# Assessment of the EPA approvals for the logging of five state forests in north-eastern NSW immediately following the 2019-2020 drought and bushfires, and to highlight the likely impacts on threatened frog fauna in these state forests if logging goes ahead.

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## My Qualifications

1. I am an ecologist who has specialised in the ecology of threatened fauna, particularly Australian frogs.

2. I am the past Director of Biosphere Environmental Consultants Pty Ltd, a company that specialised in fauna-related projects. Biosphere ceased trading in late 2019.

3. I have been involved in field surveys and studies on native fauna since 1978. These have included all vertebrate groups but special expertise has been developed in the area of threatened and endangered herpetofauna (frogs and reptiles).

4. I have maintained an active research interest in various aspects of frog biology in Australia since 1979. This research has included studies of the natural history, distribution, conservation status and ecology of a range of species (see publication list).

5. Other major research areas include the taxonomy of fossil and modern turtles, and the ecology of Australasian bats (see publication list).

6. While in charge of Biosphere Environmental Consultants I have undertaken various major and minor faunal studies on behalf of both private and government agencies. These include general fauna surveys, targeted surveys for threatened and endangered species, Species Impact Statement, Plans of Management and habitat management and creation programs.

7. I am also an adviser to the NSW Scientific Committee (National Parks and Wildlife Service), a member of the Department of Primary Industries and Environment Native Animal Keepers Consultative Committee, a member of the Declining Frogs Task Force and an advisor to the State Government on Cane Toad control in New South Wales.

8. I am also an Honorary Research Fellow at the University of New South Wales and am a Fellow of the Royal Zoological Society of New South Wales.

## Disclosures

I have read and agree to abide by the Uniform Civil Code Procedures Rules 2005 and the Expert Witness Code of Conduct.

In preparing this report I have read the following documents:

i. Site specific operating conditions for Collombatti State Forest, Compartments COL009, COL010, COL 011 and COL 012. NSW EPA. 3 March 2020 (Brief Tab 11).
ii. Site specific operating conditions for Bagawa State Forest, Compartment BGW028. NSW EPA. 3 March 2020 (Brief Tab 7).
iii. Site specific operating conditions for Myrtle State Forest, Compartments MYR010, MYR011, MYR012, MR014, MYR016 and MYR016. NSW EPA. 3 March 2020 (Brief Tab 4).
iv. Site specific operating conditions for Styx River State Forest, Compartments STX010 and STX011. NSW EPA. 3 March 2020 (Brief Tab 13).
v. Site specific operating conditions for Doubleduke State Forest, Compartments DOU001, DOU002, DOU003, DOU004, DOU005, DOU006, DOU007 and DOU008. NSW EPA. 3 March 2020 (Brief Tab 9).
vi. Map. Partially burned area and unburned area for site-specific operating conditions for Collombatti State Forest Compartments COL009, COL010, COL 011 and COL 012. EPA (Brief Tab 12).
vii. Map. Partially burned area and unburned area for site-specific operating conditions for Bagawa State Forest Compartments BGW028 (Brief Tab 8).
viii. Map. Partially burned area and unburned area for site-specific operating conditions for Myrtle State Forest Compartments MYR010, MYR011, MYR012, MR014, MYR016 and MYR016. NSW EPA (Brief Tab 6).
ix. Map. Partially burned area and unburned area for site-specific operating conditions for Styx River State Forest Compartments STX010 and STX011. NSW EPA (Brief Tabs 14 & 15).
x. Map. Partially burned area and unburned area for site-specific operating conditions for Doubleduke State Forest Compartments DOU001, DOU002, DOU003, DOU004, DOU005, DOU006, DOU007 and DOU008. NSW EPA (Brief Tab 10).
xi. EPA GIPA EPA623. Tab 15: site specific conditions to mitigate environmental risks associated with harvesting burned forests. March 2020 (Brief Tab 22).
xii. EPA GIPA EPA623 Tab 10A. Forestry Corporation: approval for Restricted Activities Report-Bungawalbin State Forest (Bungawalbin SF 'Protocol 5 Report') (Brief Tab 24).
xiii. EPA GIPA EPA623 Tab 10I. Forestry Corporation: approval for Restricted Activities Report-Myrtle State Forest (Myrtle SF 'Protocol 5 Report') (Brief Tab 25).
xiv. EPA GIPA EPA623 Tab 10J Forestry Corporation: approval for Restricted Activities Report-Doubleduke State Forest (Doubleduke SF cpts 001-003 'Protocol 5 Report') (Brief Tab 26).
xv. EPA GIPA EPA623 Tab 10K Forestry Corporation: approval for Restricted Activities Report-Doubleduke State Forest (Doubleduke SF cpts 005-008 'Protocol 5 Report') (Brief Tab 27).
xvi. Scientific Advice prepared by DPIE. GIPA EPA623 (Brief Tab 28).
xvii. Scientific Advice prepared by the EPA for burnt sites. 6 March 2020 (Brief Tab 31).
xix. Briefing Note: NSW EPA: Approval of site-specific operating conditions for north coast state forests. 3. March 2020 (Brief Tab 16).

# Summary

1. 2019-2020 was a time when large parts of New South Wales were subjected to record drought conditions that were immediately followed by extensive and long-lasting bushfires.

2. The drought was not only associated with record low soil moisture conditions across eastern Australia, but also record air temperatures during the spring of 2019 (BOM). By July 2019, the Bureau of Meteorology declared this drought the worst on record for Australia.

3. The drought reduced fauna numbers in bushland areas and reduced the capacity of the fauna to withstand further habitat destruction (Thompson and Jan 2020).

4. The bushfires that began in late 2019 and burned throughout the summer of 2019-2020 burned an estimated 10 million hectares of bushland and agricultural land (DAWE 2020)

5. The fires were so intense and widespread that fire-fighting resources were redirected and efforts were concentrated around towns, houses and other important infrastructure. Natural areas were left to burn (Morgan et al. 2020).

6. The only current assessment made of the scale of loss of wildlife was by Professor Chris Dickman of Sydney University. By the end of 2019, he had calculated that one billion vertebrate animals had perished in the fires and that millions more would die in the aftermath of the fires (University of Sydney 2020).

7. Several research studies have been conducted on the impact of fire on native fauna; the most notable of these were fire studies conducted in Nadgee Nature Reserve in southern NSW (fires in 1974, 1988, 2004 and 2012; (Lunney et al 2008, Recher et al. 2009), and the Royal National Park (2000 fire; Andrews 2001)

8. These studies have shown that animals that are mobile (i.e. can travel over large distance) often can move away or escape the fire front (providing the smoke and heat doesn't kill them). Animals that live in trees are at high risk and are often killed directly by fire and drought. Animals that live in or on the ground have a much better chance of surviving, particularly if they are ectothermic. Burrowing animals had the best survival prospects (Westgate et al. 2018).

9. For those animal species that can survive the immediate impact of drought and fire, their survivorship depends on the amount of ground cover still available, the timing to the first significant rainfall events and the time for food resources to be replenished. Often a large proportion of the animals that survive the initial impact of drought and fire succumb to predation (lack of cover) or starvation (Newsome et al 1975, Penman et al. 2015).

