# 2021 University Grants Scheme 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 $1,500 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 attendance at conferences at which you are presenting your work.

The Australian Wildlife Society is delighted to announce the winners of the ten grants of $1,500 each to honours or postgraduate students conducting research that will contribute to the conservation of Australian wildlife. **The winners for 2021 are:**

**BETHANY NORDSTROM -** School of Biological Sciences, University of Western Australia
**Project Title:** Assisted colonisation of the western swamp turtle

**GOD'SPOWER OKOH -** Veterinary and Biomedical Sciences, James Cook University
**Project Title:** Investigating herpesvirus infections in Australian wildlife

**BIANCA KEYS AND KARLI MYLIUS -** Institute of Marine and Antarctic Studies, University of Tasmania
**Project Title:** Assessing microplastic exposure through non-invasive examination of guano in resident Tasmanian shorebirds

**SHAE JONES -** School of Earth, Atmospheric and Life Sciences, University of Wollongong
**Project Title:** Do arbuscular mycorrhizal fungi help grasses in heat waves?

**ERICA DURANTE -** Future Industries Institute, University of South Australia
**Project Title:** Investigating the age and growth of an endemic octopus species

**GRACIE LIU -** School of Biological, Earth and Environmental Sciences, University of New South Wales
**Project Title:** How can we improve frog conservation in fragmented landscapes? Closing the gap with a novel genetic approach

**JENNA DRAPER -** School of Biological Sciences, University of Adelaide
**Project Title:** Conservation utility of *Pimelea microcephala* subsps. *microcephala* to arid zone frugivores and pollinator

**KYLE BREWER -** Clinical and Health Sciences, University of South Australia
**Project Title:** pH-Responsive 1080 implants for the mitigation of the cat-astrophic predation of native animal populations

**PATRICK FINNERTY -** School of Life and Environmental Sciences, University of Sydney
**Project Title:** Strategically exploiting plant odours to manipulate mammalian herbivore foraging behaviours as a conservational tools

**GRANT LINLEY -** Institute for Land, Water and Society, Charles Sturt University
**Project Title:** The influence of landscape-scale fire refuges and pyrodiversity on mammal communities following an unprecedented megafire










# Assisted Colonisation of the Western Swamp Turtle into Cooler Southern Wetlands

**BETHANY NORDSTROM**
School of Biological Sciences, University of Western Australia

One of the greatest threats to biodiversity is climate change, affecting various taxa through shifts in distribution, range contractions, and extinctions. These consequences of climate change are particularly concerning for reptiles, as many rely on specific temperature regimes for optimum physiological performance. Species with low reproductive rates, long generation times, and restricted ranges are particularly susceptible to climate change due to their limited capacity to adapt or move. One proposed solution for these species is assisted colonisation – the intentional translocation of species outside their Indigenous range to mitigate a threat.

The Critically Endangered western swamp turtle (*Pseudemydura umbrina*), a long-lived species endemic to south-west Australia, is a strong candidate for assisted colonisation. It has experienced extensive habitat loss and fragmentation and now only naturally persists in one small, fenced nature reserve north of Perth. Western swamp turtles rely on seasonal swamps for survival, where they feed and reproduce during the wet winter period (hydroperiod) and aestivate in upland areas for the dry summer and autumn months.

Over the last fifty years, mean rainfall during the hydroperiod has declined by approximately twenty-five percent. Further declines in winter rainfall, hotter summers, and fewer rainfall events are expected in south-west Australia under projected climate scenarios. These factors result in shorter critical wet periods in seasonal wetland ecosystems and uncertain future habitat suitability in the western swamp turtle's small natural range. If critical wet periods become too short, turtles will grow very slowly and may be unable to reproduce. The future success of the western swamp turtle depends on conservation tactics such as drought-proofing habitat in the western swamp turtle's natural range and exploring options that account for future climate change – such as assisted colonisation.

Assisted colonisation trials exploring growth rates of turtles in cooler climates began in 2016, with captive-bred juveniles released to two locations approximately three hundred kilometres south of their historic range. These wetlands were cooler, had longer hydroperiods, and were predicted to offer ideal microclimates for western swamp turtles in twenty years. They performed well in one of the southern sites in 2016, with comparable growth rates to those in a warmer wetland much further north. It is thought that ideal growth rates were achieved, partly due to the timing and abundance of aquatic food resources such as tadpoles and longer wet periods resulting in extended foraging opportunities. As foraging rates and body temperatures are often synergistic in reptiles, it is critical to understand whether cooler environments (and therefore reduced activity of western swamp turtles) can be offset by high prey abundance and extended periods of prey availability.

The project builds on the recent assisted colonisation trials and aims to understand whether western swamp turtle energy requirements can be met in cooler climates over both the short- and long-term. As

**Top:** Bethany Nordstrom is a PhD candidate at the University of Western Australia

A juvenile western swamp turtle (*Pseudemydura umbrina*). Image: Bethany Nordstrom.

A juvenile western swamp turtle fitted with a radio transmitter tag with inbuilt activity and temperature sensors. Image: Bethany Nordstrom.

part of this project, a third assisted colonisation trial commenced in mid-August 2021, where individuals are closely monitored. Western swamp turtles have been fitted with a radio transmitter with inbuilt temperature and activity sensors to help determine when turtles are capable of foraging. Data from the sensors is transmitted to a stationary receiver set up in the wetland. Tadpole and macroinvertebrates surveys will also be conducted to determine prey availability throughout the hydroperiod. The growth of turtles will be assessed through morphological measurements and the calculation of specific growth rates.

Environmental DNA methods will help detect the species using a species-specific primer/probe. This method will assess the western swamp turtle's immediate food web and ecosystem impacts in novel environments via DNA metabarcoding of faecal samples. The project will also incorporate western swamp turtle food intake in the novel environment into a dynamic energy budget model to study how food availability at translocation sites interacts with body temperature to drive individual growth and reproduction. Growth and reproduction across the turtle population will also be investigated. Understanding the capacity of turtle foraging in cooler climates will help inform practical conservation management outcomes for the swamp turtle, including whether southern wetlands can provide viable habitats for one of Australia's rarest reptiles.

The western swamp turtle is thought to be the first vertebrate species to undergo trials of assisted colonisation in response to the threat of climate change. The project presents a unique opportunity to study assisted colonisation from several applied angles (eDNA, food-web dynamics, and mechanistic energy budget models). The research benefits are not limited to the western swamp turtle, as findings from this case study will provide insights on assisted colonisation as a conservation option for other species unable to adapt *in situ* or migrate in response to rapid climate change.

**FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY** will be used to purchase materials to build the stationary receiver tower, iButtons to monitor the carapace temperature of turtles when they go into aestivation, and accommodation costs.

Doctor Nicola Mitchell and Bethany Nordstrom are releasing two juvenile swamp turtles, commencing the 2021 assisted colonisation trial. Image: Alan Harvey.

A stationary receiver tower was set up at the assisted colonisation site to collect data from transmitters attached to the turtles. Image: Bethany Nordstrom.

# Investigating Herpesvirus Infections in Australian Wildlife

**GOD'SPOWER OKOH**
Veterinary and Biomedical Sciences,
James Cook University

Australian wildlife is made up of a large variety of animals that are endemic to the continent and constitute major environmental and cultural values. An interesting feature of Australia's wildlife is the abundance of reptiles and marsupials and monotremes occupying vast ecological niches. However, the survival of wildlife populations in Australia have been constantly threatened through natural disasters, climate change, urbanisation, introduced non-native species, and diseases. Historically, these threats have led to the extinction of animals such as the paradise parrot (*Psephotus pulcherrimus*), southern pig-footed bandicoot (*Chaeropus ecaudatus*), and the broad-faced potoroo (*Potorous platyops*).

Currently, many Australian wildlife populations are considered vulnerable and are potentially susceptible to outbreaks by various infectious agents, including herpesviruses. In Australia, herpesviruses have been identified in wild reptiles, birds, and marsupials. However, most of these viruses have been poorly characterised, and there is a paucity of epidemiological data, which limits our understanding of the impacts of these viruses and possible control measures. Additionally, the lack of sensitive assays for viral surveillance has led to the under-reporting of novel and known herpesviruses in Australia.

