

# Complex species interactions across local environmental gradients in a novel annual plant community



Claire E. Wainwright<sup>1</sup>

Janneke Hille Ris Lambers<sup>2</sup>, Margaret M. Mayfield<sup>1</sup>

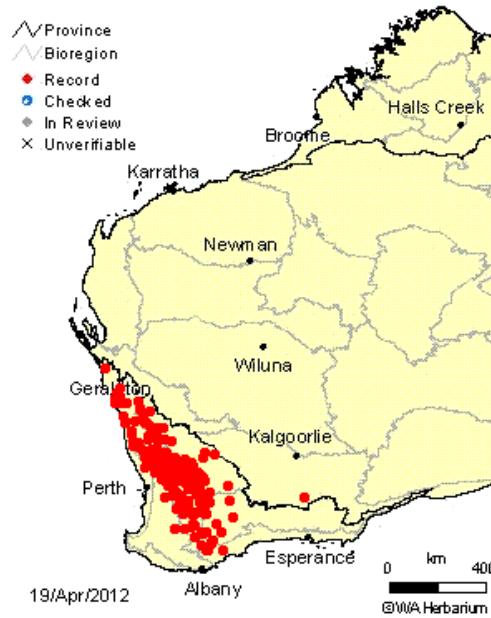
<sup>1</sup> School of Biological Sciences, The Ecology Centre, The University of Queensland, Australia

<sup>2</sup> Department of Biology, University of Washington, Seattle, WA

# York Gum woodlands: novel ecosystem



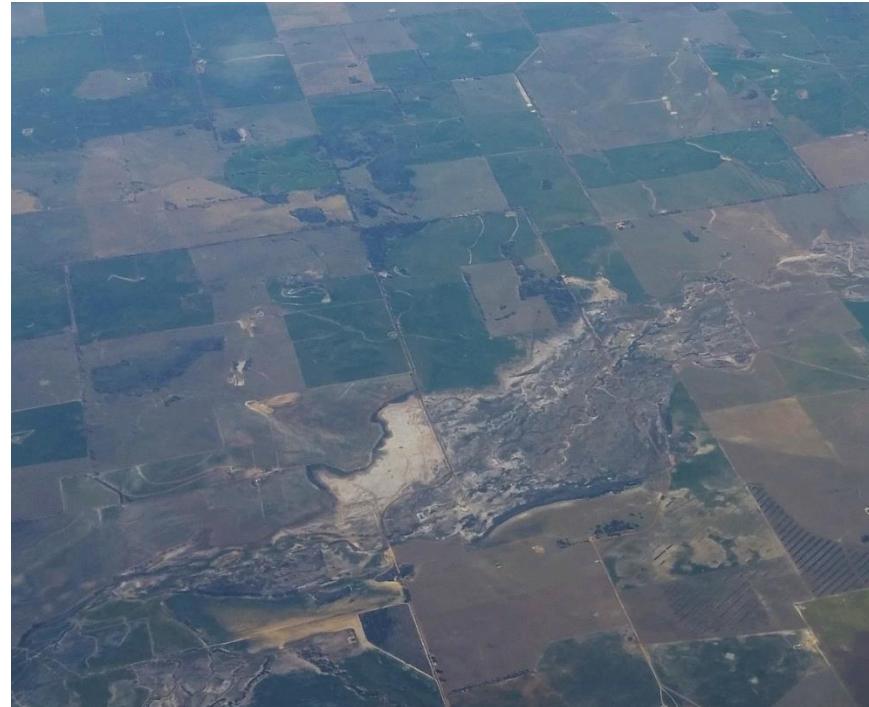
*Eucalyptus loxophleba* subsp. *loxophleba*



