Australia's Biodiversity and Climate Change:
Meeting the Adaptation Challenge

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Photo: D. Lindenmayer

Background: The Process

Commissioned in late 2006 by the Natural Resource Management (NRM) Ministerial Council as a strategic assessment of the vulnerability of Australia's biodiversity to the impacts of climate change.

An Expert Advisory Group was appointed by the Dept of Climate Change, AustralianGovernment, to carry out the assessment.

Process initiated, supported and facilitated by DCC.

The assessment provides the basis for the National Adaptation Research Plan (NCCARF) for terrestrial biodiversity.

Expert Advisory Group

Andrew Burbidge, Consultant, Western Australia

Lesley Hughes, Macquarie University, NSW

Roger Kitching, Griffith University, Queensland

David Lindenmayer, ANU, ACT

Warren Musgrave, University of New England, NSW

Mark Stafford Smith, CSIRO, ACT

Will Steffen (Chair), ANU, ACT

Pat Werner, ANU, ACT

5 expert workshops held throughout project

Climate change, species and ecosystems: identifying key science questions for Australia (13-19 Oct 2007)

States and Territories and climate change (18-19 Dec 2007)

Climate change impacts on biodiversity: honours presentations (5 Feb 2008)

Institutional and governance issues in a climate changing world (12 Feb 2008)

The effects of climate change on fire regimes in areas managed for biodiversity (26 Mar 2008)

Assessment products

Co-production of Knowledge

Excellent example of "participatory" research - policy and management communities were centrally involved in the process from the very beginning until the final publication.

Consultation with stakeholders - both formally and informally throughout the process. Briefings on a "work in progress" basis to NRMMC and other stakeholders.

Robust dynamic throughout the process between the needs, constraints and cultures of the policy and management communities and those of the academic research community.

Final products represent the success of this process - they are both academically rigorous and useful for policy and management.

1. Context

Responses to climate change are observable now

Genetic	Shifts in genetic composition of fruit fly (*Drosophila spp*)
Species	Decreases in avian body size in passerines
Geographic range	Migration of bird species to high latitudes
Life cycles	Earlier mating of large skinks (*Tiliqua Rugosa*)
Populations	Increases in fur seals on Heard Island
Ecotonal boundaries	Expansion of monsoonal rainforest into savanna woodland and grassland (?)
Ecosystems	Mass bleaching events in the Great Barrier Reef
Disturbances	Changing fire regimes in southern Australia

Current stressors on biodiversity

Land clearing and fragmentation, changed land uses

Introduction of new species

Altered disturbance regimes

Redistribution of water resources; changes in nutrient capital

Direct removal of species through hunting and fishing

Mineral extraction

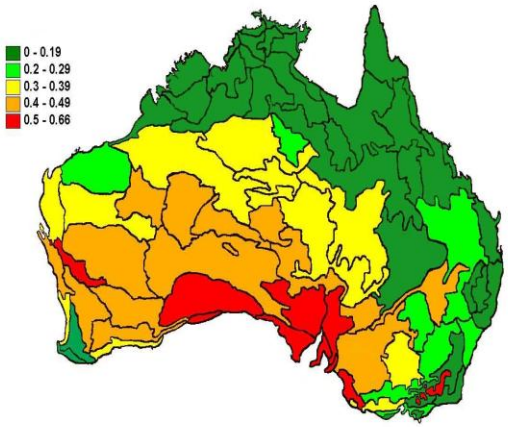
Current State of Australia's Biodiversity

Changes at the species level

- Extinction, functional extinction, threatened species
- Changes in relative abundance and distribution
- Introduced species

Changes in communities and ecosystems

- Species-species interactions
- Ecological cascades
- Novel communities and ecosystems



