Your details

Title
Mr

First name
Robert

Last name
Bertram

Submission details

I am making this submission as
A resident in a bushfire-affected area

Submission type
I am making a personal submission

Consent to make submission public
I give my consent for this submission to be made public

Share your experience or tell your story

Your story
I've lived in the 'bush' on the far south coast for 40 years and have been involved in various aspects of forest management for the past 35 years. During that time and particularly over the past 25 years there have been significant negative environmental changes including the spread of Bell-miner associated dieback and the first extensive canopy dieback event occurred during a dry spell in 1998.

Production forests around where I live were converted to 'flora reserves' in 2016 for the few remaining koalas on the far south coast. The final draft working plan for the flora reserves indicates " . . . Impacts on koalas and their habitat from clearing, other land-use and environmental changes (temperature increase and drought) have been significant contributors to the decline of koalas in the Eden region (Lunney et al. 2014). Within this context wildfire (and associated reactive management) and predation are probably the most immediate and major threats to the Murrah koala population. However, should the higher temperatures and more severe periods of drought predicted for the region (OEH 2016c) occur, additional declines are likely to occur, particularly due to wildfire, degradation of browse quality (Lawler et al. 1997) and defoliation (Jaggers 2004). Changes in other more complex threats such as dieback are less clear."(1)

All submissions to the final draft plan were suppressed but in an attempt to simplify the complexity and reduce the uncertainty around dieback, a nomination to jointly list Bellminer associated dieback (BMAD) that occurs downslope, with Dieback associated with dry weather and drought (DADD) that occurs upslope was sent to the NSW Threatened species scientific committee (TSSC) in 2019 (Attachment -DADDKTP). Seemingly confirming complexity can be rapidly overcome, within six weeks the TSSC responded indicating-

" . . . The Committee has reviewed your nomination in detail and has decided that rather than being a Key Threatening Process this phenomenon represents a symptom of a broad range of Key Threatening Processes and other factors including "natural climate extremes". This is particularly so for the issues of change to soil fertility, soil erosion, soil water holding capacity and impacts on vertebrate fauna such as the Koala which form the basis of your nomination. Die-back associated with dry weather and drought is a result of a range of other Key Threatening Processes rather than being a KTP itself.
Of the KTPs already listed by the NSW TSSC there are at least 10 which have an impact on the biotic processes and interactions essential for forest health and have caused a disruption of biotic processes and interactions and soil quality as you have discussed. These include:
Forest Eucalypt Dieback Associated with Over-abundant Psyllids and Bell Miners (BMAD)
Anthropogenic Climate Change
Clearing of Native Vegetation
High Frequency Fire
Loss of Hollow-bearing Trees
Removal of Dead Wood and Dead Trees
Predation by Feral cats; Foxes
Grazing and habitat destruction by rabbits, feral deer, feral horses, goats "

The degree to which Anthropogenic Climate Change influences DADD cannot be readily determined, however there is no doubt that during periods of DADD forests move from being carbon sinks to massive sources of CO_2. There is also no doubt that water content reduces in the leaves of koala feed trees and eucalyptus species generally prior to and during periods of DADD. There is also no doubt that feral cats and foxes have played a significant role in advancing the land degradation processes leading to DADD. However the TSSC's decision that DADD results from BMAD requires a belief that water, the substance generally associated with soil erosion and dispersion, moves up-slope against the law of gravity.

In reality the TSSC's arguably reckless decision is a green light for the agencies to continue ignoring the issues and the threats they pose to plants and animals including people.

While there have been many fires over the past 40 years, the fires on the north coast during 2019 and subsequent ignitions on the south coast were unprecedented. The fire of greatest local concern was the Badja Forest Rd – Countegany fire where the predicted potential ember attack area on New year's eve reached to about 15 kilometres from our property (Attachment -BFI att2).

I was woken at 4.30 am on New Year's eve (2019) by a phone call from a neighbour saying the towns of Cobargo and Quaama had been destroyed and the fire was heading toward where we live in the Murrah River catchment. It was apparent that something large was happening to the west and the 'Fires Near Me' website suggested fire had crossed Mumbulla Mountain and a 'finger' of fire was passing through Biamanga NP and heading toward Mumbulla State Forest (Attachment BFI att2).

While the sky looked disturbingly ominous it was dead still. One of our community koala drinking stations was close to the suggested location of the fire and with the thought that daylight would appear, at 5.15 am I drove 7km west to the location to retrieve the station. Upon arrival it was still pitch dark and dead still but the car lights were sufficient to retrieve the station.

Then I decided to see if it was possible to drive to the next station, about 5km to the south and theoretically through the fire. As it turned out there was no fire but it was too dark to retrieve the station so I returned home.

Upon arrival I was advised that an evacuation warning had been issued and Fires Near Me website suggested a far greater area, that I had just driven through, was on fire. Clearly this was not the case and over the next 4 weeks two other evacuation warnings were issued, based on worst case scenarios that didn't eventuate in the valley (Attachment BFI att2). While much control line construction and back burning was carried out during that time there is no evidence the fire would have reached this location due to north-easterly winds prevailing on the eastern side on Mumbulla mountain.

(1) Forestry Corporation of NSW and Office of Environment and Heritage (2017) Murrah flora reserves final draft working plan. 59 Goulburn Street, Sydney NSW 2000 PO Box A290, Sydney South NSW 1232
https://www.environment.nsw.gov.au/research-and-publications/publications-search/murrah-florareserves-draft-working-plan

Terms of Reference (optional)

The Inquiry welcomes submissions that address the particular matters identified in its Terms of Reference.

1.1 Causes and contributing factors
The Badja Forest Rd - Countegany fire is thought to have started from a lightning strike and subsequently spotted into the largely inaccessible and non-commercial forests in Wadbilliga National Park where it eventually turned into a firestorm. Clearly the drought had a significant influence on this outcome and while the additional influence of climate change cannot be excluded, such fires are what has shaped this environment over tens of thousands of years.

The role of fuel loads during a fire storm becomes fairly irrelevant when one considers that organic dust in otherwise bare paddocks can literally explode under such conditions. After engulfing Cobargo the fire seemingly ran out of 'puff' and residents to the east in Coolagalite, where the fire did not reach reported rainfall. To the south the fire appears to have been 'trapped' behind Mumbulla mountain and residents reported fire coming in from all sides.

However what isn't considered is how human activity contributes to an environment that dries out quicker, changes forest structure and species composition in production forests to 'ladder fuel' forests, as found in Wadbilliga NP and how forest die-back increases the potential for crown fires. Due to the fires in NSW the International Fund for Animal Welfare (IFAW) has called on the NSW government to 'emergency uplift' the conservation status of koalas to endangered. A report commissioned by the IFAW (2), refers to the ecological phenomena of eucalyptus dieback indicating-
" . . . In addition to population loss and consequent range contraction in western parts of the koala's range in NSW, and the impacts arising from the 2019/20 fire season, not yet taken into account are the many hundreds of thousands of hectares of otherwise unburnt koala habitat that have additionally been rendered unsuitable for koalas through water-stress leading to leaf-browning and loss of preferred browse species."

(2) Lane, A., Wallis, K., and Phillips, S. 2020. A review of the conservation status of New South Wales populations of the Koala (Phascolarctos cinereus) leading up to and including part of the 2019/20 fire event. A report prepared for the International Fund for Animal Welfare (IFAW).
https://www.ifaw.org/au/resources/koala-conservation-status-new-south-wales

1.2 Preparation and planning
The Rural Fire Service called for submissions (Attachment - rfs comms) on its draft Bega Valley Bushfire management plan. The major concern was that the NPWS proposed broad acre burning in and around the areas occupied by koalas. This process followed the same path as the Flora reserve working plan. Twelve months or so later the plan

appeared on the RFS website indicating it had been approved by the Bushfire management committee prior to the closing date for community input.
A subsequent request to the RFS asking for detail regarding the claim about koalas that "Scientific data suggests this population has unique characteristics that justify a higher level protection." was ignored.

It is apparent that the RFS, the Forestry Corporation and the NPWS colluded to ignore the science (3), funded by the RFS demonstrating their preferred management does not provide 'leverage' over bushfires.

(3) Price O. F. Penman T. D. Bradstock R. A. Boer M. M. & Clarke H. (2015) Biogeographical variation in the potential effectiveness of prescribed fire in south-eastern Australia. Journal of Biogeography, 42 (11), 2234-2245. https://onlinelibrary.wiley.com/doi/abs/10.1111/jbi.12579

1.3 Response to bushfires
The only opportunity to control fires is when weather conditions allow for such measures. However much time is spent on constructing control lines for back-burning during the fire rather than routine management that prepares for fires in advance. Clearly in the case of the Badja Forest Rd - Countegany fire the communities impacted by the fire on New Year's eve were at an extreme disadvantage given the rapid spread of the fire was not predicted. It is difficult to believe that a system able to provide a little more warning of a fire storm is not technically feasible and given the outcomes should be a priority.

On the other hand repeated public warnings based on a worst case scenario that doesn't eventuate because it isn't based on an understanding of local conditions are not conducive to enhancing public confidence in decision makers. In most instances under such conditions and as the RFS has stated their capacity to attend all properties threatened by fire is quite limited. Evacuation orders that do not account for a landholders capacity to manage fire under more benign conditions reflect a superior and arguably contemptible attitude.

Supporting documents or images

Attach files

- DADDKTP.pdf
- BFI att2.pdf
- rfs comms 18.pdf

Nomination form for listing a Key Threatening Process under the NSW *Biodiversity Conservation Act 2016*

Background

The purpose of this form is to provide a nomination to the NSW Threatened Species Scientific Committee (NSW TSSC) for assessment of a Key Threatening Process under Schedule 4 of the NSW *Biodiversity Conservation Act 2016* (BC Act). Please refer to the NSW TSSC Nomination Background Information document and the NSW TSSC Guidelines for information on the BC Act and criteria in the *Biodiversity Conservation Regulation 2017* (BC Regulation).

For a Key Threatening Process to be listed under the BC Act specific criteria must be met (see BC Act Part 4, Division 5, section 4.32). A threatening process is eligible to be listed as a Key Threatening Process if, in the opinion of the Scientific Committee:

(a) it adversely affects threatened species or ecological communities, or

(b) it could cause species or ecological communities that are not threatened to become threatened.

How to complete the nomination form

This nomination form consists of a series of questions to help you provide the information necessary to address the

criteria in the BC Act. Note, terms used in the nomination form and marked with asterisk (*) are defined in section 5 of the NSW TSSC Nomination Background Information document.

The NSW TSSC recognises that completing a nomination form is demanding due to the volume and detail of the information that is required to undertake an assessment. Nominators are encouraged to seek expert advice where appropriate to assist in the completion of the nomination form. Complete as much of the nomination form as you can. While the NSW TSSC will seek advice from other sources, any information not provided in the nomination may delay the assessment process.

Include references to published journal articles or other material that support the information you have provided. Unsupported or anecdotal information may not provide sufficient evidence to demonstrate the ecological community meets the criteria for listing.

If there is insufficient information to enable details to be provided because of a lack of scientific data or analysis please include any information that is available or provide a statement next to the relevant question identifying that the data or analysis is not available.

Do not quote or provide information you have obtained from other people (usually referenced as personal communications) unless you have obtained the agreement of those people to use those statements in the nomination.

Indicate if you are providing information you have obtained on a confidential basis or data under a data licence that prohibits its release to other parties and if you have obtained permission to publicly release the confidential information or data.

Ensure you know and agree to how the NSW TSSC will use and share your nomination and the information contained in the nomination and any attachments including your personal details by signing the declaration section. If you request confidentiality please ensure you have you have not included your personal information, or any information that can be used to identify you, in the nomination or attachments.

DO NOT DELETE ANY SECTION OF THE NOMINATION FORM INCLUDING SECTIONS LEFT BLANK

Lodgement of nomination

The original, signed hard copy of the nomination can be posted or scanned and a pdf emailed to:

The Chairperson,
NSW Threatened Species Scientific Committee
PO Box 1967
HURSTVILLE BC NSW 1481

Scientific.committee@environment.nsw.gov.au

In addition to the signed copy, completed nominations can also include supporting documentation in WORD, Excel (may be used for data) or PDF formats.

