Factors Influencing Spatial Plant Diversity in California Vernal Pools

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Introduction

- California vernal pools are seasonal wetlands that support unique plant and animal communities, including many endemic and endangered species
- They inundate during winter and dry by spring with a diverse plant community (Fig 1)
- This habitat has been reduced to less than 10% of its original distribution and is also threatened by many invasive plant species
- Much of their basic ecology is still largely unknown, which becomes more pressing with anticipated climate change in California
- The purpose of this study was to assess the environmental factors associated with native and invasive plant diversity using data from across California (Barbour et al. 2007)

Fig. 1: The aquatic phase (left) and flowering phase (right) of California vernal pools.

Methods

- Databases were used which included species presence, location (latitude and longitude), species traits, pool size, and climate for >500 vernal pools
- Data was compiled and variables calculated included diversity (α, β, and γ; Fig.2) for plant categories (native vs invasive *and* forb (herbs) vs graminoids (grasses)) and temperature and rainfall data
- Data (diversity, pool size and location, and climate) was analyzed by for each of the 19 USFWS-categorized regions in California
- Multiple regression (backward elimination) was used to assess which variables explained diversity at different spatial scales (Fig. 2).

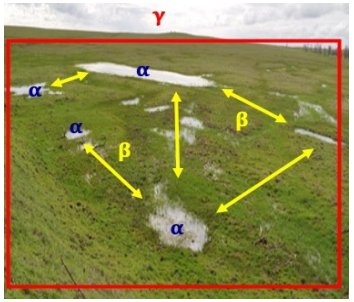

Fig. 2: Three measures of diversity used in this study: alpha is diversity in a vernal pool, beta is differences in diversity among pools, and gamma diversity is total diversity in the region.

Results

Table 1. Multiple regression results for native species diversity. The + and – in parentheses indicate direct of relationship.

Species	α (pool)	β (differences)	γ (regional)
Forbs	Surface area (+) Latitude (+) Temp ave (+) **R^2 = 0.76**	Surface area (-) Temp SD (-) Rainfall SD (+) **R^2 = 0.55**	Temp ave (+) Temp SD (-) **R^2 = 0.61**
Graminoids	Surface area (+) Temp ave (+) Temp SD (+) Rainfall ave (+) Rainfall SD (-) **R^2 = 0.82**	Surface area (-) Rainfall ave (-) Temp SD (-) **R^2 = 0.61**	Latitude (+) Longitude (+) Temp ave (+) **R^2 = 0.71**

Table 2. Multiple regression results for invasive species diversity.

Species	α (pool)	β (differences)	γ (regional)
Forbs	Latitude (+) Rainfall ave (-) Rainfall SD (+) **R^2 = 0.62**	Longitude (+) Temp SD (-) **R^2 = 0.40**	Latitude (+) Temp ave (+) **R^2 = 0.67**
Graminoids	Latitude (+) Longitude (+) Temp SD (-) Rainfall ave (-) Rainfall SD (+) **R^2 = 0.88**	Surface area (-) Rainfall ave (+) Rainfall SD (-) **R^2 = 0.67**	Latitude (+) Rainfall ave (-) **R^2 = 0.37**

Results

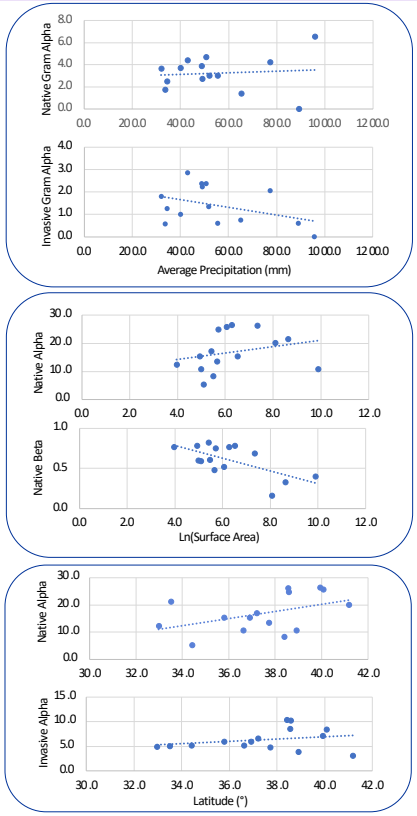

Fig. 3. Scatterplots of diversity values against different abiotic factors.

Discussion

- Plant diversity in vernal pools was significantly influenced by abiotic factors, and plant groups responded differently to environmental variables
- Invasive species declined with rainfall. They are not adapted to standing water compared to native species (Gerhardt and Collinge 2007)
- Increased surface area of pools increased α diversity, but decreased β diversity for some groups. This has been previously been found with vernal pool animals (Kneitel 2016)
- There was an increase in α diversity for both native and invasive species as latitude increases, supporting other studies of the *reverse* latitudinal diversity gradient (Hillebrand 2004, Kneitel 2016)

Conclusions

- The environment affects diversity at different spatial scales. Pool size, climate, and location all influenced diversity of native and invasive plants
- Management and restoration of vernal pools will need to consider how these change plant diversity, including plant status, plant type, and invasibility
- Further ecological research into vernal pools should consider the effects of species interactions (e.g., competition), land use, and future climate change

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