# Revegetation practice & a changing climate


Nola Hancock

MACQUARIE University


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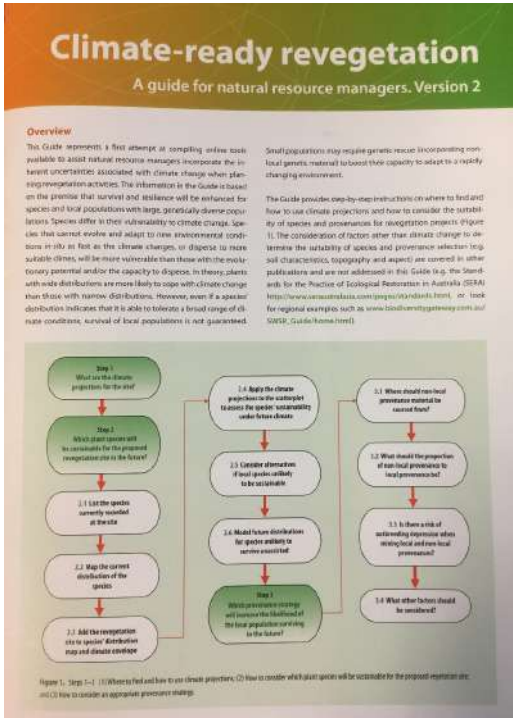
## Hovells Creek Landcare Group

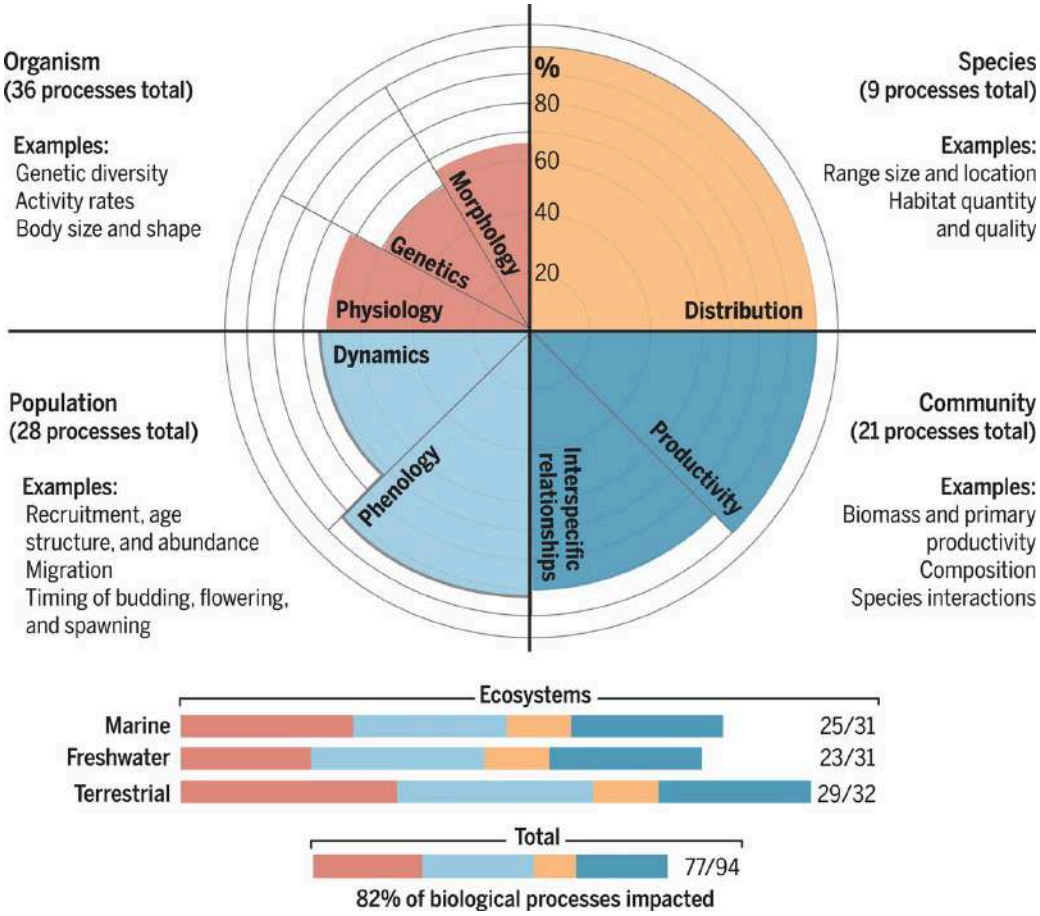
# Climate-ready Reveg Guide

N. Hancock, R. Harris, L. Broadhurst & L. Hughes, 2016, V2 2018




- Increase awareness that CC is a game changer
- Provide information & websites to help at the local level
- Online tools (tool box)
- Considers climate change only

