



Restoration in a Changing World

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What changes are we expecting?

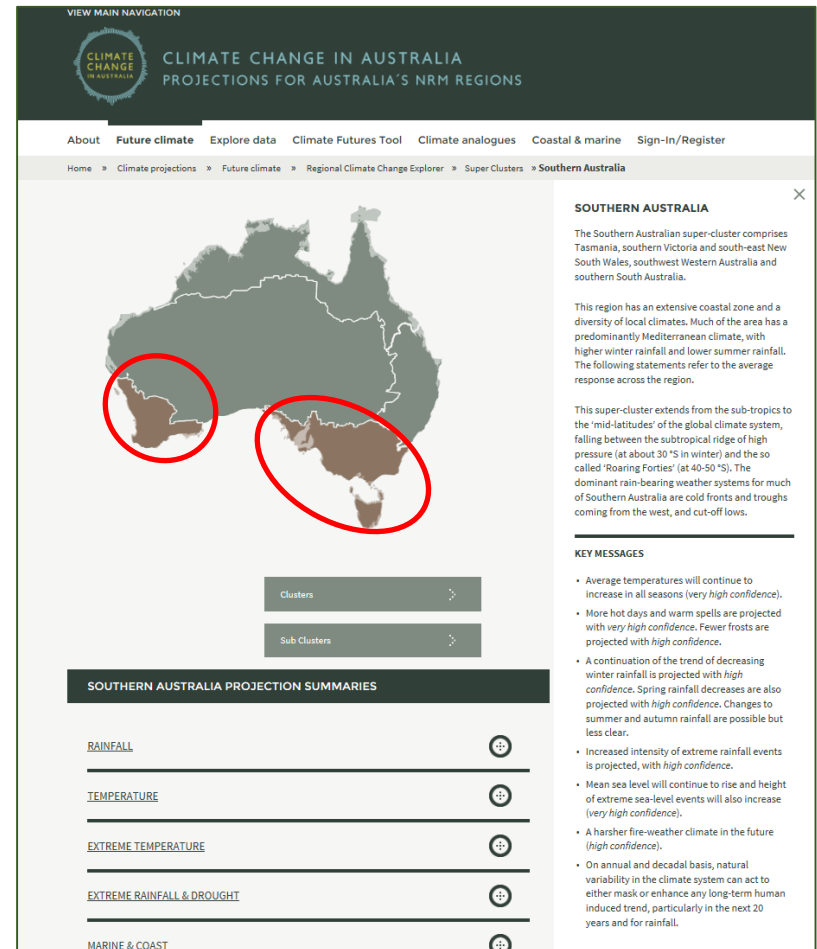
The 'Climate Change in Australia' website is a good place to learn and explore about climate change



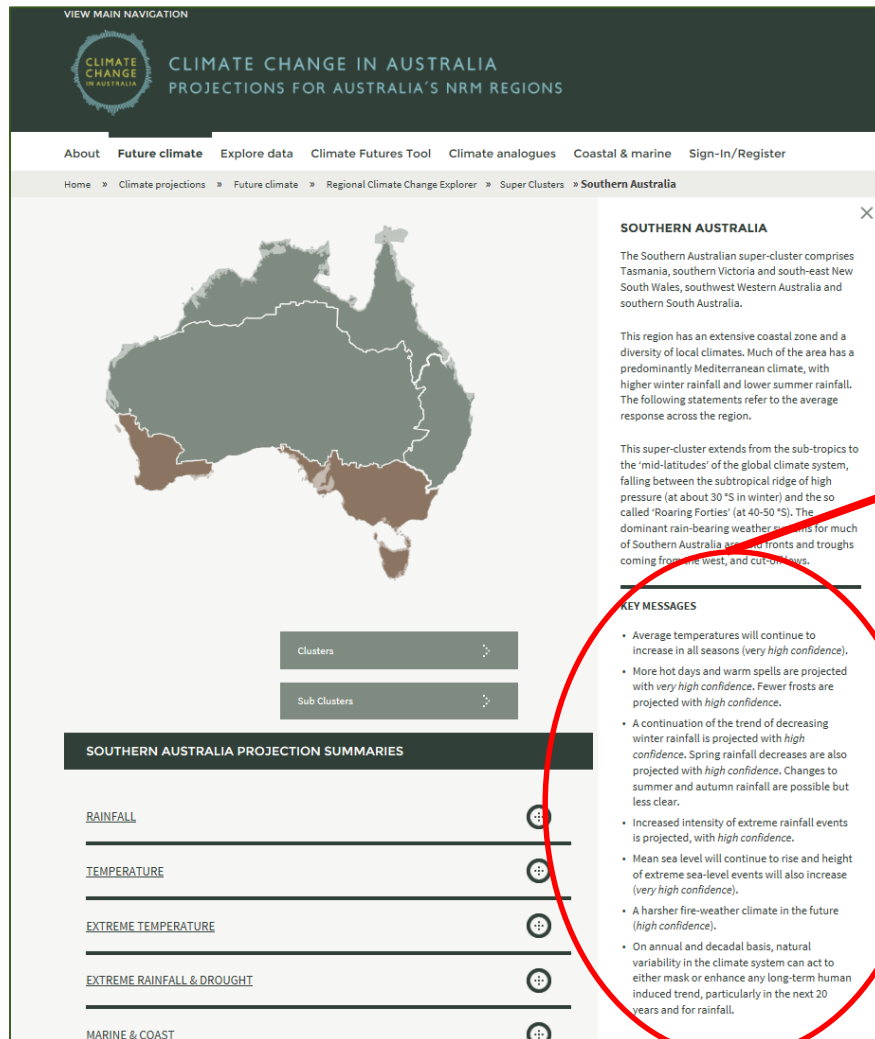
Southern Australia

Includes specific information about regions across Australia

Broad brush strokes – other tools also available



Southern Australia



- Increasing average temps (VHC)
- More hot days (VHC)
- Fewer frosts (HC)
- Decreasing winter and spring rain (HC)
- More heavy rain events (HC)
- Harsher fire-climate (HC)

VHC – very high confidence
HC – high confidence

Implications for restoration

Some predictions:

- Altered planting times
 - Seasonal shifts (e.g. crop planting times already shifting)
- Increased risk of planting failure
 - Increased soil temps may impact on germination and growth
 - Increased risk of severe events (e.g. rain, hail, fire)

