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# Jump-starting ENVIRONMENTAL MONITORING

There has been a critical decline in Australia's capability to monitor environmental changes. Experts say there is now a need for a new, national approach to form the basis of our ability to crucially adapt to immediate climate change impacts, while also opening opportunities for better, innovative science. **Graeme O'Neill** reports.

The world is changing as global warming modifies terrestrial and marine environments at a rate unprecedented since the end of the last glacial period 11 500 years ago.

Ecosystems are in flux, and species are under threat. As the custodian of an entire continent and a vast marine zone, Australia would seem to be uniquely placed to monitor environmental change on a continental scale and across its marine territories.

But three of the nation's leading environmental science experts, Andrew Campbell, Professor Hugh Possingham and Professor Will Steffen, believe the execution – at least for our terrestrial environment – falls well short of the requirement, and of standards set by the US and Britain.

They paint a depressing picture of Australia's efforts to systematically track changes in terrestrial ecosystems due to human activity and climate change, and say environmental monitoring is underfunded, and under-resourced. Projects, they say, tend to reflect personal interest, or focus on iconic or rare species, which are suboptimal indicators of widespread change.

State and institutional parochialism hampers efforts to develop national-scale syntheses, and long-term environmental research for the common good languishes, lacking clearly defined customers,

commercial sponsors and bankable dividends.

Campbell, former Executive Director of Land and Water Australia, says taxonomy, the bedrock of the biological sciences, is in serious decline, along with other basic science disciplines. Australia has too few botanists, entomologists, vertebrate taxonomists and soil scientists – and, astonishingly for the 'marsupial country', just one full-time marsupial taxonomist.

The problem lies with shrinking university budgets, falling enrolments and entry scores for the basic sciences, agriculture and forestry, and time's toll on taxonomy's mentors and teachers, who are not leaving successors.

Campbell, proprietor of the sustainability consultancy Triple Helix, laments a breakdown in technical capability within many state agencies that retain responsibility for land, water and biodiversity management under the Australian Constitution.

'Public sector employers have gone through a 20-year period of restructuring and rationalising to achieve smaller government, so they're investing far less in staff development.

'Landcare started in Victoria, then became a national program that is being copied in more than 20 countries. The four key people who developed that program in the early 1980s all benefited



**A male gang-gang cockatoo eating berries, Victoria.** James Porteous

from full-time study leave from their state agency to do postgraduate extension research at the University of Melbourne. The return on that investment has been phenomenal, but I can't imagine a state agency anywhere in Australia investing comparably in its staff today.'

Australia urgently needs a truly national environment monitoring strategy. 'A lot of groundwork done in the past to physically measure components of the landscape is in disrepair,' Campbell says.

'We've just drifted into a dreadful situation. We wouldn't dream of making major economic decisions without good data on the Australian economy, yet we do it with the Australian environment. We sweat on the latest employment and balance of trade figures, yet we allocate





Ancient rock formations and landscape, Western Australia. iStockphoto



Banksia in flower. Ron Hohenhaus, iStockphoto



Fresh falls on the Snowy Mountains, NSW.

Edwin Chu, iStockphoto

\$10 billion to a national water plan, with almost no reliable water data. The best thing about that plan is its commitment of \$480 million for a new water accounting framework for Australia.

‘Five years ago a number of national committees with representatives from all jurisdictions were set up under the National Land and Water Resources Audit to work on different themes, including monitoring biodiversity. They’ve worked out – and agreed across all jurisdictions – what needs to be measured, and how to measure it. The unglamorous, painstaking work is largely done, and we now need to use it to roll out a national environment monitoring strategy.

‘We need to be doing baseline monitoring that targets critical questions:

how fast is the environment changing, and where? What are the tipping points? And what does this mean for the services we currently derive from natural ecosystems?’

‘We need to track the agreed parameters in a repeatable way, we need to establish sentinel sites, and major transects, and monitor them with state-of-the-art sensors, feeding data directly into a supercomputer network that will provide real-time information on key indicators of environmental change.’

He says Australia has only a handful of long-term ecological studies, run by dedicated scientists with minimal funding. ‘The approach is ramshackle – there’s no sensible national coordination or funding.’

