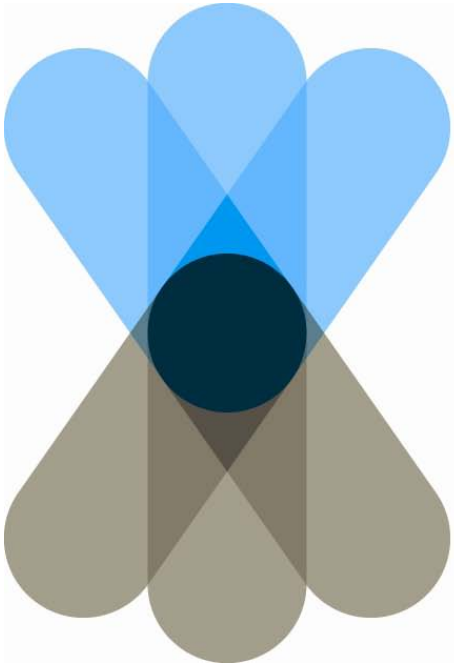

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Climate Change Adaptation
Research Facility

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Australian Government
Department of Climate Change

Queensland Government

CSIRO

Griffith UNIVERSITY

Charles Darwin UNIVERSITY
Australia

THE UNIVERSITY OF MELBOURNE

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MACQUARIE UNIVERSITY
SYDNEY ~ AUSTRALIA

JAMES COOK UNIVERSITY
AUSTRALIA

UTAS

THE UNIVERSITY OF ADELAIDE
AUSTRALIA

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Professor / Director
Centre for Tropical Biodiversity & Climate Change
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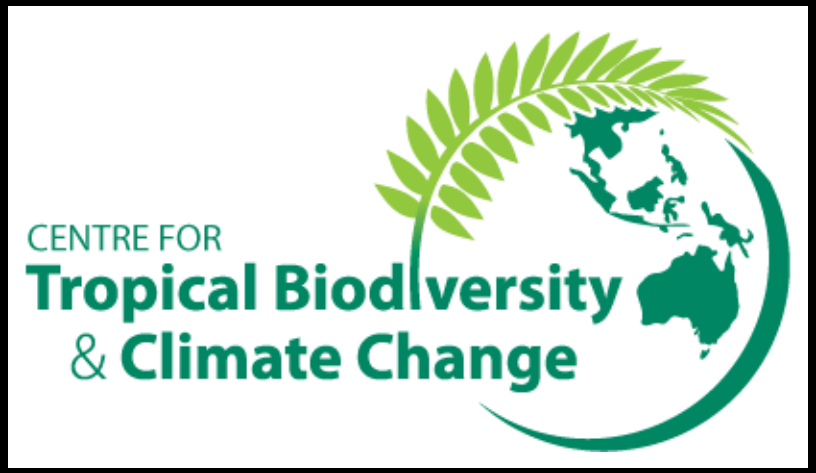
James Cook University
Townsville, Australia



How do we adapt to global climate change in order to help protect our terrestrial biodiversity?

Today's agenda

- **9:05 – 9.30 am** National Overview: Prof Stephen Williams
- **9.30 - 9.40 am** TB network – what you can get out of it? Dr Yvette Williams
- **9.40 - 10.00 am** What are the key issues for Northern Territory Prof Stephen Garnett
- **10.00 – 10.30 am** Discussion
- **10:30 - 11:00 am** **MORNING TEA**
- **11:00 - 11:15 am** **The science of biodiversity adaptation**
  - Climate change, biodiversity and adaptation: Dr Dick Williams
  - Scenario modelling and biodiversity: Dr Adam Liedloff
- **11:15 - 11:30 am** Discussion
- **11:30 - 1: 00 pm** **How are managers and policy-makers dealing with climate change adaptation for biodiversity and what are the greatest challenges?**
  - NT Government: Dr Alaric Fisher (NRETAS)
  - Local Government Association of the NT: Ms Shenagh Gamble
  - Environment Centre NT: Dr Melanie Bradley
  - Policy and Climate Change Unit, Department of the Chief Minister: Mr Leigh Eldridge
- **1:00 - 2:00 pm** **LUNCH**
- **2:00 - 2:30 pm** **Identify key themes for adaptation challenges.**
- *Group Discussion*
- **2:30 - 3:30 pm** **Working groups draw up adaptation research priorities**
- **3:30 - 4.00 pm** **Report back and close**
- **4.00 - 4:30 pm** Close with afternoon tea and informal discussion.





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Why have a Roadshow?

Why are we here?

- Roadshow across Australia in each state/node
- Scope of workshop:
  - What is adaptation?
  - Sector / State / Regional / Ecosystem priorities
  - Increase stakeholder involvement in network

- How can involvement benefit everyone concerned?

- Outcomes:
  - Raising awareness and participation in NCCARF & the Terrestrial Biodiversity network
  - Increased networking/collaboration between research & stakeholder groups
  - Summary of each node workshop – network website / DCCEE
  - Report collating results across all nodes





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How do YOU think the national priorities fit your ecosystem / region / sector?

- Are there any serious omissions?
- What are the priorities / challenges in your area of interest ?
- What research is needed to have the knowledge to make the best possible choices about adaptation?
- What are the main impediments?





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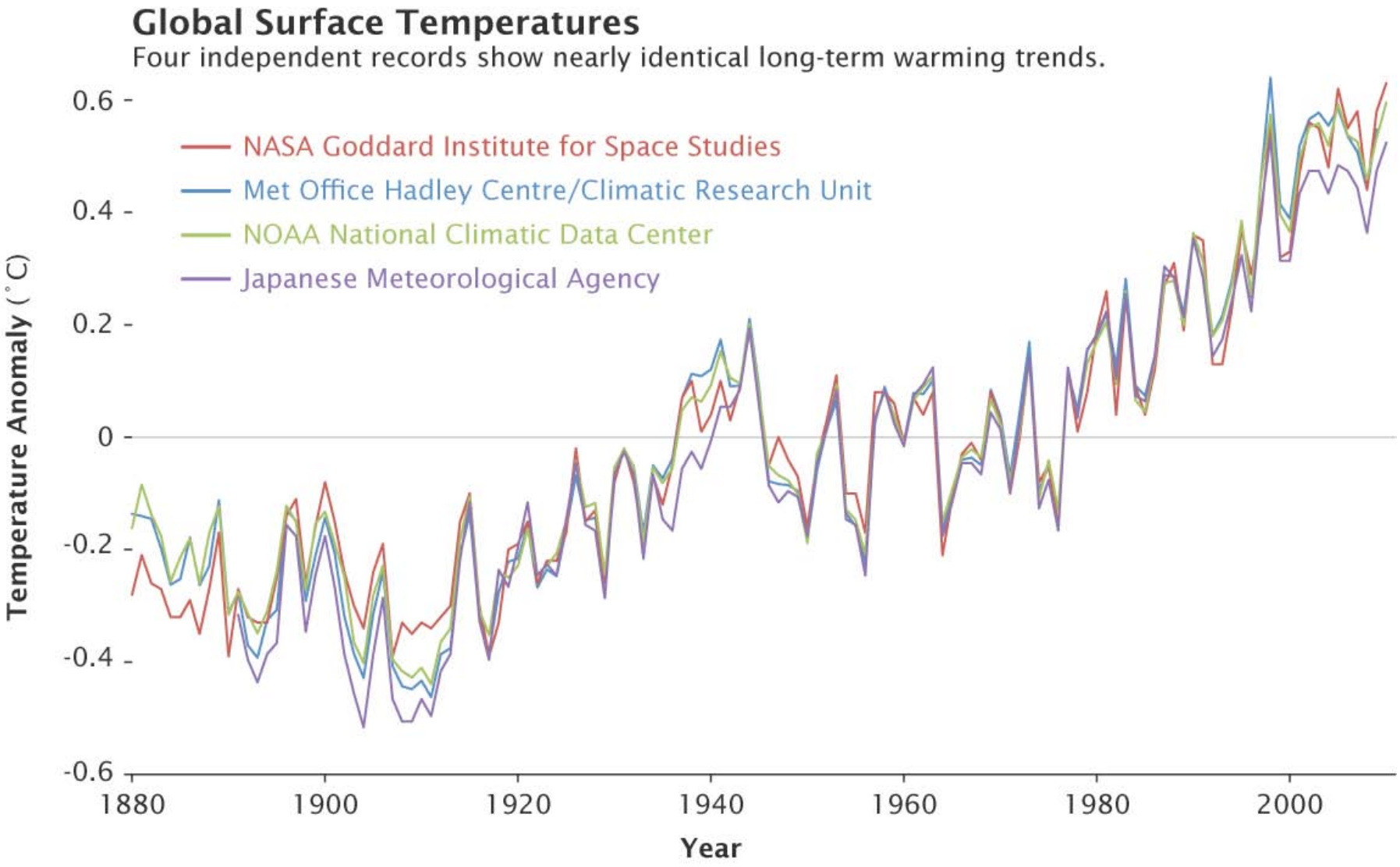
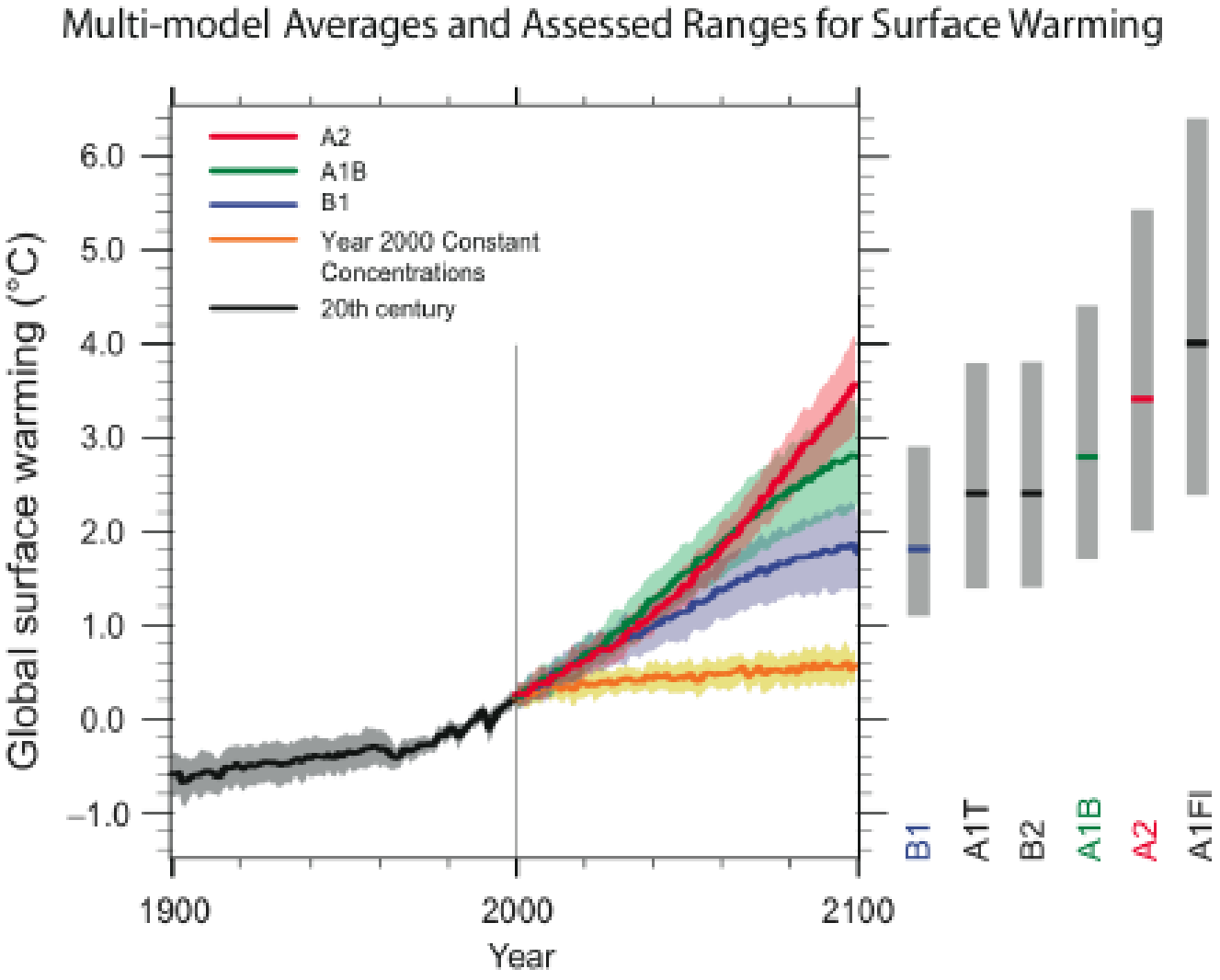
The climate is changing……



Credit: NASA Earth Observatory/Robert Simmon

Data Sources: NASA Goddard Institute for Space Studies, NOAA National Climatic Data Center, Met Office Hadley Centre/Climatic Research Unit, and the Japanese Meteorological Agency.

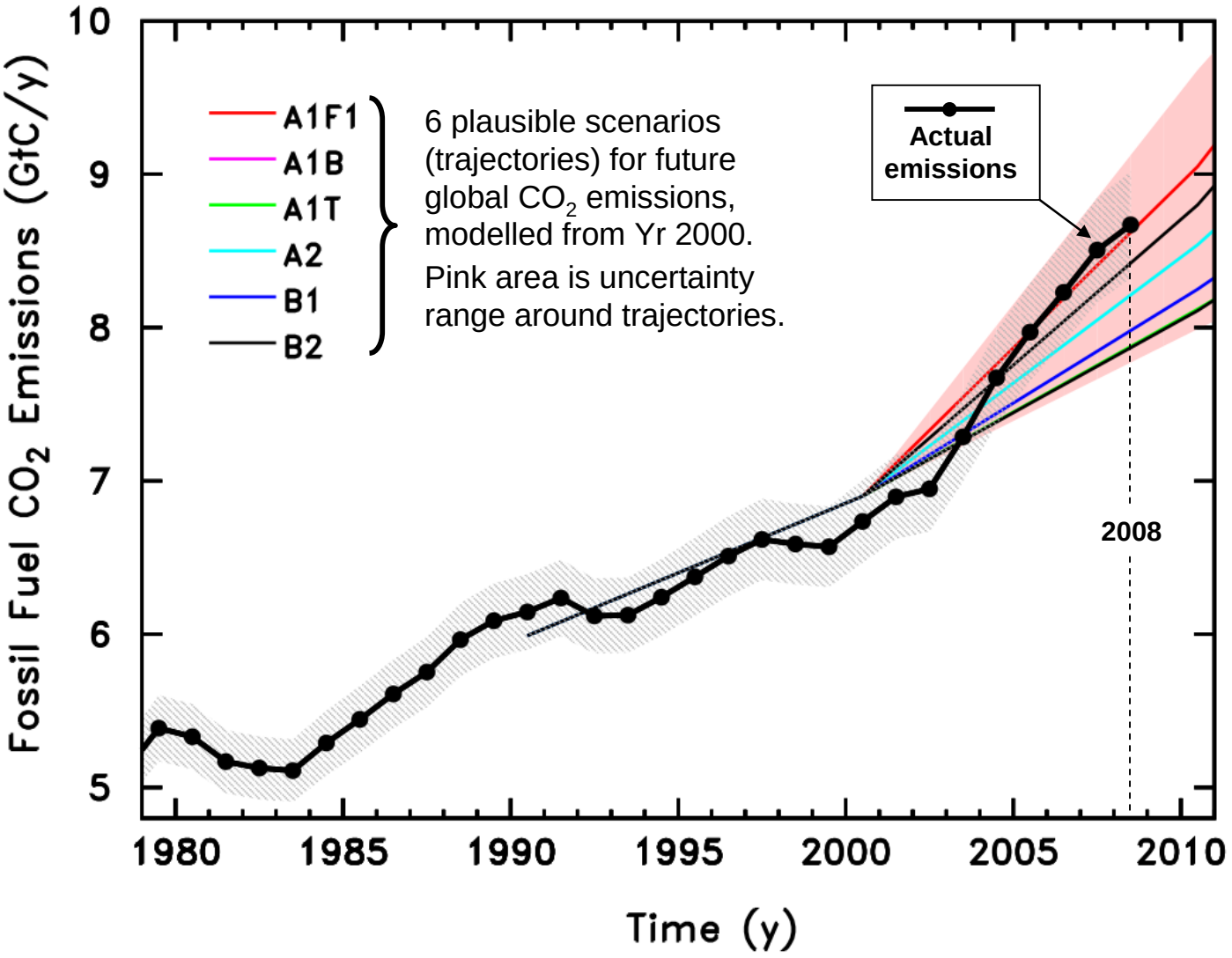
Global Temperature Projections



- 0.2°C per decade to end of 21st century
- 1.8-4.0°C warming (range 1.1-6.4°C)

