AUSTRALIAN Wildlife

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Celebrating a new century of wildlife preservation in Australia

Journal of the Wildlife Preservation Society of Australia Limited
(Founded 1909)

Spring has Sprung

The garden at the front of the National Office before it was revegetated.

The garden at the front of the National Office after it was revegetated.

L to R: Philip Sansom and Ken Mason preparing the garden for weed extraction.

Patrick Medway AM and staff from Bayside Garden Centre delivering the native plants.

L to R: Patrick Medway AM and Ken Mason working hard in the garden.

Ken Mason extracting weeds from the garden.

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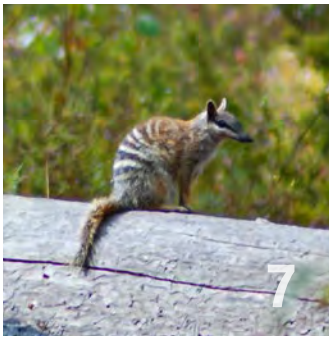

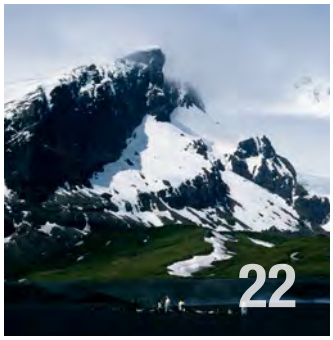

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Megan Fabian
Editor, Australian Wildlife

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The black-tipped spider orchid *(Caladenia anthracina*), endemic to Tasmania, is an extremely rare species listed as Endangered. Better protection and increased awareness of this species are vital for its survival into the future. Image: Bruno Bell.

Back Cover:
The squirrel glider (*Petaurus norfolcensis*), a nocturnal gliding possum, is listed as Vulnerable in New South Wales and Endangered in South Australia due to a range of factors including loss of hollow-bearing trees. We must take action to protect its key habitat and prevent the loss of hollow-bearing trees. Image: Chris Theobald.

Australian Wildlife Society
Conserving Australia's Wildlife since 1909

Australian Wildlife

is the official journal of the Australian Wildlife Society (Wildlife Preservation Society of Australia Limited).

Founded in 1909, the Society is dedicated to the conservation of our unique Australian wildlife in all its forms.

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Member Notice

The Australian Wildlife Society (Wildlife Preservation Society of Australia Limited) is managed and controlled by an elected board of ten volunteer directors. The Society is a tax-deductible gift recipient and registered with the Australian Charities and Not-for-profit Commission. Its public fund is listed on the Register of Environmental Organisations under item 6.1.1 of subsection 30-55(1) of the Income Tax Assessment Act 1997.

Any member who might like to consider serving as a director of the Society is invited to contact the national office for more details. The most important qualification to serving as a director is 'a commitment to and love of Australian wildlife'.

The Society holds regular monthly meetings on the first Wednesday of each month in Sydney.

The Editor would like to feature a member's profile in the fortnightly email newsletter and occasionally in our quarterly magazine. Members are invited to consider submitting a short article with a photograph for possible publication.

Our Mission

The Australian Wildlife Society (Wildlife Preservation Society of Australia Limited) is a national not-for-profit wildlife conservation organisation, formed in 1909, and is committed to the preservation of Australia's precious flora and fauna. We act as a watchdog and provide advice to government agencies and institutions regarding environmental and conservation issues concerning all aspects of wildlife preservation.

Our mission is to conserve Australia's fauna and flora through education and involvement of the community. We are dedicated to the conservation of our unique Australian wildlife in all its forms through national environmental education, advocacy, public awareness, community involvement, and hands-on conservation work.

Our Society has always known that a conservation battle is never really won until the victory is enshrined in legislation. We have always attempted to convince politicians of the necessity to include the preservation of Australia's precious wildlife and its vital habitat in all their planning, environmental issues, and discussions.

From the President's desk

Doctor Julie Old - President

Each year, thousands of native wildlife become entangled and die horrific deaths from ring-shaped items such as plastic rings, rubber bands, hair ties, the loops of facemasks, and dome-shaped plastic lids. The #SnipRingsforWildlife campaign aims to raise awareness and encourage individuals to protect Australia's wildlife by cutting through ring-shaped items before disposing of them.

Welcome to the Spring 2021 Edition of Australian Wildlife.

Sadly, the ongoing covid-19 crisis seems to be never-ending, with many of us unable to visit family and friends, #stayingsafe at home, and only venturing out for essentials and a brief exercise reprieve. As always, the Society, with the support of its members, has been busy supporting the preservation of our unique flora and fauna throughout this time, and even a pandemic will not stop our efforts! The Directors have become adept at online meetings and have been busy working on many different projects.

The Society continues to advocate for the protection of platypus populations across the nation. We wrote to the Federal and Queensland Ministers advocating for the protection of Mt. Etna's rare and vulnerable ghost bat (*Macroderma gigas*), whose declining populations now number only about 3,000 individuals. We have written to the New South Wales Minister for Energy and Emissions Reduction regarding the Intergovernmental Panel on Climate Change report encouraging the government to take urgent action on climate change. We continue to write to companies urging them to improve the design of their products to a wildlife-friendly option. We spoke about the Society's role in wildlife conservation to first-year students at Charles Sturt University.

Water for wildlife in the National Office's new garden.

We are also asking for everyone to get on board and support the Society's #SnipRingsforWildlife campaign. Each year, thousands of native wildlife become entangled and die horrific deaths from ring-shaped items such as plastic rings, rubber bands, hair ties, the loops of facemasks, and dome-shaped plastic lids. The campaign aims to raise awareness and encourage individuals to protect Australia's wildlife by cutting through ring-shaped items before disposing of them.

An online petition was launched calling on the New South Wales Parliament to take action to protect native wildlife from the risk of entanglement and death. Unfortunately, we did not reach the 20,000-signature target. Regardless, we will continue to advocate to protect native wildlife from the threat of entanglement and death from ring-shaped items and write to companies informing them of the danger ring-shaped items pose to native wildlife. Our change.org petition is still live if you would like to support the campaign https://www.change.org/SnipRingsForWildlife.

Protect native animals and #SnipRingsforWildlife.

Congratulations to the Threatened Wildlife Photographic Competition winners for 2021. The Society was delighted to receive a vast number of entries, making it an extremely tough competition. Thank you to all our entrants; all entries were magnificent.

We also received several applications to the University Research Grant Scheme, with the quality of the applications being extremely high. A special thank you to Doctor Al Glen for his time and effort in selecting the ten finalists.

Also, spring has, of course, sprung! Warmer temperatures in much of Australia make adventures outdoors even more inviting, even if it is only at a nearby park or bushland, to enjoy the abundance of wildflowers and wildlife. I have been spending time in the backyard bird watching. I have been particularly thrilled to observe some relatively new visitors to my garden, blue-faced honeyeaters (*Entomyzon cyanotis*), carefully extracting small threads of palm leaves and carrying them off to an unknown location.

Whilst watching the birds, I often sit near a small pond. Ponds provide habitat for invertebrates and amphibians, as well as providing a water source for larger animals such as lizards and birds and is something everyone can easily incorporate into a garden to support native wildlife. We have even recently installed water for wildlife in the National Office's new garden.

Ponds can be decorated in many ways, with rocks and a strategically placed stick in case an animal unexpectantly falls in and is in need of escape, or perhaps even a native waterlily. Even a small bowl with decorative pebbles on a balcony can provide relief to heat-stressed wildlife like our native bees.

So, no matter where we live, or work, we can contribute in a small way to help support our native wildlife; we just need to add a little water!

Protecting Australia's Fauna Through Native Seed Management

Samantha Craigie and Harry Moore

Australia's diverse and highly distinct fauna assemblage is currently in a state of precipitous decline. Since 1788, Australia has lost over four species per decade, and more species are projected to disappear within the next two decades. Factors driving these declines are known to be many, however the destruction and degradation of native vegetation – through human-mediated processes such as land clearing, altered fire regimes, and climate change – is thought to be among the most important.

Restoring native vegetation is a priority for the conservation of Australia's biodiversity, and this is reflected in the most recent Federal Government Threatened Species Strategy, a document which, among other objectives, aims to support the restoration of threatened species habitat and the regeneration of habitat in priority places.

Restoration of remnants is a key part of habitat restoration. Remnants are areas of native vegetation still existing in the landscape. These are incredibly important as they provide habitat and food for fauna species, especially those with specific plants in their diet, such as glossy black cockatoos (*Calyptorhynchus lathami*) that almost exclusively eat the seeds of Allocasurina species.

Habitat restoration is especially critical for species that continue to experience large scale habitat loss, such as the greater glider (*Petauroides* species). Despite being federally listed as Vulnerable to extinction, recent estimates suggest these species lost 18,622.5 hectares of habitat to logging during the 2016-2018 period and 5,300,000 hectares in the 2019-2020 wildfires. Ensuring the continued persistence of species, such as the greater glider, is likely to require the protection of existing habitat and the restoration of habitat formally cleared.

Where habitats cannot be naturally regenerated, human intervention may be required through landscape restoration and reconstruction. In some cases, small and isolated remnant areas can be extended through landscape restoration or linked to create corridors to allow fauna species to disperse and move safely across the landscape. Landscape restoration can also create new areas for animal populations to move into and inhabit.

The availability of native seed is a key part of the landscape restoration process; however, it is also a finite and valuable resource to be managed carefully. Currently, the environmental restoration sector is not consistently able to source, store and use seeds easily. Those buying seed report a lack of seed availability from a broad range of species. Suppliers claim that seed demand is inconsistent and unpredictable, and the market is unwilling to pay the true cost of seed collection and production.

