# Science
## for saving species

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## Better detection and monitoring vital for better conservation outcomes

## Detection dogs filling gaps for rare antechinus

Threatened plants and fire

Genetic rescue

Beyond captivity for Christmas Island reptiles

Exploring a haven for Yawuru Country

Possum and glider monitoring app

Tribute to Dr David Blair

Threatened Species Recovery Hub

National Environmental Science Programme

IMAGE: ANDREW BAKER

Editorial...

# **Better detection and monitoring** vital for better conservation outcomes

The detection and monitoring of threatened species have been a strong area of research in the National Environmental Science Program and also the two national environmental research programs which preceded it. In the Threatened Species Recovery Hub, we have tackled this topic from many angles, including a national review of monitoring across all species, optimisation of a major parks monitoring program, trials for promising novel technologies and targeted research for specific elusive species, such as the Kangaroo Island dunnart. Hub Director Professor **Brendan Wintle** takes a look at what we've been achieving and why it is so important to the conservation of Australia's threatened species.

To some people in the broader community, spending resources on monitoring instead of action could seem a waste but, in reality, for many species, without monitoring we do not know where to direct our investments or whether they will work. Indeed, there are many cases in Australia where investments in 'obvious' conservation actions have proven to be futile, but with that result only discovered after monitoring began, meaning years of wasted effort. With over 1800 threatened species in Australia, conservation investments need to be highly targeted, and as resources are limited every dollar must count.

Making good investments can start with the basics of knowing where a species is. While the olfactory superpowers of dogs have been used in biosecurity for decades, the transition to ecology and conservation has been slower but is gaining speed. Under the National Environmental Research Program, Cindy Hauser and Parks Victoria demonstrated the effectiveness of using detection dogs for finding hawk weed, an invasive plant species in the Victorian Alps.

Detection dogs are also being used in a hub project that seeks to find populations of two rare mountain-top antechinus species in Queensland (see page 12).

The rarity and low numbers of these two elusive species make them difficult and unreliable to detect with traditional survey methods. Stephane Batista from Queensland University of Technology and collaborators from the Queensland Department of Environment and Science are using species distribution modelling to predict where populations may occur and are using detection dogs to rapidly survey these sites.

Other novel technologies we have trialled include thermal imagers, drones, sound recorders and automated call recognition software for discovering new records of frogs, birds and bats, and e-DNA approaches to finding rare fish and platypus. All of today's common ecological monitoring techniques were once new, but the value of new technology is not automatically assured. Properly conducted trials are important to test the effectiveness and efficiency of promising novel methods compared to existing methods. Some will turn out to be more effective than existing methods, and some will be valuable for some circumstances but not all. Developing this evidence allows conservation managers to make informed decisions.

José Lahoz Monfort from The University of Melbourne Hugh McGregor from University of Tasmania have preliminary findings from field experiments with hand-held thermal imagers that indicate significant improvement over spotlights for particular species, including koalas, tree kangaroos, cats and feather-tailed gliders, because of the ability of imagers to better distil hot bodies from dense vegetation, particularly for species with relatively little eye-shine.


ABOVE: A thermal camera image of a rock wallaby.

## Inside the Spring 2019 issue of *Science for Saving Species*



Threatened Species Recovery Hub

National Environmental Science Programme

IMAGE: JAANA DIELENBERG

RIGHT: Cat tracks across a sand dune in central Australia. One hub project is working with over 40 groups across Australia's arid zones, including Indigenous Rangers, Government Agencies, Conservation NGOs and environmental consultants, to monitor threatened wildlife and feral animals using sand-tracking data.

Thermal imagers attached to drones seemed like a neat way of finding tree kangaroos on cool mornings, so we tested it. While they were good at finding hot bodies in rainforest canopy, species-level identification was near impossible because the tree kangaroos couldn't be separated from possums and birds in the canopy. However, there seems to be great promise in using drone-mounted thermal cameras for monitoring rare macropods in arid landscapes – stay tuned for that one!

I've only touched on a few of our monitoring/detection-related projects, but you can read more about this research at the Monitoring and Management research theme on our website. Other fascinating projects include working with 40 other groups across Australia's arid zones to monitor threatened wildlife trends using sand-tracking data, and researching detectability and species distributions to help underpin a major redesign of the monitoring program for Top End parks.

A new synthesis project will identify the top national-level priorities for improved threatened species monitoring. This will include identifying threatened species that have had little or no monitoring to date, and those for which new or enhanced monitoring is most critical. In addition, it will develop monitoring program plans for key groups of threatened species, and costed pathways for their implementation.

So much of what we do in conservation relies on biological field surveys and monitoring, which is why we have invested so much supporting survey and monitoring research across the country. However, a large gap remains between current practice and the amount and quality of monitoring we need to properly understand the status of our species (and our highest management priorities) and the success of past recovery interventions.

This makes it very hard for us to argue for more on-ground conservation funding, because without the evidence provided by monitoring, we can't convincingly demonstrate to funders what we achieved from the last round of funding. As a community of conservation researchers and practitioners, we need to continually encourage agencies and conservation organisations to factor monitoring costs into every program, and to instigate monitoring from the very beginning of programs and not at their end, when it is too late to demonstrate what was achieved.

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BELOW: Hub researcher Daniella Teixeira is using bioacoustics to monitor breeding success in two endangered sub-species of black-cockatoos in southern Australia.

IMAGE: NICOLAS RAKOTOPARE

IMAGE: MARK OOI

# ‘Tis the season... Understanding how threatened plants respond to different fires

ABOVE: Key’s Boronia *(Boronia keysii)*.

Many landscapes in Australia are fire-prone, and increasingly so. Altered fire regimes can have a serious negative impact on threatened plant species and ecological communities. A Threatened Species Recovery Hub project is working to better understand the effects of different fire regimes on threatened flora in order to improve fire management strategies and conservation outcomes. Hub researcher **Mark Ooi** of the University of New South Wales talks about how the season of burns appears important to Queensland’s Key’s Boronia.

Fire is common in many of Australia’s native plant communities, and a wide variety of species have evolved to persist under a regime of fire. However, in an apparent conundrum, approximately half of all threatened plants in Australia are considered to be at risk from ‘inappropriate’ fire regimes.

IMAGE: MARK OOI

Fire patterns have changed due to a number of reasons including landscape fragmentation, loss of Indigenous cultural burning, changed fuel loads, active suppression of fires and implemented fuel reduction or ecological burns being undertaken in different seasons. Understanding how such changes can effect plant persistence is critical for assessing risk.

A key aim of our research is to understand how to implement burns to maintain healthy populations of species occurring in fire-prone habitats. A second aim is to develop a greater understanding of different fire regimes that can be a threat to plants.

