Science
for saving species

ISSN 2652-1334

Autumn 2018
Issue 7

Reasons to be hopeful

New findings for refuges

Protecting our mountain giants

Indigenous action for threatened species

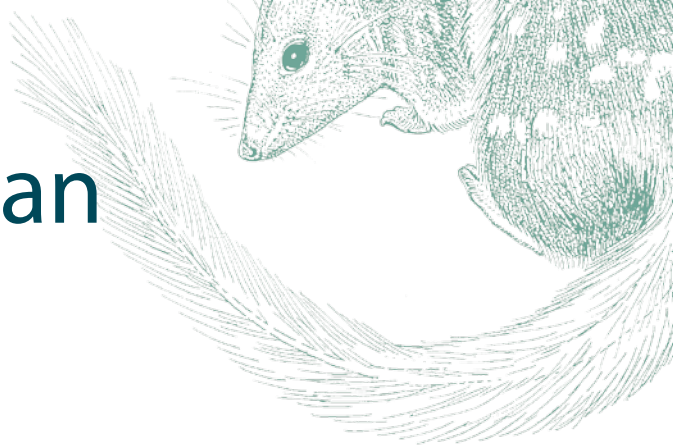
Rusty plants

Tracking the far eastern curlew

Threatened Species Recovery Hub

National Environmental Science Programme

IMAGE: BY GAVIN O'BRIEN



Recovering Australian threatened species

Reasons to be **hopeful**

While media reports often focus on the doom and gloom of species sliding to extinction, it is important to also take note of where we are succeeding. Hub Deputy Director **Professor Stephen Garnett** talks about the importance of learning from conservation successes and celebrating how far we have come.

IMAGE: KARENRETA CC BY-NC-SA 2.0 FLICKR

ABOVE: Co-ordinated conservation efforts by government agencies and the local community have given the Oakland diuris (*Diuris callitrophila*), an endangered NSW donkey orchid, a much brighter future.

A hundred years ago the global catastrophe that was the First World War came to an end. Today it is inconceivable that slaughter of people on such a scale would be tolerated, as world views are changing. And so it is with conservation. A hundred years ago most people would have been baffled by the conversations we now have about threatened species. Even fifty years ago conservation was a new concept to many, extinction seen as an inevitable, if slightly regrettable, by-product of development. A book on successful conservation of threatened species, such as Recovering Australian Threatened Species: A Book of Hope (CSIRO Publishing), could not have been imagined.

Now it can. Surveys show over 80% of Australians do not want further extinctions, and they are willing to invest in preventing them.

Changing attitudes are also reflected in our evolving legislation. Australia's earliest environmental legislation was created to reduce hunting of birds and only became concerned with threatened species in the latter part of the 20th century. It is still evolving in response to societal expectations but both legislation and policy are increasingly explicit about preventing extinction.

At the same time, governments, non-government organisations and private individuals have all made major contributions to ameliorating threats once they have become known. Often particular champions have stepped forward to ensure a species is not lost for future generations and put in extraordinary efforts to turn population trajectories around. As one of the editors of the Book of Hope, along with Peter Latch, David Lindenmayer and John Woinarski, I had enormous pleasure working with many such people, some of whom had dedicated over half a century of their lives to particular species.

This says something about species recovery – it needs to be given time. Often declines have been slow, and their reversal can take decades. When a pair of glossy black-cockatoos produce one young a year at the most (see box), and often raise none, supporters of programs must have patience from the start. Even identifying how to reverse declines can take a long time. For example efforts to recover the Helmeted Honeyeater yielded dismal results until only a few years ago when suddenly a new technique, supplementary feeding of wild birds, seemed to push them into overdrive.

A vital first step in any successful recovery program is understanding the problems that need solving.

Inside the Autumn 2018 issue of *Science for Saving Species*

Threatened Species Recovery Hub

National Environmental Science Programme

In the Book of Hope, each case study describes the research phase that has guided recovery action. The great thing is that knowledge begets knowledge. What works on one species can work on others. New technologies – digital, genetic, electronic - are being applied in ways that would have been unimaginable a decade ago. In many ways it is a thrilling time to be a researcher.

Society is also changing. Indigenous people are becoming increasingly involved with threatened species recovery on their land and sea country. Many Indigenous people have been greatly distressed by the loss of small mammals that were abundant just a few decades ago. Now many Indigenous ranger groups are seizing the opportunities provided by threatened species management to bring country back to life.

The Book of Hope began with a workshop in 2016. The Threatened Species Recovery Hub brought together 40 conservation managers and researchers wanting to learn from and share existing successes in threatened species recovery work. The results, now compiled in the book, are 35 case studies of conservation success and a framework of seven factors that were found to be important to success. The book's launch has also brought many more people and examples of successful conservation forward.

Overall working on the Book of Hope was a huge privilege, just as it is to be undertaking threatened species research. The next step is to ensure that its messages reach the right people so they too realise what a long way we have come and that threatened species recovery is possible when we have commitment and investment. The success stories are also a reminder to those supporting threatened species conservation that their investment of time and money is worthwhile.

Professor Stephen Garnett
Deputy Director, TSR Hub
http://www.nespthreatenedspecies.edu.au/

Success for Kangaroo Island's **glossy-black cockatoos**

Glossy black-cockatoos on Kangaroo Island eat just one thing – seeds of the drooping she-oak. To provide enough food for their nestlings, breeding adults spend the entire day picking one cone after another until their crop is full with about 10,000 of the protein rich kernels. The food is reliable and there are no real competitors but the price is a desperately low reproductive rate.

By 1995 it became apparent that the reproductive rate was even lower than feared. A survey found just 150 birds with five begging chicks. So the islanders kicked off one of Australia's most successful recovery programs. As a starting point research was undertaken to identify the key threats causing such low reproduction.


