Science
for saving species

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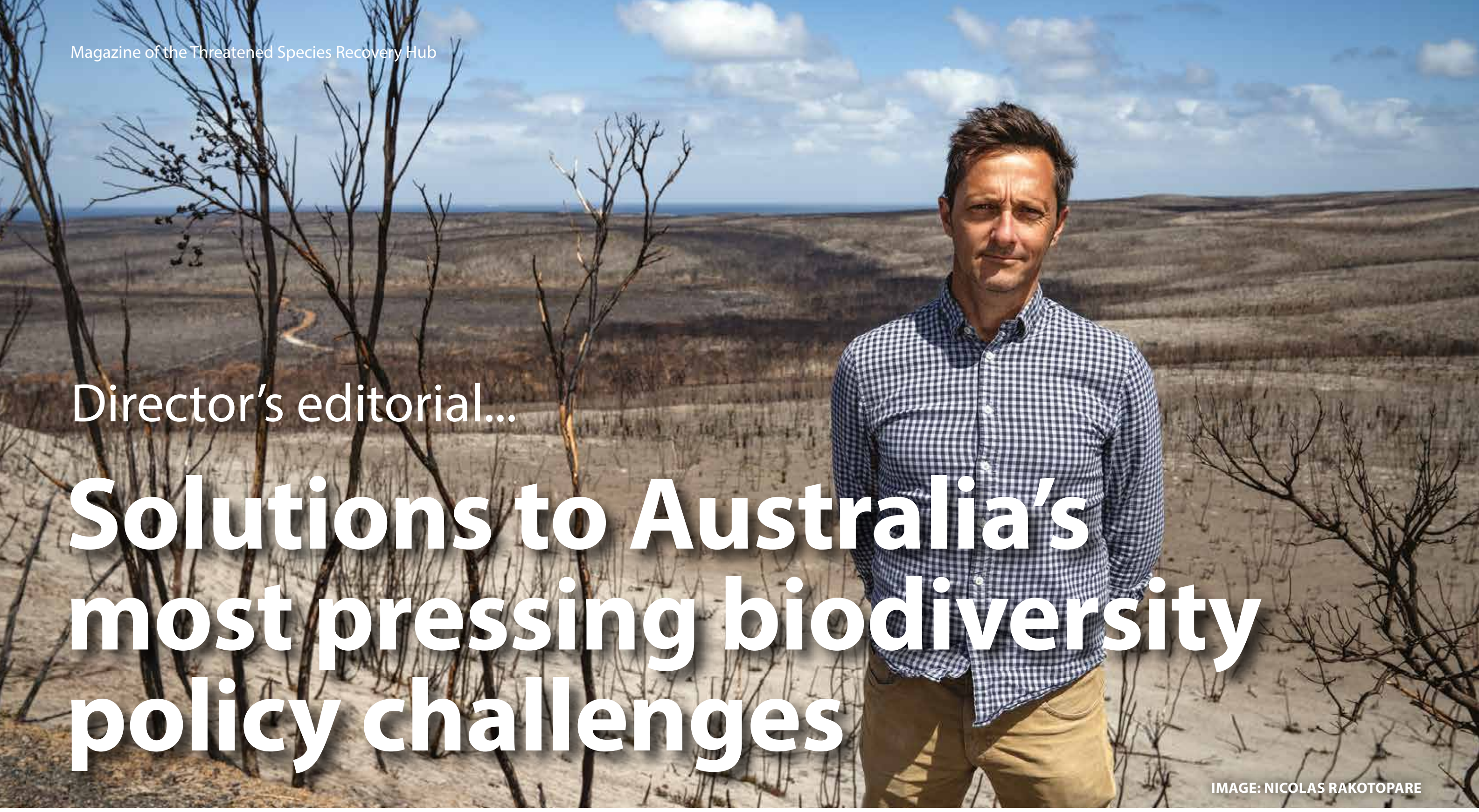
IMAGE: ANDREW CRAWFORD

Beyond offsetting: Target-based ecological compensation

Solutions to biodiversity policy challenges

Threatened Species Recovery Hub

National Environmental Science Programme



Director's editorial...

Solutions to Australia's most pressing biodiversity policy challenges

IMAGE: NICOLAS RAKOTOPARE

As we reach the final months of the **Threatened Species Recovery Hub's research program** we're starting to reflect on our legacy. Looking back, our six-year program was incredibly ambitious, delivering 147 research projects, but the need was great; Australia has over 1800 species and communities listed as threatened by a large, complex and interacting set of threats.

ABOVE: Brendan Wintle went to Kangaroo Island following the island's devastating 2019–20 bushfires to work with stakeholders on recovery planning.

In Australia's first ever national compilation of threatened species monitoring data, our Threatened Species Index revealed that in just over 20 years (1995–2017) the population sizes of threatened Australian birds have declined by about one-third, mammals by about half and plants by almost three-quarters (72%) (see p18).

Preventing extinctions and halting and reversing long-term declines at meaningful scales ultimately depends on effective policies and strategies at all levels of government, and by non-government organisations, Traditional Owner land managers, and civil society.

Each of our projects is providing valuable new knowledge to support better decision-making for pressing challenges facing threatened biodiversity. In some cases we have also moved to more direct contributions to policy development and outcomes.

For example, Professor Martine Maron's (UQ) work on biodiversity offsets is providing important tools to improve the implementation of Australia's most widespread policy mechanism for compensating for the impacts of development on biodiversity (see p4) and has even presented an alternative called target based ecological compensation (see p6).

Professor Sarah Bekessy and Dr Georgia Garrard's (RMIT/UniMelb) work is embracing opportunities for biodiversity conservation in cities and the benefits that this has for residents by developing a framework to support local governments, urban planners and architects to implement biodiversity sensitive urban design (BSUD) (see p14).

In addition to our research projects, I and many of our senior scientists have also provided advice, evidence and support to important national strategies and reviews, for example, Professor Samuel's review of the EPBC Act, Senate Inquiries into the Faunal Extinction Crisis and the problem of feral and domestic cats in Australia, and the first and the new Threatened Species Strategy.

IMAGE: PATRICK K59 CC BY 2.0 WIKIMEDIA COMMONS

ABOVE: Hub research found that the plains wanderer is one of the native bird species at highest risk of extinction within 20 years unless there is new conservation effort.

Inside the Summer 2021 issue of *Science for Saving Species*

Threatened Species Recovery Hub

National Environmental Science Programme

Our science and scientists have also been shaping action on cats through the Feral Cat Taskforce.

Research on havens and the mammals most vulnerable to cats led by Professor Sarah Legge (UQ/ANU) has directly informed Australian Government strategies and investment decisions to support new havens (see p4).

Immediately following the 2019–20 bushfires we worked closely with our government and non-government partners to offer our support. We made a significant contribution to support the recovery of threatened biodiversity impacted by the crisis through many regional, state and Commonwealth forums and the Wildlife and Threatened Species Bushfire Expert Panel.

The large number of hub scientists asked to contribute to various Ministerial roundtables, including in response to the 2019–20 bushfires, is testament to the standing that our members have in policy circles. The list of our direct policy contributions is long, and is one of the key strengths of the hub.

Good policy is based on good evidence. Robust monitoring is essential to know whether species are recovering, stable or declining; whether management is working; and which species are in greatest need of assistance. Yet, a nationwide inventory completed by the hub in 2017 found that around one-third of Australia's listed threatened species had not been the focus of any monitoring, and the monitoring of many others had been poor. To address this, Professor David Lindenmayer (ANU) led an integrated program which has substantially moved the state of knowledge and capacity in Australia for threatened species monitoring and management (see p5).

In many cases, decisions must be made before robust empirical evidence can be compiled. In the absence of existing data for many species and management actions, we have used a range of structured expert elicitation processes to fill strategically essential knowledge gaps by tapping into the experience and knowledge of hundreds of the most relevant scientists and on-ground conservation managers across the country.

Using these methods, Professors Stephen Garnett and John Woinarski led projects that estimated the likelihood of extinction within 20 years of the most imperilled birds, mammals, freshwater fish, reptiles, frogs and butterflies. Such estimates and listings of the most imperilled species allow managers and the community time to act before species are lost. Several of these species are not yet listed as threatened under Australian law and a few are not formally described; without this research some may have become extinct before they even received a name.

Effective policies and plans for threatened biodiversity also depend on a comprehensive understanding of the costs of conservation action. However, lack of data on costs has previously led many recovery plans remaining uncosted, reducing their practical utility. New hub research led by Professor Stephen Garnett, Dr Ram Pandit (UWA) and Professor David Pannell (UWA) provides guidance for budgetary planning for recovery plans, including detailed indicative direct and related costs for a range of actions, and their estimated benefits.

Business as usual will see a continuation of biodiversity declines. An engaged and educated public will be essential to support ongoing and expanded investment in recovery actions, monitoring and research. Community awareness of Australia's threatened biodiversity and support for action is growing rapidly (see p4-5).

The work of our dedicated scientists and partners has captured public attention, attracting over 6,000 media stories on hub research, with an estimated reach of over 19 million people.

We have made huge gains in the knowledge needed to recover many threatened species and ecological communities. We have also built an incredible network with policy makers, planners and on-ground partners to ensure that those findings are applied and have the greatest possible impact.

This hub has been a monumental collective effort and I have been humbled by the incredible commitment of so many people working selflessly in the interests of Australia's threatened species. While many more challenges remain, we should pause to reflect on the substantial contribution we have made to the preservation of Australia's nature.

Professor Brendan Wintle
Director, Threatened Species Recovery Hub


IMAGE: NICOLAS RAKOTOPARE

ABOVE: Karajarri Rangers have led research on the impact of fire management on desert biodiversity.