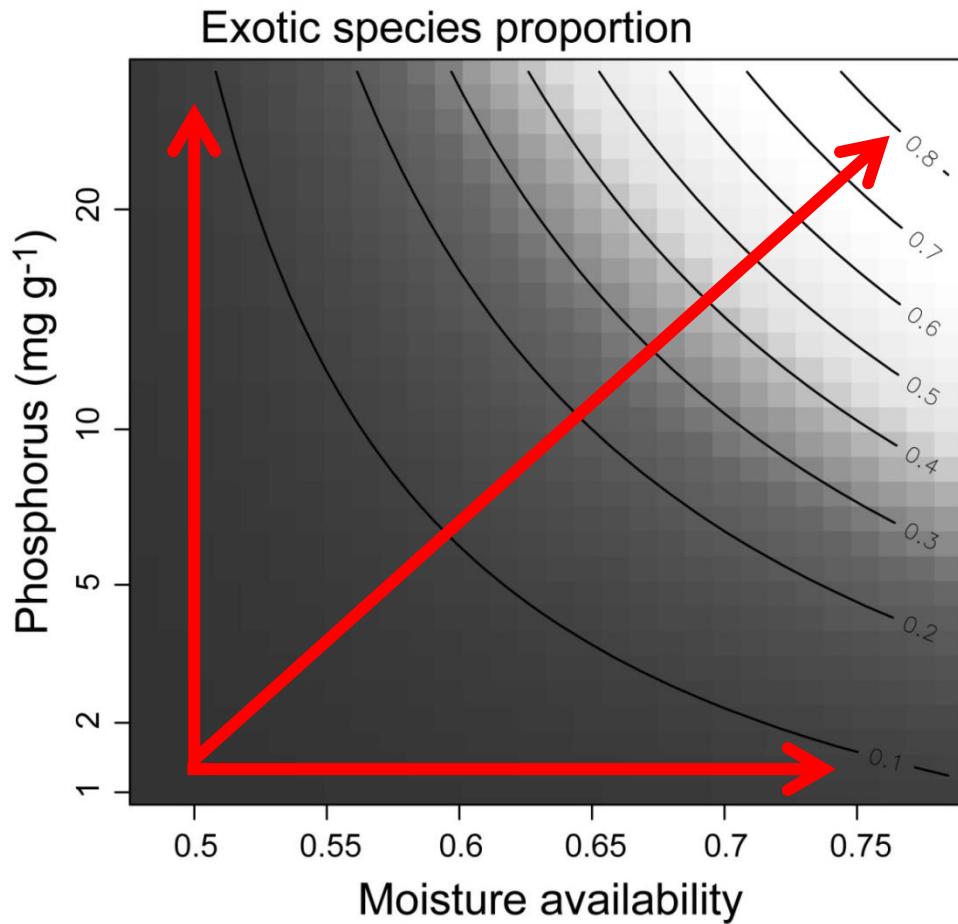
# York Gum woodlands: novel ecosystem

Western Australia's “wheatbelt”

→ Eutrophication + invasion



# York Gum woodlands: novel ecosystem



Dwyer, John M., et al. "Climate moderates release from nutrient limitation in natural annual plant communities." *Global Ecology and Biogeography* 24.5 (2015): 549-561.

# How does performance vary with:

- Local abiotic gradients?
  - canopy cover, soil P
- Neighbor presence?
- Neighborhood attributes?
  - Functional traits, species diversity, density, exotic proportion