In recent years, cutaneous lesions were observed in some freshwater turtles that were captured as part of routine health assessments and monitoring of some wild turtle populations in North Queensland. The characteristics of these lesions were consistent with previously described lesions caused by herpesviruses in freshwater turtles. Furthermore, several studies have reported herpesviruses in freshwater turtles, with case fatality nearing one hundred percent. Unfortunately, initial attempts to isolate and characterised the causative agents of these lesions were unsuccessful. Current diagnostic methods used for outbreak investigation and surveillance for novel and known herpesviruses are faced with numerous challenges, including low sensitivity and high cost.

The project aims to overcome these challenges and improve herpesvirus detection by developing a consensus multi-pathogen detection system that uses universal polymerase chain reaction (PCR) technology to detect herpesviruses at the subfamily level (alpha-, beta- and gammaherpesvirus). This approach is highly cost-effective and will enable the detection of unknown herpesviruses.

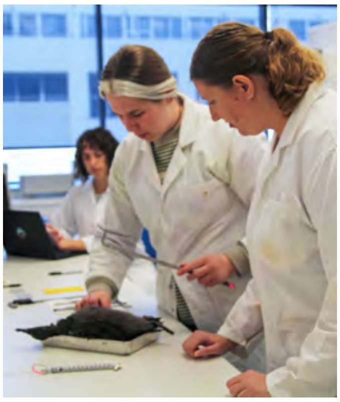
Permits for collecting samples from two different freshwater turtle species from Alligator Creek and Ross River in Townsville, North Queensland, have been granted. The project will survey herpesviruses in the Krefft's turtle (*Emydura macquarii krefftii*) and saw-shelled turtle (*Myuchelys latisternum*) to ascertain the circulating species. Cloacal and oral swabs and lesion samples from the two species have been collected. All samples were immediately transported in ice to the laboratory and stored at -80°C until required for testing. Morphometric data and general health observations were also recorded, and the turtles were released unharmed.

Herpesviruses have also been reported to potentially impact the survival of vulnerable and endangered marsupial species. The virus can cause life-long infections and remains latent in its primary host until reactivated by different factors, including stress, co-infections, and immuno-suppression. Although herpesviruses can form latent infections in the primary hosts, it can cause severe acute diseases when it jumps and infects closely related naïve animal populations. Therefore, it has become pertinent to monitor herpesvirus occurrence in both captive and wild marsupial populations. The project plans to adopt a multiple pathogen detection strategy (including a metagenomic approach) to assess the health of marsupial species and identify other viruses of conservation importance in Australia. Marsupial samples from herpesvirus suspected outbreaks will be tested and characterised opportunistically.

Overall, the project will provide significant epidemiological tools and baseline data for herpesvirus surveillance and reporting, improving managerial practice and strengthening current conservation efforts in Australia.

**Top:** God'spower Okoh is a PhD Candidate at James Cook University.

**FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY** will be used for assay validation, sample analysis, and DNA sequencing.



# Quantifying Microplastic Exposure in Coastal and Marine Sentinel Species

**BIANCA KEYS AND KARLI MYLIUS**
Institute of Marine and Antarctic Studies, University of Tasmania

Research is continuously uncovering the vast amounts of plastic debris polluting our marine environment, with an estimated 4.8 to 12.7 million tonnes of plastic entering the ocean each year. Plastic has now been reported in sediments – from the deepest parts of the ocean to coastal beaches, the atmosphere, and the top of our highest mountain peaks. Due to the buoyancy of plastics and the dynamic nature of marine environments, plastic items are easily dispersed throughout the ocean. Smaller fragments of plastics, termed microplastics, are particularly concerning due to their ubiquitous nature. Despite being invisible to the naked eye, microplastics represent over ninety percent of plastic debris found in our oceans today.

Microplastics can be divided into two groups – primary and secondary. Primary microplastics refer to microplastics that are purposely manufactured for specific uses, such as microbeads found in personal care products and industrial pellets. Whereas, secondary microplastics refers to smaller fragments of larger plastics that have mechanically broken down over time. Most microplastics found in marine environments are secondary particles, having been weathered and degraded by physical and biological forces such as wave action and ultraviolet (UV) light exposure. The combination of microplastics being both miniscule and pervasive make them especially difficult to identify, and as a result, their effects on marine ecosystems are poorly understood.

One of the reasons why microplastics are difficult to study is because of the inconsistencies surrounding the classification of microplastics by size and polymer type (composition). Currently, particles less than five millimetres in diameter are considered microplastics. However, microplastics can include particles that are visible to the naked eye (1–5 millimetres) down to nanoparticles (less than 0.1 micrometre) that are only visible through a powerful microscope. Precise definitions of these size categories have been the source of much scientific debate, and few data exist for birds, particularly in Australia. The lack of data is primarily due to the complexity and resources required to analyse such small particles. However, without accounting for nano-plastic particles, accurate assessments of plastic exposure within individual organisms (i.e., when wildlife accidentally ingest plastic) cannot be achieved, resulting in underestimations and data gaps. Additionally, providing information on the polymer type will enable researchers to assess the exposure of wildlife to plastic-derived chemicals.

### Why Are Microplastics a Concern?

Increasing evidence of the harm posed by plastic ingestion in marine birds consists of blocked digestive tracts leading to harmful perforation, altered feeding and foraging behaviours, and exposure to harmful chemicals. The health implications of exposure to small microplastics and especially nano-plastics, are poorly known. It has been reported that nano-plastics are able to cross the boundaries of membranes in marine organisms, impacting biological functions, for example, changes in growth rate, malformations, and mortality. However, before we can begin to understand the consequences of microplastic exposure on marine birds, we first need to know how much plastic the marine birds are consuming.

Two projects are being conducted, one on seabirds and the other on shorebirds. Both projects aim to:

1. Investigate and quantify plastics found within the gastrointestinal tract of seabirds, and compare size ranges between all stomach compartments,
2. Investigate and quantify whether shorebirds in Australia are also ingesting microplastics, and
3. Generate baseline data sets specifically for nano-plastics, as there is currently limited data on their accumulation in marine wildlife.

### Seabird Project

Most seabird studies have focussed on the ingestion of larger plastic items (greater than one millimetre) and have provided data only for the main stomach compartments (proventriculus and/or gizzard). For this project, plastics will be collected from the entire digestive tract of two Australian seabirds: the short-tailed shearwater (*Ardenna tenuirostris*) and flesh-footed shearwater (*Ardenna*

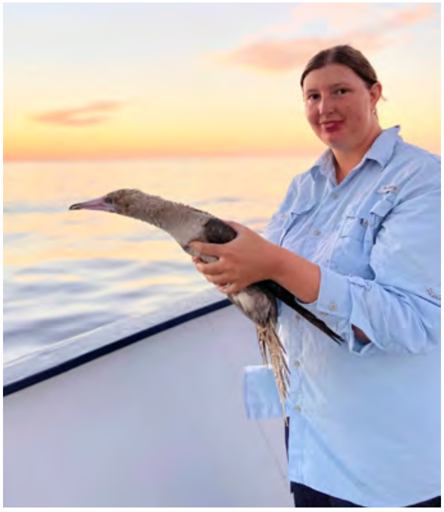
The dissection of a short-tailed shearwater (*Ardenna tenuirostris*), showing part of the gastrointestinal tract. Image: Lillian Stewart.

**Top:** Collaborative teamwork during shearwater dissections. Image: Doctor Jennifer Lavers.

A hooded plover (*Thinornis rubricollis*) providing a precious guano sample on a Tasmanian beach. Image: Doctor Eric Woehler.

Karli Mylius is looking for shorebirds. Image: Javier Merrill.

Karli Mylius is a Master student at the Institute for Marine and Antarctic Studies at the University of Tasmania. Karli hopes to contribute to wildlife conservation by shining a light on the impacts of plastic pollution unseen to the naked eye. Image: Doctor Eric Woehler.



Bianca Keys with a red-footed booby (*Sula sula*). Bianca Keys is an Honours student at the Institute for Marine and Antarctic Studies at the University of Tasmania. After participating on a research voyage for one month in the Coral Sea, she instantly fell in love with seabirds and their adaptations to life at sea. Moving to Tasmania and discovering a new part of Australia allowed Bianca to immerse herself in a unique environment and join a collaborative and supportive laboratory team while contributing to seabird research. Image: Kaarel Raia.

