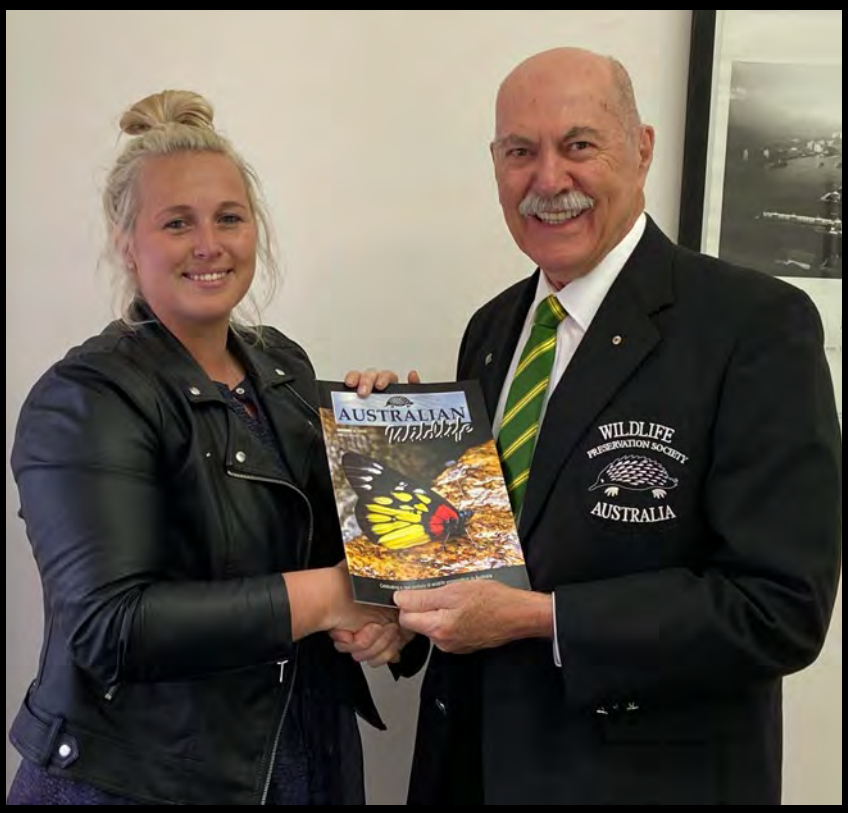
AUSTRALIAN Wildlife

SPRING Vol: 4/2022
$10 (non-members)

Celebrating a new century of wildlife preservation in Australia

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

Thank You to Our Volunteers



L to R: Kate Schmahl and Patrick Medway AM. Image: Megan Fabian.

Mid-Western Sydney Volunteer Team Nominee Certificate – the Society's Volunteer Conservation Committee. Image: Megan Fabian.

L to R: Jason Yat-sen Li MP (Member for Strathfield), Wayne Greenwood, and Brian Scarsbrick AM. Image: Megan Fabian.

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Megan Fabian
Editor, *Australian Wildlife*

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Front Cover:
The Australian sea lion (*Neophoca cinerea*) is listed as Endangered on the *International Union for Conservation of Nature Red List of Threatened Species*. The biggest threat to Australia's sea lion colonies is gillnets. Commercial fisheries use gillnets to capture sharks, predominantly for the 'flake' and chip market. However, sea lions get snagged and entangled in the mesh of gillnets and, unfortunately, drown. Dylan captured this image at Carnac Island off Perth, Western Australia. These sea lions were curious and playful, often checking themselves out in the reflection of Dylan's camera dome, as seen in the photograph. Image: Dylan DeHaas.

Back Cover:
Australian sea lions (*Neophoca cinerea*) are part of a group known as 'eared' seals. They use their front flippers to prop themselves up and their back flippers to help them 'walk' on land. In the water, their back flippers act as a rudder. This photo was taken at Seal Bay Conservation Park, Kangaroo Island, where the sea lion had just returned from an exhausting hunting trip. Image: Jari Cornelis.

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.

Print Post Approval No: PP 100024559

ISSN 0155-266X

Price $10 (for non-members)

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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.

Articles and comments expressed in this magazine do not necessarily reflect the opinions of the Editor, Society, or members. Articles contributed from outside sources are included for the reading enjoyment of members and to encourage discussion on different points of view.

Articles may be copied or quoted with appropriate attribution.

From the President's Desk

Dr Julie Old – President

With great sadness, we announce one of our lifetime members and 2022 Roll of Honour recipients, Dr Clive Williams OAM, passed away on 4 September 2022. He was ninety years old. Clive joined the Society in 1986 and served on the Board of Directors for over thirty years.

Welcome to the Spring 2022 Edition of *Australian Wildlife*

Welcome to the Spring 2022 edition of *Australian Wildlife*.

Spring is already here, and as always, the Society has continued to advocate and support the conservation of Australia's unique flora and fauna. This edition of *Australian Wildlife* features articles on the importance of soil microbiota (pages 25-26) and genomic technologies to find new viruses (pages 15-16), as well as the impacts of feral deer (pages 19-21).

The Society has continued to support research that enhances our understanding of flora and fauna, and how best we can conserve our precious and unique Australian species. Specifically, the Society has a proud history of supporting conservation through funding university research grants for the next generation of conservationists. In this edition of *Australian Wildlife,* the recipients of our ten 2022 university grants showcase their research (pages 27-47).

On the front cover of this edition of *Australian Wildlife* is a magnificent Australian sea lion (*Neophoca cinerea*) by Dylan DeHaas, and it was one of the many fabulous photographs entered as part of the Society's 2021 threatened wildlife photographic competition. The back cover also features an Australian sea lion submitted by Jari Cornelis as part of the Society's 2020 threatened wildlife photographic competition. Disturbingly, recent media coverage on the numbers of 'seal bombs' and 'bean bags' used to protect salmon farms from sea lions and seals highlighted the conflicts between the commercial fish industry and our wildlife, and the threats posed to these species. Unfortunately, we are also seeing the continued impacts of ghost nets, other lost or discarded fishing gear, and plastic, on our marine environment, as well as the huge numbers of non-target species impacted by shark nets along our coastline. For this reason, the Society's campaign to #snipringsforwildlife has been expanded to include this netting, and to highlight the importance of snipping all rings and netting, to support the conservation of our unique wildlife. As a Society, we will continue asking for all rings and netting to be snipped before being discarded. As a member of the Society, we ask for your help to get this important message out and to #snipringsforwildlife.

We are hopeful you can enjoy some of the fabulous images submitted to the Society's threatened wildlife photographic competition captured by the many talented photographers in the Australian Wildlife Week Art Display at Hurstville Museum and Gallery (24 September to 23 October 2022). In this edition, the Society announces the annual threatened wildlife photographic competition winners. This year, the Judge's Choice was awarded to George Madani for their photograph of a Vulnerable eastern pygmy-possum (*Cercartetus nanus*) (page 7), whilst the People's Choice was awarded to Kynan Tang for their photograph of a helmeted honeyeater (*Lichenostomus melanops cassidix*) (page 8).

We are delighted to introduce you to our new Project Officer, Kate Schmahl, who started her new role with the Society on Monday, 5 September 2022. Kate is an Environmental Science and Management student at the University of Newcastle majoring in sustainability. She has been fortunate to have been able to be involved with the conservation and management efforts on the green and golden bell frog (*Litoria aurea*) across many areas of New South Wales, as well as being involved in survey field trips for many at-risk or endangered amphibians. We wish Kate all the best in her new role and are confident she will be a valuable asset to the team. An image of Kate is featured on the front inside cover of this edition.

With great sadness, we announce one of our lifetime members and 2022 Roll of Honour recipients, Dr Clive Williams OAM, passed away on 4 September 2022. He was ninety years old. Clive joined the Society in 1986 and served on the Board of Directors for over thirty years. Clive significantly contributed to our major wildlife conservation

L to R: Dr Julie Old, Dr Clive Williams OAM, and Patrick Medway AM.

projects, including Towra Point Nature Reserve rehabilitation and restoration work for migratory wading birds, Rockdale Wetland Corridor restoration, and National Tree Day programs. Clive played a substantial role in judging the Society's annual awards. We honour Clive's dedication and contribution to wildlife conservation.

We are also saddened by Her Majesty, the Queen of Australia's passing. We are immensely proud of her lifetime of tireless service and her long reign as our Monarch and Head of the Commonwealth of Nations.

On Wednesday, 7 September 2022, Threatened Species Day, the Society attended the Minister's Threatened Species Conservation: Powered by Partnerships event, hosted by the Taronga Conservation Society. The event took place at Taronga's Institute of Science and Learning. Many people and organisations were in attendance to celebrate this special occasion, and we provide further information on pages 22-24.

In 2020, the Society partly funded a new mountain pygmy-possum (*Burramys parvus*) breeding facility at Secret Creek Sanctuary to help save the species from a changing climate and possible extinction. On Sunday, 11 September 2022, the official opening of the mountain pygmy-possum breeding facility took place, and we provide more detail on pages 17-18.

On Sunday, 18 September 2022, the Society attended the Greater Sydney Landcare Day at the Australian Botanic Garden, Mount Annan. Some fabulous talks took place in the Acacia Theatre inside the PlantBank building. Saul Deane, Urban Sustainability Campaigner, Total Environment Centre, spoke about saving Sydney's Koalas. Sue Martian, Cattai Hills Environment Network, talked about our connection to the natural world through dreaming and getting involved in caring for our local places. Lisa Gibson, Public Officer, Wild Seed Landcare Network, spoke about a local community effort to boost wildlife habitat. Clare Raffan, Chair of Cooks River Alliance, spoke about the challenges facing the Cooks River. Lastly, Turlough Guerin, Chief Executive Officer, Landcare NSW, provided an update from Landcare NSW. The afternoon concluded with a guided tour of the Australian PlantBank and National Herbarium of New South Wales.

The Society's Conservation Committee was delighted to be nominated for the Centre for Volunteering 2022 Volunteer Team of the Year Award for their efforts in wildlife conservation at the NSW Volunteer of the Year Mid-Western Sydney Regional Ceremony on Monday, 12 September 2022. Congratulations! Thank you to the volunteer committee chairs, Director Wayne Greenwood and Vice President Brian Scarsbrick AM, and the volunteers on the committee. Images from the event are featured on the front inside cover of this edition.

Lastly, we congratulate the Hon Tanya Plibersek MP for releasing the Threatened Species Action Plan 2022-2032. We are delighted that the plan sets out strong targets for threatened species conservation and recovery over the next ten years, including preventing new extinctions and protecting at least thirty percent of Australia's land mass.

We hope you enjoy this Spring edition of *Australian Wildlife*.

Dr Julie Old in the Australian PlantBank at the Australian Botanic Gardens, Mount Annan.

