

National Environmental Science Programme



Survival and recovery of threatened animal species in fire-affected Gondwana Rainforest World Heritage Areas **Final Report**

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July 2021







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Weed growth at the rainforest's edge, Main Range. Image: Diana Fisher

Cite this publication as: Fisher, D., Jose Lopez, M., Davidson, E., Butt, N., 2021. Survival and recovery of threatened animal species in fire-affected Gondwana Rainforest World Heritage Areas. NESP Threatened Species Recovery Hub Project 8.3.8 final report, Brisbane.

Cover image: Weed and sapling growth, Main Range Image: Diana Fisher

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Survival and recovery of threatened animal species in fire-affected Gondwana Rainforest World Heritage Areas - Final Report **3**

Executive summary

In the spring and summer of 2019–20 wildfires burned more than half of the area of the Gondwana Rainforests World Heritage Area in northern NSW and southern Queensland. Many rainforest areas that burned had very seldom or never burned in recorded history, and along with surrounding eucalypt forest, are important habitat for threatened mammals and other species. Mammal species with restricted ranges in this region include the black-tailed dusky antechinus (*Antechinus arktos*), spotted-tailed quoll (*Dasyurus maculatus*), Hastings River mouse (*Pseudomys oralis*), and long-nosed potoroo (*Potorous tridactylus*). This region also supports important populations of the more widespread but declining brush-tailed rock wallaby (*Petrogale pencillata*) and koala (*Phascolarctos cinereus*).

This project aimed to assess the persistence of these species in patches of forest that experienced fires of varying severity or were unburned, in key areas of the Main Range section of the Scenic Rim in Queensland, including Main Range National Park, Mt. Barney National Park, and Spicers Peak.

We detected only one of the four target threatened mammal species, the long-nosed potoroo (*P. tridactylus*). This species was in two of the monitored locations: Mt Superbus and Spicer's Peak. We also detected koalas (*P. cinereus*); 35% of camera trap observations of koalas were in sites subject to high intensity fires.

More than a third of our camera trap observations were of invasive mammals. Feral cats were concentrated in unburnt patches of rainforest, along with long-nosed potoroos and long-nosed bandicoots. Cats were particularly common at Mt Superbus.

Introduction

Rainforests associated with the Gondwana Rainforest World Heritage area occur in several National Parks and adjacent properties across southeast Queensland and northeast New South Wales, and this area is part of the world's largest remaining area of subtropical rainforest. Threats to this World Heritage Area include climate change, invasive animals and plants, and uncontrolled fire. Although fire plays an ecologically important role in many Australian ecosystems (driving forest regeneration for example), rainforest vegetation is particularly sensitive to fire, and rainforest canopy species may be killed by intense wildfires. The frequency, extent and severity of fire is likely to be exacerbated by climate change-driven increases in drought, heatwaves, storms (lightning), and disturbances that increase dry fuel, such as lantana and invasive grass incursion into rainforest.

This project aims to contribute to research testing how and where threatened mammals of the Gondwanan forest region of southern Queensland were affected by the 2019 / 2020 fires (Ward et al. 2020). This project was planned to integrate with concurrent Queensland Department of Environment and Science surveys, mapping and camera trapping at other sites in the Gondwana Rainforest World Heritage area, and with the National Environment and Science Program's Threatened Species Recovery Hub Project 8.1.3 (which addressed effects of fire on herpetofauna). Based on our survey and mapping data, we recommend sites for threat management, including feral predator control, weed control, and monitoring.



Context

The 2019–20 bushfires affected 97,000 km2 of native vegetation including woodland, grassland, heathland, and also rainforest, which is rarely affected by fires (Godfree et al. 2021; Ward et al. 2020). Initial mapping estimated that 53% of the Gondwana Rainforest World Heritage Area had been affected by the 2019-2020 bushfires. More recent surveys estimated that 45.8% of the area of Queensland reserves was affected by the fires, and concluded that Mount Barney National Park and Main Range National Park were the most affected (78% and 68.6% of their area, respectively) (Commonwealth, 2020).

The black-tailed dusky antechinus (*A. arktos*), and long-nosed potoroo (*P. tridactylus*) inhabit cool, moist eucalypt forest and rainforest, which rarely burns. If severely burned, these areas may become unsuitable for these species for many years, especially if weed incursion alters the leaf litter layer and soil moisture.

