2017 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 2017 are:

GLEN BAIN - School of Biological Sciences, University of Tasmania
Project title: Restoring Resilience in woodland bird populations of the Tasmanian Midlands

SIEARA CLAYTOR - James Cook University, Cairns
Project title: The role of serotonin in frog host response to chytridiomycosis

CHRISTOPHER GATTO - Monash University, Melbourne
Project title: The role of nest moisture in sea turtle primary and operational sex ratios Introduction

ANA GRACANIN - University of Wollongong
Project title: Does deforestation promote developmental stress in spotted-tailed quolls?

MD ANWAR HOSSAIN - School of BioSciences, University of Melbourne
Project title: Assessment of the vulnerability of freshwater crayfish to climate change

LE MA - School of Veterinary and Life Science, Murdoch University, Perth
Project title: Protecting our unique key stone species, *Westralunio carteri,* the only species of freshwater mussel in South-western Australia

DIANA PRADA - School of Veterinary and Life Sciences, Murdoch University, Perth
Project title: Conservation of insectivorous microbats; connecting genetics and infectious disease threats in Australia's global biodiversity hotspot

KIT PRENDERGAST - Curtin University, WA
Project title: Determinants of native bee assemblages in urban habitat fragments in the southwest Australian biodiversity hotspot and interactions between honeybees (Apis mellifera) and native plant-pollinator communities

PETER PUSKIC - School of Biological Sciences, University of Tasmania
Project title: Novel assessment of the relationship between plastic ingestion and fatty acid profiles in three species of Australian shearwaters

EMILY QUINN SMYTH - University of Technology Sydney
Project title: Impacts of lantana invasion in remnant forest on habitat use by native fauna: a multi-taxon approach for conservation










Glen Bain with a male superb fairy-wren (*Malurus cyaneus*) moulting into nuptial plumage.

Restoring resilience in woodland bird populations of the Tasmanian Midlands

GLEN BAIN
The University of Tasmania

"What to restore?" remains a central question for restoration ecologists. This is particularly so when considering long-degraded landscapes where a clearly defined historical state is often unknown. The University of Tasmania has partnered with Greening Australia to take an animal-centric approach to landscape restoration in the Tasmanian Midlands – one of fifteen nationally recognised biodiversity hotspots and Australia's second oldest agricultural landscape. Behavioural data collected from local wildlife will be used to guide restoration efforts and ensure that those habitat elements most important to fauna are prioritised. This is in contrast to traditional methods of restoration that have been guided by human perceptions of 'good quality' habitat. Plantings are often established with the hope that wildlife will naturally settle and recreate a complex community structure but instead many remain devoid of wildlife or support only the most common or exotic species. This is an experience so frequently encountered it has appropriately been described under the title of *field of dreams hypothesis*. The Midlands Restoration Project explores habitat use and gap-crossing behaviour in a range of wildlife including eastern bettongs (*Bettongia gaimardi*), eastern and spotted-tailed quolls (*Dasyurus* spp.), Tasmanian devils (*Sarcophilus harrisii*), feral cats (*Felis catus*), microbats (Microchoptera) and the focus of my research – woodland birds.

The woodland bird community of the Tasmanian Midlands is unique within Australia. However, it is increasingly threatened by habitat clearing for the installation of large pivot irrigation systems and a rise in feral cat activity following the decline of the native apex predator (Tasmanian devil). Eleven of Tasmania's endemic bird species can be found in the Midlands. Much of the region's avifauna is also distinctive at the subspecies level with unique colourations, vocalisations and migratory behaviours that set them apart from their mainland cousins. It is perhaps surprising then that Tasmania's woodland birds are so poorly represented in Australian bird data. Very little is known about local population dynamics. To begin to address this, I have collected two years of observational and acoustic bird survey data from 75 sites across the Midlands. This information will be related to vegetation and landscape characteristics at each site and be used to form a baseline against which the effectiveness of restoration efforts can be gauged in the future. Through comparisons with historical data collected at the same locations 20 years ago, I also hope to obtain a sense of which species are increasing in number

Striated pardalote (*Pardalotus striatus*) nesting in a tree hollow. Striated pardalotes (8g) migrate from Tasmania across the Bass Strait to the mainland each winter.

Aerial photo showing a small section of the restoration works adjacent to the Macquarie River.

Tasmanian wedge-tailed eagle (*Aquila audax fleayi*) soaring above the often foggy Midlands.

Tasmanian silvereyes (*Zosterops lateralis*) migrate as far north as Queensland and can be identified by their chestnut brown flanks.

(e.g. introduced long-billed and little corellas) and which species may show signs of population decline.

Initial survey data has highlighted the significance of noisy miners (*Manorina melanocephala*) as a key management challenge for the restoration program. Noisy miners favour open and degraded landscapes such as occur in the Midlands. They have been described as hyper-aggressive, despotic, reverse-keystone species and are well known to exclude smaller birds from suitable habitat across eastern Australia. Such exclusion by noisy miner colonies has been listed as a key threatening process under environmental legislation. My preliminary data shows that those sites where noisy miner densities have significantly increased have also experienced worrying declines in species richness. Thankfully, the opposite appears true for sites where miner densities have decreased. To better understand how miners and habitat degradation influence the way in which small birds perceive their environment, I am using differential white blood cell counts to measure chronic stress in a model bird species, the superb fairy-wren (*Malurus cyaneus*).

In birds, the ratio of white blood cell types in the blood is regulated by the stress hormone corticosterone. I will collect blood samples from wrens, create blood smears and determine the ratio of heterophil cells to lymphoctyte cells. This ratio is known to provide a reliable measure of long-term stress levels (i.e. weeks to months) in birds. I will compare stress in wrens that occupy degraded noisy miner dominated woodland with that of wrens living in undisturbed covenants, plantings and nature reserves. Chronic stress will be related to site-specific vegetation structure and the composition of the bird community (e.g. number of predatory birds) to explore what factors might moderate the stress response.

For any restoration program, successful reproduction by resident wildlife is an ultimate goal. Given that nest-predation is the main cause of reproductive failure in birds, I am also investigating what aspects of vegetation structure might explain the incidence of nest-predation in the Midlands. I have used motion-sensor cameras to monitor nests of brown thornbills (*Acanthiza pusilla*) and superb fairy-wrens. Cameras have allowed me to identify the local nest predator assemblage and calculate the frequency of nest predation in this highly modified agricultural landscape. I used cutting-edge handheld LiDAR techniques to model vegetation structure at nesting sites and measured features such as canopy cover above the nest and nest concealment. Though this research is in its infancy, it appears that rates of nest failure in the Midlands remain comparable to populations of these species elsewhere in Australia. However, the nest predator assemblage is unique with native mammals like the Tasmanian devil and spotted-tailed quoll recorded raiding nests more frequently than was anticipated. Future research could consider how the frequency of nest predation in wrens and thornbills compares between remnant woodlands and planting sites as they mature.