# Study site: West Perenjori Nature Reserve



## Exotics

*Arctotheca  
calendula*



*Pentameris  
airoides*



*Medicago  
minima*



*Hypochaeris  
glabra*



*Hyalosperma  
glutinosum*



*Trachymene  
cyanopetala*



*Velleia  
rosea*

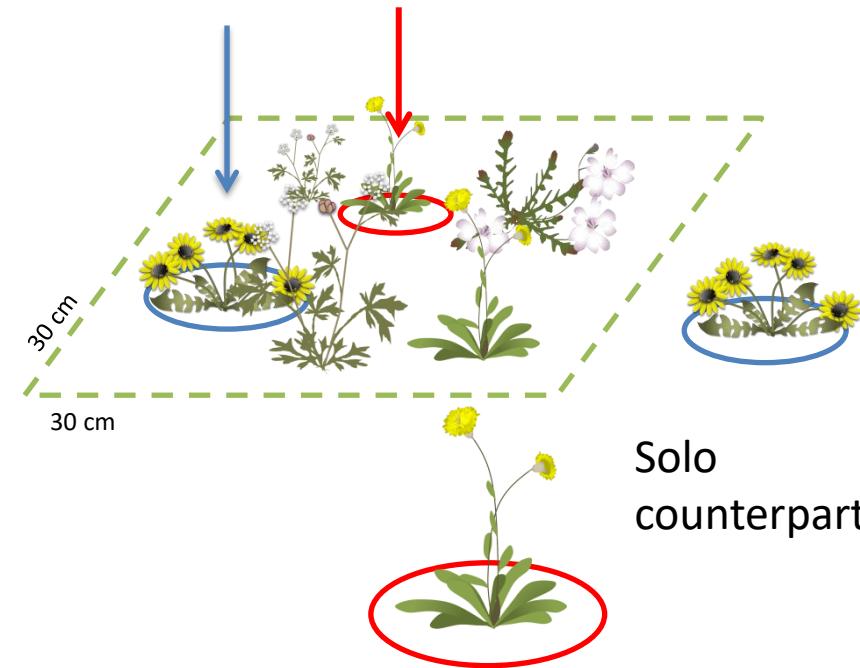


*Podolepis  
canescens*



# Experimental design

Focal individuals

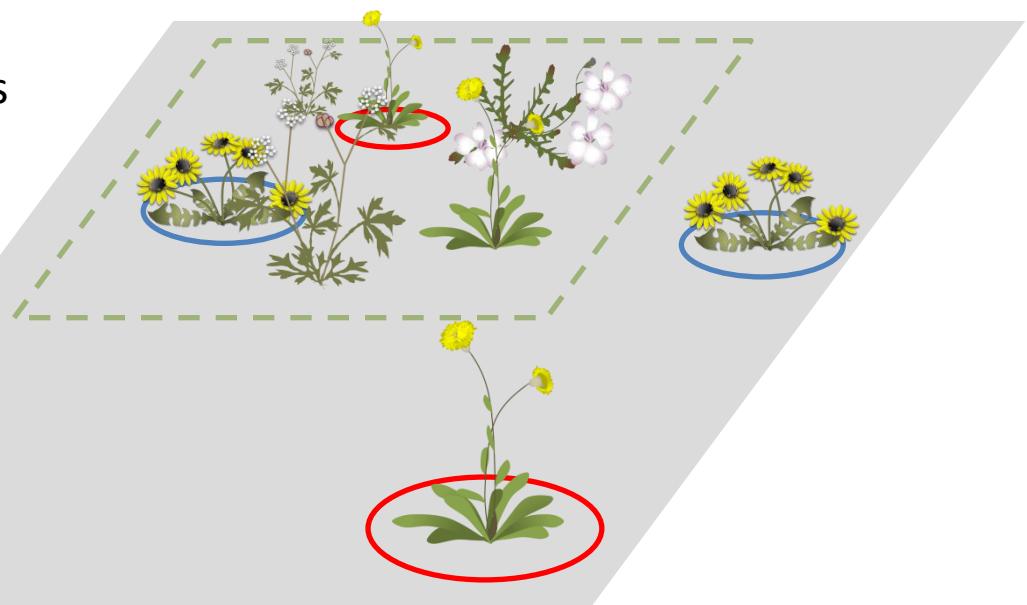


Shade treatment:

