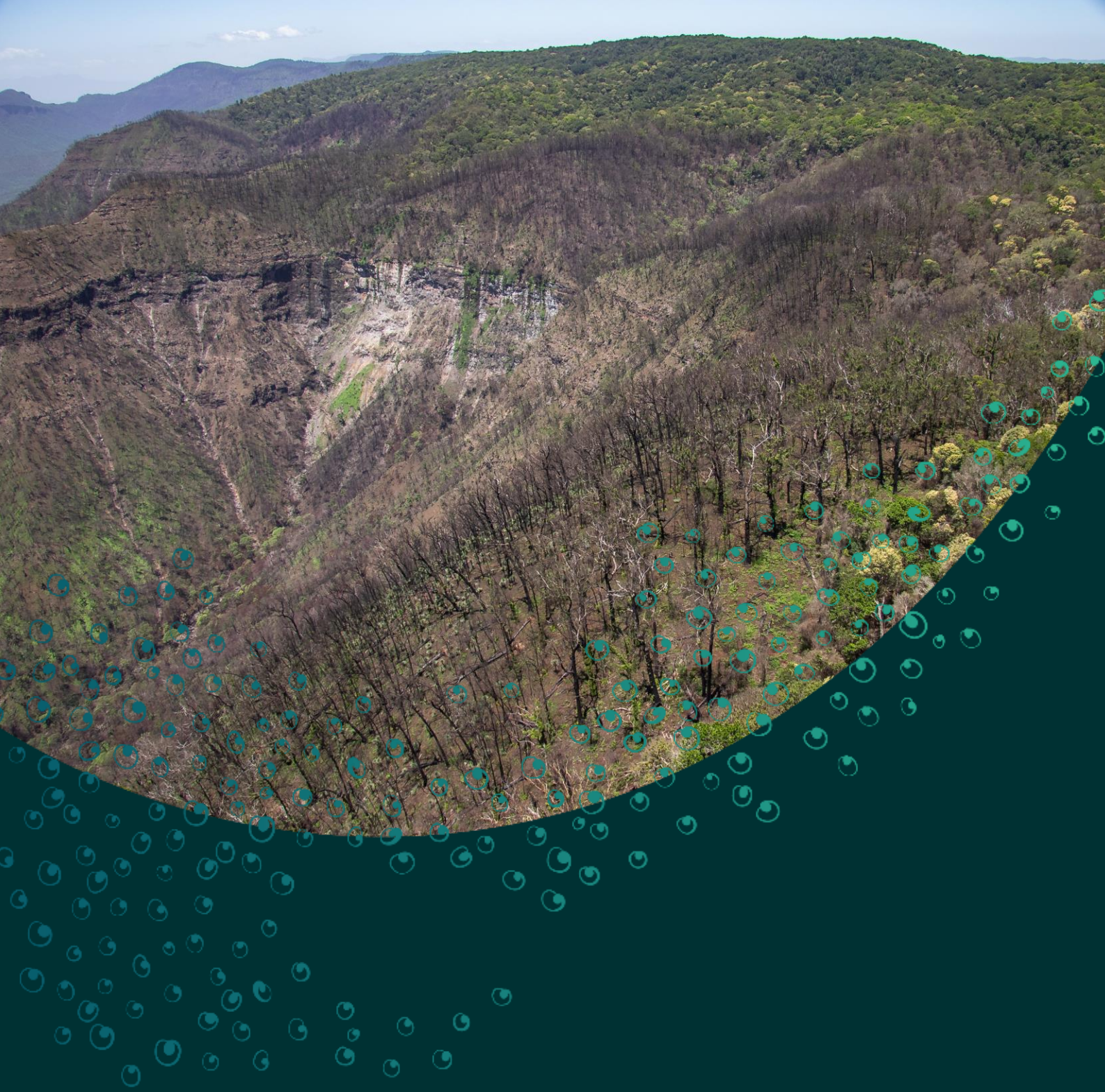

Post-fire Assessment Report—Natural Values:

2019 bushfire complex, Main Range National Park and adjacent QPWS estate, South West Queensland Region

March 2021

Queensland Government

Prepared by: Technical Services and South West Queensland Region of Queensland Parks and Wildlife Service and Partnerships and the Queensland Herbarium, Department of Environment and Science

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Front cover

Northern section of Main Range National Park, 20 February 2020, showing extensive extreme fire severity in open eucalypt forests and woodlands and significant incursions of fire into adjoining upland subtropical rainforests. Instability of the talus slope and increased erosion along drainage lines is also apparent (Photo: R. Ashdown).

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).
CP	Conservation Park.
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.
FR	Forest Reserve.
IBISCA	The international research program: *Investigating the Biodiversity of Soil and Canopy Arthropods.*
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	National Park.
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).
RR	Resources Reserve.
SF	State Forest.
V	Vulnerable.
VIIRS	Visible Infrared Imaging Radiometer Suite.
WHA	World Heritage Area.

1 Executive summary

Following serious rainfall deficiencies, a complex of bushfires burnt extensively within QPWS managed estate of the Main Range area of south-east Queensland (Main Range NP, Swanfels SF, Glen Rock SF and Spicers Gap Road CP) and adjoining tenures. The fire complex consisted of three fires: Point Pure fire (ignition: 19 September 2019), Swanfels fire (ignition: 28 September 2019) and the Chalk Rd fire (ignition: 16 December 2019), with all fires deemed out by 15 January 2020 (although subsequent minor relights were observed up until at least April 2020). Fire weather conditions at the time of the fires ranged upwards of Severe on many days with periods of Extreme to locally Catastrophic conditions.

Fire severity mapping was undertaken using satellite imagery processing. Field assessments of fire severity and impacts were undertaken from January through to May 2020 and included accessing remote areas on foot, such as the Mount Superbus area, and an aerial inspection.

The total area burnt within QPWS estate of the Main Range area was approximately 19 592ha, including 11 723ha 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 small areas of full canopy consumption including within rainforest. Substantial areas of rainforest, wet eucalypt open forests and rainforest/eucalypt forest ecotones were burnt. The potential ecological impact to burnt ecosystems was assessed as mostly moderate or high to catastrophic 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 thickets – Regional Ecosystems with a fire sensitive canopy and understorey – BVGs 2, 5, 6 and 7.
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, 11, 13, 15 and 16.
NV 4	Montane heaths and shrublands – Regional Ecosystems with a fire tolerant canopy and understorey – BVGs 29.
NV 5	Riparian corridors – Regional Ecosystems fringing streams and rivers 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 QPWS estate of the Main Range area 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 1 700ha, or 17% of the total extent of rainforests within QPWS estate of the Main Range area, burnt during the fires. All but 30ha of burnt rainforests fall within Main Range NP, with most of the rainforests that burnt in these fires occurring within the Gondwana Rainforests WHA. In some areas fire penetrated long distances (hundreds of

metres to kilometres) through rainforest communities, including burning temperate rainforests at altitudes in excess of 1350m in the Mount Superbus area. Within affected rainforests approximately 49.7% burnt at low, 32.5% at moderate, 14.7% at high and 3.1% at extreme relative severity, with likely ecological impact ranging from moderate to catastrophic (section 5.1.1). About 300ha of rainforests burnt at high to extreme severity with catastrophic ecological impacts likely in these areas. This represents 3% of the area of rainforest within the affected QPWS estates. 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 4 000ha, or 53.8% of the total extent of wet eucalypt open forests within QPWS estate of the Main Range area, burnt during the fires. Approximately 42.8% burnt at low, 39.9% at moderate, 15.5% at high and 1.9% 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 the fires 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 fires, 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 Main Range NP and have been heavily impacted by fires. Their post-fire management requirements are similar to those of wet eucalypt open forests.

About 13 323ha, or 60% of the total extent of dry eucalypt forests and woodlands within QPWS estate of the Main Range area, burnt during the fires. These ecosystems are fire-adapted, however ecological impacts are expected to be significant in areas of high to extreme fire severity, because of the loss of critical habitat features such as hollow-bearing trees and large hollow logs. Approximately 15.1% of the area of these communities burnt at high and 1.6% at extreme severity. During field assessments we observed some areas with: significant loss of canopy, although in places some of this appears to have been due to preceding drought; loss of large trees from basal fires; complete loss of ground cover resulting in exposed mineral earth. We also observed widespread recovery of trees with post-fire coppicing and epicormic regrowth. 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 100ha, or 52.1% of the total extent of mapped montane heaths and shrublands within QPWS estate of the Main Range area, burnt during the fires. Approximately 36.3% burnt at low, 39.2% at moderate, 22.9% at high and 1.6% at extreme relative severity with significant areas with potential ecological impact of moderate to high. Weeds are a significant issue for the recovery of some of these areas, and in some localised areas visitor impacts may be an issue.

Significant areas of riparian corridors within QPWS estate of the Main Range area, burnt during the fires. Riparian corridors are an important value of Main Range 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. Weeds are a significant issue for the recovery of many of these areas.

A large number of conservation significant flora and fauna species are known, or have potential habitat, within the burnt area (section 5.2). Impacts on these species will vary, but those in fire sensitive communities are likely to have been most severely affected. Seven fauna species have more than 15% (up to 61%) of their potential Queensland habitat falling within the affected Main Range estates, with 22-69% of this habitat burnt. The species are: rufous scrub-bird, eastern bristlebird, Albert's lyrebird, *Mixophyes fleayi, Philoria kundagungan, Petrogale penicillata* and *Pseudomys oralis.* The latter five species are currently known to have significant populations within the burnt areas. Previously occupied eastern bristlebird habitat at Spicer's Gap was also burnt during the bushfires. Eleven flora species have more than 15% (up to 65%) of their potential Queensland habitat falling within the affected Main Range estates, with 42-86% of this habitat burnt. The species are: *Brachyscome ascendens, Eucalyptus dunnii, Bothriochloa bunyensis, Gonocarpus hirtus, Westringia sericea, Pimelea umbratica, Arundinella grevillensis, Dendrobium schneiderae* var. *schneiderae, Sarcochilus hartmannii, Bulbophyllum weinthalii* subsp. *weinthalii*, and *Muellerina myrtifolia*. Two Critically Endangered plant species known from Main Range NP (*Lenwebbia* sp. (Main Range P.R.Sharpe+ 4877) and *Rhodamnia rubescens*) are primarily threatened by myrtle rust. We observed significant impacts from myrtle rust on *Rhodamnia rubescens* resprouting from the bushfires.

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 and rainforest ecotone 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 northern part of Main Range 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 that is 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 take into account 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).
7. Assess the distribution and abundance of feral deer, cats, foxes and pigs, and undertake strategic control program where significant values are being impacted or threatened.
8. Reinstate damaged, or install new, strategic boundary fencing to prevent cattle entering regenerating areas.
9. Undertake a basic inventory of the natural values of Swanfels SF, in particular to confirm the presence and condition of threatened ecological communities.
10. Assess the impacts of feral horses on the natural values of Swanfels SF and undertake control to reduce or remove impacts.
11. Undertake surveys or monitoring of the threatened species most likely to have been impacted by the fires, to determine their distribution and abundance in the area, and to better understand the impacts of the fires and associated threats, to identify refugia and better target management actions.
12. 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.
13. Undertake Health Checks to facilitate early detection of pest plant and animals and enable condition to be evaluated across the park.
14. Resurvey existing vegetation monitoring plots to quantify impacts.
15. Establish additional long-term vegetation monitoring plots in burnt communities to evaluate recovery and management effectiveness.
16. Assess impacts from pathogens such as myrtle rust.
17. Investigate additional remote sensing methods to map more precisely the ecological impact in rainforests currently assessed as having low fire severity.
18. 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 fires provide 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, and,
c) adaptive park management under a changing climate where severe bushfires are likely to increase in frequency, area and duration.

2 Introduction and purpose of this report

This report is a rapid assessment of the known and likely impacts to the natural values with 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 bushfires, 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 complex of bushfires that occurred in the Main Range area (Figs 1 and 5; section 4.1) in the Southeast Queensland and adjacent Brigalow Belt Bioregion that burned over the period September 2019-January 2020. Landscape features and place names used in this report as per 1:25 000 scale topographic mapping available online at QTopo: https://qtopo.information.qld.gov.au/.

3 Background

The bushfires assessed here burnt extensive areas of Main Range NP, Swanfels and Glen Rock SFs and Spicers Gap Road CP, collectively referred in this report as the Main Range 2019 bushfire complex. This assessment focuses on Main Range NP (34 690ha), which forms part of the Scenic Rim south-west of Brisbane, towards the south-western most extent of the South East Queensland Bioregion (Swanfels SF and very small areas along the western margin of Main Range NP fall in the Brigalow Belt Bioregion). The terrain is mountainous (up to nearly 1400m altitude), with a steep eastern escarpment, 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 Main Range NP is available at https://parks.des.qld.gov.au/parks/main-range.

The burnt QPWS estates have a long history of human disturbance with widespread logging of both eucalypt and rainforest communities and grazing of open country. Also, infestations of bell miners *Manorina melanophrys* are frequent in Main Range with significant areas of Bell Miner Associated Dieback (BMAD) (Silver & Carnegie 2017). Some areas affected by the bushfires 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.

3.1 Landscape overview of the fire and timeframe

3.1.1 Overview

The Main Range 2019 bushfire complex comprised three fires: Chalk Road, Point Pure, and Swanfels fires, burning over the period September 2019 through to January 2020 (Fig. 1).

The Point Pure fire was first detected on 19 September 2019 from a lightning strike to the east of Point Pure in a remote area in the north-west of Main Range NP, on the high plateau area to the west of the Mistake Range escarpment. This fire was contained to the west along Blackfellow Creek in Glen Rock SF, in country that was planned burnt the previous year, and to the south along the Mount Castle West and Sphincter Fire Breaks, despite very challenging fire-fighting conditions. The hills and ranges to the north of the ignition point along the western fall of the Mistake Range are inaccessible, and largely dominated by open forests and woodlands, so the fire burnt to the northern most extent of Main Range NP over the following weeks. To the east, the fire burnt up to the high altitude rainforests, where it mostly stopped near the ecotone, although significant incursions into rainforest did occur in some areas. Once the fire reached the northern extent of the rainforest areas on Mistake Range it then burnt south along the eastern escarpment of the park, eventually burning to the north-east and south-west of Mt Castle. Severe to Extreme fire weather on numerous days caused the fire to burn intensely and move rapidly at times, with spotting occurring over considerable distances, despite some small rainfall events during the fire. Communities to the north of Mt Mistake were threatened by the fire, resulting in a major response from QFES and other agencies. There was considerable active fire in mid-November 2019 but by December 2019 the fire was largely inactive within QPWS estate. Isolated areas of reignition were observed in burnt areas in mid-January 2020, but significant rains thereafter apparently extinguished the fire. However, a small column of smoke was observed to the north of Bare Rock on 30 April 2020, but no significant reignitions occurred during 2020.

The Swanfels fire was first reported on 28 September 2019. It is believed to have started off-estate to the west of Sentinel Point and was burning on estate by the following day, in the vicinity of Sentinel Point, on the western side of Main Range NP. Further south in the Emu Vale valley, a separate fire was found by QPWS rangers to be burning at Reedy Creek on 7 October 2019 and a park neighbour lit a fire on the same day around 1km to the west. These extra fires joined with and are considered in this report as part of the Swanfels fire. Extreme fire weather at various times caused the fire to spread rapidly and through rainforest communities. For example, the fire front was estimated to have moved about 16km in 24 hours on 8 October 2019, including a large run out through the eastern side of the park and across freehold land, to threaten the Mt Moon section of Moogerah Peaks NP (back-burning operations stopped the fire reaching Moogerah Peaks NP). Over the following weeks the fire spread through Main Range NP to the north, east and south, and also burnt west through Swanfels SF. The south-eastern extent of this fire was contained by back-burning along The Head Road. To the north this fire crossed Cunningham Highway on the western and eastern sides of the range from about 12 November 2019. On the eastern side of the range the fire burnt north over Mt Cordeaux to join with the Point Pure fire on the eastern escarpment in the vicinity of Bare Rock. On the western side of the range the fire burnt north of the highway to North Branch Creek where it was contained by back burning and rainforest about 25 November 2019. The fire also travelled west along dry sclerophyll ridges burning Swanfels SF and almost reached Mt Dumaresq CP: Spicers Peak Lodge and numerous other properties were threatened. By December 2019 active fire was patchy and mostly confined to inaccessible areas. Some areas burnt again in December with fire running through leaf litter that fell after the first fire. Isolated areas of reignition were observed in mid-January 2020, but significant rains thereafter apparently extinguished the fire. Again, however, a small column of smoke was observed in the Mt Mitchell area during early April 2020, but there were no significant reignitions of this fire in 2020.

The Chalk Road fire was suspected arson, with multiple ignition points along Chalk and Hardcastle Roads, on 17 December 2019. It rapidly burnt through the disjunct section of Main Range NP adjacent to Carneys Creek Road and the NSW border and nearby Wilsons Peak Section of Main Range National Park. It burnt north to the Head Road where it burnt up to the southern extent of the Swanfels fire. It was contained on the eastern, southern and western flanks by back burning and rainforest patches. The fire was contained on 24 December 2019.

Within Main Range NP the three fires burnt extensively. Only three major catchments remained unburnt or were spared significant incursions of fire: Dalrymple Ck in the north and Farm Ck and the Condamine River North Branch in the south. The largest contiguous unburnt area within Main Range NP runs from about Bald Mountain south-west to Paddys Knob in the south, with the disjunct Point Townson (in the north), Blackfellows Knob and Queen Mary Falls sections (both in the south) also unburnt.