IMAGE: DANIELLA TEIXEIRA

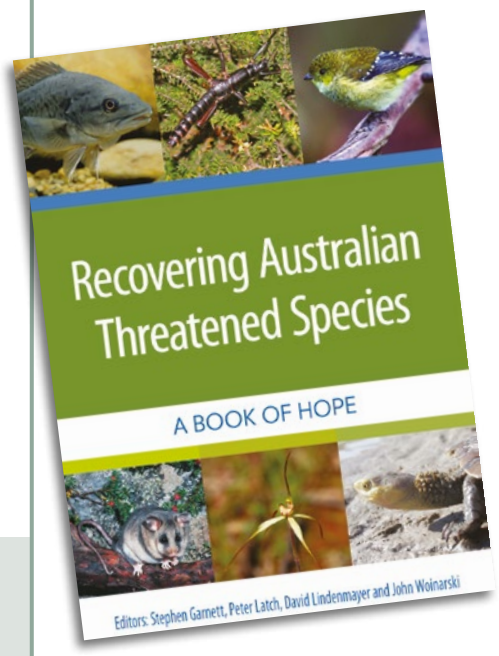
Brush-tail possums had proliferated in the absence of foxes to eat them or rabbits to compete for fertilised pasture. The possums found a cockatoo egg or chick a fine snack before sleep in a nest hollow. Protecting nesting trees with collars of corrugated iron and trimming connecting branches from neighbouring trees reduced contact with possums and doubled the reproductive rate.

Historic clearing of trees had removed many nesting hollows, which was then compounded by competition with other parrots for the scarce remaining hollows. Nest box erection, casuarina planting and the removal of corellas and galahs competing for remaining scarce hollows helped. By 2017 there were nearly 400 birds and the population continues to grow, expanding its range across the island.

The program had all key elements to succeed: strong local leadership; community involvement and institutional commitment from government; management built on research; and the ongoing investment over many decades that is essential to recover a species that is so very specialised. Kangaroo Islanders love their cockatoos and there is every chance that extinction has been averted.

BESIDE: The population of the South Australian subspecies of glossy black-cockatoo (*Calyptorhynchus lathami halmaturinus*) has more than doubled in the last two decades in response to conservation actions.

An inspiring showcase of **conservation success stories**



Against a relentless tide of threats to our biodiversity, many Australians, and government and non-government agencies, have devoted themselves to the challenge of conserving and recovering plant and animal species that now need our help to survive. This dedication has been rewarded with some outstanding and inspiring successes.

Recovering Australian Threatened Species: A Book of Hope (edited by Stephen Garnett, Peter Latch, David Lindenmayer and John Woinarski and published by CSIRO Publishing) showcases 35 of these stories and identifies the common factors that have been most effective in recovering threatened species.

The diverse case studies – dealing with threatened plants, invertebrates, fish, reptiles, birds and mammals – show that the conservation of threatened species is achievable: that it can be done and should be done. They collectively serve to inform, guide and inspire other conservation efforts.

The Book of Hope is available to purchase online at: www.publish.csiro.au/book/7705

The what, where and **how** of refuges for threatened animals

Ecological Society of Australia Refuges symposium

IMAGE: A STEWART

As Australia recovers from another sizzling summer, have you ever wondered how our native animals get by when the going gets really tough? TSR Hub researchers from our refuges project are putting a lot of thought into that very question, they also organised a refuges symposium at the last Ecological Society of Australia conference. Here they talk about some exciting new findings in this space.

Article by **April Reside** (UQ), **Natalie Briscoe** (UM), **Luke Collins** (Latrobe), **Euan Ritchie** (Deakin), **Lauren Young** (USyd), **Geoffrey Heard** (CSU) and **Ben Scheele** (ANU).

Just as we head for the beach on those heatwave days, many animals move to a refuge when faced by hard times. Hard times might include drought, fire, introduced predators, heatwaves or outbreaks of disease.

So, what are refuges?

Refuges are places animals use until the extreme conditions ease. This might be for a day, a week, or even years, and may even prevent extinctions. For example, animals restricted to refuges during drought can re-expand when the drought breaks, moving back into the wider landscape. So understanding where refuges are, and how to protect or even create them, is critical for managers charged with conserving our native species.

At the end of 2017, scientists working on refuges came together at EcoTas 2017 (the Ecological Society of Australia's joint conference with the New Zealand Society of Ecology) to share their expertise on the what, where and how of refuges. Here's some of the exciting new findings shared at this Refuges Symposium (organised by TSR Hub researchers April Reside and Natalie Briscoe).

Where are refuges and how do you identify one?

To identify refuges that animals use, first you need to find out where the animals normally live, and then determine where they are when faced with a major threat. This can prove challenging. Years of searching for animals when they disappear from their broader range may be needed to find out where they find refuge (which may be from extreme events or introduced threats like foxes or disease). And a refuge for one species may not be a refuge for another: a ground species like a bush rat will need a different refuge than a greater glider in the tree tops to survive fire.

Advances in finding refuges

Advances in technology, and particularly the availability of detailed satellite data, are making the task of identifying refuges much easier. For example, Luke Collins (La Trobe University and Arthur Rylah Institute) has been using satellite data to identify refuges from wildfire in south-eastern Australia. By analysing high-resolution LANDSAT images, he came up with a method to better map areas that are protected from wildfire.

ABOVE: When cats, rabbits, foxes and stock make living hard for the plains mouse (*Pseudomys australis*) it can still hold on in the cracked clay and stones of the gibber plains of the Lake Eyre Basin.

Key messages

Refuges enable species to survive hard times. Losing an important refuge may mean losing a species.

Technological advances and satellite data are aiding the identification and mapping of refuges.

Refuges are not only fixed places like a rocky gully, they can be places with few predators, less disease or better resources.

IMAGE: NATALIE BRISCOE

Burrows enable many animal species to survive the temperature extremes of arid and semi-arid regions, including native animals and feral cats.

He was also able to work out which types of places provide fire refuges, and under what conditions. Under mild fire weather conditions, areas like gullies are often protected from fire – yet under extreme fire weather, these refuges can also burn, highlighting the need for more targeted protection as the likelihood of extreme fire weather increases.

Satellite data are also useful for identifying refuges from drought. The plains mouse is a threatened native rodent restricted to central Australia. Using trapping data collected over two years (from cameras and traps) and soil and vegetation data, PhD student Lauren Young (Sydney University) was able to map refuges used by the plains mouse during a dry period. These refuge areas likely provide a relatively consistent and reliable supply of resources even in drought.

