Science
for saving species

The magazine of the Threatened Species Recovery Hub

Winter 2017
Issue 4

A wreath of rarities
Developing a Red Hot List for plants

Making more of the business of biodiversity

Of foxes and fires

When the cat's away, do the dunnarts play?

Threatened Species Recovery Hub
National Environmental Science Programme

IMAGE: ILSE PICKERD

Doing the **business** for **biodiversity**

An ice-cream company recently hitched its marketing efforts to an awareness program about threats facing bee pollination. In the process it sold a lot of product. **Brendan Wintle** reckons threatened species conservation needs to open its eyes to new business opportunities if it is to secure enduring investment. Here's why.

There is an outstanding, yet underrated, opportunity out there for conserving biodiversity and threatened species, and its name is 'business'. More specifically, there are opportunities in business that are good for biodiversity and where biodiversity can be very good for business. I've long suspected this but two events I've recently attended have highlighted what is possible.

The first was the launch of the Threatened Species Commissioner's Threatened Species Prospectus in February at Taronga Zoo (Sydney). Minister for the Environment and Energy, Josh Frydenberg, TS Commissioner, Gregory Andrews and several representatives from the corporate sector all highlighted the fundamental link between our sense of identity and our amazing native species. This link is not lost on business.

Haagan Daas demonstrated the link between ecosystem services (in this case bee pollination) with ice-cream production. In the process they sold more ice-cream.

The majority of brands – think sporting teams, airlines, cars companies and food labelling to name a few – exploit the power of Nature's great mascots (see the Shutterstock blog 'why successful brands use furry mascots' for some background on this). And yet, our success in leveraging this popularity to conserve the animals has been limited. We can do better.

Gregory Andrews talked of sitting in a Qantas plane with an iconic macropod (think red kangaroo) on its tail, flying above the Australian deserts where cats, foxes and human exploitation have driven six macropods to extinction, leaving seven other species hanging by a thread and 18 others vulnerable to extinction. How can we have failed to convince Qantas to sink significant resources into ensuring no more iconic macropods go extinct?

The 'brand value' of nature does not end with iconic mammals. At the Taronga Zoo launch, Rosemary Bissett, Head of Sustainability at the National Australia Bank and a member of the TSR Hub Steering Committee, told me about Haagan Daas' most successful advertising campaign EVER (and these guys know how to advertise). It was based on concerns about declining bee populations and what it means for consumers of ice-cream! The intense public interest they invoked with their adverts not only sold lots of ice-cream, it also got them an audience with the US congress to talk about global declines in pollination services! This is an ice-cream company, not WWF, or Paul Ehrlich.

Businesses ingratiating themselves with potential customers via their contributions to conservation is definitely a strategy that can be effective. However, by itself it's unlikely to fundamentally change the conservation game. To actually save species, we need much more investment in conservation than can be achieved just through brand enhancement – we need new ways of doing business that are good for biodiversity AND good for profit. 'It's the bottom line, stupid'.

So what might some of these win-win opportunities look like? This brings me to the second event I mentioned earlier. Our Hub recently staged a 'Conservation Opportunities' workshop at RMIT in Melbourne. Hosted by Georgia Garrard and Sarah Bekessy at RMIT, the workshop brought together representatives from the corporate, science, government, philanthropy and conservation sectors to brainstorm and develop a range of emerging opportunities for threatened-species conservation.

"We need new ways of doing business that are good for biodiversity AND good for profit."

Business leader and farmer David Shelmerdine shares his reflections with RMIT's Sarah Bekessy on the ideas emerging from the recent Conservation Opportunities Summit in Melbourne. David is the President of the Gold Standard Foundation. (See page 14 for a full report on the Summit)

A number of business opportunites were discussed. James Fitzsimons from The Nature Conservancy outlined their water-markets impact-investment schemes, and Cullen Gunn from Kilter Rural described working examples of landscape improvement projects that deliver better environments AND better returns to investors.

This is a hard and long road, but one that is ultimately more financially sustainable than short term grants from governments or philanthropy. So here is the challenge – can NESP researchers come up with threatened species recovery projects that can help save species AND deliver financial returns to land owners or investors? Creative conservationists like Mt Rothwell owner Nigel Sharp, National Australia Bank, and big companies like Ferrero Rocher all tell me they're interested and investors are out there. So if you have a good idea, please get in contact!

Professor Brendan Wintle
Director, TSR Hub

Inside this issue

Innovative **partnerships** to fight **extinction**

2017 is a year for innovation. Only a few months in, we have already seen new and innovative solutions investigated for feral cat control using 'trojan baits', exciting citizen-science opportunities with the release of the night parrot call, and successes in engaging the private sector in conservation. As I mentioned in the summer issue of *Science for Saving Species*, we were able to meet the majority of the first year targets of the Threatened Species Strategy. And now we are focused on new and innovative partnerships to help achieve the ambitious Year 3 and Year 5 targets.

The Threatened Species Commissioner with a warru (or black-footed rock-wallaby). You can read about a proposal to save the warru on page 50 of the *Threatened Species Prospectus*.

I was delighted to launch the *Threatened Species Prospectus*, alongside Minister Josh Frydenberg at Taronga Zoo, and promote the opportunity for corporate Australia to support conservation. Businesses are increasingly becoming more responsive to environmental efforts and collaborations with non-government groups, and we need to be ready to explain with conviction why and how they can invest. And on the day of the launch of the *Prospectus*, we celebrated the funding of one of its projects when San Diego Zoo committed $500,000 to platypus and freshwater fish conservation.

Gregory Andrews with Josh Frydenberg, Minister for the Environment and Energy, at the launch of the new *Threatened Species Prospectus* at Taronga Zoo in Sydney.

The Conservation Opportunities Summit held at RMIT in February was another important step. The outcomes of the Summit are part of the TSR Hub's Project 6.3 (Methods for better communication and community buy-in to threatened species conservation), and it sought to explore ways to better engage corporate Australia in species-saving science. Over 30 proposals were considered and action plans developed for five of the most promising projects. This is important work for the Hub and for the community, creating a sound foundation to build collaboration with businesses.

Of course innovation is not only about innovative financing. Project 6.5 (Making the most of citizen science for threatened species) aims to identify citizen-science projects which directly align with the Threatened Species Strategy and support these projects to harness the passion and enthusiasm of their communities. This is a great example of how new technology and new ways of thinking can create new datasets and encourage on-ground recovery actions.

