# 2022 University Research Grant Winners

The Australian Wildlife Society's University Research Grants are scholarships offered to honours or postgraduate students at Australian universities. Each year, ten grants of $3,000 are awarded. Grants are available for research projects of direct relevance to the conservation of Australian wildlife (flora or fauna). Grants may be used to purchase equipment and consumables, travel expenses related to field research, or to attend conferences at which you are presenting your research.

The Australian Wildlife Society is delighted to announce the winners of the ten grants of $3,000 each to honours or postgraduate students conducting research that will contribute to the conservation of Australian wildlife.

**The winners for 2022 are:**

**ADAM YANEY-KELLER**
School of Biological Sciences, Monash University
**Project Title:** Disentangling the long-term effects of marine debris on Australian fur seals

**CLAIRE BUTLER**
Institute of Marine and Antarctic Studies, University of Tasmania
**Project Title:** Comparative effects of ocean warming on kelp-herbivore interactions on Australian temperate reefs

**ELISE OAKMAN**
School of Life and Environmental Sciences, University of Sydney
**Project Title:** Does restoration return insect pollinators to our endangered ecosystems?

**ERICA CSEKO NOLASCO**
School of Biological Sciences, Queensland University of Technology
**Project Title:** Social-ecological drivers and outcomes of conservation in private lands

**JACLYN HARRIS**
School of Biological Sciences, Monash University
**Project Title:** Fire and Reptiles: An investigation into threatening processes and potential management solutions

**JAVIERA OLIVARES-ROJAS**
School of Biological Sciences, Monash University
**Project Title:** What is required to recover Australian threatened ecosystems?

**JESSICA KEEM**
School of Ecosystem and Forest Sciences, University of Melbourne
**Project Title:** Refuges are vital for the survival and persistence of fauna in the wake of disturbance events

**NICHOLAS MACDONALD**
School of Life and Environmental Sciences, Deakin University
**Project Title:** Investigation of the immune response of the Tasmanian devil (*Sarcophilus harrisii*) to cancer and altered environmental conditions

**NICOLE LYNCH**
School of Life and Environmental Sciences, University of Sydney
**Project Title:** Spot the quoll: Tactical use of olfactory information to improve detection and conservation of a rare, native carnivore

**SHAWN SCOTT**
UniSA STEM, University of South Australia
**Project Title:** Post-fire population recovery and chytrid occurrence in frogs of the Mount Loft Ranges, South Australia










# Disentangling the Long-Term Effects of Marine Plastic Debris on Australian Fur Seals

**ADAM YANEY-KELLER**
School of Biological Sciences, Monash University

Each year, tens of millions of metric tonnes of plastic waste are estimated to enter our oceans from land- and water-based sources. For marine life, this plastic can pose serious problems, especially in discarded fishing gear or other debris which can entangle or trap wildlife, causing injury and death in an untold number of cases. This problem is disturbingly ubiquitous for seals, having been documented in more than half of all species. Videos of seals being rescued from materials ranging from nets and fishing lines to discarded toys and clothing have garnered hundreds of millions of views. The images of these once playful animals weighed down and strangled by our pollution distressingly resonate with many individuals.

Australian fur seals (*Arctocephalus pusillus doriferus*), the most widespread of Australia's endemic seal species, are no strangers to this problem. Nearly hunted to extinction by colonial seal hunters in the early 19th century, one of the most important breeding colonies for this species, Seal Rocks off the coast of Phillip Island, Victoria, has one of the highest rates of entanglement of any seal population. The entanglement rate is particularly troubling as, after decades of recovery following legislative protection in 1975, long-term monitoring of their population has revealed a decline in pup numbers over the past fourteen years. However, the true extent and causes of this problem are unknown. What is known is that marine plastic debris, mostly discarded fishing gear, is estimated to entangle hundreds of fur seals at Seal Rocks each year.

Unfortunately, the full effect of entanglement on marine wildlife populations is hard to determine. Only a portion of entangled seals is ever seen. Usually, seals that become entangled out at sea close to their colony, or those that are strong enough, return to land after being entangled out at sea. Those who cannot return to land may die at sea, and for those who survive, serious injuries caused by their entanglements may be detrimental to their ability to forage, survive, and reproduce. The most affected age classes are pup and juvenile seals, including the fur seals off Phillip Island. Their curious nature, small size, and fast growth rate make them especially vulnerable to the risk of entanglement. But despite the global publicity, we know surprisingly little about the long-term effects these entanglements have on both individuals and populations.

For Australian fur seals, the remote nature of the seals' colonies on offshore, rocky islands makes travel to the study site to investigate the risk of entanglement extremely challenging, even in the best conditions. This challenge has led wildlife researchers at Phillip Island Nature Parks, who manage the Seal Rocks colony, to adopt a popular new technology for monitoring wildlife populations – drones. Every two months, a small drone is remotely piloted over the colony (high enough not to disturb the seals). Hundreds of overlapping photographs are taken to create a precise snapshot of the population. This snapshot is used to monitor the size and demographics of the seal population in real time. It counts potential entanglements using the innovative citizen science portal, SealSpotter, in which members of the public can log on from home and help count seals and entanglements seen in the drone photographs.

**Top:** Adam Yaney-Keller is a wildlife ecologist interested in biodiversity conservation and emerging technologies in the School of Biological Sciences at Monash University.

A dead Australian fur seal (*Arctocephalus pusillus doriferus*) found on a beach with a plastic packing strap tightly constricting its neck on Phillip Island, Victoria. Image: Phillip Island Nature Parks.

An entangled Australian fur seal (*Arctocephalus pusillus doriferus*) is restrained and freed from entanglement in fishing gear. Image: Phillip Island Nature Parks.

Entanglements that are large and brightly coloured, such as fishing trawl netting, can be recognised by an observant eye, but a transparent fishing line which can get wrapped around the neck of a young seal and cut into them as they grow, is much more challenging to spot.

Entanglement has troubling implications for the conservation of a species and its environment. Entanglements can theoretically cause various issues, from debilitating infected wounds and lowered thermoregulatory ability to extended time until weaning, but little modern, empirical evidence is available. While preliminary experiments from the 1980s showed that entangled Northern fur seals (*Callorhinus ursinus*) have a marked reduction in survival, foraging ability, and reproduction following severe entanglement, no similar studies have been conducted since for any other seal species. Where and how seals become entangled remains not readily understood. A host of variables can come into play to determine where, when, and how severe an entanglement might be for any given seal, let alone the long-term consequences for the population. What is well documented is that entanglement causes immediate concerns for wildlife welfare, as individuals can face debilitating injuries and slow, painful deaths.

Seals (like many top marine predators) are ecosystem sentinels, meaning their populations respond to changes in the environment in timely, measurable, and interpretable ways. As they move between and are exposed to threats in both the marine and terrestrial realms, studying their health allows us to observe the effects of pollution and other issues generally hidden from plain view. By studying Australian fur seals, we can understand how plastic pollution affects the species throughout their range, allowing for the design of more effective conservation policies for the ecosystem.

