AUSTRALIAN Wildlife

SPRING Vol: 4/2020
$10 (non-members)

Celebrating a new century of wildlife preservation in Australia

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

Dural land snail (*Pommerhelix duralensis*) | Image by Steve Paterson

Heroes are not always fast or flashy. In fact, some just move around silently and are rarely noticed. Meet the Dural land snail, which is listed as Endangered and is endemic to New South Wales, confined to the northwest fringes of the Cumberland Plain. They are nocturnal and only move up to one metre a night. For this reason, they are very vulnerable to local extinction due to fire and loss of habitat. Steve spotted the Dural land snail at Hunts Creek in Carlingford in the misty morning rain. On one occasion, he saw three snails together. Steve hopes that this image emphasises the importance of our local unsung heroes and enhances exposure and appreciation of their precarious plight.

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Suzanne Medway AM
Editor, Australian Wildlife

Megan Fabian
Sub-Editor, Australian Wildlife

ON THE COVER:

Golden-eyed gecko (*Strophurus trux*). The golden-eyed gecko was only recently described in 2015 and is not yet classified. The gecko species is found in central Queensland and is thought to be endemic to the Brigalow Belt region. Image: Wes Read.

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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Directors 2020

Notice to our members

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 registered company limited by guarantee with ASIC and is responsible for complying with all its regulations.

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 an independent, voluntary, non-profit 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 programs, political lobbying, advocacy 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 tried to convince politicians of the necessity to include the preservation of Australia's precious wildlife and its vital conservation habitat in all their planning and environmental issues and discussions.

From the President's desk

Suzanne Medway AM - President

During these difficult times, where many of us have been isolated from our family and friends, I am sure that many have received comfort and great joy from your animal companions. But, unfortunately, many of us do not have pets.

Through various avenues, we do have access to the beautiful world of nature through multi-media, our outdoor areas and the public areas surrounding us. Each day through emails, Facebook, Twitter and Instagram, I receive wonderful photos of nature in all its glory and the wildlife surrounding us. One Facebook site I have enjoyed is *View from my window* – https://bit.ly/viewfromwindow. *View from my window* has millions of followers from all around the world and people post what they can see from their window. They also write of their experiences, and some of their stories are inspiring. The site inspired me to evaluate the view from my window (from the balcony) where I look straight out onto a gum tree and then the garden where I have planted lots of native flowering trees and installed two birdbaths. Although my husband and I live in suburbia, each day we might be lucky enough to see forest ravens, pied currawongs, pied butcherbirds, magpie-lark, noisy minors, little wattlebirds, channel-billed cuckoos, white-faced herons, laughing kookaburras, superb fairywren, rainbow lorikeets, New Holland honeyeaters and willie wagtails. Unfortunately, we do also see Indian mynas, common starlings and house sparrows. These invasive species are a rarity though because we have so many native birds coming into the garden and they seem to chase the feral species away.

Of particular delight, in our garden, are two resident brushtail possums. We have only managed to see one of them once, sheltering in the overhang of the eves of our house. I know they are there though because each night they leap from the gum tree to the roof of our home. Thump! Thump! Then what sounds like two baby elephants scampering from the roof on the back of our house to the front. We also have a huge avocado tree in the backyard, which seems to feed all the flying-foxes in the area. Each morning we search for fallen avocadoes and find them on the lawn, chewed with little teeth marks. We do hope that it is the flying-foxes eating them and not rats. We also see the currawongs pecking at the fruit. Lately, out the front of our house, we keep finding empty mandarin skins – something is collecting them from nearby, having a feast in our driveway and leaving the empty skins. We also find chewed guavas that have been collected from the neighbourhood and eaten in our driveway. For such a small suburban house on a small block of land, there is lots of activity from native wildlife!

One of my sisters lives in a high-rise apartment, and she regularly receives visits to her balcony from rainbow lorikeets. They seem to know her and are very cheeky, seeming to call to her and go crook if she does not respond. There is a colossal flowering gum in the front garden of the apartment block, and the lorikeets come into feed on the nectar in the afternoon.

Another sister lives in a townhouse in rural New South Wales, and her regular visitors are a family of Australian magpies. She has watched them bring in their new little chick, raise it and then when the chick matured, chase it away. Now she has just the two adult birds visit each day. They sit on her outdoor furniture and look into the house to see what is going on. Such a small and treasured occasion each day for my sister to enjoy and marvel at the cycle of nature.

My eldest sister lives on a farming property, and she has a different experience with native wildlife. She says that she never feels alone when she can lift her eyes to the sky or the treetops. Whether she spots a single willie wagtail flitting around the farm ute while she is having a midday break, or sees vigilant magpies swooping to defend their nests in the eucalypts adjacent to the cattle yards. The strident masked lapwings can be seen strutting around the dam defending their single egg positioned exactly where my sister and her husband need to drove the 'mob' towards the yards. Perhaps she might see the red parrots who occasionally take possession of the melaleuca at the back door of their house, quietly occupying a space more usually frequented by noisy miners. Ducks are never far away from the dams, now brimful with incredible legumes and grasses nearby. Then there are vast mobs of sulphur-crested cockatoos who choose, each year in early summer, a small clearing as a feeding place before roosting, almost as though they need a communal period before retiring to their usual trees. Finally, the blessing and something now regrettably rare, the special visitations of the wedge-tailed eagles in their complete mastery of their airy territory, or the arrival of huge numbers of galahs which descend upon a dead eucalyptus behind the sheds looking for all the world like a cherry-tree in full bloom, each branch a tightly packed blaze of jostling bodies. She says farmers are never bored! The wedge-tailed eagle is Australia's largest bird of prey. It was once considered to be a menace by farmers, who were convinced that eagles swooped down and carried lambs off in their talons. As a result, thousands of eagles were shot and poisoned. It is now known that wedge-tailed eagles mostly take rabbits, and seldom eat lambs – usually the carcases of dead lambs rather than live ones. Nevertheless, in some parts of Australia, these majestic raptors are still shot and poisoned, despite being a legally protected species.

It is very tempting to feed native wildlife to encourage them into our home environment, but I urge you to consider some of the ramifications of making native wildlife dependent on your supplementary feeding. One of the most persuasive arguments against feeding native animals in the backyard is the danger to the native animals from domestic predators such as cats and dogs. If the native animal loses its natural instinct to survive, then they become easy prey. Feeding birds around the house does neither the birds nor cats any favours, unless the birds are starving due to adverse climatic conditions. Bird feeders are irresistible magnets to some cats, and even if they only watch proceedings from a distance, this may be sufficient to send cat haters into a frenzy. However, a far bigger problem is that feeding native birds encourages the larger grain-eating parrots, which soon displace most other species like the smaller honeyeaters and insect eaters from the vicinity. Even worse,

is encouraging the large meat-eating birds like currawongs and kookaburras with handouts of mince and meat. Currawongs, with their melodious call, have taken over entirely in some urban areas. Not only do they viciously attack and drive away other smaller birds, but they raid nests and eat eggs and chicks. Other reasons wildlife experts discourage the feeding of native birds, is that the birds become dependent on the easy handouts and human handouts are often not correct or balanced for the particular species of bird or animal.

The two strongest arguments against feeding native animals are **dependency** and **poor nutrition**:

1. Dependency – animals may become dependent upon artificial sources of food and become less inclined to forage naturally. This is still debated, as most birds retain their feeding patterns, but if you are concerned, feed irregularly, do not give too much food and provide different kinds of food at various times; and
2. Poor nutrition – many people do not provide appropriate food or sufficient variety to cover the bird and animals' dietary needs. In the case of birds, parental birds may take poor foods back to the nest, which may affect the healthy development of young birds.

If you want to observe native Australian wildlife, it is preferable to design a native garden that provides a variety of foods all year round. Such a garden provides shelter, water and nesting sites and should be safe from a domestic pet attack. A native garden is the best way to attract native wildlife to your backyard. An ideal habitat for local native wildlife will provide a safe natural home, natural food and clean fresh water.

Basic requirements for a native garden include:

1. A variety of pollen, seed, fruit and nectar-producing Australian native plants (hybrids do not produce pollen). Preferably, those native to your locality so that the natural balance of wildlife species is not adversely affected. Ask your local nursery for more advice; and
2. Dense shrubs and trees and spiky-leaved plants provide shelter for small birds at a range of heights. Native plants appeal to a variety of species and include ground cover, such as leaf litter, rocks and plants for lizards and old trees for nesting sites.

If water and nesting places do not occur naturally, you might like to make a nesting box, water pond or birdbath. However, these should be safe from predators like the neighbour's cat!

If you want to keep native animals in the garden, be aware of the chemicals you use around the yard. Many chemicals such as pesticides have adverse effects on wildlife. People often spray their gardens with insecticides and herbicides, as well as putting out snail and rat baits. All these poisons can kill native animals:

1. Possums, birds and flying-foxes eat sprayed fruit, flowers and leaves;
2. Insect-eating bats, birds and spiders can be affected by insecticides;
3. Small native marsupials and possums can be killed by snail and rat baits;
4. Native predators may also eat animals that have been poisoned. Insecticides can kill many beneficial insects such as ladybirds which eat aphids;
5. Bird eggshells can be weakened by some pesticides so that the eggs are crushed before the baby birds have time to develop, i.e. Dichlorodiphenyltrichloroethane products;
6. Poisons can accumulate and become more concentrated in animals further up the food chain; and
7. Poisons can be washed through the soil into waterways and affect animals, and their habitats further downstream. Residues should not be flushed down toilets or poured down the sink. Frogs are very vulnerable to poisons.

A healthy garden and good soil, with a healthy balance of beneficial organisms like worms, mycorrhizas (fungi), insects and micro-organisms, will produce strong, nutritious plants. Spiders, birds, frogs, reptiles and insectivorous bats all eat insects and other bugs that naturally thrive in your garden.

Suggested actions/solutions in your garden:

1. Encourage spiders, birds, reptiles and insectivorous bats which eat insects and other bugs;
2. Build up healthy soil with compost, mulches and earthworms;
3. Control pests by preventative measures like soil drainage, water management, rotating crops, natural predators and companion planting. When necessary use bug traps, handpicking and organic sprays such as garlic and onions, liquid seaweed, pyrethrum, derris, milk or even a strong stream of water; and
4. Contact your state waste management authority, Water Board or local council to take away old poisons from your home.

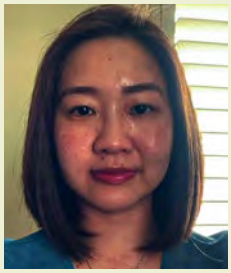
For our Society's members, family and friends, we have a Facebook page where we would love to hear of your own experiences of Australia's native wildlife during these difficult times – https://bit.ly/AWSFaceBook. The Society also has Twitter – https://bit.ly/AWStweet and Instagram – https://bit.ly/AWSinsta available to share your experiences and good luck with your environmentally sound native garden project.

Hundreds of years ago a wise person said "*...nobody made a greater mistake than those who did nothing because a single person could do so little...*". It is the 'little' work of thousands who care, that has created the current interest and impact in wildlife conservation.

THE MORNING STAR paled slowly, the Cross hung low to the sea,
And down the shadowy reaches the tide came swirling free,
The lustrous purple blackness of the soft Australian night
Waned in the grey awakening that heralded the light;
Still in the dying darkness, still in the forest dim
The pearly dew of the dawning clung to each giant limb,
Till the sun came up from ocean, red with the cold sea mist,
And smote on the limestone ridges, and the shining tree-tops kissed;
Then the fiery scorpion vanished, the magpie's note was heard,
And the wind in the sheoak wavered and the honeysuckles stirred;
The airy golden vapour rose from the river breast,
The kingfisher came darting out of his crannied nest,
And the bulrushes and reed-beds put off their sallow grey
And burnt with cloudy crimson at the dawning of the day.

The Australian Sunrise
James L Cuthbertson, 1851–1910
(Barwon Ballads)

A NEW NATIONAL OFFICE OPENS IN HURSTVILLE, NEW SOUTH WALES



Sisilia Citrajaya - the new Clerical Assistant.

The President of the Australian Wildlife Society, Suzanne Medway AM, is delighted to announce the opening of the Society's new National Office at 29B/17 Macmahon Street Hurstville in New South Wales, to cope with the expanding work of the Society.

The Australian Wildlife Society, founded in 1909, is a national not-for-profit wildlife conservation organisation. We are dedicated to the conservation of Australian wildlife through national environmental education, advocacy, and involvement of the community

For the first time in over one hundred years, the board of the Society has decided to establish a new National Office to cope with the expanding work of the Society in wildlife conservation across Australia. We have always relied on our volunteer board of directors to carry the workload, but in recent times, governance compliance has become so complex that we employed a National Office Manager, just over one year ago and, this month, have employed a Clerical Assistant to ensure that we comply with the various regulations by several government agencies, such as the Australian Charity and Not-for-profits Commission.

The new Clerical Assistant will help with the Society's bookkeeping systems and national membership program. We are keen to expand our membership to continue our wildlife conservation work to help save Australia's native wildlife for future generations.

"We recently decided to offer free membership to all school students so they may be encouraged to develop a deeper understanding of environmental issues, gain the necessary skills to make informed decisions, and take action to improve the environment. Students are a key group in our membership and make significant contributions to the conservation movement through innovative projects and ideas. It is students who can drive lasting and sustainable change, who will become the next ambassadors in environmental conservation and hopefully the successors to the current board of the Society," Suzanne said.

We believe that everyone can play a role in the conservation of Australia's wildlife and this belief is reflected in the Society's magazine, newsletters, and structure of our membership.

We encourage everyone interested in wildlife conservation to join the Society to help save Australia's unique and precious native flora and fauna.

Australian Wildlife Society banner.

New National Office shopfront at Hurstville in New South Wales.

National Office reception area.

L to R: Suzanne Medway AM and Megan Fabian.

Snip Rings for Wildlife

Megan Fabian – National Office Manager

This month, the Society founded a new campaign called *Snip Rings for Wildlife*. The campaign aims to raise awareness and encourage individuals to protect Australia's wildlife, by cutting through plastic rings, rubber bands and hair ties before disposing of them. Each year, thousands of birds and air-breathing aquatic wildlife such as platypuses (*Ornithorhynchus anatinus*), turtles and water dragons (*Intellagama lesueurii*) are strangled, obtain significant injuries and often die horrific deaths from discarded litter. Wildlife becomes entangled in plastic rings, rubber bands and hair ties that wrap around the animal's beak or muzzle, preventing them from eating. These items can also tangle up their feet, wings, or fins, limiting their movement. Young animals can become entrapped in these items, and as they grow, these items cut into their flesh, sometimes amputating limbs or killing the animal. Other animals mistake these items for food and ingest them.

Despite contacting numerous manufacturers, informing them of the danger that plastic rings, rubber bands and hair ties pose to native wildlife and encouraging them to take action to improve their products, we are still experiencing the same problem and many companies are not taking action. Some manufacturers produce jars, bottles, and tetra packs with plastic lids that come with a plastic ring that snaps apart from the lid upon opening or a peel-off seal under the cap. While we continue to encourage companies to act, we turn to our followers to ask for your support to protect Australia's wildlife and *Snip Rings for Wildlife*. We encourage everyone to cut through plastic rings, rubber bands and hair ties before disposing of them. It is important to remind ourselves that we can act, both as individuals and collectively, to bring about important changes ourselves and create real change. We acknowledge and commend the companies that have already taken action to make a positive change and improve their products for Australia's wildlife.

The Society encourages everyone to get behind and help promote the campaign, by posting a video of themselves on

social media snipping through a plastic ring, rubber band or hair tie before disposing of it. Do not forget to use the hashtag #snipringsforwildlife. We also welcome any artwork related to *Snip rings for Wildlife* for publication in our newsletter and on our website, to help promote the campaign and emphasise the actions people are taking to protect Australia's wildlife. Material for publication can be sent to info@aws.org.au

We welcome you to send a letter to any company producing plastic rings, rubber bands or hair ties, encouraging them to take action to improve their products for Australia's wildlife. The Society has created a template letter, displayed on the following page, to make it easy for our followers to take further action to protect Australia's wildlife. Thank you for your support.

Letter over page >

Page Eight: This Australian water dragon (*Intellagama lesueurii*) got his head stuck through the safety seal ring of a discarded bottle and would have slowly starved to death if it had not been rescued. Image: WIRES Northern Rivers

Top Middle: Mae West, a common snapping turtle (*Chelydra serpentina*), has been horribly deformed from a plastic ring. As she grew, she could not break this plastic belt around her waist. Her shell is now permanently deformed, giving her an hourglass-like shape. Image: Marcus Eriksen.