We all have a role to play in the fight against extinction. Innovative partnerships between the private sector and conservation groups, in combination with robust support from the Australian Government, are critical in the fight against extinction. Whether it is innovative financing, new technologies, or new ways of thinking and organising, it will help us to tackle the complex and ambitious targets we have set. Together we can improve the trajectories of Australia's magnificent threatened plants and animals.

Gregory Andrews
Threatened Species Commissioner

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"Innovative partnerships between the private sector and conservation groups, in combination with robust support from the Australian Government, are critical in the fight against extinction."

Citizen, where art thou?

It's time to get the **public directly engaged** with saving threatened **species**

IMAGE: CLAIRE FULLER

'Citizens' collecting data out in the field may be an effective way of obtaining information in a vast country.

Citizen science has been steadily increasing in recent years, both in terms of number of projects and people involved. Environmental research has been the focus of many citizen-science projects, and now the TSR Hub has launched a project to help improve outcomes for threatened species. What's the connection between citizen science and threatened species? Dr **Rochelle Steven** from the University of Queensland sets out the arguments.

Australia's threatened species are facing numerous threats across the continent. The vast area this beautiful land occupies makes for a unique and diverse fauna and flora, but its sheer vastness also creates a major challenge for our efforts to track and manage the decline of those species facing imminent extinction. That vastness makes monitoring difficult and getting around very expensive. So how do we maximise efficiency while also learning more about the species whose very existence is under threat?

Many have touted 'citizen science' as a strategy to alleviate the cost burden on conservation managers and researchers. At the same time, citizen science is touted as increasing the engagement between the public and nature.

So, what is citizen science and what is its potential? There are a few definitions around but, generally speaking, citizen science involves getting volunteers (citizens) to participate in the collection of data that can be used to answer scientific questions. At a minimum, citizen science involving the environment and conservation gets people thinking about nature. But it can achieve much more as well; with citizens collecting valuable biological data that will contribute to better conservation outcomes.

Mixing threatened-species conservation and citizen science presents a few challenges. First, many threatened species do not occur in urban areas, where the greatest pool of potential participants reside. How do we overcome this mismatch? Finding ways to connect urban citizen scientists to projects in regional areas that need additional human resources is a start. This could assist regional projects and provide rich experiences to people from cities.

One citizen-science platform that is already established and regularly contributing to the published scientific literature is Redmap. It's a citizen-science reporting tool for recording the sightings of uncommon marine species. With 55 species of fish currently listed on the *Environment Protection and Biodiversity Conservation Act (1999)* and numerous grey nomads and regionally based citizens enjoying fishing as their recreational pastime, this link presents an exciting opportunity for threatened-species monitoring.

The second challenge is that threatened species may be 'sensitive' or 'vulnerable' to the potential disturbance of direct monitoring activities. A strategy to deal with this is to recruit citizen scientists to monitor species remotely. That is, to review images and footage

Key messages

Citizen science has enormous potential to help gather information on threatened species and the threats they face

The TSR Hub is building a framework of best practice for citizen science that maximises the impact of citizen science for threatened species recovery

The **citizen** and the **cassowary**


IMAGE: ROCHELLE STEVEN

The southern cassowary (*Casuarius casuarius johnsonii*) is an enigmatic species found in the Wet Tropics Word Heritage Area (http://www.wettropics.gov.au/cassowaries) of North Queensland. It is hard to look at a cassowary and not think 'dinosaur', because they truly look like something that walked out of a Jurassic Park movie set.

This 'keystone' species plays a critical role in maintaining ecosystem processes in the rainforests as they are the key disperser of large-fruited rainforest plants throughout the region. Unfortunately, the species is facing multiple threats in the form of habitat loss, car strikes and attacks from dogs. They are currently classified as Endangered under the national EPBC Act.

The more we can learn about these extraordinary birds the better placed we will be to protect them, and this is where citizen science can play a role. Visitors and residents alike can assist local conservation work by reporting sightings of all cassowaries throughout the Mission Beach (http://www.missionbeachcassowaries.com/cassowary-id-and-tracking.html) and Daintree (http://www.daintreecassowary.org.au/) areas, two of the main hotspots for the species. Recording every sighting is important to understand how the birds move through the landscape through time, and can inform where corridor plantings and additional signage are needed to ensure the species safety and survival.

from camera monitors to identify occurrences of threatened species (all done without setting foot in their habitat).

One network combining several of these types of projects into a central portal is called Wildlife Spotter. Wildlife Spotter is administered by the Australian Broadcasting Corporation (ABC) and provides citizens with the chance to contribute to science by identifying threatened species remotely. Species that have been worked with so far include malleefowl, bandicoots, bettongs and feral cats. Feral cats, of course, are not threatened species but they are a key threat to many native mammals.

Aside from preventing disturbance to threatened species, the additional benefit of remote monitoring is the reduced logistical cost for the participant (ie, no travel) and health and safety risks are also largely removed. It also enables urban citizen scientists to contribute to the conservation of regional and remote threatened species.

With increasing interest in the use of remote technology like cameras, drones and acoustic recorders, this approach is likely to really take off in the years to come.

Researchers in the Threatened Species Recovery Hub are currently reviewing the link between citizen science and threatened species in Australia. We are working on building a framework for best practice that maximises the positive impact that citizen science might have for our nationally-listed threatened species.

To develop this best-practice framework, we will be talking with practitioners and project officers associated with citizen science and threatened species in Australia. We will be asking them how they measure their successes, what impact their citizen-science projects are having and what challenges they have faced in the past and continue to deal with. Essentially, we are hoping to create a recipe for success for how citizen science is best done for threatened species.

By sharing experiences and developing a generic framework that can be applied to multiple situations, we hope to give practitioners peace of mind about their day-to-day operations. Often they are doing their work with little guidance on what is a good benchmark to work towards. Or it might be that we can provide guidance on how they can implement strategies for dealing with obstructions to them achieving their goals.

Our citizen-science project has only recently started. We are eager to hear from anyone with knowledge of citizen-science programs actively involved in threatened-species monitoring and recovery. If you can help us or would like more information about our project, please get in touch.

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IMAGE: ROCHELLE STEVEN

The lesser swamp-orchid (*Phaius australis*) was once found along the east coast from north Queensland to north-east New South Wales. Citizens can assist in the recovery of the lesser swamp-orchid by working with local NRM groups to monitor the remaining populations of the species and protect them from weed invasion and illegal collection by orchid enthusiasts. Plants can also be purchased from licensed and reputable nurseries which may assist in supplementing local populations.

