Independent Forestry Panel

Public submission

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Topic 1. Sustainability of current and future forestry operations in NSW

Save Bulga Forest (SBF) is a community group that has been campaigning to stop native forest logging in Bulga Sate Forest on the north coast of NSW since 2020.

SBF is firmly convinced that native forest logging is unsustainable. Observations and research by SBF and our citizen scientists and ecologists have evidence to support this claim, particularly where the future of endangered species such as the Greater Glider and the Koala are concerned. There can be nothing sustainable about logging operations where local people, in a last-ditch act of desperation to stop the further destruction of endangered species habitat, have to be arrested before the industrial logging behemoths can start their destruction.

There is nothing sustainable in a forest where timber yields have declined by 40% in a decade. There is nothing sustainable in a forest that continues to have its structure compromised by repeated logging operations. Healthy forest communities, just like healthy human communities need a range of age classes. Many lowland native forests today have young and semi mature trees but show few, if any mature, overmature and senescent trees. Past practices including timber stand improvement (sic), clear-felling and wood chipping have severely compromised the structural and ecological values of public native forests.

The higher altitude forests have also been heavily denuded of older, hollow bearing trees. Sadly, many areas where this critical habitat remains are available for logging. Indeed, areas in Bulga State forest with dense populations of Greater Gliders are being logged as we write.

The NSW Forestry Corporation is totally intransigent in its dealings with the community and SBF and dismissive to community concerns about the adequacy and compliance of Harvesting Plans.

During the 2019-20 bushfires many SBF supporters helped co-ordinate our local community support hub, which served meals to all the fire crews attending in our area, including the dozens who participated in the management of forestry back burns.

Most of the state forests in our area were burnt in either the Rumba Dump Complex or the Coombes Gap Complex Fires. The severity of the burn varied, but for much of the forest the ground and mid-storey layers of vegetation burnt and there was some canopy scorch. In our visits to the forests in the months following the fires there was little evidence of any animal life- no lizards, few animal droppings and almost no birds.

Following the fires the Forestry Corporation announced it intended to begin logging an area of Bulga State Forest that had largely escaped the fire, although parts of the compartments had suffered some fire damage. The area in question was known koala habitat. The local community were outraged that logging was due to commence and spent several weekends in the forest looking for koala survivors. Evidence was found to show recent koala activity, mainly, but not exclusively, in many of the larger grey gums.

SBF shared our concerns with all who would listen: from the Ministers, to the EPA and Boral Timber. How, after unprecedented fires causing catastrophic damage to habitat and killing millions of animals, could a government agency continue logging business as usual? We provided fire intensity maps to the EPA. Logging was deferred but the habitat values that were damaged by the fires could take many years to recover. https://www.epa.nsw.gov.au/-/media/epa/corporate-

site/resources/forestry/review-of-cifoa-mitigation-conditions-for-timber-harvesting-in-burnt-landscapes.pdf?

In 2023, post Covid. SBF began regular citizen science field trips to the forest. What we found was that Bulga State forest is a refuge for Greater Gliders. We began to document our findings and look for Greater Glider den trees, as this is the only record that can achieve a small measure of protection on the ground.

At the same time, the Forestry Corporation was looking for Greater Glider and Yellow-bellied Glider den trees during the daytime and thus found none! Thus triggering no logging exclusion zones. This is a brazen example of the lack of duty of care that the Forestry Corporation has for our native wild life. A series of embarrassing media stories has seen them forced to now conduct minimalist surveys over a tiny fraction of the area they propose to log, but they probably find less than 1% of the den trees that form part of those animal's home ranges.

What this means is that logging is occurring in vital habitat to sustain species that have been uplisted from threatened to endangered, and the Forestry Corporation is fighting tooth and nail to minimise protections and has been caught out on several occasions logging within the 50m exclusion zones.

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

We know the benefits of intact forest ecosystems, Healthy and diverse forests are critical to a wide range of environmental services. Tall healthy mature forests slowly release clean water in times of drought, generate rainfall and cool and clean the air. Forests provide homes to up to 150 threatened species in NSW.

Mature and unlogged native forests are critical for pollinators and play a key role in pollination across the landscape, both inside and outside of forests. Native forests provide recreation and improved health outcomes to locals and visitors alike and are a source of community pride and connection to place

Native forests are culturally and spiritually significant for Aboriginal people and are embedded in their identity. Forest regeneration and recovery along with cultural and ecotourism can and will provide ideal employment opportunities for Aboriginal people

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

Ending native forest logging will not significantly impact the supply of timber products. Native forest logging comprised less than 10% of the total log production in 2023 of which half went to export woodchips.

Hardwood sourced from native forests or plantations are no longer necessary for any of the uses identified in this section. Sawn and treated softwood logs, composite timber products and hardwood plantations can replace all current uses for native forest timbers.

The argument that ending native forest logging will lead to greater imports from unsustainable logging overseas is a furphy as the government has the power to prevent the import of timber from questionable sources.

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

Private Native forestry (PNF) may be able to meet some of NSW's future timber needs. However, PNF is inadequately monitored. There are concerns surrounding PNF operations in Areas of Regional Koala Significance and in the critical habitats of other endangered species.

The future needs to be based on private landholders being incentivised to establish plantations and incentivised to protect their remnant native forests rather than fell it and sell it.â€¯

Topic 5. The role of State Forests in maximising the delivery of a range of environmental, economic and social outcomes and options for diverse management, including Aboriginal forest management models

Native forests that are not logged or are being allowed to recover from logging have many benefits to the entire ecology and economy of NSW.
The native forest hardwood division of the Forestry Corporation operates at a loss that runs into tens of millions of dollars, at the expense of the NSW public. It also additionally receives tens of millions of dollars in regular equity injections .The people of NSW should not be paying millions of dollars to destroy the biodiversity of our own state and critical habitat for threatened species
Public native forests have a much higher economic value when they are allowed to function naturally and without logging
First Nations Ranger Programs have been hugely successful at managing the recovery and health of native forests. Programs like the Githabul Rangers have shown how First Nations knowledge and management can restore the natural and critical function of forests in the landscape

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

Native forest logging in NSW is estimated to release 3.6 million tonnes of carbon every year
Ending native forest logging would be the equivalent to removing 840 thousand cars from the roads per year
Logging in a native forest reduces the amount of stored carbon by more than half of the original value
Ending native forest logging will allow previously logged forests to regain lost carbon and make a significant contribution to meeting our emissions targets
Climate change is driving increased risks for forest health and continued logging in native forests is exacerbating that risk
Forests that have not been logged are more resilient to the changing climate and catastrophic fires that are occurring as a consequence

bolwarra
environmental services

Bulga State Forest Citizen Science Threatened Species Survey

May/August 2023

Cover photographs: All taken during spotlight survey by Save Bulga Forests

Top: Southern Greater Glider – Knodingbul Road, Bulga State Forest

Bottom: Koala – Knodingbul Road, Bulga State Forest

Inner cover photo: Southern Greater Glider, Knodingbul Road, Bulga State Forest

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by
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[redacted]

Contents

1.0 EXECUTIVE SUMMARY 3

2.0 INTRODUCTION 5

3.0 BACKGROUND INFORMATION 6

3.1. Location of the Study Site 6
3.2. Site Soils, Topography and Geology 6
3.3. Climate 6
3.4. Vegetation 6
3.5. 2019/2020 Catastrophic Black Summer Fires 8
3.6. Bulga State Forest Harvest Plans & Threatened Species 9
3.7. NSW Bionet Atlas threatened species records Bulga SF 15
3.8. Southern Greater Glider protection - FCNSW CIFOA and Bulga SF Compartments 41/43 Harvest Plan 16
3.8.1. Taxonomy 16
3.8.2. NSW and Commonwealth threatened species status for Petauroides volans 16
3.8.3. Forestry Corporation - Southern Greater Glider 16

4.0 FAUNA SURVEY 24

4.1. Methodology 24
4.1.1. Weather 24
4.1.2. Citizen Science Volunteers Experience 24
4.1.3. Survey Methods 24
4.1.4. Limitations 29
4.2. Fauna Survey Results 29
4.2.1. Results of Threatened Fauna Survey 29
4.2.2. Results Discussion 46

5.0 DISCUSSION 55

5.1. Southern Greater Glider 55
5.2. Koala 59
5.3. Large forest owls 59
5.4. Glossy Black-cockatoo 60
5.5. Other threatened species and forest habitat 60

6.0 CONCLUSION 61

7.0 REFERENCES 62

Table of Figures

Figure 1: Bulga SF Forestry Corporation Planning Portal search 05/09/2023 11
Figure 2: Approved Harvest Plan Map Compartments 41 and 43 Bulga SF 12
Figure 3: Bionet Threatened Species Records Compartments 41 & 43 & surrounds-Bulga SF 13
Figure 4: Bionet Atlas Threatened Species Records Bulga SF 14
Figure 5: Forestry Corporation Bulga SF Greater Glider Density. 18
Figure 6: Location of the study site 20
Figure 7: Plant Community Type Vegetation Map 21
Figure 8: Vegetation Classes Map 22
Figure 9: 2019/20 Fire Extent and Severity (DPE) Map 23
Figure 10: Citizen Science Survey Results 29th and 30th May 2023 40
Figure 11: Citizen Science Survey Results 3rd and 4th August 2023 41
Figure 12: Citizen Science Survey Results Koala secondary evidence 3rd and 4th August 2023 42
Figure 13: Citizen Science Survey Results Dingo SF Transect 3rd August 2023 43
Figure 14: Threatened Species records relative to Compartments 41-43 Harvest Plan, Bulga SF 50
Figure 15: Bionet records for threatened Glider species in Bulga SF relative to 2019-20 Fire Extent & Severity Mapping 51
Figure 16: Bionet records for Koala in Bulga SF relative to 2019-20 Fire Extent & Severity Mapping 52
Figure 17: Bionet records for Koala in Mid-North Coast relative to 2019-20 Fire Extent & Severity Mapping 53
Figure 18: Bionet records for Forest Owls, Glossy-black Cockatoo and Parma Wallaby in Bulga SF relative to 2019-20 Fire Extent & Severity Mapping 54

List of Tables

Table 1. Plant Community Types Bulga State Forest 7
Table 2: Bulga State Forest Bionet threatened species records. 15
Table 3: Weather conditions during surveys – BoM Taree Airport AWS {station 060141} 24
Table 4: Spotlight transect survey details. 27
Table 5: Spotlight survey results summary table 29
Table 6: Fauna observations, scat search and secondary evidence recorded during the 29th/30th May Survey 30
Table 7: Fauna observations, scat search and secondary evidence recorded during the 3rd/4th August Survey 32

1.0 Executive Summary

- Citizen Science spotlight surveys in Bulga State Forest undertaken across four nights, in two separate surveys (May 29rd/30h and August 3rd/4th), resulted in a total of ninety-two Southern Greater Glider observations and another nineteen incidental observations. 14 Southern Greater Gliders were observed in a 1km transect section of Compartments 41-43. Three Southern Greater Glider den trees were located. A total of 6 Koala observations were made across all four survey nights. 3 clusters of Koala secondary evidence were found (scats and trunk scratchings).

- Uncorrected, raw, spotlight survey counts for Southern Greater Gliders is known to underestimate population sizes by approximately 25 % (Buckland *et al.* 1993, Lindenmeyer *et al.* 2001 and Cripps *et al*. 2021). These Citizen Science survey results are likely to be an underestimation of the Southern Greater Glider population by as much as a factor of four. FCNSW calculated Greater Glider density for Bulga SF relies on uncorrected raw counts and is also likely to be an underestimation of the population size (Forestry Corporation 2016).

- Given the likelihood of underestimation of Southern Greater Glider population size, the high number of Bionet records together with detections gained from this Citizen Science survey it is likely that a high density population is present and that Bulga SF represents a stronghold for Southern Greater Glider. The importance of this endangered population in Bulga State Forest has not been recognised by Forestry Corporation in any planning documents.

- Fire Extent and Severity Mapping shows that a significant portion of Bulga SF was not burnt in the 2019-2020 Mega-fire. Compartments 41-43 of Bulga SF, which are planned for logging, qualify as important unburnt refugia.

- The Bionet Atlas records 25 threatened fauna species for Bulga SF, including 176 Koala records and 297 Southern Greater Glider records. Bulga State Forest, inclusive of Compartments 41 and 43, contains significant habitat values for a range of threatened fauna.

- Bulga State Forest, inclusive of Compartments 41-43 is likely to meet all the important criteria for distribution and population abundance for Southern Greater Glider. It is also likely to function as an important refugia for Southern Greater Glider. Bulga SF is a high elevation, high soil fertility, cool climate, wet habitat with a diversity of known Greater Glider preferred *Eucalyptus* species and a high proportion of Giant Hollow-bearing trees present.

- Only two den trees have been identified in the Compartment 41-43 Harvest Plan. This is a severe underestimation of the den trees present given the Southern Greater Glider records for Compartments 41-43 and the high number of detections gained in this Citizen Science survey.

- Direct mortality of Southern Greater Gliders is likely during logging operations and inevitable without all den trees identified and protected via exclusion zones. The post timber harvest environment will also be one of den tree losses and habitat modification that will inevitably cause the resident Southern Greater Gliders that have survive the harvesting operations to shift their home range. This is likely to cause indirect mortalities also.

- Current CIFOA prescriptions require only the retention of a small number of hollow-bearing trees (8/ha) for usage by all hollow dependent fauna. A Hollow-bearing tree retention of 8/ha will represent a significant loss of den tree opportunities required for a high or even medium density Southern Greater Glider population with between 4-20 den trees required per animal within a home range.

- The logging of Compartments 41-43 and elsewhere in Bulga SF is likely to be catastrophic for the local population of Southern Greater Gliders, especially so with a drought cycle returning, and an extremely hot summer and high fire risk forecast (BoM 2023c; Carbonbrief 2023).

- The Compartment 41-43 Harvest Plan has a stated expiry date of 10/5/2023 and a survey expiry date of 10/5/2023 provided within it. The Forestry Corporation Ecology Report (Forestry Corporation 2016), which is provided by FC as a supportive document for this Harvest Plan pre-dates the elevation of Southern Greater Glider to Endangered status by both the NSW Threatened Species Scientific Committee and Commonwealth Threatened Species Scientific Committee in 2022.

2.0 Introduction

Operating as a citizen volunteer the undersigned joined the Save Bulga Forest community group to undertake spotlight surveys targeting threatened Glider species but also other threatened species including Koalas and Large Forest Owls within Bulga State Forest and to a lesser extent within Dingo State Forest. Other survey activities included Koala scat searches, some limited Glider Stag watch surveying and general habitat observations.

The Citizen Science Bulga Forest Camp spotlight survey aimed to cover a broad area of Bulga SF by road/track to undertake limited reconnaissance and possibly gain preliminary presence data that could inform a more targeted and detailed survey under a Forestry Permit later. These preliminary Citizen Science spotlight surveys were undertaken in May (29rd and 30th) and August (3rd and 4th). The 29th and 30th May spotlight transects resulted in the confirmed visual identification of thirty four Southern Greater Gliders across both nights with an additional two Southern Greater Glider incidental visual detections and three Koala confirmed visual detections. To confirm these surprising results another spotlight survey was undertaken on the 3rd and 4th August, which largely replicated the May spotlight transects. These resulted in the confirmed visual identification of fifty eight Southern Greater Gliders across both nights with an additional seventeen Southern Greater Glider incidental visual detections, three Koala visual detections, a Powerful Owl and Masked Owl visual detection.

Both the Southern Greater Glider and Koala are listed as Endangered under both the NSW Biodiversity Conservation Act 2016 (BC Act 2016) and Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act 1999). Both the Masked Owl and Powerful Owl are listed as Vulnerable under the NSW Biodiversity Conservation Act 2016 (BC Act 2016).

Given the volume of threatened species detections gained from this preliminary Citizen Science survey it became important for the Save Bulga Forests community group to report on these results immediately, before undertaking any subsequent, more extensive surveys under Forestry Permit. The habitat quality and high numbers of Southern Greater Gliders observed suggest that Bulga State Forest is likely to be a stronghold for this species.

- I certify that:
- The data, analysis, mapping for this report were compiled by Matthew Bailey (Ecologist);
- That the results presented in this report are a true and accurate record in the opinion of the author;
- That the results of the Citizen Science ecological surveys carried out for this project will be supplied to NSW Department of Planning and Environment (DPE) for their Atlas of NSW Wildlife database;
- The primary author of this report is Matthew Bailey.

Matthew Bailey.
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[redacted]

3.0 Background Information

3.1. Location of the Study Site

See Figure 3 for location of the Bulga State Forest site (and surrounding State Forests) in the local context. The site is located approximately 50km northwest of the township of Wingham, on the mid north coast of NSW. Bulga State Forest adjoins Tapin Tops and Biriwal Bulga National Parks.

3.2. Site Soils, Topography and Geology

The Bulga State Forest is located west of the Bulga Plateau, among ranges that form the eastern extension of the of the Great Escarpment in the Manning River catchment. This elevated landscape is composed of elevated steep hills to very steep hills with dissected plateau surfaces and rolling low hills to rolling hills at an elevation of 400 – 1000m asl.

Diverse metasediment and metamorphic geology has produced a range of complex soils including: Brown-Orthic and Red-Orthic Tenosols (Lithosols), Yellow Dermosols (Yellow Earths) Red Dermosols and Kandosols (Krasnozems, Red Earths, Red Podzolic Soils), Brown Dermosols and Kandosols (Brown Earths, Chocolate Soils), Brown Kurosols and Chromosols (Brown Podzolic Soils), Red Kurosols and Chromosols (Red Podzolic Soils) Brown-Orthic Tenosols (Lithosols), Brown and Yellow Kandosols (Yellow Earths), and Brown and Yellow Kurosols and Dermosols(Yellow Podzolic Soils).

Soil mass movement, sheet erosion and topsoil loss are known soil hazards in this landscape. (Spade 2023).

3.3. Climate

The upland environment of Bulga SF is characterised by a cool, wet and humid climate, with an average annual rainfall (recorded at Mount Seaview) of 1740 millimetres.

3.4. Vegetation

Thirty–five different Plant Community Types are mapped within the 13,361 hectares of Bulga State Forest by the Revised Eastcoast State Vegetation Type Mapping (version C1.1.M1.1) (DPE 2022a), see Figure 4. This PCT mapping however requires field validation and should be considered indicative in a general sense. The Plant Community Types present form a diverse and complex mosaic in relationship to the variable geology and highly dissected landform. Derived from the Revised Eastcoast State Vegetation Type Mapping, Rainforest formations form 37.5 % (5,017 hectares) with Sclerophyll formations forming the remaining 62.5% (8339 hectares) see Figure 5. Of these Sclerophyll formations 94% is Wet Sclerophyll (7,840 hectares) with Dry Sclerophyll Woodlands and a Grassy Woodland comprising the remainder.

The Old Growth Forest mapping of the Comprehensive Regional Assessment (1999, revised 2019) shows approximately 2,489 hectares (18.6%) of Bulga State Forest mapped as Old Growth Forest by the CRAFTI Lower North East mapping revised in 2019 (DPE 2011).

The adjoining Tapin Tops National Park (10,964 hectares) contains a similarly high biodiversity with thirty-six different Plant Community Types mapped. Approximately 42% of the park is mapped as Old Growth Forest.

Table 1. Plant Community Types Bulga State Forest

PCT Id	Plant Community Type Name	Area Ha
3288	Northern Escarpment Messmate Moist Grassy Forest	1.43
3101	Northern Hinterland Shatterwood Dry Rainforest	280.70
3240	Lower North Escarpment Red Gum Grassy Forest	1964.19
3252	Northern Hinterland Grey Gum-Mahogany Grassy Forest	169.37
3254	Northern Hinterland Tallowwood-Forest Oak Grassy Forest	1794.26
3205	Northern Escarpment New England Blackbutt-Tallowwood Wet Forest	321.90
3241	Lower North White Mahogany-Spotted Gum Moist Forest	87.84
3250	Northern Foothills Blackbutt Grassy Forest	252.83
0	Not classified	473.66
3169	Northern Hinterland Tallowwood-Brush Box Wet Forest	287.97
3032	Northern Escarpment Sassafras-Booyong-Corkwood Rainforest	4107.47
3166	Northern Escarpment Brush Box-Tallowwood-Maple Wet Forest	788.40
3174	Northern Turpentine-Brush Box Wet Forest	8.44
3286	Northern Escarpment Blackbutt Cool Moist Forest	1414.18
3033	Northern Escarpment Sassafras-Prickly Ash Rainforest	475.80
3206	Northern Escarpment Corkwood-Brush Box Wet Forest	474.12
3207	Northern Escarpment Layered Blackbutt Fern Forest	27.75
3244	Lower North Spotted Gum-Mahogany-Ironbark Sheltered Forest	16.00
3170	Northern Hinterland White Mahogany Moist Grassy Forest	40.28
3329	Northern Hinterland Valleys Red Gum Grassy Forest	18.76
3099	Northern Escarpment Shatterwood Dry Rainforest	26.46
3031	Northern Escarpment Coachwood-Beech Rainforest	107.00
3677	Lower North Escarpment Rocky Shrub Woodland	3.10
3202	Mid North Escarpment Ranges Blackbutt Forest	103.75
3167	Northern Hinterland Blackbutt-Forest Oak Wet Forest	16.21
3160	Lower North Turpentine-Tallowwood-Grey Gum Forest	23.24
3248	Northern Blackbutt-Turpentine Shrub Forest	3.52
3021	Northern Lowland Subtropical Rainforest	17.32
3087	Lower North Ranges Riparian Turpentine Forest	14.63
3019	Northern Hinterland Baloghia-Booyong Subtropical Rainforest	2.42
3464	Northern Gorges Grey Gum-Tallowwood Grassy Forest	2.98
3201	Mid North Escarpment Blue Gum Moist Forest	2.56
3253	Northern Hinterland Grey Gum-Turpentine Mesic Forest	0.56
3168	Northern Hinterland Brush Box-Quince Wet Forest	0.75
3249	Northern Bloodwood-Ironbark Moist Grassy Forest	12.81
3171	Northern Lowland Viney Wet Forest	13.55

3.5. 2019/2020 Catastrophic Black Summer Fires

There is general widespread agreement amongst Scientists that we are now living either within or on the cusp of the 6th Great Extinction event (Bradshaw *et al,* 2021; IPBES, 2019; Cowie *et al,* 2022). The Anthropocene extinction event can be linked to human impact on the environment (Bradshaw *et al,* 2021; IPBES, 2019). Australia's extinction rate is one of the worst in the world (Woinarski *et al.* 2015), and the rate of biodiversity decline and loss is continuing unabated (Ward *et al.* 2019). One of the significant problems is that species may decline more quickly than it takes for them to be listed as threatened under state and federal legislation. The Southern Greater Glider is an example of this, once abundant along Australia's east coast they are now considered at risk of extinction with an overall rate of population decline exceeding 50% over a 21-year period (DPE 2022b; DCCEW 2022). A history of approximately 200 years of forest logging and disturbance which continues today, places once abundant species, like the Southern Greater Glider and Koala, on a trajectory for extinction. Species already recognised as threatened with extinction are those experiencing the worst declines (TSX 2022). Predicted increases in natural disasters – such as the 2019/2020 megafire season – are likely to increase the risk of extinction for many impacted species and ecosystems including the Southern Greater Glider and Koala.

Climate change is a significant impact, especially as it impacts over the existing and ongoing impact of habitat loss. Southern Greater Gliders are vulnerable to high temperatures and low water availability, with prolonged exposure to temperatures over 40°C likely to lead to high mortality (Rübsamen *et al.* 1984). The sensitivity of Greater Gliders to heat has been suggested by Moore *et al.* (2004) to be the key factor in driving the preference of greater gliders for higher elevations. Populations in the Blue Mountains World Heritage Area have steeply declined; at lower altitude (<500 m) sites in the Blue Mountains, increasing mean annual temperatures have been attributed to be the cause of Southern Greater Glider declines (Smith and Smith 2018; Smith and Smith 2020). Similar scenarios are reported in Victoria with increasing temperatures implicated in reductions of Southern Greater Glider numbers (Wagner *et al.* 2020).

