

DECISION POINT

Connecting conservation policy
makers, researchers and practitioners

Issue #78 / April 2014



Bison - a victim of its own nature?

Incorporating threat
information into
extinction risk



**Which species do we
monitor to measure the
success of our management**



**Summer scholars and
threatened species**



**Riparian restoration acts
against climate change**

Decision Point

Decision Point is the monthly magazine of the Environmental Decisions Group (EDG). It presents news and views on environmental decision making, biodiversity, conservation planning and monitoring. See the back cover for more info on the EDG. *Decision Point* is available free from <http://www.decision-point.com.au/>

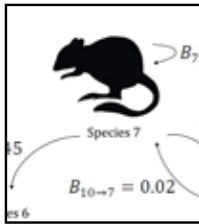
Plus

Evaluating threats to koalas in NSW
Strategic planning and cumulative impacts
Assessing a species mapping tool
Early warning index for vulnerable species

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Like many species, the bison's risk of extinction has been shaped by its intrinsic traits as well as extrinsic threats. Traditionally, extinction risk has been mainly based on intrinsic traits but EDG research is suggesting we need to also factor in extrinsic threats for this type of analysis to be useful to conservation managers. See page 8 for a run down on this research.

On the point

We're here to help!

Hi. Welcome to the Environmental Decisions Group. We're a network of conservation researchers. We aim to generate world-class research. We publish in high impact journals and, as with all researchers, we hope our work gets well cited. However, at the end of the day, the important outcome is that our work makes a difference in saving species and ecosystems.

Indeed, we put this expectation into our mission statement: "Our research will result in new tools, data, models and authoritative syntheses that enable Australian governments to make evidence-based decisions that protect biodiversity." Sounds a bit dry and lofty when phrased like this (like most mission statements) but it's far from empty rhetoric. Consider this issue of Decision Point. We're serving up several examples of top notch research but in each case it's crystal clear the aim is enabling more effective conservation management (in very real, tin tacks, do-it-now ways).

Jonathan Rhodes explains how we evaluate threats to koalas across New South Wales (see page 4) and gives us another example of how citizen science is making a difference to biodiversity conservation.

Chrystal Mantyka-Pringle applies a Bayesian Belief Network analysis to explore threats to our precious freshwater habitats (see page 6) and finds riparian restoration has a lot going for it. It even has the capacity to mitigate some of the impacts of climate change.

Martina Di Fonzo discusses how by incorporating information about threats into extinction risk analysis can make this form of analysis more relevant to the needs of managers (see page 8).

Ayesha Tulloch sets out a better way of selecting indicator species in order that we can better monitor our conservation actions (see page 10) and Brendan Wintle explains the logic behind strategic assessments and summarises the many ways our researchers have contributed to this approach (see page 12).

To cap it off, this issue also carries two reports from this year's Summer Scholars: Lottie Boardman and William Chan (see page 13). This is the third year in which EDG has placed final year uni students in the Department of the Environment in the hope of helping our environmental policy makers with discrete challenges while building new bridges between academia and government.

All of which, in some small way, backs up our claim – we are here to help. 🍌

David Salt / Editor, Decision Point / David.Salt@anu.edu.au

DECISION POINT

Decision Point is the monthly magazine of the Environmental Decision Group (EDG). The EDG is a network of conservation researchers working on the science of effective decision making to better conserve biodiversity. Our members are largely based at The University of Queensland, The Australian National University, The University of Melbourne, The University of Western Australia, RMIT and CSIRO.

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Short accounts of papers from EDG researchers. If you would like copies of any of these papers see: <http://decision-point.com.au/research-briefs.html>

On ski resorts and reptiles

As ski resorts bring in more tourists there is demand for more skiing infrastructure. As these resorts are located in sensitive alpine/subalpine environments this expansion can lead to habitat being modified and fragmented. Unfortunately, there's not much research in Australia on the effects of ski resorts on wildlife, particularly reptiles. Nor is much known about the effectiveness of management strategies in mitigating adverse impacts. To quantify the effects of ski-related disturbances on specialist and generalist reptile species, Chloe Sato and colleagues surveyed sites in disturbed and undisturbed subalpine habitats. They also examined vegetation composition and habitat structure to determine whether structural or compositional habitat features were driving patterns of reptile occurrence.

Their results indicate that the effects of ski-related disturbance varied between species, but that adverse effects – particularly on ski runs – were more pronounced for specialists. Given that each species studied was positively associated with compositional or structural features of the environment, they argue that alterations to these habitat attributes when creating ski runs will suppress lizard abundances in these areas. However, while ski runs have an adverse effect on reptiles, the persistence of these animals in ski resorts can be facilitated by retaining habitat structure and minimizing disturbance to native vegetation. 🍷

Reference

Sato, CF, JT Wood, M Schroder, K Green, DR Michael & DB Lindenmayer (2013). The impacts of ski resorts on reptiles: a natural experiment. *Animal Conservation*.
<http://onlinelibrary.wiley.com/doi/10.1111/acv.12095/full>

An early warning index for vulnerable species

Understanding the impacts of climate warming and land use change represent a major challenge for conservation managers. To date it has largely been based on projections of the future distribution of species. The aim of this study, led by CEED Postdoc Fellow Ramona Maggini, was to move beyond the simple projections of likely impacts of global change to identify the most vulnerable species. Towards this end the researchers proposed a new vulnerability index that integrates estimations of projected range change and different proxies of species resilience in a quantitative way. The proposed index is generally applicable, completely quantitative, and it allows ranking species so as to prioritize conservation actions.

To illustrate the applicability of the vulnerability index they used breeding birds in Switzerland as an example of a conservation target. The vulnerability index relies on five indicators quantifying different aspects of the projected change in distributional area, the reservoirs available for the species and their recent population trend. Species distribution was modelled using three different techniques (GAM, MARS and BRT) and then projected for 2050 and 2100 according to two different IPCC scenarios of climate change coupled with two regional land use scenarios to represent different magnitudes of the stressors and the range of possible outcomes.

According to the different contributions of the base indicators, different patterns of vulnerability can be distinguished. In

Paying farmers for biodiversity conservation

Trying to get farmers to protect biodiversity is a difficult task, particularly as it often imposes a cost on them. Australia has been at the forefront of the use of payments to encourage land retirement, in both the short- and long-term, or other activities associated with improving biodiversity conservation. Tapping into this experience, Graeme Doole and colleagues sought to identify the factors that are important within these programs. Their analysis identifies the relative importance of a range of factors that determine the overall cost-effectiveness of these programmes to guide future management, based on the perceptions of survey respondents with experience in their design and implementation.

Conservation tender programs, in which farmers compete for conservation funding, are shown to require (in order of decreasing importance): (a) provision of adequate funding, (b) development of flexible tender designs to aid organisational efficiency, (c) promotion of landholder competition, (d) identification of low-cost means of monitoring, and (e) establishment of strong relationships with landholders.

In contrast, biodiversity offset markets, in which activities that augment or reduce biodiversity are traded, are shown to require (in decreasing order of importance) the: (a) establishment of efficient organisational processes, (b) promotion of a short time lag between development and the restoration of ecological values, (c) employment of contracts of extended duration, (d) investment in landholder education and support, and (e) development of appropriate biophysical models.

While Australia is a world leader in the use of economic instruments to protect biodiversity, a number of key improvements are required if these programs are to be broadly effective. 🍷

Reference

Doole GJ, L Blackmore & S Schilizzi (2014) Determinants of cost-effectiveness in tender and offset programmes for Australian biodiversity conservation. *Land Use Policy* 36: 23-32.
<http://dx.doi.org/10.1016/j.landusepol.2013.05.023>

Switzerland, breeding birds inhabiting coniferous woodlands, alpine habitats and wetlands have significantly higher vulnerability to climate and land use change than species in other habitats.

