DECISION POINT

Connecting conservation policy makers, researchers and practitioners

Issue #97 / August 2016

The tides they are a changing

Mapping intertidal habitats in Australia

Preserving wetlands with payments for ecosystem services

Mangroves and multiple ecosystem services in Fiji

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ARC ceed Centre of Excellence for Environmental Decisions

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Decision Point is the 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.

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Our cover: Migratory shorebirds depend upon intertidal habitats here in Australia and overseas. This issue of *Decision Point* examines threats and opportunities for our intertidal spaces.
(Photo by Rob Clemens)

On the point

The times, they are a changing...

Come gather 'round people
Wherever you roam
And admit that the waters
Around you have grown
And accept it that soon
You'll be drenched to the bone…

These lyrics, which open Bob Dylan's classic song 'the times, they are a changin', might be a chorus for climate change. However, I they also resonate with several themes explored in this issue of *Decision Point*.

The first is that, indeed, the waters really have grown. Sea level rise, caused by climate change, is happening and that means we need to reflect on the many values of the ecosystems that exist on the ocean fringe, and develop frameworks for how we will manage these ecosystems into the future. Towards that end we have stories on intertidal habitats around Australia (p4), multiple ecosystem services from mangroves in Fiji (p5) and using payments for ecosystem services to preserve wetlands around Moreton Bay (p10).

The second theme is the changing face of conservation where increasing focus is being placed on conservation on private land (and especially farmland). We discuss the permanency of conservation covenants (p12), trade offs in developing agriculture in northern Australia (p14), restoring creeks and house values (p18), and a new CEED text book on designing agri-environment policy (p16).

And the third theme relates to changes in CEED itself. Being a dynamic network, people are always joining and leaving CEED. We normally don't make too much fuss about these movements as it's the nature of a research network. However, four of our early- to mid- career researchers have just taken up posts in the UK so we thought we should get them to tell us what they think about CEED. Read their stories on page 19.

Also leaving us are Karen Gillow and Michelle Baker, who have both provided invaluable support to CEED and me in putting out *Decision Point*. Karen has been assisting since issue #1 and Michelle was the architect of our *Decision Point* online site and many of the design tweaks in this issue. Thanks heaps Karen and Michelle.

But possibly the biggest change to note is the departure of our Director, Hugh Possingham (who is leaving to become the Chief Scientist at the TNC, see p3). Hugh has been a passionate supporter of *Decision Point* since its inception and has provided some ripper editorials during its life. I've listed my top three Possingham editorials (with links) next to his final word on page 3. They're worth rereading if you have a moment.

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DECISION POINT #97
August 2016

Looking back, moving on

Better decision making, better conservation outcomes

By Hugh Possingham (Director, CEED)

As most of you know, I'm leaving CEED to take on the role of The Chief Scientist at The Nature Conservancy. This is my last issue of *Decision Point* as CEED's Director. I've been working with you in this network (in its various forms) for the past decade and it's been a wonderful time – full of exciting science and valuable and respectful collaborations. I have been humbled and inspired by the friendship and dedication of you, my colleagues. I may be deluded, but I think that our collective efforts have put decision science for conservation front and centre in people's thinking, both in Australia and around the world.

It was ten years ago that we established the Applied Environmental Decisions Analysis Hub (AEDA). Back in those days decision science for conservation barely existed. These days, the ideas of prioritisation, trade-offs, optimisation, risk management, value of information and dealing with uncertainty are all commonly included in policy formulations and public discussions on biodiversity.

CEED (and its earlier manifestations) has played an important role in making these concepts real and relevant. That's something we can all be proud of. The collaborative research networks and culture that we have nurtured (AEDA, CEED, NERP ED, NESP TSR and EDG) have been the vehicles to prosecute the case for smarter environmental decision-making. The legacy of this work is in more robust environmental policies, a bigger management and policy tool box and a cadre of extremely talented environmental decision scientists. Many of the Early Career Researchers that our networks helped nurture some ten years ago are now heading up highly influential groups both here in Australia and overseas.

Decision Point has chronicled the life and times of CEED and its antecedents, and I believe this publication has made a real difference in building a community of interest in environmental decision science. It has helped bridge the gap between research, policy and management and given the general public a real insight into how interesting and important conservation problems are – as evidenced by my recent public lecture in the Brisbane City Library which was sold out with 300 attendees.

I'm excited about the next chapter for CEED (and whatever networks continue beyond the lifespan of CEED). I look forward to continuing to collaborate with the researchers and organisations who are contributing so much to better environmental decision making globally.

The original AEDA crew (circa 2006).

Hugh speaks at the Brisbane library on environmental decision science. Over 300 people turned out to hear his message.

Editor's Pick

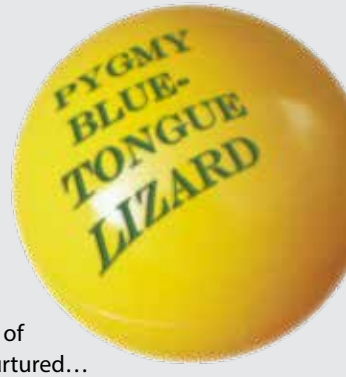
By David Salt

Long-term readers of *Decision Point* would know that, over the years, Hugh Possingham has floated some excellent and sometimes off-the-wall conservation ideas in his editorials. Some of them have been eminently do-able and grounded, others have been fantastic and controversial. All of them have been provocative and stimulating. Here are my top three.

The Biodiversity Endowment Trust
Decision Point#23, p2

The Federal Government places $200 million dollars in a trust for every one of the 56 NRM regions. That trust fund is an endowment releasing about 4% per annum to the regional body. We create a composite biodiversity index for each region that is set to a value of 100. Every five years the biodiversity accounting office provides another composite biodiversity index and according to these outcomes the amount of funds released to NRM regions is adjusted accordingly…

Threatened Species Lotto
Decision Point #31, p2



Every year the Minister for the Environment draws out ten coloured balls. On each ball is the name of a threatened species. To each ball (species) one million dollars is allocated. If you are the lucky owner of a property on which that species lives, you will be given a fraction of the million dollars in proportion to the number of individuals of the species that you have so carefully nurtured…

The Acoustic Environmental Accounts
Decision Point #44, p2

Establish a network of acoustic monitoring boxes across the continent. Let's say two boxes per bioregion vegetation structure. Each box records an hour of sound four times a day, one day a week: the first at dawn, at dusk, an hour after dusk and an hour in the middle of the night. Over the years we would be able to cost-effectively detect changes in the abundance (based on calling rate) of hundreds of species (bats, birds and frogs) across the entire continent. It would be the first continent-wide survey of any group of fauna in Australia.

Blurred lines in the mud

Mapping the distribution and protection of intertidal habitats in Australia

By Kiran Dhanjal-Adams (University of Queensland)

Somewhere between land and sea lie intertidal habitats such as sandflats, mudflats and rocky reefs. These in-between places provide a wide range of valuable services including fisheries, recreation, buffers to sea-level rise and storm protection. Yet the distribution of these habitats, and therefore how well they are protected in reserves, remain unknown at a national level, below a 10km resolution.

Of course, mapping the distribution of a habitat which is repeatedly inundated can be remarkably complex, even using remote sensing. That's a big part of the reason we know so little about the distribution of these habitats. With Landsat imagery for example, images (which are taken only every 16 days) must coincide with the highest and lowest astronomical tides on a day without cloud, to create a map. Finding suitable images at a national level is therefore difficult, but not impossible.

In our study, we were able to combine 15 years of images to produce the first map of intertidal habitats for Australia at a 30m resolution (the shapefile can be found at https://doi.pangaea.de/10.1594/PANGAEA.845726) (Dhanjal-Adams et al, 2016). The method we used to map the extent and distribution of intertidal habitats in Australia was based on a continental-scale mapping project conducted across Asia by Nick Murray and colleagues (Murray et al, 2012; and see *Decision Point #81*).

Of the 9,856 km^2 of mapped habitat, we discovered large intertidal areas, particularly in Western Australia, Queensland and South Australia, along embayed coastlines and river mouths. Furthermore, we discovered that 39% of mapped intertidal habitats fell under the jurisdiction of one protected area designation or another (fig. 1).

Levels of protection varied considerably between states ranging from 80% in Victoria to 6% in the Northern Territory. We were also surprised to discover that some states mainly protected intertidal habitats as part of marine protected areas (eg, Queensland), and others as part of terrestrial protected areas (eg, Victoria). In some cases, 3% intertidal habitats were protected both by marine and a terrestrial protected areas (10% in South Australia).

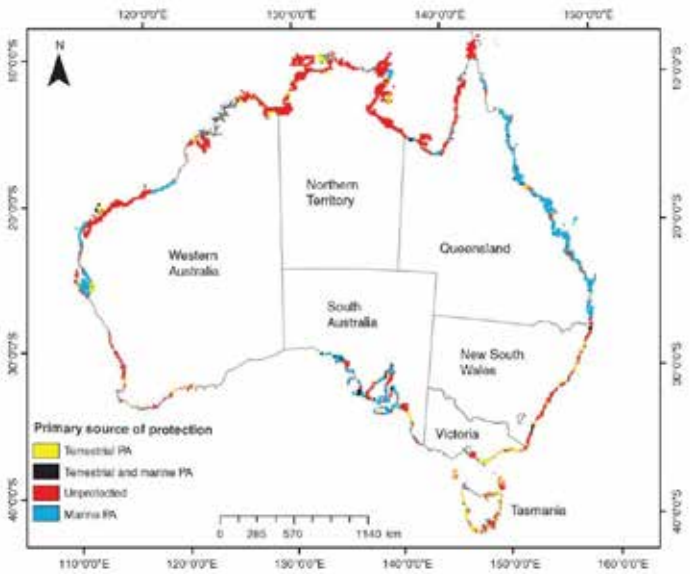


Figure 1: Primary source of protection of intertidal habitats across Australia (mapped at a 14 km grid resolution; PA=Protected Area).

Key messages:

The distribution and conservation status of intertidal habitats across Australia is poorly understood

We produced the first map of intertidal habitats across Australia (estimating a minimum intertidal area of 9,856 km^2)

39% of intertidal habitats are protected in Australia with some primarily within marine protected areas and others within terrestrial protected areas. 3% of intertidal areas fall under the jurisdiction of both marine and terrestrial protected area designations

Five million shorebirds rely on intertidal habitats for feeding in Australia. Several of these species are considered nationally or globally threatened with extinction.

