

North East Forest Alliance submission to Environmental Protection Agency Draft Climate Change Policy and Climate Change Action Plan

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In August 2021, NSW Land and Environment Court ordered the NSW Environment Protection Authority (EPA) to develop environmental quality objectives, guidelines and policies to ensure the protection of the environment in NSW from climate change. According to the judgement, the EPA have a duty to adapt their objectives, guidelines and policies to address emerging threats to the environment. These Draft Climate Change Policy and Climate Change Action Plan do nothing to ensure the protection of forests in NSW from climate change, rather they display an intent to ignore the already abundant studies and research available to them while by their inaction they allow ongoing degradation of forests while they threaten the survival of numerous species and ecosystems.

Over decades there have been numerous studies and scientific papers that identify the increasing vulnerability of, and risk to, threatened species and ecosystems due to the accelerating impacts from climate change, including from the 2019/20 fires. Despite these growing threats, for over a decade the EPA have overseen progressive weakening of the Integrated Forestry Operations Approval (IFOA) and Private Native Forestry (PNF) Codes of Practice, and thereby increased the vulnerability of threatened species and ecosystems to climate change.

The EPA have failed their legal obligations to acknowledge the threats to forest species and ecosystems from climate change, or identify actions to mitigate impacts, in their proposed Climate Change Policy and Climate Change Action Plan,

It is claimed that the Comprehensive Regional Assessment and RFAs were negotiated in a “pre climate change” environment and consequently did not consider the issue. This is a nonsense as climate change was a significant issue by then. The 1992 ‘National Forest Policy Statement, a new focus for Australia’s forests’ states:

The global focus culminated in the United Nations Conference on the Environment and Development in Rio de Janeiro in June 1992, at which Australia endorsed the Global Statement of Principles on Forests and signed a number of conventions relating to Biological Diversity and Climate Change.

...

In developing the nature conservation reserve system and forest management approaches in other public native forests, each Government will, where possible, ensure that effective corridor systems link reserves, refuges and areas with a relatively large range of altitudinal and other geographical variation so as to take into account the possible impacts of climate change.

In relation to climate change, the Governments acknowledge the need, identified in the National Greenhouse Response Strategy, to manage forests so as to maintain or increase their 'carbon sink' capacity and to minimise the emission of greenhouse gases from forest activities.

NEFA tried to have climate change taken into account in the Comprehensive Regional Assessment in 1997, though we gained no support from agencies.

The fact that climate change was a recognised issue by the time North East NSW RFA was signed in 2000 is evidenced by 'anthropogenic climate change' being listed as a key threatening process to NSW biodiversity in the same year under the Threatened Species Conservation Act 1995. In 2001 "Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases" was identified by the Commonwealth as Key Threatening Process

Thereafter concern about the impacts of climate change rapidly escalated. For example in 2002 the Biological Diversity Advisory Committee held a workshop on 'Climate change impacts on biodiversity in Australia' (Hilbert. and Chilcott 2003), identifying climate change as a threat to numerous species and the need to take action and apply the principal of adaptive management.

In 2008, the Garnaut Review reported that 'significant changes in ecosystems are occurring on all continents and in most oceans, and that anthropogenic climate change is having a significant impact on these systems globally and on some continents', identifying:

Natural biological systems in Australia have been dramatically altered by human actions. The added stressors from climate change would exacerbate existing environmental problems...

Some species can tolerate the changes where they are or adapt to change. Other species will move to more suitable habitat if possible. Some species may dwindle in numbers in situ, threatening their viability as a species and ultimately leading to extinction.

Also in 2008 the CSIRO report, *Implications of climate change for Australia's National Reserve System* identifies 'eight key implications' for biodiversity conservation and the national reserve system arising from climate change. Importantly, a number of these point out that climate change has significant implications for conservation objectives generally and, in particular, how 'comprehensiveness', 'adequacy' and 'representativeness' are understood and achieved, noting:

... The question of adequacy is much more challenging. In general, larger areas and more populations of species would probably be required to ensure the same viability for species as could be expected without climate change. However, it is almost certain that some species will become extinct in the wild.

...

... Thus climate change can be expected to affect both levels of adequacy but also the concept of adequacy. Climate change will alter the nature of threats, species ecology and population dynamics, species interactions, species distributions and ecosystems as a whole (thus habitat). It will also alter land use and ecosystems in neighbouring areas and environmental variability that will contribute to viability.

Therefore the adequacy of protected areas in a region will almost certainly be affected by climate change (Araújo et al. 2004); and in most cases species will be facing increased variability and threat which will decrease their viability and the adequacy of the protected areas in which they live. In general, it can be expected that greater conservation effort may be required to ensure current levels of adequacy are maintained for given species; this might include: increasing the number of protected populations, the size of habitat areas, decreasing threats, and more "sympathetic management" in adjacent areas.

In 2009 the Commonwealth Government published *Australia's Biodiversity and Climate Change: A strategic assessment of the vulnerability of Australia's biodiversity to climate change* (a report of some 303 pages). The Summary Report for Policy Makers reports that [e]ffects of climate change

[on Australia's unique biodiversity] are already discernible at the genetic, species and ecosystem levels in many parts of the continent and coastal seas'. Among other things, the report makes the following general comment about the implications of the 'dramatic rate 'at which anthropogenic climate change is occurring:

From the perspective of impacts on biodiversity, a crucial point is that the rate of projected climate change is almost certainly unprecedented for the last several million years (Steffen et al. 2004). ... Selective pressure on many organisms, particularly long-lived organisms, will be extreme - especially as the incidence and severity of extreme events will increase even more rapidly than climatic means. Such dramatic rates of change have prompted some assessments to suggest that the Earth will experience a massive wave of extinctions this century, with rates of species loss about 1000 times background levels (MA 2005).

In 2010 DECCW published 'Priorities for Biodiversity Adaptation to Climate Change, Statement of Intent in response to the listing of Anthropogenic Climate Change as a Key Threatening Process under the NSW Threatened Species Conservation Act 1995'. The Summary of actions (2010–15) includes:

- 1.1 Develop research priorities for biodiversity adaptation to climate change with advice from the Climate Change Science Research Network*
- 1.2 Review and evaluate current long-term monitoring programs and develop guidance for considering climate change impacts in monitoring design*
- ...*
- 2.6 Identify characteristics and locations of climate refugia in NSW bioregions and prioritise these in criteria for protection*
- ...*
- 3.1 Review land management programs (fire, invasive species and water management) in light of potential climate change impacts, bringing together key researchers and operational program staff*
- ...*
- 3.5 Assess the vulnerability of species and ecosystems at high risk from climate change in NSW rangelands*
- ...*
- 4.1 Refine and expand existing modelling approaches and decision support tools (for terrestrial and aquatic biodiversity) to incorporate climate change impacts ...*

The Statement of Intent identifies it is fundamentally important to “integrate climate change considerations into regional biodiversity conservation and land-use planning and regulation”. It identifies the need for monitoring and a range of actions including:

It is important to identify and protect any known fire and climate refugia, and relict habitats, which may provide important habitat allowing species to persist in the face of climatic stress. However, the characteristics of refugia differ between regions, depending on their scale and the species that target them. For example, refuge areas might include sites that provide microhabitats that are moister and cooler than the surrounding environment (such as deep south-facing gullies in hilly terrain), drought refugia (for example areas with reliable surface or groundwater and wetlands that persist during severe droughts), and areas sheltered from fire (such as rocky or granitic outcrops) (Mackey et al. 2002; Byrne 2007; Dunlop and Brown 2008).

...
Protecting remnant native vegetation across the landscape will play a key role in the capacity of biodiversity to persist in the face of a changing climate. For example, remnant habitats in fragmented areas may provide refugia or stepping stones for dispersal to sites

that may become suitable habitat in the future (Auld and Keith 2009). Maintaining or improving the condition of existing vegetation is likely to be more productive than trying to restore land that has been substantially altered. In NSW, the clearing of native vegetation is primarily regulated through the Native Vegetation Act 2003. The objects of the Act include ending broad-scale clearing unless it improves or maintains environmental outcomes, protecting native vegetation of high conservation value, improving the condition of existing vegetation, and encouraging revegetation of land. ...

Despite the growing awareness of climate change, the DECCW/EPA continued to ignore it in relation to forestry and forestry regulation. There were no attempts to establish a monitoring program or to adapt the RFA, IFOA or Threatened Species Licence (TSL) to take into account the growing awareness of the likely consequences. The only changes to the TSL (ie in 2013) were to remove or weaken protections for threatened species.

The EPA chose to ignore climate change and do nothing about it, it was “gonna” do something but never did. The public submissions to the 5, 10 and 15 year RFA reviews highlighted climate change as a major issue that was being ignored, with the independent reviews highlighting the need to address the issue.

The ‘Final Report on Progress with Implementation of NSW Regional Forest Agreements: Report of Independent Assessor November 2009’ identified

However, other than timeframes, a key issue raised in the majority of submissions was climate change or more particularly, the fact that the Draft Report does not consider climate change. As indicated previously RFAs were negotiated in a “pre climate change” environment and consequently could not feature in the Draft Report. This is not to deny that climate change is a major issue. However any forest-related climate change matters must fall into the broader climate change policy consideration by both the NSW and Commonwealth governments. Impacts on the RFAs will need to be considered in that process.

...

However climate issues should not be ignored. They provide genuine opportunities for forest related economic activity and but also pose potential threats to the long term sustainability of forests generally.

Forest agencies and other interested parties need to engage in the broader climate change policy development processes to ensure forest issues are factored in to these policies. While it may be tempting to wait, early engagement is important to ensure appropriate consideration.

From an RFA perspective there may be some scope to deal with climate change matters through adaptive management and continuous improvement in practice. For instance, it is at least theoretically possible to build climate change considerations into forest models. Codes of Practice can be modified to be more climate-sensitive. New forest based economic opportunities are likely to emerge. In any process of this nature existing commitments would need to be taken into account.

Accommodating climate change impacts will not be easy or without cost. However early responses are likely to maximise opportunity and allow any negative impacts to be reduced.

The ‘Independent review of the report on progress with the implementation of the New South Wales Regional Forest Agreements for the second and third five-yearly reviews 2004 – 2014’ identified:

The reviewer has made a number of recommendations for the Parties to consider. These are listed in section 2.4 of this report and address such things as:

...

- improved adaptive management approaches to prepare for risks such as climate change, bush fires, pest invasions and ecological changes

2.2.2 Key issues raised in the submissions

The key issues raised in the submissions were:

...

The RFAs were written several decades ago and do not include a process for adapting to the findings of research or to other changed circumstances over that time. They do not take into account modern environmental perspectives, international standards and or make any consideration for climate change. The National Forest Policy Statement 1992, that underpins the RFAs, is out-of-date.

2.3 General comments

This section comprises general comments made by the reviewer.

...

2.3.2 Native forest logging

... The submissions also highlight the potential impact of climate change on logging operations in increasing the risk to conservation values.

... However, the reviewer believes a more thorough review is required to properly assess the future of the industry. Key issues for review are the risks that come with climate change, the reported overall decline in the conservation value of native forests, the declining log supply, the value of the forest for carbon storage and a contemporary study of the socio-economic position of relevant rural communities.

...

Recommendation – The Parties conduct a contemporary review of the native forest timber industry considering the effect of climate change, the overall conservation status of the forest, the socio- economic position of relevant rural communities and support for the industry.

2.3.4 Climate change and risk

The RFAs and the Report make a passing mention of climate change and the associated risks. Predicted hotter and drier conditions for NSW are likely to affect all values in both State forest and conservation reserves. This is likely to increase pressure on ecological sustainability, with damage compounding when the forest is disturbed. A key risk is the potential for more frequent high intensity bushfires over large areas.

Recommendation – The Parties ensure future RFAs fully consider the risks associated with climate change and agencies plan, monitor and report on changes made to forest management practice to adapt to the changing environment.

The NSW Government's 2017 "NSW Regional Forest Agreements, A report on progress with implementation of the New South Wales Regional Forest Agreements Second and third five-yearly reviews July 2004 to June 2014, A report on the implementation of the North East, Eden and Southern Regional Forest Agreements" failed to consider climate change except in the context of Forestry Corporation propaganda on carbon sequestration.

In regards to Climate Change the "NSW Regional Forest Agreements – Assessment of matters" (NSW and Commonwealth 2018) only considered carbon storage in State Forests and timber products, with the assessment limited to DPI-forestry studies, which are at odds with numerous other studies. The failure to consider the known and growing threat of climate change to species, ecosystems, forest health and future timber production is an astounding omission.

In 2001 "Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases" is identified by Commonwealth as Key Threatening Process, yet the "NSW Regional Forest Agreements – Assessment of matters" (NSW and Commonwealth 2018) considers it Not Applicable, stating (p85):

NA - Commonwealth, States and Territories have actions underway to abate this Key Threatening Process and therefore a threat abatement plan is not considered a feasible, effective or efficient way to abate the process.

In its submission, the North East Forest Alliance objected strongly to the proposed Environment Protection and Biodiversity Conservation Amendment (Regional Forest Agreements) Bill 2020, including on the grounds that the NE RFA:

effectively ignores the issue of climate change and how this affects the increasing vulnerability of forests to dieback, extinctions, droughts, heatwaves and wildfires, and how these threats necessitate a total reappraisal of how we manage forests to help mitigate climate change and withstand the increasing threats to species and ecosystems. NEFA considers the highest value of forests is for carbon sequestration and storage, while maintaining native species.

There is no consideration of Climate Change impacts on species or ecosystems anywhere in the RFA or CIFOA processes. In another "gonna" statement the 'Joint Australian and New South Wales Government response to the Independent review of the report on progress with the implementation of the New South Wales Regional Forest Agreements for the second and third five-yearly reviews 2004-2014 August 2018' claims they will do something sometime in the future, stating:

The Parties agree that NSW RFAs should include commitments to consider and respond to the risks associated with climate change, and this is reflected in the renewed NSW RFAs. The Parties agree that climate change is having and will continue to have diverse and significant impacts in New South Wales. Rising temperatures and sea levels, changes in rainfall quantity and seasonality as well as changes in fire regimes and water quality, will have wide-ranging impacts on biodiversity and will intensify existing threats such as habitat loss, weeds, pest animals and drought. The projected increases in intensity and frequency of extreme events such as bushfire, droughts, floods and storms could have a profound influence on forest management. Climate change is also a serious threat to native species and ecosystems and is expected to be an ongoing challenge to their effective conservation.

The NSW Government agrees that agencies will continue to plan, monitor and report on changes made to forest management practices to adapt to the changing environment and note that the NSW Government has committed substantial additional funding from 2018/19 for a Forest Monitoring Program. This will align with NSW's strategic objective to provide tools and strategies for land managers across all NSW land tenures. NSW is committed to the integration of climate change adaptation and mitigation into biodiversity conservation measures and the management of the forest estate across NSW through:

- identifying dynamic risk management avenues and adaptation pathways to minimise the loss of biodiversity and biodiversity values and maximise adaptive capacity across the landscape*
- integrating adaptation pathways into Species Management Plans, management of*

high conservation value assets and Fire Management Plans across the landscape

- *increasing knowledge of adaptation management for species and ecosystems across the landscape*
- *developing guidelines and guidance materials to support adaptation management across the landscape*
- *identifying and integrating climate change considerations into the monitoring and evaluation requirements for the IFOAs on State Forests*
- *assessing climate change risks, and integrate adaptation responses into FCNSW Forest Management System to maintain the objectives of ESFM*
- *pursuing management opportunities that maximise socioeconomic, carbon sequestration and other benefits that flow from forests*
- *considering mitigation actions and opportunities across the forest estate to generate improved greenhouse gas outcomes.*

For decades the NSW Government and the EPA have ignored the growing evidence of the climate heating impacts on forest species, ecosystems and threatening processes, such as Bell Miner Associated Dieback, droughts, heatwaves and wildfires. After decades of abrogation of their responsibilities, and the devastation of the 2019/20 drought and bushfires, now they are once again “gonna” do something, or at least have a pretence of doing something sometime in the future as they continue business as usual.

The 2022 draft “EPA Climate Change Policy, The NSW Environment Protection Authority’s policy for addressing climate change and protecting the environment” has a single entry relating to forestry:

Emissions due to land use, land-use change and forestry can either be an emission source (positive emissions) or sink (negative emissions) - EPA has a role in regulating some forestry activities (e.g. native forestry).

The EPA has the gall to claim:

We recognise that many of our licensees are already forging ahead of mandated requirements, in response to expectations from shareholders, financial institutions, customers and the broader community. Equally, we acknowledge that many of our licensees are already disclosing and addressing their exposure to climate-related risks and investing resources to reduce greenhouse gas emissions, as this makes good business sense. We’ll listen to our licensees to understand their climate approaches, and provide support to enable change where this is needed.

This is just policy wanking, with nothing substantive or meaningful proposed, just more of the same abrogation of duty and climate inaction.

The EPA’s 2022 Draft ‘Climate Change Action Plan 2022–25’ is no better as it ignores the issue of landclearing and proposes nothing to redress this problem, despite recognising:

Rehabilitating or extending forested areas on regulated sites sequesters carbon, reducing net greenhouse gas emissions. It also provides ground cover, improving drought tolerance and resilience to climate change. This action helps protect biodiversity and provides other ecosystem services, such as helping to reduce soil loss from erosion and improving water quality.

