2023 University Research Grant Winners

The Australian Wildlife Society's University Research Grants are offered to honours or postgraduate students at Australian universities conducting research that contributes to the conservation of Australian wildlife (flora or fauna). Ten grants are awarded each year: one $5,000 scholarship and nine $3,000 grants.

The Society is proud to have awarded our very first Dr Clive Williams OAM Memorial Wildlife Conservation Scholarship in honour of former Director, Dr Clive Williams. The scholarship is awarded to the highest-ranked applicant of all our University Research Grants.

Grants may be used to purchase equipment and consumables, travel expenses related to field research, or attend a conference where the student presents their research.

The Australian Wildlife Society is delighted to announce the winners for 2023:

Jack Bilby

(Dr Clive Williams OAM Memorial Wildlife Conservation Scholarship Recipient)

School of Biological, Earth and Environmental Sciences, University of New South Wales.

Project Title: Beating the Heat: How do Bandicoots Respond to Extreme Heat in Burnt and Unburnt Habitat?

Natarsha McPherson

School of Biological Sciences, The University of Adelaide.

Project Title: Distribution and Density of the Southern Hairy-Nosed Wombat (*Lasiorhinus latifrons*) under the Influence of Future Climate Change and Invasive Rabbit Competition.

Anne Ibbotson

School of Biomedical Sciences and Pharmacy, The University of Newcastle.

Project Title: The Potential for Stress and Reproductive Hormones to Inform Conservation Decisions for Endangered Amphibians.

Océane Attlan

School of Biological Sciences, The University of Western Australia.

Project Title: Temperate Marine Ecosystems under Tropicalisation: An Insight of Species Reshuffling and Ecological Function Changes along the Western Australia Coastline.

Hannah Gerke

Fenner School of Environment and Society, The Australian National University.

Project Title: Measuring Movement Behaviour and Personality of Eastern Brown Snakes in Urban Areas: Snaking our Way Towards Successful Conflict-Driven Translocation.

Olivia Johnson

Institute for Marine and Antarctic Studies, University of Tasmania.

Project Title: Safeguarding Threatened Reef Species.

Holly Farnan

Centre for Tropical Environmental and Sustainability Science, James Cook University.

Project Title: Investigating the Effects of Insecticide Exposure and Pathogens on Bee Diversity, Abundance, and Health.

Paula Ruiz

Institute for Marine and Antarctic Studies, University of Tasmania.

Project Title: Mechanisms of Stability for Degraded 'Turf-Dominated' Reef States.

Natalie Grassi

School of Environmental and Conservation Sciences, Murdoch University.

Project Title: Faunal Assemblages and Ecology at Conservation Connectivity Areas Within a Fragmented Agricultural Landscape.

Raquel Parker

School of Life and Environmental Sciences, The University of Sydney.

Project Title: Using Carcasses to Investigate Ecosystem Processes in Feral Predator-Free Fenced Areas, NSW.

Out of the Frying Pan, Into the Fire:

How do Bandicoots Respond to Heatwaves in Burnt Habitats?

Jack Bilby

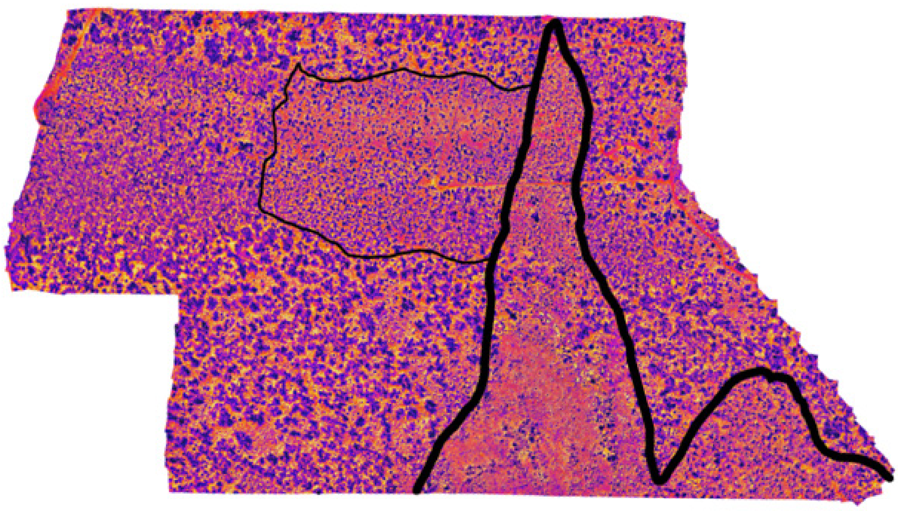
School of Biological, Earth and Environmental Sciences, University of New South Wales

Dr Clive Williams OAM Memorial Wildlife Conservation Scholarship Recipient

Arid habitats include a diverse range of desert, grassland, and woodland and comprise over 70 percent of the Australian continent, hosting significant assemblages of Australian biodiversity, including many threatened mammal species. Under anthropogenic climate change, these arid habitats are projected to experience an increase in the frequency and intensity of extreme heat events in the coming decades.

Australia is notorious for its high extinction rate of native mammals, particularly in the arid zone. This concerning and continuing extinction rate of small native mammals has resulted from significant habitat modification and predation by feral cats and foxes. Extreme heat events and their interacting effects with droughts and changing fire regimes represent a novel threat to vulnerable mammal taxa, and the ability of these species to adapt and survive these abiotic pressures is poorly studied. Heatwave intensity and frequency may soon exceed critical physiological limits for these species.

Many arid zone mammals, such as bilbies and wombats, construct complex burrow systems to evade daytime thermal extremes. These burrows are often occupied by other species that may be incapable of constructing such protective shelters, allowing them to survive in such harsh conditions. Other species, including dunnarts and planigales, use deep soil cracks to escape the dangerous heat of the day. However, some mammal species completely forgo the use of underground shelters, instead sheltering beneath surface vegetation or within hollow logs. During summer, it is likely that these species survive at the very edge of their thermal limit.



Thermal drones investigate differences in peak surface temperatures across burnt ages and habitat types. The thick outline indicates the extent of the 2019 uncontrolled burn, while the thin outline denotes a low-intensity controlled burn in 2013. Image: Jack Bilby.

The Shark Bay bandicoot (*Perameles bougainville*), the smallest bandicoot species averaging just 250 grams, is one such species to shelter on the surface. They nest in shallow depressions concealed by leaves and sticks, which may leave them vulnerable to extreme surface temperatures. Their small body size is also a disadvantage, as their body temperature will likely increase rapidly, resulting in increased water loss during thermoregulation. Considering their endangered status, these additive factors indicate that this species is highly susceptible to extreme heat events.

A population of Shark Bay bandicoots has been established in the Secret Rocks Mallee Refuge, a predator-free reserve in semi-arid South Australia. In 2019, a high-intensity wildfire burnt a substantial area of the reserve, significantly reducing understory and canopy cover. Bandicoots continue to occupy these burnt areas, suggesting they can find suitable shelters for typical summer temperatures. It remains unclear, however, how bandicoots will respond to future extreme heatwaves and if fires will limit their ability to survive during these increasingly regular events.

The primary goal of this project is to answer the following questions:

1. How does fire influence the thermal buffering capacity of bandicoot shelter sites?,
2. Do bandicoots adjust their shelter selection to account for these conditions?, and
3. Do bandicoots adjust their activity times and foraging areas during extreme heat events?

We are investigating shelter availability and quality across different habitat types and fire histories to answer

The Shark Bay bandicoot (*Perameles bougainville*) is the smallest bandicoot species and may be especially susceptible to extreme heat events. Image: Jack Bilby.

This bandicoot (*Perameles bougainville*) will receive a tail transmitter, a VHF and a GPS transmitter to examine her movements across the landscape. Image: Jack Bilby.

Jack conducts bandicoot (*Perameles bougainville*) measurements in the field. Image: Harrison Kent.

