The Howitt Society Inc

Submission to the Inquiry into Ecosystem decline in Victoria and measures to restore habitats and populations of threatened and endangered species

An historic photograph of very tall, open, mixed-aged forest that was maintained for tens of thousands of years by mild burning. Howitt wrote of mountain ash (*Eucalyptus regnans*) that: "Under its common name of black-butt it is found in the western part of Gippsland … *It reaches 300ft. in height, and according to the statements of some observers to 400ft. and above that height*."

This submission was coordinated by Howitt Society member Vic Jurskis who would be pleased to give evidence and provide further information on behalf of The Howitt Society.

Summary

Terms of reference:
(a) the extent of the decline of Victoria's biodiversity and the likely impact on people, particularly First Peoples, and ecosystems, if more is not done to address this, including consideration of climate change impacts;

Decline of biodiversity has historically been most severe in lightly populated, non-forested areas. The impact on people has been most severe in heavily populated areas at the interface with forests. The severity of this impact will increase until such time as there is recognition that biodiversity declines as fuel increases. There are three aspects to ecological maintenance by mild burning: interspecific competition amongst plants; vegetation/fuel mass/structure; and nutrient cycling. In eucalypt forests, biodiversity starts to decline as shrubs increase in density and add to fuel mass and structure within 4 years of mild burning. This can be addressed by sustainable fire management as employed by Aboriginal people for 40,000 years before Europeans arrived. Modern technology can be easily integrated with traditional and scientific management principles to improve efficiency.

(b) the adequacy of the legislative framework protecting Victoria's environment, including grasslands, forests and the marine and coastal environment, and native species;

The framework is adequate, but the legislation is mostly counterproductive because it based on *Terra Nullius* or the Wilderness Myth. Australian ecosystems need people. Ecosystems have declined, and will continue to decline, with lack of management. *Lock it up and let it burn* is a proven recipe for socioeconomic and environmental disaster.

(c) the adequacy and effectiveness of government programs and funding protecting and restoring Victoria's ecosystems;

Ongoing decline of ecosystems and loss of biodiversity show that government programs are ineffective. There has been much expenditure on planting trees and shrubs and massive expenditure on emergency response to bushfires, at the expense of sustainable land management. Ironically, loss of biodiversity and unstoppable firestorms are both consequences of woody thickening and increasing fuel loads.

(d) legislative, policy, program, governance and funding solutions to facilitate ecosystem and species protection, restoration and recovery in Victoria, in the context of climate change impacts;

The solution is simply to reorganise regulations and bureaucracies to support sustainable fire management. No increase in funding is required. Funds must be redirected from bureaucratic box-ticking and futile emergency response, to achieve real positive outcomes.

(e) opportunities to restore Victoria's environment while upholding First Peoples' connection to country, and increasing and diversifying employment opportunities in Victoria;

Australian ecosystems were maintained by human burning and natural lightning fires over about 40,000 years. The very few habitats that don't depend directly on mild fire to maintain their ecological processes, nevertheless depend on it for protection from wildfires. Lightning ignitions during extreme weather weren't a problem to Aborigines living in a healthy and safe landscape. Loss of species, chronic decline of eucalypts and megafires are all facets of ecosystem decline in the absence of frequent mild burning.

Victoria's fire management strategy is not supported by either ecological, physical or social sciences, and it is totally divorced from conservation strategies. The so-called residual risk approach attempts to separate fuel management from the inextricably interwoven aspects of forest health and biodiversity. It is a recipe for ongoing ecosystem decline and socioeconomic disaster. Dangerous fuels are a symptom of and contributor

to ecosystem decline. Firebreaks, waterbombers and fuel reduced zones on urban fringes can't stop firestorms, ember showers and catastrophic destruction. Declaring reserves, writing plans and policies and having community meetings isn't protecting biodiversity. Only landscape management can restore healthy and safe landscapes.

All peoples' connection to country has been lost through environmental regulations that exclude human culture and economy. A healthy and safe environment can only be restored by people working in the bush, primarily with mild burning. Traditional Aboriginal, pastoral and forestry burning skills must be brought together with modern technology. People need to be retrained in sustainable fire management, i.e. ecological maintenance rather than so-called hazard reduction burning, much of which has lately increased hazards as a result of poor techniques. This could ease the burden on volunteer firefighters from diverse ancestries and provide some of them with employment.

Employment and authority in land and fire management must be decentralised as well as diversified. Landscapes can't be managed by remote control. Local knowledge and flexibility to deal with emergent circumstances are essential to successful ecological maintenance as well as wildfire control.

Ecosystem Decline in Victoria

History of People in Australia

Australian Aborigines hold the world record for sustainable development. They first arrived at least 65,000 years ago when Australia was part of Sahul. Between about 50,000 and 40,000 years ago, under a gradually cooling and drying climate, long before the Last Glacial Maximum (LGM), people proliferated across Sahul. About 10,000 years ago, rising sea levels with global warming separated New Guinea, Tasmania and many lesser islands from the mainland.

Sediment cores show increases in charcoal deposition and changes in pollen composition, apparently unrelated to climate change, around 40,000 years ago, indicating that Aborigines used fires to extend open grassy areas by reducing dense woody vegetation. Any megafauna that had survived the Penultimate Glacial Maximum were exterminated as their browse was gradually eliminated over a few millennia. For example, in what is now North Queensland, greatly increased fire activity relative to climate converted araucarian dry rainforest on the Atherton Tableland to grassy sclerophyll woodland.

Open grassy ecosystems with a diversity of small and medium-sized fauna dependent on lightning and human application of mild fire became widely established. Mild burning consumed less woody biomass and produced less charcoal. Aboriginal burning maintained healthy and safe landscapes. Burning of woody biomass declined steeply with increasing aridity and decreasing temperature for 10,000 years leading to the LGM. After the LGM about 20,000 years ago, woody vegetation and charcoal deposition increased during warmer and wetter periods. Rising seas created Bass and Torres Straits, and lush rainforest clothed the Atherton Tableland when it became too wet for people to burn. Then charcoal deposition on the Tableland dropped to low levels.

