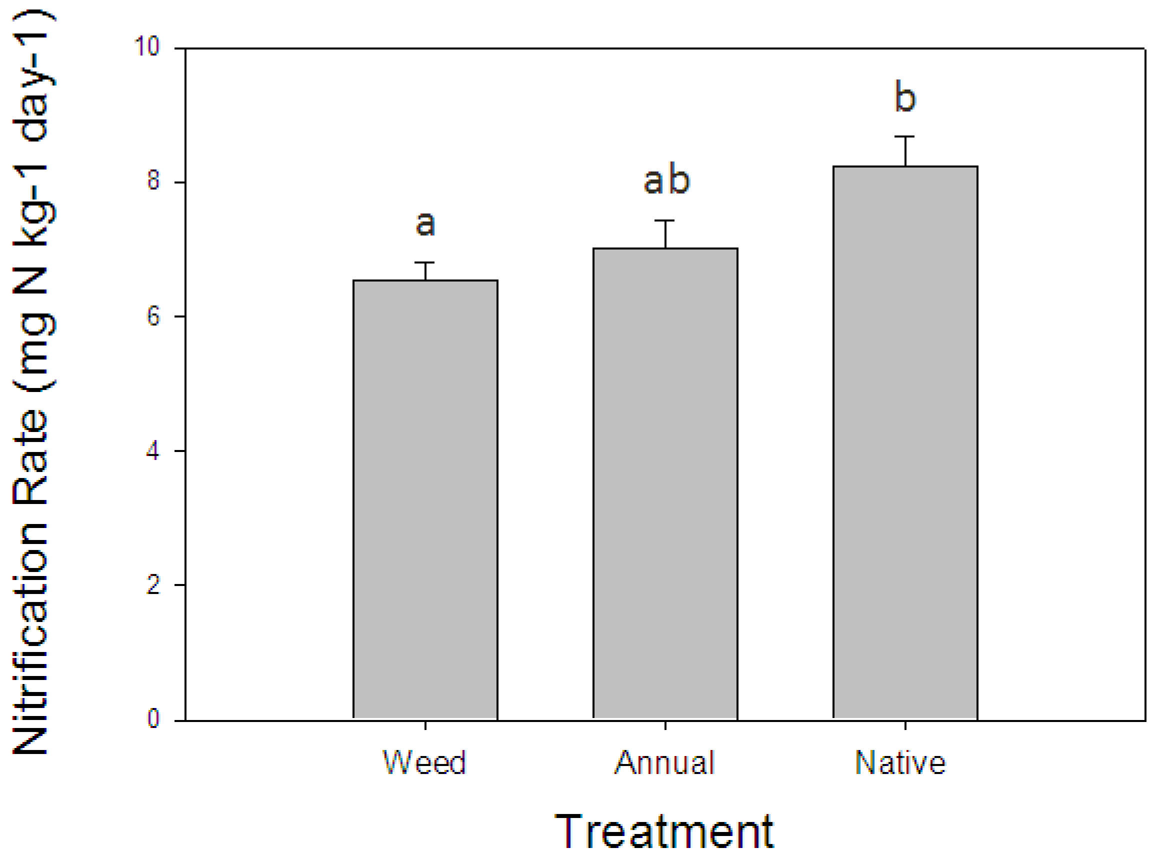
- Ten replicates per treatment (n = 10)
- Per plot: composited 5 randomly selected cores from top 15 cm of mineral soil
- Variables measured:
  - Soil parameters
    - Total C and N
    - Nitrification potentials
    - pH
    - Soil moisture
  - Biotic parameters
    - Total bacteria and fungi
    - Protozoa
      - Amoeba
      - Ciliates
      - Flagellates

