Independent Forestry Panel

Public submission

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North East Forest Alliance

Submission to

Independent Forestry Panel

October 2024

North East Forest Alliance submission to: Independent Forestry Panel

Dailan Pugh, NEFA, October 2024

Now is the time to stop logging public native forests, there is no time to waste as forests and their inhabitants come under increasing stress and threat from climate heating, compounded by logging. We are in the midst of climate and extinction crises for which we need healthy and functioning forests. The over-riding imperative must be to stop degrading forests and rehabilitating them to restore their natural resilience and allow them to mitigate the worst impacts of climate heating by sequestering our CO_2 from the atmosphere and storing it out of harm's way in their wood and soils. We urgently need to stop logging the homes of threatened species if there is a genuine intent to save them from extinction.

NEFA supports the inclusion of all State forests satisfying the criteria for the national park estate as National Parks, Nature Reserves, State Conservation Areas, Regional Parks, or other conservation tenures, subject to Joint Management Agreements agreed with Aboriginal custodians, and preparation of Plans of Management with community consultation.

1 Sustainability of current and future forestry operations in NSW

Logging of public native forests is unsustainable because it is;

- a tree mining operation, progressively cutting out sawlogs and running down biomass, while it is being outcompeted by plantations
- an economic basket case, costing taxpayers a fortune, leaving degraded forests that will cost a fortune to repair and not paying the community any resource rent
- of declining importance for regional economies and employment as it depletes resources, centralises sawmills and becomes increasingly mechanised
- not ecologically sustainable because prioritising inflated timber yields above ecological needs is driving species to extinction, depleting essential resources provided by old trees, degrading forests, spreading weeds, causing ecosystem collapse, increasing fire risk, degrading soils, reducing streamflows and polluting waters

2 Environmental and cultural values of forests, including threatened species …

Forests have a multitude of environmental values, they generate rainfall and cool the land, clean the air, provide homes for a plethora of threatened species, are important for recreation and improved health, filter and regulate runoff to streams, and remove carbon dioxide from the air and store it in their wood and soils.

There is a need to increase protection for forests as 44% of NSW's species are forest dependent, with a high proportion of these threatened by extinction and predictions that half these threatened species will be extinct within 100 years. North east NSW is of national importance for threatened forest dependent fauna and flora. The ecological carrying capacity of most of NSW has been greatly reduced, with east coast forests having the highest remaining carrying capacity. North-east NSW's forests are the main climate change refugia of outstanding importance for the long-term survival of a plethora of native species. To satisfy our commitments to satisfy the goal to protect 30% of IBRA Bioregions by 2030 most State Forests require protection. For 175 priority fauna species in north-east NSW's forests identified in 1998, logging was considered a serious threat to 68% of species. It is evident that the current reserve system in north-east NSW does not protect viable populations of most priority fauna species. The basis of the problem is that national reserve targets for forest

reserves were over-ridden by timber resource commitments in 1998, since then logging has intensified and protections wound back to maintain timber volumes, and even after the devastating impact of the 2019/20 wildfires needed increases in protections for threatened species are not allowed to have any material impact on timber commitments. To give our threatened species a future it is essential we stop logging their homes and protect public native forests,

3 Demand for timber products, particularly as relates to NSW housing, construction, mining, transport and retail.

There is no longer any need to log public native forests. The market has already driven most production to plantations and it is time to complete the transition. Sawn timber from pine plantations and engineered timbers have largely displaced hardwood from the construction industry, which is an ongoing process. Export woodchipping is increasingly being displaced by plantation woodchips. Engineered timber from plantations is stronger than sawn timber for structural purposes. Composite fiberglass poles are replacing timber power poles. Solid hardwood flooring is an expensive product with far cheaper engineered, laminated and hybrid alternatives. Composite decking made from recycled plastic and pine sawdust is a cheaper and more durable alternative to solid timber. Pallets can be made from plantation timbers, and usage could be decreased by better recycling. There are many alternatives to native hardwoods for fencing. Mining props can be met from plantations. With a change in emphasis and a focus on supporting domestic manufacture of engineered timber products we can satisfy all our timber needs from existing plantations. Timber from private properties can satisfy requirements for speciality hardwood products.

4. The future of softwood and hardwood plantations and the continuation of Private Native Forestry in helping meet timber supply needs

With a change in emphasis, we can meet all our current timber needs from existing plantations. Hardwood and softwood plantations already provide 91% of Australia's log production. Already hardwood plantations produce 3.5 times the timber produced from native forests, The proportion of saw and veneer logs obtained from hardwood plantations needs to be increased, rather than 87% being exported as woodchips. Without competition from subsidised public native forests there will be an increased incentive for utilising plantation timber for higher uses, and selective logging of speciality purpose hardwoods from private forests. Some Government assistance may be required to assist the transition, particularly by filling gaps in domestic composite timber manufacturing.

5 The role of State Forests in maximising the delivery of a range of environmental, economic and social outcomes and options for diverse management …

The community have clearly identified over decades their over-whelming support for conservation, with Koalas of particular importance. It is evident that logging has been an economic disaster for taxpayers due to the high subsidies required to log public native forests, the lack of a resource rent and the degradation of ecosystem services, such as by diminishing large old trees, carbon storage, water yields, nectar (i.e. honey), tree-hollows and wildlife populations, while spreading weeds and dieback. Stopping logging will stop running down these assets and allow them to recover over time. Forests provide numerous quantifiable and intangible benefits to the broader community that far outweigh the economic benefits of logging, and are diminished by it. Rehabilitation of these degraded assets can provide direct and significant economic benefits by increasing carbon storage, tourist visitation and water yields, as well more intangible benefits such as increasing wildlife and people's health. All these values need to be considered and accounted for in determining the best use of State forests.

6. Opportunities to realise carbon and biodiversity benefits and support carbon and biodiversity markets, and mitigate and adapt to climate change risks, including the

greenhouse gas emission impacts of different uses of forests and assessment of climate change risks to forests

Rapidly increasing atmospheric CO_2 is causing climate heating, which is an existential threat to our future and quality of life. As temperatures rise, and droughts and wildfires increase in frequency and extent, it is a growing threat to the health and survival of numerous other species and is causing ecosystem collapse. We rely upon forests for numerous ecosystem services, including sequestering CO_2 from the atmosphere and storing it out of harm's way in their wood and soils. While we release large quantities of CO_2 by clearing and logging forests, the existential threat is that if forest ecosystems collapse and become net emitters of CO_2 then our ability to limit the extremes of climate heating will be lost. Given the developing climate crisis we urgently need to reduce our emissions of CO_2, particularly from fossil fuels, and allow forests to increase their sequestration of CO_2, which can be achieved by stopping logging them. It is important to recognise that plantations will take over a decade to begin sequestering, and many more decades before they start sequestering significant volumes, whereas if protected existing degraded forests can begin sequestering meaningful volumes immediately. This assessment is that logging of public forests in north east NSW releases over one million tonnes of CO_2 each year, and that by stopping logging the recovering forests will be able to sequester over two million tonnes of CO_2 per annum. Protecting existing forests and allowing them to regain their lost carbon is part of the solution to climate heating.

Additional summaries of related principal issues discussed in this submission

1 Sustainability of current and future forestry operations in NSW

Native forest logging is a tree mining operation, only maintained by increasing logging intensities, reducing log sizes, increasing utilisation, and removing protections for mature trees. It has progressively run down the biomass of forests as large trees are removed as they are progressively reduced to young regrowth or lantana. Sustainable yield estimations are invariably inflated and over committed, resulting in over-logging of sawlog resources and increasing emphasis on pulpwood. There have been a series of downward yield revisions, compensatory payments for inability to supply commitments, substitutions of small sawlogs for large, Wood Supply Agreement buybacks, logging in excess of estimated yields, and progressive wind backs of environmental constraints. Despite the 2019/20 wildfires killing many large trees and significantly impacting resources there has only been a token reassessment of resources and Wood Supply Agreements were extended at pre-fire levels until 2028, intentionally over-cutting. Yields continue to be overstated and over-committed as they continue to cut tomorrow's timber today.

The logging of public native forests has always been an economic burden on taxpayers due to the high subsidies paid, both through maintaining the loss-making native forestry operations of the Forestry Corporation, regular equity injections, and through direct payments to sawmill owners and occasionally workers. In 2022/23the Forestry Corporation lost $15 million on its hardwood operations, despite receiving a record handout of $31 million for its community service obligations, and having received over $200 million in government equity injects over the previous three years. Millers too received hundreds of millions in taxpayer funds over that time. Logging of public native forests is an economic basket case, due to declining yields, rising costs, and competition with sawntimber from softwood plantations, imported engineered wood products, and plantation woodchips. The hidden costs are the rundown in timber volumes, water quality and quantity, and wildlife populations, as well as the increase in weeds and dieback. Given that plantations are far more efficient and profitable it is past time to complete our transition to them for future timber needs.

The timber industry themselves are responsible for ongoing declines in employment in the forestry sector. With massive losses of 7,992 direct jobs due to industry restructuring over 15 years hardly rates a mention, with no consideration of multiplier effects. While inflated claims about the numbers of jobs reliant upon logging public native forests in NSW abound, it is apparent that if all logging of public native forests across NSW stopped less than 1,000 direct jobs would be affected, with around 500 of these in north-east NSW. This is in an industry in decline as they cut out the larger sawlogs, mechanise, restructure and are outcompeted by plantations.

Logging of native forests is not ecologically sustainable as it reduces biomass and carbon storage, removes mature trees and their abundance of nectar and browse essential for many species, removes and kills remaining hollow-bearing trees that provide essential homes for a plethora of NSW's species, increases fire threat and intensity, reduces stream flows, promotes weeds such as lantana, causes Bell Miner Associated Dieback and ecosystem collapse, reduces streamflows, degrades soils and increases erosion and stream pollution. The Forestry Corporation practices Ecologically Sustainable Forest Management in name only. It is repeatedly mentioned, though in practice is only a consideration, with ecological requirements systematically over-ridden by the requirement that protections for threatened species have no impact on timber yields. Changing logging prescriptions to account for the immense impact of the 2019/20 wildfires was met with obfuscation by the Forestry Corporation, ignoring of expert recommendations, political suppression of reports, and ended with continuation of business as usual, with at the best token voluntary measures in some areas.

4. The future of softwood and hardwood plantations and the continuation of Private Native Forestry in helping meet timber supply needs

The Forestry Corporation has been engaging in a process of [redacted] claiming areas of native forest as plantations since they first identified hardwood plantations in around 1990, with the criteria being that there was some evidence of seeds being scattered or seedlings planted decades earlier, with no site assessment required. Since then the Forestry Corporation has been steadily converting native forests into plantations. In 2000 and again in 2018 the Forestry Corporation claimed greatly expanded areas as hardwood plantations. Now once again the Forestry Corporation are claiming an expanded area, even adding areas in the past 2 years. While it is recognized that the forestry corporation has purchased some cleared lands for plantations, the conversion of native forests to plantations by stealth in objected to and many claimed plantations are not considered valid. Even where plantations were genuinely planted by clearing native forests, some are inappropriately sited and need to be restored for ecological reasons.

It is apparent that in north east NSW a significant volume of resources are obtained from private properties that will not be affected by protecting public native forests, thereby allowing a continuing supply of speciality hardwood products. The problem is that Private Native Forestry is not ecologically sustainable and not adequately regulated. Hopefully without competition from Government subsidised logging, landholders will be able to require a higher price and be encouraged to manage their forests in a more sustainable manner. It is considered that given their significant impacts and extent, PNF operations should be subject to a Development Application process like other developments on private lands.

5 The role of State Forests in maximising the delivery of a range of environmental, economic and social outcomes and options for diverse management …

Logging of public native forests is an economic basket case. In 2023 Forestry Corporation lost $15 million on their hardwood operations, that is a cost of $1,281 for each hectare logged. This is despite being paid $31 million for their community service obligations that year, and obtaining tens of millions in regular equity injections. We should not be paying to degrade forests and log the

homes of threatened species. Public forests are of greater economic benefit for water yields, tourism and carbon storage than they are for logging. It is in the best interest of taxpayers to stop logging of public native forests.

Tourism is far more important to the north coast economy than logging, and is the fastest growing sector promising increasing economic and employment benefits. National Parks attract significant numbers of tourists to north east NSW, and encourage extended stays, to experience their landscapes and wildlife. In 2019 there were over 15 million tourist visits to the north coast, and in 2018 over 7 million visits to national parks. It is in the community's economic interest to convert more of our public native forests to national parks as this will provide more fulfilling recreational opportunities and attract tourists to the region, as well as encouraging them to stay longer. In 2019 over $867 million of tourist expenditure on the north coast can be taken as associated with forested national parks. Due to the economic benefits of tourism in only takes a relatively small increase in visitation to outweigh any perceived benefits of logging, most importantly tourism can provide direct economic stimulus and employment in rural towns. The potential regional benefits of converting State forests to National Parks have been demonstrated by the University of Newcastle's assessment that over 15 years the creation of the Great Koala National Park would result in 9,135 additional full-time jobs, and increases in total output of $1.18 billion and value add of $531 million. The Government will maximise long term regional benefits by directing its resources into enhancing and diversifying forest recreational facilities, rather than subsidising logging and upgrading private sawmills.

Exposure to natural environments reduces most people's psychological and physiological (i.e. pulse rate, blood pressure, cortisol, salivary amylase, adrenaline) indicators of stress, while improving their mood and happiness. The experience can overcome mental fatigue and restore cognitive function. It is apparent that visiting natural areas makes a significant contribution to people's mental and physical health. Relating this to the self-perceived Personal Wellbeing Index has resulted in an estimation of the annual health services value of Australia's national parks as ~ $145 billion. Reserves that encourage increased recreation contribute to increasing this benefit.

Forests perform an essential function in regulating the volume and quality of water in streams, and are therefore important for maintaining aquatic ecosystems, providing potable water for many coastal towns, and providing water for downstream residences, fisheries and irrigation. Streamflow is the left-over rainfall that the forest does not use. Regrowth forests use significantly more water than old forests, thereby reducing water yields to streams. The effects of yield reductions are most pronounced in dry periods, when water is most valued, as the vegetation utilises proportionately more of the rainfall. Old forests also store water and regulate stream flows through groundwater, while removal of vegetation and soil compaction by logging increases rapid runoff and erosion, reducing water quality. Protecting degraded forests and allowing them to mature will increase water yields, improve water quality, and improve stream health, which will provide direct benefits to all downstream landholders and fisheries, with the highest economic value being where the catchments provide potable water for cities, towns and villages.

Community attitude surveys over the past 24 years clearly show that the community prioritise wildlife, water and carbon storage values of forests above timber production. The University of Newcastle assessed the biodiversity value (Willingness To Pay) of creating the Great Koala National Park as around $530 million for the NSW population and $1.7 billion for all Australians. A 2016 survey for the timber industry of 12,000 people found that native forest logging was considered unacceptable by 65% of rural/regional residents across Australia, and acceptable by just 17% of rural residents. Logging of native forests has very low levels of social license and is clearly not in the public interest.

6. Opportunities to realise carbon and biodiversity benefits and support carbon and biodiversity markets, and mitigate and adapt to climate change risks, including the greenhouse gas emission impacts of different uses of forests and assessment of climate change risks to forests

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. We urgently need to stop degrading forests and begin rehabilitating them to restore their resilience to climate changes, and enable them to continue their essential role in removing our carbon from the atmosphere and mitigating the worst impacts of climate heating for their and our futures.

Native forests play a crucial role in the storage of carbon and the sequestration of carbon dioxide from the atmosphere, with oldgrowth forests maximising carbon storage while continuing to sequester carbon. The volume of carbon stored in logged forests has been more than halved. Stopping logging will enable forests to regain their lost carbon and make a significant contribution to meeting our climate targets. This assessment indicates that stopping logging of native state forests in north-east NSW could sequester in the order of an additional 2 million tonnes of CO_2 per annum over the next hundred years, though another assessment put this as 0.45 million tonnes per annum over 65 years. While there is a need for an accurate assessment, it is apparent that recovering forests can sequester significant volumes of CO_2 and thereby help redress climate heating. It is essential that logging stop to allow forests to reduce the impacts of climate heating by removing CO_2 from the atmosphere, and recover their integrity to better withstand future disasters.

Following logging that most of a tree, being the leaves, branches, defective trunks, bark, stump and roots are left in the forest to decompose, with some burning or decomposing rapidly to release their carbon, while the larger residues, such as stumps and larger branches, may take decades to decompose and release their carbon. Of the timber removed from the forest, most ends up as sawdust or in short-lived products, which rapidly release their carbon, with only a small proportion ending up stored for decades in relatively long-lived products. Once its usefulness is finished, a small proportion may end up in landfill, where decay may be extremely slow due to the anaerobic conditions.

With the currently limited pulpwood market in north-east NSW, based on the limited data available the indications are that of each tree felled:

- 66.5% of its biomass is left in the forest, where around half will rot or burn rapidly releasing its carbon to the atmosphere and half (logs, stumps) slowly releasing its carbon over decades due to decay.
- 33.5% of its biomass may be removed in log form, with 20.7% of the tree carbon rapidly released from short-lived residues and hardwood products, and 12.8% ending up in longer lived hardwood timber products (at best) with various carbon retention times of 15 years to over 100 years (where buried in landfill).

Based on conservative assumptions, current logging of State Forests in north east NSW results in the release of over a million tonnes of CO_2 per annum, which is an ongoing process with carbon temporarily stored in products and logs over previous decades also progressively releasing its stored carbon. It is important to recognize that if the Forestry Corporation’s claims for sustainable yields are ever realized this could nearly double.

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Summaries of principal issues discussed

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1.1. Timber sustainability

Native forest logging is a tree mining operation, only maintained by increasing logging intensities, reducing log sizes, increasing utilisation and removing protections for mature trees. It has progressively run down the biomass of forests as large trees are removed as they are progressively reduced to young regrowth or lantana. Sustainable yield estimations are invariably inflated and over committed, resulting in over-logging of sawlog resources and increasing emphasis on pulpwood. There have been a series of downward yield revisions, compensatory payments for inability to supply commitments, substitutions of small sawlogs for large, Wood Supply Agreement buybacks, logging in excess of estimated yields, and progressive wind backs of environmental constraints. Despite the 2019/20 wildfires killing many large trees and significantly impacting resources there has only been a token reassessment of resources and Wood Supply Agreements were extended at pre-fire levels until 2028, intentionally over-cutting. Yields continue to be overstated and over-committed as they continue to cut tomorrow's timber today.

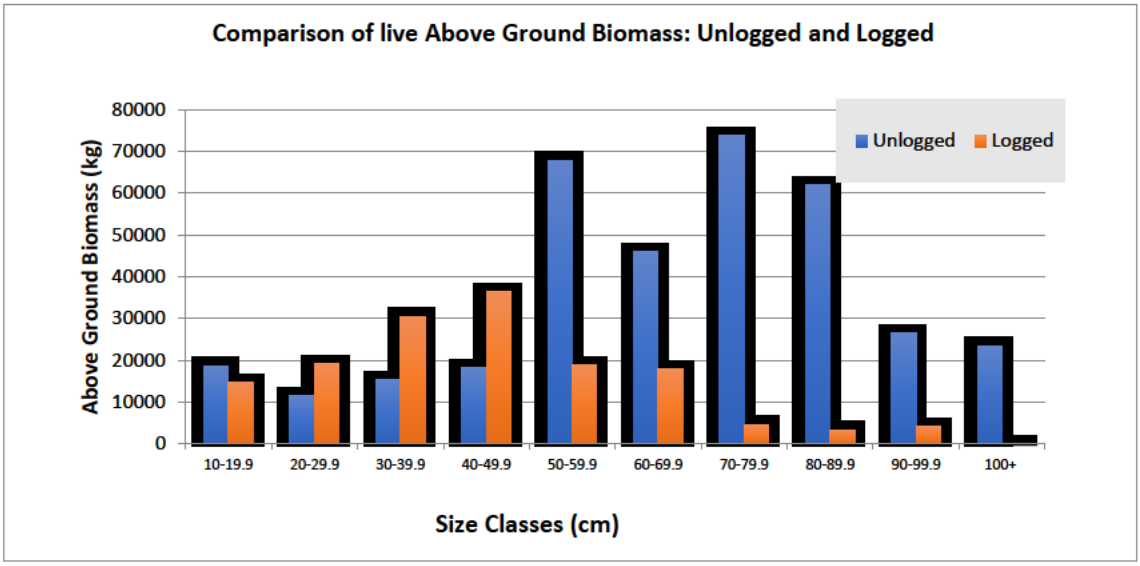
Allocations of timber from public native forests in Wood Supply Agreements in north east NSW has always been plagued by over estimation and allocation of resources. Resource shortfalls have been used as excuses to cut environmental constraints, while requiring payouts of over $13 million of public monies to buy back, or compensate for, commitments of phantom timber since the North East RFA was signed.

The Forestry Corporation's FRAMES is used to identify future resources. There is something fundamentally wrong with this software because it has been repeatedly found to generate inflated resource estimates. Since 2014 FRAMES has adopted radically different parameters that resulted in more than double the identified long term modelled yields of high-quality logs. At the time there were no tenure or exclusion area changes, so the doubling of volumes was purely based on changed modelling parameters.

Most recently the 2019-20 wildfires burnt through half on north-east NSWs State forests, causing widespread tree deaths, with estimates that at least a third of the region's State Forests were significantly affected, with a loss of 10-50% of large sawlog sized trees over 30 cm diameter at breast height, and 50-100% of smaller trees. Despite this the Forestry Corporation are unbelievably claiming short-term losses of only 4% and long-term losses of just 1%.

What is most disturbing is that the Forestry Corporation is primarily relying on subjective opinion and extrapolation from a sample of just 0.85ha of south coast forests to estimate impacts on 424,200 ha of the very different north coast forests. For some unfathomable reason they have still not remeasured and accounted for their 659 field plots within the heavily burnt forests to obtain real data on the fire impacts.

Current estimates of sustainable yields are therefore guesstimates. Using these as justification, Wood Supply Agreements due to expire in 2023 were extended until 2028 at the same volumes, thereby entrenching unsustainable logging, and continuing the time-honoured practice of cutting tomorrow's timber today.



Comparison of Above Ground Biomass of logged (over 20 years ago) and unlogged plots in Spotted Gum forest showing the dramatic reduction in the biomass of larger trees (from Pugh 2020). These data show there has been an overall loss of 59% of live above ground biomass from these forests, which increases to 65% of biomass for trees above 30 cm dbh and to 84% of biomass for trees above 50 cm dbh. These forests are now being relogged with over half the biomass (including most trees in the 40-80cm size class) allowed to be removed.

NEFA has undertaken a detailed appraisal of actual and modelled timber yields for north east NSW in 2015 The Battle for Sustainable Yields is Lost and in 2018 A Review of North East NSW Timber Predictions and Yields from Public Forests over the Past 20 Years. Also see https://www.nefa.org.au/logging_industry

1.1.1. A declining yield

In the North East NSW Regional Forest Agreement regions, Wood Supply Agreements (WSAs) were issued (for free) in 1998 for 269,000 m^3/yr (cubic metres per annum) of Large High Quality (LHQ) Logs from north-east NSW public forests and hardwood plantations, to log at 124% of the then estimated sustainable yield for the next 20 years. At that time NEFA presented detailed evidence to the Government that resources had been over-estimated.

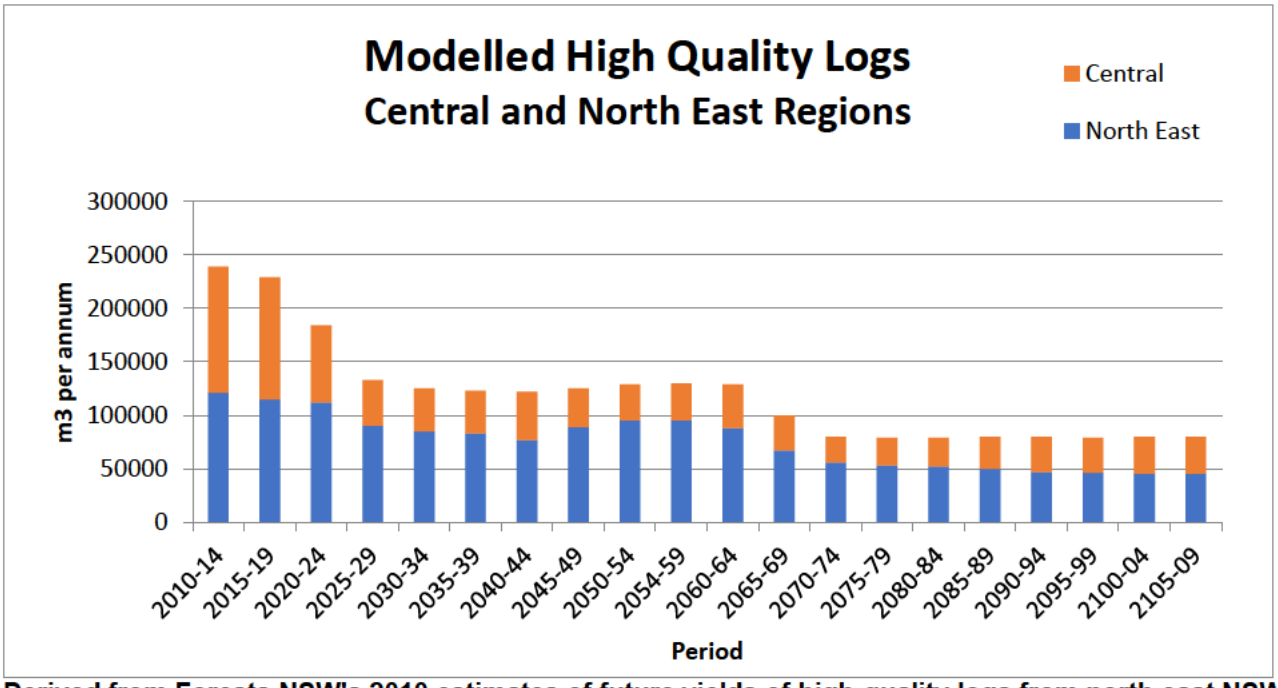
The 2000 North East Regional Forest Agreement with the Commonwealth Government entrenched this unsustainable logging, with grants for purchasing private land for logging, purchasing timber from private land and establishing plantations to make this more sustainable beyond 2020. It soon became apparent that the estimated resources weren't there as by 2002 it was evident that the actual yields were 87 per cent of that predicted, which was followed by a series yield revisions, compensatory payments for inability to supply commitments, substitutions of small sawlogs for large, WSA buybacks and progressive wind backs of environmental constraints.

In June 2001 State Forests of NSW forgave a $1 million debt of Ford Timbers in return for a WSA of 15,000 m^3/yr of Large HQLs. The Public Accounts Committee questioned the appropriateness of this given that Ford Timbers was never required to pay an up-front fee for the original allocation.

In September 2004 State Forests released their report "A Review of Wood Resources on the North Coast of New South Wales" which gave modelled yields of Large HQ sawlogs over 20 years of 205,000 m^3/yr, with yields modelled to drop to around 64,000 m^3/yr after 2023. The caveat was "*the modelled outcome is generally 10-15% above the likely outcome*".

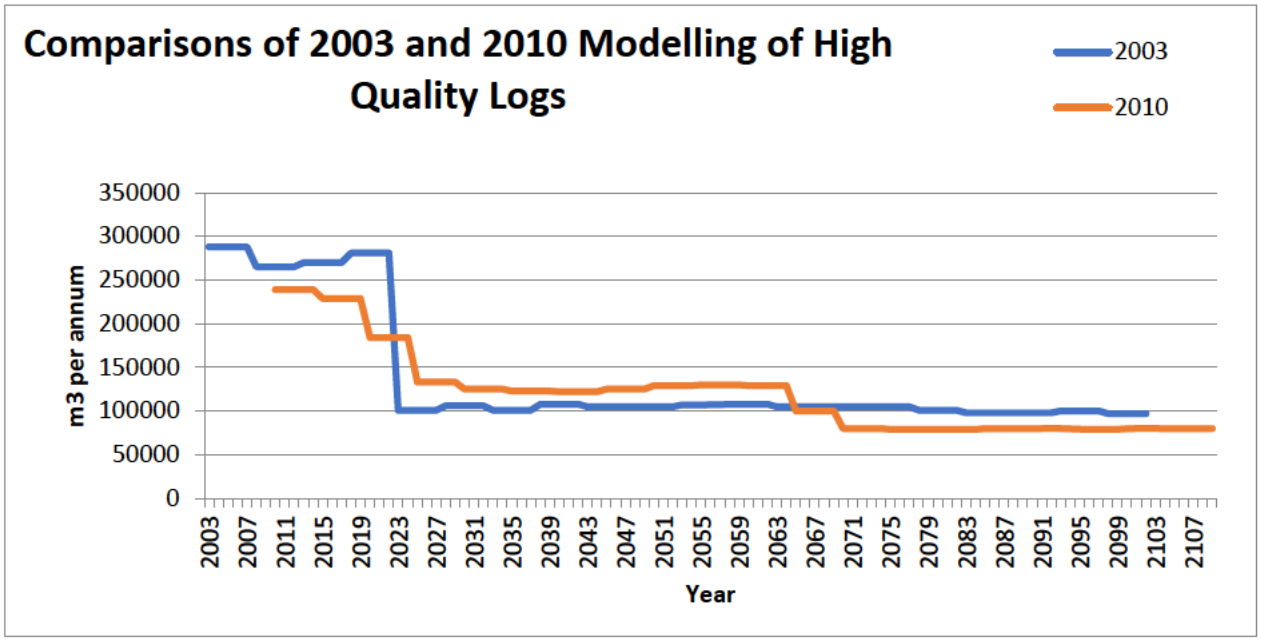
New Wood Supply Agreements were issued in 2003 (for free), reputedly for 224,244 m^3/yr of Large HQ sawlogs (though various figures are used) until 2023, then in 2005 the Forestry Corporation added the equivalent of some 32,000 m^3/yr of LHQ sawlogs in new WSA commitments for girders. veneer, piles and poles. Not unsurprisingly these new commitments were again found to be unattainable, with Boral taking Forests NSW to court for failure to honour WSAs for every year from 2004 until 2010, resulting in a government payout to Boral of $550,000 for the first 3 years, and undisclosed amounts thereafter.

For this assessment the data for the "North East" and "Central" regions were combined to identify the 2010 estimated long-term yields of large and small high-quality logs from north east NSW. This shows that yields of HQL would begin to drop after 2020 down to some 127,000 m^3/yr, before declining further after 2064 down to around 80,000 m^3/yr. This long-term trend of declining yields was consistent with all yield projections up to that time. These show the significance of the yield decline expected to occur in the near future at that time.



Derived from Forests NSW's 2010 estimates of future yields of high-quality logs from north east NSW.

This assessment is consistent with the 2003 modelling, taking into account the over-logging that had since occurred.



Comparison between FRAMES yield models for HQL from 2003 and 2010. Note: The 2003 modelling has the caveat "*the modelled outcome is generally 10-15% above the likely outcome due to factors that cannot be incorporated for practical reasons or cannot be adequately represented mathematically*" - these figures have not been adjusted to account for this.

The modelling shows a dismal future for hardwood supply from north east NSW, which was always an intended outcome of the intentional overcutting for 20 years. Despite the buybacks and yield reductions, and intentional over-cutting, by 2012 sawmillers were openly expressing concerns about future timber yields, proposing that national parks needed to be opened up for logging to meet expected shortfalls after the expiry date of the WSAs in 2023, or sooner.

In his evidence to inquiry into the management of public land in New South Wales Grafton sawmiller, [redacted] Notaras, (2012) complained:

> *I have stopped investing because we are not sure whether we are going to have wood. All indications are that by 2019 it will be pretty tough. I am not sure whether forestry can estimate really how much is out there, because what I have seen is that where we used to work in a 28-year rotation, we are now going back into the same areas in six to 10 years and it is surprising the amount of wood that you are getting out of those areas.*

The General Purpose Standing Committee No. 5 (2013) inquiry into the management of public land in New South Wales reported:

> ***6.46*** *Serious concerns over the sustainability of current logging practices have been raised by inquiry participants from the timber industry with particular concerns over future resources. Greensill Bros Pty Ltd expressed that the view that 'under the current regulations restricting access, the small area of forests is being overcut'. Newells Creek Sawmilling Company similarly said that 'we are overcutting the bush because we are limited to a small area for sustainable forestry while vast areas have been locked up for timber production and placed under the management of National Parks'. Mr Notaras highlighted the long term implications for the industry, contending that 'they will not have high quality large logs in the future'.*
>
> ***13.44*** *On the North Coast, wood supply agreements that were originally signed in 1998 were reviewed in 2003 following further reservation of native hardwood forests. Mr Douglas Head*

> *described the situation on the North Coast as being unsustainable post 2023, when the current agreements are due to expire. He commented that 'At the moment, we are in an unsustainable pattern … in the longer term' and contended that 'we will not be able to do in 2024 what we are doing now, and nor should we'.*

Rather than regulating their use of available sawlogs on a sustainable basis the industry wanted to be given more land to log. In 2012 the Chair of the General Purpose Standing Committee No. 5 asked the Executive Director of the NSW Forest Products Association, how much area of land *"would need to be returned and made available for harvesting in order to meet the contractual obligations and the forecast timber delivery in those RFAs?"*, to which Mr. Ainley (2012) responded "*At a guess, I would suggest that we would need a little more than one million hectares to be returned. However, it depends on which hectares, where they are and how the regulations may affect them*."

The Forestry Corporation (Annual Report 2014-15) also acknowledges it *"… may have onerous contracts in relation to wood supply agreements for native forest timber",* for which the present value of the contract is negative.

The gist of the problem has been the progressive removal of better-quality sawlogs, running down supply. [redacted], General Manager of Domestic Operations, Pentarch Forestry, commented at the Inquiry into long term sustainability and future if the timber and forest products industry (29 April 2022):

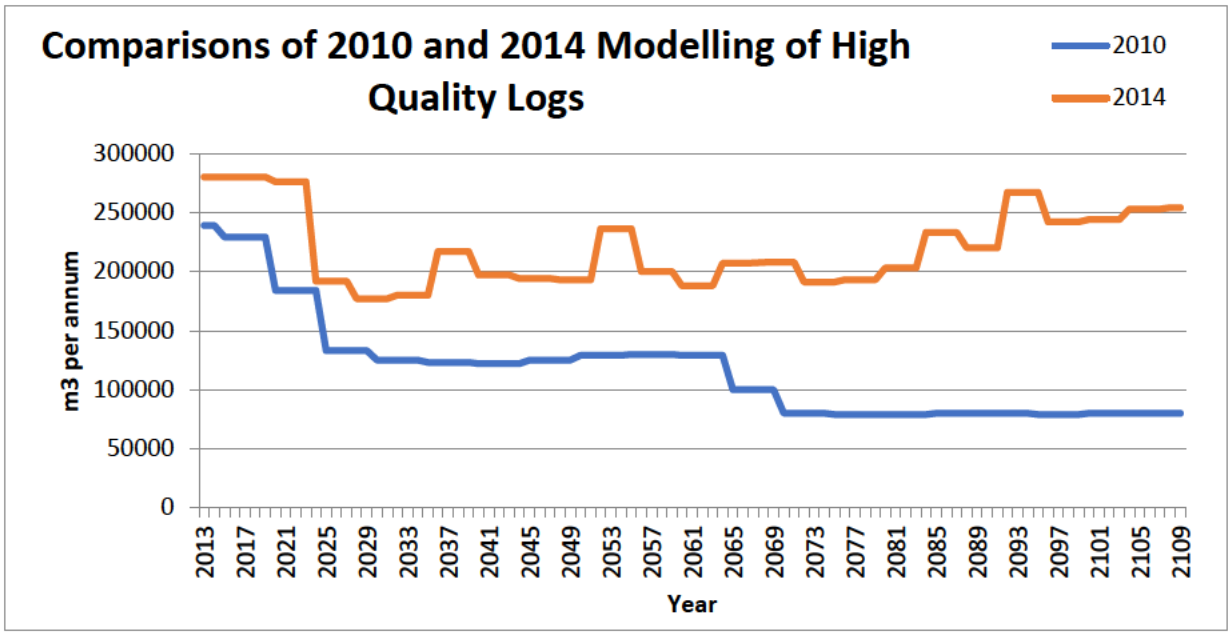
> *With any native harvesting, the type of harvesting you do varies over the cycle. If you are doing, say, four lots of harvesting over 150 years, the first harvest you take the better quality trees out. Over time, you get to a stage where the material that is left in the bush is generally of a poorer quality. That is where the reset harvesting is required, where you take those poorer species. Generally, at that point, because there is more disturbance, you get predominance of a single species coming up. Then, over time, that composition of the bush will change back to a more normal and then a poorer quality bush over time.*

1.1.2. The Latest Great Reset

In 2005 Boral bought out Fennings Timbers who operated a flooring plant at Gloucester and a sawmill in Walcha. In July 2008 Boral announced it would shut down the Walcha site with 20 job losses, blaming a weak housing market and increasing costs. In 2012 Boral decided to retire their WSA for 23,723 m^3/yr of tablelands timber, though it is unclear who paid whom to retire this volume.

In May 2012 the NSW Government established a Project 2023 Steering Committee to investigate the issues associated with timber supply on the north coast including sustainability of supply to the end of the term of current wood supply agreements in 2023 and over the long term. This identified major resource shortfalls at the end of the current WSA. The Steering Committee engaged URS Australia Pty Ltd to conduct a review of timber resources on the north coast, though refused to release the URS reports.

While the assumptions used to underpin the new modelling are not revealed, the outcomes are dramatically different from previous yield modelling which all display far more significant drops in supply after the end of the then WSAs and declining yields thereafter. This is demonstrated by a comparison between the 2010 modelling and the 2014 remodelling.



Note the very dramatic increases in volumes expected by the 2014 modelling compared to Forests NSW's 2010 modelling. The differences are so large compared to all Forestry Corporation's previous modelling that it is hard to give the 2014 claims any credibility.

Based on their highly questionable modelling the Steering Committee determined:

> *... that the option of buyback of 50,000 m3 per year of HQ logs including 40,000 m3 per year of Blackbutt is the most effective way of bringing harvest levels to an even flow, sustainable yield. ... The Government accepted this recommendation of the Steering Committee.*

In 2014 the NSW Minister for Primary Industries, Katrina Hodgkinson, announced the decision to pay Boral $8.55 million to buy back 50,000 m^3/yr of HQL allocations for the next nine years, claiming (24 June 2014) "*projections show that without this buyback we would have needed to dramatically reduce the volume of timber supplied to industry after 2023 to ensure the forests continue to be healthy and productive.*"

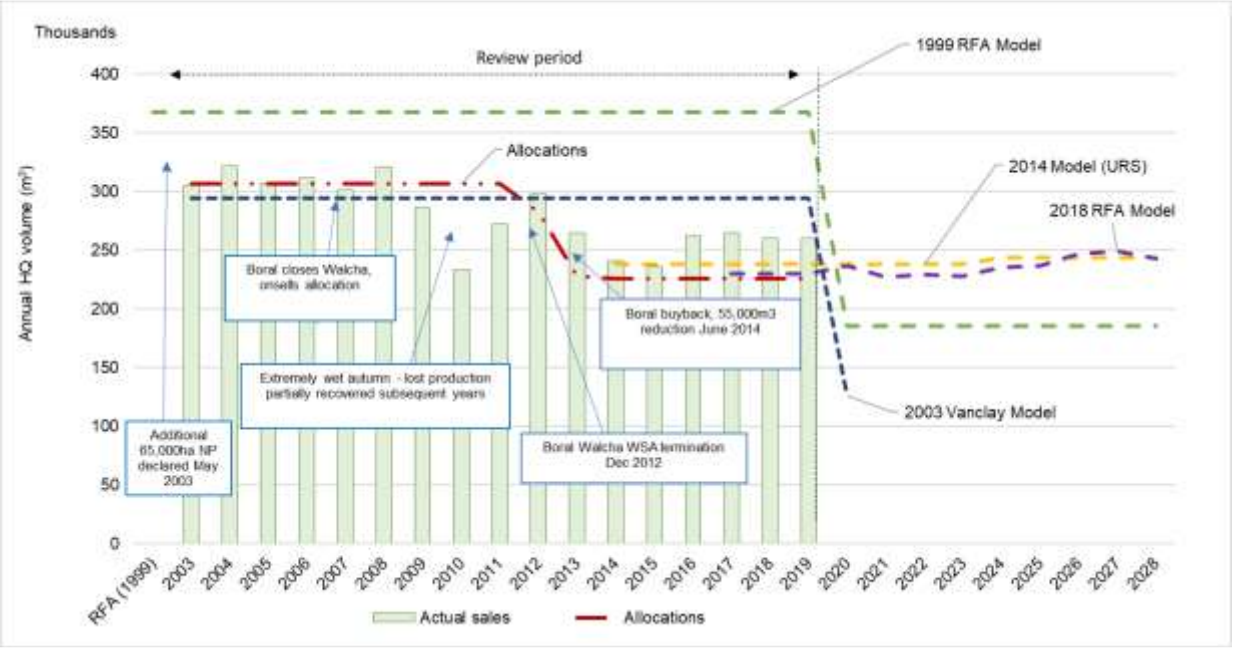
As a result of the Boral buyback the Forestry Corporation reduced the 2014 Wood Supply Agreement commitments for LHQ sawlogs to 127,137 m^3/yr, with an additional 31,351 m^3/yr of LHQ sawlogs as girders. veneer, piles and poles. Boral's WSA was extended from December 2023 to December 2028, giving them an additional 5 years allocation. This means that the Government paid $8.55 million to buy back a total of 450,000 m^3 of sawlogs (9 years), while giving the company an additional 580,000 m^3 of sawlogs for free. Boral also had their preferential allocation of Blackbutt and log qualities extended for a further 5 years.

The NRC (Todd Maher, pers comm, 12 Jun 2018) maintain that in 2018 the modelled yield of High Quality Logs over a hundred year period is an average of 237,000 m^3/yr, with an average of 132,000 m^3/yr LHQ sawlogs and 105,000 m^3/yr small high quality (SHQ) sawlogs per annum. Over the next 20 years the mix was assessed as being an average 166,000 m^3/yr LHQ and 71,000 m^3/yr SHQ logs per annum.

The Forestry Corporation data provided under GIPA on yields and WSAs shows that from 2014/19 (the 5 years after the Boral buyback and reduction of WSA commitments) there was a total overcut of 64,729m^3 of Large HQL, 31,524 m^3 of Small HQL, 8,298 m^3 of girders, 3,302 m^3 of piles and 917m^3 of poles, with an undercut of 11,571 m^3 of veneer. Conversion to Large HQL shows this represents an overcut of 67,591 m^3 of LHQ logs and 29,608 m^3 of SHQ logs.

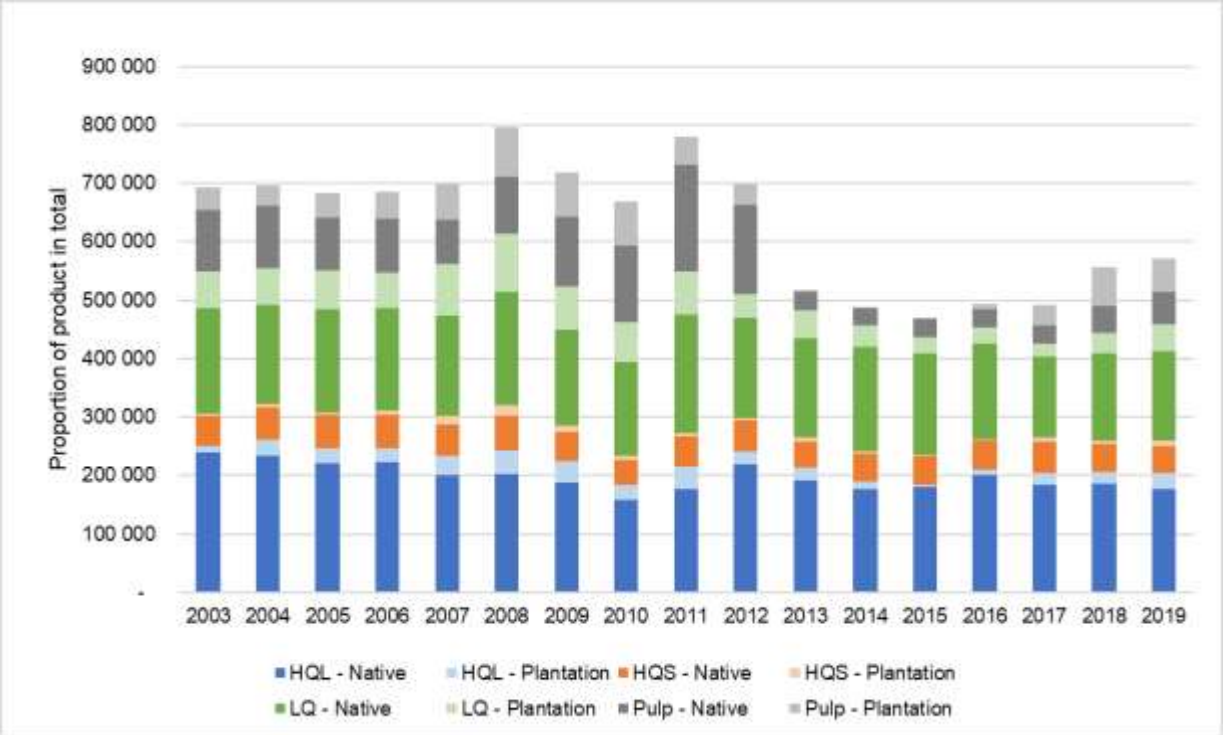
The total over-cut of 97,119 m^3 high quality logs is timber that was bought back by the NSW Government from Boral at a cost of $1,847,000 ($19 m^3) on the grounds that the volume needed to be retired to achieve sustainable yields. Surprisingly it was being sold back to the sawmillers at the Forestry Corporation's profit, and significant environmental cost. This sacrificing of long-term sustainability for short-term profits is part of Forestry Corporation's need to return a profit.

INDUFOR: A21-22109 NRC Wood Supply. Figure 4-1: Key HQ supply event overview (North Coast)



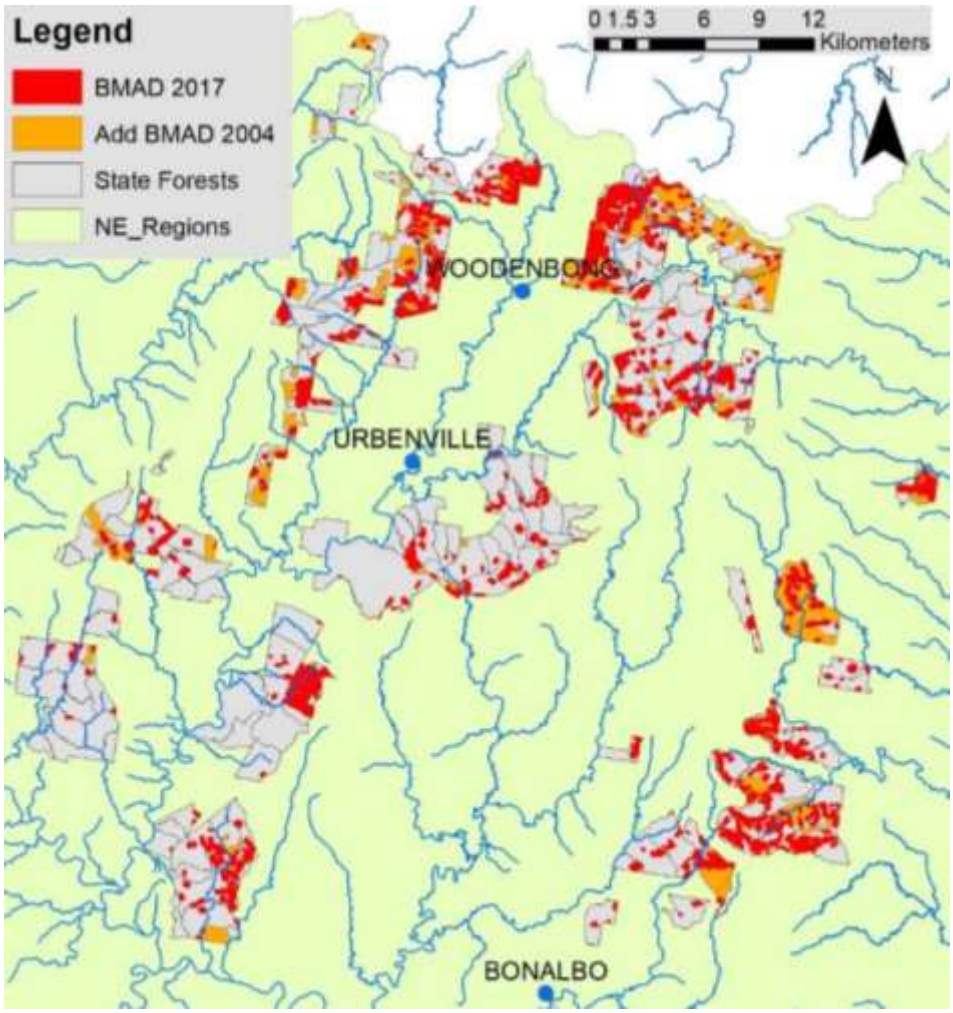
Changes in high quality sawlog actual and modelled yields. Note the various inflated modelled yields (its important to recognise that the 1999 RFA model and the 2003 Vanclay model were for Large HQ sawlogs, whereas the displayed yields and subsequent yield models are for both large and small HQ sawlogs), reduction in the revised 2014 URS model and allocations, and the intentional over-logging above reduced WSAs after the Boral buyback which will have significant ramifications for future yields.

INDUFOR: A21-22109 NRC Wood Supply: Figure 2-6: North Coast volume by product group



Yields of hardwood products show the reducing volumes over time, with significant milestones being the reduction in pulplogs following the closure of Boral's Tea Gardens woodchipping facility in 2013, the retirement of Boral's WSA for 23,723 m^3/yr of tablelands timber in 2012, the buyback of 50,000 m^3/yr of Boral's WSA in 2014, and the continued over-cutting of high-quality logs following the buyback.

The Auditor General's Performance Audit "Sustaining Native Forest Operations: Forests NSW" of April 2009 required Forests NSW (now Forestry Corporation of NSW - FCNSW) to "compare harvest results against its yield estimates over five year periods as a means of testing the accuracy of estimates" and "report the results annually starting June 2010". The simplistic reports found on Forestry Corporation's website for "FRAMES Actual vs Predicted Harvest Reconciliation" for "2010/11 to 2014/15", and "2014/15 to F2018/19" concluded that all was good with modelling of high-quality sawlogs. Though the results for the North Coast show that over those periods across the 72,506 ha logged yields were 87.3% of predictions, while one mid north coast area (COF_BBT_STS & MNC_BBT) was close to predictions, the other (COF_COASTAL_STS & MNC_COASTAL) was only 77% of predictions. Given that standard practice is to target higher yielding areas first, this deficit should be of concern, particularly as it has now been exasperated by the significant loss of trees in the 2019/20 fires.



An example of BMAD on State Forests in the Border Ranges region. The map shows the area mapped in 2017 (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 several areas known to be affected and does not recognise those areas in the early stages of BMAD. It is extraordinary that these dead and dying forests have not been accounted for in modelled yields.

Bell Miner Associated Dieback (see 1.4.5) has had extensive impacts on forests and resources throughout coastal NSW, yet is not accounted for in modelled yields. The only time that it had an influence, we are aware of, was when the Forestry Corporation decided to abandon 11,000 ha of some of the worst affected forest. Though the problem is a lot worse than this.

The Natural Resources Commission (2016 p54) *'Advice on Coastal Integrated Forestry Operations Approval remake*' identifies

> *A substantial portion of Urbenville Management Area in Supply Zone 1 is excluded from harvesting through this analysis. Five of the state forests in this area were considered impractical to manage for commercial purposes given reductions in net harvest area and areas affected by Bell Miner Associated Dieback.*

The NRC identifies the area as comprising of Donaldson, Mount Lindsay, Unumgar, Bald Knob and Woodenbong State Forests, which have an area of 11,006 ha, with half this outside harvest exclusions (including for EECs). It is likely that this removal from sustained yield calculations for the CIFOA, which contributed to reduced protections for threatened species, has now been forgotten.

Since then, the CIFOA was amended to include a Site Specific Biodiversity Condition for Greater Gliders, which the Forestry Corporation claimed would reduce the supply of high-quality sawlogs by 3%, though it is unlikely that this too has been factored into current yield estimates (see 1.4.2).

1.1.3. Ignoring Wildfires

The 2014 remodelled volumes have underpinned all subsequent yield assessments, the latest of which is the Forestry Corporation report '2019–20 Wildfires, NSW Coastal Hardwood Forests Sustainable Yield Review' , which undertakes a preliminary desktop review of the likely impacts of the Black Summer wildfires on timber resources. They identify that within the North Coast RFA region, 49 per cent of the native forest area available for harvesting (referred to as net harvestable area or NHA) was impacted by fire. It is noted that "*There are 1821 active plots used for native forest modelling on the North Coast. … 19 per cent of the active plots in the region were impacted by a hot fire (RAFIT Class 4), and 17 per cent by crown fire (RAFIT Class 5)*".

For their review the Forestry Corporation did not remeasure any of their north coast plots. Instead, they relied on are a token 17x0.05-hectare plots from a 2016 Class 5 fire in the Eden Region. A 0.85ha a sample of one burn class in the southern forests cannot be considered to have any credibility for the Eden region, let alone be considered representative of the 424,200 ha of the very different north coast forests assessed.

The Forestry Corporation estimated that there has been a significant loss of trees across at least a third of the north coast's State Forests (north from Gosford), with a loss of 10-50% of large sawlog sized trees over 30 cm diameter at breast height, and 50-100% of smaller trees. Averaged across the north coast State Forests, the Forestry Corporation estimate there has been a loss of around 10% of sawlogs and 25% of smaller trees. North from Coffs Harbour these losses increase to 15% of sawlogs and 35% of smaller trees.

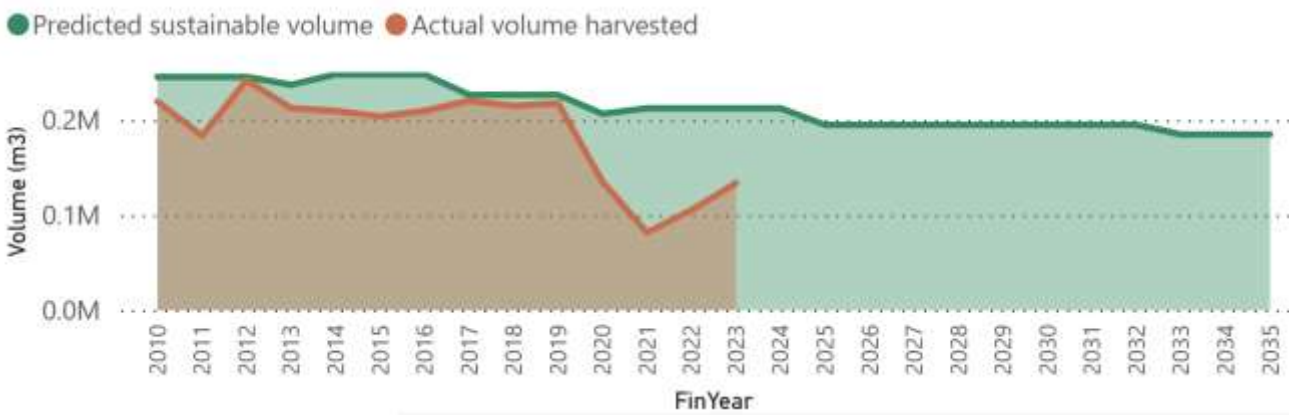
It is bewildering how the Forestry Corporation can conclude from this data that there will only be a 4% reduction in high quality sawlogs from the north coast over the next decade and only a 1% reduction over the next century. And it is shocking that the NSW Government relied upon this simplistic review, which builds on the unbelievable doubling of yield estimates in 2014, to sign new Wood Supply Agreements in 2022 to extend the Wood Supply Agreements due to expire in 2023 until 2028, at the same volumes.

It is astounding that four years after the fires the Forestry Corporation tell us they have not completed remeasuring of their 659 field plots within the heavily burnt forests to obtain real data on

the fire impacts so that they can more accurately quantify impacts and future yields. For this assessment they are still accounting for the impact of the 2019/20 wildfires on yields across 424,200 ha of north coast forests based on a sample of 0.85ha of Eden forests!

It is not apparent that the worsening impacts on tree growth and mortality from droughts and Bell Miner Associated Dieback have been taken into account in adjusting yield projections, including the previous decision to exclude 11,000 ha of BMAD affected forests from yield calculations. The spatial data available on drought and BMAD affected forests has not been removed from net area calculations.

North Coast Native High Quality Hardwoods predicted and actual volumes (FCNSW 2023 Sustainability Report). Note the reduction in actual volumes harvested post 2019/20 wildfires, and the predicted ongoing decline in high quality sawlogs. Also note the modelled difference in high quality sawlogs for the period 2014-19 between this graph and the previous Indufor graph of predicted and actual yields.



Following the 2019-20 wildfires yields of high-quality logs from native state forests dramatically declined (in part due to salvaging burnt pine and a focus on premature logging of hardwood plantations). By 2023 yields should have recovered, though yields had declined by 39% from 218,000 m^3 in 2019 down to 134,000 m^3 in 2023, and are currently only 63% of claimed sustained yields of 212,000 m^3, with the massive loss of resources in the 2019/20 fires yet to be factored in. Note that there were similar reported declines in all hardwood products across NSW. It is a tree mining operation, that has only been able to be maintained by removing protections for most mature trees and increasing logging intensity in 2018.

1.2. Economic sustainability

The logging of public native forests has always been an economic burden on taxpayers due to the high subsidies paid, both through maintaining the loss-making native forestry operations of the Forestry Corporation, regular equity injections, and through direct payments to sawmill owners and occasionally workers. In 2022/23the Forestry Corporation lost $15 million on its hardwood operations, despite receiving a record handout of $31 million for its community service obligations, and having received over $200 million in government equity injects over the previous three years. Millers too received hundreds of millions in taxpayer funds over that time. Logging of public native forests is an economic basket case, due to declining yields, rising costs, and competition with sawntimber from softwood plantations, imported engineered wood products, and plantation woodchips. The hidden costs are the rundown in timber volumes, water quality and quantity, and wildlife populations, as well as the increase in weeds and dieback. Given that plantations are far

more efficient and profitable it is past time to complete our transition to them for future timber needs.

The Forestry Corporation have historically operated at a loss on native forests. Pugh (1992) reviewed the then Forestry Commission 1981/2 to 1990/1 Annual Reports for the adjacent Management Areas of Murwillumbah, Urbenville, Casino West and Grafton, finding that over the ten years the losses totalled over $1 million (in 1991 dollars), without accounting for head office costs, noting that:

> *most of the Management Areas began to improve financially around 1987/88. This was due to the passage of the Forestry Amendment Act which gave an additional subsidy to the Forestry Commission by relieving them of the interest payable on their accumulated debt of some $110 million! They were supposed to pay a dividend to Treasury in return, though failed to do so in 1987/88 or 1988/89 (PAC 1990 p27)*

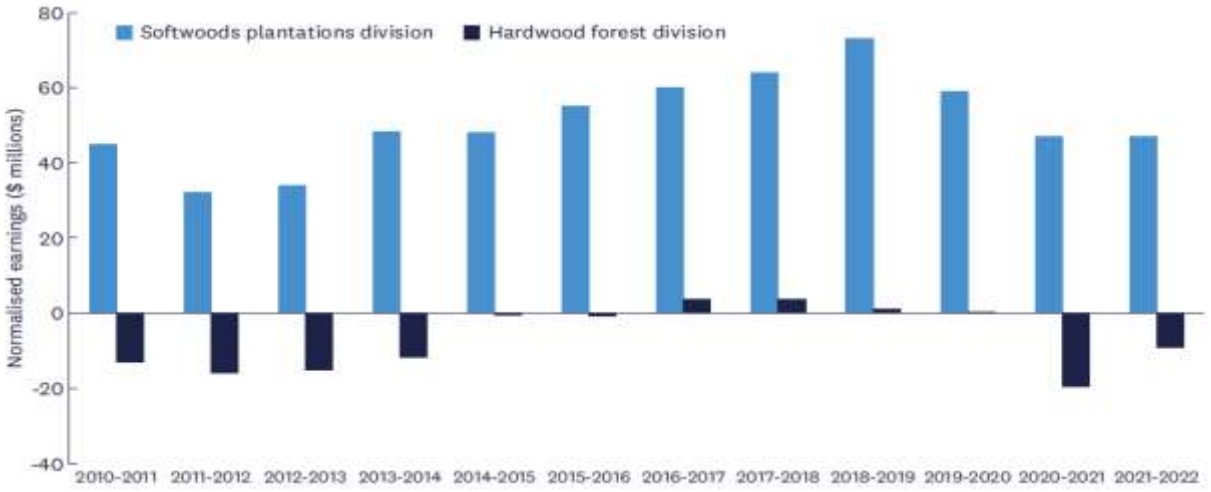
The NSW Auditor-General (2009) wondered how Forests NSW will perform in the future, given that:

> *... Native forest operations operated at a loss of $14.4m for 2007-08. We are unable to conclude if this is the result of inefficient operations, or because prices do not reflect the true cost of meeting wood supply commitments or a mixture of both.*

In response to questions on notice from the General Purpose Standing Committee No.1 Budget Estimates 2009-10, the Forestry Minister Steve Whan identified that Forests NSW's native forest operations ran at a loss of $8.1 million in 2009/10, stating:

> *Given, as reported by the Auditor General in 2009. that the current cash flow of Forests NSW Native Forests Operations Branch is negative, any NPV calculation now will result in a valuation of zero.*

The Forestry Corporation's losses in 2012/13 were $15 million and in 2013/14 $11.8 million. From 2014/15 until 2018/19 the Forestry Corporation have had a marginal "*positive result*" on 'hardwood' operations, totalling $13.2 million over the 5 years. For example the 2018/19 Annual Report gives "*normalised earnings*" (*Excludes significant items such as revaluation impact, impairments and impact on superannuation funds, before taxes*) for the 2019 financial year as $1.1 million. Since then, the Forestry Corporation has been running at a loss again, in 2020/21 the losses were $19.6 million and in 2020/21 $9 million and in 2022/23 the losses were $15 million, meaning it cost $1,281 per hectare to log the homes of Koalas and Greater Gliders that year. Over the past 15 years (2008/9 to 2022/3) the Forestry Corporation has lost $110 million in logging NSW's public native forests (and hardwood plantations).



Normalised earnings of Forestry Corporation's hardwood and softwood divisions (Blueprint Institute 2023).

There is a deliberate confusing of plantations with native forests in NSW. Profits from hardwood plantations are included with losses from native forests which masks the actual losses from native forest logging. Plantations are used to subsidise native forest logging.

The Forestry Corporation's small positive result for 2018/19 was dependent on receiving $17.5 million as Government grants for Community Service Obligations (provision of recreation facilities, education and advisory services, government liaison and regulatory services, community fire protection and research). It is intriguing that the claimed expenditure on CSOs increased from $11.1 million in 2006/7 (URS 2008) to $18.1 million in 2018/19, a $7 million (39%) increase in 12 years. Payments for Community Service Obligations increased inexplicitly from $17.8 million in 2021/22 to $31million in 2022/23. This is certainly a good way to minimise reported losses.

Then there are the costs of regulation by the EPA and forestry research by DPI Forestry. The latter is effectively an offshoot of the Forestry Corporation, being moved to DPI to cut costs, and their research reflects their forestry bias.

There are also numerous other public subsidies to the timber industry. For example, as an outcome of the NSW Regional Forest Agreements the NSW and Federal Governments spent $131.5 million from 1995 to 2007 on the New South Wales Forest Industry Structural Adjustment Package (NSW FISAP) programs to assist 192 businesses and 683 displaced forest workers. Industry Development Assistance totalled $77.2 million, Worker Assistance $29.5 million and Business Exit Assistance $24.8 million.

There have been numerous State and Federal grants to the Forestry Corporation to purchase land over the decades. For example, FISAP included $7.5 million to purchase forested or substantially forested private properties in north-east NSW for logging. The Forestry Corporation 2018/19 Annual Report identifies that "*around 350 hectares of new land was purchased as part of a four-year, $24 million equity injection from the NSW Government to acquire new land for establishing timber plantations*."

Frontier Economics (2023) identify that over two years the NSW Government grants to FCNSW totalled $232 million (excluding CSO payments). These include aid recovery after the 2019/20 fires, the NSW Government announced NSW Government's $140 million Bushfire Industry Recovery Package to help forestry, horticulture, agriculture and aquaculture industries impacted by the recent bushfires, including up to $20 million for haulage of burnt timber and $40 million to help privately-owned wood processing facilities recover and rebuild. And on 21 May 2020 the NSW Government announced a $46 million "*stimulus funding*" for "*the largest replanting program in the state's history*".

Frontier Economics (2023) identify that the broader downstream industry associated with native forest logging in NSW also received recent financial support of over $200 million from taxpayers via a number of grants from the Commonwealth and NSW governments, to respond to natural disasters and to encourage industry innovation.

As an example of the public subsidy to sawmillers:

> *As at October 2001, Boral has spent more than $10 million in capital as part of the FISAP program and a further $5.5 million is currently being invested in a key project to upgrade Boral's green mill at Koolkhan on the NSW north coast. The remaining $29.5 million of Boral's planned investment will be made at Boral's north coast timber mills including those at Murwillumbah, Koolkhan, Kyogle, Maxwells Creek and Herons Creek.*
>
> *The overall program involves total expenditure of $45 million by Boral Timber, with the NSW and Federal Governments providing $22.5 million.*

> *Timber companies also received government funding under various Commonwealth Regional Development programs, including the dairy industry restructuring scheme.*

As Boral received public money with one hand they took with the other. Soon after new Wood Supply Agreements (WSAs) were given to sawmillers for free in 2003, in a series of court cases Boral took Forests NSW to court for failure to honour WSAs for every year from 2004 until 2010, resulting in a government payout to Boral of $550,000 for the first 3 years, and undisclosed amounts thereafter. This was ultimately resolved by the Government paying Boral $8.55 million in 2014 to buy back some 50,000 m^3/yr of Boral's WSA for HQ sawlogs, as well as extending their WSA for a further 5 years (effectively giving them more timber than they bought back).

The price customers pay for logs includes a 'stumpage charge' to encompass the cost of forest management and growing, and a 'delivery charge' to encompass the actual harvesting and transport costs for delivering the logs to the mill. The delivery charge incorporates the costs of the harvesting contractor, the trucking of logs to the mill gate, along with a FCNSW harvesting administration charge.

In 2016-17 Forestry Corporation customers paid an average of $128.66 per cubic metre for logs obtained from native forests, comprised of a stumpage charge of $56.26 and a delivery charge of $72.40. The delivery charge is comprised of harvesting costs of $44.54, haulage costs of $29.81, and is meant to include administrative costs of $3.60 (IPART 2017). It is interesting that in 1995 State Forests (1995b) identified "*the costs of management directly associated with harvesting, selling and marketing in the Casino management area*" as $5.25 per cubic metre, so, even without accounting for CPI there has reputedly been a major reduction in administration costs since then.

	Stumpage charges	Delivery charges	Harvesting costs	Haulage costs	ABS CPI
Average price per m^3 in 2016-2017	$56.26	$72.40	$44.54	$29.81	
Average price/cost increase over 2002-2003 to 2016-2017	4.3%	3.8%	5.1%	3.7%	2.5%[a]

Table 2.6 from IPART (2017): FCNSW's per unit costs and revenue. Stumpage charges are the estimated cost of forest management and growing. Harvesting and haulage costs are paid by FCNSW to contractors doing harvesting and haulage. Delivery charges are paid by sawmills to FCNSW for the harvesting and haulage services.

Stumpage costs vary with products, though specific details of these were not obtained except graphically.