Aborigines didn't survive on Kangaroo Island after it was cut off by rising seas. The latest evidence of their economy dates to around 5000 years ago, when casuarina woodland predominated. After this, there was a spike in charcoal, a large increase in acacias and a decline in grassy and ferny groundcovers, indicative of a high intensity fire regime and woody thickening. Eucalypts gradually increased. By 2,500 years ago, sustained high levels of charcoal deposition indicated a regime of infrequent severe fires fueled by accumulation of woody material. This confirms Matthew Flinders' deductions when he visited the island in 1802. Flinders described some grassy flats with abundant kangaroos, against a backdrop of dense young eucalypt forest with large standing and fallen dead timber. He contrasted the unmanaged vegetation and lightning-driven high-intensity fire regime against the healthy and safe, managed landscape of the continent.

Overall there has been a generally rising trend in biomass burning as growth of vegetation increased with global warming since the LGM. But, when the arrival of Europeans or their exotic diseases disrupted Aboriginal burning, there was very rapid woody thickening which fueled extensive high intensity firestorms

and megafires. These produced unprecedented quantities of charcoal in 70,000 years of sedimentary records. After mild burning at a landscape scale was reintroduced from the mid-20th Century, forest health and safety improved and charcoal deposition suddenly declined against the trend of rising temperature. Mild burning was once again reduced, supposedly for environmental reasons, from the late 20th Century. Forest health declined whilst pestilence and megafires increased. The consequent upsurge in charcoal deposition has not yet been sampled in sediment cores and reported in the literature.

Impacts of European colonisation

Woody thickening, megafires and pestilence

Ecosystem decline in Victoria commenced before European occupation, with the smallpox plague of 1789, which swept through Aboriginal populations from north to south. It probably originated from Macassan trepangers visiting northern Australia after epidemics in the Sunda Islands. Brigalow scrubs developed in central Queensland. E.M. Curr described some small scrubs that had grown up on the Central Murray after local Aboriginal populations were reduced, and he independently estimated the timing of the epidemic from the size of trees growing in abandoned cooking ovens. The Yowenjerre people of South Gippsland were virtually eliminated by smallpox. Dense woody understoreys escaped the deep dark gullies where they had been confined by mild burning, and took over the unmanaged landscape.

Around 1820, lightning strikes during extreme weather ignited explosive three-dimensionally continuous fuels which erupted into firestorms. The resulting megafires created some dense young forests in the Strzelecki Ranges and the Central Highlands. After Europeans disrupted traditional Aboriginal management throughout Victoria, the resulting growth of scrub fuelled the Black Thursday megafires of 1851 which ravaged 5 million hectares of this State. Since then, lack of sustainable fire management has fuelled at least nine other megafires – Red Tuesday 1898, 1926, 1932, Black Friday 1939, Ash Wednesday 1983, 2003, 2007 and Black Saturday 2009, culminating in Black Summer 2019. Less extensive infernos also incinerated considerable areas of forests in between (Adams & Attiwill 2015, Lindenmayer *et al.*2015).

Despite all these calamities, no forest dependent species have become extinct because there are still plenty of trees and forests to sustain them. In fact, many forest species irrupted into plagues as ecosystems declined in the absence of mild burning. Koalas are a prime example. When Strzelecki's party battled for 26 days to travel 50 miles through the dense young forests in the ranges that now bear his name, they ate koalas to avoid starvation. The traditional explorers' fare of kangaroo and emu wasn't available in the dense scrub. However, when Europeans started clearing the scrub thirty years later, they found stone axes and spear points, grindstones and cooking ovens, showing how drastically the ecosystems had changed with the demise of Aboriginal management (Jurskis 2017a, 2020).

Unfortunately, aquatic species living downstream of forests have declined as a result of erosion, siltation and ash pollution of our waterways. They've been scourged by unnatural megafires, introduced into our natural cycle of *droughts and flooding rains*, so unforgettably enshrined in Dorothea Mackellar's poetry. Our country used to be resilient. Mackellar wrote: *For flood and fire and famine She pays us back threefold.* Now the flooding rains that inevitably follow droughts cause massive fish kills when debris and silt and ash pollute the lower reaches and estuaries before breaking out and blackening the beaches and muddying the seas. It's cruelly ironic that species dependent on clean water from forests are endangered, whilst irruptive species, which can take advantage of dirty, scrub infested forests are booming.

Koalas keep bouncing back into unsustainably high densities in the Strzeleckis, despite some of the most intensive clearing in Australia and 20 high intensity fires in 200 years. Contrary to what experts tell us, high numbers of koalas have nothing to do with translocations. The Strzelecki koalas were the 'source population'. When koalas were translocated into supposedly empty habitats, they were 'protected' by excluding burning. Koalas can irrupt in the absence of mild burning for two reasons: firstly, soils and tree roots deteriorate and declining trees constantly turn over soft young foliage which is highly nutritious and palatable to koalas; secondly megafires produce dense young regrowth with masses of nutritious and palatable young leaves. So-called koala overbrowsing is but one of many symptoms of ecosystem decline with exclusion of mild fire.

One hundred and fifty years ago, Howitt identified disruption of Aboriginal burning as the ultimate cause of eucalypt declines that were apparently caused by folivores. He described the death of large tracts of red gum (*Eucalyptus tereticornis*) on the East Gippsland plains and of manna gum (*E. viminalis*) at Omeo. Similar processes today are known as 'Rural Tree Dieback' in Gippsland, 'Monaro Dieback' at Berridale (in NSW) and 'Koala Overbrowsing' at Cape Otway. Though Howitt didn't correctly identify the intermediate processes between disruption of burning and outbreaks of insects or other supposed causes of chronic eucalypt decline, this deficiency has since been rectified by widespread historical observations, and research across Australia (e.g. see Ellis 1964; Ellis *et al*. 1980; Ellis and Pennington 1992; Landsberg 1985; Landsberg *et al.* 1990; Jurskis & Turner 2002; Jurskis 2005, 2008, 2015, 2016, 2017b, 2020; Turner *et al.* 2008; Close *et al.* 2011; Jurskis *et al.* 2011; Horton *et al.* 2013; Baker 2015; Dijkstra & Adams 2015).

