DECISION POINT

Connecting conservation policy makers, researchers and practitioners

Issue #73 / September 2013

Field science

Strategies to get researchers to work with managers & decision makers

Gondwana Link and decision theory

Citizen scientists in the woods

Of fencelines and effective weed control

Decision Point

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

Plus

DECISION POINT

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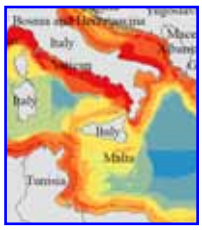

EDG researcher Phil Gibbons (on the right) talking about biodiversity offsets out in the field with local government conservation managers. Researchers need to work with managers and decision makers as they do their science if they are to bridge the implementation divide. (See our story on page 6.) Photo by David Salt

On the point

Collaboration is the name of the game

Everyone has heard the catch cry 'publish or perish'. To get ahead in an academic career you have to publish and publish, and then publish some more. Unfortunately, the ever greater number of scientific journal articles on conservation biology don't appear to be stemming the catastrophic decline in biodiversity being witnessed around the world.

Well, I'd like to put forward a less well known saying (mainly because I just made it up): 'collaborate or croak'. The 'croaking' here is the decline of thousands of species as they slip towards the precipice of extinction. The 'collaboration' is the joint activity of multiple groups and individuals trying to save those species. In this issue of Decision Point we give you multiple reasons why understanding this collaboration is important.

Up front is a reflection on a research collaboration involving a landscape-scale conservation collaboration called Gondwana Link (page 4). GLink has achieved great things but we contend our research has added value to those efforts.

Following this, Carly Cook suggests strategies to help scientists and decision makers work better together (page 6); Tessa Mazor shows how collaboration between countries around the Mediterranean Sea could reduce costs of marine conservation by two thirds (page 8); Ascelin Gordon analyses how collaboration between organisations can more efficiently save species (page 11); Nathalie Butt describes how citizens collaborating with scientists can generate invaluable data; and Shaun Coutts discusses how collaboration between landowners is critical to effective weed control (page 14).

So, whatever your preferred form of collaboration might be, there's something in this issue of Decision Point that hopefully will inform it.

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DECISION POINT

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

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

Optimising citizen science

Citizen science is on the rise. Aided by the internet, the popularity and scope of citizen science appears almost limitless. For citizens the motivation is to contribute to 'real' science, public information and conservation. For scientists, citizen science offers a way to collect information that would otherwise not be affordable.

The longest running and largest of these citizen science programs are broad-scale bird monitoring projects. There are two basic types of protocols: (a) cross-sectional schemes such as Atlases – collections of surveys of many species contributed by volunteers over a set period of time, and (b) longitudinal schemes such as Breeding Bird Surveys (BBS) – on-going stratified monitoring of sites that require more coordination. Ayesha Tulloch and colleagues reviewed recent applications of these citizen-science programs to determine their influence on science. They used return-on-investment thinking to identify the minimum investment needed for different citizen-science programs, and the point at which investing more in these programs has diminishing benefits.

Atlas and BBS datasets are used to achieve different objectives, with more knowledge-focused applications for Atlases compared with more management applications for BBS. Estimates of volunteer investment in these datasets show that compared to cross-sectional schemes, longitudinal schemes are more cost-effective, with increased BBS investment correlated with more applications, which have higher impact in the scientific literature, as measured by citation rates. This is most likely because BBS focus on measuring change, allowing the impact of management and policy to be quantified.

To ensure both types of data are used to their full potential, they recommend that: elements of BBS protocols (fixed sites, long-term monitoring) are incorporated into Atlases; regional coordinators are in place to maintain data quality; communication between researchers and the organisations coordinating volunteer monitoring is enhanced, with monitoring targeted to meet specific needs and objectives; application of data to under-explored objectives is encouraged, and data are made freely and easily accessible.

Reference

Tulloch AIT, LN Joseph, JK Szabo, TG Martin & HP Possingham (2013). Realising the full potential of citizen science monitoring programs. *Biological Conservation* 165, 128-138. http://dx.doi.org/10.1016/j.biocon.2013.05.025

Religion and conservation

EO Wilson, one of the world's most influential ecologists, once wrote: "Religion and science are the two most powerful forces in the world today… If [they] could be united on the common ground of biological conservation, the problem [of biodiversity loss] would soon be solved."