The ‘fire regime’ refers to characteristics of fire patterns, including how often an area is burnt, how hot or intense the burn is, and the season of burning. Research on maintaining species in temperate fire-prone regions has previously concentrated on frequency. For example, if populations of some fire-dependent species are burnt too frequently, their seedlings may not have long enough to grow and mature between fires to produce sufficient amounts of seeds for subsequent regeneration.

However, other components like seasonality and intensity have had little previous attention but may play equally important roles in the ability of threatened species to persist. The season in which a fire occurs is potentially critical to flowering, germination and seedling establishment. Disentangling the relative importance of different fire regime elements and how they can have an impact on various functional groups of plant species requires detailed experimental work investigating plants and their life-cycles, which we are undertaking for a range of case study plants.

## Key’s Boronia

One of our study species, Key’s Boronia (*Boronia keysii*), is a native shrub growing up to 2 m high with deep rose-pink or white flowers. There are only 15 known populations, some on private land, and all within a 5 km radius on coastal lowlands around Cooloola, in south-east Queensland. It was thought to be extinct until rediscovered in the early 1970s and inappropriate fire regimes are listed as playing a role in the threat faced by this species.

RIGHT: Research students Tom Le Breton and Sophie Natale during field work.

We used a variety of methods including laboratory trials and experimentally conducted burns to understand the ecology of this threatened species and how it responds to fire. To undertake this work we collaborated with the South East Queensland Fire and Biodiversity Consortium, Sunshine Coast University, the Fire Management team at Queensland Parks and Wildlife and private landholder HQ Plantations.

PhD student Justin Collette from the University of New South Wales examined seed viability and germination requirements. This type of work is essential for understanding potential limitations of threatened species. Seed viability was assessed by x-raying seeds at the Australian PlantBank at the Australian Botanic Garden in Sydney, and identified that the species produced plenty of healthy seeds.

Justin also undertook laboratory germination trials and found that warm temperatures were needed for seeds to germinate, along with the addition of smoke – something that may translate to a warm season seedling emergence response in the field, mainly after fire. If this were the case, it indicates that Key's Boronia may have better gemination in the wild if burnt when relatively warm daytime temperatures were still likely for extended periods following the fire event – say early autumn. This means that the timing of fire may impact how well this Boronia will recover; however, the best way to get the most informed view is via experiments in the field.

## Trialling fire seasons

A field trial of implemented fires was carried out in 2018. Burns were conducted in two different seasons to assess fire response, germination and seedling growth in response to the timing of the burn. The key to successfully conducting field experiments like this is strong collaboration between managers, fire crews and researchers, in order to produce well-replicated experimental burns. A coordinated effort between Queensland Parks and Wildlife, landholder HQ Plantations and their fire crews provided similar burns across the two different seasons, allowing University of New South Wales researchers to compare the effects of the season of burn, while minimising the influence of other fire factors.

While several years of data are required to obtain any clear results of fire season impacts on plants, early results indicate a clear seasonal pulse of seedling emergence, matching lab results. The next question is whether the relative delay in emergence after different burns has had any effects on seedling growth.

Work like this is essential for informed fire management of threatened species and, as part of our project, and in collaboration with the New South Wales Government's Bushfire Risk Management Research Hub, we have identified seasonal germination requirements for other threatened species, the Endangered *Asterolasia buxifolia* and Vulnerable *Leucopogon exolasius*. Winter burns significantly slowed growth and time to maturity for *Leucopogon*. We have also found a strong effect of season of burn on subsequent soil microbial activity. These findings combined highlight the strong potential for fire seasonality to influence the recovery of threatened species and the need to consider season of burn in management plans of susceptible species.

## Other ongoing work

A coordinated program investigating broader fire regime impacts on re-sprouting plants, fire refugia and soil–plant interactions is currently underway to fill the gaps in our understanding of fire and plants. This has focused not only on fire season, but also on the potential impacts of different fire severities and their interactions with fire frequency.

PhD student Tom Le Breton has been identifying the temperature requirements for breaking seed dormancy of the threatened species *Pomaderris bodalla* on the south coast of New South Wales, to investigate whether they are fire-adapted.

Former Honours student Jason Chan screened another 14 threatened *Pomaderris* species and found that nearly all required very high temperatures to germinate.

These lab experiments indicate that all species would recruit well and likely persist with occasional fire, even though many of them occur in riparian habitats, commonly thought of as fire refugia.


IMAGE: MARK OOI

ABOVE: Justin Collette taking post-fire measurements at a Boronia site.

Balancing the needs of such species to promote recruitment with the needs of the broader habitat in which they persist is a management challenge. The results from empirical work from the types of experiments conducted in our project can help to provide a robust basis for management decisions that need to be made. Without knowledge about the potential threats that plants face, there is a possibility that we could unintentionally implement fires that actually increase risks to threatened species, rather than burning to improve the plants' chances of persistence.

*This Threatened Species Recovery Hub research is a collaboration between the University of New South Wales, Queensland Parks and Wildlife Service, HQ Plantations, the NSW Office of Environment and Heritage, the Australian National Botanic Gardens and the SEQ Fire & Biodiversity Consortium. It receives support from the Australian Government's National Environmental Science Program. Ongoing work is also supported by the NSW Bushfire Risk Management Research Hub.*

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IMAGE: MARK OOI

Carrington Falls Pomaderris (*Pomaderris walshii)* in bud.

# Genetic rescue for threatened species: **Bandicoot bounces back**


IMAGE: NICOLAS RAKOTOPARE

RIGHT: An eastern barred bandicoot from the genetic rescuce breeding program at Mount Rothwell being released to one of the large paddocks.

Genetic rescue is a relatively new tool in the conservationists' kit for recovering populations of imperilled species. Internationally, it has only been used a handful of times, but is gaining momentum as an important strategy for threatened species conservation in Australia. Conservation geneticist **Andrew Weeks** of The University of Melbourne believes it is going to be an increasingly important strategy for many species of flora and fauna with small and heavily fragmented populations. In this Threatened Species Recovery Hub project, he and his colleagues have been further testing genetic rescue and compiling genetic guidelines for use by conservation practitioners based on successes with threatened species like the mountain pygmy possum and eastern barred bandicoot. Here, he gives a brief history of genetic rescue in Australia, the success stories, and what the future holds for this new cutting-edge approach.


IMAGE: NICOLAS RAKOTOPARE

LEFT: Over 500 eastern barred bandicoots call Mount Rothwell home. The feral predator-proof fence protects 473 ha, making it Victoria's largest haven.

Populations of some threatened species have become so small that inbreeding and a lack of genetic diversity are reducing the health of the animals, their breeding success, and compromising the ability of populations and species to adapt to environmental change. Local examples include helmeted honeyeaters and rock wallabies. Genetic rescue aims to restore the genetic variation of an animal population by taking individuals from a genetically healthy (i.e, diverse) population and introducing them into a genetically compromised population. One of the first steps is to assess the likely compatibility of individuals from the two populations, particularly if they have been isolated for a long period of time; some concerns are often raised that genetic issues may arise in offspring or the offspring of offspring, such as sterility or poor growth. Assessments can occur directly through cross-breeding trials or undertaken through other approaches to provide confidence in compatibility.