The proposed vulnerability index represents an early warning system as it identifies species that are currently not threatened, but are very likely to become so. As such, it complements the assessment of risk of species' extinction based on the Red List and on their international importance. 🍷

Reference

Maggini R, A Lehmann, N Zbinden, NE Zimmermann, J Bolliger, B Schröder, R Foppen, H Schmid, M Beniston & L Jenni (2014). Assessing species vulnerability to climate and land use change: the case of the Swiss breeding birds. *Diversity and Distributions*. doi: 10.1111/ddi.12207

“The proposed vulnerability index represents an early warning system as it identifies species that are currently not threatened, but are very likely to become so.”

Charting the road to koala recovery

Evaluating threats and identifying recovery priorities for a species in decline

By Jonathan Rhodes (NERP ED, University of Queensland)

In April 2012 the koala was listed as vulnerable in Queensland, New South Wales and the Australian Capital Territory under national environmental law (the EPBC Act). The koala is currently widely distributed across eastern Australia, but the listing acknowledges that the species is declining rapidly across much of its range and protection is critical. Having invoked Commonwealth protection, a major challenge now is to develop strategies for recovering declining populations so as to ensure the koala's persistence into the future.

The koala's wide distribution is a double-edged sword. On one hand, having populations spread widely helps to reduce the chance that the species goes extinct because it means we don't have all our eggs in one basket.

On the other hand, it also means that, because it is spread across many different land-uses, climatic zones and vegetation types, it is exposed to different threats in different places. This makes it incredibly difficult to plan for koala recovery because we don't have a 'one-size-fits-all' recovery strategy that we can apply everywhere. Rather, successful koala recovery is likely to require very different recovery strategies in different places. Identifying what these strategies might look like and where to apply them across the koala's range will be a fundamental component of developing a national recovery strategy for the koala.

An objective way to identify what the best mix of recovery actions might be and where and when to implement them is to frame this question as a decision problem, which is exactly what researchers from the NERP Environmental Decisions Hub have been doing for New South Wales.

The first steps that we have been undertaking to be able to identify sensible recovery strategies is to map koala distributions and threats and to develop tools that allow us to predict outcomes for koalas under alternative recovery actions.

Mapping distributions and threats

The key threatening processes for koalas in New South Wales include loss of habitat, changing climate and climate extremes, roads, urban development and disease. However, we lack basic spatial information about the distribution of these threats in relation to the distribution of koalas.



Go west young koala! Actually, on reading Santika et al 2014, maybe don't go west. Indeed, go any way except west if you want to reduce your risk of extinction. (Photo by Liana Joseph)

We addressed this by using data obtained from the general public on their sightings of koalas over time (something often referred to as citizen science, see the box 'Citizen science survey data'). This public-based data provided information on the past and present distribution of koalas across New South Wales since 1987 and this allowed us to spatially map the effect of each threatening process (apart from disease) on koalas (Santika et al, 2014). Importantly, we

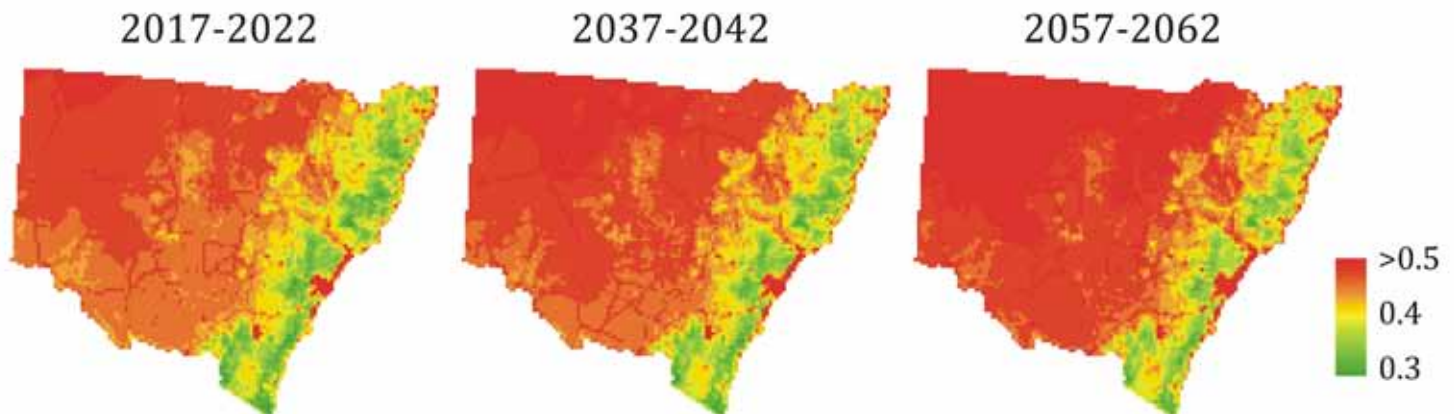


Figure 1: Predicted extinction risk for koalas for the years 2017-2022, 2037-2042, and 2057-2062.

were able to quantify the effect of these multiple threats on the persistence of koalas and their distributions and identify where different threats were highest and lowest across New South Wales. A similar finer-scale analysis was also conducted in Eden in the south east of the state (Lunney et al., 2014).

The most striking pattern that this work revealed was that koala extinction risk was estimated to be substantially higher in the west of the state than in the east (see figure 1). This was primarily associated with differences in the levels of eucalyptus forest cover, but maximum summer temperature was also an important determinant of extinction risk.

The effect of urban development on extinction risk was also found to be important, but was ameliorated by forest cover. Consequently, the major threats to koalas in New South Wales appear to be loss of forest cover and changes in maximum summer temperatures together, but these effects vary across the state. However, the presence of roads were also shown to negatively impact on koalas.

In Eden, the koala population has exhibited a significant contraction over the past 35 years. Our finer scale analysis in Eden revealed climate, fire and human population growth as key factors driving the observed decline in this region. This is consistent with the state-

Citizen-science survey data

One of the most ground-breaking aspect of these studies are that they used data collected through citizen science projects. This enabled us to build predictive models across an area as large as the whole state of New South Wales that would not otherwise have been possible with the limited data typically collected using field-based data collection.

The data for koalas (whether they were present or absent in different areas) came from state-wide surveys of the public asking them whether koalas were present near where they lived. They were undertaken in NSW as part of a national effort in 1987, 2006 and 2009–2011. In a novel step, the public were also asked whether they had also seen other common species, allowing an assessment of whether they were actively searching for wildlife and therefore enabling an estimation of detection error. This work, once again, underscores how important citizen-collected data can be to our efforts to save our precious biodiversity.

See [Decision Point #64](#) for a story on how the 'citizen scientist' stacks up against the 'professional scientist' when it comes to bird watching.



The next step

- The next step is to identify where and when to implement a range of recovery actions across NSW over the next 50 years, for different levels of resources available. This research is currently being done. We are considering four possible actions: dog control, fencing highways, habitat protection and habitat restoration and estimated the costs and benefits of implementing each action.
- In terms of benefits, we are using estimates of how much we could potentially reduce extinction risk by when alternative recovery actions are implemented. We also estimated their costs, showing that habitat protection and restoration are generally more costly than dog control and fencing highways. This is because using private land for habitat protection or restoration carries a relatively high opportunity cost since you lose production values on this land. Using these costs and benefits we are mapping where and when we should implement each action in a way that would achieve the highest possible reduction in extinction risk given alternative levels of resources available.
- We hope to bring you these results in the coming year.

wide analysis, but with some idiosyncratic threats around factors such as fire being important in this region.

Predicting outcomes for koalas

An important application of our model's treatment of distributions and threats across NSW is in predicting the likely trajectory of koala distributions based on alternative future scenarios, including alternative recovery strategies. Based on a continuation of recent land-cover change patterns into the future and an A1FI future emission climate scenario our model suggests a continued contraction of the distribution of koalas in NSW. This suggest that carefully planned strategies to recover koala populations in NSW will be required if this decline is to be reversed. 📌

More info: Jonathan Rhodes j.rhodes@uq.edu.au

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- Santika T, CA McAlpine, D Lunney, KA Wilson & JR Rhodes (2014). Modelling species distributional shifts across broad spatial extents by linking dynamic occupancy models with public-based surveys. *Diversity and Distributions*. DOI: 10.1111/ddi.12189

“The major threats to koalas in NSW appear to be loss of forest cover and changes in maximum summer temperatures together, but these effects vary across the state.”