Nomination form to list a Key Threatening Process under the NSW *Biodiversity Conservation Act 2016*

1. General information

1.1 Title of the nominated Key Threatening Process:
Extensive canopy die-back, associated with dry weather and drought (DADD)
1.2 Description of the key threatening process by reference to its biological and non-biological components and the processes by which these components interact – if known.

Biological and non-biological components:

The major biological component leading to DADD, one of several forms of dieback, is the significant decline of biodiversity, particularly the decline and local extinction of digging and burrowing marsupials, monotremes and birds. Over varying time-frames, depending on location, a very large disruption to biotic processes and interactions that are essential for forest health (Department of Agriculture and Water Resources. 1992), leads to a reduction in soil fertility and broad scale environmental degradation.

A reduction in soil fertility, in this case soil water holding capacity, is most likely to result from a long term reduction of calcium inputs into soils. Calcium is known to reduce the impact of sodium that, when not balanced with calcium, increases soil acidity, sodicity and dispersion of water retaining soil materials (Little,1994). Soil sodicity may develop over a period of 10,000 or 20 years, can develop at any depth and becomes more difficult to ameliorate at depths of a metre or more (Rengasamy and Walters 1994). (ibid).

In common with agricultural lands, increasing soil acidity and sodicity in forested areas results from a reduction in plant and animal materials containing calcium (Thompson, A. 2007). Prior to European occupation, naturally acid soils have been estimated to cover over 60 million hectares in Australia. Clearing for agriculture has contributed an additional 30 million hectares and perhaps up to 35 million hectares in areas with an annual rainfall greater than 600mm (ibid).

Sodium occurs naturally in many Australian soils and comes from various sources including the weathering of rocks, rainfall and proximity to the coast (Rengasamy and Walters 1994). Studies undertaken in NSW into nutrient inputs from rainfall (Turner et al. 1986), found the volume of sodium deposited with rainfall can be up to 9 times the volume of calcium in coastal forests. While sodium volume in rainfall generally decreases as the distance from the coast increases, at one location sodium concentrations where 4 times that of calcium some 400 kilometres from the coast (ibid).

The majority of biological activity in forest soils involves microorganisms (Debano et al. 2008). In Australia this activity is aided by bioturbation, resulting from the actions animals and birds that burrow in or turn over soil and organic matter. Studies on the NSW north coast found tree bark, leaves and branches contained the greatest concentrations of calcium (Department of Primary Industries -NSW. 2017).

Bioturbation processes also aid in the spread of seeds and spores of various fungi that increase nutrient availability, including mycorrhizae, important for phosphorus availability and uptake (Trappe and Bollen. 1979-cited Debano et al. 2008).

Unpublished research on volumes of soil materials and litter some animals turn over suggest more than 200 m3 per year per animal for echidna, Eastern Barred Bandicoot ‘over a number of tonnes of soil’ and “ . . . Quenda (*Isoodon obesulus fusciventer*) has 34 digs per day, this equates to approximately 12 tonnes of soil displaced per hectare per year." (Ezzy. 2108).

All animals fertilise soils through their faeces, although reptiles and birds in particular produce calcium in a form that readily enters soils with rainfall. A reduction in reptiles, particularly large monitor lizards, can be readily explained through the significant reduction and local extinction of their former prey, due largely to introduced foxes and cats.

With regard to birds, Lyre-birds, for example, have a broad diet of mostly invertebrate prey including the Forest Hopper or "Carpet Prawn" (*Talitroides topitotum*). There may be dozens of these crustaceans per square metre of forest floor litter. However, insect populations in the northern hemisphere are declining (Hallmann et al. 2017) and anecdotal evidence suggests a similar decline in Australia. While there may be several reasons for this decline, a reduction in soil pH, as a consequence of reduced calcium inputs, may have negative impacts on forest hoppers and other invertebrates.

For example, research on marine shrimp found reduced pH conditions for 21 days led to a greater Ca:Mg ratio in cuticle development. The research found " . . . even short-term exposure to CO2-induced pH reduction can significantly affect exoskeleton mineralization and shrimp biophotonics, with potential impacts on crypsis, physical defense, and predator avoidance." (Taylor etal. 2015) An increase in soil acidity may also favour the life-cycles of less palatable invertebrates.

It seems likely that climate change is, or will be, an additional contributing factor to increased occurrences of DADD. Some research has been undertaken finding common thresholds for trees exhibiting drought stress however, " . . . the controls on species survival under extreme drought remain poorly resolved and limit our ability to adequately predict future changes in ecosystem structure and function." (Mitchell et al. 2014) The same can be said for dieback that occurs in particular locations during dry weather and in the absence of sufficient rainfall, prior to evidence of extensive tree stress and dieback.

Other major non biological components contributing to a reduction in biodiversity and soil nutrient inputs include planned and unplanned fire and logging.

The processes by which these components interact, if known:

The detailed soil analysis on which this nomination is based (Little. 1994), found the most disperible soils were the greatest depths, suggesting the calcium deficiency has been developing for so time. The particular soils are classified as Kurosols, under the Australian Soil Classification (Australian Soil Classification: OE&H 2019). The frequency of bell-miner occurrence has been found to be greatest in coastal forest growing on Kurosols (Silver and Carnegie. 2017). Under the Great Soil Groups classes (Great Soil Groups; OE&H 2019), these soils are classified as Yellow podsolics- infertile.

Like soil erosion, the process of subsoil dispersion is influenced by rainfall events, particularly prolonged rainfall after rain has wet soils. Soil erosion reaches its maximum potential when soils became saturated and overland flow increases. Similarly, soil dispersion is likely to reach its maximum potential when the volume of sub-surface water flow reaches it maximum potential, prior to the water, including any unconstrained dispersed colloidal materials, emerging from the soil and entering watercourses. The dispersion of susceptible clay aggregates is a result of chemical processes that create several colloidal materials, some of which are toxic to plants.

As these materials move down-slope with the sub-surface water flow, they can block soil pores, resulting in negative impacts on soil drainage at lower topographies (Rengasamy and Walters 1994). Among the materials produced as a consequence of clay aggregate degradation is aluminium. At higher levels aluminium will result in 'stunted roots and reduced growth of sensitive plants' (Tulau, 1997).

Over time the continuing break down and dispersion of clay aggregates reduces soil water holding capacity in susceptible soils (ibid). Consequently, extant forest ecosystems most affected by DADD, due to increasingly limited soil water holding capacity, are generally located at upper and mid slope positions.

DADD differs from Bell-Miner Associated Die-back (BMAD) due to its topographic position above areas subject to BMAD. However, it seems likely the two processes are inversely related, given DADD's association with increasingly dry soils at higher topographies and BMAD with increased soil water at lower topographies.

The latter, coupled with changes to soil chemistry, may explain the significant broad scale increase in shallow rooted native species at lower topographic positions in coastal forests, generally found to be associated bell miner colonies. In particular, species including kangaroo vine (*Cissus antarctica*) giant water vine (*C. hypoglauca*) and sweet pittosporum (*Pittosporum undulatum*) (Silver and Carnegie. 2017). An increase or over abundance of these species at lower topographic locations may provide more reliable indicator of forests currently or potentially subject to DADD, where BMAD is not evident.

While it has been suggested that some nutrients, particularly potassium and magnesium are always in surplus in forests, due to inputs from rainfall (Department of Primary Industries -NSW. 2017) Inputs from rainfall of these particular nutrients were both found to be highly variable at monitoring sites (Turner et al. 1986). The monitoring found " . . . Annual potassium inputs (Table 8) varied from 1.64 kg ha ¯1 near Eden to 16.59 kg ha¯1 at Riamukka State Forest." and " . . . The mean annual input of magnesium (Table 7) ranged from 0.36 kg ha¯1,at Carabost to 8.95 kg ha¯1, at Muswellbrook.."

Unlike magnesium, calcium and manganese, that have high temperature thresholds, those for potassium and phosphorous are much lower and both can be combusted during fires of moderate intensity (Tulau. 2015). At the lower end of temperature threshold classes, fire has a poorly understood impact on critical processes including " . . . sensitive materials are living microorganisms (for example, bacteria, fungi, mychorrizae), plant roots, and seeds. This class also includes many of the biologically mediated nutrient cycling processes in soils." (Debano et al. 2008)

In Australia, " . . . It is also likely that any negative effects from HR burning may be more complex and take longer to become manifest. For example, Woods & Raison (1983) noted that major releases of bio-available organic nutrients did not occur until litter had undergone several years of decomposition in moist conditions. In dry sclerophyll forests however, the frequency of prescribed HR burns may not allow this process to complete (Raison *et al*. 1983), as repeated, frequent burning would tend to dry these deeper litter/organic layers and hence reduce decomposition." (Tulau. 2015)

A comparative study of fire and nutrient loss in New Zealand and Tasmania reached the following conclusion regarding differences between soils.

> " . . . Fire depletes nutrients in forests by causing losses to the atmosphere, losses by runoff, and losses by leaching. Nutrient loss by fire encourages fire-tolerant vegetation adapted to lower soil nutrient status, so frequent fire is a feedback mechanism that causes progressive soil nutrient depletion. By destroying organic matter and diminishing organic matter supply to the soil surface fire inhibits clay–organic matter linkages and soil faunal mixing and promotes clay eluviation. Fire frequency is likely to have increased markedly with the arrival of humans at ca. 34 000 years B.P. in Tasmania and ca. 800 years B.P. in New Zealand. We argue that texture-contrast soils have not formed in New Zealand because of the short history of frequent fires in that country. A corollary of this conclusion is that texture-contrast soils in Tasmania are, at least in part, anthropogenic in origin." (McIntosh et al. 2005)

An example of progressive soil nutrient depletion may be the generally heavily logged native forests in the Eden region, where Black forest oak (*Allocasuarina littoralis*) can be the most abundant species that grows back after logging and more recently, DADD events. In thick 30-40 year old stands the volume of surface litter, mostly oak needles, can reach 6 kilograms per square metre (pers obs). While the nutrient value of this litter is yet to be assessed, the majority, if not all of this material is consumed in fuel reduction burns.

At a tree level the initial outcome from DADD events are similar to those in areas subject to BMAD. A reduction in water availability coupled with an inability to produce starch kills first the leaves, then small

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scientific.committee@environment.nsw.gov.au

branches, then large branches and frequently the whole tree. Consequently, the eucalyptus forest canopy becomes more open and species better adapted to lower soil fertility create a denser lower and mid storey. The increase in mostly non-eucalyptus lower and mid-storey species is likely to explain why broad acre forest burning does not provide leverage against bushfire, in the South East Corner Bio-region (Price et al. 2015)

It is acknowledged that there are many knowledge gaps with regard to the interaction between fire and soils (Tulau. 2015). In particular " . . . whether increasing HR targets and burning at reduced intervals could result in adverse impacts on soils and the hydrologic responses of catchments." (ibid). There are similar and probably associated knowledge gaps when it comes to DADD and BMAD, although they are both known to exist. However, a reduction in soil fertility is yet to be considered as a potential influence on either BMAD or DADD. There is little research on DADD and BMAD at a fundamental or subcatchment scale and varying nomemclature make broad scale spatial seperation of the two problematic, beyond the Eden region.

However, there is a general acceptance that koalas prefer *Eucalyptus* species that provide the most palatable foliage and these trees are generally associated with areas of higher soil fertility or site productivity (Law. et al 2017). Hence it is reasonable to consider koalas and their historic decline is likely to be an indicator of reducing soil fertility and this reduction is associated with increasing instances of dieback.

Following are some examples of dieback, associated reseach and commentary, mostly with regard to the south east of NSW and 'southern koalas'. (Kjeldsen et al 2018)

Research begun in 1965, during a drought on the South Eastern Highlands and the ACT found " . . . communities most severely affected were dry sclerophyll forests, especially on shallow, stony soils, on northerly and westerly aspects." (Pook and Forrester 1984)

Given its implications for koalas and greater gliders in particular, the research found the " . . . relative moisture content of living leaves could be reduced to 40-45 %, and maintained at these levels for long periods." The continuing dry weather led to the dieback of leaves and twigs and " . . . In the most severe cases, shrinkage and fissuring of the bark of E. rossii, with ultimate separation at the cambium, was observed." (ibid)

This stress, particulary evident in 'smooth barked' eucalyptus trees, was followed by a significant increase in longicorn beetle numbers. Tree mortality included 29% of E.rossii and15% of E macrorhyncha in the study, with lesser percentages for other species, although many of these died a year or so later. Dominance was found to be a factor in the mortality, with smaller trees succumbing first. It was thought that the age of some trees that died in the ACT and Monaro, suggested a drought of similar severity may not have occured in the previous 200 years (ibid).