‘I believe Australia can do it better than anyone, if we get our act together.

There are good examples overseas, in the UK, Canada and the US, from which we can learn, and we also have unique capabilities here, especially in our capacity to link more formal, scientific efforts with “citizen science” carried out by enthusiastic volunteers.’

He says Australia now needs to build on the work of projects such as the Birds Atlas, Water Watch and Frog Watch, complemented by data archaeology efforts to identify useful information and digitise it in accessible formats.

Professor Hugh Possingham, Director of the Ecology Centre at the University of Queensland, and Director of the Centre for Applied Environmental Decision Analysis, says Australia has been preoccupied with space, rather than time.



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‘We have a vast continent, so we’re good at using remote sensing, geographic information systems and spatial data, but we’ve neglected long-term data collection.

‘We’ve been monitoring the birds of the Mt Lofty Ranges around Adelaide three times a year, from 150 sites. It’s one of only a few such studies supported by ARC [Australian Research Council] discovery and linkage grants, plus philanthropic grants and several tens of thousands [of dollars] from state agencies.

‘Nature Conservation Society volunteers give us point counts for individual species over a million hectares. My father checks data and set up the database as a volunteer, and it costs us only \$35 000 a year to collect – it’s incredibly cheap data. If we contracted out the management, it would cost \$200 000.

‘We’re secure for a year or two, but we dread the grants cycle. It’s very hard to secure long-term resources.

‘We’ve produced 10 papers – mostly methodological. With a decade of data, we’re only now detecting the more dramatic changes. We’re seeing quite remarkable increases in several species. Logging stopped years ago, but because of year-to-year variability, we’re only just beginning to get a signal.

‘The state of monitoring in this country is abysmal – we don’t really know if our interventions on the ground are working. This kind of regional scale data may be our only hope.’

Professor Possingham regards the South-East Queensland Healthy Waterways Partnership study, due out this year, as *the* standard in regional environmental reporting.

‘The water stuff is spectacular – they’ve monitored over 300 sites for 30 indicators for eight years, and rated stream health on an A to F scale. It’s focused on marine, freshwater and estuarine waters, and looks at fish, macro-invertebrates and water quality. It’s the gold standard – every region in Australia should have this type of basic waterway health data.’

At the recent 2020 Summit in Canberra, Professor Possingham, Dr Campbell and former Australian Heritage Commissioner Leith Bouilly proposed a system of national environmental accounts, including measures of biodiversity.

Despite a groundswell of enthusiasm for committing state and federal governments to environmental monitoring, history gave little reason for optimism.

Australian museums were begging for



Subtropical riverine habitat near Gympie, south-east Queensland. Christopher Meder, iStockphoto

money to digitise hundreds of thousands of specimens and put them online, while the Australian Biological Resources Survey had recently lost half its budget.

‘I’ve been pushing for national, large-scale biodiversity sets – for example, in cooperation with the states, Professor Gordon Grigg, Dr Tony Pople, Dr Stuart Phinn and I assembled and analysed over 20 years of kangaroo data from aerial surveys. Furthermore Birds Australia has over 400 000 bird lists in their ongoing atlas of Australia birds,’ said Professor Possingham.

‘We’ve invested a six-figure sum getting both the bird and kangaroo data, but nobody wants to spend the extra money required to curate it, and embed it in some stable institution like Birds Australia or a university.

‘We need a website where anyone interested can access information on the amount of vegetation at a regional or sub-regional scale, because vegetation is a good surrogate for biodiversity.’

He believes governments should at least commit to measuring vegetation and counting species such as kangaroos, emus or waterbirds with regular aerial surveys – these indicator taxa are good proxies for biodiversity and easy to survey over large areas.

His parsimonious approach would require only easily counted organisms.

‘We would then see what we could afford to build on to increase the data yield.’

‘The agency responsible – a university, CSIRO or a state government department – should be given \$300 000 a year, forever, to curate, analyse and deliver the data. Governments don’t seem to understand “forever”. Deliver this, and people will add to it.’

