Takeaways from Aust

"I love a sunburnt country, a land of sweeping plains . . . of ragged mountain ranges . . . of droughts and flooding rains."

By James Aronson and Philip Zylstra

The above line—in particular, the phrase "sunburnt country"—from the popular 1908 poem, *My Country*, by Australian poet and fiction writer, Dorothea Mackellar, now has a different emotional resonance with Australians, ever since last year's "black summer." During an exceptionally long and devastating fire season—from late July 2019 to early March 2020—an estimated 46 million acres burned, wreaking havoc and terror, especially in southeastern Australia. These monster fires came after three years of drought, during Australia's hottest and driest year on record, and were followed by massive rains causing floods and storm surges in Sydney, Brisbane, and elsewhere.

In normal years, rain forests and other humid ecosystems provide moist barriers to fire. In 2019-2020, a confluence of ocean currents and massive warming over Antarctica drove hot dry air over the Australian continent, breaking down these natural landscape controls and making usually moist plants flammable. Some of the last vestiges of Gondwanaland's once-great rain forests remain in misty valleys and plateaus of Australia's eastern ranges—many of these areas have, very possibly, not seen fire for thousands or even millions of years. Last summer more than half of them burned.

In the October 2020 issue of *Nature Ecology & Evolution*, conservation biologist Michelle Ward of the University of Queensland and twenty-four colleagues reported: "These fires were at least fifty times more extensive than California's worst wildfires on record and five times the size of the 2019 fires in the Amazon. They were also exceptionally severe, burning Australian ecosystems that typically do not burn, including the World Heritage-listed Gondwanan rain forest." The authors found that roughly 97,000 square kilometers (km^2) of vegetation across southern and eastern Australia burned, "which is…habitat for 832 species of native vertebrate fauna. Seventy taxa had a substantial proportion, more than 30 percent, of habitat impacted; twenty-one of these were already listed as threatened with extinction…The full impacts on biodiversity will not be fully understood for years to come. Yet among the significantly impacted species, 114 have lost at least half of their habitat and 49 have lost over 80 percent." Twenty-one percent of Australia's temperate forests were burned—an order of magnitude more than any other year in modern records. Nearly three billion terrestrial vertebrates—especially reptiles—were affected.

The fires were also devastating for people. Smoke from some of the fires was lofted into the stratosphere in eighteen separate pyrocumulonimbus events—intense thunderstorms created by the heat of the fire. As a consequence,

ralia's Black Summer

Smoke from the Dunn's Road Fire on December 31, 2019, as seen while hiking out of the Jagungal Wilderness area in New South Wales

PHILIP ZYLSTRA

smoke and ash from the fires landed in Tasmania, and Aotearoa, New Zealand, and even reached Chile. Tasmania—a quintessentially wet, green land—had been ravaged by fire a year earlier. In January 2019, the capital city, Hobart, and many other cities and towns were smothered by smoke and ash as dozens of bushfires swept across the island.

The 2019-2020 fires destroyed 3,500 homes and 10,000 buildings, killing thirty-four people. An additional 400 people died from the complications and comorbidity related to the ash and dust storms that wafted over most of the country and persisted for weeks in Canberra, Melbourne, and Sydney. One report indicated that approximately 57 percent of all Australians were directly affected by the runaway fires, either physically and/or mentally.

In order to bring the complex subject of fire management in Australia into clearer focus, recall that the land area of Australia, including Tasmania, is 7.7 million km^2—78 percent the size of the United States and just as varied, ecologically. But it has twenty-five to thirty times more biodiversity than the U.S. in plants and animals. The ecosystems of Australia are exceedingly diverse—rain forests in the Tarkine Wilderness of Tasmania; steamy tropics in Queensland; grasslands and baked spinifex on red desert sand; Mediterranean-type forests, woodlands, and shrublands on the ancient soils of the Southwest; deserts spanning the vast Red Centre in the Northern Territory; and the Snowy and Blue Mountains of the Great Dividing Ranges. And its biodiversity is unique to the continent. It has extraordinary fauna and flora of Gondwanan origins, and has some of Earth's oldest life forms, such as living marine stromatolites, survivors of cyanobacteria that lived 3.5 billion years ago—the earliest fossil evidence of life on Earth—at Gutharraguda (Shark Bay), in Western Australia.

Central to the country's identity is the heritage of its Aboriginal and Torres Strait Islander peoples—more than 500 different language groups—linked to more than 65,000 years of presence on the land, and the "crafting" of landscapes. This crafting took place partly through careful modification of fire regimes, also known as firestick farming, a term coined by archaeologist Rhys Jones (1941–2001) of Australian National University.