Rainfall for the first six months of 1965 was the lowest on record for Canberra at the time. Although as indicated in the table below and without the effects of temperature, humidity and wind,1944 was a drier year overall, than 1965. Monthly temperatures were above the mean maximum throughout 1944, although daily temperatures aren't available.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
1944	3.5	1.3	13.7	18.6	51	49	28.4	6.1	11	39.4	46.2	30	254.1
1965	0.8	2.8	0.8	14.9	13.8	24.7	13.7	56.4	83.6	152.6	36.5	32	432.6

The broadscale browning of trees and shrubs was first observed in mid-March of 1965. While not entirely applicable to the southern tablelands, research on the Liverpool plains found rainfall of less than 20mm did not elicit a signicant increase of tree water use (Zeppel. et al 2008). While there were issues with the sensitivity of the equipment, most of this volume can be interceped by the tree canopy, understorey and surface litter. Hence, based on rainfall alone, there would seem to be no reason why broadscale browning would not be evident in early 1944.

There was little or no evidence of predrought tree mortality in the study area. However, it is possible that older longditudinal fissures observed on the trunks of some trees during 1960's (Cremer. 1966) were created during 1944. These fissures differed from fissures created by fire, the latter being located at and around the base of burnt trees (ibid).

Research has found tree water use in 'water limited ecosystems', as in Australia, can be broadly determined from leaf area, sapwood area and diametre at breast height and the first of these, leaf area, may be the most significant (Zeppel. 2013) . Although " . . . Information on - (1) tree responses to extreme precipitation and (2) mechanistic processes leading to drought mortality is needed to improve the representation of physiological processes in vegetation models." (ibid)

Further studies on E.rossii growing on 'rocky ridges', in this case with Eucalyptus sideroxylon the sub-dominant species in the stand, found E.rossii " . . . was less responsive to rainfall and water use appeared to be less seasonally dependent" (Eberbach and Burrows. 2006). The study included adjacent valleys where E. Macrorhyncha and E. Albens were the sub and dominant species, with similar water use results. " . . . Analysis of the water use response indicated that the two sub-dominant species had shallower roots while the major of roots of the dominant trees were likely to be located deeper in the substratum. This suggested that the stony ridges may store water deeper in the substratum than previously thought, to sustain some remnant vegetation over the dry summers, and ultimately, contribute less recharge to groundwater." (ibid)

A description of scribbly gum indicates "Eucalyptus rossii at its best is a medium sized tree, up to 25 m tall, with a dbh of 1m. On poor sites where it is more commonly found, the tree may be only 10-15 m tall, with a short, crooked bole and a heavy, irregularly branched crown. . . . The soils on which it grows are frequently skeletal, well drained and of little value for pastures." (Boland et al. 1984)

As with many Eucalyptus, the height, diametre and leaf area of mature trees may be highly variable, depending on site productivity.

Trees studied during and after the 1965 drought were mostly in the 10-30 cm DBH range and dieback " . . . tended to be more advanced in relatively small canopy trees" and " . . . Dieback was less advanced or was proceeding more slowly in larger trees than in smaller trees." (Pook and Forrester 1984)

An ability to access water at deeper levels, in otherwise generally shallow soils, may reflect a greater capacity for roots and associated hydraulic architechure of some species, to access and exploit water resourses in cracks and fissures in the bedrock. However, given the potential for a 'funneling effect', such locations may also be subject to increased water flows during prolonged rainfall, relative to surrounding areas.

Research on the factors influencing soil dispersion, on the NSWnorth coast and southern tablelands concluded more work was required.

> " . . . Much of the laboratory data seemingly contradicts field observations, where the field evidence suggests large dispersion. The soils examined in the Bungawalbin have small to moderate dispersion but exhibit features typical of largely dispersive soils, in particular large gullies. Such erosive features may occur as a result of a combination of factors working in concert. Soils with moderate dispersion due to large sodium and/or magnesium contents being buffered by large aluminium, are still very prone to erosion during the intense summer rainfalls that occur on the north coast of New South

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scientific.committee@environment.nsw.gov.au

> Wales. Gully erosion is rare on the non-sodic soils in similar environments.
>
> The Southern Tablelands lacks the intense summer rainfall of the Northern Rivers region yet the highly erodible nature of the acid-sodic soils is once again borne out by field observation. B82/3, C318/3, C318/5 all had very small dispersion percentages yet field observations suggested that they were highly erodible soils (Jenkins 1996, 2000).
>
> Thus, there may be a threshold value where dispersion in the field is controlled by the amount and intensity of rainfall, sodium, magnesium and aluminium contents and salinity. Texture may also play a role, as most of the sodic subsoils are sandy clays which are susceptible to mechanical breakdown; presumably as the clays disperse sand grains are removed." (Jenkins and Morand. 2004)

Since the 1965 drought broadscale dieback and death of Manna gum (*E. viminalis*) has been recorded on the South Eastern Highlands around Cooma. Research into the dieback has found it may be associated with an " . . . endemic but previously undescribed species of eucalyptus weevil (Gonipterus sp.)." (Ross and Brack, 2015)

The research suggests " . . . There does not appear to be sufficient evidence to conclude that changed land management practices, recent fire history or declining levels of structural complexity are responsible for this 'Monaro dieback' " (ibid)

Manna gum, like Forest red gum (*E.tereticornis*) on the coast, was previously considered to be a primary koala feed species on the southern tablelands, when growing on flat and fertile soils (Department of Environment and Climate Change. 2008) . The evidence indicates these forests were growing on more producive sites and supported relatively high densities of koalas, prior to clearing. The association of dieback with endemic borers, beetles, psyllids, amarilla fungus or Phytophthora cinnamomi, may all be a secondary consequence impacting on stressed trees, due to an ongoing reduction in soil fertility. Koalas are thought to have become extinct on the South Eastern Highlands and in the ACT prior to 1900. Subsequent translocations of koalas to Canberra, from Victoria and South Australia, began in the 1930's. Many of these koalas are thought to have 'escaped' and may be the source for much of the southern tablelands population.

More recent information on tablelands koalas southeast of the ACT found -

> " . . . Analysis of DNA samples revealed that two genotypes of koalas exist within the study area with samples from the southern section (including Numeralla) being of a different genotype to those collected from the north of the Chakola Fire Trail. Both populations contained haplotypes that were also found in the koala populations in the Strzelecki Ranges in south eastern Victoria and those in the greater Sydney area. However, there was no overlap of haplotypes between the population in the study area and the coastal forest population to the south east (D. Phalen pers. Comm.)" (Allen. 2014).

Dieback of Manna gum has also been observed in this area (Allen. 2017), although unlike primary koala habitat, strike rates for manna gum are slightly lower than those for E rossii and Brittle gum (*E mannifera sbsp mannifera*). Previous reserch on the southern tablelands found salt affected soils were located in particular areas and " . . .The chewing and licking of these materials by animals was noted at several locations." (Cunn et al.1969)

Victorian island koalas and their translocated offspring, have been found to generally prefer younger Eucalyptus leaves and assumedly to ensure adequate nutrition, they will also eat old leaves, buds, flowers and bark (Hindell. et al. 1985). Koalas in this area also eat bark. Research has found Sodium is lacking in tablelands eucalyptus leaves and " . . . the use of bark as a source of sodium in the Monaro is likely to be critical in these animals meeting their daily sodium requirements." (Au et al. 2017*)* Consequently " . . . the conservation of chewed trees should be a priority as they are likely essential for maintaining the sodium

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balance of Monaro koala populations." (ibid)

Chewed Brittle gum were found in patches, ranging from 0.5 to 9 km apart and with 1 to 5 chewed trees in each patch. Sodium concentrations in bark varied widely some trees having an " . . . almost 10-fold lower sodium concentrations in its bark than a chewed neighbor 2 m away." The researchers suggest " . . . It is possible that the roots of these chewed trees are accessing a saline water source that is not available to their neighbors." (ibid)

One of the online articles has photos of a bark eaten tree that appears to show longitudinal fissures on the tree trunk consistent with impact of the 1965 drought on *E.rossii* and other species (Francis. 2015). It is not clear when these fissures would have appeared, although tree growth rates must be assumed to be slow, if they date back to the 1965 drought. It has been suggested that bark eating is an adaptive strategy (ibid). However, as the availability of bark would need to be non depeleting, a reduction in tree growth rates would be a factor limiting availability.

The average time-frame for recurring extreme drought events of 14 years on the southern tablelands, is expected to drop to 12 years (Mitchell. et al 2014).

Historical evidence from Bega, in the South East Corner Bioregion (SECB), indicates koalas were numerous from 1860 and despite extensive clearing and hunting, did not begin to decline until 1905 (Lunney and Leary. 1988). A significant increase in erosion of 'upland valley fills'was initiated in the Bega river and many other catchments soon after European occupation and associated land clearing (Brierley et al.1999) Studies in the Narira creek catchment (137 km²) found most of the erosion occured in upland areas of three subcatchments totalling some 60 km² (Brierley and Murn. 1997). An estimated 3.3x 10^6 m³ of valley fills were eroded from an area of around 10 km² (ibid).

While there is some uncertainty about the extent of areas cleared at the time. The following table provides a coarse estimate of florisitic assemblages (Keith and Bedward. 1999) cleared and retained forest upstream of the valley fills. All of these assemblages were quite diverse with dominant bark shedding gums growing with various other rough barked tree species. The gum trees may have reduced sodium levels in soils and maintained other biota by storing and shedding excess sodium in their bark.

Catchment	Area	% catchment cleared	% fill removed	% dry grass cleared	% wet shrub cleared	% wet vine cleared	Average % cleared
Wilgo	621	49.83	80.8	72.77	95.42	71.35	83.00
Murrabrine	1039	37.85	56.3	77.06	81.04	76.78	71.47
Bredbatowra	788	54.98	20.9	38.33	63.58	21.99	40.94

While there appears to be a relationship between the areas cleared and the volume of fill removed. The extinction of koalas in primary habitat occurred around the same time as erosion of fill approached present day proportions. The physical erosion resulted from a rise in the water table due to significanlty increased sub-soil runoff from the cleared areas coupled with a significant increase of overland flow. The rise in the watertable would explain the occurence of ponds, between which cattle walking are thought to have created some of the initial 'nick points'. On going seepage from lateral sub-surface flows would combine with overland flow to increase the depth and width of erosion gullies, with subsequent flood events.

Gully developement and erosion in Narira creek subcatchments was futher exacerbated by a large flood 1971and continues with every subsequent flood.

Populations of feral cats were probably established before or soon after European settlement. Foxes were

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probably established by the 1890's, assuming there weren't earlier introductions (Dickman. 1996). It seems likely that the initial negative impact of foxes and cats would have been in forests immediately adjacent to cleared land. The extinction of koalas, in what was primary koala habitat, had occurred by 1910 (Lunney and Leary 1988). Anecdotal reports suggest koalas were no longer seen in 'open country' after this time and " . . . The popular belief was that they were stricken with a disease which resulted in 'paralysis and eventual starvation' (ibid).

These symtoms aren't consistent with those generally associated with Chlamydia or retro-virus. It is possible that koalas were stressed from malnutrition, increasing the potential for disease, due to a reduced tolerance to infection (McCallum. et al. 2017). This is likely to be the case if their preferred feed trees, particularly Forest red gum (*E.tereticornis*), were producing less leaves that were less nutritious and more toxic. Such an outcome would be expected if there were a reduction in soil fertility, below the threshold required to sustain koalas.