April Reside (University of Queensland) outlined how some landscape features, like rocky outcrops, can provide critical refuge from multiple threats. Australia has 158 vertebrates (10 amphibians, 10 birds, 60 mammals and 78 reptiles; 39 of which are threatened) that are found only in areas with rocky habitats, and many more that seek refuge in rocky terrain. Rocky outcrops can protect animals from drought, fire, heatwaves and introduced predators. For example, large rocky outcrop areas can break up a large wildfire; they can provide deep, shady and moist crevasses for refuge during drought; and they can provide places to hide from cats and foxes. Again, satellite data is used to find out where these important rocky areas are to help improve their management.

Understanding predator refuges

Finding the places that serve as refuges from heatwaves and drought can be aided by better understanding a species' physiology and behaviour. As well as identifying refuges of threatened species like koalas and greater gliders from heatwaves and climate change, Natalie Briscoe (The University of Melbourne) showed that this approach can help understand refuges used by feral cats. The arid zone is a particularly challenging environment for cats, with surface temperatures frequently reaching 50 to 60°C and water scarce. Small-scale micro-environments, such as burrows, provide feral cats with cool refuges, and are likely critical to their survival in these environments during times of stress. Identifying these refuges provides targets for eradication campaigns under hot conditions, and can be used to control cat populations more broadly by removing their access to landscape features they need to survive in desert environments.

Refuges created by environmental factors

In contrast, warm, dry and slightly saline environments can provide key refuges for frogs threatened by chytridiomycosis, an emerging disease caused by the chytrid fungus that has decimated amphibian populations globally. Chytrid does not prosper in hot, saline or dry environments, and researchers have shown that these areas can act as disease refuges for threatened frog species. Geoff Heard (Charles Sturt University) showed that warm and slightly saline wetlands are refuges from chytrid for growling grass frogs around Melbourne. His works suggests creating wetlands with these characteristic could help protect this threatened species, as could manipulation of existing wetlands to give them refugial properties (for example, removing shading vegetation to increase wetland water temperatures).

BELOW: The large gulbaru gecko (*Phyllurus gulbaru*) is restricted to two small patches of rocky rainforest in North Queensland. If fires and weeds degrade this refuge we could lose the species.


IMAGE: ERIC VANDERDUYS


IMAGE: NATALIE BRISCOE

Warm and slightly saline wetlands provide growling grass frogs with refuges from chytrid fungus.

Refuges created by species interactions

Refuges are often created by environmental factors but they can also be created by interactions between species. For example, Euan Ritchie (Deakin University) and colleagues have shown that areas with dingoes may provide refuges from predation for small mammals. This is because dingoes may suppress the density or activity of feral cats and foxes. In another example, Ben Scheele (ANU) has found that refuges from disease for threatened northern corroboree frogs occur in areas that are unsuitable for other frogs that act as reservoir-hosts.

Other favourable conditions allowing a threat to be weathered

In contrast to the previous examples, some environments act as refuges because they allow a species to tolerate a high level of a threat associated with an extreme event. An example is the alpine tree frog, which has contracted to perennial ponds following the emergence of chytrid fungus. The frogs experience very high mortality in these perennial ponds due to favourable conditions for chytrid fungus. However, adults are able to successfully breed before dying and the fungus has minimal impacts on tadpoles and juvenile frogs.

Why we should protect refuges

Without refuges many species could not survive the tough times. Healthy refuges also mean having seed populations that can grow and re-expand when conditions improve, which helps to recover depleted populations in the wider landscape.

How might we protect refuges so they can protect species into the future? This is the focus of our work, so stay tuned.

For further information

April Reside
a.reside@uq.edu.au

Pavey et al. (2017). The role of refuge in the persistence of Australian dryland mammals. *Biological Reviews*, 92, 647–664.

Scheele, B. et al. (2017). Niche contractions in declining species: mechanisms and consequences. *Trends in Ecology & Evolution*, 32, 346–355.

IMAGE: JOHN TANN CC2.0 FLICKR

Myrtle rust is here

What are we doing about a new fungal disease hitting Australia's most iconic plant family?

LEFT: Myrtle Rust is infecting many important species across a broad geographic range.

A new contagious fungal plant disease has entered Australia, myrtle rust. It's highly mobile, can reproduce rapidly and is infecting many species across a broad geographic range. Containment and eradication responses have so far been unsuccessful. In short, the risks posed by myrtle rust are a perfect storm for plant species within one of Australia's most important plant families, the Myrtaceae. **Jarrah Wills** from the Queensland Herbarium describes why this plant disease poses such a threat and what we are doing about it.

Myrtle rust (*Austropuccinia psidii*) is believed to have originated in South America. It was first described in Brazil in 1884, where it was observed infecting the common guava, and it has been infecting eucalypt timber species on that continent since the 1970s. From that time, it has spread rapidly, impacting many species of commercial and ecological significance in the US (Hawaii, Florida and California), New Caledonia, South Africa, Indonesia and Singapore.

Myrtaceae is a large and iconic plant family in Australia, with over 1600 described species. It includes the eucalypts (*Eucalyptus, Corymbia* and *Angophora*) and paperbarks (*Melaleuca*) and many other genera. The leaves of these trees, often called myrtle species, have oil dots that usually yield a distinctive eucalypt-oil smell when crushed. The family includes hard-fruited species that are prominent in the open-forests and soft-fruited species that are particularly diverse in rainforests. Members of the Myrtaceae family provide food and homes for nectar- and fruit-eating birds and mammals. Some myrtle species have limited distributions and are especially vulnerable to new disease.

Detection, range and impacts

Myrtle rust was first detected in Australia at Gosford on the New South Wales coast just north of Sydney in 2010. Since then, it has spread rapidly, particularly through air-borne spores, honeybees and the live plant trade. It has now been detected the entire length of the eastern seaboard, from gardens in Tasmania and Victoria to Bamaga at the tip of the Cape York Peninsula. More recently, it has also been detected in the Tiwi Islands and Darwin in the Northern Territory.

Infection by myrtle rust is known to affect more than 347 species. So far, occurrence west of the Great Dividing Range is rare, and restricted to nurseries and urban gardens. The disease has crossed the Tasman to New Zealand, where it is likely to threaten another economically significant myrtle species, Manuka, which is important to the honey industry. Successful monitoring and subsequent eradication has taken place on Lord Howe Island; however, reinfection is likely to occur.

Globally, several different strains of myrtle rust occur which can infect different hosts, and here in Australia we have the pandemic strain.