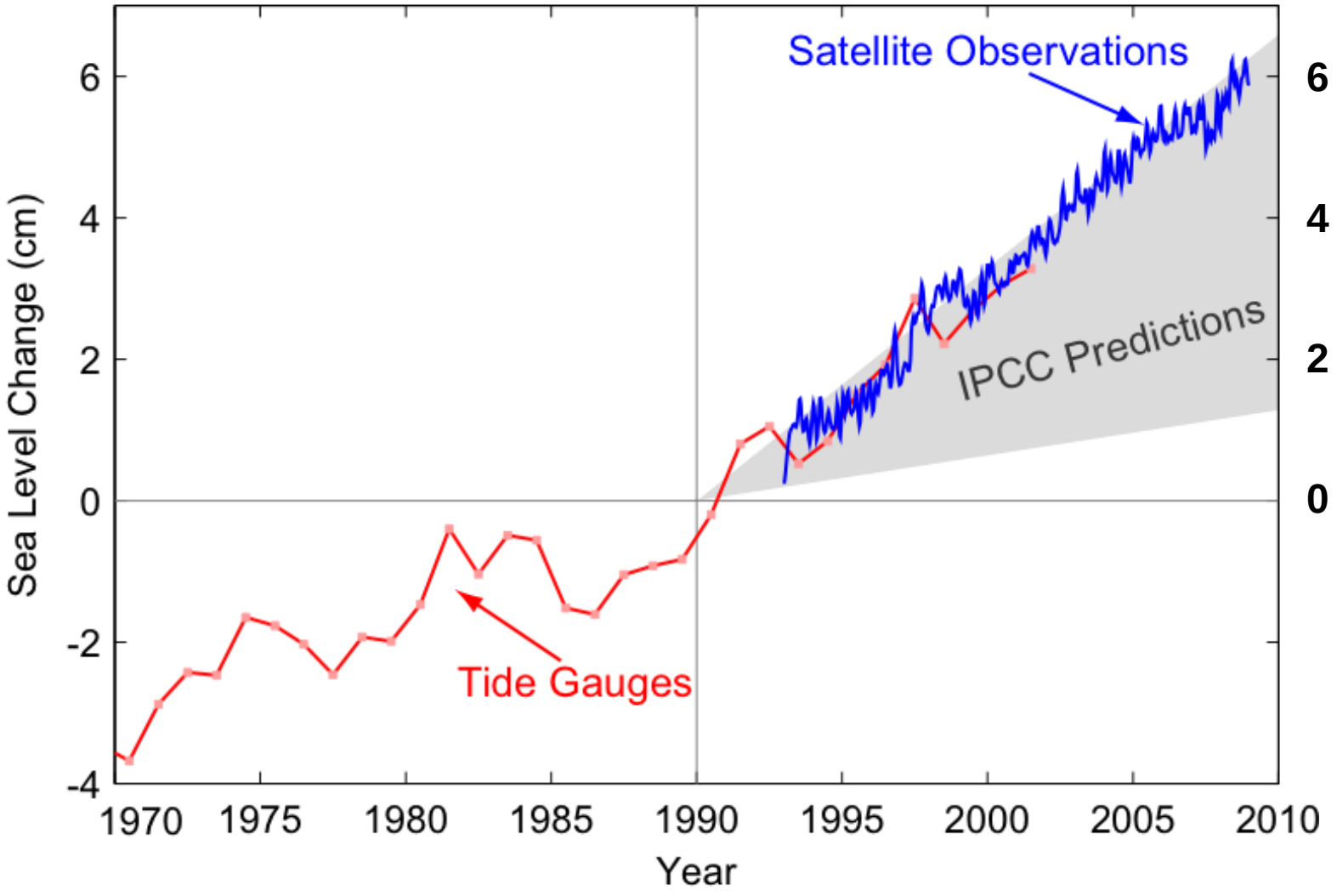
(IPCC 2007)

Actual emissions travelling at uppermost IPCC projection



www.copenhagendiagnosis.com

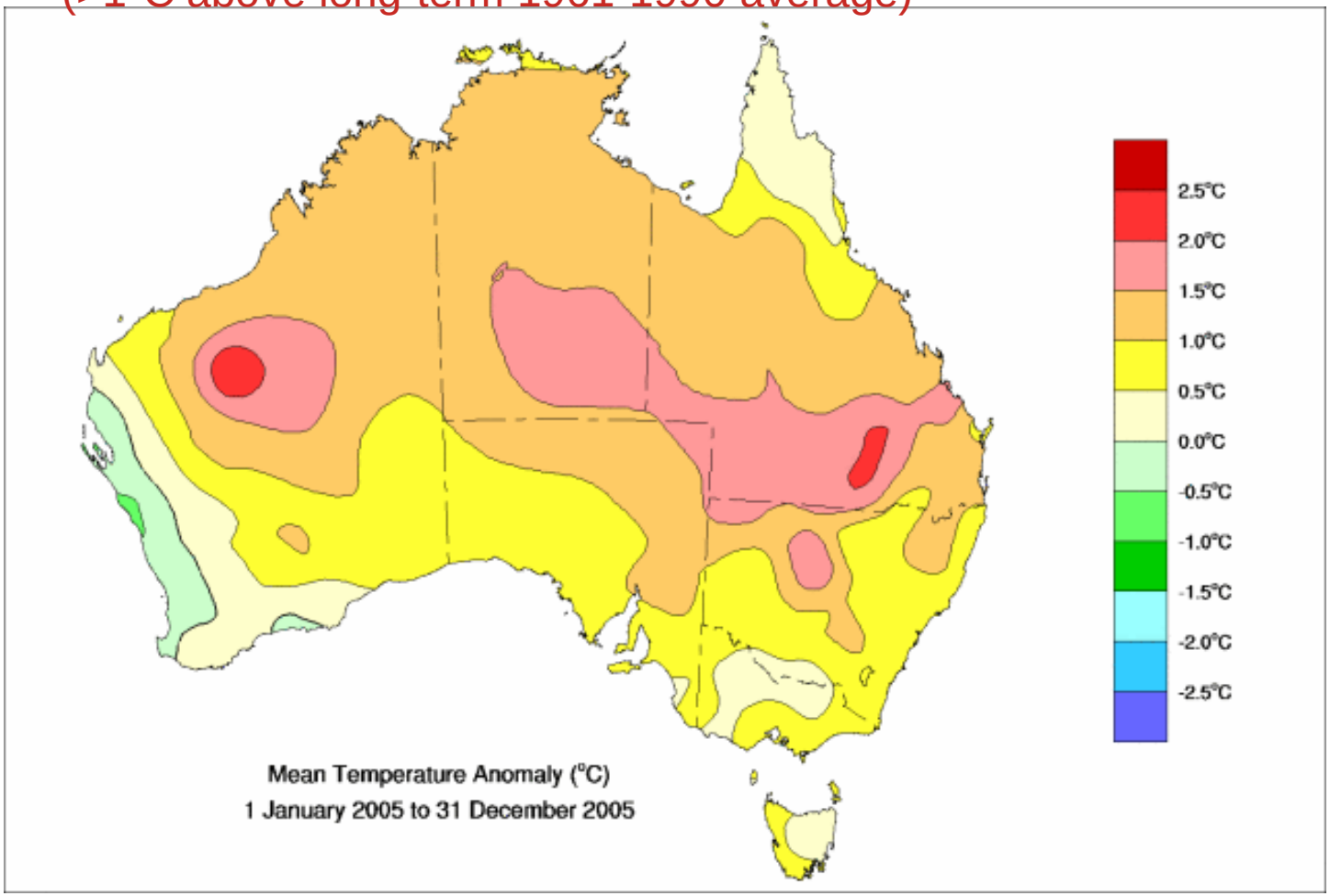
Global sea level



www.copenhagendiagnosis.com

2005: Warmest year on record

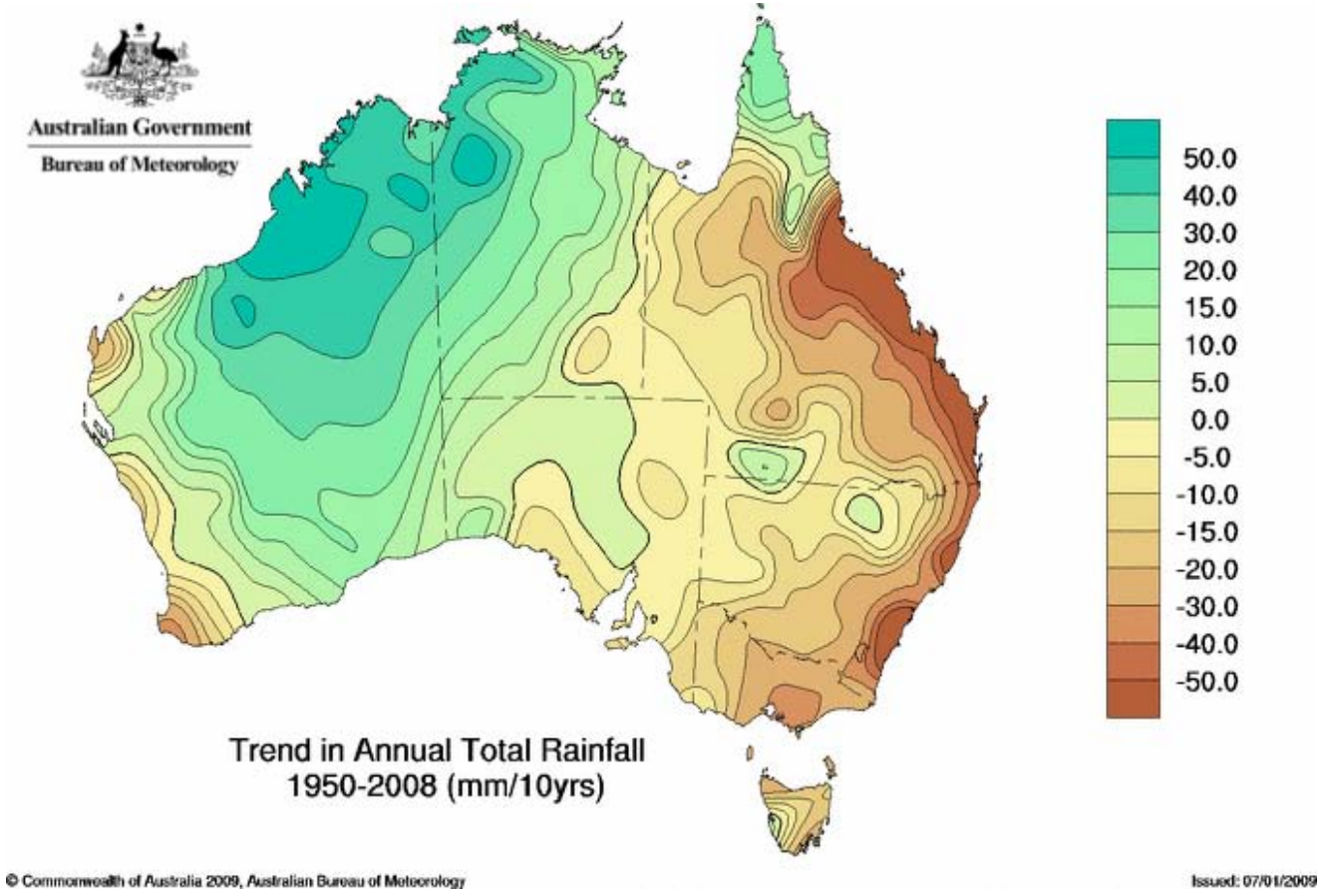
(>1°C above long-term 1961-1990 average)



2009: 2nd warmest year (0.09°C above average)

2010" equal warmest year globally

Rainfall



- General drying trend in east
- Rainfall decreased 14.3 mm/ decade since 1950 in NSW
- Heavy rainfall events increased, particularly since 1960s

In Summary:

- Higher average temperatures
- More frequent and more intense heat waves
- Changing rainfall patterns
- Increased frequency and intensity of droughts
- Increasing fire weather & incidence of extreme fire danger days
- Higher cloud base





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What will be the impacts on our natural environment?

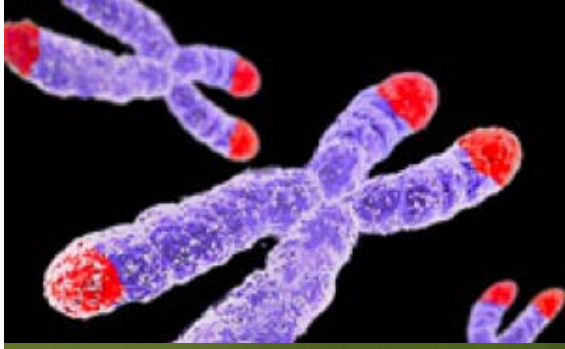
The scale of the problem for biodiversity

- Time for a species to evolve ~ 1 million years
- ~ 20-30% of species likely to be at increasingly high risk of extinction at 2-3^{o}C above pre-industrial levels (Thomas *et al.* 2004)
- Global warming already implicated in species declines across marine, terrestrial and freshwater ecosystems & at least one extinction
- **Climate change will be one of the major drivers of species extinctions in the 21st century.**

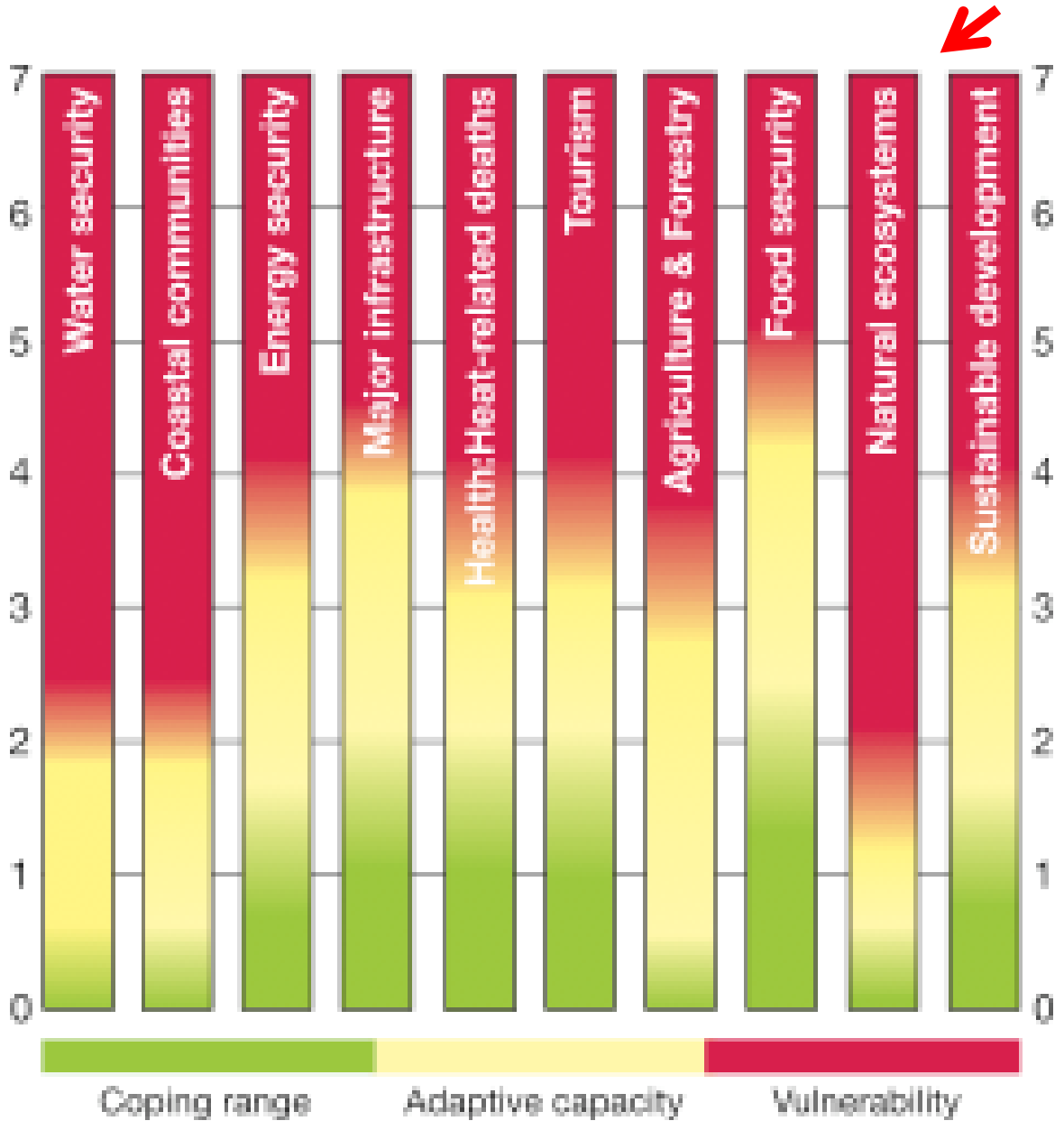
Impacts of climate change on species & communities already evident

Examples include:

- Geographic range shifts (mainly south, some upwards)
- Life cycles (eg. advances in flowering, bird migration)
- Genetic change (heat shock proteins)
- Body size (latitudinal clines shifting)
- Proportions of warm-adapted species in communities increasing at expense of cool-adapted
- Increased frequency of coral bleaching
- Declining rates of calcification in corals
- Emergence of new diseases




Vulnerability of biodiversity cf other sectors



IPCC 2007

What can we do about minimising the impacts of global climate change on biodiversity?