Top Right: This platypus (*Ornithorhynchus anatinus*) was bound and killed by injuries from a rubber band. The band was tangled tight around the animal's neck, and under its left flipper, clearly cutting into its flesh. Image: Wildlife Rockhampton

Middle Left: This Australian magpie (*Gymnorhina tibicen*) was lucky enough to be found before starving to death. Many entrapped birds do not fare so well, and they succumb silently, in agony and out of sight. Image: WIRES Northern Rivers

Bottom: This short-beaked common dolphin (*Delphinus delphis*) starves to death after being unable to open its mouth from discarded twine-like plastic that got caught around the dolphin's beak. Image: Sandra Hilton

Australian Wildlife Society
Conserving Australia's Wildlife since 1909

SNIP RINGS FOR WILDLIFE

Date: ..... / ..... / .....

Name/Company: .....

Address: .....

Suburb: .....**State:** .....**Postcode:** .....

Re: plastic rings, rubber bands and hair ties pose danger to Australia's native wildlife

Dear .....

Each year, thousands of birds and air-breathing aquatic wildlife such as platypus, turtles and water dragons are strangled, obtain significant injuries and often die horrific deaths from discarded litter. Wildlife often becomes entangled in plastic rings, rubber bands and hair ties that wrap around their beak or muzzle, preventing them from eating. These items can also tangle up their feet, wings, or fins, limiting their movement. Young animals can become entrapped in these items, and as they grow, these items cut into their flesh, sometimes amputating limbs or killing the animal. Other animals mistake these items for food and ingest them.

Some manufacturers produce jars, bottles, and tetra packs with plastic lids that come with a plastic ring that snaps apart from the lid upon opening or a peel-off seal under the cap. If a plastic ring is not snipped before disposal, by a particularly environmentally aware person, then it enters our waste or natural water systems as a whole ring. This ring has the potential to cause a slow and painful death to a variety of Australia's native wildlife through strangulation, starvation, deformation, or infection.

I write to urge your company to change the design of your product and tetra packs to a peel-off seal under the cap or ring that snaps apart easily upon opening, to prevent the needless suffering of Australia's precious native wildlife.

Thank you in advance for your time and I look forward to your response.
My details are provided below.

Yours sincerely

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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 the medium of photography. The Australian Wildlife Society invited photographers to raise the plight of Australia's threatened wildlife. Thank you to all our entrants. The Society was delighted to receive a record number of entries, which made it an extremely tough competition. We look forward to continuing the successful Threatened Wildlife Photographic Competition again next year, to raise the plight of endangered wildlife across Australia.

Judges' Choice

The annual judges' prize of $1,000 was won by **Wes Read.** The winning entry was a photo of a golden-eyed gecko (*Strophurus trux*) which was only recently described in 2015 and is not yet classified. The gecko species is found in central Queensland and is thought to be endemic to the Brigalow Belt region. It has light-brown skin, dotted with medium-dark brown spots; well camouflaged for the arid environments it inhabits. The gecko's most striking feature is its golden to bright yellow eyes. The added advantage of living in a beautiful habitat of *Triodia* hummock open woodlands, also known as spinifex or porcupine grasses, completes an intriguing and unique species of gecko. Wes spotted the lone male gecko on a very hot night in January 2020.

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 people's choice prize of $500 was won by **Tiffany Naylor**. The winning entry was a photo of a dingo (*Canis lupus dingo*). The dingo is a medium-sized carnivorous mammal and males are usually larger and heavier than females. Colours vary from sandy-yellow, to red-ginger, with a small percentage being black, tan, cream or white. The dingo is an apex predator that contributes to the control of many feral species, that threaten Australia's wildlife, and plays a very important role within the environment keeping natural systems in balance. The dingo is recognised as Vulnerable on the *International Union for Conservation of Nature Red List of Threatened Species.* Dingo numbers in the wild have declined over the years, with the main causes being interbreeding with domestic dogs as well as being shot, trapped or baited by those who believe the dingo is a threat to their livestock. Tiffany took this photo at Dingo Den Animal Rescue with the hope that the image would represent the dingoes' beautiful character and the importance of preserving this species for future generations.

Tasmanian wedge-tailed eagle (*Aquila audax fleayi*)

Image by Jack Taylor

The Tasmanian wedge-tailed eagle is listed as Endangered and found only in Tasmania and nearby islands. It is a subspecies of the more common wedge-tailed eagle. The Tasmanian wedge-tailed eagle is reliant on Tasmania's old-growth forests as key nesting habitat. Despite this, the forestry industry continues to destroy its habitat. Tasmanian wedge-tailed eagles are especially vulnerable to disturbances caused by human activity and have been known to completely abandon a perfectly good nest when human activity comes too close. Jack took this photograph just outside of Maydena, Tasmania.

Southern emu-wren (*Stipiturus malachurus intermedius*)

Image by Gregory Cramond

All but two populations of the Mount Lofty Ranges southern emu-wren occur in the Fleurieu Peninsula swamps in the southern Mount Lofty Ranges of South Australia. The southern emu-wren is listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* and the swamps in which it inhabits is also listed as Critically Endangered under the same Act. With less than five hundred adults remaining in the wild, habitat loss and fragmentation, inappropriate slashing, draining and spraying regimes, over-grazing and repetitive burning continue to contribute to the decline of this species. Gregory captured this image in the early morning light near the Finniss River on the Fleurieu Peninsula, South Australia.

Australian sea lion (*Neophoca cinerea*)

Image by Jari Cornelis

The Australian sea lion is listed as Endangered on the *International Union for Conservation of Nature Red List of Threatened Species*. The biggest threat to Australia sea lion colonies are gillnets, which are thin mesh nets suspended in the water and often invisible to the eye. Gillnets are used by commercial fisheries to capture sharks, predominantly for the flake and chip market in Australia. However, Australian sea lions also get snagged in the mesh of gillnets and drown. The only solution to accidental gillnet deaths and other fishery-related deaths of sea lions, is to close the areas where sea lions forage for food out at sea and prevent fishing with gillnets in those areas. This photo was taken at Seal Bay Conservation Park at Kangaroo Island where the sea lion had returned from an exhausting hunting trip.

Eastern pygmy-possum (*Cercartetus nanus*)

Image by Brett Vercoe

The eastern pygmy-possum is found in south-eastern Australia and Tasmania. In New South Wales, it is listed as Vulnerable and its habitat extends from the coast inland as far as the Pilliga, Dubbo, Parkes and Wagga Wagga. The eastern pygmy-possum feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes. Habitat loss through logging, altered fire regimes, and introduced predators all pose significant threats to the species. Furthermore, inappropriate fire regimes can lead to a decline in the nectar-producing plants on which the possums feed. Brett captured this image in the rainforest of the Dorrigo Plateau in New South Wales.

Long-nosed potoroo (*Potorous tridactylus*)

Image by Brett Vercoe

The long-nosed potoroo is found on the south-eastern coast of Australia, from Queensland to eastern Victoria and Tasmania, including some of the Bass Strait islands. In New South Wales, they are found in scattered locations generally restricted to coastal heaths and forests where they can be a real challenge to locate due to low population densities. The long-nosed potoroo eats fungi, roots, tubers, insects and other soft-bodied animals that live in the soil. The long-nosed potoroo is listed as Vulnerable, with a very large number sadly lost over the 2019-2020 fire season. Additional threats include logging, unplanned clearing and the removal of dingoes, which expose potoroos to fox predation due to the removal of a top order predator.

Davies' tree frog (*Litoria daviesae*)

Image by Wes Read

The Davies' tree frog is endemic to the eastern side of the Great Dividing Range in New South Wales. It is listed as Vulnerable and is at risk of local extinction due to small population size, geographic range and isolation. Further threats to this species include habitat loss, reduction in water quality, altered water stream flows due to agriculture, predation and poor knowledge of the species. Wes spent a considerable amount of time wading around a freezing cold river to find the Davies' tree frog. It was early April 2020 and outside their breeding season/calling time, however Wes was lucky enough to spot and capture a photo of this unique individual.

Ghost bat (*Macroderma gigas*)

Image by Bruce Thomson

The ghost bat is the largest microbat endemic to Australia, with a head and body length of ten to thirteen centimetres. It is Australia's only carnivorous bat. It has long ears which are joined, large eyes, a simple noseleaf and no tail. The ghost bat is listed as Vulnerable and is threatened due to habitat loss and degradation due to mining activities. The species' slow reproductive rate, and the lack of suitable habitat, which restricts its movement, renders it vulnerable to threats and localised extinctions. Bruce spotted this ghost bat leaving a cave in the Northern Territory as dusk descended.

Platypus (*Ornithorhynchus anatinus*)

Image by Edith Wiskar

The platypus is one of Australia's most unique and iconic species. It is a semi-aquatic egg-laying mammal (monotreme) that inhabits a variety of freshwater systems along the eastern coast of Australia and throughout Tasmania. The platypus is listed as Near Threatened on the *International Union for Conservation of Nature Red List of Threatened Species.* The biggest threats to platypus include loss of habitat due to land clearing and fragmentation, drought, modification of natural waterways, predation by foxes and feral cats, and entanglement in litter, especially discarded fishing line, rubber bands and enclosed yabby traps which cause many drowning deaths of platypus. Edith captured the image of this platypus in a natural waterway near Centenary Village in Brisbane, Queensland.

Gouldian finch (*Erythrura gouldiae*)

Image by Joshua Bergmark

Observing from a safe distance, Joshua watched this drama play out as several Gouldian finches desperately competed for one particularly enticing nest hollow near Katherine in the Northern Territory. Hoping to raise their chicks successfully against a backdrop of changing fire regimes and increasingly dismal wet seasons, the competition was fierce. The red-headed male divided his time between inviting females back for open-house inspections and chasing off several other males who had their eye on his prime real estate. After impressing one prospective partner, he was understandably irritated to suddenly find a rival male inside the hollow he was trying to show off. The intruder and his accomplice tried to escape, but a few feathers may have been plucked in the process. With the Gouldian finch listed as Endangered and approximately only 2,400 left in the wild, we can only hope that all three males were able to settle down before the breeding season concluded.

Hairy correa (*Correa aemula*)

Image by John Muchan

The hairy correa is a species of shrub that is endemic to south-eastern Australia. It is listed as Rare in South Australia and Victoria. It has broadly heart-shaped leaves arranged in opposite pairs and pendent flowers arranged singly or in pairs. John captured this photograph of the hairy correa during a botany workshop in Grampians National Park, Victoria. The hairy correa has beautiful purple petals and lovely stellate (star-shaped) hairs on the leaves which the photograph intended to capture.

Go to the inside front cover to see Steven Paterson's amazing image of a Dural land snail >

Melbourne's Flying Night Gardeners

Doug Gimesy and Heather Kiley

As the sun finally slips below the horizon, the small crowd that gathered on a hill, just off Yarra Boulevard, to see a glorious Melbourne summer sunset, slowly start to drift away. If only they had waited another fifteen or twenty minutes, they would have witnessed something much more spectacular, much more memorable, and much more unique than just another sunset over a big city – the daily exodus of up to fifty thousand grey-headed flying-foxes (*Pteropus poliocephalus*) making their way from their urban camp of Yarra Bend Park, to the suburbs of Melbourne and beyond.

But why do they fly out each night and where are they going? Like many Melbournians, they are heading out for a meal, but these guys are hoping to feed on the nectar of our flowering eucalypts and native hardwoods (such as banksias and melaleucas). Of course, they cannot always get the meal they are looking for. Sadly, their preferred trees and plants are not as plentiful as they used to be and therefore flying-foxes resort to eating the exotic introduced fruits commonly found in our gardens. Whether eating native or exotic food, it is when they drop in for a meal that most people get their first close-up encounter with these amazing flying mammals. Whilst an incredible spectacle to witness, this daily nocturnal excursion also plays a vital role in the health of our native forests.

Travelling on average around twenty kilometers a night to feed before returning home, means that they help disperse pollen and seeds and, in doing so, contribute to the reproductive and evolutionary processes of forest communities. In fact, they are our most effective long-distance native pollinators and seed dispersers – at least as important as other well-known pollinators such as birds and bees, who are often given all the credit for this role. Indeed, grey-headed flying-foxes have been recorded travelling between Melbourne and Sydney in just two days – that is 880 kilometers.

The spreading of pollen and seeds is not just limited to the area around an established camp. The trees that flying-foxes rely on for food, tend to flower at different times in different parts of the Australian landscape. Therefore, local nectar and pollen supplies are generally not stable enough for many flying-foxes to base themselves in a single place for the entire year. As winter approaches in Victoria, many of our grey-headed flying-foxes will leave the safety of their Melbourne camp and move up the east coast in search of large flowering events to help them get through the lean colder months. During this time, the Melbourne grey-headed flying-fox population, which can swell to nearly fifty thousand over summer, will drop to between just two thousand and five thousand. As President of the Australasian Bat Society explains,

> *Camps are more like backpacker hostels than stable households, housing a constantly changing clientele that comes to visit local attractions. camps are connected into large networks through which flying-foxes move in response to changes in local food resources.*

Above: A rescued and orphaned grey-headed flying-fox (*Pteropus poliocephalus*) feeds on the nectar of a flowering native eucalyptus tree. Image: Doug Gimesy

Seeing up to fifty thousand flying-foxes venture out across the Melbourne sky can give the impression that this species is doing well. Unfortunately, that is not the case, and the national population is now estimated to be just a small fraction of what it once was. Sadly, population decline and continued threats mean they are now listed as Vulnerable. Furthermore, the decline not only impacts them directly, but also our forests.

Leaving the safety of their homes at Yarra Bend Park in search of food can be extremely dangerous for flying-foxes. Natural predators include large birds of prey, large snakes and goannas, however it is the human-driven impacts such as entanglement in fruit-tree netting and barbed wire, as well as electrocution on power lines that can take a terrible toll. In January 2020, it was estimated that at least one hundred flying-foxes were entangled in inappropriate fruit-tree netting and barbed wire, in Victoria alone. Sadly, the majority of these flying-foxes were either not rescued in time or did not survive after being rescued.