The Process of Chronic Eucalypt Decline

Studies across Australia and around the world have shown a consistent association of forest decline and *trophic cascades* with changes in nutrient cycling, especially elevated soil nitrogen (N), as a result of reduced burning (e.g. Bond & Keeley 2005, Bond *et al*. 2005, Hessburg *et al*. 2005, Jurskis 2005, Close *et al*. 2011, Turner *et al*. 2008, Jurskis *et al.* 2011). It is now recognised that N accumulation is the main driver of changes in species composition in a wide range of ecosystems around the globe, and that chronic tree decline is a facet of this phenomenon (Bobbink *et al*. 2010, Jurskis *et al.* 2011). Dijkstra & Adams (2015) reported that fire eases imbalances of N and phosphorus (P) in woody plants. Grazing of native pastures can perform a nutrient cycling role that is ecologically analogous to mild burning. In addition to lack of mild fire and/or grazing, other causes of eucalypt decline may be pasture improvement, earthworks, water impoundment or diversion, industrial or urban pollution, or any combination of these.

All aspects of the process of have been detailed by studies in woodlands and forests across Australia including Tasmania. Burning and/or grazing of native pastures maintains sunny, airy, warm and dry topsoils and natural nutrient cycling processes which support mature trees, herbs and grasses. In the absence of burning and/or grazing, soil physics and chemistry change and vegetation responds, reinforcing the changes. Rank herbage, mulch and/or woody understorey builds up, sunshine and air circulation are reduced. Nitrogen in litter, seedlings and herbage that had previously been volatilised by fires and returned to the atmosphere, or mineralised by fires and taken up by the flush of new growth, now accumulates in the soil and dense rank growth or developing shrubbery. Topsoils become cooler, damper, softer and deeper.

Changes in vegetation structure and microclimate make it very difficult to burn in mild conditions, especially for people who haven't grown up with a culture of burning the right bits at the right time by lighting spots in patterns governed by topography, vegetation, recent prior burning and weather. However, under extreme weather conditions, these same changes promote firestorms, crownfires and long-distance embershowers, making wildfire control impossible.

Carbon to Nitrogen (C:N) ratios of soils are reduced, acid forest soils become more acid and microtoxins such as aluminium and manganese are released. These, along with high N, inhibit tree roots and mycorrhizae. They become more susceptible to drought, waterlogging, frost and root rots such as phytophthora. The deteriorating soils and roots cause nutrient imbalances, particularly in N:P ratios, and physiological changes in the trees. New leaves are aborted before they mature and there is ongoing recycling of epicormic shoots. Thin canopies and sick roots promote scrub invasion. Trees' sapstreams and foliage become more attractive and nutritious to arbivores – that is anything that derives nutrients from any part of the tree including roots, sapwood, sap and leaves.

Depending on the type of forest and the species of eucalypts, different arbivores can irrupt in response. Armillaria or phytophthora can attack sick roots, or parasites such as native cherries can proliferate on them. A variety of borers can take advantage of the nutritious sap flow in declining trees. Various fungi and sap-sucking, mining or chewing insects can attack the leaves as can koalas or possums. Hemi-parasitic vines and mistletoes can attack stems and branches. In some types of forest, eucalypt decline can feed irruptions of psyllids which in turn support irruptions of bellbirds.

Unfortunately, specialist ecologists and pathologists haven't come to grips with the fundamental ecological principal of the *Trophic Pyramid* (more accurately described as a ziggurat), established by Charles Elton a century ago. All plants and animals are limited by their food. They can irrupt when disturbance such as fire suppression and consequent eucalypt decline temporarily increases their food. As decline progresses and trees die their food diminishes and populations of arbivores crash. The specialists have it back to front. They think that the arbivores such as koalas are killing the trees, when they're actually irrupting as symptoms of and secondary contributors to tree decline. Even tertiary symptoms such as irruptions of bellbirds have been blamed for eucalypt decline.

Loss of biodiversity

Mammals

Australia is famous for our high rate of extinction of small and medium-sized mammals. Victoria has lost at least 21 species since European arrival. None of them are forest-dependent and most of them (17) didn't even live in forests, so their extinction had little to do with megafires and nothing to do with logging. These were ground dwelling species that fed on herbs, grasses and seeds or preyed on other animals that relied on herbage in woodlands, shrublands and grasslands. Clearing also had little or nothing to do with their extinction. Fifteen of them disappeared from a small area in the northwest corner of the State where there was no clearing until long after they disappeared and where there is still more native vegetation than cleared country. The extinctions occurred before the rabbit plagues and fox plagues that are typically blamed (Strahan 1983, AUSLIG 1990, DSE 2013, Jurskis 2015).

It has been argued that competition from sheep was the ultimate cause, but flocks of sheep continued to grow as native animals disappeared. This was the edge of The Great Central Scrub which grew up after Aboriginal management was disrupted. There were enough robust tussocks and edible shrubs to feed huge flocks of sheep, but in the absence of mild burning this invasive vegetation choked out the diversity of more delicate herbs and shrubs that had sustained the native animals over many millennia. Modern ecological studies have confirmed that lack of mild burning favours a few robust native and exotic plants allowing them to shade out more delicate and diverse groundcovers. These impacts can be exacerbated by fertiliser applications which favour exotics over natives (Noble 1997, Jurskis 2015).

Here again, ecological specialists have got it back to front. They analysed the historical data and found that small to medium sized ground-dwelling marsupials in arid areas were more likely to have disappeared than arboreal marsupials, marsupials in wetter areas or larger marsupials. They concluded that the little ground dwelling marsupials, had been eaten out by foxes and cats because they were so easy to get at and the right size to eat (Johnson & Isaac 2009). However, the small-medium sized (so-called *Critical Weight Range* CWR) marsupials survived alongside feral cats in Australia's Western Deserts, because Aboriginal fire management remained in place until quite recently. The desert Aborigines incorporated cats in their diet, but neither of these so-called apex predators hunted any CWR species to extinction.

