Review of forest fire intervals for planned burns and bushfires in South Eastern Australia

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Contents

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This review of forest fire intervals for planned burns and bushfires in South Eastern Australia is outlined in the sections below.

1 Introduction

It is an opportune time to review forest fire intervals following ongoing intense bushfire disasters across NSW and South East Australia over large areas, especially noting loss of forest bushfire resilience, ongoing concerns in relation to community, firefighter and forest safety and concerns in relation to increasing eucalypt decline.

This review has been undertaken in good faith in relation to reviewing forest fire intervals, in order to tease out opportunities to reduce intense bushfires over huge areas, reduce the impacts of these bushfires, increase forest bushfire resilience, improve community and firefighter safety and better address eucalypt decline.

Photo from an intense bushfire disaster in 2019/ 20 in central NSW with high fuel loads, its past time to move away from this outcome.

2 Preferred optimum fire intervals for forest burning

Prescribed fire intervals for forests are generally too long, refer information provided in Section 3 and Section 4.1, up to 60 years and many with no fire.

Boer et al **(2009)** note the importance of regular burning less than 6 years to adequately manage fuel loads:

Prescribed burning has pronouncedly changed the spatial distribution of fuel age in the study area and has significantly reduced the incidence and extent of unplanned fires. This effect on both the incidence and extent of unplanned fires was minimal for time lags greater than 6 years between fuel treatment and response. When averaged over 6-year periods, the annual extent of prescribed burning explained 24% and 71% of the variation in the mean annual number and extent of unplanned fires, respectively. The incidence of large unplanned fires was significantly less than the long-term average for the region when the annual extent of prescribed fire was at a maximum and significantly more when the annual extent of prescribed fire was at a minimum. Since the 1960s, the length of time sites remain unburned by wildfire has approximately doubled to 9 years. We found that each unit area reduction in unplanned fire required about four units of prescription fire. These findings concur with the observations of experienced field practitioners who identify the 6-year mark as effective at reducing wildfire hazard. Our findings provide strong empirical evidence of the effectiveness of prescribed burning for mitigating wildfire hazard in SW Australian forests.

Jurskis (2011) considers biodiversity issues in relation to regular burning:
Studies of frequent prescribed burning in New South Wales State Forests have confirmed that most obligate seeders are promoted by burning whilst a few common shrubs are disadvantaged (Jurskis et al. 2003; Penman et al. 2008). Species richness starts to decline within a short time after fire while shrubs are increasing in numbers and density (Penman et al. 2008, 2009). This points to competition rather than burning as the cause of species loss and several studies have shown that a few common 'fire sensitive' shrubs proliferate at the expense of many smaller species in the absence of fire and/or grazing (e.g. Jurskis et al. 2003; Penman et al. 2008, 2009; Price and Morgan 2009; Jurskis 2011). This contributes to chronic tree decline, fire hazard problems and loss of rare biota (Jurskis 2011). Instead of basing prescribed fire intervals on disproven theories we should be looking at the timing of the processes of competition, nutrient cycling and fuel accumulation that cause these problems.

and;
The efficacy and longevity of fuel reduction by burning has been demonstrated empirically in the dry eucalypt forests of southwestern Australia. Boer et al. (2009) found that burning reduced the extent and incidence of wildfires over half a century and that the effect lasted for 6 years after burning. Since the three aspects of competition, vegetation/fuel mass/structure and nutrient cycling are inextricably linked, it is not surprising that they point to similar fire intervals (3-6 years) to maintain biodiversity, health and fire safety of dry eucalypt forests.

Stanton et al (2014) highlight changes in forest structure with inadequate mild fire in Queensland:

The critical factor in preventing the initiation of irreversible change in an open forest situation to a closed forest one is the maintenance of a grassy ground cover and this can only happen in the presence of regular fire. Grasses disappear when the shade of a developing understory reaches a critical level and this can be reached in a period as short as 10 years without fire. From that point, fires penetrate with increasing difficulty, and when they do, a grassy ground cover is slow to re-establish, requiring, as demonstrated in an experimental area near Paluma, repeated fires at 2- to 3-year intervals, to prevent the re-establishment of shading. This observation demonstrates a satisfactory explanation for why much of the bioregion is experiencing a widespread irruption of rainforest across broad areas of open forests and woodland within the bioregional landscape in the absence of regular fire.

and;

Briefly, it was discovered that after 3 or 4 years without burning the grassland collapsed in numerous small areas and quickly rotted, leaving bare areas that were often invaded by sedges. Where the sedges built up at the expense of the grass, fire frequency was reduced as the sedges were difficult to burn. Melaleuca seedlings, which easily established among the sedges, were frequently protected by them long enough to establish. These, if established in sufficient density, can have the longer term consequence of converting the grassland to a paperback woodland.

Others have looked at the importance of regular burning in relation to forest health and avoidance of eucalypt decline. Based on rates of Nitrogen (N) accumulation in the absence of fire and N removal by prescribed burning, Turner et al. (2008) suggests a return fire period of 5 years*:*

To maintain a stable C/N ratio with low mineral N production, a fire periodicity is required where N losses are about equivalent to N inputs. If inputs of N were about 12 kg N ha1 year1 and losses in low intensity fire were 65 kg N ha1, a period between fires of about 5 years would maintain stability. This would vary according to the fertility of the soil and the fire intensity.

Turner and Lambert (2005) note in their concluding comments:
It is proposed that dieback occurring in east coast eucalypt forests is a result of predisposition to nutritional imbalances. The imbalances are a result of the accumulation of both total and mineral nitrogen within the soil over extended periods of time. The increased nitrogen availability can lead to negative impacts on root and mycorrhizal development and/or biochemical changes within the tree, and this predisposes the trees to insect- and other damage. The changes in nitrogen availability are, in part, a result of understorey development together with differences in nutrient cycling patterns (relatively high quantities of nitrogen in low C:N ratio material) within this component of the ecosystem.

Burning and disturbance due to grazing reduce the impact of the understorey on overstorey health and growth, and also stabilise the pools and availability of nitrogen. Water stress can additionally affect both the availability of nutrients and the accumulation of amino acids, and this results in the trees being vulnerable to insect attack.

At the times that dieback symptoms are apparent on trees, the processes in the soil have been at a stage that may be termed 'negative' for at least ten years, if not longer. Hence, there is a significant lag between a change in soil conditions and dieback becoming obvious in the tree crowns.

The baseline or control is a 'normal' low-intensity fire cycle (3–6 y). Absence of burning is the equivalent of a treatment. Stands affected by dieback but in the final stages may be recoverable, but will probably require three or more fire cycles or the effects of continuous grazing to restructure the understorey and have an impact on soil nitrogen pools before any improvement in the health of the overstorey is observed. Modifications to the understorey (such as mechanical disturbance of weeds) under this model will exacerbate the rate of dieback.

The obvious presence of high insect populations is not the primary cause of dieback but is a result of sick trees sick roots sick soils.

As summarised well by Jurskis (2011):
There has been a resurgence in eucalypt decline, extensive wildfires and loss of species over recent decades with expansion of unmanaged conservation reserves and reduced prescribed burning

Other important words by Jurskis (2021) sum this issue up:

We need a coalition of traditional knowledge; black, white and brindle, with fairdinkum science to restore sustainable management across the landscape. It would save heaps of money and reduce the massive emissions from megafires which aren't brought to account because it doesn't suit our Lock It Up and Let It Burn 'conservation' paradigm.

The author considers that appropriate intervals between mild fires to maintain forest fuel load/ strata/ firebrands, community and firefighter safety, forest health and biodiversity range between 3-6 years for both dry and wet sclerophyll forests. Support for this is outlined below, noting there are a large number of other references.

3 Review of current fire intervals in NSW

Current fire intervals for planned burns and bushfires in NSW are outlined below.