In response to seed shortages, a ten-year Strategy for the Australian Native Seed Sector has been developed by Project Phoenix, an initiative funded by the Australian Government's Wildlife and Habitat Bushfire Recovery Package, and is managed by Greening Australia. The purpose of the Strategy

Top: A remnant patch of open eucalypt woodland, which provides critical habitat for a diversity of species, some of which are threatened with extinction. Image: Harry Moore.

is to increase native seed supply in preparation for the restoration and conservation of valuable habitats, including those impacted by bushfires.

Developing the Strategy has been a collaborative effort, including a period of public consultation with practitioners, buyers, conservationists, and invested entities within the Australian native seed sector. The Strategy is now with the Commonwealth for approval. Among other activities, the Strategy will enable coordination of the sector across Australia, making it easier to re-introduce native species into the landscape and increase our options for restoration for future stochastic events. It will also connect the thousands of organisations, groups, and individuals who make up the native seed sector.

Ultimately, more native seed and a more coordinated sector will mean Australia can restore landscapes and support biodiversity, especially after natural disasters, including supporting the species that rely on these plants for their food sources and habitat.

To find out more about native seed and the resources available through Project Phoenix, visit the website https://www.greeningaustralia.org.au/project-phoenix-resources/

Further Reading

Ashman, Kita R., Darcy J. Watchorn, David B. Lindenmayer, and Martin FJ Taylor. "Is Australia's environmental legislation protecting threatened species? A case study of the national listing of the greater glider." Pacific Conservation Biology (2021).

Hancock, N., Gibson-Roy, P., Driver, M. and Broadhurst, L. (2020). The Australian Native Seed Sector Survey Report. Australian Network for Plant Conservation, Canberra.

An endangered Carnaby's cockatoo (*Calyptorhynchus latirostris*) – a species known to use habitat that has been restored. Image: Harry Moore.

A numbat (*Myrmecobius fasciatus*) – a species that relies heavily on remnant patches of vegetation. Image: Harry Moore.

The greater glider (*Petauroides volans*) is a species that has recently lost extensive amounts of habitat due to logging and megafire. Image: Mark Gillow.

Samantha Craigie has over eighteen years of experience in delivering quality environmental outcomes in natural resource management. She has specialist knowledge in native seed management, including co-coordinating Australia's first National Native Seed Strategy.

A boodie (*Bettongia lesueur*), or burrowing bettong, relies on intact vegetation communities to shelter from predators. Image: Harry Moore.

A holy cross frog (*Notaden bennetti*) – a species known to be sensitive to the threat of land degradation. Image: Harry Moore.

Hatching a Plan for Marine Turtles:

The Artificial Incubation of Marine Turtle Nests in Cold Climates

Sarah Jantos, Green Heroes, and Associate Professor David Booth, University of Queensland

Australian waters are known to host six of the world's seven marine turtle species. It is thought that three of these turtle species, the loggerhead sea turtle (*Caretta caretta*), the green sea turtle (*Chelonia mydas*), and the flatback sea turtle (*Natator depressus*), have altered their nesting locations up and down the east coast of Australia in response to changing climatic conditions, over tens of thousands of years, leading to the choice of ideal thermal nesting conditions.

As we enter an accelerated climate change period in Earth's history (relative to historical data), it is unknown whether, as a species, marine turtles will be able to naturally adapt and shift from nesting beaches that have become too hot for optimal nesting, to cooler beaches further south along the east coast of Australia.

All sea turtles have temperature-dependent sex determination, where the sex of the turtle hatchlings is determined by the temperature of the nest during the middle third of embryonic development. Cooler temperatures favour male turtle hatchling production, and warmer temperatures favour female turtle hatchling production. Because of climate warming, a rapid feminisation of marine turtle hatchlings is observed at many sea turtle nesting beaches, including some beaches along the northern latitudes of the east coast of Queensland. In some cases, nest temperatures can reach and even exceed 36°C – proving fatal to many developing embryos. In these northern latitudes, management efforts at some sites focus on cooling nests to produce a healthy clutch of hatchlings, especially the increasingly rare male turtle hatchling. It is understood that cooling turtle nests cannot offer an effective long-term solution for preserving the large numbers of marine turtle species that choose to nest on Australian shores each year.

At more southern latitudes, in northern New South Wales, current statistics and observations show an increase in the number of sea turtles breeding and seeking out nesting sites. Here, additional conservation efforts are underway to support nests laid in the current cooler climates, with some nests being laid at the very end of summer or early autumn when sand dunes, and hence nest temperatures, are falling below optimal incubation temperatures. These cooler, late-season nests create a compromised scenario for the eruption of a healthy, live clutch of hatchlings. However, it is anticipated that some southern nesting sites could become climatically optimal sites for marine turtle nesting and breeding in the not-too-distant future.

In the 2020-2021 summer season, expert Green Heroes volunteers were able to design and build a high-quality prototype system for the artificial incubation of marine turtle eggs. With the generous support from the Australian Wildlife Society, the incubation system has been created to support marine turtle clutches that are 'more than likely to fail' if left *in situ* at their current locations at these southern latitudes.

In cooperation with the New South Wales National Parks and Wildlife Service and local Aboriginal Land Council, Green Heroes conducted a pilot

Top: The successful release of the loggerhead sea turtle hatchlings into the ocean. Image: Ashi Hilmer.

trial and artificial incubation of three locally rescued loggerhead sea turtle nests – one from Pottsville Beach and two from Fingal Head Beach, New South Wales.

In the northern latitudes, it is typical for loggerhead sea turtles to hatch naturally between fifty-five to seventy-five days after the nest is laid. However, permission was given for the Green Heroes incubation trial to excavate three loggerhead sea turtle nests ninety days after they were laid and only after temperatures within the nest had dropped below 22°C for several consecutive days. It was unknown whether any eggs would still be viable, however after two weeks of artificial incubation at 30°C, the first clutch produced 107 male hatchlings from 113 eggs, yielding an unprecedented hatchling rate of over ninety-six percent. Two additional clutches hatched shortly after with similar success and were released into the ocean.

Many successes were attributed to the design of the incubation chambers, capable of maintaining an optimal temperature within half a degree Celsius and combined efforts to minimise handling and transport of eggs. Many other considerations such as the inclusion of sand and nutrients from the nest site, exclusion of ferrous metals, exclusion of electrical currents and heating devices, and the ability to monitor temperature and humidity remotely via an application are also noteworthy, but the impact of these considerations are yet to be quantified.

More research is required to understand the long-term effects or changes that artificial incubation may have on hatchling development and the life of a marine turtle. Green Heroes is committed to working alongside like-minded organisations to take a multi-pronged approach to the conservation of marine turtles whilst monitoring outcomes of any manipulations applied. Some conservation efforts will prove more successful than others over time, however artificial incubation will ensure that all efforts are made without delay to provide the best possible chance for species recovery as outlined in the Marine Turtle Recovery Plan.

In brief, the pilot trial showed very promising results for the benefit of threatened and endangered marine turtle species, and with careful planning and support, the artificial incubation and hatching of males in northern New South Wales could help to:

1. Provide an appropriate male-female balance along the east coast of Australia,

Loggerhead sea turtle (*Caretta caretta*) eggs. Image: Sarah Jantos.

The Endangered loggerhead sea turtle (*Caretta caretta*) hatchlings. Image: Ashi Hilmer.

A health assessment of a loggerhead sea turtle before its release. Image: Ashi Hilmer.

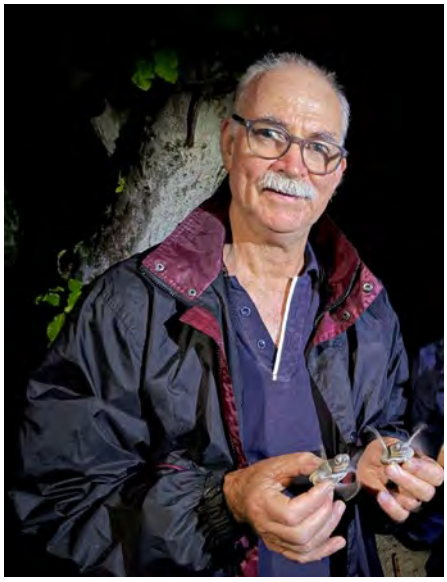
Measuring the loggerhead sea turtle hatchlings before being released. Image: Ashi Hilmer.

Steven Kudzius, a Green Heroes volunteer, operating the marine sea turtle (*Caretta caretta*) incubation system. Image: Sarah Jantos.

2. Support several viable locations for loggerhead and green sea turtle nesting aggregations to form along the north coast of New South Wales, and
3. These efforts will also aim to counter the feminisation effect of warming incubation temperatures at the current nesting aggregations in Queensland.

Green Heroes is pleased to continue working with authorities, the local Aboriginal Land Council, the Australian Wildlife Society, and like-minded conservation organisations to prepare for the upcoming turtle nesting seasons. Stay tuned! If you would like to find out more about the work of Green Heroes, please visit www.greenheroes.org.au

Sarah Jantos is the Founder of Green Heroes, a wildlife conservation and education organisation established in 2016. Sarah has been actively involved in wildlife rescue and rehabilitation for over twelve years.



Doctor David Booth is an Honorary Associate Professor in the School of Biological Sciences at the University of Queensland. He has been involved in the research of sea turtle incubation biology for over twenty years. David is pictured here with two turtle hatchlings at Heron Island, Queensland, in February 2021.

THREATENED WILDLIFE PHOTOGRAPHIC COMPETITION

Winners Announced

The Australian Wildlife Society Threatened Wildlife Photographic Competition is a national competition that awards and promotes threatened Australian wildlife through photography. The Australian Wildlife Society invited photographers to raise the plight of Australia's threatened wildlife - flora and fauna. The Society was delighted to receive a record number of entries, making it an extremely tough competition. Thank you to all our entrants.