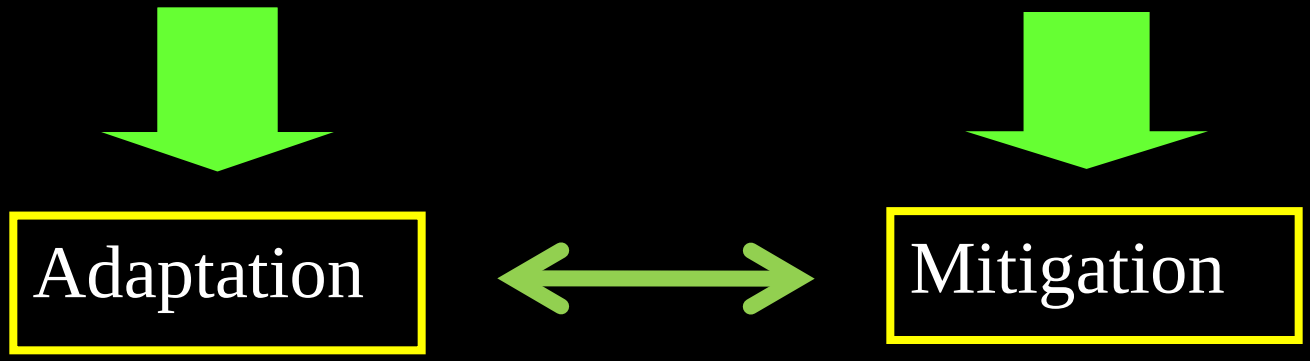
"I skate to where the puck is going to be, not where it has been."

– Hockey great, Wayne Gretzky.

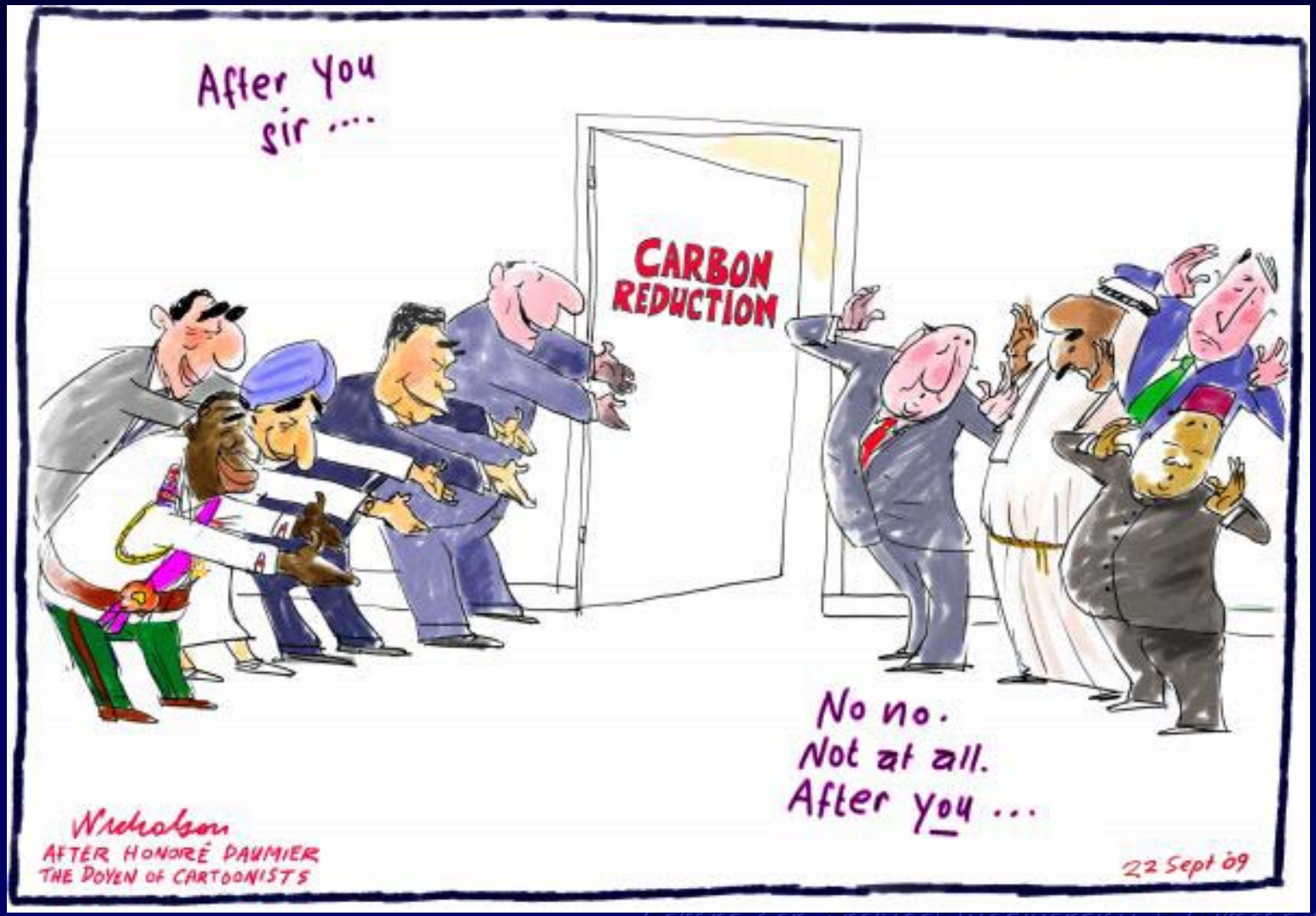
So where is the "puck" going to be?

…and what the "puck" can we do about it?

Conservation planning for climate change



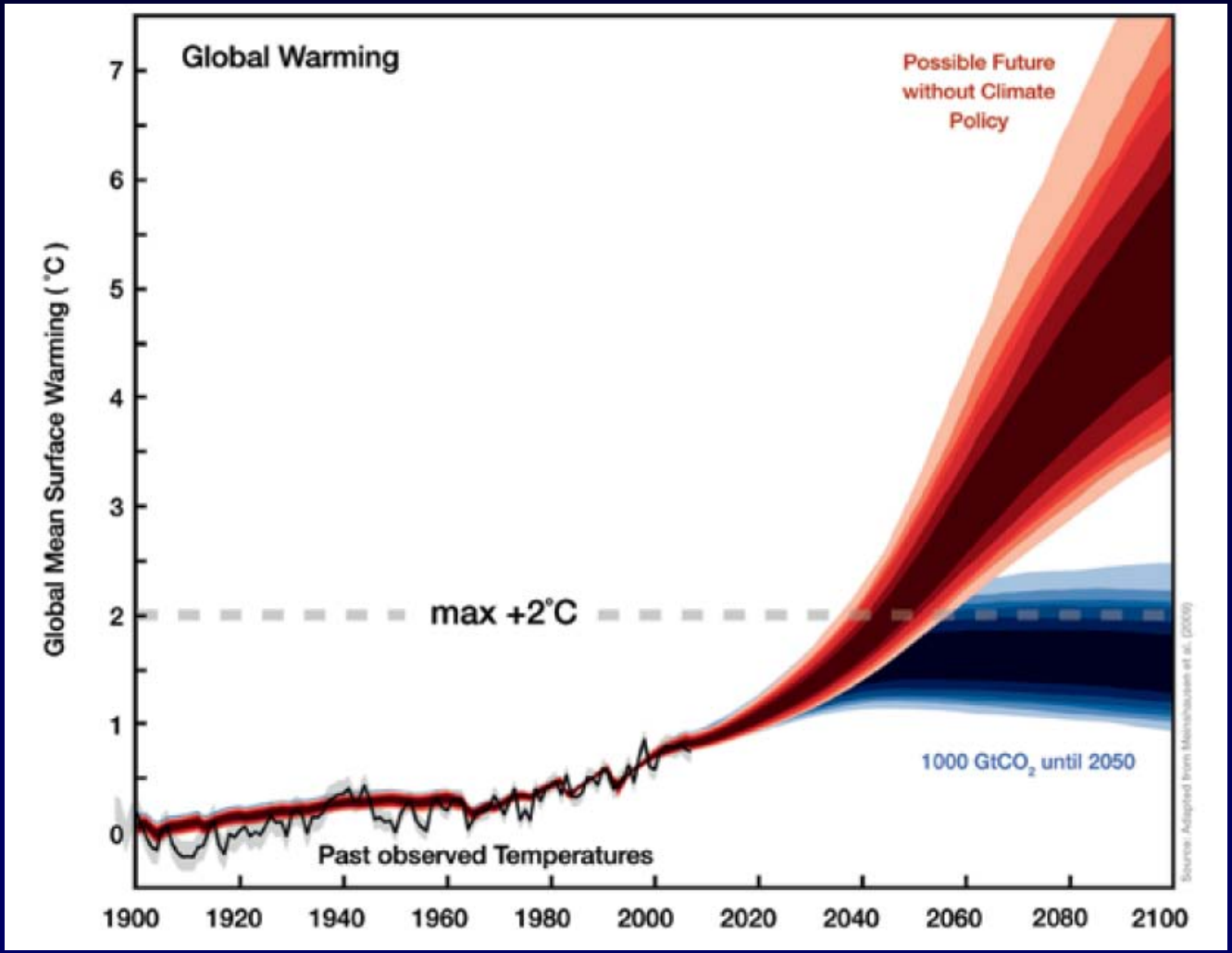
MITIGATION:
But no-one wants to go first…….



Adaptation

Can we adapt enough to prevent major impacts on biodiversity?

Mitigation & Adaptation



No mitigation – Adaptation not possible

Some mitigation – Adaptation very important

Strong mitigation – Adaptation not needed

Can biodiversity adapt autonomously?

1. Geographic change:
   - Possible for highly mobile taxa, but rate of change too rapid for most
   - Flat topography, fragmentation of landscape & lack of habitat presents substantial challenges

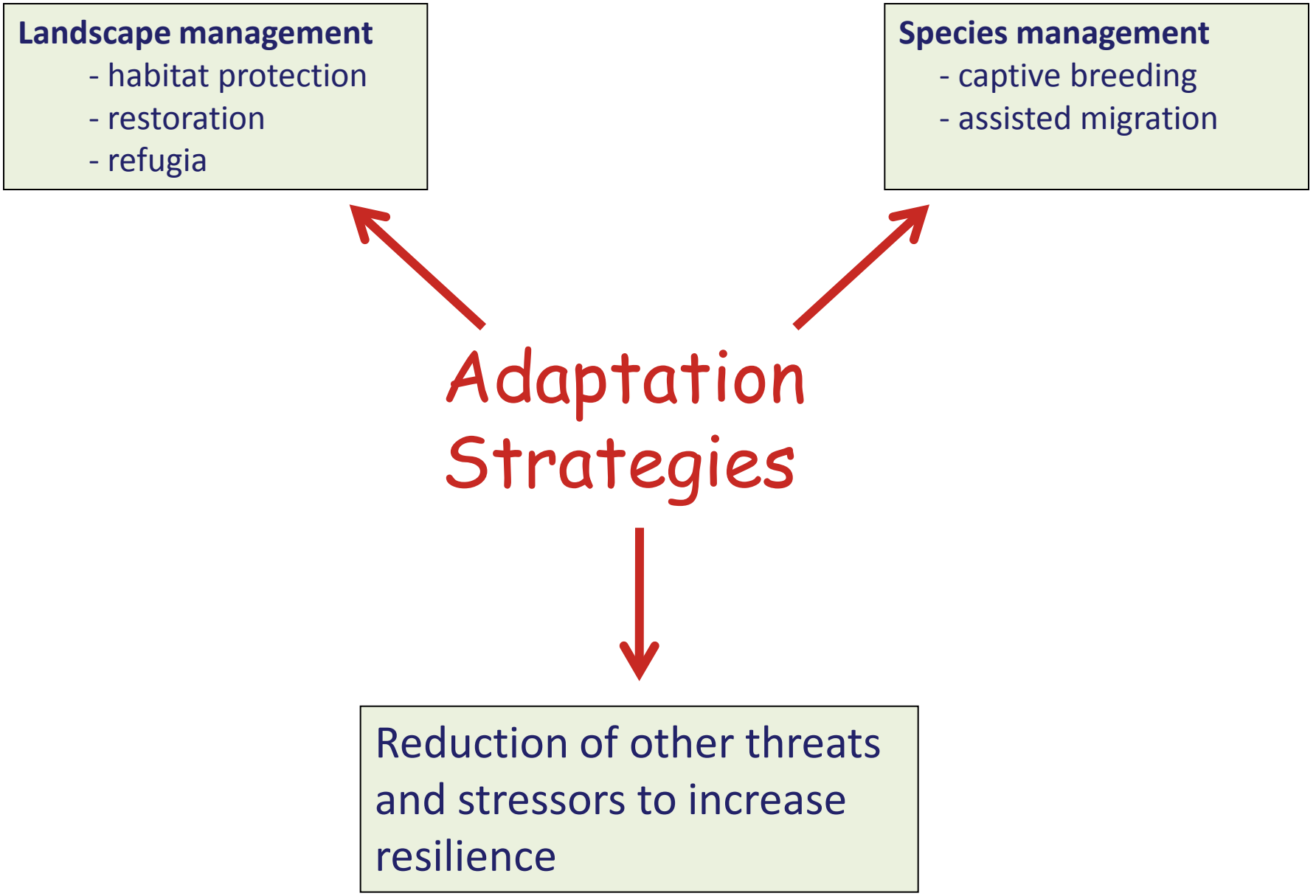
2. Phenotypic (including behavioural) plasticity:
   - Likely to be most common response
   - Changes in timing of life cycles likely to lead to significant changes in species interactions

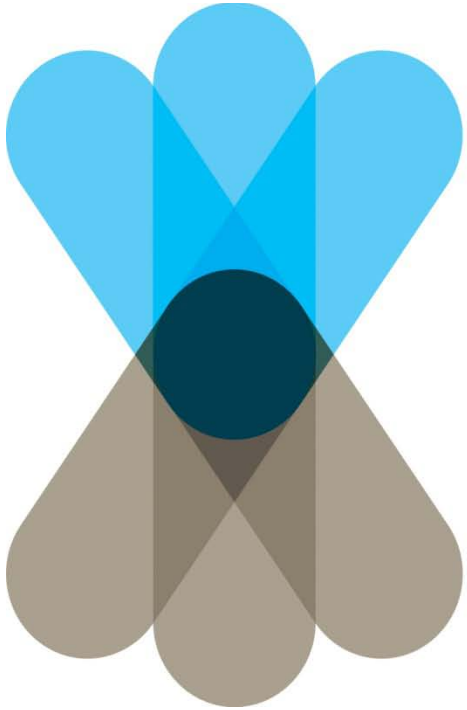
3. Genetic change:
   - Few species studied but limited evidence so far

→ Need for human-mediated adaptation

- Implementation of strategies that enhance the ability of species, communities or ecosystems to cope with climatic changes

Aim: to maximise adaptive ability and increase resilience


Landscape management
- habitat protection
- restoration
- refugia
Species management
- captive breeding
- assisted migration
Adaptation Strategies
Reduction of other threats and stressors to increase resilience



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AUSTRALIA

UTAS

THE UNIVERSITY OF ADELAIDE
AUSTRALIA

Curtin
University of Technology

National Climate Change Adaptation Facility

- An initiative of the Australian Government, based at Griffith University's Gold Coast Campus.

- ~$117 million (from 2008 to 2012) in climate change adaptation policies, programs and research through the Department of Climate Change
  - ~$10m NCCARF
  - ~$10m networks
  - ~$30m NARP research funding

The key roles of NCCARF include:

- developing National Adaptation Research Plans (NARP's) to identify critical gaps in information available to decision-makers
- synthesising existing and emerging national and international research on climate change impacts and adaptation, and developing targeted communication products
- undertaking a program of integrative research to address national priorities, and
- establishing and maintaining Adaptation Research Networks (ARN's) to link key researchers and assist them in focussing on national research priorities.





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National Climate Change Adaptation Facility

Eight Adaptation Research Networks:

- **Terrestrial biodiversity**
- Water resources and freshwater biodiversity
- Marine biodiversity and resources
- Primary industries
- Human health
- Emergency management
- Settlements and infrastructure
- Social, economic and institutional dimensions.





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Network Role – NCCARF Network Strategic Plan

Four key roles:

1. To promote and facilitate open exchange of information and sharing of resources.
2. To contribute to the work of NCCARF in synthesising existing and emerging research.
3. To contribute to the development and implementation of National Adaptation Research Plans.
4. To nurture the careers of young investigators and research students by promoting a sense of community, collaboration and strong, effective mentoring.