Jack and volunteer, Laura Murray, check the final cage trap of the morning. Image: Harrison Kent.

these questions. This assessment will occur at both a micro-scale, assessing thermal buffering of individual shelter sites, and a macro-scale, measuring heat distribution and shelter availability across the landscape. To evaluate the thermal buffering of shelter sites, data loggers are being used to measure and compare local ambient and surface temperatures with temperatures experienced within different types of bandicoot nests. By performing point-intercept transects and using a drone to create a temperature map of our extensive study area, we can investigate average and peak surface temperatures in relation to burn age and habitat structure.

To investigate bandicoot shelter selection, we determine the proportion of shelter sites used and how their occupancy changes with increasing temperatures. To identify shelter occupancy and movement of bandicoots, VHF transmitters are attached to the tail, and individuals are tracked to their diurnal shelter sites. These units emit a radio pulse every second, which increases in frequency as you approach the unit, allowing us to triangulate the precise location of the bandicoot with minimal disturbance.

Bandicoot nocturnal behaviour during heatwaves will also be monitored using GPS transmitters attached to their tails. These devices record the bandicoot's location every 30 minutes each night, facilitating spatiotemporal analysis of their movements and foraging habits within their home ranges. Combined with the thermal drone footage, we can see whether they are selectively foraging in cooler areas. We will observe active bandicoots with a thermal scope during extreme heat events and record any apparent microhabitat selection or novel thermoregulatory strategies where possible.

Over 30,000 hours of temperature logging data have been collected from bandicoot shelter sites, and ten individuals have been radio-tracked to thirty-nine unique shelter sites over 217 days. This project will allow us to develop knowledge on how burning, wildfire and prescribed, will affect critical thermal refugia in a mallee ecosystem, and the potential consequences for threatened surface-dwelling species.

Shark bay bandicoots may be especially vulnerable to the effects of extreme heat events, but they certainly will not be the only species affected.

Funds provided by the Australian Wildlife Society will assist with project-related travel and the purchase of temperature and humidity data loggers, VHF transmitters, and a thermal scope.

The Missing Link:

Understanding Stress and Reproduction in Integrated Conservation for Imperilled Amphibians

Anne Ibbotson
School of Biomedical Sciences and Pharmacy, The University of Newcastle

Investigating new approaches and methods to amphibian conservation to assess population health is critical, given that over 40 percent of amphibian species are classified as threatened with extinction. This status makes amphibians the most impacted group of vertebrates in the current global mass extinction crisis. The fungal skin disease chytridiomycosis (or chytrid, for short) is the primary driver of the decline in many species. However, climate change and human-driven threats such as habitat loss and disturbance, pesticide use, and invasive species operate as multiple stressors on amphibian populations. While both in-situ and ex-situ conservation efforts are growing in an attempt to arrest global amphibian declines, they are not always successful, and the cause of these failures is often elusive.

As amphibians are forced to adapt to a rapidly changing environment, chronic stress may impair breeding and suppress the immune system, leaving populations less able to fight disease. Failure to reproduce starts a slippery slope to local population extinction. Thus, there is a need to understand the impacts of threats and stressors on reproduction, disease susceptibility, and overall fitness of individual threatened species. In human and veterinary medicine, biomarkers are used to gain a snapshot of individual fitness and population health to better direct limited resources to where they are most effective. This approach could be used to understand amphibian health with minimal impact on the animal and maintain the welfare of the endangered species. Utilising this approach would represent a critical improvement to traditional methods that are often invasive and, therefore, unsuitable for endangered species.

A survey for Littlejohn's tree frog (*Litoria littlejohni*) in the Blue Mountains National Park. Image: Anne Ibbotson.

Integrating non-invasive conservation physiology using biomarkers might be the missing link in amphibian recovery efforts. Biomarker data from stress and reproductive hormones measured in urine will be collected from the endangered Littlejohn's tree frog (*Litoria littlejohni*). Littlejohn's tree frog is restricted to three small and isolated mountainous regions in New South Wales, and is susceptible to chytrid and ongoing threats, including habitat loss and disturbance, and increased frequency and magnitude of drought and wildfires resulting from the shifting climate. Assessment of hormone levels complements current in-situ and ex-situ amphibian conservation efforts by the Conservation Science Research Group at The University of Newcastle and their partners, NSW National Parks and Wildlife Service and Forestry Corporation. Understanding the response of individuals to habitat supplementation efforts in the Watagan Mountains on the New South Wales Central Coast and monitoring the effectiveness of breeding efforts to supplement population size is of utmost importance.

The project will track seasonal hormonal changes in amphibians using urine sample volumes as low as 0.02 millilitres. The primary stress hormone, corticosterone, and the reproductive hormones testosterone, oestrogen, and progesterone will be analysed using mass spectrometry – the gold standard for human hormone measurement. This novel approach in conservation physiology generally uses enzyme immunoassay methods that are limited in their scope.

Top: Anne is swabbing a Littlejohn's tree frog (*Litoria littlejohni*) for chytrid during a survey in the Watagan Mountains. Image: Nadine Nolan.

A Littlejohn's tree frog (*Litoria littlejohni*) in the wild in the Watagan Mountains. Image: Anne Ibbotson.

This project complements research conducted by PhD student, Nadine Nolan, and Dr Rose Upton, who measure sperm quality in male frogs and egg development via ultrasound in females. This collaboration allows biomarkers to be correlated with reproductive output (sperm quality) and reproductive status (egg development), which should aid the interpretation of biomarker results. If non-invasive hormone levels prove to be a valuable biomarker for reproductive output, they may contribute to the appropriate selection of individuals for breeding and investigation of cases of reproductive failure.

The stress and reproductive hormone data from the wild population of Littlejohn's tree frog in the Watagan Mountains will be correlated with results from chytrid testing and integrated with current ecological measures and genetic diversity research to gain valuable knowledge regarding the relationship between disease (chytrid), stress and reproductive hormones, and genetic diversity. Low genetic diversity is often associated with inbreeding depression, where reduced survival and fertility of offspring are seen with related individuals. Chytrid is tested using a polymerase chain reaction from non-invasively collected skin swabs. Together, these projects may help determine sublethal environmental stressors and effectively monitor the success of current conservation strategies beyond counting the number of individuals occupying a habitat.

The overarching goal is the development of optimised methods for collecting non-invasive biomarkers of stress and reproduction in threatened amphibians, and the subsequent publishing of guidelines to determine population health in the wild. It should provide land managers with the practical and conceptual framework to include gold standard assays of physiological health alongside traditional ecological survey methods to make the best evidence-based conservation decisions. While the project is centred around threatened amphibians, the platforms we wish to develop can be translated to any threatened vertebrate species.

Funds provided by the Australian Wildlife Society will fund reagents and consumables, and measure hormone levels in Littlejohn's tree frogs using mass spectrometry.

An example of Littlejohn's tree frog (*Litoria littlejohni*) habitat in the Watagan Mountains. Image: Anne Ibbotson.

Movement Behaviour and Personality of Eastern Brown Snakes in Urban Areas:

Snaking Our Way Towards Successful Translocation

Hannah Gerke
Fenner School of Environment and Society,
The Australian National University

If you have spent time in the bush in spring or summer, you may have encountered a familiar sight – a big brown snake stretched across a path, soaking up the sun before it slithers off into the grass. But have you ever encountered one unexpectedly in the garden or your home? Such a scenario happens to hundreds of people yearly in the Australian Capital Territory alone, where eastern brown snakes (*Pseudonaja textilis*) are the most-encountered snakes in urban areas. Although life in human-occupied spaces is fraught with danger for a snake, many individuals take the risk to access the plentiful food, water, and refuge opportunities available in suburbs and cities. Once spotted by humans, the result is often a call to the snake catcher and a quick trip to the nearest nature reserve.