Shifting our practices - current

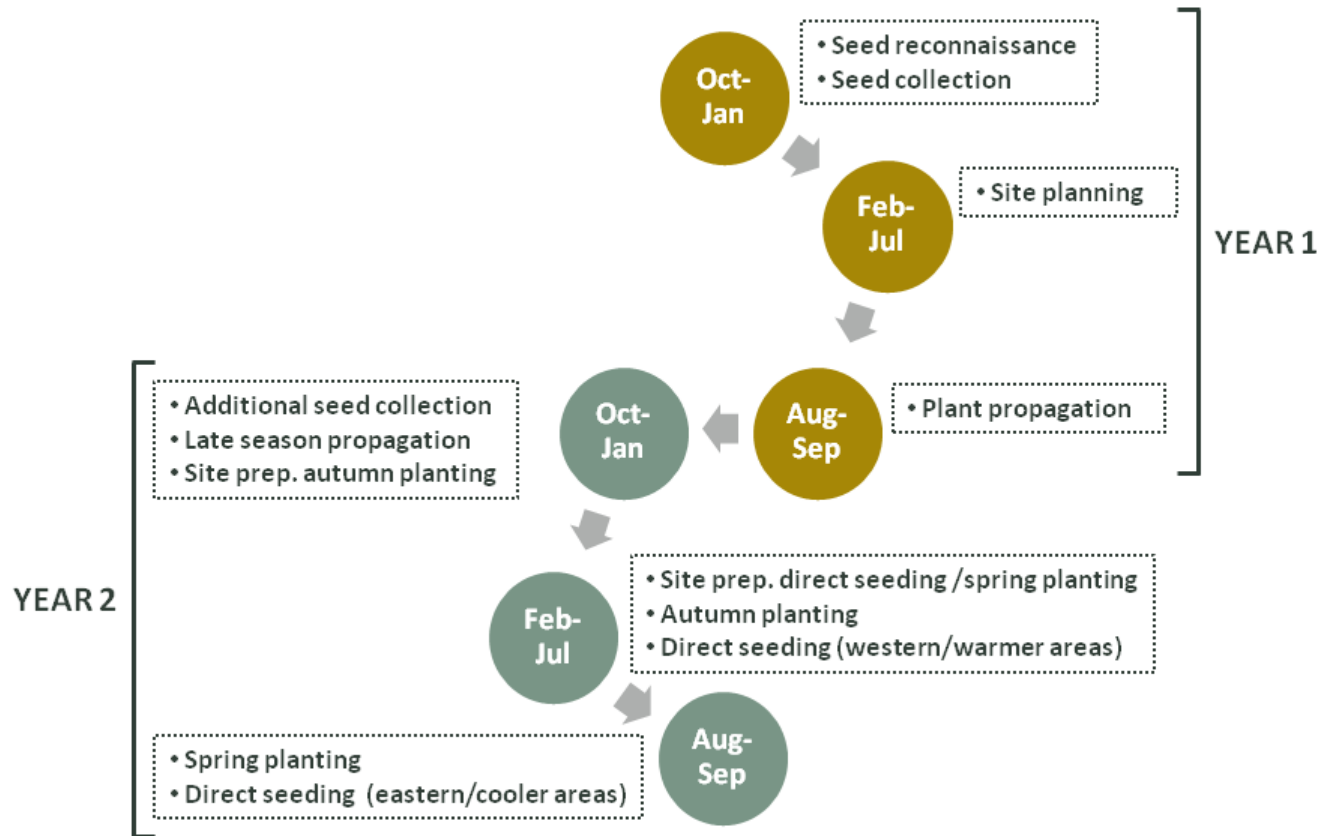
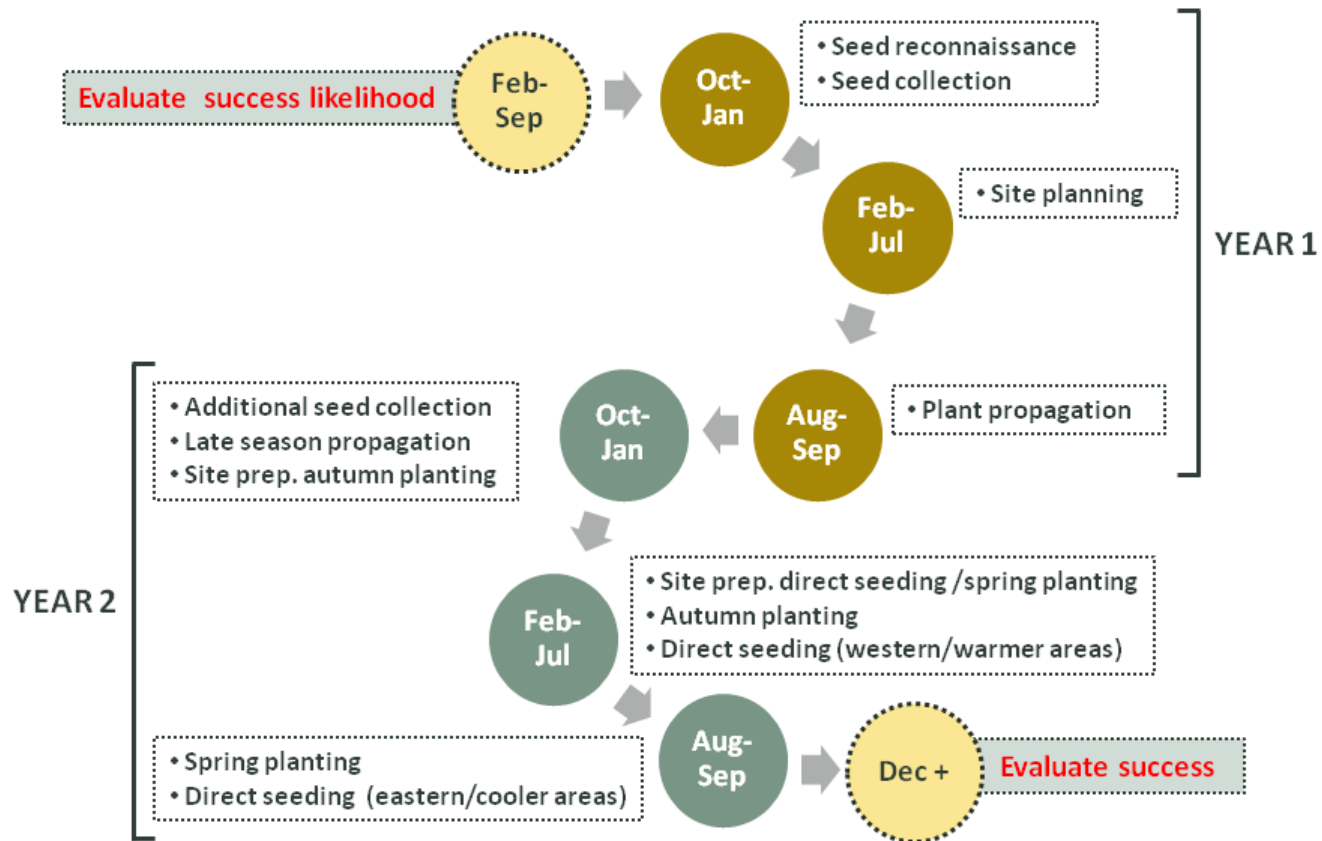
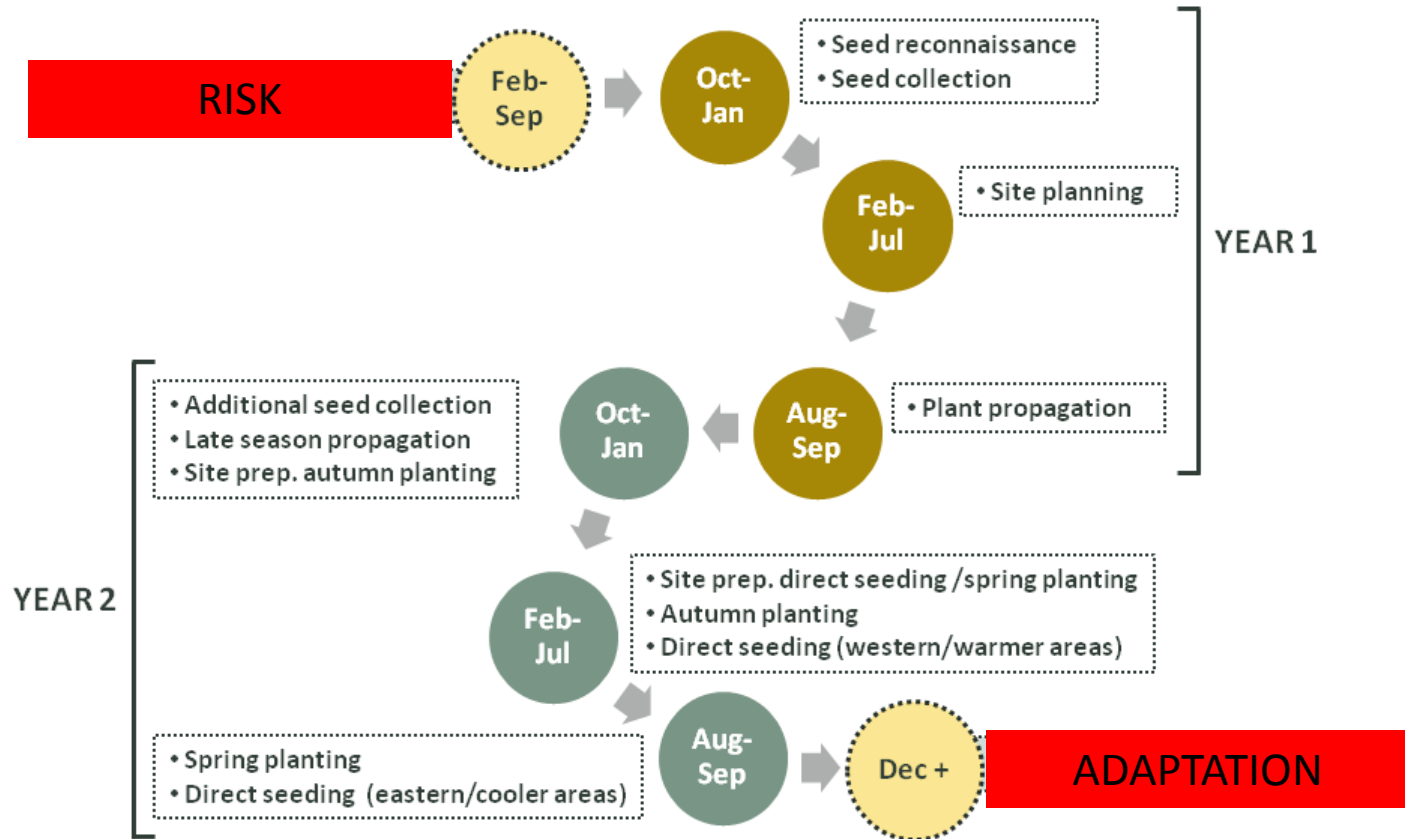