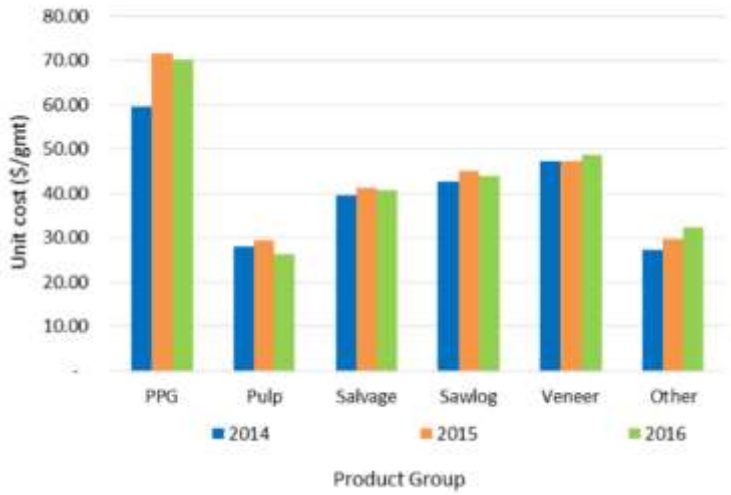


Figure 3-2: from Indufor (IPART 2017) Average Cost by Product 2014 - 2016

Regarding administrative costs, IPART (2017) found the Forestry Corporation's "*current delivery charges recover only about 1% (or 5 cents per m^3) of these costs*", noting:

> *Administration costs are now being indirectly recovered by FCNSW through the stumpage royalty, not through delivery charges.*
>
> *This analysis suggests that FCNSW's average administration charge per m^3 of native timber supplied has fallen from about $3 in the period 2003 to 2010 to –$2 in 2017.*

IPART (2017) identify harvesting and haulage costs are increasing:

> *FCNSW's harvesting and haulage costs, as well as stumpage prices, have generally increased at a faster pace than CPI inflation. In particular, harvesting costs have increased at around 5% per year, on average, over 2002-2003 to 2016-2017. .. average haulage distances have risen for major sawmill customers over the last 15 years.*

In 2022/23 it cost (including hardwood plantations, and excluding Community Service Obligations, equity injections, industry assistance, EPA regulation and DPI Forestry research) $1,280 per hectare to log public native forests. There is no direct public benefit from logging of public native forests. By comparison in 2018/19 the Forestry Corporation's Softwood Plantations Division managed 242,738 hectares of pine plantations in NSW and returned 'normalised earnings' of $73 million, which is $301 per hectare. The sooner the Government transitions to plantations the better off taxpayers will be.

Further, should the NSW government fully consider the poor performance of the Forestry Corporation as an entity that is deemed to be dedicated to making the most of the "common wealth" shared by the NSW residents, the result would no doubt be either the closing down or total re-structuring of the Forestry Corporation. It is clear that this entity has consistently failed to meet the minimal economical returns required to successfully operate a business; its activities continue to rapidly depreciate the intrinsic value of its native forests portfolio (which is a common property of the residents of NSW); and it has been consistently subsidized by the NSW Government, while other areas that require funding have been neglected.

Then there are the costs of losses of mature trees and carbon storage, increased carbon emissions, reduced carbon sequestration, reduced streamflows, degraded soils, increasing erosion, increasing weeds, and declining populations of threatened species. There is no resource rent being paid to the community, so we are being duded in many ways, as noted by URS (2008):

> *Extracting resource rent from the use of the state's forest resources – resource rent is the additional profit above "normal" business profits that can be gained by providing access to a natural resource. Because resource rent is in excess of normal business profits, there is a rational for governments to collect some of this rent on behalf of the owners of the resource – the community.*

As identified by the University of Newcastle (2021) the economic and social benefits of protecting forests far outweigh the economic costs. With carbon credits, increased recreation, increased water yields and other benefits it clearly in the community's best economic interest to stop logging public forests. This is also in accord with community preferences.

From their review, Frontier Economics (2023) concluded:

> *As this report shows, the publicly owned native forestry businesses have provided little to no financial returns over this period. NFL businesses have become financial risky for governments and their forestry harvesting activities eat away at the increasingly scarce environmental value of Australia's dwindling native forests.*

> *We find that downstream markets, particularly domestic markets, have likely already adjusted to lower levels of native forest wood supply and signalling the closure of this industry would simply accelerate the downstream transition that is already occurring.*

Stopping logging has been shown to be of economic benefit to the NSW economy, as increased tourism, carbon sequestration and water yields are worth far more. A 2023 study by the conservative Blueprint Institute found that immediately ending native forest logging in north-east NSW, and instead utilising the land for carbon sequestration and tourism will deliver a net benefit valued at $45 million in present-day dollars (incorporating the estimated cost of providing transitional packages to the industry as it shuts down, as well as the cost of breaking wood supply agreements that extend to 2028). A 2021 study by Frontier Economics 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. A 2021 study by the University of Newcastle found that protecting 175,000 ha of State Forests between Coffs Harbour and Grafton as the Great Koala National Park would, over the next 15 years, generate additional regional economic output of $1.2 billion and create more than 9,800 extra full-time jobs compared to logging.

Logging based on public forests is a miniscule proportion of regional economies, though there will need to be transition packages for affected workers and the buying out of remaining Wood Supply Agreements from sawmill owners. The University of Newcastle (2021) notes:

> *The NPA further cites 2015 Parliamentary Budget Office (PBO) costings for establishing the proposed GKNP of $119.5 million over two years, including:*
> - *The cost of redundancy payments ($50.8 million)*
> - *Business exit assistance which incorporates timber buy-backs, worker retraining and reliant business assistance ($64.1 million)*
> - *Mill clean-up costs ($4.6 million).*
>
> *The NPA notes that the PBO's costings (similar to the EY report) also assumed that all state native forest logging would be impacted, that all WSAs in the north east NSW would need to be cancelled and therefore that state native forest logging would end.*

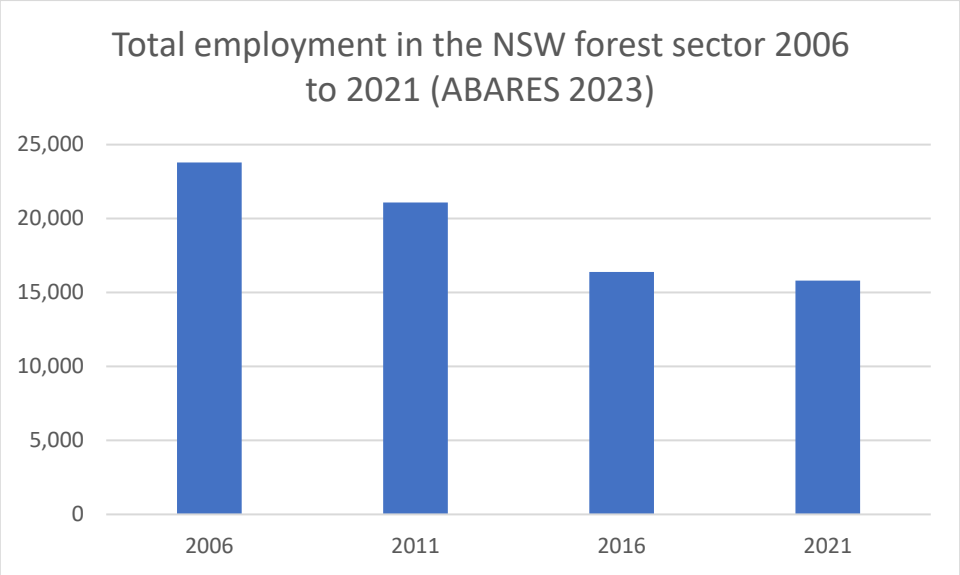
For north-east NSW a 2023 study by the conservative Blueprint Institute identified a benefit of $120M from increased tourism and $170M from increased carbon sequestration if logging ceased immediately. This would offset the $215 million cost of a generous structural adjustment package - which comprised $60M for worker redundancy and retraining, $11M for harvesting and haulage contractors, $38M for mill equipment, $39M to buyout WSAs, and $64 million for regional economic diversification.

1.3. Employment Sustainability

The timber industry themselves are responsible for ongoing declines in employment in the forestry sector. With massive losses of 7,992 direct jobs due to industry restructuring over 15 years hardly rates a mention, with no consideration of multiplier effects. While inflated claims about the numbers of jobs reliant upon logging public native forests in NSW abound, it is apparent that if all logging of public native forests across NSW stopped less than 1,000 direct jobs would be affected, with around 500 of these in north-east NSW. This is in an industry in decline as they cut out the larger sawlogs, mechanise, restructure and are outcompeted by plantations.

ABARES (2023, for Indicator 6.5a) identify that in NSW total employment in the forestry sector declined from 23,792 in 2006 to 15,800 in 2021, which equates to a loss of 7,992 jobs. ABARES (2018) identify that this was primarily due to *'consolidation of processing into larger facilities with*

higher labour efficiencies, and restructuring of the sector'. If Ernst & Young's (2023) multiplier of 2.46 for total job losses is applied, this equates to a total loss of 19,660 jobs. It is intriguing that the industry does not consider the loss of so many jobs due to over-logging and restructure as a problem, though any losses due to conservation are portrayed as a disaster.



ABARES identify that at the 2021 census NSW employment in "forestry and logging" was 1,686, "forestry support services" 1,183, "wood product manufacturing 9,048, and "pulp and paper product manufacturing" 3,866, giving total employment in the sector of 15,783, or 0.4% of the workforce. In 2020/21 native hardwoods represented 6.2% of NSW's log production, so it is apparent that only a small percentage of employment can be attributed to native forest logging.

Ernst & Young (2023) was engaged on the instructions of North East New South Wales Forestry Hub to conduct an economic impact assessment of the Hardwood Forestry industry on four different NSW regions. Their report 'Economic Contribution Study of the NSW hardwood timber industry' has the caveat "*We do not imply and it should not be construed that we have verified any of the information provided to us, or that our enquiries could have identified any matter that a more extensive examination might disclose."* The principal problem with their report is that it does not present the data that is used to derive their figures. Even with the inclusion of private forests, their claims that the hardwood timber industry supports 5,920 in direct employment seem grossly inflated compared to other estimates, including their own of a few years previously. They conclude:

> *Hardwood timber industry in NSW supports an estimated 8,900 FTEs in employment, including 5,920 in direct employment and 2,980 in indirect employment. … Direct economic contribution is largely driven by economic activity in the processing industries – sawmill product manufacturing and other wood product manufacturing (76% of direct employment), followed by wholesale (17% of direct employment) and production (7% of direct employment).*

On behalf of the Australian Forest Products Association, Ernst and Young (2019) prepared the report '*The economic impact of the cancellation of NSW North Coast Wood Supply Agreements due to the creation of the Great Koala National Park*'. It is based on the assumption that the creation of the GKNP will result in the cancellation of all Wood Supply Agreements in the north-east NSW RFA area (termed NCFA), loss of 415,000m^3 of harvested hardwood timber per annum, and the closure of most sawmills, including the whole of Boral's operations. So their scenario is shutting down all logging of public native forests in north-east NSW.

The Ernst and Young (2019) report identifies "*The cancellation of WSAs will negatively impact the forestry industry in NSW and the NCFA. Almost 30% of the total output, jobs and value add from the forestry and logging industry will be lost in the NCFA*", while recognising "*the forestry industry is not a major generator of output or employer in the NCFA when looking at the whole economy (1% of total output and jobs)*".

The current timber industry in north-east NSW was claimed to employ 1,048 people in production and 3,687 in processing, totalling 0.71% of total employment (Ernst and Young 2019). Ernst and Young (2019) claim that **their "*worse case scenario*" of cancelling all WSAs and Boral closing their timber business will result in the loss of 566 direct jobs in north-east NSW** (which is only 12% of industry employment, and 0.08% of regional employment), which is claimed to flow on to 826 indirect jobs. Ernst and Young (2019) advise that rather than converting their employment data to 'full-time equivalent', their employment figures *include casual, part-time and fulltime jobs*.

For public native forest logging the Natural Resources Commission 2021 identifies direct jobs before the 2019/20 wildfires as 590 on the north coast (Table 10) and 332 on the south coast (Table 8). They were expected to be significantly reduced because of the loss of resources in the wildfires. The NRC (2021) considered "*Given the current limited data in NSW, the Commission has relied on the assessments for other states with similar conditions to Coastal IFOA regions to infer indicative impacts for employment in the native forest industry and regional communities.*", adopting employment ratios of 1.25 direct forest industry jobs per 1000 m^3 of wood supply for the north coast, south coast and Tumut, and 1 job per 1000 m^3 of wood supply for Eden (due to higher woodchipping. With increasing mechanisation and efficiency, reducing supply of high-quality logs and increasing woodchipping, the jobs per 1000 m^3 will continue to decline.

It is important to factor in the employment associated with plantations and private native forestry when considering industry employment. The DPI (2018) 'North Coast NSW Private Native Forest Primary Processors Survey Report' estimated 'the private property primary processing sector on the north coast of NSW directly employs 516 people, with the production flow-on and consumption flow-on likely to create a further 344 jobs regionally.

Table 19 Ratios for hardwood processing calculated from data in 'The Economic Impact of the NSW Timber Industry 1995 Margules Groome Poyry' for the north coast of NSW[30]

Hardwood processing of private native forest logs	Direct	Production flow-on	Consumption flow-on	Total
Employment calculated ratios	1	0.1130	0.5039	1.6170
Employment numbers	516	58	260	835

DPI (2018) 'North Coast NSW Private Native Forest Primary Processors Survey Report'

Multipliers of questionable veracity are often used to inflate the value of the timber industry. Ernst and Young (2019) do not explain the derivation of their multiplier of 2.46, though By comparison NSW Department of Primary Industries 2018 adopts a multiplier of 1.617 to account for production and consumption flow-on into the regional economy, which only totals 349 indirect jobs rather than the 826 claimed by Ernst and Young 2019. NRC (2021) consider "*Multipliers determined from interstate studies indicate that the number of additional flow-on jobs at risk by the pathways could be roughly equivalent to the number of direct jobs at risk. However, the Commission notes there is considerable uncertainty around these figures, and they should be applied with caution*."

In relation to multipliers, Driml (2010) observe:

> *Total effects are direct plus flow-on effects. It is important to take care in interpreting the larger total effect figures. They should not be used to directly compare industries, due to double counting issues. For instance, in the café example above, the sales from agriculture to tourism will also be recorded as output from agriculture. Direct effects should be used when making comparisons among industries or across regions.*

1.4. Ecological Sustainability

Logging of native forests is not sustainable as it reduces biomass and carbon storage, removes mature trees and their abundance of nectar and browse essential for many species, removes and kills remaining hollow-bearing trees that provide essential homes for a plethora of NSW's species, increases fire threat and intensity, reduces stream flows, promotes weeds such as lantana, causes Bell Miner Associated Dieback and ecosystem collapse, reduces streamflows, degrades soils and increases erosion and stream pollution. The Forestry Corporation practices Ecologically Sustainable Forest Management in name only. It is repeatedly mentioned, though in practice is only a consideration, with ecological requirements systematically over-ridden by the requirement that protections for threatened species have no impact on timber yields. Changing logging prescriptions to account for the immense impact of the 2019/20 wildfires was met with obfuscation by the Forestry Corporation, ignoring of expert recommendations, political suppression of reports, and ended with continuation of business as usual, with at the best token voluntary measures in some areas.

Section 69L of the Forestry Act 2012 requires the carrying out of forestry operations in accordance with principles of ecologically sustainable forest management, section 14.1 of the Coastal Integrated Forestry Operations Approval has an overall objective to authorise the carrying out of forestry operations in accordance with the principles of ecologically sustainable forest management, Attachment 14 to the North East NSW Regional Forest Agreement details at length the requirements of ecologically sustainable forest management.

It is important to recognise that despite the pretence, there is no requirement to implement Ecologically Sustainable Forest Management, rather it is just a consideration and in practice is over-ridden by timber commitments. The Forestry Act 2012 (10(1)) identifies that there are five objectives for the Forestry Corporation which can be summarised as:

1. Be a successful business
2. Have regard to community interests
3. Comply with the principles of Ecologically Sustainable Development
4. Contribute to regional development and decentralisation
5. Be an efficient and environmentally sustainable supplier of timber

Though clause 10(2) stipulates *Each of the principal objectives of the Corporation is of equal importance*

When the Government was remaking the Coastal Integrated Forestry Approval (CIFOA) the claim was (EPA 2014):

> *The objectives of the coastal IFOAs remake are to reduce the costs of implementation and compliance and to improve the clarity and enforceability of IFOA conditions. The NSW Government has committed to delivering these objectives with no net change to wood supply and maintenance of environmental values.*

The NRC (2016) was requested to resolve prescriptions over which the EPA and Forestry Corporation were unable to reach agreement, often siding with the Forestry Corporation on the grounds of resources impacts, and concluding:

> *Following analysis of the expected cumulative impact of the agreed and recommended settings, the Commission has determined that it is not possible to meet the Government's commitments around both environmental values and wood supply. In addition, a range of external factors outside of the IFOA settings affect the ability to meet the commitments both now and into the future, such as emerging threats from climate change and changing fire regimes.*

In practice the over-riding requirement was to have no impact on committed timber volumes, when combined with cost reductions and an intent to simplify prescriptions, this meant that logging intensity was increased, protections for most mature trees were removed, most species-specific prescriptions were removed, and riparian buffers reduced. The outcome was not Ecologically Sustainable Forest Management.

This requirement to have no significant impact on timber supply continues to dominate all decisions on the CIFOA. In the estimates hearing for Planning and Environment on 29 August 2024 Chief Executive Officer, NSW Environment Protection Authority, Tony Chappel stated:

> *We will continue to review and adapt each of those conditions to try and improve them as much as possible, within the constraints of the balance we are required to take. Perhaps I didn't clarify it today but, in contrast to the other legislation the EPA operates under that allows us to integrate environmental, social and economic issues, the Forestry Act requires us explicitly to balance environmental protection with the economic and contractual obligations that the corporation has. Within those constraints, we work very hard to be rigorous and independent.*

The EPA and FCNSW collaborate on prescriptions, A review of GI(PA) documents over the introduction of a Site Specific Biodiversity Condition for Greater Gliders shows that in their negotiations it is reiterated time and again that there cannot be a significant impact on timber and none on Wood Supply Agreement (WSA) commitments. Proposals from the EPA to increase protections for Greater Gliders on ecological grounds were dismissed on claims by FCNSW that they would have unacceptable resource impacts. FCNSW effectively get to write their own logging rules.

There can be no doubt that we are in an extinction crisis. The 2024 NSW Biodiversity Outlook Report identifies that species continue to decline in NSW, with only 50% of the 1000 threatened species and 55% of the more than 100 threatened ecological communities expected to survive in 100 years. It expects that we will lose 24% of all 6000 of NSW's plants within 100 years. This is being compounded by the climate crisis, as exemplified by the record drought and wildfires that ravished north-east NSW's forests in 2019/20.

While the Government and loggers often pretend otherwise, logging the homes of threatened species is a significant contributor to our extinction crisis. This impact has been amplified by the lack of an adequate response to account for the impacts of the 2019/20 wildfires.

Ward *et. al.* (2024) identified that 29 million ha (54%) of NSW's pre-1788 native forest and woodland vegetation has been cleared, with 9 million ha of the remaining 25 million ha estimated to be degraded. They identified there are 269 forest-dependent nationally (EPBC Act) listed threatened taxa in NSW. An estimated 435,000 ha of State Forests was logged from 2000-2022, affecting 150 EPBC taxa, 13 of which are listed as Critically Endangered, 51 as endangered, and 86 as vulnerable. Fauna with the highest proportion of their NSW distribution affected by logging include long-footed potoroo, southern mainland long-nosed potoroo and southern brown bandicoot. Taxa

with the most distribution by area that overlapped with logging included koala (400,000 ha), south-eastern glossy black-cockatoo (370,000 ha), and spotted-tailed quoll (310,000 ha).

It is also relevant to consider that forests subject to logging are being progressively degraded, with the EPA (2021) identifying that State Forests have been reduced to only 30% of their original ecological carrying capacity for native species, while national parks have 63% of their original ecological carrying capacity remaining.

There is abundant evidence that numerous animal species prefer larger trees for increased resources, such as browse and nectar, and that many are dependent upon the hollows provided by the oldest trees. Hatanaka *et. al.* (2011) sought to measure the direct relationship between carbon and birds in Victorian forests aged from less than 5 years old to mature stands more than 100 years old, finding

> *Mature forest stands had the highest number of bird species, abundance and biomass, and the most distinctive bird assemblages compared with regrowth forest sites ... On average, there were 72% more species per stand in mature stands than in older regrowth (41–60 years). There also were 72% more individuals and a huge increase in bird biomass (176%).*

In addition to logging, the 2019/20 wildfires greatly compounded the impacts on forest structure and forest species. From August 2019 until January 2020 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, around half the remnant native vegetation, 35% of rainforests and 54% of State Forests. This had profound impacts on trees, ecosystems and an array of populations of numerous threatened species, despite this, four years after the fires there is only one change to the logging rules to increase protection for Greater Gliders.

Summary of principal issues discussed

Eight examples of forest management are considered herein to highlight the NSW Government's abject failure to implement Ecologically Sustainable Forest Management.

> **Flowering, and thus the volume of nectar available for nectarivores, increases with tree maturity and size. Larger trees also flower more regularly. Unfortunately nectar production increases markedly when trees reach the size taken for sawlogs. By progressively reducing the age classes of trees in State forests this is reducing nectar availability for a plethora of nectarivores. The provision of nectar is a declining resource in logging areas, and continues to decline as tree sizes reduce and protections for mature trees are removed. This problem will escalate in response to increasing droughts and fires due to climate heating.**
>
> **Seventy species in north-east NSW depend upon the hollows provided by old trees for dens, roosts and nests. Logging has decimated hollow-bearing trees and the animals that rely upon them, particularly those reliant upon the large hollows provided by trees over 200 years old. As the few retained old trees dies, or are burnt out in wildfires, the next largest trees are not being retained to replace them. The Government's response to this housing crisis was to remove protection for recruitment trees and allow surviving hollow-bearing trees to be wantonly damaged in logging operations. All attempts to redress the increasing disaster have been rebuffed, as has Ecologically Sustainable Forest Management.**
>
> **A case study of the development and implementation of a Koala prescription from 1997 to 2024 exemplifies the political process used to establish prescriptions for many threatened species. This is particularly alarming given the iconic status of**

Koalas. Regulation of logging public native forests to mitigate logging impacts on Koalas by protecting the most significant occupied Koala habitat and protecting preferred Koala feed trees has been demonstrated to have failed through lack of will, poor enforcement, ignoring of expert advice, and failure to apply adaptive management. Claims that logging has no impact on Koalas are based on fundamentally flawed research, yet are relied upon to deny Koalas the protection they deserve. It is astounding that, irrespective of how significant a Koala population is, currently the only requirements are to protect a few trees below optimal size in poorly modelled habitat, and if a Koala happens to be seen, to wait for it to leave its tree before cutting it down. The principles of Ecologically Sustainable Forest Management, and the precautionary principle, have not been applied to Koalas.

Lantana (*Lantana camara)* is one of the worst invasive weeds in Australia and recognised as a Key Threatening Process since 2006. It invades logged forests aided by canopy and understorey removal, and soil disturbance. It increases with repeat disturbances. It prevents regeneration of native species through mechanisms such as shading, smothering and allelopathy. Where it occurs at high densities it can become self-perpetuating, lead to declines in native flora diversity, reduce foods for fauna and hinder their movements. Lantana increases fire risk and intensity. It is a threat to ecosystem health, community structure and ecosystem functioning. As a result of logging, it has infested tens of thousands of hectares of State forests in north-east NSW, and gets worse with each logging. There are legacy infestations in previously logged forests, including rainforests, now protected from logging. The refusal of the Forestry Corporation to manage lantana and rehabilitate infected forests is the antithesis of Ecologically Sustainable Forest Management.

Dense infestations of lantana (and sometimes other dense understories) can create habitat for colonies of Bell Miners which aggressively mob predators and perceived competitors and drive them from their territories. This initiates a process of ecosystem collapse whereby populations of sap-sucking psyllids proliferate and drain the life out of the eucalypts, resulting in extensive areas of dead and dying eucalypts over a dense understorey of lantana. This problem has been evident for decades, and is getting worse, yet the EPA and Forestry Corporation fail to acknowledge its causes or take any meaningful action to rehabilitate affected forests. In contravention of Ecologically Sustainable Forest Management the Government is in denial, despite the significant consequences for future timber yields, while affected and susceptible forests continue to be logged.

As shown by the 2019-20 fires we do not have any time to waste. That event had a profound impact, causing the loss of many trees and significant declines in populations of numerous threatened species. With climate heating the risks of extreme events increasing in amplitude and frequency poses a growing threat. We need to immediately stop degrading forests by logging, stop increasing their vulnerability to burning, and instead focus on rehabilitating degraded forests to increase their resilience to future extreme events. It was apparent that the CIFOA logging rules were inadequate to mitigate the worst impacts of logging following the 2019/20 wildfires, and additional measures were required to make logging more sustainable. The EPA and Forestry Corporation agreed to additional Site Specific Operating Conditions (SSOCs) to mitigate the worst impacts, After a year the Forestry Corporation rejected the EPA's request to extend the SSOCs as *essential to ensuring harvesting activities in fire-impacted forests are carried out in an ecologically sustainable manner*, instead adopting some token voluntary constraints of their own.

The NRC was directed to develop recommendations in concert with the Forestry Corporation which required minimal changes [redacted] Following the uplisting of the threatened status of numerous species because of the fires, in October 2023 the EPA began trying to negotiate minor amendments to the CIFOA for Koalas, Greater Gliders, Swift Parrots and Glossy Black Cockatoos on the basis *that the proposed amendments would not have any material impact on timber supply*. The Forestry Corporation accepted some in principle, while opposing increased protections for Koalas, though four years after the fires the only change to the protocols that eventuated was for Greater Gliders. This displays the abject failure to apply adaptive management and implement Ecologically Sustainable Forest Management.

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, while increasing the extent, intensity and frequency of wildfires. 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. Logging is increasing the vulnerability of forests to burning, which in an era of global warming is not sustainable in any way.

There is nothing sustainable about the cumulative impacts of logging on soils, erosion and sedimentation of streams. Logging results in decreasing Soil Organic Carbon, increasing bulk density and increasing pH, suggesting poorer soil structure and condition, that increase runoff and reduce water holding capacity. Logging changes hydrology, redirecting water and affecting the pattern of surface and subsurface waterflows. Roads and snig-tracks are the primary sources of erosion, resulting in significant increases in sediment laden runoff entering streams. In streams sediments can persist for decades, filling up pools and interstitial spaces used by fauna for refuge and breeding. Riparian buffers are the principal means of mitigating logging impacts on streams, with 30m wide buffers recommended for headwater streams, yet only 5m buffers are applied. In streams increased flows in extreme rainfall events can erode streambanks and deposit sediments where waters slow.

In the midst of the current extinction and climate crises it is essential that we stop the ongoing degradation of our public forests and help rehabilitate them to restore their integrity to enable them to best survive their increasingly uncertain future.

1.4.1. Declining nectar

Flowering, and thus the volume of nectar available for nectarivores, increases with tree maturity and size. Larger trees also flower more regularly. Unfortunately, nectar production increases markedly when trees reach the size taken for sawlogs. By progressively reducing the age classes of trees in State forests this is reducing nectar availability for a plethora of nectarivores. The provision of nectar is a declining resource in logging areas, and continues to decline as tree sizes reduce and protections for mature trees are removed. This problem will escalate in response to increasing droughts and fires due to climate heating.

Nectar is a key food that many vertebrate species depend on. Eucalypt species can produce copious nectar though most flower unreliably, often at intervals of several years, so nectarivorous

species need to be able to track nectar across the landscape or switch to other foods when nectar is in short supply. Law and Chidel (2007) found "*in exceptional years, 1000 ha of spotted gum forest flowering from April-August could yield five tonnes of honey"*.

The flowering of trees and abundance of nectar is directly affected by rainfall over the previous 6 months (Hawkins 2017), reducing in droughts and following bushfires (Law *et. al.* 2000, Law and Chidel 2009, Moore *et. al.* 2016). The erratic production of nectar is likely to become more so in the future as climate heating gathers momentum, as stated by Butt *et. al.* (2015) "*as a consequence of the increasing incidence of droughts and heat waves, the net quantity of nectar at flower, stand and landscape scales may be reduced, and its temporal variability increased*".

The conversion of multi-aged forests to regrowth greatly compounds resource shortfalls for increasingly threatened species.

Older trees produce significantly more flowers and nectar than young trees and thus are of particular importance to fauna relying on these food sources, such as the threatened Regent Honeyeater, Swift Parrot, Black-chinned Honeyeater, Little Lorikeet, Grey-headed Flying Fox, Squirrel Glider and Yellow-bellied Glider.

For Mountain Ash trees Ashton (1975) found "*The mature forest produced 2.15-15.5 times as many flowers as the pole stage trees, and 1.5-10 times as many as the spar stage forest".* From her study of the flowering phenology displayed by seven Eucalyptus species in a Box-Ironbark forest, Wilson (2003) found *"trees in size - classes >40 cm flowered more frequently, for a greater duration, more intensely and had greater indices of floral resource abundance than trees < 40 cm DBH"*.

For Spotted Gum forest in southern NSW Law and Chidel (2007, 2008, 2009) found large trees (>40cm dbh) carried 3,600 flowers compared to 816 flowers on medium trees and 283 flowers on small trees (<25cm dbh), noting "*mature forest produced almost 10 times as much sugar per ha as recently logged forest, with regrowth being intermediate*" And for Grey Ironbark *Eucalyptus paniculata* forests large trees carried 12,555 flowers compared to ,1024 flowers on medium trees and 686 flowers on small trees, noting "*old regrowth forest (232 g sugar per night per 0.2 ha) produced just over 7 times the sugar of recently logged forest (32 g), while regrowth forest was intermediate (91 g)*."

As well as producing more flowers larger trees also tend to flower more often (Law *et. al.* 2000, Law and Chidel 2007), for example Law *et. al.* (2000) found that large Spotted Gum *Corymbia variegata* flowered every 2.3 years whereas medium sized trees flowered every 5.9 years.

The abundance of flowers provided by trees directly affects their suitability for foraging by numerous animals. Mature and older trees have been significantly diminished across these forests, and along with them the abundance and reliability of nectar essential to maintain resident and seasonal populations of nectar feeders.

To obtain an indicative estimation of the loss of nectar due to logging, the averages of the number of flowers per Spotted Gum and Grey Ironbark in the 3 size classes identified by Law and Chidel (2007) were applied to the plot data for the proposed Sandy Creek Koala Park to identify the indicative reduction in nectar likely to have been caused by logging to date.

It was found that the number of trees per hectare, and thus the numbers of flowers per hectare, have increased in the 15-39.9 cm dbh size classes, though halved in the more prolific flowering trees >40 cm dbh. This gives an indicative overall decline of 43% in the number of flowers, and thus nectar, per hectare. Though the reduction would be higher than this, likely over 50%, due to the more abundant flowering in the heavily depleted larger size classes (i.e. particularly 50-80cm dbh), and less frequent flowering of smaller trees.

Size Class	Trees/ha		Flowers/tree[1]	Flowers/ha		
	Logged	Unlogged		Logged	Unlogged	Change
15-24.9	98.4	95	484.5	47,675	46,028	+1,647
25-39.9	71.6	43.3	920	65,872	39,836	+26,036
40+	45.9	95	8,077.5	370,757	767,363	-396,606
			TOTALS	**484,304**	**853,226**	**-368,922**

Indicative changes in abundance of flowers, and thus nectar, per hectare likely to have resulted from past logging of proposed Sandy Creek Koala Park

1. Flowers per tree is the average of the numbers given for Spotted Gum and Grey Ironbark by Law and Chidel (2007).

Extrapolating from the example cited by Law and Chidel (2007) where "*in exceptional years, 1000 ha of spotted gum forest flowering from April-August could yield five tonnes of honey"*, if applied to the 7,000 ha proposed Sandy Creek Koala Park the likely >50% reduction in nectar would equate to >17.5 tonnes of honey. The current wholesale price of honey is around $6.20 a kilo, so this loss of flowers could be worth at least $108,500 in a single good year. That is also a lot of food for a lot of animals.

Researchers at Australia's Threatened Species Recovery Hub (Geyle *et. al.* 2018) recently identified that the Regent Honeyeater and Swift Parrot have a 57% chance of extinction and a 31% chance of extinction respectively within the next 20 years, ranking them the 7th and 13th most threatened birds in Australia.

The Regent Honeyeater is listed as Critically Endangered under the EPBC Act. The 2016 National Recovery Plan for the Regent Honeyeater identifies "*It is important to identify and retain trees that produce relatively high levels of nectar. In some areas where there has been a history of removal of large trees, regent honeyeaters often select the largest available trees of the 'key' species".* John Gould (cited by Crates 2018) stated *"Although it is very generally distributed, it's presence appears to be dependent upon the state of the Eucalypti, upon whose blossoms the bird mainly depends for subsistence; and it is, consequently, only to be found in any particular locality during the season when those trees are in full bloom. It generally resorts to the loftiest and most fully-flowered trees".*

The Recovery Plan identifies key feed tree species for the Regent Honeyeater as including Swamp Mahogany *Eucalyptus robusta,* and Spotted Gum *Corymbia macula,* noting "*Mature, large individual trees tend to be more important as they are more productive, particularly on highly fertile sites and in riparian areas (Webster & Menkhorst 1992; Oliver 2000). Trees in such areas tend to grow larger (Soderquist & MacNally 2000) and produce more flowers (Wilson & Bennett 1999)*".

The Swift Parrot *Lathamus discolor* is listed as 'Endangered' under the EPBC Act. The 2011 National Recovery Plan for the Swift Parrot identifies the loss of mature trees and the abundance of nectar they provide as a major threat, noting:

> *Based on current knowledge of the ecology and distribution of the Swift Parrot the persistence of this species is mainly threatened by loss and alteration of habitat from forestry activities including firewood harvesting, clearing for residential, agricultural and industrial developments, attrition of old growth trees in the agricultural landscape, suppression of forest regeneration, and frequent fire. The species is also threatened by the effects of climate change, food and nest source competition, flight collision hazards, psittacine beak and feather disease, and illegal capture and trade.*
>
> *Forestry activities, including firewood harvesting result in the loss and alteration of nesting and foraging habitat throughout the Swift Parrot's range ... The harvesting of mature box-ironbark woodlands of central Victoria and coastal forests of New South Wales for forestry reduces the suitability of these habitats for this species by removing mature trees which are*

> *preferred by Swift Parrots for foraging and that provide more reliable, as well as greater quantity and quality of food resources than younger trees (Wilson and Bennett 1999; Kennedy and Overs 2001; Kennedy and Tzaros 2005)*

The Recovery Plan identifies "*Swift Parrots have been found to preferentially forage in large, mature trees (Kennedy 2000; Kennedy and Overs 2001; Kennedy and Tzaros 2005) that provide more reliable foraging resources than younger trees".* Brereton *et. al*. (2004) found:

> *Swift Parrots showed a clear preference for larger Blue-gum trees: Blue-gum trees in which Swift Parrots foraged were ~40% larger than surrounding (non-forage) trees, while the size-class distribution of forage trees was significantly skewed towards larger tree-size compared with surrounding non-forage trees. The mean flowering intensity of forage trees was also significantly greater than the mean flowering intensity of non-forage trees. Both flowering frequency and flowering intensity increased with tree size, although there was a trend for both flowering frequency and intensity to decline in the largest tree size-classes.*

Coastal forests have been identified as significant winter food resources for Swift Parrots, with Forest Red Gum accounting for 49% of all coastal foraging observations (Saunders and Heinsohn 2008). It is important to recognise that the north coast forests with an abundance of these winter flowering species are of increased importance for nectarivores during droughts, when drier western forests are too drought stressed to produce much nectar. For Swift Parrots Saunders and Heinsohn (2008) found:

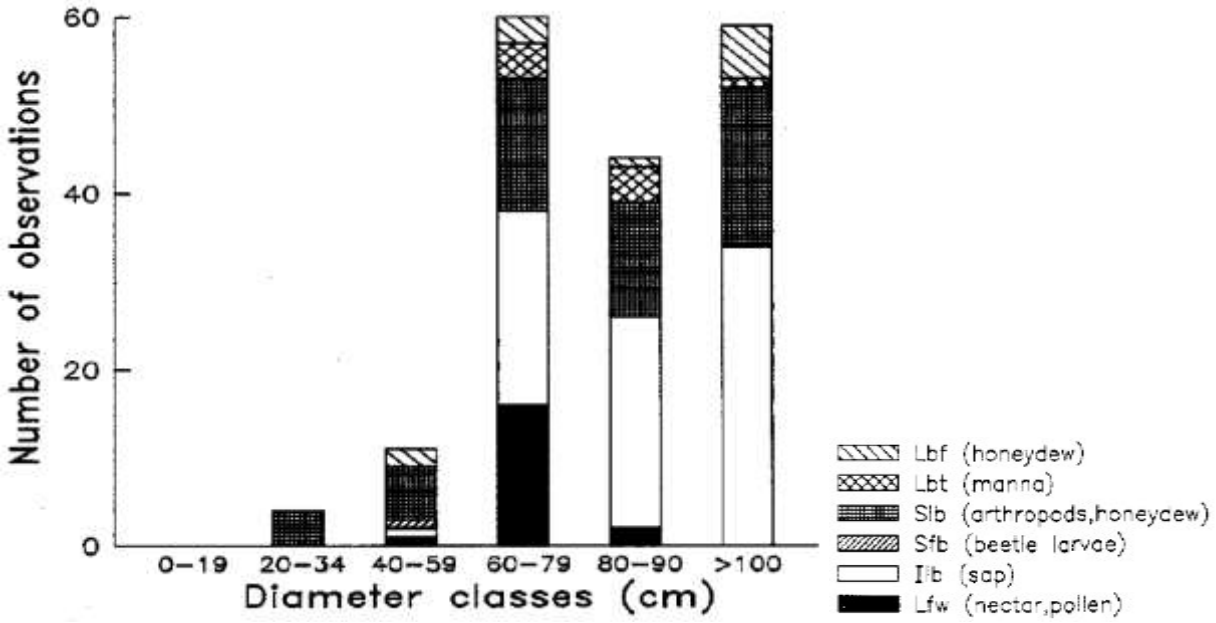
> *The greatest variability in use of habitat in this study occurred on the central and northern coasts of NSW. Although these coastal regions often supported small numbers of Swift Parrots, this changed dramatically during drought conditions in 2002 (Bureau of Meteorology 2002; Bureau of Meteorology 2006). The numbers of Swift Parrots foraging in these coastal regions increased substantially during this year, with a large proportion of the population apparently using these areas as drought refuges. Our study draws attention to the importance of these refuge areas for the long-term viability of the Swift Parrot population, as for other fauna dependent on highly variable environments*

Yellow-bellied Glider and Squirrel Glider are two marsupials that have a high reliance upon older trees for the abundance of nectar and other resources they provide.

Eyre and Smith (1997) found that Yellow-bellied Gliders preferred forests containing gum-barked and winter flowering species, and that within these forests they were "*more abundant in the more productive forests with relatively high densities of ironbark and gum-barked species > 50 cm diameter*". Wormington *et. al.* (2002) found that "*the density of hollow-bearing trees >50 cm dbh, tree height and increased length of time since the last logging contributed to the presence of yellow-bellied gliders*".

Kavanagh (1987) found that Yellow-bellied Gliders primarily selected trees of certain species and secondarily trees of larger size for foraging, with 92% of trees used for foraging over 60 cm dbh and 58% over 80 cm dbh. Kavanagh (1987) found that larger trees provide a variety of resources:

> *Tree size. The size of trees used by foraging animals was influenced by the type of substrate being exploited (Fig. 5). Gliders were observed licking flowers mainly in medium to large trees, and licking honeydew from the branches of some very large trees. Large trees (> 80 cm DBH) were important as a source of sap: the diameters of important sap-site trees in the study area ranged from 56 to 164 cm in E. viminalis (mean ~SD1,10 t 31.3 cm, n = lo), and from 74 to 143 cm in E. fastigata (105 k21.2 cm, n = 14). Decorticating bark provided a foraging substrate which gliders utilised from trees of a wide range of size, and was the only substrate to be exploited from small (<40 cm DBH) trees.*



Diameter classes of trees in which the different foraging behaviours of yellow-bellied gliders were observed (from Kavanagh 1987).

Kavanagh (1987) concluded:

> *The gliders in my study area selected the trees with the greatest number of flowers in which to forage for nectar; these would have been the older trees, because mature trees (c.200 years old) produce 2.2-15.5 times as many flowers as pole stage trees (c.25 years old). The importance of manna, lerp and honeydew as food for forest vertebrates has only recently been appreciated ... The gliders obtained them from large trees.*
>
> *...*
>
> *These results suggest that mature forests which provide sufficient diversity of the favoured eucalypt species will be the habitats with the highest concentration of yellow-bellied gliders.*

Mackowski (1988) found that the trees tapped for sap by Yellow-bellied Gliders in northern NSW had a mean diameter (dbh) of 65.6 cm and *"a minimum dbhob of about 30 cm"*. Similarly in south-east Queensland Eyre and Goldingay (2005) found "*Of the tree species used for sap feeding by gliders, trees >40 cm in diameter at breast height (DBH) were used more than would be expected on the basis of their abundance in the forest*". They also found *" An increase in the basal area of cut stumps and dead trees in the forest stand was related to an increase in the number of sap trees observed that more trees were tapped for sap"*, considering:

> *This is thought to be due to reduced availability of other foraging resources. ...In southern Queensland, this basal area threshold is equivalent to 9 trees ha^{-1} in the 61–80-cm DBH class, or 17 trees ha^{-1} in the 41–60-cm DBH class, which in general (based on regional-scale data) approximates 25–35% removal of the original tree basal area, or 20–30% removal of the overstorey canopy. This could lead to a decrease in potential foraging substrates, such as decorticating bark (for arthropod searching) and flower cover (for nectar and pollen feeding), necessitating a heavier reliance upon sap trees in glider diet to maintain energy requirements".*

Hawkins (2017) consider "*The one consistent feature of the annual nectar cycle was a period of scarcity in late winter and spring (August-September); this has also been identified as a time of scarcity in northern New South Wales by Law et al. (2000)*". Law *et al* (2000) comment:

> *shortages commonly occur from late winter to spring. Species that flower reliably in this period include Eucalyptus robusta, Eucalyptus tereticornis and Eucalyptus siderophloia in late winter and E. siderophloia and E. acmenoides in spring.*

From their study of Squirrel Gliders in Bungawalbin Nature Reserve, Sharpe and Goldingay (1998) observed Squirrel Gliders feeding on nectar and pollen in 59% of all observations, noting *"[Banksia] integrifolia accounted for over 50% of these observations*", and "*Squirrel gliders appeared to use all flowering E. siderophloia available to them at this time. Eucalyptus seeana was also used heavily when in flower*". From radio-tracking Sharpe and Goldingay (2007) concluded "*the spatial organisation of home ranges of squirrel gliders at Bungawalbin was strongly influenced by the distribution of key winter- and spring-flowering trees*". Sharpe (2004) concluded "*The over-harvesting of E. siderophloia in timber production forests would have the potential to adversely affect nectarivorous species, such as the squirrel glider and the yellow-bellied glider, both of which are listed as threatened in NSW*".

At their study site in south-east Queensland Dobson *et.al.* (2005) found that Squirrel Gliders fed 48% of the time on nectar and pollen derived from 10 tree species, with *E. tereticornis* accounting for 55% of all records. From their studies of this population Sharpe and Goldingay (2010) concluded "*Variation in nectar availability appears to have a substantial influence on the dynamics of squirrel glider populations*".

Nectar and pollen were particularly important for Squirrel Gliders during winter and early spring (Sharpe and Goldingay 1998), with their populations varying with the number of flowering trees, and susceptible to crashing when key nectar trees fail to flower. Sharpe (2004) observed that "*Gliders rapidly lost weight between July and September 2000, which coincided with extremely dry conditions and a lack of flowering in Eucalyptus siderophloia, an important nectar source*". This was followed by a loss of almost 80% Gliders between September and November 2000, likely due to the "*sudden onset of hot conditions in the late winter of 2000*".

From their study of Squirrel Gliders in Victoria, Holland *et. al.* (2007) concluded:

> *The high density of large trees is a critical element of habitat quality. Not only were large trees preferentially selected for foraging, they also provide gliders with hollows for nesting (van der Ree 2000). Retention of large trees should therefore be a priority, and lack of regeneration is of serious concern, with trees not being replaced as they senesce.*

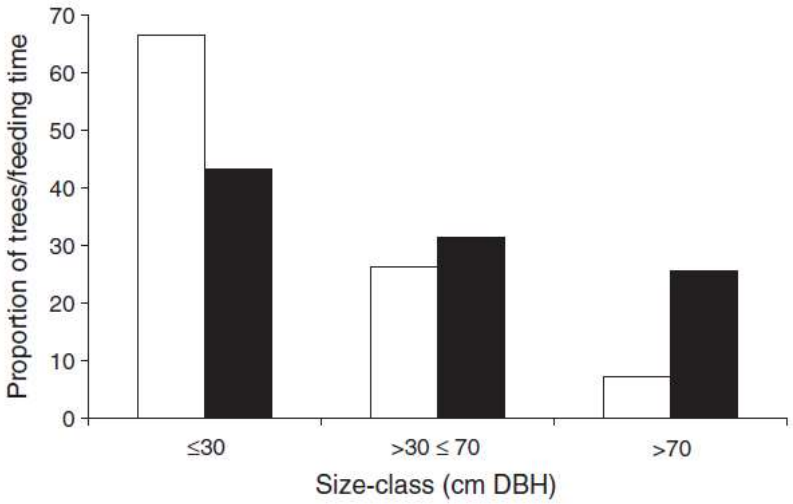


Fig. 3. from Holland *et. al.* (2007): The proportion of total *Eucalyptus microcarpa* trees in each size category (clear bars), and the proportion of total feeding time of squirrel gliders within trees in each size category (shaded bars) near Euroa, Victoria.

These results show that Squirrel Gliders are vulnerable to logging that reduces tree sizes and thus the quantity and regularity of nectar, and that nectar shortages also make them particularly vulnerable to unseasonal heat waves due to climate heating.

Flying foxes are another key nectar feeding species, Ebby (1999) considers:

> *... more reliable resources are produced in lowland coastal woodlands in northern New South Wales and in southern Queensland dominated by E. tereticornis, E. robusta, M . quinquenervia and Banksia integrifolia (Clemson 1985; Pressey and Griffith 1992). In approximately 30% of years the only significant winter foraging resources available in New South Wales occur in coastal woodlands at low elevations and large numbers of flying-foxes congregate in these areas, as illustrated by this study. Grey-headed Flying foxes are known to migrate from camps many hundreds of kilometres away to utilize these winter resources (Ehy 1991).*
>
> *Grey-headed Flying-foxes are additionally impacted by incremental reductions in food availability throughout their range as a result of forest clearing and degradation, forestry practices, eucalypt dieback, drought, fire and the vulnerability of nectar flow to fluctuations in temperature and rainfall".*

For the Grey Headed Flying Fox, Ebby and Law (2008) consider:

> *Winter presents the greatest food resource bottleneck for the species. In winter, productive areas are concentrated in coastal floodplains, coastal dunes and inland slopes in SEQ and northern NSW. The majority of winter habitats are heavily cleared, poorly conserved and recognised as endangered vegetation communities.*

The fact that in 2019 masses of flying foxes starved to death is testimony to this problem of declining nectar resources.

The previous Threatened Species Licence under the IFOA had a variety of requirements for the retention of mature trees as recruitment habitat trees to replace hollow-bearing trees, as 3-5 eucalypt nectar feed trees per hectare, and as feed trees around records of a variety of threatened fauna (such as 15 mature smooth-barked feed trees within 200m of Yellow-bellied Glider records).

With the rewrite of the 2018 Coastal IFOA logging rules the initial intent of the EPA was to remove all requirements to protect mature trees, though, presumably after intervention by the Commonwealth, the required retention of 5 mature to late-mature nectar feed trees per hectare in compartments within 2km of existing records (less than 20 years old) of Swift Parrot and Regent Honeyeater was reinstated. However, the requirement to survey for these species was removed.

There are vaguely expressed intentions to include mature trees in Wildlife Habitat and Tree Retention clumps, though nothing is quantified or enforceable.

Law and Chidel (2007) found that while in good years eucalypts can produce a surplus of nectar, in poor years the limited nectar was rapidly consumed, leading them to observe "*Depletion of nectar in poor flowering years justifies management prescriptions that retain mature trees of locally important flowering species (currently six per ha) in the areas zoned for logging. The fact that total sugar content tends to be higher in lower slope areas (e.g. riparian zones) is also important in ameliorating logging impacts*". It speaks volumes for the integrity of NSW's IFOA remake that the Forestry Corporation ignored their own research recommendations.

1.4.2. Loss of hollow-bearing trees

Seventy species in north-east NSW depend upon the hollows provided by old trees for dens, roosts and nests. Logging has decimated hollow-bearing trees and the animals that rely upon them, particularly those reliant upon the large hollows provided by trees over 200 years old. As the few retained old trees dies, or are burnt out in wildfires, the next largest trees are not being retained to replace them. The Government's response to this housing crisis was to remove protection for recruitment trees and allow surviving hollow-bearing trees to be

wantonly damaged in logging operations. All attempts to redress the increasing disaster have been rebuffed, as has Ecologically Sustainable Forest Management.

Once eucalypts are over 120-180 years old they begin to provide the small hollows needed by a plethora of native wildlife for denning, nesting and shelter. Though it is not until they are over 220 years old that they provide the larger hollows required by species such as owls, cockatoos and gliders. They may live for 300-500 years, sometimes longer.

Seventy species (28%) of vertebrates use hollows in north-east NSW (Gibbons & Lindenmayer 2002). The loss of the hollows provided by large old trees has been identified as a primary threat to a variety of priority species in north east NSW (Environment Australia 1999, Appendix 1); 4 mammals (non-flying), 20 bats, 3 birds, 2 frogs, 3 reptiles and 4 snakes.

Gibbons and Lindenmayer (2002) documented that relatively undisturbed temperate and sub-tropical eucalypt forests contain 13–27 hollow-bearing trees per hectare. Only some hollows have appropriate entrance sizes and depths for fauna, with only 43-57% of hollows found to be used by fauna, and 49-57% of hollow-bearing trees used (Gibbons and Lindenmayer 2002).

Animals do not select hollows at random; factors such as entrance size and shape, depth, degree of insulation and location greatly affect the frequency and seasonality of hollow use. Many species use multiple hollows which they move between. For example, the Brush-tailed Phascogale has been found to use 27-38 different hollows (Gibbons & Lindenmayer 2002), Craig (1985) found that a family group of 3 Yellow-bellied Gliders "*used at least eight den trees within their home area*", and Brigham *et. al.* (1998) found that Australian Owlet-nightjars move approximately 300m between roost sites every 9 days on average, with individuals using 2-6 different cavities over 1-4 months, noting "*our results suggest that birds may be loyal to a group of 2-6 trees in a relatively confined area*".

Based on several assumptions, various estimates of the numbers of hollow-bearing trees occupied by vertebrate fauna have been made, with Gibbons & Lindenmayer (2002) assuming that *"hollow-bearing trees in forests are likely to be occupied at a rate of around 6-15 per hectare".*

For our plot assessments of the proposed Sandy Creek Koala Park NEFA measured plots in both unlogged and logged Spotted Gum forests south of Casino in order to be able to assess structural changes resultant from past logging. The original forests contained a minimum of 18.3 trees/ha with the large hollows suitable as dens and roosts of large hollow-dependent animals such as the threatened Powerful Owl, Masked Owl, Barking Owl, Greater Glider, Yellow-bellied Glider, and Glossy-black Cockatoo. Due to past logging, there are now only an average of 0.3 trees/ha with large hollows left, a 98.4% reduction in these vital resources, meaning that populations of such species have been significantly affected, with strong competition for remaining hollows. The loss of small hollows has been less severe (78%), though many of those left may be uninhabitable. Of the 17 threatened hollow-dependent species using these forests, 15 had reserve targets set in 1998 and only 2 of these met targets and can therefore be considered to be adequately protected in national parks.

There are numerous species occurring in this proposal that depend upon the large hollows provided by old eucalypts for nesting or denning, such as the Vulnerable Powerful Owl, Masked Owl, Barking Owl, Greater Glider, Yellow-bellied Glider, and Glossy-black Cockatoo. Others that require smaller hollows include the Vulnerable Brush-tailed Phascogale, Squirrel Glider, Hoary Wattled Bat, Yellow-bellied Sheathtail-bat, Greater Broad-nosed Bat, Turquoise Parrot, Dusky Woodswallow, Brown Tree-creeper and Little Lorikeet. There is an urgent need to restore hollow-bearing trees to recover these species.

The NSW Scientific Committee (2007) has identified Loss of Hollow-bearing Trees as a Key Threatening Process. The maintenance of large old hollow-bearing trees in perpetuity is the single most important requirement for the survival of the numerous animal species that rely on their hollows for denning, nesting or roosting**.** To maintain continuity of supply of these resources by such long lived organisms it is essential to ensure that there are enough small hollow-bearing trees to replace the large hollow-bearing trees when they die, and enough strong and health mature trees to develop into the hollow-bearing trees of the future.

As noted by Gibbons and Lindenmayer (2002):

> *Hollow-bearing eucalypts are extremely long-lived 'organisms'. Eucalypts typically have a life span of 300-500 years, and dead trees may provide hollows for a further 100 years. The age at which they 'reproduce' hollows (typically 150-250 years) represents one of the slowest 'reproductive cycles' for any organism. Failure to replace hollow-bearing trees as they are lost will result in prolonged temporal gaps in the resource that will not only reduce the area of suitable habitat for hollow-using fauna, but could also fragment populations of species unable to occupy areas lacking hollows. The dispersal of hollow using species also will be impaired."*

Lindenmayer *et. al.* (2014) recognise that:

> *... drivers of large old tree loss can create a "temporary extinction," that is, a prolonged period between the loss of existing large old trees and the recruitment of new ones (Gibbons et al. 2010b). The length of a temporary extinction may vary (e.g., 50 to 300+ years) ... Temporary extinction has the potential to drive species strongly dependent on large old trees to permanent local or even global extinction. In other cases, existing large old trees may be doomed to eventual extinction because the animals that dispersed their seeds have disappeared."*

Logging significantly increases tree mortality. After logging the retained trees are more vulnerable to windthrow and post-logging burning (Saunders 1979, Recher, Rohan-Jones and Smith 1980, Mackowski 1987, Smith and Lindenmayer 1988, Milledge, Palmer and Nelson 1991, Smith 1991a, Gibbons and Lindenmayer 2002). Gibbons and Lindenmayer (2002) note *"studies consistently show that the number of hollow-bearing trees that occurs on logged sites is negatively associated with the number of harvesting events*", and *"logging may result in a pulse of mortality among retained trees after each cutting event"*.

Examples of significant logging damage to trees marked for retention as Hollow-bearing trees in Wild Cattle Creek SF, this was reported to the EPA though, despite such damage likely resulting in premature tree death, they invariable dismiss such complaints.

From a study of the effects of logging and fire on hollow-bearing trees on the Dorrigo, Guy Fawkes and Chaelundi plateau, McLean *et. al.* (2015) concluded:

> *Logging intensity was negatively correlated with tree diameter at breast height (DBH), and the density of both hollow-bearing trees and hollows. Losses of hollow-bearing trees and hollows occurred through an interaction between logging intensity and fire frequency, resulting in an absence of recruitment of hollow trees. However in unlogged forest, fire was positively correlated to the density of hollows. Under a regime of frequent fire, in areas that have had some degree of logging activity, a net loss of hollows may occur. We recommend additional hollow recruitment trees be retained on logged sites in the future if no net losses of hollows are to occur in the future, or for wider unlogged buffers to be established adjacent to the cutting area.*

To maintain habitat trees in perpetuity there is a necessity to account for natural and logging/burning induced tree-deaths when prescribing retention rates for both hollow-bearing trees and recruitments sufficient to maintain the prescribed number of habitat trees over long time frames (Recher, Rohan-Jones and Smith 1980, Mackowski 1984, 1987, Recher 1991, Scotts 1991, Traill 1991). In natural forest there is a self-thinning process that results in significant mortality as trees mature (Mackowski 1987, Smith 1999). Though there is also a high likelihood of mortality due to other factors. As noted by Mackowski (1987 p124) *"the frequent occurrence of fire in this site height blackbutt forest precludes a 100% chance of survival - a proportion will be damaged, or weakened, or burnt down by each fire. These trees are also subject to the risk of lightning and windstorm damage."*

To account for mortality over time there is a necessity to retain progressively increased numbers of trees in smaller age classes.

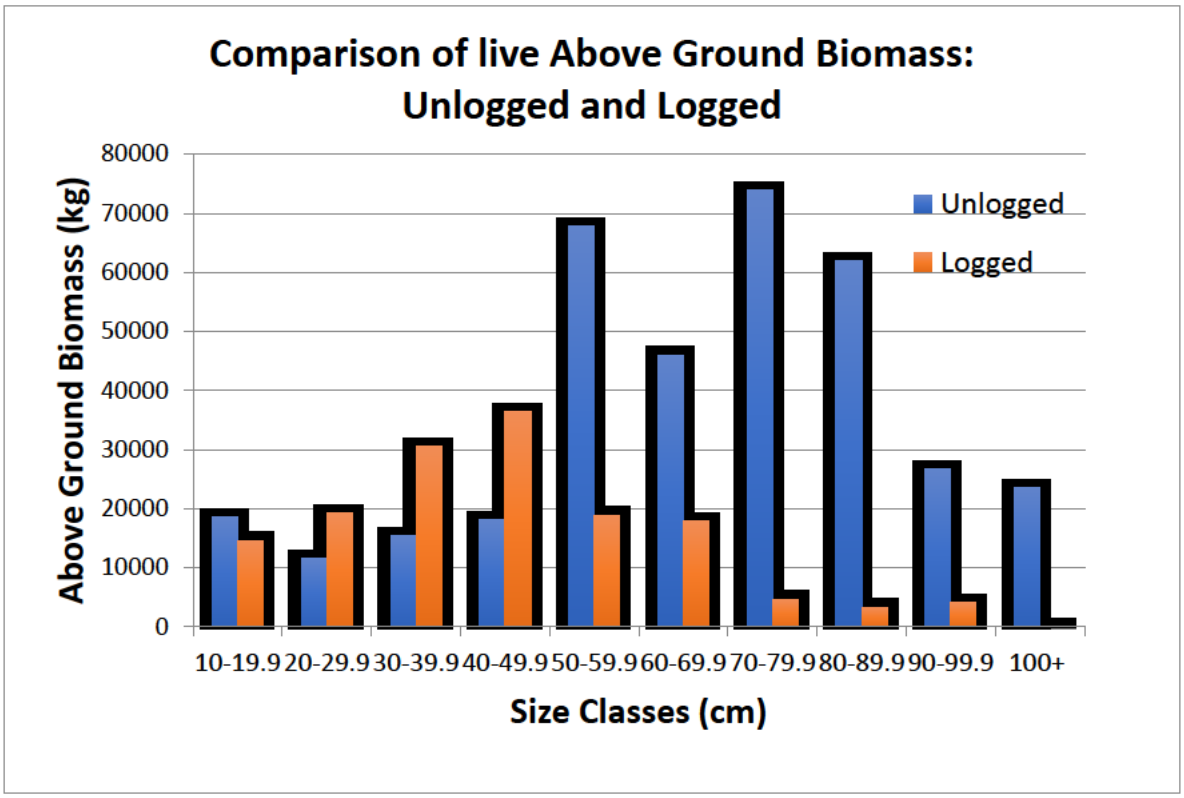
COASTAL BLACKBUTT RETENTION RATES REQUIRED TO MAINTAIN 10 HABITAT TREES PER TWO HECTARES IN PERPETUITY. The assumption is made that there will be 50% mortality of recruitment trees every 80 years. Adapted from Mackowski 1987.

Diameter (dbhob) cm.	Age yrs	Time-span in size class yrs	Mackowski's requirements for 3 Habitat Trees per Hectare over 100cm	Requirements to retain 10 Hollow-bearing Trees per Two Hectares
20-60	16-68	52	11.5	38.3
60-100	68-144	76	4	13.3
100-140[A]	144-224	80	2	6.6
140-180[B]	224-304	80	1	3.3

A - stage at which hollows suitable for small wildlife form.
B - stage at which hollows suitable for large wildlife form.

Most of the loggable State Forests have been subject to repeated logging events and thus there are few large hollow-bearing trees left. The low numbers are a significant constraint on the viability and populations of many species. Restoring populations of hollow-dependent species in these forests depends upon retaining sufficient mature trees to be able to develop the necessary hollows to replace, maintain and restore hollow-bearing trees over time.

For example, the assessment undertaken by NEFA for their proposed Sandy Creek Koala Park found there are currently only 9.7 trees per hectare in the 60+ cm dbh size class, and only 2.4 per hectare in the 70+ cm dbh size class. There are thus few trees to replace the remnant large-hollow bearing trees as they die, let alone restore these vital resources to a sustainable level. Meaning that unless all large trees are retained there will be a continuing attrition of large-hollow bearing trees into the future.



Comparison of Above Ground Biomass of logged and unlogged plots in the proposed Sandy Creek Koala Park showing the dramatic reduction in the biomass of larger trees due to logging.

Lindenmayer *et. al.* (2014) warn "*Existing policies are failing. New polices and management actions are required to conserve existing large old trees, provide for their recruitment, and maintain an age structure for tree populations that ensures a perpetual supply of large old trees thereby sustaining the critical functional properties that such trees provide. Without urgent action this iconic growth stage and the biota and ecological functions associated with it are in danger of being seriously depleted or even lost in many ecosystems*".

Lindenmayer *et. al.* (2014) consider "*A critical step in large old tree management is to stop felling them where they persist and begin restoring populations where they have been depleted*".

Hollow-bearing trees, and with them hollow-dependent species, have already been decimated within State forests. The problems such fauna are facing is expected to exponentially worsen as the few remaining large old hollow-bearing trees die-out without replacement trees being available. The full ramifications of irreversible changes already set in place will take a century or more to become fully manifest as the few retained hollow-bearing trees die with even fewer replacements available. A "temporary extinction," due to a prolonged period between the loss of existing large old trees and the recruitment of new ones is inevitable under current management. The few patches from which logging is excluded will do little to ameliorate this.

For example, Milledge (2019) undertook surveys for Barking Owls at 56 sites in the Bungawalbin Creek catchment and at 33 sites in the Upper Coldstream River catchment, finding that they display high site fidelity, though appeared to have significantly diminished on State Forests:

> *The Barking Owl population in the Bungawalbin Creek catchment appears to have remained stable over the past three decades whereas that in the Upper Coldstream River catchment has apparently declined. In Pine Creek State Forest in the latter catchment, four of five previously occupied territories appear to have been lost, possibly due to intensive forestry and associated management practices.*
>
> *The apparent decline in habitat quality in State Forests in the study area was also evident to a lesser extent in Bungawalbin, Doubleduke and Gibberagee State Forests where areas with historical records no longer appeared to be supporting Barking Owls during the current survey ...*

Squirrel Gliders only require small hollows for denning, though these still require relatively large trees to form. Beyer *et. al.* (2008) found at Bungawalbin that 9 (50%) of 18 den trees used by squirrel gliders were dead trees and 9 were live trees, with diameters of 53.2 ± 6.8 cm for dead trees, and 72.4 ± 7.9 cm for live trees. They identified den trees as a declining resource, observing a den tree collapse rate of 3% per year, with the dead trees considered particularly vulnerable to burning.

The previous Threatened Species Licence under the IFOA had a variety of requirements for retention of a minimum of 5-8 hollow-bearing trees per hectare, or however many were left. For each hollow-bearing tree they also required retention of a large healthy mature tree as its recruitment (R trees). The 2018 CIFOA requires the retention of 8 hollow-bearing trees per hectare. To increase timber the 2018 CIFOA significantly increased impacts by removing protection for mature recruitment trees and most nectar feed trees, as well as allowing for increased logging intensities.

With the change to the new logging rules in Braemar SF, which remove the need to retain mature recruitment (R) trees, the Forestry Corporation cancelled protection for those identified under the old rules. In this case 26 Koala scats were found under this cancelled Grey Gum.

The key question is whether existing National Parks alone are sufficient to maintain viable populations of such species into the future. The answer is clearly no. For example the Barking Owl only achieved a mean of 14%, and the Squirrel Glider a mean of 17%, of the reservation targets set for viable populations (Flint *et. al*. 2004). The existing reserve system is grossly inadequate to maintain hollow-bearing dependent species into the future.

Hollow-bearing trees are a declining resource as they continue to be logged, damaged in logging operations, and exposed to windthrow. They are not retaining the mature trees needed to replace retained hollow-bearing trees as they die. The treatment of hollow-bearing trees is clearly not sustainable, and is deteriorating.

The 2019/20 fires took a significant toll on large trees. Forestry Corporation (2020) identify that in Far North Coast State forests the fires killed an estimated average of 12.5% of trees >30 cm DBH. In the 30% of forests subject to a hot burn this was comprised of 10% of trees >30 cm DBH and in the 19% of forests subject to a crown fire the losses were some 50% >30 cm DBH. Milledge and Soderquist (2022) found 22.6% large trees and stags (≥60cm DBH) were lost or severely damaged in burnt forests, including 38.1% of trees >100 cm DBH.

Due to a dispute between the EPA and Forestry Corporation about post-fire prescriptions, the Natural Resources Commission (NRC) was instructed by the Government to come up with some post fire additional prescriptions. The NRC report ‘Final report Coastal IFOA operations post 2019/20 wildfires, June 2021’ was provided to the NSW Government in June 2021 with a recommendation for urgent action. Unfortunately, the Government refused to act on its recommendations. The NRC recommendations were prepared in consultation with the Forestry Corporation (FCNSW) to minimise impact on the industry, and included requirements for variable protection of percentages of the least affected forests in Forestry Management Areas, according to risk, for up to 3 years after the wildfires, as well as increased retention of hollow-bearing trees and recruitment trees.

The NRC recognised:

> *The Coastal IFOA standard prescriptions do not provide effective retention of feed and habitat trees, including recruitment trees in timber harvest areas of state forests, to support the persistence of species dependent on these resources in a severely fire-affected landscape*

Explaining:

> *… there is evidence that trees retained on logged sites have higher rates of mortality and collapse than trees in comparable unlogged sites and the mortality and collapse of trees retained in logged sites increases with logging intensity and the severity of post-logging fire.*
>
> *To be effective, the retention of hollow-bearing trees and recruitment trees must be permanent.*
>
> *… Advice received from the EPA and FCNSW during this review indicates that in some forests hollow bearing trees do not exist at* [eight hollow-bearing trees per hectare] *and the resource may be limited or non-existent. Our review also suggests that after the extensive and severe fires the hollow-bearing tree resource is at risk of loss.*

The only long-term change to the CIFOA logging rules recommended by the NRC was:

> *The Commission has proposed temporary additional measures relating to hollow-bearing trees and recruitment trees for medium and high-risk zones. However, the Commission considers the following measures could also enhance the standard Coastal IFOA prescriptions:*
>
> - *retain a minimum of eight hollow-bearing trees per hectare where they exist (as per the requirement in the standard Coastal IFOA prescriptions)*
> - *if hollow-bearing trees are not available, then retain suitable substitutes, in priority order being, potential future hollow-bearing trees, the largest mature tree in the stand or a regrowth tree that is not suppressed*
> - *retain two recruitment trees per retained hollow-bearing tree*

The NRC considered that this change should be permanent and applied across all native State forests. This was the least that could be done to improve sustainability in recognition of the massive impacts of the 2019/20 wildfires. Though the NSW Government ignored all the recommendations and [redacted].