I'd like to express my great thanks to the Australian Wildlife Society for funding my research and supporting my attendance at the Society for Ecological Restoration conference in Brazil. At this conference, I will present my initial findings and use the opportunity to strongly promote the integration of animal behaviour research with the design of landscape restoration. As a whole, the Midlands restoration project provides an excellent example of how researchers studying vastly different wildlife groups can work together and with land managers on the ground to improve conservation outcomes.

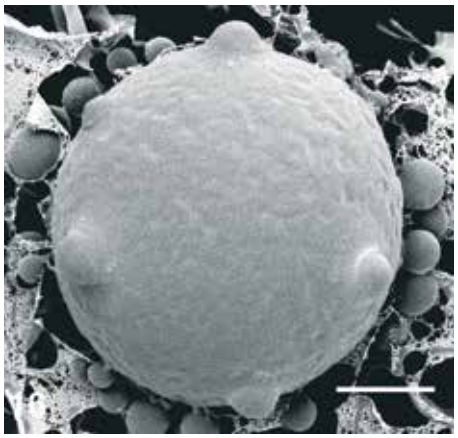
Remnant woodland after a light snow. Though the Midlands is a temperate region, in recent years it has experienced extreme drought, unusual snowfall events, record flooding and wildfires.

The role of serotonin in frog host response to chytridiomycosis

SIEARA CLAYTOR
College of Public Health, Medical and Veterinary Sciences
James Cook University, Cairns

Since the 1980s, frog populations internationally and in Australia have declined dramatically due to the amphibian disease chytridiomycosis, caused by the chytrid fungus *Batrachochytrium dendrobatidis* (Bd). Currently, 15 species of Australian frogs are endangered, 12 are listed as vulnerable, and six have already become extinct. Bd is an aquatic fungus that colonises frog skin and disrupts skin functioning causing electrolyte loss, which then leads to death via cardiac arrest.

My research goals are to: a) investigate the metabolites in frog skin that fight Bd infection, and b) examine if antioxidants are involved in Bd's ability to evade host defences. There is little understanding of how metabolites are used in frog skin. Frogs lack a cellular inflammatory response to Bd infection. This suggests that innate biochemical responses, rather than acquired immunity, are acting in host defence against Bd. Some pathogens have developed antioxidant defences to protect themselves from the host's immune system. Presently, it is unknown how Bd protects itself from oxidative stress from the host.



Scanning electron microscope image of chytrid sporangia. Photo: Dr Lee Berger

L to R: Dr Alexandra Roberts (researcher), Rebecca Webb (research assistant), Sieara Claytor, Dr Tiffany Kosch (postdoctoral researcher) holding Australian green tree frogs.

Currently, there are no means to practically control the disease in the wild. Bd is widely distributed over the continent, making research more important than ever for management and mitigation of the impacts of the disease. It is important to understand how some frogs can resist Bd so that managers can use this knowledge to better protect threatened species. This information may lead to targeted methods to improve frog survival.

Great barred frog (*Mixophyes fasciolatus*) showing symptoms of chytridiomycosis. Photo: Dr Lee Berger

Christopher with a leatherback sea turtle at Cabuyal, Costa Rica.

How does moisture during incubation influence sea turtle sex ratios?

CHRISTOPHER GATTO
Monash University, Melbourne

Sea turtles have existed on our planet for millions of years but today they are at a crossroad, and their survival is anything but certain. There are seven extant sea turtle species, and all seven are listed as vulnerable or endangered by the International Union for Conservation of Nature. Sea turtle populations have been decimated by egg poaching, habitat loss, by the harvesting of meat and shells as well as by individuals drowning as bycatch in fishing nets. This is on top of the fact that only one in 1,000 hatchlings survive to adulthood, thanks to the myriad of predators that feast upon hatchlings as they disperse from their nests. Despite all of this, the greatest threat facing sea turtles today is climate change.

Typically, research into the effects of climate change has focused on the impact that increasing air and sea temperatures will have on incubating sea turtle eggs. Changes in temperature during incubation have been shown to alter hatchling size, incubation duration, hatching success rates and the ability of hatchlings to crawl and swim. Fascinatingly, temperature has also been shown to determine sea turtle primary sex ratios or the ratio of males to females at hatching. Like many reptilian species, sea turtles have temperature-dependent sex determination where, in the case of sea turtles, higher temperatures result in more female hatchlings, and lower temperatures produce more male hatchlings. As our planet slowly warms so do sea turtle nests, resulting in more female hatchlings. Eventually, it is possible that nests will only produce female hatchlings. And despite what some may say, males are a vital part of maintaining a healthy population.

However, temperature is not the only environmental factor that is going to change because of humanity's impact on the Earth. Another key factor is moisture. During my time working with The Leatherback Trust in Costa Rica, I would spend the first few months of the nesting season huddled under my poncho in a vain attempt to stay dry. By the end of the nesting season five months later, I hadn't seen a cloud, let alone rain, in months. The amount of moisture contained in the sand of nesting beaches worldwide is also expected to change as sea levels rise while changes to rainfall patterns are expected to vary depending on location. This means that, like temperature, moisture levels vary across a nesting season and will be altered by climate change. However, very little research has been done to investigate how moisture levels during incubation influence sea turtle eggs and hatchlings. Too much or too little moisture can result in higher rates of egg mortality and increases in moisture result in heavier hatchlings but what about sex ratios or a hatchling's ability to swim?

My project's goal is to understand how moisture during incubation influences sea turtle primary sex ratios and the ability of hatchlings to disperse from their nesting beach. I will collect the eggs of three sea turtle species and incubate them at different moisture levels. I will measure differences in hatchling size, body shape and crawling speed. I will also measure the amount of force that hatchlings produce while swimming to quantify hatchling swimming ability. Finally,

A green sea turtle rests momentarily as it camouflages its nest.

An Olive Ridley sea turtle lays its eggs at Ostional, Costa Rica.

I will determine primary sex ratios by examining hatchling gonads via laparoscopy.