3.1 Fire interval periods for vegetation formations adopted in in NSW

The NSW EPA (2021) report and link provides information in relation to fire intervals for vegetation formations for planned burns and bushfires in NSW:

https://www.soe.epa.nsw.gov.au/all-themes/land/fire

NSW State of Environment Fire Table 22.2 Fire intervals for NSW vegetation formations and proportions burnt during the 2019-20 fires outlines minimal and maximum fire intervals for NSW vegetation formations and proportions burnt during the 2019-20 fires. There are very very long fire intervals between prescribed burning events over most of NSW as outlined this table, with return maximum fire intervals of up to 60 years, likely longer with very low rates of prescribed burning being undertaken. The author understands these intervals also applies for bushfires.

Minimum fire intervals for vegetation formations

Minimum interval between fires for vegetation formations where the focus is managing for biodiversity (years). Minimum fire intervals range from 3 to 30 years, some include no fire. Minimum fire intervals of 15 years for Wet sclerophyll forests (grassy sub-formation) and 30 years for Wet sclerophyll forests (shrubby sub-formation) is way too excessive a timeframe between prescribed burning.

The document notes that *Minimum interval between fires where the focus is operational to reduce risk to human life and property (years)*. These intervals are absolute minimums for maintaining biodiversity, for asset protection zones within an operational firefighting context, as they provide little or no buffer for adequate seed production.*

These areas reducing the risk to human life and property would be much smaller in area than the forested areas across landscapes for managing biodiversity.

The minimum intervals for areas managing biodiversity only are much longer, a perverse approach to the author considering the long-term impacts of intense bushfires in these same areas to biodiversity, associated with high fuel loads and strata. Moist/ wet forests also have more rapid fuel accumulation that needs better considered and addressed.

And there is no consideration of intense bushfires and long bushfire runs impacting communities and fire fighters from forests 50 kilometres plus from communities, refer to the larger bushfires in NSW in 2019/ 20.

Maximum fire intervals for vegetation formations

Maximum fire interval (years) for vegetation formations range from no fire to 10 to 60 years, as outlined in Table 22.2. These are excessive, anything longer than 3-6 years for prescribed burning/ post bushfire burns is too long, taking into account all the factors that aren't being considered as outlined in this document.

Proportion of some vegetation associations were burnt in the 2019/ 20 bushfire firegrounds

It is noted in Table 22.2 of the SOE Fire report that large proportions of some vegetation associations were burnt in the NSW 2019/ 20 bushfire firegrounds:

- 51.24 % of Wet Sclerophyll (grassy sub formation); and
- 48.81 % of Wet Sclerophyll (shrubby sub formation).

These proportions were considerably higher than other vegetation associations outlined in Table 22.2 of the report. A major factor would likely be long fire intervals used for prescribed burning and bushfires, the threshold approach to fire management across the state (refer Section 3.2) and the increasing presence of eucalypt decline. There are likely other factors and the author doesn't have other detail in relation to these.

Issues in need of further explanation for the public

It is difficult for concerned members of the public to ascertain how and how often these maximum fire return intervals are being used in developing annual prescribed burning programs. It would be a good option if fuel

age mapping by last burn year (with both planned and bushfire detail) is provided across NSW annually to best assess what is happening across NSW forests.

It would be a good option if fuel age mapping by last burn year (with both planned and bushfire detail) is provided across NSW to best assess what is happening across NSW forests.

3.2 Consideration of NSW SOE vegetation fire interval issue mapping and information before and after the 2019/ 20 bushfires

NSW EPA (2021) NSW State of Environment (SOE) Fire report includes mapping information, but this information highlights a considerable range of concerns in regards to fire and fuel management in NSW. This information is highlighted within Map 22.2a, Map 22.2b and Table 22.3. The NSW EPA (2021) link provides information in relation to fire intervals for planned burning and bushfires in NSW:

https://www.soe.epa.nsw.gov.au/all-themes/land/fire

Comments in relation to the vegetation formation mapping and information:

In relation to **Map 22.2a of the SOE report, vegetation fire interval threshold status in 2019 before the 2019-20 NSW Black Summer fire season mapping**:

- There are very large areas of long unburnt forests across the east coast of NSW and it is totally clear this situation was not useful in regards to fire fighting along the east coast and the consequent large intense bushfires across many of these same areas. This is a Major Lesson Issue; it is essential that fuel is broken up and sound landscape burning programs are undertaken. Information from WA highlights that area annually burnt by bushfire escalates exponentially when the area of prescribed burning in a region falls below 8 percent per annum, burning about 8% per annum results in about 40 % of bushland carrying fuels 0 to 5 years old;
- There are very large areas of within threshold forests across eastern NSW, these are very large is size and not assisting with mosaic approaches in improve biodiversity. Questions include what fuel ages are within threshold, including what fuel age for each vegetation association; are fuel ages up to 40-60 years for differing associations within threshold; and if the fuel age is beyond 3 to 6 years, how can be that within a sound threshold to protect forests and ecosystems, communities, infrastructure and firefighters;
- Large areas around the Blue Mountains are marked as vulnerable, this isn't surprising considering the lack of regular prescribed burning in this very timbered area of NSW (and across NSW generally) and regular intense bushfires;
- Many western forests in the south of NSW are marked as long unburnt, why aren't these forests receive regular prescribed burns; and
- To the author this mapping highlights the very poor state of fire and fuel management.

In relation to **Map 22.2b of the SOE report, vegetation fire interval threshold status in 2020 after the 2019-20 NSW Black Summer fire season mapping**:

- There are a lot areas of long unburnt forests across the east coast of NSW following the 2019/ 20 bushfires;
- There are large areas of within threshold forests across eastern NSW, these are very large is size and not assisting with mosaic approaches in improve biodiversity. Questions include what fuel ages are within threshold, including what fuel age for each vegetation association; are fuel ages up to 40-60 years for differing associations within threshold; and if the fuel age is beyond 3-6 years, how can be that within a sound threshold to protect forests and ecosystems, communities, infrastructure and firefighters;
- Large areas of NSW are marked as vulnerable following the 2019/ 20 bushfires, this isn't surprising considering the lack of regular prescribed burning across NSW generally over a very long period prior to 2019/ 20and mega fires were coming. What is very concerning now, is that these locations are large contiguous areas of the same fuel age, will unlikely be burnt for a considerable period and there is a lot of dead fuel with very dense regrowth from intense bushfires of 2019/ 20. These areas are timebombs waiting to go off and further damage these vegetation types;
- Many western forests in the south of NSW are marked as long unburnt, why aren't these forests receive regular prescribed burns; and
- To the author this mapping highlights the very poor state of fire and fuel management.

In relation to **Table 22.3 of the SOE report, change in vegetation fire interval status before and after Black Summer fire information**:

- Many of the comments above relate to this table;
- Much of the NSW native forest vegetation of approximately 20 Million hectares is not included in the table, not sure why not;
- Long unburnt fuel areas went down from 3,074,500 hectares to 2,203,800 hectares, a reduction of 871,500 hectares, this would be larger with all forest data included. Fuel loads and strata would have been at very high levels and suppression very difficult to impossible in high intensity fuel areas. Long unburnt fuels do readily burn in many bushfires;
- Within threshold fuel areas went down from 2,599,700 hectares to 1,141,000 hectares, a reduction of 1,458,700 hectares, this would be larger with all forest data included. Fuel loads and strata would have been at very high levels and suppression very difficult to impossible in high intensity fuel areas. Within threshold fuels do readily burn in many bushfires; and
- From the author's perspective, it is likely any areas across NSW forests with fuels older 6 years old, is likely to burn in difficult bushfire conditions and is going to be difficult to put out, especially where there are multiple bushfires.

3.3 Consideration of NSW SOE vegetation fire interval issue text before and after the 2019/ 20 bushfires

NSW EPA (2021) NSW State of Environment Fire includes textural information in relation to fire and fuel management in NSW.

https://www.soe.epa.nsw.gov.au/all-themes/land/fire

The author has provided comment below each individual section of extracted text in bolded italics.

Fire is a natural part of the Australian landscape and much of the flora of NSW depends on fire to assist in its reproduction and growth. Altered fire regimes as a result of European settlement – too much or too little fire or fire of too high an intensity – have had a major detrimental impact on the integrity, structure and sustainability of most ecosystems and many threatened species.