The koala (*P. cinereus*) occurs mainly in eucalypt forests and woodlands. These types of vegetation were most affected by the 2019–20 fires (Godfree et al. 2021). Previous studies have estimated a decline of 71% in koala occupancy in fire-affected areas, but the full extent of effects on koalas through habitat alteration and direct mortality is not yet clear (Phillips et al. 2021). The spotted-tailed quoll (*Dasyurus maculatus*) and Hastings River mouse (*Pseudomys oralis*) can occur in a variety of vegetation types including eucalypt forest and rainforest. In the Scenic Rim region these species are scarce, patchy, and most often occur in eucalypt forest. The brush-tailed rock wallaby (*P. pencillata*) occurs in patchy populations along the Great Dividing Range in Queensland, in rocky habitat adjacent to grasslands and woodlands. Foxes, cats, and dogs are predators of these mammals. Feral pigs can damage habitat, especially in rainforest areas, and they may also be potential predators.

Methodology

Study area

We selected priority survey locations in collaboration with the Department of Environment and Science (DES) species monitoring and assessment section fire mapping experts Ian Gynther and Harry Hines. The aim of this collaborative site selection was to address spatial gaps in DES monitoring for the target species. We also consulted with the Queensland Trust for Nature, which also has monitoring sites in this region. Camera trapping locations were based on fire severity mapping and past locations where the target species had been recorded. These priority locations included Cunningham's gap and Mt. Superbus in Main Range National Park, Mt. Barney National Park and Spicers Peak (adjacent to Main Range National Park) (Figure 1).

Camera trapping

We deployed 46 motion-sensitive trigger camera traps to target priority mammal species in burnt and unburnt sites, using severity maps provided by the Queensland Department of Environment and Science and left them in the field for ~two months per site in the first half of 2021. Total trapping effort was 1730 nights (Table 1). Twenty camera trapping sites were in rainforest and 26 sites in sclerophyll vegetation (wet or dry eucalypt forest), adjacent to rainforest patches. Where possible we interspersed cameras at burnt and unburnt rainforest and Eucalypt forest. Based on fire severity mapping (Fig. 2) confirmed with observation of scorch height, we recorded whether vegetation was highly burnt, moderately burnt, or slightly burnt at each camera location. Most of the burnt vegetation was sclerophyll vegetation (88%), and most rainforest sites were unburnt (85%) (Figure 2).

We used defined walking tracks to access the camera trapping sites. We defined a minimum distance of 350 linear metres between cameras to avoid dependency between sites. Cameras were installed at knee-height facing outward, between one and ten metres off the track. We used Reconyx (models Hyperfire 2, Hyperfire 2 HF2X, HC500 Hyperfire Semi-Covert), Covert (DLC model) and X-Trail (3CR model) camera traps. These cameras were set at high-sensitivity and to take 3 photos when triggered, with a lag period of one second.

Data analysis

Data were unsuitable for occupancy modelling methods (there were too few individuals of the target species for this method). We compared the relative abundance index of each species between burnt and unburnt sites, vegetation types, and locations (Cunningham's Gap, Mt. Barney, Mt. Superbus, and Spicers Peak). We calculated an abundance index (100 * number of independent locations / nights) for each species across the study area and in each of the four locations. We placed cameras on an elevational gradient at each site, including the highest peak in southeast Queensland (Mount Superbus), at 1375 m asl.

Findings

Priority threatened species

We detected only one of the five threatened target species on camera trap images; the long-nosed potoroo (*P. tridactylus*) (Figure 3). We recorded potoroos at three independent locations at two sites: Mount Superbus and Spicer's Peak (Table 2). One of these was in burnt (moderately) dry sclerophyll vegetation, and two in unburnt rainforest vegetation.

Feral animals

We observed feral animals at 26% of camera trap sites, including cats (*F. catus*), pigs (*S. scrofa*) and foxes (*V. vulpes*). Cats were the most common introduced species recorded. We found no evidence of feral cats being attracted to or advantaged by fire in the Gondwana Rainforest World Heritage Area, rather cats appeared to avoid moderately to severely burned and fire-prone vegetation and focus their activity in rainforest. Feral cats occurred everywhere except Mount Barney. 90% of observations of cats were in rainforest vegetation; 50% at Mount Superbus and 40% at Cunningham's Gap. Eleven percent of cat observations were in dry sclerophyll forest at Spicer's Peak. Of the rainforest observations of cats, two thirds were in unburnt vegetation, and one third in burnt vegetation (83% low fire intensity, and 17% in moderate intensity). A third of dry sclerophyll forest observations were in low fire severity vegetation. Overall, cat detections in burnt vegetation were in areas that had suffered low fire severity. The abundance index of cats was highest at Mount Superbus, where cats were detected on half of the cameras.