Turning up the heat on freshwater interactions

Riparian restoration mitigates the impacts of climate change

By Chrystal Mantyka-Pringle, Tara Martin & Jonathan Rhodes
(University of Queensland)

Freshwater habitats are critically important for a broad range of animals and plants (see the box, 'the importance of freshwater habitat') and they are in trouble. Worldwide these habitats are experiencing declines in biodiversity far greater than those being experienced in other terrestrial and marine ecosystems. New research involving EDG modelling is hoping to help managers identify how this decline might be best dealt with.

The problems confronting freshwater habitats are many. The combined and interacting influences of multiple stressors in

freshwater ecosystems have resulted in population declines and range reductions of freshwater species all around the world. Yet, our understanding of the combined effects of climate change and land-use change on freshwater biodiversity is limited. For example, large uncertainties remain regarding which processes (eg, biophysical processes such as water temperature or nitrogen enrichment) will have the greatest impact on biodiversity in freshwater ecosystems and whether the sum of the individual stressor effects are greater than any stressor alone (ie, a synergistic interaction).

Freshwater habitat and SEQ

- Freshwater habitats occupy less than 1% of the Earth's surface, yet they contribute disproportionately to global biodiversity. They support approximately 10% of all known species, and one third of all vertebrates. Unfortunately, they are also under the hammer with many freshwater habitats being degraded by a range of processes including exotic invasions, eutrophication, over extraction (of water) and flow regulation.

- River catchments in South-east Queensland (SEQ) hold a special value when it comes to freshwater biodiversity in Australia. They contain the highest level of richness and/or endemism of freshwater lungfish, gobies, catfish, rainbowfish, eels, bass, snails, damselflies, limpets, dragonflies, water striders, water beetles and backswimmers in Australia. The loss of 75% of the native vegetation in SEQ has caused significant changes in catchment hydrology and sediment delivery, resulting in declining water quality and loss of aquatic biodiversity.

- SEQ is also Australia's fastest growing metropolitan region. From 2006 to 2031 its population is expected to grow from 2.8 to 4.4 million people requiring an additional 754,000 additional dwellings. Predicted population increases in the region are likely

to further impact on the ecological health of its waterways. Projected changes in climate will therefore act on freshwater ecosystems that are already under considerable stress and have reduced adaptive capacity. For these reasons, SEQ provides an excellent case study for understanding the consequences of global change on freshwater biodiversity and how we might conserve it.



The crimson-spotted rainbow fish (Melanotaenia duboulayi), a native of Queensland waterways. Will it suffer more from climate change or existing stressors? Or is it a combination of these impacts that we need to be most worried by? And what is the most appropriate form of management?

“High nutrients and high runoff resulting from urbanization interacted with high nutrients and high water temperature as a result of climate change. This was the leading driver of potential declines in macroinvertebrates and fish at finer scales.”

Working with UQ, CSIRO, Griffith University and the Queensland Government, EDG researchers modelled the independent and combined effects of climate change and land-use change on freshwater macroinvertebrates and fish using South East Queensland and the Ecosystem Health Monitoring Program (<http://www.healthywaterways.org/ehmphome.aspx>) as a case study (Mantyka-Pringle et al. 2014). The first step was building a conceptual model to identify the major causal links between land-use (ie, the amount of hard impervious surfaces and the amount of riparian vegetation) and climate (ie, air temperature, precipitation and rainfall variability) on freshwater biodiversity (see figure 1). The scientific literature identifies nitrogen, phosphorus, runoff and water temperature as among the most important drivers of biodiversity loss in freshwater habitat. These were included as variables in the conceptual model. Elevation was also included because it is an important natural determinant for predicting macroinvertebrate and fish distributions.

The team then used this conceptual model to build a Bayesian Belief Network. This was parameterized using current land-use and climatic conditions and enabled the researchers to predict the effect of future land-use and climate change on the richness of macroinvertebrates and fish.

They discovered little change in species richness averaged across catchments, but identified important impacts and effects at the finer scale. High nutrients and high runoff resulting from urbanization interacted with high nutrients and high water temperature as a result of climate change. This was the leading driver of potential declines in macroinvertebrates and fish at finer scales. This is the first study to separate out the constituent drivers of impacts on biodiversity that result from climate change and land-use change.

By identifying the mechanisms behind predicted biodiversity

Riparian restoration

The construction or restoration of riparian habitats is one common management strategy that can directly reduce terrestrial runoff, indirectly filter nutrients and provide shade, therefore reducing solar radiation absorbed by the water. Given that these results found a strong riparian vegetation restoration effect in the presence of climate change and urban growth, this study supports the use of riparian restoration as an important buffering tool for reducing the negative effects of climate change and land-use change. In contrast, they also found that streams with low riparian cover and/or high riparian loss are likely to be more vulnerable to the effects of climate change and land-use change.



loss, the researchers were able to identify management strategies that can simultaneously tackle both climate change and land-use change. The good news coming out of this study was that the restoration of riparian vegetation was identified as an important tool for adaptation that can mitigate the negative effects of climate change and land-use change on freshwater biota.

In Australia and elsewhere, riparian restoration management has been transformed over the last few decades from engineer-based to ecosystem-based approaches. As a result, planting of native riparian buffers has become a priority for restoration projects as it improves ecological conditions within streams without negatively impacting riparian soils. 🌱

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Reference

Mantyka-Pringle CS, TG Martin, DB Moffatt, S Linke & JR Rhodes. (2014) Understanding and Predicting the Combined Effects of Climate Change and Land-Use Change on Freshwater Macroinvertebrates and Fish. *Journal of Applied Ecology* doi: 10.1111/1365-2664.12236

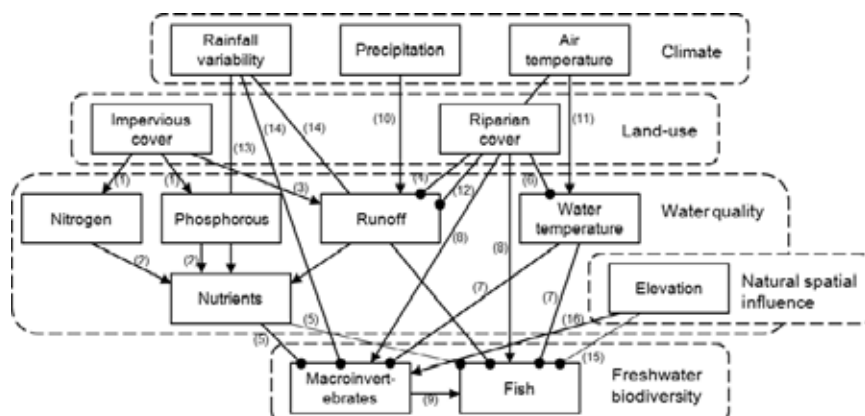


Figure 1: A conceptual model of the key climate, land-use and water quality variables that interact and impact macroinvertebrate and fish richness in the freshwater habitat being considered. A solid arrow indicates a positive effect or link, whereas a closed circle indicates a negative effect or link. (See Mantyka-Pringle et al., 2014 for more details.)

Threat information and extinction risk

Improving comparative extinction risk analysis

Martina Di Fonzo (University of Queensland) and Kris Murray (EcoHealth Alliance)

'Extinction risk' is a powerful notion and plays an important role in guiding optimal resource allocation decisions, when considered together with the potential cost and likelihood of success of a conservation project. New research is suggesting, however, that there's much we can do to improve the way we calculate extinction risk.