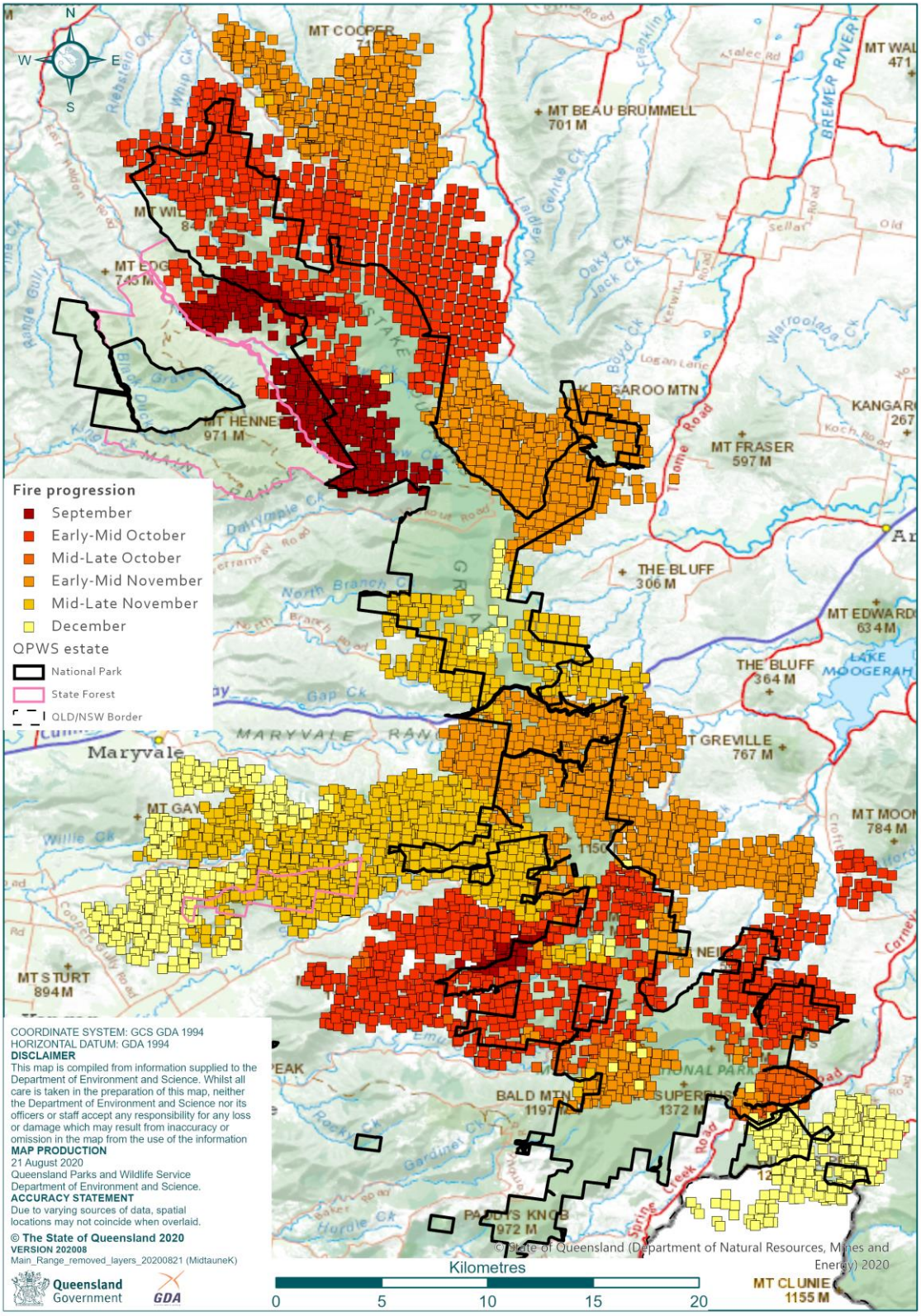

Figure 1. The progression of the Main Range 2019 bushfire complex across the landscape from September to December 2019 based on VIIRS hotspots FIRMS (2020). The Main Range NP boundary is shown in black and Glen Rock and Swanfels SF boundaries in pink. Note VIIRS pixel size is 375m, and hotspots can be 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

- Local staff calculated drought index for the Cunningham's Gap QPWS office. Drought index for 2019 reached 100 on the 15 January 2019 and was 161 by the 1 March 2019, due to the failure of summer rain. The drought index reached a maximum of 187 on the 9 December 2019, but stayed above 100 until the 16 January 2020, when substantial rain fell.
- Rainfall records have been kept at the Cunningham's Gap QPWS office since 1965. February 2019 (22.4mm) was the lowest February rainfall on record, with January 2019 (5.2mm) the second lowest January rainfall on record. The 2019 annual rainfall total was more than 700mm below the long-term median.
- In the years preceding the 2019 bushfires, Main Range NP staff carried out 2 113ha of planned burning in 2017 and 1 074ha in 2018. No planned burning was possible in 2019, due to the extremely dry conditions. Despite previous planned burning efforts, fire conditions were so severe in 2019 that no previously burnt areas halted the progression of the bushfires.
- For many years, areas of the park with brush box in the canopy and rainforest understorey, were largely thought of as rainforest, because they were largely impossible to burn in a planned and safe way. It did however become clear during the 2019 bushfires that these areas were flammable and as such couldn't be relied on for fire breaks in the extreme conditions.
- Main Range QPWS staff had never experienced fire conditions like those in 2019 and were somewhat overwhelmed by the difficulty of suppression, the length of time the fires 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 Main Range NP burn, but the intensity would appear to have been unprecedented over such a large area. Many of the parks' significant mountain peaks including, Spicers Peak, Mt Mitchell, Mt Cordeaux and Mt Castle, burnt with intense uphill running fire. This also resulted in the ignition of spot fires well in advance of the fire front.

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 September 2019 had been below average on a range of timescales from months to years, leading to a prolonged and severe drought.
- Rainfall for the Southern Downs (which adjoins the Main Range are to the west) was the lowest on record 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 Figures 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).

Some rainfall was received on the fire ground during October 2019 (19mm on 12 Oct and 9mm on 18 Oct 2019 at Cunningham's Gap) which only moderated fire behaviour for short periods. Falls of 20+mm were received at Cunningham's Gap on 12 and 26 Dec 2019, but it wasn't until mid-January 2020 that significant rain started falling and essentially extinguished the fires (640mm of rain was received in the 28 days from 16 January 2020).

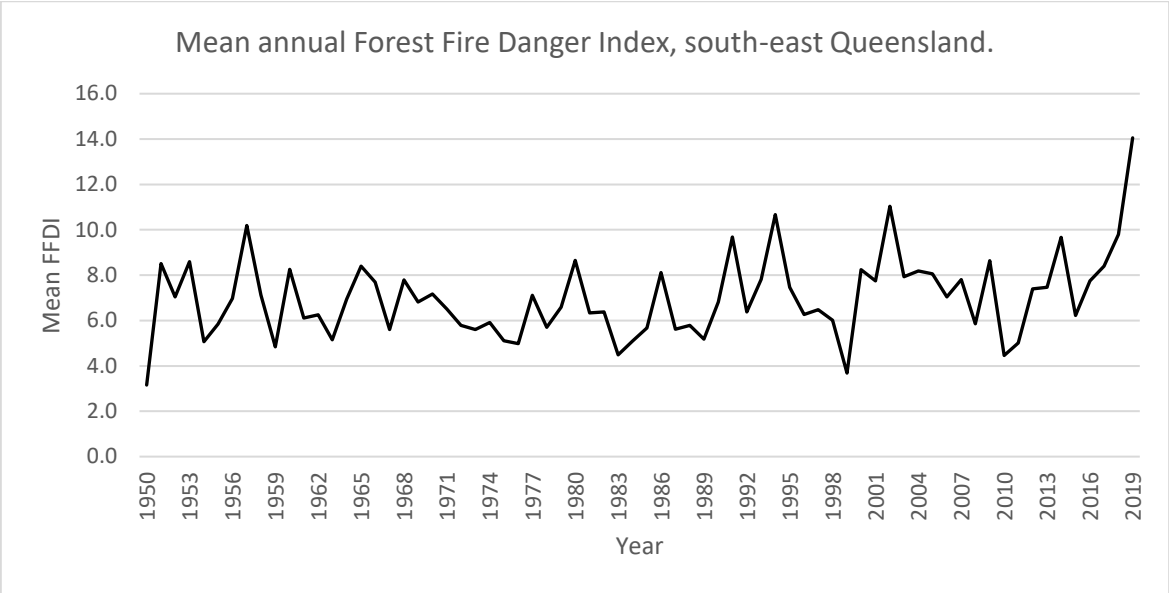

Figure 2. Time series of mean annual Forest Fire Danger Index (FFDI) for south-east Queensland (28-29S 152-153.5E).

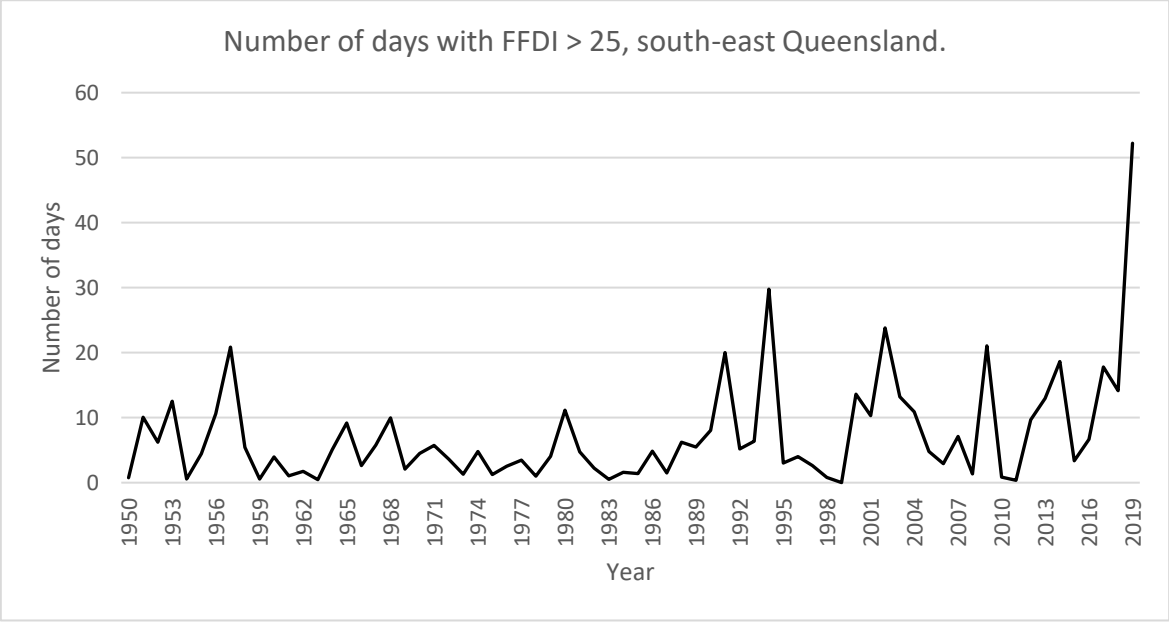

Figure 3. Time series of the number of severe Forest Fire Danger Index days (FFDI >25 = Very High) per year, for south-east Queensland (28-29S 152-153.5E).

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 a number of major incident control centres to coordinate response to the fires 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 was used on park. Both QPWS and contractor machinery, such as dozers, loaders and positracks, where used at various times to improve or reconstruct fire breaks. Back-burning off roads and fire breaks was also undertaken.

An old logging track, east of Mailmans Road along the southern side of North Branch creek, was opened up. It’s not intended to keep this as a maintained firebreak; however it could be used for future fire suppression. A gate and fencing are required to restrict unauthorised vehicle access.

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 complex: 12 September 2019 and 16 December 2019 respectively for the Point Pure and Swanfels fires and 7 October 2019 and 5 January 2020 respectively for the Chalk Road 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 Point Pure and Swanfels fires**	**Maximum dNBR value Chalk Road fire**
Unburnt	Unburnt, canopy and subcanopy unchanged (within the mapped extent).	0.28	0.20
Low	Canopy and subcanopy unscorched, shrubs may be scorched, fire-sensitive low shrubs may be killed.	0.40	0.30
Moderate	Partial canopy scorch, subcanopy partially or completely scorched, and/or fire-sensitive tall shrub or small tree layer mostly killed.	0.55	0.45
High	Full canopy scorch to partial canopy consumption, subcanopy fully scorched or consumed.	0.75	0.60
Extreme	Full canopy, subcanopy and understorey consumption.	10.00	10.00

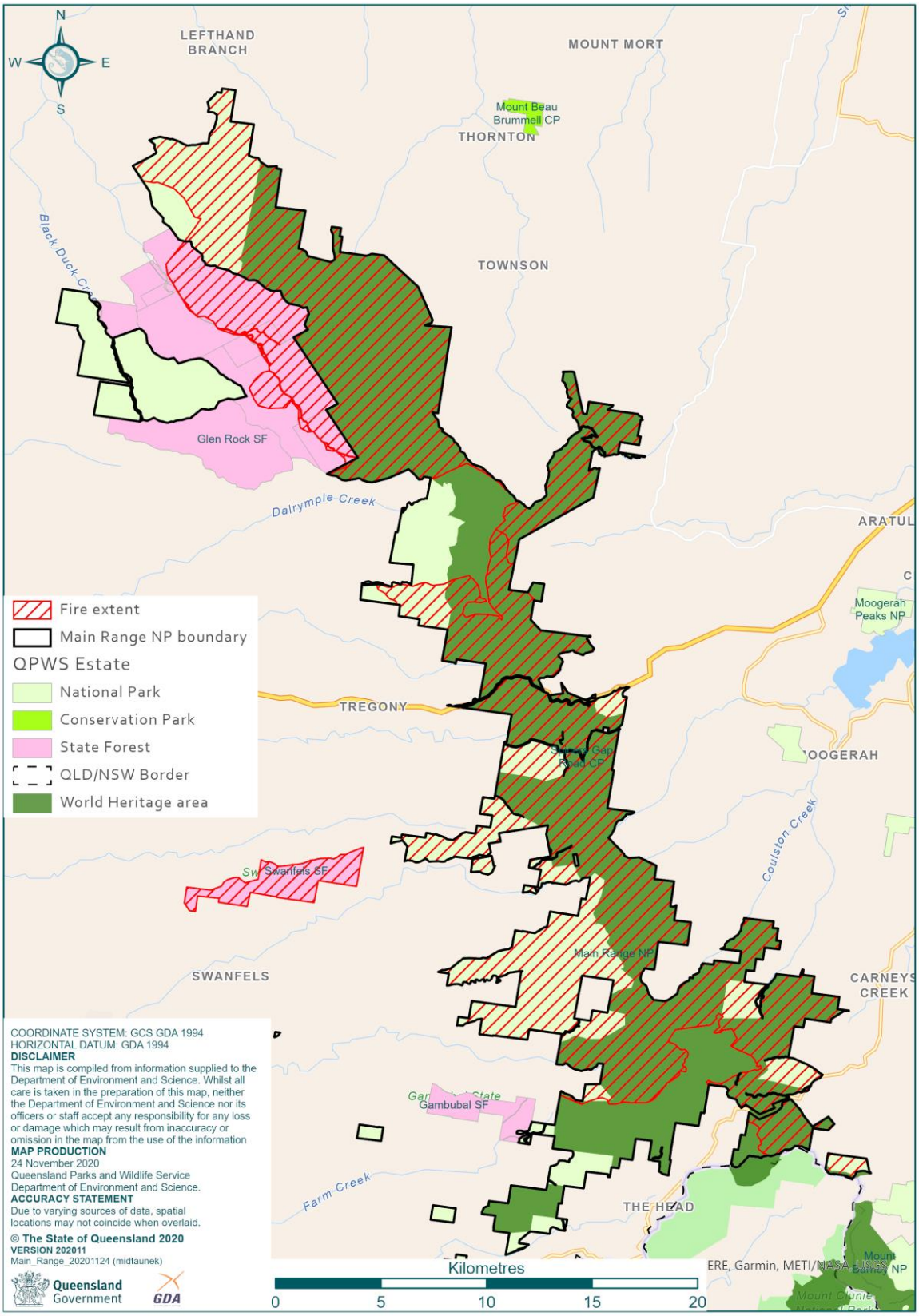

Figure 4. Extent of the Main Range 2019 bushfire complex, in relation to the Gondwana Rainforests WHA

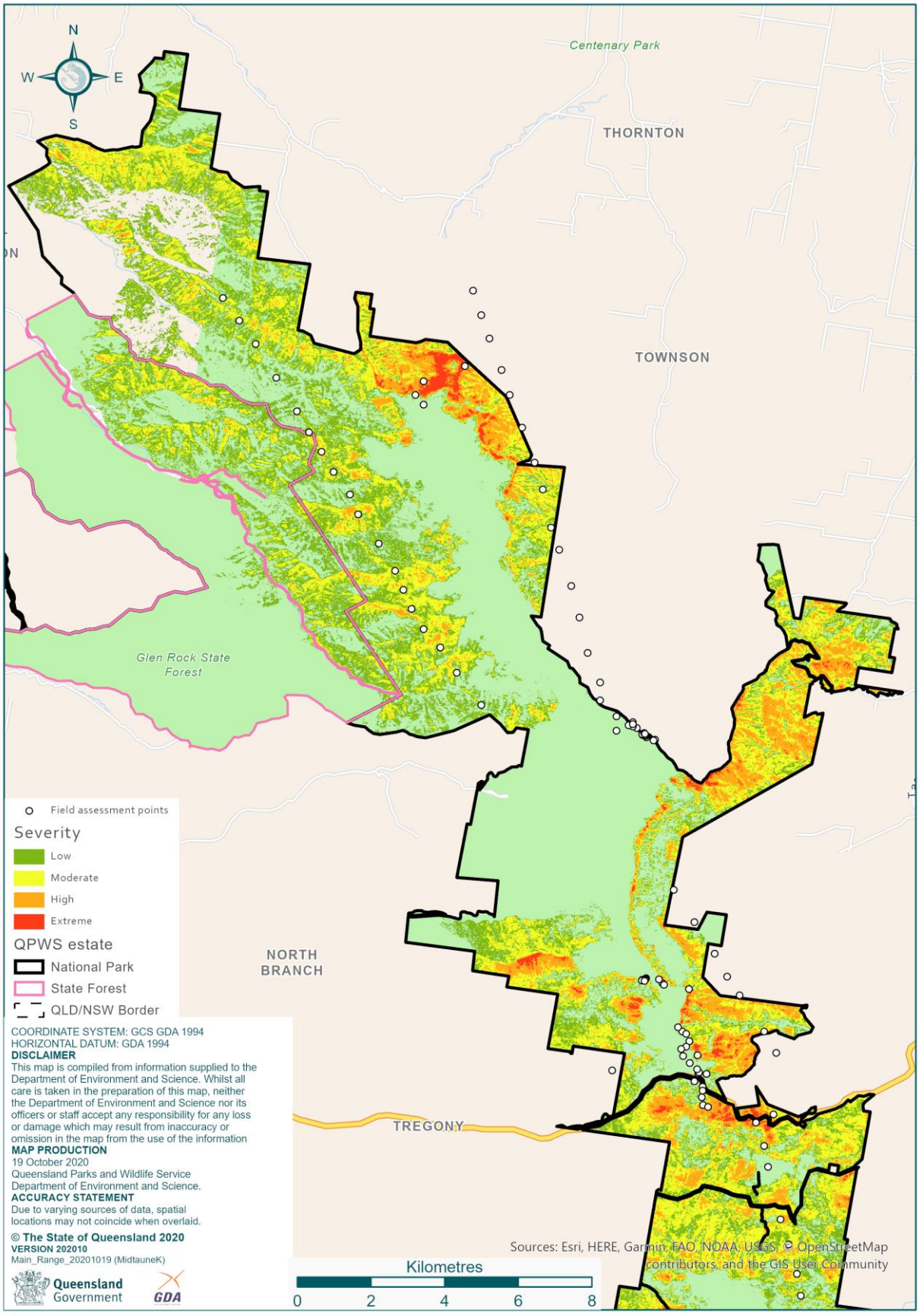

Figure 5a. Relative fire severity of the northern area of the Main Range 2019 bushfire complex. White circles show the location of verification sites (note some aerially assessed sites fell outside QPWS estate).

