DECISION POINT

Connecting conservation policy makers, researchers and practitioners

Issue #101 / July 2017

Frogs and birds in the 'burbs

Retaining wildlife in and around our cities

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ARC ceed

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Decision Point is the free bimonthly magazine of the ARC Centre of Excellence for Environmental Decisions (CEED). CEED 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 and RMIT University.

Editor David Salt
Website decision-point.com.au

Our cover If you want to keep the endangered growling grass frog around in our suburbs, you need to create wetlands for them. See why on page 10. (Photo by Geoff Heard)

On the point

Decision science 101

Earlier this year CEED's Chief Investigators came together at O'Reilly's Rainforest Retreat (Lamington National Park, Qld, CIs are pictured below) to reflect on CEED's impact on the world of environmental decision science and to plan a 'book of lessons' emerging out of our research. CEED didn't invent decision science but, through its research and tool development, it has played a pivotal role in placing environmental decision science at the centre of good conservation management and policy.

The CEED Book (the working title of this book of lessons) will emerge over the coming year. It will include chapters on conservation planning, adaptive management, structured decision making, value-of-information analysis, triage, cost effectiveness and much more besides. Each chapter will present a bite-sized overview of the topic, discuss how CEED science has extended the field and serve up case studies demonstrating the value of good environmental decision-making.

Each chapter will also provide content feeding into a range of other communication outputs such as policy briefs, short videos and, down the line, an online environmental decision science course. You can also see elements of each chapter in a new series of *Decision Point* articles on the basics of good environmental decision making. That series kicks off in this issue of *Decision Point* with David Lindenmayer presenting the case for long-term ecological research providing an evidentiary base for good management and policy – more important than ever in a 'post-truth' world (see page 12).

So, what is the key to good environmental decision making? Having been a privileged observer of the science being developed by CEED over the past decade (as the Editor of *Decision Point*), I have to say that my answer to this has changed. Here is my take on environmental decision science 101.

As a younger man I believed a good environmental decision was one that generated a good outcome (saved a species over here, protected valuable habitat over there). While I still think a good outcome is important, it is possibly secondary to the process by which it is generated. A good decision for the environment is one that is transparent, efficient and effective; that came about with real stakeholder engagement and support; one that enables learning; and something that serves as a stepping stone to even better decisions down the line.

How is this achieved? Read the book and find out (and continue to read *Decision Point*).

David Salt
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Ethics, equity and a 'good' environmental decision

Ethics and environmental decision science

By Kerrie Wilson & Elizabeth Law (University of Queensland)

When researchers hear the word 'ethics' they often groan. That's because the term usually arises in connection to ethics committees; panels which university-based scientists need to go through to get permission to undertake research. They 'groan' because it's another transaction cost on getting their research done. Having said that, every 'good' researcher also acknowledges how important this process is – it's the basis of their societal permission to do research.

Just as the notion of 'ethics' underpins the legitimacy of our research, ethical philosophies permeate our science in many fundamental ways. For example, it influences our choices about what to study and how we frame conservation problems. Social ethics is one of the defining features of the 'new conservation'. It is therefore becoming increasingly critical to understand the interplay between ethical considerations and environmental decision making.

An important ethical consideration that demonstrates this is the idea of equity. CEED researchers have been attempting to incorporate equity into environmental decision frameworks over many years. In simple terms, it refers to fair or just treatment of individuals or groups. It can range from consideration of procedures and the distribution of resources, to the recognition of stakeholder values and knowledge. Equity is multidimensional and means different things to different stakeholders. Just like the idea of 'biodiversity', equity is not a single thing.

There are also many possible motivations for engaging with equity when working in conservation decision-making. Sometimes these motivations are divided into two themes: fundamental (virtues) or outcome-based (social or environmental). Fundamental motivations perceive equity as inherently right or valuable, whether it leads to support for conservation or not. In contrast, outcome-based motivations see equity as instrumental to achieving desirable ends.

For example, increasing the equity of decision-making processes may facilitate greater acceptance by the community of conservation management decisions and this can result in a higher likelihood of success for the policy being implemented.

And it's important to note that it is possible to be motivated by multiple fundamental and outcome-based rationales simultaneously.

As equity is seen as both a virtuous policy ideal in itself and instrumental to the success of conservation, it is no surprise that equity has become embedded in many national and international conservation agreements. However, these policies often lack the conceptual and methodological clarity required to deliver equity in practice. For instance, Aichi Target 11 (part of the Convention on Biological Diversity, see *Decision Point #100*) specifies that networks of protected areas must be "equitably managed", yet no operational definition of equity is provided.

This emphasizes that equity is a highly normative and multifaceted concept. As a policy or program goal, it can be highly contested and problematic to implement. In the domain of conservation research our attention to date has largely been focussed on considerations of distributional equity. This has limited the appreciation of equity and ethical considerations in some environmental decisions.

We also need to recognise that decisions are not just an application of rationality: ethical considerations are critical for framing the problem, for example when comparing different options for prioritising species conservation given limited budgets (a process often referred to as 'conservation triage'). It may be that different approaches to conservation triage (rights vs outcomes) create conflict that is ultimately irreducible given different ethical perspectives. However, we have recently shown how these ethical controversies could be minimised with greater attention to the wider decision environments (Wilson & Law, 2016).

We show how conservation triage can be more acceptable, by addressing distributive justice, respecting autonomy, placing triage in a broader system of care, explicitly dealing with risk and risk preferences, and questioning whether these normative ideals are delivered in practice.

Our reflection here doesn't answer all the questions emerging when discussing ethics and environmental decision making, if anything it just raises more questions. What we hope it does demonstrate, however, is that when it comes to exploring good environmental decision making, we can't afford to leave ethics out of the equation.

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Reference

Wilson KA & EA Law (2016). Ethics of conservation triage. *Front. Ecol. Evol.* http://dx.doi.org/10.3389/fevo.2016.00112

The ethics of offsetting

For a demonstration of the importance of ethics in developing our decision frameworks, consider offsetting. Biodiversity offsetting is transforming conservation practice around the world (see *Decision Point #85*). Development activities that degrade or destroy biodiversity at one location are now increasingly acceptable because of compensatory environmental gains generated elsewhere. This change represents a major shift in how nature is protected, and yet its philosophical justification has received little attention. Chris Ives and Sarah Bekessy from RMIT argue that biodiversity offsetting aligns most easily with a utilitarian ethic, where outcomes rather than actions are the focus. However, offsetting schemes often neglect to account for the multiple values that people assign to biodiversity – including unique, place-based values. Furthermore, the implications of defining nature as a tradeable commodity may affect our sense of obligation to protect biodiversity. Ironically, offsetting may exacerbate environmental harm because it erodes ethical barriers based on moral objections to the destruction of biodiversity. By failing to consider the ethical implications of biodiversity offsetting, we risk compromising the underlying motivations for protecting nature.

Reference

Ives CD & SA Bekessy (2015). The ethics of offsetting nature. *Frontiers in Ecology and the Environment* 13: 568–573. http://onlinelibrary.wiley.com/doi/10.1890/150021/abstract

To weed or not to weed…

Impacts of reveg and weed control on urban-sensitive birds

By Carla Archibald (University of Queensland)

Above: One bird's 'weed' is another bird's refuge. Lantana, pictured here, is widely recognised as an undesirable and noxious invading weed, and its removal is often the aim of many restoration efforts. New research is suggesting this is not helping many species of urban-sensitive bird such as this chestnut-breasted manikin.
(Image by Esther Horton - Van Der Woude)

Urbanisation is a driver of bird declines in many cities. Land managers often manage green spaces as wildlife refugia. We examined the value of some of these refugia and found that not all forms of vegetation restoration serve the needs of the bird species we would like to retain in our cities. Our analysis suggests that there needs to be careful thought about which bird species are the targets of our conservation efforts prior to implementing them.

Native bird species are in decline in many parts of our landscapes. That decline is even visible in our own back gardens. Urban development, through intensification and expansion, poses a serious threat to wildlife living in green spaces scattered around cities. Protecting and restoring green spaces is important, as cities often overlay highly productive areas that are hotspots for biodiversity. Retaining our native bird species is important in itself, and it's also one way to connect people to nature, and to promote a conservation ethic among society.

Habitat restoration is an activity often undertaken by local councils, non-government organisations and environmental consultancies. A common goal often cited in these efforts is to 'increase biodiversity'. This goal is vague at best, as clearly some species can be viewed as more valuable conservation targets than others. Increasing populations of common birds like noisy miners and magpies, probably isn't synonymous with increasing small song birds like fairy wrens and silvereyes. It is important to identify how individual bird species and groups of birds are interacting with habitat restoration actions to ensure these efforts are promoting the species which we want to inhabit our urban parks.