10. The likelihood of impacted populations that have been reduced by drought and fire surviving depends on the presence of remnant refugia (i.e. areas with adequate ground cover, soil moisture and food resources; Crowther et al. 2018)

11. The Giant Barred Frog, the Stuttering Frog, Green Thighed Frogs and Wallum Froglet are threatened frog species that occurs in northern New South Wales. These species occupy quite different ecological niches including riparian corridors in wet forest sites, mixed wet forest, lowland wet sclerophyll forest and wallum habitats. Terrestrial frogs, like other ground-dwelling ectotherms, generally survive the immediate impacts of fire and drought (providing that some water is available in the ground or in nearby watercourses). In my opinion, these frogs will not survive in fire-affected

areas where drought has removed the available water refuges that they require, or the fringing vegetation cover that they require has been lost.

12. In 2020, the EPA was asked to consider approving logging operations in five state forests in north-eastern New South Wales. These state forests had been impacted by drought and by fire to different extents- but all had been impacted.

13. The EPA was provided with selected information to help formulate their decision. The most useful was the Risk Mitigation Table (Environmental Risks Table; Tabs 22 and 32). This table identified the potential risks associated with harvesting in burnt forest. The table is a useful guide for responses to fires generally but is inadequate in dealing with broad-scale catastrophic wildfires. It also does not consider the impacts of fires on the surrounding areas. Some parts of the state forest did not burn while large areas within and around the state forests did burn. This results in the remaining unburnt area now having greatly elevated environmental significance (as they may be the only refuge areas available for threatened and non-threatened fauna that survived the initial impacts of the fires).

14. The scientific advice provided to the EPA in helping them prepare their decision was minimal and focussed on a few threatened species (such as koalas, threatened birds) and EECs- see documents xvi and xvii in document list. The advice did not include assessing impacts on the surrounding areas and the change in environmental value of the remaining unburnt areas in the state forests.

15. Further information provided (see documents i, ii, iii, iv, v, xii, xiii, xiv, xv) also provide information for operational procedures in normal fire impacted forests. The information provided does not match the scale of the fires that have affected the north-eastern forests and did not provide useful information for the broad scale fires that affected the north-eastern forest regions.

16. I understand that that the logging coup maps (documents vi, vii, viii, ix, x) were not included in the decision brief to the EPA but may have been available at the time when the approvals were being prepared. These maps only depict the logging areas where logging was proposed to occur and did not include the surrounding areas. For this reason, these maps are uninformative in terms of appreciating the scale of destruction and habitat loss in the local area, and hence the strategic importance of the remaining unburnt areas for surviving fauna.

17. Forestry operations already include a series of environmental mitigation measures such as protocols for selective logging practices that involved the identification and protection of environmental areas along particular water courses, the protection of identified habitat trees and the minimisation of extraneous damage to the site e.g. in the preparation of access tracks, loading bays, slope barriers, and other standard forestry operation protocols.

18. The existing protocols do not include special provisions for catastrophic wildfires and how to protect and conserve the remnant, unburnt areas in state forests.

19. The information provided to the EPA was adequate for standard bush fires conditions but not extensive enough, in my opinion, to form a judgement for state forests affected or surrounded by catastrophic fires. For example, the information provided could not provide any measure of the surviving numbers or physical conditions of the threatened frogs that had survived the initial impacts of the drought and fires. State Forest logging protocols rely on the identification and allocation of environmental zones along designated watercourses. These environmental zones are not logged or subject to pre- or post-logging burns. The environmental zones are intended to retain critical habitat for the threatened species (such as frogs) that occur in those habitats. This approach works reasonably well under normal conditions but does not work following a record drought and bush fire.

The usefulness of these environmental zones is currently unknown - it is likely that they have been highly compromised during the drought and fires and their role as refugia may no longer apply. The only way to know if they can fulfill their role as refugia and functional habitat is to ground-truth each site in advance of any further disturbances to the area. This has not been done and so the assumption that the environmental zones will provide the necessary protection for threatened species during logging activities no longer applies.

20. The bushfire burn maps that were available (documents **vi, xii, xiii, xiv, x)** are a particular concern for me as they may convey completely the wrong impression about the impacts of the fires on the state forests. The fire maps with the EPA logo on them depict the logging coups that are to be felled, for some reason the burnt areas are coloured green. Logging has been proposed in areas where there are still fellable trees present despite the areas having been burnt. To give a better appreciation of the extent of the fire damage I have taken a wider perspective and included bushfire burn maps for the wider area around these state forests (GEEBAM 2020). Unlike the EPA maps, the GEEBAM maps show that forests such as Doubleduke SF, Collombatti SF, Bagawa SF and Styx River SF were not the only lands to be severely burnt. Surrounding lands have been severely impacted and often only small, isolated vegetated areas remain, some of which occur in the state forests. Unfortunately, it is isolated remnants such as these that have been proposed to be logged in the north-eastern state forests.

Logging in these isolated forest remnants poses a significant threat to the surviving fauna (including frogs) because it removes the remnant refugia available to these already dislocated and stressed animals. The animals that have survived the initial onslaught of the fires now desperately need to be able to feed. Food is scarce as the ground cover vegetation has been removed or damaged. For these animals, such as threatened frogs and reptiles, foraging means moving through burnt, open country where there is a high risk of predation. The survival of these animals post-fire depends almost entirely on the presence of some protective vegetation cover. The intention to log these areas means further removal of protective cover and the possible extermination of those animals that survived the initial fires.

Consider the example of Myrtle State Forest: this state forest was the least directly impacted of the five state forests by the recent fires (about half of the state forest was fire affected). The areas around Myrtle SF however, were severely burnt. The state forest represents the most viable local refuge for survival of terrestrial animals. Logging was proposed for the burnt sections of the forests, and although the burnt areas have less cover and habitat value for fauna at present, the local scarcity of habitat and foraging areas means that these areas should also be excluded from logging. Under these extreme circumstances this small state forest should be considered a fauna sanctuary until the surrounding vegetation both inside and outside the state forest recovers

21. While the EPA duly considered the available information in preparing its decision, the information was inadequate in that it did not contain any data about the state of the surviving populations of threatened frog species, whether the environmental areas that have been set aside still have any habitat value after the drought and fire or if any other refugia are still remain for these species.

22. In my view, given the unusual circumstances created by the drought and bush fires and the significant void in critical information available to the EPA, the EPA should not have been asked to approve logging in these state forest. As approval has already been granted if approval is given, it should be immediately rescinded until a proper assessment of the state of the threatened species and their habitats is carried out and an appropriate species recovery plan is developed and initiated.

## What information should the EPA have available to form a balanced decision about the likely impact of logging operations in state forests in north-eastern New South Wales following record drought and bush conditions?

1. State forests in New South Wales provide habitat for a number of threatened and non-threatened animal species. Current logging protocols require that impact assessments be carried out for each proposed logging coup and that the adverse impacts be mitigated where possible. Standard mitigation measures involve the identification and exclusion of habitat trees, identification and exclusion of environmentally significant areas (such as near rocky outcrops, rainforest areas, selected heath and scrub areas), and the identification and exclusion of riparian protection areas.

2. These measures are intended to provide protection for threatened species by ensuring the maintenance of viable habitat for those animals whilst logging operations are ongoing.