Dr Daniella Teixeira developed a new efficient acoustic technique to monitor black-cockatoo breeding, which is difficult and expensive to monitor with traditional methods.

IMAGE: NICOLAS RAKOTOPARE

Delivering science for saving species: A few of our big successes

Better outcomes from biodiversity offsets

IMAGE: BUTUPA, WIKIMEDIA COMMONS, CC2.0

Malleefowl.

To function as intended, biodiversity offsetting depends on a robust quantified understanding of both the amount of impact a development will cause to a threatened species or community, and the benefit that will result from offset actions proposed by a developer.

The latter, estimating the offset benefit, has been difficult for many communities and species, such as the northern quoll or malleefowl, due to a lack of evidence about the effectiveness of management actions.

To fill this gap, Professor Martine Maron's team (UQ) has developed a benefit expert elicitation method, which has been used by the Queensland Government to improve outcomes for Queensland's threatened species, and is expected to be a valuable resource for other biodiversity offset managers nationwide.

Getting fish past manmade barriers

IMAGE: MATTHEW GORDOS

Road culverts can be major barriers to fish movement.

A significant cause of native fish declines is barriers to fish movement, which can lead to population fragmentation and loss of access to key habitat. A team led by Professor Craig Franklin (UQ) used a biohydrodynamics laboratory to fill critical knowledge gaps about the swimming ability and behaviour of key native fish species, and tested existing and novel designs for fishways.

Their research now underpins the New South Wales Department of Primary Industries Fisheries' Road Crossing Design Guidelines that are currently being drafted, and will help reduce the impact of manmade barriers that limit native fish from accessing key habitat.

The team delivered both the largest quantified dataset on native fish swimming ability and a practical and cost-effective new design for culverts that waterway managers and engineers can use to improve native fish passage through retrofitted and new waterway culvert designs.

Improving Australia's havens network

IMAGE: AWC

The fence at Australian Wildlife Conservancy's Newhaven Sanctuary.

Research led by Professor Sarah Legge (ANU/UQ) will have major benefits for mammals that are susceptible to cats and foxes and to Australia's conservation haven network of cat- and fox-free islands and fenced reserves.

The national team identified which mammal species most urgently need the protection of a haven to support their persistence, and where Australia's future havens should be developed in order to provide the greatest conservation benefit across all mammal species that are susceptible to predation by feral cats and foxes.

Their work is already guiding investment decisions to support new havens through the Environment Restoration Fund – Safe Havens Grants, and has informed actions in the Australian Government's Threatened Species Strategy on "tackling feral cats", and "safe havens for species most at risk".

Managing the impacts of cats

IMAGE: NORTHERN TERRITORY GOVERNMENT

A feral cat in a conservation area.

The hub's large and integrated program of research to better understand and manage the impact of cats on Australian wildlife was shortlisted for the prestigious Eureka Prize for Applied Environmental Research.

The work led by Professor Sarah Legge (ANU/UQ) and Professor John Woinarski (CDU) has included: the first robust estimates of the cat populations in Australia and their toll on wildlife; testing and improving poison-baiting and trapping methods; integrated control of cats and other pests including rats, rabbits and foxes; and managing fires and grazing to maintain habitat refuges and reduce predation impacts.

The findings have provided a broad and comprehensive evidence base that supports coordinated action by states and territories through the work of the Feral Cat Taskforce, and meets many of the research targets identified in the Australian Government's Threat Abatement Plan for Predation by Feral Cats. Hub findings were also referenced 53 times in the final report of the Parliamentary inquiry into the problem of feral and domestic cats in Australia.

The hub's high-impact communication campaigns on the research findings have also informed and significantly advanced public conversation about cat control, which has increased support for cat management.

Recovering biodiversity impacted by Black Summer fires

Almost three billion animals were killed or displaced in the 2019–20 bushfires. Following the fires we worked closely and quickly with Commonwealth, state and territory governments to identify and deliver the science they needed to recover fire-affected species and communities.

The fire-recovery workshop on Kangaroo Island.

This included working with the Expert Panel to rapidly analyse and determine the species most affected and the management actions that were most needed to prevent their extinctions and help their recovery. We helped develop collaborations across research, landholder, government agency and other groups to deliver essential research, monitoring and management actions needed for recovery.

We also helped to develop and apply criteria to identify priority projects for government investment, and supported regional workshops on recovery actions and investments for fire-affected biodiversity which were facilitated by Dr Libby Rumpff.

Additionally, we informed the community of the extent and consequences of biodiversity loss in the fires, which contributed to public support for biodiversity recovery investments.

Improving threatened plant translocation

Banksia anatona translocation site in Western Australia.

Dr David Coates (DBCA) led a national team that undertook a review of every known plant translocation project Australia-wide and other integrated research which has substantially advanced knowledge, capacity and support for successful threatened plant translocations.

The work has greatly advanced our understanding of factors affecting the success of projects; genetic management of translocated populations; and how to best implement, monitor and learn from ongoing projects.

New knowledge from the research has underpinned the development of new processes adopted by DBCA which: assess trade-offs and synergies between *in situ* and *ex situ* plant species conservation; assess the cost-effectiveness of translocations compared to other recovery; and are used to prioritise plant translocation projects.

Guidelines for the translocation of threatened plants in Australia developed by the team were presented at workshops across the country and widely distributed. They are now being used by threatened plant policy-makers and conservation managers nationwide and have been adopted into the New South Wales translocation operational policy.

Supporting threatened biodiversity monitoring

Karajarri Ranger Marissa Munroe setting up a camera trap, pit traps and drift fence.

The hub has delivered essential new knowledge and tools to support improved threatened biodiversity monitoring across Australia.

Professors David Lindenmayer (ANU), Sarah Legge (ANU/UQ) and John Woinarski (CDU) drew together over 70 of the most experienced managers and scientists involved with monitoring programs in Australia to develop a framework, detailed guidance, case studies and book to support improved monitoring of threatened species and ecological communities.

At a regional scale, we provided input to the redesign of a large-scale national park monitoring program and worked with Indigenous groups on arid zone monitoring based on Traditional Ecological Knowledge and tracking skills. We also supported Indigenous groups to develop practical monitoring programs targeted to their own biodiversity management priorities, such as Martu's Mankarr (bilby) monitoring program, and Karajarri's investigation of fire management effects on biodiversity.

We developed new and efficient methods for hard-to-monitor species like dusky and silver-headed antechinuses, black-cockatoos, burrowing petrels, the Kangaroo Island dunnart, brush-tailed rabbit-rat and brush-tailed phascogale. Plus we tested a range of practical and emerging monitoring methods such as artificial habitat, thermal cameras, drones and eDNA.

Developing the ecology policy-makers of the future

PhD candidate Jessica Agius with a Christmas Island gecko.

The hub has nurtured 65 PhD, three masters and six honours students. By embedding students in collaborations with on-ground conservation managers we have ensured that their work will make a valuable contribution to important real-life challenges.

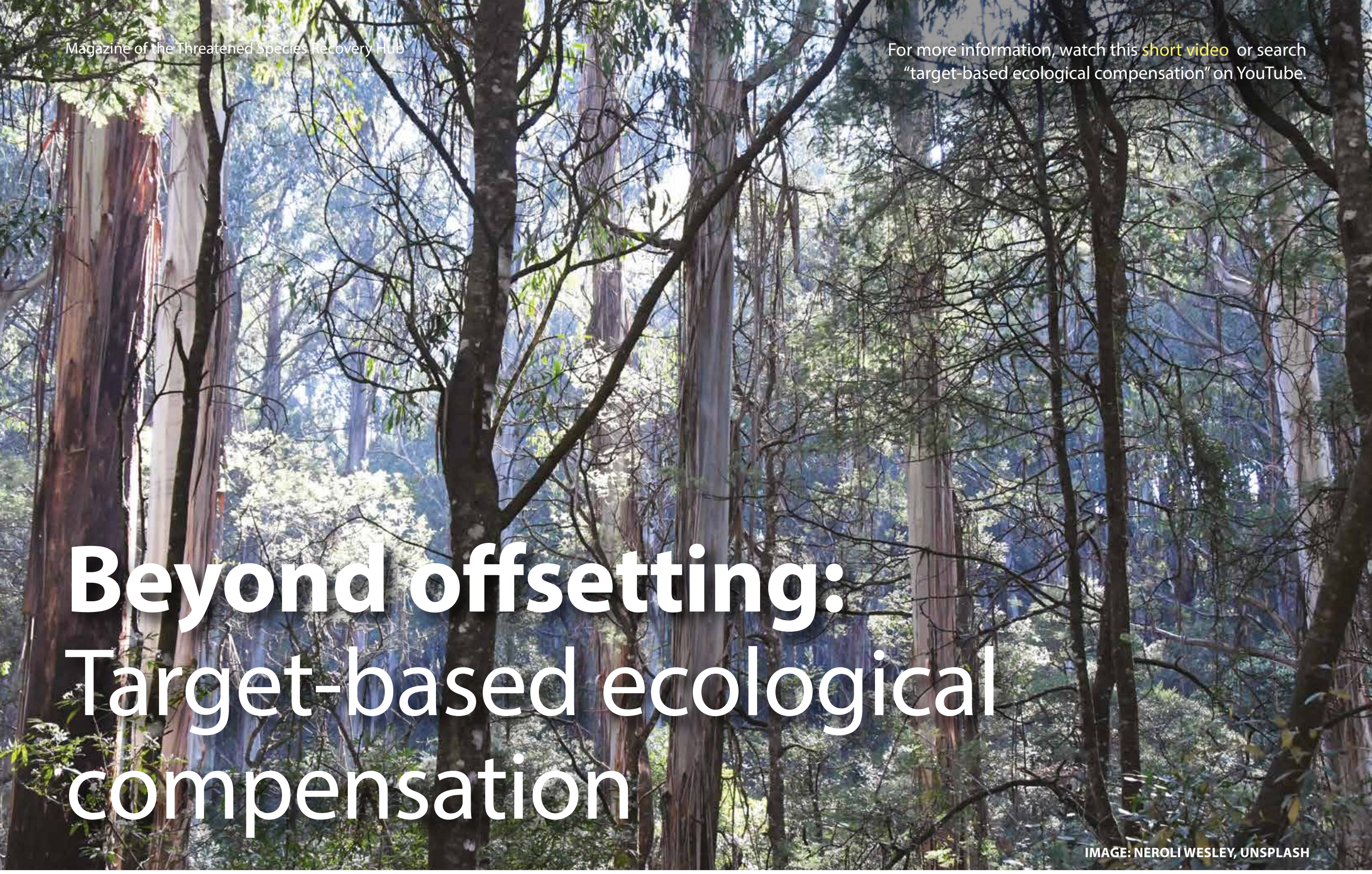
For example, working closely with Parks Australia, Jessica Agius (USyd) has made major advances in our understanding of and management options for a new disease that is impacting threatened reptiles on Christmas Island.