Habitat restoration is expensive to implement and such effort is expected to benefit urban bird diversity. However, birds known to be sensitive to urbanisation may not be interacting with restoration in the ways we anticipate. For example, controlling weedy plant species, such as lantana, and revegetating with native species are two common restoration actions but how do they benefit different bird species? We wanted to know if these restoration actions are benefiting birds that find living in cities difficult; or if they simply benefit those species that have adapted well to urban environments (species that already call cities their home).

Key messages:

- Birds with varying sensitivities to urban areas interact with habitat restoration differently
- Reveg provides the greatest benefit for urban-sensitive species, and weed control provides neutral or in some cases negative outcomes
- Weed control should be implemented in concert with replanting of native vegetation to provide understory structure

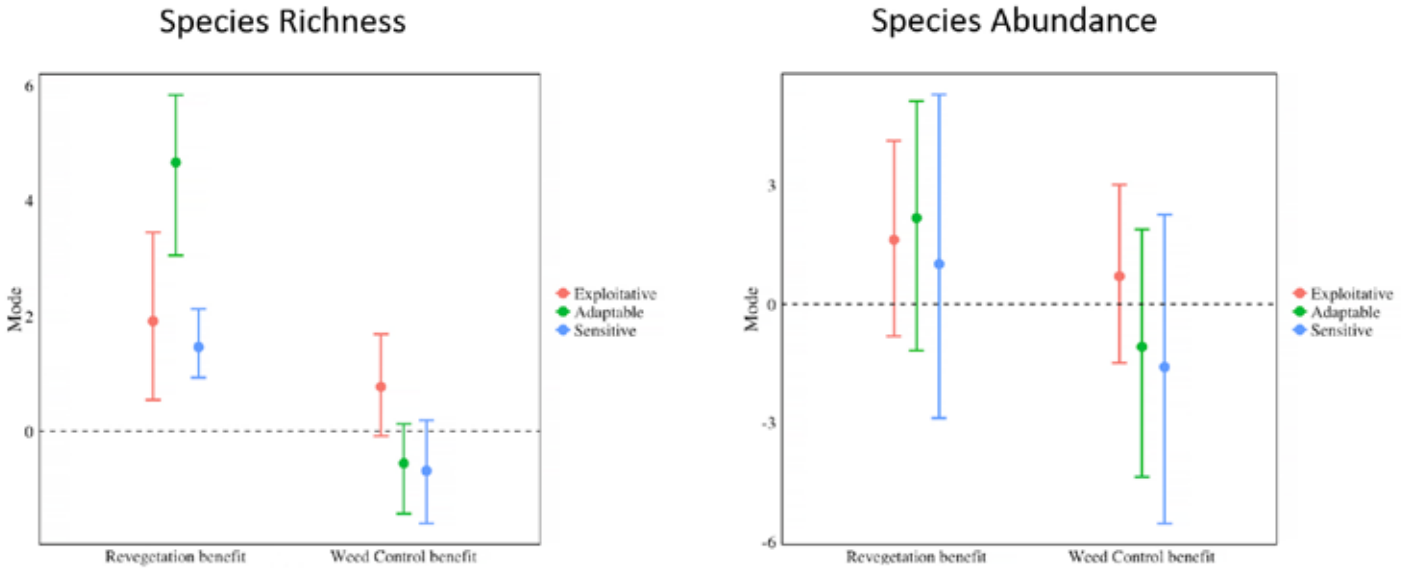

Figure 1: Species richness (a) and species abundance (b) of birds in the three urban classes for each restoration type—weed control and revegetation. Values represent mean and credible intervals, where by the proportion of the line above zero indicate positive responses to the treatment, and values below the line indicate negative responses. (From Archibald et al, 2017)

To answer this we surveyed birds in restoration sites in Brisbane. These sites are owned by local councils and maintained by community members and the main form of restoration they have experienced are revegetation and weed control. We then applied a hierarchical community model to estimate the response of different bird groups to these management actions. The three groups we examined were classed as: urban exploitative, adaptable and sensitive bird species. This allowed us to create probability curves of individuals and species group responses to urban restoration. Providing probabilities of 'success' for individual species and species groups expands the information available to land managers within their decision-making space.

We found that birds most reliant on nature in cities do not seem to benefit in patches that have been controlled for weeds, while birds which exploit the urban environment do benefit. These shifts in diversity might relate to the possibility that shrubby habitat, whether they are native plants or exotic weeds, are needed by bird species that are sensitive to urban landscapes. Or it could be an effect of territorial species such as noisy miners infiltrating and displacing birds in these areas. This could have serious implications for urban bird diversity, which may have flow on implications to the way in which cities experience and relate to nature.

Revegetation, on the other hand, seems to benefit all groups of species, even though some individual species may suffer declines in abundance.

Habitat restoration is a common conservation practice in cities; and we put a lot of time, money and effort into making it happen (especially in community managed spaces). To achieve a greater conservation benefit from these areas, especially for birds that rely on these greenspaces, a change in the way we implement these actions is needed. To increase bird diversity within cities, we need to disentangle the effect of different types of habitat restoration and make sure we are managing these areas with urban-sensitive species in mind.

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Reference

Archibald CL, M Mc Kinney, K Mustin, DF Shanahan & HP Possingham (2017). Assessing the impact of revegetation and weed control on urban sensitive bird species. *Ecology and Evolution* 00: 1–10. https://doi.org/10.1002/ece3.2960

A silvereye amidst the (lantana) thorns. (Photo by Jasmine Zeleny)

Using range maps to plan protected areas

Trade-offs in the use of species distribution maps for protected area planning

By Moreno Di Marco (University of Queensland)

From the local to the global scale, conservation decisions are heavily influenced by the knowledge of where species are found. Maps of the geographic range of species (or simply 'range maps') are typically used to determine the overlap between threatened species and protected areas, and to find new places in need of protection.

However, range maps are usually incomplete and often contain errors. Commission errors are where species are supposed to be present in locations where they are actually absent, and omission errors describe the opposite situation, where species are mapped as being absent when in fact they are present.

Commission errors are particularly worrisome in conservation because they can lead to a false perception of species protection – ie, that a species is better protected than it actually is. They can also steer conservation investment toward areas of little conservation value, where species are not present.

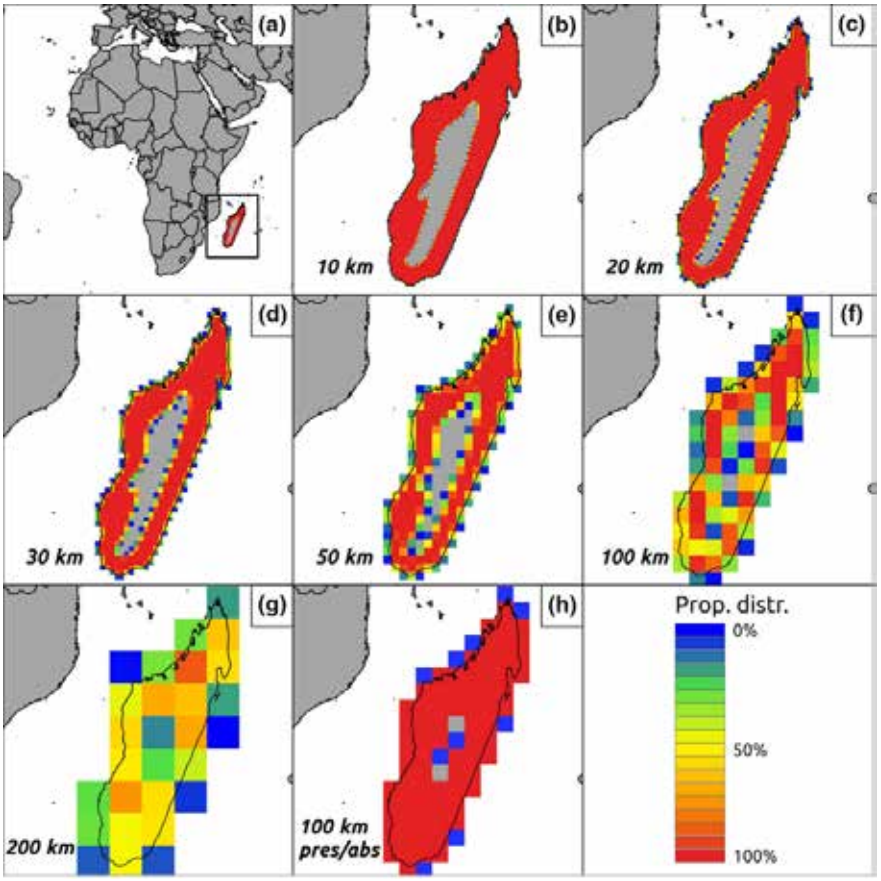
Habitat suitability models can be used to reduce the effect of commission errors by removing from a range map those areas which are considered unsuitable for the species. However, habitat models are data demanding and their use is not always possible, especially for analyses focused on many species.