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. The Society was delighted to receive a record number of entries, making it an extremely tough competition. Thank you to all our entrants.

Judges' Choice

The annual judges' prize of $1,000 was won by **George Madani** for their photograph of a **Vulnerable eastern pygmy-possum (*Cercartetus nanus*)**. Eastern pygmy possums are tiny and appropriately whiskered for one primary purpose – raiding native inflorescences to get at that ambrosial sugary goodness! Sadly, being so small makes these bug-eyed nectar bandits prone to becoming snacks to marauding foxes and cats. While feral predators can identify these small animals easily, it is much harder for humans with conventional survey methods. As a part of his research, George focuses on the best ways to detect these banksia thieves. Knowing how to find them will help us gain new insights into their ecology and, hopefully, help to identify how best to protect them.

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 **Kynan Tang** for their photograph of a **helmeted honeyeater (*Lichenostomus melanops cassidix*)**. Acting as the bird emblem for Victoria, the beautiful, helmeted honeyeater is Critically Endangered, with fewer than two hundred individuals remaining in the wild. Once found in areas around Healesville to South Gippsland, the population of helmeted honeyeaters has dramatically declined due to deforestation and habitat loss, with their range now reduced to just three swamp forest areas to the east of Melbourne. Fortunately, since 1989, Zoos Victoria has coordinated a recovery program for these endangered birds through captive breeding to help increase their numbers in the wild. As of this year, they have successfully managed to breed more than 370 honeyeaters and release more than 250 into the wild, helping to triple the native population. This photograph was taken at Healesville Sanctuary in Victoria.

Carnaby's black cockatoo (*Calyptorhynchus latirostris*)
Image by Joseph Ball

The Endangered Carnaby's black cockatoo occurs only in south-west Western Australia, between Cape Arid and Kalbarri. Their population has significantly declined in recent decades due to land clearing and habitat fragmentation (especially in the wheatbelt), the loss of hollow-bearing trees, and the impact of climate change. Joseph followed a Carnaby's black cockatoo flock for a while over the 2021 Christmas period. The flock consisted of around thirty to forty female birds. Joseph hopes the recent Wooroloo bushfire helped to push the Carnaby's black cockatoo flock up the coast, and they start to cover a more extensive range.

Fairy tern mother feeding its chick (*Sternula nereis*)

Image by Julie Knight

The fairy tern is a threatened species on Abrolhos Islands, Western Australia. They are listed as Vulnerable federally and in Western Australia. Their nests are shallow scrapes in the sand along the beach. Each spring and summer, they locate to various parts of Western Australia to breed. The largest and most successful breeding colony for over ten years was at Pyramids Beach, Mandurah. Under the supervision of Dr Claire Greenwell, the local council, rangers, and volunteers helped keep the colony safe from predators and educate the public on the vulnerability of these small birds. Temporary fencing, signs, shelters, and CCTV were installed. For research, a banding night took place to track and identify the fairy tern chicks. The oldest detected fairy tern is now twenty-two years old. The fairy tern chick in this photograph is excited because its parent is arriving with a fish. Fairy terns can detect their own chick by its call.

Koala (*Phascolarctos cinereus*)

Image by Matt Theophile

This photograph is of a mother and baby koala sharing an intimate moment at the top of the canopy in Great Otway National Park, Victoria. Following the 2019-2020 bushfires that decimated the koala population, Matt wanted to capture a photograph of them in the glory of their natural habitat – which is now somewhat of a rarity. Once Matt found the koalas, capturing the image required him to climb the tree with his camera. The process took around an hour, as he was cautious not to scare the koalas in the tree as he climbed. Whilst they were surprised by his presence, the pair ignored him for the brief period he shared with them in the tree. The young one was quite large, so this was likely one of the last moments they shared together before it would leave mum and become independent.

Gang-gang cockatoo (*Tympanocryptis lineata*)

Image by David Cunningham

A fledgling gang-gang cockatoo prepares to leave his nest in Canberra, Australian Capital Territory. This young wild gang-gang cockatoo is one of two brothers that emerged from its nest in early 2022 in Aranda Bushland Nature Reserve. The pair were monitored as part of a citizen science research project on gang-gang breeding. Their father, nicknamed ‘Baldy’, has also been monitored for research on gang-gang movements. The distinctive pattern of missing feathers on his crest made him easy to identify. Sadly, the population of gang-gang cockatoos has significantly declined in recent decades. In March 2022, the species was formally listed as Endangered under Australia’s *Environment Protection and Biodiversity Conservation Act 1999*. The Australian Capital Territory and states where the gang-gang lives are now moving ahead with recovery plans for this iconic Australian bird, the faunal emblem of the Australian Capital Territory.

Kangaroo Island southern emu-wren (*Stipiturus malachurus halmaturinus*)
Image by Sam Correll

This photograph was taken on the south coast of Kangaroo Island in Vivonne Bay Conservation Park. A large majority of the habitat for this tiny bird was burnt in the 2019-2020 bushfires on Kangaroo Island, leaving only a few unburnt pockets within Flinders Chase and along the southern coastline. Sam wanted to find and record some of these isolated populations of Endangered emu-wrens and found a small group, unafraid of people, posing for some lovely up-close photographs.

Greater glider (*Petauroides volans*)
Image by Lincoln Flynn

This photograph was taken in Wheatsheaf, Victoria, on private land adjacent to Wombat State Forest. This is of one of the six greater gliders that live in the forest around Lincoln's home in central Victoria. The Wombat State Forest is at the south-west end of their habitat range and is becoming more fragmented. It has been recommended to become a national park, but this decision is not yet final. With the recent separation of greater gliders nationally into three distinct species, their conservation status may be changed as the population of *Petauroides volans* is now much smaller than it was previously believed to be. Habitat destruction and climate change are significant threats to these incredible animals, with the recent bushfires no doubt responsible for more losses.

Giant barred frog (*Mixophyes iteratus*)

Image by Angus Cairney

This photograph was taken in Newcastle, New South Wales. Angus was out for a walk on a rainy night and came across multiple giant barred frogs. It was his first time seeing this species, so he was extremely excited and managed to get a few photographs. The giant barred frog is listed as a Vulnerable species due to habitat clearing, reduction in water quality, inadequate protection of riparian habitat, as well as chytrid fungus (*Batrachochytrium dendrobatidis*).

Pink-tailed worm-lizard (*Aprasia parapulchella*)

Image by Bridget Lunn

The pink-tailed worm-lizard is a Vulnerable species of legless lizard found in some parts of New South Wales, Victoria, and the Australian Capital Territory. Although they could be confused for a worm, evolutionary phylogenies reveal they are a type of gecko. They are considered Vulnerable primarily due to habitat destruction and modification. Pink-tailed worm-lizards live within ant galleries underneath rocks – the rocks aid in thermoregulation, and the ants provide an excellent source of nutrition. Rocks are often removed for farming or land development, displacing these tiny lizards. While completing a university report on the species, Bridget photographed this individual in the Australian Capital Territory.

Grevillea (*Grevillea linsmithii*)

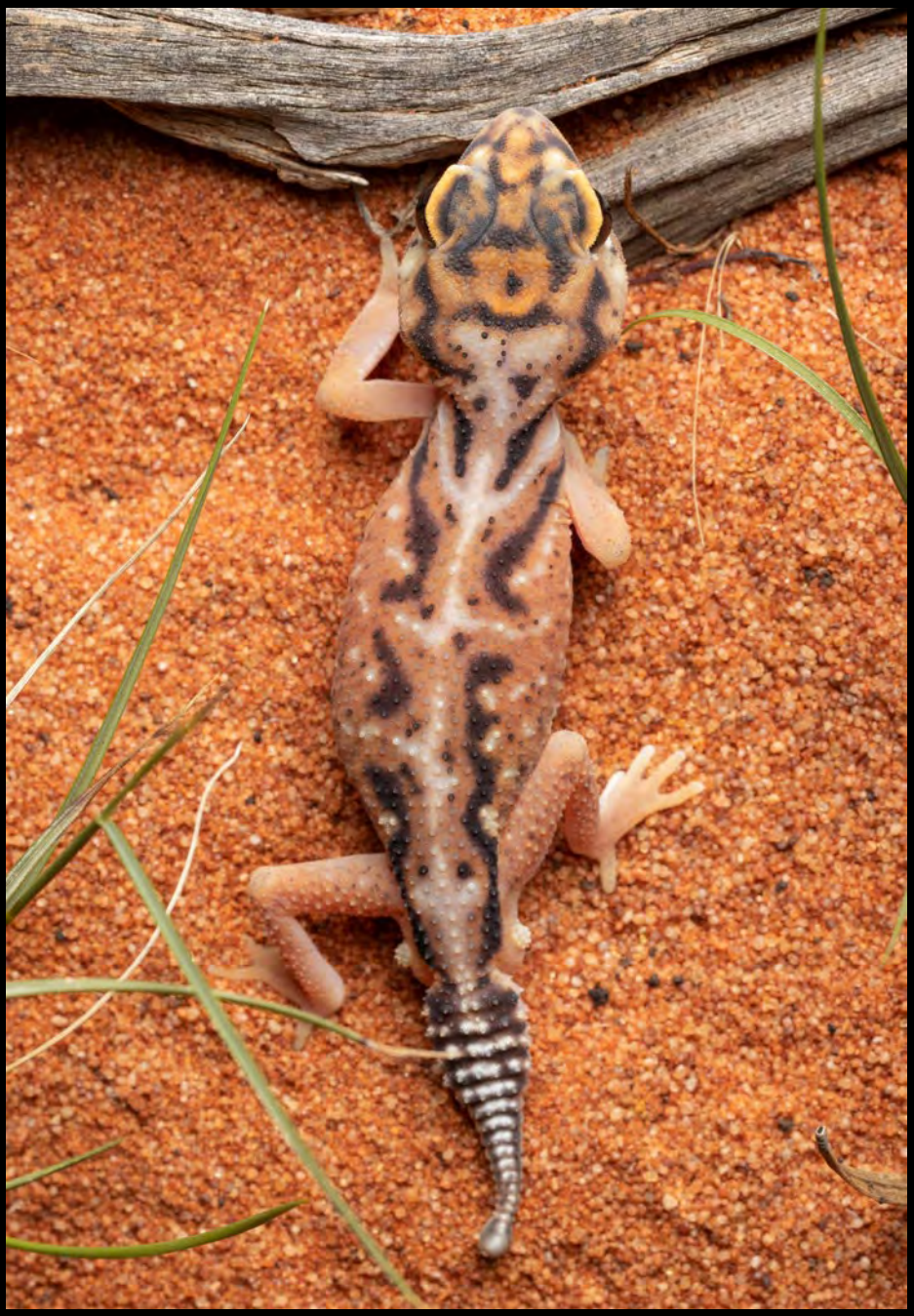
Image by Annie Nguyen

Grevillea linsmithii is a shrub species native to New South Wales and Queensland. Don McGillivray first described it in 1986. The species is listed as Endangered in Queensland under the *Nature Conservation Act 1992* and found only in three small populations in southeast Queensland and northern New South Wales. During a hike at Mount Edwards, Moogerah Peaks National Park, Queensland, Annie saw the grevillea flowering. It was a surprise encounter, and she did not know it was Endangered until she identified it later.