As part of the 2023/24 negotiations between the EPA and Forestry Corporation over a Site Specific Biodiversity Condition for Greater Glider, in response to their uplisting to endangered, they proposed increasing tree retention according to a High Density Glider Zone and a Low Density Glider Zone based on modelled Greater Glider habitat, as well as a Northern Intensive Zone and Eden Coastal Zone based on FCNSW's intensive logging zones. For these the EPA and FCNSW proposed different tree retentions rates, in addition to retention rates for Hollow-bearing trees already prescribed in the CIFOA, as summarised below. Basically, the EPA proposed the retention of one of the next largest trees, or an additional hollow-bearing tree, for each of the 8 hollow-bearing trees required to be retained under the CIFOA - which was a partial return to the pre-2018 prescription. FCNSW proposed the retention of less trees selected from trees >50cm dbh that did not qualify as high quality sawlogs. FCNSW estimated that their retention rates would result in an overall 2% reduction in resources, whereas the EPA's would result in an overall 15% reduction in resources. The end result was a compromise based on minimal impacts on resources, but far less than what was ecologically required.

Habitat Tree Types:
H Trees: Hollow Bearing Trees as per CIFOA
P Trees: Potential/Suitable Den Trees (H Tree with large hollow)
R Trees: healthy tree capable of developing hollows > 50cm dbhob

	Tree Selection Focus	High Density Glider Zone	Low Density Glider Zone	Eden Coastal Zone	Northern Intensive Zone
EPA Proposal	Modelled HBT+Biggest Available	16=8H+8P	16=8H+8P	16=8H+8P	All H (min 16 H+P)
FCNSW Proposal	NonHQ>50cm	12=8H + 4P (or R)	10=8H+2P (or R to 10)	8=Up to 8H (min 8 R)	All H (min 5 H +R)
FINAL SSBC OUTCOME		14=8H+6>80cm	12=8H+4>50cm	8=Up to 8H and/or trees>50cm	All H (min 5H and/or trees >50cm)

There is no commitment to Ecologically Sustainable Forest Management in NSW.

1.4.3. Case study: development of a Koala prescription

A case study of the development and implementation of a Koala prescription from 1997 to 2024 exemplifies the political process used to establish prescriptions for many threatened species. This is particularly alarming given the iconic status of Koalas. Regulation of logging public native forests to mitigate logging impacts on Koalas by protecting the most significant occupied Koala habitat and protecting preferred Koala feed trees has been demonstrated to have failed through lack of will, poor enforcement, ignoring of expert advice, and failure to apply adaptive management. Claims that logging has no impact on Koalas are based on fundamentally flawed research, yet are relied upon to deny Koalas the protection they deserve. It is astounding that, irrespective of how significant a Koala population is, currently the only requirements are to protect a few trees below optimal size in poorly modelled habitat, and if a Koala happens to be seen, to wait for it to leave its tree before cutting it down. The principles of Ecologically Sustainable Forest Management, and the precautionary principle, have not been applied to Koalas.

1.4.3.1. Creating a Koala Prescription

In a 1989 Forestry Commission survey of what actions district foresters took in response to Koalas, many did not do anything, and the best they could find was the Coffs Harbour District Forester [redacted] 29/11/1989):

> "*About the only thing done in a logging operation when a koala is located is to not fall the tree, at that time. It may be felled later (next day) if the koala has moved*"

In 1991 NEFA took the Forestry Commission to court for 'taking or killing' endangered fauna without a license from the National Parks and Wildlife Service. Justice Stein (1991) found they should have had a licence:

> *I find that the koala is very likely to be disturbed, or injured by the proposed forestry operations. The species is clearly sensitive and has limited food tree sources. The koala will likely be detrimentally affected by permanent changes in the forest structure. Its numbers will diminish as its habitat is disturbed.*

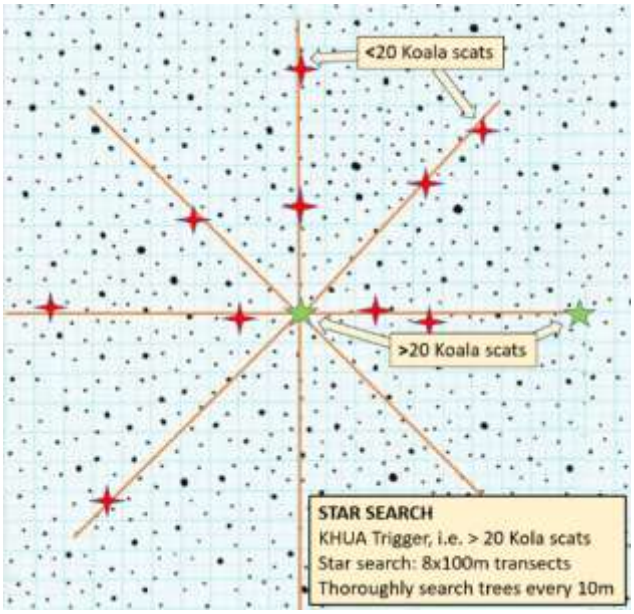
Consequently, the Endangered Fauna (Interim Protection) Act 1991 was passed, against the will of the minority Greiner Government. NPWS gave the Forestry Commission “temporary” licences while they prepared Fauna Impact Statements, which they never did. Instead, the licences were repeatedly extended while the Forestry Commission continued, at best, to wait for Koalas to vacate their trees before cutting them down.

In 1995 the Forestry Commission proposed a methodology for protecting Koalas that was adopted in the 1997 Threatened Species Licence (TSL) applied as an outcome of the NSW Interim

Assessment Process. The requirement was to search for Koala scats under likely feed trees at around 10m intervals along transects in likely habitat. Where 2 trees out of 10 were found with Koala scats the compartment became an intermediate use area requiring the retention of 10 koala feed trees per hectare.

The trigger for identifying a Koala High Use Area (KHUA) was where 3 trees out of 10 were found with Koala scats, or where a Koala was identified in a tree, or a tree had >20 scats beneath it, or a tree had different sized scats indicating a mother and joey. The requirement then was to undertake additional radiating 100 m transects (star search) to total 8. Where 3 out of 10 trees were identified on a transect it and the trigger tree became a KHUA. Transects had to be extended for 100m past any identified KHUA. A 50m exclusion area was to be permanently protected around Koala HUAs.

Indicative star search:



After the Comprehensive Regional Assessment a revised TSL was adopted in 1999, with significant changes to the Koala prescription. The need to undertake pre-logging surveys to identify high use areas was removed and replaced with surveys at the time of logging, the need to search for scats within 2m of a tree was reduced to 1m, the recognition of any area where any 2 out of 10 consecutive trees search was identified as a high use area was changed to require a trigger tree (i.e. sighting, >20 scats, mother and baby) and 3 out of 10 trees consecutively searched with scats, the need to exclude logging from within 50m of high use areas was reduced to 20m, the need to protect individual trees with >20 scats was removed, and the need to protect ten primary browse trees (or secondary browse species if primary are unavailable) per hectare in intermediate use areas was reduced to five per hectare.

The Forestry Corporation was required to “thoroughly” search for Koala scats ahead of logging in compartments which contain preferred forest types. The reduced 20m buffers around KHUAs no longer required permanent protection, instead only being protected until the end of that operation. There was a new assessment next time the area was logged, often resulting in areas previously identified as KHUAs being logged.

Significantly the clause relating to monitoring (TSL p139) was removed:

Monitoring:

Koala monitoring will be conducted as part of the general monitoring procedures planned by SFNSW. Compartment monitoring may be advantageous to Districts for future planning in areas that have positive Koala records and prior management.

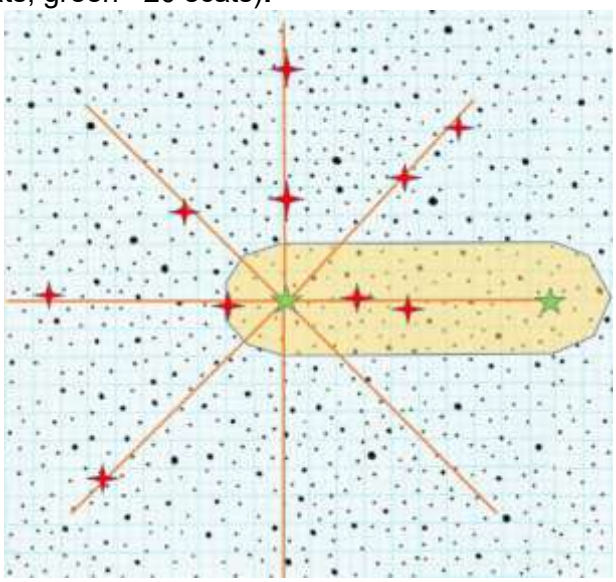
At the initial stage the state wide monitoring of Koala populations will require a comprehensive compilation of the location and extent of high use areas. The monitoring program will be designed to give information on the effectiveness of these prescriptions in meeting their objectives.

The survey methodology for detecting Koalas and determining high use areas (contained in these prescriptions) may be reviewed in the light of findings from the monitoring program.

While the TSL Koala prescription was applied for another 20 years there was no attempt to monitor its efficacy.

In 2003 the TSL was further altered to remove the requirement to undertake additional star searches when additional trigger trees were identified on transects, thereby further reducing the area requiring protection.

Outcome of indicative star search applying post 2003 rules, showing resultant KHUA (red crosses represent <20 scats, green >20 scats)**:**



The combination of a high threshold for delineation of a KHUA, the limited habitat requiring protection, and a strong aversion to undertaking the required surveys on behalf of many foresters, resulted in few areas being protected. In forests where a Koala's home range could be 10-30ha a KHUA could be as small as 0.4 ha. The Natural Resources Commission (NRC 2016) identified that only "*200 hectares of koala high use area has been protected over the past 15 years".* Despite some 10,000 ha of north-east NSW's State Forests being logged each year, only an average of 13 ha was being protected a year. With some of these areas logged in subsequent operations.

For the 19 years this prescription was in force there was no attempt to improve its application, and no monitoring of its effectiveness. With the exception of Law *et. al.* (2018) including them in their acoustic surveys, and finding "*Koala high-use areas supported nearly three times the bellow rate (3.1 bellows night^{-1}) as other treatments, but an ANCOVA found that the difference among treatments was not significant*".

1.4.3.2. Implementing the first prescription

The 1999 Threatened Species Licence for logging on public lands was based upon **thoroughly** searching for Koala scats ahead of logging to identify intermediate use areas where 5 Koala feed trees per hectare were required to be retained, and where sufficient scats were found to delineate Koala High Use Areas (KHUAs) for protection. The first problem was that there was no definition of the feed trees that needed to be retained, meaning that any sized tree would do, and the abundance of saplings met requirements. The second problem was that thoroughly searching for Koala scats under trees at 10m intervals was an onerous task that most foresters were unwilling to undertake, meaning that scat searches were often not attempted, and most KHUAs went unrecognised and unprotected.

Since the first Threatened Species Licence was introduced in 1997 there has been an ongoing refusal on behalf of the Forestry Corporation to thoroughly search for Koala scats. This went on for 15 years while the EPA (and their predecessors) turned a blind eye, until NEFA exposed the failure to search for Koala scats and the logging of KHUAs in Royal Camp State Forest in 2012. For a while thereafter the EPA made auditing of the Koala prescription a compliance priority, though soon changed their position to removing the need for pre-logging surveys for Koalas and stopped trying to enforce the requirement.

On 4th and 5th August 2012 NEFA (Pugh 2012) undertook a brief audit of compartments 15 and 16 of Royal Camp State Forest, finding high densities of Koala scats and identifying 4 areas that met the criteria for KHUAs, including one actively being logged. Given that many of the scats were clearly visible on the surface it beggars belief that anybody could have even undertaken a cursory look and not seen any. Both the Environment Protection Authority (EPA) and Forestry Corporation confirmed these as Koala HUAs and logging was stopped. Logging resumed in compartment 16 on 9 August, and on 19 August NEFA identified that the Forestry Corporation were still not looking for Koala scats and that another KHUA had been logged.

The Forestry Corporation maintained that they had undertaken the required Markup Survey (TSL 5.1., 5.2.1.) and Koala Markup Search (TSL 5.2.2), identifying it as an "intermediate use" area, but not identifying any KHUAs. Despite the requirement to mark 10 primary browse trees per 2 ha, not one tree was found by NEFA (Pugh 2012) to have been marked specifically for retention as a Koala feed tree, and in most areas the marked hollow-bearing and recruitment trees (which can double as Koala feed trees) were far too few and of the wrong species to satisfy this requirement. The few marked trees were primarily in the vicinity of tracks and the boundary of exclusion areas, indicating that Mark-up Surveys had not been conducted throughout the logging area.

The EPA found that 61 trees had been logged and 405m of snig tracks constructed in the koala high use exclusion zone identified by NEFA on 4-5 August. In compartment 16 the EPA concluded that 7 trees were logged and 230m of snig tracks constructed within the KHUA identified by NEFA on 19 August, which had occurred after logging had resumed on 9 August. The EPA (2014b) later identified the problem as

> *The EPA identified the root cause of the breaches of the licence as the Forestry Corporation's failure to undertake searches for evidence of koala in compliance with the licence. The EPA considered that if searches are inadequate or not undertaken at all, the default protection provisions in the licence become ineffective. That is, if you don't look, you don't find and if you don't find, you don't protect.*

Regional Forester Craig Busby (28/8/12, see Pugh 2014) told the EPA "*There are some grey areas in the licence about thoroughly doing the search. It is about what thoroughly means - our searches look under trees it doesn't say to get on your hands and knees and scrape the surface - it just says thoroughly*". Craig Busby's email to CEO Nick Roberts of 7 November 2012 stated (Pugh 2014):

> *We are still in dispute with EPA over the interpretation of "thoroughness" of searching and techniques used and are standing our ground based upon the fact that we have not changed our techniques since the introduction of the TSL.*

In February 2013 the foresters responsible for the scat-searches and marking-up in Royal Camp told the EPA that they hadn't changed the way they searched for Koala scats and would not (Pugh 2014).

In April 2013 Regional Forester, Craig Busby, told the EPA that they had done the required pre-logging surveys and not done anything wrong, stating (Pugh 2014):

> *... no triggers for star searches were found at the time of pre-harvest mark-up around log dump 20. ...The techniques for pre-harvest koala mark-up searches has been audited by the EPA many times since the introduction of the TSL. The EPA's current interpretation of the relevant TSL condition is inconsistent with historical practices.*

Despite the Forestry Corporation displaying no remorse or contrition, on 28 June 2013 the EPA issued FCNSW three penalty notices (with fines of $300 each) for contravening the Threatened Species Licence (TSL), including:

- undertaking specified forestry activities (timber harvesting) in koala high use areas - TSL 6.14(c)(i)
- undertaking specified forestry activities (timber harvesting) in koala high use exclusion zones - TSL 5.1(a)(i)
- failing to conduct a thorough search for, record and appropriately mark koala high use and intermediate use areas – TSL 5.2.1(a)(b)

The penalties were taken to be inconsequential by the Forestry Corporation and they continued to deny any wrongdoing or display any contrition. On 12 July 2013 ABC North Coast reported:

> *But regional manager Craig Busby says the breaches were administrative, and akin to staying too long in a parking lot.*
>
> *…*
>
> *"I can understand that there's a perception in the community that ($300) would be a light sort of fine.*
>
> *"The reality is that the fines reflect the environmental outcome.*
>
> *"Look in terms of the fines, they're administrative, they're like staying in a parking lot for a little bit too long, but the reality is there has been no environmental harm to koalas in that area."*

In 2013 NEFA became alarmed that the Forestry Corporation was proposing to commence logging in Compartment 13 of Royal Camp SF. The Forestry Corporation's draft Harvesting Plan identified "nil" Koalas. On 4 July 2013 NEFA located 34 trees with Koala scats about their bases, including two KHUAs. The EPA (Aboud 24 July 2013) again confirmed NEFA's findings, concluding:

> *Based upon these findings and recent findings made from investigations undertaken in compartments 14, 15 and 16 of Royal Camp State Forest, the EPA considers these areas contain koala habitat and play an important role to Koala populations in the region. The EPA consider compartment 13 to have areas that indicate koala high use that is ongoing and contemporary.*

As a result of NEFA's Royal Camp complaints Koalas were made a compliance priority by the EPA. The EPA subsequently identified that the Forestry Corporation had not undertaken thorough searches for Koala scats ahead of logging in Wang Wauk State Forest (from an assessment of just 12 trees) and Bulahdelah State Forest (from an assessment of just 9 trees).

The EPA October-November 2012 final audit report of Wang Wauk State Forest Compartment 116 found that Koala scats were still not being adequately searched for, despite the presence of a Koala High Use Area. They found a tree had been logged within a marked Koala High Use Area, noting *"Given the fact that high use koala activity has been discovered within the compartment it is significant importance that compartment mark up surveys are undertaken in compliance with the licence requirements to facilitate environmental features being located and accordingly protected. For example further koala high use areas,"* finding:

> *The brief assessment undertaken by the EPA including 12 trees only. All 12 trees had evidence to suggest that a 'thorough' search, as per the licence requirement had not taken place. EPA officer observations note that all 12 trees had not had their base disturbed at all, i.e. no leaf litter displaced. Please note that the majority of the EPA assessment was undertaken at the most recently active (currently active) log dump area, which would have been indicative of the likely-hood of SFO searches.*
>
> *Of the 12 trees searched, 5 trees were marked as K or R (or both) trees for retention. Of the 5 marked trees, 8 and 35 koala scats were located at the base of these trees, indicating that the SFO/FNSW personnel had been to the tree, yet hadn't disturbed the surface of leaf or grassy understorey. One search of a marked "K" tree yielded 35 koala scats in a very short space of time, which is a trigger for a koala star search. EPA officer observations noted that age of these koala scats and the likelihood of these scats being deposited prior to or shortly before the commencement of operations in these areas.*

The EPAs response was simply to require an action plan:

> *FNSW must ensure that immediate short term actions are taken to ensure that upcoming koala searches are done in a thorough manner. A long term action plan must be developed and implemented immediately to ensure that all future koala searches are done in a thorough manner for proper identification and appropriate protection of koala high use areas.*

In response to the EPA's draft findings the Forestry Corporation (2013) admitted inadequate mark-up but refused to accept the need to thoroughly search for Koala scats, responding:

> *FCNSW cannot accept the detail and method associated with the specific allegations relating to ... retained koala feed trees. The link the EPA has made between tree marking and searching is not contained in the licence. The EPA's approach to searching for koala scats is not specified in the licence. The very nature of both the koala mark-up technique and star-search technique is subjective and inevitably different results may be expected on a particular day of searching, let alone results from surveys on different days, weeks or months.*

The EPA and Forestry Corporation met in January 2013 to discuss the failure to thoroughly search for Koala scats at Royal Camp, Wang Wauk and Bulahdelah State Forests, the Forestry Corporation (2013b) later submitting:

> *Medium term - In order to deliver an improved outcome for Koalas, at reduced cost and that is auditable and enforceable, FCNSW proposes the licence should move to a landscape approach for koalas. A new landscape prescription could better specify primary browse tree retention requirements based on current information, apply them to all compartments where primary browse species occur, rather than to just those compartments with records, and maintain a proportion of potential habitat unharvested area in each compartment. FCNSW will work towards developing and drafting a landscape prescription suitable for discussion with the EPA over the coming weeks.*

The Forestry Corporation (2013b) identified the problem with having no size limit for the retention of trees in "intermediate use" areas and proposed a "short-term" (until the new **CIFOA**) interim change to the TSL (1999) which was never implemented:

> *... a preference for mixed species forests with a high proportion of preferred browse trees, and trees between 30-80 cm dbh. Tree size preference has been linked to climbing efficiency, tree vigour/nutritional value or even lack of competition with Greater Gliders in areas with few large, old trees.*
> *...*
> *The intermediate-use condition, which FCNSW considers could be the most relevant and practical protection measure, has a flawed definition of 'primary browse trees', with no minimum tree size limit, quality requirements or protection requirements.*
> *...*
> ***Short-term** – in compartments in which the intermediate use prescription is triggered, FCNSW will apply a higher standard to identification and management of primary browse trees. That is, FCNSW will add to the end of the intermediate use prescription 'primary browse trees should have as many of the following characteristics as possible; >30 cm dbh, mature and have a healthy crown. Retained primary browse trees must be protected from damage to the greatest extent practicable. When locating and marking these trees, the thorough search for evidence of koala scats must include disturbance of the grass and/or leaf-litter layer, where visibility for the detection of koala scats is compromised.*

Making such a change to TSL (1999) was in accordance with the principle of adaptive management, though it was never implemented. For the 19 years the browse tree prescription was in force it was applied to over 130,000 hectares (NRC 2016), yet there was no minimum size limit applied for tree retention nor monitoring to assess its effectiveness, contrary to adaptive management. Though after this letter several logging plans were noted to require the retention of Koala feed trees >30cm DBH, as a voluntary measure.

While the EPA failed to legally implement the short term measure suggested by the Forestry Corporation (for no apparent reason) they quickly became strong advocates for the Forestry Corporation's landscape approach for koalas. The EPA (2014) submission to the General Purpose Standing Committee No. 5 *'Inquiry into the performance of the NSW Environment Protection Authority'* states:

> *Core koala habitat mapping*
>
> *The EPA is mapping core koala habitat so that it can be protected at the landscape level. This is intended to replace the existing presence/absence triggers and is a far more effective way of ensuring koalas and their habitat are protected.*
>
> *Regulatory improvements to ensure koala protection*
>
> *As part of the proposed consolidated Coastal IFOA, the EPA and Forestry Corporation have committed to moving to regional koala habitat mapping. As noted above, the EPA has commenced broad-scale mapping of koala habitat. The outcome of this mapping project will be used to inform appropriate conditions, including exclusion zones, the protection of feed trees and other alternative provisions in the consolidated Coastal IFOA.*

Koalas were identified as one of the EPA's Cross-tenure environmental compliance priorities for 2013-14, 2014–15 and 2015-16. For "*Protecting koalas and their habitat*" the action proposed was "*Assess compliance with Integrated Forestry Operations Approval (IFOA) and PNF Code requirements relating to protecting koalas and their habitat*", with the purpose being "*Assess compliance and raise awareness of regulatory requirements around Koala protection*", and the output *"Publish compliance summary on EPA website".*

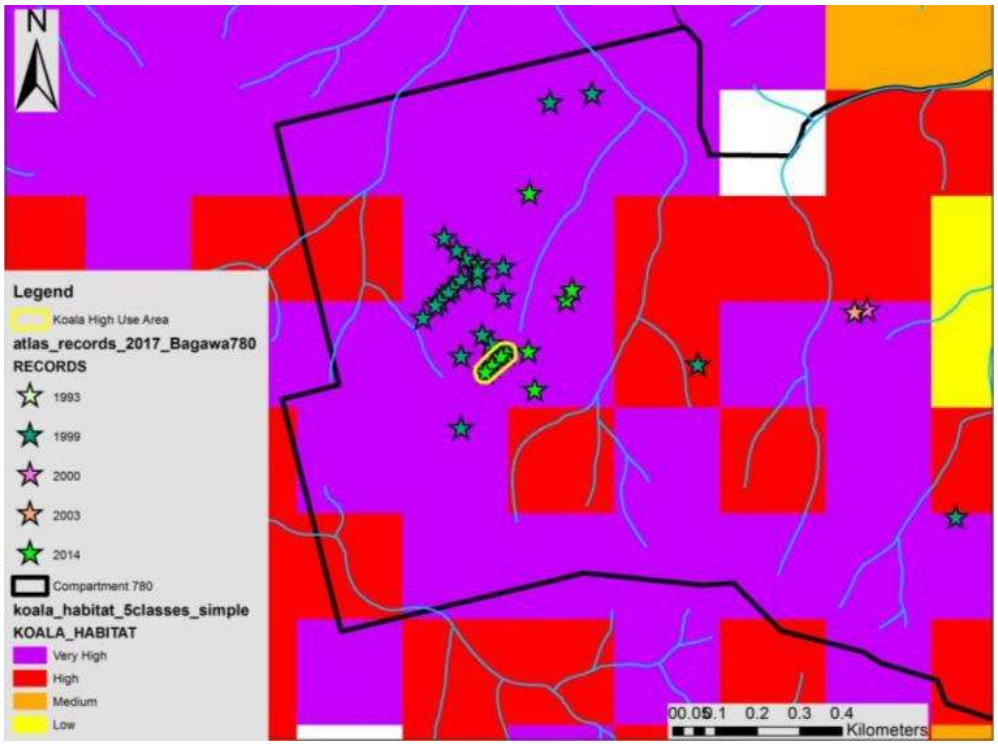
Despite this, NEFA consistently found in subsequent audits that the Forestry Corporation were routinely failing to thoroughly search for Koalas elsewhere (i.e. Koreelah SF, Richmond Range SF, Cherry Tree SF, Sugarloaf SF), though the EPA summarily dismissed our complaints.

The EPA did make some token efforts before totally giving up in 2015. For example, a review of the 8 proactive audits undertaken by the EPA in 2015 found the EPA started the year documenting that across 3 operations they inspected a total area of 3.32ha and saw no evidence of Koala scat searches, with the 21 Tallowwoods assessed showing no signs of being searched, though no breaches were recorded. After May 2015 the EPA stopped identifying the area assessed for Koala searches and stopped identifying whether individual feed trees had evidence of searching, simply saying that they were not able to determine whether searches had been undertaken or not.

In NEFA's review Clearing Koalas Away (Pugh 2017) of DPI's Koala Habitat model, an analysis of State Forests Biodata (from Wildlife Atlas) over the years 1997-2016, limited to high quality and very high quality habitat, revealed an average of 9.6 Koala observations, the hearing of an average of 3.6 calls and finding of 74.6 trees with Koala scats under them each year despite requirements for thorough surveys. This is an extremely low strike rate for what is meant to be some of the best Koala habitat left for Koalas in New South Wales.

Across the 22,586 ha of north-east NSW's public lands that were then being logged, Pugh (2017) identified a total of 4,663ha of modelled high quality (including very high quality) Koala habitat and 4,530ha of moderate quality habitat, with just 2 Koala High Use Areas totalling 1.2ha: one 0.5ha in size in very high quality habitat in Bagawa SF (cmpt. 780), and one 0.7ha in size in moderate quality habitat in Wang Waulk SF (cmpt. 118).

It is apparent that very few Koala High Use Areas have been identified. The Natural Resources Commission (2016) identify that "*Around 200 hectares of koala high use area has been protected over the past 15 years and tree retention requirements have been triggered on around 33 percent of compartments (130,000 hectares)*".



Bagawa SF Compartment 780, showing Koala habitat classes, records and the miniscule 0.5 ha Koala High Use Area protected in 2017. Note that the rows of 1999 records indicate where the Koala High Use Area would have been located in the previous logging, which is now available to be logged despite its obvious significance due to still being part of a Koala's home range 18 years later.

1.4.3.3. Protecting Virtual Koala Habitat

To progress the Forestry Corporation's alternative of using modelled habitat rather than pre-logging surveys, in 2015 the EPA (2016) undertook a project overseen by a three-person expert panel to review various approaches to map potential Koala habitat, with extensive groundwork to test the mapping.

The project found that neither modelling nor ecosystem mapping (high resolution Plant Community Types) were accurate enough to identify the "*occurrence of feed trees and therefore habitat class at the level of detail required for management in state forests*", with the panel unanimously agreeing that "*the primary intent and focus should be to identify the location, distribution and extent of areas that are supporting extant/resident koala populations*". Basically, because of the inaccuracy of the models they advised of the need for pre-logging surveys to identify extant populations of Koalas for protection.

In his review for the EPA's (2016) Pilot Mapping Project, Smith (2015) stated:

> *The models and mapping can only be reliably used to predict areas of non or unsuitable habitat. All tested models were too inaccurate to predict relative koala abundance within areas of "potential Habitat". Consequently, the determination of primary, secondary, core and refuge habitat will only be possible by undertaking ground surveys of koalas and or scats over repeated time intervals. The best fit model (Baseline Map) was based on the results of actual past koala surveys rather than predictive modelling.*
>
> *...*
>
> *The poor performance of predictive models is consistent with the widely held hypothesis that koalas are frequently absent from areas of good quality "potential" habitat because of past disturbance from disease, hunting, urbanization, drought, fire, predation or other unknown causes. When koala populations are below carrying capacity for these reasons their distribution is likely to reflect aggregation for social or mating purposes as much or more than availability of food trees. This hypothesis is supported by the results of the Pilot Study which found a large number of zero scores in areas of predicted moderate and high potential habitat suitability.*
>
> *...*
>
> *Results of the Pilot Study have shown that koala habitat models are not reliable for identifying areas currently occupied by koalas. The only circumstances under which koala habitat models could be used to replace pre-logging surveys for koalas and koala scats would be the blanket application of highly precautionary Conservation Protocols across all areas of "Potential" habitat (all areas that are not predicted to be unsuitable) regardless of the actual presence or absence of koalas at the time of logging.*

In his review for the EPA's (2016) Pilot Mapping Project, Phillips (2015) stated:

> *I suspect there may have been an underlying assumption/ expectation that koala activity would be associated with higher quality habitat areas such that high habitat quality = high probability of occupancy. However, this is rarely the case because other factors such as fire history/intensity and logging history/intensity, as well as koala sociobiology will need to be considered.*
>
> *...*
>
> *Partly in response to Federal Govt issues relating to identification of critical habitat areas for EPBC purposes I advise that we have been working on development of a unbiased rapid assessment technique (Single Pellet Rapid Assessment Technique) for assessing large forested areas for koalas, the outcomes from which enable areas to be identified within which more detailed assessment(s) can be undertaken if required. Current trials have proved very successful in terms of rapidly ascertaining presence/absence of koalas and informative in terms of accurately identifying areas warranting more detailed investigation. To this end I*

> *consider the approach we are developing to be superior to that currently being considered by FCNSW as a new Koala Survey Protocol for licensing purposes …*
>
> *… note that the question of what is being protected has also been raised. I would have thought that this was a question that should not have required an answer when surely the most important thing to protect are remaining areas of habitat that are currently supporting resident koala populations. This consideration remains independent of the issue of habitat quality and so should be the primary objective of management.*

In his review for the EPA's (2016) Pilot Mapping Project, Kavanagh (2015) stated:

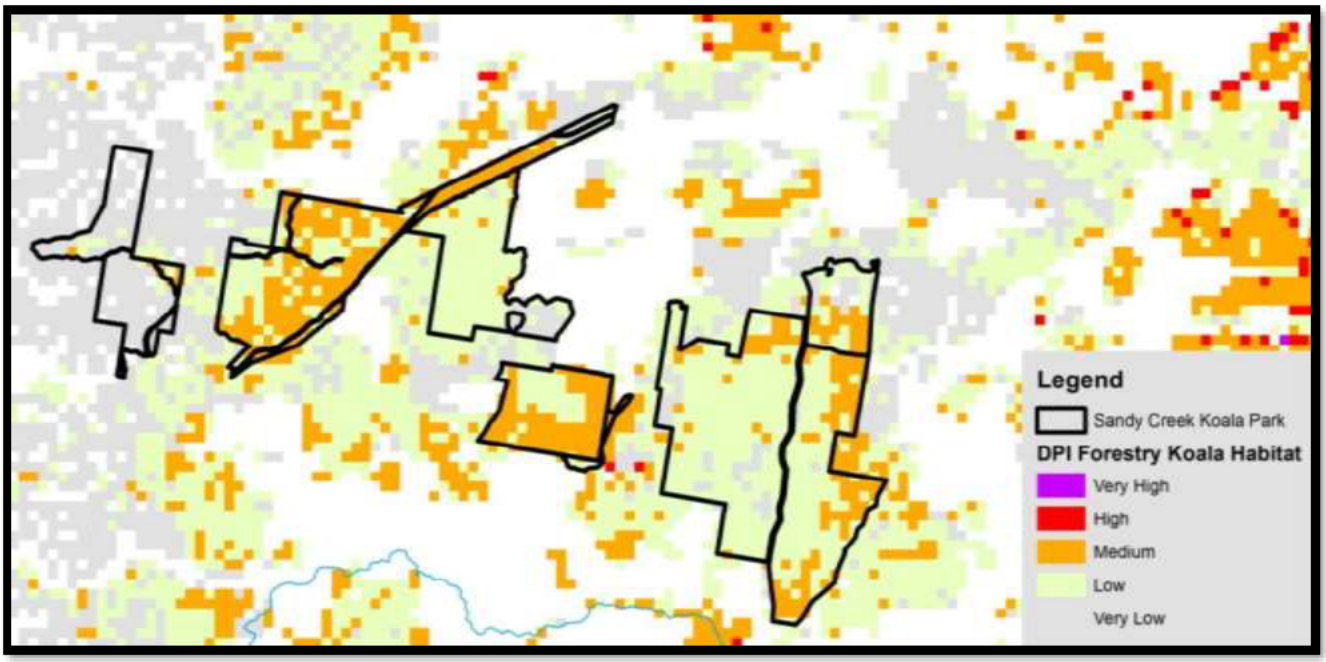
> *In summary, each of the above mapping products developed for this project were incapable of accurately identifying the locations of core Koala habitat, or concentrations of the Koala, at the scale (e.g. logging coupe) required to manage them without recourse to further on-ground surveys. However, each of the mapping products was capable of identifying broad areas (e.g. 5 km grid square in northern NSW) within which Koala habitat was likely to occur.*
> *…*
> *The main finding from the Crown Forestry Mapping Pilot study was that Koala presence (and activity) was not strongly correlated with any of the main predictor variables i.e. occurrence of Koala feed trees, RN17 forest types, or Plant Community Types (PCT).*

Despite the conclusion from their study that modelling is too inaccurate for regulation at the scale of individual logging operations, the EPA refused the alternative of using a model to identify broad areas for surveys using a more efficient methodology. Instead, the EPA remained committed to removing the need for pre-logging surveys and funded DPI Forestry (Law *et. al.* 2017) to complete their model, despite its being considered as inadequate by the expert panel. In a shoddy effort to improve it, this model was intersected with an OEH (2016) likelihood model to identify high/high, moderate/high and moderate/moderate quality Koala habitat. These three classes were to be the basis for identifying tree-retention rates.

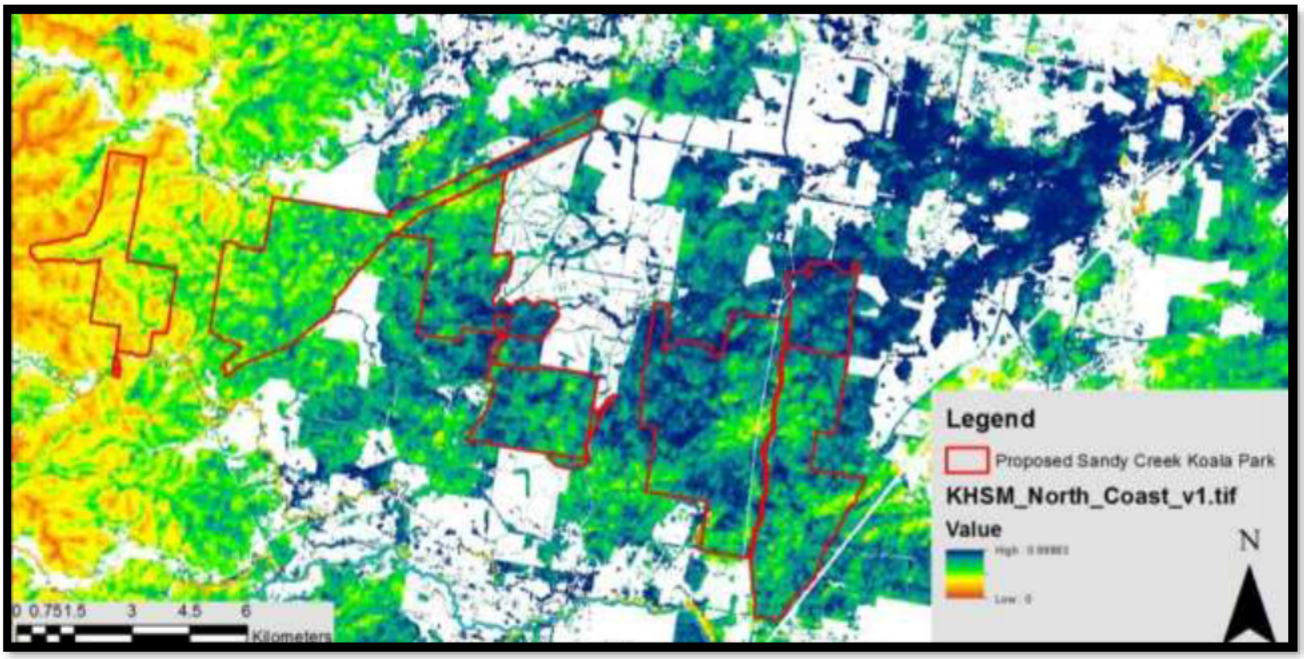
The EPA's professed intent to use a model to identify *exclusion zones* as an alternative to undertaking scat searches to identify Koala High Use Areas, was quietly dropped when it became apparent that the models would not be able to do this.

After the EPA adopting the DPI Forestry (Law *et. al.* 2017, 2018) Koala Habitat mapping for regulation in the CIFOA, against the advice of their expert panel, DPIE (2019) released their Koala Habitat Suitability Model (KHSM). There are significant differences between the two models in many areas, exemplifying a fundamental problem with the CIFOA's reliance upon a model the EPA knew to be inaccurate.

Examples of the extreme variation in modelled Koala habitat between the DPI Forestry and DPIE Koala habitat models for NEFA's proposed Sandy Creek Koala Park (Pugh 2020):



DPI Forestry (Law *et. al.* 2017, 2018) Koala Habitat mapping used for forestry regulation.



DPIE 2019 Koala Habitat Suitability Model.

Note that the DPI Forestry model bears little resemblance to the more recent KHSM, with many areas classed as very low habitat value by DPI Forestry reclassed as very high by KHSM. NEFA's scat surveys have found high densities of Koalas, including extensive areas qualifying as Koala High Use Areas, in habitat classed as low and very low by the DPI Forestry model. It is demonstrably wrong. It is no wonder that the expert review by EPA (2016) recommended against using the Law *et. al.* model for forestry regulation. Regrettably the EPA did not listen to their own experts and now rely upon this shonky model for setting tree retention requirements for Koalas in public-land logging across north-east NSW.

Because of differences between the EPA and Forestry Corporation on the number and size of feed trees that should be retained in modelled habitat, the Natural Resources Commission (2016) was

directed to resolve a prescription based on a "*modest increase in tree retention rates aim to minimise impacts on wood supply to best possible extent while recognising Government's policy initiatives and targeted investment in Koalas as an iconic species (no net change to wood supply)*".

The NRC (2016) falsified claims of high quality sawlog (HQL) shortfalls to over-ride most of the EPA's recommended CIFOA settings by excluding yields from hardwood plantations from their calculations. This had the effect of turning a surplus into a deficit. Plantations were expected to provide 11% of the HQL resource from 2017-2028, 16% of the resource over the period 2029-2040 and 22% of the resource over the next 100 years. As identified by the EPA (2017) in the longer term:

> *... once mature, the plantations can produce 75,000 m_3 p.a. of high quality log products over a 50-year period to augment native forest log yields. This represents about one third of the total sustained yield and significantly supplements the native forest resource for the North East RFA region.*

At that time the Forestry Corporation modelling for HQL over the 2017-2028 (12 year) period was for 236,700 m^3/yr to be available, with 26,100 m^3/yr coming from plantations, while the claimed current allocations were 220,423 m^3 per annum (See NEFA's 2018 yield review, notably Section 8, for details). NEFA complained that the NRC's exclusion of hardwood plantations to justify their claims of resource shortfalls was fraudulent, as if they had of been included (as is normal practice) then there would have been a significant surplus of HQL that would have allowed the restoration of many of the spurious cuts to environmental protections made by the NRC.

Based on the advice of their Expert Fauna Panel, the EPA (NRC 2016) proposed a retention rate of "*25 trees per hectare in High/high quality habitat, 20 trees per hectare in High/moderate quality habitat, and 15 trees per hectare in Moderate/moderate quality habitat*". The NRC over-rode the EPA to support a retention rate proposed by the Forestry Corporation specifying "*10 healthy trees per hectare with cell based application in High/high quality habitat, 5 trees per hectare with compartment wide application in High/moderate or moderate/moderate cells over 25 percent or more of compartment*".

Proposed Feed Tree Retention (per ha): EPA/Expert Fauna Panel vs NRC adopted.

Modelled Habitat	EPA Proposal	NRC Adopted
High	25	10
High/moderate	20	5
Moderate	15	5

Under the new prescriptions Koala browse trees are required to be greater than 20 cm diameter at breast height (DBH) (30cm DBH outside the north coast). The EPA (NRC 2016) proposed that "*retain trees with minimum 25 centimetre diameter DBHOB, prioritising primary browse species, then secondary browse species*:". The NRC over-rode the EPA to support the Forestry Corporation, deciding "*retain trees with minimum 20 centimetre diameter DBHOB, retaining trees where available with 50 percent primary browse species*".

These trees only need to be retained until the end of each logging operation, meaning new small trees can be selected at the start of the next operation – ensuring retained trees never grow into sawlogs. It needs to be recognised that up until then the widely applied Single Tree Selection prescription required retention of all trees <20 cm DBH, and that to qualify as a small-sawlog they had to have a centre diameter of 30cm, and often a butt diameter of 41 cm under bark. Meaning that trees under 40 cm DBH did not count as quota sawlogs and so it is hard to fathom how NRC could claim that retention of trees not targeted for logging could impact timber yields.

Even with the exclusion of hardwood plantations, it is thus perplexing as to how the NRC could claim that "*it is not possible to meet the Government's commitments around both environmental values and wood supply",* citing that the retention of Koala feed trees (just until the end of a single logging operation) in limited areas would reduce timber volumes by 3,000-4,000m^3/yr (i.e. up to 2% of total volumes).

Despite having removed the requirement to protect Koala High Use Areas, and contravened the advice of the EPA and the Expert Fauna Panel on the numbers and size of feed-trees to retain, the NRC (2016) claimed:

> *The agreed and proposed settings are designed to not erode environment values ... koala protections are key advances in environment protection.*

Going so far as to maintain:

> *The Commission's recommended koala protections are likely to impact the native timber industry across the North Coast. ... An analysis of the impacts of North Coast koala settings on high quality sawlogs indicates around a 9 percent reduction in harvestable volumes of Koala browse tree species is expected (around 3,500 cubic metres per year).*

The NRC (2018) later recommended the opening up of oldgrowth forest protected in 1998 from logging to compensate for this claimed reduction in timber.

It is important to recognise that up until that time, as well as 5 Koala feed trees per hectare and KHUAs, the Forestry Corporation was required to retain all trees under 20 cm dbh in most operations. The new rules only required the temporary retention of 5-10 Koala feed trees >20 cm dbh per hectare, with new small trees able to be selected in subsequent operations.

In their submission to the IFOA, the Office of Environment and Heritage (2018) complained that the new Koala feed tree retention rates are less than half the number and of a smaller size than proposed by the Expert Fauna Panel, concluding that the increased logging intensity proposed under the new rules is expected to impact Koalas through diminished feed and shelter tree resources:

> *Koalas are selective both in their choice of food tree species and in their choice of individual trees. The scientific basis for proposed tree retention rates in the Draft Coastal IFOA is not clear, and the rates are less than half those originally proposed by the Expert Fauna Panel.*
>
> *While Koalas will use small trees, research has shown that they selectively prefer larger trees. In our experience, the proposed minimum tree retention size of 20cm dbh will be inadequate to support koala populations and should be increased to a minimum of 30cm dbh. Many Koala food trees are also desired timber species, so there is a high likelihood that larger trees will be favoured for harvesting, leaving small retained trees subject to the elevated mortality rates experienced in exposed, intensively-logged coupes.*
>
> *Koalas require large areas of connected habitat for long-term viability. The increased logging intensity proposed under the draft Coastal IFOA is expected to impact Koalas through diminished feed and shelter tree resources. Animals will need to spend more time traversing the ground as they move between suitable trees that remain, which is likely to increase koala mortality.*

The 2020 NSW Legislative Council inquiry report 'Koala populations and habitat in New South Wales' notes:

> ***2.101** The committee understands that the recent changes to the Coastal IFOA agreements relating to tree retention in koala habitat were contentious, even amongst the NSW*

Government's agencies. The committee is of the opinion that the current regulations are insufficient to conserve large intact areas of koala habitat and corridors.

1.4.3.4. Current Logging Impacts

For public lands the current Coastal Integrated Forestry Approval (CIFOA) does not require pre-logging surveys, though does require a visual assessment of a tree before it is felled, with the requirement (75.2):

If a Koala is located in a tree, an exclusion zone with a radius of 25 metres or greater must be retained around the tree. The exclusion zone may be removed once the Koala moves from that tree.

As stated by logging contractor [redacted] on ABC Landline (27/8/2023):

… and you do upset them at times you know, you brush a tree at one end or unfortunately may fell a tree with a bear in it, so you see the bear, we have protocols we must use, we leave that area, get the ecology boys out from forestry and do the searches and they can say oh well he's moved, but you generally find they are not stupid they move, the noise upsets them, you know ...

This is a return to the 1989 "best practice" of "*if you see a koala in a tree wait for it to leave before you cut down its tree*". Surely a tree actually utilised by a Koala should be preferentially retained.

There is no requirement to retain trees actually used by Koalas, rather 5 or 10 small trees >20 cm DBH of a limited number of species are required to be retained in poorly modelled moderate-high Koala habitat. There is no requirement to assess them for evidence of Koala usage (i.e. scratches, scats). The relevant condition of the CIFOA is:

65. Koala browse tree retention (Upper North East Subregion and Lower North East Subregion)

65.1 The following trees must be retained for the duration, and at the completion of, each forestry operation in accordance with Protocol 23: Tree retention:

(a) a minimum of 10 Koala browse trees per hectare of net harvest area where Koala browse prescription 1 applies;

(b) a minimum of five Koala browse trees per hectare of net harvest area where Koala browse prescription 2 applies and in any (or remaining part of a) compartment where a contemporary koala record exists but is not otherwise attributed Koala browse prescription 1 or 2; and

(c) all Koala browse trees in areas where the minimum coverage of Koala browse trees set out in conditions 65.1(a) and 65.1(b) does not exist in the net harvest area before the commencement of the forestry operation.

In good habitat, Koalas can use all preferred feed trees (>30 cm DBH), therefore the number and size of feed trees is the key determinant of the number of Koalas a stand can support. Logging prescriptions can allow the logging of over 70% of Koala's preferred feed trees >30cm DBH and thus can significantly reduce the carrying capacity of a stand, and thus the Koala population. While there are requirements to retain potential feed trees we find in practice they are often severely damaged, and the EPA refuse to do anything about it.

Examples of significant damage to Tallowwood trees marked for retention as Koala feed trees in Wild Cattle Creek SF, this was reported to the EPA though, despite such damage likely resulting in tree death, they invariable dismiss such complaints.

The logging of a few trees within a Koala's home range can cause actual harm to Koalas. In Environment Protection Authority v Forestry Corporation of New South Wales [2022] NSWLEC 70, the Forestry Corporation pleaded guilty to constructing two snig tracks and felling four potential browse trees within a "Koala high use area exclusion zone" ('KEZ') J Robson [125] found:

> *I accept Dr Crowther's evidence and I find beyond reasonable doubt that the felling of the large Eucalyptus trees and the construction or operation of snig tracks were highly likely to have had an adverse impact by reducing the size and the quality of the habitat available to the breeding female and offspring. As such, I accept the position adopted by the prosecutor and find that there has been actual harm.*

In Independent Review into the Decline of Koala Populations in Key Areas of NSW, the NSW Chief Scientist (2016) recognises:

> *In many cases, the reliance on traditional point-in-time surveys (such as scat surveys conducted according to licence conditions under IFOAs) has proven ineffective at providing data on population trends, as they are not designed for comparative or repeat surveying (Woosnam-Merchez, Cristescu, Dique, Ellis, Beeton, Simmonds, & Carrick, 2012; Slade & Law, 2016). A robust monitoring program is essential to understand the impact of interventions and activities at a landscape scale and at specific sites and how populations respond over time.*

The Natural Resources Commission (NRC) is charged with monitoring prescriptions. The CIFOA Protocol 38.3 *Design and contents of a monitoring program* identifies that '*The monitoring program must be designed to monitor and evaluate the effectiveness of the conditions of the* ***approval'***, including Koala conditions.

The NRC 2020 'Coastal IFOA: Monitoring plan, Research program October 2020' identifies an initial research question as:

> ▪ *How are koalas responding to conditions, including changes in tree retention rates, species, distribution and size?*

This of course is the key requirement for assessing the efficacy of condition 65. And the efficacy of the Koala condition is effectively the only condition that the NRC claim to have addressed in their monitoring studies. Regrettably the NRC made no attempt to assess Koala feed tree retention and removal rates or how this affected Koalas. Instead, the NRC relies upon assessments by DPI Forestry using recordings of male Koalas in partially logged areas to assess presence/absence, without any assessment of changes in feed trees and ignorance of how females or densities are being affected.

For their monitoring the NRC engaged DPI Forestry (Law *et al.* 2022) to assess logging impacts based on the before and after calls of male Koalas within 300m of recorders for 2 weeks during the breeding season. Based on this, the NRC (2023) make a variety of claims, including:

> *Overall, the research findings suggest that selective harvesting at the research sites did not adversely impact koala density*
>
> *… tree species composition – not tree size – is the key determinant of habitat nutritional quality for koalas and, therefore, the density of koalas that can be supported*
>
> *Overall, the research indicates the current forestry rules to protect koalas are effective at managing the risks to koalas from selective harvesting …*

Law *et. al.* (2022) from DPI Forestry used male Koala recordings from song-meters to assess the impacts of logging on Koalas in 3 State Forests in the north-east NSW. The Law *et. al.* (2022) paper 'Regulated timber harvesting does not reduce koala density in north-east forests of New South Wales' claims "*There was no significant effect of selective harvesting on density and little change evident between years*" and "*that native forestry regulations provided sufficient habitat for koalas to maintain their density"*. NEFA have previously criticised this work.

The Law *et. al.* (2022) study was undertaken using acoustic sensors at 3 sites before and after logging in State Forests to assess logging impacts, and 3 sites in previously logged National Parks as controls. The sites averaged around 400ha, though only parts of the logging sites were logged with significant areas remaining unlogged, including exclusion areas. The initial sampling was undertaken for 2 weeks during the severe drought in Spring 2019, with second assessments undertaken following widespread rains in Spring 2020, so this is likely to have confounded results as male calling activity is likely to have been greater in the more favourable 2020 climate.

The fundamental problem with Law *et. al.* (2022) is that it only records male Koala bellows (up to 300m away) during the breeding season and ignores female Koalas. Their assumption is that male Koala calls are representative of female population densities and breeding habitat. This fundamental assumption has now been shown to be invalid.

Smith and Pile (2023) found that male Koalas call in a wide variety of degraded and poor quality habitat, which may in part reflect transient, dispersing males in unsuitable habitat, whereas observations of reproducing females were largely confined to the highest quality habitat '*characterized by a high density of trees across all size classes that have only been lightly selectively logged to remove large and old senescent trees, and that have a high diversity of locally preferred food tree species and an abundance of preferred koala food trees'.*

Smith and Pile (2023) state:

> *… claims are based on findings and conclusions of recent surveys (Law et al. 2017, 2018, 2022, NRC 2021,22) that used remote call recorders to model male koala distribution and response to harvesting in NSW timber production forests. These same surveys are also*

> *currently being used to justify expansion of clear-fell harvesting in northern NSW State Forests (NRC 2022) using practices comparable with those in 1960's and 1970's woodchip production areas of southern NSW and Victoria. The findings and conclusions of NRC (2022) and Law et al. (2017,2018, 2022ab) rely on an unproven assumption that male and female koala distribution and habitat preferences are identical, and that the frequency of male koala calls in intensively logged forest is a reliable and accurate indicator of core female koala habitat, or female koala abundance and long-term reproductive success, in logged forest. The findings of this study demonstrate that this assumption is invalid.*
>
> *Our findings lead us to conclude that the failure of Law et al. 2022b to find an impact of intensive logging on koalas is an example of a type 2 statistical error (acceptance of a null hypothesis that there is no effect of timber harvesting when in fact there is) caused by widespread distribution of transient male koalas in suboptimal or sink habitat, and deficiencies in habitat modelling …*

NEFA have reviewed Law's assessment identifying numerous problems, including:

- Use of song meters which only record male calls, which can be anywhere within 300m of the recorder (i.e. not within 50m of the recording site where environmental data is collected)
- Inclusion of unlogged areas and exclusions in the assessment areas, resulting in masking of apparently significant declines within the logged areas
- Only undertaking one pre-logging assessment during the worst drought to affect north-east NSW, and one post-logging assessment following significant rain and recovery, precluding any accurate assessment of impacts
- Assuming that each male territory corresponds to a female territory.

According to NRC (2021) in areas that "*experienced direct harvesting, canopy cover declined by an average of 7 percent*", whereas in the control sites recovering from drought "*the canopy cover had increased by an average of 10 percent*". NRC (2021) also identify that the preferred Koala feed species, Tallowwood (*Eucalyptus microcorys*) "*contributed an average of three percent of the canopy in control sites and five percent in treatment sites*", an increase in Tallowwood canopy cover at both the treatment and control sites in 2020 (due to drought recovery), and a decrease of the feed tree Blue Gum (*E. saligna*) in the control sites. These results indicate that the availability of potential feed trees was less in the control sites, and confirm that the drought had confounding effects on such limited sampling.

Law *et. al.*'s (2022) results are contrary to the findings of Smith (2004):

> *Koalas preferred structurally complex, uneven-aged forests with some mature and oldgrowth elements, a large basal area, and mixed species associations dominated by tallowwood, grey gum and forest oak. Koalas were least abundant in plantations and structurally uniform, blackbutt dominated regrowth native forests with a low tree species diversity. Trees of 40-80 cm dbh and stands with more than three koala food tree species per survey plot (50 by 50 m) were preferred.*

Law *et. al.* (2022) acknowledge the contradictory findings of Smith (2004), though [redacted] they ignore these in their discussion, instead relying upon studies undertaken in Victorian Bluegum plantations and the Piliga as corroborating their findings "*that during and after selective harvests koalas will continue to occupy their home ranges*". The Piliga study by Kavanagh *et.al.* (2007) specifically excluded all Koala feed trees from logging and was limited to "*about one-quarter of the stand basal area*" of cypress pine. In relation to the Victorian Bluegum, NRC (2021) note "*After harvest, most koalas moved up to 5.5 km from the harvested plantation, with a small proportion remaining in patches of unharvested trees in the harvested area*". No corroboration in either case.

A Biolink (2013) study for Port Macquarie-Hastings Council found that State Forests had less than half the number of active Koala sites than nearby National Parks and concluded that logging had decimated the once substantive local Koala populations, commenting:

> *... koala activity was recorded less commonly from areas of State Forest where field data and other knowledge strongly points to cumulative impacts of logging over time resulting in significantly lower size classes of preferred food tree species which in turn results in a lower koala carrying capacity.*
>
> *...*
>
> *It is significant that koala activity was least commonly recorded from State Forests generally; these being areas wherein both the historical record and local knowledge can attest to the presence of once substantive local populations. However, data arising from this survey supports an assertion that the long-term logging of tree species preferred by koalas is having an effect on koala carrying capacity in these forests, ...*

As well as the loss of preferred feed and roost trees, and direct impacts on individual Koalas, there are significant impacts from logging practices on Koalas consequent from the conversion of multi-aged forest to young regrowth, which:

- increases the time spent by Koalas on the ground moving between feed trees and thus their vulnerability to predation.
- increases transpiration of the forest while decreasing rooting depth (and thus access to deeper water tables) drying the forest and increasing water stress for Koalas during droughts and heatwaves.
- changes forest structure by reducing tree height and increasing tree density, while promoting dense weedy understories (i.e. lantana), thereby increasing fire intensities and the risk of crown fires affecting Koalas.
- removes tall broad crowned trees, with shaded understories, that function as heat and fire refuges.

It is of particular concern that the study of Law *et. al.* (2022) was funded by the NSW Koala Strategy and overseen by the Natural Resources Commission (NRC). The NRC (2021) report "Koala response to harvesting in NSW north coast state forests" adopted the findings of Law *et. al.* (2022) uncritically. These findings are now being relied upon by the NSW Koala Strategy and the Koala Recovery Plan to claim that logging has no impact on Koalas and therefore there is no need to protect Koala habitat from logging.

NEFA obtained the [redacted] to Environment Minister Penny Sharpe in response to a NEFA complaint about the impartiality and competence of NRC which verifies many of NEFA's concerns. For example, in relation to their logging study the EPA states "*EPA shares NEFA's concern that the NRC study of koala presence before and after selective harvesting has limitations*," including that "*There is uncertainty associated with the use of, and therefore the conclusions that can be drawn from, acoustic surveys*." And in relation to Koala feed tree prescriptions determined by the NRC, the EPA note "*Similarly, EPA shares the concern that NRC's interpretation of available information on koala use by tree size has been inappropriately used in considering the adequacy of the koala prescription settings*", "*claims around the insignificance of tree diameter have limited support in literature*" and "*The EPA position in development of the CIFOA koala browse tree prescriptions was for much higher rates of retention of larger trees with a clear priority for protection of higher quality browse species*". The EPA also highlights that the NRC's CIFOA monitoring program is dominated by DPI and FCNSW and not targeted at actually assessing the efficacy of the Koala prescription, just like over the previous 20 years they do not want to know how badly it is failing Koalas.

The EPA notes that they acknowledge NEFA's concerns about logging prescriptions "*and is currently in negotiations with FCNSW on the implementation of precautionary measures in the proposed GKNP area*" which "*may relate to the changes proposed by NEFA*." NEFA also pieced together the [redacted] to protect Koalas within the Great Koala National Park. It clearly shows that despite the EPA's intent to make relatively minor amendments to the Protocols since at least May 2023, the Forestry Corporation's agreement to do so, and drafting of the changes, on the 25 July the Protocol amendments were abandoned.

As early as April 2023 the FCNSW were adamant that the EPA cannot unilaterally alter the Protocols:

> *"FCNSW reiterated their position: FCNSW does not agree that the EPA can amend protocols (or conditions) without the consent of both Ministers."*

The EPA began proposing to the Environment Minister Penny Sharpe in May 2023 that she amend the CIFOA to provide better protection for Koalas, recommending (EPA 23/5/23):

Ministers can jointly amend the IFOA to:

- *restrict forestry in certain habitat for refuge*
- *increase the amount of koala trees to be retained, or*
- *reduce logging intensity in koala habitat*

The EPA can amend several IFOA Protocols to:

- *increase the size of koala feed trees to ensure the largest trees are being retained;*
- *increase the proportion that should be preferred feed tree species; and,*
- *require koala habitat to be preferentially retained in permanent protected areas (clumps)*

The EPA warned that the risk of their changing the protocols was:

> *FCNSW (and industry) dispute that EPA can make Protocol amendments and may legally challenge the changes – Government support may be required to mitigate the legal risks*

The EPA did not recommend FCNSW adopting voluntary measures because "*The EPA cannot enforce voluntary measures if they aren't complied with*."

By early July (EPA 4/7/23) there appeared to be agreement to proceeding with amendments to the CIFOA Protocols (for the GKNP), which the EPA were preparing:

> *• The precautionary measures seek to increase transparency and accountability, increase koala habitat protection, improve the information on koalas in the area.*
>
> *• The measures should be enforceable (via protocol amendments) where possible …*
>
> *…*
>
> *• EPA to draft Protocol amendments for FCNSW consideration and identification of necessary transition needs*

An undated "GKNP precautionary measures – protocol updates" identifies proposed changes to the Protocols to apply throughout the GKNP to a 'precautionary measures area' (proposed to be KHSM modelled high and very high koala habitat, and possibly moderate), including:

- setting retention of Koala feed trees as 10/ha
- Koala Feed Trees to be greater than 30 cm DBHOB
- adding Small-fruited Grey Gum as a primary browse tree
- requiring FCNSW to prioritise protection of high value Koala habitat in wildlife habitat clumps
- excluding the 'precautionary measures area' from 'intensive harvesting'.

On the 25 July the Protocol amendments were abandoned in favour of legally unenforceable voluntary measures, [redacted]

[redacted] The EPA (27/7/23) claiming “the EPA will consider the need to impose these requirements via amendments to existing protocols, particularly if we see FC not operating within the intentions of this letter”.

[redacted]

This is despite the Forestry Corporation concurrently claiming in court that the EPA can quickly change the Protocols whenever they consider it necessary (Hemmings transcript of 15 August 2023 in NEFA vs Forestry Corporation):

> *If there was a concern that the koala was not adequately being protected because of the way in which the Browse trees were being retained, then that is an easy temporary fix, if I can express it that way, by the EPA, because you can amend protocol 23 and change the way in which we must retain trees for the koalas, and that could be done as an interim protection while there is the iterative process for changes to the condition itself, if that's what’s required.*

Following NEFA’s lobbying of the Environment and Forestry Ministers in August 2023, which canvassed the protection of the 20,000 ha of Koala Hubs on State Forests, the Ministers made the decision to protect the 8,500 ha of Koala Hubs on State Forests within the GKNP, but not outside it. In response to a request by the NSW Chief Scientist, in 2017 OEH had analysed Koala records *"to delineate highly significant local scale areas of koala occupancy currently known for protection".* Like all inconvenient data the report was not publicly released and the Forestry Corporation was allowed to go on logging them indiscriminately, though NEFA had been advocating for their protection for years.

In October 2023 the EPA tried again to get amendments to the CIFOA to increase protection for Koalas, particularly within the proposed GKNP, and improve protection for other species worst affected by the 2019/20 wildfires. The changes were minor and predicated on the basis they *would not have any material impact on timber supply.* In December 2023 the Forestry Corporation agreed in principle with CIFOA amendments for Koala clumps and Koala browse tree prescription within the GKNP, though rejected the proposal to increase the size of trees retained as Koala feed trees to 30 cm dbh and increase retention rate of preferred feed trees, even though it would have marginal impacts, and rejected excluding intensive logging in high quality koala habitat and Koala Hubs outside the GKNP on the grounds of resource impacts (see 1.4.6). None of the proposed protocol amendments for Koalas proceeded.

1.4.4. Lantana Invasion

Lantana (*Lantana camara)* is one of the worst invasive weeds in Australia and recognised as a Key Threatening Process since 2006. It invades logged forests aided by canopy and understorey removal, and soil disturbance. It increases with repeat disturbances. It prevents regeneration of native species through mechanisms such as shading, smothering and allelopathy. Where it occurs at high densities it can become self-perpetuating, lead to declines in native flora diversity, reduce foods for fauna and hinder their movements.

Lantana increases fire risk and intensity. It is a threat to ecosystem health, community structure and ecosystem functioning. As a result of logging it has infested tens of thousands of hectares of State forests in north-east NSW, and gets worse with each logging. There are legacy infestations in previously logged forests, including rainforests, now protected from logging. The refusal of the Forestry Corporation to manage lantana and rehabilitate infected forests is the antithesis of Ecologically Sustainable Forest Management.

Lantana *Lantana camara* is regarded as one of the worst invasive weeds in Australia, it is recognised as a *Weed of National Significance,* declared a Noxious Weed under the *NSW Noxious Weeds Act 1993* and its establishment and spread identified as a Key Threatening Process. It is recognised as a disturbance adapted species, invading logged forests and increasing with repeated logging. It blocks native regrowth (including timber species), out competes and smothers native understorey species, renders some habitats unsuitable for resident animals, hinders dispersal, increases flammability and can lead to ecosystem collapse. It is a major, widespread and persistent problem across the forests of north-east NSW, and while the activities of the Forestry Corporation extend and compound infestations, they do extremely little to remedy their impacts or control infestations.

The Invasion, establishment and spread of Lantana (Lantana camara L. sens. lat) was identified as a key threatening process by the NSW Scientific Committee (2006), noting:

> *L. camara readily invades disturbed sites and communities. Various types of sclerophyll woodlands, sclerophyll forests, rainforests and dry rainforests are all susceptible to Lantana establishment (Driscoll and Quinlan 1985; Lamb 1988; Fensham et al. 1994; Gentle and Duggin 1997a), although in communities with a naturally dense canopy, Lantana colonisation may be heavily dependent on, and limited to, disturbance zones, edges, and canopy breaks. There is a strong correlation between Lantana establishment and disturbance (Stock and Wild 2002; Stock 2004), with critical factors being disturbance-mediated increases in light and available soil nutrients (Gentle and Duggin 1998) … Lantana typically forms dense thickets, suppressing less competitive native vegetation and seedlings through shading (Swarbrick et al. 1995, ARMCANZ ANZECC&FM 2001), surface-soil nutrient sequestration (Lamb 1988 cited in Swarbrick et al. 1995; Gentle and Duggin 1998; CRC Weed Management 2003), smothering ("strangling" - ARMCANZ ANZECC&FM 2001) and perhaps through allelopathy (Gentle and Duggin 1997b; Day et al. 2003). …*

The NSW Scientific Committee (2006) identifies that Lantana can have a range of impacts on natural ecosystems, it "*may change soil microhabitat through shading, self-mulching, and altered water and nutrient balances*", "*may adversely affect the richness of some soil faunal assemblages*", "*inhibit growth of at least some microorganisms*", can "*arrest vegetation succession for decades*", prevent the establishment of "*eucalypt seedlings*", is "*thought to be allelopathic, i.e. able to inhibit or suppress by chemical means the germination and/or growth of at least some competing plant species*", can cause "*a large (at least 70%) decline in inferred recruitment (number of native tree and shrub saplings present)*", and "*adversely affects the ability of Koalas to move between trees*".

DECC (2008) also comment '*In other areas of NSW, dense thickets of lantana, blackberry and morning glory reduce the ability of koalas to move freely between trees*'.

From their literature review Silver and Carnegie (2017) observed that lantana can become self-perpetuating, with impacts increasing over time:

> *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). Gooden et al. (2009b) described a change in vegetation structure whereby increasing invasion of lantana results in a reduction in native species richness, especially of*

> *shrub and tree species, leading to a change from tall open forest to an understorey dominated by lantana. Fensham et al. (1994) described areas long-invaded by lantana as having a dense understorey consisting of >5000 lantana plants per hectare, compared to <1000 plants per hectare in newly invaded areas … Invasion by woody weeds, such as lantana, affects native vegetation regeneration, ultimately affecting species diversity, including of understorey, mid-storey and canopy species, thus perpetuating a dense understorey (Gooden et al. 2009a, b; Cummings et al. 2007)*

Lantana invasion is enhanced by the opening of the canopy by logging (i.e. Gentle and Duggin 1997, Day *et. al.* 2003, Wardell-Johnson *et. al*. 2006). As noted by Wardell-Johnson *et. al*. (2005) "*the proliferation of dominant understorey weeds, such as Lantana (Lantana camara), in the north-eastern region of NSW has largely been attributed to the disturbance caused by logging and associated activities*".