As part of a DBCA threatened plant conservation team, Leonie Monks (Murdoch) and Rebecca Dillon (UWA) have uncovered key factors influencing the survival and persistence of a range of threatened plants, which will improve translocations of these species.

Working with Bush Heritage Australia, Nicholas Leseberg (UQ) has vastly expanded knowledge about the night parrot and how to detect and monitor it, which has already underpinned new detections in Western Australia and will substantially contribute to the recovery plan for the species.

Being part of collaborations like these and providing them with additional guidance on how to work with policy-makers (see p10) gives our early career researchers important experience that will support them to continue to make an impact in future roles.

For more information, watch this short video or search "target-based ecological compensation" on YouTube.



Beyond offsetting: Target-based ecological compensation

IMAGE: NEROLI WESLEY, UNSPLASH

Target-based ecological compensation is a new and promising policy tool for governments to ensure that biodiversity loss caused by development is adequately compensated, while also offering more certainty to developers than existing biodiversity offset approaches. **Professor Martine Maron** and **Dr Jeremy Simmonds** of The University of Queensland explain how target-based ecological compensation overcomes some of the challenges associated with biodiversity offsetting, such as the difficulty of achieving genuine "No Net Loss".

The challenge for society is to balance development and conservation. Biodiversity offsetting has become a widespread approach by governments around the world to try to achieve this, but as it is currently practised, despite a goal of "No Net Loss" (NNL) biodiversity offsetting can entrench ongoing losses of species and ecosystems.

It comes down to how NNL is calculated. Currently, the amount of gain that needs to be provided for a given loss is generally calculated compared to a "counterfactual scenario" of what would have happened without the project and its offset.

So, while people may assume NNL means "No Net Loss" to the environment, it might be more accurately described as "no additional loss caused by this development". In an all-too-common context where biodiversity is declining due to multiple threats, NNL allows a development to simply match that decline.

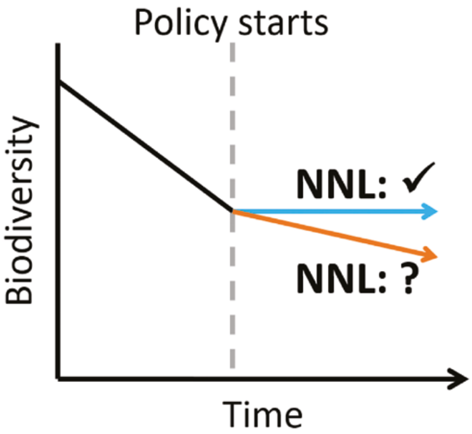


Figure 1. Under target-based ecological compensation, NNL takes on a more intuitive meaning.

IMAGE: RAW FILM, UNSPLASH

Doing away with counterfactuals

Counterfactual-based biodiversity offset calculations are complex. They are subject to uncertainty and susceptible to manipulation, and they tend to be done in a piecemeal project-by-project manner. But under a new and alternative approach, they are not needed at all, and NNL takes on its more intuitive meaning.

As its name suggests, *target-based ecological compensation* links compensation to biodiversity targets, which are set at a

RIGHT: Balancing development and conservation is a challenge for society.

jurisdictional level, which could be national or regional. This means that the requirements for developers and the outcomes for stakeholders are clear and consistent. The associated conservation outcomes are more transparent and less susceptible to manipulation, and the relative contribution of different sectors to achieving those targets is more explicit.

The type and amount of compensation required for a particular loss is determined using a simple framework. Compensation requirements are set to achieve the goal for a particular species or ecosystem. See Figure 2.

Implementing the target-based approach

Just four enabling factors are required to implement target-based ecological compensation. With this information, the type and amount of compensation required for losses caused by development can be determined.

1. Outcomes-based biodiversity targets for species populations or ecosystems (or other specific biodiversity features) in a jurisdiction, whether national or regional. For example, a target for the number of breeding individuals of a threatened species might be a minimum of 10,000; a target for the area of a vegetation community in a region might be at least half its original extent, in good condition.
2. Estimates about the current state of the biodiversity feature in the jurisdiction (e.g., its population size or area).
3. The amount of the species or ecosystem that is or will be effectively secured (e.g., in protected areas).
4. Regulatory control of at least some sectors that cause biodiversity loss through their activities.

To achieve a trajectory of NNL or Net Gain, *improvement* is the minimum standard of compensation. See Figure 2.

A better approach

In this new framework, compensation is integrated with targets, because every unit of loss is compensated for in a way that contributes to achieving specified targets. Outcomes at the project level mirror the desired outcome at the jurisdictional level.

In doing so, it advances ecological compensation beyond a reactive, ad-hoc response. Rather, target-based ecological compensation ensures alignment between actions that address unavoidable biodiversity losses and the achievement of targets for conservation.

Meanwhile, standard conditions that apply to biodiversity offsetting remain valid. These include limits to what can be compensated for; equity; and adherence to the mitigation hierarchy, which is the process by which environmental impacts from development are avoided, unavoidable impacts minimised and residual impacts then offset as an option of last resort.

The framework builds on best-practice safeguards and principles, in a workable approach for conservation.

Further information

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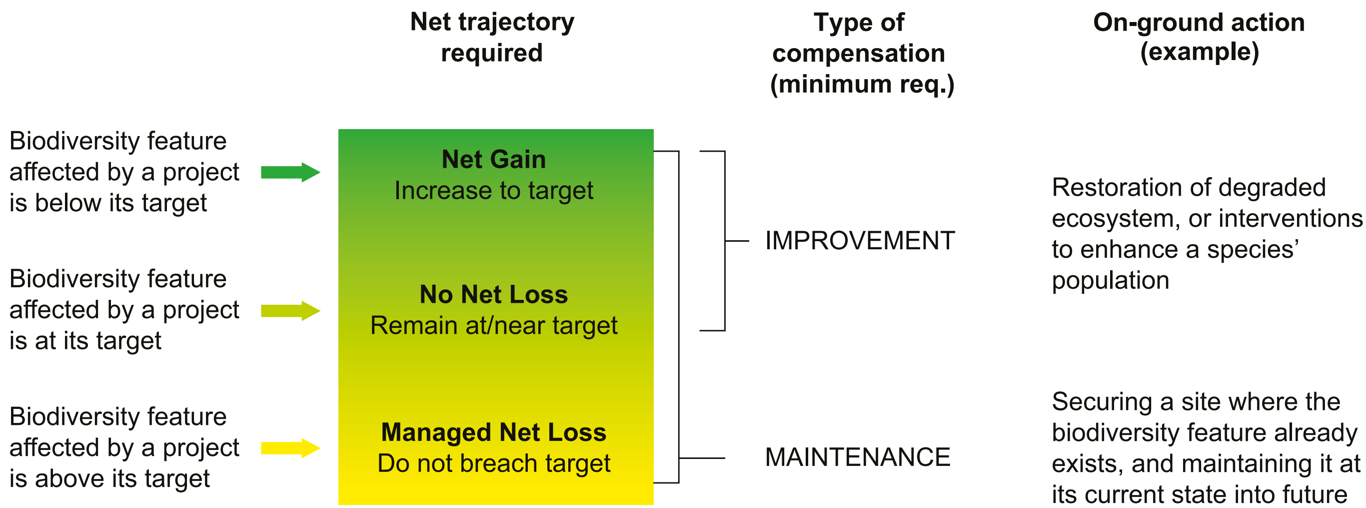

Click here for an interactive target-based ecological compensation calculation spreadsheet.

Figure 2. Compensation for losses of biodiversity caused by development projects can be designed to contribute to jurisdictional biodiversity targets. The target-based ecological compensation approach provides a clear framework for determining how much and what type ('Improvement' or 'Maintenance') compensation is required for a loss to a given biodiversity, such that the overall outcome is consistent with the achievement of that feature's target.

The Sandstone Shrubland Complex on the Arnhem Plateau is an ecological community of national conservation significance comprised mostly of native shrubs, grasses and animals living in rock country. It is a vital habitat to a big number of plants and animals in Australia's Top End.

The economics of threatened species

IMAGE: JAANA DIELENBERG

What price persistence? **Dr Ram Pandit** of the University of Western Australia (UWA), **Dr Kerstin Zander** of Charles Darwin University (CDU), and several researchers from both UWA and CDU are taking a close look at how people value threatened species, with some surprising – and heartening – results. Here they share their insights into what it means to Australians to avert extinction of vulnerable species.