Climate change influenced mega-fires, such as that of the 2019-20 Black Summer fires, present a significant impact. Inappropriate fire regimes including extensive, severe fires and high frequency fires are known to have resulted in substantial Southern Greater Glider population losses or declines (McLean *et al*. 2018), with losses occurring both directly and indirectly via key habitat features (eg Hollow-bearing trees) and resource losses. Hollow-bearing trees (HBTs) affected by fire during planned burns were 28 times more likely to collapse than HBTs that were not burnt, reported by Bluff (2016) and cited by the Commonwealth Threatened Species Scientific Committee as evidence for the threat posed by extensive severe bushfires for the Greater Glider (Southern and Central) (DECCW 2022). A single fire in a ten-year period is capable of reducing the abundance of Southern Greater Gliders by more than half (McLean *et al*. 2018). Recently logged forest has been shown to substantially increase fire severity (Lindenmeyer *et al*. 2021).

Years of drought and Australia's hottest and driest year on record in 2019 created catastrophic wildfire conditions which culminated in the 2019-20 Black Summer fires that covered an unprecedented large area of eastern and southern Australia (DCCEW 2022). This mega-fire burnt with high severity in many places, including the mid north coast, such that the entire upper canopy was consumed (Boer *et al.* 2020). It was estimated that there was an immediate

Southern Greater Glider population loss of 85% at sites exposed to severe fire due to this megafire event (Legge *et al*. 2022). In citing evidence for the threats impacting the Southern and Central Greater Gliders the Commonwealth Threatened Species Scientific Committee (DECCW 2022) has commented the following with the caveat that the full impact of the 2019-20 bushfires is yet to be determined;

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

Fire poses an increasing risk to many species, as it is predicted that Australia will experience increases in intensity and frequency of fires into the future (BOM 2023a). 'High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition' is listed as a Key Threatening Process under the BC Act (2016).

At a local scale, the unprecedented scale of the 2019-20 Black Summer fires in the Mid-Coast and Port Macquarie-Hastings Local Government Areas resulted in fewer unburnt refuges than would normally be the case after a fire. Despite high severity fires occurring north, south, east and west of Bulga State Forest (See Figure.7: 2019/20 Fire Extent and Severity (DPE) Map) a large portion of Bulga State Forest remained unburnt. Compartments 41 and 43 which are approved for logging fall within this unburnt refuge of Bulga SF. Remaining unburnt areas provide critical refuges for species heavily impacted by fires, as they will be the only areas with mature habitat within extensive landscapes for many years (Dickman *et al.* 2020).

Climate Change and its effects are not an immediately controllable threat for a range of threatened species however that threat posed by harvesting native forests is one that can be eliminated immediately.

3.6. Bulga State Forest Harvest Plans & Threatened Species

Bulga State Forest has a number of Harvesting Plans in various statuses (see Figure 1) including the current approved plan for harvesting Compartments 41 and 43. The current status of this plan is 'Active' (as of 5/09/2023). Previously it was 'Suspended', following approximately 4 months of 'Active' status. However, this Harvest Plan has a stated expiry date of 10/5/2023 printed on it. Figure 2 shows the approved harvesting plan, including notations of threatened species which are remarkably limited. The harvest prescriptions for threatened species records are limited to some records for Scrub Turpentine (*Rhodamnia rubescens*), some locations for stream-breeding frogs, three Koala locations, one Glossy Black-Cockatoo (*Calyptorhynchus lathami*) location and just two glider den tree locations.

These remarkably limited threatened species notations on the approved harvest plan are in stark contrast to the high number of threatened species records (including threatened species not identified on the harvest plan) recorded within the NSW Bionet Wildlife Atlas and located within Compartments 41 and 43. (see *Figure 3. Bionet Atlas Threatened Species Records Compartments 41 and 43 and surrounds* and *Bulga SF Table 1. Bulga State Forest Bionet threatened species*

records). Many of these State and Commonwealth listed threatened species records are from Forestry Corporation NSW's (FCNSW) own records.

The Coastal Integrated Forestry Operations Approval (CIFOA) (renewed in 2018) is the legal instrument which determines Forestry Corporation NSW (FCNSW) harvesting activities in NSW state forests at an operational level. The CIFOA, as a mechanism for determining how threatened species are addressed in harvesting plans, takes little account of the available threatened species data, held by the NSW state government. A limited series of protocols and conditions determine requirements for survey for a very limited number of species and habitat features. This report reviews the known or expected presence of threatened fauna species in Compartment 41 and 43, and more broadly within Bulga State Forest and contrasts this information to the limited array in the harvesting plan. The likely impact of timber harvesting on these species is discussed.

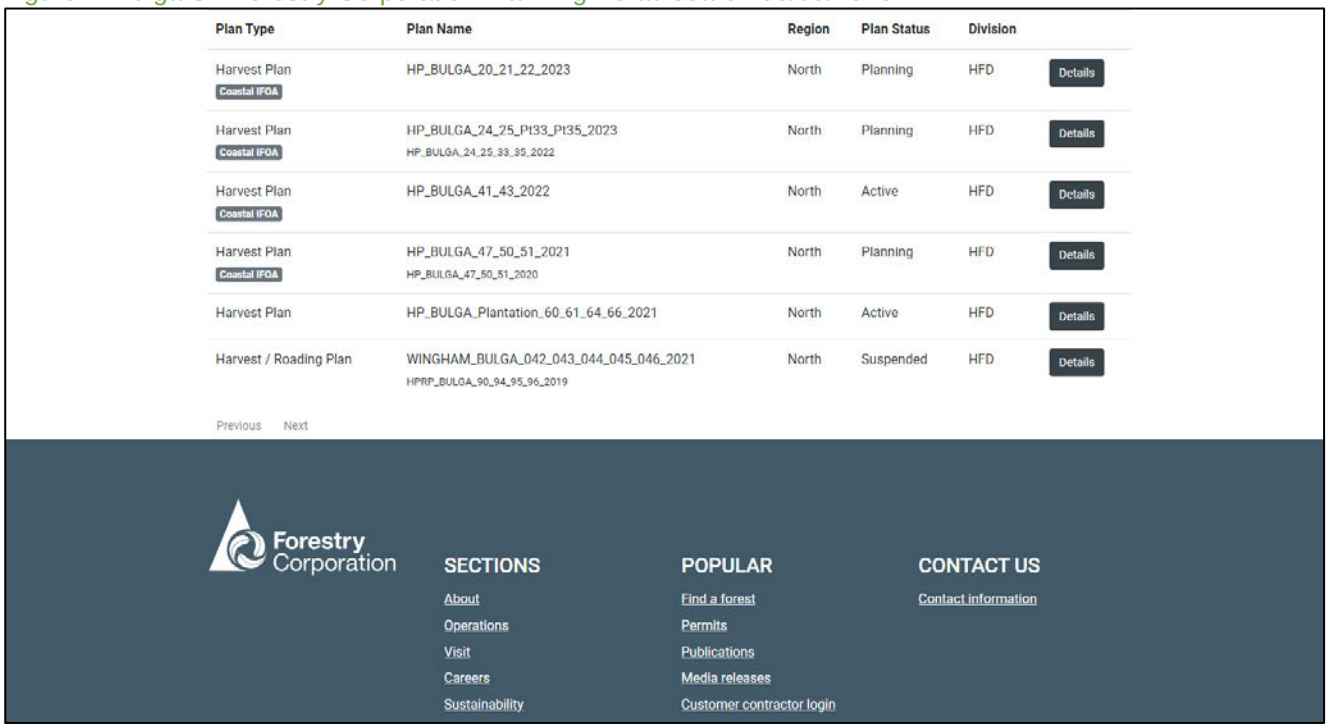
Two key State and Commonwealth listed threatened focus species of this report are;

- Southern Greater Glider (*Petauroides volans*) – Conservation Status NSW: Endangered (BC Act 2016), Conservation Status Commonwealth: Endangered (EPBC Act 1999)
- Yellow-bellied Glider (*Petaurus australis*) - Conservation Status NSW: Vulnerable (BC Act 2016), Conservation Status Commonwealth: Vulnerable (EPBC Act 1999)

The Compartments 41 and 43 harvesting plan makes little provision for these species, despite their being known to occur within these Compartments. It is deeply concerning that only two den trees have been identified within the Harvest Plan and that as little as 8 Hollow-bearing trees/Ha will be retained for usage by all hollow dependent fauna occupying Compartments 41 and 43. For the other Compartments within Bulga State Forest, which are in the planning phase, and for which no Harvest Plans are currently available, a similar lack of provision for these threatened Glider species is considered likely.

Oher threatened fauna species known to occur in the compartment or in the vicinity, include Koala (*Phascolarctos cinereus*), Parma Wallaby (*Notamacropus parma*), Glossy Black-cockatoo as well as large forest owl species Powerful Owl (*Ninox strenua*), Sooty Owl (*Tyto tenebricosa*) and Masked Owl (*Tyto novaehollandiae*). Again, many of these records are from FCNSW's own data however none generate a specific management response under the CIFOA. Under current rules, logging can occur without any direct protective measures for these species.

Figure 1: Bulga SF Forestry Corporation Planning Portal search 05/09/2023



Plan Type	Plan Name	Region	Plan Status	Division	
Harvest Plan Coastal IFOA	HP_BULGA_20_21_22_2023	North	Planning	HFD	Details
Harvest Plan Coastal IFOA	HP_BULGA_24_25_Pt33_Pt35_2023 HP_BULGA_24_25_33_35_2022	North	Planning	HFD	Details
Harvest Plan Coastal IFOA	HP_BULGA_41_43_2022	North	Active	HFD	Details
Harvest Plan Coastal IFOA	HP_BULGA_47_50_51_2021 HP_BULGA_47_50_51_2020	North	Planning	HFD	Details
Harvest Plan	HP_BULGA_Plantation_60_61_64_66_2021	North	Active	HFD	Details
Harvest / Roading Plan	WINGHAM_BULGA_042_043_044_045_046_2021 HPRP_BULGA_90_94_95_96_2019	North	Suspended	HFD	Details

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Figure 2: Approved Harvest Plan Map Compartments 41 and 43 Bulga SF

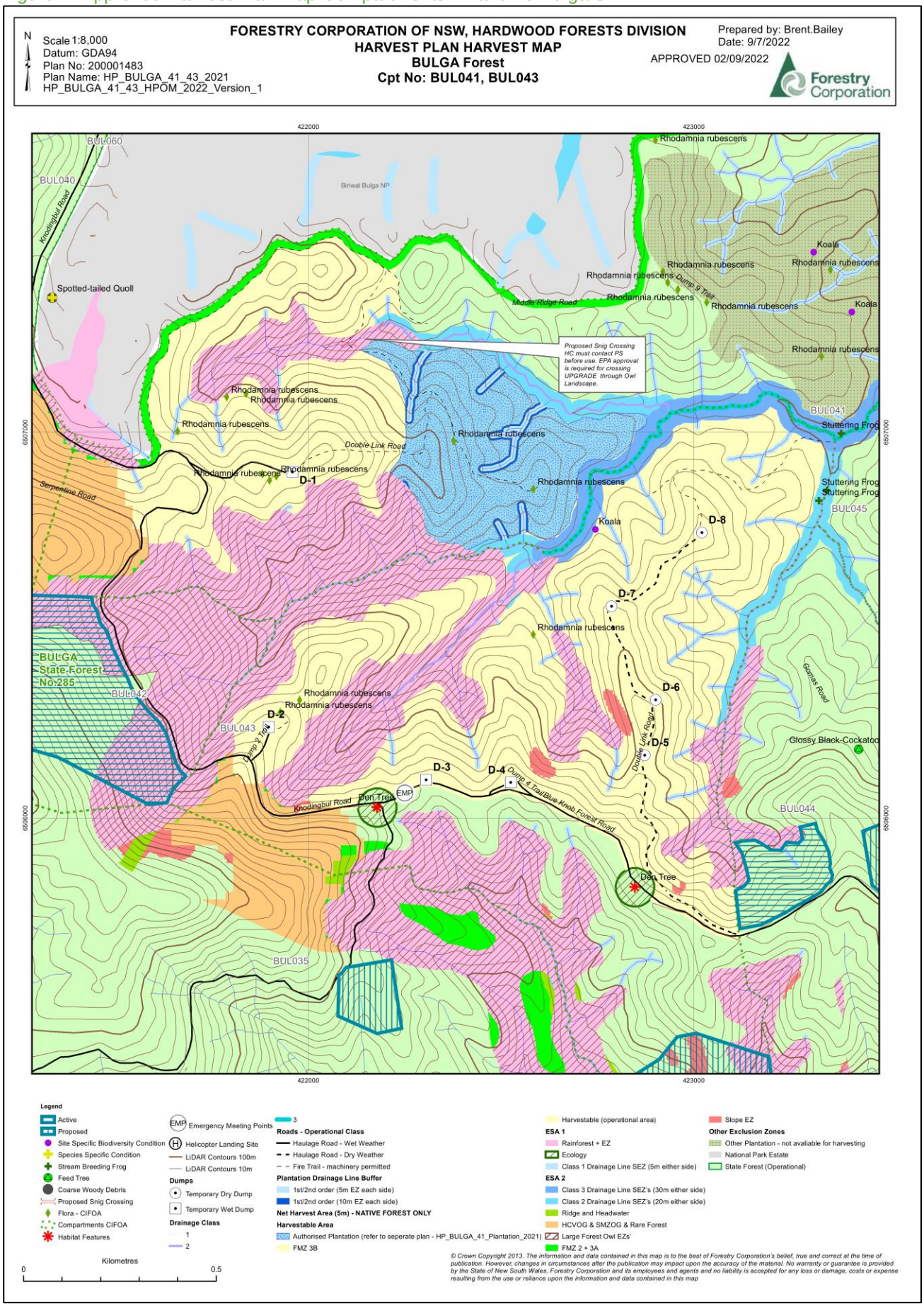


Figure 3: Bionet Threatened Species Records Compartments 41 & 43 & surrounds-Bulga SF

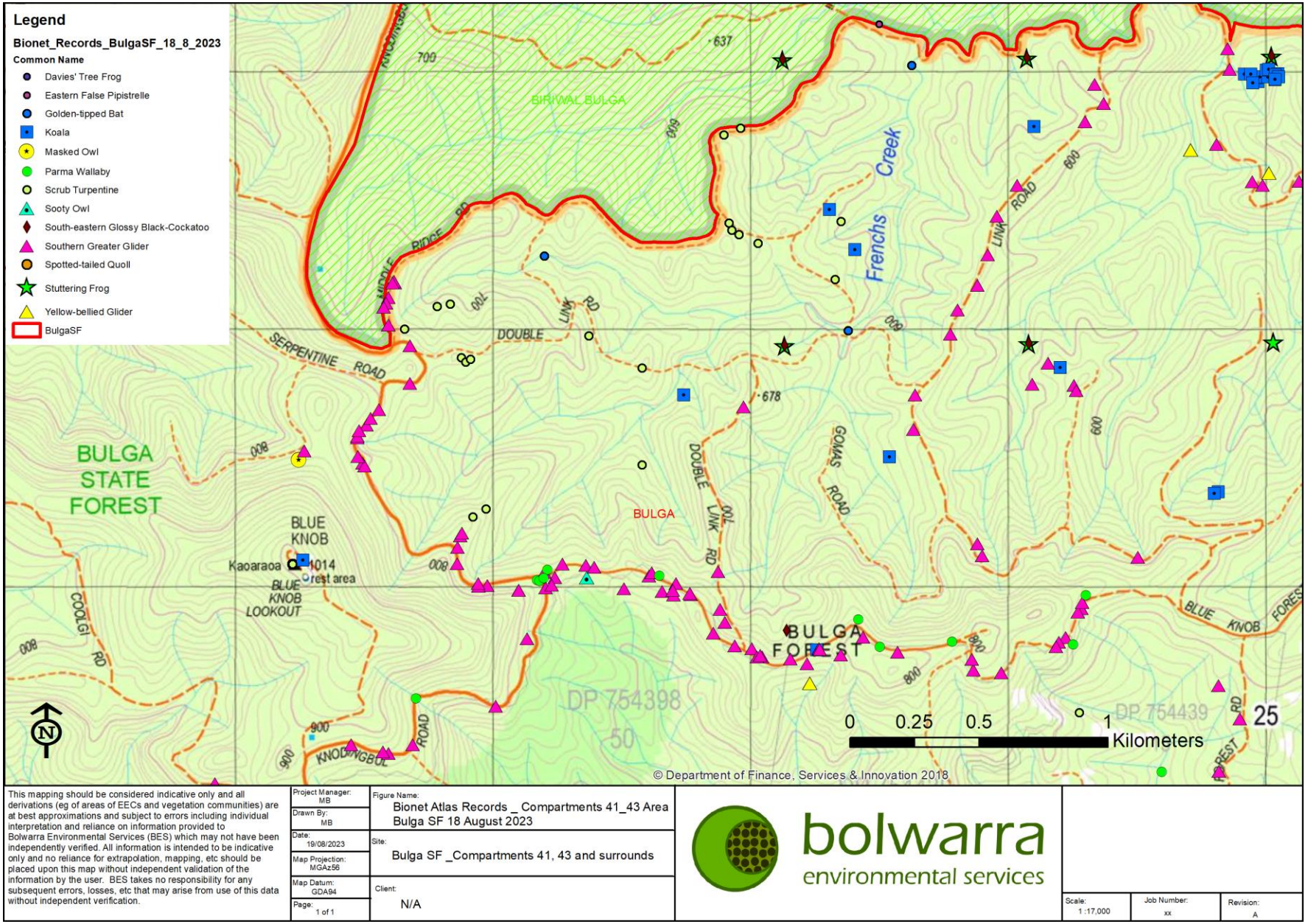
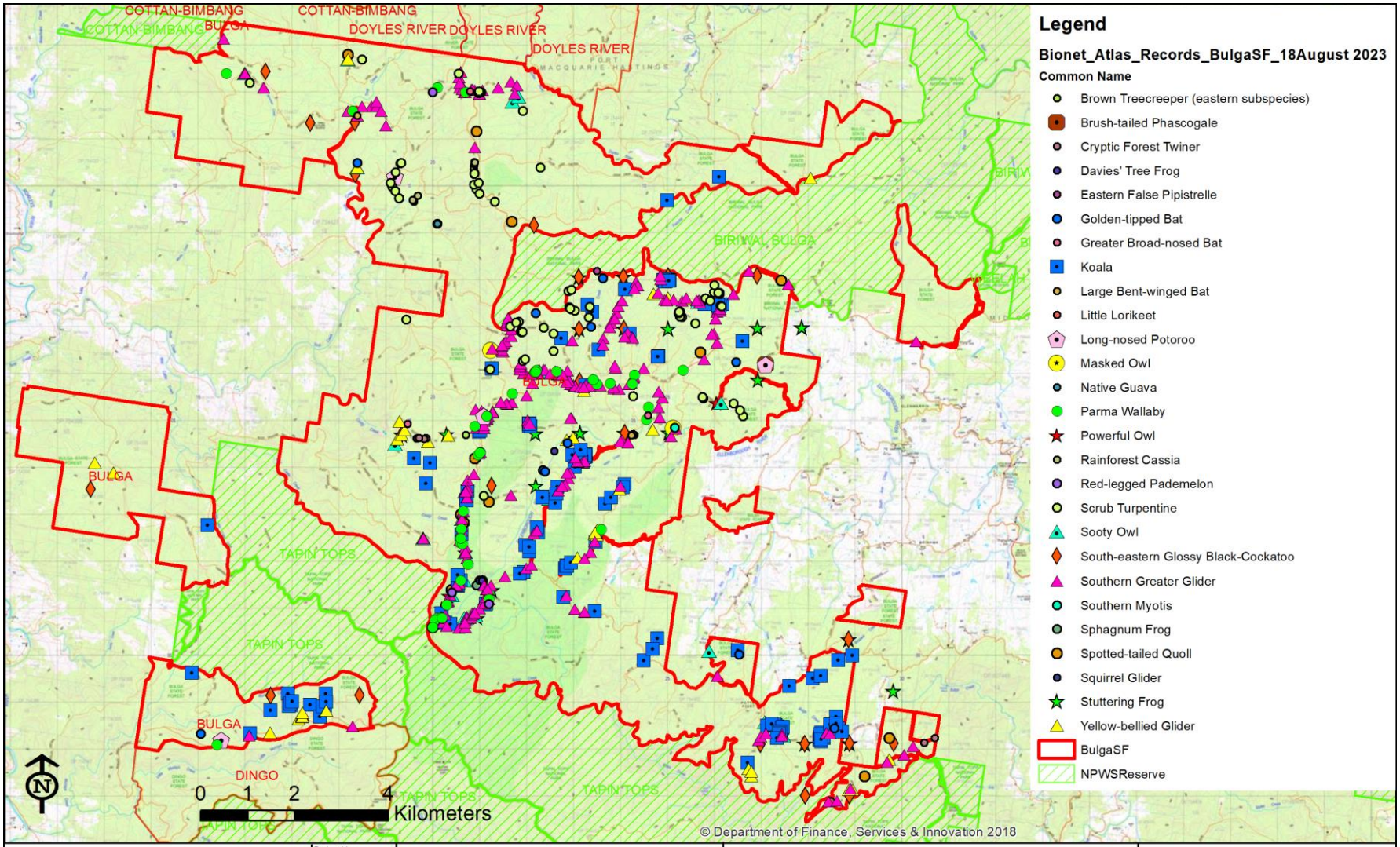


Figure 4: Bionet Atlas Threatened Species Records Bulga SF



3.7. NSW Bionet Atlas threatened species records Bulga SF

A search of the DPE Bionet database (DPE 2023a) indicated that the following threatened species occur within Bulga State Forest:

Table 2: Bulga State Forest Bionet threatened species records.

Data from the BioNet Atlas website, which holds records from a number of custodians. The data are only indicative and cannot be considered a comprehensive inventory, and may contain errors and omissions. Species listed under the Sensitive Species Data Policy may have their locations denatured (^ rounded to 0.1°C; ^^ rounded to 0.01°C. Copyright the State of NSW through the Department of Planning, Industry and Environment. Search criteria : Licensed Report of all Valid Records of Threatened (listed on BC Act 2016) or Commonwealth listed Entities in BULGA State Forest returned a total of 923 records of 29 species.
Report generated on 18/08/2023 2:24 PM

Class	Family	Scientific Name	Common Name	NSW status	Comm. status	Records
Amphibia	Myobatrachidae	^^*Mixophyes balbus*	Stuttering Frog	E1,P,2	V	94
Amphibia	Limnodynastidae	*Philoria sphagnicolus*	Sphagnum Frog	V,P	V	11
Amphibia	Hylidae	*Litoria daviesae*	Davies' Tree Frog	V,P		11
Aves	Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked Stork	E1,P		2
Aves	Accipitridae	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	V,P		3
Aves	Cacatuidae	^^*Calyptorhynchus lathami lathami*	South-eastern Glossy Black-Cockatoo	V,P,2	V	61
Aves	Psittacidae	*Glossopsitta pusilla*	Little Lorikeet	V,P		1
Aves	Strigidae	*Ninox strenua*	Powerful Owl	V,P,3		5
Aves	Tytonidae	*Tyto novaehollandiae*	Masked Owl	V,P,3		2
Aves	Tytonidae	*Tyto tenebricosa*	Sooty Owl	V,P,3		27
Aves	Climacteridae	*Climacteris picumnus victoriae*	Brown Treecreeper (eastern subspecies)	V,P		1
Mammalia	Dasyuridae	*Dasyurus maculatus*	Spotted-tailed Quoll	V,P	E	17
Mammalia	Dasyuridae	*Phascogale tapoatafa*	Brush-tailed Phascogale	V,P		1
Mammalia	**Phascolarctidae**	***Phascolarctos cinereus***	**Koala**	**E1,P**	**E**	**176**
Mammalia	Petauridae	*Petaurus australis*	Yellow-bellied Glider	V,P	V	43
Mammalia	Petauridae	*Petaurus norfolcensis*	Squirrel Glider	V,P		1
Mammalia	**Pseudocheiridae**	***Petauroides volans***	**Southern Greater Glider**	**E1,P**	**E**	**297**
Mammalia	Potoroidae	*Potorous tridactylus*	Long-nosed Potoroo	V,P	V	4
Mammalia	Macropodidae	*Notamacropus parma*	Parma Wallaby	V,P	V	40
Mammalia	Macropodidae	*Thylogale stigmatica*	Red-legged Pademelon	V,P		3
Mammalia	Vespertilionidae	*Falsistrellus tasmaniensis*	Eastern False Pipistrelle	V,P		1
Mammalia	Vespertilionidae	*Myotis macropus*	Southern Myotis	V,P		4
Mammalia	Vespertilionidae	*Phoniscus papuensis*	Golden-tipped Bat	V,P		14
Mammalia	Vespertilionidae	*Scoteanax rueppellii*	Greater Broad-nosed Bat	V,P		4
Mammalia	Miniopteridae	*Miniopterus orianae oceanensis*	Large Bent-winged Bat	V,P		2
Flora	Apocynaceae	*Tylophora woollsii*	Cryptic Forest Twiner	E1	E	9
Flora	Fabaceae (Caesalpinioideae)	*Senna acclinis*	Rainforest Cassia	E1		17
Flora	Myrtaceae	*Rhodamnia rubescens*	Scrub Turpentine	E4A	CE	71
Flora	Myrtaceae	*Rhodomyrtus psidioides*	Native Guava	E4A	CE	1

3.8. Southern Greater Glider protection - FCNSW CIFOA and Bulga SF Compartments 41/43 Harvest Plan

3.8.1. Taxonomy

Genetic testing research published in 2020 supported previous morphological work on *Petauroides volans* such that *P. volans,* formerly the only species in the genus *Petauroides,* is now considered to be at least two separate species: *P. volans* (Southern Greater Glider) and *P. minor* (Northern Greater Glider) (McGregor *et al.* 2020). *Petauroides volans* (Southern Greater Glider) is the only Greater Glider species that occurs in New South Wales (NSW).