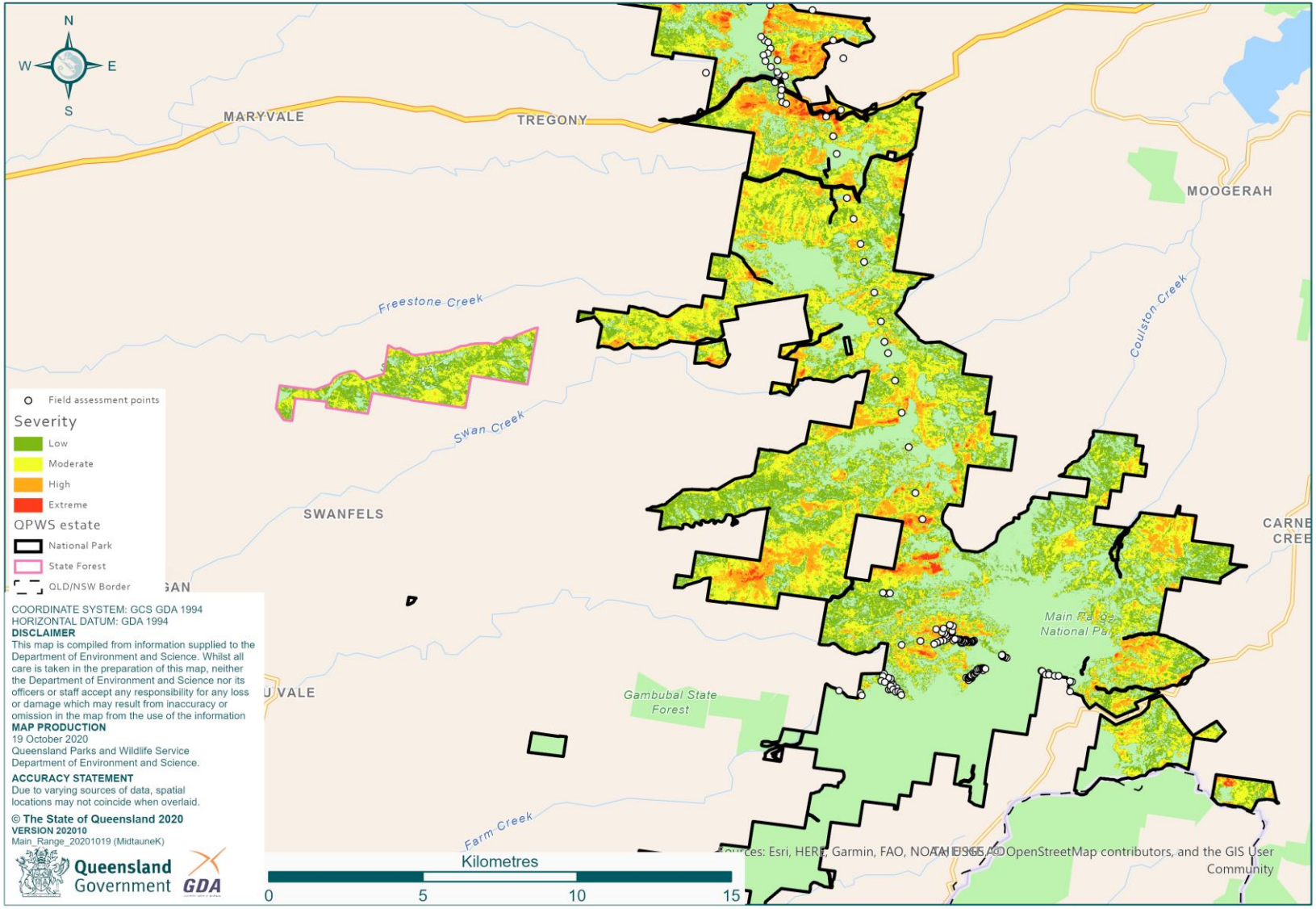

Figure 5b. Relative fire severity of the southern area of the Main Range 2019 bushfire complex. White circles show the location of verification sites (note some aerially assessed sites fell outside QPWS estate).

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. 11.3.2/11.3.25), 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 take into account 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 October 2020), 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 -27.77959 and -28.28085 and longitudes of 152.22152 and 152.55285 (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 unburnt Moogerah Peaks area (isolated peaks to the east of Main Range, some of which fell in 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 over the following periods:

- 9/01/2020 Gambubal and Cunningham's Gap
- 20/02/2020 aerial inspection along the length of Main Range
- 21/03/2020 Goomburra
- 30/04/2020 Bare Rock
- 8/05/2020 Teviot Falls - Mt Superbus
- 14/05/2020 The Steamers-Emu Ck
- 15/05/2020 Emu Ck - Mt Superbus

Inspections were made on foot or by vehicle except for the aerial (helicopter) inspection of 20/02/2020. Observations of impacts on, and recovery of vegetation, fire severity and a series of photographs were recorded at many locations. Verification sites are shown as white circles on Fig. 5. During the initial assessment period, ongoing burning precluded safe access to some areas.

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 http://qldspatial.information.qld.gov.au/catalogue/custom/index.page. 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 = 28156, and is searchable using the keywords: fire, severity, ecological, natural values, assessment, Main Range or via the link: http://wildnet/wildnet/bin/WNE0130$VMEDIAQRY.QueryView?P_MEDIA_ID=28156

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	13270041 – Point Pure 13270650 – Swanfels 13278437 – Chalk Road	Main Range National Park/NP/W/2019/001 Main Range National Park/NP/W/2019/002 Main Range National Park/NP/W/2019/003
QFES fire name(s)	Swanfels, Clumber, Glen Rock, Thornton, Left hand Branch, Towson, Mulgowie, Carneys Creek, Tarome, North Branch, plus others	QFES Newsroom https://newsroom.psba.qld.gov.au/
Fire start date	Point Pure: 19/09/2019 Swanfels: 28/09/2019 Chalk Road: 16/12/2019	FLAME
Fire started on or off-estate	Point Pure: on Swanfels: off Chalk Road: off	FLAME (except Chalk Road fire, which was S. Finlayson pers. comm.)
Date fire first recorded on estate	Point Pure: 19/09/2019 Swanfels: 28/09/2019 Chalk Road: 16/12/2019	FLAME
Date fire declared out	Point Pure: 15/01/2020 Swanfels: 15/01/2020 Chalk Road: 24/12/2019	FLAME
Total area burnt (on and off estate)	Point Pure: 22 626.98ha Swanfels: 34 750.53ha Chalk Road: 2 188.56ha **Total: 59 566.07ha**	FLAME extent mapping
Bioregion(s)	South East Queensland Brigalow Belt	This report
Estate name(s) burnt	Main Range NP Swanfels SF Glen Rock SF Spicers Gap Road CP	FLAME and this report
QPWS Region(s)	South West Queensland	
Area burnt within QPWS estate	19 592ha	This report (Table 4, Appendix 3), based on relative fire severity mapping. See also Table 4.
Area burnt within World Heritage Area	11 723ha	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	116ha	Directory of Important Wetlands in Australia (DEE 2019): Dalrymple and Blackfellow Creeks
Area burnt of habitat of State Biodiversity	15 215ha	This report, based on relative fire severity mapping. SIR dataset:

Significance (BAMM)		ENVBAT.BPA_SEQ See also Table 4.
Area of core Koala habitat (SEQ Koala Conservation Strategy 2019-2024) burnt	1 904ha	This report, based on relative fire severity mapping. SIR datasets: ENVBAT.HSM_SEQRP_KOALA See also Table 4.

Table 4. Area burnt (ha) by relative fire severity class within the Main Range 2019 bushfire complex.

Severity class	QPWS estate	Gondwana Rainforests WHA	BAMM State Biodiversity Significance	Core Koala habitat
Low	8701	4825	6226	849
Moderate	7612	4462	6045	820
High	2932	2156	2625	229
Extreme	346	280	320	6
Total	19592	11723	15215	1904

5.1 Vegetation burnt

Summaries of the area of Regional Ecosystems and Broad Vegetation Groups within QPWS estates affected by the Main Range 2019 fire complex and the area of each burnt, within each 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 Figures 6a and b, 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 QPWS estate burnt during the Main Range 2019 bushfire complex.

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.	842	1742	5863
Moderate	Partial canopy scorch, subcanopy partially or completely scorched, and/or fire sensitive tall shrub or small tree layer mostly killed.	551	1624	5315
High	Full canopy scorch to partial canopy consumption, subcanopy fully scorched or consumed.	249	632	2029
Extreme	Full canopy, subcanopy and understorey consumption.	53	75	218

Table 5B. Potential ecological impact (ha) to burnt remnant vegetation based on fire tolerance and relative fire severity class, for RE1.

Note that the concept of potential ecological impact class also takes into account 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		**1742**	**11178**
Moderate	**842**	**1624**	**2029**
High	**551**	**632**	**218**
Catastrophic	**302**	**75**	

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.

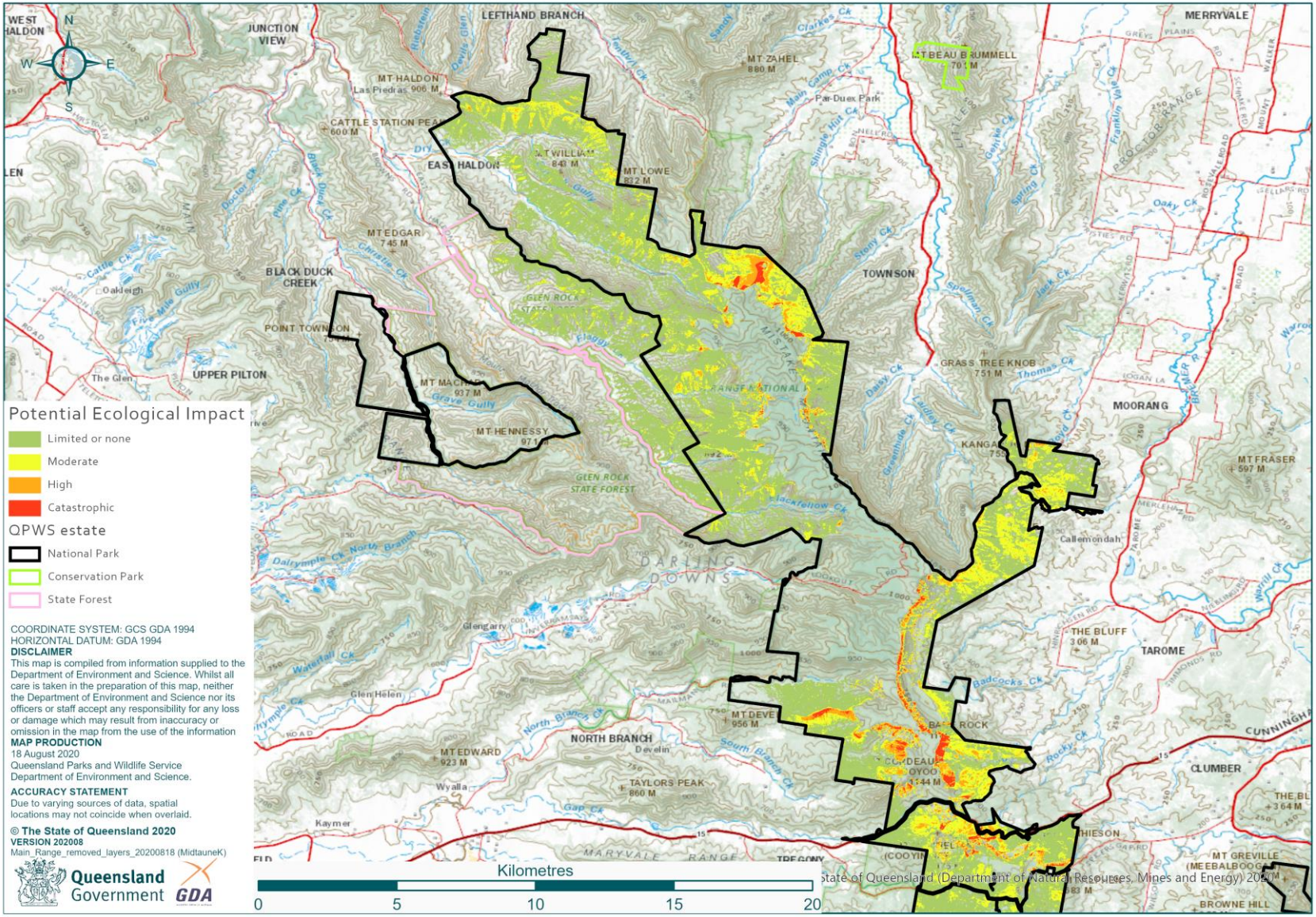

Figure 6a. Map of potential ecological impact within the northern area of the Main Range 2019 bushfire complex.

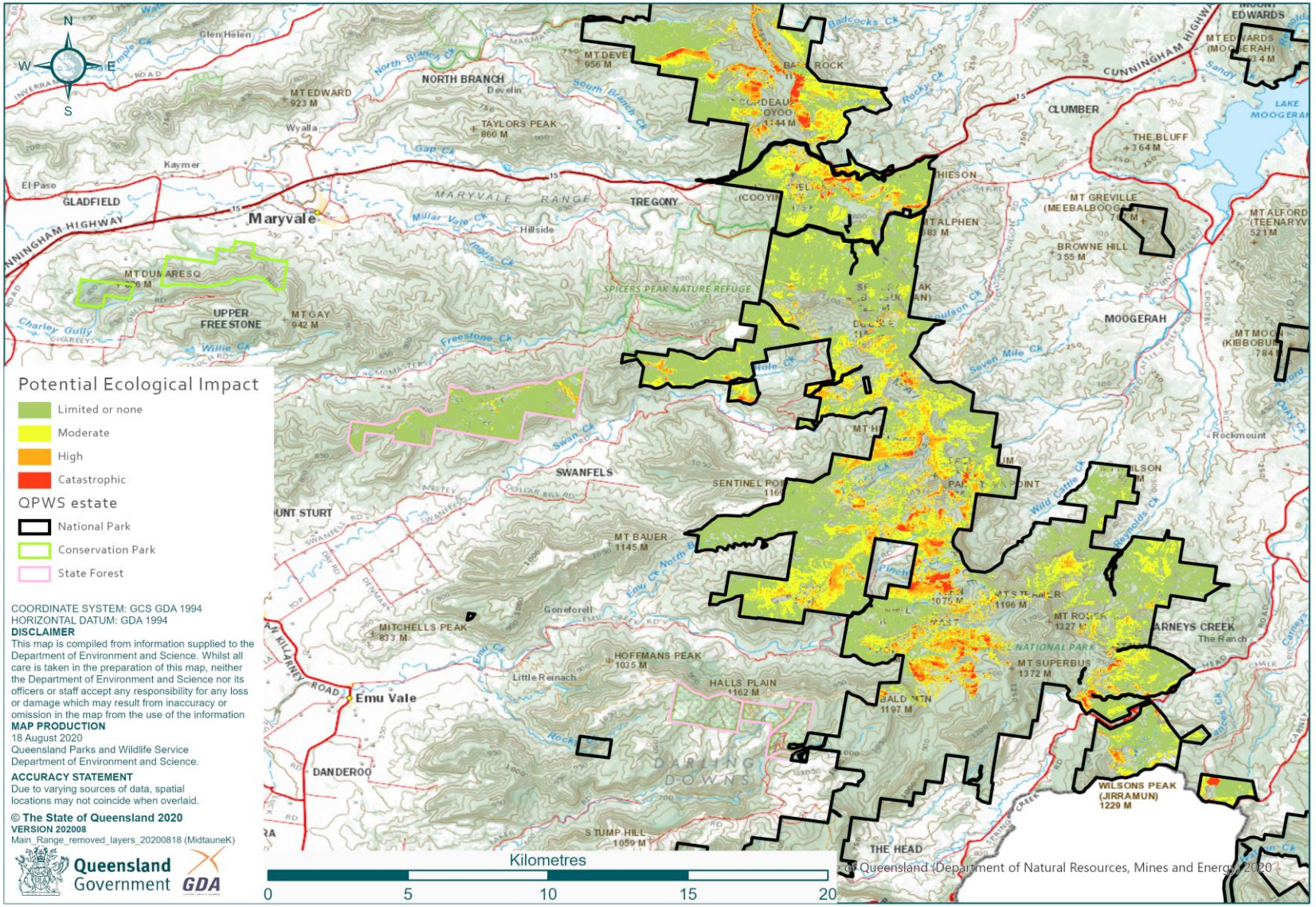

Figure 6b. Map of potential ecological impact within the southern area of the Main Range 2019 bushfire complex.

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. Potential impacts on threatened species are discussed in section 6.3.

A large number of conservation significant flora and fauna species are known, or have potential habitat, within the burnt area. Seven fauna and 11 flora species have more than 15% of their potential Queensland habitat falling within the affected Main Range estates.

The seven fauna species with more than 15% (up to 61%) of their potential Queensland habitat falling within the affected Main Range estates are: rufous scrub-bird, eastern bristlebird, Albert's lyrebird, *Mixophyes fleayi, Philoria kundagungan, Petrogale penicillata* and *Pseudomys oralis.* These species had 22-69% of this potential habitat burnt.

The 11 flora species with more than 15% (up to 65%) of their potential Queensland habitat falling within the affected Main Range estates are: *Brachyscome ascendens, Eucalyptus dunnii, Bothriochloa bunyensis, Gonocarpus hirtus, Westringia sericea, Pimelea umbratica, Arundinella grevillensis, Dendrobium schneiderae* var. *schneiderae, Sarcochilus hartmannii, Bulbophyllum weinthalii* subsp. *weinthalii*, and *Muellerina myrtifolia*. These species had 42-86% of this potential habitat burnt.

Maps, showing potential ecological impact, overlain with potential habitat for these species are presented in Appendix 8. Impacts on these species will vary, but those dependent upon fire sensitive communities are likely to have been most highly affected – for example rufous scrub-bird, Albert's lyrebird, *Mixophyes fleayi* and *Philoria kundagungan*.

5.3 Area of Natural Key Values burnt

Natural Key Values (NKV) have not yet been identified for the Main Range area, under the Values Based Management Framework. However, significant areas of Main Range NP meet criteria for inclusion as NKVs, including cool temperate and other rainforests, wet eucalypt and open forest, montane heath communities and riparian areas.

Much of Main Range NP, including a majority of the burnt area, falls within the Gondwana Rainforests World Heritage Area (IUCN 2017), meeting various natural heritage criteria for Outstanding Universal Value. The Natural Key Values identified for Main Range NP will incorporate these values. Further detail of the World Heritage Value of Main Range NP is included in Appendix 7.