There is a common misconception that economics is about money. It is not. Economics is the science of allocating scarce resources and making decisions – whether about allocating money or anything else. The total economic value of something includes not just how much money one can get for it on the open market but many other values that do not involve money at all. Dollar values help people understand the worth of something in monetary terms, but they are only one small part of the story in making decisions.

The value of persistence

Threatened species illustrate this point beautifully. The fact that you cannot trade boggomoss snails does not mean that Australian people do not value them. Most respondents will never get the tiniest monetary gain from the snail's persistence – they will never sell one, eat one, photograph one or visit one of the few boggy mossy springs where they persist in Queensland's Dawson Valley. Yet, respondents to our species-specific surveys said they were willing to pay around $47 per year to make sure boggomoss snails are not lost forever, with 69% of respondents willing in principle to pay something for the snail to survive. Multiplied across the country's population, that's a pretty high existence value.

Even when respondents had to choose how much they are willing to pay among three or five threatened species, they were willing to give $0.33 and $0.20 per year, respectively, to make sure the snail no longer qualifies for the threatened species list.

In fact, what we discovered was that the dollar value of a species increases substantially as it approaches extinction. That effectively says that threatened species are beyond dollar value. This was consistent with another of our surveys, in which 70% of respondents thought extinction should be prevented *regardless of the cost.* Some might think that impractical – except that the US Endangered Species Act aims "to halt and reverse the trend toward species extinction, whatever the cost", as the US Supreme Court put it.

That's not to say that people do not value some species more than others. So long as extinction

BELOW: The Critically Endangered boggomoss snail is found only in the Dawson River catchment, in the Brigalow Belt Bioregion of Queensland.

IMAGE: JOHN STANISIC

is avoided, the amount people would be willing to pay for conservation varied by species. In contrast to general perception that birds and charismatic species are valued more than the others, we found that charisma-challenged species like skinks are also valued highly. In our multiple species valuation study, we found that people are willing to pay $3.12 per year to conserve the great desert skink and about $0.37 per year to conserve the eastern bristlebird. We also assessed the community's values for threatened ecosystems like salt pans ($0.10/year) or Sandstone Shrubland Complex ($0.93/year). Much of our research was quite new – nowhere in the world have multiple species been assessed simultaneously, ecological communities been valued, or anyone tried to uncover the community's values for anything other than high-profile species.

As a result, we can work out some general rules for determining a species' non-market value that will help policy-makers estimate the cost to the public if a development increases the probability of species extinction, or the benefits that can arise from habitat restoration. Such values represent the benefits to society of conserving species, and help to make decisions about species conservation while considering the costs.

Management – and trust

In another study, we assessed how the worth of threatened species was affected by their management. We asked whether people would pay less if a species were kept in a zoo, if feral animals were killed as a part of threat management or if a species' genetic makeup were managed to avoid inbreeding effects. Somewhat to our surprise, the killing of feral animals was embraced by a large proportion of respondents. They were more cautious about genetic management, but only actually opposed active manipulation of genes.

In all the valuation studies, what came through was a trust of the scientists. If scientists were concerned a species might go extinct, and proposed a process to make sure that would not happen, most respondents were willing to make a contribution. As we know, such trust places a great responsibility on those who are trusted, and can easily be lost.

IMAGE: PARKS AUSTRALIA

The Christmas Island blue-tailed skink would be extinct if not for the time and care of dedicated staff and captive breeding facilities provided by Parks Australia and Taronga Park Zoo.

On the money

A final part of our work did also look at the monetary economy and threatened species. For instance, many species may survive only if they are kept in zoos or behind large fences. To help planning for such expenditure, the country's zoos provided estimates of the costs of keeping different types of animals – and mammals and birds are much more expensive to keep than other, smaller animals. We costed the different types of fencing that are increasingly being erected to protect native mammals from feral predators. For a sample of species, we also calculated the institutional costs of threatened species management. Rangers erecting nest boxes can only do their job if there are people in offices arranging their weekly pay or training them how to climb trees. Such costs are almost never calculated in threatened species budgets, which fall short as a result.

However, not all costs are outlays. Threatened species managers often live in rural and remote communities; their children go to local schools; they buy food from the local shops. For every dollar invested in such a community, there are flow-on benefits in terms of jobs and local investment. That information is being fed into an analysis of threat management needs across the country to allow calculation of at least some of the monetary benefits that communities can derive from hosting threatened species and their managers.

Economic analysis is critical to most policy-making by government. Our work aims to ensure that the very real values Australians place on threatened species, the values that explain the existence of the Threatened Species Recovery Hub, and of the legislation aimed at protecting threatened species, are given a seat at the decision-making table. If boggomoss snails could cheer, we are sure they would.

Further information

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Saving a species can require a major long-term commitment. The bridled nail-tail wallaby was widespread across eastern Australia at the time of European arrival, but foxes, cats and land clearing drove major declines. The species was thought extinct until a single small population was found in central Queensland in 1973. To prevent the extinction of the species, Taunton National Park (Scientific) was established at the site and feral predator control and other conservation actions have been put in place since that time to conserve and support its recovery.

IMAGE: NICOLAS RAKOTOPARE / QUEENSLAND PARKS AND WILDLIFE SERVICE

Producing science for policy

RIGHT: Hub researchers discussing the policy implications of research related to the Victorian Central Highlands with stakeholders at a hub workshop in Melbourne, 2017.

You've done some cutting edge research, but will it make a difference? **Dr Rachel Morgain** of The Australian National University and **Professor Martine Maron** of The University of Queensland talk about what researchers need to know about engaging with policy-makers.

Conservation researchers are a passionate bunch. We don't just do what we do because we love the species and ecosystems we work on. We want to do research that helps them. We want what we discover to support better decisions about conserving biodiversity. And, ideally, we want to see the basis of these better decisions embedded systematically. In other words, we want to impact policy.

"Policy" generally refers to a broad range of mechanisms and systems implemented by government agencies at all levels (and non-government organisations too) to address specific issues. It includes regulation, planning, legislation, strategies, program design, evaluation, agreements, and decisions related to government funding and investment.

One of many factors

There is wide agreement among policy-makers and researchers that policy should be informed by research evidence. But it's important to recognise that scientific findings are just a part of a much larger ecosystem of values, laws and wider knowledge that influence policy. This generally includes social values, competing needs and priorities, constitutional responsibilities, interjurisdictional agreements, existing legislative frameworks and international obligations.

Policy must also be robust enough to address messy reality. Policy ideas can be elegant and sleek, internally consistent, and promise effectiveness and efficiency – then fail to survive in the "wild". They need to be implementable.

So if you are a researcher, you already know you have to make your work accessible and explain its importance in plain language. But what else do you need to know to produce research for policy? Our hub has recently produced the *Connecting Research with Policy* guidelines to help researchers seeking to engage policy-makers.

Here are some of the key tips:

1. Learn the context and who to engage

Learn as much as possible about your policy context: how is responsibility distributed between jurisdictions and agencies? What are the constitutionally defined responsibilities between the Commonwealth, states and territories? What other agreements or related policies are in place? What other non-government, business or community players have a stake?

2. Work closely with policy stakeholders

Contact important policy stakeholders and offer to discuss your research and discuss ideas. Offer to give presentations in a format that suits them. Often an interactive presentation, with plenty of opportunity for discussion and questions, is better than a formal talk.

Ask whether a tailored piece of research or tailored product for policy would be helpful, and in what form. Work with policy partners throughout, listen to them, and seek their input at all stages – they likely have valuable insights into any number of issues material to what you are developing, such as what is currently feasible, constitutionally possible, or has been tried in the past.

Communicate regularly.

3. Time it well

Research has to be timely as well as relevant. Your research is most likely to be considered and to have impact when a policy, strategy or legislation is in formation or under review. If you present your findings after a policy has been finalised and announced, you are not likely to influence it until it is next due for review.

Regular communication with relevant policy teams is a good way to keep an ear open for these timely opportunities. Keeping policy-makers informed of your key research areas also allows them to contact you if and when your research becomes timely.

Parliamentary committee reviews, inquiries and other processes that ask for public comment are another great opportunity to share your research at an opportune moment. The reviewers generally have a very narrow remit and may receive hundreds of submissions, so focus clearly on the terms of reference.

4. Spell out options and implications

Research papers are renowned for stating "this has policy implications" without drawing these out in a way that can be readily understood and used by policy-makers. Spell out the implications of your research for potential policy or management options and the likely consequences (including perverse outcomes) that could arise from particular decisions.

If proposing policy change, make clear: a) the policy objective that could be better achieved; b) a summary of the evidence for the shortcoming; c) the reasons for the shortcoming; and d) options for addressing the shortcoming, with a summary of supporting evidence.

5. Be patient

Policy change is a long game. Most research on the subject suggests it can take 10–20 years for major new insights to be taken up in policy in significant ways.

Turnover in policy-relevant positions can also be high, so be ready to engage new people, and don't assume that they are aware of the background discussions you've already had.

It is heartening to see the importance of research impact increasingly recognised in indicators of research quality. Effectively working with policy stakeholders takes time – time which may seem hard to prioritise within academic frameworks, which have typically rewarded a focus on academic publishing. However, it is time well spent if you want your science to make the biggest difference to the biodiversity challenges you are working to solve.

The past six years of the Threatened Species Recovery Hub have underscored the commitment and passion of a wide range of policy-makers and policy users across Australia for engaging with the research community. We are fortunate in the hub to have many policy partners and established processes for connecting with the right people. The legacy set in train will, we hope, last for many years more.