IMAGE: ROD FENSHAM

Boris Laffineur leaning on a dead native guava (*Rhodomyrtus psidioides*) at Tallebudgera Valley, Queensland, another victim of myrtle rust.

While the potential threat of this strain of myrtle rust is enormous, its full impact on our native species and ecosystems is not yet well understood. We do know the rust seems to be particularly threatening to the fleshy-fruited myrtle species that occupy rainforests and their margins. And it is believed the fungus could have a significant impact on more than 40 range-restricted myrtle species. The rust may dramatically decrease the range of these species, even pushing some of them to extinction within an estimated five to 10 years.

TSR Hub myrtle rust project

The TSR Hub is supporting a six-month pilot project that incorporates existing data to generate and store broad baseline

Key messages

Since it arrived in 2010, myrtle rust has infected many species across the Myrtaceae family.

The rust is particularly threatening for the fleshy-fruited myrtle species in rainforests. It has the potential to significantly impact more than 40 range-restricted myrtle species.

Baseline information is being collated and collected to evaluate the geography of the disease and assess its impact through time.

information needed to evaluate the impact of the disease. It grows from a review of myrtle rust and its impacts and will build on baseline data generated by a small group of plant pathologists. It will help us identify which plant species or populations are at greatest risk, enabling us to prioritise our responses.

The research team will gather information by interviewing botanists, researchers, bush regenerators, government scientists and engaged citizens. The research will also conduct targeted field surveys to fill the gaps in our knowledge.

We will bring the information together in a database to assess the impact of myrtle rust on Australian plant species and ecosystems. This database will help inform decision-makers and managers on the fate of individual species such as the native guava (*Rhodomyrtus psidioides*).

From information to action

Native guava was once common across its range, which extends north from Gosford in northern New South Wales to Tinana Creek, south of Maryborough, Queensland. Previous studies have identified that this species has declined by more than 50% in less than five years, with further declines expected. The database will identify guava populations that may be resistant to myrtle rust, or determine whether this species is at risk of being lost in the wild and will require speedy conservation actions.

The database will also help us to determine threats to other species and the impact on ecosystems. It will point to where the disease has been particularly damaging, which species may be resistant in certain parts of their range, and which species are at greatest risk of extinction across their range.

As myrtle rust evolves, the manner in which the disease impacts different plants will change. One aim of our research is to find populations that may show resistance or identify moves between host species. To safeguard some species, we may need to translocate them beyond their current ranges.

New Zealand is devoting considerable resources to the fight against the scourge of myrtle rust. In Australia, however, resources were targeted to the potential commercial consequences of the disease, but have dwindled when it was realised that natural ecosystems would suffer the major impacts. Given the wide range and rapid spread of the disease it is essential that assessment of impacts are extended in order to best prioritise conservation action.

For further information

Jarrah Wills
jarrah.wills@des.qld.gov.au

BELOW: Jarrah Wills and Rod Fensham assessing myrtle rust impact at D'Aguilar National Park, south-east Queensland.

IMAGE: BORIS LAFFINEUR

IMAGE: JOHN TANN CC2.0 FLICKR

Myrtle rust on a thready-bark myrtle (*Gossia inophloia*). This plant species is listed as Near Threatened.

Rusty Plants

Rusts are fungal plant diseases that infect living plant tissues. Infections begin when a fungal spore lands on the plant surface, germinates and invades its host. Rusts are named for their infections, which often make host plants look rusty, an effect caused by deposits of powdery rust-coloured or brown spores on the plant's surface. Humans have been contending with rusts since the beginning of agriculture.

The strain of myrtle rust spreading through Australia is having a severe impact on some myrtle species. The disease can cause deformed leaves, heavy defoliation of branches, reduced fertility, dieback, stunted growth and plant death.

It is not known how myrtle rust entered Australia. However, now that it is here, its spores are easily spread via wind, people, infected plant material and equipment. It can also be dispersed by insect/animal movement. These characteristics make it extremely difficult to control and impossible to eradicate from natural settings.

Saving species at the development frontier

Strategic assessment, offsets and **no-net-loss**

IMAGE: GREENS MP CC BY NC ND 2.0 FLICKR

ABOVE: Government approval for a Liquid Natural Gas plant on Curtis Island QLD required at least 700 hectares of private land to be secured and rehabilitated to compensate for environmental impacts.

The development frontier is where decisions on new land developments are made. It's a space where conflicts between biodiversity and multi-tenure land-use needs are constantly encountered. However, it's also where ecological knowledge has some of its greatest potential to reduce biodiversity losses by guiding development to locations and practices with the least negative impact. **Heini Kujala** explains some of the developing science regarding biodiversity conservation at the development frontier.

In many countries, legislation already stipulates that development impacts on biodiversity are to be reduced through environmental impact assessments and offsetting of unavoidable impacts. Yet, concerns have been raised about the evaluation of development and their offsetting needs, particularly when evaluations are considered project-by-project in isolation from other development in the same region. The lack of holistic assessment and accounting of cumulative impacts mean that species are often faced with a 'death by thousand cuts'. This means that biodiversity is degraded by many small impacts that individually do not appear to threaten species' persistence; and, as such, these impacts are not met with adequate mitigation or compensation through offsetting mechanisms.[1]

Facing and addressing impacts

In the recent joint meeting of the ecological societies of Australia and New Zealand (EcoTAS) in the Hunter Valley, the Threatened Species Recovery Hub ran a symposium that focused on some of the key issues and recent advancements within this topic.

A cost-efficient way of reducing biodiversity losses is to anticipate and act on foreseeable development-conservation conflicts before they take place. This is because conservation costs increase rapidly when species become less widespread and options narrow for their conservation.

IMAGE: RACHEL MORGAN

The symposium on 'Putting ecology to work at the development frontier' was well attended at the last Ecological Society Conference.

As an example of such impact avoidance, I presented our work from the University of Melbourne. We used species distribution models and spatial prioritisation tools to minimise development impacts on 227 threatened species and ecological communities in the Perth and Peel region's 30-year development plan.[2]

Our work showed that when biodiversity data are made available and used early in the planning process, significant reductions in development impacts can be achieved (with lost habitat reducing from 60% to less than10% for some species). Here, collaboration with stakeholders is central for both validating input data and refining and adopting research outputs. This was highlighted by the work of Dr Katherine Selwood (UM) with the TSR Hub on identifying biodiversity priority areas on Christmas Island.