Cowtail stingray (*Pastinachus ater*)

Image by Jaelen Myers

Like many coastal stingray species, the cowtail stingray is listed as Vulnerable by *The International Union for Conservation of Nature Red List of Threatened Species.* Threats include inshore fishing, habitat loss, the destruction of mangrove habitats, and pollution. In Australia, this species occurs in Western Australia, Queensland, and New South Wales. This photograph was taken at Orpheus Island in North Queensland, a productive stingray nursery where juvenile cowtail stingrays are abundant on the intertidal sandflats inshore from the coral reef. Jaelen captured this image during an aerial drone survey as part of her PhD research, which is how she learnt more about fine-scale habitat use and behaviours of rays.



Pernatty knob-tailed gecko (*Nephurus deleani*)

Image by Bridget Lunn

The pernatty knob-tailed gecko, endemic to South Australia, is listed as a Vulnerable species. They are nocturnal, roaming the sand dunes at night for food, which may explain their massive eyes. During the day, they burrow underground and fill in the entrance to remain both hidden and cool. They are at risk of predation by cats and foxes, and overgrazing by rabbits restricts their available habitat. This individual was photographed near Pimba, South Australia. It was thrilling seeing a pair of those large eyes glowing in the sand; the light was reflected from Bridget's head torch. Bridget wanted to photograph this species for its stunning colouration – it is almost like they have been painted, carrying a piece of artwork on their back.

Southern heath frog (*Litoria watsoni*)

Image by George Madani

No one needs reminding of the destruction that the 2019-2020 summer fires wrought upon the forests of the eastern seaboard. Even now, the landscape still shows the scars of devastation and ruin. Whilst working in Morton National Park, New South Wales, George set up camp one chilly winter evening near a clearing among charcoal cloaked gums. He immediately heard the distinct low reedy whistle of a southern heath frog. Upon investigation, in a shallow water-filled depression, there were a few lonely males, chorusing in unison their optimistic hymn in the hope of a female's amplexa embrace. In contrast to the still blackened and burnt perches, they were resilient calls that signalled hope in a recovering landscape.

Green sea turtles emerging from the nest (*Chelonia mydas*)

Image by Jeff Ikin

When it is time to race towards the ocean, there is safety in numbers. This photograph depitcs the first two green turtle hatchlings to make it to the surface from their underground nest on Heron Island, Queensland, still freshly covered in sand. After digging their way to the surface, these two waited an hour while it cooled down and became darker, allowing time for their clutch mates to climb closer to the surface. As the clutch erupts from the nest, they move in a flurry of flippers towards the water. Anything to help confuse predators and improve the likelihood that some of these turtles will make it to adulthood and contribute to enhancing the Vulnerable status of the species.

Rosenberg's goanna (*Varanus rosenbergi*)

Image by Ian Cairney

The heath monitor, or Rosenberg's goanna, is listed as a Vulnerable species. They were once common across the southern coast of Australia. However, today, small, isolated populations occur in south-west Western Australia, coastal regions of South Australia, Victoria, the Australian Capital Territory, and the sandstone country of New South Wales. Threats to this species include the loss of native habitat, increased pressure from feral predators, and collision with motor vehicles. The Rosenberg's goanna is a fascinating breeder. They lay up to fourteen eggs into a termite mound, sealed into the chamber by the goanna or termites. The morning after egg-laying, this female began back-filling her nest hole (note the scratch marks surrounding the hole). After some light rain, the termites filled the remainder of the hole that night.

How a Decade-Long Protection Program for Endangered Australian Sea Lions Got the Seal of Approval

Jo Manning, Australian Marine Conservation Society

Twelve years ago, in South Australia, a report was released showing that more than 250 Australian sea lions (*Neophoca cinerea*) were being killed in gillnets in one fishery every year.

These beautiful, charismatic creatures native to southern Australia were already in decline following widespread hunting in the 18th and 19th centuries, from which their numbers never fully recovered. Their population fell by sixty percent in just four decades, mostly due to fishing pressures from an industry targeting sharks to feed the Australian appetite for what is commonly known as 'flake' at the fish and chip shop.

Gillnets, hung vertically in the ocean to entangle fish, are dangerous because they are invisible to sea lions and many other marine species which get tangled and drown. The loss of a few female sea lions in these gillnets can devastate their colony. Females are incredibly philopatric, meaning they return to the same rookery, or breeding colony, to reproduce. Consequently, each rookery is its own subpopulation, and if only a few females die, it can permanently wipe out an entire colony.

The South Australian report was met with dismay by marine conservationists from the Australian Marine Conservation Society and Humane Society International, who knew this death rate was too high for the dwindling sea lion population to withstand. Thankfully, they found allies among scientists, the government, and crucially within the fishing industry to come up with a rescue plan.

Earlier this year, research (bit.ly/FrontiersResearch) found that the greatest success in reducing the bycatch of marine mammals in gillnet fisheries comes from management measures that limit or restrict gillnet effort (through spatial and temporal closures), or remove it entirely by switching to alternate fishing methods. The research highlighted the success of the management measures, where a combination of permanent and temporary spatial closures linked to bycatch trigger limits, and the switching from gillnets to longline fishing methods, resulted in reduced deaths of Australian sea lions by an estimated ninety-eight percent. This action means more than 2,000 of these animals were likely saved across a decade – a rare and welcome conservation success story.

So how did the rescue plan progress? Australian Marine Conservation Society Campaigns Director, Tooni Mahto, explains that it was not easy. Initially, there was 'fierce resistance' from fishers to the implementation of regulations. But over time, community pressure for seafood to be more sustainable and caught without an impact on unique and endangered Australian wildlife pushed progress along.

A sea lion management strategy was introduced, including measures such as gillnet fishing exclusion zones near breeding colonies, cameras on fishing boats and the introduction of closures in parts of the fishery if a certain number of sea lions were caught. This management strategy mitigated the issue of fishers failing to report to authorities how many sea lions were being killed in their nets.

The moves eventually incentivised fishers to switch to the less damaging longline method to catch their target shark species. Now fishing catches have returned to pre-management levels from a decade ago, proving that tough management decisions do not have to be disastrous for fishers.

Ms Mahto said, *"It was heartening to fully understand the success of this strategy because it was a very tough battle to implement. Hopefully, it will inspire others working in and for our oceans about all that can be achieved if stakeholders work together, and the public is educated and informed."*

Alexia Wellbelove, a campaigner from Humane Society International, who has since moved to work at the Australian Marine Conservation Society, said proving these strategies can succeed will be crucial in future conservation work for sea lions.

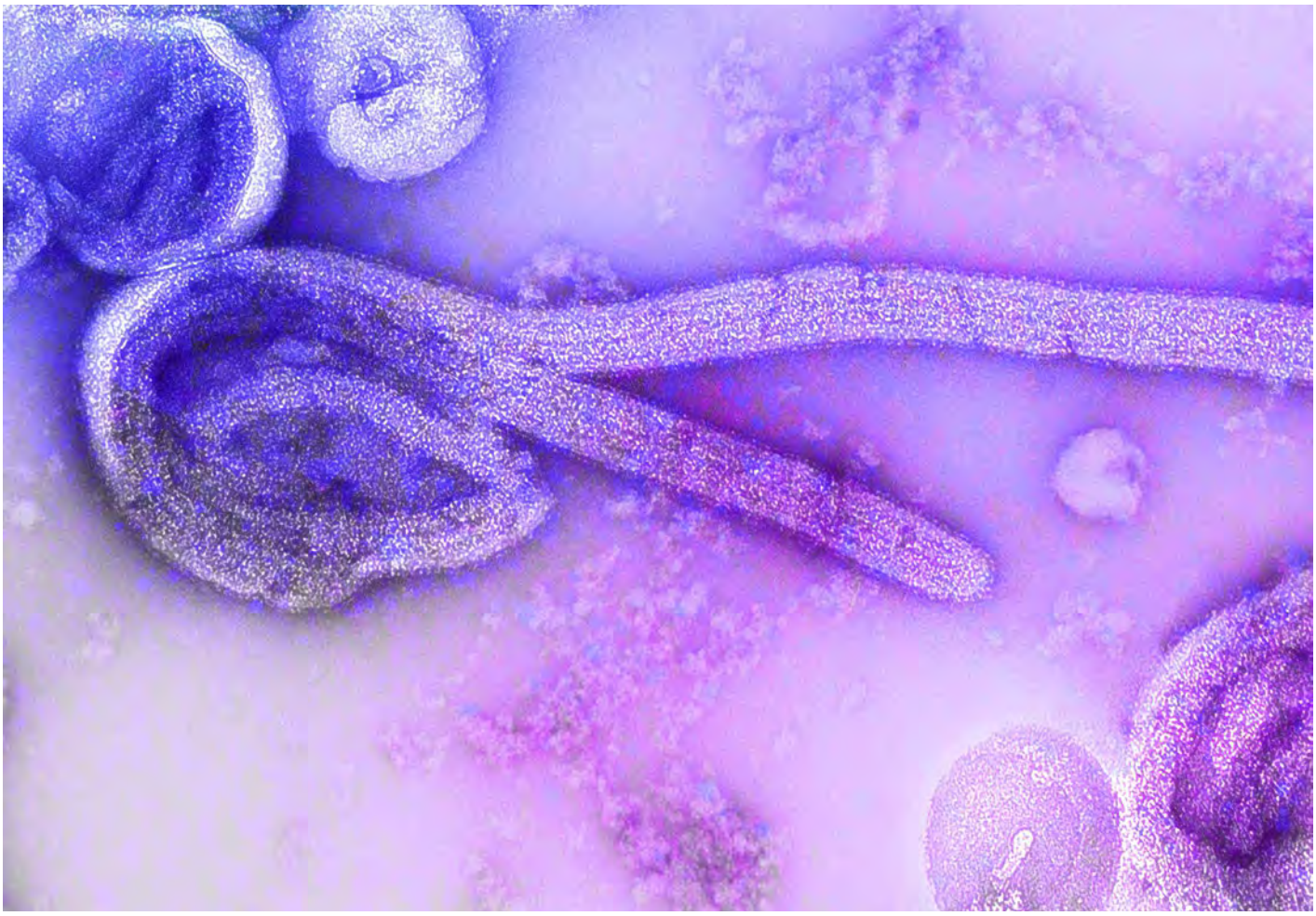
"This management strategy must continue in the waters off South Australia, and its measures are replicated in Western Australia where gillnetting still takes place. The Western Australia shark fishery has committed to introducing certain measures, including increased monitoring by 2024. We are hoping they see this success story and commit to fast-tracking strengthened measures."