Further information

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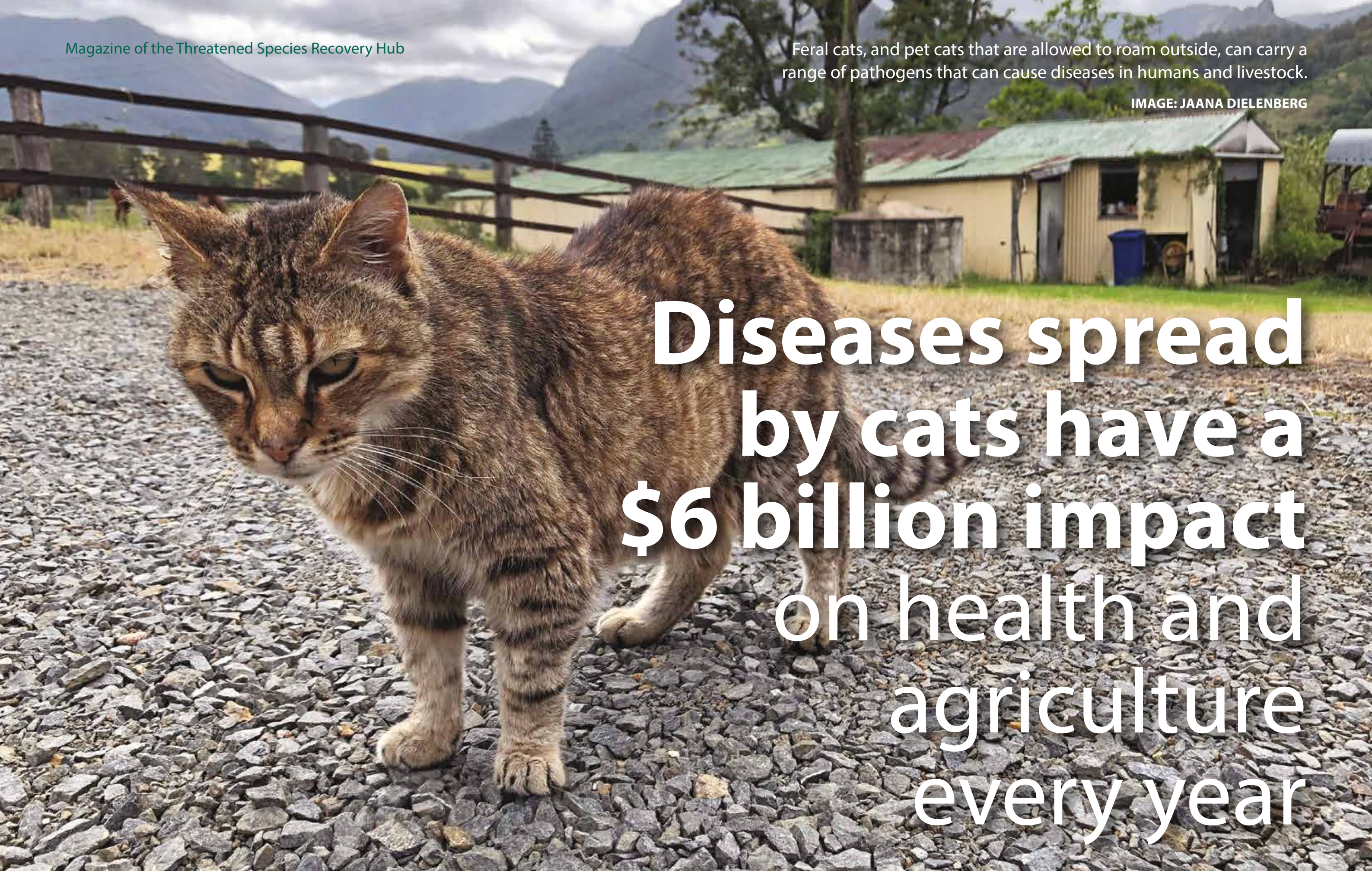

Feral cats, and pet cats that are allowed to roam outside, can carry a range of pathogens that can cause diseases in humans and livestock.

IMAGE: JAANA DIELENBERG

Diseases spread by cats have a $6 billion impact on health and agriculture every year

A new study led by **Professor Sarah Legge** at The Australian National University and **Dr Patrick Taggart** from The University of Adelaide has quantified the national impact of cat-borne diseases on human health and agriculture in Australia for the first time.

Toxoplasmosis, toxocariasis, sarcocystosis and cat scratch disease are caused by pathogens that depend on cats – pet or feral – for part of their life cycle. But these diseases can also be passed to humans and other animals, sometimes with severe health consequences.

Our study in *Wildlife Research* looked at the rates of these diseases in Australia, their human health and agricultural impacts, and the cost to the Australian economy.

Human health

Based on findings from a large number of Australian and international studies, Australian hospital data and information from the Australian Bureau of Statistics, we estimate that more than 8,500 Australians are hospitalised and about 550 die annually from causes linked to cat-dependent diseases, while thousands more suffer more minor injuries or illnesses.

We estimated the economic cost of these pathogens in Australia at more than $6 billion per year based on the costs of medical care for affected people, lost income from time off work, and other related expenses.

Toxoplasmosis is the cat-dependent disease with the greatest human health impact in Australia. The disease is caused by a single-celled parasite called *Toxoplasma gondii*. People contract the parasite by eating undercooked meat that is infected with the parasite, or by accidentally consuming a microscopic “oocyst”, which is like an egg, that is shed in the cat’s faeces. Oocysts are environmentally resistant and can be washed or blown around by water and wind, contaminating soil or water, and consequently consumed via drinking contaminated water, eating unwashed vegetables or not washing hands after gardening or playing in a sandpit.

We estimate that 125,000 people are infected with *Toxoplasma* in Australia each year. Many infected people appear asymptomatic or have symptoms that are easily misdiagnosed as a flu, but immunocompromised people such as cancer patients can get very sick and even die.

If a woman contracts the parasite while pregnant, it can cause miscarriage or lifelong congenital impacts for her unborn baby,

BELOW: If cats access sandpits it increases the chance of children being exposed to *T. gondii* and cat roundworm.

IMAGE: LBOI, FLICKR, CC BY NC ND 2.0

including hearing, vision and intellectual impairments.

Even if the initial infection causes little illness, the parasite stays with us for life, encased in a cyst, often in the brain. These "latent" infections may affect our mental health and behaviour, such as delaying our reaction times.

Studies have shown that people with a *T. gondii* infection are more likely to be involved in a car accident. A review of several studies found if there were no *T. gondii* infections, car accident rates would theoretically be 17% lower. In an Australian context, these fewer car accidents would result in about 200 fewer deaths and 6,500 fewer hospitalisations each year.

T. gondii infections are also associated with an increased risk of mental health disorders. For example, reviews across many studies suggest that without *T. gondii* infections, there could be 10% fewer suicides and 21% fewer schizophrenia cases.

Scratches and worms

Cat scratch disease is a bacterial infection (*Bartonella henselae*) that people can contract if bitten or scratched by an infected cat. Typical symptoms include sores, fevers, aches and swollen glands. But more serious symptoms, such as inflammation of heart tissue, cysts in the organs and loss of vision, can also occur. We estimate that at least 2,700 Australians get sick annually from cat scratch disease, and 270 are hospitalised.

Cat roundworm is a parasitic infection (*Toxocara cati*) that people and other animals can contract by accidentally consuming the parasite's egg, which infected cats shed in their faeces.

Most cat roundworm infections cause mild symptoms, but the migration of the larvae through the body can cause tissue damage, which can be serious if it occurs in a place like the eye or heart.

Agriculture

We found that *T. gondii* is the cat-dependent pathogen with the greatest impact on agriculture in Australia, and that the sheep industry is the worst impacted. Toxoplasmosis causes the loss of over 62,000 unborn lambs each year in Australia, costing the industry around $10 million annually.

Sarcocystosis, caused by the single-celled parasites *Sarcocystis giganteus* and *S. medusiformes*, causes cysts in sheep meat which then require trimming and can even result in whole carcasses or shipments being rejected. It costs the Australian meat industry around $2 million per year.

Studies in other countries with comparable lamb production industries, like New Zealand and the UK, have found production losses of similar magnitude.

Agricultural impacts are probably uneven across Australia, because infection risk varies with climate. The prevalence of *T. gondii* in feral cats is much higher in cooler, wetter areas, where oocysts can survive longer in the environment.

As a result, sheep-producing areas of South Australia and Tasmania may be worst-affected by cat-dependent pathogens. Sarcocystosis-positive farms are 15 times more common on Kangaroo Island than on the adjacent mainland and cysts are observed on up to two-thirds of slaughtered adult sheep from the island.

What can we do?

There are no human or animal vaccines for these diseases.

Currently, over 700,000 feral cats and 3.8 million pet cats roam our towns and suburbs, and another 2.1 million feral cats roam the bush and rural areas acting as reservoirs of these diseases. We can lower rates of all cat-dependent diseases by reducing the numbers of cats.

The community can help lower the urban feral cat population by preventing access to easy food sources on farms, at rubbish bins and tips – and by not feeding stray or feral cats, as this can lead to local aggregations of cats ("clowders"), where infection rates are higher.

Cat owners can help by keeping pet cats indoors or in a securely contained outdoor area, to reduce the chance their pet will contract or pass on a disease-causing pathogen.

IMAGE: BEENTREE/WIKIMEDIA COMMONS, CC BY SA 4.0

ABOVE: Cat roundworm.

Pet cats should also be desexed to prevent unwanted litters that end up as free-roaming ferals.

Cats should be kept out of vegetable gardens and children's sandpits. Washing hands after handling kitty litter and gardening, washing vegetables thoroughly and cooking meat well can also reduce the risk of transmission.