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

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	Cunningham's Gap, Goomburra and Emu Ck areas	Harry Hines, QPWS	High
Red and yellow mountain frog	Diurnal headwater gully censuses	Cunningham's Gap and Goomburra-Mistake Range areas	Liam Bolitho/David Newell Southern Cross University	High
Hastings River mouse and habitat	Elliott trapping Vegetation assessment	Gambubal, east of Bald Mountain	Ian Gynther, QPWS	High
Hastings River mouse and New Holland mouse	Elliott trapping	Cunningham's Gap	University of Queensland - Kelly Dixon/Luke Leung	High
Gambubal vegetation	Long-term dataset, various vegetation monitoring in rainforest, ecotone and sclerophyll communities	Gambubal, east of Bald Mountain	University of Queensland – Steve Howell	High
Eastern bristlebird	Point based playback surveys and monitoring	Various locations	David Stewart QPWS BirdLife Southern Queensland – Sheena Gillman	High
	Vegetation and photo monitoring	Spicers Gap	QPWS (The Gap)	Moderate
Rufous scrub-bird	Point based listening surveys	Cunningham's Gap – Palm Grove and Mt Cordeaux	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 thickets – Regional Ecosystems with a fire sensitive canopy and understorey. – BVGs 2, 5, 6 and 7.
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, 11, 13, 15 and 16.
NV 4	Montane heaths and shrublands – Regional Ecosystems with a fire tolerant canopy and understorey. – BVGs 29.
NV 5	Riparian corridors – Regional Ecosystems fringing streams and rivers 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 large proportion of burnt areas 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 moderate but with small areas of 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. 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 moderate to high in recognition of potential weed issues and trampling by visitors could significantly impede recovery. 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) 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 in the Main Range area 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 the Main Range area. 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) and in unburnt refuges (e.g. Dalrymple Ck catchment).
- **Feral deer** (mostly red deer but fallow deer have also been observed in the area) have been increasing over the last 10 to 15 years and are generally at low density but are widespread. Their ecological impacts in forest communities in south-east Queensland are not well understood. Baseline information on their distribution and abundance in the Main Range area will help inform assessments of potential ecological impact and direct control efforts if required.
- **Feral horses** are known to occur at Swanfels SF, but their abundance and impact there is not known. There have been no ecological assessments of Swanfels SF (WildNet lists only two species from the SF) but it supports a sizeable area of RE 11.8.8 (*Eucalyptus albens, E. crebra* woodland on Cainozoic igneous rocks) which forms part of the *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland ecological community* that is listed as Critically Endangered under the federal *Environment Protection and Biodiversity Conservation Act 1999*. Due to its vegetation and difficult access the state forest has probably had very limited timber harvesting. Feral horses may therefore be a significant threat to this highly threatened ecosystem that may otherwise be in reasonable ecological condition.
- **Cattle** from adjoining properties range widely within the burnt QPWS estates, including well inside the Gondwana Rainforests WHA. This is due to either a lack of, or poorly maintained boundary fencing or fences destroyed in the fires. Cattle grazing will likely significantly impede post-fire recovery, particularly grassy ecosystems and seedling regeneration of some canopy species (e.g. *Eucalyptus tereticornis*). 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 the Main Range area.

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 the Main Range area 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 brush box *Lophostemon confertus* open forest with a rainforest understorey are often incorporated as a sub-dominant RE within rainforest polygons (rather than being mapped as homogeneous polygons of RE 12.8.9). In this instance, this community is mapped within vegetation communities that fall into a different Broad Vegetation Group that may have different fire tolerances. Communities dominated by brush box in Main Range have a fire tolerant canopy and a fire sensitive understorey, whereas rainforest is entirely fire sensitive. Field observations showed that some areas mapped with moderate severity fire within rainforest polygons contained brush box, 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 and undertake. This requires an early and regular ongoing response.
3. Surveillance and strategic control of tree and shrub weeds and undertake 6-12 monthly, targeted 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. Continue efforts to control pigs in the northern part of Main Range NP as the population is relatively small but has the potential to severely impact significant values (e.g. habitat degradation or predation of threatened rainforest frogs and *Euastacus jagara*).
6. Assess the distribution and abundance of feral deer, cats, foxes and pigs (central and southern Main Range) within rainforests and undertake strategic control program where significant values may be impacted or threatened.
7. Reinstate damaged, or install new, strategic boundary fencing to prevent cattle entering regenerating rainforest areas. Priority areas include Cryptocarya, South Branch of Emu, Steamer, Pinchgut and Barney 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] east of Spicers Gap). 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 encroachments 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 across the estates.
12. Resurvey burnt Gambubal rainforest vegetation plots over time to quantify impact and recovery.
13. Establish additional long-term vegetation monitoring plots in burnt rainforest communities (e.g. high altitude temperate forests in the Mount Superbus and Mount Castle areas) 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).
14. Monitor for increased biosecurity risk from pathogens such as myrtle rust (which favours new growth, common post-fire).
15. 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 (i.e. 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 of the affected estates and includes Regional Ecosystems with a fire sensitive canopy and understorey within BVG 2M groups 2, 5, 6 and 7 (Appendices 2 and 3). Fire severity and impact photographs are provided in Appendix 1, Figs A1.1-6.

Rainforests are a primary natural and aesthetic value of Main Ra 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 1 700ha, or 17% of the total extent of rainforests within QPWS estate of the Main Range area, burnt during the fires. All but 30ha of burnt rainforests fall within Main Range NP, with most of the rainforests that burnt in these fires occurring within the Gondwana Rainforests WHA. In some areas fire penetrated long distances (hundreds of metres to kilometres) through rainforest communities, including burning temperate rainforests at altitudes in excess of 1350m in the Mount Superbus area.

Within affected rainforests approximately 49.7% burnt at low, 32.5% at moderate, and 14.7% at high and 3.1% at extreme relative severity (Appendix 2), with likely ecological impact ranging from moderate to catastrophic (section 5.1.1). About 300ha of rainforests burnt at high to extreme severity with catastrophic ecological impacts likely in those areas, which represents 3% of the total extent of rainforest within the affected QPWS estates.

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. A1.4), 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, *Coeranoscincus reticulatus*, *Mixophyes fleayi*, *Philoria kundagungan*, 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 very 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.

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. *Hyparrhenia* spp.) 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. *Ligustrum lucidum*, *L. sinense*), 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 rainforests.

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) and *Solanum nodiflorum* (deadly nightshade). 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 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 relatively small, isolated populations of feral pigs in the rainforests of Main Range NP (e.g. Goomburra-Mistake Mountains area). 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 the endemic *Euastacus jagara* and *Philoria kundagungan*), as well as spread pathogens such as phytophthora.

Cattle from adjoining properties range widely within rainforest areas of Main Range NP, including well inside the Gondwana Rainforests WHA. For example, during field assessments we observed cattle skeletal remains at an altitude of 980m on the western slopes of Mount Superbus, 2km in a straight line from the nearest park boundary. Fresh cattle scats were observed in the bed of a nearby stream, within known habitat for two species of threatened frogs. At lower altitudes, closer to the park boundary, cattle freely access rainforest patches, with obvious foot pads, camps and grazing of grass and shrubs (e.g. Pinchgut and Steamer Creeks).

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

Potential ecological impact: mostly moderate to high, with small areas of 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 and strategic control of vine and herbaceous weeds and undertake strategic control. This requires an early and regular ongoing response.
3. Surveillance and strategic control of tree and shrub weeds and undertake 6-12 monthly, targeted 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 take into account 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 program where significant values may be impacted or threatened (e.g. habitat degradation or predation of Hastings River and New Holland mice).
7. Trial the use of Felixer cat and fox control system in recovering burnt areas where known populations of threatened Hastings River and New Holland mice are potentially at risk due to cats (e.g. Cunningham's Gap, Gambubal).
8. Reinstate damaged, or install new, strategic boundary fencing to prevent cattle entering regenerating areas. Priority areas include Cryptocarya, South Branch of Emu, Steamer, Pinchgut, Reedy, Barney, Swan, Millar Vale, North Branch, Blackfellows, Greenhide and Laidley Creeks.
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. Resurvey burnt Gambubal wet eucalypt and ecotone plots over time to quantify impact and recovery.
13. Resurvey burnt Gambubal Hastings River mouse monitoring grid over time to better understand the fire ecology of this threatened species.
14. 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).
15. 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 (i.e. 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 A1.7-8 and 17.

Wet eucalypt open forests and rainforest/eucalypt forest ecotones are a significant value of Main Range 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 4 000ha or 53.8% of wet eucalypt open forests burnt within QPWS managed estate during the Main Range fire complex of 2019 (Appendix 3). Within burnt wet eucalypt open forests approximately 42.8% burnt at low, 39.9% at moderate, 15.5% at high and 1.9% 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, some low intensity fire (often probably as smouldering fire with little or no flame) burnt deep into leaf litter 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.

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 habitat for threatened species such as Hastings River mouse and eastern bristlebird. As the overstorey is sclerophyll dominated, these communities provide feeding and shelter habitat for 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 rainforest communities. High biomass exotic grasses (e.g. *Hyparrhenia* spp.) and *Lantana camara* are common in disturbed 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, rainforest 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 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) and *Solanum nodiflorum* (deadly nightshade). 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 Main Range 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) and introduced vines is a priority in these areas.

Cattle from adjoining properties range widely within wet eucalypt forests and rainforest ecotones of Main Range NP, including well inside the Gondwana Rainforests WHA. During post-fire field assessments we observed significant cattle impacts on recovering wet eucalypt forests and rainforest ecotones (for example in the Pinchgut, Steamer and Emu Creek catchments).

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: extensive 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 and strategic control of vine and herbaceous weeds and undertake strategic control. This requires an early and regular ongoing response.
3. Surveillance and strategic control of tree and shrub weeds and undertake 6-12 monthly, targeted 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 program where significant values are being impacted or threatened (e.g. habitat degradation or predation of Hastings River and New Holland mice).
6. Undertake a basic inventory of the natural values of Swanfels SF, in particular to confirm the presence and condition of threatened ecological communities.

7. Assess the impacts of feral horses on the natural values of Swanfels SF and undertake control to reduce or remove impacts.
8. Reinstate damaged, or install new, strategic boundary fencing to prevent cattle entering regenerating areas.
9. Review strategies for weed and fire management in these communities; aim to reduce the risk of future fire encroachments into adjacent rainforests, and to identify and protect important unburnt (particularly longer unburnt) dry eucalypt forest refugia.
10. 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.
11. Establish long-term vegetation monitoring plots in 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).
12. 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 (i.e. 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, 11, 13, 15 and 16 (Appendices 2 and 3). Fire severity and impact photographs are provided in Appendix 1, Figs A1.9-10.

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). Extensive areas of high to extreme severity fire in these communities are likely to have serious ecological impacts in the short-medium term.

About 13 323ha of dry eucalypt forests and woodlands burnt within QPWS managed estate during the Main Range fire complex of 2019 (Appendix 3), which represents 60% of BVG 2M groups 9, 11, 13, 15 and 16 within those estates. Within burnt dry eucalypt forests and woodlands approximately 43.7% burnt at low severity, 39.6% at moderate severity, 15.1% at high and 1.6% at extreme severity (Appendix 2) with potential ecological impact mostly limited or none to moderate (section 5.1.1). During field assessments we observed some areas with significant loss of canopy, although in places some of this appears to have been due to preceding drought; loss of large trees from basal fires; complete loss of ground cover resulting in exposed mineral earth. 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 to minimise the risk of fires encroaching rainforests or burnt wet eucalypt forests.

Dry eucalypt forests and woodlands within the extent of the fire complex 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. long-nosed potoroo, *Adelotus brevis*), depend upon foliage for food (e.g. koala, greater glider), or large hollow bearing trees (e.g. greater and yellow-bellied gliders, various micro bats and birds) are likely to be most significantly impacted.

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 hirta*) and *Lantana camara* are common in disturbed areas 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 of the QPWS estates burnt in the Main Range 2019 fire complex. During post-fire field assessments, we observed significant cattle impacts on recovering dry forests and woodlands (for example in the Pinchgut, Steamer and Emu Creek catchments). Feral horses occur in Swanfels SF, but their abundance and impact there is not known. However, a sizeable area of RE 11.8.8 (*Eucalyptus albens*, *E. crebra* woodland on Cainozoic igneous rocks) which forms part of the *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland ecological community* that is listed as Critically Endangered under the federal *Environment Protection and Biodiversity Conservation Act 1999* occurs in the state forest, with feral horses likely to be the main threat to its post-fire recovery.

6.3.4 NV 4: Montane heaths and shrublands

Potential ecological impact: moderate to high, at least in the short-term.

Recommended recovery actions

1. Protect regenerating areas from visitation, particularly areas with populations of threatened plants.
2. Surveillance and strategic control of vine and herbaceous weeds and undertake strategic control, particularly in areas where populations of endemic or threatened plant species occur (e.g. Mount Cordeaux area). This requires an early and regular ongoing response.
3. 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 and protecting rainforests and burnt wet eucalypt forests from fire.
4. Support the release/spread of biological control agents for *Ageratina* species.
5. 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.
6. 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).
7. 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 group 29 (Appendices 2 and 3). Fire severity and impact photographs are provided in Appendix 1, Fig A1.11-12.

Montane heaths and shrublands are a significant value of Main Range 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 Main Range NP, festooned red in spring when the giant spear lilies *Doryanthes palmeri* are flowering. 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 are typically small and patchy in extent and generally burn at high intensity. 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 period until the next fire event and fire frequency thereafter, and degree of physical disturbance from visitation.

About 100ha or 52.1% of mapped montane heaths and shrublands burnt within QPWS managed estate during the Main Range fire complex of 2019 (Appendix 3). Within burnt mapped montane heaths and shrublands approximately 36.3% burnt at low, 39.2% at moderate, 22.9% at high and 1.6% at extreme relative severity (Appendix 2) with significant areas with potential ecological impact of moderate to high (section 5.1.1).

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 to minimise the risk of fires encroaching rainforests or burnt wet eucalypt forests.

Montane heaths and shrublands are fragile, naturally fragmented communities, with a distinctive flora. Many areas are too small to be mapped as 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 Mitchell and Mt Cordeaux, Bare Rock, Mount Castle, Mount Bangalora, The Steamers, the steep eastern escarpment (e.g. The Ramparts) and various other cliff lines (e.g. western fall of Mount Superbus). 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 *Petrogale penicillata*. 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.

Important habitat for two significant plant species of the area – the near endemic *Pimelea umbratica* and the Critically Endangered *Lenwebbia* sp. (Main Range P.R.Sharpe+ 4877) – is the ecotone between the montane heath/shrublands and adjoining rainforests (typically a temperate cloud forest community). From our field assessments and fire severity mapping some of these areas have been significantly impacted by the fire. *Lenwebbia* sp. (Main Range P.R.Sharpe+ 4877) is highly susceptible to myrtle rust and there is evidence that the impacts of rust are exacerbated after fire, as recovering plant shoots are highly susceptible to infection (Fernandez Winzer et al. 2018). While we did not observe *Lenwebbia* sp. (Main Range P.R.Sharpe+ 4877) in these fire impacted areas, we did observe the closely related *Rhodamnia rubescens*, which is also listed as Critically Endangered due to myrtle rust. We observed post-fire coppicing of *R. rubescens* in the montane ecotone of Mount Cordeaux (and various other habitat and locations elsewhere in Mount Barney and Main Range National Parks) severely compromised by myrtle rust (Fig A1.16)

In places the montane heaths and shrublands of Main Range NP are quite 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.

A threat to these communities is impacts from visitation (walking, unauthorised rock climbing and abseiling) and such impacts will be exacerbated during recovery post-fire. Ongoing efforts to encourage visitors to remain on walking tracks or other structures (e.g. lookouts) are necessary. If populations of threatened plants are being impacted by visitors, then additional actions may be required. 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 high–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 and strategic control of vine and herbaceous weeds and undertake strategic control. This requires an early and regular ongoing response.
3. Surveillance and strategic control of tree and shrub weeds and undertake 6-12 monthly, targeted control.
4. Assess the distribution and abundance of feral deer, cats, foxes and pigs, and undertake strategic control program where significant values are being impacted or threatened (e.g. habitat degradation or predation of threatened frogs or *Euastacus jagara*).
5. Reinstate damaged, or install new, strategic boundary fencing to prevent cattle entering regenerating riparian areas. Priority areas include Cryptocarya, South Branch of Emu, Steamer, Pinchgut and Barney Creeks.
6. 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.
7. Review weed and fire management planning in adjacent sclerophyll communities to reduce the risk of future fire encroachments into riparian areas.
8. 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.
9. Establish long-term vegetation monitoring plots in burnt riparian areas (e.g. Emu 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).
10. Monitor for increased biosecurity risk from pathogens such as myrtle rust. The latter favours new growth which is common post-disturbance.
11. Investigate additional remote sensing methods to map more precisely the ecological impact in riparian rainforests currently assessed as having low fire severity.

Contracting of pest and weed control and boundary fencing may be necessary due to competing priorities (i.e. 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 the Main Range area, 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 A1.13-14.

Riparian corridors are a significant value of Main Range 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 Reynolds, Wild Cattle, Cryptocarya, South Branch of Emu, Steamer, Pinchgut, Barney, Oaky, Swan, Millar Vale, Coulson, West Gap, North Branch, Blackfellows, Shady, Flaggy, Dry and Straight Forward Creek and Teviot Brook catchments were burnt, with fire burning the riparian zone over many tens of kilometres. Where the higher parts of these catchments supported extensive wetter rainforests communities, fire incursions were typically limited to the drier ridgelines. The only significant catchments within Main Range NP that remained largely unburnt were the Condamine River North Branch, Teviot Brook (upper reaches only) and Dalrymple Creek.

The burnt riparian corridors at Main Range NP are known to provide core habitat for the threatened crayfish *Euastacus* spp. and core breeding habitat for the threatened frogs *Litoria pearsoniana, Mixophyes fleayi* and *Philoria kundagungan* 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 Cunningham's Gap the first significant rainfall post-fire occurred in late Jan 2020 and resulted in a significant flow in Gap Creek West. The catchment of this stream was only partially burnt but was still burning in early January 2020. An inspection of this creek on 29 January 2020, within a few days of the rainfall event showed that whilst the water was clear and still flowing well, significant amounts of silt, charcoal and forest debris had been deposited in the stream (Figs A1.13-14). Breeding congregations of frogs had also formed along the streams, including in areas where the fire had burnt to the stream margin (Fig A1.15). Subsequent inspections of this stream and other large streams 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 the affected QPWS estates 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 QPWS estate. More open drainage lines, with warmer, more turbid waters may provide breeding opportunities for cane toads that were not available prior to the fires.

6.4 Rehabilitation of previously cleared areas

Several areas within Main Range NP and Glen Rock SF 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, 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.

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Appendix 1. Fire severity and impact photographs

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

Cunningham's Gap, Main Range NP. Top: H. Hines 14 May 2020. Lower: R. Ashdown 20 February 2020.

Figure A1.2. Impacts of the fire on upland complex notophyll vine forest at Main Range NP.

Top left: Unburnt forest, showing the degree of leaf-fall and drought impact on piccabeen palm *Archontophoenix cunninghamiana* (heads have 'wilted' and collapsed. Top right: Low intensity fire that has resulted in the removal of ground cover and death of shrubs. Both photos Cunningham's Gap (H. Hines 9 January 2020).
Lower: High to extreme severity fire, resulting in death of rainforest stand. No resprouting is apparent more than five months post-fire, following the wet season (western flanks of Mount Superbus H. Hines 15 May 2020).

