Post-fire Assessment Report—Natural Values:

2019 bushfire, Mt Barney National Park, South East Queensland Region

March 2022

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Queensland Government 2022, '2019–20 Bushfires: Queensland's Threatened species recovery program', https://www.qld.gov.au/environment/plants-animals/conservation/bushfires-threatened-species-recovery'

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Front cover

Eastern slopes of Mount Barney, Mount Barney NP, 21 November 2019, showing the extent of active fire in the early evening (Photo copyright: Ben Blanche).

Contents

List of acronyms and abbreviations used in the text

BMAD	Bell Miner Associated Dieback (see Silver & Carnegie 2017).
BVG	Broad Vegetation Groups (BVGs) as described by Neldner *et al.* (2019).
dNBR	Normalised Burn Ratio difference product.
E	Endangered.
EPBC	Federal *Environment Protection and Biodiversity Conservation Act 1999.*
FIRMS	Fire Information for Resource Management System available online at https://firms.modaps.eosdis.nasa.gov/.
FLAME	QPWS Fire Management System.
LC	Least Concern.
myrtle rust	the disease caused by the exotic fungal pathogen *Austropuccinia psidii*
NAFI	Northern Australia & Rangelands Fire Information.
NBR	Normalised Burn Ratio.
NCA	Queensland *Nature Conservation Act 1992.*
NKV	Natural Key Value.
NP	NP.
NT	Near Threatened.
OUV	Outstanding Universal Value of a World Heritage Area.
QFES	Queensland Fire and Emergency Service.
QPWS	Queensland Parks and Wildlife Service.
QPWS estate	Conservation Parks, National Parks, Resources Reserves, State Forests and Forest Reserves (in the context of the area encompassed by this report).
RE	Regional Ecosystem, as defined by Queensland Herbarium (2018), is a vegetation community in a bioregion that is consistently associated with a particular combination of geology, landform and soil (Neldner *et al.* 2020).
REDD	Regional Ecosystem Description Database, Version 10.1 (Queensland Herbarium 2018).
V	Vulnerable.
VIIRS	Visible Infrared Imaging Radiometer Suite.
WHA	World Heritage Area.

1 Executive summary

Following serious rainfall deficiencies, a bushfire burnt extensively within Mount Barney NP and adjoining tenures in south-east Queensland and north-eastern New South Wales. The fire started on 17 October 2019 from a lightning strike near the summit of Double Peak and was deemed out by 7 January 2020. Fire weather conditions at the time of the fire ranged upwards of Severe on many days with periods of Extreme to locally Catastrophic conditions. An intense rainfall event in mid-January 2020 resulted in significant erosion and deposition of sediment in drainage lines.

Fire severity mapping was undertaken using satellite imagery processing. The authors undertook field assessments of fire severity and impacts from March through to May 2020, mostly in areas accessible from the fire trail network. Additional observations from Mount Barney Lodge staff, bushwalkers and QPWS&P staff undertaking post-fire threatened species surveys ensured that this assessment was well-informed.

The total area burnt within Mount Barney NP area was approximately 8 785ha, including 7 012ha burnt within the Gondwana Rainforests World Heritage Area. A summary of the natural values impacted, is provided in Table 1. Relative fire severity varied considerably across the fire ground and included areas of full canopy consumption including within rainforest. Substantial areas of rainforest, wet eucalypt open forests and rainforest/eucalypt forest ecotones were burnt. About a fifth of the burnt area is assessed as having high to catastrophic potential ecological impact due to burning of fire-sensitive vegetation communities, particularly rainforests.

This report identifies known and likely impacts of the bushfire event to the natural values on QPWS estate. It provides practical recommendations for mitigation, recovery and monitoring over the short- to long-term.

Table 1. The natural values known or likely to have been significantly impacted by the bushfire event
Five natural values were assessed as being significantly impacted by the bushfire event. For the purposes of our assessment these are defined using Broad Vegetation Groups at the 1:2 000 000 scale (BVG 2M)

Value ID.	Value descriptor
NV 1	Rainforests – Vine forests and fern forests to thickets – Regional Ecosystems with a fire-sensitive canopy and understorey. – BVGs 2, 4, 5 and 6.
NV 2	Wet eucalypt open forests and rainforest/eucalypt forest ecotones – Regional Ecosystems and rainforest/eucalypt forest ecotones with a fire tolerant canopy and a fire-sensitive understorey. – BVG 8.
NV 3	Dry eucalypt forests and woodlands – Regional Ecosystems with a fire tolerant canopy and understorey. – BVGs 9, 10, 11 and 13.
NV 4	Montane heaths and shrublands – Regional Ecosystems with a fire tolerant canopy and understorey. – BVGs 28 and 29.
NV 5	Riparian corridors – Regional Ecosystems fringing streams with either a fire-sensitive or fire tolerant canopy and a fire-sensitive understorey. – various BVGs.

An assessment of the potential impact to these natural values within Mount Barney NP is provided in section 6 and recovery actions are identified. There are likely to be ongoing indirect impacts from the fire due to erosion, landslips and additional tree falls due to wind throw and/or disease in compromised trees. Such events will exacerbate impacts (e.g. weed invasion) identified in this report and prolong ecosystem recovery.

About 2 194ha, or 41% of the area of rainforests within Mount Barney NP burnt. Most of the rainforests that burnt fall within the Gondwana Rainforests WHA, with the exception of some areas in the Burnett Creek catchment. In some areas fire penetrated long distances (hundreds of metres to kilometres) through rainforest communities, including burning temperate rainforests and cloud forests at altitudes in excess of 1000-1100m. Within affected rainforests approximately 39.0% burnt at low, 45.5% at moderate, and 12.0% at high and 3.5% at extreme relative

severity, with likely ecological impact ranging from moderate to catastrophic as these ecosystems are fire-sensitive. About 341ha of rainforests burnt at high to extreme severity with catastrophic ecological impacts likely in these areas. This represents 6.3% of the area of rainforest within Mount Barney NP. Recovery of these ecosystems will take at least decades, if not centuries, and will be dependent upon exclusion of further fires. Facilitating natural regeneration through the management of ecosystem-changing and or fire-promoting weeds is a key management recommendation.

Over 2 321ha or 61.2% of wet eucalypt open forests burnt during the bushfire. Within burnt wet eucalypt open forests approximately 32.9% burnt at low, 49.7% at moderate, 12.5% at high and 4.8% at extreme relative severity, resulting in mostly moderate to high, with small areas of catastrophic, potential ecological impact. There were also significant areas where potential ecological impact was likely limited or none. An occasional high intensity fire is recognised as a natural part of the fire regime of these forests. However, the extent of fire within these communities, likely facilitated by past logging, storm damage and weed/shrub invasion, and the potential for bell miner associated dieback and weeds to spread further following the fire, is a serious concern. Facilitating natural regeneration through strategic weed control is a key management recommendation. Exclusion of cattle is also critical for the timely recovery of wet eucalypt forest.

Rainforest-eucalypt forest ecotones are common within Mount Barney NP and have been heavily impacted by the fire. Their post-fire management requirements are similar to those of wet eucalypt open forests.

About 4 050ha of dry eucalypt forests and woodlands burnt during the bushfire, which represents 49.0% of their extent within Mount Barney NP. Within burnt dry eucalypt forests and woodlands approximately 48.5% burnt at low severity, 44.4% at moderate severity, 5.4% at high and 1.6% at extreme severity with potential ecological impact mostly limited or none. During field assessments we observed some areas with significant loss of canopy/tree death, although in places some of this appears to have been due to preceding drought. There was also loss of some large trees from basal fires and complete loss of ground cover resulting in exposed mineral earth in areas of higher severity. We also observed widespread recovery of trees with post-fire coppicing and epicormic regrowth. However, there has been subsequent death of a significant number of reshooting trees in the period up to 12 months post-fire, highlighting that impacts in fire-adapted communities may continue for months to years following fire. Ongoing management of fire in the dry eucalypt communities, is important for the health of these systems and also for minimising the risk of future fire incursions into fire-sensitive ecosystems. Exclusion of cattle is also critical for the recovery of dry eucalypt forests and woodlands, many of which naturally have a grassy understorey.

Significant areas of montane heaths and shrublands and exposed mountain peaks and escarpments burnt. High intensity fire is typical in montane heaths and shrublands, but they require long inter-fire periods, in the order of 20-50 years. About 164ha or 37.4% of the mapped extent of montane heaths and shrublands burnt. Approximately 37.3% burnt at low, 38.8% at moderate, 16.3% at high and 7.6% at extreme relative severity with significant areas with potential ecological impact of moderate to high. Visitor impacts and recurrent fire are considered the greatest threats to recovery of these ecosystems.

Riparian corridors were significantly impacted by fire. These corridors include a range of vegetation communities that have differing sensitivity to fire. Areas of high to extreme severity fire in these communities are likely to have serious ecological impacts in the medium to long term, regardless of the vegetation community. Areas of low to moderate severity in rainforested riparian areas are also likely to have serious ecological impacts in the medium to long term. Weeds are a significant issue for the recovery of many of these areas, with cattle an issue in the Burnett Creek catchment.

A large number of conservation significant flora and fauna species are known from, or have potential habitat, within the burnt area. Impacts on these species will vary, but those in fire-sensitive communities are likely to have been most severely affected. Six fauna species have more than 5% (up to 15.3%) of their potential Queensland habitat falling within Mount Barney NP: rufous scrub-bird, eastern bristlebird, Albert's lyrebird, *Mixophyes fleayi,* brush-tailed rock-wallaby and Hastings River mouse*.* These species had 41-57% of their potential habitat within Mount Barney NP burnt. Seventeen flora species have more than 15% (up to 100%) of their potential Queensland habitat falling within Mount Barney NP: *Acacia acrionastes, Agiortia cicatricata, Banksia conferta, Bertya ernestiana, Comesperma breviflorum, Coopernookia scabridiuscula, Dendrobium schneiderae* var*. schneiderae, Eucalyptus codonocarpa, Euphrasia bella, Hibbertia monticola, Leionema elatius* subsp. *beckleri, Leptospermum barneyense, Phlegmariurus varius, Pseudanthus pauciflorus* subsp*. pauciflorus, Pultenaea whiteana, Tetramolopium vagans* and *Zieria montana.* These species had 5-89% of their potential habitat within Mount Barney NP burnt. Two Critically Endangered plant species known from Mount Barney NP (*Rhodamnia rubescens* and *Rhodomyrtus psidioides*) are primarily threatened by myrtle rust. We observed significant impacts from myrtle rust on *Rhodamnia rubescens* resprouting from the bushfire.

The following list summarises key management recommendations:

1. Prevent the establishment of high biomass grasses and lantana (*Lantana camara*) immediately adjacent to and within burnt rainforest, wet eucalypt open forest, rainforest ecotone and riparian communities.
2. Assess the establishment of vine and herbaceous weeds and undertake strategic control.
3. Assess the establishment of tree and shrub weeds and undertake strategic control.
4. Continue efforts to control pigs in the Burnett Creek catchment of Mount Barney NP as the population is relatively small but has the potential to severely impact significant values.
5. Surveillance and strategic thinning of native vine, shrub or tree species only if causing arrested rainforest or rainforest ecotone ecosystem recovery over a broad area and over a long duration or is impacting a highly restricted significant natural value.
6. Review the fire strategy and reassess approved planned burns, to consider the location and extent of ecosystems that burnt, with the aim of maintaining or re-establishing a range of fire age classes including long-unburnt (the latter particularly in wet eucalypt forests and montane heaths and shrublands).
7. Assess the distribution and abundance of feral deer, cats, foxes and pigs, and undertake strategic control programs where significant values are being impacted or threatened.
8. Reinstate damaged, or install new, boundary fences in strategic locations to prevent cattle entering regenerating areas, particularly in the Burnett Creek catchment.
9. Initiate or continue to monitor the threatened species most likely to have been impacted by the fire, to better understand the impact of the fire and associated threats, identify refugia and target management actions. For flora this includes studies of regenerative mechanisms e.g. resprouting, seedling germination.
10. Review weed and fire management planning in dry eucalypt communities to reduce the risk of future fire encroachment into rainforests, and unplanned encroachment into wet eucalypt open forests and ecotones and riparian corridors, and to ensure unburnt (particularly longer unburnt) dry eucalypt forest refugia are maintained.
11. Protect unburnt refuges from fire until the burnt communities recover sufficiently.
12. Undertake Health Checks to facilitate early detection of pest plant and animals and enable condition to be evaluated across the park.
13. Establish additional long-term vegetation monitoring plots in burnt communities to evaluate recovery and management effectiveness.
14. Assess impacts from pathogens such as myrtle rust.
15. Investigate remote sensing methods to map the longer-term ecological impact to rainforests.
16. Protect regenerating rock pavement, cliff lines and montane heath and shrubland areas from visitation.

There are very limited opportunities to rehabilitate via direct planting. Such actions should be confined to areas of cleared land where natural regeneration is slow or stalled due to dense weed infestations.

The fire provides research and monitoring opportunities to better understand post-fire recovery and threats, that will help inform:
a) post-fire management actions for future fires impacting rainforest, wet eucalypt open forest, montane and riparian communities in south-east Queensland,
b) ongoing fire and pest management planning, planned burning, pest control activities and bushfire suppression,
c) adaptive park management under a changing climate where severe bushfire are likely to increase in frequency, area and duration, and
d) priorities for threatened species monitoring and recovery planning

2 Introduction and purpose of this report

This report is a rapid assessment of the known and likely impacts to the natural values within QPWS estate arising from a significant bushfire event. It is not intended to be a comprehensive report. It provides an overview of the fire and provides information to inform recovery planning for natural values, in particular Natural Key Values determined through the QPWS Values Based Management Framework (DES 2020).

The report succinctly documents the extent, ecological severity and potential ecological impacts of the bushfire, prevailing weather conditions, and suppression methods. It describes the spatial data used in the evaluation and summarises areas and values within the burnt area (section 5). It provides QPWS with a snapshot of the priority impacts and associated risks to natural values following the bushfire, and provides practical recommendations for mitigation, recovery and monitoring (section 6).

Scoping the scale and nature of short- to long-term recovery actions as soon as possible after a fire event better supports land managers to manage immediate risks and plan for the future. It also assists in determining likely cost and resourcing implications.

This assessment is limited to the bushfire that occurred in Mount Barney NP (Figs 1 and 5; section 4.1) in the South East Queensland Bioregion that burned over the period October 2019-January 2020. Landscape features and place names used in this report as per 1:25 000 scale topographic mapping available for Queensland online at QTopo: https://qtopo.information.qld.gov.au/ and for New South Wales online at SIX Maps: https://maps.six.nsw.gov.au/. This report does not include any assessment of the impacts within adjoining protected areas of New South Wales (e.g. Mount Nothofagus NP).

3 Background

The bushfire assessed here burnt extensive areas of Mount Barney NP and adjoining tenures both within Queensland and New South Wales. This assessment only covers Mount Barney NP (18 265ha), which forms part of the Scenic Rim, south-west of Brisbane, towards the south-western most extent of the South East Queensland Bioregion. The terrain is mountainous (to just over 1300m altitude), rising steeply from the valleys of Burnett, Mount Barney and Cronan Creeks and the upper Logan River and supports a wide range of landforms, vegetation communities and significant species. Much of the park is included within the Gondwana Rainforests WHA (UNESCO 2019). Further background information on Mount Barney NP is available at https://parks.des.qld.gov.au/parks/mount-barney.

Mount Barney NP has a history of human disturbance with extensive logging of both eucalypt and rainforest communities and grazing of open country. Also, infestations of bell miners *Manorina melanophrys* occur in parts of Mount Barney NP with areas of Bell Miner Associated Dieback (BMAD) (Silver & Carnegie 2017). Some areas affected by the bushfire included well established infestations of *Lantana camara* and other weeds and/or areas with disturbed or low canopy height with a dense vine or shrub understorey due to timber harvesting and/or BMAD.

3.1 Landscape overview of the fire and timeframe

3.1.1 Overview

The Mount Barney NP 2019 bushfire burnt over the period October 2019 through to early-January 2020 (Fig. 1). It started on 17 October 2019 from a lightning strike near the summit of Double Peak in extremely rugged terrain. The fire then burnt north and east around the northern slopes of Mowburra Peak and into the headwaters of Yamahra Creek, in both national park and adjoining tenures. It was contained using backburning south of Yamahra Creek and to the west of Waterfall Creek Road (down Fearby's Break to Burnett Creek Road). The fire burnt south from Yamahra Creek up into the high ground around Focal Peak and Monserrat Lookout, crossing numerous rainforested drainages that would stop a fire under typical bushfire conditions. The fire continued burning further south-east to Mount Barney Creek, where with the aid of considerable water bombing the fire was held. Meanwhile the fire had burnt south from the ignition point over Minnages Mountain, through the White Water Gully catchment and up into the eastern headwaters of Burnett Creek, burning up to and over the Queensland-New South Wales border in multiple places on the McPherson Range southwest of Mt Ballow. In this area considerable upland subtropical rainforest burnt, with several incursions into cool temperate rainforest dominated by Antarctic Beech *Nothofagus moorei,* although the timing of these areas burning was probably towards the end of the fire event, in December, following further drying of rainforests. In this area, the also fire burnt through three areas subjected to planned burns in the two years prior: Yowie Break (135.6ha, burnt less than three months earlier), Drummer Break (58.0ha) and Burnett Creek (17.25ha).

Into November 2019 the fire progressed south past Bald Knob, burning into and extensively in New South Wales. It burnt through the south-eastern and southern headwaters of Burnett Creek, across the main channel of Burnett

Creek and west through its western headwaters to Stags Head and Mount Clunie. By the end of November and into December 2019 the fire had burnt extensive areas of Donaldson and Mount Lindesay State Forests and Nothofagus National Park in New South Wales and north back across the Queensland-New South Wales border in the vicinity of Barney Spur and Mount Ernest. Severe to extreme fire weather resulted in the fire crossing the Mount Lindsay Highway in multiple places, with the fire burning over Mount Lindsay. It was however contained between Mount Lindsay and Mount Glennie and to the north of Mount Lindsay. During this time, Mount Ernest burnt at high to extreme severity despite being burnt in a bushfire two years earlier.

Through late November and December 2019 the fire continued its progression north along the steep eastern slopes and summits of Mount Barney (East and West Peaks), crossing Mount Barney Creek and continuing north and west across private lands to the Paddys Peak and Mount May area of Mount Barney NP. During this phase of the fire aerial incendiaries were used along upper ridges and summits to try and burn out areas ahead of the fire-fronts, with down-slope fire late in the day (refer Suppression Methods section). This in conjunction with the fire burning into northerly winds, resulted in much lower severity fire over extensive areas in the northern parts of the fire ground. The fire was contained along Paddys Gully to the south of the Mount Maroon massif.

The fire was deemed to be out on 7 January 2020.

Fire was extensive within Mount Barney NP, however several significant areas remained unburnt including the headwaters of Palen Creek, Mount Gillies, Mount Maroon and the interior of the most extensive area of rainforest in the park, in the catchments of Ballow Creek and the headwaters of Mount Barney Creek.

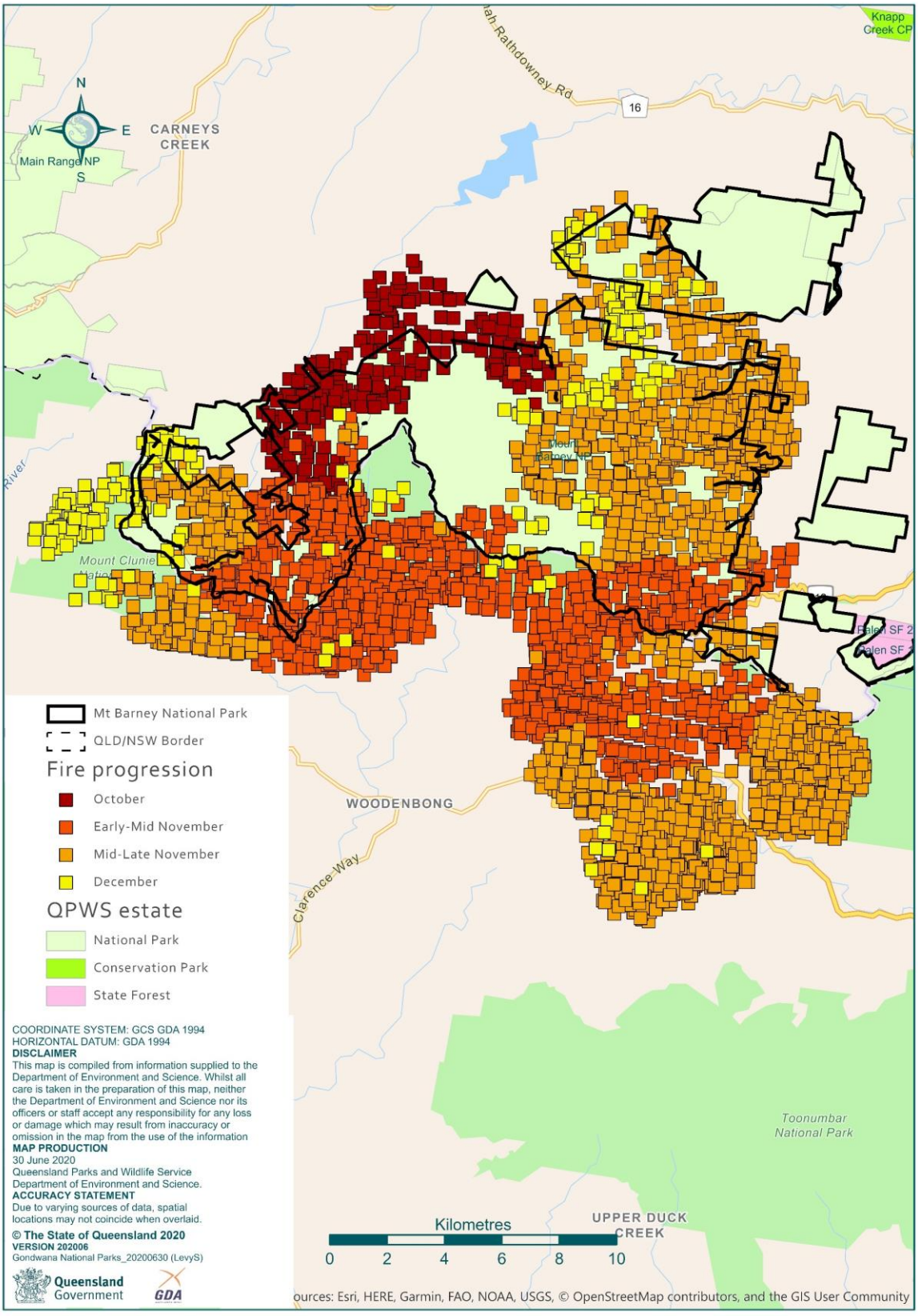

Figure 1. The progression of the Mount Barney NP 2019 bushfire across the landscape from October to December 2019 based on VIIRS hotspots FIRMS (2020). The Mount Barney NP boundary is shown in black. Note VIIRS pixel size is 375m, and hotspots can be missed due to low intensity fire, cloud cover or incomplete satellite passes. This map therefore provides a coarse overview of the fire's progression. Note that there was some ongoing fire during January 2020 but not significantly beyond the extent depicted.

3.1.2 Observations of fire behaviour by local QPWS staff

- In the two fire seasons preceding the 2019 bushfire, 3 138ha of Mount Barney NP had burnt. Limited planned burning was possible in 2018 and 2019, due to extremely dry conditions, however 135.6ha was burnt in the Yowie Break area in July 2019. Despite the extensive prior burning, fire conditions were so severe in 2019 that no recent, previously burnt areas halted the progression of the bushfire, including the area burnt in July 2019, just a few months prior to the bushfire.
- Previously, areas of the park with brush box canopy and rainforest understorey, were largely thought of as rainforest, as they were largely impossible to burn in a planned and safe way. It did however become clear during the 2019 bushfire that these areas were flammable and as such couldn't be relied on for fire breaks in the extreme conditions.
- Mount Barney NP staff had never experienced fire conditions like those in 2019, and along with other firefighting agencies were understandingly overwhelmed by the difficulty of suppression, the length of time the fire burnt and the area of the park that was burnt. It's likely that all staff have in some way been psychologically affected by the bushfire event.
- Not only did large areas of Mount Barney NP burn, but the severity in some areas appears to have been unprecedented, for example flame heights of 1-2m in palm forest on a creek flat.

3.2 Weather

The Bureau of Meteorology (2019a & b, 2020) undertook detailed analyses of the fire weather affecting north-east New South Wales (NSW) and south-east Queensland (Qld) during spring 2019 and early summer of 2019-2020. Key climate and weather factors leading up to and during the fire event include:

- Rainfall prior to October 2019 had been below average on a range of timescales from months to years, leading to a prolonged and severe drought.
- Rainfall for the area was within the first decile (i.e. very much below average) for the period January to August 2019.
- In conjunction with the low rainfall, temperatures for 2019 had been consistently warmer than average contributing to greater rates of drying and higher values of the drought factor.
- From early September 2019 through December 2019 there were periods with much warmer than average daytime temperatures, very low relative humidity (<5%), and gusty winds.

The McArthur Forest Fire Danger Index (FFDI) is commonly used in Australia to indicate the combined influence of various weather factors associated with dangerous bushfire conditions. It reflects longer-term rainfall and temperature patterns and shorter-term weather. A time series of the FFDI data (as described by Dowdy 2018) for the Gondwana Rainforests WHA areas of south-east Queensland is provided in Figs 2 and 3: annual averaged FFDI, and average number of Very High FFDI days per year (i.e. FFDI greater than 25), respectively. These figures show much higher than average FFDI for the region in 2019 and substantially higher number of days with Very High FFDI in 2019 compared to the historical data (data provided by A. Dowdy, Bureau of Meteorology, August 2020).

Daily FFDI values can be accumulated (summed) over longer periods of time and the accumulated FFDI values for spring 2019 were very much above average (BoM 2019a) and were the highest on record for the region during December (based on all years since 1950).

Only very small amounts of rain (cumulatively 54mm) fell on the fire ground from mid-October 2019 to mid-Jan 2020, with only two significant falls (10mm on 11 Dec 2019 and 20mm on 23 Dec 2019) (Burnett Creek Pluviograph - https://water-monitoring.information.qld.gov.au/) which moderated fire behaviour for short periods. The predominantly northerly airflow late in the fire event, slowed the northern progression of fire and provided opportunities to contain the fire without significant rainfall.

It wasn't until mid-January 2020 that significant rain started falling on the fire ground (411mm of rain was received in the 30 days from 14 January 2020 at Burnett Creek Pluviograph).

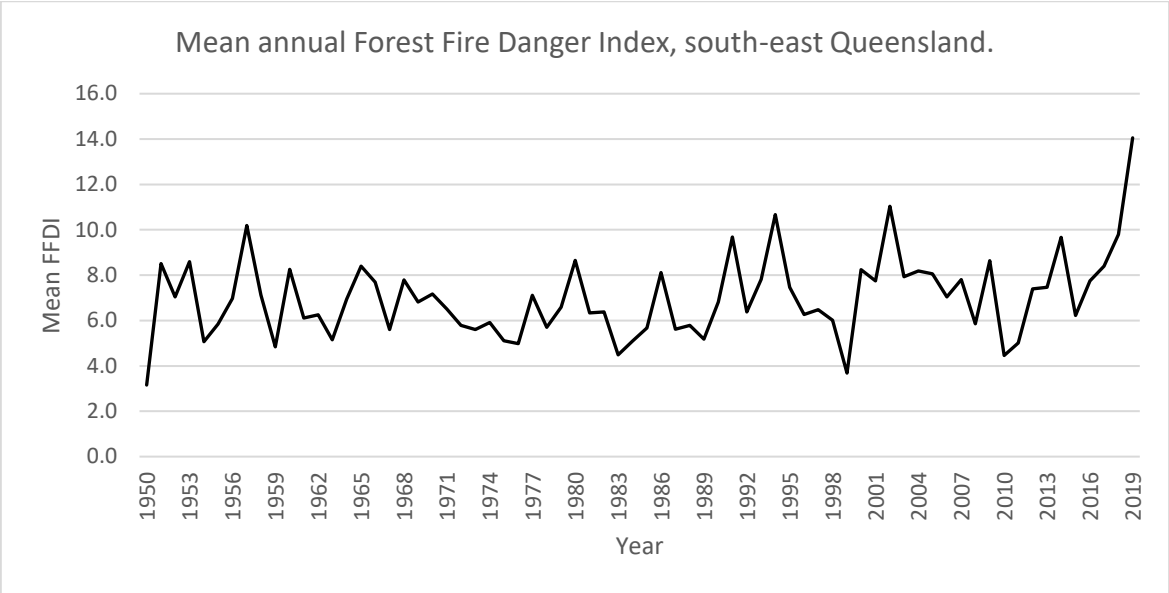

Figure 2. Time series of mean annual Forest Fire Danger Index (FFDI) for south-east Queensland (28-29S 152-153.5E).