We look forward to continuing the successful Threatened Wildlife Photographic Competition again next year to raise the plight of threatened wildlife across Australia.

Judges' Choice

The annual judges' prize of $1,000 was won by **Bruno Bell** for his photograph of a black-tipped spider orchid (*Caladenia anthracina*). The black-tipped spider orchid is endemic to Tasmania and is listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* and the Tasmanian *Threatened Species Protection Act 1995.* The black-tipped spider orchid is extremely rare, with field surveys identifying a total of ninety individuals in four populations, none comprising more than thirty individuals. The extent and quality of habitat, the number of populations and mature individuals, agricultural development, fire regimes, and disturbance events determine the survival of this species. Better protection and increased awareness of this species are vital for its survival into the future.

Thank you to all the contributors to the Society's Threatened Wildlife Photographic Competition – please enter again next year.

A selection of the photographic entries is featured on the following pages

People's Choice

The annual people's choice prize of $500 was won by **Chris Theobald** for his photograph of a squirrel glider (*Petaurus norfolcensis*). The squirrel glider is widely but sparsely distributed across eastern Australia and prefers wet and dry sclerophyll forests and woodlands. Squirrel gliders take shelter in tree hollows during the day and come out at night to feed on insects, pollen, and nectar. Being arboreal, they are very adept at climbing and can glide from tree to tree using skin membranes that stretch between their front and back legs. The squirrel glider is listed as Vulnerable in New South Wales and Endangered in South Australia. Threats to this species include fragmentation of habitat, loss of hollow-bearing trees and understorey food resources, inappropriate fire regimes, mortality due to entanglement on barbed wire, vehicle strike, climate change, and invasive species occupying hollows. This image was photographed in Wolgan Valley, New South Wales.

Numbat
(*Myrmecobius fasciatus*)
Image by Tamara Wilkes-Jones

The numbat is a small marsupial restricted to isolated pockets in Western Australia and reintroduced to South Australia. Numbats are one of the more unusual Australian marsupials. They are diurnal, carnivorous, and have an incredibly long sticky tongue created to catch termites. At night, numbats take refuge in logs, tree hollows or burrows, to help protect them from predators. The numbat is listed as Endangered and is under threat from foxes and feral cats and habitat loss and fragmentation from land clearing, making numbats more vulnerable to birds of prey. It is estimated that there are less than 1,000 mature individuals left in the wild. Tamara lives in south-west Western Australia, where she can visit Perup Nature Reserve to observe and photograph these elusive marsupials. It took Tamara one week to find and photograph the numbat. Low daylight temperatures and rain are conditions that numbats do not favour. Tamara's patience was rewarded on a sunny day, aided by her keen eye and quiet movements through the woodland, where she was lucky to capture this image of a young numbat exploring a log for termites.

Brush-tailed rock-wallaby (*Petrogale penicillata*)

Image by Adie Connor

Hundreds of thousands of brush-tailed rock-wallabies once roamed across eastern Australia, now just 10-20,000 remain. Affected by introduced predators, habitat loss, and hunting, brush-tailed rock-wallaby is listed as Vulnerable. Through genetic research, scientists have determined that there are three genetically distinct forms of brush-tailed rock-wallabies. The wallaby photographed here belongs to the central form, south-east New South Wales, consisting of only five hundred individuals. Adie captured this image in Kangaroo Valley, where the Friends of the Brush-tailed Rock-Wallaby and National Parks and Wildlife Service have been working to conserve the southernmost population of thirty rock-wallabies. As a youth volunteer, Adie has assisted with radio-tracking, monitoring camera traps, and educating the local community. These wallabies are particularly vulnerable as joeys. When they become too heavy for their mothers, they are stashed away in rock crevices and are susceptible to predation. Adie captured an image of this joey at its most vulnerable stage to raise awareness of its plight as it comes to face its roughest months.

Grey-headed flying-fox (*Pteropus poliocephalus*)

Image by Maddie Walcher

The grey-headed flying-fox is a native species endemic to Australia on the eastern seaboard – southern Queensland, New South Wales, and Victoria. It is listed as Vulnerable under New South Wales and Australian legislation due to its decreasing population. Their favourite food is the pollen and nectar of eucalypt blossoms, followed by other native hardwood blossoms, such as melaleuca (paperbark) and banksia, and rainforest fruits including lilly pillies and figs. Exotic fruits are generally not preferred, but the lack of selected food sources will force flying-foxes into orchards and backyard fruit trees, where they face dangers such as shooters and loose netting. The grey-headed flying-fox transfers pollen and seeds over vast areas, which makes them so crucial to the growth of our native forests. Maddie took this photograph while visiting her grandparents in Tenterfield, New South Wales. It was Maddie's first time seeing the precious animal, so she had to take a photograph to draw attention to their plight.

Platypus (*Ornithorhynchus anatinus*)

Image by Jonathan Bartlett

The platypus is one of Australia's most unique and iconic species. It is a semi-aquatic egg-laying mammal (monotreme) that inhabits various freshwater systems along the eastern coast of Australia and throughout Tasmania. The platypus is listed as Endangered in South Australia and Vulnerable in Victoria. The biggest threats to platypus include habitat loss, drought, modification of natural waterways, predation by foxes and feral cats, and entanglement in litter, especially discarded fishing line, rubber bands, and enclosed yabby traps, causing many drowning deaths of platypus. There is nothing more satisfying than seeing an animal in its natural habitat. After staking out Mt Field's Russell Falls (Tasmania) for several mornings, Jonathan and his partner were delighted that this platypus finally decided to show its bill. It foraged at the brink of the waterfall for at least an hour; they had never had such an incredible encounter. Jonathan and his partner hope that early conservation actions can bring platypus declines to a halt across Australia.

Australian sea lion (*Neophoca cinerea*)

Image by Dylan DeHaas

The Australian sea lion is listed as Endangered on the *International Union for Conservation of Nature Red List of Threatened Species.* The biggest threat to sea lion colonies is gillnets, thin mesh nets suspended in the water and often invisible to the eye. Commercial fisheries use gillnets to capture sharks, predominantly for the flake and chip market in Australia. However, sea lions also get snagged in the mesh of gillnets and drown. The only solution to accidental gillnet deaths and other fishery-related deaths of sea lions is to close the areas where sea lions forage for food out at sea and prevent fishing with gillnets in those areas. Dylan captured this image at Carnac Island off Perth, Western Australia. These sea lions were inquisitive and playful, often checking themselves out in the reflection of Dylan's camera dome, as seen in the photograph. Dylan took this photograph to try and educate people on the importance of keeping our oceans clean and healthy.

Frogs: Remarkable and Important Creatures, but Under Threat!

Josephine Humphries and Doctor Laura Grogan

Frogs have captivated our imaginations for millennia. One of the best-loved Australian Indigenous Dreamtime stories is about Tiddalik, the frog who caused a flood when made to laugh. Did you know that the ancient Egyptian goddess of fertility, Heqet (pronounced 'He-ket'), was represented in the form of a frog? She watched over the annual flooding of the Nile and protected women during childbirth. Throughout time and across multiple lands and cultures, the frog has been associated with life-giving water, birth, and abundance. Indeed, from the 1940s to the 1960s, female African clawed frogs (*Xenopus laevis*) were even used routinely in human pregnancy testing. Forget Easter bunnies and chickens – frogs are the original symbol of renewal, and with good reason.

Frogs are members of the taxonomic class, Amphibia. The word amphibious literally means suited for both water and land. Ancient amphibian-like creatures, such as Tiktaalik, were among the first vertebrates to develop legs and transition to living on land. Most modern-day frogs are closely tied to water – their larval tadpole form is usually aquatic, and the adults typically return to water to breed, usually in association with the rainy season. Even the metamorphic transition between a tadpole and an adult frog could be considered a form of renewal. Additionally, frog populations are associated with abundance because they can expand rapidly under favourable conditions. Those foamy little egg masses you find near the garden pond after rain can give rise to many thousands of tadpoles!

We would all be familiar with the concept of rapid expansion or exponential growth when considering the introduced cane toad (*Rhinella marina*). Cane toad populations exploded and spread right around the north and east of Australia since their introduction in 1935 to control the cane beetle. While cane toads are considered frogs (officially part of the order Anura), the cane toad is not native to Australia, and their spread has disrupted many of our ecosystems.

On the other hand, our native frogs play a crucial and underappreciated role in Australian environments. Most of our 240 known species occur nowhere else in the world. Our native frogs are an integral part of the food web, where they regulate insect populations. Indeed, frogs can help control levels of insect pests that carry human diseases, such as mosquitoes, and all without the need for harmful chemicals or the risk of developing chemical resistance. Declines in amphibian populations have even

Top: An Endangered Fleay's barred frog (*Mixophyes fleayi*). Image: Matthijs Hollanders.

been linked to increases in the prevalence of human malaria in central America.

In their turn, frogs also provide an abundant food source for a range of other native animals, including reptiles, birds, and mammals. The cane toad incursion in Australia has been so problematic because all life stages of the cane toad are poisonous to our native predators. Fortunately, some of our native species are now developing techniques to avoid the poison glands of the cane toad or some degree of tolerance to its toxins.

Talking about poison glands, frogs are also important from a medical science perspective. Amphibians produce the most diverse repertoire of chemical defence compounds in their skins to combat infection. For many decades now, amphibians have been a valuable source of novel compounds for bioprospecting, and pharmaceutical companies have made good use of these discoveries. These discoveries are becoming even more valuable now with the ever-increasing threat of antimicrobial resistance caused by the widespread and indiscriminate use of antibiotics.

Indeed, when it comes to the topic of chemical pollution in our environment, frogs have long been recognised as excellent indicators of ecosystem health. They are 'canaries in the coal-mine', as it were, due to their sensitivity to external stressors. Frogs can absorb oxygen, water, electrolytes, and potential pollutants directly through their highly permeable skin. They also frequent aquatic habitats where run-off pollutants tend to accumulate. Consequently, by monitoring the responses of our amphibians, we can better understand the state of our environment.