Three quarters of feral pig detections were in burnt (moderate / low intensity fire) dry sclerophyll vegetation, and a quarter in unburnt rainforest, at Cunningham's Gap. Unlike cats, feral foxes did not occur in rainforest and fox activity was focused in burnt vegetation. 13% of fox observations were in wet sclerophyll at Mount Barney (burnt with moderate severity), and 88% in dry sclerophyll at Spicer's Peak (low severity fire). We also detected dingoes / wild dogs (*C. lupus*) on 22% of the cameras, at all locations except for Mount Barney.

Koalas

This project did not target koalas, however we found koalas persisting at most sites. Koalas in the Gondwana Rainforest World Heritage Area have been relatively resilient to the effects of fire, and tolerant of burnt sclerophyll vegetation. We found photographs of koalas (*P. cinereus*) on 20% of cameras, and in all locations except for Mount Superbus. Koalas were photographed by more than a third (35%) of the cameras located in eucalypt-dominated sclerophyll vegetation. 37% of koala observations were in wet sclerophyll forest at Mount Barney, and 32% in dry sclerophyll forest at Cunningham's Gap and Spicer's Peak. Nearly three quarters of observations of koalas were in substantially burnt vegetation; 64% moderately burnt and 36% burnt at high intensity.

Other species

The long-nosed bandicoot (*P. nasuta*), also appears to have been tolerant of moderate fire severity at our sites. The long-nosed bandicoot is a non-threatened mammal species suspected to have been impacted by the 2019-2020 bushfires in other parts of its range (Ward et al 2020). We detected this species on 20% of cameras. 45% of observations were in burnt vegetation (moderate and low severity). Sixty percent of long-nosed bandicoot observations were in rainforest and 40% were in sclerophyll forest (20% wet and 20% dry).

We detected the small antechinus species *A. stuartii* on 7% of the cameras, at all sites. All observations were in unburnt vegetation, half in rainforest and half in wet sclerophyll forest.

Native mammals appeared to be more tolerant of severely burnt vegetation than were introduced species. Around half of observations of both native and introduced species were in burnt vegetation. Of these, three quarters of photographs of native species were in vegetation burnt at moderate or low severity, and a quarter occurred in severely burnt vegetation. All introduced species in burnt vegetation were in areas burnt with moderate or low severity.

Discussion

This was a relatively short duration study, designed to strategically integrate with concurrent (Queensland Department of Environment and Science (DES) and Queensland Trust for Nature) and future/ongoing (DES and World Wide Fund for nature) monitoring of the Gondwana Rainforest World Heritage Area, and to answer location-specific questions to benefit Qld DES management of post-fire vegetation and invasive mammals. We surveyed areas of burnt vegetation with embedded areas of unburned vegetation at each of four sites (Fig. 1). We had originally planned to also include searches for threatened herpetofauna, however that aim was addressed by NESP TSR Project 8.1.3.

The black-tailed dusky antechinus occurs in very low abundance at a handful of high elevation rainforest and cloud forest locations in the Scenic Rim (which includes the Gondwana Rainforests World Heritage Area). It is absent from many sites of apparently suitable habitat, and none of its recorded locations were burnt (Baker et al. 2021). Mount Superbus appears to be a potential location for this species based on habitat suitability modelling, and it had not previously been surveyed there using methods to target *A. arktos*. Unfortunately, we did not detect this species there. However, we did not use attractant to target small mammals in this project, or use close-focus downward-facing cameras designed specifically to detect *A. arktos*. Hastings River mice *P. oralis* and spotted-tailed quolls *D. maculatus* also have very patchy distributions and occur at few sites in the Gondwana Rainforests World Heritage Area, more often in Eucalypt forest. Trained detection dogs have been successful in detecting *A. arktos* at Springbrook NP (in the GRWHA) and elsewhere, and would be especially valuable to survey both threatened small mammals (*A. arktos* and *P. oralis*) at fire-affected sites.