A further challenge in sustainable planning is how to retain ecological processes in human-dominated landscapes. Dynamic processes are more difficult to map in comparison to distribution patterns, as they require information on inter-site dependencies in the landscape. In our symposium, Dr Mirela Tulbure from UNSW showed how information on historic land use and surface water patterns can help to explain how landscape connectivity is affected by human activities in comparison to natural climatic variation in the Murray-Darling Basin.[3] Such information can be used to avoid the loss of critical connections when planning development in highly dynamic Australian landscapes.

No-net-loss: Compensating impacts

But keeping an eye on the bigger picture is also important after a development has taken place. Associate Professor Martine Maron (UQ) and Dr Ascelin Gordon (RMIT) with their respective teams have studied how the concept of 'no-net-loss' (i.e., the benchmark at which development impacts are considered compensated), has been defined in policy and used in practice in biodiversity offset schemes.

Associate Professor Maron explained how the selection of reference scenarios against which no-net-loss is to be achieved can make for entirely different outcomes for the environment. Her team's research has found that current offsetting policies tend to relate no-net-loss to either overarching policy goals (such as halting the loss of biodiversity) or responses to specific development impacts. Each of these can have contradicting objectives if applied in same jurisdiction.[4]

Work lead by Dr Gordon further highlighted that if and when no-net-loss is achieved depends on three factors:

- the counterfactuals for determining the development impact and the additionality of the offset
- the scales at which offsetting activity is evaluated (whether site, program or landscape)
- the time horizon over which the offsets are required to accrue their gains.

Added to this is the comparison by Florence Damiens (RMIT) of biodiversity offsetting schemes between Australia (Victoria) and France. This work reveals that whereas offsetting as a compensation mechanism has similarly long-rooted histories in both countries, they have developed policies that offset different types of nature.

In Australia, offset policies are framed around the concept of native vegetation, used as a proxy for biodiversity. In France, where native vegetation bears little meaning, offsetting has been built around a number of environmental legislations and hence uses a more heterogeneous set of measures, targeting species, diverse elements related to water, forests and the Natura 2000 network.

Impact assessments and offsetting

So how to move forward from here? In Australia, the Strategic Assessment protocol already provides a tool for holistic impact assessments; however, it can only be used for large development projects where both the federal and relevant state governments agree to initiate the process. Strategic Assessments also focus only on impacts on Matters of National Environmental Significance. This restricts assessments and avoidance of impacts for species that are not yet listed but may become so as a result of the proposed development.

More critically, the offsetting of final impacts is still predominantly approved under the standard project-by-project EPBC Act process rather than under Strategic Assessments. Interviews of government, industry and non-gorverment stakeholders by Dr Megan Evans (UQ) indicate an appetite for moving from project-by-project into more holistic and strategic biodiversity offsetting across the Australian environment and development sector.

However, several factors currently inhibit this shift:

- lack of interaction and information flow within and between federal, state and territory government departments
- the 'focal species' approach of federal and state threatened species legislation
- policy uncertainty and inconsistency
- lack of capacity to coordinate and align efforts across multiple jurisdictions and tenure.

These factors, as well as bridging the gap between impact assessments and offsetting, are some of the key challenges in moving towards more efficient conservation of biodiversity at the development frontier.

For further information
Heini Kujala
heini.kujala@unimelb.edu.au


IMAGE: RACHEL MORGAN

Dr Katherine Selwood presenting research that estimates the impacts of potential future land-use proposals for Christmas Island and how to maximise conservation outcomes for the island.


IMAGE: DOMINIC SHERONY CC BY-SA 2.0 WIKIMEDIA COMMONS

The southern black-throated finch has become endangered mostly through habitat loss due to agricultural development. Remaining habitat is now under pressure from proposed coal mine developments.

1. Hawke, A. (2009). *The Australian Environment Act: Report of the Independent Review of the Environment Protection and Biodiversity Conservation Act 1999*. (Department of the Environment, Water, Heritage and the Arts). <www.environment.gov.au/epbc/review>
2. Whitehead, A. L., Kujala, H. & Wintle, B. A. (2017). Dealing with cumulative biodiversity impacts in strategic environmental assessment: a new frontier for conservation planning. *Conservation Letters,* 10, 195–204.
3. Bishop-Taylor, R., Tulbure, M. G. & Broich, M. (2017). Surface-water dynamics and land use influence landscape connectivity across a major dryland region. *Ecological Applications*, 27, 1124–1137.
4. Maron, M. et al. (2018). The many meanings of no net loss in environmental policy, *Nature Sustainability*, 1, 19–27.

IMAGE: DAVID BLAIR

Protecting our mountain giants

Why losing large old **hollow-bearing mountain ash trees** matters

LEFT: Mountain brushtail possums use this tree hollow - which bears their tracks.

Australia is losing large old hollow-bearing trees in our mountain ash forests due to logging, fires and climate change. A team at the **Australian National University** have been investigating the importance of these trees, the implications of their loss and things we can do to ensure we have enough mountain giants for the future.

Large old trees are keystone structures in many of the world's forests. Despite being of great ecological importance and fulfilling critical roles in these forest ecosystems, globally, large old trees are in decline.

In the mountain ash forests of south-eastern Australia, the loss of large old trees has been rapid and is ongoing, with the average forest age now younger than it has ever been. This changes the fundamental dynamics of the forest, as young forest is more fire-prone, stores less carbon and has less water runoff.

Old forests provide many features not found in smaller, younger trees like hollows, large lateral branches, buttresses, and extensive canopies with large numbers of flowers. They also provide vital habitat for cavity-dependent animals such as Leadbeater's possum and other species of arboreal marsupials like the greater glider and yellow-bellied glider.

Our old trees at risk

These grand and critical trees are in rapid and catastrophic decline. Chief among the threats to large old hollow-bearing mountain ash are logging, fire and climate change (and the interaction of these drivers of decline). After 200 years of European management, mountain ash ecosystems are now listed as Critically Endangered under the IUCN Red Listed Ecosystem assessment.

