Buffel grass invasion causing Mulga decline, Giles WA, S Prober

Combating ecosystem collapse through the 3As

Awareness – Anticipation – Action

Dana Bergstrom, Suzanne Prober, Euan Ritchie, Kristen Williams, Shaun Brooks et al.

Australia's National Science Agency

OPINION

Global Change Biology WILEY

Combating ecosystem collapse from the tropics to the Antarctic

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CSIRO


Woody plantings in agricultural landscape, NSW, S Prober

3As pathway

- Awareness: Recognise where ecosystems are declining
- Anticipation: Identify risks/pressures
- Action: Protection or restoration responses

Examined literature for evidence of collapse

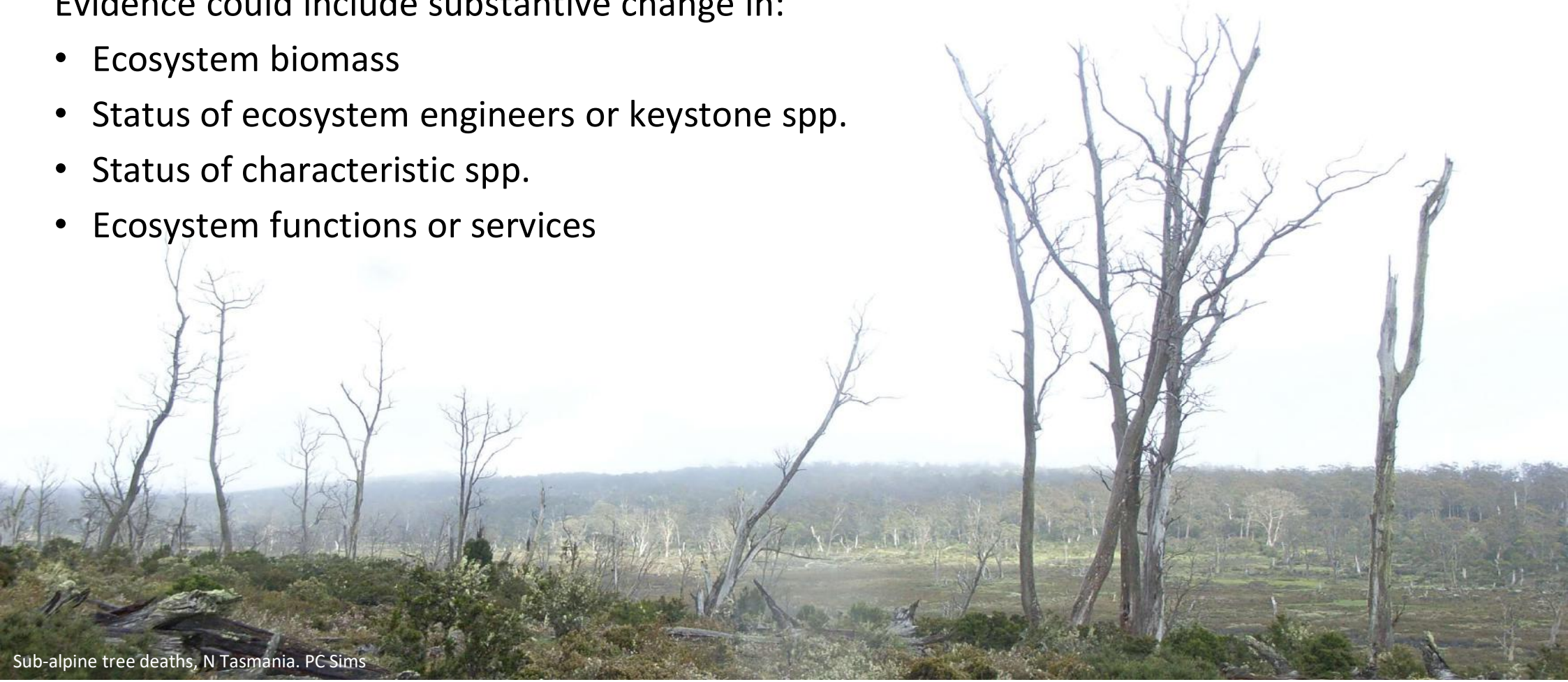
1. Ecosystem structure/function/composition has transformed from a base state to a new state
2. Quantitative evidence of change, preferably spanning >10 years
3. Evidence that the magnitude of the change implies a low likelihood of recovery to the base state.