# Why use a climate lens? Already impacting…



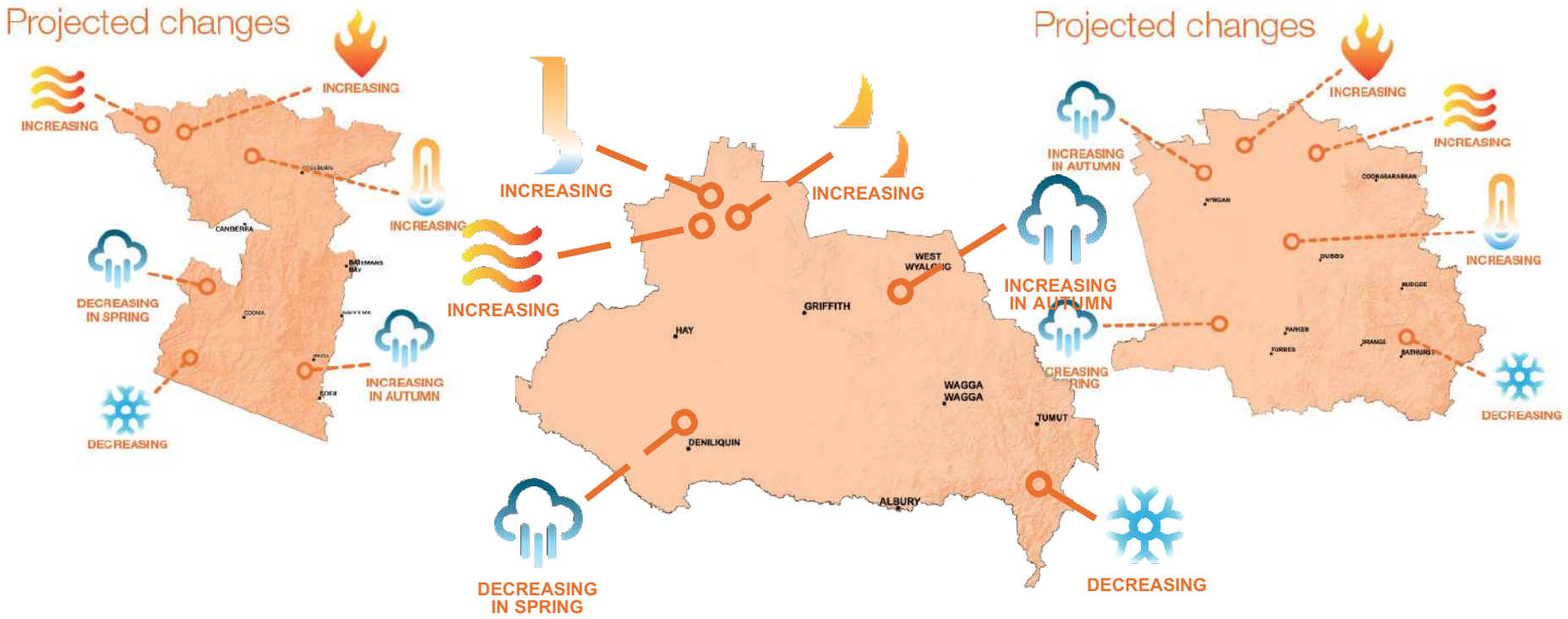

Science
AAAS

**Brett R. Scheffers et al.**
**Science**
**2016;354:aaf7671**

# Why use a climate lens?
# … & will continue to impact

## NARCLiM regional projections

https://climatechange.environment.nsw.gov.au/




**S. E. & Tablelands** **Murray Murrumbidgee** **Central West & Orana**

# Why important for you?

Native vegetation/revegetation used for:

- Agricultural: managing ground water and salinity, erosion control and riverbank stabilization, shelter & food for stock
- Natural resource management / ecology: protecting threatened species, planting corridors for wildlife, multi purpose

# Practical decisions now

- Continue to revegetate in the manner that we have done in the past?
- Plant the same species?
- Use the same seed source (local or a different provenance strategy)?
- Time of planting?
- Change the way we have been doing things?



# Uncertainty and the vulnerability of species to climate change

Species differ in their vulnerability to climate change (exposure, sensitivity, adaptive capacity). Coping mechanisms:

- **Stay & tolerate or genetically adapt**
- **Move & keep pace with climate change**

**or become locally extinct**

# Uncertainty and vulnerability of species to climate change

Generally, those advantaged:

- Can tolerate, adapt or move
- Keep pace with climate change
- Have wide distributions

# Balance urgency / perfect knowledge

- Models imperfect but consistently show a reduction / change in species' distributions
- Whole veg communities to change
  = Implications for revegetation
- Failed plantings = lost effort, time, money & biodiversity

# Step 1: What are the climate projections for the site?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Step 2: Which plant species

currently recorded at my site

2.2 Map the current distribution of the species

2.3 Add the reveg site to species' dist map and climate en

2.4 Apply the climate projections to the scatterplot to assess the species' sustainability under future climate

5. Consider alternatives if cal species unlikely to be stainable

2.6 Modelling future distributions for species unlikely to survive unassisted

Step 3: Which provenance

3.1 Where should non-local provenance material be sourced from?

3.2 What should the proportion of non-local provenance vs local provenance be?

3.3 Is there a risk of outbreeding depression when mixing local and non-local provenances?

rs should

# Step 2: Which plant species will be sustainable for the proposed revegetation site in the future?

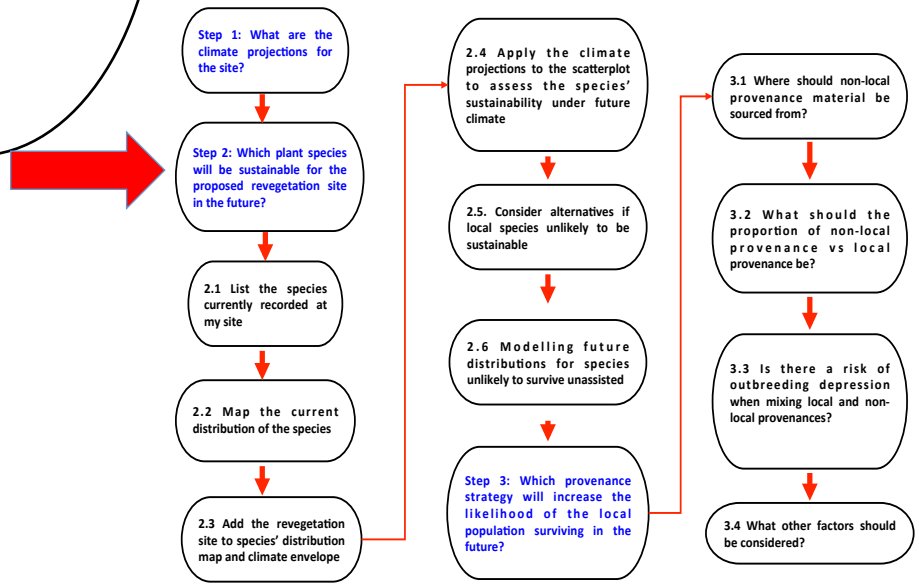
# Step 3: Which provenance strategy will increase the likelihood of the local population surviving in the future?