It is no better regarding the EPA’s statutory responsibilities for public and private forestry, simply claiming it will continue business as usual, identifying as **Existing actions the EPA will continue and strengthen**

Ensure climate risks are considered in native forestry via the Forest Monitoring and Improvement Program

This is elaborated upon, including the statements:

The EPA is responsible for the compliance and enforcement of native forestry operations; however, the NSW Government is responsible for the environmental regulations that apply. While native forests can act as long-term carbon storage and sequestration, the health of native forests and the biodiversity they support are both increasingly vulnerable to the impacts of climate change, particularly fire, pests and pathogens, drought, floods and higher-intensity rainfall.

The EPA will continue to work with the NSW Natural Resources Commission, Regional NSW and the Forestry Corporation of NSW as part of the FMIP to ensure climate risks are identified and consequences are appropriately managed in the Integrated Forestry Operations Approvals and Private Native Forestry Codes of Practice.

So the EPA is abrogating its statutory role to the NSW Government, where it is in effect saying it will continue to collaborate in the “gonna” culture of taking no action to redress climate change in its forestry regulation.

Specific recommendations

Loss of habitat

The EPA needs to acknowledge that climate change is having a profound impact of the habitat available for a plethora of native species, including many that are already threatened by other processes, including logging and landclearing. They need to recognise that such species require enhanced habitat protection, including the identification and protection of climatic refugia. There is no time to waste as climate heating gains momentum as there is already enough information to identify many of these species, needed improvements to mitigation measures, and priority areas for protection as climatic refugia. The EPA must act now.

Protecting forests is climate action

It is essential that the current structure of native forests, and their current carbon storage is identified with a reasonable level of accuracy across all tenures, and separately reported on within the land use, land use change and forestry (LULUCF) sector.

Stopping logging of north-east NSW's public forests will avoid the emission of 820,000 tonnes of CO₂ per annum from tree biomass, and the creation of legacy emissions of 700,000 tonnes of CO₂ per annum that will be realised over decades as logs left in the forest decay and wood used in buildings reach the end of its useful life. Protecting the half a million hectares of north-east NSWs public native forests currently available for logging would allow them to sequester in the order of an additional 2.7 million tonnes of CO₂ per annum. The EPA needs to acknowledge that stopping logging of public native forests will increase carbon sequestration and storage and thereby make a significant and immediate difference in this current climate emergency.

Stopping burning forests for electricity

The EPA needs to recognise that creating a market for burning native forests for electricity will increase logging intensity and log removal, and the rapid release of carbon from coarse woody debris that would otherwise be left in the forest to slowly decompose over decades.

The EPA must ensure that all actual carbon emissions from burning wood for electricity are fully disclosed and considered, with any offsets clearly and separately distinguished.

The burning question.

The EPA needs to recognise that the 2019-20 fires, and accompanying drought, had a major impact on forest species and ecosystems, leaving many in a heightened state of vulnerability and at increased risk of extinction, and thus necessitating a permanent increase in protection. Requirements include implementing and rehabilitating 100m buffers around rainforest.

The EPA needs to recognise that logging makes forests more vulnerable to wildfires and increases their flammability by drying them, increasing fuel loads, promoting more flammable species, and changing forest structure. This includes increasing the risks of canopy fires by reducing canopy height, increasing tree density and increasing fuel connectivity from the ground into the canopy.

Running down soil carbon.

So in response to this evidence of declining Soil Organic Carbon (SOC) due to climate change, what has EPA done to ensure “forest managers will have to implement appropriate soil carbon-enhancing strategies to maintain current SOC levels”? How have they changed the CIFOA or PNF Code of Practice to increase retention of SOC? Despite being made aware of this problem they have done nothing.

We are fast running out of time.

The EPA needs to recognise that trees are increasing sickening and dying as the result of increasing droughts and heatwaves generated by global warming. This problem is aggravated by a variety of stressors on tree health, including logging, grazing and weed invasion. As evidenced by the increasing severity of droughts, heatwaves, and wildfires we are perilously close to a cascading series of feedbacks that cause the irreversible decline of forest ecosystems and the release of vast quantities of carbon stored in forest vegetation and soils into the atmosphere, making them into carbon sources rather than sinks. As shown by the 2019-20 fires we don't have any time to waste.

Bell Miner Associate Dieback

Given the abundant evidence that logging is the primary cause of Bell Miner Associated Dieback, that re-logging affected forests makes it worse, and that climate change is increasing tree stress and thus dieback, it is well past time that the EPA stopped turning a blind eye to the logging of BMAD affected and susceptible forests, and begins promoting restoration. If logging is to be allowed, it needs to be on a case by case basis, where lantana and Bell Miners are surveyed before the logging and monitored for five years afterwards. In keeping with the principle of adaptive management the results must be analysed, any needed corrective actions taken, and methods altered to minimise impacts before being trialled again.

As the current aerial mapping is subjective and does not provide a reliable basis for identifying the current extent of BMAD or to be able to monitor changes over time, it is recommended that the worst BMAD affected areas be subject to objective and repeatable mapping using High Resolution Multi-spectral imagery and ALS Lidar to:

- accurately identify the current extent of BMAD affected and susceptible forests
- provide a baseline from which to assess changes over time
- identify the variables affecting BMAD distribution
- quantify the accuracy of current mapping and other remote sensing technologies
- monitor the success of rehabilitation works.

It is reprehensible that despite the public monies spent of rehabilitation works on both public and private lands over the past 20 years that only three studies have monitored the outcomes of treatments on BMAD affected forests in north east NSW, and that for the two studies undertaken on State forests the Forestry Corporation has been allowed to largely suppress and ignore the unfavourable results. In order to better understand the causes of BMAD and assess the effectiveness and costs of rehabilitation, the Mount Lindesay and Donaldson trials need to be updated, and independent and transparent lantana (and other problem plant) removal trials need to be undertaken, using manual methods that minimise disturbance, with clear objectives, monitoring and reporting requirements.

1. Loss of habitat

The need to account for climate change's impacts on species habitat, physiology and distribution has long been recognised, but ignored in the NSW forest processes, including by the EPA. NEFA tried to have climate change taken into account by adapting fauna models that relied upon climatic variables in the Comprehensive Regional Assessment in 1997, though we gained no support from agencies.

Despite many national Recovery Plans identify the need to account for climate change, as demonstrated above, the EPA have ignored this threat, and in particular anticipated habitat loss and range contractions, in identifying prescriptions for them. To the contrary the EPA have collaborated in removing and weakening prescriptions for many threatened species over the past decade.

The National Recovery Plan for the Stuttering Frog *Mixophyes balbus* (Hunter and Gillespie 2011) identifies climate change as a threat:

Steffen et al. (2009) identifies frogs as the terrestrial vertebrates possibly most at risk from climate change in Australia. Frogs typically have a life cycle that is strongly governed by climatic variables, particularly temperature and rainfall (Duellmann & Trueb 1996). Hence, changes in climatic variables are likely to have a strong influence on the viability and distribution of frog populations. While the influence of climate change is well documented for pond breeding amphibians (Pounds et al. 2006; Steffen et al. 2009; MacNally et al. 2009; Bickford et al. 2010), there is little information on the influence of this process on stream breeding species such as the Stuttering Frog. Several aspects of the Stuttering Frog's life cycle are likely to be strongly influenced by climate, including calling and breeding activity, capacity to move and forage and whether certain habitat types are suitable. For instance, large numbers of Stuttering Frogs have been observed actively moving over the ground after heavy rainfall events (Mahony 1993).

The impact of climate change in south-eastern Australia is likely to result in overall increasing temperatures, decreasing rainfall and increasing evaporation, which is likely to reduce the availability of suitable habitat for Stuttering Frogs. During drought conditions, smaller streams typically used by the species for breeding are no longer suitable, due to reduced flow rates (Mahony 1993). Lower rainfall is also likely to decrease mobility above ground, reducing chances for finding a mate and dispersal between populations and habitats. As such, rapid climate change is likely to be a major threat to the Stuttering Frog. Climate change may also operate synergistically with other threatening factors, such as habitat disturbance or disease, to exacerbate their impacts on the species.

The National Recovery Plan for the Swift Parrot *Lathamus discolor* Recovery Plan (2011) states: *Loss of nesting and foraging habitat from climate change, caused by anthropogenic emissions of greenhouse gases, is likely to pose a significant threat to the Swift Parrot. The*

Swift Parrot has been identified by Bennett et al. (1991) as potentially having suitable climatic conditions within its current range reduced by 50% in Victoria as a result of increased temperatures (3 degrees Celsius) due to global warming (based on bioclimatic models only). Brereton et al. (1995) identified the Swift Parrot as being particularly vulnerable to changes in spatial and temporal distribution of its habitats. Climate change in Australia may affect the geographic range, migration patterns, physiology and abundance of species (such as the Swift Parrot) as well as the phenology and community composition of their habitats (Chambers et al. 2005). Climate change management requires both domestic and international action to stop further accumulation of anthropogenic greenhouse gases. Although management of this global issue is beyond the scope of this plan, long-term monitoring of the species in conjunction with climate monitoring stations may be needed to understand the sensitivities of the Swift Parrot to climate change. Such a monitoring program may provide valuable insights and a basis for future adaptive conservation management strategies. The cumulative effects of other threats together with climate change need to be considered for effective and adaptive long-term management of the Swift Parrot.

2.2□	Monitor and manage for climate change□	□	□
2.2a□	Establish a climate change monitoring program to provide a basis for future adaptive conservation management. □	3□	Swift Parrot monitoring sites identified and established in association with climate monitoring stations throughout the range of the species to provide a basis for adaptive climate change conservation management plans. □
2.2b□	Investigate the potential impact of climate change on the Swift Parrot and its habitat. □	1□	Spatial and temporal climate change models produced for the Swift Parrot based on species records, habitat mapping and bio-climatic models throughout the range of the species. ¶ Review the potential influence of climate change on the species and identify future management strategies to address this issue. □

The 2016 National Recovery Plan for the Spotted-tailed Quoll *Dasyurus maculatus* (DELWP 2016) identifies for climate change:

Climate changes that are predicted to occur as a consequence of increasing greenhouse gas levels in the atmosphere are likely to result in habitat modification (Howden et al. 2003), with fragmented populations of the northern subspecies of the Spotted-tailed Quoll that occupy highland rainforest habitats being particularly at risk (Burnett 2001; Jones et al. 2003). Habitat models have suggested that a 1°C increase in average temperatures will decrease the area of this habitat type by 50% (Hilbert et al. 2001). It is estimated that by 2030 the annual temperature across Australia will have risen by 1.0 °C (above 1990 temperatures), with a warming of 0.7–0.9 °C in coastal areas and 1–1.2 °C inland. A substantial increase in fire weather risk is also likely across most sites in south-eastern Australia (CSIRO: http://www.climatechangeinaustralia.gov.au/technical_report.php). Climate change also has the potential to extend the range of pest species such as the Cane Toad. As a result an increased number of Spotted-tailed Quoll populations would be exposed to this poisonous species (Burnett 1997; Andrew 2005).

One of the recovery actions is "Determine the likely impact of climate change on Spotted-tailed Quoll populations".

For Greater Glider the 2016 'Conservation Advice *Petauroides volans greater glider*'. identifies climate change as a severe threat:

Biophysical modelling indicates a severe range contraction for the northern subspecies (Kearney et al., 2010). Occupancy modelling indicates that the degree of site occupancy is associated with vegetation lushness and terrain wetness (Lumsden et al., 2013). Water stress affects growth in forest eucalypts (Matusick et al., 2013) and the availability of browse, and higher temperatures may cause heat stress and mortality (Vic SAC2015)

The 'National Recovery Plan for the Regent Honeyeater (*Anthochaera phrygia*), Commonwealth of Australia 2016', under 10 Social and economic considerations states:

Climate change also threatens the regent honeyeater's habitat through both increased risk of drought and fire and altered flowering patterns, potentially leading to further habitat loss and degradation. Threats from climate change can only be addressed through efforts to make regent honeyeater populations and their habitat more resilient.

The 2017 Conservation Advice for *Mixophyes fleayi* (Fleay's frog) includes as **Information and research priorities**:

Improve understanding of how climate change could impact Fleay's frog due to altered temperatures, rainfall, environmental stressors and diseases

These Recovery Plans are just a sample of the numerous reports and scientific papers that have identified the need to take into account the increasing vulnerability of species and ecosystems to climate heating, that the EPA have ignored in their relentless attrition of logging prescriptions for threatened species. This is evidence that has been before the EPA for a long-time.

Hoffmann et. al. (2019) identify the long evolution of modelling of climate impacts on species:

Early on, CLIMEX modelling was developed as a semi-mechanistic approach to understand how species interact with climate, to predict distribution shifts in a range of species (Sutherst & Maywald [1985](#)). This was followed by local applications of these, and other species distribution models, to predict extinction risk (e.g. Williams et al. [2003a](#)). Such models have highlighted the limits of our national reserve system in maintaining biodiversity under climate change (Dunlop & Brown [2008](#)). Detailed mechanistic models have also been developed to incorporate timing issues and evolutionary changes in predicting climate change impacts (e.g. Kearney et al. [2009](#); Bush et al. [2016](#)). There is now a vast body of Australian literature on the predicted effects of climate change on species distributions, phenotypic traits and biodiversity more generally.

In 2011 Adams-Hosking (2011) modelled climate-change-induced shifts in the distribution of the koala, noting:

The impacts of climate change on the climate envelopes, and hence, distributions of species, are of ongoing concern for biodiversity worldwide. Knowing where climate refuge habitats will occur in the future is essential to conservation planning. ... Climate change pressures will likely change priorities for allocating conservation efforts for many species. Conservation planning needs to identify areas that will provide climatically suitable habitat for a species in a changing climate. In the case of the koala, inland habitats are likely to become climatically unsuitable, increasing the need to protect and restore the more mesic habitats, which are under threat from urbanisation. National and regional koala conservation policies need to anticipate these changes and synergistic threats. Therefore, a proactive approach to conservation planning is necessary to protect the koala and other species that depend on eucalypt forests.

In their 2015 paper 'Mapping the drivers of climate change vulnerability for Australia's threatened species', Lee et. al. (2015) determined the factors driving climate change vulnerability for a representative set of 213 threatened species across Australia to indicate which climate adaptation actions (management to conserve species in a changing climate) will be needed in each bioregion across the continent.

Effective conservation management for climate adaptation rests on understanding the factors driving species' vulnerability in a spatially explicit manner so as to direct on-ground

action. ... Almost half of the threatened species assessed were considered vulnerable to the impacts of climate change: amphibians being the most vulnerable group, followed by plants, reptiles, mammals and birds. ... Our results show that actions to address climate adaptation will need to be spatially appropriate, and that in some regions a complex suite of factors driving climate change vulnerability will need to be addressed. Taxonomic and geographic variation in the factors driving climate change vulnerability highlights an urgent need for a spatial prioritisation of climate adaptation actions for threatened species.

The assessment of the 2019/20 fires by the University of Wollongong (Risks to the NSW Coastal Integrated Forestry Operations Approvals Posed by the 2019/2020 Fire Season and Beyond) identifies those species most likely to suffer significant declines in predicted suitable habitat under future climate scenarios by 2030, and known to be vulnerable to increased fire, include: Eastern Pygmy-possum, Spotted-tailed Quoll, Yellow-bellied Glider, White-footed Dunnart, Red-legged Pademelon, Glossy Black-Cockatoo, Powerful Owl, Masked Owl, Sooty Owl, Eastern False Pipistrelle, Golden-tipped Bat, Greater Broad-nosed Bat, Stuttering Frog, and Giant Barred Frog (Note Koala was unable to be modelled).

Hoffmann *et. al.* (2019) 'Impacts of recent climate change on terrestrial flora and fauna: Some emerging Australian examples' identify some climate change case studies, concluding:

The above examples illustrate both the substantial changes already occurring in Australia's terrestrial ecosystems and point to the nature of changes to be expected in the future. The examples highlight that changes can be relatively subtle, like phenological shifts in flowering time, and phenotypic shifts in components of body size, or much more dramatic, such as severe local species declines in the Wet Tropics and sub-antarctic islands, community shifts in Alpine areas, and direct damage to forests exposed to heat stress, drought and frequent fire. Regardless of whether changes are subtle or much more apparent, major repercussions are likely for the structure and composition of communities and ultimately for ecosystem processes.

...

Minimizing the impacts of future climate change will require a multi-faceted policy and management strategy that uses information from targeted and systematic monitoring at the regional level to identify vulnerable species via comprehensive vulnerability assessment, particularly emphasizing endemic, specialized, ancient and rare species, and to identify high priority biodiversity refugia for protection and management. Habitat restoration is needed in places that will make the most significant contribution to both current and future connectivity, thereby maximizing the potential for species to move with their required climate. Local non-climate stressors, such as invasive species and habitat fragmentation, also need to be reduced. Research and adaptive management is needed to start testing potential adaptation strategies now, so we have the knowledge to act appropriately in the future.

The EPA needs to acknowledge that climate change is having a profound impact of the habitat available for a plethora of native species, including many that are already threatened by other processes, including logging and landclearing. They need to recognise that such species require enhanced habitat protection, including the identification and protection of climatic refugia. There is no time to waste as climate heating gains momentum as there is already enough information to identify many of these species, needed improvements to mitigation measures, and priority areas for protection as climatic refugia. The EPA must act now.