The **fire,** the **fox** and the **feral cat**

ABOVE: 1. A prescribed burn in the Otway Ranges removes understorey vegetation, making it easier for invasive predators such as foxes (2.) and feral cats (3.) to move around and hunt.
The tea-strainers hanging from the marking peg contain peanut butter, golden syrup and oats.

How do **invasive predators** and **native prey** respond to prescribed **forest fire?**

How do foxes and feral cats fare after forest fire? And what does the loss of protective understorey mean for the native mammals that foxes and cats prey upon? Dr **Bronwyn Hradsky** from the University of Melbourne working with colleagues Craig Mildwaters, Julian Di Stefano, Euan Ritchie and Fiona Christie (in collaboration with Victorian Government land managers) set up an experiment and found out. Here Bronwyn explains what they discovered.

Life's tough when you're a fox. Bandicoots don't just sit around waiting for you to catch them. And when you finally sniff one out, all that dense understorey gets in the way of a speedy chase.

But what happens if there's no understorey in the way? Does the fox's job become easier? Or, to put it another way, do things become a lot tougher for bandicoots? In a land that is increasingly fire-prone, the interaction between predators, fire and native mammals in forest ecosystems is an important knowledge gap for land managers aiming to conserve native fauna. Both planned (or prescribed) fires and wildfires tend to remove a lot of understorey vegetation cover, at least temporarily.

During my PhD with the School of Ecosystem and Forest Sciences at the University of Melbourne, I worked with an Honours student, Craig Mildwaters and land management agencies, to determine how foxes, feral cats and their native prey responded to a prescribed burn.

The study took place in the stringybark-peppermint forests of the Otway Ranges, in south-western Victoria. It was a before-after control-impact experiment based around a prescribed fire conducted by Parks Victoria and the Department of Environment, Land, Water and Planning (DELWP) in autumn, 2013. Our field work involved using motion-sensing cameras to survey invasive predators and native mammals, and collecting fox scats to analyse what they were eating ('scat' is another term for animal poo).

Fun fact #1: You can still smell fox scats when they're ziplocked in three layers of polypropylene. A collection of 224 of them makes your freezer a bit whiffy!

Our first session of camera surveys took place before the fire, and showed that invasive predators and swamp wallabies were more commonly found at sites with an open understorey. In contrast, smaller native mammals such as bush rats and long-nosed bandicoots were positively associated with understorey cover in unburnt forest.

This supports previous research which has found that foxes and feral cats hunt more effectively in open habitats, while small native mammals seek out dense cover for protection.

The prescribed fire was patchy. It burnt just over half of the 1200 ha block, and created a mosaic of burnt ridges and unburnt strips of vegetation along gullies. At the burnt sites, understorey cover was reduced by approximately 80%.

Key messages

In unburnt forest, foxes and feral cats were more likely to occur at sites with an open understorey

After fire reduced understorey cover, there was a five-fold increase in the occurrence of invasive predators

At the same time, consumption of medium-sized native mammals by foxes doubled

A motion-sensing camera records a red fox making off with a freshly killed bandicoot in the Otway Ranges.

What does this mean for foxes and cats? Our survey work showed that there was a five-fold increase in the occurrence of invasive predators at burnt sites after the fire (relative to changes at the unburnt control block). Furthermore, foxes began preying heavily on medium-sized native mammals such as echidnas and long-nosed bandicoots, instead of the swamp wallabies which had made up 50% of their diet prior to the fire.

This suggests quite strongly that fire made the forest more suitable habitat for invasive predators, and increased the vulnerability of medium-sized native mammals to fox predation. Such changes are highly concerning, as interactions between threatening processes can exacerbate the risk of extinction, particularly for already vulnerable species.

(Less) fun-fact #2: Three of the most important drivers of decline in Australia's native mammals are predation by feral cats, predation by red foxes, and inappropriate fire regimes.

Whether or not the changes we observed were large enough to impact the native mammal populations was unclear — this needs further investigation.

Our findings only relate to one fire at one block of forest, and require further replication. Nonetheless, if predation by invasive species limits the recovery of native fauna after fire, integrated management of fire and invasive predators may be essential for biodiversity conservation in flammable forest ecosystems.

A long-nosed potoroo caught by one of the motion-sensing cameras.

I am continuing to research this as a Postdoctoral Research Fellow supported by the TSR Hub, DELWP and Parks Victoria. I'm currently building simulation models of the impacts of fire and fox management on native mammal populations, and working with students to conduct further field studies that have direct relevance to land management decisions.

Australia has an enormous challenge with managing foxes and feral cats. This challenge becomes even greater when you introduce fire into the mix. By continuing to collaborate with land managers to tackle important knowledge gaps regarding the management of invasive predators and fire, our research aims to improve conservation outcomes for threatened species in forest ecosystems.

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Bronwyn is supported by the Threatened Species Recovery Hub, the Victorian Department of Environment, Land, Water and Planning (DELWP), and Parks Victoria. Her PhD with the Fire Ecology and Biodiversity research group was supported by DELWP, Parks Victoria and the Holsworth Wildlife Research Endowment. To see a copy of her paper on this work please visit here.

Spying on **foxes**

An old trapper once told me: "It takes three years to learn to catch a fox. Three years, girlie."

Unfortunate fact #3: he was pretty much right.

To complement these camera-based surveys, I trapped individual foxes and fitted them with GPS-tracking collars. This allowed me to collect high-resolution data on fox ranging behaviour and movement 24 hours a day, something I never could have done if I'd had to track them all on foot. This work, which showed that 'bush foxes' are not so different from 'town foxes' (or are even the same animal!), is currently in review.

RIGHT: Bronwyn fits 'Gammy' the fox with a radio collar.
You can read about what she discovered about Gammy, and the pros and cons of the technology she deployed at Bronwyn's blog: Working on the Wild Side at https://wildzoologist.wordpress.com/2014/09/13/technological-musings/

In search of the KI dunnart

Island conservation after the feral cat

Earlier this year the TSR Hub initiated an ambitious project to determine how a small endangered native marsupial, the Kangaroo Island dunnart, responds when one of its prime threats, predation by feral cats, is controlled or removed. The idea, of course, is to secure a future for the dunnart but in doing so it's hoped there's a whole lot more we can learn about saving threatened species. Dr **Rosemary Hohnen** from Charles Darwin University is leading the work and explains here what's involved.

Feral cats are a key cause of biodiversity loss in Australia and overseas. Across Australia there are thought to be between 2.1 and 6.3 million feral cats and they have been implicated in the decline and extinction of some 20 mammal species. Many threatened Australian mammal species now only persist in fenced 'feral-free' exclosures or offshore islands. The national Threatened Species Strategy has made tackling feral cats a core priority and particularly on biodiversity rich offshore islands.