# Projections:
# Murray Basin / Murray Murrumbidgee

| | 2060 – 2079 NARCLiM | 2080 -2099 CSIRO & BOM |
|---|---|---|
| **Mean Annual Temp** | **+1.5 - 2.5 °C** | **+ 2.7 – 4.5°C** |
| **Winter Precipitation** | **-20 - +16%** | **-40 - +5%** |

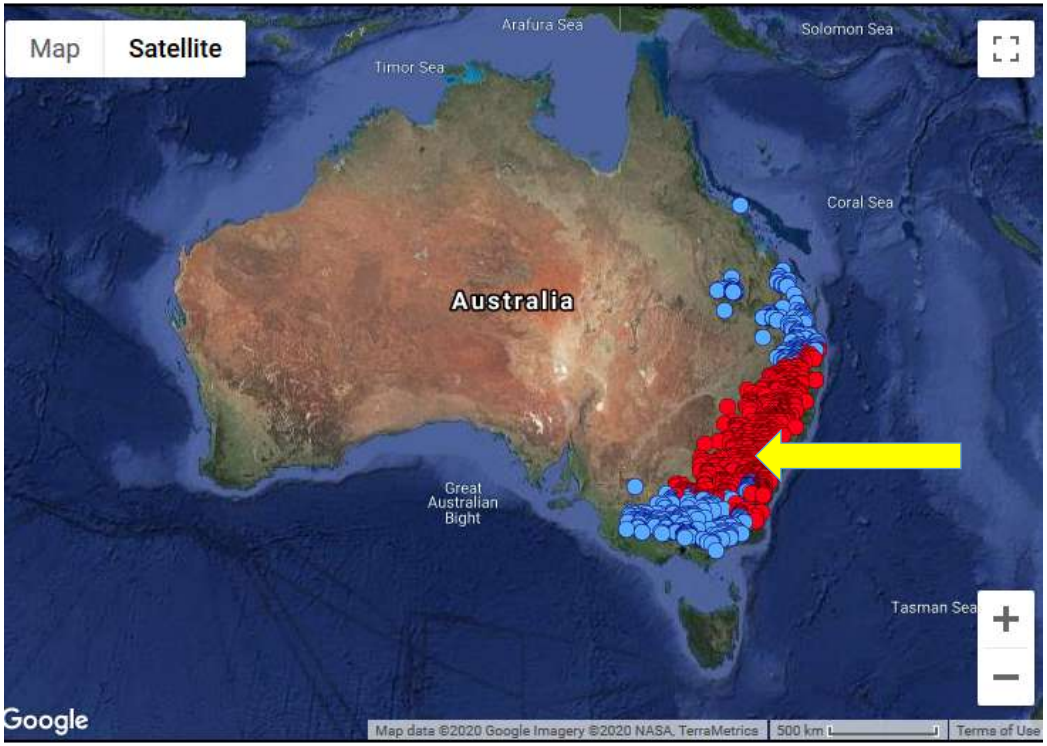
- Projection variabilities: source, region, range, future dates, base line, RCP
- Also: max, mins, no. hot days, cold nights, fire weather, seasonal vs annual