Unfortunately, the fate of translocated snakes is usually unknown. Advances in tracking technology, such as GPS and radio transmitters, have transformed our ability to monitor animal movements and survival. However, the costs and effort required remain a significant barrier in most management scenarios. Nonetheless, a small but growing body of research indicates that moving snakes outside their home range can negatively affect their welfare because snakes must find prey, search for shelter, and evade predators while navigating an unfamiliar environment. Translocated snakes often move greater distances compared to resident snakes, which can increase their energy expenditure and stress, and impair their reproductive ability or overwinter survival. Excessive movement also increases the chance of predation and may unintentionally cause more conflict with humans, as translocated snakes frequently return to residential areas.

Developing effective management strategies that reduce human-wildlife conflict without comprising animal welfare is essential in the face of growing biodiversity declines linked to human activities. A significant challenge for improving snake management outcomes is the lack of species-specific data on basic life history and behaviour. Research on snakes has been historically underfunded and understudied compared to groups like mammals and birds, partly due to their cryptic nature. Ecological research on venomous snakes is vital, as spatial ecology, activity patterns, and behaviour influence human-snake interactions. However, individual snakes can vary in their movement and behaviour due to a variety of factors (including sex, size, reproductive status, and previous experience), which can make it more difficult to predict their behaviour. An increasing number of studies indicate animals have different 'personalities' that contribute to this variation among individuals, and snakes are no exception.

An eastern brown snake (*Pseudonaja textilis*) cruises down an urban path in Canberra, Australian Capital Territory. Image: Gavin Smith.

Animal personality can be defined as 'consistent individual differences in behaviour that are repeatable over time' and is often measured along axes in five main categories: boldness, exploration-avoidance, activity, aggressiveness, and sociability. When confronted with a situation such as a novel environment or a predatory threat, individuals in a population may react differently from each other, thus resulting in a diversity of behavioural types that can result in evolutionary trade-offs. For example, some research suggests bolder individuals may have a survival advantage in high-risk situations, such as occupying urban environments. Personality influences several key ecological factors, including survival, movement and dispersal, habitat selection, disease transfer, and reproduction. It also has repercussions for wildlife management, as differences in behaviour can lead to biased detection probability and sampling (e.g., bolder individuals are more willing to enter traps). By accounting for among-individual variation in behaviour, we can improve conservation outcomes and better predict wildlife responses to disturbances caused by human activities.

A particularly stunning eastern brown snake (*Pseudonaja textilis*) in a typical defensive posture, hoping to be left alone. Image: Damien Esquerré.

This project aims to understand how translocation influences eastern brown snake movement behaviour and survival in the Australian Capital Territory. Specifically, our research asks the following questions:
1. Do translocated snakes experience reduced growth or survival compared to resident brown snakes?,
2. Do translocated snakes move further and/or more frequently than resident snakes, or show differences in habitat selection?,
3. Are translocated snakes able to maintain similar body temperatures and thermoregulate as efficiently as resident snakes?, and
4. Do brown snakes exhibit variation in personality traits among individuals, and if so, is personality linked to behaviour, movement, or survival in the field?

To answer these questions, we will fit resident and translocated male brown snakes with radio transmitters to track their movement behaviour and overall welfare. We will also implant miniature data loggers to measure the internal body temperatures of all snakes, compare them to environmental temperatures, and examine differences in thermoregulatory efficiency between resident and translocated snakes. If translocated snakes are unable to maintain (or take longer to reach) preferred body temperatures, this could have consequences for fitness or growth, as temperature influences a variety of physiological processes in ectotherms (digestion, immune function, and reproduction).

We will quantify variation in personality traits by recording individual behavioural responses to ecologically relevant tests repeated in a controlled lab setting prior to radio transmitter implantation and release. Snakes will be introduced to a novel enclosure with cameras used to record:
1. Activity level,
2. Latency to emerge from a shelter (boldness),
3. Exploration of a novel area, and
4. Anti-predator defensive behaviour and latency to strike during a simulated 'attack'.

An individual's change in behaviour to repeated tests will also be measured, as it indicates habituation and has implications for their ability to adapt to a new environment. We will then evaluate the effects of personality on snake survival and movement metrics in the field. Our results will further our understanding of causes of variation in individual snake movement and provide crucial insight into the ecology of a common but understudied venomous snake.

This research is being conducted as part of the Canberra Snake Tracking Project. The project, founded in 2020 by Associate Professor Gavin Smith, is a collaborative effort that brings together academics, wildlife conservation professionals, and the public in an interdisciplinary approach to snake conservation. It is dedicated to community engagement and education to decrease human-snake conflict. Visit https://tinyurl.com/CBRSnakeProject to follow our progress on Facebook.
We would also like to acknowledge the support and funding of the ACT Government, the Ginninderry Conservation Trust, the Royal Zoological Society of NSW, the Holsworth Wildlife Research Endowment (Equity Trustees Charitable Foundation), and the Ecological Society of Australia.

Radio tracking a resident eastern brown snake (*Pseudonaja textilis*) who frequently hangs out at a farm bordering an urban nature reserve. The interface of suburbs, paddocks, and protected land offers a tempting combination of resources for a brown snake. Image: Sarin Tiatragul.

The funds provided by the Australian Wildlife Society will be used to purchase critical equipment for conducting behavioural tests, including cameras for recording snake behaviour and materials to build a customised test arena suitable for holding large venomous snakes.

Top: Holly with a bee hotel. Image: Campbell Simpson.

Investigating the Effects of Insecticide Exposure, and Pathogens and Parasites on Bee Diversity, Abundance, and Health

Holly Farnan

Centre for Tropical Environmental and Sustainability Science, James Cook University

While the introduced honeybee (*Apis mellifera*) provides essential pollination services to agricultural ecosystems in Australia, our native bees are often overlooked, and many people do not even realise that other bees exist. Australia is home to around 1,800 species of bees, with 20,000 species described globally. Our native bees are incredibly diverse in size, form, colour, and behaviour. While some appear similar to honeybees, many others are wasp-like in appearance. Bees have evolved to specialise in a diet of nectar and pollen, transporting pollen from flower to flower and pollinating plants as they forage.

Despite their immense importance in pollinating native vegetation and agricultural crops, bees are threatened by a myriad of stressors, including habitat loss, pathogens and parasites, competition from introduced species, poor nutrition, and insecticide exposure. The effects of these stressors will be exacerbated by global climate change. Studies investigating these threats favour the introduced honeybee, and little is known about their impact on the thousands of other species. Furthermore, many studies stop short of exploring stressors in combination with other factors.

Insecticides

While the development and global implementation of insecticides in agriculture have revolutionised crop production, these chemical compounds have brought the welfare of non-target beneficial insects, including bees, into direct conflict with industrial agriculture. Along with the lethal effects of insecticides, many sublethal effects have been documented in bees, including disrupted learning and memory, impaired reproduction, and impaired locomotion. However, most research on the impact of insecticides on bees has focused on the introduced honeybee, with many questions remaining as to what impacts they may have on non-*Apis* bees.

Pathogens and Viruses

In the introduced honeybee, pathogens and viruses directly affect the colony's foraging function, longevity, and fitness, and can also interact with other stressors, such as insecticide exposure, to degrade bee health. While studies on non-*Apis* bees are scarce, research has shown that pathogens and parasites can be transferred between the introduced honeybee and other insect species, including non-*Apis* bees.

Bee Hotels

Concern for bees among the public has led to the augmentation of bee habitats by adding food plants ('bee-friendly' plants) and nest sites (bee hotels). Bee hotels, also known as trap nests, use some bees' nesting preferences for above-ground cavities, such as pithy stems and holes in wood. Bee hotels are often claimed to increase bee diversity and abundance. However, they artificially aggregate nesting sites above densities naturally available for cavity-nesting bees, which could lead to increased prevalence of pathogens and parasitism, higher predation rates, and transmission of pathogens to novel host species that would not usually nest together.