The susequent stress on koalas could have exacebated the effects of one or more of various *Trypanosoma* spp., mostly spread by ticks and implicated in " . . . pathological changes such as muscle degeneration in woylies (*Bettongia penicillata ogilbyi*)" (Barbosa et al. 2017)

By the 1970's the 'mallee' form of regrowth Forest red gum was apparent to even the uninformed observer (pers.obs). In 1997, soil landscape mapping found soils, where Forest red gum historically grew, have several limitations to tree germination and growth including low fertility, frequent sodicity, dispersibility, low permeability, hard setting surfaces and moderate to strong acidity (Tulau. 1997).

Ten years later, Lowland Grassy Woodland in the SECB, where Forest red gum was usually the dominant species, was listed as an endangered ecological community and the diminutive nature of regrowth trees was acknowledged (NSW Scientific Committee. 2007).

Despite this listing, the obviously poor form of regrowth, consistent with low soil fertility and the lack of koalas in retained trees, the following year saw the release of the NSW koala recovery plan indicating

> " . . . The research conducted to date on koala management has revealed critical elements of koala population biology, and the effects of earlier koala management actions on today's koala populations are known. For example, at the end of the nineteenth century there were two koala skinning factories in the Bega district – koalas in the region today are rare. The loss of population was caused by the loss of koala habitat on the flat, fertile soils of the district, but the data from koala fur records indicates that the farmed region is capable of sustaining a high koala population. This is encouragement for a replanting and restoration program such as on the fertile soils along the Bega River." (Department of Environment and Climate Change. 2008)

BMAD was first raised as a concern in 1994, when there was a noticable increase in bell miner colonies in wet forests across the SECB. Earlier studies found Bellminers became more abundant after logging, although this was only in certain coupes and they occurred "especially in moist forest types at the heads of gullies" (Kavanagh and Stanton, 2003). The subsequent significant increase in areas subject to BMAD has frequently not been associated with a visible disturbance, but is also mostly constrained to moist forest types and the heads and gullies of small catchments.

The first unprecedented extensive DADD event in the SECB occurred during the summer of 1997- 98, (pers obs) and was obvious from the air in forests from Merimbula to the northern most point of the SECB, northwest of Ulladulla.

In 2001, it was observed that " . . . in each coastal drainage system within Bega Valley Shire on the south coast of New South Wales, every near-coastal drainage system contains bellbird dieback." (Jurskis and Turner. 2002) Consequently , it was theorised that BMAD and 'rural dieback' are associated with the global nitrogen cycle and " . . . . A simple model of eucalypt dieback is proposed to account for both rural and forest dieback, including an increasing range of 'susceptible' species and sites. It associates eucalypt dieback with increased soil moisture and nitrogen status that stresses the roots of established eucalypt trees." (ibid)

However, the authors also suggested that " . . . Episodes of dieback can be distinguished from the process of chronic decline. Dieback episodes were associated with natural climatic extremes whereas chronic decline was associated with human management. . . . Drought scorch mostly occurs in higher and more exposed positions whereas decline is usually associated with lower and more sheltered positions in the landscape." (ibid)

The second DADD event began during the winter and spring of 2002 and co-incided with what became a state wide drought that despite a small break, continued until 2004 in the SECB. Neither of these DADD events were entirely consistent with the identified thresholds for trees exhibiting drought stress (Mitchell et al. 2014).

Mapping of dieback was undertaken across various forestry areas in eastern NSW during the 2002-2004 drought (Jurskis and Wamsley 2012 - b to m). The mapping did not differentiate between BMAD and DADD, perhaps because information on soil and site factors weren't available (ibid).

Since that time DADD has appeared at particular locations during short bouts of dry weather in the SECB, generally in previously logged forest on northerly facing slopes and among Coastal mahogany (*E. botryoidies*) close to the ocean (pers.obs).

Surveys have confirmed the existance of three small disjunct koala populations remaining in forests from the Dignams creek catchment in the north to the Bega river in the south in the SECB. None of these koalas have been located on farmland and community plantings in 1999 of Forest red gum, along river flats, between two of the populations, found while initial growth was promising, many trees died within the first few years and at most locations the growth of surviving trees has been poor.

A nomination to list these koalas as an endangered population has previously been rejected (NSW Scientific Committee, 2007). However, the determination did acknowledge 'extensive canopy dieback' as a threat. More recently, experts attending a koala workshop did not consider dieback as a threat or a 'knowledge gap' to be filled (Hemming et al. 2018).

State forests occupied by two of the koala populations, were transfered to Flora reserves, under the management of the Office of Environment and Heritage, in 2016. According to the management plan for Flora reserves:

> " . . . Impacts on koalas and their habitat from clearing, other land-use and environmental changes (temperature increase and drought) have been significant contributors to the decline of koalas in the Eden region (Lunney et al. 2014). Within this context wildfire (and associated reactive management) and predation are probably the most immediate and major threats to the Murrah koala population. However, should the higher temperatures and more severe periods of drought predicted for the region (OEH 2016c) occur, additional declines are likely to occur, particularly due to wildfire, degradation of browse quality (Lawler et al. 1997) and defoliation (Jaggers 2004). Changes in other more complex threats such as dieback are less clear." (State of NSW, Forestry Corporation of NSW and Office of Environment and Heritage. 2017)

The plan goes on to indicate:

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> " . . . A number of areas throughout the flora reserves have a modified condition and structure due to past use and disturbance and a more recent absence of fire. In particular there are a number of areas dominated by thick *allocasuarina* and/or silvertop ash (and more rarely stringybark) regrowth which is supressing the regeneration of other eucalypt species, including some of the more important koala browse species, such as woollybutt." (ibid)

As indicated the management plan refers to several threats, starting with clearing, other land-use and global climate change as 'significant contributors' to koala decline. The research implicating climate change (Lunney.et al 2014), was focused on the Eden forestry region, that forms the southern half of the SECB in New South Wales. The modelling employed information on " . . . changes in foliage projective cover, fire, increases in the human population and climate change in the form of changes in temperature and rainfall." (ibid)

The research suggests " . . . By 1970, the once abundant koala populations had declined to a handful of largely isolated populations in the hillside forests on the edge of the fertile Bega and Towamba valleys and around Bermagui." and " . . . The distribution of the koala population in the region contracted markedly between 1980 and 1995 to two distinct and disjunct areas, namely, Mumbulla–Murrah–Bermagui in the north-east, and Tantawangalo–Yurammie approximately in the mid-region of the study area, with scattered records in the north-west and southern part of the study area. After 1996, the Tantawangalo–Yurammie population had disappeared from the record (DECCW 2010).

As previously indicated, while there is some uncertainty regarding full extent of clearing, in the formally fertile valleys, most of the clearing had occurred some decades before koalas became extinct. This would suggest retained trees and those on the periphery of cleared areas sustained high numbers of koalas for some decades.

The information on temperature and rainfall does suggest at least 2 days above 35 degrees, although those appear to have occurred after the Tantawangalo–Yurammie population had disappeared from the record and after the 2002-2004 DADD event. Two days of temperatures above 35 degrees aren't extraordinary, as recorded in the Eden region during 1980 (Bridges.1983). There is also some uncertainty as to why koalas on the tablelands, where numbers are said to be increasing, would not be subject to similar impacts.

Similarly, the initial observed instances of DADD, associated with changes in foliage projective cover, occurred after the Tantawangalo–Yurammie population had disappeared from the record, as implied in the following quote.

> " . . . *Drought is not listed as an injurious agent in the forests at Eden by the Forestry Commission of New South Wales (1982) nor is it discussed as a factor effecting forest health by State Forests (1994). Wilting was associated with the loss of koalas during a drought in Queensland (Gordon et al., 1988). General wilting of forest trees due to drought has not, to our knowledge, been observed at Eden."* (Jurskis and Potter. 1997)

However, it is possible that one or more unobserved broad scale reductions in leaf moisture content may have occurred in the SECB, prior to the first DADD observations. Such a reduction could have fatal consequences for koalas, particularly if other water sources are not available. Annual rainfall data may not identify periods when these circumstances are likely to develop.

Fire is also indicated as a threat (Lunney.et al 2014), although the information appears to suggest a reduction in areas burned, over the 26 years. This was certainly the case for koalas in the Murrah Flora reserves, until they were set aside from logging. Information on any impact broad acre burning has had on koalas since 2016 is not publicly available.

Increases in the human population are also implicated (ibid), although it is possible to observe koalas in highly developed areas, the Gold coast for example. In some locations koalas can be observed feeding in small trees planted in nature strips (pers. obs). Some residents have also observed koalas walking along the top of paling fences, to access retained or planted trees in backyards. While this is not an ideal situation, development has not driven koalas to extinction, where suitable feed trees are available.

The Flora reserve management plan (State of NSW, Forestry Corporation of NSW and Office of Environment and Heritage. 2017), also refers to the potential for a 'degradation of browse quality (Lawler et al. 1997)'. While the particular research was directed at leaf nutrient availability under increased green house gas levels, the impact of DADD would seem consistent with a degradation of browse quality.

The term 'defoliation' in the Flora reserve management plan (State of NSW, Forestry Corporation of NSW and Office of Environment and Heritage. 2017), isn't used in the referenced document titled, 'Estimating Estimating the Extent of Declining Forest in South East NSW (Jaggers. 2004). As indicated in the following table, adapted from the research (Jaggers 2004), all lower altitude forests in the Eden region are suggested have a 'probability of decline'. DADD appears to have been less apparent in historically less fauna diverse non commercial forests growing on shallow soils, as in found Wadbilliga National Park, for example.

PROBABILITY OF DECLINE	STATE FOREST	NATIONAL PARK	PRIVATE	TOTAL	% OF TOTAL	% declin ng
High	11,521	36,217	40,709	90,684	16	21.88
High / Low	11,017	14,659	6,233	33,281	6	8.03
Low	83,767	111,853	24,338	223,387	41	53.89
High Potential	25,051	9,186	8025	42,835	8	10.33
High / Low Potent al	18,944	3,315	1,805	24,353	4	5.87
				414,540	0	100.00
High Altitude	10124	55946	37186	110,193	20	
				524,733	95	

A global overview provided the following definition of forest decline " . . . an episodic event characterized by premature, progressive loss of tree and stand vigour and health over a given period without obvious evidence of a single clearly identifiable causal factor such as physical disturbance or attack by an aggressive disease or insect." (Ciesla and Donaubauer. 1994) The review also indicates " . . . that some experts consider declines as a collection of diseases with incompletely understood aetiology and many situations were initially designated as declines or diebacks because their causes were unknown." (ibid)

With regard to the " . . . number of areas dominated by thick *allocasuarina* and/or silvertop ash (and more rarely stringybark)". Silvertop ash is a Monocalypts, the leaves of which have been found to contain the lowest available nitrogen, relative to more preferred koala feed trees, in the Murrah Flora reserves (Stalenberg et al. 2010).

At the time most of the integrated logging was undertaken the Murrah Flora reserves, for the purposes of regeneration, the Eden forestry region was divided into three zones (Bridges. 1983). These were:

1. The Silvertop Ash-Stringybark type forests, with a low proportion of non-pulpwood species.

2. The dry mixed-species forests, with a high proportion of non-pulpwood species.

3. The moister, higher altitude forests: those dominated by *Eucalyptus maidenii* and those in the *E. Jastigata-E. nitens* forest type.

Some of the species indicated as being unsuitable for pulpwood and therefore more likely to be retained during logging, include, *Angophora floribunda, E. bosistoana, E. consideniana* and *Eucalyptus longifolia.* (ibid)

These species have also been classified as being 'predisposed to decline' in the Eden region, along with

Eucalyptus angophoroides, *E. bauerana, E. botryoides*, *E. elata*, *E. melliodora*, *E. ovata*, *E. radiata*, *E. smithii* and *E. tereticornis* and *E. pilularis,* on 'difficult sites'. (Jurskis and Wamsley. 2012)

Unfortunately, there is little long-term information on what grows back or at what rate after logging in the Eden region,the SECB onr NSW generally generally. However, in western Australia, where dieback associated with drought has also been reported (Matusick. et al. 2013, Davison. 2014), information is available on 'cut over' jarrah forest, valued for its dense red timber. 'other land-use',

> " . . . The growth rate of jarrah was measured in 47 plots situated in high and low quality cut-over forest between Mundaring and Collie. Mean growth increments per decade for jarrah in high and low quality forest respectively were: diameter, 1.7 and 1.0 cm; basal area, 1.9 and 0.6 m2ha−1; volume, 11.8 and 2.0 m3ha−1. In high quality forest, diameter increment varied inversely with initial basal area whereas basal area increment and volume increment varied directly with initial number of stems per hectare. In low quality forest, basal area increment varied directly with initial basal area and initial number of stems per hectare.