Key messages:

- Planning for new protected areas using range maps can lead to overestimating the level of protection, due to commission errors
- The adoption of a coarse analytical resolution can slightly mitigate this effect but leads to inefficient planning
- Intermediate resolutions are the best compromise to reduce commission errors while maintaining efficient planning

Another method for reducing commission errors is by using a coarser analytical resolution. For example, if a range map uses coarse grids (100-200 km squares), the probability of including unoccupied grid cells is reduced. Commission errors are averaged out. Unfortunately, the adoption of a coarse resolution also affects the efficiency of a conservation plan (ie, the ability to select a minimal additional area to be protected for achieving an adequate representation of all species).

While the problem of commission errors in range maps has long been known, the size of the trade-offs (ie, what is lost and gained through the use of coarser analytical resolution), has never been quantitatively explored. We set out to fill this hole by performing a set of analyses comparing protected-area planning for the world's threatened terrestrial mammals at various resolutions. We compared species range maps with habitat models to show the difference between protected species ranges and protected habitats (Di Marco et al, 2017).



Spatial distribution of the fossa (*Cryptoprocta ferox*), a threatened mammal (a cat-like, carnivore closely related to the mongoose) endemic to Madagascar (pictured on the right, image by Chad Teer, CC BY 2.0). Panel (a) shows the global location of the species range. Panels (b–g) show the proportion of species geographic range within grid cells at various resolutions (from 10 km to 200 km). Panel (h) shows a binary reclassification (presence/absence) of the species range at a 100 km resolution; in this case a cell was considered to be entirely occupied if 5% or more of its area overlapped with the species range, and entirely unoccupied otherwise.

Our analysis involved a global conservation planning analysis. We began by using range maps from the IUCN for the world's 1,115 species of threatened terrestrial mammals. When employing a resolution of 10 km per map square, a global protected area expansion of 3 million km^2 (an area almost the size of India) would suffice to achieve adequate protection for all the species.

However, if you used habitat models to determine what parts of that designated extra protected area was actually unsuitable for the species it was supposed to protect, you find a shortfall of 28 species (ie, species that appear to be adequately protected by their ranges, but not by their habitats).

At a coarser resolution of 200 km (per map grid), the shortfall for an equal figure of protected area expansion would be just 7 species. At this coarse resolution it was also twice as likely (80% vs 40% at a 10 km resolution) that the priority grids for the protection of species ranges were also considered a priority for protecting species suitable habitats. However the adoption of a 200 km resolution lead to the selection of a total of 12 million km^2 of protected area in order to achieve adequate coverage for all species, which is four times larger than the area selected under a 10 km resolution.

We believe these findings demonstrate that adopting coarse resolutions in protected area planning results in an unsustainable increase in costs, with limited reduction in the effect of commission errors in IUCN range maps. Given this, we recommend that, if some level of uncertainty is acceptable to managers, using range maps at resolutions of 20–30 km is the best compromise for reducing the effect of commission errors while maintaining cost-efficiency in protected area planning analyses.

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Reference

Di Marco M, JEM Watson, HP Possingham & O Venter (2017). Limitations and trade-offs in the use of species distribution maps for protected area planning. *J Appl Ecol* 54: 402–411. http://onlinelibrary.wiley.com/doi/10.1111/1365-2664.12771/full

Editor's choice

The Editor of the *Journal of Applied Ecology* was very impressed with the analysis undertaken by Moreno Di Marco and his colleagues. So much so that he made this paper the Editor's choice in issue 54. Below is an excerpt from the Editor's blog. Read the entire blog at https://jappliedecologyblog.wordpress.com/2017/03/17/editors-choice-542/

"Protected Areas have been the 'big idea' of biodiversity conservation over the last one hundred years. The total area and the number of protected areas have increased dramatically from a handful in the 1900s to over 160 thousand covering over 28 million square km today. However, they still only cover about 5.6% of the earth's surface which is not sufficient to slow down the extinction crisis.

Setting up new protected areas is a challenging task. One of the important aspects of the process is to minimize costs of effectively protecting an area with choosing an area to maximise the biodiversity inside. Di Marco et al (2017) have made a valuable contribution to this optimisation problem. This paper is a fine example where a global-scale analysis has very practical value for site-specific conservation challenges such as protected area planning. Di Marco et al also pave the way for future work to analyse the trade-offs for less-studied groups of species such as amphibians, reptiles and insects."

Prescribed burns for multiple objectives

Fire management for asset protection and the environment

Reducing fuel around assets is considered a good hazard-reduction strategy, however, a more effective approach may be to burn for a mosaic throughout the ecosystem. This may reduce the overall fuel of the system, as well has have added benefits for the environment.

Land managers and scientists increasingly recognise the importance of identifying areas for burning that not only reduces fuel load around assets, but also effectively reduce the overall fuel load of the system.

CEED researchers are helping in identifying these areas by developing a decision-support framework for planning prescribed burning. They have applied this to the dry sclerophyll forests of southeast Queensland in collaboration with the City of Gold Coast (Williams et al, 2017). The team has quantified the trade-offs between asset protection and conservation objectives and show that it is possible to achieve good outcomes for conservation with minimal impact on asset protection.

Their framework also improves asset protection by identifying a better distribution of prescribed burns in space and time. This work provides a transparent, objective and flexible framework that can be applied to many different prescribed burn scheduling problems at large spatial scales.

Reference

Williams BA, LP Shoo, KA Wilson & HL Beyer (2017). Optimising the spatial planning of prescribed burns to achieve multiple objectives in a fire-dependent ecosystem. *J Appl Ecol* http://onlinelibrary.wiley.com/doi/10.1111/1365-2664.12920/abstract

Introducing CEED Research Briefs: If you would like to read more about this research, check out our new CEED Research Brief on Williams et al, 2017. This is the first in a series of research briefs that CEED will be posting on its website over the coming months. http://ceed.edu.au/resources/research-briefs.html

Grow your own

Wildlife gardening for public–private biodiversity conservation

By Laura Mumaw (RMIT University)

Involving communities in appreciating and caring for nature is a key goal in most conservation strategies. Yet, how is this achieved, particularly in cities where 'nature' is sometimes hard to come by? Wildlife gardening is one commonly suggested solution but what ingredients make for a successful program?

Although the urban landscape is dominated by human activities and cannot be restored to a wild state, the persistence of native flora and fauna can be fostered. Effective native-species conservation requires sympathetic management of plots of public and private land in a way that protects and improves patches of native habitat (generally on public land). This is enhanced by establishing protective buffers around them and improving connectivity between them through corridors and stepping stones in residential and other land-use areas.

Residents may feel this is the responsibility of experts and parks staff, or that they have little to offer. Yet residential gardens are important: they make up a large proportion of urban land, many community members have them, and they can provide habitat that is important for the survival of native species.

Above: The superb fairy-wren feeds on insects and small grubs, and will often appear in small groups in gardens with dense, low, native shrub cover. (Image by Geoff Park)

Unfortunately, there is currently little guidance about how best to involve residents in wildlife gardening and align their work with public land management.

To help fill this hole, we looked at how a partnership between a local council (Knox City Council) and community group (Knox Environment Society – KES) in greater Melbourne involves residents in gardening to help conserve the biota native to the municipality. The wildlife gardening program, Knox Gardens for Wildlife (G4W), began in 2006 and currently has over 700 participating households (see http://www.knox.vic.gov.au/g4w).

We interviewed sixteen G4W members of varying ages, backgrounds, gardening experience, property characteristics, and time in the program to understand what program features motivated and supported them to change their gardening to assist the Council and KES to foster locally native (indigenous)

Key messages:

Five features help collaborative wildlife gardening programs engage residents to manage their land to achieve landscape-focused conservation goals -
1. on-site garden assessment
2. indigenous community nursery
3. communication hubs
4. a framework that fosters experiential learning and community linkages
5. endorsement of each garden's potential conservation contribution

species. We supplemented the interview data with a Council survey of the G4W membership.

So, what motivates people to make an effort to get into wildlife gardening? We found that program features instrumental in supporting wildlife gardening are an inspiring, face-to-face garden assessment; a community nursery to which members can return to for advice and support; communication hubs, including the nursery and Council offices; a framework that fosters experiential learning and community linkages; and endorsement by Council and KES of each garden's potential conservation contribution. Interviewees with or without prior intention or knowledge of wildlife gardening became involved; what was common to all of them was an interest in keeping a garden.

