Post-fire Assessment Report—Natural Values:

2019/2020 bushfire, Bulburin National Park, South East Queensland Region

August 2020

Queensland Government

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

Citation

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Twitter- @envirogov #BushfireRecoveryAU

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Front cover

Burnt rainforest on Granite Creek, Bulburin National Park (W.J. McDonald 2020).

Contents

List of acronyms and abbreviations used in the text

BVG	Broad Vegetation Groups (BVGs) as described by Neldner *et al.* (2019b).
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.
gbh	Girth at breast height – a standard tree measure in vegetation assessment.
LC	Least Concern.
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.
QPWS	Queensland Parks and Wildlife Service.
QPWS estate	National Parks, Resources Reserves, State Forests and Forest Reserves.
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.* 2019a).
REDD	Regional Ecosystem Description Database, Version 10 (Queensland Herbarium 2018).
V	Vulnerable.

1 Executive summary

The bushfire event in Bulburin National Park commenced on 25 November 2019, with a fire that ignited on freehold land east of Bulburin NP. That fire, referred to as the southern fire in this report, moved onto the park on 27 November. A second fire (referred to as the northern fire in this report), ignited by a lightning strike on the park on 9 December 2019. While the northern fire was contained on 16 December, the southern fire continued to burn on the park through to early February 2020. It crossed the western boundary of the park into neighbouring freehold land on 5 January 2020. The fire was declared out on 6 February 2020.

The field inspection of fire severity and impacts was undertaken in late May 2020, having been delayed as a consequence of COVID-19 restrictions.

The total area burnt within Bulburin NP was approximately 7541ha. A summary of the natural values impacted, and the degree of known or likely impact, is provided in Table 1. Substantial areas of rainforest (2,116ha), wet eucalypt open forest (915ha) and eucalypt woodlands to open forests (4,488ha) were burnt representing 26%, 27% and 22% of the total area of each of these ecosystem types within the park. Relative fire severity varied considerably across the fire ground with low to moderate severity predominating but also hundreds of hectares at high relative severity and tens of hectares at extreme relative severity (section 5). A detailed assessment of the impact to natural values is provided in section 6 together with recommended recovery actions. The highest priority recommendations for on-ground operations are to:

1. Prevent the establishment of non-native high biomass grasses and *Lantana camara* (lantana) immediately adjacent to and within burnt communities, and implement control in the vicinity of unburnt communities at risk from future fires.
2. Surveillance for new weed species and/or new incursions that may impact recovery or increase future fire risk and undertake strategic control.
3. Undertake control programs for feral cats and pigs.

The fire provides research and monitoring opportunities that will help inform a) post-fire management actions for future fires impacting rainforest and wet eucalypt open forest communities in south-east Queensland, and b) ongoing fire management planning, planned burning and bushfire suppression. Some recommendations are provided in section 6.3.

Several threatened flora and fauna species are endemic to Bulburin NP – *Macadamia jansenii, Medicosma elliptica, Phyllanthus* sp. Bulburin and *Phyllurus caudiannulatus* (ringed thin-tailed gecko), and it is one of only three known locations (all on protected area) for *Antechinus argentus* (silver-headed antechinus). Further survey and monitoring of these species is warranted.

Table 1. Summary of the ecosystems and impacts of the fire.

The total area burnt, the area burnt within four relative fire severity classes (percentage of the total in parentheses) and area of the potential ecological impact for of each natural value.

Natural value descriptor	Total area burnt (ha)	Relative fire severity (ha) with percentage of total in parentheses	Potential Ecological Impact for burnt area (ha)
Rainforests: • Includes draft Natural Key Value (NKV) – Rainforest (RE 12.12.13, 12.12.16; BVG 2). • Fire sensitive ecosystems. • Known or likely habitat for a suite of threatened flora and fauna species including three flora and one fauna species known only from Bulburin NP.	2116	Low: 929 (44) Moderate: 925 (44) High: 249 (12) Extreme: 13 (0.6)	Limited or none: 0 Moderate: 929 High: 925 Catastrophic: 262
Wet eucalypt open forests: • A draft NKV (RE 12.12.4 & 12.12.6; BVG 8) • Ecosystems with a fire-adapted canopy; understorey varies from fire-adapted to fire-sensitive. • Known or likely habitat for a suite of threatened flora and fauna species including one fauna species known only from Bulburin NP.	915	Low: 422 (46) Moderate: 381 (42) High: 107 (12) Extreme: 5 (0.5)	Limited or none: 422 Moderate: 381 High: 107 Catastrophic: 5
Eucalypt woodlands to open forests: • Includes draft NKV – *Corymbia citriodora, E. crebra* woodland (RE 12.12.5; BVG 10) & E. tereticornis woodland on alluvium (RE 12.12.3; BVG 10). • Fire-adapted ecosystems. • Known or likely habitat for a suite of threatened flora and fauna species.	4488	Low: 2045 (46) Moderate: 2034 (45) High: 385 (9) Extreme: 24 (0.5)	Limited or none: 4079 Moderate: 385 High: 4 Catastrophic: 0
Stream fringing: • RE 12.3.7 • Ecosystem includes both fire-adapted, and highly fire-sensitive, species. • Known or likely habitat for several threatened fauna species.	12	Low: 8 (67) Moderate: 4 (33) High: 0 Extreme: 0	Limited or none: 0 Moderate: 8 High: 4 Catastrophic: 0

2 Introduction and purpose of this report

This report is a rapid assessment of the known and likely impacts to the natural values of a protected area 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 and ecological severity of the fire, 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 bushfires within Bulburin NP (Figs 1 and 4) in the Southeast Queensland Bioregion that burned over the period from late November 2019 to early February 2020. Landscape features and place names used in this report are as per 1:25 000 scale topographic mapping available online at QTopo: https://qtopo.information.qld.gov.au/.

3 Background

Bulburin NP (34,355ha) is approximately 120km south of Gladstone and 40km south-west of Miriam Vale and lies towards the northern extent of the South East Queensland Bioregion. The terrain is generally mountainous with an altitudinal range of 110m, in the Granite Creek Valley, to 720m, on the Dawes Range. The park contains the head-waters of the Boyne River, Baffle Creek and Kolan River. It became a national park in 2006 as part of the South East Queensland Forests Agreement. Prior to this, the area was logged for hardwood and softwood species, in particular *Araucaria cunninghamii* (hoop pine) with the declaration of an un-numbered reserve for timber purposes in 1901 (Department of Primary Industries 1994, Department of National Parks, Recreation, Sport and Racing NPRSR, 2013a). Evidence of the forestry industry is common and widespread in the park and includes old snigging tracks, ramps and clearings and associated weeds – in particular *Lantana camara* (lantana), and relatively low abundance, particularly of large individuals, of some target species such as *Araucaria cunninghamii* (hoop pine) and white beech *Gmelina leichhardtii* (white beech). Old maps and satellite imagery reveal the extent of the network of roads and tracks throughout Bulburin during the forestry era (pers. obs. author PH).

3.1 Landscape overview of the fire and timeframe

3.1.1 Overview

Two separate bushfires occurred in Bulburin National Park in 2019/2020 and are referred to in this report as the southern and northern fires (Figs 1 and 4).

The southern fire commenced on freehold land east of Bulburin NP on 25 November 2019. QPWS crews attended on 26 November. Attempts at containment off-park were unsuccessful and the fire entered the park on 27 November. The objective was to contain the fire within the first few days and prevent it entering *Macadamia jansenii* (Endangered) habitat, prior to an expected deterioration in weather. It was hoped that a combination of dozed fire-lines, backburning and rainforest would achieve the objective. Rainforest was expected, based on considerable past experience, to largely exclude and so contain fire and for the first few days that appeared to be the case. However, the prolonged, extremely dry conditions leading up to, and during, the fire resulted in rainforest burning, together with wet and dry sclerophyll communities. Rainforest was, however, noted to slow the spread of the fire. Spot-overs into inaccessible terrain exacerbated the situation. Fire crossed the Dawes Range Road on 8 December. Despite fairly widespread and heavy rain on 26 and 27 December and light rain on 31 December the fire continued to burn on-park and it entered freehold property to the south-west on 5 January 2020. Small falls of rain occurred around 13-14 January but were patchily distributed and the fire was reported on 29 January as still active in south-east and south-west parts of the park. Substantial rain finally fell in early February and on 3 February there were no signs of active fire. The fire was declared out on 6 February 2020.

The northern fire started on Bulburin NP on 9 December 2019, as a result of lightning strike. It burned almost entirely within eucalypt woodland. Backburning operations were successful and the fire was contained by 16 December 2019.

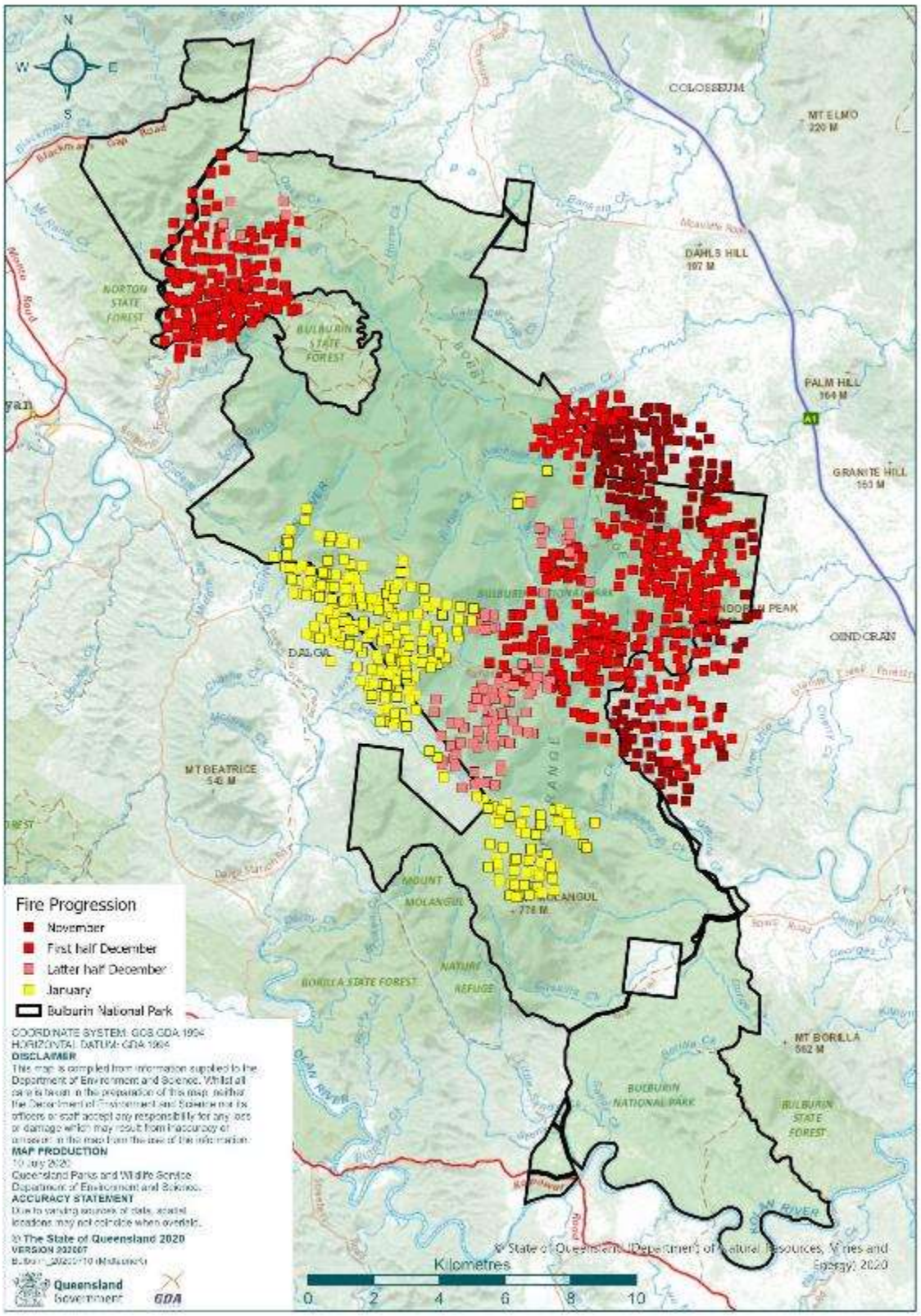

Figure 1. The progression of the Bulburin bushfires across the landscape from November 2019 to January 2020 is based on VIIR hotspots FIRMS (2020). Note VIIR pixel size is 375m, and hotspots can be missed due to low intensity fire, cloud cover or incomplete satellite passes. This map therefore provides a coarse overview of the fire's progression. The Bulburin NP boundary is shown in black.

3.1.2 Observations of fire behaviour by local QPWS staff

Southern fire

- The fire started on freehold land east of Bulburin NP as a result of machinery operations.
- QFES Gladstone had responsibility for control, with QPWS in supporting roles both in the Incident Control Team and in on-ground operations.
- Key objective identified early in the fire suppression process was to exclude fire from the threatened macadamia sites around Granite Creek.
- While fire entered the park on 27 November it did not threaten any key values and moved straight back out onto freehold land.
- Containment strategy using vine thicket (rainforest) on the western edge was largely successful until 2 December when fire began spreading through rainforest.
- Backburn operations were undertaken to contain fire on Granite Creek Road and Bobby Range Road.
- On 5 December, fire jumped Granite Creek Road – this was first time the fire actually significantly entered Bulburin NP and posed a significant threat to values within.
- Three of four original wooden bridges on the track adjacent to Granite Creek were destroyed in the fire.
- From this point on, containment options within the park were very limited. Crews continued to work to secure fire where possible but with limited existing containment lines, steep topography and conditions that allowed fire to spread unmitigated through the rainforest.
- Fire burned in rainforest during the night as well as day.
- When the northern fire ignited, resources were redeployed leaving limited resources to contain the southern fire.
- At this point control objectives were broadened to consider control lines off-park on freehold land that were more manageable in the prevailing conditions. Crews worked with neighbours to establish these control lines.
- Backburn operations were undertaken on 10-14 January to contain fire along northern edge.
- After this time rains commenced which eventually controlled the spread of fire.
- Fire was declared out on 6 February 2020.

Northern fire

- Fire commenced from lightning strike in the park on 9 December.
- Existing resources were redeployed to contain this fire on-park.
- Existing tracks were re-established and used for containment.
- Fire was contained on 16 December.

Note that no significant fencing was destroyed in the fires.

3.2 Weather

The Bureau of Meteorology undertook detailed analyses of the fire weather affecting north-east New South Wales (NSW) and south-east Queensland (Qld) during early September 2019 (BOM 2019a), and issued further statements regarding dangerous bushfire weather during spring (BOM 2019b) and extreme heat and fire weather in December 2019 and January 2020 (BOM 2020). Key climate and weather factors, for the Bulburin area, from these reports include:

- Rainfall for January to August 2019 was very much below average and below average for spring.
- The year-to-date mean maximum temperature to the end of spring 2019 was highest on record.
- Maximum temperatures in December were the highest on record and minima were above average.
- Daytime temperatures were very much above average for spring.
- Rockhampton, Gayndah and Bundaberg had monthly mean maximum temperatures that were the highest on record for December.
- Very much above average accumulated Forest Fire Danger Index (FFDI) values during winter and the highest on record in December.
- For Queensland, December 2019 continued a run of three consecutive months of highest FFDI on record.
- Modelled root-zone soil moisture was below average to driest on record for the first week of September over much of south-east Queensland.
- From 6 September, high temperatures, low humidity and strong winds, coupled with the dry conditions led to elevated fire danger across southeast Queensland.

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 Bulburin area of south-east Queensland is provided in Figures 2 and 3: annual averaged FFDI, and the number of severe FFDI days per year (i.e. FFDI greater than 50), respectively. These figures show much higher than average FFDI for the region in 2019 compared to the historical data (data provided by A. Dowdy, Bureau of Meteorology, August 2020).