*carneipes*). Few data are available that describe the role seabirds play in transporting and depositing plastics in their breeding habitats (e.g., islands). Therefore, the project will also discuss the fate of ingested particles, with reference to nanoparticles for which there is currently no data. Freshly deceased carcasses of both shearwater species will be necropsied to quantify the ingested plastics and describe their distribution within the digestive tract.

### Shorebird Project

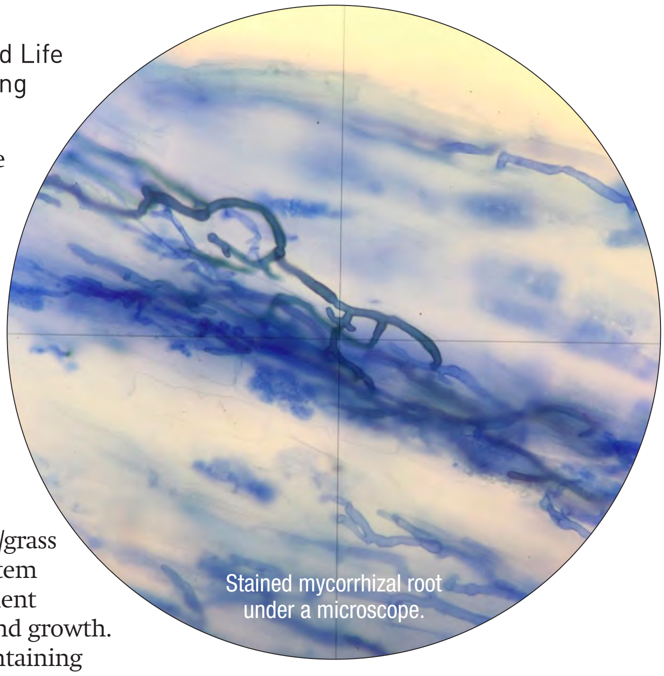
The second project focuses on two Tasmanian resident shorebird species, the hooded plover (*Thinornis rubricollis*) and Australian pied oystercatcher (*Haematopus longirostris*). The project will assess micro- and nano-plastic exposure by examining guano. The data on plastic ingestion in shorebirds is extremely limited, globally, with no research on Australian resident shorebird species. The project will provide insight into whether the birds are ingesting small plastics via the intertidal sediments where they forage. By assessing the microplastics found in the guano of the birds and comparing these to sediment samples, we can assess whether the plastics are being excreted or retained by the birds (i.e., within their digestive tract).

Both projects have been designed with non-invasive methodology in mind, using necroscopy of already deceased shearwaters and the guano of shorebirds, thereby limiting disturbance to these vulnerable species. Two digestion treatments will be used to extract the plastics and eliminate any biological material to assess microplastics within the digestive tract and guano samples. The first will be an enzymatic digestion using trypsin, and parallel to this, the project will also use potassium hydroxide for a chemical digestion. Flow cytometry and Fourier transform infrared spectroscopy (FT-IR) will be used to obtain precise measurements of the abundance and composition (polymer type) of the ingested plastics.

**FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY** will contribute to field and travel expenses to the chosen study sites, including University car hire. Funds will also be used to purchase laboratory equipment such as anodisc filters, which will allow the researchers to perform the desired analysis using flow cytometry and FT-IR. These instruments provide accurate and efficient quantification and identification of microplastics.

# Do Arbuscular Mycorrhizal Fungi Help Grasses in Heatwaves?

**SHAE JONES**
School of Earth, Atmospheric and Life Sciences, University of Wollongong



Stained mycorrhizal root under a microscope.

Heatwaves will become more frequent and intense under climate change. Heatwaves are highly stressful for plants as they are associated with periods of low rainfall and high heat. Facilitative interactions may help plants cope with heatwaves. Fungal symbionts such as arbuscular mycorrhizal fungi (AMF) are ubiquitous in terrestrial grasses, but their role in alleviating plant stress in response to stress events, such as heatwaves, remains poorly understood.

Agricultural studies show that AMF can mitigate the negative effects of heat and drought separately, but few studies investigate the ecologically relevant conditions of both heat and water stress over several days. While there is some information that AMF may improve plant tolerance to stress events, the data is primarily based on some agricultural species; we know nothing about native grasses and how AMF may help in survival. Increasing our understanding of how these fungal symbionts protect grasses and how this may vary amongst species is crucial in predicting community change in grasslands to increasingly more frequent heatwave and drought events.

Combined heatwave and drought events present unique challenges for plants. As water becomes limited, plants can limit water loss by closing pores in the leaf, called stomata. Water loss through stomata can cool leaves during high temperatures, but the leaves begin to heat up if these stomates close. Thus, high temperatures and water limitations present a unique problem for plants. The project will attempt to understand how AMF may modify plant water use. AMF may help plants use water more efficiently and could improve water scavenging capabilities. The project will use stable carbon isotope analysis, which will give a carbon isotope ratio ($^{12}C$:$^{13}C$); the higher the ratio, the lower the water use efficiency of the plant and thus the greater stress the plant is under.

Grasslands are one of the most threatened ecosystems globally. Major threats include overgrazing and invasion by exotic pasture grasses. Grasslands act as some of the largest carbon sinks, signalling their high value. The increasing frequency of heatwaves and low rain periods may modify AMF/grass relationships and ecosystem function, including nutrient acquisition, water use, and growth. Thus, restoring and maintaining ecosystem function is essential for biodiversity conservation and land managers and agricultural practices.

The researcher will conduct a heat and water stress experiment to determine the role of AMF as a facilitator. The researcher will undertake fieldwork to collect soil inoculum containing AMF spores from natural grassland areas. The inoculate will be added to sterile soils within a glasshouse experiment on several native grass species to investigate how heat and water stress (and their combination) change colonisation and influence plant physiology and growth.

The project aims to answer the following questions:

1. How does AMF help native grasses cope with extreme stress and heatwave events?, and
2. How does the AMF community assemblage change in response to extreme stress events, and how does this influence the role of AMF as a facilitator?

The project will identify how plant physiological and ecological responses to heat waves differ when grown with and without AMF and identify what physiological and morphological mechanisms AMF may alter to enhance the hosts' performance during stress.

The project will measure how host responses vary between species and identify differences in AMF associated with different grass species.

The project will also outsource stable carbon isotope analysis to help answer some of the project aims in understanding how AMF changes plant physiological responses under stress, particularly how water use efficiency may be altered.

Overall, the project results will build an understanding of AMF symbioses under a changing climate and help us predict how native plant communities may respond under elevated stress. Knowing how these fungi facilitate their hosts during these stress events will be vital in predicting shifts in native vegetation community composition and inform management, ecosystem restoration, and broad agricultural applications.

**Top:** Shae Jones is a PhD candidate at the University of Wollongong.

**FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY** will be used to pay for stable carbon isotope analysis to determine how arbuscular mycorrhizal fungi (AMF) may be modifying plant water use. The analysis will be outsourced to an external lab.

Top: Erica Durante with a large Australian giant cuttlefish (*Sepia apama*) cuttlebone. Image: Erica Durante.

# Investigating the Age and Growth of an Endemic Octopus Species

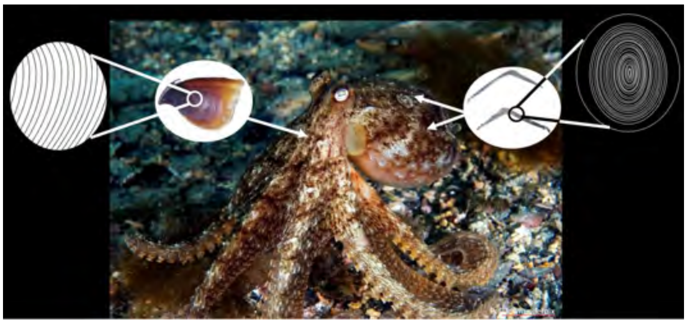
**ERICA DURANTE**
Future Industries Institute, University of South Australia

As the alien cousin of snails, cephalopods are a branch of the mollusc phylum that inhabit oceans either in the water column (squids and cuttlefish) or on the sea floor (octopus). They have internalised their traditional hard exoskeleton of a mollusc shell and now freely swim, hover, or crawl around. Cephalopods are keystone species, meaning they are crucial links in marine food webs, predators of crustaceans, small fish, and a variety of small invertebrates and prey for many animals, including marine mammals, seabirds, fish, and humans. Yes, humans! We eat them too! Cephalopods such as squid and octopus are a staple food source in many cultures worldwide.