All of this raises several critical questions necessary to understand and better manage this severe threat to wildlife conservation and welfare:

1. How many seals are becoming entangled?,

2. What effect does an entanglement have on the health and behaviour of these seals?, and

3. Where are seals becoming entangled, and how can we improve the management of these areas to mitigate this threat?

This project aims to assess the utility of thermal aerial imaging to improve the detection of fur seal entanglements. Thermal cameras, which translate infrared surface radiation into pixels in an image corresponding to temperature, may enhance our ability to detect entanglements ordinarily challenging to spot in standard photographs. The project will compare the effectiveness of these technologies for detecting entanglements by combining thermal infrared cameras with the standard colour photography taken during drone surveys. A side-by-side comparison of thermal and standard colour photographs captured from the drone will be used to determine if thermal imagery can detect a unique thermal signature of entanglements that can be viewed and recognisably categorised to improve current survey efforts.

A photograph captured during drone surveys of fur seals on Seal Rocks. A pup entangled in green trawl netting can be seen in the centre of the photograph. Image: Phillip Island Nature Parks.

Entangled and non-entangled seals of similar age and sex will be captured (under approved animal ethics) to determine how entanglement affects fur seal behaviour, body condition, and overall health. The seals' body condition and blood markers for general stress and health will be compared.

Entangled seals will have their entanglements removed and will be outfitted with bio-loggers and GPS trackers that will yield critical information on where the seal is going and how entanglement may affect its subsequent foraging ability. By tagging and following these seals for subsequent years through re-sight surveys, the project will aim to understand how entanglement may affect their long-term growth, survival, and reproduction.

GPS tracking data from tagged seals will determine where seals' foraging routes overlap with commercial and recreational fishing activity throughout their range. A model of plastic accumulation areas within this same region will be created and overlayed with tracking data, allowing for a map of potential entanglement hotspots to be created.

The data collected will allow wildlife and resource managers to review where better protections for fur seals and other species at risk from entanglement may be necessary. The project will also improve current methods to understand and respond to threats to wildlife welfare, and effectively conserve and manage fur seals and other marine species affected by marine plastic pollution.

If you would like to help with the conservation and management of Australian fur seals by counting entangled and non-entangled seals in drone photographs, check out the SealSpotter Citizen Science portal at https://bit.ly/3CNfmlt. To follow the progress of the project, please follow the Monash University Ecophysiology and Conservation Research Group @LetsGetPhysEcol and Adam Yaney-Keller @_adam_yk on Twitter.

We acknowledge the Bunorong People of the Kulin Nation as the Traditional Owners of the land and sea country this project takes place. We also pay our respects to Elders, past, present, and emerging.

**FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY** will be used to pay for operational expenses associated with flying the drone to detect entanglements via thermal imagery, including flight time, critical training, and licensing.

# Comparative Effects of Ocean Warming on Kelp-Herbivore Interactions on Australian Temperate Reefs

**CLAIRE BUTLER**
Institute of Marine and Antarctic Studies, University of Tasmania

Ocean warming is occurring at an unprecedented rate, and to predict the ecological consequences, we first need to understand how marine species will respond. However, not all species respond in the same way, and ocean warming is not even across the ocean, leading to a mosaic of potential responses to climate change among marine organisms.

Much of what we currently know about how species respond to ocean warming is based on studies that have experimentally assessed thermal limits for a given species using a single population and location per species. Observational studies that use the species' current thermal distribution to infer its upper and lower thermal limits have also been examined. These approaches overlook two key areas that would significantly enhance our understanding of the ecological impacts of ocean warming. One of these areas is within-species variation in thermal performance. In much the same way that not all humans find Tasmanian winters cold, or that your best friend is able to cope with hotter climates much more readily than yourself, populations and individuals within a given species may respond differently to temperature depending upon a host of different factors including evolutionary history, life history traits, behaviour, and genetics.

Another key area of variation in the realised thermal performance of a species is indirect, through species interactions. How a species performs relative to its predator or prey is of critical importance, and any changes to the strength of this interaction may, in turn, alter whole-ecosystem function and resilience. For example, in marine ecosystems, herbivorous urchins and fishes can play a key role in mediating the abundance of macroalgae. Overgrazing may occur if ocean warming favours the physiological performance of herbivores relative to

**Top:** Claire with a long-spined sea urchin (*Centrostephanus rodgersii*). Image: Yenny Wang.

Beneath the canopy of a kelp forest. Just like the trees in a terrestrial forest, canopy-forming kelps such as these create a unique habitat for a vast diversity of algal, invertebrate, and fish species. Image: Matt Doggett.

their macroalgal food source. In the case of habitat-forming kelps, which act as the marine equivalent of trees in a forest, this overgrazing can lead to 'deforestation' and remove all ecological, economic, and social values from temperate reef ecosystems.

When urchins overgraze and cause the collapse of kelp bed ecosystems, they form what is known as an 'urchin barren'. Barrens form when sea urchins change their feeding behaviour from passive feeding, on drift algae, to active grazing of attached macroalgae. Barrens are maintained through a switch in the urchin diet from large macroalgae to encrusting and filamentous forms. Once formed, urchin barrens present an alternative, impoverished, stable reef state that is extremely difficult to reverse. In recent decades, the barren formation has been occurring across large areas of temperate rocky reefs globally, including across the south-east coast of Australia, where up to 50 percent of temperate reef habitat has been lost in some areas. The formation (destructive overgrazing of large adult kelps) and maintenance (scraping of microalgae and juvenile kelps) of barrens represent two different forms of herbivory, each governed by different processes and each with a potentially different response to ocean warming.

Using the temperate reefs of south-east Australia as a case study, this project aims to investigate how temperature impacts urchin-kelp interactions that underlie the destructive overgrazing of kelp beds and the maintenance

A dense kelp forest at Fortescue Bay in Tasmania. Image: Matt Doggett.

of urchin barrens. Changes among populations at the warm (New South Wales) and cool (Tasmania) edges of these species' thermal distributions will also be compared.

Urchins and macroalgae from barrens and kelp bed habitats will be collected and taken to a lab where they will be acclimated to six different temperatures up to thirty degrees Celsius. After acclimation, urchins will be fed a known amount of macroalgae, and the amount consumed within twenty-four hours will be measured. A series of similar grazing assays will address the second aim, and metabolic rate trials will be conducted in situ at three locations within each state. The metabolic trials will use a custom-built and transportable chamber system to assess the acute thermal sensitivity of urchins and macroalgae by exposing them to a series of trials at increasing temperatures.

The results of this work will provide crucial information on the future resilience of our temperate reef ecosystems, aid in their management and conservation, and contribute to our understanding of the role of within-species variation and species interactions on the ecological impacts of ocean warming.

**FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY** will be used to purchase materials and equipment to build a portable system to assess the metabolic rates of urchins across a range of different temperatures.

An urchin barren at St Helens on the east coast of Tasmania, an area that once supported dense and biodiverse kelp forests. Image: John Keane.