Diagram developed from information provided by Bindi Vanzella Broadhurst et al. 2016 *Climate-ready restoration* CSIRO Report

Shifting our practices - future



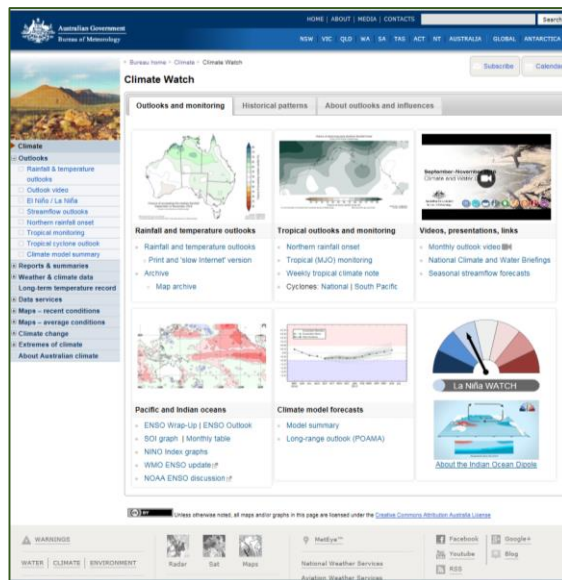
Shifting our practices - future



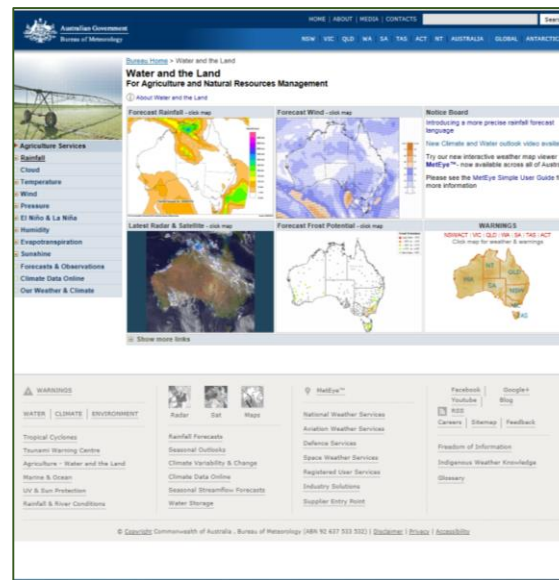
Forecasting success

No NRM-specific tools but Bureau of Meteorology (BoM) has several useful pages

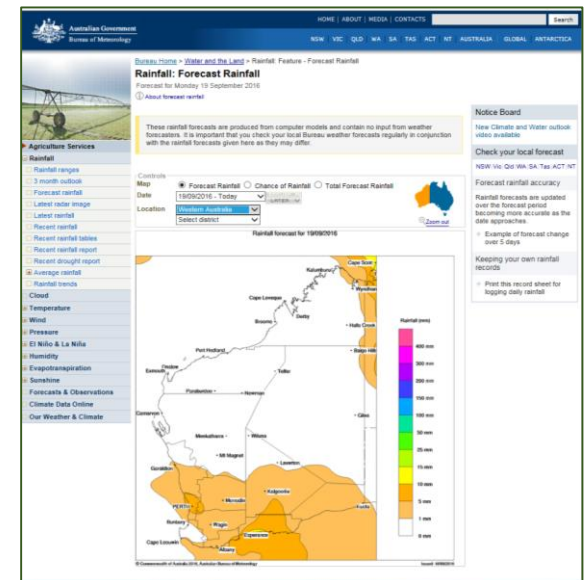
Climate outlooks



Ag & NRM



Rainfall outlooks



<http://www.bom.gov.au/>

Adaptation options

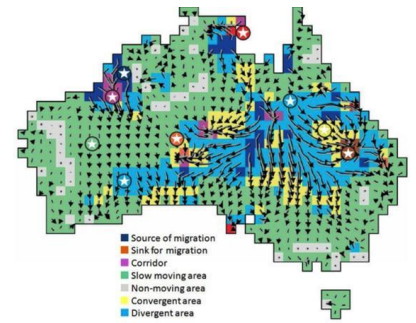
Using climate forecasts will not guarantee success or failure but do give an indication of risk.

