Why losing Australia's biodiversity matters for human health: insights from the latest State of the Environment assessment

Biodiversity in Australia is in steep decline, posing major risks to human health

Australia is one of 17 megadiverse countries globally, with many plants, animals and ecosystems found nowhere else on Earth. Unfortunately, over 200 years since European colonisation, Australia has suffered the largest decline in biodiversity of any continent, including the highest rate of extinctions in the modern world.[1]

Now, a comprehensive and sobering report on the state of Australia's environment (SOE) over the past five years has been released. This shows ongoing environmental deterioration at a continent-wide scale.[2] Pressures from climate change, habitat loss, pollution, resource extraction, and invasive species are threatening every Australian ecosystem, with 19% showing signs of collapse.[2] These pressures have resulted in the number of threatened species growing by 8% since 2016, such that 21% of Australian mammal species are now threatened. Moreover, this number is predicted to increase substantially over coming decades, with further extinctions expected unless radical changes are made.[2]

Yet, although we are increasingly hearing dire warnings about our environment, there is a lack of reflection on the consequences for human health among policy makers and the general public. Addressing this, for the first time, the SOE report explores environment–human health linkages, recognising that the state of our environment is highly consequential for the health and wellbeing of Australians.

The implications of this report for the medical community cannot be ignored. It is imperative that we acknowledge human dependence on nature and respond to Australia's accelerating environmental decline with the same urgency as any other public health emergency.

The importance of biodiversity and healthy ecosystems for humans

Humans depend on nature for a wide range of ecosystem services (Box 1 and Box 2).[3-5] In general, the more biodiverse an ecosystem, the greater its stability, productivity and resilience, especially in the face of climate change. Conversely, loss of biodiversity disrupts ecological functioning and undermines the ability of ecosystems to support humankind.[6]

Food

Good nutrition and food security depend on biodiversity. Diverse species promote a balanced diet, and pollinating insects and animals are essential for a healthy food supply. Close to 75% of the world's crops depend on pollinators.[7] In turn, pollinators depend on healthy habitats including native vegetation for their survival. Many organisms act as natural pest control agents, and genetic diversity helps protect crops against changing weather and pest impacts.[3]

The SOE report notes that "quality, affordable food is one of the key material contributions of nature to people".[2] However, urban sprawl and impacts of climate change are putting increasing pressure on food provision and security. Our native vegetation and soils are in poor and deteriorating condition, and drought, heatwaves, changing rainfall patterns, storms and cyclones are increasingly affecting crop quality and quantity.[2] This has real-world implications, with Australians increasingly affected by rising food prices related to these issues.[8]

Medicines

Animal, plant and microbial biodiversity is an important source of unique medicinal compounds and biophysical materials for research. More than half of commercially available medicines are based on bioactive compounds either extracted or patterned from non-human species. For example, angiotensin-converting enzyme inhibitors were derived from Brazilian pit viper venom, and the venom of Australia's eastern brown snake is a component of a newly developed innovative gel that acts as a haemostatic wound sealant.[9,10]

Coral reefs have the highest density of biodiversity globally.[11] This results in intense species competition and evolution of complex defensive chemicals, many of which have pharmacological value. Compounds from reef sponges, tunicates, molluscs, bryozoans and many other species are being explored for analgesic, anti-inflammatory, antimicrobial and antineoplastic activity.[11] For example, hundreds of species of marine cone snails depend on coral reefs, and the venom of each contains up to 50 unique peptides that selectively inhibit the function of ion channels involved in the transmission of nerve signals. The first drug derived from cone snail venom, ziconotide, was approved in 2004 for treating chronic, intractable pain, but many more applications are being researched.[12]

The SOE report notes that drug discovery from wild species will continue to be critical for health care, wellness, and disease prevention. Yet, simultaneously, we are losing these natural pharmacies as biodiversity declines.[13] Reefs, including Australia's Great Barrier Reef, are being rapidly degraded, at a time when less than 10% of their biodiversity is known. Nature is

Katherine A Barraclough[1,2]
Marion Carey[3]
Kenneth D Winkel[4]
Emily Humphries[5]
Brooke Ah Shay[6]
Yi Chao Foong[7]

1 University of Melbourne, Melbourne, VIC.
2 Royal Melbourne Hospital, Melbourne, VIC.
3 University of Notre Dame Australia, Sydney, NSW.
4 Centre for Health Policy, University of Melbourne, Melbourne, VIC.
5 Ulladulla Medical Clinic, Ulladulla, NSW.
6 Mala'la Health Service Aboriginal Corporation, Maningrida, NT.
7 Alfred Health, Melbourne, VIC.