Wide aperture mesh



Solo  
counterparts



# Experimental design

Focal individual



Shade structures

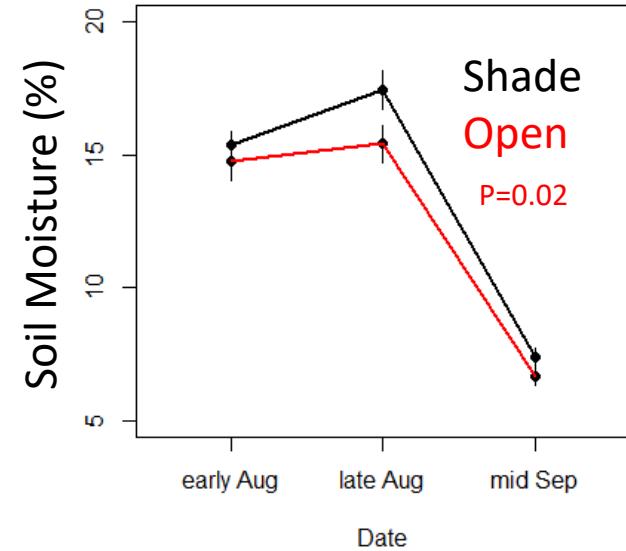
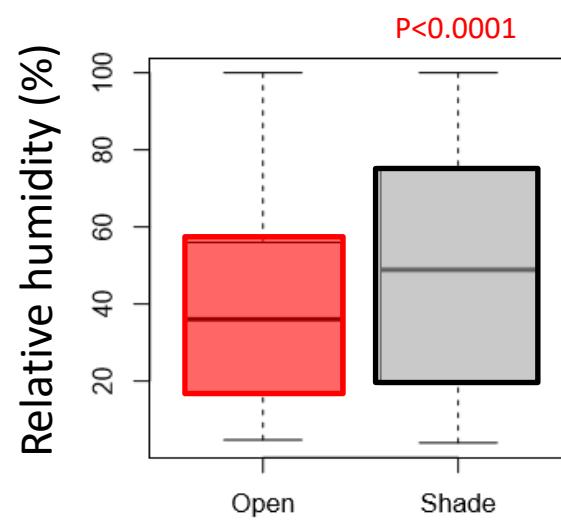
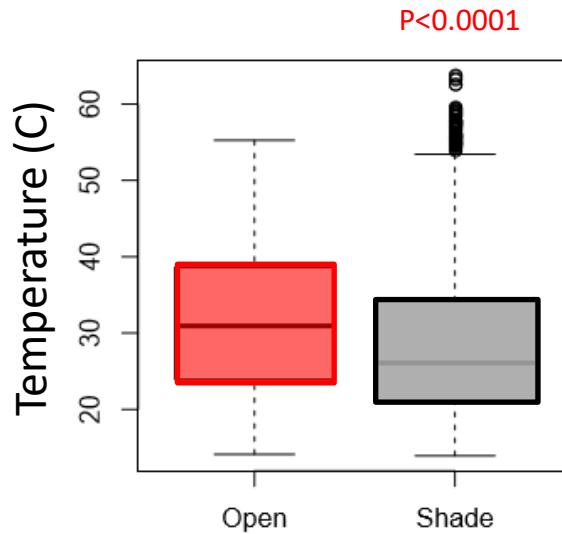


10-15 replicates (individuals) of 8 focal species

4 levels of shade x competition treatment

→ 373 focal individuals across 5 blocks

# Shaded plots cooler, more humid



# How does performance vary with:

- Local abiotic gradient type?
  - canopy cover, soil P
- Neighbor presence?
- Neighborhood attributes?
  - Functional traits, species diversity, density, exotic proportion

# Effects of competitors, shade, and P

GLMMs (Poisson) each species :

Seed production ~ Neighbors \* Shade treatment + P, random effects: Block/Plot/Individual

# Solos hotter, drier above & belowground

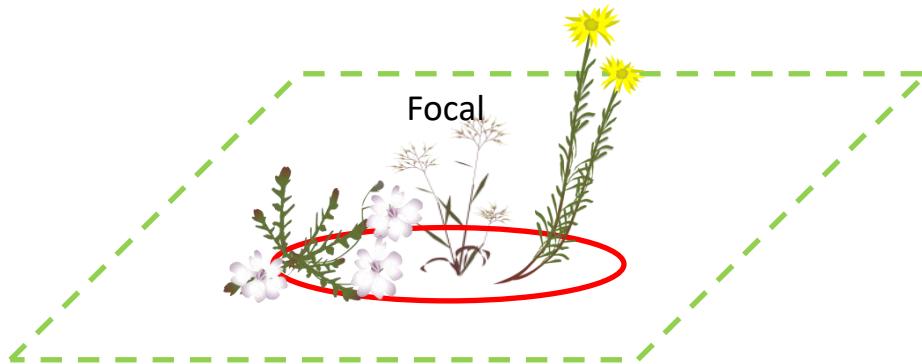


# How does performance vary with:

- Local abiotic gradients?
  - canopy cover, soil P
- Neighbor presence?
- Neighborhood attributes?
  - Functional traits, species diversity, density, exotic proportion

# Traits, diversity, density, or invasion?

Height  
SLA  
Seed mass  
Canopy shape index (lateral:vertical extent)