2. Protecting forests is climate action

It is well recognised that natural climate solutions are essential to draw down enough atmospheric CO₂ to give us a chance of limiting global heating to less than 1.5°C, or even 2°C (Sohngen and Sedjo 2004, Wardell-Johnson *et. al.* 2011, Keith *et. al.* 2015, Griscom *et. al.* 2017, Houghton and Nassikas 2018, Fargione *et. al.* 2018, IPCC 2018, Moomaw *et. al.* 2019, Goldestein *et. al.* 2020). Griscom *et. al.* (2017) consider that "*Forest pathways offer over two thirds of cost-effective NCS mitigation needed to hold warming to below 2°C and about half of low-cost mitigation opportunities pathway*". While ambitious reforestation and plantation projects have been launched, many have failed and all suffer from the problem of the lag between when they are conceptualised to when they begin sequestering significant volumes of atmospheric carbon (if ever).

By comparison there are millions of hectares of existing native forests that have had their carbon stocks depleted by past logging, that still have substantial carbon stocks, and which can immediately begin to regain their lost carbon. Many scientists have attested to the significant role that protecting degraded forests (sometimes termed proforestation) can have in reducing atmospheric carbon on a global scale with the urgency required (Mackey *et. al.* 2008, Houghton and Nassikas 2018, Moomaw *et. al.* 2019, Mackey *et. al.* 2022). As stated by Moomaw *et. al.* (2019):

Proforestation serves the greatest public good by maximizing co-benefits such as nature-based biological carbon sequestration and unparalleled ecosystem services such as biodiversity enhancement, water and air quality, flood and erosion control, public health benefits, low impact recreation and scenic beauty.

... proforestation provides the most effective solution to dual global crises – climate change and biodiversity loss. It is the only practical, rapid, economical and effective means for atmospheric carbon dioxide removal among the multiple options that have been proposed because it removes more atmospheric carbon dioxide in the immediate future and continues to sequester it into the long-term future.

The IPCC (2021) identifies that, based on cumulative emissions to 2020, the world can release an additional 500 billion tonnes CO₂ to have a 50% chance of limiting global warming to 1.5° C. The budget shrinks to 400 billion tonnes to increase the chance to 67%. The world emits around 43 billion tons of CO₂, though emissions are rising as the world rebounds from Covid. At this rate we have about 9-11 years left to use-up our budget. Australia's share has been estimated as 3,521 million tonnes of CO₂ from 2021 (Climate Targets Panel 2021). In the year ended June 2020, emissions were 513.4 million tonnes. Based on this Australia has less than 7 years left.

IEA identify that global CO₂ emissions from energy combustion and industrial processes reached their highest ever annual level in 2021 of 36.3 billion metric tonnes. Worldwide forests absorb 15.6 billion metric tonnes of CO₂ per year from the atmosphere, though through clearing, logging and other disturbances they also emit 8.1 billion metric tonnes of carbon dioxide (Harris *et. al.* 2021). It is clear that we depend on forests to remove the carbon we emit to avoid runaway climate heating, though what is not clear in carbon accounting are the effects of logging on forest carbon stocks and the mitigation potential of protecting forests.

In 2018–19, NSW emitted around 141 million tonnes carbon dioxide equivalent (CO₂-e), which was partially offset by trees having the net effect of reducing total emissions by 5 million tonnes (3%) due to photosynthesis. The 2021 NSW State of the Environment Report considers the land use, land-use change and forestry sector (LULUCF) is currently considered a carbon 'sink' as it stores more carbon than it emits and thus reduces the state's emissions by 3%, while noting "*the sequestration by 'forest remaining forest' has halved*" since 2005, with "*a decline in the forest sink by around 14%*" relative to 2005, and warning that without further action the land sink is estimated

to peak in 2022 as the “forest land sink decreases” (EPA 2021). Such statements are indicative of the value of forests as carbon sinks, their fragility, and the necessity of accounting for them in an open and transparent manner in carbon accounts (Mackey et. al. 2022).

There have been a number of assessments of the carbon benefits of protecting public native forests in south-east Australia (Mackey et. al. 2008, Dean et. al. 2012, Perkins and Macintosh 2013, Keith et. al. 2014b, Macintosh et. al. 2015, Keith et. al. 2015). For their assessment of 14.5 million ha of eucalypt forests in south-eastern Australia, Mackey et. al. (2008) found that:

... the effect of retaining the current carbon stock (equivalent to 25.5 Gt CO₂ (carbon dioxide)) is equivalent to avoided emissions of 460 Mt CO₂yr⁻¹ for the next 100 years. Allowing logged forests to realize their sequestration potential to store 7.5 Gt CO₂ is equivalent to avoiding emissions of 136 Mt CO₂yr⁻¹ for the next 100 years. This is equal to 24 per cent of the 2005 Australian net greenhouse gas emissions across all sectors; which were 559 Mt CO₂ in that year.

While all sorts of methodologies, parameters and offsets have been variously applied, the conclusions have been that it is in our best interests to stop logging public native forests. Recently [Frontier Economics](#) (2021) found stopping logging of public native forests in southern NSW would produce a net economic benefit to the state of approximately \$60 million, while also reducing net greenhouse gas emissions by almost 1 million tonnes per year over the period 2022-2041, compared to logging.

It is particularly important at this crucial time in our climate crisis to recognise that we need to protect forests to get the rapid reductions in atmospheric carbon we need. As part of their review of national greenhouse gas inventories, Mackey et. al. (2022) found:

... the State of Tasmania delivered negative emissions due to a change in forest management—a large and rapid drop in native forest logging—resulting in a mitigation benefit of ~22 Mt CO₂-e yr⁻¹ over the reported period 2011/12–2018/19. This is the kind of outcome required globally to meet the Paris Agreement temperature goal. All CO₂ emissions from, and atmospheric removals into, forest ecosystem carbon stocks now matter and should be counted and credited to achieve the deep and rapid cuts in emissions needed over the coming decades.

Logging reduces the age classes of trees in forests, particularly the old giant trees, and thus their carbon storage. On average, production forests are considered to have lost 40-60% of their carbon stores (Harmon et. al. 1990, Roxburgh et.al. 2006, Mackey et. al. 2008, Wardell-Johnson et. al. 2011, Dean et. al. 2012, Keith et. al. 2014b, Keith et. al. 2015, Noormets et. al. 2015). Carbon stocks are maintained at these low levels by repeat harvesting events, never allowed to regain their natural carbon carrying capacity. Mackey et. al. (2008) note:

The majority of biomass carbon in natural forests resides in the woody biomass of large old trees. Commercial logging changes the age structure of forests so that the average age of trees is much younger. The result is a significant (more than 40 per cent) reduction in the long-term average standing stock of biomass carbon compared with an unlogged forest.

This suppression of carbon storage is illustrated by Keith et. al. (2014b):

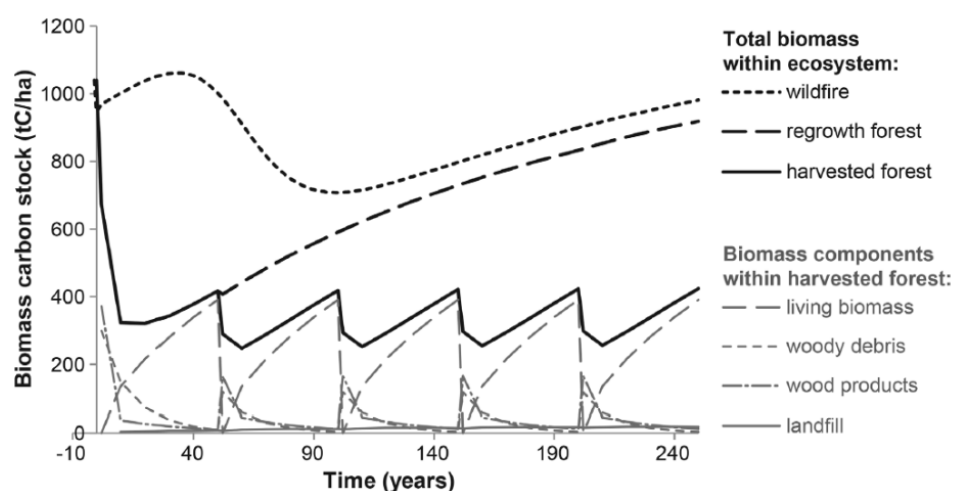


Fig. 10. from Keith *et. al.* (2014b): Changes in total biomass carbon stock of the ecosystem over time under three scenarios (shown as black lines) from an initial stock of a native forest: (1) wildfire that occurred at time 0 years and then the forest regenerated and dead biomass decomposed over time, (2) regrowth forest after logging once and regeneration, and (3) harvested forest under a regime of repeated logging rotations consisting of clearcutting and slash burning on a 50 year cycle

This 40-60% suppression in the carbon stored in logged forests is supported by the results of Ximenes *et al.* (2016). Ximenes *et al.* (2016) assessed live above ground biomass of what they considered representative sites managed for production and older forests with no management history, their dry above ground biomass was converted to account for below ground biomass ($\times 1.25$), with 50% of the dry weight taken to be carbon. For Silvertop Stringybark forests on the south-coast, this gives 128 tC/ha for the production forest and 298 tC/ha for the older forests, a loss of 170 tC/ha (57%). For Blackbutt forests on the north coast, this gives 161 tC/ha for the production forest and 261 tC/ha for the older forests, a loss of 100 tC/ha (38%), though the older forest had a low density of large trees and the “*production*” site yielded a slightly higher proportion of high quality logs than the average blackbutt forest”, meaning they likely understate the average carbon loss.

It is important to recognise that recent heavily logged forests will have significantly lower carbon stores that need to be accounted for.

It is essential that the current structure of native forests, and their current carbon storage is identified with a reasonable level of accuracy across all tenures, and separately reported on within the land use, land use change and forestry (LULUCF) sector.

In regions with large pulpwood industries the majority of the logs removed from the forests are likely to be woodchipped and thus release their carbon quickly, with as little as 4-6% of the logged trees ending up in sawn products (ie Keith *et. al.* 2014). Export woodchipping from north-east NSW was stopped in 2013, and pulpwood currently comprises less than 5% of the logs removed from native forests.

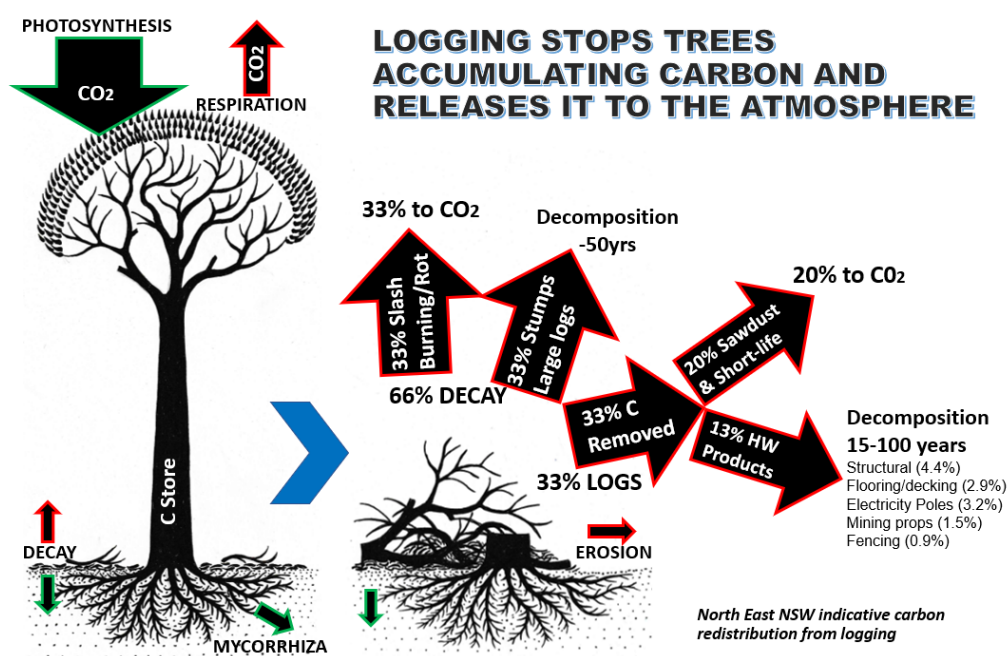
Based on Ximenes *et al.* (2016) assessment of a north-east NSW blackbutt site, 52% of logged trees will be left on site with 48% removed in logs. Though with account for tree roots, it is likely that around 33.5% of each tree is removed in log form.

Meaning 66.5% of each tree is left in the forest. Leaves, bark and small branches and rootlets will rapidly decompose, releasing their carbon in the process, though stumps, sections of trunks, large branches, and large roots will decompose more slowly. In dry environments standing dead trees and other Coarse Woody Debris (CWD) may remain for decades, with longevity dependent on species and temperature (Woldendorp *et. al.* 2002, Mackensen *et. al.* 2011, Keith *et. al.* 2014b).

Keith *et al.* (2014b) assume that half the logging debris will have a life of around 50 years. Mackensen *et al.* (2011) found:

In total, 184 values for lifetimes ($t_{0.95}$) of CWD were calculated from studies available in the literature. In 57% of all cases, the calculated lifetime ($t_{0.95}$) is longer than 40 years (Fig. 4). The median of this distribution is at 49 years and the mean is 92 years.

Of the timber removed from the forest, according to Ximenes *et al.* (2016) 61.8% will end up as short-lived mill residues and products, and 38.2% as relatively long-lived hardwood products, this is just 12.8% of tree biomass. Of the hardwood products, over half can be expected to be in exposed situations conducive to decay (decking, poles, mining props and fencing) and thus have a lifespan of 15 to 40 years, with the balance (flooring, some structural timber) expected to have a lifetime equivalent to the building it is used in. After its useful life is over, a portion of the timber product may end up in landfill, where very low rates of decomposition are reported because of the anaerobic conditions. Keith *et al.* (2014) consider the proportion of the initial forest carbon stock that remains in long-term storage in landfill is less than 3%.



Indicative fate of carbon in current logging in north-east NSW.

Before the 2019/20 wildfires some 400,000 m³ of native tree logs per annum were removed from north-east NSW's public forests. Based on Ximenes *et al.* (2016) some 66.5% of the trees logged can be expected to remain in the forest as residues, meaning for the removal of 277,200 tonnes of dry biomass, 550,263 tonnes of dry biomass will be left in the forest, increasing the total generation of biomass from logging to 827,463 tonnes per annum. Some 50% of this can be assumed to be carbon, totalling 413,732 tonnes (t/yr) of carbon per annum.

Based on this (without an increase in pulpwood) 413,732 t/yr of carbon likely to be converted by logging from storage in living biomass to dead biomass per annum in north-east NSW's public forests, 275,132 t/yr will be left in the forest as residues where half will quickly release its carbon as CO₂, and of the 138,600 t/yr of carbon removed as logs some 85,655 t/yr can be expected to be quickly released as CO₂. This 223,221 t/yr of quick release carbon reacts with oxygen to form 819,220 t of CO₂. The balance of 137,566 t/yr of carbon in CWD forest residues and 53,945 t/yr in longer-lived wood products will ultimately be converted to an additional 699,175 t of CO₂, though over a timeframe of 15 to 100+ years.

The North-east NSW RFA regions, north from the Hunter River, total 8.5 million ha, of which 1,472,000 hectares is national parks and nature reserves and 838,000 hectares is State Forests. Some 278,000 ha of State Forests is classed as FMZ 1, 2 and 3A and taken to be informal reserves, 505,000 is native forests available for logging in various stages of degradation, with 127,000 hectares is plantations. Around half the national parks and the informal reserves were protected either as an outcome of the Regional Forest Agreement process in 1998 or the Forest Icon decision in 2003, so significant parts had previously been logged.

Oldgrowth forests best approximates those forests that have not been significantly affected by logging or other disturbances such as intense wildfire, though many of these areas survived as oldgrowth because they are steep and low productivity forests (i.e. with relatively low carbon volumes). The last regional assessment of forest structure was for the Regional Forest Agreements, so can only be considered current as at around 1997. It is one of the biggest failings of the RFA process that the changes in forest structure since then have not been monitored or updated.

The 1997 data identifies 1.3 million hectares of old growth forest in that part of the North East RFA region north from the Hunter River. There has been no assessment of how much of the 462,000 ha of rainforest identified in the RFA is oldgrowth,

North East NSW (CRA Regions - north from Hunter River) broad forest structure as mapped at 1998 according to current tenure, note that growth-stage mapping was primarily limited to eucalypt and Brush Box dominated forests and excluded rainforest, melaleuca forests and non-forest communities.

GROWSTAGE	National Park (ha)	State Forest Informal Reserve (ha)	State Forest General Logging (ha)	Other tenures (ha)	TOTALS (ha)
Rainforest	263,504	81,491	2,862	114,227	462,084
Candidate Old Growth	720,120	120,347	49,674	419,075	1,309,216
Other Forests	348,306	61,298	452,516	1,508,017	2,370,136
TOTALS	1,331,930	263,136	505,052	2,041,318	4,141,436

Based on the CRA data from 20 years ago, around 2.3 million ha (64%) of remnant eucalypt forests had then been logged (or otherwise degraded) and had significantly reduced carbon storage below original carrying capacity. Since then it can be expected that most of the oldgrowth forest in the general logging area on State Forests has been logged, along with significant areas of oldgrowth forest on private lands, though it also needs to be considered that a large proportion of oldgrowth remaining at that time had survived because it was low-productivity forest on poor soils and steep slopes.