# Step 2: Which plant species will be sustainable for the proposed revegetation site in the future?



# Local species sustainability under climate change: some methods

1. Distribution – map occurrences
2. Position of planting site within the occurrences



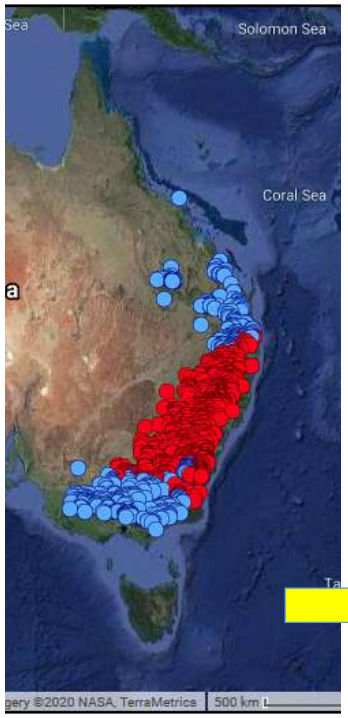

*E. melliodora Yellow box* NSW Nichefinder

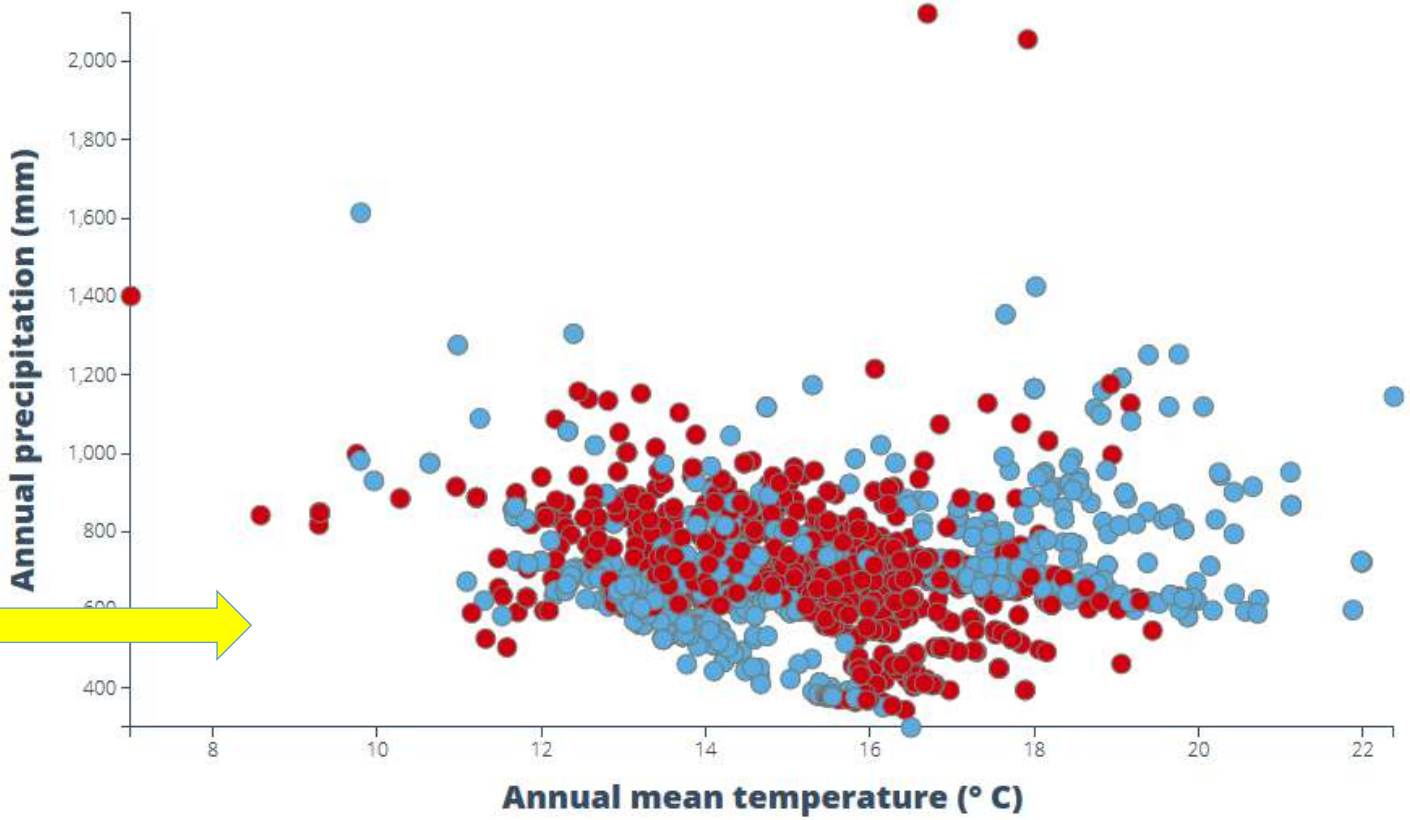
# Local species sustainability under climate change: some methods

1. Distribution – map occurrences
2. Position of planting site within the species' occurrences
3. Climate projections overlaid onto species current climate envelope

# Species' current climate envelope

The association between a species' occurrences & its current climate variables to estimate its current distribution