South Australian Research and Development lead author, Professor Simon Goldsworthy, of the research paper mentioned above which showed the success of the management measures, described the outcome as extraordinary.

"This kind of conservation and management outcome is extremely rare and sets an important precedent both nationally and internationally," he said.

"Not only has bycatch mortality been reduced to levels that should enable sea lion populations to recover, but fishing catches have also returned to pre-management levels from a decade ago. In the context of managing marine mammal fishery bycatch globally, it is an extraordinary outcome."

Top: An Australian sea lion (*Neophoca cinerea*). Over 250 Australian sea lions were killed in gillnets in one South Australian fishery every year until conservationists teamed up with scientists, the government, and fishers to make a rescue plan. Image: Jason Spafford.



How to find New Viruses and Prevent Disease:
Using Genomic Technologies

Emma Harding, Lewis Mercer, Tanu Sridhar, and Prof. Peter White

Modern problems require modern solutions. Many vulnerable Australian animals live in small remote populations, sometimes in at-risk habitats, far from medical help. In these populations, rapid detection of outbreaks is vital for disease management and prevention strategies to ensue, which have traditionally relied on fieldwork and physical examinations. However, research using genomic technologies now offers an alternative computer-based solution to identify and understand new viruses capable of causing outbreaks in animal populations.

In projects led by virology Prof. Peter White at the University of New South Wales, Sydney, PhD candidates Emma Harding, Tanu Sridhar, and Lewis Mercer use a combination of sequencing and computer analysis to find viruses in a range of Australian animals, including: marsupials, fish, amphibians, lizards, bats, and ticks, to identify new viruses that could threaten native populations.

One method involves studying the entire RNA profile inside animal cells. Every virus contains RNA or creates RNA during a viral infection. When total RNA is sequenced, scientists can detect the viral RNAs using a process called bioinformatics, often processed on a supercomputer. This method can detect viruses when animals are asymptomatic, have subclinical infections or have a chronic viral infection, which can often be missed in physical examinations. This bioinformatic approach allows us to estimate the prevalence of viruses within a population without relying on spotting symptoms in diseased animals.

Another benefit of this bioinformatic approach is that a viral infection can be diagnosed from just a few cells collected from a mouth or nose swab without the need to harm the animals during the collection. This process even works on animal faeces, allowing viruses in a population to be studied without needing to catch or touch the animal. Since this project began in 2018, we have identified over fifty new viruses in Australian animals.

Once a virus genome has been sequenced, we can design new methods to detect it rapidly and design treatments and vaccines to limit its spread. In the case of small reptile populations, rapid detection and action are vital. In 2015, a viral disease outbreak almost rendered the Bellinger River turtle (*Myuchelys georgesi*) extinct in northern New South Wales. Three years later, scientists finally identified the cause – a type of pathogenic virus called a nidovirus. Because this virus had not been seen in Australian turtles before, identifying the virus was slow and laborious. No known treatment or vaccine could be developed quickly enough to save any turtles. However, now that the virus has been sequenced and characterised, it will be much faster to detect it or a related virus linked to outbreaks in the future using molecular biology methods.

With the knowledge gained from RNA sequencing and bioinformatics, we can

Top: Some endogenous viral elements in Australian marsupials are related to the Ebola virus. Image: Centers for Disease Control and Prevention.

Koalas are currently threatened by a pandemic of a retrovirus. Image: David Clode.

PhD candidates, Emma Harding (left) and Tanu Sridhar (right) work in Prof. Peter White's lab researching new viruses in Australian animals. Image: Grace Yan.

DNA and RNA sequencing for wildlife research is undertaken at sequencing facilities like the Ramaciotti Centre for Genomics at the University of New South Wales. Image: Ramaciotti Centre for Genomics.

build a database of the types of viruses that infect Australian animals. During an outbreak, we have the potential to use this database to identify the etiological agent within days, potentially improving the outcomes for the animals. If projects like this are implemented on a wide scale, we will begin to understand the complex interactions between viruses and animals within different ecosystems and the diseases they cause to at-risk populations.

Another genomic method used in Prof. White's research group involves looking for records of past viral infections buried inside animal DNA termed 'paleovirology'. During infection, viruses can leave fragments of their genome (RNA/DNA) inside the host, termed endogenous viral elements. Endogenous viral elements from different viruses exist inside the DNA of every animal (even humans). They can be studied in a similar way to fossils of extinct animals (paleontology), providing glimpses of what viruses infected our ancestors thousands to millions of years ago. A recent study identified over thirty endogenous viral elements in Australian marsupials derived from ancient viruses related to the Ebola virus, Borna Disease virus, and Parvovirus B19. Whilst these endogenous viral elements no longer cause the animals any harm, it does provide evidence that these viruses used to circulate and infect marsupials.

Along with providing a record of historical infections, studying endogenous viral elements can also help us understand the types of viruses that animals are likely to be susceptible to. For example, koalas (*Phascolarctos cinereus*) are currently under threat from an outbreak of koala retrovirus – a virus related to Human Immunodeficiency Virus in humans. A study of endogenous viral elements in the koala genome reveals that koalas have hundreds of retrovirus endogenous viral elements. However, the retroviruses that historically infect koalas are very different from koala retrovirus and help to explain why koala retrovirus has been so damaging – because koalas have never 'seen' this virus in the past, therefore they do not have any immunity to it. Based on this information, we can also tell that koala retrovirus was unlikely to originate in Australia and was probably brought by birds or bats to northern Queensland.

RNA sequencing and paleovirology are two of many applications of genomic technologies which can be used for animal conservation. As sequencing and computer technology improve, it is becoming increasingly easier to study virus prevalence and evolution on a whole population scale. Genomic methods aim to identify viruses so we can make preemptive plans and management strategies to help protect vulnerable wildlife populations. As we understand more about animal genetics and diseases that affect them, more virology can be done behind the scenes without needing to capture and study animals from the wild.

Australian Wildlife Society Supports a New Mountain Pygmy-Possum Breeding Facility at Lithgow

Megan Fabian

The mountain pygmy-possum (*Burramys parvus*) is a small nocturnal marsupial endemic to the alpine regions of Australia. The survival of the mountain pygmy-possum depends not only on its immediate environment but also on the regional migratory patterns of its primary food source, the bogong moth (*Agrotis infusa*). In New South Wales, the mountain pygmy-possum is listed as an Endangered Species on Schedule 1 of the *Threatened Species Conservation Act 1995* and is classified as Critically Endangered on the *International Union for Conservation of Nature's Red List of Threatened Species*. This species is under threat due to habitat loss, predation from foxes and feral cats, fire damage to mountain plum-pine and other shrub covers, impacts on bogong moths from drought, agricultural practices, and chemicals in the winter breeding grounds, and climate change.

In 2020, the Society partly funded a new mountain pygmy-possum breeding facility at Secret Creek Sanctuary to help save the species from a changing climate and possible extinction – with an estimated less than 3,000 pygmy-possums left in the wild. The breeding program, led by the University of New South Wales Sydney and partnered with wildlife foundations and government conservation programs, is the first of its kind in New South Wales.

On Sunday, 11 September 2022, the official opening of the mountain pygmy-possum breeding facility took place. The opening was a remarkable success, with some fifty people attending the event to celebrate a milestone in history for mountain pygmy-possum conservation.

Guests were welcomed by Secret Creek Sanctuary Owner, Trevor Evans, with a welcome to Wiradjuri country and a cleansing smoking ceremony – an ancient and contemporary custom involving smouldering eucalyptus leaves and branches to bring a strong spiritual and physical cleansing to the people and the new mountain pygmy-possum facility.

Dr Linda Broome (Ecologist and threatened species expert) and Dr Hayley Bates (one of Australia's leading experts on the species) introduced the mountain pygmy-possum. They spoke about its evolutionary history, emphasised the importance of its environment and the survival of its key food source – the bogong moth, and concluded with the threats to this species, highlighting the importance of its conservation.

Dr Bates stated that the breeding facility has three primary purposes:

1. To increase mountain pygmy-possum numbers via captive breeding as an insurance policy against natural disasters,
2. To provide an opportunity for researchers to study their behaviour, and
3. To conduct monitored trial releases into areas of lowland wet forests of the kind where their ancestors had thrived.

The first stage of the breeding program is to get the possums acclimatised to their new environment, including sourcing new foods. *"We want to investigate how the possums will respond to modern changes in their environment so that when impacts of climate change occur, we can make better informed, science-based management decisions to protect this species in the wild. Understanding how the possums have dealt with changing climates in the past is key to this story,"* said Dr Bates.

Top left: The mountain pygmy-possums (*Burramys parvus*) thermally stable outdoor enclosure. Image: Megan Fabian.

Top right: The mountain pygmy-possum (*Burramys parvus*) nest boxes are enclosed in an insulated rock wall. Image: Megan Fabian.

L to R: Dr Hayley Bates, Dr Linda Broome, Trevor Evans, and Dr Julie Old. Image: Megan Fabian.

President, Dr Julie Old, participated in the smoking ceremony. Image: Megan Fabian.

President, Dr Julie Old, at the entrance of Secret Creek Sanctuary. Image: Megan Fabian.

President, Dr Julie Old, unveiled the plaque during the official opening ceremony. Image: Megan Fabian.

Before entering the mountain pygmy-possum breeding facility, the President of the Society, Dr Julie Old, was invited to say a few words and unveil a plaque to celebrate the momentous occasion. Dr Old conveyed the importance of the mountain-pygmy possum in terms of our ecology in Australia, and congratulated Trevor Evans and the broader team for their efforts in conserving this species into the future.

Guests were then taken on a tour of the breeding facility. The breeding facility is equipped with thermally stable outdoor enclosures and insulated rock walls with nest boxes deep inside, a research and observation room, an office area, quarantine rooms, a storage room, and a food preparation area.

So far, fourteen pygmy-possums are thriving in their new habitat, and the birth of six babies has been witnessed since moving in.

When the official proceedings concluded, guests were invited to continue to celebrate the conservation of Australia's mountain pygmy-possums at Secret Creek Cafe and Restaurant.

Through the support of the Australian Wildlife Society, Secret Creek Sanctuary has established a mountain pygmy-possum breeding facility to provide the opportunity to study the species and its breeding behaviours at a warmer temperature. The breeding facility will help the mountain pygmy-possum transition back into a more comfortable environment and survive the lethal changes coming to the alpine regions of Australia.