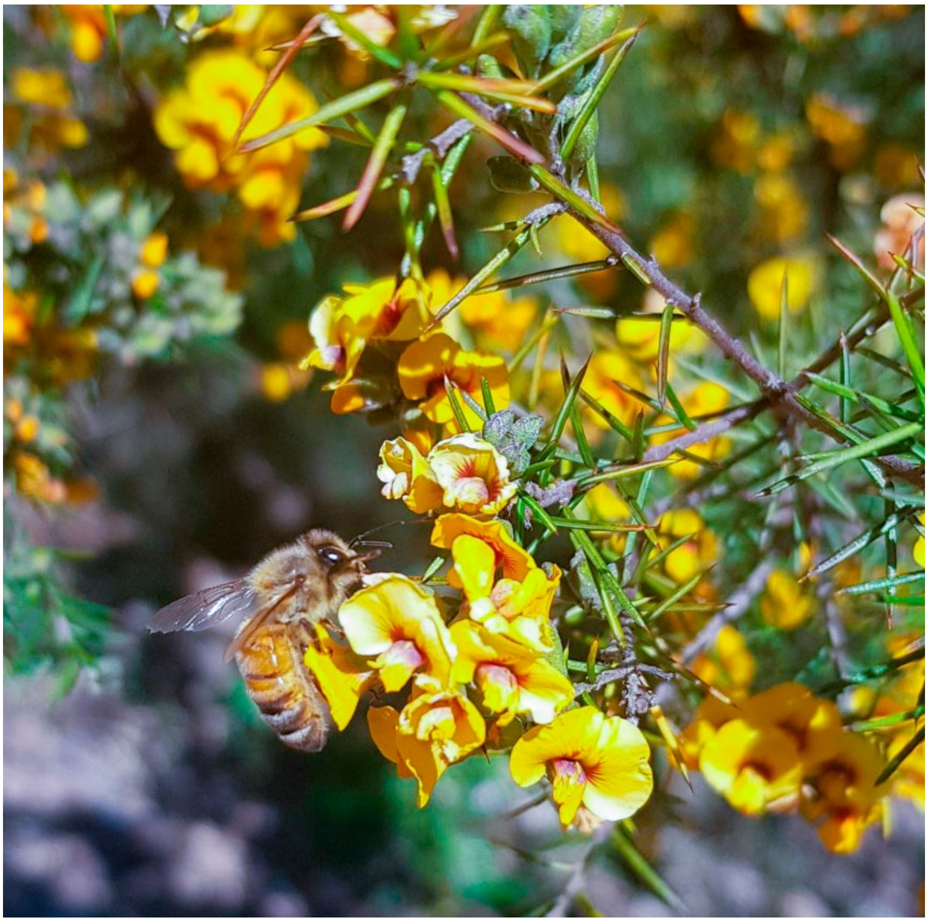
# Does Restoration Return Insect Floral Visitors to Critically Endangered Ecological Communities?

**ELISE OAKMAN**
School of Life and Environmental Sciences, The University of Sydney

Environmental restoration is not a new concept. Most people would have seen environmental restoration in action, whether at your local park or in larger areas such as national parks. Some classic examples of restoration include weed clearing and planting trees. The typical goal is to try and return the space to its natural state. Eventually, the re-planted areas will look like the original pre-clearing forest, and the animals and ecosystem services will return. However, the reality is often not that seamless.

Restoration evaluation often only considers structural change to determine success. For example, one method is to take a before and after photograph to prove that plant abundance and species diversity have increased. However, this method does not mean that animals have returned to a habitat. Neither does it ensure that the ecosystem services required are present. There is now a stronger focus on evaluating how functional ecosystems develop long-term and whether these restored areas can provide environmental services such as pollination – that benefit organisms, including humans.

Environmental services are needed for any of these restoration efforts to continue long-term, such as pollination. Without pollination, the plants will fail to reproduce, suffer from a poor variety of genetic variation, and struggle to support animals in the face of disturbances. Not to mention how much money gets sunk into repeatedly having to fix up restored areas that failed to take off. Our restored areas need pollination, and we need our floral visiting insects.



A European honey bee (*Apis mellifera*) visits a Sieber's parrot-pea (*Dillwynia sieberi*) flower. Image: Elise Oakman.

Without animals such as insects being present to perform pollination, ecosystems lose the ability to self-maintain. Much of the pollination credit goes to our bees (whether they be the European honey bee (*Apis mellifera*) or our native bees). But other insects such as butterflies, flies, moths, and even sometimes beetles help contribute to pollination. Insects that are our pollinators are not necessarily the same as our floral visitors. But, to proceed, we must determine who the floral visitors are. We can then determine what attracts and supports them in these restored areas. After this, further research can determine their role in pollination.

Research on how restoration methods and environmental factors impact floral visiting insects is highly variable. The result can change significantly depending on the location, species, and restoration method. Both large- and small-scale environmental factors could influence insect floral visitors. However, what impacts insects and how cannot be assumed, but it does present a wide variety of potential factors to consider.

Firstly, floral abundance. While it seems evident that higher floral resources often mean greater insect abundance, other factors, such as canopy cover, ground cover type, and weed presence, can impact insect abundance and species richness. Other

**Top:** Elise Oakman is a PhD Candidate at the University of Sydney. Elise's research aims to determine what pollinating insect communities return after restoration. Image: Elise Oakman.

large-scale environmental factors such as restoration method and intensity, patch size, and restoration age can also impact insect abundance and species richness. The impacts of these different factors will ultimately vary between locations. We need to know what supports our floral visiting insects to understand how to restore areas to maximise pollination services.

When restoring endangered ecological communities, there is even more pressure to ensure that these communities persist into the future. The Cumberland Plain Woodland of Western Sydney is a critically endangered ecological community. Only 8 percent remains today. The list of endangered and vulnerable plants and animals that call the Cumberland Plain Woodland area home is long. Some are as well-known as the koala, others less so, such as the regent honeyeater (*Anthochaera Phrygia*) and the Cumberland Plain land snail (*Meridolum corneovirens*). Insects are not on the endangered species list in the Cumberland Plain Woodland. However, they are recognised as a vital source of pollination.

The Cumberland Plain Woodland is home to a number of endangered and vulnerable plants, such as the juniper-leaved grevillea (*Grevillea juniperina subsp. juniperina*). These plants and others that characterise the community depend on pollination services. Without pollination, these already at-risk plants will struggle to survive.

Surveys for the research project will include sweep netting, pollard walks, and trap nests (bee hotels). These surveys will be conducted in privately owned biobanking sites, national parks and reserves, and public botanical gardens. The surveys will recognise the contribution that various land ownerships and management types play in restoring these endangered ecological communities.

This project will determine what environmental factors influence the presence of insects, and how and if current restoration practices return insect floral visitors. The Critically Endangered Cumberland Plain Woodland is an excellent example of a restored ecosystem that we must know how to improve. The Cumberland Plain Woodland is already a small percentage of what it once was. Restoration cannot afford to be short-sighted, and we need to know from the get-go what these endangered ecological communities need. We need to know what the insects need and how to support them. We cannot just plant and assume they will come back.