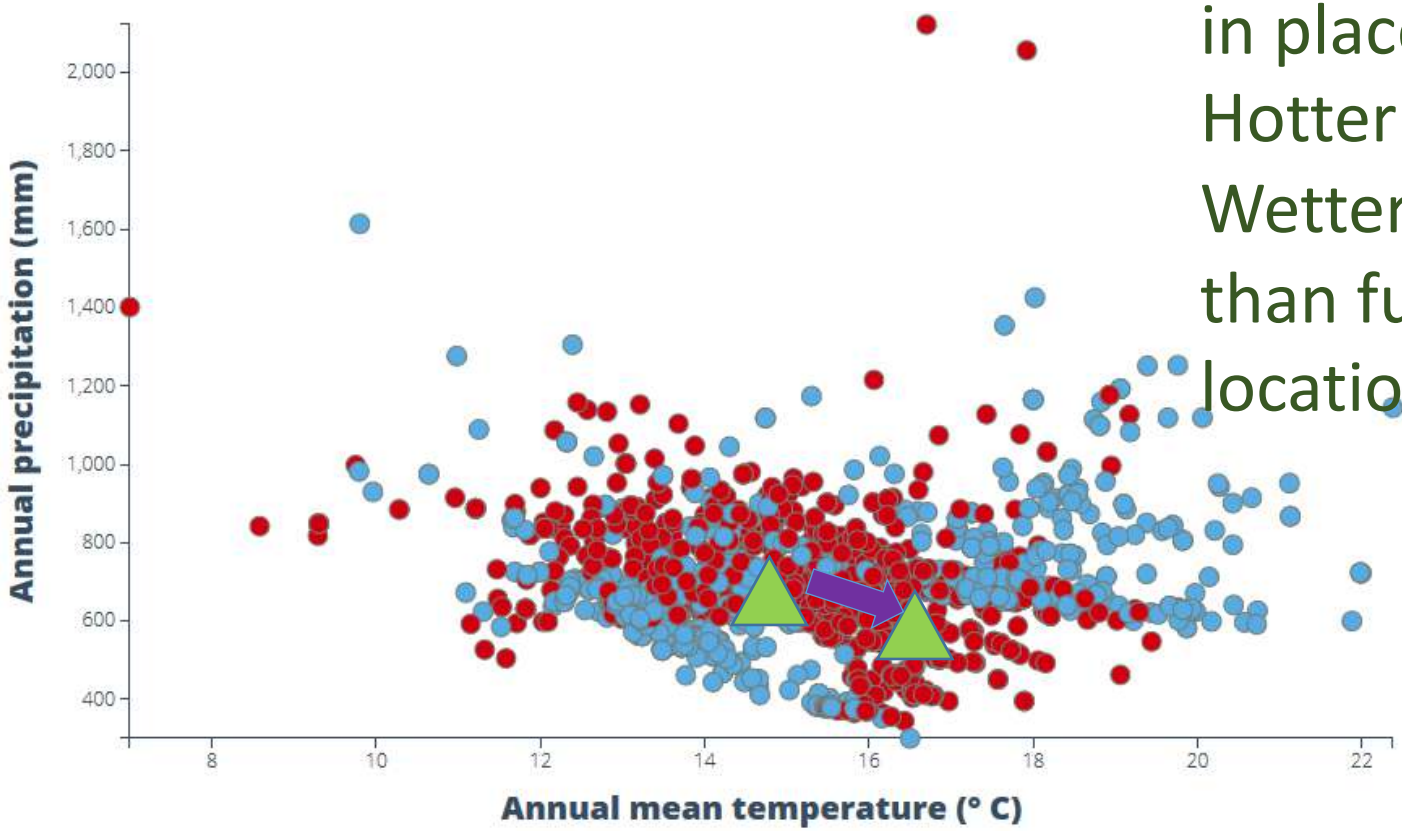



# Species' current climate envelope

Range of occurrences in terms of 2 climate variables

But where is the planting site?

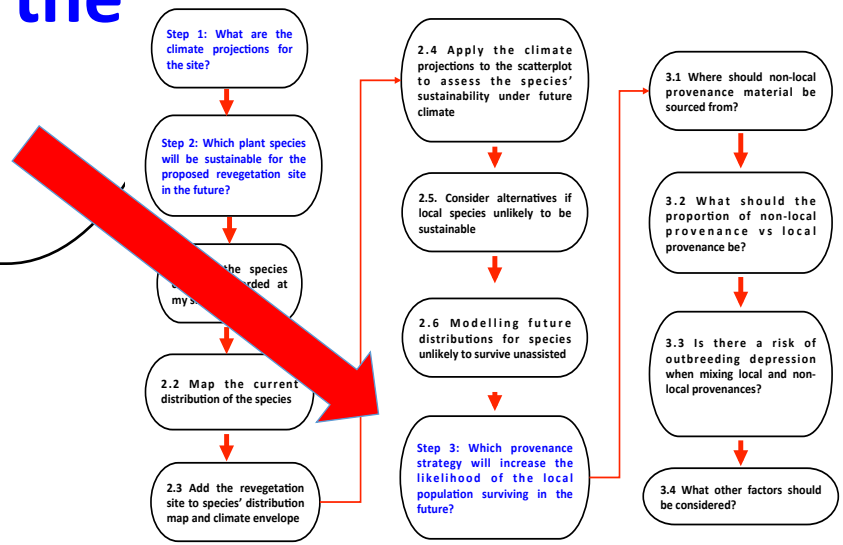
Species occurs in places Hotter /Cooler Wetter /Drier than future site location



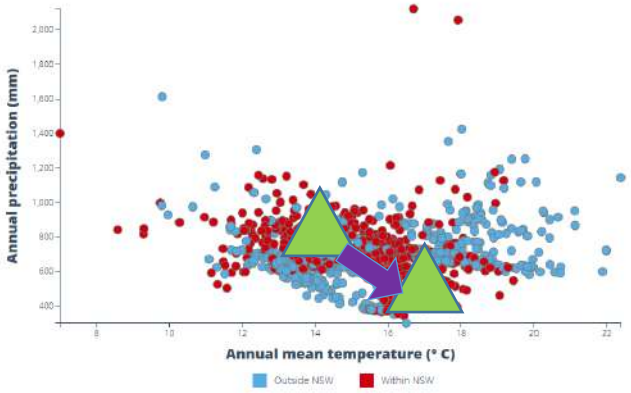
# Summary

1. Distribution – map occurrences
2. Position of planting site within the species' occurrences
3. Climate projections overlaid onto species current climate envelope
4. Species distribution modelling

# Step 3: Which provenance strategy will increase the likelihood of the local population surviving in the future?



# Even if species is sustainable, the local population may not be




- Levels of *insitu* genetic diversity & / or plasticity?
- Local paradigm
- Local conditions changing
- Local now no longer local in future
- Consider supplementation with non-local provenance(s)
  - preadapted to future climate
  - large genetically healthy pops

# Where should non-local provenance material be sourced from & what proportion should be used?

Context specific

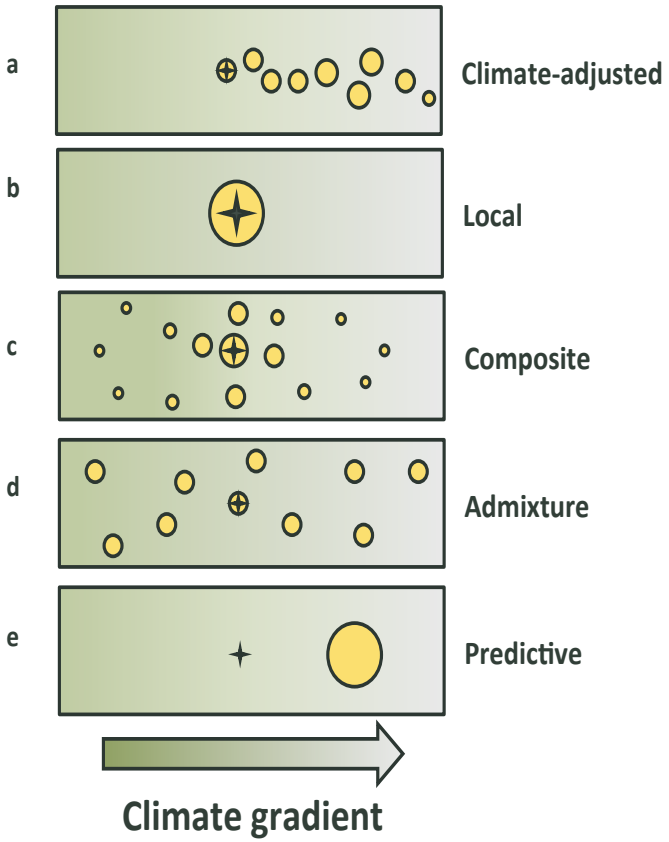



Figure modified from Prober *et.al.* 2015

Prober, S. M., Byrne, M., McLean, E. H., Steane, D. A., Potts, B. M., Vaillancourt, R. E. & Stock, W. D. Climate-adjusted provenancing: a strategy for climate-resilient ecological restoration. *Frontiers in Ecology and Evolution*
**Available at:** http://www.frontiersin.org/Journal/FullText.aspx?s=1472&name=interdisciplinary_climate_studies&ART_DOI=10.3389/fevo.2015.00065, doi:10.3389/fevo.2015.00065 (2015).

