Innovative Research Universities

Protecting

Australia's most endangered landscapes

A team of eminent ecologists from **Innovative Research Universities** across **Australia** has identified the environments in our continent at greatest risk of catastrophic change – and what we can do to save them.

Learning
Collaboration
Opportunity

Protecting Australia's most endangered landscapes

There is a part of Australia its grandchildren, and their grandchildren, may never see.

It is a part of our ancient continent that may soon be gone, its vestiges preserved only in 19th century paintings or fading photographs. It is the Australian landscapes which reached a '**tipping point**' – then altered profoundly, their former, quintessential character and composition lost beyond recall.

It is also, say 26 of the nation's most eminent ecologists, a tragedy which wise and early local measures can forestall – just as well-planned bushfire defences may shield a home in season of high risk.

A tipping point, simply put, is a point of no return. Concerned that so many of our landscapes now show signs of approaching this, leading ecologists from Australia's Innovative Research Universities (IRU) assembled in Cairns to identify the continent's ten ecosystems most at risk of tipping into an entirely new state due to mounting human and external pressures.

It is the first, essential step in evolving a national plan of action to prevent their loss.

"*In ecological terms, a tipping point is a threshold beyond which major change becomes inevitable. It often happens quite fast, such as when a rainforest is destroyed by fire, damaged coral reefs become seaweed-infested, or savannas are devoured by invading weeds*," explains Professor Bill Laurance of ***James Cook University***, who is the lead author of the team's report. "*When this occurs, it's very difficult – if not impossible – to restore the original natural system*."

The answer to saving as much as we can of the Australia we know, love and identify with, he says, is: **act early, act local.**

> "*Our threatened ecosystems and their wildlife are under stress from a deadly synergy of both global and local threats. At global level there is the impact of rising temperatures, sea-levels and oceanic acidity. Locally the big killers are fragmentation of these unique environments, coupled with pest and weed invasions, changes in bushfire regimes and poor land use planning*."

1. Margaret River, WA Burnt Vegetation – *Kerris Berrington/Newspix*
2. Damsel Fish on Coral Reef – ARC Centre of Excellence for Coral Reef Studies/*Marine Photobank*
3. Wireweed (Amphibolis species) – *Tsun-Thai Chai/Marine Photobank*
4. Grassfire in tropical savanna grassland, NT – *Dave Watts/ANTphoto*

Leading ecologists from seven Australian universities have identified **ten ecosystems most at risk.**

Bill highlights the dilemma with the plight of the white lemuroid possum – of which only four individuals are evidently now left on Earth, clinging on in a dwindling cool-climate habitat atop a north Queensland mountain. "*Climate change leads to stronger heatwaves, reducing the cool, moist forest area and cloud habitat on which this animal depends. As the planet warms, these mountaintop environments shrink until, as they say, the only place these unique animals can go is heaven*." Scientists debate whether such animals can be moved to other refuge ecosystems – or left to their fate, rather than risk disrupting a similar ecosystem by introducing them.

"We need to do all we can locally to limit the other pressures that human activities like land development, farming, mining, fire management and the introduction of pests and weeds impose on stressed ecosystems," Professor Laurance says. *"To fight harmful global change we must first fight harmful local change."*

Murdoch University Sustainable Ecosystems Director Professor Bernie Dell explains, *"Currently Australia has no co-ordinated national system to alert us to which ecosystems are closest to their tipping points, so we can prioritise action. That's why we came together from universities across Australia to develop this list of ecosystems most at risk of tipping."*

In Western Australia he says, four decades of declining winter rainfall and a severe drought is causing permanent streams to dry out completely, groundwater to disappear and whole stands of hardy eucalypts in the south-western forest to die. *"We are seeing alarming changes in the ecosystem, driven by multiple pressures."*