Genetic rescue is generally possible when populations haven't diverged for long periods of time, although there is increasing evidence that under at least some circumstances, populations that have diverged tens or even hundreds of thousands of years ago can still be used in genetic rescues. This is an area of active research for our team, because there may be increasing need to cross populations that have been diverged for significant periods of time, as natural populations of many animals continue to get smaller and smaller. In fact, this is where we started our research on genetic rescue.

## Starting with a very tiny possum

Genetic rescue was first implemented in Australia in 2010–2011 in a program I led for the recovery of the Mount Buller mountain pygmy-possum population in eastern Victoria. This program was a great success, and amply demonstrated the viability of genetic rescue as a method to support population recovery. We were able to avert the extinction of the Mount Buller mountain pygmy-possum by introducing as few as six males from Mount Hotham, a genetically healthy population

that has been isolated from the Mount Buller population for tens of thousands of years. The population recovery was so great that we now have more mountain pygmy-possums at Mount Buller than ever previously recorded at this location and the population is the third largest in its entire distribution.

The genetic rescue of the mountain pygmy-possum was born out of necessity – the population would likely have gone extinct if we didn't implement it back in 2010–11. However, we wanted to explore genetic rescue in a more controlled experiment and this led to our next step on our journey, which was undertaking genetic rescue with another small marsupial, the Victorian eastern barred bandicoot.

## From just 19 bandicoots

Once widespread throughout western Victoria, the species declined substantially after European settlement due to habitat degradation and predation by the invasive red fox. The last wild mainland eastern barred bandicoot was spotted at Hamilton in south-western Victoria in 2002. Fearing the potential loss of the species in the wild, 40 animals were collected at Hamilton in 1988 and formed the start of a captive breeding program that has continued to this day. Later genetic analysis indicated that only 19 of these animals bred successfully, becoming the founders of the current population of roughly 900 individuals that are divided across six captive and island populations where foxes are absent.

One of the largest populations is found at Mount Rothwell, which is just 50 km from Melbourne and is the largest feral predator-free haven on the mainland in Victoria. Currently, Mount Rothwell houses a population of around 500 to 700 eastern barred bandicoots, and our present project aims to study the genetic rescue of this population because our previous research suggests that the Victorian eastern barred bandicoot is suffering from low genetic diversity and inbreeding.

## Tasmanian infusion

Fortunately, wild populations of this bandicoot are still found in Tasmania. What we are aiming to do, then, is to restore genetic variation in the Victorian population by taking some Tasmanian eastern barred bandicoots and cross-breeding them with Victorian eastern barred bandicoots to increase their genetic variation, population fitness and adaptive potential.

My colleague Professor Ary Hoffmann and I have been running this genetic program for the past three to four years in collaboration with Mount Rothwell. In 2017, we travelled to Tasmania and collected some Tasmanian bandicoots. We built captive pens at Mount Rothwell and set up crosses between the Tasmanian wild individuals and the Victorian captive-bred eastern barred bandicoots. After ensuring the genetic compatibility of the two populations in the small breeding pens, we then released them into large fenced enclosures at Mount Rothwell in order to assess their fitness and make sure that they were showing normal behaviour.

## Great grandkids doing well

Three generations have passed since that initial cross-breeding trial. We are now assessing how well cross-breeding has worked, both from a fitness perspective as well as at a genomic level. We want to understand exactly what happens when you cross two different populations that have been isolated for a long period of time. This is to see what effect that has on the recipient (Victorian) genome, which we now expect to be mixed up with the Tasmanian one, boosting genetic variation.

Once our trials are complete, we will use these bandicoots as founders for a new fenced feral-proof conservation reserve that has been built at Tiverton in western Victoria. This new site has the potential to hold over 1000 bandicoots and secure the long-term future for this species on mainland Australia. Then we will start filtering these bandicoots out to other populations, such as Woodlands Historic Park, Hamilton Community Parklands and even Phillip Island and French Island.

Importantly, this research is providing a foundation for how genetic rescue can be used more broadly in threatened species programs in Australia and overseas by dissecting the phenotypic and genomic consequences. We believe genetic strategies and genetic interventions are likely to become an important component of threatened species recovery programs, particularly in a time of rapid environmental change.

## Further reading

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*This Threatened Species Recovery Hub project is a collaboration between The University of Melbourne and Mount Rothwell. It receives support from the Australian Research Council, the Victorian Department of Environment, Land, Water and Planning, the Australian Government's Department of Environment and Energy and National Environmental Science Program, the Douglas Family, Zoos Victoria, and Funder@Melbourne (crowdfunding).*

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BELOW: Inside one of the breeding pens at Mount Rothwell where Tasmanian eastern barred bandicoots were crossed with the mainland subspecies to introduce new genetic diversity.

IMAGE: NICOLAS RAKOTOPARE

Blue-tailed skink.

IMAGE: JON-PAUL EMERY

# Beyond captivity for Christmas Island reptiles

In 2009, the Christmas Island blue-tailed skink and Lister's gecko were headed for imminent extinction. Parks Australia acted quickly to collect remaining wild individuals in order to establish captive breeding programs on Christmas Island and at Taronga Zoo, Sydney, which have been highly successful. A Threatened Species Recovery Hub project team is working closely with Parks Australia to help secure a future for the two lizards beyond captivity. **Jessica Agius, Jon-Paul Emery** and **John Woinarski** report on the latest developments and the challenge of protecting these ancient and unique island reptiles.

Many species occur only on islands, a characteristic that has long fascinated biologists. But while evolution in isolation has led to new species, it has also rendered these species highly vulnerable to changes in their environment, such as the arrival of new predators. In Australia, our three most recent extinctions have all been island endemics.

The Australian external territory of Christmas Island, which lies 1550 km off the north-western coast of mainland Australia, is a case in point. The island had an intriguing reptile fauna, comprising one endemic blind snake, two endemic geckos, two endemic skinks, and one native skink that also occurs elsewhere. These endemic species existed on the island for several million years, and all of the lizards remained common up to the 1970s, but four then declined precipitously. These declines now seem most likely to have been caused by the inadvertent introduction of the Asian wolf snake (*Lycodon capucinus*) from stowaways on freight shipping.

Observing the decline in wild populations, in 2009 and 2010 Parks Australia managed to secure enough individuals of the blue-tailed skink (*Cryptoblepharus egeriae*) and Lister's gecko (*Lepidodactylus listeri*) to establish captive breeding populations. Shortly after, they became extinct in the wild. The opportunity came too late for the Christmas Island forest skink (now extinct) and coastal skink (now extirpated from Christmas Island). However, the captive populations of the blue-tailed skink and Lister's gecko have flourished. The 66 skinks collected have swelled in 10 years to over 1500 captive individuals, and Parks Australia is exploring options beyond captivity.