kdw@unimelb.edu.au

doi: 10.5694/mja2.51904

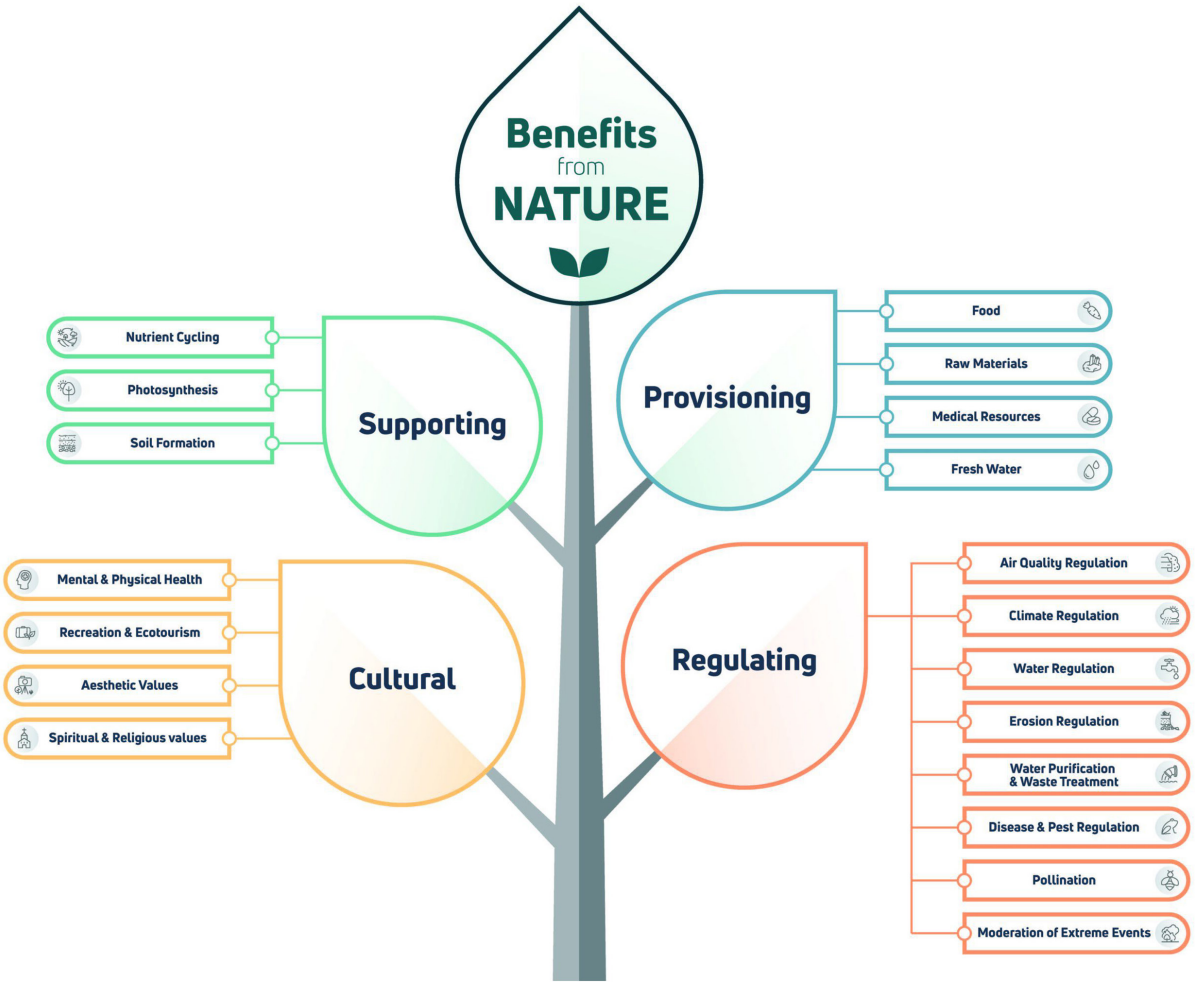
1 Biodiversity, ecosystems and associated definitions

Biodiversity. The variability among living organisms. It includes diversity within and among species and diversity within and among ecosystems.

Ecosystem. A dynamic complex of plant, animal and microorganism communities and the non-living environment, interacting as a functional unit.