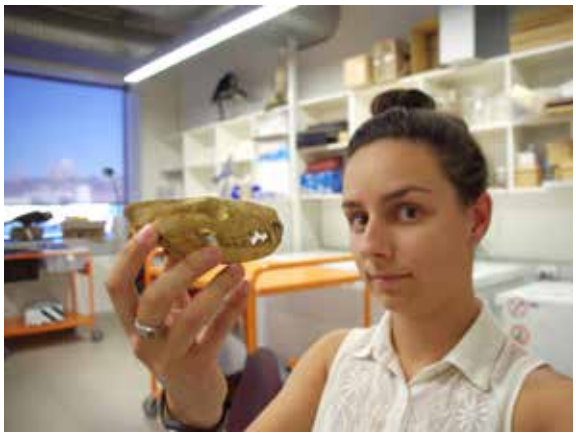
The data collected from the three sea turtle species will be used to create a model that predicts the sex-specific survival of hatchlings and operational sex ratios. Operational sex ratios are the sex ratios of breeding adults in a population and are a key indicator of population viability. Incubation conditions will be used to predict crawling and swimming performance, which will be used to estimate mortality rates. When combined with primary sex ratios, also estimated from incubation conditions, it will be possible to predict how sex ratios and swimming performance interact to determine male and female survival as well as operational sex ratios.

Currently, sea turtle population monitoring, conservation and management all focus on the effects of temperature. This is despite the fact that temperature does not explain 100 percent of observed variation in hatchling traits. Our ability to accurately predict primary sex ratios is vital for the effective conservation and management of these iconic and culturally significant species. This project would be one of the first studies to incorporate hatchling performance variation into predictions of hatchling recruitment and operational sex ratios. My model will aid nesting beach managers by providing more accurate estimates of sea turtle primary and operational sex ratios, which form the basis of any management plan or targets. It will also allow us to predict future changes to primary and operational sex ratios. This will allow managers to identify key beaches, the most productive months for producing males and females as well as the best sites for relocating nests.

Green sea turtle hatchlings, incubated at Monash University, slowly emerge from their eggs.

None of this would be possible without the amazing support of the Australian Wildlife Society. Without their help, I wouldn't be able to buy the load cells that I will use to measure the amount of force that hatchlings produce while swimming or to measure other indicators of hatchling performance. Thank you to all of you for your support!

A green sea turtle hatchling.



Does deforestation promote developmental stress in spotted-tailed quolls?

ANA GRACANIN
University of Wollongong

The threatened spotted-tailed quoll (*Dasyurus maculatus*) has experienced significant range contraction and population decline. My project is investigating the use of fluctuating asymmetry as a bioindicator of stress in these quoll populations. I will measure asymmetry in the skulls of spotted-tailed quolls, from a range of museums. I will be taking photographs of the skull, and digitising the points of features through software. These landmarks reflect the shape of the skull and can be analysed for asymmetry. Based on where it was found I will then use past satellite imagery (from 1972 and onwards) to calculate a level of deforestation and disturbance associated with each specimen. I will see if this disturbance was a source of significant stress in quolls by relating this with their level of asymmetry. Overall, the specimens span over 100 years. An investigation of these temporal patterns of fluctuating asymmetry in spotted-tailed quoll populations could provide conservation management with information that can: identify areas experiencing significant disturbance, evaluate existing reserves and national parks, and provide an indication of future trends.

Another species of the same genus, the eastern quoll (*Dasyurus viverrinus*), experienced significant decline on the Australian mainland, as the species is now considered extinct. I will also study fluctuating asymmetry in extinct eastern quolls. This will help understand the vulnerability of extant spotted-tailed quolls, by comparing them to levels of fluctuating asymmetry in the extinct eastern quoll. This could provide further evidence for higher prioritisation of conservation initiatives if some populations of spotted-tailed quolls are experiencing similar levels of stress.

Above: Ana holding a spotted-tailed quoll skull.

Eastern quoll skull from Sydney, 1915.

About me:

I'm studying Conservation Biology at the University of Wollongong. This is my first true lab-based project, as so far I've only ever worked on field-work based projects. From camera-trapping quolls on the ground to climbing into the canopy to camera-trap glider species, I'm passionate about studying elusive and threatened species.

My main interests lie in arboreal marsupials and their behavioural ecology. I also help manage the conservation research organisation Team Quoll Illawarra and Southern Highlands. I have yet to see a quoll in the wild though, despite almost three years of searching for them!

Eastern quoll specimens from the CSIRO Wildlife Collection, Canberra.

Protecting our tiny water treatment factories: Carter's freshwater mussel (*Westralunio carteri*), the only freshwater mussel in south-west Australia

LE MA
Centre for Fish and Fisheries Research
Murdoch University, Western Australia

Freshwater is extracted for drinking, irrigation and industrial use, so sustainable freshwater ecosystems are crucially important for human life, as well as for domesticated plants and animals and wildlife. Freshwater mussels are important contributors to the sustainability of freshwater ecosystems. Their filter feeding is able to remove seston, phytoplankton and bacteria from the waterbody and improve water quality. In addition, the activities of freshwater mussels, such as burrowing, excreting and bio-depositing, enhance the nutrient connection between benthic and pelagic systems. After they die, their empty shells may become refuges for other aquatic fauna.

However, freshwater mussels constitute one of the most endangered groups of organisms throughout the world because of habitat destruction, and for some species, overfishing. Carter's freshwater mussel (*Westralunio carteri*) is the only freshwater mussel species in south-west Australia and is endemic to this region. Recent studies have found that the range of the species has contracted by over 50 percent in the last 10 years, principally because of secondary salinization and reduced water flow from a drying climate. As this species of freshwater mussel is able to live for at least 50 years, and we do not know whether extant populations are actively recruiting, its viability remains in doubt. If we continue to do nothing for it, it is possible that the species has a massive extinction debt which will be realised sometime in the coming decades and both the natural ecosystem and human society will pay for this extinction.

This project aims to fill current knowledge gaps by investigating

Mussel survey in Gingin Brook. Photo: Nathan Berkens

A mussel hides in the substrate. Photo: Le Ma

A dead mussel shell occupied by a crayfish. Photo: Le Ma

the habitat preference, population structure and limits of salinity and drought tolerance of the freshwater mussel *Westralunio carteri*. We hope that the information gained from this project will assist the development and implementation of conservation management plans for this species.

So far, a team consisting of my supervisors, staff of Western Australia's Department of Parks and Wildlife, volunteers and land owners have investigated 30 rivers and found that *Westralunio carteri* has a highly aggregated population structure, with a greater density (about 29 mussels per square metre) than other Australian freshwater mussel species. Mussels appear to have a preference for fine and loose silt in shallow and slow running water, with abundant large, woody debris. In a simulated drought experiment, mussels did not increase their horizontal movement but burrowed vertically into the substrate before the substrate completely dried. Loose silt allowed the mussels to burrow more deeply. Shading greatly increased survivorship under drought conditions. Salinity tolerance experiments are ongoing.

Mussels provide us with a salutary lesson. It is not just large, charismatic fauna that needs protection. Sometimes it is the loss of small and seemingly insignificant creatures that will have the greatest impact on our lives and lifestyles. As a society, we would do well to pay more attention to our little aquatic neighbours and learn to live with them in harmony.