Eucalyptus gunnii mortality Central Plateau Tas, S Prober

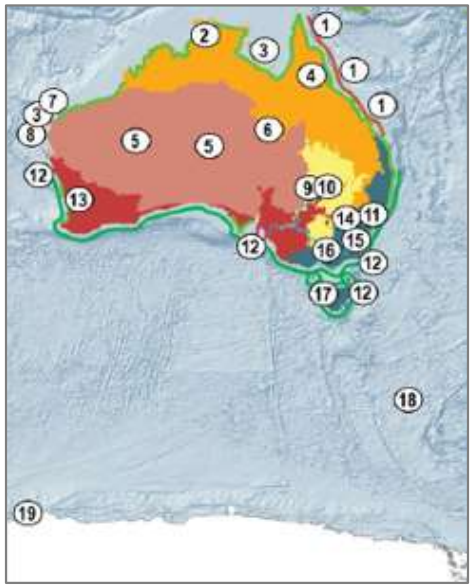
Types of evidence

Evidence could include substantive change in:

- Ecosystem biomass
- Status of ecosystem engineers or keystone spp.
- Status of characteristic spp.
- Ecosystem functions or services



Sub-alpine tree deaths, N Tasmania. PC Sims



Bergstrom et al. (2021) **Combating ecosystem collapse from the tropics to the Antarctic**. Global Change Biology 27, 1692-1703.

