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Introduction

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Fire is an integral part of the Australian landscape. Over a long history, including tens of thousands of years under Indigenous use and management, it has shaped most of Australia's terrestrial environments and moulded its plant and animal assemblages (Bowman 1998; Bowman *et al.* 2009).

Yet in 2019–20, much of eastern and southern Australia was burnt in 'megafires' at high severity, across an unprecedented extent and over an unusually long duration (Collins *et al.* 2021). The term and incidence of megafire is relatively new: reflecting a global increase in fire sizes, it is recognised as 'an emerging concept' (Linley *et al.* in press). Here we apply it to fires that are more than 100 000 ha in extent, although we note that others have advocated applying the term megafire to fires > 10 000 ha and have coined the terms *gigafire* for fires > 100 000 ha, and *terafire* for fires > 1 000 000 ha (Linley *et al.* in press).

This season of fires was a landmark event in the country's post-colonial history, a year of exceptional loss. For many, these megafires provided a stark demonstration that the consequences of global climate change are occurring now. This was a frightening glimpse of a dystopian future, of a world beyond our control (Fig. 1.1).

The 2019–20 wildfires exacted a considerable toll on people and the economy. They killed 33 people directly and in fire-fighting operations, led to the death of approximately another 430 people through smoke pollution, imposed a $2 billion impost on the Australian health budget (Johnston *et al.* 2021), destroyed many homes and livelihoods and caused significant damage to the national and regional economies. However, in this book our focus is on the environmental impact of these fires.

Australians, and the global community more broadly, watched on as images of burnt koalas and kangaroos haunted the nightly news footage, and experts estimated that billions of animals may have been killed (van Eeden *et al.* 2020). But the dead or injured animals represented only the most conspicuous margins of the impacts of these fires on wildlife. Places of outstanding biodiversity significance, such as World Heritage areas, were damaged. Some environments intolerant of fire, such as rainforests, burnt for the first time in living memory (Kooyman *et al.* 2020). A preliminary analysis estimated that, over the period of 6–8 months, the fires burnt the habitat or range of 107 of Australia's 436 threatened terrestrial and freshwater vertebrate species. The fires rapidly pushed many already imperilled species further to the brink, and caused hundreds of other species formerly considered secure to now be threatened (Ward *et al.* 2020). Scientists have begun

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Fig. 1.1. The 2019–20 wildfires were exceptional in scale and duration, burning large areas at high severity. Here, flames from the fires rolling over the ridges of Tidbinbilla Nature Reserve and Namadgi National Park. (Photo: Markus Dirnberger)

documenting likely extinctions as a result of the fires (Moir 2021) – we will learn more in the coming years. However, because of decades of chronic underfunding of survey and monitoring efforts, the actual number of such extinctions may never be known (Scheele *et al*. 2019; Wintle *et al*. 2019).

The fires galvanised an extraordinary response by the Australian community, governments, Indigenous groups and conservation organisations. Record sums of money were contributed to wildlife rescue and recovery efforts. The Australian Government established a $200 million wildlife recovery fund, for urgent and short-term actions designed to limit biodiversity losses and support post-fire recovery – this one-off funding initiative was almost twice that of the normal annual expenditure by the Australian Government on management of all threatened species (Wintle *et al*. 2019). Rapid responses – often heroically undertaken in dangerous situations and with great urgency – helped save some species and constrain some losses (Morton 2020). These responses showed how much the Australian community valued our nature, and were concerned and moved by its potential loss.

But while many of these responses were admirable and achieved some successes, these fires also highlighted the *ad hoc* status, and inadequacies, of planning, management, policy and legal settings for the protection of biodiversity. Emergency management for biodiversity was not previously given prominence by government agencies, and these fires exposed the limited capacity to deal with situations that were beyond what was previously thought to be the extreme limit. Established soon after the fires, a series of government inquiries probed these revealed weaknesses, and proposed some major changes to attempt to reduce

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the likelihood of future comparable events and to improve the effectiveness of fire planning and operational control (Chapter 30).