Ecosystems services. The benefits people obtain from ecosystems. They include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational and cultural benefits; and supporting services, such as nutrient cycling that maintain the conditions for life on Earth.[4]

2 Ecosystem services



Source: Reproduced with permission from TERN Australia.[5] ◆

akin to a public library of information waiting to be accessed and we are losing books before we have read them.[14]

Water

Healthy, biodiverse ecosystems — forests, grasslands, rivers, lakes, streams, wetlands and estuaries — are critical for purifying, protecting and supplying water.[15] By preventing soil erosion, trapping sediments and pollutants and helping prevent floods, they improve our water quality. For example, water from Melbourne's protected forested water catchments requires less treatment than water from other sources.[15] It is estimated that the water purification services provided by Victorian forests avoid costs of $33 million per year in metropolitan areas and $50 million per year in non-metropolitan areas.[15] Forests and native vegetation also increase water infiltration into soils, helping to recharge groundwater supplies.

However, we have lost nearly 40% of our forests since European arrival and much of our remaining vegetation is highly fragmented.[2] It has been estimated that ongoing logging in Melbourne's forested water catchment is leading to loss of 15 000 megalitres of water annually, equivalent to the amount used by 250 000 people.[16] Drought, resource mismanagement, invasive

3 Actions for the medical community

- Recognise Australia's environmental crisis as a health crisis.
- Ongoing environmental advocacy in our role as health experts.
- Greater research into evidence-based nature therapy and subsequent translation into clinical practice.
- Transition to an environmentally sustainable health care system.

4 Definitions of Planetary and One Health

Planetary Health. This is defined as "the health of human civilisation and the state of the natural systems on which it depends". The concept focuses on better balancing human needs with the preservation of the Earth to sustain the health and wellbeing of current and future generations.[28]

One Health. This is an approach that aims to sustainably balance and optimise the health of people, animals and ecosystems. It recognises the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and interdependent.[29]

species, pollution and bushfires have also left our inland waters in poor and worsening health. Less water availability is predicted for agriculture, urban water supplies and ecosystems in coming decades, including areas around Adelaide, Melbourne and Perth.[2]

Infectious diseases

Intact ecosystems such as forests and other wilderness areas serve as a key defence against the emergence and spread of infectious diseases. Conversely, when we clear forests and remove natural habitat, wildlife behaviour is altered, in turn increasing the likelihood of human contact with wildlife and risk of cross-species infection transmission.

The number and diversity of emerging infectious diseases have increased over time.[17] This has been linked to land use change from deforestation, agriculture, urbanisation and climate change. According to the SOE report, the emergence of pandemics is "entirely driven by human activities, which disrupt natural interactions between species and their microbes".[2]

A recent 25-year study has shown that bat behaviour change due to climate change and habitat destruction has led to increased Hendra virus spillover risk in Australia.[18] Other examples of spillover events in the Australian context include lyssavirus, Ross River virus, and Japanese encephalitis virus.[19,20] Although mitigation strategies such as livestock vaccination and exposure minimisation exist in Australia, a broader ecological approach remains lacking. Coronavirus disease 2019 (COVID-19) provides a recent devastating example of a global pandemic with likely animal origins.[21]

Psychological health and wellbeing

The body of literature supporting a link between nature exposure and improved psychological health is extensive and compelling. The benefits seen extend from increased happiness and self-worth to reduced mental health disorders including anxiety and depression.[22] The SOE report affirms this, noting the role of urban biodiversity and blue and green spaces in reducing stress and improving overall wellbeing. It also draws attention to the fundamental importance of environmental health for the wellbeing of First Nations Australians.

The lives of First Nations Australians are intrinsically connected to the flora and fauna of the lands on which they live. First Nations Australians place great cultural and spiritual value on native species and ecosystems, meaning their destruction results in a loss of their culture and identity.[2] The SOE report identifies that negative shifts in environmental conditions are causing worry and deep distress in First Nations communities. As noted in an SOE consultation workshop, "People have connection and if it's taken away, we are left with nothing".[2] Conversely, participating in caring for Country activities by First Nations peoples can improve health and wellbeing, while also improving environmental health.[2]

Cascading impacts

Ecosystems can be highly dependent on keystone or foundational species, the loss of which leaves the whole system vulnerable to collapse. This may have particularly substantial consequences for human health due to the loss of the broad range of services that the ecosystem in question provides. An example is the progressive loss of kelp species in the Giant Kelp Marine Forests of South East Australia, which form part of the 8000 km long Great Southern Reef stretching from the Queensland border to Western Australia. These forests provide habitat for many socio-economically important plants and animals, contributing more than $10 billion per annum to the Australian economy.[23] They are also an important source of medicines and generate some of the highest rates of primary production and carbon sequestration of any global ecosystem. However, due to kelps' dependency on cold, nutrient-rich water, they are increasingly threatened by climate change, among other anthropogenic stressors.[24]

What can be done to protect biodiversity and health?