The Commonwealth Threatened Species Scientific Committee in its *Conservation Advice for Petauroides volans (greater glider (southern and central))* (DCCEW 2022) refer to the Southern Greater Glider species (NSW/Victoria) and the Central Greater Glider species (Qld).

3.8.2. NSW and Commonwealth threatened species status for *Petauroides volans*

On the 5th May 2016 the Commonwealth Threatened Species Scientific Committee, established under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), listed *Petauroides volans* (Greater Glider) in the Vulnerable category of the threatened species list under the EPBC Act (1999).

On the 5th July 2022 the Commonwealth Threatened Species Scientific Committee elevated *Petauroides volans* (Greater Glider) from the Vulnerable category to Endangered citing an overall rate of population decline exceeding 50 percent over a 21-year (three generation) period, including population reduction and habitat destruction following the 2019–20 bushfires as the main factors that make the species eligible for listing in the Endangered category (DCCEW 2022).

On the 25th November 2022 The NSW Threatened Species Scientific Committee, made a Final Determination to list *Petauroides volans* (Southern Greater Glider) Kerr 1972 as an Endangered Species in Part 2 Division 1 of Schedule 1 of the Biodiversity Conservation Act (2016), state wide in NSW on the basis of the risk of extinction in NSW (DPE 2022). This NSW listing has ensured consistency with the Commonwealth listing.

3.8.3. Forestry Corporation - Southern Greater Glider

3.8.3.1. Forestry Corporation - Inconsistent opinion with NSW and Commonwealth TSSC's

First published 9 h July 2021 and revised 6th October 2022, the Addendum Forestry Corporation Rationale for operations under the CIFOA with additional environmental safeguards (FC 2021) states:

"*The greater glider is widely distributed throughout NSW. The species is listed as vulnerable by the federal government but not listed as a threatened or vulnerable species in NSW as most of the concern around the species is in Victoria, where fire impacts on the species and its habitat have been significant with multiple mega fires in the last decade*." (FC 2021, Pgs 28,29)

This Forestry Corporation opinion on the Southern Greater Glider is inconsistent with that of both the NSW and Commonwealth Threatened Species Scientific Committees, within their respective Final Determination and Listing Assessment for the Greater Glider Endangered listing. Both Threatened Species Scientific Committees have identified the clear risk of extinction for the Greater Glider in NSW while Forestry Corporation does not recognise this.

3.8.3.2. Southern Greater Glider protected only by standard conditions under the CIFOA

Within the CIFOA, introduced in November 2018, Southern Greater Gliders are listed as adequately protected by the standard conditions, due to the protection of hollow-bearing trees and general exclusion zones in the CIFOA. The status of Southern Greater Gliders as 'adequately protected' by Forestry Corporation also relies on the stated protections for the species habitat in the reserve system on national parks. This assumes that such habitat is occupied by Southern Greater Gliders, functional - following the 2019/2020 wildfires and viable in the climate change context. No Species-Specific Conditions for the Southern Greater Glider are provided for within the Coastal CIFOA.

Forestry Corporation acknowledges that Hollow-bearing trees are a major limiting factor for Southern Greater Glider persistence. A minimum of 8 Hollow bearing trees per hectare are to be retained as a standard condition under the CIFOA. These are however not retained specifically for Greater Gliders but to be shared between all hollow dependant species present. The other standard conditions provided in the CIFOA are:

- The retention of wildlife habitat and tree retention clumps;

(a) at least five per cent of the base net area in each compartment in the regrowth zone; and

(b) at least eight per cent of the base net area in each compartment in the non-regrowth zone.

The implementation of these the CIFOA states the retention of hollow-bearing trees and potential future hollow-bearing must be *prioritised*. However there appears to be no guarantee that any retained trees, clumps or the minimum Hollow-bearing trees retained per hectare within a logged coupe will meet the site-specific ecological requirements of Southern Greater Gliders and that these measures will prevent the risk of local extinctions. The risk of extinction can only be heightened by the habitat loss posed by the harvesting operations in the first place with native forest logging recognised as a significant threat to the population of Southern Greater Gliders in both the NSW and Commonwealth Threatened Species Scientific Committee's assessment.

3.8.3.3. Southern Greater Glider Density Bulga SF

A report titled Threatened Species Licence Pre-Logging and Pre-Roading Flora & Fauna Survey Report Bulga State Forest, Compartments 90, 94, 95, 96 (Forestry Corporation 2016) was

located on the Forestry Corporation Planning Portal. These compartments appear to overlap with compartments 41 and 43 and may have been renumbered. Unfortunately, the report is a shell report without any supporting data within it. It does however provide a Southern Greater Glider Density table, and this is reproduced below from that report.

Figure 5: Forestry Corporation Bulga SF Greater Glider Density.

COMPARTMENTS 90, 94, 95, 96 , Bulga STATE FOREST

3 Greater Glider Density

Number of Greater Gliders (N)	Length of Spotlight Transect (L)	Width (W)	Greater Glider Density (No/ha)
8	1600	20	2.5

Notes:

- No Greater Gliders were detected within the compartment. Therefore no additional prescriptive measures are required. For each transect, the census with the greatest number of Greater Gliders was used to assess the density of Greater Gliders per hectare.
- Greater glider density (in number per ha) was calculated using the equation;
  N/((L x 2W)/10000)
  where N = number of greater gliders recorded on spotlight transects within W;
  L = total spotlight transect length (in metres), including all replicates; and
  W = 20 m (or other as specified), the presumed minimum distance away from transect that records could be made.
- Therefore, as the abundance of Greater Gliders is >1 eight hollow bearing trees per ha must be retained within the net logging area. (Condition 6.9 d)

(*Threatened Species Licence Pre-Logging and Pre-Roading Flora & Fauna Survey Report Bulga State Forest, Compartments 90,94,95,96 (2016).* Author: Mark Drury 1/11/16. Report validity stated to 10/2/2026)

Given that the details of the survey and the survey data in the above table are not provided it is assumed that it represents actual field survey data collected from Bulga SF relative to the stated compartments.

Given the limitations of spotlight surveys in terms of underestimating population sizes (Buckland *et al.* 1993) with detection rates as low as 26% reported by Lindenmeyer *et al.* (2001) it is likely that the FCNSW calculated Greater Glider density is an underestimation and therefore any prescriptions based on this density are likely to be deficient.

Southern Greater Glider population densities in suitable habitat vary from 0.5 to 3.8 animals/ha (Harris & Maloney 2010). Within northeastern Queensland, north-west of Townsville a population density of 3.3-3.8/ha has been reported which is considered a very high population density of Central Greater Gliders (Comport *et al*. 1996). Average densities of 0.2 to 3.0 individuals per hectare in NSW are provided in the DCCEEW Determination (DCCEW 2020).

The patchy distribution and variable population abundance of Greater Gliders in NSW is attributed primarily to:

- Temperature - number of nights over 20°C is the greatest predictor of greater glider distribution (Wagner *et al*., 2020) with high elevation, cool, wet habitat patches (>500m asl) important refugia (DCCEEW 2022).

- Differences in foliar nutrient levels (Wagner *et al.*, 2021b).
- The presence and density of suitable tree hollows (DCCEEW 2022).
- Soil fertility, eucalypt tree species, forest age and structural complexity, disturbance history, and predator abundance (Harris & Maloney, 2010).

Bulga SF is likely to meet all these important criteria for distribution and population abundance and function as an important refugia. However, no studies appear to have been done in this regard for Bulga SF. Despite the lack of population and habitat studies for Southern Greater Glider in Bulga SF it is important to note that logging is planned in Bulga SF and that logging is known to have a negative correlation to Greater Glider density (in terms of logging intensity) (McLean *et al.* 2018) and that Greater Gliders have a high sensitivity to logging (Kavanagh, 2000; Lunney, 1987).

3.8.3.4. Limitations of spotlight surveys in estimating population sizes

Spotlight light surveys have limitations and are known to underestimate the populations sizes of Southern Greater Gliders (Buckland *et al*. 1993). A low detection rate of 26% for radio-collared Greater Gliders that were definitely known to be in the vicinity of a transect was reported by Lindenmeyer *et al*. (2001).

Cripps *et al.* (2021) more recently have also shown that the detection probability of gliders on occupied sites (i.e. the proportion of gliders present in the vicinity of a transect at the time of the survey that are actually detected) is relatively low. As a result, reliance on raw spotlight counts will result in potentially severe underestimation of the density and abundance of gliders present at a site. Spotlight counts, uncorrected for probability of detection can at best be interpreted as a crude index of relative abundance. (Cripps *et al*. 2021).

Two common Greater Glider spotlight methods, strip transects and off-track distance sampling methods have both been found to underestimate the abundance of Greater Gliders (*Buckland et al.* 1993). A double observer mark-recapture distance sampling method spotlight transects sampling method has been tested and identified as a preferred technique within forestry coupes in the Strathbogie Ranges, Victoria to provide robust estimates of Southern Greater Glider abundance (Cripps *et al.* 2021).

Accurate estimates of population size of Southern Greater Glider are important as it allows population densities to be estimated, accurate assessments of a populations status and viability and evaluate the relative benefits and effectiveness of management actions. Accurate population and density estimates also allow habitat requirements to be more accurately inferred such as den tree numbers required per hectare, habitat suitability as well as the mating system to be inferred (monogamous, polygamous, or polygynous) (Harris & Maloney, 2010).

Figure 6: Location of the study site

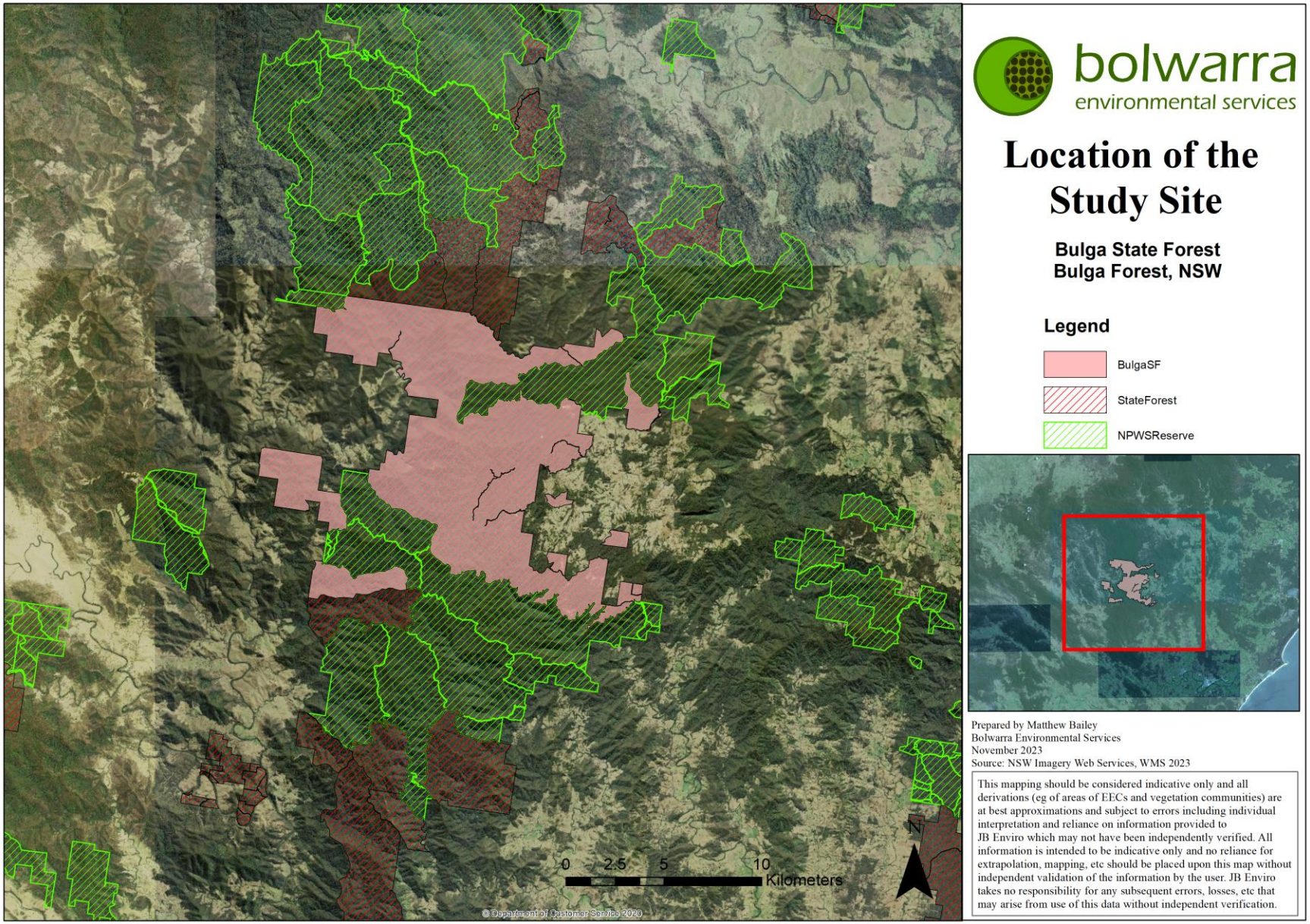


Figure 7: Plant Community Type Vegetation Map

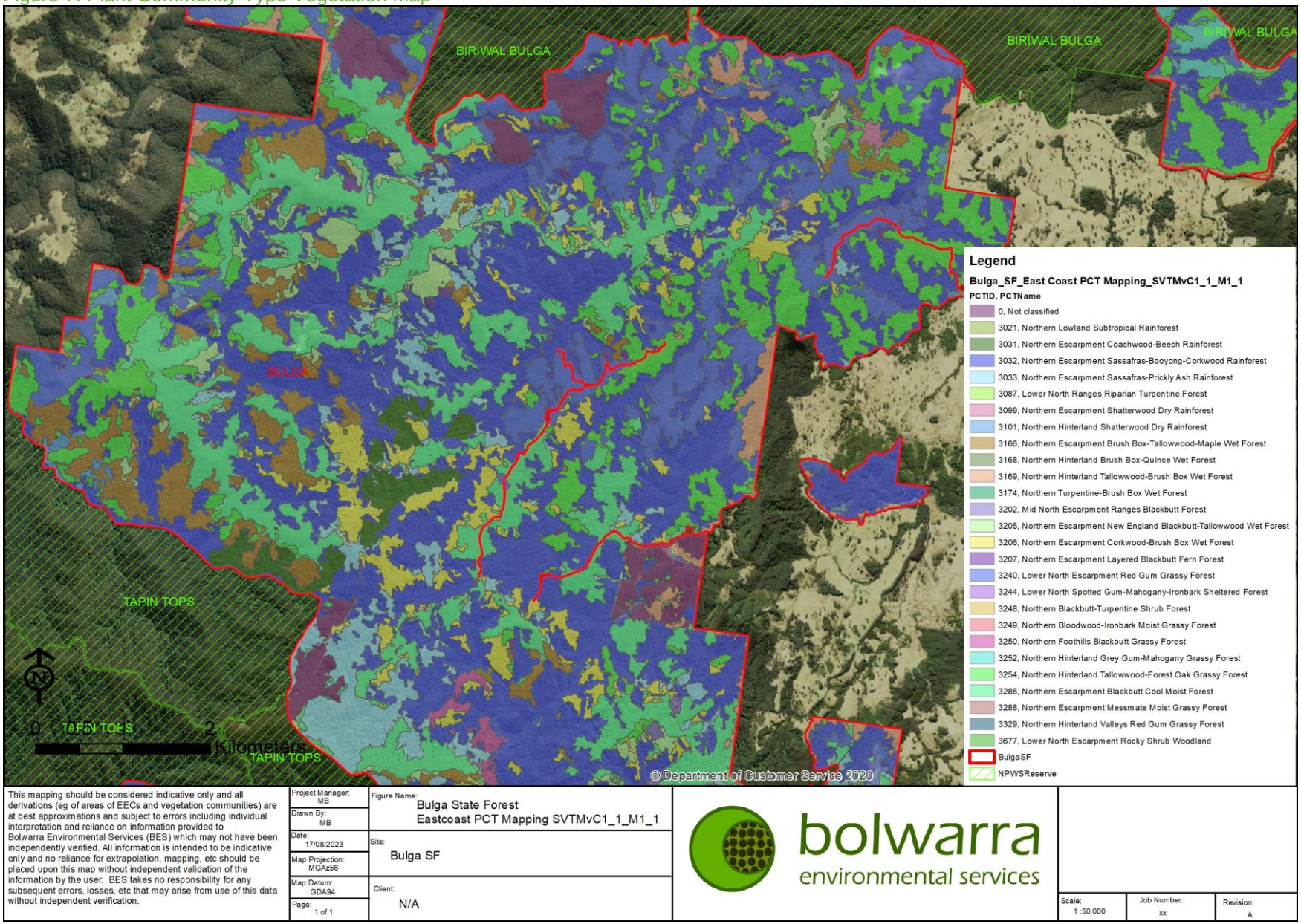


Figure 8: Vegetation Classes Map

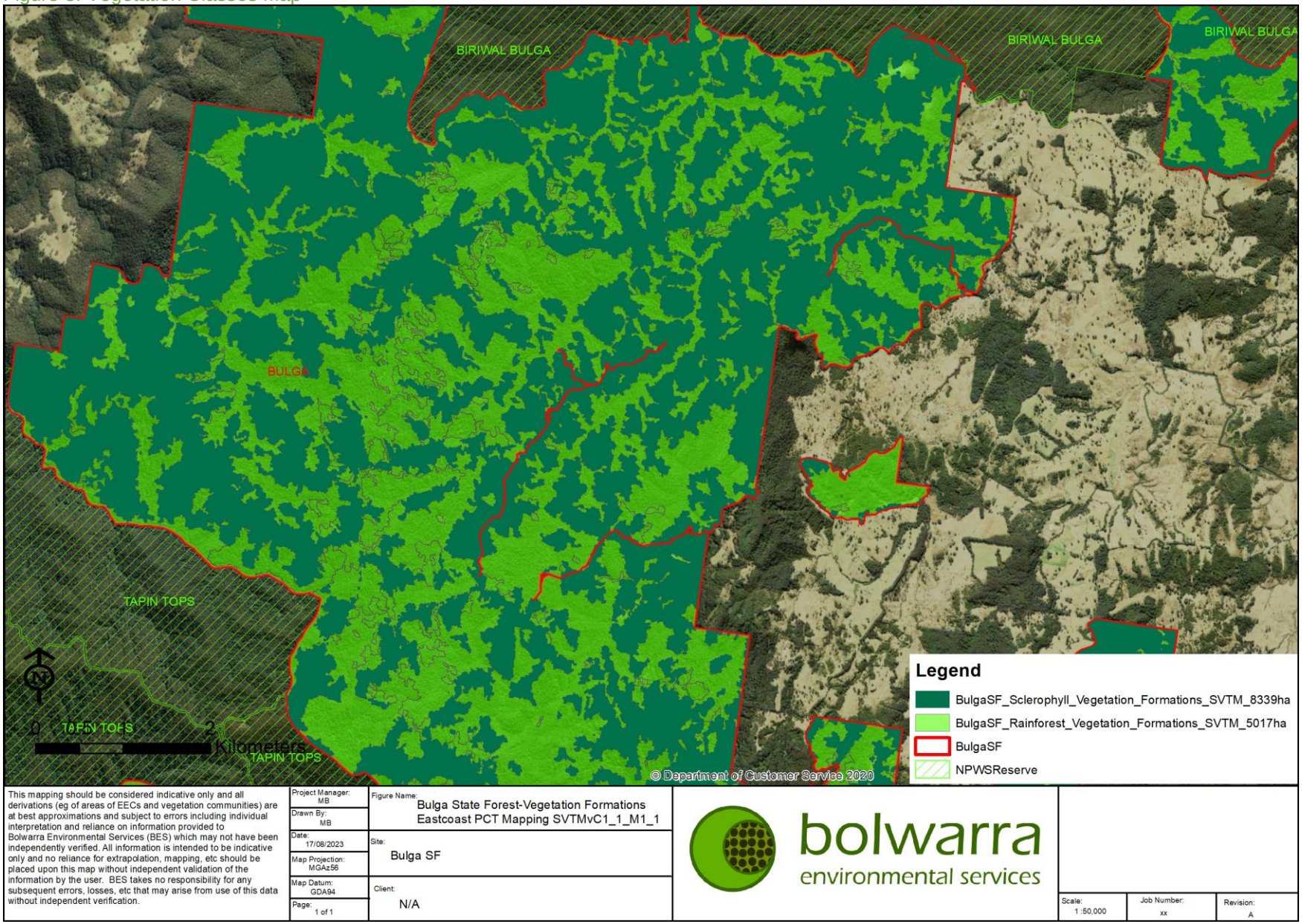
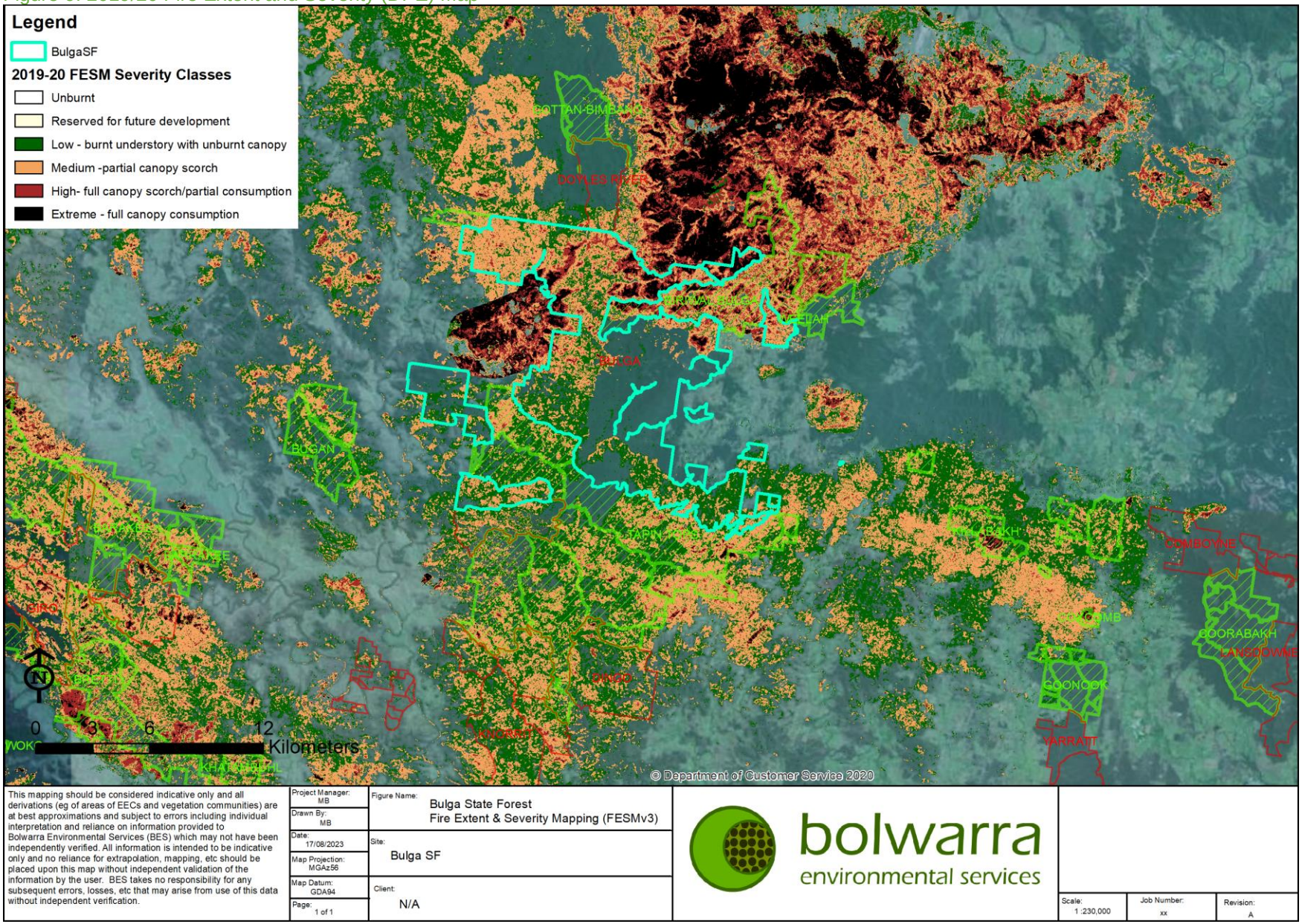


Figure 9: 2019/20 Fire Extent and Severity (DPE) Map



4.0 Fauna Survey

4.1. Methodology

4.1.1. Weather

Table 3: Weather conditions during surveys – BoM Taree Airport AWS {station 060141}

Date	Minimum temperature (°C)	Maximum temperature (°C)	Rainfall (mm)	Direction of maximum wind gust	Speed of maximum wind gust (km/h)	Time of maximum wind gust	9am Temperature (°C)	9am relative humidity (%)	9am cloud amount (oktas)	9am wind direction	9am wind speed (km/h)	9am MSL pressure (hPa)	3pm Temperature (°C)	3pm relative humidity (%)	3pm cloud amount (oktas)	3pm wind direction	3pm wind speed (km/h)	3pm MSL pressure (hPa)
29/05/2023	4.7	21.4	0				13.1	62	0			1018.5	20.2	36	2			1016.7
30/05/2023	2.3	21.4	0				12.8	81	0			1024.2	20.8	19.2	49			1021.1
3/08/2023	7.3	21.1	0	E	30	15:34	13.4	99		WSW	7	1036.2	20.2	52		ENE	19	1032.7
4/08/2023	4.0	22.7	0.2	ENE	35	15:34	11.4	99		W	7	1034.9	21.2	58		ENE	24	1030.3

BoM 2023b accessed 22/08/2023 BoM Taree Airport AWS {station 060141} weather data

Note: Taree Airport is the closest BoM weather station approximately 50kms east. Day time maximums temperatures at the site were notably lower and other weather data may vary also.