Proportion of loss of mammalian fauna

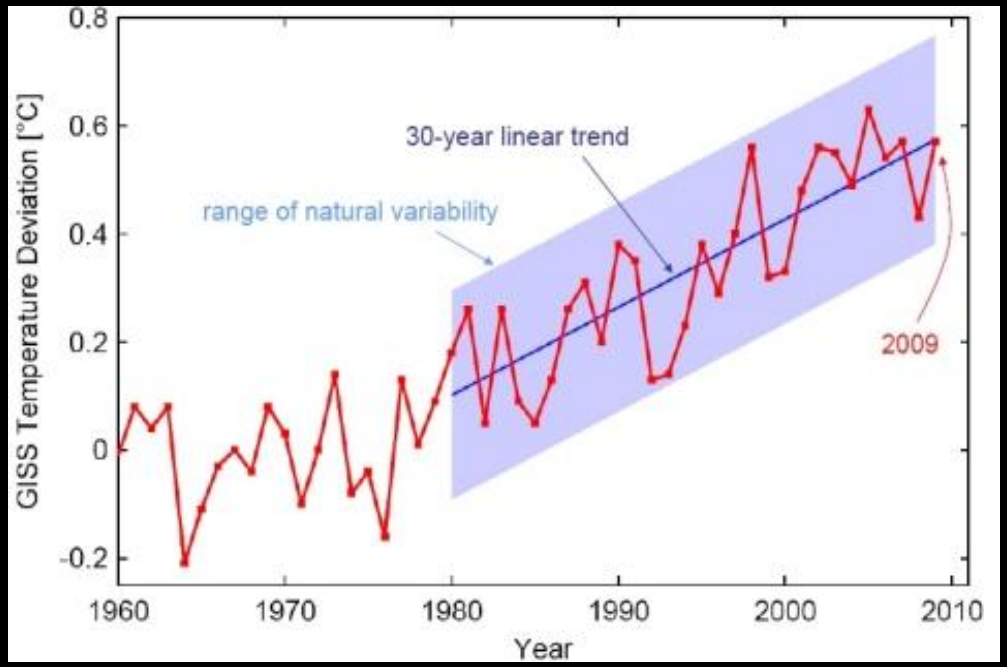
2. The nature of the climate change challenge

Climate Change: A new and different stressor

Threats from climate change arise from changes in the basic physical and chemical underpinning of all life - temperature, precipitation, CO_2 concentration, acidity…

Rate of contemporary climate change is unprecedented since the last massive extinction event 60 million years ago.

Trends in global air temperature



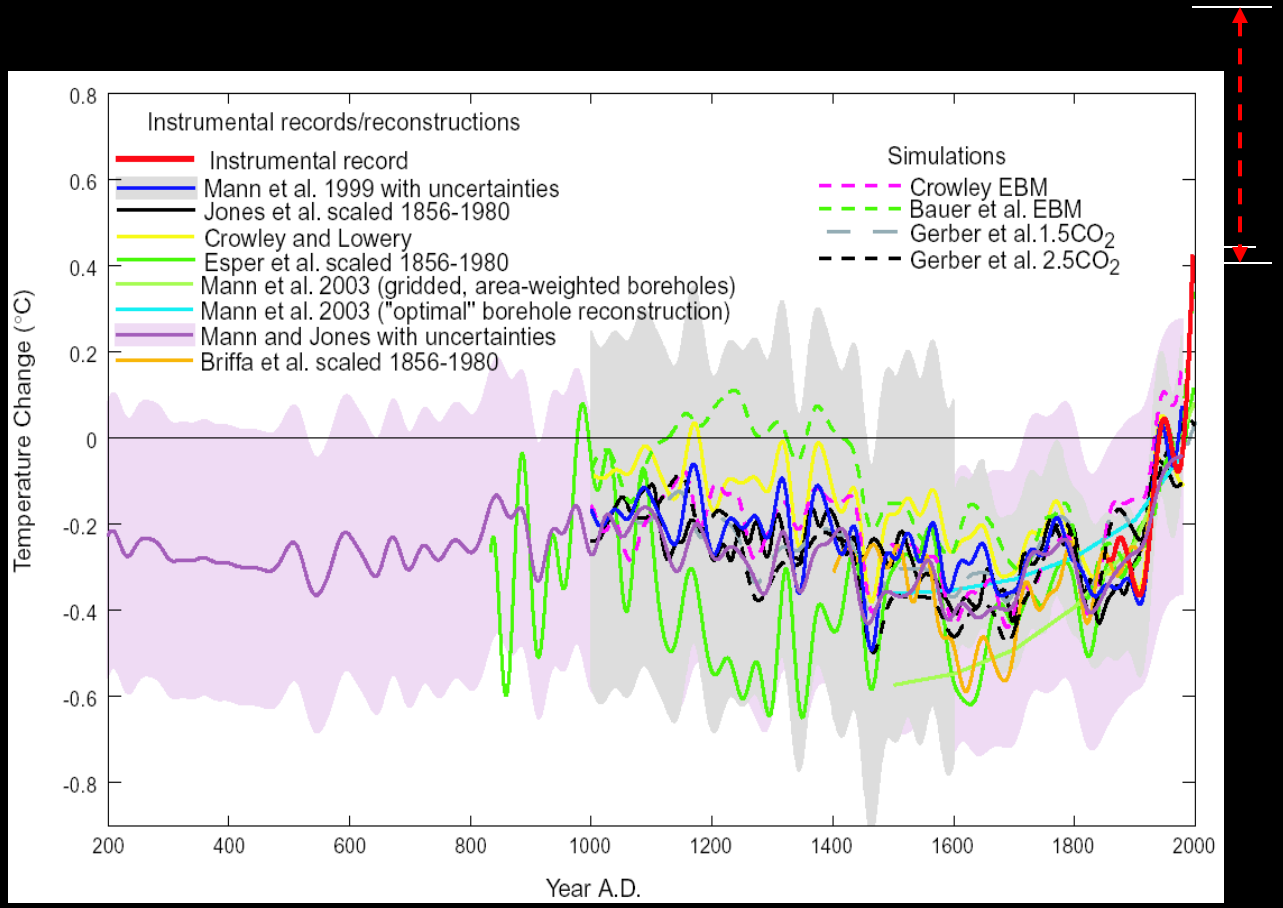
NASA GISS, 2010

The multi-decadal T trend from 1980 to 2009 has been warming at 0.2 °C per decade. This trend has not slowed during the 2000-2009 decade.