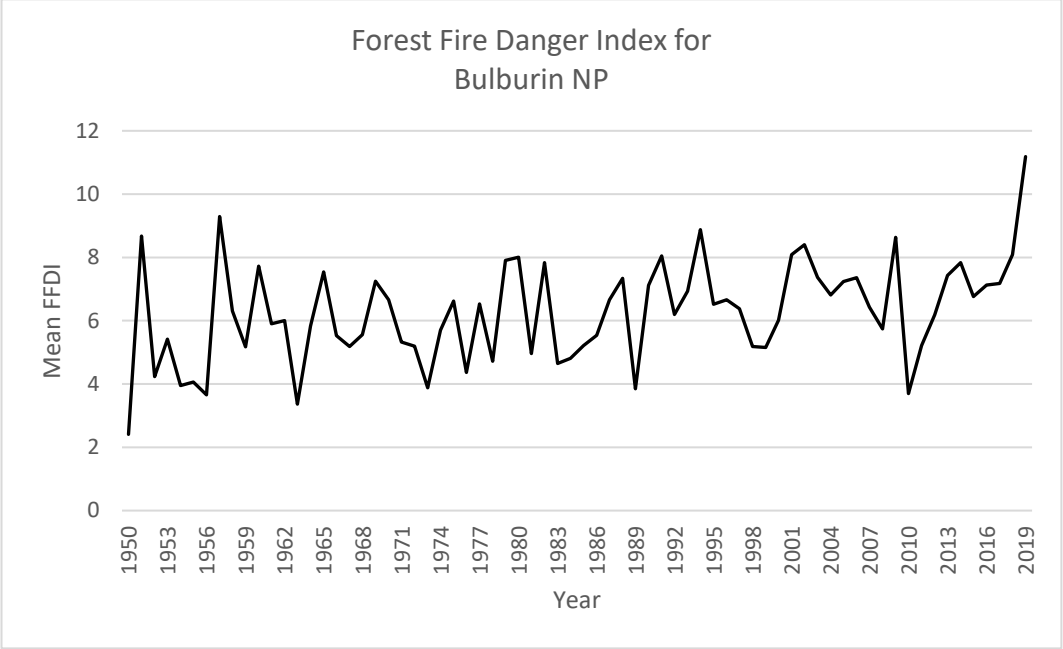

Figure 2. Time series of annual averaged Forest Fire Danger Index for Bulburin National Park region, south-east Queensland.

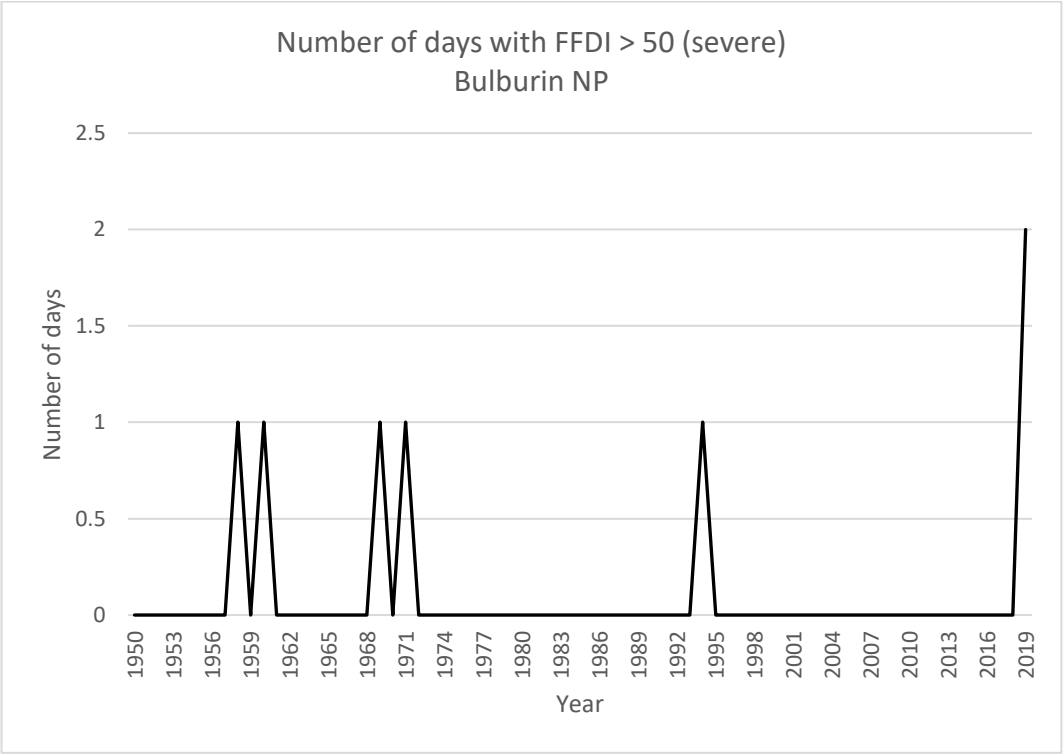

Figure 3. Time series of the number of severe Forest Fire Danger Index days per year, for Bulburin National park, south-east Queensland.

3.3 Suppression methods used on estate

A range of suppression methods was used on QPWS estate during the event. Brief details are provided here.

- Aerial water bombing support using planes and helicopter (direct attack to slow progress of the fire). Water was sourced from Lake Monduran, Baffle Creek and the Tannum water treatment facility.
  There was a request by QFES to use BlazeTamer380® fire suppressant but it was denied.
- Water, for on-ground fire-fighting, was obtained from an old forestry dam and brought in by tankers, including two council tankers. Collar dams were also set up around the fire ground. No water was sourced from creeks in the Park for fire-fighting purposes.
- Fire-fighting foams were used in mop-up operations but not in environmentally sensitive areas.
- Back-burning on-park was conducted along various fire-lines in a range of forest types. Back-burning was undertaken north of the fire on 11 January, along sections of Bobby and Dawes Range Roads and Scott Road (4WD Loop Road) that are within large tracts of rainforest. These back-burns penetrated approximately 30-40m through rainforest in upslope situations (refer section 6.3.1).
- A dozer was used to construct new fire-lines, widen current lines, push over hazardous trees and re-open old forestry tracks within Bulburin NP. Additional details for the two fires are provided below and shown on maps provided in Appendix 8.

Southern fire:

- Approximately 400m of new fire-line was constructed on the northeast side to tie into a rock scree (fire-line 1 on Map 1 in Appendix 8).
- Approximately 3km of existing, but overgrown, track was reopened (fire-lines 2 and 3 on Map 1, Appendix 8) in an attempt to prevent the fire progressing north into the large area of park between Dawes Range Road and Bobby Range Road.
- Fire-lines 1, 2 and 3 have subsequently been closed by using excavators to spread the pushed forest material across them.
- A section of Bobby Range Road (shown in green on Map 1, Appendix 8) was very dangerous for fire crews because of very large burning trees falling across the fire-line. A bulldozer was used during the fire to push over large burning trees, and other large trees likely to catch fire, on this fire-line. The track was not widened.
- Sections of Dawes Range Road, Bobby Range Road and Scott Road (4WD Loop Road) were dozed and graded but not widened.
- Dawes-Dalga fire-line (existing and in reasonable condition) (shown on Map 1, Appendix 8 as Dalga Track) was dozed in preparation for back-burning and dozed again after the event. A new cutting was put in.

Northern fire:

- Existing, partially overgrown tracks were re-opened with dozers; a boundary lighting strategy was used to contain the fire.

4 Assessment methods

4.1 Fire extent and severity mapping

Spatial data was supplied by Department of Environment and Science, Queensland Fire and Emergency Services, 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 Queensland Fire and Emergency Services. 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 (16/11/2019 and 2/2/2020, respectively) covering the extent of the fire. Images had a resolution of approximately 20m. A Normalised Burn Ratio (NBR) classification was developed for both the pre-fire and post-fire images (Brewer *et al.* 2005, Miller and Thode 2007), using Sentinel-2 bands 8 (b8) and 12 (b12) according to the following formula:

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

A NBR difference product (dNBR = Pre fire NBR - Post fire NBR) was derived and divided into five relative fire severity classes (Extreme, High, Moderate, Low and Unburnt) (Table 2). These classes were informed by ground-based field assessment using the severity class descriptions to determine the severity at each site. The maximum dNBR value for each severity class was then adjusted so that it matched the majority of field assessment sites (Table 2). Appendix 1 contains photographs of burnt sites from within the assessment area.

Cloud cover in post-fire imagery complicated the analysis of extent and severity. Approximately 16% of the total area identified as being burnt was obscured by cloud and approximately 28% of the total area of rainforest identified as being burnt was obscured by cloud. Nevertheless, the dNBR analysis created a consistent and generally reliable classified product reflecting relative damage to the forest canopy and subcanopy.

The relative fire severity classification must be treated as an approximation as the analysis was rapid in nature and verification limited, so users need to be aware of potential limitations. 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 observation). It shouldn't be confused with fire intensity, which in its simplest definition is the energy output of a fire (which is influenced by a range of variables including amount of fuel, fuel configuration, fuel dryness, prevailing weather, slope, residence time). Thus, a low intensity fire in some vegetation communities (e.g. grasslands) can result in high fire severity (complete removal of standing vegetation) but a fire of the same intensity in an open forest can result in low fire severity (complete removal of the grassy understorey, with no scorching or consumption of shrub or canopy layers).

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

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

Severity class	Relative fire severity class description	Maximum dNBR value
Unburnt	Unburnt, canopy and subcanopy unchanged (within the mapped extent).	0.07
Low	Canopy and subcanopy unscorched, shrubs may be scorched, fire-sensitive low shrubs may be killed.	0.20
Moderate	Partial canopy scorch, subcanopy partially or completely scorched, and/or fire-sensitive tall shrub or small tree layer mostly killed.	0.40
High	Full canopy scorch to partial canopy consumption, subcanopy fully scorched or consumed.	0.60
Extreme	Full canopy, subcanopy and understorey consumption.	1.50

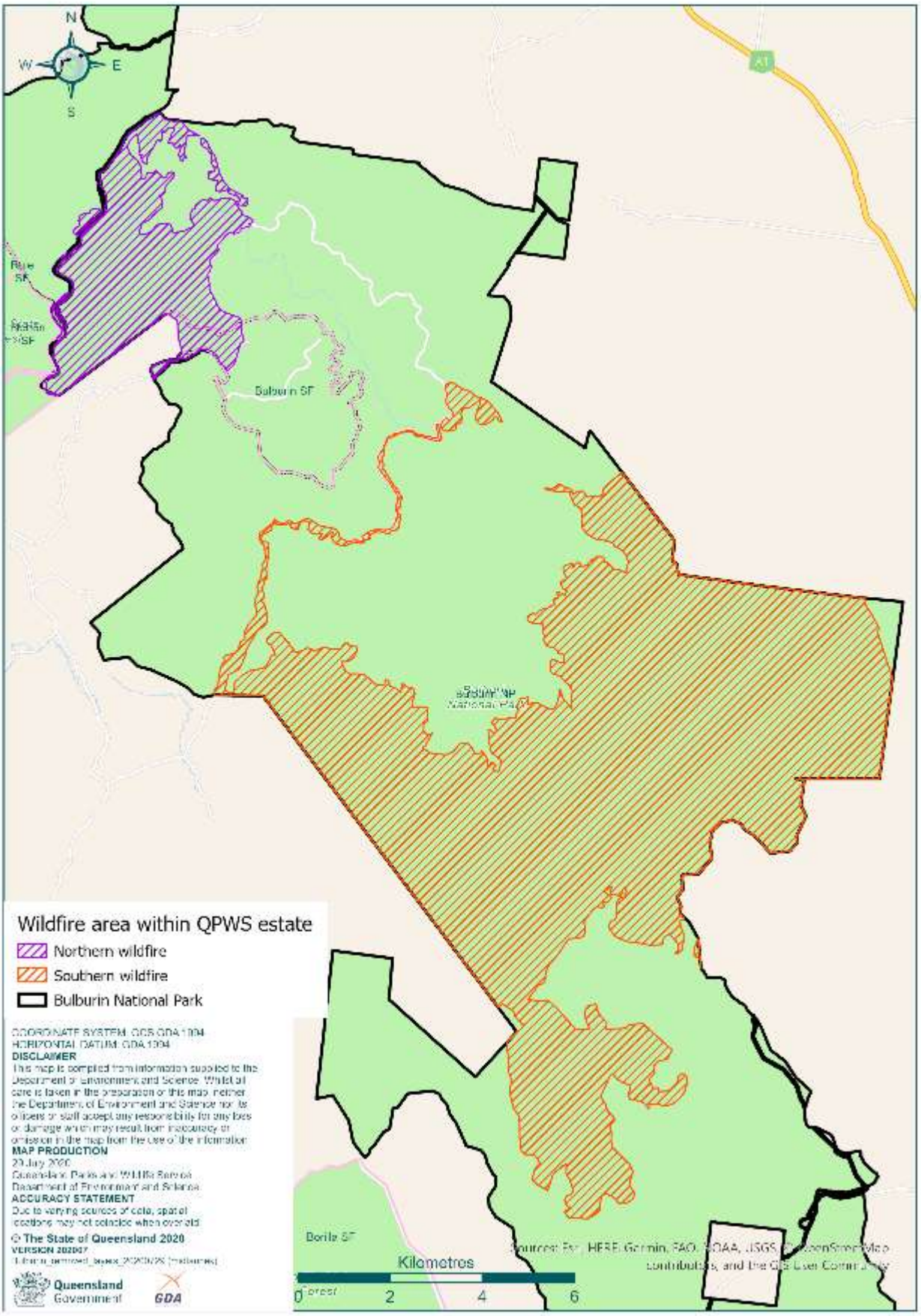

Figure 4. Extent of the northern and southern bushfires within Bulburin NP. The NP boundary shown as black; protected areas and state forests shaded light green; estimated fire extent within Bulburin NP shown as purple (northern bushfire) and orange cross-hatch (southern bushfire).

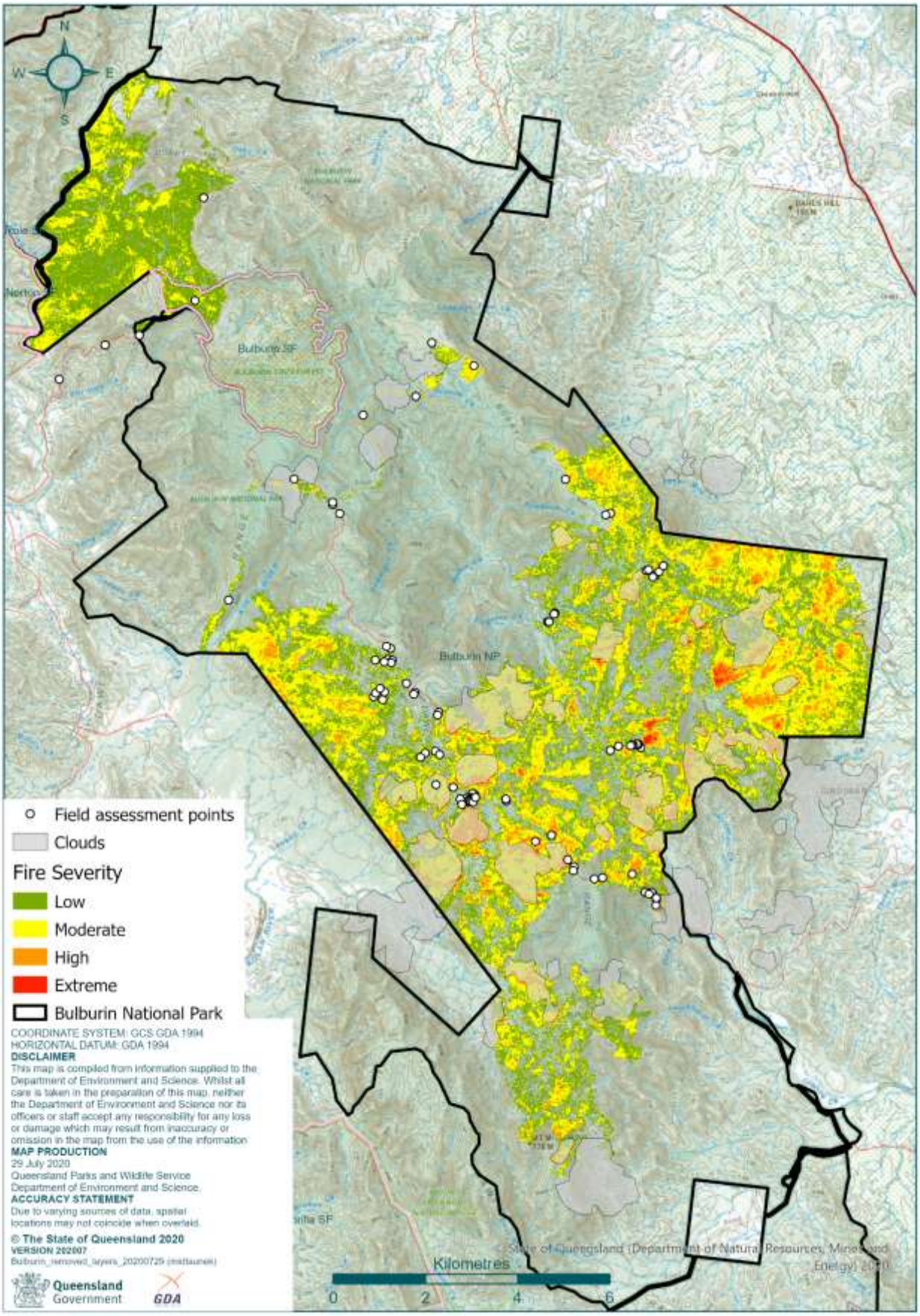

Figure 5. Relative fire severity of the bushfires within Bulburin NP. White circles show the location of verification sites. Base map: QTopo.