But these are not the only threats they face. Habitat destruction, shooting in orchards, attacks from domestic dogs, climate change-induced heat stress events, and camp disturbance by some locals, developers, and councils, continues to impact heavily on flying-fox numbers. However, there are many simple things we can all do to help Australia's grey-headed flying-foxes:

1. Protect their homes. They are already running out of space and places to live and eat, so reject any development that encroaches on or disturbs their homes (i.e. established colonies or camp sites) or impacts to our native forests;
2. Plant flowering gums and nectar-bearing native trees and shrubs. Ask your local council to do the same;
3. Do not disturb them. If you are visiting a colony or camp, or lucky enough to find a flying-fox or two enjoying a meal of fruit or nectar somewhere, keep noise to a minimum, keep your distance and keep pets away;
4. Welcome them. If they visit your garden, welcome them for dinner. You are lucky to have them and it is always nice to have guests pop over;

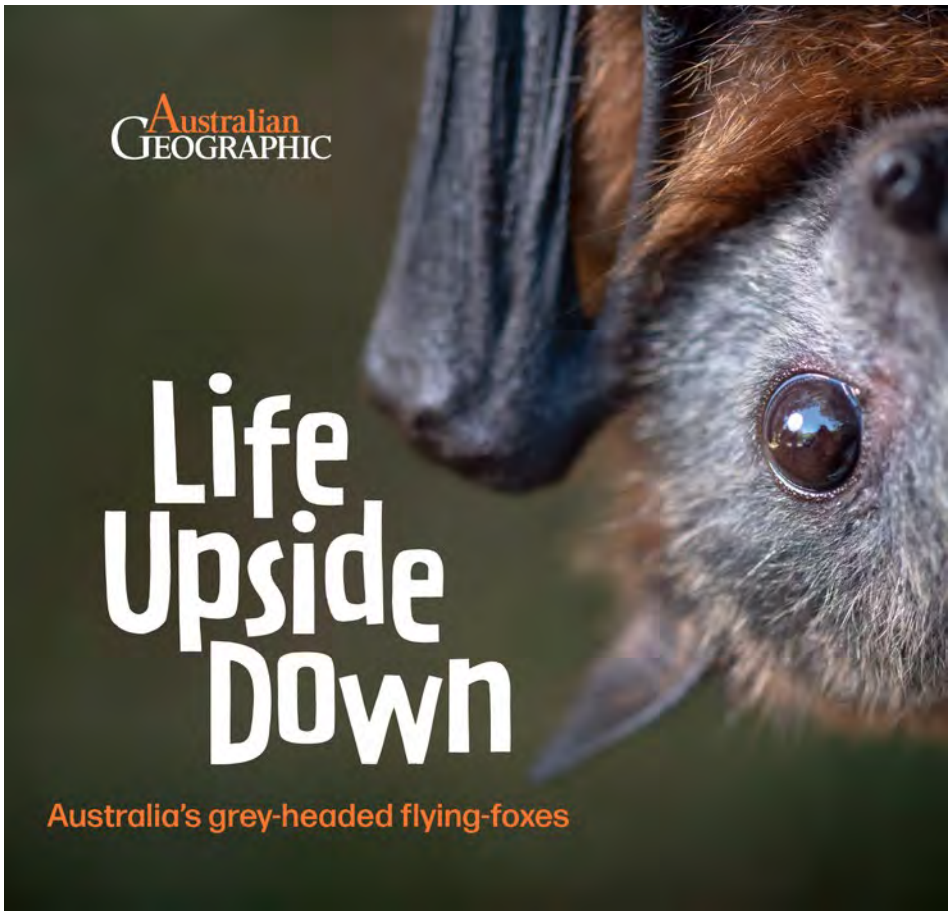
Grey-headed flying-foxes (*Pteropus poliocephalus*) fly out over the Melbourne city skyline at sunset. In summer, flying-fox numbers can reach a spectacular fifty thousand. Image: Doug Gimesy

A grey-headed flying-fox (*Pteropus poliocephalus*) hangs entangled in inappropriate urban fruit-tree netting. Despite being rescued, the netting had cut the circulation to its wing for too long and unfortunately, the flying-fox needed to be euthanised. Image: Doug Gimesy

On hot days, when resting in trees, flying-foxes will spread their highly vascular wings allowing more air to flow over them and helping them to cool down. Image: Doug Gimesy

A grey-headed flying-fox (*Pteropus poliocephalus*) takes a high-speed belly-dip at the end of a very hot day. They do this to wet their fur, which acts as a form of evaporative cooling as well as allowing them to take a drink. Image: Doug Gimesy

A female grey-headed flying-fox (*Pteropus poliocephalus*) carries her not so small pup, whilst heading for shelter back at the colony/camp. Image: Doug Gimesy



Doug Gimesy and Heather Kiley have produced a forty-eight-page children's book on Australia's amazing grey-headed flying-foxes for release in October 2020. Please see page 50 for further details.

5. Use only wildlife-friendly fruit-tree netting. Ideally, fruit-tree netting should not be used at all. But if it must, ensure it is wildlife-friendly, which means:
    a. It should not have a gap-size of more than five millimetres when taut. If you can put your little finger through it, it is too big; and
    b. Avoid using black and/or monofilament types.
6. Manage any barbed wire. Avoid using barbed wire if you can, as it can maim and kill many wildlife species, not just flying-foxes. If you must use it, paint the top strand fluoro or white as this allows them to see it more easily at night. Also, consider covering any wire with plastic pipes near trees where flying-foxes may feed. If you have barbed wire that no longer has any purpose, get it removed;
7. Get help immediately if you find an injured flying-fox. If you find one alone during daylight hours it is most likely in trouble. If you see one tangled in fruit-tree netting, on power lines or caught on barbed wire, it is in trouble and requires urgent care. The longer they are trapped, the more damage they will do to themselves and the more stress they are under. Also, in the breeding season (late September to December) keep an eye out for possible babies with electrocuted flying-fox mums on power lines. Sometimes the mother will be dead, but the baby is still alive. Immediately call Wildlife Victoria on 03 8400 7300, or your local wildlife group for assistance, who will arrange for a trained, vaccinated volunteer to attend;
8. Never touch a flying-fox if you find one. Call your local wildlife group immediately for assistance; and
9. Bring your friends and enjoy the view. If you want to show your friends a glorious summer sunset over Melbourne's city skyline, head to the hills near Yarra Bend Park and maybe just wait a few minutes longer once the sun has finally set. If you do, you will have a good chance of witnessing something spectacular and unique – up to fifty thousand flying mammals heading out for a meal, which in turn helps provide a vital service to our native forests and ecosystems.

Note: A version of this article was first published in Australian Geographic in 2019.

The Age of Flowering Plants

Santiago Ramírez Barahona

Flowering plants are the most important group of living plants. We just need to think about all the animal life, including humans, that depend on them for nutrition and shelter. Flowering plants are by far the most diverse group of plants alive today, with a total of 290,000 – 400,000 species, compared to those of the other five groups of living plants, including mosses – 10,000 species, hornworts – 200 species, liverworts – 8,000 species, ferns – 10,000 species, and conifers – 1,000 species. Almost every plant that we see today has flowers but there was once a time when there were no flowers on earth.

Flowering plants are at least 140 million years old, being the youngest of all major plant groups. Ferns, on the other hand, are more than 350 million years old and have dramatically increased in numbers in a relatively short period of time, eventually leading to fundamental changes in the earth's ecosystems. Nevertheless, for a long time, flowering plants were but a tiny fraction of the plants that inhabited the planet. How and when did our planet become a flowering world?

To answer this question, myself and two colleagues (based in Australia and Mexico) teamed up to document the temporal sequence of the appearance of all flowering plant families. But what exactly are plant families? Plant families are groups of related species that share a common history and usually unique combinations of morphological attributes (e.g. orchids, palm trees, and cacti). By combining data from both fossil and living species of plants, we were able to explore the history of flowering plants since their origin. Did most flowering plant families originate back when dinosaurs roamed the earth, between 145 to 66 million years ago?

Yes, almost all flowering plant families are as old as dinosaurs, but their evolution is more complicated than that. What my colleagues and I found is that the rise to dominance of flowering plants was delayed for a long time after they first appeared. Apparently, most modern-day flowering plant families evolved more than one hundred million years ago, survived the end of the Cretaceous mass extinction, and then became the dominant elements of terrestrial ecosystems. Flowers revolutionised life on earth along the way.

Above: Austrobaileya scandens (*Austrobaileyaceae*) is a vine native to the tropical rainforests of Queensland. Image: Hervé Sauquet

We can look at family ages across the environments where flowering plants thrive today. Take Australia for example, which is the epitome of an old and isolated lost world, with relicts of old-growth Gondwanan rainforests that harbor unique flora species (e.g. Wollemi pine and tree fern), but also the home to extraordinary arid ecosystems. The latter contains unique plant groups that have adapted to the extreme arid environments that are often subjected to intense wildfires, for example *Goodenia* (Goodeniaceae), *Eucalyptus* (Myrtacea), and *Hakea* (Proteaceae).

When we map the age of flowering plant families across Australia, we observe a close match between the distribution of family ages and the distribution of different types of ecosystems. Younger plant families are found in Central Australia, while older plant families are found towards the east-coast of Queensland, New South Wales, and Victoria.

When compared to the Australian rainforests, the deserts of Central Australia appear to have younger flowering plant families. But why? We think that this has something to do with the fact that the first flowering plants were probably small plants living in warm and humid climates, which also explains why most of the oldest families are found today in tropical ecosystems. Only after tens of millions of years since flowering plants first appeared, they started to invade these extreme arid environments, thus the young ages in these areas.

Indeed, many flowering plants in Australia's tropical ecosystems are part of some of the oldest families that we know today. Some of these families, such as the climbing plant species *Austrobaileya scandens* (Austrobaileyaceae), is estimated to have originated nearly 137 million years ago when Australia was still part of the mega-continent Gondwana. Although Australia's tropical rainforests are the living image of a distant past, *Austrobaileya scandens* is much younger. In fact, many flowering plants of these tropical rainforests are relatively young species.

If we trace the age of extant species, we obtain a very different picture. The vast majority of living species, in old plant families, only started to appear after the end of the Cretaceous period sixty-six million years ago, and many are probably much younger. The copper laurel is an endemic Australian shrub from the family Eupomatiaceae, which is almost one hundred million years old, yet the three living species date back to less than thirty million years ago. A more extreme example is the family Hydatellaceae, a group of tiny aquatic plants closely related to the water lilies, which are one of the oldest flowering plant families alive today with 147 million years of history. But the living species of the Hydatellaceae family form a group that evolved only forty-five million years ago, nearly one hundred million years after the family originated.

The age of extant species paints a very interesting picture of tropical ecosystems. By geological standards, modern-day tropical ecosystems are a very recent development in the history of the planet and appear to be true across the entire spectrum of terrestrial ecosystems, from tropical rainforests to deserts. Seen differently, it is true that most flowering plant families can be traced back hundreds of millions of years, but only during the last sixty-six million years did the living descendants of these old lineages emerge to produce the extraordinary flowering ecosystems we know today.

Santiago Ramírez Barahona is a plant biologist from the National Autonomous University of Mexico, and is interested in the ecological, geographical, and historical factors that influence biological diversity at different spatial and temporal scales. You can find more information on his work at ramirezbarahona.com.

Further reading

Ramírez-Barahona S, Sauquet H, Magallón S. 2020. The delayed and geographically heterogeneous diversification of flowering plant families. *Nature Ecology and Evolution*: 4, 1232–1238.

Hakea teretifolia (*Proteaceae*) is a shrub native to the scrub and heath of New South Wales. Image: Hervé Sauquet

THE RAINFOREST SEED
CONSERVATION PROJECT

Dr Karen Sommerville, Australian PlantBank, Australian Institute of Botanical Science

Did you know that fifty or so million years ago, rainforests covered much of Australia's landmass? As the continent shifted and the land became drier, the rainforests gradually disappeared until all that was left was a band around the northern and eastern edges of the mainland, and the western half of Tasmania. When Europeans arrived, the remaining rainforests were a great resource for timber and agricultural land, particularly in New South Wales and Queensland. In some areas – such as the 'Big Scrub' rainforest in northern New South Wales – the rainforests were cleared so heavily that very little rainforests remain. Today, rainforests occupy less than 0.4 percent of Australia's landmass, but still hold a large proportion of Australia's plant diversity with over 3,500 seed-producing species, and many more ferns, mosses, and liverworts. These plants provide food and shelter for a vast array of animal species – from large birds like the southern cassowary (*Casuarius casuarius*), to small marsupials like the musky rat-kangaroo (*Hypsiprymnodon moschatus*), and beautiful insects like the Richmond birdwing butterfly (*Ornithoptera richmondia*).

Although some rainforest remnants are now protected, the plants inhabiting them are subject to ongoing threats – some as a direct consequence of the original land clearing by Europeans, and others as a result of changes in the climate or introduced species. Fragmented plant populations, for example, have reduced opportunities for cross-pollination which can lead to poor seed production or no seed production at all. The increase in exposed edges resulting from fragmentation, has led to greater opportunities for weed invasion and greater susceptibility to drying out in periods of drought, which increases the risk of fire. Rising temperatures are threatening the existence of plants restricted to the cool peaks of the tropical mountains in Queensland. Furthermore, a recently introduced plant disease, *Puccinia psidii* (Myrtle rust), has resulted in three once common species being listed as Critically Endangered. It is evident that a back-up plan is needed to preserve what is left of our rainforest diversity, to prevent the extinction of individual species and to support rainforest restoration.

Part of the solution to the extinction problem is seed banking – storing dry seeds at sub-zero temperatures. Seed banking is a technique that is being used to preserve the world's crop species in the Global Seed Vault at Svalbard, and is also being used to preserve wild plants around the world in facilities like the Australian PlantBank (a member of the Australian Seed Bank Partnership). Seed banking is a simple and effective conservation technique for many dryland species; however, relatively little is known about

Above: The Australian PlantBank is a plant conservation and research facility situated within the Australian Botanic Garden, Mount Annan in New South Wales. Image: John Gollings

Rhodomyrtus psidioides in tissue culture. *Rhodomyrtus psidioides* (Native guava) is now critically endangered due to myrtle rust. This species, initiated into tissue culture as viable seed, has become difficult to find in the wild.

Assorted rainforest fruits. Rainforest plants produce fruit and seed in a wide variety of colours, shapes and sizes. Image: Simone Cotterell

which rainforest species will tolerate the drying and freezing necessary for long term storage. To remedy this lack of data, researchers at the Australian PlantBank have been collecting rainforest seeds and testing their response to drying and freezing. The process involves a series of experiments to see how well the seeds germinate when they are fresh, after drying, and after freezing at -20°C. The work is on-going and there are thousands of plant species still to test. However, of the 208 plant species the Australian PlantBank have tested, sixty-three percent have been tolerant of drying and a further eight percent have been at least partially tolerant. Some of these species have proven to be sensitive to freezing but can be stored for shorter periods in a refrigerator.

The information gathered from seed banking is useful for conservation programs, at facilities like the Australian PlantBank, and is also useful to organisations collecting and using seeds for rainforest restoration projects, such as Landcare groups.

Two of the biggest challenges, at the Australian PlantBank, are to find alternative ways to conserve plant species with drying-sensitive seeds and to determine an improved means to conserve freezing-sensitive seeds. Species with drying-sensitive seeds are being initiated into tissue culture as a first step. The process involves growing plants in small glass jars on sterile agar that contains all the nutrients essential for plant growth. Once a plant is growing well in tissue culture, we can work on preserving the tiny shoot tips by treating them with chemicals that prevent the formation of damaging ice crystals, and then store the shoot tips at -192°C (a process known as cryopreservation). To better preserve seeds not tolerant to freezing, we are using a machine called a 'differential scanning calorimeter' to see what reactions are occurring internally, as the seeds freeze and

thaw. The project is funded by the Ian Potter Foundation and is helping us to work out why the seeds are damaged during storage at -20°C and whether we can utilise other sub-zero temperatures to avoid the damage.

The difficulties of collecting seeds in the rainforest, and the length of time it takes for some seeds to germinate, means that it can take a year or two to determine whether a species is suitable for seed banking. To target this dilemma, we are looking at seed characteristics that can be used as indicators of desiccation and freezing tolerance. These seed characteristics will be used to develop a key to enable us to quickly determine which seeds are suitable for storage, so that we can concentrate our research efforts on those that are more difficult to conserve.

The rainforest plants conserved at the Australian Plantbank, whether as seeds, tissue cultures, or cryopreserved collections, provide a valuable store of material that can be used for research, to re-establish any species that become extinct in the wild, and to support efforts to restore rainforest habitats. If you would like to know more about the project, please visit the Rainforest Seed Conservation Project at http://bit.ly/SeedProjectABG

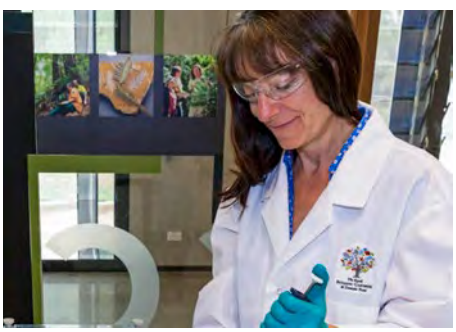
Germinating seeds of *Pararchidendeon pruinosum* (Snow wood). These seeds are suitable for seed banking.

Archirhodomyrtus beckleri (Rose myrtle) is a beautiful rainforest shrub with freezing sensitive seeds.
Image: Graeme Errington

The Ian Potter Foundation

About the Author

Dr Karen Sommerville is a Research Scientist based at the Australian PlantBank, a conservation and research facility of the Australian Institute of Botanical Science. She has worked in plant conservation research since 2003 and currently leads the Rainforest Seed Conservation Project.



Wildcard-Sue

Creativity for wildlife conservation

Sue Liu

Hello fellow wildlife enthusiasts. My name is Sue Liu and I am an artist, author, communications professional, and community builder from Sydney, New South Wales. I discovered my drawing abilities in late 2019 when I picked up a pen to give drawing a go.

My purpose as an artist and communicator is to foster an enduring appreciation and fascination for a wide array of Australian animals. I hope that my creativity and advocacy work, with researchers, educators, and through implementing wildlife projects, translates into conservation actions to help save Australia's threatened wildlife and their habitats. It is certainly true for me that as I study and draw an animal, I fall into a curious fascination with their faces, structures, textures, and movements, always wanting to know more about each animal.

I am pleased to announce that my website, wildcard-sue.com.au, has launched and showcases over sixty unique Australian native wildlife illustrations, offered as fine art prints, posters, and more. Wildcard-Sue is dedicated to raising funds for wildlife conservation and will be donating five percent of profits, from every artwork sold between October to December 2020, to the Australian Wildlife Society to help protect Australia's wildlife.