Day *et. al.* (2003) note:

> *In disturbed native forests, it can become the dominant understorey species, disrupting succession and decreasing biodiversity. Its allelopathic qualities can reduce vigour of plant species nearby …*
>
> *Lantana in forest communities has the potential to block succession and displace native species, resulting in a reduction in biodiversity (Lamb 1991; Loyn & French 1991). Under conditions of high light, soil moisture and soil nutrients, lantana is a very effective competitor against native colonisers (Gentle & Duggin 1998). Lantana infestations result in marked changes in the structure and floristics of natural communities. One of the obvious changes that occur with the replacement of forest understorey by lantana is a decrease in community biomass and a proportional increase in the foliage component in the vegetation (Bhatt et al. 1994) (Figure 13). As the density of lantana in forest increases, species richness decreases (Fensham et al. 1994). One possible explanation is that allelopathic effects of lantana result in severe reductions in seedling recruitment of almost all species under lantana and a reduction in the girth growth of mature trees and shrubs (Lamb 1982; Gentle & Duggin 1997a). …*
>
> *Lantana does not invade intact rainforests, but is found on its margins (Diatloff 1975; Humphries & Stanton 1992). Where wet sclerophyll forests and rainforests have been disturbed through logging, gaps are created; this allows lantana to encroach on the forests. Further logging aggravates the condition and allows the lantana to spread or become thicker (Waterhouse 1970). At some sites, lantana infestations have been so persistent that they have completely stalled the regeneration of rainforest for three decades (Lamb 1991). …*

For lantana invasion in dry rainforest–open forest ecotones in north-eastern NSW, Duggin and Gentle (1998) found:

> *Invasion was positively increased with disturbance intensity and increased resource availability. Light at ground level increased from 21.3 to 30.5% of ambient light when the shrub layer was damaged while it increased to 84.3% when the overstorey was damaged. A pattern of increasing plant performance with increasing intensity and number of combined disturbances was evident.*

The Conservation Advice for the EEC Grey box-grey gum wet forest (DCCEEW 2022c) identifies:

> *Lantana camara (lantana) is one of the most common weeds where the ecological community occurs (DECC 2007; DECC 2008b, DECC 2008c). Lantana has been recorded in 95% of vegetation sites surveyed of Grey Box - Grey Gum Wet Sclerophyll Forest (DECC*

> *2008a). Lantana infestation is known to prevent regeneration of native species through mechanisms such as shading, smothering (Lamb 1991) and allelopathy (Gentle & Duggin 1997) and lead to declines in native flora diversity, especially where it occurs at high densities (Gooden et al. 2009). The relatively fertile and moderately well-watered soils supporting the ecological community typically support dense stands of invasive weeds when they establish. The presence of dense weeds can suppress the regeneration of all layers of Grey box-grey gum wet forest. The documented prevalence of lantana within the ecological community and its impacts on ecological succession and understorey development and native flora diversity indicates a very severe reduction in community integrity across most of its geographic distribution.*

Lantana can also increase fire intensity and increases the risk of rainforests being burnt (Day *et. al.* 2003, NSW Scientific Committee 2006, Johnson 2007, DCCEEW 2022c). Day *et. al.* (2003) summarise:

> *Lantana can greatly alter fire regimes in natural systems (Humphries & Stanton 1992). Grassy woodlands rarely have sufficient fuel load to produce fires intense enough to penetrate into the surrounding rainforest, but the fuel load provided by lantana has been implicated in a destructive wildfire in northern Queensland (Fensham et al. 1994). The fire hazard provided by lantana in rainforest situations is paralleled in deciduous forests of the northern hemisphere (Anon. 1962). Lantana burns readily during hot, dry conditions, even when green (Gujral & Vasudevan 1983). Lantana occurring on rainforest margins is seen as a major threat to this community as a result of increased inroads of fire into the rainforest. ….*

Berry *et. al.* (2011) found:

> *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 non-invaded 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. Management should focus on targeting L. camara removal around forest edges adjacent to frequently burned savannas and in areas of high conservation value.*

The Conservation Advice for the EEC Grey box-grey gum wet forest (DCCEEW 2022c) identifies:

> *Fire is also known to facilitate lantana invasion in vine-forest (rainforest)-open forest ecotones (Duggin & Gentle 1998). In this study it was shown that the increase in light availability, and to a lesser extent nutrient availability, from the disturbance of the shrub and canopy layers by fire led to an increase in lantana germination, survival and growth. Therefore, escalating fire impacts from climate change are likely to further facilitate and maintain lantana infestation in the ecological community. This is likely to lead to further losses of the ecological community through suppression of regeneration and succession.*
>
> *In addition, lantana infestations have been known to facilitate fire incursions in dry rainforest (Fensham et al. 1994) -The mechanism by which lantana facilitates such incursions is by introducing more fuel and a more continuous fuel load (Berry et al. 2011). The prevalence of lantana in the ecological community therefore increases the risk of fire to the understorey of the ecological community over significant areas, heightening the risk of loss of the fire sensitive dry rainforest elements of the understorey and therefore the community itself. Taken together, these studies, showing the ability of lantana to promote fire and the ability of fire to promote lantana invasion supports the Fire-Lantana Cycle Hypothesis by Hiremath and Sundaram (2005). This suggests that positive lantana-fire feedback loops may be operating within the ecological community, contributing to its further degradation.*

Examples of Lantana invasion from old logging in Cherry Tree SF. The patches and scattered rainforest trees indicate that much of this area would have had a rainforest understorey before the last logging event. Lantana is actively competing with the remnant rainforest understorey.

1.4.5. Bell Miner Associated Dieback

Dense infestations of lantana (and sometimes other dense understories) can create habitat for colonies of Bell Miners which aggressively mob predators and perceived competitors and drive them from their territories. This initiates a process of ecosystem collapse whereby populations of sap-sucking psyllids proliferate and drain the life out of the eucalypts, resulting in extensive areas of dead and dying eucalypts over a dense understorey of lantana. This problem has been evident for decades, and is getting worse, yet the EPA and Forestry Corporation fail to acknowledge its causes or take any meaningful action to rehabilitate affected forests. In contravention of Ecologically Sustainable Forest Management the Government is in denial, despite the significant consequences for future timber yields, while affected and susceptible forests continue to be logged.

Forests affected by Bell Miner Associated Dieback (BMAD) are characterized by low dense understories of weeds (mostly lantana) or vines, overtopped by scattered dead or dying eucalypts, with a cacophony of Bell Miner calls.

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 rive*r" 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, onsite 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 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, nutrient enrichment, altered fire regimes and weed-invasion (Wardell-Johnson et al. 2006). ... Over-abundant psyllid populations and Bell Miner colonies tend to be initiated in sites with high soil moisture and suitable tree species where tree canopy cover has been reduced by 35 – 65 % and which contain a dense understorey, often of Lantana camara.*

Lantana itself is a weed of national significance and a key threatening process. The NSW Scientific Committee has also listed the 'Invasion, establishment and spread of Lantana (*Lantana camara* L. *sens. lat*)' as a Key Threatening Process, noting *"There is a strong correlation between Lantana establishment and disturbance ..., with critical factors being disturbance-mediated increases in light and available soil nutrients."*

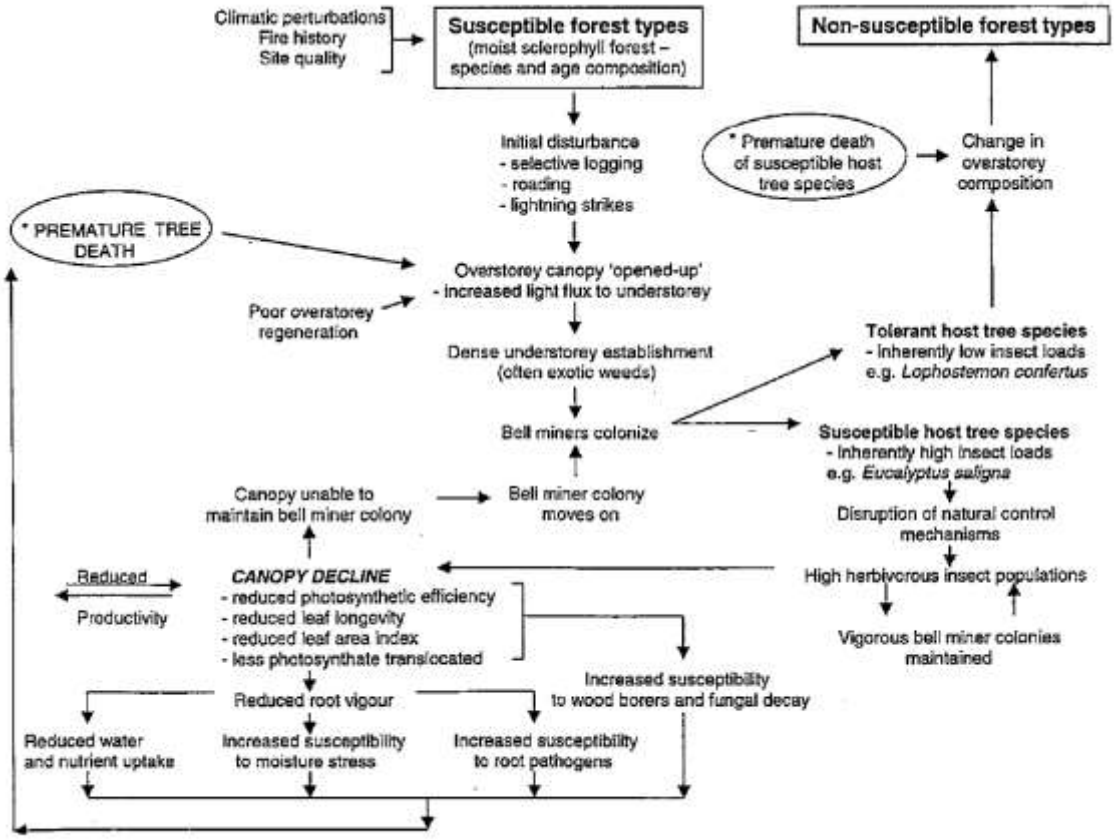


Figure 1. A conceptual model illustrating possible relationships and several feedback loops between processes which may contribute to canopy dieback associated with bell miners in moist eucalypt forests.

Stone *et. al.* (1995) undertook a review for State Forests, finding that *"The vast majority of plots (97%) had been exposed to some degree of logging and were on their second or third rotations ... A possible long-term explanation of why the dieback problem may be increasing, is that the proportion of moist sclerophyll forest being exposed to selective logging is increasing throughout the State."*

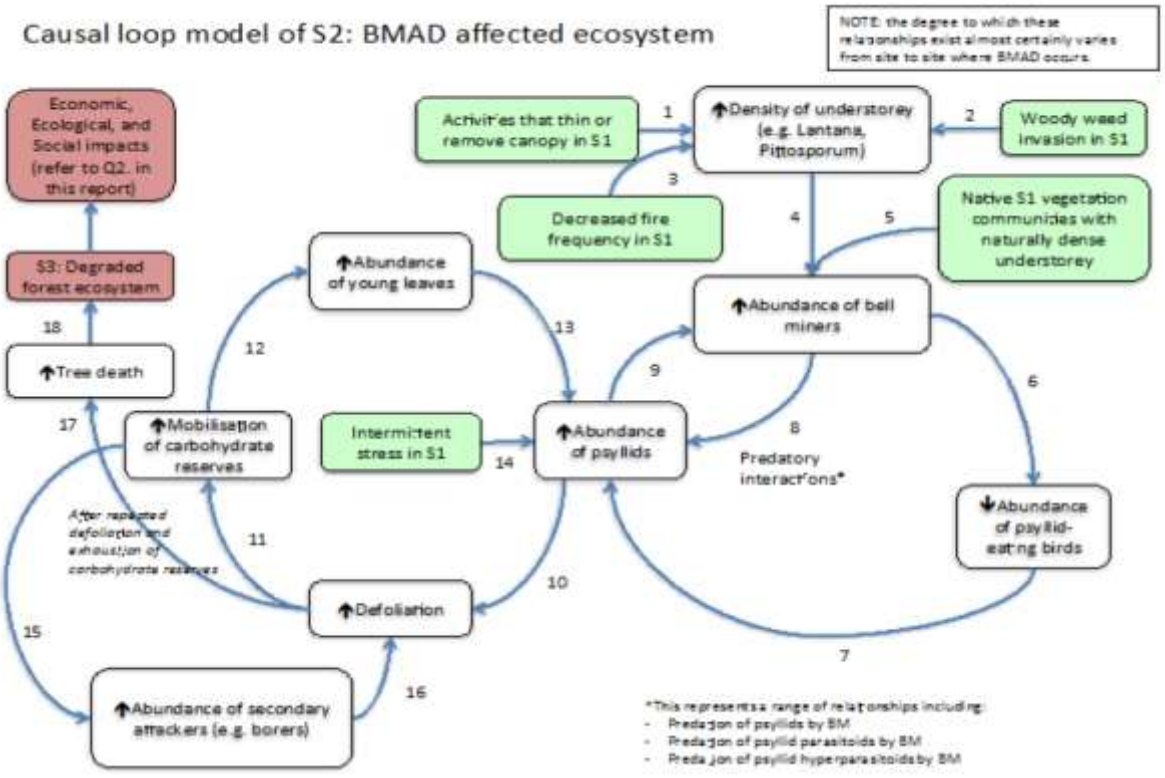
Based on her research for the Forestry Corporation and review of the literature, Stone (1999) put forward a conceptual model for BMAD identifying logging as the initial cause:

Kavanagh and Stanton (2003) in their assessment of logged and unlogged coupes over 22 years near Eden, considered that the increase in Bell Miners in moist forest types at the heads of two gullies in logged coupes *"provides support for the hypothesis (Stone 1999) that logging disturbance can be a contributing factor in creating the habitat conditions required by the Bell Miner"*.

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*

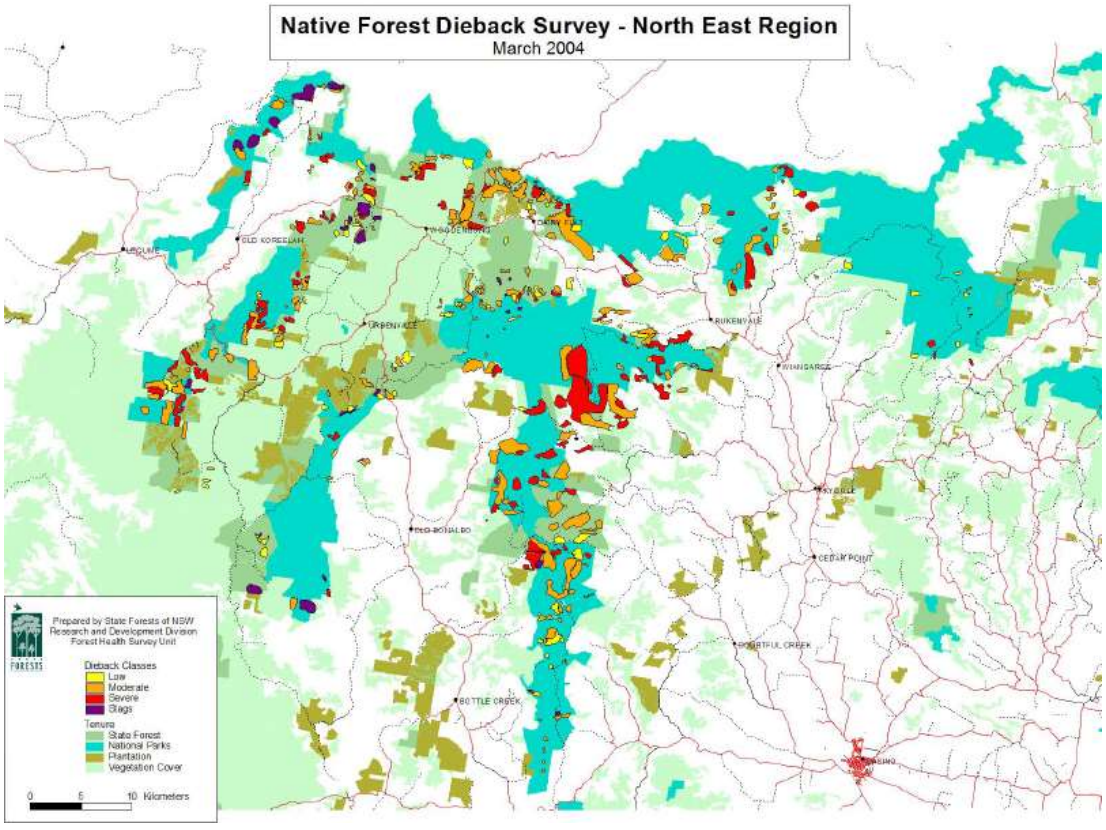
NEFA have been trying for years to get the Environmental Protection Authority to act on this issue and to stop the Forestry Corporation from targeting BMAD affected and susceptible stands for logging, and to rehabilitate areas after logging. BMAD has been specifically identified in NEFA reports and audits 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. [redacted]

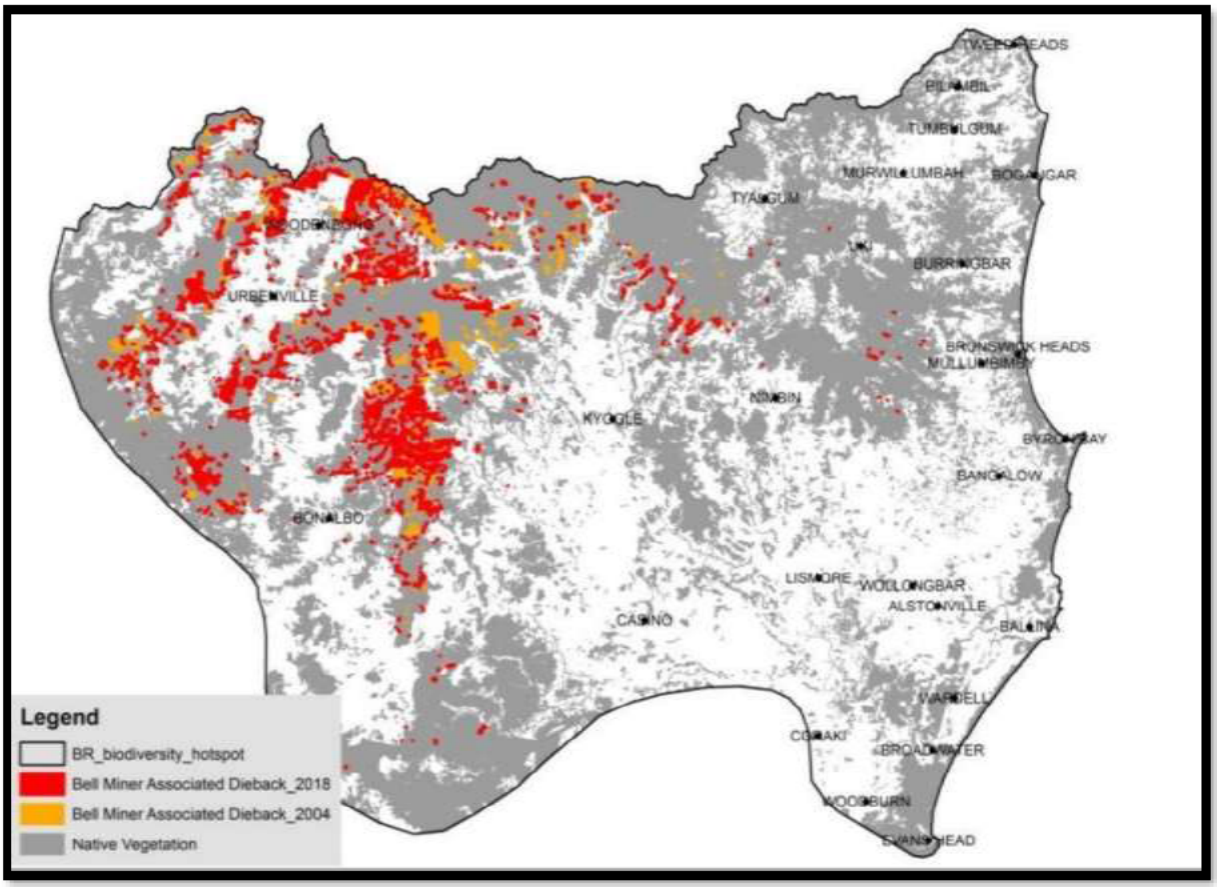


State Forests' (Carnegie 2004) 2004 mapping of BMAD in the western Border Ranges.

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 Stags1,382ha. 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).

In 2005 (Stone *et.al.* 2005) used high resolution multi-spectral imagery (DMSI) to map BMAD across 30,000ha of the Richmond Range. For the 23,700 ha of potentially susceptible forest, Stone *et.al.* (2005) identified 37% with '*moderately to severely BMAD affected trees*', 25% '*mildly affected (slightly stressed) tree crowns'*, and 38% with '*healthy tree crowns*'.

The helicopter to sketch-map 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.



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.

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.

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 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.

There has also been no recent BMAD mapping south from Taree. yet past mapping has identified significant areas of BMAD in that region, it would be reasonable to assume that a third of BMAD occurs south of Taree. Given these considerations it is reasonable to assume that there are over 100,000 ha of BMAD affected forests in north-east NSW.

The Forestry Corporation, with the connivance of the EPA, have been routinely flouting the principles and intent of Ecological Sustainable Forest Management by logging forests affected by, or susceptible to Bell Miner Associated Dieback

It is very disheartening to visit dying forests year after year as the Forestry Corporation target them for liquidation logging, removing all merchantable trees, and leaving seas of lantana with scattered dead and dying trees in their wake. In general, they refuse to undertake rehabilitation, at best planting some token seedlings that they do not maintain. The problems of facilitating the spread of lantana and dieback are ignored.

The wanton devastation of vast areas of forests and their wildlife has been underway for decades and is rapidly worsening, yet both those responsible for the environmental atrocities and those responsible for stopping them could not care less.

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, onsite inspections of BMAD to demonstrate the problem. We have made numerous submissions to inquiries, identified the problem in forest audits, and publicised the problem. Many others have pursued other paths to having the problem recognised. And they all end in the same place, deliberate obfuscation and denial by NSW Government agencies.

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.

The 2018 CIFOA includes a requirement for ESFM that is theoretically enforceable by the EPA. Though their intent is to rely on a protocol that sets a high threshold before requiring intervention. Basically '*Protocol 37: Regeneration and stocking*' is aimed at ensuring a minimum for regeneration of trees, considering Bell Miner Associated Dieback (BMAD), by requiring at least 65 per cent of a harvested area is stocked with 'natural floristic composition'. This still allows a significant proportion of the harvested area and all the exclusions to be badly affected by BMAD before any action is triggered, and if the threshold is subsequently exceeded no action will be required until the next harvesting plan is prepared.

In response to my query, the EPA (Steve Orr, Director Regulatory Operations, 23 November 2021) responded:

> *The Coastal IFOA does not have specific requirements concerning how Bell Miner Associated Dieback is managed. However, it does contain requirements for regeneration and stocking assessments which can trigger remedial actions and rehabilitation plans if, following an operation, regeneration fails for any reason (including as a result of Bell Miner Associated Dieback).*

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.

NEFA have done detailed reviews, see Our Forests are Dying … Logging Dieback.

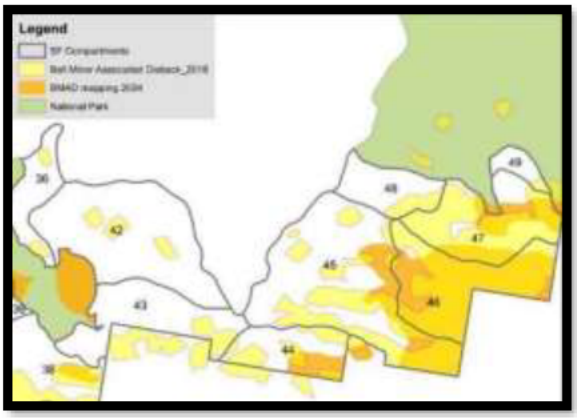
1.4.5.1. 3.4.1. Donaldson Case Study

The Forestry Corporation prepared a Harvest & Rehabilitation Operational Management Plan for Compartments 44-49 of Donaldson State Forest on 17 October 2003. The forest was last logged in 1976-82 and had "*not been grazed or burnt for approximately 10 years*" (Shipman 2006).

In 2005 the BMAD Working Group determined to help fund trials of lantana control on Donaldson State Forest as one of three trials of using understorey control to redress BMAD (Pugh 2014). The trial was intended to:

- *Remove 25 hectares of dense shrub understorey in moist sclerophyll forest using dozer with follow-up spraying of herbicide.*
- *Remove 20 hectares of dense shrub understorey in grassy forest using dozer with follow-up regular low intensity fire.*
- *Remove 34 hectares of light to medium density shrub understorey in grassy forest using regular low intensity fire.*

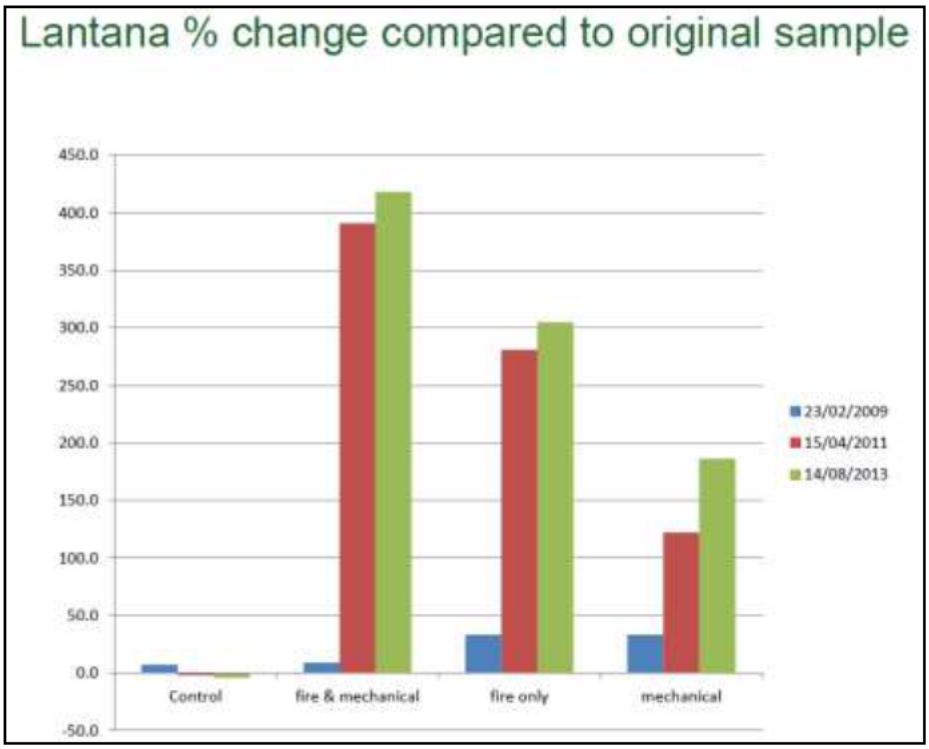
The trial was meant to go for 15 years from November 2005 till 2020, with annual reports for first 3 yrs, then every 2 years thereafter. Costs were given as $35,203 in kind and $67,336 from the Environmental Trust via the BMAD working group.

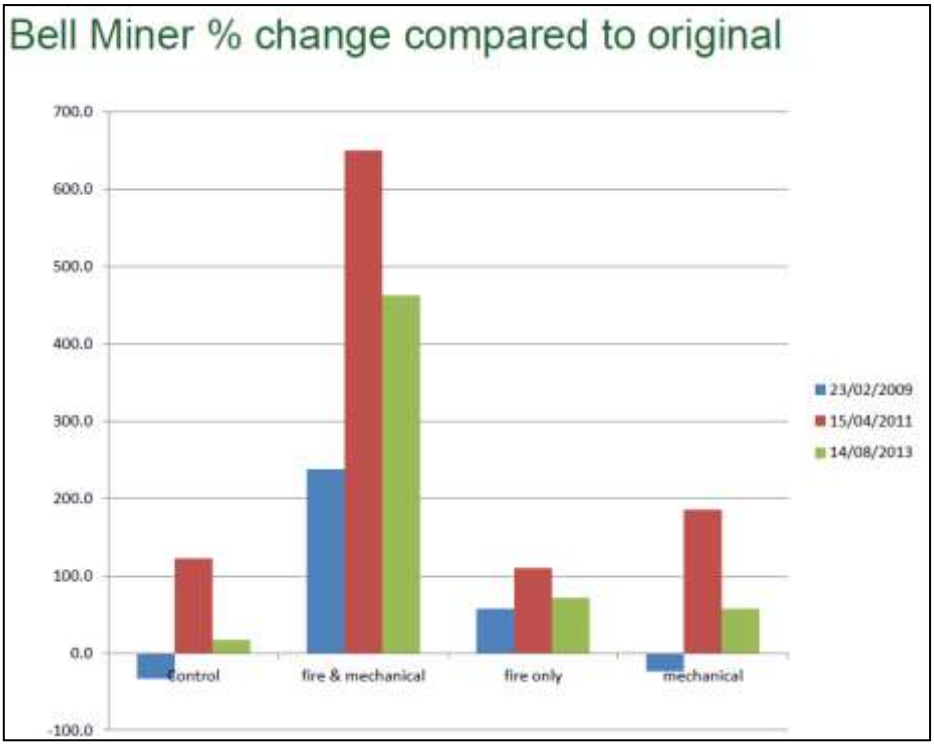


2004 and 2018 mapping of BMAD, Donaldson State Forest.

Shipman (2006) undertook intensive sampling of part of this area in compartment 46. Unfortunately, the write up of results is poor, selective (i.e. native species other than eucalypts were classed as "weeds") and confusing. Shipman (2006) reports that *"the prolific weed growth became a problem after fire*", and that "*There was patchy and generally poor regeneration of native forest eucalypts over the three treatments*".

The Donaldson Trials clearly show dramatic increases over 8 years, with, for example, the combination of fire and mechanical treatments resulting in 420% increases in lantana, and 460% increases in Bell Miners after 8 years (FCNSW 2015).





The Forestry Corporation (2015) results for Donaldson State Forest.

The Forestry Corporation (2015) summarising:

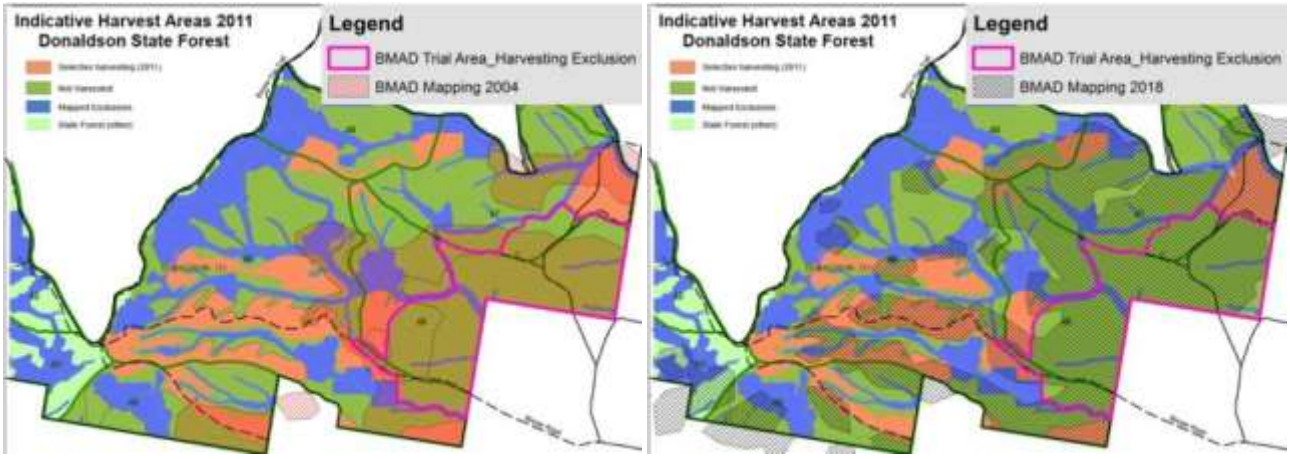
- *Compromised experimental design reduces confidence in trial results*
- *Increase in Lantana especially in combined fire & mechanical treatment*
- *Bell Miner increase, but issues with data collection, inconsistent recording methods*
- *No regeneration or canopy health data*
- *Both treatments and control sites remain seriously unhealthy stand*

In 2011 the Forestry Corporation ignored the outcomes from their Donaldson trial, returning to Donaldson 44, 45, 46, 47, 48 and 49 in 2009. Logging commenced on 23 September 2009 and was suspended on 27 October 2009 presumably when the Forestry Corporation recognised that they were logging in contravention of the requirements of the 2003 Harvest & Rehabilitation Operational Management Plan. A new Harvesting Plan was prepared in 2010, identifying:

> Dieback is evident in various levels across parts of the harvest area. In affected areas the site is understocked and trees have thin crowns. There are numerous dead stags scattered across the harvest area. In affected areas understorey is predominately lantana under more open canopy and there is little healthy regrowth or potential for regrowth in the current state.

There was no mapping of BMAD. The trial area was to be excluded from logging, though elsewhere the intent was to "*Remove unhealthy merchantable trees*", with any treatment to be decided by the forester in charge:

> **Treatment**
>
> Treatment is to be developed on a site specific basis as operations progress by the Harvesting Team Leader and may involve a combination of harvesting, seed tree retention, mechanical disturbance, planting, weed control, and reintroduction of a low intensity fire regime. Treatments to be applied as required to obtain satisfactory regeneration event..



Comparison of BMAD mapping for 2004 (LEFT) and 2018 (RIGHT) overlaid on 2011 logging area (orange). While both mappings are of questionable veracity, they indicate that the treatment of the trial area had no appreciable positive benefit on BMAD extent (and may have had a negative effect) and that the 2011 logging may have expanded the BMAD problem to higher elevations.

As the Forestry Corporation were undertaking preparatory roadworks to commence logging in compartments 36 and 42 of Donaldson State Forest in May 2014 the North East Forest Alliance undertook a brief inspection of compartments 36 and 42 (Initial Assessment, Donaldson State Forest), finding several stream breaches and relatively small patches of BMAD, recommending:

1. *Given the rampant Bell Miner Associated Dieback at lower elevations in compartments 43, 44, 45, 46, 47, 48 and 49, the abject failure of rehabilitation trials in compartments 44-49, the yet limited occurrences in compartments 36 and 42, and the high susceptibility of these forests to lantana invasion and BMAD that no logging should take place until:*
    a. *The extent and severity of BMAD in compartments 36 and 42 is fully and accurately mapped;*
    b. *The area of susceptible forest types is clearly delineated;*
    c. *An explicit management and rehabilitation strategy is identified for affected and susceptible areas; and*
    d. *Sufficient resources are available to immediately undertake and monitor required rehabilitation works.*

NEFA followed this up with the report "For Whom the Bell Miners Toll" (Pugh 2014) on BMAD, which included a review of the BMAD trials in Donaldson and Mount Lindesay State Forests, emphasising the failure of the Forestry Corporation to undertake the required monitoring and reporting. Forcing the Forestry Corporation (2015) to belatedly compile their monitoring results into a brief report.

Part of the Donaldson trial area in compartments 45 and 46 was visited in May 2014, with the track forming the boundary of the Shipman (2006) area walked and visually assessed. NEFA (Pugh 2014) found:

> *Dense lantana growth meant that the area could not be readily assessed away from the track. The visual evidence is that, in this area at least, the trials utterly failed to control lantana, Bell Miners or BMAD. Lantana dominates the understorey, many trees are dead, most remaining eucalypts show evidence of BMAD (mostly severe), regeneration of eucalypts is patchy, wattles or lantana dominate large areas with few eucalypts. The Forest Red Gum stands at lower elevations seem to have been particularly severely affected with numerous dead and dying trees and little eucalypt regeneration.*

ABOVE Photos of the BMAD trial area taken in May 2014.

ABOVE Photos of the 2011 logging adjacent to the BMAD trial area taken in May 2014.

In response to a complaint about the proposed logging from [redacted] the EPA [redacted] 1 August 2014) responded:

> Although the EPA is taking action on BMAD, it should be noted that there is no clear consensus between experts on the causes or viable treatments for this threat. BMAD involves complex interactions between a number of biological factors and occurs across state forests, national parks and private lands.
>
> The EPA has raised the issue of BMAD with the Office of Environment and Heritage, the National Parks and Wildlife Service and the Forestry Corporation of NSW and will continue to work with these agencies where appropriate to develop cross tenure approaches to improve knowledge on this issue.
>
> The EPA will continue to monitor the situation in Donaldson State Forest and has included the area in our forward native forestry audit program. However, as noted above, there is no mechanism in the existing forestry approvals to prevent or restrict harvesting in BMAD affected or potential areas.

The outcome was that the Forestry Corporation's logging schedules identified logging as current in compartments 36 and 42, later adding compartments 44-49, of Donaldson State Forest for years, though thankfully logging has not yet resumed.

1.4.5.2. 3.4.2. Mount Lindesay Case Study

NEFA inspected compartment 276 and 279 of Mt Lindesay SF in 1997 when on the North East State Forest Harvesting Advisory Board (NESFHAB) in response to the Forestry Corporation's proposal to log the area. At that time the whole compartment was dominated by Bell Miners, particularly at lower elevations where BMAD was evident. Bell Miners had apparently been in the vicinity for a long time as the nearby "Bellbird Rest Area" was shown on the 1985 Second Edition of the Forestry Corporation's Forest Project Map.

BMAD in the vicinity of the now removed Bell Bird Rest Area, Compartment 276, May 2014

This area highlighted the issue of BMAD for the NESFHAB, leading to the preparation of "Discussion Paper: Psyllid/Bell Miner dieback area management" (Sharpe 1997) that proposed undertaking large scale rehabilitation of severely affected areas, and as part of the Harvesting Plan

process mapping areas affected (by class), identifying proposed management (including excluding logging from areas *"if it is decided that harvesting will further exacerbate the problem and that rehabilitation works are either impractical or unlikely to succeed"*) and details of specific remedial works. Unfortunately, the Forestry Corporation blocked progress on this until the NESFHAB was disbanded and then abandoned it.

An outcome of the NESFHAB was a project to use Digital Multi-Spectral Video (DMSV) to quantify the extent and degree of canopy dieback in a 10,000 ha study area centred on Mount Lindesay, with the aim to be able to later use map comparisons *"to determine the stability of bellminer colonies, rate of spread of the dieback, make predictions on future spatial patterns and directions of the dieback across the landscape and confirm the stand risk criteria"*. In the end 5,000ha of State Forests was mapped using DMSV (all of Mt. Lindesay SF and compartments 34, 38, 55-58 of Donaldson SF), with 1:25,000 aerial photographs of all compartments and infra-red aerial photos of 8 compartments. It appears this $100,000 project was subsequently abandoned.

The Forestry Corporation established logging trials in BMAD in compartments 276 and 279 of Mt Lindesay State Forest in 2007 with over $50,000 of Environmental Trust monies contributed through the BMAD Working Group as one of four trials of using understorey control to redress BMAD (Pugh 2014). It must have been apparent by then that the Donaldson trials failed. The forest had been variably logged, with the logging trials situated in a variety of forest types and a mixture of growth stages (disturbed oldgrowth, disturbed mature and young) mostly heavily logged from 1974-84, and the "control" mostly re-logged in 1996. The trials involved logging in combination with variable applications of mechanical disturbances, weed spraying, and burning, with some follow up weeding and planting. Objectives of the project were:

1. Lantana cover reduced to less than 15%
2. Increased health of retained trees
3. Decrease in abundance of bell miners (An indication of reduced habitat or food)
4. Maintenance of grassy understoreys
5. Restoration of severely degraded stands with natural regeneration, supplementary seeding and enrichment planting of native over-storey species
6. Integration of harvesting and rehabilitation

Forty plots were established in treated and 20 in control areas (logged in 1996 and suffering from dieback) with stratification based on broad forest types. Harvesting was conducted over the period May to September 2007. The results were apparently confounded by good rainfall leading to an improvement in tree health, a decline in lantana and a decline in Bell Miners on all plots, including the control. The reported results were only for the first two years. St.Clair (2009) reports on the outcomes, which can be summarised as:

- within 2 years Bell Miner numbers had recovered to pre-treatment levels relative to controls;
- Bell Miner numbers were related to lantana density;
- reductions in lantana cover were significant only in moderate and high intensity fire treatments, though lantana was showing significant recovery in the second year;
- the treatments did not improve the health of the retained trees relative to controls;
- Brush Box regeneration was two orders of magnitude greater than the eucalypts;
- regeneration of eucalypts was inadequate at most sites; and
- planting of eucalypt seedlings is vital to maintain a natural species composition in mixed stands.

The number of variables involved (such as 6 different forest types, numerous different canopy species, different understorey types, different disturbance histories and intensities, 4 disturbance types, lantana control, replanting etc) confounds meaningful interpretation of the results, particularly

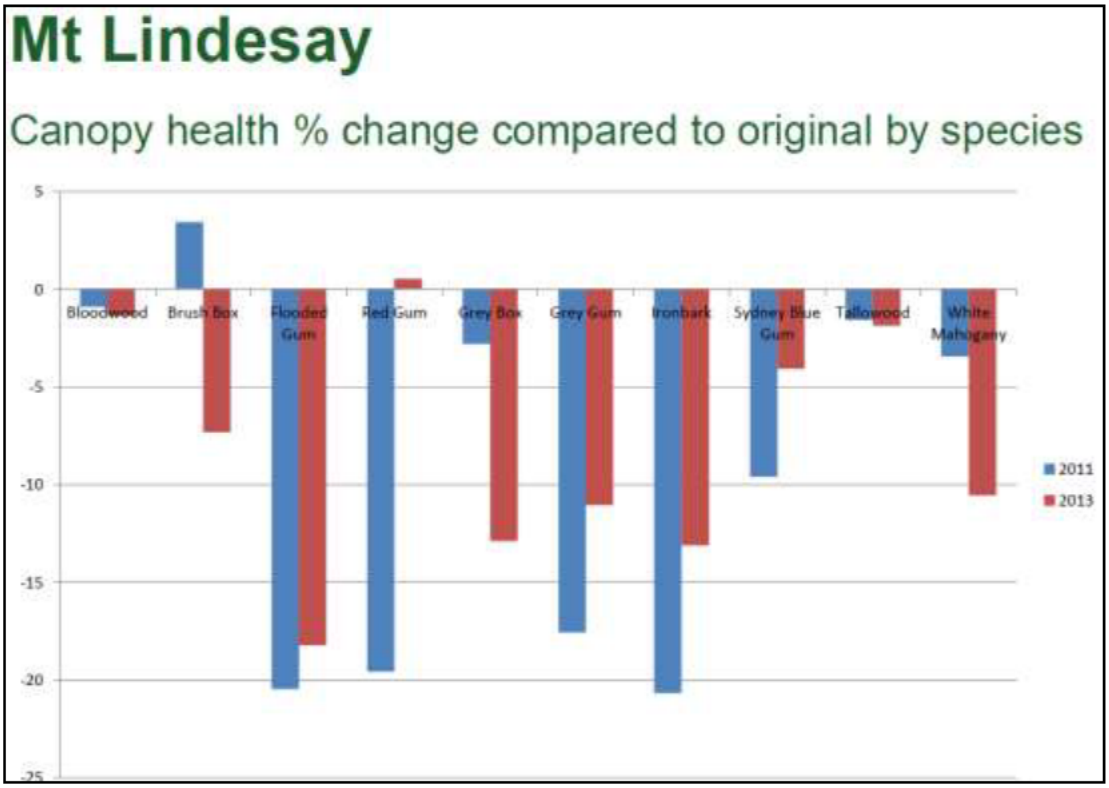
as there is "*No recording of what has occurred where*" (Forestry Corporation 2015). Undaunted St.Clair (2009) uses his short-term results and some convoluted logic to support his pre-determined position that the *"removal of bell miners and poisoning or burning of lantana per se will not improve tree health. The phenomenon of linked lantana, psyllid and bell miner invasions is a consequence of poor tree health caused by deteriorating root function under changing soil conditions in the absence of fire as proposed by Jurskis (2005)"*. Based on this flawed assumption he goes on to make a variety of far reaching recommendations.

St.Clair (2009) does note "*Whilst the cost of the project was significant, the opportunity cost of doing nothing is greater. The cost of rehabilitation was less than the likely loss of production if the forest continued to decline and die*." St.Clair's (2009) estimated rehabilitation costs per hectare over 40 years ranged from $200-2,500, though given the poor prognosis for much of his sites this may just reflect initial costs.

For Mt. Lindesay over 6 years the Forestry Corporation found significant increases with a variety of treatments, including logging and burning: lantana 145%, Bell Miners 104%,

Forestry Corporation (2015) results for 2011 and 2013 reported for Mt. Lindesay State Forest. For these graphics blue represents the 40 trial plots and brown the 20 control plots.

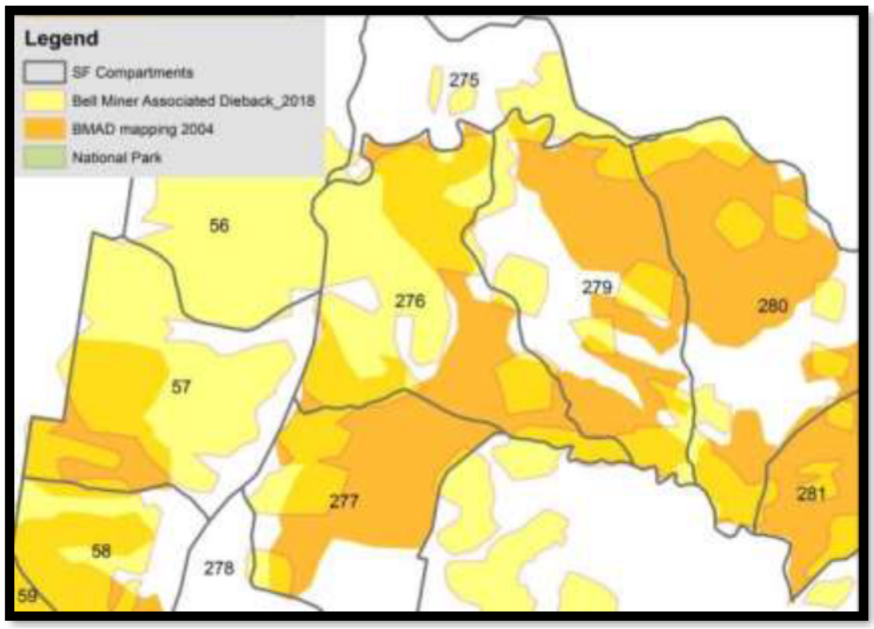
The Forestry Corporation (2015) also report 10-20% declines in canopy health of Flooded Gum, Grey Box, Grey Gum, Ironbark and White Mahogany over the 6 years, which they consider "good".



From Forestry Corporation (2015) showing significant declines in the health of most species following the trials.

Strangely the Forestry Corporation (2015) concluded these results showed:

- *Variable change in Lantana*
- *Variable change in Bell Miner abundance*
- *Variable change in canopy health by species, some recovery may be evident*
- *Canopy health generally ok.*
- *Regeneration good in parts (particularly where planted) but no data has been collected on this yet*



2004 and 2018 mapping of BMAD, Mt Lindesay State Forest.

NEFA (Pugh 2014) inspected the area and found:

> *For this review Hildebrand Road on the boundary between the compartment 276 and 279 was traversed in May 2014. BMAD was found to be widespread. The abundance of Bell Miners and lantana appeared to have markedly increased, and the structure of the forest deteriorated, since our 1997 assessment. There are numerous dead, dying and other BMAD affected trees, large areas have no or little overstorey, lantana dominates most of the understorey with large areas of wattles and patchy regeneration of eucalypts. As with Donaldson it is apparent that the full ramifications will become apparent over the next 15-25 years once the wattles begin to senesce and the regrowth reaches pole stage and begins to show the effects of BMAD. It is evident that the objectives of the trial were not achieved and that the trials were once again an abject failure.*

BMAD in Yabbra State Forest, 4 years after logging, with rehabilitation refused.

Photo of BMAD in Mount Lindesay taken in 2004.

1.4.6. Impact of wildfires on logging

As shown by the 2019-20 fires we do not have any time to waste. That event had a profound impact, causing the loss of many trees and significant declines in populations of numerous threatened species. With climate heating the risks of extreme events increasing in amplitude and frequency poses a growing threat. We need to immediately stop degrading forests by logging, stop increasing their vulnerability to burning, and instead focus on rehabilitating degraded forests to increase their resilience to future extreme events.

It was apparent that the CIFOA logging rules were inadequate to mitigate the worst impacts of logging following the 2019/20 wildfires, and additional measures were required to make logging more sustainable. The EPA and Forestry Corporation agreed to additional Site Specific Operating Conditions (SSOCs) to mitigate the worst impacts, After a year the Forestry Corporation rejected the EPA's request to extend the SSOCs as *essential to ensuring harvesting activities in fire-impacted forests are carried out in an ecologically sustainable manner*, instead adopting some token voluntary constraints of their own. The NRC was directed to develop recommendations in concert with the Forestry Corporation which required minimal changes, never-the-less the Forestry Corporation immediately flouted them, and the NSW Government refused to accept any of the recommendations and [redacted]. Following the uplisting of the threatened status of numerous species because of the fires, in October 2023 the EPA began trying to negotiate minor amendments to the CIFOA for Koalas, Greater Gliders, Swift Parrots and Glossy Black Cockatoos on the basis *that the proposed amendments would not have any material impact on timber supply*. The Forestry Corporation accepted some in principle, while opposing increased protections

for Koalas, though four years after the fires the only change to the protocols that eventuated was for Greater Gliders. This displays the abject failure to apply adaptive management and implement Ecologically Sustainable Forest Management.

From August 2019 until January 2020 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, around half the remnant native vegetation, 35% of rainforests and 54% of State Forests. This had profound impacts on trees, ecosystems and an array of populations of numerous threatened species (see 6.2).

1.4.6.1. Impact of the 2019/20 wildfires

As shown by the 2019-20 fires we do not have any time to waste. That event had a profound impact, causing the loss of many trees and significant declines in populations of numerous threatened species. With climate heating the risks of extreme events increasing in amplitude and frequency poses a growing threat. We need to immediately stop degrading forests by logging, stop increasing their vulnerability to burning, and instead focus on rehabilitating degraded forests to increase their resilience to future extreme events.

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)

There can be no doubt that a multitude of wildlife died in the fires, from the invertebrate world of the leaf litter to up to Koalas in the tree tops. The fires were of unprecedented proportions, in north-east NSW burning out half the forests, including a contiguous 1.9 million hectares from Tenterfield on the tablelands to Iluka on the coast and from near Bonalbo in the upper Clarence River down to near Gloucester on the Manning River. Within the burnt grounds it was so dry that fires burnt through riparian vegetation and rainforests, the usual refuges for many species.

The fires were superimposed on an existing fire regime, with many areas burnt just a year or two ago burnt again, and occurred during an extreme drought when the forest was exceptionally dry and stressed. The drought continued after the fires, compounding impacts and hindering recovery.

Ellangowan State Forest 3 months after the fires - displaying the delayed recovery due to the drought persisting.

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 effects 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 fires had a significant impact on Far North Coast State forests by killing an estimated average of 12.5% of trees >30 cm DBH and 34% of trees <30cm DBH (Forestry Corporation 2020). In the 30% of forests subject to a hot burn this was comprised of 50% of trees <30 cm DBH and 10% of trees >30 cm DBH. In the 19% of forests subject to a crown fire loss were some 100% of trees <30 cm DBH and 50% >30 cm DBH.

Fauna were equally impacted, with fire impacts cited as a reason for up listing the threatened status of many species, such as Koala, Southern Greater Glider and Yellow-bellied Glider.

The Conservation Advice (DCCEEW 2022) for Southern Greater Glider states:

> *The full impact of the 2019-20 bushfires has yet to be determined. However, an estimated 40% of the distribution of the greater glider (southern and central) overlapped with the areas affected by the bushfires (Legge et al. 2021). A population decline analysis for the greater glider (southern and central) that incorporates spatial variation in fire severity plus estimated declines for differing fire severity classes, provided an estimate of overall decline for the taxon of 24% (range 17-31%) one year after the fire, assuming current management conditions (Legge et al. 2021).*

The Conservation Advice (DAWE 2022) for Yellow-bellied Glider states:

> *This is most clearly evidenced by the catastrophic bushfires of 2019–20, where an unusually large area burned at high severity, (DPI 2020) intersecting with 41 percent of the distribution of the yellow-bellied glider (Legge et al. 2021).*
>
> *… Site-level population declines from the 2019–20 bushfires are estimated at 82 percent for severely affected sites using expert elicitation, and post-fire on-ground surveys suggests that declines may be up to 83–97%*

The Conservation Advice (DAWE 2022b) for Koala states:

> *Koala monitoring records from north-east New South Wales following the 2019/2020 bushfires, indicate that sites characterised by high-severity fire (e.g., canopy scorch) had zero koala occupancy (i.e., zero return/recovery) immediately post fire. At sites where koalas have been detected following fire, refuge areas were present in the surrounding landscape, or fire severity was lower (NSW Government 2021b). While koala's have returned to bushfire impacted locations it is likely to take many years before populations are fully re-established.*

The burning of some 160,000 ha (35%) of rainforests should have been a wake-up call. This will result in significant loss and degradation of these priceless relicts from our Gondwanan past. Those burnt are now more vulnerable to further burning. The damage is so severe that with the increasing likelihood of repeat events this could be the start of ecosystem collapse. The burning of rainforest is akin to the bleaching of coral reefs, and is likely to follow a similar trajectory.

As climate heating progresses, events similar to the 2019/20 fires are going to become more extreme and frequent, with continuing losses of larger trees and significant impacts on populations of threatened species. Compounding impacts with logging is no longer tenable.

1.4.6.2. Response to 2019/20 wildfires

Such extensive disturbance undermined the basic assumptions on which the Integrated Forestry Operations Approval for Forestry Corporation's logging are based. As recognised by the EPA website (accessed 10 April 2020) "*The Coastal Integrated Forestry Operation Approvals (IFOA) was not designed to moderate the environmental risks associated with harvesting in landscapes that have been so extensively and severely impacted by fire"*. Given the EPA's acknowledgement that the IFOA is no longer fit-for-purpose, and that the Forestry Corporation were unable to comply with some requirements, they state "*This has required the EPA to issue additional site-specific conditions that tailor protections for the specific circumstances of these burnt forests*".

After the fires, the EPA (website https://www.epa.nsw.gov.au/your-environment/native-forestry/bushfire-affected-forestry-operations) identified:

> *The Coastal Integrated Forestry Operation Approval (IFOA) was not designed to moderate the environmental risks associated with harvesting in landscapes that have been so extensively and severely impacted by fire. This required us to issue additional site-specific conditions that tailored protections for the specific circumstances of these burnt forests.*

The EPA obtained scientific advice on the risks posed by the CIFOA logging rules in burnt landscapes, tabulating the outcome as Site-specific conditions to mitigate environmental risks associated with harvesting burned forests, identifying as high risk: (EPA 2020a)

Loss of critical habitat,

> *The extent and severity of fire is unprecedented and many species, plant community types and ecosystems have had much of their habitat impacted.*
>
> *Loss of habitat placed increased pressures on unburnt areas/habitat and any residual biodiversity legacies to provide critical habitat.*
>
> *Areas of important habitat, such as old growth forests, rainforest, habitat corridors and other protected areas have been impacted and may no longer serve as habitat refuges during logging operations.*
>
> *Much of the permanent protection network has been impacted and may no longer provide the short-medium term habitat intended by the IFOA in unburnt landscapes.*
>
> *Drought impacts have also exacerbated impacts on critical habitat.*
>
> *Impacts are not uniform, and recovery will be variable.*

Impacts on threatened animals,

> *Many species have sustained impacts across their range, with some seeing almost complete habitat impact[1]. The impacts are unprecedented in scale and severity.*
>
> *Some species that have persisted may be further impacted by logging, with habitat refuge, food and biodiversity legacies further impacted either directly or indirectly (i.e. wind).*
>
> *Some species are early colonisers and reliant on post fire environments to persist. Logging may impede their ability to colonise and persist and have flow on impacts on habitat restoration which these species contribute to.*

Impacts on rare and threatened plants and plant/ecological communities,

Many species have sustained impacts across their range, with some seeing almost complete habitat impact[2]. The impacts are unprecedented in scale and severity.

Some species that have persisted or regenerate following fire may be further impacted by logging either directly (i.e. machinery compaction or damaged by tree debris) or indirectly (i.e. wind, erosion).

Species that rely on post fire environments to germinate and persist that could be impacted by further disturbances before they have a change to seed (or other).

Loss of hollows, nesting habitat and feed trees (biodiversity legacies)

Fires have had significant impacts on the persistence of hollows, feed trees and nesting habitat. Their loss was already registered as a key threatening process for the persistence of many arboreal mammals, birds, bats and reptiles.

Further logging impacts (directly or indirectly) on such habitat at time when they are in short supply due the impacts of the fires, may cause serious and irreversible impacts on biodiversity.

After negotiations with the Forestry Corporation, and in accordance with the CIFOA, the EPA began issuing Site Specific Operating Conditions (SSOCs) for logging burnt forests. For example, for Myrtle, Bungawalbin and Doubleduke State Forests the EPA issued SSOCs on 25 May 2020 requiring a variety of additional measures to limit erosion and notably: (EPA 2020b)

- Protect unburned areas or partially burned areas of at least 0.05ha
- Retain all hollow-bearing trees
- permanently retain all live Red Gum (E. Tereticornis, glaucina, seeana and hybrids) and Swamp Mahogany E. robusta trees over 20cm DBH
- retain all live Allocasuarina spp. trees over 30cm DBH
- retain all unburnt and mature banksia spp., acacia spp. and xanthorrhoea spp.
- Retain temporary (for the duration of the operation) feed tree clumps at a rate of 7 per cent of the area available for harvesting operations for the purpose of protecting and retaining, to the greatest extent possible:
    i. Koala browse trees;
    ii. nectar trees;
    iii. Greater glider feed trees; and
    iv. live Allocasuarina spp. trees that in the reasonable opinion of FCNSW are capable of producing cones;
- Retain an exclusion zone of at least 30 metres around all heath and scrub and rocky outcrops and cliffs.
- Retain an exclusion zone of at least 10 metres around all rainforest
- Increase exclusions on unmapped drainage lines and Class 1 classified drainage lines from 5m to 20m
- Increase exclusions on Class 2 classified drainage line from 20m to 30m
- Increase exclusions on Class 3 classified drainage line from 30m to 40m
- Increase exclusions on Class 4 classified drainage line from 50m to 60m

The EPA commissioned Dr. Andrew Smith (Smith 2020) to evaluate whether the CIFOA, both with and without SSOCs provides adequate mitigation for ecological and environmental impacts from timber harvesting in areas impacted by the 2019/20 wildfires. He 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. Smith (2020) states:

> *It can be concluded that the standard CIFOA will not deliver ecologically sustainable management as required under the objectives of the Forestry Act 2012 and is likely to cause a significant impact under the NSW Biodiversity Conservation Act 2016 and the Commonwealth Environment Protection and Biodiversity Conservation Act 1999*

Smith (2020) summarised:

> *1. In 2019/20 extreme wildfires burnt 37-42% of public forests in NSW and caused an unprecedented reduction in the distribution and abundance of key threatened species including the fire sensitive Koala.*
>
> *2. The primary effect of fire and past logging was to restrict fauna populations to a series of small, fragmented and isolated patches of unburnt or lightly burnt forest, referred to as fire refuges, scattered throughout the severely burnt forest.*
>
> *3. Fauna populations in fire refuges are likely to survive and recover by expanding outwards over the next 120 years in large unlogged public forest reserves. 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.*
>
> *4. Fauna populations surviving in fire refuges in state forests are at risk of elimination by timber harvesting under the normal Coastal Integrated Forestry Operations Approvals (CIFOA) which could prevent recovery, and cause catastrophic population decline in species such as the Koala, Greater Glider and Yellow-bellied Glider.*
>
> *5. Following the 2019/20 fires, the Environment Protection Authority (EPA), in consultation with Forestry Corporation of NSW (FCNSW), developed a suite of Site-Specific Operating Conditions (SSOCs) to manage environmental risks associated with timber harvesting in burnt landscapes to supplement standard CIFOA.*
>
> *6. The purpose of this review was to evaluate whether the CIFOA, both with and without SSOCs provides adequate mitigation for ecological and environmental impacts from timber harvesting in areas impacted by the 2019/20 wildfires, and to provide recommendations for any changes/additions to proposed conditions consistent with the objectives and requirements of the Forestry Act 2012 and application of the precautionary principle.*
>
> *7. While the literature on fire and logging impacts is comprehensive there remain significant areas of uncertainty. Scientific studies have relied heavily on surveys of past fire and logging events which were generally less intense than recent harvesting and fire. This has caused the risk from current harvesting practices to be significantly underestimated, especially at landscape scales.*
>
> *8. This review found that timber harvesting disturbance is more severe than the effects of fire in several important respects including the following:*
>
> > *• it preferentially removes rather than retains natural fire refuges in gullies, sheltered aspects and stands of older forest that contain developing or actual hollows;*
> >
> > *• retained forest patches are generally too small to sustain viable local populations for the number of years (10-60) required for surrounding forest to recover after logging and fire; and*

> *• selective logging is too intense and the basal area of retained trees is too low to maintain the natural post-fire forest structure required by mature and late stage dependent fauna like Greater Gliders and Yellow-bellied Gliders, especially in Dry Sclerophyll Forests.*

9. It was concluded that the normal CIFOA in the context of the 2019/20 wildfires will not deliver ecologically sustainable management as required under the objectives of the Forestry Act 2012 and is likely to cause a significant impact under the NSW Biodiversity Conservation Act 2016 and the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999.

10. It was also concluded that special conditions in SSOCs for the burnt areas are inadequate to mitigate fire and logging impacts, primarily because their time frame (12 months) of application is too short.

11. The SSOCs include a recommendation to provide temporary protection from logging for all unburnt and lightly burnt forests within the net harvest area for a period of 12 months. This recommendation has been opposed by FCNSW which proposes to harvest unburnt and lightly burnt forest immediately in some areas. 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.

12. In general, as a precautionary principle, it can be assumed that species of native fauna and flora are adapted to, and able to sustain viable populations, under scales and patterns of fire and logging that do not exceed the scale and pattern of natural disturbances occurring after severe wildfire. Current CIFOA fall well short of constraining timber harvesting to the scale and pattern of natural disturbance.

13. This report recommends implementation of a whole new suite of standards that take into account the impacts of both wildfire and timber harvesting at regional and landscape scales across all public tenures, to supplement existing CIFOA controls which are largely focused on regulation of biodiversity impacts at logging compartment scales.

14. New conditions are required that focus on permanent protection of large forest patches across regions and landscapes and which capture and include fire refuges (areas of forest that are least likely to be burnt and which provide wildlife oases after fire) and old growth and which link all retained forest in patches larger than 5 hectares in size in a network of permanent wildlife corridors.

15. This report also recommends that the intensity of so called selective harvesting in all Dry Sclerophyll Forest types be significantly reduced by increasing minimum tree basal area limits and minimum medium and large tree stocking limits, to ensure that populations of threatened and sensitive fauna such as Koala and Greater Glider are maintained at close to normal densities within the net harvest area consistent with principles and requirements for ecologically sustainable harvesting required under Regional Forest Agreements and the Forestry Act 2012.

Smith (2020) identified seven key conditions he considered should be applied to all timber production forests:

> *1) That timber harvesting be excluded from all mapped unburnt and lightly burnt forests within state forests for a minimum period of 20 years.*

2) That all timber harvesting be limited to a maximum average 50% of compartment area (with a maximum of 75% within individual compartments) and maximum 50% of the total local landscape Area.

3) That the pattern of harvesting at the compartment and landscape scales be modified to ensure that all retained forest patches > 5 ha in size are connected by permanent corridors and that all gaps in corridors created by roads, rivers and other non-forest areas do not create barriers to glider movement and dispersal.

4) That fire refuge areas be modelled and mapped across all compartments and landscape areas to identify and protect those areas of each forest type within each compartment considered least likely to burn or with the lowest burn frequency, and where such areas will initially (for the next 20 years) include all areas unburnt or lightly burnt in the 2019/20 fires.

5) That intensive harvesting (all forms of logging that remove more than 40% of the natural (unlogged) tree stem basal area) be limited to Blackbutt and Alpine Ash forest types, and the size of harvesting patches be limited to "gaps" of 10 hectares or less where gaps are defined as areas wholly surrounded by either unlogged forest or low intensity logged forest (forest that retains 60% or more of the natural tree basal area across all tree size classes.

6) That harvesting intensity under selective harvesting in all [Dry Sclerophyll Forest] *be limited to retention of 60% or more of the natural stand basal area across all medium and large tree size classes to ensure that biodiversity is maintained within the net harvest area.*

7) That all compartments are subject to comprehensive pre-logging surveys at least once every logging rotation to gather all essential information for application of mitigation conditions and that post logging surveys are undertaken at repeat intervals of 1 to 10 years after harvesting at a minimum representative selection of sites sufficient for statistical analysis and feedback for adaptive management at compartment and landscape scales.

Area identified by Forestry Corporation for protection in Myrtle State Forest after the 2019/20 wildfires under the SSOCs, and in accordance with the CIFOA, as a wildlife habitat clump for protection in perpetuity (Pugh 2020). This wilful non-compliance with the intent of legislation is commonplace. Complaints to the EPA were to no avail.

The Forestry Corporation decided not to proceed with logging Myrtle, Bungawalbin and Doubleduke SFs under the SSOCs, and the SSOCs expired 12 months after they were issued. The EPA website

(https://www.epa.nsw.gov.au/your-environment/native-forestry/bushfire-affected-forestry-operations/update-february-2021) further identifies:

> *On 10 February 2021 Forestry Corporation of NSW (FCNSW) advised the EPA that they would be returning to regular operations under the Coastal IFOA (CIFOA) in South Coast, Eden and Tumut for the coming period, while the Natural Resources Commission (NRC) carry out their assessment of post fire harvesting. In returning to regular operations, FCNSW will no longer be seeking additional site-specific operating conditions which have been used until now, in fire-impacted forests.*
>
> *They further advised that they would be undertaking additional voluntary measures to the requirements of the CIFOA. The EPA is not aware what these voluntary measures are, and we will not be able to regulate against these. The EPA advised against FCNSW's proposal, on the basis that additional site-specific operating conditions have been essential to ensuring harvesting activities in fire-impacted forests are carried out in an ecologically sustainable manner, and therefore meet the requirements of the Forestry Act 2012, the CIFOA and relevant Regional Forest Agreements.*
>
> *…*
>
> *The precautionary principle requires that the EPA does not wait for full scientific certainty to take measures to prevent environmental degradation. The EPA has always acknowledged that there are gaps in the science that prevent absolute certainty on all aspects of the impact of timber harvesting following the 2019-20 fires. However, it is clear from the literature and recent reports that enough is known to suggest that the threat of the twin impacts of fire and post-fire harvesting demands very careful management.*
>
> *…*
>
> *Key threatened species were considered higher-risk as part of this assessment and include the Yellow-Bellied Glider, Greater Glider, Glossy Black Cockatoo, Koala, Southern Brown Bandicoot, Swift Parrot and the Spotted-tailed Quoll.*

The Forestry Corporation (October 2021) adopted their own Voluntary Safeguards additional to the **CIFOA** to account for the fire impacts, though these are not overseen by the EPA or legally enforceable, and only apply to burnt forests in 6 Management Areas. These Voluntary Safeguards only applied until the Forestry Corporation considered recovery adequate. They applied a very different criteria for ranking than the NRC (2021) (see below) to identify the risk to Management Areas. They require:

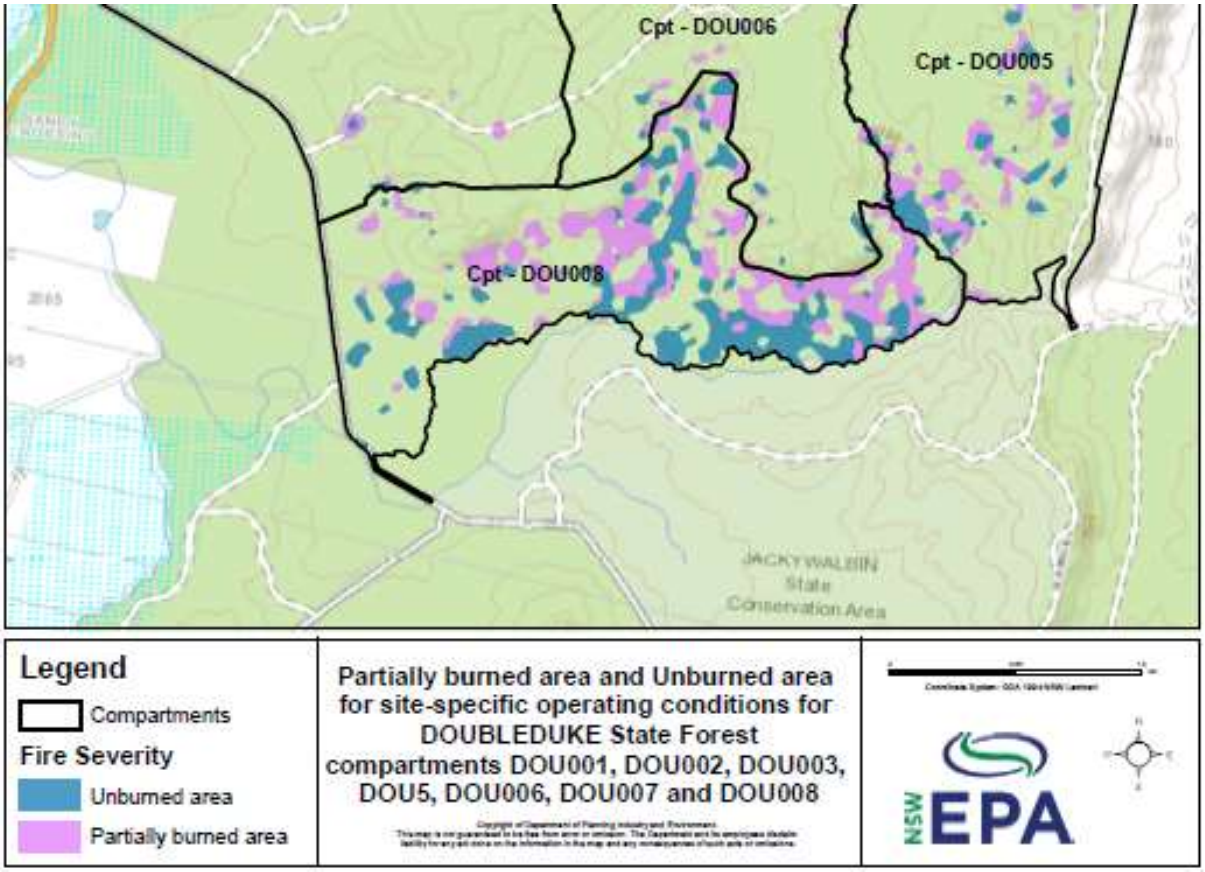
> *A maximum of 50% of the Gross LLA* [Local Landscape Area] *area can be harvested.*
>
> *Minimum 8 Habitat trees retained per hectare Habitat trees include in order of priority:*
> - *Hollow Bearing Trees where they exist*
> - *Add up to 8 'Recruitment' trees where hollow bearing trees don't exist*
>
> *Additional 5% BNA (at compartment scale) identified as Koala temporary tree retention clumps in LLAs with contemporary koala records.*
>
> *10m additional buffer on riparian zones class 3+ Plus*
> - *OSA (ESA 2 rules)*
>
> *10m additional buffer on Mapped EZ's*
> - *OSA (ESA 2 rules)*
> - *GPS boundary identification allowed*
>
> *Additional operational surveys. Traverse: 1km/100ha. Apply normal clump development methodology. Additional traverse can be undertaken by drone where appropriate.*

Forestry Corporation to use ground cover assessment methodology to determine if additional conditions are required. If yes, apply additional soil and water prescriptions details in the Post-fire Planning Assessment Report.