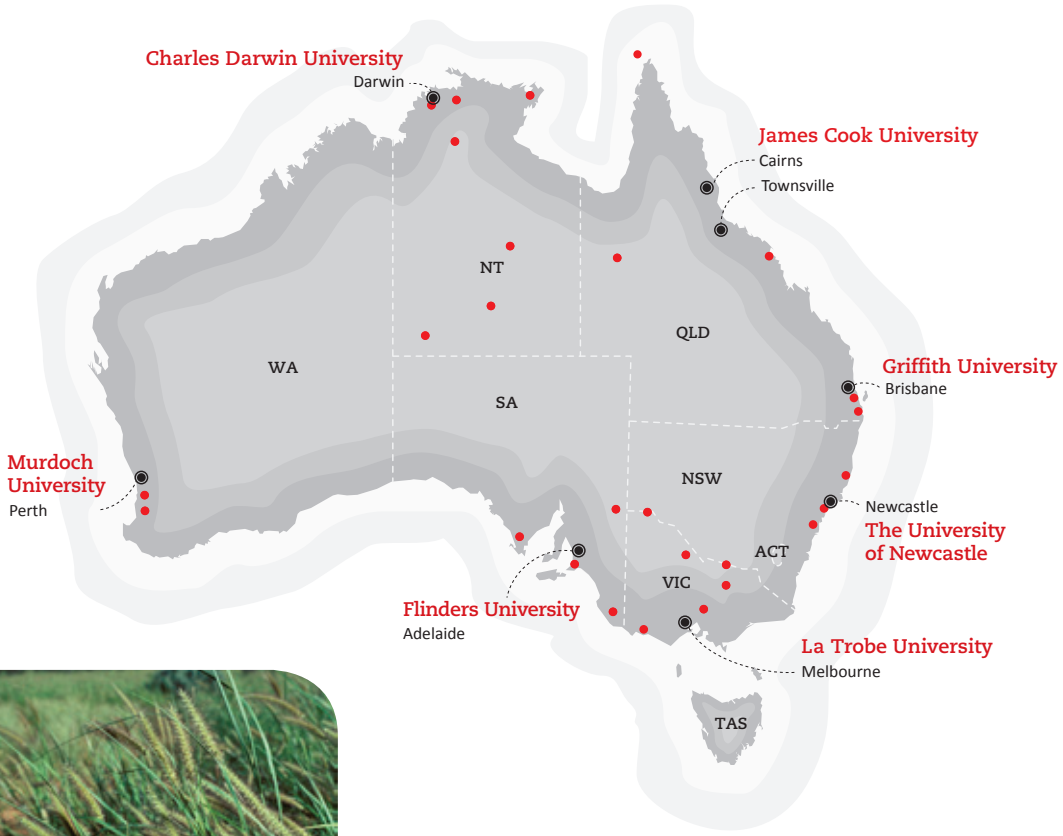
Finding effective solutions to such large scale threats is complex and takes time to implement: "*For example, we may have to change how we manage our forest ecosystems and develop better prescriptions for reforestation after mining in order to preserve a better water balance. This can't be achieved overnight, so it is important to act early,*" Professor Dell says. Other strategies, such as re-connecting isolated fragments of native bush in the biodiversity hotspot of the south-western sandplains, also take years, even decades to achieve – and the work must progress as rapidly as possible.

1. White Lemuroid Possum – *Mike Trenerry*
2. Daintree, Qld – *Brad Newton/Newspix*

One of the great risks in Australia's present approach is that the public and policy makers often assume that vast sweeps of thinly inhabited landscape are still 'pristine' and in good condition, cautions Professor Michael Lawes of ***Charles Darwin University.***

"For example, our tropical savannas fall into this category. They cover roughly 22 percent of the continent, and there are clear signs of breakdowns in their ecosystem processes and services which indicate tropical savannas are not as stable or pristine as we had thought."

Half a century or more ago, some parts of the northern tropical savannas were dominated by a native cypress pine, *Callitris intratropica*, the only local tree that relies solely on seed to propagate. Today, in areas marked "*Callitris forest*" on early 20th Century maps, the tree is largely gone. "*Its abundance has plummeted. It has retreated into gorges and areas safe from fires. It's an indicator of what is happening in the wider landscape*," Professor Lawes says.



Invasions of gamba grass (in the north) and buffel grass (in the centre) are causing huge increases in the ferocity and frequency of fires, to levels greater than Australian native vegetation can withstand. "*There are many similar signs that large parts of the tropical savannas are at risk. An ecosystem which some say dates back 60 million years is in danger of falling over under the cumulative weight of these pressures*".

"*It is all telling us: don't be complacent. There are things we can do, but if we delay too long, it may be too late. A tipping point may have passed.*"

Professor Lawes lists improved fire management, control of feral animals like buffalo and cats, more sensitive grazing policies, control of weeds and the re-establishment of native species as possible steps. "*We need to be optimistic that we can make a difference, that we can prevent the tipping points from being reached*," he counsels.