A common approach for determining the likelihood of a species going **extinct** within the foreseeable future involves something like this:

1. Take a group of species of interest (eg, stinkbugs)
2. Look at their levels of endangerment using some metric (eg, 'extinct' vs 'still here' or their IUCN Red-List status)
3. Gather some information about those species (eg, how many offspring they have per year, how much they weigh), and
4. Search for correlations between their level of endangerment (2) and this species information (3) using your favourite statistical method (generally known as a 'comparative extinction risk analysis').

Such analyses have been instrumental in highlighting that the risk of species' extinction is not random. For example, a common pattern is that larger-bodied, longer-lived and more ecologically specialised species are at greater risk (Purvis et al., 2000).

However, despite the potentially useful application of comparative extinction risk analyses for conservation practice and policy, they have generally had little influence in the real world (Cardillo and

“If you decide that comparative extinction risk analysis could be a tool of use in your extinction-fighting toolbox, you should do the best you can to quantify and represent threats before drawing any management conclusions.”

Meijaard 2012). One reason for this underperformance may be that few of these studies seem to incorporate information on the threats affecting species' survival (eg, habitat loss, invasive species, overhunting). Rather, many seem to focus on life-history and ecology as factors that predispose species to decline or extinction. While this can lead to general management conclusions (eg, protect big predatory fish), it may not tell you why they are under threat in the first place (eg, overfishing) or how you might go about protecting them.

In other words, a species' risk of extinction is shaped by the interactions that arise between its intrinsic traits and the extrinsic factors to which it may be exposed, such as threats. Recognising those interactions could help pinpoint better management options.

In our paper, we investigate whether threats really are under-



Of intrinsic traits and extrinsic threats

Once numbering tens of millions, American bison (*Bison bison*) were almost hunted to extinction during the 1800s for their meat and pelts. Yellowstone National Park was the only refuge in North America that did not see total extirpation of wild, free-ranging bison. Like many species, the bison's risk of extinction has been shaped by its intrinsic traits as well as extrinsic threats – its body size, behaviour and abundance made it an easy and valuable target

for human exploitation. Protecting the species from over-hunting and enacting active management has been responsible for its partial recovery. More recently, culling to manage risk of brucellosis transmission to domestic cattle has hurt breeding herds, altered breeding structure, reduced female cohorts and suppressed productivity. It is now listed as Near Threatened by the IUCN because viable populations are very limited and it is a conservation dependent species. (Photo by Chris Murray)

utilised in extinction risk studies and whether this actually matters from a conservation management perspective (Murray et al., 2014). The answers are: yes and yes!

First, we reviewed almost 100 studies and found that the majority (63%) did not include threat variables at all, even though most (59%) of the threat variables that have so far been employed have been significant predictors of extinction risk. Despite this, we did find an increasing trend over time in the number of studies that include threats to explain patterns of extinction risk, which is promising (see Figure 1).

Second, we investigated the value of threat information in extinction risk analyses by comparing predicted IUCN Red List classifications from extinction risk models with and without threat variables. We made comparisons using two study systems of differing taxonomic and geographic scales: a global dataset on mammals and a continental dataset on amphibians.

We found that including threat variables only modestly improved our overall ability to predict threatened species. However, models with and without threats disagreed considerably on the identity of threatened species (11% and 5% for amphibians and mammals, respectively, translating to dozens and hundreds of species).

Third, we examined the potential ramifications of this disagreement for a conceivable management end-use. As a hypothetical example,

we shortlisted species to receive increased conservation attention on the basis of their relative 'endangerment', predicted from our model. We found that models with and without threats disagreed on 20-60% of the species that would be on the shortlist, depending on the proportion of all species included in the list.

So, if you decide that comparative extinction risk analysis could be a tool of use in your extinction-fighting toolbox, our study suggests you should do the best you can to quantify and represent threats before drawing any management conclusions. 🍎

More info: Martina Di Fonzo m.difonzo@uq.edu.au or Kris Murray murray@ecohealthalliance.org

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Murray KA, LD Verde Arregoitia, A Davidson, M Di Marco & MMI Di Fonzo (2014). Threat to the point: improving the value of comparative extinction risk analysis for conservation action. *Global Change Biology* 20:483-494.

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Diagnosing decline

When should managers step in to stop an animal from becoming extinct? An obvious answer is that something should be done when the population is experiencing a significant decline. But how can you distinguish between declines that are the result of human pressure as opposed to declines that are merely a part of the population's natural fluctuations?

Martina Di Fonzo and colleagues have worked on this very issue and believe they have an answer (Di Fonzo et al., 2013). They simulated typical mammalian population time-series under different human pressure types and intensities and identified significant distinctions in population dynamics. Based on the concavity of the smoothed population trend and the algebraic function which was the closest fit to the data, they determined those differences in decline dynamics that were consistently attributable to each pressure type.

They then applied their newly developed method to 124 wildlife population time-series and investigated how those threat types diagnosed by their method compare to the specific threatening processes reported for those populations. They were able to show that wildlife population decline curves can be used to discern between broad categories of pressure or threat types, but do not work for detailed threat attributions. More usefully, they found that differences in population decline curves can reliably identify populations where pressure is increasing over time, even when data quality is poor. So, here is a cost-effective technique for determining whether the decline being witnessed is a decline we should be worrying about.

Reference

Martina Di Fonzo Ben Collen & Georgina M. Mace (2013). A new method for identifying rapid decline dynamics in wild vertebrate populations. *Ecology and Evolution* 3: 2378-2391.

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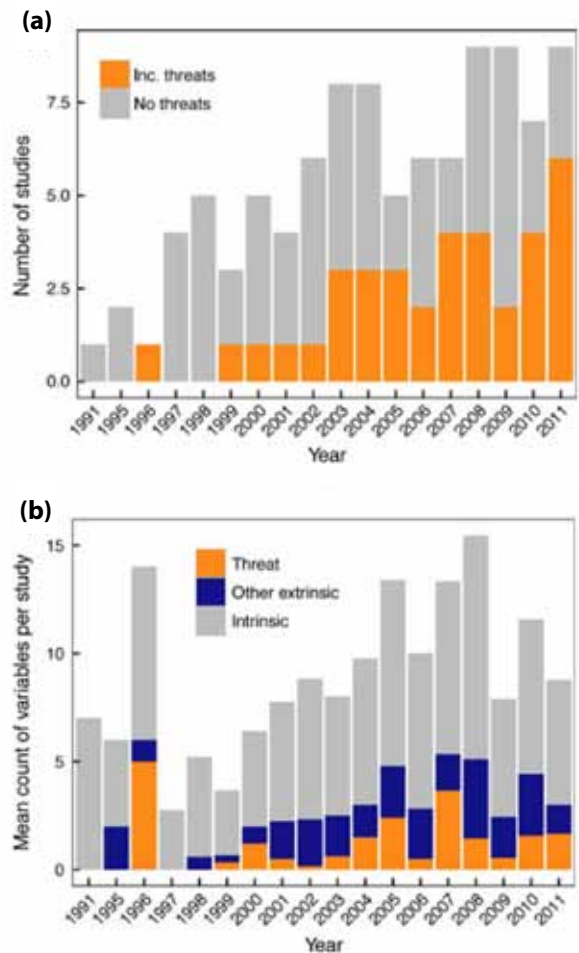


Figure 1: Trends in extinction risk publications. (a) The proportion of studies considering threats has increased through time, against a background of more publications per year. (b) In step with more publications per year, models of extinction risk have also become more variable rich with fairly consistent inclusion of threat or other extrinsic factors since 2000; however, on average, models remain dominated by intrinsic trait variables. (From Murray et al., 2014)

Prioritising species for monitoring conservation actions

Combining cost-effectiveness with complementarity

By Ayesha Tulloch (University of Queensland) and Iadine Chadès (CSIRO Ecosystem Science)

Evaluating the success of a conservation strategy is a crucial element of best practice management. Without it, managers can't benefit from the experiences of others and scarce funds available could be wasted. And, if the strategy isn't actually working, a lack of evaluation could lead to misguided policy directives and a loss of confidence of donors.