As the global demand for sustainable seafood increases and traditional finfish stocks decline, cephalopod fisheries are expanding. Despite being an essential part of the marine ecosystem and popular seafood, knowledge about cephalopods is lacking compared to other marine animals such as fish. For this reason, there is a need to study cephalopods, and one way of doing this is by looking at their hard parts.

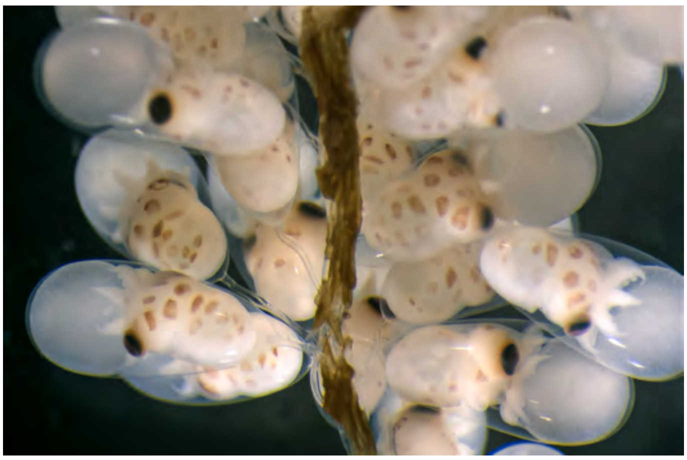
Although cephalopods are invertebrates, they have a variety of hard calcified or keratinous parts that can be used to understand their ecological and environmental histories. Two primary approaches for utilising cephalopod hard parts include growth increment analysis and chemical analysis (e.g., trace elements and stable isotopes). Growth increment analysis provides age data that can be used to learn more about the species life history. Chemical analysis helps to understand the animal's biology, environmental history, and specifically how it incorporates chemical elements from its environment into its body. These analyses can determine where the animal has been in its lifetime, which is then used to study migration patterns and seafood provenance (tracing seafood back to origin). Alternative monitoring methods used to collect such data include tagging, field observations, and lab-based studies. However, these methods can be expensive and time-consuming. By comparison, collection and analysis of hard parts is cost-effective and can add value to pre-existing samples held in museums and research agencies.

The first step towards the sustainable management of a species is understanding its life history. How long do they live? At what age are they sexually mature? These questions can be answered by looking at age data. Age data can tell us more about the species, such as the age of maturity, reproductive seasons, growth, and mortality rates. You can identify the age



Growth increments on the beak (left) and stylets (right) in relation to where they are found in the octopus' body. Image: Erica Durante.

Freshly laid midget octopus (*Octopus huttoni*) eggs. Image: Erica Durante.



Midget octopus (*Octopus huttoni*) eggs in their last stages of development. Image: Erica Durante.

of an octopus by counting the growth rings of its hard parts, such as beak and stylets (remanent of the mollusc shell). Generally, octopuses deposit one growth ring per day, but because all species of octopus are different, the deposit of growth rings needs to be validated by staining the hard part with a fluorescent dye.

The southern keeled octopus (*Octopus berrima*) is found throughout south-eastern Australia and is commonly caught in the largest octopus fishery in South Australia, making up ninety-four percent of the catch. Yet, next to nothing is known about the species, and subsequently, we could be depleting wild populations unsustainably without even knowing it. The project aims to generate the first age and growth data on the southern keeled octopus using increment analysis of its hard parts to understand how long they live, how fast they grow, and how individuals differ between populations.

The project, under animal ethics approval, will inject live octopuses with tetracycline, an antibiotic that fluoresces under ultraviolet light, and after a certain number of days, they are humanely killed, and their hard parts are observed. The number of growth rings deposited after the stain will be counted and compared to the actual number of days passed to determine whether or not they deposit daily growth rings.

At this point, only five species of octopus have validated ageing methods developed, including one by Erica Durante of the midget octopus (*Octopus huttoni*) and another by her supervisor, Doctor Zoë Doubleday, the pale octopus (*Octopus pallidus*). Once an ageing method has been developed and all the information is gathered, proper management of wild octopus stocks can begin. Overall, the results of the project will build a better understanding of the southern keeled octopus, provide a better idea of how to conserve and manage this endemic species, and can be used to inform the sustainable management of fisheries.

If you would like to go along the eight-legged journey, follow the MARIS lab on Twitter @MARISLabs and Instagram @maris_labs and Erica Durante on Twitter @DonlonErica.

**FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY** will be used towards lab and aquaria consumables and travel to Venus Bay, Victoria, to collect live octopuses.

A baby midget octopus (*Octopus huttoni*) (paralarvae) showing its strength by standing up. Image: Erica Durante.

A close-up image of a midget octopus (*Octopus huttoni*) eye. Image: Leonardo Durante.

Feeding an octopus at the Kanaloa Octopus Farm in Hawaii, where Erica Durante worked as a research biologist. Image: Zach Taylor.

# How Can We Improve Frog Conservation in Fragmented Landscapes? Closing the Gap with a Novel Genetic Approach

**GRACIE LIU**
School of Biological, Earth and Environmental Sciences, University of New South Wales

Habitat clearing, degradation, and fragmentation is occurring faster than ever before, causing species declines and extinctions. Many landscapes now exist as heterogeneous mosaics of land-use types, with patches of native vegetation between vast expanses of modified habitat. Within these landscapes, a significant concern is how species' movements will be impacted, and this is especially true for frogs as their dependency on aquatic and terrestrial environments makes them particularly sensitive to habitat modification.

At the landscape level, movement is vital for population persistence as it helps to maintain genetic connectivity. Populations that suddenly become isolated across the landscape are at an increased risk of becoming inbred and experiencing negative fitness consequences, such as reduced survival and development. Maintaining genetic diversity in fragmented populations is therefore crucial for preventing further species' declines.

However, the degree to which habitat fragmentation leads to population fragmentation depends on the landscape and the species. We know that mobility and gene flow is often restricted in fragmented landscapes in taxa that are highly mobile and have large area requirements (such as many birds and mammals). The effects of habitat fragmentation on the genetic structure of less mobile taxa have received comparatively little attention. Information on the genetic structure of frogs under habitat fragmentation is lacking, and equally, detailed movement data, particularly of juveniles (whose dispersals are thought to be key to population connectivity), is unavailable for most frog species. Information paucity is one of the greatest barriers to effective frog conservation, and this is especially true for Australian frog species, of which more than one in six are threatened with extinction.

It is estimated that as many as seventy percent of Australia's frog species are intolerant of habitat modification. However, protected areas and land set aside for nature conservation make up less than a quarter of our nation's land area. Unless more effective land management practices are adopted, Australian frogs are likely to undergo further declines.

For species occurring in fragmented habitats, identifying the levels of genetic diversity and gene flow across the landscape can help to identify vulnerable populations, inform the most appropriate scales of land management, and prioritise areas to protect or restore. This information can vastly improve conservation outcomes. Unfortunately, studies on gene flow and movements of frogs in modified landscapes have been mostly limited to European and North American species that undertake annual migrations to breeding ponds. There is little data from Australian frog species, which have vastly different life histories and ecological associations, including stream breeders that do not undergo distinct annual migrations.

In particular, we know surprisingly little about the effects of habitat modification at the species level. However, it is clear that different species, sometimes even those that are closely related and occur in the same habitats, can respond in contrasting ways to habitat modification, with some declining and others thriving. The project sought to understand why using the Endangered booroolong frog (*Litoria booroolongensis*) and the common stony creek frog (*Litoria wilcoxii*) as model species.

Booroolong frogs were once broadly distributed across New South Wales

**Top:** Gracie is a PhD candidate at the Centre for Ecosystem Science at the University of New South Wales and the Australian Museum Research Institute. Her research focuses on the effects of habitat modification on frogs. She also works as a FrogID validator at the Australian Museum, where she identifies frog species from audio recordings submitted to the national citizen science project, FrogID.

The Endangered booroolong frog (*Litoria booroolongensis*) in typical stream-side habitat. Image: Gracie Liu.