## Trial reintroduction

The first of these explorations was trialling blue-tailed skinks in a 2600 $m^2$ semi-wild enclosure on Christmas Island, which was surrounded by a 1m-high barrier designed to exclude wolf snakes, rats and giant centipedes. In April 2017, Parks Australia released 139 blue-tailed skinks into the exclosure and hub PhD candidate Jon-Paul Emery from the University of Western Australia monitored the new population. Jon-Paul recorded a gradual decline in their numbers, and by September 2017 none were detected. While there was no obvious cause of decline, monitoring also recorded large numbers of introduced giant centipedes. Despite efforts to remove them through active searches and trapping prior to and post release, centipede numbers could not be suppressed. As the centipedes had been on Christmas Island for at least 100 years, they had not previously been considered the primary threat to the skinks, but they are ferocious predators capable of preying on vertebrates much larger than themselves.

IMAGE: JON-PAUL EMERY

Jessica Agius and supervisor David Phalen analyse samples for pathogens.

Jon-Paul undertook an experiment exposing skinks in smaller enclosures to a density of centipedes that matched that of the exclosure

for three months and found that it reduced the survival of the skinks by over 30%. Christmas Island National Park staff consequently made great efforts over the next six months to eradicate centipedes from the reintroduction site, in preparation for another trial. Parks staff and Jon-Paul also added an estimated 20 tonnes of logs and branches, 10 tonnes of rock, ceramic tiles and wooden pallets to the site, to improve its habitat suitability.

## Second trial

With centipedes removed and habitat made more suitable, in early August 2018, 170 blue-tailed skinks were released into the site. Before the release, the animals were weighed, measured and toe-clipped for unique identification, and inspected for signs of the *Enterococcus* bacterium (see below). Now, 12 months post-release, mark-recapture of more than 200 additional individuals has shown that the population in the trial area has increased substantially. The continuing success of this trial provides for another insurance population of skinks on Christmas Island, has helped resolve the main threats, and has shown that – at least at small scale – those threats can be successfully controlled.

## Their own tropical island

A new stage of recovery action for the blue-tailed skink is underway. In September 2019, Parks Australia, supported by the Shire and community of the Cocos (Keeling) Islands, introduced 300 skinks to the tiny uninhabited Pulu Blan Island (2.08ha) in the Cocos (Keeling) Island group. The first 150 skinks came from the captive breeding program at Taronga Zoo, and were followed soon afterward by an additional 150 skinks from the captive breeding program on Christmas Island. The release was made possible following successful rat eradication on the island by Parks Australia in January 2019. Hub Masters student Kristen Schubert from the University of Western Australia will monitor the released animals and make comparisons between the survival of animals from the different breeding programs. A second release to another island in the Cocos group, Pulu Kembang (3.38ha), is planned for early 2020.

## Assessing reptile health on Christmas Island

Infectious diseases are an increasing threat to wildlife populations worldwide, and have been associated with species declines and extinctions, particularly on islands. In 2014, an *Enterococcus* bacterium was discovered in the captive breeding population of Lister's geckos on Christmas Island and resulted in the death of over 40 individuals. This outbreak prompted a more in-depth health analysis of Christmas Island reptiles, which was undertaken by PhD candidate Jessica Agius from The University of Sydney. The assessment additionally discovered two papillomaviruses and several parasites in both invasive and endemic geckos.

## The bacterium

The *Enterococcus* bacterium results in inevitable death of infected animals. Screening has revealed that, fortunately, introduced geckos on Cocos Islands, the site of the recent skink introduction, are not affected. Antibiotics have been trialled on invasive geckos on Christmas Island to see whether Parks Australia could treat infected animals, and while some promising results were achieved, those results also suggested the bacterium may be highly resistant to the antibiotics. This disease therefore threatens the conservation management of the Critically Endangered reptiles on Christmas Island, and poses a high biosecurity risk.

## The viruses

The discovery of two papillomaviruses in Christmas Island lizards is the first report of papillomavirus in lizards globally. The papillomavirus and *Enterococcus* bacterium showed in some animals at the same time, meaning they may work together to cause disease. A diagnostics test to detect the viruses in apparently healthy animals has been developed, and continuing research is seeking to unravel the effects of these viruses on Christmas Island lizards.

## The parasites

During the health assessment several internal and external parasites were found: mites, tapeworms, lungworms, roundworms, flukes and coccidia. Infestation by parasites can cause damage to the reptiles' internal organs, increase their susceptibility to disease and, in some cases, cause death.


IMAGE: LEONIE VALENTINE

ABOVE: Jon-Paul during monitoring of the first trial reintroduction.

Cocos Islands and Christmas Island reptiles are equally affected by parasites, so understanding them will be valuable to managing populations on both Christmas Island and the Cocos Islands.

## What's next for Christmas Island reptiles?

The reintroduction of blue-tailed skinks into Christmas Island exclosures has been successful to date, and continued monitoring will help us to evaluate longer-term success. It is early days for the skinks on Pulu Blan, but monitoring will reveal the outcomes of that trial.

The disease research will now attempt to understand more about the genome of the *Enterococcus* bacterium, its resistance to antibiotics, and the most effective antibiotic treatments.

We will also continue our investigation into the impact of introduced species on the Lister's gecko and blue-tailed skink, which stand as fascinating examples of millions of years of reptile evolution in the isolation of Christmas Island.

*This Threatened Species Recovery Hub project is a collaboration between Parks Australia (Christmas Island National Park), the University of Western Australia, Charles Darwin University, The University of Sydney, Taronga Conservation Society Australia, the Australian Registry of Wildlife Health, Taronga Zoo and the Holsworth Wildlife Research Endowment, with input and advice from the Christmas Island Reptile Advisory Panel (a committee of Parks Australia staff and independent experts). The project is supported by the Australian Government's National Environmental Science Program.*

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The semi-wild enclosure on Christmas Island provides 2600m² of habitat but excludes non-native Asian wolf snakes.

IMAGE: ALEX JENSEN

Yawuru cultural leaders, Indigenous Rangers and Nyamba Buru Yawuru (NBY) staff were welcomed to Ngunnawal land by Richie Allan.

IMAGE: NYAMBA BURU YAWURU

# Exploring a haven for Yawuru Country

Nyamba Buru Yawuru, whose traditional lands cover 5300sq km of subtropical coastal and inland savannah country around Broome in Western Australia, are exploring opportunities to develop a predator-free wildlife sanctuary on their country. If a fenced feral predator-free wildlife haven was established on Yawuru country it would be the first in northern Australia and the first to be led and managed by an Indigenous organisation. **Mike Wysong**, the Indigenous Protected Area Coordinator, told us about Yawuru's recent visit to Canberra to see the Mulligans Flat sanctuary and the opportunities a haven could open up for Yawuru.