Kangaroo Island (KI) is one of five priority islands committed to under the Threatened Species Strategy to undergo cat eradication. The process is being supported by the South Australian Department of Environment, Water and Natural Resources (DEWNR), through Natural Resources Kangaroo Island. At 4416 km2, KI is Australia's third largest island (after Tasmania and Melville Island) making the effort both challenging and rewarding.


IMAGE: JODY GATES

The Kangaroo Island dunnart, a small carnivorous marsupial mouse that might make a come back if feral cats are taken out of the equation.


IMAGE: ROSEMARY HOHNEN

Coastal heath on Kangaroo Island. Researchers and managers from multiple groups came together earlier this year to discuss progress on the cat eradication project and how best to go about monitoring the island's threatened species.

The rewards are both economic and environmental. Feral cats most likely are contributing to the high incidence of the diseases toxoplasmosis and sarcosporidiosis in KI livestock, which significantly reduces their market value.

KI is also home to several species of threatened mammal that stand to benefit from the removal of feral cats. These include the southern brown bandicoot (*Isoodon obesulus*), the heath mouse (*Pseudomys shortridgei*) which is believed to be found on KI, and the endemic KI dunnart (*Sminthopsis aitkeni*).

The island is also a good candidate for eradication of cats as it is already free of foxes and rabbits (two other significant threats to native mammal species). The eradication project commenced with a range of trials on the eastern side of the island in late 2015, and is expected to reach the western side of the island by 2021. Importantly, the proposed feral-cat eradication on the island is supported by both the State Government and the local community and funded by the Federal Government.

The status of the elusive KI dunnart is of particular interest. It's currently listed as endangered under the EPBC Act, critically endangered under the IUCN's Red List and it's one of ten priority threatened mammal species targeted in Australia's Threatened Species Strategy.

The dunnart is a small dasyurid (a group of carnivorous or insectivorous marsupials). It has soft grey fur, a pointed face and bright, dark eyes. It's tricky to catch and probably persists in very low numbers, so very little is known regarding its habitat preferences and ecology. Even its current distribution across KI is uncertain. Historical records indicate it was once found in central KI, but all 35 records since 1990 have come from six sites within Flinders Chase National Park and Ravine des Casoars Wilderness Protected Area, on the island's far western side. The decline of the KI dunnart has been attributed primarily to habitat loss (via land clearing and inappropriate fire regimes), and, in particular, to predation by feral cats.

The commencement of the KI cat-eradication program provides an opportunity to document the outcomes and potential benefits of investing in conservation management for threatened species. The project aims to determine how best to detect the elusive KI dunnart, and then how populations of this endangered species will respond to targeted cat control.

In April, a group of researchers from the TSR Hub met with project partners including land managers, Kangaroo Island staff from DEWNR and Natural Resources KI to learn about the cat eradication program, visit key monitoring sites and create a timetable for the research. Fieldwork is scheduled to begin in August.

The results of this study will provide insight into the status of the KI dunnart, and inform both land management and future eradication practices in the area and on islands generally. Naturally, we hope this effort will save the KI dunnart. However, in the process of saving it, we're also hoping that what we learn will contribute to saving many other threatened species in the future.

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What's the overlap?

ABOVE: Indigenous land in central Australia is home to many threatened species.

Indigenous land and threatened species conservation

Indigenous people govern and manage just over half of all of Australia's terrestrial land. Are these Indigenous lands important when it comes to conserving threatened species? Dr **Anna Renwick** led a team of researchers from CSIRO, Charles Darwin University and University of Queensland to carry out this analysis and found the answer was a resounding yes. Here she explains why.

Indigenous lands are extremely important for biodiversity. Compared to the rest of the country, Indigenous lands are largely unmodified and lightly populated. Consequently, on the whole they are ecologically intact and rich in species.

The national Threatened Species Strategy aims to halt the decline of threatened species, however there is a lack of understanding of how local-scale Indigenous land management can link to this national strategy. The first step in identifying viable options for partnerships is to identify the overlap between Indigenous land and biodiversity value. The aim is to maximise outcomes for biodiversity, while also providing oppoprtunities to augment Indigenous livelihoods.

We compared the distributions of 272 threatened native vertebrate species across Australia with the location of various Indigenous land tenures across Australia (see Figure 1). Indigenous land was found to contain almost an equal proportion per hectare of the ranges of threatened vertebrate species as non-Indigenous land. Almost three quarters of Australian threatened vertebrate species have at least part of their range on Indigenous land.

Key messages

Almost three quarters of Australian threatened vertebrate species have at least part of their range on Indigenous land

Indigenous land is essential for the persistence of many threatened vertebrate species

Across Australia's 89 (terrestrial) bioregions, Indigenous lands in northern, eastern and southern Australia are of highest importance for threatened species.

Indigenous land is essential for the persistence of many threatened vertebrate species as they occur predominantly on Indigenous lands or the opportunities for conservation on other parts of their range are limited by threats and human activity. The overlap is especially high for the priority mammals and birds listed in the national Threatened Species Strategy.

Because there is such a high overlap, this analysis highlights the need for an intercultural approach in the challenge of threatened-species conservation on Indigenous land. Indigenous people need to help guide appropriate goals and strategies to develop threatened-species conservation action plans that accommodate different interests.

Recognition of the importance of Indigenous lands to threatened species conservation can also hopefully assist Indigenous people in gaining support for threatened-species conservation that aligns with their own local priorities, including opportunities to expand their portfolio of income sources.

Finally, this information can assist policy makers to engage strategically with Indigenous people whose land supports large numbers of threatened species and to guide funding programs focused on supporting Indigenous land management.

