Science for Saving Species

Research findings factsheet

Project 8.1.3

Threatened Species Recovery Hub

National Environmental Science Programme

The impact of fire on mountain frogs in Gondwanan rainforests

In brief

The 'Black Summer' fires affected over half of the Gondwana Rainforests of the Australia World Heritage Area, including habitats that rarely burn or have never been recorded to do so.

The red and yellow mountain frog (*Philoria kundagungan*), Richmond mountain frog (*Philoria richmondensis*) and Loveridge's mountain frog (*Philoria loveridgei*) are all are restricted to wet areas within Gondwanan Rainforests and adjoining wet sclerophyll forests. This project repeatedly surveyed over 100 sites to assess wildfire impacts on frog habitat suitability, frog occurrence and abundance.

Wildfires impacted extensive areas of habitat for all three species, and frogs were more likely to be found post-fire at unburnt sites – especially for the red and yellow mountain frog. Local drought stress was a key predictor of occupancy and abundance of calling males for the red and yellow mountain frog and Richmond mountain frog. There was a decline in the Richmond mountain frog just prior to the fires during severe drought conditions, but post-fire rainfall has led to a recovery in site occupancy and abundance.

These frogs have some resilience to drought and fire, but the increasing frequency and severity of fire under climate change represents a clear threat to these species.

Recovery of these species from the 2019–20 fires is dependent on the maintenance of unburnt refuges and recovery of burnt habitat. We propose several management approaches and areas for future research.

Background

Bushfires in Australia are predicted to increase in frequency and severity with climate change. The large-scale 'Black Summer' fires of 2019–20 validated these predictions, burning millions of hectares of forest and woodland across eastern Australia. The fires began during Australia's hottest and driest year on record. In northern New South Wales and southern Queensland, over half of the Gondwana Rainforests of Australian World Heritage Area was affected, including habitats that have never or rarely been burnt.

These rainforests support a number of endemic, range-restricted frogs, including several mountain frog (*Philoria*) species. These species include the red and yellow mountain frog (*Philoria kundagungan*), Richmond mountain frog (*Philoria richmondensis*), and Loveridge's mountain frog (*Philoria loveridgei*). Each have non-overlapping ranges in Australian Gondwanan Rainforests and are a key component of the Outstanding Universal Values of the World Heritage Area. Any decline in these species therefore equates to a decline in the World Heritage Values.

Mountain frogs primarily occur in rainforest or wet sclerophyll vegetation, where they breed in drainage lines and bogs, and their terrestrial nests rely on seepages of freshwater. Their dependence on wet areas, their limited and fragmented ranges, and 'slow' life-history traits (small clutch sizes and slow growth rates) make these frog species sensitive to increased recruitment failure associated with drought and increased adult mortality associated with fire.

Richmond mountain frog occupancy rates were significantly lower in 2019 just prior to the fires, during intense drought. Image: David Newell

Australian National University

Southern Cross University

NSW Government Planning, Industry & Environment

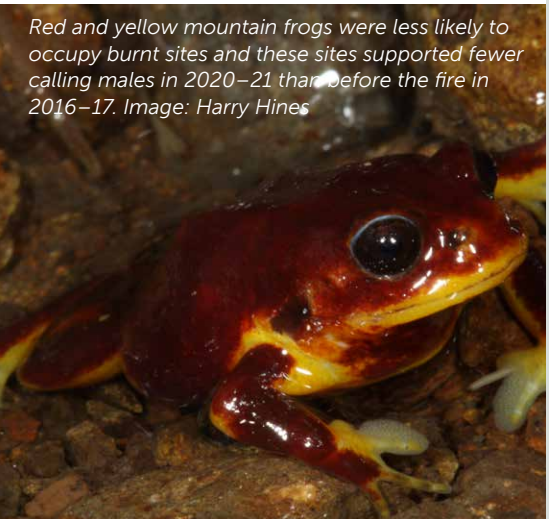
Queensland Government

LEFT: Research officer Liam Bolitho deploying a call recorder in the field. Recordings of calling males are used to estimate frog population sizes. Image: David Newell

Aims

This project aimed to assess the impact of the 2019–20 'Black Summer' fires on three species of mountain frogs that occur in the World Heritage-listed Gondwanan Rainforests.

We set out to estimate the portion of each species' habitat that was burnt and estimate the amount of habitat that they could potentially occupy. We investigated if site occupancy and abundance of calling males had declined in burnt habitat compared to unburnt habitat.



Red and yellow mountain frogs were less likely to occupy burnt sites and these sites supported fewer calling males in 2020–21 than before the fire in 2016–17. Image: Harry Hines

What we did

We conducted the study in the northern section of the Gondwana Rainforests of Australia World Heritage Area taking in the uplands of north-eastern New South Wales and south-eastern Queensland.

Red and yellow mountain frog - surveys were completed at 48 sites in Tooloom and Koreelah National Parks in New South Wales, and along the length of Main Range National Park in Queensland.