3. The record drought conditions of 2019 and the widespread bush fires that followed in 2020 have impacted many bushland areas including state forests. The EPA reported that at least 5 million hectares of bushland burned in New South Wales, including 890,000 hectares of State Forest land (EPA 2020). The north-east forests of New South Wales were not spared from the bushfires and some state forests were almost completely burnt out (GEEBAM 2020).

4. No direct measures have been possible of the number or species of animals that perished in the drought and bushfires. Professor Chris Dickman from the University of Sydney has been able to estimate the number of vertebrate animal deaths in Australia (University of Sydney 2020): in December 2019 he had calculated that about 800 million animals had perished, by February 2020 that number had passed the 1 billion mark. He further added that many millions more will die in the post-fire period from predation, exposure, physical exhaustion and starvation (Newsome et al. 1975, Penman et al 2015).

5. The impact on particular species is still unknown at this stage although it appears that koalas have lost at least 30% of their total population numbers (Koala Foundation 2020). Koalas were one of the few native animal species that had a specific bush-fire management program developed to minimise their deaths during the drought and fire. Most other species had no special protection.

6. The EPA acknowledges that bush fire and drought pose special environmental risks to threatened fauna (EPA Risk Management Schedule).

7. In order to appreciate the magnitude of the combined impacts of the drought and fires on the threatened fauna remaining in the unburnt or lightly burnt bushland remnants, the EPA would have needed site specific information about the habitat value of the remaining remnants.

8. Current forestry impacts assessments are based on identifying habitat features in the proposed logging coup areas prior to logging. When these areas have been subjected to widespread environmental stress (through drought and fire) habitat values change. Areas of critical habitat may have been lost and only secondary (peripheral) habitat may remain. The secondary habitat has now become critical but this could not be known unless targeted surveys had been carried out in the proposed logging areas in advance of logging.

9. Riparian environmental areas are now problematic. The drought reduced ground water to such an extent that many watercourses ceased to flow, fringing vegetation withered and died (BOM 2020). Many of these riparian areas under the current assessment protocols would not be deemed as environmentally useful. Yet if they are not recognised as environmental areas threatened frogs may

have no protected habitat available to them. The SSOCs recognise this as a problem and have suggested increasing the riparian buffers accordingly (see CIFOA Tables 6a and 6b). However, it is still the case that the few riparian corridors remaining have to provide the habitat for all of the surviving riparian species (especially threatened frog species). Allowing logging to take place around the extended riparian zones only puts greater pressure on the remaining refuges and forces riparian species, that might otherwise be able to occasionally forage outside of the riparian zone, to remain in the only undisturbed areas available.

10. The burn maps that were available for the proposed logging areas for each state forest did not help assess the scale of the environmental change that had taken place in the local area. Naturally, the areas to be logged were those that still retained some tree cover whereas the more severely burnt areas of the forest were excluded from logging. The importance of the remaining isolated vegetated areas in an otherwise burnt landscape cannot be understated. For a number of species this may be the only habitat that is available.

11. I have looked at the burn maps for five state forests in north-eastern New South Wales; they are Doubleduke SF. Styx River SF, Myrtle SF, Collombatti SF and Bagawa SF. I attach the burn maps marked with the EPA insignia and shared publicly by the EPA of the coups to be logged, and burn maps of the whole state forest and surrounding areas). The purpose in doing this is to provide a rough visualisation of the extent of the environmental damage caused by the fire and how the remaining relatively unaffected areas stand out as green islands of refuge in an otherwise devastated landscape. These unburnt areas are the only available for some threatened fauna. The coup maps provided to the EPA do not convey the landscape pattern and the increased significance of the unburnt areas to the surviving fauna.

*Burn Map for Doubleduke SF:*

12. Doubleduke SF is not a particularly large state forest; it is 5,675 Ha in area and severely impacted in places by the 2020 fires. The coup map (Map 1a) with the EPA logo does not show the burnt areas whereas Map 1b looks at the whole state forest and surrounding areas. Map 1b and all other wider scale maps are derived from the Dept. of Agriculture, Water and Environment (DAWE) website-the Australian Google Earth Engine Burnt area map.