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; 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 homogeneous (pure) polygons. Consequently, mapped RE polygons are often heterogeneous, such that a polygon is attributed more than one regional ecosystem code (e.g. 12.12.5/12.12.12), 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. Narrow bands of notophyll vineforest with feather palms are therefore not captured in the RE mapping for Bulburin.

REs are grouped into higher-level vegetation communities referred to as Broad Vegetation Groups (BVGs) (Neldner *et al.* 2019b) and summaries, at the 1:2 000 000 and 1:5 000 000 scales, are provided.

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 derived from the state's wildlife information system WildNet (accessed 6/7/2020), 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 latitudes of -24.454 and -24.681 and longitudes 151.404 and 151.622, capturing both the northern and southern fire areas but not the entire park (Appendix 4). Limited spatial validation of these records was undertaken; some records were rejected due to likely taxonomic errors or because they were unconfirmed and likely to be vagrant or their known habitat is not present in Bulburin.
Spatial datasets on significant species are inherently limited and biased to accessible locations, so we also summarised the area of modelled potential habitat 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 dependence upon fire-sensitive ecosystems.

Species nomenclature, taxonomy and statuses used in this report follow WildNet.

4.4 Field assessment

Field assessment of ecological impacts and limited verification of fire extent and severity mapping was conducted on foot and by vehicle over the period 26-30 May 2020. Field assessments were delayed because of COVID-19 restrictions. Verification sites are shown as white circles on Figure 5. No aerial inspections were undertaken.

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 through the Spatial Information Resource (SIR) (administered by Department of Natural Resources and Mines).

This report is available in WildNet Multimedia, Media ID = 27901, and is searchable using the keywords: fire, severity, ecological, natural values, assessment, Bulburin or via the link:
http://wildnet/wildnet/bin/WNE0130$VMEDIAQRY.QueryView?P_MEDIA_ID=27901

5 Summary of areas burnt

Basic fire details and a summary of areas burnt is provided in Table 3. Statistics were derived using ArcGIS pro and the sources identified in the table. A summary of the area 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(s)	13276525	FlAME Label: Bulburin National Park/NP/W/2019/001
FLAME Fire name(s) (FLAME)	Bulburin NP	
Fire start date	25/11/2019	FLAME
Fire started on or off-estate	Off estate	FLAME/ FIRMS hotspots (Fig. 1).
Date fire first recorded on estate	27/11/2019	FLAME
Date fire declared contained	14/01/2020	FLAME
Total area burnt (on and off estate)	13 938ha	FLAME extent mapping
Bioregion(s)	South East Queensland	
Estate name(s) burnt	Bulburin NP	FLAME
QPWS Region(s)	South East Queensland	
Area burnt within QPWS estate	7541ha	This report (Table 4, Appendix 2, 3), based on relative fire severity mapping.
Area burnt within World Heritage Area	0ha	
Area burnt within Ramsar areas	0ha	Name of Ramsar area: N/A
Directory of Important Wetlands of Australia within burn extent	Granite Creek	Directory of Important Wetlands in Australia
Area burnt of habitat of state Biodiversity Significance (BAMM) (on and off estate)	5485ha	This report, based on relative fire severity mapping.
Area of core koala habitat (SEQ Koala Conservation Strategy 2019-2024) burnt	Not applicable	

Table 4. Area burnt (ha) by relative fire severity class within Bulburin National Park.

Note: totals include non-remnant vegetation (412ha in total on the park of which 8ha burnt)

Severity class	Bulburin NP	BAMM State Biodiversity Significance	Directory of Important Wetlands
Low	3406.61	2204.06	212.26
Moderate	3348.82	1775.92	189.74
High	743.75	369.31	59.14
Extreme	41.57	18.60	4.40
Total	**7540.75**	**4367.90**	**465.53**

5.1 Vegetation burnt

Summaries of the area of Regional Ecosystems and Broad Vegetation Groups within Bulburin National Park 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

Regional Ecosystems were classified into four broad groups based on their fire tolerance {guidance drawn from NPRSR (2013b), Regional Ecosystem Description Database (Qld Herbarium 2019) and expert knowledge}:

- Rainforest – fire-sensitive canopy and understorey,
- Wet eucalypt open forest (OF) – fire-adapted canopy and fire-adapted to fire-sensitive understorey,
- Eucalypt woodland (W) to open forest – fire-adapted canopy and understorey, or
- Stream fringing (Fringing) – the community (RE 12.3.7) includes both fire-adapted species (e.g. *Eucalyptus tereticornis*) and highly fire-sensitive species (e.g. *Casuarina cunninghamiana*).

The area, of each of the four broad groups, subjected to low, moderate, high or extreme relative fire severity, is shown in Table 5. Burnt areas were assigned to four Potential Ecological Impact classes based on the matrix 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 (refer Appendix 7), that could significantly impede recovery.

The concept of Potential Ecological Impact was developed to help highlight ecosystems and areas that have been most impacted, and/or may require increased resources (e.g. pest management), or changed management approaches (e.g. modification to planned burn program) to facilitate recovery, and conversely to indicate those that require little or no additional management intervention. It is not an exact science! A brief overview of 'characteristics' of the Potential Ecological Impact classes is provided in Box 1.

A summary of the Potential Ecological Impact is provided in Table 6, is mapped in Figure 6, and discussed in section 6.0.

Table 5. Area (ha) of burnt remnant vegetation (based on RE1) classified by broad fire tolerance and relative fire severity class.

Note: the shading denotes Potential Ecological Impact class as per Table 6.
The percentage of the total burnt area of each ecosystem type, within a relative fire severity class, is given in parentheses.

Relative Fire Severity Class		Rainforest Fire-sensitive canopy & understorey	Wet eucalypt OF Fire adapted canopy & fire-adapted to fire-sensitive understorey	Eucalypt W–OF Fire-adapted canopy & understorey	Fringing Fire-adapted with some highly fire-sensitive elements
Low	Canopy and subcanopy unscorched, shrubs may be scorched, fire-sensitive low shrubs may be killed.	**929 (44)**	**422 (46)**	**2045 (46)**	**8 (67)**
Moderate	Partial canopy scorch, subcanopy partially or completely scorched, and/or fire-sensitive tall shrub or small tree layer mostly killed.	**925 (44)**	**381 (42)**	**2034 (45)**	**4 (33)**
High	Full canopy scorch to partial canopy consumption, subcanopy fully scorched or consumed.	**249 (12)**	**107 (12)**	**385 (9)**	**0**
Extreme	Full canopy, subcanopy and understorey consumption.	**13 (0.6)**	**5 (0.5)**	**24 (0.5)**	**0**
	Total burnt	**2116**	**915**	**4488**	**12**

Table 6. Potential Ecological Impact (ha) to burnt remnant vegetation (RE1 only) based on fire tolerance and relative fire severity class.

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.

	Rainforest	Wet eucalypt OF	Eucalypt W–OF	Fringing
Potential Ecological Impact Class	Fire-sensitive canopy & understorey	Fire adapted canopy & fire-adapted to fire-sensitive understorey	Fire-adapted canopy & understorey	Fire-adapted with some highly fire-sensitive elements
Limited or none		**422**	**4079**	
Moderate	**929**	**381**	**385**	**8**
High	**925**	**107**	**24**	**4**
Catastrophic	**262**	**5**		

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. For shade tolerant species the loss of canopy cover can exclude them from a site until significant canopy closure is achieved. 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; and loss of epiphytes and niches suitable for their re-establishment at least in the mid-term. It is recognised that occasional high intensity fire in wet eucalypt open forests is likely critical to the ecology of the ecosystem in terms of providing opportunity for eucalypt regeneration in sites where rainforest dominates the understorey and may assist, in conjunction with a planned burn program, in maintaining a grassy to mixed shrubby understorey in others. The risk of invasion by ecosystem-changing weeds is likely to be high, and may be exacerbated by past disturbance regimes.

Catastrophic Potential Ecological Impact (red):

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

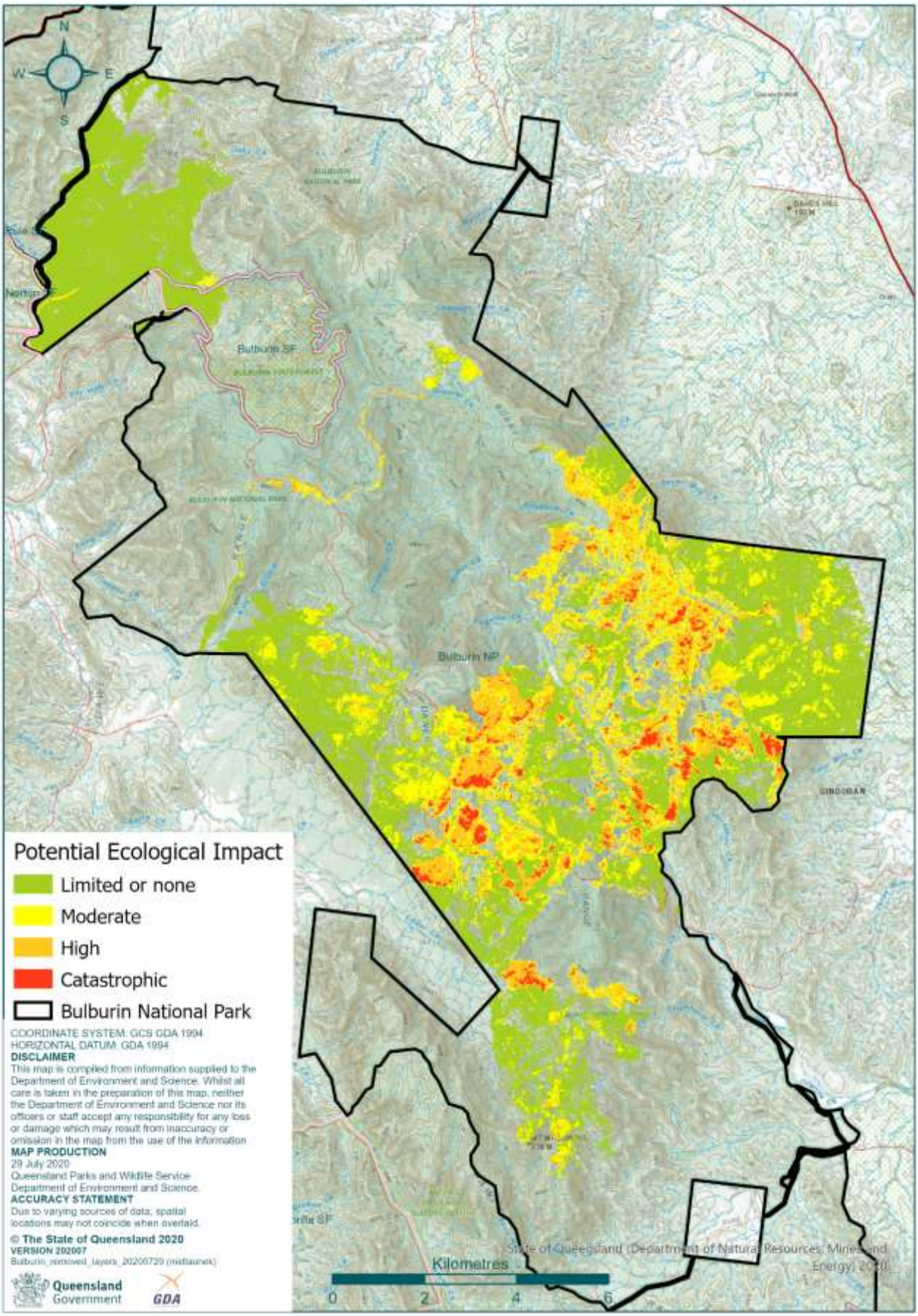

Figure 6. Map of potential ecological impact within Bulburin National Park

5.2 Conservation significant species potentially impacted

The list of 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 modelled Queensland potential habitat for selected conservation significant species within each relative fire severity class.

There are eight threatened species (two fauna, six flora) for which a substantial proportion (≥15%) of their modelled potential habitat occurs in Bulburin (refer Appendix 5). Of these species, five had a substantial (≥15%) proportion of their modelled habitat in Bulburin burnt in the bushfire event. Summary details are provided for these five species in Table 7 and maps, showing the modelled potential habitat and relative fire severity, are provided in Appendix 6.

With the exception of *Antechinus argentus* (silver-headed antechinus) these species are currently known only from Bulburin NP.

Potential impacts on threatened species, in particular the five listed in Table 7, are discussed in section 6.3.

Table 7. Threatened species with a substantial proportion of modelled potential habitat burnt.

Scientific name	Common name	Status		Potential Habitat (PH)			
		NCA	EPBC	Total PH in Bulburin (ha)	% Qld PH in Bulburin	Total PH burnt in Bulburin (ha)	% Bulburin PH burnt
Antechinus argentus	silver-headed antechinus	E	E	2832	17	929	33
Phyllurus caudiannulatus	ringed thin-tailed gecko	V		7251	84	2045	28
Macadamia jansenii		E	E	574	86	87	15
Medicosma elliptica		V	V	6424	73	1398	22
Phyllanthus sp. Bulburin		V		6510	69	1261	19

5.3 Area of Natural Key Values burnt

Natural Key Values (NKV) have not yet been formalised for Bulburin NP under the Values Based Management Framework (DES 2020). Information from the preliminary Values Assessment has been used here. Figure 7 shows the location of potential NKVs with respect to the extent of the 2019/20 bushfires. The area burnt for each NKV by relative severity class is summarised in Table 8. The Regional Ecosystem/s comprising each potential NKV, and the Broad Vegetation Group (BVG) to which they align, is shown in Table 8 in parentheses. Note that it is unlikely that all of a Regional Ecosystem will be selected in its entirety as a NKV in the final version of the Values Assessment.

Table 8. Area of draft Natural Key Values (NKV) burnt (ha) in Bulburin NP, by relative fire severity class.

Draft Natural Key Value	Area of NKV within estate (ha)	Percentage NKV burnt	Relative fire severity (ha)			
			Low	Moderate	High	Extreme
Rainforest (RE 12.12.13 & 12.12.16; BVG 2)	9257	23	923	907	238	13
Wet eucalypt open forest (RE 12.12.4 & 12.12.6; BVG 8)	3346	25	422	381	107	5
***Corymbia citriodora, Eucalyptus crebra* woodland** (RE 12.12.5; BVG 10)	16680	22	1708	1653	317	21
***Eucalyptus tereticornis* woodland on alluvium** (RE 12.3.3; BVG 16c)	572	35	81	100	16	1
Total	29856		3134	3041	679	40

*Under the Values Based Management Framework, a NKV for a protected area may include all or part of a BVG mapped within that protected area. Refer to Appendix 3 for a description of the BVG and a summary of the area burnt within each relative severity class for Bulburin NP.

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 9 together with basic details and the priority (high to low or not a priority) for re-sampling the sites/plots to better inform an assessment of the impact of fire on natural values and subsequent recovery. Some of the *Macadamia jansenii* sites were impacted by the fire (refer section 6.3.1).

Table 9. 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
Macadamia jansenii sites	Long term quantitative sites	Granite and Pine Creeks	Dr Alison Shapcott, Queensland Herbarium	High
Antechinus argentus (silver-headed antechinus)	Medium term quantitative sites; sampled May 2017, 2019 & 2020	Dawes Range Road & Bobby Range Road	Ian Gynther & Harry Hines, QPWS&P	High

Detailed *Macadamia jansenii* population demographic surveys were undertaken by Glenn Hayward (Honours student, University of Sunshine Coast USC) in 2019, prior to the fire. The populations will be re-surveyed in July 2020.

