



CONTINENTAL SHIFT

AS SCIENTISTS WORK TO IDENTIFY THE MAIN IMPACTS OF CLIMATE CHANGE ON OUR VAST CONTINENT, A PARLIAMENTARY INQUIRY HAS BEEN LAUNCHED INTO AUSTRALIA'S BIODIVERSITY IN A CHANGING CLIMATE. SCIENCE WRITER JULIAN CRIBB TALKS TO CSIRO SCIENTISTS ABOUT SOME OF THE KEY ISSUES.

By the end of this century four fifths of Australia will have landscapes and wildlife that appear rather different to those we have grown up to think of as 'Australian'. Species will have moved: new ones appeared, familiar ones declined, new ecosystems will be forming. The kind of scenery immortalised by Hans Heysen and Tom Roberts may in many places have yielded to something new – in some cases unrecognisable – to today's Australian eyes.

The arrival of Aboriginal people and European settlers both wrought vast transformations on the face of our continent and the mix of species it contains. But today's science now suggests these transformations may prove small compared with the overwhelming effects of climate change on every forest, grassland or desert, mountain, lake, river and wetland, beach, dune, estuary or reef and the plants and animals that inhabit them.

In CSIRO's Climate Adaptation Flagship a team of scientists is seeking to bring us a clearer picture of how profound those changes may be, how they will affect our perception of Australia and hence our own identity as Australians. Accepting that things

are changing with a gathering pace in inexorable ways, they are examining the different sorts of species mixes, ecosystems and landscapes that are possible in the future. This will enable them to advise on which adaptation options are likely to be achievable, the amount of Australia's unique life that is retained by enacting them, how and when to make critical decisions, how much those decisions will cost and how adjustable actions that play-out over long periods could be.

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The changes in the earth system now being observed by scientists around the world are driven by carbon dioxide and other emissions whose rates now track the 'worst case' scenario envisaged by the Intergovernmental Panel on Climate Change (IPCC). If these emissions persist on their present track, by 2100 they will deliver 3-6 degrees Celsius average rise in global temperatures, an unprecedented level

of ocean acidification, a 0.5-1.1 metre rise in sea levels (on its way to higher levels over the following century) and more extreme weather events – floods, fires, cyclones, heatwaves and droughts. This will affect all life in Australia dramatically and with a rapidity not seen for many millions of years.

Understanding what this means, both for Australia's unique biota and for ourselves, and what we can do as its stewards, goes to the heart of who we are and where we live. It challenges many of our cherished self-beliefs about our love of country, how we understand and care for it, our ability to shield it against harm and preserve its essential qualities.

"The scale of the changes we expect climate change to impose will cause us to question the fundamental basis of how we now conserve Australia's biodiversity," says Dr Craig James, who leads the Managing Species and Natural Ecosystems Theme of the Climate Adaptation Flagship.

"The challenge is to preserve the unique character of Australian biota. This is a challenge more complex than many of those faced by human-mediated systems because the number of effective actions we can make are fewer. Under the radically new



SURVIVAL: Some ecosystems will adapt while others will diminish



conditions some species will thrive, some will tough it out – and some, regrettably, will go under. We will have to learn how to manage them all for the best, in increasingly dynamic circumstances.”

Results from the models which the CSIRO researchers are developing to interpret the scale of environmental change have the power to shock. By the end of the century, environmental changes will most likely drive transformation of the mix of species – in some cases radically – on more than 80 per cent of the continent. Factors such as habitat loss and land clearing, erosion, water extraction, urban development and pollution all intersect with, and often exacerbate, the effects of climate change.

The models and expert knowledge suggest that, in the most heavily-affected areas, life is ‘thinned out’ as species move, diminish in abundance or disappear. The most adaptable and hardy survive in their current locations. From the iconic eucalypts of Sydney and the Blue Mountains to the spinifex grasslands of central Australia, to the wetlands of Kakadu, to the vineyards of the south, the Australian landscapes we know and love will yield to new and unfamiliar scenes.

Knowing how to cope with change on such a scale, and over so relatively short a time scale is an environmental challenge like none our scientists, policy makers or conservationists have confronted before. It calls for a rethink of how we



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value and protect the quintessential character of Australia's natural environments and its unique life forms. It calls for a fresh national look at the value of natural areas to our wellbeing, and new stewardship concepts, goals and strategies. It demands we make every effort to mitigate the extremes of climate change by curbing our emissions.