4.1.2. Citizen Science Volunteers Experience

Matthew Bailey – Volunteer, report author and principle surveyor. As a Consulting Ecologist the author is experienced in Koala surveys gained mostly on the Mid-north Coast NSW (habitat assessment, scat searches, Spot Assessment Technique and Spotlighting), Glider Spotlight Surveys (Southern Greater Glider, Yellow-bellied Glider, Squirrel Glider and Sugar Glider detections at Comboyne, Muswellbrook and Warialda), Large Forest Owl surveys (Comboyne (Masked Owl and Powerful Owl detections), Muswellbrook, Baradine and Warialda).

Scott MacKenzie – Veteran naturalist, experienced in Glider identification.
Mitra Ellis – Veteran naturalist, experienced in Glider identification.
Luca Lamont – Experienced naturalist, experienced in Glider identification.
Kayleigh Warren - Veteran naturalist, experienced in Glider identification.
Tony Summers - Veteran naturalist, experienced in Glider identification.
Susie Russell - Veteran naturalist, experienced in Glider identification.

4.1.3. Survey Methods

This Citizen Science spotlight survey aimed to undertake limited reconnaissance and possibly gain preliminary presence data that could inform a more targeted and detailed survey under a Forestry Permit later. These preliminary Citizen Science spotlight surveys covering a broad area of Bulga SF by road/track were undertaken in May (29th and 30th) and August (3rd and 4th). The surveys conducted also allowed the threatened species prescriptions in the harvesting plan to be contrasted with the actual presence of species found by the Citizen Scientists in Bulga SF.

This fauna survey was limited to the following;

- *Spotlight transect survey;*
- *Incidental Observation*;
- *Stag watch survey*;
- *Koala scat, secondary evidence searches and habitat assessments.*

4.1.3.1. Citizen Science skills workshop

Prior to undertaking any survey work a skills validation workshop and discussion took place between all participants at the Citizen Science Camps. Resources and reference material accessed included; Tracks, Scats and Other Traces (Triggs 2004), Gliders of Australia (Lindenmayer 2002), Spotlighting for Gliders (Wildlife Preservation Society of Queensland 2016), Gliding Possums (DPE webpage accessed 20th May), Survey Techniques for Citizen Scientists (NPA NSW 2014),

Key identification features discussed for the Southern Greater Glider (*Petauroides volans*) included:

- It is the largest gliding possum with a head and body length of 35 to 45cm and a long furry tail measuring 45 to 60cm.
- It has large ears with hair that projects past the outer ear edge.
- It has strongly reflective eyeshine in the beam of a spotlight making it easily detectable with an eye shine generally bright white.
- It is generally quiet with slow movements and prolonged periods of inactivity.
- Various colour morphs are possible, even within a population.

Key identification features discussed for the the Yellow-bellied glider (*Petaurus australis*) included:

- It is a large, active, sociable and vocal glider.
- Adults weigh 450-700 grams, have a head and body length of about 30cm and a large bushy tail that is about 45cm long.
- It has grey to brown fur above with a cream to yellow belly, which is paler in young animals and a characteristic dark stripe down the back.
- The dark stripe down the back is characteristic of the group.
- It has a large gliding membrane that extends from the wrist to the ankle.

Spotlight technique and animal ethics considerations discussed included:

- avoid prolonged exposure to the light (i.e. more than two minutes);
- use a light with a narrow beam; and
- when practical, use a red filter or, preferably, a dimmer switch to reduce light intensity for prolonged observations once the animal has been spotted.
- Survey with a low wattage light (30 to 50 w) and briefly use a narrow beam of brighter light for identification (SEWPAC 2011a).
- Risk of raptor predation.

4.1.3.2. Survey Method Details

The methods per survey measure employed in this study are detailed below:

a) Spotlight transect survey

These citizen science spotlight surveys aimed to generate species presence data across a broad area of Bulga SF (confined to the road and track network) that could;

- Provide reconnaissance information on Southern Greater Glider locations for a subsequent more detailed citizen science spotlight survey, under Forestry Permit (pending), employing a double observer distance sampling method (Cripps et al., 2021) so that estimates of Southern Greater Glider abundance could be more accurately modelled than the common strip transect and off-track distance sampling methods.

- Potentially inform the adequacy of FCNSW Southern Greater Glider protections measures within the Harvest Plan for Compartments 41 & 43 Bulga SF.

The first spotlight transect undertaken 29th May was Pole Dump Forest Road. This was conducted by foot by a team of four walking together, with the author operating as the principle spotlight surveyor using a Led Lenser H74 Core - 1000 lumen white light head torch (see below for the details of all spotlights used in these surveys). Following this the 311m Gomas Road transect was also undertaken on foot. For the purpose of covering more distance spotlighting was undertaken from within a dual cab vehicle ('Vehicle 1'), for the remaining transects on the 29th May.

To potentially increase detection rates 'Vehicle 2' was used for all other transects across subsequent survey nights (30h May, 3rd August and 4h August). 'Vehicle 2', a tray back dual cab 4WD allowed the principal spotlight surveyor to stand in the tray for full 360o spotlighting capability while vehicle passengers also spotlighted from their respective windows within approximate 90o horizontal and vertical arcs avoiding light crossover.

For the 4th August spotlight survey two surveyors (including the principle spotlight surveyor) undertook spotlighting from the tray of 'Vehicle 2' side by side, each spotlighting their side of the road (drivers or passengers side of the road).

Average vehicle speed measured from the vehicle's speedometer was between 3-6kms/hr for all transects. The vehicle was stopped once eye shine was detected, either adjacent to the roadside location of the animal or so the author could exit the vehicle and move on foot to the location or near the location to confirm the identification via 10x50 binoculars and take a GPS waypoint of the observed animal. Wherever possible the animal's distance was estimated from the road edge and direction estimated using the compass within the GPS.

Each animal recorded was a different animal and this was verified in the field between observers and by the principal surveyor who was the only recorder of detections for all surveys for data handling consistency and to ensure any duplication of detections was eliminated.

A Garmin GPSMAP66s was used to record locations of each animal detected. Survey tracks were recorded within the GPS together with Avenza Maps recording a track over a Topographic map

showing the road/track network and State Forest estate boundaries. GPS field data collected was subsequently converted to shapefile format and imported into ArcMap (ESRI ArcGIS 10.5).

The following spotlight equipment was used for these surveys:

- Led Lenser H74 Core - 1000 lumen head torch - white light
- Led Lenser H7R.2 - 300 lumen head torch - white light
- Led Lenser H15R Core - 2500 lumen head torch – white light
- Wanderer 430 – 430 lumen head torch – white light
- Vehicle connected 80w Halogen spotlight – identification confirmation only

Table 4: Spotlight transect survey details.

Transect Name	**29th May** Waxing Gibbous moon 64%- cloudy	**30th May** Waxing G bbous moon 73%-cloudy	**3rd August** Waning Gibbous moon 97%- cloudy	**4th August** Waning G bbous moon 92%- cloudy
	Method & Length & time			
Tallowood Flat Rd, Dingo SF	-	-	Vehicle 2 8 minutes 6.17-7.25pm	-
Pole Dump Forest Road	Walking 2934m 132minutes 5.13-7.25pm	-	Walking 2934m 76minutes 6.40-7.56pm	-
Blue Knob Forest Road	Vehicle 1 3581m 50minutes 7.26-8.16pm	-	Vehicle 2 3509m 88minutes 8.20-9.42pm	-
Knodingbul Road south of intersection with Blue Knob Forest Road	Vehicle 1 3984m 63minutes 8.16-9.19pm	-	Vehicle 2 3370m 53minutes 9.42-10.35pm	-
Gomas Road, off Blue Knob Forest Road (265m west of Pole Dump Forest Rd intersection)		Walking 311m 20minutes 5.30-5.50pm		Vehicle 2 1614m 30minutes 6.41-7.11pm
Double Link Road	-	Vehicle 2 1594m 42 minutes 6.20-7.02pm	-	Vehicle 2 1628m 51 minutes 7.29-8.20pm
Knodingbul Road past Blue Knob Forest Road intersection and section of Middle Ridge Road	-	Vehicle 2 2581m 77 minutes 7.11-8.28pm	-	Vehicle 2 2712m 66 minutes 8.34-9.40pm
Knodingbul Rd south of (420862, 6503840) 395m North of Old Blue Knob Rd to boundary of NP and small section of Padmans Rd.	-	Vehicle 2 5231*m 110 minutes 8.35- 10.25pm	-	Vehicle 2 4040m 65 minutes 10.04- 11.09pm

***30th May survey included a track section east side of Knodingbul Rd opp. Blackbutt Ridge Rd**				

b) Incidental Observation

This simply involved any passive observations either during the day or night. Incidental night observations consisted of;

- Southern Greater Glider detections in and around the stag watch location by a single volunteer following the stag watch for an hour.
- Observations made by volunteers while gaining photographs of fauna (outside of spotlight transect areas).
- Observations made by volunteers (single car) while undertaking Owl spotlight searchs. This occurred outside of spotlight transect areas.
- Observations made by transect spotlight team in transit between transect areas.

c) Stag watch survey

A limited stag-watch survey was undertaken by a single volunteer, experienced in Southern Greater Glider detection on the 3rd and 4th August centred on the Knodingbul Road Blackbutt Ridge Road intersection. At this location in the May survey Southern Greater Gliders were observed and >10 Giant Hollow-bearing Trees were identified within a 60m radius of the road junction enabling multiple trees to be checked. For 1 hour prior to dusk and approximately 1 hour after the Hollow-bearing trees were watched. This was repeated on the second night to confirm Den Tree identification.

Another citizen science stag watch on Saturday 2nd September on a single possible den tree beside Double Link Road (within Compartments 41-43) was able to confirm its status as a den tree with two Greater Gliders observed emerging from two hollows on the one Tallowood tree.

d) Koala Scat, secondary evidence searches and habitat assessments

On both days of each survey, two teams searched for potential Koala habitat, identified as vegetation with Tallowwood (*Eucalyptus microcorys*) and or Grey Gum (*Eucalyptus propinqua*/*punctata*/*canaliculata*) dominant, co-dominant or as a common associate. Within these locations, which were found by roadsides, Koala scats were searched for. Trees under which Koala scats were found, were located in the field with survey tape. In the afternoons of the 29th and 30th May these locations were visited by the author, together with the search team, and the Koala scat identification was confirmed, photos taken and the tree species and location recorded via GPS. These sites were checked again during the August survey. Where scratch evidence was present with Koala scats absent, these Grey Gums were located in the field using Avenza maps GPS and photos of trunk scratches taken of each tree for confirmation.

Limited day searches for habitat of Glossy-black Cockatoos, Parma Wallaby, Yellow-bellied Glider occurred during daytime general habitat assessment.

4.1.4. Limitations

As discussed before in 2.8.3.4. *Limitations of spotlight surveys in estimating population sizes* spotlight light surveys are known to underestimate the populations sizes of Southern Greater Gliders. This Citizen Science reconnaissance spotlight survey aimed to establish presence only data and to determine areas suitable for 1km walking double observer mark-recapture distance sampling method spotlight transects. The vehicle based transect employed is likely to have failed to detect a proportion of Southern Greater Gliders present in Bulga SF. In addition, the transects in this survey were not conducted 'quietly' as the vehicle was running most of the time. This would have excluded the opportunity to detect Yellow-bellied Gliders via their distinctive vocalisations and limited hearing the movement of any Southern Greater Gliders within foliage.

Individual gliders are not always visible as they may be obscured by thick foliage in the often high, tree canopy and even when close to the observer or overhead. In addition, as detection of Gliders during spotlight surveys mostly depends on detection of eye-shine, many individuals may go undetected if their orientation at the time the observer passes does not produce reflection of eye-shine (Cripps *et al*. 2018).

Despite this, the volume of Greater Gliders detected, including 14 detected in a 1km section of Knodingbul Road (within Compartments 41/43), suggest that it is likely a high-density population is present in Bulga SF.

4.2. Fauna Survey Results

4.2.1. Results of Threatened Fauna Survey

Table 5: Spotlight survey results summary table

	Southern Greater Glider	Koala	Powerful Owl	Masked Owl
29 h May Spotlight Transect Survey – 4hrs5mins total	12	Nil	Nil	Nil
30 h May Spotlight Transect Survey – 2hrs19mins total	22	3	Nil	Nil
3rd August Spotlight Transect Survey – 3hrs45mins total	21	Nil	Nil	Nil
4th August Spotlight Transect Survey – 2hrs27mins total	37	2	1	Nil
Incidental and Stag-watch observations across all surveys	19	1	Nil	1 (3rd August)
Southern Greater Glider Stag-watch survey - 3/4th August - Knodingbul Rd and Blackbutt Ridge Rd intersection area	2 Den trees confirmed. 1 likely.	-	-	-

Table 6: Fauna observations, scat search and secondary evidence recorded during the 29th/30th May Survey

Date / Time	COMMON NAME	EASTING	NORTHING	OBSERVATION TYPE	NOTES
Spotlight Survey					
29/05/2023 19:32:46	Southern Greater Glider	424292	6505941	Obs	dark phase colour morph
29/05/2023 19:39:02	Southern Greater Glider	424190	6505770	Obs	dark phase colour morph
29/05/2023 19:49:24	Southern Greater Glider	423977	6505667	Obs	dark phase colour morph
29/05/2023 19:54:20	Southern Greater Glider	423863	6505720	Obs	dark phase colour morph
29/05/2023 20:11:08	Southern Greater Glider	422273	6506090	Obs	dark phase colour morph
29/05/2023 20:28:05	Southern Greater Glider	421693	6505389	Obs	dark phase colour morph
29/05/2023 20:32:37	Southern Greater Glider	421577	6505361	Obs	dark phase colour morph
29/05/2023 20:42:04	Southern Greater Glider	421280	6505182	Obs	dark phase colour morph
29/05/2023 20:47:12	Southern Greater Glider	421149	6505104	Obs	dark phase colour morph
29/05/2023 21:21:20	Southern Greater Glider	420997	6504303	Obs	dark phase colour morph
29/05/2023 21:14:37	Southern Greater Glider	420883	6503858	Obs	2 individuals in adjoining trees, dark phase colour morph
30/05/2023 18:05:58	Southern Greater Glider	424274	6505903	Incidental Obs	dark phase colour morph
30/05/2023 18:28:54	Southern Greater Glider	423029	6505730	Obs	dark phase colour morph
30/05/2023 18:31:28	Southern Greater Glider	423041	6505735	Obs	dark phase colour morph
30/05/2023 18:35:12	Southern Greater Glider	422904	6505864	Obs	dark phase colour morph
30/05/2023 18:42:22	Southern Greater Glider	422878	6506060	Obs	dark phase colour morph
30/05/2023 19:00:47	Southern Greater Glider	422976	6506701	Obs	dark phase colour morph
30/05/2023 19:16:08	Southern Greater Glider	421947	6506015	Obs	dark phase colour morph
30/05/2023 19:28:17	Southern Greater Glider	421865	6506091	Obs	3 individuals in 3 adjoining large trees, identification dark phase colour morph
30/05/2023 19:34:02	Southern Greater Glider	421867	6506154	Obs	dark phase colour morph

Date / Time	COMMON NAME	EASTING	NORTHING	OBSERVATION TYPE	NOTES
30/05/2023 19:38:16	Southern Greater Glider	421883	6506211	Obs	dark phase colour morph
30/05/2023 19:53:31	Southern Greater Glider	421484	6506608	Obs	dark phase colour morph
30/05/2023 20:10:11	Southern Greater Glider	421589	6507103	Obs	dark phase colour morph
30/05/2023 20:16:27	Southern Greater Glider	421580	6507087	Obs	dark phase colour morph
30/05/2023 20:25:07	Southern Greater Glider	421614	6507181	Obs	dark phase colour morph
30/05/2023 20:43:55	Southern Greater Glider	421160	6505046	Obs	dark phase colour morph
30/05/2023 20:51:55	Southern Greater Glider	421107	6504837	Obs	dark phase colour morph
30/05/2023 21:34:32	Southern Greater Glider	420654	6503056	Obs	dark phase colour morph
30/05/2023 21:38:51	Southern Greater Glider	420658	6503065	Obs	dark phase colour morph
30/05/2023 21:59:52	Southern Greater Glider	420377	6501293	Obs	dark phase colour morph
30/05/2023 22:10:02	Southern Greater Glider	420344	6501157	Obs	2 individuals in separate trees, dark phase colour morph
30/05/2023 22:33:27	Southern Greater Glider	421546	6501685	Incidental Obs	dark phase colour morph
30/05/2023 21:01:05	Koala	421017	6504784	Obs	In young *Eucalyptus microcorys*
30/05/2023 21:22:57	Koala	420732	6503295	Obs	In young *Eucalyptus saligna* 4m east of road edge. Small animal likely female.
30/05/2023 10:17:30	Koala	420277	6500691	Obs	In *Eucalyptus microcorys* 3m NE from road edge, large animal, likely male.
29/05/2023 18:29:57	Common Ringtail Possum	424641	6504994	Obs	
29/05/2023 17:41:45	Common Brushtail Possum	423509	6504267	Obs	
30/05/2023 21:50:44	Common Brushtail Possum	420738	6502198	Obs	
Koala scat searches					
29/05/2023 00:00:00	Koala	422826	6501841	Scats	scat identification confirmed by consulting ecologist
29/05/2023 00:00:00	Koala	422857	6501909	Scats	scat identification confirmed by consulting ecologist

Date / Time	COMMON NAME	EASTING	NORTHING	OBSERVATION TYPE	NOTES
29/05/2023 00:00:00	Koala	422867	6501903	Scats	scat identification confirmed by consulting ecologist
29/05/2023 00:00:00	Koala	422954	6501975	Scats	scat identification confirmed by consulting ecologist
30/05/2023 00:00:00	Koala	423216	6504125	Scats	scat identification confirmed by consulting ecologist
30/05/2023 00:00:00	Koala	423267	6504229	Scats	scat identification confirmed by consulting ecologist
30/05/2023 00:00:00	Koala	423191	6504245	Scats	scat identification confirmed by consulting ecologist
30/05/2023 00:00:00	Koala	423189	6504261	Scats	scat identification confirmed by consulting ecologist
30/05/2023 00:00:00	Koala	423180	6504272	Scats	scat identification confirmed by consulting ecologist
30/05/2023 00:00:00	Koala	423251	6504217	Scats	scat identification confirmed by consulting ecologist
30/05/2023 00:00:00	Koala	423241	6504218	Scats	scat identification confirmed by consulting ecologist
30/05/2023 00:00:00	Koala	423270	6504272	Scats	scat identification confirmed by consulting ecologist
30/05/2023 00:00:00	Koala	423262	6504269	Scats	scat identification confirmed by consulting ecologist
30/05/2023 00:00:00	Koala	423176	6504118	Scats	scat identification confirmed by consulting ecologist
30/05/2023 00:00:00	Koala	423176	6504119	Scats	scat identification confirmed by consulting ecologist
30/05/2023 00:00:00	Koala	423170	6504129	Scats	scat identification confirmed by consulting ecologist
30/05/2023 00:00:00	Southern Greater Glider	421160	6505069	Scats	scat identification confirmed by consulting ecologist
30/05/2023 00:00:00	Southern Greater Glider	423199	6504109	Scats	scat identification confirmed by consulting ecologist

Table 7: Fauna observations, scat search and secondary evidence recorded during the 3rd/4th August Survey

Date / Time	COMMON NAME	EASTING	NORTHING	OBSERVATION TYPE	NOTES
Spotlight Survey					
03/08/2023 18:33:04	Southern Greater Glider	420252	6491643	Obs	dark phase colour morph
03/08/2023 18:40:17	Southern Greater Glider	420183	6491595	Obs	Greater Glider scats beneath large old growth tree >200cm DBH, with visible hollows, 2

Date / Time	COMMON NAME	EASTING	NORTHING	OBSERVATION TYPE	NOTES
					Greater Gliders in tree, likely den tree.
03/08/2023 20:33:57	Southern Greater Glider	424289	6505917	Obs	dark phase colour morph
03/08/2023 20:39:30	Southern Greater Glider	424227	6505805	Obs	dark phase colour morph
03/08/2023 20:44:43	Southern Greater Glider	424200	6505786	Obs	2 Greater Gliders in 2 separate trees close by, dark phase colour morph
03/08/2023 20:56:11	Southern Greater Glider	423870	6505679	Obs	dark phase colour morph
03/08/2023 21:05:55	Southern Greater Glider	423575	6505748	Obs	dark phase colour morph
03/08/2023 21:13:24	Southern Greater Glider	423269	6505762	Obs	dark phase colour morph
03/08/2023 21:21:21	Southern Greater Glider	422772	6505972	Obs	dark phase colour morph
03/08/2023 21:27:28	Southern Greater Glider	422609	6506043	Obs	dark phase colour morph
03/08/2023 21:32:52	Southern Greater Glider	422365	6506086	Obs	2 individuals in adjoining trees, dark phase colour morph
03/08/2023 21:36:25	Southern Greater Glider	422245	6506038	Obs	dark phase colour morph
03/08/2023 21:42:52	Southern Greater Glider	422209	6505997	Obs	dark phase colour morph
03/08/2023 21:55:20	Southern Greater Glider	422014	6505538	Obs	dark phase colour morph
03/08/2023 22:04:51	Southern Greater Glider	421598	6505355	Obs	dark phase colour morph
03/08/2023 22:12:27	Southern Greater Glider	421281	6505203	Obs	dark phase colour morph
03/08/2023 22:14:25	Southern Greater Glider	421277	6505171	Obs	dark phase colour morph
03/08/2023 22:26:26	Southern Greater Glider	421017	6504327	Obs	2 Greater Gliders in separate trees, dark phase colour morph
04/08/2023 18:54:39	Southern Greater Glider	424507	6506116	Obs	dark phase colour morph
04/08/2023 19:13:21	Southern Greater Glider	423903	6506122	Obs	dark phase colour morph
04/08/2023 19:39:39	Southern Greater Glider	423049	6505729	Obs	dark phase colour morph
04/08/2023 19:42:08	Southern Greater Glider	423009	6505761	Obs	dark phase colour morph
04/08/2023 19:47:02	Southern Greater Glider	422942	6505773	Obs	dark phase colour morph