When it comes to evaluation, the challenge is always designing and implementing effective monitoring programs when funds are limited. Decisions need to be made about how, where, and what to monitor. To deal with this problem, many have suggested monitoring just one or a few indicator species rather than many species (see 'Selecting good indicators' in [Decision Point #36](#)). However, the vast literature on selecting indicators usually ignores one of the basic motivations for their use – provision of cost-effective information on whether an action is working. Decisions on what to monitor are routinely made ignoring the costs and benefits of alternative choices, and many organisations either end up monitoring everything (wasting lots of money that could be spent on management), or end up doing no monitoring at all (for fear of making the wrong choice).

The challenges of choosing indicators

Choosing which species to monitor is a big challenge. In part that's because of uncertainty surrounding management outcomes. We often have very little idea of whether the action that's been implemented will be effective. This should not stop us from acting or evaluating the impacts of our actions. But it does mean we need to ensure we account for this uncertainty in our decision-making.

There are two kinds of errors we can make when choosing indicators. The first is thinking an action is working when it isn't. The second is believing an action is not working when it is. Each has consequences that may differ depending on the change we are trying to monitor and the number or characteristics of species being represented by the indicators. In a threatened species management context, thinking an action is working when it is not (ie, the species is still declining) could lead to the loss of a species because we fail to take further action. Alternatively, we might manage the system, fail to detect recovery of threatened species because of insufficient monitoring (or monitoring the wrong species), and stop management prematurely.

Either way, the consequences of these errors can be catastrophic. Consequently, we need a way to select an indicator species that accounts for these uncertainties. Using decision science, we have devised a new way to do just this, a method that combines the uncertainties and costs. We demonstrated the value of our new method by applying it to a situation in the south-west of Australia, a region which has been declared a biodiversity hotspot due to its high plant endemism and high number of threats to declining biodiversity (See [Decision Point #73](#)).

One of the threats in this region is the introduced red fox preying on native mammals. Since the 1990s an extensive baiting program of foxes has been carried out by the Department of Environment and Conservation's Western Shield program. The aim is to restore threatened mammal populations in WA's reserve system. It has also recently been proposed by non-government organisations in private reserves to help protect fragmented remnant fauna populations. With millions of dollars required to monitor and manage all fragments and all species, decisions need to be made about which species will tell us the most about the effectiveness of poison baiting for recovering declining populations of native fauna.

We selected fourteen mammal species from the south-west Australian landscape as possible indicators and we evaluated them for monitoring the effects of the fox baiting program. We had previously developed an approach for selecting indicator species that ranked each mammal on the basis of its cost-effectiveness for monitoring fox management

“The principle of complementarity allows us to choose different species, each of which provides information on other species.”



The dibbler is an endangered mammal formerly widespread across south-western Australia and now threatened with extinction by feral predators.

(Tulloch et al. 2011), but a simple ranking approach does not account for complementarities between species.

In the case of indicator selection, the principle of complementarity allows us to choose different species, each of which provides information (eg, on behavioural ecology, habitat use, or responses to management) on other species, by measuring the extent to which one species contributes unrepresented values to an existing set of species. For instance, if two species provide the same information on responses to a given management action, do we need to monitor both of them, or would it be more sensible to try to find two species that respond in different ways? Because species often respond in different ways to a given management action (or might not respond at all), it is wrong to assume that all will respond positively without evidence. To date, no indicator-selection frameworks have accounted for all the uncertainties in management outcomes as well as the potential for complementarity between species. We therefore decided a new framework was needed.

How decision science helps

Our new decision-science approach to cost-effective monitoring consisted of six steps: (1) define monitoring objectives and constraints; (2) list candidate indicators and calculate costs of monitoring each; (3) define data underlying species responses to management and determine the likelihood of detecting a trend when management is undertaken; (4) determine species surrogacy values (how representative one species is of another); (5) combine information on trend detection and surrogacy to calculate monitoring benefits (the amount of information each species will provide on another); and (6) solve optimisation problems.

We realised a simple benefit function was required that was easy to apply to any management problem, yet still accounted for uncertainty in the way it evaluated the monitoring power of an indicator. The

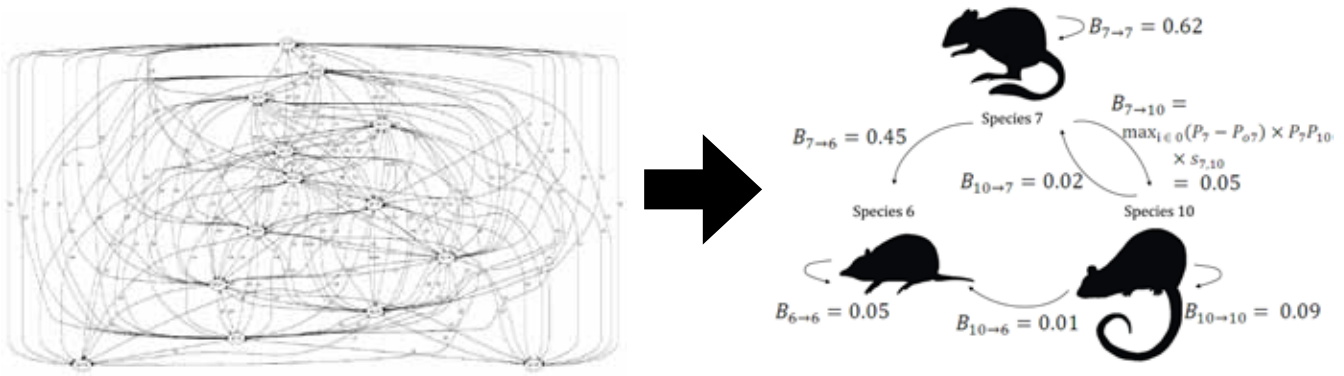


Figure 1: The network of complementary species for monitoring a decline due to fox management, where species are nodes and arrows are the species' monitoring benefits. The benefit of monitoring indicator species (i) 7 (woylie) for target species (j) 10 (western ringtail possum) is shown as $B_{i \rightarrow j}$; s_{ij} is the surrogacy value of species i for species j; P_i and P_j are the likelihood of detecting a trend under

management for species i and j respectively, and P^{0i} is the likelihood of detecting a trend when species i is not managed. In this case, the benefit of monitoring the woylie to inform one of a trend in the ringtail possum is 0.05. We assume a significant decline rate is 10%. The bandicoot has no arrows leading to another species and thus has a monitoring benefit of zero for detecting a response of 10% population decline.

benefit of monitoring a species was therefore the combination of the likelihood of successfully detecting a real change in the indicator, and the probability that this indicator successfully represented a set of target species. The benefits of monitoring every species for every other species can be represented in a network diagram that at first look appears complex and impossible to use for decision-making (Fig. 1). Because this information is difficult to digest and use in its raw form, we set a range of expected responses and simplified the network to find the set of species that best represented that response (eg, Fig 1). By maximising the benefits of monitoring for a given expected response, we could then easily and transparently select the set of indicator species with the highest monitoring power for a given budget.

There is no single 'best' indicator species

By setting clear objectives for species recovery during invasive predator control, which included positive and negative target growth rates, we found that the likelihood of detecting a response to management changes depending on the desired direction and magnitude of the response. Different sets of species were therefore useful for telling us about different types of responses. We used published and unpublished time-series of responses to management to determine the benefits of monitoring each species, but the quantitative benefit function that we developed is flexible for multiple scenarios and types of data.

Our new benefit function showed that the species currently monitored in our case study area were not always the most representative, cheapest, or most informative indicators of the responses of species to invasive-predator management. A number of species were either too variable in their expected response (eg, southern brown bandicoot) or had a high likelihood of showing a response in the absence of management (eg, western quoll). The two species selected most frequently for detecting an increase under fox management were the tamarin and western brush wallabies. These species, although rare, are

not listed as threatened but they have low variability and high growth rates when managed. The dibbler was also frequently selected as an indicator (Fig 2). This species is highly threatened and found in few locations, but its high certainty of response to management meant it was often selected over other species with higher surrogacy values.