Richmond mountain frog - surveys were completed at 50 sites in Yabbra National Park, Richmond Range National Park and Toonumbar National Park.

Loveridge's mountain frog - surveys were completed for western populations of the species at five sites in Mount Barney National Park.

Survey sites were based on areas previously studied in the 2012–13 and 2016–17 breeding seasons and included both burnt and unburnt areas.

We surveyed for calling males during the breeding season between September 2020 and February 2021, with sites surveyed between one and five times (with a median of three surveys per site). During surveys, we listened for calls along sections of headwater streams, aided by imitating and/or broadcasting calls.

To identify factors that influenced site occupancy and calling male abundance we collected field information on habitat attributes, climate, fire severity, stream saturation and a range of additional environmental variables. We also collected remote-sensed and spatial variables relating to fire and drought stress.

We assessed the area of habitat burnt for each species by defining the area of potential habitat and overlapping these areas with the mapped 2019–20 fire extent. We developed site occupancy models for the red and yellow mountain frog and Richmond mountain frog.

RIGHT: Research officer Liam Bolitho and Alan Goodwin from the National Parks and Wildlife Service downloading recordings of frog calls in the field. Image: David Newell

What we found

The occupancy and calling activity of the red and yellow mountain frog and Richmond mountain frog has fluctuated in recent years in response to drought and fire. We detected frogs at a higher proportion of unburnt sites than burnt sites. Red and yellow mountain frogs were significantly less likely to occupy burnt sites and these sites supported fewer calling males in 2020–21 compared to before the fire in 2016–17. The Richmond mountain frog showed a similar pattern, although as fire primarily affected areas of low habitat suitability, this limited our ability to statistically detect the effect of fire.

Field surveys during the post-fire 2020–21 breeding season suggested that the red and yellow mountain frog and Loveridge's mountain frog have some resilience to fire. We observed calling males at low abundance at some burnt sites, even those burnt at moderate-to-high severity.

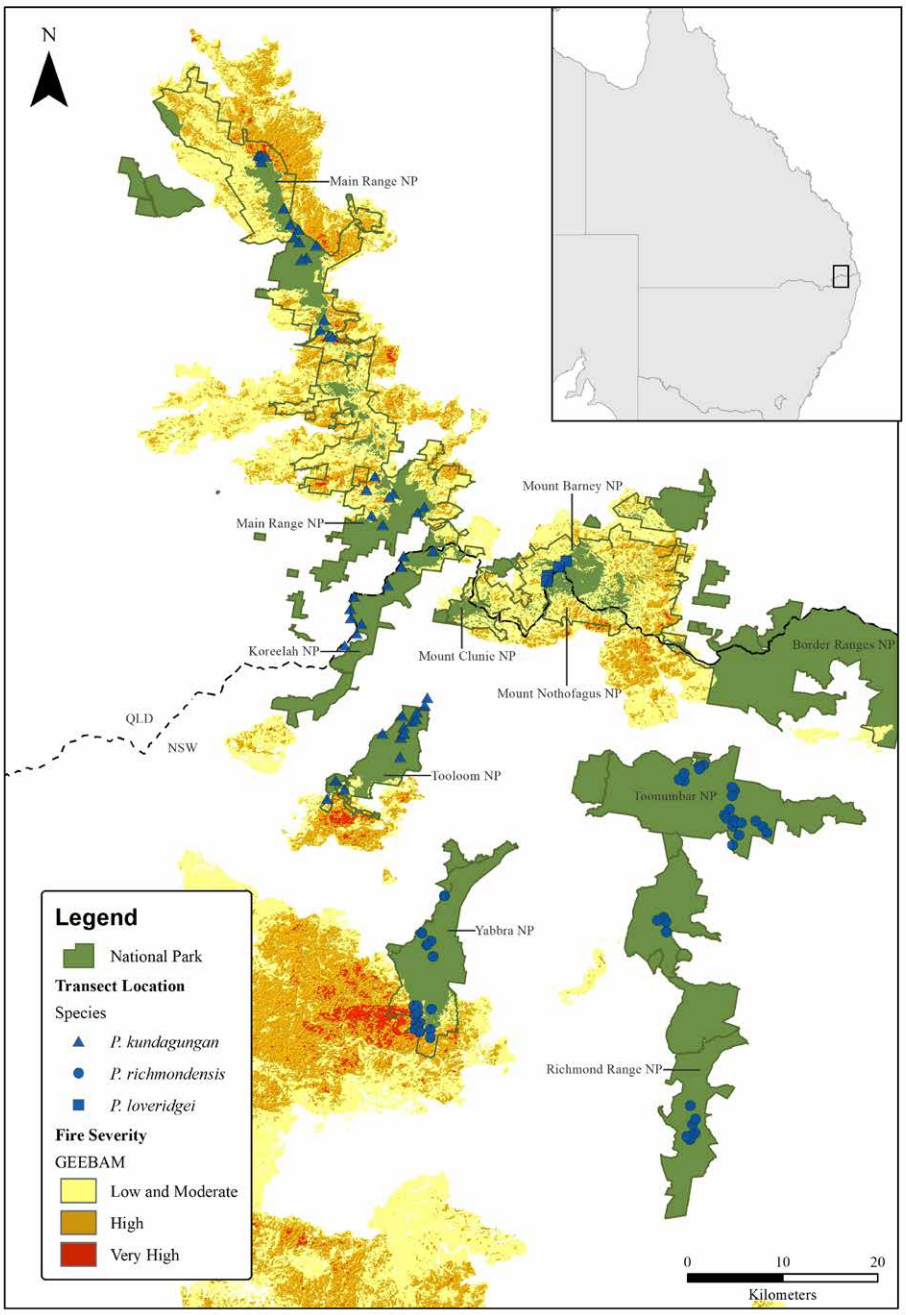
Stream saturation extent (a measure of local drought stress) was a key predictor of occupancy and calling male abundance for both red and yellow mountain frogs and Richmond mountain frogs. The frogs were more likely to be present or occur at a higher abundance at moister sites.