Forests and woodlands


Tropical savanna with Gamba grass, S Prober


Montane and sub-alpine forests, PJ Zylstra


Mountain ash forests, D Lindenmayer


Murray Darling Basin floodplain ecosystems, M Good


Monaro Tableland eucalypt decline, S Prober


Mediterranean forests & woodlands, K Ruthroff

Rainforests

Cyclone-impacted wet tropical rainforest, S Prober

Gondwanan conifer forests, A Bliss

Alpine/tundra

Alpine snowpatch herbfield, C Pickering

Tundra, C Dickson

Arid zone

Western-central arid zone with Buffel grass, S Prober

Georgina gidgee woodland, G Wardle

Inland waters, coastal and marine


Murray Darling Basin waterway, J Dielenberg

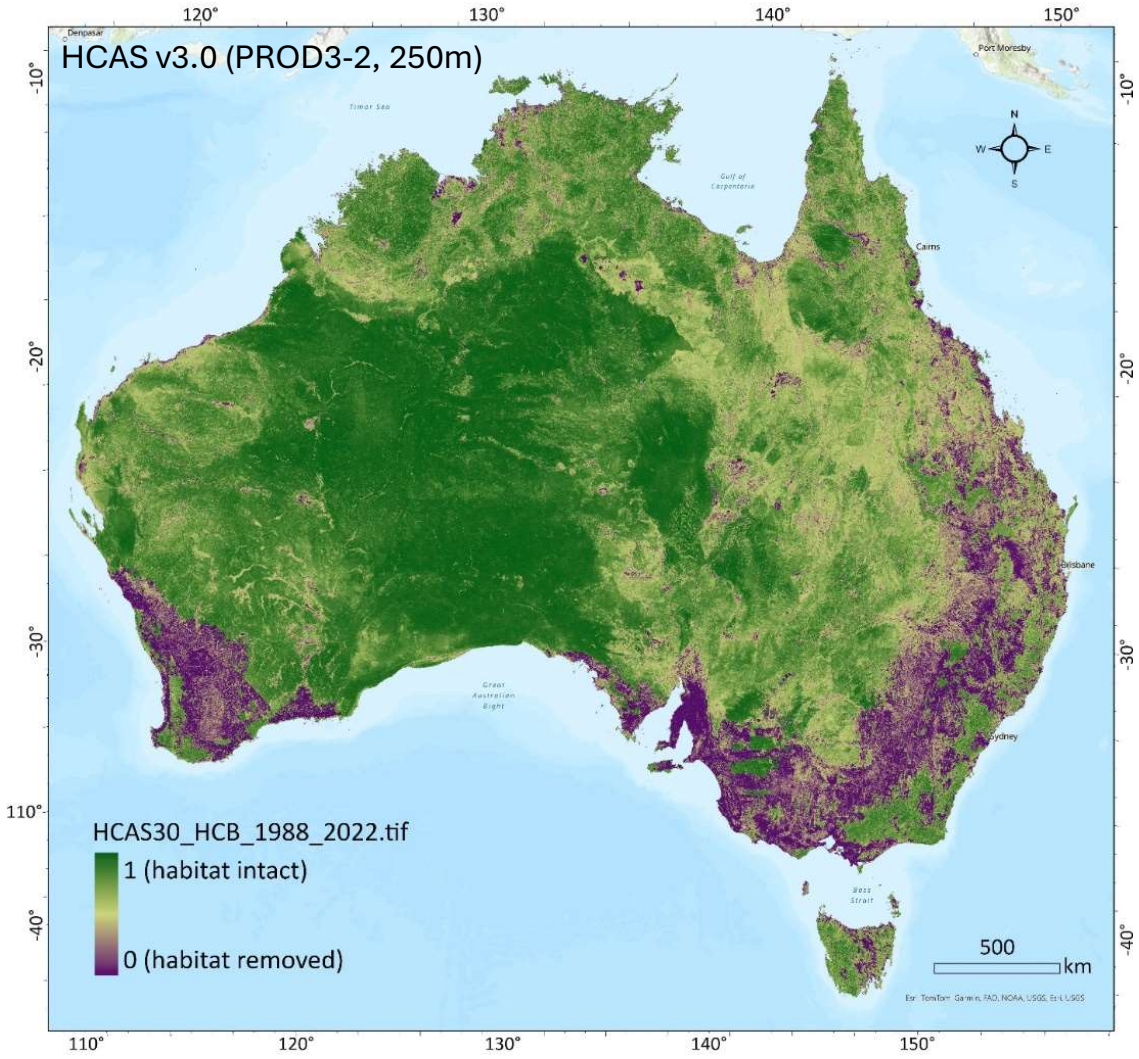

Mangrove forest, NC Duke


Ningaloo reef, J Turnbull Flickr


Great Barrier Reef, A Fordyce


(ex) Shark Bay seagrass beds, S Styrdom


(ex) Great Southern kelp forest, E Flukes

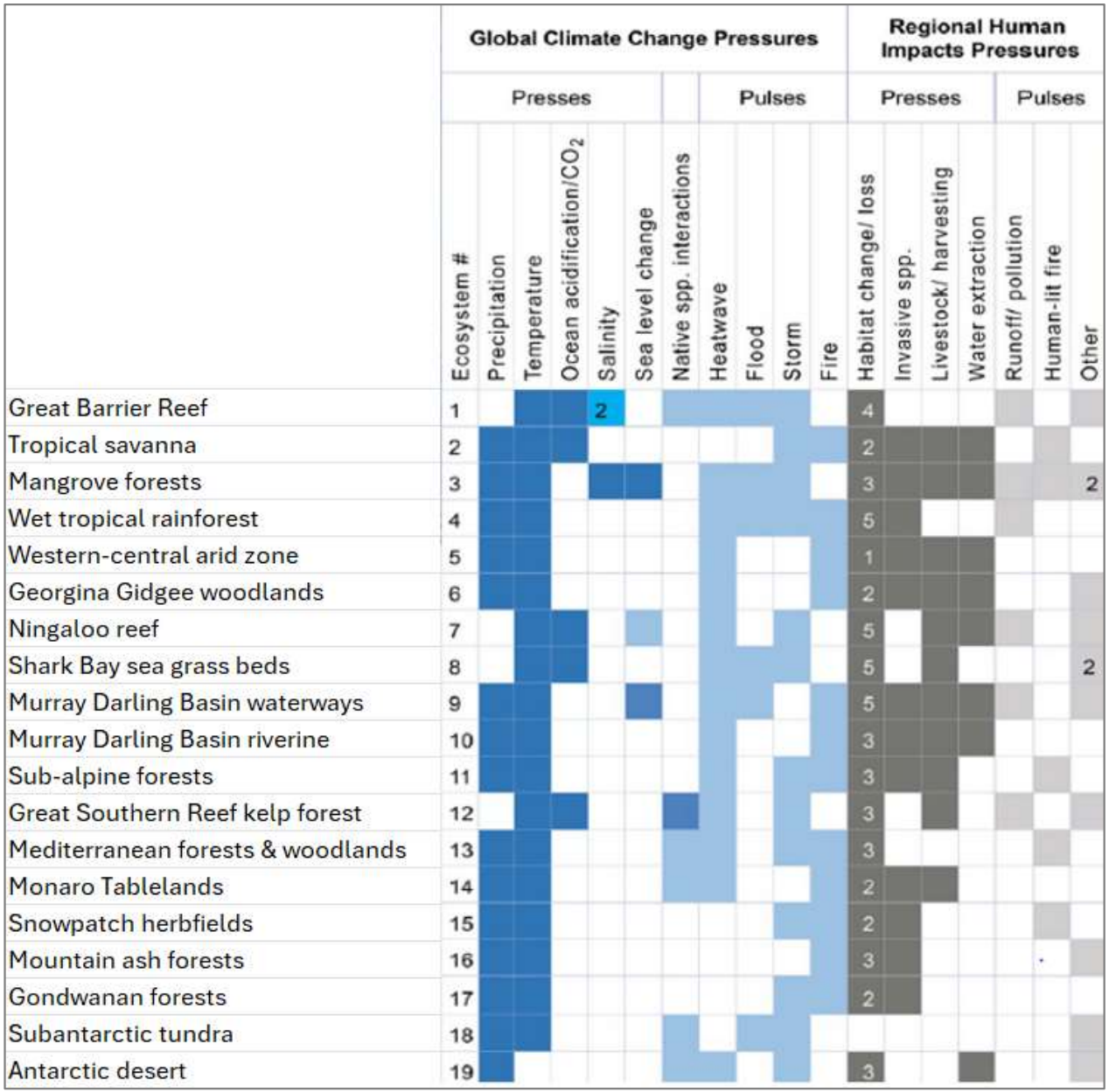


Habitat Condition Assessment System version 3.0

- Valavi R, Williams KJ, et al… Ferrier S (in review) HCAS 3.0 (1988-2022) base model estimate of habitat condition (250m grid), National Connectivity Index (NCI) 2.0, 3-year average annually rolling epochs of HCAS and NCI from 1990 to 2022, trends and other derivatives for continental Australia. Data Collection. CSIRO, Canberra, Australia.
