

Preface

The profound impacts of fire on natural ecosystems have moulded many aspects of life on Earth, but many of these effects remain poorly understood, other than in the most general terms. Contributors to the voluminous, and expanding, literature on ‘fire ecology’ have formulated and discussed numerous suggested paradigms on the roles of fire, but many workers support the two major hypotheses of Pausas and Keeley (2009) that ‘(a) the world cannot be understood without considering fire, because fire has strong ecological, and evolutionary consequences for biota, including humans; and (b) . . . people have heavily influenced fire regimes, often in ways that greatly affect the sustainability of some ecosystems’. These human manipulations, widespread and often purported to mimic natural processes in their impacts on natural ecosystems, have much wider justifications in asset and life protection through fuel reduction burning, pest suppression, land clearing, successional maintenance in agriculture and agroforestry, and many other contexts in which the balance between beneficial management and severe threat to native biota is tenuous, unclear or unknown. As a major disturbance to natural ecosystem dynamics, the possibility of threat is an important concern in planning land management for conservation, and in using fire as a tool in managing individual plant or animal species. Also, as recognised widely, natural fires (with more than half of Earth’s land surface considered to be fire-prone) constitute ‘a global ecosystem process . . . whose role in shaping the distribution of fauna and flora is widely underappreciated’ (Keeley et al. 2012, p. 1). As another pertinent summary comment ‘Fire is one of the key environmental factors that controls the composition and functioning of biota globally’ (Spehn et al. 2006, p. 337). Whilst such comments apply especially to wildfires, the use of prescribed fires (‘control burns’) in management of land and individual species extends this principle tailored for a wide variety of environments and contexts.

As climates change, incidence, extent and intensity of wildfires is apparently also increasing, and losses of human lives and property are reported ever-more frequently. The common outcome is high level calls for increased areas to undergo ‘control burns’, with the expectation that manipulated reduction of flammable

material ('fuel' for wildfires) will reduce impacts of future wildfires or arsonist attacks. Those calls are wholly understandable – the community reaction to the tragic February 2009 fires in Victoria (Australia), in which 173 lives were lost and more than 2,000 buildings obliterated, was accompanied by such a recommendation from the ensuing Royal Commission, advocating that increased areas should undergo control burns, with little priority regard for the sensitivity or ecology of different biotopes and their resident taxa. Parallels in North America and elsewhere urge the needs for protection of human lives and assets by decreasing flammable fuels across landscapes, so that the priority may then become simply to burn greater areas, without adequate consideration or investigation of the wider ecological characteristics, values and resilience of the areas subjected to such disturbance and impacts. That awareness can draw on knowledge of long histories of fire usage for forest, prairie and other biome management, in which the desirable 'fire regime' can be defined and understood much more closely and, at least in some cases, linked with conservation practices more effectively. For many ecosystems, however, such assurances cannot be given.

Both increase in fires and measures for fire suppression (decrease in fires) can alter the species composition of vegetation markedly. Implications that much vegetation is in some way 'fire-dependent', so cannot thrive or reproduce without burning or exposure to smoke, have created a widespread scenario based on the belief that 'fire is necessary' and, so, vital to sustain or regenerate many ecosystems or successional stages. However, the diversity of outcomes is gradually becoming more appreciated, with impacts differing widely across biomes, for different species, and in relation to the 'fire regime' employed, a major theme later in this book. In general, knowledge of roles of fire in relation to insects and other invertebrates is sporadic and highly incomplete, with many contrasting examples reported. The same fires that are used to suppress pest insects deliberately may unknowingly endanger other species in the same areas, for example, and following Bond and Keeley's (2005) dramatic analogy that fire is a 'global herbivore' the key resources needed by numerous ecologically specialised taxa may be unwittingly lost. That analogy reflects that fires 'consume' biomass and in that way compete with animal consumers for plant and other food material. Fires may thereby exclude herbivores by reducing or eliminating their critical food resources. Fire and herbivory are both major transformative agents that have influenced evolution in ecosystems in many parts of the world. Those natural influences are now also influenced heavily by human interventions, including prescribed burns.

The purpose of this book is to survey some of these themes and encapsulate some of what is known of the intricate relationships between insects and fire, and how these may inform the deliberate use of fire in insect conservation management. As Swengel et al. wrote (2011, p. 328, referring to North American prairies but of much wider relevance) 'The effects of ecosystem management with fire on insects are subjects of both research and controversy'. Controversy and strong, often polarised, opinions will persist, reflecting different priorities and viewpoints – and also highly charged emotion. The adage included in O.W. Richards' early

comment in relation to insect population dynamics (Richards 1961) that ‘once more fundamental studies are accomplished . . . we may be able to discuss our theories with more light and less heat’ transfers easily to fire usage in conservation management, in which insect populations are here treated as a key concern.

This book is not about the politics or socioeconomic aspects of burning, other than as background to demonstrate the pressures that influence ecological and land management outcomes. Likewise, many important aspects of fire ecology have been treated in series of books, symposia and other publications, with their wide relevance presented also in specialist journals such as *Fire Ecology* and *International Journal of Wildland Fire* and a great variety of ecological, land management and entomological journals in many parts of the world. The text by Whelan (1995) remains an indispensable synthesis of fire ecology, setting perspective of ideas and principles that encapsulates most of the current pertinent issues. Whelan noted the paucity of understanding on invertebrate responses to fire, and the difficulties of interpreting field observations; these are major themes in the present book. Most chapters in Whelan (1995) conclude with a list of ‘outstanding questions’, itemising major gaps in then available information and themes for priority future investigation. Nearly two decades later, many of these are still highly relevant priorities for continuing research. As Cheal (2012) commented, for Victoria, Australia ‘We remain largely ignorant of many aspects of fire in native landscapes’. Similar sentiments are widespread, but ‘fire management’ is a key consideration in sustaining many important biotopes, from grassland and savanna ecosystems to forests and thus as a component of conservation management in many different ecosystems. Integrating science, policy and practicality to achieve the ‘best outcomes’ for all interested parties is complex.

Many eminent ecologists have passed their professional lives wrestling for satisfactory protocols or recommendations for optimal management of manipulated fires, seeking balance between the various conflicting priorities that are common, and for preventing catastrophic wildfire damage through prior planning, including fuel reduction and landscape modifications such as construction of firebreaks. Part of this rationale is to conserve ecological processes, assure the wellbeing of native biota and minimise detrimental impacts to them in the areas affected, within the framework of strong uncertainty and, often, the controversial nature of the process. I deal, more simply, with a much more restricted field – some of the impacts and roles of fires in the ecology and conservation of the most diverse components of terrestrial fauna, the insects and their allies – largely unheralded but also vital to sustaining most ecological processes and food webs, including many directly relevant to human welfare.

This synthesis brings together, and draws from, many research papers and reports (available to me up to very early 2014) to demonstrate the considerable ignorance and uncertainty that persists over predicting outcomes of fire, the numerous variations in fire performance that affect insects and related arthropods, and the great variety of studies that sometimes confuse scientists and land managers alike. Many of the key themes recur in different chapters in this short book,

emphasising the confusing variety of contexts and their possible interpretations. I hope that increased awareness of how little we know of these impacts, coupled with careful attention to the subtleties of insect biology, may lead to more sensitive and ecologically valid considerations over use of fire in achieving sustainable balance between human needs and those of the natural world.

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