However, even the most extensive mitigation measures will not prevent many of these changes from taking place in Australian biodiversity – they are already locked in by past emissions. We therefore need to find ways to enable the biota to respond and adapt to the changing conditions.

Says biodiversity analyst Dr Michael Dunlop: “Almost everywhere, changes will affect the abundance and distribution of species, creating new assemblages and communities. This

will alter the very structure of ecosystems and how they function. There could well be huge losses – some think this may involve up to 30 per cent of the local species moving, declining or disappearing. We can reduce this loss by managing wisely and flexibly, but cannot prevent the changes altogether.”

What this means, say the CSIRO researchers, is that Australia's existing “static” approach to conservation – trying to protect and manage particular species in particular places – will no longer apply in the dynamic and fast-evolving environments of the future. Our stewardship needs to adapt – just as the plants, animals and humans are themselves already adapting to the new conditions.

Among the many changes, few are likely to affect urban and coastal Australia so much as sea level rise, exacerbated by an increase in storm surges and coastal erosion. A rise of 0.8m by 2100 sounds modest, but in many places it will drive wetlands, mangroves, coastal dunes and beaches hard against the inflexible barrier of human infrastructure. Unless they can find new high ground to occupy, the extent of these important coastal habitats will decline.

Mangroves and dunes, especially, often shield coastal communities from the elements and their loss will expose them to the blows of a more turbulent climate. Trying to retain them may, in some cases, mean abandoning seaside areas and allowing nature to take its course: the effect on coastal people and their homes gives a sense of the stress that all natural ecosystems will face. Conversely, in flat, uninhabited parts of the continent, mangroves and salt marshes may flourish – sometimes at the expense of icons like the near-coastal freshwater wetlands of Kakadu.

Scientific predictions for the Great Barrier Reef and Kakadu are well known, but other iconic Australian ecosystems face transformations as great or even greater, say the scientists. The continent's alpine and montane forests and heathlands may disappear, due to heat, loss of snowfall, drought and incursions of other species – and with them entire suites of cold-adapted marsupials, birds, reptiles, plants and frogs. For these, it will be immensely hard to find new, cool, wet havens.

Desert and rangeland ecosystems are likely to expand and even prosper, the scientists consider, gnawing into the outer fringes of Australia's grain belt and temperate woodlands. Climate change may bring more rain to certain environments (such as the north-western deserts) – but it also brings higher rates of evaporation, and the net result may be increased aridity, unfavourable to some species and favouring those most adapted to long, dry spells.

Our ‘Mediterranean’ climate zone, our current foodbowl and home of the southern woodlands with their spectacular abundance of native plants, animals and birds, will drift implacably towards the finite southern boundary of the continent, warns ecologist Dr David Hilbert. Whether these ecosystems can adapt or be rescued before they finally run out of suitable land is not yet clear. An analogy in the human world is that regions ideally suited for grape-growing will also gradually shift southward, first into Tasmania and then, eventually, to the far south of New Zealand.

Many Australian ecosystems are shaped by recurrent fire and thrive on it. “Fire regimes, the patterns of recurrence of fire across the landscape, are highly dependent on climate



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– the behaviour of individual fires is highly dependent on weather,” says Darwin-based fire ecologist Dr Dick Williams. “We can expect fire regimes to change as a consequence of climate change.”

By the end of the century there will be seasons of blazing heat and the incidence of fire risk levels well ‘off the scale’ of today’s familiar bushfire warning signs will increase: such trends are already emerging. Only the most fire-adapted plants and animals are likely to withstand such extremes – and that applies also to the human communities which choose to make their home in fire-prone bush.

Many individual Australian species are likely to cope with more intense fire because they have well-developed mechanisms of regeneration, honed over millions of years of evolution. But some native species are sensitive to the intervals between fires, and others are sensitive to the intensity; so more frequent and more intense fires as a consequence of climate change may be a threat to them.

The overall result is that landscapes, species mix and ecosystems are liable to change significantly. Some introduced weeds, not being as fire-adapted as the locals, may suffer a setback, but others, such as gamba grass in the north, buffel grass in the centre and veldt grass in the south respond to fire better than the native species and will drive ecosystem change because they promote fiercer, more frequent fires.

Drought too has shaped our landscape and crafted our unique plants and animals: its effects will amplify as the century advances. Drought may indeed favour the most dry-adapted of Australian species – but equally it could favour the hardy alien grasses and shrubs which many Australians have, without thought to the consequences, imported to sow in pastures, for soil stabilisation or water-saving gardens. These invaders have potential to reshape Australian landscapes and their mix of native species in ways just as devastating as the rabbit, the fox, blackberries or buffel grass, says weed ecologist Dr John Scott.