After Aborigines let go their traditional way of life, many of the small mammals disappeared. But traditional knowledge of fire regimes and fauna has not been lost. One elder, Warlimpirringa Tjapaltjarri, first made contact with whitefellas as recently as 1984. Ngaanyatjarra Aborigines said that the *mitika*, or burrowing bettong (*Bettongia lesueur*), had "*gone to the sky because the country had not been cleaned up*", i.e. maintained by burning (de Graaff 1976). Pintupi people think that a "*big bushfire*" consequent to lack of maintenance caused the golden bandicoot (*Isoodon auratus*) to disappear (Burrows *et al.* 2006).

Ecologists Neil Burrows and Andrew Burbridge camped with Aborigines in the desert to learn about their use of fire. They also compared historic aerial photographs against recent satellite images to determine how the country changed after Aborigines left the deserts. A fine mosaic of small burnt patches of vegetation at different stages of development was replaced by a very coarse mosaic. Vast tracts of long unburnt senescent vegetation are now interspersed with equally vast tracts incinerated in fires started by lightning storms. Burrows and colleagues gathered information on small mammals that consequently became extinct, by examining and discussing museum specimens with the elders.

In The Mallee, where most Victorian mammal extinctions have occurred, extensive dense, even-aged stands created by post-European megafires are now portrayed as though they are a natural phenomenon that existed under Aboriginal management. Ecologists have stated that:

> *Mallee vegetation has a low canopy (generally <5 m), and so almost all fires (prescribed or wildfire) result in the canopy burning and the death of above-ground stems and branches. New stems then arise post-fire from synchronous resprouting from the lignotubers. Consequently, most mallee stems in a particular location are the consequence of a single fire event* (Clarke *et al.* 2010).

This misleading statement was contradicted by an admission, in another paper, that multiaged stands were deliberately excluded from sampling. Nevertheless it became the foundation for papers arguing against prescribed burning of mallee. They claimed that long-unburnt stands are the only reservoir of faunal habitat features such as holes in trees that take a long time to develop. Had these ecologists understood our ecological history, they may have argued instead for more intelligent prescribed burning of mallee so that young trees could grow old. During the 1980s, CSIRO trials had demonstrated that frequent burning could restore grasslands in swales which had been invaded by mallee and other woody plants after Aboriginal burning was disrupted. Ecologists should be arguing for mild mosaic burning to restore biodiversity, fuel diversity, fire safety and old trees on the dunes.

Aborigines mostly burnt the mallee with low-intensity fires that sometimes scorched the canopy but did not consume it as do modern megafires. Dormant 'bud' strands in branches sprouted and produced abundant soft and nutritious foliage which fed large numbers of bugs. These produced a bounty for Aboriginal people. People on the Central Murray described the process to Curr in the 1840s and showed him their stores of manna or lerp. Aboriginal fires together with the physical mosaic of dunes and swales maintained a small scale mosaic.

Now "*almost all fires (prescribed or wildfire) result in the canopy burning*" (Clarke *et al.* 2010) because dry leaves, bark and twigs of mallee as well as dense rank stands of porcupine grasses (*Triodia*) are allowed to accumulate for decades before they are burnt either deliberately or accidentally. Over 35 years spanning the turn of the millennium, infrequent (> 35 years between fires) megafires (> 10, 000 hectares per fire) ravaged the Murray Mallee Region because heavy three-dimensionally continuous fuels inevitably produce uncontrollable crown fires in extreme weather, whatever the height of the canopy. This has been blindingly obvious in tall mountain ash forests for almost two centuries.

There is no doubt that human fire was the most important force in Australian ecology for tens of thousands of years. Howitt (1891) was right to conclude that anything lessening that force would "*very materially alter the balance of nature*". Most faunal extinctions occurred in semi-arid or arid areas without any decent sized trees because that's where the most diverse ground layers were lost with disruption of Aboriginal burning. Nearly 200 years ago, Surveyor General Mitchell (1839, 1848) discussed some of the factors that govern or maintain biodiversity. For example he compared the ground-layer diversity near the Bogan and the Darling Rivers respectively:

> *It has also its plains along the banks, some of them being very extensive ; but the soil of these is not only much firmer, but is also clothed with grass and furnished with a finer variety of trees and bushes, than those of the Darling. Yet in the grasses, there is not such wonderful variety as I found in those on the banks of that river. Of twenty-six different kinds gathered by me there, I found only four on the Bogan, and not more than four other varieties, throughout the whole course. It appeared that where land was best and grass most abundant, the latter consisted of one or two kinds only, and, on the contrary, that where the surface was nearly bare, the greatest variety of grasses appeared, as if nature allowed more plants to struggle for existence where fewest were actually thriving.*

Mitchell described how biodiversity was lost after Aboriginal management was disrupted on the Cumberland Plain west of Sydney:

> *Fire, grass, kangaroos, and human inhabitants, seem all dependent on each other for existence in Australia ; for any one of these being wanting, the others could no longer continue. Fire is necessary to burn the grass, and form those open forests, in which we find the large forest-kangaroo ; the native applies that fire to the grass at certain seasons, in order that a young green crop may subsequently*

spring up, and so attract and enable him to kill or take kangaroo with nets. In summer, the burning of long grass also discloses vermin, birds' nests, &c., on which the females and children, who chiefly burn the grass, feed. But for this simple process, the Australian woods had probably contained as thick a jungle as those of New Zealand or America, instead of the open forests in which the white men now find grass for their cattle. ...

The omission of the annual periodical burning by natives, of the grass and young saplings, has already produced in the open forest lands nearest to Sydney, thick forests of young trees, where, formerly, a man might gallop without impediment, and see whole miles before him. Kangaroos are no longer to be seen there; the grass is choked by underwood ; neither are there natives to burn the grass.