The following calculation is undertaken in order to identify the indicative magnitude of the carbon sequestration potential of north-east NSW's degraded forests if they were free of further disturbance. It can be expected that over 2.4 million ha of north-east NSW's eucalypt forests currently have carbon stores at varying levels significantly below their carbon carrying capacity, comprised of 0.4 million ha of national parks and informal reserves, 0.5 million ha of loggable State Forests, and 1.5 million ha of private lands. If, by way of illustration, the lower estimate of a Mean Annual Increment of 1.44 tC ha⁻¹ identified by Keith *et. al.* (2015) for NSW south-coast forests is applied, this represents the potential to sequester 5.3 tonnes of CO₂ per hectare per annum. Application of this multiplier indicates that degraded forests in our current reserve system is recovering in the order of 2.1 million tonnes of atmospheric carbon per annum, if logging was stopped on public native forests another 2.7 million tonnes per annum could be sequestered, and if private landholders were encouraged to protect their forests (some of whom are) there is the potential for an additional 8 million tonnes of CO₂ to be sequestered per annum.

To put this into perspective, in 2018–19, NSW emitted around 141 million tonnes carbon dioxide equivalent (CO₂-e), so stopping logging of public native forests can have a significant and immediate effect on increasing the drawdown of atmospheric carbon, while avoiding increased emissions from logging.

Stopping logging of north-east NSW's public forests will avoid the emission of 820,000 tonnes of CO₂ per annum from tree biomass, and the creation of legacy emissions of 700,000 tonnes of CO₂ per annum that will be realised over decades as logs left in the forest decay and wood used in buildings reach the end of its useful life. Protecting the half a million hectares of north-east NSW's public native forests currently available for logging would allow them to sequester in the order of an additional 2.7 million tonnes of CO₂ per annum. The EPA needs to acknowledge that stopping logging of public native forests will increase carbon sequestration and storage and thereby make a significant and immediate difference in this current climate emergency.

3. Stopping burning forests for electricity

There is currently a proposal by Verdant Earth to restart a closed coal-fired power station at Redbank, near Singleton in the Hunter valley, with 850,000 tonnes of biomass, with at least 70% of the biomass sourced from forestry residues.

In most southern forests the majority of the timber removed from the forests is for woodchips or pulplogs, meaning most of their carbon is relatively quickly released to the atmosphere as CO₂. This is not currently the situation in north-east NSW as export woodchipping was stopped in 2013, and pulpwood currently comprises less than 5% of the logs removed from native forests. Ximenes *et al.* (2016) note:

The ratio of pulp logs to sawlogs (on a C basis) was 70/30 for silvertop ash, and 64/36 for mountain ash. There was no difference between the commercial log recoveries for blackbutt and for silvertop ash (59%) – however if there was a pulp market in the mid-North coast of NSW, the production log recoveries for blackbutt would have been considerably higher.

One of the scenarios considered by Ximenes *et al.* (2016) was “50% of forest residues left on site utilised for pulp”, which would predominantly be comprised of the relatively long-lived Coarse Woody Debris and trees which otherwise wouldn't be logged. Currently only some 20,000 m³/yr is removed from north-east NSW as pulpwood, though DPI (2017) identify that 399,958 tonnes (247,974 tonnes dry biomass) per annum are potentially available from public native forests for biomass. The removal of this material, intended to be for burning to generate electricity, would significantly increase short-term CO₂ impacts.

Contrary to claims that the timber proposed to be removed from forests for biomass is waste, most will be removed as logs with leaves, branches, tree crowns, bark and stumps left in the forest. DPI's (2017) North Coast Residues report identifies:

For native forests, residue estimations were conservative, as we only considered logs that met the specifications for pulpwood as available for extraction (typically 10 cm small end diameter overbark, and a minimum of 2.5 m in length – no species restrictions – and the crown was typically left in the forest). This was partly due to the fact that the local industry already has experience harvesting and transporting pulpwood from the forest. Extracting pulpwood only, means that a significant proportion of the residues generated (stump, bark, leaves, small branches, large and defective stem sections) are left in the forest,

The values assume that a substantial proportion of the biomass (typically at least 20% of the total biomass) is left in the forest after harvest.

Some of these pulplogs will be obtained from parts of trees otherwise felled for sawlogs, though most pulplogs will come from trees that would not otherwise be felled without a biomass market.

The EPA needs to recognise that creating a market for burning native forests for electricity will increase logging intensity and log removal, and the rapid release of carbon from coarse woody debris that would otherwise be left in the forest to slowly decompose over decades.

We have the perverse situation where trees are increasingly being proposed to replace coal in power stations on the pretence that wood can be burnt without releasing carbon dioxide. The absurdity is that power stations burning wood can now pretend that they are not emitting any CO₂ at all. For example, the Planning Report (URBIS 2021) for Verdant Earth's Redbank power station claims the burning of 850,000 tonnes of biomass will result in no CO₂ emissions what-so-ever, stating:

The National Greenhouse Accounts Factors state the emission factor for CO₂ released from the biogenic carbon fuels is zero. This is in accordance with the position of the IPCC. The reason for this is, in simple terms, that the carbon emissions from the combustion of biomass from sustainable forestry are offset by the carbon capture from the regenerating biomass within the managed forestry system.

DPI's Dr Cowie's [Expert report on Climate Change and Ecologically Sustainable Development matters](#) identifies that this annual volume used will be equivalent to 637,500 t dry matter. If half this is taken to be carbon, then its combustion will generate 1.2 million tonnes of CO₂ per annum, though this is not mentioned or considered anywhere in the supporting documents. Because of the Federal rules they just pretend these emissions don't exist.

This pretence is an outrageous sham, particularly as burning wood is worse than coal. Sterman *et al.* (2018) emphasise that burning wood for energy is more polluting than coal and that it takes many decades for regenerating forests to regain that lost:

We simulate substitution of wood for coal in power generation, estimating the parameters governing NPP and other fluxes using data for forests in the eastern US and using published estimates for supply chain emissions. Because combustion and processing efficiencies for wood are less than coal, the immediate impact of substituting wood for coal is an increase in atmospheric CO₂ relative to coal. The payback time for this carbon debt ranges from 44–104 years after clearcut, depending on forest type—assuming the land remains forest.

Norton *et al.* (2019) reinforce that burning biomass releases more CO₂ to the atmosphere than burning coal:

Woody biomass contains less energy than coal (biomass pellets 9.6–12.2 GJ/m³; coal 18.4–23.8 GJ/m³; IEABioenergy, 2017), so that CO₂ emissions for the same energy output are higher (110 kg CO₂/GJ for solid biomass, 94.6–96 kg CO₂/GJ for coals in IPCC, 2006). Combined with the energy needs to gather from diffuse sources and intermediate treatment (drying and pelleting), replacing fossil fuels in electricity generation results in significant increases in emissions of CO₂ per kWh. The net effect of switching to biomass is thus usually to increase emissions and thus increase atmospheric levels of CO₂.

It is thus of considerable concern that scientific analyses indicate that, far from reducing GHG emissions, replacing coal by biomass for electricity generation is likely to initially increase emissions of CO₂ per kWh of electricity as a result of the lower energy density of wood, emissions along the supply chain, and/or less efficient conversion of combustion heat to electricity (see later). The resulting increase in atmospheric concentrations of CO₂ increases radiative forcing and thus contributes to global warming. This initial negative

impact is only reversed later if and when the biomass regrows. Research has shown that the time needed to reabsorb the extra carbon released can be very long, so that current policies risk achieving the reverse of that intended—initially exacerbating rather than mitigating climate change.

McKechnie et. al. (2011) undertook a life cycle assessment and forest carbon analysis to assess total Greenhouse Gas (GHG) emissions of forest bioenergy over time, finding:

For all cases, harvest-related forest carbon reductions and associated GHG emissions initially exceed avoided fossil fuel-related emissions, temporarily increasing overall emissions. In the long term, electricity generation from pellets reduces overall emissions relative to coal, although forest carbon losses delay net GHG mitigation by 16–38 years, depending on biomass source (harvest residues/standing trees).

Ter-Mikaelian et. al. (2015) undertook a review of the theory and principles for correctly assessing the Greenhouse Gas (GHG) effects of forest bioenergy, observing “accounting for emission benefits when fossil fuels are replaced requires accounting for forest carbon (either in forest or in traditional wood products) that would have continued to exist if fossil fuels were not replaced by bioenergy”, and noting:

When correctly accounted for, GHG emissions from live tree forest biomass used for energy exceed those from fossil fuels for periods of a few years to more than a century, and the difference can be substantial, depending on the characteristics of the forest harvested and the fossil fuel replaced by bioenergy. Even when bioenergy from live tree biomass from temperate forests replaces coal, a CO₂-intensive fossil fuel, the time to obtain a net reduction in atmospheric CO₂ can be decades; if it is replacing a less CO₂-intensive fossil fuel, the time to achieve an atmospheric benefit may be more than 100 years.

Recently Peter Raven, Director Emeritus Missouri Botanical Society, and around 500 scientist co-signatories wrote a [Letter Regarding Use of Forests for Bioenergy](#) (February 11, 2021) to President Biden, President von der Leyen, President Michel, Prime Minister Suga, and President Moon, urging them “not to undermine both climate goals and the world’s biodiversity by shifting from burning fossil fuels to burning trees to generate energy”, noting:

... In recent years ... there has been a misguided move to cut down whole trees or to divert large portions of stem wood for bioenergy, releasing carbon that would otherwise stay locked up in forests.

The result of this additional wood harvest is a large initial increase in carbon emissions, creating a “carbon debt,” which increases over time as more trees are harvested for continuing bioenergy use. Regrowing trees and displacement of fossil fuels may eventually pay off this carbon debt, but regrowth takes time the world does not have to solve climate change. As numerous studies have shown, this burning of wood will increase warming for decades to centuries. That is true even when the wood replaces coal, oil or natural gas.

The reasons are fundamental. Forests store carbon - approximately half the weight of dry wood is carbon. When wood is harvested and burned, much and often more than half of the live wood in trees harvested is typically lost in harvesting and processing before it can supply energy, adding carbon to the atmosphere without replacing fossil fuels. Burning wood is also carbon-inefficient, so the wood burned for energy emits more carbon up smokestacks than using fossil fuels. Overall, for each kilowatt hour of heat or electricity produced, using wood initially is likely to add two to three times as much carbon to the air as using fossil fuels.

Increases in global warming for the next few decades are dangerous. This warming means more immediate damages through more forest fires, sea level rise and periods of extreme

heat in the next decades. It also means more permanent damages due to more rapid melting of glaciers and thawing of permafrost, and more packing of heat and acidity into the world's oceans. These harms will not be undone even if we remove the carbon decades from now.

Government subsidies for burning wood create a double climate problem because this false solution is replacing real carbon reductions. Companies are shifting fossil energy use to wood, which increases warming, as a substitute for shifting to solar and wind, which would truly decrease warming.

The claim that biomass is carbon neutral is based upon an accountancy trick that allows the emissions generated by burning biomass to be fully discounted on the assumption that sometime in the future the land from which it was obtained will be allowed to regrow and recapture the lost carbon, though even if the forest is allowed to regrow it may take decades or centuries to recapture the released carbon. In our current climate emergency, when we urgently need to reduce CO₂ emissions, biomass is part of the problem, not a solution.

Most significantly if the forest was left to grow older, rather than being logged, the trees and soils would go on sequestering ever increasing volumes of carbon over time. Logging trees for biomass creates an incentive to increase tree removal and land-clearing.

The recent [NSW parliamentary inquiry](#) into 'Sustainability of energy supply and resources in New South Wales' found the burning of forest biomass for power generation is "*not economically or environmentally sustainable, and it generates significant carbon emissions*", recommending "*the government takes steps to declassify forest biomass as a form of renewable energy and ensure it's not eligible for renewable energy credits*". They note:

We consider that energy from native forest biomass is not sustainable, and should not be classed as a renewable source. Many inquiry participants told us that this form of bioenergy leads to deforestation, produces more emissions than fossil fuels, reduces the number of older trees that can reabsorb carbon from the atmosphere, and negatively impacts on biodiversity. It is also an expensive form of energy generation

The EPA must ensure that all actual carbon emissions from burning wood for electricity are fully disclosed and considered, with any offsets clearly and separately distinguished.

4. The burning question.

The increasing risk of droughts and fires due to climate heating is another of the issues that the EPA and RFA processes have chosen to ignore despite being made aware of it for a long time.

In 2008, the Garnaut Review reported that, in the period 1973-2007, there had been 'a general increase in the Forest Fire Danger Index across the east and south-east of the country'. It reported on 2007 predictions that 'fire seasons will start earlier, end slightly later, and generally be more intense. This effect increases over time, but should be directly observable by 2020.' Garnaut also reported that, '*even an increase of 2°C above pre-industrial levels would have significant implications for the distribution of rainfall in Australia, ... and the intensity and frequency of conditions for catastrophic bushfires*'.

Again in 2013, SOFR 2013 predicted an increase in the incidence of extreme fire danger days: *Modelling suggests an increase of 5-65% in the incidence of extreme fire danger days by 2020 in southeastern Australia, compared with 2009*

...

There may be increased risks to species that are sensitive to either fire intensity or the interval between fires. Eucalypts and other species that are killed by fire and regenerate from seed may be at risk if fire frequency exceeds the time required for the plants to reach reproductive maturity.

Due to climate heating bushfires are becoming more frequent and intense. As evidenced in 2019-20, droughts and heatwaves are drying forests out and making them more flammable. In 2019, New South Wales had its warmest January to August period on record for overall mean temperature (1.85 °C above average). By 9 September, more than 50 fires were active in NSW, with five fires burning out of control and 3 watch and act alerts in place for blazes at Drake near Tenterfield, Ebor near Armidale and Shark Creek in the Clarence Valley.

From August 2019 until January 2020 the wildfires devastated 2.4 million hectares of north-east New South Wales (north from the Hunter River to the Queensland border, and from the coast west to include the New England Tablelands), encompassing 29% of the region and around half the remnant native vegetation. For this review primary reliance was placed on DPIE's GEEBANG v2 burn mapping

These fires were unusually extensive and intensive because of record low rainfalls and extreme temperatures. In summary comparison of GEEBAM v2 fire mapping with other data for north-east NSW shows the fires burnt:

- 1,324,772ha of Public Lands (54.2% of burn) and 1,118,659ha of Private Lands
- 868,714 ha (59%) of National Parks, with 517,802 ha suffering significant (full or partial) canopy loss. This includes 180,295 ha (58.3%) of the NSW section of the Gondwana Rainforests of Australia World Heritage area, including some 26,283 ha (24.4%) of World Heritage listed rainforest.
- 456,058 ha (54.4%) of State Forests, with 259,293 ha suffering significant canopy loss. This includes 16,000 hectares (43%) of Pine Plantations, most of which burnt intensively, rendering them useless for future production.
- Some 160,000 ha (34.7%) of rainforest, with 124,494 ha (78% of burnt rf) suffering significant canopy loss
- 851,847 ha (66%) of mapped oldgrowth forest, with 420,257 ha suffering significant canopy loss
- 322,191 (29.4%) of Koala Habitat Suitability Model (north-east NSW) classes 4&5, with 196,663 ha suffering significant canopy loss. (Note this is limited to the north-east NSW bioregion)

North-east NSW (north from the Hunter River) provides core habitat for half of the 113 animal species that the experts commissioned by the [Commonwealth Department of Agriculture, Water and the Environment](#) identified as needing urgent help to survive in the wake of devastating bushfires.

The 57 species occurring in north-east NSW identified as being at highest risk of extinction are comprised of 10 birds, 13 mammals, 9 reptiles, 11 frogs, 12 spiny crayfish and 2 freshwater fish species. These include the Rufous Scrub-bird, Regent Honeyeater, Hastings River Mouse, Long Sunskink, Manning River Helmeted Turtle, Broad-headed Snake, Pugh's frog, Mountain frog, Sphagnum frog, Peppered Tree Frog, New England treefrog, Tyler's toadlet, Small Crayfish, Smooth Crayfish, Ellen Clark's Crayfish, Hairy Cataract Crayfish, Oxleyan Pygmy Perch, and Clarence River Cod.

The crayfish in particular are not recognised as threatened species in NSW and thus not provided with any specific protection. Given their stream habitats they are directly affected by logging due to its affects on riparian habitat, water quality and streamflows, there needs to complete protection of

upstream catchments so as not to compound burning impacts. This applies to listed frogs, turtles and fish as well.

The Commonwealth identifies the highest priority actions for all species as protecting unburnt habitat patches and carrying out rapid ground assessments of remnant populations.

In their simplistic assessment [the NSW Government](#) also identified Pugh's frog, Hastings River Mouse, Brush-tailed rock-wallaby, Parma wallaby, Yellow-bellied glider, New England Tree Frog, and Davie's Tree Frog as having more than half their known localities burnt.