The project results can be used to inform recommendations and policy on how restoration work is conducted and evaluated. It will focus on supporting our floral visiting insects from the start, and the restoration management will focus on long-term survival. It will emphasise the importance of ecosystem services and not just structural change. The research can then act as an advancement to evaluate the insect floral visitors' role in providing pollination services.

**FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY**
will be used towards travel expenses to field sites, survey equipment, and a research license for working in National Park protected areas.

A cabbage white butterfly (*Pieris rapae*) visits a blue heliotrope (*Heliotropium amplexicaule Vahl*) flower. Image: Elise Oakman.

# **Better Outcomes for People and Nature:** Improving Private Land Conservation

**ERICA CSEKO NOLASCO**
School of Biology and Environmental Science, Queensland University of Technology

At present, wildlife is threatened by human activities such as land clearing and pollution. Globally, more than 40,000 species are currently at risk of extinction. This increasing number is concerning not only for species but for the human society that relies on many services delivered by wildlife and ecosystems. For example, insects are vital for agriculture as they have a prominent role in crop breeding systems (pollination), and vegetation holds riverbanks together, contributing to healthy rivers. It is easy to observe vegetation importance when considering a landslide. After the heavy rains in March 2022, many roads and hiking trails in Queensland and New South Wales were closed due to landslides. In these areas, the vegetation was cleared, and the roots could not hold the damp soil causing movements and affecting people.

World nations agreed on sustainability and restoration goals (e.g., Sustainable Development Goals and Global Biodiversity Framework) to address the decline in biodiversity, aiming not only to recover and protect the environment and wildlife but to do it in a way that improves people's life. With those goals in mind, nations have established national parks and other protective measures. However, government efforts alone do not have the logistic and financial power to protect biodiversity. For this reason, private land conservation – management of private lands to protect nature and wildlife – has been largely incentivised in various ways, for example, with financial or technical information support. In addition, private lands cover the greatest areas of most countries, overlapping with many threatened wildlife.

Unfortunately, Australia is not an exception to the biodiversity crisis. The State of Environment, released in July 2022, reported 1,918 species are at risk of extinction, 8 percent more than five years ago. Almost half of the Australian threatened species distribution overlaps with private lands (freehold). Some endangered and critically endangered species, like the pygmy blue-tongue lizard (*Tiliqua adelaidensis*) and the shapely zieria (*Zieria formosa*), occur only in this type of land tenure. The importance of private lands is even more evident when they represent about a third of the Australian territory, meaning that some species rely on private land conservation to survive.

Partnerships between government and private landholders, such as the Biodiversity Conservation Trust, support the lives of many threatened wildlife. Fungi surveys were conducted by the Biodiversity Conservation Trust with landholders of the Cowra region, New South Wales. Image: Biodiversity Conservation Trust.

## Private Land Conservation in Australia

Initiatives to encourage private land conservation occur in various ways, including in the form of laws, although these initiatives rely on individuals to manage their land in a way that preserves wildlife and the environment. In Australia, voluntary agreements (covenants) and partnerships, such as the Land for Wildlife in Queensland, New South Wales, and Victoria, are becoming popular. Agreements are binding partnerships between landholders and agencies, such as Biodiversity Conservation Trust and Bush Heritage, who encourage farmers to preserve the environment while still making profits from the land. Over 3 million square kilometres and more than 3,000 landholders are in some type of private land conservation partnership. High financial investments are being made nationwide to support private land conservation initiatives. For example, the New South Wales government committed to a $350 million investment from 2019 to 2020 to deliver private land conservation programs and agreements.

Regrettably, many private land conservation programs are unsuccessful or expensive relative to their outcomes.

**Top:** Erica Cseko Nolasco is a PhD Candidate at the Queensland University of Technology.

One probable reason for this ineffectiveness is the failure to consider the relationships between humans and the environment (or social-ecological system) in private land conservation initiatives. Interactions in social-ecological systems significantly impact wildlife and human well-being because people's behaviours and actions toward nature depend on their socioeconomic and cultural contexts. On the other side, nature influences human well-being and livelihood because biodiversity shapes ecosystem services and functions people use.

## How to Improve Private Land Conservation Outcomes

Studies have shown that positive biodiversity outcomes are more likely to occur when positive socioeconomic outcomes are also present. In addition, considering the social context while planning conservation initiatives tends to increase the probability of positive outcomes for both people and nature.

By accounting for interactions between biodiversity and human well-being in private land conservation program design and management, one can maximise positive outcomes and get a better return for the investment. With that in mind, the main goal of the project is to develop guidance for private land conservation initiatives to maximise positive outcomes for humans and wildlife by evaluating and prioritising private land conservation through the perspective of both social and ecological systems.

This project will work directly with private land conservation landholders and program managers, looking into how to improve outcomes for Australian wildlife through understanding the social-cultural contexts they are immersed in. Understanding the factors that lead private land conservation programs to success will enable higher rates of adoption and retention of landholders, thus leading to long-term outcomes.

By engaging with Landcare communities and government agencies, the project promotes pro-environmental behaviours and habits from the inside, with enormous potential to protect Australian wildlife. If you know successful stories about landholders and communities that carry Landcare and conservation initiatives, please get in touch to share their experiences and ideas.

**FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY WILL**
support research communication and case studies fieldwork, helping to increase the understanding of the context and conditions where positive outcomes for people and nature are possible in the private land conservation context.

Nest building event conducted by the Biodiversity Conservation Trust with landholders of South Coast region, New South Wales. Image: Biodiversity Conservation Trust.



The pygmy blue-tongue lizard (*Tiliqua adelaidensis*) and the shapely zieria (*Zieria formosa*) are two of the threatened species that only occur in private lands. Images: *Tiliqua adelaidensis*, Atlas of Living Australia, CC BY 4.0, via Wikimedia Commons; *Zieria Formosa*, Betty and Don Wood, CC BY 3.0, via Wikimedia Commons.

# Fire and Reptiles:

## An Investigation into Threatening Processes and Potential Management Solutions

**JACLYN HARRIS**
School of Biological Sciences, Monash University

In this sixth mass extinction, native species are facing a myriad of threats. Extinction drivers such as climate change, habitat loss, pollution, invasive species, and natural system modifications (e.g., changes to hydrology and fire regimes) can interact to a greater effect. We are now beginning to understand that these drivers can have interactive and synergistic effects, prompting even greater pressure on remaining wildlife populations.

Fire is an integral component of Australian ecosystems, and anthropogenic fire regimes (i.e., prescribed burns) are widely used across Australia. These fulfil the dual purpose of preventing bushfires, predicted to occur at greater frequency and severity with climate change, while also promoting biodiversity and ecological assets. Failure to strike a balanced fire regime is a threatening process under state and federal legislation. Getting the balance right is difficult, as fire can be both beneficial and detrimental, depending on the species. Significant variations in fire preferences can be found even amongst species that co-occur. Furthermore, while prescribed fire is widely applied, our understanding of faunal responses to fire and the underlying mechanisms is limited.