# Provenance strategies: Local

- Seeds sourced within a certain geographical distance to the planting site

Star = planting site
Size of circle = quantity

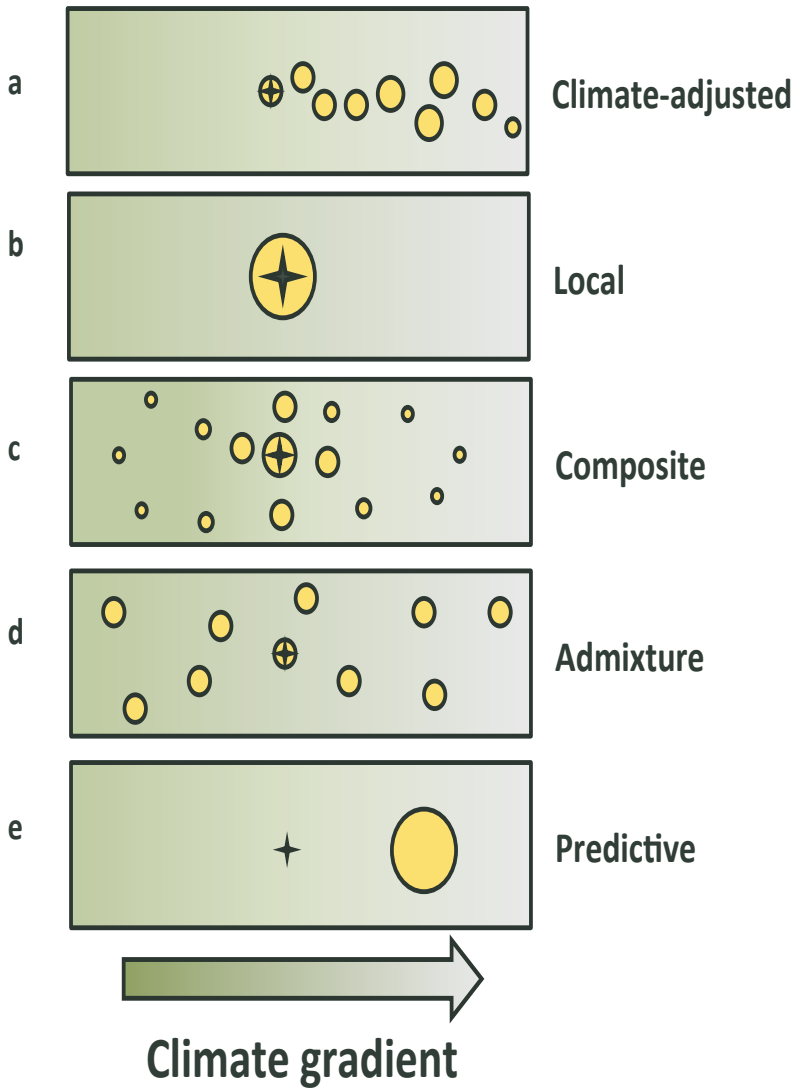
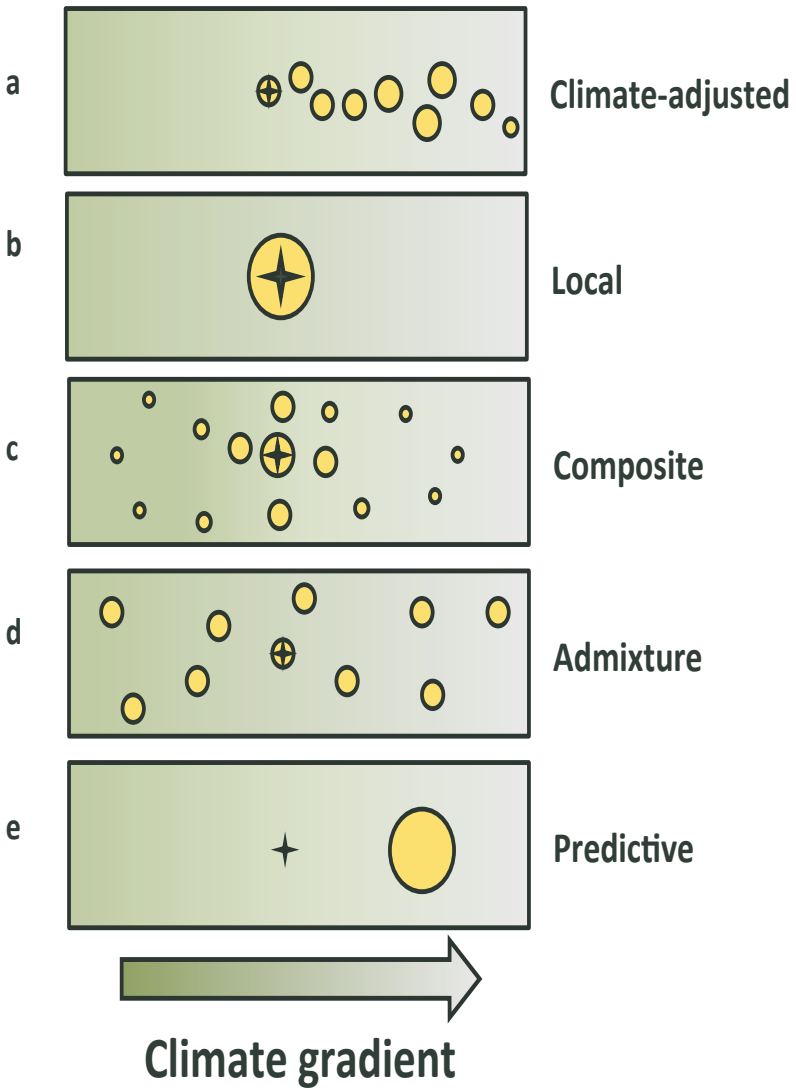