There are 29 Corveg sites (Queensland Herbarium) in Bulburin NP (Fig. 8). Some of the sites provide opportunity for long-term monitoring.

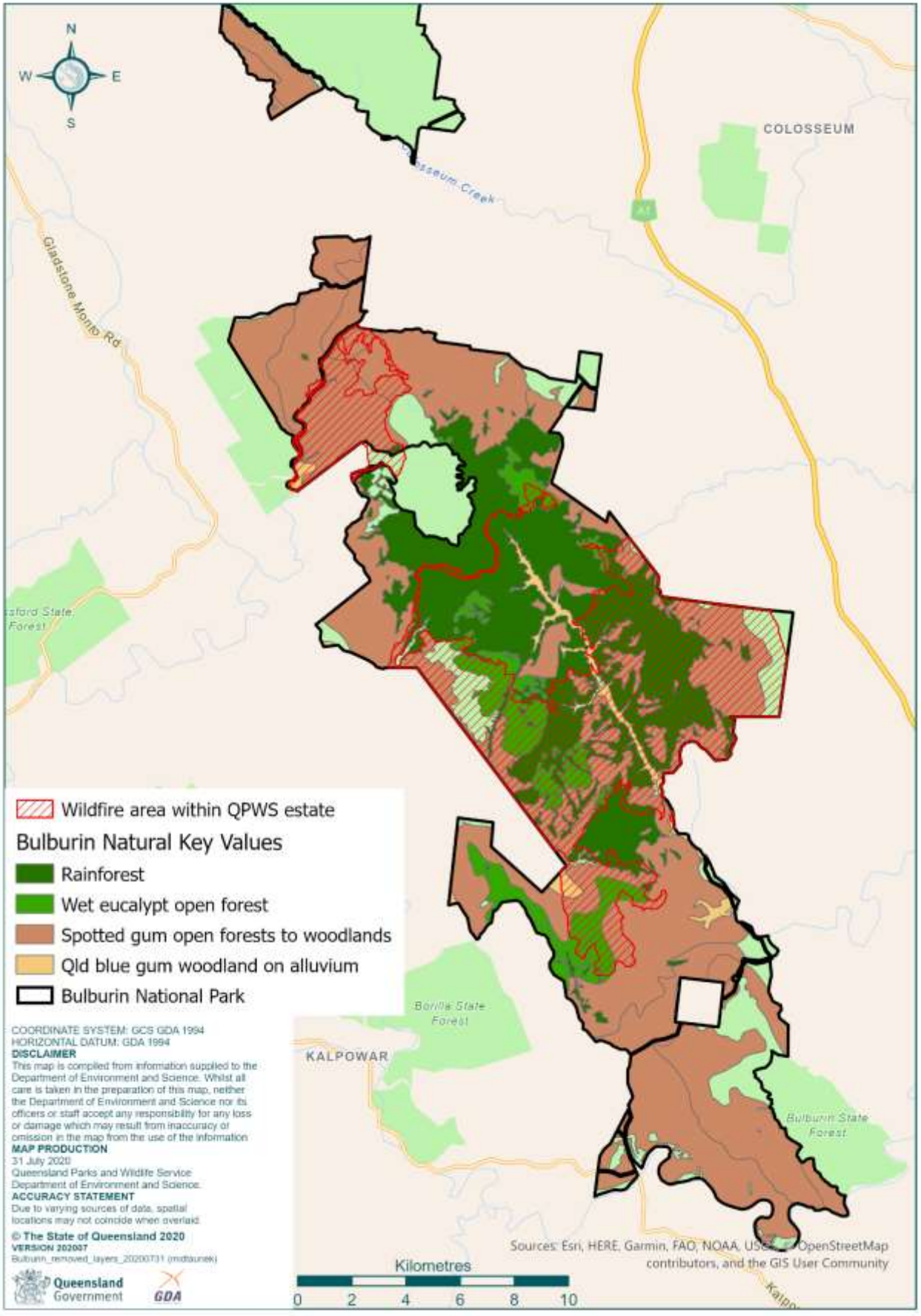

Figure 7. Estimated extent of the bushfires within Natural Key Values of Bulburin National Park.

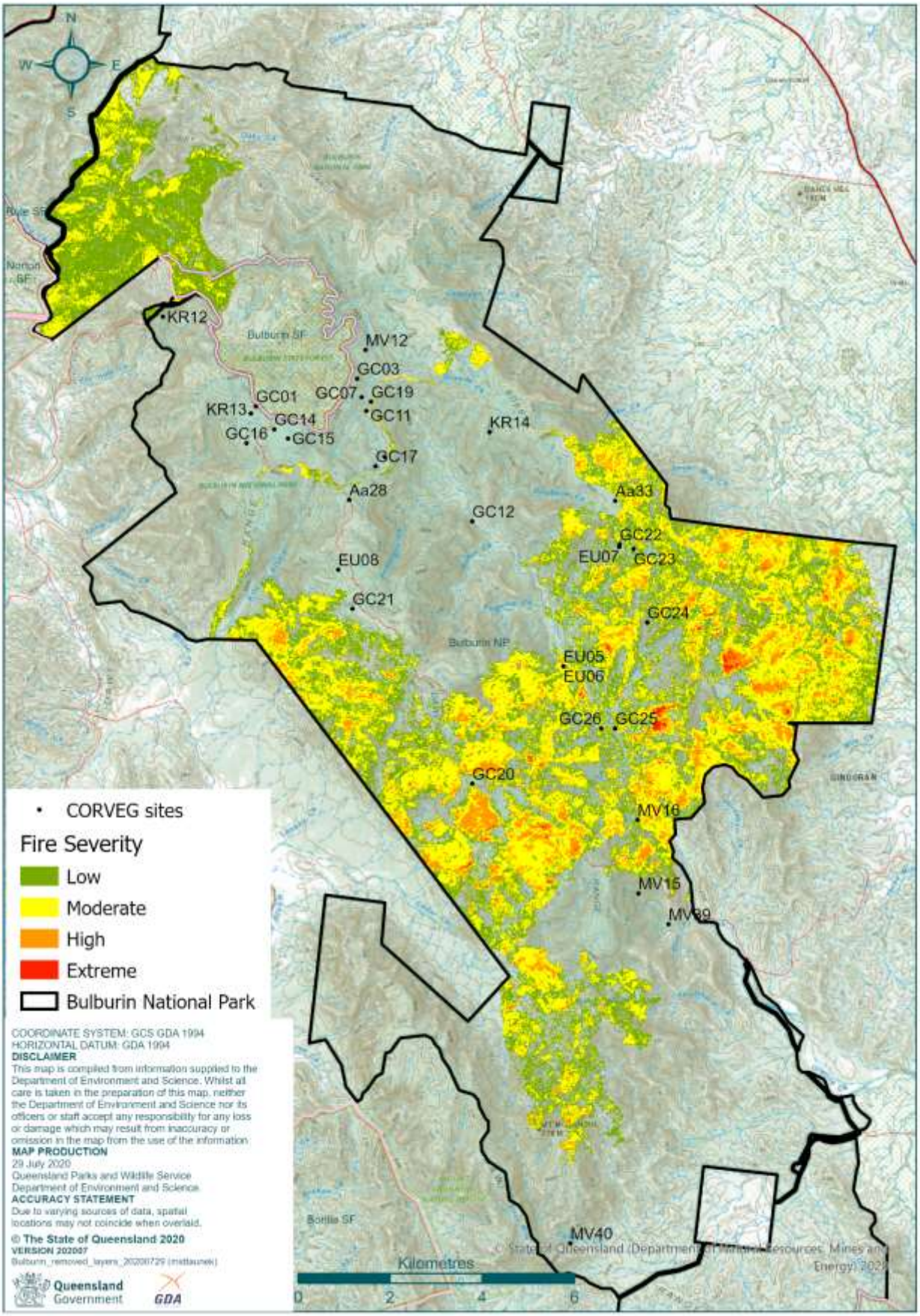

Figure 8. Map of Queensland Herbarium Corveg sites in Bulburin National Park.

6 Significant impacts and recovery actions

6.1 Summary of priority impacts and recovery actions

Ecosystems/habitats have been classified into four broad groups based on fire tolerance:

- **Rainforest** (RE 12.12.16 and 12.12.13 in BVG 2; RE 12.3.16 and 12.3.17 in BVG 4)
- **Wet eucalypt open forest** (RE 12.12.4 and 12.12.6 in BVG 8)
- **Eucalypt woodland to open forest** (RE 12.12.12 and 12.12.23 in BVG 9, RE 12.12.5 and 12.12.6 in BVG 10, RE 12.12.7 in BVG 13, RE 12.3.3 in BVG 16c)
- **Stream-fringing** – *Eucalyptus tereticornis, Casuarina cunninghamiana* ± *Melaleuca* spp. woodland (RE 12.3.7 in BVG 16a)

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** – Approximately one quarter of the total area of rainforest on Bulburin NP was impacted by the fire resulting in moderate to catastrophic Potential Ecological Impact due to the sensitivity of the ecosystems to fire and hence 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. The control of ecosystem-changing weeds and review of fire management planning for surrounding fire-adapted ecosystems – with the aim of minimising risk of future fire incursion into recovering rainforest (and unburnt rainforest), are the highest priority actions. Cat and pig control are recommended to minimise impact on threatened species and their habitat. Monitoring is warranted for some threatened plant and animal species.

- **Wet eucalypt open forests** – Approximately one quarter of the total area of these communities in the park were burnt in the bushfire. Most burnt areas have limited to moderate Potential Ecological Impact with some areas high and a very small area likely catastrophic. The requirement for occasional high intensity fires in these ecosystems is recognised; however, given the drought conditions at the time, it is likely that significant loss of large old growth trees has occurred. The risk of invasion by ecosystem-changing weeds that have the potential to impede recovery (directly through competition and indirectly through changed future fire regimes) is a concern. The risk of weed invasion is exacerbated where the fire has substantially impacted the canopy and subcanopy. The control of ecosystem-changing weeds, and the review of strategies for weed and fire management in adjacent drier communities, are the highest priority actions. Cat and pig control is recommended to minimise impact on threatened species and their habitat. Monitoring is warranted for some threatened animal species.

- **Eucalypt woodland to open forests** – Approximately 22% of the total area of these communities in the park was burnt in the bushfire but for the majority (ca. 90%) there is expected to be limited or no Potential Ecological Impact given minimal canopy/subcanopy damage and highly fire-adapted ground stratum. There has been partial to full consumption of the canopy and subcanopy in places and this represents longer term impact with respect to faunal habitat values, some of which 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, in particular non-native high biomass grasses and the legume *Neonotonia wightii,* is the priority action.

- **Stream fringing** – These narrow communities are likely to have moderate to high Potential Ecological Impact. Given the drought conditions, leading up to and during the fire, it is likely that significant death of the highly fire-sensitive *Casuarina cunninghamiana* as well as various rainforest species such as figs will have occurred, including of large old trees. Reviewing fire management planning in adjacent fire-adapted communities, to reduce the risk of future fire encroachments into the fringing community and prioritising areas for weed control, are the priority actions.

6.2 Limitations

This report focuses on a single fire event; we recognise that the response/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 among sites and species.

In our assessment of the Potential Ecological Impact of the fire we assumed that impacts to ecosystems dominated by fire tolerant species 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.

Limited field evaluation was possible. Sites burnt with high and extreme relative fire severity were mostly inaccessible, although were viewed from various vantage points. The northern fire, which predominantly burnt eucalypt grassy open forest and woodlands was only assessed from vantage points along the 4WD Loop Track, but these observations confirmed that the fire severity mapping was accurate. Lowland eucalypt woodlands to open forests and stream fringing communities in the southern fire were not visited during the primary assessment (26-30 May 2020); however, some additional assessment was conducted by W. J. McDonald in late July 2020, in conjunction with *Macadamia jansenii* surveys undertaken by University of Sunshine Coast. His observations have informed the report.

The delay in field assessment meant that it was not always possible to attribute canopy death to drought, the immediate impacts of the fire (i.e. scorch), or subsequent death of the tree or shrub. This may have affected our field assessment of fire severity but was unlikely to unduly affect our assessment of the ecological outcome.

Regional Ecosystem mapping and Broad Vegetation Groups underpin our assessment. Some polygons mapped within Bulburin NP are heterogeneous, meaning more than one regional ecosystem occurs within the polygon, generally because the REs occur in a mosaic below the scale of mapping. Our quantitative analyses are based on RE1 (the dominant RE in a mixed polygon). The limitations of scale and heterogeneity are unlikely to grossly affect recommended post-fire management actions.

6.3 Impact assessment and recovery actions

Refer to Appendices 2 and 3 for details of the area burnt within each fire severity class by Regional Ecosystem and Broad Vegetation Group, respectively.

6.3.1 Rainforests

Potential ecological impact: mostly moderate to high but for some areas catastrophic (Table 6).

Fire severity and impact photographs are provided in Appendix 1, Plates A1.1-16.

Overview of value and impact

This value encompasses a draft Natural Key Value under the VBMF for Bulburin NP comprised of BVG 2 – complex to simple semi-deciduous to evergreen rainforest and including RE 12.12.16 (notophyll vine forest on igneous rocks) and RE 12.12.13 (Araucarian complex microphyll to notophyll vine forest on igneous rocks). The value also includes small areas of two Endangered regional ecosystems: RE 12.3.16 (complex notophyll to microphyll vine forest on alluvial plains) and RE 12.3.17 (simple notophyll fringing forest). Both of the latter are in BVG 4 (notophyll and mesophyll vine forest with feather palms on alluvia, along streamlines and in swamps).

Rainforests are highly fire-sensitive communities and the management intent is to exclude fire from them. They are self-protecting from fire under most conditions and can usually be relied upon to stop fires. Having fire burn through rainforest, including during the night, was therefore a sobering experience for long-term QPWS staff attending the 2019/20 fires.

Rainforests are a significant natural and aesthetic value for Bulburin NP and provide habitat and/or potential habitat for a suite of threatened flora and fauna species (refer Appendices 5 and 6). Impacts on these species will vary but those that live in or depend upon the forest floor (e.g. black-breasted button-quail, long-nosed potoroo, *Adelotus brevis,* plants with seedling banks) are likely to be most significantly impacted, together with plant species with no or limited capacity for resprouting.

Three threatened plant species are known only from Bulburin NP – *Macadamia jansenii, Medicosma elliptica* and *Phyllanthus* sp. Bulburin. Some *Macadamia jansenii* populations along Granite Creek have been impacted by the fire. Pine Creek, which also has populations of this species was not impacted. Preliminary assessments indicate that a reasonable proportion of burnt individuals are resprouting from the base. The impact of the fire on the other two species, and their capacity to regenerate is not known. A population of *Phyllanthus* sp. Bulburin was noted on

each of Granite and Pine Creeks in unburnt areas, and in burnt areas on Granite Creek. Those in burnt areas had been killed and showed no signs of resprouting. A population of *Medicosma elliptica* was found in unburnt notophyll vine forest on Dawes Range Road.

One threatened fauna species is endemic to Bulburin – *Phyllurus caudiannulatus* (ringed thin-tailed gecko), and a second – *Antechinus argentus* (silver-headed antechinus) is known only from Bulburin, Kroombit Tops and Blackdown Tableland NPs. The former is arboreal but is known to be active on or near the ground and shelters in buttress cavities of species such as figs, under bark and in rock piles. It has a diet of arthropods. It would be expected to be directly impacted in sites burnt with moderate to extreme relative severity at least, unless sheltering deep in rock piles or under fire resistant bark, and likely indirectly impacted in the short to mid-term as a consequence of a decline in food resources. *Antechinus argentus* (silver-headed antechinus) occurs in tall open forests, dominated by rough bark eucalypts with a grassy to ferny or shrubby understorey, as well as upland rainforests. A well-developed ground layer may be important for foraging (they consume a broad range of invertebrates), denning and refuge from predators. Hollow tree stumps, tree buttresses and fallen logs may also be important. Loss, in particular widespread loss, of the ground layer is likely to impact directly and indirectly on this species. The population is known to have survived the fire as individuals were caught at various burnt sites at Bulburin during a trapping survey conducted in May 2020 (4-6 months post-fire): within notophyll vine forest burnt with moderate relative severity, and wet eucalypt open forest burnt with low to moderate relative severity.

Approximately 2116ha of rainforest burnt, representing about one quarter of the total area of rainforest in Bulburin NP. Within burnt rainforest approximately 44% burnt at each of low (929ha) and moderate (925ha) relative severity and a further 12% (249ha) and 0.6% (13ha) at high and extreme relative severity, respectively; moderate to catastrophic Potential Ecological Impact (refer Table 6, Box 1) is likely.