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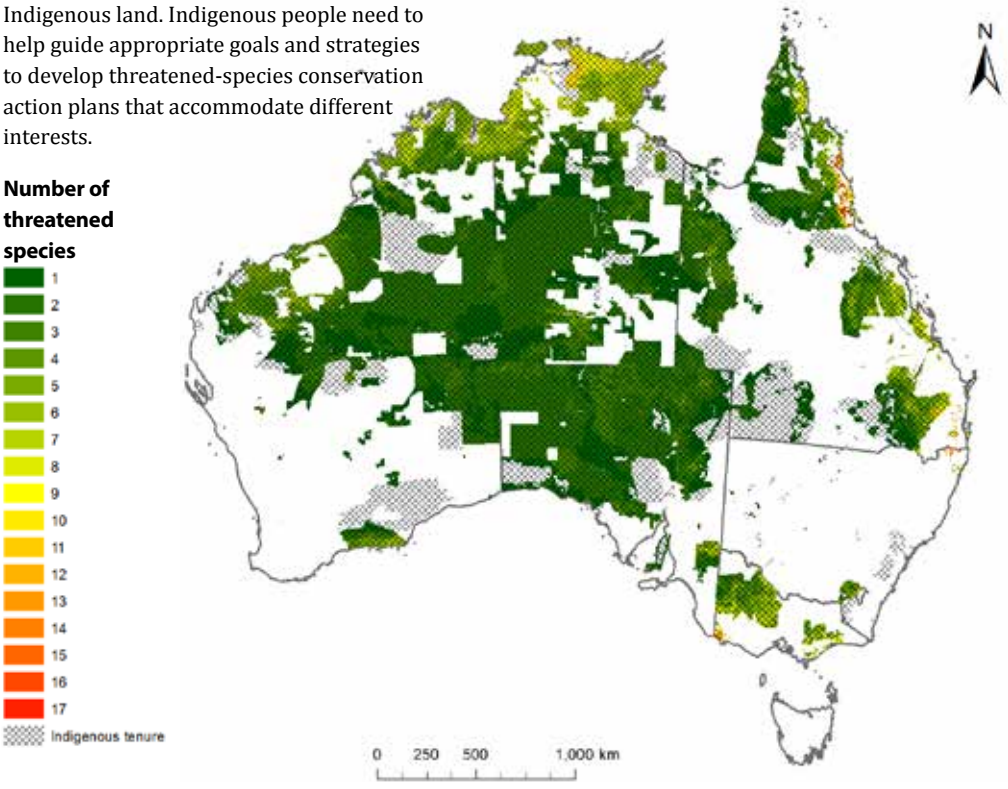

Figure 1: Numbers of threatened vertebrate species within each 10km^2 of Indigenous land across Australia. White areas on the map is land that is not formally recognised as being under Indigenous tenure. See http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0173876

The **Niche-Reduction** Hypothesis

Rethinking how we study and manage threatened species

IMAGE: JOSLIN MOORE

The threatened alpine tree frogs (pictured below) is now only found in larger alpine ponds such as those pictured above, where high breeding success allows the frog to persist even if the population is afflicted with chytrid disease.

When researching or managing threatened species, the status of the species is commonly described in terms of percentage declines. For example, species X may have experienced a 90% decline in distribution, or species Y may have seen an 85% decline in abundance in the last 20 years. Declines in range and population abundance are standard metrics in conservation science. However, only focusing on the rate and magnitude of species declines can miss important aspects about why species are declining, and this missing information could be crucial for developing effective management. Dr **Ben Scheele** and Dr **Claire Foster** from the Australian National University explain work they are involved in that explores threatened species and the idea of a reduced niche breadth.

To conserve species, we need to know why they decline more rapidly or severely in some locations than others. It's more than just measuring the size of the overall decline. Our new research shows that it is common for species to decline much more in some parts of their range than others. This is because the severity of threats can be reduced or amplified by environmental conditions, or because the species' ability to tolerate the threat is different in different environments. We describe these environmentally-determined declines as 'reductions in niche breadth'.

A species niche is the multidimensional environmental space in which a species is able to survive and reproduce. As a species' niche is shaped by its environmental tolerances, interactions with other species and movement barriers, threats that modify one or more of these factors can lead to reductions in the size of that niche (niche breadth).

An example helps to illustrate this. The armoured mistfrog is a species that was originally thought to live only in tropical rainforest. With the arrival of chytrid fungus (an introduced pathogen that has been wiping out many different species of frog), it was feared the armoured mistfrog had gone extinct when all known populations disappeared. However, a new population of the frogs was later discovered in open savanna habitat. This site was hot and dry enough that it was poor habitat for the chytrid fungus, and so even though chytrid is present, its impacts on the mistfrogs are greatly reduced. Since the arrival of chytrid, the armoured mistfrog has been unable to survive in rainforest, its pre-decline primary habitat, but it can persist in open savanna sites because they are less suitable for chytrid.

Another example is the decline of many small Australian mammal species that have now been lost from open grassy habitats due to predation by introduced feral cats and foxes. Before the arrival of cats and foxes, many small mammal species used a variety of habitats, from open grassy woodland, to dense heath and forest. However, these days, many of these small mammals are now only found in dense, structurally complex habitats, where they can more easily escape predation by foxes and cats. This represents a major reduction in these species' niche breadth.

IMAGE: :DAVID HUNTER

Recognizing that declining species can experience reductions in niche breadth can help to identify where to focus conservation actions. For example, for species which declined many decades ago, recognising that currently occupied habitat (where they are found now) could represent only a small part of the species' potential habitat may open up new areas for conservation actions. In contrast, for species that have declined only recently, it is important to identify whether the species' niche has been reduced, and what has caused this reduction. This understanding is