Australian reptiles are known to be impacted by fire, but despite a burgeoning understanding of species' fire preferences, the mechanistic drivers of their population increases and decreases are largely unknown. There is limited evidence of high levels of direct mortality from fire for reptiles; therefore, it is not considered a strong contributor to population trends. However, the impacts of a fire regime extend beyond direct mortality, indirectly affecting populations through changes to a range of aspects such as habitat suitability, gene flow, thermal environment, and vulnerability to predation. Understanding how these changes impact reptiles will provide further insight into why and how populations are impacted.

An indirect impact of particular interest is the heightened predation vulnerability that occurs in a recently burnt environment, as it may work to explain the decline seen in some species after a fire. After a burn, there is a significant decrease in cover and vegetation complexity, leaving fauna more exposed to predators. Furthermore, predation risk is also heightened by the drastic alteration in the colouration of the environment, which may disrupt camouflage. For example, species that are cryptic against vegetation or leaf litter will be more visually conspicuous against a charred and blackened substrate after a fire. While prescribed burns are less intense than bushfires, heightened predation vulnerability can still be expected as vegetation cover and ground debris are still lost, impacting the refuge availability for smaller terrestrial species, such as reptiles.

Heightened post-fire predation vulnerability can lead to synergistic activity with other threatening processes, particularly invasive predators. For example, feral cats are known to have a synergistic impact with fire, having greater hunting success in recently burnt areas and altering their range use accordingly. Previously, the impacts of feral cats on reptiles have largely been overlooked, but current

Little Desert National Park, Victoria, is home to many beautiful reptile species, such as the shingleback lizard (*Tiliqua rugosa)*, performing a threatening display. Image: Jaclyn Harris.

**Top:** Jaclyn Harris is a PhD Candidate at Monash University and Museums Victoria. Her research focuses on the indirect impacts of fire and the management of fire regimes in Australia. Image: Jaclyn Harris.

estimates indicate over 450 million reptiles are killed by feral cats each year, with a greater impact in arid areas.

If prescribed fires are to be ever increasingly used as a land management tool, we hope to trial a conservation action that can be taken to prevent native species from being exposed to heightened post-fire predation vulnerability. This project aims to analyse the effectiveness of artificial shelters in mitigating post-fire predation pressure on reptiles after a prescribed burn in the fire-prone mallee habitat of Little Desert National Park in Victoria. Mallee habitat supports high levels of reptile diversity, thus allowing the project to test these shelter sites across a range of species. Specifically, the project will test two major hypotheses:

1. Artificial shelters will mitigate post-fire predation vulnerability leading to heightened species richness and abundance, and
2. Artificial shelters will not act as an ecological trap.

The project is already underway, with artificial shelter sites installed at Little Desert National Park, Victoria. These shelter sites consist of 50 m long wire mesh semi-circular tunnels that will provide a physical barrier to predators. Additionally, they will be intermittently covered with shade cloth, and within the tunnel, roof tiles will be placed along its length. Roof tiles are a typical tool used in reptile surveying as they retain radiant heat from the sun, providing warm basking or sheltering opportunities. This shelter design has been chosen as it will allow reptiles protection across their range of regular behaviours, including movement, foraging, basking, and sheltering.

Two primary survey techniques will be used: remote camera trapping and pitfall trapping. Camera traps have been installed for two purposes. They will be aimed at shelters to help us understand the use of the shelters by reptiles and the broader landscape, allowing us to track potential predator interest in the shelters. These predator cameras will also help us understand whether these shelters become ecological traps. Pitfall trapping will also be conducted to collect reptile abundance and diversity data across sites to help us determine whether shelter sites are beneficial to species' survival and abundance.

Overall, the project will allow us to assess an actionable management outcome to provide the output of this research to management agencies, and provide insight into predator behaviour after a prescribed burn.

**FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY**
**will be used to help pay for shelter material and field expenses during surveying in Little Desert National Park, Victoria.**

Little Desert National Park, Victoria, is home to many beautiful reptile species, such as the colourful male painted dragon (*Ctenophorus pictus*). Image: Jaclyn Harris.

Artificial shelter tunnels installed in habitat after a prescribed burn in Little Desert National Park, Victoria. Image: Jaclyn Harris.

# What is Required to Recover Australian Threatened Ecosystems?

**JAVIERA OLIVARES-ROJAS**
School of Biological Sciences, Monash University

Ecosystems provide important wildlife habitats, critical for ensuring species survival and long-term persistence. However, human-induced threats such as land-use change, pollution, invasive species, and climate change impact biodiversity worldwide, increasing species' extinction risk and undermining the resilience of ecosystems. Declines in ecosystem integrity (i.e., ecosystem degradation) and ecosystem loss mean loss of habitats and the capacity to sustain species, disruption of ecological processes and functions, and the inability to maintain and enhance nature's contribution to people (e.g., ecosystem services).

Currently, Australia has over 1,800 threatened species and eighty-three ecosystems listed as threatened ecological communities under its conservation law – the *Environment Protection and Biodiversity Act.* Similarly, hundreds of ecosystems globally are categorised as threatened under the *International Union for the Conservation of Nature Red List of Ecosystems*, the global standard adopted in 2015 for assessing the risk of ecosystem collapse, and setting threat categories (i.e., Critically Endangered, Endangered, Vulnerable) and criteria.

An ecosystem can be at risk of collapse due to a reduction in size (geographic extent); by having an inherently small yet threatened, distribution; and/or abiotic degradation and alteration of biotic processes and interactions (for example, overgrazing or invasive species). Hence, ecosystems can recover when a degraded ecosystem regains its composition, structure and function relative to a reference state through restoration activities such as revegetation, pest control or soil modificationsregard- less of the time required to achieve recovery.\n\ nEcological restoration projects or programs include one or more targets that identify the native eco- system to be restored (as informed by the reference model). Ecosystem recovery is at the forefront of the global conservation agenda, led by organisations such as the International Union for the Conservation of Nature and the Convention on Biological Diversity.

For example, ecosystems like the Mountain ash (*Eucalyptus regnans*) forest in the Central Highlands of

**Top:** Javiera Olivares-Rojas is a PhD Candidate in the Conservation Outcomes and Decisions lab in the School of Biological Sciences at Monash University.

Mountain lake alpine sphagnum bogs are a threatened ecosystem under the *Environment Protection and Conservation Act*. Image: Jessica Walsh.

Victoria provide important habitat for critically endangered species such as the Leadbeater's possum (*Gymnobelideus leadbeateri*). The Leadbeater's possum is a marsupial confined to this region whose survival depends on hollow-bearing trees from old-growth forests. This ecosystem, however, is considered Critically Endangered under the *International Union for the Conservation of Nature Red List of Ecosystems* due to the loss of trees, which are facing threats, such as fire and logging.