Of the hollow-bearing trees standing in 1997, 41% had collapsed by 2015. Of 166 one-hectare long-term monitoring sites examined in 2015, 50% had two or fewer large old hollow-bearing trees. On current projections, populations of such trees will decline by more than 90% from 1997 levels by 2040, even assuming no further disturbance by fire and logging, although both are almost certain to continue within that period.

Remaining forests are experiencing competing and sometimes conflicting demands – for water supply, tourism, biodiversity conservation and timber harvesting. How forests are used, especially with respect to logging, is decided under the Regional Forest Agreement, which is currently under negotiation.

IMAGE: DAVID COOK CC BY NC 2.0 FLICKR

The main threats to the survival of yellow-bellied gliders are fire and logging.


IMAGE: DAVID BLAIR

ABOVE: Old growth mountain ash forest in the O'Shannassy catchment.


IMAGE: DARREN BELLERBY CC BY 2.0 FLICKR

ABOVE: Greater sooty owls depend on tree hollows.

Room available – good views, no heating

Mountain ash typically begin to develop hollows at around 120 years, with cavities becoming suitable for use by arboreal marsupials, like gliders and possums, after around 190 years.

Arboreal marsupials typically use a number of hollow-bearing trees for dens within their home range. Good habitat will have high densities of large old trees and a variety of hollow-bearing tree types, including live and dead trees. This is due to the different possums and gliders having different tree preferences. For example, gliders prefer tall live old trees with hollows high in the canopy, while many of the possums prefer dead trees with cracks and internal rot.

Nest boxes are often proposed as a solution to the dwindling number of natural tree hollows. But any strategies to use artificial nest boxes need to take into account those individual species' preferences. There are many hollow-bearing species (including birds) that are in decline and one type of box cannot satisfy the needs of every species. Current nest box programs target only Leadbeater's possum, so do not overcome the broader problem of hollow loss.

The sheer logistics of installing boxes or chainsawing artificially cut hollows to suit the preferences of some species could be prohibitive. For example, greater gliders typically use hollows up to 60 metres off the ground. Boxes also need to be checked regularly as damage or collapse of boxes is an issue. Overall, nest boxes are expensive to install and maintain, and the costs of rolling out nest boxes at a meaningful scale across the landscape needs to be factored in when considering the economics of logging.

What can we do?

Strategies are required both to protect all remaining large old hollow-bearing mountain ash trees, as well as to recruit more. Currently only 1% of the forest is in an old growth state. All existing live and dead old trees must be adequately protected from logging or regeneration fire damage. Sufficient areas of the next oldest age cohort (regeneration from the 1939 fires) must also be retained to rebuild the overall future area of old growth forest.

As climate change increases high fire-danger weather, losing forests to fire is an ongoing threat. What we can control is how much forest is disturbed by timber harvesting.

Withdrawing large areas of forest from timber harvesting is one of the most effective strategies that could be undertaken to protect both today's large old hollow-bearing trees and the younger forests that are the large old hollow-bearing trees of the future. Increasing the overall age of the forests in the mountain ash ecosystem will also reduce fire risks, as older forests are less fire-prone than forests landscapes dominated by young trees.

In areas where logging remains, established live and dead trees should be protected by buffers. Current research indicates buffers would need to be at least 100m in radius. Large buffers should also be provided along stream lines, which generally contain more large old trees and are also vital for other aspects of biodiversity and water quality. Ecological reserves are also effective at conserving large old trees and should be expanded.

For more information, please refer to the TSR Hub factsheet, "Implications of the rapid loss of large old hollow-bearing trees in Victorian Mountain Ash forests" www.nespthreatenedspecies.edu.au/publications-tools/factsheet-implications-of-the-rapid-loss-of-large-old-hollow-bearing-trees-in-victorian-mountain-ash

BELOW: Even when retained within logging coupes, large old trees can be killed by follow up regeneration burns.


IMAGE: DAVID BLAIR


IMAGE: DAVID COOK CC BY NC 2.0 FLICKR

ABOVE: Leadbeater's possum is dependent on tree hollows and prefers hollows in very old trees.

Tracking the **far eastern curlew**

News from Darwin and beyond


IMAGE: GAVIN O'BRIEN

ABOVE: Inspecting wing moult on a far eastern curlew

The Hub's far eastern curlew project team has tagged a bird travelling as far as North Korea this year. Along with other recent discoveries, the Darwin-based project is succeeding in its aim of closing significant knowledge gaps in the breeding habits and migratory movement of the bird. **Amanda Lilleyman** provides an update on their latest research findings and activities.

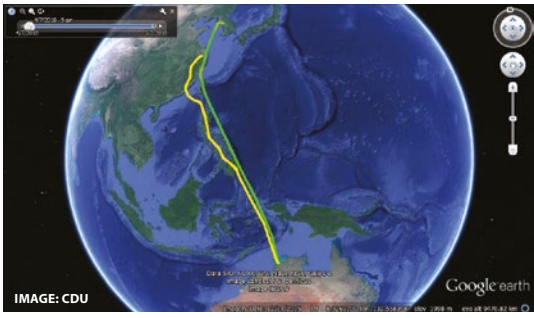
The far eastern curlew is in rapid decline in Australia – listed as Least Concern in 2004, it was upgraded to Endangered in 2015 and Critically Endangered in 2016. But while concerted effort is being made in Australia to conserve the species, we will not succeed unless we also consider the threats facing the bird along other parts of its migration route.

The exceptionally long-beaked bird is the world's largest migratory shorebird. It travels 9,000 to 12,000 km each way along the 'East Asian–Australasian Flyway', between breeding grounds in Russia and China and non-breeding habitats in south-east Asia, Australia and New Zealand. Hub researchers focusing on one of Australia's largest populations, which is found in Darwin Harbour, want to discover exactly where their birds go to breed as well as the migration path they take.

They also want to better understand their local movements within Darwin Harbour as this will provide valuable information about the birds' preferred habitats and how and when they use them.


IMAGE: AMANDA LILLEYMAN

Far eastern curlew make epic cross-globe migrations between breeding and non-breeding areas.



GPS tags have revealed the migratory routes of two far eastern curlew that left Darwin Harbour to travel to Northern Hemisphere breeding areas. One stopped in China to refuel mid-route, the other in South Korea.

This will include the most important feeding and roosting areas, and how these vary with tides.