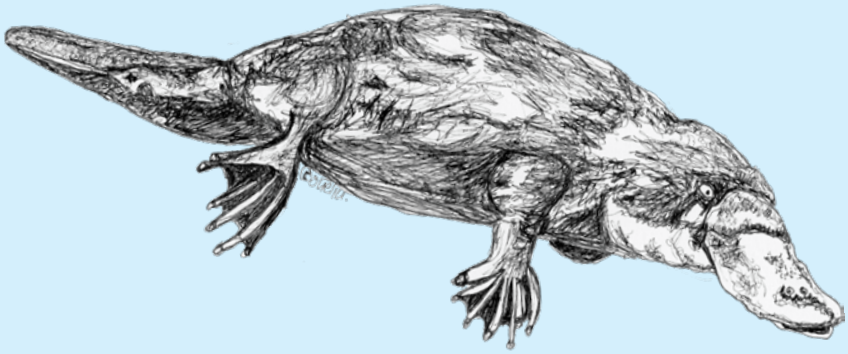
Art inspired by the sea

As a self-taught illustrator, I have established a personal style of drawing – drawing mainly with black ink, grey markers, and sometimes grey ink. Although I adore colour, it appears that the glorious complexity and texture, that brings these unique animals to life, work better in monochrome!

It is a preference for me to draw from my own experiences. I am fortunate to have had the opportunity to observe and study some of Australia's exquisite sea animals on my scuba dives in Sydney, such as the weedy seadragon (*Phyllopteryx taeniolatus*) and White's seahorse (*Hippocampus whitei*). I enjoy sharing my scuba diving experiences, and the interactions I have with the sea animals, with my non-diving friends – via photographs and short films. My friends are astounded by the diversity and beauty of the unique sea animals often encountered offshore. I am passionate about raising awareness and inspiring a greater interest in Australia's native animals, not widely known to many people.

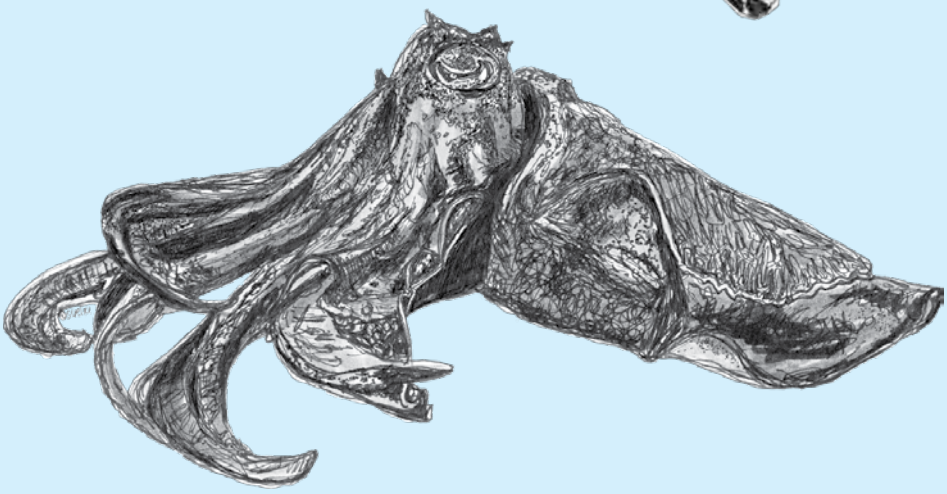
A growing awareness of land animals

As bushfires raged across the country, my curiosity quickly came to include Australia's land animals. Watching television, I was reminded about the many animals, such as the elusive platypus (*Ornithorhynchus anatinus*) and many small mammal species, whose habitat was destroyed as fires tore through Australia's bush and urban lands. I watched from afar in helpless horror, grieving the loss of our unique and precious wildlife and their habitats.



During December 2019, I contributed funds to bushfire relief and volunteered with communities that were supporting the New South Wales Royal Fires Service. With reality set in, I felt compelled to do more to protect Australia's native wildlife. I initiated a small fundraising campaign and donated profits from artwork sold, to a koala rescue project in Taree, New South Wales. I was so overwhelmed by the community's response to my fundraising efforts, that I was encouraged to develop ideas for a nature-focused business – integrating my art and philosophy of service to the community and continuing fifteen years of work for humanitarian causes.

I feel that I have now found an effective way to combine my core passion for creativity, community building, and wildlife conservation. I am delighted to be participating in wildlife conservation action, by donating five percent of profits to the Australian Wildlife Society to help protect Australia's wildlife, with additional fundraising efforts going towards koala conservation. For further information or to view and purchase wildlife art prints, posters, and more, please visit https://wildcard-sue.com.au



Captions

Page 26 left: Meet Sandra the seahorse, drawn from one of my personal photos of a seahorse taken under the jetty at Clifton Gardens in Mosman, New South Wales.

Page 26 right: Staring into the eyes of a wombat makes you fall deeply in love with them. Meet David and Betty wombat.

Top left: Fernando, the platypus, has so much personality and movement.

Top right: With Spike the echidna, I attempted to capture the softness of his spikes and portray the gentle nature of the echidna.

Middle right: When I see a turtle in its natural habitat, I am thrilled. This is Jacki the turtle from Cabbage Tree Bay in Manly, New South Wales.

Bottom right: Clive the cuttlefish, was inspired by photos from photographer Carl Charter who takes snorkellers and divers to experience the aggregation of giant cuttlefish in Whyalla, South Australia.

Bottom left: I usually draw upright on an easel. In this image, I am creating Cuddles the cuttlefish.

IT TAKES A RARE COMMUNITY TO SAVE ENDANGERED TREES

How Coastal Fontainea came back from the brink of extinction

Ten years ago, there were just ten *Fontainea oraria* (Coastal Fontainea) trees left in the world. Struggling in isolated rainforest remnants in Bundjalung country around Lennox Head on the New South Wales north coast, the highly threatened plant was on the brink of extinction. Today, the population has surged to more than 1,500 trees – thanks to strong partnerships between the local community, scientists, state government agencies, and bush regeneration professionals.

The 1980s – surfing, plants, and ping pong

Back in the early 1980s, the relatively new Northern Rivers College of Advanced Education in East Lismore – now Southern Cross University – had started a new environmental science course, and with it the birth of an herbarium. For students Peter Sheraton and David Fell, botany became their quest. They would surf off boulders, just south of Lennox Head, then walk into the bush behind Skennars Head to collect plant samples for the herbarium. They would then go back to Peter's place to play ping pong; followed by plant identification, drying, labelling, and mounting specimens onto paper.

Under the guidance of Southern Cross University's lecturer, Doctor Margaret Greenway, and with participation from the other students, the herbarium was born and slowly grew. It was shown to a group of visiting lecturers and botanists who were part of the University of New England's 'Ecofest' program, including Queensland herbarium botanists' Doctor Gordon Guymer and Laurie Jessup. The two botanists' eyes widened at the samples from the Lennox Head site, in particular at a plant the two students had struggled to identify. Doctor Guymer and Laurie visited the site in November 1982 and returned soon after in December the same year to collect fertile specimens of the plant. These specimens were used to formally describe a new species to science – Coastal Fontainea, which was published in 1985 as part of a revision of the genus Fontainea. Soon after, Peter and David graduated (and David moved interstate) and neither was aware that the new plant species had been scientifically discovered.

However, when they had found out about the scientific discovery, they were thrilled. "We were fortunate we started collecting plant specimens," David said about their student days. "We were just young fellas learning about our trees, inspired by blokes like Alex Floyd and John Williams. We had a look in a few patches of local scrub, collected a record of a few things and it turned out that some of those records had pathways."

A changing landscape: science and legislation

Coastal Fontainea is an attractive rainforest tree, with beautiful glossy leaves, a slender tall form, small white flowers, and red round fruit. After the legislation was enacted in New South Wales to protect threatened species, recovery plans for plants such as Coastal Fontainea were developed, with the original plan drafted by Maria Matthes.

By the late 1990s, Dianne Brown, a threatened species officer with the Department of Planning, Industry, and Environment, started talking with a post-doctorate researcher at Southern Cross University, Doctor Maurizio Rossetto, about the dilemma of the ten remaining adult Coastal Fontainea trees.

With a scientist's eye, Doctor Maurizio Rossetto, now the Senior Principal Research Scientist at the Royal Botanic Garden Sydney, devised a plan to establish viable Coastal Fontainea populations. Cuttings were taken from each of the ten trees, which were then grown in local nurseries, and planted in clusters across private and public land.

"We did some genetic testing and realised that one tree was overcontributing. The species was at risk of becoming inbred and there was relatively little diversity. It was a highly

Above: An image of Skennars Head, looking south from the Lennox Head side. Littoral rainforest remnants can be seen in the background. **Inset:** Evelyn and Alan Rich.

threatened site. The only solution was to take cuttings and translocate the tree into safe sites and maximise the diversity by ensuring that all individuals contributed equally," Maurizio said.

"We were kind of bringing back a living zombie," Maurizio explained. "The trees were alive but not able to re-establish as a self-sustaining population, so the translocation event was critical. The next step is to assess how successful the translocation has been, by monitoring their reproductive success."

What happened on the ground?

Fortunately, there were two in-situ sites where Coastal Fontainea was growing in the wild. Weed control was the first step. Dianne, along with the assistance of the Bushland Restoration Services – Rhonda James and Bob Smeuninx, helped to restore the trees through weed control. The wider team – Dianne, John Nagle, and Annette McKinley – then selected translocation sites which were weeded, fenced, and then planted with groups of ten cuttings. The process was repeated across twenty-six sites from 2010 onwards.

Rhonda, the restoration ecologist, still monitors the sites alongside Annette McKinley, a plant ecologist from Landmark Ecological Services. Annette has been involved in Coastal Fontainea vegetation surveys since the 1990s when she worked alongside her Landmark Ecological Services partner Barbara Stewart.

Annette has followed the Coastal Fontainea progress from translocation to growth, where part of her role has been to monitor the populations for the long-awaited fruiting. She recently collected the round red fruit and sent it down to Maurizio at the Royal Botanic Garden Sydney for testing.

"It was a few years before they were big enough to produce fruit," Annette said. "They are an amazing looking fruit."

Riding the environmental wave

Another very personal journey in the fight to save Coastal Fontainea comes from the late Alan Rich, a lynchpin in the project.

"He was really quite famous," Dianne said. "He and his wife, Evelyn Rich, moved to the Ballina Shire with their twins after running an international surf filmmaking business for many years. He completed his degree in Environmental Science at Southern Cross University and did an honours degree on Coastal Fontainea.

"Alan was such an outrageous and larger than life character, he ended up running for Ballina Shire Council as a Greens candidate. The first time we ever met, we were doing bushland regeneration and leeches were an issue. He was wearing pantyhose – he reckoned they kept the leeches off while working!"

A small patch of littoral rainforest behind Lennox Head, showing typical coastal forest on basalt hills.

David Fell pressing plants in the Torres Strait Islands.

Coastal Fontainea fruit.

L to R: April Rich, Nikki Rich, and Evelyn Rich.

Friends and family planting Coastal Fontainea at Evelyn Rich's house in dedication to Alan Rich. John Nagle gave an opening presentation, alongside Dianne Brown.

Coastal Fontainea leaves and flowers.

April Rich and Willow the dog with Coastal Fontainea to be planted.

Dianne Brown and John Nagle planting Coastal Fontainea in 2010. This tree is now 5m tall.

Doctor Maurizio Rossetto, Senior Principal Research Scientist, Royal Botanic Garden Sydney.

Coastal Fontainea recovery team. L to R: Annette McKinley, Barbara Stewart, John Nagle, Ian Gaskell, and Rhonda James.

Evelyn saw her husband's surfing passion shift to trees. "Alan went from staring at the ocean to staring at trees. When he found out about Coastal Fontainea, he was extremely driven in trying to locate more individual trees and have them protected."

Alan took his passion for Coastal Fontainea protection to the Ballina Shire Council where he was elected as a Councillor for nine years. Ballina Shire Council now has three Environmental Officers as a result of Alan's efforts. Sadly, Alan passed away five years ago. In 2015, the then New South Wales Office of Environment and Heritage held a dedication ceremony at Evelyn and Alan's house in honour of his work, planting ten Coastal Fontainea trees.

"Incredibly, there were only ten trees and now they have managed to generate over 1,500 individual trees," Evelyn said. "If Alan were around today, he would be beside himself with joy."

Many hands make light work

The New South Wales Department of Planning, Industry and Environment's Saving our Species program has led the Coastal Fontainea regeneration project since 2015. Twenty-six sites of ten plants now stretch across the unusual deep, red fertile soil of the Lennox Head surrounds. Ballina Shire Council's Natural Resource Officer, James Brideson, said the regeneration project and tree planting has been a team effort between organisations and the community.

Today, multiple sites of Coastal Fontainea are maintained as part of a broader species conservation strategy developed under the Saving our Species program. After close to thirty years, Diane still works to conserve Coastal Fontainea coordinating recovery efforts under the Saving our Species program.

Each year, Ballina Shire Council holds a public event restoring Lennox Head and attracting between 150 and 200 excited community members who plant around 1,000 mixed littoral rainforest tree species. Some of these annual plantings include Coastal Fontainea cuttings at various littoral rainforest Landcare sites.

Dianne explained that the plants that have been translocated on the beautiful deep rich red soil have grown extremely well. They are now producing flowers and fruit – and hundreds of seedlings. "That is the really exciting part," she said. "Not only have we planted more trees, but they are doing their own thing now. The key is not giving up on threatened species. With a little bit of money, informed science, and a lot of hard work, persistence really does pay off."

To find out more about the Coastal Fontainea Saving our Species program, please visit: http://bit.ly/CoastalfontaineaSOS




Plant conservation and fire

Doctor Tony Auld, Heidi Zimmer and Lucy Commander

We have just experienced the most extensive fires ever recorded in eastern Australia. It is timely to consider how fire influences our approaches to plant conservation, and the challenges that a changing climate brings.

How fire affects the persistence of plant species and vegetation communities

Fire plays a role in the development and structure of most Australian vegetation communities. Fires have different components (called the fire regime) and include fire frequency, severity, season, type (e.g. surface and peat fire), extent and patchiness. These components interact to affect species survival at a site. The impact of a fire on a plant at a particular site (including the recent 2019-2020 fires) depends on both the past fire history at that site and the characteristics of the current fire (severity, season and patchiness), along with what happens after the fire. Fires do not completely destroy bushland, as both plants and many animals have strategies to survive fires and recover after the fire has passed. However, depending on the fire regime (e.g. fire severity, frequency, and type) and the extent of habitat clearing, some species may decline or fail to recover.

Many plants can survive being burnt in a fire. These plants are called resprouting plants and they are often long lived. Examples of resprouting plants include eucalypts (many of which can resprout from buds protected by bark on the trunk); shrubs that resprout from underground lignotubers; and grasses, sedges, and herbs that resprout from underground rhizomes, tubers, and bulbs. However, the ability to resprout can vary (even within species), depending on things such as fire severity, plant size, drought, and disease. To replace those plants that die either in a fire, or between fires, many resprouting plants also produce seedlings after a fire and these seedlings need to be able to grow to survive the next fire if populations are not to decline. Grasslands, rainforests, and alpine vegetation are dominated by resprouting plants. Other plants die when they are burnt, and these are called fire-sensitive plants or obligate seeders. In these particular species, if a plant is completely burnt or is close enough to the heat of the flames to have all its leaves scorched, it will die. These plants rely on regenerating from a seed after a fire and they can be common in species-rich areas such as heathlands of southwestern Western Australia and Sydney's sandstone vegetation. Seeds may be located on the plant in woody fruits that insulate the seeds from the lethal fire temperatures (e.g. *Banksia*, *Hakea, Lambertia*, *Callistemon*, *Melaleuca*, *Allocasuarina*, *Leptospermum* and *Eucalyptus*). Alternatively, seeds may survive in the soil (e.g. *Acacia*, *Persoonia*, *Dodonaea* and *Boronia*), with the soil being a great insulator protecting the seeds from the heat of the fire above. However, not

Top left: A patchy fire in Australia's heathlands.
Top right: *Banksia serrata* (old man banksia) seedling after a fire.
Botttom left: Pimelea seedlings after a fire.
Bottom right: Resprouting *Leptospermum* (tea-tree).

Woody fruits of *Banksia serrata* (old man banksia) open after a fire and release their seeds.

all plants can tolerate all fire regimes and building an understanding of the degree of each species' tolerance to each component of the fire regime, is important for the long-term conservation of native vegetation.