Many north coast species have had most of their known localities burnt, with Pugh's Frog losing 89% and Hastings River Mouse 82%. Rainforests have been burnt, with some unlikely to recover, numerous hollow-bearing trees have been burnt out and cut down, eucalypt flowering has been set back for years, many understorey feed trees (i.e. forest oaks for Glossy Black Cockatoos) have been killed, streams have been polluted. Due to the extent of the fires, these are significant impacts on the populations and survival of numerous threatened species.

The 2019-20 wildfires burnt some 1,118,659ha of Private Lands in north-east NSW, including over 45% of north coast PNF areas, though the PNF rules had no contingencies for fires. After the fires there were no changes to the logging rules to reduce impacts on burnt forests, depleted threatened species or streams, and no changes have been made to the 2022 PNF Codes to accommodate these changes.

Based on scientific advice of the significant impact of the fires, in early 2020 the Environment Protection Authority (EPA) and Forestry Corporation (FCNSW) negotiated Site Specific Operational Conditions to apply in addition to the standard logging rules (CIFOA) in burnt forests. These included temporary retention of unburned or lightly burned forest and increased exclusions, protection of all hollow-bearing trees, 10m buffers around rainforest, stopping logging on steep slopes, and increases of buffers around headwater streams from 5m to 20m.

The EPA commissioned [Dr. Andrew Smith to undertake a review](#), who found that the standard logging conditions fail to guarantee ecologically sustainable forest management and are likely to cause an ongoing decline and significant impact on biodiversity, primarily due to the increased logging intensity they allow and inadequate exclusions. He considered that the EPA's Site Specific Operational Conditions would only be effective if made permanent, commenting:

The time required for recovery of threatened and sensitive species after average fires ranges from around 10 - 120 years. Recovery times are likely to be around 10 years for the Hastings River Mouse, up to 45 years for the Koala and 20-120 years for the Greater Glider and Yellow-bellied Glider ... An examination of case studies indicates that protection of unburnt and lightly burnt areas could mitigate logging impacts in burnt landscapes if it was made permanent (or longer than 20-120 years) and extended to protect a minimum 50% of the least burnt area of forest in each compartment across the entire landscape.

Following disputes between the EPA and FCNSW, the NRC (2021) was asked to assess the prescriptions in the aftermath, concluding the standard logging rules (CIFOA) "was not designed to mitigate the risks of harvesting in severely fire-affected landscapes like those from the 2019/20 wildfires".

The NRC engaged [University of Wollongong](#) to undertake an assessment of the impacts of the 2019/20 wildfires on NSW Regional Forest Agreement (RFA) areas. They cited findings that 59 to 91 percent of the 700 listed threatened plant species in NSW had some part of their range burnt, about 5 percent having > 90 of their range burnt, and 411 out of 1600 threatened and/or endemic plant species in NSW are now at high risk. Within the RFA regions they identified particular concern for the burning of up to 40% of rainforests, and moist riparian habitats important for refugia and

erosion control. Because of the increase in fire frequency they identified more than half of the forests at risk of a potential decline in plant diversity if disturbed again within the next 5-10 years. They conclude:

These changes to fire regimes, wrought by the 2019/20 fires, were likely to pose significant risks to the CIFOA objectives and outcomes. Importantly the magnitude of the fires and their effect on disturbance regimes have placed the CIFOA, generally, in a highly vulnerable state where risk may be maintained at an elevated level into the immediate future. In particular, the integrity of riparian buffers, regeneration, hollows and carbon stocks may have been negatively directly affected by the 2019/20 fires and resultant changes to disturbance regimes.

Indicators of plant biodiversity responses were significantly shifted into a vulnerable state (circa 50 percent of the area of National Parks estate and State Forests), along with a small increase in the proportion of area of most vegetation formations that were deemed to be too frequently burnt. Notably, a large proportion of rainforest assessed was shifted into this state (> 50 percent). Predicted suitable habitat for 25 threatened vertebrate species (including 17 focal species listed for the CIFOA) was substantially burnt by the 2019/20 fires (up to 62 percent) and resultant shifts in fire regimes for the bulk of these species may constitute a significant risk to key habitat elements such as hollows, nesting and food resources. A substantial proportion (about 15 percent) of a sample of major catchments across the CIFOA was burned in 2019/20. The magnitude of burning and severity patterns, coupled with well above average rainfall post-fire throughout 2020 into early 2021 were likely to have resulted in significant erosion, transport and deposition of soil, ash and other material into waterways and estuaries. Resultant compromised water quality was likely to have posed significant risk to aquatic biodiversity.

Increases in adverse fire weather were predicted across CIFOA using the NSW and ACT Regional Climate Modelling (NARClIM) ensemble, in both the near (2020 to 2039) and far (2060 to 2079) future. Such shifts in fire weather were likely to result in increased area burned by wildfires in sample case studies corresponding to the range of CIFOA regions across the domain of the CIFOA. Such trends potentially elevate risks to CIFOA objectives and outcomes, while capacity to mitigate these risks may be constrained. Changes in projected suitable habitat for the range of threatened vertebrate species may either elevate or buffer risks sustained by changes in future fire regimes.

The [University of Wollongong](#) study assessed impacts on 25 animal species in the RFA regions using habitat models, finding about 27-62% of predicted suitable habitat burnt in the 2019/20 fires, with about half this burnt at the highest levels of severity. Koalas had about 40% of their modelled habitat burnt, 17% at high and extreme fire severity. They conclude:

While the overall proportion of the area of harvested predicted habitat burned in 2019/20 within the forested portion of the CIFOA domain was relatively low (< 7 percent), compounding effects of these disturbances may have been acute. Given the size of the fires, their overlay across dispersed pockets of recent harvesting may have diminished connectivity of suitable potential habitat in the short term.

The study also assessed future impacts of climate change scenarios on fires and the modelled distribution of 24 fauna species, identifying 14 animal species affected by the fires that are also likely to suffer significant declines in predicted climatically suitable habitat under future climate heating scenarios by 2030, with 8 species potentially losing over half their suitable habitat by then. This makes them even more vulnerable to fires and logging over the next decade. They conclude:

under a hotter and possibly drier future risks to the integrity of forests are likely to be directly and indirectly elevated (i.e. through changed fire regimes). Whether or not such changes are

incremental or sudden, as wrought by the 2019/20 fire season, there remains a strong likelihood that change will be rapid.

The EPA's Action Plan ignores this increased vulnerability and proposes nothing to redress it.

For their part [FCNSW estimated](#) significant losses of trees in heavily burnt forests, particularly on the south coast. On the north coast in 62,100 ha affected by crown fires all trees less than 30cm diameter were killed and half those over 30cm, increasing to 90% of trees killed in forests logged within the past 4 years. Losses halved in the 82,400 ha subject to hot burns.

NRC's (2021) recommendations to the Ministers for Forestry and Environment to take urgent action to require increased retention of unburnt and partially burnt forests for 3 years post fire, according to the assessed risk on a broad Management Area (MA) basis, and to change the logging rules for State forests (CIFOA) to retain or restore 8 hollow-bearing trees per hectare and to retain 2 recruitment trees for each of these.

It is clear that the NRC (2021) consider that this change should be permanent and applied across all native State forests. Three years after the fires, and almost a year and a half after the NRC recommendations were made to the Ministers for urgent action, nothing has been done.

Logging makes forests more vulnerable to wildfires and increases their flammability by drying them, increasing fuel loads, promoting more flammable species, and changing forest structure. This includes increasing the risks of canopy fires by reducing canopy height, increasing tree density and increasing fuel connectivity from the ground into the canopy.

Lindenmayer *et. al.* (2009) note:

Logging can alter key attributes of forests by changing microclimates, stand structure and species composition, fuel characteristics, the prevalence of ignition points, and patterns of landscape cover. These changes may make some kinds of forests more prone to increased probability of ignition and increased fire severity

Conversion of natural multi-aged forests to predominately regrowth increases their vulnerability to burning by:

- increasing transpiration and loss of available soil moisture (Vertessy *et. al.* 1998)
- reducing canopy density, changing the microclimate and causing drying of understorey vegetation and the forest floor (Lindenmayer *et. al.* 2009)
- changing forest structure by creating a more horizontally and vertically continuous fuel layer - increasing shrub cover, increasing stocking densities, reducing inter crown spacing, reducing canopy base-height (Gill and Zylstra 2005, Lindenmayer *et. al.* 2009, Cohn *et. al.* 2011, Taylor *et. al.* 2014, Zylstra 2018, Cawson *et. al.* 2018)
- natural self-thinning of post-fire regrowth creating large amounts of fine fuels from suppressed plants in the early stages of regrowth (Taylor *et. al.* 2014, Zylstra 2018),
- changing the understorey vegetation composition by opening the canopy and increasing disturbance adapted species (Gill and Zylstra 2005, Lindenmayer *et. al.* 2009, Zylstra 2018, Cawson *et. al.* 2018)
- spreading lantana and increasing understorey flammability (Fensham 1994, Gill and Zylstra 2005, Murray *et. al.* 2013)
- logging slash fuelling fires (Lindenmayer *et. al.* 2009)

Forest canopies create their own microclimate by moderating temperature extremes and enhancing humidity. Davis *et. al.* (2019) found "*microclimate buffering was most strongly related to canopy cover*", while Kovács *et. al.* (2017) found "*The midstory and the shrub layer play key roles in maintaining the special microclimate of forests with continuous canopy-cover*".

Logging changes the structure of forests and thus increases ground temperatures and reduces humidity (Brososke *et. al.* 1997, Chen *et. al.* 1999, Dan Moore *et. al.* 2005,), as identified by Chen *et. al.* (1999) "*Patches that have been recently disturbed by human-induced or natural processes tend to have higher daytime shortwave radiation, temperature, and wind speed than undisturbed patches; in addition, these variables show greater spatial and temporal variability*".

From their review of the effects of logging on riparian areas in America, primarily in catchments less than 100 ha in area or streams less than 2 to 3 m wide, Dan Moore *et. al.* (2005) concluded:

Forest harvesting can increase solar radiation in the riparian zone as well as wind speed and exposure to air advected from clearings, typically causing increases in summertime air, soil, and stream temperatures and decreases in relative humidity.

They identify "*the magnitude of harvesting related changes in riparian microclimate will depend on the width of riparian buffers and how far edge effects extend into the buffer*", citing a variety of studies which show "*that much of the change in microclimate takes place within about one tree height (15 to 60 m) of the edge. Solar radiation, wind speed, and soil temperature adjust to interior forest conditions more rapidly than do air temperature and relative humidity*".

Stand age has a significant effect on hydrological processes in forests, with regrowth significantly increasing transpiration and rainfall interception by canopy trees, which in turn creates a drier microclimate and increases drying of soil and litter. This in turn influences litter decomposition and the build up of surface fuels.

Vertessy *et. al.* (1998) have attempted to quantify the different components of rainfall lost by evapo-transpiration, identifying them as: interception by the forest canopy and then evaporated back into the atmosphere; evaporation from leaf litter and soil surfaces; transpiration by overstorey vegetation; and transpiration by understorey vegetation. All of these have been measured as declining with increasing forest maturity, with the exception of understorey transpiration which becomes more important as transpiration from the emergent eucalypts declines.

Rainfall interception is the fraction of gross rainfall caught by the forest canopy and evaporated back to the atmosphere. This is water lost to the understorey and groundwaters, as noted by Vertessy *et. al.* (1998):

rainfall interception rate rises to a peak of 25% at age 30 years, then declines slowly to about 15% by age 235 years. If we assume a mean annual rainfall of 1800mm for the mountain ash forest, stands aged 30 years intercept 190 mm more rainfall than old growth forest aged 240 years.

Evaporation is also greater from soils and litter in regrowth forests.

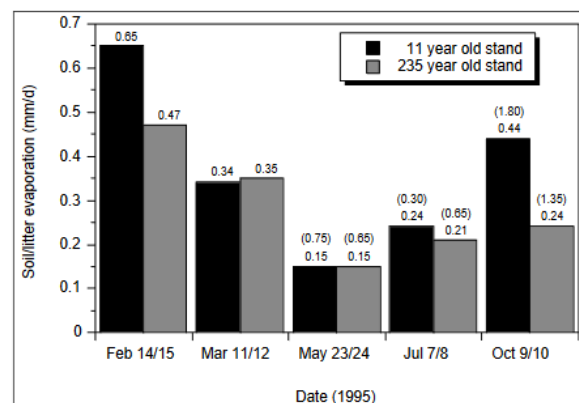
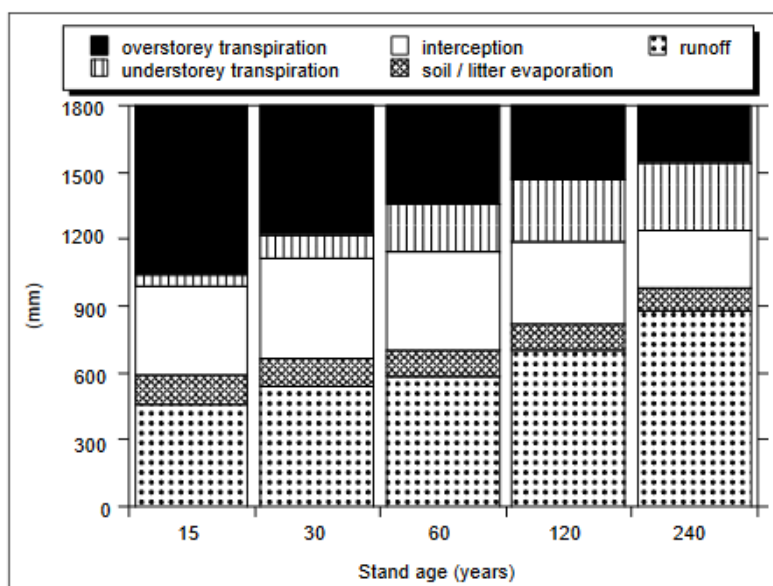


Figure 22 from Vertessy *et. al.* (1998): Comparison of soil/litter evaporation estimates beneath 11 and 235 year old mountain ash forest stands.

Reduction of oldgrowth forests to regrowth thus clearly dries out the forest and thereby increases the flammability of leaf litter.



Water balance for Mountain Ash forest stands of various ages, assuming annual rainfall of 1800 mm (Figure 24 from Vertessy et. al. 1998)

The reduced water yields particularly affect riparian areas and the availability of free water.

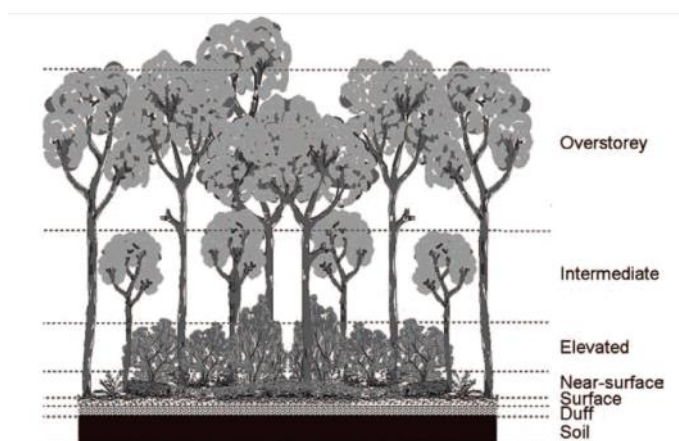


Figure 3.6 from Sullivan et. al. (2012) showing categories of forest fuel strata.

Flammability of surface fuels in forests is influenced by their nature and structure, though moisture content of living and dead fuels is the most fundamental constraint on biomass flammability. Forests which have denser canopies result in microclimates characterized by higher humidity, lower wind velocities, cooler temperatures, reduced evaporation and hence reduced fire risk compared to more open-canopied forests. From their comparisons of temperate rainforests and eucalypt forests, Clarke et. al. (2014) found *"there was no evidence of higher flammability of litter fuels or leaves from frequently burnt eucalypt forests compared with infrequently burnt rainforests"*, concluding *"the manifest pyrogenicity of eucalypt forests is not due to natural selection for more flammable foliage, but better explained by differences in crown openness and associated microclimatic differences"*.

Lindenmayer et. al (2009) observe *"logging in some moist forests in southeastern Australia has shifted the vegetation composition toward one more characteristic of drier forests that tend to be more fire prone"*.

Forests can be separated into strata, with the surface fuels being primarily responsible for most of the fuel consumed and energy released by a fire, though it is the tall shrubs and regenerating trees of the elevated fuel layer that "has a major influence on flame dimensions, particularly flame height" and the development of crown fires (Sullivan *et. al.* 2012).

As forests age the gap between canopy and understorey plants and fuels develops, reducing stand flammability and the risk of canopy fires (Cohn *et. al.* 2011, Taylor *et. al.* 2014, Zylstra 2018). As identified by Zylstra (2018) eucalypt forests have evolved the ability to create mature environments that suppress the spread of fire. It is logical that as logging removes mature trees and promotes regrowth that it increases connectivity with ground fuels and therefore the risk of crown fires, though there is strong opposition to any suggestion that such fundamental changes in forest structure can influence crown fires (i.e. Attiwill *et. al.* 2014).