Wet Tropics Rainforest

The project site is 50 metres from the edge of urban residential areas and agricultural land abutting lowland rainforest. Further uphill from the site is the Wet Tropics World Heritage Area rainforest. The Wet Tropics

Building bee hotels. Image: Campbell Simpson.

Inspecting bee hotels for occupants. Image: Campbell Simpson.

A fire-tailed resin bee (*Chalicodoma mystaceana*) is building her nest in one of the bee hotels. Image: Holly Farnan.

The kleptoparasitic neon cuckoo bee (*Thyreus nitidulus*) lays her eggs in the nests of other native bees so that her larvae can devour the resources of other bees and the other bees' babies. Image: Dr Peter Yeeles.

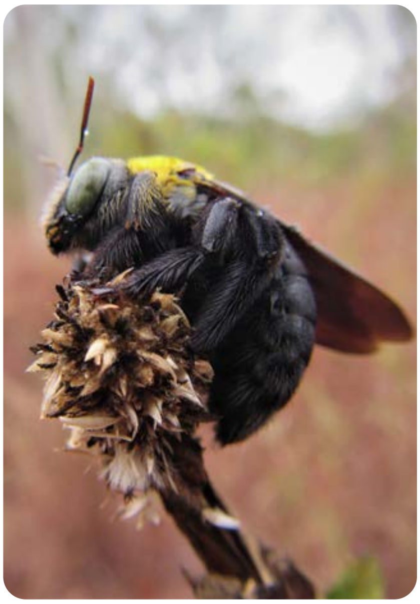
A male great carpenter bee (Xylocopa aruana) takes flight. Image: Dr Peter Yeeles.

A disrupted beautiful-masked bee (*Palaeorhiza disrupta*) perched atop a flower. Image: Dr Peter Yeeles.

Mellitidia tomentifera shakes tiny pollen grains into the air. Image: Dr Peter Yeeles.

The intriguing green *Amegilla aeruginosa* foraging on a water lily. Image: Matthew Connors.

Lithurgus atratus nestled inside a flower. Image: Matthew Connors.



A female great carpenter bee (*Xylocopa aruana*). Image: Matthew Connors.

One of the luscious field sites situated in the Wet Tropics rainforest. Image: Campbell Simpson.

World Heritage Area rainforest has been coined one of the most remarkable places on earth. It is home to ancient remains of the Gondwana Forest that once covered the Australian continent. It has been listed as the second most irreplaceable natural World Heritage site on earth by the International Union for the Conservation of Nature.

Despite the apparent importance of rainforest areas, studies are yet to document the effects of spillover from insecticide onto rainforest communities of pollinators such as bees. The project will elucidate some of the threats that rainforest bees may face in tropical rainforests.

The Research Project

The project will investigate the effects of insecticide exposure and pathogens and parasites on native bees in the tropics of Far North Queensland.

The first aim will investigate whether insecticide spillover from agriculture and invasive species management in these forests impacts the diversity, abundance, and functional diversity of native bees, and the abundance of bee predators, parasites, and pathogens. Sites will be set up with and without insecticide treatment and use sampling methods, including trap nests, vane traps and direct sampling to measure the parameters of the bee communities. Nest tubes will be dissected to determine whether parasites (such as the cleptoparasitic bee species *Thyreus* spp. and parasitic wasp species like *Gasteruption* spp.) or predators such as spiders or wasps are present. Once larvae in trap nests have been removed from the field and reared in the laboratory, DNA and RNA from nest entrance swabs and adult bees will be examined to determine pathogen presence.

The second aim is to set up a field experiment to assess whether the density of bee nests affects predation rates, and pathogen and parasite prevalence of trap nesting bees. An aggregated trap nest/bee hotel design, in which twelve individual blocks with nesting cavities are secured together, will be compared with a dispersed design in which twelve individual blocks with nesting cavities are distributed across a 120m² site.

Funds provided by the Australian Wildlife Society will assist in conducting quantitative polymerase chain reactions on RNA and DNA extracted from bees and swabs to assess for several common introduced honeybee viruses and the microsporidian parasite *Nosema* spp., and using metabarcoding to screen for bacterial and fungal pathogens.

Wildlife Ecology at Conservation Corridors:

Does Revegetation Really Help?

Natalie Grassi
School of Environmental and Conservation Sciences,
Murdoch University

After decades of agricultural development, only 10 percent of the original native vegetation that once existed in the Southwest Australian Floristic Region remains. What was a previously continuous, undisturbed landscape is now isolated blocks of fragmented habitat interspersed amongst a cleared matrix. The agricultural matrix that separates habitat patches is difficult for native wildlife to cross due to the presence of introduced predators and a lack of suitable habitat. This isolation makes it difficult for individual animals to seek resources at alternate habitat patches. It also restricts the ability of populations to intermingle with each other, which may have implications for gene flow.

Revegetation efforts have become increasingly concerned with improving landscape connectivity, usually by establishing wildlife corridors. These are physical linkages that connect two or more isolated patches to reduce the amount of cleared matrix an animal must pass when moving through the landscape. The most common are micro-corridors, such as wildlife overpasses or shelterbelts, primarily thin, linear strips directly connecting two patches. There are also macro-corridors, which often work using a stepping-stone design to provide smaller satellite habitats between two large patches to reduce the distance of cleared matrix between habitats.

Unfortunately, the success of wildlife corridors as a conservation tool may be impacted by the presence of introduced predators such as red foxes (*Vulpes vulpes*) and feral cats (*Felis catus*). These predators prefer to hunt in more open, simple landscapes, often associated with a cleared matrix or revegetation. These simple landscapes offer little resistance to movement, and their lack of habitat complexity restricts the avoidance or escape behaviours of native wildlife. Since corridors filter the movement of native

Unfragmented landscapes provide ample resources for local wildlife, support larger population sizes than fragmented landscapes, and provide an opportunity for gene flow between populations. Image: Joel Wilson.

Macro-corridors, such as the Fitz-Stirling Reserves (pictured), are landscape-scale linkages that improve landscape connectivity. These macro-corridors often use stepping-stone designs to decrease the distance between patches to increase the ability of wildlife to move within the landscape. Image: Sarah Comer.

wildlife into either revegetated areas or stepping-stone corridors, predators may use these areas as key hunting grounds. This could make corridors too dangerous for native wildlife to use, restricting their success as a conservation tool.

Corridors may also lack the habitat complexity that native fauna need for behaviours such as foraging, nesting, and thermoregulation. Revegetated wildlife corridors must be complex and diverse enough to meet the ecological needs of native fauna (functional connectivity), and a lack of habitat complexity may arise if revegetation efforts do not plant the flora species that native fauna rely on. Additionally, revegetation is a slow process, and it may take decades before habitat matures sufficiently to support a diverse faunal community.

Using the Fitz-Stirling Reserves as a case study, this project will investigate whether wildlife corridors provide usable habitat to native wildlife or whether their success is hindered by introduced predators and a lack of habitat complexity. Camera traps will be deployed within a cleared matrix, revegetation and remnant habitat to identify which species can return to revegetated areas or disperse along the cleared matrix and which are excluded from corridors. Diet analyses on predator carcasses and scats will validate habitat selection choices and identify which native species are most at risk of predation in this landscape. Finally, this study will analyse which fine-scale structural features (such as canopy cover, leaf litter depth, percentage of bare ground cover, and log presence) best support local biodiversity.

The results will provide insight into the effectiveness of corridors as a conservation tool and recommendations for future revegetation projects. It will also identify sites frequented by introduced predators to help guide predator control actions by detecting key areas for placing traps or baits.

Funds provided by the Australian Wildlife Society will support fieldwork for camera trap deployment, scat and carcass collections for predator diet analyses, and vegetation surveys to analyse how structural connectivity supports local fauna compositions.