The Kimberley is a massive region which has unique ecosystems across its land and sea, and much of its land tenure is under Indigenous control. While there are many Indigenous ranger groups and conservation projects, there are no fenced safe havens in the Kimberley. The Yawuru community is largely unaware of what havens are or the benefits they may offer, so we sent a Yawuru delegation to Canberra in September 2019 to visit Mulligans Flat so that we could get a first-hand understanding of what fenced safe havens are and how they work.

The delegation of nine people included Indigenous rangers, senior Yawuru Traditional Owners and staff from the Environmental Services unit of Nyamba Buru Yawuru (NBY), the operational company for the Yawuru native title holders.

## A Ngunnawal welcome

On the first day Richie Allan, a Ngunnawal Traditional Owner, provided a Welcome to Country and offered his perspective on the cultural value that Indigenous groups can provide to safe haven programs. We also met with Jason Cummings and others at Mulligans Flat wildlife sanctuary to hear about the project and to tour the sanctuary. At night, we learned about the research program, went on a great spotlighting tour and saw some of the threatened animals within the sanctuary. We also had an opportunity to meet with the Threatened Species Commissioner and the Minister for the Environment in Canberra to discuss our interest in developing a Yawuru fenced safe haven.

This trip was about imagining possibilities for a local project that is strongly aligned to Yawuru's values and mission and not dependent on traditional development options for regional economies such as mining or agriculture. During the trip we realised that returning missing fauna to country heals country in a holistic way by restoring lost or broken ecological processes.

Yawuru Rangers Eduardo Maher and Sharee Dolby present Ngunnawal custodian Richie Allan with a pearl shell from Yawuru country.

IMAGE: BRADLEY MOGGRIDGE

This is a powerful message for both healing Country and the people of Yawuru Country who have been on this land for tens of thousands of years. This is valuable in a post native title world when healing can start with healthy country and foster healthy people and communities through maintenance of culture, traditions and values.

## Taking it back to community

To ensure we have community support for this project, we hosted a Yawuru community meeting to share what we learnt and discuss the project with Yawuru members. There was strong support for the project from the members present to develop it into the next stages.

Given this support, we will be seeking funds to further develop this project so that we have capacity to take on such a large endeavour and develop a feasibility study exploring funding models and options. We will reach out to organisations who can provide program support to establish mutually beneficial partnerships for the long term.

## A multitude of possible benefits

The fenced safe haven project aligns strongly with our mission of *Mabu buru, mabu ngarrungunil*, *mabu liyan* (healthy country, strong community, and good feeling). A sanctuary could potentially bring benefits to the whole of NBY, including Environmental Services, Community Development, the Yawuru Language Centre and Economic Development.

Yawuru is the largest private landholder in the Shire of Broome and a strong civic partner. An opporutnity to develop a valuble conservation project would benefit the wider community and offers a sustainable investment in line with Yawuru values.

A number of threatened and culturally important species could be included in a fauna recovery program. Some threatened species historically known in Yawuru country such as the burrowing bettong, golden bandicoot, golden-backed tree rat or northern quoll could be re-introduced. Other rare species like the bilby, northern nail-tail wallaby or the spectacled-hare wallaby could be candidates for protection. Some culturally important species that are either rare or under threat, such as the echidna, the spotted goanna or the bush turkey could be included.

## Growth opportunities

As the native title holders of the Broome area, Yawuru is in a unique position to develop economic, social and cultural opportunities associated with a fenced safe haven which could be located on the Yawuru Indigenous Protected Area only 15 minutes outside of town.


ABOVE: A section of coastline within the Yawuru Indigneous Protected Area.


ABOVE: The delegation of Yawuru cultural leaders, Indigenous Rangers and NBY staff presented the idea of a haven and what they had learned at Mulligan's Flat Sanctuary to Yawuru community at a community meeting after they returned.

This project could include guided cultural tours, spotlighting tours or high-end visitor accommodation facilities targeting the many visitors who come to Broome each year bringing revenue to NBY or local Yawuru businesses. Another important benefit could include the development of cultural programs around language, traditions or artwork associated with recovered fauna or though strengthening cultural ties with other Kimberley Aboriginal groups that share these animals.

There is also the opportunity to engage the broader Broome community through school projects, youth retreats, or the development of an interpretation centre. This project may also provide short- and long-term employment opportunities for Yawuru people, provide training and new skills for Indigenous rangers and create career pathways in science and conservation management for young aspiring Yawuru students.

In short, this project has the potential to provide many cultural, social and economic opportunities beyond just threatened species conservation, which makes it highly attractive to the Yawuru community.

*Nyamba Buru Yawuru received support from the Western Australian Government's State NRM Program and the Threatened Species Recovery Hub of the Australian Government's National Environmental Science Program to undertake the trip to Mulligans Flat to explore wildlife sanctuary options for their Country.*

***For further information***

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IMAGE: ANDREW BAKER

# Detection dogs rapidly filling the gaps for rare **antechinus species**

The silver-headed antechinus and black-tailed dusky antechinus are carnivorous marsupials found in high-elevation forests in parts of central-eastern and south-eastern Queensland. They were only described in the past six years, but they are already listed as Endangered. Knowing where they occur is essential for effective conservation, but current distribution knowledge is patchy. To address this, PhD candidate **Stephane Batista** in partnership with the Queensland Herbarium and Queensland Department of Environment and Science is modelling the habitat where these threatened species are likely to occur, and is using detection dogs to rapidly survey these sites.

ABOVE: A silver-headed antechinus *(Antechinus argentus)* caught during monitoring at Kroombit Tops National Park in Queensland.

The silver-headed antechinus (*Antechinus argentus*) and black-tailed dusky antechinus (*Antechinus arktos*) have a lot to contend with. They have very specific habitat requirements, needing cool and high-elevation forests. Climate change poses a threat to these species, as their mountain-top habitats are expected to become warmer, drier and more fire-prone. Within these areas, they are also threatened by a range of feral animals. Feral cats and red foxes prey on the antechinuses; pigs, cattle and horses trample and modify their habitat.

## Where to look?

Knowing where populations occur is essential for effective conservation planning and ensures resources can be directed to manage threats in the most important areas. To date, there are only a small number of geographic records for these recently described species. They are likely to occur at some other sites, but knowing where to look for them is challenging.

We are tackling this problem by creating models of potential habitat use. The models incorporated habitat characteristics derived from existing records to predict areas most likely to have suitable habitat. We selected sites to survey within areas modelled with high probability, but as the models were based on relatively small numbers of records, and we want to continue to test and refine them, we also surveyed some sites that the models identified with lower probability.

## Release the hounds

With a large number of sites to search, we needed an efficient survey method. Previous surveys have primarily relied on Elliott (metal-box) trapping, but as well as being resource-intensive, the method may be less reliable if animals occur at very low densities, as is the case with these two antechinuses.