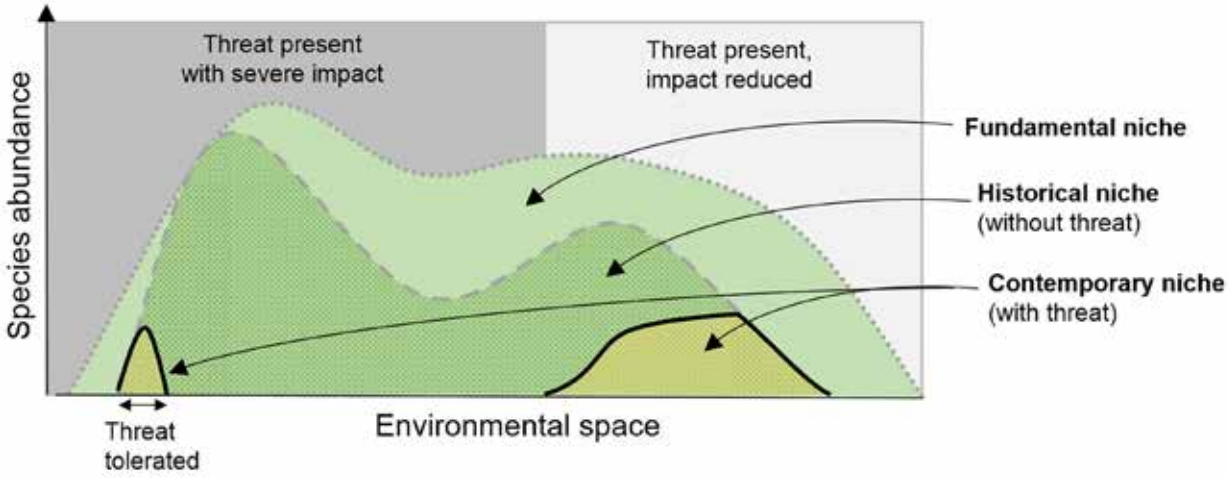

Figure 1: A conceptualised model of how the abundance of a species can vary over space. The fundamental niche is the environmental space the species can occupy when it is not limited by other species and threats. Its historical niche is that part of the fundamental niche the species occupied prior to threat emergence, being limited by native competitors, predators and pathogens. Its contemporary niche is where it is currently found following the introduction of some new threat (such as chytrid fungus for frogs, or cats for small mammals). The important thing about this conceptualisation is that we shouldn't constrain our thinking or our management to where a threatened species is found today without considering the implications of threats and management to the other parts of its niche where it no longer occurs. (Modified from Scheele B, CN Foster, SC Banks & DB Lindenmayer (2017). Niche Contractions in Declining Species: Mechanisms and Consequences. *TREE* http://www.cell.com/trends/ecology-evolution/fulltext/S0169-5347(17)30049-6)

important to avoid conservation efforts being wasted on areas that are no longer suitable for the species.

In many cases, long-term control or removal of threats is not possible. In these cases, recognising parts of a species' niche where threats are reduced or where the impacts from threats can be tolerated is crucial. For example, threatened alpine tree frogs in the Snowy Mountains are now locally extinct in sphagnum wetlands because of chytrid fungus. The species is now only found in larger ponds, where high breeding success allows the frog to persist, even though most frogs now die after only one year (compared with the frog's 'normal' life span of four or more years prior to chytrid). As it is not feasible to eradicate chytrid from wetland habitats, a practical conservation option is to create new large ponds to increase the number of populations of this species.

Species such as the armoured mistfrog have been lost from closed canopy rainforest sites where they were known to historically occur and now persist only in open savanna sites where the chytrid fungus doesn't do so well.

Recognising that a species niche is shaped by many different but interacting factors can be useful for identifying novel conservation actions, particularly when direct threat control is not possible. Returning to the example of a small mammal that now persists only in dense scrubby habitats, this habitat may be good for predator evasion, but poor in other ways, such as food availability. In such circumstances, conservation actions to increase food resources may help to increase species abundance. In other areas, it may be possible to artificially create some of the features that help the species to evade predators in dense habitats, allowing the species to re-expand into more open habitats.

Key messages

Threatened species can experience reductions in niche breadth and this understanding of niche reductions can help to identify where to focus conservation actions

It is important to identify whether the species' niche has been reduced in order that conservation efforts are not wasted on areas that are no longer suitable for the species

Recognising parts of a species' niche where the severity of threats is reduced (or where the impacts from threats can be tolerated) is crucial

Informing **action**

How does the Niche-Reduction Hypothesis inform conservation actions? Where it is possible to control the impacts of a threat, then management within the historical niche, such as threat control and species reintroduction, can have the greatest potential conservation gains. However, when threat control is not achievable, management within the contemporary niche to increase the abundance, increase the number of locations (eg, through habitat creation or translocation to environmentally similar but previously unoccupied areas) or improve the stability of populations can be most beneficial. It might also be possible to work at the boundaries of the where the species occurs today, using habitat manipulation, or managing interacting processes (eg, fire), to allow a species to re-expand into its historical niche. Finally, assisted colonisation to create insurance populations in areas outside the realised niche (but within the fundamental niche), where the threat is absent or has low impact, might be useful to ensure the survival of highly threatened species.

In an era of mass biodiversity loss, understanding how threats shape the realized niche of declining species can assist the development of new management responses and identify where to prioritise conservation actions. This 'niche-reduction hypothesis' provides a new lens for understanding why species decline in some locations and not others, with important implications for how we research and manage declining species.

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A Red Hot List for threatened plants

IMAGE: JEN SILCOCK

But which species do you choose?

Threatened plants tend to receive less attention than threatened animals, yet the loss of native plant species is as devastating and irreversible. Which is why the TSR Hub has dedicated a project to building a Red Hot List for Australia's most imperilled plants. Botanist Dr **Jen Silcock** from the University of Queensland is developing that list. Here she explains that while the task shares many similarities with the development of the animal Red Hot List, focussing on plants comes with its own unique set of challenges.

ABOVE: A botanical wonderland in the Simpson Desert, far western Queensland, after exceptional rainfall, with numerous poorly-known species including the rare and restricted shrub *Maireana lanosa*.

Australia has many threatened plants; around 1150 species are listed as Endangered or Critically Endangered under State or Federal laws. That's around 5% of our known plant species, and many of these are extremely vulnerable. For example, a fifth survive in only a single population, while 60% are known from five or fewer populations.

Think about that; the rarity and tiny distribution of many of these species make them highly vulnerable to human impacts and chance events. If the wrong patch of scrub is cleared for a development or a wildfire scorches an area, we could lose a species forever.

Fifty Australian plant species are presumed to have already become extinct. The idea of the Red Hot List is to identify those plants that are on the edge and could go over if we don't do something.

The aim is to highlight the plight of Australia's most imperilled plant species (those at risk of extinction), identify and prioritise conservation actions, and alert community groups, scientists and landholders and managers.

Developing a Red Hot List

So, the first action here is to develop a concise statement of the state of play for the 1150 Critically Endangered and Endangered Plants (as listed under Commonwealth or States/Territories law). This is being done by gathering data from over 100 plant experts. This data includes information on current threats and population trends.

To be eligible for the Red Hot list, a species must be rare and declining from threats that we can feasibly overcome. This rules out most 'narrow-range endemics' – naturally rare or restricted species such as trees or shrubs that grow only on a few mountain tops or rocky outcrops. These species often occur in remote and inaccessible habitats and while their distribution is small they typically have few threats.

The majority of species I assessed, around 60%, have suffered massive declines from habitat destruction, usually for agriculture and sometimes urban development. Remaining populations of these threatened plant species are restricted to small remnants, often on roadsides or in rail reserves. These remnants are susceptible to destruction, disturbance, weeds, disease, and chance events such as fire.

The good news is that the populations of many species appear to be stable or even increasing

Key messages

To be eligible for the Red Hot list, a species must be rare and declining from threats that we can feasibly overcome

To engage as many community groups as possible, the Red Hot List will include a diverse and dispersed range of species

A wreath of rarely-seen plants growing by a remote salt lake accessed only by camel trek (the camel in this instance is called Eddie).

(at least this appears to be the case where the monitoring has been done). Conserving these species is often a matter of safeguarding their habitat and keeping an eye on them.