Secret Creek Sanctuary has been operating since 2001 and is situated near Lithgow, New South Wales. The sanctuary was established to provide a feral-proof enclosure where endangered native species are protected from predation. The sanctuary aims to show visitors what Australia used to look like before European settlement, with most species previously endemic to the area.

The sanctuary is best known for reintroducing the eastern quoll (*Dasyurus viverrinus*) to New South Wales in 2001. Now also home to brush-tailed rock-wallabies (*Petrogale penicillate*), long-nosed potoroos (*Potorous tridactylus*), bettongs (*Bettongia lesueur*), Tasmanian devils (*Sarcophilus harrisii*), tiger quolls (*Dasyurus maculatus*), dingoes (*Canis lupus dingo*), koalas (*Phascolarctos cinereus*) and, of course, our precious mountain pygmy-possums.

Tasmania's Deer Dilemma

Invasive Species Council

Tasmania's population of fallow deer (*Dama dama*) has exploded. With no signs of slowing down, they threaten to leave a path of ecological, cultural, and economic destruction in their wake.

Fallow deer were introduced into the Midlands region of Tasmania in the 1830s for hunting and meat. There they remained in relatively small numbers for over a century. However, since the 1980s, the population has increased exponentially and expanded beyond its historic range. While the exact numbers are uncertain, Tasmania's feral deer population now numbers well above 50,000 and occupies 27 percent of the state.

A Biological Powder Keg

Fallow deer populations already occupy the eastern Tasmanian Wilderness World Heritage Area. Deer are found in relatively high abundance in the Central Plateau Conservation Area, around the Great Western Tiers, and have even been observed in the Walls of Jerusalem. Deer have also spread into some of Tasmania's most iconic national parks, including Freycinet National Park, Ben Lomond National Park, and Douglas-Apsley National Park. Satellite populations of deer can now be found all over Tasmania, including on Bruny Island, around Temma, and on the outskirts of Launceston, Hobart, Mole Creek, Deloraine, and Dover.

Tasmania's growing deer population shows no signs of slowing down. Scientists at the University of Tasmania predict that if deer continue to be managed under the current policies, the population will exceed one million by 2050 and will likely inhabit more than 56 percent of Tasmania. Fallow deer could live almost anywhere in Tasmania apart from the densest and wettest forests and the low productivity buttongrass plains of the west. Scientists predict that a warming climate and increased wildfire frequency will further increase the number of regions fallow deer can inhabit.

The Consequences of Doing Nothing

Tasmania is a remarkable landscape of unique and outstanding natural and cultural value, along with prized agricultural and forestry industries. This landscape is also the cornerstone of Tasmania's economy, and is threatened by the burgeoning feral deer population.

Many of Tasmania's most precious wilderness areas are susceptible to the negative environmental impacts of deer. Even small numbers of deer in sensitive areas can have dramatic impacts. Deer can damage native vegetation and ecologically fragile areas by overgrazing, browsing, trampling, rubbing their antlers against trees, spreading weeds, creating trails, and degrading water quality in creeks and rivers. Grazing pressure can reduce the density and diversity of vegetation in peatlands, heathlands, grasslands, and the forest understorey, reducing habitat quality for native wildlife. In fire-sensitive ecosystems, browsing deer can inhibit post-fire recovery and potentially result in permanent changes to the ecosystem.

Not only can feral deer inflict significant damage to the environment, but they are also an affront to Tasmania's identity as a pristine, natural place. Feral deer threaten the ecological integrity of Tasmania's wild places.

Fallow deer do not yet occur at high densities in most of the Tasmanian Wilderness World Heritage Area, but the latest research from the University of Tasmania shows that if current management practices continue, deer will inevitably establish, and once they do, they will be nearly impossible to eradicate. According to Dr Calum Cunningham of the University of Tasmania, who has been researching deer in Tasmania, *"Our models indicate there is ample suitable habitat for deer in the world heritage area, and that deer are on the cusp of firmly establishing there."*

Top: Feral fallow deer (*Dama dama*) Tasmania. Image: Faye Beswick.

Deer can damage native vegetation and ecologically fragile areas by overgrazing, browsing, and trampling. Image: Nicole Anderson.

Even small numbers of deer in sensitive areas can have dramatic impacts, particularly in fragile alpine ecosystems. Image: Bob Brown.

Deer inflict damage not only on Tasmanian ecosystems but also the Tasmanian economy. Estimates suggest deer cost Tasmania farmers eighty million a year due to destroyed infrastructure and damaged crops. Protecting trees from deer incurs significant costs to forest plantations, ecological restoration, and carbon farming. Greening Australia estimated that 30 percent of its six million budget for the Midlands Restoration Program was spent preventing deer impacts.

Conflicted Management

Tasmania is lagging behind the rest of the country regarding recognising deer as a serious feral pest and managing them appropriately. Tasmania's deer policy remains firmly focused on recreational hunting, with fallow deer classified as 'partly protected wildlife'. A policy of maintaining the supply of prized hunting targets rather than controlling the population and mitigating their negative impacts has allowed for feral deer's dramatic expansion across Tasmania.

In February 2022, the state's Liberal government released a five-year plan to manage the population of fallow deer. While this plan has made several improvements, it lacks ambition and detail. Properly managing deer numbers will require very serious action plans with identified actors, budgets, and targets, none of which have been provided. Disturbingly, the plan sanctions the retention of deer in some areas of the Tasmanian Wilderness World Heritage Area, and Ben Lomond and Douglas-Apsley National Parks.

Failure to control the exploding numbers of fallow deer (*Dama dama*) across Tasmania could see them invade the world-renowned Cradle Mountain in Lake St Clair National Park. Image: Richard Siu.

Tasmania is at a Crossroads

There is no question that the deer population is expanding, and with it, their negative impacts on the environment, society, and economy. The current policies will not prevent deer from establishing throughout Tasmania. The situation is serious and dire, but there is hope. With concerted and targeted action, the invasion of deer into Tasmania's most valuable and iconic wilderness areas can be prevented. *"We need targeted control by the state government to eradicate deer from areas of outstanding natural value like the Tasmanian Wilderness World Heritage Area. There are also a number of small, isolated populations that should be prioritised for eradication, like Bruny Island and northwest Tasmania, before they become problematic and impossible to eradicate. These outlying populations are economic low-hanging fruit – a no-brainer,"* says Dr Cunningham.

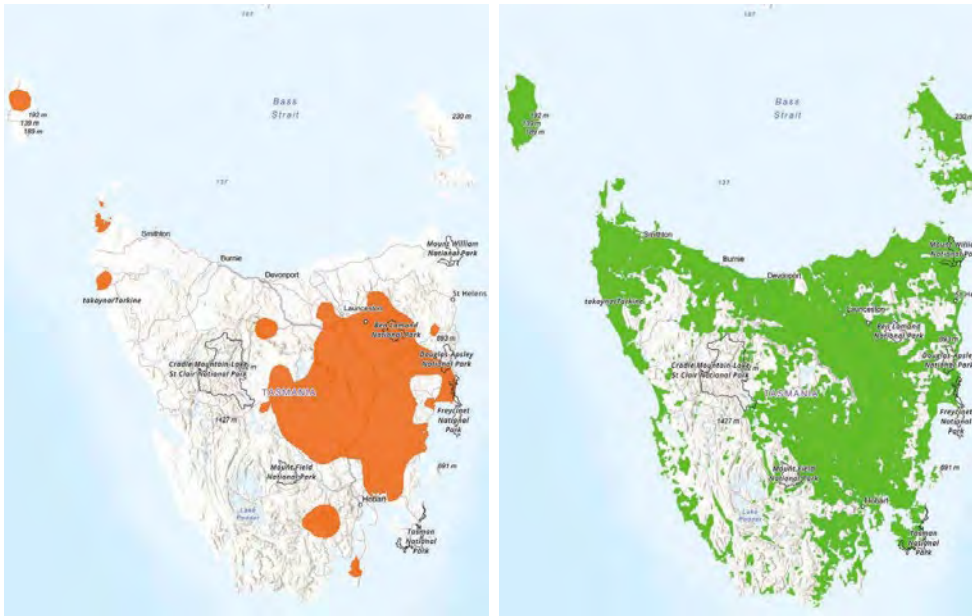
It is time to stop managing feral deer for the enjoyment of the few at the cost of the many. As stated by former Tasmanian Senator Christine Milne, *"The Tasmania Government has ignored the mainland experience of massive feral deer environmental damage, has ignored the pleas of Tasmanian land managers, has ignored its responsibilities to protect the Tasmanian Wilderness World Heritage Area, all to curry favour with a few deer hunters."*

For further information on feral deer in Tasmania or to get involved in our campaign, please visit https://tinyurl.com/TASDeer

Fallow deer (*Dama dama*) have established throughout Tasmania, including in the Tasmanian World Wilderness Heritage Area. Image: Tasmanian Land Conservancy, Five Rivers Reserve.

Fallow deer (*Dama dama*) can now be found throughout Tasmania, including Ben Lomond National Park. Image: Richard Siu.

The new management plan sanctions the retention of deer in some areas of the Tasmanian Wilderness World Heritage Area. Image: Tasmanian Wild Fallow Deer Management Plan 2022-27.



Current (left) and potential future (right) distribution of fallow deer (*Dama dama*) in Tasmania based on climate and habitat suitability. Image: Cunningham et al., 2021.

Threatened Species Conservation:
Powered By Partnerships

Megan Fabian

On Wednesday, 7 September 2022, Threatened Species Day, the Society attended the Minister's Threatened Species Conservation: Powered by Partnerships event, hosted by the Taronga Conservation Society. The event took place at Taronga's Institute of Science and Learning. Many individuals and organisations were in attendance to celebrate this special occasion, including representatives from Taronga Conservation Society, New South Wales Government Environment and Heritage Group, World Wildlife Fund-Australia, University of New South Wales, University of Sydney, Australian Wildlife Management Society, Woolworths, Australian Geographic, World Animal Protection, and, of course, Australian Wildlife Society.

As we entered Taronga's Institute of Science and Learning, we were welcomed by some drinks and nibbles where we could speak with like-minded individuals from various organisations on the importance of threatened species conservation. We were then ushered into the lecture hall, where Cameron Kerr AO, Chief Executive, Taronga Conservation Society, welcomed the guests and invited Susan Moylan-Coombs, Founding Director, The Gaimaragal Group, on stage for the Acknowledgement of Country.

Cameron then followed with an introduction on why we were brought together for this special event. Cameron's key message was that we must work together to achieve conservation outcomes. As the title states, when conservation strategies are 'Powered by Partnerships', working together to achieve the same goal, we are most likely to succeed in protecting Australia's native flora and fauna. Not just professional partnership but also community involvement and participation in citizen science projects. Citizen science projects such as the University of New South Wales Environment Recovery Project and WomSAT are vital to informing future conservation efforts.