Precolonial fire management is a subject of relevance and much contentious debate in the aftermath of the black summer. Landscape ecologist and conservation biologist David Lindenmayer, also of Australian National University, and his colleagues assert that rates and degree of recov-

ery following severe fires vary dramatically among forest and woodland types in Australia. They note that, historically, many of these ecosystems burned no more than once every 75–125 years. And yet, prescribed burning in many regions now operates on a six or seven year fire return cycle. Some intentionally burned forests have been burned as many as four times in the last twenty-five years.

Dense, mature rain forests are natural controls on fire. At this site in the Nightcap National Park, in northeastern New South Wales, a bushfire burned through a eucalyptus forest but stopped when it reached rain forest.

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This practice has partially sprung from the way many Australians think about fire management—that the bush craves fire and the need grows the longer it is deprived. The evidence seems overwhelming—forests seemingly bursts into life after a fire and the number of species skyrockets. Long-buried seed beds push new leaves through the ash, blackened trunks carpet themselves with leaves resprouting from buds so deep in the wood that apocalyptic flames cannot scorch them, and banksia cones burst open to throw seeds across the newly sunlit soil. These are often considered to be fire adaptations, but others argue they are just as likely adaptations to nutrient-poor soils and dry climates. Fire can cause mass germination through heat and smoke, but whether it caused the evolution of those traits, or whether those species need it to persist or not is a separate question. After all, banksia, which is one of the most iconic genera in the Gondwanan family Proteaceae, evolved pods many millions of years *before* fire became common in Australia. Without fire, pods simply open on hot days, or as they age.

So, does the burst of life after fire mean that a forest craves fire, or is it a race to restore itself after catastrophe? Research across diverse forests is now showing that this burst of new growth actually renders disturbed forests more flammable. It means that plants are now regrowing densely at the ground surface where they will easily ignite, whereas in old stands, the bulk of their foliage was beyond the reach of most flames. In other words, Australian forests in general do not become more likely to burn the longer they are left without fire. Once they have restored their basic structure, they create environments that become increasingly *less likely* to burn as time goes on. Forests that are not widely burned create less flammable landscapes; lightning strikes ignite only patch fires, which may promote species that benefit from fire but leave wider areas untouched so fire-resistant species can thrive.

Other human factors over the past few centuries have added to the current situation Australia is facing. Agriculture and animal husbandry practices imported from England, such as deforestation, ploughing, and prolonged overgrazing, are proving unsustainable. Postcolonial Australia is young, in many ways, and forests continue to be seen as a frontier to be exploited. In many places, native forests of giant trees have been reduced by decades of logging and widespread prescribed burning and have been replaced with open stands of dense, fire-germinated, flammable regrowth. Wood production forests in the Southeast have burned far more often than conserved native forests, and the burning of mature forests has made them up to eight times more likely to reburn for

decades thereafter. Similar results are emerging from the semi-arid Great Western Woodlands in Western Australia, as shown in multiple studies by research scientist Carl Gosper and colleagues, of Australia's Commonwealth Scientific and Industrial Research Organization.


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Evidence from charcoal and fire scars show that fire was far less frequent before English colonization. However, the decade leading up to last summer saw more prescribed burning in New South Wales National Parks than had ever occurred before—more than double the preceding decade. Instead of slowing the occurrence of fires, landscapes of dense regrowth most likely fanned the flames. Many areas that had been prescribed burns earlier burned again, spontaneously, in the same season.

The fuel reduction policy and practices that are generally used today are said to be mimicking pre-colonial fire regimes, but in fact, they miss all the complexity and nuance that was accumulated over countless generations by Aboriginal people. The suggestion that modern fleets of helicopters, using drip torches and fire bombs, are carrying out a similar practice, seems difficult to reconcile with what is now known.


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*The Kuranda tree frog (*Litoria myola*) is Critically Endangered due to habitat loss, fungal disease, predation, and competition from another Endangered native species, the Australian lace-lid frog (*Litoria dayi*).*

Prior to European contact, people living in various forest and woodland biomes differed greatly in how they lived and in their natural fire regimes. These "Traditional Owners" of Australia circumscribed their respective lands, or countries, by natural geographic boundaries. But the concept of "country" had a great depth of meaning to all of these peoples, though the concept varied by group. Uncle Rod Mason, a Ngarragu elder from the high mountains of the Southeast, described country as having its own "warru"—a collection of stories, kinship connections, and spiritual pathways. Students who learned the ways of their country, even the most experienced practitioners, entered new country as infants until they had learned the warru for that land. If European descendants and newcomers from other countries are to live in that land today, they must begin to embrace that complexity and shed the simple—or irrelevant—beliefs they hold about fire management. This is