During field assessments we observed that rainforests with low severity fire varied considerably in impacts. In some locations fire appears to have burnt through quickly, resulting in relatively minor impacts such as loss of the uppermost leaf litter layer and death of the ground layer through to the small tree layer. Weeds were few or absent and post-fire seedlings of species such as *Homalanthus populifolius* (bleeding heart), *Trema tomentosa* (native peach), *Toona ciliata* (red cedar) and *Mischarytera lautereriana* (corduroy tamarind), were sometimes present; in the case of corduroy tamarind seedlings, these were occasionally abundant (A1.1). Elsewhere, however, apparently low intensity fire has resulted in far more significant impacts – perhaps as a consequence of slow burning in deeper leaf litter, with widespread tree death. In these areas, some larger trees that had suffered damage (e.g. burnt bases, cracked bark) were still alive. Their survival is uncertain. Tree death in burnt rainforest has been observed elsewhere to continue for several years after fire (e.g. Nth NSW – R. Peacock pers. comm.; central Qld – House *et al*. 1998; Wet Tropics – Marrinan *et al*. 2005) as a consequence of secondary effects such as fungal infection and insect attack.

The loss of figs (A1.16) is likely to be significant with impacts to species for which they are a critical food source (e.g. fruit doves, fruit bats) as well as roosting and sheltering habitat (e.g. micro bats) as well as providing habitat for many epiphytic plants.

With subcanopy and canopy scorch (moderate relative fire severity and above) the direct impact on epiphytes is significant as these are highly sensitive to fire. Those that survive are likely to be impacted by indirect impacts such as dehydration due to increased exposure to sun and wind.

Back-burning along the Scott Road (4WD Loop Road), although impacting a relatively narrow strip (typically penetrating 30-40m in upslope burns) and burning with a relative fire severity of low to moderate, has resulted in significant and long-term damage with widespread death in the canopy and understorey (A1.6, A1.7). Some large and/or very old trees have been killed, and the community is now highly susceptible to weed invasion. Back-burning in rainforest should be a last resort and undertaken only when it is clear a fire-line will be breached, resulting in unacceptable threat to significant values.

Many rainforest species do not have a persistent seed-bank but rather seedling and sapling banks which accumulate over decades of recruitment. In burnt areas these banks of potential recruits will have been substantially reduced or lost. Soil or litter seed-stores will have been destroyed or significantly depleted. The loss of these sources of recruits will be a particularly significant issue where the mature individuals in a population have been killed. *Araucaria cunninghamii* (hoop pine) was once dominant in places along the range but has been decimated by intensive and prolonged logging (pers. obs. author WJMcD). Hoop pine typically regenerates, from seed, on the edge of rainforest communities where the light environment is favourable. Mature trees are often killed by fire but individuals were found to have survived in some burnt sites and recently germinated seedlings were found in the now open ground stratum.

A wide range of rainforest species have the capacity to resprout, predominantly from the base or rootstock, at least in some circumstances. Examples of tree species noted to be resprouting basally at some sites impacted by low to moderate relative fire severity include *Arytera dictyoneura* (Bulburin coogera, Near Threatened), *Neolitsea dealbata* (white bolly gum), *Ehretia acuminata* (koda), *Mischarytera lautereriana* (corduroy tamarind), *Mischocarpus*

pyriformis, Synoum glandulosum and *Sloanea woollsii* (yellow carrabeen). *Macadamia jansenii* and *Endiandra discolor* (domatia tree) were resprouting at all sites at which they were encountered.

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.

Regeneration of pioneer species which typically establish quickly and grow rapidly {e.g. *Homalanthus populifolius* (bleeding heart) and *Trema tomentosa* (native peach)} will assist in suppressing weeds. Prolific germination of *Acacia* spp. sometimes occurs in burnt rainforest, particularly in, or near, disturbed areas. *Acacia* may play an important role in the post-fire environment (e.g. soil protection, soil nitrogen enhancement) but can sometimes persist for many years and preclude regeneration of other species. There was no evidence of this occurring at the sites we inspected.

Some sites, particularly those closer to access tracks, had abundant weed species that will naturally decline through time as the ecosystem recovers. These include species such as *Phytolacca octandra* (inkweed), *Solanum nodiflorum* (deadly nightshade) and *Crassocephalum crepidioides* (thickhead). A proliferation of vines has occurred in many sites – these are however, dominated by native species, in particular *Calystegia marginata, Cayratia clematidea* (slender grape) and *Zehneria cunninghamii* (slender cucumber). These are likely to be important in the immediate aftermath of the fire in binding soil and providing rapid cover. They will be suppressed as the ecosystem recovers.

There were generally low numbers of ecosystem-changing species, such as *Lantana camara,* in the interior of sites. The exception were sites previously significantly impacted by forestry operations (e.g. snigging tracks) including along Granite Creek in close proximity to *Macadamia jansenii* populations. The establishment or promotion of ecosystem-changing weeds, such as non-native high biomass grasses and *Lantana camara* (refer Appendix 7), poses a serious risk to both burnt and unburnt rainforest communities at Bulburin. They are common to abundant along some roadsides (A1.15) and in other disturbed areas in the park. Shade tolerant species such as *Megathyrsus maximus* var. *pubiglumis* (green panic) and *Paspalum mandiocanum* (broad-leaved paspalum) are of particular concern. *Dolichandra unguis-cati* (cat's claw creeper) is also a threat to communities in riparian areas such as along Granite Creek. Ecosystem-changing weeds outcompete native species and greatly increase the risk of future fire incursion and fire intensity. 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. Further fires are likely to prevent the recovery of these communities.

The post-fire environment may enhance opportunity for some pest species including cats and cane toads – both 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 are likely to have contributed 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 into the communities. Cats are a significant threat to a range of ground-dwelling animals including several threatened species.

Signs of pigs were observed within burnt rainforest on the range and along Granite Creek. They pose a direct risk to some threatened flora and fauna species through consumption of individuals and propagules and destruction of habitat. They pose an indirect threat through the movement of soil and so potentially soil-borne pathogens such as chytrid fungus (*Batrachochytrium dendrobatidis*) and phytophthora (e.g. *Phytophthora cinnamomi*).

Recommended recovery actions

1. Prevent the establishment of high biomass grasses adjacent to and within the burnt rainforest communities, and implement control in the vicinity of unburnt communities, with regular herbicide treatment in the growing season. This requires an early and regular ongoing response and is the highest priority. Avoiding road widening so as to facilitate canopy cover/shading over access tracks will help suppress shade intolerant invasive species. Avoiding soil disturbance (e.g. slashing rather than routine grading providing the slasher is 'clean') will also minimise conditions suitable for weed invasion.
2. Prevent the establishment of *Lantana camara* adjacent to and within the burnt rainforest communities, and implement control in the vicinity of unburnt communities, with regular herbicide treatment in the growing season.
3. Surveillance for new weed species and incursions that may impact recovery or increase future fire risk and undertake strategic control. This requires an early and regular ongoing response. Ensure that the identification of species is certain so that natives that appear weedy (e.g. vines such as *Calystegia marginata*) are not misidentified.
4. Undertake a control program for feral cats.
5. Undertake a control program for feral pigs.

6. Review strategies for weed and fire management in adjacent fire-adapted communities with the aim being to reduce the risk of future fire encroachments into rainforests; examine options for fire-line network on strategic boundaries and neighbouring lands.
7. Undertake Health Checks (Melzer *et al*. 2019) for the rainforest communities – these will facilitate early detection of weeds and enable condition to be evaluated across the park.
8. Establish long-term vegetation monitoring plots in paired burnt and unburnt rainforest communities, using Corveg sites where possible, to evaluate the rate and direction of recovery and to fill knowledge gaps with respect to the fire response of species.
9. Monitor for increased biosecurity risk from pathogens such as myrtle rust (which favours new growth, common post-fire).
10. Remote sensing of canopy changes over longer time periods may be required to get a better understanding of the ecological impact of fire, including low intensity fire, in these rainforests.
11. Additional survey and monitoring is warranted for some threatened species, in particular – *Phyllanthus* sp. Bulburin, *Medicosma elliptica, Macadamia jansenii*, *Phyllurus caudiannulatus* and *Antechinus argentus* (silver-headed antechinus) (refer Appendix 6).

Contracting of pest animal and weed control 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. minimising non-target impacts during weed control).

6.3.2 Wet eucalypt open forests

Potential ecological impact: mostly limited to moderate, with some areas high, very small area likely catastrophic (Table 6).

Fire severity and impact photographs are provided in Appendix 1, Plates A1. 17-20.

Overview of value and impact

This value encompasses a draft Natural Key Value under the VBMF for Bulburin NP comprised of BVG 8 – wet eucalypt open forests and includes RE 12.12.4 (*Eucalyptus acmenoides* ± *Syncarpia glomulifera* woodland) and RE 12.12.6 (*Eucalyptus montivaga* open forest), the latter having a biodiversity status Of Concern.

Wet eucalypt open forests and associated rainforest/eucalypt forest ecotones are a significant value of Bulburin NP. The understorey varies from a diverse, largely fire tolerant, grassy or mixed herbaceous ground stratum and shrub layer to a fire-sensitive understorey dominated by rainforest species. Recommended intervals between planned burns are about 8-25 years in communities with a shrubby understorey and shorter where there is a grassy understorey (NPRSR 2013b, DES 2019), with an occasional high intensity fire. In many communities in Bulburin NP there is a well-developed understorey (including subcanopy) of rainforest which precludes planned burning.

About 915ha of wet eucalypt open forests burnt in Bulburin NP, which represents about 27% of these ecosystems (BVG 8) on the Park. Within burnt wet eucalypt open forests approximately 46% (422ha) burnt at low, 42% (381ha) at moderate, 12% (107ha) at high and 0.5% (5ha) at extreme relative severity, resulting in significant areas of limited and moderate, a not insignificant area of high, and very small area of catastrophic Potential Ecological Impact.

In sites where the understorey was dominated by rainforest there were similar impacts, and responses, as discussed for rainforests (refer section 6.3.1).

In sites with a largely fire tolerant understorey the regenerative response in sites burnt at low relative fire severity was substantial, with a high diversity of native species in the post-fire ground stratum, four months post-fire. However, with even moderate relative severity the impacts were substantial in some sites, with large trees burnt out and falling causing additional canopy damage. The presence of basal scars from previous fire events probably exacerbated the impact. It is likely, given the drought conditions at the time of the fire, that significant numbers of large, hollow bearing trees were destroyed in the fire.

Where these communities have a well-developed rainforest understorey they provide known or likely habitat for the same suite of threatened wildlife species as rainforests, with similar potential impacts (refer 6.3.1). They are known to provide habitat for *Antechinus argentus* (silver-headed antechinus) and *Phyllurus caudiannulatus* (ringed thin-tailed gecko) (refer 6.3.1 for details). As noted in section 6.3.1, the former species is known to have survived the fire as individuals were caught in notophyll vine forest burnt with moderate relative severity, and wet eucalypt open forest burnt with low to moderate relative severity, during a trapping survey conducted in May 2020. The eucalypt-

dominated canopy provides habitat for *Petauroides volans* (greater glider) and *Phascolarctos cinereus* (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, such as non-native high biomass grasses and *Lantana camara* (lantana) (refer Appendix 7), poses a serious risk to both burnt and unburnt wet eucalypt open forests in Bulburin NP. Ecosystem-changing weeds outcompete native species and can greatly increase the frequency and intensity of fires. They are common to abundant along some roadsides and in other disturbed areas in the park, and the bare ground and loss of canopy cover resulting from the fire provide an ideal environment for their germination and establishment. Shade tolerant species such as *Megathyrsus maximus* var. *pubiglumis* (green panic) and *Paspalum mandiocanum* (broad-leaved paspalum) are of particular concern. An increased dominance of some native grasses (e.g. *Imperata cylindrica,* blady grass) may also be undesirable due to their flammability.

The post-fire environment may enhance opportunity for some pest species including cats and cane toads – both 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 are likely to have contributed to the local decline of spotted-tail quolls. Cats are a significant threat to a range of ground dwelling animals including several threatened species.

Signs of pigs were observed on the range in the vicinity of wet eucalypt open forests. They pose a direct risk to some threatened flora and fauna species through consumption of individuals and propagules and/or destruction of habitat. They pose an indirect threat through the movement of soil and so potentially soil-borne pathogens such as chytrid fungus (*Batrachochytrium dendrobatidis*) and phytophthora (e.g. *Phytophthora cinnamomi*).

Recommended recovery actions

1. Prevent the establishment of high biomass grasses adjacent to and within the burnt wet eucalypt forests, and implement control in the vicinity of unburnt communities, with regular herbicide treatment in the growing season. This requires an early and regular ongoing response and is the highest priority. Avoiding road widening so as to facilitate canopy cover/shading over access tracks will help suppress less shade tolerant invasive species. Avoiding soil disturbance (e.g. slashing rather than routine grading) will also minimise conditions suitable for weed invasion.
2. Prevent the establishment of *Lantana camara* adjacent to and within the burnt wet eucalypt open forests, and implement control in the vicinity of unburnt communities, with regular herbicide treatment in the growing season.
3. Surveillance for new weed species and incursions that may impact recovery or increase future fire risk and undertake strategic control. This requires an early and regular ongoing response. Ensure that the identification of species is certain so that natives that appear weedy (e.g. vines such as *Calystegia marginata*) are not misidentified.
4. Undertake a control program for feral cats.
5. Undertake a control program for feral pigs.
6. Review strategies for weed and fire management in adjacent drier fire-adapted communities so that recommended fire frequencies are achieved in wet eucalypt open forests.
7. Undertake Health Checks (Melzer *et al*. 2019) for the wet eucalypt open forests – these will facilitate early detection of weeds and enable condition to be evaluated across the park.
8. Establish long-term vegetation monitoring plots in paired burnt and unburnt communities, using Corveg sites where possible, to evaluate the rate and direction of recovery and to fill knowledge gaps with respect to the fire response of species and to evaluate regeneration of the dominant eucalypt species.
9. Monitor for increased biosecurity risk from pathogens such as myrtle rust (which favours new growth, common post-fire). The latter favours new growth which is common post-disturbance.
10. Remote sensing of canopy changes over longer time periods may be required to get a better understanding of the ecological impact of fire, including low intensity fire, in these wet eucalypt open forests.
11. Additional survey and monitoring is warranted for some threatened species, in particular – *Antechinus argentus* (silver-headed antechinus) and *Phyllurus caudiannulatus* (ringed thin-tailed gecko) (refer Appendix 6).

Contracting of pest animal and weed control 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. minimising non-target impacts during weed control).

6.3.3 Eucalypt woodlands to open forests

Potential ecological impact: predominantly limited to no impact with some moderate and a small area of high impact**.**

Fire severity and impact photographs are provided in Appendix 1, Plates A1.21.

Overview of value and impact

This broad group encompasses two draft Natural Key Values under the VBMF for Bulburin NP: *Corymbia citriodora, Eucalyptus crebra* woodland (RE 12.12.5; BVG 10); and the Endangered *Eucalyptus tereticornis* woodland on alluvium (RE 12.3.3; BVG 16c). Other ecosystems within this broad grouping are *E. crebra* woodland (RE 12.21.7; BVG 13), *E. tereticornis, Corymbia intermedia, E. crebra +/- Lophostemon suaveolens* woodland (RE 12.12.12; BVG 9; Of Concern) and *E. tereticornis* ± *E. eugenioides* woodland to open forest on crests, upper slopes and elevated valleys and plains (RE 12.12.23, BVG 9).

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 2013b, Queensland Herbarium 2018).

About 4488ha of these communities burnt in Bulburin NP, which represents about 22% of their total area on the Park. Of the burnt area of these communities approximately 46% (2045ha) burnt at low, 45% (2034ha) at moderate, 9% (385ha) at high and 0.5% (24ha) at extreme relative severity, resulting in the majority (ca. 90%) with limited or no Potential Ecological Impact.

Epicormic regrowth was common in locations where the canopy had been scorched or burned.