Of course, there is a history of severe and destructive wildfires; these have been a recurring and scarring feature of Australian life, especially in temperate Australia. Although exceptional, the 2019–20 wildfires had precursors that also had major impacts on biodiversity. For example, although little of Tasmania was burnt in the 2019–20 season, extensive fires there in the previous season, and in 2016, imposed significant impacts on the Tasmanian Wilderness World Heritage Area and on species and ecological communities that are highly susceptible to wildfire (Foulkes *et al*. 2021). But no previous Australian wildfires have caused such loss of biodiversity as the 2019–20 wildfires. And our starting point in 2019–20 was influenced and contextualised by a changing fire regime – the complex spatial and temporal patterning of fires has been shifting. Some species and environments may recover from the impacts of the 2019–20 fires, but recovery may not occur for many decades, and recovery for others may be stymied if another comparable fire occurs in the near future. The precarious prospects for these species and environments depend now on our willingness and capability to better manage this country.

Why we wrote this book

We write as scientists, respectful of the objectivity of data and fascinated by the analysis and interpretation of it. But here we also write for the benefit of our children, and for their descendants, and for the world that they will live in. We write at a critical time for the health of our planet, for the wellbeing of humanity, for the future of nature. These are at increasing risk from cascading episodes of catastrophic events such as the 2019–20 Australian wildfires, from the factors that made those fires happen, from our demonstrable ineffectiveness in managing them, and from an insufficient provision of supporting resources and inadequate protection (Samuel 2020). We write because we don't want to bequeath to our children a tarnished world in which such fires – and the devastating and compounding losses of nature that they cause – become the new normal. Such a world would become inhospitable for humanity and for nature (Fig. 1.2).

So, in this account we want to document and communicate as accurately as possible the impacts of this single year of fire across the breadth of Australia's species and natural environments; we also want to propose that such losses are unacceptable. Furthermore, we want to distil the lessons hard won from these fires, to recommend responses that will make it less likely that comparable fires will blight our future, so that we can respond more effectively (before, during and after fire) if they do happen. We want to use the 2019–20 fires as a pivot in learning to live in this country and for better safeguarding of our natural heritage.

Accounting for biodiversity loss in these fires is not straightforward, because shortcomings in Australia's biodiversity monitoring (Legge *et al*. 2018) mean that there is no robust pre-fire benchmark of the population status of most species, at most sites, against which to measure loss. Furthermore, post-fire sampling, of population sizes or the condition of ecosystems, is a time-consuming process, and especially so across the gamut of species and ecological communities affected by these fires. And while it is important for accounting purposes to document the immediate population reductions due to these fires, a more critical conservation focus should be on the longer-term impact and the pathway to and likelihood of recovery (the return to pre-fire status): how long such

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Fig. 1.2. Landscape in the aftermath of the 2019–20 wildfires, Kangaroo Island. (Photo: Nicolas Rakotopare/Threatened Species Recovery Hub)

recovery may take; what factors may help support it; and what factors may constrain or prevent it. We can document the wounds to nature relatively easily, but more critical is the process of healing, and our capability and willingness to contribute to such healing. We are at the edge of the unknown. There are few precedents for chronicling recovery from environmental catastrophes of the scale of the 2019–20 fires, and such recovery will be tenuous in a future world if comparable fires recur, and highly unlikely without a significant increase in focus on recovery and increasing the resilience of our biodiversity and landscapes.

The shape of this book

This account is focused on those regions of southern and eastern Australia – mostly forested areas – in which wildfires in 2019–20 were exceptional (Fig. 1.3). This area was circumscribed by the Australian Department of Agriculture, Water and the Environment and designated the 'Preliminary Analysis Area' (PAA), and has been used as the basis of many analyses of impacts (e.g. Ward *et al*. 2020; Legge *et al*. 2022). The total area burnt in this region by fires in 2019–20 was 10.3 million ha. There were many fires in 2019–20 elsewhere in Australia, but those fires were much more within normal bounds.