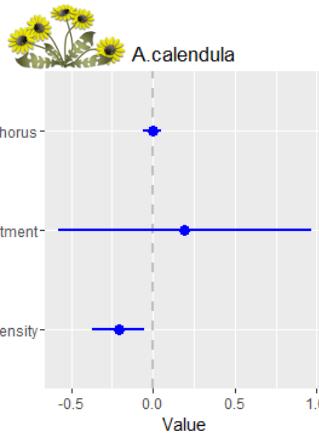
1. Trait distance  
(|focal trait–neighbor trait|)
2. Trait hierarchy  
(focal trait–neighbor trait)
3. Species diversity (Shannon)
4. Neighborhood density
5. Exotic proportion

GLMMs (Poisson):

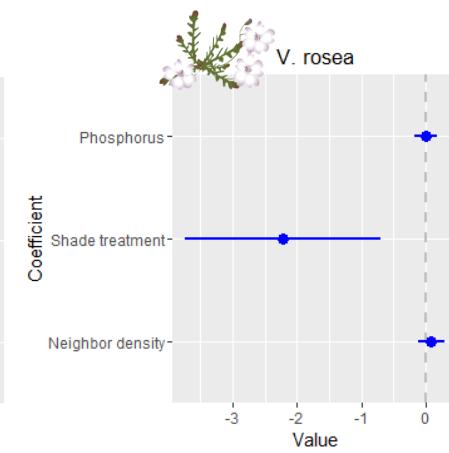
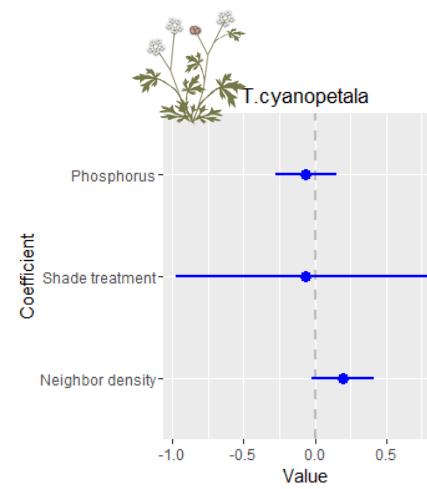
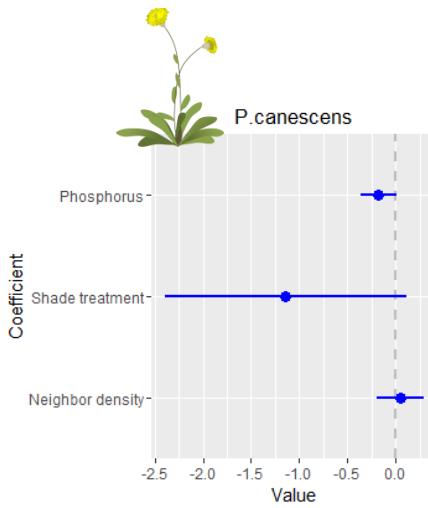
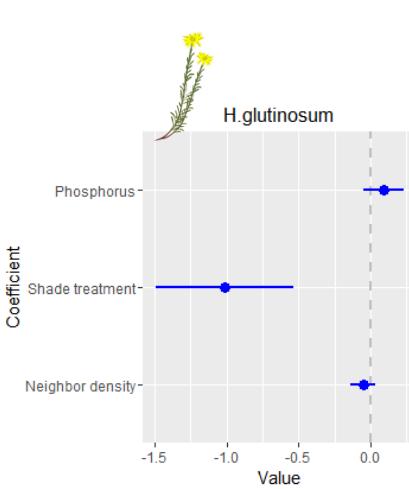
Seed production ~ Neighbourhood attribute \* Shade + P, random=Block/Individual