Figure 1 A. Proposed Logging Coups in Doubleduke SF

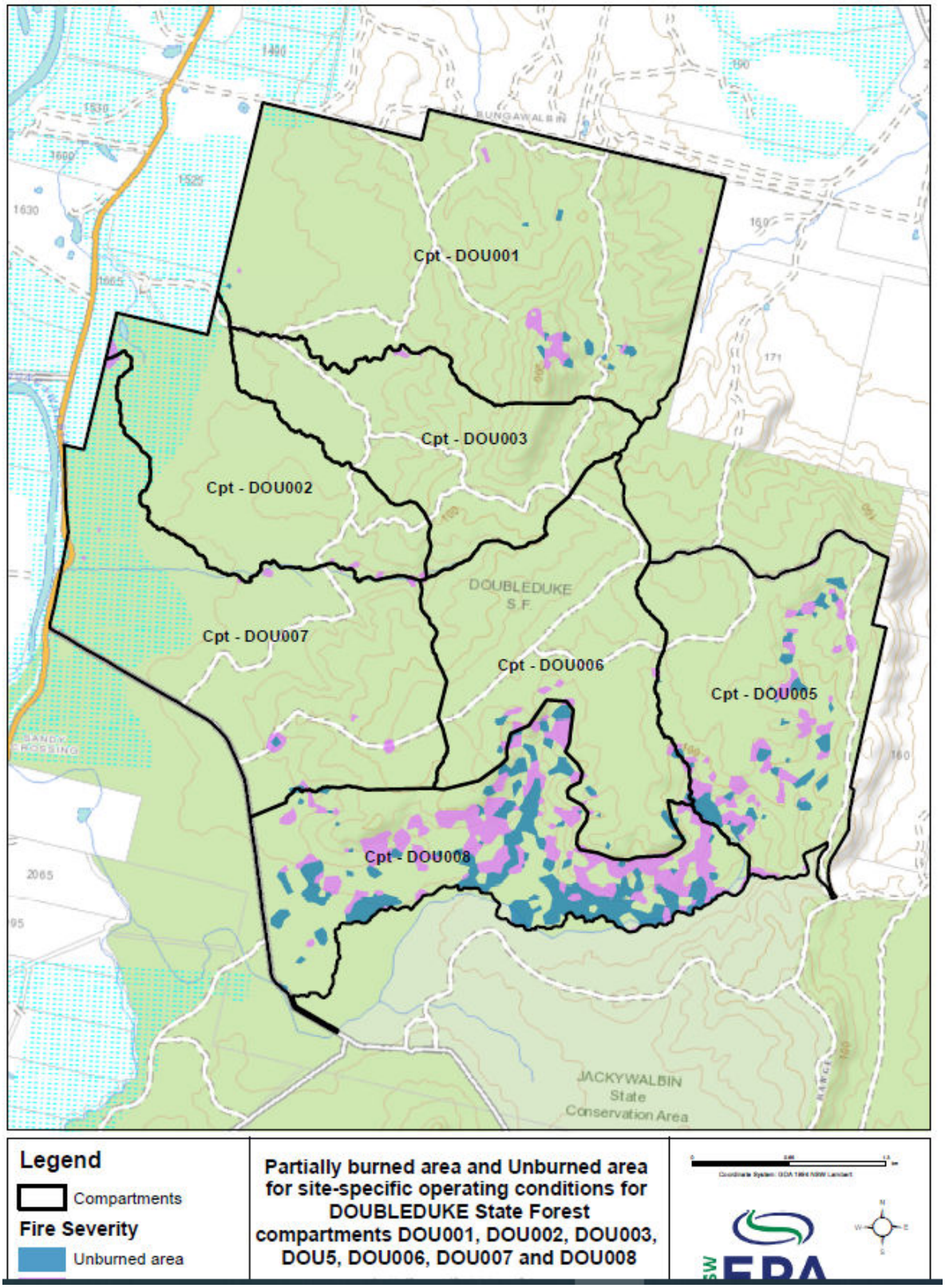
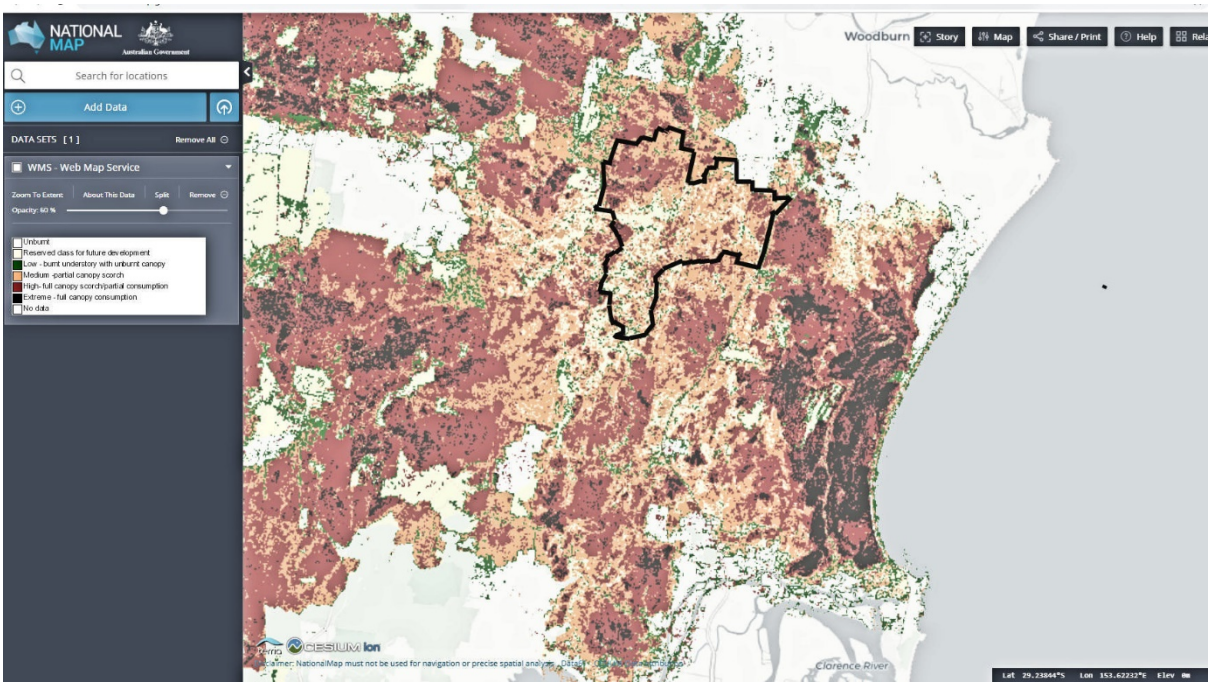


Figure 1 B.  Doubleduke SF and Surrounding Areas Fire Map




13. Doubleduke SF was the most severely burnt of the five state forests with about 85% of the state forest being severely burnt or lost total canopy. Immediately north of Doubleduke SF is cleared pasture land that was unburnt.

*Burn Map for Bagawa SF:*

Figure 2 A. Proposed Logging Coups in Bagawa SF.

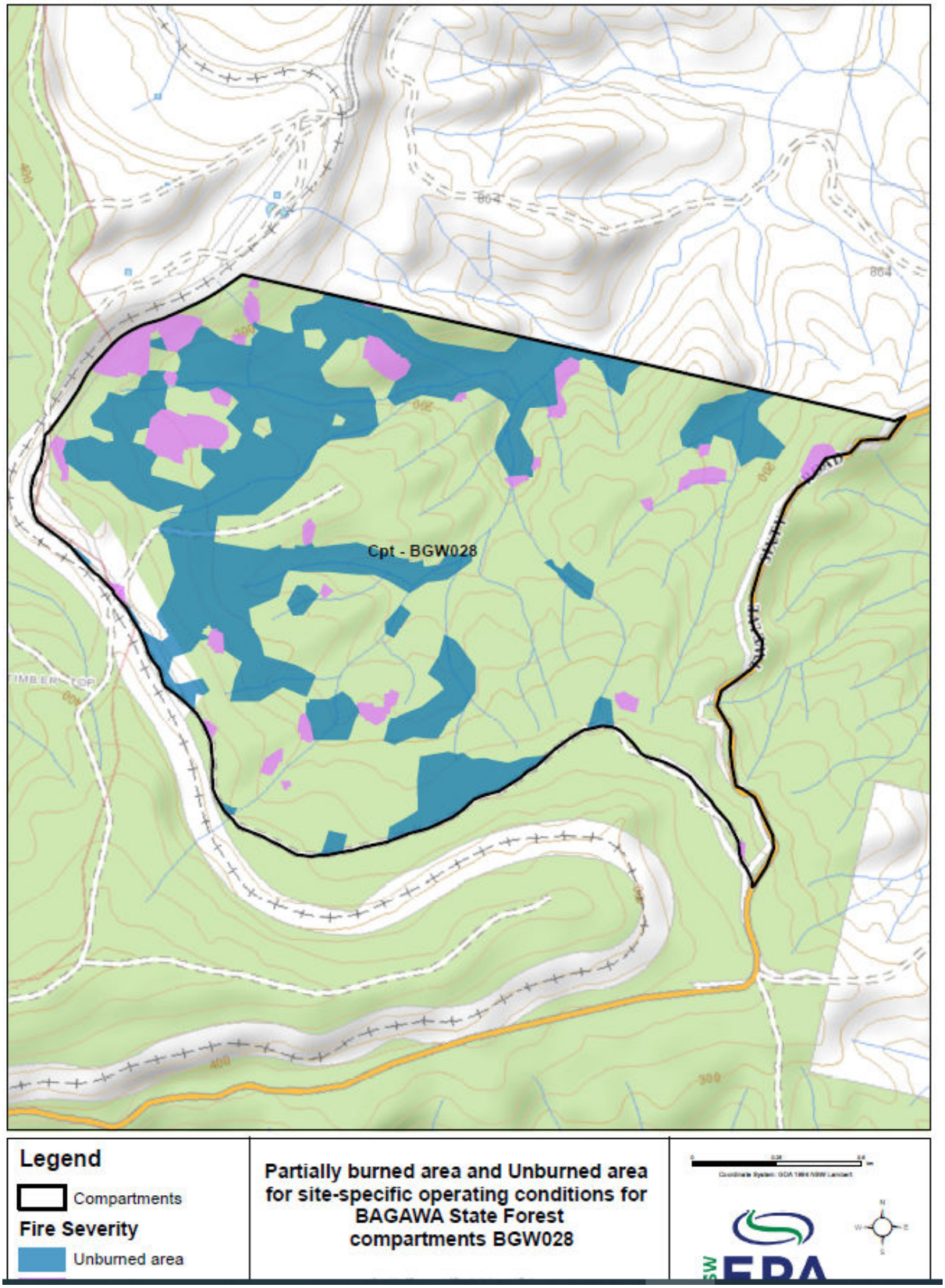
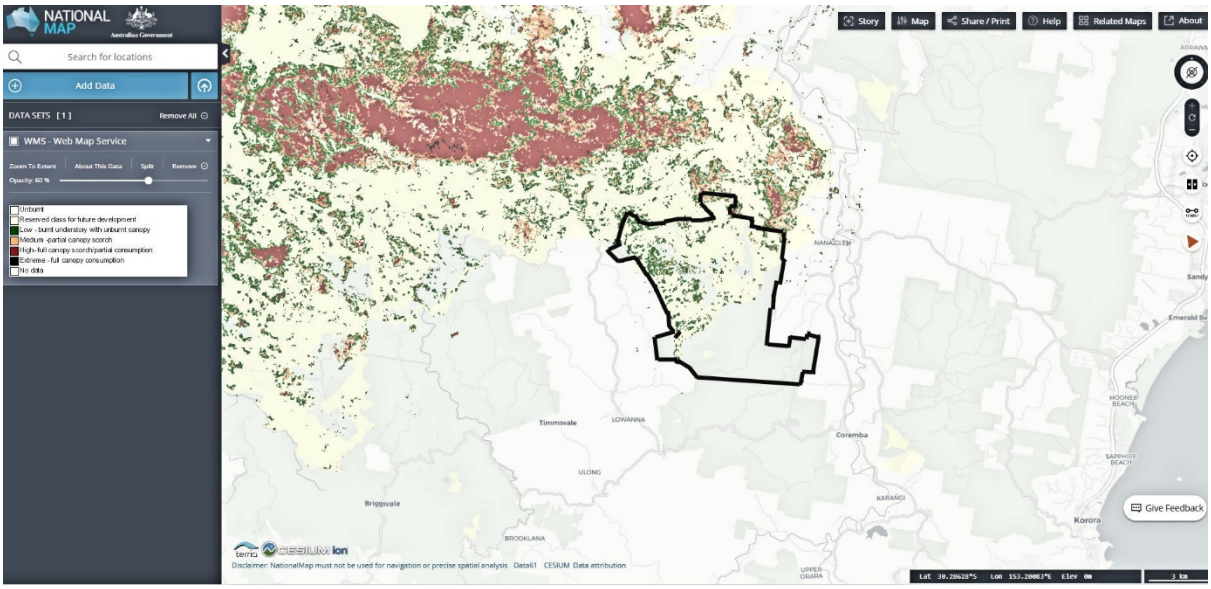