We conclude that wildlife gardening programs with community features can engage urban residents to manage their land to help council and community to conserve indigenous biota. The hands-on involvement of community members and local government is critical to stimulate interest and support for municipal biodiversity conservation. Beyond stimulating and supporting members to wildlife garden, the program builds relationships between participating members, the community group, and council around a shared interest in fostering the municipality's wildlife.

In part informed by research from this study, a pilot program, Gardens for Wildlife Victoria, has been initiated to support urban local government-community group partnerships to engage local residents in caring for nature through gardening and other habitat-improvement activities. A consortium that includes the Victorian Department of Environment, Land, Water and Planning (DELWP), a regional catchment management authority, and local government and community group members has been established to lead the initiative. Their intent is to help make Victoria's new biodiversity strategy understood and pragmatically applied in urban communities, and to develop research tools and knowledge about how to facilitate community engagement in fostering biodiversity while strengthening social cohesion.

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Reference

Mumaw L & S Bekessy (2017). Wildlife gardening for collaborative public–private biodiversity conservation. *Australasian Journal of Environmental Management*. http://dx.doi.org/10.1080/14486563.2017.1309695

Wildlife gardening

Wildlife gardening is more than simply sticking in a few natives (though this is often a good starting point). It includes removing environmental weeds, planting indigenous species (that's not just any old native but native species that grow locally) and encouraging vegetative structure (for example prickly thicket for small birds), retaining nesting trees and hollows, adding water features, and preserving self-seeding indigenous species. (Photos by Laura Mumaw)

Urban development and the growling grass frog

Good decisions under high uncertainty

By Lucy Rose (University of Melbourne)

How do we choose among conservation options when resources are scarce and there is uncertainty regarding the effectiveness of actions? It's the core challenge of good environmental decision making and its dimensions make more sense when applied to a specific situation. In this case we wanted to explore what actions would give the endangered growling grass frog (*Litoria raniformis*) a better chance of persisting in the developing urban zone around Melbourne.

We tackled this by linking population viability analysis (PVA) with a cost-effectiveness analysis (CEA) (Rose et al, 2016). While this is an approach that has been used in other places, we found that no one had adequately accounted for uncertainty in such an integration.

Well-developed tools exist for prioritising areas for one-time, binary actions such as making a plot of land a protected area (or not), but methods for prioritising incremental or ongoing actions (such as creating or maintaining habitat) remain uncommon. We devised an approach that combines metapopulation viability and cost-effectiveness analyses to select among alternative conservation actions while accounting for uncertainty.

In our study, cost-effectiveness is the ratio between the benefit of an action and its economic cost, where benefit is the change in metapopulation viability. And the metapopulation we were interested in was of the endangered growling grass frog, which is threatened by urban development. The area we focused on was zoned for urbanization in the rural north of Melbourne.

The growling grass frog is one of Australia's largest frog species. It likes to live amongst reeds, sedges and rushes growing in and along slow moving streams, ponds, lakes and farm dams. (Photo by Geoff Heard).

Key messages:

- We linked a PVA with a CEA to determine which actions would best help the growling grass frog persist in a development zone
- Our approach allows uncertainty in species persistence to be explicitly accounted for in the CEA of different actions
- This analysis found that simply reserving core habitat for the frog entailed high risk
- Creating and maintaining wetlands dedicated to the growling grass frog was a better way to go

We extended this analysis by using a Bayesian model to predict metapopulation viability under nine urbanization and management scenarios and incorporated the full probability distribution of possible outcomes for each scenario into the cost-effectiveness analysis. This allowed us to discern between cost-effective alternatives that were robust to uncertainty and those with a relatively high risk of failure.

We found a relatively high risk of extinction following urbanization if the only action was reservation of core habitat (which is often the only thing that happens in these situations). Actions that foster the creation of habitat performed better than enhancement actions; and cost-effectiveness ranking changed depending on the consideration of uncertainty.

Our results suggest that the creation and maintenance of wetlands dedicated to the growling grass frog is the only cost-effective action likely to result in a sufficiently low risk of extinction in this case. To our knowledge we are the first study to use Bayesian metapopulation viability analysis to explicitly incorporate parametric and demographic uncertainty into a cost-effective evaluation of conservation actions. The approach offers guidance to decision makers aiming to achieve cost-effective conservation under uncertainty.

The most satisfying outcome from this work is that it has had a real influence on the decisions made by key decision-makers involved in the case study. Both Melbourne Water and the Victorian Government have read the work and contacted me on advice about how to modify plans in the area so that our findings are taken into account.

This gives the growling grass frog a far greater chance of hanging in there. It also highlights the importance of strengthening networks and sharing knowledge between practitioners, government and academia. In addition to making the findings public through the traditional peer-reviewed publishing process, direct communication with Melbourne Water at the beginning and end of the study (through discussions and a presentation) drove changes in decision-making.

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Reference

Rose LE, GW Heard, YE Chee & BA Wintle (2016). Cost-effective conservation of an endangered frog under uncertainty. *Conservation Biology* 30: 350–361. doi: 10.1111/cobi.12626 http://onlinelibrary.wiley.com/doi/10.1111/cobi.12626/abstract

Telemetry technology for better conservation

Integrating animal-borne technology with conservation management

By Jennifer McGowan (University of Queensland)

Animal-borne telemetry has revolutionised our ability to study animal movement, species physiology, demography and social structures. It has given us brilliant new insights into how animal behaviours respond to changing environments and has enabled us to better understand threats that animals are experiencing. And yet, for all that, we are still seeing catastrophic declines in biodiversity. Which prompted us to ask: Is our fabulous telemetry technology contributing to better environmental decision making?

While there will always be a need for basic ecological research, the current conservation crisis demands we look more pragmatically at the data required to make informed management decisions. Given the potential of telemetry-derived data to inform conservation decisions, and the various costs involved in collecting these data (eg, financial costs of equipment and salaries, impact on mortality and reproduction of animals involved), it is important to evaluate the conservation benefit of these research techniques.

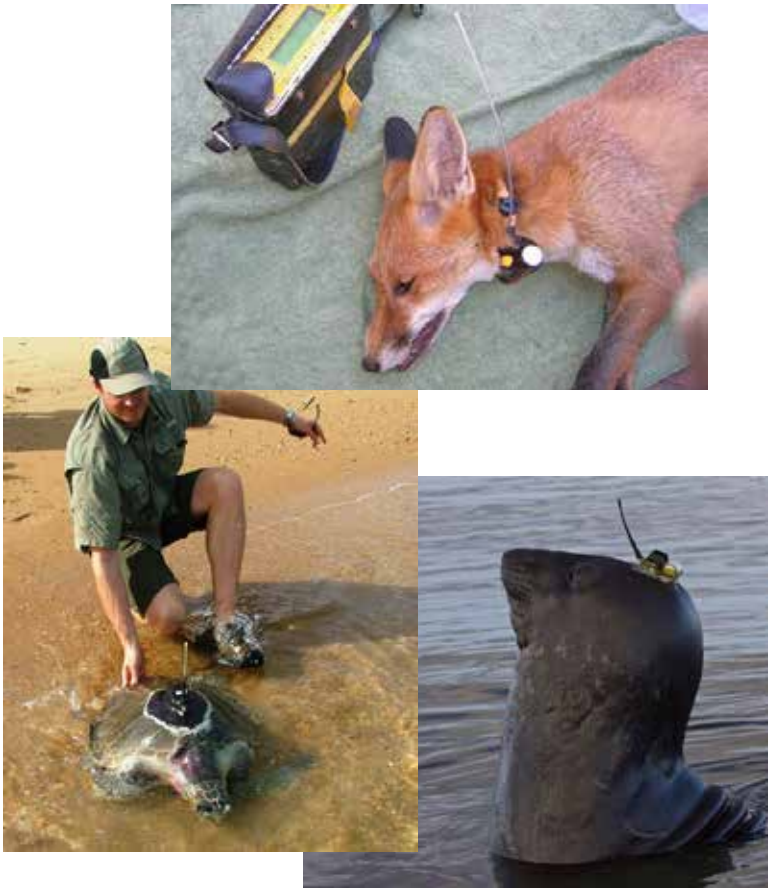
We recently reflected on what might be the essential elements of such an evaluation (McGowan et al, 2017). We defined a framework that distinguishes how research using animal telemetry devices can influence conservation. In the process, we came up with two critical questions for any researcher looking to use telemetry devices to address conservation challenges:
1. Would my choice of action change if I had more data? And
2. Is the expected gain worth the money and time required to collect more data?

The fundamental issue involves linking telemetry-derived data to conservation decision-making by explicitly reducing uncertainties concerning management actions relating to where, when and what (where do we act, when and how in order to maximise net benefits to species?)