That leaves 251 plants on the shortlist for the Red Hot List. Of these 61 species (6% of assessed species) show evidence of continuing decline and 190 species (18%) have suspected or predicted declines but lack monitoring data.

In addition to ongoing habitat loss (from urban expansion and agriculture), the major threats causing recent declines in these threatened plant species are: inappropriate disturbances on roadsides and in rail reserves; weed invasion (especially vigorous perennial grasses which take over entire habitats and can increase fire frequency and intensity); and disease (such as phytophthora dieback and myrtle rust).

The annual herb *Ballantinia antipoda* used to occur across grasslands and grassy woodlands of Victoria and Tasmania, but is now restricted to a few small patches on permanently moist seeps on Mt Alexander near Bendigo. This population has declined since 2010 due to disturbance and a drying climate. It requires committed, long-term funding of recovery efforts, and was an obvious choice for the Red Hot list.

This undescribed *Geranium* species was last collected in 1903, until a La Trobe University student found a small population on a rail reserve in suburban Melbourne. It is now known from six small populations in grassland remnants threatened by encroachment from urban development and infrastructure expansion.

Threats such as inappropriate fire regimes and grazing don't seem as pressing, and their severity has not been established for many species. Climate change is considered a threat at high altitudes and for species vulnerable to extended dry periods, but there is uncertainty about the impacts on most species.

Of lists and flagships

In an attempt to winnow our shortlist down even further, we have clumped our threatened plant species geographically and taxonomically – most occur where centres of endemism intersect with broad-scale threats, and some plant groups have a disproportionate number of threatened species.

To engage as many community groups as possible (and to raise the profile of threatened plants in general), the Red Hot List will include a diverse and dispersed range of species. Preference will be given to plants that can serve as 'flagships' to leverage conservation to benefit a suite of species or a habitat type.

Flagships include ground orchids with small, fragmented populations; shrubs and herbaceous plants restricted to remnants in southwest Western Australia and southeast South Australia; plants from rapidly urbanising areas such as southeast Queensland, south of Darwin, western Sydney and the Victorian Volcanic Plain; victims of dieback in Stirling Range montane heath; and plants in imperilled habitats such as the eastern lowland rainforests, fertile grasslands in higher-rainfall areas and desert springs.

Another flagship is plants which require disturbance to germinate and complete their life-cycle. The West Australian shrub *Daviesia microcarpa* was presumed extinct until roadside grading triggered germination. The Atherton Tableland shrub *Solanum hamulosum* became so common and troublesome during the rainforest clearing years of the 1930s and 40s that it was dubbed the 'Dirran curse'. The only large populations seen in recent years were in cyclone damaged forests.

Guichenotia seorsiflora is listed as Critically Endangered in Western Australia. Just 78 individuals survive, in 6 populations on roadsides and private property in the heavily-cleared Wheatbelt. Seed has been collected, so there is the potential for translocations if suitable sites can be found. Research on its life history is needed to inform recovery efforts.

The 'disturbance-dependent' flagship challenges our notion of rare plants needing to be 'locked up' for their protection. Because if we did lock them up and remove all 'threats', we may well consign these species to extinction.

Known unknowns & forgotten species

Many rare species beyond population centres are neglected, and we simply don't know how they are faring. We have put these in a 'data-deficient' category, and the aim will be to engage botanists to go out and actively look for them – or go for a look ourselves. Most will require baseline counts and monitoring.

There are also species not on any list that might be good candidates for the Red Hot List. They may have slipped through the sometimes haphazard listing processes, or have been recently discovered or described. Even after 200 years of scientific effort, botanists are still finding 'new' species, particularly in remote areas such as the Kimberley. By interviewing experts we aim to identify these species, so they don't slip away unnoticed – "no surprises, no regrets" is our mantra.

The challenges of developing this list are considerable; the dimensions of the problem of threatened plant species are enormous. Sometimes the size of the problem can be depressing. What I have found uplifting in this work, however, is the dedication and knowledge of people working to save many of these plants. And I feel privileged to be a part of this work. Over the next couple of years, I will get to meet some of these people and the plants they work on.

It will be a botanical journey around our vast and beautiful land that promises as many enigmas as it does answers, encounters both inspirational and saddening, and no end of surprises.

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Seize the **day**

IMAGE BY DAVID SALT

LEFT: Stuart Anstee (second from right) shares perspectives at the summit on the elements of an attractive conservation opportunity from the perspective of the mining sector.

BELOW: Summit participants gather for the group pic with the Melbourne CBD in the background.

Identifying opportunities for threatened species conservation

A unique business-research summit was staged in the heart of Melbourne earlier this year to identify and explore emerging business opportunities that also have benefits for threatened-species conservation. The TSR Hub workshop was led by RMIT and held in the appropriately named 'Green Brain Room' overlooking the city's central business district. It brought together representatives from a range of sectors, and generated some 45 win-win project opportunities. What might it take to make them real? RMIT's Dr **Georgia Garrard** explains how the summit approached the challenge.

Change can be challenging. It can be disruptive, sometimes even overwhelming. But it also throws up new ideas, possibilities and opportunities. How do you identify and harness emerging opportunities when it comes to threatened species conservation? We believe it's all about foresight and good networks.

We need foresight from a diversity of sectors to identify which emerging trends will present in the near future, and then we need to foster cross-sectorial networks to ensure that these opportunities are appropriately resourced and implemented.

How do you make this happen in the real world? We attempted it by staging a business-research summit in February that brought together representatives from the business, research, NGO, Traditional Owner, government and philanthropic sectors. Participants were invited to identify emerging and novel opportunities for conserving Australia's most critically endangered species. Ideas that emerged included sustainable business opportunities that can deliver tangible biodiversity benefits, as well as new business opportunities that might arise from strategic biodiversity planning and conservation.

We compiled a list of these ideas and then, as a group, we selected a handful of them and workshopped pathways for how they might be realised. Part of the facilitation of these opportunities was through the development of new cross-sectorial networks and working relationships.

On the second day of the summit we developed a business case or action plan for implementation of the four 'leading' opportunities (as voted by summit participants). This involved consideration of, among other things:

- **The Vision:** What is the opportunity and why should anyone support it?
- **Background**: Relevant information including the current status, historical and policy contexts.
- **Business Case**: What is the product/opportunity? Who wants it?
- **Targets**: Including specific species, locations, and business outcomes.
- **Actions**: What actions are required? By whom?

"On the second day of the summit we developed a business case or action plan for implementation of the four 'leading' opportunities."