Conserving ecosystems and focusing efforts on their recovery is a critical task if we aim to protect biodiversity and achieve the objectives of Australia's Threatened Species Strategy 2021–2031, the Sustainable Development Goals, and the commitments to the Convention on Biological Diversity's post-2020 Global Biodiversity Framework. Furthermore, as we enter the United Nations Decade of Ecosystem Restoration, it is important to answer: What is required to recover threatened ecosystems to potentially de-list them from the *Red List of Ecosystems* listings and *Environment Protection and Biodiversity Act* in Australia, so species are no longer threatened? What would be appropriate targets for ecosystem recovery if this is not possible?

By focusing on the *International Union for the Conservation of Nature Red List of Ecosystems* risk assessment criteria, this project aims to:

1. Evaluate the feasibility of recovering threatened Australian ecosystems using case studies,
2. Develop a prioritisation framework to identify cost-effective areas to recover ecosystem geographic extent, and
3. Develop broadly applicable guidelines to determine how to recover ecosystems to potentially de-list them from their threat status.

## Case Studies

The project will use two Australian threatened ecosystems as case studies to develop and test this framework: Cumberland plain woodlands, listed as Critically Endangered both nationally and under the Red List of Ecosystems, and the nationally Endangered alpine sphagnum bogs and associated fens, for which Red List of Ecosystems assessment is currently underway.

Initially, the project will focus on developing methods to assess the recovery potential of ecosystem integrity (i.e., biotic and abiotic degradation). The project will elicit expert knowledge through workshops for each case study ecosystem, with experts from academics, practitioners, and recovery teams. The idea is that, through these workshops, participants will assess the *ecological feasibility* of recovery potential using existing conceptual models, which help to represent ecosystem change, predict response to disturbance and management, and identify potential pathways for recovery. We will identify the best restoration actions to transition each ecosystem from its current degraded state into a restored or recovered state. Socio-economic factors, such as existing land uses, land tenure, and cost of restoration actions will also be considered to assess the *technical feasibility* of recovery. The project team will then generalise these findings into a broadly applicable framework and guidelines for other ecosystems, summarise common issues that arise during the process, and recommend solutions.

Another aspect of this research, using the same case studies, is to focus on recovering lost ecosystem areas by restoring their original extent. This project aims to answer: How much of the original (i.e., pre-clearing) distribution of a degraded ecosystem would need to be restored to transition from Endangered to Vulnerable and potentially Least Concern? Where in the landscape should we prioritise restoration to maximise recovery of an ecosystem's area?

This research will provide a structured process that can support practitioners during strategic planning, guiding the prioritisation of ecosystem recovery.

**FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY** will be used to cover travel plans to visit key experts of the case study ecosystems to obtain a good understanding of these ecosystems, update and collate relevant data, and build rapport with experts before the workshops. It will also cover travel expenses to attend the 2023 Society of Ecological Restoration World Conference in Darwin, where this work will be presented.

Mountain lake alpine sphagnum bogs. Image: Jessica Walsh.

# Fire, Fauna, and the Future: Identifying Biodiversity Refuges and Protecting Them From Extreme Disturbance Events

**JESSICA KEEM**
School of Ecosystem and Forest Sciences, The University of Melbourne

Global biodiversity is under mounting pressure from environmental change as a result of anthropogenic pressures, such as agriculture, logging, pollution, and climate change. As natural disturbance regimes shift in response to anthropogenic pressures, ecosystems will become vulnerable to additional stresses.

While fire is a natural component of a healthy ecosystem, climate change is altering fire regimes with catastrophic consequences. However, climate-altered fire regimes are already increasing the risk of large and frequent fires. Catastrophic fire events such as the 2020 mega-fires are threatening species already on the edge of extinction.

Refuges are vital for the survival and persistence of animals in the wake of disturbance events, such as bushfires. A fire refuge is an unburnt patch of vegetation that allows organisms to escape incineration. Bushire refuges remain unburnt as either the whole patch or the components within it are intrinsically less flammable than the surrounding landscape or not flammable at all.

There is consensus in the literature that during and after fires, unburnt patches of vegetation provide refuge for animals. Yet, the attributes of these patches that make them effective fire refuges are poorly understood. How do aspects of fire refuges such as size, spatial arrangement, topography, and vegetation structure influence the post-fire survival of animals? Can we use this knowledge to map potential fire refuges? Three mechanisms have been conceptualised as potentially underlying effective fire refuge functions: in situ survival, connectivity and movement, and ex situ recolonisation.

Identifying areas of high biodiversity value (biodiversity 'hotspots') is one strategy to prioritise areas for conservation. In theory, fire refuges that constitute biodiversity hotspots can be buffered from future threats by using planned fire (or fire suppression) and enhancing connectivity between refuge habitats. Thus, there is a great need to identify areas of high biodiversity value and explore the potential for fire refuges to act both as strongholds for biodiversity, and as stepping-stones to post-fire recovery. Once identified, there is an additional challenge in protecting fire refuges from future fire events.

A potential fieldwork site in the Otways in heathland vegetation. Image: Jessica Keem.

The project aims to safeguard biodiversity from future catastrophic fire events. Specifically, the project aims to:

1. Identify the attributes of unburnt vegetation patches that result in fire refuges,
2. Identify areas of high biodiversity value ('hotspots') using spatial modelling and field data, which constitute fire refuges,
3. Determine how fire refuge configuration affects species' connectivity, and
4. Explore how planned burning can protect fire refuges from future fires.

Areas of potential fire refuges are being mapped in Victoria using a combination of results from the systematic review, and fire risk modelling. A deep dive and systematic review have investigated fire refuge attributes in the literature reporting animal survival from fire. These data are combined with 3,000 species distribution models to pinpoint locations in Victoria with high biodiversity value and biodiversity hotspots that overlap with potential fire refuges.

Field data on birds and reptiles will be collected to validate hotspot spatial modelling. Acoustic recorders will be used to record bird calls, and roof tiles and funnel traps will be used to trap skink species. Concurrently, reptile genetic data will be collected to examine the relationship between fire refuge spatial arrangement and animal movement. Movement is a fundamental process for the persistence of animal populations, but movement rates depend on landscape connectivity. The degree of connectivity and genetic diversity among hotspots will reflect the overall resilience of species populations and therefore the effectiveness of fire refuges.

A fire regime simulation tool called FROST (Fire Regime and Operations Simulation Tool) will be used to investigate methods of safeguarding combined fire refuges and biodiversity hotspots. FROST will model varying planned burning scenarios under current and future climate conditions to analyse the capacity of fire management actions to protect or enhance these areas.

The outcome of the project will be a conceptual framework directing management actions. Using the Great Otway National Park, Victoria, as a focal landscape, the project will provide managers with validated maps to prioritise the protection of fire refuges. It will also use replicable methodology to identify and protect areas of high biodiversity value from fire.

**FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY**
will be used to purchase equipment for reptile tissue samples and acoustic recorders to survey birds. Funds will also be used to complete a reptile and venomous snake handling course.