When Aborigines originally spread across Australia about 40,000 years ago they reduced nutritious soft leaved trees and bushes, exterminating the megafauna that browsed them. Medium-large generalist herbivores such as kangaroos, wombats and emus were able to survive whereas the big specialist browsers couldn't. For example, broken eggshells from ancient campfires show that Aborigines feasted on the eggs of a giant flightless bird called Genyornis as well as emu eggs. Isotopic studies of fossilised eggshells and wombat teeth show that emus and wombats survived on a poorer diet under Aboriginal management, whilst the more specialised Genyornis disappeared because it was unable to adapt.

The smaller, specialised eaters of herbs, grasses and/or their seeds or tubers thrived as Aborigines opened up country and maintained it with mild burning over millennia. But, when Europeans disrupted this maintenance, the smaller specialists suffered. There were fewer extinctions in moister areas with trees because there was less ground layer floral diversity and consequently there were fewer and less specialised herbivores. Being less specialised, they were widespread around the moister coastal fringe of the continent in forests, woodlands and grasslands. Those small, less specialised, herbivores that are now extinct in Victoria were nocturnal animals that sheltered and foraged in different parts of their habitat.

Not much is known about the white-footed rabbit rat. John Gould (1863) wrote that "*it is dispersed over all parts of New South Wales* [including southeast Queensland] *Port Phillip and* [southeastern] *South Australia, but is nowhere very abundant ... it sleeps during the day in the hollow limbs of prostrate trees, or such hollow branches of the large eucalypti as are near the ground, in which situations it may be found curled up in a warm nest of dried leaves*". Obviously it was vulnerable to pastoral and agricultural development that targeted open woodlands.

The Tasmanian bettong and Tasmanian pademelon used to live in Victoria. They forage in grassy vegetation: the bettong on seeds, fungi, bulbs and roots; the pademelon on herbage and occasional browse. The bettong builds a nest among tussocks whilst the pademelon shelters in thickets. Living on the edge of treed country and grassland, they were affected by intensive agriculture, woody thickening and megafires in Victoria. The bettong is now declining in Tasmania, with recent woody thickening, whereas the pademelon remains secure in its daytime shelter and forages on grassy edges at night.

Hastings River mouse is extinct in Victoria but still lives in northern NSW and southeast Queensland. It lives in grassy open forest maintained by burning and/or grazing but has disappeared from some National Parks in NSW as a result of woody thickening which has favoured common bush rats and antechinus. The smoky mouse is a close relative which is declining in Victoria. It shelters from predators in burrows under dense heath. However, breeding females seem to rely for nutrition on legumes growing on runners that thrive on sunny bare ground. This is the critical part of its habitat that is disappearing.

Two of three quolls have become extinct in Victoria since Europeans arrived. Originally the most widespread, western quolls occurred right around the continental margin except for the Nullarbor Plain. They didn't live in the arid zone, and clearing obviously wasn't a factor in their demise. A distinct subspecies still lives in the forests of southwestern Australia, reinforcing the observation that forest dependent species are not vulnerable to extinction in Australia. Western Australia also has the best track record for prescribed burning in forests.

The western quoll can become torpid in frosty conditions, so it never lived in Tasmania. However, unlike the Tasmanian tiger and Tasmanian devil, it survived the arrival of the dingo on the mainland. Obviously it was not a competitor because it relied on smaller prey. The eastern quoll is a close relative. It is extinct on the mainland and declining in Tasmania where feral competitors are increasing. Recent woody thickening and declines in smaller herbivores as well as their native predators, again point to loss of groundlayer diversity in the absence of mild burning as a major factor in faunal declines or extinctions.

Spotted-tailed quolls are much larger than the other two. They still live in Victorian forests but have disappeared from most woodland/agricultural areas. This seems to be a consequence of loss of suitably large remnants with a diversity and abundance of small/medium prey combined with increasing competition from feral predators.

Three mammals are critically endangered in Victoria. None of them are arboreal or forest dependent. The mountain pygmy possum is naturally rare because it lives in alpine boulder fields and scree slopes where it can hibernate in, and sometimes navigate, the interstices under a thick insulating blanket of snow. There are low shrubs and grasses as well as some mallee-form snow gums in parts of its habitat. This habitat was protected and/or maintained by mild burning of the alpine landscape. Aborigines visited the Alps in summer to feast on bogong moths which are a critical food resource for the tiny possums. They burned above the treeline while they were there, and the different clans burned the lower altitude woodlands and forests on their various return journeys to their own country.

After Europeans disrupted Aboriginal management, seasonal alpine graziers continued to manage the landscape by mild burning as they drove their flocks or herds back to their cold-season pastures. Since green academics and bureaucrats have succeeded in ‘protecting’ the alpine habitats from grazing and burning, they have been incinerated by a succession of megafires. Furthermore, during the 2017/18 and 2018/19 summers there was a dramatic reduction in the number of moths turning up in the mountains, so there are grave concerns about the future of the possums.

Bogong moths breed in dry areas of the Murray-Darling Basin where their larvae, known as black cutworms feed on broadleaved weeds and also damage crops and pastures. There doesn’t seem to be much information on what they ate before whitefellas came, but the cutworms have been known to damage saltbush (Common 1954). Unsurprisingly, ecologists blame drought for the lack of moths, but even the Met Bureau admitted that the drought wasn’t unprecedented. They mentioned the Federation, World War II and Millennium Droughts, interspersed with wet periods in the late 19th and 20th Centuries (Bureau of Meteorology 2018).

The Bureau didn’t mention that the Darling also ran dry in the early 19th Century as reported by Mitchell when he foreshadowed our existing water conservation and irrigation schemes. What is unprecedented is that the moth grubs now rely on exotic weeds and crops which have recently been denied water in preference for so-called environmental flows to sustain a huge unnatural freshwater pond near the mouth of The Murray.

The critically endangered brush-tailed rock wallaby is, unusually, a forest dweller. It lives in forests because they are the dominant vegetation on the steep broken country with rock overhangs and fallen blocks of stone that provide the wallabies with shelter. Brush-tailed rock wallabies are endangered because they are grazers who rely on grass and herbage that is choked out by woody thickening in unmanaged landscapes. Woody thickening also favours feral herbivores which can browse woody shrubs, and their feral predators which also eat rock wallabies.