Options to change include:

1. **Accept the risk** – plant as usual
 2. **Scale back projects** to conserve seed resources, time and money
 - i. Reduce number of species – plant hardiest groups only
 - ii. Plant fewer sites – best environments only (e.g. riparian zones)
 - iii. Reduce area to be planted
 3. **Defer projects** until conditions improve
- *Very important to manage funding agency and community expectations*
 - *Requires revision of funding policy to allow projects to be deferred/scaled back*

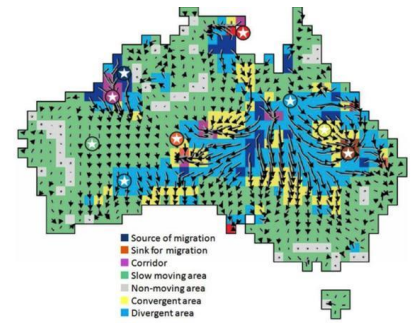
Species choice

- Probably the most challenging part of trying to restore for future climates
 - Similar issues to those associated with provenance – weediness, maladaptation
 - Species substitution
 - *Acacia* for *Acacia*, eucalypt for eucalypt?
 - *Acacia* for eucalypt as *Acacia* more likely to survive?
 - What else do these species need to become functional?
 - Pollinators, symbionts



Burrows *et al.* Nature 2014

Species choice

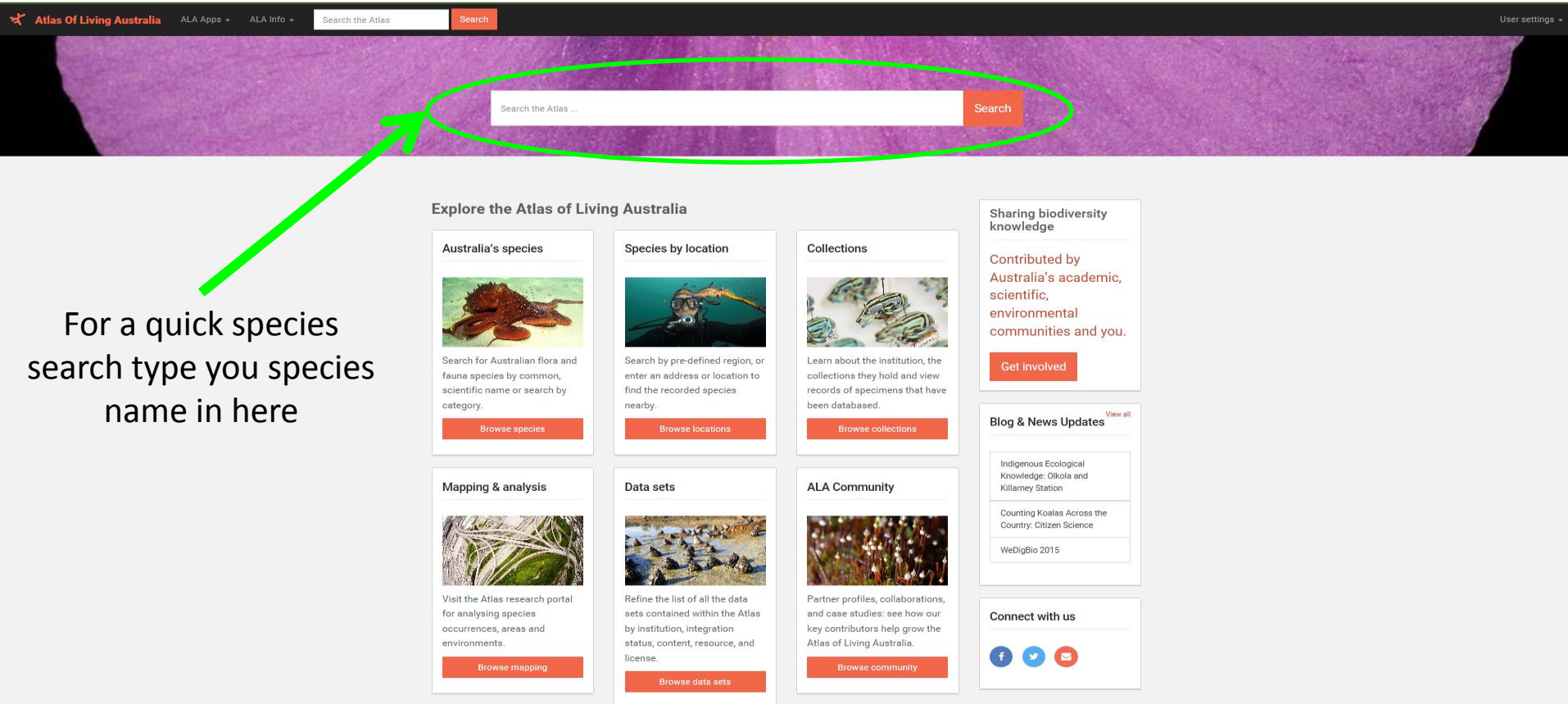


Burrows *et al.* Nature 2014

- Need to be clear about restoration objectives
 - What is the purpose (e.g. windbreak, high conservation area)?
 - Novel habitat (e.g. saline scald)?
 - What climate scenario am I planting for?
 - How far into the future am I considering?
- Possible risks
 - Plants from new areas poorly adapted current conditions - fail to germinate or grow
 - Not bringing in new species will leave landscapes wanting as current species move or die
 - Moving new species outside natural distribution releases them from natural enemies – overwhelm current species

Species – who, where and what?

Atlas of Living Australia




The screenshot shows the Atlas of Living Australia website. A green arrow points to a search bar in the header, which is also circled in green. The search bar contains the text "Search the Atlas ...". Below the search bar, there are several sections for exploring the atlas, including "Australia's species", "Species by location", "Collections", "Mapping & analysis", "Data sets", and "ALA Community". Each section has a brief description and a "Browse" button. On the right side, there are sections for "Sharing biodiversity knowledge", "Blog & News Updates", and "Connect with us".

Atlas Of Living Australia ALA Apps ALA Info Search the Atlas Search User settings

Search the Atlas ... Search

Explore the Atlas of Living Australia


Australia's species



Search for Australian flora and fauna species by common, scientific name or search by category.

[Browse species](#)


Species by location



Search by pre-defined region, or enter an address or location to find the recorded species nearby.

[Browse locations](#)


Collections



Learn about the institution, the collections they hold and view records of specimens that have been databased.

[Browse collections](#)


Mapping & analysis



Visit the Atlas research portal for analysing species occurrences, areas and environments.

[Browse mapping](#)


Data sets



Refine the list of all the data sets contained within the Atlas by institution, integration status, content, resource, and license.

[Browse data sets](#)

ALA Community



Partner profiles, collaborations, and case studies: see how our key contributors help grow the Atlas of Living Australia.

[Browse community](#)

Sharing biodiversity knowledge

Contributed by Australia's academic, scientific, environmental communities and you.