From diameter growth curves calculated with these data the average diameter attained by trees in high or low quality forest after 400 years would be about 70 cm or 50 cm respectively. When only trees with above average increments are considered, 70 cm diameter would be attained after 250 years in high quality forest and 310 years in low quality forest. If only the 25% of the trees with the greatest increments are considered, these figures would be 200 and 250 years respectively." (Abbot and Loneragan. 1983)

The suggestion in the management plan that 'more important koala browse species, such as woollybutt', that like Forest red gum, has a dense and durable red timber, are being suppressed by other species, tends to imply that conditions are more favourable for the quicker growing less valuable species. It is also understood that the tree data referred to in the plan is from trees 150mm DBH or greater. If one assumes woollybutt (*E. longifolia*) seeds do germinate after logging, based on the growth of Jarrah, it could take several decades for the trees to attain 150mm DBH.

The majority of soils, whether on cleared land or forested areas in the Eden region are classified as Kurosols Kandosols or Kandosols natric, under the Australian Soil Classification.

In the Sydney Basin Bioregion, a study was initiated after dieback was observed in Sydney Harbour National Park (Burrows and University of Sydney. 1999). Anecdotal evidence suggested the dieback had begun during a drought in 1994 and this "may have predisposed the trees to insect attack" (ibid).

In this case the study concluded that the 'dieback is not associated with Phytophthora cinnamomi, soil salinity or acidity'. However, elevated levels of phoshorous were found in soils suggesting urban runoff may be a contributing factor. The author suggests management and research 'focusing on understanding causes of dieback at local scales'.

To the west mapping of dieback across the Cumberland plain during 2004 indicates " . . An area of 56, 000 ha of forest and woodland was estimated to be prone to decline" (Jurskis and Wamsley -map,g 2012). In addition " . . . declining stands occur in the water supply catchments, National Parks and Wilderness Areas west of this region (VJ pers. Obs.)" (ibid)

According to Water NSW " . . . Sodicity is a major cause of land degradation in the Sydney drinking water catchments". (Sydney Water.2019) A decrease in soil water holding capacity, due to changed land management practices, has been found to increase catchment runoff (Mahe et al. 2005). Although any increase is likely to include a reduction in water quality. The majority of soils in the Sydney water supply catchments are Kurosols, Rudsols and Tenosols.

The Australian Soil Classification provides the following definition and comment on Kurosols.

"... Definition - Soils other than Hydrosols with a clear or abrupt textural B horizon and in which the major part of the upper 0.2 m of the B2 horizon (or the major part of the entire B2 horizon if it is less than 0.2 m thick) is strongly acid.

Comment - The relevance of sodicity in strongly acid soils is open to question as in theory the presence of aluminium in such soils should counterbalance the usual deleterious effect of sodium (via dispersion) on soil physical properties. Unpublished data from many localities in Australia imply that for B horizons the critical limits of pH 5.5 and ESP of 6 to distinguish dispersive and non-dispersive soils seems to generally work in practice, although as might be expected, some soils do not behave as predicted. For this reason, sodicity is also used in Kurosols, but at a lower hierarchical level, to cater for those soils which have an ESP > 6 and may disperse in spite of having a pH less than 5.5. The role of the high exchangeable magnesium in many Kurosols is largely unknown." (CSIRO. 2019)

Genetic studies have identified three koala populations in the broader Sydney basin (Lee et al. 2010). The Blue mountains population, found to have the genetic diversity 'comparable to the highest diversity found in any koala population previously investigated'. The Campbell town population, 'with considerably lower genetic diversity' and 'evidence of a recent population bottleneck (effective population size estimated at 16–21)'. The third and closest to the Campbelltown population being the Southern Tablelands population where 'strong differentiation of two geographically close populations separated by several potential barriers to gene flow suggested these land-use features pose barriers to gene flow'. (ibid)

More recent genetic research 'reveal two historical shallow genetic groupings or "clades" across Australia.' finding in the broader Sydney basin form the northen most part of a southern clade (Kjeldsen et al. 2018) However, found the Strzelecki and South Gippsland populations "appear to be relatively divergent from the other southern koala populations, forming a distinct subclade apart from other southern populations in both phylogenetic constructions using PAV markers." (ibid). Where south coast koalas may fit into this clade isn't known.

In the Wauchope forestry area, of the North coast Bioregion 115, 000 hectares was estimated to be declining in 2004 (Jurskis and Wamsley, 2012 map- m). Much of this area is suggested to be 'red gum'. Although dieback was not identified during 2004, DADD was observed on North and Middle Brother Mountains, near Port Macquarie, during 2013 (Pretorius. 2013).

On this occasion the NSW National Parks and Wildlife service suggested the dieback could be, 'Bell Miner Associated Dieback, localised fires with canopy die off as a result or, severe dry conditions, especially given that these areas are on very shallow, rocky soils.' (ibid)

The following table is adapted from the management plan for Dooragan National Park (NSW Department of Conservation 2004) and provides detail on forest ecosystems on North Brother, likely to be involved in the DADD event.

Plant community **Dry Sclerophyll Forest**	**Occurrence**
Dry Blackbutt Forest is dominated by blackbutt *Eucalyptus pilularis*. In most places, tallowwood *E. microcorys*, pink bloodwood *Corymbia intermedia*, white mahogany *E. acmenoides*, and ironbark *E.siderophloia* are also common canopy species.	Widespread in the park. Occurs on moderately steep slopes.
White Mahogany/Tallowwood Forest canopy is dominated by white mahogany *E. acmenoides* and tallowwood *E. microcorys*. Other canopy species	Found in patches in the northern part of the park. This association is locatedon exposed north and north-east facing slopes where soils are shallow.

include pink bloodwood *Corymbia intermedia*, red bloodwood *C. gummifera*, red mahogany *E. resinifera*, grey ironbark *E. placita*, ironbark *E. siderophloia* and forest red gum *E. tereticornis*.	
Blue-leaved Stringybark/White Stringybark Forest is dominated by stringybarks, *Eucalyptus agglomerata* and *E. globoidea,* with blackbutt, small-fruited grey gum *E. propinqua*, tallowwood, pink bloodwood and red bloodwood also present.	Confined to drier west to north facing hill slopes

Reports from carbon flux sites during 2013 found that "major forest and woodland ecosystems were resilient to that event." (Montreal Process Implementation Group for Australia and National Forest Inventory Steering Committee, 2018).

However, DADD events are likely to have several negative impacts at a local scale. Soils on the mountains are Kandosols, Kurosols and although Dooragan National Park has " . . . significant areas listed under State Environment Planning Policy No. 44 as koala habitat". The management plan indicates " . . .The koala *Phascolarctos cineraus* and brush-tailed rock wallaby *Petrogale penicillata* were reportedly common on the mountain up until the 1930s but have not been recorded in recent years."

Further to the north in the Casino forestry area, some '57, 000 ha of susceptible forest and woodland' was indicated as being subject to decline (Jurskis and Wamsley. 2012). Large areas were identified in the previously referred to Bungawalbin catchment (Jenkins and Morand. 2004).

To the west in the Nandewar Bioregion around Tamworth a report indicates extensive areas of forest turned brown in 2018, in the (Bath. 2018). In this case a lowering of the water table was proposed although water tables aren't generally associated with steep hilly country.

1.3 Could this nominated key threatening process be considered to be included within a key threatening process that has already been listed under the BC Act (see Schedule 4 of the BC Act)?

Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners

1.4 Is the key threatening process unique to NSW (i.e. does it only occur in NSW)?

☐ ~~Yes~~	☐ No, provide other states or territories - Queensland, Victoria, South Australia, Western Australia, Tasmania, Australian Capital Territory

1.5 Does the key threatening process occur in the following areas?

Lord Howe Island: Yes	Australian Capital Territory: Yes

1.6 Is the key threatening process (or a similar process) currently listed under the Commonwealth *Environment Protection Biodiversity Conservation Act 1999* (EPBC)? If so, under what name is it listed?

Land clearing

2. Geographic Distribution

2.1 Describe the extent of the key threatening process within NSW and Australia (where relevant). If possible, include a map indicating the current distribution and location(s) of the key threatening process in NSW.
Generally coastal forests within the range of Bell Miners (*Manorina melanophyrs*) in NSW.
2.2 Is the key threatening process restricted to a specific habitat type or locality?
Coastal dry eucalyptus forests
2.3 Does the key threatening process vary in its severity across its distribution?
Yes

3. Impacts of Key Threatening Process

3.1 List the Threatened Species*, Populations* and Ecological Communities* (as listed under Schedules 1 and 2 of the BC Act), that are adversely affected by the nominated key threatening process.

Provide information that demonstrates how the nominated key threatening process adversely affects these threatened species, populations and ecological communities.

Provide information on the extent and severity of the nominated key threatening process on these threatened species, populations and ecological communities, i.e., does the nominated threatening process adversely affect them throughout their range?

Species, populations and ecological communities	Adverse effect	Extent and severity of threat
Petauroides volans (Kerr, 1792)	Unplanned disturbance that reduces leaf moisture content	Greater Glider population in the Seven Mile Beach National Park area
Phascolarctos cinereus (Goldfuss, 1817)	Unplanned disturbance that reduces leaf moisture content	Koala, Hawks Nest and Tea Gardens population
Phascolarctos cinereus (Goldfuss, 1817)	Unplanned disturbance that reduces leaf moisture content	Koala in the Pittwater Local Government Area
Phascolarctos cinereus (Goldfuss, 1817)	Unplanned disturbance that reduces leaf moisture content	Koala population between the Tweed and Brunswick Rivers east of the Pacific Highway

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Petaurus australis Shaw, 1791 Yellow-bellied Glider	Unplanned disturbance that reduces sap availability	NSW coastal bioregions
Petaurus norfolcensis (Kerr, 1792) Squirrel Glider	Unplanned disturbance that reduces sap availability	NSW coastal bioregions
Phascolarctos cinereus (Goldfuss, 1817) Koala	Unplanned disturbance that reduces leaf moiture	NSW coastal bioregions
Lowland Grassy Woodland	Continuing decline, probable collapse	South East Corner Bioregion
Brogo Wet Vine Forest	Continuing decline, probable collapse	South East Corner Bioregion

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3.2 List any species*, populations* and ecological communities* not currently threatened (i.e., not listed under the BC Act in Schedules 1 and 2) in NSW that could become threatened due to the nominated key threatening process. Provide information that demonstrates how the nominated key threatening process adversely affects these species, populations and ecological communities. Provide information on the extent and severity of the key threatening process on these species, populations and ecological communities, i.e., does the nominated key threatening process adversely affect these species, populations and ecological communities throughout their range?		
Species, populations and ecological communities	Adverse effect	Extent and severity of threat
Myanba Dry Scrub Forest (Keith and Bedward. 1999)	Disruption of biotic processes and interactions: Reduction in geographic distribution	Throughout range
Rocky Tops Dry Shrub Forest (Keith and Bedward. 1999)	Disruption of biotic processes and interactions: Reduction in geographic distribution	Throughout range
Coastal Foothills Dry Shrub Forest (Keith and Bedward. 1999)	Disruption of biotic processes and interactions: Reduction in geographic distribution	Throughout range
Coastal Gully Shrub Forest (Keith and Bedward. 1999)	Disruption of biotic processes and interactions: Reduction in geographic distribution	Throughout range
Eden Dry Shrub Forest (Keith and Bedward. 1999)	Disruption of biotic processes and interactions Reduction in geographic distribution	Throughout range
Escarpmment dry grass forest (Keith and Bedward. 1999)	Disruption of biotic processes and interactions Reduction in geographic distribution	Throughout range
Inland Intermediate Shrub Forest (Keith and Bedward. 1999)	Disruption of biotic processes and interactions: Reduction in geographic distribution:	Throughout range
Foothills Dry Shrub Forest (Keith and Bedward. 1999)	Disruption of biotic processes and interactions: Reduction in geographic distribution:	Throughout range

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Lowland Dry Shrub Forest (Keith and Bedward. 1999)	Disruption of biotic processes and interactions Reduction in geographic distribution:	Throughout range
Lowland Gully Shrub Forest (Keith and Bedward. 1999)	Disruption of biotic processes and interactions: Reduction in geographic distribution:	Throughout range
Coastal Lowland Gully Shrub Forest (Keith and Bedward. 1999)	Disruption of biotic processes and interactions: Reduction in geographic distribution:	Throughout range
Coastal Range Dry Shrub Forest (Keith and Bedward. 1999)	Disruption of biotic processes and interactions: Reduction in geographic distribution:	Throughout range
Eden Dry Shrub Forests (Keith and Bedward. 1999)	Disruption of biotic processes and interactions: Reduction in geographic distribution:	Throughout range
Hinterland Dry Grass Forestry (Keith and Bedward. 1999)	Disruption of biotic processes and interactions: Reduction in geographic distribution:	Throughout range

3.3 Explain how the species, populations and ecological communities could become threatened as a result of the nominated key threatening process.
The ecological communities have undergone a large degree of environmental degradation within a time span likely to have a significant negative impact on life cycle and habitat characteristics of their component species.