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Adaptation Research Network -Terrestrial Biodiversity

Convenors:

Prof Steve Williams (JCU, nth QLD)

Prof Lesley Hughes (Macquarie, NSW)

- Co-ordinator: Dr Yvette Williams (JCU)

Steering committee (geographic, expertise, ecosystems):

Prof Andrew Lowe, Prof Barry Brook (SA)

Dr Dick Williams, Prof Stephen Garnett (NT)

Prof Ary Hoffmann, Dr Lynda Chambers (VIC)

Prof Roger Kitching, Prof Hugh Possingham, Prof Bob Pressey, A/Prof Jean-Marc Hero (QLD)

Dr Trevor Booth, Dr Mark Stafford Smith (ACT; CSIRO CAF)

Prof David Bowman, Dr Kerry Bridle (TAS)

Prof Richard Hobbs, Dr Grant Wardell-Johnson, Dr Nicola Mitchell (WA)





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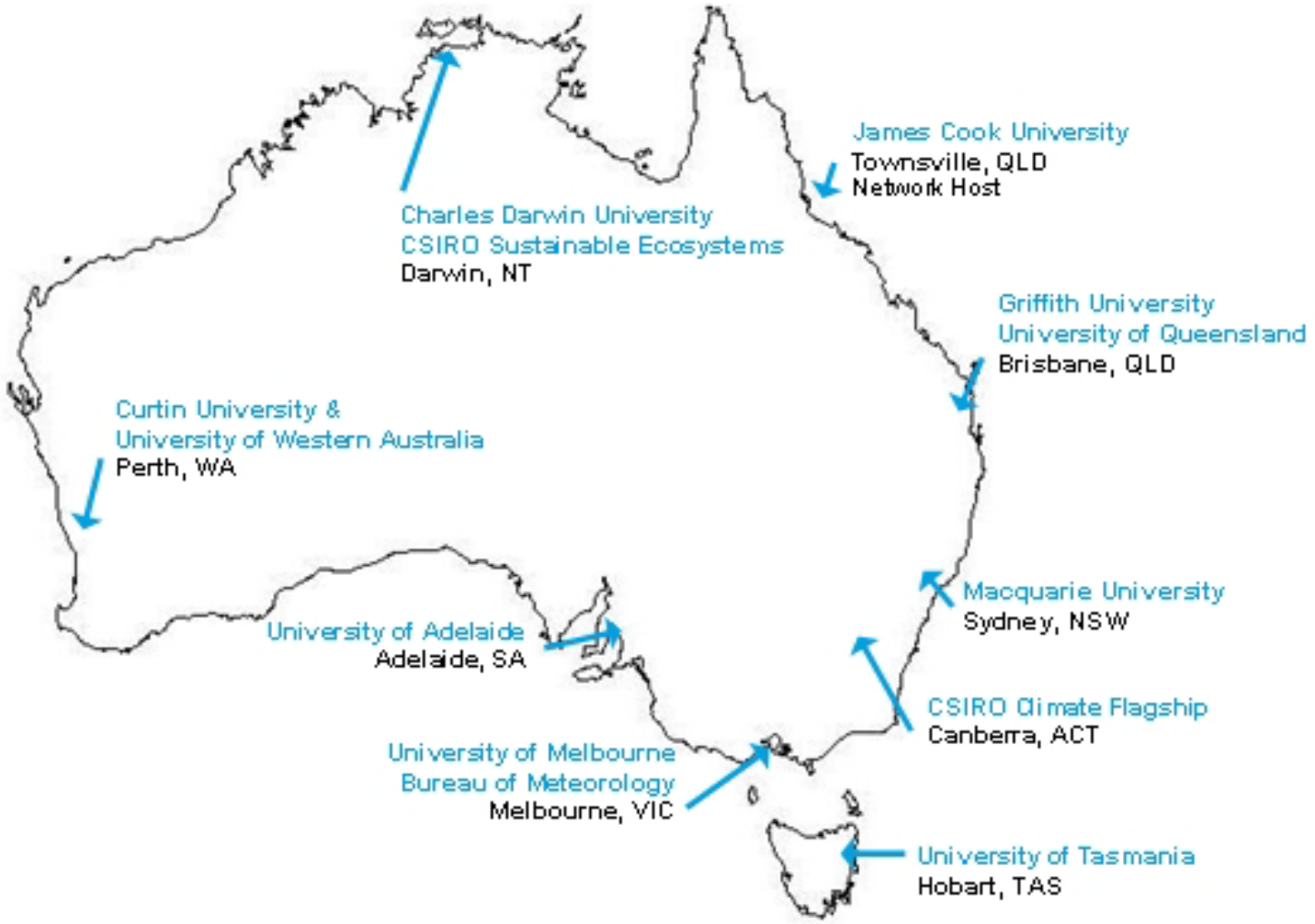
Regional Nodes







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Network Structure

National Climate Change Adaptation Research Facility NCCARF

Steering Committee

External Network Links

Other NCCARF Networks
Australian Research Council Networks
Commonwealth Environmental Research Facility
Government Agencies
State Agencies
NGO's
Research Centres

Network Participants

Over 1000 participants from 200+ institutions providing expertise across all state and major ecosystems, and in all aspects of global change biology and terrestrial biodiversity

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Our Primary Goals (no bull#&% version)

- Link expertise nationally
- Get people together
- Share information
- Foster collaboration
- Reduce duplication
- Facilitate exchange
- Encourage training and development
- Make a difference





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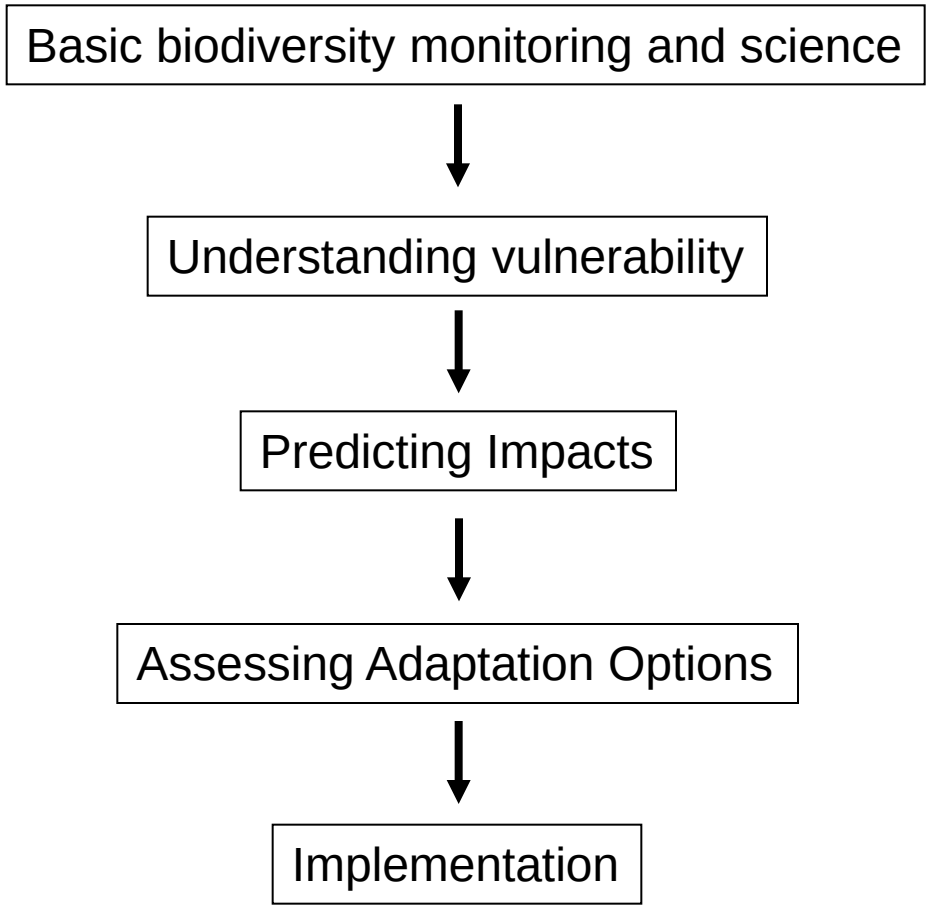
Example:

Adaptation and protecting the biodiversity of Australian tropical rainforests







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The rainforests of the Australian Wet Tropics

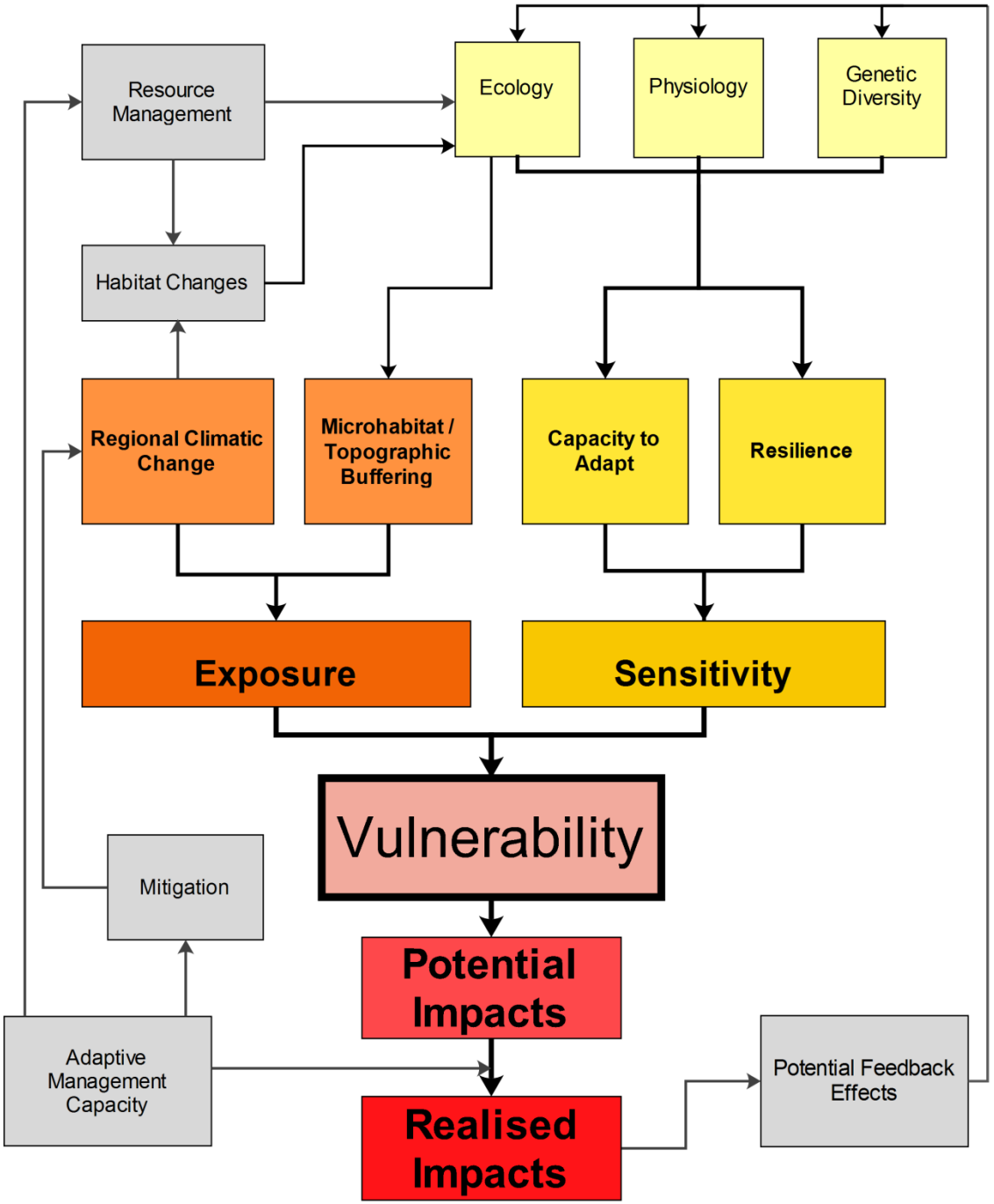
Informed adaptation

We need to carefully assess the vulnerability of species, habitats, processes and ecosystems so we can prioritise our responses…

- **What ?**
- **Where ?**
- **When ?**
- **Why ?**
- **Is there anything we can do?**

CHALLENGE:

Assessing vulnerability and predicting impacts is VERY complex.