Embracing uncertainty

Monitoring is a critical step that allows managers to learn from their experiences and to adapt management practices to maximize their effectiveness. Past research on indicator selection has ignored the varying costs of monitoring different species. It has also failed to account for uncertainties such as the likelihood of species responding to management, ability to detect real rather than spurious trends in populations, and how well one species represents another. If costs and species complementarity are not incorporated into the planning process, decisions could be costly and inefficient and uninformative species might be monitored.

Many actions will not benefit all species. In our case study on invasive-predator management, we found a likelihood of negative effects on some species. In these cases, we recommend a risk-averse strategy of selecting the set of species that maximises the expected benefit of detecting any change (negative or positive) that informs actions relevant to most species.

Our new framework incorporates all these components in a transparent benefit function and can be used as a model for decision makers to select a set of species for monitoring that provides the most reliable information on the responses of other species that cannot all be monitored due to funding constraints. This framework has the potential to enhance the utility and transparency of monitoring programs in the future. 🍷

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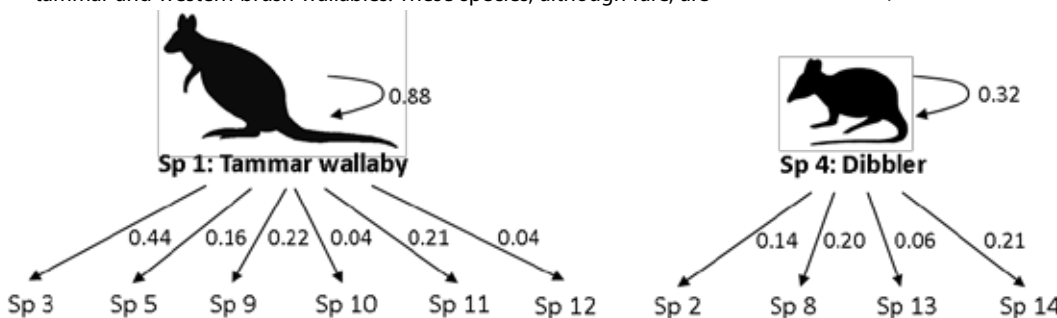


Figure 2: The species selected for monitoring as an indicator of a positive response to fox management, with arrows showing the species that they were indicators of because they responded in similar ways.

Reference

Tulloch AIT, Chadès I & HP Possingham (2013). Accounting for Complementarity to Maximize Monitoring Power for Species Management. *Conservation Biology* 27, 988-999.

Tulloch A, HP Possingham & K Wilson (2011). Wise selection of an indicator for monitoring the success of management actions. *Biological Conservation* 144, 141-154.

Strategic approaches to planning for conservation *and* development

Putting a stop to cumulative impacts on threatened species

By Brendan Wintle (University of Melbourne)

•••••
• I spy an outcome
• While the Environmental Decisions Group can boast of many important outputs such as publications in high impact journals, at the end of the day our real value lies in the outcomes our science helps enable. To highlight the many contributions our research is making towards conservation outcomes, Decision Point will be running a series of short stories on what we have achieved. To get the ball rolling, Brendan Wintle, NERP ED's Dep Director, discusses our contribution to strategic assessment.
•••••

NERP Environmental Decisions is working closely with the Strategic Approaches Branch (Department of the Environment) to apply state-of-the-art decision analysis to guard against cumulative impacts on threatened species and ecological communities (as listed under the EPBC Act).

The idea of strategic assessment, supported by regional sustainability planning (RSP), is to move away from case-by-case approvals of actions under the EPBC Act towards a plan for sustainable development and conservation of biodiversity in a region or State. Case-by-case approval can lead to the 'death by a thousand cuts' whereby the cumulative impacts of many small actions may lead to serious biodiversity declines (and ultimately extinction).

In addition to creating better regional outcomes, strategic approaches can also reduce the administrative burden on governments, companies and individuals by assessing the appropriateness of actions and mitigation responses (eg, offsets) in a pro-active and strategic way. Regional sustainability planning improves clarity and certainty around conservation and development by identifying which places are appropriate for particular types of development and how biodiversity values will be maintained in the face of potential impacts. Regional sustainability plans can provide a strategic context in which to organize restoration efforts and other forms of impact offsets in a way that maximizes net biodiversity benefits for the least cost.

The NERP Environmental Decisions Hub is contributing to regional sustainability planning in several places around Australia including Perth and the Pilbara in WA, the Upper Spencer Gulf in SA, the Hunter Valley in NSW, and Greater Melbourne in Victoria. NERP ED provides support to RSP and strategic assessments by (i) mapping the distribution of suitable habitat for EPBC Act species throughout their range in an assessment area, (ii) quantifying impacts of competing development and offsetting scenarios being considered (as a whole)

History of an outcome

Collaboration on strategic approaches between NERP ED researchers and the Department of the Environment began early in the Commonwealth Environment Research Facility (CERF) program, the program which preceded NERP. Early research on conservation planning in urban environments by Sarah Bekessy and Ascelin Gordon at RMIT preceded a submission by CERF researchers (led by Kirsten Parris) to the Hawke Review of the EPBC Act and involvement of Brendan Wintle in the Australian Government's regional sustainability planning advisory committee. Strategic approaches became a key recommendation of the Hawke review and the Strategic Approaches Unit was formed. This Unit then approached NERP ED to undertake the targeted research work described here.



By moving to strategic assessments the hope is we can avoid the 'death by a thousand cuts' where a tree is lost here, a patch of native grass there when a number of individual development applications are assessed without reference to each other.

on individual species and ecosystems in the regional planning process, (iii) helping to identify mitigation and offsetting options using state-of-the-art spatial prioritisation software, and (iv) analyzing the degree to which the best planning options contribute to the long-term persistence of a subset of threatened and priority species compared with a status quo scenario (eg, Carnaby's cockatoo).

NERP ED researchers actively engage with the Department of the Environment and other researchers and stakeholders in the RSP process. For example, Amy Whitehead, Heini Kujala and Brendan Wintle have been actively engaged with the WA State Government and other biodiversity and planning researchers in their assessment of planning options for the Perth-Peel growth corridor in WA.

Strategic approaches are likely to have a much broader role in environmental legislation, policy and planning over the next few years because of the capacity to assist with streamlining environmental regulation. The key challenge is to ensure that the very best approaches to strategic assessments have been rigorously tested and are ready, practical and available to be utilized in policy and planning processes. This is where the Environmental Decisions Hub hopes to play a pivotal role.

It is hoped that NERP research on strategic approaches will continue through a variety of mechanisms including ongoing collaborations with State agencies and private companies seeded by the NERP research. The future of regional sustainability planning research will see a much closer integration of biodiversity conservation and planning research, leading to more timely inclusion of biodiversity in regional planning processes and better conservation outcomes. 🍎

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“The key challenge is to ensure that the very best approaches to strategic assessments have been rigorously tested and are ready, practical and available to be utilized in policy and planning processes.”

Summer research across the divide

The 2013/2014 summer break saw the third round of the NERP Summer Scholar program where leading undergraduate students are placed in the Department of the Environment to work on science/policy issues. The hope is that, in the process, a bit of light is thrown on that enduring, seemingly intractable challenge of how science might better engage with policy.

The students are selected through the ANU Summer Research Scholarship program, and placed in DotE with the help of the Sustainability Research and Science Policy Section, SRaSPS (facilitators of the NERP Program). NERP ED researcher Don Driscoll oversees the process.

Last year, the second round of the program, Matthew Anderson reviewed policy on connectivity, Marlese Fairgray examined monitoring in strategic assessment and Sarosh Sikander investigated detectability (See [Decision Point #69](#)).