4. Appendices and Information sources

4.1 If you have attached any information to his nomination please list or describe the information below.	
Appendix 1	
Appendix 2	

4.2 Has this document been refereed? If so, indicate by whom.

Name	Postal Address	Telephone	Email

4.3 Document all written sources, published and unpublished. Where information is not freely available please include a copy.

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4.4 List any other experts, researchers or organisations relevant to the assessment of this Key Threatening Process.

Privacy information

The information you provide in this nomination form will be used by the NSW TSSC in the assessment to determine the conservation status and listing or delisting of threatened or extinct species and threatened or collapsed ecological communities.

The NSW TSSC may forward your nomination to other people, researchers and organisations to seek advice on the information provided and/or to obtain more information relevant to the assessment and management of the species.

The NSW Government has agreed with the Commonwealth and other state and territory governments to collaborate on national threatened species assessments using a common assessment method. Your nomination, including your details as nominator, may be provided to state and territory government agencies and scientific committees as part of this collaboration unless you have requested that your personal information be treated as confidential and you have not included your personal information in the nomination or attachments.

Individuals can access their personal information or request a correction of personal information held by the NSW TSSC by contacting the NSW TSSC's Executive Officer.

The NSW TSSC has adopted the procedures set out in the DPE Cluster Privacy Management Plan (PMP). The PMP defines personal information and provides details about the privacy principles that the NSW TSSC follows when dealing with personal information.

4. Nominator information

Declaration

I declare that the information in this nomination and any attachments is true and correct to the best of my knowledge.

I permit the NSW Threatened Species Scientific Committee to provide a copy of the nomination and any attachments to other people or organisations for expert comment or advice.

I permit the NSW Threatened Species Scientific Committee to provide location details or data included in the nomination and any attachments to the Office of Environment and Heritage for inclusion in GIS databases managed by OEH, including publicly accessible databases.

I permit the NSW Threatened Species Scientific Committee to use, reproduce, publish, communicate and distribute information (see also 4.2) contained in the nomination and any attachments, in Committee publications including determinations, assessment reports, documents for public information and on the Committee's website.

I permit the NSW Threatened Species Scientific Committee to provide a copy of the nomination and any attachments to Commonwealth, State and Territory government agencies and associated committees or other bodies undertaking threatened species and ecological community assessments for those agencies.

Signed: Date:

4.1 Nominator's details	
Name	Robert Bertram
Organisation	Community
Postal address (required information)	
Email	
Phone	

4.2 Do you wish the information provided in the Nominator's details section to be regarded as confidential?
~~Yes~~ / **No** **If you have requested confidentiality please ensure you have you have not included your personal information, or any information that can be used to identify you, in the nomination or attachments.**

Please note: The Committee is subject to the provisions of the *Government Information (Public Access) Act 2009* and access to the nomination and any accompanying information may be sought in accordance with that Act.

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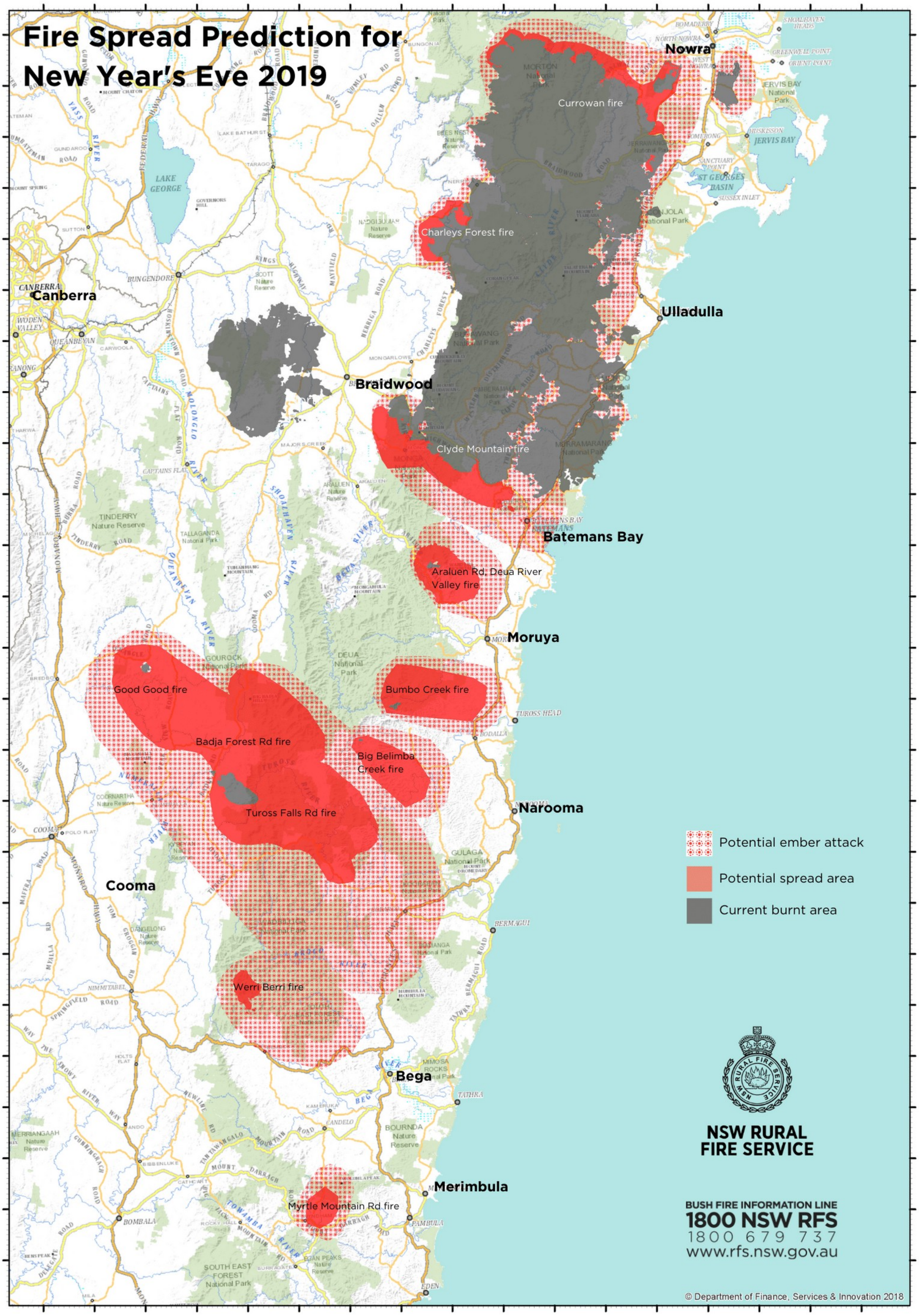
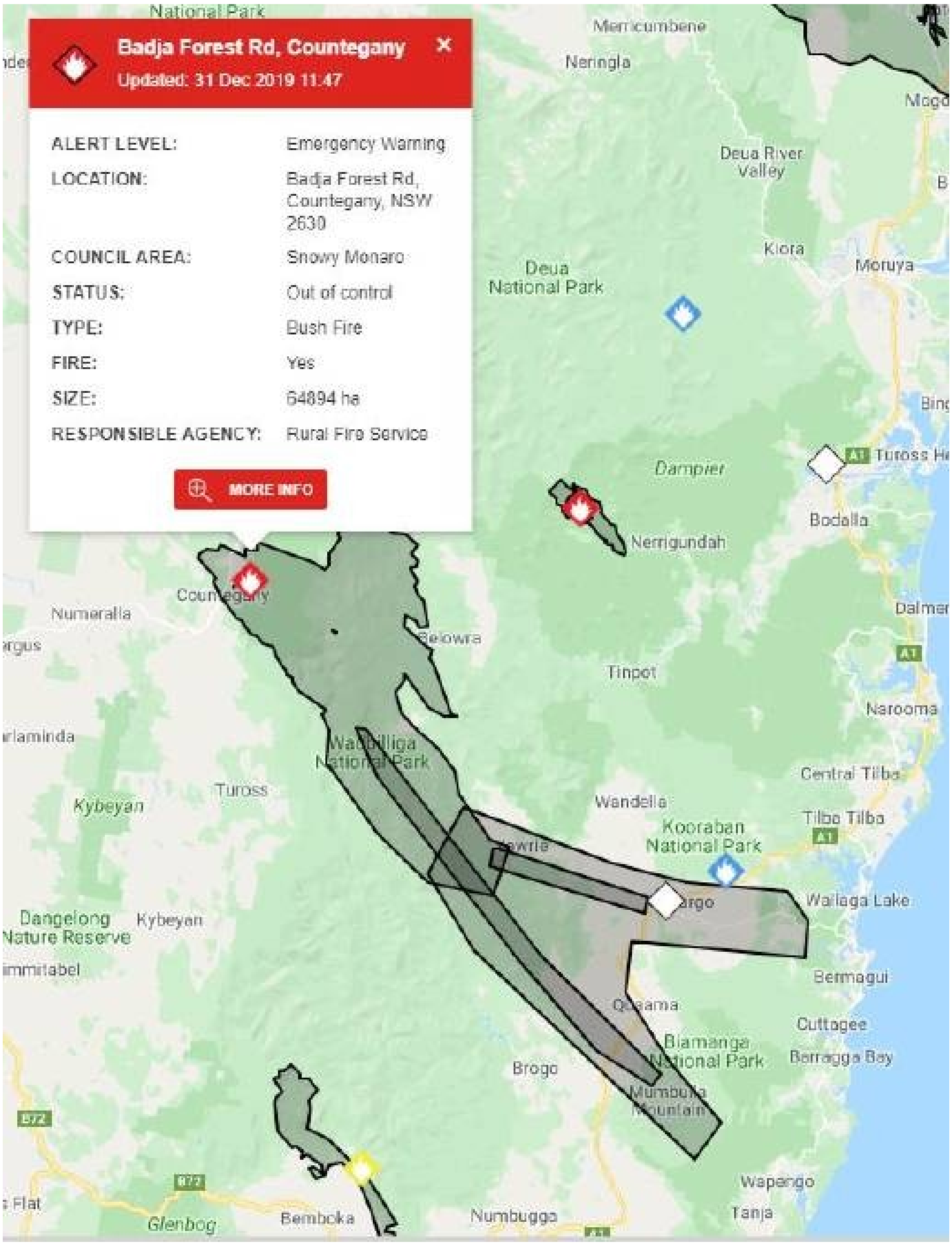
Attachment 2 -