Adult and juvenile of *Westralunio carteri*. Photo: Le Ma

Microbats of the South West Botanical Province of Western Australia: Infectious disease risk and its relation to population connectivity

DIANA PRADA
School of Veterinary and Life Sciences
Murdoch University, Perth

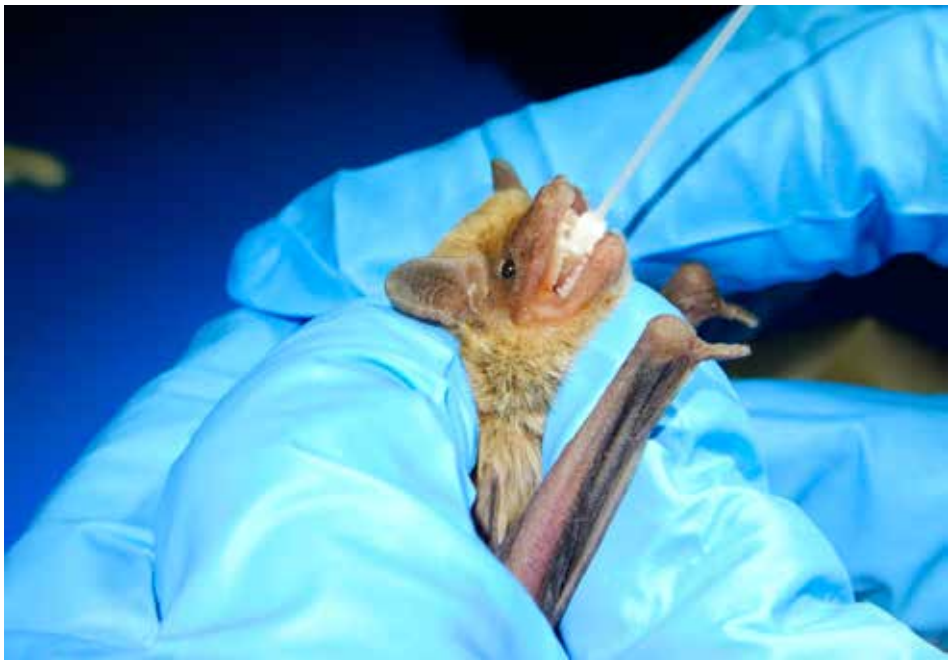
Bats are reservoirs of zoonotic infectious disease agents that impact on global health, such as lyssaviruses and Hendra virus. Large amounts of funding have gone into the study of these diseases as they can have a high fatality rate in humans. Comparatively, little is known about the impacts of infectious diseases on the conservation of Australian microbats. Due to their gregarious nature, combined with specific habitat and climate requirements, bat populations are considered highly sensitive to emerging infectious diseases. This is evidenced by white nose syndrome, an infectious fungal disease currently threatening microbat species with local and regional extinction in the USA and Canada.

The South West Botanical Province (SWBP) of Western Australia, Australia's only global biodiversity hotspot, is home to 13 species of microbats. Despite information on their distribution and ecology, there is limited information on their genetic diversity, population structure, and their infectious disease status.

My study will determine the associations between the infectious agents of microbats in the SWBP and their population structure and connectivity. Combining these areas of study facilitates the understanding of bat movement patterns, which underscores the epidemiology of the pathogens they carry and thus potential infectious threats (inclusive of zoonotic agents) across separate populations at a landscape scale. This information is central to predict possible consequences of distributional changes of microbat species and the pathogens they carry under different climate change scenarios. Additionally, the creation of a baseline dataset of viral species present within healthy bat communities is

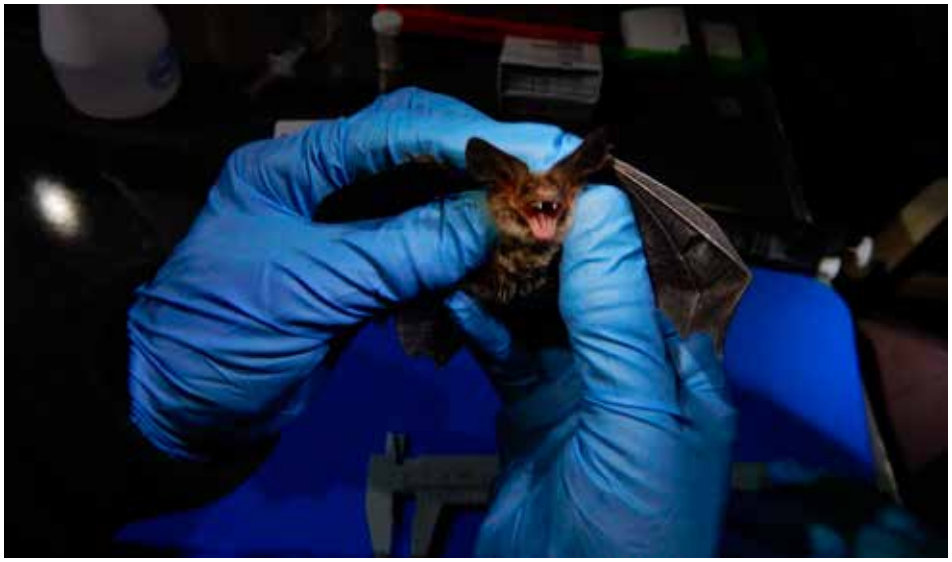
Harp traps set up over an open water well. Photo: Mikaylie Wilson

Working the night shift: researchers at the sampling station. Photo: Mikaylie Wilson



Taking a buccal swab of an inland broad-nosed bat (*Scotorepens balstoni*). Photo: Mikaylie Wilson

A Gould's wattled bat (*Chalinolobus gouldii*) about to be released. Photo: Mikaylie Wilson



A long-eared bat (*Nyctophilus geffroyi*) about to be released. Photo: Mikaylie Wilson

essential to bat conservation. It allows wildlife health authorities to respond to and manage bat mortality events in an informed manner, as well as providing data required for the development of diagnostic tools.

I am using molecular techniques and antibody testing for targeted detection of key viruses, e.g. lyssaviruses and coronaviruses, on all captured bats. These two methods are complementary as they can identify whether the tested individuals are actively infected with, or have been previously exposed to, these viruses. I will employ next-generation sequencing for viral discovery from faecal samples and to isolate genetic markers from tissue samples for four species of microbats with differential distributions and niche requirements: *Chalinolobus gouldii, Nyctophilus geffroyi, Nyctophilus gouldi* and *Vespadelus regulus*.

A fantastic team of volunteers was essential for the sampling of over 300 bats of nine different species during my first field season. We sampled over water bodies at sites within conservation land as well as areas managed by Bush Heritage or the Australian Wildlife Conservancy.