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

Top left: Unburnt forest, showing the density of walking stick palm *Linospadix monostachyos* shrub layer pre-fire.
Top right: Low intensity fire that has resulted in the removal of ground cover and death of walking stick palms. Photos from close proximity, eastern slopes of Mount Superbus (H. Hines 8 May 2020).
Lower: Aerial photo of the Mistake Mountains area, showing severe fire in eucalypt dominated tall open forest with relatively minor incursions into adjacent upland rainforests. Note that this area burnt early in the fire event (R. Ashdown 20 February 2020).

Figure A1.4. Impacts of the fire on upland complex notophyll vine forest at Main Range NP.

Top: loss of large rainforest trees from basal fire, eastern slopes of Mount Superbus (H. Hines 8 May 2020). Lower: landscape photo showing long runs of moderate intensity fire through upland rainforest, western slopes of Mount Superbus (H. Hines 15 May 2020). Note this area burnt late in the fire event. The upper most extent of the fire scar on this photo is about 1300m asl, with ground assessments in this area showing fire continued higher up through more gently sloping terrain to at least 1350m asl.

Figure A1.5. Impacts of the fire on cloud forest on Mount Superbus, Main Range NP.

Top: unburnt. Lower: burnt at low intensity, with loss of ground cover, death of shrubs, loss of seedling bank and reduced regeneration potential. Photos are from close proximity, above 1300m altitude, and were taken at least five months post-fire and following the wet season, demonstrating the slow recovery of burnt rainforest. (H. Hines 8 May 2020).

Figure A1.6. Impacts of the fire on cloud forest on Mount Superbus, Main Range NP.

Top left: cloud forest on steep western facing slope of Mount Cordeaux, burnt at low to moderate intensity (H. Hines 30 April 2020). Top right: cloud forest on gently sloping ridgetop, above 1300m altitude on Mount Superbus, burnt at moderate intensity (H. Hines 8 May 2020).
Lower: scar of moderate intensity fire in windswept cloud forest above 1300m altitude on a north facing slope on western side of Mount Superbus (H. Hines 8 May 2020).

Figure A1.7. Impacts of the fire on wet eucalypt open forests and rainforest/eucalypt forest ecotones.

Brush box wet sclerophyll forest with a well-developed rainforest understorey, Cunningham's Gap, Main Range NP.
Top: unburnt, showing the considerable drought induced leaf fall and a large basal hollow in a brush box from historic fire.
Lower: low intensity fire burning in coarse woody debris, sometime after the initial fire. Long residence time of the fire at the bases of trees, particularly brush boxes, resulted in many large trees toppling.
Both photos Cunningham's Gap, H. Hines, upper 9 January and lower 7 January 2020.

Figure A1.8. Impacts of the fire on wet eucalypt open forests and rainforest/eucalypt forest ecotones.

Top left: low intensity fire in *Eucalyptus campanulata* tall open forest, Gambubal, Main Range NP (H. Hines 9 January 2020), showing consumption of ground vegetation and leaf litter but no impacts on the canopy. Top right: high to extreme intensity in *Eucalyptus campanulata* tall open forest, causing crown fire and subsequent loss of numerous large old hollow-bearing trees, and showing extensive coppicing 5-6 months post-fire, western fall of Mount Superbus, Main Range NP (H. Hines 15 May 2020).
Lower: moderate intensity fire in a rainforest - eucalypt forest ecotone, with limited recovery 5-6 months post-fire, Steamer Creek, Main Range NP (H. Hines 14 May 2020)

Figure A1.9. Impacts of the fire on dry eucalypt forests and woodlands

Aerial landscape views of the eucalypt forests and woodlands communities of the northern section of Main Range NP. Top: extensive, contiguous moderate to extreme severity fire scar. Lower: extensive fire scar, mostly of low to moderate severity with some unburnt patches. R. Ashdown 20 February 2020.

Figure A1.10 Impacts of the fire on dry eucalypt forests and woodlands.

Top: Moderate to high severity fire, showing complete loss of ground cover, death of shrubs, extensive exposed mineral earth and post-fire leaf fall, Cunningham's Gap Main Range NP (H. Hines 9 January 2020).
Lower: high to extreme fire severity west of Bare Rock Main Range NP, showing the limited degree of recovery 3-4 months post-fire and following the wet season (H. Hines 30 April 2020)

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

Top left and lower: moderate to high severity fire in shrubland at Bare Rock Main Range NP. Recovery at this site is at risk from visitation. (H. Hines 30 April 2020). Top right: extreme fire severity in shrubland at the top of an escarpment on the western side of Mount Superbus, Main Range NP, showing the limited degree of recovery 3-4 months post-fire and following the wet season (H. Hines 8 May 2020).

Figure A1.12 Impacts of the fire on montane heaths and shrublands.

Mount Cordeaux, showing relatively rapid recovery of *Xanthorrhoea* sp. and *Doryanthes palmeri* 3-4 months post-fire and existing signage encouraging visitors not to access areas of this fragile ecosystem beyond the footprint of the lookout (H. Hines 30 April 2020)

Figure A1.13. Impacts of the fire on riparian areas - Gap Creek West, Cunningham's Gap, Main Range NP.

Upper: fire burnt downslope on the northern edge of the creek with a significant area of the catchment burnt. Note that isolated pools remained in this stream acting as a refuge for stream fauna during the drought and fires (H. Hines 7 January 2020). Lower: same section of stream, (photographed from slightly lower downstream but including the pool shown in the upper photo) following significant rain in late January 2020. Note the large deposit of fine sediment on the right-hand bank and the clarity of the water (H. Hines 29 January 2020).

Figure A1.14. Impacts of the fire on riparian areas - Gap Creek West, Cunningham's Gap, Main Range NP.

Large deposits of fine sediment, charcoal and unburnt forest debris were present in many places along the creek following the first significant rains following the bushfires. Note the clarity of the water (H. Hines 29 January 2020).

Figure A1.15. Incidental observations of wildlife within the burnt area.

Top left and lower: Gap Creek West, Main Range NP, (H. Hines 29 January 2020) - *Litoria chloris* formed breeding choruses following the first significant rains after the bushfires and *Morelia spilota* in the ambush position.
Top right: tree fern resprouting within a month of the bushfire, Gambubal, Main Range NP (H. Hines 9 January 2020).

Figure A1.16. Myrtle rust infections on post-fire resprouting of the Critically Endangered *Rhodamnia rubescens*
Top left and lower: Mount Cordeaux, Main Range NP (H. Hines 30 April 2020). Lower: Emu Creek area, Main Range NP (H. Hines 15 May 2020)

Figure A1.17. Regeneration of wet eucalypt forest
The Winder Track (R. Ashdown 20 February 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, except for those shown with a # which form part of the *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland ecological community* that is listed as Critically Endangered under the federal *Environment Protection and Biodiversity Conservation Act 1999* (note that minor components of RE 12.8.6 also fall in this community). 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.

Estate name	RE1	Short description	Status	BVG2M	Estate	Burnt	Low	Moderate	High	Extreme
Glen Rock SF	non-rem	Non remnant or not vegetated			1569.05	222.93	165.32	56.18	1.43	
	12.8.9	Lophostemon confertus open forest on Cainozoic igneous rocks	No concern at present	8	647.44	138.52	94.85	41.51	2.16	
	11.8.2a	Eucalyptus tereticornis and E. melliodora woodland occurring on low hills	# No concern at present	11	20.19	0.00				
	12.8.14	Eucalyptus eugenioides, E. biturbinata, E. melliodora +/- E. tereticornis, Corymbia intermedia open forest on Cainozoic igneous rocks	No concern at present	11	2082.14	732.10	451.68	260.99	19.39	0.03
	12.8.16	Eucalyptus crebra +/- E. melliodora, E. tereticornis woodland on Cainozoic igneous rocks	Of concern	11	25.79	0.00				
	12.8.17	Eucalyptus melanophloia +/- E. crebra, E. tereticornis, Corymbia tessellaris woodland on Cainozoic igneous rocks	No concern at present	11	1969.59	247.93	203.97	43.44	0.52	
	12.3.7	Eucalyptus tereticornis, Casuarina cunninghamiana subsp. cunninghamiana +/- Melaleuca spp. fringing woodland	Of concern	16	102.41	16.30	12.74	3.35	0.21	
	12.8.19	Heath and rock pavement with scattered shrubs or open woodland on Cainozoic igneous hills and mountains	Of concern	29	22.44	10.17	7.33	2.74	0.10	

Estate name	RE1	Short description	Status	BVG2M	Estate	Burnt	Low	Moderate	High	Extreme
Main Range NP	non-rem	Non remnant or not vegetated			692.63	181.18	90.47	68.16	21.92	0.63
	12.8.4	Complex notophyll vine forest with Araucaria spp. on Cainozoic igneous rocks	No concern at present	2	2676.88	170.65	72.24	50.88	31.19	16.33
	12.8.5	Complex notophyll vine forest on Cainozoic igneous rocks. Altitude usually >600m	No concern at present	6	6398.90	1322.86	700.05	434.79	164.66	23.36
	12.8.7	Simple microphyll fern thicket with Acmena smithii on Cainozoic igneous rocks	Of concern	6	727.60	164.68	48.32	51.77	51.50	13.10
	12.9-10.15	Semi-evergreen vine thicket with Brachychiton rupestris on sedimentary rocks	Endangered	7	25.00	0.00				
	12.9-10.16	Araucarian microphyll to notophyll vine forest on Cainozoic and Mesozoic sediments	Of concern	5	10.28	5.52	2.53	2.22	0.71	0.06
	12.8.1	Eucalyptus campanulata tall open forest on Cainozoic igneous rocks	No concern at present	8	4318.50	2585.75	927.80	1098.46	493.83	65.66
	12.8.9	Lophostemon confertus open forest on Cainozoic igneous rocks	No concern at present	8	2435.22	1199.56	682.11	425.95	86.69	4.80
	12.8.10	Eucalyptus laevopinea tall open forest on Cainozoic igneous rocks	Of concern	8	35.28	33.08	4.24	8.37	19.33	1.13
	12.8.11	Eucalyptus dunnii tall open forest on Cainozoic igneous rocks	Of concern	8	123.20	98.77	31.62	45.63	21.39	0.13
	12.8.12	Eucalyptus obliqua tall open forest on Cainozoic igneous rocks	Of concern	8	12.96	12.77	0.47	1.20	7.45	3.66
	11.3.23	Eucalyptus conica, E. nobilis, E. tereticornis, Angophora floribunda woodland on alluvial plains. Basalt derived soils	# Endangered	15	15.23	7.92	5.66	2.22	0.04	
	11.8.2a	Eucalyptus tereticornis and E. melliodora woodland occurring on low hills	# No concern at present	11	24.14	0.00				
	11.8.8	Eucalyptus albens, E. crebra woodland on Cainozoic igneous rocks	No concern at present	11	28.77	50.85	33.18	16.93	0.73	
	11.9.13	Eucalyptus moluccana or E. microcarpa open forest on fine grained sedimentary rocks	Of concern	13	12.50	0.00				
	12.8.14b	Eucalyptus quadrangulata, E. eugenioides +/- E. biturbinata tall open forest on Cainozoic igneous rocks	No concern at present	11	38.04	0.00				
	12.8.14a	Eucalyptus moluccana woodland on Cainozoic igneous rocks	No concern at present	13	6.80	4.14	0.05	1.52	2.51	0.06

Estate name	RE1	Short description	Status	BVG2M	Estate	Burnt	Low	Moderate	High	Extreme
Main Range NP	12.8.14	Eucalyptus eugenioides, E. biturbinata, E. melliodora +/- E. tereticornis, Corymbia intermedia open forest on Cainozoic igneous rocks	No concern at present	11	9608.41	7025.07	2749.37	3023.91	1091.02	160.77
	12.8.16	Eucalyptus crebra +/- E. melliodora, E. tereticornis woodland on Cainozoic igneous rocks	Of concern	11	2161.50	1827.08	461.44	792.91	532.93	39.80
	12.8.17	Eucalyptus melanophloia +/- E. crebra, E. tereticornis, Corymbia tessellaris woodland on Cainozoic igneous rocks	No concern at present	11	3998.21	1766.43	1073.66	474.46	208.83	9.48
	12.8.20	Shrubby woodland with Eucalyptus racemosa subsp. racemosa or E. dura on Cainozoic igneous rocks	Of concern	9	419.57	361.91	135.13	159.44	67.17	0.17
	12.9-10.7	Eucalyptus crebra +/- E. tereticornis, Corymbia tessellaris, Angophora spp., E. melanophloia woodland on sedimentary rocks	Of concern	13	287.09	175.51	89.94	52.22	32.95	0.40
	12.9-10.17e	Eucalyptus acmenoides, E. propinqua, Corymbia intermedia +/- E. microcorys, Lophostemon confertus open forest on sedimentary rocks	No concern at present	9	356.07	283.81	145.40	112.87	25.03	0.51
	12.3.3	Eucalyptus tereticornis woodland on Quaternary alluvium	Endangered	16	9.89	4.29	3.88	0.39	0.02	
	12.3.7	Eucalyptus tereticornis, Casuarina cunninghamiana subsp. cunninghamiana +/- Melaleuca spp. fringing woodland	Of concern	16	108.54	6.94	5.95	0.92	0.08	
	12.3.9	Eucalyptus nobilis open forest on alluvial plains	Of concern	16	123.81	95.17	37.12	34.15	19.17	4.74
	12.8.19	Heath and rock pavement with scattered shrubs or open woodland on Cainozoic igneous hills and mountains	Of concern	29	169.94	90.05	29.04	36.57	22.87	1.56
	12.8.15	Poa labillardierei var. labillardierei grassland on Cainozoic igneous rocks	Endangered	32	0.46	0.35	0.15	0.16	0.04	
	12.3.8a	Elevated swamps with Carex appressa, Juncus spp., Persicaria spp., and Cyperus spp.	Of concern	34	0.16	0.00				
	12.3.8	Swamps with Cyperus spp., Schoenoplectus spp. and Eleocharis spp.	Of concern	34	1.11	0.00				

Estate name	RE1	Short description	Status	BVG2M	Estate	Burnt	Low	Moderate	High	Extreme
Spicers Gap Rd CP	12.8.11	Eucalyptus dunnii tall open forest on Cainozoic igneous rocks	Of concern	8	5.57	5.47	1.40	2.61	1.46	
	12.8.14	Eucalyptus eugenioides, E. biturbinata, E. melliodora +/- E. tereticornis, Corymbia intermedia open forest on Cainozoic igneous rocks	No concern at present	11	0.88	0.88	0.33	0.54	0.01	
Swanfels SF	non-rem	non-rem			1.73	0.07	0.07			
	12.8.4	Complex notophyll vine forest with Araucaria spp. on Cainozoic igneous rocks	No concern at present	2	54.66	30.15	18.46	11.26	0.43	
	11.8.8	Eucalyptus albens, E. crebra woodland on Cainozoic igneous rocks	# No concern at present	11	487.72	394.48	276.94	116.16	1.38	
	12.8.14	Eucalyptus eugenioides, E. biturbinata, E. melliodora +/- E. tereticornis, Corymbia intermedia open forest on Cainozoic igneous rocks	No concern at present	11	345.07	322.43	139.57	179.09	3.76	

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.

Estate name	BVG 5M	BVG 2M	Estate	Burnt	Percentage	Low	Moderate	High	Extreme
Glen Rock SF	Non remnant or not vegetated.	Non remnant or not vegetated.	1569.05	222.93	14.2%	165.32	56.18	1.43	
	2. Wet eucalypt open forests.	8. Wet eucalypt tall open forest on uplands and alluvia.	647.44	138.52	21.4%	94.85	41.51	2.16	
	3. Eastern eucalypt woodlands to open forests.	11. Moist to dry eucalypt open forests to woodlands mainly on basalt areas (land zone 8).	4097.71	980.03	23.9%	655.65	304.43	19.91	0.03
	4. Eucalypt open forests to woodlands on floodplains.	16. Eucalyptus spp. dominated open forest and woodlands drainage lines and alluvial plains.	102.41	16.30	15.9%	12.74	3.35	0.21	
	12. Other coastal communities or heaths.	29. Heathlands and associated scrubs and shrublands on coastal dunefields and inland/ montane locations.	22.44	10.17	45.3%	7.33	2.74	0.10	
Total			**6439.05**	**1367.94**	**21.2%**	**935.89**	**408.22**	**23.81**	**0.03**

Estate name	BVG 5M	BVG 2M	Estate	Burnt	Percentage	Low	Moderate	High	Extreme
Main Range NP	Non remnant or not vegetated.	Non remnant or not vegetated.	692.63	181.18	26.2%	90.47	68.16	21.92	0.63
	1. Rainforests, scrubs.	2. Complex to simple, semi-deciduous mesophyll to notophyll vine forest, sometimes with Araucaria cunninghamii (hoop pine).	2676.88	170.65	6.4%	72.24	50.88	31.19	16.33
		5. Notophyll to microphyll vine forests, frequently with Araucaria spp. or Agathis spp. (kauri pines)	10.28	5.52	53.6%	2.53	2.22	0.71	0.06
		6. Notophyll vine forest and microphyll fern forest to thicket on high peaks and plateaus.	7126.50	1487.54	20.9%	748.36	486.56	216.16	36.45
		7. Semi-evergreen to deciduous microphyll vine thicket.	25.00	0.00	0.0%				
	2. Wet eucalypt open forests.	8. Wet eucalypt tall open forest on uplands and alluvia.	6925.17	3929.93	56.7%	1646.24	1579.60	628.70	75.39
	3. Eastern eucalypt woodlands to open forests.	9. Moist to dry eucalypt open forests to woodlands usually on coastal lowlands and ranges.	775.64	645.71	83.2%	280.53	272.30	92.19	0.69
		11. Moist to dry eucalypt open forests to woodlands mainly on basalt areas (land zone 8).	15859.07	10669.43	67.3%	4317.65	4308.21	1833.51	210.05
		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).	306.39	179.65	58.6%	90.00	53.73	35.46	0.46
		15. Temperate eucalypt woodlands.	15.23	7.92	52.0%	5.66	2.22	0.04	
	4. Eucalypt open forests to woodlands on floodplains.	16. Eucalyptus spp. dominated open forest and woodlands drainage lines and alluvial plains.	242.24	106.40	43.9%	46.94	35.46	19.26	4.74
	12. Other coastal communities or heaths.	29. Heathlands and associated scrubs and shrublands on coastal dunefields and inland/ montane locations.	169.94	90.05	53.0%	29.04	36.57	22.87	1.56
	13. Tussock grasslands, forblands.	32. Closed tussock grasslands in coastal locations.	0.46	0.35	77.5%	0.15	0.16	0.04	
	15. Wetlands (swamps and lakes).	34. Wetlands associated with permanent lakes and swamps, as well as ephemeral lakes, claypans and swamps. Includes fringing woodlands and shrublands.	1.27	0.00	0.0%				
Total			**34826.71**	**17474.32**	**50.2%**	**7329.83**	**6896.08**	**2902.07**	**346.35**

Estate name	BVG 5M	BVG 2M	Estate	Burnt	Percentage	Low	Moderate	High	Extreme
Spicers Gap Rd CP	2. Wet eucalypt open forests.	8. Wet eucalypt tall open forest on uplands and alluvia.	5.57	5.47	98.2%	1.40	2.61	1.46	
Spicers Gap Rd CP	3. Eastern eucalypt woodlands to open forests.	11. Moist to dry eucalypt open forests to woodlands mainly on basalt areas (land zone 8).	0.88	0.88	99.9%	0.33	0.54	0.01	
Total			**6.45**	**6.35**	**98.5%**	**1.73**	**3.15**	**1.48**	**0.00**
Swanfels SF	Non remnant or not vegetated.	Non remnant or not vegetated.	1.73	0.07	4.0%	0.07			
Swanfels SF	1. Rainforests, scrubs.	2. Complex to simple, semi-deciduous mesophyll to notophyll vine forest, sometimes with Araucaria cunninghamii (hoop pine).	54.66	30.15	55.2%	18.46	11.26	0.43	
Swanfels SF	3. Eastern eucalypt woodlands to open forests.	11. Moist to dry eucalypt open forests to woodlands mainly on basalt areas (land zone 8).	832.79	716.90	86.1%	416.51	295.24	5.14	
Total			**889.18**	**747.12**	**84.0%**	**435.04**	**306.50**	**5.57**	**0.00**
All estates			**42161.38**	**19595.74**	**46.5%**	**8702.48**	**7613.94**	**2932.92**	**346.39**

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, E = endangered, V = vulnerable, NT = near threatened, LC = least concern, SL = special least concern. **Rf** = rainforests, **Sclero** = *Lophostemon*, *Eucalyptus* and or *Corymbia* woodlands and forests; with X = the habitat is important for the species in the focal region. *The blue spiny crayfish is listed as V on the IUCN Red List.