*Northern quoll (*Dasyurus hallucatus*) is listed as Endangered due to predation by feral cats, dingoes, and foxes, particularly after fire or grazing has removed protective ground cover.*


Western spiny-tailed skink (Egernia stokesii badia), Endangered subspecies endemic to the Western Deserts, is threatened by habitat loss from expansion of mining and farming.
HOLLY BRADLEY

ADAM BRICE

*Western ringtail possum (*Pseudocheirus occidentalis*) is Critically Endangered due to habitat loss and predation by introduced species.*

SOPHIE CROSS

*Malleefowl (*Leipoa ocellata*) is Critically Endangered in some areas of Australia due to habitat destruction.*

where intimate knowledge of historic fire practices should be sought and applied.

Research with the Martu people in arid Australia by anthropologist Rebecca Bliege Bird, of Pennsylvania State University, (*see "Dreams of Fire" in the September 2019 issue of* Natural History), shows that "burning symbolically reenacts the forces of creation that shaped the land in the Dreaming, the eternal foundation of Australian Aboriginal ritual belief systems." Bird's "studies confirm that hunting and gathering, accomplished mainly (but not solely) through fire, serves a critical ecological function . . . Martu fire also shapes the distribution of plant resources. Prehistorically and historically, grass seed was an important subsistence staple in some seasons, and the easiest varieties to collect and process were found only in recently burned patches."

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*Nocturnal marsupial quokka (*Setonix brachyurus*) is Vulnerable due to introduced predators, habitat loss, and fire.*

Since the 1993 enactment of the Native Title Act, many Aboriginal and Torres Strait Islander peoples have been recognized as owners of their lands. Many of them are now well organized politically and seeking advice on land management, fire management in the current era, business development along with training for jobs in land management, and broader employment. An excellent example is Gelganyem Limited, a charitable organization that manages funds and assets on behalf of the Miriuwung and Gajerrong peoples in the Argyle Diamond Mine area in the East Kimberley region of Western Australia. Mining had been taking place on these traditional lands under a weak Good Neighbour Agreement in 1980 between these indigenous peoples and the mine operating company, Rio Tinto Corporation (*see "Rio Tinto and the Mines" by Adam Lederer,* Natural History*, May 2017*). In September 2004, a substantially stronger agreement was signed that provides "a formal and binding acknowledgement of Traditional Owners' rights and interests, including native title rights, in the mining lease area" and annual payments.

The mine closed operations in November 2020, and now the people of the region are involved in the restoration of their traditional lands. Gelganyem Limited is creating native plant nurseries to study the germination requirements of native species, learning how to produce carefully identified nursery stock of known provenances. They begin planting on-site this year, to be followed by careful monitoring and evaluation. Their aim is to develop business opportunities from engagement in repairing the devastated landscape, offering rehabilitation services across the Kimberley region that could also inspire other indigenous communities across

Western Australia to collect seed in their own country, establish nurseries, and learn to plant and undertake restoration projects.

According to Curtin University researcher Adam Cross, the native seed industry is relatively small in Australia, made up primarily of a small group of individuals and businesses in each state. Its expanding main market is in land restoration for mine sites after closure and also for fire-damaged land, often funded through carbon sequestration. The legal requirements and community pressure for political and corporate underwriting of restoring degraded land are rising, and the native plants and seed industry could become very attractive and lucrative to many Aboriginal communities.

In the last twenty years, there has also been extraordinary progress in plant and soil sciences, microbiology, ecosystem and landscape ecology, seed science, fire ecology, and agronomic and horticultural sciences and technologies crucial to sustainable management of "country" and to drive active ecological restoration of degraded lands. A great deal of these efforts are now being brought into practice, often at impressively large spatial scales. These advances are also critical to regenerative farming, a relatively new trend in Australia.

Ecological restoration is an essential part of the post-fire response and pre-fire modification of land management to reduce risks of megafires in the future. There is a growing number of grassroots environmental and land care, ecological restoration, habitat conservation and species protection, and "reconnecting to country" movements of all sorts and at all spatial scales throughout Australia. Some of the oldest movements are the Australian Association of Bush Regenerators and the Land Care movement, both founded in 1986. Gondwana Link, established in 2002, is a coalition that calls itself "keeper of the vision" for a 1,000 km-long restoration effort operating across 23,000 km^2 of southwestern Australia, from the wettest corner

*A prescribed burn germinated a dense layer of flammable shrubs that greatly increases the likelihood of a severe and uncontrollable fire in this Alpine ash (*Eucalyptus delegatensis*) forest in northern Kosciuszko National Park, New South Wales.*

PHILIP ZYLSTRA

of the Southwest up to the edge of the Central Desert.