A 2020 review of Australia's chief environmental law — the *Environment Protection and Biodiversity Conservation* (EPBC) *Act* — found it woefully inadequate to protect biodiversity and recommended significant reforms.[25] More recently, the federal government has taken some important steps towards addressing environmental decline, such as:

- committing to an overhaul of the EPBC Act, including new national environmental standards and a national Environmental Protection Agency;
- committing to protection of 30% of Australian land and sea by 2030;
- releasing a new threatened species plan, including a goal of no new extinctions; and
- increasing budgetary funding for environmental protection, including for Indigenous land and sea management programs.

However, it is unclear whether the proposed legal reform is commensurate with the challenges faced. Concerningly, native vegetation clearing is barely mentioned in the threatened species plan, despite the SOE identifying this as the leading cause of biodiversity loss. Furthermore, the funding allocated falls well short of the estimated $1.69 billion per year required to reverse Australia's biodiversity crisis,[26] making it unlikely that no new extinctions will occur. Of note, the amount required is one-seventh of that spent by federal and state governments on fossil fuel subsidies during the past financial year.[27]

There are several key messages in the SOE report for the medical profession (Box 3). First, we must recognise that Australia's environmental crisis is a health crisis. We need to use our positions as health experts to advocate for environmental protection for the sake of health. To government, this includes calling for environmental laws with teeth, adequate funding for biodiversity recovery, and ending support for the fossil fuel industry. Of our colleges, we must ask that they advocate on our behalf about the threat of biodiversity loss to health, in the same way they are doing with climate change.

There is a need for increased research, application and promotion of nature-based therapies to health problems, noting that support for environmental protection is greater when health co-benefits can be demonstrated. In our daily practice, we must consider the lifecycle environmental impacts of our purchasing, investigating and prescribing to avoid the paradox of harming health while seeking to improve it. Increasingly, these ideas are being incorporated into health care practice through the Planetary and One Health approaches (Box 4).[28,29]

In the words of Margaret Chan,[30] former director of the World Health Organization, "A ruined planet cannot sustain human lives in good health. A healthy planet and healthy people are two sides of the same coin".

Open access: Open access publishing facilitated by The University of Melbourne, as part of the Wiley - The University of Melbourne agreement via the Council of Australian University Librarians.

Competing interests: No relevant disclosures.

Provenance: Not commissioned; externally peer reviewed. ■

1 Woinarski JCZ, Burbidge AA, Harrison PL. Ongoing unraveling of a continental fauna: decline and extinction of Australian mammals since European settlement. *Proc Natl Acad Sci US* 2015; 112: 4531-4540.

2 Cresswell I, Janke T, Johnston E. Australia State of the Environment 2021. *Commonwealth of Australia*, 2021. https://soe.dcceew.gov.au/ (viewed Nov 2022).

3 Chivian E, Bernstein A; editors. Sustaining life: how human health depends on biodiversity. New York: Oxford University Press, 2008.

4 Reid WV, Mooney HA, Cropper A, et al. Ecosystems and human well-being: synthesis — a report of the millennium ecosystem assessment. Island Press, 2005.

5 Terrestrial Ecosystem Research Network. How do we quantify Australia's ecosystem services? Brisbane: TERN, 2021. https://www.tern.org.au/news-quantifying-ecosystem-services/ (viewed Feb 2023).

6 Isbell FI, Polley HW, Wilsey BJ. Biodiversity, productivity and the temporal stability of productivity: patterns and processes. *Ecology Letters* 2009; 12: 443-451.

7 Klein AM, Vaissière BE, Cane JH, et al. Importance of pollinators in changing landscapes for world crops. *Proc Biol Sci* 2007; 274: 303-313.

8 Smith K, Lawrence G, MacMahon A, et al. The resilience of long and short food chains: a case study of flooding in Queensland, Australia. *Agriculture and Human Values* 2016; 33: 45-60.