Critically endangered southern bent-winged bats shelter in caves and culverts. They don’t depend on forests. The relatively recent decline of this little bat suggests that recent woody thickening and/or agricultural developments may have affected the insects that it feeds on.

Birds and snakes

Two species of birds – the night parrot and the chirruping wedgebill have become extinct in Victoria since European arrival. Unsurprisingly, they lived in the arid interior and were not affected by clearing, logging or

anthropogenic climate change. They were victims of ecosystem decline consequent to disruption of ecological maintenance by mild burning. Similarly, the only reptile to become extinct in post-European Victoria is the fierce snake or western taipan from the semi-arid zone.

The broad-headed snake is now Australia's most endangered snake. It is known from NSW and is predicted to occur in northeastern Victoria. During most of the year, this nocturnal snake sleeps under sunny sandstone rocks, using them as heatbanks to recharge its thermoregulation. At the height of summer, it doesn't need heating, so it uses holes in big old trees under the cliffs and crags for insulation. The snake is extinct in national parks around Sydney and is declining in parks further south because lack of burning and high intensity wildfire have promoted scrub that has shaded out its heatbanks (Pringle *et al.* 2009) and burnt down its airconditioners. However, NSW Government lists the main threats to the snake as collection of bushrock, collection of snakes, or removal of big old trees.

A dozen bird species are critically endangered in Victoria. None of them are forest birds, they live in wetlands, woodlands, grassy plains, mallee and shorelines. NSW Government purchased a grazing property to conserve one of these species – the plains wanderer. "*Ecologically sensitive*" sheep grazing has been continued to reduce the dominant grasses and maintain the diverse groundlayer that sustains this bird. Again, grazing can be an ecological analogue for mild burning.

Fish

Matthew Flinders didn't find the mouth of the Murray, our longest river, when he was charting our coastline in 1802. Presumably, there was no outflow because the mouth was closed. However, when Sturt entered Lake Alexandrina from the Murray in 1830 he found it very salty and he saw a seal at the lower end. A diversity of euryhaline fish (tolerant of a wide range of salinity) and a valuable mulloway fishery have been lost from the lake since barrages were built to exclude the sea, making the former intermittent tidal estuary unnaturally dependent on freshwater inputs (Marohasy 2012).

In eastern Australia, pastoral and agricultural development has been concentrated in the Murray-Darling Basin, west of the Great Dividing Range, where climatic irregularity is most severe. But of our four freshwater cod, The Murray cod is listed as vulnerable under the EPBC Act, whereas the eastern species and the trout cod, from the forested upper reaches of the Basin with more reliable rainfall, are endangered. After the 2003 megafires, 200 tonnes per hectare of sediment eroded from some hillslopes in Canberra's main water supply catchment. Ash and debris from the Black Summer megafires produced massive fish kills on NSW's north coast and recently in the Betka River near Mallacoota.

Plants

Plants form the broad base of the trophic zigurrat. Floral biodiversity maintained by frequent mild burning sustained faunal biodiversity over tens of thousands of years of Aboriginal management and was rapidly lost from woodlands, grasslands, shrublands, swamps and heaths after 1789.

Weeds and Feral animals

Lack of mild burning promotes robust invasive native and exotic plants which provide food and/or shelter for feral herbivores at the expense of natives. Increased overall biomass of herbivores – feral, domestic and native – provides increased food resources for feral carnivores.

Ecosystem decline

An example:

Gippsland Red Gum Grassy Woodland and Associated Native Grassland were listed by the Federal Government as a Critically Endangered Ecological Community in 2009.

Grassy coastal red gum valleys were the first ecosystems targeted for occupation by Europeans, starting with the Cumberland Plain near Sydney from 1789, the Hunter Valley to the north and Coolangatta Estate to the south in the 1820s, and the Moruya and Bega Valleys in the 1830s (via the Argyll and the Monaro). Europeans occupied Gippsland by way of the Monaro, Benambra and Omeo in the 1840s. Red gum

ecosystems still occur in suitable habitats right through the coastal strip from Gippsland to far north Queensland, but they are mostly listed as endangered ecosystems.

In the 1830s, Mitchell reported woody thickening and loss of biodiversity consequent to disruption of Aboriginal burning on the Cumberland Plain. In the 1860s, Howitt observed widespread death of red gum on the Gippsland plains. He deduced that plagues of gum-leaf skeletoniser (moth larvae) were a consequence of disruption of Aboriginal burning. At the same time and for the same reasons, there were plagues of koalas in the red gums of the Bega Valley in NSW. Howitt (1891) recognised that "*the ravages of the larvae of Lepidoptera are at present greatly aided by the sickly state in which many of the Red-gum forests of Gippsland now are*", referring to pasturage, soil compaction and drought. He wrote that "*the Red-gum is deprived of much moisture which it would otherwise have in reserve*. *The trees are wanting in vigour, and thus unable to withstand the attacks of insect pests*".

In effect, Howitt identified the process of chronic eucalypt decline and irruptions of arbivores in the absence of mild burning. We can easily forgive him for misinterpreting or missing some of the underlying scientific detail, which has been coloured in since the late 20th Century. However it is unforgivable that modern ecologists and conservation bureaucrats are still 150 years behind the times. For example, here are some extracts from the relevant Commonweath publication on conservation of Gippsland red gum ecosystems (DEWHA 2010), together with our comments:

> *Many patches of the ecological community require recovery efforts because they are so degraded due to weed and feral animal invasion, loss of native biodiversity and rural tree dieback that their capacity to maintain ecosystem function is impaired.*
>
> *Historically, management of the ecological community has involved grazing and/or burning. Although the grassland and woodland forms have many species in common, different land use histories have resulted in some differences in plant species between the two forms of the ecological community. As a result, both grassland and grassy woodland remnants now require separate and specific management regimes to preserve the full remaining biodiversity of the ecological community.*

Comment: Weed and feral invasion, loss of biodiversity and chronic eucalypt decline result from lack of frequent mild burning which is essential to maintain all the native species. The only difference is that intervals between burning in grasslands are governed solely by development and curing of the dominant grasses, whereas accumulation of eucalypt litter is another relevant factor in woodlands.