Comment.

Agreed, there is too little lower intensity fire across NSW and SE Australia, in the case of NSW averaging 0.6 % of forests per year over the last 6 years.

Agreed, there are way too much intense bushfires across NSW and SE Australia. The impacts of these fires are huge in relation to structure, integrity, sustainability, flowering, tree health and biodiversity. Dead fuel and dense forest regrowth is resulting from many of these bushfires, further increasing bushfire hazards across large contiguous areas. Yet these critical issues receive minimal attention.

About 7% (5.5 million hectares) of NSW was burnt during the prolonged 2019–20 Black Summer fire season. The total area burnt was four times greater than the previous worst forest fires recorded in a fire season.

Over 450 threatened plant species and 293 threatened animal species occur in the footprint of the Black Summer fires. The prospects of long-term survival of a significant proportion of these species have been impacted by the fires.

Comment.

Para 1. This was an outcome experienced land and fire managers were expecting for a long time. These same land and fire managers haven't been listened to by inquiries or commissions. Fuel loads and ladders are increasing, there are large contiguous areas of old fuels, dead fuel and dense regrowth from intense bushfires areas are increasing and eucalypt decline is increasing fuel loads, all increasing bushfire hazards for the next round of disasters.

Para 2. Surely this alone highlights the importance of reviewing current minimal prescribed burning rates and approaches in NSW and SE Australia, but alas no, that doesn't appear to be the case.

Prior to the Black Summer fires, the fire interval status for vegetation communities was evenly spread – with about third each – within safe thresholds, or under pressure due to being too frequently burnt or insufficiently burnt. Following the fires, about 62% of all vegetation for which recent fire history is available is now under threat from too much burning and only 13% are within thresholds.

and:

Fire interval status 62% of all vegetation with fire history available is under pressure from too much burning following the 2019–20 Black Summer fires

Comment.

Spotlight Figure 22 of the report highlights that before the 2019/ 20 bushfires, approximately 35 % of all NSW forest vegetation with fire history available was under pressure. This figure would likely include bushfires over a certain period, but if this is based on the maximum fire intervals, this could be up to 60 years for some vegetation associations, but there is no information on what this period or periods is based on. This figure would likely include prescribed fire for a certain period/s, but there is no information what this period is based on. The author believes this approach is setting forests up for ongoing disasters.

This fire interval status notes 62% of all NSW forest vegetation with fire history available was under pressure from too much burning following the 2019–20 Black Summer fires appears unbelievably high, this means only 38 % or less of NSW forests is currently available for prescribed burning, noting a bit over a quarter of NSW (not all forests) was burnt during the NSW 2019/ 20 bushfires. The 62 % figure appears very suspect, likely based on excessive fire intervals. The author believes that it is no wonder megafires are occurring.

From the above, it is readily apparent that there are some major issues that need to be explained to the community, the basis of this needs to be publicly available information. Because of all the dense regrowth development from moderate-high intensity fires, there is urgent need for much more burning to restore open forests.

It is not clear how much of the fire history is missing.

There is too little lower intensity fire across NSW and SE Australia, in the case of NSW averaging 0.6 % of forests per year over the last 6 years. This inadequate prescribed burning is having massive impacts with increasing intense bushfires and is allowing eucalypt decline to increase.

The Spotlight figure 22 shows the change in status of vegetation fire intervals before and after the 2019–20 Black Summer fires. The time interval between fires is an indicator of the health of vegetation communities, with the recommended time interval, which varies for different vegetation communities, allowing for healthy regeneration and regrowth (apart from some specific communities, such as rainforest, where no fire is tolerated). If the time interval is not within the recommended threshold (i.e. it is too short or too long) this affects the condition and ultimately the integrity of the plant community.

Previously there was an even spread of fire interval status, but now they are strongly weighted towards overburning. This represents a fundamental shift in the ecological condition of vegetation communities and their response to fire.

Comment.

The above text notes that "The time interval between fires is an indicator of the health of vegetation communities". This may be true for repeat intense bushfires, but it is not true for low intensity burning which is happening at less than 1 % of forests per year in NSW, in the last 6 six years at 0.6 % of NSW forests. At that rate, it would take over 100 years to get through all forested areas with prescribed burning, noting some areas would not be burnt. Taking this into account, the comment "Previously there was an even spread of fire

interval status, but now they are strongly weighted towards overburning" is frankly not a fair reflection of the current situation, and there are many questions in relation to the magic box approach to how all this is calculated.

There is a massive problem in SE Australia/ NSW in relation to increasing eucalypt decline associated with inadequate low intensity burning programs.

Minimum fire intervals of 15 years for Wet sclerophyll forests (grassy sub-formation) and 30 years for Wet sclerophyll forests (shrubby sub-formation) is way too excessive a timeframe between prescribed burning and bushfires, especially considering the rapidity of fuel build up, damage from intense bushfires and eucalypt decline.

Maximum fire interval (years) ranges from no fire to 10 to 60 years as outlined in Table 22.2. Anything longer than 6 years is excessive, as noted note Boer et al 2009 WA low fuel maintenance effects of low intensity fires persist max 6 years (Jurskis 2011), especially considering the fuel build up, damage from intense bushfires and eucalypt decline.

On top of all this, there are large often contiguous areas of dead fuels and dense regrowth is resulting from many of the intense bushfires, further increasing bushfire hazards across large areas. A spiral of death fire management has been created

The key to achieving appropriate fire management is getting the balance right between maintaining natural ecosystems while ensuring community safety and protection of property, infrastructure and livestock.

All 76 recommendations from the NSW Bushfire inquiry announced in January 2020 were accepted by the NSW Government and around $460 million in funding allocated to their implementation in June 2020, including for new bushfire risk management plans, increased hazard reduction works, enhanced rapid response capacity, improved bushfire modelling and upgraded fire trails.

One of the principal tools for fire management is hazard reduction burning. The overall level of hazard reduction has increased over time but is quite variable from year to year, depending on need and favourable conditions.

Comment.
Para 1. The author considers that there is no current balance between maintaining natural ecosystems while ensuring community safety and protection of property, infrastructure and livestock. Communities/ ecosystems aren't being protected using adequate rates of prescribed burning across landscapes and community/ infrastructure protection is certainly not at adequate levels.

Para 2. The author questions where are all the new bushfire risk management plans, increased hazard reduction works, enhanced rapid response capacity, improved bushfire modelling and upgraded fire trails?

Hazard reduction hasn't increased, it is averaging 0.6 % of NSW forests over the last 6 years. The data for NSW over the last three years highlights:

- 90,089 hectares in 2022/ 23 (estimated 0.5 % (actually 0.045 %) of NSW forested area. Including 82,393 ha burning and 7,696 ha mechanical treatment;
- 44,642 hectares in 2021/ 22 (estimated 0.2 % of NSW forested area); and
- 176,499 hectares in 2020/ 21 (estimated 0.9 % of NSW forested area).

Para 3. From data available to the author hazard reduction has not increased over time and is not meeting planned targets.

Since European settlement and farming practices, patterns of how fire is managed have changed significantly. Land use and tenure regimes such as urbanisation, industrialisation, agriculture and protected areas have resulted in drastically altered fire regimes and unbalanced ecological systems. Today, these fire regimes and the growing impacts of climate change continue to pose significant hazards to life, property, heritage and the environment.

The principal aim of current fire management is to reduce the risk that fires pose to human life, property and cultural heritage. However, the key to appropriate management is achieving the right balance between ensuring community safety and the protection of property, infrastructure and livestock while maintaining benefits to natural ecosystems and biodiversity and our built, living and historic cultures.

Comment.

Para 1. This para is full of excuses. This doesn't discuss the required by law fire intervals and resultant fire regimes as discussed in this document. The author's opinion is that minimum and maximum fire intervals are way to excessive. Disastrous intense megafires are the outcome of the fire regimes being adopted in NSW and much of SE Australia.