1. Buffel Grass, Northern Territory – *Denis O'Byrne/ ANTPhoto*

At their Cairns meeting the IRU ecologists set **five goals:**

1. to identify the 'top 10' Australian ecosystems most vulnerable to tipping points,
2. to highlight the parts of each ecosystem type currently at critical risk,
3. to identify the weak points that expose each ecosystem to tipping points,
4. to identify the main external threats,
5. to look for common features of all ecosystems that make them vulnerable.

This will contribute towards a nationwide approach to protecting the most vulnerable.
Their assessment is based on:

- **vulnerability factors** – such as fragmentation, geographical restriction and reliance on a few key species; and
- **threats** – such as extreme climate events, fires, pests and diseases, sea-level rise and overexploitation by people.

It is the combination of these that can thrust an ecosystem to the point of no return.

Table 1: Threats to Australian ecosystems that make them vulnerable to tipping points

Environmental threats to 10 Australian ecosystems that render them vulnerable to tipping points, as perceived by 26 environmental experts. For each ecosystem type, the most important threat is numbered 1 with those of lesser importance numbered subsequently.

Environmental threat	Australia's 10 most vulnerable landscapes									
	Mountain ecosystems	Tropical savannas	Coastal floodplains and wetlands	Coral reefs	Dry rainforests	Murray-Darling	SW Mediterranean Ecosystems	Offshore islands	Temperate eucalypt forests	Mangroves and salt marshes
Increased temperatures	1			1	2	4	2	6	2	
Changes in water balance and hydrology	2		3		3	2	1		3	3
Extreme weather events	3	3	2	2		8	3	2		1
Ocean acidification				3						
Sea-level rise			1			9		3		2
Changed fire regimes	8	2	8		1		4		1	
Habitat reduction	5		5	5	5	5	8	4	4	4
Habitat fragmentation	6	4	6	6	6	6	9	5	5	
Invasives	4	1	4		4		6	1		
Pests and pathogens	7						5	7	7	
Salinization				4		3	7			
Pollution			7			7				5
Overexploration		5		7	7	1	10		6	

Australia's 10 most vulnerable landscapes


1


2


3


4


5

1. MOUNTAIN ECOSYSTEMS

Mountain ecosystems like those of the Great Dividing Range, Tasmania and southwest WA are especially vulnerable to climate change. This may bring warmer and drier conditions, a rising cloud base, more extreme weather events, loss of snow cover, more fires and invasive pests. Animals and plants long-adapted to these high, cool regions will be under growing threat as their habitats shrink and fragment and outside competition increases. Tipping points will be reached sooner here than almost anywhere else.

Countermeasures:

- *Reduce habitat loss and fragmentation and other direct local human impacts*
- *Re-establish 'corridors' linking fragmented forest remnants*
- *Conserve threatened habitats as long as possible*
- *Maximize the size and elevational range of nature reserves to increase their resilience to global warming, and if necessary*
- *Consider relocating some declining, heat-sensitive species to cooler habitats.*

2. TROPICAL SAVANNAS

Savannas cover almost a quarter of the continent, and significant parts of them are already stressed, as seen in the continual catastrophic loss of small marsupials. Here the primary threats are changes in fire regimes, invasive plants and pest animals, and extreme weather events. The primary concern is that, as temperatures and moisture availability change, there will be continual invasions of weeds which will modify entire landscapes, by altering fire regimes, competing for water, replacing native ecosystems and changing delicate nitrogen and carbon cycles. The sandstone savannas – those around Uluru and the Olgas - are at particular risk from inferno fires.

Countermeasures:

- *Better manage fire regimes*
- *Control weeds and feral animals where feasible*
- *Limit grazing and other impacts.*

3. COASTAL FLOODPLAINS AND WETLANDS

These freshwater or slightly brackish systems scattered along the Australian coastline are at particular risk from sea-level rise, storm surges, weed invasions and coastal development.

Those most at risk are low-lying and easily flooded with salt water, like the famed freshwater Kakadu wetlands, or those on coastlines with big tides. Salinity is toxic to animals such as frogs, and causes major shifts in fish and aquatic plant populations.

