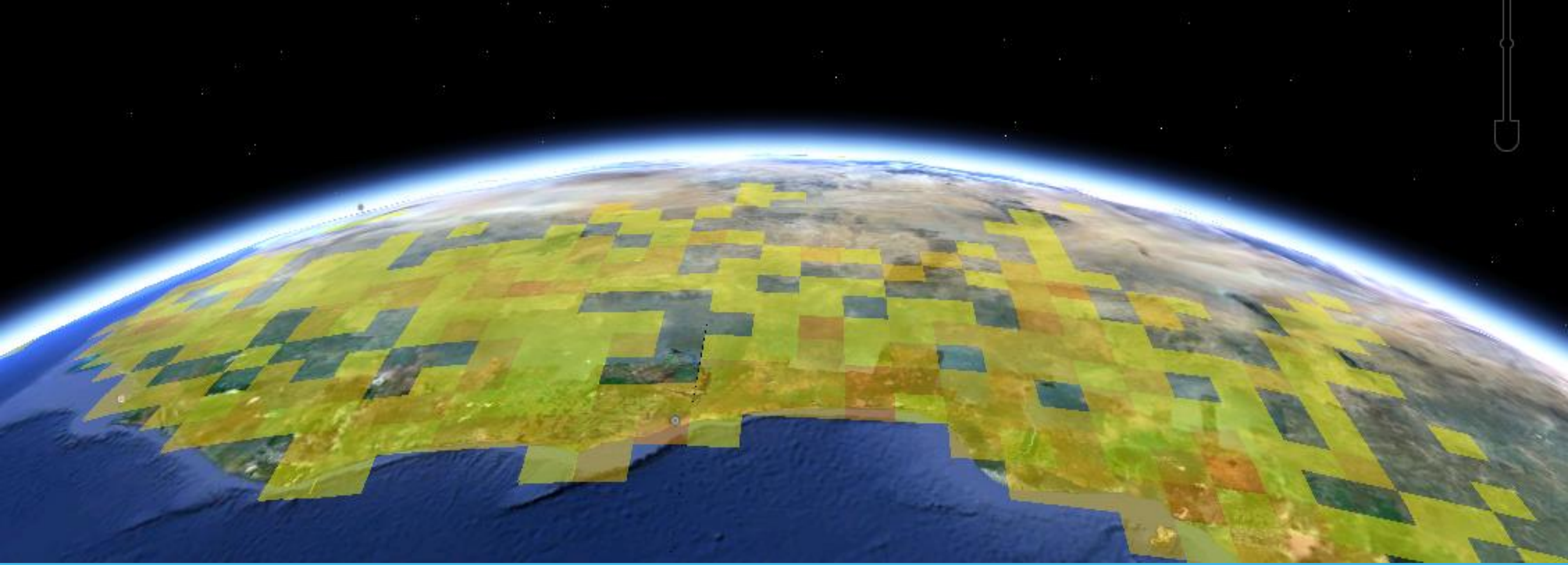
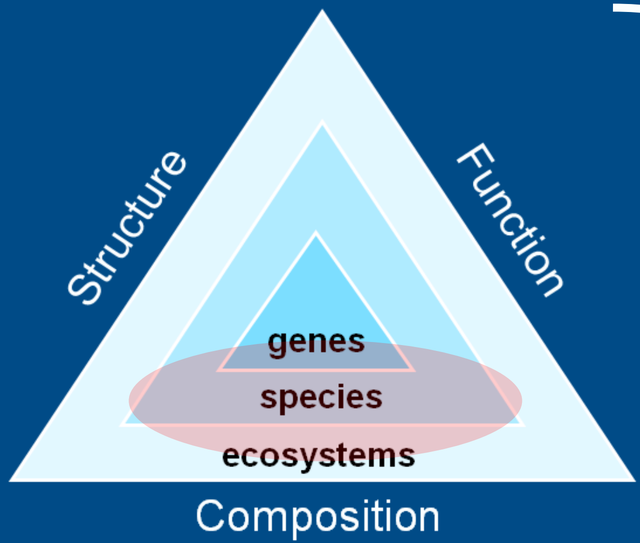


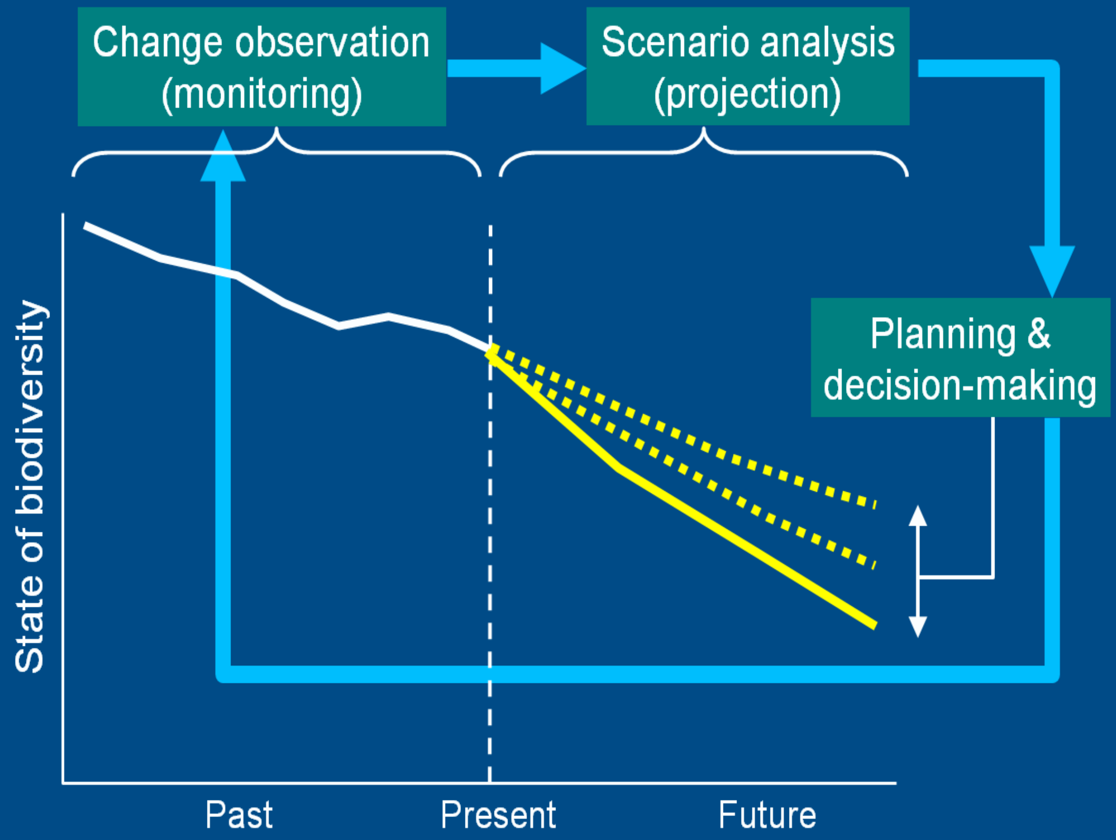
Using models of biodiversity as policy support tools to anticipate, avoid and manage impacts of global environmental change

Simon Ferrier, CSIRO Ecosystem Sciences

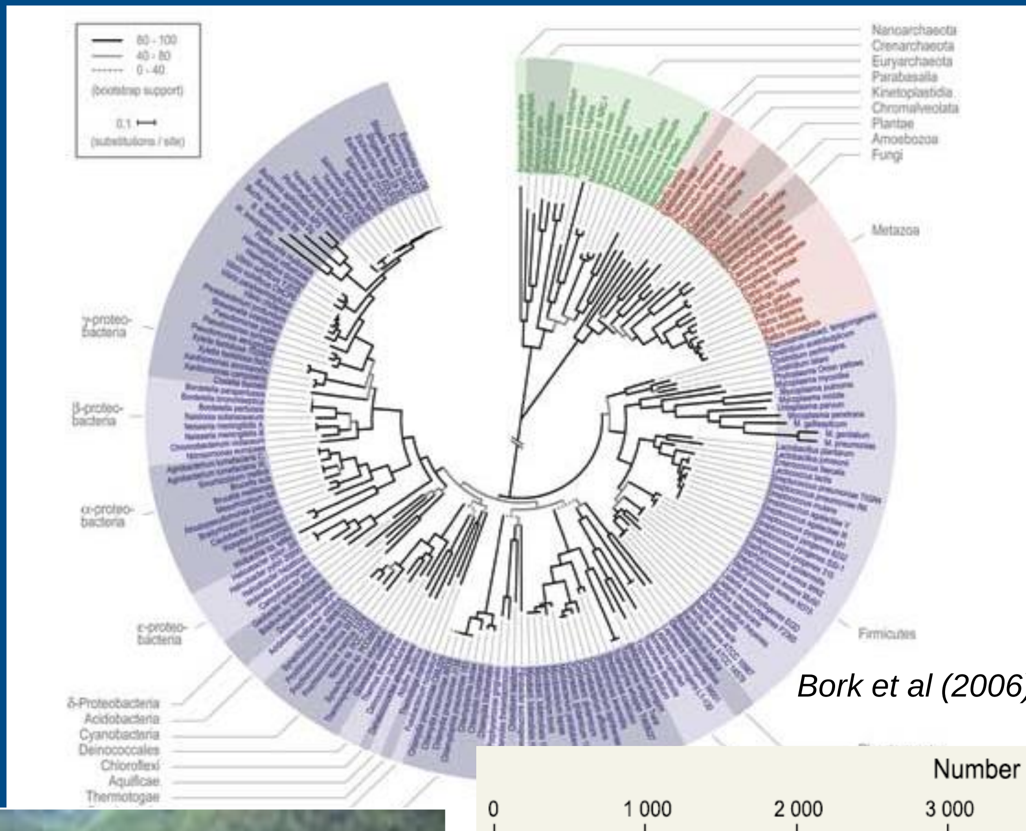
Belmont Forum Scoping Workshop on Biodiversity & Ecosystem Services
21 October 2013

Models inform multiple scales & modes of assessment addressing multiple dimensions & levels of biodiversity

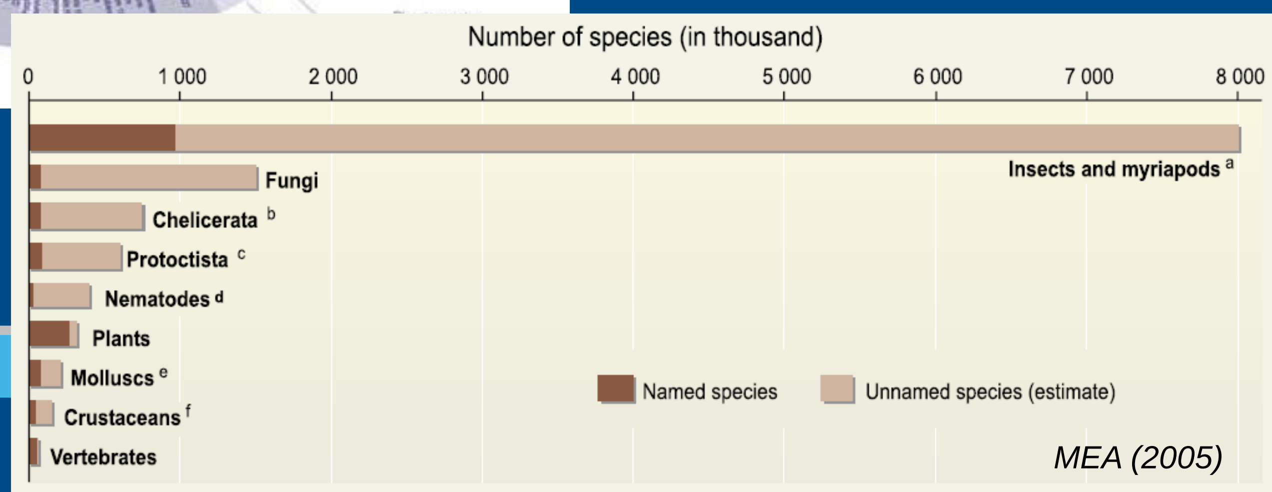




The challenge of the compositional dimension - biodiversity really is diverse, and poorly known

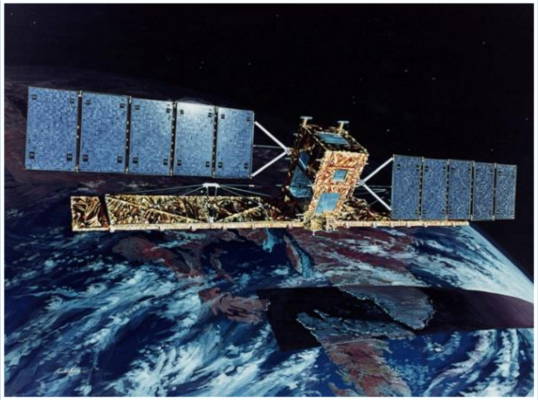


Bork et al (2006)



MEA (2005)

Two major sources of information on the state of biodiversity, with complementary strengths



Remote sensing

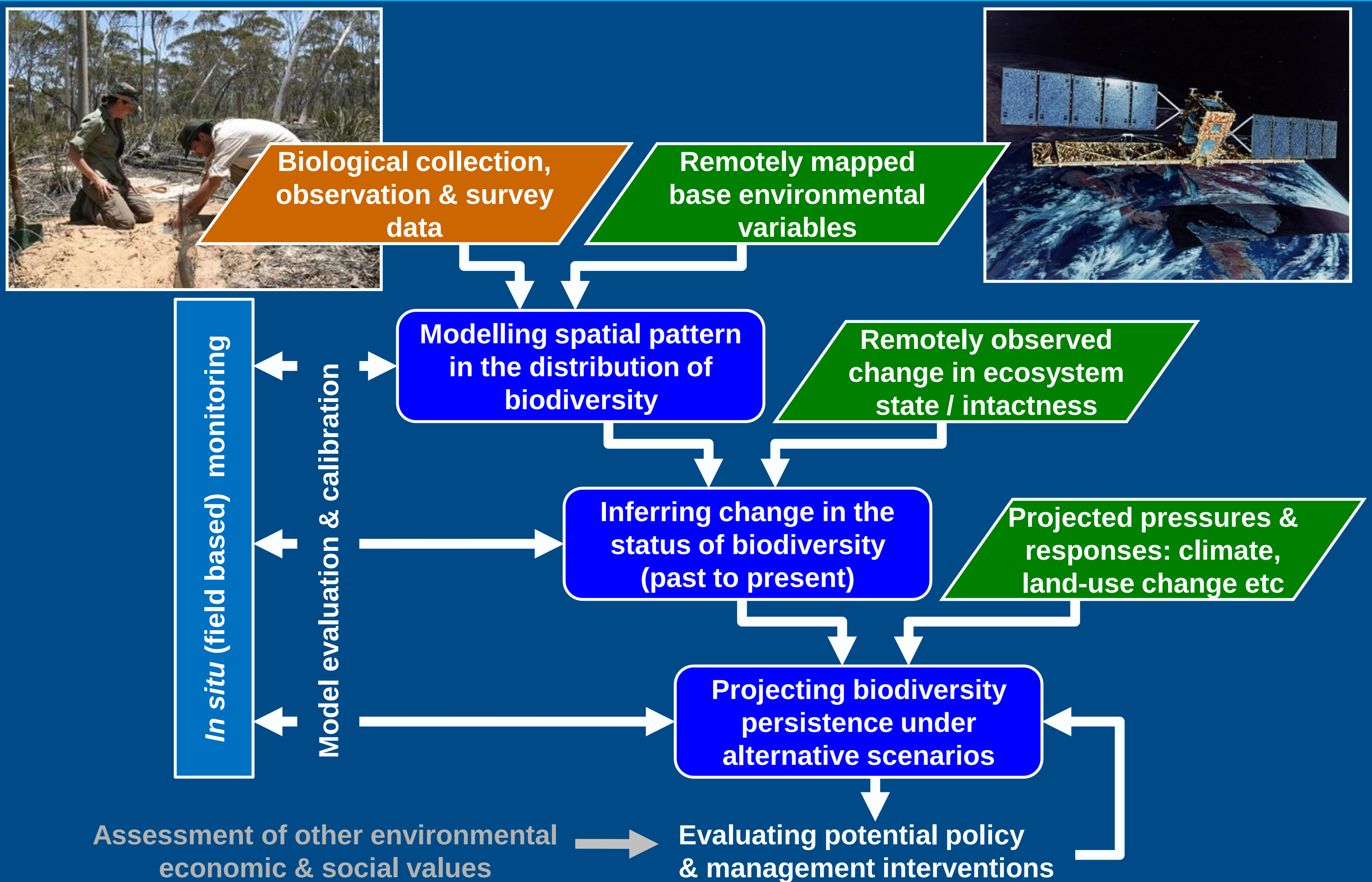
- complete spatial coverage
- reasonable detection of ecosystem structure & function, but not of biodiversity composition at species/gene level

- direct detection of structure, function and composition
- but sparse, and uneven, spatial coverage

In situ (field based) observation

CSIRO

Therefore need integration through modelling, laying the foundation for change observation & projection



Spectrum of distributional modelling strategies

Ferrier & Guisan (2006) *Journal of Applied Ecology*

- interested in individual species of particular concern
- reasonable number of records per species