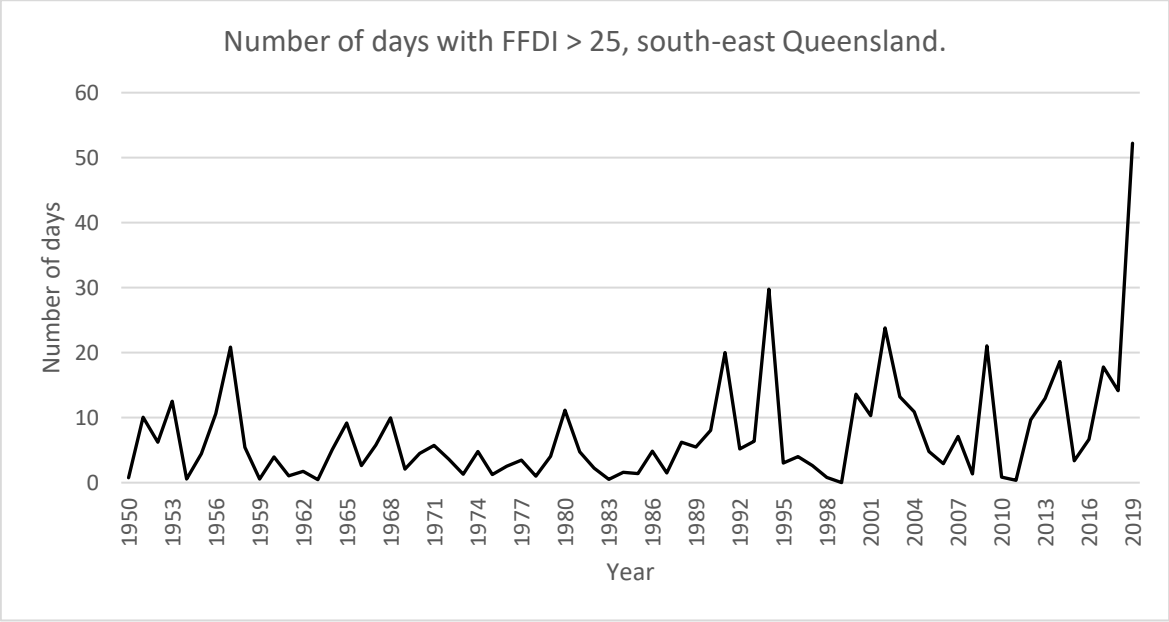

Figure 3. Time series of the number of severe Forest Fire Danger Index days (FFDI >25 = Very High) per year, for south-east Queensland (28-29S 152-153.5E).

3.3 Suppression methods used on estate

The aim of this section is to briefly describe fire suppression methods used within QPWS estate, particularly those that may have significant impacts on natural values (e.g. construction of new fire lines, use of foams and retardants in sensitive ecosystems).

Due to the threat to life and property posed by the fires, QFES took control of the fire for much of the time. During the course of the bushfire event QFES set up major incident control centres to coordinate response to the fire both on- and off-QPWS estate. QPWS staff were deployed both on the fire ground and within the control centres. Firefighters were drawn from QPWS, rural fire and urban brigades, interstate agencies and internationally (New Zealand). Natural values were not always considered when implementing suppression strategies with, for example some back burns lit outside of QPWS estate that subsequently burnt onto estate with high severity.

A range of suppression methods was used on QPWS estate during the event. Aerial water bombing on QPWS estate was mostly carried out using helicopters and no retardant or gels were used on park. Both QPWS and contractor machinery, such as dozers, loaders and positracks, where used at various times to improve or reconstruct fire control lines. Several old logging tracks were reopened (e.g. Sugarloaf area) and two previously dead-end tracks were joined in the Golden Stairs area. Extensive back-burning off roads and fire breaks was undertaken. As the fire progressed aerial incendiaries were dropped from helicopter on the peaks of Mt Barney and Mt May to slow the spread of fire and reduce fire severity by allowing fire to burn downslope in the late afternoon and overnight. Significant efforts were made to successfully protect the Mt Maroon section from the fire.

4 Assessment methods

4.1 Fire extent and severity mapping

Spatial data was supplied by Department of Environment and Science, QFES, and Department of Natural Resources Mines and Energy.

Fire progression was mapped daily at times using satellite imagery from Planet.com imagery, Sentinel-2 and linescan data. A shortwave infrared rendering was used to depict the fire front and burnt area in Sentinel-2 and false colour rendering was applied to the Planet.com imagery. Linescan data was provided by QFES. The final fire extent (Fig. 4) was derived from the above sources and refined using fire severity mapping described below and field assessments. Digitising was completed using ArcGIS Pro 2.4.2.

Fire severity mapping (Fig. 5), using 12 band Sentinel-2 L2A satellite imagery, formed the basis of the assessment for the bushfire. The fire severity classification was derived from pre- and post-fire imagery covering the extent of the fire. Images had a resolution of approximately 20m. A Normalised Burn Ratio (NBR) classification was developed for both the pre-fire and post-fire images (Brewer *et al.* 2005, Miller and Thode 2007), using Sentinel-2 bands 8 (b8) and 12 (b12) according to the following formula:

$$(b8 - b12) / (b8 + b12)$$

A NBR difference product (dNBR = Pre fire NBR - Post fire NBR) was derived and divided into five relative fire severity classes (Extreme, High, Moderate, Low and Unburnt) (Table 2). These classes were based on visual interpretation of the imagery, informed by ground-based field assessment. Appendix 1 contains photographs of burnt sites from within the assessment area.

Overall, the dNBR analysis created a consistent and generally reliable classified product reflecting relative damage to the forest canopy and subcanopy. The classification worked best in sclerophyll ecosystems. Field assessments showed that some areas of rainforest mapped with low severity fire were unburnt and some areas mapped as unburnt had experienced low severity fire. This is a known limitation of the method for tall forests with dense canopies or subcanopies.

The relative fire severity classification must be treated as an approximation, as the analysis was rapid in nature with limited verification. However, these limitations are unlikely to significantly affect overall assessments of likely ecological impacts nor unduly influence management and recovery recommendations.

Note that fire severity refers to an observable effect on vegetation (in our assessments through the use of satellite imagery, with some ground observations). It shouldn't be confused with fire intensity, which in its simplest definition is the energy output of a fire (which is influenced by a range of variables including amount of fuel, fuel configuration, fuel dryness, prevailing weather, slope, residence time). Thus, a low intensity fire in some vegetation communities (e.g. grasslands) can result in high fire severity (complete removal of standing vegetation) but a fire of the same intensity in an open forest can result in low fire severity (complete removal of the grassy understorey, with no scorching or consumption of shrub or canopy layers).

Table 2. Relative fire severity classes derived from the dNBR analysis.

Note: Canopy here refers to the ecologically dominant layer – the layer that contributes most to the overall biomass of the vegetation community (Neldner *et al*. 2020).

Severity class	**Relative fire severity class description**	**Maximum dNBR value**
Unburnt	Unburnt, canopy and subcanopy unchanged (within the mapped extent).	0.22
Low	Canopy and subcanopy unscorched, shrubs may be scorched, fire-sensitive low shrubs may be killed.	0.32
Moderate	Partial canopy scorch, subcanopy partially or completely scorched, and/or fire-sensitive tall shrub or small tree layer mostly killed.	0.50
High	Full canopy scorch to partial canopy consumption, subcanopy fully scorched or consumed.	0.62
Extreme	Full canopy, subcanopy and understorey consumption.	10.00

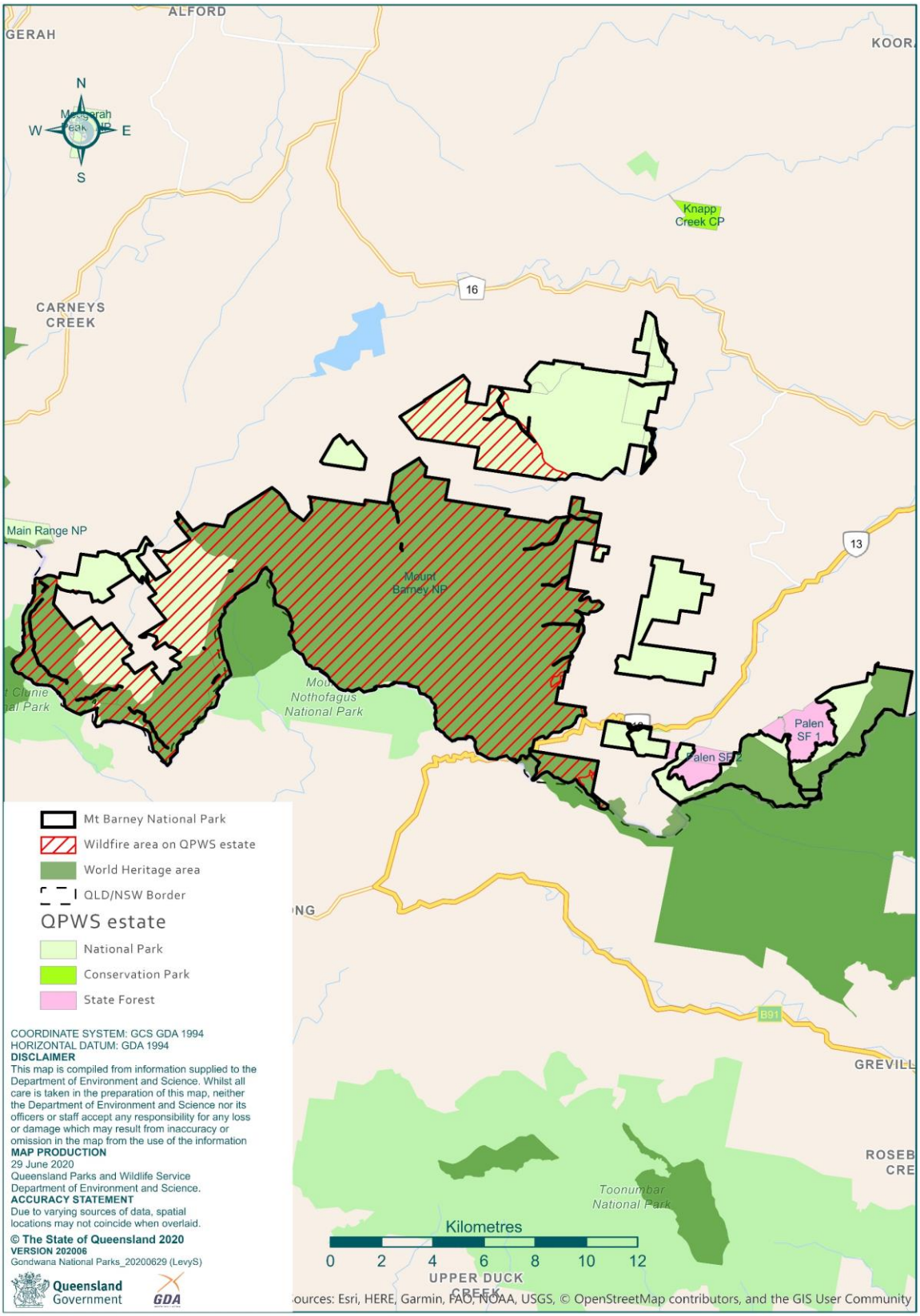

Figure 4. Extent of the Mount Barney NP 2019 bushfire, in relation to the Gondwana Rainforests WHA within Mount Barney NP (shown as olive green).

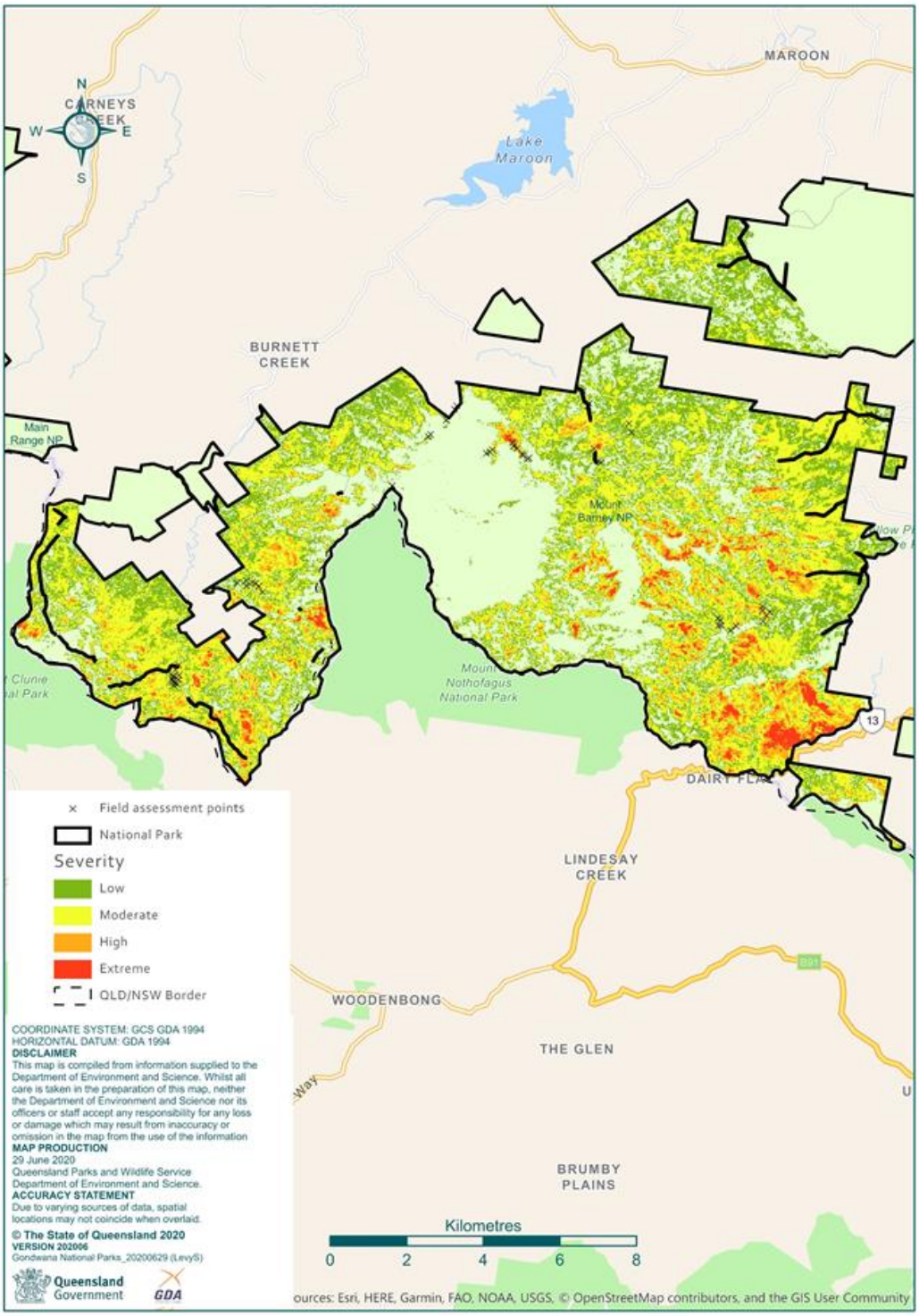

Figure 5. Relative fire severity of the Mount Barney NP 2019 bushfire. Black crosses show the location of verification sites.

4.2 Vegetation

Regional Ecosystems (REs) are vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil. The Queensland Herbarium has mapped REs throughout Queensland and version (10.1) was used for this assessment (Queensland Herbarium 2018). Many areas have a high spatial diversity of vegetation communities, so at 1:100 000 scale it is not always possible to spatially delineate each vegetation community into homogenous (pure) polygons. Consequently, mapped RE polygons are often heterogeneous, such that a polygon is attributed to more than one regional ecosystem code (e.g. 12.8.6/12.8.7), with the percentage of the area of the polygon occupied by each regional ecosystem or vegetation recorded (Neldner *et al.* 2020). For the purposes of this report the RE assessment utilises RE1, or the dominant RE for each mapped polygon, and doesn't attempt to consider the percentage of it within the polygon. The resolution or scale of RE mapping delineates a minimum area for remnant vegetation of 1ha and/or 35m in width.

REs are grouped into higher-level vegetation communities referred to as Broad Vegetation Groups (BVGs) (Neldner *et al.* 2019) and summaries of RE1, and BVG 1:2 000 000 and 1:5 000 000 scales are provided (see Appendices 2 and 3).

4.3 Conservation significant species data sources

Information on conservation significant species (threatened, Near Threatened, Special Least Concern or endemic forest fauna and flora species) known, or likely, to occur in the burn area, was principally derived from the state's wildlife information system WildNet (accessed 15 November 2021), which includes plant species locality information held by the Queensland Herbarium. WildNet was searched for records with a locational precision of 2000m or better that fell within the latitudes of -28.18428 and -28.37252 and longitudes of 152.50516 and 152.75427 (Appendix 4). This rectangle included an approximate 2km buffer on the northern, eastern, southern and western extent of the QPWS estate affected by the fire event. Limited validation was undertaken, but some records or species were rejected due to likely spatial or taxonomic errors or vagrants. Some plant species were excluded, as the only records of them were from the Mount Bangalora area of Main Range NP, (to the west of Mount Barney NP, but fell within the latitude/longitude search rectangle).

Spatial datasets on significant species are inherently limited and biased, so we also summarised the area of modelled potential habitat (DES 2019) for selected conservation significant species within the burn area. Refer to Appendix 5 for a description of methods used. The lists generated by the models were scrutinised by departmental experts and species deemed highly unlikely to occur on the park were removed.

Knowledge of local staff, published and unpublished information, as well as expert opinion, were used to augment the spatial analyses and inform the impact assessment process. To help identify those significant species most at risk from bushfire each was classified according to their known or likely fire sensitivity, or dependence upon fire-sensitive ecosystems.

Species nomenclature, taxonomy and statuses used in this report follow WildNet. In the body of the report we use common names for birds and mammals and scientific names for all other species.

4.4 Field assessment

Field assessment of ecological impacts and limited verification of fire extent and severity mapping was conducted by the authors over the following periods:

- 13/03/2020 Burnett Ck
- 06/05/2020 Cronan Ck
- 07/05/2020 Mt Ernest, Barney Ck and Yamahra Ck

Inspections were made on foot or by vehicle. Verification sites are shown as black crosses on Fig. 5. Completion of this report was delayed due to competing post-fire activities, however these activities included targeted threatened species surveys in additional areas of the park (e.g. Mount Barney saddle and peaks, summit of Mt Ernest, slopes of Mount Ballow and Stags Heads). Whilst the results of the threatened species work are not presented here, observations of fire impacts and post-fire recovery made during this work informed the assessment presented in the report.

In addition to the QPWS&P field assessments, draft severity mapping was provided to Innis Larkin of Mount Barney Lodge and he and his staff undertook assessments in remote areas of the park, targeting high altitude rainforests, as follows:

- late May – early June 2020 Montserrat Lookout – Focal Peak – Mowburra and Durramlee Peaks, Minnages Mountain – Mount Ballow – ridge south of Mount Ballow – Double Peak

Bushwalkers provided further insights into the extent and severity of fire in the remote or very difficult to access parts of the park, for example:

- Kristian Smith traversed open forests, montane heaths/shrublands and some rainforest areas over the period 17-19 August 2020. He documented the fire through a series of georeferenced photographs. His route included an ascent of the ridge to the south of Egan Creek (Savages Ridge), western slopes of Mount Barney West Peak, Barrabool, headwaters of Barrabool Creek and Burrajum Peak.
- Michael Meadows undertook a traverse of Mount Lindesay in July 2020 and provided a series of photographs.
- Tim Capes walked from Mount Nothofagus along the Queensland-New South Wales border, then north along Barney Spur to Gwyala Peak and Upper Portals, in September 2020, and shared a series of georeferenced photographs.

Overall observations of impacts on, and recovery of vegetation, fire severity and a series of photographs were recorded at many locations across the very rugged and difficult to access Mount Barney NP. These combined observations greatly aided this assessment.

4.5 Data and report availability

The fire severity mapping is available via the Queensland Government's Open Data Portal, through the Queensland Spatial Catalogue at https://qldspatial.information.qld.gov.au/catalogue. Internally the mapping is available through the Spatial Information Resource (SIR) (administered by Department of Natural Resources and Mines). The dataset name is “Fire Extent and Severity 2019-2020 - South East Queensland”.

This report is available in WildNet Multimedia, Media ID = 28155, and is searchable using the keywords: fire, severity, ecological, natural values, assessment, Mount Barney NP or via the link:
http://wildnet/wildnet/bin/WNE0130$VMEDIAQRY.QueryView?P_MEDIA_ID=28155

5 Summary of areas burnt

Basic fire details and a summary of areas burnt are provided in Table 3. Statistics were derived using ArcGIS and the sources identified in the table. A summary of the areas burnt (ha) by relative fire severity class is provided in Table 4. The map of relative fire severity is provided in Figure 5.

Table 3. Summary of burnt areas

Description	Value and units	Source and notes
FLAME Fire ID, name and label	1337107 – Double Peak	Mount Barney National Park/NP/W/2019/001
QFES fire name(s)	Mount Barney, Mount May, Mount Maroon, Mount Lindesay, Rathdowney, Barney View, Palen Creek and Carneys Creek	QFES Newsroom https://newsroom.psba.qld.gov.au/
Fire start date	17/10/2019	FLAME
Fire started on or off-estate	On	FLAME
Date fire first recorded on estate	17/10/2019	FLAME
Date fire declared out	07/01/2020	FLAME
Total area burnt (on and off estate)	30 399.36ha 27 255.36ha	FLAME extent mapping FireHistory (QPortal)
Bioregion(s)	South East Queensland	This report
Estate name(s) burnt	Mount Barney NP	FLAME and this report
QPWS Region(s)	South East Queensland	
Area of QPWS estate burnt	8 784.87ha (Mount Barney NP)	This report (Table 4, Appendix 3), based on relative fire severity mapping. See also Table 4.
Area burnt within World Heritage Area (Mount Barney NP tenure only)	7 012.07ha	This report, based on relative fire severity mapping. Name of WHA: Gondwana Rainforests World Heritage Area ENVBAT.QLD_WORLDHERTAREA See also Table 4.
Area burnt within Ramsar areas	0ha	Name of Ramsar area: N/A
Directory of Important Wetlands of Australia within burn extent	0ha	Directory of Important Wetlands in Australia (DEE 2019).
Area burnt of habitat of State Biodiversity Significance (BAMM) (Mount Barney NP)	7 859.16ha	This report, based on relative fire severity mapping. SIR dataset: ENVBAT.BPA_SEQ See also Table 4.
Area of core Koala habitat (SEQ Koala Conservation Strategy 2019-2024) burnt (Mount Barney NP)	7 204.97ha	This report, based on relative fire severity mapping. SIR datasets: ENVBAT.HSM_SEQRP_KOALA See also Table 4.

Table 4. Area burnt (ha) during the 2019 bushfire, by relative fire severity class, within Mount Barney NP.

Severity class	QPWS estate	Gondwana Rainforests WHA	BAMM State Biodiversity Significance	Core Koala habitat
Low	3682.58	2790.61	3189.73	3110.18
Moderate	4033.43	3250.81	3640.92	3318.42
High	802.00	716.36	767.36	582.40
Extreme	266.87	254.29	261.14	193.96
Total	**8784.87**	**7012.07**	**7859.16**	**7204.97**

5.1 Vegetation burnt

Summaries of the area of Regional Ecosystems and Broad Vegetation Groups within Mount Barney NP burnt during the 2019 bushfire, by relative fire severity class, are provided in Appendices 2 and 3 respectively.

5.1.1 Potential ecological impact

The ecological impact of any given fire event on a vegetation community depends upon the extent and severity of the fire and the tolerance or sensitivity of the community to fire, as well as the history of previous fires. Many ecosystems are adapted to fire and require fire of an appropriate severity and interval to maintain ecosystem health. Other ecosystems are fire intolerant or fire-sensitive and if they burn significant long-term ecological damage is likely.

For this assessment, REs were classified into three fire tolerance categories using fire management guidelines provided in the Regional Ecosystem Description Database (Qld Herbarium 2019) for RE1 and expert knowledge:

- *fire-sensitive canopy and understorey,*
- *fire tolerant canopy/fire-sensitive understorey,* or
- *fire tolerant canopy and understorey.*

The area, of each of the three fire tolerance categories, subjected to low, moderate, high or extreme fire severity, is shown in Table 5A. Burnt areas were assigned to three Potential Ecological Impact classes, based on the matrix (Table 5A) of fire severity and fire tolerance of the vegetation communities and the susceptibility of the ecosystem to threats, such as invasion by ecosystem-changing weeds, that could significantly impede or derail recovery. A summary of the Potential Ecological Impact is provided in Table 5B, is mapped in Fig. 6, and discussed in section 6.

The concept of Potential Ecological Impact, which integrates fire severity mapping with knowledge of vegetation community fire tolerance and threats to post-fire recovery, helps identify areas likely most severely impacted that may require increased resources (e.g. pest management), or altered management approaches (e.g. modification to planned burn program) to facilitate recovery. Conversely, areas may be identified as likely requiring little or no additional management intervention. The classes of Potential Ecological Impact used for this assessment are further explained in Box 1.

Table 5A. Area (ha) of burnt remnant vegetation classified by fire tolerance and relative fire severity class within Mount Barney NP during the 2019 bushfire.

Fire severity		Fire tolerance of vegetation community (based on RE1)		
		Fire-sensitive canopy and understorey	Fire tolerant canopy/fire-sensitive understorey	Fire tolerant canopy and understorey
Low	Canopy and subcanopy unscorched, shrubs may be scorched, fire-sensitive low shrubs may be killed.	**855**	**918**	**1872**
Moderate	Partial canopy scorch, subcanopy partially or completely scorched, and/or fire-sensitive tall shrub or small tree layer mostly killed.	**998**	**1247**	**1771**
High	Full canopy scorch to partial canopy consumption, subcanopy fully scorched or consumed.	**264**	**264**	**273**
Extreme	Full canopy, subcanopy and understorey consumption.	**76**	**94**	**97**

Table 5B. Potential ecological impact (ha) to burnt remnant vegetation based on fire tolerance and relative fire severity class, for RE1, within Mount Barney NP during the 2019 bushfire.

Note that the concept of potential ecological impact class also considers the susceptibility of the ecosystem (given the fire severity to which it has been subjected) to threats post-fire that could significantly impede recovery.

Potential ecological impact class	Fire tolerance of vegetation community (based on RE1)		
	Fire-sensitive canopy and understorey	Fire tolerant canopy/fire-sensitive understorey	Fire tolerant canopy and understorey
Limited or none		**918**	**3643**
Moderate	**855**	**1247**	**273**
High	**998**	**264**	**97**
Catastrophic	**341**	**94**	

Box 1. Overview of the Potential Ecological Impact classes

Limited or no potential ecological impact (green):

The consequence of the fire is likely to be short-term with persistent canopy and subcanopy cover, and expected relative rapid regeneration by native, fire-adapted, understorey species, helping to minimise the risk of weed invasion by ecosystem-changing species (if they were not already established prior to the fire). There will be limited or no impact on fauna species reliant on the canopy species for food and/or shelter (e.g. hollows) and likely relatively short-term impacts on species reliant on the understorey.

Moderate potential ecological impact (yellow):

There may be localised decline in, or loss of, some understorey species, over the short-term as a direct consequence of the fire and associated poor regenerative capacity or specialised requirements of some species for successful regeneration, and/or as a consequence of a reduction in resources or specialised niches.

High potential ecological impact (orange):

Rainforest recovery requires recovery of both structure and composition and is expected to be slow (decades to hundreds of years) given: the loss of some to many trees (either as a direct consequence of the fire or because of associated stressors such as fungal attack – there may be ongoing death of some tree species/individuals for several years after the fire); vegetative regeneration, where it occurs, is likely to be predominantly basal or from the rootstock; loss of the seedling bank and likely limited seed-bank means that the recovery of some species will be dependent on seed being transported into the site. The risk of invasion by ecosystem-changing weed species (e.g. *Lantana camara*) is likely to be high and may be exacerbated by past disturbance regimes.

For the eucalypt-dominated communities this class reflects: the immediate to short or mid-term impacts on food resources for fauna; loss of critical structural elements and faunal habitat features such as large hollow bearing trees which take decades to hundreds of years to replace; likely changes in understorey species composition, in the short to mid-term at least, in the wet eucalypt open forests that have a rainforest understorey and the potential flow-on effects to faunal assemblages; loss of epiphytes and niches suitable for their re-establishment at least in the mid-term. It is recognised that occasional high intensity fire in wet eucalypt open forests is likely critical to the ecology of the ecosystem in terms of providing opportunity for eucalypt regeneration in sites where rainforest dominates the understorey and may assist, in conjunction with a planned burn program, in maintaining a grassy to mixed shrubby understorey in others. The risk of invasion by ecosystem-changing weeds is likely to be high and may be exacerbated by past disturbance regimes.

Catastrophic potential ecological impact (red):

There is significant risk of an ecosystem not recovering as a consequence of the substantial changes in structure, composition and microclimate and associated likelihood of invasion by ecosystem-changing weeds or native species better adapted to the post-fire environment than the impacted ecosystem, and/or risk of future fire. Some, possibly many, flora and fauna species can be expected to be permanently lost from the location. The risk of permanent change is greater where surrounding ecosystems are also significantly impacted by the bushfire or other disturbances and/or there are no sources of propagules nearby.