Date / Time	COMMON NAME	EASTING	NORTHING	OBSERVATION TYPE	NOTES
04/08/2023 19:56:14	Southern Greater Glider	422886	6505915	Obs	dark phase colour morph
04/08/2023 20:29:38	Southern Greater Glider	423272	6505758	Incidental Obs	2 Greater Gliders in two trees spotted incidentally while locating Koala detection site. Dark phase colour morph
04/08/2023 20:37:11	Southern Greater Glider	421982	6506007	Obs	dark phase colour morph
04/08/2023 20:39:04	Southern Greater Glider	421948	6506003	Obs	2 individuals in separate trees, dark phase colour morph
04/08/2023 20:45:21	Southern Greater Glider	421877	6506199	Obs	dark phase colour morph
04/08/2023 20:56:31	Southern Greater Glider	421498	6506481	Obs	dark phase colour morph
04/08/2023 21:01:22	Southern Greater Glider	421506	6506471	Obs	dark phase colour morph
04/08/2023 21:02:09	Southern Greater Glider	421480	6506508	Obs	dark phase colour morph
04/08/2023 21:04:16	Southern Greater Glider	421478	6506580	Obs	dark phase colour morph
04/08/2023 21:05:58	Southern Greater Glider	421478	6506587	Obs	dark phase colour morph
04/08/2023 21:08:39	Southern Greater Glider	421513	6506630	Obs	dark phase colour morph
04/08/2023 21:09:26	Southern Greater Glider	421529	6506656	Obs	dark phase colour morph
04/08/2023 21:13:30	Southern Greater Glider	421561	6506689	Obs	dark phase colour morph
04/08/2023 21:20:39	Southern Greater Glider	421682	6506792	Obs	dark phase colour morph
04/08/2023 21:25:21	Southern Greater Glider	421682	6506938	Obs	dark phase colour morph
04/08/2023 21:30:59	Southern Greater Glider	421598	6507018	Obs	dark phase colour morph
04/08/2023 21:35:47	Southern Greater Glider	421598	6507125	Obs	dark phase colour morph
04/08/2023 21:38:45	Southern Greater Glider	421623	6507182	Obs	dark phase colour morph
04/08/2023 21:40:59	Southern Greater Glider	421620	6507188	Obs	dark phase colour morph
04/08/2023 22:05:40	Southern Greater Glider	420750	6503735	Obs	dark phase colour morph
04/08/2023 22:07:28	Southern Greater Glider	420751	6503587	Obs	dark phase colour morph
04/08/2023 22:11:00	Southern Greater Glider	420739	6503366	Obs	dark phase colour morph

Date / Time	COMMON NAME	EASTING	NORTHING	OBSERVATION TYPE	NOTES
04/08/2023 22:12:29	Southern Greater Glider	420744	6503357	Obs	dark phase colour morph
04/08/2023 22:17:52	Southern Greater Glider	420651	6503063	Obs	dark phase colour morph
04/08/2023 22:23:40	Southern Greater Glider	420633	6502751	Obs	dark phase colour morph
04/08/2023 22:29:59	Southern Greater Glider	420588	6502453	Obs	dark phase colour morph
04/08/2023 22:34:24	Southern Greater Glider	420743	6502072	Obs	dark phase colour morph
04/08/2023 22:41:53	Southern Greater Glider	420534	6501480	Obs	2 Greater Gliders in two separate trees, dark phase colour morph
04/08/2023 22:56:33	Southern Greater Glider	420343	6501159	Obs	dark phase colour morph
04/08/2023 23:02:54	Southern Greater Glider	420216	6500739	Obs	dark phase colour morph
04/08/2023 19:31:11	Koala	423261	6505757	Obs	Koala at 10m height in Tallowwood. Koala scats at base of tree.
04/08/2023 19:39:00	Koala	420998	6504753	Incidental Obs	Koala detected roadside via incidental spotlight survey.
04/08/2023 22:43:31	Koala	420540	6501473	Obs	Koala at 15m height in Blue Gum, eastern roadside Knodingbul Road 790m North of Padmans Road intersection.
04/08/2023 22:49:55	Powerful Owl	420355	6501260	Obs	Powerful Owl observed in tree for 5 minutes, perched at 12m height via spotlight beside Knodingbul Road opposite roadside clearing on opposite/western side of road.
03/08/2023 20:24:41	Common Brushtail Possum	424843	6505829	Obs	In roadside tree, identification confirmed via spotlight and 10x50 binoculars.
03/08/2023 00:00:00	Common Ringtail Possum	424433	6504957	Obs	Western side of road in vine covered small trees.
04/08/2023 21:31:13	Southern Boobook	421592	6507026	Heard Call	Heard call repeated in middle distance
03/08/2023 21:17:03	Southern Boobook	423101	6505708	Heard Call	Heard call repeated in middle distance
04/08/2023 20:05:16	Sugar Glider	422829	6506378	Obs	Identification confirmed via spotlight and 10x50 binoculars

Date / Time	COMMON NAME	EASTING	NORTHING	OBSERVATION TYPE	NOTES
03/08/2023 21:23:51	Masked Owl	421250	6506496	Obs	Perched in roadside tree. Visible for 30seconds. Large white and chestnut Tyto owl.
Stagwatch Results					
03/08/2023 18:15:00	Southern Greater Glider	421156	6505125	Incidental Stagwatch Obs	Den watch results. Greater Glider spotted on nightfall - not in Hbt. Den unconfirmed.
03/08/2023 00:00:00	Southern Greater Glider	424044	6504579	Incidental Stagwatch Obs	dark phase colour morph
03/08/2023 00:00:00	Southern Greater Glider	424003	6504553	Incidental Stagwatch Obs	dark phase colour morph
03/08/2023 00:00:00	Southern Greater Glider	424822	6505285	Incidental Stagwatch Obs	dark phase colour morph
04/08/2023 00:00:00	Southern Greater Glider	421128	6505111	Stagwatch Obs	Confirmed Greater Glider den tree via Stagwatch survey on dusk. Greater Glider observed leaving hollow of half dead fibrous barked Eucalypt. Dark phase colour morph
04/08/2023 00:00:00	Southern Greater Glider	421069	6505150	Stagwatch Obs	Confirmed Greater Glider den tree via Stagwatch survey on dusk. 2 Greater Gliders observed leaving hollow of Bloodwood on south side of Road. Dark phase colour morph
04/08/2023 00:00:00	Southern Greater Glider	421052	6505208	Incidental Stagwatch Obs	Incidental observation from Stagwatch survey. Greater Glider in *Allocasuarina torulosa* on North side of road. Dark phase colour morph
04/08/2023 00:00:00	Southern Greater Glider	420924	6505237	Incidental Stagwatch Obs	Incidental observation from Stagwatch survey. Greater Glider in large *Allocasuarina torulosa* 8m up steep hill. Dark phase colour morph
04/08/2023 00:00:00	Southern Greater Glider	421162	6505025	Incidental Stagwatch Obs	Incidental observation from Stagwatch survey. 2 Greater Gliders in large Hollow-bearing Tree observed after dusk. Likely den tree. Dark phase colour morph
04/08/2023 00:00:00	Southern Greater Glider	420938	6504845	Incidental Stagwatch Obs	Incidental observation from Stagwatch survey. 1 Greater Glider in large Tallowood beside Road, observed after

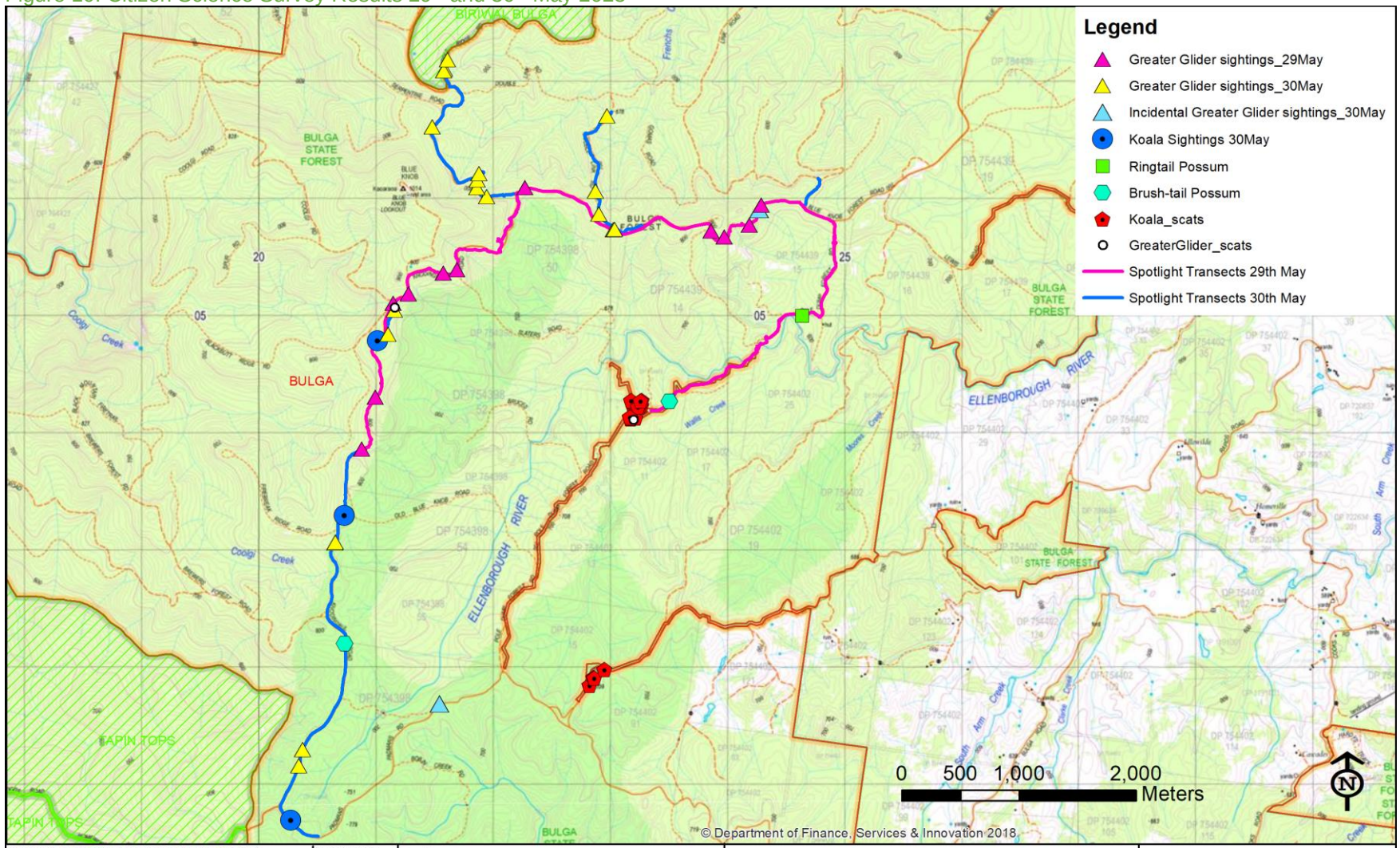
Date / Time	COMMON NAME	EASTING	NORTHING	OBSERVATION TYPE	NOTES
					dusk. Dark phase colour morph
02/09/2023 18:21	Southern Greater Glider	422901	6505858	Stagwatch Obs	Confirmed Greater Glider den tree via Stagwatch survey on dusk. 2 xGreater Glider observed leaving hollows in Tallowood beside Double Link Road.
Koala habitat, scat and secondary evidence searches					
3/08/2023 00:00:00	Koala	424920	6507993	Trunk scratches	Pock marked scratchings and longer rake marks consistent with Koala scratchings as described by Triggs 1996, on Grey Gums.
03/08/2023 00:00:00	Koala	424973	6507963	Trunk scratches	Pock marked scratchings and longer rake marks consistent with Koala scratchings as described by Triggs 1996, on Grey Gums.
03/08/2023 00:00:00	Koala	424967	6507979	Trunk scratches	Pock marked scratchings and longer rake marks consistent with Koala scratchings as described by Triggs 1996, on Grey Gums.
03/08/2023 00:00:00	Koala	424981	6507982	Trunk scratches	Pock marked scratchings and longer rake marks consistent with Koala scratchings as described by Triggs 1996, on Grey Gums.
03/08/2023 00:00:00	Koala	425011	6507982	Trunk scratches	Pock marked scratchings and longer rake marks consistent with Koala scratchings as described by Triggs 1996, on Grey Gums.
03/08/2023 00:00:00	Koala	425006	6508008	Trunk scratches	Pock marked scratchings and longer rake marks consistent with Koala scratchings as described by Triggs 1996, on Grey Gums.
03/08/2023 00:00:00	Koala	425015	6508011	Trunk scratches	Pock marked scratchings and longer rake marks consistent with Koala scratchings as described by Triggs 1996, on Grey Gums.
03/08/2023 00:00:00	Koala	425050	6507994	Trunk scratches	Pock marked scratchings and longer rake marks consistent with Koala scratchings as

Date / Time	COMMON NAME	EASTING	NORTHING	OBSERVATION TYPE	NOTES
					described by Triggs 1996, on Grey Gums.
03/08/2023 00:00:00	Koala	425041	6507989	Trunk scratches	Pock marked scratchings and longer rake marks consistent with Koala scratchings as described by Triggs 1996, on Grey Gums.
03/08/2023 00:00:00	Koala	425053	6507981	Trunk scratches	Pock marked scratchings and longer rake marks consistent with Koala scratchings as described by Triggs 1996, on Grey Gums.
03/08/2023 00:00:00	Koala	425040	6507971	Trunk scratches	Pock marked scratchings and longer rake marks consistent with Koala scratchings as described by Triggs 1996, on Grey Gums.
03/08/2023 00:00:00	Koala	425040	6507972	Trunk scratches	Pock marked scratchings and longer rake marks consistent with Koala scratchings as described by Triggs 1996, on Grey Gums.
03/08/2023 00:00:00	Koala	425040	6507972	Trunk scratches	Pock marked scratchings and longer rake marks consistent with Koala scratchings as described by Triggs 1996, on Grey Gums.
03/08/2023 00:00:00	Koala	424947	6507993	Trunk scratches	Pock marked scratchings and longer rake marks consistent with Koala scratchings as described by Triggs 1996, on Grey Gums.
03/08/2023 00:00:00	Koala	425040	6507972	Trunk scratches	Pock marked scratchings and longer rake marks consistent with Koala scratchings as described by Triggs 1996, on Grey Gums.
03/08/2023 00:00:00	Koala	424953	6507958	Trunk scratches	Pock marked scratchings and longer rake marks consistent with Koala scratchings as described by Triggs 1996, on Grey Gums.
03/08/2023 00:00:00	Koala	425040	6507972	Trunk scratches	Pock marked scratchings and longer rake marks consistent with Koala scratchings as described by Triggs 1996, on Grey Gums.

Date / Time	COMMON NAME	EASTING	NORTHING	OBSERVATION TYPE	NOTES
Miscellaneous incidental observations					
03/08/2023 21:10:07	Southern Greater Glider	424849	6505060	Incidental Observation	Incidental sighting
03/08/2023 20:54:10	Southern Greater Glider	422705	6505970	Incidental Observation	Incidental sighting
03/08/2023 20:39:47	Southern Greater Glider	422137	6505800	Incidental Observation	Incidental sighting
03/08/2023 20:09:07	Southern Greater Glider	421272	6506530	Incidental Observation	Incidental sighting
13/08/2023 00:00:00	Koala	420716	6503307	Incidental Observation	Incidental sighting of Koala roadside near previous sighting location.
04/08/2023 13:21:07	Southern Greater Glider	420572	6500581	Scats	Greater Glider scats under roadside Tallowwood

Photo: 11 detections were made of 2 or more Greater Gliders -in the same tree or adjoining trees.

Figure 10: Citizen Science Survey Results 29th and 30th May 2023



This mapping should be considered indicative only and all derivations (eg of areas of EECs and vegetation communities) are at best approximations and subject to errors including individual interpretation and reliance on information provided to Bolwarra Environmental Services (BES) which may not have been independently verified. All information is intended to be indicative only and no reliance for extrapolation, mapping, etc should be placed upon this map without independent validation of the information by the user. BES takes no responsibility for any subsequent errors, losses, etc that may arise from use of this data without independent verification.

Project Manager: MB	Figure Name: Citizen Science Volunteer Survey Bulga SF 29th & 30th May 2023
Drawn By: MB	
Date: 15/08/2023	Site: Bulga SF
Map Projection: MGAz56	
Map Datum: GDA94	Client: N/A
Page: 1 of 1	

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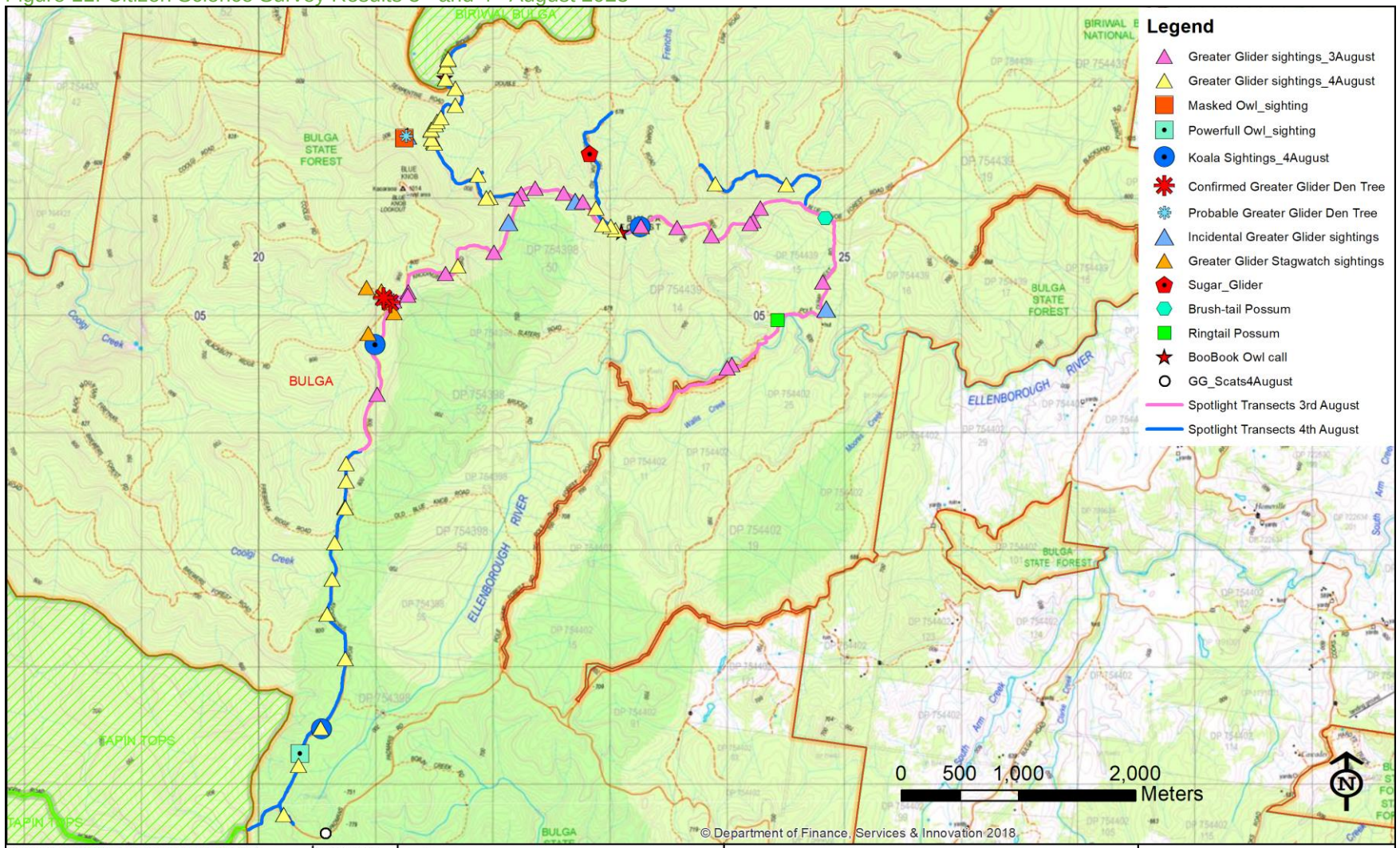
Scale:	Job Number:	Revision:
1 :40,000	xx	A

Figure 11: Citizen Science Survey Results 3rd and 4th August 2023



This mapping should be considered indicative only and all derivations (eg of areas of EECs and vegetation communities) are at best approximations and subject to errors including individual interpretation and reliance on information provided to Bolwarra Environmental Services (BES) which may not have been independently verified. All information is intended to be indicative only and no reliance for extrapolation, mapping, etc should be placed upon this map without independent validation of the information by the user. BES takes no responsibility for any subsequent errors, losses, etc that may arise from use of this data without independent verification.