I am very grateful for the financial support of the Australian Wildlife Society. It greatly contributes to my upcoming field season, which is going to be very busy, as I will be trapping at an additional five sites within the south-west of Western Australia. The Gunduwa Regional Conservation Association, the Holsworth Wildlife Research Endowment and the Alistair Bursary also generously support this project.

Chocolate wattled bat (*Chalinolobus morio*), a species widely distributed in the South West Botanical Province. Photo: Mikaylie Wilson

Determinants of native bee assemblages in urban habitat fragments in the southwest Australian biodiversity hotspot and interactions between honeybees (*Apis mellifera*) and native plant-pollinator communities

KIT (AMY) PRENDERGAST
Curtin University, WA

Native bees in the 'burbs' in a biodiversity hotspot

The long history of Australia's isolation from other continents and the unique climatic and geological history has given rise to a very unique flora and fauna. Australia has a rich diversity of native bees, estimated at 2,000 species, many of which occur nowhere else in the world. Pollination, predominantly performed by bees, is a vital ecosystem service that not only contributes to food security for humans, but underpins the health of ecosystems through sustaining the fitness of plants and the myriad organisms that interact with the flora. It is likely that native bees have evolved mutualisms with native flora and that threatening processes such as habitat loss, degradation and fragmentation driven by agriculture, and increasingly by urbanisation, as well as invasive species, jeopardise the integrity of native plant–pollinator networks.

Perth, the capital city of Western Australia, is situated in an internationally renowned biodiversity hotspot. What native bee species exist in this urbanised region, what functional traits they exhibit, and what local and landscape factors determine the abundance, diversity, and assemblage composition of native bees remains unknown. Southwest Western Australia is also renowned for its world-class honey. Unlike most of the world, where honeybees have undergone drastic declines, the thriving honeybee populations in Western Austalia – both managed and feral – may have detrimental impacts on native bees and, in turn, native plant–pollinator communities. Whether the non-native honeybee outcompetes native bees is a topic of ongoing controversy, with negative, neutral and even positive effects on native bees or native flora being reported.

Female *Xanthesma (Xenohesma) vittata:* they may be tiny, but native bees can be incredibly beautiful, as evidenced when seen under magnification.

The results of my study will have a range of important applications. My comparison of techniques of sampling bee communities can inform us what methods are most suitable for monitoring programs – a vital activity to assess the conservation status of bees and their response to environmental changes and conservation schemes that is severely lacking in Australia.

Male *Xanthesma (Xenohesma) vittata:* the males of this brilliant tiny euryglossine species have enlarged eyes, presumably to seek out females as they fly in mating 'shoals'.

Hylaeus (Hylaeorhiza) nubilosus: this 'masked bee' (genus Hylaeus) is relatively unhairy, for it carries pollen not in specialised pollen-carrying hairs, but instead internally in the bee's crop.

My study will also be the first to systematically survey native bees in this biodiversity hotspot, and investigate the relative value of residential gardens vs. bushland remnants as foraging and nesting habitat for native bees. It will also contribute scientific data to resolve the ongoing controversy regarding the impact of honeybees on native bees in Australia and their contribution to native pollination networks. My study will identify what factors jeopardise or promote native bees, so that individuals, communities, and policy makers and institutions can apply my scientific findings to design, manage, and restore urban habitats better so that people, pollinators and plants can thrive.

Australia, and especially the southwest Western Australia biodiversity hotspot, hosts an amazing assemblage of animal and plant species, many of which exist nowhere else on earth. The unique evolutionary history of our wildlife means that losing them entails a loss of our natural heritage.

Discovering what habitats give bees a 'buzz'

To address these key knowledge gaps, my project involves intensive surveying of native bees in bushland fragments and residential gardens across the urbanised region of southwest Western Australia; namely, the 170-kilometre urban sprawl of Perth, the capital city of Western Australia. I am surveying seven sites of each habitat type, dispersed throughout the landscape and at distances exceeding the foraging range of most native bees (one kilometre) to ensure independence of each site. I am conducting my surveys during the spring and summer months, which encompass the main flight seasons of native bees. To determine what influences the abundance, diversity and composition of native bee assemblages, at each site I am measuring local variables and landscape variables that can be predicted to have an impact on native bees, including floral diversity and abundance, the proportion of native flora, the amount of 'greenspace' around a site, and proxies for nesting habitat. These variables have been found to be influential in some cases in previous studies on bees in cities elsewhere across the globe, and on studies on bees in other disturbed landscapes (mainly agricultural landscapes, in which the majority of bee studies have been conducted).

At the local scale, I am measuring food resources by quantifying the following: floral species diversity and abundance, the proportion of these species that are native , the number of woody trees and percentage of bare ground as proxies for nesting habitat for cavity-nesting and ground-nesting bees, respectively, and site area. Landscape variables measured include the distance to the nearest reserve, and the proportion of green space (vegetation) and built space (impervious structures) at a 500-metre radius around each site (within the foraging range of most native bee species, and the scale at which previous studies have found effects to be significant).

The impact, if any, of honeybees on native plant–pollinator communities is being assessed by correlating the abundance of honeybees with native bees, both across sites and across a day. The potential for competition is being evaluated by comparing niche overlap based on both floral visitation data and data collected by analysing the pollen collected by honeybee colonies and cavity-nesting native bees. A before–after control–impact design will be utilised to further experimentally assess the effect of honeybees on native bees by removing feral colonies at half of my sites prior to the second season of surveys. This will additionally assess the impact of feral colonies, which are of concern not only to native bees but also to commercial apiarists (including urban beekeepers) as they may compete with their honeybees. Feral honeybees are also known to usurp the limited tree hollows that threatened native birds and possums rely on.

I am sampling bee communities using a number of well-established sampling methodologies: blue and yellow bee bowls (aka pan traps), blue and yellow vane traps, sweep netting, and trap nests.

To directly look at not only the ability of native bees to forage in urbanised habitats, but also their ability to nest and reproduce in such habitats, as well as look at the fitness impacts of honeybees on native bee reproduction, I am directly quantifying nesting success via 'bee hotels' also known as trap nests. At each of my sites I have installed wooden jarrah blocks with 12-centimetre deep holes, into which cardboard tubes of three diameters (4 mm, 7 mm and 10 mm) are inserted.

Utilised tubes are being collected and the bees reared in the lab to identify the diversity of cavity-nesting bee species; evaluate nesting success, parasitisation and predation rates, emergence rates, sex ratio and body-size; and how these vary according to habitat type, habitat characteristics, and honeybee abundances.

Analyses will be performed by month, by year and across the two years of my site surveys. This will also uncover patterns regarding how the shift in floral composition across a season influences bee communities, and the variability across years. To identify if there are particular ecological traits that render bees susceptible to urbanisation and/or honeybee competition, I am analysing my data according to key ecological traits of bees (namely, body size, nesting habitat, floral specialisation and taxonomic group).