Countermeasures:

- *Improve coastal planning*
- *Minimise human obstacles to natural movements of species*
- *Protect ecosystems of exceptional rarity.*

1. Sandstone Rock Formation, Queensland Australia – *Mattie Baljet/Blue Gum Pictures*

OPPOSITE PAGE

1. River Red Gum – *Mattie Baljet/Blue Gum Pictures*
2. Reef edge Great Barrier Reef and Coral Sea – *Jurgen Freund/Aurora Photos*
3. Gulf Country – *Wayne Lawler/Ecopix*
4. Golden bowerbird – *G. Guy*
5. Baw baw frog – *G. Webster*

4. CORAL REEFS

Despite their abundance along Australia's northern coastlines, coral reefs are particularly vulnerable to sharp changes in water temperature, pH, quality and runoff from the land – evidenced in the almost complete loss of coastal fringing reefs in Queensland over the past 50 years. The most vulnerable reefs in future are those located near large rivers – where sediment and nutrients may be dumped on them – and in regions exposed to hot currents or extreme cyclones. Isolated reef systems, like Ningaloo in WA, are also vulnerable, because if species go locally extinct there it is difficult for them to recolonize.

Countermeasures:

- *Mitigate climate change and acidification by reducing CO_2 emissions*
- *Reduce direct human impacts on corals and fish to preserve resilience*
- *Control coastal runoff.*

5. DRY RAINFORESTS

Dry rainforests like Mabi Forest in Queensland occur in relatively moist, fire-proof valleys. However as temperatures rise and fire-regimes change these will become far more vulnerable to extreme weather and fire, to invasions of weeds like lantana and rubber vine or to land clearance, development and overgrazing by cattle. The replacement of native plants with invasives will lead to the loss of some native birds, animals and insects like butterflies. For instance, Forty Mile Scrub in far north Queensland is being completely overrun by lantana infestations. Dry forests are highly vulnerable to tipping points because of their patchy distribution, and susceptibility to fire and severe weed invasions.

Countermeasures:

- *Manage fire regimes and weed infestations wherever feasible*
- *Avoid human impacts adding to the already fragmented nature of these forests*
- *Reduce overgrazing and nearby development.*

1. Dry forest of Spotted Gum – *Otto Rogge/ANTPhoto*
2. Lantana invading open woodland – *Cyril Webster/ANTPhoto*
3. Dieback of native vegetation, Fitzgerald National Park WA – *G. Hardy*
4. Coorong and Murray River North – *Murray River Photos/Shane Strudwick*

6. MURRAY-DARLING BASIN WETLANDS AND FLOODPLAINS

The wetlands and floodplains of the MDB are very vulnerable to tipping points because they are already highly fragmented by agriculture and other human activities and face increased water and invasives stress. They also depend on a relatively small number of 'framework species', such as the river red gum, many of which are already approaching a critical stage. The southern half of the Basin is at risk of further drying under climate change. We consider the most threatened areas, however, are those with acid-sulphate soils – which can send flushes of toxic water along creeks and rivers. The Coorong is also at high risk of tipping permanently to a highly saline state.

Countermeasures:

- *Reconnect natural bush and riverine ecosystems*
- *Reconnect rivers to their floodplains*
- *Reduce land clearance and over-extraction of water*
- *Allocate more water for natural ecosystems and river flows*
- *Manage environmental water strategically*
- *Remove redundant structures (e.g. weirs) within streams and rivers, and install fish ladders on those that remain*
- *Limit the spread of feral fish populations and exploit extreme drought conditions to eradicate them from priority wetlands*
- *Keep acid soils flooded.*

7. SOUTHWESTERN MEDITERRANEAN ECOSYSTEMS

Recognised as a global biodiversity hotspot for their astonishing variety of plant fauna, the southwest ecosystems - especially the forests - are exposed to tipping points because they are already close to their limits in terms of temperature and moisture. These risks are intensified by changing fire regimes, loss of key species, weed and pest invasions and fragmentation by human activity (farming, mining and urban development). In future these pressures will be multiplied by climate drying, hotter temperatures, changing fire regimes, the spread of salinity, diseases and pests and human population growth.

Countermeasures:

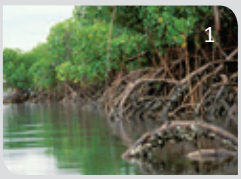
- *Reconnect isolated fragments of bush with national parks*
- *Enable species to move naturally with changing climate. Limit human impacts by good planning and land management*
- *Manage forests, runoff and bushfires better.*

8. OFFSHORE ISLANDS

Australia has 8,300 offshore islands, ranging in size from less than a hectare to over half a million hectares. Like all islands, these are highly vulnerable to tipping points because of their limited size, isolation and special mix of native plants and animals. Among them the most vulnerable are those which already have narrow ranges of species and are thus open to invasion – and those with large human populations. Equally, some offshore islands which have not been invaded represent vital refugia where original Australian landscapes, plants and animals can be preserved. The main risks to islands are from changes in ocean currents, sea level rise, extreme events and new invasions of pests and diseases.