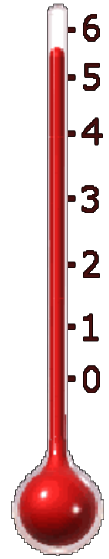
Williams & Shoo et al. 2008 *PLoS Biol*

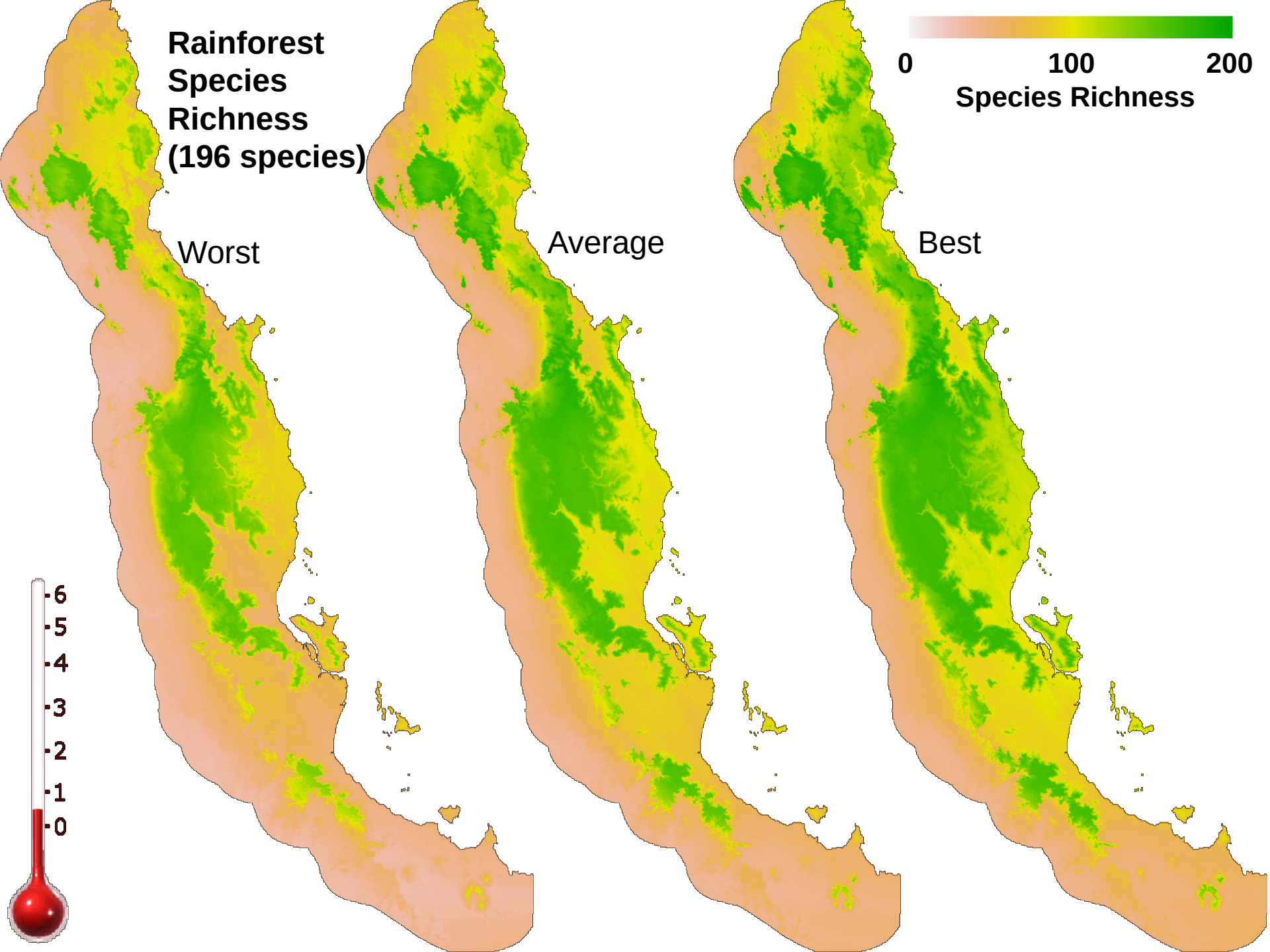
Golden Bowerbird

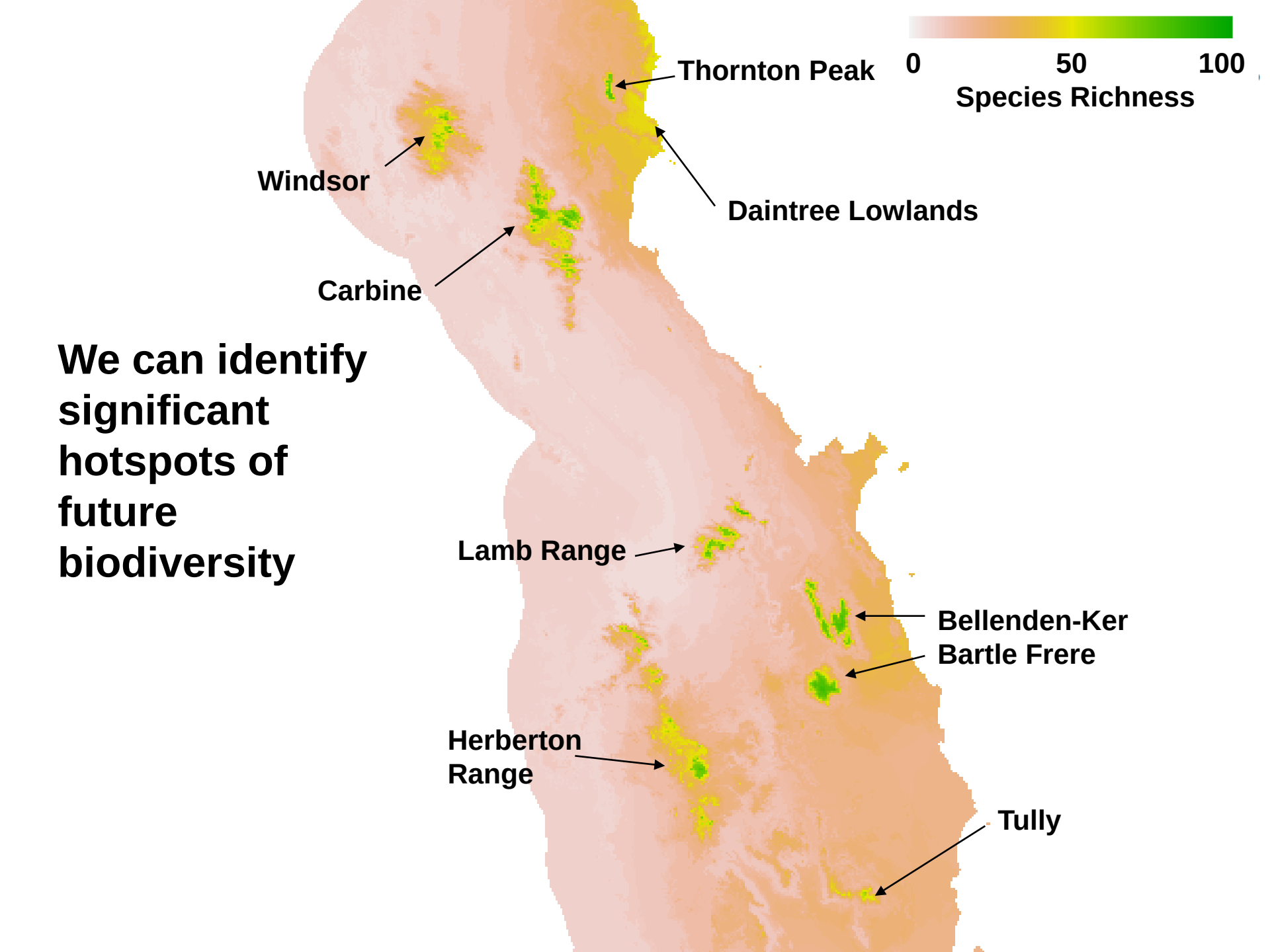
Worst

Average

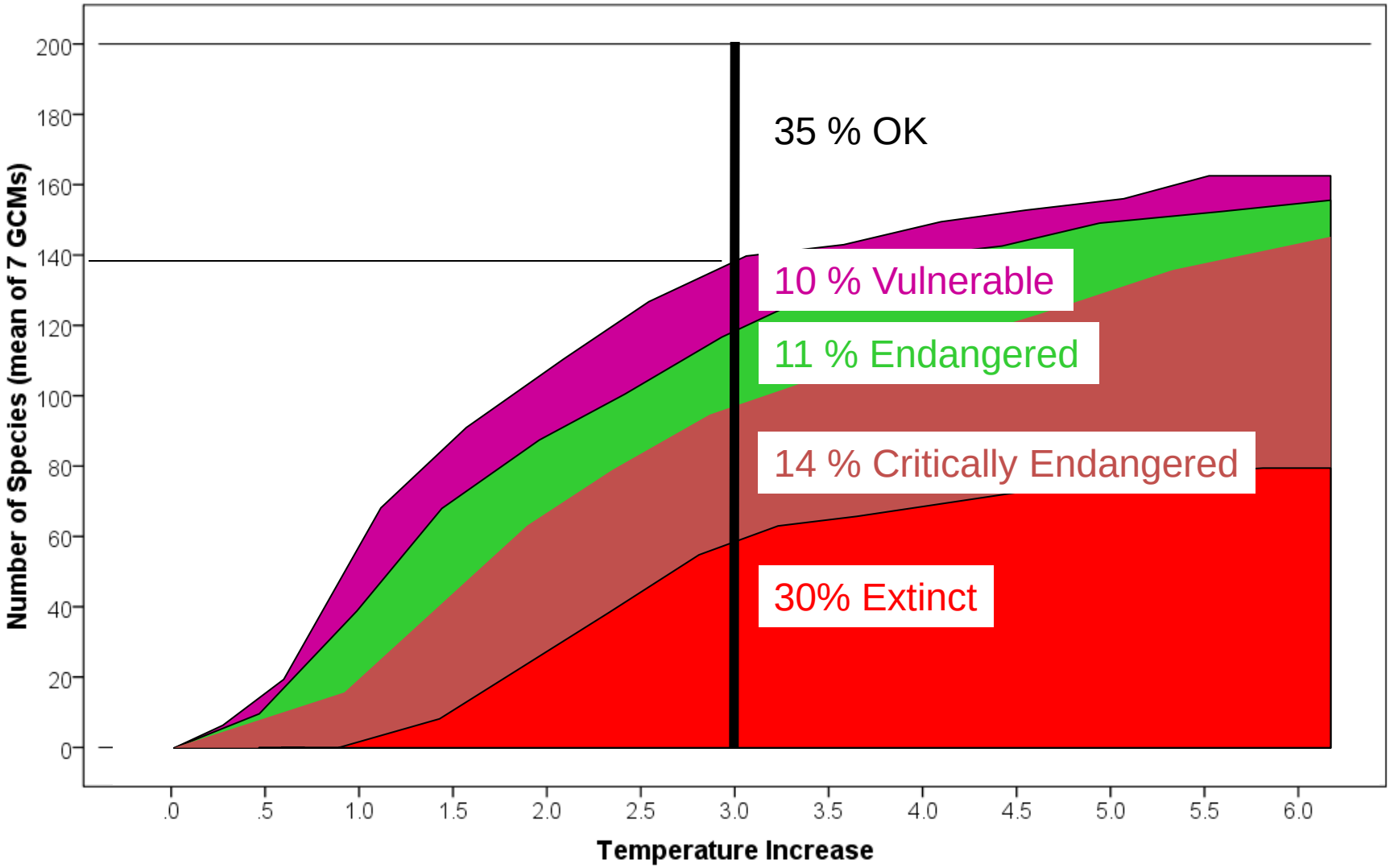
Best

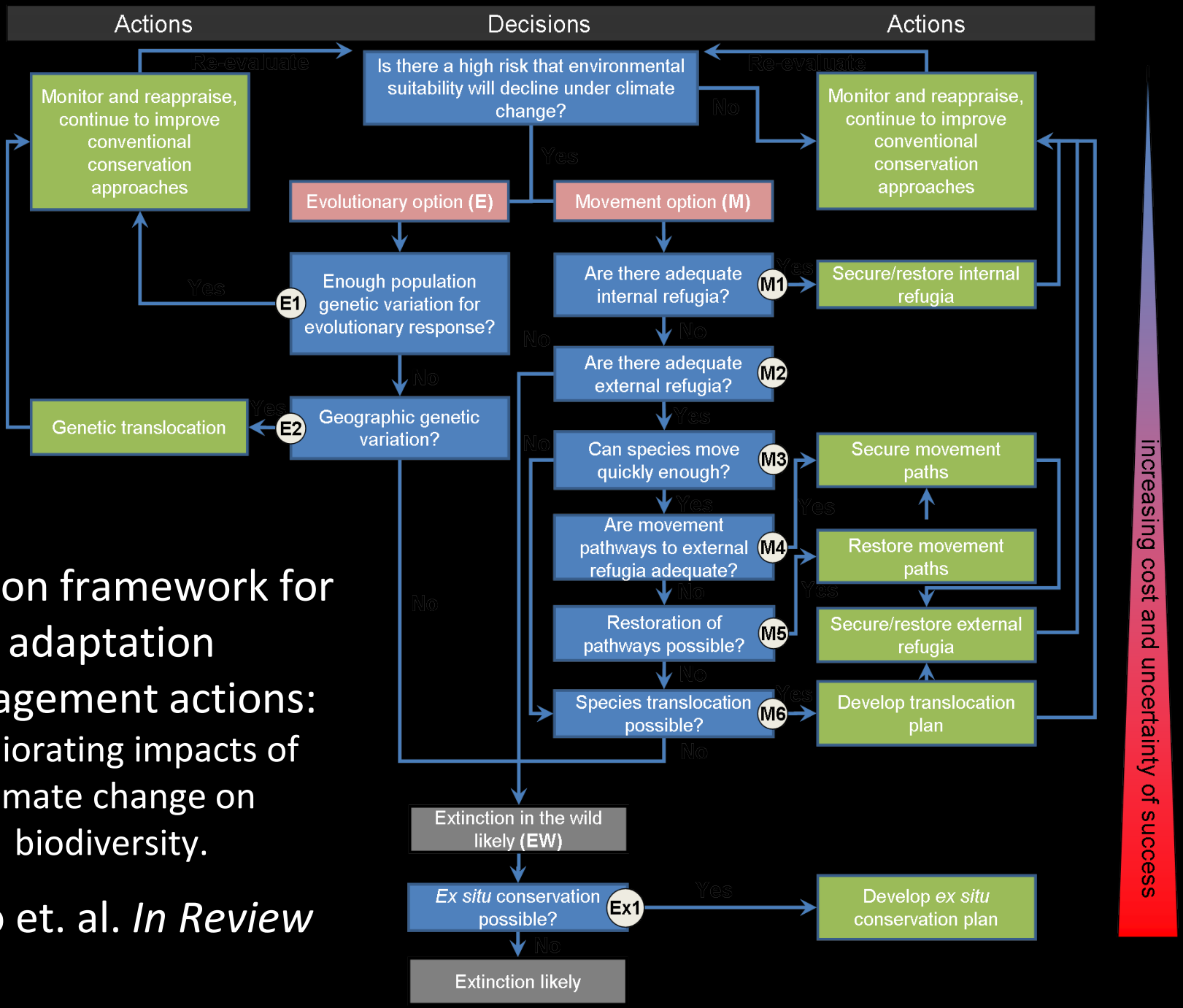



Rainforest
Species
Richness
(196 species)
Worst
Average
Best
0
100
200
Species Richness
6
5
4
3
2
1
0


0
50
100
Species Richness
Thornton Peak
Windsor
Daintree Lowlands
Carbine
We can identify significant hotspots of future biodiversity
Lamb Range
Bellenden-Ker
Bartle Frere
Herberton Range
Tully

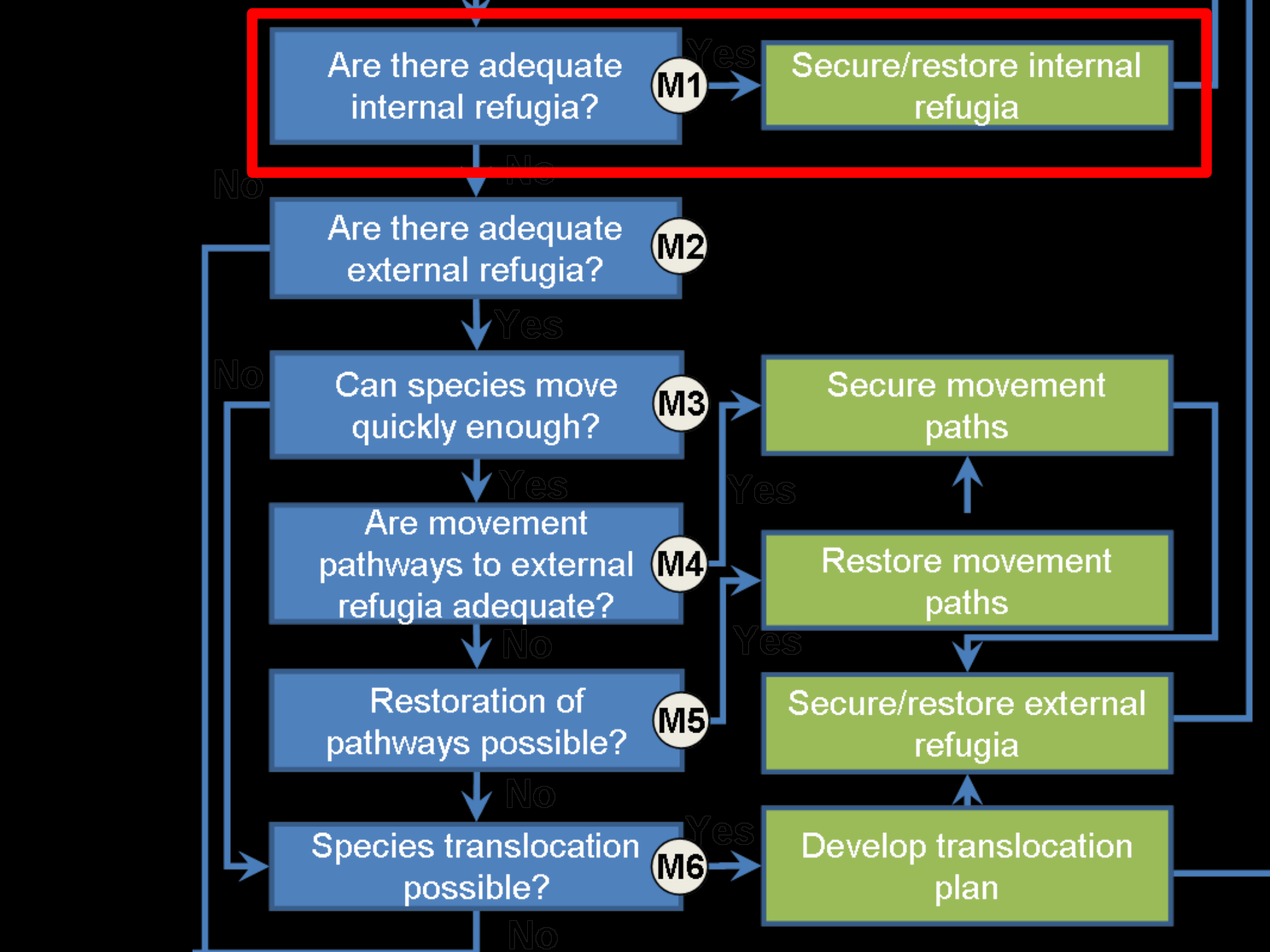
Wet Tropics biodiversity is extremely vulnerable to climate change





Decision framework for adaptation management actions: ameliorating impacts of climate change on biodiversity.

Shoo et. al. *In Review*


Are there adequate internal refugia?
M1
Yes
Secure/restore internal refugia
No
Are there adequate external refugia?
M2
Yes
No
Can species move quickly enough?
M3
Yes
Secure movement paths
Are movement pathways to external refugia adequate?
M4
Yes
Restore movement paths
No
Restoration of pathways possible?
M5
Yes
Secure/restore external refugia
No
Species translocation possible?
M6
Yes
Develop translocation plan
No

What adaptation actions are possible to protect a system where 84% of the species rely on cool refugia?

Cool Refugia

CENTRE FOR Tropical Biodiversity & Climate Change

Where will they be?

How big do they need to be to be effective?

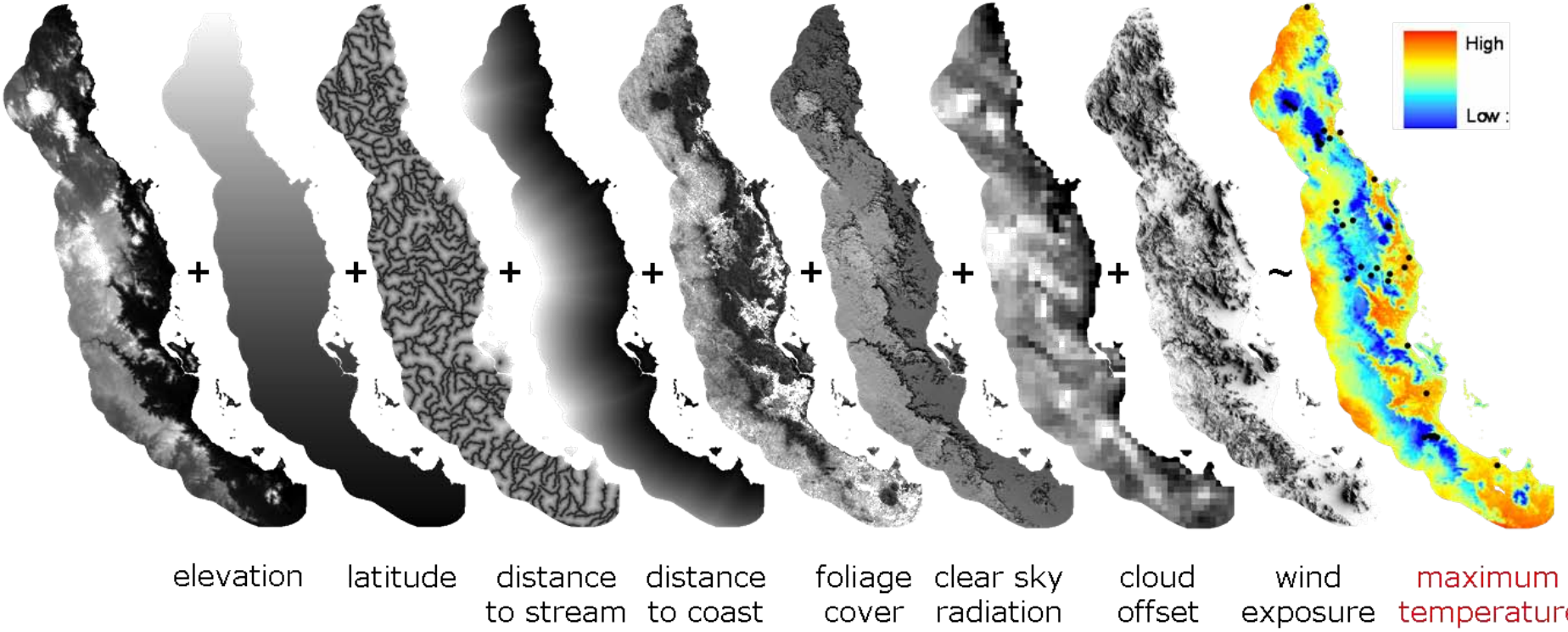
Which species will benefit?