Figure 2 B.  Bagawa SF and Surrounding Areas Fire Map.




14. Bagawa SF is a small state forest being 5,405 Ha in area. Only the northern portion of the state forests was affected by the fire but the whole forest was drought affected.

*Burn Map for Collombatti SF:*

Figure 3 A. Proposed Logging Coups in Collombatti SF.

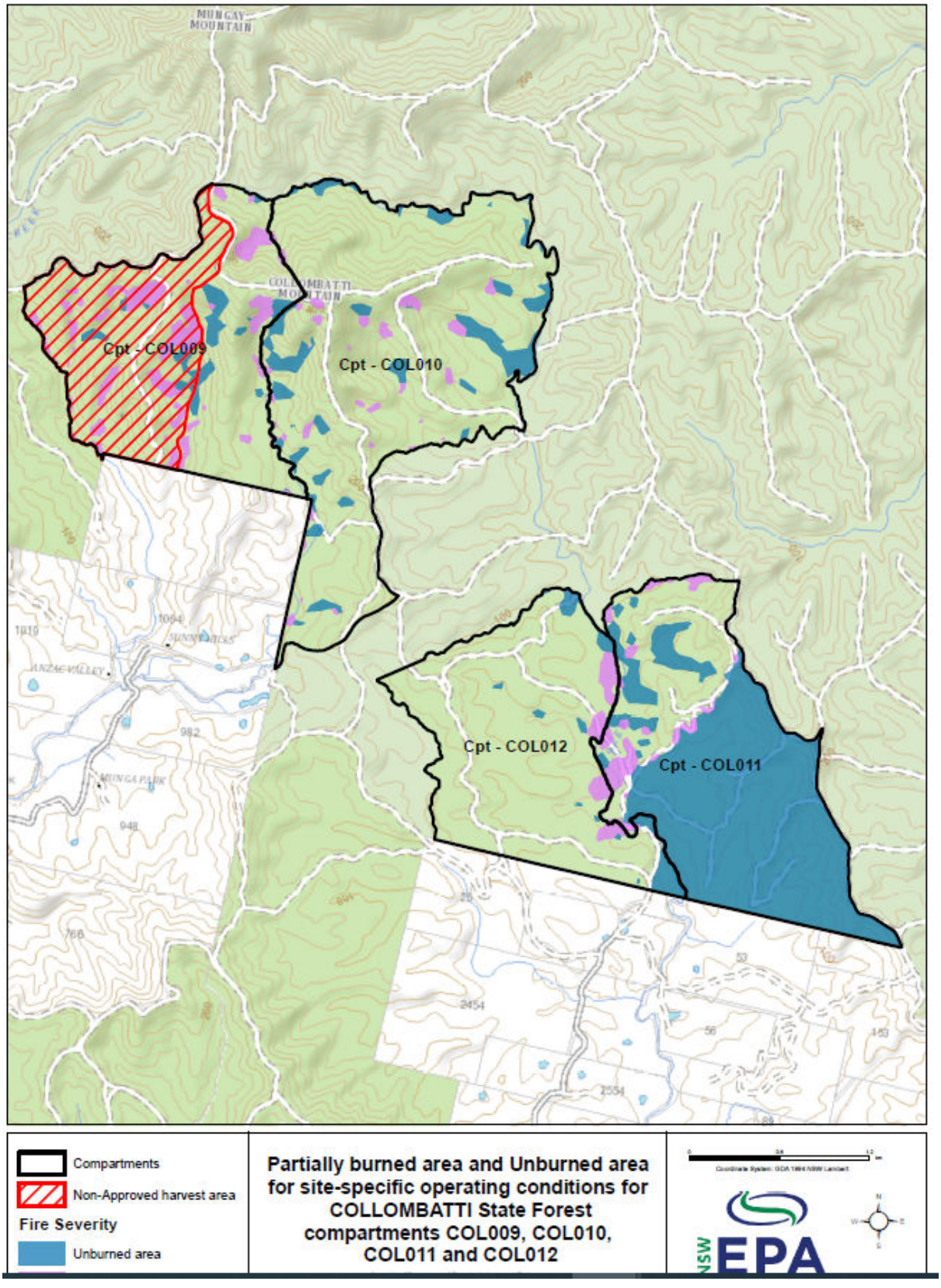
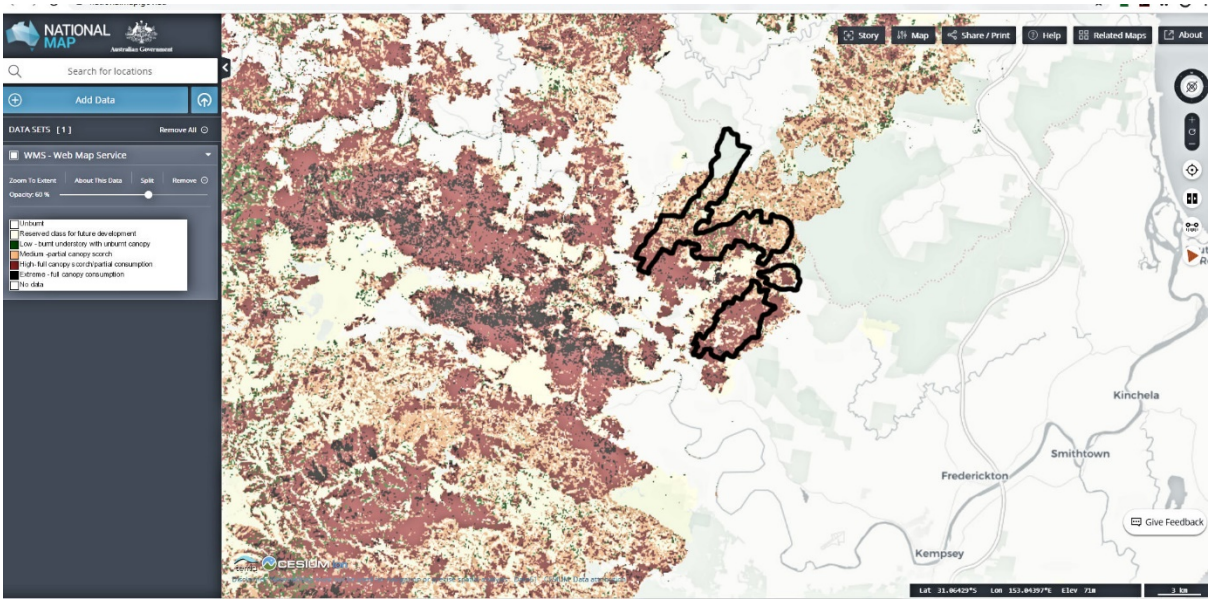