2009 was the equal-second warmest year on record (since the mid-1850s at least).

The decade 2000-2009 was the warmest decade on record, significantly warmer than the 1990s, which in turn were significantly warmer than the 1980s.

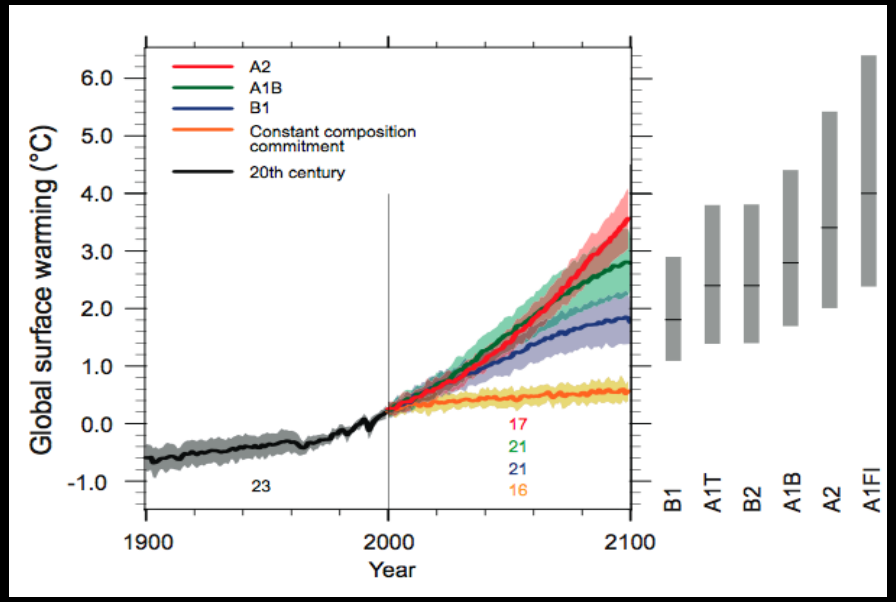
Outside the Envelope of Natural Variability



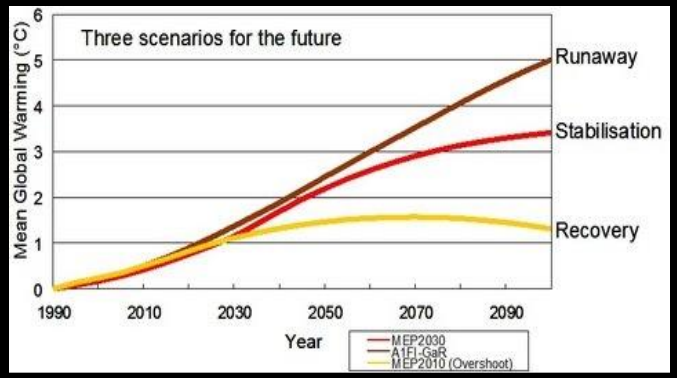
"Committed" temperature rise due to the slow response of the oceans. This rise is estimated to be about 0.6 °C by 2100.