Figure modified from Prober *et.al.* 2015

# Provenance strategies: Composite

- Mix a small % of seed from non-local high quality & genetically diverse populations
- Reinstate historical gene flow
- Address potential inbreeding & adaption issues




Broadhurst et al 2008

Figure modified from Prober *et.al.* 2015

# Provenance strategies: Predictive

- Source seeds solely from location experimentally determined to be the best match for the site
- Doesn't allow for gradual shifts

Crowe & Parker, 2008

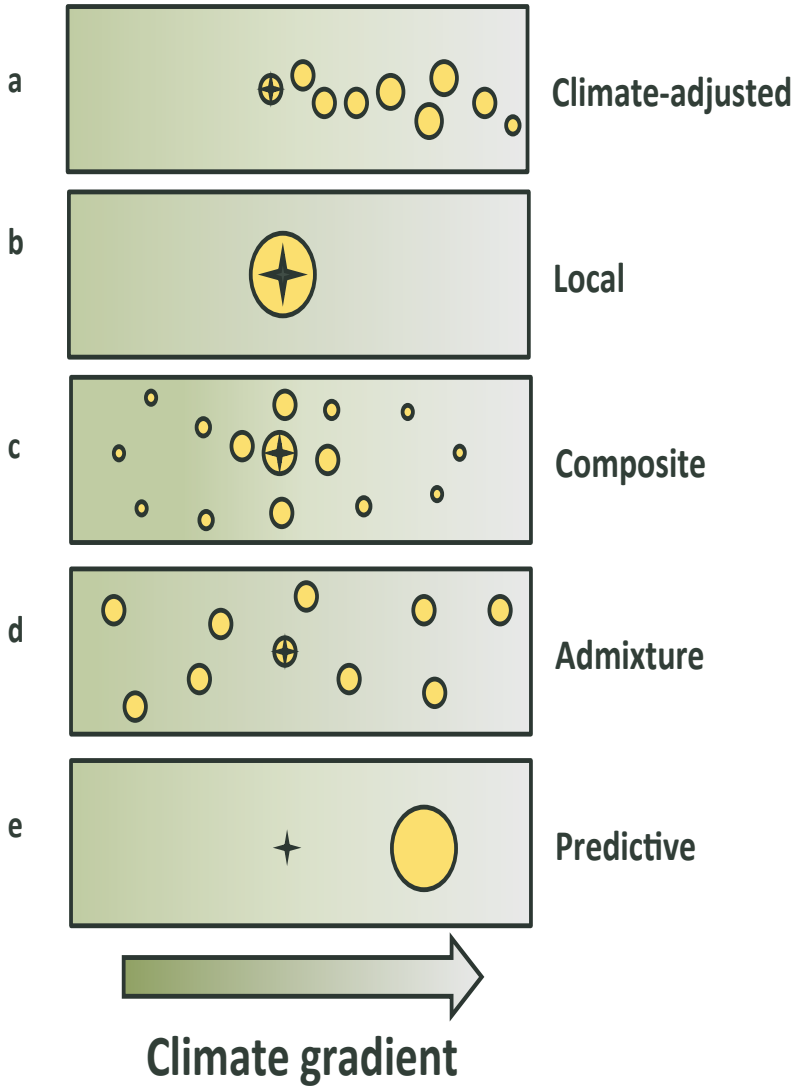
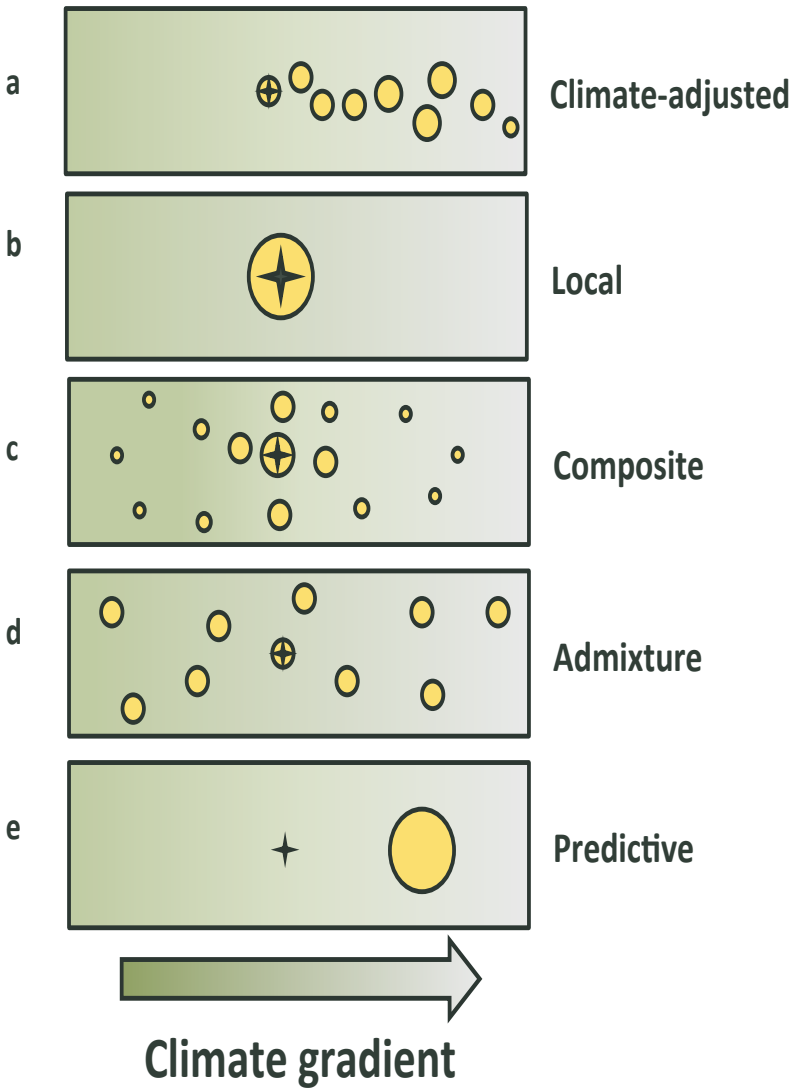