- Williams KJ, Liu N, et al…Ferrier S (2024) Description of input data for National Ecosystem Accounts – Ecosystem Condition: Supplementary metadata for a data collection from the National Ecosystem Accounting Project. A report from the National Ecosystem Accounting Project. CSIRO, Canberra, Australia.

Pressures

Global Change Drivers											Regional Human Drivers						
Presses						Pulses					Presses				Pulses		
Ecosystem	Precipitation	Temperature	Ocean acidification	Salinity	Sea level rise	Heatwave	Flood	Storm	Fire	Spp interactions	Habitat loss/ change	Invasive spp	Livestock	Water extraction	Runoff/pollution	Fire	Other
1																	
2																	
3																	
4																	
5																	


Global Climate Change Pressures
Regional Human Impacts Pressures
Presses
Pulses
Presses
Pulses
Ecosystem #
Precipitation
Temperature
Ocean acidification/CO_2
Salinity
Sea level change
Native spp. interactions
Heatwave
Flood
Storm
Fire
Habitat change/ loss
Invasive spp.
Livestock/ harvesting
Water extraction
Runoff/ pollution
Human-lit fire
Other
Great Barrier Reef 1
Tropical savanna 2
Mangrove forests 3
Wet tropical rainforest 4
Western-central arid zone 5
Georgina Gidgee woodlands 6
Ningaloo reef 7
Shark Bay sea grass beds 8
Murray Darling Basin waterways 9
Murray Darling Basin riverine 10
Sub-alpine forests 11
Great Southern Reef kelp forest 12
Mediterranean forests & woodlands 13
Monaro Tablelands 14
Snowpatch herbfields 15
Mountain ash forests 16
Gondwanan forests 17
Subantarctic tundra 18
Antarctic desert 19


