Dynamic Relationships: annual plants in an urban ecosystem

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Urbanization may alter ecosystems

Human activities in cities can modify ecosystem properties and functions. Desert annual plants, like those in Phoenix, AZ, can be regulated by precipitation, soil nitrogen availability, and plant consumers (herbivores). In this study, we asked: ***How do water availability, soil nitrogen availability, and herbivory influence the growth and diversity of winter annual plants in desert urban parks of Phoenix, AZ compared to the surrounding desert?***

Our results indicate that urbanization may not effect the growth and diversity of annual plants as expected.

Our Study Site:

- **5 urban sites** in Phoenix remnant desert parks and **5 non-urban sites** in the Sonoran Desert (Fig. 1).
- Average winter rainfall 2005-11: 90/133 mm (urban/non-urban). Winter rainfall in study year (2010-2011): 82/113 mm (urban/non-urban).

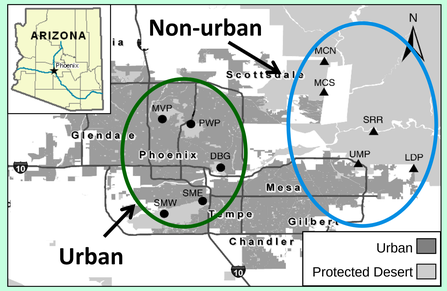


Fig. 1: Urban and non-urban study sites in Phoenix, AZ and the surrounding Sonoran Desert

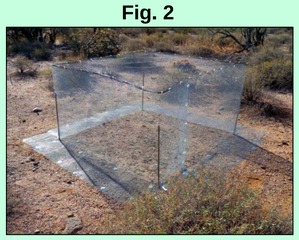
Methods:

1. Soil nitrogen and precipitation data were collected from all sites during winter annual plant growing season.

2. **3 herbivore exclosure plots** were built at each site to exclude small mammals and birds with **3 control plots** (Fig. 2).

3. Plant biomass and community composition data were collected in Apr 2011.

Fig. 2



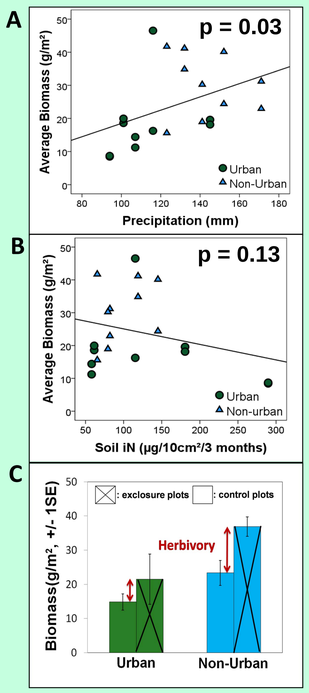
Exclosure plots exclude herbivores

Control plots allow herbivore access

Plant growth in Phoenix, AZ

Predictions:

- Plant growth will be positively related to precipitation and soil nitrogen
- Increased soil nitrogen in the city may lead to greater plant growth
- Herbivores will consume (reduce) annual plant biomass



Results:

- Plant growth is significantly positively correlated with precipitation (Fig. 3A), but not correlated with soil nitrogen across Phoenix (Fig. 3B)
- Plant growth is naturally greater at the wetter, non-urban sites (**p<.05**; Fig. 3C)
- Herbivory reduced biomass at all sites (**p=0.05**)
- Herbivory was not significantly different between urban and non-urban sites (two-way ANOVA interaction, **p=0.52,** Fig. 3C)

Fig. 3: A) Plant growth significantly correlated with precipitation and B) not significantly correlated with soil nitrogen (iN); p-values represent significance of multiple regression between groups. C) Average biomass across sites and plots.

Most important factors for plant growth

Precipitation

Herbivores

Soil nitrogen?

Overall, **precipitation was the most important predictor of plant growth**, followed by herbivory (one-way ANCOVA: **p=0.02, p=0.04**, respectively). Unexpectedly, soil nitrogen was not significantly related to plant growth.

Annual plant diversity in Phoenix, AZ

Predictions:

- Plant diversity will be greater outside of the city where rainfall and plant growth are greater
- Herbivores will reduce plant diversity via consumption

Most common annual plant species at urban and non-urban sites:

Pectocarya recurvata (Native)

Schismus arabicus (Non-native)

Plantago ovata (Native)

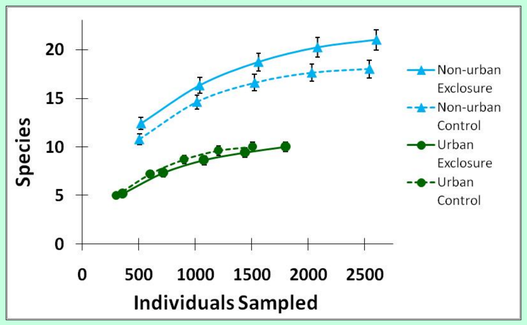


Fig. 4: Individual-based rarefaction curve (with 95% confidence intervals) shows greater species richness at non-urban sites than urban sites and herbivory reduces richness more in non-urban than urban locations.

Results:

- Species richness is significantly lower at urban sites (17 species) than non-urban sites (22 species) (**p<0.05**, Fig. 4)
- Herbivory reduced species diversity at non-urban locations, but not at urban sites (Fig. 4)

Conclusions and Next Steps

- Herbivores reduce plant biomass similarly across Phoenix, but cause reductions in species richness outside of the city.
- The impacts of urbanization on annual plants may lead to changes in ecosystem functioning such as soil fertility, soil food webs, and nutrient cycling within the urban core.
- This study is ongoing through spring 2012 and we plan to collect plant biomass and community composition data to monitor the effects of urbanization on plants over multiple seasons.

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