Eucalypt forests and woodlands within the extent of the fire are known or likely habitat for a number of threatened wildlife species (Appendices 4 and 5). Impacts on these species will vary but where the fire has been of low intensity and patchy the impact will be minimal. Those that live in or depend upon the forest floor (e.g. long-nosed potoroo, death adder, squatter pigeon) are likely to have been impacted where the fire has been more intense, removing the ground stratum over substantial areas. Where the canopy has been extensively scorched or burned there may be localised impact on species dependent upon foliage for food (e.g. koala, greater glider) or large hollow bearing trees for denning or nesting (e.g. greater glider, glossy black-cockatoo). The dominant or sub-dominant eucalypt species in all of the communities within this broad group are dominated or co-dominated by preferred food species for the koala (e.g. *Eucalyptus tereticornis, Eucalyptus crebra*).

The establishment or promotion of ecosystem-changing weeds (refer Appendix 7) poses a risk to these communities. Non-native high biomass grasses (e.g. *Megathyrsus maximus* var. *maximus,* Guinea grass; *Hyparrhenia rufa,* thatch grass*)*, *Lantana camara* (lantana) and the legume *Neonotonia wightii* (glycine) occur along some roadsides and in other disturbed areas on the park. They outcompete native species and/or significantly increase the risk of higher fire frequency and intensity which in turn facilitates their spread. The post-fire environment (e.g. bare ground and more open canopy) favours their germination and establishment, particularly in moister communities on higher fertility soils (e.g. alluvial flats).

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 and in eucalypt communities where the ground stratum is currently dominated by native grasses. Use regular herbicide treatment in the growing season. This requires an early and regular ongoing response.
2. Surveillance for new weed species and incursions that may impact recovery or increase future fire risk and undertake strategic control. This requires an early and regular ongoing response. Ensure that the identification of species is certain so as to prevent non-target impacts.
3. Review strategies for weed and fire management in these communities; aim to reduce the risk of widespread, high to extreme relative severity fires in these communities and fire encroachment into adjacent rainforests.
4. Undertake Health Checks (Melzer *et al*. 2019) – these will facilitate early detection of weeds and enable condition to be evaluated across the park.
5. Remove stray stock.

Contracting of weed control 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. minimising non-target impacts during weed control).

6.3.4 Stream fringing community ('fringing')

Potential ecological impact: moderate

Overview of value and impact

This value consists of an Of Concern regional ecosystem *Eucalyptus tereticornis, Casuarina cunninghamiana* ± *Melaleuca* spp. fringing woodland (RE 12.3.7; BVG 16a). This community includes both fire-adapted species (e.g. *E. tereticornis*) and highly fire-sensitive species (e.g. *C. cunninghamiana*). The aim of management is to avoid intentionally burning the community by implementing planned burns in surrounding fire-adapted communities when there is good soil moisture (NPRSR 2013b, Qld Herbarium 2019).

These communities are by their nature very narrow. They comprise about 146ha in total in Bulburin National Park of which approximately 8% burnt. Of the burnt fringing community, approximately 67% (8ha) and 33% (4ha) experienced low and moderate relative fire severity, respectively.

Given the drought conditions, leading up to and during the fire, it is likely that significant death of *Casuarina cunninghamiana*, including of large old trees, occurred. The species does not regenerate vegetatively and germination after fire is typically poor. Seedling recruitment may be associated with flood events and creation of sandy levees in the streamline.

The fringing community provides habitat for threatened species such as the koala, greater glider and glossy black-cockatoo.

The establishment or promotion of ecosystem-changing weeds (refer Appendix 7) poses a significant threat to the community. Non-native high biomass grasses (e.g. *Megathyrsus maximus var. maximus,* Guinea grass; *Megathyrsus maximus var. pubiglumis,* green panic) and *Lantana camara* are common in disturbed areas on the park. They increase the risk of higher fire frequency and intensity. The bare ground and loss of canopy cover resulting from fire provide an ideal environment for their germination and establishment, particularly in these relatively moist and fertile areas. They are naturally somewhat disturbed areas but have also been impacted by past stock grazing with weeds already well established. Fire provides an opportunity for further incursion of these weeds in the fringing and adjoining communities. *Dolichandra unguis-cati* (cat's claw creeper) is also a threat to these communities.

Recommended recovery actions

1. Review weed, and fire management planning in adjacent fire-adapted communities, to reduce the risk of future fire encroachments into the fringing community.
2. Prioritise areas for weed control where high biomass grasses, *Lantana camara* are not established or dominant; implement control with regular herbicide treatment in the growing season. This requires an early and regular ongoing response.
3. Develop control program for other ecosystem-changing weeds such *Dolichandra unguis-cati* (cat's claw creeper) and *Biancaea decapetala* (wait-a-while).
4. Remove stray stock.

Contracting of weed control 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. minimising non-target impacts during weed control).

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7.1 Personal Communications

Ross Peacock, Senior Research Fellow, Macquarie University, on-line presentation, June 2020.

Appendix 1. Fire severity and impact photographs

Photos by R. Melzer unless otherwise noted.

A1.1 (above) Photos within an area of notophyll vine forest, on Dawes Range Road, burnt with low relative severity. Lower right: *Mischarytera lautereriana* (corduroy tamarind) seedlings.

A1.2 Notophyll vine forest on Granite Creek burnt with low relative severity. Native vines have proliferated.

A1.3

Left hand side: notophyll vine forest on Bobby Range Road burnt at moderate relative severity. The most abundant vines are the native species *Calystegia marginata* and *Zehneria cunninghamii*

Right hand side: unburnt notophyll vine forest on the opposite side of the road.

A1.4 Above and top right: Notophyll vine forest burnt with high relative **severity**. The impac ts are severe and will be long lasting. (H. Hines)

A1.5 Large *Syzygium francisii,* killed by fire, in burnt rainforest on alluvia beside Granite Creek at the foot of Bobby Range Road. (W.J. McDonald)

A1.6 Left hand side: back burn off 4WD Loop Road (Scott Road, Appendix 8) in notophyll vineforest – a low to moderate relative severity fire resulting in significant death. The proliferation of native vines provides rapid cover which will assist in protecting the soil.

Right hand side: In contrast, notophyll vine forest immediately above the back burn. Note the *Gossia acmenoides* (orange and green stem in top right).

Above: Burnt out roots.

Right*: Arytera dictyoneura* resprouting from the base.

A1.7 Same site as previous page.
Top left: *Gossia acmenoides* (refer previous page) killed by the burn. Its gbh was ca. 54cm. It is likely to have been very old as they are extremely slow growing – a specimen of the *Gossia bidwillii* in a garden near Rockhampton has a gbh of 4cm (approximately the circumference of the black pen at the base of the tree in the photo) and is ca. 15 years old.
Lower left: Burnt side of the road. **Lower right:** Opposite side of the road – unburnt.

A1.8 Old snigging track, adjacent to Granite Creek, through notophyll vine forest. Past disturbance has exacerbated the fire impacts. This site burnt with high relative severity.

Left and above: *Brachychiton discolor* trunk and canopy, respectively.

Above and below: *Ailanthus triphysa* canopy and trunk, respectively.

A1.9 Burnt rainforest along Granite Creek. (W.J. McDonald)

A1.10 Burnt rainforest along Granite Creek. (W.J. McDonald)

A1.11 Burnt rainforest along Granite Creek. (W.J. McDonald)

A1.12 Burnt rainforest along Granite Creek. (W.J. McDonald)

A1.13 Burnt rainforest along Granite Creek. (W.J. McDonald)

A1.14 Burnt rainforest along Granite Creek. (W.J. McDonald)

A1.15 High biomass non-native grasses adjacent burnt and unburnt rainforest. (W.J. McDonald)

A1.16 Burnt, toppled fig. (H. Hines)

Above: *Syncarpia glomulifera* (turpentine) seedlings (W.J. McDonald) at the site.

A1.17 Wet eucalypt (*E. acmenoides, E. montivaga, Syncarpia glomulifera*) open forest burnt with low relative severity fire.

A1.18 Wet sclerophyll open forest (*E. montivaga*), with brushbox (*Lophostemon confertus*) in the subcanopy, burnt with moderate to high relative severity fire. Substantial loss of large habitat trees is likely to have occurred given the drought conditions leading up to and during the fire.

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A1.19 Photos are of one site in wet eucalypt open forest (*E. acmenoides, Syncarpia glomulifera*), with a rainforest understorey, burnt with moderate relative severity.

Mid left: *E. acmenoides* burnt out at the base & toppled.

Lower left: *Neolitsea dealbata* (basal resprouts); *Homalanthus populifolius* (bleeding heart) seedlings; *Blechnum cartilagineum* sprouting from rhizome

Lower right: *Elaeocarpus grandis* alive but with damaged, cracked bark. Its survival is uncertain.

A1.20 Photos are of one site in a wet eucalypt (*E. acmenoides*) open forest with occasional hoop pine (*Araucaria cunninghamii*) in the canopy, burnt at high relative severity. Seedlings of both eucalypts and hoop pine (above) present.

A1.21 Top left: *E. acmenoides, E. crebra & C. citriodora* open forest – unburnt for several years.

Above: *E. acmenoides, C. intermedia, E. tereticornis* open forest burnt with low relative severity. Ground stratum dominated by *Arundinella nepalensis* (reed grass) with *Themeda triandra* (kangaroo grass).

Left: *C. intermedia* open forest burnt with high relative severity.

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.* (2019b & 2020). All areas are in hectares, for RE1 (see Section 4.2). Estate refers to Bulburin National Park. Column headings are: RE1 – Regional Ecosystem identifier for RE1; Short Description – brief description of RE1; Status* – Biodiversity Status; BVG 2M – Broad Vegetation Group at the 1:2 000 000 scale; Estate – area of RE1 within QPWS estate; Low, Moderate, High, Extreme – area of RE1 burnt at each fire severity class; % – percentage of the total area of RE1 on the park that has been burnt.

RE1	Short description	Status	BVG2M	Estate	Burnt	Low	Moderate	High	Extreme	%
12.12.13	Araucarian Complex microphyll to notophyll vine forest on Mesozoic to Proterozoic igneous rocks	No concern at present	2	1330.65	0.00					0.00%
12.12.16	Notophyll vine forest on Mesozoic to Proterozoic igneous rocks	No concern at present	2	7925.59	2080.83	922.97	906.89	237.54	13.43	26.25%
12.12.1	Simple notophyll vine forest usually with abundant Archontophoenix cunninghamiana (gully vine forest) on Mesozoic to Proterozoic igneous rocks	Of concern	4	15.50	0.00					0.00%
12.3.16	Complex notophyll to microphyll vine forest on alluvial plains	Endangered	4	70.25	35.07	6.21	17.84	10.92	0.10	49.93%
12.12.4	Eucalyptus acmenoides +/- Syncarpia glomulifera woodland on Mesozoic to Proterozoic igneous rocks, especially granite	No concern at present	8	3145.34	822.44	382.19	342.72	93.14	4.40	26.15%
12.12.6	Eucalyptus montivaga open forest on Mesozoic to Proterozoic igneous rocks	Of concern	8	200.96	92.97	40.13	38.15	14.35	0.34	46.27%
12.12.12	Eucalyptus tereticornis, Corymbia intermedia, E. crebra +/- Lophostemon suaveolens woodland on Mesozoic to Proterozoic igneous rocks	Of concern	9	1377.59	306.58	122.44	144.30	38.33	1.51	22.25%
12.12.23	Eucalyptus tereticornis subsp. tereticornis or E. tereticornis subsp. basaltica +/- E. eugenioides woodland to open forest on crests, upper slopes and elevated valleys and plains on Mesozoic to Proterozoic igneous rocks	No concern at present	9	460.46	284.60	132.77	137.46	14.37		61.81%
12.12.11	Eucalyptus portuensis or E. acmenoides, Corymbia trachyphloia subsp. trachyphloia woodland on Mesozoic to Proterozoic igneous rocks	No concern at present	9	705.59	0.00					0.00%

RE1	Short description	Status	BVG2M	Estate	Burnt	Low	Moderate	High	Extreme	%
12.11.6	Corymbia citriodora subsp. variegata, Eucalyptus crebra woodland on metamorphics +/- interbedded volcanics	No concern at present	10	297.92	0.00					0.00%
12.12.5	Corymbia citriodora subsp. variegata, Eucalyptus crebra woodland on Mesozoic to Proterozoic igneous rocks	No concern at present	10	16679.45	3699.68	1708.31	1653.34	317.49	20.54	22.18%
12.11.14	Eucalyptus crebra, E. tereticornis, Corymbia intermedia woodland on metamorphics +/- interbedded volcanics	Of concern	13	12.70	0.00					0.00%
12.12.7	Eucalyptus crebra woodland on Mesozoic to Proterozoic igneous rocks	No concern at present	13	431.42	0.51	0.51				0.12%
12.3.7	Eucalyptus tereticornis, Casuarina cunninghamiana subsp. cunninghamiana +/- Melaleuca spp. fringing woodland	Of concern	16	145.62	11.49	7.83	3.65			7.89%
12.3.3	Eucalyptus tereticornis woodland on Quaternary alluvium	Endangered	16	1078.84	198.14	80.74	99.84	16.32	1.24	34.62%
12.12.10	Shrubland of rocky peaks on Mesozoic to Proterozoic igneous rocks	Of concern	29	5.43	0.00					0.00%
non-rem				413.19	8.44	2.51	4.63	1.30		2.05%
Total				**33790.01**	**7540.75**	**3406.61**	**3348.82**	**743.75**	**41.57**	**22.3%**

Appendix 3. Area burnt within each relative 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. Estate refers to Bulburin National Park.

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; Low, Moderate, High, Extreme – area of BVG 2M burnt at each relative fire severity class. Note: the total areas do not include the non-remnant vegetation.

BVG 5M	BVG 2M	Estate	Burnt	Percentage	Low	Moderate	High	Extreme
1. Rainforests, scrubs.	2. Complex to simple, semi-deciduous mesophyll to notophyll vine forest, sometimes with Araucaria cunninghamii (hoop pine).	9256.24	2080.83	22.48%	922.97	906.89	237.54	13.43
	4. Notophyll and mesophyll vine forest with feather or fan palms on alluvia, along streamlines and in swamps on ranges or within coastal sandmasses.	85.74	35.07	40.90%	6.21	17.84	10.92	0.10
2. Wet eucalypt open forests.	8. Wet eucalypt tall open forest on uplands and alluvia.	3346.30	915.42	27.36%	422.32	380.87	107.49	4.74
3. Eastern eucalypt woodlands to open forests.	9. Moist to dry eucalypt open forests to woodlands usually on coastal lowlands and ranges.	2543.65	591.18	23.24%	255.21	281.76	52.69	1.51
	10. Corymbia citriodora (spotted gum) dominated open forests to woodlands on undulating to hilly terrain.	16977.38	3699.68	21.79%	1708.31	1653.34	317.49	20.54
	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).	444.12	0.51	0.12%	0.51	0.00	0.00	0.00
4. Eucalypt open forests to woodlands on floodplains.	16. Eucalyptus spp. dominated open forest and woodlands drainage lines and alluvial plains.	1224.46	209.63	17.12%	88.57	103.49	16.32	1.24
12. Other coastal communities or heaths.	29. Heathlands and associated scrubs and shrublands on coastal dunefields and inland/ montane locations.	5.43	0.00	0.00%				
Total		33883.31	7532.31	22.23%	3404.10	3344.19	742.45	41.57

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

Column headings:
Status – **NCA** (*Nature Conservation Act* 1992) and **EPBC** (*Environment Protection and Biodiversity Conservation Act* 1999); E = endangered, V = vulnerable, NT = near threatened, SL = special least concern.

Habitat type – Rf = rainforests, **We** = wet eucalypt woodlands to open forests in BVG 8, **De** – broad grouping of relatively drier eucalypt woodlands to open forests in BVG 9, 10, 13,16; with x = the habitat is known or expected to be important for the species in the focal region.