Koala (*Phascolarctos cinereus*), Great Otway National Park. Image: Gryffyn via unsplash.com

# Investigation of the Immune Response of the Tasmanian Devil (*Sarcophilus harrisii*) to Cancer and Altered Environmental Conditions

**NICHOLAS MACDONALD**
School of Life and Environmental Sciences, Deakin University

The Tasmanian devil (*Sarcophilus harrisii*) is the largest living carnivorous marsupial in the world and is an iconic Australian wildlife species. These expert scavengers are vital in maintaining Tasmania's pristine ecosystem, as they aid in clearing carcases that can cause disease, and they help to scare away feral cats that hunt endangered species like the eastern quoll (*Dasyurus viverrinus*).

Unfortunately, devil population numbers have decreased significantly since the emergence of a transmissible cancer in the 1990s, known as Devil Facial Tumour Disease (DFTD). Transmissible cancers involve cancer developing in one individual, followed by the cancer cells spreading to other individuals. These intriguing cancers are incredibly rare, only occurring in devils, dogs, and a few species of bivalves.

For devils, lightning has struck twice, hitting them right in the face. Two separate and unrelated strains of Devil Facial Tumour Disease are present in the devils, one (DFT1), discovered in 1996, originated from a female devil and the second (DFT2), discovered in 2014, originated from a male devil. In devils, Devil Facial Tumour Disease is transmitted through biting. The chance of transmission is very high, as devils bite each other during mating and while squabbling over carcasses. Even though both Devil Facial Tumour Disease strains are different genetically and in cellular morphology, their symptoms are the same. Most tumours are found around the face and neck, as devil bite wounds tend to occur there, but the cancer can spread to organs and other parts of the body. Infected devils can die within six

**Top:** Nicholas MacDonald is a PhD Candidate at Deakin University.

A wild Tasmanian devil (*Sarcophilus harrisii*) caught in a trap. Image: Anne-Lise Gerard.

to twelve months of the first signs of the tumours appearing. The tumours are detrimental to the devils' health – not only does the physical disfigurement stop the devils from moving and eating normally, but the tumours also use up important nutrients the devils need for survival, potentially starving the devil to death.

To give the devils the best chance of survival, insurance devil populations were established in 2012 in zoos and other wildlife centres across Tasmania and mainland Australia. Devils from these populations can eventually be released back into the wild when the threat of Devil Facial Tumour Disease is no longer present. The high standards of animal husbandry used for these populations, which limit inbreeding and breed only the healthiest individuals, ensure that devils have the best possible health outcomes in captivity. But this does not always equip the animals with the most suitable immune system in the wild. The immune system becomes accustomed to being pampered in captivity and can struggle in the wild when faced with pathogens the animals have not previously experienced.

Currently, research is focused on supporting the devils to overcome Devil Facial Tumour Disease by either developing a treatment (e.g., a vaccine) or aiding the development of natural immunity to the cancer over time. Both approaches need devils to have a strong immune response.

The project aims to further understand the immunology of captive devils as well as the infected devil's response to the cancer to help inform future conservation efforts. This information will be achieved by measuring the expression of immune genes in captive and wild devils, focusing on exploring the difference between their immune capacity and activity under different environmental conditions. Additionally, the expression of immune genes in response to DFT1 and DFT2 will be compared to identify potential differences in immune responses to the challenges caused by the different lineages of transmissible cancer.

**FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY** will be used to purchase molecular consumables involved in RNA extraction and measuring gene expression.

Devil Facial Tumour Disease in the mouth of a wild Tasmanian devil (*Sarcophilus harrisii*). Image: Anne-Lise Gerard.

A Tasmanian devil (*Sarcophilus harrisii*) is in the process of being sampled. Image: Anne-Lise Gerard.

# **Spot the Quoll:** Tactical use of Olfactory Information to Improve Detection and Conservation of a Rare, Native Carnivore

**NICOLE LYNCH**
School of Life and Environmental Sciences, University of Sydney

Reliable detection is key to the successful conservation of endangered Australian wildlife. Poor detection leads to underestimating population presence, numbers, and changes over time, yet these measures are crucial for conservation decision-making. Camera traps are an increasingly important tool for wildlife detection. Cameras cause less human disturbance to animals and habitats, and are more efficient than other methods, such as live trapping. Understanding what affects detection is essential to maximise the reliability of camera surveys.

Lures are often used near cameras to improve detection. For example, adding food lures in a camera survey significantly increased the detectability of leopards (*Panthera pardus*). In contrast, using a conspecific odour lure improves the trappability of American mink (*Mustela vison*) compared to a food odour lure. These results fit with recent theoretical work suggesting the type of lure is important. Understanding what drives the efficacy of certain lures is key to their use in wildlife surveys.

In general, odour lures work because odour plays a crucial role in the web of information animals use to assess their environments, including information about food, friends, and foes. Odour can act broadly to provide information without animals directly interacting with the source, and is especially important if the odour comes from a dangerous source, such as a predator. So, while predator odour repels many species, it attracts others because it carries information about the activities of enemies. For example, mesopredators, especially stoats (*Mustela erminea*), visit more sites more often and for longer when a dominant predator odour lure (from ferrets (*Mustela furo*)) is added to a food odour lure. Dominant predator odour likely provides mesopredators with important information about competitors and threats.

Our understanding of individual variation in attraction to camera trap lures is very poor. Importantly, not all individuals are expected to respond to all lures the same way. Many factors influence individual responses, including sex, age, reproductive status, experience, animal personality, body condition and internal states such as hunger. For example, body condition of hares (*Lepus timidus*) influenced trappability with lighter, likely hungrier, individuals more likely to approach a food lure and be trapped than heavier individuals.

Here, the project will study an endangered marsupial carnivore, the spotted-tailed quoll *(Dasyurus maculatus maculatus*). Typical of carnivores, quolls have large home ranges and are rare, making them difficult to find. Detection of quolls can be less than one individual

**Top:** Nicole Lynch is a PhD Candidate at the University of Sydney. Image: Tracy Tervoort.

Nicole Lynch released a spotted-tailed quoll (*Dasyurus maculatus maculatus*) after processing, and Becky Chen timed the release for a personality test known as the 'release test'. Image: Brendan Alting.


A spotted-tailed quoll (*Dasyurus maculatus maculatus*) investigating a chicken odour lure. Image: Nicole Lynch.

per one hundred trap nights, yet we know little of what factors influence their detection. A better understanding of what affects the detection of quolls during surveys will improve survey protocols and population estimates, both essential to their conservation.

The project aims to solve the conservation problem of poor detectability of quolls by exploiting their natural drive to investigate olfactory information while accounting for behavioural differences among individuals. Specifically, the project intends to:

1. Test the effects of different odour lures, which provide different sets of information, on the detectability of quolls,
2. Quantify the attraction radius of the most effective lure, and
3. Test how detectability of quolls varies among individuals.