Given the importance of intertidal habitats, there is a strong need to better understand how these designations can impact management of intertidal species. Intuitively, we might expect such designations to lead to better protection with both marine and terrestrial protected area managers collaborating. However, there is also the potential for confusion, with neither organisation sure who should take the burden of responsibility.

The protection of intertidal habitats is undeniably blurred, but with great potential for improvement. By providing the most accurate map of intertidal habitats to date, our research provides the data needed to better align protected area boundaries with intertidal habitats. In so doing we can improve the protection afforded to the many amazing species these habitats support.

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Making more of mangrove ecosystem services

Planning that acknowledges spatial differences in the services mangroves provide

By Scott Atkinson (University of Queensland)

For much of our recent history societies have often viewed mangroves as swamps, health hazards, and only good for draining and developing. Yet, fast forward to the present day and it's widely acknowledged that mangroves are anything but wastelands, and do in fact generate highly valuable services such as coastal protection, habitat for wildlife, breeding grounds for fisheries, and carbon storage. This is especially the case in developing Pacific nations where mangroves provide vital services that contribute enormously to both the economy and the wellbeing of local peoples and cultures.

Despite their value, mangroves are an ecosystem under threat. Up to a third of mangroves around the world have been cleared for coastal development and aquaculture since 1980. And what is left is facing pressure from other factors including climate change and rising sea levels. The resources available to save this precious ecosystem are scarce so it is important to invest them wisely.

Recently, we have developed an approach that helps prioritise investments in mangrove conservation in a way that takes into account the different values of the ecosystem services that individual mangroves provide across a management area. We demonstrated the value of this approach by mapping multiple ecosystem services being provided by Fiji's mangroves and their relative value across all of Fiji. Our new approach could prove vital to policy makers and funding organisations seeking specific policy outcomes when planning investments in mangrove ecosystems.

Incorporating the values of the services that ecosystems provide into decision making is becoming increasingly common in nature conservation and resource management. However, with limited funds for conservation, identifying priority areas where investment efficiently conserves multiple ecosystem services becomes incredibly important.

We showed this could be done by mapping four mangrove ecosystems services (coastal protection, fisheries, biodiversity, and carbon storage) across Fiji. Using a cost-effectiveness analysis, we ranked mangrove areas for each of those four services, where the effectiveness of managing the mangrove was a function of the benefits provided to the local communities, and the costs were associated with restricting specific uses of the mangrove.

We found that different areas of mangroves around Fiji provided different values of the individual ecosystem services. Spatially explicit mapping such as this can help decision-makers direct funding to localities that best meet specific funding objectives. For example, financing for disaster-risk reduction and climate adaptation (eg, from the Green Climate Fund) can be directed toward mangrove areas with the highest coastal protection services. Biodiversity funds (eg, from the Global Environment Facility) can be directed towards areas with the highest potential to conserve species.

Presently, funding for biodiversity in Fiji has been 'bundled' with funding for climate adaptation and sustainable land management. As a consequence, this funding has been directed to some of the most degraded habitats in the country. This might improve sustainable land management but it's likely a major lost opportunity for effective biodiversity financing and conservation. Examples such as this demonstrate why it's important to distinguish between areas that provide differing levels of ecosystem services.

Key messages:

- The value of ecosystem services can vary greatly across relatively small scales
- Spatially explicit mapping of ecosystem services can better guide conservation investment
- Equity in rural areas is a key concern, particularly in data-poor regions

We also believe our approach might help in the designation of 'no-go zones' for development in Fiji based on their national significance for the provisioning and value of ecosystem services. Our national-scale assessment might allow for guiding the selection of the highest priority areas for each ecosystem service where development and extractive activities are not allowed.

There are many challenges with this type of approach (indeed, with any form of spatial planning). Mapping exercises such as this need to deal with issues of poor data availability and associated equity concerns in rural areas, where available data is often even less reliable. However, we believe our approach provides a significant improvement on existing approaches that either deal with a single ecosystem service, ignore them all together, or do not account for the spatial differences in ecosystem services across entire management areas.

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Atkinson SC, SD Jupiter, VM Adams, JC Ingram, S Narayan, CJ Klein & HP Possingham (2016). Prioritising mangrove ecosystem services results in spatially variable management priorities. *PLoS ONE* 11(3): e0151992. doi:10.1371/journal.pone.0151992 http://journals.plos.org/plosone/article?id=10.1371%2Fjournal.pone.0151992

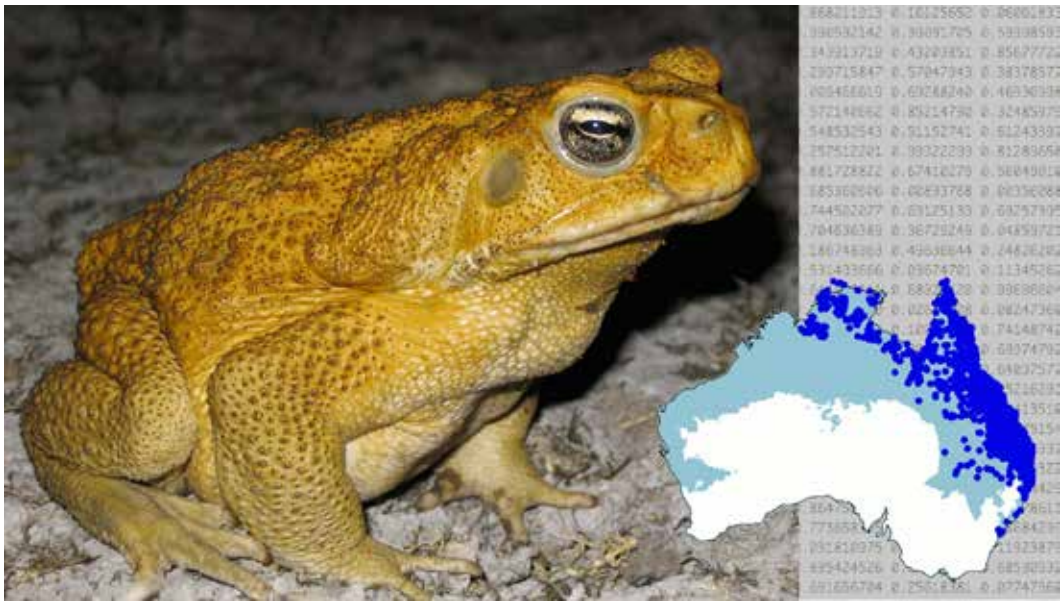
Mangroves provide a range of valued ecosystem services. New research is enabling managers and policy makers to take this into account in their decision making. (Image by Scott Atkinson)

Is my model fit for purpose?

Matching data and species distribution models to applications

By Gurutzeta Guillera-Arroita & José Lahoz-Monfort (University of Melbourne)

Knowing where a species occurs, or could occur, is important for a wide range of conservation applications. However, we rarely have complete information about species distributions, and we normally need to infer them through modelling approaches. By building species distribution models (SDMs), we aim to 'reconstruct' the distribution of species, based on a sample of data. These models are often correlative, that is, they work by relating the observed pattern of species presence/absence to some explanatory variable(s).



Species distribution models are used for all sorts of purposes in conservation planning and management. For example, they have been used to understand the invasion of cane toads in Australia. (Cane toad image by Ben Phillips).

Species distribution modelling is becoming a fundamental tool in our discipline. For instance, SDMs are used to identify areas suitable for reintroduction of threatened species, sites at risk of biological invasions or to direct the search for new populations of species.

There are many considerations involved in building useful correlative SDMs. For an SDM to have good predictive ability we need to identify critical environmental predictors. For example, do average temperature, average rainfall and soil pH accurately capture why this plant species happens here and not there? Defining a suitable extent for the model is also fundamental. Am I interested in describing the habitat preferences for this mammal species at a continental scale, or do I want to understand its preferences at a local scale? There is a lot written about these and other aspects of building SDMs (and Brendan Wintle has developed an excellent checklist of the basics in *Decision Point #67*).

But how does the type of data available for a species affect the interpretation and reliability of SDM outputs? This is a critical question in the practice of species distribution modelling yet it's an issue often overlooked. Users often underestimate the strong links between data type, model output and suitability for end-use. Species distribution models can lead to suboptimal conservation outcomes and misguided theory if the underlying data are not suited to the intended application.

Key messages:

- Species distribution models aim to 'reconstruct' the distribution of species using a sample of data
- The type of data available for a species affects the interpretation and reliability of SDM outputs
- It is essential that users consider carefully whether their SDM outputs are suitable for their intended application

Data types and biases in SDMs

Often, the only data available about the occurrence of a species are 'presence' records from databases or from museum/herbarium collections. Sometimes, data about both species presences and absences are available. These are often produced through planned surveys, but can also be obtained from other sources such as checklists of volunteer contributors. Presence/absence data may also be augmented to include information about the detection process (eg, how long it took to detect the species).

The level and reliability of information that we can extract from an SDM strongly depends on which of these types of species data we have available, and how we use them:

- **Presence-only methods (PO):** There are methods to study species distributions that make use of presence-only records paired with information about the environmental conditions at those presence locations (eg, BIOCLIM). While these methods can provide interesting insights about environmental conditions where a species can exist, they have important limitations because species habitat preferences and habitat availability in the landscape are confounded. If many occurrences of a species come from areas with similar characteristics, this could be because these represent a real habitat preference, but it could also be that they are just very common in the landscape in general.