Mann et al. 2003; IPCC AR4 2007

Implications of accelerating climate change



IPCC projections

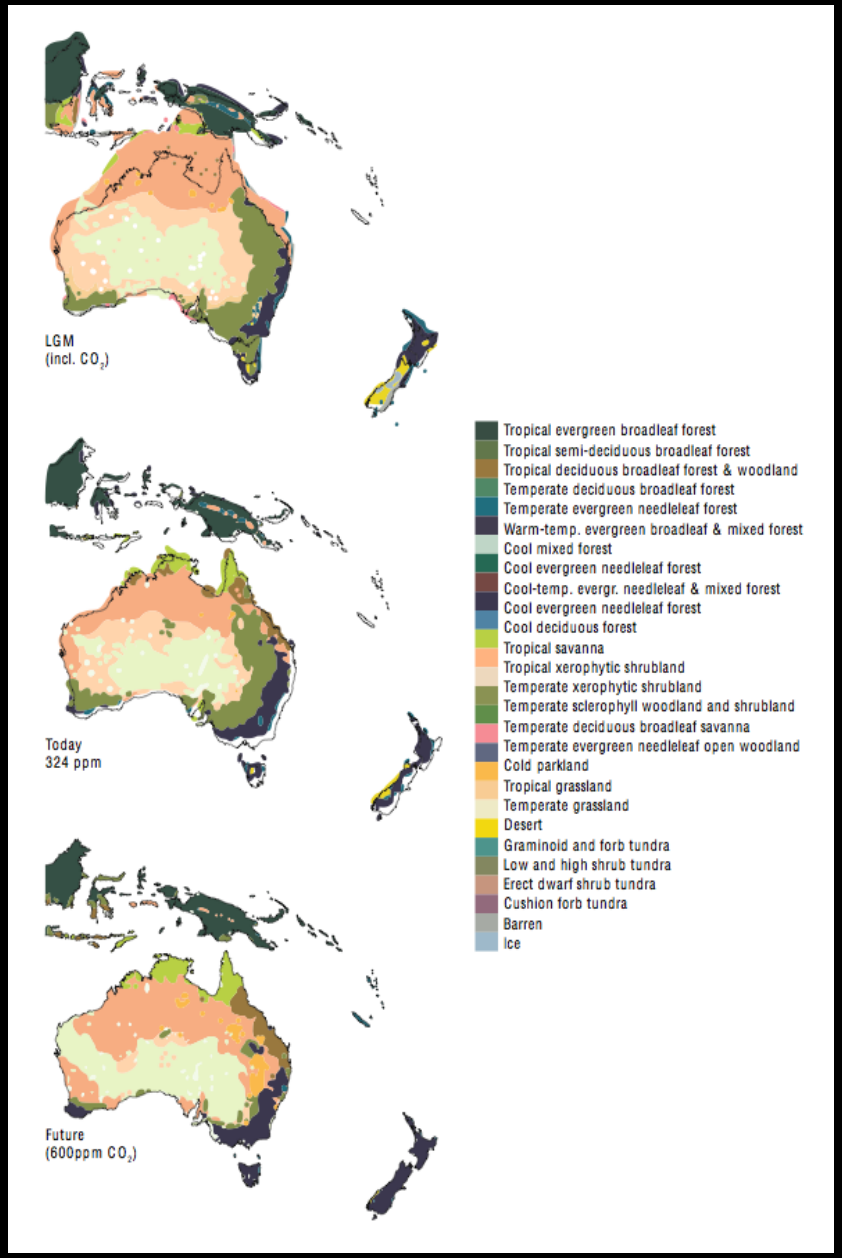


Stylised projections used in BVA

Biome shifts on geological timeframes

Biomes distributions at the LGM (Last Glacial Maximum, ca. 20,000 years ago), present day, and at 2100 with a mid-range CO_2 scenario and the corresponding climate.

Note that even larger changes in biomes are projected over the next 100 years that occurred in the transition from the LGM to present (over 5000 years at least)



Source: Sandy Harrison, Univ of Bristol

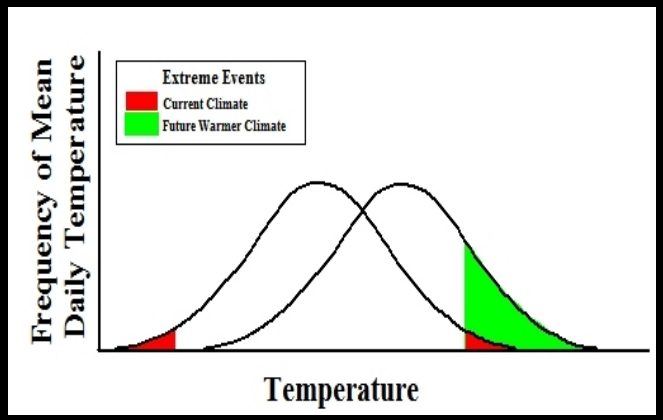
Dealing with Ecological Complexity

Indirect effects rule!!

Averages v. extremes

Synergistic effects & surprises

Nonlinearities, time lags, thresholds feedbacks, rapid transformations



Dealing with ecological complexity implies that most (>90%) of research on "climate change and biodiversity" has little relevance for adaptation, or for policy and management in general.

