What determines species distribution limits along an altitudinal gradient in Acacias?

Katie Rolls, Corey O’Brien, Paul Rymer

p.rymer@westernsydney.edu.au
@DNAPrymer
Climate Change

- Hot extremes will be more frequent and intense with increases in drought and heat waves and less rainfall in Southern Australia.
- Mountain ecosystems particularly vulnerable to higher temperatures with a trend towards drier conditions and increased fire risk.

Harris et. al. 2018 Nature Climate Change
Aim:
To investigate species distribution limits and local adaptation in *Acacia* along an altitudinal gradient.

Research Questions:
• What determines species distribution limits along an altitudinal gradient?
• Are plants locally adapted to different altitudes?
Experimental Design

Reciprocal Transplant

Widespread species
*Acacia suaveolens, A. ulicifolia*

Restricted species
*Acacia linifolia (low)  A. obtusifolia (high)*

Low altitude

Mid altitude

High altitude

low (< 400m)  mid (450 - 750m)  high (> 800m)
Species contrasts

Widespread

*A. suaveolens*
Collections: 2 low, 2 mid, 2 high

*A. ulicifolia*
Collections: 2 low, 2 mid, 2 high

Restricted

*A. linifolia* (low)
Collections: 2 low, 2 mid

*A. obtusifolia* (high)
Collections: 2 mid, 2 high
Seed Collection

- **Low**: <400m
- **Mid**: 450-750m
- **High**: >800m

**Collection**
- Mt Hay North
- Mt Hay South
- Ingar Fire Trail
- BLM MN
- MBKMB
- BIL 8PA
- KUR WH
- KUR BUR
- BOW BM
- GRO CTR
- WIN WB
- Valley Heights
- SPR YO
- Darks Common
- Pisgah Ridge

**Planting**

- 5 km scale
Site Selection

- Recently burnt
- Sandstone soil
- *Acacia* species present
- Similar site characteristics
- >1km apart

Site Characterisation

- Temperature
  air and soil logged hourly
- Soil analysis
  collection and planting sites
Seedling preparation

- Sorted to remove immature/damaged seed
- Sterilized seed and sand
- Established in a randomised block design
- Grown in nurseries with a constant watering regime to acclimatize

- High sites - Katoomba (Wild Plant Rescue)
- Low sites - Glenbrook (Native Plant Reserve)
Transplant

Experimental plantings
- 3 low, 3 high sites
- 6 plots per site
- 4m x 4m
- Seedlots randomised within plots

Scarified seed - Establishment
- 4 seed cache (10) per seedlot

Seedlings – Growth and survival
- 4 seedlings per seedlot

Canopy Volume

Survival

Transplanted Seed

Seedlings

12,800

2,880

Transplanted

Seed

12,800

Seedlings

2,880

Experimental plantings
- 3 low, 3 high sites
- 6 plots per site
- 4m x 4m
- Seedlots randomised within plots

Scarified seed - Establishment
- 4 seed cache (10) per seedlot

Seedlings – Growth and survival
- 4 seedlings per seedlot

Canopy Volume

Survival

Transplanted Seed

Seedlings

12,800

2,880
Temperature variability

Average air temperature

[Graph showing temperature variability from 24-Apr to 01-Sep]
Hypotheses

1. Local origin will have greater fitness than foreign material (i.e. local is best)

2. Restricted species have greater fitness than widespread species in their local climate

3. Planting beyond the species distribution will result in greater fitness losses than similar distances within species range limits
Key outcomes

• Plant fitness decreased with altitudinal transfer distance providing evidence for local adaptation in low altitudes.

• Seed were able to establish beyond their range indicating dispersal limitation.

• High altitudes may be more vulnerable to climate change with low establishment and reduced local fitness.

• Assisted migration for low to high altitudes would provide enhanced adaptive capacity to climate change.
Thank You!

Katie Rolls
Corey O’Brien

Tony Auld
Mark Tjoelker
Edward Mifsud
Collin Ahrens
Desi Quintans
Anthea Challis

NSW Scientific License
NPWS staff