For the third year of my study, I intend to provide a more controlled experiment to assess the impact of honeybees on native bee fitness, and to look at the relative contributions of honeybees vs. native bees in the pollination of native flora. To do so, I will be looking at pollen deposition and fruit set, and niche breadth and overlap, and reproductive success of cavity nesting native bee species with and without honeybees. This is relevant to native bees in small isolated habitat patches and provides a more rigorous approach to testing competition by controlling extraneous environmental factors. Experiments will be conducted in controlled environments (greenhouses), with two replicates per treatment.

Preserving pollinators in the 'burbs' and beyond

Against the backdrop of a biodiverse community is the realisation that much of our wildlife has been lost and the remainder is threatened. I have a deep love and passion for the flora and fauna of this country I call home, and want to use my skills as a scientist to understand, protect and restore wildlife. I want to address the processes that threaten their existence and the integrity of the ecosystems in which both these organisms co-exist alongside our species, so that the amazing animals and plants in Australia's ecosystems

A megachilid bee, genus *Megachile.*

can thrive now and in the future – including in the regions where the majority of the human population live. Native bees are diverse and have an array of behaviours, morphologies and life-history traits that make them exemplary in representing the biodiversity this country hosts. In turn, they are vital for performing the ecosystem service of pollination, on which the majority of plants depend, and diverse plant communities support a diversity of other organisms. Plant–pollinator networks are incredibly fascinating, as well as pivotal for sustaining biodiversity. I truly get a real buzz out of this project, which I devised and designed myself, and believe my research is vital to understanding how we can manage our gardens and cities so that pollination networks are not jeopardised.

I am honoured to be a recipient of the Australian Wildlife Society university schemes grant. The funding will enable me to extend my research and explore more avenues to really get a thorough understanding of the diversity of native bees in the 'burbs', and how we can better share our living spaces with pollinators, so that people, plants and pollinators – both introduced and native – can coexist, and indeed, thrive.

Euryglossina (Euryglossina) perpusilla: a tiny euryglossine bee.

Novel assessment of the relationship between plastic ingestion and fatty acid profiles in three species of Australian shearwaters

PETER PUSKIC
School of Biological Sciences
University of Tasmania

Shearwaters: sentinels of strange tides

The journey so far

After spending the first 80-90 days of life inside a sandy burrow, hunger and instinct force her to leave the comfort of the only home she has ever known. Stepping out into the daylight she stretches her wings for the first time in anticipation for the epic journey ahead. She must travel to the Sea of Japan, navigating and foraging without the help of any adults, who have already migrated in the weeks before. She will not return here for at least another five years when she will breed. She must undertake this journey never having seen the ocean before!

This timeless story is familiar to many species of Australian shearwater who undertake a migration of epic proportions. Unfortunately, the odds are stacked against them.

Shearwater fledgelings spend their early days of life being provisioned by their parents. Diet varies among species, but populations tend to be faithful to their foraging areas and opportunistically feed in these regions. These first meals are vital in promoting the fledgelings' growth and building up fat stores which are critical for the young birds' early life.

Like most seabirds, shearwaters are regarded as sentinel species, reflecting pressures and changes in their environment. This is because their migration patterns and feeding grounds are predictable and the birds return to the same breeding sites each season allowing us to study individuals and populations over time.

On Lord Howe Island, New South Wales, the largest breeding colony of flesh-footed shearwaters (*Ardenna carneipes*) has been declining for many years. Adults of this species ingest plastic from the surrounding waters of the Tasman Sea, offloading it to their chicks during feeding. Almost every single fledgeling on Lord Howe Island has ingested plastic ranging from 20 to 200 pieces of varying size, type and colour. The ingestion of plastic has many physical effects on the bird, including lacerations and ulcers in the stomach, and in cases where birds have ingested large amounts of plastic, this may lead to death by starvation. Similar impacts are likely being felt by two other Australian species, the short-tailed shearwater (*A. tenuirostris*) and the wedge-tailed shearwater (*A. pacificus*).

Peter presenting an introductory seminar on how we can use seabirds as sentinels of the marine environment.

Plastics have other, more sinister impacts when ingested. Plastics are manufactured using toxic chemicals and when in the marine environment, the surface of plastics provides the perfect medium for persistent organic pollutants (POPs) to sorb to the plastics creating a chemical cocktail. When ingested, these chemicals leach directly into the organism where they accumulate in the tissues, particularly those high in fats.

Fat is important for wild animals as it provides an energy reserve. For young fledgelings, having high-fat stores is vital to surviving their first big migration. Fledglings that have ingested high amounts of plastic may have variable growth and are often malnourished. Understanding the dynamics of this – for example, whether utilising fat stores liberates accumulated POPs – will provide insights into the health of an individual and the likelihood of success during migration.

The use of fatty acid and total lipid analysis will provide robust, quantitative information on tissue lipid composition in healthy and emaciated birds. Gas chromatography mass spectrometry (GC-MS)

will provide crucial data on the concentrations of plastic-derived chemicals present in the birds.

Our team at the Institute for Marine and Antarctic Studies is doing exactly this. To better understand the threats posed by marine plastics, including the less visual impacts of plastic ingestion and associated chemicals, we are analysing muscle, liver and fat tissues of three species of Australian shearwater: flesh-footed and wedge-tailed shearwaters from Lord Howe Island and short-tailed shearwaters from Great Dog Island, Tasmania. We recently completed the first stage of processing (bird necropsy) and have begun dehydrating and extracting the resulting tissue samples in preparation for GC-MS analysis.

The journey ahead

Our knowledge of the processes impacting shearwaters can assist us in understanding these impacts and can be used to call on governments and policy makers to make much-needed changes.

Limiting the impacts of marine plastic pollution is possible, but it requires the assistance of every single one of us. Making small changes in our behaviours and attitudes can have enormous impacts. We can refuse to buy products wrapped in unnecessary plastics and simply say no to single-use plastic items such as straws, bags and coffee cups. Perhaps you can organise a community beach or park clean-up or better yet, create change at the highest, most impactful level by petitioning your local governments to change policy.

There is still a lot of work to be done by researchers, governments, communities and individuals. Working together to prevent plastics from entering our oceans is possible and is the only way to ensure the continued survival of shearwaters and marine life around the world.

About the Author

Peter Puskic is an honours student at the Institute for Marine and Antarctic Studies, University of Tasmania, studying the sublethal impacts of plastic ingestion on Australian shearwaters. He studied zoology and archaeology in his undergraduate degree exploring how people use, impact and depend on the natural world and is passionate about education and outreach to create social and environmental change.

A wedge-tailed shearwater adult returning to its breeding island.

Thirteen pieces of plastic found within the stomach of one individual Tasmanian short-tailed shearwater.

Eight pieces of plastic found within the stomach of one bird. The plastic pieces can be dull (as shown here) or quite colourful.