Soil Total Carbon and Nitrogen

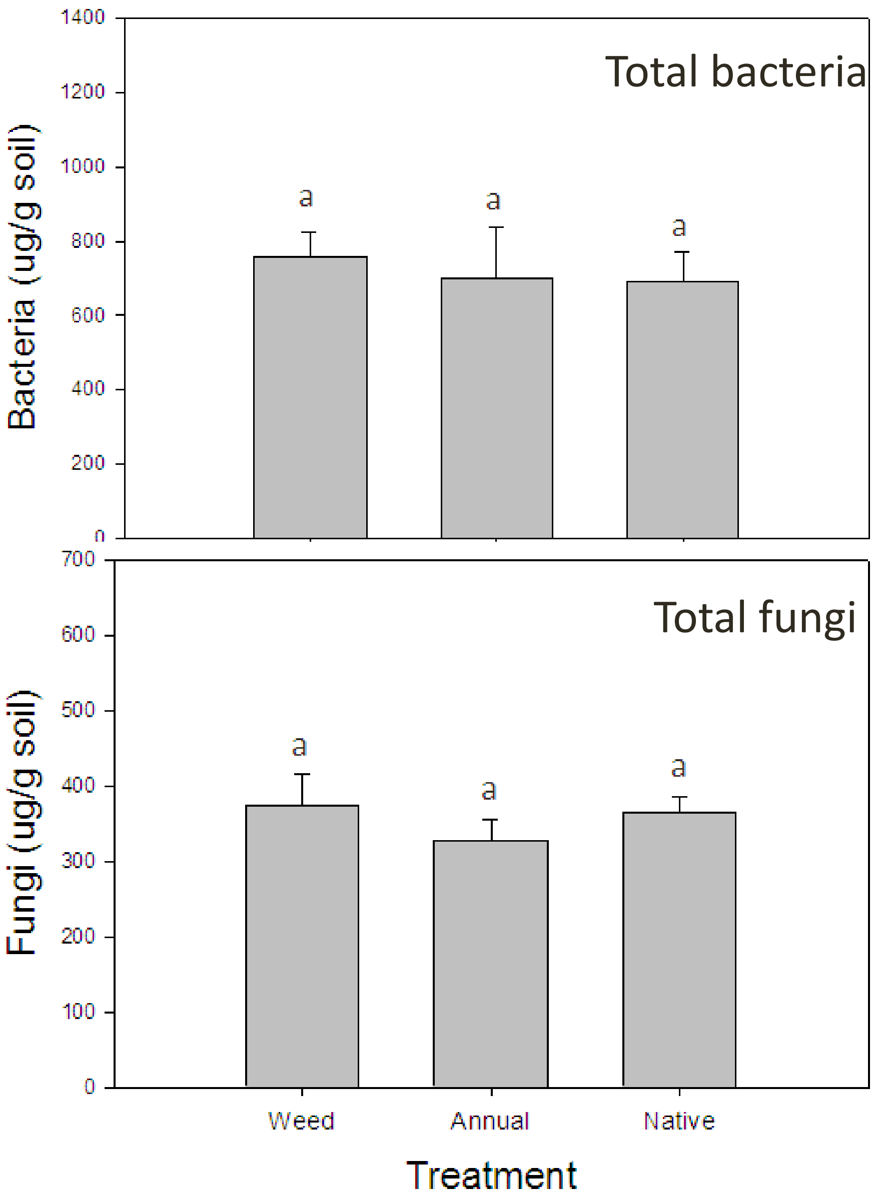


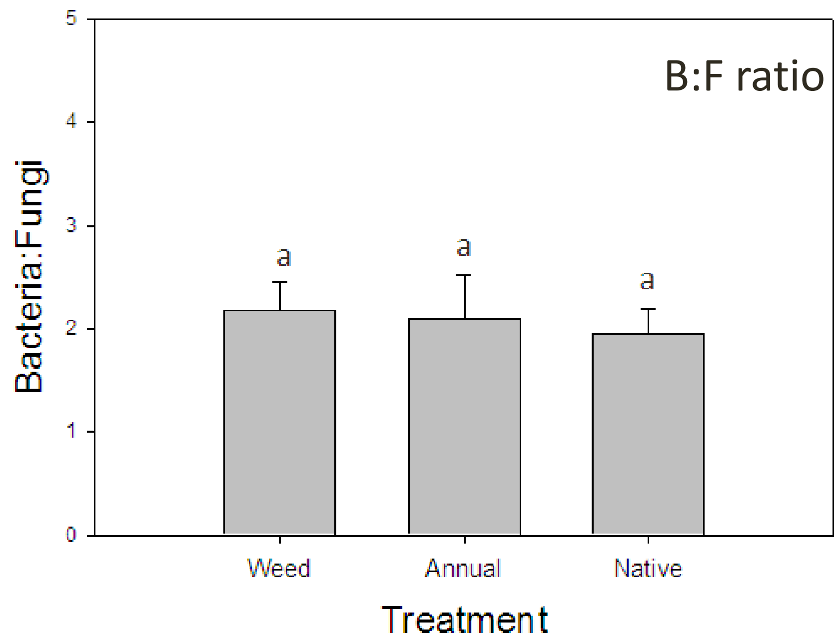


Nitrification potentials

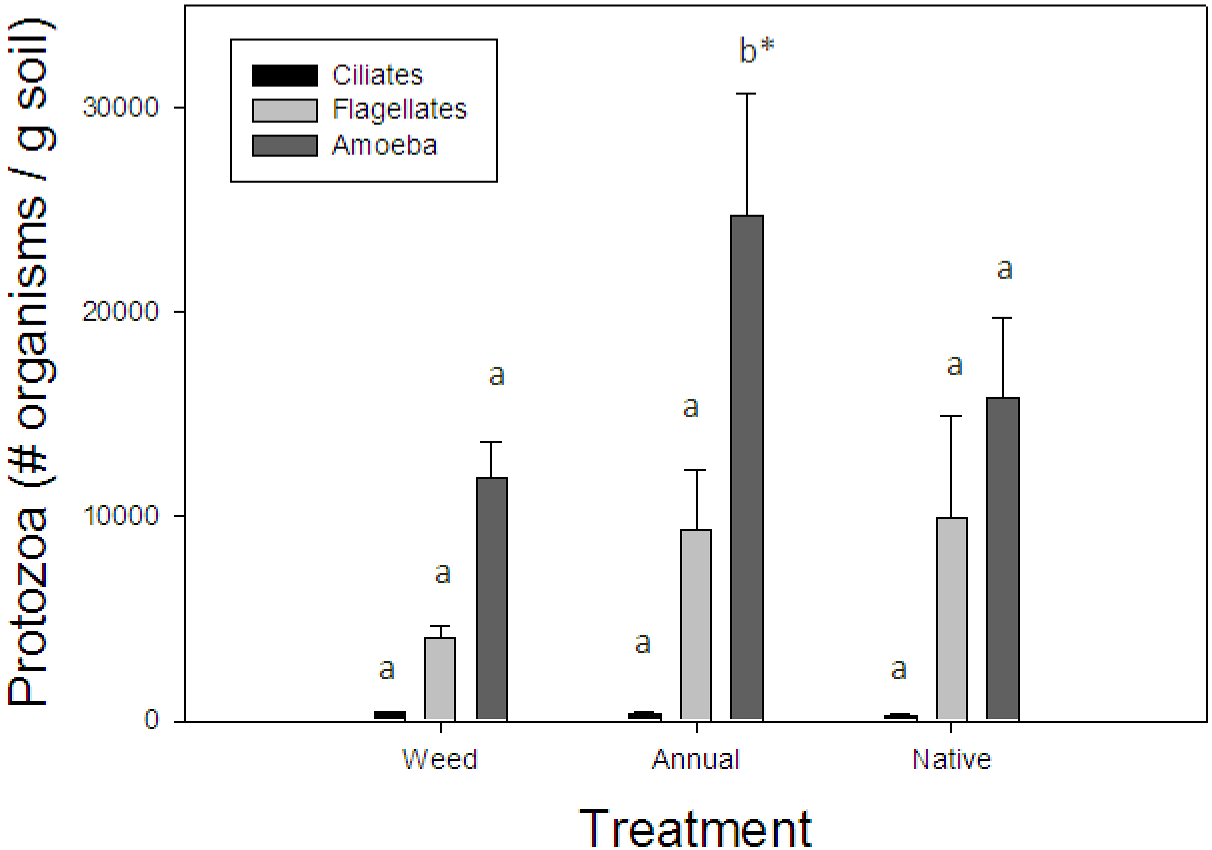


Total bacteria and fungi





Protozoa



* Marginally significant ($p \leq 0.10$)

Conclusions

- Hypothesis 1 was supported
  - Total N pools of invaded soils were lower than native soils
  - C:N ratio of the soil was increased in invaded soils
  - Nitrification potentials decreased with invasion

- Hypothesis 2 was supported
  - Total N and nitrification potential values of “old” invasives were intermediate between “new” invasives and natives

- Hypothesis 3 was not supported
  - Total bacteria and fungi did not differ by treatment
  - Ciliates and flagellates did not differ by treatment; Amoeba were only marginally affected

Implications

- Invasive species can significantly alter N dynamics in a California grassland
- Plant-soil feedbacks and legacies of altered N may interfere with restoration efforts
- Soil amendments may be necessary
- Not all invasive species produce the same ecosystem-level effects
  - Species and context dependent

Future research

- Soil conditioning/plant-soil feedback experiments
- Multiyear investigation
- Investigate the soil microbial community at a finer scale
    - Active bacteria and fungi
    - Nitrifying and denitrifying community
    - Microbial community composition

Acknowledgements

- Dr. Stephen Hart
- Dr. Valerie Eviner
- Jill Baty
- The Beman Lab
- The Hart Lab

<u>Funding</u>

- UC Merced Graduate Research Council
- UC Merced Environmental Systems Program