And the year before that, Annabel Lusk looked at managing the impacts of invasive species while Prudence Roberts reviewed development approvals in areas that are cassowary habitat. (See [Decision Point #57](#)).

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The aim of Lottie Boardman's project was to assess the representativeness of the collection of threatened plant species held at the Australian National Botanic Gardens.

Ex situ conservation at the ANBG

By Lottie Boardman

Australia's commitment to preserving its native plant biodiversity is shown by its domestic policy goals and by the international agreements Australia has entered into. While the protection and enhancement of the habitat of native species (sometimes called *in situ* conservation) is obviously a priority, it is also recognised that *ex situ* conservation may be necessary to prevent the extinction of some species. For plants, *ex situ* conservation could mean being grown in a botanic garden or having seed or genetic material in storage.

According to Australia's Biodiversity Conservation Strategy 2010-2030, it is the responsibility of governments, the science sector, Indigenous peoples, and private landholders to maintain and enhance *in situ* and *ex situ* conservation measures to conserve species and genetic diversity. Australia's international targets with regard to *ex situ* plant conservation (as set out in the Global Strategy for Plant Conservation (GSPC) under the Convention on Biological Diversity – CBD – of which Australia is a signatory) are more specific: "at least 75% of threatened plant species in *ex situ* collections, preferably in the country of origin, and at least 20% available for recovery and restoration programmes."

In order to assess Australia's progress towards meeting these policy goals, it is important to determine which species, especially threatened species, are in *ex situ* conservation and how well those *ex situ* collections are preserving the genetic diversity of the species into the future. Maintaining genetic diversity is essential as it allows a species to respond to changing conditions and other threats. It is not enough simply to have an example of a threatened species in a botanic garden. For such *ex situ* collections to be useful for conservation, they need to be representative of the genetic diversity of the wild populations of the species.

For my Summer Scholar project, I was placed in the Biodiversity Science Branch of Parks Australia, part of the Department for the Environment, and based at the Australian National Botanic

Gardens (ANBG) in Canberra. The aim of my project was to assess the representativeness of the collection of threatened plant species held at the ANBG to allow informed decisions to be made about the future direction of this collection. Much of my time was therefore spent analysing the records relating to the plant species in the ANBG's Living Collection that are listed under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The rest of my time was spent talking to the people at the ANBG to find out how it works and how decisions are made about threatened species.

The first part of my work was a general analysis of all the EPBC-listed species. While genetic diversity of each threatened species could, in theory, be assessed directly, this would take considerable time and resources. Therefore, it was necessary to use a proxy for genetic diversity to assess the representativeness of the ANBG collections. For this project, the wild provenance of the ANBG Living Collection was compared to the geographic distribution of the species. Given the number of species, the first analysis just looked at the number of genotypes of each EPBC-listed species that were held in the ANBG Living Collection and how many of the original wild locations of those genotypes are known.

The second part of the project was to develop a methodology to target future collecting of specific threatened species in order to increase representativeness. This involved looking at each species and mapping its known geographic distribution against the provenance of the ANBG Living Collection plants to identify where the gaps are.

To assess *ex situ* plant conservation on a national scale, it would be necessary for all the botanic gardens and seed banks to do a similar assessment. While useful to the ANBG itself, this project was also intended to produce a methodology to show other botanic gardens

Continued on page 14

“The ANBG Living Collection is holding about 24% of the EPBC-listed plant species, almost a third of the aspirational target of 75% of threatened species in the Global Strategy.”

Ex situ conservation at the ANBG

Continued from page 13

how such an assessment could be done. The third part of my project was to examine the usefulness of the idea of coordinating the efforts of all Australia's botanic gardens in a National Living Collection and how that might work in relation to threatened species.

There are currently 1255 plant species listed as being Critically Endangered, Endangered or Vulnerable under the EPBC Act. 298 of these species are held in the ANBG Living Collection. This means that the ANBG Living Collection is holding about 24% of the EPBC-listed plant species, almost a third of the aspirational target of 75% of threatened species in the GSPC. The second part of this target is that 20% of those species are ready for recovery or restoration. For this to be feasible, a reasonable representation of the species' genetic diversity would be necessary, and yet 54% of the EPBC-listed species in the ANBG Living Collection are represented by only one genotype (indeed, only 20% of the analysed species are represented by more than three genotypes).

There is considerable enthusiasm and expertise at the ANBG about the conservation and cultivation of threatened natives. However, the ANBG has limited resources and conservation is but one of its aims. It is also a space for learning and enjoyment and serves the public in many ways.

In addition to this, growing plants in the garden is just one method of ex situ conservation. Many threatened species are conserved in the Australian National Seed Bank and in other seed banks around Australia. It is possible to more easily store a great range of genetic diversity in seed. However, representativeness in the Living Collection is still important as there are species whose seeds do not respond well to seed banking or who do not produce viable seed. And growing plants in the garden also provides important information for restoration efforts about how best to cultivate the plant.

It is never going to be possible for one seed bank or one botanic garden to conserve all of Australia's threatened plants. At the moment, ex situ conservation of the threatened species in botanic gardens around Australia is left to the collections policy of the individual botanic gardens. Given the resources and expertise required to conserve these species, it would be sensible to have some sort of National Living Collection, if only so that everyone knows who is already conserving what species. This would allow botanic gardens to share expertise on the conservation of particular species and potentially, to make decisions about which species it would be worth devoting their energy to. Is it the right approach to focus on individual species as opposed to conserving ecosystems? Should the preservation of the genetic diversity of common but important species be prioritised over rare and threatened species? These are areas where science can inform policy choices.

At the ANBG there are three areas where science is informing policy. The ANBG's information management systems allow policy makers to know what is in the ANBG's collections and make decisions about future strategies based on this. The horticultural and germination expertise of the ANBG's staff inform policy makers about what is possible when it comes to conserving particular species and what sort of resources are needed. Science can also inform policy when it comes to making decisions about which species the ANBG should use its limited resources to conserve. My project fits into the information management area; its findings will be used to inform the development of the ANBG's Conservation Policy.

I thoroughly enjoyed my time at the ANBG and at the Fenner School at the ANU. I would like to acknowledge all the people in both places who were so generous with their time and expertise, as well as the NERP team who facilitated the project. 🍀

Assessing the automated species mapping tool

By William Chan

It's the responsibility of the Australian Government's Department of the Environment to make sure that development proposals don't negatively impact on threatened species listed under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). How do they do this? Part of the job is simply checking where listed species occur in relation to planned developments. It's important, therefore, to have reliable species distribution maps and a lot of effort goes into maintaining and updating these records. My project, as part of the ANU Summer Scholars Scheme, was to investigate the accuracy of aspects of the Department's mapping procedures.

Since 1998, the Environmental Resources Information Network (ERIN), a branch within the Department, has compiled and maintained digital distribution maps of species listed under the EPBC Act. If a species' population is not indicated on the distribution map, then the species may not be considered during the development assessment process. On the other hand, if a species is mapped in a location where it does not occur, then time and effort may be lost by the developers and the Department. The accuracy of these distribution maps is therefore critical.

In order to ensure that the species distribution is accurate, the ERIN species team has developed and implemented a tool that automatically updates the existing distribution maps. The automated species-mapping tool incorporates into maps reported sightings of species from external organisations (which include state and territory environment departments, herbariums, museums and some citizen science sightings). Each individual record is checked by an algorithm that ascertains the quality of the data and statistically checks to exclude outliers.

One of the main processes involved here is evaluating each record against 20 bioclimatic surfaces. Developed by Professor Michael Hutchinson from the ANU Fenner School of Environment and Society, these surfaces consist of spatial modelling of climate and terrain. Two key outcomes are outlier identification and surface malfunction. A record is considered as an outlier when it fails to meet the attributes of five or more surfaces. However, when more than 10% of the species records have been flagged as outliers, then the respective surface is considered to have malfunctioned and is then excluded from the process. This helps ensure anomalies in the surfaces do not affect the outlier calculation.