Para 2. As noted above, the author considers that there is no current balance between maintaining natural ecosystems while ensuring community safety and protection of property, infrastructure and livestock. Ecosystems across landscapes aren't being protected using adequate rates of prescribed burning across landscapes and community/ infrastructure protection is certainly not at adequate levels.

Long bushfire runs are a critical outcome of the adopted approach of minimal prescribed burning, minimal mechanical treatment, minimal fire breaks, minimal burning of ridges across landscapes and other necessary measures.

The intense 2019/ 20 bushfires had huge impacts on Aboriginal and European heritage. The current adopted fire regime and fire intervals doesn't assist heritage protection.

Altered fire regimes have been described as a threat to over 80% of the state's vegetation classes (see topic). High-frequency fire has been identified as a significant cause of biodiversity loss in NSW and is listed as a key threatening process under the **NSW Biodiversity Conservation Act 2016*.***

Comment.
Aboriginal burning was regular burning practiced across landscapes over 60,000 years. Prescribed burning has been around 1 % or less for a very long period for much of SE Australia and certainly hasn't been practiced at high frequency, there are a number of urban locations crying out for another prescribed burn after very long waits. So it is unclear what this text is aimed at. What is causing the impacts are intense bushfires associated with miniscule rates of low intensity burning.

Information extracted:

- ***Over 450 threatened plant species, listed under the NSW Biodiversity Conservation Act 2016, the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 and/or in the IUCN's Red List of Threatened Species are known to have been affected by burning. More than 60% of these species are considered at high or medium risk of decline because of impacts of the 2019–20 fires.***
- ***Approximately 640 plant species endemics to NSW but not currently listed as threatened are also expected to have been burnt in the 2019–20 fire season. More than half of these (52%) were found to be at high or medium risk of decline as a result (Bushfire Hub 2020b).***
- ***Of the total 114 Threatened Ecological Communities (TECs) under the NSW Biodiversity Conservation Act, 87 were wholly or partly within the footprint of the 2019–20 Black Summer fires.***
- ***There are 293 threatened animal species or populations with records in the footprint of the 2019–20 Black Summer fires (DPIE 2020)***

Comment.
This is the outcome you get with prescribed burning less than 1 % of forested areas and a focus on very long minimum and maximum fire intervals. Ecosystems aren't being protected using adequate rates of prescribed burning across landscapes and community/ infrastructure/ environmental asset protection is certainly not at adequate levels.

3.4 Consideration of individual threatened species and communities fire interval issues

Requirements with-the-Threatened-Species-Hazard-Reduction-Lists (NSW RFS Threatened species hazard reduction lists on the web) are outlined below:

- Threatened Species Hazard Reduction List-Part1-Plants-06-04-2017. No fire more than once every 5 to 25 years or no fires at all.
- Threatened Species Hazard Reduction List-Part2-Animals. This includes species with many different requirements, from no fire to other site-specific requirements.
- Threatened Species Hazard Reduction List-Part3-ThreatenedEcologicalCommunities This outlines hazard reduction arrangements for a large number of (Endangered Ecological Communities (EEC's) from 5-25 years, one 2 years and many nil burning.

There are differing time intervals for vegetation associations, flora, fauna and EEC's across NSW. It is extremely hard to manage prescribed burning under this complex fire interval approach. And these intervals fail to address a large number of important issues as outlined in Section 3.1.

And the whole concept of different intervals for same vegetation associations in different zones is very questionable. All burning of Eucalypt forests should be 3-6 years for fuel build up, forest health, community and firefighter safety and biodiversity.

From the authors perspective, there is a prescriptive, restrictive and narrow focus in many south eastern states, including NSW, in regards to inadequate low intensity burning of forested areas across landscapes. Not applying low intensity fire over periods longer than 3 to 6 years clearly increases risks to these same threatened species when the regular intense bushfires come around yet again from failure to manage fuel loads and strata across landscapes.

3.5 Other concern issues that need to be considered in NSW to improve fire mitigation and reduce intense bushfire disasters

There is further information contained in the document "NSW Government Office of Environment and Heritage (2013) (refer link), specifically Section 5.5 Managing the future fire mix (with this author comments non bolded):

https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Parks-reserves-and-protected-areas/Fire/living-with-fire-in-nsw-national-parks-strategy-2012-2021-120690.pdf

Section 5.5. ***The primary fire management objectives for NPWS include managing the risk of wildfire impacts to life and property and managing fire regimes to maintain and enhance biodiversity. Given that land and fire management practices are already under pressure in the face of present wildfire risk levels, and due to the potential increase in the threat of wildfires due to climate change, some changes to current land and fire management practice will be necessary if these escalating risks are to be managed.***

Comment.
The adopted fire management approaches are clearly not working well, there is inadequate fire mitigation/ prescribed burning/ mechanical thinning in NSW forests and disastrous intense bushfires are occurring over much of NSW, as outlined in this review.

The above notes "some changes to current land and fire management practice will be necessary if these escalating risks are to be managed". The author agrees, hasn't seen any major actions to address these changes and certainly there are no real changes in rates of prescribed burning. The author believes considerable changes to current land and fire management practice would be needed.

Section 5.5. ***In order to manage escalating risks to these objectives a combination of strategic prescribed burning and rapid response to wildfires will be used. Over the last 20 years the average ratio of area burnt by wildfire to prescribed burns on NPWS lands is about 5:1. Over the next 10 years NPWS aims to decrease the area burnt on park from wildfires relative to the area burnt from prescribed burning, and to continue to reduce the average size of wildfires.***

Comment

The author strongly suggests that the average ratio of area burnt by wildfire to prescribed burns on NPWS lands over the recent periods would be much higher than 5:1, taking into account extensive bushfires across NSW over the last 10 years. This was going to happen when prescribed burning remains at such low values around or less than 1 % of NSW forests per year.

Section 5.5. ***By strategically implementing prescribed burning, NPWS can meet its legislative drivers and plan where, when and how to use fire to achieve its management objectives and at what cost, thus giving NPWS greater control over the intensity, timing, location and costs associated with fire management. Using the state-wide bushfire zoning system and its reserve fire management strategies, NPWS will prioritise hazard reduction activities in APZs and SFAZs to reduce the risks to life and property and to provide strategic areas of fire protection to aid containment, while maintaining biodiversity values and thresholds in LMZs which make up 90% of the parks and reserves. Where the variety of fire regimes is reduced, intervention with prescribed burning can be used, particularly in dry forest, woodland and native grassland ecosystems, to increase variation in vegetation structure and seral stages, to improve habitat variety and biodiversity outcomes.***

Comment.
It is a major concern that 90 % of parks and reserves in LMZs (Land Management Zone) receive low priority for prescribed burning, the priority is given being for APZs (Asset Protection zones) and SFAZs (Strategic Fire Advantage Zones). The adopted approach results in high fuel loads over large areas and make containment very difficult. The author suggests that prescribed burning needs to increase to 8 to 10 % of forested areas annually as used in WA, including LMZs and dry and moist forest types.

Section 5.5. ***By using improved detection techniques and implementing an enhanced rapid response program, NPWS can react quickly to ignitions in parks and reserves and manage them accordingly.***

Comment.
In relation to firefighting, this is extremely difficult where prescribed burning in NSW conservation areas and generally across NSW is very low and this puts fire fighter and community safety at risk. Access and regular prescribed burning of fire access locations is critical.

Section 5.5. ***If prescribed burning is planned strategically, to link other recently burnt areas or naturally less flammable areas and align with fire trail networks and areas of mechanical fuel reduction, there will be improved opportunities to contain or reduce the extent of drought season wildfires in the future.***

Comment
This is sensible, but not going to happen with very small rates of prescribed burning and limited fire mitigation reducing the extent of opportunities to contain bushfires.

Overall key comments:
There are learning opportunities in relation to issues identified above, including:

- there is inadequate fire mitigation in forests and disastrous intense bushfires are occurring all over NSW forested areas;
- it is a major concern that 90 % of parks and reserves in LMZs (Land Management Zone) receive low priority for prescribed burning, the priority is given being for APZs (Asset Protection zones) and SFAZs (Strategic Fire Advantage Zones); and
- In relation to firefighting, this is extremely difficult where prescribed burning in NSW conservation areas and generally across NSW is very low and this puts fire fighter and community safety at risk. Access and regular prescribed burning of fire access locations is critical.