Conservation detection dogs have been used since the 1990s, and can confirm the presence or absence of species more effectively than most other methods, especially when species are very rare. We are working with the detection dog team, Canines for Wildlife. Field trials in 2017 and 2018 confirmed that the trained dogs are highly reliable at detecting the scents of both antechinuses.

The dog surveys are fast, taking a single dog and handler only 45 minutes per site. In comparison, previous trapping surveys in new areas typically invested 300–600 trap-nights of effort at each site, requiring three days with a team of at least two people.

BELOW: Silver-headed antechinus (*A. argentus*) recorded by camera trap after a dog detection at the site.

IMAGE: STEPHANE BATISTA

There is still great value in deploying Elliott traps at historical sites and new sites detected by the dogs, as there is the potential to capture live animals (determining age, sex and reproductive status of individuals, as well as collecting genetic samples), confirm current presence of the target species and assess population trends over time across different sites. So, we are using both techniques in tandem, along with subsequent deployment of remote camera traps.

In 2019, we used the dogs to survey 95 sites in national parks in Queensland and northern New South Wales. This included both historical sites and those identified by the predictive habitat model. We were assisted by Indigenous rangers from the Gidarjil team (within the Port Curtis Coral Coast Trust) during the surveys at Kroombit Tops National Park. Their local knowledge and on-ground assistance were invaluable in making the trip a success.

As in past field trials, the dogs identified antechinus presence in new locations, including a couple of sites where we did not expect the target species to be. These new records will help refine the potential habitat modelling and provide more accurate distribution information for species management plans.

## What's new for the silver-headed antechinus?

The silver-headed antechinus was first discovered on the eastern escarpment of Kroombit Tops National Park, near Gladstone, and subsequently in isolated high-elevation areas at Blackdown Tableland and Bulburin National Parks, also in central-eastern Queensland.

In our 2019 field work, we surveyed 53 sites with the detection dogs, and they positively detected the species at 13 sites, 11 of which were new. This included new records for several sites in Blackdown Tableland, Kroombit Tops and Bulburin National Parks. Many of the dog detections were later corroborated by Elliott- or camera-trapping.

Staff from the Department of Environment and Science (DES) are already using these results to guide conservation planning for the species and to prioritise pest and fire management in these national parks.

## Where are the black-tailed dusky antechinuses?

In 2019, we surveyed 42 sites with detection dogs in our search for the black-tailed dusky antechinus. The dogs recorded positive detections at 17 sites, of which 10 were new.

But the story unfolding for this threatened species is concerning.

They were first described in 2014, after animals were captured in the cool subtropical rainforests of the Scenic Rim, in Springbrook National Park, about 100 km south of Brisbane.

However, a field trip to Springbrook in June of 2019 to collect scats and other odour samples to refresh dog training returned some startling results. We caught no black-tailed dusky antechinuses, despite 800 trap-nights at a site where our research team had made 10–12 captures in previous years using a similar effort. Even the very common brown antechinus (*A. stuartii*) was not caught in any traps during June, when we would usually catch one in every 6–8 traps deployed.


IMAGE: IAN GYNTHER, DES

ABOVE: Stephane Batista, the PhD student, holding a black-tailed dusky antechinus (*A. arktos*) captured after three months of intensive trapping.

Trapping results from similar field trips in July and August of 2019 were equally disappointing.

Three months of intensive but unsuccessful Elliott-trapping in one of the species' best-known areas in south-east Queensland alarmed us with the possibility of local extinction. However, when the dogs joined the search in August, they did detect black-tailed dusky antechinus at a few locations in Springbrook where the traps had turned up nothing.

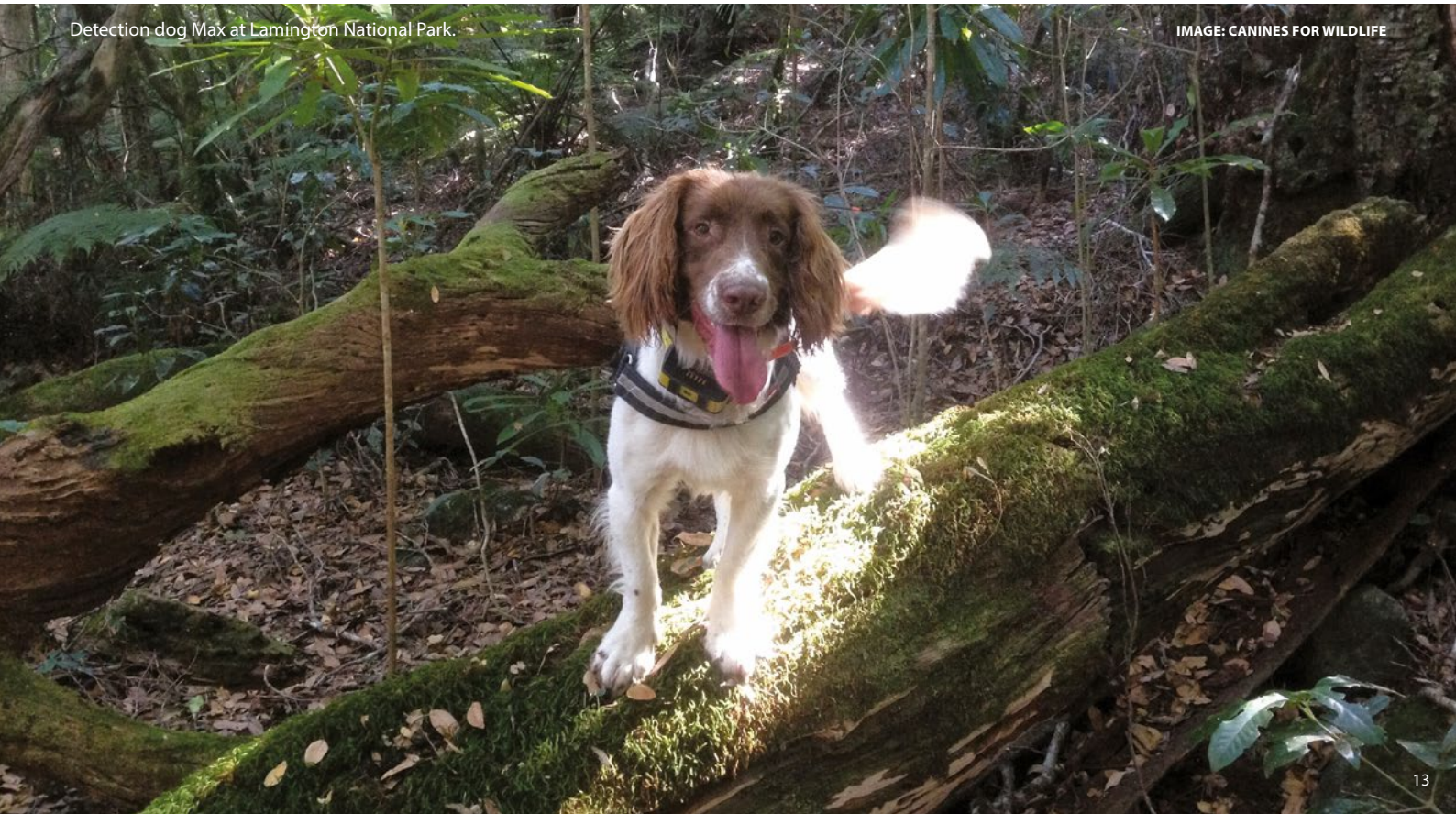
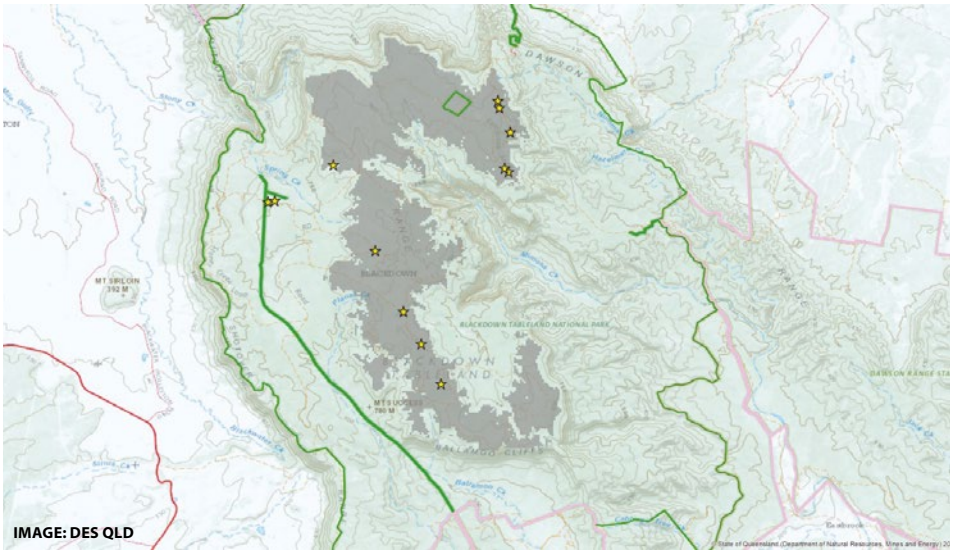