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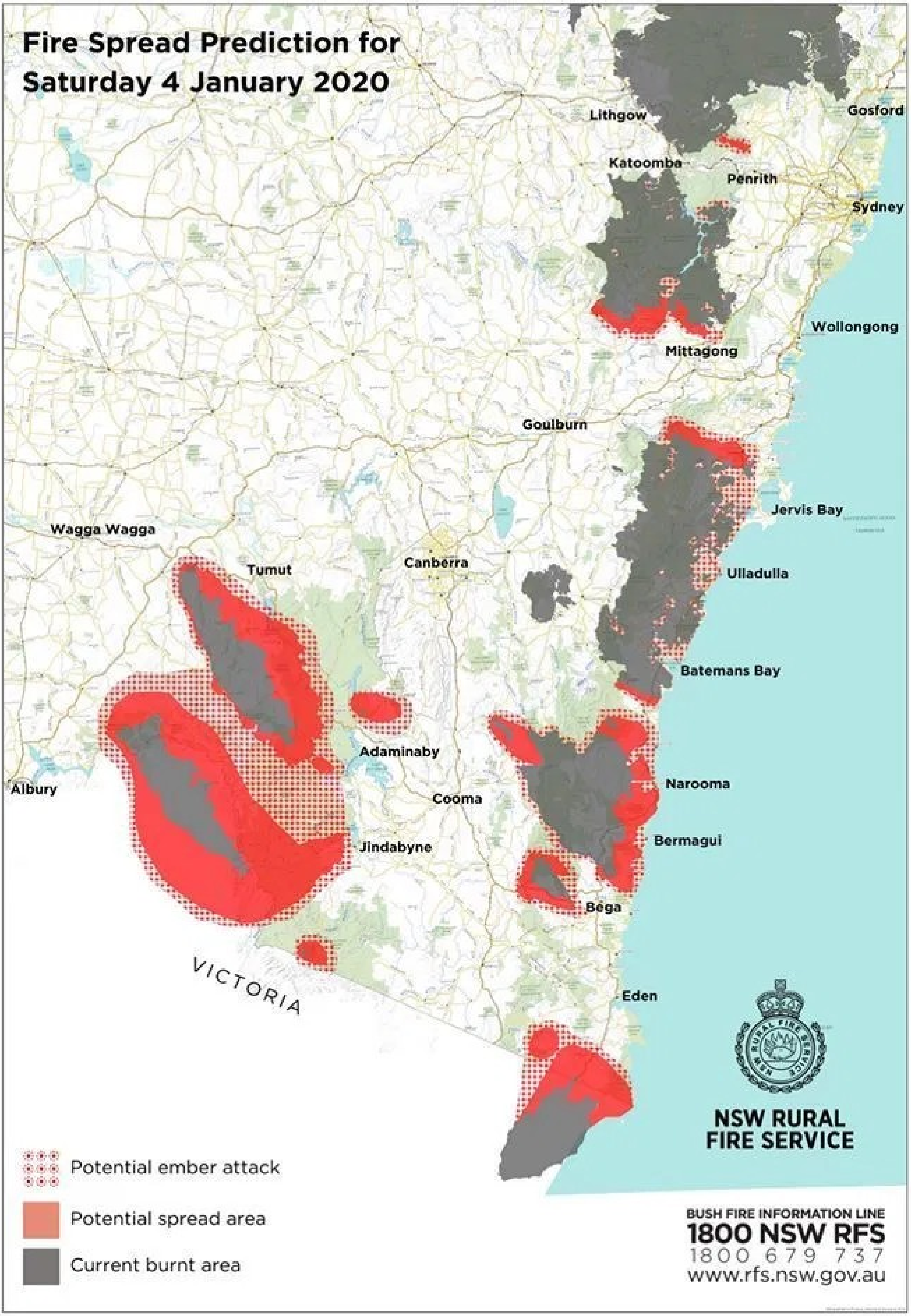
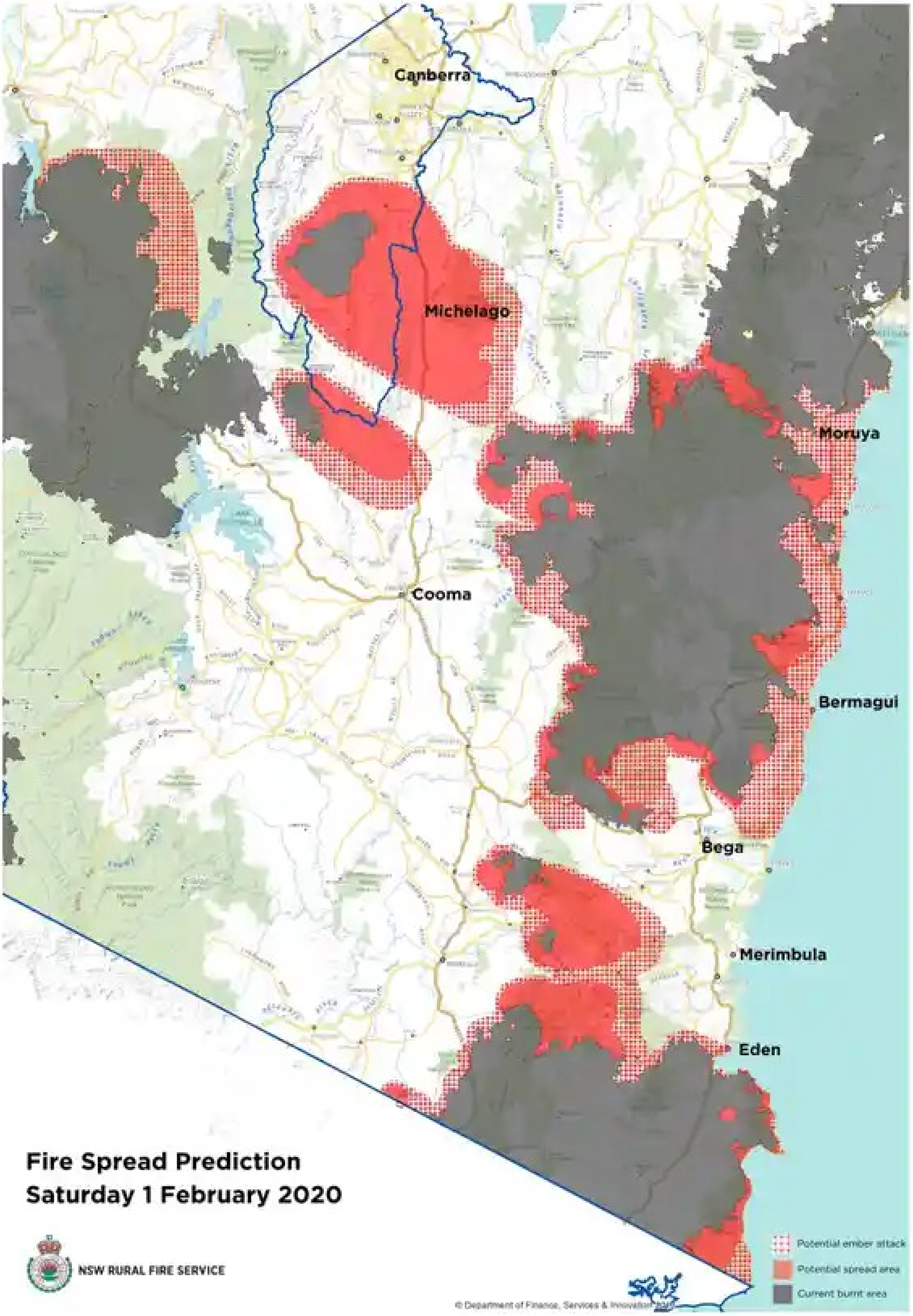
Updated: 31 Dec 2019 11:47
ALERT LEVEL: Emergency Warning
LOCATION: Badja Forest Rd, Countegany, NSW 2630
COUNCIL AREA: Snowy Monaro
STATUS: Out of control
TYPE: Bush Fire
FIRE: Yes
SIZE: 64894 ha
RESPONSIBLE AGENCY: Rural Fire Service
MORE INFO
National Park
Merricumbene
Neringla
Deua River Valley
Kiora
Moruya
Deua National Park
Dampier
Tuross He
Bodalla
Nerrigundah
Countegany
Numeralla
Belowra
Tinpot
Dalmer
Narooma
Wadbilliga National Park
Tuross
Kybeyan
Central Tilba
Wandella
Tilba Tilba
Kooraban National Park
Wallaga Lake
Dangelong Nature Reserve
Kybeyan
Bermagui
Cuttagee
Barragga Bay
Biamanga National Park
Brogo
Wapengo
Tanja
Glenbog
Bemboka
Numbugga


Fire Spread Prediction for
Saturday 4 January 2020
Lithgow
Gosford
Katoomba
Penrith
Sydney
Wollongong
Mittagong
Goulburn
Jervis Bay
Wagga Wagga
Tumut
Canberra
Ulladulla
Batemans Bay
Adaminaby
Albury
Cooma
Narooma
Jindabyne
Bermagui
Bega
VICTORIA
Eden
NSW RURAL
FIRE SERVICE
Potential ember attack
Potential spread area
Current burnt area
BUSH FIRE INFORMATION LINE
1800 NSW RFS
1800 679 737
www.rfs.nsw.gov.au



Canberra
Michelago
Moruya
Cooma
Bermagui
Bega
Merimbula
Eden
Fire Spread Prediction
Saturday 1 February 2020
NSW RURAL FIRE SERVICE
Potential ember attack
Potential spread area
Current burnt area
© Department of Finance, Services & Innovation

Comments on the Bega Valley Bush Fire Risk Management Plan

Thank you for the opportunity to comment on the 2018 Bush Fire Risk Management Plan. These comments are directed toward forests in the north of the shire, but have relevance to most forest environments.

The introduction indicates ". . . A BFRMP is a strategic document that identifies community assets at risk and sets out a five-year program of coordinated multi-agency treatments to reduce the risk of bush fire to the assets. Treatments may include such things as hazard reduction burning, grazing, community education, fire trail maintenance and establishing community fireguard groups."

There is a concern that with regard to forested environments, agency treatments to reduce the risk of bushfire do not achieve that aim and based on the information agencies aren't required to consider, only increase the threat of uncontrollable fire and further degrade the environment.

The introduction also suggests ". . . the Bega Valley BFMC is required to have regard to the principles of ecologically sustainable development (ESD)"

One aspect of ESD is the precautionary principle "- namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation."

The Regional Forest Agreements were supposed to require the Forestry Corporation and the National Parks and Wildlife to also have regard to the principles of ecologically sustainable development. In particular the Eden RFA (Part 3, 95.6) required the Forestry Corporation to implement the forest inventory developed by the Forest Resources and Management Systems Technical committee (FRAMES).

The intention of the inventory was to provide the Forestry Corporation with a scientifically based methodology, such that it could provide proof of its claim that what was growing before logging grows back after logging and confirm the rate at which any regenerating trees grow back. Unfortunately the Forestry Corporation decided not to implement this requirement and its absence means there is no credible data to demonstrate historic or current public forest management is sustainable.

However, koala surveys undertaken in forests in the north of the shire have demonstrated what grows back after logging is not consistent with the original trees species distribution and where preferred koala feed trees have grown back they are generally much shorter than the main eucalyptus species that regrow, Silver-top ash.

This outcome is consistent with impact of clearing on Lowlands Grassy Woodland in the South East Corner Bio region, formally primary koala habitat in the Bega Valley " . . . *Contemporary tree-dominated stands of the community are largely relics or regrowth of originally taller forests and woodlands, which are likely to have had scattered shrubs and a largely continuous grassy groundcover. At some sites, mature trees may exceed 40m, although regrowth stands may be shorter than 10m.*" (NSW Scientific Committee, 2011)

At the time of European occupation there were three major forest types in the Bega Shire. The aforementioned grassy woodland, what were to become 'production forests', being more accessible hilly land where grass doesn't grow, but with trees large enough for saw logs and non-commercial forests as found in the generally steep and inaccessible Wadbilliga NP and much of the area burnt in the Yankees Gap fire.

Since that time the all of the accesible commercial forests have been logged and most of these have been subject to integrated logging and burning over the past 45 years. The outcome, as the decline in species like koalas and greater gliders demonstrates, is that like the grassy woodlands, production forests are losing their soil fertility, their species diversity and becoming more like non-commercial forests. Hence in most cases the vegetation fire threshold categories (Table 3.3) that combine commercial and non-commercial forest, bear little relationship to the actual forest.