What factors will threaten these refugia?

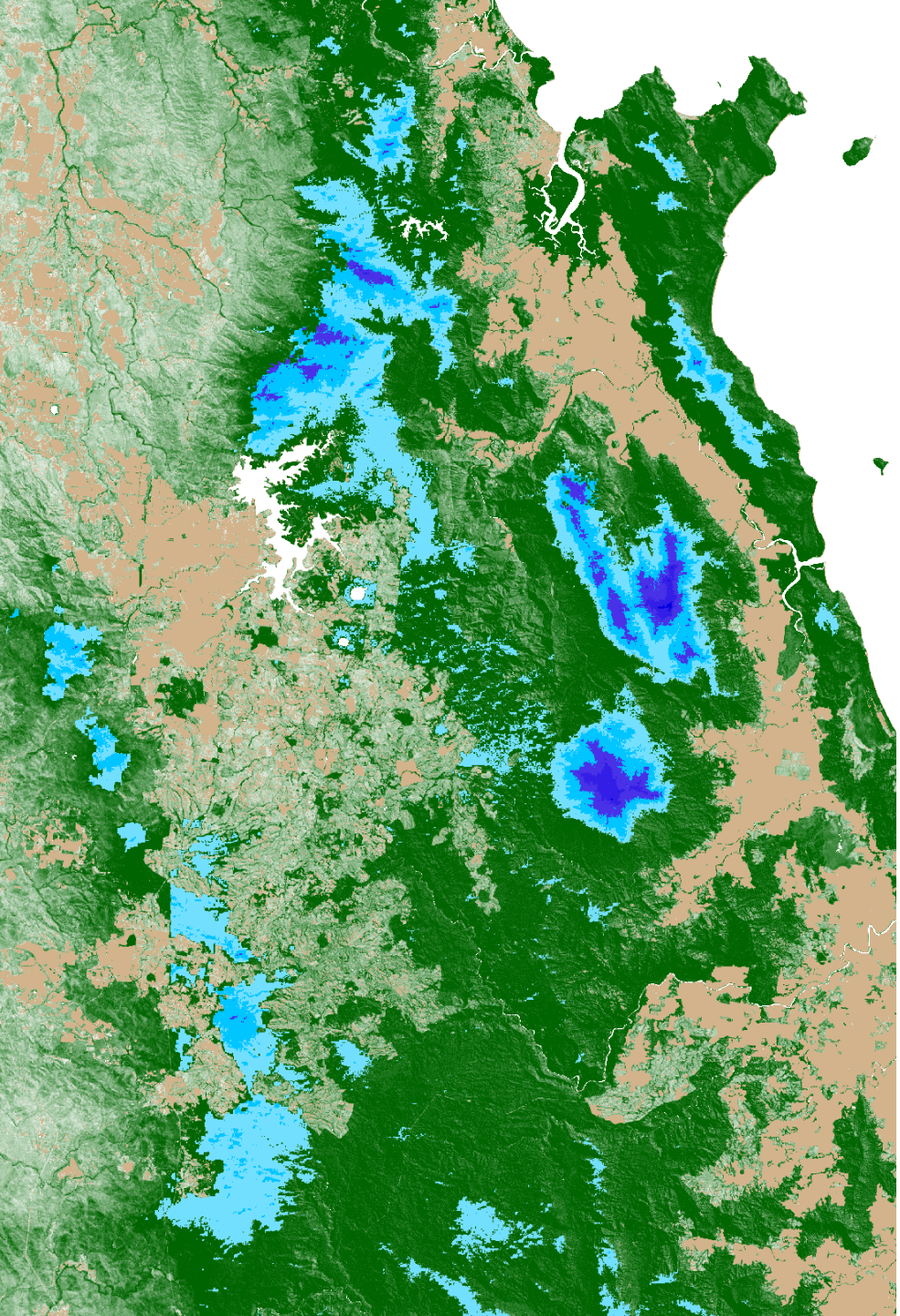
How do we protect, enhance and manage them?

Cool Refugia

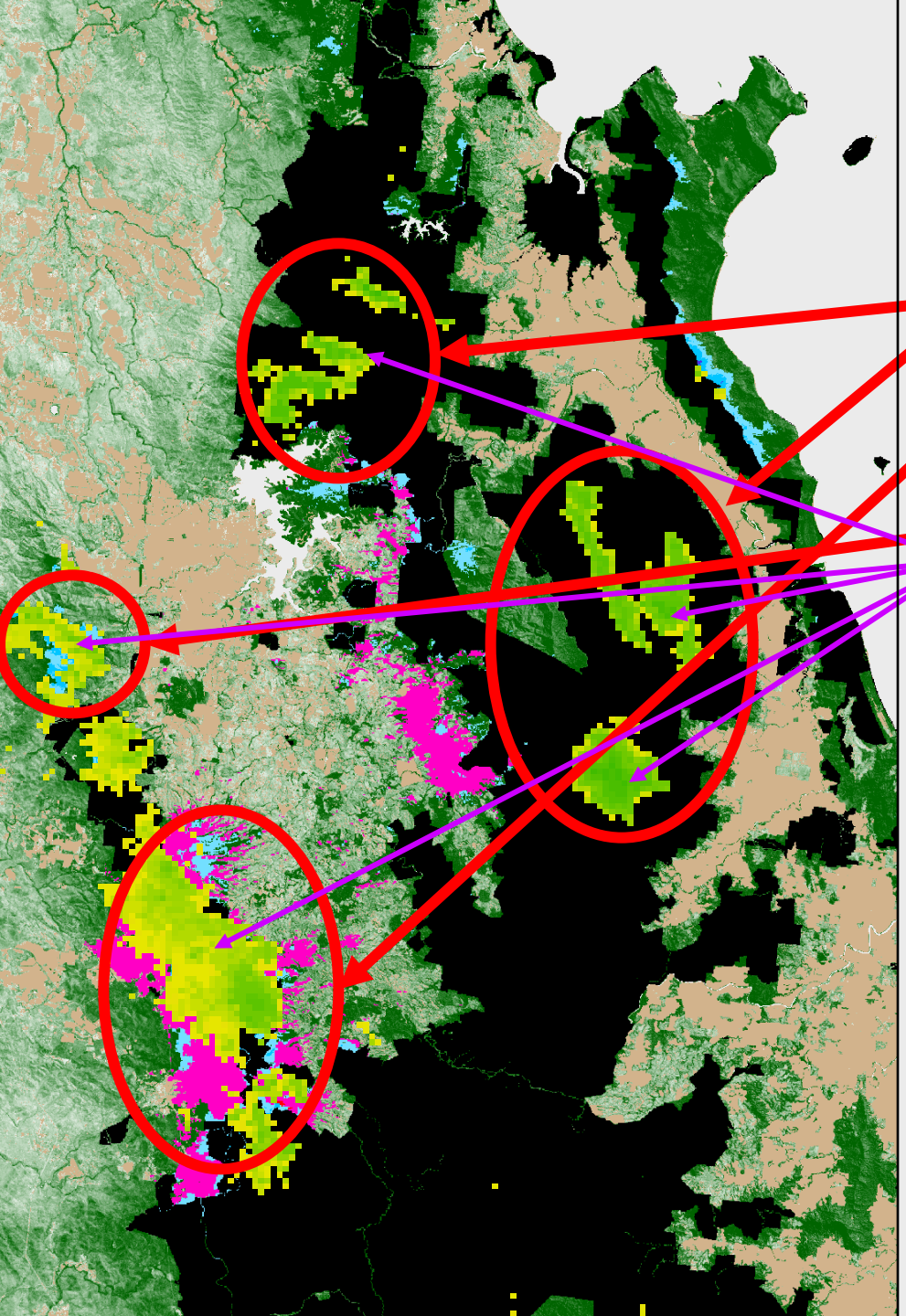
A map showing the maximum temperature actually experienced by an organism in any part of the region



Shoo, Vanderwal & Williams. *Glob Change Biol* 2010



Existing thermal refugia



Adaptation Options

High value refugia already in protected area:

- Maintain connectivity to other refugia

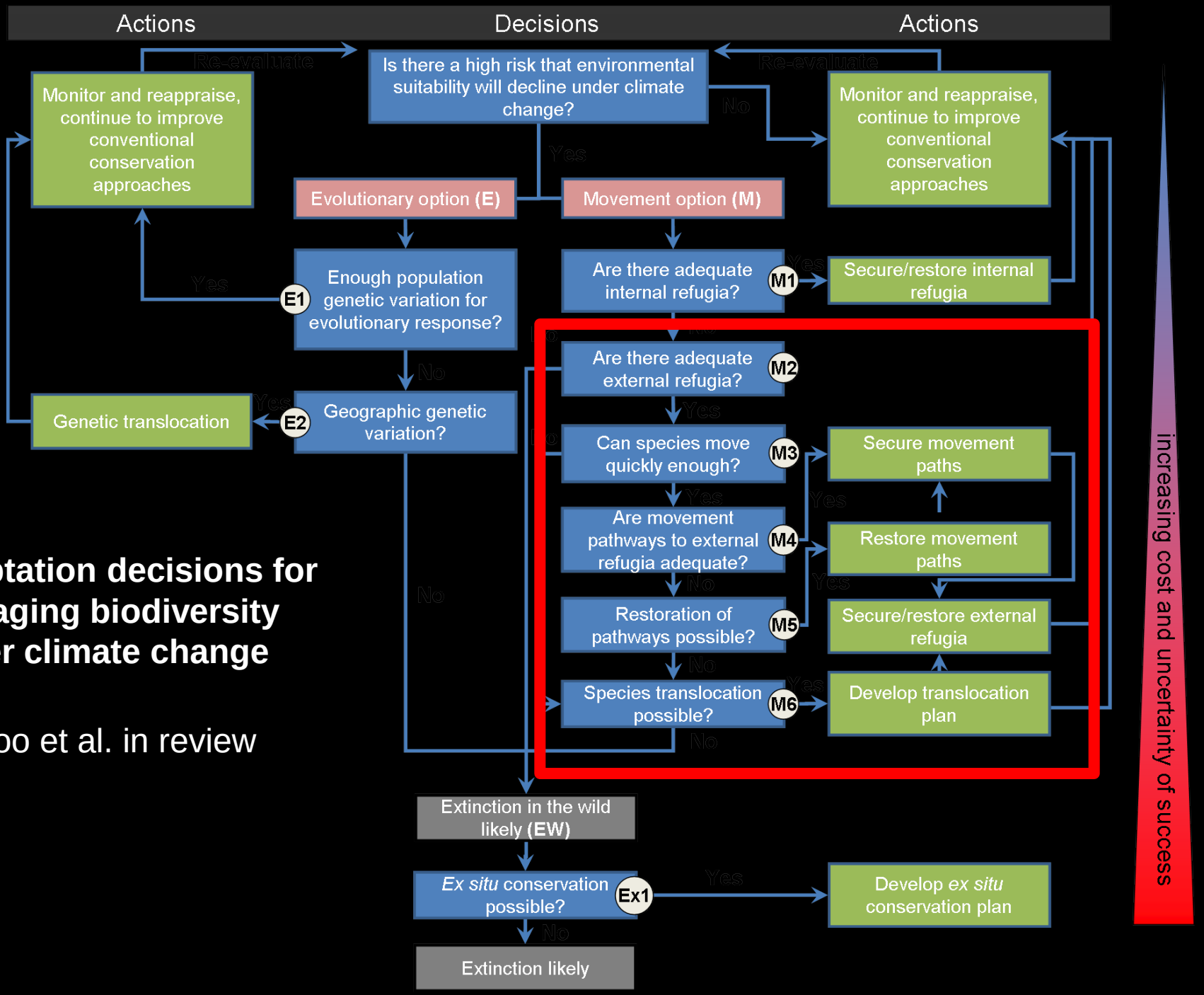
High value refugia not in protected area:

- Land acquisition and/or off-reserve management agreements
- Habitat restoration
- Re-establish corridor for movement and gene flow

Biodiversity refugia based on overlayed distributions of all 200 rainforest vertebrates modelled using averaged Maxent future distributions of 7 GCMs at 4 deg C increase

Degraded landscape with potential to be high value refugia

- Potential for assisted migration
- Off-reserve management agreements
- Maintain corridors to refugia