First, we challenge the assumption that more data will invariably lead to better management. Then we argue for the systematic incorporation of value-of-information analysis to answer these questions (See *Decision Point #67*).

Our objective is to encourage researchers utilising telemetric technology with an underlying conservation rationale to target their research towards gathering information that is more likely to change actions and maximise species persistence. Our approach helps those thinking they need to use animal telemetry technologies to decide what are the most useful studies to pursue.

To frame the application of telemetry-derived data to conservation management and policy, we note that threats to species viability fall into three broad classes where management actions can intervene: species demographics (birth and death); the amount and quality of available habitat; and connectivity – the ability of a species to colonise or recolonise vacant habitat, or 'rescue' a dwindling population. We highlight the conservation opportunities telemetry-derived data provides and offer specific examples of how telemetry data enables managers to choose between conservation actions that abate threats and deliver outcomes for conservation objectives.



It is indisputable that animal-borne telemetry has enriched our understanding of the natural world and the animals that inhabit it. But could it also be providing a better guide to environmental decision making? (Images: Fox by Catherine Lynch; turtle by Hamish Campbell; and seal by Clive McMahon)

Given the global investment in telemetry devices for threatened species, we have an ethical and practical obligation to maximise this investment's benefit to conservation. To improve the conservation return-on-investment in these techniques, we need new tools and frameworks to effectively link the growing catalogue of animal telemetry-derived data to conservation and management.

Key messages:

Research using animal telemetry devices can influence conservation decisions, and should be better integrated with management and policy

Value-of-information analysis enables a quantitative assessment on the return-on-investment of animal telemetry-derived data for conservation decision-making

More info: Jennifer McGowan j.mcgowan@uq.edu.au

Reference

McGowan J, M Beger, RL Lewison, R Harcourt, H Campbell, M Priest, RG Dwyer, HY Lin, P Lentini, C Dudgeon, C McMahon, M Watts & HP Possingham (2017). Integrating research using animal-borne telemetry with the needs of conservation management. *J Appl Ecol* 54: 423–429. http://onlinelibrary.wiley.com/doi/10.1111/1365-2664.12755/abstract

Five things about long-term monitoring

Good decisions for the environment need an eye on the longer term

By David Lindenmayer (The Australian National University)

(Above) Billions of dollars have been invested in large-scale restoration programs across farming landscapes in Australia and overseas. Some projects involve the protection of remnant native vegetation, others involve linear or block plantings of native trees. Some involve innovative mixes of native and traditional crops. Which approaches work? Which designs are most cost effective and enduring? Long-term monitoring can generate the evidence on which to judge these programs and build better policy (evidence-based policy). Unfortunately, long-term monitoring for such programs is more the exception than the rule. (Image by Dean Ansell)

Effective long-term environmental monitoring is difficult and challenging; it requires good design, careful review, long-term commitment, and often gets overlooked when resources are handed out by our political leaders. Given this, why bother? We bother because long-term monitoring is the cornerstone of effective environmental policy and management. In a 'post-truth' age witnessing a crisis in biodiversity decline, long-term monitoring is something we can't afford not to do.

But, if you are going to do it, it needs to be done properly. Here are five things that you should keep in mind in any consideration of long-term monitoring.

1. Evidence-based policy needs long-term monitoring

The mantra of modern governments and other bodies responsible for managing natural resources (including biodiversity) is that both management and policy must be 'evidence based'. In a world in which 'truth' is constantly under attack the need is only greater, but where does that evidence come from. Long-term monitoring is often the essential source.

In terms of biodiversity, long-term monitoring is often needed to measure change in a given entity (such as a population of a species or the condition of an ecosystem), but also to measure how those entities change in response to some kind of management intervention (like pest control or habitat enhancement). Long-term monitoring is essential to determine if actions taken to manage the environment are effective, and therefore whether decisions made to invest in particular actions are vindicated (or whether different interventions are needed).

Key messages:

- Long-term monitoring provides essential evidence on which to base good environmental decisions
- Good design is essential for effective long-term monitoring
- Things change over time; to remain effective, long-term monitoring needs to adapt around these changes
- Partnerships are crucial for ensuring long-term monitoring is maintained and listened to
- Long-term monitoring is most effective where it is complemented by other value frames (such as economics)

What is long-term monitoring?

There are many formal definitions of what constitutes long-term monitoring but a good rule of thumb I apply is that it is any investigation involving repeat measurement that has been running continuously for ten or more years. Ten years is not a magical number separating 'short-term' from 'long-term', however monitoring programs that have run for longer than ten years usually have a 'long-term' framing aimed at capturing trends and variability that are often not evident in shorter programs.

The problems of not conducting long-term monitoring are evident from many failed environmental programs, including those in which very large investments were made.

For example, despite billions of dollars of investment in river restoration programs in the USA, a paucity of robust long-term monitoring made it impossible to determine whether such restoration efforts had been effective. Likewise, the effectiveness of billion dollar agri-environment schemes to better manage biodiversity and other conservation values in farming landscapes in Europe and North America is poorly known because of a lack of long-term monitoring. Similarly, large-scale restoration programs funded by Australian governments remain poorly monitored (if monitored at all). This fundamental oversight leads to ineffective programs, vast amounts of wasted taxpayer funding and a public misperception that environmental problems cannot be resolved.

2. Effective long-term monitoring is built on good design

Long-term monitoring programs need to be underpinned by good design if they are to generate data that can guide effective environmental decisions. And that design begins with asking what the monitoring will actually be used for. And, if there is no intention on the part of managers to change their management or if there is no capacity to learn from the monitoring results, then a monitoring program may not even be appropriate (see *Decision Point #52*).

If there is capacity to learn and a willingness of managers to respond, then there are some fundamental ingredients which contribute to good monitoring design. These include:

a. Careful articulation of the objectives of monitoring, with all partners being clear about the aims and objectives.

b. Good and tractable questions of management relevance (often being informed by a well-developed conceptual model of the system being monitored).

c. Implementation of a robust statistical design (that answers key questions).

d. Regular assessment of the data gathered (to ensure errors in a dataset are corrected or key missing variables can be gathered).

e. The inclusion of trigger points for action if major changes occur in the system being monitored.

Conversely, long-term monitoring programs established without these considerations can result in an expensive waste of resources.

3. Adaptive monitoring can be essential

Things change, it's a given. It's better to adapt to changes than stick with a monitoring program that is no longer relevant.

Often there is a need to change the questions being posed over time and/or change the underlying experimental design in response to those changed questions. Or there might be other reasons for change like the development of new technology that requires altered field-based measurement protocols.

Poor earlier policy and/or management decisions also might

Part of the long-term monitoring program established for the Environmental Stewardship Program. (Image by David Salt)

Adaptive monitoring and the ESP

The Environmental Stewardship Scheme (ESP) was established to assess the effectiveness of management interventions associated with a major agri-environment scheme in the temperate woodlands of eastern Australia. Farmers are paid to carry out specific management actions to improve the condition of patches of endangered Box Gum Grassy Woodlands (BGGWs) on their land. The ESP comprises a total of 158 farms in a region stretching over 2000 km (south to north). A patch of BGGW targeted for stewardship management on each of the 158 farms is also targeted for monitoring with a matched control patch (where no stewardship management occurs) also monitored on each farm.

The budget for the monitoring was initially substantial as the government agency responsible for the ESP demanded that every patch on every farm be monitored every 1-2 years. However, funding cuts occurred four years into the 15-year program (as is often the case with long-term environmental programs). Adaptive monitoring had to be adopted to prevent the entire monitoring effort collapsing. A rotating sampling monitoring approach was introduced in which 65% of farms were surveyed in any given year with a complete 'census' of all farms undertaken twice in four years. (Lindenmayer et al 2012)

The emphasis of monitoring switched from an assessment of compliance for implementing particular kinds of conservation management to an estimation of changes in condition across a large 'population' of sites. Importantly, recent analyses of the data gathered in the monitoring program show that stewardship management is leading to significantly improved woodland condition and also increases in biodiversity.

Reference

Lindenmayer DB, C Zammit, SA Attwood, E Burns, CL Shepherd, GE Kay & J Wood (2012). A novel and cost-effective monitoring approach for outcomes in an Australian biodiversity conservation incentive program. *PLOS One* 7:e50872.

create extra cascading environmental problems, demanding a reworking of the original scope of a monitoring program. An adaptive monitoring approach may be required to redesign a pre-existing monitoring program so that it can answer new key questions of management relevance that are useful in guiding environmental decisions.

An example of adaptive monitoring comes from monitoring the Environmental Stewardship Program (see the box on the ESP).

4. Partnerships are critical

Effective long-term monitoring programs need good partners – partners that will help frame the purpose of the program, assist in translating the monitoring results into effective management decisions, and act as champions for the program to ensure it has a long-term future.