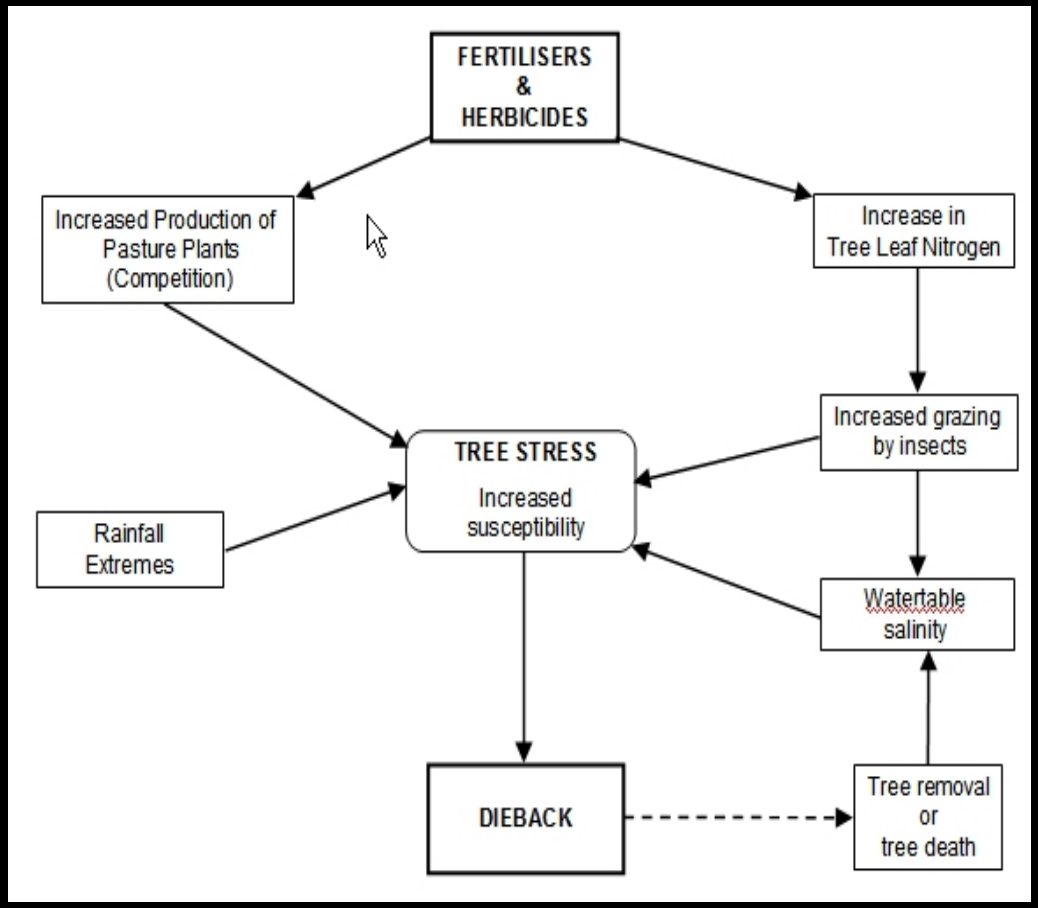
Ecological Complexity: Surprises

Little penguins have no experience of fire and so have no instinct to flee when fire approaches. They are simply burnt in their nests. As climate change warms and dries the environment around the penguins, the risk of fire increases.

This effect was not (and probably could not have been) predicted by modelling or analysis. It is truly a surprise.