The Guest of Honour, The Hon James Griffin MP, New South Wales Minister for Environment and Heritage, was then invited to say a few words. Minister Griffin mentioned some critical conservation efforts that are to take place over the next few years, such as:

1. The New South Wales government's Saving our Species program being backed by a $175m commitment over the next ten years,
2. A record $200m for koala conservation to help double the state's population of the endangered Australian icon, and
3. New South Wales is further expanding its rewilding efforts with 65,000 hectares of national parks that will be feral-free and provide a significant conservation benefit for more than fifty species.

Minister Griffin also highlighted the success of the Wild Deserts Sturt National Park rewilding program. As part of the New South Wales government's feral-predator free area partnerships project with the Sturt National Park site, managed by the University of New South Wales Wild Deserts, reintroduced mammals such as the greater bilby (*Macrotis lagotis*), crest-tailed mulgara (*Dasycercus cristicauda*), Shark Bay bandicoot (*Perameles bougainville*) and golden bandicoot (*Isoodon auratus*) are thriving in the landscape since their reintroduction to Sturt National Park.

Top left: The event took place at the Taronga Institute of Science and Learning. Image: Megan Fabian.

Top right: L to R: Patrick Medway AM and Trevor Evans. Image: Megan Fabian.

These mammals were translocated to the area between 2020 and 2022. The project is run in collaboration with Ecological Horizons, NSW National Parks and Wildlife Service, and Taronga Conservation Society and was partly funded by the Australian Wildlife Society.

"We set out a bold plan backed by science to create areas where we could eradicate feral predators and reintroduce locally extinct animals like the bilby, which have been extinct in the wild in New South Wales for more than one hundred years," Mr Griffin said.

"It is incredible to see that in such a short period of time, we are on track to remove at least ten animals from the New South Wales extinct list – the first time this will have happened anywhere in the world."

"These results are so important for the long-term goal of restoring this magnificent desert ecosystem to something like it once was," says University of New South Wales, Professor Richard Kingsford, Wild Deserts project lead – who was also present at the event. *"Every year's results are exciting. We are looking to transform this environment out here by putting these animals back in and establishing food webs that were once here."*

The Wild Deserts Sturt National Park rewilding program is an excellent example of what can be achieved for native species conservation when Powered by Partnerships.

Rachel Lowry, Chief Conservation Officer, World Wildlife Fund – Australia, was the next to speak. Rachel provided insight into the importance of Threatened Species Day and why it matters. *"It is a day of reflection,"* Rachel said. *"On 7 September each year, many people stop and reflect that on that same date in 1936, Australia's Tasmanian tiger, also known as our thylacine (Thylacinus cynocephalus), slipped over that extinction line."*

Threatened Species Day allows us to reflect on Australia's flora and fauna worth fighting for. It encourages us to share stories with our family and friends, celebrate the uniqueness of our native species, and learn more about the current threats and what we can do to help mitigate them.

Rachel also played a sound recording of the last Christmas Island pipistrelle (*Pipistrellus murrayi*) to exist. The Christmas Island pipistrelle was a species of vesper bat found only on Christmas Island, Australia. The species is now extinct, with the last individual bat seen in August 2009 with no further sightings despite intensive efforts to locate the species.

However, *"Threatened Species Day is a day to remind people that there is hope,"* Rachel said. *"If we scale up our ambition, move faster, and work together, we can get ahead of the extinction crisis."*

L to R: Panel discussions: Cameron Kerr AO, Chief Executive, Taronga Conservation Society, The Hon James Griffin MP, Minister for Environment, Rachel Lowry, Chief Conservation Officer, World Wildlife Fund – Australia, Atticus Fleming, Coordinator-General, Environment and Heritage Group. Image: Megan Fabian.

L to R: Trevor Evans, Professor Richard Kingsford, Director of the Centre for Ecosystem Science, UNSW, Patrick Medway AM. Image: Megan Fabian.

L to R: Cameron Kerr AO, Chief Executive, Taronga Conservation Society and Patrick Medway AM. Image: Megan Fabian.

The Hon James Griffin MP, Minister for Environment. Image: Megan Fabian.

L to R: Patrick Medway AM, Paul Maguire, Director of Education, Taronga Conservation Society, and Trevor Evans. Image: Megan Fabian.

An Australian brushturkey (*Alectura lathami*) on the grounds of Taronga Zoo. Image: Megan Fabian.

A panel discussion then took place. On the panel were The Hon James Griffin MP, Rachel Lowry, and Atticus Fleming, Coordinator-General, Environment and Heritage Group. The audience asked some robust questions, encouraging great discussions concerning protecting our marine species, especially about the lack of available data. Minister Griffin responded, *"creating databases is innovative, but more can be done to help inform better policy decisions"*. Minister Griffin referred to the Sydney Harbour restoration project – a new program that will improve marine habitat and water quality in Sydney Harbour. The $9.1m restoration project is a partnership between the New South Wales government agencies, Taronga Conservation Society, and the Sydney Institute of Marine Science.

There was a question regarding tackling the threats to biodiversity. The response focused on short-term goals, being better at taking risks, tackling a changing climate, being adaptable, implementing sustainable farming, managing feral cats and foxes, encouraging community and political action, and working together to break conservation barriers.

Professor Katherine Belov from the University of Sydney asked how we can tackle habitat fragmentation when seventy-one per cent of Australia is privately owned. The response was to engage with landowners and talk to key stakeholders, implement strategic conservation and urban planning, address the housing crisis, speak with developers, change how we look at protecting biodiversity, and consider the role of community regeneration through an innovative psychology conservation lens.

We then broke into one of three workshops. The Society selected workshop two – Education for Conservation Outcomes which took place in the Guru/Burra Meeting Room. We were welcomed by Paul Maguire, Director of Education, Taronga Conservation Society. Paul introduced us to the behaviour change model where you 'connect' with people through ambassadors or species, 'understand' the situation or conservation issue, and 'act' using appropriate tools and incentives to engage people in conservation action. The conservation action must be fun, multi-sensory, positive, layered, and comfortable to keep people proactive and engaged.

We returned to the main foyer when the workshops concluded, where a light dinner was served. We had the opportunity to continue our discussions before the evening ended.

Saving threatened species is vital for a healthy and diverse ecosystem. Once flora and fauna become extinct, they are gone forever. Today, most species become endangered due to habitat destruction and the invasion of non-native species. However, with effective management and conservation strategies like Powered by Partnerships, threatened species can be protected for future generations.

2021 Australian Wildlife Society

University of New South Wales Wildlife Ecology Research Scholarship

Restoring Biodiversity and Ecosystem Function from the Ground Up: Response of Soil Biota to Reintroduced Digging Mammals

Jana Stewart

Drylands cover seventy percent of Australia and are primarily impacted due to land management practices such as overgrazing and water extraction. Other various threatening processes contribute to the decline of biodiversity, including the loss of habitat, invasive species, and the direct impact of human activities. Biodiversity loss disrupts the biogeochemical processes that sustain these ecological systems. With naturally low and infrequent rainfall, arid and semi-arid (hereafter drylands) systems are particularly vulnerable to the impact of climate change over longer and more severe dry periods.

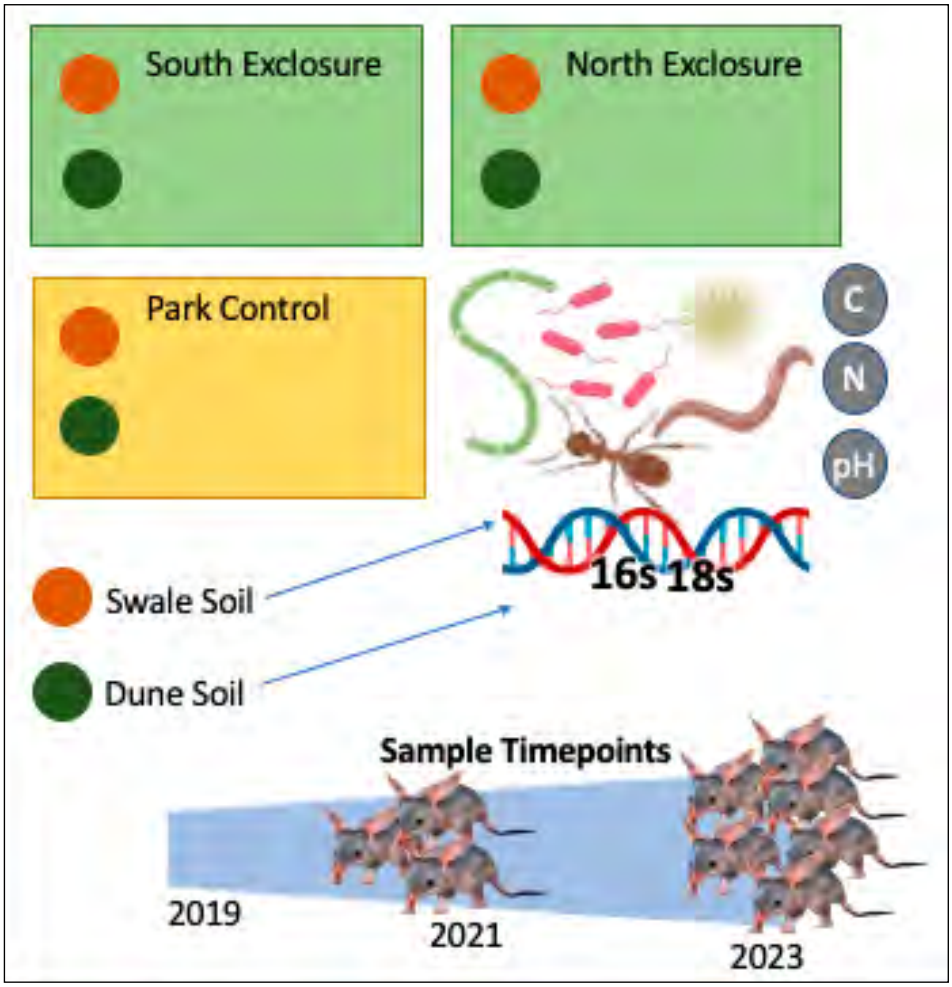
Australian soil is unique, lacking in recent geological history regeneration processes such as uplift, glaciation, or volcanic activities. Biological activity in the upper layers is the primary source of soil regeneration in Australia, with biodiversity therefore intrinsically linked to its function. Efforts to preserve and restore Australian dryland ecosystems have largely been unsuccessful and costly.