4 Assessment of current failures in relation to fire intervals, fire management and fire outcomes

These matters are outlined in four sections below, Sections 4.1 to 4.4.

4.1 A broad assessment of failure areas in relation to restrictive fire interval criteria in NSW

The author considers that there are many failure areas in relation to restrictive fire interval criteria in NSW and other factors restricting prescribed burning. Failure areas include:

1. Very long theoretical fire intervals for vegetation associations between prescribed burning over most of NSW as outlined in Table 22.2, with return fire intervals up to 60 years, likely longer with very low rates of prescribed burning. The author considers that regular burning every 3-6 years is needed across forested landscapes to reduce fuel loads and strata, intense bushfires and better protect sensitive areas, this reduces fuel loads and strata, firebrands and reduces eucalypt decline;
2. There are very large contiguous areas of high fuel load forests for vegetation formations/ associations, fuelling a disaster that came about in 2019/ 20 from long fire intervals and large contiguous forested areas of same thresholds. An example was the long fire interval location mapping in NSW prior to the 2019/ 20 bushfires (Map 22.2a). There are very large contiguous areas that have not received any burning for up to 60 years, possibly longer, if this is what threshold data is highlighting. It would be much better all round and safer if there was a mosaic of fuel ages of regular fire across different parts of the landscape;
3. There is little to no consideration of different growth and fuel load accumulation rates in each of the vegetation associations, moist/ wet forests have rapid fuel accumulation but then very long fire intervals;
4. There is no consideration of fire behaviour nor difficulty of bushfire suppression in the mostly long to very long fire intervals between burning;
5. Fire regimes are now vastly different to regular Aboriginal burning practices across landscapes;
6. Current policies and regulations in NSW exclude low intensity burning from much of the landscape including by fire intervals, wilderness, old growth, rare ecosystems, habitats of rare plants or animals and drainage lines as outlined in Section 3.4;
7. Just considering biodiversity alone, there are differing fire intervals lists and periods for vegetation associations, flora, fauna and EEC intervals across NSW;
8. There are differing time intervals for vegetation associations, flora, fauna and EEC's across NSW. It is extremely hard to manage prescribed burning under this complex fire interval approach. And these intervals fail to address a large number of important issues as outlined in Section 3.1;
9. Fire interval thinking is focussed on biodiversity and is wrong based on silly theories disproven by real data (Jurskis 2011) and there is inadequate focus on community and infrastructure safety, if in any doubt took into the impacts on towns and cities in 2019/ 20, 2009 and 2003. In relation to current town safety and risk management plans, the author suggests that there is little chance most of them would work in a repeat of the 2019/ 20 bushfires;
10. Current fire interval thinking does not address the increasing costs of disasters on communities and individuals nor the increasing cost of living and disaster insurance;
11. With the fire interval approach, there is no real consideration of understorey build up over time associated with eucalypt decline and also resulting from intense bushfires, and consequent impacts on intensity and rate of spread. The current bushfire prescribed model is basically a spiral of death and destruction model, as minimal prescribed burning occurs, and large areas of intense bushfires occur with consequent development of dead trees and dense understories and as eucalypt decline expands, the spiral of death and destruction continues;
12. There are increased fire brand risks associated with very limited prescribed burning, long fire intervals and little focus on firebrand risk forests;
13. There is inadequate focus on firefighter safety in forested areas, the vast majority of areas outside the town areas where intervals are less;
14. As a result of the above matters, there are consequent intense bushfires and huge impacts on flora, fauna, communities, the environment, fire fighters etc;
15. There is decreased crown health and flowering after intense bushfires over very long periods, and large numbers of tree deaths, a result of the minimum lower intensity burning and long intervals;
16. There is declining forest health, increasing forest understories with forested landscapes less and less bushfire resilient as a result of very long fire intervals; and
17. There is inadequate consideration of ongoing impacts of large intense bushfires on the Australian climate and greenhouse gas generation. Fasullo et al. (2023) notes "The climate response to biomass burning emissions from the 2019–2020 Australian wildfire season is estimated from two 30-

member ensembles using CESM2: one of which incorporates observed wildfire emissions and one that does not. In response to the fires, an increase in biomass aerosol burdens across the southern hemisphere is simulated through late 2019 and early 2020, accompanied by an enhancement of cloud albedo, particularly in the southeastern subtropical Pacific Ocean. In turn, the surface cools, the boundary layer dries, and the moist static energy of the low-level flow into the equatorial Pacific is reduced. In response, the intertropical convergence zone migrates northward and sea surface temperature in the Niño3.4 region cools, with coupled feed- backs amplifying the cooling. A subsequent multiyear ensemble mean cooling of the tropical Pacific is simulated through the end of 2021, suggesting an important contribution to the 2020–2022 strong La Niña events". In other words, there are ongoing impacts from intense bushfires in SE Australia in the following years, these La Nina impacts need to be considered.

These 17 failure areas highlight the need for urgent review of the current fire interval approach in NSW.

There needs to be greater accountability on reducing intense bushfires and the disastrous impacts, utilising regular burning practices, increasing community safety, fire fighter safety and actioning eucalypt decline in revised and shorter fire intervals.

There is little obvious input from on the ground bushfire specialists, foresters, landowners, firefighting associations, fire fighters and community people apart from ecologists in the development of fire interval criteria and prescriptions for fire management. These issues need to be thoroughly examined by more than just ecologists and sensible fire intervals and fire prescriptions urgently developed.

There is little apparent openness of process to communities and the public in relation to fire intervals and planning sensible burning regimes and setting thresholds.

4.2 A broad assessment of failures of approach in relation to undertaking forest fuel mitigation/ prescribed burning in South Eastern Australia

The author considers that there and many failures of approach in relation to managing prescribed burning in South Eastern Australia, including:

1. There is inadequate fire mitigation in forests, often around 1 % of forested areas or less, and due to this, disastrous intense bushfires are occurring all over large areas of SE Australia forested areas. On top of this, there has been a focus on suppression at the expense of mitigation;
2. There is inadequate use of opportunities to increase low intensity burning and mechanical treatment operations across private lands, noting a level of 4,270 hectares treated across NSW in 2022/23. Using a forest area of 6,937,308 hectares on private lands, this represents 0.06 % of forest area treated per year. Another major issue is the removal of grazing from many state forest areas. There are major apparent opportunities for cooperative fuel reduction and maintenance programs between private landholders and government;
3. There is a lot of bureaucracy in requesting, prioritising and implementing prescribed burning works;
4. There are a lot of barriers in relation to prescribed burning and sound fire management;
5. There is little strategic mosaic burning across landscapes to break country up, so fuel areas aren't being broken up;
6. Community and fire fighter safety is poorly considered in relation to the scale and locations of prescribed burning, and long bushfire runs are poorly considered in reducing bushfire risks;
7. In relation to firefighting, this is extremely difficult where prescribed burning in NSW conservation areas, and generally across NSW, is at very low levels, and this puts fire fighter and community safety at risk. Access and regular prescribed burning of fire access locations is critical;
8. It is a major concern that 90 % of parks and reserves in LMZs (Land Management Zone) receive low priority for prescribed burning, the priority is given being for APZs (Asset Protection zones) and SFAZs (Strategic Fire Advantage Zones);
9. Prescribed burning along evacuation routes is inadequate; and
10. Inadequate use of opportunities to expand the use of small aircraft, helicopters and drones for low intensity burning operations, using placed grid patterns for fires to join up in the cool of the evening and unburnt patches. There are potential opportunities for a number of prescribed burning drones with individual brigades/ mitigation officers and fire regions.

There are many opportunities to address these failure areas.

A good practical example of better fire management is that undertaken by Australian Wildlife Conservancy (2020), it is understood that this is from outside of SE Australia, but useful:

AWC's team of fire practitioners and our Dambimangari and Wilinggin Partners in the Kimberley have gone to extreme lengths to ensure that this year's prescribed burning program is able to proceed, despite the restrictions imposed by the current COVID-19 lockdown in Western Australia.