[Get involved](#)

Blog & News Updates [View all](#)

Indigenous Ecological Knowledge: Oikola and Killarney Station

Counting Koalas Across the Country: Citizen Science

WeDigBio 2015

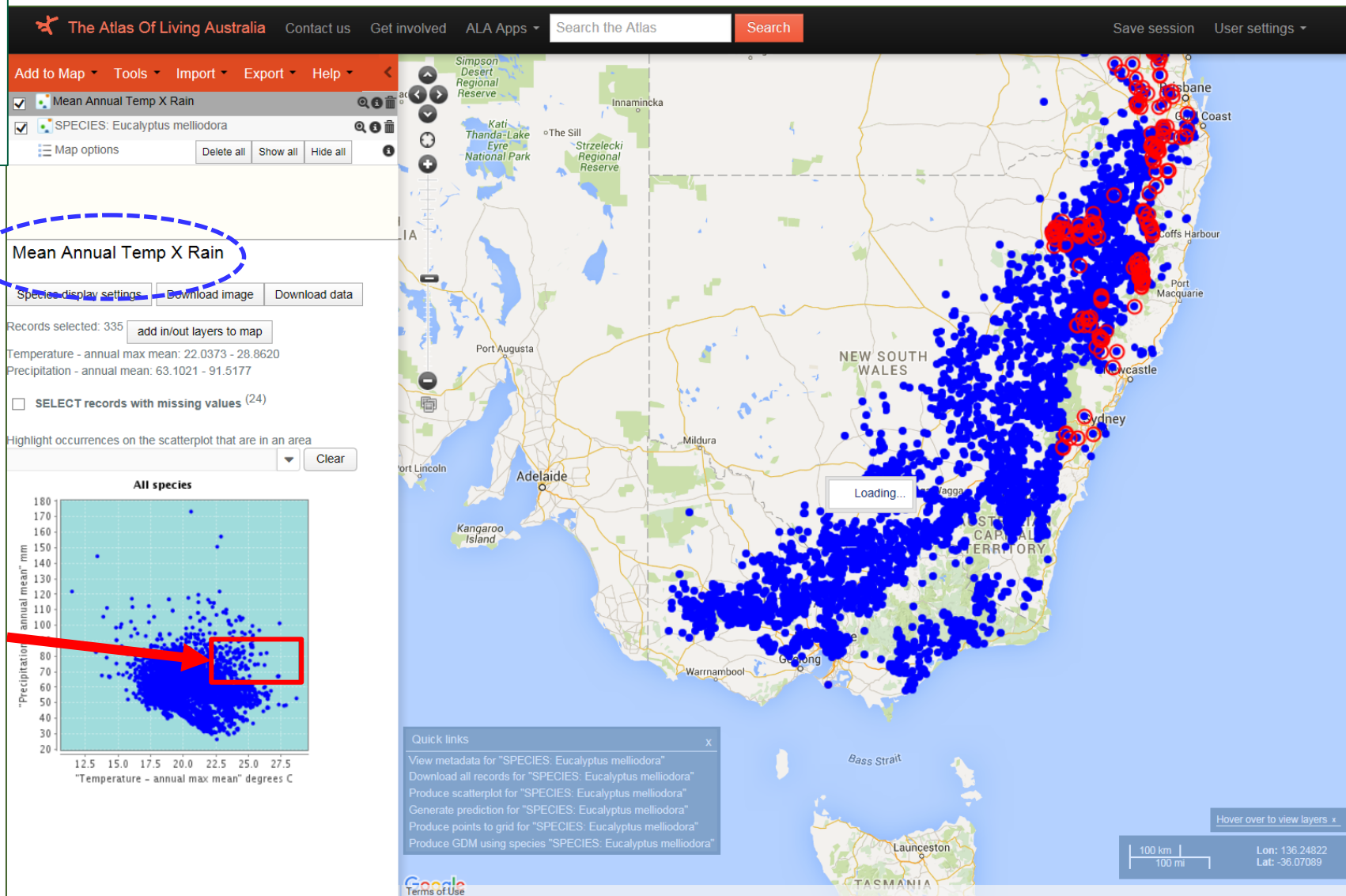
Connect with us

[f](#) [t](#) [e](#)

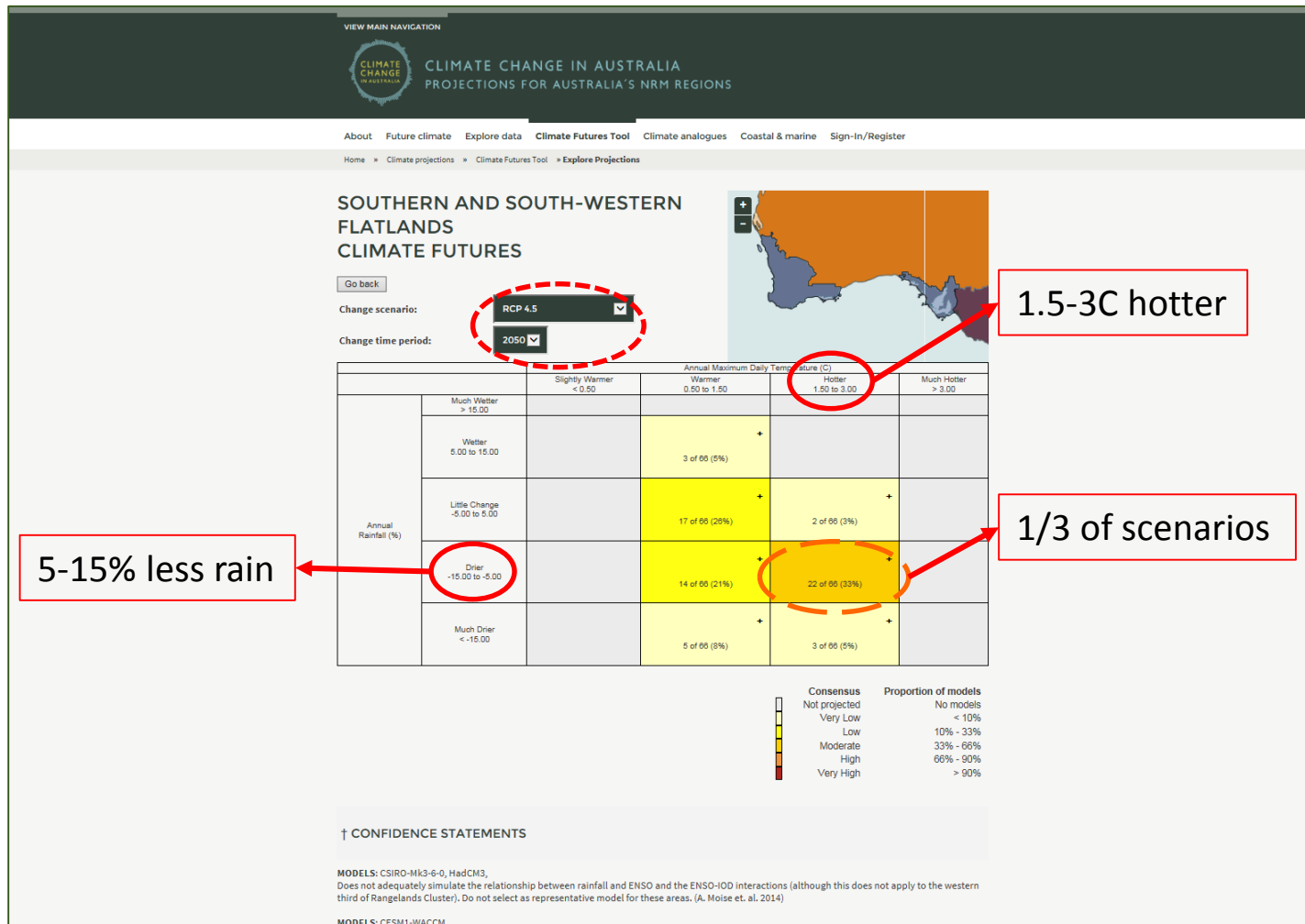
For a quick species search type your species name in here