Despite the potential value of revegetation to improve connectivity, it can take decades for these habitats to mature enough to support the needs of local species, such as Carnaby's black cockatoos (*Zanda latirostris*- pictured), which require complex old-growth forest for roosting and feeding. Image: Joel Wilson.

Distribution and Density of the Southern Hairy-Nosed Wombat (*Lasiorhinus latifrons*) Under the Influence of Future Climate Change and Invasive Rabbit Competition

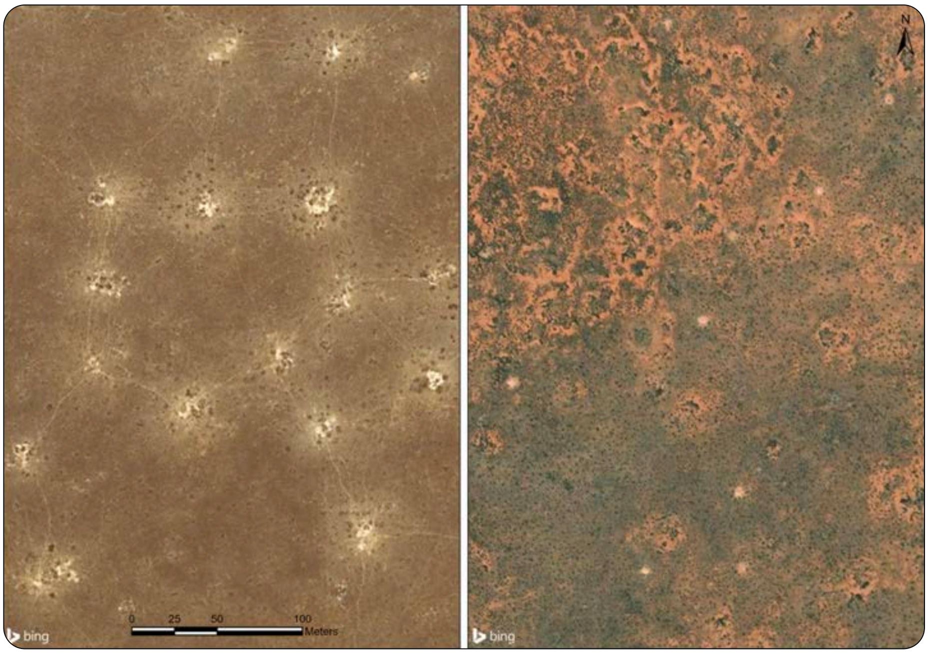
Natarsha McPherson
School of Biological Sciences,
The University of Adelaide

Across the remote semi-arid landscape of the Nullarbor Plain, the future of South Australia's faunal emblem – the southern hairy-nosed wombat (*Lasiorhinus latifrons*) – is uncertain. Declared as 'Near Threatened' by the *International Union for Conservation of Nature Red List of Threatened Species* in 2014, ongoing concerns of drought, habitat loss, disease, and deteriorating resource availability persist. However, comparable to many of Australia's native mammals, limited data and incomplete knowledge of population ecology jeopardise our capacity to safeguard future populations.

Currently residing within five main fragmented sub-populations across South Australia, the wombat is no stranger to unfavourable conditions. As a nocturnal species, underground warrens provide an essential thermoregulatory strategy – allowing individuals to attain refuge from severe temperature and sun exposure. Supplemented with various physiological and behavioural traits to further reduce energy expenditure and water loss, mitigation against short-term disturbance can be effective. However, these traits are unlikely to act as long-term coping mechanisms proficiently.

Australia has demonstrated the worst mammal extinction rate since European settlement, with a notable concentration within semi-arid regions. As recent climate projections suggest that the prevalence and magnitude of drought will escalate, understanding how wombat populations may respond is critical to implementing productive management.

A possible key to population stability can be attributed to resource availability. Reproduction and maturation within the wombat are slow, coinciding with the germination and growth of native perennial grasses comprising the species' diet. But as environmental pressures amass upon susceptible habitats, seed viability and recruitment within native vegetation are unlikely to be upheld at adequate rates, potentially causing the omission of breeding altogether.



Satellite observations of wombat (left) and rabbit (right) warrens across the Nullarbor region; distinguished by colour, shape, and presence/absence of linking surface tracks. Images: Bing maps aerial imagery.

Exacerbating these stressors, the wombat's most extensive and abundant sub-population in the Nullarbor region co-exists with an invasive grazing competitor, the European rabbit (*Oryctolagus cuniculus*). Here, resource competition favours the rabbit, a smaller species with a more generalised diet, higher relative fecundity, and greater home range. But despite the recognition that the wombat's reproductive success and population growth are supported by the ease of resource acquisition, our knowledge and evidence for how biophysical attributes shape current distributions is still insufficient in abundance, quality, and scale.

Nocturnal and semi-fossorial species are particularly challenging to monitor in remote regions. Often relying on data from citizen science observations and traditional ground-based surveys, presence data for remotely distributed species is frequently biased (e.g., sampling effort, geospatial concentration and insufficient coverage). Subsequently, the historical record for the wombat and rabbit across the Nullarbor vastly underestimated the geographic range and density.

In the early 1980s, the utilisation of enhanced satellite imagery for the detection of wombat warren clusters across open landscapes was introduced. With improvements in the availability and resolution of remote sensing technology, so has our capacity to identify individual warren structures as a proxy for presence.

Large active wombat warren in the Nullarbor Plain's chenopod shrubland. Images: Natarsha McPherson.

Inactive rabbit warren in the Nullarbor Plain's chenopod shrubland. Images: Natarsha McPherson.

The Nullarbor Plain is a predominately flat, open landscape that stretches across both South and Western Australia. Image: Bertram Ostendorf.

We have been developing a comprehensive dataset across the Nullarbor region by combining geographic information system software with high-resolution satellite imagery from the Environmental Systems Research Institute and Bing Maps (<1 m). Here, systematic sampling within randomised grid cells (1 km^2) has generated a dataset comprising both wombat (n = 33,364) and rabbit (n = 7,367) warrens for approximately 120,000 km^2 of the open, flat bioregion.

The project comprises two main aims. The first is to evaluate the viability of remote detection methodology for monitoring applications. Using field validation conducted across two main road transects, sampling from equal interval sites will derive field-based geospatial observations of warren features and provide contextual estimates of size, activity, and burrow counts. Subsequent buffering of transects using geographic information system software will then be sampled for comparative satellite observations, providing data to assess accuracy and sources of error.

The second aim is to combine presence datasets with environmental variables (e.g., climate, soil, etc.) and future climate data, producing the first set of multidimensional species distribution models for each species. Current models using the maximum entropy algorithm will identify key variables that drive distribution patterns and permit the analysis of environmental tolerance across the study extent. Sequential habitat suitability projections will then be predicted for three successive climate scenarios at increasing severity, estimating how and where changes in environmental suitability might occur.

The determination of conservation urgency is limited without developments to improve wildlife monitoring across remote regions for such species. Outputs from this research will better inform conservation and control decisions, providing critical knowledge regarding key variable tolerances, potential range contractions, and regions vulnerable to ensuing degradation.

Funds provided by the Australian Wildlife Society will be used for travel expenses associated with field validation across the remote Nullarbor landscape to implement the project aims.