This is Australia's largest non-government fire management program. This year, AWC is working with our Wilinggin and Dambimangari Aboriginal Corporation Partners to carry out prescribed aerial burning over an area equivalent to the size of Tasmania – about 6.5 million hectares.

At the time of writing, fourteen staff and Rangers are working on-site as part of this intensive two-month effort.

Strategically, burning the country at this time of year is central to AWC's conservation land management across northern Australia's tropical savannas and continues our Partners' tradition of right-way fire. By reducing fuel loads and breaking up homogeneous patches of older vegetation, prescribed burns in the early dry season substantially reduce the threat of high intensity, large-scale wildfires igniting later in the year.

Historically, large uncontrolled wildfires have been a leading cause for wildlife declines and AWC research has shown that wildfires compound the impacts of feral cats and feral herbivores on native animals.

AWC's fire management program has halved the extent of wildfire in properties we manage across northern Australia.

Early dry season burns tend to be cooler and burn more patchily than late dry season wildfires. Over 15 years at Mornington Wildlife Sanctuary, AWC's ecological survey program has demonstrated that small mammals, seed-eating birds and birds that rely on creek-side vegetation have responded positively to the reduction in wildfires.

By reducing large-scale wildfires, early dry season burning in this way also leads to a reduction in greenhouse gas emissions. In the central Kimberley alone, AWC's EcoFire project (comprising prescribed burning on AWC sanctuaries and commercial grazing land), is estimated to avert the emission of up to 75,000 tonnes of CO2e into the atmosphere annually – the equivalent of taking 18,750 cars off the road for a year.

On Charnley River-Artesian Range Wildlife Sanctuary, the team has already dropped more than 20,000 incendiaries to complete the planned burns.

When the 2020 burning program wraps up later this month, the total distance flown across the Kimberley will amount to around 40,000 kilometres, with a total of 220,000 incendiaries dropped.

4.3 A broad assessment of failures of approach in relation to fire outcomes in South Eastern Australia

The author considers that there and many failures of approach in relation to fire outcomes in South Eastern Australia:

1. Community and fire fighter safety is poorly considered in relation to the scale and locations of prescribed burning, and long bushfire runs are poorly considered in reducing bushfire risks. In relation to firefighting, this is extremely difficult where prescribed burning in NSW conservation areas, and generally across NSW, is at very low levels, and this puts fire fighter and community safety at risk. Access and regular prescribed burning of fire access locations is critical;
2. If we don't increase prescribed burning and reduce long fire intervals, Australia will continue to get more of the same intense bushfires. Intense impacts of bushfires include forest ecosystems, fauna, water quality, waterways, fish, air quality and heritage. It is clear to the author that these factors haven't been addressed adequately by government at any stage in NSW's European history;
3. In addition, most of the forests with extensive hot bushfires of 2019/ 20 are now 4 plus years old and in many cases, there are extensive areas of dead trees, heavy grass/ bark etc fuel and dense understories contributing to a potential timebomb in many bushfire seasons and a spiral of death;

4. Community and fire fighter safety is poorly considered in relation to the scale and locations of prescribed burning, and long bushfire runs are poorly considered in reducing bushfire risks. In relation to firefighting, this is extremely difficult where prescribed burning in NSW conservation areas, and generally across NSW, is at very low levels, and this puts fire fighter and community safety at risk. Access and regular prescribed burning of fire access locations is critical;
5. There is often difficulty of suppression of bushfires in high fuel load and strata areas;
6. There is inadequate prescribed burning and mechanical fuel treatment around areas in need of protection and in difficult fire years this will increase likelihood of bushfires entering fire sensitive areas. Treated areas much broader than a narrow ring of confidence treatment are necessary;
7. Before the 2019-20 NSW Black Summer fire season, there were very large areas of long unburnt forests across the east coast of NSW and it is totally clear this situation was not useful in regards to firefighting along the east coast and the consequent large intense bushfires across many of these same areas. This is a Major Lesson Issue; it is essential that fuel is broken up and sound landscape burning programs are undertaken. Information from WA highlights that area annually burnt by bushfire escalates exponentially when the area of prescribed burning in a region falls below 8 percent per annum, burning about 8% per annum results in about 40 % of bushland carrying fuels 0 to 5 years old;
8. In relation to areas of within threshold forests across eastern NSW, these have been very large is size and not mosaic burning approaches in improve biodiversity. The obvious question is what fuel ages are within threshold, including what fuel age for each vegetation association? Are fuel ages up to 40-60 years for differing associations within threshold, how does this address fire behaviour and intensity? If the fuel age is beyond 3-6 years, how that can be within a sound threshold to protect forests and ecosystems, communities, infrastructure and firefighters?;
9. There are a considerable number of research papers and authors who have identified exclusion of low intensity mild fire as the major cause of eucalypt decline across a number of Australian native forests and woodlands outlined in the references used list;
10. Recent fuels resulting from the 2019/ 20 bushfires in northern NSW, including dead fuels, heavy undergrowth fuels and heavy grass/ litter fuels are set to fuel the next intense bushfires, providing a ladder into the weakened tree crowns. These areas are not safe conditions for firefighters, especially in adverse conditions. One description of a recent bushfire through these regrowth areas was “like a knife through butter”;
11. It is a major concern that 90 % of parks and reserves in LMZs (Land Management Zone) receive low priority for prescribed burning, the priority is given being for APZs (Asset Protection zones) and SFAZs (Strategic Fire Advantage Zones). The adopted approach results in high fuel loads over large areas and make containment very difficult. The author suggests that prescribed burning needs to increase to 8 to 10 % of forested areas annually as used in WA, including LMZs and dry and moist forest types;
12. Poor flora and fauna outcomes from intense bushfires, as outlined in Section 3.4; and
13. The statement within Section 3.5 “If prescribed burning is planned strategically, to link other recently burnt areas or naturally less flammable areas and align with fire trail networks and areas of mechanical fuel reduction, there will be improved opportunities to contain or reduce the extent of drought season wildfires in the future” clearly isn’t working.

There are many opportunities to address these failure areas.

4.4 Reduction in forest flora and fauna habitat quality with inadequate low intensity fire management

As noted in WWF (2020) in total, they estimate that almost 3 billion native vertebrates are likely to have been present within the disastrous 2019-20 bushfire areas. Their estimate comprised approximately 143 million mammals, 2.46 billion reptiles, 181 million birds and 51 million frogs.

National Parks and Wildlife Service (2021) highlight the following in relation to extinctions across tenures:

There is evidence that the overall decline in biodiversity in NSW is occurring even in the national park estate. Key threats affecting threatened species populations in national parks include feral predators and other feral animals; invasive weeds; changed fire regimes; and a range of impacts associated with climate change. On park declines are occurring, or have occurred, in a range of threatened species including small- to medium-sized mammals, woodland birds, koalas and gliders, frogs and a range of plant species.

Onfray (2023) lists specific example of species not doing well in conservation reserves across Eastern Australia associated with inadequate use of low intensity fire:

- Mount Imlay mallee, Connie's guinea flower and Imlay boronia;
- The helmeted honeyeater and Leadbeater's possum;
- The orange-bellied parrot;
- The forty-spotted pardalote;
- The southern brown bandicoot and long-nosed potaroo;
- The greater glider;
- The Herbert River ringtail possum;
- River red gums;
- The southern corroboree frog;
- The little penguin; and
- The golden-shouldered parrot.

Onfray (2023) notes in wrapping up:
The examples above provide a stark reality check about the nation's obsession of placing millions of hectares of land into reserves and failing to manage them. Protecting species needs active human management, which has occurred for millennia in this country. To argue otherwise is to say that Aborigines didn't exist and did not play any role in the make-up of our country before Europeans arrived.

The SETA (2022 a) highlights concerning information in regards to management of the Imlay mallee on NPWS land.