Animation [show](#)

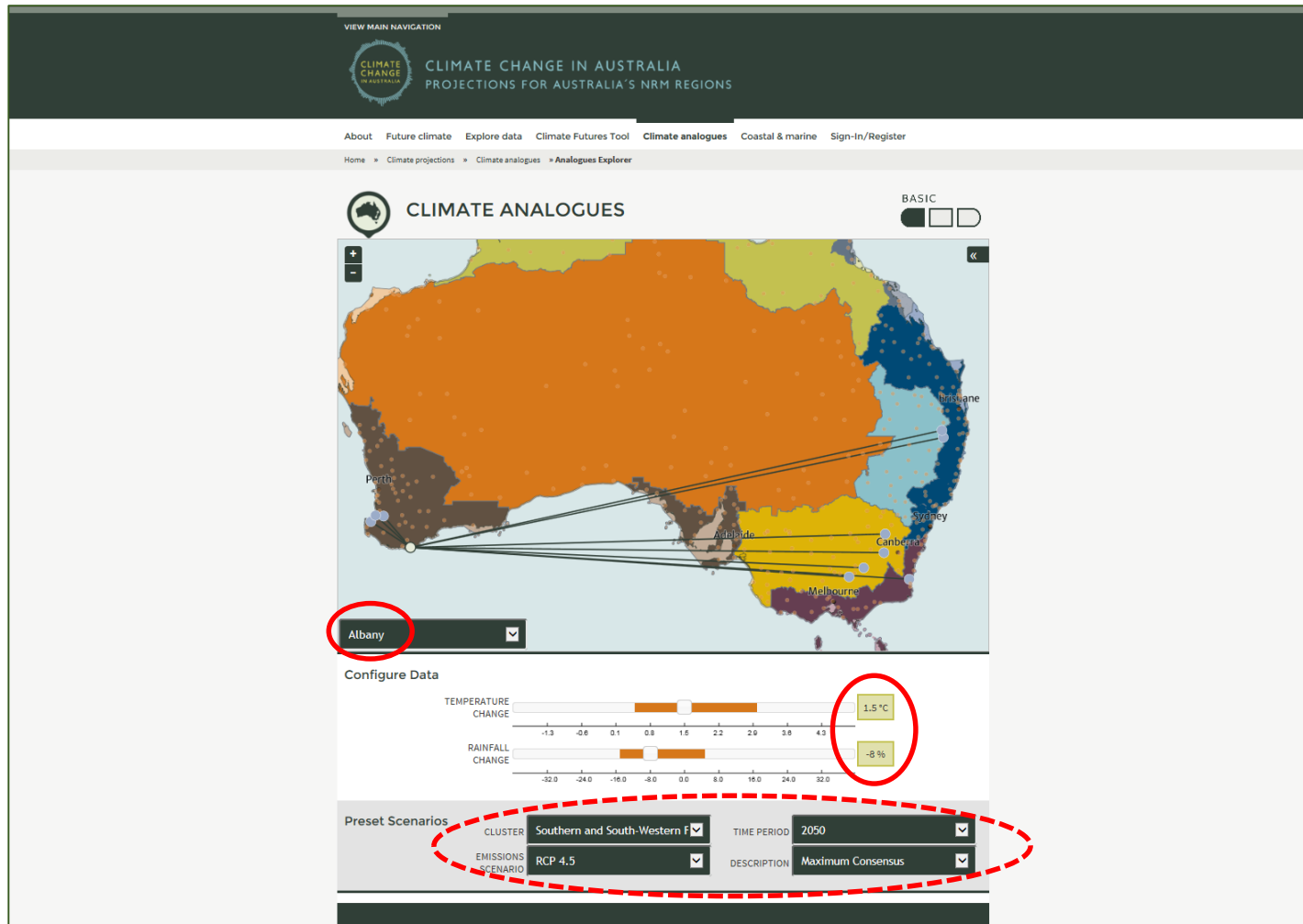




What future climates?



Climate analogues



Implications for restoration

Some predictions:

- Altered planting times
 - Seasonal shifts (e.g. crop planting times already shifting)
- Increased risk of planting failure
 - Increased soil temps may impact on germination and growth
 - Increased risk of severe events (e.g. rain, hail, fire)
- Less seed to work with
 - Higher temps, less water
 - Ethical considerations if less seed available – required by other animals for survival

Some seedy assumptions

- Seed is plentiful
 - Erratic, environmentally driven
 - Largely unavailable for key species/groups
 - Species substitution
 - Low species diversity (low resilience)
- Seed is of equal (high) quality
 - Environmentally driven, pollinator limitation
- Seed is genetically diverse
 - Inbreeding in fragmented landscapes
 - Production of future generations
 - Low diversity – coping with change



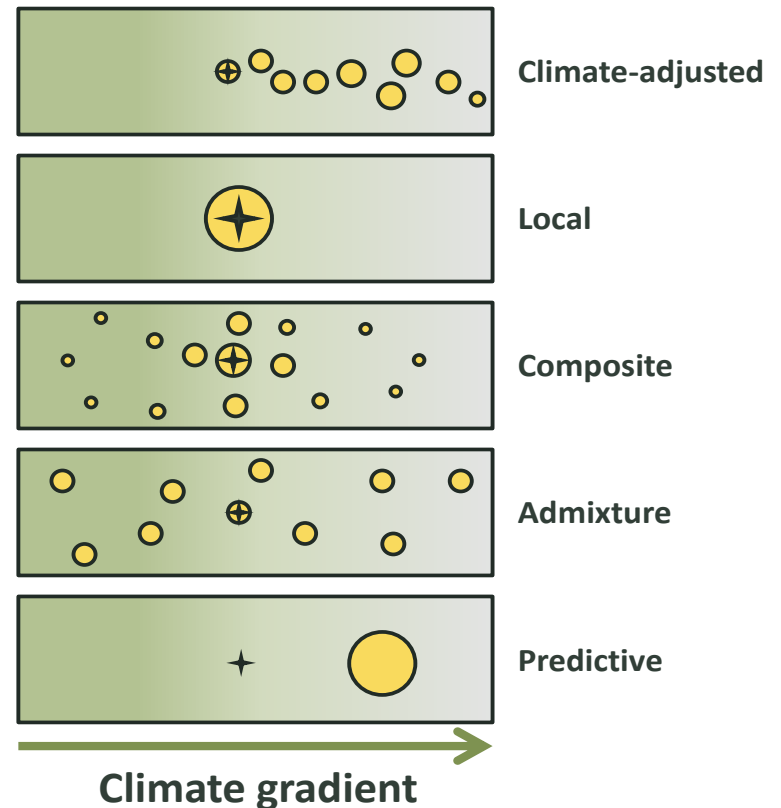
Provenance

- Not a new concept - early 19th Century (forest) scientists
 - Common garden experiments
 - Especially important forestry
- Often assumed that plant populations are highly locally adapted
- BUT NOT JUST CLIMATE – soils, altitude, disease, pathogens, herbivores etc. are part of the natural systems and influence local adaptation