Species Reshuffling and Ecological Function Changes Along the Western Australian Coastline

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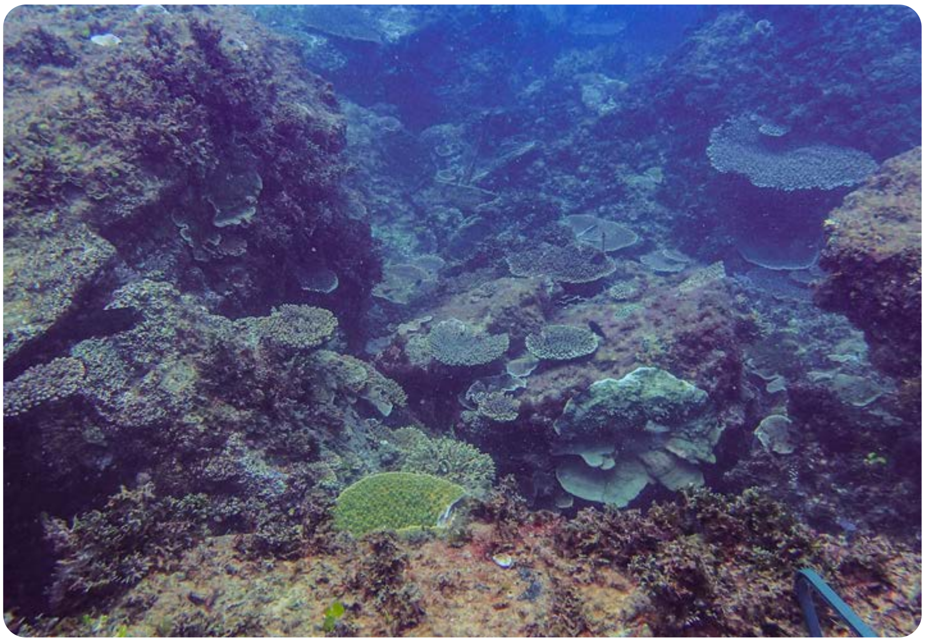
Ocean warming and marine heatwaves have emerged as profound and pervasive threats to marine wildlife. One of the most conspicuous effects of ocean warming is 'tropicalisation', where rising seawater temperatures prompt species to shift poleward to track their ecological niches. This shift results in an influx of tropical species into temperate reef ecosystems, ultimately reconfiguring these environments. This reconfiguration is particularly evident at the warmer edges of the Great Southern Reef, an interconnected temperate reef system dominated by kelp forests spanning over 8,000 kilometres of Australia's coastline, from the subtropical waters of Kalbarri, Western Australia, to New South Wales. Much like the Great Barrier Reef, the Great Southern Reef harbours exceptionally high biodiversity and holds profound ecological, cultural, and economic significance for Australians. The Great Southern Reef is home to an array of phylogenetically diverse species that exist nowhere else on the planet, where main habitat-forming species are forecasted to lose more than 70 percent of their current distribution or become extinct in the next century.

The south-west coast of Western Australia experienced dramatic marine heatwaves in 2011, which led to the loss of kelp forests along portions of Western Australia's coastline. Due to temperate reef tropicalisation, scattered coral colonies and turfs currently dominate areas once ruled by kelp forest communities. While the tropicalisation of Western Australia's marine communities is well-documented, we are only beginning to understand how such changes directly transform ecosystem functions and processes (e.g., primary productivity, herbivory, and habitat provision). Despite recent progress, most studies have focused on primary producers (e.g., seaweed, seagrass) or their direct consumers (e.g., fish herbivores), with little known about other flora and fauna. The tropicalised ecosystems at the warmer edge of Western Australia's temperate reefs serve as a natural laboratory for studying the reconfiguration brought about by climate change. Assessing these rapid changes and the emergence of ecological substitutes is crucial for shaping effective conservation strategies and management approaches.



The study site is in Port Gregory, Western Australia, where kelp forests are now dominated by scattered coral colonies and turf patches. Image: Océane Attlan.

One of the most striking ecological transformations along the Western Australia coastline is the increasing abundance of tropical corals at high latitudes (28°S). The shift from primary producers like kelps to calcifying organisms – such as corals or coralline algae – irremediably modifies the geomorphology of temperate reefs. The precipitation of calcium carbonate by these calcifying organisms is a fundamental biological process in marine ecosystems. Besides contributing directly to inshore carbon cycling, these carbonate-producing organisms support numerous geo-ecological functions such as reef framework production, the creation of habitat complexity, and sediment generation. These processes, in turn, impact the seascape and associated organisms. To comprehend the future of these reefs and their capacity to provide functional habitats for marine life, we need to better understand the consequences of shifting from kelp forest to coral-dominated ecosystems, particularly regarding the balance between net carbonate production and erosion – the 'carbonate budget'.

The project aims to better understand the changes in ecological functions occurring as Western Australia's kelp forest-dominated environments give way to an alternative state dominated by coral colonies. Various coral species from the kelp-to-coral transition zone in Port Gregory, Western Australia, will be collected, and samples will be affixed to acrylic tiles, enabling continuous weight and size measurements over

Océane in the field examining a piece of coral.

multiple seasons. These coral colonies will be retrieved every three months for growth measurements before returning to the dive site. The data collected will be analysed to determine the calcium carbonate precipitation rates of high-latitude coral colonies, assess their comparability with rates observed in tropical reefs, and evaluate whether calcification rates exhibit seasonal variations.

The outcomes of this study will offer crucial insights into the shifting ecological processes that Western Australia's temperate reefs are undergoing due to climate change. Gaining insight into these processes at the warmer edge of the Great Southern Reef can inform strategies in regions at lower latitudes where kelp forests still thrive.

Funds provided by the Australian Wildlife Society will assist with travel expenses to field sites, accommodation, and scuba diving-related activities.

Kelp forests are dominated by brown kelp (*Ecklonia radiata*) (at the back), with some coral colonies competing for space (at the front). Image: Océane Attlan.

Safeguarding Threatened Reef Species

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Reef ecosystems (coral and rocky reefs) are some of the most productive and diverse systems on the planet. However, global marine biodiversity is under unprecedented pressure, facing many threats, including anthropogenic climate change, marine heatwaves, fishing, habitat degradation, local impacts, and pollution. A landmark 2019 United Nations report revealed that globally, an astonishing one million species are now faced with the risk of extinction in the coming decades. With the oceans currently facing a biodiversity crisis, a critical need exists to identify which reef species are most vulnerable before they are lost.

Australia's marine biodiversity is rich, with some of the highest endemism found globally; our distinct coastlines create unique biogeographic regions for rocky and coral reef systems to exist. Identifying threatened species in the marine environment is more challenging compared to terrestrial environments. The out-of-sight-out-of-mind mentality often applies to the ocean, and without a deliberate and conscious effort to monitor these realms, changes will go unnoticed. Consequently, unnoticed changes result in inadequate management and response to these environmental issues. The collection of long-term data is therefore important for a suite of reasons, such as ecologists, managers, and policymakers to evaluate the responses of species and ecosystems to disturbance caused by anthropogenic changes and pressures, like those mentioned above (climate change, pollution, habitat degradation, and introduced species). Perhaps one of the most essential elements of long-term data is that it provides a baseline; this allows us to understand trends and detect and predict changes, all critical elements in broader ecosystem assessments, and implement policy and management for these species and systems, including early intervention to prevent extinction.

The citizen science program Reef Life Survey Program was established in 2007 and aimed to provide quantitative data on marine species over large temporal and spatial scales by training an international network of volunteer citizen scientists, as well as professional biologists, in a voluntary capacity to collect high-quality, structured, quantitative data. Reef Life Survey is an ecological monitoring program that trains experienced recreational divers in the underwater visual census method to the level of a skilled scientist. The program works closely with other organisations and has surveyed 3,537 sites across fifty-three countries. Programs such as this provide broad community engagement – signals of positive results that arise from conservation interventions are important motivators for engendering 'hope' and, in turn, more effort from the community.

Along with the Reef Life Survey, the Australian Temperate Reef Collaboration partners with leading state and federal government agencies to collect data using similar methods across temperate Australia (also known as the Great Southern Reef). The collection of Australian Temperate Reef Collaboration data was initiated in 1992, meaning there are over three decades of long-term temperate shallow-reef biodiversity data. The

Top: Completing a Reef Life Survey night survey, Heron Island, Queensland. Image: Scott Ling.