These steps would cost us little, but help safeguard our pet cats and could prevent unnecessary impacts on our health and wellbeing, our economy and to farmers.

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Work cited

Legge, S., Taggart, P.L., Dickman, C.R., Read, J.L., Woinarski, J.C.Z. 2020. Cat-dependent diseases cost Australia AU$6 billion per year through impacts on human health and livestock production. Wildlife Research *47(8), pp. 731–746. DOI: 10.1071/WR20089*

BELOW: The cat eradication program on Kangaroo Island will benefit sheep producers as well as native wildlife.

IMAGE: TANNER YOULD, UNSPLASH

In the south-west of Western Australia, fences are a part of human infrastructure enabling threatened western ringtail possums to co-exist with humans in urban areas.

IMAGE: L. KNIGHT

Biodiversity sensitive urban design: **The future of cities**

Experiencing nature, including in cities, is good for human health and wellbeing. Cities are also important to biodiversity conservation, and are home to many species of plant and animal, including threatened species. **Dr Georgia Garrard** of The University of Melbourne explains how a new framework for biodiversity sensitive urban design (BSUD) can support local governments, urban planners and architects to reduce development impacts on biodiversity and increase the benefits that nature in cities can deliver to residents.

The impacts of urbanisation can be devastating for biodiversity. Negative effects include habitat loss and fragmentation, the introduction of exotic species, alteration of local climates via the urban heat island and increased levels of chemical, light and noise pollution.

Careful urban design has the potential to reduce these impacts, and to increase the benefits that biodiversity and everyday nature experiences in cities can deliver to residents.

BELOW: Dr Georgia Garrard in a native grassland surrounded by new urban development in Melbourne.

IMAGE: GEORGIA GARRARD

To achieve this, planners and developers must reframe biodiversity as an opportunity rather than a constraint, consider biodiversity early in their decision-making and access sound ecological information to support it – yet to date little guidance has been available, and take-up of such practice has consequently been slow.

Action for urban design

This is where biodiversity sensitive urban design (BSUD) fits in. We distilled five principles of BSUD from the urban biodiversity literature and devised a flexible framework for their implementation.

This framework can be applied across a range of urban development types and densities, allowing for a transparent trade-off between biodiversity benefits and other environmental, social and economic goals. It can be used during the early stages of a new or retrofitted development of any size, from individual houses to large-scale urban developments.

The five principles hold across all habitat types and geographic regions. Further, the framework and its principles ensure better, more reliable development outcomes for nature and people by encouraging members of local communities to engage with the BSUD process.

The BSUD framework begins by evaluating native animals and plants on a site, key landscape features and any potential threats. Planners and communities then identify biodiversity objectives for the site, which inform BSUD actions or recommendations. Next is quantifying the potential impact of these actions and using the data to decide which designs best meet the biodiversity and development objectives (see Figure 1).

Five principles to guide actions

The BSUD framework has five essential principles.

1. **Maintain existing and create new resources for nature.** Develop areas of low ecological value to avoid habitat loss. Use native plant species, and encourage resident-led wildlife gardening to create habitat for native species. Look for opportunities to add novel habitats such as habitat walls and other green infrastructure.
2. **Support animal movement across the landscape.** Establish habitat connectivity corridors through public and private land, taking care not to spread invasive weeds or pests. Again, think outside the square

as novel approaches such as road underpasses might be needed.

3. **Reduce threats to and disturbance of nature.** Landscape with indigenous plants and establish pet containment programs to reduce the impact of weeds and exotic predators. Plant vegetated swales and rain gardens to mitigate runoff and nutrient loads. Reduce light and sound pollution through the use of sound barriers and temporary road closures and by dimming street lights.
4. **Protect natural cycles and ecological communities.** Reduce the disruptions of urbanisation by providing adequate resources for the native species you want to support, protect pollinator habitat, and plan for things like fire and flooding.
5. **Create opportunities for positive interactions between people and nature.** Facilitate public engagement and local stewardship of biodiversity by providing "cues to care" and creating opportunities for positive interactions with nature.

An alternative to offsetting

This work brings innovative ideas to sustainable urban development. It creates on-site biodiversity gains, finds synergies between development and biodiversity objectives and offers a way to measure the success of nature-based designs. It has particular value to professionals involved with urban planning, and development, including urban planners, architects, local government, developers and urban conservation practitioners.

BSUD involves a fundamental shift in thinking from current practice, where biodiversity losses are "offset" elsewhere. Biodiversity offsetting delivers questionable ecological outcomes because retained patches face continuing threats from the surrounding environment, and in practice the offset is unlikely to adequately compensate for the loss incurred over the long term. Furthermore, offsetting ignores place-based values of nature, and results in an unmitigated loss of nature in the places where urban residents live, work and play.

Next steps

BSUD principles have recently informed voluntary performance tools such the Green Building Council of Australia's Green Star Communities as well as urban development plans in established and growth areas. A critical next step will be to build an evidence base for the ecological and co-benefits of BSUD through cross-sectoral partnerships to implement and evaluate BSUD in a range of applied settings.

Cities are increasingly recognised for their importance to biodiversity conservation. BSUD provides an innovative framework for our times and has the potential to shape a new conception of urban landscapes where native plants and animals can thrive and residents can reap the benefits that living with biodiversity offers.

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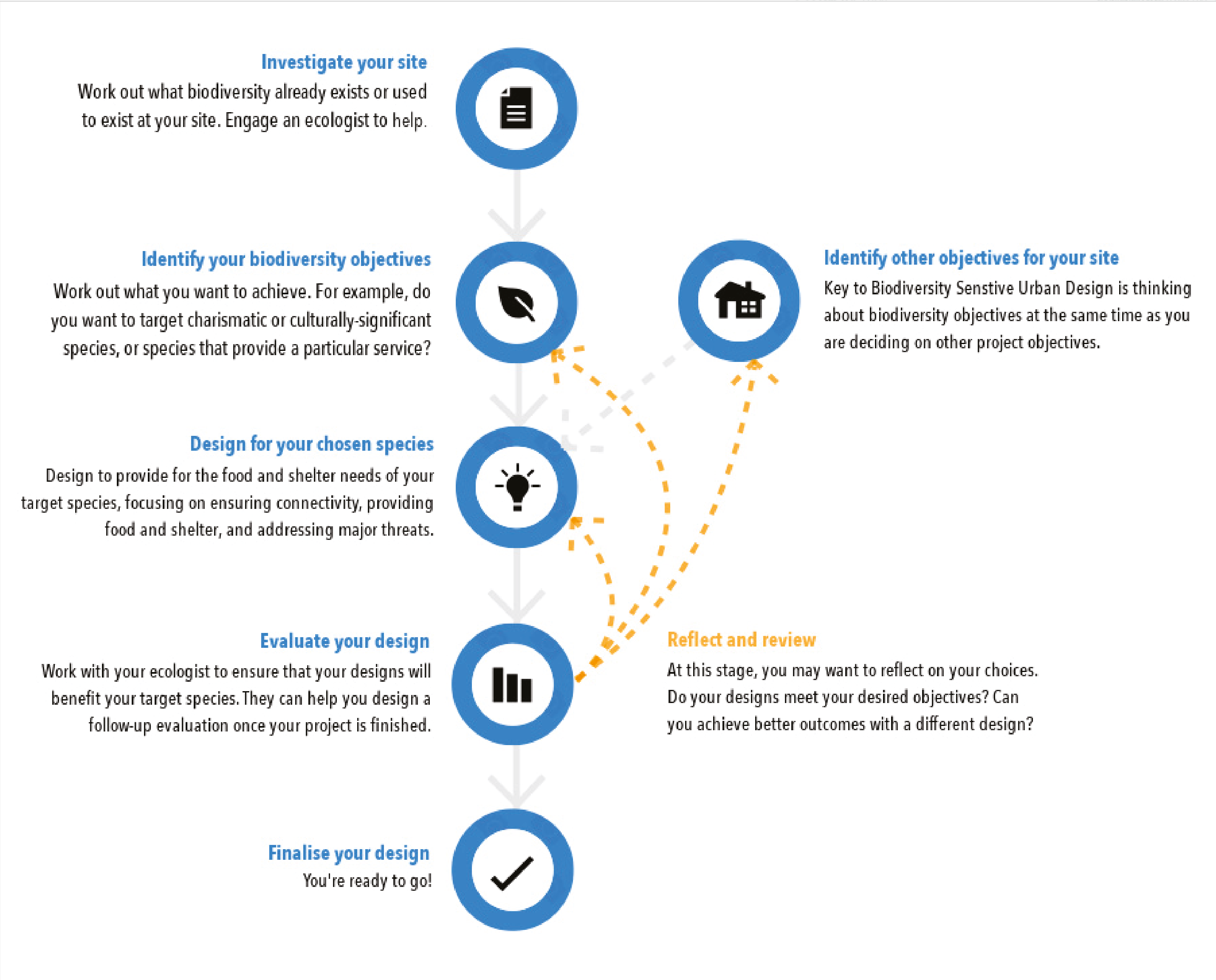
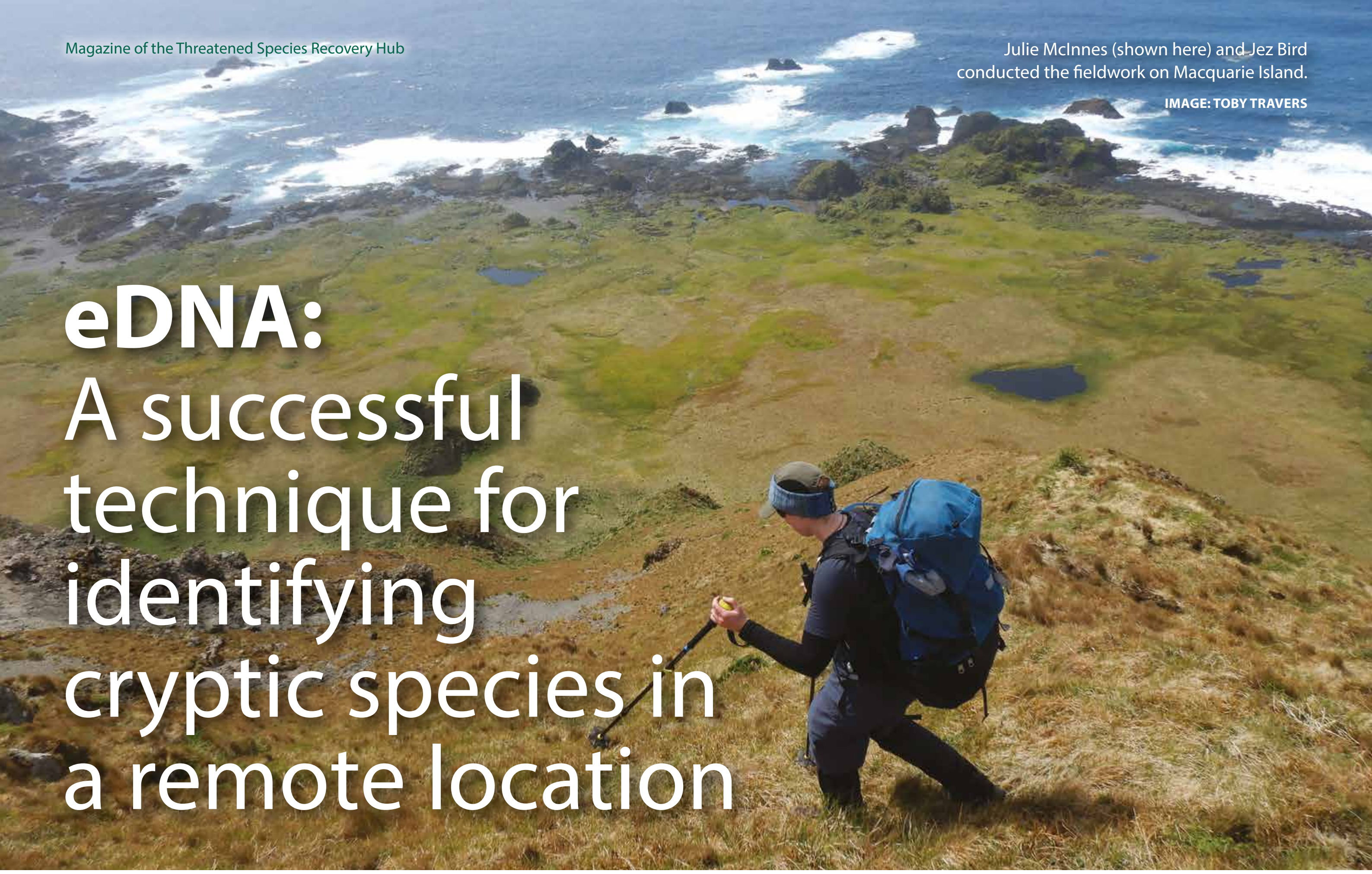