A male stony creek frog (*Litoria wilcoxii*) in breeding colour. Image: Gracie Liu.

and north-eastern Victoria, but their numbers have plummeted since the mid-1980s. Today, their declines continue to be strongly driven by habitat loss and degradation. They now only occur in a small part of their former range and are listed as Endangered under the Environment Protection and Biodiversity Conservation Act 1999 and Critically Endangered by the International Union for Conservation of Nature. They are rare in the Central Tablelands and were even presumed extinct from the Northern Tablelands for more than forty years (until they were rediscovered in 2017).

Yet, stony creek frogs appear to be thriving in these very landscapes. Despite being closely related and sharing many superficial similarities with booroolong frogs (similar life histories, physical appearance, broad habitat preferences), both species occupy riparian habitats and often the same stretches of stream. However, stony creek frogs are common and non-threatened.

Given the importance of genetic diversity and population connectivity for ensuring population resilience, could differences in gene flow and genetic variation be shaping the species' different responses under habitat modification and fragmentation? The project will use Diversity Array Technology sequencing (DArTseq), a next-generation sequencing approach to test this prediction. Specifically, the project aims to:

1. Assess and compare genetic diversity and gene flow in the booroolong (declining and endangered) and the stony creek frog (common and secure) within a highly fragmented landscape,
2. Determine whether the genetic structure of these two species is related to their threat status, and
3. Use the information to identify management units for species conservation.

Over the spring and summer of 2020-2021, the project collected over 120 genetic/tissue samples from booroolong and stony creek frogs across their shared geographic range in the New South Wales Central Tablelands. Under an approved scientific license and animal ethics protocol, a small tissue sample from one of the frog's toe pads (which can regrow) was collected; collecting a tissue sample guarantees that there will be enough suitable quality DNA to analyse. Booroolong frogs persist in several disjunct locations in the region, which features a range of land-use types, including pine plantations, agricultural and private land, and native vegetation. The project sampled several sites representing many of the major river systems in the region that are known to support booroolong and the more common stony creek frog.

These genetic samples will be sequenced and analysed using DArTseq. DArTseq is more time- and cost-effective than traditional molecular techniques and improves power to detect population differentiation at small scales relevant to management. It will allow the researchers to explore and directly compare the fine-scale genetic structure within and between booroolong and stony creek frog populations.

The data from the project will enhance the ability to assess the conservation value of various land management techniques for species living in highly fragmented landscapes. For example, it can help to determine whether increasing connectivity between populations (via landscape restoration or habitat corridors) will be a worthwhile strategy.

The information acquired from the project will also contribute directly to the conservation management of booroolong and stony creek frogs. Combined with the detailed movement and microhabitat use data that has been gathered from radiotracking these frogs, the project will help build a comprehensive picture of the species' movements and habitat requirements. With this information, we can identify genetically unique or vulnerable populations, prioritise important habitats and, ultimately, improve the conservation management of some of Australia's most vulnerable species.

**FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY** will be used to sequence and analyse the frogs genetic/tissue samples using Diversity Array Technology sequencing (DArTseq).

**This Page:** The New South Wales Central Tablelands consists of a variety of habitats, including pine plantations, agricultural land, and national parks. Images: Jodi Rowley and Gracie Liu.

# Conservation Utility of *Pimelea microcephala* subsps. *microcephala* to Arid Zone Frugivores and Pollinators

**JENNA DRAPER**
School of Biological Sciences, University of Adelaide

The conservation of native fauna that inhabits semi-arid zones is aided by understanding food sources and their use in these nutrient-poor landscapes. But what determines the usefulness of a resource to a food web; How many species use it? Are those species native, introduced, or threatened? Is it nutritious? The project aims to answer all three questions about the arid zone dioecious plant – mallee rice-flower (*Pimelea microcephala*) subspecies *microcephala*.

The mallee rice-flower is a dioecious plant, meaning that male and female reproductive roles are separated to different individuals. Both sexes of mallee rice-flower produce nectar, however only male plants produce pollen which pollinators gather, and only females produce bright fleshy fruits, which frugivores may consume. The mallee rice-flower was first identified at Hiltaba Nature Reserve, South Australia, in a Bush Blitz expedition in 2012. Since discovering the Hiltaba population, the significance of these potential pollinator and frugivore resources to Hiltaba's arid zone fauna has not been investigated, and the utility of mallee rice-flower for conservation has not been explored.



Preliminary camera trap imagery of a ringneck parrot (top) and wattlebird (bottom) searching for *Pimelea microcephala* subsps. *microcephala* fruits. Images: Jenna Draper.

Two attributes of mallee rice-flower make this species a potentially valuable species within the arid zone food web and for conservation: dioecy and toxicity. Regarding dioecy, while separating male and female reproductive roles is seen in six percent of Angiosperm species globally, it can be highly advantageous to reproduction and survival for arid species. By separating pollen and fruit production to different sexes, the production of one sex is not compromised by the production of the other, which allows for independent optimisation. Rather than dividing vital resources like nitrogen, carbon, or water between making pollen and fruits, dioecious individuals can focus on allocating resources to produce a high quantity and quality of just one product. Meanwhile, as a by-product of the different resource allocation and use patterns caused by primary reproductive function, resources produced by both sexes are adapted to utilise available resources best. Hence, the nectar profile of males and females can vary to manipulate pollinator behaviour to direct pollen-carrying insects to female flowers for pollination.

From a frugivore or pollinator's perspective, producing such high quantities of pollen by male plants, fruit by female plants, and nectar by both sexes means that foraging effort is reduced because resources are clustered at higher densities on individual plants. Pollen and fruits may also be more concentrated in terms of specific (macro) nutrients because of the independent production of each.

**Top:** Jenna Draper is a PhD Candidate in the School of Biological Sciences at the University of Adelaide.

The potential for mallee rice-flower to provide nutrient-dense and widely used food resources could make it a staple plant to consider during revegetation and monitoring efforts. Doing so will enable populations of pollinators and frugivores to return to or be sustained in arid habitats.

Another important factor that makes mallee rice-flower a potentially useful species for conservation is that it contains the toxin simplexin. Simplexin is a potent vasoconstrictor known to be toxic to cattle, and as a result, cattle will avoid grazing mallee rice-flower. This toxicity presents a unique conservation opportunity, as it chemically protects the mallee rice-flower from being grazed by introduced species. Grazing would counteract revegetation or prevent resources benefiting vulnerable native species. Additionally, as the fruits are attractive and appear to be consumed and dispersed by frugivores, it would be beneficial to ascertain if the fruits are also toxic. Should simplexin also occur in the fruits and native fauna are found to consume them safely, it could reveal the specificity of the resource for native fauna.

Therefore, focusing on the pollen and fruits produced by the mallee rice-flower, the project aims to: 1. Determine how many species gain sustenance from these food resources, and 2. Identify and quantify the nutrients available to species that consume them.

To address the first aim, frugivores and pollinators will be observed to determine the diversity of species visiting the mallee rice-flower for food. Frugivores will be observed and identified in the field and by camera trap photography. Pollinators will be observed and captured for identification after confirming interaction with male and female plants. After species identification, a diversity assessment will be made to determine how broadly food resources are used by native fauna and how frequently they are used. Preliminary camera trap data and opportunistic pollinator observation have so far indicated that a variety of native birds and insects interact with the mallee rice-flower, likely seeking fruits or nectar and pollen, respectively. However, further observation of frugivores, especially by eye, will be required to confirm the consumption of the mallee rice-flower fruits.

The second aim, which has been partially undertaken and completed, will be addressed by subjecting the pollen and fruit of the mallee rice-flower to nutrient analysis. Pollen will be analysed for protein content, a key indicator of nutritional value to insects. Protein content will be compared between the mallee rice-flower and co-flowering species to see if the protein content (nutritional value) is higher for the mallee rice-flower pollen. Fruit nutrient analysis has already been conducted and indicates that mallee rice-flower fruits are a vital source of water and antioxidants and contain high levels of the toxin simplexin.

Identification of species utilising mallee rice-flower, combined with nutrient studies of pollen and fruits, will provide a complete picture of the benefits of the mallee rice-flower as a potentially broadly used, chemically defended, and native specific food source. The project will provide conservation recommendations to inform the management of the relatively new mallee rice-flower population in Hiltaba Nature Reserve, South Australia, and potentially other native and threatened arid zone fauna species.