Detection dog Max at Lamington National Park.

IMAGE: CANINES FOR WILDLIFE

# Detection dogs rapidly filling the gaps for rare **antechinus species** (continued)


ABOVE: Dog handler Lynn Baker from Canines for Wildlife with Ash, one of the detection dogs.




ABOVE: Map of Blackdown Tableland National Park showing detection records of *Antechinus argentus* and modelled potential habitat, used to inform pest-management activities.

Questions remain: Are the antechinuses still actually there or are the dogs detecting old scents? Or are the animals currently in such low numbers that only the dogs can find them? Either way, drought seems to have had a hand in their apparent decline. National Park rangers and local people also believe that the recent dry years have reduced the presence of other vertebrate animals and insects – the latter are important food for the antechinuses. In addition, feral predators such as cats are still being recorded at the sites.

Although *A. arktos* populations appear to have reduced right across the Scenic Rim, results at Lamington National Park were somewhat better. In August, dogs at both Binna Burra and Green Mountains detected the antechinus in most sites where we expected to find them and established new sites in adjacent areas on the edge of the Tweed Caldera. We also captured the first individual *A. arktos* after an intensive three months of Elliott-trapping, and dog detections guided other trapping locations, resulting in a couple more captures. Deployed camera traps may yet provide further corroborations of the dog detections when they are collected in December.

However, at some sites, it has taken months or even years for cameras to corroborate dog detections due to low numbers of animals.

Our evidence indicates that black-tailed dusky antechinus populations have contracted to the highest and wettest areas, and even in these areas, populations have declined. Given the changing global climate, and recent fires in the Scenic Rim and rainforest communities elsewhere in Queensland, we must recognise that fire may become an additional threat to their habitat and ongoing survival.

## What's next?

Field work will continue and include new sites. We will also intensify camera-trapping at sites where there have only been detections by dogs, which would corroborate current presence of target species. A series of different species distribution models will be run, tested and then compared for definitive outcomes for these species' most accurate distribution. There is an urgent need to understand how to conserve these rare marsupials before they are lost. Through this research, we will refine our understanding of their ecology, distribution and habitat and climate preferences.

This knowledge will be crucial to inform strategic management plans for the antechinuses and, more broadly, as a model for effective detection practices to conserve small mammals.

*This Threatened Species Recovery Hub project is a collaboration between Queensland University of Technology, The University of Queensland, Queensland Herbarium, Queensland Department of Environment and Science and Canines for Wildlife.*

*It is supported by the Australian Government's National Environmental Science Program and the New South Wales Office of Environment & Heritage (Saving our Species program), Queensland Parks and Wildlife Service and Partnerships, Port Curtis Coral Coast Trust and the Gidarjil Development Corporation.*

*The research builds on and is part of broader research on these species by Dr Andrew Baker (QUT) and Associate Professor Diana Fisher (UQ).*

***For further information***

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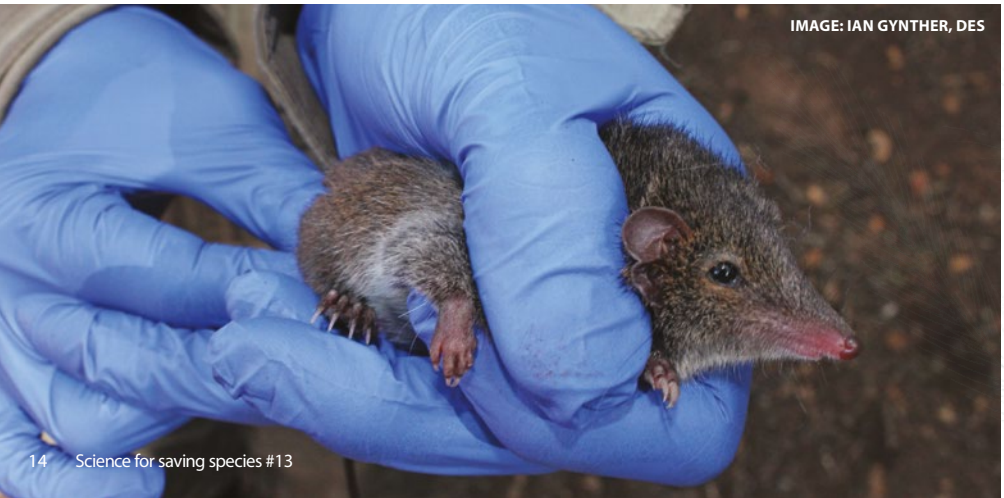


LEFT: A female black-tailed dusky antechinus (*Antechinus arktos*).