Animals

Group	Common name	Scientific name	NCA	EPBC	Rf	Sclero
amphibians	cascade treefrog	*Litoria pearsoniana*	V		X	X
amphibians	tusked frog	*Adelotus brevis*	V		X	X
amphibians	red-and-yellow mountainfrog	*Philoria kundagungan*	V		X	X
amphibians	Fleay's barred frog	*Mixophyes fleayi*	E	E	X	X
birds	red goshawk	*Erythrotriorchis radiatus*	E	V	X	X
birds	rufous scrub-bird	*Atrichornis rufescens*	V	E	X	
birds	glossy black-cockatoo (eastern)	*Calyptorhynchus lathami lathami*	V			X
birds	oriental cuckoo	*Cuculus optatus*	SL		X	X
birds	eastern bristlebird	*Dasyornis brachypterus*	E	E		X
birds	regent honeyeater	*Anthochaera phrygia*	CR	CE		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	X
birds	spectacled monarch	*Symposiachrus trivirgatus*	SL		X	X
birds	Coxen's fig-parrot	*Cyclopsitta diophthalma*	E	E	X	
birds	swift parrot	*Lathamus discolor*	E	CE		X
birds	rufous fantail	*Rhipidura rufifrons*	SL		X	X
birds	powerful owl	*Ninox strenua*	V			X
birds	black-breasted button-quail	*Turnix melanogaster*	V	V	X	
malacostracans	Jagara hairy crayfish	*Euastacus jagara*	CR		X	
malacostracans	*blue spiny crayfish	*Euastacus sulcatus*			X	
mammals	spotted-tailed quoll (southern subspecies)	*Dasyurus maculatus maculatus*	V	E	X	X
mammals	brush-tailed rock-wallaby	*Petrogale penicillata*	V	V	X	X
mammals	New Holland mouse	*Pseudomys novaehollandiae*	V	V		X
mammals	Hastings River mouse	*Pseudomys oralis*	V	E		X
mammals	platypus	*Ornithorhynchus anatinus*	SL			
mammals	koala	*Phascolarctos cinereus*	V	V		X
mammals	long-nosed potoroo	*Potorous tridactylus tridactylus*	V	V	X	X
mammals	southern greater glider	*Petauroides volans volans*	V	V		X
mammals	grey-headed flying-fox	*Pteropus poliocephalus*	C	V	X	X
mammals	short-beaked echidna	*Tachyglossus aculeatus*	SL		X	X
mammals	large-eared pied bat	*Chalinolobus dwyeri*	V	V	X	X
reptiles	common death adder	*Acanthophis antarcticus*	V			X
reptiles	three-toed snake-tooth skink	*Coeranoscincus reticulatus*	C	V	X	

Plants

Group	Common name	Scientific name	NCA	EPBC	Rf	Sclero
Apocynaceae	slender milkvine	*Marsdenia coronata*	V		X	X
Apocynaceae		*Marsdenia longiloba*	V	V		X
Asteraceae	Binna Burra daisy	*Brachyscome ascendens*	V			X
Asteraceae		*Picris evae*	V	V		X
Asteraceae		*Rhaponticum australe*	V	V		X
Brassicaceae		*Lepidium peregrinum*	C	E		X
Dilleniaceae	mountain guinea flower	*Hibbertia monticola*	NT			X
Euphorbiaceae		*Bertya pinifolia*	V	V		X
Fabaceae	brush sophora	*Sophora fraseri*	V	V	X	
Haloragaceae		*Gonocarpus hirtus*	V			X
Lauraceae	gorge laurel	*Cryptocarya floydii*	NT		X	
Loranthaceae		*Muellerina myrtifolia*	NT			X
Myrtaceae	Dunn's white gum	*Eucalyptus dunnii*	V			X
Myrtaceae	Main Range Lenwebbia	*Lenwebbia* sp. (Main Range P.R.Sharpe+ 4877)	CR		X	
Myrtaceae	scrub turpentine	*Rhodamnia rubescens*	CR		X	X
Myrtaceae	native guava	*Rhodomyrtus psidioides*	CR		X	X
Orchidaceae		*Bulbophyllum weinthalii*	V		X	
Orchidaceae		*Dendrobium schneiderae*	NT		X	
Orchidaceae		*Sarcochilus hartmannii*	V	V	X	
Poaceae		*Arthraxon hispidus*	V	V		X
Poaceae		*Arundinella grevillensis*	V			X
Poaceae	Bunya Mountains bluegrass	*Bothriochloa bunyensis*	V	V		X
Proteaceae	ball nut	*Floydia praealta*	V	V	X	
Proteaceae		*Grevillea linsmithii*	E			X
Rhamnaceae		*Discaria pubescens*	NT			X
Rhamnaceae		*Pomaderris crassifolia*	V			X
Santalaceae	toadflax	*Thesium australe*	V	V		X
Solanaceae	brush nightshade	*Solanum callium*	V		X	
Thymelaeaceae		*Pimelea umbratica*	NT		X	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.

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

Affected QPWS estate = Main Range 2019 bushfire complex (see Table 3).
Column headings: **Status** – **NCA** (*Nature Conservation Act* 1992) and **EPBC** (*Environment Protection and Biodiversity Conservation Act* 1999) statuses are: CE = critically endangered, E = endangered, V = vulnerable. **Habitat type** – **Rf** = rainforests, **Sclero** = *Lophostemon*, *Eucalyptus* and or *Corymbia* woodlands and forests; 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		14448	2351	16.3%	1146	48.7%	338	433	339	37
Birds	*Calyptorhynchus lathami*	glossy black-cockatoo	V			X	527111	8320	1.6%	4659	56.0%	1950	1964	683	61
Birds	*Cyclopsitta diophthalma coxeni*	Coxen's fig-parrot	E	E	X		173270	14326	8.3%	5353	37.4%	1921	2157	1053	221
Birds	*Dasyornis brachypterus*	eastern bristlebird	E	E		X	26765	6300	23.5%	4356	69.2%	1732	1887	632	106
Birds	*Lathamus discolor*	swift parrot	E	CE		X	970350	4002	0.4%	2351	58.7%	906	985	425	34
Birds	*Menura alberti†*	Albert's lyrebird	NT		X	X	55117	10829	19.6%	4377	40.4%	1611	1631	982	153
Birds	*Ninox strenua*	powerful owl	V			X	2239060	31306	1.4%	15498	49.5%	6798	6148	2294	258
Birds	*Stipiturus malachurus**	southern emu-wren	V			X	31182	455	1.5%	85	18.6%	37	39	8	1
Birds	*Turnix melanogaster*	black-breasted button-quail	V	V	X		1013079	4086	0.4%	1890	46.3%	1035	711	138	5
Frogs	*Adelotus brevis*	tusked frog	V		X	X	985730	14373	1.5%	5677	39.5%	2299	2261	987	130
Frogs	*Litoria pearsoniana*	cascade treefrog	V		X	X	193704	8509	4.4%	3375	39.7%	1453	1272	560	90
Frogs	*Mixophyes fleayi*	Fleay's barred frog	E	E	X	X	48380	7695	15.9%	3186	41.4%	1358	1223	539	66
Frogs	*Philoria kundagungan*	red-and-yellow mountainfrog	V		X	X	15922	9733	61.1%	2154	22.1%	967	723	367	97
Mammals	*Chalinolobus dwyeri*	large-eared pied bat	V	V	X	X	1060419	27985	2.6%	13307	47.5%	5411	5457	2124	315
Mammals	*Dasyurus maculatus maculatus*	spotted-tailed quoll (southern subspecies)	V	E	X	X	396753	24759	6.2%	11394	46.0%	4736	4703	1702	253
Mammals	*Nyctophilus corbeni**	eastern long-eared bat	V	V		X	1897768	2872	0.2%	218	7.6%	103	67	33	15
Mammals	*Petauroides volans*	greater glider	V	V		X	4275994	24393	0.6%	10924	44.8%	4418	4523	1709	274
Mammals	*Petrogale penicillata*	brush-tailed rock-wallaby	V	V		X	193687	30742	15.9%	15719	51.1%	6854	6136	2428	302
Mammals	*Phascolarctos cinereus‡*	koala	V	V		X	629597	2834	0.5%	1904	67.2%	849	820	229	6

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	*Potorous tridactylus tridactylus*	long-nosed potoroo	V	V	X	X	190173	9336	4.9%	4821	51.6%	1639	2044	953	185
Mammals	*Pseudomys novaehollandiae*	New Holland mouse	V	V		X	60485	3397	5.6%	1898	55.9%	1005	698	190	5
Mammals	*Pseudomys oralis*	Hastings River mouse	V	E		X	25349	5878	23.2%	2275	38.7%	724	986	492	74
Reptiles	*Acanthophis antarcticus*	common death adder	V			X	3452148	31985	0.9%	16601	51.9%	7365	6531	2428	277
Reptiles	*Delma torquata**	collared delma	V	V		X	1954521	14323	0.7%	6360	44.4%	3276	2178	862	45

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	*Marsdenia longiloba*		V	V		X	67681	3345	4.9%	2127	63.6%	827	863	389	48
Asteraceae	*Brachyscome ascendens†*	Binna Burra daisy	V			X	1344	298	22.2%	256	85.8%	104	103	49	0
Asteraceae	*Picris evae*		V	V		X	266875	472	0.2%	16	3.4%	12	3	0	0
Byttneriaceae	*Lasiopetalum* sp Proston*		E	CE		X	8879	633	7.1%	114	18.0%	43	27	18	26
Cyperaceae	*Caustis blakei* subsp *macrantha**		V			X	58942	326	0.6%	274	84.0%	149	101	25	0
Cyperaceae	*Cyperus clarus**		V			X	1069192	2691	0.3%	994	36.9%	461	375	144	13
Dilleniaceae	*Hibbertia monticola†*	mountain guinea flower	NT			X	3003	332	11.1%	232	69.9%	43	71	89	29
Ericaceae	*Leucopogon recurvisepalus**		E			X	17252	37	0.2%	27	72.8%	4	9	13	1
Euphorbiaceae	*Bertya pinifolia†*		V	V		X	1923	36	1.9%	28	78.2%	23	5	0	0
Euphorbiaceae	*Ricinocarpos speciosus**		V			X	187298	4666	2.5%	2714	58.2%	934	1143	566	71
Fabaceae	*Sophora fraseri*	brush sophora	V	V		X	379715	13585	3.6%	5072	37.3%	2174	1972	804	122
Haloragaceae	*Gonocarpus effusus**		V			X	8456	297	3.5%	151	51.1%	38	53	52	9
Haloragaceae	*Gonocarpus hirtus†*		V			X	1571	288	18.3%	241	83.5%	104	90	46	0
Haloragaceae	*Haloragis exalata* subsp *velutina**		V	V		X	765276	38569	5.0%	17824	46.2%	7775	6995	2729	326
Lamiaceae	*Coleus nitidus**		E	E	X		118005	475	0.4%	311	65.6%	91	107	86	27
Lamiaceae	*Westringia sericea*†*	native rosemary	V			X	1855	285	15.4%	186	65.0%	107	67	12	0
Loranthaceae	*Muellerina myrtifolia†*		NT		X		5528	886	16.0%	511	57.7%	179	260	71	2

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 dunnii†*	Dunn's white gum	V			X	3574	1369	38.3%	681	49.8%	243	278	137	23
Myrtaceae	*Eucalyptus taurina**	Helidon ironbark	V			X	147575	275	0.2%	244	88.9%	95	99	49	0
Myrtaceae	*Leptospermum oreophilum**		V			X	15809	159	1.0%	112	70.6%	35	47	29	1
Myrtaceae	*Rhodamnia rubescens*		E		X		290240	26053	9.0%	12567	48.2%	5082	5152	2030	302
Myrtaceae	*Rhodomyrtus psidioides*	native guava	E		X		294703	752	0.3%	91	12.1%	13	24	39	15
Orchidaceae	*Bulbophyllum weinthalii* subsp *weinthalii†*		V		X		1256	521	41.4%	342	65.7%	111	108	98	25
Orchidaceae	*Dendrobium schneiderae* var. *schneiderae†*		NT		X		1885	331	17.6%	231	69.8%	107	94	28	2
Orchidaceae	*Diuris parvipetala**		V			X	389679	3036	0.8%	518	17.1%	342	167	9	0
Orchidaceae	*Sarcochilus hartmannii†*		V	V	X		1256	275	21.9%	189	68.7%	63	85	38	3
Poaceae	*Arthraxon hispidus*		V	V		X	1094540	33843	3.1%	15868	46.9%	6857	6270	2448	294
Poaceae	*Arundinella grevillensis†*		V		X		3043	505	16.6%	377	74.8%	187	140	50	0
Poaceae	*Bothriochloa bunyensis*	Bunya Mountains bluegrass	V	V		X	59510	15288	25.7%	6472	42.3%	2752	2617	933	170
Poaceae	*Paspalidium grandispiculatum**		V	V		X	114314	562	0.5%	259	46.0%	173	72	13	0
Proteaceae	*Banksia conferta**		V			X	3152	47	1.5%	36	76.4%	5	12	17	1
Proteaceae	*Floydia praealta*	ball nut	V	V	X		319846	4573	1.4%	3589	78.5%	1257	1493	697	142
Proteaceae	*Grevillea linsmithii*		E			X	4397	497	11.3%	391	78.7%	176	144	69	1
Ranunculaceae	*Clematis fawcettii**		V	V	X		112227	16312	14.5%	5858	35.9%	2729	2247	783	99
Rhamnaceae	*Discaria pubescens†*		NT			X	2303	201	8.7%	195	97.0%	56	120	18	1
Rhamnaceae	*Pomaderris crassifolia*		V			X	121170	17754	14.7%	9873	55.6%	3890	4043	1685	255
Rutaceae	*Leionema obtusifolium**		V	V		X	52928	201	0.4%	36	18.1%	24	10	2	0
Santalaceae	*Thesium australe*	toadflax	V	V		X	1105581	34936	3.2%	18294	52.4%	8237	7149	2621	287
Solanaceae	*Solanum callium†*	brush nightshade	V		X		1706	237	13.9%	141	59.6%	49	70	21	0
Thymelaeaceae	*Pimelea umbratica†*		NT			X	2191	1418	64.7%	815	57.5%	257	286	232	41

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

More pest species have been recorded in the Main Range area than those listed below. Only those that are currently known to occur on 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	feral cat	*Felis catus*
mammals	feral pig	*Sus scrofa*
mammals	red fox	*Vulpes vulpes*
Plants		
Apocynaceae	white moth vine	*Araujia sericifera*
Asteraceae	annual ragweed	*Ambrosia artemisiifolia*
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*
Caesalpiniaceae	Easter cassia	*Senna pendula var. glabrata*
Caesalpiniaceae	smooth cassia	*Senna septemtrionalis*
Crassulaceae	mother of millions	*Bryophyllum* spp.
Fabaceae	silverleaf desmodium	*Desmodium uncinatum*
Fabaceae	Archer axillaris	*Macrotyloma axillare*
Liliaceae	Formosan lily	*Lilium formosanum*
Oleaceae	large-leaved privet	*Ligustrum lucidum*
Oleaceae	small-leaved privet	*Ligustrum sinense*
Poaceae	Indian couch	*Bothriochloa pertusa*
Poaceae	coolati grass	*Hyparrhenia hirta*
Poaceae	thatch grass	*Hyparrhenia rufa*
Poaceae	green panic and Guinea grass	*Megathyrsus maximus*
Poaceae	Parramatta grass	*Sporobolus africanus*
Poaceae	giant Parramatta grass	*Sporobolus fertilis*
Poaceae	giant rats-tail grass	*Sporobolus natalensis*
Rosaceae	Blackberry	*Rubus anglocandicans*
Sapindaceae	golden rain tree	*Koelreuteria elegans* subsp*. formosana*
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 Main Range 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

See K:\Post fire assessments\2019_2020\Main Range\QPWS post fire evaluation Main Ra complex natural values Appendix 8 20201030.docx

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

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

- a significant proportion (>15%) of their potential Queensland habitat occurs in the affected Main Range QPWS estates, and
- a significant proportion (≥15%) of their potential habitat within the affected Main Range QPWS estates was burnt in the bushfire.