Project Manager: MB	Figure Name: Citizen Science Volunteer Survey Bulga SF 3rd & 4th August 2023
Drawn By: MB	
Date: 15/08/2023	Site: Bulga SF
Map Projection: MGAz56	
Map Datum: GDA94	Client: N/A
Page: 1 of 1	

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Scale:	Job Number:	Revision:
1 :40,000	xx	A

Figure 12: Citizen Science Survey Results Koala secondary evidence 3rd and 4th August 2023

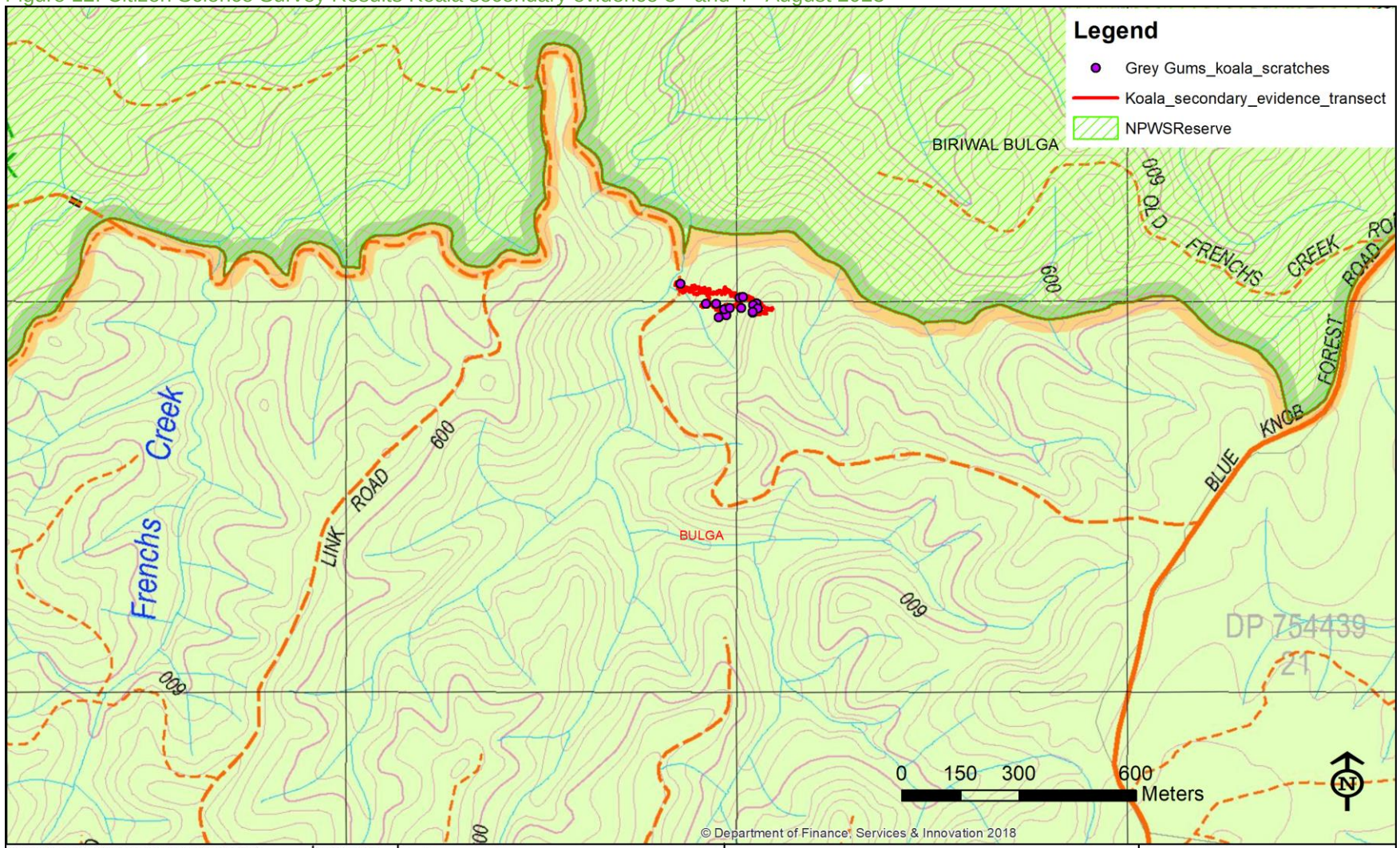
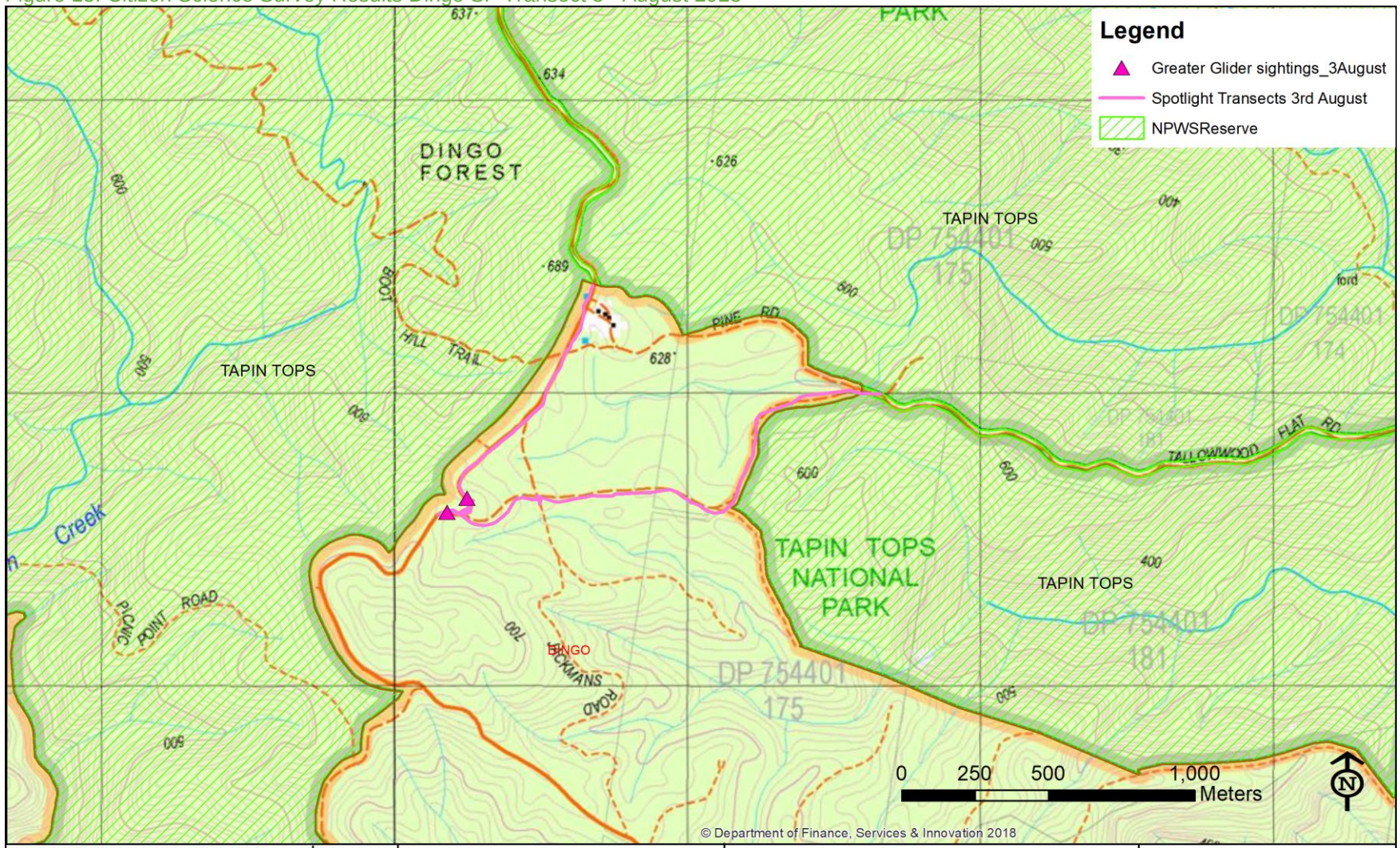


Figure 13: Citizen Science Survey Results Dingo SF Transect 3rd August 2023



This mapping should be considered indicative only and all derivations (eg of areas of EECs and vegetation communities) are at best approximations and subject to errors including individual interpretation and reliance on information provided to Bolwarra Environmental Services (BES) which may not have been independently verified. All information is intended to be indicative only and no reliance for extrapolation, mapping, etc should be placed upon this map without independent validation of the information by the user. BES takes no responsibility for any subsequent errors, losses, etc that may arise from use of this data without independent verification.

Project Manager:	MB
Drawn By:	MB
Date:	15/08/2023
Map Projection:	MGAz56
Map Datum:	GDA94
Page:	1 of 1
Figure Name:	Citizen Science Volunteer Survey Dingo SF 3rd August 2023
Site:	Dingo SF
Client:	N/A

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Scale:	Job Number:	Revision:
1 :16,000	xx	A

Photo below: Koala scats found beneath Tallowood. Slaters Road, Bulga SF.

Photo below: 1 of 17 Grey Gums with typical Koala scratching, near to Compartments 41-43.

Photo: Giant New England Blackbutt, >2m DSHOB - Bulga SF.

4.2.2. Results Discussion

4.2.2.1. Gliders

Southern Greater Gliders were observed on all spotlight survey nights (see *Table 5. Spotlight survey results summary table*), with a total of ninety-two recorded across the four spotlight transect nights and another nineteen incidental recordings over the four nights. They were easily detected with bright white eye shine (some animals showed a pale yellow/orange eye shine) where this could be seen (ie not obscured by foliage). Identification out to 50m from the road edge was often possible via 10 x 50 binoculars, with the large, furred ears, white ventral surface including throat and long dark tails clearly discernable when not obscured by foliage. However, in general, detectability of Greater Gliders >30m from the road edge diminished due to foliage obscuring eye shine and Greater Gliders actively moving into dense foliage away from light. Many observations were made within 15m of the road edge with gliders sitting more or less still for extended periods allowing detailed observation by the spotlight team. All citizen science participants (separate to the spotlight team) were also able to easily observe, photograph and video these roadside Greater Gliders. All Southern Greater Gliders observed were the dark colour morph (dark brown/black fur with white ventral surface including throat).

Start and finish times, distances etc. are shown in Table 4. *Spotlight transect survey details*. Higher volumes of observations tended to occur >1hour after dusk. Clusters of Southern Greater Gliders were often observed; three <20m apart in adjoining trees, pairs within the same tree and clusters of 2 - 4 within 60m. These cluster observations may be a result of an increase in detectability as the survey vehicle was stopped allowing more thorough spotlighting of those locations. Across all four spotlight survey nights bright white eyeshine was observed out past approximately 50m from the road edge. These animals could not be seen clearly through binoculars and were not recorded though were likely to be Greater Gliders. Bright white eye shine was also observed <50m from the road edge multiple times however the animals moved into foliage before confirmation on identification could be made via binoculars. Across all nights both classes of observations not recorded (>50m from road edge and < 50m from road edge foliage obscured), that were unable to be confirmed via binoculars, totalled > 20 animals (likely Southern Greater Gliders). Figures 9, 10 and 12 show the distribution of Southern Greater Glider spotlight records.

The aggregations of detections along the 30th and 31st May survey transects may be partly attributable to the survey occurring at the end of the breeding season which is restricted to a very brief period in February-May for Southern Greater Gliders (Harris & Maloney, 2010). However, the repeated spotlight transects surveyed on the 3rd and 4th August, outside of the breeding season, show similar aggregations or clusters of detections and are indicative of a higher density population.

Southern Greater Gliders were observed in the following tree species: *Eucalyptus acmenoides*, *Eucalyptus pilularis*, *Eucalyptus campanulata*, *Eucalyptus obliqua*, *Eucalyptus saligna*, *Eucalyptus microcorys*, *Lophostemon confertus*, *Corymbia intermedia*, *Allocasuarina torulosa* and within *Parsonsia straminea* vine shrouding. A specific study within Bulga SF to understand the preferred Glider feed trees is urgently needed so that the impacts on the local population of Southern Greater Gliders of harvesting certain tree species can be understood.

Two Southern Greater Glider den trees were recorded as a result of a stag watch survey on the 3/4th August at the Knodingbul Rd and Blackbutt Ridge Rd intersection area. A pair of Gliders was seen leaving one hollow in a Bloodwood and another observed leaving a hollow in a rough barked

Eucalypt. Greater Glider scats were identified under multiple trees. As Greater Gliders are known to defecate upon leaving den hollows these are possibly also den trees. Old growth trees with multiple large and mid-sized hollows are abundant within Bulga SF, particularly in and around Compartments 41 and 43, the northern portion of Knodingbul Road and Blue Knob Forest Road. A Survey effort focusing on stag watch surveys would be highly likely to yield a high number of den trees recorded. Demonstrating this, a single citizen science stag watch on Saturday 2nd September at a possible den tree on Double Link Road (within Compartments 41-43) was able to confirm its status as a den tree with two Greater Gliders observed emerging from two hollows on the one Tallowood tree. It is clear that the identification of den trees is a simple function of applied survey effort.

The higher number of observations on the 4th August is attributed to the transect locations but also utilising two spotlight surveyors (including the principle spotlight surveyor) spotlighting from the tray of 'Vehicle 2' side by side, each spotlighting their side of the road (drivers or passengers side of the road). For our vehicle-based Glider spotlighting this is considered the optimal method for detection, though further refinements in technique would likely yield improved detection rates.

There are eighty-three Bionet Southern Greater Glider record within Compartments 41-43 and surrounds (based on a 1700m buffer area from the approximate centre of Compartments 41 and 43, see Figure 14). Of these eighty-three records, fifty-six records come from this 2023 Citizen Science survey and twenty-four are FCNSW records (2016 and 2014). Based on these Southern Greater Glider Bionet records it appears that FCNSW, prior to the finalisation of the Compartment 41-43 Harvest Plan, either did not undertake any Glider surveys or none were detected. Either explanation is inexplicable given the obvious high quality habitat present across multiple criteria for the Southern Greater Glider.

Nil Yellow-bellied Gliders were detected and this is attributed to;

1. The survey method - which involved a vehicle motor running, this coupled with a team of four was sub-optimal for being able to hear Yellow-bellied Glider vocalisations.
2. No call playback was played.
3. The roadside habitat surveyed was not preferred. Most previous Bionet records of Yellow-bellied Glider are located away from the areas we surveyed.
4. Yellow-bellied Gliders have a large home range.

4.2.2.2. Koala

Three Koalas were recorded on the 30th May spotlight transect survey and two on the 4h August spotlight transect survey (see Figures 9 and 10 Citizen Science Survey Results). Another Koala was recorded on the 4th August at a separate location (non-duplicate) to the two recorded during the spotlight transect. This was recorded by a citizen science group while filming Southern Greater Gliders beside Knodingbul Road.

16 Koala scat locations were recorded at two clusters on the 29th and 30th May;

1. Rapids Road off Padmans Road;
2. Slaters Road off Pole Dump Road

A cluster of 17 Grey Gums with Koala scratch marks were recorded near Frenchs Creek Bridge Road, within 1.5kms of Compartments 41-43 on the 3rd August.

There are three Koala records shown on the Compartment 41-43 Harvest Plan. Five Koala records are present within a 1700m buffer area from the approximate centre of Compartments 41 and 43 (see Figure 14). These records are restricted to road edges and some tracks.

Tallowwood, a primary Koala Feed Tree, occurs commonly through much of Bulga SF both as a dominant canopy species and as a common associate in multiple Plant Community Types present. Tallowwood is a common occurrence within and near to Compartments 41 and 43. The presence of Tallowwood is an important predictor of Koala distribution and comprises an important habitat resource within Compartment 41 & 43 and Bulga SF. It is also a target timber species for logging by FCNSW.

Koalas are widely distributed within Bulga SF with 176 records (See Figure 15.), though records are biased towards the road and track network where surveys have been undertaken. Bulga SF and the surrounding area has a high concentration of Koala records relative to its escarpment landscape position. A significant portion of Bulga SF was unburnt in the 2019-20 catastrophic fires (see Figures 15 & 16) and represents one of the few upland areas to remain unburnt. Bulga SF is a critical forest link between National Park estate to the north and south and between upland and lowland populations. Figure 16 shows distribution of Koala records across the wider region.

4.2.2.3. Forest Owls

Three species of large forest owls (Powerful Owl, Sooty Owl and Masked Owl) occur in Bulga SF (Table 2: Bulga State Forest Bionet threatened species records). The Southern Greater Glider is regarded as an important prey item for the Powerful Owl and Sooty Owl (Bilney *et al*. 2011), with Masked Owls favoring terrestrial mammals. These forest owl species are heavily reliant on old growth trees with hollows for breeding and respond negatively to logging pressure. Bulga SF currently offers high value Owl habitat and isolation from the threat of secondary poisoning via the baiting of prey items such as mice and rats within agriculture and farming districts.

A Masked Owl was observed during a general night spotlight survey near Compartments 41-43, 215m west off Knodingbul Rd. It was able to be clearly distinguished from the much smaller Barn Owl due to its large body size, large feet and feathered, robust legs. A Powerful Owl was also observed during the 4th August Spotlight transect beside Knodingbul Road. The Powerful Owl was easily identifiable and perched for 5 or so minutes in a small tree approximately 20m from the vehicle. A single FCNSW Sooty Owl record on BioNet is located within Compartments 41-43.

Figure 17 shows the location of Bionet Forest Owl records within the Bulga SF focus area. Of the Forest Owls, Sooty Owls have the greater number of records, spanning from 1991 to 2017. This suggests a stable, significant population which likely reflects the high-quality habitat present and availability of resources in the form of;

- A mix of Rainforest and Wet Sclerophyll vegetation with deep gullies/ravines within a heavily dissected landscape.
- Abundant Old growth trees and large hollows.
- A significant portion of Bulga SF remained unburnt in the 2019-20 fires and what did burn mostly fell into the low and medium fire severity categories. See Figures 8 & 17.

- Abundant food resources, ie. mid to high density Glider population.

4.2.2.4. Parma Wallaby

Parma Wallaby is a threatened species of small macropod with 7 records in Compartments 41-43 of Bulga SF and 9 within a 1700m buffer from the approximate centre of Compartments 41-43. Figure 17 shows records of Parma Wallaby within Bulga SF relative to the 2019-2020 Fire Extent & Severity Mapping. There are 40 records in total for Parma Wallaby within Bulga SF. Parma Wallaby prefers a mix of wet and dry forest with dense undergrowth which is present within Bulga SF. The suitability of habitat within Bulga SF is evident by the high number of records of Parma Wallaby.

4.2.2.5. Glossy-black Cockatoo

Limited searches were made for the presence of Glossy Black-cockatoo feed trees. At the time of searching very few trees were producing cones, so it was not possible to ascertain whether there were feeding sites. However, it was noted that throughout Bulga SF, particularly on upper ridge areas and slopes with a north to western aspect very dense stands of *Allocasuarina torulosa* were present. These are likely be an important food source given the Bionet records of Glossy Black-cockatoos within Bulga SF and should be verified when trees are bearing cones. One record for Glossy-black Cockatoo is shown on the Compartments 41-43 Harvest Plan map (See Figure 2.)

4.2.2.6. Other threatened species

In addition to the three Koala records, one Glossy-black Cockatoo record and two Den trees there are three Stuttering Frog records within Compartments 41-43 on the Harvest Plan with a Spotted-tail Quoll record also present but located within the adjoining Biriwal-Bulga National Park.

In addition to these species the Bionet Wildlife Atlas records Sooty Owl, Masked Owl, Southern Greater Glider, Yellow-bellied Glider, Parma Wallaby, Golden-tipped Bat, Eastern False Pipistrelle and Davies Tree Frog for the comparable shown on the Compartments 41-43 Harvest Plan. Habitat investigations undertaken in this citizen science survey confirmed that Compartments 41-43 represent habitat for all these Bionet recorded species but also potential habitat for threatened species such as Long-nosed Potoroo, Red-legged Pademelon and Powerful Owl.

Figure 14: Threatened Species records relative to Compartments 41-43 Harvest Plan, Bulga SF

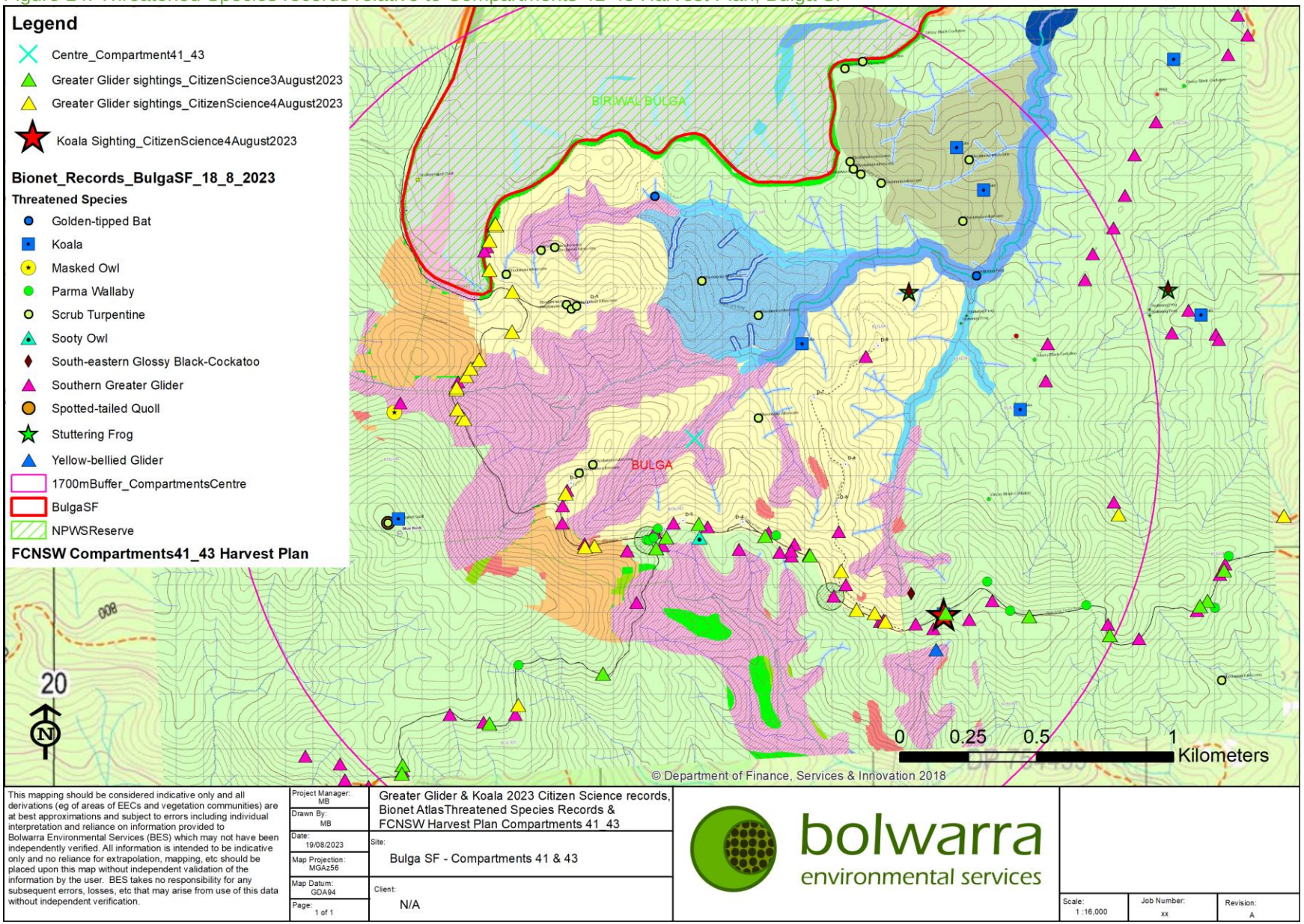


Figure 15: Bionet records for threatened Glider species in Bulga SF relative to 2019-20 Fire Extent & Severity Mapping

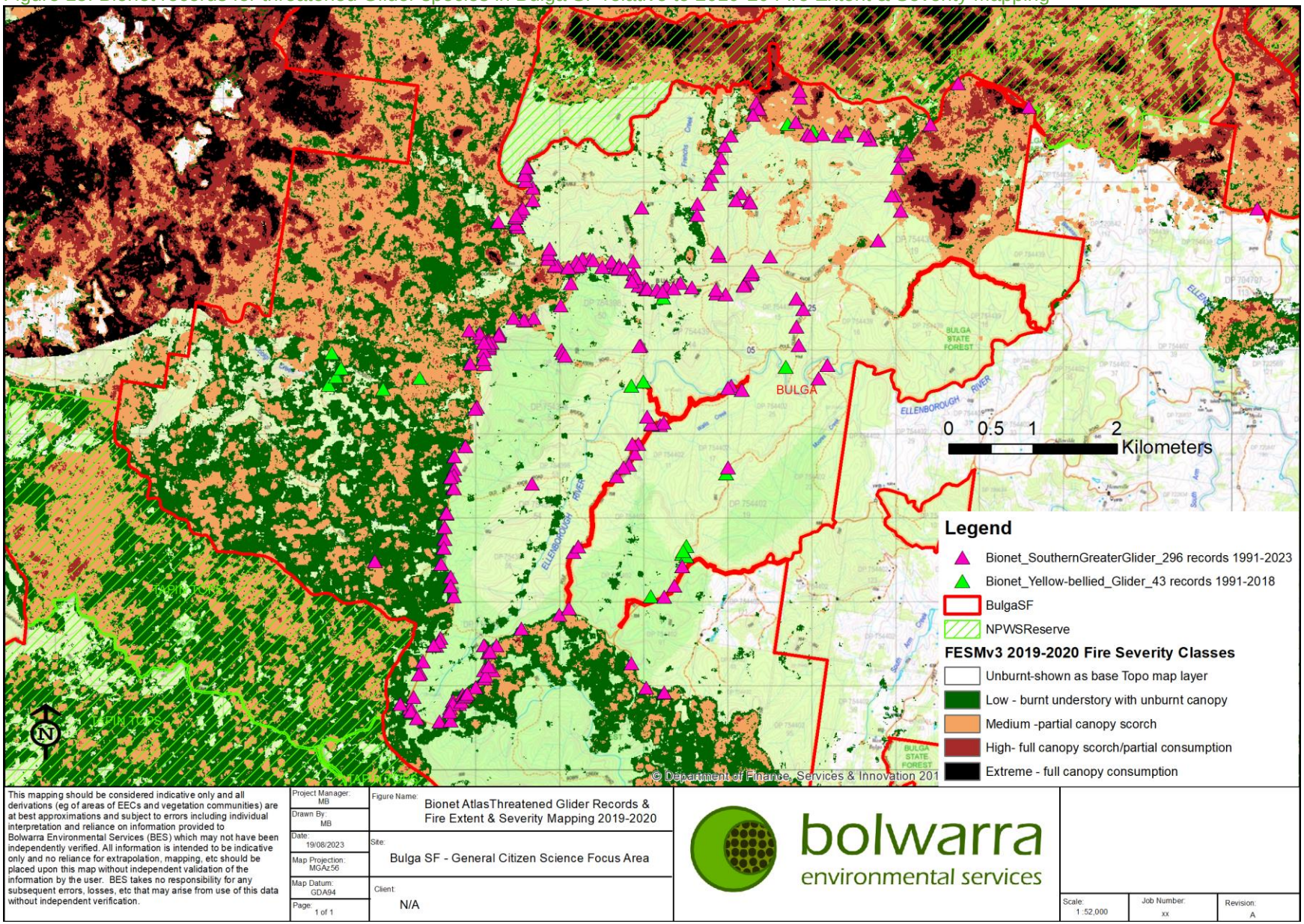


Figure 16: Bionet records for Koala in Bulga SF relative to 2019-20 Fire Extent & Severity Mapping