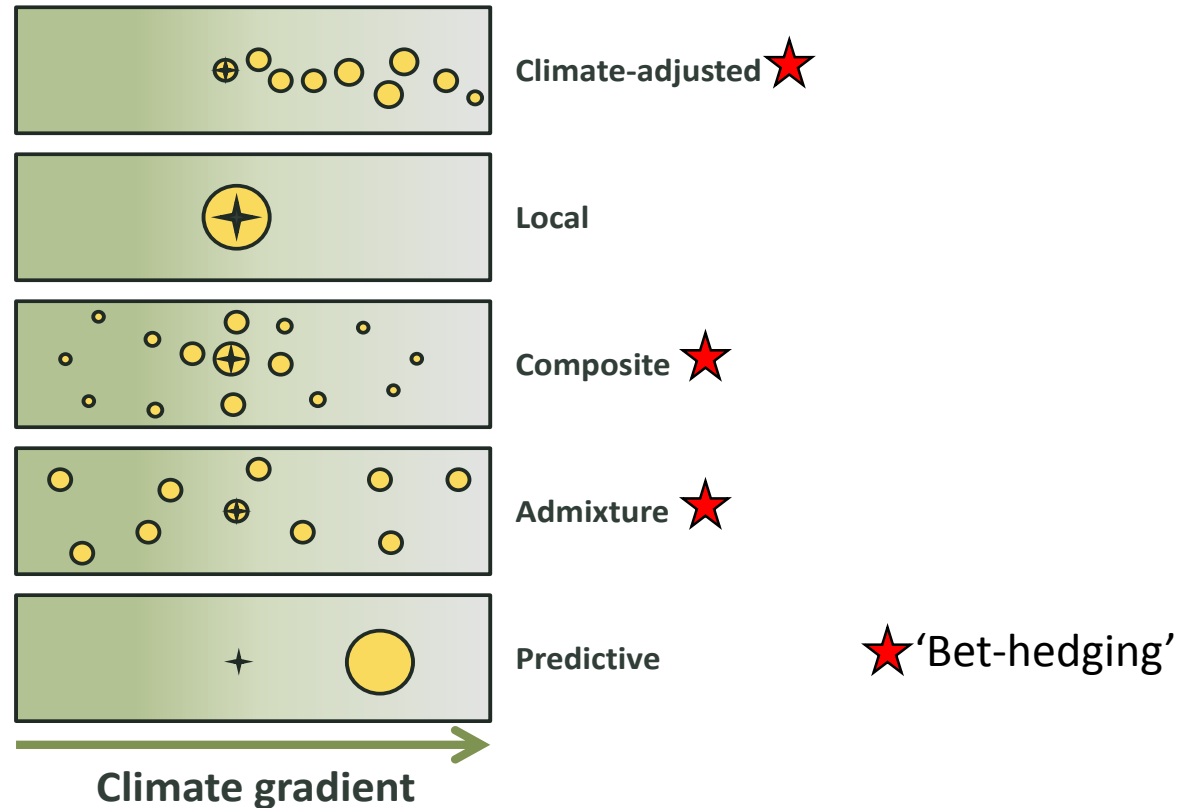
Provenancing black box

- Consider the different types of provenancing you may want to use
- One approach may not fit all the species – may need different approaches within a single planting mix



Provenancing black box

- Which one to chose?



Prober *et al.* 2015

Adaptation options

Start planting a range of species in an experimental design now and watch performance

- Consider partnering with researchers
- Maintain meticulous record keeping – seed sources, germination rates, etc. (partner with a researcher)
- Record keeping must have long term legacy to ensure that anyone can monitor plantings over next 20-30 years



Adaptations options

Seed stockpiling

- Infrastructure (suitable size and conditions)
- Record keeping – seed in and out, where planted, viability, collections conditions etc.
- Many seed banks set up under NHT closed or declining
 - Avoid past mistakes
 - Mechanism share regional restoration experiences about species



Adaptations options

- Seed production areas (SPAs, seed orchards)
 - Horticultural conditions (water, nutrients) to maximise seed production
 - Difficult to collect species (understorey, explosive seed dispersal)
 - Significant financial investment, long time for return some species
 - Running costs may increase as temps rise and water less available
 - High genetic quality



Climate-ready revegetation

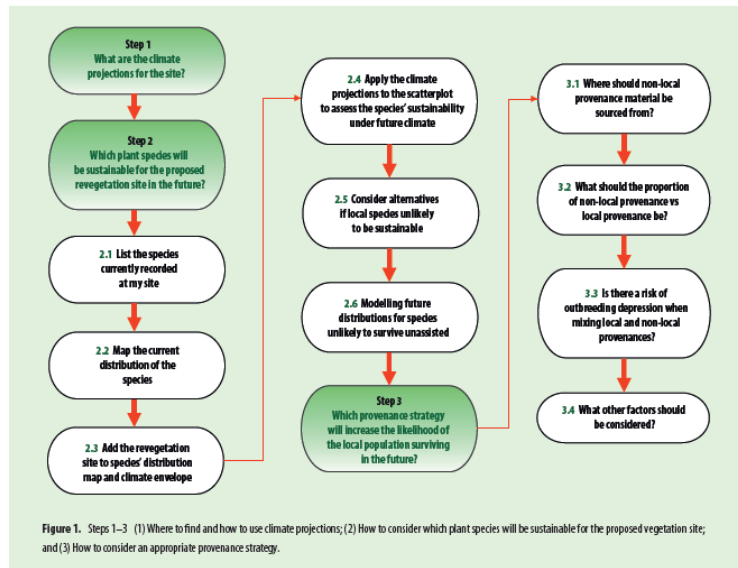
A guide for natural resource managers

Overview

This Guide represents a first attempt at compiling online tools available to assist natural resource managers incorporate the inherent uncertainties associated with climate change when planning revegetation activities. The information in the Guide is based on the premise that survival and resilience will be enhanced for species and local populations with large, genetically diverse populations. Species differ in their vulnerability to climate change. Species that cannot evolve and adapt to new environmental conditions *in-situ* as fast as the climate changes, or disperse to more suitable climates, will be more vulnerable than those with the evolutionary potential and/or the capacity to disperse. In theory, plants with wide distributions are more likely to cope with climate change than those with narrow distributions. However, even if a species' distribution indicates that it is able to tolerate a broad range of climate conditions, survival of local populations are not guaranteed.

Small populations may require genetic rescue (incorporating non-local genetic material) to boost their capacity to adapt to a rapidly changing environment.

The Guide provides step-by-step instructions on where to find and how to use climate projections and how to consider the suitability of species and provenance selection (e.g. soil characteristics, topography and aspect) are covered in other publications and are not addressed in this Guide (e.g. the Standards for the Practice of Ecological Restoration in Australia (SERA) <http://www.seraustralia.com/pages/standards.html>, or look for regional examples such as www.biodiversitygateway.com.au/SWSR_Guide/home.html).