Model selection based on AICc

# Traits, diversity, density, or invasion?



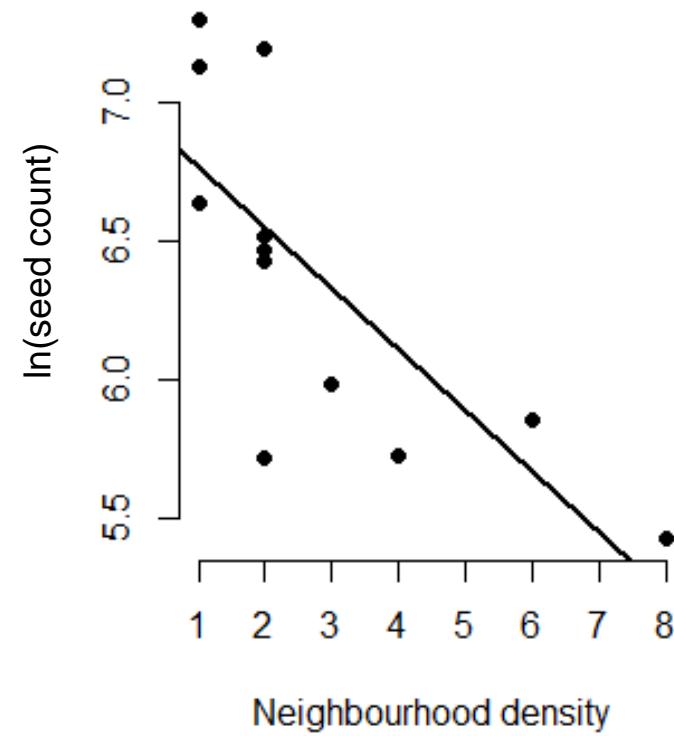
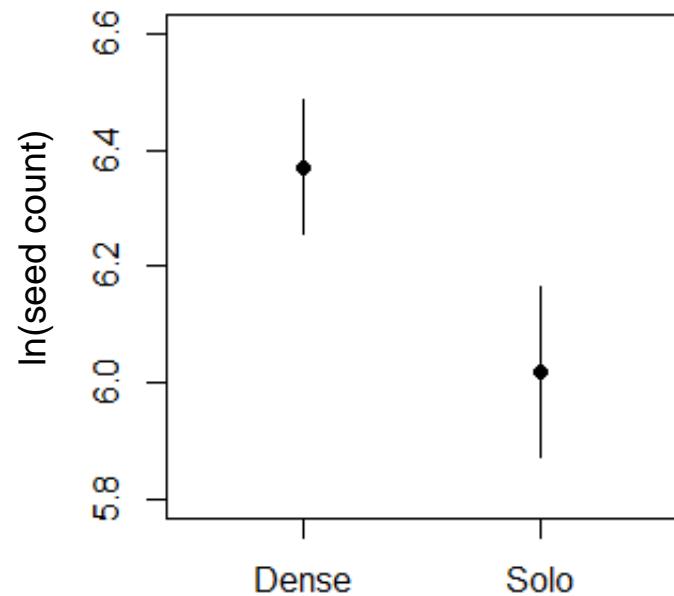
Best candidate model:  
P, shade treatment, and neighbor density (additive)



# Traits, diversity, density, or invasion?



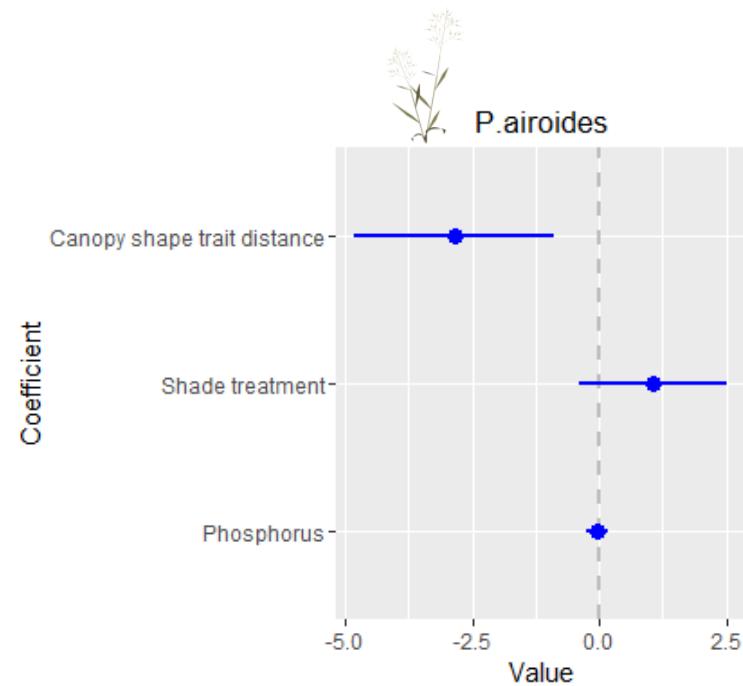
*A. calendula* (exotic)