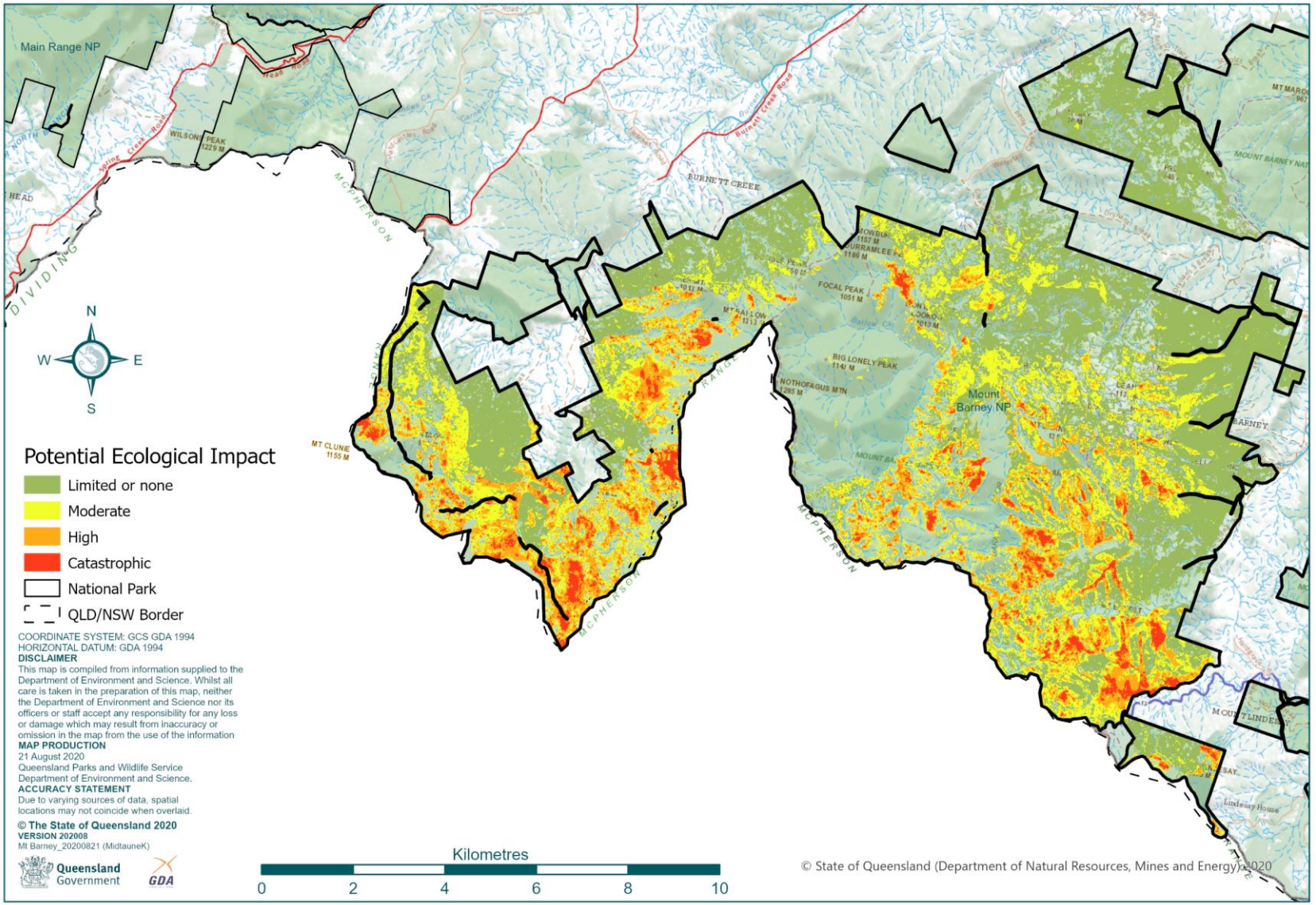

Figure 6. Map of potential ecological impact of the Mount Barney NP 2019 bushfire.

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5.2 Significant species potentially impacted

The list of conservation significant forest fauna and flora species recorded from within a buffered bounding rectangle of the fire extent is provided in Appendix 4. Appendix 5 summarises the area of potential habitat for selected conservation significant species within each relative fire severity class. A large number of conservation significant flora and fauna species are known, or have potential habitat, within the burnt area. Potential impacts on threatened species are discussed in section 6.3. Impacts on these species will vary, but those dependent upon fire-sensitive communities are likely to have been most affected – for example rufous scrub-bird and *Mixophyes fleayi*.

Six fauna species have more than 5% (up to 15.3%) of their potential Queensland habitat falling within Mount Barney NP: rufous scrub-bird, eastern bristlebird, Albert's lyrebird, *Mixophyes fleayi,* brush-tailed rock-wallaby and Hastings River mouse. These species had 41-57% of their potential habitat within Mount Barney NP burnt.

Seventeen flora species have more than 15% (up to 100%) of their potential Queensland habitat falling within Mount Barney NP: *Acacia acrionastes, Agiortia cicatricata, Banksia conferta, Bertya ernestiana, Comesperma breviflorum, Coopernookia scabridiuscula, Dendrobium schneiderae* var*. schneiderae, Eucalyptus codonocarpa, Euphrasia bella, Hibbertia monticola, Leionema elatius* subsp. *beckleri, Leptospermum barneyense, Phlegmariurus varius, Pseudanthus pauciflorus* subsp*. pauciflorus, Pultenaea whiteana, Tetramolopium vagans* and *Zieria montana.* These species had 5-89% of their potential habitat within Mount Barney NP burnt.

Maps, showing potential ecological impact, overlain with potential habitat for species not deemed by the department to be confidential, are presented in Appendix 8.

5.3 Area of Natural Key Values burnt

Under the Values Based Management Framework, eight draft Natural Key Values (NKV) have been identified for Mount Barney NP. Table 8 lists these draft NKVs and the Broad Vegetation Groups (BVG 2M) they comprise. Fig. 7 shows the location of the draft NKVs with respect to the extent of the 2019 bushfire. The area burnt for each draft NKV by relative severity class is summarised in Table 8.

Much of Mount Barney NP, including a majority of the burnt area, falls within the Gondwana Rainforests World Heritage Area, meeting various natural heritage criteria for Outstanding Universal Value. The draft NKVs identified for Mount Barney NP incorporate these values. Further detail of the World Heritage Value of Mount Barney NP is included in Appendix 7.

Our assessment below of the potential impacts of the bushfire on natural values is structured such that potential impacts to NKVs (when they are finalised and approved in the near future), and Outstanding Universal Value can be readily evaluated.

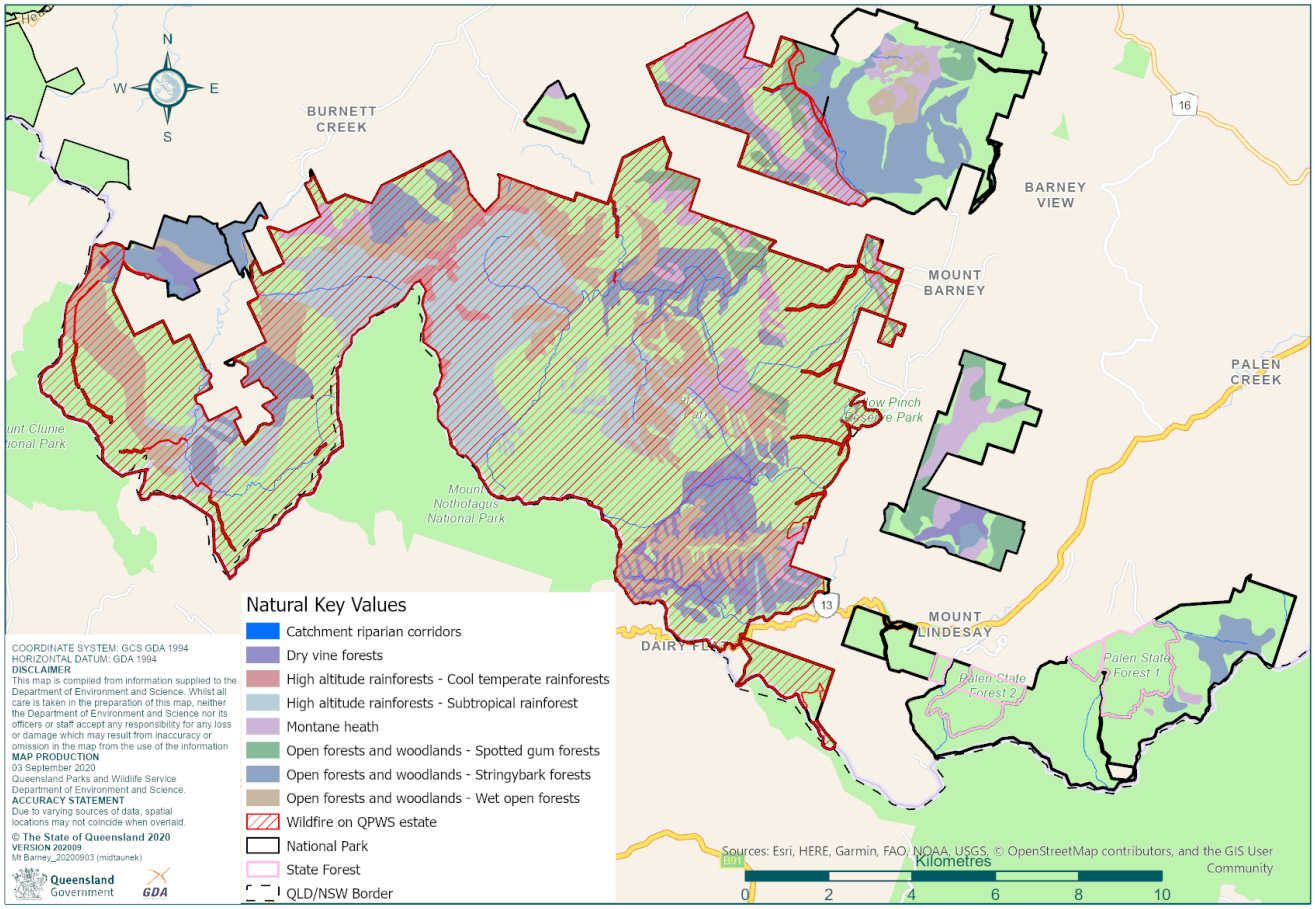


Figure 7. Draft Natural Key Values of Mount Barney NP showing the extent of the 2019 bushfire.

Table 8. Area burnt of draft Natural Key Values (NKV) (ha) in Mount Barney NP, by relative fire severity class (Mod = moderate, Ext = extreme). The Broad Vegetation Group (BVG 2M) of each NKV is shown in parentheses.

Natural Key Value (Draft)	Area of NKV (ha)	Percent NKV burnt	Low	Mod	High	Ext
Catchment riparian corridors (various BVGs)	130.37	47.6	31.15	24.68	4.39	1.79
Dry vine forests (BVG 5)	246.11	79.7	65.64	89.02	34.38	7.04
High altitude rainforests - cool temperate rainforests (BVG 6)	139.44	7.8	6.33	3.49	0.94	0.15
High altitude rainforests - subtropical rainforest (BVG 6)	2148.52	30.8	266.48	303.81	72.29	19.12
Montane heath (BVG 29)	821.76	66.2	289.19	208.77	30.43	15.72
Open forests and woodlands - spotted gum forests (BVG 10)	251.30	65.4	108.37	51.31	3.90	0.76
Open forests and woodlands - stringybark forests (BVG 9)	1530.18	80.0	491.20	543.42	137.43	52.40
Open forests and woodlands - wet open forests (BVG 8)	1999.52	76.9	525.82	768.92	179.32	63.32
Total	**7267.20**	**60.5**	**1784.18**	**1993.43**	**463.06**	**160.30**

5.4 Ecological monitoring sites

Existing ecological monitoring sites that are known to, or are likely to, have burnt during the event are listed in Table 6 together with basic details and the priority (high to low or not a priority) for re-sampling the site/plots to better inform an assessment of the impact of fire on natural values and subsequent recovery.

Table 6. Existing ecological monitoring sites that are known to or are likely to have burnt during the event.

Dataset name	Type of monitoring	General location of monitoring site(s)	Custodian	Priority for resampling
Threatened frogs	Nocturnal stream censuses	Cronan Creek area	Harry Hines, QPWS	High
Eastern bristlebird	Point based playback surveys and monitoring	Mount Barney saddle/summits	David Stewart QPWS BirdLife Southern Queensland – Sheena Gillman	High
Rufous scrub-bird	Point based listening surveys	Mount Barney saddle/summits	David Stewart QPWS	High

6 Significant impacts and recovery actions

6.1 Summary of priority impacts and recovery actions

Five natural values were assessed as being significantly impacted by the bushfire event. For the purposes of our assessment these are defined using Broad Vegetation Groups at the 1:2 000 000 scale (BVG 2M):

Value ID.	Value descriptor
NV 1	Rainforests – Vine forests and fern forests to thickets – Regional Ecosystems with a fire-sensitive canopy and understorey. – BVGs 2, 4, 5 and 6.
NV 2	Wet eucalypt open forests and rainforest/eucalypt forest ecotones – Regional Ecosystems and rainforest/eucalypt forest ecotones with a fire tolerant canopy and a fire-sensitive understorey. – BVG 8.
NV 3	Dry eucalypt forests and woodlands – Regional Ecosystems with a fire tolerant canopy and understorey. – BVGs 9, 10, 11 and 13.
NV 4	Montane heaths and shrublands – Regional Ecosystems with a fire tolerant canopy and understorey. – BVGs 28 and 29.
NV 5	Riparian corridors – Regional Ecosystems fringing streams with either a fire-sensitive or fire tolerant canopy and a fire-sensitive understorey. – various BVGs.

The highest priority impacts and actions for recovery are summarised below. A detailed assessment of each significant known or likely impact to natural values and a full list of recommended recovery actions are provided in section 6.3.

- **Rainforest:** iconic, highly diverse, fire-sensitive ecosystems. A majority of burnt rainforests have high to catastrophic potential ecological impact due to the sensitivity of the ecosystems to fire, the fire severity and its impact on the structure and composition, and the significant risk of invasion by ecosystem-changing weeds. Recovery is likely to take decades (at least) and will require exclusion of fire and the prevention of invasion by weeds. A review of fire management planning for surrounding fire-adapted ecosystems – with the aim of minimising risk of fire incursion into recovering rainforest (and unburnt rainforest), and control of ecosystem-changing weeds are the highest priority actions.
- **Wet eucalypt open forests and rainforest/eucalypt forest ecotones:** diverse ecosystems, some with high temporal and spatial variability, with a range of fire sensitivities. Most burnt areas have moderate to high potential ecological impact. The ecological requirement for occasional high intensity fires in some of these ecosystems is recognised. However, the risk of invasion by ecosystem-changing weeds that have the potential to derail recovery (directly through competition and indirectly through changed future fire regimes) is factored into the evaluation of potential ecological impact. The risk of weed invasion is exacerbated where fire has substantially impacted the canopy and subcanopy. The control of ecosystem-changing weeds, and a review of strategies for weed and fire management in adjacent drier sclerophyll communities, are the highest priority actions.
- **Dry eucalypt forests and woodlands:** diverse, fire dependent ecosystems with a range of ecological fire requirements. Potential ecological impact is predominantly low, but there are significant areas of moderate to high impact. Whilst these ecosystems are fire-adapted the partial to full consumption of the canopy and subcanopy in some areas represents long-term impact with respect to faunal habitat values, some of which may take decades to hundreds of years to form (e.g. hollow-bearing trees). Opening up of the canopy and subcanopy also increases the risk of invasion by ecosystem-changing weeds. Preventing the invasion of ecosystem-changing weeds is the priority action.

- **Montane heaths and shrublands:** fragile, naturally fragmented communities, with a distinctive flora, including species endemic to the park. They are fire-adapted and high to extreme fire severity is likely to be within the ecological tolerance of the ecosystem. Some areas are prone to weed invasion. The potential ecological impact has been identified as mostly low to moderate, however there are small but significant areas with high potential ecological impact in recognition of issues concerning weeds, fire frequency and trampling by visitors. Priority actions include excluding visitors from burnt sites and reviewing fire strategies to ensure the period until the next fire event, and fire frequency thereafter, is within the ecological tolerance of the ecosystems.
- **Riparian corridors:** these ecosystems are particularly susceptible to weed invasion and erosion. The control of ecosystem-changing weeds, and the review of strategies for weed and fire management in adjacent drier sclerophyll communities, are the highest priority actions.

In addition to the risks identified above the following threats have potential to significantly impact post-fire recovery or unburnt refuges:

- **Bell Miner Associated Dieback (BMAD)** is widespread in the moister eucalypt communities of the area and is likely to be exacerbated where fire has impacted the canopy and or is likely to lead to increased understorey density (Silver & Carnegie 2017). Management of woody weeds (particularly *Lantana camara*) is a priority in these areas.
- **Feral cats** are a significant threat to a range of ground dwelling animals including several threatened species and are known to target recently burnt areas for foraging (McGregor *et al.* 2014). Cats are likely widespread within Mount Barney NP but data on their distribution and abundance are lacking. Trials of emerging cat control technology are recommended in areas where there may be post-fire predation risks to populations of threatened mammals.
- **Feral pigs** are an emerging issue in Mount Barney NP. An assessment of their current distribution and abundance is required, with ongoing targeted control recommended, particularly in highly sensitive recovering communities (e.g. temperate rainforests, riparian corridors).
- **Feral deer** (mostly red deer but fallow deer have also been observed in the area) have been observed sporadically over the past 10 to 15 years. Their ecological impacts in forest communities in south-east Queensland are not well understood. Baseline information on their distribution and abundance in Mount Barney NP will help inform assessments of potential ecological impact and direct control efforts if required.
- **Cattle** from adjoining properties range widely in parts of Mount Barney NP, including well inside the Gondwana Rainforests WHA. This is due to boundary fences being poorly maintained, absent or destroyed by the fire. Cattle grazing will likely significantly impede post-fire recovery, particularly for grassy ecosystems and seedling regeneration of some canopy species. Disturbance from cattle will facilitate weed establishment. Cattle may also damage riparian areas, including breeding sites for threatened frogs, and reduce water quality through erosion, sedimentation and fouling. Recommendations include urgent repair of critical existing fence lines, installation of priority new fence lines and increased liaison with adjoining landowners to exclude stock from protected areas.
- **Pathogens** such as myrtle rust, *Phytophthora* and amphibian chytrid fungus are current or potential threats to a range of significant values of Mount Barney NP.

It is recommended that restoration plantings are not undertaken within the World Heritage Area given the risk of introducing novel genetic material, invasive plants or fungi (e.g. orange pore fungus *Favolaschia calocera*) or pathogens. Soil compaction caused by repeated visitation to a site can also be detrimental and impede natural regeneration. Previously cleared areas may be an exception and are discussed in section 6.4.

6.2 Limitations

This report focuses on a single fire event, and we recognise that the response or recovery of ecosystems and species will vary depending on fire history, and future fire and climate. For many species, information on their fire ecology is lacking or poorly known. The direct impact from fire, post-fire response and recovery potential will vary widely among sites and species. For example, for some plant species the above-ground part of the plant is killed by the fire but may recover by resprouting from the base or rootstock (e.g. some rainforest species), or above-ground parts of the plant are scorched, and recovery is from epicormic resprouting (e.g. eucalypts). However, much regeneration (especially rainforest) will be from seed as the seedling bank has been killed. For those species dependent upon basal resprouting or seed, recovery may take decades, but in some cases species may, unfortunately, be locally lost. In our assessment of the potential ecological impact of the fire we assumed that impacts to ecosystems dominated by fire tolerant vegetation types were likely to be relatively lower and of shorter duration than impacts to fire-sensitive communities, based on known and assumed species and ecosystem fire response.

Regional Ecosystem mapping and Broad Vegetation Groups underpin our assessment. Many polygons mapped within Mount Barney NP QPWS estate are heterogeneous, meaning more than one vegetation or regional ecosystem occurs within it, generally because the REs occur in a mosaic below the scale of mapping. A local example demonstrates this issue where small areas of New England blackbutt *Eucalyptus campanulata* tall open forest with a rainforest understorey are at times incorporated as a sub-dominant RE within rainforest polygons (rather than being mapped as homogeneous polygons of RE 12.8.9), and vice versa. In this instance, this community is mapped within vegetation communities that fall into a different Broad Vegetation Group that has different fire tolerances. Communities dominated by New England blackbutt in Mount Barney NP have a fire tolerant canopy and typically a fire tolerant understorey, whereas rainforest is entirely fire-sensitive. Field observations showed that some areas mapped with moderate severity fire within rainforest polygons contained New England blackbutt, which germinated from fires likely to have occurred centuries ago. These issues of scale and heterogeneity within RE mapping complicate our assessment, however RE mapping provides a reasonable framework for quantitative analysis.

These limitations are unlikely to grossly affect recommended post-fire management actions. Local-scale knowledge of park managers during implementation of on-ground recovery programs will help ensure effective conservation outcomes.

6.3 Impact assessment and recovery actions

6.3.1 NV 1: Rainforests

Potential ecological impact: extensive areas of moderate and high, with significant areas of catastrophic.

Recommended recovery actions

1. Prevent the establishment of high biomass grasses and *Lantana camara* immediately adjacent to and within the burnt rainforest communities, with regular herbicide treatment in the growing season. This requires an early and regular ongoing response.
2. Surveillance and strategic control of vine and herbaceous weeds. This requires an early and regular ongoing response.
3. Surveillance of tree and shrub weeds and undertake 6-12 monthly, strategic control.
4. Surveillance and strategic thinning of native vine, shrub or tree species, only if causing arrested ecosystem recovery over a broad area and over a long duration or is impacting a highly restricted significant natural value.
5. Continue efforts to control pigs in the Burnett Creek catchment as the population is relatively small but has the potential to severely impact significant values (e.g. degradation of the habitat of threatened rainforest frogs).
6. Assess the distribution and abundance of feral deer, cats, foxes and pigs within rainforests and undertake strategic control programs where significant values may be impacted or threatened.
7. Reinstate damaged, or install new, boundary fencing in strategic locations to prevent cattle entering regenerating rainforest areas. Priority areas include Burnett and Watson Creeks.
8. Undertake a survey for the threatened black-breasted button-quail, to determine its distribution and abundance within the area (currently known from a single sign-based sighting [feeding marks or platelets] at Palen Creek). This species is potentially highly susceptible to cat predation.
9. It is recommended that restoration plantings are not undertaken within the World Heritage Area (refer section 6.4 for exceptions) in order to avoid the unintended introduction of novel genetic material, invasive plants or fungi (e.g. orange pore fungus *Favolaschia calocera*) and pathogens including myrtle rust. Soil compaction caused by repeated visitation to a site is also detrimental to rainforest soils and can impact natural regeneration.
10. Review strategies for weed and fire management in adjacent sclerophyll communities with the aim to reduce the risk of future fire encroachment into rainforests.
11. Undertake Health Checks (Melzer *et al*. 2019) for rainforest – these will facilitate early detection of pest plants and animals and cattle and enable condition to be evaluated over time.
12. Establish additional long-term vegetation monitoring plots in burnt rainforest communities to evaluate the rate and direction of recovery and to fill knowledge gaps with respect to the fire response of species (Queensland Herbarium and Ecological Assessment Unit with support from Regional Technical Support and Management Unit).
13. Monitor for increased biosecurity risk from pathogens such as myrtle rust (which favours new growth, common post-fire).
14. Investigate additional remote sensing methods to map more precisely the ecological impact in rainforests currently assessed as having low fire severity.

Contracting of pest and weed control and boundary fencing may be necessary due to competing priorities (e.g. undertaking planned burning) in the growing season, the extent of the treatment area and access constraints. Where contractors are engaged, strong oversight is required to ensure works are undertaken appropriately (e.g. minimal clearing of fence lines, minimising non-target impacts during weed control).

Overview of value and impact

This value includes all rainforests and includes Regional Ecosystems with a fire-sensitive canopy and understorey within BVG 2M groups 2, 4, 5 and 6 (Appendices 2 and 3). Fire severity and impact photographs are provided in Appendix 1, Figs A1.1-4.

Rainforests are a primary natural and aesthetic value of Mount Barney NP and Gondwana Rainforests WHA. They are fire-sensitive communities and therefore park management aims to exclude fire from them. Higher intensity fires in these communities have high to catastrophic and long-lasting impacts. Drier rainforest communities may have more resilience to low intensity fire than moister rainforest communities, although response to such fire in these communities is not well understood.

About 2 194ha, or 41% of the total extent of rainforests within Mount Barney NP burnt during the fire. Most of the rainforests that burnt fall within the Gondwana Rainforests WHA, with the exception of some areas in the White Water, Drummer and Yowie Gullies, Watsons Creek and the main branch of Burnett Creek. In some areas fire penetrated long distances (hundreds of metres to kilometres) through rainforest communities, including burning

temperate rainforests and cloud forests at altitudes in excess of 1000-1100m (e.g. Minnages Mtn – Fig A1.3., southwest of Mount Ballow – Fig. A1.4, north of Mount Ballow, Burrajum, Durramlee and Focal Peak areas).

Within affected rainforests approximately 39.0% burnt at low, 45.5% at moderate, and 12.0% at high and 3.5% at extreme relative severity (Appendix 2), with likely ecological impact ranging from moderate to catastrophic (section 5.1.1). About 341ha of rainforests burnt at high to extreme severity with catastrophic ecological impacts likely in those areas, which represents 6.3% of the area of rainforest within Mount Barney NP. The interior of the large rainforest patches at Mount Barney NP (e.g. majority of Ballow Creek catchment, headwaters of Mount Barney and Cronan Creeks) did not burn and are considered important refuges and sources of wildlife.

During field assessments we observed that rainforests with low intensity fire had considerable variation in ecological impacts. Where fire appears to have burnt quickly, then extinguished, impacts were relatively minor, with loss of the uppermost leaf litter layer and death of ground cover, seedlings and saplings, with no loss of sub-canopy and canopy trees. However, in rainforest areas where low intensity fire persisted (often probably as smouldering fire with little or no flame), deeper leaf litter burnt. Where this occurred in accumulated litter around the base of larger trees this caused the roots and or base of trees to burn out with the tree subsequently dying and at times toppling (Figs. A1.2, A1.4), causing significant additional canopy damage. In these areas, low intensity fire has caused significantly higher ecological impact. Remote sensing of canopy changes over longer time periods may be required to get a better understanding of the ecological impact of low intensity fire in these rainforests, to help direct on-ground management actions.

The rainforests within the extent of the fire are known or likely habitat for a large number of threatened or other significant wildlife species (Appendices 4 and 5). Impacts on these species will vary but those that live in or depend upon the forest floor (e.g. rufous scrub-bird, black-breasted button-quail, long-nosed potoroo, *Mixophyes fleayi*, *Philoria* sp., threatened rainforest plants with seedling banks) are likely to be most significantly impacted, together with plant species with no or limited capacity for resprouting.

A significant number of large fig trees were lost (fire burning out the dead host trunk and causing the fig to collapse or die – Fig. A1.1). Figs are keystone species, providing a critical food source for many animals (e.g. Coxen's fig-parrot, fruit doves, fruit bats) as well as roosting habitat (e.g. micro bats, sooty owl) or sheltering/foraging habitat (e.g. snakes, *Saltuarius swaini*) as well as providing habitat for many epiphytic plants. Where possible protect large established figs from future fires or competition through manual removal of high biomass grasses, *Lantana camara* and smothering vines.

The seedling and sapling bank in rainforests is assembled over decades of recruitment and in fire-impacted areas is likely to have been greatly reduced or eliminated, removing the next generation of recruits. This will be a particularly significant issue where the mature individuals in a population have been killed. In areas where fire has also burnt the soils' organic horizon, it is likely that the seed bank has also been substantially reduced or removed. Seed dispersal from surrounding areas of forest into the understorey of fire-impacted areas and the suppression of competition from weeds will be vital to recovery. A range of rainforest species have the capacity to resprout, predominantly from the base or rootstock, at least in some circumstances. For those species dependent upon basal resprouting and/or seed, recovery may take decades. Species reliant solely on regeneration from seed may be locally lost unless there is a nearby source and suitable vectors for dispersal.

The establishment or promotion of ecosystem-changing weeds (refer Appendix 6) or high biomass native grasses poses a serious risk to rainforest communities. High biomass exotic grasses (e.g. *Megathyrsus maximus*.) and *Lantana camara* are common in some disturbed areas of the park and adjoining lands. They greatly increase the risk of future fire incursion and higher intensity fire. The bare ground and loss of canopy cover resulting from the current fire provide an ideal environment for their germination and establishment adjacent to, and within, rainforest communities. Further fires in burnt rainforest are likely to eliminate any possibility of the recovery of these communities.

Tree and shrub weeds (e.g. *Solanum torvum*), various vines (e.g. *Araujia sericifera*) and herbaceous weeds (e.g. *Ageratina adenophora, A. riparia*) are highly invasive in disturbed rainforests of the region. Conditions post-fire are ideal for their establishment or spread. While these weeds are unlikely to pose a significant future fire risk, they can seriously impede recovery of rainforest.

Other weed species were widespread, and in places very dense, in rainforests within the first year of the fire, particularly where fire severity was higher, or in areas with large tree falls. These included species such as *Phytolacca octandra* (inkweed). A proliferation of vines occurred in other areas, but these were however, dominated by native species. These herbaceous weeds and native vines are likely to be important in the immediate aftermath of the fire in binding soil and providing rapid cover. In the absence of further disturbances, these weeds and vines will likely be suppressed in the short to medium term as the burnt rainforests recover.

Burnt rainforest communities are however at risk of:
– arrested recovery, with communities dominated for years to decades by native rainforest pioneer species including *Acacia* or vine species,

– conversion to a more fire tolerant regional ecosystem facilitating further fires along rainforest ecotones or acting as a conduit for fire further into rainforests, or
– novel communities dominated by non-native species (e.g. *Lantana camara*).
Where native species are observed to be causing arrested recovery there are two situations where management intervention may be warranted. The first is where the issue is occurring over a large area and the impact is likely to be long-term (decades). The second is where a significant natural value with a highly restricted distribution (e.g. an important population of a threatened plant species) is being impacted. Management of this issue in rainforests is limited to manual thinning, which has been used successfully in restoration of disturbed tropical rainforests. Any removal of native species needs to be well justified and should be trialled at a small scale with monitoring to determine whether the desired result is achieved.

Burnt rainforest communities are at risk due to increased edge effects including weed and pest animal invasion. Cats and cane toads are known to prefer open areas for foraging and movement, with cats known to target recently burnt areas for foraging (McGregor *et al*. 2014). Cane toads are toxic to predators and have likely been a significant contributor to the local decline of spotted-tail quolls. It is not anticipated that the cane toads will establish breeding populations within burnt rainforest, but the more open understorey in the short-term is likely to facilitate dispersal of post-metamorphic animals in the park. Cats are a significant threat to a range of ground dwelling animals including several threatened species. Currently there appears to be only a relatively small, isolated populations of feral pigs in the rainforests of Mount Barney NP (e.g. Burnett Creek valley). Pigs have the potential to seriously impact recovering rainforest and habitat in unburnt refuges (e.g. the soaks and boggy stream margins which form critical habitat for *Euastacus sulcatus* and *Philoria* sp.), as well as spread pathogens such as phytophthora. We observed post-fire coppicing of the Critically Endangered *Rhodamnia rubescens* in rainforests and rainforest ecotones in various locations in Mount Barney NP severely compromised by myrtle rust (e.g. Fig. A1.15), a key threat to this and other myrtaceous species, particularly post-fire (Fernandez Winzer *et al.* 2020).