9 Patlak M. From viper's venom to drug design: treating hypertension. *FASEB J* 2004; 18: 421.

10 Yegappan R, Lauko J, Wang Z, et al. Snake venom hydrogels as a rapid hemostatic agent for uncontrolled bleeding. *Adv Healthc Mater* 2022; 11: e2200574.

11 Jha RK, Zi-rong X. Biomedical Compounds from Marine organisms. *Mar Drugs* 2004; 2: 123-146.

12 Safavi-Hemami H, Brogan SE, Olivera BM. Pain therapeutics from cone snail venoms: from Ziconotide to novel non-opioid pathways. *J Proteomics* 2019; 190: 12-20.

13 Pimm SL, Russell GJ, Gittleman JL, Brooks TM. The future of biodiversity. *Science* 1995; 269: 347-350.

14 Piper R, Kagansky A, Malone J, et al. Nature is a rich source of medicine-if we can protect it. *The Conversation*, 14 Dec 2018. https://theconversation.com/nature-is-a-rich-source-of-medicine-if-we-can-protect-it-107471 (viewed Nov 2022).

15 Melbourne Water. Water management [website]. Melbourne Water, 2022. https://www.melbournewater.com.au/water-and-environment/water-management (viewed Feb 2023).

16 Taylor C, Blair D, Keith H, Lindenmayer D. Modelling water yields in response to logging and Representative Climate Futures. *Science of the Total Environment* 2019; 688: 890-902.

17 Keesing F, Belden LK, Daszak P, et al. Impacts of biodiversity on the emergence and transmission of infectious diseases. *Nature* 2010; 468: 647-652.

18 Eby P, Peel AJ, Hoegh A, et al. Pathogen spillover driven by rapid changes in bat ecology. *Nature* 2023; 613: 340-344.

19 Thompson RCA. Parasite zoonoses and wildlife: One Health, spillover and human activity. *Int J Parasitol* 2013; 43: 1079-1088.

20 Yakob L, Hu W, Frentiu FD, et al. Japanese encephalitis emergence in Australia: the potential population at risk. *Clin Infect Dis* 2023; 76: 335-337.

21 Lawler OK, Allan HL, Baxter PW, et al. The COVID-19 pandemic is intricately linked to biodiversity loss and ecosystem health. *Lancet Planet Health* 2021; 5: e840-e850.

22 Aerts R, Honnay O, Van Nieuwenhuyse A. Biodiversity and human health: mechanisms and evidence of the positive health effects of diversity in nature and green spaces. *Br Med Bull* 2018; 127: 5-22.

23 Bennett S, Wernberg T, Connell SD, et al. The "Great Southern Reef": social, ecological and economic value of Australia's neglected kelp forests. *Marine and Freshwater Research* 2015; 67: 47-56.

24 Layton C, Coleman MA, Marzinelli EM, et al. Kelp Forest restoration in Australia. *Frontiers in Marine Science* 2020; 7.

25 Samuel G. Independent review of the EPBC Act [website]. *Commonwealth of Australia*, 2021. https://epbcactreview.environment.gov.au/resources/final-report (viewed Oct 2022).

26 Wintle BA, Cadenhead NCR, Morgain RA, et al. Spending to save: what will it cost to halt Australia's extinction crisis? *Conservation Letters* 2019; 12: e12682.

27 Campbell R, Littleton E, Armistead A. Fossil fuel subsidies in Australia: federal and state government assistance to fossil fuel producers and major users 2020–21. Canberra: Australia Institute, 2021. https://australiainstitute.org.au/wp-content/uploads/2021/04/P1021-Fossil-fuel-subsidies-2020-21-Web.pdf (viewed Nov 2022).

28 Whitmee S, Haines A, Beyrer C, et al. Safeguarding human health in the Anthropocene epoch: report of the Rockefeller Foundation–*Lancet* Commission on planetary health. *Lancet* 2015; 386: 1973-2028.

29 One Health High-Level Expert Panel (OHHLEP); Adisasmito WB, Almuhairi S, Behravesh CB, et al. One Health: A new definition for a sustainable and healthy future. *PLoS Pathog* 2022; 18: e1010537.

30 Chan M. WHO Director-General addresses event on climate change and health [website]. World Health Organization, 2015. https://www.who.int/director-general/speeches/detail/who-director-general-addresses-event-on-climate-change-and-health (viewed Nov 2022). ■