The 2019-2020 fires were unprecedented in extent and severity. While most plant species should readily recover after these fires, some will decline due to a range of factors including:

1. Increasing fire frequency – reducing the amount of seeds that are available for recovery;
2. Increasing fire severity – leading to increased plant mortality in resprouting plants;
3. Post-fire grazing by horses, deer, rabbits, goats and stock, reducing or eliminating seedlings and resprouting plants;
4. Weeds and pathogens affecting growth and survival of seedlings and resprouts; and
5. Ongoing drought affecting seedling and resprouting plant survival.

Recruitment and flowering after fire

The environment immediately after a fire is very favourable for plant recruitment. Nutrients released by the fire are available to growing plants. The fire also results in an increased abundance of natural sunlight and space, due to burnt and fallen trees. Consequently, many plants in fire-prone communities recruit new individuals in the first few years after a fire and then flower prolifically. Fires promote seed germination in many species through soil heating, smoke and the interaction of heat and smoke, and during and after a fire (e.g. wattles and native peas). Some resprouting plants have no seed banks (maintenance of a supply of seeds) at the time of a fire and need to flower soon after fire to recruit new plants. Therefore, a fire often leads to a spectacular floral display in the first few flowering seasons after a fire has passed through, such as in *Xanthorrhoea* (grass trees), *Telopea* (waratahs), *Conospermum* (smoke bush) and *Doryanthes* (Gymea lilies). In addition, there are other species thought of as 'fire ephemerals' because they appear (germinate, or resprout from below ground storage organs) after a fire in relatively large numbers. These plants then flower and set seed, before largely disappearing from the above ground vegetation. They then await the next fire as seeds, bulbs, or tubers in the soil. Some may be present above ground for a very short time (less than two to three years). Examples include flannel flowers and Christmas bells.

Plant resilience to climate change and fire

Australia is predicted to experience an increase in the number of days with extreme/catastrophic fire events, increased temperatures, and ongoing episodes of drought, which is likely to lead to more fires and the slower recovery of a species after each fire. Two characteristics of plants that play a key role in their ongoing persistence, is the storage of resources to allow successful resprouting, and the maintenance of a supply of seeds (called seed banks). Both roles will be impacted by climate change. Although, seed banks tend to buffer plants against changes in climate, plants that rely on seed banks can be vulnerable if they do not have enough time to recover between fires (i.e. time to grow to maturity and produce seeds). Reductions in plant growth as a result of drought will also delay and reduce seed production after a fire. Any reduction in seed bank size affects a plants' capacity to recover, not only if it is killed by a fire, but also from other disturbances such as drought, grazing, weeds, or pathogens.

For resprouting plants, regrowth after a fire is dependent on stored reserves and these reserves need to be replenished between fires. Short intervals between fires can lead to a reduced resprouting capacity and increased rates of plant death in fires. Moreover, resprouters are unlikely to be able to rely on recruitment from seeds to replace adults that die in such situations, as juvenile plants need sufficient time to become large enough to survive a fire. If drought becomes more frequent, a plant that resprouts after a fire may also be more susceptible to the impacts of drought stress (embolisms in vascular tissue leading to death of new shoots).

We need to plan how to protect important plant species and communities in the wild, under increasing conditions of more frequent and severe fires. The success of actions to minimise the severity of the fires that burnt the wollemi pine, illustrates what can be done or at least attempted. Successful strategic planning is needed to protect ancient rainforest remnants, long-lived conifers and other plants and vegetation that is of significance but cannot tolerate the fire regimes of tomorrow.

Doctor Tony Auld is a plant ecologist with over thirty year's experience working for the New South Wales government on the impacts of fire on plants. He is currently the President of the Australian Network for Plant Conservation.

2020 University Student Grants Scheme winners

The Australian Wildlife Society's University Research Grants are scholarships offered to honours or postgraduate students at Australian universities. Each year, ten grants of $1,500 are awarded. Grants are available for research projects of direct relevance to the conservation of Australian wildlife; plant or animal. Grants may be used for the purchase of equipment and consumables, travel expenses related to field research, or attendance at conferences at which you are presenting your work.

The Australian Wildlife Society is delighted to announce the winners of the ten grants of $1,500 each to honours or postgraduate students conducting research that will contribute to the conservation of Australian wildlife.
The winners for 2020 are:

ANGELA RAÑA - School of Life and Environmental Sciences, University of Sydney
Project Title: Assessing the success of the rewilding of small mammals into North Head

BALI LEE - Faculty of Biology, Medicine and Health, University of Tasmania
Project Title: Are microplastics causing inflammation in seabirds?

BEN STEPKOVITCH - School of Biological, Earth and Environmental Sciences, University of New South Wales
Project Title: Ecosystem effects of western quoll (*Dasyurus geoffroii*) reintroduction on prey species inside a fenced reserve

CAROLYN WHEELER -
ARC Centre of Excellence for Coral Reef Studies, James Cook University
Project Title: A novel approach to investigate reproduction in a model shark species threatened by ocean warming

CHRISTINE MAUGER - School of Biological Sciences, University of Queensland
Project Title: The effect of fire regimes on habitat structure, demography and predator avoidance in northern brown bandicoots (*Isoodon macrourus*) and northern quolls (*Dasyurus hallucatus*)

EMILY JARVIS - School of Biological Sciences, Monash University
Project Title: Artificial microhabitat use of the agile antechinus *(Antechinus agilis*) in wet-forest environments

JOSHUA ZIMMERMAN - School of Environmental and Rural Science, University of New England
Project Title: Next-generation sequencing of *Felis catus* in Australia: Helping to elucidate feral cat population dynamics and interaction with domestic cats

JULIANNA SANTOS - School of Ecosystem & Forest Sciences, University of Melbourne
Project Title: Mammals on the move in fire-driven mosaics

KELLY WILLIAMS - School of Life Sciences, La Trobe University
Project Title: Surviving predators: Assessing antipredator behaviours in an endangered wallaby to improve threatened species conservation

MOSES OMOGBEME - School of Veterinary & Life Sciences, Murdoch University
Project Title: Dingoes and trophic interactions in landscape-scale cell fencing










How invasive predators and fire interact and affect the persistence of native mammals

CHRISTINE MAUGER
School of Biological Sciences
University of Queensland

Australia has more mammals listed extinct than any other country in the world, we have lost more than twenty-five species since European colonisation. Smaller mammals weighing between 35g – 5.5kg (known as the critical weight range), such as rodents, bandicoots, and carnivorous marsupials such as quolls, have been the most affected. The impact of habitat loss due to land clearing, invasive species such as foxes and feral cats, and altered fire regimes on Australia's biodiversity is both profound and complex and are all contributing factors to such extinctions.

Predators are advantaged by land clearing and large wildfires. For example, field experiments, in the Kimberley savanna region of northern Western Australia, showed that management with small cool fires reduced the severity of late dry-season fires and promoted the survival of small and medium mammals. Severe late dry-season fires increase the hunting capabilities of feral cats, which travel large distances to hunt vulnerable prey. Such experiments have not yet been replicated in Far North Queensland, particularly in the more heavily wooded but fire-prone tropical open forest of this region.

Without effective fire management, crucial habitats can be rapidly devastated as seen in Australia's catastrophic 2019 – 2020 summer bushfires. Researchers estimate that approximately three billion animals (mammals, aves, amphibians, and reptiles) perished in the recent bushfires, indicating that now is a critical time to understand how fire management practices can be used to better conserve Australia's threatened and declining wildlife species.

In saying this, and since the recent bushfires, interest and attraction in fire practices by Indigenous Australians have greatly increased. Indigenous Australians, and researchers across the country, suggest that traditional fire practices can restore landscapes and are crucial to conserving Australia's wildlife and ecosystems.

This project aims to understand the role of habitat complexity in predator-prey dynamics and how invasive predators and fire interact and affect the persistence of native mammals, focusing on the Endangered northern quoll (*Dasyurus hallucatus*), and the northern brown bandicoot (*Isoodon macrourus*). The northern brown bandicoot is listed as Least Concerned but is declining in savannas and was shown to be sensitive to large fires in an experiment in Kakadu in the 1990s and early 2000s.

The project takes place in Far North Queensland, near Mareeba, on Muluridji country, and draws on Indigenous ecological knowledge and fire practices to explore faunal responses to different types of fires. Mareeba has one of the stronghold populations of northern quolls, and so is an important site to research and understand species' ecology. Because threats such as fire and predators often interact, the project will examine how fire influences predator movement and presence in recently burnt areas. It will also look at how predators affect the presence and abundance of small mammals over time in a fire-affected landscape.

The northern brown bandicoot is a common species and is being included in the project because small digging marsupials are known to be greatly affected by the impact of habitat loss due to land clearing, invasive species such as foxes and feral cats and altered fire regimes. Several bandicoot species are now extinct, and the northern brown bandicoot is locally extinct in some parts of Queensland and New South Wales. Monitoring common species can identify any arising issues that have the potential to worsen in the future, where the conservation listing of a species may need to be updated. Bandicoots are ecosystem engineers, turning soil as they dig for invertebrates, seeds, and roots as well as fungi. This digging creates air and water flow, turns nutrients, spreads fungal spores, and encourages seed germination. Reductions in northern brown bandicoot numbers could have an overall negative effect on the ecosystems they occupy.

Fieldwork for this project will involve undertaking habitat assessments, camera trapping and live animal trapping of northern brown bandicoots and northern quolls and camera trapping of feral cats and foxes. The chosen sites will vary in flora understorey density, number of retreat sites, rock and vegetation density, past fire frequency, and fire intensity.

Short-term responses of the northern brown bandicoot and northern quoll to fire will be tested along with their responses to predators, by monitoring their activity in sixteen different sites, four recently burnt, four long-unburnt, four current burning treatment sites and four control sites. Sites will be in areas of woodland to open woodland on basalt plains, metamorphic hills, and rhyolite hills, and they will vary in elevation so there is a large coverage of potential habitat for the two species. The project will assess habitat complexity at each site after wet and dry season conditions, record the density of obstacles, potential den sites, nest sites, and ground and understorey cover at different heights. The project will also monitor insect abundance (prey availability) using close-focus time-lapse cameras and pitfall trapping.

The project will test how capture-mark-recapture survival probabilities in northern brown bandicoots and northern quolls vary with size and performance indicators, habitat structure, and fire history. To monitor survival and population dynamics, the project will trap northern quolls and northern brown bandicoots three times a year, individually microchip and record age, morphological measurements, pouch young measurements (to estimate age and reproductive rate), and take DNA samples (a small piece of skin from the ear) from each newly caught individual. To monitor populations continually throughout the year, an additional method of capture-mark-recapture analysis will be performed, and habitat use of northern quolls will be recorded (which can be individually identified from fur spot patterns). To capture the activity of predators in each treatment, the project will install five camera traps at each of the sixteen sites, each baited with a punctured sardine tin (long-term attractant) above ground level.

The short-term outcomes of this study will allow for a better understanding of the ecology and physiology of northern brown bandicoots and northern quolls in a naturally occurring population in Far North Queensland, and a clearer understanding of the relationship between predators and prey population dynamics within habitats. Understanding how invasive predators and altered fire regimes interact to affect both an Endangered and common marsupial, can help land managers conserve populations to prevent further declines and identify important areas to conserve so threatened species continue to have refuge. Furthermore, understanding how fire and predators influence species' distribution and habitat use, is critical to wildlife conservation. Data and results from this study, will inform conservation and management decisions (particularly fire management) for these selected species, not only in Far North Queensland, but across their range on mainland Australia.

Dingo control and trophic interactions

MOSES OMOGBEME is a PhD candidate in Environmental and Conservation Science at Murdoch University

Livestock production is one of the primary land uses across Australia. Rangelands are desert, grassland, shrubland, wetland and woodland areas, of which fifty-four percent is used for extensive grazing of domestic livestock. Across these landscapes, domestic livestock often co-exists with other wildlife such as native and non-native herbivores, small mammals and reptiles, as well as their natural predators – dingoes (*Canis lupus dingo*).

The dingo is a medium-sized carnivorous mammal native to Australia and an apex predator that contributes to the control of many feral species that threaten Australia's wildlife. In saying this, macropods are an important component of a dingo's diet, however they also prey on feral herbivores and domestic livestock. Research indicates that whilst dingoes play an important role within the environment, keeping natural systems in balance, their impact on lower trophic levels is still uncertain.

The dingo's predatory behaviour on domestic livestock has caused economic and social distress for pastoralists, resulting in a loss of approximately eighty-nine million dollars per annum. Predation by dingoes has also contributed to a shift in domestic livestock enterprise choice. In Western Australia, there has been a decline in sheep and goat production and a significant move to cattle production, as cattle are more resilient to dingo predation, although calves can be susceptible. Consequently, dingoes are considered as pests by many people and are targeted for control across most rangelands in Australia. In addition to dingo-proof cell fencing, targeted trapping, shooting, and broadscale deployment of toxic baits is carried out to control dingo populations.

The combined approach of dingo-proof cell fencing and lethal control of dingoes has the potential to increase the presence of native and non-native herbivores, and consequently the total grazing pressure between these herbivores. Increased grazing results in habitat loss which exposes small native mammals and reptiles to predation by feral cats and foxes. Furthermore, increased grazing pressure reduces overall pasture biomass and alters habitats used by small native wildlife, which can be detrimental to these species. Therefore, dingoes home ranges, and their predation on native and non-native herbivores, can be considered as refuge zones for small native wildlife, however this hypothesis is highly debated as dingoes often prey on the same small wildlife they are presumed to protect. However, research on the direct predation risks of dingoes on small native wildlife is limited.

Previous research suggests that the presence of dingoes plays a key role in enhancing biodiversity. The predation behaviour of dingoes on native and non-native herbivores, lethal and non-lethal (e.g. fear causing aversion and altered space use), is predicted to result in greater vegetation cover and biomass of plant species in areas where dingoes are present. In saying this, the ecological, environmental, and economic benefits of dingoes on rangelands vegetation is limited and yet to be fully explored.

The project takes place in the southern rangelands of Western Australia. The project will examine the abundance and activity patterns of dingoes, and population dynamics and activity patterns of native and non-native herbivores. The community composition of small native mammals and reptiles, within a planned single large dingo exclosure (the Murchison Regional Vermin Council cell fencing), will also be explored. To do this, camera trap and sand plot monitoring will be carried out across thirty-six sampling transects over two years. The thirty-six transects are nested within six study sites, inside and outside the dingo-proof cell fencing. Between July and August 2020, the project deployed over one hundred motion-sensor cameras (Reconyx Hyperfire) across the six study sites. Vegetation composition will also be examined over the two-year period using satellite imagery to evaluate any changes in vegetation.

The project will be the first to investigate and research the top-down trophic cascade impact/control of dingoes on native and non-native herbivores in the southern rangelands of Western Australia. The outcome of this project will help with the management of improved livestock production and conservation of small threatened native mammals and reptiles.

Moses setting up a motion-sensor camera on a vehicle dirt track. Dingoes, macropods, and non-native herbivores are most efficiently surveyed on tracks.

Assessing the success of the reintroduction of small mammals into North Head

ANGELA RAÑA
School of Life and Environmental Sciences
University of Sydney

Australia's mammal species have been subjected to elevated rates of extinction following European settlement and, as a result, wildlife conservation experts have progressively turned to reintroductions in the hopes to protect Australia's declining native mammals. Previously, attempted reintroductions have resulted in some success, where native species have not only been able to persist in the landscape, but the reintroductions have also resulted in positive ecosystem-level effects. However, these successes are not commonplace, as the reintroduced species often face low rates of survival and establishment.

Post-release monitoring is essential to determine the success of a reintroduction program, and to investigate factors that may affect the establishment and persistence of the reintroduced species. Immediate post-release tracking of animal movements is also crucial, as reintroduced animals often disperse extensively throughout the landscape, and may display poor site fidelity. In these cases, reintroduced animals may disperse too far to contribute to the reproductive pool and therefore to population establishment.

When animals do stay near the release site, their post-release movements are often atypical. Translocated animals often move further than their resident counterparts, presumably taking time to become familiar with their surroundings, which is followed by an establishment phase in which home ranges are determined. Home ranges determine factors such as an animal's foraging and sheltering behaviour and conspecifics interaction, and will therefore influence individual fitness and determine long-term survival at both the individual and population level. Furthermore, individual fitness and the long-term survival of a species results in ecosystem-level effects, such as the restoration of ecological services including pollination, seed dispersal, and soil aeration via digging. Post-release monitoring is therefore critical in determining the success of reintroduction efforts and understanding the impacts of reintroduction efforts on the wider ecological system.