Chick growth is highly variable. Two same-age Tasmanian short-tailed shearwaters side by side. The smaller one (left) has ingested 11 pieces of plastic and the larger individual has only ingested two pieces.

Avoid, utilise or neutral? Habitat use by animals in response to Lantana camara invasion

EMILY QUINN SMYTH
University of Technology Sydney

Lantana camara is one of Australia's most problematic weeds, particularly in New South Wales, and is recognised as a Key Threatening Process causing biodiversity decline (Australian Weeds Committee 2010). Given the potential for further considerable spread under climate change, lantana is of increasing concern to land managers as well as conservation scientists and practitioners.

It is unclear if faunal responses to lantana invasion are consistent across different animal groups including mammals, birds, reptiles, amphibians and invertebrates. Some fauna species exhibit strong declines in abundance, while others demonstrate neutral or increased abundance in response to exotic plant invasion.

Do native fauna species utilise or actively avoid areas invaded by lantana? Or is there a neutral response? This is where my research comes in. My project aims to determine the impacts of lantana on habitat use by native fauna, across taxonomic groups. By comparing the ecological responses of these faunal groups, I will inform weed management strategies, ensuring that management caters for the differing habitat requirements of fauna.

My study is located in and around the city of Lake Macquarie, where, typical of many coastal cities, lantana readily establishes in disturbed areas within forests, particularly at bushland interfaces with roadsides and at other forest edges. In order to study across taxonomic groups, I am employing a range of sampling techniques including camera trapping, pitfall trapping, active searches and sound recording. This research is integral to filling the gaps in knowledge required for land managers and councils to effectively manage lantana. My research also has the potential to change the way the public thinks about and manages weeds.

Emily measuring tree DBH at one of her field sites in the Lake Macquarie region.

This research would not be made possible without the generous contribution made by the Australian Wildlife Society University Student Grant. The grant provides a significant contribution to my project in allowing me to share my research and contribute to increased understanding of the impacts of lantana on animals. I am incredibly grateful and very excited to see what the future of my project brings!

About me

I have always been passionate about learning about animal and plant interactions and absolutely love being out in the field. Thus, I am excited to study for a Master of Science (Research) with the University of Technology Sydney, to explore habitat use by animals in response to lantana invasion.

Studying across taxonomic groups is a particularly rewarding part of my research. I am able to apply a range of surveying techniques and gain experience in working with a wide range of animals. In the future, I hope to contribute to the conservation of Australia's unique flora and fauna through continued research projects. I also thoroughly enjoy teaching undergraduate environmental science subjects at my university. In the future, I would like to be an educator and mentor for upcoming environmental scientists, while travelling to experience the world's incredible biodiversity first-hand. The assistance provided by the Australian Wildlife Society's University Student Grant is a significant contribution in allowing me to continue my research and progress my academic career. Thank you!

Assessing the vulnerability of freshwater crayfish to climate change

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The University of Melbourne

Freshwater ecosystems are largely neglected in global conservation priority-setting, yet have been shown to be some of the most threatened ecosystems on earth, with similar patterns observed in freshwater species on the IUCN Red List of Threatened Species (IUCN, 2017). Freshwater crayfish are a diverse group of crustaceans with more than 600 species identified globally. Geographically crayfish are distributed in 60 countries with high species diversity found in the south-eastern Appalachian Mountains in the USA and in south-east Australia (**Fig. 1**). Freshwater crayfish are an interesting case study for assessing the vulnerability of freshwater species to climate change because they are economically important and globally threatened (**Fig. 2**).

Climate is the predominant environmental variable that shapes biogeography of organisms, and affects the thermal ecology of freshwater species, controls their growth and performance. Changes in climate may affect a species' persistence through a number of mechanisms including sensitivity, exposure and low adaptive capacity. The Intergovernmental Panel on Climate Change estimates that 20–30 percent of the world's species are likely to be at high risk of extinction from climate change impacts within this century, while 83 species of Australian freshwater crayfish are predicted to be vulnerable due to climate change (IUCN, 2017).

Here, I assess how the specific traits and geographic areas of each species are threatened by climate change and discuss possible mitigation measures to aid adaptation and conservation policy making. I ask three questions:

1. Can the trait-based approach for climate change vulnerability be applied to data-poor freshwater invertebrates, and what are the implications for their conservation?
2. How does uncertainty in trait selection and data quality affect the overall vulnerability assessment?
3. How do the results of the vulnerability assessment compare with species already identified as threatened by climate change on the Red List?

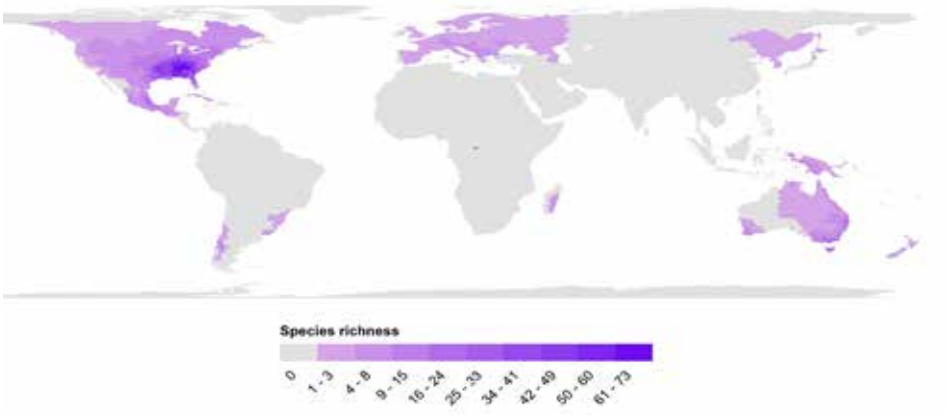


Fig. 1. Global richness map of freshwater crayfish.

In this study, I followed a trait-based climate change vulnerability assessment of 574 species (including 132 species from Australia) of freshwater crayfish included in the global IUCN Red List assessment (IUCN, 2010). This trait-based approach combines three key dimensions of climate change vulnerability: sensitivity, exposure and adaptability. For each dimension, key traits are selected and thresholds used to determine whether a species is scored as 'low' or 'high' susceptibility under that trait. To assess species' exposure to climate change, I used climate change projections at 30 seconds' resolution based on an ensemble of four General Circulation Models from Worldclim (www.worldclim.com), and at three emission scenarios. Species which are highly sensitive and exposed to climate change as well as poorly adaptable are considered as *climate change vulnerable* species.