Top: Stony-creek frogs (*Litoria wilcoxii*) in amplexus. Note the smaller and brightly coloured male on top. Image: Matthijs Hollanders.

Middle: Cascade tree frog (*Litoria pearsoniana*) perched atop orange-eyed tree frog (*Litoria chloris*). Found and photographed *in situ* without manipulation. Image: Matthijs Hollanders.

Bottom: Red-backed toadlet (*Pseudophryne coriaceae*). Image: Matthijs Hollanders.

Amphibians are Under Threat

Despite the great importance of amphibians and the vast benefits they provide, many people still do not appreciate them. Research has shown that species' charisma significantly influences the amount of research attention and funding they receive. Threatened amphibians receive far less attention than other species that are much less threatened, for example, the koala (*Phascolarctos cinereus*).

Being undervalued is a big problem because our precious native frogs are in serious trouble. Amphibians, globally, are more threatened with extinction than any other vertebrate class (e.g., mammals, birds, reptiles, fish). Frogs are leading an anthropogenic (human-caused) catastrophe in what has been called the 'sixth mass extinction' (the fifth occurred sixty-five million years ago with the extinction of the dinosaurs).

In recent decades, amphibians have been subject to a range of threats, primarily driven by human activities. As human populations expand and the urban environment increases, the amount of habitat suitable for amphibians is declining. Climate change is also negatively affecting amphibians. Many species have small distributional ranges and limited capacity to disperse to new environments when their previous habitat becomes unsuitable.

Frog Chytrid Disease is a Major Problem for our Frogs

One of the most significant threats that amphibians have faced in recent years is the fungal skin disease chytridiomycosis (pronounced ki-trid-i-o-my-co-sis). The disease emerged as a global pandemic, similar to the COVID-19 pandemic that we humans are currently facing. Approximately ninety species of amphibians are now presumed extinct around the world due to the emergence of this fungal disease. In recent decades, we have lost seven of our native

Top: Orange-eyed tree frog (*Litoria chloris*). Image: Matthijs Hollanders.

Middle: Mountain stream tree frog (*Litoria barringtonensis).* Image: Matthijs Hollanders.

Bottom: Emerald-spotted tree frog (*Litoria peronii*). Image: Matthijs Hollanders.

Australian frog species, with many populations of our native frogs still declining.

You may have heard of frog chytrid disease lately through the media, or you might even have personal experience of finding sick or dead frogs in your backyard. Chytridiomycosis is now endemic (here to stay) in Australia, but under certain conditions, outbreaks of the disease can cause widespread mortalities, which has been the case this last winter season. If you find sick or dead frogs, the information you provide can help in understanding and responding to chytridiomycosis outbreaks. You should contact your local/regional frog group or email the FrogID team from the Australian Museum.

But it is not all bad news! There is light at the end of the tunnel. Some frog species that previously suffered declines following the emergence of the disease are now showing signs of population recovery. Some species seem to be learning to live with it. Our research team is investigating the mechanisms that are allowing these frog populations to recover and if these results can be applied to species that are still declining?

The Frog Research Team (frogresearch.com) is based mainly at Griffith University in Queensland, but they have members across several universities and states and many more collaborators worldwide. However, scientific research is just one way to help amphibian conservation, and there are many ways that the general public can help, often without too much effort.

What Can You do to Help Frogs?

1. Be careful as you explore Australia's beautiful national parks. Enjoy our amazing wildlife without disturbing them. Take all your rubbish with you when you leave and stay on designated trails, to avoid damaging habitat,
2. Take steps to protect the environment in general. Conserve resources such as water usage, and reduce wastes, particularly plastic and chemical wastes. Chemicals can drain into waterways and pollute amphibian environments,
3. If you have a pool, consider installing a 'critter skimmer' to allow frogs and other animals to escape if they fall in by accident,
4. Build garden frog ponds and 'frog hotels', remove non-native fish from ponds (they eat native tadpoles), and plant diverse native vegetation to provide habitat for our frogs,
5. Ensure that you are confident you can accurately identify cane toads (your local frog group should be able to provide guidance) before humanely euthanising them (the 'stepped hypothermia' approach is currently recommended – talk to your local frog group for details),
6. Report any sick or dead frogs you come across to frog societies in your local area to help them track disease spread,
7. Learn about your local frog species, and get the kids involved! Different frog species can be identified by their distinct calls. You might also be able to find frogs in the garden as they rest during the day or by using a head-torch to look for their eyeshine at night. If you have access to a pond or stream, look for eggs and tadpoles, and follow them through development as they metamorphose into juvenile frogs, and
8. Finally, keep an eye on the current news from the Frog Research Team (frogresearch.com/publications). You can even volunteer with them on field trips to track the spread of disease and monitor population change.

Pouched frog (*Assa darlingtonia*). Image: Matthijs Hollanders.

Go Ahead, Snake my Day

Story and Images by Sharon Timmermans

My name is Sharon Timmermans, and I am a passionate photographer living in Victoria. I have an obsession and passion for all wildlife and landscapes. I crave to capture all animals, big and small, to demonstrate that there is beauty in all animals, even snakes. This passion began many years ago when I was a young girl in primary school and a proud junior member of the Royal Society for the Prevention of Cruelty to Animals (RSPCA). My love for wildlife grew out of fear of endangered wildlife becoming extinct. Through my photographic collections, I hope to give people the opportunity to develop the same passion and respect I have for all living things.

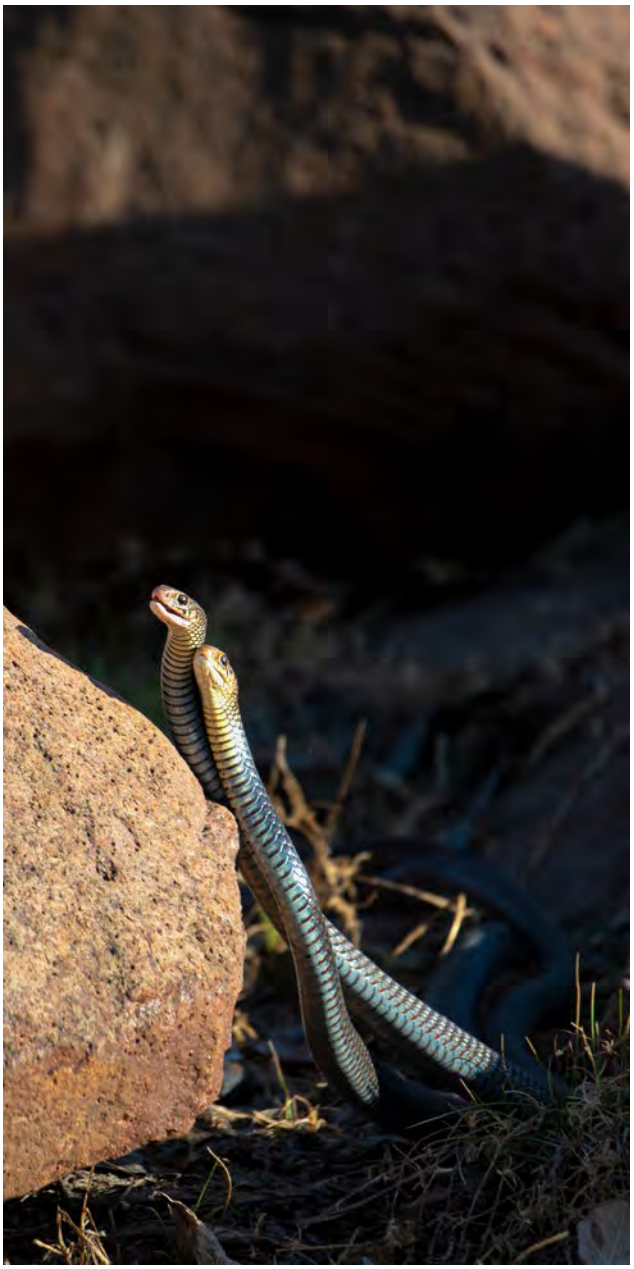
I have just returned from a six-week camping road trip around New South Wales, Queensland, the Northern Territory, and South Australia. The Northern Territory leg of the journey was our third and final visit to an incredible nature reserve. Each visit brought new photographic opportunities for me. So, there I was in a remote Indigenous community, 220 kilometres south-west of Darwin, at a billabong, known to the locals as 'Fish Creek Billabong', far off the beaten track just before sunset. The beautiful journey to the Northern Territory confirmed that we truly do live in the lucky country.

It was 5:10 pm on a very warm 35°C Saturday in July this year. On our way to find an enormous crocodile that we spotted on our first visit to the nature reserve, my husband suggested that we walk near a pile of rocks by the billabong just in case we spotted something interesting. I had my eyes on the edge of the water because the enormous crocodile was there, basking in the last sun rays of the day, and I only had a focus on him.

At this stage, I had walked through and past the rock pile when my husband called out, "Shaz, snakes". I was in between the edge of the billabong with a basking crocodile and two snakes slithering and wrestling over the rocks near me. The crocodile had to wait.

For a person who frequently has nightmares of snakes, this was a challenging few moments. Kneeling and steadying the camera, and luckily for me, my camera was in sports

Top: Two male lesser black whip snakes (*Demansia vestigata*) fighting in the outback of the Northern Territory. The lesser black whipsnake is a species of venomous snake. Images: Sharon Timmermans.



mode, I snapped away at the slippery characters moving fast and sporadically. They knew very well we were there. However, they were on a mission, and at first thought, I believed them to be mating. As they spun and twisted their long bodies around each other, I found myself full of adrenaline and excitement and praying I was able to capture the moment in focus and live another day to convey this epic story.