Olivia Johnson and dive fellow/PhD candidate Tyson Jones, after completing a Reef Life Survey in Albany, Western Australia. Image: Rick Stuart-Smith. Johnson.

Undertaking a Reef Life Survey, Heron Island, Queensland. Image: Tyson Jones.

A senator wrasse (*Pictilabrus laticlavius*) captured during a Reef Life Survey at Tinderbox Marine Reserve, Tasmania. Image: Olivia Johnson.

A loggerhead turtle (*Caretta caretta*) inspecting divers after a survey, Heron Island, Queensland. Image: Olivia Johnson.

benefit of these methods is they are both cost- and time-effective. Although the methods may not be considered 'high-tech', when undertaken by experienced surveyors, they allow data to be collected on species that other methods cannot achieve.

This project, with assistance from other PhD candidates over the past two years, has been collecting additional field data at sites around Australia (including Albany, Rottnest Island, Ningaloo Reef, Lizard Island, Heron Island, and around Tasmania) to add to the broadscale and extensive time series data across continental Australian shallow reefs (less than 30 metres in depth). Surveys comprise the globally standardised SCUBA-based underwater visual census surveys using the Reef Life Survey and the Australian Temperate Reef Collaboration methods. Collecting population trends and distribution data is logistically difficult for nearly all marine species, as scientists are limited by the amount of time they can spend underwater or the resources available to perform ongoing studies. Few species beyond those commercially exploited or highly charismatic have been studied extensively. Many species in the marine ecosystem are highly cryptic and rare, making them difficult to locate, let alone study. While immensely important to reef biodiversity values, little is known of the roles different species play in marine ecosystems, resulting in the extinction risk of marine taxa being much higher than terrestrial systems.

In analysing this long-term data on reef species trends, the hope is to identify shallow-reef species (fish, invertebrates, macroalgae, and coral species) that may be classified as threatened based on international (*The International Union for Conservation of Nature Red List of Threatened Species*) and federal (*The Environment Protection and Biodiversity Conservation Act 1999*) criteria and categories that have not previously or recently had their conservation status assessed. Preliminary results of the project show that nearly 50 percent of species with declining trends are endemic species, with a greater proportion of the species found in temperate reef ecosystems. The overarching aims of this project are to:

1. Identify potentially threatened reef species,
2. Provide an understanding of shared characteristics (life history and ecological traits),
3. Identify locations that are currently most important for multiple threatened species,
4. Compile documentation to formally list species identified that meet threatened species criteria, and
5. Highlight species that require the most urgent management attention for conservation and broader community education.

This project intends to bring underrepresented marine species listings up to speed, a critical element in safeguarding future conservation efforts for these species and their overall contribution to global biodiversity.

Funds provided by the Australian Wildlife Society will be used to attend an international conference in November 2023, the Indo-Pacific Fish Conference, combined with the Australian Society for Fish Biology Conference in New Zealand. This conference is considered one of the world's premier ichthyological conferences, allowing me to present my work to an international audience and the Indo-Pacific's leading ichthyologists, marine scientists, and specialists in their fields – an invaluable opportunity to gain new knowledge and develop my research and outreach capabilities.

A school of spangled emperors (*Lethrinus nebulosus*), Heron Island, Queensland. Image: Olivia Johnson.

A snapshot of the biodiversity seen on Heron Island, Queensland, during a Reef Life Survey, site Heron Bommie. Image: Olivia Johnson.

The Rise of the Turf on the East Coast of Australia

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Climate change and anthropogenic disturbances have modified the ecosystems during the last decades. The increase in temperatures has occasioned the migration of non-native species through the East Australian Current. Moreover, overfishing of key predator species has reduced the resilience in temperate areas and resulted in the decline of kelp forests.

The decrease of foundational species such as kelp has allowed first colonisers like mat-forming algae (turf) to grow in the disturbed areas, causing kelp recruits not to settle due to the inability of these recruits to settle in solid surfaces. Besides, in tropical reefs, the increase of mass bleach events allows the proliferation of turf algae in several areas of the Great Barrier Reef, which inhibits the settling of coral larvae and the recovery of coral reefs. The inhibition mechanisms of turf include sedimentation, forming a settlement barrier for recruits and the overgrowth of turf algae for small recruits.

What is Turf Algae?

Turf algal mats consist of densely packed, low-lying filaments of algae. These relatively simple algal life forms can dominate rocky coastlines in intertidal and subtidal zones and are commonly found in benthic habitats at various scales, from local to global.

Turf algae are rapid colonisers of degraded environments with high nutrient levels and sediment loads. The morphological flexibility, large numbers, and functional redundancy of turf algae species contribute to their ability to colonise coral tissues and resist coral invasion. As a result, turf algae have replaced kelp as the dominant primary producers in certain areas, and the stability of the turf-dominated ecosystem is maintained through ecological feedback, where lower survival and slower growth of kelp prevent its successful establishment within turf algae.

How can Turfs Persist in the Reefs?

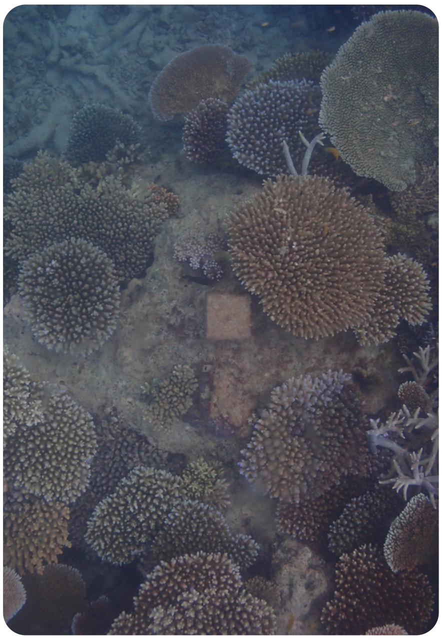
Turf algae have been observed to persist in degraded reef ecosystems through the processes of sedimentation and herbivory. While high sedimentation rates can be detrimental to coral reefs, certain species of turf algae have shown resilience. They can even benefit from sedimentation which provides a stable substrate and a nutrient source for their growth.

In healthy reef ecosystems, herbivorous fish are crucial in controlling algae growth. In reefs, fishes play a dominant role as herbivores, and their functional groups are classified based on feeding mode and ecosystem role. Browsers primarily consume foliose and canopy-forming seaweeds, while grazers focus on feeding on epilithic algal turfs.

Grazers, including scrapers and excavators, are crucial for maintaining and enhancing the resilience of coral-dominated reefs. Their high feeding rates on algal turfs help to keep algal and sediment biomass low, facilitating settlement, growth, and persistence. However, in degraded reef ecosystems, the populations of herbivorous fish are often diminished, increasing to less palatable and less nutritious turf algae. This proliferation of turf algae can further reduce available space and resources for corals and other organisms, leading to a simplified and less diverse ecosystem.

A healthy patch, St Helens Island, Tasmania. Image: Scott Ling.

A collapsed patch, St Helens Island, Tasmania. Image: Scott Ling.


A healthy patch in a coral reef, Lizard Island, Queensland. Image: Scott Ling.


A collapsed patch in a tropical reef, Lizard Island, Queensland. Image: Scott Ling.


The deployment of settlement tiles, Heron Island, Queensland. Image: Scott Ling.

Turf algae can be found in tropical and temperate reef environments, and their survival strategies differ. In tropical reefs, turf algae directly compete with corals, suffocating adjacent coral tissue and impeding larval settlement, ultimately causing damage to neighbouring corals. However, corals can inhibit turf algae through shading, settling in vacant areas for vertical growth, and digesting mesentery filaments. Turf algae thrive in disturbed ecosystems due to their resistance to herbivory, as a combination of low nutrient levels and high herbivory eliminates most forms of fleshy microalgae and macroalgae. Studies have demonstrated that reducing herbivory without altering nutrient levels can rapidly increase fleshy algae on coral reefs.