This project aims to understand the interactions and relations that drive soil functionality. Soil functionality is vital to maintain overall ecosystem health and sustainability through bottom-up interactions, with up to eighty percent of ecosystem processes associated with soil functions. Ecosystem engineers are particularly needed in the process as they provide services that restore the functionality and biodiversity of the soil. These include nutrient fixing microbes, decomposing invertebrates, and soil turning mammals, which improve soil stability, water and nutrient availability, seed recruitment, and germination. Microbes are also essential to maintain ecosystem functions. They are key drivers of processes such as pest suppression and nutrient cycling, with dominant species significantly influencing a systems' resistance, and resilience to change and disruption. The multifaceted cycles of interacting microbes, invertebrates, plants, and mammals are critical for ecosystem functioning. Knowledge of these interactions is increasing, but spatial and temporal effects remain poorly known. Understanding the

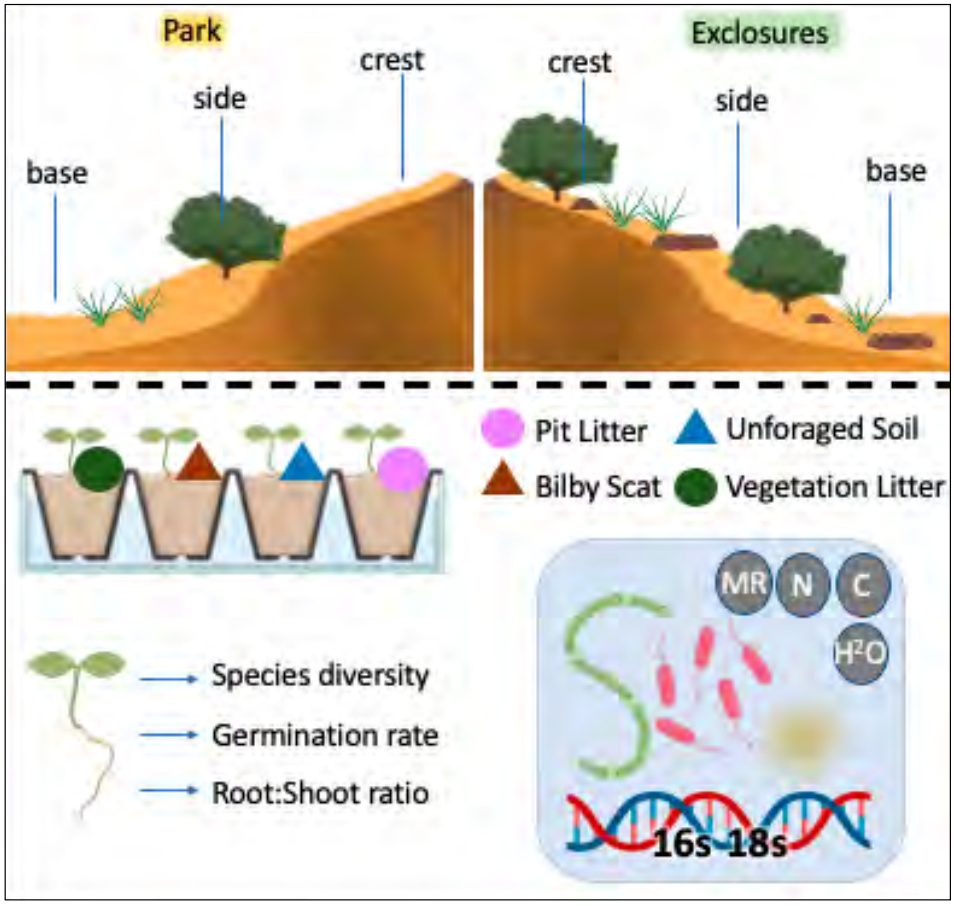
Top: Jana is a PhD Candidate at the University of New South Wales looking at soil microbes in dryland ecosystems.

Digging mammals can move large amounts of soil during their foraging activities which can help to disperse nutrients.

Soil biota in drylands improves stability, water availability, and nutrient access.



The first aim will investigate the response of soil biota to reintroduced digging mammals over time and density.



Using a glasshouse experiment, the project will compare how digging mammals facilitate nutrient dispersal and seed establishment.

dynamics of interactions that support soil functionality would allow the development of indicators to enable adaptive management for successful ecosystem restoration.

The project will analyse how soil biota diversity responds to mammal presence, and identify improved soil functionality. The project will focus on burrowing and digging mammals, which are powerful ecosystem engineers with their foraging behaviour and burrows providing many benefits such as dispersing soil nutrients, refugia for other species, and increasing landscape heterogeneity. Previous studies have compared habitat and microbial abundance with and without these engineers, showing variance. However, evidence of functional diversity differences is lacking. Understanding these differences may help understand how ecosystems benefit from these interactions and how these would be impacted if one of these pieces is altered.

The project will occur at the Wild Deserts project site in Sturt National Park, New South Wales, to investigate the response of soil biota to digging mammals. Wild Deserts is reintroducing locally extinct mammals to predator-free exclosures within the park. With many of Australia's native digging mammals threatened or locally extinct, Wild Deserts offers the unique opportunity to examine these interactions spatially and temporally. Reintroductions of bilbies (*Macrotis lagotis*), bettongs (*Bettongia leseuer*), bandicoots (*Perameles bougainville*), and *Isoodon auratus*) to Wild Deserts allows for comparison of areas without reintroductions and time points throughout the reintroductions (e.g., before, early-stage, and late-stage), and to enable comparisons of population density impacts. Glasshouse experiments will also allow the project to assess the role of these digging mammals in seed establishment.

Overall, the outcomes of the project can be used to improve the monitoring of drylands and potentially facilitate targeted restoration plans by restoring ecosystem functions driven by soil. Further information on Wild Deserts can be found at https://www.ecosystem.unsw.edu.au/research-projects/wild-deserts

Funds provided by the Australian Wildlife Society will be allocated towards genetic sequencing to identify soil biota that provides key ecosystem services and potential indicators for restoration success.

2022 University Research Grant Winners

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

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

The winners for 2022 are:

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

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

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

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

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

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

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

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

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

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










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

ADAM YANEY-KELLER
School of Biological Sciences, Monash University

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

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

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

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

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

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

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

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

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

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

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

1. How many seals are becoming entangled?,
2. What effect does an entanglement have on the health and behaviour of these seals?, and
3. Where are seals becoming entangled, and how can we improve the management of these areas to mitigate this threat?

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Using the temperate reefs of south-east Australia as a case study, this project aims to investigate how temperature impacts urchin-kelp interactions that underlie the destructive overgrazing of kelp beds and the maintenance of urchin barrens. Changes among populations at the warm (New South Wales) and cool (Tasmania) edges of these species' thermal distributions will also be compared.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Better Outcomes for People and Nature: Improving Private Land Conservation

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

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

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

Private Land Conservation in Australia

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

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

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

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

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

How to Improve Private Land Conservation Outcomes

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

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

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

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

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

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

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

Fire and Reptiles:

An Investigation into Threatening Processes and Potential Management Solutions

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

What is Required to Recover Australian Threatened Ecosystems?

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

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

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

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

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

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

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

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

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

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

Case Studies

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

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

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

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

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

Mountain lake alpine sphagnum bogs. Image: Jessica Walsh.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

NICHOLAS MACDONALD
School of Life and Environmental Sciences, Deakin University

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

SHAWN SCOTT
UniSA STEM, University of South Australia

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

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

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

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

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

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

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

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

The project will use before-after control-impact (BACI) and chronosequence experimental designs to systematically assess the immediate and long-term effects of prescribed fire on frog richness, calling, and chytrid occurrence, respectively, in remnant stringybark woodlands. The before-after control-impact sites will be exposed to prescribed fire from mid-spring 2022, and other sites represent increasing times since prescribed fire and include 'long-unburned' (20+ years) control sites. The project will use multiple methods at all sites, including pitfall traps with drift fences, active searching, and deployment of artificial shelters (including tiles and iron sheets) and acoustic recorders. To determine whether frog health and chytrid load are related to fire age, we are collecting morphometric and mass data from

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

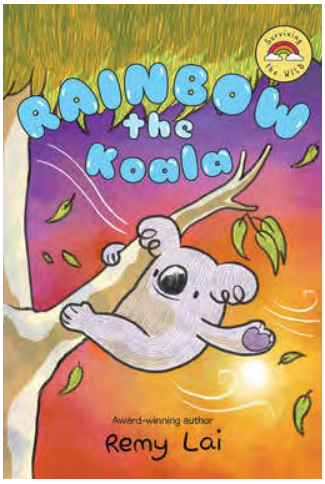
individuals, recording sex, age group, and reproductive status, and swabbing the ventral surface for chytrid spores. For capture-mark-recapture analyses, photography of unique features or colour patterns and visible implant elastomer will be used to identify changes in condition and chytrid occurrence in individuals over time.

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

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

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

Book Reviews



Rainbow the Koala – *Remy Lai*

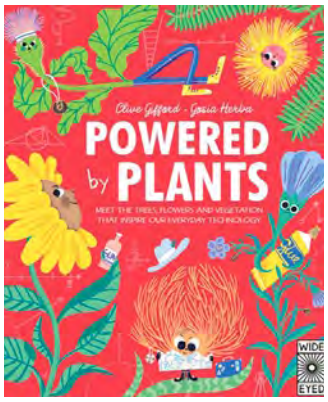
This graphic novel is about a young koala called Rainbow. Rainbow's mum says it is time for him to go out and find a new home to call his own. But life in the bush can be scary, and it is often difficult to find the perfect tree. Rainbow now needs to learn how to survive in the Australian bush on his own. It is hot, he is thirsty, and he smells smoke. Inspired by true stories from the 2019-2020 bushfires, Rainbow's story is one of both sadness and hope as he faces an unpredictable force. An excellent introduction to the wonders of the natural world and what we can do to protect it.

Publisher: Allen & Unwin
RRP: $14.99

A First Book of Beautiful Bird Songs – *Fred van Gessel*

Listening to birds singing is said to improve mood and boost positive feelings. From one of Australia's loudest songsters, the golden whistler (*Pachycephala pectoralis*) to one of New Zealand's flightless birds, the little spotted kiwi (*Apteryx owenii*), this beautifully illustrated sound guide is the perfect way to introduce children to the wonders of bird song, at the touch of a button. Each species has a brief description explaining fascinating facts about that bird, plus a handful of beautiful colour photographs.

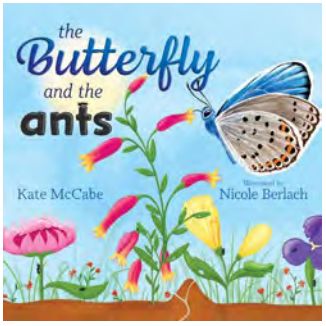
Publisher: New Holland Publishers
RRP: $26.99



Powered by Plants – *Clive Gifford and Gosia Herba*

Plants exhibit an incredible range of diversity in their shape, structures, and interaction with other living things and their environment. *Powered by Plants* guides readers through a stunning collection of fascinating plant life, from super-sized sea-dwelling kelp that provides food and shelter for numerous marine animals to algae, a highly diverse group of aquatic plants that, if farmed appropriately, might be the blockbusting biofuel of the future. Bright and lively illustrations and pop-out fact boxes bring the science in this book to life. So put your innovative cap on as *Powered by Plants* shows us how much we can learn from studying the magnificence of the natural world.