Figure modified from Prober *et.al.* 2015

# Provenance strategies:
# Admixture

- High uncertainty re scale & rate of change
- Source seeds from wide variety of locations
- Predicted to build evolutionary resilience




Breed et al 2013

Figure modified from Prober *et.al.* 2015

# Provenance strategies: **Climate-adjusted**

- Promotes resilience in a changing climate
- Seed sourcing biased towards the direction of predicted climate change (but not exclusive)

Prober et al 2015

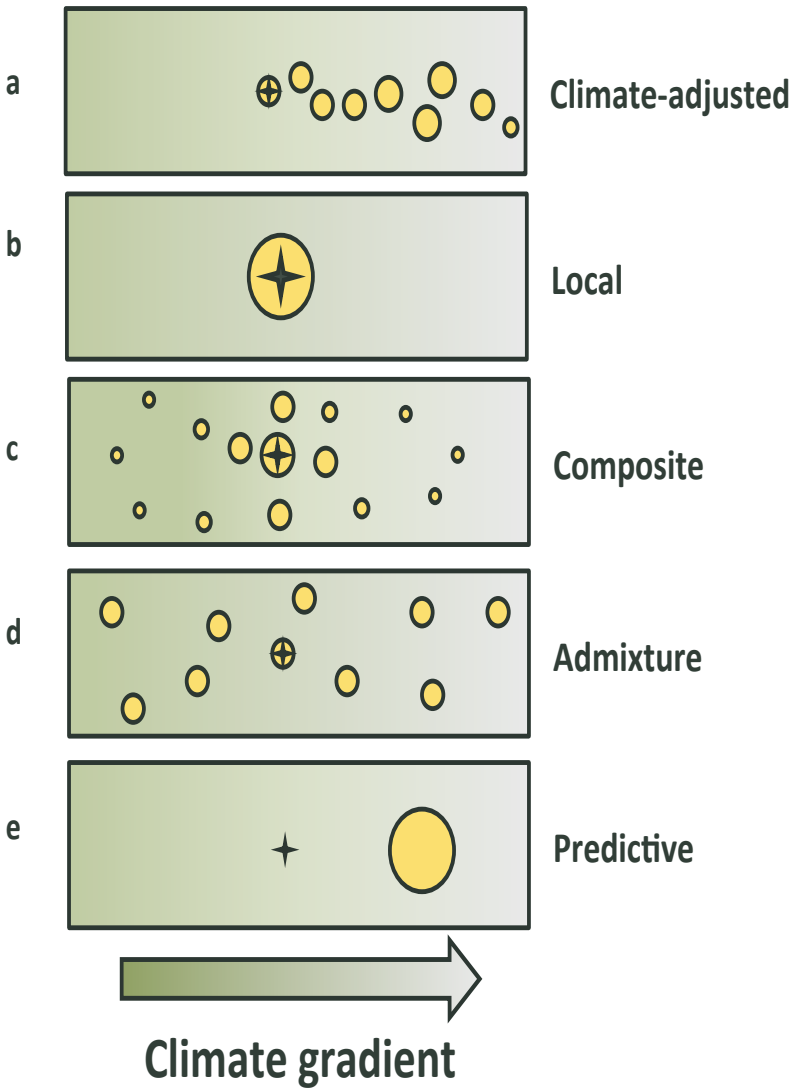



Figure modified from Prober *et.al.* 2015

# Limitations include:

- Unknown if species are currently occupying all suitable habitat (available niche space vs actual niche space)
- Climate envelopes & other modelling not exact or perfect (data in = data out i.e. RCPs)
  - Under and over estimation of sustainability
  - Biotic interactions not included (CC only)
- Climate suitability (range) for near and far future

# Climate-ready revegetation trials



https://www.olelantanaseeds.com.au/product/eucalyptus-viminalis-manna-gum-seed-x200/


https://castlemaineflora.org.au/pic/e/eucal/eubla/eubla.htm

# Help is just around the corner!

Yass Area Network of Landcare Groups

**Isobel Cummings**
*Cultural and Ecosystem Adaptation* - NSW DPIE
Isobel.Cummings@environment.nsw.gov.au



# Strategies for uncertainty

Change is occurring and will continue:

- Enhance resilience and adaptive capacity
- Will be effective under a range of possible future climates
- Have multiple benefits and are low or no-regret
- Promote adaptive management and contribute to improved understanding
- Allow flexibility

(Lourenço *et.al.,* 2014, *Adapting to an uncertain climate: lessons from practice,* Springer International Publishing*)*

# Other strategies

**Build resilient vegetation communities for the future:**

- Genetically diverse populations
- Identify / rectify constraints & barriers
- Manage / reduce existing stressors




# Thank you

Linda Cavanagh & Hovells Creek Landcare Group

Isobel Cummings (DPIE)
Isobel.Cummings@environment.nsw.gov.au

'Prediction is very difficult, especially if it is about the future'.

Nils Bohr, Nobel Laureate Physics