Cattle from adjoining properties range widely within rainforest areas of Mount Barney NP, including inside the Gondwana Rainforests WHA. Considerable cattle activity was observed in the bed of Burnett Creek, within known habitat for three species of threatened frogs.

6.3.2 NV 2: Wet eucalypt open forests and rainforest/eucalypt forest ecotones

Potential ecological impact: mostly moderate, with significant areas of high-catastrophic, significant areas of limited of no potential ecological impact.

Recommended recovery actions

1. Prevent the establishment of high biomass grasses and *Lantana camara* immediately adjacent to and within these communities, with regular herbicide treatment in the growing season. This requires an early and regular ongoing response.
2. Surveillance of vine and herbaceous weeds and undertake strategic control. This requires an early and regular ongoing response.
3. Surveillance of tree and shrub weeds and undertake 6-12 monthly, strategic control.
4. Surveillance and strategic thinning of native vine, shrub or tree species that is causing arrested ecosystem recovery over a broad area and over a long duration or is impacting a highly restricted significant natural value.
5. Review the fire strategy and reassess approved planned burns within wet eucalypt forest, to consider the location and extent of these ecosystems that burnt, with the aim of maintaining a range of fire age classes including long-unburnt.
6. Assess the distribution and abundance of feral deer, cats, foxes and pigs within these communities, and undertake strategic control programs where significant values may be impacted or threatened (e.g. degradation of habitat or predation of long-nosed potoroo).
7. Trial the use of Felixer cat and fox control system in recovering burnt areas where known populations of threatened long-nosed potoroo are potentially at risk (e.g. Burnett Creek catchment).
8. Reinstate damaged, or install new, boundary fences in strategic locations to prevent cattle entering regenerating areas in the Burnett Creek catchment.
9. It is recommended that restoration plantings are not undertaken within the World Heritage Area (refer section 6.4 for exceptions) in order to avoid the unintended introduction of novel genetic material, invasive plants or fungi (e.g. orange pore fungus *Favolaschia calocera*) and pathogens including myrtle rust. Soil compaction caused by repeated visitation to a site is also detrimental to rainforest soils and can impact natural regeneration.
10. Review strategies for weed and fire management in adjacent drier sclerophyll communities so that recommended fire frequencies are achieved in wet eucalypt open forests and rainforest/eucalypt forest ecotones.

11. Undertake Health Checks (Melzer *et al*. 2019) – these will facilitate early detection of pest plants and animals and cattle and enable condition to be evaluated across the estates.
12. Establish long-term vegetation monitoring plots in these communities to evaluate the rate and direction of recovery and to fill knowledge gaps with respect to the fire response of species (Queensland Herbarium and Ecological Assessment Unit with support from Regional Technical support and Management Unit and/or external researchers).
13. Monitor for increased biosecurity risk from pathogens such as myrtle rust (which favours new growth, common post-fire).

Contracting of pest and weed control and boundary fencing may be necessary due to competing priorities (e.g. undertaking planned burning) in the growing season, the extent of the treatment area and access constraints. Where contractors are engaged, strong oversight is required to ensure works are undertaken appropriately (e.g. minimal clearing of fence lines, minimising non-target impacts during weed control).

Overview of value and impact

This value includes Regional Ecosystems and rainforest/eucalypt forest ecotones with a fire tolerant canopy and a fire-sensitive understorey, including BVG 2M group 8 (Appendices 2 and 3). Note that ecotones may not be mapped as RE polygons as they are typically narrow and dynamic – refer section 6.1. Fire severity and impact photographs are provided in Appendix 1, Figs A1.5-6.

Wet eucalypt open forests and rainforest/eucalypt forest ecotones are a significant value of Mount Barney NP and Gondwana Rainforests WHA. They have a fire-sensitive understorey and management aims for long intervals, 8-20+ years (shorter where there is a grassy understorey), between planned burns, with an occasional high intensity fire.

Over 2 321ha or 61.2% of wet eucalypt open forests burnt during the Mount Barney NP 2019 bushfire (Appendix 3). Within burnt wet eucalypt open forests approximately 32.9% burnt at low, 49.7% at moderate, 12.5% at high and 4.8% at extreme relative severity (Appendix 2), resulting in mostly moderate to high, with small areas of catastrophic, potential ecological impact. There were also significant areas where potential ecological impact was likely limited or none.

During field assessments, we observed significant ecological impacts within these communities, even in some areas where fire severity was mapped as low. As we observed in rainforests, fire burnt deep into leaf litter and decomposed organic matter accumulated around the base of larger trees, causing the roots and or base of trees to burn out, with the tree toppling, causing significant additional canopy damage (Fig. A1.5). In these sclerophyll communities, this issue was probably exacerbated by the presence of basal hollows or scars from previous fire events. Due to past timber harvesting large hollow-bearing trees are relatively scare at Mount Barney NP, so the further loss of such an important resource (for denning, roosting, breeding) is significant.

Given the extensive impacts of fire in these communities, reviews of approved planned burns and the fire strategy are necessary. This will ensure an appropriate range and distribution of post-fire age classes are maintained or re-established, including long-unburnt patches which are a feature of this community.

Where these communities have a well-developed rainforest understorey, they provide known or likely habitat for the same suite of threatened or other significant wildlife species as rainforests, with similar potential impacts (refer NV_1). Where these communities have a dense native grass understorey, they provide potential habitat for threatened species such as southern emu-wren, long-nosed potoroo, Hastings River mouse and eastern bristlebird. As the overstorey is sclerophyll dominated, these communities provide feeding and shelter habitat for central greater glider and koala. Large old growth trees in wet eucalypt forests provide numerous hollows critical to the shelter and or breeding of many species (e.g. micro-bats, possums and gliders, owl nest sites).

The establishment or promotion of ecosystem-changing weeds (refer Appendix 6) or high biomass native grasses poses a serious risk to these communities. High biomass exotic grasses (e.g. *Megathyrsus maximus*) and *Lantana camara* are common in disturbed (e.g. logged) areas of the park and adjoining lands. They greatly increase the risk and severity of future fire in these communities. The bare ground and loss of canopy cover resulting from the fire provide an ideal environment for their germination and establishment adjacent to, and within, these communities. Likewise, an increased dominance of some native grasses (e.g. blady grass *Imperata cylindrica*) may also be undesirable due to their flammability.

Tree and shrub weeds (e.g. *Ligustrum lucidum*, *L. sinense*), various vines (e.g. *Araujia sericifera*) and herbaceous weeds (e.g. *Ageratina adenophora, A. riparia*) can be invasive in wet eucalypt forests and rainforest-wet eucalypt forest ecotones of the region. Conditions post-fire are ideal for their establishment or spread. While these weeds are unlikely to pose a significant future fire risk, they can seriously impede recovery of rainforest-wet eucalypt forest ecotones.

Other weed species were widespread, and in places very dense, in wet eucalypt forest and rainforest-wet eucalypt forest ecotones, within the first year of the fire, particularly where fire severity was higher, or in areas with large tree

falls. These included species such as *Phytolacca octandra* (inkweed). A proliferation of vines occurred in other areas, but these were however, dominated by native species. These herbaceous weeds and native vines are likely to be important in the immediate aftermath of the fire in binding soil and providing rapid cover. In the absence of further disturbances, these weeds and vines will likely be suppressed in the short-medium term as the burnt wet eucalypt forest and rainforest-wet eucalypt forest ecotones recover.

Burnt rainforest-wet sclerophyll forest ecotones are however at risk of:
– arrested recovery, with communities dominated for years to decades by native rainforest pioneer species including *Acacia* or vine species,
– conversion to a more fire tolerant regional ecosystem facilitating further fires along rainforest ecotones or acting as a conduit for fire further into rainforests, or
– novel communities dominated by non-native species (e.g. *Lantana camara*).
Where native species are observed to be causing arrested recovery in these ecotones there are two situations where management intervention may be warranted. The first is where the issue is occurring over a large area and the impact is likely to be long-term (decades). The second is where a significant natural value with a highly restricted distribution (e.g. an important population of a threatened plant species) is being impacted. Management of this issue in rainforests is limited to manual thinning, which has been used successfully in restoration of disturbed tropical rainforests. Any removal of native species needs to be well justified and should be trialled at a small scale with monitoring to determine whether the desired result is achieved.

Disturbed wet eucalypt open forests increase the risk of bell minor populations, leading to declines in passerine diversity and an increase in bell miner associated dieback (BMAD). BMAD is widespread in the moister eucalypt communities of Mount Barney NP and is likely to be exacerbated where fire has impacted the canopy and or is likely to lead to increased understorey density (Silver & Carnegie 2017). Management of woody weeds (particularly *Lantana camara*) and introduced vines is a priority in these areas.

Cattle from adjoining properties range widely within wet eucalypt forests and rainforest-wet eucalypt forest ecotones of Mount Barney NP, including inside the Gondwana Rainforests WHA. During post-fire field assessments we observed significant cattle impacts on recovering wet eucalypt forests and rainforest-wet eucalypt forest ecotones (for example in the Burnett Creek catchment).

Where these communities have lost their rainforest understorey, they are at risk due to increased edge effects including weed and pest animal invasion. Cats and cane toads are known to prefer open areas for foraging and movement, with cats known to target recently burnt areas for foraging (McGregor *et al.* 2014). Cane toads are toxic to predators and have likely been a significant contributor to the local decline of spotted-tail quolls. Cats are a significant threat to a range of ground dwelling animals including several threatened species.

6.3.3 NV 3: Dry eucalypt forests and woodlands

Potential ecological impact: a majority of the burnt areas are likely to have limited to no potential ecological impact, but there are significant areas of moderate to high potential ecological impact.

Recommended recovery actions

1. Prevent the establishment of high biomass grasses and *Lantana camara*, especially in areas adjacent to fire-sensitive communities such as rainforest. Use regular herbicide treatment in the growing season. This requires an early and regular ongoing response.
2. Surveillance of vine and herbaceous weeds and undertake strategic control. This requires an early and regular ongoing response.
3. Surveillance of tree and shrub weeds and undertake 6-12 monthly, strategic control.
4. Review the fire strategy and reassess approved planned burns within dry eucalypt forests and woodlands, to consider the location and extent of these ecosystems that burnt, with the aim of maintaining the recommended range of fire age classes and protecting rainforests and burnt wet eucalypt forests from fire.
5. Assess the distribution and abundance of feral deer, cats, foxes and pigs, and undertake strategic control programs where significant values are being impacted or threatened (e.g. habitat degradation or predation of Hastings River and New Holland mice).
6. Reinstate damaged, or install new, boundary fences in strategic locations to prevent cattle entering regenerating areas.
7. Review strategies for weed and fire management in these communities; aim to reduce the risk of future fire encroachments into adjacent rainforest, and to identify and protect important unburnt (particularly longer unburnt) dry eucalypt forest refugia.
8. Undertake Health Checks (Melzer *et al*. 2019) – these will facilitate early detection of pest plants and animals and cattle and enable condition to be evaluated across the estates.

9. Establish long-term vegetation monitoring plots in severely burnt dry eucalypt forest and woodland communities to evaluate the rate and direction of recovery and to fill knowledge gaps with respect to the fire response of species (Queensland Herbarium and Ecological Assessment Unit with support from Regional Technical support and Management Unit and/or external researchers).
10. Monitor for increased biosecurity risk from pathogens such as myrtle rust (which favours new growth, common post-fire).

Contracting of pest and weed control and boundary fencing may be necessary due to competing priorities (e.g. undertaking planned burning) in the growing season, the extent of the treatment area and access constraints. Where contractors be engaged, strong oversight is required to ensure works are undertaken appropriately (e.g. minimal clearing of fence lines, minimising non-target impacts during weed control).

Overview of value and impact

This value includes Regional Ecosystems with a fire tolerant canopy and understorey within BVG 2M groups 9, 10, 11 and 13 (Appendices 2 and 3). Fire severity and impact photographs are provided in Appendix 1, Figs A1.7-8.

Dry eucalypt forests and woodlands are a significant value of the area and a component of the Gondwana Rainforests WHA. They are fire-adapted communities and fire management is critical to their conservation. Management of these communities includes burning to maintain their health, with desired extent, frequency and intensity of burning guided by the ecology of these systems and the threats to them (e.g. weed invasion) (NPRSR 2013, Queensland Herbarium 2018). Significant areas of high to extreme severity fire in these communities are likely to have serious ecological impacts in the short-medium term.

About 4 050ha of dry eucalypt forests and woodlands burnt during the Mount Barney NP 2019 bushfire (Appendix 3), which represents 49.0% of BVG 2M groups 9, 10, 11, 13 and 16 within Mount Barney NP (with none of BVG 2M 16 burning during the 2019 bushfire). Within burnt dry eucalypt forests and woodlands approximately 48.5% burnt at low severity, 44.4% at moderate severity, 5.4% at high and 1.6% at extreme severity (Appendix 2) with potential ecological impact mostly limited or none (section 5.1.1). During field assessments we observed some areas with significant loss of canopy/tree death, although in places some of this appears to have been due to preceding drought (e.g. areas with shallow, seasonally waterlogged soils such as in the Stags Head area). There was also loss of some large trees from basal fires and complete loss of ground cover resulting in exposed mineral earth in areas of higher severity. We also observed widespread recovery of trees with post-fire coppicing and epicormic regrowth. However, there has been subsequent death of a significant number of reshooting trees in the period up to 12 months post-fire, highlighting that impacts in fire-adapted communities may continue for months to years following fire.

Given the extensive impacts of fire and drought in these communities a review of approved planned burns and the fire strategy are necessary. This will ensure an appropriate range and distribution of post-fire age classes are maintained or re-established, important refuges are protected, and the risk of fires encroaching rainforests or burnt wet eucalypt forests is minimised.

Dry eucalypt forests and woodlands within the extent of the fire are known or likely habitat for a number of threatened or other significant wildlife species (Appendices 4 and 5). Impacts on these species will vary but those that live in or depend upon the forest floor (e.g. *Adelotus brevis*), depend upon foliage for food (e.g. koala, central greater glider), or large hollow bearing trees for denning, roosting or breeding (e.g. central greater and yellow-bellied gliders, various micro bats and birds) are likely to be most significantly impacted. Due to past timber harvesting large hollow-bearing trees are relatively scare at Mount Barney NP, so the further loss of such an important resource during the bushfire is significant.

The establishment or promotion of ecosystem-changing weeds (refer Appendix 6) poses a risk to dry eucalypt forests and woodlands communities. High biomass exotic grasses (e.g. *Hyparrhenia* species) and *Lantana camara* are common in disturbed areas (e.g. logged) of the park and adjoining lands. They increase the risk of higher fire frequency and or severity. The bare ground and loss of canopy cover resulting from the fire provide an ideal environment for their germination and establishment, particularly in moister communities on higher fertility soils.

Burnt communities are at risk due to increased edge effects including weed and pest animal invasion. Cats and cane toads are known to prefer open areas for foraging and movement, with cats known to target recently burnt areas for foraging (McGregor *et al.* 2014). Cane toads are toxic to predators and have likely been a significant contributor to the local decline of spotted-tail quolls. The more open understorey in the short-term is likely to facilitate dispersal of cane toads in the park. Cats are a significant threat to a range of ground dwelling animals including several threatened species.

Cattle from adjoining properties range widely within dry eucalypt forests and woodlands burnt in the Mount Barney NP 2019 fire. During post-fire field assessments, we observed significant cattle impacts on recovering dry forests and woodlands (for example in the Burnett Creek catchment).

6.3.4 NV 4: Montane heaths and shrublands

Potential ecological impact: low to moderate with some areas of high, at least in the short-term.

Recommended recovery actions

1. Where possible restrict visitor access across rocky pavements, outcrops and cliff tops to avoid trampling, illegal collecting and nutrient additions from food waste and excrement.
2. Familiarise staff with threatened montane heath species in the field so that accidental damage due to track maintenance or weed control can be avoided.
3. Surveillance of vine and herbaceous weeds (*Ageratina* spp.) and undertake strategic control, particularly in areas where populations of endemic or threatened plant species occur. This requires an early and regular ongoing response.
4. Assess the impacts of disturbance and grazing from pigs and deer.
5. Support the release of biological control agents to reduce impacts from *Ageratina* weed species.
6. Review the fire strategy and reassess approved planned burns within montane heaths and shrublands, to consider the location and extent of these ecosystems that burnt, with the aim of maintaining the recommended range of fire age classes.
7. Protect unburnt refugia, including Mt Maroon, where possible from any fire, whilst burnt montane heath and shrubland communities recover sufficiently.
8. Prioritise suppression of bushfires that start within or threaten montane heaths and shrublands.
9. Avoid the use of fire retardants and gels in montane heaths and shrublands.
10. Limited use of aerial incendiaries may be warranted to reduce fire severity if the unburnt or recovering montane communities come under direct threat of bushfire.
11. Undertake Health Checks (Melzer *et al.* 2019) – these will facilitate early detection of pest plants and animals and cattle and enable condition to be evaluated across the estates.
12. Establish long-term vegetation monitoring plots in montane heath and shrubland communities to evaluate the rate and direction of recovery and to fill knowledge gaps with respect to the fire response of species (Queensland Herbarium and Ecological Assessment Unit with support from Regional Technical support and Management Unit).
13. Undertake research on the distribution and ecology of threatened montane heath and shrubland plant species.
14. Monitor for increased biosecurity risk from pathogens such as myrtle rust. The latter favours new growth which is common post-disturbance.

Overview of value and impact

This value includes Regional Ecosystems with a fire tolerant canopy and understorey within BVG 2M groups 28 and 29 (Appendices 2 and 3). Fire severity and impact photographs are provided in Appendix 1, Figs A1.9-11.

Montane heaths and shrublands are a significant value of Mount Barney NP and Gondwana Rainforests WHA. They sit at the top of mountains, or on the cliffs and steep scarps which form the iconic landscape of Mount Barney NP. They are fire-adapted communities and fire management is critical to their conservation. Management of these communities includes burning to maintain their health, with desired extent, frequency and intensity of burning guided by the ecology of these systems and the threats to them (NPRSR 2013, Queensland Herbarium 2018). These communities generally burn at high intensity but extensive areas of exposed bedrock within these systems at Mount Barney NP tend to provide a mosaic of burn severity and age. Areas of high to extreme severity fire in these communities is likely to be within the ecological tolerance of the ecosystem, although there will likely be significant ecological impacts in the short-medium term. Whether there are longer-term impacts will be dependent upon the time since previously burnt, the period until the next fire event and fire frequency thereafter, and the degree of physical disturbance from visitation.

About 164ha or 47.5% of the mapped extent of montane heaths and shrublands burnt during the Mount Barney NP 2019 bushfire (Appendix 3). Within burnt mapped montane heaths and shrublands approximately 37.3% burnt at low, 38.8% at moderate, 16.3% at high and 7.6% at extreme relative severity (Appendix 2) with significant areas with potential ecological impact of moderate to high (section 5.1.1). There were two significant areas of montane heaths and shrublands that did not burn during the Mt Barney 2019 bushfire: Mt Maroon and rock outcrops in the Mt Gillies area. Parts of the latter however burnt during August-September 2020.

Montane heaths and shrublands are fragile, naturally fragmented communities, with a distinctive flora. Many areas are too small to be mapped as homogeneous Regional Ecosystems, but we include all such vegetation communities as well as rock pavements and cliff lines, within this value. Significant areas within this value include the peaks of Mt Barney and Mt Maroon and the rock outcrops of the Mt Ernest and Mt Gillies areas. Within the mapped extent of fire within montane heaths and shrublands, there is known or likely habitat for a number of threatened or other significant wildlife species (Appendices 4 and 5) and some of these areas form critical habitat for brush-tailed rock wallaby and several plant species. Impacts on these species will vary but most will be well-

adapted to living in such fire-prone habitat, with some potentially dependent upon fire for regeneration. Some of the significant plant species grow on rock outcrops (cliffs, peaks or rock platforms) which can provide protection for some individuals from fire. These areas would have been badly drought affected prior to the fire, resulting in increased impacts from the fire, possibly causing significant ecological impact.

Given the extensive impacts of fire and drought in these communities a review of approved planned burns and the fire strategy are necessary. This will ensure an appropriate range and distribution of post-fire age classes are maintained or re-established, important refuges are protected. Mt Maroon is considered a key refuge for montane heath and shrub species, and it should be protected from fire in the near future, until other areas of montane heath and shrublands have recovered (15+ years). Suppression of fire within or that poses a threat to any of the montane heath and shrub communities of Mount Barney NP, especially Mt Maroon, should be considered a very high priority. The open nature of this community and remoteness from fire trail networks means that aerial water bombing is likely the only effective suppression method available. Given the low nutrient status of the soils and waters of these areas, the use of fire retardants, gels or waters with high nutrients (e.g. partially treated sewage) should be avoided. Limited use of aerial incendiaries, to burn downslope, may be warranted to reduce fire severity if the unburnt or recovering montane communities come under direct threat of bushfire.

In places the montane heaths and shrublands of Mount Barney NP are prone to weeds, particularly post-fire. Many of these weeds are relatively short-lived with likely limited long-term impacts. However, weeds such as *Ageratina adenophora* can form dense long-lived infestations within these habitats. Surveillance and strategic control of significant weeds is recommended. An assessment of pig and deer impacts on these communities is also required.

A highly significant threat to these communities is impacts from visitation. Where possible visitor access should be restricted across rocky pavements, outcrops and cliff tops to avoid trampling, illegal collecting and nutrient additions from food waste and excrement. Formalising walking tracks in many of these areas is not possible but the increased use of track markers and signage may be beneficial. Ensuring local staff are familiar with threatened plant species is critical to avoid inadvertent impacts from walking track maintenance and weed control. There is also evidence of illegal camping and campfires within or adjacent to montane heaths, which increases the risks identified above. Additional compliance activities may be necessary. Some areas are particularly dangerous post-fire as the substrate is loose under foot, so visitation may also need to be restricted for public safety reasons.

6.3.5 NV 5: Riparian corridors

Potential ecological impact: moderate to catastrophic

Recommended recovery actions

1. Prevent the establishment of high biomass grasses and *Lantana camara* immediately adjacent to and within the burnt riparian communities, with regular herbicide treatment in the growing season. This requires an early and regular ongoing response.
2. Surveillance of vine and herbaceous weeds and undertake strategic control. This requires an early and regular ongoing response.
3. Surveillance of tree and shrub weeds and undertake 6-12 monthly, strategic control.
4. Assess the distribution and abundance of feral deer, cats, foxes and pigs, and undertake strategic control programs where significant values are being impacted or threatened (e.g. degradation of habitat or predation of threatened frogs or *Euastacus sulcatus*).
5. Support the release of biological control agents for *Ageratina* species.
6. Reinstate damaged, or install new, boundary fences in strategic locations to prevent cattle entering regenerating riparian areas, particularly Burnett Creek catchment.
7. It is recommended that restoration plantings are not undertaken within the World Heritage Area (refer section 6.4 for exceptions) in order to avoid the unintended introduction of novel genetic material, invasive plants or fungi (e.g. orange pore fungus *Favolaschia calocera*) and pathogens including myrtle rust. Soil compaction caused by repeated visitation to a site is also detrimental to rainforest soils and can impact natural regeneration.
8. Review weed and fire management planning in adjacent sclerophyll communities to reduce the risk of future fire encroachment into riparian areas.
9. Undertake Health Checks (Melzer *et al.* 2019) for riparian communities – these will facilitate early detection of weeds and enable condition to be evaluated across the park.
10. Establish long-term vegetation monitoring plots in burnt riparian areas (e.g. Burnett Creek valley) to evaluate the rate and direction of recovery and to fill knowledge gaps with respect to the fire response of species (Queensland Herbarium and Ecological Assessment Unit with support from Regional Technical support and Management Unit and/or external researchers).
11. Monitor for increased biosecurity risk from pathogens such as myrtle rust. The latter favours new growth which is common post-disturbance.

Contracting of pest and weed control and boundary fencing may be necessary due to competing priorities (e.g. undertaking planned burning) in the growing season, the extent of the treatment area and access constraints. Where contractors are engaged, strong oversight is required to ensure works are undertaken appropriately (e.g. minimal clearing of fence lines, minimising non-target impacts during weed control).

Overview of value and impact

Vegetation fringing streams and rivers have either a fire-sensitive or fire tolerant canopy and typically a fire-sensitive understorey. Riparian communities are often not mapped as distinct Regional Ecosystems, with streams traversing a range of mapped Regional Ecosystems. As such, for Mount Barney NP, there are no spatial statistics available on extent and severity of fire in these communities. Fire severity and impact photographs are provided in Appendix 1, Figs A1.12-13.

Riparian corridors are a significant value of Mount Barney NP and Gondwana Rainforests WHA. They include a range of vegetation communities that have differing sensitivity to fire. Areas of high to extreme severity fire in these communities are likely to have serious ecological impacts in the medium to long term, regardless of the vegetation community. Areas of low to moderate severity in rainforested riparian areas are also likely to have serious ecological impacts in the medium to long term.

Riparian corridors within the mapped extent of the fire are known or likely habitat for many threatened or other significant wildlife species (Appendices 4 and 5), including many of those from rainforests, wet eucalypt forests and ecotones. Potential impacts on those species will be similar to those identified for NV_1 and NV_2.

Significant portions of Watsons, Burnett, Mount Barney, Barrabool, Cronan, Egan and Rocky Creeks, Logan River, Barney Gorge and White Water Gully catchments were burnt, with fire burning the riparian zone over many tens of kilometres. The only significant catchment within the main section of Mount Barney NP that remained largely unburnt was Ballow Creek.

The burnt riparian corridors at Mount Barney NP are known to provide core habitat for the threatened crayfish *Euastacus sulcatus* and core breeding habitat for the threatened frogs *Adelotus brevis*, *Litoria pearsoniana, Mixophyes fleayi* and *Philoria* sp. and (Appendix 4). Catchments heavily impacted by fire may have altered hydrology, water chemistry, sediment and charcoal load, although this depends on timing, duration and intensity of rainfall events post-fire. At Mount Barney NP the first significant rainfall post-fire was an intense event with 154mm in the 24hrs to 9am 16 January 2020 (244mm cumulatively over 4 days) recorded at the Mount Barney Pluviograph (https://water-monitoring.information.qld.gov.au/). As the catchments at Mt Barney are very steep with shallow soils and were extensively denuded due to the bushfire, this intense rainfall event resulted in very significant erosion with deposition of large sediment and charcoal slugs in the major drainages (Figs A1.12-13). Subsequent inspections of Cronan, Egan and Burnett Creeks (all within the burnt landscape) suggest that water quality remains reasonable and that the fine silt and debris had largely flushed away.

The establishment or promotion of ecosystem-changing weeds (refer Appendix 6) poses a risk to riparian corridors. High biomass exotic grasses, smothering exotic vines (e.g. *Dolichandra unguis-cati, Anredera cordifolia)* and *Lantana camara* are common in disturbed areas of Mount Barney NP or adjoining lands. Some of these weeds increase the risk of higher fire frequency and or severity. The bare ground and loss of canopy cover resulting from the fire provide an ideal environment for their germination and establishment, particularly in these moister, higher fertility areas. Riparian corridors are naturally disturbed areas, susceptible to weeds, with weeds already well established in some areas. Fire provides an opportunity for further incursion of these weeds along the riparian zone and into adjoining communities.

Burnt communities are at risk due to increased edge effects including weed and pest animal invasion. Cats and cane toads are known to prefer open areas for foraging and movement, with cats known to target recently burnt areas for foraging (McGregor *et al*. 2014). Cats are a significant threat to a range of ground dwelling animals including several threatened species. Cane toads are toxic to predators and have likely been a significant contributor to the local decline of spotted-tail quolls. The more open understorey in the short-term is likely to facilitate dispersal of cane toads within Mount Barney NP. More open drainage lines, with warmer, more turbid waters may provide breeding opportunities for cane toads that were not available prior to the fire.

6.4 Rehabilitation of previously cleared areas

Some areas within Mount Barney NP that were cleared prior to gazettal burnt during the current bushfire event. Some of these areas were heavily weed infested and impacts from the fire on regeneration of native species is high. The fire provides an opportunity to access these areas and undertake active rehabilitation. Such areas potentially allow for community groups/members to become involved in direct bushfire recovery, through tree plantings, weeding and other maintenance. Plantings could also be targeted to provide known high-quality food resources for threatened species such as koala, central greater glider and glossy black-cockatoo. Such rehabilitation is expensive and time-consuming (Peeters, Butler and Laidlaw 2014) and the concerns raised in previous sections means that it is only appropriate for these highly degraded areas. An assessment of the success of previous plantings in adjacent or similar areas should be undertaken first to identify the most suitable species and rehabilitation methods.

7 References

Bureau of Meteorology (BoM) (2019a) Special Climate Statement 71 — severe fire weather conditions in southeast Queensland and northeast New South Wales in September 2019. Commonwealth of Australia, 24 September 2019.

Bureau of Meteorology (BoM) (2019b) Special Climate Statement 72 — dangerous bushfire weather in spring 2019. Commonwealth of Australia, 18 December 2019.

Bureau of Meteorology (BoM) (2020) Special Climate Statement 73 — extreme heat and fire weather in December 2019 and January 2020. Commonwealth of Australia, 17 March 2020.

Brewer, K.C., Winne, J.C., Redmond, R.L., Opitz, D.W. & Mangrich, M.V. (2005) Classifying and mapping bushfire severity: a comparison of methods. *Photogrammetric Engineering and Remote Sensing*, 71: 1311−1320.

Department of Environment & Energy (2019) Directory of Important Wetlands in Australia Available at: http://www.environment.gov.au/water/wetlands/australian-wetlands-database/directory-important-wetlands (accessed 27 November 2019).

Department of Environment & Science (DES) (2020) Values Based Park Management Framework available at https://parks.des.qld.gov.au/managing/framework, accessed 03 April 2020.

