Species interactions in a heavily invaded ecosystem: the role of competition among California exotics

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Abstract

Plant ecologists have long recognized the importance of species interactions, such as competition, in structuring plant communities. However, the role of plant-plant interactions in communities dominated by non-native, exotic species is poorly understood. To date, we lack a clear understanding for when interactions among co-occurring exotic species may be positive (facilitation) or negative (competition). In this study we asked if an exotic dominated ecosystem operates under the same rules as a naturally occurring native ecosystem. Specifically we addressed three main questions: 1) What is the direction and strength of plant-plant interactions among a suite of exotic species? 2) Do plant traits (SLA, LDMC, seed mass or leaf area) of these species predict their response to a neighboring individual? And 3) Can competitive response of these species predict field abundance? Five common exotics species of Northern California grasslands- *Elymus caput-medusae, Festuca perennis, Bromus hordeaceus, Hypochaeris glabra, and Erodium botrys*- were planted individually and pairwise in a greenhouse. After 6-8 weeks, biomass and leaf traits were collected for each species grown individually and in the presence of another individual. Species grew similarly alone or with a neighbor, suggesting neutral interactions among these exotics, lending to an idea that equalizing fitness processes may allow species to coexist. Competitive response of individuals in all treatments was significantly predicted by SLA and leaf area traits. With higher SLA, plants responded negatively to the presence of a neighbor. With increasing leaf area, individuals were less sensitive to the presence of a neighbor. In addition, competitive response of experimental plants was significantly correlated to SFREC relative field abundance. Individuals whom responded positively to the presence of a neighbor had lower field abundance. These data provide insight into the dynamics structuring these northern California exotic dominant grasslands. Understanding the processes that allow exotic species in an invading range to coexist is key to providing insights into how to manage noxious invaders.

Introduction

- California grasslands have experienced a large shift from native forb/perennial grasslands to exotic annual grasslands.
- Traditionally, ecologists have focused on the role of competition in facilitating the invasion of these grasslands; however it less clear the role that competition has in structuring exotic dominated grasslands.
- This novel ecosystem presents a unique opportunity to evaluate the role of plant-plant interactions in driving composition within an exotic dominated grassland.
- Plant traits provide additional insights into the mechanisms driving the strength of plant-plant interactions.
- Understanding the nature and strength of plant-plant interactions within this ecosystem may provide insight for future invasion management.

Research Questions

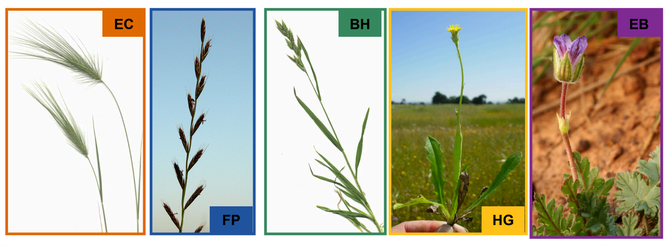
Q1: What is the direction and strength of plant-plant interactions among a suite of exotic species?

Q2: Do plant traits (SLA, LDMC, seed mass, leaf area) predict competitive response?

Q3: Does competitive response predict field abundance?

Methods

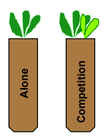
Focal Species



Species used in this study included the following: *Elymus caput-medusae* (EC), *Festuca perennis* (FP), *Bromus hordeaceus* (BH), *Hypochaeris glabra* (HG), and *Erodium botrys* (EB).