**THE FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY** will be used to purchase camera traps (to increase the observational coverage of frugivores) and will be used towards accommodation and associated travel costs to conduct observations at Hiltaba, South Australia.

Mallee rice-flower (*Pimelea microcephala*) subspecies *microcephala* pollen-producing male inflorescence (left) and fruit-bearing female inflorescence (right). Images: Jenna Draper.

A hoverfly (Syrphidae) interacting with male flowers of Mallee rice-flower (*Pimelea microcephala*) subspecies *microcephala.* Image: Jenna Draper.

# Population Protecting Implants - Targeted Control of Problem Individuals to Mitigate *CAT-astrophic* Predation

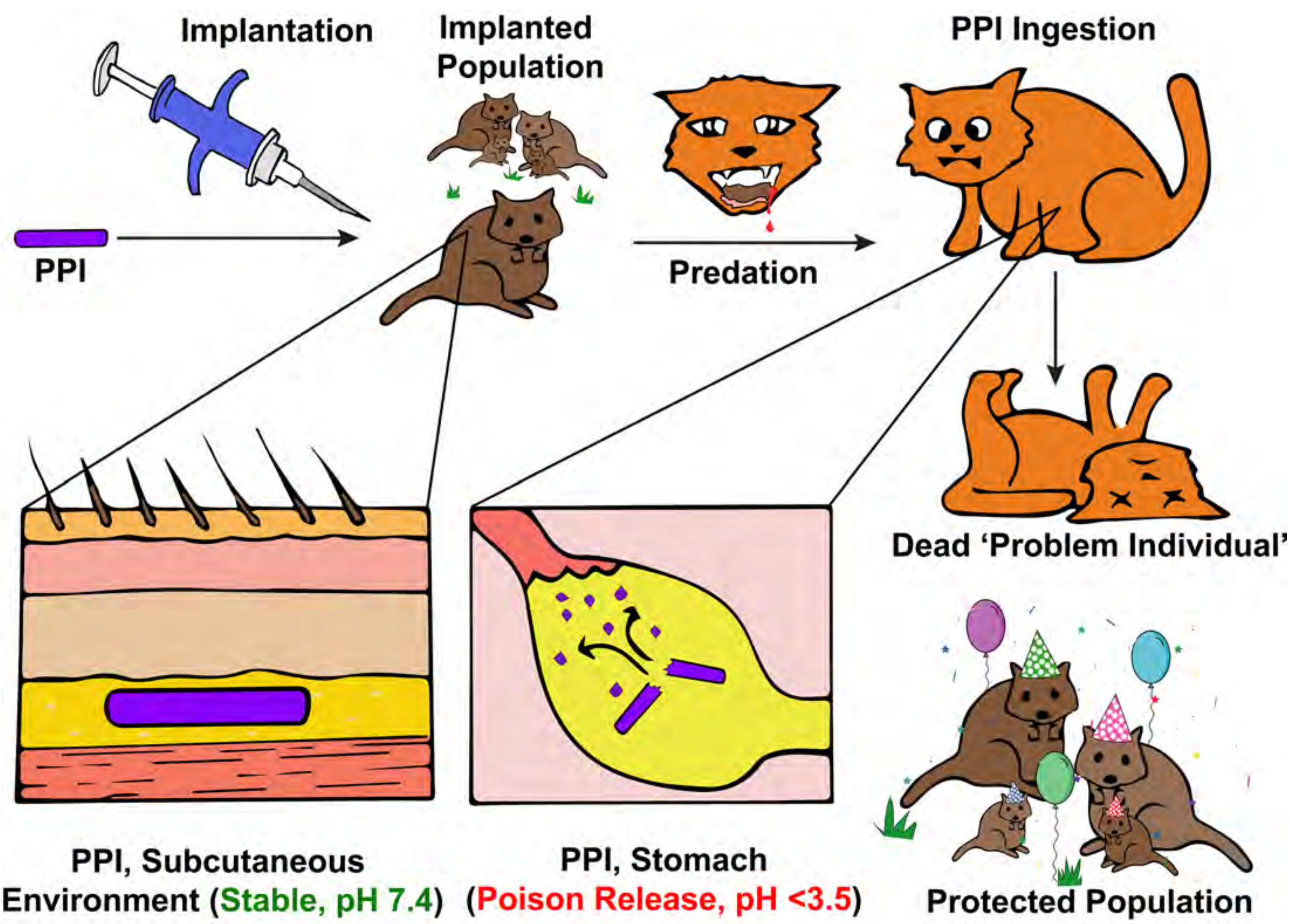
**KYLE BREWER**
Clinical and Health Sciences, University of South Australia

Feral cats (*Felis catus*) present the greatest predatory threat to Australian mammals. They occur across more than 99.8 percent of Australia's landscape and kill more than eight hundred million mammals annually, with the majority being native species. Small terrestrial mammals are most susceptible to predation due to their 'meal-size' and naivety to introduced predators. Efforts to mitigate the catastrophic effects of feral cat predation generally involve the attempted removal of feral cats from a target landscape and subsequent attempts to re-establish populations of threatened species through reintroduction (or translocation) programs within the area.

Generally, predation of the population of threatened mammals must be reduced to less than ten percent until a sufficient population has been established. However, there is no effective landscape-scale method of controlling feral cats, and existing programs are marred by the inability to remove feral cats from a target landscape altogether. The failure to remove feral cats from a target landscape can be due to the lack of universal pertinence of current control methods. Factors such as landscape suitability (e.g., exclosure fencing) or proximity to urban environments (e.g., poison baiting) can prevent the use of these control methods due to the resistance of feral cats to the control methods. In addition, it is rarely possible to maintain a completely predator-free landscape, as the continued intrusion of feral cats into the landscape often occurs.

Invariably, the presence of feral cats within a landscape in which a

**Top:** Kyle Brewer is a PhD candidate at the University of South Australia. Kyle is pictured here with a quokka (*Setonix brachyurus*) at Adelaide Zoo.




An illustrated overview of the Population Protecting Implant concept. Image: Kyle Brewer and Doctor Todd Gillam.

reintroduction program is established is met with swift predation and the decline of reintroduced native mammals. In many cases, a single control-resistant feral cat, or 'problem individual', has been responsible for destroying most, if not all, the reintroduced native mammals. Furthermore, 'problem individuals' have contributed to the collapse of some reintroduction programs. These results outline the dire need to protect reintroduced mammal populations from 'problem individuals' and, ultimately, improve the successful conservation outcomes of a reintroduction program.

The project aims to develop the Population Protecting Implant (PPI) – a device that could selectively target 'problem individuals' and safeguard native mammal populations during reintroduction programs. The PPI is a small implant designed to mimic the size and shape of the identification microchips, currently used in domestic pets. Similarly to the microchip, the PPI would be injected under the skin of a native mammal using a conventional microchip syringe implanter.

The PPI performs a distinctly different function to a microchip. It is manufactured with an outer 'smart' coating responsive to its environment and an inner core containing a lethal poison. Following implantation, in a selected population of native mammals, the 'smart' coating protects the implant, enabling it to remain inert for the life of the mammal. However, if preyed upon by a feral cat (i.e., a 'problem individual'), the PPI enters the acidic stomach environment of the predator, resulting in the dissolution of the 'smart' coating and the release of the poison contained within the core. Ultimately, resulting in the death of the 'problem individual' and protecting the remaining native mammal population, as no further predation can occur.