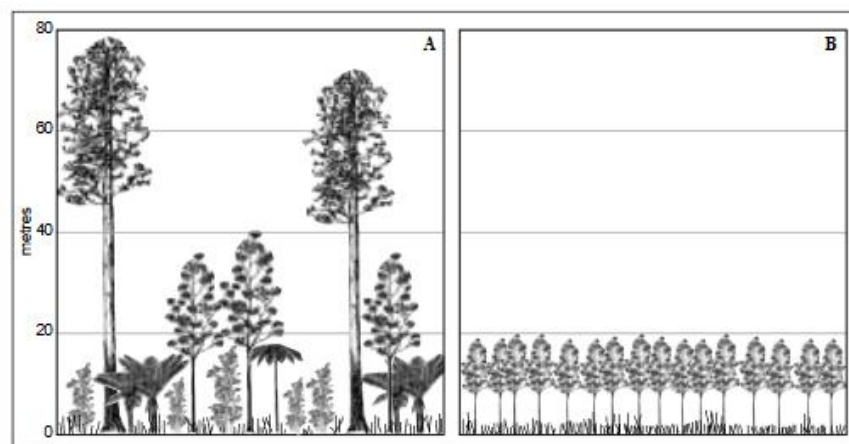


Figure 9 from Vertessy *et. al.* 1998: Comparison of forest structure in (A) old growth and (B) regrowth mountain ash stands. It beggars belief the anybody could deny that the reduced canopy height and increased canopy continuity in a drier regrowth forest is likely to result in increased crown fires.

From their studies of the 2009 Victorian fires Price and Bradstock (2012) concluded "*Probability of crown fires was higher in recently logged areas than in areas logged decades before*"

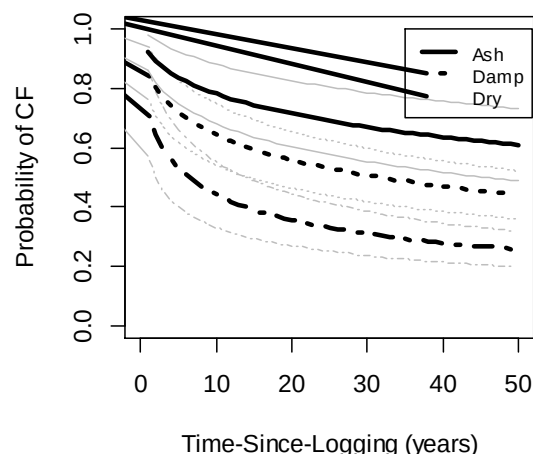


Figure 1 from Price & Bradstock (2012): Model predictions for crown fire (CF) against time-since-logging and forest type using the best model. In all cases, the models are for fire weather Moderate, slope = 0, topographic position = 50%, time-since-fire = 25 years, and aspect = East. Confidence limits for predictions for each forest type are shown.

Developing Rainforest

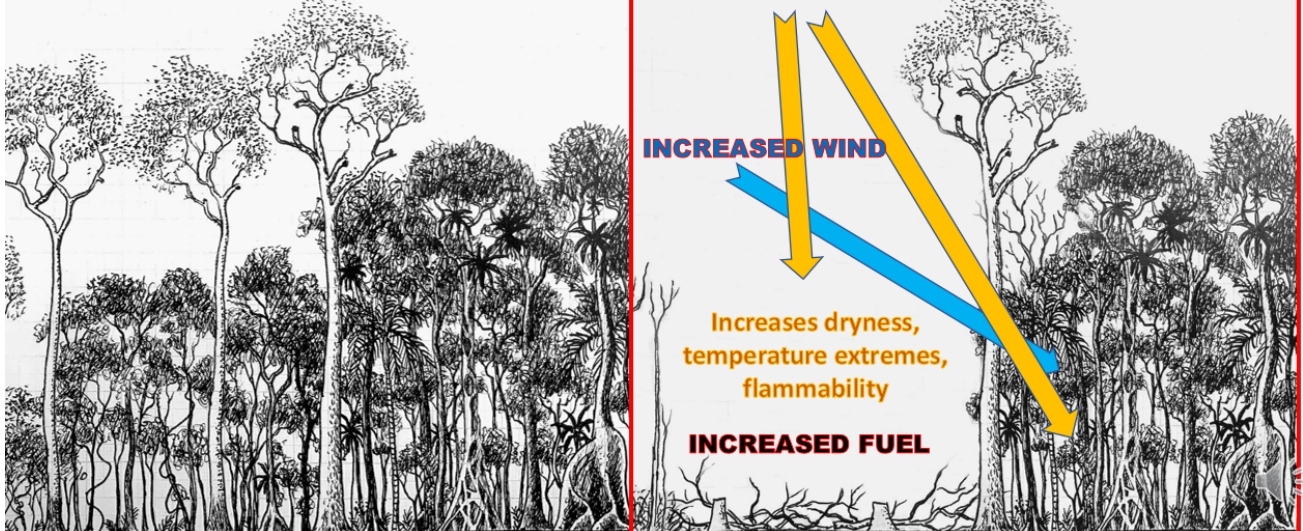
IMPACTS OF LOGGING ON FLAMMABILITY

Increased drying: due to evapotranspiration of regrowth, opening of canopy, solar radiation, wind etc.

Increased fuel: from logging debris, self-thinning of post-fire regrowth, increase in more flammable weeds and plants, etc.

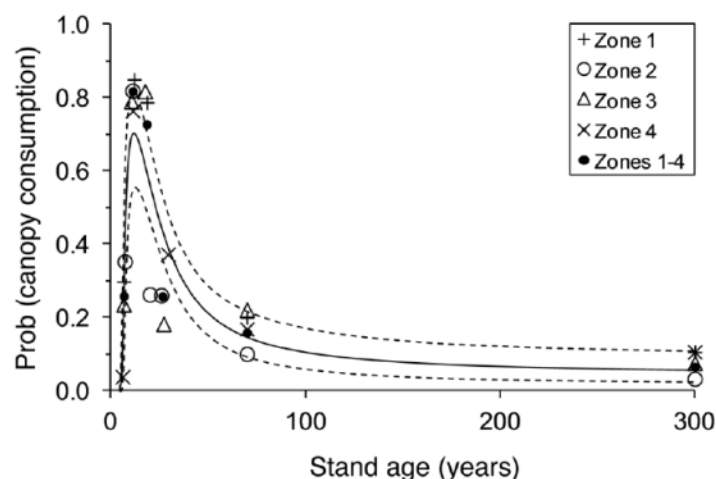
More contiguous foliage aids flame spread: due to contiguous regrowth canopy and connection to ground fuels.

The changes extend well into mature rainforest



Taylor *et. al.* (2014) assessed the impact of Victoria's 2009 wildfires on Mountain Ash forests, finding "the probability of canopy consumption increased rapidly with age up to approximately 15 years ... In stands older than 15 years, the probability of canopy consumption decreased with age, such that it rarely occurred in stands aged around 300 years". They note:

... a strong relationship between the age of a Mountain Ash forest and the severity of damage that the forest sustained from the fires under extreme weather conditions. Stands of Mountain Ash trees between the ages of 7 to 36 years mostly sustained canopy consumption and scorching, which are impacts resulting from high-severity fire. High-severity fire leading to canopy consumption almost never occurred in young stands (<7 years) and also was infrequent in older (>40 years) stands of Mountain Ash.



Probability of canopy consumption versus stand age (Fig 7 from Taylor *et. al.* 2014)

From his study of 58 years of fires in the Australian Alps Zylstra (2018) found that "forests were most likely to experience crown fire during their period of regeneration", noting:

The strongest response was observed in tall, wet forests dominated by Ash-type eucalypts, where, despite a short period of low flammability following fire, post-disturbance stands have been more than eight times as likely to burn than have mature stands. The weakest feedbacks occurred in open forest, although post-disturbance forests were still 1.5 times as likely to burn as mature forests.

After logging the large quantities of tree crowns, crushed plants and reject logs make the forest more vulnerable to burning, as noted by Lindenmayer *et. al.* (2009):

Large quantities of logging slash created by harvesting operations can sustain fires for longer than fuels in unlogged forest and also harbor fires when conditions are not suitable to facilitate flaming combustion or the spread of fire

For Jarrah forests, Burrows *et. al.* (1995) identify that the severity of wildfires and damage to retained trees has increased since pre-European times which "can be attributed largely to logging debris which ignites during summer wildfires".

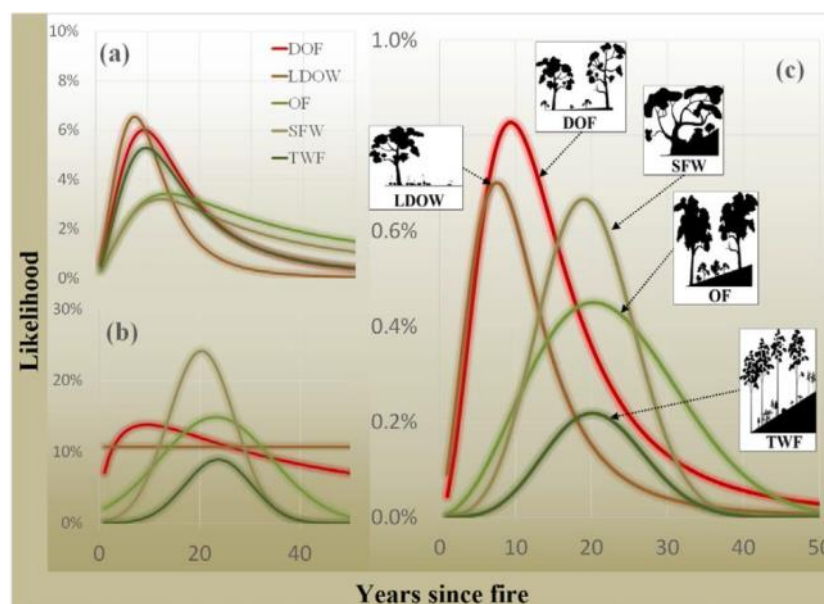


Figure 5 from Zylstra (2018). Flammability trends for each formation, where the x-axis gives years since the last fire, and the y-axis gives likelihood for (a) fire burning a point (L_r), (b) crown fire occurring if that point is burning (L_{cb}); and (c) crown fire occurring at any point (L_c). Labels refer to dry, open forest (DOF), low, dry open woodland (LDOW), open forest (OF), subalpine forest and woodland (SFW), tall, wet forest (TWF).

In the longer term weed invasion can also make the forest more vulnerable to burning. Lantana (*L. camara*) is the most widespread and successful weed throughout north-east NSW, benefitting from logging and other activities that open the forest canopy enough for it to thrive. Lantana now dominates the understorey in tens of thousands of hectares of northeast NSW's forests. Fire and cattle grazing are significant contributors to the successful invasion of lantana (Gentle and Duggin 1997), and it in turn can increase the flammability of vegetation (Fensham *et. al.* 1994, Gill and Zylstra 2005, Berry *et. al.* 2011, Murray *et. al.* 2013, Bowman *et. al.* 2014). Of the 79 species from dry sclerophyll forests tested by Murray *et. al.* (2013), lantana had the third shortest mean time to ignition for fresh leaves.

From their study of the Forty Mile Scrub National Park, Fensham *et. al.* (1994) found "the proliferation of lantana results in the build up of heavy fuel loads across the boundary of dry rainforest and savanna woodland. Recent fires have killed the canopy trees in a large area of dry rainforest within the Park". From their study of dry rainforests, Berry *et. al.* (2011) concluded that *L. camara* was less ignitable than native dry rainforest species, though:

Fuel bed depths, leaf litter depths, percentage cover by fuels and amount of medium size class fuels were higher in dry rainforest invaded by L.camara than in noninvaded forests. This suggests that the mechanism by which L.camara alters the fire regime in dry rainforest is by shifting the distribution of available fuels closer to the ground and providing a more continuous fuel layer in the understory

The increasing dominance of forest understoreys by lantana in north-east NSW due to logging significantly increases forest's flammability and the wildfire threat.

The EPA needs to recognise that the 2019-20 fires, and accompanying drought, had a major impact on forest species and ecosystems, leaving many in a heightened state of vulnerability and at increased risk of extinction, and thus necessitating a permanent increase in protection. Requirements include implementing and rehabilitating 100m buffers around rainforest.

The EPA needs to recognise that logging makes forests more vulnerable to wildfires and increases their flammability by drying them, increasing fuel loads, promoting more flammable species, and changing forest structure. This includes increasing the risks of canopy fires by reducing canopy height, increasing tree density and increasing fuel connectivity from the ground into the canopy.

5. Running down soil carbon.

The Natural Resources Commission (NRC) released the DPIE/University of Sydney report "Determining baselines, drivers and trends of soil health and stability in New South Wales forests – Regional Forest Agreement regions". Basically they concluded there was very little baseline data to measure anything against, so more information will be collected as we blunder on in ignorance, despite the evidence that soil health is declining. It is noted "*very little monitoring has been undertaken in the last decade*". It is interesting that they refer to a 2008/9 NSW Monitoring, Evaluation and Reporting (MER) program initiated by NRC that sampled 800 paired soil sites as baselines to be remeasured every 5 years, but only 60 have since been remeasured – and none were remeasured for this project. This is a clear demonstration of what we can expect in the future - ignorance is bliss.

WTF. It is astounding that soil data collected by the Forestry Corporation as part of its licence requirements is not shared and was not considered!

Forestry Corporation of NSW collect soil regolith information within the RFA regions from state forests as part of an inherent soil erosion and water pollution hazard assessment prior to timber harvesting and commencement of roading operations in native forests as a requirement of the Coastal Integrated Forestry Operations Approvals. This information is not submitted to the NSW Soil and Land Information System and is thus not available for this analysis.

Despite model performance being limited by the lack of current soil data, the digital soil modelling undertaken indicates significant impacts of logging, burning and grazing on soil organic carbon (SOC), that will be greatly increased as climate change progresses, representing a major impact:

- *Increased forest disturbance (as represented by the FDI) results in decreasing SOC and increasing bulk density, suggesting poorer soil structure and condition. These changes are typical for any human operation that removes carbon-based products and sees a reduction in vegetation cover, such as timber harvesting and stock grazing. The modelling revealed that areas of moderate disturbance (e.g. subject to periodic stock*

grazing) had greater impact on forest SOC, bulk density and associated soil condition than less disturbed areas.

- Climate change was shown to contribute to a decline in SOC over most of the region. The projected decline in SOC suggests an associated decline in soil condition suggests that forest managers will have to implement appropriate soil carbon-enhancing strategies to maintain current SOC levels. This also has implications for identifying ongoing net carbon emissions from NSW lands, with respect to aiming for Net Zero Emissions (NSW Government 2016; DPIE 2020) and mitigating climate change.*
- Climate change was also shown to contribute to a slight rise in pH over most of the region. Any significant change in soil pH, either rise or fall, can be detrimental to natural ecosystems that are adapted to particular pH ranges. A resulting degree of migration of ecosystems may be an eventual consequence of these changes (Steffen et al. 2009).*
- Bushfires are demonstrated to have a major influence on SOC, with a dramatic loss predicted immediately following the bushfire, in the order of 50% (relative loss). This is followed by a gradual recovery of SOC in the following years, with over 60% recovery after 20 years and approaching re-equilibrium levels after approximately 75 years. Based on this scenario, SOC may be subject to continuous decline with more frequent fires. Further analysis is required to evaluate this trend. The influences of prescribed and cultural burning on SOC were not assessed in this study, but should be examined in ongoing monitoring programs.*

...No SOC decline occurs over relatively undisturbed lands, then moderate declines (mean - 9% in relative terms for 0-30 cm) over partially disturbed lands, and highest declines (mean - 20.38% in relative terms) over moderately disturbed, periodically grazed forest lands ...

[By 2070 climate change causes] A mean relative loss of 17% for the 0-30 cm interval is projected over both North east subregions, rising to over 37% relative loss in the Southern region. The results represent the mean of 12 climate model projections under the IPCC intermediate A2 emission scenario applied in the NARClIM program (Evans et al. 2014).

So in response to this evidence of declining Soil Organic Carbon (SOC) due to climate change, what has EPA done to ensure “forest managers will have to implement appropriate soil carbon-enhancing strategies to maintain current SOC levels”? How have they changed the CIFOA or PNF Code of Practice to increase retention of SOC? Despite being made aware of this problem they have done nothing.

6. We are fast running out of time.

There is no time to waste in turning this around as forests are already succumbing to climate change and reducing their ability to take up the carbon we emit. The increasing frequency of wildfires is accelerating the degradation of forests, as evidenced by the burning of 35% of north-east NSW's rainforests in the 2019-20 fires. If forests are turned from carbon sinks into carbon sources we have no chance of averting the unfolding climate catastrophe. We must act now while forests still have the ability to assist the transition.

The consequences of increasing temperatures and more erratic rainfall due to climate change are more frequent droughts and extreme temperatures. Steffen et.al. (2015) identify that by 2070 Sydney's average number of hot days (>35°) will increase from 3.4 to somewhere between 4.5-12 days per annum. As identified by Fensham et. al (2009)

A doubling in the frequency of severe droughts has been predicted under future climate scenarios. The physiological effect of drought on trees may well be enhanced by rising

temperatures, ... Enhanced drought conditions will intensify tree-death which is likely to be a symptom of global climate change.