We did not detect brush-tailed rock wallabies in this project, although the monitored areas have recorded this species before the fires, particularly at Mt Barney and Spicer's Peak. This may be because we did not focus on parts of rocky outcrops that had known populations before the fire. It may also be because rock wallabies are the largest-bodied of the threatened mammals in the region, and in these areas they may not be travelling far from rock shelters through burnt sclerophyll forest that has dense and tall growth of weeds.

This project indicated that the threatened priority species the long-nosed potoroo persists mainly in unburnt rainforest patches in the Gondwana Rainforest World Heritage Area, along with long-nosed bandicoots (suspected to be fire sensitive and impacted by the 2019/2020 fires which overlapped with 30% of their range (Ward et al. 2020)). Feral cats were also concentrated in unburnt and lightly burnt rainforest. At all of our sites there were small patches of unburnt rainforest in larger areas of burnt eucalypt forest, so it is possible that these unburnt rainforest areas are acting as post-fire refuges for both potoroos and cats, and to some extent bandicoots. Low densities of bandicoots also persisted in lightly and moderately burnt vegetation.

Burnt areas of rainforest and eucalypt forest had a dense cover of weeds and saplings ~ 18 months after the fires (often too thick to place cameras more than a few metres off the track). Despite this, koalas were relatively common in burnt eucalypt forest, and even occurred in the most severely burned sites. Cameras detected koalas at or close to ground level. Unlike long-nosed potoroos, koalas were not concentrated in unburnt patches of vegetation; nearly three quarters of observations of koalas were in substantially burnt forest. These observations of koalas are why native species appeared more tolerant of burnt vegetation than were introduced species. Because very little unburnt eucalypt forest persisted at any of our sites, koalas are unlikely to find unburnt refuges that contain food trees (Eucalypts).

Application of research

More than 50 threatened and non-threatened species are being assessed to find if their conservation status needs to be changed to reflect the large proportion of their distribution impacted by the 2019-2020 bushfires (Ward et al. 2020). These include the long-nosed potoroo, long-nosed bandicoot, and koala (Ward et al. 2020). Our data contribute to distribution records in fire-affected vegetation in Queensland for these species. Our finding that koalas are persisting well in severely burnt eucalypt forest in this area of their northern range (part of the koala distribution with recent population declines), including moving on the ground in heavily weed-infested vegetation 18 months after fires is unexpected.

The association between fire severity and the habitat use and behaviour of feral cats and foxes is an important topic in Australian conservation. In particular, there are few studies examining how fire affects cat distribution in rainforest and wet scerophyll vegetation in the subtropics. Our data contribute new results to research on feral cat ecology in this environment. The finding of cats apparently concentrating in unburnt rainforest and other unburnt and lightly burnt vegetation is unexpected. This information will help managers to target cat control, especially at sites containing small populations of long-nosed potoroos in the same vegetation.

Impact of the research

This project will contribute to long-term population monitoring programs by Qld DES and WWF. WWF is beginning a new multi-year project to monitor fire recovery of threatened species in the Gondwana Rainforest World Heritage Area. We are collaborating with them (including co-supervision of a new PhD student), and they are extending our camera locations at Mt Barney and Main Range. WWF and QTFN are both expanding research on brush-tailed rock wallabies, and will test the effects of weed incursion (and weed control) on brush-tailed rock wallaby movement and ecology in the Scenic Rim and the GRWHA.

The Queensland Department of Environment and Science will include this information in decisions regarding where to focus control of feral cats and fire risk, and where to monitor these threatened species. The Turner Family Foundation at Spicer's Gap is also using this information to begin a fox control project at Spicer's Peak.

This project has strengthened collaboration networks with the Department of Environment and Science (DES), Queensland Trust for Nature (QTFN) and World Wildlife Fund (WWF), The University of Queensland (UQ) and Queensland University of Technology (QUT). This will allow each organisation to share data, information and equipment for more effective monitoring and practical conservation research in the future.

Broader implications

Large scale collaborative camera trapping involving coordinated pooling of resources by several conservation and research organisations can achieve more than individual projects. This approach is the stated aim of several groups around the world (including WWF).



Future research priorities

We are continuing collaborative monitoring of threatened species in areas of the Gondwana Rainforest World Heritage Area and adjacent regions of the Scenic Rim affected (and not affected) by the 2019-2020 fires. This will include the NSW side of the area, and priority species that we did not detect in this project: brush-tailed rock wallabies, spottedtailed quolls, black-tailed dusky antechinus, and Hastings River mouse. Extending detection dog methods to Hastings River mouse surveys is a priority, along with understanding the mechanisms of post-fire weed incursion and threat from feral foxes for brush-tailed rock wallabies. We will survey Mt Superbus and further sites for black-tailed dusky antechinus using species-specific attractant and monitoring methods.