Australian Network for Plant Conservation Inc

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THE NATIONAL NETWORK THAT LINKS PEOPLE, RESEARCH AND ACTION IN PLANT CONSERVATION

APCC11

11th Australasian Plant Conservation Conference 2016

14 - 18 November 2016 | Royal Botanic Gardens Victoria, Melbourne

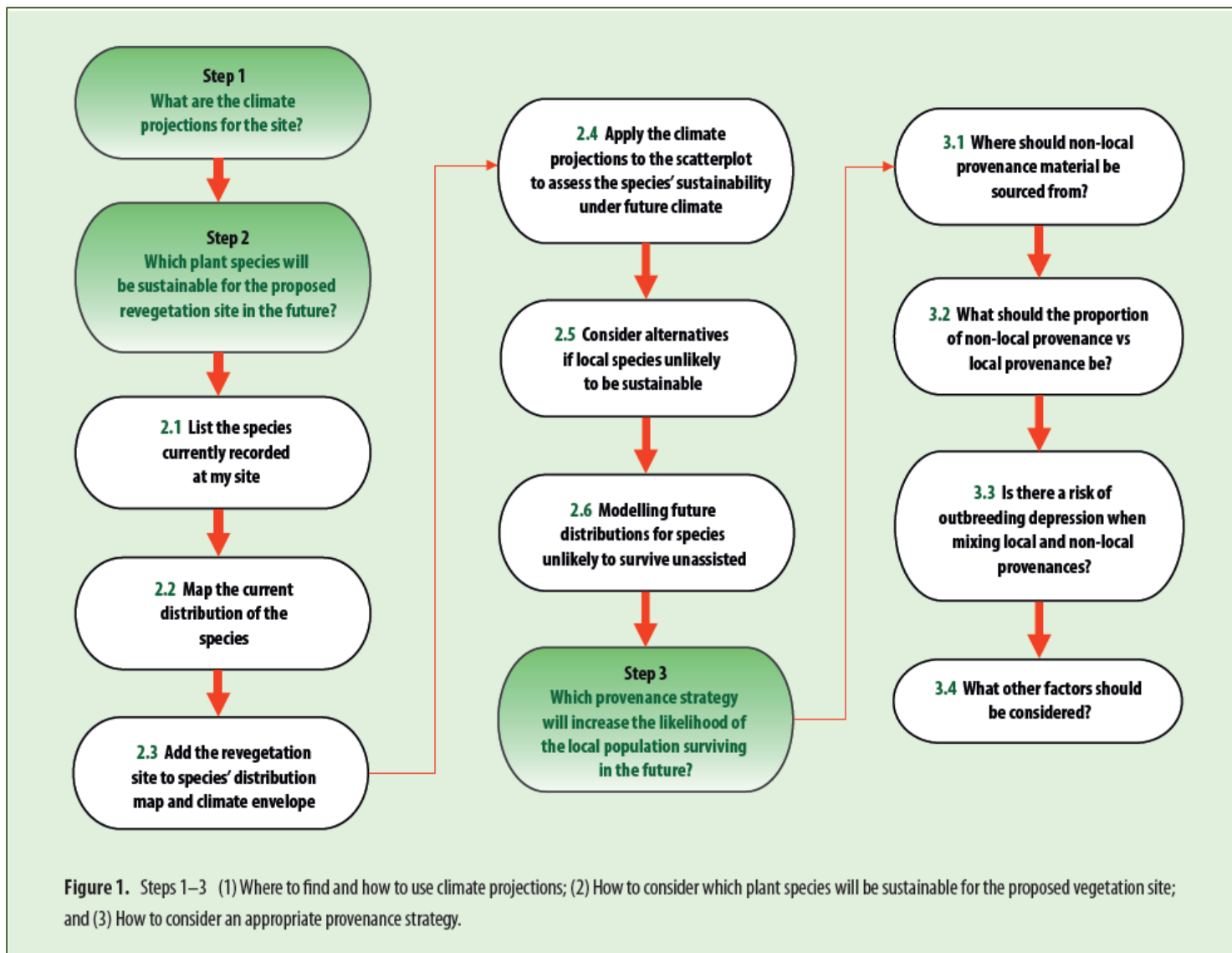
www.anpc.asn.au/conferences/2016

APCC11 EARLY BIRD REGISTRATIONS CLOSE FRIDAY 26 AUGUST 2016

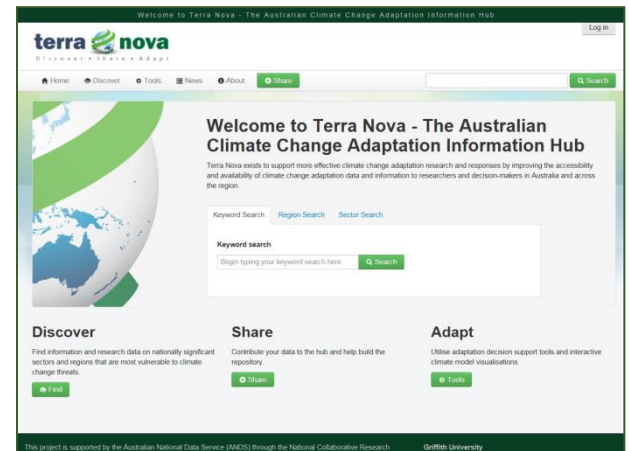
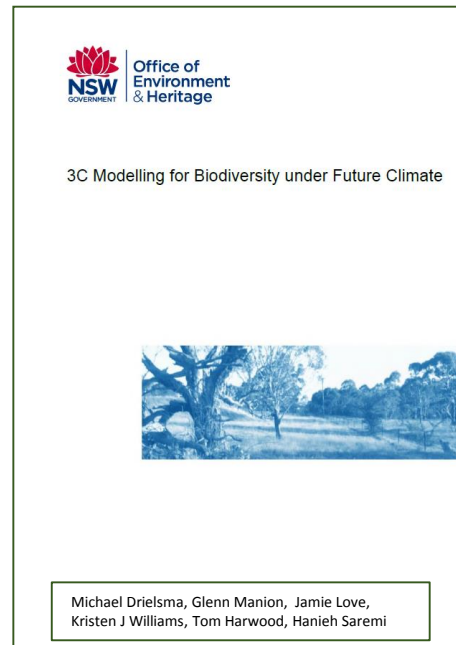
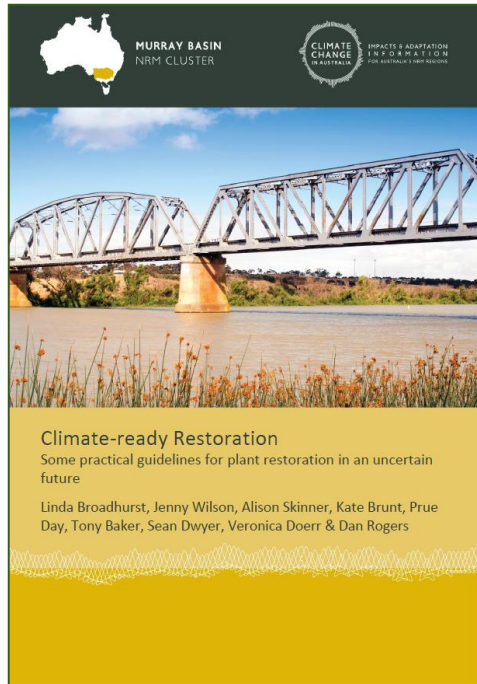
[Click here for more information.](#)

Hancock, Harris, Broadhurst & Hughes

Almost in print and downloadable from the ANPC website



Useful reports and information



<https://www.terranova.org.au/>

Thank you

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