Figure 3 B.  Collombatti SF and Surrounding Areas Fire Map.




15. Collombatti SF is another small state forest, being 4422 Ha in area. Most of the state forest was burnt and only the far northern parts of the forests escaped the fires.

*Burn Map for Myrtle SF:*

Figure 4 A. Proposed Logging Coups in Myrtle SF.

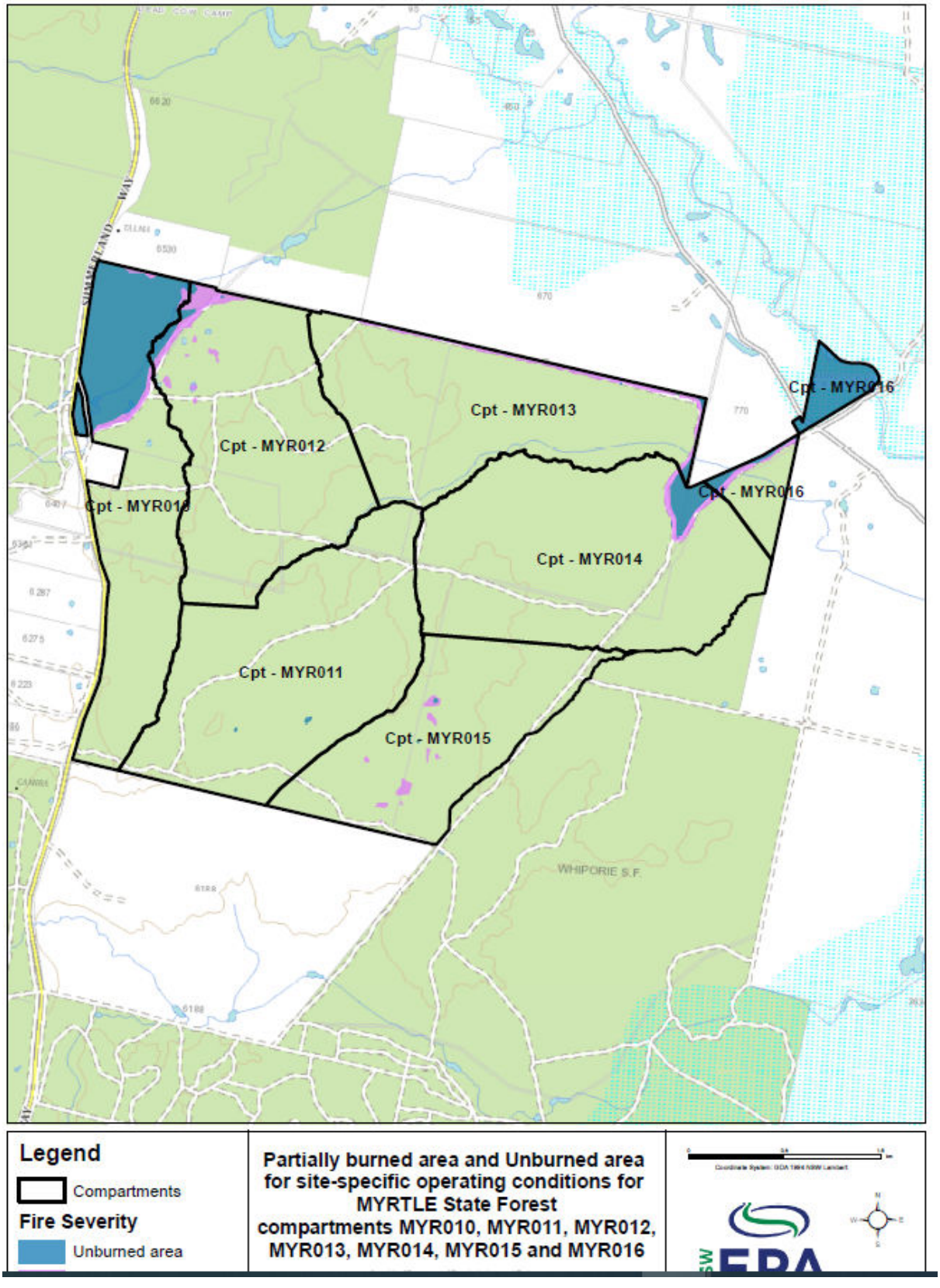
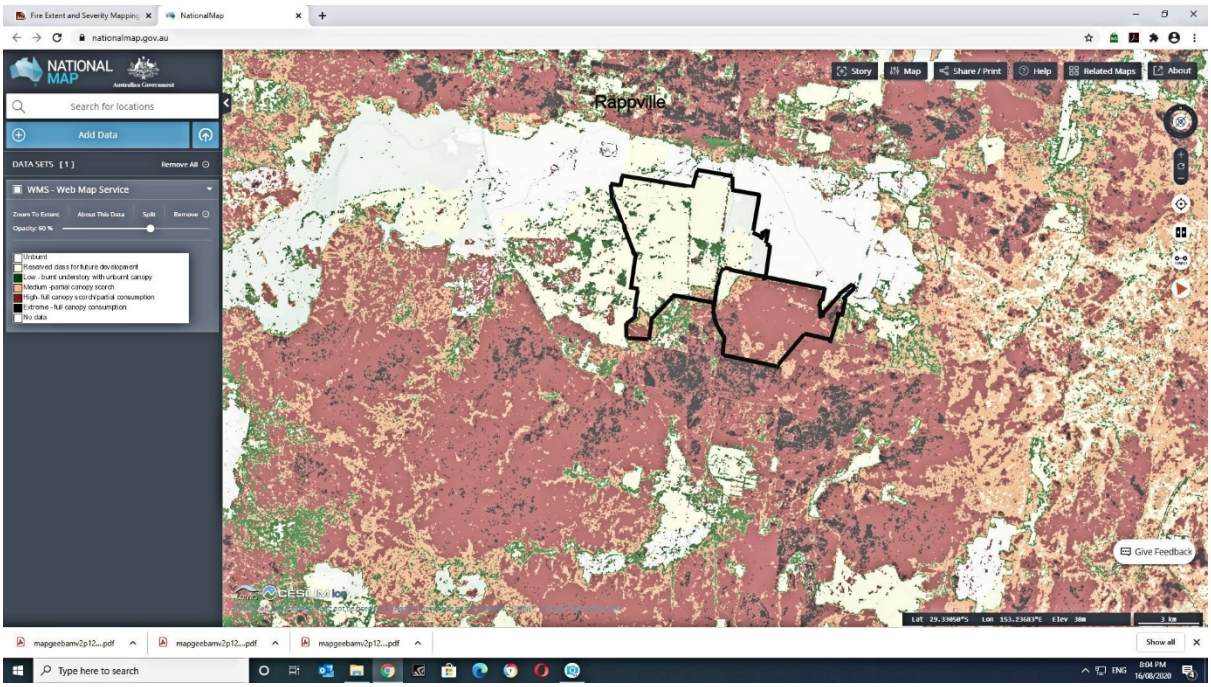