In a known stronghold population, a wild population of spotted-tailed quolls in north-eastern New South Wales will be studied. The project will test the impact of an odour treatment (three levels) on quoll detection at camera traps using a food odour lure (chicken wings in a bait station, unavailable for eating), conspecific, and dominant predator odour lures (hessian from sleeping areas of captive quolls and dingoes respectively). These odour lures provide different sets of information. Chicken odour provides information about food. Quoll odour provides information about potential mates, competitors, and resources. As a dominant predator, dingo odour provides information about risk. GPS collars will be used and set for five-minute fixes to quantify the attraction radius of the most effective lure from the first part of the project (chicken). Individual traits, such as body mass and personality, will be measured during trapping to test for the effects of individual traits on detection.

The research is essential for conserving quolls as practitioners can use the results to improve survey protocols and resulting population estimates. The project is also important to wildlife conservation as it will demonstrate whether individuals are likely to respond differently to different lures. Most surveys use one lure, but if individuals respond to different lures, then using one lure may miss a considerable proportion of the surveyed population.

**THE FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY**
**will be used for accommodation and travel costs of fieldwork, specifically fieldwork to trap quolls and retrieve GPS collars.**


Nicole Lynch and Becky Chen processing a captured spotted-tailed quoll (*Dasyurus maculatus maculatus*). Image: Brendan Alting.

Angus is doing a personality test known as the 'arena test'. Spotted-tailed quolls (*Dasyurus maculatus maculatus*) are placed in the arena, where their behaviour is videoed for five minutes. Image: Nicole Lynch.

# Post-fire Population Recovery and Chytrid Occurrence in Frogs of the Mount Lofty Ranges, South Australia

**SHAWN SCOTT**
UniSA STEM, University of South Australia

Globally, human-mediated changes to climate, land use, and ecosystem integrity and function are accelerating biodiversity loss and increasing the frequency and intensity of wildfires, especially in fire-prone regions such as Australia. The recent catastrophic wildfires of 2019/2020 across south-eastern Australia were unprecedented in intensity, severity, and spatial scale, and consumed large portions of the geographic distributions of many threatened plant and animal species. Such severe fires, combined with predictions of more devastating 'megafires', must catalyse a significant increase in research efforts to support our native taxa in the face of such a flammable future.

Prescribed burning is undertaken across Australia to mitigate wildfire severity by reducing vegetative fuel loads. Although prescribed burning is typically employed to reduce the likelihood or severity of wildfires for the protection of human life and assets, it is also advocated as beneficial for biodiversity. The pyrodiversity paradigm asserts that 'pyrodiversity begets biodiversity' or that biodiversity benefits from the creation of landscape heterogeneity and habitat mosaics consisting of a wide range of post-fire vegetation ages. By introducing low- to mid-intensity fire to small habitat patches across the landscape and heterogeneity in vegetation age, structure, and diversity, prescribed burning is speculated to be beneficial to a wider diversity of species that may have contrasting ecological requirements. Although our understanding of the consequences of prescribed burning for biodiversity is increasing, we still know very little about these implications for native species in the highly fire-prone and fragmented Mediterranean environments of southern Australia.

Mediterranean climatic regions in Australia are limited to south and south-western Australia, where they are recognised biodiversity hotspots for their high diversity of endemic, isolated, and threatened plant and animal taxa. However, these regions are also highly degraded, and experience frequent wildfires and mitigative prescribed burns. These regions are home to a diversity of

**Top:** Shawn Scott is a PhD candidate within UniSA STEM at the University of South Australia. His research focuses on the effects of prescribed fire on herpetofauna in the fragmented remnant woodlands of the Mount Lofty Ranges, South Australia. Here, he is photographing the ventral patterns of a Bibron's toadlet (*Pseudophryne bibronii*), which can be used to identify individuals. Image: Assoc. Prof. Topa Petit.

The typical condition of long-unburned stringybark (*Eucalyptus obliqua*) woodlands in the Mount Lofty Ranges, South Australia. Image: Shawn Scott.

endemic and threatened frog taxa. Multiple processes threaten the frogs of southern Australia, many caused or accelerated by anthropogenic activity, including climate change, habitat degradation and destruction, inappropriate fire regimes, and the panzootic chytrid fungus (*Batrachochytrium dendrobatidis*).

Chytrid fungus causes the disease chytridiomycosis, which is implicated in the global decline and extinction of over five hundred frog taxa, with thirty-six frog species decreasing in population size and seven frog species going extinct in Australia. Fire exacerbates the effects of other threats, including fragmentation and predation but does it exacerbate disease? The relationship between fire and chytrid prevalence has received little attention. However, a 2013 study demonstrated that wildfire-induced reduction of canopy and surface vegetation facilitated higher surface temperatures, thus allowing frogs to attain body temperatures higher than are suitable for chytrid. While wildfires and prescribed fires differ in a multitude of ways, does prescribed fire have similar or contrasting effects on the prevalence of chytrid in frog populations in fire-prone environments?

This project is centred on the fire-prone Mount Lofty Ranges of South Australia, where the fire ecology of native frogs, and the relationship between fire and chytrid occurrence are yet to be assessed. The seasonal use of prescribed fire may be especially threatening for local frog species owing to the highly fragmented state of remnant habitat in the region and its status as a biological island, and the repeated use of prescribed burning during key breeding and surface-active periods.

The project will use before-after control-impact (BACI) and chronosequence experimental designs to systematically assess the immediate and long-term effects of prescribed fire on frog richness, calling, and chytrid occurrence, respectively, in remnant stringybark woodlands. The before-after control-impact sites will be exposed to prescribed fire from mid-spring 2022, and other sites represent increasing times since prescribed fire and include 'long-unburned' (20+ years) control sites. The project will use multiple methods at all sites, including pitfall traps with drift fences, active searching, and deployment of artificial shelters (including tiles and iron sheets) and acoustic recorders. To determine whether frog health and chytrid load are related to fire age, we are collecting morphometric and mass data from individuals, recording sex, age group, and reproductive status, and swabbing the ventral surface for chytrid spores. For capture-mark-recapture analyses, photography of unique features or colour patterns and visible implant elastomer will be used to identify changes in condition and chytrid occurrence in individuals over time.

Shawn Scott collects the morphometric data of a Bibron's toadlet (*Pseudophryne bibronii*) following ventral swabbing for chytrid spores. Image: Assoc. Prof. Topa Petit.

The project will assess the implications of prescribed fire on frog richness, breeding behaviours, and chytrid occurrence in the Mount Lofty Ranges, South Australia. These data will be crucial to developing recommendations for prescribed fire regimes that consider the ecological requirements of local frogs. Approval for the research has been obtained through the University of South Australia Animal Ethics Committee and a scientific research permit through the Department for Environment and Water. The Ecological Society of Australia also supports this project.

**FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY** will be used for travel and to purchase equipment for marking and swabbing frogs, collecting acoustic data, and analysing chytrid swabs.

A bibron's toadlet (*Pseudophryne bibronii*) with eggs present. This male called from a shallow nest in a drainage line in stringybark woodlands last burned in 2014. Image: Shawn Scott.