Capture and tagging

Researchers caught two far eastern curlew in December 2017 and fitted GPS tags to them so they could track their movements around Darwin Harbour. The birds also have coloured flags with number codes attached to their legs so they are individually recognisable in the field. The two birds were coded '00' and '01', respectively.

It was quickly discovered that the birds were roosting at Darwin Port's East Arm Wharf during high tide and using very small areas within Darwin Harbour for feeding during lower tides. Curlew 00's tag switched off within a month of tracking as its solar panel was obstructed by wing feathers and prevented from recharging, staying off for several months. But Curlew 01 gave the researchers five months of fine-scale tracking from Darwin Harbour.

This bird would often roost in the dredge ponds at East Arm Wharf, and move between there and two saltpans nearby and four kilometres away in Charles Darwin National Park. This extensive use of saltpans was unexpected. The bird also used the mudflats out the front of the mangroves of this area, at low tide. It used these four sites exclusively over the five months of tracking and was often resighted at East Arm Wharf during high tide.

Northern flight

Curlew 00's tag switched on again on 4 April 2018, where it was logged on the coast between Taiwan and Fujian. The next day it arrived on the coast of North Korea, where it stayed for four days, before flying over the border to South Korea. It spent its time feeding on the mudflats near Incheon. It has since moved on to breeding grounds on the Kamchatka Peninsula in far East Russia.

Curlew 01 started its northward migration on 25 April. The researchers tracked it flying over the Philippines, then arriving on the coast between Hong Kong and Fujian before flying further north to Hangzhou Bay in China (which is the far southern part of the Yellow Sea). The late April departure date is very late for the species – curlew usually depart north in late February and early March. The team were expecting this bird to stay in Darwin as it was sub-adult, and were surprised to see it start migration and reach so far north so quickly.

All eyes will be on whether it travels to the northern hemisphere breeding grounds.

For further information

Amanda Lilleyman
amanda.lilleyman@cdu.edu.au

New Chinese policy a **big win** for Australia's **curlew**

The shorelines that many coastal shorebirds rely on have changed dramatically over the last several decades. Land reclamation has transformed much of the natural coastline of the Yellow Sea into hardened seawalls, inside which intertidal flats have been converted into hard land for ports, aquaculture and industrial zones.

Seven threatened Australian shorebird species pass through China on migration. Loss of tidal flats, including through land reclamation, has driven steep population declines across many species, including those listed as threatened in Australia. But a recent announcement from the Chinese government is a hugely positive development for shorebirds and their coastal habitats.

China's State Oceanic Administration stated in early 2018 that henceforth the agency will only approve coastal wetland development that is important for public welfare or national defence (rather than for business-related reasons), that unauthorized reclamation projects will be stopped, damaging structures on illegal reclamation areas torn down, and already-reclaimed wetlands that have not yet been built will be nationalised.

If systematically implemented, this new policy could greatly reduce one of the largest pressures on intertidal shorebird habitat (development-related reclamation),


IMAGE: MICHA JACKSON

Sea walls and land reclamation have greatly reduced the extent of mud flat habitats in China.

and allow for increased focus on the maintenance and improvement of existing intertidal and supratidal habitat to foster shorebird recovery.

Intertidal flats are also threatened by the invasion of *Spartina* cordgrass, pollution and coastal erosion, requiring concerted management efforts, while less developed supratidal areas have enormous potential to improve available coastal shorebird habitat if strategically managed to benefit bird species.

For further information

Micha Jackson m.jackson@uq.net.au

BELOW: A far eastern curlew being fitted with a GPS tag to track movements around Darwin Harbour and along its migration route.


IMAGE: GAVIN O'BRIEN

Indigenous engagement vital to saving species


IMAGE: KANYIRNPA JUKURRPA (KJ)

ABOVE: KJ Jigalong rangers taking Dr Anja Skroblin out searching for bilbies.

Enhancing **Indigenous engagement** in threatened species

The **TSR Hub** recognises that outcomes for threatened species will be improved by increasing Indigenous involvement in their management. In response to this, the Hub is guided by an **Indigenous Reference Group** and has a number of projects across Australia that are collaborating with Indigenous groups on threatened species research on their country. We also have a project that is looking at ways to enhance Indigenous engagement in threatened species conservation more broadly. Here we provide a brief look at what is happening in this space and a couple of recent events.

Indigenous Reference Group

In recognition of the valuable ecological knowledge that Indigenous people and groups can bring to the management of threatened species, the TSR Hub established an Indigenous Reference Group (IRG) in mid-2017.

The IRG is coordinated by the Hub Indigenous Liaison Officer, Brad Moggridge, a Kamilaroi man and hydrogeologist. It has four members, with one from Broome, two from far north Queensland and one from northern New South Wales. The IRG provides advice and guidance to the Hub's leadership group and project teams to help ensure that Hub projects are delivering research that aligns with Indigenous needs and that research outputs are culturally appropriate for Indigenous end-users and stakeholders.

Why more Indigenous engagement is needed

Indigenous people and groups play a vital role in protecting and saving threatened species. The range of most threatened species overlaps with Indigenous lands; and many threatened species occur only or mainly on Indigenous land. In addition, Indigenous people have deep cultural and spiritual obligations towards their land and its species. This makes engagement with Indigenous people vital to the conservation of many threatened species.

Many Indigenous people and groups are already achieving biodiversity outcomes, often without recognition. Enhanced engagement with Indigenous people will help to provide formal recognition of the work these groups are doing. It also provides opportunities for these groups to participate in broader planning and discussions about threatened species conservation, with researchers, government agencies and other conservation groups. This is of benefit to Indigenous groups, who can have a greater say in the management of species of significance to them, and also to non-Indigenous group, who benefit from the knowledge, experience and input of the Indigenous groups.


IMAGE: AMANDA LILLEYMAN

Larrakia Ranger Sarah Rolland holding a great knot caught during monitoring of migratory shorebirds.


IMAGE: CAUL HUB

LEFT: Melbourne's MPavilion Indigenous knowledge and nature in our cities event.

Indigenous research collaborations

The TSR Hub is undertaking or developing collaborations with Indigenous partners across Australia including Arakwal, Olkola, Martu, Tiwi, Larrakia, Ngunnawal, Kakadu and Wreck Bay people and other groups. Partnerships cover a wide variety of threatened species from shorebirds to parrots, and bilbies and other mammals to orchids.