# Backyard scientists helping **possums and gliders**

IMAGE: JAANA DIELENBERG

RIGHT: A common brushtail possum in a Brisbane roof space

Almost a quarter of Australia's possums and gliders are listed as threatened under Australian environmental law, and many more are showing signs of decline. **Dr Rochelle Steven** from The University of Queensland believes people in the community can do a lot to support conservation, especially in urban areas. Here, she talks about how people can contribute to meaningful science, right in the palm of their hand.

Possums and gliders are amazing animals that deserve to survive for future generations to appreciate. Australia has 27 types of possums and gliders in a huge variety of sizes, shapes and appearances, and most are found nowhere else in the world. The smallest are the tiny pygmy possums, which are less than half the size of a house mouse. One of the largest is the mountain brushtail possum or bobuck, which at up to 4.5kg is the size of a small dog. Then there is the green ringtail possum, which really does have a yellowish-green tinge to its fur!

We are calling on citizen scientists to record sightings of Australia's possums and gliders in the new, free CAUL Urban Wildlife app (available for Android and iPhone). Citizen science is playing a crucial role in conservation, and we are discovering just how important urban areas can be for some threatened species.

## The western ringtail possum

Urban areas can have abundant possum populations. Regular sightings of the western ringtail possum in an area may suggest to residents that the species is not in trouble, but that isn't necessarily the case. The western ringtail is one of Australia's most threatened possums.

Although it is threatened, this ringtail is still regularly seen in several urban centres in the south-west of Western Australia where it is found, as much of its former range has been developed and is now a mosaic of urban and commercial areas, including vineyards.

Knowing where species are and how they are using the urban environment are important first steps to conserving them. Citizen scientists can submit sightings of possums through the app, which is easy to use and can be accessed anywhere in Australia.

We would like people to record the possums and gliders that they see in their backyard or in parks, or even while on holiday. It is also helpful to record information on the behaviour of the possums, such as where they are sleeping and what they are eating.

You don't need any special expertise to participate. The app features photos and information on every Australian species, and using your device's in-built GPS will present you with the species found in your region, which makes it even easier and more rewarding to use.

Citizen science is good science. In a related part of this project, we collaborated with researchers at the University of Western Australia to ask people around Bunbury and Albany to identify whether they had western ringtail possums or common brushtail possums in their back yards. We found citizen scientists and professional scientists agreed up to 85% of the time regarding the presence or absence of these two species.

## Living with possums

The information that people record through the app will help us to learn more about urban-dwelling possums and gliders. While the main threat to Australia's possums and gliders is habitat loss, in urban areas, dogs, cats and road traffic are also major problems.

Possums and people also sometimes find themselves in conflict; for example, when possums make a mess in roof spaces or eat our favourite plants. We know these kinds of conflicts occur, but could they be impacting on the conservation of threatened species like the western ringtail possum? That's another aspect we are investigating.

Learning more about possum behaviours and issues will also help us provide guidance for urban development and more strategic conservation actions. Sound, evidence-based solutions are sorely needed for managing urban biodiversity, and we hope that the observations made by citizens through this app will enhance this body of evidence.

The CAUL Urban Wildlife app is available from the App Store and Google Play. In addition to identifying and recording possum and glider sightings, users can contribute to research on beneficial insects, frogs and flying-foxes.

*This possum and glider citizen science project is a collaboration between the Threatened Species Recovery Hub and the Clean Air and Urban Landscapes Hub with funding from the Australian Government's National Environmental Science Program and the National Landcare Program through the South West Catchments Council.*

***For further information***

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IMAGE: SAM BANKS

IMAGE: DAVID BLAIR

# Obituary
# Dr David Blair

I have been to too many funerals – especially recently – and at times things are said about a deceased person that might be considered a little stretch of the truth. Not so with Dave Blair, who sadly died in a tragic skiing accident in September 2019. Dave Blair was a valuable member of the National Environmental Science Program's Threatened Species Recovery Hub who worked extensively in the wet ash forests of the Central Highlands of Victoria. He worked tirelessly in these forests for more than a decade.

One of my friends has on his email signature block *"What will you do with your one precious life?"* Well, Dave Blair did an enormous amount with his precious life. As Dave's extraordinary partner Sera Blair said, "He wasn't one to waste his life sitting on the couch watching Netflix". This was reflected in the fact that Dave Blair was a terrific father and a wonderful family person; he loved his football, his climbing, his hiking, his camping. He was also an amazing photographer, an outstanding botanist, and a dedicated conservationist who loved forests. Dave Blair trained in forestry and then, just a few months ago, was awarded his PhD for a series of excellent studies of the impacts of disturbance on plants.

There was enormous respect for Dave Blair from so many people, even those with opposing views on forests (and there were a few of them). This was because he was a person of integrity, detail and reasoned argument.

Indeed, Dave Blair was passionate about forests and he would have wanted for his legacy of hard and meticulous work on plants and vegetation to continue. The Australian National University and the Victorian Government have now ensured that this will happen. ANU has opened a post-doctoral fund for Dave Blair with the person filling the position responsible for focusing on writing up the meticulously collected vegetation datasets that he had collected. At the same time, the Victorian Government has provided funding for the next five years to ensure ongoing field data collection at ANU long-term sites in the wet forests of Victoria.

So, despite our sadness, the world is still a beautiful place – the forests nearby in which Dave Blair worked nearly every day are a testament to this. Just as the world is still a beautiful place, it also has many good people in it – and Dave Blair was undoubtedly one of the best of those. Thank you to Dave Blair for the truly colossal contribution he made to the world in so many ways!

David Blair's life was also recognised in Parliament on 10 September 2019 by Senator Rice from Victoria: https://www.aph.gov.au/Parliamentary_Business/Hansard/Hansard_Display?bid=chamber/hansards/fa4eb7cb-4d6f-4c8d-9f9d-61609bc1003a/&sid=0200

David Lindenmayer
ANU Node, Threatened Species Recovery Hub

ABOVE LEFT: David Blair hiking in Central Tasmania.

ABOVE RIGHT: David measuring a large old hollow-bearing tree in the Central Highlands of Victoria.

BELOW: David a long-term monitoring site prior to leading a possum watch for arboreal marsupials.

IMAGE: TABITHA BOYER

The Threatened Species Recovery Hub is supported through funding from the Australian Government's National Environmental Science Program.

***Science for saving species***

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**COVER IMAGE: A SILVER-HEADED ANTECHINUS (*ANTECHINUS ARGENTUS*). (SEE PAGE 12 FOR THE FULL STORY.) IMAGE: ANDREW BAKER**

Threatened Species Recovery Hub
National Environmental Science Programme