I watched through the lens of my camera for two to three minutes, and just like that, the snakes went their separate ways as if nothing had happened. I can still feel the grin on my face and the exhilaration of what I had just witnessed. It was not until I got back to camp, where I had reception and internet service to check the photographs, that I realised just how lucky I was. It was perfect timing.

My husband and I sent a video of the snakes to a snake Facebook page asking for some assistance with identification. At the time, we were not exactly sure what type of snakes they were, given we were Victorians in the Northern Territory. We were informed that they were lesser black whip snakes (*Demansia vestigata*).

The lesser black whipsnake is a species of venomous snake in the family Elapidae. It is found in the northern parts of Queensland, Northern Territory, and Western Australia. This species of snake is slender and extremely fast, hence the name 'whip'. Its finely tapering tail is one of its key characteristics. It is usually found in drier habitats where it feeds mainly on small vertebrates, especially lizards.

It is listed as Least Concern on the *International Union for Conservation of Nature Red List of Threatened Species* and is found in numerous protected areas throughout the Northern Territory. Regardless, the ever-increasing risk of habitat loss from land clearing and agriculture should prompt us to preserve this species and its precious outback habitat for future generations. All animals are vital members of our ecosystem, including snakes. Maintaining a high level of biodiversity is crucial for the healthy functioning of Australia's natural ecosystems and balance of life on Earth.

In the end, I managed to take some photographs of the enormous crocodile that sat patiently waiting for me, but somehow, after my snake experience, the big fella was somewhat uninteresting.

Please feel free to follow me on Instagram @sharonjyphotography and check out my website http://www.sharonjoyphotography/

Cold Climate Fostered our Most Isolated Biodiversity:

A Journey Back in Time

Doctor Helena Baird and Professor Steven Chown

Australian ecosystems are rarely pictured as ice-capped, windswept mountains rising from the deep ocean. Yet, Heard Island, Australia's southern-most island, is just this. Situated remotely in the Southern Ocean, Heard Island is an active volcano partially covered in glaciers up to 150 metres thick, designated as a World Heritage Area. It is considered part of the sub-Antarctic region, together with several other vastly spaced islands that encircle Antarctica, roughly between 46° and 60° South. Despite extreme isolation and cold, harsh climates, these sub-Antarctic islands teem with unique wildlife, from peculiar insects to majestic albatross, colourful penguins, and three-tonne elephant seals (*Mirounga leonina*). Unsurprisingly, the islands have intrigued and allured naturalists, sealers, and explorers alike over the last two hundred years.

Human History of the Sub-Antarctic

From the 1800s, a booming sealing industry drew many ships to the treacherous shores of the sub-Antarctic islands. Vast numbers of seals and penguins were slaughtered for their fur and oil-rich blubber, tragically wiping out swathes of the resident populations. Fortunately, this practice was ultimately banned, though many shipwrecks throughout the region pay an eery testament to this time.

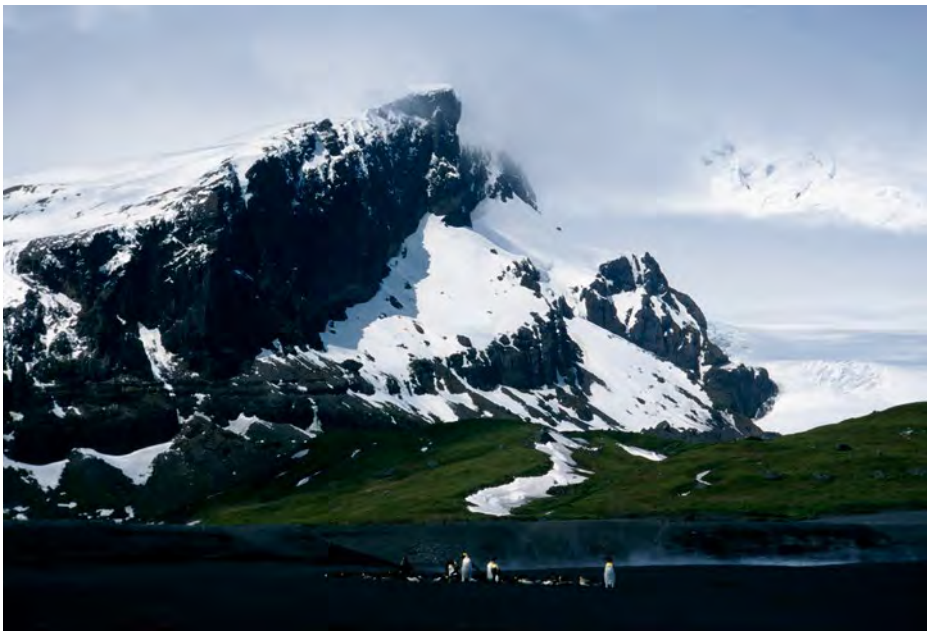
During the same period, scientific voyages began to sample the unique biology and geology of the islands, including the *HMS Challenger,* which visited Heard Island in 1874. Specimens were carefully curated and studied by naturalists far and wide, including Charles Darwin himself. The islands were quickly recognised as homes to an unusual array of plants and animals found nowhere else on Earth; a high proportion of flightless insects (strange for a group best known because it can fly); and enigmatic species which had no apparent relatives anywhere else on the planet. The puzzle of how life arrived on these remote specks of land, and how it evolved here, has intrigued scientists throughout the centuries. Emerging genetic tools are now unveiling the deep evolutionary history of this remarkable region.

Biological History of the Sub-Antarctic

Along with numerous collaborators, our research team explored the history of the evolution of sub-Antarctic biodiversity by studying the DNA of a group of beetles – the Ectemnorhinini weevils. These weevils are found on several sub-Antarctic islands but nowhere else across the globe. Even in the sub-Antarctic, the weevils can be quite rare; several species have only been sighted or collected once every few decades. Our research team were fortunate to have the opportunity to collect specimens by visiting several islands onboard the international Antarctic Circumnavigation Expedition in 2016, and by working together with scientists from Australia's Commonwealth Scientific and Industrial Research Organisation and other institutes globally.

Examination of evolutionary relationships constructed using over 500 genes from these weevils (together with other beetles worldwide) revealed that they colonised the sub-Antarctic islands a remarkable fifty million years ago, from Africa. Given the huge oceanic distances required to make this journey, and the weevils' inability to swim or fly, they either 'hitched a ride' on strong-flying seabirds like albatross, or 'rafted' on floating clumps of kelp or driftwood. More surprisingly, however, our research team found that once established on the islands, these weevils diversified dramatically into many new species around fifteen million years ago, right when global temperatures were plummeting. Speciation then accelerated further as the climate continued to cool; a pattern remarkably similar to that observed in Antarctic marine animals from the surrounding ocean.

Top: One of Australia's World Heritage Areas, Heard Island, is an ice-covered volcano rising from the Southern Ocean. Image: Steven Chown.



Dramatic landscapes and abundant wildlife characterise Australia's Heard Island. Image: Steven Chown.

Researcher, Helena Baird, is collecting insects on the sub-Antarctic Island of Crozet. Image: Florian Brucker.

Several Antarctic marine groups, including icefish, penguins, and brittle stars, are known to have evolved rapidly into a diverse array of species when the Southern Ocean began to cool. This diversity was largely driven by the growth and contraction of ice sheets across the seafloor, which would have forced populations apart, promoting evolution into different species. Specific adaptations to a cold environment enabled certain groups to thrive as temperatures dropped, allowing them to speciate when other, less adapted groups went extinct.

Our work on weevils demonstrates that an equivalent, climate-driven 'species pump' progressed on land as well. The sub-Antarctic islands, much like the surrounding seafloor, were routinely fragmented by cyclic growth of ice sheets as temperatures dropped, in particular over the last five million years. There is still evidence today of populations of the same species possessing clear genetic differences on either side of historic glacier boundaries, supporting the idea that ice actually helped to drive speciation. The Ectemnorhinini weevils are also unique in that many of them feed on moss and algae, unlike almost all other beetles worldwide (which feed primarily on flowering plants). When cooling temperatures wiped out most flowering plants throughout the sub-Antarctic, plants like moss came to dominate – giving these weevils an evolutionary advantage. It is no surprise then that more weevil species arose on the islands as the global climate cooled.

For a long time, scientists have focused on the notion that speciation and biodiversity peak at warm latitudes. While this may be the case for many groups, it is now apparent that unique biodiversity has also emerged not in spite of, but because of, colder conditions toward the bottom of our planet. This finding challenges the narrative that Antarctica and its surrounding islands are unlikely cradles for life because of their harsh climates.

One of the unique, moss-feeding sub-Antarctic beetles studied *Bothrometopus randi*. Image: Eleanor Hay.

The sub-Antarctic, including our own Heard Island, clearly has a long and rich history of colonisation and evolution involving many different species, despite its remarkable isolation.

Future of the Sub-Antarctic

While the biodiversity of the sub-Antarctic might seem well distanced from most human impacts, we are already witnessing the negative effects of increased human activity on many of the islands. The introduction of exotic species, such as rabbits, rats, and weedy plants, can have a profound detrimental effect on the islands' unique natural ecosystems, given their long history of evolution in isolation. Fortunately, Australia's excellent biosecurity management of Heard Island means that exotic species are unlikely to significantly threaten the island any time soon. Furthermore, the successful eradication of introduced mammals was recently completed on Australia's other sub-Antarctic island, Macquarie Island.

Climate change, however, poses a substantial threat to these islands. Rising global temperatures have already driven considerable retreat of Heard Island's glaciers and will reverse the very conditions that promoted speciation across this region of the world. The rare flora and fauna on these islands are adapted to a very specific, cold environment, and have nowhere to migrate to when these conditions change. Therefore, the future of Heard Island, much like another of Australia's World Heritage sites – the Great Barrier Reef – remains uncertain. Prompt action is necessary to ensure we do not lose too many of the irreplaceable values of these unique wilderness regions.