Individual species distribution (niche) modelling

"Predict first, assemble later" techniques

Simultaneous multi-response modelling of multiple species

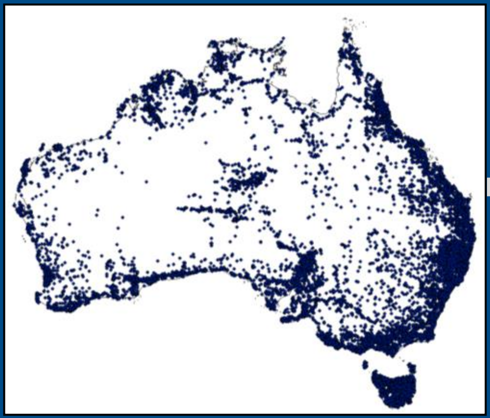
"Assemble first, predict later" techniques

Macroecological modelling of collective biodiversity properties (richness, compositional turnover etc)

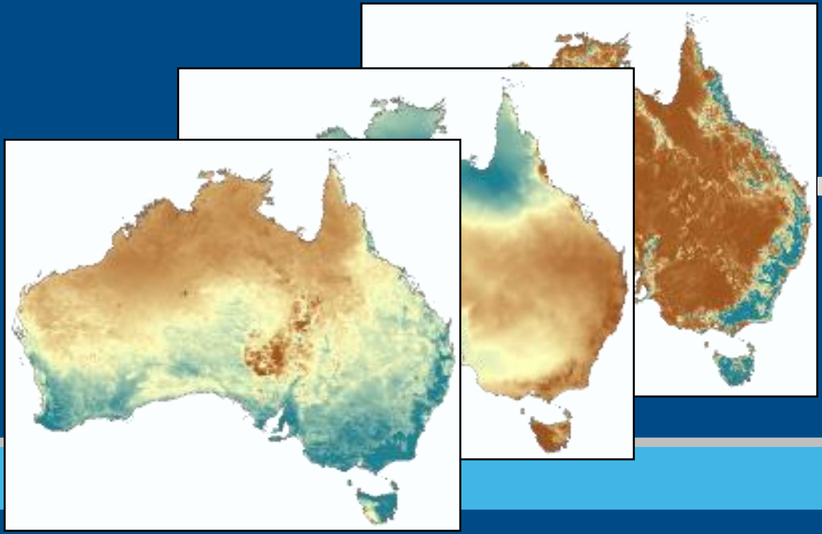
- interested in biodiversity as a whole
- huge number of species, each with few (or no) records

- e.g. modelling spatial turnover in biodiversity composition using generalised dissimilarity modelling

77,000 records of 2,700 land-snail species

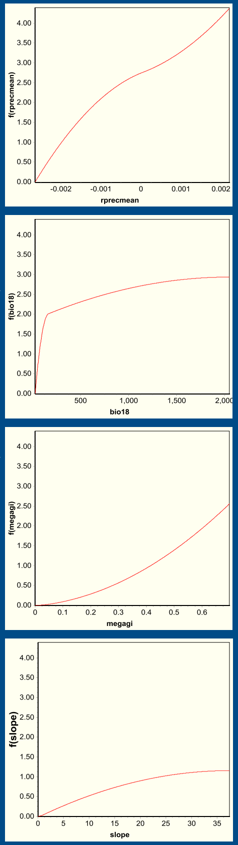


Remotely derived environmental variables:
climate, terrain, soils, geographic isolation etc



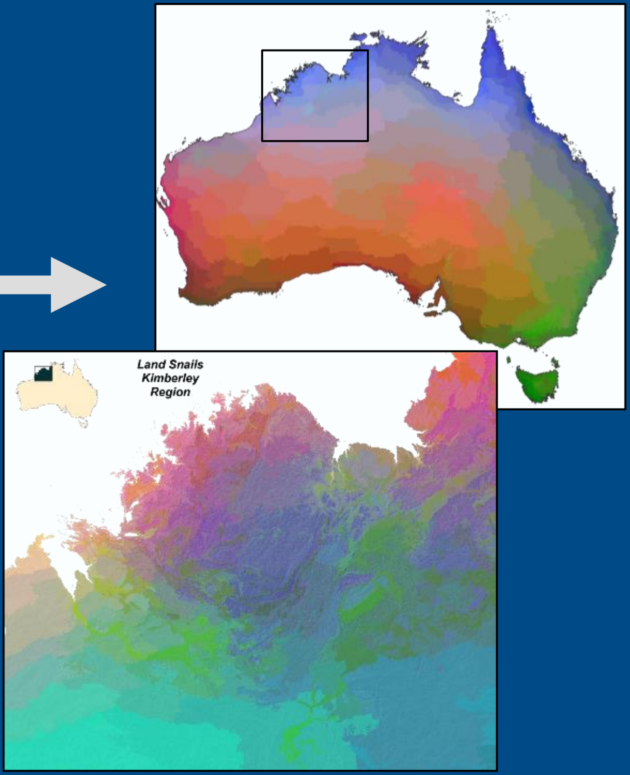
etc ...

Generalised dissimilarity modelling (GDM)



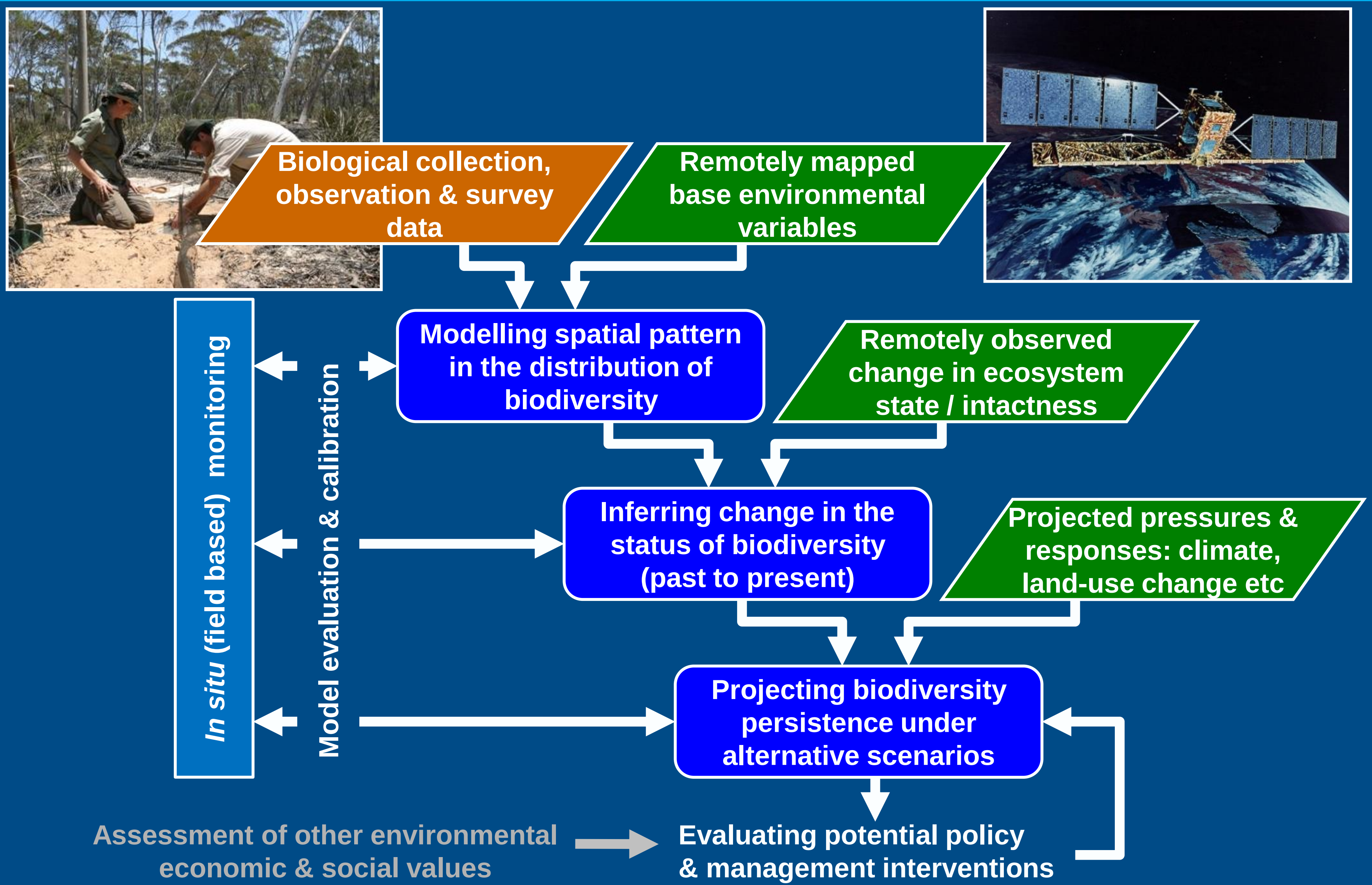
etc ...

Spatial pattern in compositional turnover

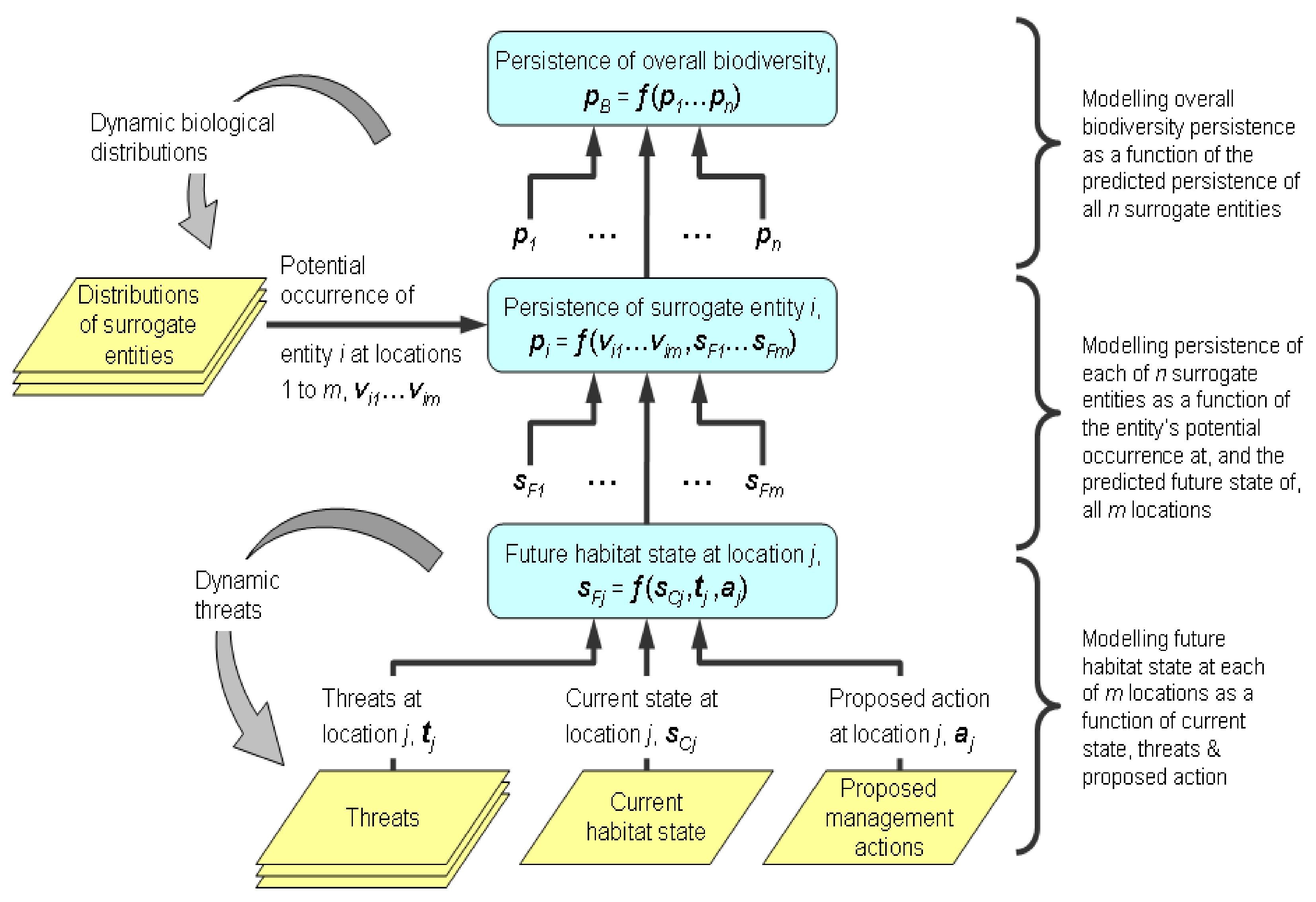


Funded by Aust. Dept of Sustainability, Environment, Water, Population & Communities

Adding the temporal dimension – projecting biodiversity persistence under alternative scenarios

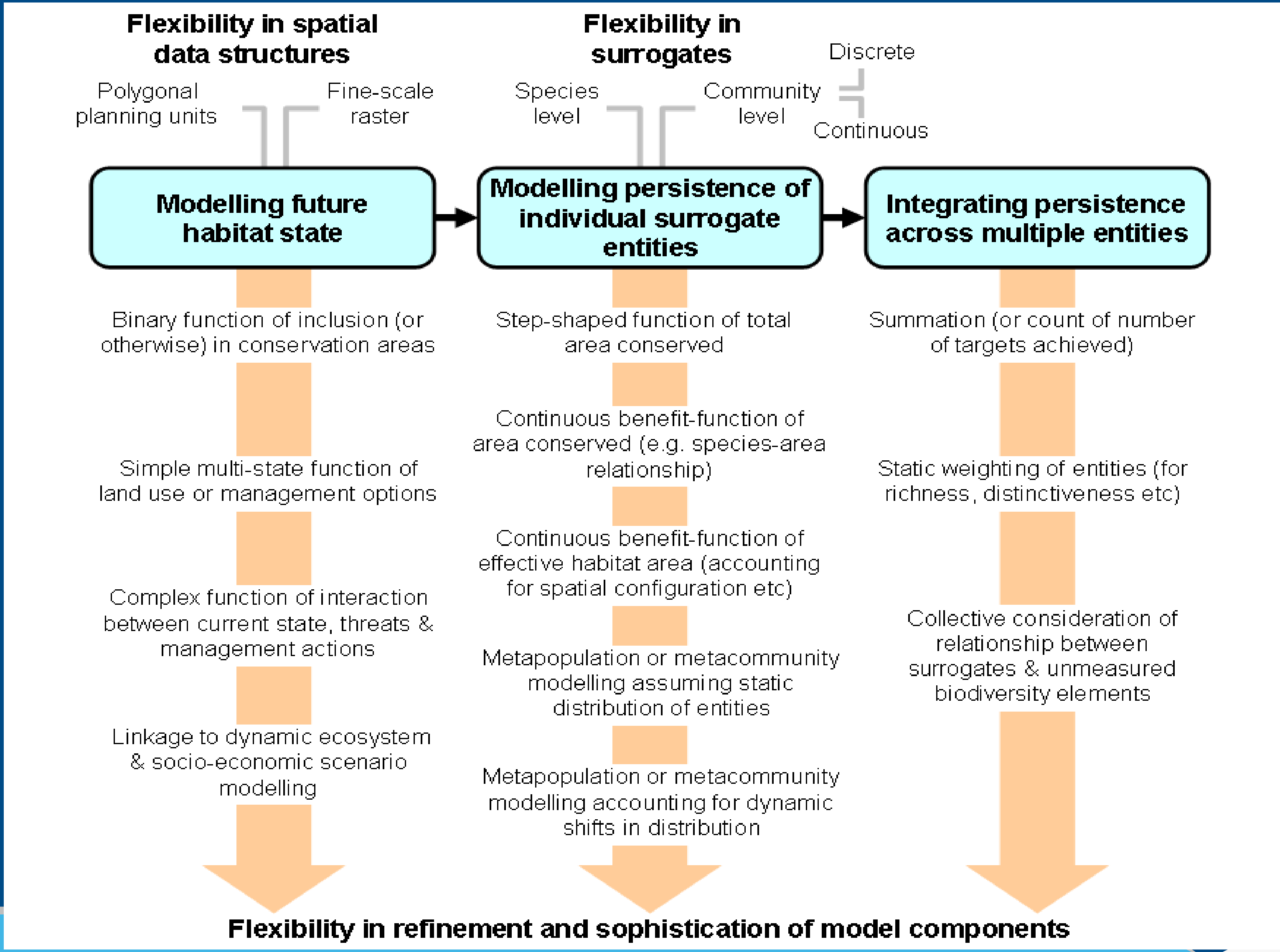


A general framework for modelling persistence of compositional diversity – three broad components