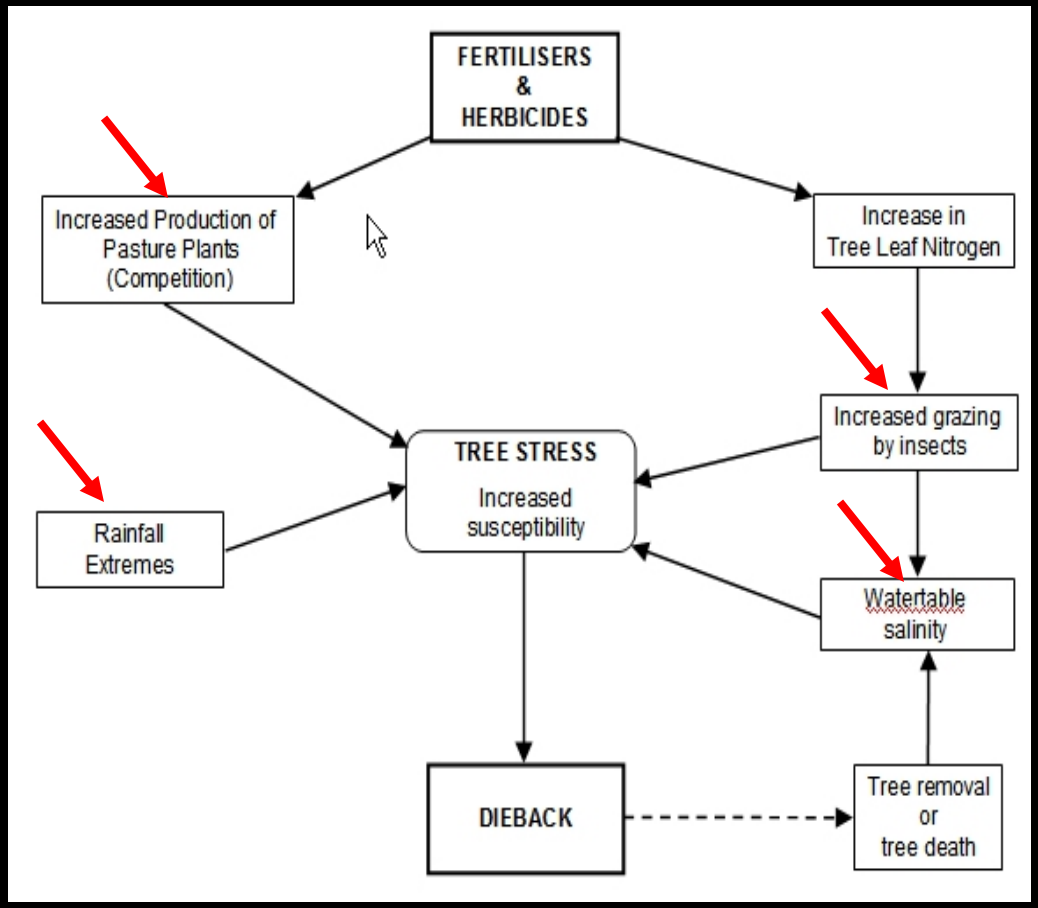
L. Chambers et al. 2009

An Ecological Cascade



Dieback of pasture trees

An Ecological Cascade



Dieback of pasture trees

Consequences of a business-as-usual (runaway) scenario for Australia's biodiversity

As for the rest of the world, Australia would likely face a massive wave of extinctions by the second half of the century. Areas/ ecosystems at particularly high risk include:

Great Barrier Reef - most coral ecosystems converted to algae

Australian Alps - alpine ecosystems largely eliminated

Kakadu wetlands - salinisation of freshwater lagoons

SE forests - more intense, frequent and larger (areally) bushfires

SW Western Australia - megadiverse Gondwanan relict system; loss of cool, wet habitats - loss of plants, birds, mammals, reptiles

Qld wet tropics - loss of cloud forest & cool-adapted species

3. The approach: Biodiversity conservation in a changing climate

A business-as-usual approach - or modifications of what we have been doing in the past - will not work. We are sailing into “planetary terra incognita”. Concepts like agility, adaptability, resilience and transformation are crucial.

New perspectives and goals

Potential magnitude and rate of change is beyond anything fully modern humans or the ecosystems from which we derive essential services have experienced

In Australia, we cannot go back to a 1770 world. Expect the unexpected - novel ecosystems and species in different places.

Develop policy and management for change - build fluid landscapes and agile managers; aim to maximise diversity in a multi-scale and dynamic sense (not maintain species in existing locations). Emphasis on maintenance of well functioning ecosystems and critical ecosystem services.

Fundamental Ecological Principles

Going back to fundamental ecological principles allows us to develop robust rules-of-thumb that can support effective responses to climate change despite large uncertainties.

- Relationship between individual species and the surrounding environment
- Role of individual species in communities & ecosystems
- Ecosystem structure and functioning (including landscapes)
- Phenomena associated with environmental change at all levels - genetic to biome

Robust rules-of-thumb: Predicted general trends

Local extinctions at low elevations; northern latitudes - colonisation at high elevations; southern latitudes

Initial range expansions of most mobile species, leading ultimately to range shifts.

Progressive de-coupling of species-species interactions

Spread of ecological generalists (both native & exotic) at the expense of native specialists

Global extinction of narrow-ranged endemics (with point above = homogenisation of the biosphere)