Figure 1. The BSUD framework. Adapted from Garrard et al. (2018), Biodiversity Sensitive Urban Design. *Conservation Letters*, 11: e12411. doi:10.1111/conl.12411



Julie McInnes (shown here) and Jez Bird conducted the fieldwork on Macquarie Island.

IMAGE: TOBY TRAVERS

eDNA: A successful technique for identifying cryptic species in a remote location

Sub-Antarctic Macquarie Island is an important breeding site for many seabirds. Pest animals introduced by sealers in the 1800s drove some species of burrowing petrels to extinction on the island, and reduced the number of other petrel species. Now that cats, rabbits, rats and mice have all been successfully eradicated, Macquarie Island's conservation managers wanted to know how species respond to the removal of these animals, and if any of the lost species had returned. It was a hard question to answer as burrowing petrels spend most of their time at sea, burrowing underground in two-metre long nesting tunnels, and leaving their burrows only at night. In addition, several species look very similar. **Dr Justine Shaw** and PhD candidate **Jeremy Bird** from The University of Queensland talk about how they tested new eDNA methods to see if they could shed light on some aspects of the island's burrowing petrels. They collaborated with molecular ecologist **Dr Julie McInnes** from The University of Tasmania to undertake this work.

Macquarie Island, located midway between Tasmania and Antarctica, is a remarkable place. The 34 km–long treeless island is covered in grasslands, herbfields and tundra-like vegetation. It supports vast congregations of wildlife, including breeding colonies of seal, penguin and seabird species, including numerous species of burrowing petrels.

Cats, rabbits, rats and mice established on the island after they were introduced by sealers and whalers during the 19th century. They caused extensive damage to island habitats and wildlife, including the local extinction of some seabird species. Rats and cats ate birds and their eggs; rabbits destroyed nesting habitat.

To overcome this, the Tasmanian Parks and Wildlife Service began feral animal eradication programs on Macquarie Island in the 1970s and the island was declared free of invasive mammals in 2014. Now that the threats to burrowing petrels have been removed on the island, conservation managers wanted to know whether populations were increasing, and whether some species are now returning to the main island. They were also curious about whether species never seen or not seen for many decades were returning to the island.

Previously, Tasmanian DPIPWE Parks and Wildlife rangers and government scientists surveyed these birds with methods like hand searches, spotlighting and burrow-scopes – but the birds remain hard to detect throughout the landscape.

We wanted to test the application of eDNA to identify these cryptic species in the landscape. Scats and feathers are easy to find and quick to collect.

Feathers and scats the key

Our methods involved collecting 222 scat and 108 feather samples from breeding sites of either known species or mixed/unknown species on Macquarie Island, then analysing

BELOW: Petrel scats and feathers outside a burrow on Macquarie Island.

IMAGE: JULIE MCINNES

the samples later in the lab by extracting and sequencing the DNA. This gave us valuable insights into what species occur where.

Our eDNA sampling at the established and known colonies confirmed that the species thought to occur there were indeed present, verifying previous survey methods.

Further, our research detected some burrowing petrels at new locations. Diving petrels and fairy prions have rarely been detected on Macquarie Island, with the latter previously recorded only on offshore rock stacks and Bishop and Clerk Islets since monitoring began. Yet, we found diving petrel DNA in samples from five locations around the island and fairy prion (or fulmar prion) DNA from three locations.

Two rock stacks were hotspots of burrowing petrels, with at least four species identified on each. One of these rock stacks likely provided a refuge to burrowing petrel species while rats, cats, mice and rabbits existed on Macquarie Island, as it is not connected to the main island. However, the presence of four petrel species on the second, connected, rock stack, which was accessible to the invasive pest animals, is encouraging and provides the first evidence in recent years of fairy prions on the main island.

All up, we detected DNA that matched reference sequences for seven of the burrowing petrel species previously recorded breeding on Macquarie Island or offshore islands, with an additional two sequences that could only be identified to genus level. Table 1 shows the species we were able to identify from the scat and feather DNA.

Table 1. Burrowing petrel species detected on Macquarie Island from scat and feather DNA

Common species	Less common species
Antarctic prion, *Pachyptila desolata*	Diving petrel, *Pelecanoides* sp.
Blue petrel, *Halobaena caerulea*	Fairy prion, *Pachyptila turtur*
Sooty shearwater, *Ardenna griseus*	Soft-plumaged petrel, *Pterodroma mollis*
White-headed petrel, *Pterodroma lessonii*	Fulmar prion, *Pachyptila crassirostris* – DNA sequences indicative, but inconclusive
	Grey petrel, *Procellaria cinerea* (winter breeder)

Next challenges

The project tested and confirmed both the efficacy of on-ground survey techniques for threatened burrowing seabirds on the island, and the efficacy of eDNA methods using scats and feathers to identify species in the landscape.

Future work could provide insight into the provenance of recolonising populations and population genetics, such as we identified for white-headed petrels during this study.

The methods we developed are relevant and useful for surveys of cryptic species on other islands in Australia, and globally, that are remote, such as Heard Island, and where field trips are consequently infrequent and/or where resources, logistics and access are limited.

Our findings can also be used to help inform surveying of cryptic species and future eradication projects on other islands, where managers, funders and researchers are required to anticipate ecosystem responses to eradications of pest animals.


IMAGE: JULIE MCINNES

ABOVE: Burrowing petrel scat.


IMAGE: JEZ BIRD

ABOVE: White-headed petrel in burrow.

Collaborating with molecular ecologist Dr Julie McInnes from the beginning of the project, in the initial design phase, was critical to the success of our project.

This work was supported by the Australian Antarctic Science Program.

Further information

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Petrel in flight.

IMAGE: JEZ BIRD

The Coochin Hills grevillea (*Grevillea hodgei*) is restricted to two mountains in the Sunshine Coast hinterland, and has declined substantially at one of these since the early 1990s due to infrastructure development and lack of recruitment.

IMAGE: COURTESY BLACK DIAMOND IMAGES

Threatened plant trends in the spotlight

The Threatened Species Index now includes monitoring data for threatened plants. **Dr Ayesha Tulloch** of The University of Sydney and **Dr Micha Jackson** of The University of Queensland discuss what the index has revealed about Australia's threatened plants.

Why we need an Index

Australia has more than 1,800 threatened species, and there are hundreds of threatened species monitoring programs across the country being undertaken by many different government and non-government groups, community groups, Indigenous organisations, citizen scientists, researchers and individuals.