The set of 2019–20 Australian fires has been labelled the Black Summer, an evocative description of the sense of doom felt by many people in fire-affected areas, and by those in nearby capital cities blanketed for many weeks by thick smoke. However, that epithet overlooks one of the key distinctive features of these fires – that they started unseasonably

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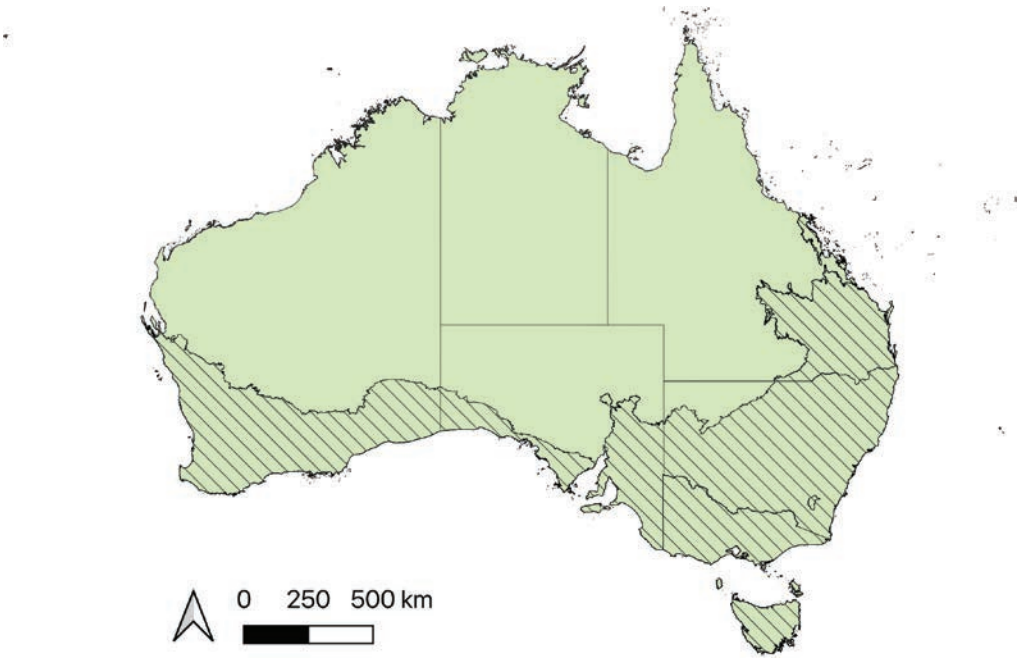

Fig. 1.3. The geographical scope of this book is focused on those regions of Australia (hatched in this figure) in which the 2019–20 fires were exceptional: the 'Preliminary Analysis Area' (PAA).

early, in south-eastern Queensland in early September 2019 (Inspector-General Emergency Management 2020; Smith *et al*. 2021).

In the following chapter, we contextualise and characterise the 2019–20 fires, and the factors that catalysed them. We then describe (in Chapter 3) the impacts of these fires on Indigenous cultural values and Country. In Chapters 4 to 16, we document the immediate and short-term impacts of these fires across different components of Australia's biodiversity. As noted above, the longer-term impacts cannot yet be known. In Chapters 17 to 19, we also recognise that many species and ecosystems faced threats (such as introduced animals, weeds and plant disease, and forestry) before the 2019–20 wildfires, and that these factors may continue to operate after fire, compounding the impacts from fire alone. For post-fire recovery to occur, such interactions need to be understood and the interacting factors effectively managed. We acknowledge that other threats may also compound the impacts of fire, including habitat loss and fragmentation. Chapter 20 provides a distillation across the different components of biodiversity of the direct and compounding impacts of the 2019–20 wildfires, and summarises key results and characteristics of this impact.

Chapter 21 provides an account of prescribed (fuel reduction) burning, an integral component of the management of fires in Australia. It notes that such pre-emptive burning to some extent reduced risks associated with the 2019–20 fires, and that prescribed burning itself may have varied impacts on biodiversity.