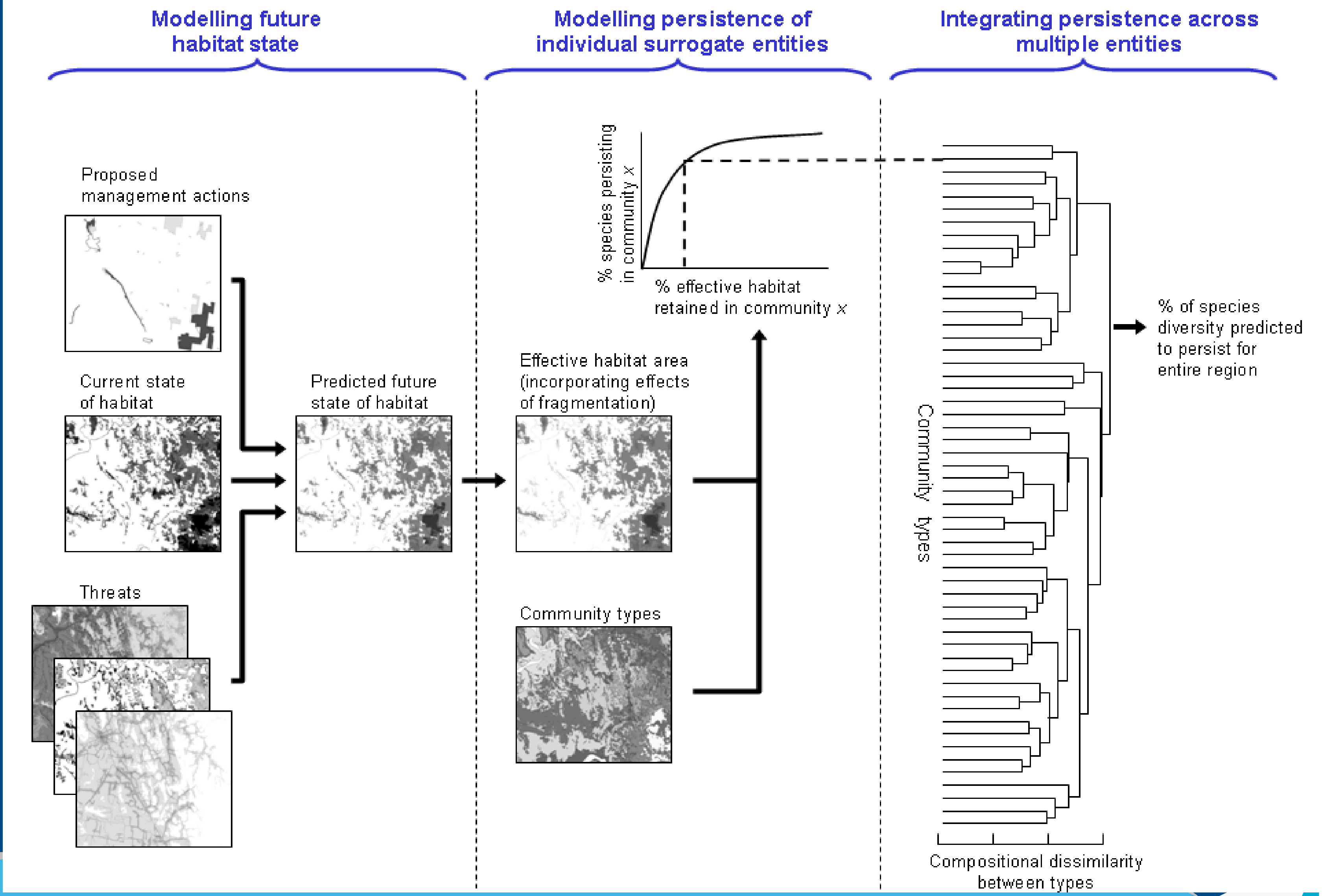
Ferrier, S & Drielsma, M (2010) *Diversity & Distributions* 16: 386-492

Flexibility in implementing these components ...



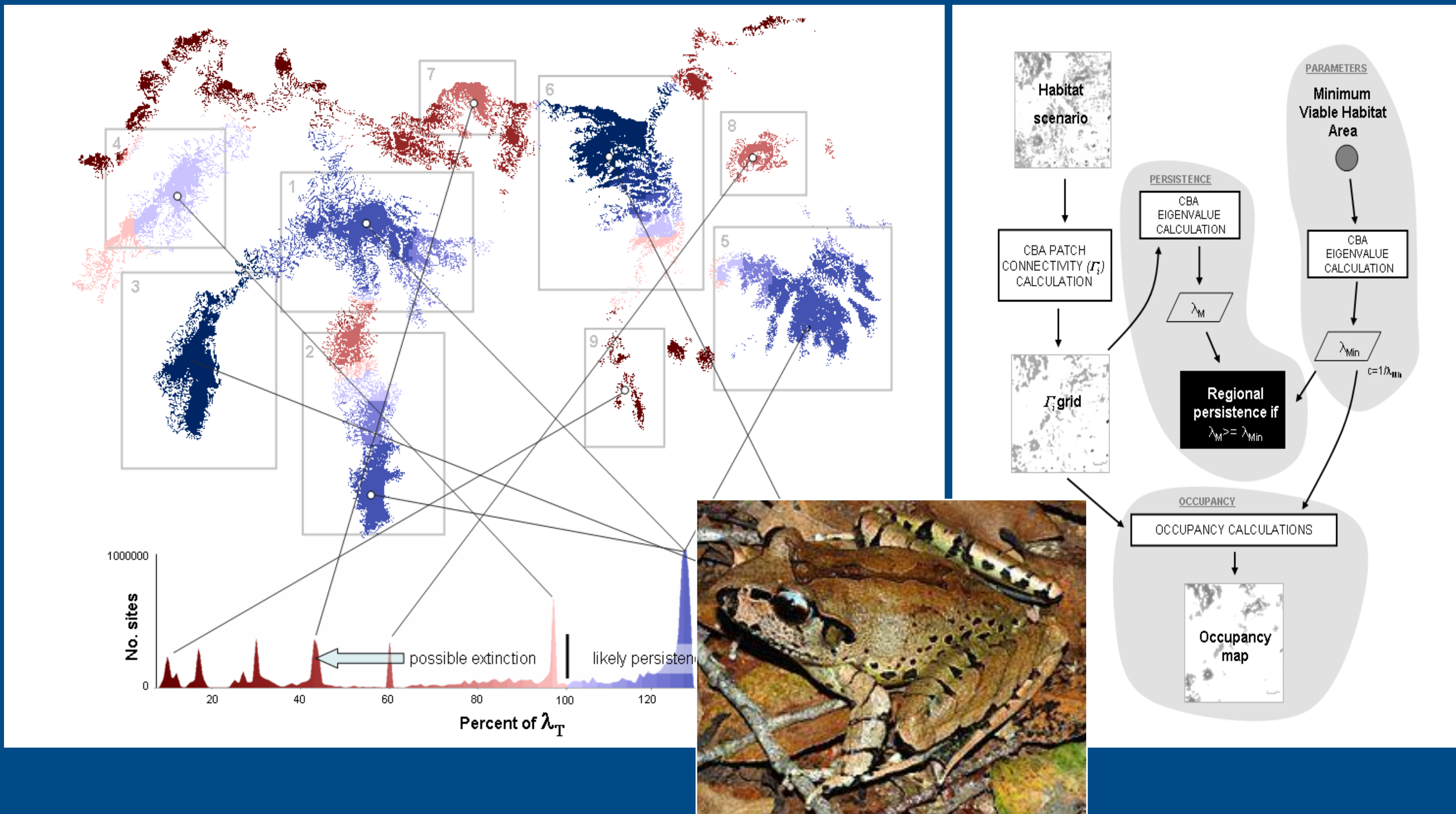
Ferrier, S & Drielsma, M (2010) *Diversity & Distributions* 16: 386-492

... from simple pattern-based approaches ...



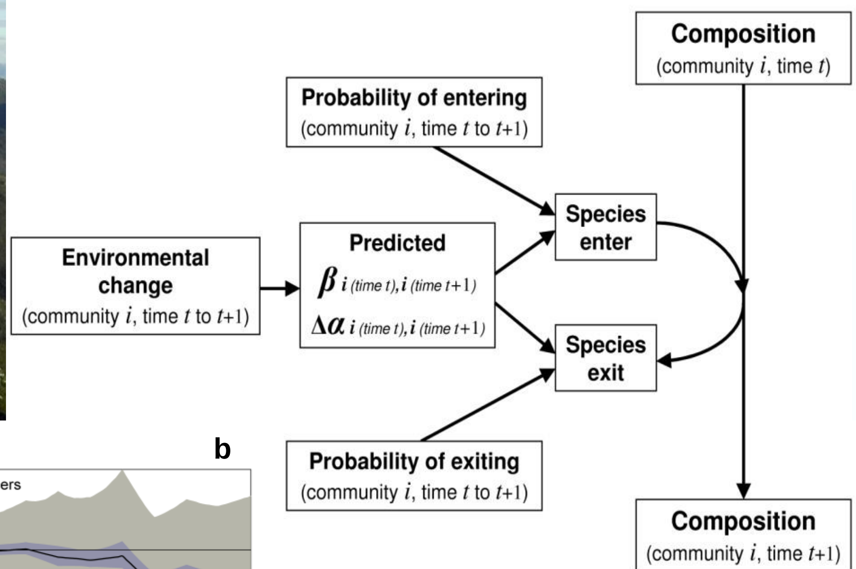
Ferrier, S & Drielsma, M (2010) *Diversity & Distributions* 16: 386-492

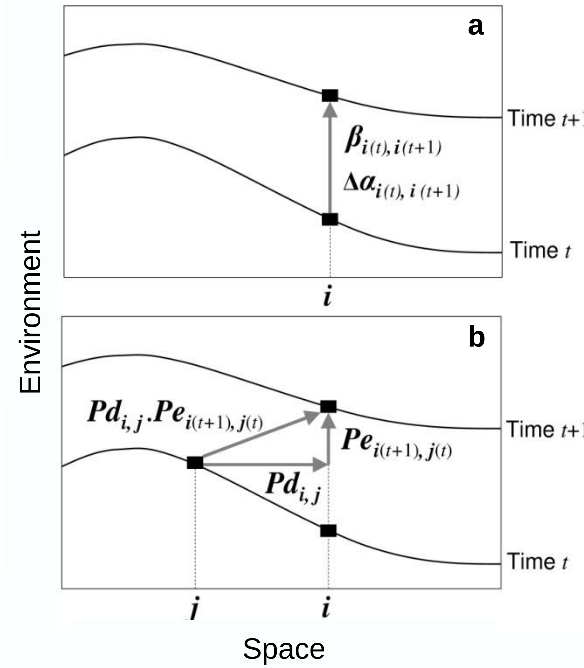
... to more complex process-based approaches, e.g. metapopulation-capacity modelling ...

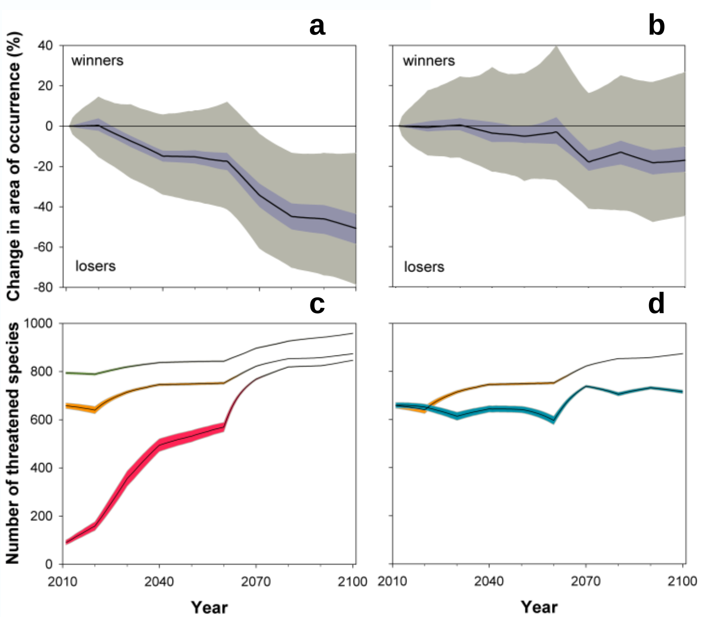


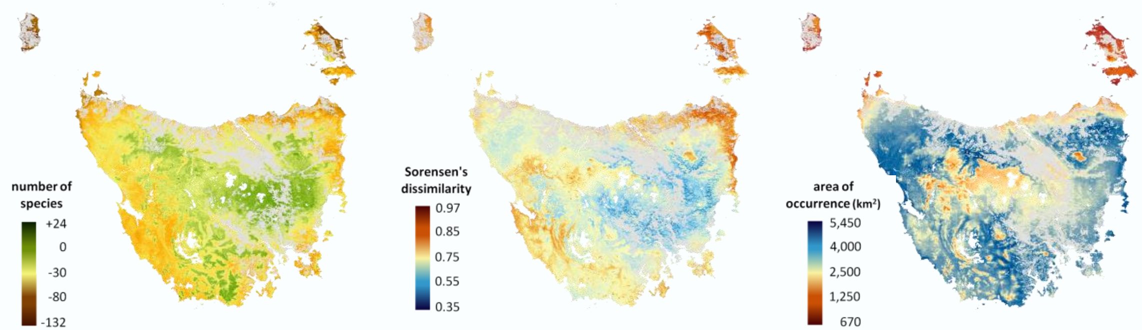
Drielsma, M & Ferrier, S (2009) *Biological Conservation* 142: 529-540

... dynamic macroecological modelling of metacommunity persistence (accounting for climate change)



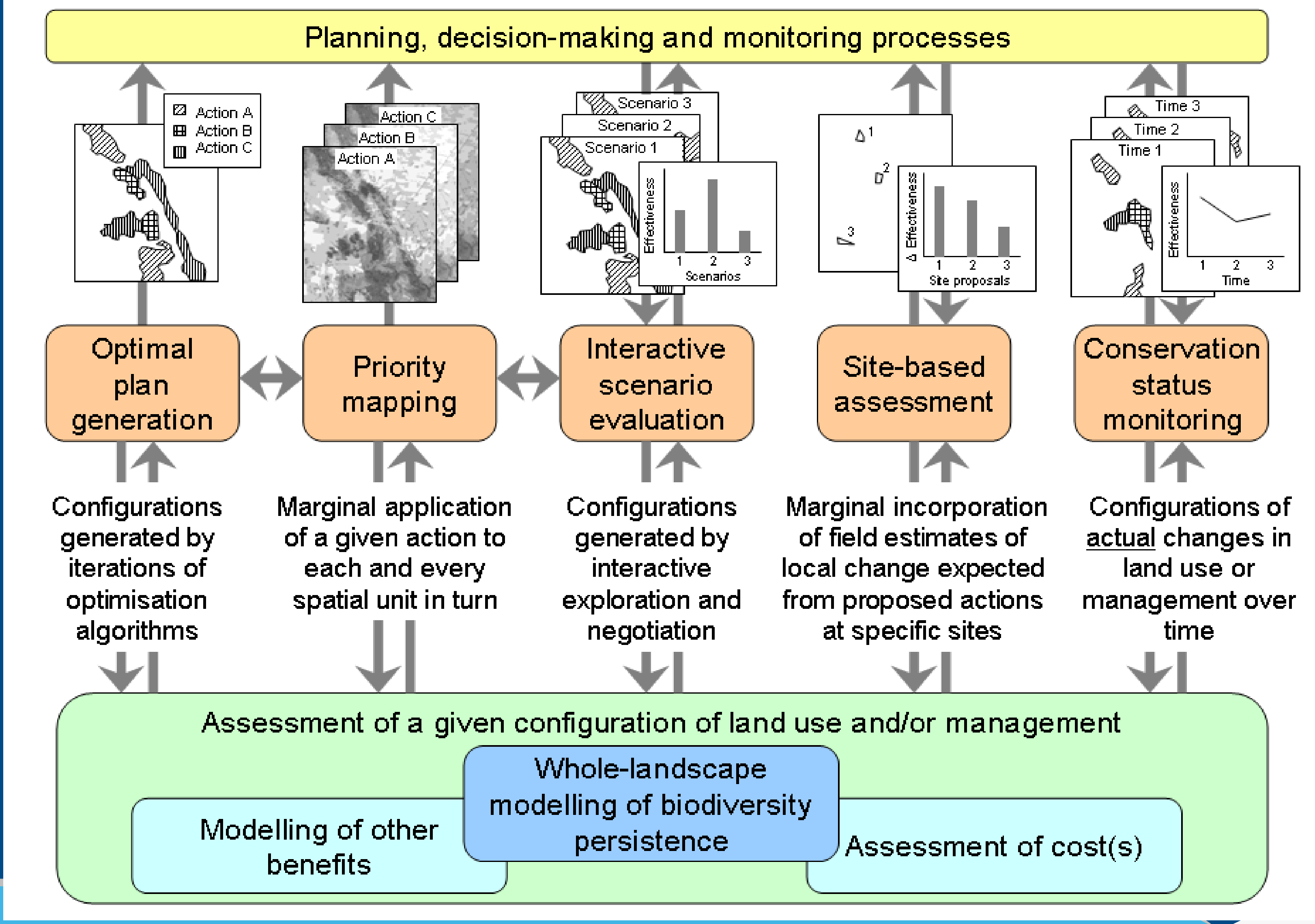






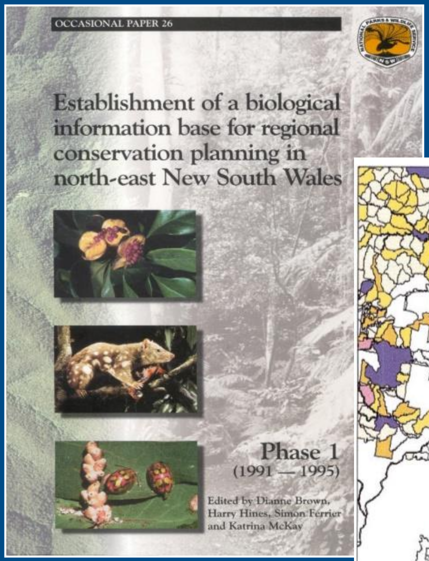
Mokany, K *et al* (2012) *Global Change Biology* 18: 3149-3159