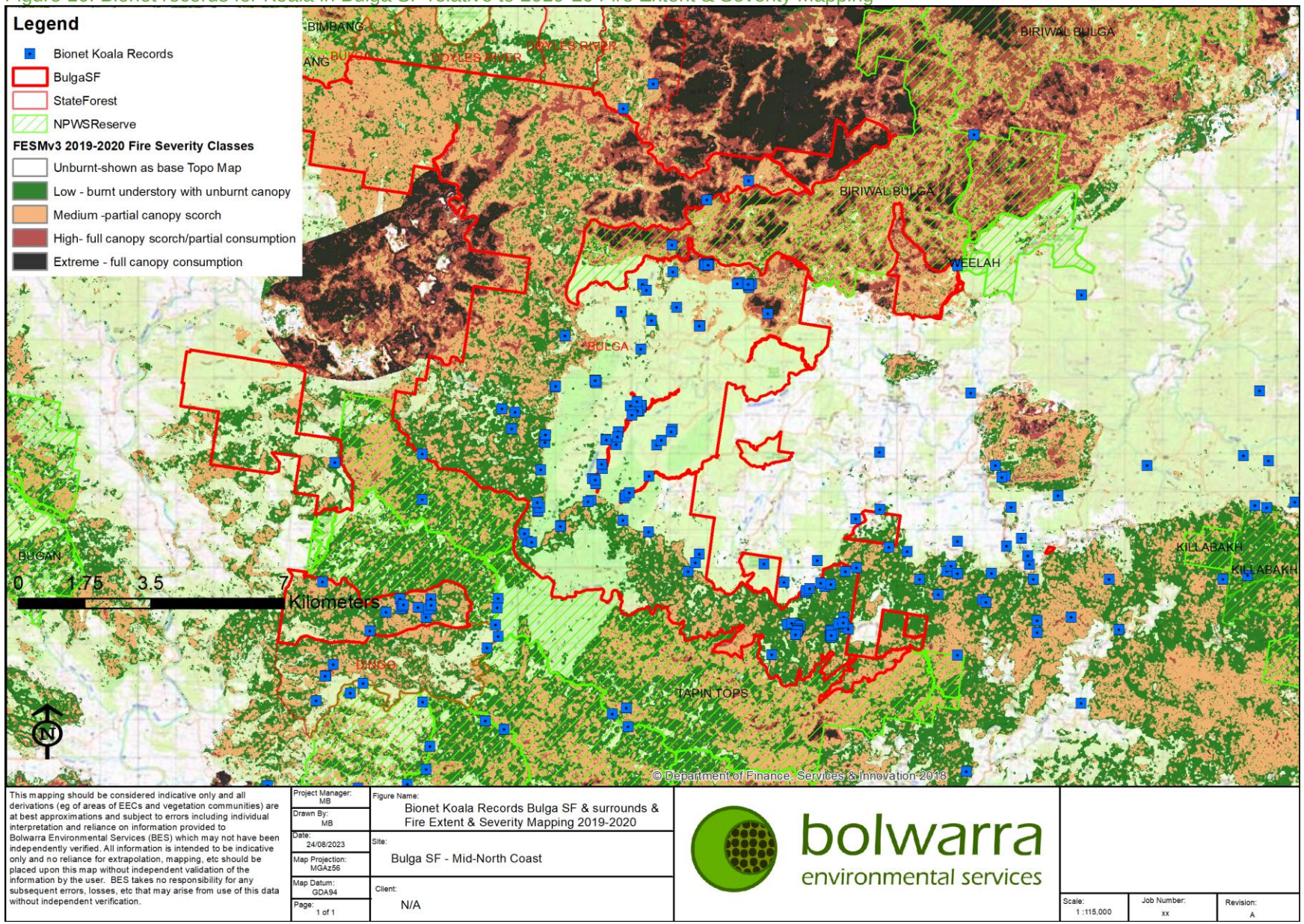
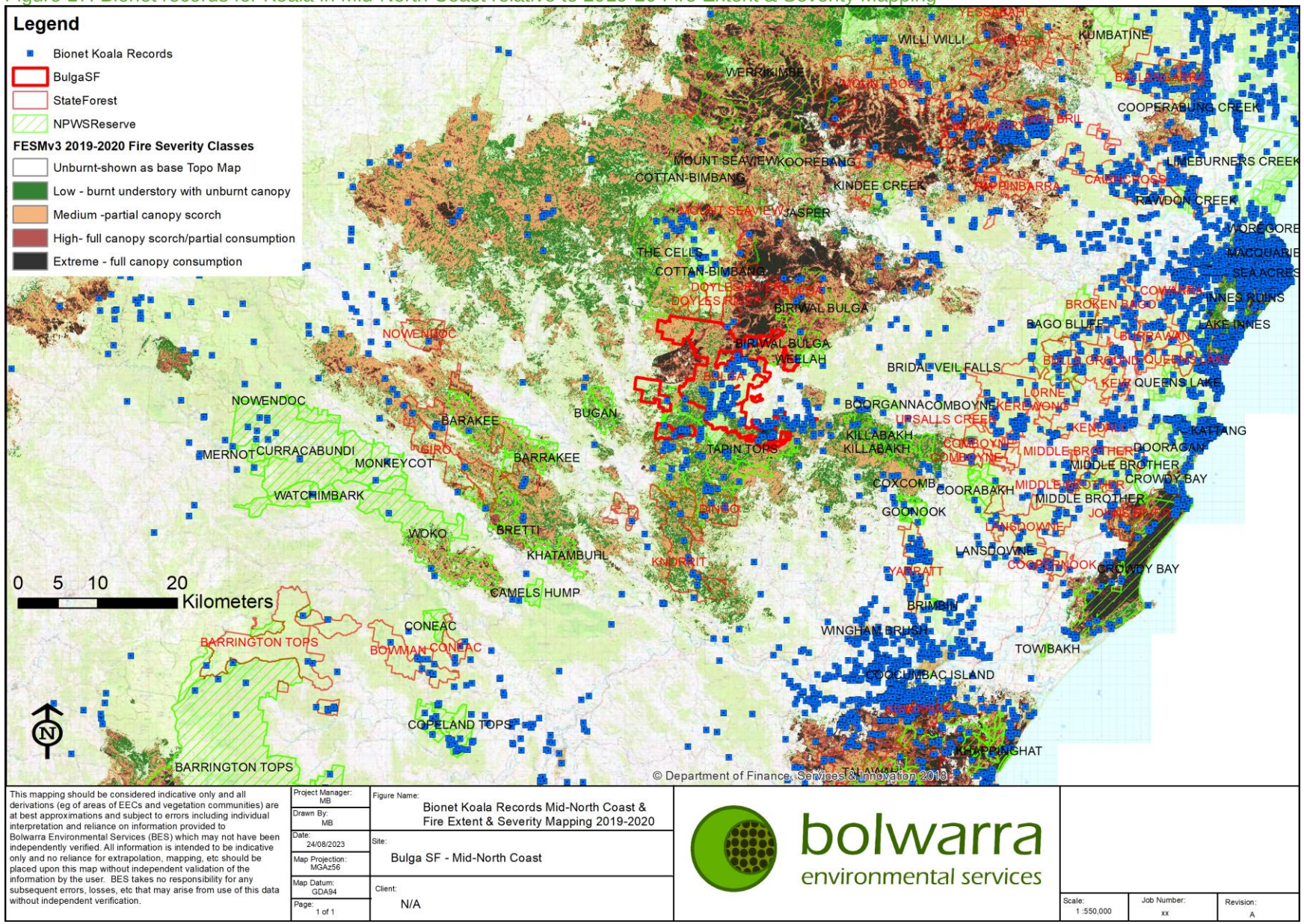


Figure 17: Bionet records for Koala in Mid-North Coast relative to 2019-20 Fire Extent & Severity Mapping



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Project Manager: MB	Figure Name: Bionet Koala Records Mid-North Coast & Fire Extent & Severity Mapping 2019-2020
Drawn By: MB	
Date: 24/08/2023	Site: Bulga SF - Mid-North Coast
Map Projection: MGAz56	
Map Datum: GDA94	Client: N/A
Page: 1 of 1	

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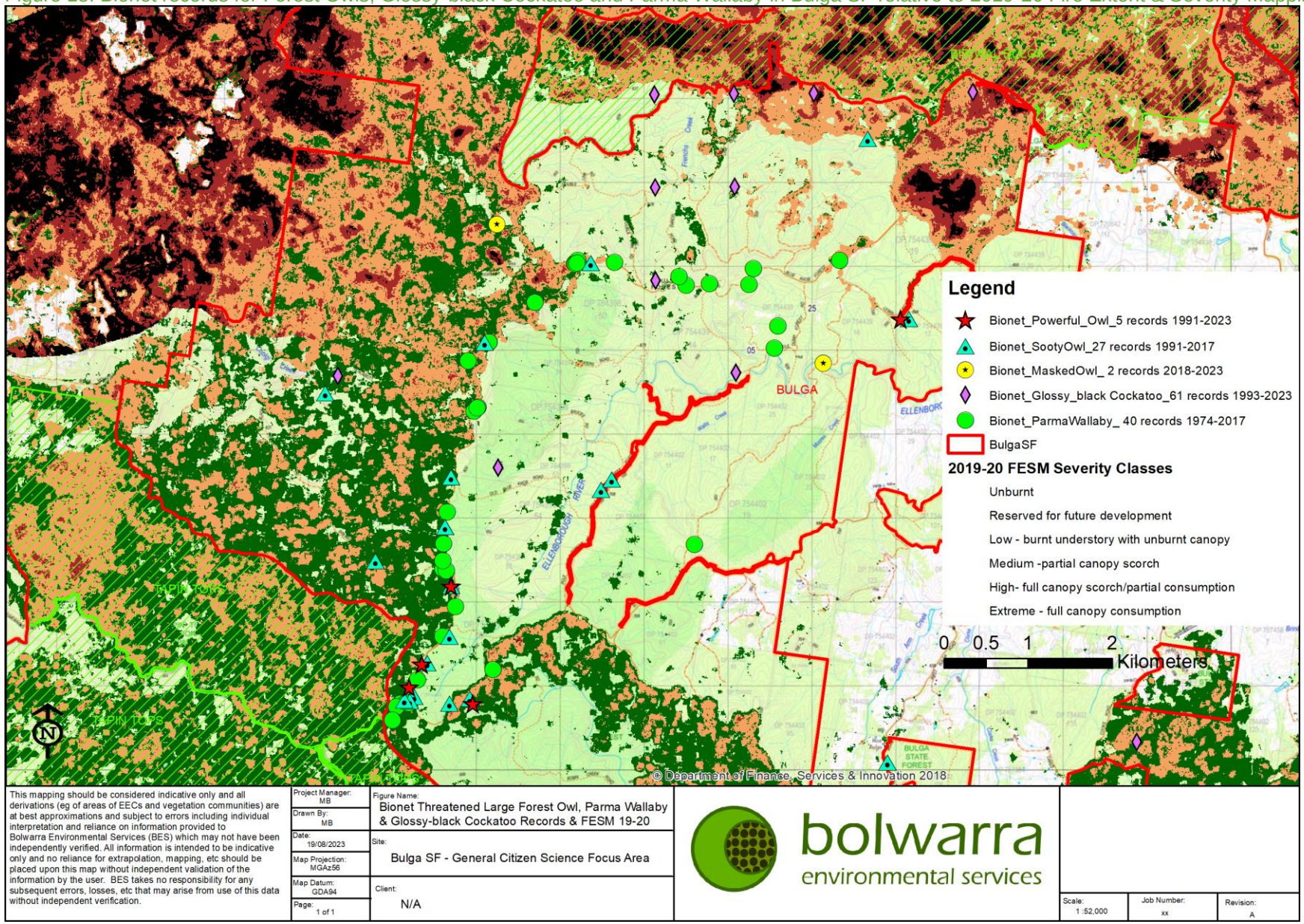
Figure 18: Bionet records for Forest Owls, Glossy-black Cockatoo and Parma Wallaby in Bulga SF relative to 2019-20 Fire Extent & Severity Mapping



5.0 Discussion

The results of this survey and Bionet database searches reveal an enormous lack of meaningful, detailed, prescriptive measures by FCNSW. Condition 15 of the CIFOA approval gives the specific objectives as follows:

15.1 In relation to threatened species conservation and biodiversity, the approval has the following specific objectives:

(a) to set out the minimum measures required to be implemented to protect species, communities and their habitats from the impacts of forestry operations.

(b) to set out multi-scale protection measures that ensure sufficient and adequate habitat is provided at the site, local landscape area, and management zone scales; and

(c) to set out measures for species or communities that require specific measures to ensure habitat is protected around known occurrences.

5.1. Southern Greater Glider

Despite the low detection rates of Greater Gliders in spotlight surveys reported by Cripps *et al.* (2018) of 21% and Lindenmeyer *et al*. (2001) of 26% this citizen science survey was able to detect 14 Southern Greater Gliders, recorded and verified by a single observer (this author) in a 1km section of vehicle based transect within Compartments 41-43 on the 4th August 2023. Across the two nights in May and two nights in August of this limited citizen science survey, initially planned as a simple reconnaissance survey, a surprising high total of ninety-two Southern Greater Glider detections were made and another 19 incidental detections. These results indicate that it is likely a high-density population of the Endangered Southern Greater Glider is present in Bulga SF.

Bulga SF is a high altitude (>500m asl), high rainfall, cool climate landscape with diverse geology producing a diverse range of high nutrient soils. Within this landscape, predominantly composed of Wet Sclerophyll Forest, a diversity of Eucalypts are present, of which many are known to be important Greater Glider feed tree species. Of immense value within Bulga SF is the abundance of giant, old growth trees with multiple large hollows. This habitat meets all the important habitat criteria for Southern Greater Gliders and importantly a significant portion of Bulga SF was unburnt in the 2019-2020 mega fire. Given the spotlight results and the high suitability of the habitat present within Bulga SF it is likely Bulga SF represents an important refugia and stronghold for the Southern Greater Glider within the lower mid north coast of NSW.

Despite this and the fact the Southern Greater Glider is a listed as Endangered under both State and Commonwealth legislation and is estimated to have undergone a large reduction in population size of 47% over the last 21 years (DPE 2022), logging is planned within this important unburnt refugia of Bulga SF. For the Southern Greater Glider (and Yellow-bellied Glider) it is difficult to see how the above objectives within Condition 15 of the CIFOA could be met with the current protocols. Condition 57 of the CIFOA requires broad area searches to be made for nest, roost and den trees. Yet there is no requirement to search actively for gliders. Den trees for gliders can only be reliably detected at night or pre-dawn and although the broad area search logs for this harvest plan were not accessed, it is doubtful whether active night-time searching occurred. Yellow-bellied Glider den tree detection is difficult, considerable survey effort would be required to reliably ascertain this information. For Southern

Greater Gliders den tree detection is a relatively easy proposition as demonstrated by the results from the very limited stag watch effort applied in this citizen science survey.

The clearest evidence of the failure of this protocol is that only a mere two den trees have been identified for protection within the Compartment 41-43 Harvest Plan.

For Southern Greater Glider, home-range estimates are typically 1.2-4.1 ha. Typically, 4-20 different dens are used by individual animals within their home range (Harris & Maloney, 2010). Southern Greater Glider densities can range between 0.5 to 3.8 gliders per hectare (Harris & Maloney, 2010) and up to 5/ha (Lindenmeyer 2002). Within the Wet Sclerophyll habitat, it is likely that Southern Greater Gliders do not have to travel far to access food resources given the abundance of preferred feed tree species present in Bulga SF. This Wet Sclerophyll habitat occurs with Rainforest habitats in Bulga SF, forming a matrix of suitable and unsuitable habitat. Such landscape habitat patterns typically give rise to smaller, over lapping home ranges and higher densities for Southern Greater Gliders (Lindenmeyer 2002).

Southern Greater Gliders exhibit den swapping behaviour and within a 1-2 ha home range of an individual 4-20 den trees are used. Considering it is likely there is a high-density population (>2.5 individuals/ha) the den tree requirement per hectare for Greater Gliders is likely to be high in Bulga SF (>20 den trees/ha). However, the Harvest Plan for Compartments 41-43 provide for a retention of 8 Hollow-bearing trees per hectare to be retained for all hollow dependant species, not just the Greater Glider. It also takes no account of feed trees, no account of recruiting mature trees into the future population of hollow-bearing trees and no assessment of whether the hollow-bearing trees are suitable den trees for either glider species or any species. However the clearest failure to meet Condition 15 of the CIFOA is that just two den trees have been identified for protection within the Compartment 41-43 Harvest Plan .

With a very limited survey effort in this limited citizen science survey two den trees were able to be confirmed with several others likely in one stag watch location outside of Compartments 41-43. Another den tree was confirmed within Compartments 41-43 at a later (September) single location stag watch. During the limited general habitat assessment in this survey Greater Glider scats were found beneath multiple trees. These are also likely den trees as Greater Gliders are known to defecate upon leaving den hollows (Trigg 2004). Fifty-six detections of Southern Greater Glider were gained in total over the 4 nights, 24 detections alone on 4th August within Compartments 41-43 of this citizen science spotlight survey. These results are likely to be underestimations of the population present. Given these results it is unfathomable that only two den trees have been able to be identified for protection by FCNSW within this same area. This is a severe under representation of the den trees that would be required by the Greater Gliders present within Compartments 41-43 and suggests a severe lack of due diligence and disregard for the precautionary principle by FCNSW.

With only two den trees identified for protection and 8 Hollow-bearing trees/ha to be retained within Compartments 41-43, which hold a high proportion of old growth giant trees, den tree damage and destruction will be unavoidable during logging operations. While Compartments 41-43 Harvest Plan identifies a limited Koala protocol – "*If a koala is located in a tree, an exclusion zone with a radius of 25m or greater must be retained around the tree. HC must be contacted. The exclusion zone may be removed once the koala moves from that tree",* no such protocols are identified for Southern Greater Gliders or any hollow dependent species. As gliders will be within hollows of their den trees during operational activity there is no chance for gliders to be located and avoided during operations.

Loss and destruction of den trees during logging operations in Compartments 41-43 will cause harm in terms of direct mortality to resident Southern Greater Gliders. When Hollow- bearing trees are felled by chainsaw or pushed over by excavator/bulldozer catastrophic destruction of the hollows is common and rarely are hollows structurally intact following terrestrial impact. Where Hollow-bearing trees or den trees are felled in this manner and are occupied by arboreal mammals these animals commonly sustain impact trauma injuries and deceleration injuries and/or are entrapped within the tree. An array of catastrophic injuries are common, ie dismemberment, extreme concussive injuries, crush injuries, lacerations, hemorrhage and shock (Finn & Stephens 2017; Johnson *et al.* 2007).

Where animals immediately survive the hollow impact with the ground they often die soon after from internal injuries, hemorrhage and physical trauma associated with concussive impact or and/or subsequent shock. Timber harvesting operations typically involve soil disturbance and the shifting of soil by machinery, this is specified as required within the Harvest Plan for Compartments 41-43. This specified soil disturbance may also cause harm to any fauna including Greater Gliders which may capture, bury and crush animals present on the surface, in the soil or in termitaria (Thompson and Thompson 2015). Animals that are still sheltering in hollows and debris may be killed when logs are sawn, transported or ground to woodchips.

All of these impacts of vegetation removal and logging are well known within the tree removal, land clearing, ecological and wildlife carer and rehabilitation sectors and well established in scientific literature (Finn & Stephens 2017; Johnson *et al*. 2007). On most, if not all, native vegetation clearing approvals under the EP&A Act (1979), development conditions will typically require;

- A two-stage clearing program where Hollow-bearing trees are present.
- Hollow inspection so that any resident fauna can be removed from the tree safely prior to tree removal.
- Hollow-bearing trees to be dismantled and lowered in a controlled manner and subsequently inspected for occupation and any resident fauna rescued.
- Hollow-bearing tree removal by two excavators (≥50 tonne excavators) with tree grab harvester attachments working in tandem per tree to ensure the tree is lowered gently.

No such prescriptions or conditions are present within the CIFOA or within the Compartments 41-43 Harvest Plan, hence harm via direct mortality of resident Southern Greater Gliders will result.

Where arboreal fauna sheltering within hollows miraculously survive the felling of Hollow-bearing trees, den trees or any habitat they are then exposed to a raft of immediate indirect impacts that often result in mortality. These include;

- Risk of predation from foxes, dingoes, feral dogs.
- Risk of predation from Powerful and Sooty Owls.
- Stress related pathologies associated with the disruption of home ranges and intraspecific competition.
- Loss of feed trees.
- Increases in gliding distances.

The Compartments 41-43 Harvest Plan states that (Stand) Basal Area is to be retained at or above an average of 10m2/ha (Regrowth Zone) to ensure compliance with CIFOA Silvicultural removal limits and that no more than 25% of plots are permitted to be <6m2/ha, and at least 50% of plots >10m2/ha. However, studies have found greater gliders have a high sensitivity to logging (Kavanagh 2000; Lunney 1987). Furthermore, a negative correlation between the intensity of logging and greater glider density has been noted (McLean *et al.* 2018). Glider populations may be maintained post-logging if 40% of the original tree basal area is left provided (adjoining) riparian vegetation was also protected according to Kavanagh (2000). The prescriptions within the Compartment 41-43 Harvest Plan for retained Basal Area fall well short of this recommended 40% retention and where adjoining riparian vegetation is rainforest, feed resources will be largely absent. Such a high rate of tree loss can only cause a decline in the resident Southern Greater Glider population of Compartments 41-43.

Andrew Smith in his *Review of CIFOA Mitigation Conditions for Timber Harvesting in Burnt Landscapes* (2020) for the Environment Protection Agency found that timber harvesting disturbance is more severe than the effects of fire in several important respects:

• it preferentially removes rather than retains natural fire refuges in gullies, sheltered aspects and stands of older forest that contain developing or actual hollows;

• retained forest patches are generally too small to sustain viable local populations for the number of years (10-60) required for surrounding forest to recover after logging and fire;

• and selective logging is too intense and the basal area of retained trees is too low to maintain the natural post-fire forest structure required by mature and late-stage dependent fauna like Greater Gliders and Yellow-bellied Gliders (Smith 2020).

Despite the logging history within Bulga SF, there are clearly still enough hollow resources to support glider populations. However, without planned recruitment of mature trees to grow into the hollow-bearing class, populations of hollow-dependent fauna will decline. Loss of hollow-bearing trees is listed as a Key Threatening Process and is widely recognised to be a critical issue for sustainable forest habitat management. Active management which allows mature trees to remain standing and progressively age is required to meet the goals of Ecologically Sustainable Forest Management (ESFM) and to maintain glider populations into the future. The current CIFOA prescriptions, despite the objectives of condition 15, will instead drive glider populations to fragmentation, habitat loss and local extinction.

Greater gliders are sensitive to habitat fragmentation. This species has a considerably low dispersal ability. Greater gliders are not known to openly disperse along the ground due to their awkward posture and gait (McKay, 2008). As a result, Greater Gliders are restricted by suitable gliding distances between canopies, with 100m the accepted maximum gliding distance. Therefore, due to their poor dispersal ability and need for specific nesting and feeding trees, Greater Gliders are deemed ‘disturbance intolerant species’ (Isaac *et al*. 2014).

Southern Greater Glider distribution is known to be shrinking to habitat patches found at higher elevations that experience cooler and wetter conditions (Smith & Smith, 2018; Wagner *et al*., 2020). These habitat characteristics are present in Compartments 41-43 and Bulga SF. Occupancy modelling has shown further range contractions as the climate continues to warm, furthermore indicating site occupancy will be associated with vegetation lushness and terrain wetness (Kearney *et al.* 2010; Lumsden *et al*. 2013). In the context of a global heating climate, it is necessary to conserve areas of climate refuge and cooler microclimates for gliders (DCCEEW, 2022).

No consideration of the importance of the habitat in Bulga SF and Compartments 41-43 for Southern Greater Gliders has been afforded in the Compartments 41-43 Harvest Plan or the CIFOA Conditions.

Within the Compartments 41-43 Harvest Plan post operational burning is identified and planned to be implemented. In this post-operational environment, which will have suffered significant losses to the habitat value for Greater Gliders already, the introduction of fire will further reduce habitat value. In the Wet Sclerophyll Forest of Compartments 41-43 and Bulga Forest as a whole, a single fire, 10 years prior, will significantly reduce the density of Greater Gliders in comparison to unburnt areas. To counteract these effects, it has been recommended to not implement prescribed fire under high or greater fire weather danger conditions near high-density populations of Greater Glider, along with increased retention of hollow-bearing trees during timber harvesting and/ or wider riparian buffers in areas where high density populations of Greater Gliders occur (Mclean 2018). No such prescriptions are present within Compartments 41-43 Harvest Plan or the CIFOA Conditions.