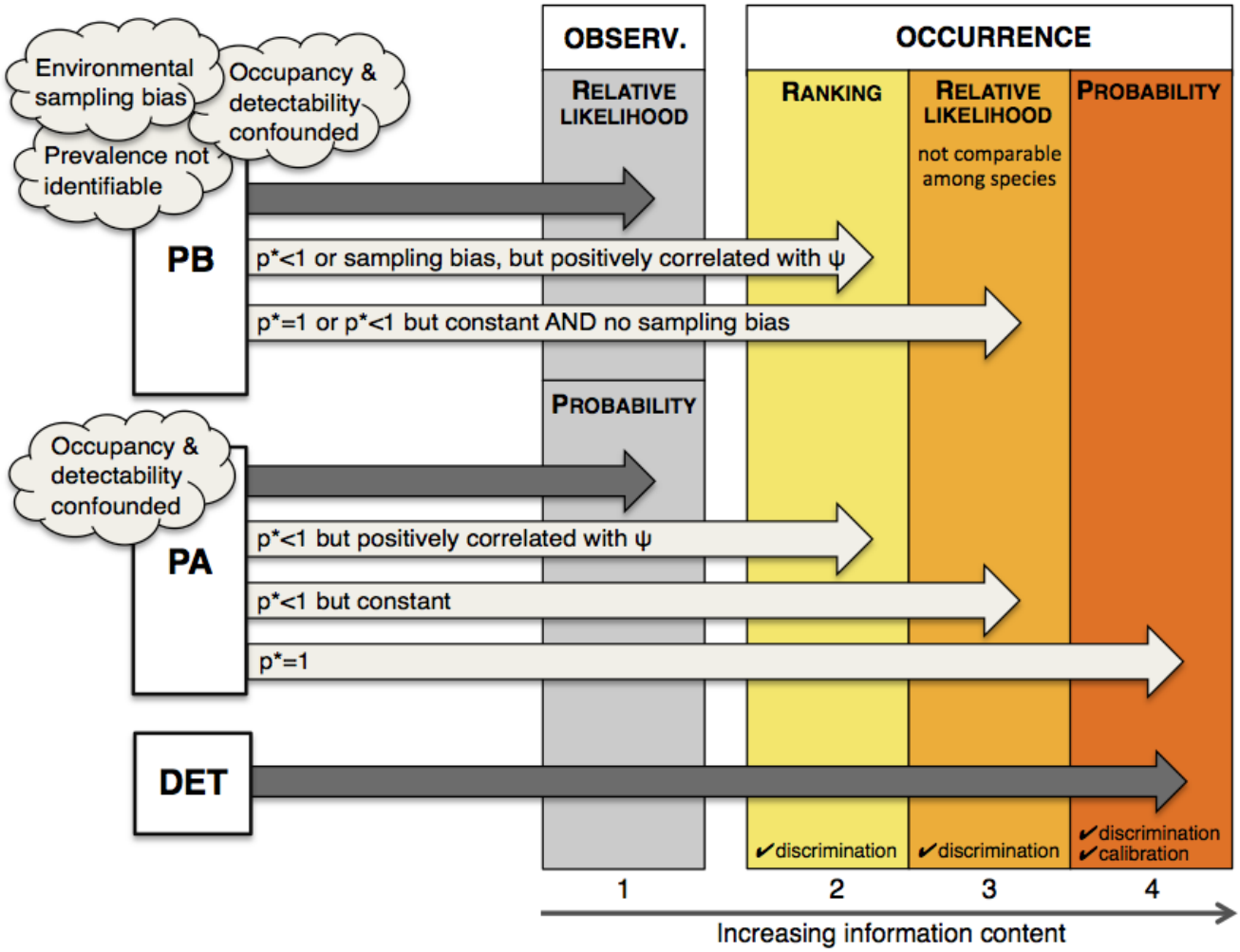


Figure 1: Synthesis of how the type of survey data interacts with sampling bias and imperfect detection to determine what a correlative SDM can estimate. Dark arrows denote the default level of information that can be achieved with each type of survey data (PA, PB, DET). Light arrows indicate under which conditions higher levels of information can be achieved from those data types. ψ denotes the probability of species occurrence at a site, and p* the probability of detecting the species at a site where present (given all the survey effort applied per site). PO is not included as this type of data cannot distinguish preferences from availability in the landscape

- **Presence-background methods (PB):** A more powerful way to utilise species presence records is to analyse these in conjunction with information about the characteristics of the environment in the wider landscape. These methods provide a more accurate picture about species habitat preferences, as they can compare the types of environmental conditions where the species was detected to how common these conditions are in the landscape. Examples include the very popular MaxEnt and point-process methods. Yet, the modelling of species distributions based on presence-background data has important caveats. As presence-background data do not contain information about sampling effort, presence-background methods are very susceptible to estimation biases induced by sampling bias. Furthermore, presence-background methods cannot provide a robust quantification of prevalence or of probabilities of occurrence; from such data one cannot tell whether few species records are due to species rarity or due to little survey effort. Hence, presence-background methods at most only provide information about relative habitat preferences of the species. The output of presence-background methods is therefore NOT a probability of occurrence.
- **Presence-absence methods (PA):** Data sets that also include species absence records are informative about sampling effort, hence they are much more robust than presence-background methods to biases in sampling and they can provide an estimation of species occurrence probabilities. However, presence-absence data can be affected by imperfect detection of the species (as are presence-only and presence-background data). Two types of errors can arise in species-occurrence data: false negatives and false positives. The first is the most prevalent in ecological surveys and occurs when species are missed in searches of occupied sites. Disregarding imperfect detection can lead to biased inference about species distributions.
- **Occupancy-detection methods (DET):** Augmenting presence-absence data by collecting information about the detectability of the species helps account for imperfect detection and hence obtain a more robust estimation of

probabilities of species occurrence. Information about detectability can be obtained for instance by conducting replicate visits to the sites or, within one visit, by recording data from multiple independent observers, or recording times to detection.

In summary, there is a hierarchy in terms of the robustness of PO/PB/PA/DET methods and the quantities they can estimate (this is illustrated in Figure 1). It is essential that users consider carefully whether their SDM outputs are suitable for their intended application. Building models with unsuitable data can waste valuable resources and deliver outputs that do not solve the problem at hand.

In addition, it is important to consider the implications of reducing SDM outputs to a binary categorization based on thresholds, a step often conducted but rarely with clearly articulated justifications. In Box 1, we provide an illustration of these important considerations.

More examples can be found in Guillera-Arroita et al, 2015, together with a comprehensive table that discusses data type implications for a wide range of applications in ecology, conservation and biogeography.

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Reference

Guillera-Arroita G, JJ Lahoz-Monfort, J Elith, A Gordon, H Kujala, PE Lentini, MA McCarthy, R Tingley & BA Wintle (2015). Is my species distribution model fit for purpose? Matching data and models to applications. *Global Ecology and Biogeography* 24: 276-292. http://onlinelibrary.wiley.com/doi/10.1111/geb.12268/abstract

Box 1: Prioritising invasive species

The potential distribution of an exotic species is a key indicator of its future capacity to cause damage. Examining the potential distribution of a range of candidate species can help in the prioritisation of management actions to prevent invasions. However, as we show here, estimates of the relative likelihood of occupancy are not suitable for prioritising species according to their potential area of occurrence.

Let's consider a set of 25 simulated species (figure 2). We sample their distributions randomly and build SDMs based on PA and PB datasets. We assume perfect detection and large sample sizes. In statistical terms, the sum of estimated occupancy probabilities across the region gives us the expected value of the area of occurrence of the species.

This is a quantity we can obtain from PA data. However, if the output of the SDM is a relative likelihood of species occupancy (from PB data), the area of occurrence cannot be estimated. Crucially, the quantities obtained are not comparable across species, and hence species cannot be prioritized based on these data. Applying a binary conversion to the SDM output (the species is assumed 'present' at sites with estimates above a given threshold, and 'absent' if below it) does not solve the problem. It does not change the fact that prevalence cannot be estimated without absence data.

Furthermore, binary conversion is detrimental compared with using the actual probabilities of occurrence when available. This is because a binary categorization represents a coarse interpretation of species occurrence probabilities and reduces the information content compared with using the full range of values provided by the SDM.

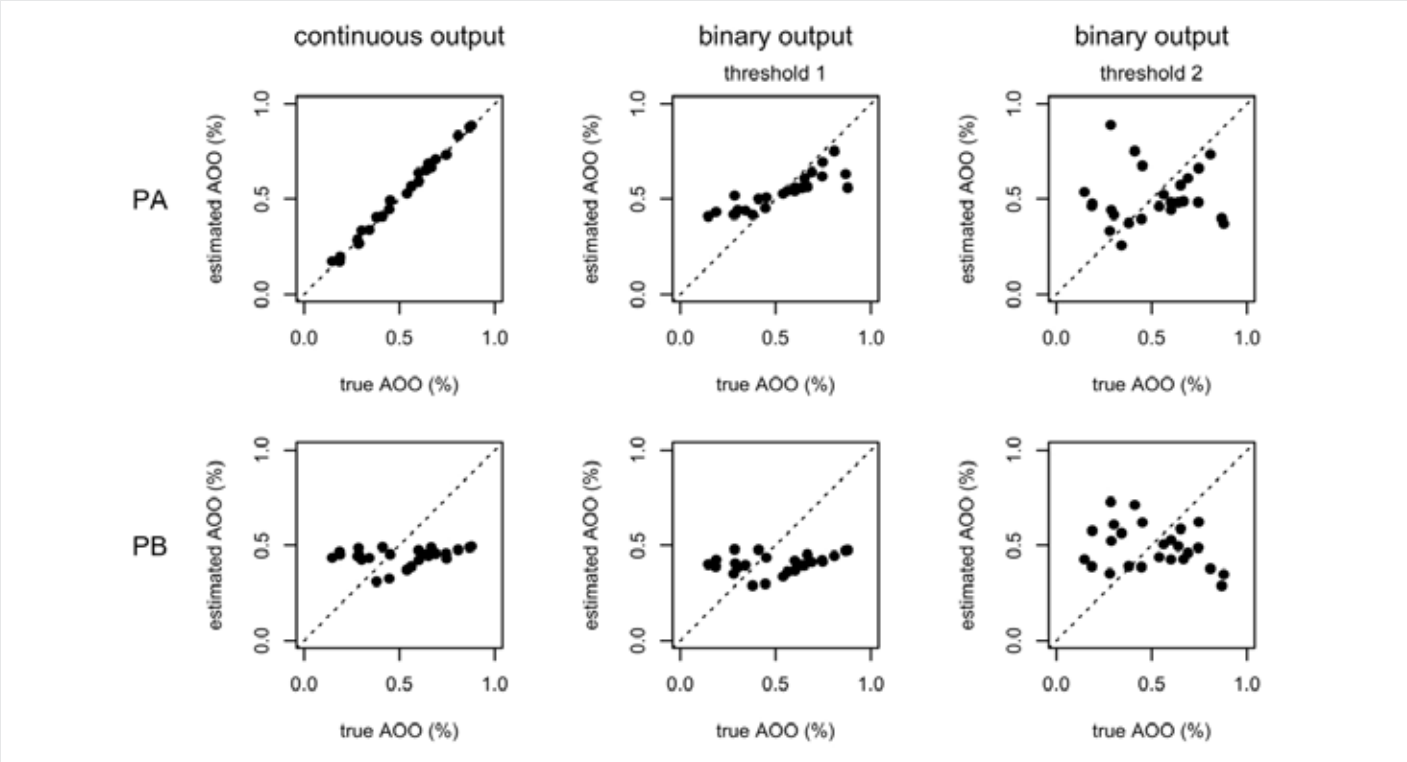

Figure 2: Estimated area of occupancy vs true area of occupancy for each of 25 simulated species, based on presence-absence data (top row) and presence-background data (bottom row).
In column 1, the continuous output is used. The other two columns use a binary conversion prior to computing AOO [threshold 1: sensitivity = specificity; threshold 2: max(sensitivity + specificity)]

The inequity in climate change?