Department of National Parks, Recreation, Sport & Racing (NPRSR) (2013) Planned Burn Guidelines-Southeast Queensland Bioregion of Queensland. Department of NPs, Recreation, Sport and Racing, Brisbane.

Department of Environment & Science (2019) Modelled potential habitat for selected threatened species – Queensland. Available at: https://www.data.qld.gov.au/dataset/modelled-potential-habitat-for-selected-threatened-species-queensland (accessed 15 January 2020)

Dowdy, A.J., (2018) Climatological variability of fire weather in Australia. *Journal of Applied Meteorology and Climatology*, 57: 221-234, *https://doi.org/10.1175/JAMC-D-17-0167.1*.

Fernandez Winzer, L., Cuddy, W., Pegg, G.S., Carnegie, A.J., Manea, A. & Leishman, M.R., 2020. Plant architecture, growth and biomass allocation effects of the invasive pathogen myrtle rust (*Austropuccinia psidii*) on Australian Myrtaceae species after fire. *Austral Ecology*, 45:177-186.

FIRMS (2020) NRT VIIRS 375 m Active Fire product VNP14IMGT. Available at: https://earthdata.nasa.gov/firms (accessed July 2020).

IUCN (2017) World Heritage Outlook Report for Gondwana Rainforests of Australia, https://www.worldheritageoutlook.iucn.org/explore-sites/wdpaid/12202

McGregor H.W., Legge S., Jones M.E. & Johnson C.N. (2014) Landscape management of fire and grazing regimes alters the fine-scale habitat utilisation by feral cats. *PLoS ONE* 9(10): e109097.

Melzer R., Ezzy L. & Hines H.B. (2019) Health Checks: A simple tool for assessing the condition of values and effectiveness of reserve management. *PARKS* 25(2), Nov. 2019.

Miller, J.D. & Thode, A.E. (2007) Quantifying burn severity in a heterogeneous landscape with a relative version of the delta Normalized Burn Ratio (dNBR). *Remote Sensing of Environment*, 109: 66-80.

Neldner, V.J., Niehus, R.E., Wilson, B.A., McDonald, W.J.F., Ford, A.J. & Accad, A. (2019) The Vegetation of Queensland. Descriptions of Broad Vegetation Groups. Version 4.0. (Queensland Herbarium, Department of Environment and Science).

Neldner, V.J., Wilson, B.A., Dillewaard, H.A., Ryan, T.S., Butler, D.W., McDonald, W.J.F, Addicott, E.P. and Appelman, C.N. (2020) Methodology for survey and mapping of regional ecosystems and vegetation communities in Queensland. Version 5.1. Updated March 2020. Queensland Herbarium, Queensland Department of Environment and Science, Brisbane.

Peeters, P.J., Butler, D.W. & Laidlaw, M. J. (2014) Rainforests - Regrowth Benefits Management Guideline, Queensland Herbarium, Toowong.

Queensland Herbarium (2018) Regional Ecosystem Description Database (REDD). Version 10.1 Queensland Department of Environment and Science: Brisbane.

Silver, M.J. & Carnegie A.J. (2017) An independent review of bell miner associated dieback. Final report prepared for the Project Steering Committee: systematic review of bell miner associated dieback.

UNESCO (2019) Gondwana Rainforests of Australia, https://whc.unesco.org/en/list/368/

Appendix 1. Fire severity and impact photographs

Figure A1.1. Loss of figs, *Ficus* species, during the fire.

Both images Drummer Gully, Mount Barney NP. H. Hines 13 March 2020.

Figure A1.2. Impacts of the fire on complex notophyll vine forest at Mount Barney NP.

Upper left: Piccabeen palm *Archontophoenix cunninghamiana* forest burnt at low severity, Cronan Creek (H. Hines 6 May 2020). Upper right: Fire has burnt out the base of a large rainforest tree causing it to topple and create a large canopy gap, Drummer Gully. H. Hines 13 March 2020.
Lower: The base of very large rainforest tree burnt out by the fire, causing the tree to topple, Cronan Creek H. Hines 6 May 2020.

Figure A1.3. Impacts of the fire on upland complex notophyll vine forest at Mount Barney NP.

Upper left: Dense walking stick palm *Linospadix monostachyos* shrub layer killed by low intensity fire. Upper right: Moderate to high severity fire that has resulted in the death of rainforest canopy trees. Photos from the Minnages Mountain area. Mt Barney Lodge staff 29 May 2020.
Lower: Headwaters of Drummer Gully, showing substantial loss of ground cover from a low intensity fire. H. Hines 9 September 2020.

Figure A1.4. Impacts of the fire on cool temperate rainforest at Mount Barney NP.

Upper left: loss of large Antarctic beech *Nothofagus moorei* trees due to basal fires. Upper right: tall trees in cool temperate rainforest fire-killed. Lower: basal resprouting of Antarctic beech *Nothofagus moorei*, 9-10 months post-fire. The large tree was burnt out during the bushfire.

Photos taken on a knoll southwest of Mount Ballow, that straddles the Qld-NSW border, at an altitude of over 1150m, H. Hines 8 September 2020.

Figure A1.5. Impacts of the fire on wet eucalypt open forests and rainforest/eucalypt forest ecotones.

Low-moderate severity fire in a wet sclerophyll forest-rainforest ecotone (previously heavily logged). Long residence time of the fire at the bases of trees, particularly brush boxes, resulted in many large trees toppling, resulting in large canopy gaps. Also considerable death of vine and rainforest shrub species.
Top: Burnett Creek, Mount Barney NP, H. Hines 19 March 2020.
Lower: Drummer Gully, Mount Barney NP, H. Hines 13 March 2020.

Figure A1.6. Impacts of the fire on wet eucalypt open forests.

Upper left: moderate severity fire resulting in loss of ground cover and death of vines and rainforest shrubs. Burnett Creek, Mount Barney NP (H. Hines 19 March 2020). Upper right: low to moderate severity fire in grassy wet eucalypt forests showing extensive regeneration of grass and ferns 5-6 months post-fire, Yamahra Creek, Mount Barney NP. H. Hines 7 May 2020.
Lower: moderate to high severity fire in grassy wet eucalypt forest. Most of the canopy loss appeared to be due to the preceding drought, rather than from the bushfire Yamahra Creek, Mount Barney NP. H. Hines 7 May 2020.

Figure A1.7. Impacts of the fire on dry eucalypt forests and woodlands

Top: High to extreme severity fire scar in the Mount Ernest area.
Lower: extensive fire scar, mostly of low to moderate severity, Lower Portals area. Note that there was significant canopy dieback in this area at the time of the fire due to severe drought conditions.
Both images H. Hines 7 May 2020.

Figure A1.8 Impacts of the fire on dry eucalypt forests and woodlands.

Upper left: extreme severity fire, showing complete loss of ground cover and crown consumption.
Upper right: low to moderate fire severity resulting in some shrub death.
Lower: moderate to high fire severity in an area with drought dieback.
All images Lower Portals area, Mount Barney NP, 4-6 months post-fire. H. Hines 7 May 2020.

Figure A1.9 Impacts of the fire on montane heaths and shrublands.

The saddle of Mount Barney showing Rum Jungle, a patch of upland subtropical rainforest, largely unaffected by the bushfire, with adjoining montane heath and shrublands burnt at low-moderate severity. New South Wales National Parks and Wildlife Service aerial image 20 March 2020.

Figure A1.10 Impacts of the fire on montane heaths and shrublands.

Top: Extreme fire severity on the summit of Mount Lindesay (Mount Barney NP), showing complete consumption of vegetation and exposure of mineral earth and bedrock on the ridgetop. The shrubland on the slopes below the peak show signs of burning in a fire storm with a large area of stems lying on the ground facing in a similar direction. New South Wales National Parks and Wildlife Service aerial image 20 March 2020.
Lower: montane heath on bedrock burnt at high severity, Mt Ernest (Mount Barney NP). H. Hines 7 May 2020.

Figure A1.11 Impacts of the fire on montane heaths and shrublands.

Upper: Slopes of the summit of Mount Barney showing montane heath and shrublands burnt at moderate-high severity.
Lower: Summit of Mount Barney showing montane mallee burnt at high-extreme severity.
Both images M. Laidlaw, 12 Oct 2020, 9-10 months post-fire.

Figure A1.12. Impacts of the fire on riparian areas, Mount Barney NP.

Upper: large deposits of sediment were present in many places along Cronan Creek as a consequence of heavy rains following the bushfire. (H. Hines 6 May 2020).
Lower: deposits of sediment and unburnt fallen large woody debris in the streambed, Burnett Creek. (H. Hines 13 March 2020)
Note the clarity of the water in both images.

Figure A1.13. Impacts of the fire on riparian areas, Mount Barney NP.

Upper: a large sediment slug in the lower reaches of Yamahra Creek. (H. Hines 7 May 2020).
Lower: deposits of sediment and unburnt fallen large woody debris in the streambed, Burnett Creek. (H. Hines 13 March 2020)

Figure A1.14. Incidental observations of wildlife within the burnt area.

Upper: rough-scaled snake *Tropidechis carinatus* feeding at night on the tadpole of a great barred frog *Mixophyes fasciolatus*
Lower: recently metamorphosed green tree frogs *Litoria caerulea*, from a breeding event following the bushfire. Note they are sitting on *Ricinus communis* a disturbance loving weed.
Both images Burnett Creek, Mount Barney NP, H. Hines 9 September 2020 upper, 13 March 2020 lower.

Figure A1.15. Myrtle rust infection on post-fire resprouting of the Critically Endangered *Rhodamnia rubescens*
Upper: Early stage infection. Lower: late stage infection showing extensive leaf shrivelling and death. Cronan Creek, Mount Barney NP (H. Hines 6 May 2020).

Appendix 2. Area burnt within each fire severity class, by Regional Ecosystem, within QPWS estate.

Regional Ecosystem (RE) mapping and Broad Vegetation Groups (BVGs) as described by Neldner *et al.* (2019 & 2020). All areas are in hectares, for RE1 (see Section 4.2). Column headings are: RE1 – Regional Ecosystem identifier for RE1; Short description – brief description of RE1; Status – Biodiversity Status; BVG 2M – Broad Vegetation Group at the 1:2 000 000 scale; Estate – area of RE1 within the QPWS estate; Low, Moderate, High, Extreme – area of RE1 burnt at each fire severity class.

RE1	Short description	Status	BVG2M	Estate	Burnt	Low	Moderate	High	Extreme
non-rem	non-rem		0	345.10	54.67	36.99	16.96	0.64	0.08
12.8.3	Complex notophyll vine forest on Cainozoic igneous rocks. Altitude <600m	No concern at present	2	15.84	0.00				
12.8.4	Complex notophyll vine forest with Araucaria spp. on Cainozoic igneous rocks	No concern at present	2	553.91	21.29	5.63	10.52	4.53	0.61
12.8.5	Complex notophyll vine forest on Cainozoic igneous rocks. Altitude usually >600m	No concern at present	6	3165.13	1444.28	543.14	668.87	177.24	55.03
12.8.6	Simple microphyll fern forest with Nothofagus moorei on Cainozoic igneous rocks	Of concern	6	139.45	10.93	6.32	3.51	0.94	0.15
12.9-10.16	Araucarian microphyll to notophyll vine forest on Cainozoic and Mesozoic sediments	Of concern	5	382.12	196.26	65.79	89.03	34.37	7.07
12.11.1	Simple notophyll vine forest often with abundant Archontophoenix cunninghamiana (gully vine forest) on metamorphics +/- interbedded volcanics	No concern at present	4	434.43	253.29	112.54	105.99	26.10	8.66
12.11.10	Notophyll vine forest +/- Araucaria cunninghamii on metamorphics +/- interbedded volcanics	No concern at present	2	725.51	268.37	121.79	120.52	21.20	4.87
12.3.2	Eucalyptus grandis tall open forest on alluvial plains	Of concern	8	12.84	12.23	0.53	5.01	5.18	1.51
12.8.1	Eucalyptus campanulata tall open forest on Cainozoic igneous rocks	No concern at present	8	2655.63	1791.08	656.63	914.00	171.15	49.30
12.8.2	Eucalyptus oreades tall open forest on Cainozoic igneous rocks	Of concern	8	276.72	236.55	43.56	111.22	57.23	24.54
12.8.8	Eucalyptus saligna subsp. saligna or E. grandis tall open forest on Cainozoic igneous rocks	Of concern	8	52.82	21.94	0.26	2.86	9.18	9.64
12.8.9	Lophostemon confertus open forest on Cainozoic igneous rocks	No concern at present	8	620.88	103.98	30.24	52.23	15.97	5.54
12.8.11	Eucalyptus dunnii tall open forest on Cainozoic igneous rocks	Of concern	8	19.39	5.90	3.51	2.29	0.09	
12.9-10.14a	Eucalyptus grandis, Lophostemon confertus, E. microcorys, Syncarpia glomulifera +/- E. pilularis open forest on sedimentary rocks occurring in moist coastal areas	No concern at present	8	156.15	150.17	29.68	67.11	32.35	21.03

RE1	Short description	Status	BVG2M	Estate	Burnt	Low	Moderate	High	Extreme
12.8.14	Eucalyptus eugenioides, E. biturbinata, E. melliodora +/- E. tereticornis, Corymbia intermedia open forest on Cainozoic igneous rocks	No concern at present	11	386.37	82.71	34.78	43.65	4.20	0.08
12.8.17	Eucalyptus melanophloia +/- E. crebra, E. tereticornis, Corymbia tessellaris woodland on Cainozoic igneous rocks	No concern at present	11	112.55	0.00				
12.8.20	Shrubby woodland with Eucalyptus racemosa subsp. racemosa or E. dura on Cainozoic igneous rocks	Of concern	9	1384.11	740.74	407.47	309.50	18.14	5.61
12.8.24	Corymbia citriodora subsp. variegata open forest on Cainozoic igneous rocks especially trachyte	Endangered	10	643.51	165.14	109.00	51.55	3.85	0.74
12.8.25	Open forest with Eucalyptus acmenoides or E. helidonica on Cainozoic igneous rocks especially trachyte	Of concern	9	1248.30	440.95	185.21	184.05	48.04	23.65
12.9-10.2	Corymbia citriodora subsp. variegata +/- Eucalyptus crebra open forest on sedimentary rocks	No concern at present	10	1054.76	478.99	317.46	154.77	6.53	0.23
12.9-10.3	Eucalyptus moluccana open forest on sedimentary rocks	Of concern	13	0.73	0.00				
12.9-10.5	Woodland complex often with Corymbia trachyphloia subsp. trachyphloia, C. citriodora subsp. variegata, Eucalyptus crebra, E. fibrosa subsp. fibrosa on quartzose sandstone	No concern at present	9	31.97	26.88	11.31	15.38	0.19	
12.9-10.5d	Eucalyptus eugenioides, E. biturbinata or E. longirostrata, E. crebra, E. tereticornis and Corymbia trachyphloia woodland occurring on sedimentary rocks	No concern at present	9	242.40	10.18	4.10	5.85	0.22	
12.9-10.7	Eucalyptus crebra +/- E. tereticornis, Corymbia tessellaris, Angophora spp., E. melanophloia woodland on sedimentary rocks	Of concern	13	247.59	200.20	123.80	74.13	2.20	0.06
12.9-10.17b	Corymbia citriodora subsp. variegata mixed open forest on Cainozoic and Mesozoic sediments	No concern at present	10	19.37	0.00				
12.9-10.17e	Eucalyptus acmenoides, E. propinqua, Corymbia intermedia +/- E. microcorys, Lophostemon confertus open forest on sedimentary rocks	No concern at present	9	1544.71	843.33	341.18	383.17	90.15	28.83
12.11.3	Eucalyptus siderophloia, E. propinqua +/- E. microcorys, Lophostemon confertus, Corymbia intermedia, E. acmenoides open forest on metamorphics +/- interbedded volcanics	No concern at present	9	668.64	443.54	201.08	205.39	30.57	6.50

RE1	Short description	Status	BVG2M	Estate	Burnt	Low	Moderate	High	Extreme
12.11.6	Corymbia citriodora subsp. variegata, Eucalyptus crebra woodland on metamorphics +/- interbedded volcanics	No concern at present	10	597.20	572.51	196.83	360.06	14.91	0.71
12.12.5	Corymbia citriodora subsp. variegata, Eucalyptus crebra woodland on Mesozoic to Proterozoic igneous rocks	No concern at present	10	56.37	44.63	32.49	12.15		
12.3.3	Eucalyptus tereticornis woodland on Quaternary alluvium	Endangered	16	18.36	0.00				
12.8.19	Heath and rock pavement with scattered shrubs or open woodland on Cainozoic igneous hills and mountains	Of concern	29	345.55	98.18	22.18	42.93	21.46	11.61
12.9-10.17a	Lophostemon spp. dominated open forest on sedimentary rocks	No concern at present	28	93.20	65.96	39.05	20.73	5.37	0.81
Total	**Total area**			**18251.61**	**8784.87**	**3682.57**	**4033.44**	**801.99**	**266.87**

Appendix 3. Area burnt within each fire severity class, by Broad Vegetation Group, within QPWS estate.

Broad Vegetation Groups (BVGs) as described by Neldner *et al.* (2019b), derived from Regional Ecosystem mapping (using RE1). All areas are in hectares. Column headings are: BVG 5M & BVG 2M – BVG number and short description at the 1:5 000 000 and 1:2 000 000 scales; Estate – area of BVG 2M within QPWS estate, Burnt – area of BVG 2M burnt on QPWS estate, Percentage – the percentage of BVG 2M within QPWS estate burnt (see section 4); Low, Moderate, High, Extreme – area of BVG 2M burnt at each relative fire severity class.

BVG 5M	BVG 2M	Estate	Burnt	Percentage	Low	Moderate	High	Extreme
Non remnant or not vegetated.	Non remnant or not vegetated.	345.10	54.67	15.8%	36.99	16.96	0.64	0.08
1. Rainforests, scrubs.	2. Complex to simple, semi-deciduous mesophyll to notophyll vine forest, sometimes with Araucaria cunninghamii (hoop pine).	1295.27	289.67	22.4%	127.42	131.04	25.73	5.48
	4. Notophyll and mesophyll vine forest with feather or fan palms on alluvia, along streamlines and in swamps on ranges or within coastal sandmasses.	434.43	253.29	58.3%	112.54	105.99	26.1	8.66
	5. Notophyll to microphyll vine forests, frequently with Araucaria spp. or Agathis spp. (kauri pines)	382.12	196.26	51.4%	65.79	89.03	34.37	7.07
	6. Notophyll vine forest and microphyll fern forest to thicket on high peaks and plateaus.	3304.58	1455.22	44.0%	549.47	672.38	178.18	55.19
2. Wet eucalypt open forests.	8. Wet eucalypt tall open forest on uplands and alluvia.	3794.42	2321.85	61.2%	764.42	1154.71	291.15	111.56
3. Eastern eucalypt woodlands to open forests.	9. Moist to dry eucalypt open forests to woodlands usually on coastal lowlands and ranges.	5120.11	2505.61	48.9%	1150.36	1103.36	187.31	64.58
	10. Corymbia citriodora (spotted gum) dominated open forests to woodlands on undulating to hilly terrain.	2371.21	1261.28	53.2%	655.78	578.52	25.29	1.69
	11. Moist to dry eucalypt open forests to woodlands mainly on basalt areas (land zone 8).	498.93	82.71	16.6%	34.78	43.65	4.2	0.08
	13. Dry to moist eucalypt woodlands and open forests, mainly on undulating to hilly terrain of mainly metamorphic and acid igneous rocks (land zones 11 and 12).	248.31	200.20	80.6%	123.8	74.13	2.2	0.06
	16. Eucalyptus spp. dominated open forest and woodlands drainage lines and alluvial plains.	18.36	0.00	0.0%				
12. Other coastal communities or heaths.	28. Open forests to open woodlands in coastal locations. Dominant species such as Casuarina spp., Corymbia spp., Allocasuarina spp., Acacia spp., Lophostemon suaveolens, Asteromyrtus spp., Neofabricia myrtifolia.	93.20	65.96	70.8%	39.05	20.73	5.37	0.81
	29. Heathlands and associated scrubs and shrublands on coastal dunefields and inland/ montane locations.	345.55	98.18	28.4%	22.18	42.93	21.46	11.61
Total	**Total area**	**18251.61**	**8784.87**	**48.1%**	**3682.58**	**4033.43**	**802.00**	**266.87**

Appendix 4. Conservation significant forest fauna and flora species recorded from the area.

Column headings: **NCA** (*Nature Conservation Act* 1992) and **EPBC** (*Environment Protection and Biodiversity Conservation Act* 1999) statuses are: EX = extinct, CR critically endangered, E = endangered, V = vulnerable, NT = near threatened, LC = least concern, SL = special least concern. **Rf** = rainforests, **Sclero** = sclerophyll habitats such as *Lophostemon*, *Eucalyptus* and or *Corymbia* woodlands and forests, and heaths and shrublands; with X = the habitat is important for the species in the focal region. #The Mount Ballow mountain frog meets IUCN criteria for listing as E. *The blue spiny crayfish is listed as V on the IUCN Red List.
Note: *Acacia saxicola* and *Corybas montanus* are endemic (i.e. entire distribution) to the Mount Maroon massif, which was unburnt during the 2019 bushfire.

Animals

Group	Common name	Scientific name	NCA	EPBC	Rf	Sclero
amphibians	tusked frog	*Adelotus brevis*	V		X	X
amphibians	cascade treefrog	*Litoria pearsoniana*	V		X	X
amphibians	Fleay's barred frog	*Mixophyes fleayi*	E	E	X	X
amphibians	Mount Ballow mountain frog#	*Philoria* sp.			X	
birds	rufous scrub-bird	*Atrichornis rufescens*	V	E	X	X
birds	glossy black-cockatoo	*Calyptorhynchus lathami*	V			X
birds	eastern bristlebird	*Dasyornis brachypterus*	E	E		X
birds	Albert's lyrebird	*Menura alberti*	NT		X	X
birds	black-faced monarch	*Monarcha melanopsis*	SL		X	X
birds	satin flycatcher	*Myiagra cyanoleuca*	SL			X
birds	powerful owl	*Ninox strenua*	V			X
birds	plumed frogmouth	*Podargus ocellatus*	V		X	
birds	rufous fantail	*Rhipidura rufifrons*	SL		X	X
birds	southern emu-wren	*Stipiturus malachurus*	V			X
birds	spectacled monarch	*Symposiachrus trivirgatus*	SL		X	X
birds	black-breasted button-quail	*Turnix melanogaster*	V	V	X	
mammals	spotted-tailed quoll (southern subspecies)	*Dasyurus maculatus maculatus*	E	E	X	X
mammals	platypus	*Ornithorhynchus anatinus*	SL		X	X
mammals	central greater glider	*Petauroides armillatus*	V	V		X
mammals	yellow-bellied glider (southern subspecies)	*Petaurus australis australis*	V			X
mammals	brush-tailed rock-wallaby	*Petrogale penicillata*	V	V		X
mammals	koala	*Phascolarctos cinereus*	V	V		X
mammals	long-nosed potoroo	*Potorous tridactylus tridactylus*	V	V	X	X
mammals	grey-headed flying-fox	*Pteropus poliocephalus*	C	V	X	X
mammals	short-beaked echidna	*Tachyglossus aculeatus*	SL		X	X
malacostracans	blue spiny crayfish*	*Euastacus sulcatus*			X	

Plants

Group	Common name	Scientific name	NCA	EPBC	Rf	Sclero
Asteraceae	Binna Burra daisy	*Brachyscome ascendens*	V			X
Asteraceae		*Ozothamnus vagans*	V	V	X	
Asteraceae		*Tetramolopium vagans*	V			X
Campanulaceae		*Wahlenbergia scopulicola*	V			X
Dilleniaceae		*Hibbertia hexandra*	NT			X
Dilleniaceae	mountain guinea flower	*Hibbertia monticola*	NT			X
Ericaceae		*Agiortia cicatricata*	NT			X
Euphorbiaceae		*Bertya ernestiana*	V	V		X
Euphorbiaceae		*Ricinocarpos speciosus*	V			X
Fabaceae	Mt. Barney bush pea	*Pultenaea whiteana*	V			X
Goodeniaceae	coopernookia	*Coopernookia scabridiuscula*	V	V		X
Lamiaceae		*Westringia blakeana*	NT			X
Lycopodiaceae		*Phlegmariurus varius*	V		X	
Mimosaceae		*Acacia acrionastes*	NT			X
Mimosaceae	Mt. Maroon wattle	*Acacia saxicola*	E			X
Myrtaceae	mallee ash	*Eucalyptus codonocarpa*	NT			X
Myrtaceae	Dunn's white gum	*Eucalyptus dunnii*	V			X
Myrtaceae		*Leptospermum barneyense*	V			X
Myrtaceae	scrub turpentine	*Rhodamnia rubescens*	CR	CR	X	X
Myrtaceae	native guava	*Rhodomyrtus psidioides*	CR	CR	X	X
Orchidaceae	small helmet orchid	*Corybas montanus*	V	V		X
Orchidaceae		*Dendrobium schneiderae* var. *schneiderae*	NT		X	
Orchidaceae	horned greenhood	*Pterostylis bicornis*	V	V		X
Orchidaceae		*Sarcochilus hartmannii*	V	V	X	
Orobanchaceae	Lamington eyebright	*Euphrasia bella*	E	V	X	X
Picrodendraceae		*Pseudanthus pauciflorus* subsp. *pauciflorus*	NT			X
Poaceae		*Arundinella grevillensis*	V			X
Polygalaceae		*Comesperma breviflorum*	NT			X
Proteaceae		*Banksia conferta*	V			X
Proteaceae		*Grevillea linsmithii*	E			X
Ranunculaceae		*Clematis fawcettii*	V	V	X	X
Rhamnaceae		*Pomaderris crassifolia*	V			X
Rutaceae		*Leionema elatius* subsp. *beckleri*	E			X
Rutaceae	Mt Barney stink bush	*Zieria montana*	CR			X

Appendix 5. Potential habitat for selected conservation significant species within the burnt area.

The Queensland Herbarium's potential habitat models were created using Maxent (v 3.4.1) (Phillips *et al.* 2006), a proven species distribution modelling tool well suited to the development of models based on records of species presence (Elith & Leathwick 2009). The models utilise vetted records of fauna species occurrence compiled for the purpose of Biodiversity Assessments by the Queensland Department of Environment and Science and additional records held in WildNet. Flora records were compiled from the Queensland Herbarium's Herbrecs specimen database. All records had location precision of better than +/- 2000m, and all fauna records had a collection date post-1975. Records were screened for taxonomic and georeferencing accuracy. As records of species occurrence are heavily biased toward accessible parts of the landscape, a mask of Queensland's road network was used to down-weight species records collected along roads to have half the value of records collected away from roads. Models were constrained within an occurrence mask for each species, defined by a buffer of 200km around a convex hull encompassing all records of that species. These masks are used in Maxent to restrict the selection of background points (pseudo-absences) to the region of species presence and have important implications for model performance (Van Der Waal *et al.* 2007).

Models were based on seven environmental variables:
1. Annual mean temperature;
2. Temperature seasonality (coefficient of variation);
3. Annual precipitation;
4. Mean moisture index of the lowest quarter;
5. Broad vegetation group (BVG 1:1M);
6. Land zone; and
7. Terrain ruggedness index (after Riley *et al.* 1999).

The four climate variables were modelled from Australian monthly mean climate values nominally centred on 1990 (1976-2005) using Anuclim Version 6.1 software (Xu and Hutchinson 2011) applied to a SRTM-derived 3 Second Digital Elevation Model (DEM) (Geoscience Australia 2019). A terrain ruggedness index was also derived from the DEM using the methodology of Riley *et al.* (1999) and indicates the change in elevation between adjacent cells across Queensland. The two categorical variables, land zone and pre-clearing broad vegetation group, were derived from the pre-clearing Regional Ecosystem mapping. Land zone provides a high-level classification of substrate and geomorphology into twelve groups ranging from marine sediments through to ancient igneous substrates (Neldner *et al*. 2020) and broad vegetation group is a high-level classification of vegetation composition at the 1:1M scale (Neldner *et al.* 2019).

Model performance was assessed by comparing the area under the ROC curve (AUC) with the 95th percentile AUC from 1000 null models for each species created by randomly selecting locations from under the species' mask (Raes and ter Steege 2007). Maxent produces a grid of continuous values, analogous to probabilities of habitat suitability, ranging from zero to one. We applied a 50% threshold to each model in order to convert this grid output into a binary prediction of high probability potential habitat. The use of conservative thresholds increases the risk of omission but reduces commission error. Any location records that were excluded as a result of this threshold were added back into the output following the application of a 1km radius buffer. The resulting output was clipped to the species' mask and simplified using a majority filter algorithm to remove outlying 'orphan' cells in the model output.

Potential habitat for species lacking sufficient presence records to allow Maxent modelling have been incorporated into this analysis through the application of a 1km buffer to location records.

References

Elith J. and Leathwick J.R. 2009. Conservation prioritization using species distribution models. In Spatial Conservation Prioritization: Quantitative Methods and computational Tools, ed. A Moilanen, KA Wilson, HP Possingham. Oxford: Oxford Univ. Press. pp 70–93 Brisbane.

Geoscience Australia (2019) SRTM-derived 3 Second Digital Elevation Models Version 1.0, Commonwealth of Australia, Canberra.

Neldner V.J., Niehus R.E., Wilson B.A., McDonald W.J.F., Ford A.J. and Accad A. (2019) The Vegetation of Queensland. Descriptions of Broad Vegetation Groups. Version 4.0. Queensland Herbarium, Department of Environment and Science.

Neldner, V.J., Wilson, B.A., Dillewaard, H.A., Ryan, T.S., Butler, D.W., McDonald, W.J.F, Addicott, E.P. and Appelman, C.N. (2020) Methodology for survey and mapping of regional ecosystems and vegetation communities in Queensland. Version 5.1. Updated March 2020. Queensland Herbarium, Queensland Department of Environment and Science, Brisbane.