5.2. Koala

Three Koala records are shown on the Compartments 41-43 Harvest Plan with five Koala records present within a 1700m buffer area from the approximate centre of Compartments 41-43. Other records are in present within 3kms. Compartments 41-43 and Bulga SF in general contain substantial areas of Koala feed trees and suitable habitat. Before the re-make of the CIFOA, active searches for Koala, including scat searches were required. Now the CIFOA does not require any survey to be undertaken for Koalas. Instead, it requires the retention of browse trees at a rate of 10 per ha with a minimum size of 20cm dbh (Prescription 1).

There is no data to suggest that this retention rate in a logged landscape is capable of sustaining Koala populations. Koala habitat modelling has identified the area including Bulga SF and surrounds as an Area of Regional Koala Significance (ARKS) (DPE 2019). Further, this area provides a critical link between upland and coastal populations.

Absence of a requirement for any pre-logging survey effectively avoids the opportunity to have any information about Koala usage of an area. The requirement for minimum food tree retention number is without scientific basis. The minimum tree size and lack of requirement for tree health to be considered also reduces any mitigation.

The harvest plan for Compartments 41-43 sharply typifies the disparity between the CIFOA's stated objectives in Condition 15 of the CIFOA. Here known high quality Koala habitat with known records is freely available for logging without any survey and without any meaningful or scientifically supported mitigation measures. This is inconsistent with Condition 15.

5.3. Large forest owls

Similarly, to the prescriptions for gliders, the CIFOA requirements for the forest owl species require only recognition of known roost or nest sites and no species-specific survey is required. Logging prescriptions include a 50m exclusion around a nest tree and a 25m exclusion around a roost tree (but only while a roost is active). These prescriptions are grossly inadequate and inappropriate for several reasons.

Owl roosts and nests are very difficult to locate, and a large survey effort would be required to reliably locate even a small number. Forest owls require large areas of habitat for a home range. In

addition, an array of suitable hollows is necessary, not just for the owls but to support their prey base.

Sustainable forest management must consider the predicted distribution of forest owls across the landscape and consider the habitat resources needed for their survival. Retention of hollow-bearing trees is critical and so too is retention and recruitment of future hollow- bearing trees. As with gliders, mature and healthy trees make up a critical habitat resource as they eventually age into the hollow-bearing class. In undisturbed forest this process may take several hundreds of years, especially for species such as Blackbutt (*Eucalyptus pilularis*), a target harvest species. Logging cycles of ten to twenty years result in a younger and younger aged forest and the progressive removal of trees that will form future hollows places downward pressure on populations of hollow-dependent fauna. Species which require the largest hollows, such as large owls, will be at high risk, since those hollows take the longest time to form. Bulga SF, including specifically Compartments 41-43, have hollow resources and a prey base which contribute to the habitat requirements for large forest owls and logging will have an immediate negative impact on the forest owl population.

5.4. Glossy Black-cockatoo

There are numerous records of Glossy Black-cockatoo in and around Bulga SF, including from within Compartments 41-43. Figure 17 shows records in and near the compartment with locations adjusted because of the sensitive nature of records for this threatened species. However nil Glossy-black Cockatoo feed trees are identified in the Compartment 41-43 Harvest Plan. The CIFOA does not require surveys for Glossy Black-cockatoo or to make prescriptions based on species records or presence of habitat. Instead, it requires exclusion zones around known active feed trees and roost trees. The requirement to search for these habitat features is to be by 'Broad Area Searching' as per Condition 57. There is no stated minimum survey effort and habitat searches for Glossy Black-cockatoo feed trees are not specified to be seasonal. Since the production of cones by *Allocasuarina spp* is seasonal, the prescription actually allows the widespread removal of large areas of potential feed trees because searches can take place when cones are not present.

In Compartments 41-43, approximately 15 to 20% of the proposed logging area has dense and abundant *Allocasuarina* midstorey and likely makes a significant contribution to resources for Glossy Black-cockatoo. The current prescriptions allow for the total removal of the resource apart from a single feed tree as mapped on the harvesting plan.

5.5. Other threatened species and forest habitat

The harvest plan based on the conditions of the CIFOA is unlikely to act to maintain populations of other threatened species in or around Compartments 41-43. Logging disturbance removes ground habitat and cover for small ground-dwelling species such as Parma Wallaby, Red-legged Pademelon and Long-nosed Potoroo. Disturbance and increased roading can also allow for incursion of feral predators. Logging will also act to dry out forest habitats, increasing vulnerability to fire.

Since the plan is not required to consider these species or these impacts and there is no requirement for pre-logging survey or post-logging monitoring there is no way to judge the impact on threatened fauna. There is no way to assess whether Condition 15 will or can be met, but the obvious assumption is that it cannot.

6.0 Conclusion

Bulga State Forest, inclusive of Compartments 41 and 43, contains significant habitat values for a range of threatened fauna and the known or likely presence of these species. The presence of threatened glider species is particularly significant and currently there are sufficient hollow-bearing trees to support a population of both Greater Glider and Yellow-bellied Gliders. However, proposed harvest prescriptions don't require the recognition of the species' presence and only require a cursory search for dens or sap trees. The high number of Southern Greater Glider Bionet records and records gained from this Citizen Science survey suggest that a high density population is present. In particular there are high numbers of records within Compartments 41-43 and nearby. There would be a significant number of den trees present within Compartments 41-43 yet only two den trees have been identified on the Harvest Plan. Direct mortality of Southern Greater Gliders is inevitable during logging operations without all den trees identified and protected via exclusion zones. The post timber harvest environment will be one of den tree losses and habitat modification that will inevitably cause the resident Southern Greater Gliders that have survived the harvesting operations to shift their home range. This is likely to cause indirect mortalities arising from competition and its associated stress within the Southern Greater Glider population as well as an increased susceptibility to predation. High quality den trees spread through their home range are critical for Southern Greater Gliders to manage their temperature requirements and so they can access all their range (Wagner *et al*. 2020; Smith and Smith 2020; Rubsamen *et al.* 1984). Logging operations will reduce den tree opportunities, create significant canopy gaps with larger gliding distances to be covered and create more open vegetation. This reduction in canopy cover from tree harvesting within this known Southern Greater Glider habitat will expose this habitat to increased solar exposure, higher temperatures and increased fire risk significantly reducing its quality for Southern Greater Gliders. Current prescriptions require only the retention of a small number of hollow-bearing trees (8/ha) with no requirement for these trees to be suitable for gliders. Current prescriptions also fail to provide for recruitment of future hollow-bearing trees, thereby consigning all glider species and other hollow-dependent fauna to a doomed future. In short the logging of Compartments 41 and 43 and elsewhere in Bulga SF will be catastrophic for the local population of Southern Greater Gliders, especially with a drought cycle returning, and an extremely hot summer and high fire risk forecast (BoM 2023c; Carbonbrief 2023).

Measures to ensure survival of other species such as large forest owls, Parma Wallaby, Koala, and Glossy Black-cockatoo are fundamentally absent from the CIFOA structure and thus from the harvest plan for Compartments 41 and 43. The results of the Citizen Science survey and Bionet Atlas searches in Bulga SF and specifically of Compartments 41-43 show that a range of threatened species are known or expected. However, the disparity between species records and the harvest plan show that sustainable populations of forest fauna will not be delivered by the CIFOA. Instead, the CIFOA will cause harm to a suite of threatened fauna and further declines.

This is especially the case also for the Koala. Since the CIFOA removed the previous requirement for survey and instigated a minimal measure for habitat retention of browse trees, there can be no expectation that this will provide any meaningful platform for survival. Instead, Koala habitat is available for logging with no requirement to survey for the species' presence.

Continued logging under these prescriptions will continue to drive populations of Southern Greater Glider, Koala and other forest fauna species on a downward trajectory. Instead, the statutory Commonwealth Conservation Advice should be implemented, in particular for both these species, to prevent extinction.

Current government policy is an abrogation of duty to protect threatened forest fauna and is grossly inconsistent with both State and Commonwealth determinations on a raft of threatened species.

Unburnt areas provide critical refuges for a suite of fauna including Southern Greater Gliders in regions heavily impacted by fires, as they may be the only areas with the requisite habitat attributes within extensive landscapes for many years (Lumsden *et al.* 2013; Chia *et al.* 2015 in DCCEW 2022). Despite this, extensive areas of Bulga SF, including Compartments 41-43, which did not burn in the 2019-2020 mega-fire are planned to be logged. This will severely compromise this high value refugia habitat for the Southern Greater Glider. It will also reduce the future potential quality of this habitat and the existence of the local population of Southern Greater Glider when logging impacts are considered together with those arising from global heating and the likelihood of future mega-fires.

7.0 References

Bilney, Rohan & Cooke, Raylene & White, John. (2011). Potential competition between two top-order predators following a dramatic contraction in the diversity of their prey base. Animal Biology. 61. 29-47. 10.1163/157075511X554400.

Bluff L (2016) Reducing the effect of planned burns on hollow-bearing trees. Fire and adaptive management report no. 95. Victorian Government Department of Environment, Land, Water and Planning. Melbourne.

Boer, M.M., Resco de Dios, V. & Bradstock, R.A. Unprecedented burn area of Australian mega forest fires. Nat. Clim. Chang. 10, 171–172 (2020). https://doi.org/10.1038/s41558-020-0716-1

BOM (2023a) Climate Change in Australia. Projections for Australia's NRM regions. Webpage access 4/08/2023. https://www.climatechangeinaustralia.gov.au/en/projections-tools/regional-climate-change-explorer/super-clusters/?current=ESC&tooltip=true&popup=true

BOM (2023b) Weather data webpage accessed 22/08/2023. http://www.bom.gov.au/climate/dwo/202308/html/IDCJDW2129.202308.shtml

BOM (2023c) Webpage accessed 24/08/2023. http://www.bom.gov.au/climate/ahead/outlooks/

Bradshaw CJA, Ehrlich PR, Beattie A, Ceballos G, Crist E, Diamond J, Dirzo R, Ehrlich AH, Harte J, Harte ME, Pyke G, Raven PH, Ripple WJ, Saltré F, Turnbull C, Wackernagel M and Blumstein DT (2021) Underestimating the Challenges of Avoiding a Ghastly Future. Front. Conserv. Sci. 1:615419. doi: 10.3389/fcosc.2020.615419

Buckland, S. T., Anderson, D. R., Burnham, K. P., & Laake, J. L. (1993). Distance Sampling: Estimating Abundance of Biological Populations. Chapman and Hall, London. 446pp.

Carbonbrief (2023) Webpage accessed 24/08/2023. https://www.carbonbrief.org/state-of-the-climate-2023-now-likely-hottest-year-on-record-after-extreme-summer/#:~:text=Both%20June%20and%20(very%20likely,C%20since%20the%20mid%2D1800s.

Cowie, R.H., Bouchet, P. and Fontaine, B. (2022), The Sixth Mass Extinction: fact, fiction or speculation?. Biol Rev, 97: 640-663. https://doi.org/10.1111/brv.12816

Cripps et al (2018) Estimating the density of the Greater Glider in the Strathbogie Ranges, North East Victoria with an assessment of coupes scheduled for timber harvesting in 2018. Arthur Rylah Institute

for Environmental Research Technical Report Series No. 293. Department of Environment, Land, Water and Planning, Heidelberg, Victoria.

Cripps, J. K., Nelson, J. L., Scroggie, M. P., Durkin, L. K., Ramsey, D. S. L., & Lumsden, L. F. (2021). Double-observer distance sampling improves the accuracy of density estimates for a threatened arboreal mammal. Wildlife Research, 48(8), 756–768.

Cann, B., Williams, J. and Shields, J.M (2000). Monitoring Large Forest Owls and Gliders After Recent Logging in Production Regrowth Forests of the Mid-North Coastal Region of NSW. In: Ecology and Conservation of Owls. Newton, I., Kavanagh, R., Olsen, J. and Taylor, I. (Editors) (2002). CSIRO Publishing, Collingwood.

Clout, M.N. (1989). Foraging behaviour of Glossy Black Cockatoos. *Aust. Wildl. Res*. 16: 467-73.

Comport SS , Ward SJ Foley WJ (1996) Home ranges, time budgets and food-tree use in a high-density tropical population of greater gliders, *Petauroides volans* minor (Pseudocheiridae : Marsupialia). *Wildlife Research* **23**, 401-419. https://doi.org/10.1071/WR9960401

Debus, S. (2009). The Owls of Australia: A Field Guide To Australian Night Birds. Envirobook, Canturbury, NSW.

DECC (2008). Recovery Plan for the Koala (*Phascolarctos cinereus*). NSW DECC, Hurstville.

Department of Climate Change, Energy, the Environment and Water (2022). Conservation Advice for *Petauroides volans* (greater glider (southern and central)). Canberra. http://www.environment.gov.au/biodiversity/threatened/species/pubs/254-conservation-advice-05072022.pdf. In effect under the EPBC Act from 05-Jul-2022.

Dickman C, Driscoll D, Garnett S, Keith D, Legge S, Lindenmayer D, Maron M, Reside A, Ritchie E, Watson J, Wintle B & Woinarski J (2020) *After the catastrophe: a blueprint for a conservation response to large-scale ecological disaster*. Threatened Species Recovery Hub. https://www.nespthreatenedspecies.edu.au/publications-and-tools/after-thecatastrophe-a-blueprint-for-a-conservation-response-to-large-scale-ecological-disaster

DPE 2011 Old Growth Forest Ecosystems Interim CRAFTI Grid for CRA Lower North East. VIS_ID 5059, accessed from The Sharing and Enabling Environmental Data Portal [https://datasets.seed.nsw.gov.au/dataset/62e70850-1bf9-4f08-a715-0e2712952f3b], date accessed 2023-08-04.

DPE 2022a Revised Eastcoast State Vegetation Type Mapping (version C1.1.M1.1)

DPE 2022b Final Determination to list *Petauroides volans* (Southern Greater Glider) as an Endangered species. NSW Threatened Species Scientific Committee.

Finn, H. C., & Stephens, N. S. (2017). The invisible harm: land clearing is an issue of animal welfare. Wildlife Research, 44(5), 377–391. https://researchportal.murdoch.edu.au/esploro/outputs/journalArticle/The-invisible-harm-land-clearing-is/991005541937807891?skipUsageReporting=true&recordUsage=false&institution=61MUN_INST

Forestry Corporation (2016) Threatened Species Licence Pre-Logging and Pre-Roading Flora & Fauna Survey Report Bulga State Forest, Compartments 90,94,95,96.

Forestry Corporation (2021) Addendum Forestry Corporation Rationale for operations under the CIFOA with additional environmental safeguards https://www.forestrycorporation.com.au/__data/assets/pdf_file/0010/1429615/addendum-rationale.PDF

Gibbons, P. and Lindenmayer, D. (2002). Tree Hollows and Wildlife Conservation in Australia. CSIRO Publishing, Collingwood.

Goldingay, R.L. and Kavanagh, R.P. (1991). *The Yellow-bellied Glider: a review of its ecology, and management considerations*. In: Lunney, D. (Ed.) (1991). Conservation of Australia's Forest Fauna. Royal Zoological Society of NSW, Mosman.

Harris, J. M., & Maloney, K. S. (2010). *Petauroides volans* (Diprotodontia: Pseudocheiridae). Mammalian Species, 42(866), 207–219.

IPBES (2019). Global Assessment Report on Biodiversity and Ecosystem Services. Paris: IPBES Secretariat.

Isaac, B., White, J., Ierodiaconou, D., & Cooke, R. (2014). Simplification of arboreal marsupial assemblages in response to increasing urbanization. PLoS ONE, 9(3).

C, Johnson & H, Cogger & Dickman, Christopher & H, Ford. (2007). Impacts of Landclearing: the impacts of the approved clearing of native vegetation on Australian wildlife in New South Wales.

Kavanagh, R.P. (2000a). Comparative diets of the Powerful Owl (Ninox strenua), Sooty Owl (*Tyto tenebricosa*) and Masked Owl (*T. novaehollandiae*) in Southeastern Australia. In: Ecology and Conservation of Owls. Newton, I., Kavanagh, R., Olsen, J. and Taylor, I. (Editors) (2002). CSIRO Publishing, Collingwood.

Kavanagh, R.P. (2000b). *Conservation and Management of large forest owls in Southeastern Australia*. In: Ecology and Conservation of Owls. Newton, I., Kavanagh, R., Olsen, J. and Taylor, I. (Editors) (2002). CSIRO Publishing, Collingwood.

Kavanagh RP (2000c) Effects of variable-intensity logging and the influence of habitat variables on the distribution of the greater glider *Petauroides volans* in montane forest, southeastern New South Wales. *Pacific Conservation Biology* **6,** 18–30.

Kearney, M. R., Wintle, B. A., & Porter, W. P. (2010). Correlative and mechanistic models of species distribution provide congruent forecasts under climate change. Conservation Letters, 3, 203–213.

Legge, S., Woinarski, J. C. Z., Garnett, S. T., Geyle, H., Lintermans, M., Nimmo, D. G., Rumpff, L., Scheele, B. C., Southwell, D. G., Ward, M., Whiterod, N. S., Ahyong, S.T., Blackmore, C.J., Bower, D.S., Brizuela-Torres, D., Burbidge, A. H., Burns, P.A., Butler, G., Catullo, R., Dickman, C. R., Doyle, K., Ehmke, G., Ensbey, M., Ferris, J., Fisher, D., Gallagher, R., Gillespie, G.R., Greenlees, M. J., Hayward-Brown, B., Hohnen, R., Hoskin, C.J., Hunter, D., Jolly, C., Kennard, M., King, A., Kuchinke, D., Law, B., Lawler, I., Lawler, S., Loyn, R., Lunney, D., Lyon, J., MacHunter, J., Mahony, M., Mahony, S., McCormack, R.B., Melville, J., Menkhorst, P., Michael, D., Mitchell, N., Mulder, E., Newell, D., Pearce, L., Raadik, T.A., Rowley, J., Sitters, H., Spencer, R., Valavi, R., West, M., Wilkinson, D.P., Zukowski, S. (2021). Estimates of the impacts of the 2019–20 fires on populations of native animal species. NESP Threatened Species Recovery Hub. Project 8.3.2 report, Brisbane.

Legge, S., Rumpff, L., Woinarski, J. C. Z., Whiterod, N. S., Ward, M., Southwell, D. G., Scheele, B. C., Nimmo, D. G., Lintermans, M., Geyle, H. M., Garnett, S. T., HaywardBrown, B., Ensbey, M., Ehmke, G., Ahyong, S. T., Blackmore, C. J., Bower, D. S., BrizuelaTorres, D., Burbidge, A. H., … Zukowski, S. (2022). The conservation impacts of ecological disturbance: Time-bound estimates of population loss and recovery for fauna affected by the 2019–2020 Australian megafires. Global Ecology and Biogeography, 31, 2085–2104.

Lindenmayer, D. B., Ball, I., Possingham, H. P., Mccarthy, M. A., & Pope, M. L. (2001). A landscape-scale test of the predictive ability of a spatially explicit model for population viability analysis. Journal of Applied Ecology, 38, 36-48

Lindenmayer, D. (2002). Gliders of Australia – A Natural History. University of NSW Press, Sydney.

Lindenmayer, D., Taylor, C., and Blanchard, W.. 2021. Empirical analyses of the factors influencing fire severity in southeastern Australia. *Ecosphere* 12(8):e03721. 10.1002/ecs2.3721

Lumsden, L.F., Nelson, J.L., Todd, C.R., Scroggie, M.P., McNabb, E.G., Raadik, T.A., Smith, S.J., Acevedo, S., Cheers, G., Jemison, M.L. and Nicol, M.D. (2013). A New Strategic Approach to Biodiversity Management - Research Component. Arthur Rylah Institute for Environmental Research Unpublished Client Report for the Department of Environment and Primary Industries, Heidelberg, Victoria.

Lunney, D. (1987). Effects of logging, fire and drought on possums and gliders in the coastal forests near Bega, N.S.W. Wildlife Research, 14(3), 263–274.

Mackowski, C.M (1988). Characteristics of eucalypts incised by the Yellow-bellied Glider in northeastern NSW. *Aust. Mamm*. 11(1) pp 1-13.

McGregor, D. C., Padovan, A., Georges, A., Krockenberger, A., Yoon, H. J., & Youngentob, K. N. (2020). Genetic evidence supports three previously described species of greater glider, Petauroides volans, P. minor, and P. armillatus. Scientific Reports, 10(1).

McLean, C. M., Kavanagh, R. P., Penman, T., & Bradstock, R. (2018). The threatened status of the hollow dependent arboreal marsupial, the Greater Glider (*Petauroides volans*), can be explained by impacts from wildfire and selective logging. *Forest Ecology and Management*, *415–416*, 19–25.

Moore BD, Wallis IR, Marsh KJ & Foley WJ (2004) The role of nutrition in the conservation of the marsupial folivores of eucalypt forests, in D Lunney (ed) Conservation of Australia's Forest Fauna. Second edition. pp 549–575.

Narayan, E.J., and Williams, M. (2016). Understanding the dynamics of physiological impacts of environmental stressors on Australian marsupials, focus on the koala (*Phascolarctos cinereus*). *BMC Zoology* (2016) 1, 2. doi:10.1186/s40850-016-0004-8

Rübsamen K, Hume I, Foley W, Rübsamen U (1984) Implications of the large surface area to body mass ratio on the heat balance of the greater glider (*Petauroides volans*: Marsupialia). *Journal of Comparative Physiology B* 154, 105–111

Spade (2023) Soil and Land Resources Outline Layer. State of NSW and Department of Planning, Industry and Environment 2023.

Sustainability, Environment, Water, Population and Communities (SEWPAC) Department (2011a) Survey guidelines for Australia's threatened mammals. Commonwealth of Australia, Canberra.

Smith A. 2020. Review of CIFOA Mitigation Conditions for Timber Harvesting in Burnt Landscapes. A Report to the NSW Environment Protection Authority.

Smith P, Smith J (2018) Decline of the greater glider (*Petauroides volans*) in the lower Blue Mountains, New South Wales. *Australian Journal of Zoology* 66, 103–114.

Smith P, Smith J (2020) Future of the greater glider (*'Petauroides volans'*) in the blue mountains, New South Wales. *Proceedings of the Linnean Society of New South Wales* 142, 55–66

Strahan, D. (Editor) (2000). Complete Book of Australian Mammals. Cornstalk Publishing, Sydney.

Thompson, S. A., and Thompson, G. G. (2015). Fauna-rescue programs can successfully relocate vertebrate fauna prior to and during vegetation-clearing programs. Pacific Conservation Biology 21, 220-225. doi: 10.1071/PC14922

Triggs, B. (2004). Tracks Scats and Other Traces: A Field Guide to Australian Mammals. Oxford University Press, Melbourne.

TSX 2022 Threatened Species Index, 2022 update. https://tsx.org.au/visualising-the-index/the-2022-tsx-update/, website accessed 4/08/2023.

Wagner B, Baker PJ, Stewart SB, Lumsden LF, Nelson JL, Cripps JK, Durkin LK, Scroggie MP, Nitschke CR (2020) Climate change drives habitat contraction of a nocturnal arboreal marsupial at its physiological limits. *Ecosphere* 11, e03262.

Wagner, B., Baker, P. J., & Nitschke, C. R. (2021b). The influence of spatial patterns in foraging habitat on the abundance and home range size of a vulnerable arboreal marsupial in southeast Australia. *Conservation Science and Practice, 3*(12), 1–18.

Ward MS, Simmonds JS, Reside AE, Watson JEM, Rhodes JR, Possingham HP, Trezise J, Fletcher R, Taylor M (2019). Lots of loss with little scrutiny: The attrition of habitat critical for threatened species in Australia. *Conservation Science and Practice* 2019; 1:e117.

Wildlife Preservation Society of Queensland (2016) Spotlighting for Gliders. https://wildlife.org.au/wp-content/uploads/2016/07/WPSQ0012-2pp-Spotlighting-WPSQ_FA.pdf , Webpage accessed 20/05/2023.

Woinarski JCZ, Burbridge AA, Harrison PL (2015). Ongoing unraveling of a continental fauna: Decline and extinction of Australian mammals since European settlement. Proceedings of the National Academy of Sciences of the United State of America 112(15), 4531-4540.