Overall, there is a lack of understanding of feedback mechanisms capable of stabilising collapsed reef ecosystems, raising concern about the ability to restore them at ecologically meaningful scales. There is little information about the transitional processes, their relationship to potential reef recovery, and the role of turf algae in transitional processes. Furthermore, there are few measurements of the standing stock or growth rates of turf and associated accumulation rates of sediment within such sediment-trapping turf mats despite turfs occurring across reef systems in nearly all geographic regions.

How are we Taking Action?

We are conducting different underwater experiments in tropical and temperate areas, evaluating the persistence of turf in healthy and collapsed patches. This project aims to address the question of recovery potential for Australian reefs by quantifying mechanisms promoting stability and instability of turf community states, which are the ultimate manifestation of collapse for temperate to tropical reefs. In addition, we are analysing the drivers of turf cover on temperate and tropical reefs using existing survey data across large scales and conducting field experiments to measure feedback processes across healthy, collapsing, collapsed, and recovering reefs by deploying settlement panels.

Funds provided by the Australian Wildlife Society will assist with travel expenses, field and laboratory research costs, and equipment to store and process samples.

Using Carcasses to Investigate Ecosystem Processes Within and Beyond Feral Predator-free Fenced Areas

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In Australia, conservation fences are primarily used to protect vulnerable wildlife from predation by introduced feral cats (*Felis catus*) and foxes (Vulpes *vulpes*). Conservation fences provide an immediate solution to reduce the likelihood of extinction for many species until the issue of predation by cats and foxes can be sufficiently ameliorated at broader scales.

The benefits of conservation fences have been well documented. These structures, also known as feral predator-proof or exclusion fences, are specifically designed to exclude cats and foxes and to create safe havens for species that are unable or unlikely to persist with cats and foxes in unprotected landscapes. Wildlife reintroductions into areas guarded by conservation fences can protect populations of predator-susceptible species and help restore a range of ecological processes that the loss of these species would otherwise impact. For example, reintroducing digging mammals to an area can facilitate seed dispersal and bioturbation, affecting soil composition and vegetation structure.

Improved management and the restoration of ecosystem processes are becoming a common goal for fenced areas. To date, much research has focused on reintroduction outcomes and the impact of predator removal on the densities of newly established or threatened extant species. Less work, however, has focused on the effect that changed densities have on less studied extant wildlife, including in situ scavengers.

In a natural setting, scavengers play a functional role by removing carrion from the landscape and transferring energy throughout a food web. Carrion can also create hotspots of predation risk, where predators are attracted to a localised area to scavenge. Within a fenced setting where various species are excluded, and others are routinely managed, processes linked to carrion and decomposition are likely to be altered. The consequences of these management activities are poorly understood.

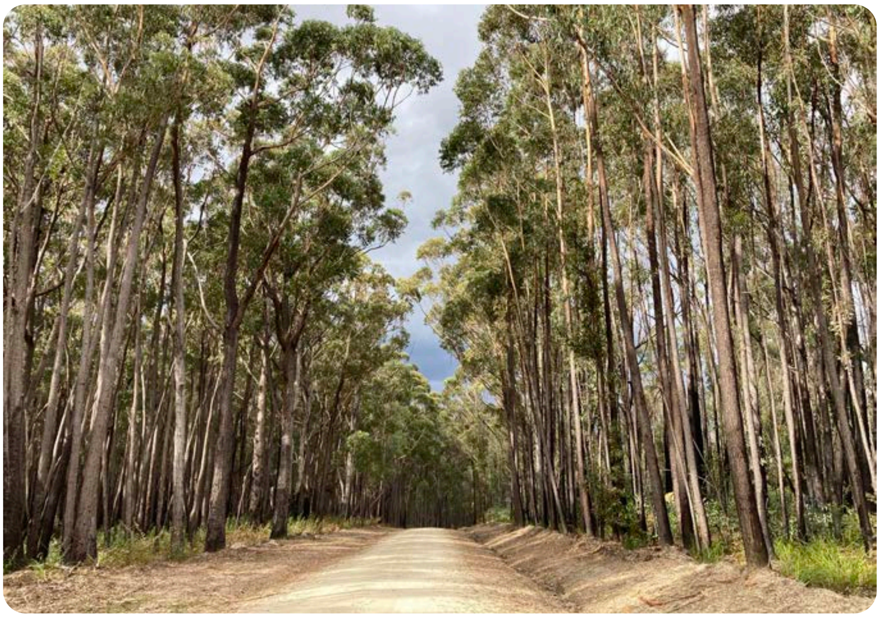
This study aims to investigate scavenger interactions and the response of various ecosystem processes surrounding carrion decomposition within and beyond fenced areas. It is assumed that in a 'healthy' ecosystem, dead animal matter will be quickly consumed and efficiently recycled back into the system. Understanding how different scavenger groups use and interact with carrion is vital to effectively managing ecosystem structure and function. Understanding how the removal of key scavengers, both native and invasive, affects carrion removal and energy transfer is equally important.

This project exists in partnership with New South Wales National Parks and Wildlife Service and World Wildlife Fund Australia. The study is being conducted at Nungatta, South East Forest National Park, New South Wales, where a 2,000-hectare feral predator-free area is being established. Following the eradication of invasive mammal predators and herbivores, several threatened native mammal species, including the long-footed potoroo (*Potorous longipes*) and smoky mouse (*Pseudomys fumeus*), will be reintroduced to the protected area.

A dingo (*Canis lupus dingo*) scavenging on a kangaroo carcass. Image: Reconyx remote camera.

Juvenile cats (*Felis catus*) scavenging on carrion during a winter monitoring period. Image: Reconyx remote camera trap.

Invertebrate scavengers and rabbit carcass are monitored within a vertebrate exclusion cage. Image: Raquel Parker.



Nungatta, South East Forest National Park in New South Wales. Image: Katie Oxenham.

A feral predator-proof fence is being established at Nungatta, South East Forest National Park in New South Wales. Image: Auryn Thomson.

Experimentally placed carrion, sourced from local and licenced culls as a natural tool, will be used to explore food web dynamics before and after the feral predator-proof fence is established. It will investigate how removing key vertebrate scavengers and subsequent wildlife reintroductions impacts energy transfer and nutrient cycling processes.

The project will aim to identify:
1. What scavenger guilds are present, and how do these guilds change following the establishment of a feral predator-proof fence and subsequent management activities such as removing introduced species?,
2. How quickly does carrion removal and decomposition occur inside and outside the feral predator-proof fenced area, given the changed management regime and which scavengers influence this the most?, and
3. What are the ecological consequences of removing key scavengers (whether native or invasive) from within fenced areas?

To answer these questions, I will monitor carrion and record a set of indicators, including the presence, activity, and diversity of vertebrate and invertebrate scavengers. The decomposition and scavenging activity rate under different scavenger exclusion scenarios will be monitored, in addition to the changes in basic soil chemistry following decomposition. Carcasses and vertebrate scavengers will be monitored via remote camera traps and on-ground surveying. Insect scavengers will be monitored using vertebrate exclusion cages around carrion and pitfall traps, and soil samples will be taken at different stages of the experiment to assess changes in soil properties (e.g., carbon, nitrogen and phosphorous) in response to altered carcass use.

Addressing this knowledge gap is crucial to understanding food web dynamics, energy flow and nutrient cycling, allowing for more informed and effective management within fenced areas. The results are expected to inform future rewilding strategies by elucidating the significance of scavenger roles, which may result in future reintroductions or maintenance of scavenger groups within fenced areas. The results may also guide standard practices associated with fenced areas, such as culling or managing various species (e.g., large herbivores).

Funds provided by the Australian Wildlife Society will contribute to travel expenses associated with fieldwork. Funds will also be used to purchase necessary equipment to monitor carrion and scavenger activity, including SD cards and pitfall traps.