Figure 4 B.  Myrtle SF and Surrounding Areas Fire Map.




16. Myrtle SF is the smallest of the five state forests that I examined, being 1573 Ha in area. Myrtle SF avoided most of the fires but the surrounding areas were severely burnt and Myrtle SF stands as an environmental oasis in a desert of blackened timber.

*Burn Map for Styx River SF:*

Figure 5 A. Proposed Logging Coups in Styx River SF.

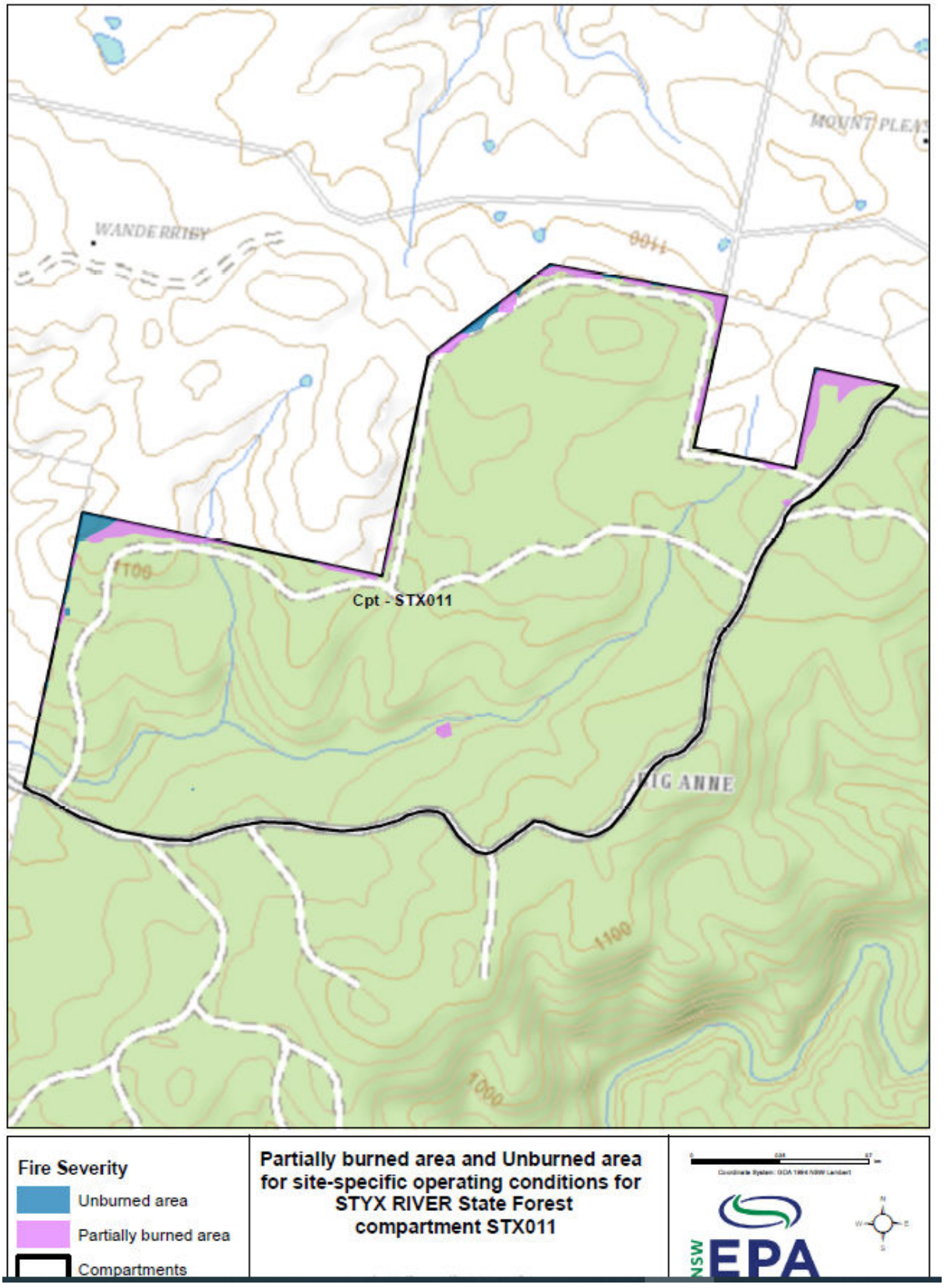
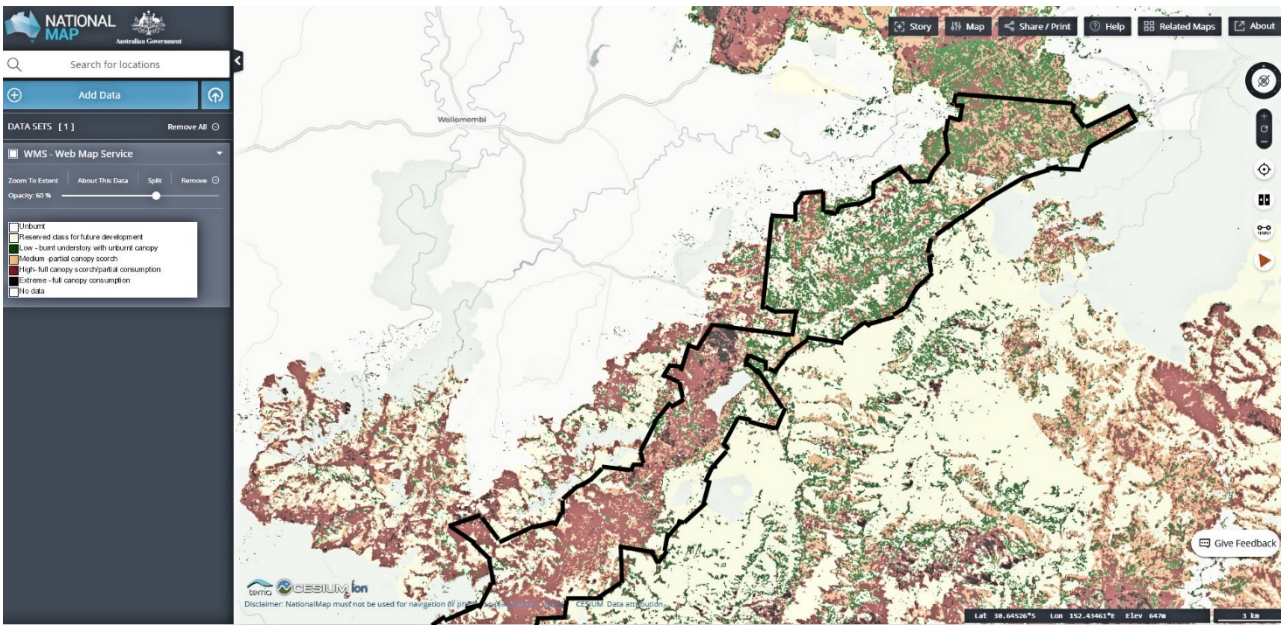