How unfair is that?

By Glenn Althor, James Watson, Richard Fuller (University of Queensland)

In a recent analysis we explored the state of global climate change inequity (Althor et al, 2016) and what we discovered struck us as most unfair. We found that fewer than 4% of countries are responsible for more than half of the world's greenhouse gas emissions.

Furthermore, wealthy, developed nations such as Australia, the United States and Canada, are essentially climate 'free-riders': causing climate change (through high greenhouse gas emissions), while incurring few of the costs (such as climate change's impact on human mortality and GDP).

On the flip side, there are many 'forced riders': communities which are bearing the brunt of climate change impacts despite having scarcely contributed to the problem. Many of the world's most climate-vulnerable countries, the majority of which are African or Small Island States, produce a very small quantity of emissions. What's more, when we looked at projections of climate vulnerability to the year 2030, this inequity is expected to worsen.

In other words (now and in the near-future), a few countries benefit enormously from the consumption of fossil fuels, while at the same time contributing disproportionately to the global burden of climate change.

To explore climate equity, we used recent data on greenhouse gas emissions (WRI 2014) and climate vulnerability (DARA 2012). We compared 2010 greenhouse gas emission data and the vulnerability data both in 2010 and 2030 to assess whether the most heavily polluting countries were also those least vulnerable to the negative effects of climate change. We used quintiles to compare the data sets and enable visualisation of climate equity in the recent past and near future (Figure 1).

Our results show a situation not fair by any definition, or as Pope Francis put it in last year's encyclical on climate change: "Our lack of response to these tragedies involving our brothers and sisters points to the loss of that sense of responsibility for our fellow men and women upon which all civil society is founded".

The Paris Agreement

The Paris Agreement and associated Paris Climate Agreement Signing Ceremony, have been widely hailed as positive steps forward in addressing climate change for all, although the details on addressing 'climate justice' are still unclear.

The UNFCCC speak of keeping global temperatures 'well below' 2^0, which is commendable. However the emissions-reduction pledges submitted by countries leading up to the Paris talks are very unlikely to deliver on this. Until the Paris agreement is ratified, and key free rider countries pledge (and act) to bring their emissions in line with targets, it is hard to see how we will achieve global temperature change below 2^0. Until these efforts are accomplished, the future of many of the world's most vulnerable countries is grim.

The creation of US$100 billion (per annum) in funding has been suggested for supporting developing nations to reduce emissions, in the form of the Green Climate Fund. However, progress toward this goal has been slow. Additionally there is very little detail on who will provide the funds or, importantly, who is responsible for their provision. Securing these funds, and establishing who is responsible for raising them will also be vital for the future of climate-vulnerable countries.

Key messages:

- Fewer than 4% of countries are responsible for more than half of the world's greenhouse gas emissions
- These same nations are also the least exposed to the impacts of climate change
- Many of the world's most climate-vulnerable countries produce a very small quantity of emissions

The most climate-vulnerable countries in the world have contributed very little to creating the global crisis of climate change. As such, there must urgently be a meaningful mobilisation of the policies outlined in the Paris agreement. However, as the Agreement's key policies are yet to be realised, member states have both an exceptional opportunity and a moral impetus to use these results to address climate change equity in a meaningful manner.

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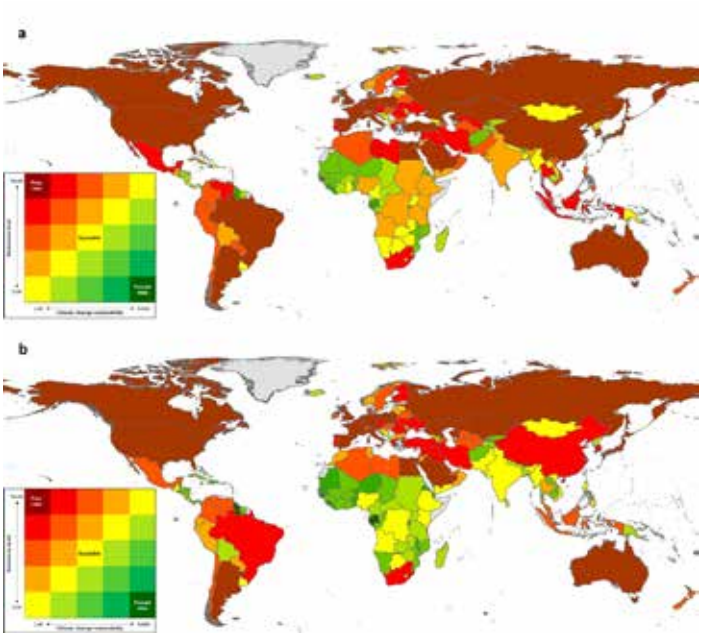

Figure 1: A map of global climate equity in 2010 (a), and projected to 2030 (b). Countries shown in dark brown are free rider nations: those contributing the most to climate change and the least vulnerable to its negative impacts. Countries shown in green produce the least greenhouse gases but experience the worst effects of climate change.

Preserving coastal wetlands under sea level rise

Can payments for ecosystem services fund climate change adaptation?

By Rebecca Runting (University of Queensland)

Coastal wetlands, such as mangroves, can be lost due to sea level rise. This means essential ecosystem services, such as the maintenance of fisheries, coastal protection, and carbon sequestration, could be lost along with them. However, it doesn't have to be this way – if allowed to, these wetlands can move landward in response to sea level rise, but only if there's no coastal development in the way.

To adapt to climate change, it's crucial that coastal land is set aside to accommodate wetland migration. Unfortunately, this comes with an opportunity cost, as this land might otherwise have been used for urban or industrial development. For cash-strapped local planning authorities, such long-term planning decisions may be prohibitively costly. However, emerging markets for ecosystem services, such as the carbon market (voluntary or otherwise), may have the potential to offset some of these high costs. Unfortunately, we currently know little about the costs and benefits of such an approach.

To throw some light on this issue we compared the cost of expanding the reserve system in Moreton Bay (near Brisbane) with and without sea level rise. And we looked at the contribution that payments for ecosystem services might make (Figure 1).

Comparing options

We used the Sea-Level-Affecting-Marshes Model (SLAMM; see *Decision Point #67*) to simulate coastal wetland change under a range of sea level rise projections (28 cm, 55 cm, 98 cm and 128 cm). This produced maps with fine-scale resolution (to around 5 m) of changes in the distributions of wetlands for each year (2013-2100) for each sea level rise scenario.

Using these wetland distributions, we modelled the provision and value of ecosystem services (carbon sequestration and nursery habitat for commercially important species) into the future.

(Above) Wetlands such as these mangroves are under threat from sea level rise. Could payments from the ecosystem services help cover the cost of their preservation? (Photo by Catherine Lovelock)

To quantify soil carbon sequestration, we used local field measurements for the different wetland types, and applied a range of carbon prices from the voluntary carbon market.

To determine the value of nursery habitat, we linked a potential levy on the gross value of production of three mangrove-dependent and commercially important species (banana prawn, mud crab, and Barramundi) to the area of mangroves that interface with the ocean.

When combined with the simulations of wetland change, this produced an economic value in each year to 2100 for both services for all properties within the study site. We then optimised the selection of additional wetland sites under the range of sea level rise projections and compared the resulting opportunity cost under different combinations of payments for ecosystem services. This allowed us to determine the potential of payments for ecosystem services to compensate the cost of reserve expansion under sea level rise.

Key messages:

- Markets for ecosystem services have the potential to relieve the financial burden of preserving coastal wetlands under sea level rise
- We found payments for carbon sequestration alone could cover the cost of this preservation under scenarios of low sea level rise
- Under high rates of sea level rise, other payment streams would be necessary

Covering costs

Sea level rise meant additional (landward) sites needed to be added to the protected area network to allow for wetland migration and to compensate for the wetlands lost at lower elevations. At all budget levels, the higher (business as usual) sea level rise projections resulted in a much higher cost of expanding the protected area network. This highlights that mitigating climate change (by the world-wide implementation of global agreements) can go a long way to making local adaptation decisions more affordable.

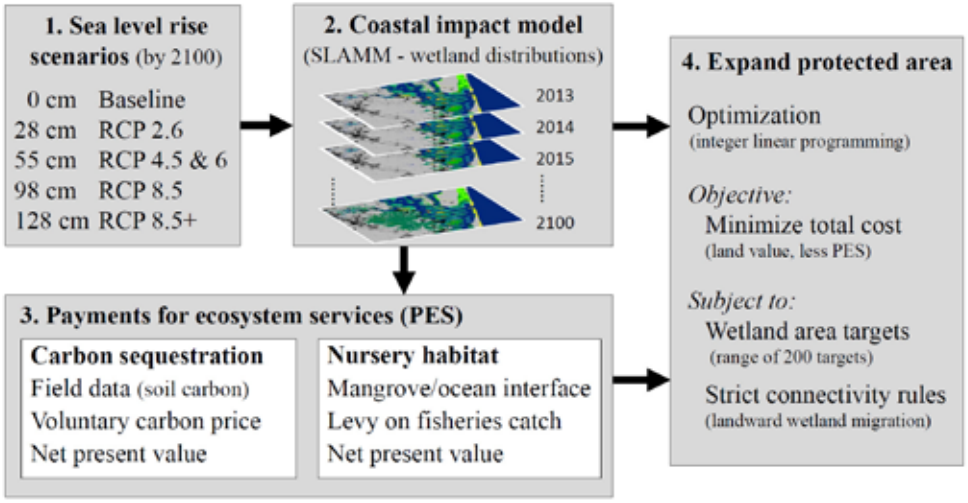

Figure 1: The methodology used to expand the reserve network under a range of sea level rise scenarios and potential payments for ecosystem services.