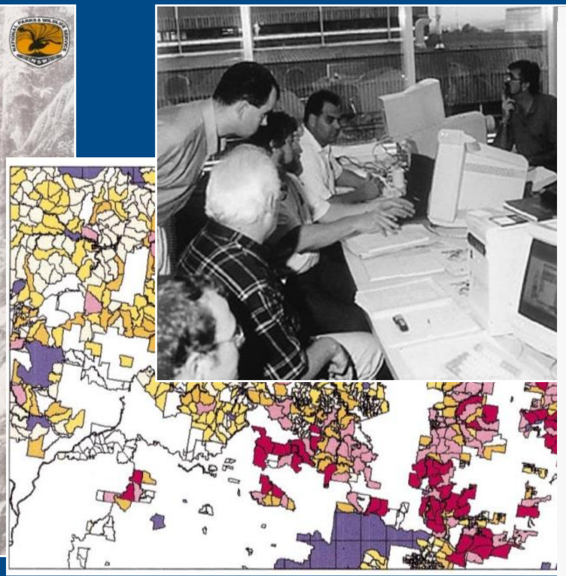
A common foundation for multiple forms of higher-level assessment across multiple scales

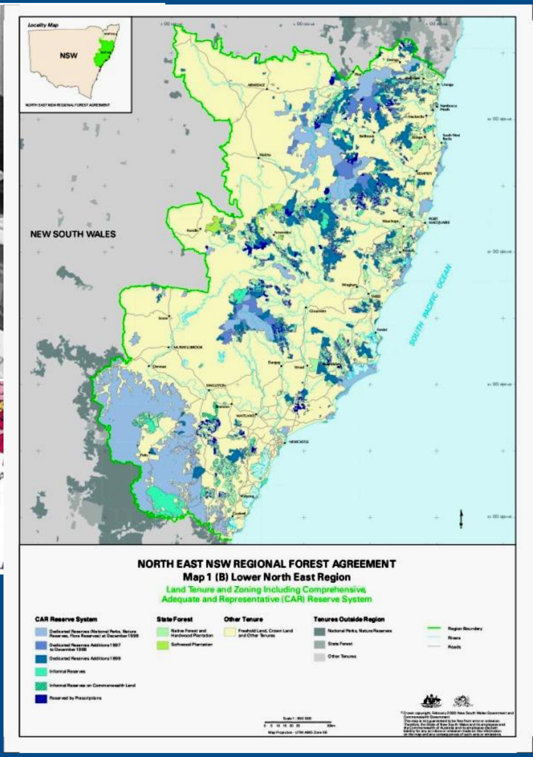


Ferrier, S & Drielsma, M (2010) *Diversity & Distributions* 16: 386-492

Landscape / regional scale applications – e.g. conservation planning in north-east NSW forests in the 1990s ...







Modelled species distributions & vegetation communities

Protection targets

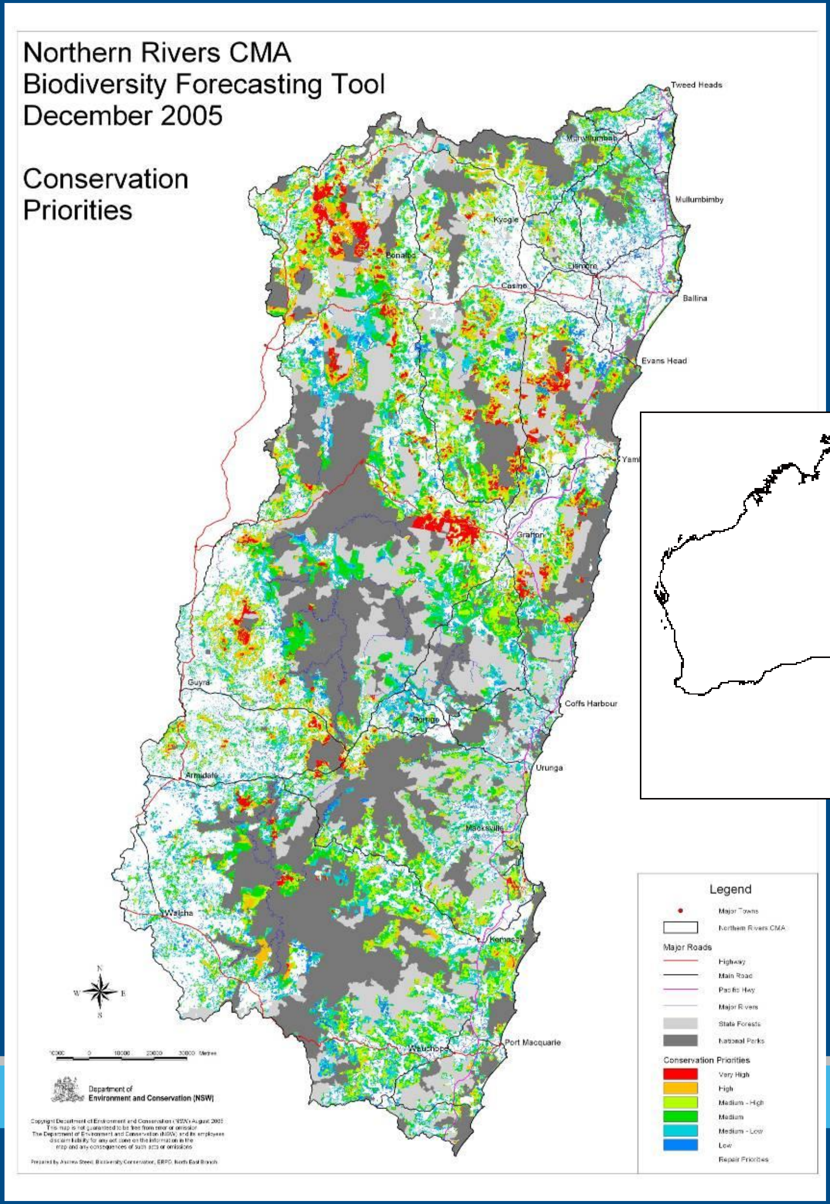
→ Conservation prioritisation (irreplaceability analysis)

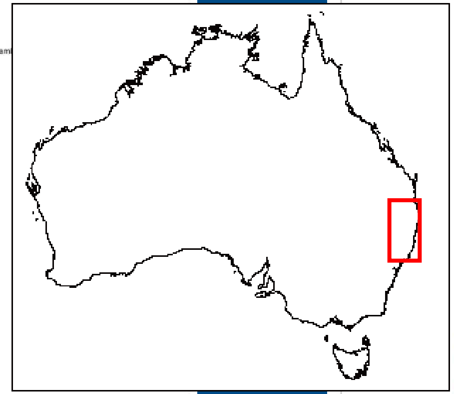
Timber resource assessment

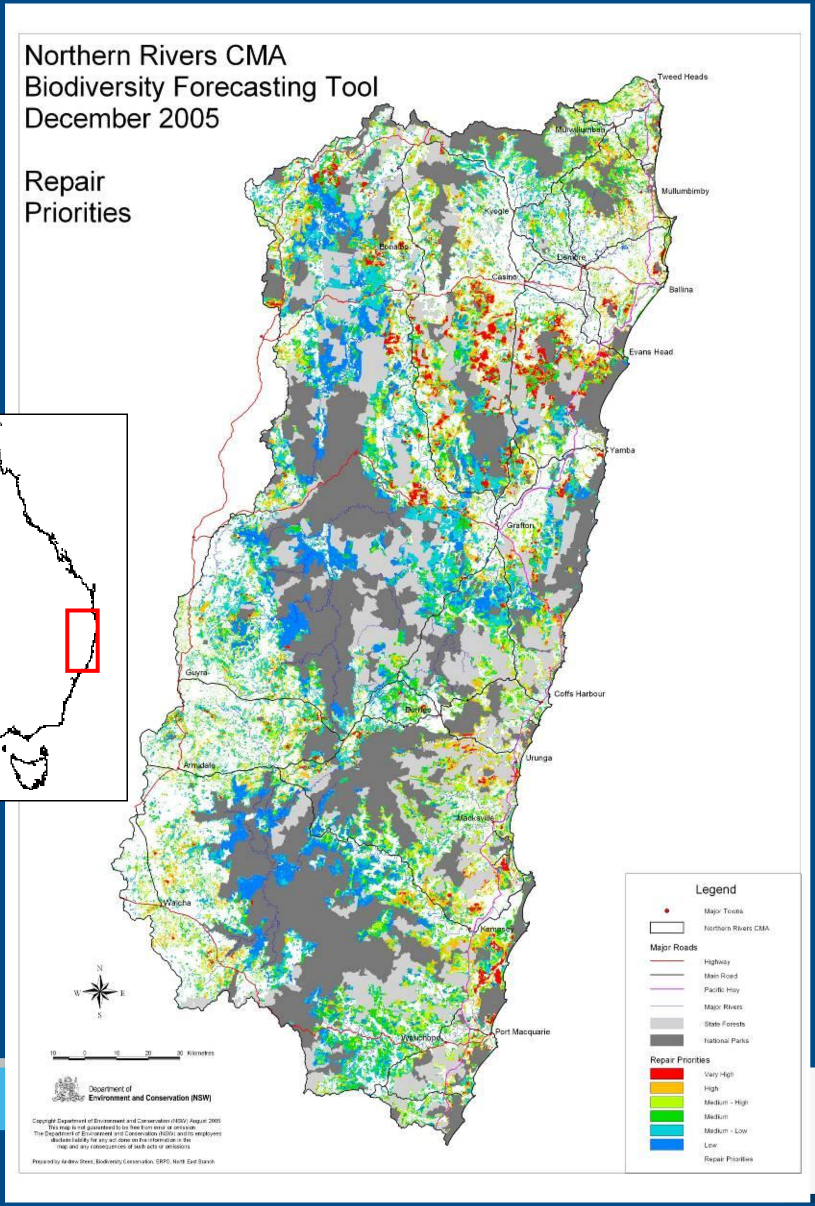
→ Negotiation & selection of new reserves

Ferrier, S, Pressey, R & Barrett, T (2000) *Biological Conservation* 93: 303-325

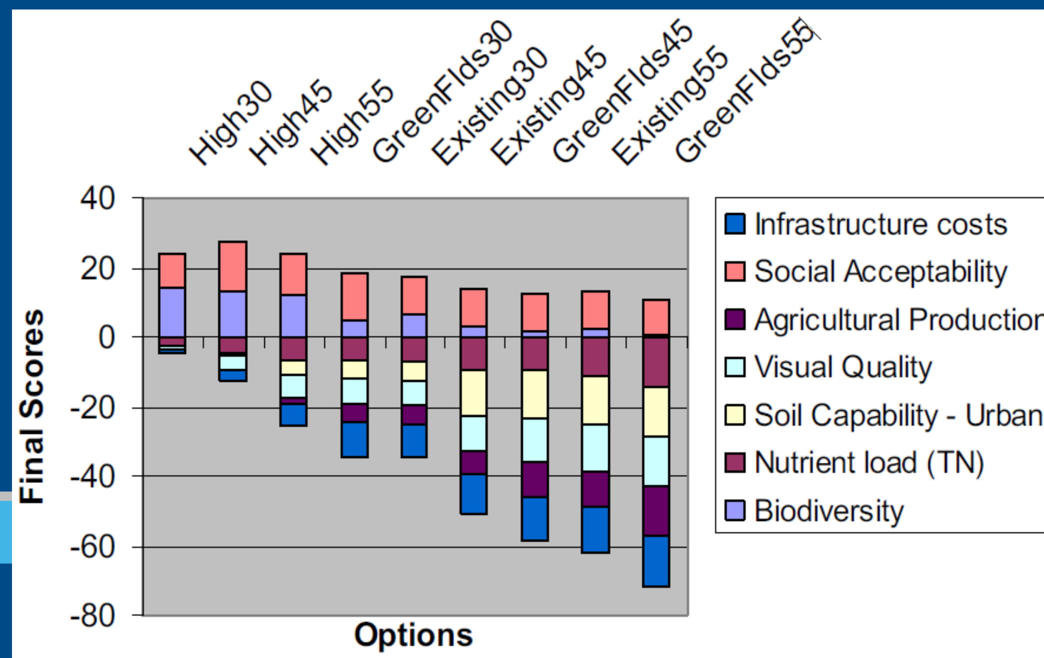
... whole-landscape prioritisation of protective and restorative management actions ...



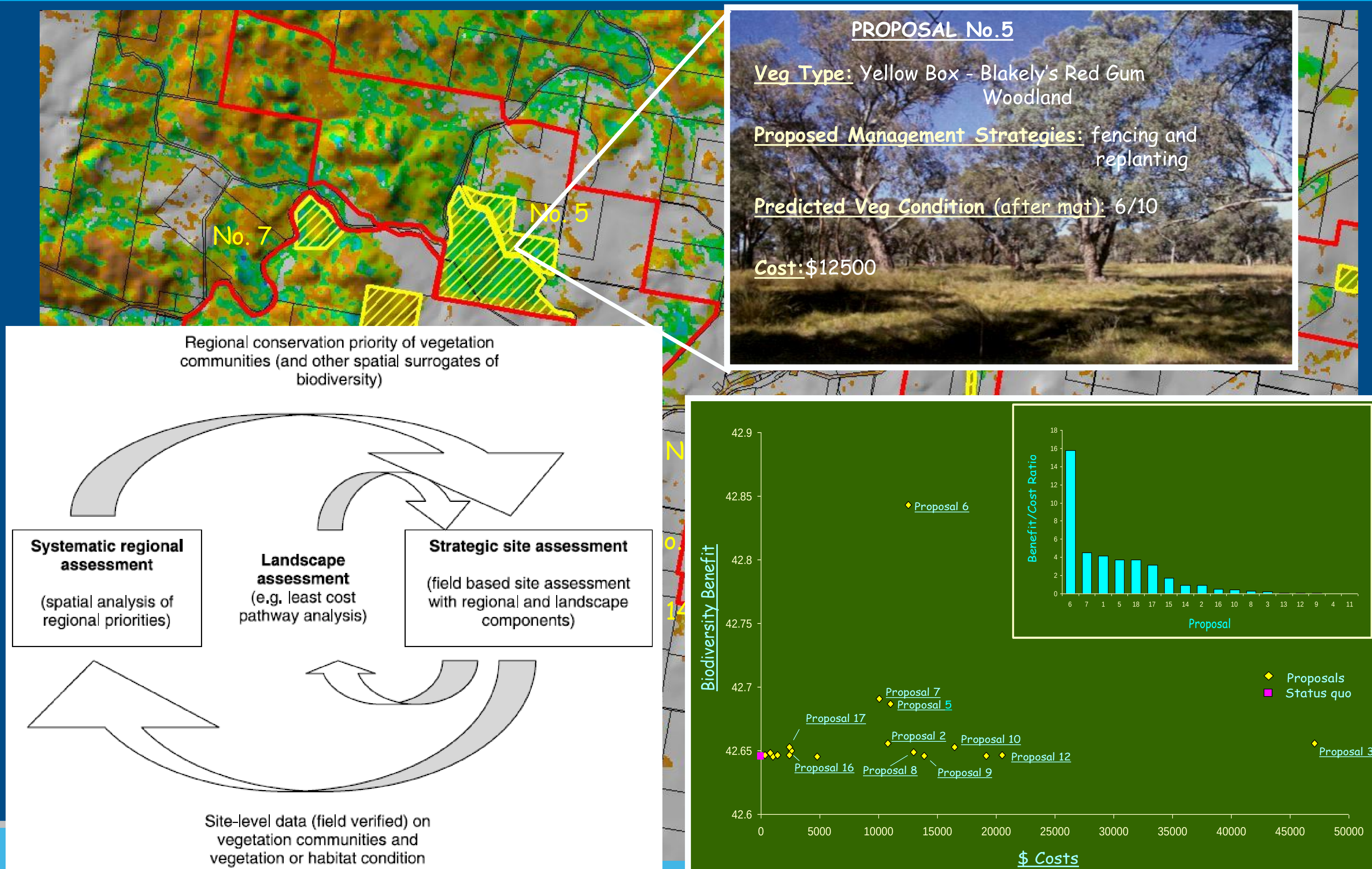




... multi-objective environmental / social / economic evaluation of alternative land-use scenarios ...