Allen et. al. (2008) note "studies compiled here suggest that at least some of the world's forested ecosystems already may be responding to climate change and raise concern that forests may become increasingly vulnerable to higher background tree mortality rates and die-off in response to future warming and drought",

Episodes of widespread tree mortality in response to drought and/or heat stress have been observed across the globe in the past few decades. As noted by Anderegg et. al. (2016):

... the principal cause of drought induced tree death has been found to be the failure of a plant's vascular water transport system through embolism caused by air bubbles during high xylem tensions caused by low soil moisture and/or high atmospheric evaporative demand during drought, though there are numerous other contributing influences

Griscom et. al. (2017) warn "Unchecked climate change could reverse terrestrial carbon sinks by midcentury and erode the long-term climate benefits of NCS. Thus, climate change puts terrestrial carbon stocks (2.3 exagrams) at risk", noting:

Delaying implementation of the 20 natural pathways presented here would increase the costs to society for both mitigation and adaptation, while degrading the capacity of natural systems to mitigate climate change and provide other ecosystem services. Regreening the planet through conservation, restoration, and improved land management is a necessary step for our transition to a carbon neutral global economy and a stable climate.

Bastin et. al. (2019)'s assessment is that forests are coming under increasing stress due to climate heating, with tropical forests most at risk of being lost by 2050:

our model highlights the high probability of consistent declines of tropical rainforests with high tree cover. Because the average tree cover in the expanding boreal region (30 to 40%) is lower than that in declining tropical regions (90 to 100%), our global evaluation suggests that the potential global canopy cover will decrease under future climate scenarios ... leads to a global loss of 223 Mha of potential canopy cover by 2050,

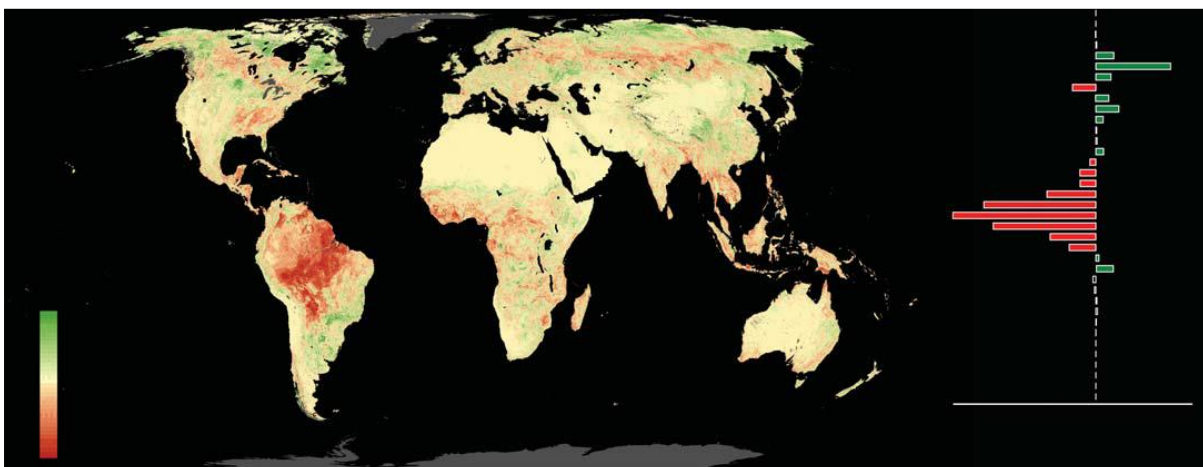


Fig. 3 from Bastin et. al. (2019): Risk assessment of future changes in potential tree cover. (A) Illustration of expected losses in potential tree cover by 2050, under the “business as usual” climate change scenario (RCP 8.5), ... (B) Quantitative numbers of potential gain and loss are illustrated by bins of 5° along a latitudinal gradient.

Tree dieback has been recognised in the New England area since the mid 1800's (Lynch et. al. 2018), though it achieved widespread notoriety during the 1970s and 1980s. This dieback has been attributed to a multitude of factors including clearing, fungi, grazing, native animals (e.g. koalas,

possums, territorial birds), climatic changes, land degradation, parasitic plants, and repeated defoliation by insects.

Ross and Brack (2015) assessed 'Monaro dieback' as affecting 2,000 km², with almost all Ribbon Gum (*E. viminalis*) within that area either dead or severely affected. The problem dated back to 2005. Ribbon Gum is the dominant species in the region, and the only one badly affected, yet they considered that at the then rate *"it seems inevitable that E. viminalis will disappear entirely from the Monaro region"*.

Lynch et. al. (2018) identify that in the ACT region there has been severe dieback of Blakely's Red gum (*Eucalyptus blakelyi*) dating back to 2004, with an additional 7 eucalypt species affected in recent years.

Australia's forests and woodlands are strongly influenced by large climatic variability and recurring droughts. Extreme droughts can cause widespread tree death in agricultural lands, woodlands and forests (Fensham and Fairfax 2007, Fensham et. al 2009, Mitchell et.al. 2014, Ross and Brack 2015). Mitchell et.al. (2014) identify that a wide range of studies have implicated temperature increases as amplifying moisture deficit, heat stress, and the impacts of biotic agents on tree species.

Within trees hydraulic failure (desiccation of water conducting tissues within the plant) and carbon starvation (depletion of available carbohydrates and failure to maintain defences against biotic agents) have been singled out as causes of tree death (Mitchell et.al. 2013, 2014). Mitchell et.al. (2014) found that periods of heat stress during droughts were likely to have been pivotal in initiating tree death. Species have been found to have differing susceptibilities (Calvert 2001, Fensham and Fairfax 2007, Mitchell et.al. 2013, Ross and Brack 2015, Lynch et. al. 2018). Fensham et. al (2009) also found trees at higher densities more vulnerable. In some cases, a drought event may simply be the coup-de-grace for a weakened stand of trees.

Mitchell et.al. (2014) consider their findings suggests that *"regardless of regional climatic differences, tree populations among many species in Australian ecosystems tolerate at least 98% of the climatic conditions they experience and become vulnerable to drought stress events beyond this common climatic threshold"*, noting *"the likelihood of drought events crossing these thresholds and inducing mortality will increase significantly under future climate scenarios for many forest and woodland ecosystems globally"*.

Interactions of drought effects with biotic agents and their feedbacks can also significantly change the demographic patterns of tree mortality (Anderegg et. al. 2016). Droughts can increase attacks by a variety of insects. Keith et. al. (2012) found the *"combined impact of drought stress and insect damage resulted in markedly reduced growth (45–80%) and higher mortality of trees (5–60%)"*, concluding *"Drought conditions result in (1) weather conditions that break the synchronisation of insects with parasites and predators resulting in insect outbreaks, (2) moisture stress that predisposes trees to attack by insects, and (3) moisture stress that restricts leaf regeneration after damage"*. Marsh and Adams (1995) found that chronic insect infestations and periodic insect outbreaks may be supported by high concentrations of nitrogenous solutes in sap and foliage, especially epicormic foliage, which in turn may be a response to drought.

Lambert (2015) observe:

Epicormic leaves of eucalypts following sessions of defoliation have been observed to contain high levels of nitrogen, particularly nitrogenous solutes such as proline, compared to mature leaves (Marsh and Adams 1995). Foliage nitrogen levels are also high during periods of drought when nitrogen soil availability increases. Xylem sap taken from dying trees contained a higher level of nitrogen than that taken from healthy trees (Marsh and Adams

1995). The increased uptake of nitrogen has been related to increases in herbivory, eventually leading to tree decline (Landsberg et al. 1990, Granger et al. 1994).

Mitchell et.al. (2014) warn:

Changes in the frequency of extreme drought under the scenario presented here and elsewhere ... may also reduce vegetation resilience through time if a complete recovery of plant vasculature, carbohydrate status and defensive mechanisms is not realized in the intervening years between drought events. A small number of predicted droughts fell outside the margins of the observed record and are perhaps indicative of "mega-drought" conditions, characterized by higher intensities and longer durations than have ever been observed in the historic record ... If realized, these climate events may generate unprecedented, extensive die-off that could induce long-term shifts in vegetation structure and function.

An American study found forests are shifting to communities that can cope with greater average water stress as well as more variability in water stress, primarily through the death of less hardy tree species (Trugman et. al. 2020)

The EPA needs to recognise that trees are increasing sickening and dying as the result of increasing droughts and heatwaves generated by global warming. This problem is aggravated by a variety of stressors on tree health, including logging, grazing and weed invasion. As evidenced by the increasing severity of droughts, heatwaves, and wildfires we are perilously close to a cascading series of feedbacks that cause the irreversible decline of forest ecosystems and the release of vast quantities of carbon stored in forest vegetation and soils into the atmosphere, making them into carbon sources rather than sinks. As shown by the 2019-20 fires we don't have any time to waste.

7. Bell Miner Associate Dieback.

Bell Miner Associated Dieback (BMAD) is a symptom of weed invasion following logging, being compounded by trees being put under stress due to climate heating. Forests affected by BMAD are characterized by low dense understories of weeds (mostly lantana) or vines, overtopped by scattered dead or dying eucalypts, a cacophony of Bell Miner calls, and depleted native species.

Bell Miners are the Bell Birds that were eulogized in Henry Kendall's 1869 poem. Henry Kendall was appointed inspector of state forests in 1881. Little did he realise that the "Bell-birds" he extolled would one day cause the degradation and death of the forests he loved at the hands of the agency he served. Now the "*notes of the bell-birds ... running and ringing*" are no longer confined to the "*spring and to river*" and are expanding throughout the landscape at an alarming rate. To many their calls no longer have connotations of "*the beauty and strength of the deep mountain valleys*" but rather of lantana understories and dying trees.

By the early 1940s (Campbell and Moore 1943) BMAD was recognised as killing thousands of hectares of forest. It is not a new problem, just a neglected one that appears to be rapidly expanding.

The seriousness of BMAD is acknowledged in the NSW & CoA (2009) 5 year review of the RFA:

The resultant cycle of tree stress commonly causes the eventual death of forest stands, and serious ecosystem decline. In NSW the potential impact of BMAD-induced native vegetation dieback represents a serious threat to sclerophyll forest communities, particularly wet sclerophyll forests, from Queensland to the Victorian border. The forests most susceptible to dieback are those dominated by Dunn's white gum (Eucalyptus dunnii), Sydney blue gum (E. saligna), flooded gum (E. grandis) and grey ironbark (E. siderophloia). There is also evidence that some normally nonsusceptible dry sclerophyll types may be affected when

dieback is extreme. Current estimates place the potential at-risk areas at a minimum of approximately two and a half million hectares across both public and private land tenures in NSW.

BMAD is emerging as a pressing forest management issue in both the UNE and LNE regions. The potential impacts include:

- *degradation of sclerophyll forest ecosystems across the UNE and LNE*
- *reduction in diversity and abundance of threatened flora and fauna species including Dunn's white gum and rufous bettong*
- *increased weed invasion and associated displacement of native forest species.*

Dieback-affected areas are located in the catchments of the major rivers of the North Coast of NSW including the Tweed, Richmond, Clarence, Macleay and Hastings. Maintenance of water quality in these river systems is critically dependent on maintenance of healthy forest cover over the catchment uplands. Bell miner associated dieback has the potential to degrade these forests, and consequently impact negatively on rivers and catchment communities through increased sediment and nutrient loads, and increased frequency and intensity of flooding.

Serious stuff, but not enough for the Government to stop compounding the problem by logging affected and susceptible stands.

Since 1992 NEFA have raised the problem of BMAD in numerous forums, committees, submissions, audit reports and complaints to both State and Federal Environment Ministers. We have accompanied the Forestry Corporation CEO Nick Roberts, the EPA's CEO Barry Buffier, and the then Minister for the Environment Mark Speakman, and a variety of others, on site inspections of BMAD to demonstrate the problem. We have made numerous submissions to inquiries, identified the problem in forest audits, and publicised the problem.

The core of the problem with having it addressed is the refusal for the Forestry Corporation or the Environment Protection Authority to admit any connection with logging – despite the abundant evidence to the contrary.

The basic process for initiating Bell Miner Associated Dieback (BMAD) is:

- Logging removes canopy and creates soil disturbance
- Lantana invades and takes over understorey
- Bell Miners thrive in altered habitat and aggressively exclude most other species
- Bell Miners 'farm' sap sucking psyllids that feed on eucalypt leaves,
- populations of psyllids explode, sucking the life out of eucalypts
- eucalypts sicken and die, often over decades
- BMAD

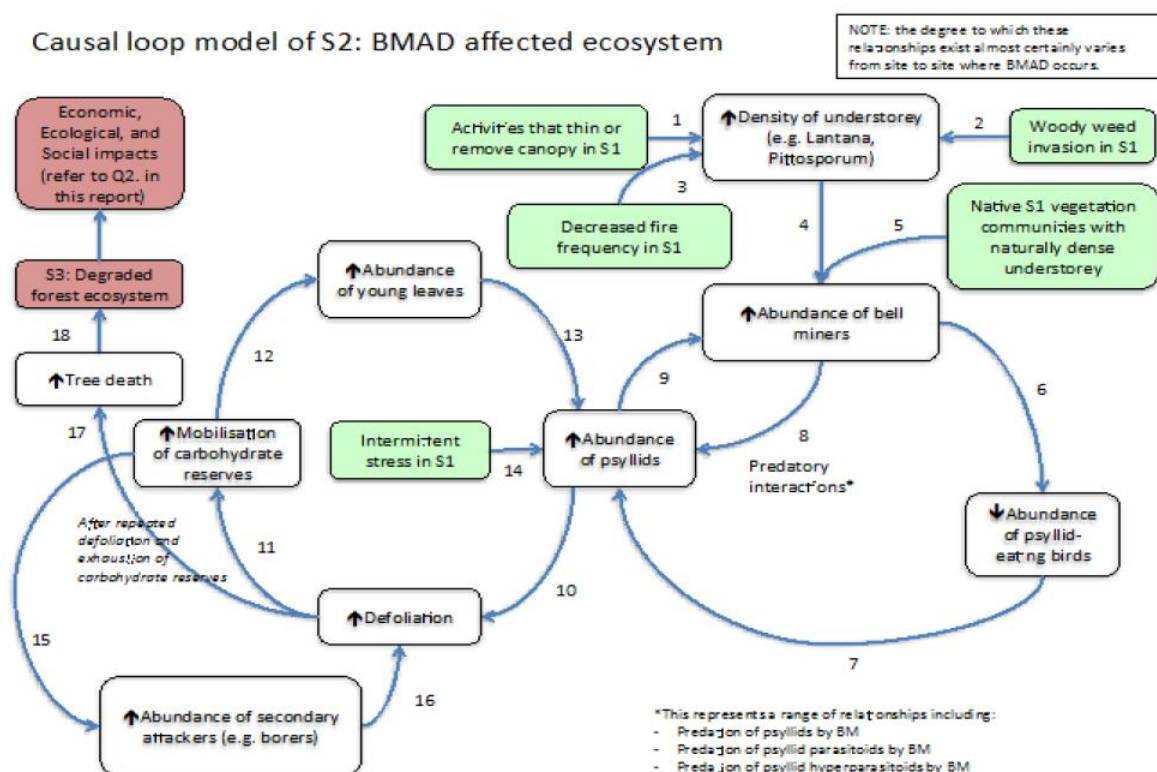
NEFA has no doubt that it is clear that logging initiates Lantana invasion and BMAD, and that relogging affected stands aggravates BMAD.

The NSW Scientific Committee's (2008) final determination for listing 'Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners' as a Key Threatening Process notes that *Broad-scale canopy dieback associated with psyllids and Bell Miners usually occurs in disturbed landscapes, and involves interactions between habitat fragmentation, logging,*

Florence (2005) also emphasised the "struggle" between eucalypt and rainforest as a fundamental factor in BMAD, basically concluding, as has been apparent for many decades, that such forests are not suitable for the management they are being subject to:

Where destabilised by post-settlement fire and logging, changes in ecosystem processes may have exposed the limits of the eucalypts' capacity to cope with soils with consistently high levels of available nutrients.

NSW DPI recently completed another literature review of the causes of BMAD (Silver and Carnegie 2017). Almost 20 years after Stone (1999) they derived yet another conceptual model, which yet again identifies "activities that thin or remove canopy" as the primary cause of BMAD.



Summary extracts from literature review of Silver and Carnegie (2017):

- Activities that reduce the density of overstorey canopy, or produce gaps in the overstorey, result in increased light availability and reduced competition for space and other resources resulting in an increase in density of understorey plants, such as lantana
- Numerous studies have shown that woody weed invasion, especially lantana, leads to an increase in density of the understorey, often to the detriment of native understorey and mid-storey tree species. Canopy thinning or gaps provide ideal conditions for lantana (primarily increased light), which tends to subsequently dominate the site (Duggin and Gentle, 1998; Gentle and Duggin, 1997). Lantana can take better advantage of increased resources (nutrients) following disturbance, thus accumulating more biomass and further suppressing native shrub species (Gentle and Duggin, 1998).
- A dense understorey, either of exotics (e.g. lantana) or natives, is said to be the preferred habitat of Bell miners for nesting as it is assumed such habitat "facilitates cooperative defence of their territory from predators and competitors (Stone et al., 2008).
- Numerous studies have shown that Bell miners apply interspecific aggression via mobbing behaviour to exclude other avian species from their colony territory.