Despite these high costs, payments for ecosystem services have the potential to substantially reduce the net cost of expanding the reserve network under sea level rise. We found that a carbon payment alone could be used to expand the reserve network by 60% under the lower sea level rise scenarios, but only up to 37% under the higher (business as usual) sea level rise scenarios. Stacking carbon payments with a potential nursery habitat payment provided only a modest additional expansion over carbon payments alone (up to an additional 2% increase in wetland area), as the most cost-efficient areas for nursey habitat were already selected by a payment for carbon.

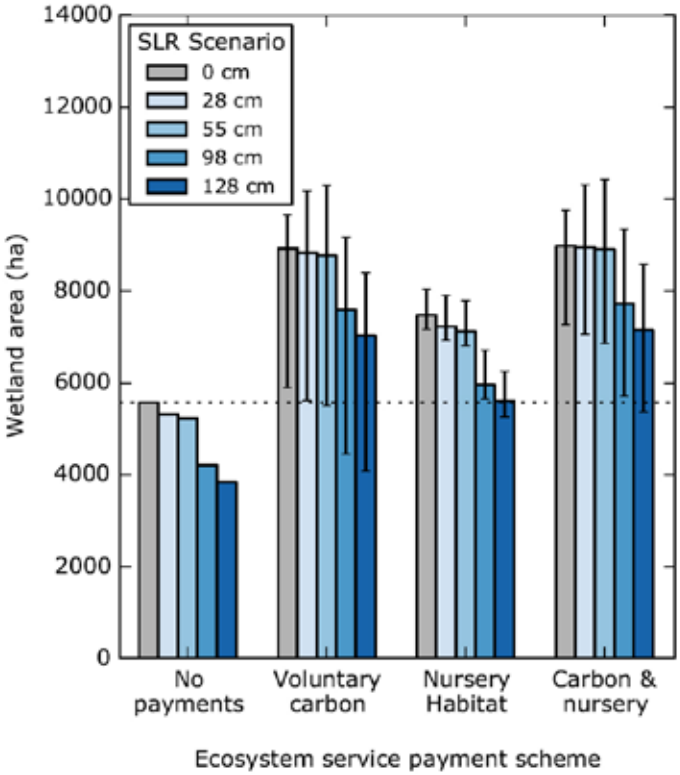

Figure 2: The maximum area of wetlands that can be preserved and still 'break-even' ($0 cost) under different sea level rise (SLR) scenarios and payments for ecosystem services. The 'break even' point is where the capitalised revenue from ecosystem service payments exceeds the opportunity cost of expanding the reserve network. 'No payments' refers to the baseline case where there are no payments for any ecosystem services.

It is possible that the benefits from payments for ecosystem services could be further increased under different market conditions. For example, even more wetlands could be preserved if the carbon price where higher, or if markets existed for additional ecosystem services (such as storm protection or nutrient retention).

Challenges of long-term planning

These cost reductions are possible because the costs are shifted from planning authorities to the people who benefit from the service. In the case of the voluntary carbon market, shifting the cost burden to the buyer is unlikely to be problematic, as the buyers' participation is voluntary (such as individuals who purchase voluntary carbon offsets for air travel). In contrast, a nursery habitat payment shifts the costs to local fisheries via a compulsory levy, which is likely to be more controversial.

It is imperative that local planning authorities pre-emptively limit development in dryland areas that are likely to transition to wetlands under climate change. The primary difficulty in implementing this strategy is that the opportunity costs of purchasing properties or re-zoning land are borne immediately, whereas the benefits from ecosystem service markets may take much longer to materialise.

This delay in receiving benefit could explain why this strategy is not adopted in many vulnerable areas, despite the long-term benefits. Unfortunately, delaying the implementation of climate change adaptation policy may risk losing key areas of coastal wetlands, the species they support, and services they provide. And in that situation, short-term economic gain comes at the price of long-term environmental loss.

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Reference

Runting RK, Lovelock CE, Beyer HL & Rhodes JR (2016). Costs and Opportunities for Preserving Coastal Wetlands under Sea Level Rise. *Conservation Letters* doi: 10.1111/conl.12239 http://onlinelibrary.wiley.com/doi/10.1111/conl.12239/abstract

Conservation covenants

An agreement forever or not worth the paper they're written on?

By Mat Hardy (RMIT University), James Fitzsimons (The Nature Conservancy), Sarah Bekessy (RMIT University) & Ascelin Gordon (RMIT University)

There's a growing trend in many parts of the world for land owners to enter into conservation covenants and easements. These formal agreements are an increasingly popular strategy for conserving biodiversity on private land but how effective are they? Our analysis of covenants in Australia has revealed there's much to commend in these agreements but there's also work needed to ensure their ongoing effectiveness (Hardy et al, 2016).

Conservation covenants are legally binding agreements that place 'permanent' restrictions on what activities landholders can undertake on their land; for example they often prevent the clearing of native vegetation. These agreements are registered on the title of the property, obligating the current and future owners to look after their property's ecological values.

Landowners voluntarily enter into these agreements because it helps them preserve the natural values of the land they love. Governments like these agreements because it helps them meet their obligations to conserve biodiversity (see the box on what's in a covenant).

The first conservation covenant in Australia was a Wildlife Refuge established back in 1951 (in New South Wales). Since then the number of covenants has grown considerably to around 7,500 across Australia (Figure 1), with most of those being established in the last 25 years.

Key messages:

- Conservation covenants are an important and enduring mechanism for conserving biodiversity on private land
- Multi-party covenants offer greater permanence than single-party agreements
- We need ongoing monitoring and reporting to assess the true contribution of these agreements

From a conservation policy perspective, the permanence and security of these agreements with private landholders are central issues. In theory, most conservation covenants in Australia are permanent in that the conditions they impose are passed on to the new owners when the land is sold. They are designed to last forever. However, landholders can change frequently with potentially negative consequences for protected land. And what about mining? Have covenants been affected by mining activities?

There was little information available on the permanence and security of covenants in Australia. So we asked the 13 major covenanting organisations that operate in this country whether the covenants they oversaw had remained in place and whether the obligations they prescribed had been observed.

Conservation covenants are usually legally binding agreements that place restrictions on what activities can take place on land in order to protect its natural values. (Image by James Fitzsimons)

The information we collected showed that of the 6,818 multi-party covenants created across Australia, only eight had been released (0.12%). Of the 673 single-party (NSW Wildlife Refuge) covenants formed, 130 had been released.

Based on these figures, very few covenants have been released, and multi-party covenants are clearly a better agreement in terms of permanence. Part of that would relate to the greater difficulty of exiting a multi-party agreement.

We also asked what's happening with covenant breaches. Are landholders abiding by the terms of the covenant?

Unfortunately, we found that detailed breach data was hard to get hold of, making it very difficult to accurately determine the number and types of breaches that had occurred. It was also difficult to assess what impact the breaches were having on the natural values the covenants had been established to protect (if any). This relates to the bigger issue of needing improved monitoring and recording of conservation covenants.

Our study showed the agreements are, on the whole, relatively secure and enduring but we need ongoing monitoring and reporting to assess the true contribution of these agreements. What's more, some organizations suggested that the turnover of conservation covenants to 'successor landholders' may be developing into a policy issue, requiring agencies to engage with the new landholders and ensure they are as committed to the terms of the covenant as the original owners.

Keep in mind that the majority of existing covenants were created in the last 25 years so we would expect to see a growing number of these agreements being transferred to new owners in the coming years.

Given this, coupled with a growing enthusiasm by governments to encourage new conservation covenants, the need for ongoing and effective monitoring has never been greater.

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Reference

Hardy MJ, JA Fitzsimons, SA Bekessy & A Gordon (2016). Exploring the permanence of conservation covenants. *Conservation Letters*. DOI: 10.1111/conl.12243 http://onlinelibrary.wiley.com/doi/10.1111/conl.12243/abstract

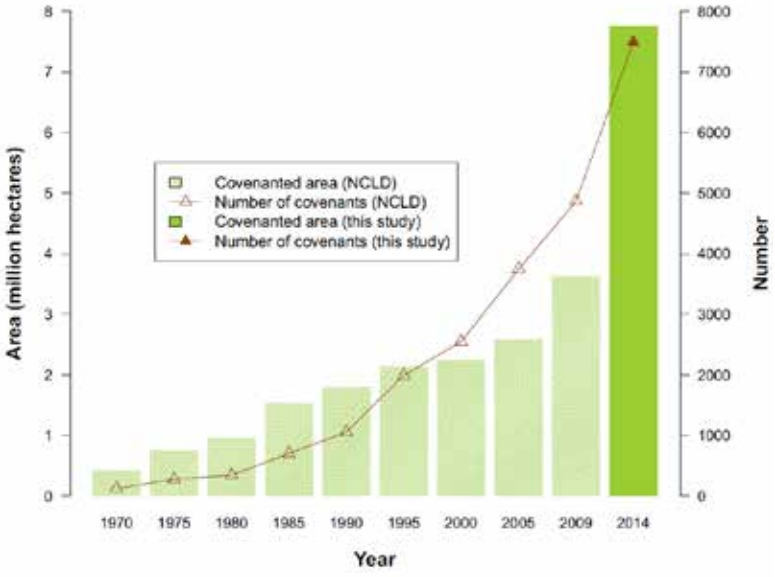
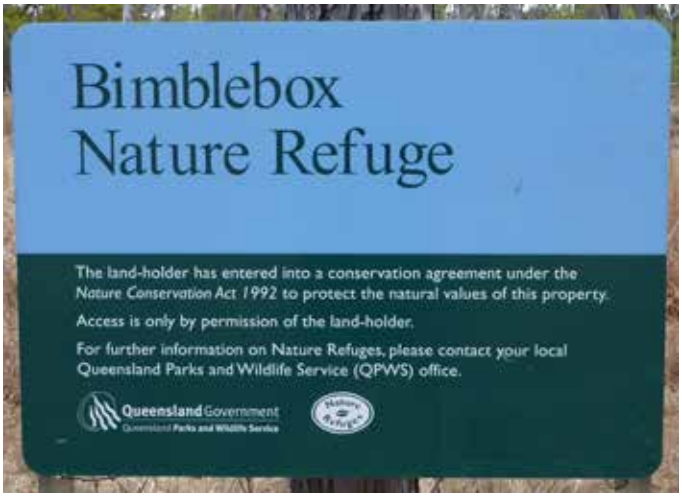


Figure 1: Cumulative trend in the number and area of covenanted properties in Australia. Columns represent covenanted area, and the triangles represent the number of covenants. Lighter green columns and hollow triangles indicate National Conservation Lands Database data, and the darker green column and the filled triangle represent data collected for this study.