For cat control and fire management, it would be valuable to find if potoroos and bandicoots continue to concentrate in unburnt rainforest patches in the medium term, and when / if they expand populations into surrounding eucalypt forest.

Data sets

We created a camera trap dataset for monitoring of threatened mammals in the Gondwana Rainforests World Heritage Area. The dataset has also been shared with DES, QTFN and the Turner Family Foundation. It can be accessed by contacting the project leader, Associate Professor Diana Fisher (University of Queensland).

Recommendations and conclusions

The conservation aims of the organisations in this project are consistent with sharing data and resources in a collaborative long-term camera trapping programme in the Gondwana Rainforests World Heritage Area. Cat control (e.g. by DES) should focus on unburnt rainforest patches that contain small populations of long-footed potoroos, especially at Mt Superbus. Fox control is recommended at Spicer's Peak. It would be valuable to monitor the ongoing recovery of koalas in moderately to severely burnt eucalypt forest in the region.

Acknowledgements

We would like to acknowledge the collaboration of Queensland Trust for Nature staff, including Renee Rossini and Georgina Braun, who were involved in the planning process and participated in field activities. We would also like to thank park rangers from Main Range and Mt Barney National Park, including Steve Finlayson and Justin O'Connell, who provided guidance for the field activities. We would like to thank the Turner Family Foundation and Megan Brady at Hidden Vale. Finally, we would like to thank our volunteers, including Colm Tong and Terena Lucas-Thornton, who assisted with the deployment and retrieval of camera traps in the field. The Threatened Species Recovery Hub is funded by the Australian Government's National Environmental Science Program.

Ethics statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the data, results or recommendations presented in this report.

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Figure 1. Study area. Map shows the different locations for camera trap surveys including Cunninghams gap and Mt Superbus (Main Range National Park), Spicers Peak and Mt. Barney National Park.



Figure 2. Camera trap sites and fire severity maps for the four locations: (A) Cunninghams Gap, (B) Mt. Superbus, (C) Spicers Peak, (D) Mt. Barney.



Figure 3. Potoroo in unburnt rainforest. Image: Diana Fisher

Table 1. Summary of the camera trapping effort across all location within the study site.

| Location | Number of cameras | Nights elapsed | | |
|-----------------|-------------------|----------------|--|--|
| Cunninghams Gap | 20 | 795 | | |
| Mt. Superbus | 8 | 284 | | |
| Spicers Peak | 7 | 245 | | |
| Mt. Barney | 11 | 406 | | |
| Total | 46 | 1,730 | | |

Table 2. Presence, detection, and abundance of threatened and feral species across the study area.

| Species | Presence | | | | Number of | Abundance |
|--|----------|----|----|----|---------------------------|-----------|
| | CG | MS | SP | МВ | independent detections | Index* |
| Long-nosed potoroo (<i>P. tridactylus</i>) | - | Х | Х | - | 3 | 0.23 |
| Black-tailed dusky antechinus (Antechinus arktos) | - | - | - | - | | - |
| Hastings river mouse (P. oralis) | - | - | - | - | - | - |
| Spotted-tail quoll (D. maculatus) | - | - | - | - | _ | - |
| Brush-tailed rock wallaby (P. penicillata) | - | - | - | - | _ | - |
| Koala (<i>P. cinereus</i>) | Х | - | Х | Х | 19 | 1.1 |
| Cat (F. catus) | Х | Х | Х | | 18 | 1.04 |
| Pig (Sus scrofa) | Х | - | - | - | 4 | 0.23 |
| European fox (V. vulpes) | - | - | Х | Х | 8 | 0.46 |
| Wild dog/dingo (<i>C. lupus</i>) | Х | Х | Х | - | 25 | 1.45 |

Abbreviations: CG: Cunninghams Gap, MS: Mt. Superbus, SP: Spicers Peak, MB: Mt. Barney.

*Abundance Index: number of independent locations*100/number of nights elapsed (for all locations).





Weed and sapling and epicormic growth, Main Range. Image: Diana Fisher

Further information: http://www.nespthreatenedspecies.edu.au

This project is supported through funding from the Australian Government's National Environmental Science Program.