The Threatened Species Index (TSX) endeavours to bring all of this information together to tell us about the big picture of how threatened species are doing in Australia, if our policies and investments are working, and which groups or regions are doing better or worse, or most need help.

Spotlight on plants

The newly released threatened plant sub-index combines monitoring data for 112 threatened and near-threatened plant species from almost 600 sites nationally.

It indicates that in just over two decades (1995–2017) the population sizes of Australian threatened plants in the index have decreased by almost three-quarters (72%) on average.

This is a much larger decline than for mammals, which have declined by about half, and birds, which have declined by about one-third, over the same time period.

BELOW: The Ginninderra peppercress (*Lepidium ginninderrense*) is one of the plants from the Australian Capital Territory in the index.

IMAGE: B CLARKE, AUSTRALIAN NATIONAL BOTANIC GARDENS 2013

Australia has more than twice as many threatened plants (1,379) as threatened animals (518), but a lot more effort has gone into monitoring or managing animals.

We took a look at different plant types and found that trees, shrubs, herbs and orchids had all suffered similar average declines over that period (65–75%). Of these, orchids had the greatest decline.

A quarter of the species in the Threatened Plant Index are orchids. Orchids make up 17% of plant species listed nationally as threatened, despite comprising just 6% of Australia's total plant species.

Challenges for plants

Common threats facing many plant species include land clearing, changed fire regimes, grazing pressure, weeds and climate change. But orchids also face some unique challenges; many depend on specific insect pollinators to reproduce and mycorrhizal fungi to grow.

The Endangered coloured spider-orchid (*Caladenia colorata*) is pollinated only by a single species of thynnine wasp, and relies on a mutualistic relationship with a single species of mycorrhizal fungi to prosper in the wild.

As species decline, new issues can also emerge. Many species have now been reduced to small populations that are cut off from each other, which can result in inbreeding, as has happened with some button wrinklewort populations in the Glenelg Region of Western Victoria.

Success is possible

Yet even for seemingly difficult species, conservation success is possible. For the coloured spider-orchid, scientists from the Royal Botanic Gardens Victoria, aided by volunteers, identified sites where the wasp was still naturally present. More than 800 spider-orchid plants were then propagated in a lab using the correct symbiotic fungus, then planted at four sites. These populations are now considered to be self-sustaining.

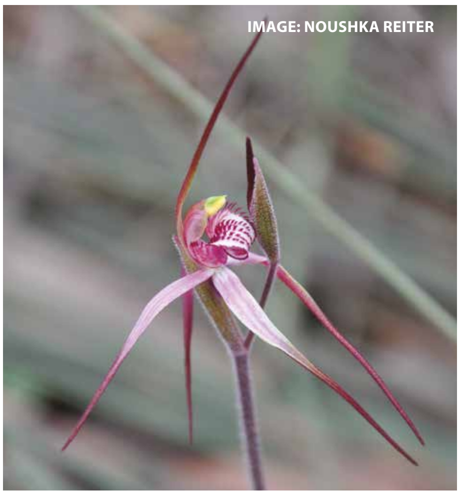
After careful genetic analysis of button wrinklewort populations, conservation managers from the Glenelg Hopkins Catchment Management Authority are now bringing in plants grown from seeds collected at other healthy populations to boost not only population sizes but also genetic diversity.

At a newly discovered site with only a single plant, seed collection from that plant and other sites will allow a genetically diverse population to be created.

The Wollemi pine (*Wollemia nobilis*) is one of the plants from New South Wales in the index.

Are we doing enough?

That the overall trend for threatened plants is a perilous decline is in large part because many species are not being actively managed – but what about if we just look at sites where management is happening?

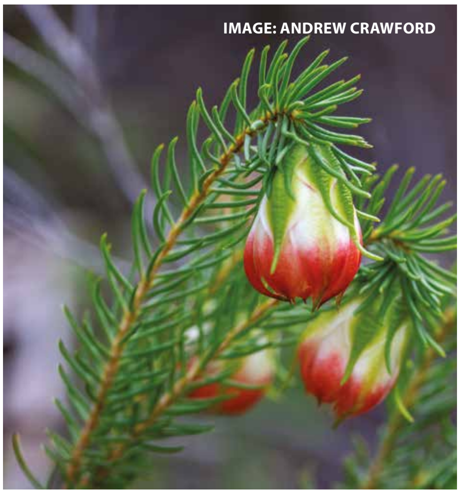


The coloured spider orchid (*Caladenia colorata*) is one of the plants from South Australia in the index.

Grampians pincushion lily (*Borya mirabilis*) is known from a single population on a rock ledge, and has declined since 2003 due to very restricted distribution, small population size and extremely low genetic diversity.

We found plant populations at managed sites suffered declines of 60% on average, compared to 80% declines at unmanaged sites.

This demonstrates that while conservation actions have reduced the rate of decline at managed sites, they have not yet been sufficient to halt or reverse declines overall; not all plants are receiving the level of care of the coloured spider-orchid.



The Wittwers darwinia (*Darwinia wittwerorum*) is one of the plants from Western Australia in the index.

Monitoring for the future

New data on threatened species is added to the index each year. Currently most of the plant data has been contributed by state government monitoring programs in just four states: South Australia, Victoria, New South Wales and Western Australia. We'd like to see more regions and species better represented in future years so that the index can reveal the true national picture.

Many species are missing from the index because they simply aren't being monitored. The index received monitoring data for only 10% of Australia's threatened plants, compared to 35% of threatened birds. While government monitoring programs are essential, citizen science–collected data is also very valuable. Ten times more monitoring data is available on threatened birds than plants, in large part due to the efforts of bird-watching citizen scientists.

We'd love to see more community groups monitor a threatened plant in their patch and contribute their data.

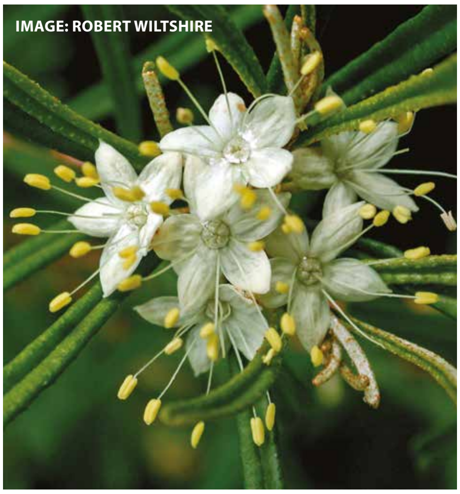
If you're keen to get involved in plant monitoring, it involves a few simple steps:

- find a local patch with a threatened plant species
- revisit it once or twice a year to count the number of individuals in a consistent, well-defined area
- use the same method and the same amount of effort each visit
- take great care to not disturb the plant or its habitat when looking for it
- contribute your data to the index.

Saving our plants

Eighty-four percent of Australian plants are found nowhere else. They are part of what makes us and our landscapes unique. They are important in their own right, but also act as habitat for other species and provide important ecosystem services.

The index's massive data-crunching exercise shows that a lot more effort is needed if we as a society want to prevent extinctions and the loss of nature around us.



Phebalium daviesii is known from a single population on private property in eastern Tasmania, and remains management-dependent.

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Researcher profile

Rachel Morgain

Connecting people, knowledge and nature

I describe myself as an environmental social scientist and knowledge broker, but my story is more complex. I've had the kind of varied career that allows me to bridge different ways of thinking about and using knowledge. I have a background in government and private industry, many years in the research sector, and a lot of experience working with community organisations. This helps me understand the needs and processes of different sectors, and gives me insights into diverse community perspectives on environmental challenges.

IMAGE: TABITHA BOYER

Rachel at the Australian National University by a Wollemi pine.

I've always loved nature, but before looking around me at plants, animals and special places, I looked upwards – to the stars.

I started out studying physics and astronomy at The University of Melbourne, while working for a geological company in stakeholder relationships, data management and programming. My honours research took on Einstein's general relativity, testing the effects of extremely massive objects on the light from pulsars. My fieldwork back then was not in forests and woodlands, but at telescopes – the big radio dish at Parkes, and a summer up in the Warrumbungles at the Anglo-Australian Observatory. Afterwards, I went bush further afield, working for a year in mining in Western Australia and the Northern Territory.

But my desire to make a difference brought me to Canberra. My technical skills were sought by the Department of Defence, but my interest in policy, and politics, shaped my career. I worked in defence reporting and analysis, then moved across to social policy. Here I focused on community cohesion and support for vulnerable families. I worked with Indigenous service providers and community organisations, built relationships across government and supported Ministers with research synthesis and policy advice. I became a senior policy officer and research manager, partnering with research institutions and community organisations and drawing on social science to better inform policy decisions.

Making connections

My own interdisciplinary research linked questions of community-building and environment. My PhD in anthropology took me to the forests, mountains and woodlands of the west coast of the United States, where I worked with environmental and social justice–focused groups to understand how they draw on ecological understandings to build relationships with each other and with the natural world.

I did postdoctoral work in Pacific studies on similar themes, looking at diverse cultural communities in Fiji to learn how they forge connections with each other and with land and sea. I drew on Indigenous studies and science communication, which offer different perspectives on knowledge and how it shapes our world.

After working briefly in science policy at the Australian Academy of Science, I became knowledge broker for the Threatened Species Recovery Hub.

It's probably clear that I'm not happy in just one place. With knowledge brokering, I can move, create and integrate across diverse sources of knowledge, multiple perspectives, and diverse sectors of policy, business and community. I can build on my experience creating partnerships and connecting research with decision-making and practice, while helping improve how systems, institutions and people care for and connect with the natural world.

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Science for saving species

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(SEE PAGE 18 FOR THE FULL STORY.) IMAGE: ANDREW CRAWFORD