Bimblebox Nature Refuge in central west Queensland is an 8,000 hectare property under perpetual conservation covenant. It is located in the Desert Uplands biodiversity hotspot, where just over 3% of the area is held in conservation reserves.

More than 150 species of birds have been recorded on Bimblebox, including the sighting of a flock of the EPBC-listed black-throated finch (*Poephila cincta*).

Originally purchased for conservation with a combination of private funds and funding from the Australian Government's National Reserve System program, the property was later protected with a Nature Refuge covenant.

Bimblebox is currently under threat from a proposed coal mine which in 2013 received approval from State and Federal Governments. At this stage the future of this covenant is uncertain. (More info - *bimblebox.org*) (Image by Sonya Duus).

What's in a covenant?

Conservation covenants are an important component of Australia's private-land conservation policy mix. Similar to conservation easements in North America, conservation covenants are mostly voluntary, legally binding agreements between an authorized organization and a landholder. They can apply to all or part of a property and are registered on the property title, usually running in perpetuity (forever).

Covenants are established primarily to protect land with high nature conservation value, where the landholder retains ownership but has a reduced 'bundle of rights', in effect giving up development and land-use rights incompatible with conservation. Whilst covenants can be tailored to individual properties, each covenant contains a standard set of obligations which remain relatively fixed over the term of the agreement, with site-specific management requirements determined during establishment

Although security provisions vary between programs, all covenants in Australia are backed by specific, enabling legislation, with release (ie, the removal of the covenant) usually requiring approval from multiple parties including the landholder and the relevant government Minister. The exception is the Wildlife Refuge program, which is only available in New South Wales and is unique amongst Australian covenants for only requiring approval for release from a single party (ie, the land holder can choose to opt out voluntarily).

Covenants are commonly considered the most permanent private land conservation mechanism in Australia. Thus they are formally able be classified as protected areas and can contribute to Australia's international protection targets.

Developing the northern savannas

Trade-offs between biodiversity, carbon and agricultural development

By Alejandra Morán-Ordóñez (Centre Tecnològic Forestal de Catalunya, Solsona, Spain and the University of Melbourne)

There's a lot of talk about developing Australia's north, of doubling the agricultural output of this region and pouring billions of dollars into new infrastructure such as irrigation. But what about the natural values of this region and it's potential for carbon storage today and into the future? Can we develop the north and still retain these other values?

Our spatial analysis revealed that the impact of agricultural development in northern Australia depends on how and where it's done. It could have a profound impact on biodiversity OR a relatively light impact. Given this, if managers and decision makers want our sweeping northern savannas to serve multiple purposes then they need to plan strategically for them.

The northern savannas occupy a vast area, approximately the combined size of both France and Germany! This region possesses a relatively intact cover of native vegetation largely consisting of open eucalypt woodlands with a grass understorey. The savannas currently support low-intensity rangeland grazing. Being largely intact, they provide home for a broad suite of native animals and plants, many of which are endemic. In recent years it's been realised that these lands also hold considerable potential for the storage of carbon by managing the manner in which fires occur (and therefore contribute to climate change mitigation).

But there are many calls to develop Australia's north. Based on soil properties, a fifth of this region is also deemed highly suitable for agricultural intensification. What are the consequences of enabling intensive agriculture in these places?

We analysed the trade-offs between biodiversity, carbon, and agricultural intensification in northern Australia. We compared maps of agricultural intensification potential, with the geographic distributions for 611 native species and 43 vegetation communities to see how they overlap.

Key messages:

We explored trade-offs among biodiversity conservation, carbon farming & agriculture production in northern Australia.

If agricultural development proceeded without consideration of biodiversity, suitable habitat of 3 species would disappear and 40 species and vegetation communities could lose more than 50% of their current distributions.

Strategically considering potential biodiversity outputs when planning for agricultural development leads to zoning options that would have a significantly lower impact on biodiversity values and carbon farming.

Irrigated agriculture in the Ord River Development. Developing the north will involve trade-offs with biodiversity. (Photo by Garry Cook)

Scenario	5%	10%	30%
1. Biodiversity-only	30,406	62,630	124,883
2. Biodiversity & Carbon	4,520	11,291	93,416
3. Carbon-only	33,496	69,163	149,034
4. Carbon & Agriculture	9,490	14,066	36,153
5. Agriculture-only	162,789	147,464	78,788
6. Biodiversity & Agriculture	10,580	20,599	60,304
7. Biodiversity, Carbon & Agriculture	238	968	7862

Figure 1a: Degree of overlap between any area suitable for agriculture and high priority areas (best 5%, 10%, and 30%) for biodiversity conservation only and carbon storage only (area in squared km). For example, whereas 30,406 km^2 of northern Australia has been identified as high priority for biodiversity (within the top 5 % of the biodiversity-only scenario landscape ranking), only 4,520 km2 overlaps with high priority areas for carbon storage (within the top 5% of the carbon-only scenario).

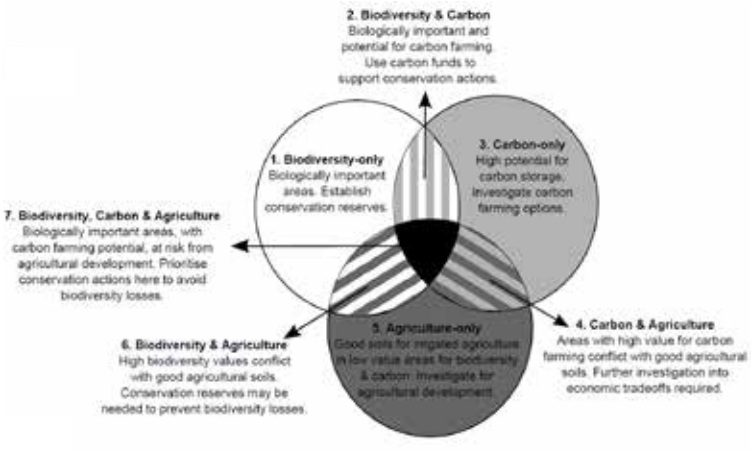


Figure 1b: Venn diagram showing the areas of potential conflict (trade-offs) or synergies between the three land-uses as well as their implications for policy making.

The northern savanna in its natural condition.
(Photo by James Fitzsimons)

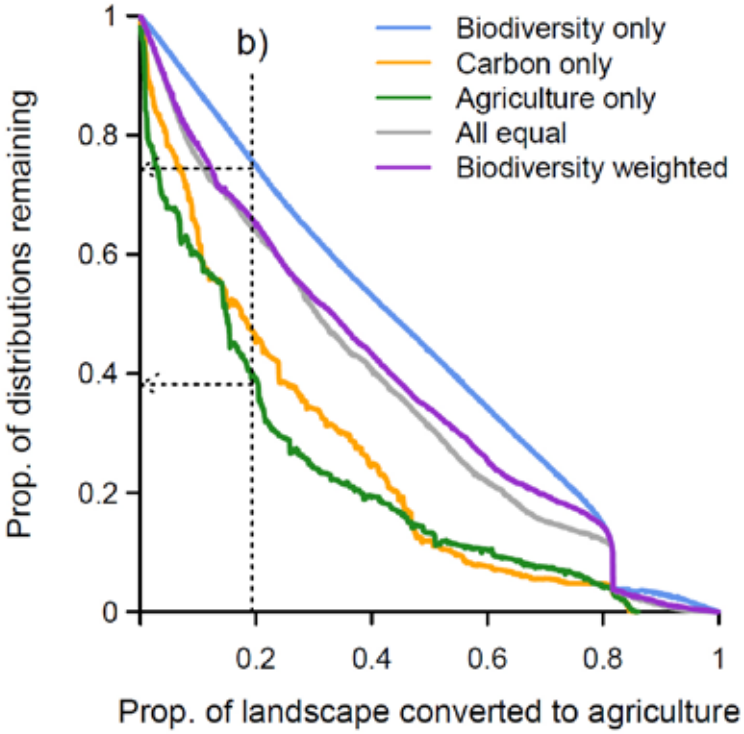


Figure 2: Performance of biodiversity features under five prioritization scenarios. The X-axis shows the proportion of the biodiversity features' distributions remaining at different levels of landscape lost due to conversion to agriculture. Lines represent the average performance of biodiversity features within the bottom 10th percentile of data for each scenario: biodiversity-only, carbon-only, agriculture-only, all-equal and biodiversity weighted. Comparison between scenarios can be made at any threshold of landscape conversion along the X-axis. For example, a conversion of all suitable soils for agriculture into irrigated crops or pasturelands would imply approximately 20% of landscape loss for other land-uses (dotted black vertical line marked with the letter b). At this proportion of landscape loss, the agriculture-only scenario predicts that the average distributions remaining for the worst 10% of the biodiversity features is 0.38 versus the 0.75 predicted by the biodiversity only scenario (ie, a reduction of approximately 50% in predicted distributions between the two scenarios).

We also compared the distribution of areas with larger carbon storage potential that are suitable for carbon farming.