Partnerships between scientists, resource managers and policy makers can ensure that the key questions being addressed in a long-term monitoring program are management relevant but at the same time scientifically tractable. Partnerships also provide a vehicle for regular exchange of information and the opportunity to build a broad constituency to maintain long-term work. Such partnerships are essential to ensure that the evidence gathered from long-term monitoring can be widely communicated to those responsible for decision making; this may include engagement with the political process to inform ministers (and minster's advisors) on what the results of long-term monitoring are showing.

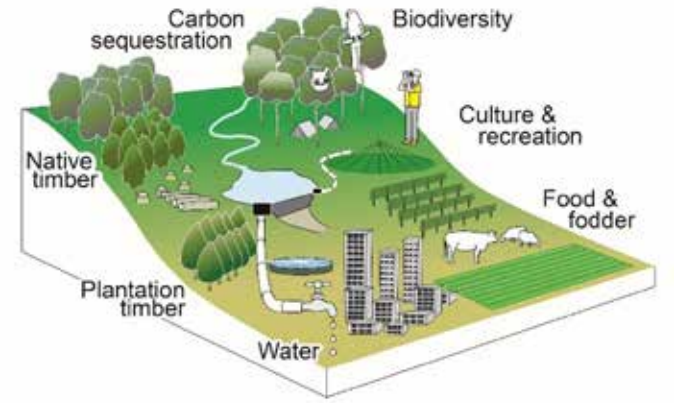
Considerable effort is needed to maintain the array of partnerships which underpin long-term monitoring and its link with effective environmental decision making. For example, the rapid turnover (churn) of staff within government agencies poses a particular challenge as champions for particular projects are needed to maintain them in the long term.

Considerable time often needs to be expended by the scientific leader of a long-term project to explain what the work aims to do, why it is important, why it is relevant to informed policy and decision making. This may need to be done repeatedly as new staff are recruited. Field trips to long-term monitoring sites can sometimes be particularly effective as these provide a practical and tangible context for how particular management problems are being examined and tackled through science-manager partnerships (Lindenmayer et al, 2013).

5. But remember, 'it's the economy, stupid!'

Many long-term monitoring programs focus on threatened species and ecosystems and we know from experience this is a good basis for deciding how to effectively manage these systems. However, when it comes to our political representatives, long-term biophysical evidence is often of secondary significance in the political calculus. They are more interested in what it means for their voters which is why when considering the outputs of long-term monitoring programs it's always valuable to consider how they can be integrated with other metrics relating to your system of interest. The environment is important but the social and economic dimensions of the system are possibly of greater significance when it comes to policy and decision making.

As an example, much has been written about the results of long-term ecological and environmental monitoring in the montane ash forests of the Central Highlands of Victoria (home to the Critically Endangered Leadbeater's possum and several other threatened species). Unfortunately, much of



Long-term biodiversity monitoring data enrich our understanding of the whole-of-landscape context for environmental accounting.

the conservation science generated over many years remains ignored. However, monitoring may have more traction with decision makers when key natural assets are monetized in economic and environmental frameworks like those developed by the United Nations, for example the System of Economic and Environmental Accounting (or SEEA).

The SEEA framework enables the 'value-added value' of industries based on natural resources like tourism, carbon, water and timber to be compared in a formal and internationally accepted accounting framework. When applied to the forests of the Central Highlands it showed that the value-added value of the native forest timber industry was approximately a tenth of the water industry ($124m) and less than a twentieth of the tourism sector ($260m). Decisions to maintain timber production (which undermines the value of the water and tourism industries) are therefore based on something other than rational economics.

Notably, in a communique from a 2016 COAG meeting, the Commonwealth Minister for the Environment and Energy and his State and Territory colleagues recommended that environmental accounting be widely applied and adopted in Australia. We suggest that the approach has the potential to add considerable value to datasets that are being gathered in environmental monitoring programs and provides a new way that such programs can help influence decision making.

Decisions and long-term monitoring

Long-term monitoring programs are often linked with many kinds of decisions; some associated with better informing on-the-ground management, others linked with changes in policies. There are also scientific decisions associated with the 'inner workings' of long-term monitoring programs such as the way they are designed or re-designed and how protocols for field measurements might be altered on the basis of the development of new techniques or the discovery of new problems (such as the colonization of new species of invasive organisms). The five themes discussed here can potentially influence each of these kinds of decisions and vice-versa.

Regardless of what influences what, the case for good long-term monitoring as an (evidence) base for better decision making is indisputable.

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References and further reading

Lindenmayer DB, D Blair, L McBurney & SC Banks (2015). Ignoring the science in failing to conserve a faunal icon – major political, policy and management problems in preventing the extinction of Leadbeater's possum. *Pacific Conservation Biology* 21: 257-265.

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Lindenmayer DB & GE Likens (2010). The science and application of ecological monitoring. *Biological Conservation* 143: 1317-1328.

Lindenmayer DB, M Piggott & B Wintle (2013). Counting the books while the library burns: Why conservation monitoring programs need a plan for action. *Frontiers in Ecology and the Environment* 11: 549-555.

15 years at Booderee

Strong and enduring partnerships have been at the heart of the success of the 15-year monitoring program at Booderee National Park (Lindenmayer et al, 2013). The data from the monitoring program have underpinned approaches to fire management by the resource managers of the park. For example, areas that have been subject to many previous fires are those where subsequent prescribed burning is avoided as long-term data shows that bird species richness at a given site is reduced for each additional time that area is burned (Lindenmayer et al. 2013).

Reference

Lindenmayer DB, C MacGregor, N Dexter, M Fortescue & P Cochrane (2013). Booderee National Park management: Connecting science and management. *Ecological Management & Restoration* 14: 2-10.

Booderee National Park ranger Nick Dexter (foreground) discusses Bitou bush control with scientists and managers during a science workshop in the park. The science/management relationship that has been cultivated at Booderee has made an important contribution to conservation outcomes in the coastal reserve. (Image by David Salt)

Virtually yours

Conferencing that won't cost the Earth

Ask any researcher: conferences are a vital part of science. And international conferences, such as the annual International Congress for Conservation Biology, can be especially important in that they offer an opportunity for scientists to present their research on an international stage, exchange ideas with the leaders in their field and develop networks that underpin their careers. And most big conferences also have a skill-development component as well. But conferences, and especially overseas conferences, come with costs. They can be very expensive to attend, and they come with a high environmental cost in the form of the carbon expended for delegates to travel internationally.

Have you considered the alternative: A conference that doesn't involve personal travel, a virtual conference? Two CEED ECRs, Hannah Fraser and Stephanie Avery-Gomm, have reflected long and hard on this idea. They believe that given the right preparation, the virtual conference has a lot going for it. Here they discuss some of the pros and cons with Stephanie explaining how the World Seabird Union has developed a Twitter conference that is really making a difference.

Virtual variety

By Hannah Fraser (University of Melbourne)

While it makes eminent sense, there has been limited uptake of virtual conference technologies in ecology and conservation (with the notable exception of the World Seabird Twitter Conferences, see Steph's story). In other fields, virtual conferencing is more common. The great thing about virtual conferencing is that the format is very flexible and only limited by the availability of time and money.

A range of services have been used for virtual conferences and some are even free (eg, secondlife, livestream.com, Twitter, Wordpress, and YouTube). Others come with a cost (eg, LabRoots, iCohere, and vConference online), and each has its own strengths and weaknesses.

The service that's the best will depend on the context of the conference and what it hopes to achieve. For example, if the budget is low, the conference is relatively small, free services like Twitter, YouTube and Wordpress can be suitable. However, if the budget is higher and the conference is larger, a proprietary service that provides IT support may be preferable.

Counting costs

Traditional face-to-face conferences are expensive and often require long-distance travel. This is particularly problematic for conservation when you add up the:

Dollars: Most conferences are held in developed nations where costs are high and the currency is strong. The cost of international flights, conference registration and accommodation can exclude researchers from developing nations where some of the more important conservation science is being conducted (Fraser et al, 2017).

Kilograms: Travelling long distances to conferences releases staggering amounts of CO_2 into the atmosphere. In 2008, the average attendee of an international conference created 849kg of CO_2 emissions. Academics from isolated countries, like Australia, emitted up to 1891 kg (Spinellis and Louridas 2013).

Virtual conferences have the potential to address both of these issues.

Another consideration when choosing (or creating) a service to host an online conference is how well it balances the two main limitations of virtual conferencing: reduced networking and, reduced opportunities for skills development.

Networking: Many people feel that virtual conferences provide fewer opportunities to network and that the opportunities they do provide may not yield the same. At a virtual conference you can't meet people in queues for lunch and you can't go for a drink with the people you do meet. On the other hand, the virtual context may take away some of the inhibitions surrounding talking with senior researchers.