> *Rural tree dieback*
>
> *The underlying causes of dieback are complex. One immediate cause of dieback in Gippsland is repeated damage to shoots by beetles, lerps and caterpillars, sometimes in large numbers or over long periods. However, the reasons why populations of defoliating insects increase, and trees become more susceptible to damage may be due to wholesale changes in landscape, land use and longer-term drought. For instance, the use of improved pastures and fertilisers also provides pest insects with a better food source. Clearing and thinning remnant native vegetation discourages the natural predators of insect herbivores, such as woodland birds and sugar gliders. And many trees now exist as isolated paddock trees or in small fragments that leaves them susceptible to further disturbance.*

Comment: Pasture improvement causes the same soil changes and deterioration of eucalypt roots and mycorrhizae as lack of mild fire. It provides the arbivorous insects with better food in constant turnover of soft young growth in eucalypts. Dr. Jill Landsberg of CSIRO established the connection 40 years ago and also demolished the mythology about lack of natural predators. There was just as much predation of pest insects in trees growing in pastures as there was in native vegetation. However, the predators breed more slowly than the insects, and can't keep up with their irruptions until trees start dying and insects decline. Ecologists from ANU recently tried, and admitted their failure, to resurrect the mythology in respect of 'Monaro Dieback'.

> *Key management actions*

- *Identify the best quality remnants and key threats.*

- *Monitor their condition and the effectiveness of management actions, and adapt them, if necessary.*
- *Avoid or minimise any permanent damage to patches of the ecological community.*
- *Protect remnants through inclusion in formal conservation reserves, or through management agreements or conservation covenants.*
- *Protect native vegetation remnants that buffer or link remnants of the ecological community.*
- *Ensure road widening, maintenance activities and other infrastructure or development activities do not adversely affect known remnants.*
- *Retain any logs, fallen timber or standing dead trees to foster habitat diversity for native fauna and promote ecological functions like nutrient cycling.*
- *Raise awareness of the ecological community within the region.*
- *Develop and implement appropriate management regimes to maintain the distinctive biodiversity elements of the ecological community (for example, strategic grazing regimes or appropriate fire regimes).*
- *Ensure that management regimes are also appropriate for any threatened species present.*
- *Encourage good management practices for remnants on all land tenures, not just to remnants under conservation tenure.*
- *Avoid the use of fertilisers within native vegetation remnants and ensure that fertiliser applications in adjoining pastures do not drift into patches of the ecological community.*

Comment: Lots of words, no real actions. We already know that the appropriate management regimes are frequent mild fire and/or grazing according to seasonal carrying capacity. These regimes, rather than accumulating dead wood, promote healthy ecological functions, especially nutrient cycling. We need to apply them across the landscape.

The relevant *Action Statement* under the Victorian Flora and Fauna Guarantee Act (DSE 2003), listed the threats to these critically endangered ecosystems, in descending order, as Clearing, Pests, Lack of suitable burning or grazing, poor understanding of and compliance with legislation and so on. Obviously, the bureaucrats regard non-compliance as the primary threat, and no legislative measures are needed to address the perceived threat of clearing.

Under *Intended Management Actions*, the Action Statement listed three and a half pages of issues around policy, planning, land reservation and community engagement, but only three paragraphs on real actions, including implementation of plans that hadn't been written:

Central Gippsland Plains Grassland

Continue ecological burning at Munro, Marriage Lane, Hillside, Lindenow South, Fernbank rail reserves, Briagolong cemetery and Golden Beach. Undertake weed control for African love-grass and St John's Wort, and tree and shrub removal (e.g. burgan, casuarinas, eucalypts, black wattles) from significant sites that suffered a cessation of burning from 1980 – 1990, especially Munro and The Knob. Undertake a Rabbit control program on Briagolong cemetery, and rail reserves from Munro to Lindenow South. Repair and maintain fences at all fenced sites to prevent accidental damage.

Forest Red Gum Grassy Woodland

Prepare and implement a management plan for The Knob Recreation Reserve, Moormung and Providence Ponds Flora and Fauna Reserves. Undertake control of priority weeds such as Sweet Vernal Grass, Yorkshire Fog, Phalaris and Bridal creeper, at Moormurng Flora and Fauna Reserve, Providence Ponds FFR, Stratford Highway Park, The Knob Recreation Reserve, The Billabong FFR.

Plains Grassland (South Gippsland)

Undertake control of introduced pasture grasses (Phalaris, Paspalum, Yorkshire Fog and Sweet Vernal Grass), Blue Periwinkle, Watsonia and native shrubs such as Swamp Paperbark and Prickly Teatree at all sites.

Comment: All properly conducted burning is *ecological burning*, essential to maintain healthy and safe landscapes, including both woodlands and grasslands. The entire extent of these critically endangered ecosystems was affected by disruption of frequent mild burning after Europeans arrived. There should be no distinctions according to recent management, other than preferential use of mild burning, grazing or a combination of both, according to site specific factors and contingencies.

Comment continued: Jurskis (2004) was awarded a grant by the J.W. Gottstein Memorial Trust to investigate eucalypt decline across Temperate Australia, including red gum decline in Gippsland. The Fellowship Report noted that grazing had been excluded from Moormung FFR about 15 years previously, but that ecosystem health and safety seemed to have been maintained by mild burning. In contrast, Billabong and Providence Ponds FFRs, as well as all roadside stands, were apparently unmanaged, declining and suffering scrub invasion. Their condition has deteriorated during the past 16 years. A grazed red gum woodland with native pasture near Stratford had healthy trees in clean grassland. The Howitt Society has since been advised by Gippsland Apiarist Association, that forest health at Moormung has declined since exclusion of grazing, suggesting that burning has not been sufficiently frequent and/or mild to sustain natural processes.