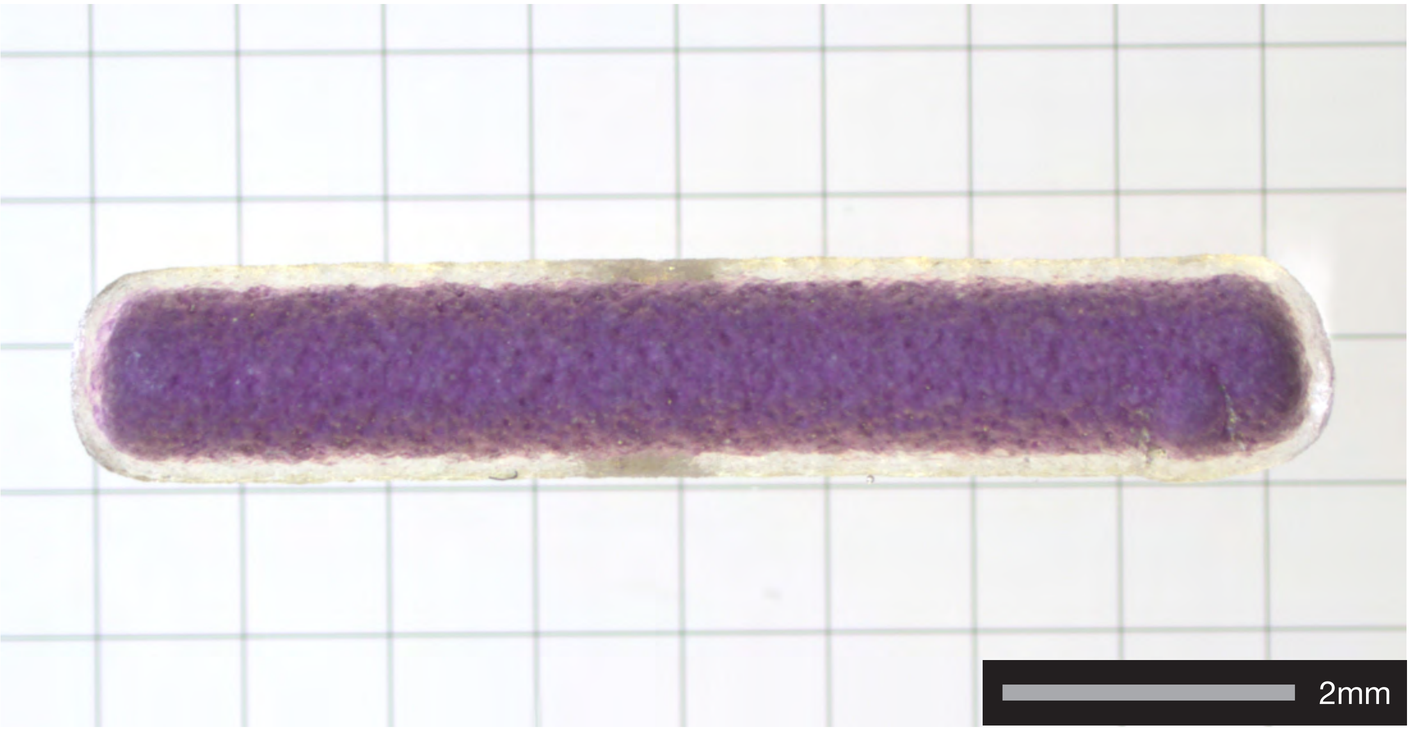
The PPI approach acknowledges and overcomes the challenging predatory behaviour of feral cats by artificially accelerating the much-needed evolution of anti-predator defences in prey naïve native mammals. In doing so, the project hypothesises that PPI's will selectively target the most dangerous and effective 'problem individuals' that prey upon reintroduced populations of native mammals. Mitigating the effects of 'problem individuals' will increase the success of mammal reintroduction programs as a result.

Initially, the project developed and tested PPI's containing a non-toxic core and optimised the design and manufacturing process until the PPI's exhibited favourable stability in vitro (i.e., outside the living organism), which took six months and in vivo (i.e., within the living organism), which took three months, and rapid release of the PPI's core material in vitro, which occurred within ninety minutes. Based on these favourable results, the project manufactured PPI's containing a toxic sodium fluoroacetate (1080 poison) core and confirmed their similar performance in vitro. In collaboration with colleagues at the University of Adelaide, researchers then demonstrated a proof-of-concept by implanting the toxic PPIs into animal carcasses fed to feral cats kept in an enclosed area (the sample size was three individuals). All three cats died within six hours of presenting symptoms of 1080 poison, showing that the toxic PPI's could rapidly release their poison cores in vivo and have the potential to be applied in the field.

Notably, the project needs to ensure that the 1080 poison contained within the toxic implant core will not diffuse through the 'smart' coating over a long period of time. Premature release of the 1080 poison from the implant core could toxify and potentially lead to the death of the implanted population of native mammals and must be avoided. The project will undertake accelerated in vitro stability experiments to determine whether the diffusion of 1080 poison from the implant occurs.

Overall, the results of this study will be used to manage 'problem individuals' to safeguard native mammal populations during reintroduction programs and aid conservation strategies for mitigating feral cats on a landscape scale.

**FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY** will be used to purchase specialised chromatographic equipment and consumables to undertake accelerated in vitro stability experiments that will determine whether the diffusion of 1080 poison from the implant occurs.




An optical microscopy image of a Population Protecting Implant, showing the 'smart' coating (transparent) and the 1080 poison core (purple). Image: Kyle Brewer.

# Strategically Exploiting Plant Odours to Manipulate Mammalian Herbivore Foraging Behaviours as a Conservational Tool

**PATRICK FINNERTY**
School of Life and Environmental Sciences, University of Sydney

By eating high-quality, palatable plants, mammalian herbivores can devastate habitat restoration efforts and post-fire vegetation recovery. In Australia, herbivores have been recorded to kill more than seventy percent of seedlings in areas recovering from a bushfire and previous disturbance. Consequently, herbivores are one of the greatest limiting factors in seedling recruitment and growth in these ecologically sensitive areas.

Current management solutions for problematic herbivores rely on approaches with social and/or economic limitations. Lethal control (e.g., shooting, baiting, trapping) may be unacceptable, especially for native species, while physical barriers, such as fences, can be expensive and work only in relatively small and accessible areas. We need alternative solutions. A new direction in developing benign, cost-effective, and non-lethal management approaches for problematic herbivores involves harnessing the smell of low-quality plant neighbours to protect vulnerable plants.

Herbivores often avoid foraging in patches of low-quality food to maximise foraging efficiency. The perceived net quality of a foraging patch can be degraded by using a neighbourhood of low-quality (high toxicity, low nutritional value) plants. Planting a neighbourhood of low-quality plants can work, but neighbours can also be problematic because they compete for water and other resources with the plants trying to be protected.

Recent discoveries have shown that herbivores rely heavily on plant odours to decide where they will forage.

The project predicts that the smell of low-quality plants will effectively delay herbivore browsing rates and increase focal plant survival. Therefore, the project will develop artificial plant odours or 'virtual' low-quality neighbours as an alternative to planting real plants. In deploying these 'virtual' neighbours, the project will answer whether we can harness the smell of plants to nudge problematic herbivores away from focal plants that are trying to be protected while avoiding the complications of planting real plants.

The project will test these ideas in an open eucalypt forest at Ku-ring-gai Chase National Park, Sydney, on its population of widespread herbivorous swamp wallabies (*Wallabia bicolor*).

**Top:** Patrick Finnerty is a School of Life and Environmental Sciences PhD Candidate at the University of Sydney.

Camera trap footage showing a swamp wallaby (*Wallabia bicolor*) eating every leaf of grey gum (*Eucalyptus puncata*) seedling. Image: Patrick Finnerty.

Although a native species and relevant to wildlife management and conservation, swamp wallabies pose a crucial threat to endangered endemic flora in the National Park. Their browsing habits are known to inhibit natural vegetation regeneration post-fire. For proof-of-concept, the project will use grey gum (*Eucalyptus punctata*) seedlings as representative focal plants. Grey gum occurs naturally in the study site and is highly vulnerable to wallaby browsing, with seedling survival rates as low as forty-four percent in the area. Protection of grey gum seedlings from swamp wallaby browsing is critical as the grey gum represents a major foundational canopy species in the area, providing habitat and food for several arboreal species.

The project will use the highly pungent, unpalatable, low-quality shrub species pink boronia (*Boronia pinnata*) as the sympatric low-quality neighbour. The project will conduct headspace Volatile Organic Compound sampling (analysis of compounds in environmental samples) and Gas Chromatography-Mass Spectrometry analysis to quantify the putative informative odour components. The project will then use the informative odour components to create artificial odour cocktails – 'virtual' pink boronia neighbours, for swamp wallabies to detect and avoid. Once the 'virtual' neighbours are deployed around the focal grey gum seedlings, the project will use remote camera traps to observe the time it takes for the first swamp wallaby to visit, the number of visits, and the time spent browsing. Additionally, the project will measure the focal seedling biomass consumption. The data will be the first of its kind and will show whether plant odour alone could be enough to reduce problematic herbivore browsing rates and increase focal plant survival. If successful, the data will provide the first step in developing novel wildlife management alternatives to broad-scale population control of problematic herbivores and/or large-scale fencing efforts.