Professor Possingham proposes a national centre such as the National Center for Ecological Analysis and Synthesis (NCEAS) in Santa Barbara, California. Funded by the Californian and Federal governments for over US\$4 million a year, it stores and curates spatial and temporal data sets, and makes them available to researchers. It provides a venue for researchers to exchange ideas, and share data and findings.

‘It funds about 15 to 20 proposals a year, which bring together international experts in particular fields to exchange ideas and information. They meet several times over two years and are given the time and resources to get the data analysed, synthesised and delivered in a way that it can be useful. The Center is an exemplar of cost-efficient science with a huge publication rate.’

Professor Will Steffen, Director of the Australian National University’s Fenner School of Environment and Society, agrees it is impossible to ‘monitor everything, everywhere’.

He says a coordinated, national approach is essential, with water, the carbon cycle and biodiversity as its highest priorities.

'We have a world-class national carbon accounting system, but we also need to understand the long-term behaviour of carbon in the environment, to complement carbon flux measurements and satellite assessments of vegetation cover, which are important tools in understanding the processes that drive the terrestrial carbon cycle.

'We can then predict whether a current terrestrial carbon sink will continue to behave that way as the climate changes – for example, we need to monitor fire frequency to understand whether fire regimes are changing significantly, with implications for the carbon cycle.'

Professor Steffen says the benefit of long-term biodiversity studies is exemplified in the work of his Fenner School colleague, Professor David Lindenmayer.

Professor Lindenmayer runs a network of long-duration projects to determine how biodiversity responds to different types of disturbance or habitat change: controlled logging in Victoria's mountain ash forests, habitat fragmentation by pine plantations around Tumut, regeneration burns in Jervis Bay's heathlands, and revegetation programs in the Riverina.

Professor Steffen says the National Collaborative Research Infrastructure Strategy (NCRIS) is designed to aggregate data from multiple sources. But he warns that strong leadership is required to develop coherent, continental-scale programs in the face of state and regional parochialism.

Australia's marine environment monitoring capabilities were boosted last year with the creation of the Integrated Marine Observing System (IMOS), through NCRIS.

IMOS Director Dr Gary Meyers describes the \$95 million collaborative facility, based at the University of Tasmania, as 'a real win for the marine research community'.

'While it's focused on marine research, in time it will deliver very significant societal and economic benefits,' he says.

'With NCRIS funding we're substantially enhancing Australia's ocean observing capability. There are no problems with state territoriality, and no rivalries between the various groups that stand to benefit from the data.

'It ensures we can continue time-series monitoring that began in the 1980s, and gives us funding for five years, instead of us limping along year by year.'

He says marine researchers already have access to temperature and salinity measurements down to 800 metres, from

instruments aboard merchant ships, and from robotic floats that can record down to 2000 metres.

The enhancements include coastal radars that generate detailed two-dimensional maps of marine currents up to 150 km from shore, and GPS-guided oceanic 'gliders' that measure ocean currents and biophysical water properties up to 1000 km from shore.

An acoustic system will allow researchers to track migratory species such as tuna and great white sharks moving around the coast.

'We're entering a period where climate change signals are emerging from the statistical noise,' Dr Meyers says. 'Things are happening in marine ecosystems, as well as on land, but we've had no baseline to monitor changes.'

'IMOS will give us that baseline, and we have started to build long time-series for a broad range of measurements.

'We will have nine national reference stations moored around the continent, with sensors to measure a range of physical and biological parameters.

'Previously, there were only three stations with a limited range of measurements, including one near Maria Island, off Tasmania's east coast.

'Temperature and salinity changes recorded over 60 years at Maria Island show the East Australian Current (EAC) is extending further south, consistent with predictions from climate change modelling. But what is the biological response to this?'

Dr Meyers says IMOS is now equipping merchant ships with towed, continuous plankton recorders that will monitor phytoplankton and zooplankton down the core of the EAC.

'We plan to run them on ships travelling between Brisbane, Sydney and Hobart, then continue with the Antarctic supply vessel *Arora Australis*. Monitoring biology on that scale – a subtropical to subpolar transect, 4000 km – just blows my mind.'

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The Southern Ocean meets Australia along the Great Ocean Road, Victoria. Christopher Seer, iStockphoto