Interestingly the key message from all these scientists seems to be that ACTION CAN STILL MAKE A DIFFERENCE - IT'S NOT TOO LATE!
fyi if I was a scientist my key message would be "you can all go and get fracked I'm going to the pub" (coincidentally also my key message as a cartoonist)
SCIENTIST
CARTOONIST
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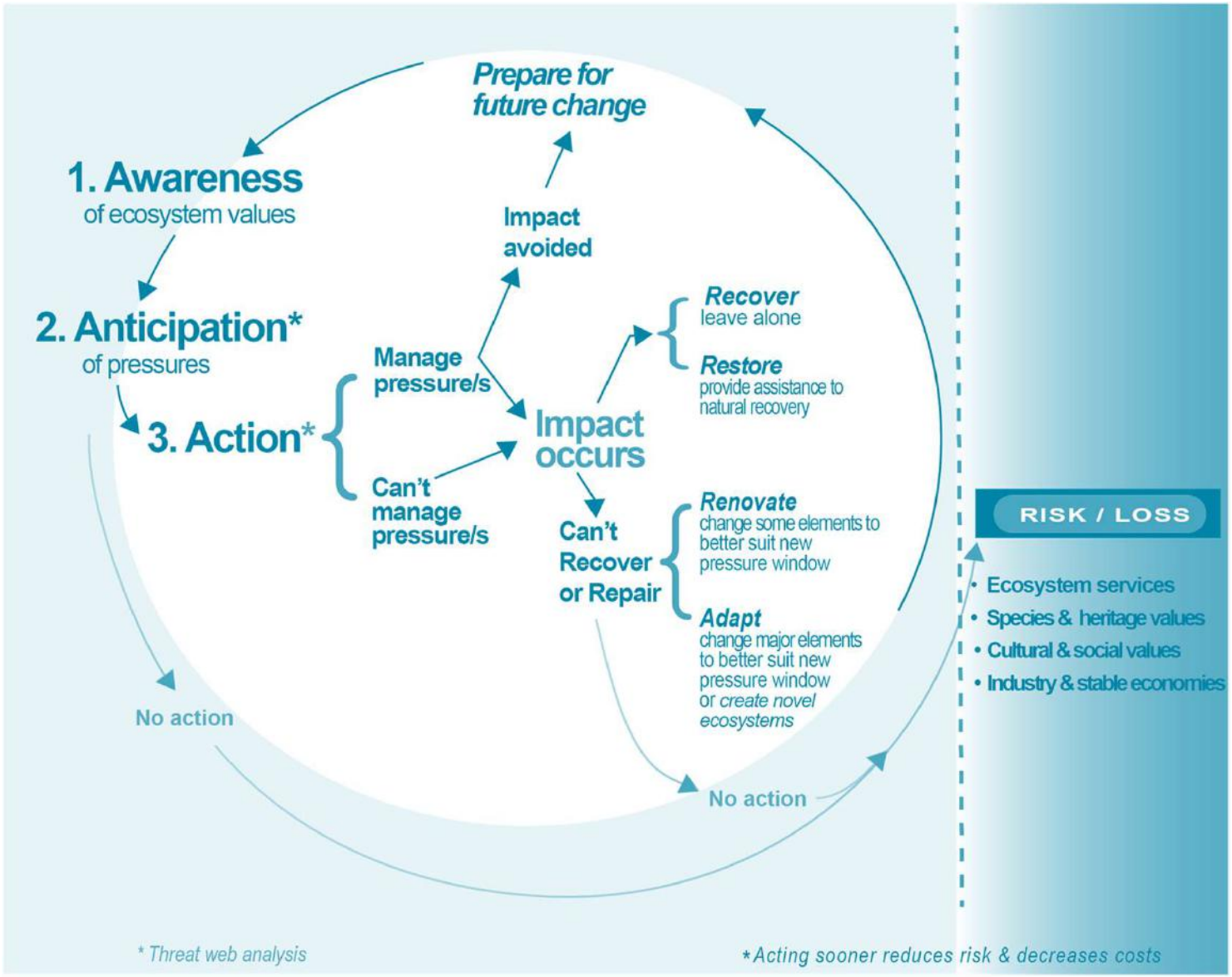
Awareness
Action
Anticipation