Comment continued: Banskia woodland at Providence Ponds FFR, home to the endangered New Holland Mouse, was severely burnt by a 'hazard reduction burn' in winter (Gippsland Times 2017). Apparently this area had last been burnt 30 years previously, highlighting the dual problem of lack of frequent mild burning and consequent lack of experience and skills amongst those responsible for burning. This was but one of many examples of counterproductive moderate-high intensity prescribed burns that have occurred in East Gippsland recently. Planning, approval and control of fire management, both ecological maintenance and response to wildfires, needs to be decentralised and given more flexibility to take account of local knowledge and emergent circumstances.

At the same time, banksias in long unburnt woodlands and forests from Bairnsdale to Bega were turning yellow. Their roots deteriorated in the absence of mild burning and phytophthora was apparently responding. Banksias grow on sandy soils and are naturally very drought tolerant. However, when soil moisture was replenished by good seasons after the Millennium Drought, widespread chlorosis (yellowing) of banksia leaves occurred, leading up to mass mortality during the drought preceding our Black Summer. A similar process occurred with burrawangs in forests north of Bega. This deterioration in ecosystem health seems not to have been reported in scientific literature or media, presumably because forest managers and pathologists didn't notice.

Lack of ecological maintenance by frequent mild burning might have caused the extinction of the Bairnsdale leek orchid, *Prasophyllum correctum,* had it not been for the traditional Australian practice of burning railway easements. The critically endangered orchid still lives in two patches with a total population of 100 plants or so, on railway reserves near Bairnsdale. Unsurprisingly, researchers found that frequent burning (at intervals < 3 years) promotes the orchid by reducing competition from grasses, dormancy and mortality, and by stimulating flowering (Coates *et al.* 2006).

The Right Fire – ecosystem maintenance

Traditional Aboriginal burning expert Victor Steffensen points out that we shouldn't be distracted by trying to manage individual species, rather we should manage whole ecosystems with "*the right fire*". He is, in effect, a proponent of holistic science and holistic management (Steffensen 2020). When Steffensen criticises "*western science*", we believe that he is really criticising the specialised academics who 'have the ear' of governments, but can't see the big picture.

Genuine scientific research based on empirical data rather than theory and modelling shows that dry and moist eucalypt forests – the vast majority of Australian forests – depend for maintenance of their ecological function, on mild fire at intervals of 3 to 6 years (Jurskis 2011). The efficacy of fuel management by burning across the landscape has been demonstrated empirically in southwestern Australia. Burning in jarrah and karri forests, limited the extent and incidence of wildfires over more than half a century. Dangerous fuel loads began to accumulate within 6 years without burning. Contrary to well-publicised claims by fire ecologists lacking data and experience of fire management, the ameliorative effect of landscape scale maintenance by burning was most apparent in severe fire seasons when large wildfires occurred.(Boer *et al.* 2009).

There are three aspects to ecological maintenance by mild burning: interspecific competition amongst plants; vegetation/fuel mass/structure; and nutrient cycling. In eucalypt forests, biodiversity starts to decline as shrubs increase in density and add to fuel mass and structure within 4 years of mild burning. Dynamic stability in soil C:N ratios, maintaining healthy trees, requires mild burning at about 5 yearly intervals. It is not surprising that studies from three different perspectives point to similar fire intervals (3-6 years) to maintain biodiversity, health and fire safety of eucalypt forests (Jurskis 2011). This is consistent with estimates of pre-European forest fire regimes derived from a combination of dendrochronology, sedimentary charcoal, grasstree records and historical accounts (e.g. Mitchell 1848; Curr 1883; Howitt 1891; Burrows *et al*. 1995; Ward *et al*. 2001; Abbott 2003; Hassell and Dodson 2003). Woodlands and grasslands require mild fire at shorter intervals to maintain their health and diversity.

'Acceptable' fire intervals, according to theoretical plant life cycle analyses, are much longer, especially for moister forests. These analyses wrongly assume that mild fires kill mature shrubs and trees. Also they fail to recognize that truly fire-sensitive plants are naturally associated with physically protected habitats such as rainforests, rock outcrops, swamps and deep dark gullies. This protection is reinforced by frequent low intensity burning in the landscape (e.g. Bowman 2003; Jurskis *et al*. 2003; Burrows 2005). Without mild burning across the landscape, the majority of fire refugia throughout whole regions can be reset to a young age by megafires as has happened repeatedly in Victoria ash forests since the 1820s.

The critically endangered southern corroboree frog provides a prime example of lost fire refugia consequent to lack of burning. It breeds only in sphagnum bogs in Kosciuszko National Park where it was abundant, but has suffered a precipitous decline in range and population since the late 1970s. This coincided with a deliberate reduction in mild burning, and severe high intensity fires in 1978, 1983, 1988 and 2003 that have damaged most or all of the bogs. After the holocaust of 2003, there were apparently only 64 frogs left – an estimated reduction of 99.999 % over three decades. Unsurprisingly, ecologists blame either the chytrid fungus or climate change (Thomas 2004). Similarly, all the granite outcrops formerly providing fire refuge to rare species in southwestern Australia were burnt throughout 18,000 hectares by a single high intensity fire in 2003 after 20 years of exclusion of fire from a National Park.

Australian ecosystems were maintained by human burning and natural lightning fires over about 40,000 years. The very few habitats that don't depend directly on mild fire to maintain their ecological processes, nevertheless depend on it for protection from wildfires. Lightning ignitions during extreme weather weren't a problem to Aborigines living in a healthy and safe landscape. Loss of species, chronic decline of eucalypts and megafires are all facets of ecosystem decline in the absence of frequent mild burning.

Victoria's fire management strategy is not supported by either ecological, physical or social sciences, and it is totally divorced from conservation strategies. The so-called residual risk approach attempts to separate fuel management from the inextricably interwoven aspects of forest health and biodiversity. It is a recipe for ongoing ecosystem decline and socioeconomic disaster. Dangerous fuels are a symptom of and contributor to ecosystem decline. Firebreaks, waterbombers and fuel reduced zones on urban fringes can't stop firestorms, ember showers and catastrophic destruction. Declaring reserves, writing plans and policies and having community meetings isn't protecting biodiversity. Only landscape management can restore healthy and safe landscapes.

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