Using this information, we explored five alternative scenarios that looked at different approaches to development and how these could impact the unique biodiversity values of this region. One scenario evaluated what might happen if only agriculture was considered in planning for agricultural expansion (agriculture-only); another if biodiversity conservation was the only consideration (biodiversity-only); the third was if only carbon-farming was considered (carbon-only); the fourth was if farming, biodiversity and carbon were all given equal weighting, seeking to balance the three goals (all-equal); and the final scenario looked at saving as much biodiversity as possible while still allowing for carbon farming and significant agricultural development (biodiversity-weighted).

We found that if all suitable soils were converted to agriculture, that all of the suitable habitat of three species would disappear, and 40 species and vegetation communities could lose more than 50% of their current distributions.

But agricultural development doesn't have to have this impact. Our analysis showed that it's possible to zone this region such that agricultural development could still occur on over 56,000 km^2 with a significantly lower impact on biodiversity values and carbon farming.

There is a significant opportunity to dramatically increase the protection of biodiversity with a minor expansion of the reserve system in northern Australia. By expanding the protected area network to capture an additional 5% of northern Australia, we could effectively double the representation of the biodiversity features from 29% to 57% (ie, the average proportion of current suitable areas for species that could be protected).

The development of extensive areas of irrigated agriculture might also cause potentially negative impacts on other industries such as tourism. Our approach could be built on to help evaluate trade-offs during planning and decision-making in relation to agricultural development in northern Australia, that incorporates more attributes than we have included in our study. For example, many other cultural, historical, social and economic can be mapped to provide an early indication of likely conflicts and trade-offs. The advantage of our approach is that it helps identify development footprints that have the lowest possible impact on biodiversity, while still providing strong economic opportunity. It can also help to identify where in the landscape are places that should most urgently be protected to avoid the worst outcomes of development for biodiversity.

The work has application beyond northern Australia. The analysis provides a template for policy-makers and planners to identify areas of conflict between competing land-uses, places to protect in advance of impacts, and planning options that balance the needs of agricultural and conservation.

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Reference

Morán-Ordóñez A, AL Whitehead, GW Luck, GD Cook, R Maggini, JA Fitzsimons & BA Wintle (2016). Analysis of trade-offs between biodiversity, carbon farming and agricultural development in northern Australia reveals the benefits of strategic planning. *Conservation Letters*
http://onlinelibrary.wiley.com/doi/10.1111/conl.12255/abstract

Paying farmers for biodiversity

Learning from agri-environment schemes in Australia

By Dean Ansell (ANU), Fiona Gibson (UWA) and David Salt (ANU)

Do our agricultural landscapes hold the key to protecting our declining biodiversity? If they do, how would it be done? And who would pay? Would it be the landowner or the general public (via the government)? These might sound like simple questions but when you consider some of the factors at play it quickly becomes apparent we're dealing with very complex issues.

A couple of years ago we (Dean, Fiona and David) were discussing the challenge of conservation on private land and payments to farmers. At that time Dean was studying cost-effective restoration (see Getting more bird for your buck in *Decision Point #77*), Fiona was into robust prioritisation metrics (Making environmental decisions using the wrong metric in *Decision Point #82*) and David was looking into the history of agri-environment schemes; so all of us had some understanding of the challenges connected to conservation on private land.

We acknowledged there were many perspectives on paying landowners for environmental services (ecological, economic and social) and realised that experts in all of these areas could be found in CEED and the Environmental Decisions Group. So, why not get some of these experts together and attempt to capture their collective wisdom?

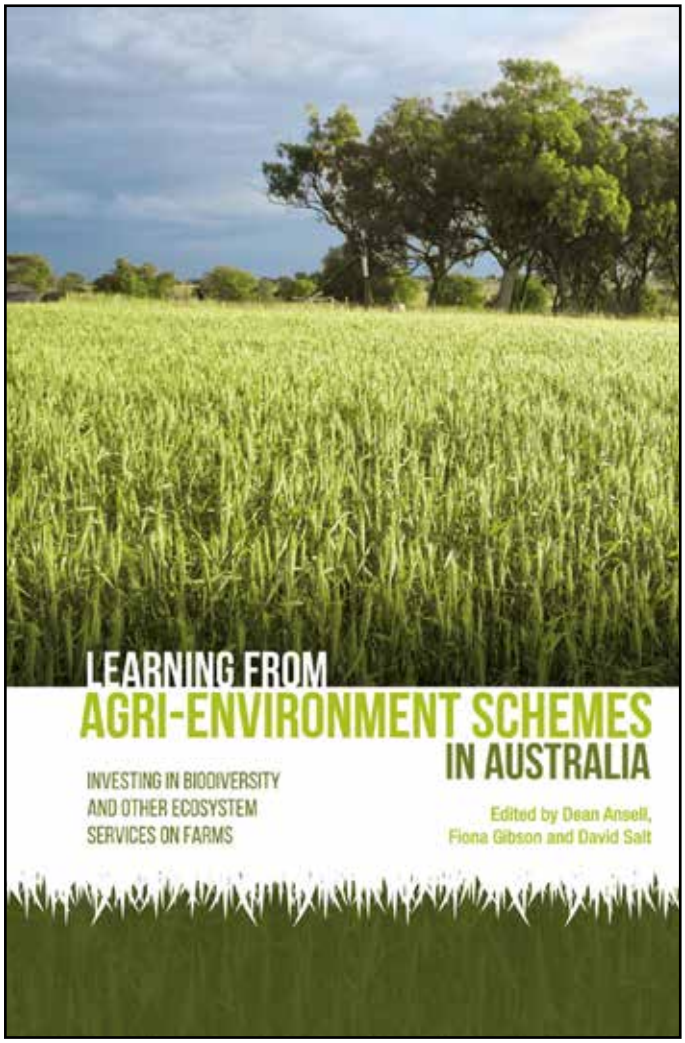
Well, that's what we did and a few weeks ago the results of our efforts was released by ANU Press in the form of an ebook: *Learning from agri-environment schemes in Australia*.

Learning from agri-environment schemes in Australia is a book about the birds and the beef — more specifically it is about the billions of dollars that governments pay farmers around the world each year to protect and restore biodiversity. After more than two decades of these schemes in Australia, what have we learnt? Are we getting the most of these investments? Should we do things differently in the future?

There are no quick answers to these questions but if you have any interest in the notion of conservation on private land then we encourage you consider reading our book. We did our best to keep chapters short, readable and engaging. And the topics that are included cover a wide spectrum of environmental, agricultural and social issues involved in agri-environment schemes.

Although, because the final output was an ebook you don't actually have to read the whole book. You could simply download the chapters that interest you. Check it out yourself.

A Greening Australia Project Manager (left) discusses a restoration scheme called Whole of Paddock Rehabilitation with a landowner. (Photo by David Salt)



Key messages:

The key criteria for successful agri-environmental policy revolve around six central themes

additionality – the difference the project makes
longevity – the length of time required to achieve change
appropriate policy mechanisms – policy tools are fit for purpose
robust prioritisation – projects are appropriately ranked
effective risk management – risk is explicitly factored in
sufficient levels of capacity – skills, knowledge and contacts are available

This book is perfect for anyone involved in agri-environment schemes; be it design, implementation or evaluation – or anyone with a general interest in the many values connected to farming in Australia (economic, social and ecological).

There are chapters on designing cost-effective agri-environment schemes, choosing different policy tools to account for public and private benefit, improving the performance of agri-environment investments, and what farmers prefer in agri-environment contracts.

Mixed in with the theory are reflections on how to work effectively with farmers, the role of environmental non-government organisations (like Greening Australia) and lessons from the Australian Government's Environmental Stewardship Program.

So, what are the take home messages from this exercise? What should governments keep in mind when designing agri-environment schemes? In our concluding chapter we attempted to distil the key messages emerging from the book. We believe that the key criteria for successful agri-environmental policy revolve around six central themes: additionality, longevity, the application of appropriate policy mechanisms, robust prioritisation, effective risk management, and sufficient levels of capacity.

Each of these themes are discussed at length throughout the book. In addition to this, Dave Pannell, one of Australia's leading experts on agricultural economics and agri-environment programs, also provides his reflections on what best practice means when it comes to agri-environmental schemes. Check out his checklist in the box.

And finally, being an ANU Press ebook, our book is free to everyone and available either as a whole book (in multiple formats) or you can just download the chapter that interests you. It's a great way to package information.

The book is also available for purchase as a hard copy.

To take up any of these options please visit the ANU Press website:
http://press.anu.edu.au/publications/learning-agri-environment-schemes-australia

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David Salt david.salt@anu.edu.au

Reference

Ansell D, F Gibson & D Salt (Eds) (2016). *Learning from agri-environment schemes in Australia: Investing in biodiversity and other ecosystem services on farms*. ANU Press, Canberra. http://press.anu.edu.au?p=346093

Does your AE scheme tick the boxes?

If you are involved with the design or implementation of an agri-environment scheme or program, can you answer the questions set below? If you can't, have you considered what this might mean to the success of your project or program?

This checklist was created by David Pannell and comes from Chapter 22: Reflections on best-practice in design and implementation.

1. Designing programs

Will it be continued? ☑
Is there appropriate institutional delivery? ☐
Is there an appropriate balance of projects? ☐
Is there adequate time for planning? ☐
Will it run for long enough? ☐

2. Designing projects

Does it have appropriate targets? ☐
Is it sufficiently funded? ☐
Does it use the right policy tool? ☐

3. Ranking projects

Are actions (projects) being ranked?
(Not problems, issues or regions) ☐
Is ranking based on value for money? ☐
Are benefits being measured against a counterfactual? ☐
Are all the benefits and risks being factored in? ☐
Is a robust metric being used for the ranking? ☐

4. Managing uncertainty

Have the key uncertainties been identified? ☐
Have feasibility assessments been done? ☐
Can we learn from the early stages of implementation? ☐

5. Managing people's interests

Has the project been designed to deal with self-interest from participants? ☐
Has independent expert review been undertaken to balance over optimistic expectations? ☐
Has efforts been made to deal with self-blindness? ☐
Has arguments for equity undermined the effectiveness of the program? ☐

6. Managing transaction costs

Does the program have too many small projects (with benefits being chewed up by transaction costs)? ☐
Does project selection start broad and finish deep? ☐

Restoring urban drains to living streams

Is it worthwhile?