All virtual conferencing services allow some form of discussion but some are less likely to supply networking opportunities than others. For example, the 'Climate Change: views from humanities' conference (part of the Environmental Humanities Initiative 2016) was hosted on Wordpress and included a number of keynote talks and a series of panels. The panels included live Q&A sessions where people could post questions in a forum for the speakers and expect a speedy response, though this was not available for keynote talks. However, the possibility for less formal discussions between attendees was limited.

In contrast, during the World Seabird Twitter Conference, people can ask questions about or comment live about each presentation and are easily able to contact other people (publicly or privately) who may be presenting or commenting on topics that interest them.

Skills development: One important reason for attending a conference is to prove to potential employers that you really do have the 'exceptional spoken presentation skills' that they ask for in job applications. Speaking at conferences backs up this claim as well as helping researchers to develop these important presentation skills. In most cases talks at virtual conferences are recorded without a live audience (often they are also pre-recorded).

When it comes to Twitter conferences, people don't speak at all. Neither option allows researchers to fully practice and prove their spoken presentation skills.

Both of these limitations could be addressed by developing a hybrid conferencing model where all attendees pre-record talks and then (if possible) travel short distances to local hubs. Attendees could then present their talk live to the local audience (in the same timeslot as their pre-recorded talk goes live) and network with local researchers face-to-face. This, of course, has higher overheads and still produces some carbon emissions, forcing conference organisers to make trade-offs between networking and skills development, cost and carbon emissions.

Virtual conferencing is all about trade-offs. The trade-offs made of each individual conference will be different depending on the size, budget and priorities of the conference. However, when it comes to minimising the impact on the environment, I think it's a trade-off worth reflecting on.

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Conferencing on Twitter

By Stephanie Avery-Gomm (University of Queensland)

I'd like to share with you one format of virtual conferencing that is proving both popular and effective – the Twitter conference.

Twitter is already a popular platform with many academics and we've found online conferences using this platform to be enormously successful.

Twitter conferences are an initiative of the World Seabird Union, and I have been involved with the production of two of these in recent years. We have shown that Twitter conferences can be a cost-effective and carbon-free complement to regular, traditional conferences.

As of April 2017, we have hosted three World Seabird Twitter Conferences and have observed incredible growth (see the box on the rise of the Twitter conference). These conferences have fostered communication and increasing engagement among researchers around the globe – even while they work in remote field sites. As an additional benefit our conferences have been a valuable science communication tool – bringing science to the public via Twitter and spin off media engagements.

Because Twitter Conferences are cost-effective and carbon free, we've proposed they are an ideal complement to global conferences seeking to maintain engagement between meetings, or in lieu of annual meetings. There is no substitute for the side-conversations that happen at face-to-face conferences, but for science to move forward, ideas must be exchanged and challenged, networks strengthened and collaborations established. Reducing the frequency of traditional conferences to reduce costs and carbon, and supplementing with Twitter Conferences could go a long way towards maintaining networks, keeping abreast of developments, and identifying new opportunities.

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A tweet from the winning presentation at WSTC3.
See: https://twitter.com/ElalmoLiz/status/852122187926470656

How does a Twitter conference run?

A Twitter conference is advertised across multiple platforms (websites, email lists, posters, Twitter) and abstracts are solicited. These are evaluated by an organizing committee and accepted presentations are scheduled according to themed sessions which span global time zones. Within each chaired session, presenters have 15 minutes to present, but instead of having 12 minutes to summarize key findings, researchers get to share a maximum of 6 tweets (140 characters each) to get their message across. This forces the presenter to be succinct and use photographs, infographics or animations to illustrate their work. Each tweet includes a number, and the conference hashtag (eg, #WSTC3) so that the audience can follow along simply by following that hashtag on Twitter.

Questions are posed by the audience and the presenter answers in real time. After the conference, presentations are collated and circulated (eg, Proceedings of the 2nd World Seabird Twitter Conference #WSTC2). The format of the conference can be expanded, by inviting prominent researchers to give plenary presentations and then participate in a live Q&A broadcast. This discussion can be viewed live on Twitter or afterwards as a link within the Proceedings.

The rise of the Twitter conference

The World Seabird Union hosted their first Twitter Conference in 2015, with 42 presenters. Our second, in 2016, had nearly doubled in size, with 72 presenters from 25 countries (Avery-Gomm et al, 2016). And we beat that again in this year's event (#WSTC3). To our surprise, the 'audience' of our most recent Twitter Conference increased to around 3.9 million Twitter users (ie, the number of users who could have seen the conference hashtag). Obviously, not all of those reached were seabird scientists, thus demonstrating the immense value of these conferences for communicating science to a broader audience - something that nearly all academics agree is critically important.

Ref: Avery-Gomm et al. (2016). The age of the Twitter conference. *Science* 352: 1404-1405. http://science.sciencemag.org/content/352/6292/1404.2

Choosing between options with limited resources

A simple Cost-Effective Resource Allocator

Faced with increasing rates of biodiversity loss and modest conservation budgets, it's essential that natural resource managers allocate their limited resources in a cost-effective manner. It's the challenge that lies at the heart of most conservation science and underpins the majority of stories appearing in *Decision Point*. While there have been many excellent strategies formulated by conservation scientists to guide such decisions (both within CEED and across the world-wide fraternity of decision scientists), many of these frameworks are highly technical and require significant skill to implement. Many managers either don't have access to those skills or aren't even aware of the research, and yet have to make critical resource-allocation decisions every day. Now CEED researchers have developed a tool to help these managers and all it requires is the knowledge to run a Microsoft Excel spreadsheet.

The researchers are quietly confident the new Cost-Effective Resource Allocator will be a reliable and user-friendly decision tool for managers because it was developed in conjunction with conservation managers to solve their specific problems. In this case the managers were national park rangers based on Christmas Island in the Indian Ocean and Kata Tjuta National Park in Australia's arid interior.

The association with CEED and NERP ED researchers began several years ago with a joint workshop in which officers from Parks Australia met with decision scientists to discuss a range of challenges being faced in national parks around Australia (see *Decision Point #61*). One recurring theme was how does a manager choose between different options to protect different species?

Key messages:

- Decision scientists working with national park managers have developed a user-friendly Cost-Effective Resource Allocator
- The allocator prioritises the set of management strategies that maximise the total number of years that a suite of species is expected to persist given a constrained budget
- The allocator uses a series of linked Microsoft Excel worksheets and can be used to analyse up to 50 candidate management strategies for a total of 30 species

To answer this question in a practical way that can be applied by park managers, the researchers, in collaboration with managers from Christmas Island National Park and Kata Tjuta National Park, devised an allocation tool using a series of linked Microsoft Excel worksheets.

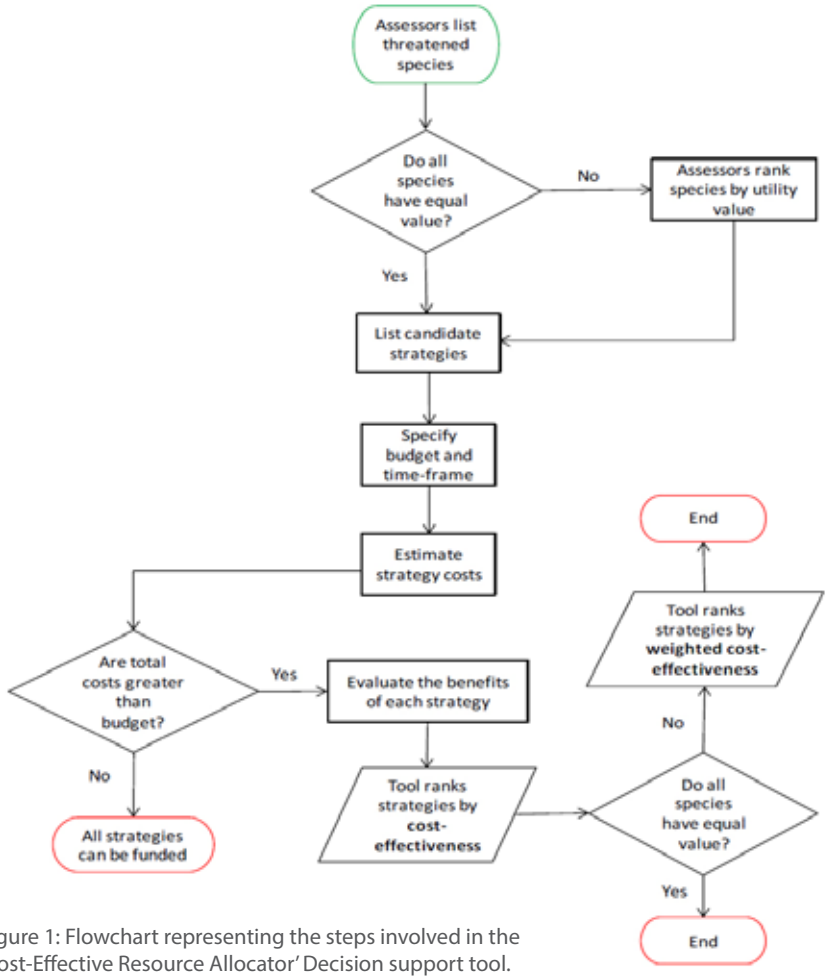

Figure 1: Flowchart representing the steps involved in the 'Cost-Effective Resource Allocator' Decision support tool.