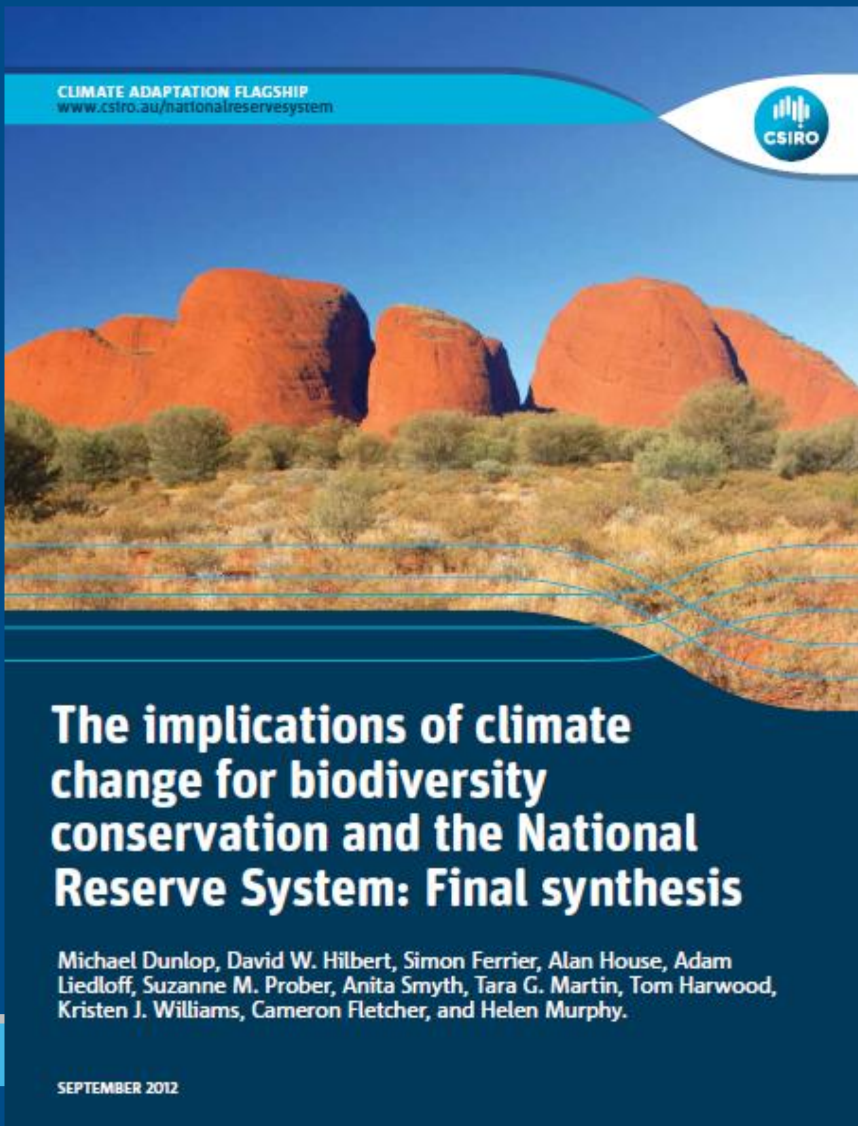


... site-based assessment of environmental stewardship proposals within a whole-landscape context



Seddon JA *et al* (2010) *Conservation Letters* 3: 415-424

National / continental scale applications – e.g. climate change impact & vulnerability assessment ...

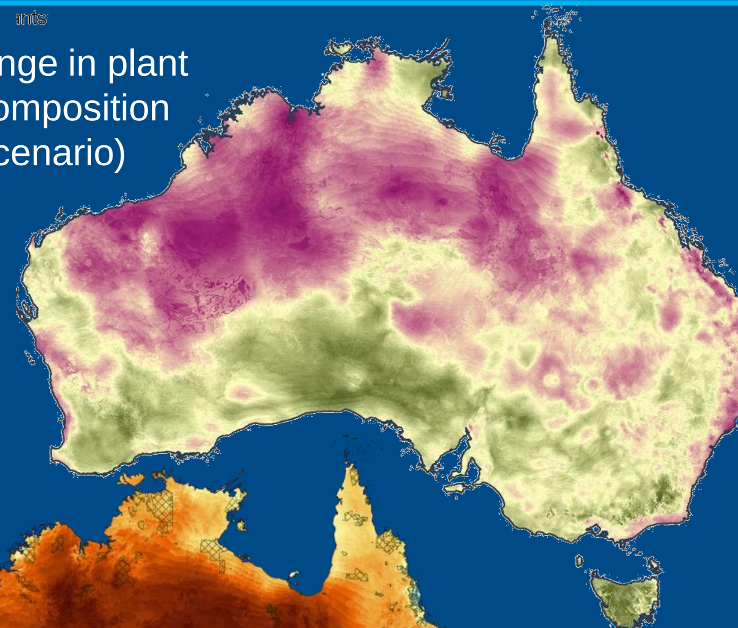

CLIMATE ADAPTATION FLAGSHIP
www.csiro.au/nationalreservesystem

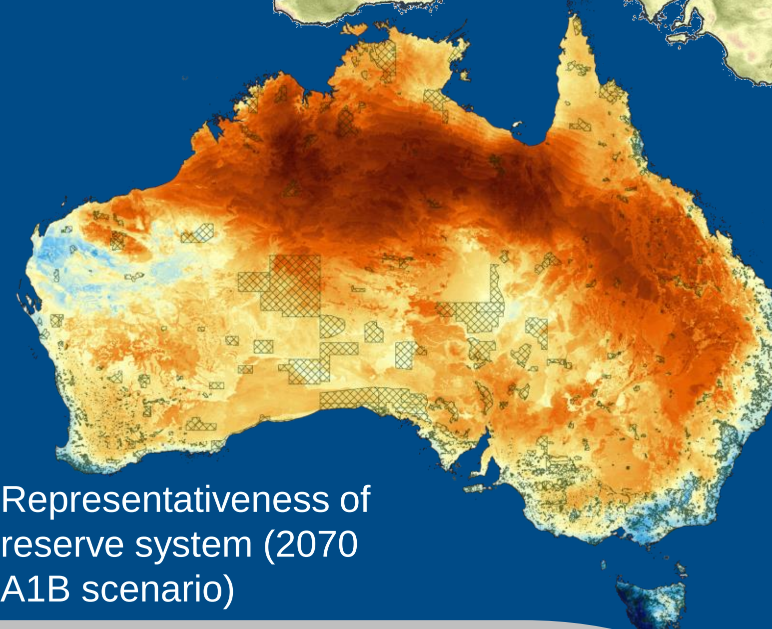
The implications of climate change for biodiversity conservation and the National Reserve System: Final synthesis

Michael Dunlop, David W. Hilbert, Simon Ferrier, Alan House, Adam Liedloff, Suzanne M. Prober, Anita Smyth, Tara G. Martin, Tom Harwood, Kristen J. Williams, Cameron Fletcher, and Helen Murphy.

SEPTEMBER 2012

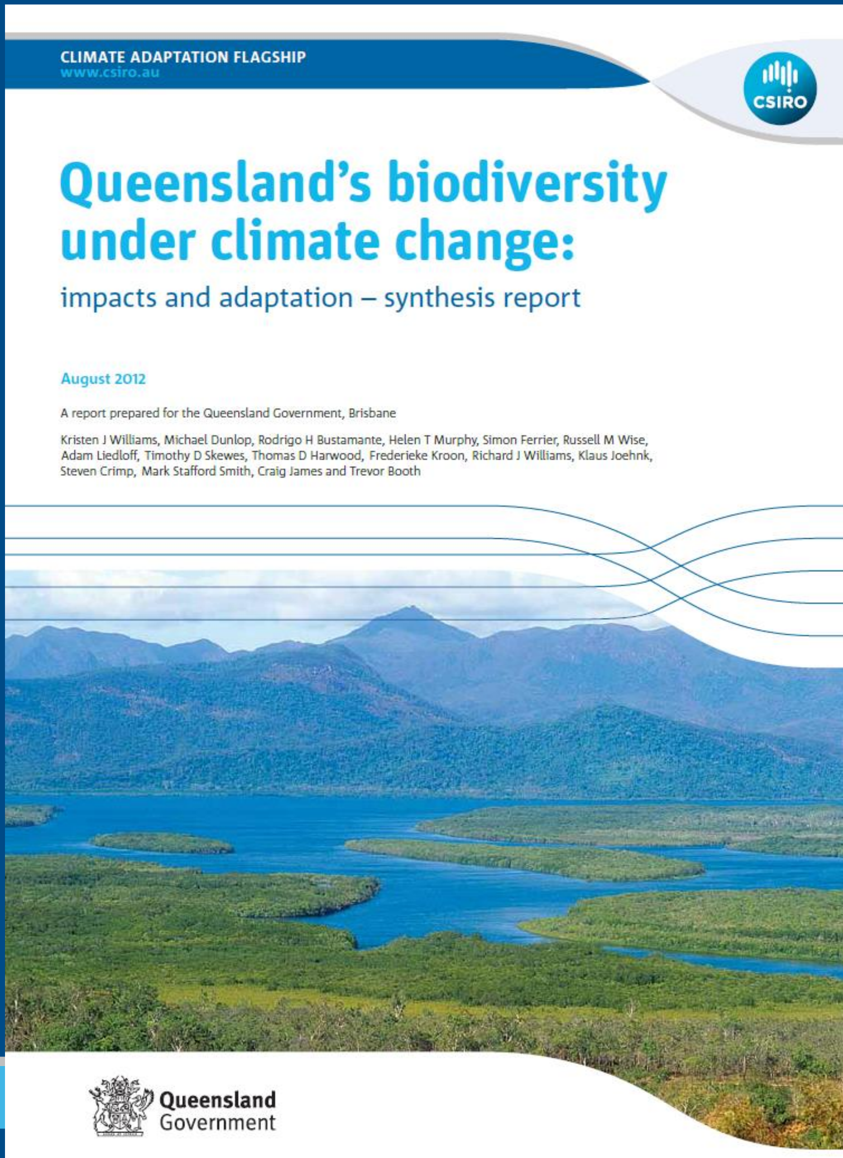
Potential change in plant community composition (2030 A1FI scenario)





Representativeness of reserve system (2070 A1B scenario)

... also informing policy & planning at state (provincial) scale ...


CLIMATE ADAPTATION FLAGSHIP
www.csiro.au

CSIRO

Queensland's biodiversity under climate change:

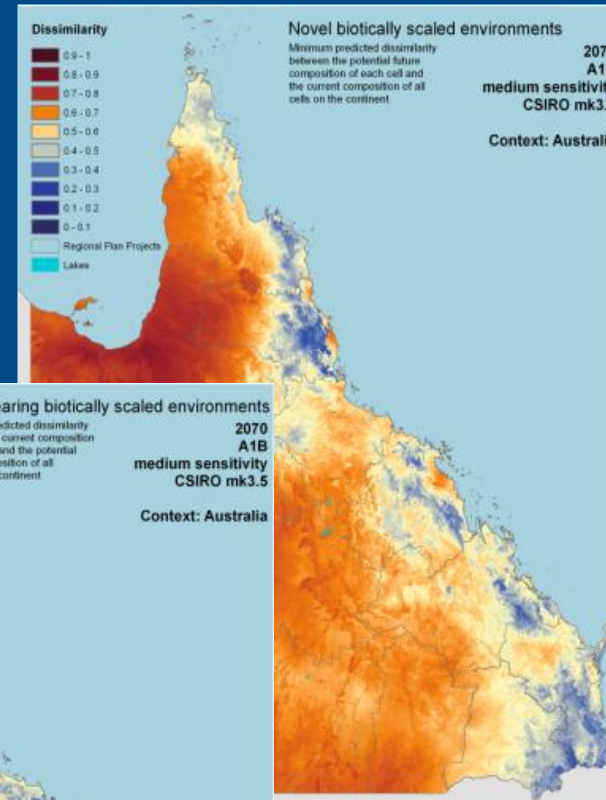
impacts and adaptation – synthesis report

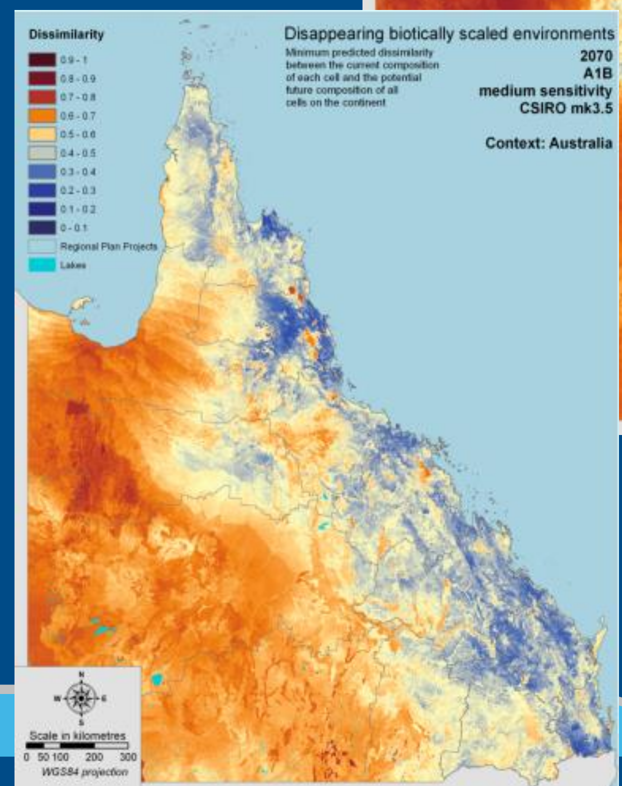
August 2012

A report prepared for the Queensland Government, Brisbane

Kristen J Williams, Michael Dunlop, Rodrigo H Bustamante, Helen T Murphy, Simon Ferrier, Russell M Wise, Adam Liedloff, Timothy D Skewes, Thomas D Harwood, Frederieke Kroon, Richard J Williams, Klaus Joehnk, Steven Crimp, Mark Stafford Smith, Craig James and Trevor Booth