For a visual summary of this research, see: https://youtu.be/71pcacpHeBU, or for further reading visit: https://antarcticbiogeography.org

Researcher, Helena Baird, is conducting fieldwork in the sub-Antarctic. King penguins (*Aptenodytes patagonicus*) are one of the species that thrive there. Image: Helena Baird.

The sub-Antarctic islands teem with unique wildlife, such as the charismatic elephant seal (*Mirounga leonina*). Image: Helena Baird.

DNA was extracted from hundreds of sub-Antarctic beetle legs to study their evolutionary history. Image: Helena Baird.

Global cooling in the past promoted the remarkable species diversity of these Ectemnorhinini weevils. Image: Bernard Chaubet.

The environment of the sub-Antarctic is cold, harsh, and windswept, as pictured here on Marion Island. Image: Steven Chown.

Glenlee, a Culturally and Ecologically Significant Site in Danger of Destruction

Glenyss Barnham

Set on the Lugarno peninsula in New South Wales, Glenlee is an oasis in a desert of urban sprawl. Relatively undisturbed since 1856 (and in the one family for over 110 years), it is one of those rare gems where nature has been free to do what nature does so well.

Over those years, Glenlee has become a vital part of a forested river foreshore corridor stretching from Oatley, through Lugarno, to Georges River National Park. It is home to a wide range of wildlife, including the Vulnerable grey-headed flying fox (*Pteropus poliocephalus*), eastern osprey (*Pandion cristatus*), powerful owl (*Ninox strenua*) and white-bellied sea eagle (*Haliaeetus leucogaster*), as well as swamp wallabies (*Wallabia bicolor)*, echidnas (*Tachyglossus aculeatus*), possums, reptiles, frogs, and a number of other threatened species of birds and mammals. Furthermore, several threatened microbats were found in the recent Georges River Local Government Area Biodiversity Study. Any microbats located in Oatley Park could also be expected to occur in the Lugarno area, where large trees with hollows are present.

The eastern osprey is breeding in the area for the first time in almost twenty years. They frequently roost and nest in large eucalypts, which Glenlee has in abundance; smooth-barked apple (*Angophora costata*), red bloodwood (*Corymbia gummifera*), grey gum (*Eucalyptus punctata*), Sydney peppermint (*Eucalyptus piperita*) and other Angophora. To the rear of the property is a remnant Blackbutt Forest which has remained untouched since Europeans set foot on the land. The coastal swamp oak (*Casuarina glauca*), found on the site, is listed as Endangered by the Environment Protection and Biodiversity Act 1999.

Many trees are well over one hundred years old and provide the hollows, cracks, and crevices essential for birds, mammals, reptiles, and invertebrates to roost and nest. These trees, 200 of them and their understory, are in danger of being destroyed by a development currently before the Land and Environment court. This 2.5 hectares of irreplaceable habitat and exceptional biodiversity is expected to be replaced with thirty-one dwellings.

Lugarno is home to a small breeding population of scaly-breasted lorikeet (*Trichoglossus chlorolepidotus*), and the loss of suitable hollows could threaten their survival on the Lugarno peninsula in the face of dozens of displaced larger and more aggressive rainbow lorikeets (*Trichoglossus moluccanus*).

Yellow-faced honeyeaters (*Caligavis chrysops*) and white-naped honeyeaters (*Melithreptus lunatus*) forage in the foreshore corridor, and several hundred were observed to alight in the mature Blackbutt canopies of Glenlee, adjacent to Heinrich Reserve. The trees provide the necessary blossom, nectar, and seed, essential food for a wide range of wildlife who forage within its borders.

Glenlee borders the mangrove forest and intertidal mudflats of the Georges River, the habitat of several threatened shorebirds and waterbirds. The Vulnerable bar-tailed godwit (*Limosa lapponica*), Endangered pied oystercatcher (*Haematopus longirostris*), and Critically Endangered

Top: Glenlee borders the mangrove forest and intertidal mudflats of the Georges River. Image: Glenyss Barnham.

eastern curlew (*Numenius madagascariensis*) are regularly recorded on the intertidal flats at the mouth of Lime Kiln Bay, Oatley.

The vast vegetation of Glenlee has acted as a filter to the stormwater runoff from surrounding streets, preserving the river. Erosion and the pollution impact from urban runoff caused by the development will potentially impact the feeding habitat of these threatened species.

Zoologist, Debbie Andrew, warns that *"The impact on threatened flora and fauna through the destruction of their habitat, and the damage that will be caused to terrestrial and estuarine ecosystems on the property, will be an environmental disaster."*

Cultural Significance

Glenlee is part of one of the earliest land grants made in Lugarno by Governor Sir William Thomas Denison in 1856. It is listed by the National Trust of Australia for its Early Settler history and Aboriginal Cultural Heritage. Well-preserved evidence of Aboriginal life remains on the site and is listed in the Aboriginal Heritage Information Management System of the state government. Throughout the 165 years since European settlement, only two families have lived on the land, so in many ways, it is a time capsule of our early Australian history. A living history, a remnant of the way things once were.

On 12 June 2021, a resident action group was formed to fight the development and save Glenlee. Over one hundred people met with the Mayor and a local councillor, and 270 submissions were lodged with Georges River Council's Planning Authority. The residents have now formed The Friends of Glenlee Association to spearhead the campaign.

Currently, an Interim Heritage Order has been enacted to allow an Archaeological Assessment to be completed as required by the National Parks and Wildlife Act 1974 and Heritage New South Wales,

Glenlee is an oasis in the urban sprawl. Image: Adrian Polhill and Garry Housley.

A white-bellied sea eagle (*Haliaeetus leucogaster*) inspecting his catch. Image: Rob Annesley.

An eastern osprey (*Pandion cristatus*) near Glenlee. Image: Rob Annesley.

Glenlee, home to the short-beaked echidna (*Tachyglossus aculeatus*). Image: Rob Annesley.

in conjunction with the Metropolitan Land Council. The Land and Environment Court process continues at the same time. The first meeting of the Court with residents is in mid-October. The Association is raising funds to increase the campaign to save this historic and environmentally significant site by engaging experts to provide reports that can be put before the Court.

The Friends of Glenlee Association is petitioning the three levels of government to provide the funds to purchase Glenlee and preserve it for the community and future generations. In a recent Sydney Morning Herald article by Julie Power, the New South Wales Minister for Planning and Open Spaces, Robert Stokes MP, was quoted saying, "*It is my goal to make Sydney a 'city within a park'. The pandemic had shown how vital our public spaces are and how we need to conserve what we have and create more where we can.*"

We do indeed need to conserve what we have because it is irreplaceable. To help preserve the precious flora and fauna that remains in Glenlee, please sign the petition, join The Friends of Glenlee Association, or donate to the fighting fund through the Save Glenlee website https://www.saveglenlee.com/

A bird's eye view of Glenlee. Image: Adrian Polhill and Garry Housley.

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,
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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.

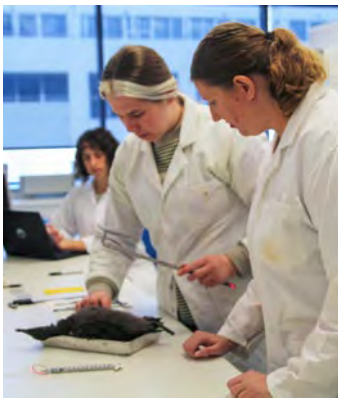
Permits for collecting samples from two different freshwater turtle species from Alligator Creek and Ross River in Townsville, North Queensland, have been granted. The project will survey herpesviruses in the Krefft's turtle (*Emydura macquarii krefftii*) and saw-shelled turtle (*Myuchelys latisternum*) 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.

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

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*

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?

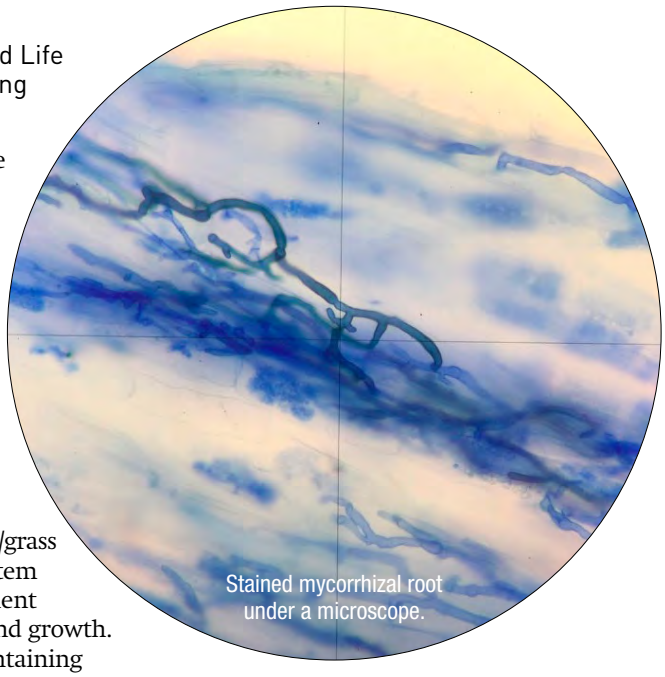
SHAE JONES
School of Earth, Atmospheric and Life Sciences, University of Wollongong

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.



Stained mycorrhizal root under a microscope.

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.