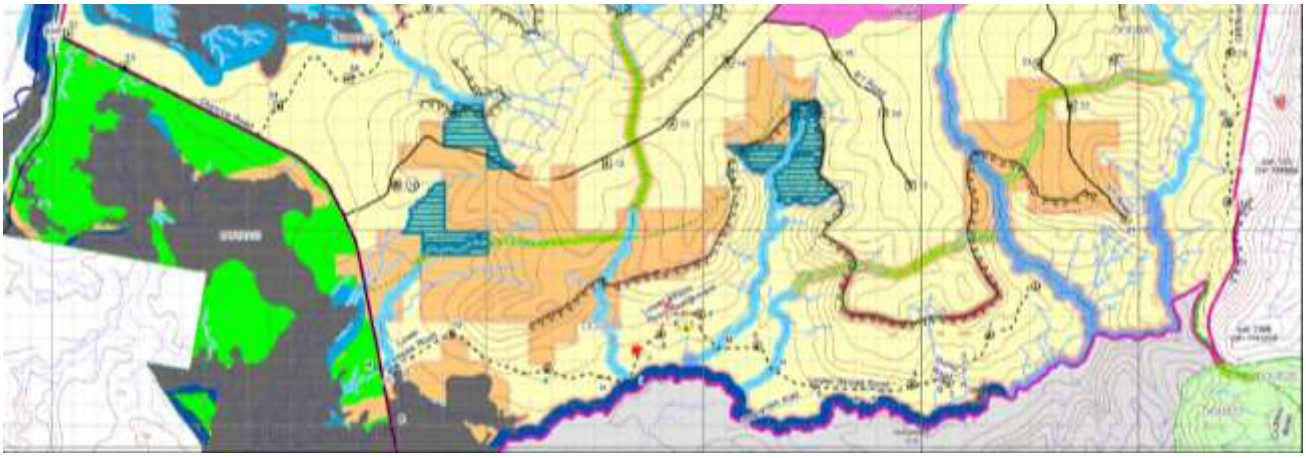
These Voluntary Safeguards are mostly vague, enabling broad discretion in interpretation and implementation, and are significantly less than the SSOCs and various other recommendations. For example:

- There are no requirements to protect unburned areas or partially burned areas (SSOC), or to extend the protection to 20 years (Smith)
- The requirement is to only retain up to 8 hollow bearing trees, rather than all remaining (SSOC). Additional trees are required to be retained to increase retained trees to 8, though there is no definition of "recruitment" tree, or mention of the priority being potential future hollow-bearing trees and the largest mature tree (NRC). The NRC requirement to retain two recruitment trees per retained hollow-bearing tree is not included.
- Minimum size of retained red gums has not been reduced from 30cm down to 20 cm (SSOC), Swamp Mahogany >20cm, Allocasuarina >30 cm, and unburnt banksia, acacia sp and xanthorrhoea are not protected (SSOC)
- The retention of temporary feed tree clumps has been reduced from 7% of the logging area (SSOC) to 5%, and the criteria to include Koala browse trees, nectar trees, Greater glider feed trees and mature Allocasuarina "to the greatest extent possible" (SSOC) removed.
- The increase in exclusions on unmapped drainage lines and Class 1 classified drainage lines from 5m to 20m and Class 2 drainage lines from 20m to 30m (SSOC) has been removed
- Limiting logging to 50% of a LLA has been adopted, though not extended as an average to compartments (Smith), and is below 65% (NRC)
- Permanent corridors between retained patches are not required (Smith)
- Fire refuge areas within each compartment have not been identified and protected (Smith)
- logging that removes more than 40% of the natural (unlogged) basal area was not limited to Blackbutt and Alpine Ash forest types (Smith)
- In Dry Sclerophyll Forest "retention of 60% or more of the natural stand basal area across all medium and large tree size classes" is not required (Smith)
- There is no requirement that all compartments be subject to comprehensive pre-logging surveys at least once every logging rotation (Smith)

In practice the voluntary measures were poorly implemented (i.e. the most heavily burnt areas were often set aside as fire offsets) and often breached. For example, the Forestry Corporation waited for the EPA's SSOCs to expire before logging the required unburnt and lightly burnt exclusions in Doubleduke State Forest, under their own voluntary measures. For an example of the Forestry Corporation putting aside the worst burnt forests, outside the proposed logging area, as voluntary offsets see Pugh 2023.



Extract of EPA (2020) identifying unburned and partially burned areas in compartments 1-8 of Doubleduke SF, required to have logging excluded under Site Specific Operating Conditions issued in 2020.



Extract from Forestry Corporation (July 2022) harvesting plan for cmpts 5, 6, 7 and 8 Doubleduke SF – the yellow areas are for logging. Prepared by the Forestry Corporation after the SSOC expired, note most of the unburned and partially burnt areas are identified for logging – which occurred. See Pugh 2023.

To resolve the dispute between the EPA and Forestry Corporation, the Government directed the Natural Resources Commission (NRC) to report on adjustments to logging of State forests in response to 2019/20 wildfires. The NRC engaged the University of Wollongong to prepare the report 'Risks to the NSW Coastal Integrated Forestry Operations Approvals Posed by the 2019/2020 Fire Season and Beyond' (Bradstock *et. al.* 2021) for NSW Regional Forest Agreement (RFA) areas. 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.*

The Natural Resources Commission (NRC 2021) report 'Final report Coastal IFOA operations post 2019/20 wildfires, June 2021' ranked Forestry Corporation Management Areas according to their post-fire risks, noting that for 3 years after the fires:

> *Management zones that receive medium or high risk ratings can have limited harvesting once there are sufficient additional temporary refuges (preferably unburnt and lightly burnt forest) retained at the local landscape area to mitigate the impacts of additional disturbance. … In medium risk management zones, a variable additional retention requirement is applied based on localised impacts, expected to be approximately 65 percent on average of a local landscape area.*

The NRC identified 3 Management Areas (MAs), Narooma and Nowra on the south coast, Taree on the north coast, with "*risk of serious and irreversible harm to environmental values from the cumulative impacts of fire and harvesting*" where "*harvesting must be temporarily suspended for three years from the time of fire*". Soon after, on 26 July 2021 FCNSW started logging 1,187ha of Yarratt State Forest, this was the only forest in the Taree MA to have escaped the fires. The Forestry Corporation continued to log unburnt refuges in medium-risk MAs.

The 2019-20 wildfires significantly increased the loss of hollow-bearing trees and the threat to hollow-dependent species, with the NRC (2021) identifying:

> *The Coastal IFOA standard prescriptions do not provide effective retention of feed and habitat trees, including recruitment trees in timber harvest areas of state forests, to support the persistence of species dependent on these resources in a severely fire-affected landscape*

Explaining:

> *There is evidence that the mortality and collapse of trees retained in logged sites increases with logging intensity and the severity of post-logging fire. Species dependent on hollow-bearing trees (such as gliders) require the retention of existing hollow-bearing trees at rates that meet the requirements of the species, as well as the permanent retention of approximately two to three recruitment trees (for example, potential future hollow-bearing trees) for each hollow-bearing tree to perpetuate the hollow resource…*

NRC (2021) recommend for significantly affected areas:

> *While the Commission has not been asked to review existing prescriptions, we have been asked to recommend, using best available evidence, best practice approaches to manage forestry operations in fire-affected forests. Available literature and work currently in progress under the Coastal IFOA monitoring program suggest that the existing prescriptions may not be adequate to maintain the hollow resource in the long-term following the 2019/20 wildfires. The Commission has proposed temporary additional measures relating to hollow-bearing trees and recruitment trees for medium and high-risk zones. However, the Commission*

considers the following measures could also enhance the standard Coastal IFOA prescriptions:

a. *retain a minimum of eight hollow-bearing trees per hectare where they exist (as per the requirement in the standard Coastal IFOA prescriptions)*
b. *if hollow-bearing trees are not available, then retain suitable substitutes, in priority order being, potential future hollow-bearing trees, the largest mature tree in the stand or a regrowth tree that is not suppressed*
c. *retain two recruitment trees per retained hollow-bearing tree*

The NSW Government refused to apply the NRC recommendations and [redacted].

In August 2023 the EPA attempted to negotiate with the Forestry Corporation to urgently change the logging rules for Koalas within the Great Koala National Park (GKNP), including requiring pre-logging surveys, increasing tree retention to 10 per hectare and size to 30cm DBH, adding Small-fruited Grey Gum as a primary browse tree, and prioritising protection of high value Koala habitat in wildlife habitat clumps. The Forestry Corporation rejected most of the EPA's requests, though agreed to some on a voluntary basis (see .

Following the uplisting of species because of the impacts of the fires, in October 2023 the EPA tried again to get amendments to the CIFOA to increase protection for Koalas within the proposed GKNP, and improve protection for other species worst affected by the 2019/20 wildfires. The changes were minor and predicated on the basis they *would not have any material impact on timber supply.* On 25 October 2023 EPA CEO Tony Chappell wrote to Forestry Corporation CEO Anshul Chaudhary:

As you are aware, under section 69P of the Forestry Act 2012 (the Act), an IFOA adopts protocols can be made and amended by the EPA from time to time, to enable adaptive management of the more prescriptive settings and authorisations of the IFOA.

The EPA has been reviewing available scientific evidence and compliance information to determine if improvements are necessary to certain CIFOA protocols to ensure they are achieving the objectives and outcome statements of the CIFOA and the Act.

…

I would like to discuss amendments to CIFOA protocols to specify survey requirements for species that have habitat required to be protected under existing CIFOA conditions. Most notably, surveys for southern greater glider dens.

…

I would also like to discuss CIFOA protocol amendments for improving the protection on habitat for koalas, swift parrots and the south-eastern glossy black cockatoo. You would be aware that since the Coastal IFOA was made in late 2018, these species have been listed, up listed or their habitat has been severely impacted by the 2019/20 fires. This puts them at increased risk of extinction. These risks continue to be exacerbated by the ongoing threat of climate change.

Please find attached a list of potential amendments that the EPA is initially considering…

Species	Proposed amendments
Koalas (north coast, in the GKNP assessment area) *Phascolarctos cinereus*	Prioritise the inclusion of high-quality koala habitat in wildlife and tree retention clumps
	Apply koala browse tree prescription 1 across the provisional GKNP assessment area.
	Prohibit intensive harvesting in the provisional GKNP assessment area.
	Increase the size of koala browse trees from 20 cm to 30 cm DBHOB, and where not available, the next largest browse tree available.
	Increase the ratio of primary to secondary koala browse trees from 50:50 to retain more primary trees where available, and secondary where they are not.
Koalas (north coast, outside the GKNP assessment area) *Phascolarctos cinereus*	Prioritise the inclusion of high-quality koala habitat in wildlife and tree retention clumps
	Prohibit intensive harvesting in any area mapped as prescription 1 and koala hubs
Southern Greater Glider *Petauroides volans*	Specify nocturnal and targeted surveys to identify records and dens. This could include: • Require nocturnal surveys in known habitat, focussing on areas with a higher density of hollow-bearing and dead standing trees; and • Specify options of suitable survey techniques, including thermal drones or nocturnal spotlight surveys. This will extend to specifying the intensity of survey requires, and the need to undertake surveys post the 2019/20 fires.
Swift Parrot *Lathamus discolor*	Temporary seasonal exclusion of known and active feeding locations, during the Autumn and Winter foraging season when the species is present in mainland Australia.
South-Eastern Glossy Black Cockatoo *Calyptorhynchus lathami*	Additional survey requirements to identify and record South-Eastern Glossy Black Cockatoos habitat (of future habitat), in the absence of areas with mature cone producing trees lost to the fires.
	Retention of a specified rate of mature (or maturing) individuals or stands of She-oaks in known habitat, irrespective of evidence of use. This is to address the loss of mature trees to the fire, and the need to grow and protect future cone producing trees for the species' long term survival.

On 15 November 2023 Forestry Corporation CEO Anshul Chaudhary replied to EPA CEO Tony Chappell, noting their opposition to protocol amendments, while emphasing *the EPA intends that the proposed amendments would not have any material impact on timber supply*:

> *Much depends on the specific content of any proposed amendments, but Forestry Corporation's general position is that substantial changes to Coastal IFOA settings should not occur via ad hoc protocol amendments. …*
>
> *…*
>
> *I note that some of the potential amendments proposed by the EPA are in response to contemporary issues and that the 5-year review may not provide timely resolution of these issues. Forestry Corporation is open to discussing these potential amendments on a 'without prejudice' basis but notes the following:*
>
> > *1. Among other objectives, Forestry Corporation is responsible for delivery of the NSW Government's commitments to supply certain quantities of timber to the domestic industry. Consequently, I would be seeking mechanisms to reconcile any conflicts between potential changes to the Coastal IFOA and these commitments. I understand that our teams have discussed this matter and the EPA intends that the proposed amendments would not have any material impact on timber supply.*

> *Forestry Corporation will need to consider the detailed drafting of each proposed amendment to assess whether any negative timber supply impact is likely. If so, the amendment will need the concurrence of both the Ministers.*
>
> *…*
>
> *Pending further discussion between our teams on the details and impact of each proposed change, Forestry Corporation reserves its position on whether a particular amendment would be acceptable and (if so) the proper implementation mechanism.*

On 27 November 2023 EPA CEO Tony Chappell responded to Forestry Corporation CEO Anshul Chaudhary:

> *The NSW Environment Protection Authority (EPA) has proposed changes to the protocols to help ensure precautionary measures are applied in the provisional Great Koala National Park assessment area, and to address more urgent improvements needed for the identification and protection of important habitat for koalas, gliders, swift parrots and glossy black cockatoos.*
>
> *One of the fundamental design principles of the CIFOA and reforms to the Forestry Act 2012 (the Act) in 2018 was to move away from updating the IFOA only as part of statutory review processes every 5 years, and move towards a more agile and adaptive regulatory framework. The intention behind the establishment and content of each IFOA protocol was explicitly to ensure it could be adaptively managed by the EPA where new information or changes to best practices evolved.*
>
> *This intention is clearly set out in the CIFOA Discussion Paper and all public consultation materials on the Act and CIFOA in 2018. This material is also still available on the EPA's website.*
>
> *Recent comments made during court proceedings by your counsel in the case North East Forest Alliance Incorporated v Forestry Corporation of NSW [2023] NSWLEC 124 also go to this point, which were to the effect that the EPA can amend protocols if there is a concern that protocol protections are inadequate.*
>
> *The Court noted in that case that the CIFOA contains mechanisms which require the EPA to consider whether the CIFOA Protocols support the objective of the CIFOA, as set out under Condition 14, to authorise forestry operations in accordance with the principles of ecologically sustainable forest management.*
>
> *I also note that in a 2022 Budget Estimates parliamentary hearing, the Director General of the Department of Primary Industry stated that:*
>
> > *"[a]s a species' status changes – such as sugar gliders, for example – as their status changes, that also acts as a trigger that enables the EPA to consider whether the current provisions within the IFOA are in fact suitable and sufficient. If they find that they are not, they actually have the capacity to either change the protocols under which Forestry Corporation operates, which they can do in consultation with Forestry Corp; or to actually change the conditions of the IFOA, which obviously requires the support of both Ministers."*

On 1 December 2023 Forestry Corporation CEO Anshul Chaudhary replied to EPA CEO Tony Chappell, discussing changes for the Greater Glider, and agreeing in principle with CIFOA amendments for Koala clumps and Koala browse tree prescription within the GKNP, seasonal restrictions on logging Swift Parrot habitat and increasing protection for Glossy Black Cockatoo feed trees. They rejected the proposal to increase the size of trees retained as Koala feed trees to 30 cm dbh and increase retention rate of preferred feed trees, even though it would have marginal

impacts, and rejected excluding intensive logging in high quality koala habitat and Koala Hubs outside the GKNP on the grounds of resource impacts:

Species	EPA Proposed Amendments	Potential Wood Supply Impact	FCNSW Response
Koalas (north coast)	**Koala clumps** Prioritise the inclusion of high-quality koala habitat in wildlife and tree retention clumps	**Not significant** • Potential impact at operational scale, but likely marginal • Already being implemented by FCNSW (to the extent that the CIFOA allows) in the GKNP area	Agree in principle with implementation of the proposed amendment, within the provisional Great Koala National Park assessment area (GKNP area), for the duration of the assessment period, subject to drafting.
	Koala browse tree prescription Apply koala browse tree prescription 1 across the provisional GKNP assessment area and/or in any area mapped as prescription 1 in koala hubs outside the provisional GKNP assessment area	**Not significant** • Potential impact at operational scale, but likely marginal • Already being implemented by FCNSW as a voluntary measure in the GKNP area	Agree in principle with implementation of the proposed amendment.
	Koala browse trees • Increase the size of koala browse trees from 20 cm to 30 cm DBHOB, and where not available, the next largest browse tree available. • Increase the ratio of primary to secondary koala browse trees from 50:50 to retain more primary trees where available, and secondary where they are not	**Not significant** • Potential impact at operational scale, but likely marginal • Already being implemented by FCNSW as a voluntary measure	Agree with the principle that feed trees that koalas are most likely to utilise should be retained and protected. Do not agree with the EPA proposal as it is out of step with recent research and creates unacceptable compliance risk. Instead, we propose that the range of feed trees species be increased to reflect recent research, particularly inclusion of *Eucalyptus propinqua* as a primary browse tree species.
	Intensive harvesting • Inside the GKNP Area: Prohibit intensive harvesting in the provisional GKNP assessment area. • Outside GKNP Area: Prohibit intensive harvesting in any area	**Significant** • Long term reduction in productivity in forests around Coffs Harbour, Urunga and Wauchope. The proposal would effectively stop all intensive harvesting due to the extent of restrictions.	Requires consideration by Minister for Agriculture due to the potential impact on long term sustainable yield. FCNSW has committed not to undertake intensive harvesting under existing voluntary post fire measures, but this has not been committed to long term.

Species	EPA Proposed Amendments	Potential Wood Supply Impact	FCNSW Response
	mapped as prescription 1 and koala hubs.	• Preliminary modelling indicates this would generate an impact in the order of 10-15% of HQ Blackbutt. • This equates to a reduction of ~15,000m3 per year of supply impact with the majority being Blackbutt.	
Swift Parrot	Temporary seasonal exclusion of known and active feeding locations, during the Autumn and Winter foraging season when the species is present in mainland Australia.	**Unknown.** • There are potentially models where a seasonal restriction would not cause disruption to timber supply. However, it is unclear from the material provided if this would be the case. • The impact could be insignificant if the area to which this applied was geographically limited (say a selection of Batemans Bay forests known to be regular feeding habitat) and if there was also a trigger based on actual seasonal records or current activity.	Agree that protection of the Swift Parrot is likely to be the subject of ongoing concern from some stakeholders. Seasonal exclusions could be implemented with minimal disruption to timber supply if applied to limited geographic areas and linked to contemporary observations. FCNSW maintains that the risk to swift parrots from selective harvesting is very low.
South-Eastern Glossy Black Cockatoo	Additional survey requirements to identify and record South-Eastern Glossy Black Cockatoos habitat (or future habitat), in the absence of areas with mature cone producing trees lost to the fires	**Unknown**	It is not clear what the purpose of any such survey would be. FCNSW believe that any additional requirements for this species would best be applied during the broad area habitat search.
	Retention of a specified rate of mature (or maturing) individuals or stands of She-oaks in known habitat, irrespective of evidence of use. This is to address the loss of mature trees to the fire, and the need to grow and protect future cone producing trees for the species' long-term survival	**Unknown**	Forestry Corporation is open to discuss approaches to improve outcomes for protection of casuarina species suitable for GBC browsing in the landscape subject to high intensity fire. For example, in severely burnt areas, clumps of live forest oak could be mapped and protected in addition to the existing clump provisions or larger live casuarina species individuals could be protected at a minimum rate (up to 5 heathy live trees>20cm dbhob).

While a Site Specific Biodiversity Condition for Greater Gliders was eventually agreed (see 1.4.2), none of the other proposed protocol amendments proceeded. It is astounding that despite the uplisting of the threatened status of numerous species because of the 2019/20 wildfires there has been no substantial change to the CIFOA logging rules to reflect this. This makes a mockery of adaptive management and compliance with Ecologically Sustainable Forest Management.

1.4.7. Impact of logging on wildfires

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, while increasing the extent, intensity and frequency of wildfires. 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. Logging is increasing the vulnerability of forests to burning, which in an era of global warming is not sustainable in any way.

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 (Brosofske *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, except for 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.

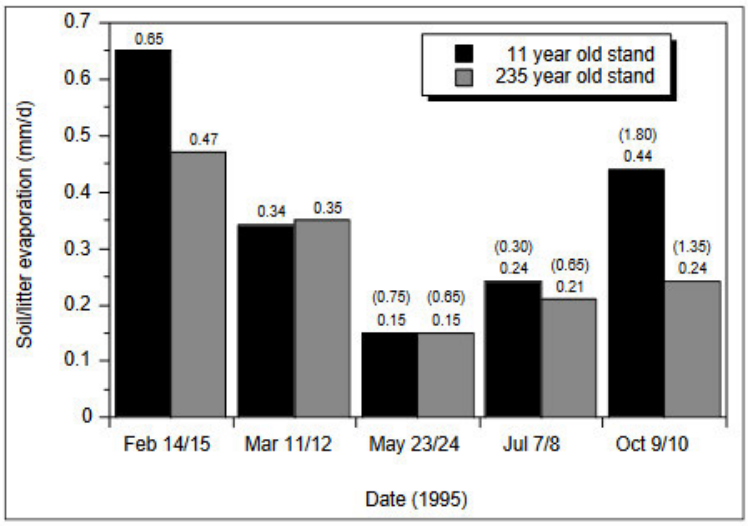
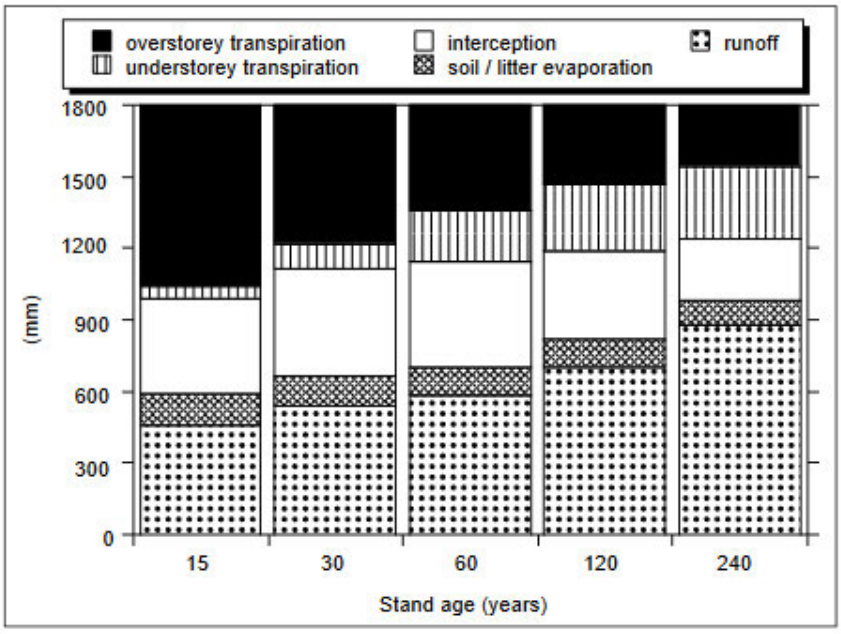


Figure 22 from Vertessy *et. al.* (1998): Comparison of soil/litter evaporation estimates beneath 11 and 235 year old mountain ash forest stands.

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.

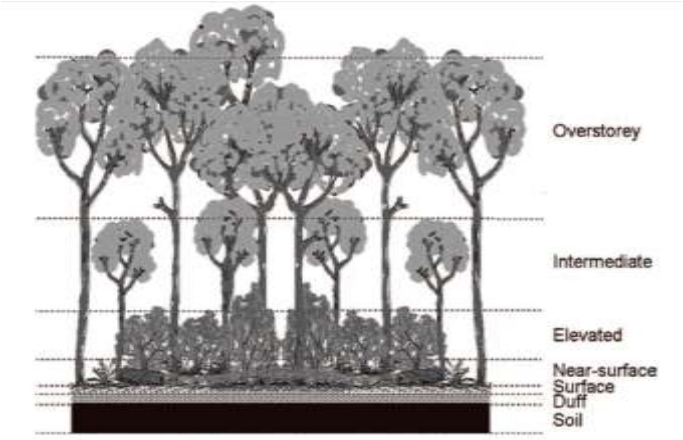


Figure 3.6 from Sullivan *et. al.* (2012) showing categories of forest fuel strata.

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).

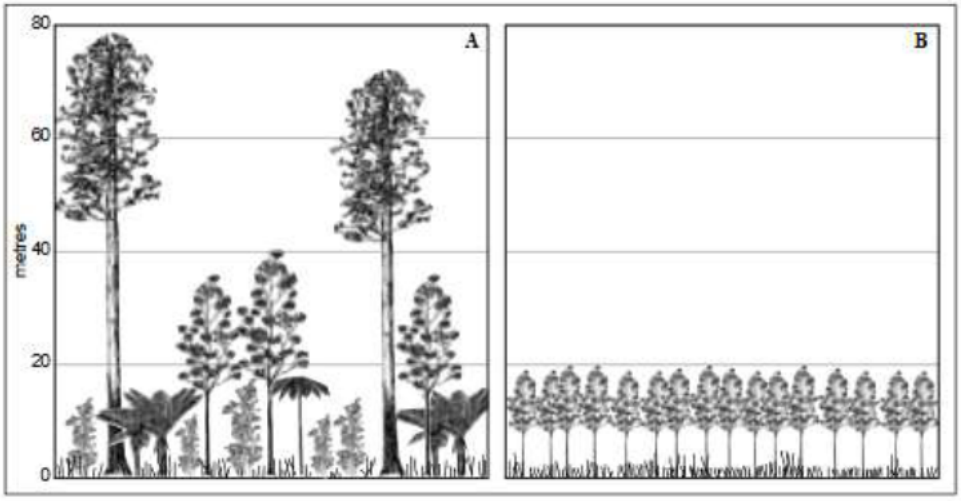


Figure 9 from Vertessy *et. al. 1998*: Comparison of forest structure in (A) old growth and (B) regrowth mountain ash stands. It beggars belief the anybody could deny that the reduced canopy height and increased canopy continuity in a drier regrowth forest is likely to result in increased crown fires.

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*"

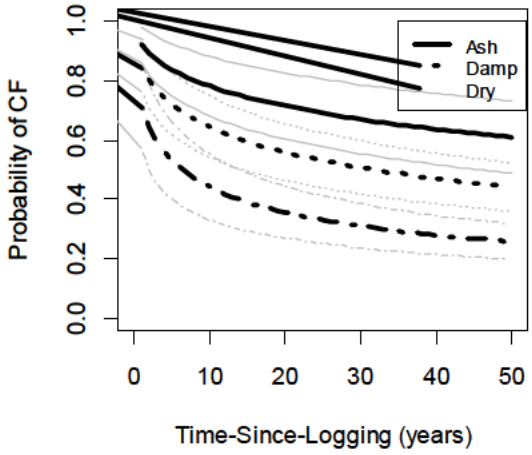
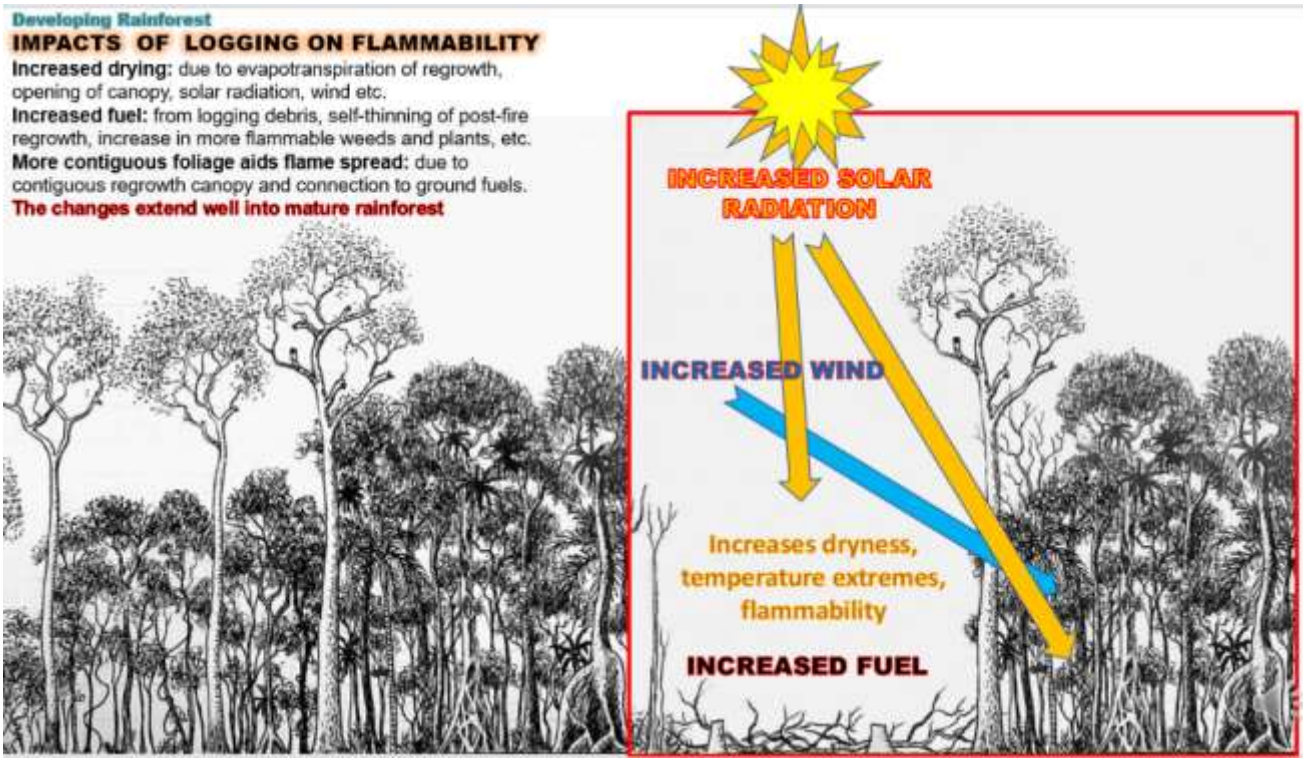
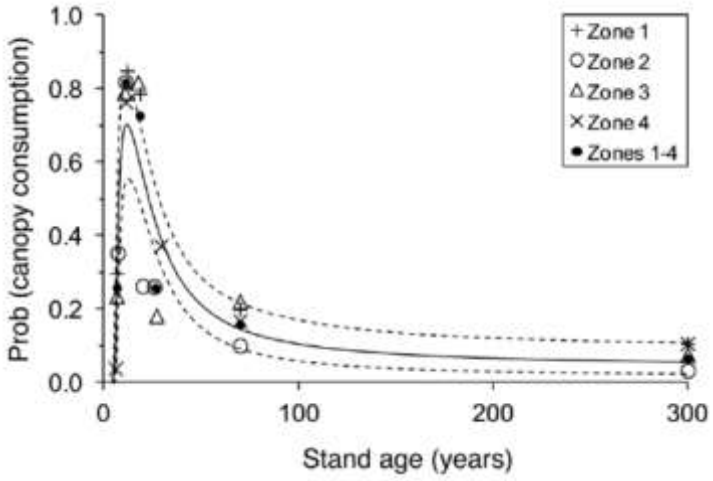


Figure 1 from Price & Bradstock (2012): Model predictions for crown fire (CF) against time-since-logging and forest type using the best model. In all cases, the models are for fire weather Moderate, slope = 0, topographic position = 50%, time-since-fire = 25 years, and aspect = East. Confidence limits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



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 (<7years) 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*".

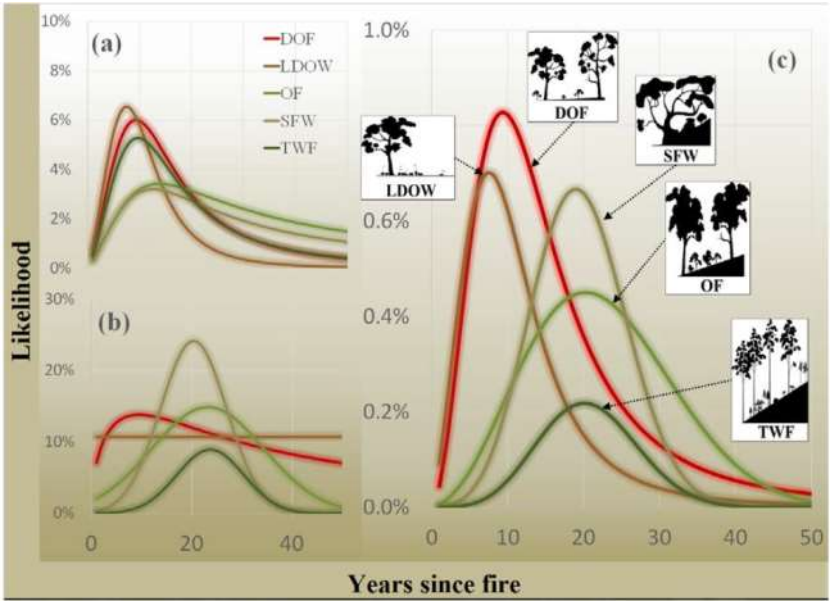


Figure 5 from Zylstra (2018). Flammability trends for each formation, where the *x*-axis gives years since the last fire, and the *y*-axis gives likelihood for (a) fire burning a point (L_f), (b) crown fire occurring if that point is burning (L_{cb}); and (c) crown fire occurring at any point (L_c). 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.

1.4.8. Impact of logging on soils and streams

There is nothing sustainable about the cumulative impacts of logging on soils, erosion and sedimentation of streams. Logging results in decreasing Soil Organic Carbon, increasing bulk density and increasing pH, suggesting poorer soil structure and condition, that increase runoff and reduce water holding capacity. Logging changes hydrology, redirecting water and affecting the pattern of surface and subsurface waterflows. Roads and snig-tracks are the primary sources of erosion, resulting in significant increases in sediment laden runoff entering streams. In streams sediments can persist for decades, filling up pools and interstitial spaces used by fauna for refuge and breeding. Riparian buffers are the principal means of mitigating logging impacts on streams, with 30m wide buffers recommended for headwater streams, yet only 5m buffers are applied. In streams increased flows in extreme rainfall events can erode streambanks and deposit sediments where waters slow.

See 4.3 for a discussion of the impacts of logging on streamflows.

1.4.8.1. Changing soil structure

Logging operations have been found to have a very significant impact on soil structure and stability. The most significant of these in relation to runoff is the compaction of soil reducing its permeability and thus increasing runoff. As noted by Croke *et. al.* (1997), *"once surface runoff commences, flows transmit relatively quickly downslope in the absence of areas of higher infiltration which can absorb large volumes of surface flow."*

During logging operations from 16% (Van Loon 1966) to 23% (Wronski 1984) of the logging area can be subject to significant disturbance by machinery, increasing to over 70% in wetter forest types where machinery disturbance is maximised to encourage regrowth (Forestry Commission 1982, Rab 1994, 1996). Rab (1996) found that *"snig tracks, log landings and disturbed general logging area occupied about 19%, 3% and 66% of the coupe area, respectively."* Current logging is primarily machine based, greatly increasing the extent of soil disturbance, more akin to the 70% disturbance level.

Compaction of forest soils during logging operations is caused by the weight of machinery, loads and falling trees. The single passage of machinery has been shown to cause major compaction (e.g. Incerti, Clinnick and Willatt 1987) while repeated loadings and logging cycles have been shown to increase compaction effects (e.g. Seymour 1981). Wronski (1984) found that after two or more passes of logging vehicles the full depth of the soil's A horizon was compacted immediately beneath the wheel tracks and to a lesser extent up to 0.75 m from the edges of the tracks.

In relation to water movement, soil compaction resultant from logging machinery and vehicles, has been shown to significantly:

- increase soil density (Greacen and Sands 1980, Seymour 1981, Jakobsen and Moore 1981, Jakobsen 1983, Wronski 1984, Incerti et al 1987, Rab 1994, Croke *et. al.* 1997), with various estimates of 20-65% increases on major snig tracks and log landings;

- reduce infiltration capacity (Langford and O'Shaughnessy 1977, Greacen and Sands 1980, Jakobsen and Moore 1981, Wronski 1984, Lamb 1986, Campbell and Doeg 1989, Rab 1994, Croke *et. al.* 1997), thereby increasing surface runoff, loss of water from the site and erosion; and,
- reduce hydraulic conductivity (Jakobsen and Moore 1981, Jakobsen 1983, Wronski 1984, Incerti et al 1987, Rab 1994).

Croke *et. al.* (1997) found that *"the bulk density of snig track soils was approximately 1.25 times higher than those on the general harvesting area. This is due partly to compaction but also to the loss of more porous surface soil during cross bank construction."* Croke *et. al.* found that because of this *"For the 1:2 and 1:10 year storms, snig tracks generate approximately seven times more surface runoff per unit contributing area than the general harvesting areas on recently logged sites."*

Rab (1994) concluded that *"The results indicated that logging significantly increased bulk density and decreased organic carbon and organic matter content, total porosity and macroporosity on over 72% of the coupe area. However, on 35% of the coupe area, the snig tracks, log landings and subsoil disturbed areas of the general logging area, bulk densities and macroporosities reached critical levels where tree growth could be affected. On these areas, organic carbon decreased between 27 and 66%, bulk density increased between 39 and 65% and macroporosity decreased between 58 and 88%."*

Rab (1994) found that *"Saturated hydraulic conductivities decreased to critical levels for runoff to occur on over 72% of the coupe area (topsoil and subsoil disturbed areas of the general logging area, snig tracks and log landings). On this area, the reduction in saturated hydraulic conductivity varied between 60 and 95%."*

The Natural Resources Commission (NRC) released the DPIE/University of Sydney (Moyce *et.al.* 2021) 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*."

Despite model performance being limited by the lack of current soil data, the digital soil modelling by Moyce *et.al.* (2021) revealed the following trends for soil organic carbon (SOC) and soil density based on different potential soil disturbances:

- *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 …*
- *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.*

Moyce *et.al.* (2021) further noting:

> *The hillslope erosion risk in the RFA regions is highest in summer. A loss of vegetation cover increases the risk of hillslope erosion*
>
> *Forest disturbance demonstrates a statistically significant positive trend, indicating the higher the level of forest disturbance, the higher the bulk density.*
>
> *These results reflect the rise in bulk density with lowering vegetation cover and increasing forest disturbance. Vegetation and organic matter serve to improve soil structure, and increased disturbance of soils with the higher FDI leads to soil compaction due to the use of forestry machinery, vehicles and hard-hooved stock: thus both variables contribute to the observed trends. The association of forestry harvesting operations with increased bulk density was reported by Huang et al. (1996).*
>
> *Highest SOC levels are associated with the least disturbed sites, then decreasing to forests available for harvesting (as per State Forest Management Zones, refer Table 8) and lowest levels associated with privately owned or leased, often grazed forest sites. Similarly, the positive influence of vegetation cover on SOC content is demonstrated.*

Other water related problems with the impact of logging machinery on soils include dramatic increases in erosion resulting from: removal of the more stable surface organic layer and channelling of overland flow and increasing its erosive force (Bonell, Gilmour and Cassells 1991).

1.4.8.2. Increasing erosion

Roads and tracks are the most significant sources of erosion in logging operations (Langford and O'Shaughnessy 1977, Lamb 1986, Grayson *et. al.* 1993, Davies and Nelson 1993, State Forests 1996b, Croke *et. al.* 1997, Lacey 1998), contributing up to 95% of sediments in streams at one NSW site (Lamb 1986). Roads and tracks also alter hydrological patterns by creating new drainage lines and affecting the pattern of surface and subsurface waterflows (Bren and Leitch 1985, Lamb 1986, Bonell, Gilmour and Cassells 1991).

Sediment production rates from unsealed roads have been found to vary from 0.2 to 2,000 tonnes per hectare per annum (t ha^{-1} $year^{-1}$) (Grayson *et. al.* 1993). Grayson *et. al.* (1993) found that sediment production from unsealed roads in the Melbourne Water catchment (annual rainfall around 1600mm) was in the order of 50-90 t ha^{-1} of road surface per year, with 15-25 t ha^{-1} of this being coarse sediment and 35-65 t ha^{-1} being suspended sediment. They note that the sediment loading being composed of two-thirds suspended sediment *"is important for management, as it is more difficult to prevent suspended sediment entering streams."*

Grayson *et. al.* found that *"with low usage* [2 return passes per week] *the level of road maintenance is not a factor in sediment production; however, with high usage* [15 return passes per week]*, the level of road maintenance becomes important"*. They considered it noteworthy that *"on several occasions after grading, very large sediment loads were deposited in fumes. On one occasion, approximately 6 t of coarse sediment was removed from the fumes in one week."*

The concentrated nature of runoff from roads, particularly when situated on side slopes, makes it difficult to control sediments and ensure their deposition prior to reaching streams.

Bren and Leitch (1985) found that spreading outflow from a road evenly over a 5m wide and 5m long area of undisturbed ground *"did not have any effect. Scrutiny of the individual storm records indicated that a possible effect was discernible only for very small storms"*, an outcome which they in part attributed to the area quickly becoming *"covered with a layer of fine sediment which blocked points of infiltration entry into the soil"* and the tendency of the water *"to flow along preferential paths, thereby reducing the opportunity for infiltration".*

The next most significant source of sediment production in a logging operation are the snig-tracks used to transport logs from where they are felled to log dumps for loading onto trucks. Cross-banks are the principal means used to control runoff and thus erosion from snig-tracks. They are used to slow runoff and thereby precipitate and trap coarser sediments on the track surface and to redirect runoff into less disturbed areas to trap additional sediment.

Croke *et. al.* (1997) assessed erosion from logged areas using simulated rainfall events and experimental plots and found that "*Snig tracks on these recently logged sites generate, on average, 20 times more sediment than the general harvesting areas for the 1:100 year* [110 mm/h] *storm intensities",* with *"for the most recently logged sites, sediment yield is in the order of 2 to 11 t/ha for the 1:2 year and 1:100 year storms"* over a 30 minute period.

Croke *et. al.* (1997) found that with various 30 minute rainfall simulations 65-100% of the mobilised sediment was deposited at cross banks at relatively low rainfall intensities of 45mm/h, while 33-88% was deposited at higher rainfall intensities of 110 mm/h, noting that *"The particle size distribution of the eroded sediment from the snig track and the cross bank outlet indicates the propensity for the coarser sediment to be deposited in this area, leaving a predominance of fine materials to be transported into the general harvesting area."*

While there was no real attempt by Croke et. al. (1997) to analyse the reduction in sediment after leaving the cross bank, it would appear that with a rainfall intensity of 110mm/hr lasting for half an hour, some 3-51% of the remaining sediment was transported across 5-7m of the forest floor, with volumes depending upon soil types and particle sizes. Croke *et. al*. note *"Relative differences in sediment yield from the cross bank outlet to the trench … suggest that approximately 50% of the sediment eroded on the metasediment sites reached the hillslope trench."*

Lacey (1998) assessed sediment production on snig-tracks in Orara West and Doyles River State Forests under natural conditions and presumably best practices, finding that *"the total average amount produced on snig tracks in the first year was 29 t ha^{-1} at Doyles River and 31 t ha^{-1} at Orara West. Second year results displayed a greater difference with 9 t ha^{-1} at Doyles River and 4.5 t ha^{-1} at Orara West."*. It needs to be noted that his sediment traps did overflow and thus unquantified volumes of silt were transported further on.

Lacey also assessed sediment accumulation at traps located 5 m below cross bank outlets on other tracks and found it *"to be of a similar magnitude to that of the on-track traps"* at all the Orara West sites and one of the four Doyles River sites. In other words, in most of the cases re-direction of silt laden water over infiltration slopes had no effect. Lacey attributed this to a fire 2 months before logging at Orara West removing ground litter and vegetation and *"some ground disturbance by logging machinery"* at the Doyles River site.

Croke *et. al.* (1997) found that *"The relationship between surface runoff and total cover varies with rainfall intensity as reflected in coefficients of variance of 36%, 34% and 5% for the 1:2, 1:10 and 1:100 year storms. This suggests that the effect of total cover in reducing runoff volumes is greater for low to medium events, but once rainfall intensity exceeds some threshold value, the influence of cover on surface runoff weakens as a greater percentage of the general harvesting area produces runoff and vegetated areas become saturated."*

1.4.8.3. Impacts on streams

The riparian zone is the interface between a stream (and other waterbodies) and land through groundwater, subsurface flows and flooding. Small headwater streams are where most of the inputs of energy, sediments, nutrients and pollutants from the adjacent terrestrial environment occurs. Hansen *et. al.* (2010) state:

> *The best opportunity for mitigation of catchment-scale disturbances is by the protection or rehabilitation of headwater systems due to their demonstrated capacity for greatest regulation of water quality and highest contribution to regional biodiversity"*.
> ...
> *Erosion in headwater areas makes a disproportionately high contribution to waterway sedimentation and elevated nutrient levels (Lowe and Likens, 2005, Naiman et al., 2005). Ephemeral streams also contribute large amounts sediment and nutrients that are mobilised during storm events (Wenger, 1999, Fisher et al., 2004)*

Davies and Nelson (1993) note that *"the role of first-order streams in sediment transport from hillslopes experiencing accelerated erosion has long been recognised".* concluding that *"enhanced fine sediment movement in streams as a result of logging is most likely to occur owing to disturbance of headwater stream channels."*

The health of streams is directly related to the health and functioning of riparian vegetation. Riparian buffers serve several functions:

- shading of streams and minimising fluctuations in water temperatures
- reducing the volumes of overland flows entering streams
- trapping sediments and associated pollutants moving from upslope towards streams
- maintenance of stable stream banks and channels;
- providing wood, leaf litter, fruits, flowers, insects and other resource inputs to streams;
- maintenance of habitat requirements for many aquatic and terrestrial species; and,
- provide corridors for the movement of a suite of terrestrial species.

The science is that we should be establishing buffers at least 30m wide around headwater streams. For example:

- Munks (1996) recommended minimum buffer widths of 30-50m for small streams with a catchment of 50 to 100 ha and 30m for small streams, tributaries, gully and drainage lines which only carry surface water during periods of heavy rainfall.
- Croke and Hairsine (1995) recommended "Minimum Streamside Reserve and Filter Strip Widths according to stream type", with 20m buffers for temporary (1 in 5 yr flow) streams and 30m buffers for small streams with a catchment less than 100 ha.
- Hansen *et. al.* (2010) identified various riparian buffers for different purposes, ranging from 30-60m to improve water quality, up to 40-100m to Improve in-stream biodiversity.

Based on her review Munks (1996) recommend minimum buffer widths for streams.

Table 3.5. Munks (1996) recommended minimum buffer widths for streams:

Type of River or Stream	Minimum width from stream bank*
Main Rivers	40 m
Creeks and streams from the point where their catchment exceeds 100 ha	30 m
Small streams with a catchment of 50 to 100 ha	30-50 m

Small streams, tributaries, gully and drainage lines which only carry surface water during periods of heavy rainfall	30 m

* If the slope of adjacent land running down to the stream is greater than 10%, the recommended width is increased to 50m.

In the 2018 CIFOA remake there was a focus on reducing protected riparian habitat, primarily to allow access to the resources in riparian areas that had been protected for decades. There was no science involved. Essentially the CIFOA reduced buffers on headwater streams from an already inadequate 10m down to 5m, and removed or reduced the requirements for increased protection of riparian habitat for 17 threatened animal species.

The Remake of the Coastal Integrated Forestry Operations Approvals Final Report Threatened Species Expert Panel Review reports all experts who commented as opposing the opening of riparian areas protected for the past 20 years for logging. For example, Brad Law, DPI Forestry, stated:

> *"In some areas where areas once mapped as riparian buffers are no longer identified then there would be a loss of habitat protected for the past 20 year period. Given the intensity of operations over the last 10 years, it would be important to try to ensure these areas remain protected"*

The EPA representative Brian Tolhurst stated:

> *"No further loss or impact on the retained riparian areas that have been protected to date under the existing rule set should occur. The expert panel agreed that these areas were the few areas seen on the site visit that still retained habitat elements and the diversity, form and structure of a native forest.*
>
> *...*
>
> *I am not convinced that the proposed riparian buffers are adequate for ecological protection of these features. The widths seem to have been generated to deliver no net loss of available harvestable area rather than driven by an appropriate buffer for the size/importance of the feature".*

Even with the implementation of erosion mitigation measures, significant proportions of mobilised sediments have been found to get into streams (Cornish 1980, Campbell and Doeg 1989, Davies and Nelson 1993, 1994, Grayson *et. al.* 1993, State Forests 1996, Wilson and Lynch 1998, Sadek *et. al*. 1998, Lacey 1998, Croke *et. al.* 1999). Campbell and Doeg (1989) conclude that most studies indicate that *"timber harvesting operations have significant effects on stream sediment levels, water quantity, water temperature, nutrients and aquatic biota"*. Sadek et. al. (1998) found that *"the disturbed forest basin produced approximately 10 to 100 times the load per unit area during storm events compared to the undisturbed basin".* Wilson and Lynch (1998) concluded that *"logging does appear to increase turbidity in small tributary streams draining logging coups, even when these streams are protected by buffer strips."*

Croke *et. al*. (1999) identified two principal sediment delivery pathways to streams:

- *Incised channels or gullies – where flow is concentrated, resulting in high sediment-transport capacity and runoff delivery downslope*
- *Non-channelised pathways – where water disperses or spreads across the hillslope, reducing flow depth, velocity and, consequently, the ability of the flow to transport sediment.*

Croke *et. al*. (1999) found that in their study area an additional 10 km of stream channels or gullies formed in previously un-channelled areas due to gully initiation at road-drainage outlets. These were made up of full channel linkages from road to stream (86%), partial channel linkages (11%) and

direct linkages (3%). This represented a 6% increase in catchment drainage density and resulted in 31% of the natural stream network receiving and carrying runoff and associated pollutants from road-drainage outlets.

Croke *et. al.* (1999) found that sediment concentrations in runoff entering a gully from a road outlet showed no change with distance downslope (no net deposition or reduction of runoff). They found that about 85% of the material delivered to channelised pathways was transported downslope to the next adjoining channel, noting:

> *"About 39 tonnes of material was generated from the surfaces of the road network in Cuttagee Creek during a 1-in-100 year storm event of 30 minutes duration. Of this about 7 tonnes or 17% was delivered directly to channels via gullied pathways".*

In non-channelised pathways the flows spread and move slowly downslope, giving time for infiltration to occur and sediments to be deposited. Croke *et. al*. (1999) found that *"About 10% of the material entering a non-channelised flow path was delivered to the bottom of the hillslope during an equivalent 1-in-100 year rainfall event".*

Logging has been found to result in a variety of impacts on stream quality:

- significant increases in peak sediment loads (Campbell and Doeg 1989, Lake and Marchant 1991, Bonell, Gilmour and Cassells 1991, Sadek *et. al*. 1998) leading to increased sediment deposition in streams with consequent short-term and long-term impacts on invertebrates and fish (Campbell and Doeg 1989, Lake and Marchant 1991, Davies and Nelson 1994);
- increased nutrient levels which can stimulate algal production in summer (Campbell and Doeg 1989, Lake and Marchant 1991, Davies and Nelson 1994), affecting the instream community in the vicinity of logging; and,
- reductions in levels of dissolved oxygen in streams because of oxygen demands of decomposing logging debris in streams, which becomes most apparent in periods of low flows (Campbell and Doeg 1989).

The increased volumes of water delivered to streams following disturbances also initiate erosion in the stream channels, as well as the catchment. Increased water flows have been found to scour gullies and undermine streambanks (Good 1973, Leitch, Flinn and van de Graaff 1983).

The increased turbidity following logging and burning have been found to result in massive depositions of sediment in stream channels (Good 1973, Leitch, Flinn and van de Graaff 1983, Lamb1986, Davies and Nelson 1993). While some of the impacts may only persist for a few years after logging, others may persist for long periods, for example Davies and Nelson (1993) found that *"road crossings were associated with large increases in infiltration in adjacent riffle pairs, 30-50 years after construction."*

Effects on macroinvertebrates have been recorded in catchments where logging has been carried out with restrictive prescriptions for the protection of aquatic habitats and the impacts have been found to persist for decades (Forestry Commission of Tasmania 1991, Davies and Nelson 1993, 1994). Davies and Nelson (1994) found that *"Logging significantly increased riffle sediment, length of open stream, periphytic algal cover, water temperature and snag volume. Logging also significantly decreased riffle macroinvertebrate abundance, particularly of stoneflies and leptophlebiid mayflies, and brown trout abundance."*

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*".

2. Environmental and cultural values of forests, including threatened species and Aboriginal cultural heritage values

Forests have a multitude of environmental values, they generate rainfall and cool the land (5.3), clean the air, provide homes for a plethora of threatened species (this section, 1.4), are important for recreation and improved health (5.2), filter and regulate runoff to streams (1.4.8, 5.3), and remove carbon dioxide from the air and store it in their wood and soils (7.2).

There is a need to increase protection for forests as 44% of NSW's species are forest dependent, with a high proportion of these threatened by extinction and predictions that half these threatened species will be extinct within 100 years. North east NSW is of national importance for threatened forest dependent fauna and flora. The ecological carrying capacity of most of NSW has been greatly reduced, with east coast forests having the highest remaining carrying capacity. North-east NSW's forests are the main climate change refugia of outstanding importance for the long-term survival of a plethora of native species. To satisfy our commitments to satisfy the goal to protect 30% of IBRA Bioregions by 2030 most State Forests require protection. For 175 priority fauna species in north-east NSW's forests identified in 1998, logging was considered a serious threat to 68% of species. It is evident that the current reserve system in north-east NSW does not protect viable populations of most priority fauna species. The basis of the problem is that national reserve targets for forest reserves were over-ridden by timber resource commitments in 1998, since then logging has intensified and protections wound back to maintain timber volumes, and even after the devastating impact of the 2019/20 wildfires needed increases in protections for threatened species are not allowed to have any material impact on timber commitments. To give our threatened species a future it is essential we stop logging their homes and protect public native forests.

North-east NSW has internationally significant conservation values that single it out as one of the world's strongholds of biodiversity. Its high diversity of threatened species, large number of endemic species, significant populations of species which have declined elsewhere in Australia and importance for migratory fauna, identify it as one of Australia's major refuge areas with the best ability to maintain Australia's declining biodiversity.

This region is the evolutionary hub of the wet sub-tropics, the high number of endemic species this has generated is enhanced by Australia's predominantly northern flora and fauna reaching their southern limits of distribution and the predominantly southern species reaching their northern limits of distribution within the region (this species overlap is, in part, referred to as the Macleay-McPherson Overlap). The region includes an overlap of Tumbunan, Bassian, Torresian and Eyrean zoogeographical influences (NPWS 1994a). As noted by the NPWS (1994a) *"Nowhere else in Australia do so many zoogeographical influences combine".*

The upper north east encompasses part one of one of Australia's 15 recognised biodiversity hotspots, the 'Border Ranges North and South (Queensland and New South Wales)'. Biodiversity hotspots are areas that support natural ecosystems that are largely intact and where native species and communities associated with these ecosystems are well represented. Areas with many endemic species where the levels of stress or future threat were considered to be high were identified by the Australian Government's Threatened Species Scientific Committee as hotspots. In relation to the Border Ranges North and South the Environment Australia website notes;

> *This sub-tropical and temperate hotspot is one of Australia's most diverse areas - and it is the most biologically diverse area in New South Wales and southern Queensland. It has a variety of significant habitats: subtropical rainforest, wet sclerophyll forest, mountain headlands, rocky outcrops and transition zones between forests.*
>
> *These habitats support a huge variety of bird and macropod species. Many are rare or threatened: the Richmond Bird-wing Butterfly, Fleay's Frog, Hastings River Mouse, Long-nosed Potoroo, Spotted-tailed Quoll, Eastern Bristle Bird, Rufous Scrub-bird and the critically endangered Coxen's Fig parrot. Notable birds such as Albert's Lyrebird and the Paradise Riflebird make their home here, and in the south-east Queensland rainforests live a rich variety of primitive plant species, many of them similar to fossils from Gondwana.*
>
> *This region's high population growth, with associated urban and tourist developments along the coast, is a major cause of habitat loss and fragmentation. Although most remaining natural areas are protected, they are under considerable threat from weeds, fire and recreational use.*

The forests of north-east NSW have been identified as part of one of the world's 35 biodiversity hotspots because of their exceptional species endemism (at least 1,500 endemic plant species, i.e., 0.5% of all known species) and habitat loss (70% or more of an area's primary vegetation cleared) (Williams *et.al.* 2011).

The global significance of the region's rainforests has long been recognised by the inscribing of those reserved in 1986 on the World Heritage List, within what is now Gondwana Rainforests of Australia property. Those rainforests reserved since then have also been assessed as qualifying. Similarly, the unique diversity of eucalypt ecosystems within the region have been identified as also warranting inclusion on the World Heritage List.

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North east NSW and south east Queensland's rainforests are considered to be of international significance because: they provide *"an unparalleled record within the subtropical climatic zone of*

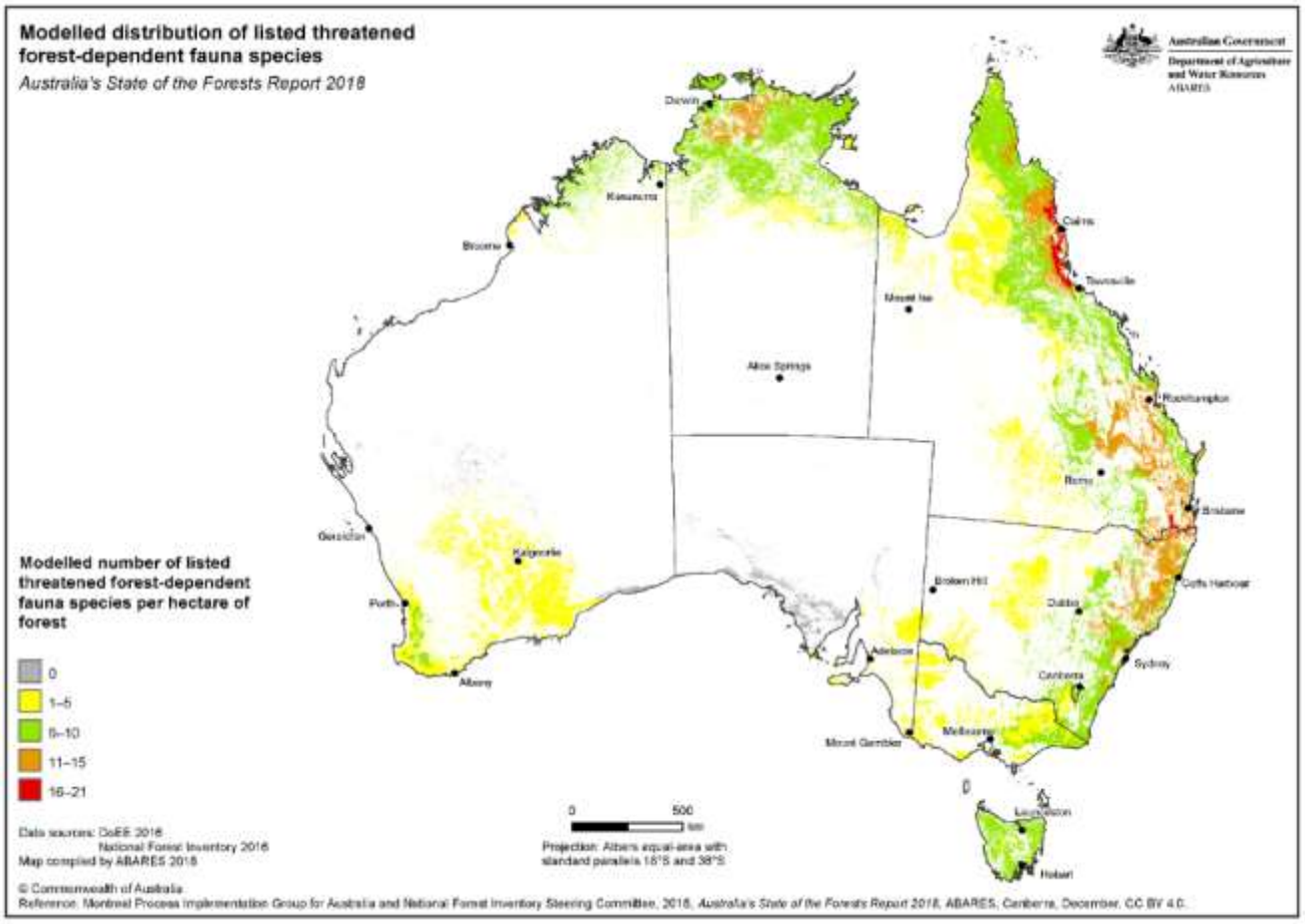
rainforests originating in the Gondwana Cretaceous but surviving the major extinction episode characterising the Cretaceous-Tertiary boundary" (DASET 1992), they are a secondary (to the Wet Tropics) centre of endemism for Australia with 42 of the 98 genera of primitive flowering plants (NPWS 1994b), they represent *"the most latitudinally, and perhaps aerially, extensive subtropical rainforest in the world"* (DASET 1992)

As of 2016, there were 762 forest-dwelling terrestrial vertebrate fauna species in NSW, with 393 vertebrate fauna species dependent on forest habitat (ABARES 2018). This indicates that 44% of NSW's terrestrial species are dependent on forests.

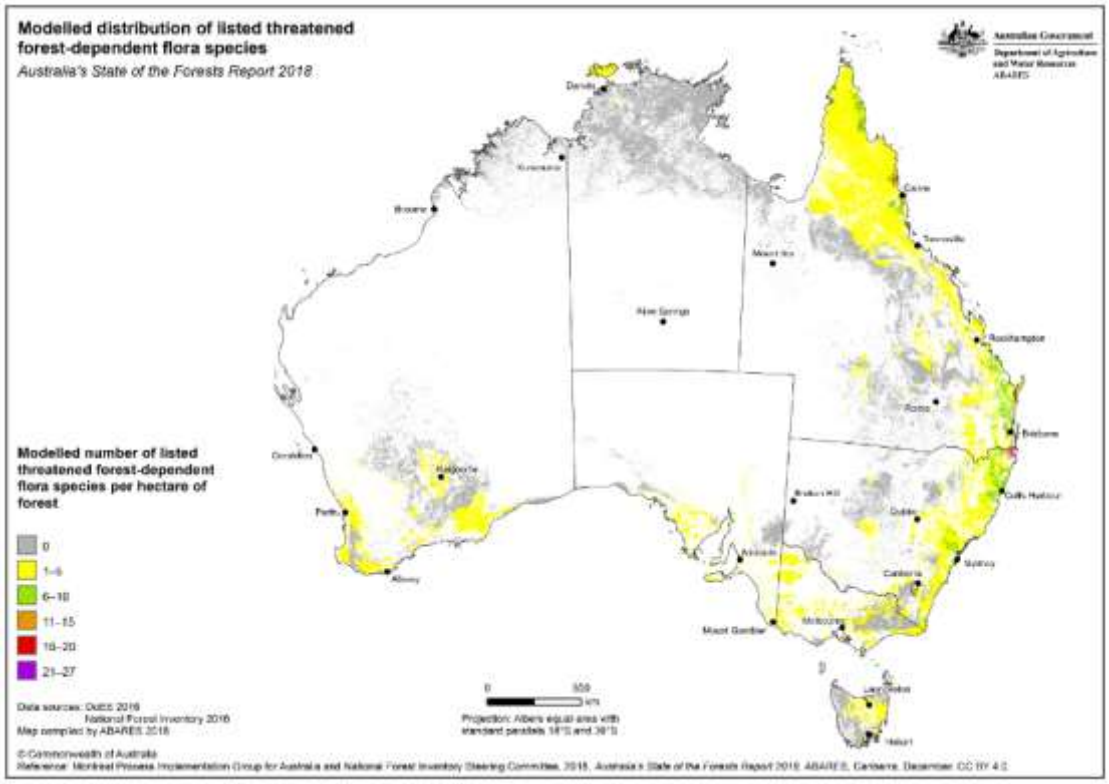
	NSW total	Forest dwelling		Forest dependent	
Amphibians	83	82	99%	32	39%
Reptiles	230	212	92%	92	40%
Birds	452	344	76%	199	44%
Mammals	138	124	90%	70	51%
TOTAL	903	762	84%	393	44%

NSW terrestrial vertebrate fauna utilising and dependent on forests (from ABARES 2018 and EPA 2024)

For NSW ABARES (2018) also identifies 134 forest-dwelling fish with 41 dependent on forests. There are probably well over 100,000 terrestrial invertebrate species in Australia's forests, of which only a small fraction have been described (ABARES 2018).



ABARES (2018) map showing the density of forest dependent threatened fauna species per hectare, showing the importance of north-east NSW's forests.