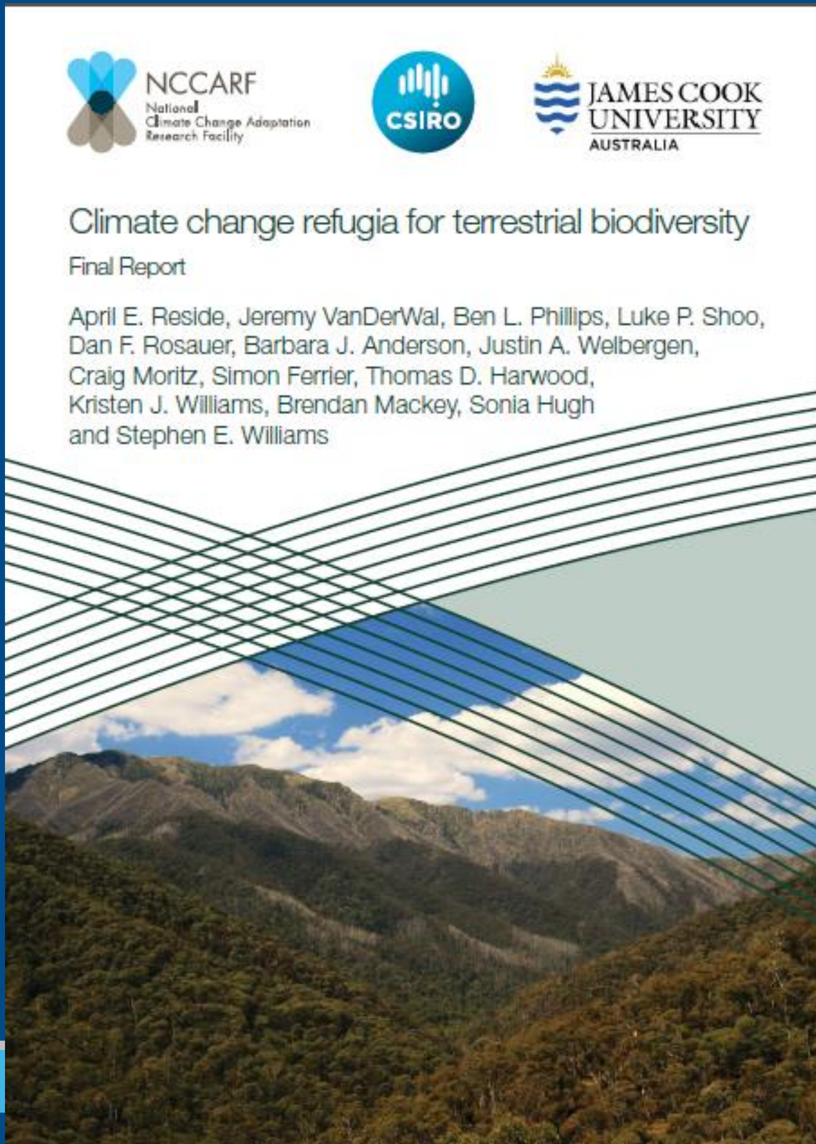
Queensland Government

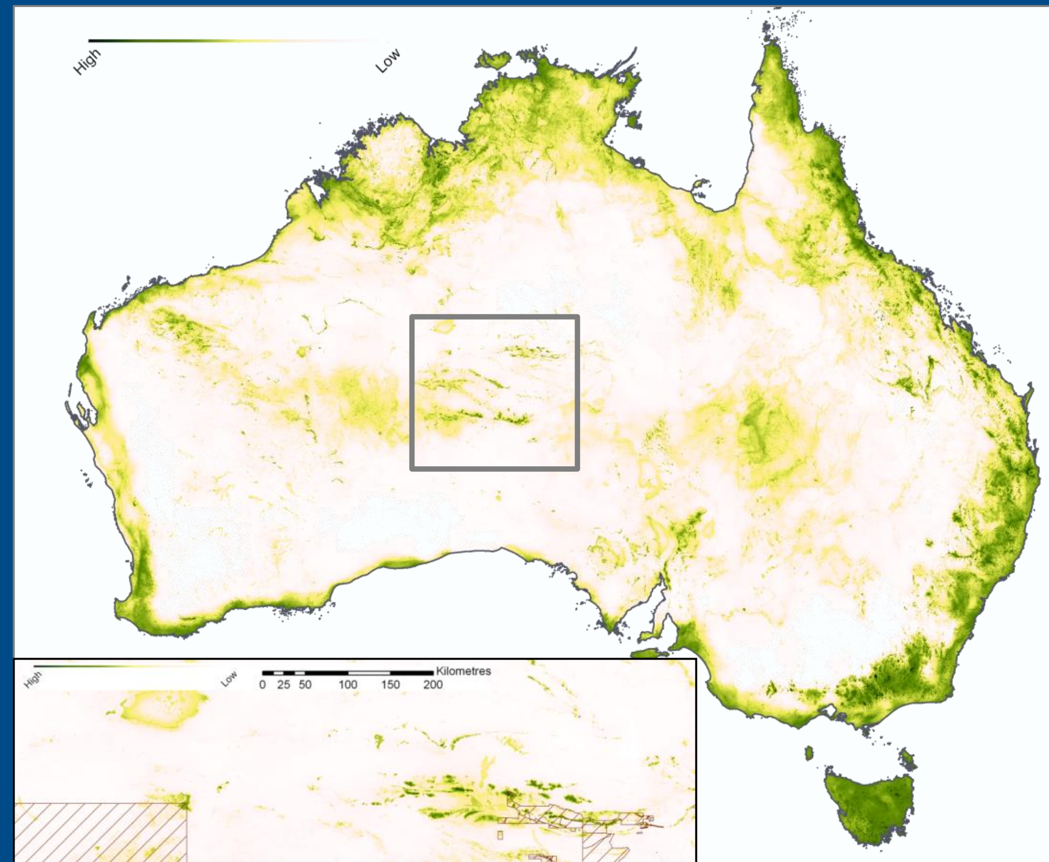


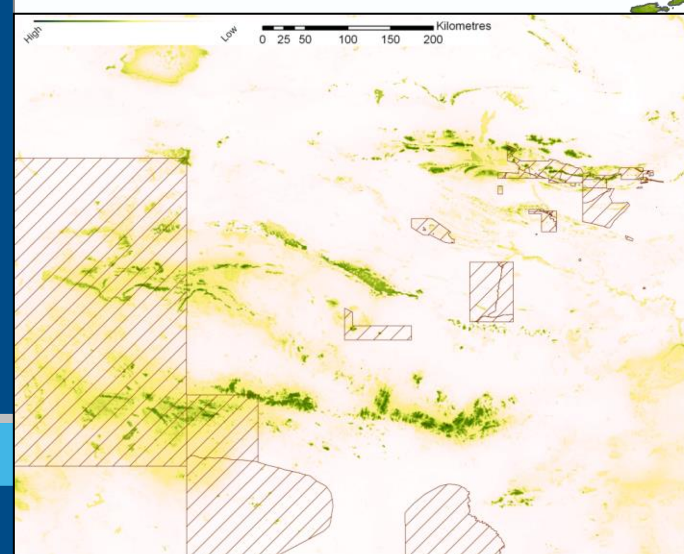


CSIRO

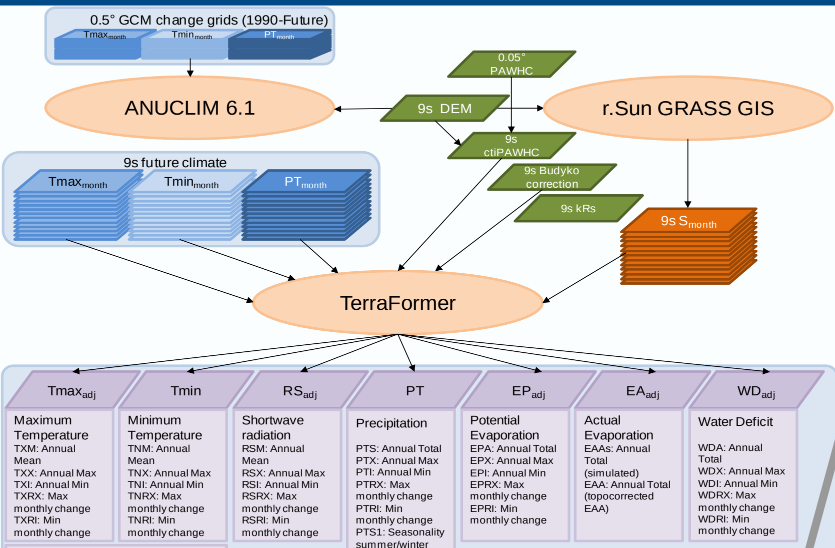
... and recently applied at much finer spatial resolution to identify potential climate refugia for biodiversity ...

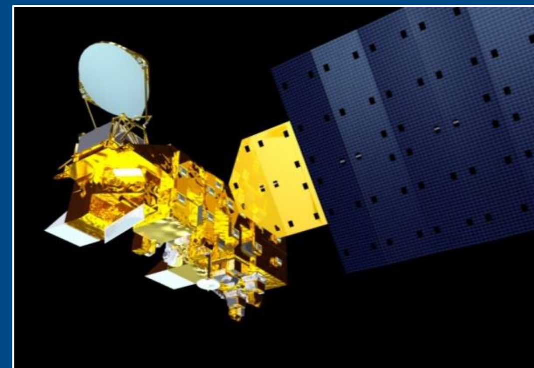


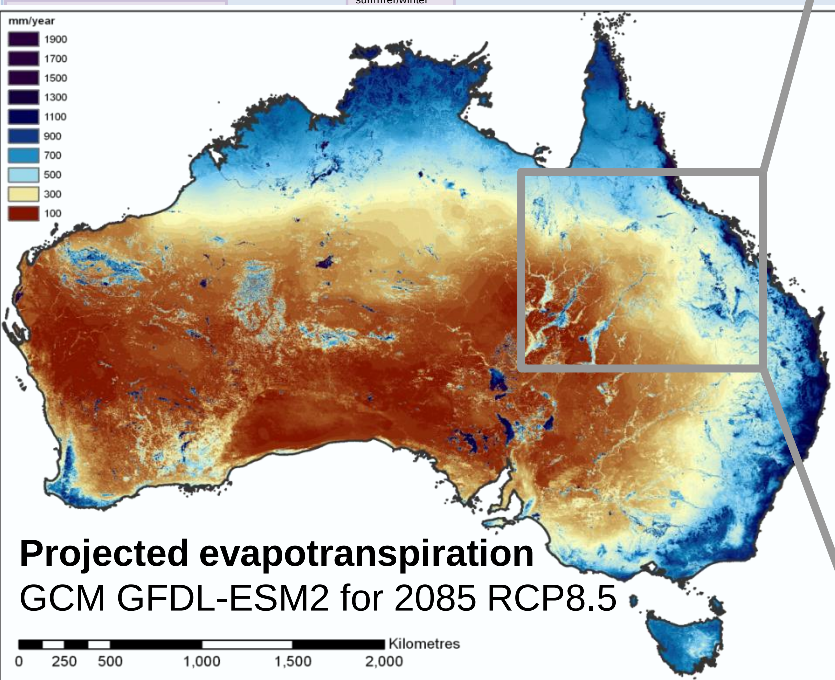


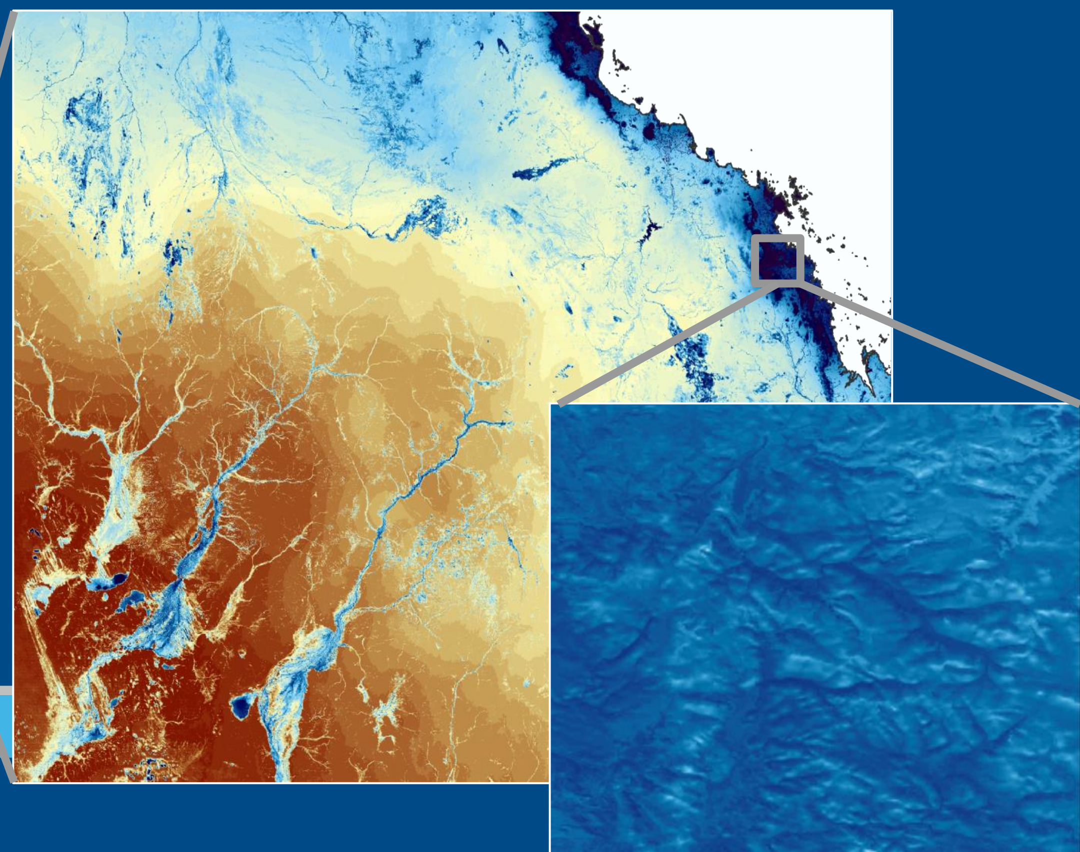


... employing a new generation of fine-scaled environmental variables & high-performance computing

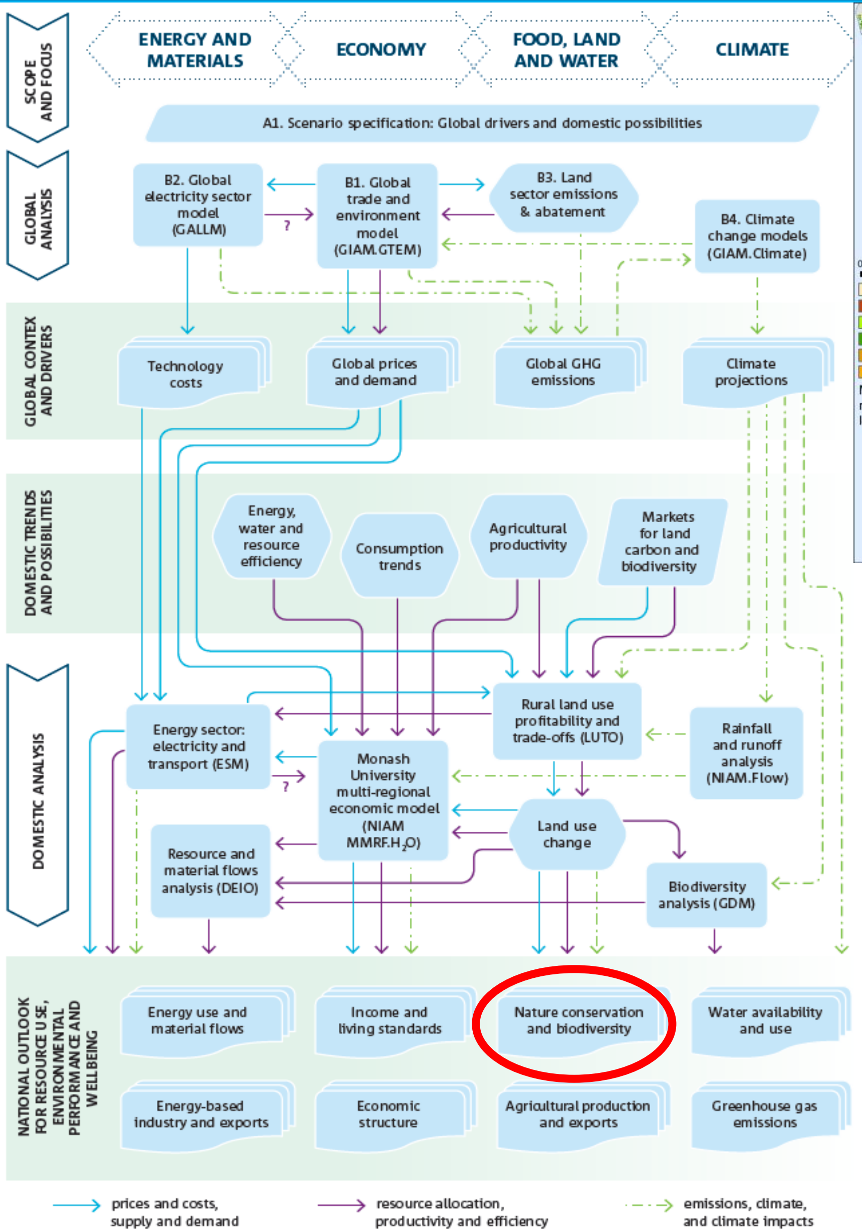


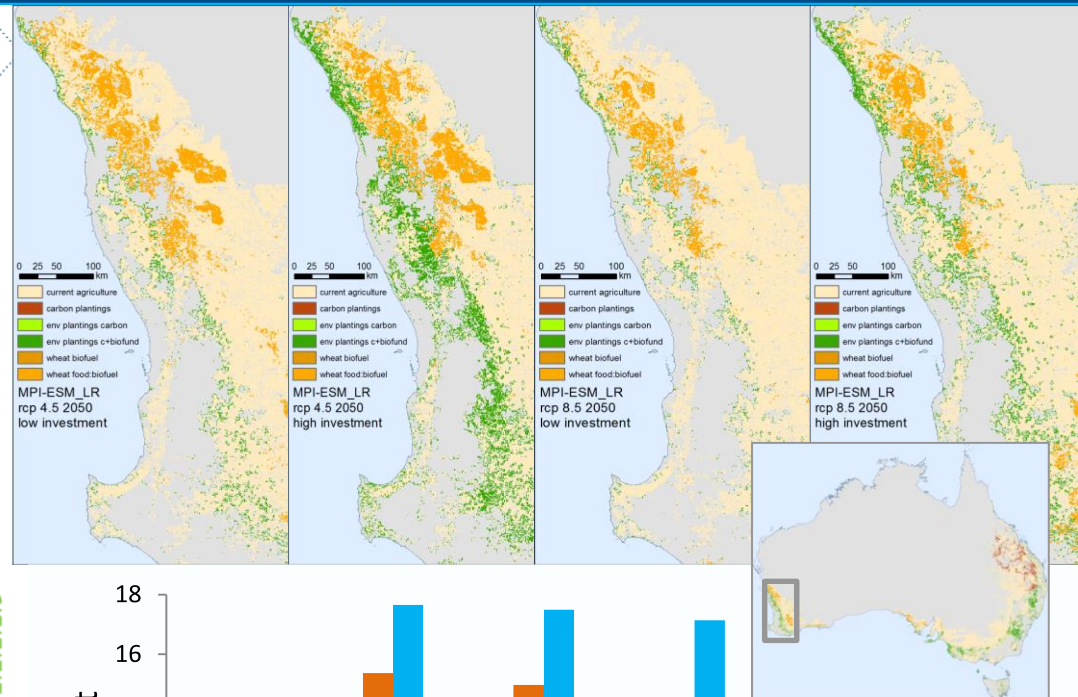


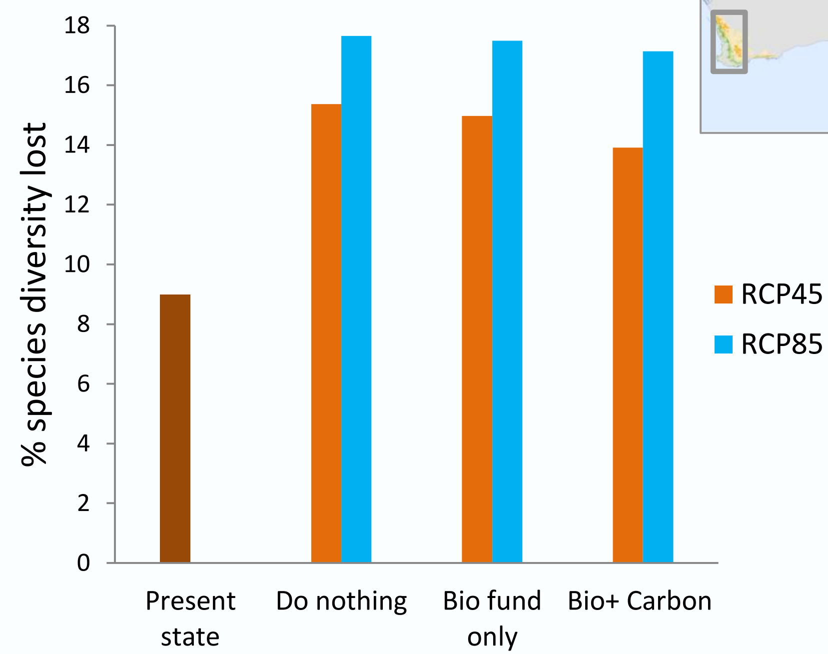




... CSIRO Australian National Outlook project – integrated assessment of natural-resource use scenarios (land, water, energy, ecosystem services)