Investigating the Age and Growth of an Endemic Octopus Species

ERICA DURANTE
Future Industries Institute, University of South Australia

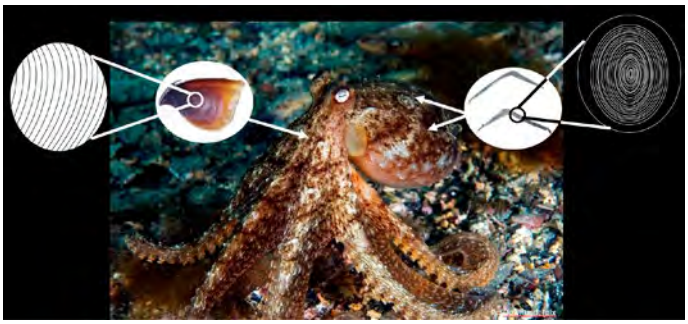
As the alien cousin of snails, cephalopods are a branch of the mollusc phylum that inhabit oceans either in the water column (squids and cuttlefish) or on the sea floor (octopus). They have internalised their traditional hard exoskeleton of a mollusc shell and now freely swim, hover, or crawl around. 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.

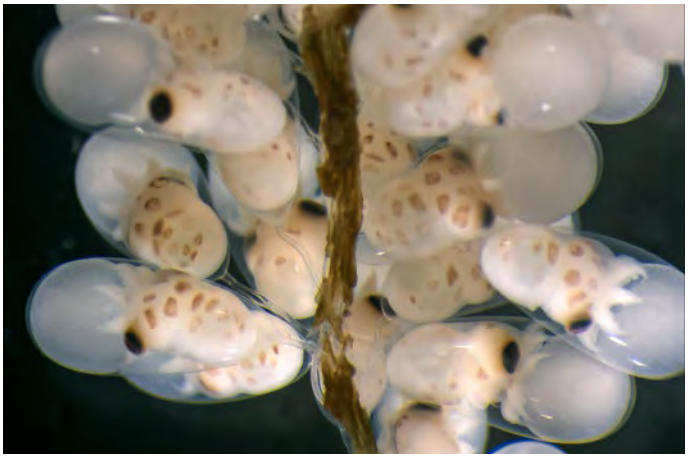
The first step towards the sustainable management of a species is understanding its life history. How long do they live? At what age are they sexually mature? These questions can be answered by looking at age data. Age data can tell us more about the species, such as the age of maturity, reproductive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

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



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.

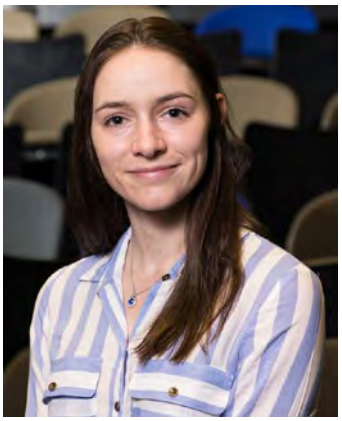
These genetic samples will be sequenced and analysed using DArTseq. DArTseq is more time- and cost-effective than traditional molecular techniques and improves power to detect population differentiation at small scales relevant to management. It will allow the researchers to explore and directly compare 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

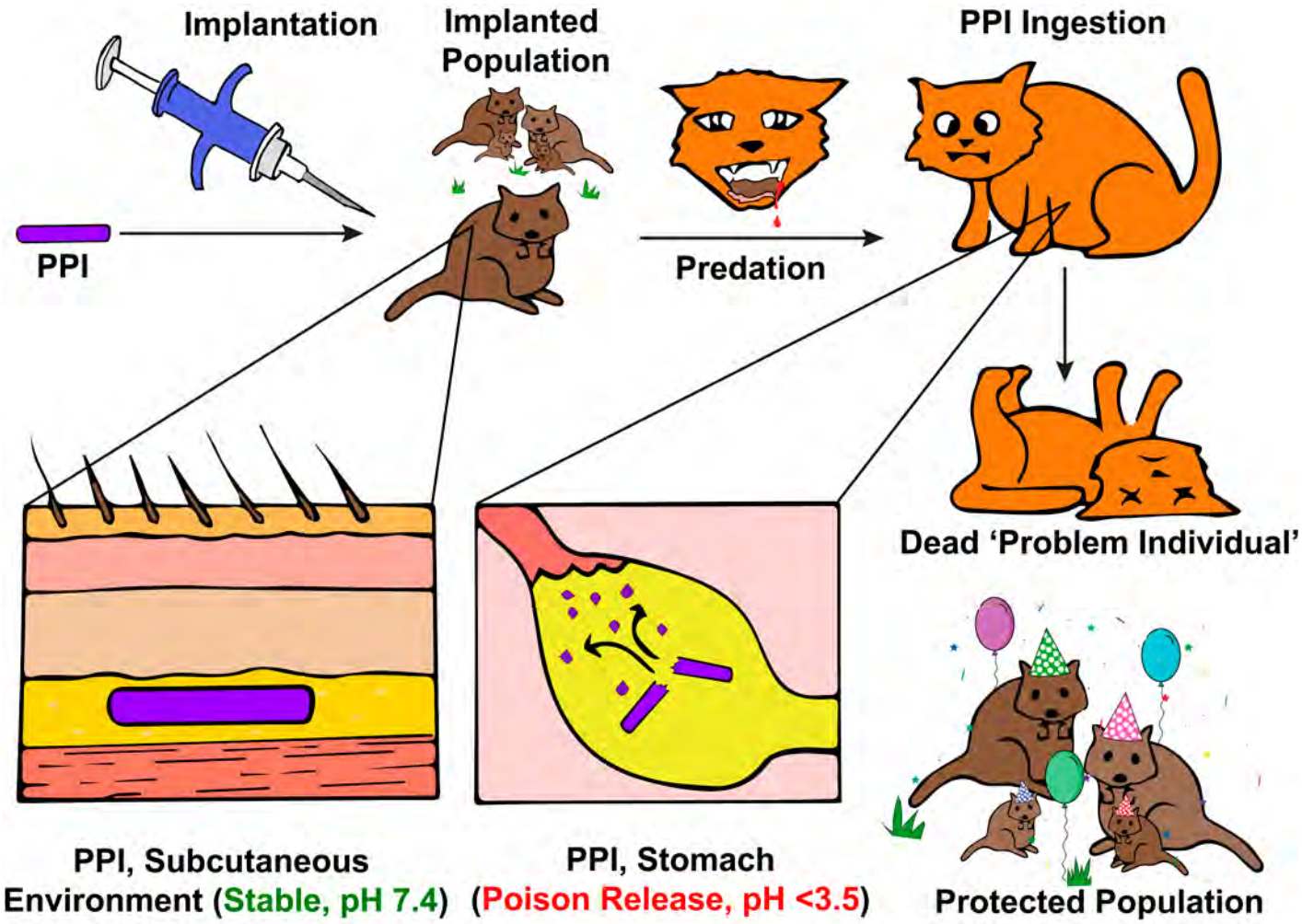
KYLE BREWER
Clinical and Health Sciences, University of South Australia

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.

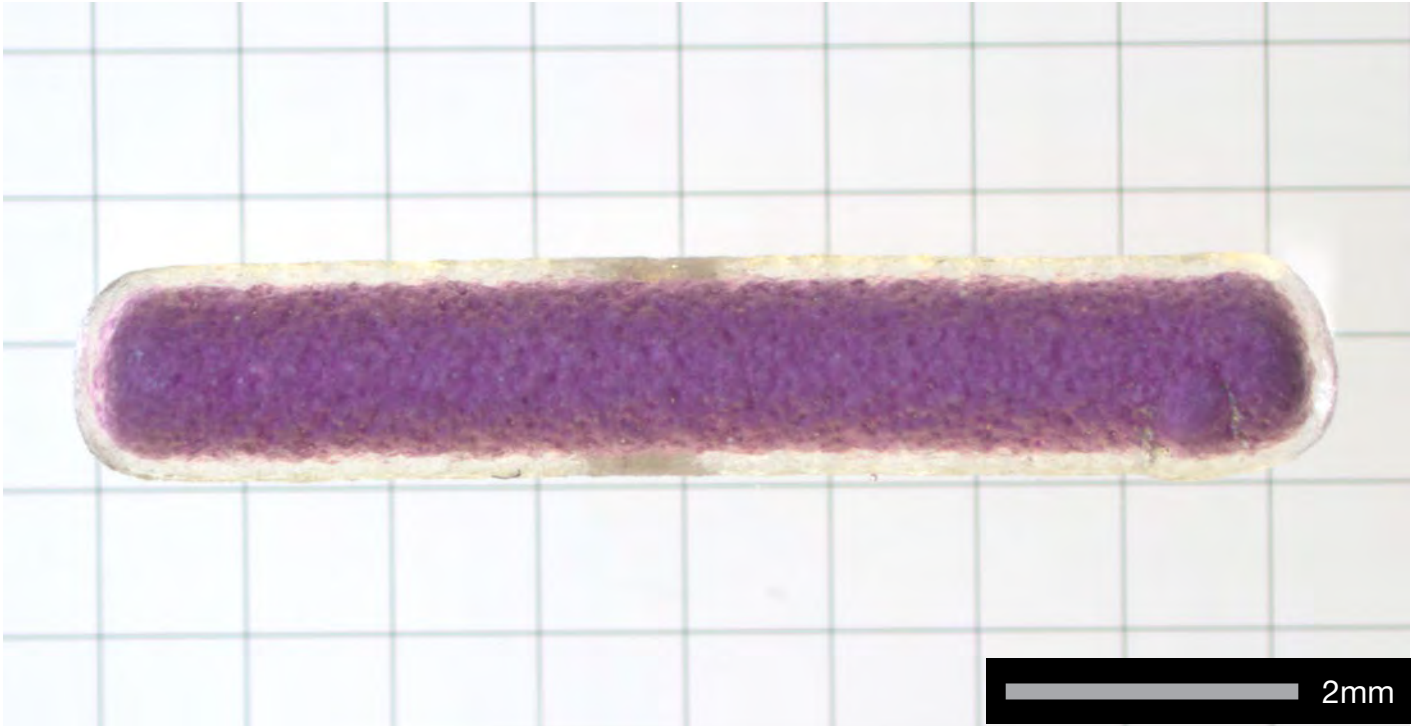
The PPI approach acknowledges and overcomes the challenging predatory behaviour of feral cats by artificially accelerating the much-needed evolution of anti-predator defences in prey naïve native mammals. In doing so, the project hypothesises that PPI's will selectively target the most dangerous and 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.