These efforts reflect a steady growth in efforts not just to prevent further species extinction and mitigate the impact of commercial land-uses, but also to restore ecological health and resilience at the scale of whole landscapes—often across a mix of different land tenures. There is also a great effort underway to support recognized "Traditional Owners," such as the Noongar and Ngadju peoples of the Southwest who are already very actively getting back to country, and managing their own lands.

In parallel, agriculture in Australia is undergoing transformation. Ongoing soil degradation, silting up of waterways, loss of fertility due to wind erosion, and increasing salinity in many areas make many farming operations unsustainable, environmentally if not commercially. Heat waves and drought are exacerbating these trends. Over the past few decades, a rapidly expanding regenerative agriculture movement has emerged that recognizes the need for new agricultural methods and philosophy. There is growing awareness that agricultural and forestry practices imported from Europe are not well suited to Australia's climate, soils, biota, or fire regimes. They have wreaked havoc in many regions, especially in the 60–70 percent of the Australian mainland that is arid or semi-arid. The increasing reliance on herbicides, insecticides and fungicides, particularly in "broad acre" cereal production, is proving financially and environmentally hard for farmers to finance and sustain. Across many farming areas the rural population has been declining for decades, bringing into question the social viability of communities in large areas, such as the Western Australia wheatbelt.

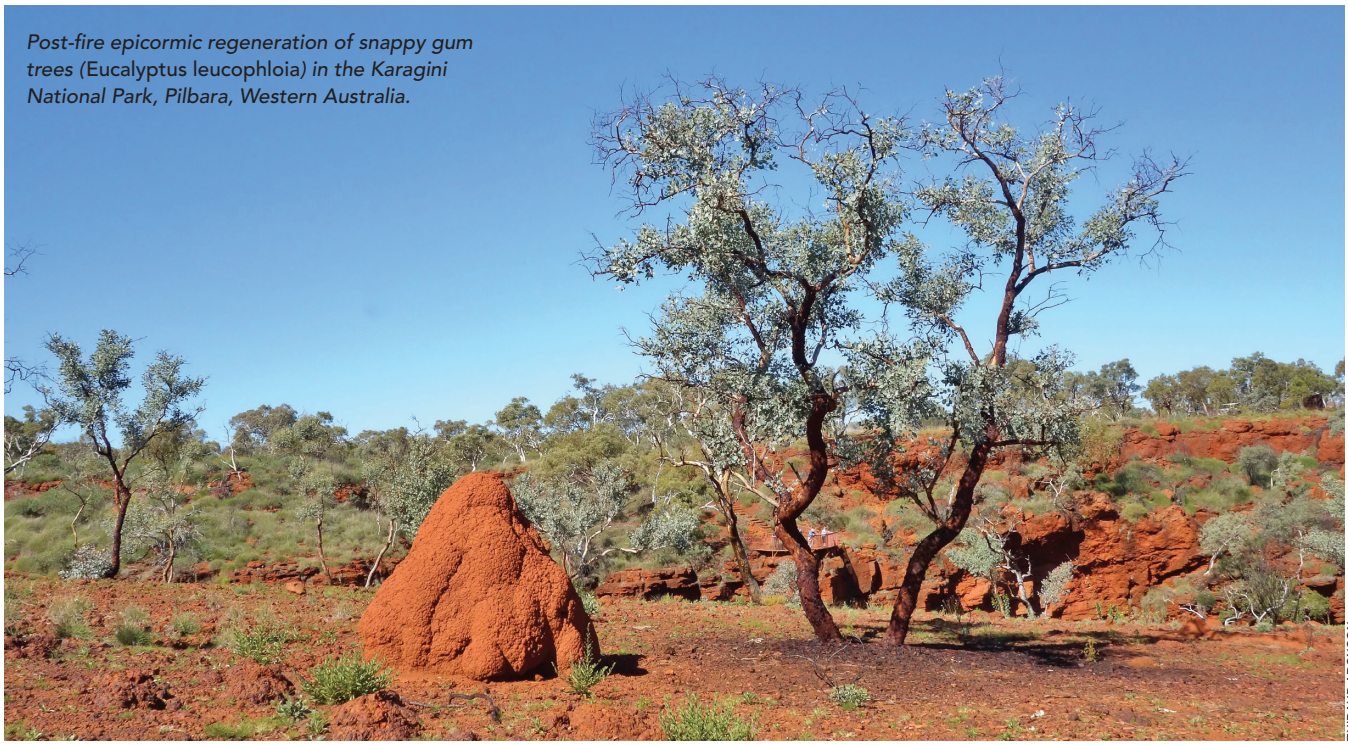
More ecologically friendly farming and grazing systems have emerged in recent years that work on ecological principles and build the biological health of the soils. Here again, these practices are part of a worldwide movement, often called "Regenerative Agriculture." In addition to infusing greater sustainability and supporting biodiversity, soil health and human health through healthier food and fodder products—commodities for which there is significant market demand—this approach leads to much greater carbon storage in farm soils and surrounding lands. To get an overview of the movement in Australia from the perspective of a farmer who has made the transition to regenerative farming over forty years and has studied the global movement in detail, see Charles Massy's 2017 book, *Call of the Reed Warbler: A New Agriculture, A New Earth* (Chelsea Green).