ABARES (2018) map showing the density of forest dependent threatened flora species per hectare, showing the importance of north-east NSW's forests.

The following data are taken from the EPA 2020 State of the Environment report. As at December 2020 1,043 species and 115 ecological were listed as threatened in NSW, with 78 species extinct. The numbers of threatened species are steadily growing, primarily due to habitat loss from the clearing and degradation of native vegetation affecting 87% and the spread of invasive pests and weeds affecting 70%, with climate heating a growing threat. A significant proportion of terrestrial species are threatened with extinction:

- Of NSW's 138 terrestrial mammals, 83 (60%) are on the threatened species list, with 26 presumed extinct
- Of NSW's 452 birds, 140 (31%) are on the threatened species list, with 14 presumed extinct
- Of NSW's 83 amphibians, 29 (35%) are on the threatened species list, with none presumed extinct
- Of NSW's 230 reptiles, 45 (20%) are on the threatened species list, with one presumed extinct
- Of NSW's 60 freshwater fish, 11 (18%) are on the threatened species list
- Of NSW's 4,677 terrestrial plants, 671 (14%) are on the threatened species list, with 32 presumed extinct
- While numbers of species are not known for other terrestrial groups, 24 terrestrial invertebrates, 12 aquatic invertebrates and 11 fungi and algae are also identified as threatened.

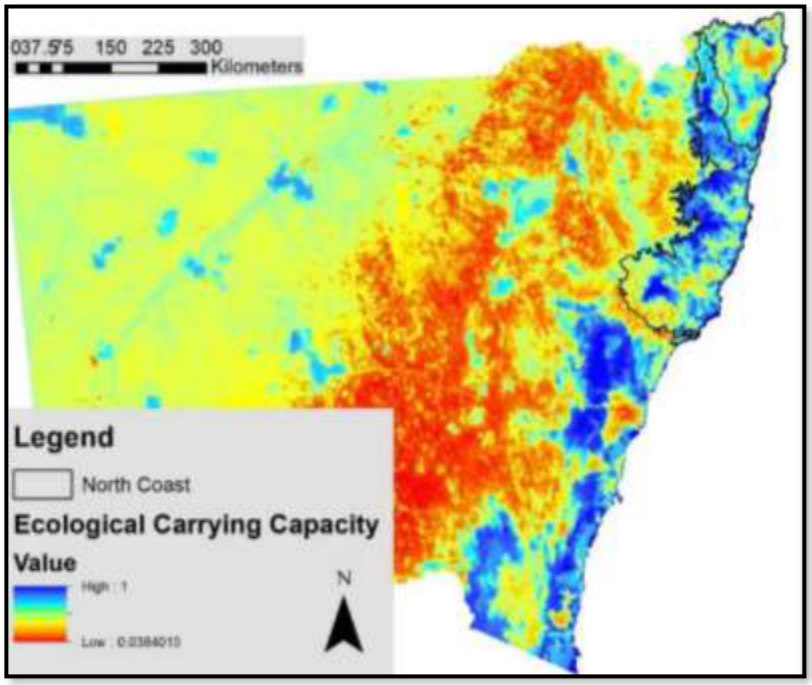
Modelling by the NSW Biodiversity Indicator Program (BIP) in 2017 predicted that only 496 or 50%, of the then 991 listed terrestrial species are predicted to survive in 100 years' time. Birds, frogs and mammals are expected to retain 92%, 83% and 84%, respectively, of their original evolutionary heritage in 100 years.

It is estimated that NSW has 49.8% woody native vegetation cover and 19% non-woody vegetation cover in which the structure has not been substantially altered, though land clearing and degradation of native vegetation continues.

Ward *et. al.* (2024) identified that 29 million ha (54%) of NSW's pre-1788 native forest and woodland vegetation has been cleared, with 9 million ha of the remaining 25 million ha estimated to be degraded. They identified there are 269 forest-dependent nationally (EPBC Act) listed threatened taxa in NSW. An estimated 435,000 ha of State Forests was logged from 2000-2022, affecting 150 EPBC taxa, 13 of which are listed as Critically Endangered, 51 as endangered, and 86 as vulnerable. Fauna with the highest proportion of their NSW distribution affected by logging include long-footed potoroo, southern mainland long-nosed potoroo and southern brown bandicoot. Taxa with the most distribution by area that overlapped with logging included koala (400,000 ha), south-eastern glossy black-cockatoo (370,000 ha), and spotted-tailed quoll (310,000 ha).

The NSW biodiversity outlook report 2024 identifies that across NSW only 29% of the capacity of habitat to support native species remains, emphasing that past habitat loss and future climate change will significantly reduce the capacity of landscapes to retain biodiversity over the next 50 years, with only 50% of currently threatened species expected to survive the next 100 years.

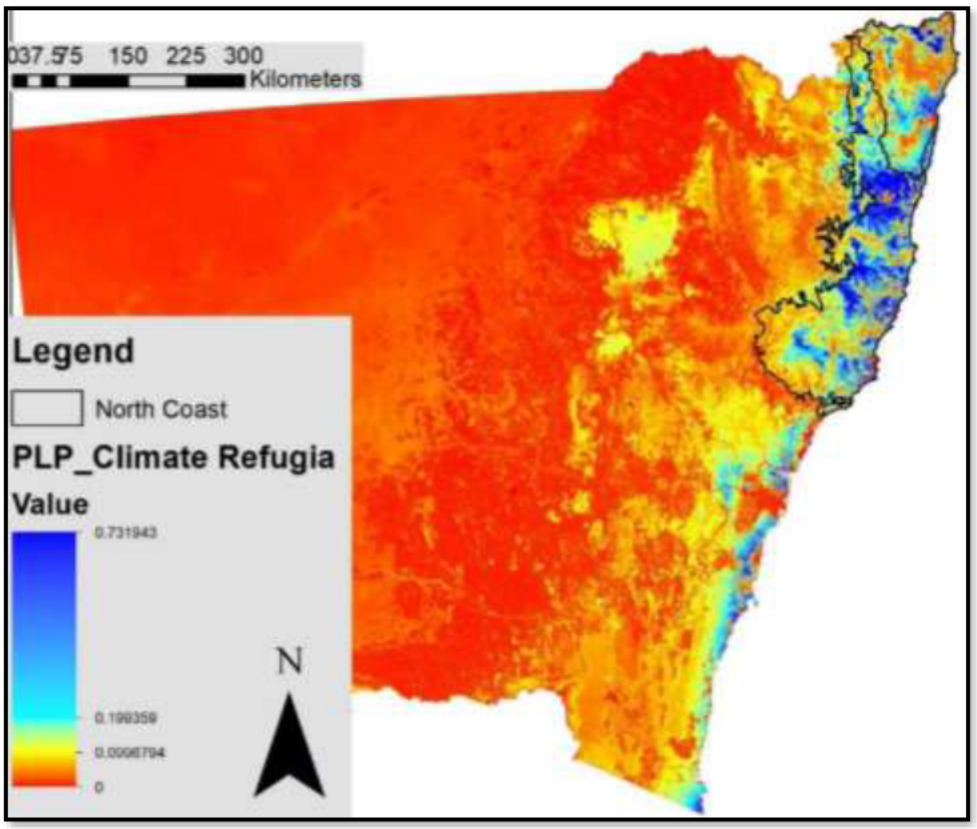
The outlook report is based upon the State Government of NSW and NSW Department of Climate Change, Energy, the Environment and Water (2022) 'Persistence in the Landscape Project' (PLP). One of the data sources is 'Ecological carrying capacity of terrestrial habitat' which is used to account for the carrying capacity of a landscape to support its original complement of biodiversity and ecosystems. This shows that the forests of eastern NSW have best retained their ecological carrying capacity, though does not reveal how much of that capacity has been lost in heavily logged forests. Along the coast the NSW biodiversity outlook report (2024) identifies a loss of 60-70% of ecological carrying capacity in each NSW bioregion, with a >10% loss due to the 2019/20 wildfires.



Map: Ecological Carrying Capacity relative to original capacity. Note the relatively high carrying capacity of east coast forests.

The 'Combined Climate Change Refugia' mapping graded combined climate refugia identified from 76 species from highest ***(dark blue)*** to lowest ***(red)*** up until 2070. Landscape capacity is a measure of how usable habitat is for supporting populations based on the quality of habitat and how easily

species can move across the landscape to access sufficient resources to support a population. This mapping shows areas that support species populations through time, identifying north-east NSW as being of outstanding importance for the long-term survival of a plethora of native species.



Map: State Government of NSW and NSW Department of Climate Change, Energy, the Environment and Water (2022) 'Persistence in the Landscape Project' (PLP) 'Combined Climate Change Refugia, mapping graded from highest ***(dark blue)*** to lowest ***(red)***. Note the exceptional long-term importance of north-east NSW as a climate refuge.

Across the 5.6 million hectares comprising the IBRA Bioregions of NSW North Coast and NSW section of South Eastern Queensland, there are currently 1.22 million hectares (21.6%) counted as part of the National Reserve System and some 0.67 million hectares (11.8 %) on State Forests. It is significant that State Forests represent a third of public lands and thus represent a significant contributor to the maintenance of biodiversity in the region.

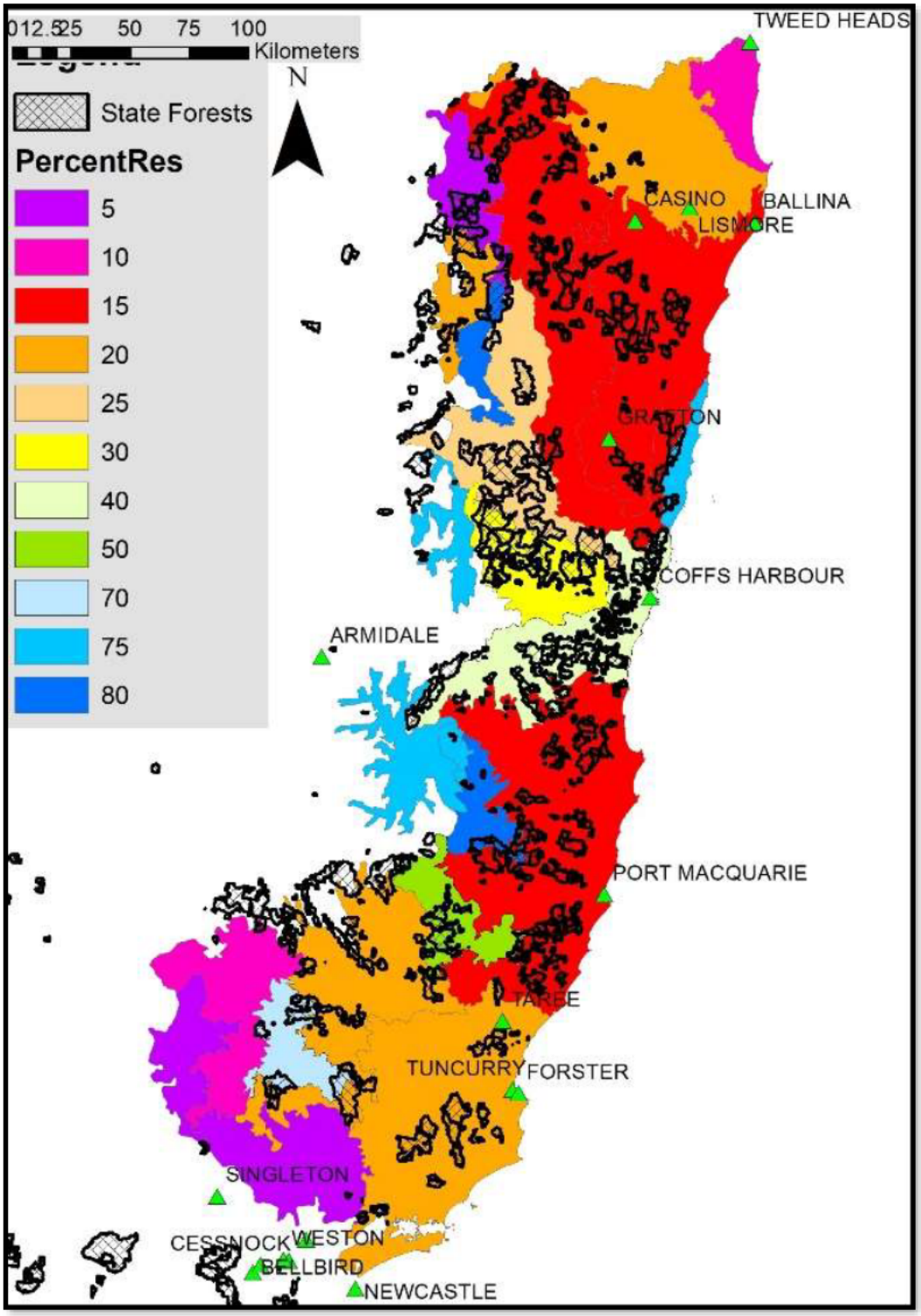
For the NSW section of the South Eastern Queensland IBRA bioregion incorporated in this assessment,14% is currently reserved, with 9.2% on State Forests, and all 6 IBRA subregions having under 20% in existing reserves:

Burringbar-Conondale Ranges 6.3%, Clarence Lowlands 11.2%, Clarence Sandstones 14.8%, Scenic Rim 18.9%, Sunshine Coast-Gold Coast Lowlands 6.3% and Woodenbong 14.4%.

For the NSW North Coast 25.3% is currently reserved, with 14% on State Forests and 8 of the 19 sub-regions below 20% reserved:

Cataract 4.8%, Ellerston 1.7%, Karuah Manning 16.1%, Macleay Hastings 14.2%, Mummel Escarpment 19%, Rocky River Gorge 15.2%, Tomalla 5.6%, Upper Hunter 1.4%.

For the New England Tablelands IBRA bioregion, which in part encompasses forests to the west of north-east NSW, only 9.6% is reserved , with 4% on State Forests.



This map depicts the reserve status (percentage of subregions in parks and reserves) of IBRA subregions within the IBRA Regions of NSW North Coast and the NSW section of South Eastern Queensland, in 5% increments (i.e. 5=0-5%, 10=5-10%, 15=10-15% etc), with an overlay of State forests (hatched). This shows that there are significant areas of State forests available for reservation in north east NSW to enable significant progress to the 30 by 30 goal.

For one of the world's 36 Biodiversity Hotspots, it is clear that we need to protect all native vegetation on State forests to progress the State and Federal Government's goal to protect 30% of our land area by 2030. Australia committed to this under the Morrisson Government in 2021, joining

100 other countries that had signed onto this “30by30” target. The Albanese Government recommitted to it in 2022.

30 by 30 is the third of 23 global biodiversity targets for 2030 in the Kunming-Montreal Global Biodiversity Framework, adopted in December 2022:

> *Ensure and enable that by 2030 at least 30 per cent of terrestrial, inland water, and of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem functions and services, are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas and other effective area-based conservation measures, recognizing indigenous and traditional territories, where applicable, and integrated into wider landscapes, seascapes and the ocean, while ensuring that any sustainable use, where appropriate in such areas, is fully consistent with conservation outcomes, recognizing and respecting the rights of indigenous peoples and local communities, including over their traditional territories.*[13]

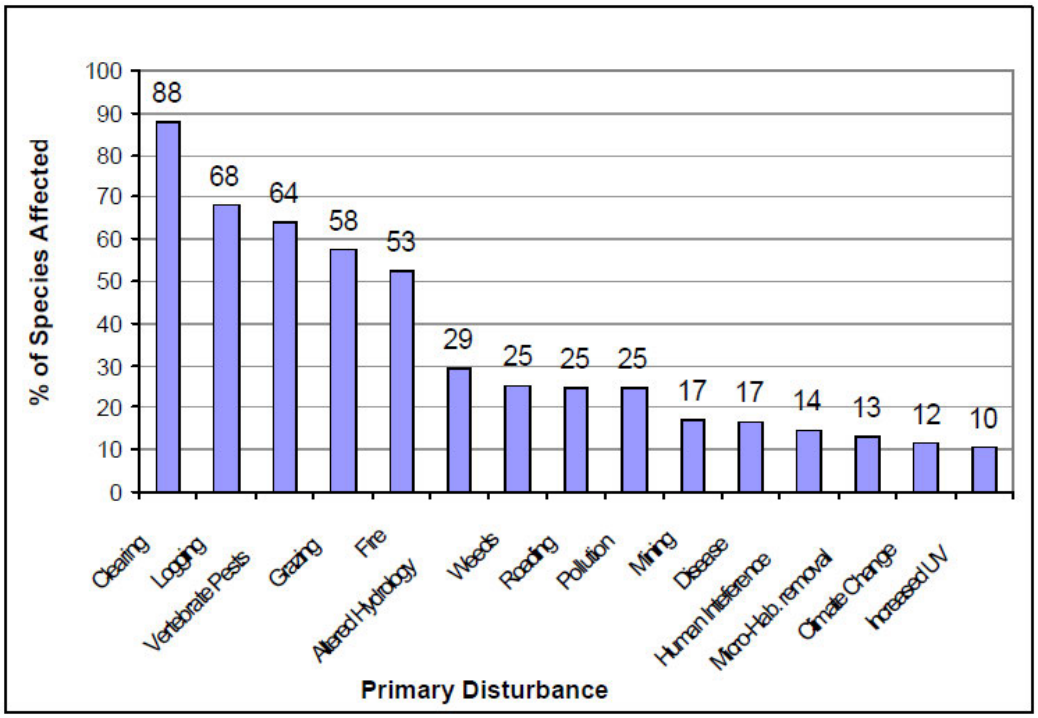
The target also sets out several elements that need to be considered, specifying:

- **At least 30 per cent of terrestrial and inland water areas, and of marine and coastal areas** – This quantitative element of the target specifies that, globally, at least 30 per cent of terrestrial and inland water areas, and at least 30 per cent of marine and coastal areas should be conserved or protected by 2030.
- **Areas of particular importance for biodiversity and ecosystem functions and services –** Areas particularly important for biodiversity include areas high in species richness or threatened species, threatened biomes and habitats, areas with particularly important habitats and areas that are important for the continued provision of ecosystem functions and services. The protection of such areas should be prioritised in reaching this target
- **Effectively conserved and managed –** Protected areas and OECMs must be managed with the primary objective of achieving positive outcomes for biodiversity. Effective management and sustained positive outcomes for biodiversity conservation requires the adoption of appropriate management objectives and processes, governance systems, adequate and appropriate resourcing and consistent monitoring.
- **Ecologically representative -** Protected area and OECMs should contain adequate samples of the full range of existing ecosystems, ecological processes and regions.
- **Well-connected –** In order for protected areas and OECMs to be effective, they should be connected through corridors as well as **integrated into wider landscapes, seascapes and the ocean.** This is an essential element of creating effective systems or networks of protected and conserved areas that can meet sustained *in situ* conservation outcomes and cope with stresses and disturbances, including from the impacts of climate change.

During expert workshops conducted as part of the CRA process for North East NSW information describing the disturbances that affect the priority species was collected (Environment Australia 1999). This involved experts listing all the disturbances affecting a species and then ranking them in terms of their impact on the regional population. Those disturbances that had the most detrimental affect were ranked one and so on. Many species have multiple threats. For 175 priority fauna species in north-east NSW the expert panels assessed threats are detailed in Environment Australia (1999). In summary the experts (including FCNSW and NPWS) identified:

- clearing is a serious threat to 88% of species, and a primary threat to 59% of species;
- logging is a serious threat to 68% of species, and a primary threat to 25% of species;
- grazing is a serious threat to 58% of species, and a primary threat to 22% of species;
- vertebrate pests are a serious threat to 64% of species, and a primary threat to 14% of species;
- fire is a serious threat to 53% of species, and a primary threat to 14% of species;

- altered hydrology is as a serious threat to 29% of species and a primary threat to 10% of species; and,
- weeds are a serious threat to 25% of species, and a primary threat to 5% of species.



The percentage of all fauna species assessed that have the listed disturbances nominated as having an adverse impact. From Environment Australia (1999).

Maintaining viable populations of fauna is a key requirement of ESFM, though it is evident that there needs to be a significant expansion of reserves in north-east NSW to achieve this. For establishing the Comprehensive Adequate and Representative Reserve System in accordance with the objective of the national forest reserve criteria (JANIS 1997*) "to maintain viable populations of native forest species throughout their natural ranges",* reservation targets were established for indicative viable populations of all priority fauna in north-east NSW on a meta-population basis (Flint *et. al.* 2004). Population targets (expressed in hectares) were used in the conservation planning database for 139 fauna species. When applied to separate populations, this resulted in targets being set for a total of 710 fauna populations.

A review of target achievement in 2004 (Flint *et. al.* 2004) found that only 31% of the targets for 710 fauna populations had been achieved, with 72 (52%) of the 139 species with targets set failing to meet target for any of their populations. Only 29% of significant fauna populations fully achieved reservation targets, and across all populations the mean target achievement was only 49%.

The expert panels ranked species according to their vulnerability to threatening process and the priority to include them in the reserve system, with Flint et. al. (2024) finding "*Species classified as highly vulnerable are less adequately reserved than low vulnerability species according to the mean target measure, with mean target achievement of 42% and 59% respectively*", further noting:

> *Of the 38 fauna species ranked by the expert panel as having the highest vulnerability to threatening processes (vulnerability 1), 30 do not attain targets for any populations, and none attain targets for all populations. Only 8 species attain targets for one or more populations. Therefore, species with the highest vulnerability to threatening processes remain very poorly reserved.*

The following are examples of target achievement for populations of some key forest species known to be adversely affected by logging on State Forests, from Flint et.al. (2004):

Table 2. Population target achievement for the nationally endangered Hastings River Mouse *P. oralis*.

Population	Population Target area (ha)	Targeted No of Breeding Units (no)	No of Breeding Units Reserved (no)	Mean Target Met (%)
1	12728	4238	3	1%
2	25456	4251	116	3%
3	25456	4251	322	8%
4	25456	4251	47	1%
5	12728	4238	523	12%
6	12728	4238	1231	29%
7	25456	4251	287	7%
8	25456	4251	334	8%
Total	**165464**	**33969**	**2863**	**8%**

Table 7. Population target achievement for the nationally endangered Spotted-tailed Quoll *D. maculatus*.

Population	Habitat target area (ha)	Area of habitat reserved (ha)	Targeted No of Breeding Units (no.)	No of Breeding Units Reserved (no.)	Mean Target Met (%)
1	519615	53845	1039	108	10.36
2	900000	163139	1800	326	18.13
3	636396	351259	1273	703	55.2
4	212132	212132	424	64	15.04
Total	**2268143**	**780375**	**4536**	**1201**	**25**

Table 9. Population target achievement for the four threatened forest owls.

Species	Population	Habitat Target area (ha)	Targeted No of Breeding Units (no)	No of Breeding Units Reserved (no)	Mean Target Met (%)
Barking Owl	1	402492	805	91	11%
	2	402492	805	143	18%
Total		804984	1610	234	14%
Masked Owl	1	734847	735	160	22%
	2	734847	735	172	23%
Total		1469694	1470	332	22%
Powerful Owl	1	377964	378	168	44%
	2	377964	378	298	79%
Total		755928	756	466	61%

Table 10. Population target achievement for the vulnerable Yellow-bellied Glider *P. australis*.

Population	Habitat Target area (ha)	Area of habitat reserved (ha)	Targeted No of Breeding Units (no)	No of Breeding Units Reserved (no)	Mean Target Met (%)
1	115470	24522	1155	245	21
2	115470	15994	1155	160	14
3	115470	33648	1155	336	29
4	115470	15226	1155	152	13
5	115470	37648	1155	376	33
6	115470	7264	1155	73	6
7	115470	14085	1155	141	12
8	230940	30684	1155	153	13
Total	**10393320**	**179071**	**9240**	**1636**	**18**

As noted by Flint et.al. (2004)

> *… the scale of the reserve outcome is inadequate to ensure the survival of priority species in north-east NSW. There is still a long-way to go to establish the promised comprehensive, adequate and representative reserve system in north-east NSW*

The fundamental problem was that the NSW Government decided that the reserve outcome had to meet minimum volumes of timber committed to the timber industry, which precluded the satisfaction of reserve targets established in accordance with the National Forest Policy and Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System for Forests in Australia (JANIS 1997), as noted by Flint et.al. (2004).:

> *When viewed comprehensively, the process of forestry reform over the last decade or so (1992-2003) in NSW raises fundamental questions about the relationship between science and politics. Despite all of the scientific data and assessments conducted during the CRA process and the strong scientifically-based policy commitments underpinning them (e.g. Anon 1992, JANIS 1997), it was ultimately pure politics that determined the size of the reserve outcome. There was a single political parameter set down by the NSW Government to constrain the result of the process - the delivery of a specified and contracted level of timber to the industry for a 20 year period. This effectively nullified any ability to satisfy conservation targets and has severely impeded future conservation opportunities on State Forests in the region.*

A decision on the north east forests was made in 1998 by the NSW Government, and in 2000 the NSW and Commonwealth Governments formalised the North East NSW Regional Forest Agreement (NERFA). The NERFA was only meant to last for 20 years before a new assessment was undertaken, which would have required a new Comprehensive Regional Assessment and a review of the purported Comprehensive Adequate and Representative reserve system. Instead, the NSW and Commonwealth Governments decided to not undertake a new assessment and extended the 2000 NERFA indefinitely with no new assessment ever required.

As part of the RFA's indefinite extension, a new coastal Integrated Forestry Operations Approval (CIFOA) was negotiated between the EPA and Forestry Corporation, on the premise that there be *no net change to wood supply* (see section 1.4 for discussion and case studies). As with the identification of a Comprehensive, Adequate and Representative reserve system, this has required reducing required protections for threatened species. To compound the problems of inadequate reservation, identified declines in populations of numerous threatened species, and increasing logging impacts, there were numerous reductions in environmental constraints that were agreed between the agencies to satisfy existing timber commitments when negotiating the CIFOA, such as:

- increasing logging intensity across public forests (mostly doubling tree removal), and creating a 140,000ha North Coast Intensive Zone to allow Eden-style alternate coupe clearfelling,
- halving the measly 10m wide stream buffers in our vital headwaters while also allowing logging of riparian habitat protected for the past 20 years,
- removing the requirements to protect the next largest trees as recruitment trees to replace the hollow-bearing trees as they die out,
- removing the requirement to protect a sample (i.e. variously 3-5 per hectare) of mature high nectar-producing trees so essential to provide the abundant nectar needed by a plethora of species.
- removing of the need to survey for most threatened species, the removal of most species specific prescriptions and the opening up for logging of most exclusions for threatened species established over the past 20 years.
- removing of requirements to thoroughly search for Koalas ahead of logging and protect Koala High Use Areas, while zoning 43% of the highest quality habitat for extensive clearfelling.

- allowing logging dieback to run rampant through our forests.

There were a variety of issues that the agencies were not able to agree on (NRC 2016), for which the Natural Resources Commission (NRC) mostly sided with the Forestry Corporation against the EPA based on resource shortfalls, including:

- reductions in the minimum area of landscape exclusions within logging areas
- reductions in the minimum numbers and size of trees to be retained for Koalas
- increases in the minimum sizes of "giant trees" to be retained
- increases in the size of patches allowed for clearfelling
- reductions in minimum basal area retention under "selective" logging

See 1.4.3. for a case study on Koalas.

It is alarming that logging does not need to comply with species or ecosystem recovery plans. The 2018 Coastal IFOA only mentions recovery plans in one place, where it requires "*incorporate actions specified in approved recovery plans, action statements and Saving our Species plans published by the Office of Environment and Heritage or equivalent*" when the Forestry Corporation are preparing "***species management plans*".** The only Federally threatened species identified as requiring Species Management Plans in north-east NSW are the Eastern Bristle Bird and the plants *Euphrasia arguta*, Native Jute (*Corchorus cunninghamii*), and Milky Silkpod (*Parsonsia dorrigoensis*).

Irrespective of what new evidence comes to light, the declining status of many species, and the impacts of exceptional events such as the 2019/20 wildfires, the EPA is not allowed to require any increased protection for threatened species that may have a material impact on timber commitments (particularly see sections 1.4.2 and1.4.6,).

Application of prescriptions in the real world is where the process can often fail. In practice poor implementation is a common occurrence in NSW. NEFA considers that this is testimony to regulatory failure in NSW. Even the small sample of convictions Justice Pepper (*Director-General, Department of Environment, Climate Change and Water v Forestry Commission of New South Wales [2011] NSWLEC 102*) reviewed led her to conclude:

> *However, in my view, the number of convictions suggests either a pattern of continuing disobedience in respect of environmental laws generally or, at the very least, a cavalier attitude to compliance with such laws.*
>
> *... Given the number of offences the Forestry Commission has been convicted of and in light of the additional enforcement notices issued against it, I find that the Forestry Commission's conduct does manifest a reckless attitude towards compliance with its environmental obligations ...*

3. Demand for timber products, particularly as relates to NSW housing, construction, mining, transport and retail

There is no longer any need to log public native forests. The market has already driven most production to plantations and it is time to complete the transition. Sawn timber from pine plantations and engineered timbers have largely displaced hardwood from the construction industry, which is an ongoing process. Export woodchipping is increasingly being displaced by plantation woodchips. Engineered timber from plantations is stronger than sawn timber for structural purposes. Composite fiberglass poles are replacing timber power poles. Solid hardwood flooring is an expensive product with far cheaper engineered, laminated and hybrid alternatives. Composite decking made from recycled plastic and pine sawdust is a cheaper and more durable alternative to solid timber. Pallets can be made from plantation timbers, and usage could be decreased by better recycling. There are many alternatives to native hardwoods for fencing. Mining props can be met from plantations. With a change in emphasis and a focus on supporting domestic manufacture of engineered timber products we can satisfy all our timber needs from existing plantations. Timber from private properties can satisfy requirements for speciality hardwood products.

Native hardwoods comprised 2.4 million (9%) of Australia's log production of 25 million cubic metres in 2023, with half this exported as woodchips. Saw and veneer logs comprised just 8% of the 8.5 million cubic metres of logs obtained from hardwood plantations, with 87% exported as woodchips. With a change in emphasis, we can satisfy our hardwood needs with sawn timber and composite timber products from existing plantations. There is no longer any need to log public native forests. The market has already driven most production to plantations and it is time to complete the transition.

There is no longer any need to log public native forests to satisfy our timber needs, with the transition well under way it is time to complete it. In north east NSW the principal products obtained from native forests are structural timber, hardwood flooring, decking, power poles, mining props, and fencing. Sawn timbers from softwood plantations and engineered timbers have largely displaced native hardwoods from the construction industry, which is a continuing process. There are a variety of engineered timber products sourced from plantations as alternatives for structural timber. Solid hardwood flooring is an expensive product with far cheaper engineered, laminated and hybrid alternatives, including bamboo flooring. Composite decking made from recycled plastic and wood fibre is also cheaper and a more durable alternative to solid timber. Pallets can be made from plantation timbers, and usage could be decreased by better recycling. There are many alternatives to native hardwoods for fencing. Energy companies are switching to fibreglass composites power poles because they are more durable and resilient to bushfires. Woodchips are increasingly being obtained from domestic and overseas plantations.

As identified in the "Inquiry into long term sustainability and future if the timber and forest products industry" (Report 54 - September 2022) sawn timbers from softwood plantations and engineered timbers are increasingly displacing hardwoods in the construction industry, which is an ongoing process:

> ***2.4*** *As was noted by several witnesses, the overwhelming majority of timber used in housing construction is from softwood plantations. Mr Warwick Drysdale from the Frame and Truss Manufactures Association of Australia said 'by far the greatest percentage of timber used in frames and trusses is presently, but not necessarily, from a softwood resources'. Mr Simon Croft from the Housing Industry Association said 'certainly I think there's less and less*

hardwood used and more of some solid pine softwoods, by a lot of engineered timbers being utilised for the structural applications'

***2.5** Timber NSW acknowledged that softwood pine has become the timber of preference for New South Wales residential house frames and is the main fibre source for commodity products like plywood, fibreboard, and paperboard.*

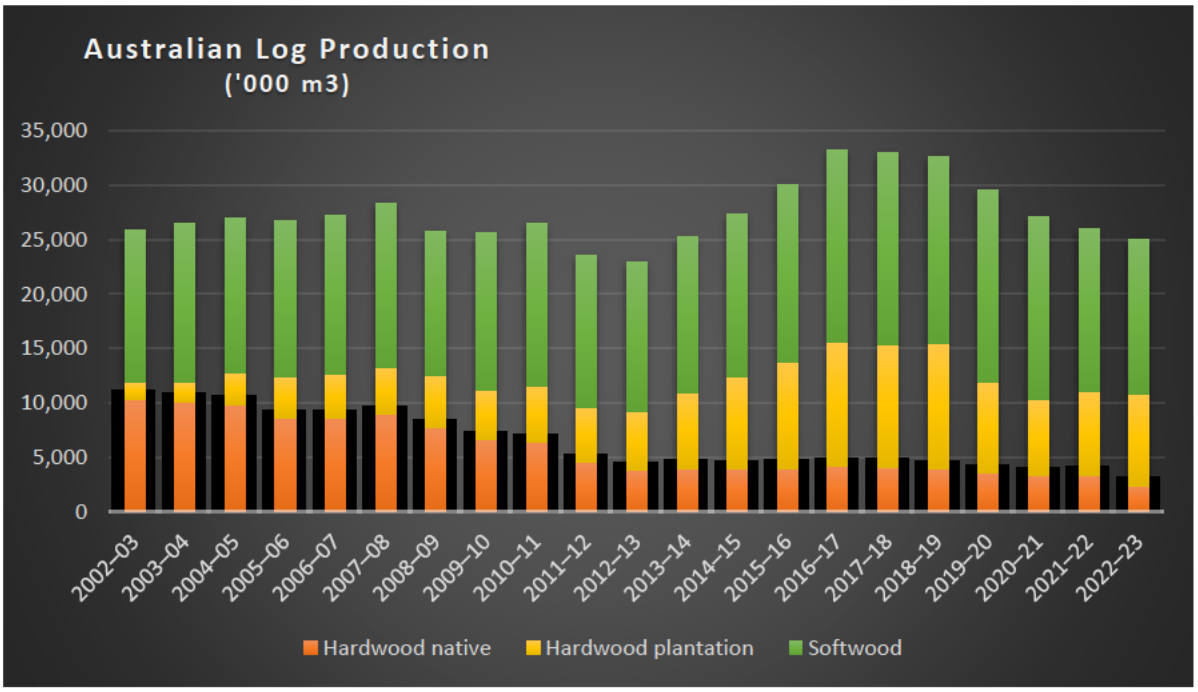
***5.49** Similarly, the committee heard that the industry across the supply chain is adopting and looking to other opportunities to address available supply.408 For instance, Timber NSW reported that to overcome the limited supply of hardwood, 'softwood products have made considerable inroads into structural markets that have been the traditional domain of native hardwood … through the production of engineered wood products and the treating of softwood timber to make it suitable for outdoor use'.409*

***5.50** Along the same lines, industry stakeholders also predicted that the new ways of construction will become more common, with many applying these efficient methodologies by mixing common building materials and engineered timber products such as Medium Density Fibreboard (MDF), Laminated Veneer Lumber (LVL) and Cross-laminated Timber (CLT).410*

***5.51** According to the Institute of Foresters Australia and Australian Forest Growers, engineered wood products utilise wood more effectively than solid timber products. The Institute further explained that 'laminated beams carry greater loads in longer spans than equivalent end-sections in sold timber and exhibit minimal lifecycle analysis [method of assessing environmental impacts] values when compared with aluminium, steel and masonry'. The Institute further considered that this would create future opportunities to meet supply and demand constraints.*

4. The future of softwood and hardwood plantations and the continuation of Private Native Forestry in helping meet timber supply needs

With a change in emphasis, we can meet all our current timber needs from existing plantations. Hardwood and softwood plantations already provide 91% of Australia's log production. Already hardwood plantations produce 3.5 times the timber produced from native forests, The proportion of saw and veneer logs obtained from hardwood plantations needs to be increased, rather than 87% being exported as woodchips. Without competition from subsidised public native forests there will be an increased incentive for utilising plantation timber for higher uses, and selective logging of speciality purpose hardwoods from private forests. Some Government assistance may be required to assist the transition, particularly by filling gaps in domestic composite timber manufacturing.



Australian log production 2022/23 (ABARES),

Native forest logging has declined by 77% over the past 20 years. An Australia Institute report (Macintosh 2013) summarised key factors that had contributed to the contraction of the native forest sector in Australia:

- Increase in competition from domestic plantation softwoods in the structural timber market.
- Increase in competition in export hardwood woodchip markets from domestic and foreign plantations, particularly in Vietnam.
- Increase in competition from domestic and imported engineered wood products.
- Weak demand in the structural timber market.
- In some jurisdictions, a reduction in the public native forest estate and introduction of more stringent forest management regulations.
- Wood-saving innovations in production processes and related product substitution that have suppressed growth in global wood demand and helped constrain global solid wood prices.
- Increasing harvesting and haulage costs.

These market trends are continuing to contribute to the decline of the sector. The clear trend is for declining production from native forests and increasing production from plantations.

ABARES (2023) data shows that in 2022/23 for Australia:

- Native hardwoods comprised 9% of Australia's log production of 25 million cubic metres, with the rest coming from plantations
- Of the 9% (2.4 million m^3), saw and veneer logs comprised 46%, with around half exported as woodchips
- Of the 8.5 million m^3 obtained from hardwood plantations, saw and veneer logs comprised just 8%, with 87% exported as woodchips.

In 2022/23 (ABARES 2023) hardwood plantations produced 3.5 times the volume of wood obtained from native forests, though only 8% of production was saw and veneer logs. Even then 690,000m^3 (39%) of hardwood sawn and veneer logs were produced from plantations compared to 1,076,000 m^3 from native forests. By comparison 8,083,000 m^3 of saw and veneer logs were produced from softwood plantations, representing 57% of timber output from pine plantations. It is apparent that an increase in production of hardwood sawn and veneer logs from plantations is feasible and could easily satisfy our hardwood timber needs, particularly with increased production of composite timber products.

In 2022/23 NSW produced 4,309,000 m^3 of timber products, with 661,000 m^3 (15%) from native forests. It is apparent that timber production from plantations in NSW is lagging other states. In 2022/23 NSW produced 2,212,000 m^3 of saw and veneer logs, with 1,729,000 m^3 (78%) coming from pine plantations, 405,000 m^3 (18%) from native forests and 78,000 m^3 (4%) from hardwood plantations. There is room for expansion of hardwood plantations in NSW on cleared land, though this is not necessary for a transition out of native forest logging given the potential in other states to satisfy demand.

With an emphasis on sawn wood and engineered wood products, existing plantations can meet our hardwood needs. While the production of sawntimber from hardwood plantations has gradually been increasing there needs to be incentives to increase supply of sawn and engineered timbers, this could also involve diverting public funds expended on upgrading native forest sawmills into new composite timber processing facilities. NEFA objects to the export of timber when it is needed for the domestic market, as identified by the recent Portfolio Committee No. 4 - Customer Service and Natural Resources inquiry into 'Long term sustainability and future of the timber and forest products industry':

> **2.120** Other calls for action to secure timber supply similarly recognise the current pressures on the industry, such as the role of recent global events which have affected the imports and exports market. While we understand that New South Wales imports significantly more timber than it exports to meet its supply needs, the committee nevertheless shares the frustrations of those stakeholders who question why timber and forest products are being exported for processing only for the finished products to be returned and sold to back to the country. We recognise the NSW Government has made moves to limit timber exports but the committee believes greater consideration needs to be given to the import and export model if local supply needs are to be met and more opportunities for local processing and manufacturing are to be provided. Indeed, the committee notes the calls for timber exports to be limited to address short-term supply needs.
>
> **2.121** As such, the committee recommends that the NSW Government prioritise a review of its current timber import and export model, including consideration of limits on timber exports, to address short term and long term supply needs.
>
> **Recommendation 6**

That the NSW Government prioritise a review of its current timber import and export model, including consideration of limits on timber exports, to address supply needs.

Summary of principal issues discussed

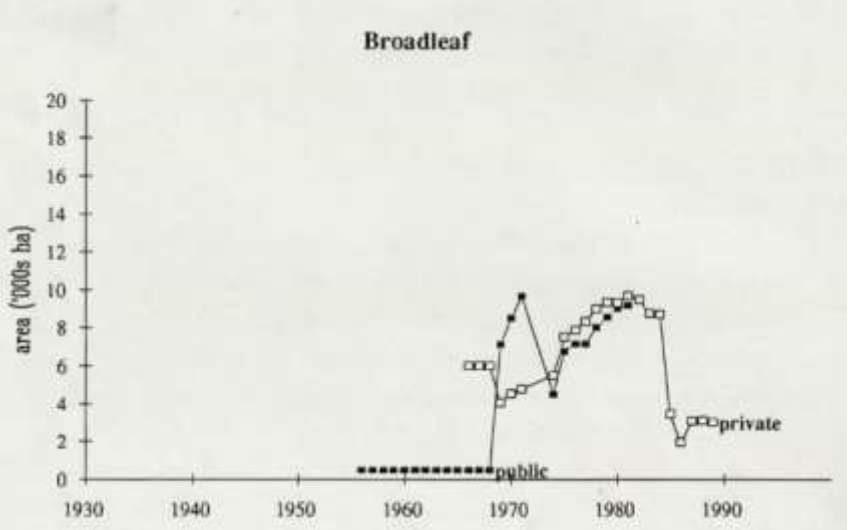
The Forestry Corporation has been engaging in a process of [redacted] claiming areas of native forest as plantations since they first identified hardwood plantations in around 1990, with the criteria being that there was some evidence of seeds being scattered or seedlings planted decades earlier, with no site assessment required. Since then, the Forestry Corporation has been steadily converting native forests into plantations. In 2000 and again in 2018 the Forestry Corporation claimed greatly expanded areas as hardwood plantations. Now once again the Forestry Corporation are claiming an expanded area, even adding areas in the past 2 years. While it is recognized that the forestry corporation has purchased some cleared lands for plantations, the conversion of native forests to plantations by stealth in objected to and many claimed plantations are not considered valid. Even where plantations were genuinely planted by clearing native forests, some are inappropriately sited and need to be restored for ecological reasons.

It is apparent that in north east NSW a significant volume of resources are obtained from private properties that will not be affected by protecting public native forests, thereby allowing a continuing supply of speciality hardwood products. The problem is that Private Native Forestry is not ecologically sustainable and not adequately regulated. Hopefully without competition from Government subsidised logging, landholders will be able to require a higher price and be encouraged to manage their forests in a more sustainable manner. It is considered that given their significant impacts and extent, PNF operations should be subject to a Development Application process like other developments on private lands.

4.1. Plantation Creep

The Forestry Corporation has been engaging in a process of [redacted] claiming areas of native forest as plantations since they first identified hardwood plantations in around 1990, with the criteria being that there was some evidence of seeds being scattered or seedlings planted decades earlier, with no site assessment required. Since then, the Forestry Corporation has been steadily converting native forests into plantations. In 2000 and again in 2018 the Forestry Corporation claimed greatly expanded areas as hardwood plantations. Now once again the Forestry Corporation are claiming an expanded area, even adding areas in the past 2 years. While it is recognized that the forestry corporation has purchased some cleared lands for plantations, the conversion of native forests to plantations by stealth in objected to and many claimed plantations are not considered valid. Even where plantations were genuinely planted by clearing native forests, some are inappropriately sited and need to be restored for ecological reasons.

By the early 1980s the then Forestry Commission had established around 9,000 ha of hardwood plantations, then decided to stop identifying hardwood plantations and treat them as a continuum with native forests.



RAC 1991 'Trends in the area of public and private plantations: New South Wales, 1930-90'. The black squares are public lands. Note that after a flurry of plantation establishment in the late 1960s, with many apparent failures, by the early 1980s there were around 9,000 ha of hardwood (broadleaf) plantations on public lands across the whole of NSW, thereafter they ceased to exist.

By 1990 the Forestry Commission were being criticised for their lack of hardwood plantations, so in 1991 they retrospectively classified 25,000 ha of native forests as hardwood plantations, in an ambit claim for any forests they had intensively logged in the past where they had records that someone had sown some seed or planted some jiffy pots (in some part of the area), or claimed they had, a common silvicultural practice in the laissez faire 1960s, 70s and 80s. In 1992 the Forestry Commission reported these new claims in "Research Paper No.15 Eucalypt Plantations in New South Wales" by Richard Stanton. It identified some 25,000 hectares of eucalypt plantations based on the definition "*An area that has been established after full site clearing, with full or at least good stocking of eucalypts, by planting or direct sowing of seed*", noting "*The areas currently recorded are taken from planting records and do not presume to make any conclusion about the current condition of the areas planted*". Further observing:

> *However, plantings of native species can easily become what appears to be a "natural" system, especially if planting is only supplementary to natural regeneration and when the area of plantation is completely surrounded by native forest.*

To resolve the status of claimed plantations for the NE NSW Comprehensive Regional Assessment (CRA), State Forests established the Eucalypt Plantation Technical Advisory Committee (EPTAC) in February 1997 to oversee the identification of areas meeting the definition of plantations in accordance with the Timber Plantations (Harvest Guarantee) Act 1995, which required the majority of the canopy to be formed by planted trees. After the 1998 forest decision which resulted in transfer of large areas of State forest to National Parks, in 2000 the rebranded State Forests decided to bypass the EPTCA and publicly exhibited 27,100 ha they were seeking accreditation for as hardwood plantations. They included some of the 1990 areas, along with 9,000 ha of additional areas. Any area where a forester claimed to have thrown around some seeds or planted some seedlings in the 1960s and 70s, or where aerial photos showed intensive logging, were fair game, irrespective of whether they met the requirement that the majority of the canopy was formed by planted trees. By then they had also purchased, with State and Federal funds, large areas of private property for hardwood plantation establishment which were not included.

In company with experts, in 2000 I undertook an assessment 'Creative Plantations, an Assessment of Whian Whian' of 5 areas of claimed Blackbutt plantations, totalling 360ha, in the then Whian Whian State Forest. This involved reviewing the grossly inadequate supporting data, and undertaking canopy transects, finding that in 3 of the areas Blackbutt only formed 3-6% of the

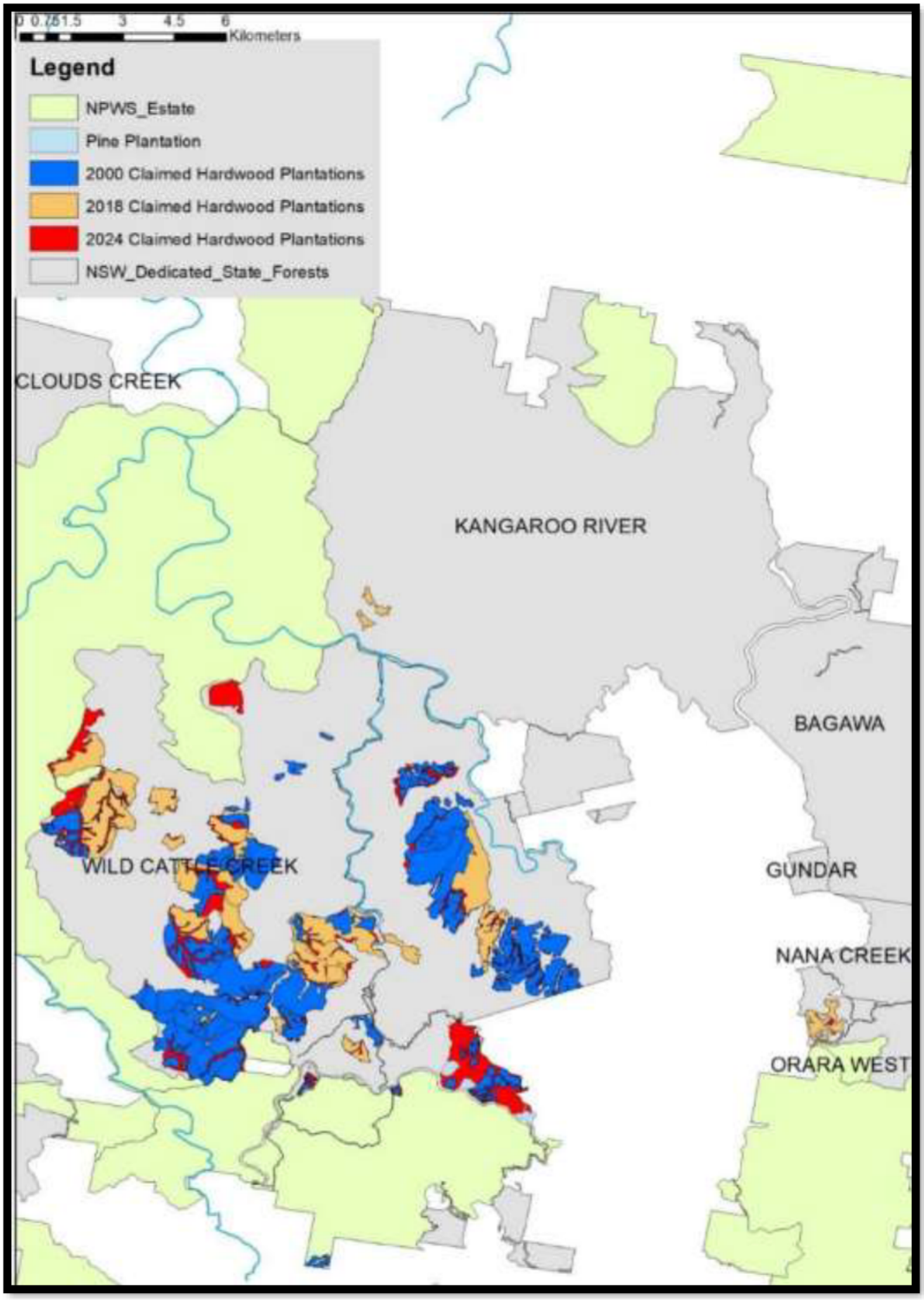
canopy, and while in the other 2 the majority of the canopy was indeed Blackbutt, they were naturally Blackbutt forest and the range of tree sizes and lack of planted rows did not allow their differentiation from regenerating natural stands. These were amongst several areas that assessments clearly showed did not meet the plantation definition that were none-the-less shamelessly approved. In this case Whian Whian was later made into a State Conservation Area.

An example of misrepresentation of rainforest as plantation, which had been identified by us as unsuitable in 2000, was confirmed in our 2010 audit Preliminary Audit of Yabbra State Forest, Compartments 162 and 163, Supplementary Report 1, where 1.9ha of mapped rainforest with flooded gum planted on snig tracks and log dumps following earlier rainforest logging was logged as plantation despite still being mapped as rainforest. More than 100 trees of at least 20 rainforest species were identified to have been felled or otherwise killed within the mapped rainforest during the harvesting operation. A subsequent assessment by Doug Binns for the Forestry Corporation identified that an additional hectare of unmapped rainforest had also been logged. The Forestry Corporation was issued a Penalty Infringement Notice, with a $300 fine, for harvesting timber within IFOA mapped rainforest. With no rehabilitation requirements it was a profitable operation.

It is emphasized that the forests claimed as plantations in 2000 are not accepted as being valid, as the documentation for justification provided to EPTAC was inadequate or non-existent for many, and there was no assessment to determine whether 50% of the canopy was comprised of planted trees. Never-the-less it provides a benchmark to asses future additions against. The varying claims in 2018 and 2024 clearly illustrate a process of plantation creep, with an ever expanding plantation estate and corresponding reduction in the areas identified as native forests.

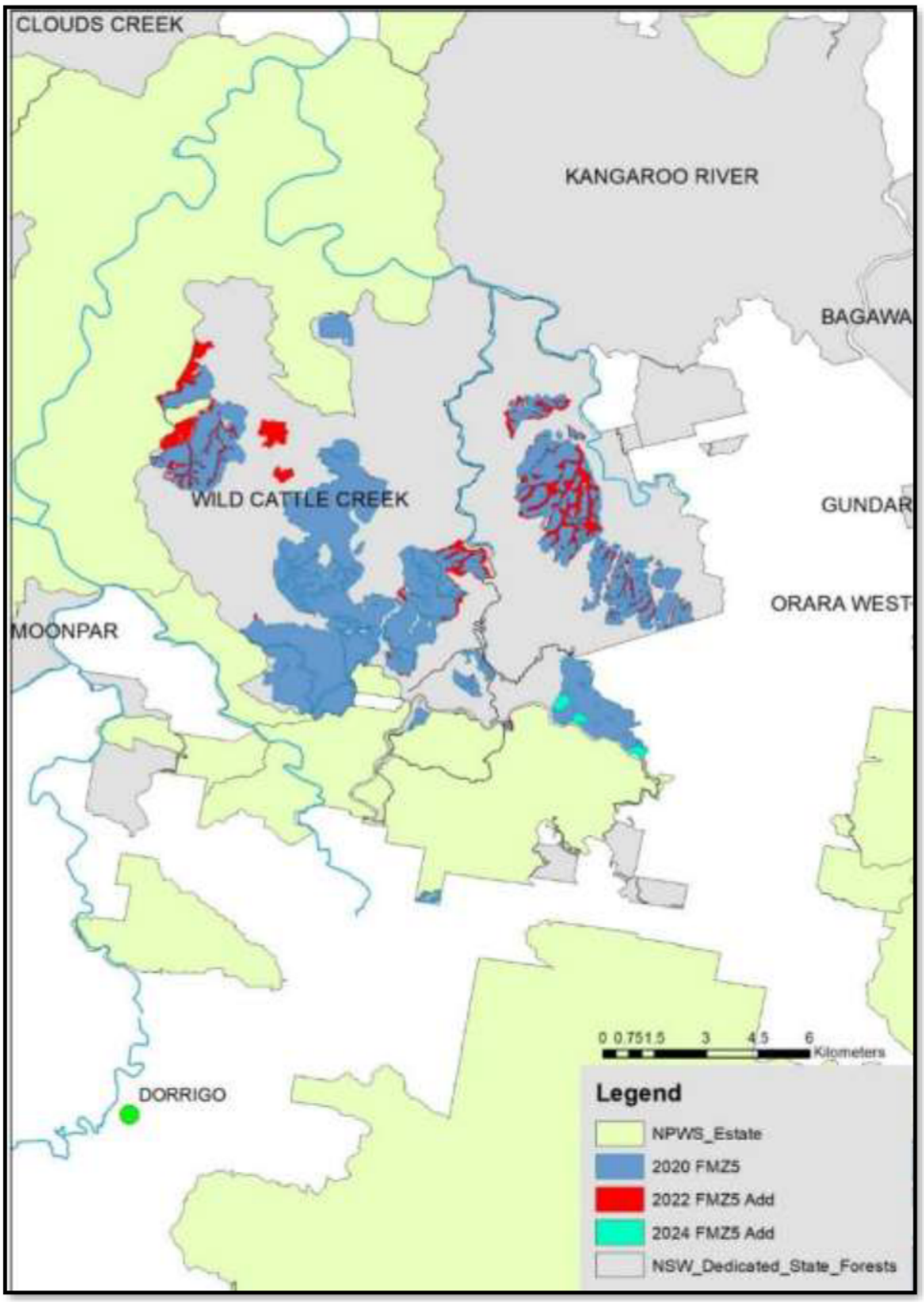
Plantation creep continued over the years, with the plantations identified in the revised forest type mapping released in 2018 as part of the outcome of the revised Coastal Integrated Forestry Operations (CIFOA) process taken to be the definitive 2018 claim for hardwood plantations. This covers 39,391 ha. Of this 1,918 ha was categorised as “failed”, which includes fragments of native vegetation in large pine plantations (i.e. Walcha and Urbenville areas) and some apparently failed plantations, which were included as it appears the intent is to convert the fragments in the pine plantations and replant the failed areas.

Since the 2018 CIFOA the plantation creep has continued, with many more areas added. An example of recent conversion of native forest to plantation is the reclassification and authorisation of 79 ha of high quality Koala habitat (Koala Hubs) identified as native forest in compartments 61, 62 and 63 of Wild Cattle Creek State Forest in 2020 as a hardwood plantation, based on the claim that some seeds were sown after logging in some part of the area in the 1960s and 70s. This was clearfelled, and planted with rows of blackbutt in 2022, with the timber obtained likely claimed as plantation timber.



An example of plantation creep in the proposed Great Koala National Park, showing the areas claimed as plantation in 2000 (**Dark blue**), areas of native forest added as claimed plantations 2018 (**Orange**), and additional areas claimed as plantations in 2024 (**Red**).

Another example of plantation creep is the Forestry Corporations recent changes in the zoning of forests as plantation, Forest Management Zone 5, in 2020, 2022 and 2024.



Another example of plantation creep in the proposed Great Koala National Park, showing the areas zoned as hardwood plantation (FMZ5) in 2000 (**Dark blue**), areas of native forest added as FMZ 5 in 2022 (**Red**) and areas most recently added as FMZ 5 in 2024 (**Aqua**).

The problem of plantation creep is more fully documented in Pugh (2022) The Plantation Debacle.

This problem is also apparent with Department of Primary Industries (DPI) authorised plantations, where despite the now applicable Plantations and Reafforestation Act 1999 definition "*plantation means an area of land on which the predominant number of trees or shrubs forming, or expected to form, the canopy are trees or shrubs that have been planted (whether by sowing seed or otherwise)*" they have knowingly authorised over 3,000 ha of 2018 mapped native forest as hardwood plantations. And there will have been numerous other areas mapped as native vegetation that were reclassified before the revised forest type maps were released.

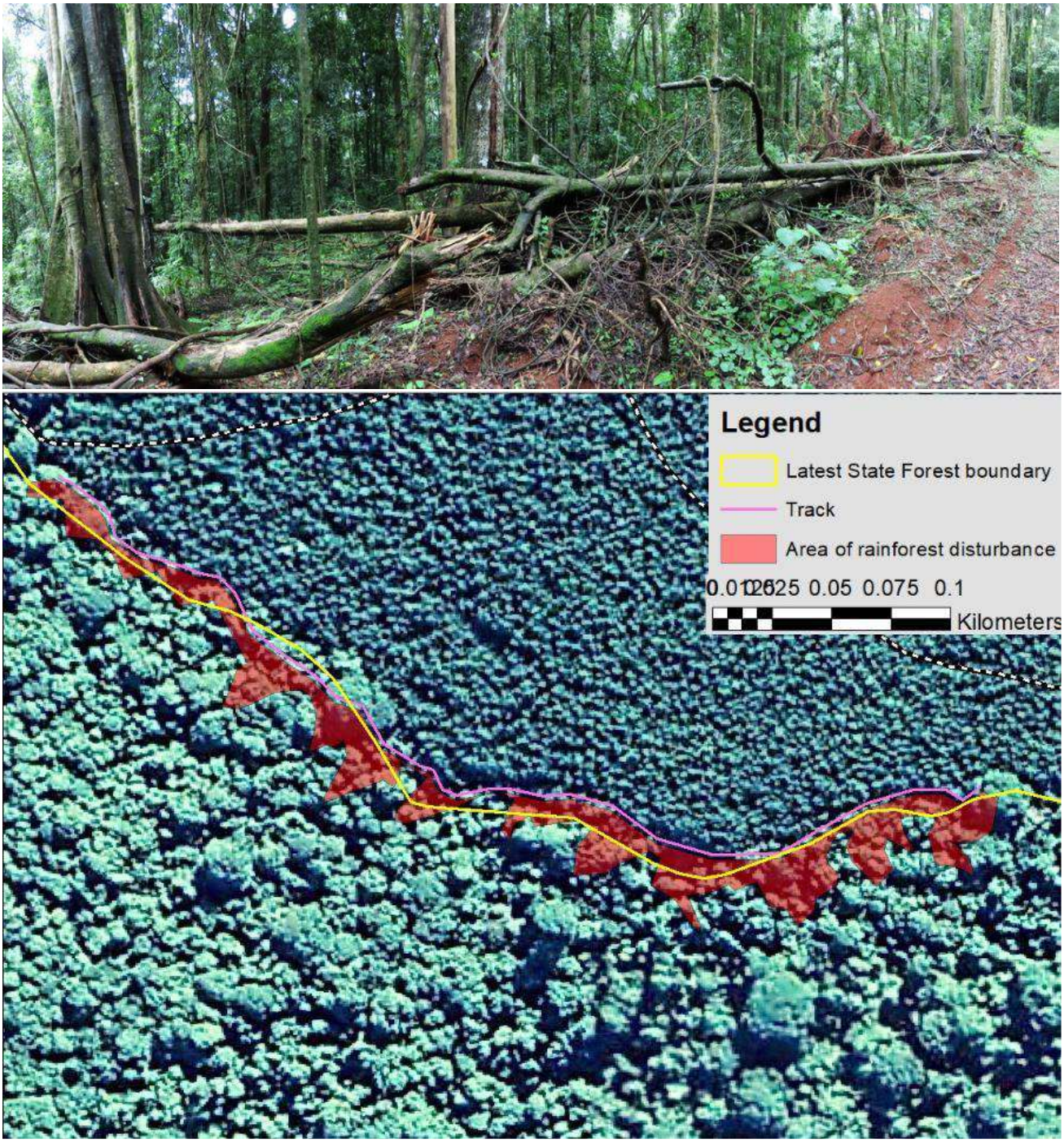
The Forest Corporation relies upon the online *Defined Forest Area map* for their Chain of Custody under the Australian Forestry Standard, claiming it "*is updated each year and provides the information needed for timber buyers with Chain of Custody (COC) Certification to the AFS or Programme for the Endorsement of Forest Certification (PEFC)"*. The Forestry Corporation website has a current map showing the distribution of hardwood plantations (Northern Hardwood Plantations) in north-east NSW, which they rely upon for certification. The unreliability of this map is clearly apparent from the changes that the Forestry Corporation made to this map after my complaints of late July and August 2022, overnight in late August, 5,814 ha was added as Northern Hardwood Plantations and 9,744 ha deleted. Strangely they also now do not claim all DPI authorised plantations are plantations.

The most recent Northern Hardwood Plantations identifies an additional 14,214 ha of claimed plantations outside existing authorised plantations, some of these are additional areas on purchased lands, some are more infilling between existing plantations, though there are many expansions to existing plantations and additional areas. It is assumed that the Forestry Corporation sells timber from these unauthorised, and to some extent invalid, "plantations" to its customers.

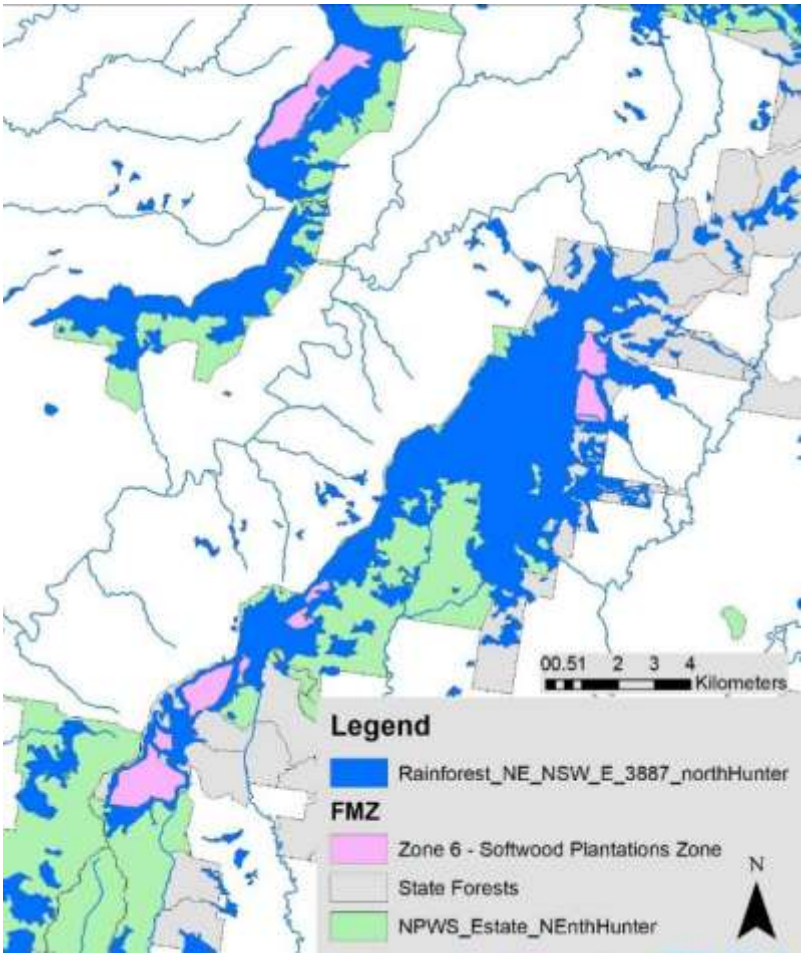
Aside from the validity of many claimed plantations in north-east NSW, there is a problem in that many of those that were legitimately planted as plantations were established by clearing native forests and now exist as inholdings within native forests or occur as essential habitat links. Consideration needs to be given to restoring these where they occur on inappropriate sites or are needed for environmental reasons.

This problem is demonstrated by plantations of hoop and bunya pine established by clearing rainforest, now identified as being of world heritage value, in the Border Ranges. These are now being clearfelled and converted to eucalypt plantations rather than restored as rainforest. In 1939 the Urbenville Reforestation Project was launched with the aim of converting most of the best developed rainforest on basalt plateau in the then Urbenville Management Area into pine plantations. Due to significant establishment problems, conversion was sporadic and eventually abandoned. Though extensive areas of hoop and bunya pine plantations were established within rainforest in Koreelah, Beaury, Toonumbar and Pikapene State Forests.

The problems of having plantations within native forest is exemplified by these plantations. During the 2019/20 wildfires the Forestry Corporation took advantage of the crisis to clear a buffer around some of these plantations by bulldozing surrounding rainforest (rather than the edge of the plantations) in a clumsy attempt to create a fire break. Inspection of one of these in Beaury State Forest (Pugh 2021) identified hundreds of rainforest trees (up to 70 cm diameter) had been bulldozed out of the ground, often directly into the rainforest. Many trees (up to 250 cm diameter) suffered damage to their bases, trunks and crowns, with some already killed and others likely to die in the future. Large areas had been cleared, with bared ground and loose soil bulldozed into the remaining rainforest, including around tree bases. Overall, 5-6 hectares of rainforest is likely to have been disturbed, with 4-4.5 hectares of this rainforest within the Tooloom National Park. NEFA complained to the Environment Minister but he refused to take any action because it was during the fire emergency.



There needs to be a reconsideration of the future of these plantations. They should never have been established on the basaltic plateaux, literally in the heart of the rainforest. With 35% of NSW's rainforests burnt in the 2019/20 fires, and the prospect of worse to come, it is essential we enhance the integrity of our rainforests as soon as possible. Over a century ago these rainforests were characterised by Hoop Pine towering to 50m tall over sub-tropical rainforest, but within decades those majestic Hoop Pine were mostly gone. Now the Hoop Pine plantations established at such high cost for the region's rainforests are being clearfelled and either left fallow as weed paddocks or converted into eucalypt plantations.



Examples of hoop and bunya pine plantations established by clearfelling rainforest where it was best developed from the 1940s-70s, hollowing out stands of rainforest now assessed as being of world heritage value. As the existing plantations are harvested these need to be restored to rainforest. Koreelah and Beaury State Forests.

To restore the integrity of these rainforests, and avoid repeats of such appalling mismanagement, it is essential that these plantations be restored to rainforest as soon as possible. They should not now be converted into eucalypt plantations.

4.2. Private property resources

It is apparent that in north east NSW a significant volume of resources are obtained from private properties that will not be affected by protecting public native forests, thereby allowing a continuing supply of speciality hardwood products. The problem is that Private Native Forestry is not ecologically sustainable and not adequately regulated. Hopefully without competition from Government subsidised logging, landholders will be able to require a higher price and be encouraged to manage their forests in a more sustainable manner. It is considered that given their significant impacts and extent, PNF operations should be subject to a Development Application process like other developments on private lands.