While most of these are local collaborations, one Hub project is taking an overarching look at ways to increase and formalise Indigenous involvement in threatened species management. This project will look at threatened species habitat and existing conservation activities on Indigenous land, and will identify new opportunities for Indigenous people to participate in protecting and recovering Australia's threatened species.

The research is being co-developed with Indigenous partners through four cross-cultural case studies, two in the Northern Territory, one in Queensland, and one in New South Wales. The project will develop a cross-cultural approach to plan, deliver and monitor on-ground threatened species recovery activities. It will also produce a framework for a national Indigenous people's threatened species strategy.

As the case study projects develop, the teams are also identifying barriers to Indigenous participation in threatened species research and conservation activity, and ways to overcome them. Another outcome will be a more detailed understanding of the range of views that Indigenous peoples hold towards threatened species.

MPavilion: Indigenous knowledge and nature in our cities

The TSR Hub supported an MTalks event on Indigenous Knowledge and nature in our cities. The high-profile event was held at the MPavilion in Melbourne's Queen Victoria Gardens in February. It brought together a panel of Indigenous speakers to discuss the challenges of responding meaningfully to the expectations, rights and aspirations of Indigenous people and communities in cities.

The event was initiated and led by the Clean Air and Urban Landscapes Hub. TSR Hub involvement was led by our Indigenous Liaison Officer Brad Moggridge, who was one of the presenters. The panel speakers explored a range of questions about the significance of nature in cities and maintaining a connection to country, including implications for the conservation of threatened species.

The bigger NESP picture

The Australian Government's Department of Environment and Energy hosted a two-day workshop in February which brought together Indigenous representatives and leadership teams from every Hub in the National Environmental Science Program (NESP). The workshop focused on the importance of Indigenous participation and engagement in the NESP program. Participants were encouraged to identify things they can do now to improve Indigenous engagement in the NESP, and opportunities to increase Indigenous participation and engagement in future projects and programs.

For further information

Brad Moggridge
bradley.moggridge@anu.edu.au


IMAGE: NATASHA ROBINSON

RIGHT: Indigenous Rangers Shane (Chicko) Sturgeon and Phillip Brown bagging a quoll at Booderee National Park during monitoring.

Dan White is demonstrating how critical genetic analysis can be to our management of threatened species. It's a level of biodiversity often overlooked by the broader public but basic to good outcomes.

From genes to **saving species**

You have to be pretty lucky to make a living by combining your passion and interests, and that's exactly how **Dr Daniel White** feels about his current state of affairs. Dan began his career studying genes, and has since applied his science to saving species. Here he describes how.

After a childhood that included watching more nature documentaries than was probably healthy, I think I completely stumped our careers advisor at school when she asked, "So, what would you like to do after school?" With her already pulling out what was required for a career in medicine I responded: 'Hmmm, I think zoology'. Since then I've followed my dream of working with, and hopefully conserving, wildlife. Sir David Attenborough had a lot to answer for that day.

A zoology honours degree at the University of Edinburgh finished with a project on the evolution of sex chromosomes. I was in the lab of Brian Charlesworth, where the tea-time chat was often spoken in a language of theoretical population and evolutionary genetics. And it was here that a flame was lit on the subject of genetic variation and what it can tell us about evolutionary forces in nature.

Next came a Masters degree (also at Edinburgh University), where I delved further into the subjects of population and quantitative genetics, with research projects that assessed pedigrees in red deer and helped resolve the phylogeny of pigs around the world using mitochondrial DNA. To satiate a desire to learn more about genetic anthropology, I chose a PhD on complex psychiatric traits in humans, which I completed at the University College London. Having 'done' *Homo sapiens*, I then re-joined the molecular ecology fraternity as a postdoc, and I've never looked back.

Over the next decade I worked at the Universities of Canterbury and Otago in New Zealand, UNSW in Sydney, and most recently at Manaaki Whenua Landcare Research, NZ. I've been tackling a broad suite of conservation challenges using my training in population genetics (with some up-skilling in the area of population genomics). For example, I developed a molecular tool for monitoring all recognised species of kiwi (New Zealand's iconic bird) using just feathers and scats. I worked on uncovering the viral causes of different wildlife diseases including exudative cloacitis (aka crusty bum disease) in the critically-endangered kakapo (another NZ icon). I applied population genetics to understanding connectivity and local adaptation in a species of recently lake-locked diadromous fish. And I modelled the genetics of translocated populations of the giant weta (insects the size of a human hand) to understand how many are needed for the retention of important genetic diversity.

When the opportunity arose to work with Nicki Mitchell at the Threatened Species Recovery Hub at UWA, I jumped at it. Here was a chance to work on a whole new suite of threatened species with a range of unique challenges. I've been with the Hub now for over half a year dividing my time between UWA and Manaaki Whenua Landcare Research back in NZ. In addition to working on New Zealand's terrestrial biodiversity challenges, I work with three threatened WA marsupials: the banded hare wallaby, western barred bandicoot and dibbler.

The focus of the UWA work is contemporary species genetic diversity and the application of population viability analyses to help decide how many individual animals (and from where in terms of genetic diversity) are needed for their successful reintroduction to Dirk Hartog island (off the WA coast), an integral part of the 'Return to 1616' initiative.

It's an incredibly exciting project which has given me the opportunity to work with a range of conservation managers at the WA Department of Biodiversity, Conservation and Attractions, at the Australian Wildlife Conservancy, and scientists from several other universities. At the end of the day, effective conservation of our threatened fauna requires input from all these sectors, and I feel lucky to have the chance to make a contribution to such an important project. Thank you, Sir David.

For further information

Daniel White daniel.white@uwa.edu.au

The Threatened Species Recovery Hub is supported through funding from the Australian Government's National Environmental Science Program.

Science for saving species

A quarterly publication of the Threatened Species Recovery Hub

Editor: Jaana Dielenberg
j.dielenberg@uq.edu.au

www.nespthreatenedspecies.edu.au

COVER IMAGE: AMANDA LILLEYMAN HOLDING A FAR EASTERN CURLEW CAUGHT FOR GPS TAGGING. (SEE PAGE 12 FOR THE FULL STORY). IMAGE: BY GAVIN O'BRIEN

Threatened Species Recovery Hub
National Environmental Science Programme