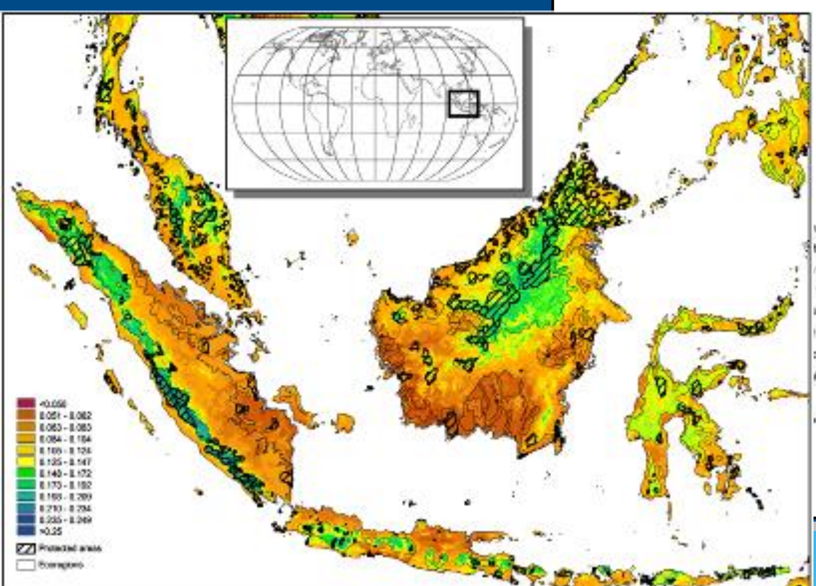


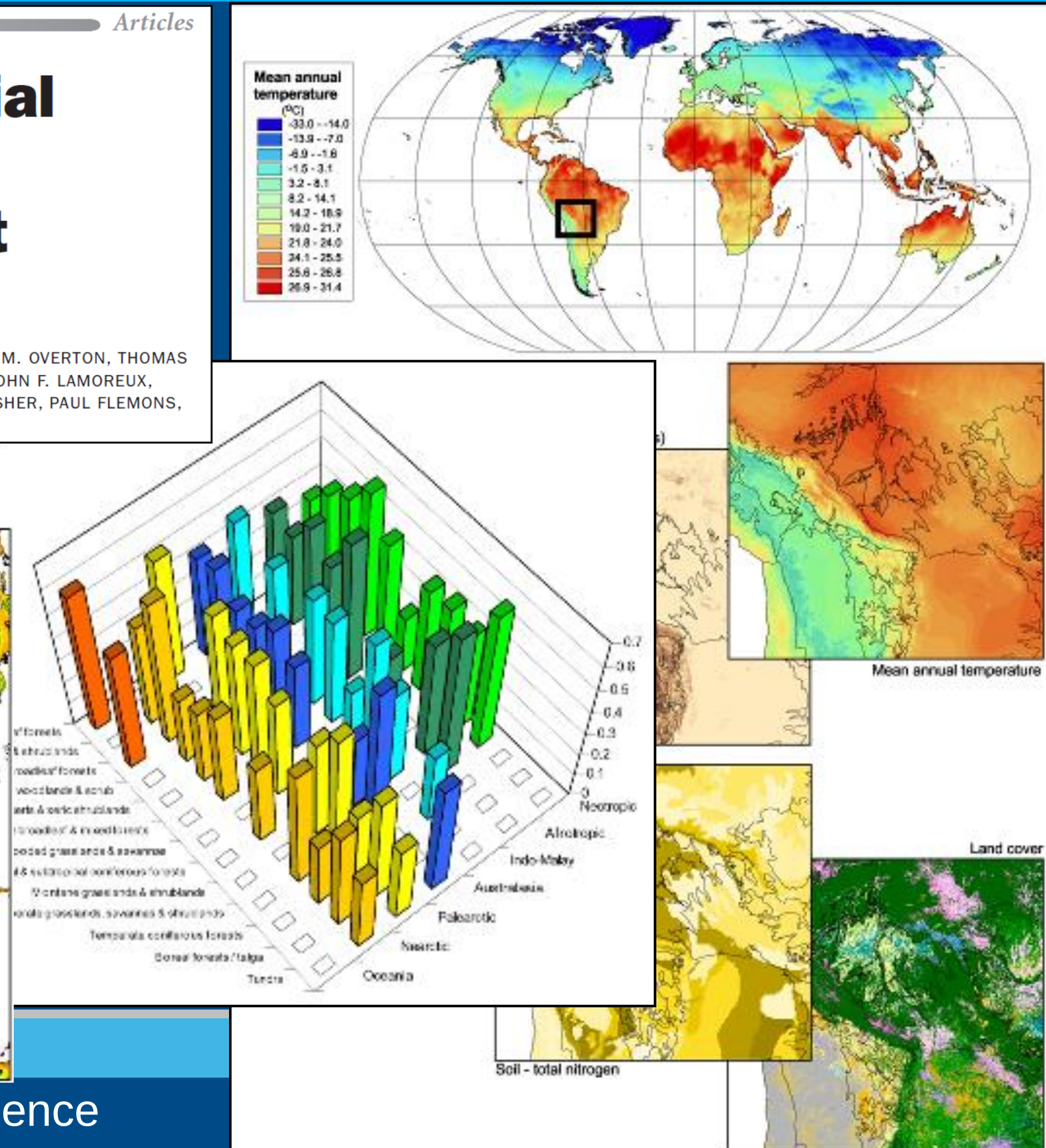


Global scale applications – e.g. proof-of-concept assessment of protected areas for 5th World Parks Congress (2003) …

Mapping More of Terrestrial Biodiversity for Global Conservation Assessment

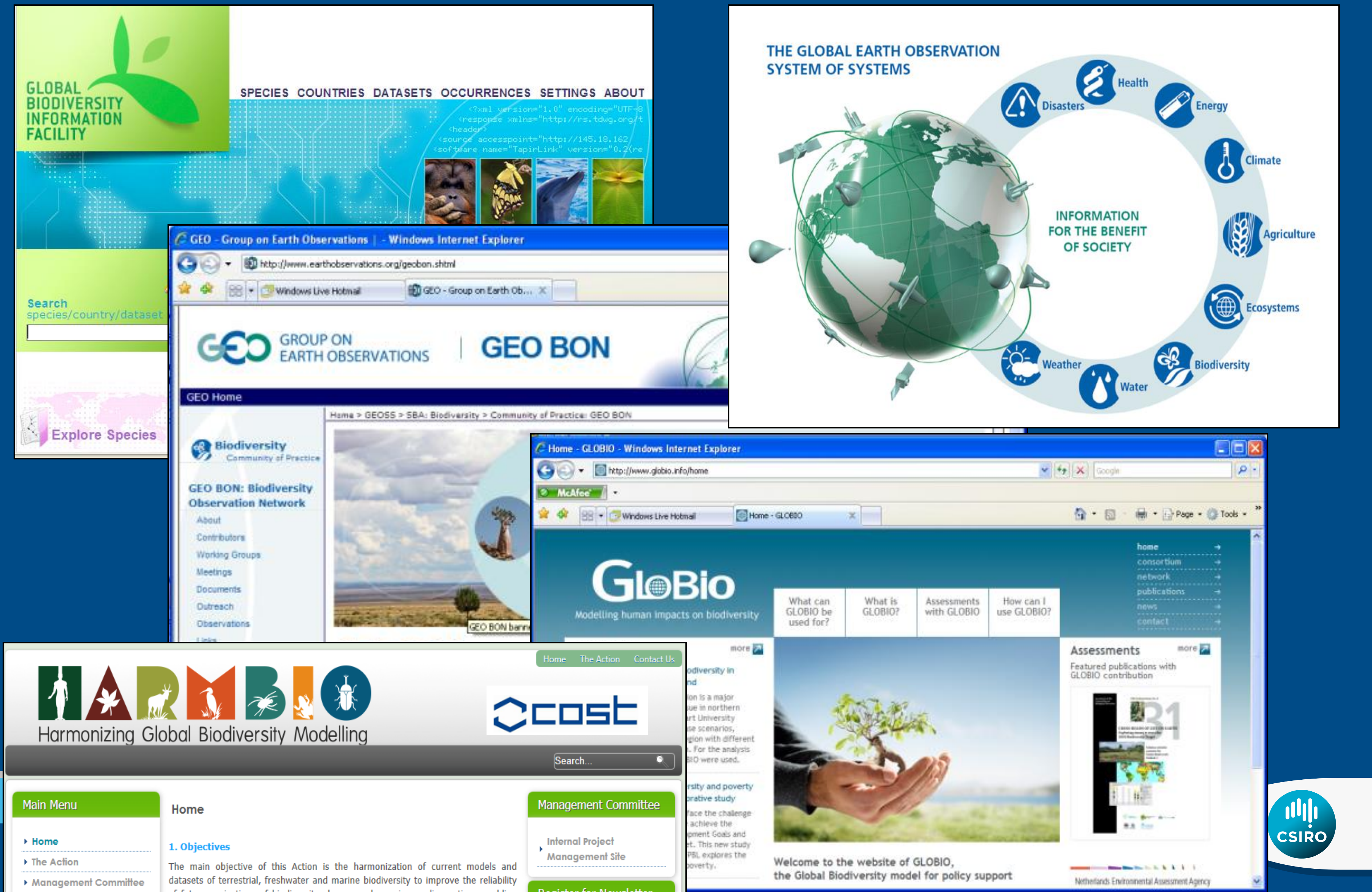
SIMON FERRIER, GEORGE V. N. POWELL, KAREN S. RICHARDSON, GLENN MANION, JAKE M. OVERTON, THOMAS F. ALLNUTT, SUSAN E. CAMERON, KELLIE MANTLE, NEIL D. BURGESS, DANIEL P. FAITH, JOHN F. LAMOREUX, GEROLD KIER, ROBERT J. HIJMANS, VICKI A. FUNK, GERASIMOS A. CASSIS, BRIAN L. FISHER, PAUL FLEMONS, DAVID LEES, JON C. LOVETT, AND RENAAT S. A. R. VAN ROMPAEY





Ferrier et al (2004) BioScience

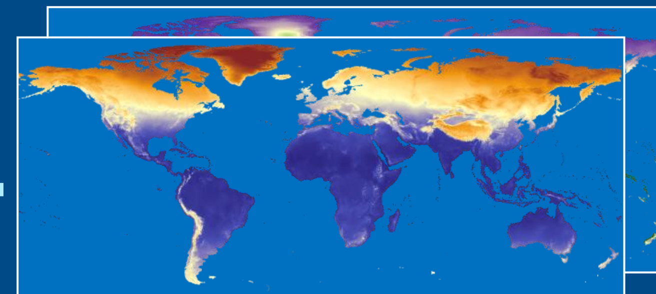
... major new opportunities have opened up over past 10 years through various global initiatives & activities ...



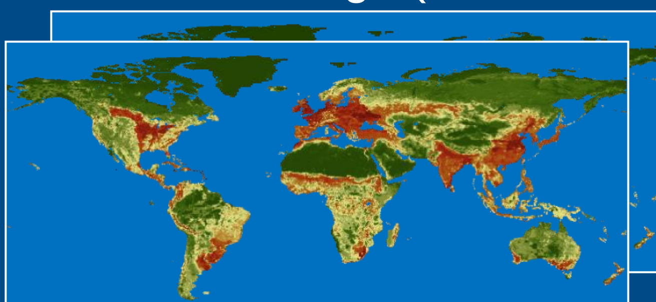
A recent proof-of-concept example – based on modelling of all GBIF data for ferns (>1.3 million records for >10,000 species)

Fern species records (GBIF)

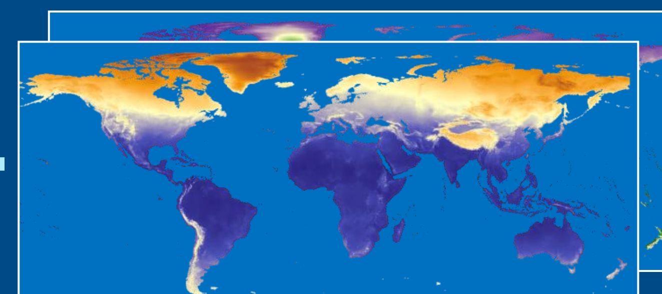
Base environment (WorldClim etc)



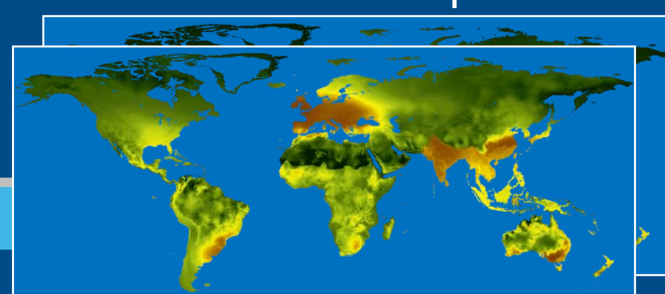
Land-use change (IMAGE etc)



Climate change (IPCC etc)

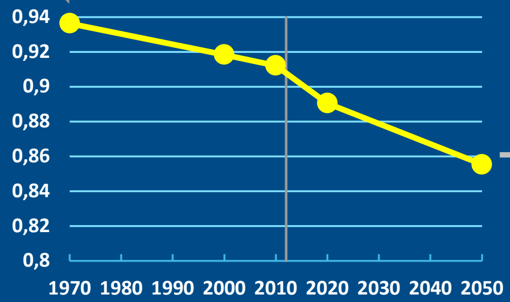


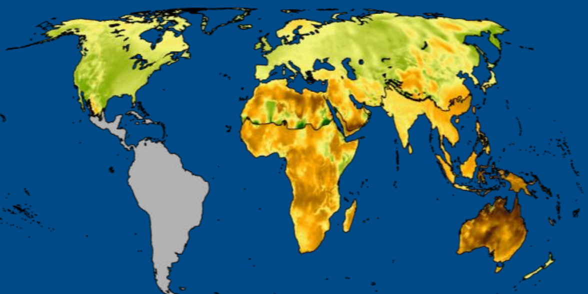
Modelled retention of compositional diversity



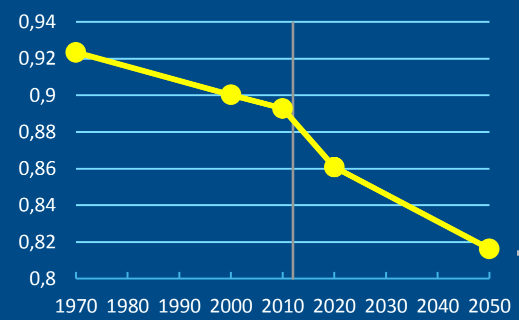
Thereby able to report change in retention of compositional diversity at any required level of spatial aggregation

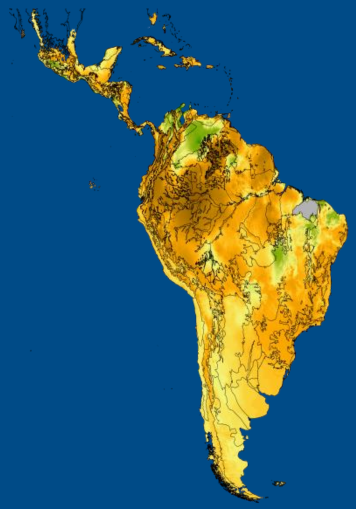
Whole planet — **Realm (or continent)** — **Ecoregion**



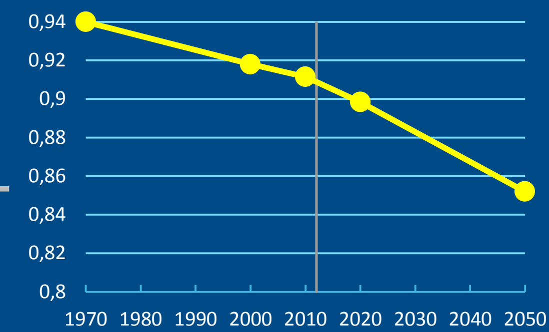


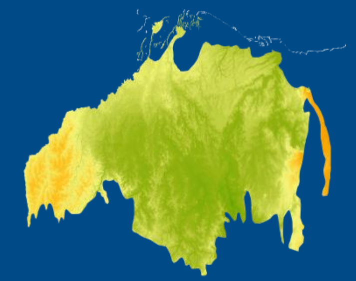
Neotropics



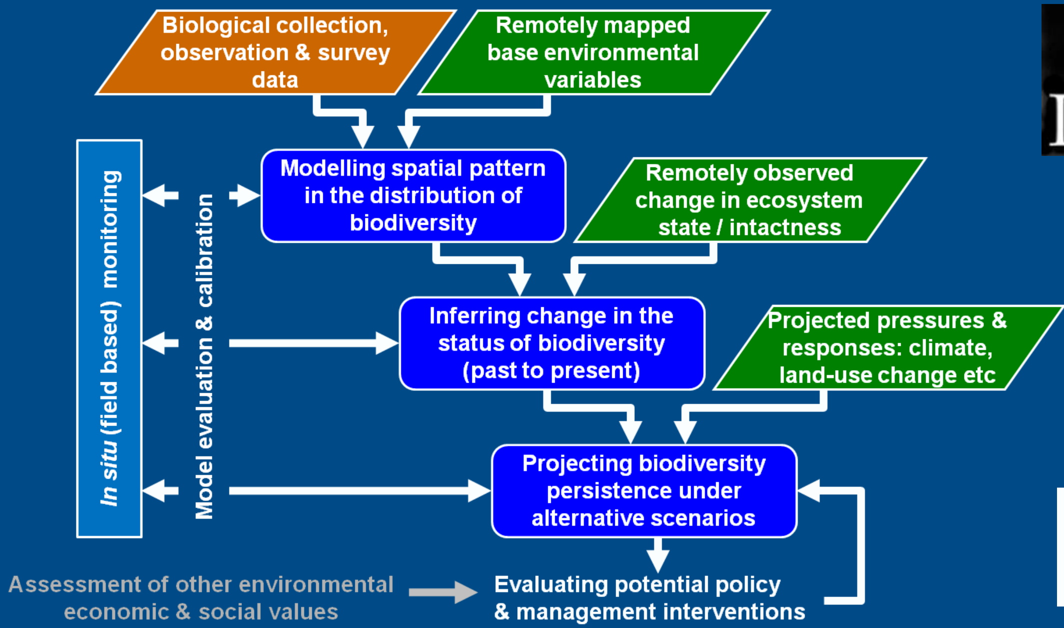


Maranhao Babaçu Forest





6th World Parks Congress (Nov 2014) serving as a catalyst for first full implementation of this approach