Countermeasures:

- *Protect the most pristine islands strictly*
- *Restrict human impacts*
- *Monitor for pest or weed invasions and eradicate where possible.*



9. TEMPERATE EUCALYPT FORESTS

Our eucalypt forests and woodlands face dramatic changes over a significant part – though not all – of their range. This will be driven by climate change, fragmentation due to human development, loss of key species and changes in bushfire patterns. Fire is a major architect of these landscapes, and fiercer, hotter fires could push them outside the range they are naturally adapted to, favouring invasive plants and trees over Australian natives.

Some eucalypt systems, such as the Brigalow Belt and Grassy Box Woodlands, have already 'tipped' and no longer resemble their original state.

Countermeasures:

- *Strengthen local conservation ethics and practices such as revegetation and Landcare*
- *Control weeds and pests more effectively*
- *Reconnect isolated fragments of bush*
- *Manage fire regimes to reduce large fires.*

10. MANGROVES AND SALT MARSHES

Mangroves and salt marshes play a key role in protecting our coastline, trapping polluted runoff and sediment from the land and so cleansing the ocean, and as nurseries for fish, birds and other animals. Mangroves and their anoxic sediments are extremely stable carbon sinks (so called "blue carbon"). However, they are increasingly isolated and fragmented by human development on the land side and sea-level rise and storm surges from the seaward side. This increases their vulnerability to sudden, dramatic changes.

Countermeasures:

- *Sensitive urban planning to allow mangrove ecosystems to move in response to sea-level changes*
- *Protection and restoration of key areas (e.g. East Trinity).*

1. Long-Fruited Stilted Mangrove – *Pete Atkinson/ANTPhoto*
2. Bushfire burning in Eucalypt forest – *Ted Hutchison/ANTPhoto*
3. Mangroves – *Bill Bachman/ANTPhoto*

Looking forward

"*Managing natural and semi-natural ecosystems in a world that is continually in flux is a great challenge, but societies globally are adapting to these realities*," the team comment in their paper.

Today's environmental regulations and policies must change – and are changing – profoundly in an effort to keep abreast the increasing rate of alteration now seen in natural systems themselves, they say.

Above all, there is a need for continual 'environmental scans' to pick up the warning signs of a tipping ecosystem before it is too late to act to remedy it, they add. They acknowledge this is no small task. Such scans would be much more feasible if we had long-term, continental scale infrastructure to facilitate ecosystem observation, and to manage large, complex datasets from diverse sources — from detailed plot, flux tower and stream gauge data to satellite imagery. We now have the technologies both to gather ecosystem data more efficiently, and to store and analyse much larger longitudinal datasets.

To identify risks clearly and take timely action calls for a society-wide effort – not just by governments and scientists, but also businesses, communities, NGOs, dedicated groups and individuals acting in concert to protect the landscapes we most value and hold dear, and whose survival is intrinsic to our own as well as to our identity as Australians.

Tipping, dipping and stripping.

'Tipping' ecosystems experience profound 'regime changes' across most or all of their geographic range. Often the landscape looks – and is – physically different and many of its key species disappear completely.

'Dipping' ecosystems experience very large changes, but these are restricted to portions of the whole ecosystem.

'Stripping' ecosystems are being stripped of key components, such as small marsupials, frogs, reptiles or large predators, but the changes are insidious and not always easy to spot.

"The 10 Australian ecosystems most vulnerable to tipping points", Biological Conservation, 144 (2011) 1472–1480, Elsevier, 2011. By William F. Laurance , Bernard Dell , Stephen M. Turton , Michael J. Lawes , Lindsay B. Hutley, Hamish McCallum, Patricia Dale, Michael Bird, Giles Hardy, Gavin Prideaux, Ben Gawne, Clive R. McMahon, Richard Yu, Jean-Marc Hero, Lin Schwarzkopf, Andrew Krockenberger, Samantha Settlefield, Michael Douglas, Ewen Silvester, Michael Mahony, Karen Vellam, Udoy Saikia, Carl-Henrik Wahren, Zhihong Xu, Bradley Smith, Chris Cocklin.

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