- Natural establishment from seed appears to be a very rare event, as no seedling or juveniles have ever been observed on Mount Imlay since the species came to the attention of science in 1977;
- The single population of Imlay mallee had not been burned for many years prior to the 2019–20 bushfires. Surveys following those fires have observed approximately 90 percent of individuals resprouting from lignotubers, with the other approximately 10 percent having been killed by the intense fire. No seedlings have been observed since the fires;
- Between 2000 and the 2019–20 bushfires the population declined by approximately 10 percent with another 10 percent perishing in the fires, bringing the number of mature individuals down to about 48 (G Wright 2021. pers comm 19 November). This represents a total population reduction over the past 44 years (1977 to 2021) of over 31 percent; and
- Surveys conducted on 6 November 2020 (after the bushfires) counted 48 mature individuals. All of these were resprouting from the base after being severely burnt.

The author notes that the threatened species hazard reduction interval for the Imlay mallee allows for no burning where this species is located. So it appears that this species does and will only receive hot bushfires.

SETA (2022 b) highlights:

A landscape scale of bushfire mitigation must be implemented again, if the scale and impact of high intensity bushfires on biodiversity and human lives and assets, including timber production from native forests and plantations, is to be reduced in future drought years.

As extracted from Morgan et al. (2020) in relation to the reduction in low intensity burning and more intense bushfires:

The risks to human lives, property, biodiversity and the environment associated with wildfire are increasing in south-eastern Australia due to climate change, and the wider use of prescribed burning is essential for managing these. The increasing extent and occurrence of wildfire disasters in the region indicates that current fire management will not sustain the full range of ecosystem processes and biodiversity, nor reduce to an acceptable level the impact of wildfires on human lives and property. There is compelling evidence for the greater use of prescribed burning to reduce wildfire risks and impacts, rather than committing increasing resources to wildfire suppression.

Jurskis et al. (2003) highlight:

Current policies and regulations in NSW exclude low intensity burning from much of the landscape including by fire intervals, wilderness, old growth, rare ecosystems, habitats of rare plants or animals and drainage lines. This approach focusses on individuals, target species and fire frequency and … something missing …. assessment of the consequences of not burning. This policy environment reinforces the shift towards more widespread high intensity fire regimes.

State of Queensland (Department of Environment and Science) (2022) provide a useful document which assessed lessons from the 2019–2020 bushfires, including a case study below:

Case study: 2019–2020 bushfires in Gondwana rainforests of Southeast Queensland—Scenic Rim and Main Range

Bushfires burnt large areas of national park across the Scenic Rim area in the bushfires of 2019 2020. Post-fire assessments found that regular burning of eucalypt forests had reduced fire severity during these bushfires. Forests with regimes of frequent planned burns were more resilient to the bushfires than forests where planned burns were infrequent.

Two years after the fire, frequently-burned forest at Mount Lindesay was in better condition than adjacent forests that experienced more-limited planned burns. This pattern was also seen at Spicers Gap section of Main Range National Park, where regularly burnt eucalypt forest remained in better health than adjacent unburnt forest.

These responses demonstrate that regular planned burning is important to mitigating the impacts of bushfires.

On a landscape scale, frequent planned burning when there is good soil moisture can greatly mitigate the potential severity and widespread damage from bushfires in drought years. Frequent burning helps maintain an open, structured grassy forest with minimal saplings.

These findings correspond with international research concluding that planned burning lowers the intensity of bushfires.

The findings in regards to frequent planned burning can greatly mitigate the potential severity from bushfires in drought years and maintain open, structured grassy forest with minimal saplings is valuable information.

5 Provision of important fire interval information for improved fire management and a better-informed public

There is important information in relation to fire intervals for planned burning and bushfires that is not available, and needs to be, so there is optimum forest fire management and the public is adequately informed in relation to these issues. This important information includes:

1. How minimum fire return intervals are being used in developing annual prescribed burning programs;
2. How and how often maximum fire return intervals are being used in developing annual prescribed burning programs;
3. How minimum and maximum fire return intervals for all burning are used in setting thresholds, including long unburnt, within threshold, vulnerable and too frequently burnt and information that highlights how this process works for prescribed burning and bushfires;
4. How dead fuel with very dense regrowth from intense bushfires of 2019/ 20 is and will be managed, when will it start and on what scale;
5. How eucalypt decline is changing forests, reducing forest health and increasing bushfire risks, including increasing understorey growth and density;
6. How minimum and maximum fire return intervals timeframes for prescribed burning and bushfires work effectively in relation to community and fire fighter safety protection, closer to communities and in the landscape, noting the very long fire interval timeframes involved, rapid fuel buildup and firebrand generation. Note minimum fire intervals of 15 years for Wet sclerophyll forests (grassy sub-formation) and 30 years for Wet sclerophyll forests (shrubby sub-formation) and maximum fire interval (years) ranges from no fire to 10 to 60 years, as outlined in Table 22.2. Anything longer than 3 to 6 years appears excessive, especially considering the fuel build up, damage from intense bushfires and eucalypt decline;
7. Recommended review of the large proportions of some vegetation associations that were burnt in the NSW 2019/ 20 bushfire firegrounds, particularly 51.24 % of Wet Sclerophyll (grassy sub formation) and 48.81 % of Wet Sclerophyll (shrubby sub formation). These proportions were considerably higher than other vegetation associations outlined in Table 22.2. A major factor would likely be long fire intervals used for prescribed burning and bushfires, the threshold approach to fire management and the increasing presence of eucalypt decline;
8. How minimum and maximum fire return intervals for prescribed burning and bushfires work effectively in relation to control of fire behaviour through management of fuel loads and strata and setting up fire resilient forests;
9. How minimum and maximum fire return intervals for prescribed burning and bushfires work effectively in relation to avoidance of large area intense bushfire disasters and repeat intense bushfire disasters;
10. How minimum and maximum fire return intervals for prescribed burning and bushfires work effectively in relation to government, community, landholder and individual fire management accountabilities;
11. How minimum and maximum fire return intervals for prescribed burning and bushfires work effectively in relation to very large contiguous areas of same threshold forests across eastern NSW (especially pre and also post 2019/ 20 bushfires), these areas are very large is size and not assisting with mosaic fuel approaches of assistance for fighting bushfires or improved biodiversity;
12. Further information in relation to “High-frequency fire has been identified as a significant cause of biodiversity loss in NSW and is listed as a key threatening process under the NSW Biodiversity Conservation Act 2016”, noting the fire regime is failing to inadequate low intensity fire, long threshold timeframes and consequent intense bushfires over long periods*;*
13. Detail in relation to how much of the fire history is missing;
14. Explanation the focus on individual threatened species and communities at the expense of whole forested landscapes with heavy fuel loads and consequent intense bushfire disasters and large community and ecosystem impacts; and
15. Provision of fuel age mapping by last burn year (with both planned burn and bushfire detail) is provided to best assess what is happening across forests.

The author would appreciate provision of this information, across 15 areas, to the public and communities across NSW/ SE Australia which are affected by bushfires. The information is of critical importance to our forest environment, adjacent communities and firefighters.

6 Conclusions

This broad review has been prepared to review forest fire intervals for planned burns and bushfires across South Eastern Australia. This review is urgent, as summarised well by Jurskis (2011) 13 years ago:
There has been a resurgence in eucalypt decline, extensive wildfires and loss of species over recent decades with expansion of unmanaged conservation reserves and reduced prescribed burning

Preferred optimum fire intervals for forest burning is outlined in Section 2.

Current fire intervals in NSW are reviewed In detail in Section 3, including Sections 3.1 to 3.5.

The author considers that current fire intervals, fire management and fire outcomes in NSW are not working effectively, as outlined in Sections 4.1 to 4.4. Section 4.1 is a broad assessment of failure areas in relation to restrictive fire interval criteria in NSW, identifying 17 failure areas.

It is suggested that there needs to be a total review of current fire intervals, noting current theoretical fire intervals set at very long timeframes that allows the build-up of high fuel loads and strata across landscapes and restricts low intensity burning across landscapes.