# Traits, diversity, density, or invasion?

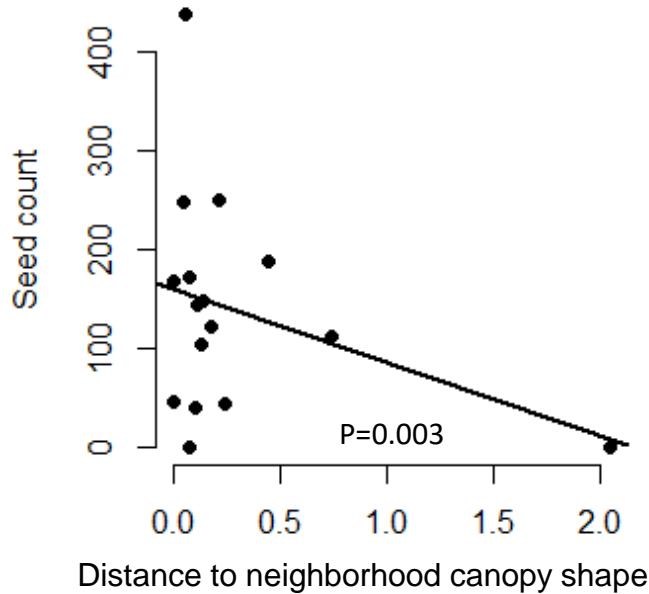
GLMMs, model selection based on AICc

Best candidate model:  
*P. airoides*: Canopy shape trait distance + shade + P

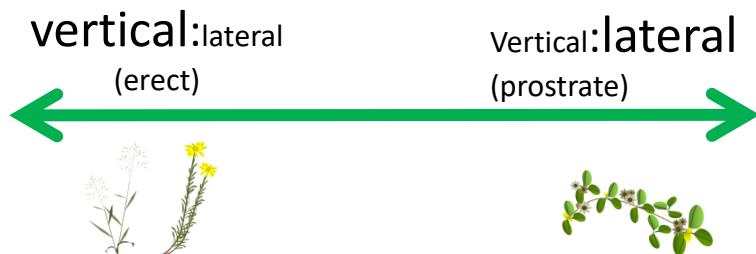


# Traits, diversity, density, or invasion?

*P. airoides* (exotic)



Seed output declines where neighborhood dominated by low, prostrate growth forms



# Summary

- Neighbor effects + and –
- P, canopy not as influential at individual level compared to community-level obs data
- Within neighborhoods, density & canopy shape differences influenced fecundities

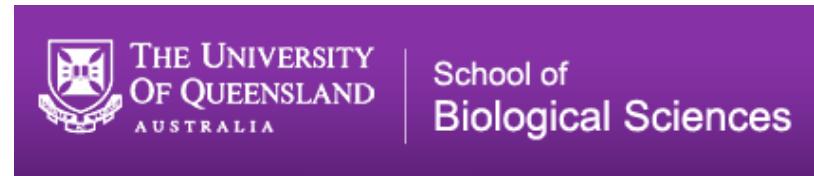
# Conclusion

- Effects of neighbors: balance between microclimate amelioration and competition?
- Origin and diversity not as predictive as density, possibly traits
- Next: inclusion of higher-order interactions, more disturbance and resources gradient types

# Acknowledgements



**Australian Government**  
**Australian Research Council**



Tom Flanagan, Maia Raymundo

John Dwyer

Ecosystem Restoration and Intervention  
Ecology Group (ERIE)

Ecological Society of America

Photos: Claire Wainwright & John Dwyer

Species cartoons: Xingwen Loy & Claire  
Wainwright



Dwyer, J. M., Hobbs, R. J., Wainwright, C. E., & Mayfield, M. M. (2015) Climate moderates release from nutrient limitation in natural annual plant communities. *Global Ecology and Biogeography*, 24(5), 549-561.

Kunstler, G., Lavergne, S., Courbaud, B., Thuiller, W., Vieilledent, G., Zimmermann, N. E., Kattge, J. and Coomes, D. A. (2012), Competitive interactions between forest trees are driven by species' trait hierarchy, not phylogenetic or functional similarity: implications for forest community assembly. *Ecol Lett*, 15: 831–840.

# Novel plant communities