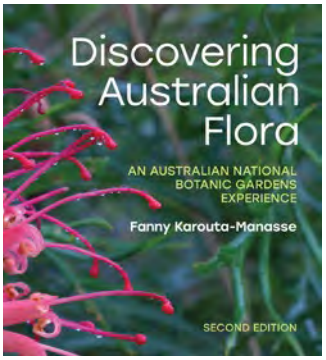
Publisher: Allen & Unwin
RRP: $29.99



The Butterfly and the Ants – *Kate McCabe and Nicole Berlach*

The Butterfly and the Ants tells the beautiful story of a butterfly's lifecycle. Follow a caterpillar named Blue as he begins his journey towards becoming a magnificent butterfly. Moreover, learn about a fascinating symbiotic relationship between butterflies and ants – who knew that such a relationship in the natural world could be so cool! This engaging true story, taking place worldwide, connects children to the caterpillars, butterflies, and ants they might see in their local wildlife reserve, a nearby park, or even in their own backyard.

Publisher: CSIRO Publishing
RRP: $24.99



Discovering Australian Flora – *Fanny Karouta-Manasse*

This magnificent book explains how the Australian National Botanic Gardens display plants according to themes. It provides clear and simple geographical, historical, and botanical information, including descriptions of plant characteristics, their reliance on fire, and their ability to survive in poor soil. The book looks in detail at the two dominant genera in the Australian landscape – Eucalyptus and Acacia. From the tallest flowering tree in the world, the swamp gum (*Eucalyptus regnans*), to the prickly tips of the flattened leaf stem of the golden wattle (*Acacia pycnantha*), *Discovering Australian Flora* will appeal to anyone with an appreciation for Australia's beautiful and diverse botanical treasures.

Publisher: CSIRO Publishing
RRP: $35.00

This Book is a Plant – *Welcome Collection*

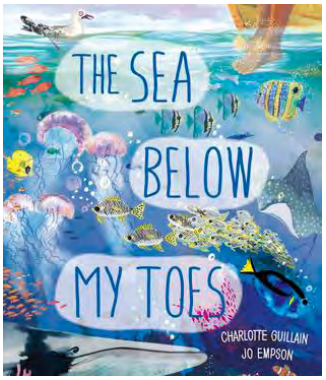
How we think about plants is about to change. We have become used to thinking of plants as things for us to use, such as food, tools, resources, or just as an attractive background to our lives. New research shows that plants can think, plan, and even have memories. *This Book is a Plant* will be your handbook to the new reality: offering you a pathway to reimagine your relationship with a different kind of natural world. Grow into a world of moss and fungi, uncover the pleasures of painting trees, and learn how this kind of natural world benefits our well-being.

Publisher: Allen & Unwin
RRP: $24.99

Kind – *Jess McGeachin*

This beautiful picture book is a unique celebration of many living things and the kindness we can show them as we wander through the world. In this book, you will find many kinds of different animals. Some have slippery scales, and some have feathered wings. From the tiny stunning beetle, the endemic feather-horned beetle (*Rhipicera femorata*), to the most majestic marine mammal, the Endangered blue whale (*Balaenoptera musculus*), every creature on Earth is a marvel, deserving of awe and compassion.

Publisher: Allen & Unwin
RRP: $24.99



The Sea Below My Toes – *Charlotte Guillain and Jo Empson*

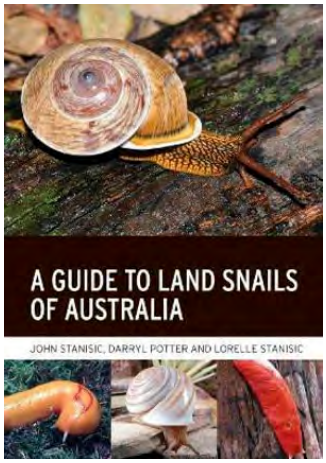
This richly illustrated book takes you on a journey through the deep dark waters, down to the very bottom of the sea, the 'twilight zone' where very little light can filter through, before floating back to the surface. You will spot weird and wonderful marine animals through the waves and into the deep, from manta rays (*Manta birostris*) to blobfish (*Psychrolutes microporos*). Discover the impact humans have had on the underwater world and what we can do to help the incredible marine animals that need our protection now and in the future.

Publisher: Allen & Unwin
RRP: $29.99

Wild Australian Life – *Leonard Cronin and Chris Nixon*

Australia is a wildlife wonderland, from the bright colours of the poisonous crucifix frog (*Notaden bennettii*) to the sharp spines of the harmless thorny devil (*Moloch horridus*). Explore how Australia's wildlife has adapted to work harmoniously with its environment and flourish in some of the most challenging habitats, from the deepest oceans to the highest mountains. Embark on a journey of discovery and uncover the remarkable stories behind some of Australia's most extraordinary wildlife.

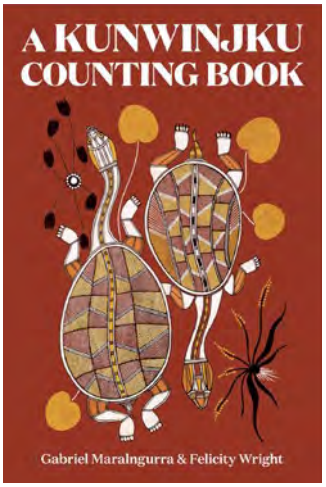
Publisher: Allen & Unwin
RRP: $29.99



A Guide to Land Snails of Australia – *John Stanisic, Darryl Potter, and Lorelle Stanisic*

Australia's native land snails are regularly overlooked but form a significant part of terrestrial biodiversity, with an estimated 2,500 species present in Australia. *A Guide to Land Snails of Australia* is an overview of Australia's native and introduced land snails and presents an increased understanding of their role in the natural environment. The book offers clear diagnostic features of live snails and their shells, and is richly illustrated with a broad range of snails, semi-slugs, and slugs (shell-less snails), including the Mount Kaputar red-triangle slug (*Triboniophorus graeffei*), which crawls on rocks and trees at night, only after rain, and the Steve Irwin's tree snail (*Crikey steveirwini*), named after the famed crocodile hunter and found on the highest mountains in the Wet Tropics of Queensland.

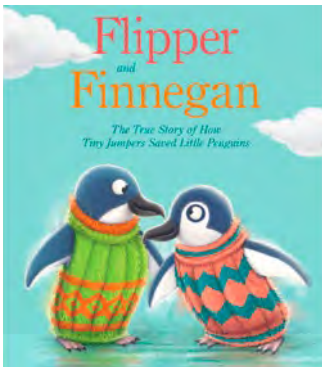
Publisher: CSIRO Publishing
RRP: $49.99



A Kunwinjku Counting Book – *Gabriel Maralngurra and Felicity Wright*

Saltwater crocodiles (*Crocodylus porosus*), royal spoonbills (*Platalea regia*), agile wallabies (*Notamacropus agilis*), and short-beaked echidnas (*Tachyglossus aculeatus*) are but a few of the unique Australian animals that live in West Arnhem Land, a region in the Northern Territory of Australia. Learn to count with the animals of West Arnhem Land and the traditional art of Indigenous Kunwinjku culture. More than just a counting book, this beautifully illustrated work of art is a tribute to Indigenous culture and a fascinating nature guide to Northern Territory ecology.

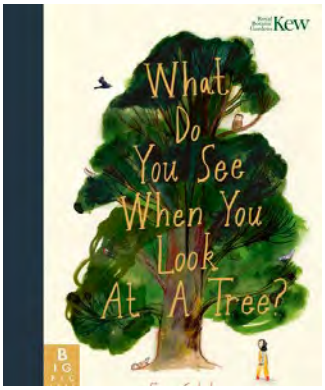
Publisher: NewSouth Books
RRP: $29.99



Flipper and Finnegan – *Sophie Cunningham and Anil Tortop*

Flipper and Finnegan is based on the miraculous true story of how a viral knitting campaign helped save the lives of Phillip Island's little penguins. Flipper and Finnegan are two beautiful little penguins (*Eudyptula minor*) that live on Phillip Island, Victoria. Every morning they hunt for fish, and every evening they waddle up the beach with all their friends to seek shelter in their burrows for the night. But one day, when Flipper comes up for air, she gets covered in something black and sticky, an oil spill, and Finnegan is nowhere to be seen. Follow the rescue story of these two remarkable little penguins and their rescuers.

Publisher: Allen & Unwin
RRP: $19.99



What Do You See When You Look at a Tree? – *Emma Carlisle*

This charming picture book is full of finely drawn forest scenes that encourage children to explore their connections with nature. The author asks readers to consider how each tree is different, what they have witnessed in their lifetime, and what animals they have sheltered.

Publisher: Allen & Unwin
RRP: $24.99

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 is 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 Dominic 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 is 31 December.

Australian Wildlife Society

Wildlife Rehabilitation Award

Nomination Form

Australian Wildlife Society
Conserving Australia's Wildlife since 1909 ®

The Australian Wildlife Society Wildlife 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, 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 is 31 December.

Australian Wildlife Society

Youth Conservation Award

Nomination Form

Australian Wildlife Society
Conserving Australia's Wildlife since 1909 ®

Australian youth can play a vital role in the conservation of Australian wildlife (flora and fauna) and can significantly contribute to wildlife conservation through innovative projects and ideas. It is young people who can drive lasting and sustainable change, who will become the next ambassadors in wildlife conservation, and hopefully the successors to the Board of the Society. We aim to inspire young people to have a stake in wildlife conservation by rewarding and recognising their efforts.

The Society will present an award of $1,000 to a young individual (or small group), between the ages of 13 and 18 years, contributing to Australian wildlife conservation (flora and fauna). A trophy and certificate will accompany the award.
All nominations must be supported by a referee (see below).

Name of nominator:

School/representative body (if applicable):

Address:

Telephone: email:

Name of nominee: **Age 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 is 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, and 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, and 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.

What is that sound?

Croaks, whistles, bleats, and barks – every frog species makes a different sound! By recording a frog call with the Australian Museum's FrogID app, you can discover which frogs live around you and gather the information needed to help conserve Australia's frogs.

FrogID

FrogID

Is the Australian Museum's citizen science project that aims to identify where Australia's frogs are distributed and learn more about how frog populations are doing.

Scan here to download the free FrogID app

FrogIDAus

Supporting Partner

NSW GOVERNMENT | Biodiversity Conservation Trust

AUSTRALIAN MUSEUM