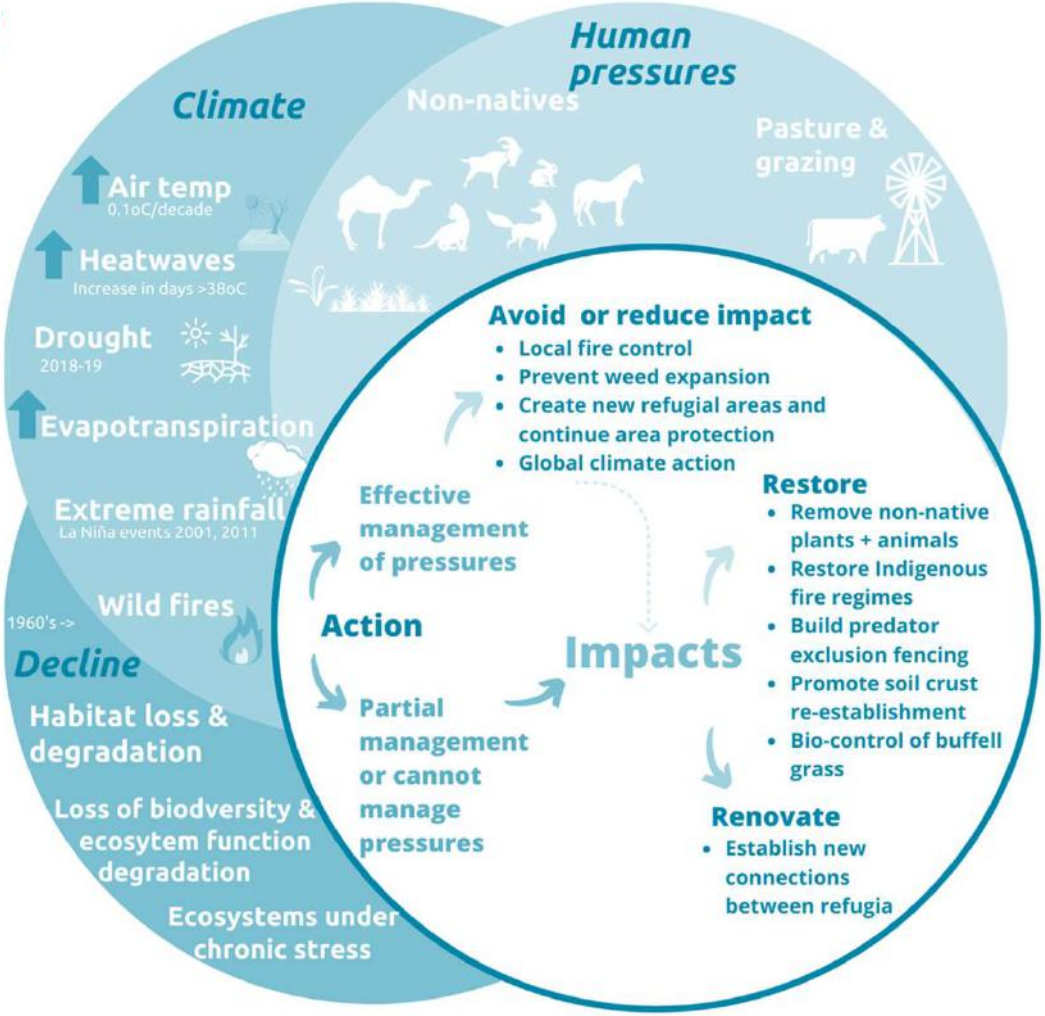


Choice of action

- Recover
- Restore
- Renovate
- Adapt

Western-central arid zones


Western-central arid zone with Buffel grass, S Prober



Learning context

Embrace the opportunity for innovation and learning for better restoration outcomes, e.g.:

- managing total grazing pressure
- managing transformer invasive species - fire interactions
- managing predators
- understorey restoration

New project in TERN

- Synthesise understanding of ecosystem response to disturbance at a process level
- Inform recovery as well as collapse profiles
- Assist decisions about what management actions to take

National Ecosystem Assessment System for Australia (NEASA): *Phase 1*

A national set of conceptual models for Australia's landscapes

Australia needs a way to map, monitor and predict trajectories of its natural and modified ecosystems at regional and national scales, in a consistent and repeatable way. Through its ***National Ecosystem Assessment System for Australia*** (Phase 1), TERN is developing new infrastructure and tools towards this goal. NEASA will synthesise empirical data and expert knowledge of ecosystem change, building conceptual models to facilitate integration of real-world data into ecosystem assessments, predictions and scenarios. Such a capability will inform local to regional land use planning decisions, systems of national ecosystem accounts, state of the environment reporting, indicators for global reporting to the Convention on Biological Diversity, nature positive initiatives and climate adaptation decisions, among other uses.