By Maksym Polyakov (University of Western Australia)

As urban populations grow and cities expand, peri-urban bush is cleared, and wetlands are filled and drained to give way to new developments. As a result, creeks and streams are transformed into open drains retaining their capability to transmit storm water across the landscape (eventually connecting to major waterways), but losing their habitat, environmental, and recreational functions. In recent years, urban planners, local governments, community groups and local residents have started to restore these open urban drains into 'living streams'. The drainage function is still there but the effort has, in many cases, created a fully functioning wetland ecosystem.

For the restoration of urban drains to living streams to be widely adopted, it is important to show that the benefits from restoration are greater than the costs. It is known that living streams provide a broad variety of benefits, and that some of these benefits, such as recreational and aesthetic benefits, are valued by local residents. Evidence shows that people are willing to pay higher prices for the houses in the vicinity of living streams in the same way that they are willing to pay more to be closer to local parks and nature reserves.

The impact of restoration projects on house prices can be determined via a statistical technique known as the hedonic pricing method. Whilst this might take a decade to realise, the increased property prices should trickle down to the local councils through the council rates to help fund such restoration projects.

Take the case of Bannister Creek Living Stream project located in the suburb of Lynwood in Perth Metropolitan Area. It was initiated by the Bannister Creek Catchment Group formed by local residents as well as staff of the City of Canning and the WA Department of Water. The management plan, drafted by Dr Judith Fisher in 1999, aimed to rehabilitate a section of the Bannister Creek main drain into a living stream that would, in addition to the flood mitigation function of the existing main drain, also provide local amenity benefits, improve catchment water quality, and slow the flow of water into the system such that the flow velocity during high rainfall events was at an acceptable level for public safety. The works were completed during 2000-2002. In approximately ten years, the living stream had evolved into a fully functioning wetland ecosystem (see images).

Key messages:

- Restoring open drains into wetland ecosystems is expensive
- We examined the increased value of nearby houses to an urban drain restoration project in Perth to assess increased home value
- We found homes within 200m of the restoration site increased in value by 4.7%, meaning benefits exceeded costs

We found that in the initial years of the restoration project the site would not have provided any local amenity benefits, and that there may have even been some dis-amenity effects due to extensive earthworks.

However, eight years after the restoration the median home within 200m of the project had increased in value by between $17,000 and $26,000 more than similar homes in the area. That's an increase in value of 4.7%.

Once aggregated along the length of the restoration project, the benefits capitalised into local homes are found to be many times the cost of the restoration project. So, even without considering other values such as water quality or biodiversity benefits, the restoration of the drain to a living stream was worthwhile.

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Polyakov M, J Fogarty, F Zhang, R Pandit & DJ Pannell (2016). The value of restoring urban drains to living streams. Water *Resources and Economics* DOI:10.1016/j.wre.2016.03.002 http://www.sciencedirect.com/science/article/pii/S2212428416300123

Bannister Creek before the restoration (November 2000). (Photograph courtesy of SE Regional Centre for Urban Landcare.)

Bannister Creek after restoration had been completed (September 2013). (Photograph courtesy of SE Regional Centre for Urban Landcare.)

CEEDlings of promise are UK bound

Maria Beger, Jane Catford, Morena Mills and Roberto Salguero-Gomez are four very different researchers (Maria is a marine ecologist, Jane is an invasion biologist, Morena is a social scientist and Roberto is a plant demographer). However, they also have several things in common: they are all members of CEED, they are all passionate about their science improving biodiversity conservation and they all leaving Australia for the United Kingdom.

Maria is taking up a five year Research Fellowship at the University of Leeds. Jane is starting a lectureship in Community Ecology at the University of Southampton (in the Centre for Biological Sciences). Morena is commencing a lectureship at Imperial College London on Conservation Science. And Roberto is joining the University of Sheffield to become a NERC (Natural Environmental Research Council) Independent Research Fellow.

All four researchers have strong international research reputations, and have played important roles at CEED. And they are all quick in acknowledging the importance of CEED both to themselves, to conservation and to the reputation of Australia.

"Despite the geographic distance between Australia and most other countries around the world, CEED has successfully created a brand of quality research which, in my opinion, is internationally recognised," says Roberto Salguero-Gomez.

"My three years at CEED has made me aware of the value of social sciences, economics, mathematical modelling and even my own specialty (ie, population ecology) in decision making. I feel that the skills that I have acquired during my time at CEED, including leadership skills, have put me in a position where I now feel fully capable of running my own lab, interacting with researchers from various groups and disciplines to tackle complex, timely questions."

It's a sentiment echoed by Jane Catford. "Working at CEED has been a great experience," she says.

"It's allowed me to work alongside some of the world's top environmental researchers and thinkers. And, because of CEED's strong international connections, I look forward to sustaining those relationships in my new position at the University of Southampton."

CEED has been Maria Beger's home for the past four years.

"To me, CEED is exceptional because it combines Australia's top conservation scientists and ecologists in a very open and transparent collaboration, with everyone committed to making a difference in conservation on the ground," says Maria.

"CEED has not only given me an exceptional quantitative tool kit in conservation science, I have also been spoilt with an extremely open research environment, and I learned about the importance of interdisciplinary work. I was given incredible freedom to pursue my interests and passions in marine conservation during my time at CEED, and this allowed me to build networks that have enabled me to make an important contribution towards the conservation of coral reefs and related ecosystems."

And Morena Mills also believes CEED has enabled her to make a real difference with her science.

"CEED has been an incredible place to work," she says. "It exposes you to a great array of scientists with different background, all focussed on how to best improve environmental decisions. Additionally, we are encouraged to work in collaboration with government and NGOs around the world and help them tackle the most pressing conservation issues. I can't imagine a better place to work as a postdoctoral researcher."

It is the very nature of a career in scientific research to move around, especially for early to mid career scientists. In this case, the United Kingdom is getting four top conservation scientists.

"The demand for our quantitatively-trained early career researchers is strong evidence that CEED's people – and their experience, skills and knowledge – are internationally sought after," says Hugh Possingham, CEED's Director.

"It also an indicator that knowledge created through CEED is being shared around the planet. We hope that researchers like Maria, Jane, Morena and Roberto will return to our shores at some point in the future. Having networks like CEED around will be important to attracting overseas talent.

"However, regardless whether they return or not, their engagement in CEED has made a real contribution to conservation science and practice. We wish them well and hope they stay part of the growing network of environmental decision scientists."

Read all about them in Decision Point

Read more about Jane's work at:
Setting environmental objectives in novel ecosystems
ttp://decision-point.com.au/article/where-are-the-goal-posts-now/

Read more about Roberto Salguero-Gomez research at:
Tree of life reveals insights on plant variation
http://decision-point.com.au/article/tree-of-life-reveals-insights-on-plant-variation/

Read more about Morena's work at:
Local implementation and regional conservation planning in Fiji
http://decision-point.com.au/article/acting-systematic-in-an-ad-hoc-world/

Read more about Maria Beger's science at:
Connecting animal telemetry and spatial conservation
http://decision-point.com.au/article/telemetry-and-better-decision-making/

And check out the June 2016 issue of *Decision Point*. It's a special issue focussing on marine conservation. In addition to carrying several stories on Maria's research, Maria played a central role in planning the issue and bringing the stories together.


Maria Beger


Jane Catford


Morena Mills


Roberto Salguero-Gomez

Climate change and extinction

Several weeks ago the world learnt of the disappearance of the Bramble Cay melomys, a small Australian rodent only known to occur on a tiny coral cay off the northern tip of Australia. The finding is noted in a government report that describes how a comprehensive search for the species in 2014 had failed to detect a single animal. CEED associate James Watson from the University of Queensland reflected on the consequences of this climate change extinction in Nature. Here's an excerpt from his article.

If we are going to have a fighting chance to avert the current extinction crisis, we must accept and communicate that climate change is already upon us and that proactive action is needed now. We should not treat the news of the extinction of the melomys as an interesting question for Trivial Pursuit or an undergraduate exam — we need to treat it as a lesson.

This species did not live in a place where its existence came into conflict with other societal needs, such as good farming land or places to live. It was on an uninhabited island, effectively protected from other threats. A wide range of actions could have been taken to manage its population without causing conflict with other competing agendas.

Australian mammals are well researched, and given the melomys's habitat requirements, the islands' low elevation and the fact that there is widespread knowledge of increasing sea levels across coastal Australia, it was not hard to work out that the species was in dire trouble. Yet almost nothing was done in time: there were no proactive plans to monitor the melomys, move a few individuals to create a rescue population or create a simple sea-level barrier. No action was taken because of the attitude that climate change is not really happening yet, and there is time to sort it out.

This is unacceptable. We need a fundamental shift in how the scientific community, the media, policymakers and environmental funders view and discuss climate change. When we think about the impact of climate change on biodiversity, we need to start framing the issue as something that is already well under way and that, in conjunction with other threats, needs to be managed now. Crucial to this will be research on what species are immediately threatened by climate change, followed by plans to help them to survive. It will be complicated, but to give nature a chance, we need to harness the fears of the future to address the realities of the present.

Reference

Watson J (2016). Bring climate change back from the future. *Nature* 21 June 2016. http://www.nature.com/news/bring-climate-change-back-from-the-future-1.20126

A Bramble Cay melomys photographed in 2002. (Image by Ian Bell)

Impacts of Kalimantan floods

Recent research published by Jessie Wells & colleagues in *Environmental Research Letters* gathers data on the impacts of flooding in Indonesian Borneo. The study, one of the first of its kind, is based on over 360 interviews and news archives examined to analyse the impact of flooding on lives, livelihoods and the environment.

Reference

Wells JA, et al (2016). Rising floodwaters: mapping impacts and perceptions of flooding in Indonesian Borneo. *Environmental Research Letters 11*

Dose of nature benefits health

People who visit parks for 30 minutes or more each week are much less likely to have high blood pressure or poor mental health than those who don't, according to new research led by CEED researcher Danielle Shanahan. The findings suggest people might need a minimum 'dose of nature'. In the paper just out, Danielle said that parks offered health benefits including reduced risks of developing heart disease, stress, anxiety and depression.

Reference

Shanahan DF, et al (2016). Health benefits from Nature experiences depend on dose. *Scientific Reports* 6, number 28551. http://www.nature.com/articles/srep28551