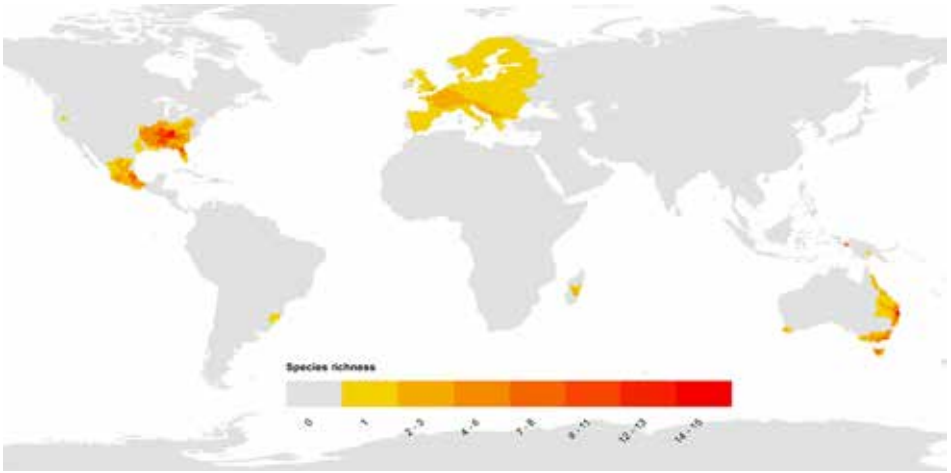
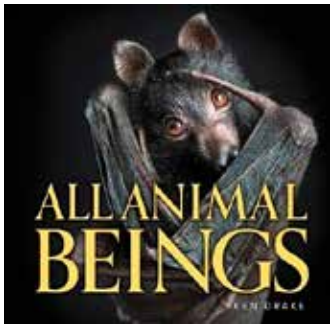


Fig. 2. Global distribution of redlist threatened freshwater crayfish.

For sensitivity, I collected data on habitat specialisation, microhabitat specialisation, restriction to high-altitude habitats, narrow tolerance in temperature and precipitation changes, dependence on high dissolved oxygen, dependence on interspecific interaction, rare within population and fragmented population. For exposure, I collected data on species' distribution in sea-level inundation habitats, changes in mean temperature, changes in temperature variability, changes in mean precipitation, and changes in precipitation variability. To assess species' exposure to climate change, I used climate change projections at 30 seconds' resolution based on an ensemble of four General Circulation Models, and at three emission scenarios. For adaptability, I collected data on geographic range restriction, extrinsic barriers to dispersal, declining population trends, and reproductive output.

The project constitutes the first application of the IUCN climate change vulnerability framework to freshwater invertebrates globally, and generates much-needed ecological knowledge on species' sensitivity and adaptive capacity. Importantly, the project provides the first systematic conservation recommendations for crayfish in Australia.

Book Reviews



All Animal Beings by Ken Drake

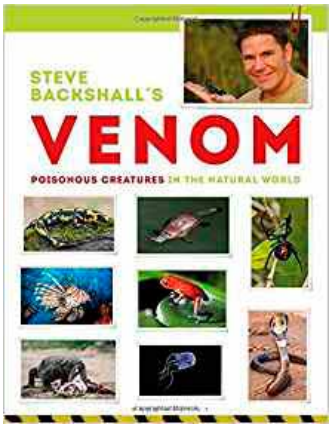
All Animal Beings comprises a stunning collection of heart-warming and curious photographs of the animals in our lives that we think we know best, as seen through the lens of Ken Drake. In this book, readers will find Zoo Studio's signature, stunning portraits of some of the most character-filled beings that Ken has met and photographed. From all manner of pets, iconic wildlife and farmed animals, subjects include the likes of Dundee the cockatoo, Penelope the pig, Cindy the camel and Raymond the koala. Animal lovers and photographic art connoisseurs alike will fall in love with this book.

Publisher: Buzz Group
RRP: $49.99

Shorebirds in Action: An Introduction to Waders and Their Behaviour by Richard Chandler

Shorebirds in Action is an outstanding and well-illustrated reference book on a special collection of birds. It serves well as an introduction to all wader birds and their behaviour as they live and feed around the beaches and lake systems across the world. The photographic collection of high-quality photos of shorebirds or waders covers over 80 percent of known shorebirds around the world. The close variation of the colour patterns of some species such as thick-knees and oystercatchers are very useful to all bird watchers. Australia is blessed with a large collection of shorebirds living and feeding around our vast coastline. The annual migration of these waders each year is one of the unique features of these birds when they fly north to breed in Siberia. A great reference book very well researched and illustrated for the keen bird lover.

Publisher: Whittles Publishing | RRP: A$31.95



Venom: Poisonous Creatures in the Natural World by Steve Backshall

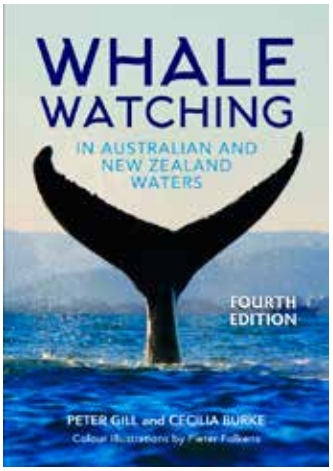
Venom: Poisonous Creatures in the Natural World is a fascinating book. Steve Backshall, who is an experienced naturalist, takes a fascinating look at the different types of natural venoms. On a tour of the world's continents, he looks at over 60 of the most venomous creatures, describing their main characteristics and explaining how they administer their venom and what its effects are. A wide variety of insects, reptiles and amphibians use toxins to subdue their prey or to stop becoming prey to another predator. Even some mammals and birds resort to poison as a means of securing a meal or deterring attack. Stunning colour photographs and exciting accounts of Steve's encounters with some of these animals bring the world of natural venom alive.

Publisher: Bloomsbury
RRP: $29.99

Dead Zone: Where the Wild Things Were by Philip Lymbery

Dead Zone is a highly readable if frightening examination of the impact of industrial agriculture on the environment, and particularly biodiversity. The book's style is part travel-book, part autobiography and part ecological critique of some of the world's most iconic and endangered species and what we can do to save them. Most of us are aware that many animals are threatened by extinction – the plight of creatures such as polar bears, tigers, and whales has been well publicised. While this is typically attributed to climate change and habitat destruction, few people realise that there is a direct link to consumer demand for cheap meat.

Publisher: Bloomsbury
RRP: $24.99



Whale Watching in Australian and New Zealand Waters by Peter Gill and Cecilia Burke

Whale Watching in Australian and New Zealand Waters is the definitive guide for holidaymakers, nature lovers and marine specialists. In recent years whale watching in Australia and New Zealand has become a passion for many people. Diverse marine environments from tropical to subantarctic mean that numerous species of whales and dolphins are drawn to our waters, while a plethora of tour operators makes it easier than ever to spot these wonderful creatures in their natural habitat.

Publisher: New Holland
RRP: $29.99