Religion inherently iinforms morality and has for centuries guided people with respect to what is right and what is wrong. Could religion play a greater role in conserving the world's declining biodiversity? A new study by ecologists in Sweden and Australia suggests that *if* the world's religions wanted to make a big difference, they are ideally placed to do so.

The study, led by Grzegorz Mikusinski from the Swedish University of Agricultural Sciences, examines the spatial distribution of different religions in the world and how they overlap with different areas important for biodiversity at a global scale. The analysis indicates that the majority of these focal areas are situated in countries dominated by Christianity, and particularly the Roman Catholic denomination (including most of the countries in Latin America). There is also a large overlap of areas important for biodiversity with Buddhism (Southeast Asia), Hinduism (Indian subcontinent) and Islam (Asia Minor, parts of North and Central Africa).

"These results indicate that Roman Catholics, per capita, have the greatest potential to save global biodiversity where they live," says Hugh Possingham, a co-author on the study (and Director of the EDG). "The Roman Catholic Church has recently elected a new Pope, Pope Francis – the name linked to the 'greenest' saint of the Catholic Church, Saint Francis of Assisi, an official Patron of Ecology. Let's hope that he and other religious leaders will seriously consider the opportunity to engage more actively in the conservation debate. Moreover, conservation researchers must actively encourage religious leaders to participate in such a debate."

Conservation scientists need to refocus on strategies that reshape ethical attitudes to nature and encourage pro-environmental thinking and lifestyles, say the researchers. Religions are central to basic beliefs and ethics that influence people's behaviour. They should be considered more seriously in the discourse on biodiversity.

Reference

Mikusinski G, HP Possingham & M Blicharska (2013). Biodiversity priority areas and religions—a global analysis of spatial overlap. *Oryx* http://www.oryxthejournal.org

What drives landholders to tender for conservation?

Tender programs are an increasingly common way of engaging landowners to undertake conservation actions on their land. High participation is critical to these schemes as competition is required for the cost-effectiveness benefits of the tender system to be fully realized. However, there is limited knowledge on why landholders participate in tender programs.

This study aims to identify the relative importance of different drivers of participation in conservation tenders being run in the state of Victoria. Because of the small sample size available, the researchers employed the novel method of maximum entropy ordinal regression to undertake the analysis. They supplemented this with qualitative data obtained through face-to-face interviews.

The regression analysis revealed that strong relationships between agencies and landholders (relationships that were respectful and continuous) and a low administrative burden drive increased participation. The provision of education, support, and easily-integrated management practices, however, may drive lower participation, with landholders confident to undertake conservation activities independently of assistance.

Some evidence emerged that ten-year contracts may be well-received. A key concern is low additionality in biodiversity benefits, with typical tender participants displaying a strong conservation ethic and high levels of management activity pre-participation. This work has shown that in conservation policies involving self-selection by participants, economic incentives for adoption may be less important than non-monetary drivers.

Reference

Blackmore L & Doole GJ (2013). Drivers of landholder participation in tender programs for Australian biodiversity conservation. *Environmental Science & Policy* 33:143-153. http://dx.doi.org/10.1016/j.envsci.2013.05.010

Gondwana Link and decision theory

Reflecting on the fruits of collaborative research

By Kerrie Wilson and Hugh Possingham (University of Queensland)

Four years ago we embarked on a collaborative research project that aimed to explore how environmental decision making and spatial prioritisation might contribute to improving the conservation outcomes of Gondwana Link, one of Australia's largest and most ambitious conservation projects (see the box on research partners or see the original article on this work in *Decision Point #25*). Four years on and Gondwana Link continues to move forward as the most successful conservation corridor in Australia. And the research projects that were initiated through the collaboration are now being published in international journals, research students are graduating, and new partnerships are emerging. At this juncture we thought it would be timely to reflect on the successes and the work that still needs to be done.