For example the photo shows the outcome following a prescribed burn during 2010, in the previous SFMZ in Biamanga National Park. In this case the fire was undertaken in a known Aboriginal women's area, while illegal logging was underway in an area of Biamanga Aboriginal Place in State Forests outside of the park.

The 600 ha fire was very hot, scorching the canopy of most of the remaining large trees and killing many of young Silver-top ash. The area in the photo is thought to have been subject to integrated logging in the early

1980’s. Here the fire has killed all of the retained Silver-top ash and all of the 30 year old regrowth and now it is again thick young Silver-top regrowth.

Based on the average 20 year return cycle for burning in National Parks and given the burn killed thirty year old trees, the future for this area under current management is conversion to ‘non-forest’.

The NSW government have temporarily placed adjacent forests, where the new SFMZs have been located, into Flora Reserves. As indicated in the photo below, immediately adjacent to the photo above, the burn hasn’t been as hot, so a smaller portion of the Black forest oaks and other trees have died.

There is no indication that vertical fuel loads have been greatly reduced, however the leaf litter that can reach 50 tonnes a hectare in mature forest oak stands and is critical for beginning to replace the hundreds of tonnes of soil lost per hectare, as a consequence of logging and burning, is now gone.

The notion that broad acre forest burning reduces the threat of bushfire neglects the fact that while the original tree species are not growing back, there is enough fertility for species that have a greater capacity to adapt to soils of lower fertility. So, like weeds in paddocks, these species will rapidly regrow and any as yet unmeasured benefit from broad acre forest burning, with regard to either reducing the potential for a fire to start or its rate of spread is unlikely to last more than a year.

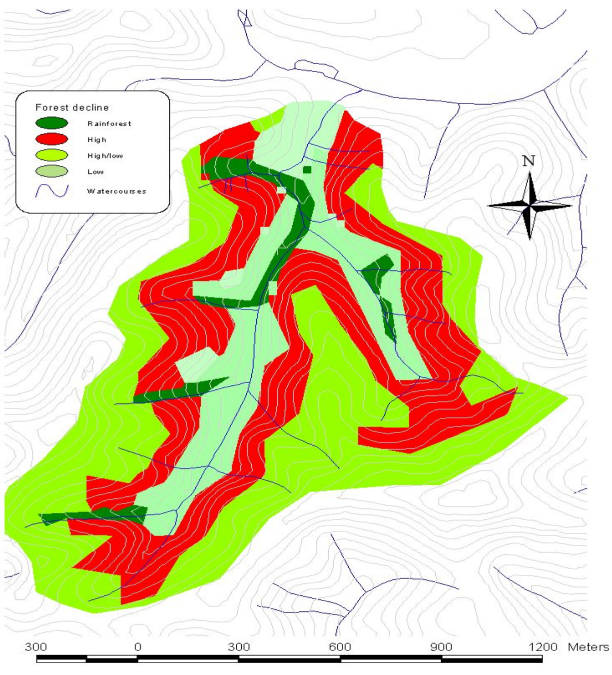
The evidence points to long-term detrimental changes to forests as the most likely reason for broad acre forest burning lacking effectiveness in this Bio-region, relative to the leverage it provides in other NSW Bio-regions (Price et al, 2015). Despite this research significant public funds are spent on broad acre burning based on unsubstantiated claims that it does provide leverage.

This brings me to the research, apparently undertaken to justify burning in and around koalas "Is there an inherent conflict in managing fire for people and conservation?" (Bentley and Penman, 2017). Much like the vegetation fire threshold categories (Table 3.3), this research did not account for structural and species change due to disturbance, despite the fact that this information is available.

In addition, the researchers appear not to have been provided with information on extensive canopy die-back (Jaggers, 2004), acknowledged as the greatest threat koalas (NSW Scientific Committee, 2007). Similarly the researchers have seeming not been advised that broad acre burning is likely to exacerbate extensive canopy die-back, given its association with dry weather and drought.

Extensive canopy die-back and Bellminer Associated Die-back (BMAD) should be a concern for forest managers in the southeast. This is particularly the case given extensive canopy die-back damages and kills trees and the loss of leaves is associated with the spread of BMAD and increases in the density of lower storey species (Silver & Carnegie, 2017). In this bioregion, extensive canopy die-back on ridges and slopes leads to increases in mid-storey or 'ladder' fuel species, particularly Black Forest Oak.

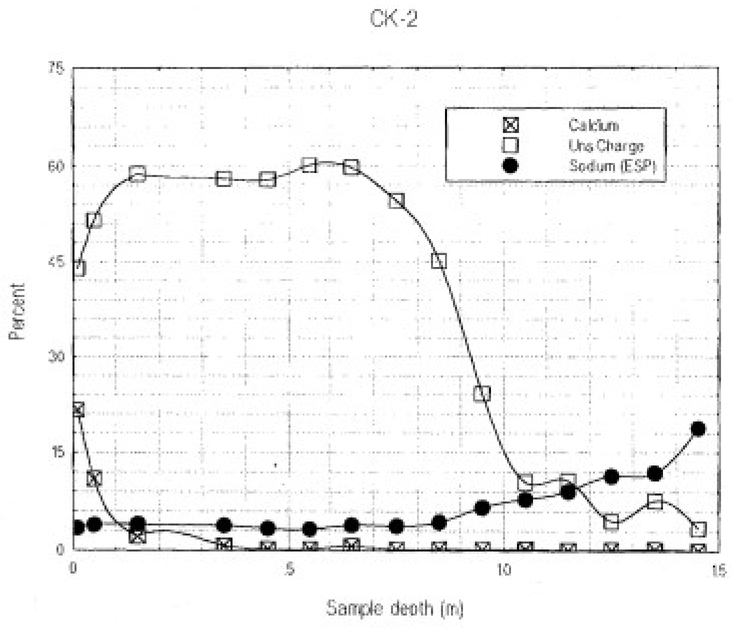
The following map shows the Forestry Corporation's various categories of extensive canopy dieback (Jaggers, 2004), within a small sub-catchment in the Murrah Flora Reserve.



As indicated, forest ecosystems with a high dieback rating are located at mid and lower slope positions in the catchment. The process of sub-soil dispersion leading to a reduction in soil water holding capacity requires a reduction in nutrients entering the soil, particularly Calcium, coupled with the natural deposition of Sodium and the lateral movement of ground water.

During prolonged rainfall events soils became saturated and the volume of sub surface water greatly increases at lower slope positions, prior to the water emerging from the soil and entering watercourses.

A deficiency of Calcium, coupled with an excess of Sodium, as indicated in the following chart from soil samples takes in the Flora Reserves, renders clay aggregates more susceptible to dispersion in water and as they disperse over time, the water holding capacity of the soil decreases. Clearly reductions in surface litter at upper slope positions will reduce nutrient inputs, increase water infiltration and exacerbate this process.



Lower slope positions are frequently subject to BMAD and associated increases in species, particularly Giant water vine (*Cissus hypoglauca*) that also kills trees and Sweet pittosporum (*Pittosporum undulatum*) that provides increased protection and nesting opportunities for bell miners (Silver & Carnegie, 2017).

According to Bentley and Penman ". . . *higher ignition probabilities occur in the west of the study area due to lighting along ridge lines and the higher likelihood of ignitions from roadways and human settlements, as shown in the historical and weighted ignition approaches. Second, the direction of severe fire weather in the region is from the west–north-west and is associated with hot, dry inland winds. A combination of these factors played a role in generating leverage under simulated conditions in this landscape during severe fire weather conditions*."

If nothing else this year's fires at Reedy Creek and Yankees Gap confirm that putting out a fire, under dry windy conditions, is likely to be impossible at anytime of year. However the difference between the two was the capacity, due to the extensive road network, to control the Reedy Creek fire, when the north-westerlies abated.

Another similarity was the initial longitudinal and latitudinal spread of the fires, suggesting that an ignition in or to the west of the flora reserves will quickly race to the coast, while spreading more slowly north and south.

However, the worst case bushfire scenario is when the canopies in the majority of trees in coastal forests turn brown, greatly increasing the chances of contiguous crown fires. Unfortunately, apart from the draft Murrah Flora Reserves management plan, there is no reference to extensive canopy die-back in the BFRMP or any management plan for adjacent National Parks or any other park or State Forest in the South East Corner Bioregion. Given the worst case scenario this omission could imply a degree of culpability.

Despite this fact, the community are required to believe management is truly aimed at the conservation of biological diversity and the maintenance ecological integrity.

Bentley and Penman also suggest " . . . *Here we only compared the cost of fuel treatment; however, more cost effective risk mitigation may be achievable through integration with other strategies. These may include mechanical fuel management, ignition management, initial attack and community engagement. Mechanical* *removal or thinning can reduce fuel loads and alter fuel structure adjacent to property or within koala habitat to manage exposure from fire due to local high fuel loads (Penman et al. 2015a)*."

Alternative and given the lack of data demonstrating burning has any positive outcomes, more cost effective risk mitigation methods were suggested in comments on the draft management plan for the Murrah Flora Reserves. Regrettably, the NSW government has abused the public consultation process, it's assumed because actually helping koalas requires active and adaptive management, that relies on a realistic consideration of the threats and the use of credible science.

According to the NSW Soil Conservation Service " . . . *Fire has physical, chemical and biological affects on the soil environment (Humphries & Craig 1981). Destruction of soil organic matter due to burning and, in some cases, consequent decreases in the available water holding capacity of soils, fewer water-stable aggregates and exposure to overland flow, makes the soils susceptible to erosion and further nutrient loss (Cth of Aust 1984). Prescribed burning repeatedly removes organic matter and nutrients and is expected to increase the rate of both soil erosion and sediment production (State Forests 1994)*." (Tulau, 1997)

Logically, given burning has a detrimental impact during the seral stages of forest growth, will further reduce soil fertility and therefore the area available for koalas numbers to expand into, this choice of mitigation is not aimed at helping the species. Rather, as the State member for Bega stated at the time the Flora Reserves were announced, logging is to be re-introduced in ten years, apparently back dated to 2013.

In the interim the plan is to burn in and around koala home ranges and log the only remaining corridor, in Bermagui State Forest, linking koalas in the flora reserve to those in and around Kooraban NP.

The first 700 hectare burn undertaken in the Flora Reserve was outside of the proposed SFMZ, in an area with koalas and the burn polluted the atmosphere for days up to several kilometres from the fire. Most recently the NPWS undertook a 70 hectare burn in at the back of Cuttagee Lake, around the time the Yankees Gap fire was lit. According to one local resident the NPWS had originally planned to burn around his property on the northern side of the lake where there are no koala records, but then changed it to the southern side, where there is a recent koala record.

This fire was not aimed at protecting koalas from bushfire coming from the west, unless the fire were to start in the area of the 700 hectare burn. Rather, the OE&H apparently believe burning forests makes them healthy and is good for koalas. On the other hand, the Forestry Corporation believe koalas are associated with unhealthy forests and it claims burning makes forests healthy and eliminates koalas.

Both of them cannot be right, although a reasonable person could only conclude burning cannot help koalas.

In its current form the Bega Valley Bush Fire Risk Management Plan perpetuates the unproven claim that the broad acre forest burning is somehow good and 'doing the right thing'. This is the attitude that enables fires like Yankees Gap to be lit and take hold and it is arguable that no-one should be allowed to light a forest fire under those conditions. If climate change is a consideration, a conservative estimate of the CO2 generated in the Yankees Gap fire equates to three and half years of emissions for the whole population of the Bega Shire. While noting the BVBFRMP was produced before the Yankees Gap fire, the proposal to burn even more of these non-commercial forests comes without any information to demonstrate it will reduce the community's vulnerability to bush fires.

In the absence of a final approved management plan for the Murrah Flora Reserves, it also confirms the NSW government's multi-agency approach to koalas is all about ignoring the major threat to the species and squandering more public funds in the pursuit of business as usual.

To date there has only been opposition to " . . . establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems."

The Bega Valley Bush Fire Risk Management Plan endorses the claim that burning will help koalas while ignoring the threat of serious and in the absence of evidence to demonstrate otherwise, irreversible environmental damage. The NSW government has an agenda, however, as the RFS has managed to maintain general public support, its endorsement of the NSW government's koala extinction plan seems unlikely to enhance that support.

Robert Bertram
December 2018

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