It is apparent that a significant volume of resources are obtained from private properties that will not be affected by protecting public native forests, DPI (2018) identified that 153,512m^3 per year of private property logs are sold each year to larger processors on the NSW north coast, conversely a survey of private property contractors estimated a production of 274,950m^3 of logs per year, some 121,000m^3 per year more. Hopefully without competition from Government subsidised logging,

landholders will be able to require a higher price and be encouraged to manage their forests in a more sustainable manner.

NEFA does not consider current management and regulation of private native forests as ecologically sustainable (i.e., see Pugh 2019, Pugh 2024), particularly as Private Native Forestry (PNF) plans are simplistic desktop collations of existing information provided by LLS, prepared by landowners without any need for site investigations or surveys for threatened species or ecosystems. They are not required to consider local, regional or strategic plans, such as Council LEPs and strategies, or state and national recovery plans and conservation advices. They are not required to consider off-site impacts on the environment (i.e. streams and wetlands or wildlife corridors), infrastructure (roads and bridges), road safety (i.e. school bus times) or local amenity (noise and visual impacts). They are prepared in secret, with no requirements to consult with neighbours or the local community or council, no public exhibition, and no accountability. They are not available for any person or even council to review.

While the PNF Code of Practice has numerous prescriptions for threatened species, there are no requirements to look before they log. With most landowners primarily interested in maximizing profits and contractors chasing dwindling sawlogs, there is no incentive to look for threatened species that will require increased tree retentions, even if they had the expertise.

Given their significant impacts and extent, NEFA considers that PNF operations should be subject to a Development Application process like other developments on private lands.

5. The role of State Forests in maximising the delivery of a range of environmental, economic and social outcomes and options for diverse management, including Aboriginal forest management models

The community have clearly identified over decades their over-whelming support for conservation, with Koalas of particular importance. It is evident that logging has been an economic disaster for taxpayers due to the high subsidies required to log public native forests, the lack of a resource rent and the degradation of ecosystem services, such as by diminishing large old trees, carbon storage, water yields, nectar (i.e. honey), tree-hollows and wildlife populations, while spreading weeds and dieback. Stopping logging will stop running down these assets and allow them to recover over time. Forests provide numerous quantifiable and intangible benefits to the broader community that far outweigh the economic benefits of logging, and are diminished by it. Rehabilitation of these degraded assets can provide direct and significant economic benefits by increasing carbon storage, tourist visitation and water yields, as well more intangible benefits such as increasing wildlife and people's health. All these values need to be considered and accounted for in determining the best use of State forests.

The degradation of this public asset has been financially subsidised by taxpayers as royalties paid by sawmillers have never covered the costs of management, or compensated the public for the loss and degradation of ecosystem services. The unvalued cost is the depleted and degraded public forests, and the immeasurable costs and immense time needed to restore the health of forests and the full suite of ecosystem services they once provided.

While once logging was a significant contributor to the economies of numerous regional towns, this has reduced over time as sawlogs have been depleted, sawmills closed, and employment decreased due to industry downsizing, restructuring, mechanisation and centralisation. As populations have increased and regional economies diversified, logging has diminished in importance to the current situation where it plays a minor and often inconsequential role in the economy of north-east NSW, far outweighed by tourism.

With climate heating gathering momentum we cannot afford to wait any longer to begin restoring the values of this forest as there is a growing risk that their resilience will be overwhelmed, as illustrated by the spread of dieback and the recent bushfires. We urgently need to restore forest's resilience to withstand the unfolding climate chaos.

A Cost Benefit Analysis is a method for organising information to allow comparison of the worth of competing alternatives to society, as an aid in making decisions about the allocation of resources. Not all costs and benefits can be easily priced, though natural values are increasingly being commodified, with prices now attached to water, carbon and increasingly to species and ecosystems through biobanking. While timber prices have long been established, and the economic value of recreation measured by how much people spend, the process of commodifying the environment is still in its infancy and biased to how much profit someone can make by selling something.

An alternative approach is Ecosystem Accounts. Keith *et. al.* (2017) consider:

> *Ecosystem accounts create a structure for integrating complex biophysical data, tracking changes in the condition and extent of ecosystems, and linking these changes to economic and other human activity, and the benefits they provide to society. The accounts are an*

integrated presentation of the environmental and economic characteristics of the region, showing both ecosystem assets (in terms of extent and condition), together with the flows or uses of these assets by people (in terms of ecosystem services and derived products). Ecosystem accounts synthesize data on all assets, goods, services and values, both those accounted for within economic systems of markets, calculations of GDP and the System of National Accounts (ABS 2016a), and those that lie outside these systems as unrecognised non-market contributions of ecosystems to economic activity and human well-being (UN et al. 2014b).

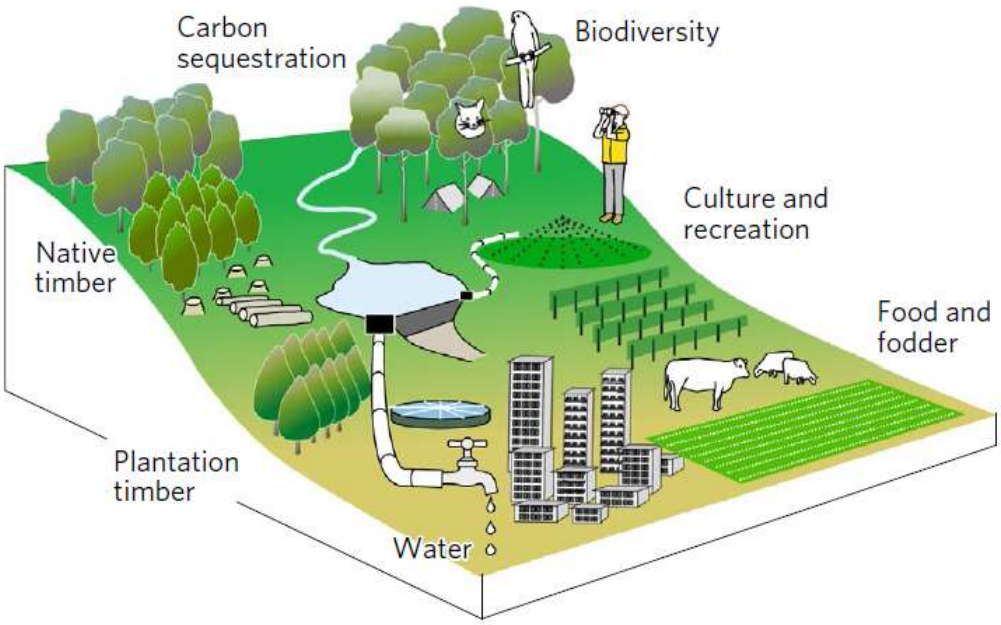


Fig. 2 from Keith *et. al.* (2017): Landscape context of ecosystem assets and services. Ecosystem accounting describes interactions of living organisms and components of the environment within specific geographical areas. Ecosystem assets and the services they provide to support human well-being are located spatially across the landscape.

Keith *et. al.* (2017) compiled Experimental Ecosystem Accounts for the Central Highlands of Victoria to assess the relative economic benefits of various uses. Theirs was a regional study encompassing a variety of land uses, including towns, concluding:

> *Our results revealed that native forests would provide greater benefits from their ecosystem services of carbon sequestration, water yield, habitat provisioning and recreational amenity if harvesting for timber production ceased, thus allowing forests to continue growing to older ages.*

Keith *et. al.* (2017)'s key findings of their ecosystem account were:

- *The value of ecosystem services used in 2013-14 for agricultural production was $121m while the water provisioning service was $101m, which were an order of magnitude greater than the native timber provisioning service ($19m).*
- *The contribution to GDP (Industry Value Added value) of the agriculture ($312m), water supply ($310m) and tourism ($260m) industries were all more than twenty times higher than for the native forestry industry ($12m).*
- *The potential IVA of carbon sequestration was estimated at $49m, based on the recent national carbon price, which is higher than the IVA of native timber production ($12m).*

Access of native forests to the carbon market is currently excluded by government regulation.

As found by Keith *et. al.* (2017) forests provide numerous measurable, mappable and quantifiable benefits to the broader community that far outweigh the economic benefits of logging, and are diminished by it. This emphasises the importance of considering all forest values when making decisions on the use of public forests.

This too is reflected in the value of tourism compared to forestry. Heagney *et. al.* (2019) "*estimate the gross value of tourism and recreation expenditure arising from the NSW protected area network at $10.4 billion per annum*", compared to "*public forestry production value is estimated at $0.46 billion per annum*".

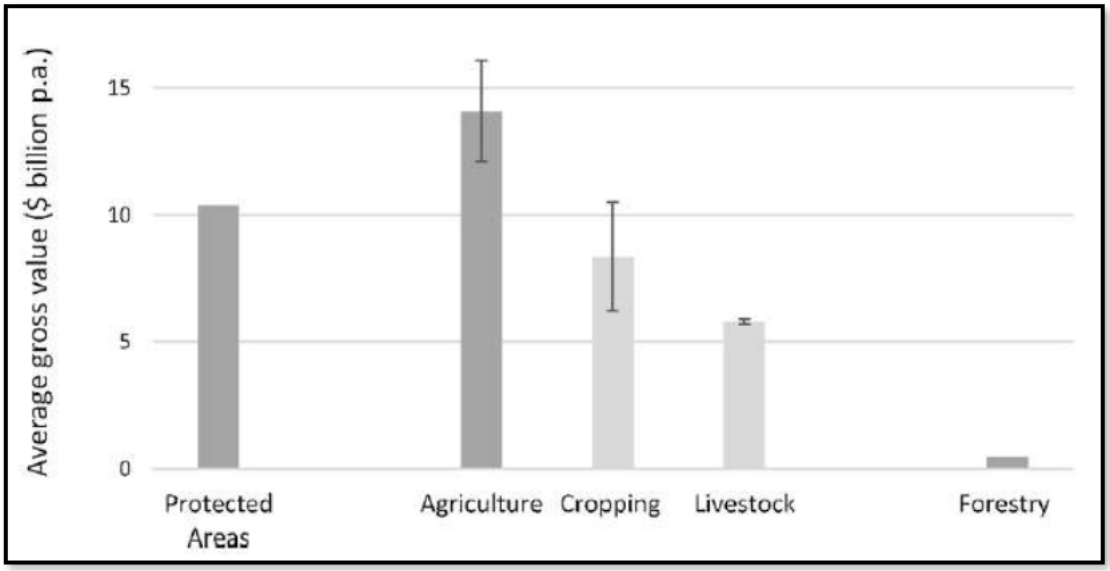


Fig. 1. from Heagney *et. al.* (2019) Average gross expenditure value of tourism and recreation in NSW protected areas compared with gross value of agriculture and forestry production. Error bars show range from 2 years of agricultural production data: 2008 (drought year) and 2014 (non-drought year).

Heagney *et. al.* (2019) note:

Protected areas provide a broad range of ecosystem services, like carbon sequestration and water filtration (Chan et al., 2006; Dudley and Stolton, 2010; Palomo et al., 2013). Global growth in carbon markets, water trading schemes, and biodiversity offset markets provide increasing opportunity to attach monetary values to some of these services, which could be added to the value estimates for tourism and recreation provided here. Protected areas also have a range of non-use values, like existence and bequest values (Turner et al., 1994; Phillips, 1998; Haefele et al., 2016). Under a total economic valuation framework (Turner et al., 1994) these are generally considered to be additional to the value of ecosystem service provision. A recent choice modelling survey undertaken in the US concluded that the non-use values of protected areas and associated conservation and education programs was at least as large as the estimated recreation value (Haefele et al., 2016).

…

While the move towards monetary valuation of ecosystem services is not without its critics (McCauley, 2006; Silvertown, 2015), it is clear that the lack of a robust estimate of economic value puts protected areas and other natural ecosystems at a disadvantage when resource allocation decisions are made on the basis of economic criteria - as they so often are. In decisions about land allocation, protected areas must compete with alternate land-uses like

> *agriculture, forestry and urban development, all of which have economic values that are easily and routinely reported. In these situations, a reliance on economic criteria is likely to yield decisions that maximise private industry gains at the expense of the broader societal values offered by protected areas.*

There are 1,153,217 ha of State Forests identified in north-east NSW, outside claimed plantations, that provide water for numerous town reservoirs, have the potential to contribute to increased tourism, and take-up and store carbon. All these can be allocated actual economic benefits, and all will significantly improve if logging of public native forests is stopped.

There is a need for decision makers to consider the 'irreplaceability' of conservation values along with the 'replaceability' of resource values when making decisions. As noted by Bennett (1998):

> *In general, forest protection benefits are likely to increase through time whereas the opportunity costs will most probably remain static. These differential growth rates are largely the result of the degree to which substitute goods are available for both the timber and non-timber forest products. Timber products are easily substituted. … The non-timber, or protection values, of forests are, however, much more difficult to substitute. For instance, habitat for endangered species cannot be readily "manufactured". Recreation in constructed or artificial sites may not be considered as providing the same experience as time spent in a protected forest reserve.*

Summary of principal issues discussed (note carbon is discussed in 6).

> **Logging of public native forests is an economic basket case. In 2023 Forestry Corporation lost $15 million on their hardwood operations, that is a cost of $1,281 for each hectare logged. This is despite being paid $31 million for their community service obligations that year, and obtaining tens of millions in regular equity injections. We should not be paying to degrade forests and log the homes of threatened species. Public forests are of greater economic benefit for water yields, tourism and carbon storage than they are for logging. It is in the best interest of taxpayers to stop logging of public native forests.**
>
> **Tourism is far more important to the north coast economy than logging, and is the fastest growing sector promising increasing economic and employment benefits. National Parks attract significant numbers of tourists to north east NSW, and encourage extended stays, to experience their landscapes and wildlife. In 2019 there were over 15 million tourist visits to the north coast, and in 2018 over 7 million visits to national parks. It is in the community's economic interest to convert more of our public native forests to national parks as this will provide more fulfilling recreational opportunities and attract tourists to the region, as well as encouraging them to stay longer. In 2019 over $867 million of tourist expenditure on the north coast can be taken as associated with forested national parks. Due to the economic benefits of tourism in only takes a relatively small increase in visitation to outweigh any perceived benefits of logging, most importantly tourism can provide direct economic stimulus and employment in rural towns. The potential regional benefits of converting State forests to National Parks have been demonstrated by the University of Newcastle's assessment that over 15 years the creation of the Great Koala National Park would result in 9,135 additional full time jobs, and increases in total output of $1.18 billion and value add of $531 million. The Government will maximise long term regional benefits by directing its resources into enhancing and diversifying forest recreational facilities, rather than subsidising logging and upgrading private sawmills.**

Exposure to natural environments reduces most people's psychological and physiological (i.e. pulse rate, blood pressure, cortisol, salivary amylase, adrenaline) indicators of stress, while improving their mood and happiness. The experience can overcome mental fatigue and restore cognitive function. It is apparent that visiting natural areas makes a significant contribution to people's mental and physical health. Relating this to the self-perceived Personal Wellbeing Index has resulted in an estimation of the annual health services value of Australia's national parks as ~ $145 billion. Reserves that encourage increased recreation contribute to increasing this benefit.

Forests perform an essential function in regulating the volume and quality of water in streams, and are therefore important for maintaining aquatic ecosystems, providing potable water for many coastal towns, and providing water for downstream residences, fisheries and irrigation. Streamflow is the left-over rainfall that the forest does not use. Regrowth forests use significantly more water than old forests, thereby reducing water yields to streams. The effects of yield reductions are most pronounced in dry periods, when water is most valued, as the vegetation utilises proportionately more of the rainfall. Old forests also store water and regulate stream flows through groundwater, while removal of vegetation and soil compaction by logging increases rapid runoff and erosion, reducing water quality. Protecting degraded forests and allowing them to mature will increase water yields, improve water quality and improve stream health, which will provide direct benefits to all downstream landholders and fisheries, with the highest economic value being where the catchments provide potable water for cities, towns and villages.

Community attitude surveys over the past 24 years clearly show that the community prioritise wildlife, water and carbon storage values of forests above timber production. The University of Newcastle assessed the biodiversity value (Willingness To Pay) of creating the Great Koala National Park as around $530 million for the NSW population and $1.7 billion for all Australians. A 2016 survey for the timber industry of 12,000 people found that native forest logging was considered unacceptable by 65% of rural/regional residents across Australia, and acceptable by just 17% of rural residents. Logging of native forests has very low levels of social license and is clearly not in the public interest.

5.1. The cost of logging

Logging of public native forests is an economic basket case. In 2023 Forestry Corporation lost $15 million on their hardwood operations, that is a cost of $1,281 for each hectare logged. This is despite being paid $31 million for their community service obligations that year, and obtaining tens of millions in regular equity injections. We should not be paying to degrade forests and log the homes of threatened species. Public forests are of greater economic benefit for water yields, tourism and carbon storage than they are for logging. It is in the best interest of taxpayers to stop logging of public native forests.

See Section 1.4 Economic Sustainability for a full discussion,

5.2. Recreational Value

Tourism is far more important to the north coast economy than logging, and is the fastest growing sector promising increasing economic and employment benefits. National Parks attract significant numbers of tourists to north east NSW, and encourage extended stays, to

experience their landscapes and wildlife. In 2019 there were over 15 million tourist visits to the north coast, and in 2018 over 7 million visits to national parks. It is in the community's economic interest to convert more of our public native forests to national parks as this will provide more fulfilling recreational opportunities and attract tourists to the region, as well as encouraging them to stay longer. In 2019 over $867 million of tourist expenditure on the north coast can be taken as associated with forested national parks. Due to the economic benefits of tourism in only takes a relatively small increase in visitation to outweigh any perceived benefits of logging, most importantly tourism can provide direct economic stimulus and employment in rural towns. The potential regional benefits of converting State forests to National Parks have been demonstrated by the University of Newcastle's assessment that over 15 years the creation of the Great Koala National Park would result in 9,135 additional full time jobs, and increases in total output of $1.18 billion and value add of $531 million. The Government will maximise long term regional benefits by directing its resources into enhancing and diversifying forest recreational facilities, rather than subsidising logging and upgrading private sawmills.

While attracting tourists to regional areas is an important value of national parks, it is important to recognise that their principal recreational value is to regional communities, as identified by Heagney *et. al.* (2019):

> *... demographic variables suggest higher rates of visitation by people living in regional areas. This trend was consistent across all surveyed states (Table 3). This suggests that the protected area network across NSW is providing important recreational services to regional communities, who generally experience lower levels of income and higher levels or deprivation than their metropolitan counterparts (Dollery and Soul, 2000).*

The Centre for Coastal Management (1993) note "*as indicated by the recreationalist survey … the most significant source of recreational forest visitation comes from the residents of the local government area*".

Visitation to, and management of protected areas, provide economic stimulation to regional economies from the associated expenditures that occur within the region. Visitors may buy food, refreshments, fuel, vehicle repairs, accommodation, and/or crafts in local towns, or stay in resorts or on farms, or take tours, all of which can add up to significant local expenditure and employment. Tourism is the most rapidly expanding sector of the regional economy. The rapidly escalating economic value of national parks for recreation does outweigh any short-term economic return from logging, mining and/or grazing.

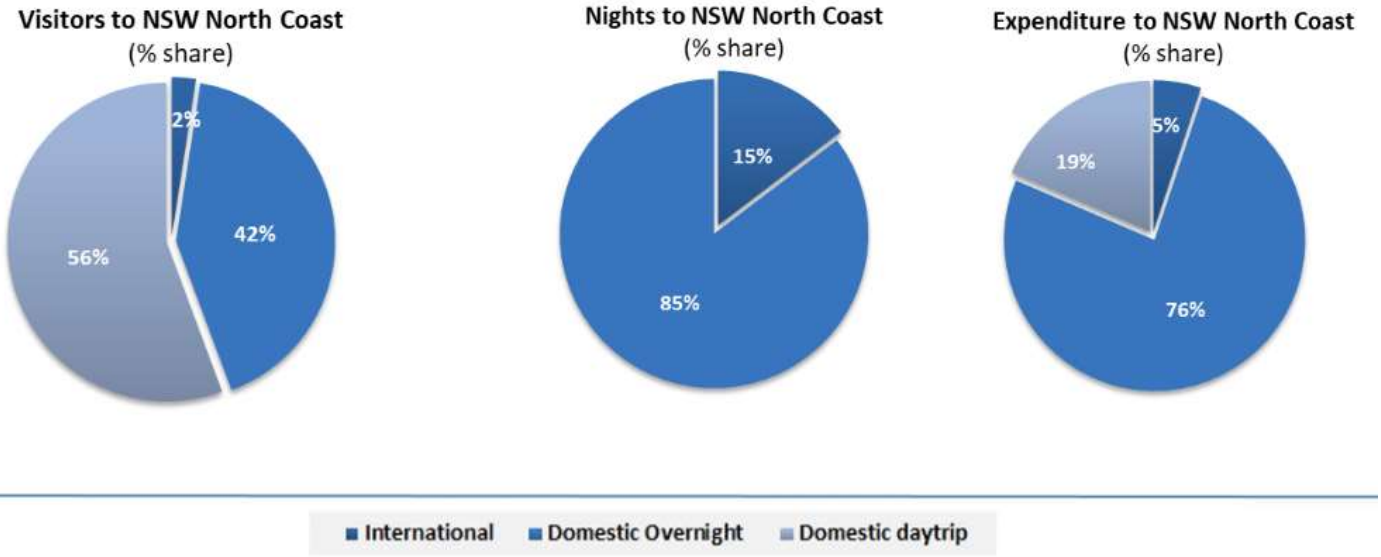
The 2019 National Visitor Survey shows in 2018–19, tourism directly contributed $18.5 billion to the NSW economy, with a flow-on effect of 84 cents for every dollar spent, generating an extra $19.6 billion to the New South Wales economy. Direct employment was 191,800 people, with a flow-on of 104,400 people. The 2019 National Visitor Survey shows that in NSW 4.4 million international tourists spent $565 million.

In the 2019 calendar year the North Coast of NSW had the third highest visitation of all Australian regions, following Sydney and Melbourne. The NSW North Coast visitor profile identifies NSW North Coast received 43.8% of international visitors, 23.5% of domestic overnight visitors and 18.1% of domestic daytrip visitors to Regional NSW.

North Coast	Visitors (millions)	Visitor Nights (millions)	Average Nights	Spending (millions)	Spend per night	Spend per visitor
domestic overnight visitors	6.4	24.3	3.8	$3,900	$163	

domestic day trip visitors	8.5			$962		$113
International visitors	0.375	4.2	11.1	$265	$63	

NSW North Coast visitor profile, Year ending December 2019



NSW North Coast visitor profile: Visitors, Nights and Expenditure of International and Domestic visitors to the North Coast for year end December 2019.

The NSW North Coast visitor profile, identifies that from the year ending December 2014 until December 2019:

- domestic visitors, nights and expenditure were up 36.5%, up 34.5% and up 53.7%, respectively.
- domestic day trip visitors and expenditure were up 39.3% and up 61.1%, respectively.
- international visitors, nights and expenditure were up 39.7%, up 41.6% and up 58.9%, respectively.

There have been many attempts over the years to identify the economic benefit of national parks and reserves to regional economies. Driml (2010) considers:

> *There are two alternative approaches to measuring the value of tourism to national parks and interpreting its economic significance. One, consumer surplus, is a measure of economic welfare and is grounded in microeconomic theory. The other is a measure of contribution of spending by tourists to the economy and fits into frameworks used in national accounting.*

The economic stimulus provided to regional economies by National Parks and reserves arises from two sources:

- expenditure in the region by visitors to the protected areas; and.
- expenditure in the region that is associated with the management of reserves.

Regarding direct use values Driml (2010) comments:

> *One approach to valuing natural environment areas, such as national parks, has been to focus on placing a dollar value on direct uses such as tourism. This is generally easier than employing some of the more challenging and less accepted methodologies to value indirect use and other values. Thus estimating direct use values can provide a partial economic value of natural environment areas.*

The expenditure of visitors to national parks can be readily assessed through visitor surveys, the challenges are identifying the proportion of that expenditure that can be attributed to national parks, and the flow-on effects of that expenditure through local, regional and State economies.

From their NSW telephone surveys Roy Morgan (2019) identify that in 2018 45.6% of NPWS park visitors indicated that their *only reason* for their trip was to visit the NPWS park, 25.2% gave the visit as the *main reason* for their trip (75% of reason) and 16.4% give the visit as one of the main reasons (50% of reason).

Based on the National Visitor Survey (TRA pers.comm.) statistics, for the north coast in 2019 there were 34,795,000 visits (visitor nights plus domestic days) generating $4,709 million in regional expenditure, with the average spend per 1,000 visits being $135,335.

North Coast NSW	Visitors ('000)	Visitor Nights ('000)	Regional Expenditure ($M)	Average Expenditure per Trip $	Average Expenditure per Night $
2018					
International	349	3,480	223	639	64
Domestic overnight	5,582	20,583	3,479	623	169
Domestic day	7,329		816	111	
	13,260	24,063	4,517	341	154
2019					
International	364	4,099	272	747	66
Domestic overnight	5,884	23,263	3,623	616	156
Domestic day	7,433		814	109	
	13,681	27,362	4,709	344	142

National Visitor Survey (TRA pers.comm.) visitation for north coast NSW

Note: Travellers who stay for one or more nights in a location while travelling (domestic overnight visitors and international visitors) or spend at least four hours on a round trip more than 50km away from home (domestic day visitors).

The National Visitor Survey (TRA pers.comm.) also collect data on tourism spending associated with 'bushwalking and rainforest walks', which is likely to reflect a subset of national park visitation. These data are averaged over four year periods. For the north coast these data indicate that 204,000 (around 60%) of international visitors engaged in these activities, spending an average of $62 per night and $595 per trip. An average of 902,000 domestic overnight visitors (around 20%) took walks, spending an average of $161 per night and $773 per trip. For domestic day visitors an average of 414,000 (around 6%) took walks, spending an average of $115 per trip. Taken together these represent 6,714,000 visits (overnights plus day trips) per annum, 19.3% of total visitation to the north coast, generating $867 million in regional expenditure, with a spend of $129,133 per 1,000 visitors.

North Coast NSW 4yr average 2016-19	Visitors ('000)	Visitor Nights ('000)	Regional Expenditure ($M)	Average Expenditure per Trip $	Average Expenditure per Night $
International	204	1,960	121	595	62
Domestic overnight	902	4,340	698	773	161
Domestic day	414		48	115	
	1520	6,300	867	1483	223

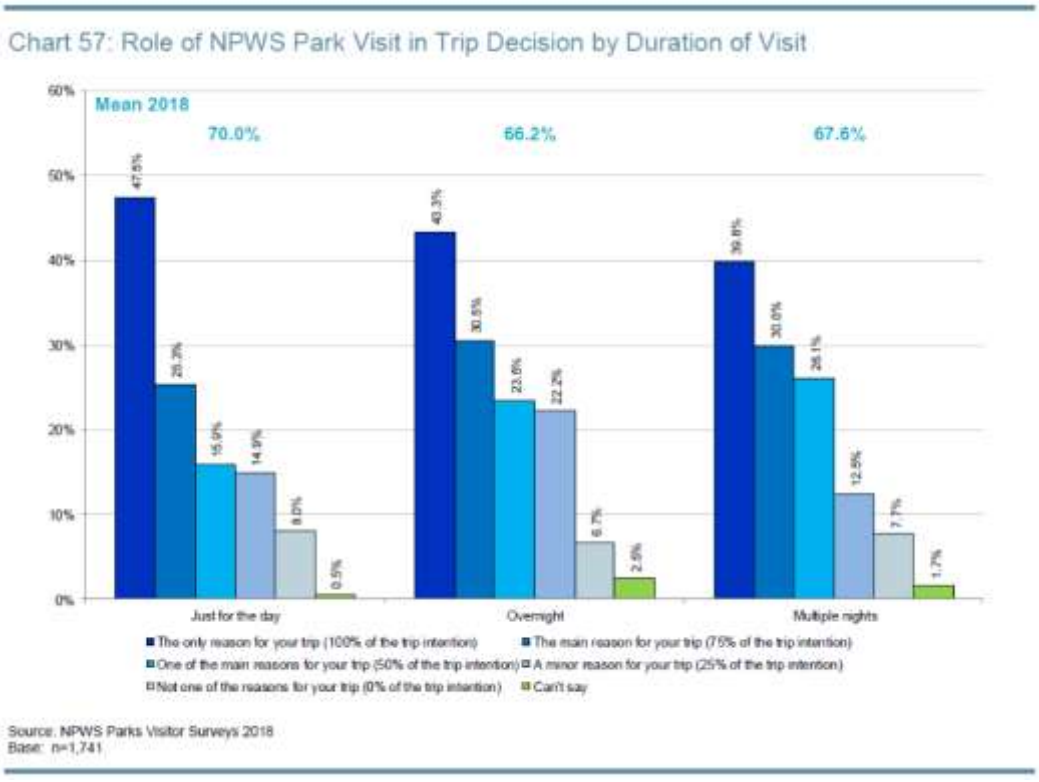
National Visitor Survey (TRA pers.comm.) Bushwalking/rainforest walks for north coast NSW

NPWS branches **Tourism Regions Australia** **Destination NSW**

Based on Roy Morgan (2019) the smaller NPWS North Coast region visitation is likely to have reached park visitation rates of 7.3 million in 2019, a significant increase from 5.2 million in in 2010. This shows that overall park visitation was far higher than identified in the National Visitor Survey category 'bushwalking and rainforest walks', which is expected given that the Roy Morgan (2019) data includes people making shorter day trips and people visiting parks for other reasons (i.e. picnicking and water-based activities).

Comparison of Roy Morgan (2019)'s 2018 visitation for the NPWS north coast branch with the National Visitor Survey's larger north-coast tourism region indicates that well over 21% of north coast visitors go to national parks.

The averaged annual North Coast regional tourist expenditure of $867 million for 2019 can be taken as a minimum conservative estimate of expenditure associated with forested national parks.



National parks are a main attractor of tourists to the region. From their NSW telephone surveys Roy Morgan (2019) identify that in 2018 45.6% of NPWS park visitors indicated that their *only reason* for their trip was to visit the NPWS park, 25.2% gave the visit as the *main reason* for their trip (75% of reason) and 16.4% give the visit as one of the main reasons (50% of reason).

Wildlife experiences are a component of the visitor experience, and an economic value in their own right. Koalas have a special value. From their study Hundloe and Hamilton (1997) found that koalas have an iconic status in attracting foreign tourists, with their "*best estimate of the contribution of koalas to the Australian tourism industry and thus the Australian economy is $1.1 billion. This translates into around 9,000 jobs directly accounted for by koalas*". More contemporarily Conrad (2014) assessed the Koala's annual contribution to international wildlife tourism as "*up to $3.2 billion and near 30,000 jobs*".

The act of converting a State Forest to a National Park can increase its recreational use, and therefore its economic contribution to the economy, because national parks are an international concept and this recognition attracts both domestic and international tourists. As noted by Buultjens and Luckie (2004):

> *National park visitation is a prominent part of both domestic and inbound travel within Australia. In a 1998 survey of international visitors to Australia it was found that 47 per cent of visitors aged 15 and over reported that they had visited at least one national park during their trip (BTR 1998). Visitation to national parks was even higher (57 per cent) among those international visitors travelling for holiday or pleasure purposes. For domestic travellers, visiting national parks is also popular. The National Visitor Survey revealed that a visit to a national park featured in 13 per cent of domestic overnight trips in 1999 (BTR 1999). This figure is significant when considering that domestic tourism in Australia represents a much larger market compared to inbound tourism.*

Visitation to, and management of protected areas, provide economic stimulation to regional economies from the associated expenditures that occur within the region. Visitors may buy food, refreshments, fuel, vehicle repairs, accommodation, and/or crafts in local towns, or stay in resorts or on farms, or take tours, all of which can add up to significant local expenditure and employment. Tourism is the most rapidly expanding sector of the regional economy. The rapidly escalating economic value of national parks for recreation does outweigh any short-term economic return from logging, mining and/or grazing.

For Queensland national parks Ballantyne *et. al.* (2008)

> *A conservative estimate, based on actual park visitation within Queensland however, indicates that national parks are a significant contributor to the tourism economy of the state with results revealing that direct spending by tourists visiting Queensland's national parks amounts to approximately $4.43 billion annually—accounting for approximately 28% of total tourist spending in Queensland. Importantly the study also identified that direct spending by tourists which can be attributed exclusively to the existence of the national parks amounts to over $749 million per annum, and contributes around $345 million to gross state product per annum.*
>
> *A less conservative estimate … under the 'maximum estimate' scenario, mean national park associated spending is $6.69 billion and mean national park-generated spending is $1.15 billion, implying a contribution of around $528 million to GSP per annum.*

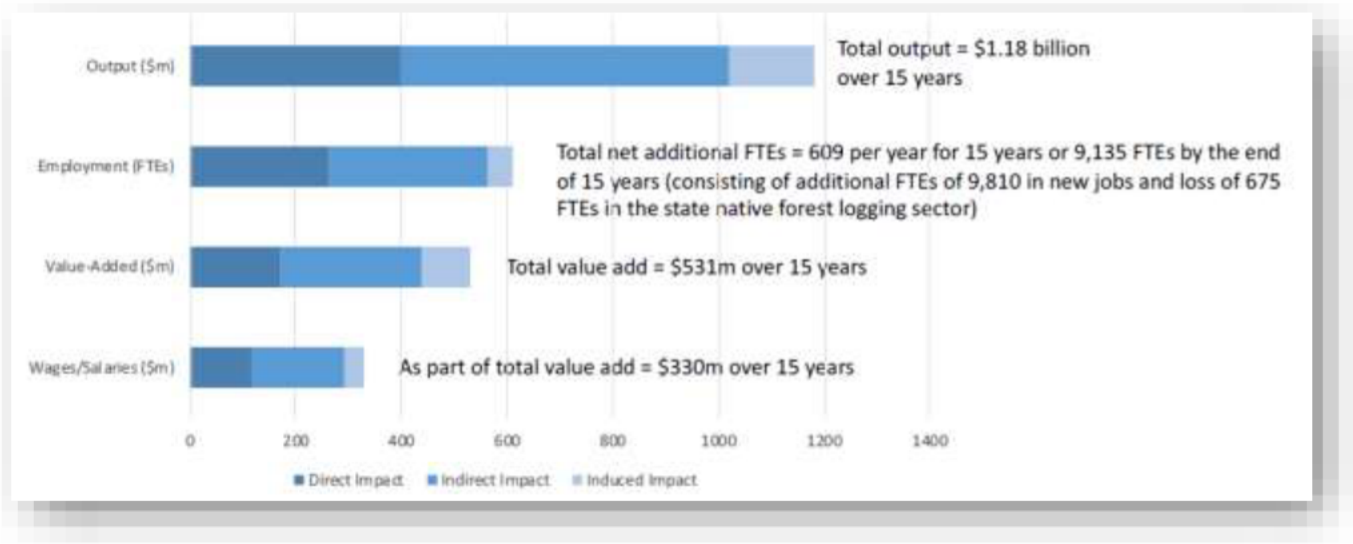
The University of Newcastle (2021) undertook an economic impact analysis (EIA) and environmental benefit assessment (EBA) of the potential regional and broader impacts of the proposed Great Koala National Park (GKNP) which is in five local government areas (LGAs): Bellingen Shire Council, Clarence Valley Council, Coffs Harbour City Council, Kempsey Shire

Council and Nambucca Shire Council. This assessment provides an indication of some of the costs and benefits of ending logging of State Forests, they note:

> *There are five broad economic impacts resulting from the proposed GKNP:*
>
> *1. An increase in capital investment in the region (from government funds)*
>
> *2. An increase in operating expenditure*
>
> *3. An increase in the number of visitors staying longer in the region and an increase in the number of international visitors and higher per visitor spending across all market segments due to a national and international marketing and branding campaign*
>
> *4. A transition from state forest native logging activity in the region*
>
> *5. The provision of an industry transition assistance package by the NSW Government.*

Their assessment shows that the potential tourism benefits of creating the proposed GKNP far outweigh the economic costs associated with phasing out the logging of public native forests within the proposal. Identifying the net impact of creating the park as:

> *•Increase in total output of $1.18 billion over 15 years*
>
> *•Additional FTEs of 9,810 in new jobs by the end of 15 years and loss of 675 FTEs in the state native forest logging sector over 10 years i.e. net additional 9,135 FTEs*
>
> *•Additional total value-added of $531million over 15 years. Of this, $330million is paid in wages and salaries in net present value terms to workers living in the region.*



The 'consumer surplus' is a commonly used metric for valuing recreation usage, this is the difference between the amount an individual is *willing to pay* and the amount actually spent. Heagney *et. al.* (2019) "*estimate that, on average, NSW residents make 5 visits to protected areas each year, and derive $90 in consumer surplus from each visit*". From a literature review, Pugh (2020) assessed that each 1,000 visits to north-east NSW national parks generates:

- Expenditure of $129,133
- One job
- A consumer surplus of $45,000 - $90,000

Blueprint Institute (2023) assessed that by stopping logging of public native forests in north-east NSW, and providing appropriate infrastructure, "increased tourism to the region through FY2040 could provide a net present value of $120 million", based on the new parks attracting 86,269 visitor nights with an average expenditure $210 per night, noting:

> *… our scenario calls for an initial allocation of 100,000 of those hectares to develop recreation facilities to encourage tourism. We estimate that an initial upfront investment of $15.7 million would be required to develop the proposed facilities. This would include the creation of the 50km walking trail, a 900km boundary as well as the construction of park infrastructure such as campsites, pathways, signs, and car parks. Cost estimates for each of these items are detailed in the appendix. Construction would take place over five years.*
>
> *Ongoing costs related to park maintenance and staffing would be approximately $2.2 million annually. We also note that the New South Wales government already allocates significant annual grants ($25 million in FY2022) to FCNSW for forest management services such as "provision of recreation facilities, education and advisory services…,flood stabilisation, tourism precincts..., light fleet fire spray protection, and strategic fire trails." We assume these expenditures would continue, albeit adjusted to focus primarily on conservation.*

5.2.1. Health Value

Exposure to natural environments reduces most people's psychological and physiological (i.e. pulse rate, blood pressure, cortisol, salivary amylase, adrenaline) indicators of stress, while improving their mood and happiness. The experience can overcome mental fatigue and restore cognitive function. It is apparent that visiting natural areas makes a significant contribution to people's mental and physical health. Relating this to the self-perceived Personal Wellbeing Index has resulted in an estimation of the annual health services value of Australia's national parks as ~ $145 billion. Reserves that encourage increased recreation contribute to increasing this benefit.

A walk through a forest influences people's well-being through our senses of sight, hearing, and smell. Organic particles suspended in the air appear to be particularly influential. Trees remove human pollutants and contribute beneficial bacteria, negatively-charged ions and phytoncides to the air we breathe. Phytoncides are organic compounds that plants produce to communicate between themselves and with other organisms.

A review by Pugh (2018) identified a large body of evidence attesting to the benefits of the natural environment on the physical health and mental wellbeing of people, summarising the benefits as:

- *People's most common and consistent responses to exposure to nature are reduced stress, anxiety and anger, with improved mood and cognitive function. These affects are confirmed by an array of physical responses indicative of reduced stress, such as reduced cortisol levels, salivary amylase, pulse rate, blood pressure, adrenaline, Skin Conductance Responding, and frontalis muscle tension. Improved cognitive function has been shown in a variety of performance tests, as well as being indicated by increased parasympathetic nervous activity.*
- *Recreating in forests can have other significant health benefits such as reducing cardiovascular disease associated factors, enhancing human natural killer cell (NK) activity, increasing anti-cancer proteins, and reducing blood sugars. This has in part been attributed to the quality of the air in forests, particularly the presence of organic compounds (phytoncides) released by trees.*
- *Experiencing ancient giant trees, unusual wildlife, spectacular natural landscapes and wilderness can invoke awe and wonder, providing transcendent and spiritual experiences.*

- *Overcoming the challenges that can occur recreating in natural environments improves self-esteem, whether it is a child climbing a tree or an adult conquering a mountain, and doing so in company can result in long-term increases in altruistic and cooperative behaviours.*

Visits to national parks thus have direct public health benefits (Heagney et. al. 2019, Buckley et. al. 2019). Heagney et. al. (2019) observe that "*The frequency of protected area visitation is also relevant in relation to public health objectives. There is increasing evidence that protected areas can contribute to physical and mental wellbeing*".

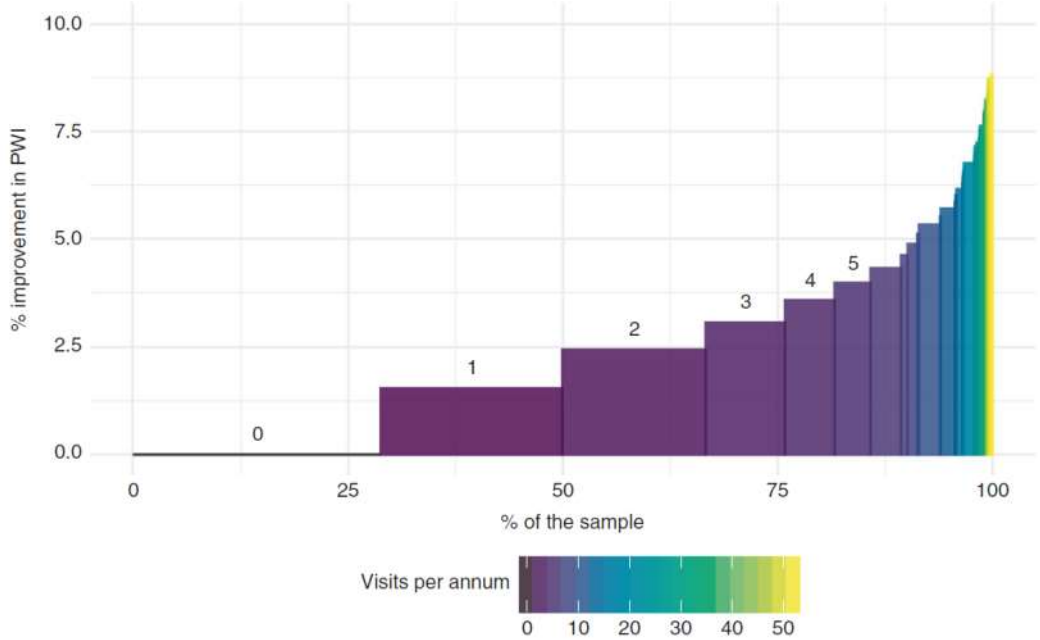


Fig. 2 from Buckley *et. al.* (2019) Distribution of quality-of-life improvement derived from protected area visitation. Distribution of quality-of-life (QOL) improvement derived from protected area visitation across the sample population, pilot trial 2. Vertical axis shows QOL improvement, measured as % increase in self-perceived personal wellbeing index, PWI, controlled for socioeconomic and demographic factors and non-park greenspace use. Horizontal axis shows proportions of sample population. Colours show the number of visits to protected areas during the preceding 12 months. For low annual visit frequencies, 0–5 inclusive, frequencies are also indicated by numerals above the bars. Thirty per cent of the sample had not visited parks at all during the past year, and hence experienced no improvement in PWI. The majority of the sample population, shown in purple, had visited a protected area 1–5 times in the preceding year, yielding small but significant improvements in self-perceived wellbeing. Much smaller proportions of the sample population, shown in blue, green, and yellow, had visited monthly, weekly or daily, with improvements in PWI up to ~8%

Buckley *et. al.* (2019) calculated the economic value of protected areas derived from the improved mental health of visitors, concluding "*A conservative global estimate using quality-adjusted life years, a standard measure in health economics, is US$6 trillion p.a. This is an order of magnitude greater than the global value of protected area tourism, and two to three orders greater than global aggregate protected area management agency budgets*". They comment:

> *Nature exposure improves human mental health and wellbeing. Poor mental health imposes major costs on human economies. Therefore, parks have an additional economic value through the mental health of visitors. We refer to this as a health services value.*
>
> *...*
>
> *We conclude that there is a direct link between protected area visits and individual human mental health and wellbeing, which translates to a very substantial but previously unrecognised economic value for protected areas and conservation. This health services value already exists, since the costs of poor mental health would increase if protected areas*

> *ceased to exist, or if people could no longer visit them. Historically, it has not been included in debates over economics and finance for either conservation or health. We argue that it should be recognised, quantified accurately and widely, and included explicitly in policy.*

Buckley *et. al.* (2019) identify that each 1% increase in the self-perceived Personal Wellbeing Index has been calculated as equivalent to "quality-adjusted life years" ($QALY) valued as US$150,000–250,000 (A$218,000-364,000), concluding:

> *Using the conservative estimate ΔPWI = 2.5%, $/QALY = US $200,000 as above, and the Australian adult population as 20 million, the annual health services value of Australia's national parks is ~US$100 billion, in addition to values from biodiversity, ecosystem services, and tourism expenditure. This is about 7.5% of Australia's GDP, 1.6 times the entire annual turnover of Australia's tourism industry, and two orders of magnitude larger than the aggregate annual budget of Australia's national parks agencies.*

US$100 billion equates to Australian ~ $145 billion. Buckley *et. al.* (2019) consider:

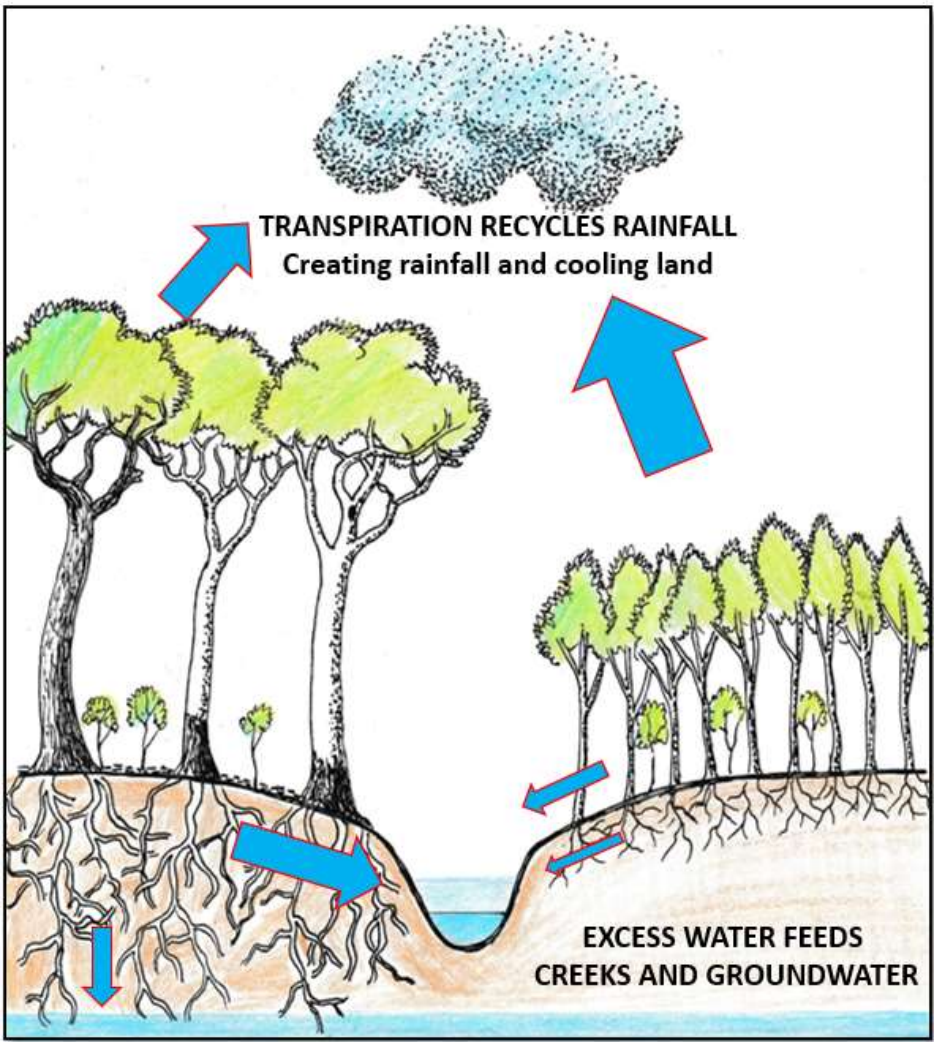
> *In Australia, the aggregate costs of poor mental health currently amount to ~10% of GDP[25]. The pilot estimates presented here indicate that without protected areas, these costs would be 7.5% greater. For protected area management agencies, the key conclusion is that operational management and infrastructure that encourages individual visitors to visit public protected areas contributes substantially more to national economies than arrangements to increase commercial tourism.*

It is apparent that visiting natural areas makes a significant contribution to people's mental and physical health. Relating this to the self-perceived Personal Wellbeing Index has resulted in an estimation of the annual health services value of Australia's national parks as ~ $145 billion. Reserves that encourage increased recreation contribute to increasing this benefit.

5.3. Water yields

Forests perform an essential function in regulating the volume and quality of water in streams, and are therefore important for maintaining aquatic ecosystems, providing potable water for many coastal towns, and providing water for downstream residences, fisheries and irrigation. Streamflow is the left-over rainfall that the forest does not use. Regrowth forests use significantly more water than old forests, thereby reducing water yields to streams. The effects of yield reductions are most pronounced in dry periods, when water is most valued, as the vegetation utilises proportionately more of the rainfall. Old forests also store water and regulate stream flows through groundwater, while removal of vegetation and soil compaction by logging increases rapid runoff and erosion, reducing water quality. Protecting degraded forests and allowing them to mature will increase water yields, improve water quality and improve stream health, which will provide direct benefits to all downstream landholders and fisheries, with the highest economic value being where the catchments provide potable water for cities, towns and villages.

Forests are key components of the earth's water cycle. Forests do not just respond to rainfall, they actively generate their own. They recycle water from the soil back into the atmosphere by transpiration, create the updrafts that facilitate condensation as the warm air rises and cools (cooling surrounding lands in the process), create pressure gradients that draw moist air in from afar, and, just to be sure, release the atmospheric particles which are the nuclei around which raindrops form. Forests store water in their trunks, litter and soils, then release water (mostly through ground-water) to maintain streamflows.



Streamflow in drier periods is the "left-over rainfall" that is not evaporated or the vegetation does not use. Regrowth forests use 2-3 times the water of oldgrowth forests, which has been attributed to their higher volumes of sapwood. This means that they pump more water into the atmosphere, leaving less water to feed streams. Due to soil disturbance and compaction more of the rainfall rapidly runs off, reducing infiltration into soils and groundwater. Stream flows are most impacted during periods of low rainfall when there may be no water surplus to the regrowth's needs. Water yields begin recovering after around 20 years, though take over a century to fully recover.

State forests encompass the crucial headwaters of numerous streams and thus have a significant contribution to:

- the health of steams and the biota that inhabit them, including fish populations
- downstream fishing industries, oyster farming and recreational fishing
- water supplies to downstream farmers and residents
- regional water supplies for towns and villages

As a tradeable commodity water has an economic value. The highest monetary value of water released from State Forests is for potable drinking water. This is reflected in household water bills and the costs of new water infrastructure when supplies become limited. Water quality is also important, affecting stream ecosystems and fisheries, as well as recreational users and treatment costs of potable water. The economic and environmental value of water yields increases in dry periods.

State Forests encompass the catchments of numerous town water supplies. Thus, the quantity and quality of water emanating from State forests can have significant impacts on regional communities, affecting needs for storage capacity and water treatment. For example, within the proposed Great Koala National Park, State Forests encompass:

- 26% of the water supply catchments for the various water storages supplying the Clarence Valley and Coffs Harbor local government areas
- 17% of the water supply catchment for the Bellingen local government area
- 36% of the water supply catchment for the Nambucca local government area

Based on the average rainfalls for these catchments, roughly a third of runoff from the State forests was likely lost because of conversion to regrowth. This lost water is recoverable over time if the forest is left to mature.

Of the rain that falls upon a forested catchment some is evaporated directly from leaf and ground surfaces and part may be redirected by surface flows directly into streams. Except in intense rainfall events, the majority can be expected to infiltrate the soil where it is used for transpiration by plants, with the excess contributing to groundwater seepage into streams or possibly seeping deep down to aquifers. In a natural forest situation, most of the streamflow response to rainfall is provided by the groundwater system.

The eWater CRC notes:

> *All plants evaporate water through their leaves. This water is extracted from the soil root zone, and the rate of evaporation depends on the weather, the available soil moisture, and the total area of leaves in the vegetation (trees and understorey). There are differences between various forest types, but basically different forests have evolved to make optimum use of the available rainfall to ensure their survival. Streamflow in drier periods is the "left-over rainfall" that passes beyond the root zone and exudes into the stream from boggy areas and the water table next to the stream. In storms, water runoff also occurs where the rainfall is intense enough to exceed the capacity of the soil to absorb it, or where the soil is already saturated. This runoff results in rapid increases in streamflow, or floods during major storms.*
>
> *For example, during an average year at a south eastern Australian catchment where the annual rainfall is 1000 mm, the forest canopy may intercept and evaporate 150 mm of the rainfall before it reaches the ground. The forest may consume a further 750 mm by plant transpiration, leaving only 100 mm to appear as streamflow (this is equivalent to a water yield of 1 megalitre per hectare). Of this 100 mm, 80 mm may occur as short-term runoff during storms, while the remaining 20 mm occurs as sustained dry-weather flow or "baseflow".*

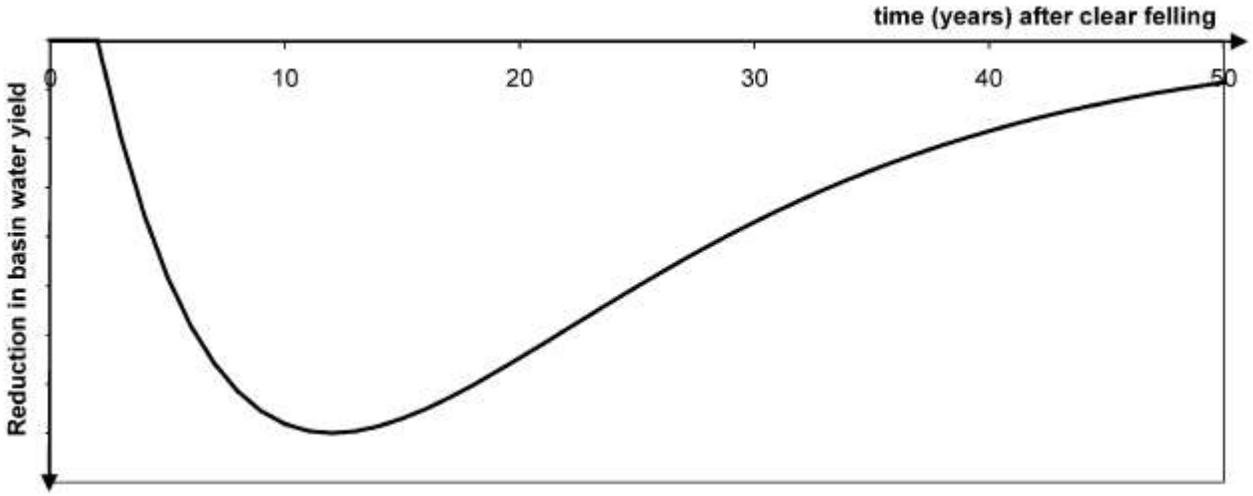
Logging has a significant impact on forest's water cycle. Dargavel *et. al* (1995) note:

> *Streamflow is the residue of rainfall after allowing for evaporation from vegetation, changes in soil storage from year to year and deep drainage to aquifers. Forest management operations can interfere with these processes by:*
>
> - *changing the type of vegetative cover on a catchment. Experimental results show that these changes can affect evapotranspiration and therefore streamflow;*
> - *changing the soil properties. The ability of the soil to both absorb and store moisture infiltration can affect the proportion of rainfall delivered. Forest operations which compact the soil can reduce both infiltration and storage capacities.*

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. The drying, particularly due to increased transpiration, significantly reduces ground water and stream flows.

The most significant relationship between water yields and vegetation is that related to forest age. The basic relationship between water yields and eucalypt forest age was established by studies of regrowth Mountain Ash forests following wildfires in Victoria. Kuczera (1985, cited in Vertessy *et. al*. 1998) developed an idealised curve describing the relationship between mean annual streamflow and forest age for mountain ash forest. This shows that after burning and regeneration the mean annual runoff reduces rapidly by more than 50% after which runoff slowly increases along with forest age, taking some 150 years to fully recover.



Kuczera (1985) Curve, reduction and recovery of water yields following loss of overstorey.

Tree water use has been found to be primarily related to sapwood extent, with the thickness of sapwood, and the basal area of sapwood declining as forests age, even though overall basal area increases (Dunn and Connor 1994, Roberts *et al.* 2001, Macfarlane and Silberstein 2009, Buckley *et.al.* 2012, Benyon *et. al.* 2017).

Dunn and Connor (1994) made diurnal measurements of sap velocity in 50-, 90-, 150- and 230-year-old mountain ash (*Eucalyptus regnans* F. Muell.) forests in the North Maroondah catchment finding "*The measurements have shown a significant decrease in overstorey water use with age. At the extreme, measured daily water use of the mature forest is 56% smaller than that of the regrowth forest.",* concluding:

> *There was a significant decline with age in the overstory sapwood conducting area of these forests. In order of increasing age, the values were 6.7, 6.1, 4.2 and 4.0 m^{-2} ha^{-1}, respectively. ... Annual water use decreased with forest age from 679 mm for the 50-year-old stand to 296 mm for the 230-year-old stand. ... The annual water use of the intermediate-aged stands was 610 and 365 mm for the 90- and 150-year-old stands, respectively.*

Roberts *et al.* (2001) studied water use of different aged stands of *Eucalyptus sieberi* (Silvertop Ash) within Yambulla State Forest, with an average annual rainfall of 900 mm per year, finding:

> *Stand sapwood area declined with age from 11 m^2 ha^{-1} in the 14 year old forest, to 6.5 m^2 ha^{-1} in the 45 year old forest, to 3.1 m^2 ha^{-1} in the 160 year old forest. LAI was 3.6, 4.0, and 3.4 for the 14, 45, and 160 year old plots, respectively. Because of the difference in sapwood area, plot transpiration declined with age from 2.2 mm per day in 14 year old forest, 1.4 mm per day in 45 year old forest, to 0.8 mm per day in 160 year old forest.*

Macfarlane and Silberstein (2009) assessed the water use related characteristics of regrowth and old-growth forest in the high (1200 mm $year^{-1}$) rainfall zone of jarrah forest in Western Australia, finding (SAI sapwood area index):

The old-growth stands had more basal area but less canopy cover, less leaf area and thinner sapwood. ...SAI of the regrowth forest at Dwellingup (7.0 m^2 ha^{-1}) was nearly double that of the old growth 3.7 m^2 ha^{-1}),..

... At the old-growth site, daily transpiration rose from 0.4 mm day^{-1} in winter to 0.8 mm day^{-1} in spring-summer. In contrast, at the regrowth site transpiration increased from 0.8 mm day^{-1} in winter to 1.7 mm day^{-1} in spring-summer. Annual water use by the overstorey trees was estimated to be ~200 mm $year^{-1}$ for the oldgrowth stand and ~420 mm $year^{-1}$ at the regrowth stand, which is 17% and 35% of annual rainfall, respectively.

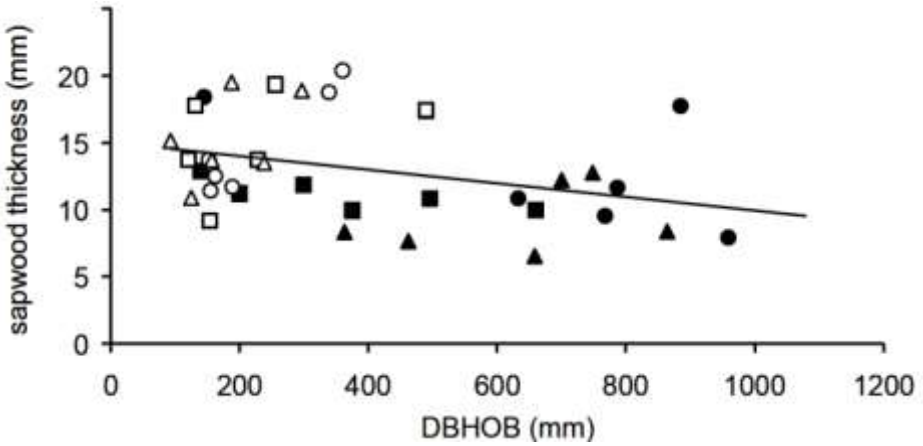


Figure 5 from Macfarlane and Silberstein (2009) sapwood thickness versus tree diameter (measured at breast height over bark, DBHOB) at the old-growth (closed symbols) and regrowth (open symbols) study sites.

For 'actual evapotranspiration' (E_a) Benyon *et. al.* (2017) identify:

... in even-aged eucalypt forests in south-eastern Australia, catchment mean overstorey sapwood area index (SAI), estimated from a relationship between stand mean sapwood thickness and tree density (trees ha^{-1}), applied to repeated measurements of tree density and mean tree diameter over several decades, was strongly correlated with catchment mean annual E_a, estimated as annual precipitation minus annual streamflow (Benyon et al., 2015).

From their study of Mountain Ash forests, Benyon *et. al.* (2017) concluded (E_a actual evapotranspiration, SAI sapwood area index):

In non-water-limited eucalypt forests, overstorey sapwood area index is strongly correlated with annual overstorey transpiration and total evapotranspiration. Interception loss from the overstorey is also positively correlated with overstorey SAI. ... Variation in SAI explained almost 90% of the between-plot variation in annual E_a across three separate studies in non-water-limited eucalypt forests. Our results support the use of measured spatial and temporal variations in SAI for mapping mean annual E_a (Jaskierniak et al., 2015b) and for modelling longterm streamflows in ungauged catchments (Jaskierniak et al.,2016).

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.

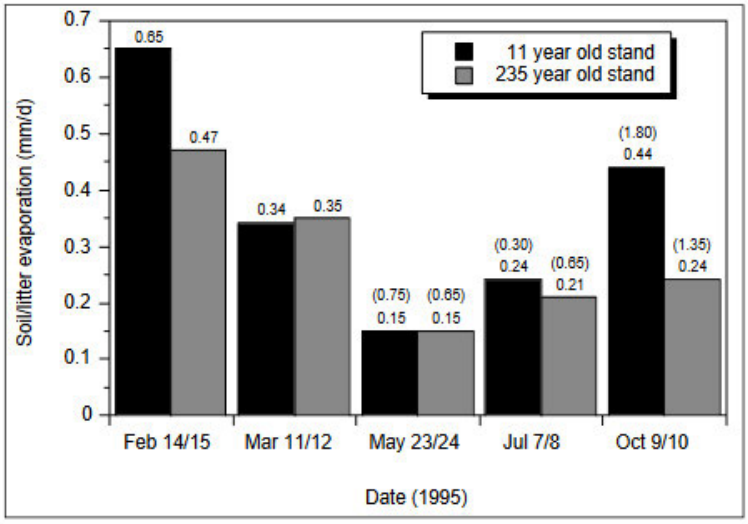
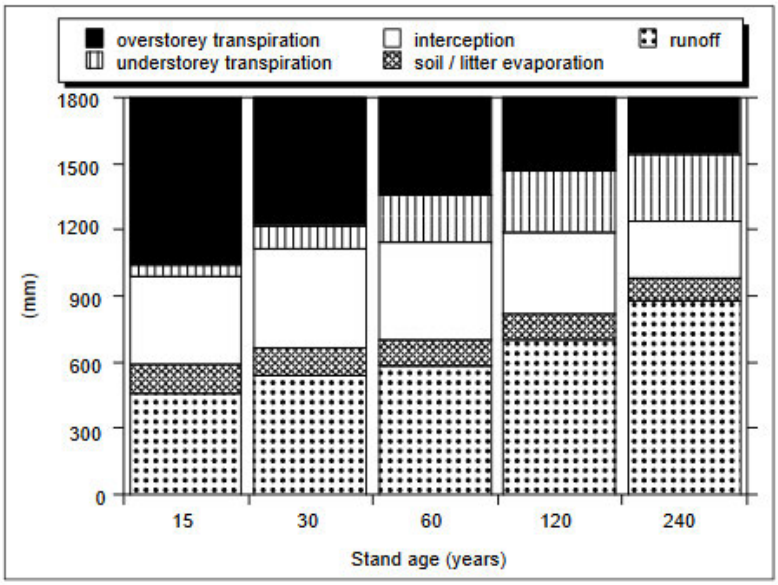


Figure 22 from Vertessy *et. al.* (1998): Comparison of soil/litter evaporation estimates beneath 11 and 235 year old mountain ash forest stands.



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

The generalised pattern following heavy and extensive logging of an oldgrowth forest is for there to be an initial increase in runoff from disturbed areas peaking after 1 or 2 years and persisting for a few years. Water yields then begin to decline below that of the oldgrowth as the regrowth uses more water. Water yields are likely to reach a minimum after 2 or 3 decades before slowly increasing towards pre-logging levels in line with forest maturity.

For Mountain Ash forest in Victoria, a mean annual rainfall of 1,800 mm/yr has been found to generate a mean annual runoff from oldgrowth Mountain Ash forest of about 1,200 mm/yr (Kuzcera 1987, Vertessy *et. al.* 1998). After burning and regeneration the mean annual runoff reduces rapidly

by more than 50% to 580 mm/yr by age 27 years, after which runoff slowly increases along with forest age, taking some 150 years to fully recover (Kuzcera 1987). Following clearfelling of a forest there may or may not be an initial increase in water yields for a relatively limited period. Thereafter water yields usually decline relatively rapidly in relation to growth indices of the regrowth, after some decades maximum transpiration of the regrowth is reached and water yields begin to recover with increasing forest maturity.

In the Barrington Tops area Cornish (1993) found that *"water yield decline exceeded 250 mm in the sixth year after logging in the catchment with the highest stocking of regeneration and the highest regrowth basal area".* This represents a major reduction given that the mean runoff pre-logging was only 362 mm (38-678 mm) and that only 61% of its catchment was logged.