Inflorescence of Banksia marginata, one of the species the reintroduced mammals may be pollinating.

North Head Sanctuary, in New South Wales, is managed by Sydney Harbour Federation Trust and New South Wales National Parks and Wildlife Services, with active wildlife management and monitoring carried out by the Australian Wildlife Conservancy. Collectively, these organisations are reintroducing locally extinct populations of Stuart's antechinus (*Antechinus stuartii*), native bush rat (*Rattus fuscipes*), and the Vulnerable eastern pygmy possum (*Cercartetus nanus*). The return of locally extinct species is achieved through a program that includes feral predator and herbivore control and fire and weed management. North Head Sanctuary is therefore an ideal site to explore how these reintroduced populations are responding and if the wider

Above: Angela Rana in the field, holding a juvenile bush rat (*Rattus fuscipes*).

ecosystem is changing as a result of the reintroductions.

The project will explore the factors affecting the establishment and persistence of reintroduced populations of Stuart's antechinus, native bush rat, and eastern pygmy possum into North Head Sanctuary. The project will radio-track the reintroduced populations for one-month post-release, which will include daylight tracking – to obtain nest locations, and nocturnal tracking – to obtain animal movement and home range data. Triangulation and non-invasive personal observation will also be used to determine the animals' dispersal.

Understanding the dispersal and space utilisation behaviour of these animals will help to provide a baseline understanding of the ecosystem-level effects of these reintroductions. The project will conduct further experiments to determine whether these reintroduced populations contribute to the pollination of the eastern suburbs banksia scrub, an endangered ecological community, and the dominant habitat type at North Head Sanctuary.

In the later stages of the project, dispersal and space utilisation data will be combined with genetic analyses to further investigate the success of the reintroduction program. The project will examine the genetic profiles of the reintroduced populations using deoxyribonucleic acid (DNA) collected from release and captured individuals. The genetic data will be used to determine the diversity of the population and whether the population is likely to be self-sustaining, or if they require further support. The data may also be analysed alongside movement data to determine whether there are genetic drivers to dispersal (interspecific) and space use.

Overall, the project will better inform the continued reintroduction of small native mammals into North Head Sanctuary, and reintroduction practices and methodologies in general. Refinement of these reintroduction practices is essential, as reintroductions are increasingly being used to save native species threatened by a changing climate and habitat loss and fragmentation.

A juvenile eastern pygmy possum (*Cercartetus nanus*).

Inflorescence of Banksia ericifolia, one of the species the reintroduced mammals may be pollinating.

A view from North Head Sanctuary.

Are microplastics causing inflammation in seabirds?

BALI LEE is a PhD student at the University of Manchester and the University of Tasmania, looking at the effects of microplastics on the immune system of flesh-footed shearwaters (*Ardenna carneipes*)

Plastics have existed for a long time. In the 15th century, the Olmecs of Mexico were known to play ballgames with rubber balls, a naturally derived plastic, while medieval craftsmen used keratin from animal horns to fashion lantern windows. However, the first fully synthetic plastic was not invented until the 1900s by a Belgian chemist, Leo Baekeland, who, soon after, wrote in his journal "unless I am very much mistaken, this invention will prove important in the future." Prescient as this statement was, Baekeland probably did not imagine quite how ubiquitous plastic was to become. Now, there are at least eight different types of commonly used synthetic plastics, whose inexpensiveness, strength, and chemical inertness mean that they have been co-opted to produce almost all our daily items – from our toothbrushes to our clothes and to the seats we sit on – synthetic plastics are everywhere.

What deems a material as plastic? Plastics are materials made up of repeating units of the same molecule that are malleable when soft but will retain their shape once hardened. Their name comes from the Greek verb plassein, which means 'to mould or shape' and now their presence, it has been argued, is shaping the very earth we live on. The omnipresence of plastics in our lives, coupled with their exceedingly long lifecycle, has led some scientists to begin calling for the naming of a new epoch termed – the Anthropocene. These scientists argue that the presence of plastic is so great, that in the future, our rock strata will be littered with the physical evidence of plastics. Indeed, since the 1950s, when mass production of synthetic plastic began, more than 8.3 billion tonnes of plastic has been created, with over half of this plastic discarded in landfill and the natural environment. In particular, marine environments have been exceedingly impacted, with forty percent of discarded plastic estimated to have ended up in the ocean.

Jennifer Lavers processes a flesh-footed shearwater (*Ardenna carneipes*) blood sample on Lord Howe Island. Image: Cameron Muir

Microplastics, which are plastics less than five millimetres in length, are the most predominant form of global plastic pollution and can originate from either primary or secondary sources. Primary microplastics are purposefully manufactured to be microscopic (e.g. scrubber beads), whilst secondary microplastics are derived from the fragmentation of larger plastic pieces. Fragmentation of larger plastic pieces generally occurs over time due to exposure to ultraviolet light. However, there is also evidence to suggest that marine animals, such as Antarctic krill (*Euphausia superba*), may also contribute to the fragmentation process via digestive fragmentation. These microplastics, once in the oceans, are often mistaken for food by marine animals and sadly there are numerous accounts of marine animal fatalities due to plastic ingestion. However, our understanding of the sub-lethal effects of these plastics on marine wildlife is limited.

Flesh-footed shearwaters (*Ardenna carneipes*), a type of medium-sized seabird within the petrel family, which has three main breeding areas, the largest of which is on Lord Howe Island, New South Wales, is a marine species that is particularly and severely impacted by plastic waste. Studies by Doctor Jennifer Lavers and her team at the University of Tasmania and Adrift Lab, have shown that roughly ninety percent of flesh-footed shearwater fledgelings

have plastic within their stomachs. Plastic in the fledgelings stomachs is thought to be due to their parents unwittingly feeding them plastic, that would have been mistaken for squid or other fish. Alarmingly, studies examining their general health also appeared to show a correlation between high levels of stomach plastics and markers of ill health, such as heightened levels of cholesterol and uric acid, markers that go beyond simple signs of malnutrition. Despite successful conservation efforts, the correlation between high levels of stomach plastics and markers of ill health may explain why many flesh-footed shearwater populations have been in decline for decades. Nevertheless, whether plastics are causing these effects and how, is still unknown at this point.

As an immunologist by training, much of Bali's research has focused on how the immune system becomes activated and what processes mediate the activation. During her Master's degree, she investigated the effects of microplastics on immune cells and found that plastics were capable of activating immune cells inflammatory pathways. Interestingly, different types of plastics were found to have different effects, with some plastics being more inflammatory than others. Nevertheless, how these inflammatory effects translate when looking at plastics ingested by living animals remains unclear.

Because inflammation is a vital part of the immune system and is the process by which we respond to infection and injury, the project predicts that the high plastic diet being fed to shearwater fledgelings is resulting in unwarranted inflammation and is the source of their well-documented sub-lethal health defects.

The project will take place on Lord Howe Island, New South Wales, at the end of April 2021, just before many of the shearwater fledgelings will be departing on their first flight out to sea. The project will collect blood samples and the stomach contents of multiple shearwater fledgelings, which will be achieved without harming the fledgelings, and should allow us to determine if there is a correlation between a high plastic load and increased markers of inflammation. Shearwater fledgelings will also be scored on their general health and wellbeing by looking at and recording statistics such as body mass and general behaviour. The fledgelings that appear the most unwell will be treated with an anti-inflammatory drug. Recapture of the fledgelings will then be attempted forty-eight hours later, and a subsequent blood sample will be taken. Blood samples and any plastics retrieved from the fledgelings stomach contents will be sent to the University of Tasmania, where the project will carry out blood sample analysis as well as identification of the ingested plastic-type.

Microplastic pollution is a growing problem and one that is not going to subside on its own. In recent years, the issue has received increasing attention, but studies investigating the sub-lethal effects of microplastics on large vertebrates are few and far between. Flesh-footed shearwaters are one of the most impacted seabirds when it comes to plastic ingestion, and they have already been shown to directly suffer as a result. However, without knowing how plastics are inducing inflammatory effects it is very difficult to mitigate against them. Furthermore, as plastic ingestion is something that has been shown to occur across species, including the human species, we hope that this research may also have a knock-on effect on the conservation of many other animals, as well as human health. If we can show that some plastics are more inflammatory than others, we could potentially push for the cessation of the use of some types of plastic altogether.

Plastic is removed from a juvenile shearwater (*Ardenna carneipes*) on Lord Howe Island. Image: Cameron Muir.

Can predation on endangered species be a good thing?

Using native predators to smarten up endangered mammals for life outside fences

BEN STEPKOVITCH is a PhD Candidate with the Centre for Ecosystem Science at the University of New South Wales.

For many of Australia's endangered mammal species, fenced predator-proof reserves provide a safe-haven from predation by introduced predators such as foxes and feral cats, often the major cause of native mammal decline and sometimes extinction on the mainland. Native marsupials, like the burrowing bettong (*Bettongia lesueur*) and western barred bandicoot (*Perameles bougainville)*, now only occur on offshore islands or are introduced into fenced predator-proof reserves which are exempt from introduced predators. In the absence of predation, these threatened species can explode beyond the capacity of the reserves. Furthermore, these animals can lose their 'smarts', or anti-predator behavioural responses. Given that the long-term goal of most fenced predator-proof wildlife reserves is to reintroduce species back into the wild, outside fenced safe-havens, wildlife managers face significant challenges to ensure the survival of native endangered species.

What if we could teach native endangered species to be warier of predators in general, while also conserving native predators? Western quolls (*Dasyurus geoffroii*), a native marsupial predator, has disappeared from most of its former range due to land clearing and predation by introduced foxes and feral cats. In 2018, western quolls were reintroduced to Arid Recovery, a large 123 km² fenced wildlife reserve in outback South Australia. Prior to 2018, Arid Recovery reintroduced the greater bilby (*Macrotis lagotis*), greater stick-nest rat (*Leporillus conditor*), burrowing bettong and western barred bandicoot to the fenced wildlife reserve. Western quolls are now breeding, expanding outside the reserve, and feeding on the native reintroduced mammals.

Ben Stepkovitch releasing a burrowing bettong (*Bettongia lesueur*) that has been fitted with a radio collar. Image: Janniko Kelk

The project will investigate the differences in behaviour between bettongs that have been exposed to western quolls in the reserve, compared to bettongs in the quoll-free area of the reserve. Previous research at Arid Recovery has shown that bettongs can coexist with low densities of feral cats and increase their wariness after two years of exposure. The project will test the multi-predator hypothesis – species' response to one predator is generalised to other predators. If the multi-predator hypothesis holds, exposing bettongs to native predators may improve their awareness of introduced foxes and feral cats.

During the initial field trip this winter, radio collars were fitted to fifteen bettongs in exclosures, with and without quolls, to monitor their survival and behaviour. The project will examine how bettongs respond to different predator scents and replicas of native and introduced feral animals, including quolls and feral cats, to see if they alter their behaviour and increase their awareness. Furthermore, to determine if the reintroduction of quolls trigger anti-predator responses in naive prey, behavioural experiments will be conducted to examine the flight initiation distance, foraging behaviour, and trap docility of prey species. To identify whether reintroduced quolls are preying on and suppressing overabundant populations of bettongs, leading to a positive impact on native vegetation, the density of bettongs in areas where quolls are absent and present will be compared over time using trapping and track counts. Plant species known to be impacted by bettongs will also be monitored in each area to measure browsing damage and recruitment. To identify whether reintroduced quolls are negatively

impacting reintroduced prey species, the survival of the greater stick-nest rat, greater bilby, burrowing bettong, and western-barred bandicoot will be compared by radio-tracking individuals where quolls are present and absent. Any carcasses found will be swabbed for quoll deoxyribonucleic acid (DNA) and sent to Helix Molecular Solutions at the University of Western Australia to confirm if the animal had been predated by a quoll. Population trajectories of prey species will be compared between areas with and without quolls, using track counts and annual cage trapping.

The results of the project will help to understand the role of native predators inside fenced wildlife reserves and if native predators significantly impact resident prey species and their ecosystems. The project will also assist in planning for other groups aiming to reintroduce native predators, such as the western quoll, into wildlife reserves. There may be lessons learnt for endangered wildlife conservation elsewhere.

The project is part of a larger ARC Linkage Grant led by the University of New South Wales Sydney

Ben Stepkovitch releasing a burrowing bettong (*Bettongia lesueur*) that has been fitted with a radio collar. Image: Janniko Kelk

focussing on addressing prey naivety and subsequent vulnerability of endangered species. The project is supported by Arid Recovery, a joint conservation initiative between BHP, the University of Adelaide, South Australia Department for Environment and Water, Bush Heritage Australia, and the local community.

If you would like further information on the work being conducted at Arid Recovery, please visit their website https://www.aridrecovery.org.au/

A western quoll (*Dasyurus geoffroii*) at Arid Recovery. Image: Janniko Kelk

Shark obstetrics:
Assessing reproduction of ocean predators to climate change

CAROLYN WHEELER is a co-tutelle PhD candidate between the School for the Environment at the University of Massachusetts, Boston and the ARC Centre of Excellence for Coral Reef Studies at James Cook University. Carolyn spent the first half of her PhD working with the Anderson Cabot Center for Ocean Life at the New England Aquarium in Boston studying the effects of temperature on development and physiological performance of epaulette shark embryos and hatchlings. Now she is continuing her research at James Cook University assessing the impacts of thermal stress on reproduction in adult epaulette sharks.

Did you know that scientists use some of the same tools as medical doctors to track reproduction in sharks? Methods using ultrasound technology and blood analyses are allowing us to assess reproduction patterns in the epaulette shark (*Hemiscyllium ocellatum*), a species that is likely to experience significant changes in its environment from ocean warming caused by climate change.

Epaulette sharks reproduce by laying thick egg capsules – sometimes called mermaid's purses – that develop for three to four months on the ocean floor. During this incubation period, warm water temperatures can reduce the number of embryos that survive long enough to hatch. We have been studying how warming waters will impact the offspring of epaulette sharks. The consequences of climate change will be direr if the capacity for the parents to reproduce, in the first place, is also compromised. The project, based at the ARC Centre of Excellence for Coral Reef Studies at James Cook University under the supervision of Doctor Jodie Rummer, will aim to fill this knowledge gap. The project will be conducted on wild epaulette sharks around the Heron Island reef flats on the southern Great Barrier Reef, a known hotspot for this species. The project will use a combination of minimally invasive methods, including ultrasound and blood sampling, to determine the real-time reproductive status of sharks and how their hormone levels change over time. The project will also tag each shark with a small transponder – similar to a microchip used in cats and dogs – so they can be identified if recaptured, which will allow the project to track their reproductive status over time.

A newly hatched epaulette shark raised under current-day Great Barrier Reef temperatures. Image: Emily Moothart

There are approximately 150 species of sharks, and their relatives (rays and skates), within the Great Barrier Reef ecosystem, ranging from the largest shark in the world – the whale shark (*Rhincodon typus*) – to sharks and rays that are smaller than one metre long and unknown to most. One of these small species of shark is the epaulette shark. Named for the prominent dark black spots flanking its sides, that resemble military epaulettes, these little sharks rarely grow larger than eighty to ninety centimetres but can be found throughout the shallows of the Great Barrier Reef. Because this species is considered Least Concerned by the International Union for Conservation of Nature, it thrives in captivity and is quite docile, they have been the subject of many ground-breaking studies over the last few decades. Indeed, this species is hearty; these sharks can survive for hours in water with nearly no oxygen in it without any damage. They can even use their modified fins to 'walk' from reef flat to reef flat, even if it means getting out of the water to do so. These attributes are some of the unique adaptations that allow epaulette sharks to hunt and feed in isolated tidal pools that may be too small and potentially too challenging for other species to endure. Moreover, these are some of the reasons our team has focused on this species to investigate the effects of climate change. However, from our research thus far, warming waters seem to be problematic for this species.

Many marine ecosystems are under threat from climate change, over the next century, where warming temperatures, ocean acidification,

and deoxygenation are rapidly changing the environment. In Australia, these impacts are already evident. The Great Barrier Reef experienced large-scale bleaching events from warmer than usual water temperatures in the summers of 2016, 2017, and 2020. The effects of these events are complex, and scientists are still unsure as to how many species of coral, invertebrates, and fishes respond to these short-term seasonal heat-wave events as well as the long-term predicted warming. Furthermore, globally, shark populations are in a state of decline, mostly due to overfishing and their slow generation times and low reproductive output. Understanding how climate change will impact epaulette shark reproduction is an important step in predicting how sharks and their relatives will fair under future ocean conditions. The project's findings will aid in developing conservation plans for these species and others, both now and into the future.