Greenhouse Experiment

- 5 species, grown alone & in competition = 15 treatments
- 15 treatments repeated 10X= 150 total



$$\text{Competitive Response} = \frac{\text{Total biomass with neighbor present}}{\text{Total biomass with neighbor absent}}$$

Trait Collection

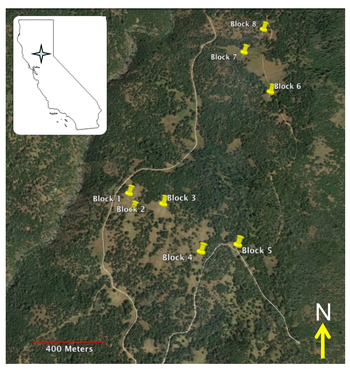
The following was collected for each individual:

- Leaf Area
- Specific Leaf Area (SLA): leaf area/dry mass
- Leaf Dry Matter Content (LDMC): dry mass/wet mass
- Seed mass (calculated once per species)

Leaves for SLA Scanning

2016 Spring Field Sampling

- Relative abundance was sampled in 3 0.5 x0.5 m plots within 8 sites at the Sierra Foothills Research and Extension Center (SFREC, Browns Valley, CA)



(Q1) In general, species had a neutral response to the presence of a neighbor.

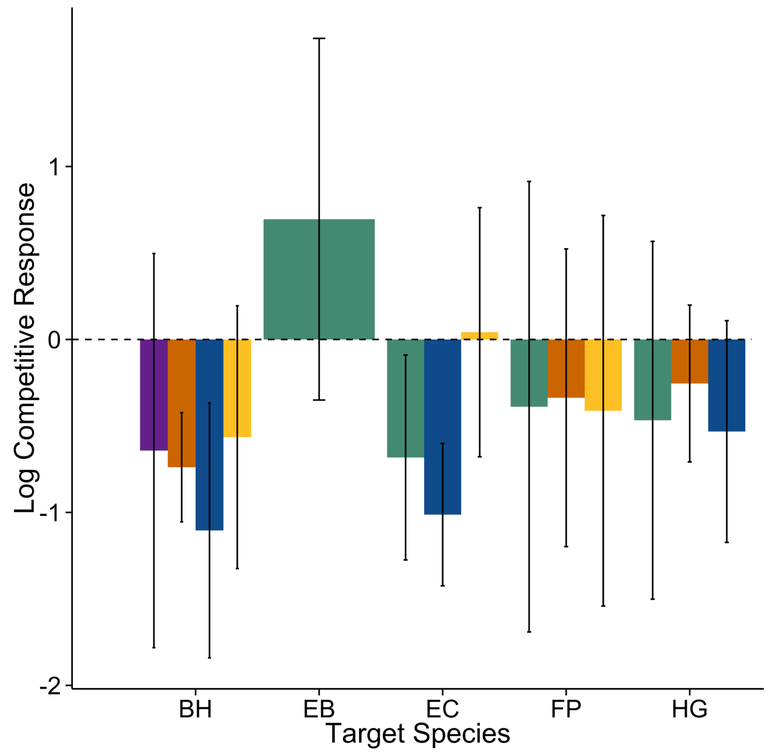


Fig 1. Log competitive response (CR) for target species in the presence of four different neighbors. CR significantly different from zero represent response to neighbor presence. CR greater than zero indicates better growth with neighbor present (i.e. facilitation), and CR less than zero indicates worse growth with a neighbor present (i.e. competition). Error bars represent 95% confidence intervals.

(Q2) SLA and Leaf Area significantly predict competitive response. With increasing SLA or decreasing leaf area, plants respond negatively to presence of a neighbor.