Australian Ecosystem Models Framework

Previous work established the ***Australian Ecosystem Models Framework***, a framework for systematically capturing ecological knowledge about the dynamics of Australian ecosystems in pre- and post-industrialisation contexts (Richards et al. 2020). The framework recognises 14 umbrella ecosystem types that reflect the Major Vegetation Groups of Australia's *National Vegetation Information System*. Within each of these umbrella groups, two types of conceptual models can be accommodated: (1) archetype ecosystem models and (2) state-and-transition models (see below for descriptions of these).

Archetype ecosystem models

The framework aims to capture best available knowledge of pre-industrialisation ecosystem dynamics in the form of "archetype" conceptual ecosystem models. These involve simple box-and-arrow diagrams, where boxes represent the different forms or "expressions" expected for an ecosystem type (defined by biotic and abiotic attributes), and arrows represent drivers of changes between expressions. Drivers in archetype models include only those likely to have been present prior to European colonisation and industrialisation (i.e. endogenous disturbances), including drivers based on Indigenous land management regimes. For example, intense wildfire may shift an obligate-seeder woodland from a mature stand to a juvenile expression comprising dense seedling recruitment (Figure 1).

Archetype models are published as they are completed. For example, Prober et al. (2023a,b) and Roxburgh et al. (2023) describe models for eucalypt woodlands, mallee and eucalypt forests, respectively.

Figure 1. Simplified archetype model for obligate-seeder eucalypt woodland, with images for each expression (modified from Prober et al. 2023, Gosper et al. 2018) SM Prober.

Ecosystem state and transition models

State and transition models in the ***Australian Ecosystem Models Framework*** aim to capture the key post-industrialisation dynamics of Australian ecosystem types (Figure 2). "States" represent modified forms of the reference ecosystems that have resulted from post-industrialisation (i.e. exogenous) disturbances. Consistency across ecosystem types will be facilitated by development of generalised sets of modified ecosystem states and drivers. These will be used as building blocks for state and transition conceptual model templates relevant to each archetype. Templates can be used to add further detail or parameterised for modelling ecosystem futures at local, regional, or national scales. Changes in expressions reflecting endogenous drivers can be captured within each state.

AUGUST 2024
EP2024-1687

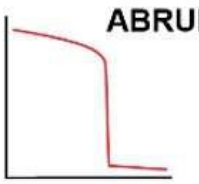
Monaro Tableland tree decline, NSW, S Prober

Thank you

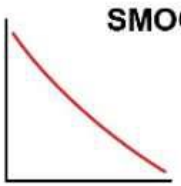
Australia’s National Science Agency


Obligate-seeder eucalypt woodlands WA, S Prober

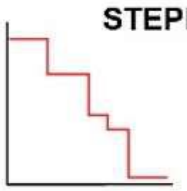
Collapse profiles



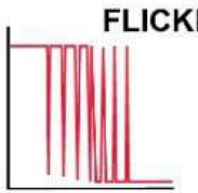
e.g. mortality due to drought/heatwave



e.g. gradual climate change, grazing, harvest



e.g. clearing, repeated fire, storms or cyclones



e.g. crown of thorns outbreaks, mass fish kills


Global Climate Change Pressures
Regional Human Impacts Pressures
Collapse Profiles
Presses
Pulses
Presses
Pulses
Ecosystem #
Precipitation
Temperature
Ocean acidification/CO_2
Salinity
Sea level change
Native spp. interactions
Heatwave
Flood
Storm
Fire
Habitat change/ loss
Invasive spp.
Livestock/ harvesting
Water extraction
Runoff/ pollution
Human-lit fire
Other
Abrupt
Smooth
Stepped
Fluctuating
Great Barrier Reef 1 2 4
Tropical savanna 2 2
Mangrove forests 3 3 2
Wet tropical rainforest 4 5
Western-central arid zone 5 1
Georgina Gidgee woodlands 6 2
Ningaloo reef 7 5
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Thank-you