6th World Parks Congress (Nov 2014) serving as a catalyst for first full implementation of this approach

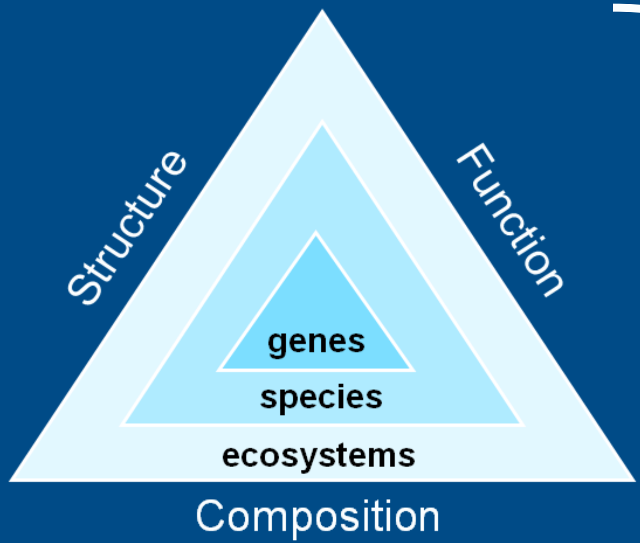
IUCN
WORLD PARKS
CONGRESS
SYDNEY 2014

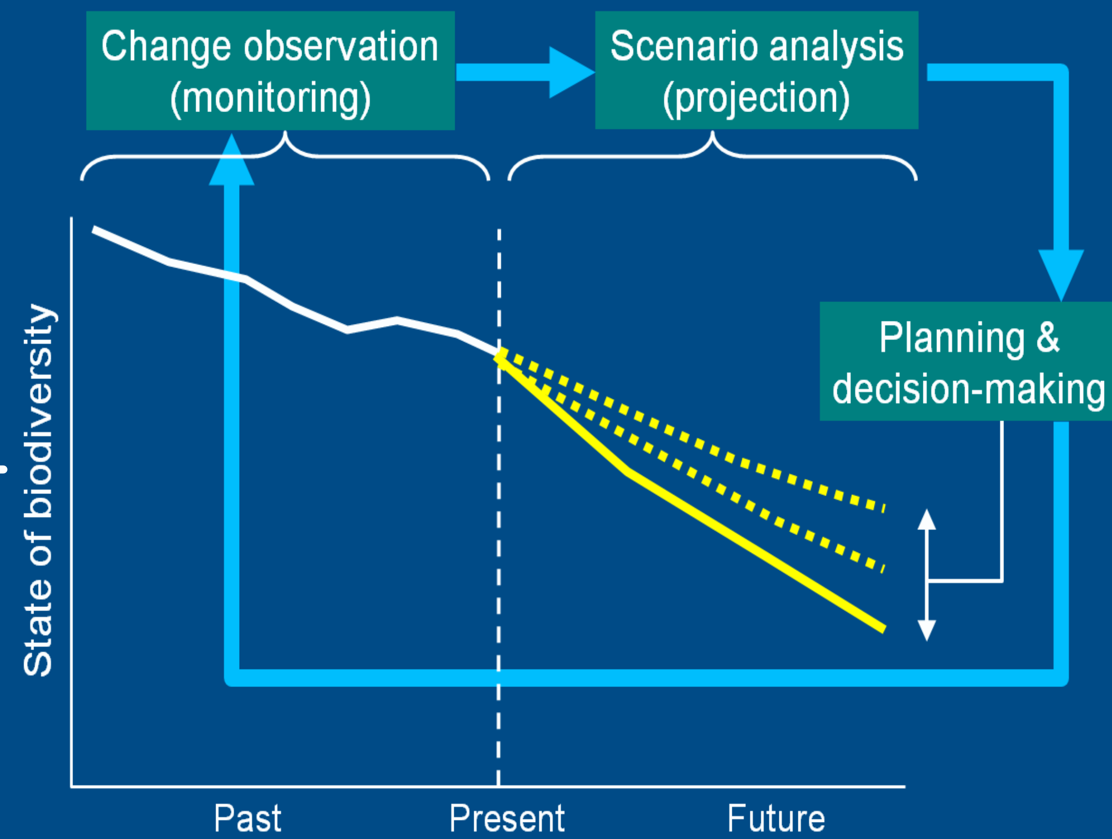
CSIRO

GEO
GROUP ON
EARTH OBSERVATIONS

- How adequately does the world's protected-area system represent current patterns of compositional diversity across a wide range of highly diverse biological groups?
- How is this level of representation expected to change given projected velocities of climate change?
- Which existing protected areas are most vulnerable to turnover and/or loss of compositional diversity under climate change?
- Where are the gaps in existing protected-area coverage that could be most critical to maximising overall whole-landscape retention of compositional diversity, in the face of ongoing climate and land-use change?

The challenge ahead - integration & harmonisation across scales, biodiversity dimensions, & assessment modes





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COMMENT

COMMUNICATION Sally Rockey reflects on two years of blogging at the NIH p.298

ECOLOGY Zoological travelogue tracks rare species worldwide p.300

WOMEN Calls to root out sexism in journals, conferences and experiments p.305

OBITUARY Rita Levi-Montalcini, nerve growth factor pioneer and science advocate p.306

A hyena surveys a flock of flamingos in South Africa.

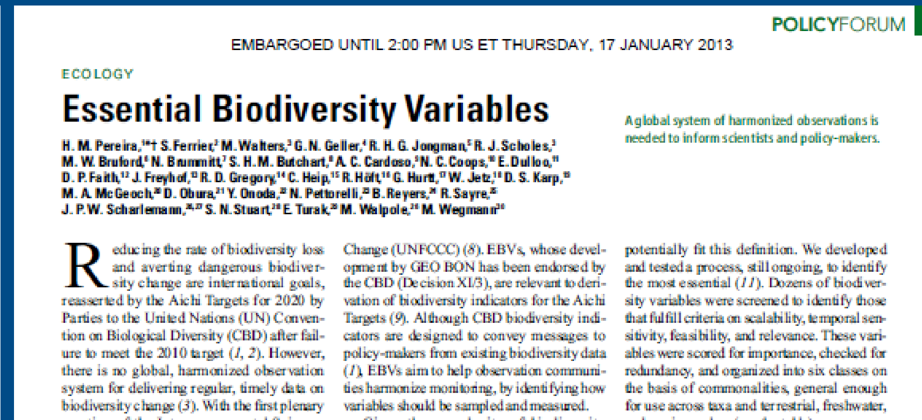
Time to model all life on Earth

To help transform our understanding of the biosphere, ecologists — like climate scientists — should simulate whole ecosystems, argue **Drew Purves** and colleagues.

No report from the Intergovernmental Panel on Climate Change would fail to mention global climate models. Yet the international bodies that are charged with addressing global challenges in conservation — including the Intergovernmental Platform on Biodiversity and Ecosystem Services, which holds its first plenary meeting next week in Bonn, Germany — cannot refer to analogous models of the world's ecosystems. Why? Because ecologists have not yet built them.

General circulation models, which simulate the physics and chemistry of Earth's land, ocean and atmosphere, embody scientists' best understanding of how the climate system works and are crucial to making predictions and shaping policies. We think that analogous general ecosystem models (GEMs) could radically improve understanding of the biosphere and inform policy decisions about biodiversity and conservation. Currently, decisions in conservation are based on disparate correlational studies, such as those showing that the diversity of bird species tends to decline in deforested landscapes. GEMs could provide a way to base conservation policy on an understanding of how ecosystems actually work.

Such models could capture the broad-scale structure and function of any ecosystem in the world by simulating processes — including feeding, reproduction and death — that drive the distribution and abundance of organisms within that ecosystem. Ecologists could apply a GEM to African savannas, for instance, to model the total biomass of all the plants, the grazers that feed on the plants, the carnivores that feed on the grazers and so on. Over time, the flows of energy and nutrients could be mapped between them. All of the organisms would be grouped not by species, but according to a few key traits such as



POLICYFORUM

EMBARGOED UNTIL 2:00 PM US ET THURSDAY, 17 JANUARY 2013

ECOLOGY

Essential Biodiversity Variables

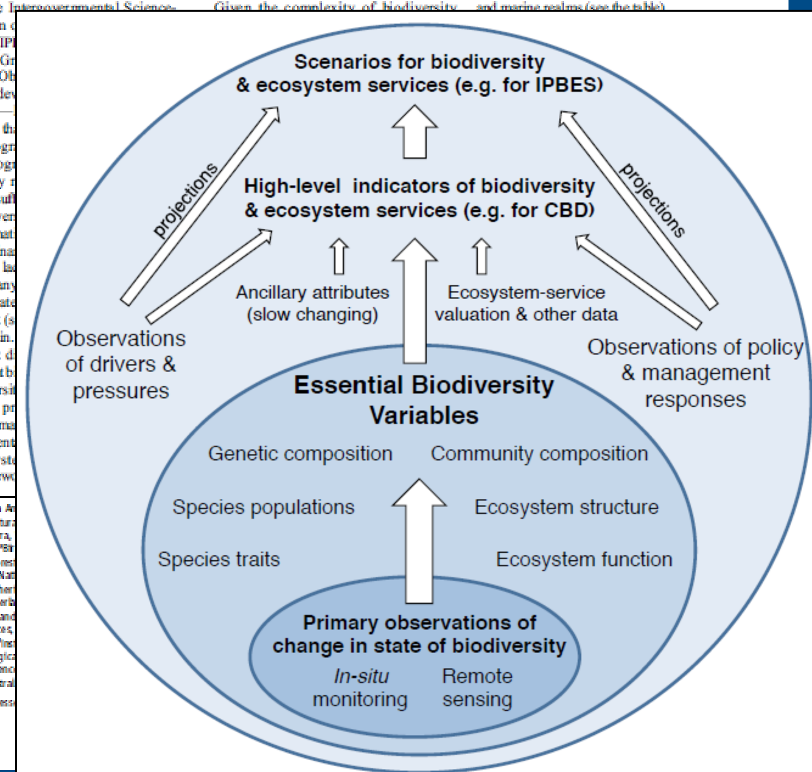
H. M. Pereira, S. Ferrier, M. Walters, G. N. Geller, R. H. G. Jongman, R. J. Scholes, M. W. Bruford, N. Brummitt, S. H. M. Butchart, A. C. Cardoso, N. C. Coops, E. Dulloo, D. P. Faith, J. Freyhof, R. D. Gregory, C. Heip, R. Höft, G. Hurtt, W. Jetz, D. S. Karp, M. A. McGeoch, D. Obura, Y. Onoda, N. Pettorelli, B. Reyers, R. Sayre, J. P. W. Scharlemann, S. N. Stuart, E. Turak, M. Walpole, M. Wegmann

A global system of harmonized observations is needed to inform scientists and policy-makers.

Reducing the rate of biodiversity loss and averting dangerous biodiversity change are international goals, reasserted by the Aichi Targets for 2020 by Parties to the United Nations (UN) Convention on Biological Diversity (CBD) after failure to meet the 2010 target (*1*, *2*). However, there is no global, harmonized observation system for delivering regular, timely data on biodiversity change (*3*). With the first plenary

Change (UNFCCC) (*8*). EBVs, whose development by GEO BON has been endorsed by the CBD (Decision XI/3), are relevant to derivation of biodiversity indicators for the Aichi Targets (*9*). Although CBD biodiversity indicators are designed to convey messages to policy-makers from existing biodiversity data (*1*), EBVs aim to help observation communities harmonize monitoring, by identifying how variables should be sampled and measured.

potentially fit this definition. We developed and tested a process, still ongoing, to identify the most essential (*11*). Dozens of biodiversity variables were screened to identify those that fulfill criteria on scalability, temporal sensitivity, feasibility, and relevance. These variables were scored for importance, checked for redundancy, and organized into six classes on the basis of commonalities, general enough for use across taxa and terrestrial, freshwater,



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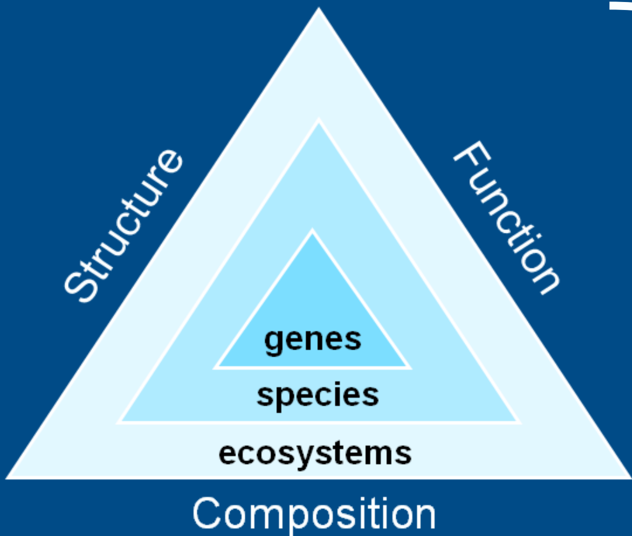

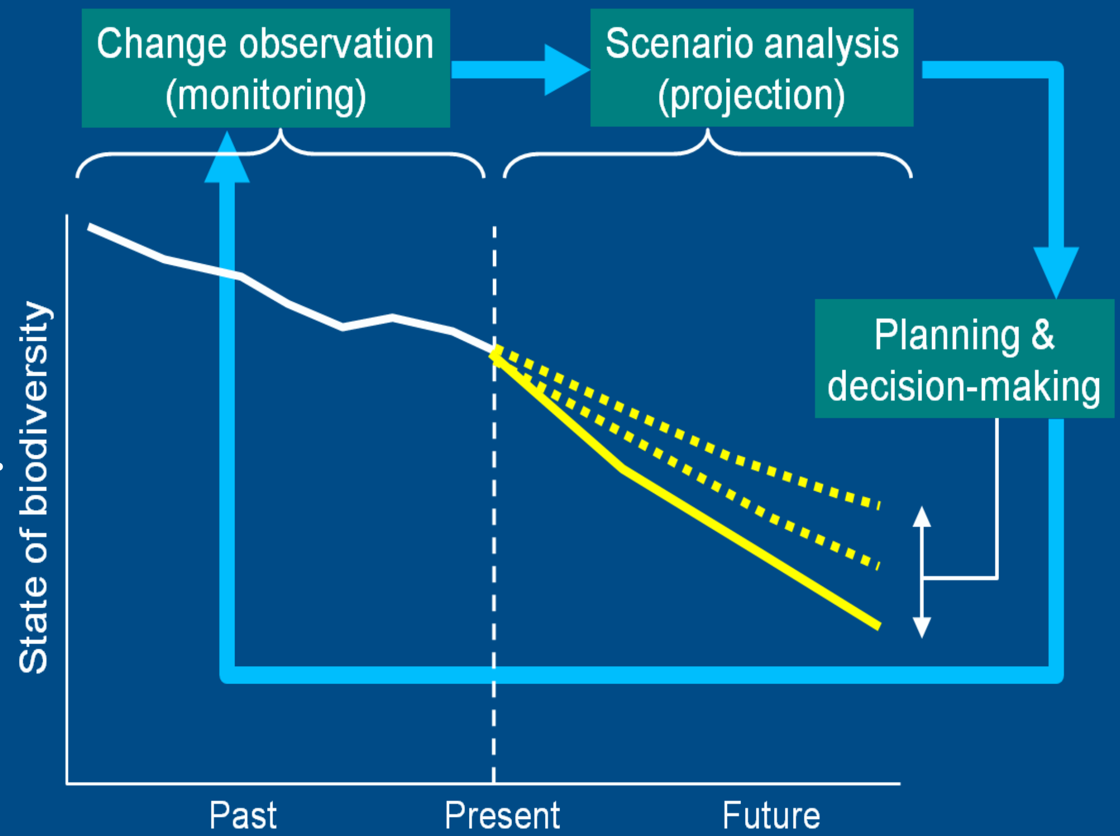

Thank you

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