Figure 5 B.  Styx River SF and Surrounding Areas Fire Map.




17. Styx River SF is the largest of the five state forests examined; it is 15,892 Ha in area and runs parallel with the New England escarpment. Styx River SF was severely burnt in the southern half and less severely burnt in the northern half.

18. The biggest information gap that was not available to the EPA in making its decision was the state of the available environmental protection areas in the state forests. These environmental areas are evaluated according to prescriptors established as part of the EPA approval process. The prescriptors are intended to assess the sites on the basis of their habitat value and so they use a combination of landscape and vegetational features to derive the final assessment. This system seems to work reasonably well under normal conditions but they were not designed to assess the sites under extreme circumstances.

19. During severe environmental stress, habitat values change. Often sites lose habitat value as the vegetation cover is lost, the soils dry out and the ground cover of vegetation and fallen branches and logs is lost. For terrestrial vertebrates, such as frogs, soil moisture content and ground temperatures are critical. For riparian frog species, such as the threatened Giant Barred Frog *Mixophyes iteratus* and the Stuttering Frog *Mixophyes balbus*, the maintenance of wet watercourse environments is crucial for their survival. Drought and fire can decimate local populations. For other terrestrial threatened frogs such as the Green-Thighed Frog *Litoria brevipalmata*, the persistence of dense ground cover and a relatively intact tree canopy is important for survival. Without these features, the frogs are at high risk of predation and dessication while foraging. For threatened frogs like the Wallum Froglet (recorded in Doubleduke SF) damp-soil wallum habitat is vital. Figure 1B shows a large area parallel to the coast marked in black-this was a large are of wallum habitat that has severely burned and it is likely that the wallum froglet population there is now extinct or reduced to extremely low levels. Surviving areas of wallum nearby, such as in Doubleduke SF now become of prime importance as reseeding sites for the coastal areas when they regenerate.

20. As indicated above, the only way that a realistic evaluation of the status of environmental areas in the state forests can be meaningfully achieved is through targeted surveys of the threatened species that are thought to utilise these areas and an assessment of what other habitats still exist for these species in nearby areas after the fires. Remnant, unburnt areas may be the only secure habitat that is currently available for these species and these may be compromised by ongoing logging activities.

## The Response of Threatened Frogs to Drought and Fire

21. Wildfires are a constant threat in modern Australian landscapes. Human-induced climate change and alterations to land systems has created an environment where wildfires are becoming larger and impossible to control using standard fire-fighting measures (Thompson and Jan 2000).

22. The response of native fauna to fires has been studied to some degree. Most of the studies have focussed on flora and fauna recovery following a fire, some have targeted individual species to see how they are impacted and then how they recover (if they do). Most of the targeted studies completed to date have focussed on mammals (eg Lunney *et al.* 1987, Recher *et al*. 2009, Lunney *et al.* 2008, Crowther *et al.* 2018) or particular iconic species, such as threatened birds or reptiles (e.g. Newsome *et al* 1975).

23. The two best studied areas for impacts of wildfires on fauna in New South Wales have been carried out at Nadgee Nature Reserve on the far south coast (fires in 1974, 1988, 2004 and 2012), and the Royal National Park (2000 fire). The Royal National Park study is particularly relevant as it included several frog species (Andrews *et al*. 2007). Other studies on the impact of fire on frogs (e.g. Melville and Potvin 2017) have found that fire frequency and fire severity are the two main factors in determining the recovery of frog populations after fire.

24. Many frogs are capable of surviving the immediate impacts of drought and fire. Tree frogs and riparian species are most at risk to the immediate impacts of fire and drought, and these frogs can easily suffer local extinctions after fire. Ground frogs have a much better survival rate while burrowing frogs have the highest survival rate of all frogs (Penman *et al.* 2015).

25. Fire severity has a major impact on ground frog populations, not because of the excessive heat killing frogs, but because the habitats after fire take much longer to recover. Many ground and burrowing frogs die on the post-fire period because of exposure and predation due to lack of ground cover, or through starvation (Andrews 2001).

## The Likely Impact of Logging fire and drought impacts forests on threatened frog species

26. The few remaining areas of ground cover following a fire are critical if frogs are to survive the post-fire period. In state forests and other native woodland areas, usually some areas survive the full impact of the bush fires and these become refuges for the survivors. It is in these remaining areas that the surviving frogs can recover and begin feeding again after the fires. Over time, if the frogs can get enough food and escape predation there may been enough adult survivors to begin breeding and re-stocking the local when more benign conditions return (Westgate *et al.* 2018).

27. The threatened frogs that have survived the fire and drought are much more vulnerable to habitat disturbances than they otherwise would be (Penman *et al*. 2015; Scheele *et al.* 2016). Given the seriousness of the drought and the massive scale of the wild fires that followed, remnant unburnt areas should be considered inviolate. Ideally, attempts should be made to protect and enhance these areas, not further damage them through logging.

28. The protection of the unburnt or lightly burnt remnants is critical for the survival of many frog and reptile species. Disturbances to these small areas could easily prevent the already weakened frog fauna from feeding, accelerate predation of the surviving frogs as the ground cover is removed and result in local extinctions of these animals (Potvin *et al*. 2017).

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24 September 2020.

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