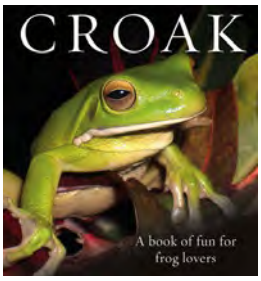
FUNDS PROVIDED BY THE AUSTRALIAN WILDLIFE SOCIETY will be used for accommodation and travel costs associated with fieldwork. Fieldwork will occur on multiple dates throughout the year for five to ten days at a time.

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.

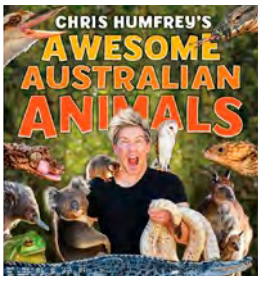
Publisher: Green Heroes
RRP: Free downloadable resource greenheroes.org.au/education



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

Australian Wildlife Society

Community Wildlife Conservation Award

Nomination Form

Australian Wildlife Society
Conserving Australia's Wildlife since 1909

The Australian Wildlife Society Community Wildlife Conservation Award will be awarded to a community group that is making a significant contribution to wildlife preservation in Australia. The Society will present an award of $5,000 to the winning community group helping to preserve Australia's precious wildlife. A trophy and certificate will accompany the award.

Persons may nominate their own organisation, or they may choose to nominate a third party who they believe should receive recognition. All nominations must be supported by a referee (see below).

Name of nominator:

Address:

Telephone: email:

Name of nominee:

Address:

Telephone: email:

Criteria:

1. How long has the group been engaged in the activities for which it is being nominated?

2. Describe how the group has involved the community in its activities.

3. Describe the nominee's contribution to educating the public on conservation issues.

4. Describe the nominee's contribution to a scientific understanding of conservation issues.

5. Outline what you consider to be the major achievements and impact of the nominee group.

The Australian Wildlife Society will accept nominations for the Community Conservation Award via email to **info@aws.org.au** or mail to 29B/17 Macmahon St, Hurstville NSW 2220. Deadline for submission 31 December.

Australian Wildlife Society

Wildlife Rehabilitation Award

Nomination Form

Australian Wildlife Society
Conserving Australia's Wildlife since 1909

The Australian Wildlife Society Community Rehabilitation Award will be awarded to an individual or a conservation group that is contributing to the preservation of Australia's wildlife. The Society is aware that many organisations and thousands of volunteers are working tirelessly to save Australia's wildlife and the habitat in which they live. Many people find the experience of rehabilitating native wildlife rewarding; however, it is time-consuming and can be very expensive. The award is intended to acknowledge and commemorate, on behalf of the whole community, the individuals or conservation groups working tirelessly to support, rehabilitate and conserve Australia's native wildlife. The Society will present an award of $5,000 to the winning individual or small organisation that contributes to Australian wildlife conservation through rescue and rehabilitation. A trophy and certificate will accompany the award.

Persons may nominate their own organisation, or they may choose to nominate a third party who they believe should receive recognition. All nominations must be supported by a referee (see below).

Name of nominator:

Address:

Telephone: email:

Name of nominee:

Address:

Telephone: email:

Criteria:

1. How long has the group been engaged in the activities for which it is being nominated?

2. Describe how the individual / group carries out its rescue and rehabilitation activities.

3. Describe the facilities the individual / group has established.

4. Outline what you consider to be the major achievements of the nominee.

The Australian Wildlife Society will accept nominations for the Rehabilitation Award via email to **info@aws.org.au** or mail to 29B/17 Macmahon St, Hurstville NSW 2220. Deadline for submission 31 December.

Australian Wildlife Society

Serventy Conservation Award

Nomination Form

Australian Wildlife Society
Conserving Australia's Wildlife since 1909

The Serventy Conservation Award is named in honour of Dr Vincent Serventy AM, his brother Dr Domonic Serventy, an international ornithologist, and his older sister Lucy Serventy. The award is intended to recognise and celebrate conservation work that has not been done as part of a professional career. It is awarded to those who labour in the conservation field for a love of nature and a determination that it should be conserved. Often, these have been non-scientists who have earned their conservation skills through sheer hard work. The Society will present an annual award of $2,500 to the winning individual helping to save Australia's precious wildlife. A trophy and certificate will accompany the award.

Persons may nominate themselves or they may choose to nominate a third party who they believe should receive recognition. All nominations must be supported by a referee (see below).

Name of nominator:

Address:

Telephone: email:

Name of nominee:

Address:

Telephone: email:

Criteria:

1. How long has the nominee been providing the service for which (s)he is being nominated?

2. Describe the nominee's work for conservation, its outcome and impact.

3. Describe the nominee's contribution to educating the public on conservation issues.

4. Describe the nominee's contribution to a scientific understanding of conservation issues.

The Australian Wildlife Society will accept nominations for the Serventy Award via email to **info@aws.org.au** or mail to 29B/17 Macmahon St, Hurstville NSW 2220.. Deadline for submission 31 December.

Australian Wildlife Society

Youth Conservation Award

Nomination Form

Australian Wildlife Society
Conserving Australia's Wildlife since 1909

The youth of Australia make significant contributions to the conservation movement through innovative projects and ideas. It is young people who can drive lasting and sustainable change who will become the next ambassadors in environmental conservation and hopefully the successors to the current board of the Australian Wildlife Society. We aim to inspire young people to have a stake in environmental conservation by rewarding and recognising their efforts. The Society will present an award of $1,000 to a young individual or small organisation contributing to Australian wildlife conservation. A trophy and certificate will accompany the award.

Persons may nominate themselves or they may choose to nominate a third party who they believe should receive recognition. All nominations must be supported by a referee (see below).

Name of nominator:

Address:

Telephone: email:

Name of nominee:

Address:

Telephone: email:

Criteria:

1. How long has the nominee been providing the service for which (s)he is being nominated?

2. Describe how the individual/group carries out conservation activities.

3. Describe the impact these conservation activities have on the 'real world'.

4. Outline what you consider to be the major achievements of the nominee.

The Australian Wildlife Society will accept nominations for the Youth Conservation Award via email to **info@aws.org.au** or mail to 29B/17 Macmahon St, Hurstville NSW 2220. Deadline for submission 31 December.

Membership Form

Membership

Become a member of the Australian Wildlife Society

Simply fill out this form.

Australian Wildlife Society
Conserving Australia's Wildlife since 1909

Name:.....

Address: .....

City/Suburb:.....Postcode:.....

Telephone:.....Fax: .....

.....Email:.....

Membership category (please tick)

- ☐ Student (conditions apply): $0
- ☐ Individual (hardcopy magazine): $55
- ☐ Family (hardcopy magazine): $70
- ☐ Concession (pensioner/student/child): $50
- ☐ E-mag (emailed as PDF, no hardcopy will be sent): $30
- ☐ Associate (library, school, conservation groups): $85
- ☐ Corporate: $125
- ☐ Life: $2,000

(Includes postage within Australia. Add $40 for overseas postage)

Three year membership (please tick)

- ☐ Individual (hardcopy magazine): $150
- ☐ Family (hardcopy magazine): $190
- ☐ Concession (pensioner/student/child): $135
- ☐ E-mag (emailed as PDF, no hardcopy will be sent): $81
- ☐ Associate (library, school, conservation groups): $230
- ☐ Corporate: $340

(Includes postage within Australia. Add $60 for overseas postage)

Payment details (please tick)

☐ Direct Debit ☐ Cheque ☐ Money Order ☐ Mastercard ☐ Visa Card Security Code (CSC) __ __ __ __

Card Number:

Name on Card:.....Expiry:.....

Signature:.....

Amount $.....

Donation $.....

Total $.....

Mail to the: **Australian Wildlife Society**
29B/17 Macmahon St, HURSTVILLE NSW 2220
Email: accounts@aws.org.au
Website: www.aws.org.au

Direct debit: **BSB:** 062 235
Account No: 1069 6157
Account Name: Wildlife Preservation Society of Australia trading as the Australian Wildlife Society

Membership Hotline: Mob: 0424 287 297

Note: All cheques to be made out to the Australian Wildlife Society

Membership Benefits

Magazine: Receive the quarterly issue of Australian Wildlife via email or post to keep up-to-date with the collective work promoted nationally.

E-Newsletter: Receive the monthly e-newsletter. Keep up-to-date with news from our members and on the work of the Society.

AWS Portal: Access the Members' Resource Centre - your destination for resources and materials on various wildlife-related topics.

Social Media: Contribute to our social media platforms: Instagram, Twitter, Facebook, LinkedIn, YouTube, and Website.

Right to Vote: You have the right to vote on important matters at Society general meetings (financial members only).

Other Benefits: Awards, Scholarships, Grants, and the opportunity to network with like-minded people.

LEAVE A BEQUEST IN YOUR WILL

If you would like to find out how to leave a bequest to the Society or how your bequest can make an impact, please download our bequest information pack.

Spring has Sprung

L to R: Patrick Medway AM and Ken Mason digging holes for the individual plants.

A range of native plants on the ledge of the garden bed.

A beautiful grevillea Robyn Gordon.

A leaf-curling spider (*Phonognatha graeffei*) has taken a liking to the new garden.

The garden at the end of the planting day.

The garden with mulch down and an amazing pattern on the back wall.