IMAGE BY DAVID SALT

LEFT: A conceptualisation of biodiversity-sensitive urban design near Fishermans Bend in Melbourne which demonstrates how natural values can be incorporated into urban renewal. This was one possible conservation opportunity discussed at the summit. For more info on this particular project, see Georgia Garrard's research blog.

- **Potential opportunities for Indigenous communities**
- **Potential risks**: What are the risks of failure? How can these be mitigated?

So what were the four leading opportunities from this process? They were:

1. Iconic species in schools (in which every school in Australia adopts an iconic threatened species);

2. Biodiversity Benefits from New or Retrofitted Infrastructure (such as new urban development in city centres);

3. Adopt-a-Species (in which Australian corporations take responsibility for saving Australian native species); and

4. Reintroduction of locally-extinct species to Traditional Owner lands (in which culturally important, but locally-extinct, native species are reintroduced to land managed by Traditional Owners).

What did we learn from this exercise? In the final session of the summit we asked participants to reflect on the critical lessons emerging from the workshop discussions. Key points included the importance of remaining optimistic while also acknowledging how challenging it is to engage the business sector; the need for new systems to be developed that can measure the value of threatened species as well as helping us assess how well interventions work; that there are no one-size-fits-all solutions; and that in developing emerging opportunities it's important to do your research (to find out what's already happening in this space).

The summit is not the end of this process, it's more the first step. We are now examining the potential to turn these opportunities into real projects. If you would like to join us in this or learn more about the summit and the many opportunities it identified, please get in contact.

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How conservation research can **benefit business**

As was identified at the business-research summit, environmental science can be mobilized to identify creative opportunities for individual businesses that represent win-win for the environment and the bottom line. But there are also important opportunities for business on the immediate horizon where research can inform decisions on a more global scale.

There is a growing international and national interest in methods of environmental accounting, such as the UN's System of Environmental and Economic Accounts (SEEA), by both governments and private industry. Methods such as the SEEA provide a means of recognising the economic benefits that environmental services provide, which are often hidden in standard economic analysis. Accounting for the flow-on benefits of clean water from areas of native vegetation to cities, of remnant vegetation to the productivity of farmland, or of biodiversity to tourism or to human health, can help businesses make better decisions on the use of natural resources to maximise the economic, social and environmental benefit.

Another example lies in offsets. As Australia continues to develop its regions, its cities, and its infrastructure, making strategic decisions that better inform how to offset the impacts of development is vital. This is not just a matter of setting aside parcels of land. The most effective way of helping a particular ecological community or threatened species population may be something quite different: improving water flow, controlling predators, providing artificial habitat. Research is helping us make informed strategic decisions on the most effective way to invest in offsets.

And then there's whole area of risk and uncertainty. The finance and insurance sectors are already beginning to draw on knowledge of environmental futures, particularly the projected impacts of climate change, to inform their analysis of risk and their investment decisions. But environmental risk is much bigger than just climate change. For example, the cost of a development project can skyrocket if it unexpectedly encounters a risk to biodiversity, where a simple alternative may have been available. Researchers with skills in project prioritisation for threatened species recovery have developed techniques that aid decision-making in the face of uncertainty and complexity. Based on scientific principles, these techniques could be used to develop tools that support investors and insurers to manage risk and make effective investment decisions.

So, while one dimension of business and science getting together is to develop conservation opportunities, the flip side of this interaction is greater engagement to identify business advantages. The ultimate aim being to deliver results that benefit both business and biodiversity.

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Rachel Morgain considers win-win opportunities at the Business-Research Summit at RMIT.

Threatened species **on the farm**

Dr Damian Michael is a strong believer in grass roots change. His work aims to enable landholders and community groups to make informed management decisions based on long-term research and sound science. As a Senior Research Officer at the ANU, Damian has been fortunate to work with over 500 landholders to help conserve threatened species and ecological communities across south-eastern Australia.

TSR Hub Researcher Profile

IMAGE: MASON CRANE

Damian has a close encounter with one of his favourite groups of native animals - reptiles (in this case an eastern water dragon).

I was born in England and it was at an early age that I developed a keen interest in wildlife, catching newts from our pond and following fox tracks left behind in the snow. On moving to Australia in the early 1980's I was fortunate to have an adventurous upbringing. Camping, hiking and rock climbing exposed me to a huge diversity of native creatures.

I knew from an early age that I wanted to work with animals and in the year 2000 I graduated from Charles Sturt University with an Applied Science degree in Ecosystem Management and Ecology. Eagerly anticipating entering the work force as a Parks Ranger, a timely offer of an Honours project rekindled my passion for reptiles. My project involved using artificial substrates to detect threatened snakes and lizards in a threatened grassland community. It's pleasing to note we now use this method to monitor reptiles across our long-term research programs.

Since joining David Lindenmayer's research team almost 17 years ago, I have had many rewarding opportunities to work on threatened species and ecological communities. My first role was to work on Leadbeater's Possum in the central highlands of Victoria, where I ran a series of Earthwatch Camps. These camps involved clients from all around the world and it was during this time that I realised what impact seeing a threatened species for the first time can have on changing people's mindset and passion for driving environmental change. I take great pride in witnessing volunteers and community groups absorb our conservation messages and then apply them to their own lives or industries elsewhere.

In my current role as a TSR Hub project team leader and researcher I am fortunate to work with local government agencies, Landcare groups and rural communities to tackle biodiversity conservation issues in one of Australia most threatened ecosystems - our Box Gum Grassy Woodlands. Sixteen years ago, we established a major study examining biodiversity benefits of tree plantings on farms. Seeing plantings mature and threatened species return to the landscape is truly an amazing feeling, and reassures my belief in the adage 'create it and they will return'.

I am encouraged by seeing threatened birds return to formerly cleared landscapes, but I am also conscious of the huge amount of effort invested by landholders and natural resource management agencies to make these changes come to fruition. One of the most rewarding outcomes of my work is forging strong relationships with farming communities, sharing knowledge and adapting science to achieve win-win opportunities.

I see one of my challenges into the future is to promote a deeper appreciation of Australia's threatened reptiles, a group of animals shrouded by myth and misconceptions. We are doing this by working with landholders to change grazing regimes and protect key habitats such as rocky outcrops.

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Science for saving species

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COVER IMAGE: JEN SILCOCK COLLECTS A WREATH OF RARE FLOWERS AS SHE DEVELOPS A RED HOT LIST OF IMPERILLED PLANTS (SEE PAGE 12 FOR THE FULL STORY). IMAGE: BY ILSE PICKERD.