- *A high proportion of the avian species that are excluded from Bell miner sites, such as spotted pardalotes, white-naped honeyeaters and crimson rosellas, predate on psyllids*
- *Several studies have reported an observed increase in psyllid numbers in areas supporting high numbers of Bell miners*
- *Numerous studies have shown the link between high numbers of psyllids and Bell miner abundance, with Bell miners observed at sites with high numbers of psyllids*
- *Numerous studies have shown a clear link between psyllid attack and defoliation*
- *When biotic or abiotic agents defoliate trees, they utilise carbohydrates — via ongoing photosynthesis or from storage organs — to replace foliage. If trees are repeatedly severely defoliated, such that photosynthesis is hindered (or ceases) due to lack of photosynthetic tissues (leaves), then carbohydrate stores can be depleted during crown replacement and ultimately result in dieback and death*
- *Numerous studies have measured the mobilisation of stored carbohydrates to replace foliage following defoliation events*
- *the favourableness of *E. blakelyi* leaves as a source of food was the principal influence affecting *Glycaspis* spp. abundance; young leaves (4–8 weeks old) were more favourable than mature leaves,*
- *Plant stress results in increased concentrations of nitrogen in the phloem, which benefits sap-sucking insects (Huberty and Denno, 2004). Conversely, the resultant reduction in turgor from drought stress may impede psyllid feeding due to reduced turgor. Intermittent water stress, therefore, appears to benefit sap-suckers as opposed to continuous water stress.*
- *Severe and repeated defoliation by insects, resulting in reduced carbohydrate reserves, has been shown to result in an increase in attack by secondary pests and diseases.*
- *Secondary pests and diseases attack trees weakened by repeated defoliation and starved of carbohydrate reserves.*
- *Several studies have shown that repeated, severe defoliation by insects (or artificial crown removal) can exhaust carbohydrate reserves due to ongoing crown regeneration — and lack of carbohydrate replacement via photosynthesis due to lack of photosynthetic organs — leading to tree mortality*

NEFA have been trying for years to get the Environmental Protection Authority to take action on this issue and to stop the Forestry Corporation from targeting BMAD affected and susceptible stands for logging, and to rehabilitate areas after logging. BMAD has been specifically identified in NEFA reports and audits of logging [Yabbra \(2009\)](#), [Royal Camp \(2012\)](#), [Koreelah \(2013\)](#), [Richmond Range \(2014\)](#), [Donaldson \(2014\)](#), [Cherry Tree \(2015\)](#) and [Sugarloaf \(2016\)](#) State Forests. The agencies refusal to apply the precautionary principle was established early on. In 2010 the Department of Environment Climate Change and Water (DECCW - the forerunner of the EPA forest unit) responding (Simon Smith, DECCW, 19/5/2010):

DECCW notes your concerns regarding Bell Miner Associated Dieback (BMAD) and the principles of ecologically sustainable forest management. It is noted however that the NSW Scientific Committee's determination in relation to broad-scale canopy dieback associated with psyllids and Bell Miners "involves interactions between habitat fragmentation, logging, nutrient enrichment, altered fire regimes and weed-invasion". The Scientific Committee's determination also notes that "at present, no single cause explains this form of dieback. And it appears that 'Forest eucalypt associated with over-abundant psyllids and Bell Miners' cannot be arrested by controlling a single factor". An Inter-agency BMAD working group is

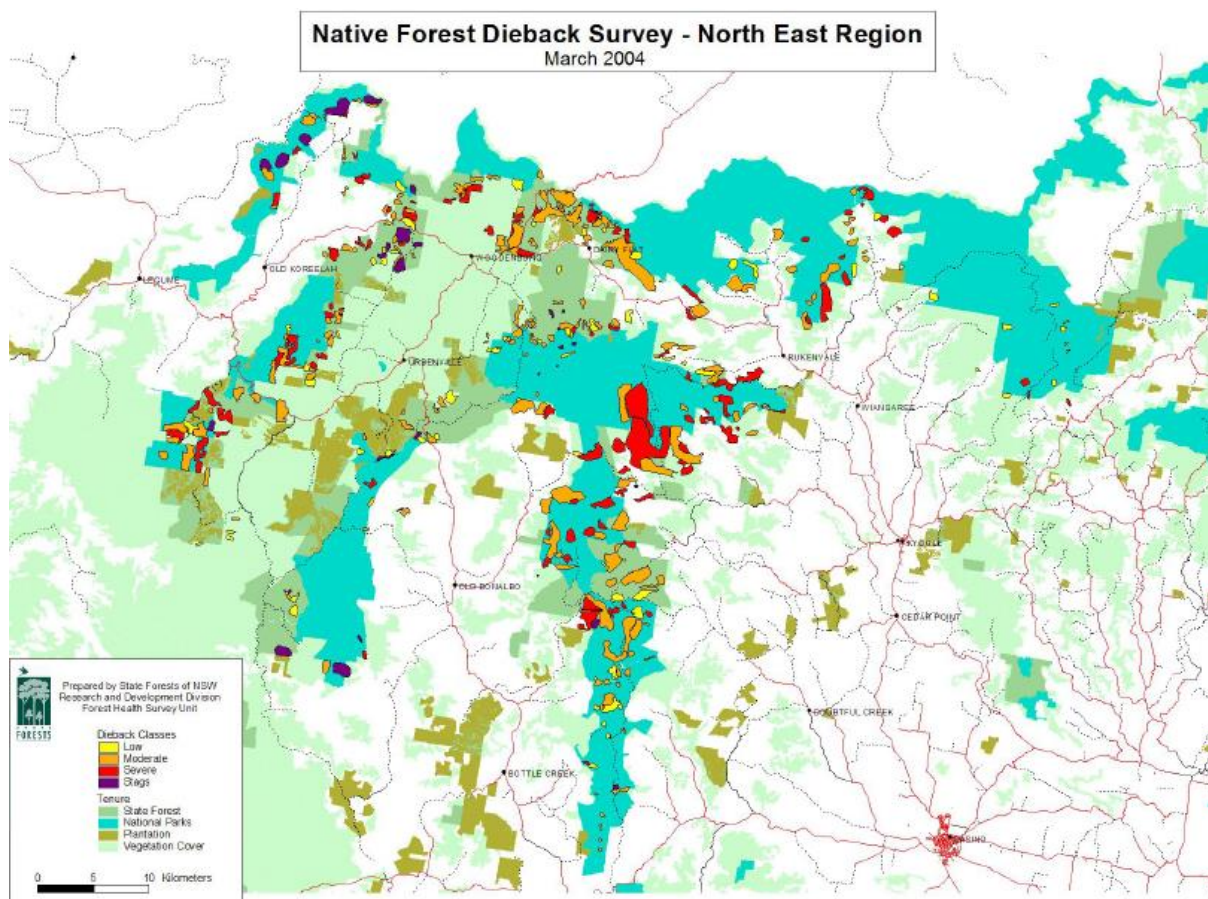
working to improve knowledge on the interrelation of land management activities and the prevalence of BMAD.

...

As noted above, the NSW Scientific Committee's determination notes that there is inadequate information available to determine if Bell Miner populations and Bell Miner associated Dieback has been favoured by these logging and burning operations.

This is not how the precautionary principle is intended to be applied.

Silver and Carnegie (2017) include a series of profiles of incomplete and anecdotal "trials", including over areas with no apparent BMAD. The only two with any relevance to forestry were conducted by the Forestry Corporation in Donaldson State Forest in 2005 and Mount Lindesay State Forest in 2007, using \$120,000 of Environmental Trust monies with a requirement that they be monitored for 15 years. Despite an inter-agency committee overseeing the project, the consultants claimed to not be aware of the outcomes of these trials until provided with a 2015 Forestry Corporation powerpoint by me, and even then they did not report on the dramatic results (see below). The fix has been in on this issue for years.

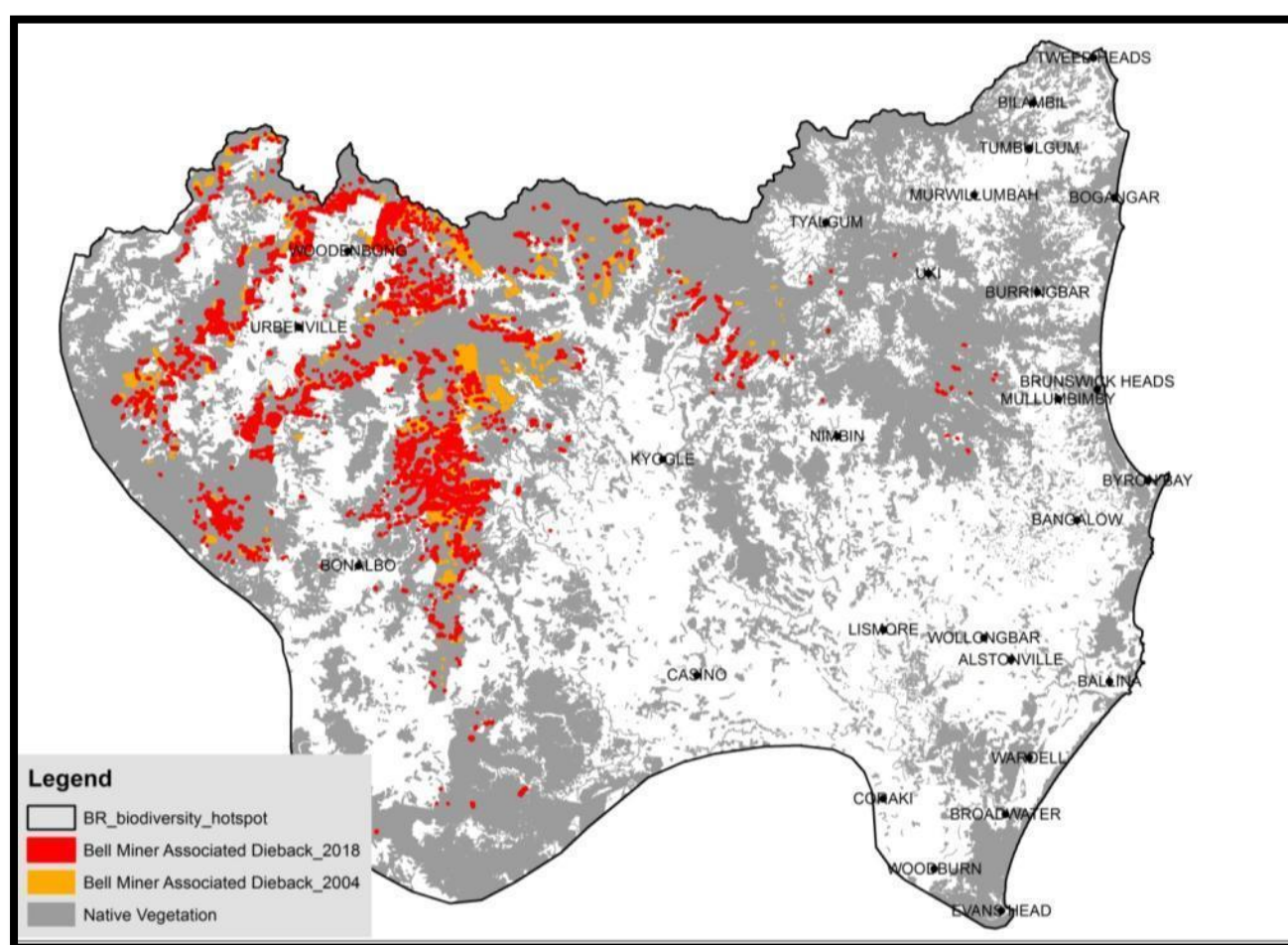


State Forests' (Carnegie 2004) 2004 mapping of BMAD in the western Border Ranges.

In 2004 State Forests (Carnegie 2004) used a helicopter to sketch-map almost 20,000 hectares of the approximately 100,000 hectares of apparently susceptible forest types in the Urbenville Management Area as being affected by dieback attributed to BMAD. The mapping identified the following areas of severity classes: Low 2,205ha Moderate 9,776ha, Severe 6,511ha, and Stags 1,382ha. The 2004 assessment was conservative as many areas known to be affected were missed, even when on the flight path (Jurskis and Walmsley 2012, Pugh 2014).

The process was repeated by Silver and Carnegie 2017, who mapped 44,777ha of BMAD over some 1,250,000 hectares of forest north from Taree, comprised of 17,005ha on State Forest, 12,822ha on National Park, 1,540 on Crown Land, 12,885ha on private property and 525ha on plantations.

For the same area covered by Carnegie (2004), the 2017 mapping identified some 22,000ha of BMAD which would seem to be a good match, except that there is only an overlap of some 5,000ha (13%) between the two mappings which is an extraordinary mismatch, though as both mapping projects were undertaken by the same lead mapper the differences cannot be attributed solely to observer bias. Differences could be partially explained by annual fluctuations in perceived canopy health with weather conditions, though as 74% of the areas identified as severely affected in 2004 (i.e. *"consisted of many dead trees, severe thinning of crowns, low stocking rate of susceptible species and greatly increased mesophyllic ground story vegetation including weeds such as lantana"*) were mapped as having no dieback in 2018, it is hard to fathom how they could now have no visual evidence of dieback.



Forestry's mapping of BMAD in the Border Ranges region. The map shows the area mapped in 2018 (red) with the additional areas mapped in 2004 (orange). It is considered that both need to be adopted to obtain a realistic assessment of BMAD distribution, though even then the mapping misses a number of areas known to be affected and does not recognise those areas in the early stages of BMAD.

Given that BMAD affected forests are not recovering, and that many areas have been observed to have deteriorated (pers. obs.) it is considered that the only way to reconcile the divergent mapping is to combine it to identify overall extent. This gives a total area of 37,100 ha, which is 40% more than mapped by Silver and Carnegie 2017. This is considered to be conservative as it appears that

the mapping is missing some areas and not picking up many areas with the early symptoms of dieback (dense lantana understories and large populations of psyllids), where trees are sickening but as yet without major canopy damage.

So it is conservatively estimated that there is well over 100,000 ha of BMAD in north east NSW.

Recently the Natural Resources Commission identified a variety of issues with dieback of various forms, though in keeping with previous obfuscation they make no mention of logging or the role that it plays in BMAD. Matusick and Fontaine (2021) do mention:

For Bell-miner dieback, and other dieback events suspected to involve miner species, trials and research experiments are required to test the hypothesis outlined by Stone (1999) and Stone et al. (2008) regarding the role of lantana and canopy disturbance in creating and maintaining forest structural conditions that are favoured by miners. If the hypothesis is confirmed to be accurate, forest treatment protocols can be developed in order to restore forest patches that currently favour Bellminers or prevent the creation of more forest in this structural condition. Some combination of active silvicultural- and weed-management will likely be required in order to correct for the current ecological dysfunction.

Under “Land-use and management” in their summary Matusick and Fontaine (2021) only highlight fire regimes as warranting investigation. Though the category of “*Leaf-feeding Insects*” does include “*Through experimentation, testing the hypothesis developed by Stone (1999) regarding the role of lantana in ecosystem dysfunction in northeastern NSW*”. This advice is then translated by Natural Resources Commission into advice on recommended research priorities for the Environmental Trust, logging is of course ignored in the 20 research categories, with only “animal and plant control” coming close to dealing with the lantana issue.

It is clear that the NSW Government intends to go on ignoring the causes of BMAD so that they can go on logging affected and susceptible stands. They are intentionally ignoring the elephant in the room yet again. This demonstrates that their new commitment to monitoring for the RFA is another sham.

Given the abundant evidence that logging is the primary cause of Bell Miner Associated Dieback, that re-logging affected forests makes it worse, and that climate change is increasing tree stress and thus dieback, it is well past time that the EPA stopped turning a blind eye to the logging of BMAD affected and susceptible forests, and begins promoting restoration. If logging is to be allowed, it needs to be on a case by case basis, where lantana and Bell Miners are surveyed before the logging and monitored for five years afterwards. In keeping with the principle of adaptive management the results must be analysed, any needed corrective actions taken, and methods altered to minimise impacts before being trialled again.

As the current aerial mapping is subjective and does not provide a reliable basis for identifying the current extent of BMAD or to be able to monitor changes over time, it is recommended that the worst BMAD affected areas be subject to objective and repeatable mapping using High Resolution Multi-spectral imagery and ALS Lidar to:

- a) accurately identify the current extent of BMAD affected and susceptible forests**
- b) provide a baseline from which to assess changes over time**
- c) identify the variables affecting BMAD distribution**
- d) quantify the accuracy of current mapping and other remote sensing technologies**
- e) monitor the success of rehabilitation works.**

It is reprehensible that despite the public monies spent of rehabilitation works on both public and private lands over the past 20 years that only three studies have monitored the

outcomes of treatments on BMAD affected forests in north east NSW, and that for the two studies undertaken on State forests the Forestry Corporation has been allowed to largely suppress and ignore the unfavourable results. In order to better understand the causes of BMAD and assess the effectiveness and costs of rehabilitation, the Mount Lindesay and Donaldson trials need to be updated, and independent and transparent lantana (and other problem plant) removal trials need to be undertaken, using manual methods that minimise disturbance, with clear objectives, monitoring and reporting requirements.

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