An adult epaulette shark (*Hemiscyllium ocellatum*) resting on the reef flat. Image: John Gaskel

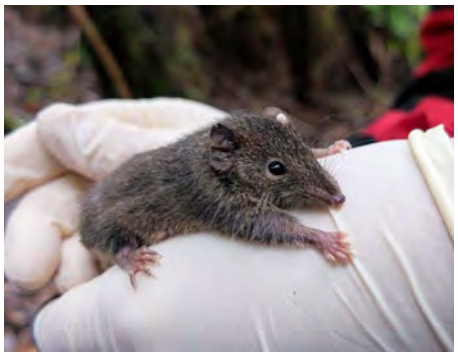
An adult epaulette shark (*Hemiscyllium ocellatum*) camouflaged on the reef. Image: Connor Gervais

A three-week-old epaulette shark embryo developing inside an egg case. Image: Martijn Johnson

Making microhabitats:
Can artificial cover enhance habitat for small mammals?

EMILY JARVIS is an honours student from Monash University, Melbourne. She completed her Bachelor of Science Degree in 2019, majoring in ecology and conservation biology. She works as a wildlife educator at Animals of Oz, an interactive and educational company, and hopes to continue researching wildlife conservation and ecology in the future.

What if the secret to protecting some of our most vulnerable native species has been hiding in the undergrowth all along? Complex microhabitats, such as rugged rocky outcrops and dense understory vegetation, reduce the hunting efficiency of feral predators by providing small animals with more places to hide. Unfortunately, rugged outcrops and dense vegetation are among the first things lost from a damaged ecosystem and are often difficult to restore. Dense ground cover and fallen timber may take decades to accumulate and some elements, such as large hollow-bearing trees, are virtually irreplaceable in our lifetime. Whilst established conservation strategies continue to lessen the impact of feral predators, their limitations mean that many species remain unprotected. With future conservation work demanding a longer-term landscape-scale approach, there is a genuine need for the development of additional budget-friendly conservation strategies.



An agile antechinus (*Antechinus agilis*).

A patient bush rat (*Rattus fuscipes*) ready for release.

A large mountain ash (*Eucalyptus regnans*) makes a prime spot for catching agile antechinus.

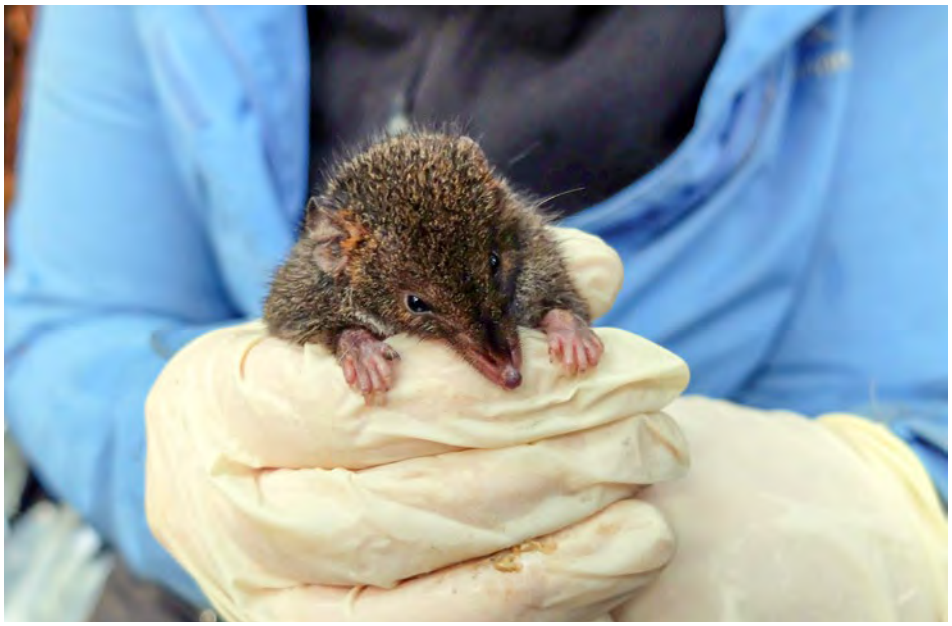
Creating complexity through artificial microhabitats

One possible conservation strategy is to use artificial microhabitats to compliment natural refuges remaining in a degraded and damaged ecosystem. Artificial tree hollows (e.g. nest boxes) are currently used as an effective conservation tool for native birds and arboreal mammals. In addition, the success of artificial 'rocks' (e.g. pavers and concrete tiles) as a viable habitat for reptiles has been widely demonstrated. Artificial microhabitats appear cost-effective at large scales and the potential for rapid deployment could offer immediate shelter for a range of native species. Importantly, it may also offer an additional management option where other conservation strategies, such as predator-proof reserves, are not viable. Nonetheless, many questions must be answered before artificial microhabitats can be readily deployed as a reliable conservation strategy.

Despite their greater vulnerability to fox and cat predation, far fewer studies have examined the potential benefits of artificial refuges for ground-dwelling mammals compared to their arboreal counterparts. Research has focused on extreme low-cover environments (e.g. deserts and post-fire) such that the effectiveness of artificial cover in more closed environments is less certain.

Artificial ground cover in wet-forest environments

The project aims to assess the effectiveness of an artificial material, hessian fabric, as a suitable refuge for small mammals in the wet-forests of southern Victoria. The project aims to contrast the effects between degraded low-cover habitat along the forest edge and denser vegetation towards the interior. The project focuses on three ground-foraging species that, despite



A dusky antechinus (*Antechinus swainsonii*) has a nibble on Emily's hand, after being weighed and measured.

being relatively common in the area, are likely already in decline. These species are the agile antechinus (*Antechinus agilis*), dusky antechinus (*Antechinus swainsonii*), and native bush rat (*Rattus fuscipes*). The project predicts that the animals will respond more strongly to the hessian microhabitat along the degraded forest edge, opposed to the denser vegetation towards the interior, given the greater benefit of additional cover on the overall habitat complexity. By using camera traps to observe how the animals interact with the fabric and comparing the live-capture rates between low and high-cover environments, we can begin to understand how small mammals respond to artificial habitats in various contexts. The results from a preliminary field trial conducted in July 2020 suggests that these species will readily utilise the hessian cover and experience it as a safe microhabitat refuge, moving through and even foraging underneath the fabric. The project hopes to confirm these results with a more expansive field experiment in late September 2020.

Why hessian fabric? Previous studies indicate that small mammals respond to artificial cover such as shade cloth and plastic tarp, however there is an overall preference among land managers for more natural refuge characteristics. Hessian fabric is a relatively inexpensive natural material that is lightweight, biodegradable and presents minimal risks to small animals (e.g. entanglement). We hope that hessian fabric may be used to enhance habitat complexity in degraded and damaged environments and will provide transitionary cover and protection for ground-foraging species whilst the forest regenerates.

Two examples of artificial cover, where hessian microhabitat was used to build habitat complexity around existing natural refuges in the forest interior.

Camera trap footage showing an agile antechinus (*Antechinus agilis*) exploring the hessian microhabitat.

Camera trap footage showing bush rat (*Rattus fuscipes*) foraging underneath the hessian fabric.

Next-generation sequencing of *Felis catus* in Australia:

Helping to elucidate feral cat population dynamics and interaction with domestic cats

JOSHUA ZIMMERMAN is undertaking feral cat genetic research at the University of New England, New South Wales

Feral cats have become ubiquitous across the Australian continent since their introduction in the nineteenth century, occurring over 99.8 percent of the mainland, and Tasmania. Cats are recognised as one of the major threats to small vertebrates across the continent, with an estimated 1,140 million animals killed by cats each year. Of these, an estimated 450 million individuals are native animals. Since European settlement, thirty native mammal species have gone extinct, with feral cats being implicated as a causal factor in most of these extinctions. As such, the management of feral cats in the landscape is one of the most important facets of small animal conservation in Australia. Though studies on cat diet and ecology have given us valuable insight into how cats interact with native animals, there is much more we need to understand about feral cats to effectively manage them in an economical, and sustainable manner.

Genomic analyses has the potential to be a powerful tool that can be used to inform the management of feral cats, and feral animals in general. They enable estimation of individual numbers in the environment, quantification of feral population interactions within and around controlled sites, and elucidation of interactions between feral and domestic cats. Previous genetic studies on cats in Australia were carried out with microsatellite markers. In these studies, they were able to determine feral cat population structures across the continent and identify two subpopulations of feral cats – a coastal western Australian population centered around Shark Bay, and a pan-Australian population encompassing the rest of the continent. Additionally, they modelled the spread of cats across the continent, identifying human-mediated dispersal as the most likely culprit for their rapid colonisation of the Australian landscape. These studies also gave some insight into the limited interactions between feral and domestic/stray cats around the Shark Bay area in Western Australia. Although these studies provided valuable information, microsatellite markers were unable to resolve population differences at sufficiently small scales to be useful for management purposes.

A feral cat with a recently killed grey shrike-thrush (*Colluricincla harmonica*). Feral cats are known to impact many small vertebrate species in Australia. Image: Daryl Panther

The project implements a newer next-generation sequencing-based genetic marker technology – 3RAD, a reduced-representation technique allowing for high-throughput and cost-effective sequencing of multiple deoxyribonucleic acid (DNA) molecules in parallel, which will provide improved resolution in downstream analysis through the generation of thousands of sequence-based markers. This new technology allows for a powerful analysis of feral cat populations at a finer scale than was previously possible with older technologies.

For this project, roughly 280 cat tissue and blood samples will be sequenced and analysed. These samples were provided by collaborators and have been taken from cats across continental Australia and Tasmania, allowing for comparison of many individuals from domestic, feral, and stray populations across numerous sites. The sampling sites in this study will include coastal Western Australia, the Kimberley region, Central Australia, multiple populations from across New South Wales, as well as populations from Tasmania, and Macquarie Island.

The aims of the project are to:

1. Elucidate genetic relationships of cats at fine-scales;
2. Test for gene flow between domestic and feral cats (whether domestic/stray cats reproduce with feral cats in areas where they may be in close contact); and
3. Quantify the levels of overall differentiation between feral and domestic populations across Australia.

In addition to these central aims, the project seeks to re-analyse continent-wide structure in feral cats, with the inclusion of more sites from eastern Australia, as well as sampled cats from the previously understudied Tasmanian mainland. Re-sequencing of roughly fifty samples, previously run using a different method, will enable comparison of the newer 3RAD technique with the older next-generation method, thereby providing a practical example of 3RAD sequencing application for wildlife studies.

Results for the project are still to come, lab work is underway, and DNA is being extracted from the tissue samples in preparation for further sequencing and subsequent analysis. The project will provide a real-world example of the efficacy of genomic analyses as an important facet in the application, appraisal, and modification of feral animal control programs in an Australian context. The ability to differentiate populations genetically at small scales could facilitate the classification of subpopulations into appropriate management units, as well as identification of subpopulations responsible for site reinvasion. Furthermore, the project could provide management officers with the ability to identify areas where control resources would be most effectively implemented, thereby improving resource use efficiency and control outcomes.

A subset of the tissue, blood, and DNA samples of domestic and feral cats held at the University of New England, New South Wales.

Mammals on the move in fire-driven mosaics

JULIANNA SANTOS is a PhD student in the School of Ecosystem and Forest Sciences at the University of Melbourne

Fire is a key part of Australian ecosystems, and many plants and animals have adaptations that help them thrive in fire-prone areas. However, substantial changes to fire-regime characteristics – including modification of fire season, intensity, frequency, and size – can cause negative impacts on wildlife. In fact, many animals and plants are currently threatened by altered fire regimes.

In fire-prone ecosystems, different fire events, that vary in intensity, frequency, size, and patchiness, create heterogeneous areas of different fire histories, that we call 'fire mosaics' (e.g. long unburnt and recently burnt areas). Because fire mosaics are composed of patches of vegetation at different successional stages, they play an important role in shaping habitat suitability and the distribution of resources for different species of animals.

An individual common dunnart (*Sminthopsis murina*) with a luminescent tag attached. The Image was taken during project trials in the Murray-Mallee region of south-eastern Australia.

The research project will be conducted in a range of fire mosaics in the Murray-Mallee region of south-eastern Australia. These semi-arid ecosystems are home to several small mammals of conservation concern, including the Mallee ningaui (*Ningaui yvonneae*), Bolam's mouse (*Pseudomys bolami*), western pygmy-possum (*Cercartetus concinnus*) and common dunnart (*Sminthopsis murina*). Based on previous studies, of species occurrence and abundance in the area, we know that some of these species prefer fire mosaics dominated by long-unburnt patches with dense vegetation, such as the Mallee ningaui. Whereas other species, such as the Bolam's mouse, can occupy a greater range of post-fire environments including more recently burnt vegetation. However, we still know little about the traits that describe the movement and foraging behaviour of small mammal species in fire mosaics. Examining animal movement patterns and habitat use can help us to better understand the mechanisms that drive species' responses to fire and adaptations that help small mammals persist in fire-prone areas.

Another important knowledge gap is how the properties of fire mosaics – such as the size, diversity, and configuration of habitats of different fire history – shape the abundance and

spatial distribution of critical resources for small mammals (e.g. habitat refuges). Patches of vegetation that remain unburnt, logs, and burrows are examples of habitat components that can be used as refuges for small mammals living in flammable areas. Refuges, a crucial habitat element, can increase the chances of an animal's survival during a fire and help them to persist in a post-fire habitat, by protecting animals from harsh weather conditions and predators.

The overarching aim of the project is to understand how animal movement is influenced by different types of fire mosaics. The project will identify critical habitat refuges within fire mosaics that enable multiple species to persist in post-fire environments. To determine how different fire mosaics shape the availability of resources and habitat refuges used by small mammals in Mallee landscapes, the project will use live trapping and direct observation to monitor the movement and habitat use of the Mallee ningaui, Bolam's mouse, western pygmy-possum and common dunnart, during periods of activity.

Individual mammals captured in pitfall traps will be fitted with small luminescent tags and tracked at night. The luminescent tags are attached to the fur on the animal's rump, using a small amount of glue. Luminescent tracking has been previously trialled with success and without harming the animal or changing its natural behaviour. Furthermore, the small luminescent tag does not impede animal movement through vegetation. After the tags are attached, individuals will be released close to their capture site and observed using a red-lensed spotlight, from approximately three metres away. The project will record data on individual activity (e.g. feeding, walking, and sheltering) and habitat complexity (e.g. leaf litter, spinifex cover, and bare ground). To determine if the small mammals prefer a specific habitat type, data on animal movement, foraging activity, and use of habitat will be compared with habitat availability and complexity at each site. These results will then be compared amongst different fire mosaics.

Fieldwork has not yet started, however is predicted to begin shortly. The project will contribute to current knowledge and understanding of the relationship between fine-scale patchiness of fires (e.g. the proportion of burnt and unburnt habitats), and the spatial arrangement and abundance of critical refuges for small native mammals. The results will inform fire management strategies in Mallee ecosystems, including how to refine the spatial arrangement of prescribed burns to protect and enhance critical habitats and refuges for small mammals. Additionally, the outcomes of the project will be critical for the development of recovery plans and conservation strategies for threatened wildlife in South Australia.

A study site, in Murray Sunset National Park, Victoria, a few months after a prescribed burn.

Are antipredator behaviours taught or inherited?

A novel approach to improve threatened species conservation

KELLY WILLIAMS is a first-year PhD candidate in the Reproductive Ecology and Conservation Biology Group at La Trobe University. She completed her Bachelor of Animal and Veterinary Biosciences with Honours in 2019, where she investigated female mate choice in the spinifex hopping mouse (*Notomys alexis*). She is now furthering her interests in animal behaviour and reproduction to conduct research that contributes towards the conservation of threatened species, a lifelong aspiration of hers.

Australia has a wonderfully unique and diverse array of fish, reptile, bird and mammal species not found anywhere else in the world. Despite this privilege, Australia is the leading country with the highest rate of mammal extinctions, with thirty-four species lost forever in the last two hundred years. Macropods are among Australia's most recognised pouched mammals, comprising the iconic kangaroos and wallabies. Of our country's fifty living macropod species, forty-two percent have a conservation status of Near Threatened or worse, while another seven species have become extinct since European settlement.