Phillips S.J., Anderson R.P. and Schapire R.E. (2006) Maximum entropy modelling of species geographic distributions. Ecological Modelling, 190, 231–259.

Raes N. and ter Steege H. (2007) A null-model for significance testing of presence-only species distribution models, Ecography, 30, 727-736.

Riley S. J., DeGloria S.D. and Elliot R. (1999) A terrain ruggedness index that quantifies topographic heterogeneity, Intermountain Journal of Sciences, 5 (1-4), 23-27.

Van Der Wal J., Shoo L.P., Graham C. and Williams S.E. (2009) Selecting pseudo-absence data for presence-only distribution modelling: How far should you stray from what you know? Ecological Modelling, 220, 589-594.

Xu T. and Hutchinson M. (2011) ANUCLIM Version 6.1, Fenner School of Environment and Society, Australian National University, Canberra.

Area burnt of potential habitat for selected conservation significant, (a) fauna, and (b) flora species, within affected QPWS estate.

Affected QPWS estate = Mount Barney NP, 2019 bushfire (see Table 3).
Column headings: **Status** – **NCA** (*Nature Conservation Act* 1992) and **EPBC** (*Environment Protection and Biodiversity Conservation Act* 1999) statuses are: CR = critically endangered, E = endangered, V = vulnerable. **Habitat type** – **Rf** = rainforests, **Sclero** = sclerophyll habitats such as *Lophostemon*, *Eucalyptus* and or *Corymbia* woodlands and forests, and heaths and shrublands; with X = the habitat is important for the species in the focal region. **Potential habitat** – **Qld area** = total area of potential habitat within Queensland (ha), **Estate area** = total area of potential habitat within affected QPWS estate (ha), **% in estate** = area of potential habitat within affected QPWS estate as a percentage of the area of potential habitat in Queensland, **Estate habitat burnt** = area of potential habitat burnt within affected QPWS estate (ha), **% estate habitat burnt** = area of potential habitat burnt as a percentage of the total potential habitat within affected QPWS estate. **Relative fire severity (ha)** = the area burnt within each relative fire severity class (low, moderate, high or extreme) (ha).
*Indicates that there are no records of the species from the area (refer Appendix 4). †Potential habitat defined by buffered points. ‡Core Koala habitat (SEQ Koala Conservation Strategy 2019-2024).

a) Fauna			Status		Habitat type		Potential habitat (ha or %)					Relative fire severity class (ha)			
Group	Scientific name	Common name	NCA	EPBC	Rf	Sclero	Qld area	Estate area	% in estate	Estate habitat burnt	% estate habitat burnt	Low	Mod	High	Ext
Birds	*Atrichornis rufescens*	rufous scrub-bird	V	E	X	X	14448	1946	13.5%	799	41.0%	264	388	106	40
Birds	*Calyptorhynchus lathami*	glossy black-cockatoo	V			X	527111	11673	2.2%	6562	56.2%	2779	3068	546	170
Birds	*Cyclopsitta diophthalma coxeni**	Coxen's fig-parrot	E	E	X		173270	5993	3.5%	2811	46.9%	989	1320	367	135
Birds	*Dasyornis brachypterus*	eastern bristlebird	E	E		X	26765	2838	10.6%	1513	53.3%	552	718	179	64
Birds	*Lathamus discolor**	swift parrot	E	CR		X	970350	3370	0.3%	1368	40.6%	611	683	62	11
Birds	*Menura alberti†*	Albert's lyrebird	NT		X	X	55117	3602	6.5%	1859	51.6%	673	875	227	83
Birds	*Ninox strenua**	powerful owl	V			X	2239060	15395	0.7%	7444	48.4%	3101	3460	667	216
Birds	*Stipiturus malachurus*	southern emu-wren	V			X	31182	543	1.7%	353	65.1%	173	157	17	7
Birds	*Turnix melanogaster*	black-breasted button-quail	V	V	X		1013079	3529	0.3%	1536	43.5%	580	738	167	52
Frogs	*Adelotus brevis*	tusked frog	V		X	X	985730	14438	1.5%	7514	52.0%	2998	3520	752	244
Frogs	*Litoria pearsoniana*	cascade treefrog	V		X	X	193704	6766	3.5%	3868	57.2%	1456	1862	435	116
Frogs	*Mixophyes fleayi*	Fleay's barred frog	E	E	X	X	48380	7387	15.3%	4237	57.4%	1595	2045	466	131
Mammals	*Chalinolobus dwyeri**	large-eared pied bat	V	V	X	X	1060419	9913	0.9%	5136	51.8%	1992	2436	539	168
Mammals	*Dasyurus maculatus maculatus*	spotted-tailed quoll (southern subspecies)	E	E	X	X	396753	14230	3.6%	7071	49.7%	2826	3248	744	253
Mammals	*Petauroides volans sensu lato*	greater glider	V	V		X	4275994	16191	0.4%	8244	50.9%	3427	3796	765	257
Mammals	*Petrogale penicillata*	brush-tailed rock-wallaby	V	V		X	193687	11746	6.1%	5645	48.1%	2390	2545	521	189
Mammals	*Phascolarctos cinereus‡*	koala	V	V		X	629597	12591	2.0%	7203	57.2%	3109	3318	582	194
Mammals	*Potorous tridactylus tridactylus*	long-nosed potoroo	V	V	X	X	190173	7343	3.9%	4273	58.2%	1590	2034	489	160
Mammals	*Pseudomys novaehollandiae*	New Holland mouse	V	V		X	60485	2661	4.4%	1244	46.7%	521	544	119	60

a) Fauna			Status		Habitat type		Potential habitat (ha or %)					Relative fire severity class (ha)			
Group	Scientific name	Common name	NCA	EPBC	Rf	Sclero	Qld area	Estate area	% in estate	Estate habitat burnt	% estate habitat burnt	Low	Mod	High	Ext
Mammals	*Pseudomys oralis**	Hastings River mouse	E	E		X	25349	2785	11.0%	1264	45.4%	399	598	186	80
Reptiles	*Acanthophis antarcticus**	common death adder	V			X	3452148	14172	0.4%	7128	50.3%	3047	3273	617	191
Reptiles	*Delma torquata**	collared delma	V	V		X	1954521	5961	0.3%	2180	36.6%	1165	886	86	43

b) Flora			Status		Habitat type		Potential habitat (ha or %)					Relative fire severity class (ha)			
Family	Scientific name	Common name	NCA	EPBC	Rf	Sclero	Qld area	Estate area	% in estate	Estate habitat burnt	% estate habitat burnt	Low	Mod	High	Ext
Apocynaceae	*Leichhardtia coronata**	slender milkvine	V			X	321605	1264	0.4%	565	44.7%	256	252	40	17
Apocynaceae	*Leichhardtia longiloba**		V	V		X	67681	5289	7.8%	3546	67.1%	1422	1687	334	103
Asteraceae	*Brachyscome ascendens†*	Binna Burra daisy	V			X	1344	170	12.6%	112	66.1%	42	57	11	1
Asteraceae	*Ozothamnus vagans†*		V	V	X		2459	251	10.2%	147	58.3%	72	63	11	1
Asteraceae	*Tetramolopium vagans†*		V			X	1585	1348	85.0%	747	55.4%	230	297	131	89
Campanulaceae	*Wahlenbergia scopulicola†*		V			X	1922	165	8.6%	108	65.8%	36	58	13	2
Cyperaceae	*Caustis blakei* subsp. *macrantha*		V			X	58942	1336	2.3%	503	37.7%	234	213	41	15
Cyperaceae	*Cyperus semifertilis*		V	V	X		18241	711	3.9%	279	39.3%	127	112	30	11
Dilleniaceae	*Hibbertia monticola†*	mountain guinea flower	NT			X	3003	1289	42.9%	609	47.2%	193	276	94	46
Ericaceae	*Agiortia cicatricata†*		NT			X	1252	622	49.7%	506	81.3%	150	262	70	23
Ericaceae	*Styphelia recurvisepala*		E			X	17252	207	1.2%	91	44.2%	20	41	20	11
Euphorbiaceae	*Bertya ernestiana†*		V	V		X	1310	693	52.9%	473	68.3%	224	184	43	22
Euphorbiaceae	*Ricinocarpos speciosus*		V			X	187298	7251	3.9%	4147	57.2%	1564	2018	427	138
Fabaceae	*Pultenaea whiteana†*	Mt. Barney bush pea	V			X	1328	1000	75.3%	453	45.4%	145	221	63	24
Fabaceae	*Sophora fraseri*	brush sophora	V	V		X	379715	11615	3.1%	6040	52.0%	2456	2833	570	181
Goodeniaceae	*Coopernookia scabridiuscula†*	coopernookia	V	V		X	2369	600	25.3%	281	46.8%	63	152	51	16
Haloragaceae	*Gonocarpus effusus*		V			X	8456	889	10.5%	464	52.2%	169	212	57	26
Haloragaceae	*Haloragis exalata* subsp. *velutina*		V	V		X	765276	13677	1.8%	6729	49.2%	2741	3085	681	223
Lamiaceae	*Coleus nitidus*		E	E	X		118005	999	0.8%	603	60.4%	163	282	113	46
Lamiaceae	*Westringia rupicola**		V	V		X	5525	82	1.5%	64	78.0%	11	27	17	9
Lycopodiaceae	*Phlegmariurus varius†*		V		X		1907	295	15.5%	86	29.2%	47	38	1	0
Mimosaceae	*Acacia acrionastes†*		NT			X	4444	1931	43.4%	627	32.5%	205	240	102	80

b) Flora			Status		Habitat type		Potential habitat (ha or %)					Relative fire severity class (ha)			
Family	Scientific name	Common name	NCA	EPBC	Rf	Sclero	Qld area	Estate area	% in estate	Estate habitat burnt	% estate habitat burnt	Low	Mod	High	Ext
Myrtaceae	*Eucalyptus codonocarpa†*	mallee ash	NT			X	3481	2170	62.3%	1484	68.4%	413	768	234	69
Myrtaceae	*Eucalyptus scoparia**	Wallangarra white gum	V	V		X	8137	42	0.5%	36	85.5%	7	15	9	6
Myrtaceae	*Eucalyptus taurina**	Helidon ironbark	E			X	147575	890	0.6%	393	44.2%	218	169	6	0
Myrtaceae	*Leptospermum barneyense†*		V			X	1623	1604	98.8%	617	38.5%	215	319	61	23
Myrtaceae	*Leptospermum oreophilum**		V			X	15809	835	5.3%	414	49.5%	167	186	43	19
Myrtaceae	*Rhodamnia rubescens*		CR	CR	X		290240	11997	4.1%	6314	52.6%	2413	2954	705	242
Myrtaceae	*Rhodomyrtus psidioides**	native guava	CR	CR	X		294703	640	0.2%	110	17.2%	38	45	19	8
Oleaceae	*Jasminum jenniae**		E		X		77817	260	0.3%	81	31.1%	37	30	10	4
Orchidaceae	*Dendrobium schneiderae var. schneiderae†*		NT		X		1885	312	16.6%	17	5.4%	10	6	1	0
Orchidaceae	*Sarcochilus hartmannii†*		V	V	X		1256	120	9.6%	100	83.2%	44	48	8	0
Orobanchaceae	*Euphrasia bella†*	Lamington eyebright	E	V	X		808	386	47.7%	113	29.4%	61	49	2	0
Picrodendraceae	*Pseudanthus pauciflorus* subsp. *pauciflorus†*		NT			X	1561	864	55.3%	450	52.0%	193	192	43	22
Poaceae	*Arthraxon hispidus**		V	V		X	1094540	8018	0.7%	4345	54.2%	1622	2104	473	146
Poaceae	*Bothriochloa bunyensis**	Bunya Mountains bluegrass	V	V		X	59510	1381	2.3%	349	25.3%	75	165	77	32
Poaceae	*Paspalidium grandispiculatum**		V	V		X	114314	1123	1.0%	250	22.3%	96	96	37	21
Polygalaceae	*Comesperma breviflorum†*		NT			X	4252	1156	27.2%	699	60.5%	218	313	112	57
Proteaceae	*Banksia conferta*		V			X	3152	736	23.4%	515	69.9%	146	287	58	23
Proteaceae	*Floydia praealta**	ball nut	V	V	X		319846	2218	0.7%	994	44.8%	356	456	134	48
Proteaceae	*Grevillea linsmithii*		E			X	4397	508	11.6%	90	17.7%	20	40	20	11
Proteaceae	*Grevillea quadricauda**		V	V		X	34334	229	0.7%	1	0.3%	0	0	0	0
Ranunculaceae	*Clematis fawcettii*		V	V	X		112227	5001	4.5%	2258	45.2%	844	1092	254	68
Rhamnaceae	*Pomaderris crassifolia*		V			X	121170	6487	5.4%	3351	51.7%	1259	1564	391	138
Rutaceae	*Leionema elatius* subsp *beckleri†*		E			X	1256	432	34.3%	385	89.1%	100	185	79	20
Rutaceae	*Leionema obtusifolium*		V	V		X	52928	509	1.0%	37	7.3%	28	9	0	0
Rutaceae	*Zieria montana†*		CR			X	524	524	100.0%	402	76.7%	115	196	61	29
Santalaceae	*Thesium australe**	toadflax	V	V		X	1105581	12247	1.1%	6020	49.2%	2572	2726	544	179
Sapindaceae	*Cupaniopsis tomentella**	Boonah tuckeroo	V	V	X		64709	244	0.4%	64	26.3%	19	32	12	2
Sapotaceae	*Planchonella eerwah**		E	E	X		229834	913	0.4%	377	41.3%	161	170	40	7

Appendix 6. Pest plant and animals likely to impact significant species or affect recovery of habitat.

More pest species have been recorded in Mount Barney NP area than those listed below. Only those that are currently known to occur on or immediately adjacent affected QPWS managed estates and have the potential to significantly impact on recovering ecosystems or threatened species, and/or impact on their future protection have been included here. For example, relatively short-lived species such as *Phytolacca octandra* (inkweed), which are prolific in some burned areas, are likely to decline in the short-medium term as ecosystems recover, so are not included.

Group	Common name	Scientific name
Animals		
amphibians	cane toad	*Rhinella marina*
mammals	red deer	*Cervus elaphus*
mammals	feral cat	*Felis catus*
mammals	feral pig	*Sus scrofa*
mammals	red fox	*Vulpes vulpes*
Plants		
Apocynaceae	white moth vine	*Araujia sericifera*
Asteraceae	Crofton weed	*Ageratina adenophora*
Asteraceae	mistflower	*Ageratina riparia*
Asteraceae	groundsel bush	*Baccharis halimifolia*
Asteraceae	fireweed	*Senecio madagascariensis*
Basellaceae	Madeira vine	*Anredera cordifolia*
Bignoniaceae	cat's claw creeper	*Dolichandra unguis-cati*
Cactaceae	velvety tree pear	*Opuntia tomentosa*
Caesalpiniaceae	round-leaf cassia	*Chamaecrista rotundifolia*
Caesalpiniaceae	Easter cassia	*Senna pendula var. glabrata*
Caesalpiniaceae	smooth cassia	*Senna septemtrionalis*
Crassulaceae	mother of millions	*Bryophyllum* spp.
Fabaceae	silverleaf desmodium	*Desmodium uncinatum*
Poaceae	coolati grass	*Hyparrhenia hirta*
Poaceae	thatch grass	*Hyparrhenia rufa*
Poaceae	green panic and Guinea grass	*Megathyrsus maximus*
Poaceae	palm grass	*Setaria palmifolia*
Poaceae	Parramatta grass	*Sporobolus africanus*
Poaceae	giant Parramatta grass	*Sporobolus fertilis*
Poaceae	giant rats-tail grass	*Sporobolus natalensis*
Solanaceae	giant devil's fig	*Solanum torvum*
Ulmaceae	Chinese elm	*Celtis sinensis*
Verbenaceae	lantana	*Lantana camara*
Verbenaceae	creeping lantana	*Lantana montevidensis*

Appendix 7. Summary of Outstanding Universal Value of Gondwana Rainforests WHA.

The United Nations Educational, Scientific and Cultural Organization (UNESCO) seeks to encourage the identification, protection and preservation of cultural and natural heritage around the world considered to be of outstanding value to humanity under an international treaty called the *Convention Concerning the Protection of the World Cultural and Natural Heritage* (World Heritage Convention).

Outstanding Universal Value (OUV) is the fundamental central concept of the World Heritage and forms the basis for World Heritage listing and reporting.

To be considered of Outstanding Universal Value, a property needs to meet one or more of ten criteria, as well as conditions of integrity and management. The Gondwana Rainforests WHA satisfies three natural heritage criteria (viii, ix and x):

viii. Outstanding examples representing major stages of Earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features.

ix. Outstanding examples representing significant ongoing ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals.

x. Contains the most important and significant habitats for in-situ conservation of biological diversity, including those containing threatened species of Outstanding Universal Value from the point of view of science or conservation.

The Statement of Outstanding Universal Value (SOUV) for the Gondwana Rainforests WHA outlines how the values of the area meet these three criteria (UNESCO 2019) and for criteria ix and x are summarised in the table below (IUCN 2017). Note these attributes apply to the entire Gondwana Rainforests WHA, of which Mount Barney NP forms a significant component at the north-western extent of the WHA.

UNESCO World Heritage Convention criteria	**OUV Attribute**	**World Heritage values**
*Criterion ix: Outstanding examples representing significant **ongoing ecological and biological processes in the evolution** and development of terrestrial, fresh water, coastal and marine **ecosystems and communities** **of plants and animals**.*		
The Gondwana Rainforests WHA contains outstanding examples of major stages in the Earth's evolutionary history as well as ongoing evolutionary processes. Major stages represented include the 'Age of the Pteridophytes' from the Carboniferous Period with some of the oldest elements of the world's ferns (1) represented, and the 'Age of Conifers' in the Jurassic Period with one of the most significant centres of survival for Araucarians (2) (the most ancient and phylogenetically primitive of the world's conifers). Likewise, the property provides an outstanding record of the 'Age of the Angiosperms'. This includes a secondary centre of endemism for primitive flowering plants originating in the Early Cretaceous (3), the most diverse assemblage of relict angiosperm taxa representing the primary radiation of dicotyledons in the mid-Late Cretaceous (4), a unique record of the evolutionary history of Australian rainforests representing the 'golden age' of the Early Tertiary (5) , and a unique record of Miocene vegetation that was the antecedent of modern temperate rainforests in Australia (6). The property also contains an outstanding number of songbird species (7) including lyrebirds (Menuridae), scrub-birds (Atrichornithidae), treecreepers	Outstanding record of the 'Age of the Pteridophytes' from the Carboniferous Period with some of the oldest elements of the world's ferns (1). Outstanding record of the 'Age of Conifers' in the Jurassic Period with one of the most significant centres of survival for Araucarians (2). Outstanding record of the 'Age of the Angiosperms' (divided into 4 phases): • a secondary centre of endemism for primitive flowering plants originating in the Early Cretaceous (3), • the most diverse assemblage of relict angiosperm taxa representing the primary radiation of dicotyledons in the mid-Late Cretaceous (4), • a unique record of the evolutionary history of Australian rainforests	Significant Species • Relict, endemic, disjunct and primitive plant species (1-5). • Relict, endemic, disjunct and primitive animal species (vertebrate and invertebrate) (7 & 8). • Cold-adapted/dry species (6).

(Climacteridae) and bowerbirds and catbirds (Ptilonorhynchidae), belonging to some of the oldest lineages of passerines (7) that evolved in the Late Cretaceous. Outstanding examples of other relict vertebrate and invertebrate fauna (8) from ancient lineages linked to the break-up of Gondwana also occur in the property. The flora and fauna of the Gondwana Rainforests WHA provides outstanding examples of ongoing evolution including plant and animal taxa, which show evidence of relatively recent evolution (9). The rainforests have been described as 'an archipelago of refugia, a series of distinctive habitats that characterise a temporary endpoint in climatic and geomorphological evolution'. The distances between these 'islands' of rainforest represent barriers to the flow of genetic material for those taxa which have low dispersal ability, and this pressure has created the potential for continued speciation.	representing the 'golden age' of the Early Tertiary (5), • and a unique record of Miocene vegetation that was the antecedent of modern temperate rainforests in Australia (6). Outstanding number of songbird species (7) belonging to some of the oldest lineages of passerines (7) that evolved in the Late Cretaceous. Outstanding examples of other relict vertebrate and invertebrate fauna (8) from ancient lineages linked to the break-up of Gondwana. outstanding examples of ongoing evolution including plant and animal taxa which show evidence of relatively recent evolution (9).	
*Criterion x: Contains the most important and significant habitats for **in-situ conservation of biological diversity**, including those containing threatened species of Outstanding Universal Value from the point of view of science or conservation.*		
The ecosystems of the Gondwana Rainforests WHA contain significant and important natural habitats for species of conservation significance, particularly those associated with the rainforests which once covered much of the continent of Australia and are now restricted to archipelagos of small areas of rainforest isolated by sclerophyll vegetation and cleared land. The Gondwana Rainforests WHA provides the principal habitat for many species of plants and animals of outstanding universal value, including more than 270 threatened species (1) as well as relict and primitive taxa (2). Rainforests covered most of Australia for much of the 40 million years after its separation from Gondwana. However, these rainforests contracted as climatic conditions changed and the continent drifted northwards. By the time of European settlement rainforests covered only 1% of the landmass and were restricted to refugia with suitable climatic conditions and protection from fire. Following European settlement, clearing for agriculture saw further loss of rainforests and only a quarter of the rainforest present in Australia at the time of European settlement remains. The Gondwana Rainforests WHA protects the largest and best stands of rainforest habitat (3) remaining in this region. Many of the rare and threatened flora and fauna species are rainforest specialists (1), and their vulnerability to extinction is due to a variety of factors including the rarity of their rainforest habitat. The Gondwana Rainforests WHA also protects large areas of other vegetation including a diverse range of heaths, rocky outcrop	Principal habitat for many threatened species (1). Principal habitat for many relict and primitive taxa (2). The largest and best stands of rainforest habitat (3) remaining in this region. Large areas of other vegetation including a diverse range of heaths, rocky outcrop communities, forests and woodlands (4).	Significant Species • Relict, endemic, disjunct and primitive plant species (2). • Relict, endemic, disjunct and primitive animal species (vertebrate and invertebrate) (2). • Rare and Threatened Plants (1). • Rare and Threatened mammals (1). • Rare and Threatened birds (1). • Rare and Threatened frogs (1). • Rare and Threatened reptiles (1).

communities, forests and woodlands (4). These communities have a high diversity of plants and animals that add greatly to the value of the Gondwana Rainforests as habitat for rare, threatened and endemic species (1 & 2). The complex dynamics between rainforests and tall open forest particularly demonstrates the close evolutionary and ecological links between these communities. Species continue to be discovered in the property including the re-discovery of two mammal species previously thought to have been extinct: the Hastings River Mouse (*Pseudomys oralis*) and Parma Wallaby (*Macropus parma*).		

References

IUCN (2017) World Heritage Outlook Report for Gondwana Rainforests of Australia, https://www.worldheritageoutlook.iucn.org/explore-sites/wdpaid/12202

UNESCO (2019) Gondwana Rainforests of Australia, https://whc.unesco.org/en/list/368/

Appendix 8. Maps of significant species potential habitat and potential ecological impact

Maps of the Mount Barney NP 2019-2020 bushfire, showing potential ecological impact, overlain with potential habitat for conservation significant species that met both the following criteria (refer Appendix 5):

- a significant proportion (>5%) of their potential Queensland habitat occurs within Mount Barney NP, and
- a significant proportion (≥15%) of their potential habitat within Mount Barney NP was burnt in the bushfire.

The species are:

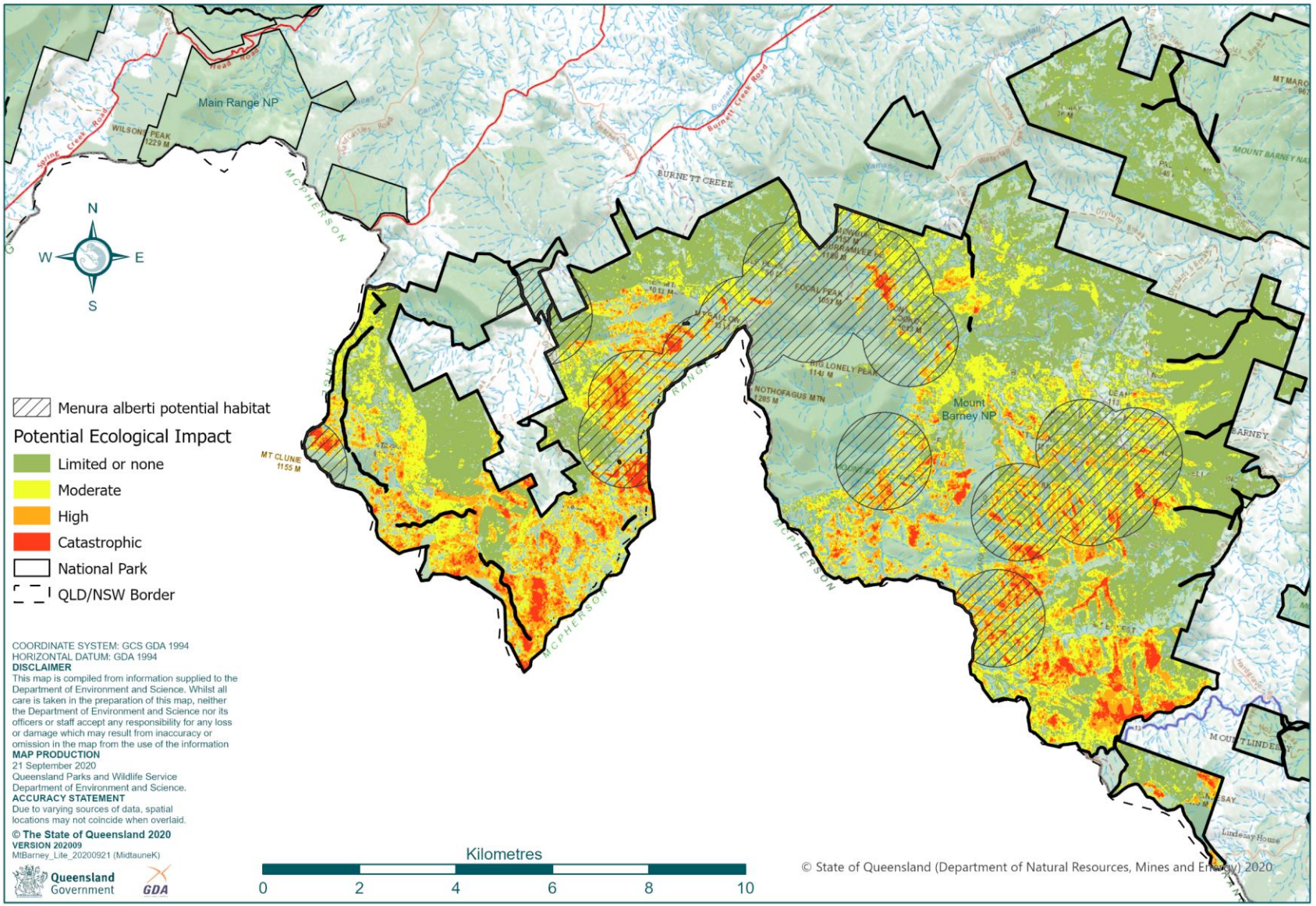
Fauna:
a) rufous scrub-bird
b) eastern bristlebird
c) Albert's lyrebird
d) *Mixophyes fleayi*
e) brush-tailed rock-wallaby
f) Hastings River mouse

Plants:
g) *Acacia acrionastes*
h) *Agiortia cicatricata*
i) *Banksia conferta*
j) *Bertya ernestiana*
k) *Comesperma breviflorum*
l) *Coopernookia scabridiuscula*
m) *Dendrobium schneiderae* var*. schneiderae*
n) *Eucalyptus codonocarpa*
o) *Euphrasia bella*
p) *Hibbertia monticola*
q) *Leionema elatius* subsp. *beckleri*
r) *Leptospermum barneyense*
s) *Phlegmariurus varius*
t) *Pseudanthus pauciflorus* subsp*. pauciflorus*
u) *Pultenaea whiteana*
v) *Tetramolopium vagans*
w) *Zieria montana*

NOTE: Maps in this Appendix for species shown in bold above have been removed because they are not for public release as they include detailed distributional information for species deemed ***confidential*** by the Department.