There are differing time intervals for vegetation associations, flora species, fauna species and EEC's across NSW. It is extremely hard to manage prescribed burning under this complex fire interval approach considering all these matters and the very long fire intervals involved. And importantly, these fire intervals fail to address a large number of important issues as outlined in Section 4.1.

Large proportions of some vegetation associations that were burnt in the NSW 2019/ 20 bushfire firegrounds were wet sclerophyll forest types which are listed with very long fire intervals and have rapid rates of fuel accumulation. This includes 51.24 % of Wet Sclerophyll (grassy sub formation) and 48.81 % of Wet Sclerophyll (shrubby sub formation). These proportions were considerably higher than other vegetation associations burnt in the NSW 2019/ 20 bushfire.

Another major concern relates to the use of fire interval threshold categories used in NSW SOE reports, including long unburnt, within threshold, vulnerable and too frequently burnt. There is no apparent information publicly available as to how minimum and maximum fire return intervals for all burning are used in setting these thresholds, including long unburnt, within threshold, vulnerable and too frequently burnt and information that highlights how this process works for both prescribed burning and bushfires. The author questions what fuel ages are within threshold, including what fuel age for each vegetation association or does the maximum interval apply? Another question relates to are fuel ages up to 40-60 years for differing associations within threshold? If the fuel age is beyond 3-6 years, the author seriously questions how that can be within a sound threshold to protect forests and ecosystems, communities, infrastructure and firefighters.

In relation to the use of thresholds, there are large areas of contiguous similar threshold forest areas across eastern NSW, these are mapped in Map 22.2a and b of NSW SOE (2021). These are often very large is size, this was a large factor in the rapid spread of the 2019/ 20 bushfires in long unburnt and within threshold areas. The author suggests that a much better approach is using mosaic burning approaches to improve fire management and biodiversity across landscapes.

There is a considerable amount of important information in relation to fire intervals for planned burns and bushfires that is not available, and needs to be, so there is optimum forest fire management and the public is adequately informed in relation to these issues. The information that the author considers should be available is outlined in Section 5.

Resilient safe, healthy landscapes is a critical issue being considered in many countries across the world, including mitigation/ adaptive management work in the US on resilient landscapes in relation to bushfires. Considering the extent of chronic eucalypt decline and thick understories in many SE Australian forests, strategies and actions to address these major issues across forested landscapes and reduce intense bushfire risks are opportune but overdue, using regular low intensity maintenance burning and mechanical treatment of forests. Current theoretical fire intervals are not going to get us close to establishing and maintaining resilient forested landscapes in SE Australia.

The safety of fire fighters entering forested areas, particularly where there are high fuel loads, is a critical issue, and is a major risk area and has been for a long time. The same observation applies in relation to the

protection of communities, including towns and cities, the safety of communities needs addition mitigation and focussed discussion with communities. These matters and opportunities are raised in order to optimise the safety of fire fighters, communities, forests, the environment and heritage sites using regular low intensity fire and sensible fire interval prescriptions.

The author considers that there should be major reviews of bureaucratic, theoretical and excessive bushfire and prescribed burning fire interval prescriptions by states, taking into account the above factors. Considering all the bushfire disasters that have occurred over a long period, and imminent future disasters, this is not an unreasonable suggestion, let alone adopting the practical opportunities available to address the issues. The author also considers that there should be a review of the low use of prescribed burning in LMZ's which make up 90% of the parks and reserves in NSW. The author considers that the ring of confidence approach doesn't work.

The Office of Environment and Heritage (2013) reference in Section 3.5 notes "some changes to current land and fire management practice will be necessary if these escalating risks are to be managed" but the author hasn't seen any major actions to address these changes and certainly no real changes in prescribed burning. As well, management of fire and fuel needs to apply across all land tenures to be effective.

Other important words by Jurskis (2021) highlights the importance of urgent action to improve fire management:

We need a coalition of traditional knowledge; black, white and brindle, with fairdinkum science to restore sustainable management across the landscape. It would save heaps of money and reduce the massive emissions from megafires which aren't brought to account because it doesn't suit our Lock It Up and Let It Burn 'conservation' paradigm.

The author considers that regular burning every 3 to 6 years is needed across forested landscapes to reduce fuel loads and strata, intense bushfires and better protect sensitive areas, this reduces fuel loads and strata, firebrands and also reduces eucalypt decline. Following high intensity burning and consequent dense regrowth in many cases, prescribed burns need to be undertaken as soon as possible after these intense bushfires to maintain previous forest structures and reduce massive fuel loads and strata.

The author considers that bushfire and prescribed burning, bushfire and fire interval prescriptions across forested landscapes should be redesigned into one practical fire prescription document, taking into account all the factors listed below:

1. A key focus on addressing the failures of current fire and bushfire fire and fire interval management across all land tenures and across landscapes;
2. A key focus on improved control of fire behaviour through management of fuel loads and strata and setting up fire resilient forests across all land tenures. Moist/ wet forests also have more rapid fuel accumulation that needs better considered and addressed. Firebrands are another critical issue that need improved consideration;
3. A focus on recognising that the increasingly extensive high intensity fire regimes and eucalypt decline are consequences of fire exclusion;
4. A focus on reducing large area intense bushfire disasters and repeat intense bushfire disasters across all land tenures. There are way too much intense bushfires across NSW and SE Australia, the impacts of these fires are huge in relation to structure, integrity, sustainability, flowering, tree health and biodiversity. Dead fuel and dense forest regrowth is resulting from many of these bushfires, further increasing bushfire hazards across large contiguous areas. Yet these critical issues receive minimal attention;
5. A focus on avoidance of and management of large volumes of dead fuel and dense regrowth from intense bushfires across all land tenures;
6. A focus on improved planning for worst case bushfires, bushfire seasons, environmental impacts and costs of intense bushfires across all land tenures;
7. A key focus on setting up sound fire regimes for forests now and into the future and less focus on going back 60 plus years looking at past fire histories and intervals based on excessive fire return intervals;
8. A key focus on community, infrastructure and firefighter protection;
9. A key focus on government, community, landholder and individual fire management accountabilities across all land tenures;

10. Improved cooperative/ alliance approaches in firefighting and prescribed burning across all land tenures;
11. A key focus on cultural burning considerations is addressed;
12. A key focus on forested landscapes broken up by prescribed burning and treating 10 % of forested landscapes per year. Focus on mosaic burning with fuels of different ages across forested landscapes and avoidance of large areas of older contiguous fuels, strata and firebrands;
13. A key focus on establishment and maintenance of resilient forested landscapes, with healthy forests and maintenance of good condition vegetation associations;
14. A key focus on improving and maintaining forest condition, health and structures using regular low intensity fire as required;
15. A key focus on establishment of improved habitat for flora and fauna using low intensity fire and using mosaic burning approaches for benefit;
16. Undertaking a review of the current focus on long interval requirements for individual threatened species and communities, at the expense of whole forested landscapes, with consequent heavy fuel loads and consequent intense bushfire disasters. Also undertaking a review of the policies of no low intensity fire in wilderness are other areas, this approach comes at a major cost when intense bushfires come around;
17. A key focus of improved protection of sensitive areas and heritage areas using low intensity burning;
18. A key focus on improved consideration on reducing major air quality and greenhouse impacts associated with intense, large area and long duration bushfires, and consequent deaths, such as during 2019/ 20; and
19. A key focus on improved consideration of research by Fasullo et al. (2023) in relation to the climate response to biomass burning emissions from the 2019**–**2020 Australian wildfire season subsequent multiyear ensemble mean cooling of the tropical Pacific is simulated through the end of 2021, suggesting an important contribution to the 2020**–**2022 strong La Niña events.

Its past time to incorporate the other important factors that haven't been adequately considered into fire prescriptions, including reducing large area intense bushfires, adequately considering the impacts of large area intense bushfires, considering fuel build up, considering fire behaviour and suppression difficulty, adequately considering community and fire safety, addressing eucalypt decline and the other concerns outlined in this review.

The author considers that this review is an essential component of learning from ongoing disastrous and intense bushfires and consequent impacts on communities, infrastructure, assets, plantations and the environment.

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