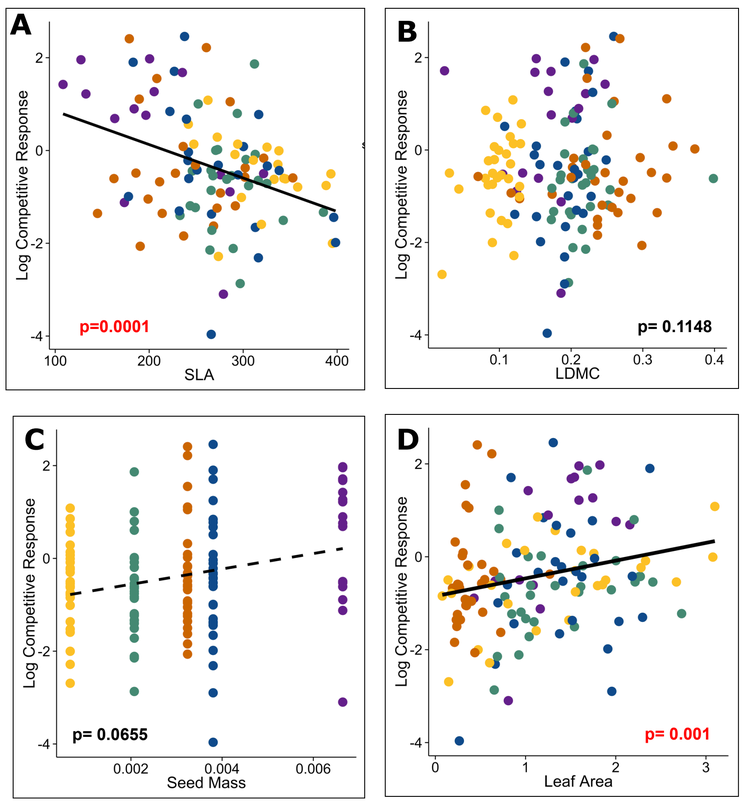


Fig 2. Log competitive response (CR) for all all individuals in treatments regressed with A) specific leaf area (SLA) B) leaf dry matter content (LDMC) C) seed mass and D) leaf area.

(Q3) Competitive response is significantly correlated to SFREC field abundance. With higher (more positive) CR, plants are less abundant.

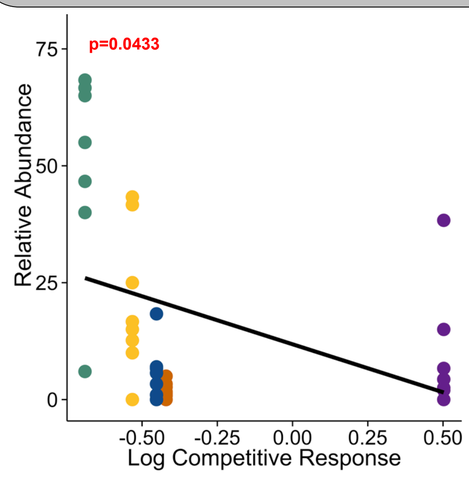


Fig 3. Log competitive response (CR) of five common exotics regressed with their relative abundance at the Sierra Foothills Research and Extension Center (SFREC).

Conclusions

Q1) What is the direction and strength of plant-plant interactions among a suite of exotic species?

- Broadly, plant-plant interactions between grasses (BH, EC, FP) and forbs (EB, HG) were neutral, suggesting abundance of these species may be a result of fitness differences
- Grasses, *Bromus hordeaceus* and *Elymus caput-medusae* were sensitive to competition from the other grass *Festuca perennis*

Q2) Do plant traits (SLA, LDMC, seed mass, leaf area) predict competitive response?

- Individuals with high SLA tend to grow quickly and may be sensitive to a neighbor utilizing resources
- Conversely, individuals with high leaf area may be less sensitive to a neighbor if the larger leaf area allows them to acquire more resources
- Native species with specific traits can be targeted for management to ensure successful re-establishment of native species.
- However, the large variation among individuals suggests these exotics have high intraspecific variation, which may affect the predictability of plant-plant interactions

Q3:Does competitive response predict field abundance?

- Competitive response was negatively correlated to species abundance, such that facilitated species were less abundant in the field.
- Counter intuitively, species sensitive to a neighbor were highly abundant. This is possibly due to high fitness compensating for competition and to strong priority effects due to invasion and land use history.

In conclusion, these results suggest that competition is present in this exotic dominated grassland. However, plant-plant interactions are likely not solely structuring composition.

Acknowledgments

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