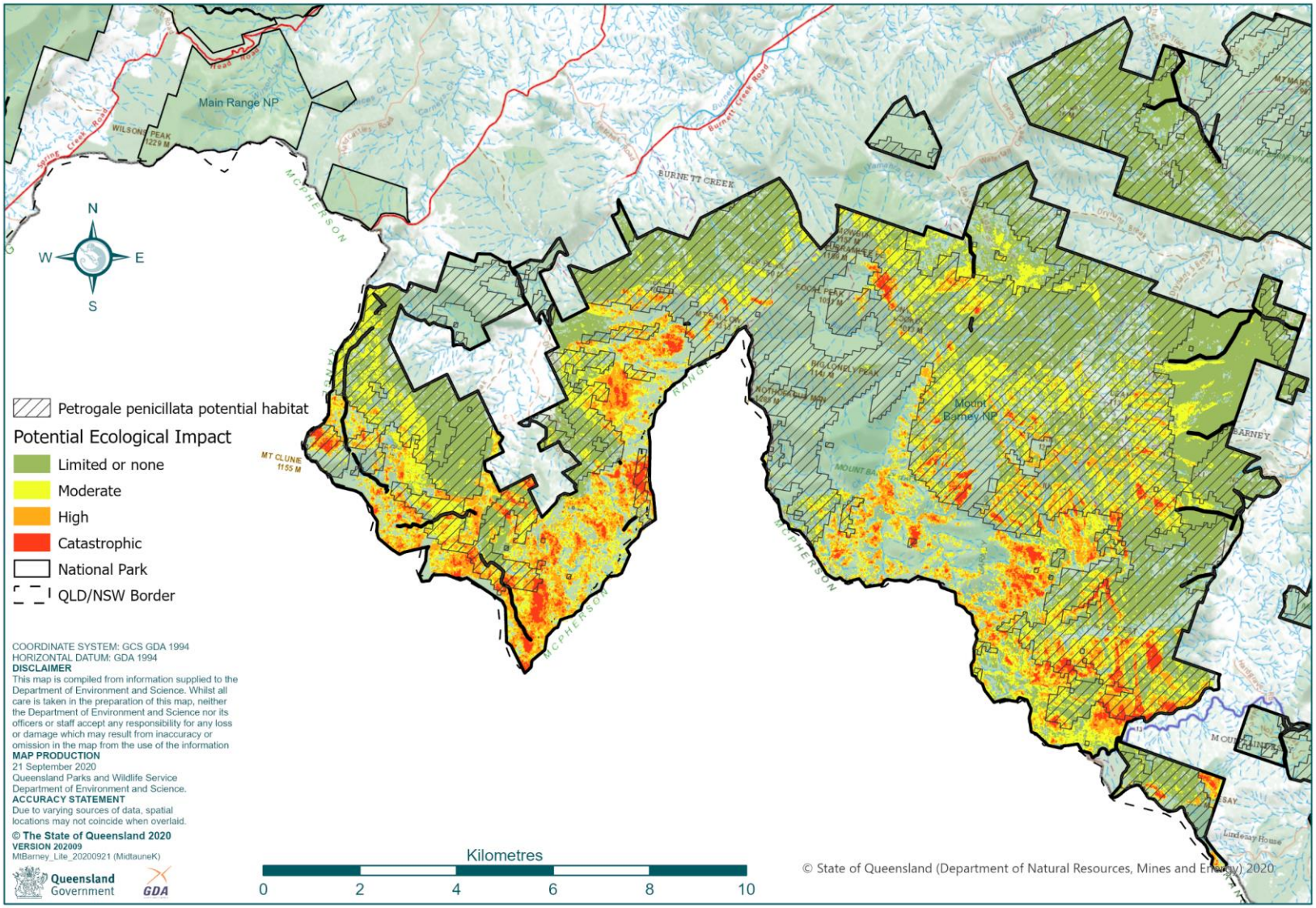
a. rufous scrub-bird – not for public release
b. eastern bristlebird – not for public release