In the following section (Chapters 22 to 28), we describe the responses made to help support the recovery of biodiversity following the 2019–20 wildfires. A feature of this response was that it involved so many groups and individuals, but that there was generally a high degree of collaboration across this network of respondents. Biodiversity

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conservation in Australia is a shared responsibility, and this was very evident in the response to these wildfires. We include in this section chapters describing the contributions made by the Australian Government, state and territory governments, some conservation non-government organisations (NGOs) and natural resource management (NRM) groups. We acknowledge here that many other conservation groups, animal welfare groups, community groups, Indigenous groups, landholder organisations, local councils, corporations and individuals also made significant contributions to this recovery effort – not all of this extraordinary effort could be reported here. This section also considers two issues that are important generally in the recovery effort, and specifically in the case of the 2019–20 fires: animal welfare and *ex situ* conservation.

In the final section (Chapters 29 to 36), we describe the planning and management context that forms the basis for dealing with fire in Australia. In this final set of chapters, we seek to identify what improvements need to be made in the way biodiversity is managed in relation to fire in Australia. In particular, we:

- consider how adequate the knowledge base is for species' response to and needs for fire, and what the key knowledge gaps are;
- assess whether biodiversity assets in fire-prone regions are clearly prioritised, defined and circumscribed, such that they can be most readily protected during fire operations;
- evaluate the extent to which biodiversity is adequately represented in fire planning and whether such inclusion has sufficient clout during fire operations and management;
- assess the extent to which conservation of biodiversity assets during fire operations is sufficiently grounded in policy and law;
- describe the current extent of biodiversity monitoring, and its role in benchmarking fire impacts and in assessment of recovery and management effectiveness;
- assess the successes and failures for biodiversity outcomes of other actions taken before, during and after fire;
- recognise the need for a more pivotal role for Indigenous land and fire management; and
- consider what actions may be taken before fire events to improve environmental resilience, to reduce the likelihood of severe fire, and to spread and reduce environmental risks from fire.

Recognising that the impacts of these fires on biodiversity also affect our sense of the value of nature and our connections to country, we also include a chapter (Chapter 34) that offers a set of personal perspectives from some individuals involved in the fire management and recovery process.

We use the information reported in all chapters to derive recommendations for planning, policy, law and management that would serve to reduce the likelihood of future catastrophic fires and their impacts on biodiversity, and that would help develop and implement manuals or strategies for enhancing the recovery of biodiversity following fire.

Note that some examples feature in several chapters. These include some of the species and ecosystems with highest profile impacts or conservation efforts in these wildfires: Wollemi pine (*Wollemia nobilis*), Kangaroo Island glossy black-cockatoo (*Calyptorhynchus lathami halmaturinus*), Kangaroo Island dunnart (*Sminthopsis griseoventer aitkeni*), Gondwanan rainforests, the heathlands of the Stirling Range, and montane ash forests. These examples recur partly because different chapters describe impacts and responses, because we wanted to describe how different agencies and

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groups contributed in different ways to their rescue or recovery, and because the impacts of fire on these species and communities were also influenced by other management contexts.

The 2019–20 wildfires showed that our community cared deeply about our natural environments and wildlife, and particularly about the extent to which our nature may be lost in catastrophic events. For example, as at January 2020, 53% of Australians had donated to an appeal to help recovery from the 2019–20 wildfires, with a median donation of $50, and an attitudinal survey concluded that 'The bushfire crisis brought out the best in us' (morestrategic 2020). If we can learn the lessons evident from the fires themselves, their impacts and our responses, these fires will provide us with the opportunity to care better for our country and to plan for a more sustainable future.

As we write this chapter, exceptional flood events are causing loss of human life, infrastructure and biodiversity in northern New South Wales and south-eastern Queensland. Writing about wildfire in such settings seems perverse, but fire and flood are part of the same fabric of escalating environmental catastrophes due to climate change that collectively will winnow biodiversity and challenge our future. Furthermore, although this book specifically documents the impacts on biodiversity of the 2019–20 Australian wildfires, the responses made, and the lessons that can be learnt, much of what we have written can be applied more generically to any environmental disaster. We cannot continue to lurch blindly from crisis to crisis, treating each as an unexpected exceptionality, learning little from each, and each prompting a patched emergency response. That pathway is a descending spiral. We need instead to try to reduce the likelihood of such disasters, to build capability to respond to them, and to better manage our country such that the status of biodiversity is not so precarious.

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