The bridled nailtail wallaby (*Onychogalea fraenata*) was once widespread throughout eastern Australia and initially thought to be extinct until a chance rediscovery in 1973. Today, the species is nationally classified as Endangered, surviving in small wild populations in Queensland and translocated populations within fenced reserves in New South Wales. However, the translocated populations comprise less than one percent of its former range. Fortunately, conservation measures are being implemented in efforts to help the species recover.

Recovery programs often aim to return species to their former range, yet to date, reintroductions of animals into wild habitats with non-native predators have been largely unsuccessful. Predation by feral cats and introduced foxes is the primary cause of reintroduction failure in threatened Australian mammals. Prey animals need to be able to recognise and respond appropriately to predators if they are to survive. However, many small mammals, like the bridled nailtail wallaby, have not evolved alongside cats and foxes and therefore have ill-equipped defences. Furthermore, when populations are isolated from predators, such as on islands, within fenced reserves and in captivity, antipredator behaviours can diminish as a result of relaxed predation pressures. These predator-naïve populations are often the source of individuals used for reintroductions, which begs the question: how are they going to cope with predators in their new, wild home?

The bridled nailtail wallaby (*Onychogalea fraenata*) is a small and Endangered mammal unique to Australia. Image: Kylie Robert

Antipredator behaviours include those used to avoid and recognise predators and respond to their attacks. A typical wallaby response to a predator involves fleeing, hiding or freezing. Many macropod species also use an alarm signalling foot-thump, in which the ground is thumped with one or both hind feet. The behaviour is thought to have one of two functions, firstly as an audible alarm signal to warn other nearby wallabies of the present danger, and the other to alert the predator that they have been detected to hopefully deter their attack. Foot-thumping has been recorded in some populations of bridled nailtail wallabies but not in others. The project aims to understand how juvenile wallabies acquire their antipredator behaviours, focusing on foot-thumping. Is it learnt or inherited?

A wallaby joey develops in the pouch over many months, offering an ideal opportunity to examine how the mother influences the behaviour of her offspring. To investigate this, the project aims to exchange pouch young between mothers that do not foot-thump and mothers that do foot-thump. The project will utilise bridled nailtail wallabies from a population not known to foot-thump and tammar wallabies (*Notamacropus eugenii derbianus*) that readily exhibit the behaviour. Both wallaby species are small, nocturnal and predominantly solitary. After cross-fostering has occurred, the joeys will be

raised in three separate groups. Once they have reached weaning age, they will have their antipredator behaviours assessed. The first group will comprise the nailtail joeys with tammar mothers to determine if the joeys acquire foot-thumping from their mothers non-genetically (hence, behaviourally). The second group will be tammar joeys with nailtail mothers to see if foot-thumping is retained, indicating a genetic basis for the behaviour. The third enclosure will be a mixed group of nailtail joeys with nailtail mothers and tammar joeys with tammar mothers to determine if the nailtails can socially learn foot-thumping by observing the tammars. To assess antipredator behaviours, mothers and joeys will be safely exposed to a live dog, with dingo-like features, on several occasions. The live dog will be located on the external side of the fenced enclosures and the wallaby's responses will be recorded via video. The project is also interested in determining if the strength of responses displayed by an individual wallaby matches that of its biological or foster mother, for example, if more vigilant mothers produce similarly vigilant offspring. The findings of this project will be invaluable, as understanding antipredator behaviours has implications for future reintroductions of threatened species.

If critical survival behaviours are being lost as a result of reduced selection pressures in environments uninhibited by predators (such as in captive breeding colonies and predator-free reserves), this will have dire long-term effects on a species' survival in any post-release environment. Reintroduced animals need to be able to recognise and respond to predators present in their new habitat if the population is to become sustainable – the overarching aim of reintroduction projects. Therefore, we must continue to improve our understanding of essential behaviours through research, so we can make informed management choices. Findings from this research can then be used to develop behavioural criteria to assist in choosing individuals most suitable for breeding or release projects. Furthermore, the continued development of novel techniques to help animals maintain, and even improve, their antipredator behaviours, is desperately needed to ensure that Australia's unique species persist for future generations.

Joeys will be swapped between bridled nailtail wallaby (*Onychogalea fraenata*) mothers (left) and tammar wallaby *(Notamacropus eugenii derbianus*) mothers (right) and then have their predator responses evaluated at weaning age. Images: Kylie Robert

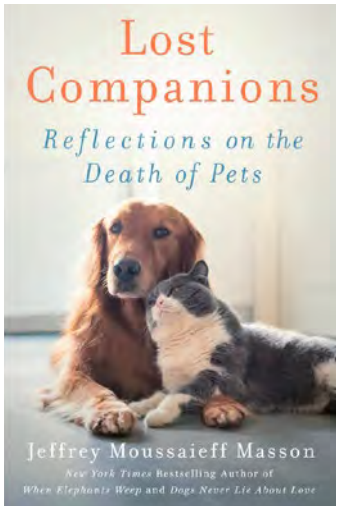
As it grows, a bridled nailtail wallaby (*Onychogalea fraenata*) joey will periodically leave its mother's pouch to explore the outside world. Image: Kylie Robert

Book Reviews

***Life Upside Down* by Doug Gimsey**

Few of nature's animals are as misunderstood as bats. Dive into the upside-down world of Australia's grey-headed flying-foxes (*Pteropus poliocephalus*) and discover more about their habitat, body structure and behaviours, while also learning about practical ways you can help protect this amazing species. Each spread captures a new side of this curious animal, brought to life with breathtaking photography and fascinating facts.

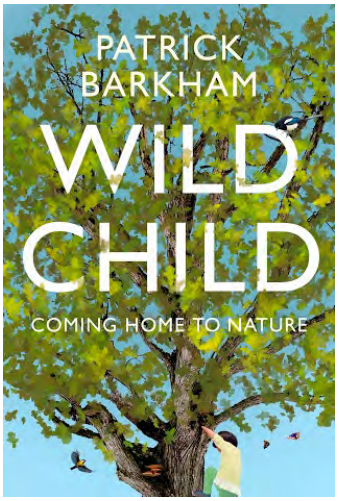
Publisher: Australian Geographic
RRP: $19.95



***Lost Companions: Reflections on the Death of Pets* by Jeffrey Moussaieff Masson**

Exploring a special bond between animals and humans, Jeffery Masson validates the grief that humans feel when a special non-human friend dies. Chapter six of *Lost Companions* incorporates a story of Val and a wombat named Birubi, which beautifully illustrates the strong bond that humans form with wild animals. The story highlights the important role of wildlife carers in ensuring the conservation of native wildlife and questions whether we can become friends with a wild animal. The author takes a personal approach, allowing readers to explore their own responses, suggesting ways through and out of grief, as well as meaningful ways to remember our best friends.

Publisher: Murdoch Books, an imprint of Allen & Unwin
RRP: $29.99



***Wild Child: Coming Home to Nature* by Patrick Barkham**

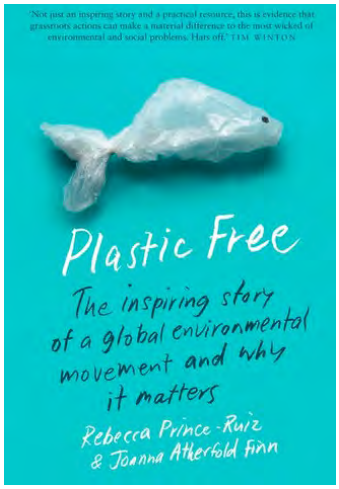
Nature writer Patrick Barkham draws on his own experience as a parent and a forest school volunteer to explore the relationship between children and nature. Unfolding over a year, *Wild Child* is both an intimate story of children finding their place in the natural world and a celebration of the delight we can find in the smallest patches of green. From climbing trees to pond-dipping, many of the activities we associate with a happy childhood take place outdoors. The reality for many children today is very different. Current research tells us that we are raising a generation who are alienated from nature that they are not able to identify common birds or plants, they do not know where their food comes from and spend very little time in green spaces. *Wild Child* will encourage you to re-establish a connection with nature.

Publisher: Allen & Unwin
RRP: $34.99

***We're Going on a Treasure Hunt* by Marsha Mumford and Laura Hughes**

This beautifully illustrated lift-the-flap book is packed full of treasure and a variety of wildlife to spot along the way. With ten gold coins to find hidden under the flaps, it is an action-packed treasure hunt! You will need to watch out for the obstacles along the way – leaping dolphins, colourful parrots, scary sharks and snappy crabs. What other wildlife can you spot? This is the perfect gift for anyone who loves animals and adventure.

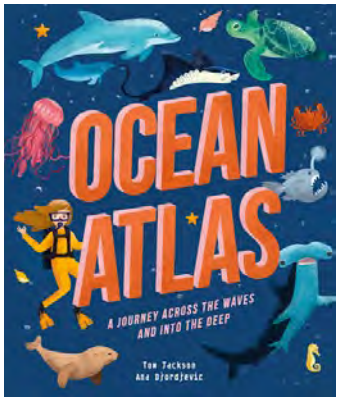
Publisher: Bloomsbury
RRP: $14.99



***Plastic Free* by Rebecca Prince Ruiz & Joanna Atherfold Finn**

Plastic Free tells the incredible story of how a simple community initiative grew into one of the world's most successful environmental movements. It shares tips from people around the world who have taken on the Plastic Free July challenge and significantly reduced their waste. *Plastic Free* is a book about positive change and reminds us that small actions can make a huge impact. Although you may feel overwhelmed by the current environmental situation, use this book to be inspired or use it as a template to change the world in your own way. By making small but significant changes in our lifestyle and buying choices, we can create real change.

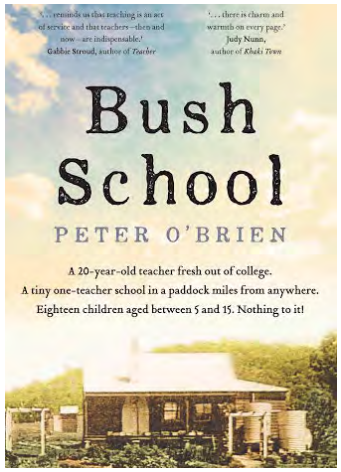
Publisher: NewSouth Publishing
RRP: $32.99



***Ocean Atlas* by Tom Jackson**

Dive into an incredible underwater journey as *Ocean Atlas* takes you on a comprehensive discovery of our oceans. From the Arctic Ocean to the Southern Ocean, a range of important topics are covered through a mix of illustrations, photographs, maps and diagrams. Map out the ocean seabed and identify the different animals that live there, learn about ocean currents and interdependent ecological systems and discover how climate change affects the oceans and what action we can take to protect our oceans for future generations.

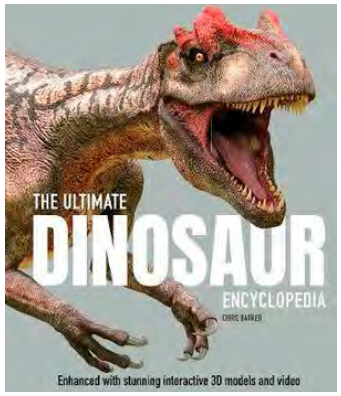
Publisher: Allen & Unwin
RRP: $24.99



***Bush School* by Peter O'Brien**

Bush School is an inspiring story of the author and former teacher, Peter O'Brien, on his first assignment in remote Australia. O'Brien's story, in a one-teacher bush school, is told with great integrity and explores the unique challenges and opportunities faced by small schools. After reading *Bush School*, you will have learnt the transformative power of a good teacher, the importance of education (particularly in regional areas of Australia), how to overcome challenges and fears (including snakes and unimaginable living conditions), and the resilience and spirit of children when they are believed in, nurtured and provided with responsibilities.

Publisher: Allen & Unwin
RRP: $29.99



***The Ultimate Dinosaur Encyclopedia* by Chris Barker**

Chris Barker, palaeontologist and author, uses Augmented Reality to bring dinosaurs to life as 3D models in your book. View the page through the free app and you will see dinosaurs spring to life, complete with interactive notes. Experience the marvels of the meat-eating Phytosaurs from the Triassic era to the herbivorous Triceratops from the Cretaceous Era. Using original CGI models and stunning paleoart, the whole world of dinosaurs has been recreated and you can even view them as terrifying life-size models. Take a step back in time and relive the wonders of the past.

Publisher: Allen & Unwin
RRP: $39.99

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 conservation group that is making a major contribution to wildlife preservation in Australia. The Society will present a plaque and a cash award of $2,500 to the winning conservation group that is helping to preserve Australia's precious wildlife.

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 Street, HURSTVILLE NSW 2220. Deadline for submission 31 December.

Australian Wildlife Society

Wildlife Rehabilitation Award

Nomination Form

Australian Wildlife Society
Conserving Australia's Wildlife since 1909

The Australian Wildlife Society Community Rehabilitation Award will be awarded to an individual or a conservation group that is contributing to the preservation of Australia's wildlife. The Society is aware that many organisations and thousands of volunteers are working tirelessly to save Australia's wildlife and the habitat in which they live. Many people find the experience of rehabilitating native wildlife rewarding; however it is time-consuming and can be very expensive. The award is intended to acknowledge and commemorate, on behalf of the whole community, the individuals or conservation groups working tirelessly to support, rehabilitate and conserve Australia's native wildlife. Our Society will present a trophy and a cash award of $1,000 to the winning individual or conservation group.

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: E-mail:

Name of nominee:

Address:

Telephone: E-mail:

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 e-mail to **info@aws.org.au** or mail to 29B/17 Macmahon Street, HURSTVILLE NSW 2220. Deadline for submission 31 December.

Australian Wildlife Society

The Serventy Conservation Award

Nomination Form

Australian Wildlife Society
Conserving Australia's Wildlife since 1909

The Serventy Conservation Award is named in honour of the Honourable Dr Vincent Serventy AM, his brother Dr Domonic Serventy, an international ornithologist, and his older sister Lucy Serventy. The award is intended to recognise and celebrate conservation work that has not been done as part of a professional career. It is awarded to those who labour in the conservation field for a love of nature and a determination that it should be conserved. Often, these have been non-scientists who have earned their conservation skills through sheer hard work. Our Society will present a plaque and a cash award of $1,500 to the winning person that is helping to save Australia's precious wildlife.

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: E-mail:

Name of nominee:

Address:

Telephone: E-mail:

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 e-mail to **info@aws.org.au** or mail to 29B/17 Macmahon Street, HURSTVILLE NSW 2220. Deadline for submission 31 December.

Australian Wildlife Society

Youth Conservation Award

Nomination Form

Australian Wildlife Society
Conserving Australia's Wildlife since 1909

The youth of Australia make significant contributions to the conservation movement through innovative projects and ideas. It is young people who can drive lasting and sustainable change who will become the next ambassadors in environmental conservation and hopefully the successors to the current board of the Australian Wildlife Society. We aim to inspire young people to have a stake in environmental conservation by rewarding and recognising their efforts. The Australian Wildlife Society will provide an annual award of $500 to a young individual or small organisation who contributes to the conservation of Australian wildlife. A trophy and certificate will accompany the cash 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: E-mail:

Name of nominee:

Address:

Telephone: E-mail:

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 e-mail to **info@aws.org.au** or mail to 29B/17 Macmahon Street, HURSTVILLE NSW 2220. Deadline for submission 31 December.

Membership Form

Membership

Become a member of the Australian Wildlife Society
Simply fill out this form.

Australian Wildlife Society
Conserving Australia's Wildlife since 1909

Name: .....

Address: .....

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

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

Email: .....

Membership category (please tick)

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

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

Three year membership (please tick)

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

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

Payment details (please tick)

☐ Direct Debit ☐ Cheque ☐ Money Order ☐ Mastercard ☐ Visa

Card Security Code (CSC) __ __ __ __

Card Number:

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

Signature: .....

Amount $ .....

Donation $ .....

Total $ .....

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

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

Membership Hotline: Mob: 0424 287 297

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

Consider - A Bequest

Another way which you can support the work of the Australian Wildlife Society is to remember us in your will.

If you would like to make a bequest, add the following codicil to your Will:

> I bequeath the sum of $..... to the Wildlife Preservation Society of Australia trading as the Australian Wildlife Society for its general purposes and declare that the receipt of the Treasurer for the time being of the Society shall be complete discharge to my Executors in respect of any sum paid to the Wildlife Preservation Society of Australia Limited trading as the Australian Wildlife Society.

"The challenge to the present adult generation is to reduce the increasing pressures on the Earth and its resources - and to provide youth with an education that will prepare them emotionally and intellectually for the task ahead."