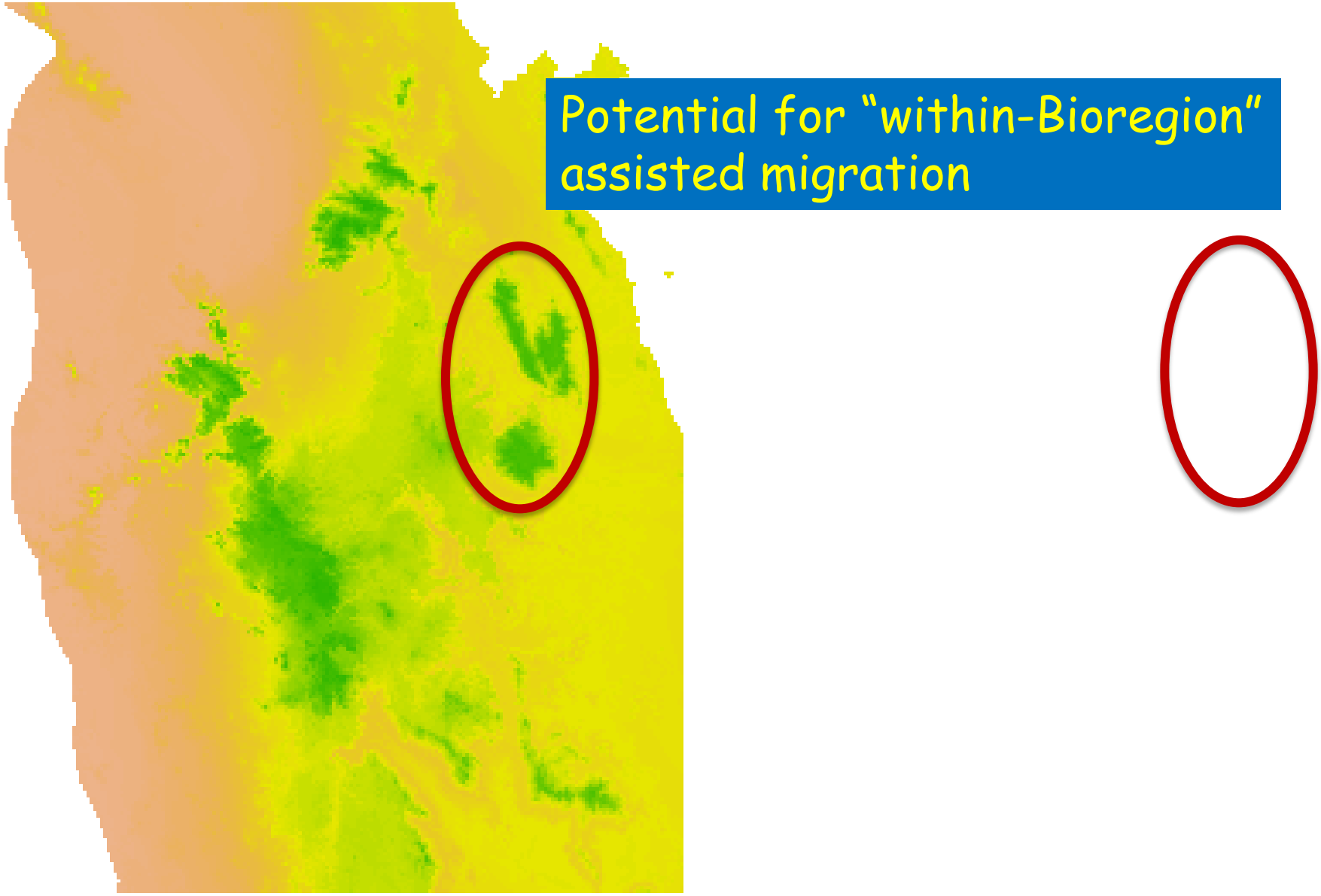


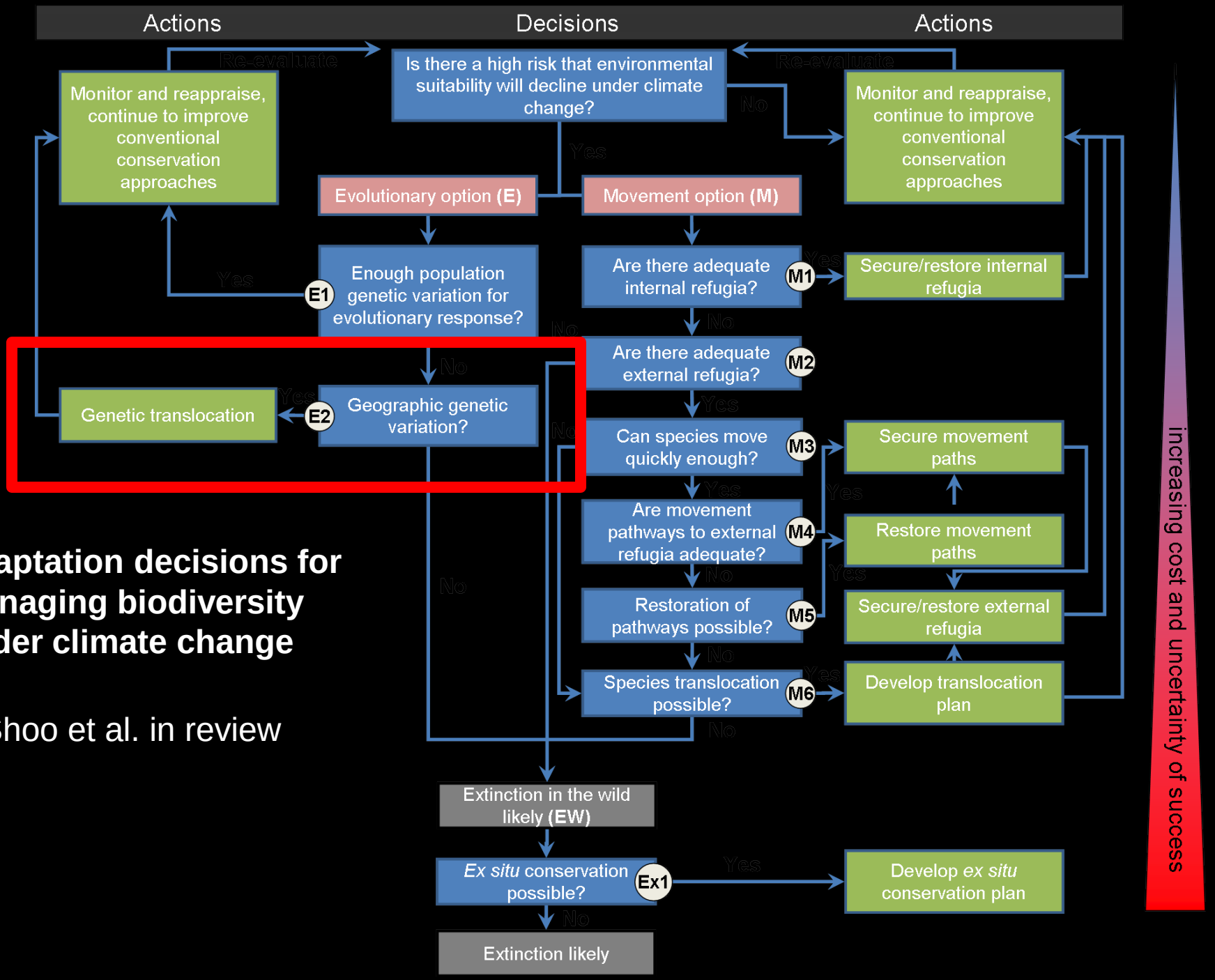
Adaptation decisions for managing biodiversity under climate change

Shoo et al. in review

Vertebrate Species Richness (A2 scenario, 2080) – about 3.5 deg increase

Unlimited dispersal





Adaptation decisions for managing biodiversity under climate change

Shoo et al. in review

Using existing genetic variation to maximise resilience

John Llewelyn – Post-doc

Test for variation in climate related traits

- Within populations
- Between populations

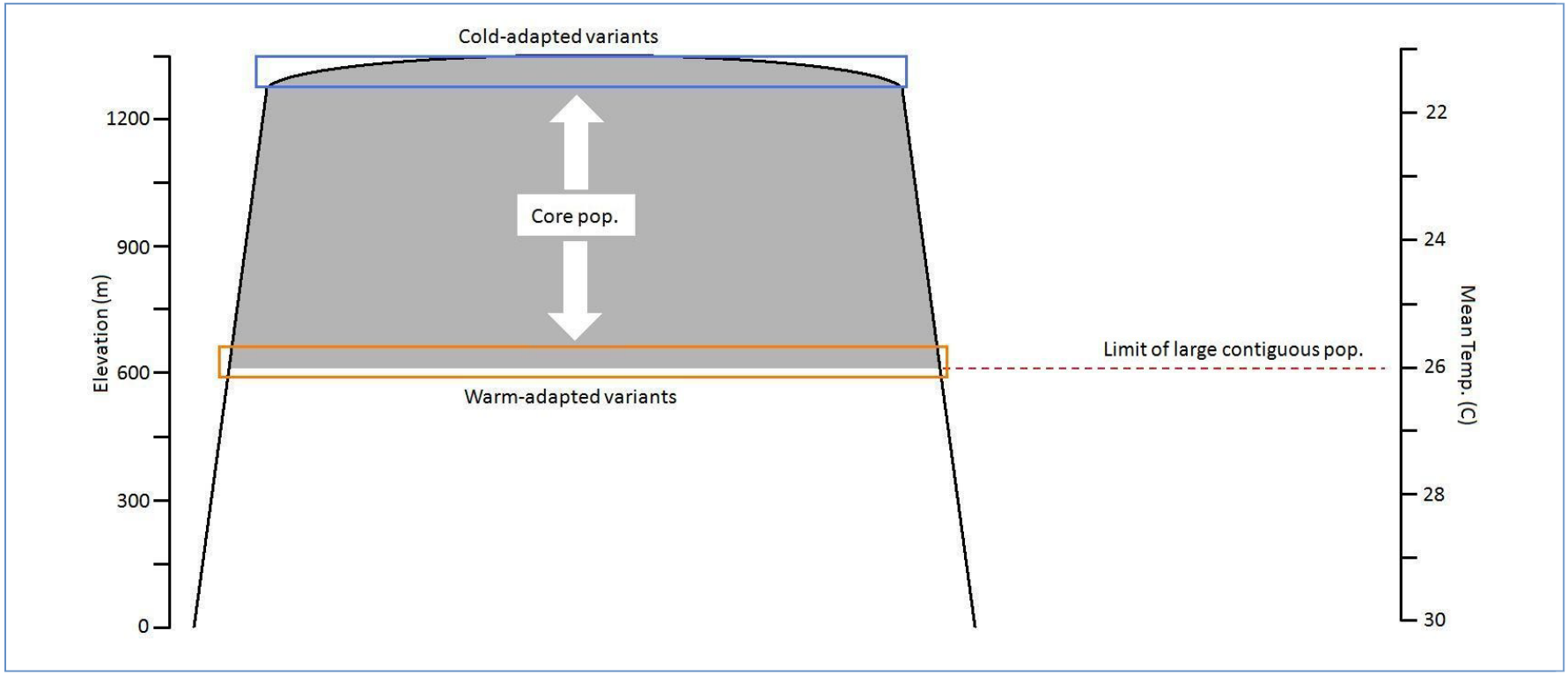
Assess potential to evolutionarily adapt to climatic change

- Protect and allow population to adapt

Test for variation btw. populations

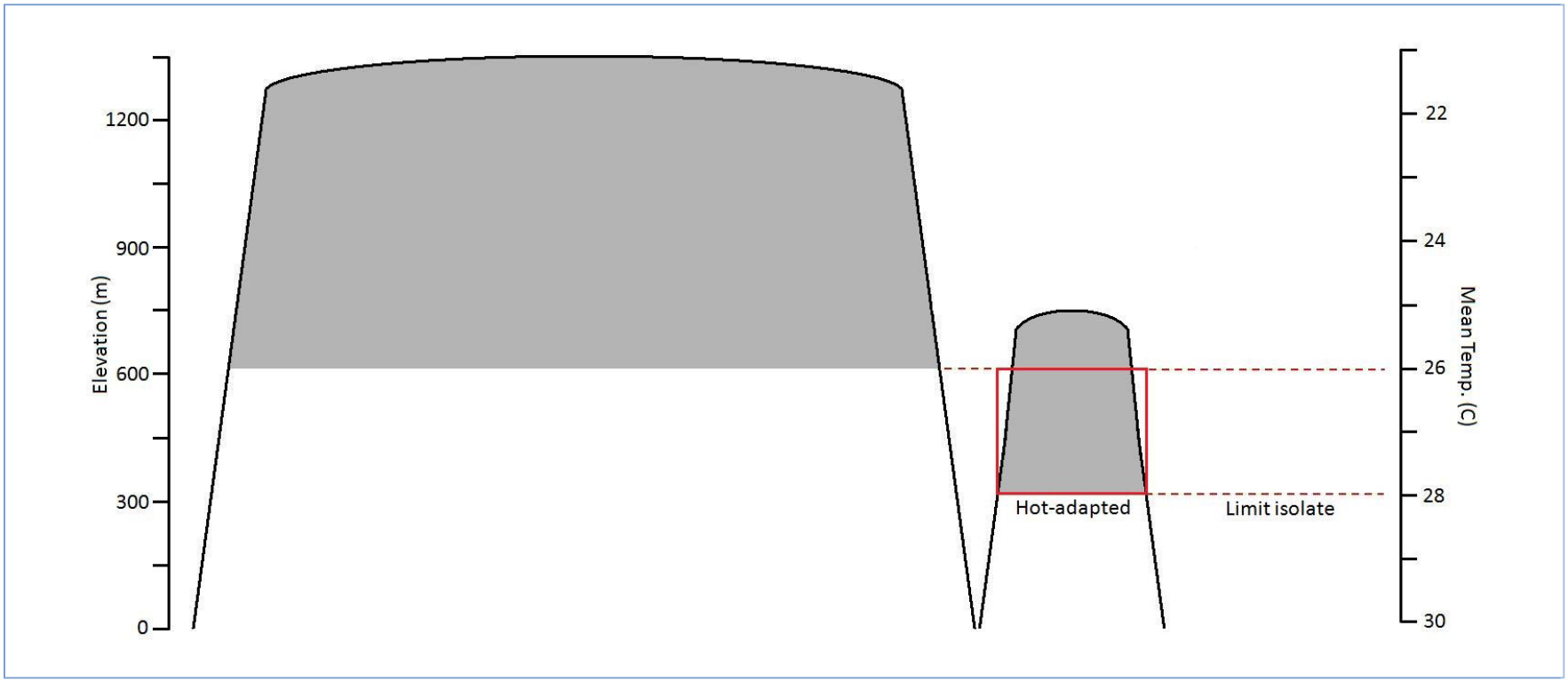
- Genetic translocation

What patterns do we expect to see?



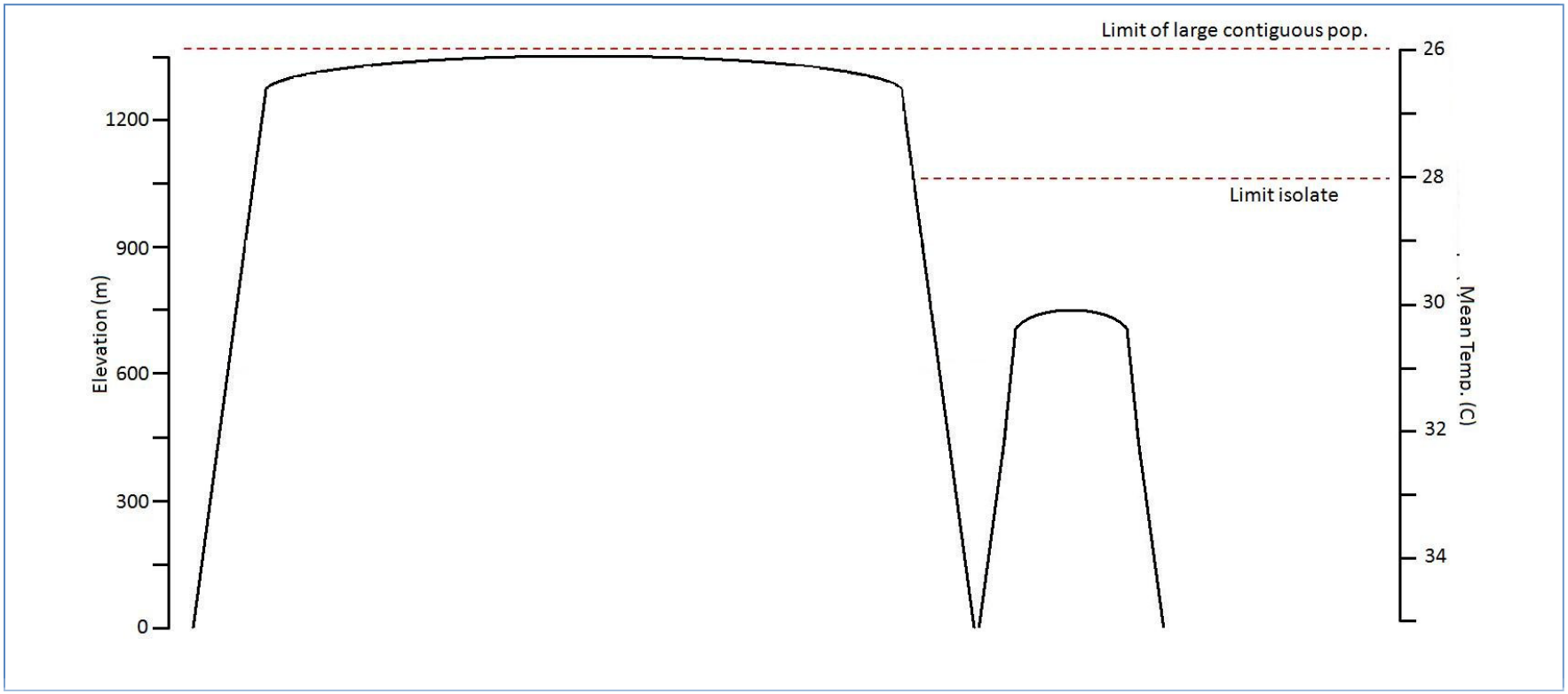
Local adaptation at the periphery held back by gene flow from the core population

Peripheral isolates



‘Release’ from the core population may allow significant local climate adaptation in peripheral

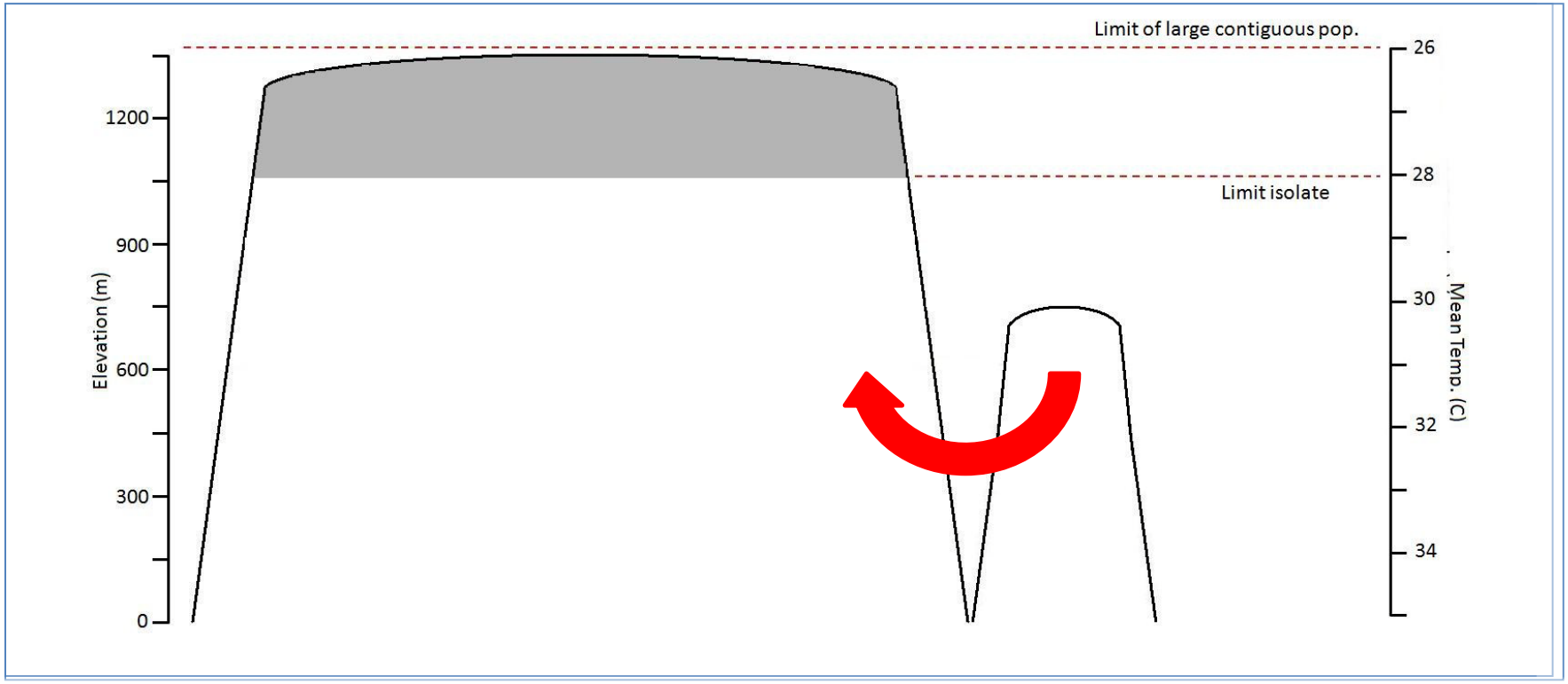
Impact of climate change on large-contiguous vs peripheral isolate



Cool refugia should be a priority for conservation

Peripheral isolates are highly vulnerable

Genetic translocation to build climate change resilience



Translocation of hot-adapted variants may prevent species' extinctions

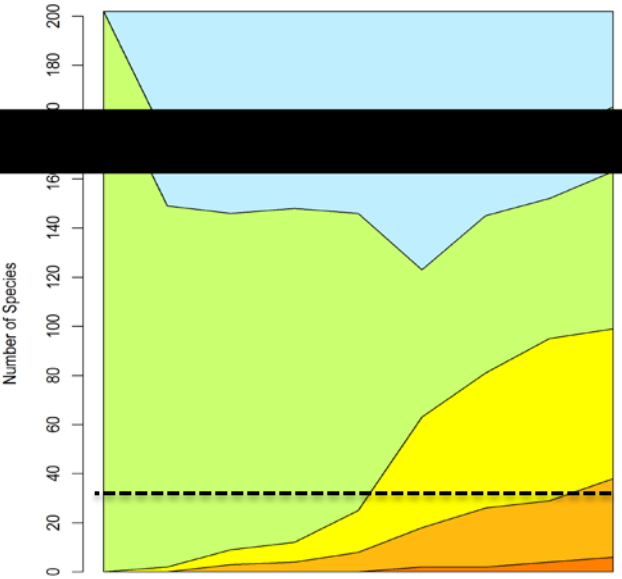
CENTRE FOR
Tropical Biodiversity
& Climate Change

Mitigation

How much difference will mitigation make?