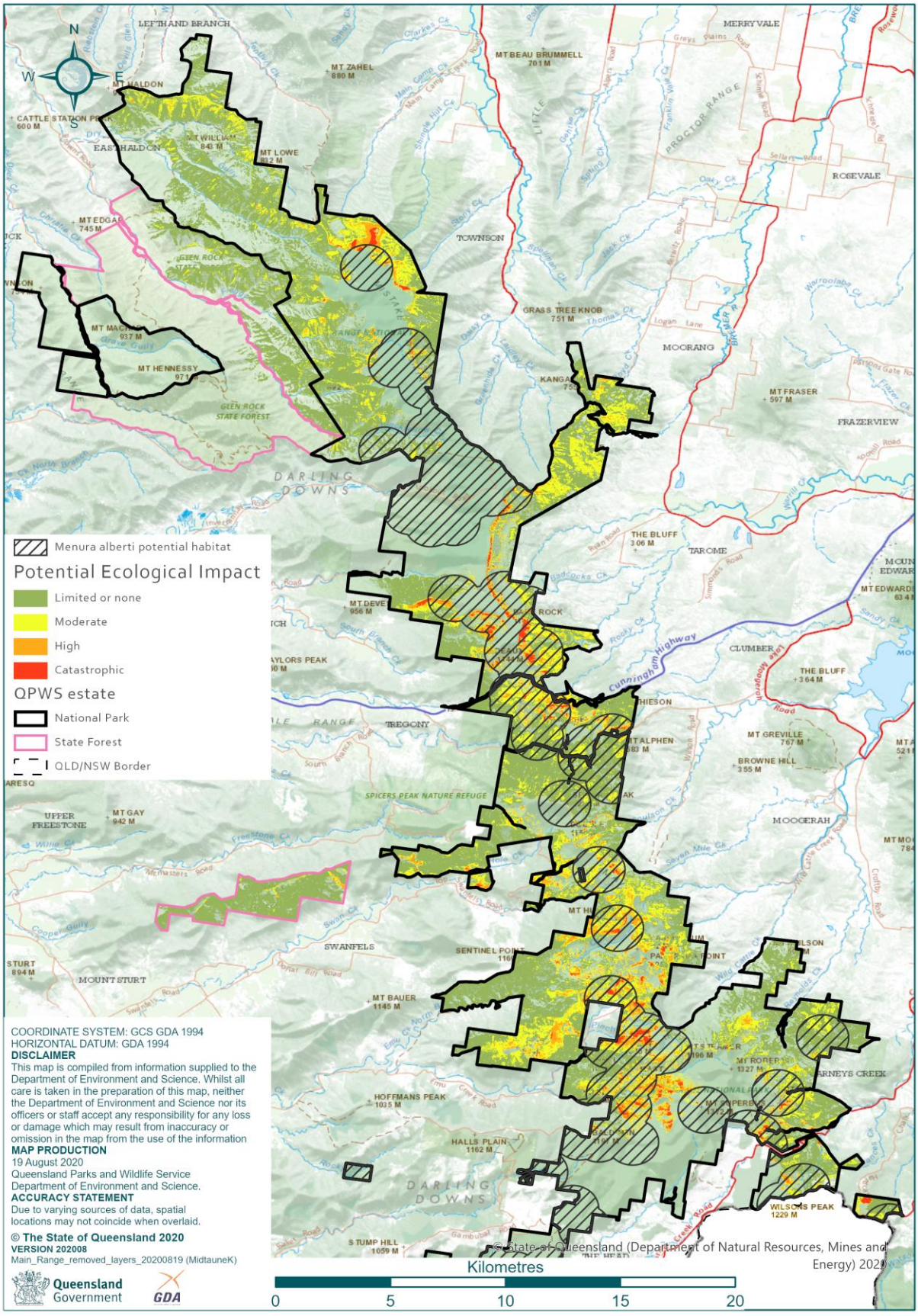
The species are fauna: rufous scrub-bird, eastern bristlebird, Albert's lyrebird, *Mixophyes fleayi, Philoria kundagungan, Petrogale penicillata* and *Pseudomys oralis*; and flora*: Brachyscome ascendens, Eucalyptus dunnii, Bothriochloa bunyensis, Gonocarpus hirtus, Westringia sericea, Pimelea umbratica, Arundinella grevillensis, Dendrobium schneiderae* var. *schneiderae, Sarcochilus hartmannii, Bulbophyllum weinthalii* subsp *weinthalii*, and *Muellerina myrtifolia*.

NOTE: Some maps in this Appendix 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

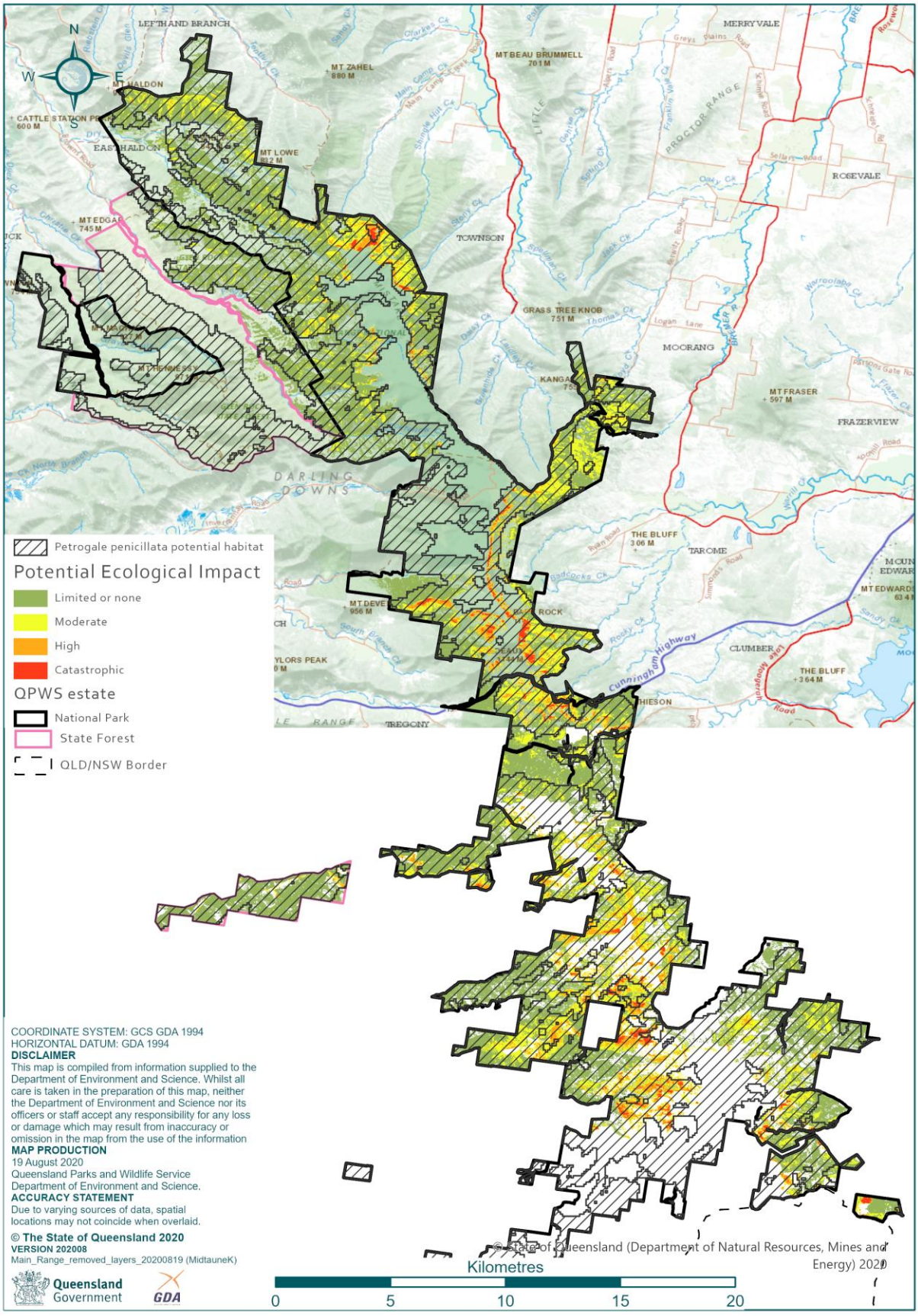
c. Albert's lyrebird



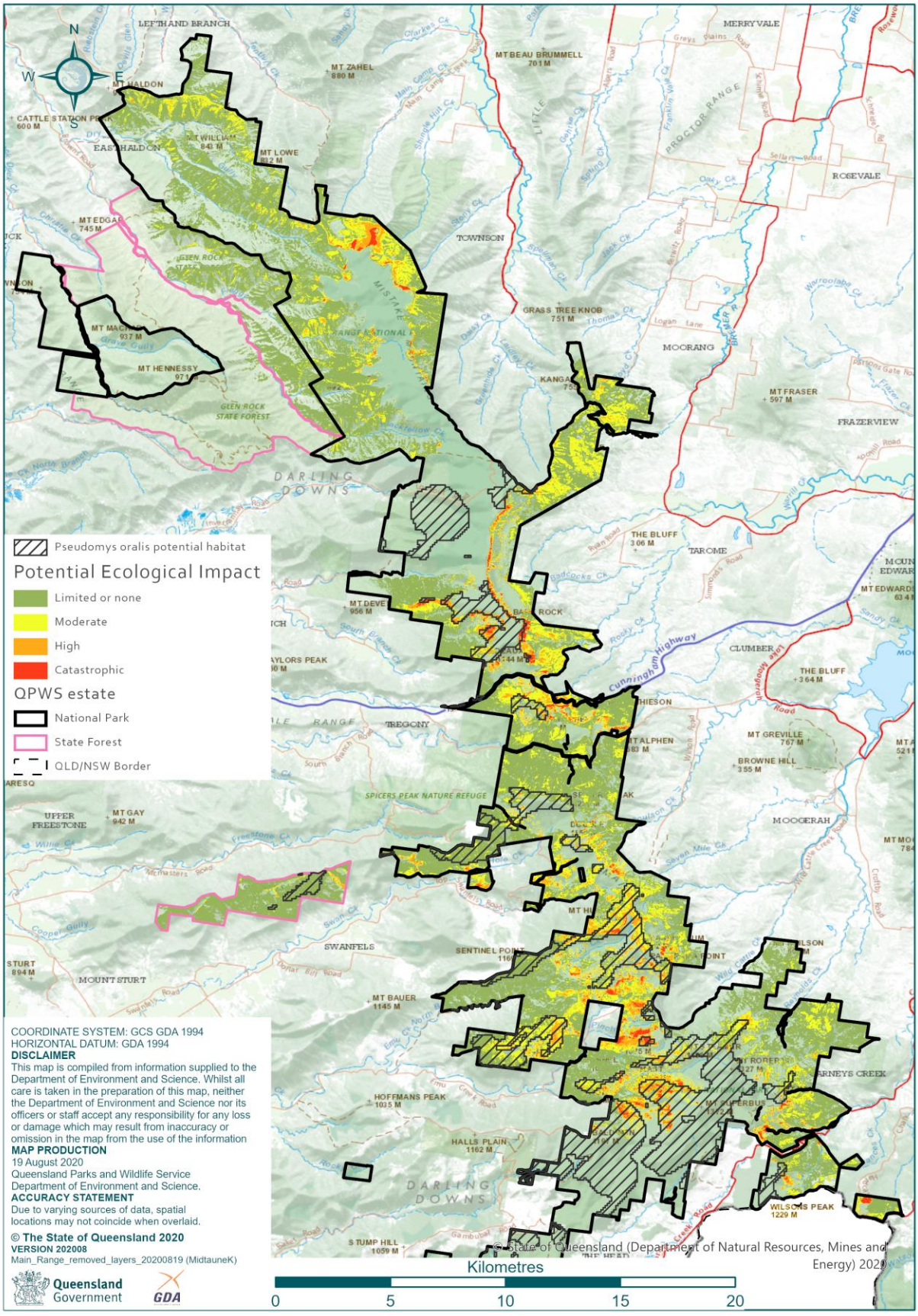
d. ***Mixophyes fleayi*** **– not for public release**