Fragmentation of geographical range of some generalists

Building resilience, facilitating transformation

Maintain well-functioning ecosystems

Protect a representative array of ecosystems

Remove or minimise existing stressors

Build appropriate connectivity

Identify and protect refugia

Pro-active interventions

Eco-engineering

Genetic preservation

Flexible policy and management approaches

Reconsider management objectives

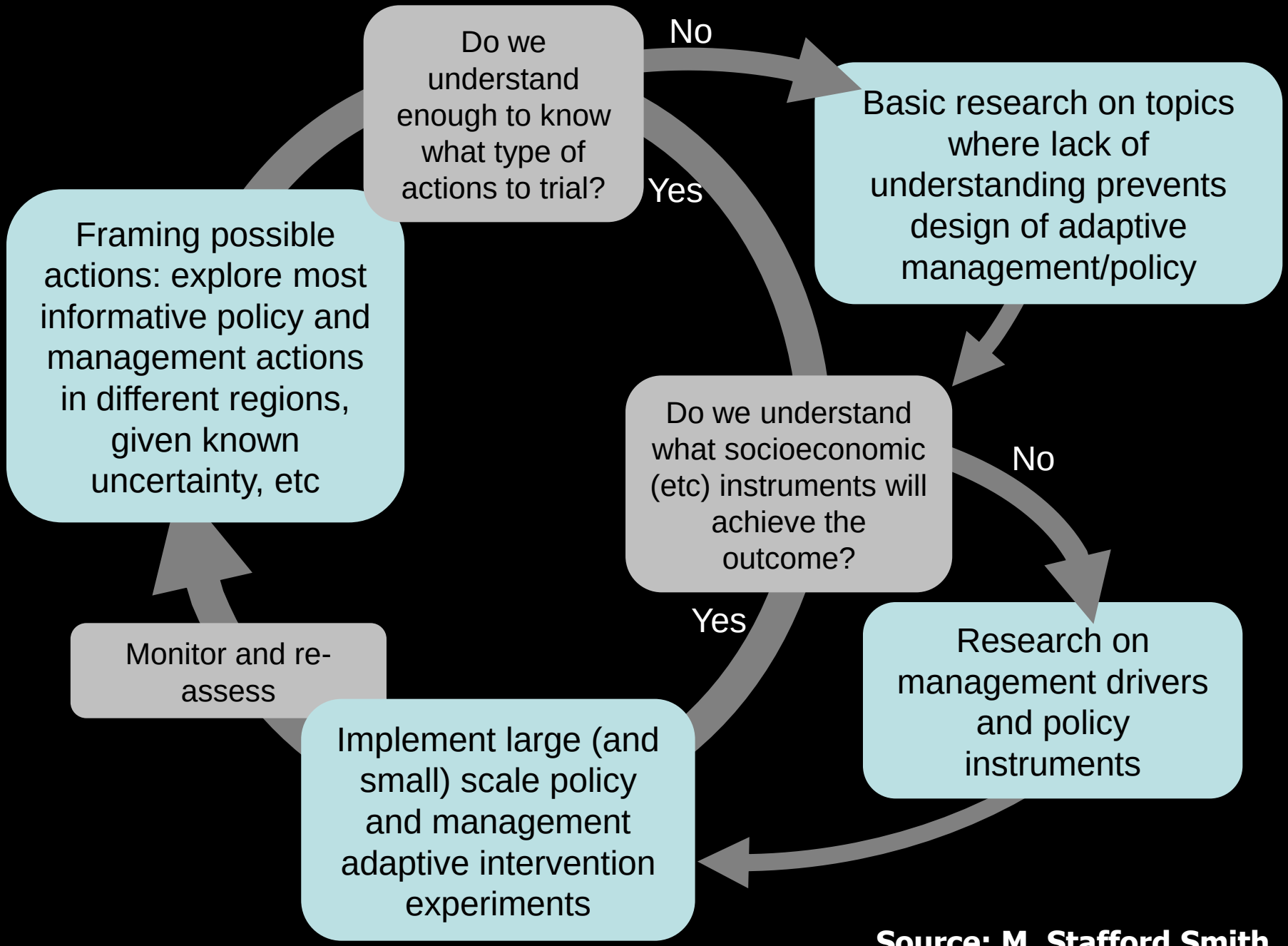
Consensus-building in society

Uncertainty about future climate projections is no excuse for delay

Greater focus on risk assessments

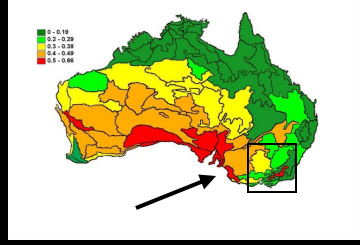
Active adaptive management

Opportunities from mitigation

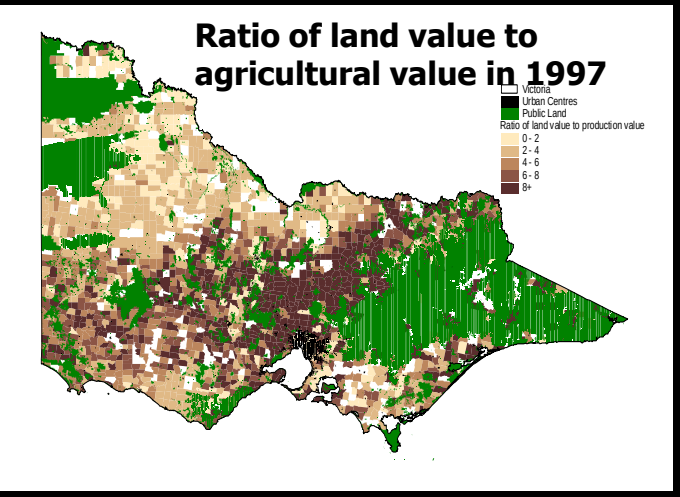


Source: M. Stafford Smith

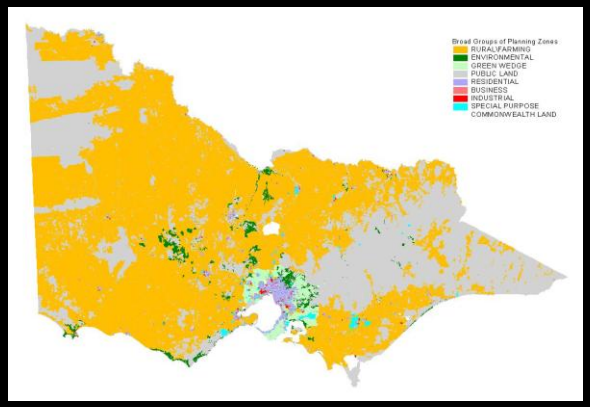
Integrated regional approaches:
State of Victoria, Australia



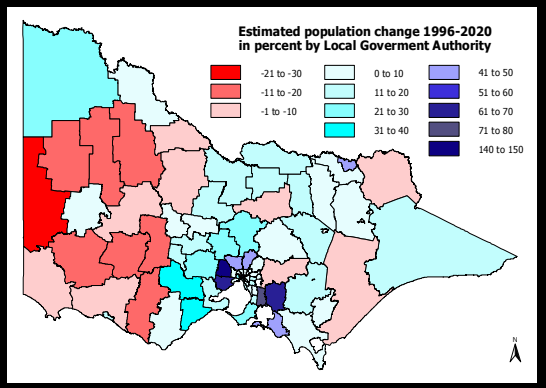
Land values



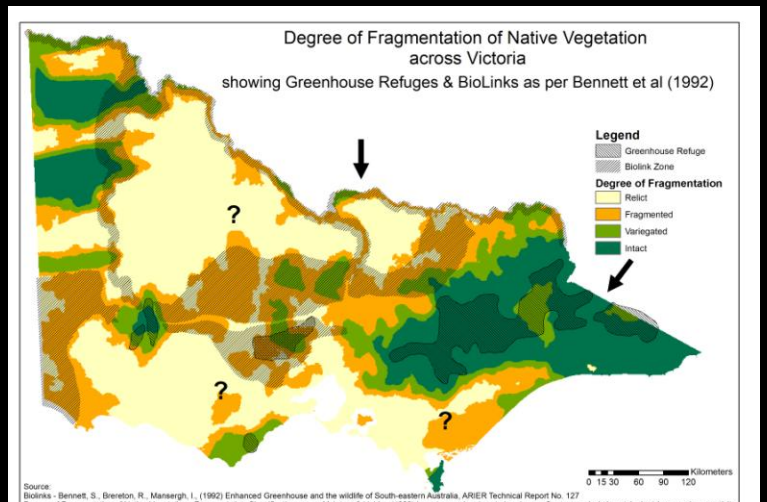
Agricultural planning zones



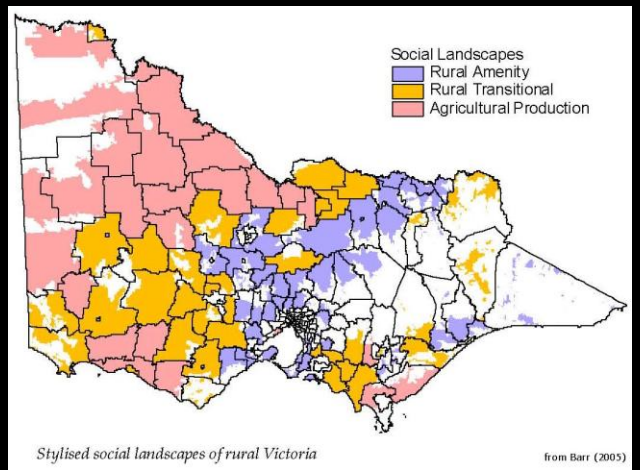
Demographic trends



Degree of vegetation fragmentation



Socio-economic trajectories



4. Key Messages

Build resilience and facilitate transformation

The most effective adaptation approach is to increase resilience of ecosystems and to "make space for species and ecosystems to self-adjust" as climate shifts. Management strategies include removing or minimising existing stressors and managing for appropriate connectivity.

Strengthen the conservation effort at all levels

Dealing with the climate change challenge effectively will require at least an order-of-magnitude increase in the conservation effort across the board - investment in natural capital; creating innovative, agile governance systems; generating widespread public support; enhancing off-reserve conservation, implementing regional integrated response strategies.

Meet the mitigation challenge

Australia's biodiversity has only so much capacity to adapt to climate change, and we are approaching that limit. Therefore, strong emissions mitigation action globally and in Australia is vital – but this must be carried out in ways that deliver both adaptation and mitigation benefits