Cornish and Vertessy (2001) report that the yields kept declining:

> *Water yields in a regrowth eucalypt forest were found to increase initially and then to decline below pre-treatment levels during the 16-year period which followed the logging of a moist old-growth eucalypt forest in Eastern Australia. ... Yield reductions of up to a maximum 600 mm per year in logged and regenerated areas were in accord with water yield reductions observed in Mountain Ash (Eucalyptus regnans F.J. Muell.) regeneration in Victoria. This study therefore represents the first confirmation of these Maroondah Mountain Ash results in another forest type that has also undergone eucalypt-to-eucalypt succession. Baseflow analysis indicated that baseflow and stormflow both increased after logging, with stormflow increases dominant in catchments with shallower soils. The lower runoff observed when the regenerating forest was aged 13–16 years was principally a consequence of lower baseflow.*

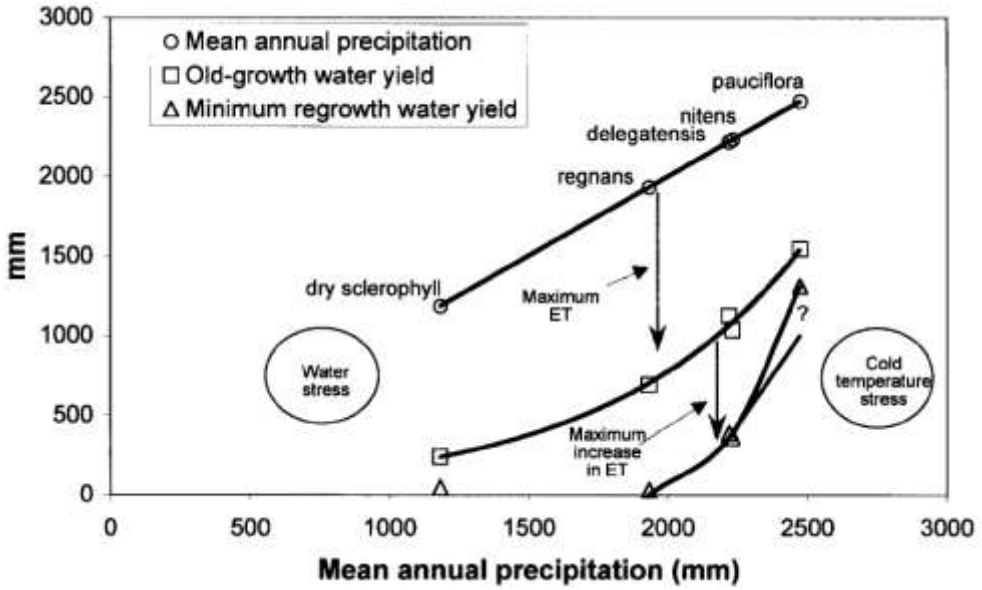
Cornish and Vertessy (2001) elaborate:

> *This analysis indicates that (in common with the results of many previous studies, e.g. Bosch and Hewlett, 1982) canopy removal increased water yield substantially. Mean increases here were frequently significant while the regrowth trees were less than 3 years old. As the trees increased in age water use increased, but mean water use was not significantly different from the pre-treatment forest between ages 3 and 12. Water yields then declined further between ages 13 and 16 years, resulting in mean reductions being statistically significant in all but one catchment.*

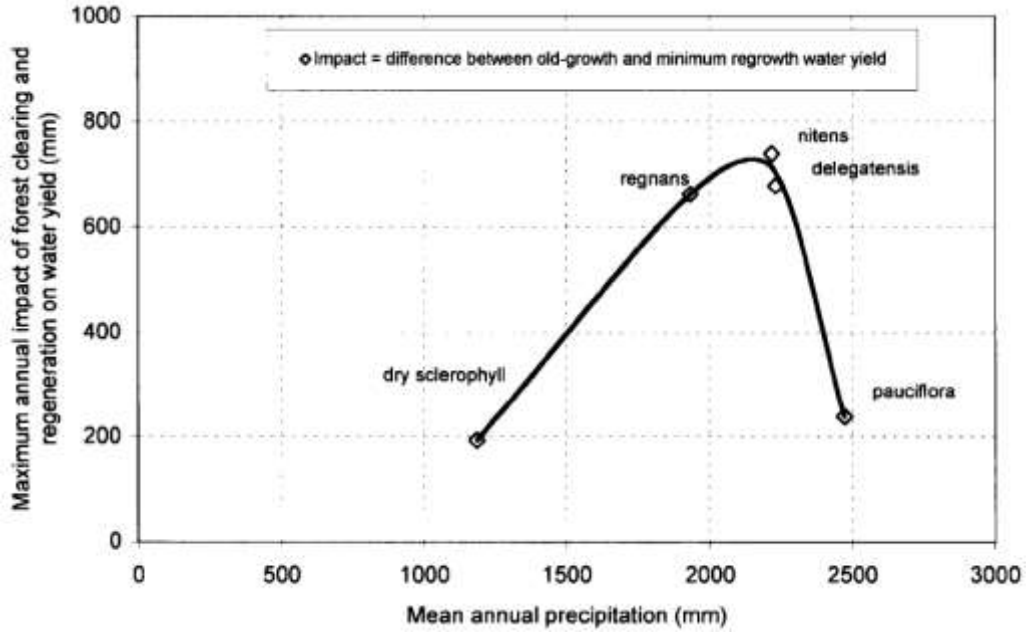
Vertessy (1999) notes that "*the maximum decrease in annual streamflow is over 60 mm per 10% of forest area treated, which is similar to the maximum reductions noted for Victorian mountain ash forests*".

The process of increasing water use by regrowth is relatively well understood and has been found to apply across forests, though localised impacts are complicated by varying vegetation types and conditions within a catchment, the depth of soils, rainfall and a multitude of environmental variables, and the compounding effects of events over time.

For example, Peel *et. al.* (2000) undertook modelling in the Maroondah and Thomson catchments to identify the variations in water yield depressions according to forest types and rainfall.



Summary of simulated impacts of forest clearing and regeneration on water yield, showing the relationship between species, precipitation, and water yields. From Peel *et. al.* (2000)



Relationship between species, precipitation and maximum impact of regeneration on water yields. From Peel *et. al.* (2000)

The effects of yield reductions are most pronounced in dry periods as the vegetation utilises proportionately more of the rainfall. As identified by Peel *et. al.* (2000) for dry sclerophyll forests, it is likely that there are prolonged periods where the regrowth is utilising most of the rainfall, leaving little for runoff into streams.

It is during dry periods, which are becoming more frequent and extreme with climate heating, that runoff is of the most value. Forests, particularly oldgrowth, are increasingly important during such periods due to their ability to hold and slowly release water. NSW Office of Water (2010) caution:

> *Many of the coastal unregulated rivers within NSW have extreme competition for water during dry periods. In-stream values can be stressed during these low flow periods, wildlife becomes concentrated in particular locations and water quality can deteriorate through eutrophication.*

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 (Brosofske *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*".

See 1.4.8 for a discussion on the impact of logging on erosion and water quality.

5.4. Community Values

Community attitude surveys over the past 24 years clearly show that the community prioritise wildlife, water and carbon storage values of forests above timber production. The University of Newcastle assessed the biodiversity value (Willingness To Pay) of creating the Great Koala National Park as around $530 million for the NSW population and $1.7 billion for all Australians. A 2016 survey for the timber industry of 12,000 people found that native forest logging was considered unacceptable by 65% of rural/regional residents across Australia, and acceptable by just 17% of rural residents. Logging of native forests has very low levels of social license and is clearly not in the public interest.

A valid consideration of the most appropriate uses of public forests must account for community preferences. These are part of the commons in which we all own a share. The aim must be to manage public forests to maximise benefits to the community. Economic benefits accruing to individuals are often used to decide uses of public lands, though private gain does not reflect what is in the best interests of the community.

Economists often use “non-use values” as a means of incorporating community values into economic valuations, these are often characterised as ecological function value, option value, existence value and bequest value. The need to incorporate these into economic assessments is well established in the literature. Community attitude surveys are a clear indicator of community preferences and the magnitude of “non-use values”. Bennett’s (1998) rule of thumb for forest protection benefits is that non-use values are worth three times the value of recreational use.

The presence of existence value is a powerful social reason for conservation and is a value felt by all Australians. All Australians own an equal share in the public forests and they are all entitled to an equal say in their future. Theoretically each Australian who feels a personal consumption loss if the proposal goes ahead should be compensated.

To identify the environmental benefits of creating the Great Koala National Park the University of Newcastle (2021) undertook a Willingness To Pay (WTP) assessment, noting:

> *Biodiversity provides a so-called ‘non-use’ value to society. This is a value which comes from knowing an environmental feature will continue to exist in future, irrespective of any expectation of actual use. This value is generally estimated on the basis of stated preference methods which assess individuals’ WTP to protect and maintain particular habitats or species which they may never themselves see*

A ‘meta-analysis’ of 159 Willingness To Pay valuations from 62 publications was undertaken, where non-use values were measured in terms of WTP for biodiversity improvements or WTP to avoid biodiversity loss, identifying:

- *The central average estimate across all studies reviewed in detail is that households would be prepared to make an annual payment of $161 (or a one-off payment of $203) to preserve biodiversity*
- *Households were found to have a WTP of $148 per annum to recover or improve biodiversity or of $186 per annum to prevent biodiversity loss*
- *The average WTP for biodiversity in Oceania (which includes Australia) is $207 per annum*
- *The average WTP for biodiversity in a forest habitat is $276 per annum (more than for other types of habitat)*
- *The annual WTP for biodiversity also varied with the indicator of interest, for instance $200 for habitat quality, $76 for species abundance, and $158 for species richness.*

The University of Newcastle (2021) assessment shows that the environmental benefits of creating the Great Koala National Park equate to added biodiversity value of:

•Around $530 million for the NSW population
•Around $1.7 billion for all Australians.

A major requirement of any social assessment, and a key component of determining the social values of public lands, is the determination of public preferences. The Community Attitude surveys undertaken for the CRAs (McGregor *et. al.* 1997, a,b) show that the regional communities place far more emphasis upon “forest protection values” than “opportunity costs” and establish that “non-use” values are extremely important to the broad regional community. McGregor *et. al.* (1997) concluded *“Forests have a very strong symbolic environmental value that people want to preserve even if this is seen to cause local social and economic difficulties.”*

On behalf of the National Parks Association, in the lead up to the 2018 State Election ReachTEL conducted a survey of 700 residents across the New South Wales state electorate of Lismore and 729 across Ballina during the night of 6th December 2017.

In response to the question '*Would you support the creation of national parks to protect koalas from logging and land clearing?'*, in Lismore 68.3% responded 'Yes', 16.8% 'No', and 14.8% ' Unsure/Don’t know', in Ballina 74.2% responded 'Yes', 15.1% 'No', and 13.0% ' Unsure/Don’t know'.

Of those with an opinion, 82% supported creating Koala parks to protect Koalas from logging and clearing.

In response to the question about relative values of native forests: *'There are two million hectares of publicly owned state forests in NSW. What do you think is the best use of these forests?*'

	Lismore (%)	Ballina (%)
The protection of forest wildlife, nature and trees	47.9	48.6
The protection of water supplies	23.4	23.4
Safely storing carbon in trees	10.9	7.9
Recreation activities	8.5	8.6
Logging for timber and woodchips	7.3	9.2
Logging and burning for biomass power	2.1	2.2

These results are consistent across both electorates and show that the community clearly prioritise wildlife, water and carbon storage values of forests above timber production, and roughly put recreation values on a par with timber values.

The logging of native forests has no social licence, as even the industry has found. The unpublished Forestry and Wood Products report "Community perceptions of Australia’s forest, wood and paper industries: implications for social license to operate" (Schirmer *et. al.* 2018) surveyed 12,000 people from throughout Australia in 2016 and found.

- Native forest logging was considered unacceptable by 65% of rural/regional and 70% of urban residents across Australia, and acceptable by 17% of rural and 10% of urban residents. Eleven per cent of rural/regional and 9% of urban residents found this neither acceptable or unacceptable, and 8% and 11% respectively were unsure whether it was acceptable.
- 45% felt the forest industry had negative impacts on attractiveness of the local landscape and only 22% that it had positive impacts; agriculture and tourism were viewed as having more positive impacts, and mining somewhat more negative impacts
- 53% felt the industry impacted negatively on local traffic (and 16% positively); similar proportions reported negative impacts on traffic from tourism and mining activities, and 30% from agriculture
- 58% felt the industry had negative impacts on local road quality while 16% felt it had positive impacts; mining was also viewed as having negative impacts, while agriculture and tourism were viewed as having slightly more positive impacts.

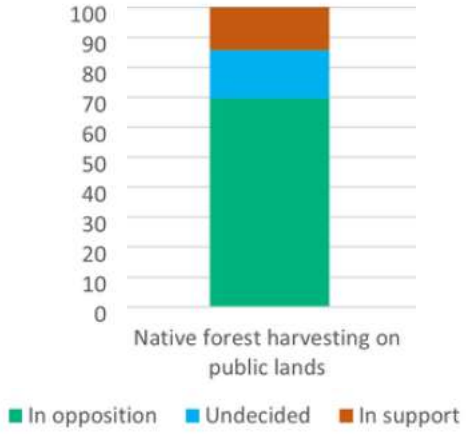
The report concludes:

> *Views were very strong about unacceptability of native forest harvesting, with most of those who indicated it was unacceptable choosing the response of 'very unacceptable' rather than moderately or slightly unacceptable.*
> *The activity of harvesting timber from native forests has very low levels of social license in Australia, both in regions where this activity occurs and in those where it doesn't. Even amongst the groups who have the highest levels of acceptance of this activity (farmers), and in the regions with highest acceptance (mostly those in which there is higher economic dependence on native forest logging), more people find this activity unacceptable than acceptable.*
> *...*
> *The activity of harvesting timber from native forests has very low levels of social license in Australia, both in regions where this activity occurs and in those where it doesn't. Even amongst the groups who have the highest levels of acceptance of this activity (farmers), and in the regions with highest acceptance (mostly those in which there is higher economic dependence on native forest logging), more people find this activity unacceptable than acceptable. The similarity of views about logging of native forest with views about mining activities suggests that it is viewed as an activity that is non-renewable or unsustainable, rather than as having some of the positive environmental attributes of actions such as establishing solar or wind farms. The strength of views of many people about native forest harvesting suggests potential that this activity is considered incompatible with values held by many people.*
> *...*
> *Native forest harvesting has very low social license, with very few people being at the 'acceptance' level. Many of those who do not find this activity acceptable are likely to be at the blocking or withheld level of social license, rather than the tolerance level, based on the strength of their negative response when asked about acceptability. Even amongst the groups and in the regions with the highest acceptance of this activity, less than 30% find it acceptable and the majority find it unacceptable. Planting trees on good agricultural land for wood and paper production, however, has higher levels of social license: 43% find timber plantations acceptable, and of the 29% who find it unacceptable most do not find it highly unacceptable (instead reporting slight or moderate unacceptability), indicating many are at the 'tolerance' level rather than withholding or blocking social license.*

This perception exists because it is a rapacious industry overseen by blind bureaucracies who just perpetuate and compound concerns by lack of meaningful constraints and poor regulation. The NSW Government agencies refuse to recognise and accept deeply and long held community concerns and preferences, instead labelling them as "*negative views", "misguided hyperbole" and "fake news", as* demonstrated by the NSW Department of Primary Industries (2018):

> *The suggestion of government 'promotion of private native forestry' is a call to counter the negative views, 'fake news' and around sustainable native forestry, and promote the industry and timber products as a sustainable, ecologically beneficial and a carbon neutral material the public should use above all others.*

During the 2023 NSW State Election, a team of Southern University researchers (Luke 2024) undertook a community survey of 1042 respondents across all main electoral booths in the Clarence Valley Community members expressed significant opposition to native forest harvesting on public lands (69%).



Participants expressed strong support for several environmental issues, of particular note being strong support for maintaining habitats and biodiversity, healthy rivers and waterways and water security.

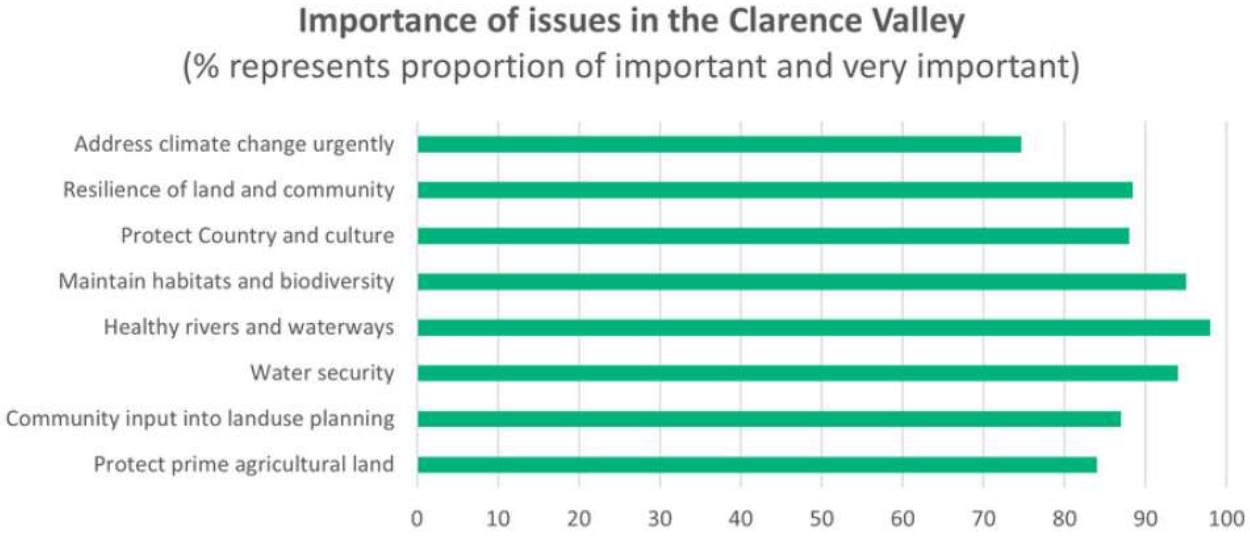


Figure 2: Importance of activities and issues in the Clarence Valley.

Social licence is something that needs to be earned, it cannot be manufactured by a public relations campaign and blatant propaganda while the root causes are ignored, and often exasperated by further weakening of rules and regulations.

5. Opportunities to realise carbon and biodiversity benefits and support carbon and biodiversity markets, and mitigate and adapt to climate change risks, including the greenhouse gas emission impacts of different uses of forests and assessment of climate change risks to forests

Rapidly increasing atmospheric CO_2 is causing climate heating, which is an existential threat to our future and quality of life. As temperatures rise, and droughts and wildfires increase in frequency and extent, it is a growing threat to the health and survival of numerous other species and is causing ecosystem collapse. We rely upon forests for numerous ecosystem services, including sequestering CO_2 from the atmosphere and storing it out of harm's way in their wood and soils. While we release large quantities of CO_2 by clearing and logging forests, the existential threat is that if forest ecosystems collapse and become net emitters of CO_2 then our ability to limit the extremes of climate heating will be lost. Given the developing climate crisis we urgently need to reduce our emissions of CO_2, particularly from fossil fuels, and allow forests to increase their sequestration of CO_2, which can be achieved by stopping logging them. It is important to recognise that plantations will take over a decade to begin sequestering and many more decades before they start sequestering significant volumes, whereas if protected existing degraded forests can begin sequestering meaningful volumes immediately. This assessment is that logging of public forests in north east NSW releases over one million tonnes of CO_2 each year, and that by stopping logging the recovering forests will be able to sequester over two million tonnes of CO_2 per annum. Protecting existing forests and allowing them to regain their lost carbon is part of the solution to climate heating.

Trees are our life support system; amongst the many benefits and services they provide us is their crucial role in the carbon cycle. Through the process of photosynthesis, they use sunlight to process carbon dioxide from the air and water from the ground into carbohydrates for energy and structure. In this process they remove carbon dioxide from the air, store carbon in their wood and soils, and provide us with oxygen to breathe.

Loss of carbon from deforestation and degradation has contributed 35% of the accumulated anthropogenic carbon dioxide concentration in the atmosphere, and annually is around 10% of global anthropogenic emissions (Keith *et. al.* 2015). With terrestrial ecosystems currently removing an amount of atmospheric carbon equal to one-third of what humans emit from burning fossil fuels (Moomaw *et. al.* 2019).

IEA identify that global CO_2 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 CO_2 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). We depend upon forests to remove the carbon we emit to avoid runaway climate heating.

It is imperative that the world decarbonizes as quickly as possible as we progress towards net zero emissions. It is recognized that even if all feasible steps are taken to reduce carbon emissions there will still be residual emissions that need to be offset by measures to remove and store atmospheric carbon. 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 1.5ºC, or even 2ºC (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). As observed by Moomaw *et. al.* (2019) "*newly planted forests require many decades to a century before they sequester carbon dioxide rapidly*". We cannot remove sufficient carbon by growing young trees during the critical next decade.

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, Mo *et al.* 2023). 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.*

Aside from permanent clearing, logging is by far the biggest threat to terrestrial carbon stores. Cutting down and bulldozing trees releases their stored carbon, with at best a small fraction stored in timber products with a life of a few decades. Within our logged forests the volumes of carbon stored have been halved and continue to decline as retained old trees die out, logging intensifies and return times become more frequent. Protecting forests enables them to regain their lost carbon and is an important contribution to mitigating the worst impacts of climate heating.

Summary of principal issues discussed

> **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. We urgently need to stop degrading forests and begin rehabilitating them to restore their resilience to climate changes, and enable them to continue their essential role in removing our carbon from the atmosphere and mitigating the worst impacts of climate heating for their and our futures.**

Native forests play a crucial role in the storage of carbon and the sequestration of carbon dioxide from the atmosphere, with oldgrowth forests maximising carbon storage while continuing to sequester carbon. The volume of carbon stored in logged forests has been more than halved. Stopping logging will enable forests to regain their lost carbon and make a significant contribution to meeting our climate targets. This assessment indicates that stopping logging of native state forests in north-east NSW could sequester in the order of an additional 2 million tonnes of CO_2 per annum over the next hundred years, though another assessment put this as 0.45 million tonnes per annum over 65 years. While there is a need for an accurate assessment, it is apparent that recovering forests can sequester significant volumes of CO_2 and thereby help redress climate heating. It is essential that logging stop to allow forests to reduce the impacts of climate heating by removing CO_2 from the atmosphere, and recover their integrity to better withstand future disasters.

Following logging that most of a tree, being the leaves, branches, defective trunks, bark, stump and roots are left in the forest to decompose, with some burning or decomposing rapidly to release their carbon, while the larger residues, such as stumps and larger branches, may take decades to decompose and release their carbon. Of the timber removed from the forest, most ends up as sawdust or in short-lived products, which rapidly release their carbon, with only a small proportion ending up stored for decades in relatively long-lived products. Once its usefulness is finished, a small proportion may end up in landfill, where decay may be extremely slow due to the anaerobic conditions.

With the currently limited pulpwood market in north-east NSW, based on the limited data available the indications are that of each tree felled:

- **66.5% of its biomass is left in the forest, where around half will rot or burn rapidly releasing its carbon to the atmosphere and half (logs, stumps) slowly releasing its carbon over decades due to decay.**
- **33.5% of its biomass may be removed in log form, with 20.7% of the tree carbon rapidly released from short-lived residues and hardwood products, and 12.8% ending up in longer lived hardwood timber products (at best) with various carbon retention times of 15 years to over 100 years (where buried in landfill).**

Based on conservative assumptions, current logging of State Forests in north east NSW results in the release of over a million tonnes of CO_2 per annum, which is an ongoing process with carbon temporarily stored in products and logs over previous decades also progressively releasing its stored carbon. It is important to recognize that if the Forestry Corporation's claims for sustainable yields are ever realized this could nearly double.

6.1. The growing risk of ecosystem collapse and degradation

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. We urgently need to stop degrading forests and begin rehabilitating them to restore their resilience to climate changes, and enable them to continue their essential role in removing our carbon from the atmosphere and mitigating the worst impacts of climate heating for their and our futures.

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 (>35º) 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,*

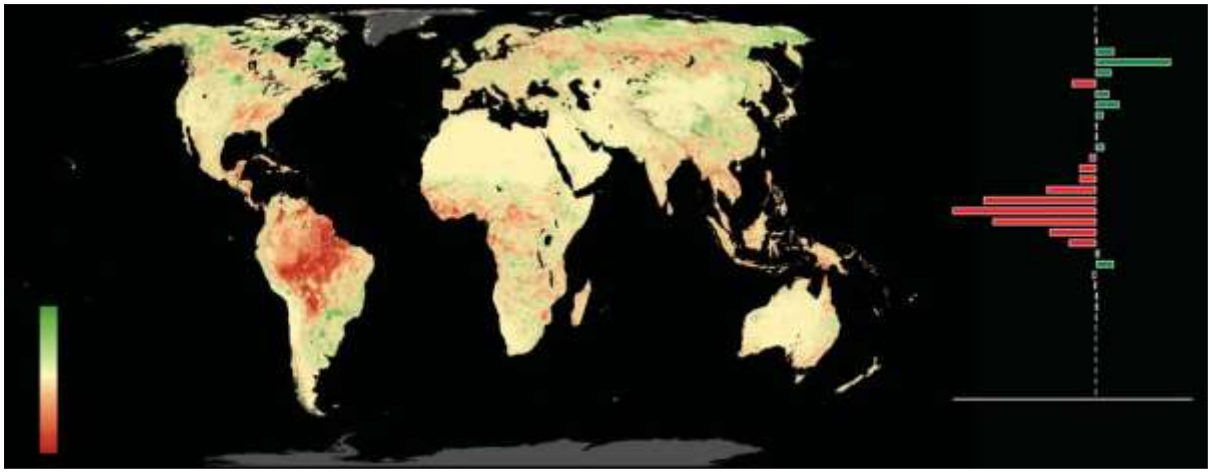


Fig. 3 from Bastin et. al. (2019): Risk assessment of future changes in potential tree cover. (A) Illustration of expected losses in potential tree cover by 2050, under the "business as usual" climate change scenario (RCP 8.5), ... (B) Quantitative numbers of potential gain and loss are illustrated by 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 km^2, 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).*

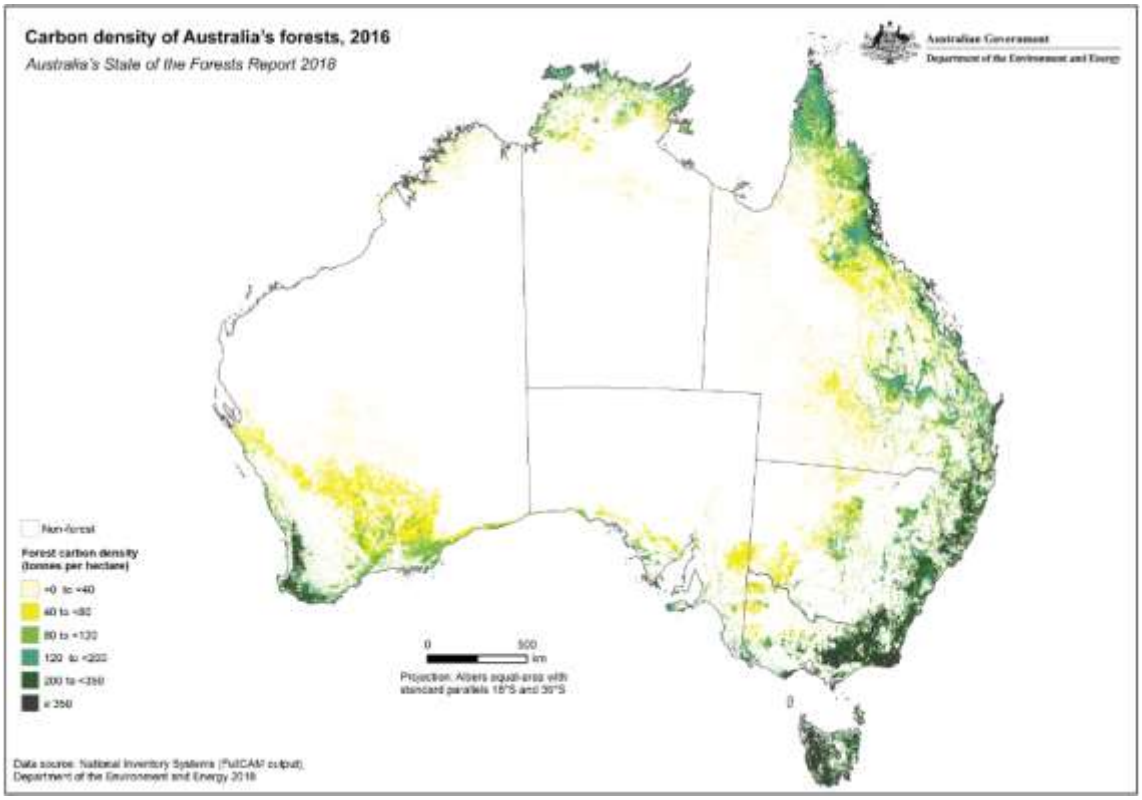
Mitchell *et.al.* (2014) warn:

> *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)

6.2. CO2 sequestration potential

Native forests play a crucial role in the storage of carbon and the sequestration of carbon dioxide from the atmosphere, with oldgrowth forests maximising carbon storage while continuing to sequester carbon. The volume of carbon stored in logged forests has been more than halved. Stopping logging will enable forests to regain their lost carbon and make a significant contribution to meeting our climate targets. This assessment indicates that stopping logging of native state forests in north-east NSW could sequester in the order of an additional 2 million tonnes of CO_2 per annum over the next hundred years, though another assessment put this as 0.45 million tonnes per annum over 65 years. While there is a need for an accurate assessment, it is apparent that recovering forests can sequester significant volumes of CO_2 and thereby help redress climate heating. It is essential that logging stop to allow forests to reduce the impacts of climate heating by removing CO_2 from the atmosphere, and recover their integrity to better withstand future disasters.



ABARES (2018) map of forest carbon density, showing the importance of north-east NSW.

As trees grow their biomass increases exponentially, sequestering ever increasing volumes of carbon and storing it in their trunks, branches and roots. As their leaves and branches decompose on the forest floor, some of the carbon returns to the atmosphere and some is stored in the soil. Underground, trees share carbon with mycorrhiza, spreading it through the soil, while both decaying mycorrhiza and roots enrich soil carbon and return some to the atmosphere. Tree's role in storing carbon can continue for decades after they die, as dead trees can take decades to collapse and downed logs decades to decompose.

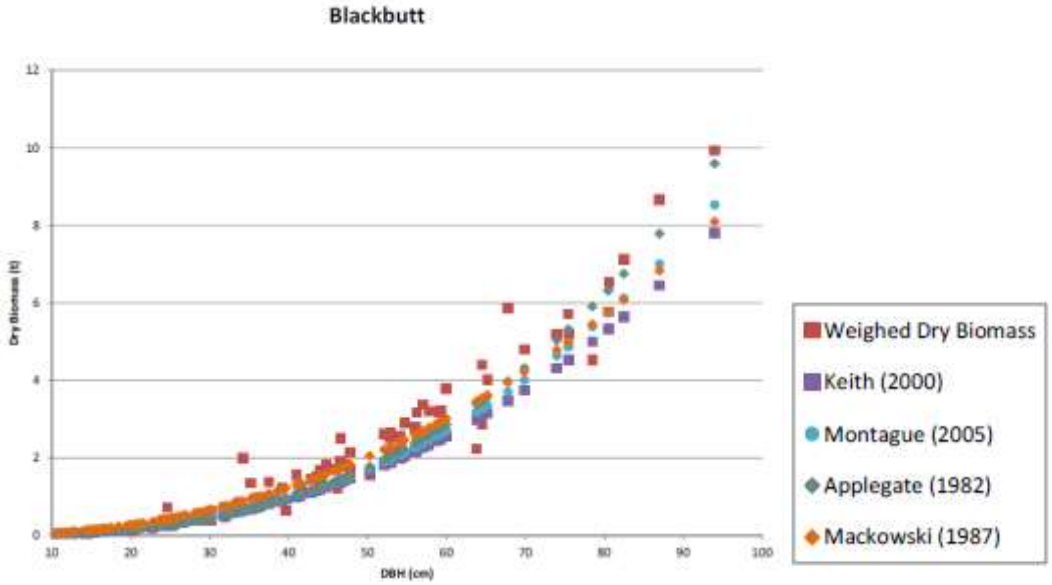
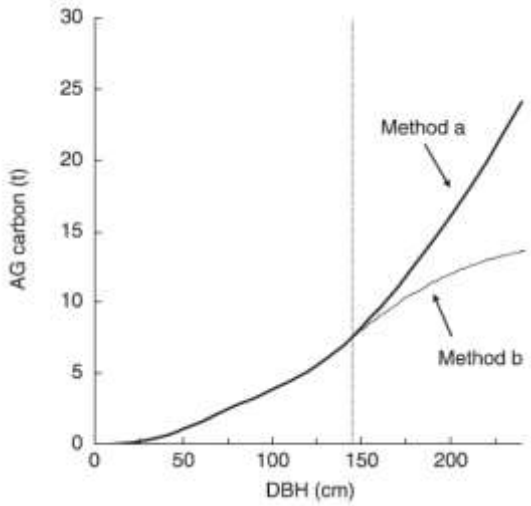


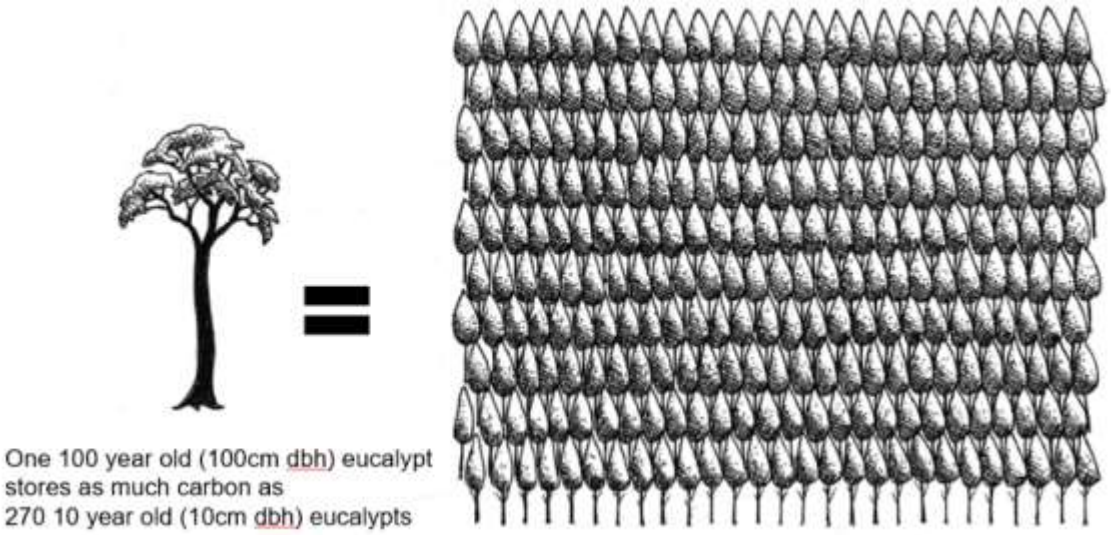
Figure 1.40. from Ximenes *et al.* (2016) showing the relationship for Blackbutt between DBH (diameter at breast height) and dry above ground biomass (tonnes), from their direct weighing compared to various biomass equations developed by other studies. Each tonne of dry biomass is equivalent to around half a tonne of carbon.

As trees age they sequester more carbon, with the volumes they store increasing exponentially, and along with this their annual rate of carbon sequestration. Far from being static carbon reservoirs, the biggest trees have also been found to sequester the most carbon (Zhou *et. al.* 2006, Sillett *et.al* 2010, Stephenson *et. al* 2014), with Stephenson *et. al* (2014) observing "*at the extreme, a single big tree can add the same amount of carbon to the forest within a year as is contained in an entire mid-sized tree".* For most trees once they reach old age internal decay can begin as they are hollowed out from within by termites and fungi. As very old trees shed branches, or loose canopy in storms, their rate of sequestration can decline.



Above-ground biomass/carbon relationship to tree diameter at breast height. From Roxburgh *et.al.* (2006). Method A assumes minimal internal tree decomposition. Method B allows for internal decay.

For example, a 10cm diameter (dbhob) Spotted Gum may have a biomass of 21kg, a 30cm diameter tree a biomass of 300 kg, a 100 cm diameter tree a biomass of 5,700 kg, and a 150 cm diameter tree a biomass of 15,200 kg (though in the older trees internal decay may begin reducing heart wood). With allowance for possibly 39% water content, and half the dry wood being carbon, a 100 cm diameter Spotted Gum may store 1.7 tonnes of carbon, with this increasing to a 150 cm diameter tree storing 4.6 tonnes of carbon. In carbon storage terms a 100cm diameter (100 year old) Spotted Gum will store the equivalent to 270x10 cm (10 year old) diameter trees, while a 150 cm diameter (say 200 year old) tree could store the equivalent of 724x10cm diameter trees.



Diameter (dbh)	Biomass	Carbon
10cm	21 kg	<0.01 tonnes
30 cm	300 kg	0.1 tonnes
100 cm	5,700	1.7 tonnes
150 cm	15,200	4.6 tonnes

Oldgrowth forests provide the baseline of how much carbon forests can contain under natural disturbance regimes; they represent a forest's **Carbon Carrying Capacity**. One method of identifying how much carbon a degraded forest can sequester is to compare its **current carbon storage** to the Carbon Carrying Capacity of the original oldgrowth forest likely to have occurred on the site. The difference between the two is a forest's **carbon sequestration potential**, indicating the volume of CO_2 a forest is capable of sequestering from the atmosphere if allowed to grow old in peace (Roxburgh *et.al.* 2006, Mackey *et. al.* 2008).

Carbon Carrying Capacity will vary with forest ecosystems, species composition, and site productivity. Even then oldgrowth forests have been found to continue sequestering and accumulating carbon indefinitely (Harmon *et. al.* 1990, Carey *et. al.* 2001, Chen *et. al.* 2004, Falk *et. al.* 2004, Roxburgh *et.al.* 2006, Mackey *et. al.* 2008, Luyssaert *et. al.* 2008, Dean *et. al.* 2012, Keith *et. al.* 2014b, Curtis and Gough 2018), so at best an indicative baseline Carbon Carrying Capacity is identified.

Mackey *et. al.* (2008) consider that for reliable carbon accounts two kinds of baseline are needed;

> *1) the current stock of carbon stored in forests; and*
> *2) the natural carbon carrying capacity of a forest (the amount of carbon that can be stored in a forest in the absence of human land-use activity). The difference between the two is called the carbon sequestration potential—*
> > *the maximum amount of carbon that can be stored if a forest is allowed to grow given prevailing climatic conditions and natural disturbance regimes*

Mackey *et. al.* (2008) assessed the Carbon Carrying Capacity for intact natural eucalypt forests of south-eastern Australia (which included north-east NSW) as an average of about 640 t C ha^{-1}, with 44% in soils, 45% in living biomass, and 11% in dead biomass.

Average Carbon Carrying Capacity of the Eucalypt Forests of South-eastern Australia. (from Mackey *et. al.* 2008)

Carbon component	Soil	Living biomass	Total biomass	Total carbon
Carbon stock ha^{-1} (t C ha^{-1})	280 (161)	289 (226)	360 (277)	640 (383)

Carbon stock per hectare is represented as a mean and standard deviation (in parentheses), which represents the variation in modelled estimates across the region.

Keith *et. al.* (2015) identified the maximum carbon stock for forests in aboveground living biomass on the south coast as 130-250 $tCha^{-1}$ and in Mountain Ash forests as 775 $tCha^{-1}$. With allowance for 25% of the biomass to be below ground, for south coast forests this translates as 162.5-312.5 $tCha^{-1}$ – an average of 237.5 $tCha^{-1}$.

Additional information on Carbon Carrying Capacity is provided by Ximenes *et al.*'s (2004, 2016) measurements of above ground biomass (AGB) at 5x0.5 ha sites in NSW, that were chosen as representative of older forests with no management history (though all appeared to have had some logging) and 2x0.5 ha sites chosen as representative of older logged forest. Ximenes *et al.*'s (2016) assessments were limited to above ground biomass, including dead biomass, so did not consider tree roots or soils. It is emphasised that as well as the small samples, these do not account for the wet sclerophyll types found in north-east NSW, dominated by species such as flooded gum, tallowwood, blue gum and brush box, which have far higher biomasses.

Ximenes *et al.*'s (2016) measurements of above ground biomass in "representative" stands of previously logged Silvertop Ash and Blackbutt (which had matured sufficiently for relogging), provide an indication of minimum biomass reductions in older logged stands:

Sites	Total live green AGB (t / ha)	Dead trees (t / ha)	CWD (t / ha)	Litter (t/ha)	Total AGB (t / ha)
Silvertop ash conservation	786.2	6.9	63.0	14.5	870.6
Silvertop ash production	320.8	28.0	85.2	14.6	448.6
Blackbutt conservation	674.8	5.4	48.1	21.9	750.2
Blackbutt production	399.0	19.8	170.4	23.4	612.6

Table 1.3. from Ximenes *et al.* (2016), Above ground biomass as measured for each site as fresh weight

Total carbon in living vegetation includes both above ground biomass (trunks, branches and leaves) and below ground biomass (roots). For conversion purposes, water may comprise 30-40% of the biomass of a tree, roots around 25% of the above ground biomass, and the dry weight of trees is taken to be comprised of 50% carbon.

For comparison Ximenes *et al.*'s (2016) assessed dry above ground biomass was converted to account for below ground biomass (x1.25), with 50% of the dry weight taken to be carbon. For Silvertop Stringybark forests on the NSW 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.

For the older forests Ximenes *et al.*'s (2016) results give a carbon content of 261-298 tC/ha in live biomass, with an average of 279.5 tC/ha, which is considered relatively low because the stands are likely below Carbon Carrying Capacity and are not representative of the more productive wet-sclerophyll types. The average carbon reduction live biomass in logged forests is 100-170 tC/ha, with an average loss of 130 tC/ha (46%). It is emphasized that current logging is more intense.

Ximenes *et al.* (2004) measured biomass in 3 "representative" south coast Spotted Gum forests on low, moderate and high site qualities which they claimed to be "*close to, or at, maximum carbon carrying capacity*" (though all had been logged in the late 1970s). The dry Above Ground Biomass was 220.2, 287 and 397.3 tonnes ha. For the low, moderate and high site qualities respectively. These are equivalent to a total (including below ground biomass) carbon content of 138, 179 and 248 $tCha^{-1}$ in live biomass – an average of 188 $tCha^{-1}$.

The Federal Government's FullCAM (Full Carbon Accounting Model) is applied at the national scale for land sector greenhouse gas emissions accounting. It includes a value for the maximum upper limit to biomass accumulation for any location based on potential site productivity, for NSW forests with a canopy cover >50% it identifies the upper limit of above ground dry matter of 210 to 287±9 t DM ha -1 (Roxburgh et. al. 2017). This is equivalent to a maximum (including below-ground) carbon accumulation of 131 to 179 $tCha^{-1}$, which are significantly below measured values, and thus bring into question the accuracy of FullCAM.

These are significantly less than the 289 tC/ha derived by Mackey *et. al.* (2008) for live biomass, the Keith *et. al.* (2015) south coast average of 237.5 $tCha^{-1}$, the derived Ximenes *et al.* (2016) average of 279.5 $tCha^{-1}$ and even the Ximenes *et al.* (2004) average for Spotted Gum of188 $tCha^{-1}$.

It is considered that for the purpose of this review it is reasonable to assume an average Carbon Carrying Capacity of 250 tC/ha^{-1} for natural forests in north-east NSW (which is conservative as it does not account for productive wet sclerophyll forests). Thus, it is considered reasonable to assume that if logged forests have retained an average of 50% of their original carbon (which is unlikely with current logging intensities), they would have a *carbon sequestration potential* of 125 tC/ha^{-1}. This is the volume of carbon that has been lost by past logging. Each tonne of carbon produces 3.67 tonnes of carbon dioxide when oxidized. Applying the multiplier of 3.67, this is equivalent to a *carbon dioxide sequestration potential* 459 tCO^2/ha^{-1}.

This is a simplistic and indicative assessment of sequestration potential, and likely to be conservative, though can be applied to indicate the magnitude of CO_2 that can be sequestered by forests recovering from logging in north east NSW.

There have been several 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 CO_2 (carbon dioxide)) is equivalent to avoided emissions of 460 Mt CO_2 yr^{-1} for the next 100 years. Allowing logged forests to realize their sequestration potential to store 7.5 Gt CO_2 is equivalent to avoiding emissions of 136 Mt CO_2 yr^{-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 CO_2 in that year.*

There are 1,153,217 ha of State Forests identified in north-east NSW outside claimed plantations (FMZ 5 and 6). It is claimed that around 50% of State Forests are available for logging, which equates as 577,000 hectares of native forest in north-east NSW. Application of the indicative carbon dioxide sequestration potential 459 tCO^2/ha^{-1} gives a total potential to sequester in the order of a total of 265 million tonnes of CO_2 if logging of State Forests in north east NSW was stopped and the logged forests are allowed to regain their lost carbon over time.

The key question is the rate of carbon sequestration. In Australian forests Roxburgh et.al. (2006) found that following logging "*Model simulations predicted the recovery of an average site to take 53 years to reach 75% carrying capacity, and 152 years to reach 90% carrying capacity*". Carbon accounting is based on a 100 year timeframe, so it can be expected that some 87% of the adopted carbon carrying capacity of 250 tC/ha could be restored if loggable forests were protected, which, assuming a current carbon volume of 125t C/ha, is an additional 92.5 tC/ha that could be regained over 100 years, or 0.93 tC/ha per annum. This converts into the sequestration of 3.4 tonnes of CO_2 per hectare per annum over 100 years, which across 577,000 hectares of native forest in north-east NSW is in the order of 2 million tonnes of CO_2 per annum.

This is substantially different to the 0.45 million tonnes of carbon (which is assumed to refer to CO_2) annually applied by Blueprint Institute (2023), Their figure is attributed to "*a 2016 FWPA study*", which used "*life cycle assessments… including the influence of carbon leakage*" over a 65 year period, though as it is not fully cited it was not able to be assessed to review the different methodology used.

It is feasible to more accurately identify north-east NSW's forest's current carbon storage, carbon carrying capacity, and thus carbon sequestration potential, by using LiDAR mapping. Griffith University is currently analysing LiDAR mapping to identify forest structure down to individual trees

across the Northern Rivers, being the Tweed, Richmond and Clarence River catchments. This mapping is being extended to include the proposed Great Koala National Park, and now that the methodological issues have been resolved, can be readily extended to include the balance of north-east NSW.

Existing LiDAR data can be analysed to identify standing tree carbon for each forest ecosystem across the landscape. Representative old stands can be assessed to quantify carbon carrying capacity for each ecosystem. Being spatial data, the current carbon storage for each ecosystem in the loggable areas of State Forests can be quantified, and their carbon sequestration potential accurately identified.

Forestry Corporation growth plots provide plots to ground truth and refine the LiDAR mapping, as well as quantifying the potential annual rate at which carbon can be sequestered by the recovering forests.

6.3. CO2 released by logging

Following logging that most of a tree, being the leaves, branches, defective trunks, bark, stump and roots are left in the forest to decompose, with some burning or decomposing rapidly to release their carbon, while the larger residues, such as stumps and larger branches, may take decades to decompose and release their carbon. Of the timber removed from the forest, most ends up as sawdust or in short-lived products, which rapidly release their carbon, with only a small proportion ending up stored for decades in relatively long-lived products. Once its usefulness is finished, a small proportion may end up in landfill, where decay may be extremely slow due to the anaerobic conditions.

With the currently limited pulpwood market in north-east NSW, based on the limited data available the indications are that of each tree felled:

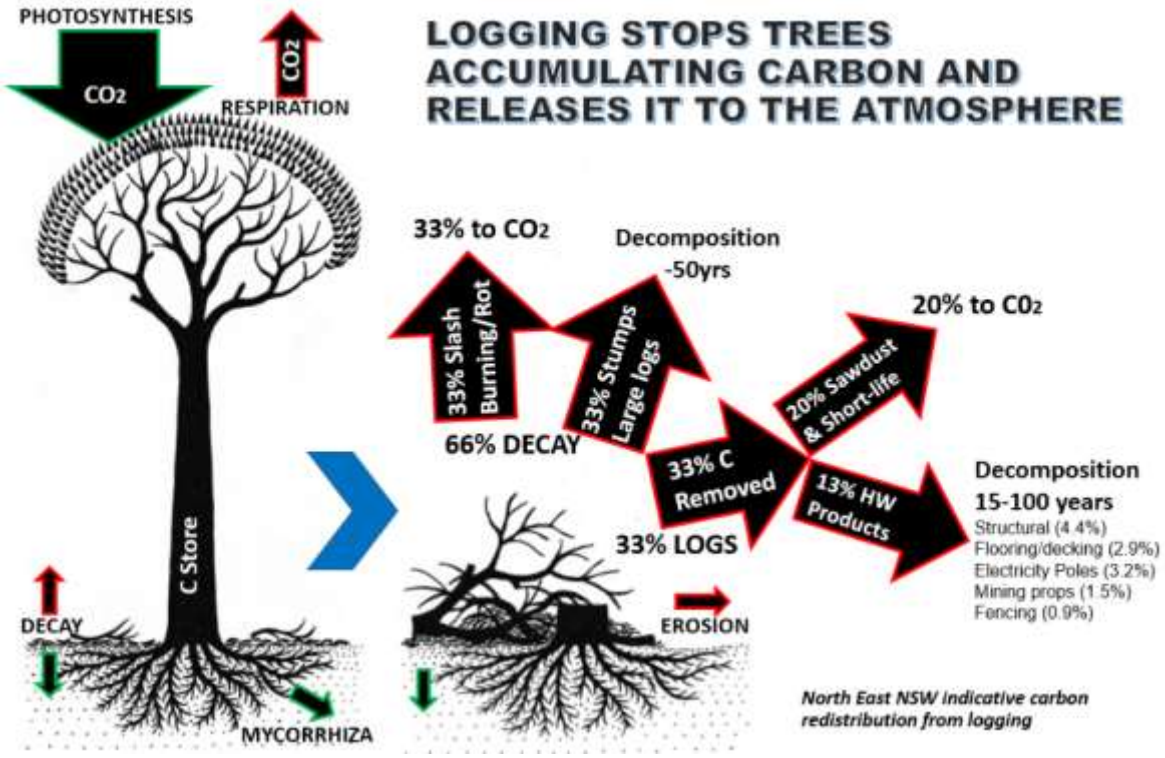
- **66.5% of its biomass is left in the forest, where around half will rot or burn rapidly releasing its carbon to the atmosphere and half (logs, stumps) slowly releasing its carbon over decades due to decay.**
- **33.5% of its biomass may be removed in log form, with 20.7% of the tree carbon rapidly released from short-lived residues and hardwood products, and 12.8% ending up in longer lived hardwood timber products (at best) with various carbon retention times of 15 years to over 100 years (where buried in landfill).**

Based on conservative assumptions, current logging of State Forests in north east NSW results in the release of over a million tonnes of CO_2 per annum, which is an ongoing process with carbon temporarily stored in products and logs over previous decades also progressively releasing its stored carbon. It is important to recognize that if the Forestry Corporation's claims for sustainable yields are ever realized this could nearly double.

Sanger (2023) assessed that native forest logging in NSW releases 3.6 million tonnes of carbon (CO2e) per year, which is equivalent to the annual emissions of 840,000 cars. She considered that by 2050 76 million tonnes of carbon can be prevented from entering the atmosphere if forests are protected rather than logged, which could provide $2.7 billion worth of climate benefit to the community.

In regions with large pulpwood industries most 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 (i.e. Keith *et. al.* 2014). Export woodchipping from north-east NSW was stopped in 2013, though has since increased (mostly from plantations), with pulpwood currently comprising less than 5% of the logs removed from native forests.

Indicative fate of Logged Forest Carbon in north-east NSW



The only relevant sampling assessments located for north-east NSW were 2 in blackbutt forests on the mid north coast undertaken by Ximenes *et al.* (2016). These are very small samples from which to extrapolate across a million hectares of public forests, particularly as Ximenes *et al.* (2016) only accept one 500m^2 site as being representative.

Ximenes *et al.* (2016) assessed above ground biomass (AGB) in old blackbutt dominated forest and advanced regrowth blackbutt forests in north-east NSW by clearfelling 500m^2 plots. These identified that the old forest had 169% more live (tree) Above Ground Biomass (AGB) than the regrowth stand, which was offset to an extent by the 354% increase in Coarse Woody Debris (CWD) in the regrowth stand, which was attributed to unmerchantable logs remaining from the original forest felled in earlier logging and ringbarking.

	Basal Area (m^2/ha)	Total live green AGB (t/ha)	Dead trees (t/ha)	CWD (t/ha)	Litter (t/ha)	Total AGB (t/ha)
Old forest	39	674.8	5.4	48.1	21.9	750.2
Regrowth	25	399.0	19.8	170.4	23.4	612.6

Above Ground Biomass (AGB), including Coarse Woody Debris (CWD), identified on cleafelled plots by Ximenes *et al.* (2016).

Ximenes *et al.* (2016) exclude the below ground portion of trees from their calculations, by only accounting for AGB. This provides an incomplete picture of the fate of carbon. As tree roots represent around 25% of the biomass of a tree, their inclusion increases the volumes of live green biomass to around 843.5 t/ha for the old forest and 498.8 t/ha for the regrowth stand. Live tree biomass thus accounts for 70-92% of a forest's carbon storage, without accounting for the significant contribution of soil carbon.

Ximenes *et al.* (2016) weighed the trees to further identify the distribution of biomass within the logged trees, expressed in dry tonnes per hectare, identifying that on the old blackbutt forest site

some 78% of the above ground biomass was left on site (bark, crown, stump and other) with 22% removed as logs, and on the regrowth site 52% was left on site with 48% removed in logs.

	Bark		Crown		Stump		Other		Logs		TOTAL
	t/ha	%	t/ha	%	t/ha	%	t/ha	%	t/ha	%	t/ha
Old forest	34	8	148	35	11	3	134	32	91	22	418
Regrowth	17	7	35	14	12	5	71	27	123	48	258

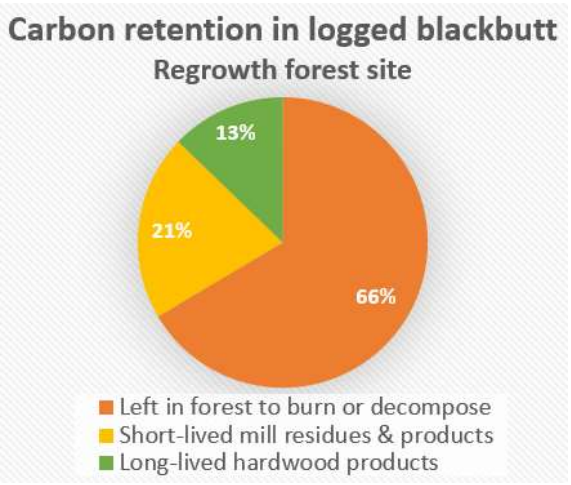
Live Above Ground Biomass (AGB), converted into dry biomass in tonnes per hectare, on cleafelled plots differentiated into tree parts left on site (bark, crown, stump and other) and removed in log form, as identified by Ximenes *et al.* (2016). The 'Other' residues include non- commercial species, dead and small trees as well as parts of the stem that had no commercial value due to damage during felling, decay or a reflection of the current market for that region. 'Other' is a lot higher for blackbutt than other types with pulpwood markets, i.e. averaging only 7% for silvertop ash.

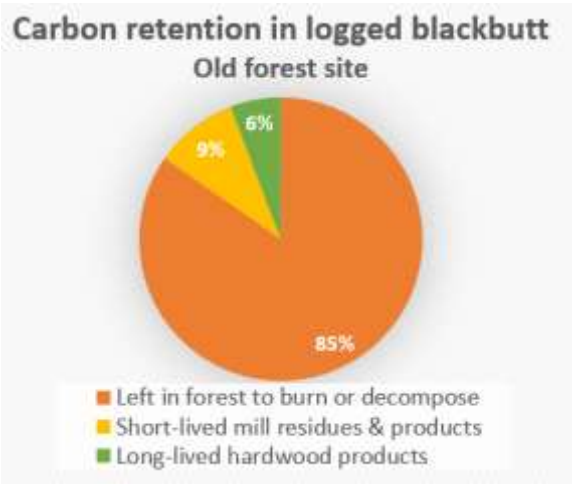
Leaves, bark and small branches and rootlets will rapidly decompose, releasing their carbon in the process, though stumps, sections of trunks, large branches, and large roots will decompose more slowly. In dry environments standing dead trees and other Coarse Woody Debris (CWD) may remain for decades, 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 (t0.95) of CWD were calculated from studies available in the literature. In 57% of all cases, the calculated lifetime (t0.95) is longer than 40 years (Fig. 4). The median of this distribution is at 49 years and the mean is 92 years.*

For this assessment it is assumed that half the biomass left on site will be burnt or decay within 3 years and half will progressively decay or burn over 60 years.

The figures of Ximenes *et al.* (2016) for dry tonnes per hectare were adapted to take into account root biomass retained on site, giving total volumes of tree biomass as 522.5t/ha for the old forest site and 322.5 t/ha for the regrowth site. In addition, the adjustment applied by Ximenes *et al.* (2016) to removed log products from the regrowth blackbutt site to reflect more realistic "*adjusted regional average production*" resulted in a decline in logs deemed to be removed from 123 t/ha down to 108 t/ha (33.5%). The application of this ratio to the old blackbutt site reduced the logs deemed to be removed from 91 t/ha down to 80 t/ha (15.3%).





Ximenes *et al.* (2016) estimates of the fate of carbon in logged forests.

Ximenes *et al.* (2016) assume that 50% of the dry biomass is carbon. They identify the yield from the 108 t/ha (33.5%) removed from the regrowth blackbutt site as 66.8 t/ha (20.7% of tree carbon) of short-lived residues and hardwood products that will rapidly release their carbon, and 41.2 t/ha

(12.8%) as longer lived hardwood products: structural (4.4%) flooring/decking (2.9%) electricity poles (3.2%), mining props (1.5%), and fencing (0.9%). For the old blackbutt site this would indicate that applying this ratio would result in 9.5% of tree carbon rapidly being released and 5.8% being held in relatively long-lived products.

Understandably Forestry Corporation and Ximenes *et al.* (2016) prefer the statistics for the regrowth (production) blackbutt stand and adopt this as being more representative of north-east NSW. While this is an extremely small sample, it has similarly been adopted for this review, though it needs to be recognised (as shown by the old forest site) that the proportion of biomass converted into long-lived products is likely to be far less on average, and thus this is a conservative assumption. Ximenes *et al.* (2016) note:

> *The data from the FCNSW for the mid-north coast covered a broad geographical area and suggests that the study "production" site yielded a slightly higher proportion of high quality logs than the average blackbutt forest in that region.*

The amount of carbon released by logging is to some extent offset by long term storage of carbon in products.

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.

The National Electrical and Communications Association identifies "*Australian Standards indicate a life expectancy of up to 40 years above ground and 25 years below ground for hardwood poles. … If your customers' poles are hardwood, it is recommended that they replace all those that have been in service for more than 25 years*". They take this further by recommending that should power poles need replacement that they "*should use new steel poles … in preference to wood poles*." Hardwood fencing has a reduced life expectancy of 15 to 30 years (when concreted in), with treated pine recommended for longer life.

In Australia, the average life of a brick home is 88 years and a timber home is 58 years (Snow and Prasad 2011), though some can last longer, while typical big box retail stores may only last 30-40 years.

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%.

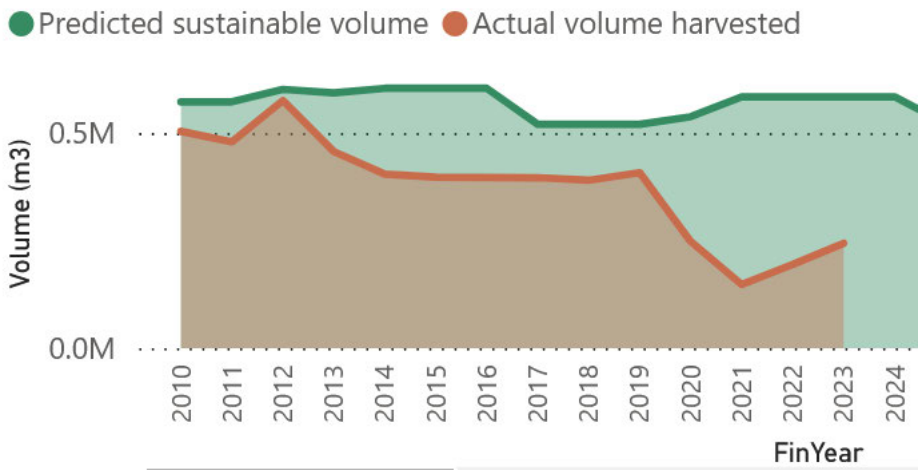
Of the timber removed from the forest, according to Ximenes *et al.* (2016) 61.8% will end up as short-lived mill residues and products, and 38.2% as relatively long-lived hardwood products, this is just 12.8% of tree biomass. Of the long-lived hardwood products, over half can be expected to be in exposed 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. Based on this, it is reasonable to assume that of the 12.8% (at best) of tree biomass made into long-life timber products, some 7% will retain its carbon for 15-30 years, 3% will last 60-90 years and 2.8% over 100 years.

Forestry Corporation's 2023 Sustainability report identifies the volumes attained from north coast hardwood forests in 2022/23 as 243,629 m3, with an annual average over the past 9 years (since

the 2014 buyback) of 313,346 m^3. This includes the significant reduction in 2019/20 due to the wildfires.

	Volume Harvested m^3
2022/23	243629
2021/22	194066
2020/21	147668
2019/20	247771
2018/19	407600
2017/18	389993
2016/17	395878
2015/16	396445
2014/15	397068
TOTAL	2820118
Annual Average	313346

The report shows yields to be declining and significantly below estimates of sustainable yields. The decline started after 2012 with retirements and purchases of quotas, with another significant drop after the 2019 wildfires, and some recovery in 2023. So, the average yields for the past 9 years are less than what can be expected under a business as usual scenario.



Graph from Forestry Corporation's 2023 Sustainability Report identifying the volumes attained from north coast hardwood forests, note the significant drop below "predicted sustainable volume" since 2012, and the further decline since the 2019 wildfires.

For 2023 the Sustainability Report, identifies the total yield from native forests on the north coast (including joint ventures) as 243,629m^3, with 94,427m^3 large HQ sawlogs, 39,302m^3 small HQ sawlogs, 71,249m^3 low quality logs and pulp/other 38,650m^3. The report identifies a sustainable yield of all products as 583,810 m^3.

Over the nine years 2014/15 to 2022/23 the average annual volume of products removed was 313,346 m^3. Using the conversions of 35% of the wood being water, and 50% of dry wood being carbon, this represents 101,837 tonnes of carbon. Based on 66.5% of the biomass being left in the forest this would represent 202,135 tonnes of carbon left in the forest each year, where it can be expected that half will be burnt or decay within 3 years and half will progressively decay or burn

over 60 years. Based on Ximenes *et al.* (2016), of the carbon removed, 62,935 tonnes (61.8%) will end up as short-lived mill residues and products, and 38,901 tonnes (38.2%) as relatively long-lived hardwood products. Of the 12.8% (at best) of total forest carbon made into long-life timber products, some 21,278 tonnes (7%) of carbon will be released over 15-30 years, 9,119 tonnes (3%) of carbon will be released over 60-90 years and 8,511 tonnes (2.8%) of carbon may remain sequestered for over 100 years.

In summary, based on conservative assumptions and with conversion into CO_2 (using a multiplier of 3.67), current logging of State Forests in north east NSW results in the release of over 1,116,000 tonnes of CO_2 per annum, with just 5.8% of the forests' sequestered carbon (equivalent to 64,702 tonnes of CO_2) expected to end up in forest products lasting more than 60 years. So, in total, each year logging of State forests in north-east NSW releases over a million tonnes of CO_2 per annum, which is an ongoing process with carbon temporarily stored in products and logs over previous decades also progressively releasing its stored carbon. It is important to recognize that if the Forestry Corporation's claims for sustainable yields are ever realized this could nearly double.

6.4. Plantations have a delayed carbon benefit

The establishment of plantations or regrowth involves significant soil disturbance and consequently the loss of soil organic carbon. It can take one or more decades for soils to recover the lost carbon. This means that it can take over a decade before biomass in plantations or regrowth result in a net increase in carbon storage. Sequestration will increase as the trees age.

Forests regenerating after logging may be net sources of carbon for several decades, due to the limited photosynthesis of the low leaf area of seedlings being overwhelmed by the respiration from decomposition of residual coarse woody debris, litter and soil organic matter (Chen *et. al.* 2004, Luyssaert *et. al.* 2008).

From their review of plantations in eastern Australia, Turner *et. al.* (2005) found that plantations may reduce soil carbon for the whole rotation (up to 30 years), with overall biomass growth often not off-setting establishment losses for 5-10 years

> *... after establishment, there are reduced inputs of carbon into the soil from prior vegetation or rapidly growing weeds, together with accelerated decomposition of soil organic matter as a result of disturbance, and this leads to a net loss of soil organic carbon. In some systems this loss of soil organic carbon is not balanced by carbon biomass sequestration until 5–10 years after establishment and on some sites, a reduction in soil organic carbon may remain until the end of the rotation. ... There was a general pattern of reduced carbon in surface soil immediately after plantation establishment and with time this extended deeper into the soil profile. The actual quantities varied greatly depending on the soil type. The decline was primarily a result of losses of labile carbon and was greater when the previous land use had essentially been native vegetation or highly improved pastures as opposed to regrowth woodland, or native pasture, or degraded land. In the absence of further disturbance, soil organic carbon can accumulate to pre-establishment levels but many short rotation plantations are terminated prior to this being attained.*

In already depleted soils, Zhang *et. al.* (2018) found that soil carbon (down to a metre) increased significantly with stand age, comprising the majority of ecosystem carbon. From their review of Australian studies Polgase *et. al.* (2000) found

> *For soil in the <10 cm or < 30 cm layers, there were significant effects of stand age on C change. Soil C generally decreased during the first 10 years (particularly the first five years) of afforestation followed by a slower rate of recovery and accumulation.*

For north-east NSW Polgase *et. al.* (2000) found

> There is a decline in C in the surface 10 or 50 cm for about 15 years after plantation establishment and then a general levelling out. The initial decline in soil C was 10%-12% yr^{-1} during the first two years after afforestation. Twenty-five years after afforestation, change in soil C was only –1.13 to –1.18 % yr^{-1}.

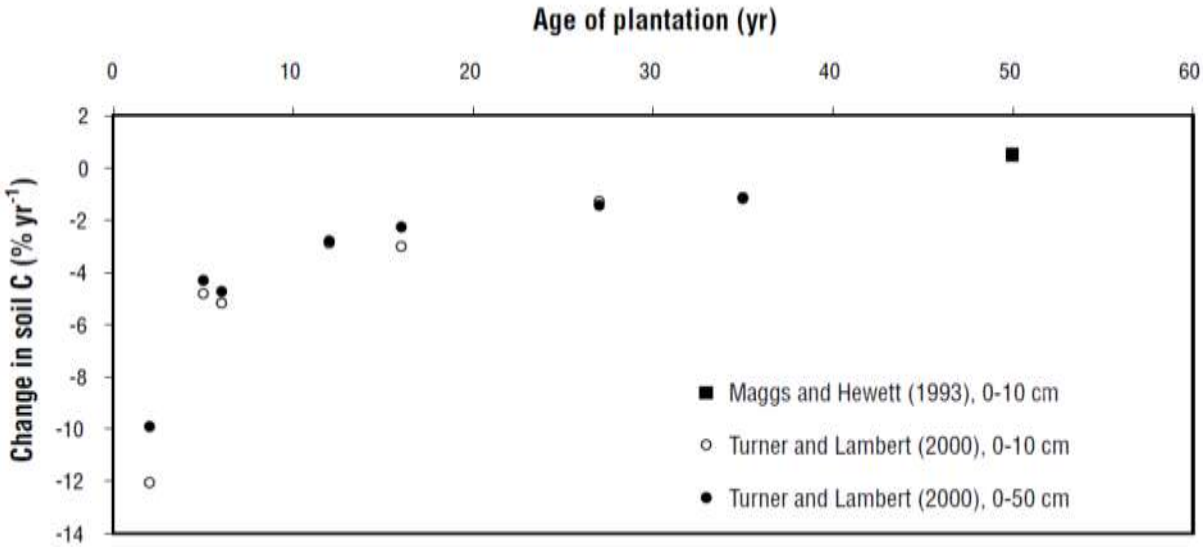


Figure 12.2. from Polgase *et. al.* (2000) Change in soil C in 0-10 cm or 0-50 cm layer under 2- to 50-year-old forest on ex-pasture land in the subtropical climatic regions of Queensland and the north coast of New South Wales.

Polgase *et. al.* (2000) consider that the "*losses in soil C*" by Turner and Lambert (2000) "*were by far the largest recorded in any of the studies reviewed*" and thus should be "*treated with caution*", summarising them as:

> *The paper by Turner and Lambert (2000) used a chronosequence approach to estimate change in soil C following afforestation. The calculated decrease (0-50 cm) during the first two years was about 3,900 g m^{-2} (1,900 g m^{-2} yr^{-1}) for* P. radiata *plantations and 8,400 g m^{-2} (4,200 g m^{-2} yr^{-1}) for the* E. grandis *chronosequence. Turner and Lambert (2000) further state that it may take 10-20 years before losses from soil C are offset by accumulation in biomass.*

From their comparison of 26 year old eucalypt reforestation with agricultural sites in Western Australia, Harper *et. al.* (2012) found that soil organic carbon up to 0.3 m depth ranged between 33 and 55 Mg ha^{-1}, "*with no statistically significant differences between tree species and adjacent farmland*".

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