c. Albert's lyrebird

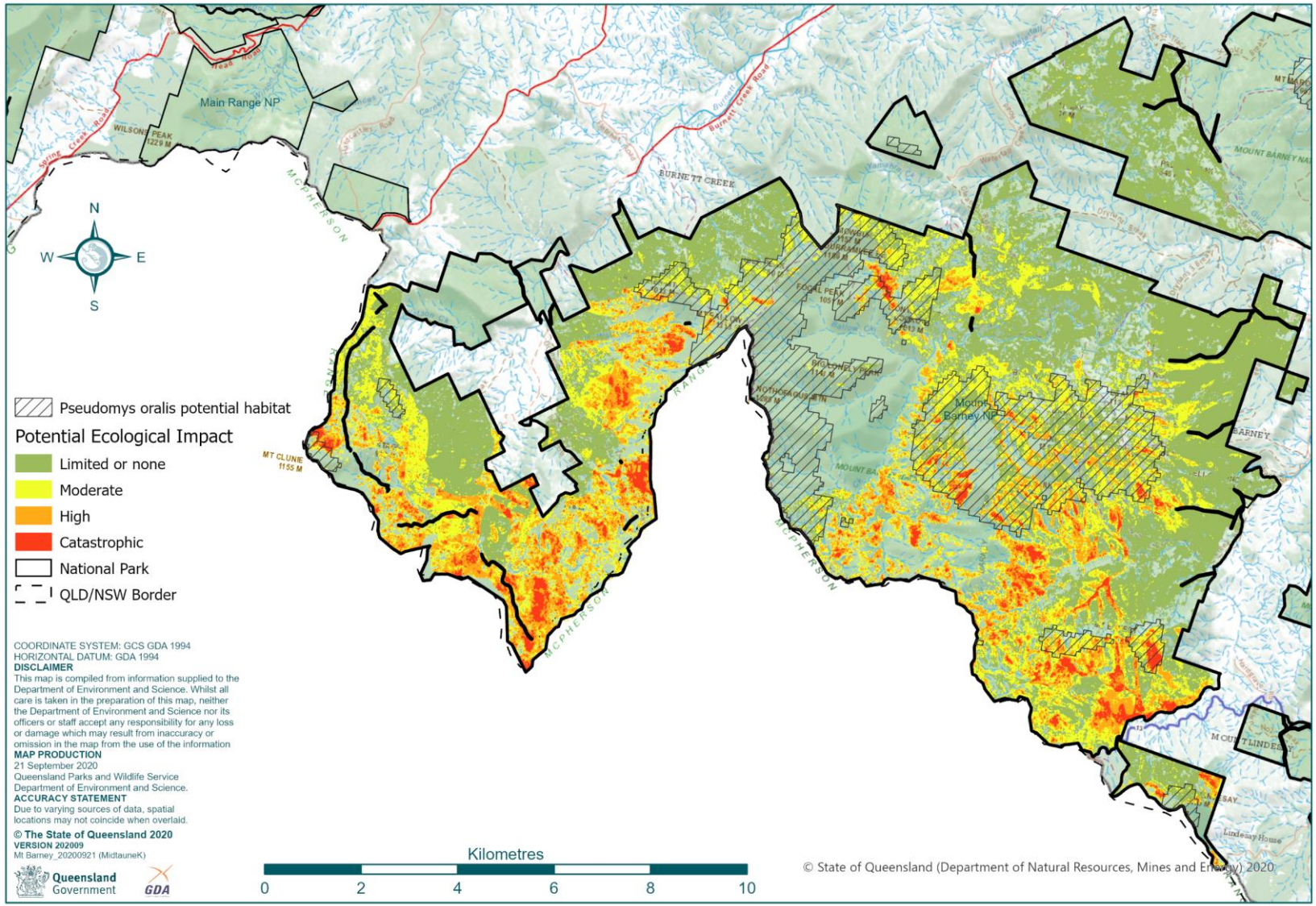


d. *Mixophyes fleayi* – not for public release

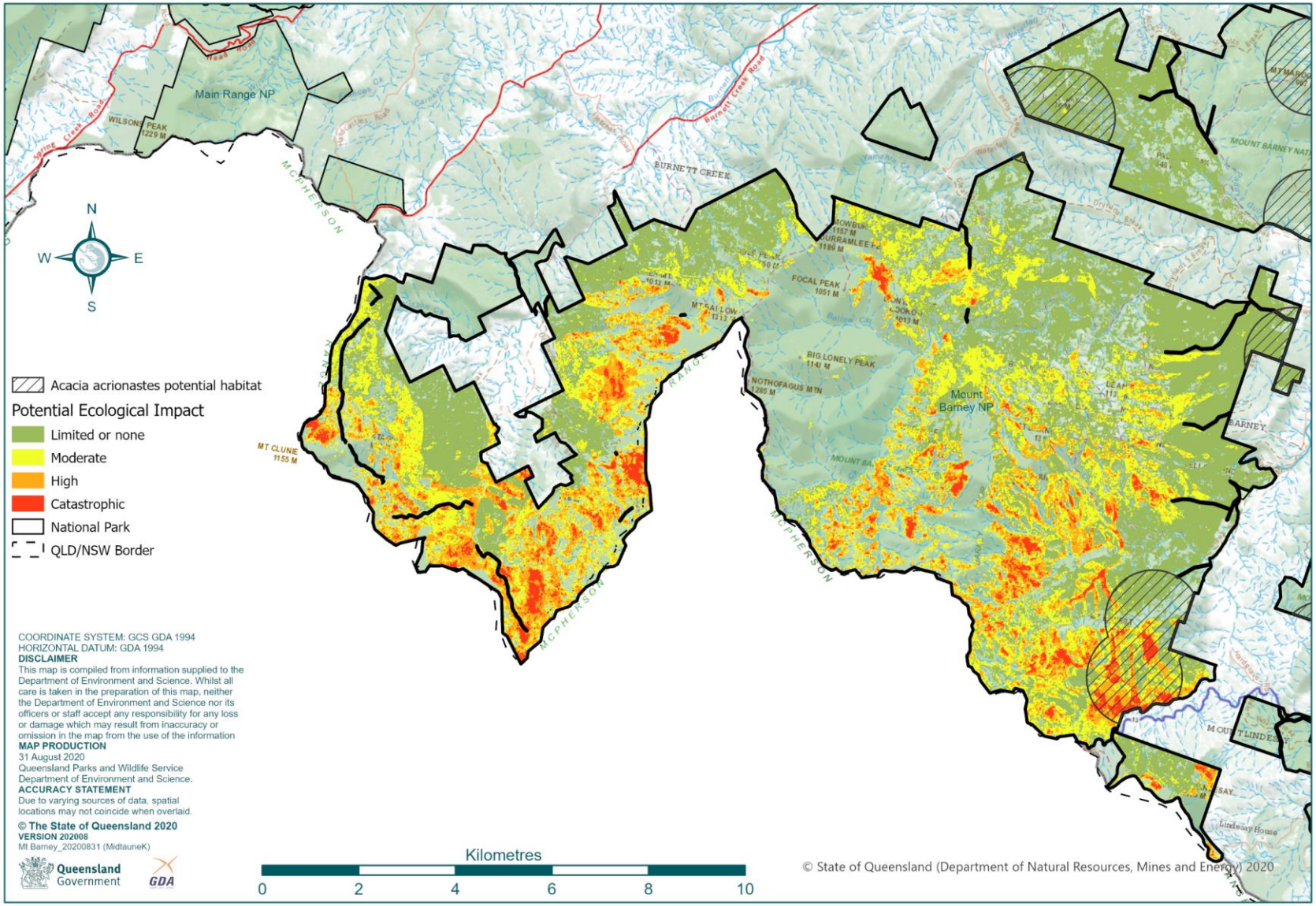
e. brush-tailed rock-wallaby



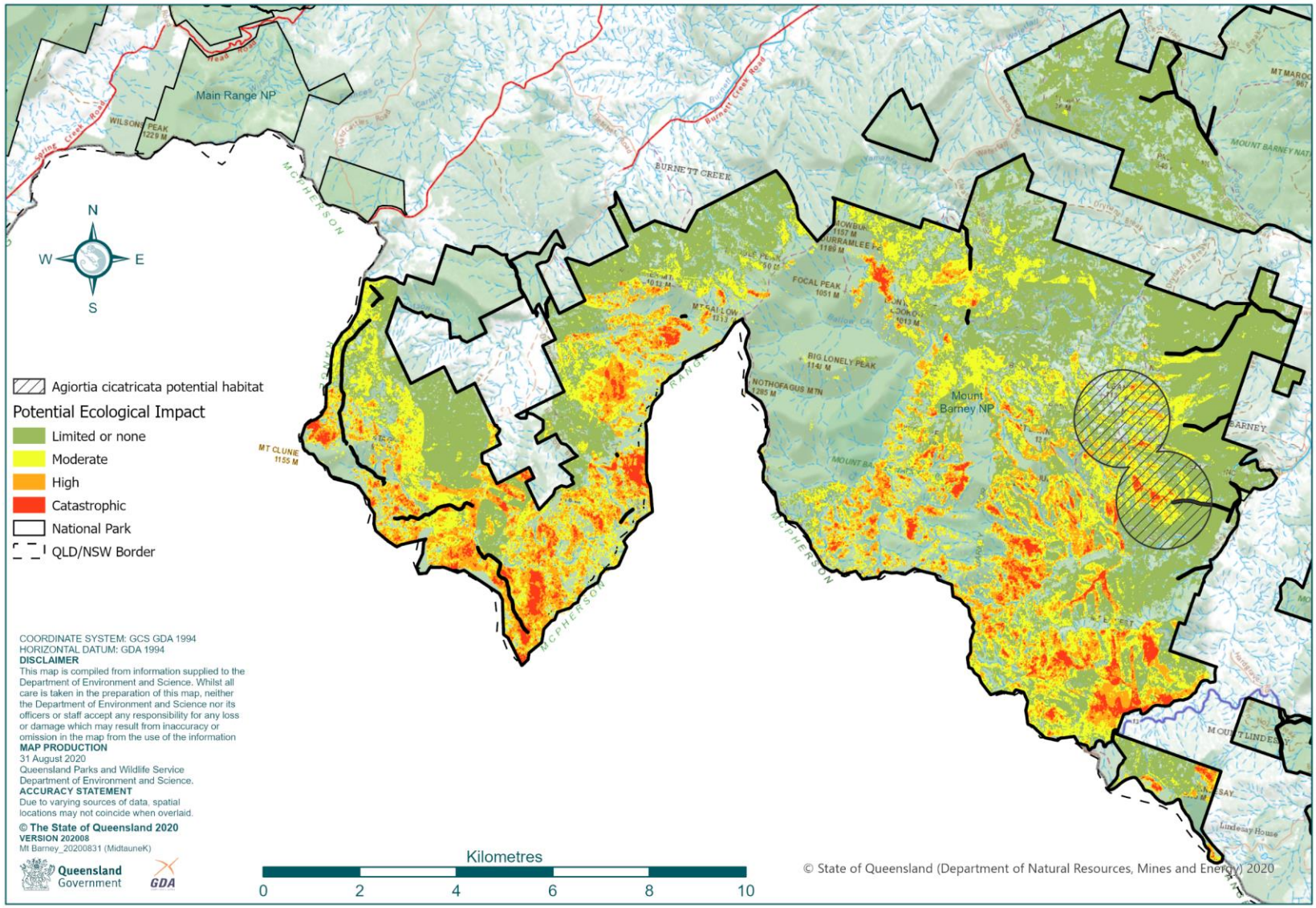
f. Hastings River mouse



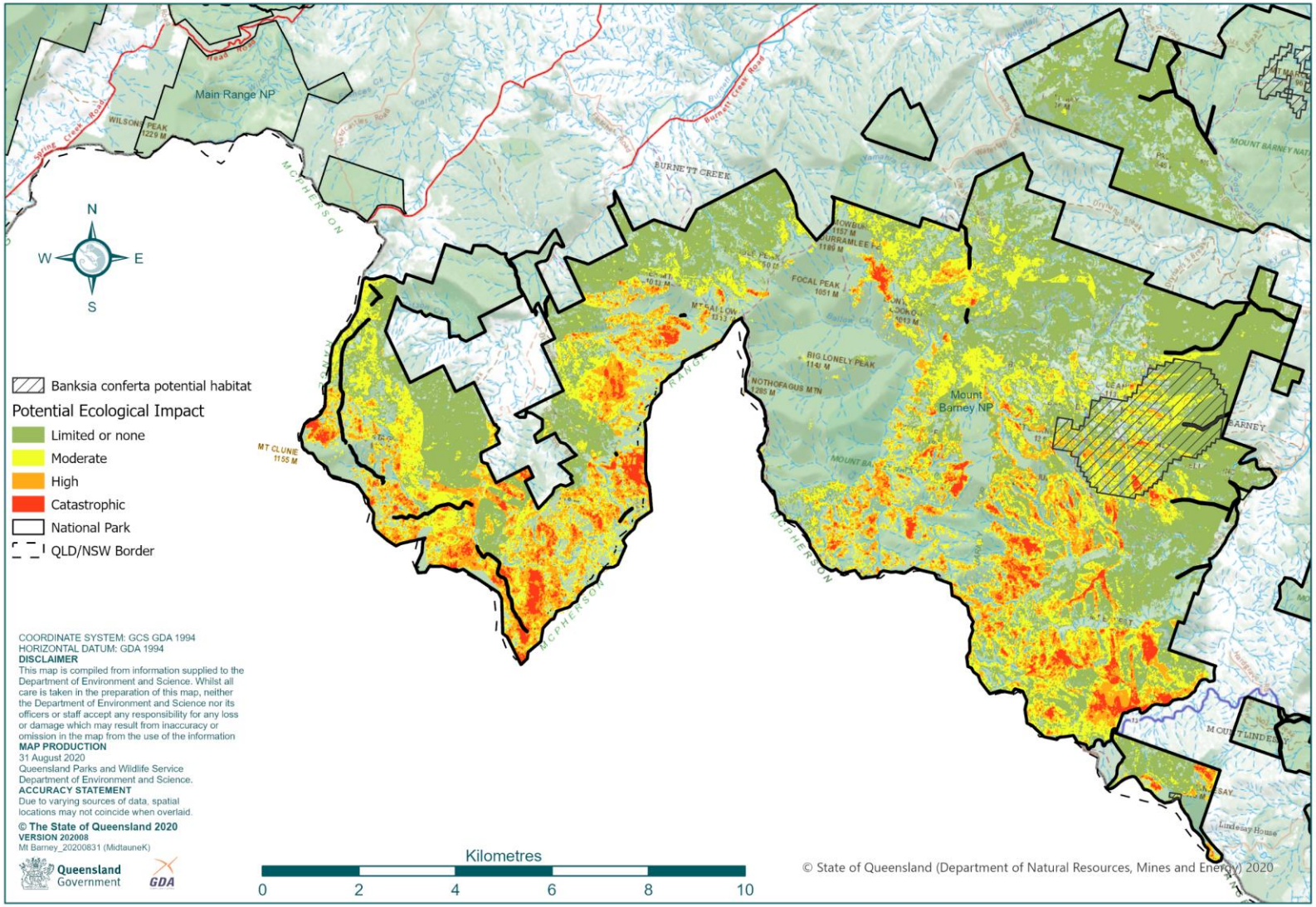
g. *Acacia acrionastes*



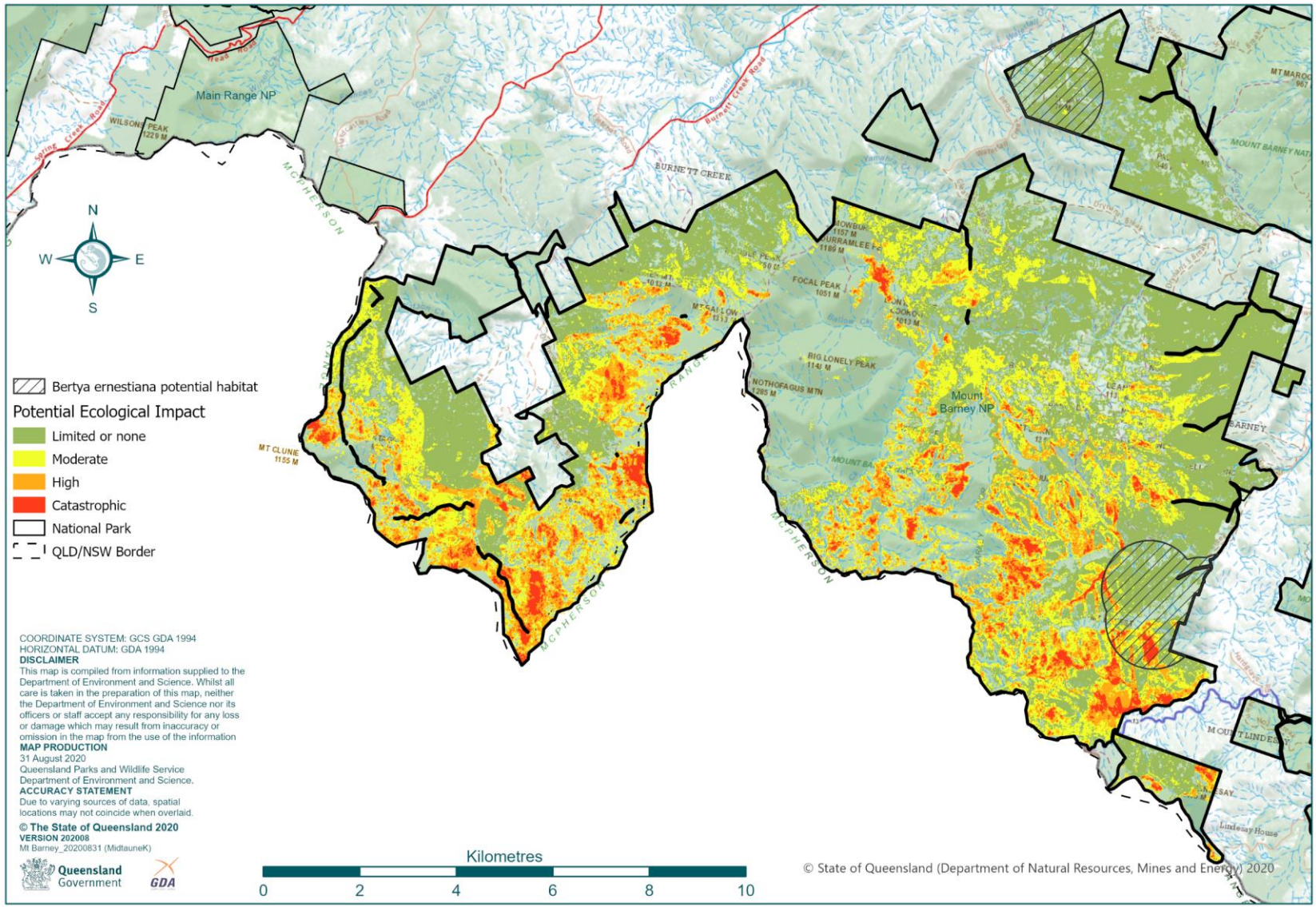
h. ***Agiortia cicatricata***



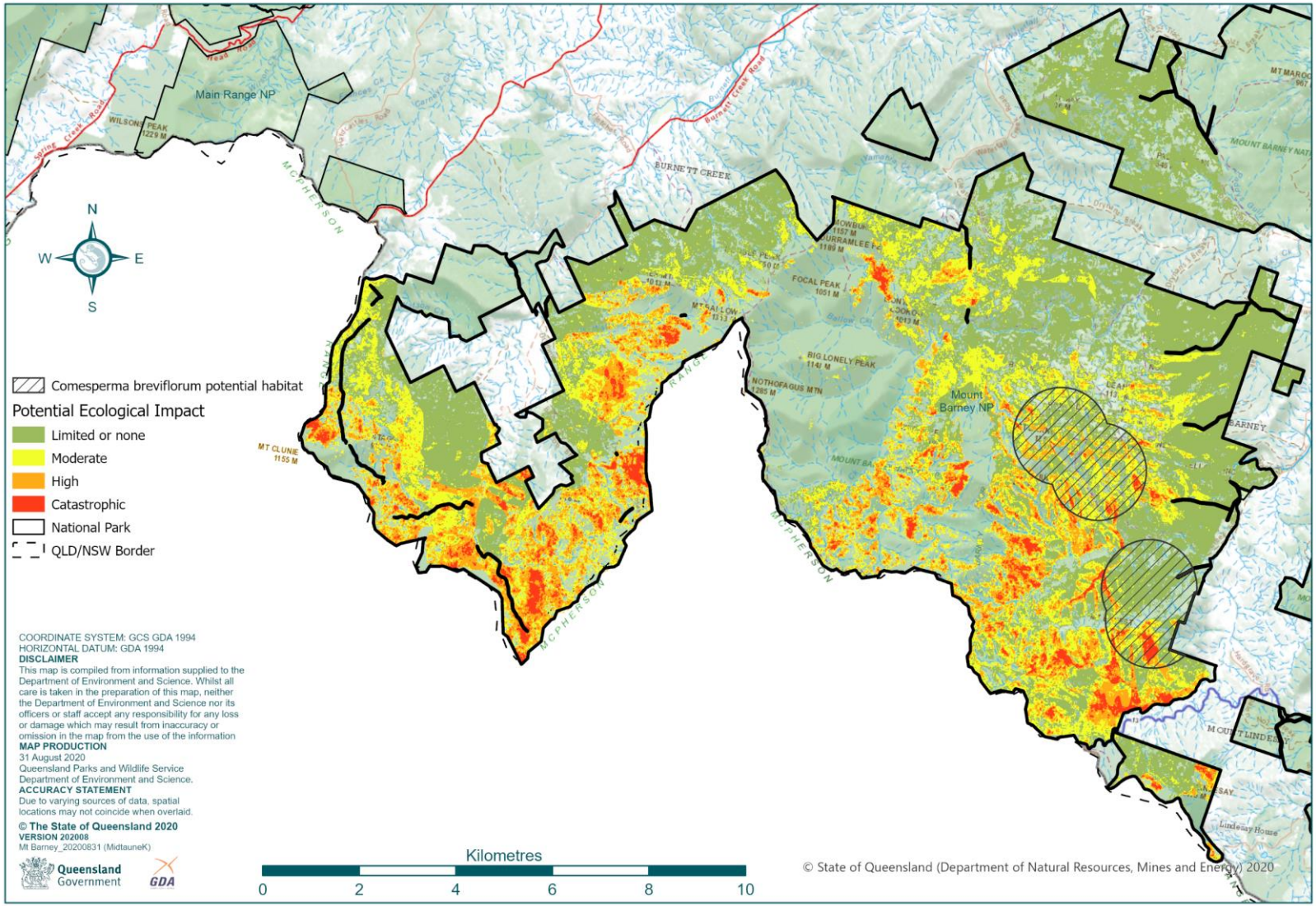
i. *Banksia conferta*



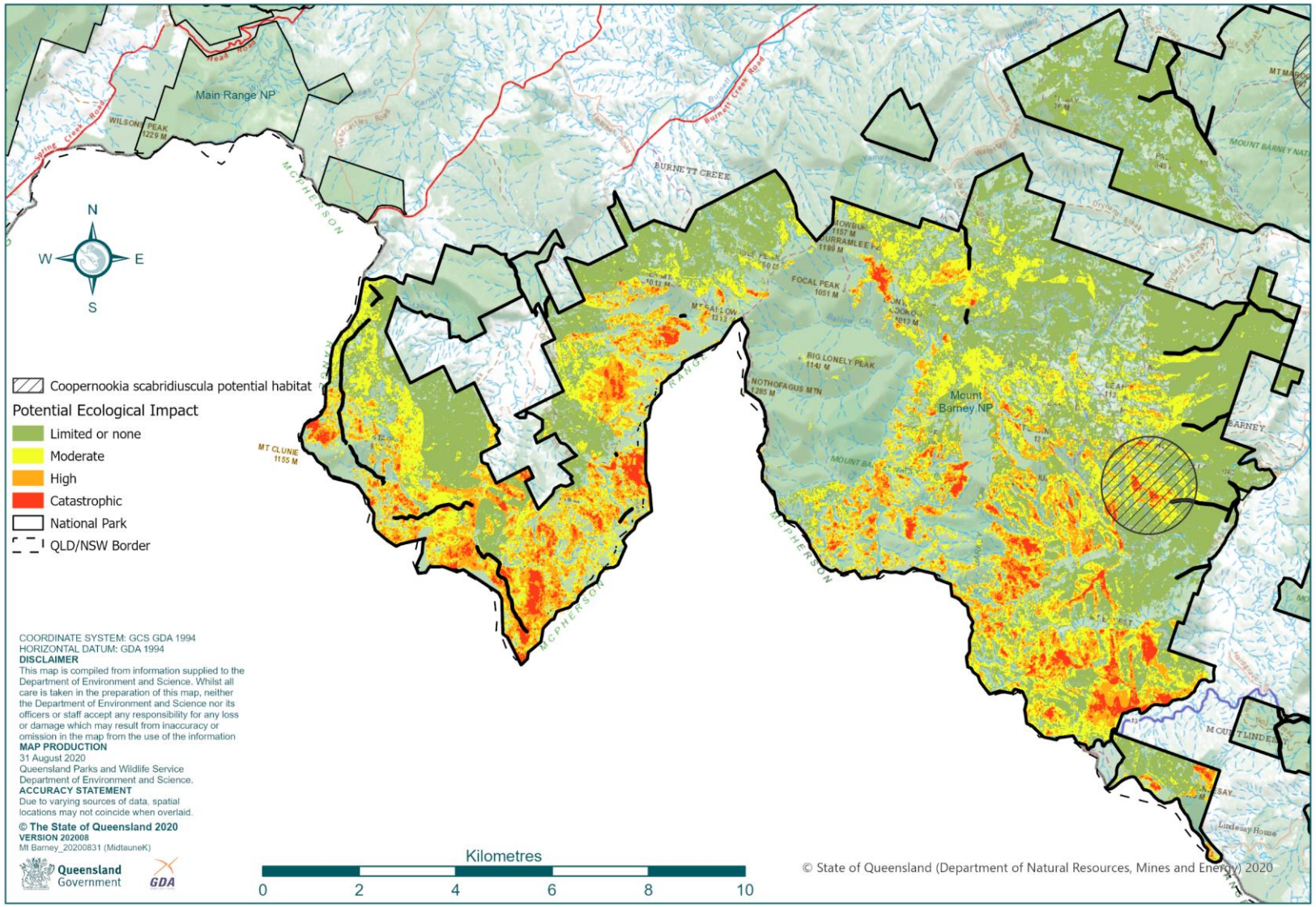
j. *Bertya ernestiana*



k. *Comesperma breviflorum*

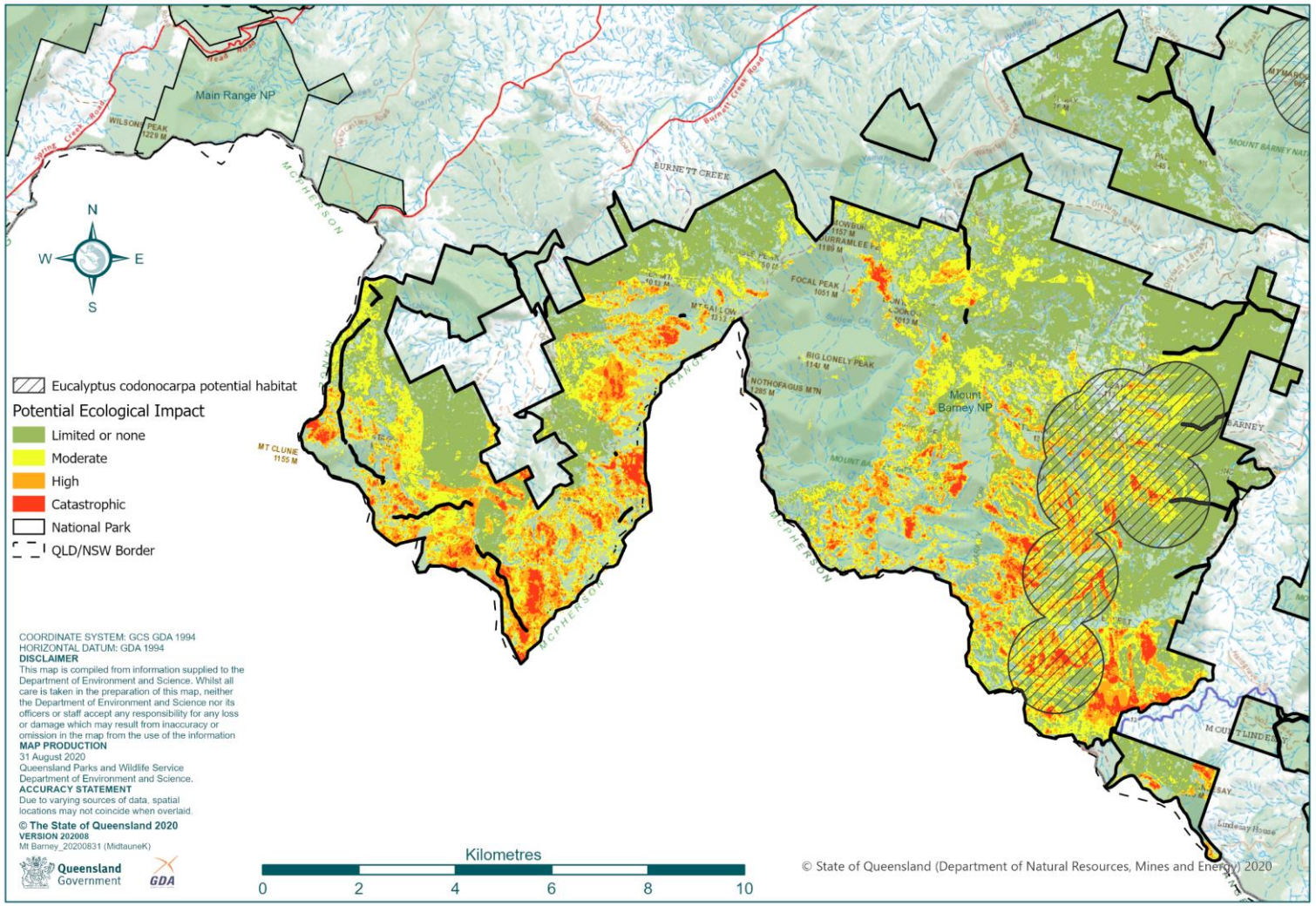


I. *Coopernookia scabridiuscula*

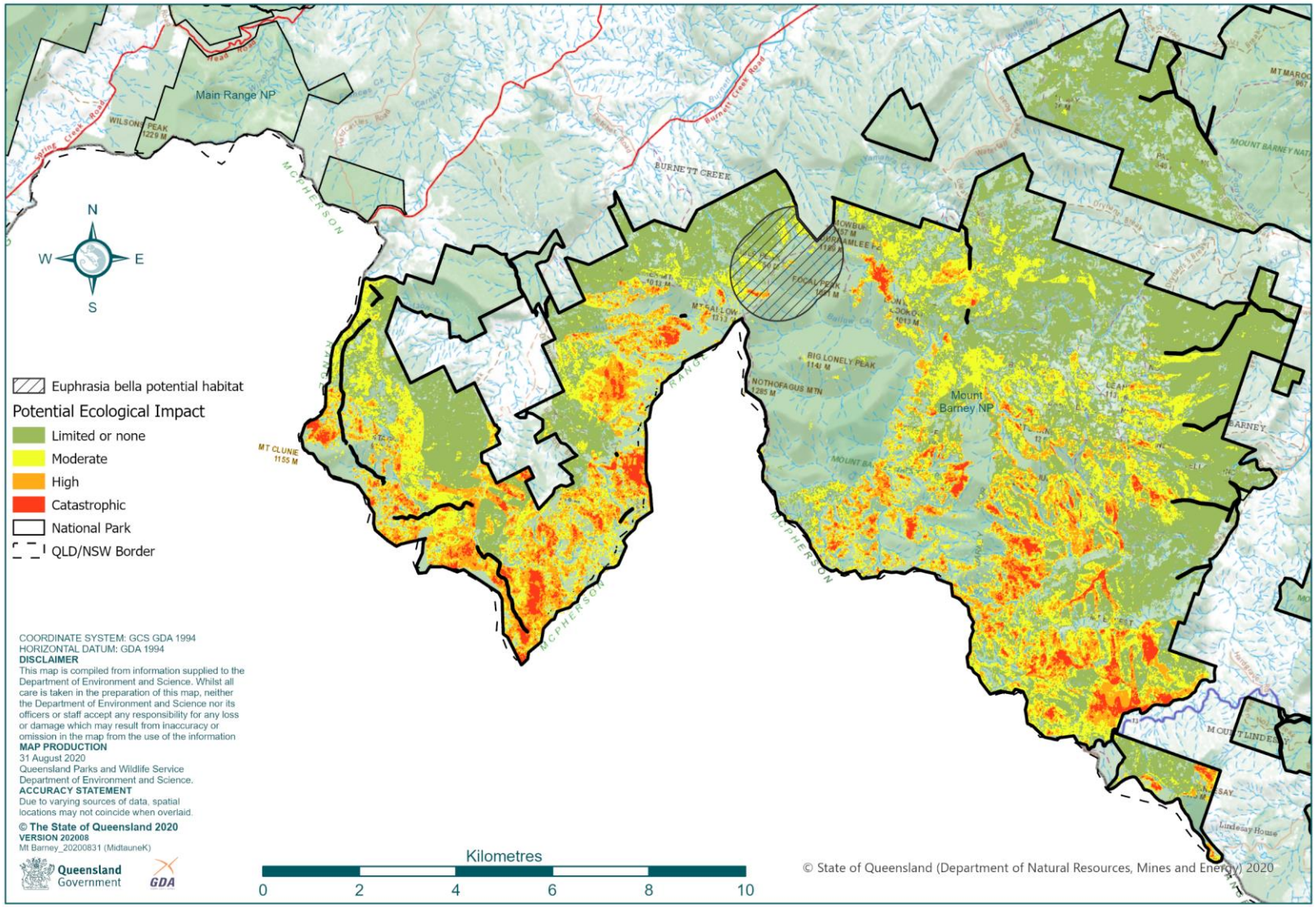


m. *Dendrobium schneiderae* var. *schneiderae* – not for public release

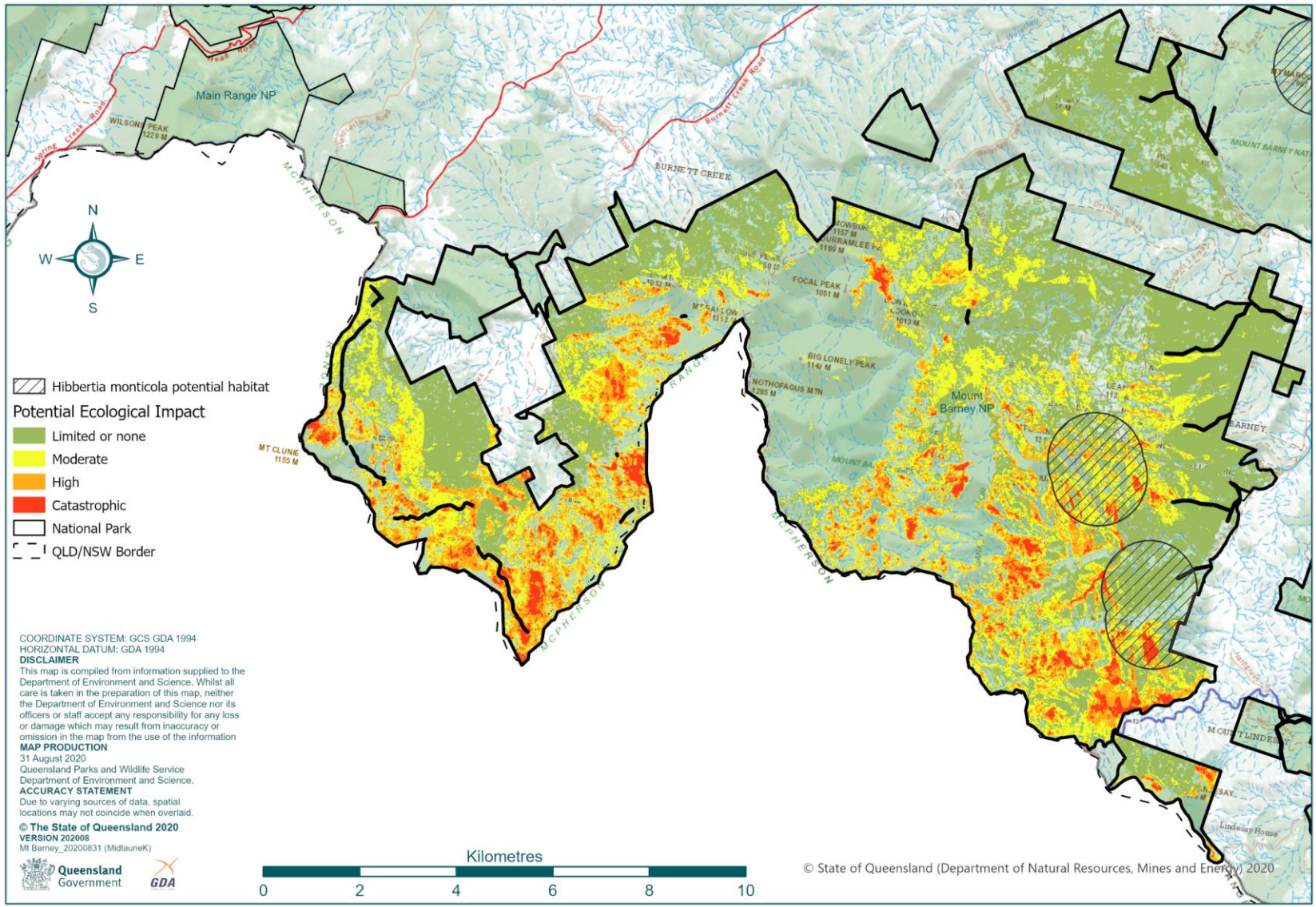
n. *Eucalyptus codonocarpa*



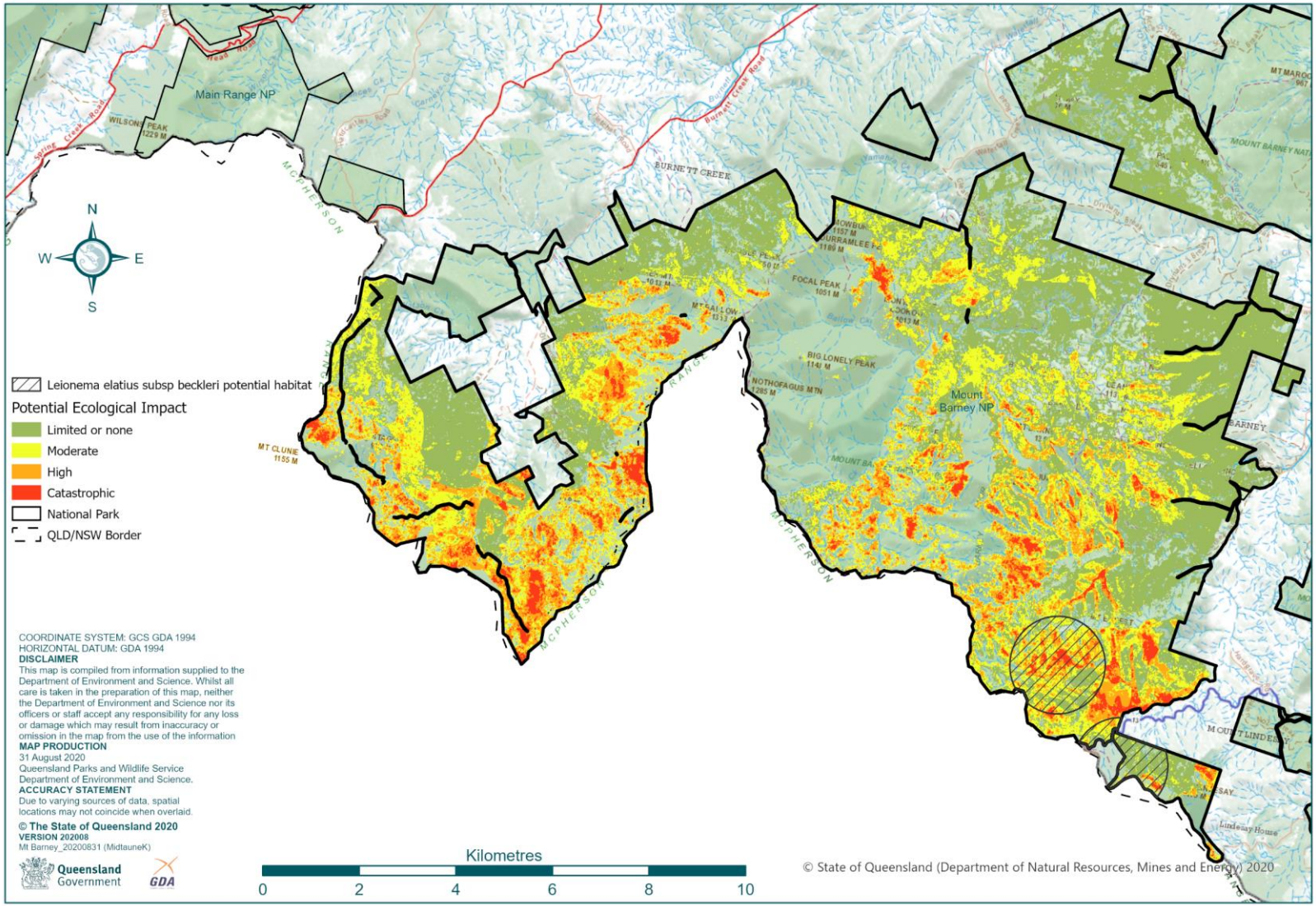
o. *Euphrasia bella*



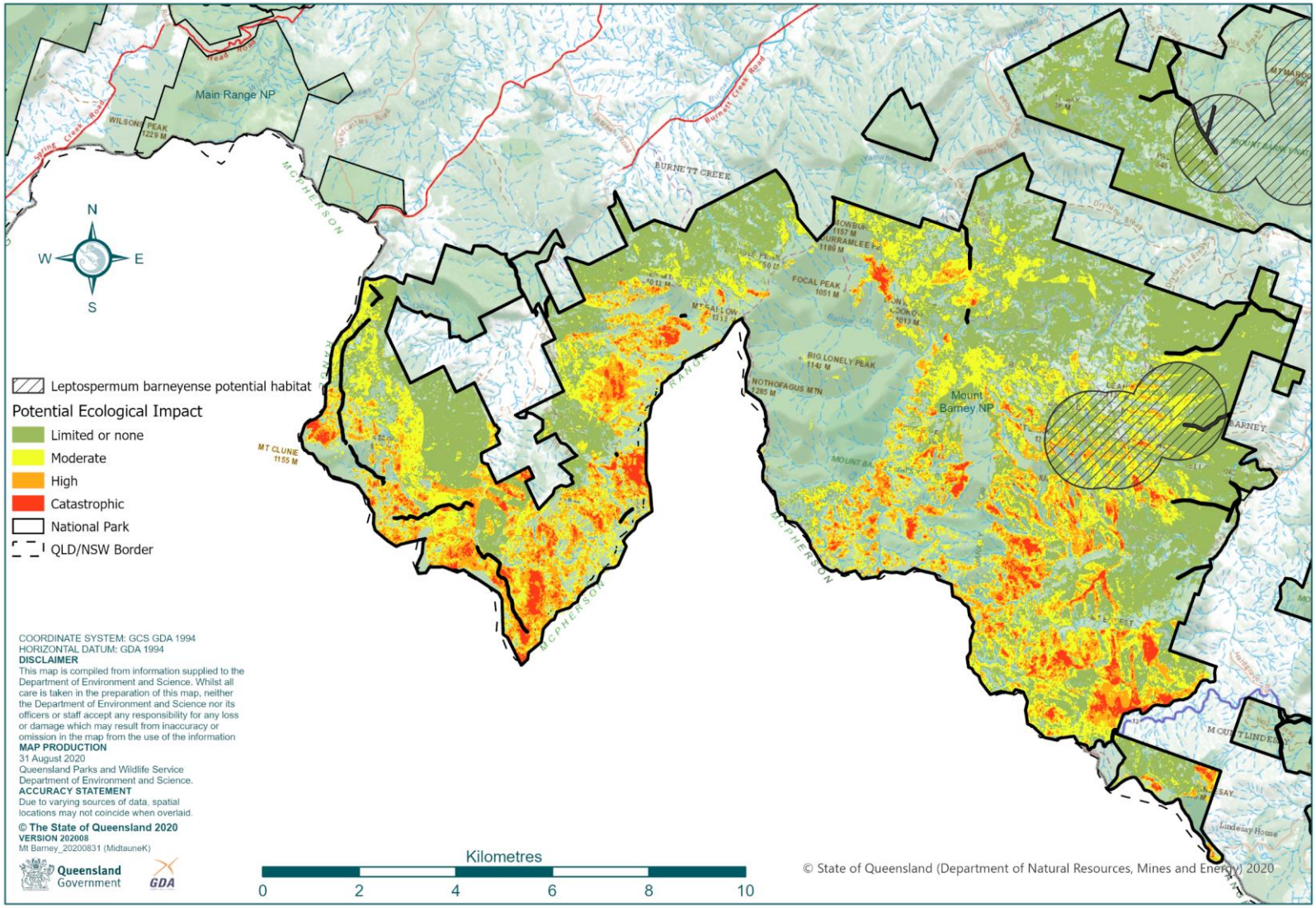
p. ***Hibbertia monticola***



q. *Leionema elatius* subsp. *beckleri*

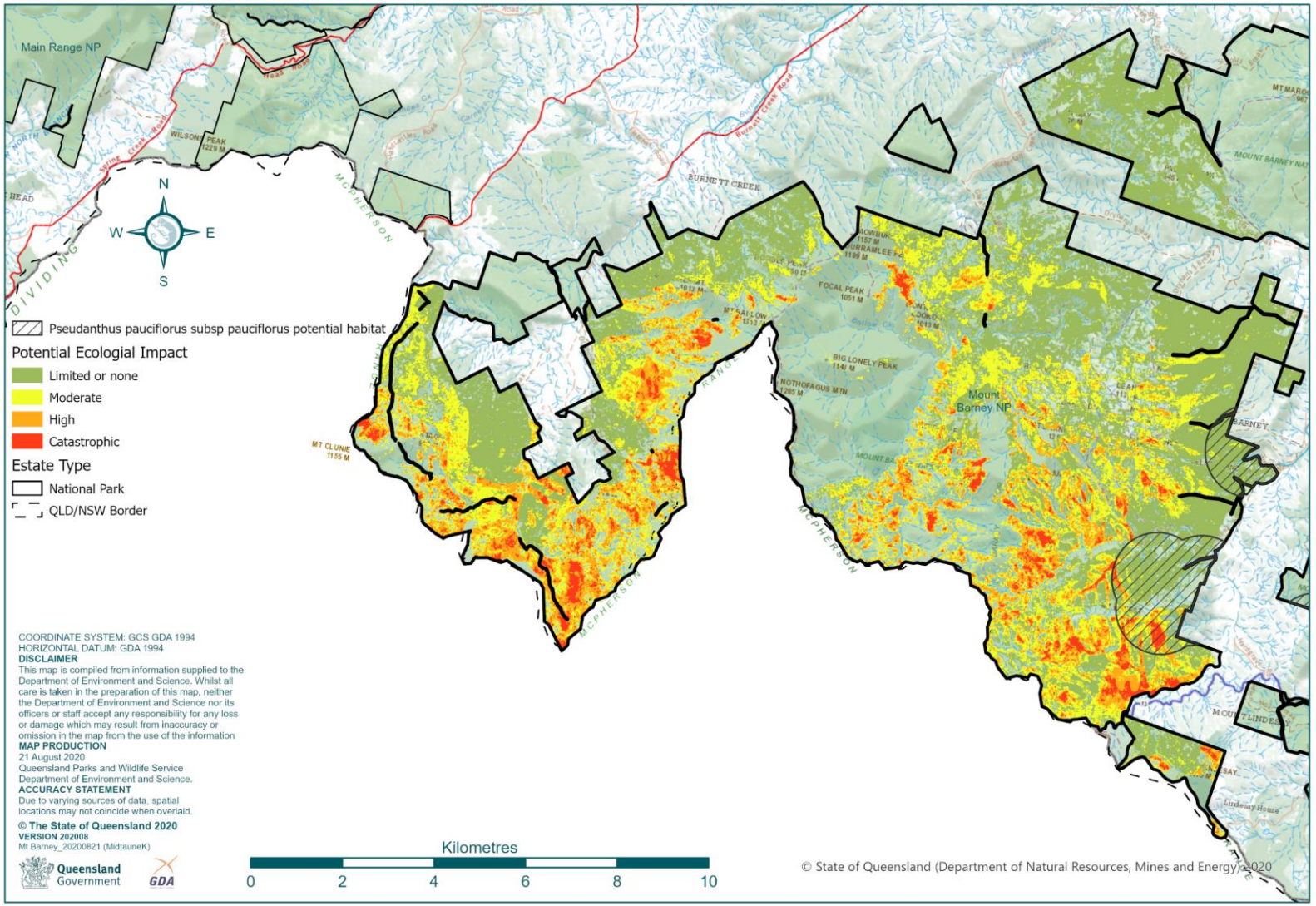


r. *Leptospermum barneyense*

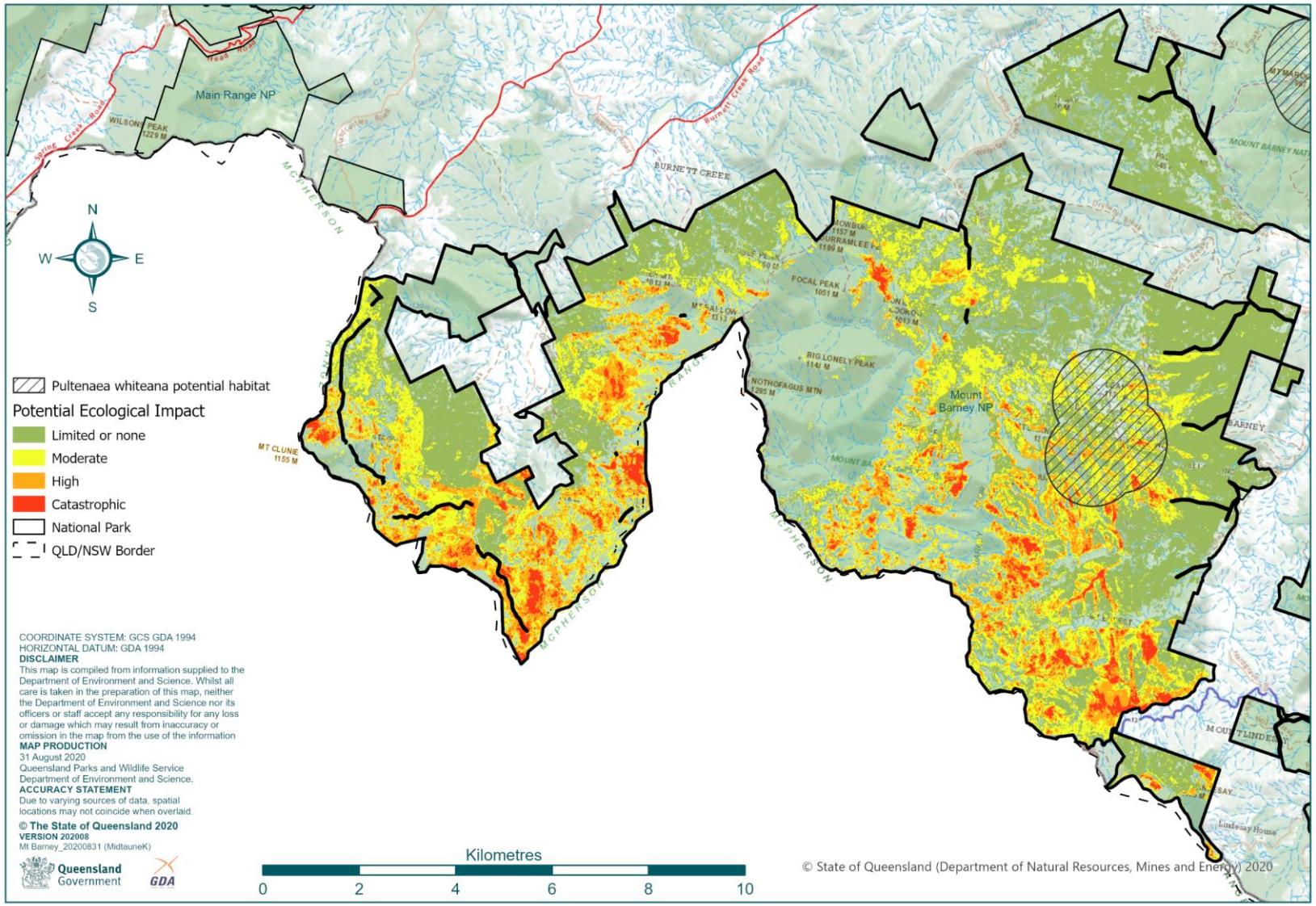


s. *Phlegmariurus varius* – not for public release

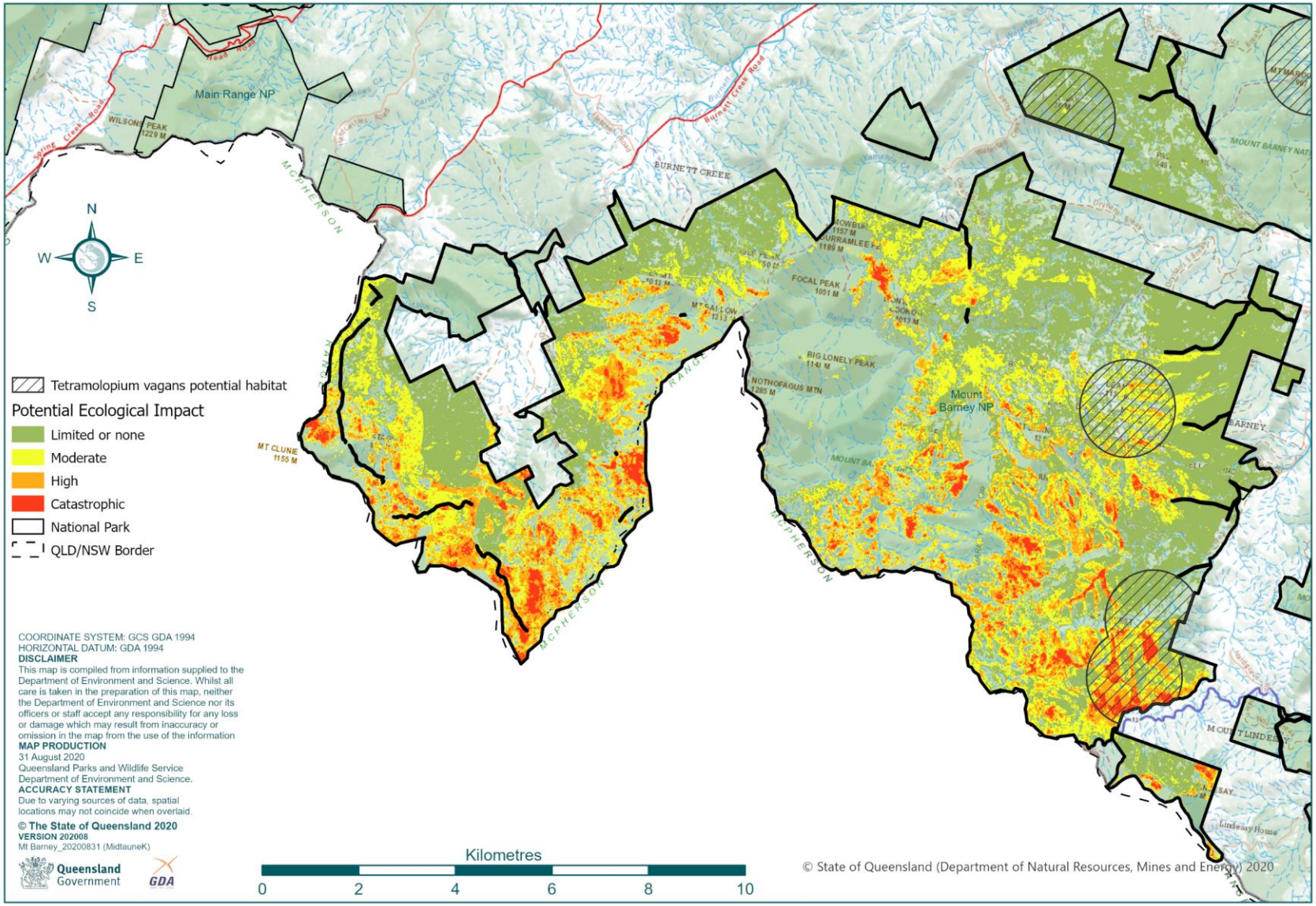
t. *Pseudanthus pauciflorus* subsp. *pauciflorus*



u. *Pultenaea whiteana*



v. *Tetramolopium vagans*



w. *Zieria montana*