Surface malfunction and false outliers

The surface with the most malfunctions recorded against it was 'Precipitation of Driest Period'. This surface malfunctioned in almost half (46.20%) of all species. The ArcGIS spatial map demonstrated that the cause of malfunction was due to 99.74% of points having a value of '0'. The 'Highest Period Moisture Index' surface had the next highest rate, which malfunctioned in almost a quarter (24.45%) of all species. Similarly, nearly all records (98.50) belonged to the same value of '1'.

“My project, as part of the ANU Summer Scholars Scheme, was to investigate the accuracy of aspects of the Department's mapping procedures.”



William Chan presents his findings back to Department of the Environment.

Overall, the results validate that the records which caused surface malfunctions are largely located in spatial areas that contain only a single value. An initial proposal was to omit these two surfaces from the automated species mapping tool due to their perceived lack of usefulness. However, these surfaces are considered helpful even though they consistently malfunctioned because they still identified outliers and may have assisted in records reaching the outlier threshold of failing five or more surfaces.

Individual case studies were also selected to assess the veracity of new species records that had been excluded in the existing distribution. The most common cause for false outliers was records with incorrect coordinates. These records were discovered on the basis that the locality metadata did not match the spatial information contained within the coordinates. In most instances, these records were horizontally or vertically away from the actual locality being within the known distribution. When such errors are discovered in the species data, the source supplier may be notified by ERIN. However, in the past, these agencies and organisations have not necessarily updated their information. Despite the knowledge that certain records are inaccurate, the lack of time, resources and staff were reasons that prevented the scientific source from having the most up-to-date information.

Personal reflections

ERIN sits at the interface between scientific research with policy and decision making. Science underpins both the source data of species sightings collected by external environmental organisations and the bioclimatic surfaces used to assess them. The value of accurate species distribution maps is worth the additional effort required for collaboration between the Department and external agencies to ensure that incorrect sources, once identified, are fixed. In addition, the malfunction of bioclimatic surfaces could be addressed through further collaboration between the Department and the ANU – either by developing more detailed surfaces or improving the outlier detection algorithm.

I am grateful for the opportunity I had in conducting research for the Australian Government's Department of the Environment. Despite the challenges of working within the realm of the natural environment (my background is in architecture and the built environment), the experience pushed me outside of my comfort zone. Specifically, I have developed a greater knowledge of the processes and systems available to the government in not only creating maps of the country's fauna and flora but in how such information assists in protecting Australia's biodiversity and threatened species. 🍷

Dbytes

Dbytes is EDG's internal eNewsletter. It gets sent to members and associates of EDG each week, and consists of small snippets of information relating to environmental decision making. They might be government documents, research articles or blogs. Here are six bytes from recent issues. If you would like to receive the *Dbytes* eNewsletter, email David.Salt@anu.edu.au

1. Aust Environmental-Economic Accounts, 2014

This publication represents the first issue of Australian Environmental-Economic Accounts (AEEA). It brings all ABS environmental accounts together in one place to deliver a broad and cohesive picture of the environmental stocks and flows of relevance to the Australian economy and society.

<http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/4655.0main+features12014>

2. SoE Common Assessment & Reporting Framework

A paper on the State of the Environment 2011 Common Assessment and Reporting Framework is now available online. The article was published in the Journal of Environmental Planning & Management and is available as open access here.

<http://www.tandfonline.com/doi/abs/10.1080/09640568.2014.891073#.U0JHYKN-9aQ>

3. TERN NCRIS Final Report now available

TERN's final report for NCRIS, which represents a culmination of over four years of commitment and vision towards building an ecosystem science research network for Australia, is now available.

<http://www.tern.org.au/TERN-NCRIS-Final-Report-now-available-bgp2936.html>

4. State of the Climate 2014

A definitive report on observed changes in long term trends in Australia's climate has been released by CSIRO and the BoM.

http://www.bom.gov.au/announcements/media_releases/ho/20140304.shtml

5. A Scientist's Guide To Social Media

This guide is designed to nudge reluctant networkers to get started with an online professional profile and help social media experts get even more out of social networking. By Chris Tachibana.

http://sciencecareers.sciencemag.org/career_magazine/previous_issues/articles/2014_02_28/science.opms.r1400141

6. Policy Handbook:

Biodiversity and Environmental Change

Biodiversity and Environmental Change describes changes in a range of Australian ecosystems that have been subject to detailed long-term research. The overarching purpose of these long-term studies has been to document the changes, identify the drivers of change and provide the evidence and knowledge needed to better inform natural resource management in Australia.

This Policy Handbook describes the key findings and messages from long-term ecological research for policy makers and the general public. The Policy Handbook can be downloaded from the LTERN website.

<http://www.tern.org.au/Long-Term-Ecological-Research-Network-pg17872.html>

Trouble in the tropics

In our story on page 6 we discussed the importance of freshwater ecosystems, their parlous state, their vulnerability to climate change and the value of riparian restoration. In a recent review of the impacts of agricultural expansion in the tropics (Laurance et al., 2014), the plight of freshwater ecosystems was underscored. Here's how William Laurance and colleagues described it:

"In the tropics, large increases in water harvesting, damming, and diversion of rivers will be needed for agricultural expansion, intensification, and associated electricity needs. Over 150 large (>2 MW) hydroelectric dams are being planned just for the Andean-Amazon region. Flood plains will be prime targets for expansion of irrigated farming, especially in Africa. Many watercourses and lakes will suffer altered flows, higher temperatures, lower dissolved oxygen levels, and elevated loads of sediments, nutrients, pesticides, and other pollutants. Declines of larger fishes, river migrants, and species requiring unpolluted, highly oxygenated waters and specialized microhabitats are common. Many locally endemic fish and invertebrates are found entirely outside of protected areas, and relatively few protected areas encompass entire watersheds. As a result, freshwater habitats are among the planet's most imperiled ecosystems." 🍌

Reference

Laurance WF, J Sayer & KG Cassman (2014). Agricultural expansion and its impacts on tropical nature. *Trends in ecology and evolution* 29: 107-116.



What's the point?

All models are wrong

- All models are wrong but some are useful. (On the other hand, some are useless.)
- A group of wealthy investors wanted to be able to predict the outcome of a horse race. So they hired a group of biologists, a group of statisticians, and a group of physicists. Each group was given a year to research the issue. After one year, the groups all reported to the investors.
- The biologists said that they could genetically engineer an unbeatable racehorse, but it would take 200 years and \$100bn.
- The statisticians said that they could predict the outcome of any race, at a cost of \$100m per race, and they would only be right 10% of the time.
- Finally, the physicists reported that they could also predict the outcome of any race, and that their process was cheap and simple. The investors listened eagerly to this proposal. The head physicist reported, "We have made several simplifying assumptions: first, let each horse be a perfect rolling sphere..."
- Source: http://www.theguardian.com/science/2013/dec/29/scientists-favourite-jokes?CMP=ema_632



The Environmental Decision Group (EDG) is a network of conservation researchers working on the science of effective decision making to better conserve biodiversity. Our members are largely based at the University of Queensland, the Australian National University, the University of Melbourne, the University of Western Australia, RMIT and CSIRO.

The EDG is jointly funded by the Australian Government's National Environmental Research Program and the Australian Research Council's Centre of Excellence program.

Decision Point is the monthly magazine of the EDG.

The funding of the research presented in this issue of *Decision Point*, like most research, comes from multiple sources and is identified in the original papers on which the stories are based (references are provided in each story). In terms of CEED and NERP ED, the research on koalas (p4,5) was supported by NERP; the work on the extinction risk (p8,9) was supported by CEED and NERP; the indicator species research (p10,11) was supported by NERP and CEED, and work on strategic assessments (p12) was supported by NERP.

To contact the EDG please visit our websites at:

<http://ceed.edu.au/> or <http://www.nerpdecisions.edu.au/>