At the height of the black summer emergency in January 2020, Richard Thornton, CEO of Bushfire and Natural Hazards Cooperative Research Centre in Melbourne, advised that "Doing more of the same on fires will not mitigate disaster impact…This is the time to consider seriously the hard questions and not continue with business as usual. This will require new thinking, new research, new investment and…new commitment."

To that advice we would add that a new vision and road map are needed for the nation's remaining natural forests, woodlands and other native ecosystems. These natural assets are both biological and cultural heritage of the highest value and should not be sacrificed to protect monocultural tree plantations and buildings. New strategies for management and response to fires should be explored, tested and applied, just as is happening in agriculture. And the new paradigm of ecological restoration and climate change miti-

KINGSLEY DIXON

*Resprouting stems of grass trees (*Xanthorrhoea preissii*) and, in the background, epicormic sprouting of Marri (*Corymbia calophylla*, a close relative of Eucalyptus) are surrounded by flowering ephemeral annuals that rely on the smoke-derived chemical karrikinolide to germinate.*



*Post-fire epicormic regeneration of snappy gum trees (*Eucalyptus leucophloia*) in the Karagini National Park, Pilbara, Western Australia.*

THIBAUD ARONSON

gation for our crowded, over-exploited, out-of-kilter world should be brought to bear on the problem of bushfires.

The recent disasters raise issues that Australia must face head on, because more climate catastrophes, cultural conflicts, and trauma are coming. The profoundly negative effects of climate change on ecosystems in Australia have been evident for years. For example, vast giant kelp forests, 40 m tall, off the east coast of Tasmania burned off *completely* in the extreme marine heat event of the El Niño period 2015-2016, and have not recovered.

Perhaps fire management in Australia can be a leverage point for a broader shift toward a new, more resilient, and more cautious set of practices in agriculture, land management, and creation of a truly multicultural country. Urban dwellers now know that bushfires affect them both directly and through smoke and ash from distant fires.

Business as usual today can no longer be a continuation of the fight to subdue the earth and transform the ecosystems, but needs to embody the wisdom to live with the constraints and joys of the natural world. Reflecting on the complexity, nuance, and vision of that deep and ancient Dreaming born in a vast sunburnt country, and thereby set a new course for the future, there would also be lessons gained of global relevance therein.

In 1976, the Australian academic and writer George Seddon speculated that "Australians are still learning to see where it is they live. The imaginative apprehension of a continent is as much a pioneering exercise as breaking the clod." The recent megafires are underlining the need to embark on this new kind of pioneering—to reimagine how Australians live in their country. This does not mean to stop economic development and go back to the pre-industrial era. It means to develop approaches that work with nature and not against it. This would entail working closely with the traditional owners of each region and biome to find the best way forward with regard to fire. As an additional benefit, this can lead to vast opportunities for new jobs and livelihoods for indigenous and other rural communities in Australia, and can catalyze great progress in promoting goodwill and cooperation across cultural lines.

Australia's Aboriginal peoples, the inventors of fire-stick farming, have known how to live in such landscapes as are found on this anomalous continent. The *Tjurkupa* or "Dreaming" of these nations was a fundamentally different paradigm to the Western perception of humanity in nature. It placed people in kinship with all other lives—not to advance our own species at the cost of others, but to take only our share as one of the lives in a vast and intricate network. The cultures of the continent's first peoples have lasted for more than 65,000 years by coexisting rather than dominating. It is not too late for modern Australia to learn that lesson.

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