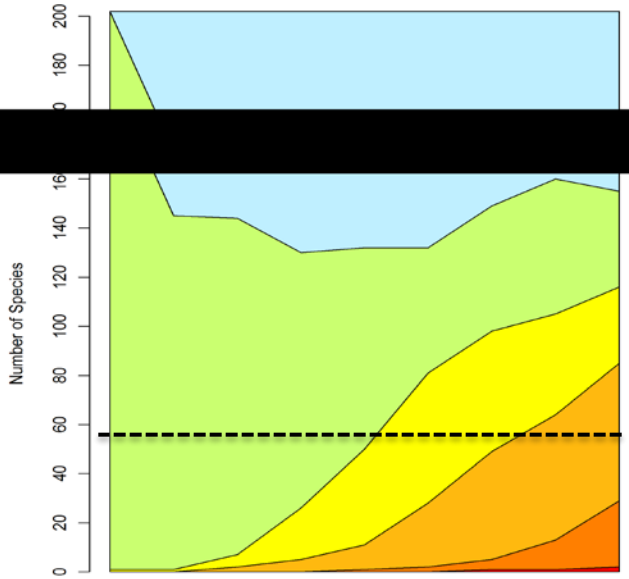
Predicted changes in the Conservation Status of Rainforest Vertebrates

Strong Emmission Control
B2



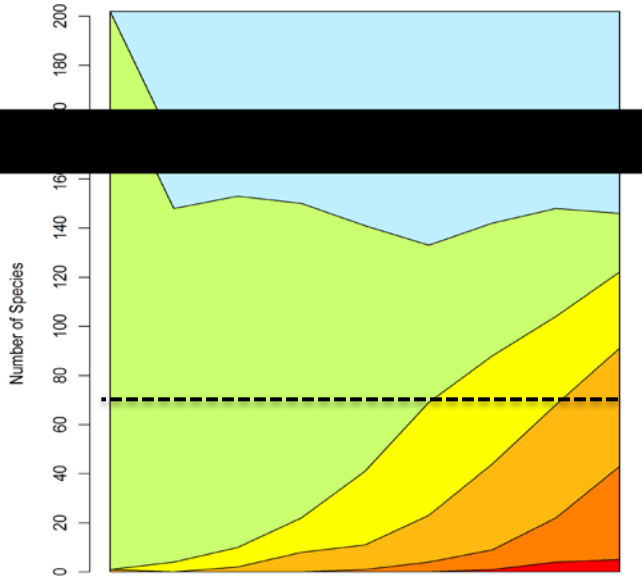
Extinct 0
Cr End 5 } 2%
End 33
Vul 60

Medium Emmission Control
A1B



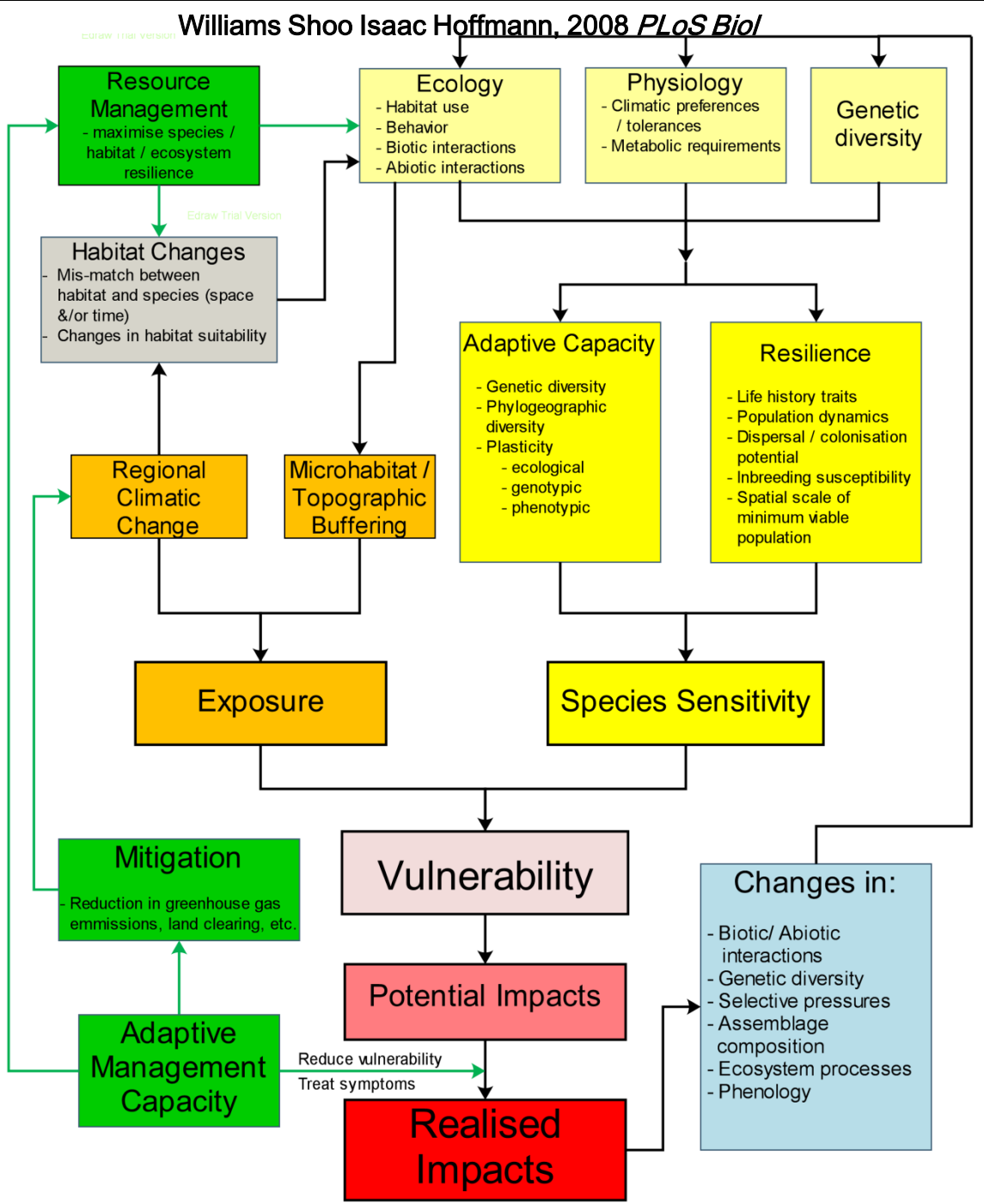
Extinct 3
Cr End 27 } 15%
End 52
Vul 40

Weak Emmission Control
A2

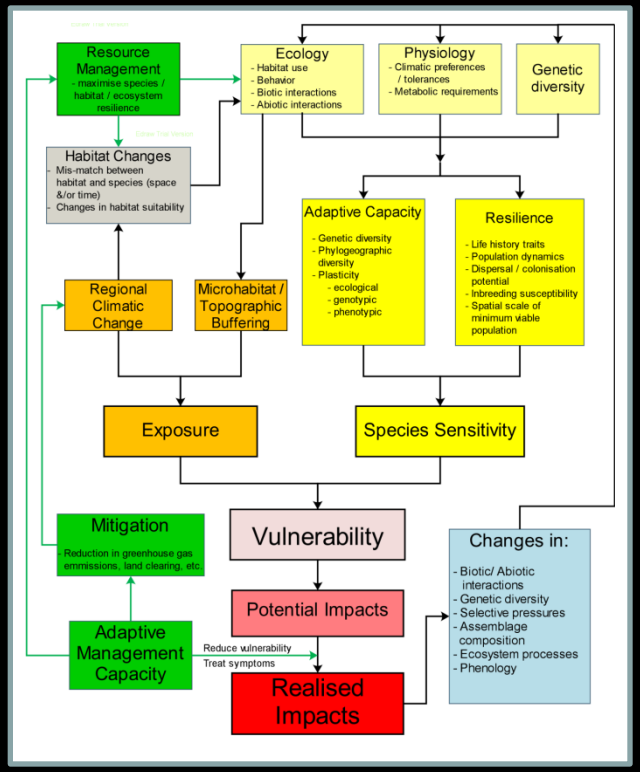


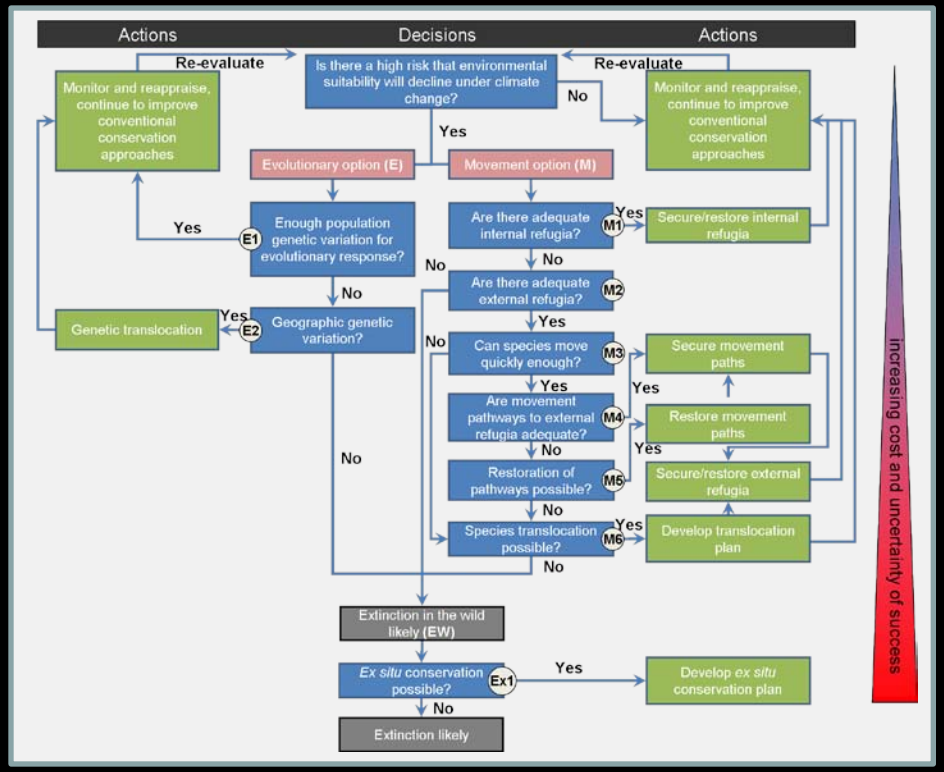
Extinct 8
Cr End 40 } 24%
End 49
Vul 22

Careful consideration of factors can help identify priority gaps in knowledge which can then be addressed



Knowledge of impacts, relative vulnerability, and the importance of the underlying determining processes all increase our ability to make informed adaptation decisions to give biodiversity the best chance possible and hopefully make the right decisions at the right time





National Adaptation Research Plan - NARP

National Adaptation Research Plan (NARP) for Terrestrial Biodiversity identifies research required to assist managers of the terrestrial estate prepare for the consequences of climate change





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National Adaptation Research Plan for Terrestrial Biodiversity

Authors:

Prof. Lesley Hughes (Macquarie University)
Prof. Richard Hobbs (Murdoch University)
Prof. Jan McDonald (Griffith University)
Dr. Mark Stafford Smith (CSIRO - CAF)
Prof. Will Steffen (ANU)
Prof. Stephen Williams (James Cook University)





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National Adaptation Research Plan for Terrestrial Biodiversity

The aims of this Plan are to:

1) **Identify important gaps in the information needed by sectoral decision-makers to respond to climate change in ways that reduce the vulnerability of terrestrial ecosystems;**

2) **Set adaptation research priorities based on these gaps; and**

3) **Identify capacity that can be harnessed or that needs development to perform priority adaptation research.**





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NARP – National Research Priorities

5.1 National/continental scale issues

- **5.1.1** How will climate change affect existing conservation goals and how should changed conservation goals be promoted and achieved?

- **5.1.2** How can the existing Australian legal, policy and institutional architecture for land management and biodiversity conservation respond to changes in conservation goals caused by climate change?

- **5.1.3** What conceptual models and long-term observation systems are needed to support the design, analysis and assessment of active adaptive management and policy experiments at regional and national scales under climate change?

NARP – Regional Research Priorities

5.2 Regional issues

- **5.2.1** What designs of landscapes in intensive and extensive land-use zones confer maximum resilience for biodiversity in the face of climate change, including the uncertainty associated with future climate scenarios?

- **5.2.2** How will climate change interact with other key stressors such as fire, invasive species, salinity, disease, water extraction, climate hydrology, grazing and clearing and what are the implications for ecosystem structure and functioning?

- **5.2.3** How can large-scale carbon mitigation initiatives such as revegetation and forest-related mitigation be designed to avoid adverse impacts on biodiversity and to maximise biodiversity conservation benefits?

- **5.2.4** How can major socio-economic trends occurring in many regions of Australia contribute to effective climate change biodiversity adaptation responses?

NARP – Local Research Priorities

5.3 Local land management issues

- **5.3.1** What are the costs and benefits of different climate change adaptation measures in key vulnerable communities and ecosystems?
- **5.3.2** How should fire management adapt to climate change?
- **5.3.3** How can management of local protected areas incorporate and adapt to climate change?
- **5.3.4** How can we better integrate conservation plans and actions across landscapes, incorporating protected area management, off-reserve conservation measures and other land-uses, to maximise biodiversity conservation benefits/outcomes under a changing climate?

NARP – Species Research Priorities

5.4 Managing key species

- **5.4.1** Which species should be the focus of investment in climate change adaptation?

- **5.4.2** How will climate change affect current management actions for protecting priority species and what management changes will be required?

- **5.4.3** How will climate change affect current or potential problem species and what management responses will be required?

Some common themes and priorities for biological research across NARP, BVA, Protected areas:

1) Develop planning strategies and policy that recognise novel ecosystems, shifting climates and conservation paradigms
2) Understand, and predict, responses and vulnerability
3) Identify refugia – both internal and external
4) Understanding the influence of extreme events
5) Interactions between climate change and other stressors
6) Protect more habitat & greater environmental diversity
7) Manage habitat to reduce threats and maintain resilience
8) Manage landscape-scale issues such as connectivity





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NARP funding:

Significant dates:

Call for Expressions of Interest	3/12/2010
Closing date for submission Expressions of Interest	21/01/2011
Invitations for Full Proposals (~20 shortlisted)	11/02/2011
Closing date for submission of Full Proposals	11/03/2011
Announcement of successful candidates by	May 2011
Funding Agreements signed by	June 2011





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Some common themes and priorities for biological research across NARP, BVA, Protected areas:

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7) **Manage habitat to reduce threats and maintain resilience**
8) **Manage landscape-scale issues such as connectivity**

How do YOU think the national priorities fit your ecosystem / region / sector?

- Are there any serious omissions?
- What are the priorities / challenges in your area of interest ?
- What research is needed to have the knowledge to make the best possible choices about adaptation?
- What are the main impediments?





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Impacts:

What are the main impacts / challenges / problems of climate change on terrestrial biodiversity in YOUR area of interest / responsibility?

- Examples:
  - Direct temperature impacts
  - Biogeographic barriers to movement
  - Changing rainfall
  - Sea level rise
  - Extreme events:
    - Fire
    - Drought
    - Cyclones
    - Floods
    - Storm surges
  - Interactions
    - Invasive species
    - Habitat Fragmentation





Local / Regional / Sectoral

Sector	Area	Ecosystem	Impacts	Ideas to manage	Adaptation Research	Impediment
National Park	Bogong High Plains	Alpine/ subalpine	• increased fire risk	•control burning	•Which species most threatened •	•Money •Changing ideas and attitudes to Climate Change •skills
National Park	Bogong High Plains	Alpine/ subalpine	• increased incidence of drought	•artificial structures to provide micro refugia / feeders	•Would the animals use structures	
National Park	Bogong High Plains	Alpine/ subalpine	•increased threat of invasives	•Sterilize vehicles	When to act	





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