The approach follows that outlined in the Project Prioritisation Protocol, a cost-effectiveness framework that compares the benefit and cost of different actions to save threatened species (see *Decision Point #29*, p8-10 and *Decision Point #47*, p7-9).

"The tool provides users with a transparent decision-making process to determine which on-ground conservation strategies should be funded to maximise the number of expected years of persistence for a set of threatened species, while taking into account assessors' uncertainty and distinctions in the value attributed to different species," explains Dr Martina Di Fonzo, the lead researcher on the project.

To demonstrate how the tool works, the team used a case-study of four locally threatened species from the Christmas Island National Park. These were a native fern (*Pneumatopteris truncata*), the Christmas-Island red crab (*Gecarcoidea natalis*), the golden bosun bird (*Phaethon lepturus fulvus*), and Abbott's booby (*Papasula abbotti*). Under a hypothetical total budget of approximately $9 million dollars over ten years, in which all species are considered equal, the tool recommends funding fern propagation and planting, rat control, cat control, and surveying and controlling the yellow crazy-ant (*Anoplolepis gracilipes*).

"We found that the cost-effectiveness rankings of these strategies were sensitive to the importance that assessors' assigned to different species," comments Di Fonzo.

"Just as important as the results the tool came up with was the ease of using it. We developed this tool with the input of a group of potential users from two Australian Commonwealth National Parks (Uluru-Kata Tjuta and Christmas Island National Parks), and refined it based on further feedback from two park staff (one of whom had no prior experience of the tool)."

And while the tool was valuable in choosing between management actions on Christmas Island, it can be used in any management situation involving choice and a limited budget.

"The tool can accommodate input from up to eight assessors and can be used to analyse a maximum of 50 candidate management strategies for a total of 30 species," explains Di Fonzo. "We encourage the input of multiple assessors. This avoids overconfidence and encourages collective decision-making (which is appropriated for many decisions)."

"It can be expanded to include more assessors, strategies and species, if required. We recommend that the tool be operated by a single assessor/expert, charged with eliciting information from the remaining experts using the instruction sheets (see Di Fonzo et al, 2017)."

More info: Martina Di Fonzo martina.mi.difonzo@gmail.com

Reference

Di Fonzo MMI, S Nicol, HP Possingham, S Flakus, JG West, L Failing, G Long & T Walshe (2017). Cost-Effective Resource Allocator: A decision support tool for threatened species management. *PARKS* 23: 101-113. http://parksjournal.com/wp-content/uploads/2017/04/PARKS-23.1-Di-Fonzo-et-al-10.2305IUCN.CH_.2017.PARKS-23-1MMIDF.en_.pdf

The Microsoft Excel tool and further supplementary material can be downloaded from PARKS Journal 23.1: http://parksjournal.com/parks-23-1/

The mass migration of red crabs on Christmas Island is one of the natural wonders of the world. But the red crab and many other species on this isolated island are under threat. Given limited resources, how do Christmas Island National Park managers choose between multiple actions to protect multiple species?
(Photo by Max Orchard, Parks Australia)

Decision Point en Español #3 is now available

For the third year running the Spanish quarter of CEED has compiled and published a Spanish-language version of *Decision Point* (you can find the first two issues of *Decision Point en Español* at http://decision-point.com.au/past-issues/). As with issues 1 and 2, the third issue contains a few stories from the English version of *Decision Point* (in Spanish) but most of its contents are original stories published nowhere else.

The line-up for issue 3 includes stories on where conservation research is happening (and where it needs to happen); fish conservation in the tropics; birdwatching and avitourism, whale songs; conservation planning in post-conflict Colombia; plant demographics and COMPADRE; using data from camera traps for conservation planning; fishing rights and conservation on the Chilean coastline; bird conservation and landslide protection; scenarios for ecosystem-service planning; and new technologies for monitoring threatened species.

As with previous issues of *Decision Point en Español*, the new issue is the result of many hours of hard work from a team of Spanish-speaking CEEDites led by Eduardo Gallo Cajiao and Duan Biggs.

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The cover of the latest issue of *Decision Point en Español*

Viv Tulloch presents at the IWC

Viv Tulloch recently completed her PhD with CEED working on several different threat-management problems in collaboration with the Wildlife Conservation Society, The Nature Conservancy, CSIRO, and the International Whaling Commission (IWC). At the most recent IWC Scientific Meeting in Slovenia, she presented findings from the multi-species model developed during her PhD. The model explores interactions between krill and five key baleen whale species that feed on krill, and predicts the future recovery of the whales given changes in primary productivity caused by climate change.

"The model presents an updated assessment for blue, fin, humpback, right and minke whales," says Tulloch. "It provides a basis for exploring ecosystem dynamics in the Southern Hemisphere. Results demonstrate key differences in population trajectories and estimates between models that account for, or ignore, predator-prey linkages.

"This is a strategic model that provides a platform for exploring additional hypotheses and management strategies, and is being modified in a step-wise fashion to explore predator-prey interactions and the effects of future environmental change on krill and whales."

A humpback whale. (Photo by Viv Tulloch)

The full report from the meeting will be available from the IWC soon.

Justine Shaw on a roll

CEED researcher Dr Justine Shaw (pictured below on the left) is on a roll. She has just had two articles published in the prestigious scientific journal, *Nature*. And she is part of a group named 'Species on the move' that won the national 2017 Peer Prize for Women.

The first *Nature* article predicts the expansion of ice-free areas of Antarctica due to climate change. The research was led by Shaw's PhD student, Jasmine Lee.

In the second *Nature* story, Shaw is a co-signatory of a comment piece ahead of the G20 in Hamburg, outlining the urgent action the world needs to see by the year 2020.

"The comment piece, led by the former Executive Secretary of the United Nations Framework Convention on Climate Change Christiana Figueres, calls for bending the emissions curve by 2020," says Shaw. "It's a monumental challenge; but it is necessary, desirable, and most of all, it's achievable. We explain why and how."

And Shaw was part of the "Species on the Move Thinkable" submission, led by Associate Professor Gretta Pecl from the University of Tasmania. The Species on the Move group includes researchers from JCU, Monash, Southern Cross University, UWA, University of Wollongong and University of NSW. The group has just won the 2017 Peer Prize for Women in the category Earth, Environment & Space. The multidisciplinary team will use the prize money from the award to support research and preparations for a Species on the Move conference to be held in South Africa in 2019. They aim to be able to support women scientists.

A video summarising the study can be viewed at:
https://www.youtube.com/watch?v=6d-3Nv2n-Xk

James Allan wins Elsevier Atlas Award

CEED PhD student James Allan was recently awarded the Elsevier Atlas Award, as the lead author on a study examining climate change impacts on World Heritage Sites (Allan et al, 2017).

The Atlas is awarded to a single journal article each month, from the thousands of articles published in Elsevier's journals. James' article revealed that over 100 world heritage sites are being damaged by human activities. The international team behind the paper also included CEED researchers and associates Sean Maxwell, Kendall Jones, James Watson and Oscar Venter.

"This paper makes significant advances to conservation science and environmental policy because it is challenging three misconceptions of our progress towards better nature preservation. Those are related to space, time, and success," says the Editor-in-Chief of Biological Conservation, Vincent Devictor.

The research found that some of the world's most valuable natural areas were suffering from forest loss and damage caused by encroaching human activities. The article outlined which World Heritage Sites have been most impacted by human pressure (roads, forest loss, infrastructure, agriculture and urbanisation).

Reference

Allan JR, O Venter, S Maxwell, B Bertzky, K Jones, Y Shi & JEM Watson (2017). Recent increases in human pressure and forest loss threaten many Natural World Heritage Sites. *Biological Conservation* 206: 47-55. https://doi.org/10.1016/j.biocon.2016.12.011

James Allan (centre), recipient of the Elsevier Atlas award, with Prof Melissa Brown (UQ Executive Dean of Science) and Prof Aidan Byrne (UQ Provost).