What we found (continued)

For Richmond mountain frogs, occupancy rates and counts of calling males were significantly lower in 2019 just prior to the fires during intense drought. Encouragingly, significant winter and spring rainfall led to a partial post-fire recovery in occupancy and calling male abundance for Richmond mountain frogs. However, overall, we counted slightly fewer calling males when compared to surveys in the 2012–13 breeding season.

All three species had extensive areas of habitat burnt in the 2019–20 wildfires. We estimated that 30% of potentially suitable habitat was affected for the red and yellow mountain frog, 12% for the Richmond mountain frog, and 54% for the western populations of Loveridge's mountain frog.

We predicted red and yellow mountain frogs and Richmond mountain frogs to have very small areas of occupancy. For the red and yellow mountain frog, the area of occupancy including potential terrestrial habitat was estimated to be 46 km^2, with only 13 km^2 of in-stream breeding habitat. For the Richmond mountain frog, the area of occupancy was 40 km^2, with just 7 km^2 of in-stream breeding habitat.



Location of survey sites for mountain frogs in Queensland and New South Wales, and the severity of fire experienced during the 2019–20 wildfires.

Implications and recommendations

Drought and fire are key threats under climate change

This study provides evidence that mountain frogs are sensitive to drought and fire. As such, the increasing frequency and severity of drought and wildfires projected under climate change represents a clear threat to these species.

Fire and drought can directly impact mountain frogs by suppressing the extent and success of breeding activity. Additional impacts may include potential loss of habitat through conversion of rainforest to sclerophyll forest or weed dominated ecosystems, and consequent loss of important microhabitats such as saturated leaf-litter and humus layers. Furthermore, increases in temperature within habitat patches may increase the risk of desiccation of frogs and egg masses, or may result in shorter breeding seasons.

Proposed management actions

A priority action to improve the conservation management for these mountain frogs is threat listing. None of the study species are currently listed under the *Environment Protection and Biodiversity Conservation Act 1999*. However, red and yellow mountain frogs and Richmond mountain frogs are under review, and this study supports their listing as Endangered.

For each of the mountain frog species to recover from the 2019–20 fires, unburnt refuges must be maintained and burnt habitat recovered.

LEFT: We estimate that 54% of the potentially suitable habitat for the western populations of Loveridge's mountain frog was burnt in the 2019–20 fires. Image: Harry Hines

Implications and recommendations (continued)

Ongoing monitoring of mountain frogs is vital to track population change and establish triggers for conservation action. This includes fire suppression management and careful planning of fuel reduction burning adjacent to rainforests.

At several sites, we detected damage to stream beds from feral pigs, as well as evidence of cattle incursions and weed invasions. The invasion of weeds such as lantana and high biomass grasses represents a significant threat in recently burnt habitats and increase the likelihood of future fires. Feral pig control, cattle exclusion and weed control is urgently required in a number of areas, particularly within Main Range, Mount Barney and Yabbra National Parks.

Establishing captive populations should be pursued as a matter of urgency for mountain frogs. Head-starting and re-introduction may also support declining populations or re-establish those that have become locally extinct.

Priorities for future research

There are significant gaps in our knowledge of the ecology of these frogs that limit our ability to estimate population viability. Identifying target habitats for post-fire management, and long-term climate change refugia will also be critical for each of the species.

To improve our overall understanding of the responses of Australian frogs to bushfire, a meta-analysis of post-fire amphibian studies would be beneficial. There is currently an important opportunity to pursue this action, given the large scale of research undertaken on the response of frogs to the 'Black Summer' wildfires.

Besides bushfire threats, we need to expand field sampling to clarify the impacts of the fungal pathogen disease chytridiomycosis on mountain frogs. Chytrid is a known threat to closely related species. Importantly, we also need to better understand the extent to which rainforest environments can mitigate climate change impacts on these species.

Further reading

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Further Information

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