As with other issues, climate change demands a complete rethink of how we deal with invasive plants and animals, he says. While invaders from overseas will remain ‘invaders’, more than 600 native Australian species have already colonised new areas of Australia: are they invaders or not?

“We need to understand and accept that our biodiversity is changing in profound ways – but clearly a vital goal will be to preserve its essential and unique Australian character,” says ecologist Dr Suzanne Prober. That will demand sharply increased vigilance on the biosecurity front, to keep invaders out.

Related to this is the huge issue of how Australia’s food production systems adapt to climate change – some scientists

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*The pressure is on to preserve
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fear that the agricultural intensification required to offset the effects of climate change on the food supply will come at a high cost to native ecosystems and biodiversity. Others think that agriculture may contract to more closely settled areas where soils and rainfall are better, leaving larger swathes of dry landscape to return to native bush or pastoralism. And still others believe Australian farming systems will become more closely integrated with native species – indeed, that we will increasingly farm indigenous plants and animals because of their ability to handle hot, dry times.

We will increasingly value our native biota for the services they provide in protecting and buffering our landscapes and coasts, and in the genetic materials and technologies we can source as insurance for our own adaptation.

Marine and aquatic environments face changes no less great from the changing climate, says CSIRO marine scientist Dr Rodrigo Bustamante. “We estimate that in particular places up to a third of our coastal wetland could move from fresh-dominated to saltwater-dominated ecosystems. Many of them will be completely transformed and the species change will be extensive,” he says.

“We will also see the increasing ‘tropicalisation’ of our south-eastern and south-western coastlines as warmer water pushes further south: tropical species which are presently temporary visitors will establish further south and this will undoubtedly alter marine ecosystems. This is already happening on both sides of the continent and will bring novel challenges and opportunities to fisheries and aquaculture.”

Perhaps the greatest change of all is the gradual acidification of the oceans, caused as human carbon dioxide emissions dissolve into them. This, says Dr Bustamante, has profound but as yet uncertain implications for all the marine organisms that build calcium carbonate shells and structures

such as the planktonic coccolithophores which are at the foundation of oceanic food webs. “It likely means a major reorganisation of the ocean food chains, but the consequences for biodiversity and food production are not yet clear,” he adds.

Interpreting exactly what changes will occur is a task of extraordinary complexity, the scientists caution. Says Dr Michael Dunlop: “First there is general uncertainty about how climate change will affect particular regions. Second, there are many different types of impacts on species, ecosystems and landscapes. Third, interactions between species will change – this will amplify the effect of climate change for some species and ecosystems and reduce it for others. But trying to unravel this complexity at this time is not a fruitful path to pursue.”

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The work of the climate adaptation scientist is to provide policy makers and land managers with the tools to make decisions despite the seemingly overwhelming sense of complexity and uncertainty. “We know what aspects of climate change are certain such as sea level rise, warming and ocean acidification and can anticipate how these will affect species and ecosystems,” Craig James adds.

“Not all decisions need to be made right away. Some decisions need to be made soon: decisions that play out over long time frames like what species of trees to plant and where to plant them to get carbon sequestration and nest hollows for species over 100 years from now. Other decisions can be deferred and made as we observe and learn about the changes, take stock of the situation both locally and across the continent and adapt our management of biodiversity to new unfolding situations.”

Among such adaptations may be moving from a focus on trying to save individual species towards one of trying to build the resilience of total ecosystems, and from maintaining particular pockets to trying to better manage whole landscapes so as to blunt the stresses climate change will impose on them: these are the new scientific and policy issues that lie before us.

The immediate outlook for Australian landscapes this century is one of considerable change through altered species composition and shifts from one set of dominant species to another set. By no means will all be lost, but future conservation programs will be confronted with the task of reducing species losses by managing ecological changes across the continent (rather than preventing changes in selected locations).

The actions we undertake to retain as much of the essential Australian biodiversity as we can through the era of climate stress will be vital for maintaining the ecosystem services that we depend on every day, and essential to the future character of Australian life. •

The public inquiry into **Australia's biodiversity in a changing climate** is being conducted by the House of Representatives Climate Change Committee. For more information on the inquiry visit www.aph.gov.au/ccea or email ccea.reps@aph.gov.au or phone (02) 6277 4580.