e. ***Philoria kundagungan*** **– not for public release**

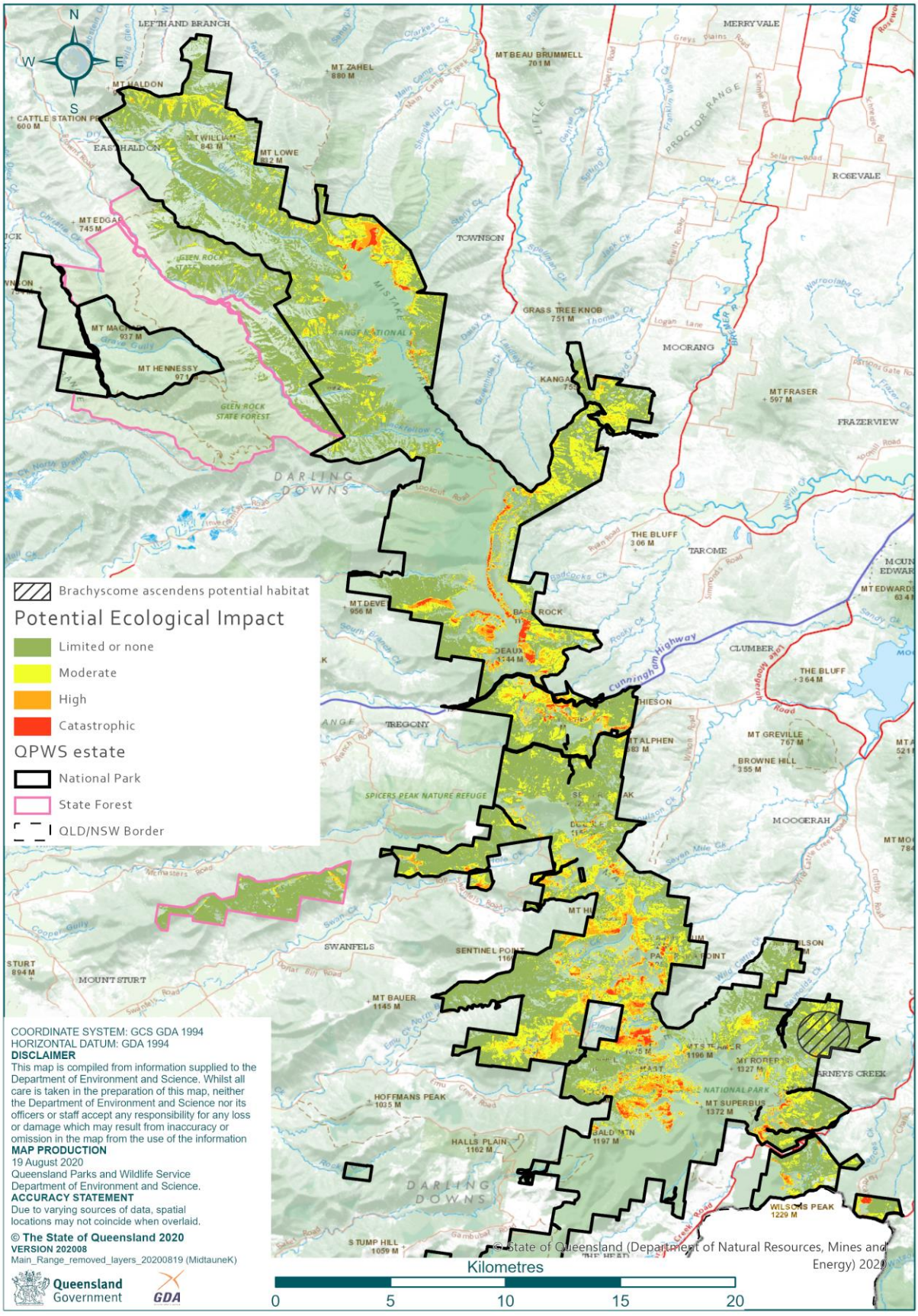
f. ***Petrogale penicillata***



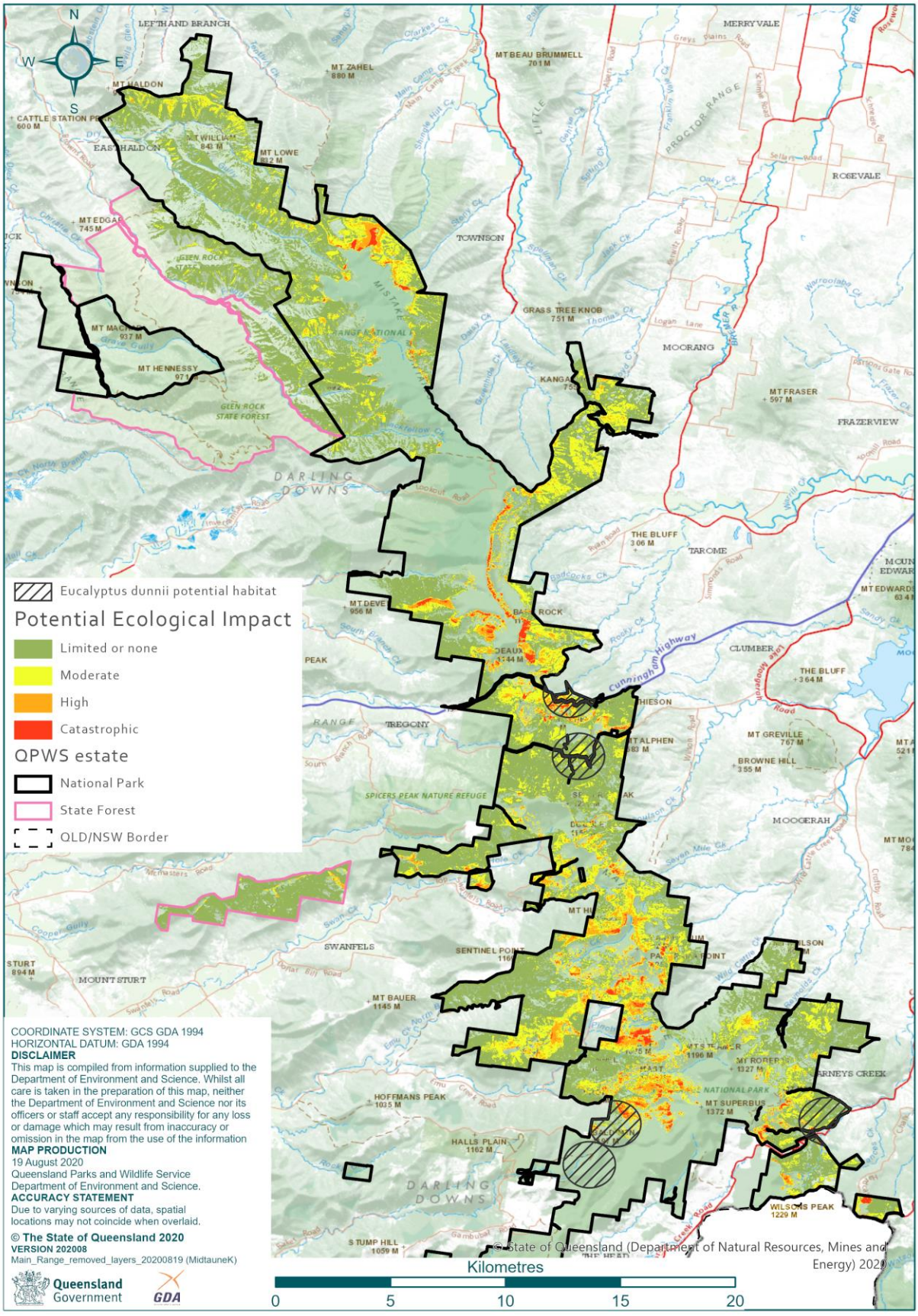
g. ***Pseudomys oralis***



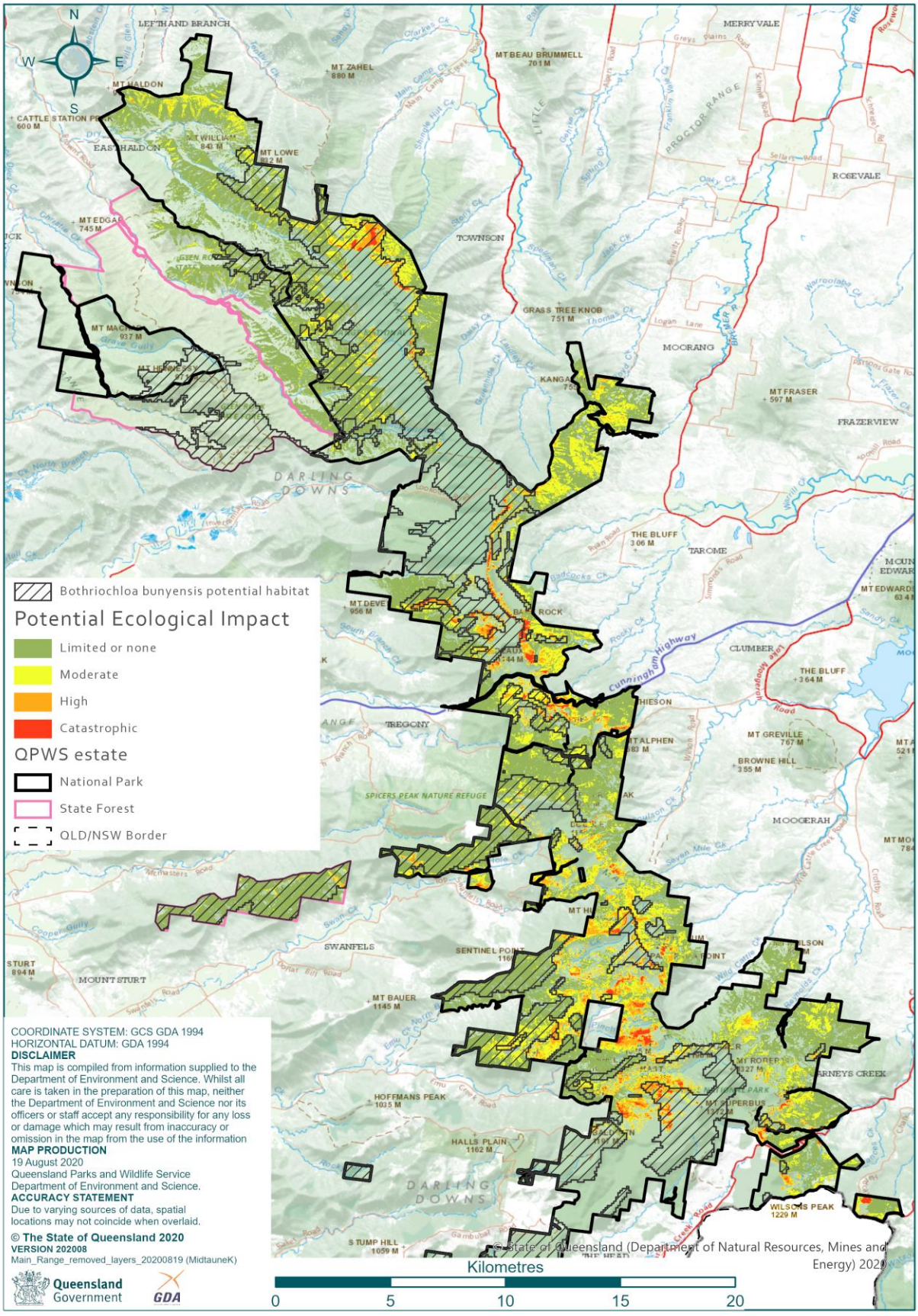
h. ***Brachyscome ascendens***



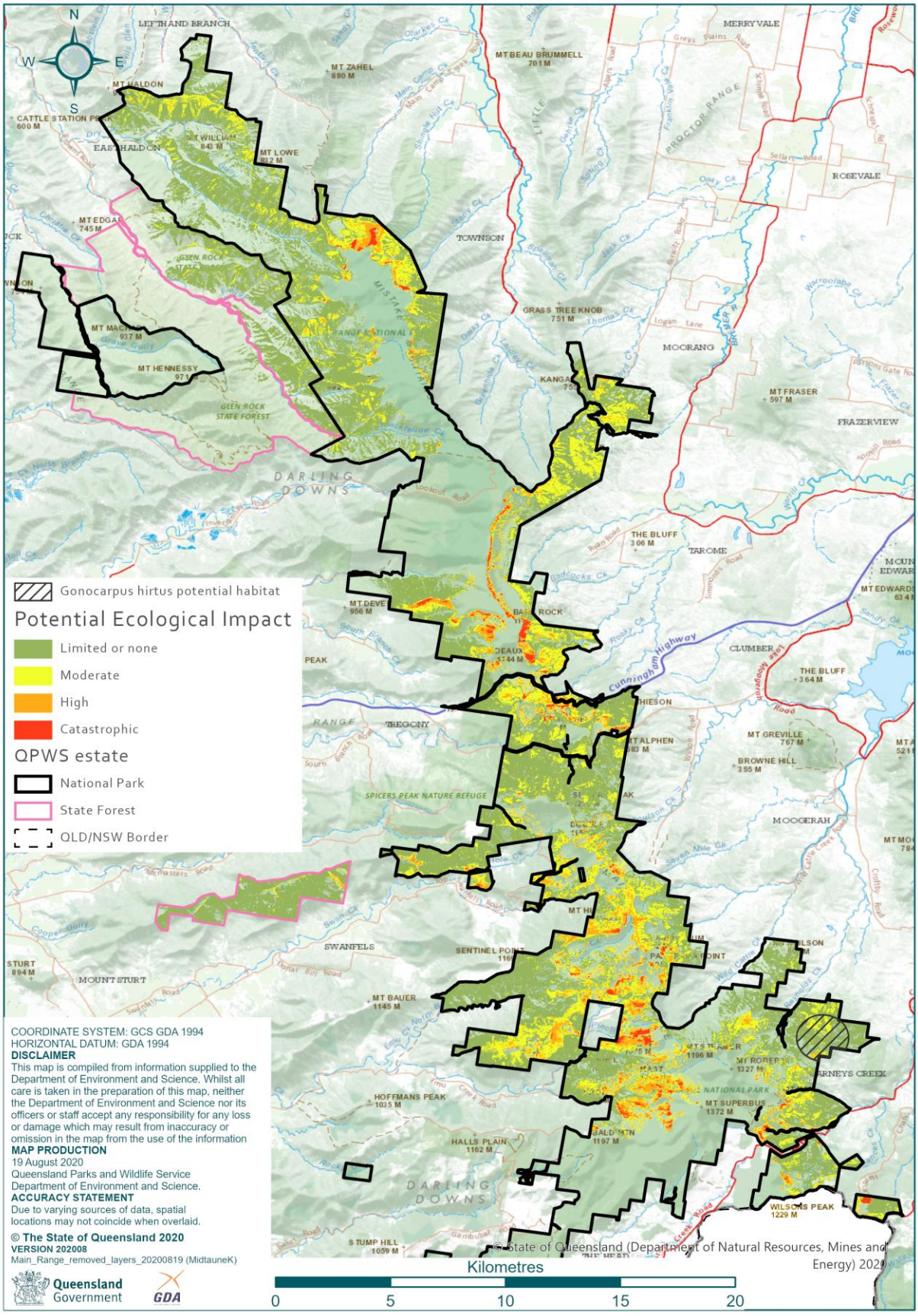
i. ***Eucalyptus dunnii***



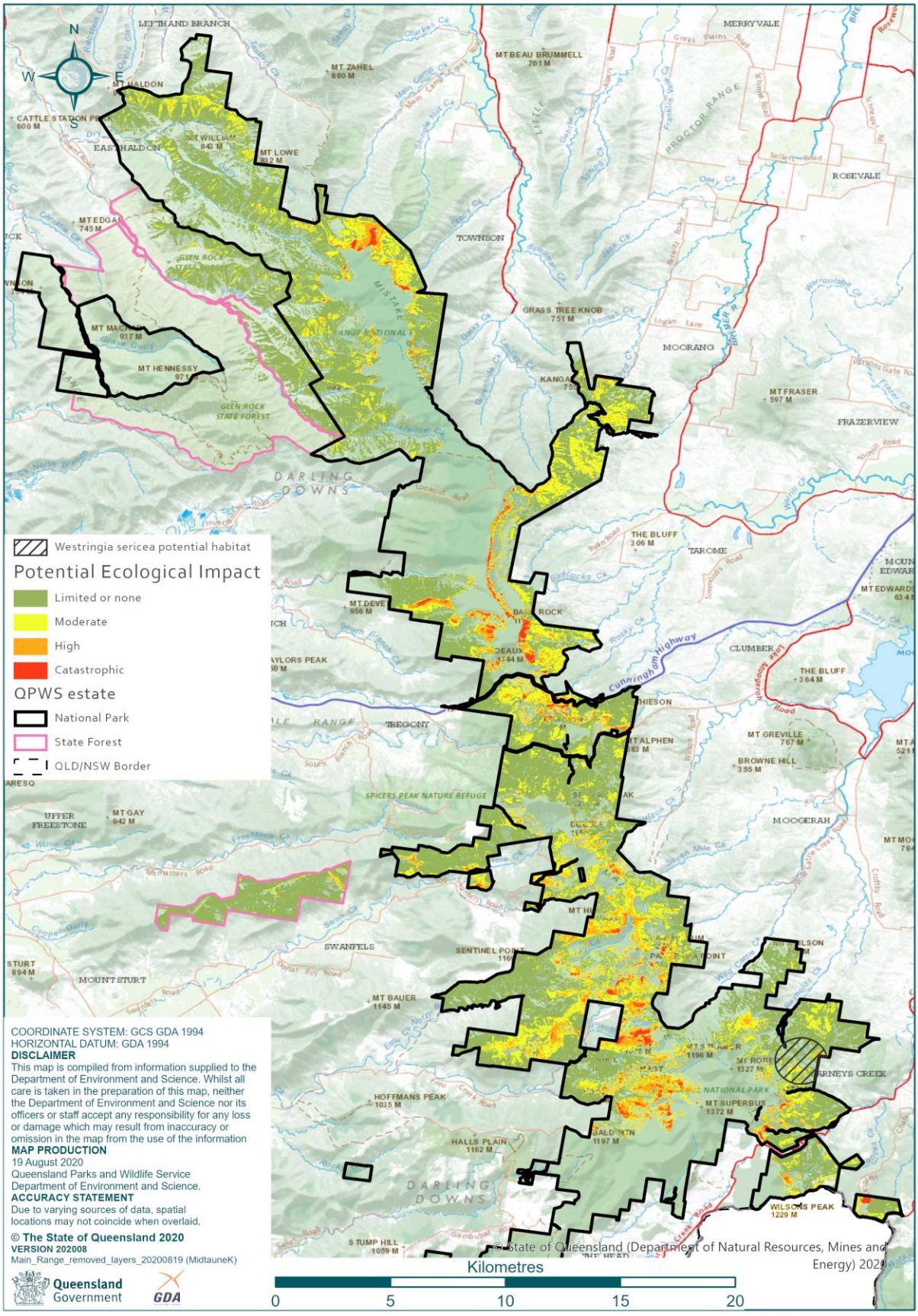
j. ***Bothriochloa bunyensis***



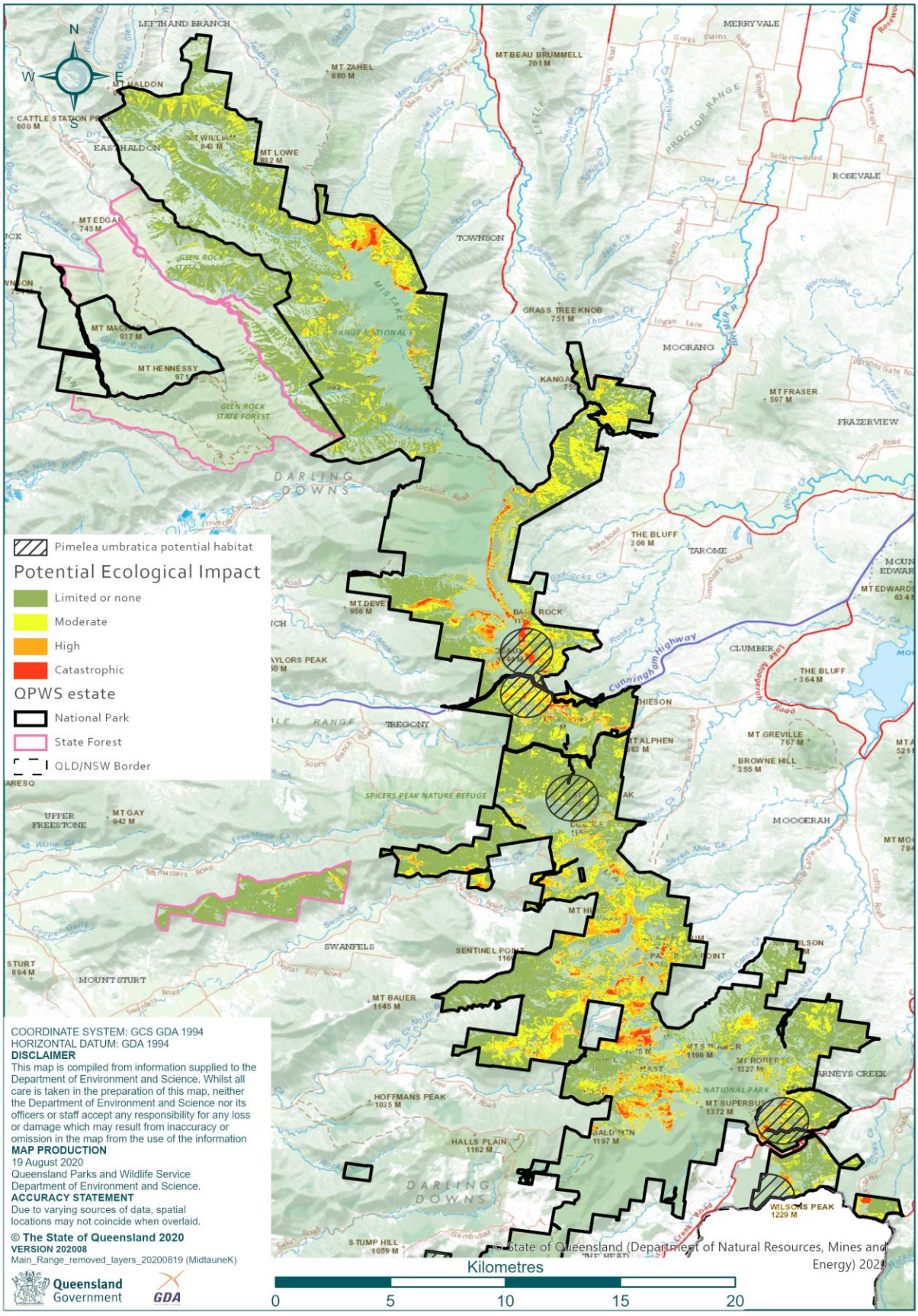
k. ***Gonocarpus hirtus***



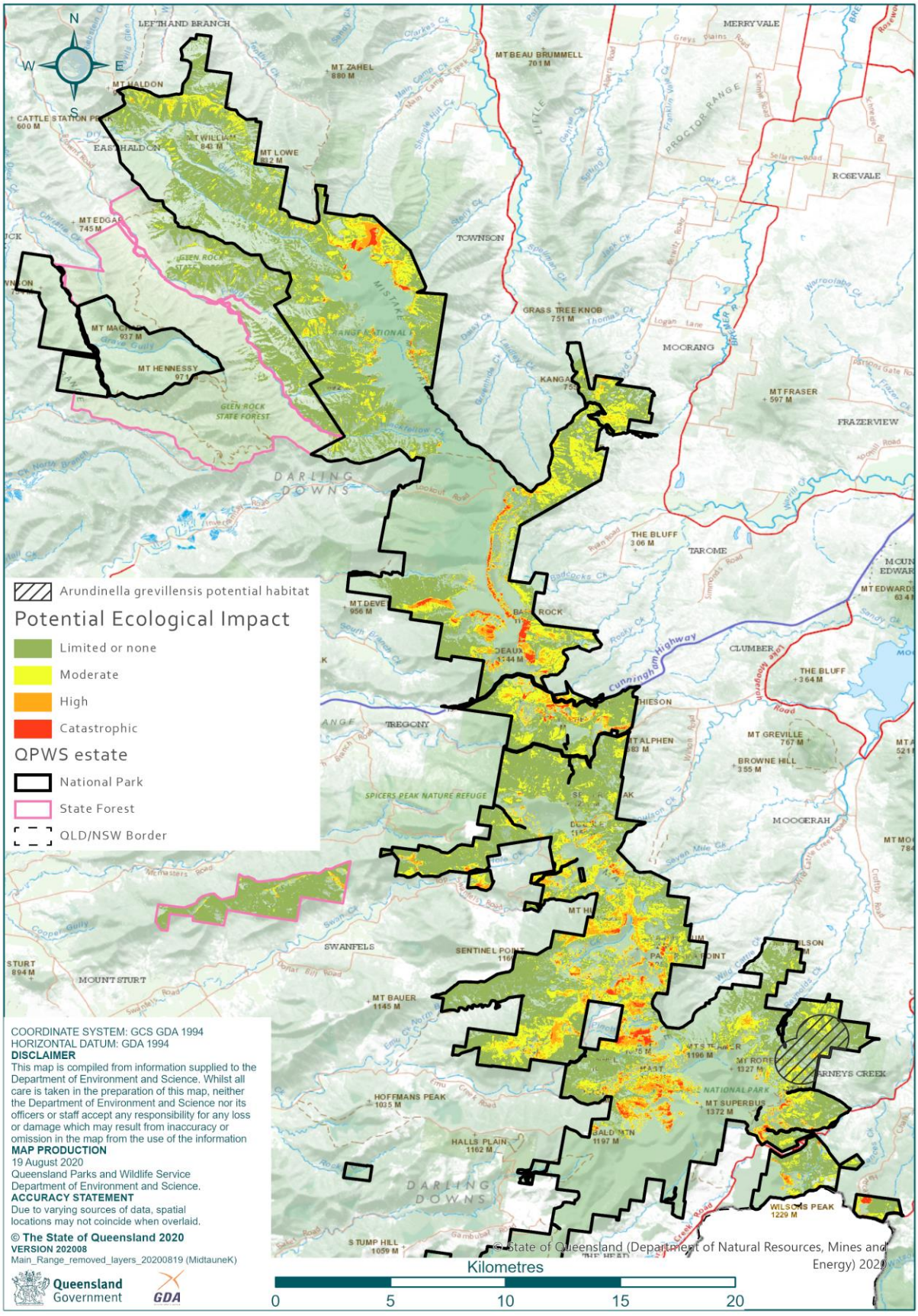
I. *Westringia sericea*



m. ***Pimelea umbratica***



n. ***Arundinella grevillensis***



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

p. ***Sarcochilus hartmannii* – not for public release**

q. ***Bulbophyllum weinthalii* subsp. *weinthalii***

r. ***Muellerina myrtifolia***