(a) Fauna

			Status		Habitat type		
Group	**Scientific Name**	**Common Name**	**NCA**	**EPBC**	**RF**	**We**	**De**
amphibians	*Adelotus brevis*	tusked frog	V		x	x	
birds	*Turnix melanogaster*	black-breasted button-quail	V	V	x	x	
birds	*Monarcha melanopsis*	black-faced monarch	SL		x	x	x
birds	*Calyptorhynchus lathami*	glossy black-cockatoo	V			x	x
birds	*Podargus ocellatus plumiferus*	plumed frogmouth	V		x	x	
birds	*Ninox strenua*	powerful owl	V		x	x	x
birds	*Rhipidura rufifrons*	rufous fantail	SL		x	x	x
birds	*Symposiachrus trivirgatus*	spectacled monarch	SL		x	x	
birds	*Geophaps scripta scripta*	squatter pigeon (southern subspecies)	V	V			x
mammals	*Pteropus poliocephalus*	grey-headed flying-fox	C	V	x	x	x
mammals	*Phascolarctos cinereus*	koala	V	V		x	x
mammals	*Potorous tridactylus tridactylus*	long-nosed potoroo	V	V	x	x	x
mammals	*Ornithorhynchus anatinus*	platypus	SL		x	x	x
mammals	*Tachyglossus aculeatus*	short-beaked echidna	SL		x	x	x
mammals	*Antechinus argentus*	silver-headed antechinus	E	E		x	x
mammals	*Petauroides volans volans*	southern greater glider	V	V		x	x
mammals	*Dasyurus maculatus maculatus*	spotted-tailed quoll (southern subspecies)	V	E	x	x	x
reptiles	*Phyllurus caudiannulatus*	ringed thin-tailed gecko	V		x	x	

(b) Flora

			Status		Habitat type		
Family	**Scientific name**	**Common name**	**NCA**	**EPBC**	**RF**	**WS**	**DS**
Cycadaceae	*Cycas megacarpa*		E	E			x
Myrtaceae	*Rhodamnia glabrescens*		NT		x		
Myrtaceae	*Xanthostemon oppositifolius*	southern penda	V	V	x	x	
Phyllanthaceae	*Actephila bella*		V		x		
Phyllanthaceae	*Phyllanthus* sp. (Bulburin P.I.Forster+ PIF16034)		V		x		
Proteaceae	*Macadamia jansenii#*		E	E	x		
Rutaceae	*Bosistoa transversa*	three-leaved bosistoa	C	V	x		
Rutaceae	*Medicosma elliptica*		V	V	x		
Sapindaceae	*Arytera dictyoneura#*		NT		x		

observed to be resprouting from the base/rootstock.

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 the burnt area.

Column headings:
Status – **NCA** (*Nature Conservation Act* 1992) and **EPBC** (*Environment Protection and Biodiversity Conservation Act* 1999); CE = critically endangered, E = endangered, V = vulnerable, NT = near threatened.

Habitat type – Rf = rainforests; **We** = wet eucalypt woodlands to open forests in BVG 8, **De** = broad grouping of relatively drier eucalypt woodlands to open forests; W = wetland; with x = the habitat is known or expected to be important for the species in the focal region.

Green 'fill' denotes species for which a substantial proportion (>15%) of their modelled potential habitat occurs within Bulburin NP.
Red text denotes species that are currently only known to occur in Bulburin. Additional information, regarding relative fire severity class, is provided in the table for these species.

(a) Fauna

Group	Scientific name	Common name	Status		Habitat type			Potential habitat					Relative Fire Severity Class (ha)			
			NCA	EPBC	Rf	We	De	Total ha in Qld	Total ha in Bulburin NP	% Qld in Bulburin	Tot. ha in Bulburin burnt	% Bulburin habitat burnt	Low	Mod	High	Extreme
Birds	*Turnix melanogaster**	black-breasted button-quail	V	V	x	x		1013079	7996	0.8	2124	27	881	968	261	15
Birds	*Calyptorhynchus lathami**	glossy black-cockatoo	V			x	x	527111	3889	0.7	1110	29	500	489	116	6
Birds	*Podargus ocellatus plumiferus**	plumed frogmouth	V		x	x		180202	2851	2	1116	39	531	490	90	4
Birds	*Ninox strenua**	powerful owl	V		x	x	x	2239060	15676	0.7	4058	26	1839	1781	409	29
Birds	*Geophaps scripta scripta**	squatter pigeon (sth subsp)	V	V			x	9761274	757	0.0	61	8	29	29	2	0.3
Birds	*Lathamus discolor*	swift parrot	E	CE			x	970350	961	0.1	286	30	132	122	30	2
Frogs	*Adelotus brevis**	tusked frog	V		x	x		985730	12424	1	3042	24	1323	1369	331	18
Mammals	*Petauroides volans**	greater glider	V	V		x	x	4275994	7683	0.2	1527	20	615	714	184	15
Mammals	*Phascolarctos cinereus**	koala	V	V		x	x	4372008	20074	0.5	5325	27	2382	2382	527	34
Mammals	*Potorous tridactylus tridactylus**	long-nosed potoroo	V	V	x	x	x	190173	2990	2	729	24	309	319	96	4
Mammals	*Antechinus argentus**	silver-headed antechinus	E	E	x	x		17167	2832	16.5	928	**33**	418	411	98	2
								Of the area of burnt 'potential habitat' in Bulburin, the following proportion is within each fire severity class:					45%	44%	11%	0.2%
								Of the area of total 'potential habitat' in Bulburin the following proportion is within each fire severity class:					15%	15%	0.4%	0.1%
Mammals	*Dasyurus maculatus maculatus**	spotted-tailed quoll (sth subsp.)	V	E	x	x	x	396753	318	0.1	81	25	40	34	7	0.4
Reptiles	*Delma torquata*	collared delma	V	V			x	1954521	12097	0.6	3352	28	1597	1462	277	17
Reptiles	*Acanthophis antarcticus*	common death adder	V		x	x	x	3452148	17504	0.5	4544	26	1969	2061	482	31
Reptiles	*Phyllurus caudiannulatus**	ringed thin-tailed gecko	V		x	x		8646	7251	83.9	2045	**28**	869	919	247	10
								Of the area of burnt 'potential habitat' in Bulburin, the following proportion is within each fire severity class:					42%	45%	12%	0.5%
								Of the area of total 'potential habitat' in Bulburin the following proportion is within each fire severity class:					12%	13%	3%	0.1%

* Record in WildNet for Bulburin NP.

(b) Flora

Family	Scientific name	Common name	Status		Habitat type				Potential habitat					Relative Fire Severity Class (ha)			
			NCA	EPBC	Rf	We	De	W	Total ha in Qld	Total ha in Bulburin NP	% Qld in Bulburin	Tot. ha in Bulburin burnt	% Bulburin habitat burnt	Low	Mod	High	Extreme
Apocynaceae	*Marsdenia brevifolia*		V	V			x		669961	26	0.0	19	72	5	12	2	0
Apocynaceae	*Marsdenia coronata*	slender milkvine	V		x	x	x		321605	2488	0.8	1390	56	465	728	180	17
Apocynaceae	*Parsonsia kroombitensis*		V				x		49628	2710	5	814	30	327	383	99	5
Apocynaceae	*Parsonsia larcomensis*		V	V	x		x		54455	1839	3	321	17	122	155	41	2
Corynocarpaceae	*Corynocarpus rupestris subsp. arborescens*	southern corynocarpus	V		x				396187	8770	2	2077	24	899	924	239	14
Cycadaceae	*Cycas megacarpa**		E	E			x		749900	9223	1	1077	12	505	461	104	7
Euphorbiaceae	*Fontainea venosa*		V	V	x				158051	3734	2	962	26	438	410	105	9
Euphorbiaceae	*Fontainea rostrata*		V	V					73402	389	0.5	14	4	9	4	1	0
Fabaceae	*Sophora fraseri*	brush sophora	V	V	x	x			379715	49	0.0	1	2	1	0	0	0
Mimosaceae	*Acacia tingoorensis*		V				x		308113	154	0.1	3	2	1	2	0	0
Myrtaceae	*Rhodamnia rubescens*		E		x	?			290240	2	0.0	1	31	0	1	0	0
Myrtaceae	*Backhousia oligantha*		E		x				38461	1177	3	310	26	123	156	29	1
Myrtaceae	*Xanthostemon oppositifolius**	southern penda	V	V	x	x			65980	428	0.6	54	13	39	15	1	0
Myrtaceae	*Rhodamnia glabrescens**		NT		x				6359	2736	43.0	165	6	92	59	14	0.4
									Of the area of burnt 'potential habitat' in Bulburin, the following proportion is within each fire severity class:					56%	36%	8%	0.2%
									Of the area of total 'potential habitat' in Bulburin the following proportion is within each fire severity class:					3%	2%	0.3%	0.0%
Myrtaceae	*Rhodamnia angustifolia*		E		x				5119	249	5	1	0	0	0	0	0.0
Phyllanthaceae	*Phyllanthus sp. Bulburin**		V		x				9443	6510	69	1261	19	526	569	158	8
									Of the area of burnt 'potential habitat' in Bulburin, the following proportion is within each fire severity class:					42%	45%	13%	1%
									Of the area of total 'potential habitat' in Bulburin the following proportion is within each fire severity class:					8%	9%	2%	0.1%
Phyllanthaceae	*Actephila bella**		V		x				1093	652	60	15	2	12	3	0	0.0
									Of the area of burnt 'potential habitat' in Bulburin, the following proportion is within each fire severity class:					80%	20%	0%	0%
									Of the area of total 'potential habitat' in Bulburin the following proportion is within each fire severity class:					2%	0.5%	0%	0%
Poaceae	*Arthraxon hispidus*		V	V	x	x	x	x	1094540	401	0.0	152	38	58	79	15	1
Proteacae	*Macadamia integrifolia*	macadamia nut	V	V	x				142935	7180	5	1320	18	546	607	157	10
Proteaceae	*Grevillea venusta*	grevillea	V				x		275278	317	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Proteaceae	*Macadamia jansenii*#*		E	E	x				666	574	86	87	15	41	34	12	0.4
									Of the area of burnt 'potential habitat' in Bulburin, the following proportion is within each fire severity class:					47%	39%	14%	0.5%
									Of the area of total 'potential habitat' in Bulburin the following proportion is within each fire severity class:					7%	6%	2%	0.1%
Proteaceae	*Floydia praealta*	ball nut	V	V	x				319846	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Proteaceae	*Triunia robusta**		E	E	x				29810	320	1	0.0	0.0	0.0	0.0	0.0	0.0
Rutaceae	*Medicosma elliptica**		V	V	x				8815	6424	73	1398	22	620	629	141	7
									Of the area of burnt 'potential habitat' in Bulburin, the following proportion is within each fire severity class:					44%	45%	10%	1%
									Of the area of total 'potential habitat' in Bulburin the following proportion is within each fire severity class:					10%	10%	3%	0.1%
Santalaceae	*Thesium australe*	toadflax	V	V			x		1105581	612	0.1	259	42	119	107	32	1
Sapindaceae	*Cossinia australiana*		E	E	x				440831	8195	2	1965	24	855	873	223	14
Sapindaceae	*Arytera dictyoneura*#*		NT		x				8299	2644	32	322	12	153	146	23	0.4
									Of the area of burnt 'potential habitat' in Bulburin, the following proportion is within each fire severity class:					48%	45%	7%	0.1%
									Of the area of total 'potential habitat' in Bulburin the following proportion is within each fire severity class:					6%	6%	0.9%	0.0%
Simaroubaceae	*Samadera bidwillii*		V	V	x	x	x		625134	6949	1	1566	23	711	683	162	10.3
Zamiaceae	*Macrozamia parcifolia*		V	V			x		28505	168	0.6	51	30	29	16	6	0.1

* Record in WildNet (and HERBRECS)

Observed resprouting from rootstock/base.

Appendix 6. Maps of significant species potential habitat and potential ecological impact.

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.

Maps, showing potential ecological impact, overlain with potential habitat for conservation significant species that met both the following criteria (refer Appendix 5):

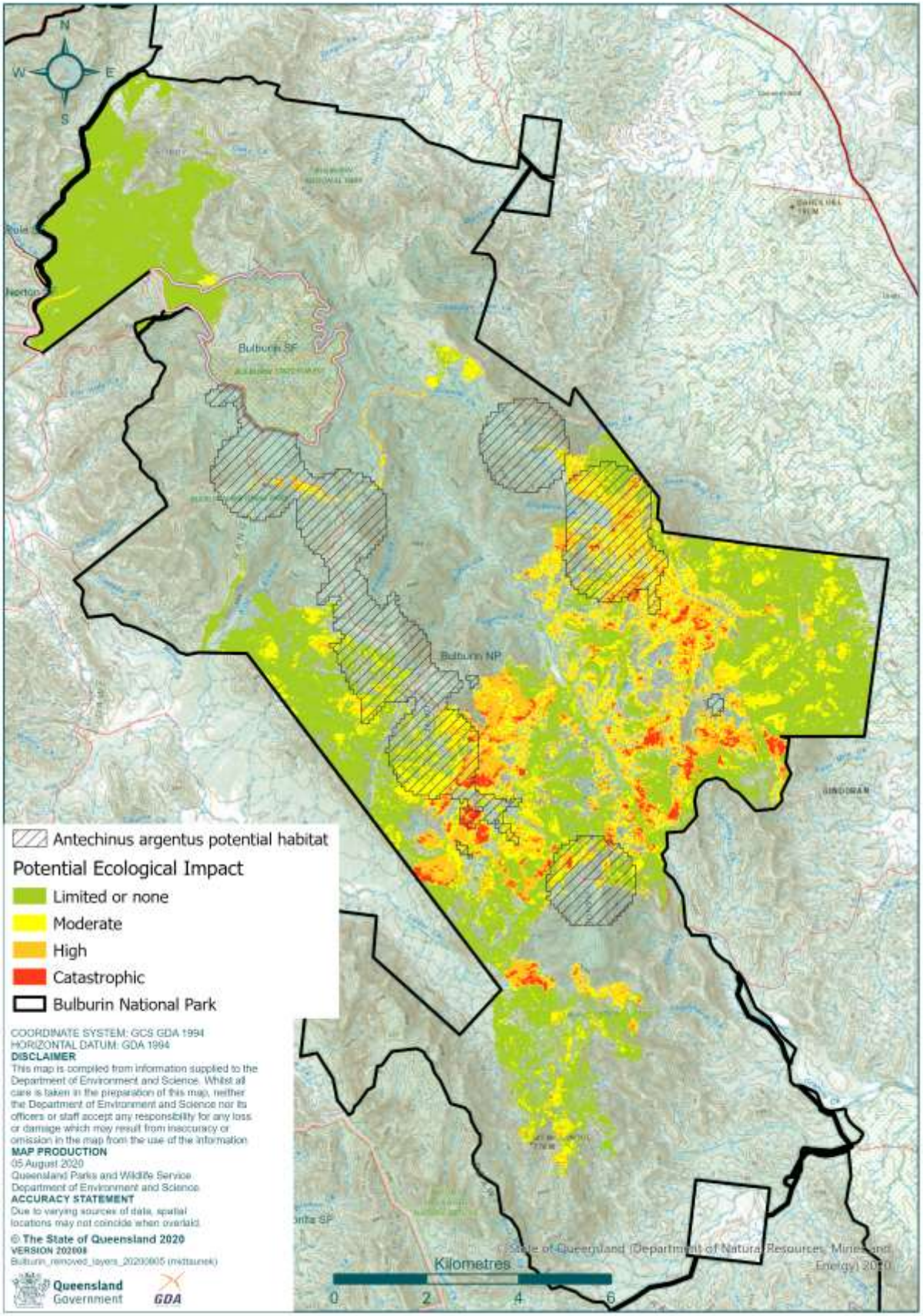
- A significant proportion (>15%) of their modelled Queensland habitat occurs in Bulburin NP.
- A significant proportion (≥15%) of their modelled habitat within Bulburin NP was burnt in the bushfire.

The species are:

- *Antechinus argentus* (silver-headed antechinus)
- *Phyllurus caudiannulatus* (ringed thin-tailed gecko) – **not for public release**
- *Macadamia jansenii* - **not for public release**
- *Medicosma elliptica*
- *Phyllanthus* sp. Bulburin

These species are currently only known to occur in Bulburin National Park, except *Antechinus argentus* which is also known from Kroombit Tops and Blackdown Tableland National Parks.