As Australian landscapes become increasingly fragmented by fire and habitat disturbance, increased habitat connectivity is critical in conserving various threatened species. The outcomes of the project should provide tangible benefits in protecting vulnerable plants in areas of habitat restoration and post-fire recovery from problematic herbivory. In the long-term, the protection of high-quality focal plants will allow increased recruitment, survival, and growth of foundational canopy species, resulting in greater habitat connectivity and the survival of threatened species.

**FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY** will be used to purchase pink boronia (*Boronia pinnata*) seedlings.

Patrick Finnerty is organising a pilot study to collect the volatile organic compound sampling of a pink boronia (*Boronia pinnata*) shrub in Ku-ring-gai Chase National Park, Sydney. Image: Catherine Price.

The volatile organic compound sampling of pink boronia (*Boronia pinnata*) in action. Image: Patrick Finnerty.

# The Influence of Landscape-Scale Fire Refuges and Pyrodiversity on Mammal Communities Following an Unprecedented Megafire

**GRANT LINLEY**
Institute for Land, Water and Society, Charles Sturt University

The Australian fires of 2019-2020 were unprecedented in their scale, burning more than twelve million hectares of south-eastern Australia, affecting an estimated three billion native animals, and incinerating the habitats of hundreds of threatened species. Although Australia is a fire-prone continent, the role of megafires and the risk they pose to biodiversity is still relatively unknown. Megafires affect larger areas than historical fires, incinerating critical resources for wildlife, such as logs, vegetation cover, and tree hollows, across millions of hectares. These resources, once lost, can take decades or even centuries to recover, slowing the recovery of the wildlife that depend on these recourses for survival across vast areas.

A significant focus in the wake of these fires is the role of unburnt refuges in post-fire landscapes. Refuges allow animals to survive the fire event and act as artificial shelters for animals for post-fire recovery throughout the broader landscape. Refuges range from microsites (e.g., rocks, large logs) that allow individual animals to escape the passage of fire to large, unburnt patches that escape fire due to deterministic or stochastic processes. While refuges have typically been conceptualised at the site or patch scale, it is well established in landscape ecology that the spatial extent of habitat through entire landscapes determines which species can persist. Hence, a landscape view of fire refuges assesses the influence of biodiversity on the degree of variation in the extent of unburnt 'refuge' vegetation within a landscape.

The Australian megafires were unprecedented in their overall scale and the amount of the landscape that burnt at high or very high-severity. Entire conservation reserves were consumed by high-severity fires, resulting in the near-total alteration of the landscape. Alteration of the landscape will likely result in alteration of biodiversity, as only species that can persist within severely burnt vegetation will remain present in the landscape. By contrast, mixed-severity fires – those that contain a broad gradient in fire severities, with patches of low, moderate, and high-severity burns – are hypothesised to increase environmental heterogeneity and thereby increase biodiversity in turn.

The project aims to understand how the amount of unburnt refuge within a landscape and spatial variation in fire severity (pyrodiversity) affects

**Top:** Grant Linley is a PhD candidate in the School of Agricultural, Environmental and Veterinary Sciences at Charles Sturt University.

Vegetation damage caused by the 2019-2020 bushfires in Woomargama National Park, New South Wales. Image: Grant Linley.

mammal communities. The project will collect data from three wilderness areas: Jingellic Nature Reserve and Woomargama National Park in southern New South Wales and Burrowa Pine Mountain National Park in Victoria's north-east. These areas were subject to two large fire complexes, the Corryong and Green Valley megafires, that eventually joined, burning vast areas (600,000 hectares) of foothill forests and woodlands, as well as sensitive alpine ecosystems. Fifty percent of the habitat burnt within this fire complex was sclerophyll forest, which contains threatened species and habitats. Variation in fire severity is evident across the region, with some reserves experiencing uniform, high-severity fire, while other areas experienced mixed-severity fires, with patches of high-severity fire intermixed with low to moderate-severity burns. Unburnt refuges, although scarce, are scattered throughout the fire grounds. These megafires create the template for a 'natural experiment' that can address some fundamental questions about how megafires impact wildlife.

A 'whole of landscape' experimental design will be used to examine the influence of unburnt refuges pyrodiversity on mammal communities following an unprecedented megafire. Twenty-four replicate study landscapes have been selected that differ in the extent of unburnt vegetation within a landscape and spatial variation in fire severity classes. A 'whole of landscape' approach is ideally suited to testing theories regarding the influence of landscape patterns on biodiversity and has been used previously to test the influence of pyrodiversity on biodiversity.

To undertake surveys of terrestrial mammals, 192 camera traps will be set up within the study landscapes to capture the extent and variation of fire severity classes throughout each landscape. In addition, vegetation surveys will be undertaken to determine the extent of fire damage and recovery, in combination with more specific vegetation surveys, which will focus on assessing the damage to refuge areas.

The results of this study will be used to improve the understanding of the impacts of the 2019-2020 bushfire season on Australia's wildlife, including on a range of priority species. It will also enhance knowledge of the importance and location of unburnt refuges for priority species and assess the risks of invasive predators within the fire-affected areas. Additionally, the quantification of habitat loss and population decline of priority species will be feed into conservation assessments at the state and national level, allowing conservation and land managers ways to mitigate the future impacts of megafire.

For this project, equipment, including camera traps, has been supported by World Wide Fund for Nature.

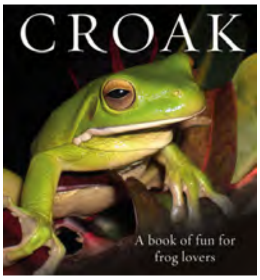
**FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY** will be used for accommodation and travel costs associated with fieldwork. Fieldwork will occur on multiple dates throughout the year for five to ten days at a time.

# Book Reviews


### Sharing Planet Earth – *Sarah Barnes, Lee-ann Grohn, and Sarah Jantos*

The Sharing Planet Earth program has been created for Australian early years and primary educators, to build the knowledge and confidence to engage children in native wildlife conservation. *Sharing Planet Earth* is a resource that includes fifteen action projects to engage children in preserving and protecting native wildlife. This free downloadable resource also contains a simple picture book based on the rescue and rehabilitation of two sugar gliders, a practical guide to organising collections and fundraisers for wildlife organisations, and Australian National Curriculum Links. Educational supplies and other resources to complement the program can be purchased from the Green Heroes store.

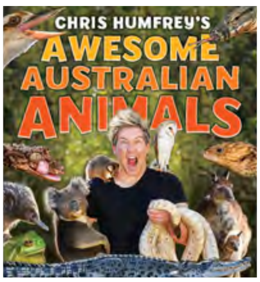
**Publisher: Green Heroes**
**RRP: Free downloadable resource greenheroes.org.au/education**




### Croak – *Phil Bishop*

Croak is a collection of delightful quotes and gorgeous photographs celebrating the underappreciated beauty of frogs. Many of the stunning, colourful images were taken by author Phil Bishop on his travels worldwide. He showcases frogs in their natural habitats, from the crucifix toad (*Notaden bennettii*), one of the few Australian frogs that display aposematism, to the stony-creek frog (*Ranoidea wilcoxii*), which is endemic to Australia and found only on the east coast. Images are paired with quotes from famous faces such as Jane Goodall and Albert Einstein. Simultaneously amusing and illuminating, this perfect coffee table book is a celebration of one of the most varied and vibrant species on earth.

**Publisher: Exisle Publishing | RRP: $29.99**




### Awesome Australian Animals – *Chris Humfreys*

Did you know that koalas poo more than two hundred times per day? – that is more than once every ten minutes! This fact is just one of the hundreds of fascinating animal facts packed into this brilliant new interactive book. Kids will see Australia's most fascinating species in close-up detail as never before through the author's eyes, ears, and voice. Interactive digital vision plunges readers from the page right into the jaws of a saltwater crocodile (*Crocodylus porosus*) and the hidden habitats of the giant burrowing cockroach (*Macropanesthia rhinoceros*). Chris believes that kids are the key to saving Australia's precious wildlife, and through his book, he aims to empower a young army of animal allies to change the future.

**Publisher: New Holland Publishers | RRP: $19.99**