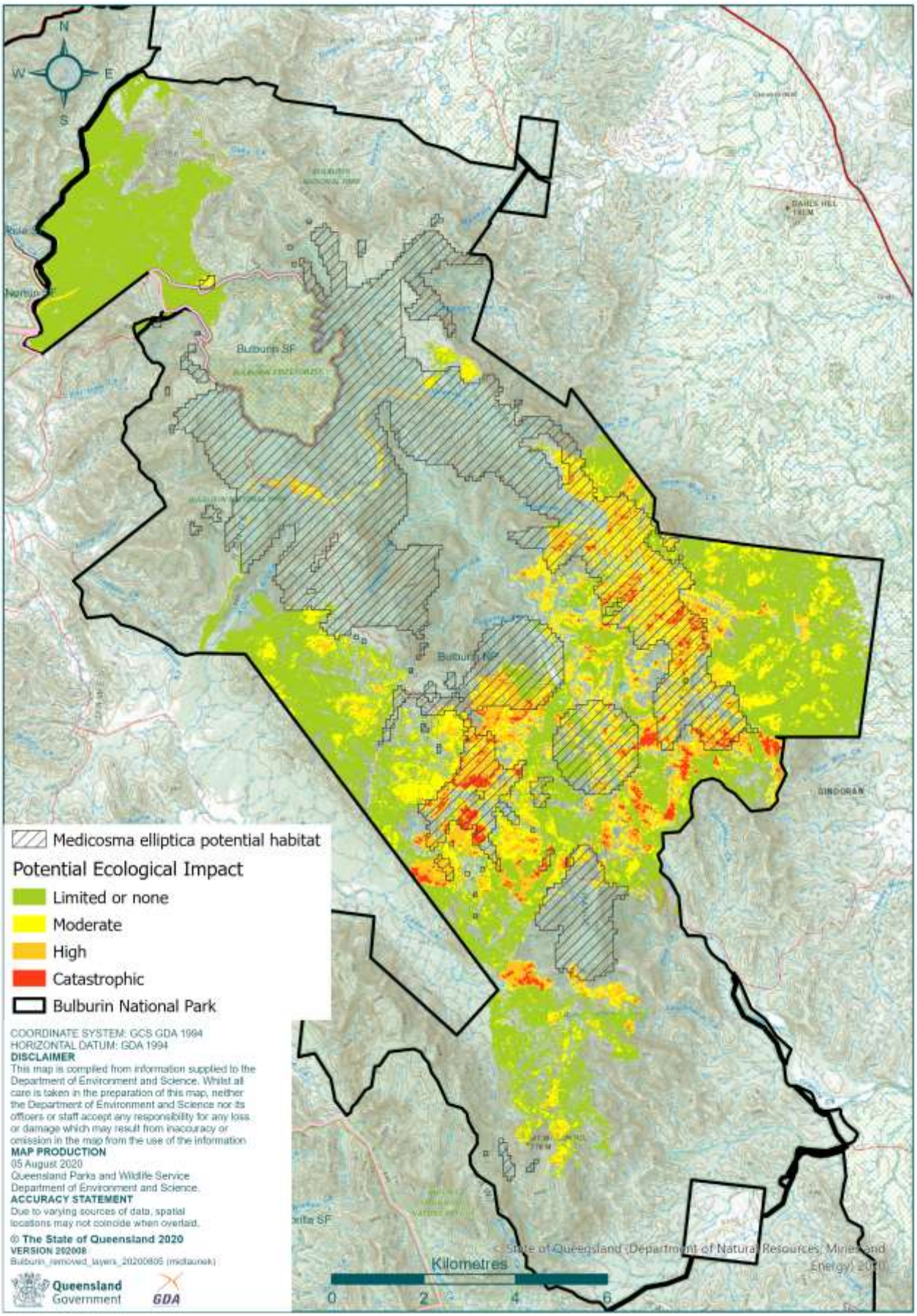
a) silver-headed antechinus *Antechinus argentus*



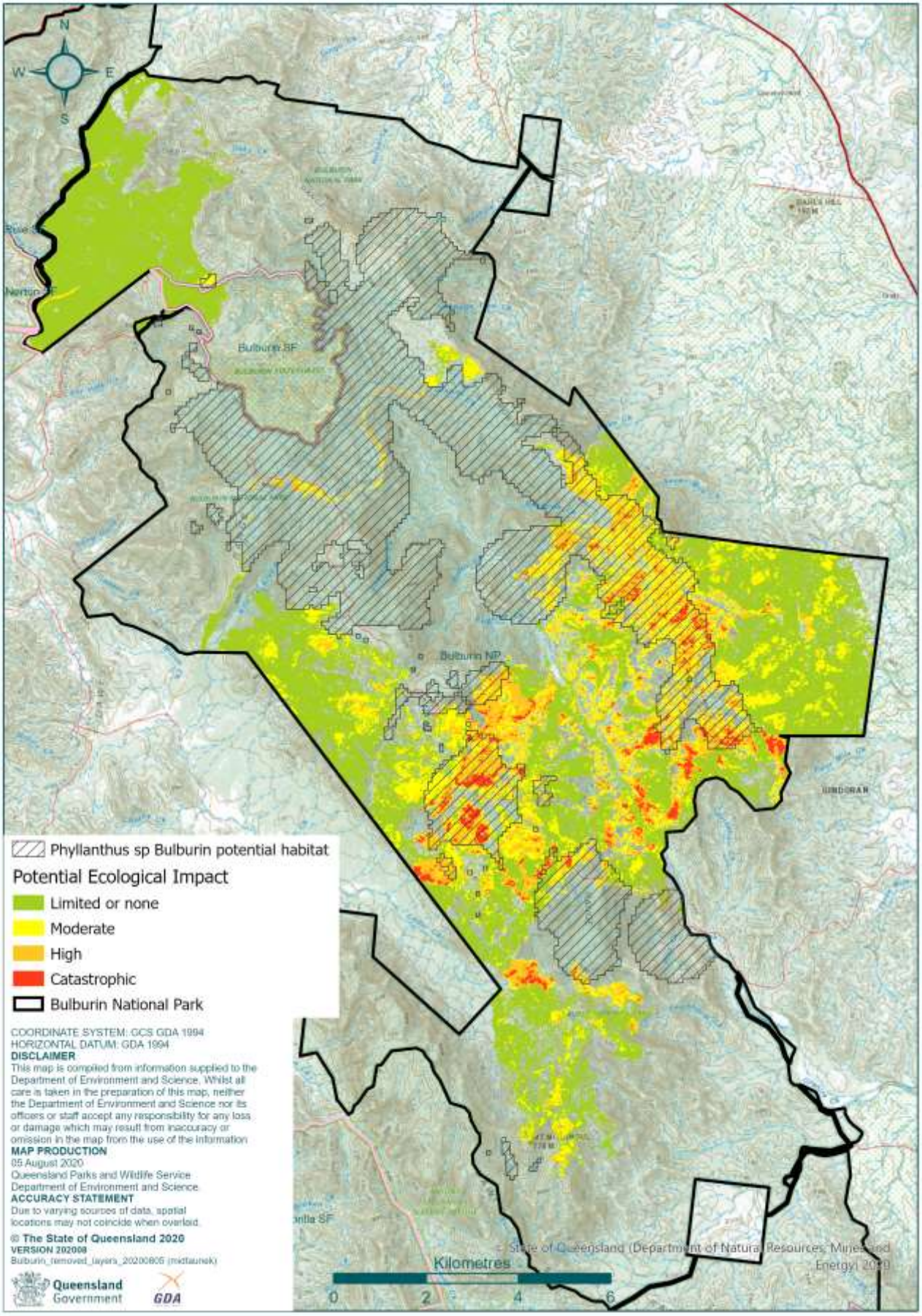
b) ringed thin-tailed gecko *Phyllurus caudiannulatus*

c) Macadamia jansenii

d) Medicosma elliptica



e) Phyllanthus sp. Bulburin



Appendix 7. Pest plants and animals likely to impact significant species or affect recovery or maintenance of habitat.

More pest species have been recorded in Bulburin National Park than those included in the tables below. Only those that are currently known to occur on the Park 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, species such as *Phytolacca octandra* (inkweed), which is prolific in some burned areas but will 'disappear' as the ecosystem recovers, have not been included.

a) Animals

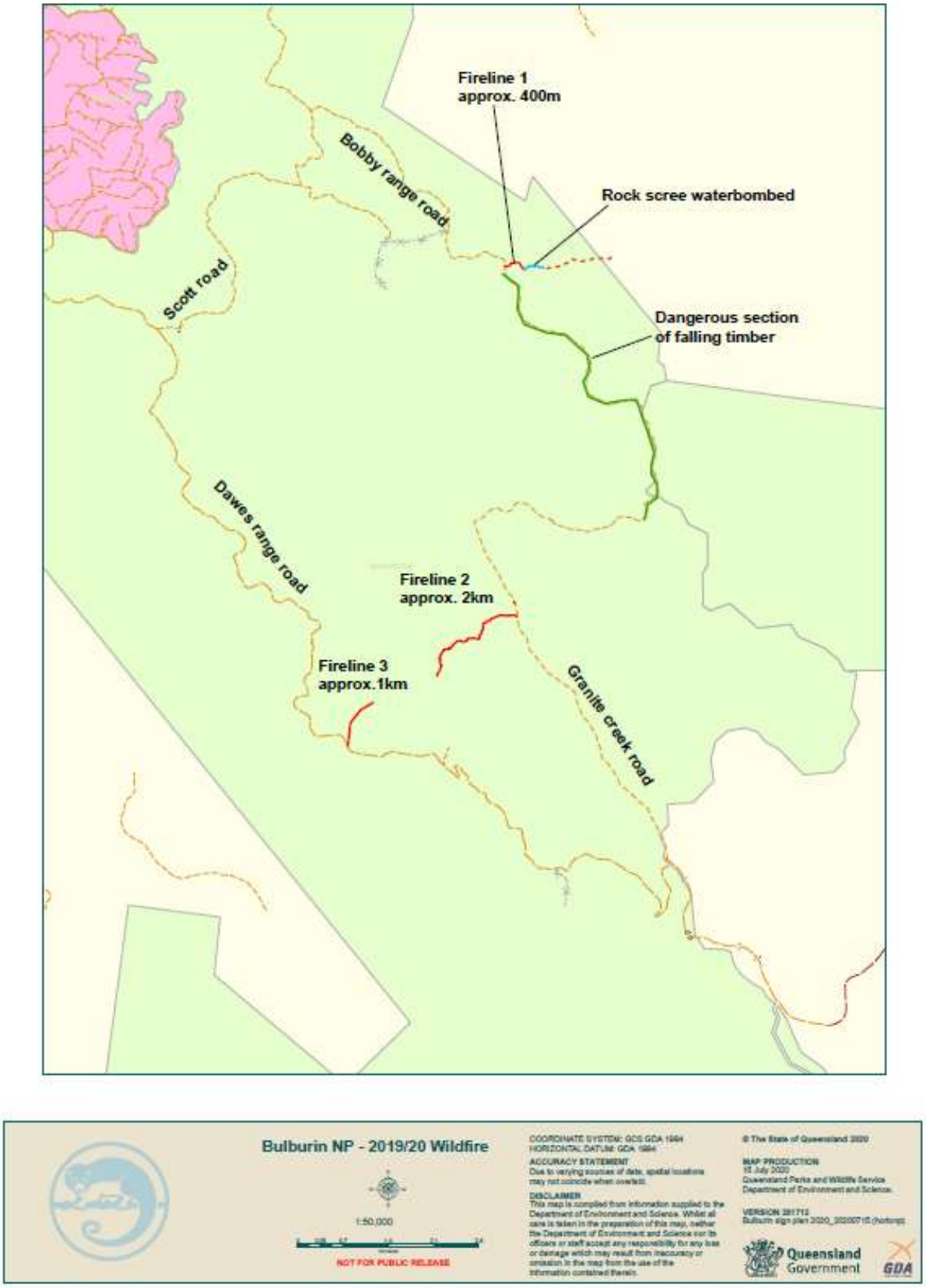
Group	Common name	Scientific name
amphibians	cane toad	*Rhinella marina*
mammals	cat	*Felis catus*
mammals	European cattle	*Bos taurus*
mammals	pig	*Sus scrofa*

b) Plants

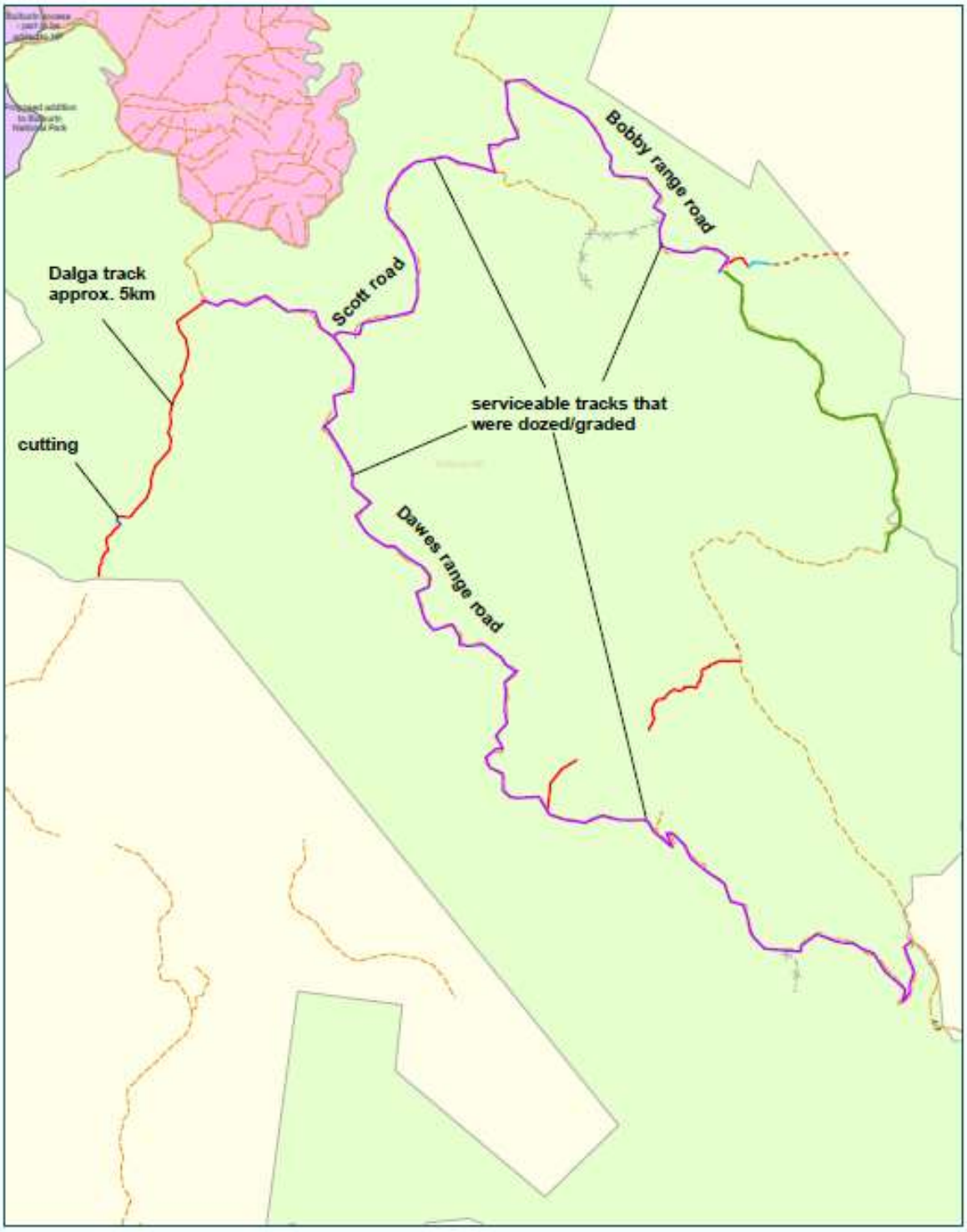
Family	Scientific name	Common name
Bignoniaceae	*Dolichandra unguis-cati*	Cat's claw creeper
Caesalpiniaceae	*Biancaea decapetala*	Wait-a-while
Fabaceae	*Neonotonia wightii*	glycine
Poaceae	*Hyparrhenia rufa* subsp*. rufa*	thatch grass
Poaceae	*Megathyrsus maximus var. maximus*	Guinea grass
Poaceae	*Megathyrsus maximus* var. *pubiglumis*	green panic
Poaceae	*Paspalum mandiocanum*	broad-leaved paspalum
Poaceae	*Sporobolus fertilis*	giant Parramatta grass
Poaceae	*Sporobolus pyramidalis*	giant rat's tail grass
Verbenaceae	*Lantana camara*	lantana

Appendix 8. Fire-line maps.

Map 1



Map 2



Bulburin NP - 2019/20 Wildfire
Dalga track and others

1:50,000

NOT FOR PUBLIC RELEASE

COORDINATE SYSTEM: GCS GDA 1994
HORIZONTAL DATUM: GDA 1994

ACCURACY STATEMENT
Due to varying sources of data, spatial locations may not coincide when overlaid.

DISCLAIMER
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15 July 2020
Queensland Parks and Wildlife Service
Department of Environment and Science

VERSION 201712
Bulburin xgn plan 2020_20200715 (horizontal)

Queensland Government

GDA