Integrating spatial conservation planning with CAP

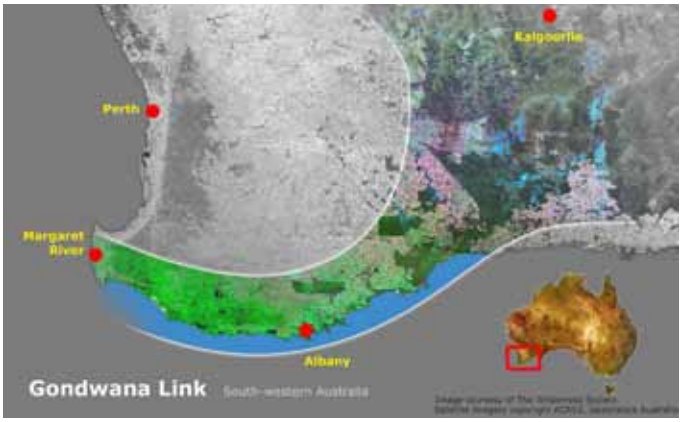
An early achievement of the project was the attempt to integrate knowledge and tools for conservation planning (specifically the Marxan suite of software tools, http://www.uq.edu.au/marxan/) and the Conservation Action Planning (CAP) process. This was informed by numerous workshops with key stakeholders led by staff with intimate knowledge of the ecological systems and the people that live in the region. Typically, these processes are used in isolation, despite many complementary features, so this effort to bring them together was significant.

From a decision theory perspective, CAP is highly informative for identifying objectives and knowledge gaps. We also explored the utility of these tools for not only identifying priority areas for protection, but also priority areas for restoration, taking the substantial on-ground knowledge of restoration in the region (see *Decision Points #27, #28*, and the box 'Three perspectives on the Link') and marrying it with new theory and decision making frameworks for restoration.

Project partners

Support for this collaborative research project came from the leading NGO partners behind Gondwana Link itself. They are The Nature Conservancy (TNC), Greening Australia, The Wilderness Society, Gondwana Link Ltd and other Gondwana Link affiliated groups (including Bush Heritage Australia).

Pictured below is the original advisory team guiding the research collaboration (and the organisations they were representing back at the beginning of the project over four years ago): back row (from the left): Dr Ayesha Tulloch (UQld), Dr Nicola Markus (Bush Heritage Australia), Dr David Freudenberger (Greening Australia), Dr Robert Lambeck (Greening Australia), Keith Bradby (Gondwana Link Coordination Unit), Professor Hugh Possingham (UQld); front row: Dr Michael Looker (The Nature Conservancy), Dr Trudy O'Connor (The Wilderness Society), Paula Deegan (UQld) and Dr Kerrie Wilson (UQld).



Gondwana Link

Gondwana Link is a landscape-scale conservation project in the ecologically significant south-west corner of Western Australia. The completed link will be an arc of bushland stretching for 1000 kilometres from the western edge of the Nullarbor Plain to the wet forests of the Margaret River region. The aim of the Gondwana Link project is to reconnect fragmented ecosystems, and to protect, restore and maintain the fundamental ecological processes that underpin these ecosystems. More info: http://www.gondwanalink.org/

Through this project we have developed more specific approaches and advanced the theory on how to take multiple threats, price, risks, and feasibility into account in fine-scale action planning, habitat restoration and threat abatement. We were humbled by the many on-ground complexities that presented themselves. Providing approaches and theory that match the detail of reality is not easy – not least because of difficulties in quantifying and describing this detail in the first place.

Monitoring

Somewhat fortuitously, we investigated the contentious issues of which indicator species to monitor to detect the success of management actions. We see this as fortuitous as it required the right PhD candidate to become involved in the project that could identify a truly significant knowledge gap. That PhD scholar was Ayesha Tulloch. Her investigation enabled us to analyse the costs and benefits of different management and monitoring decisions in Gondwana Link and devise a decision support tool to prioritise the selection of indicator species (Tulloch et al. 2011). This was the first time an approach strongly founded in economics has been applied in conservation to select indicator species.

As always, a lack of data was a limiting factor. However, rather than complain and move on, we systematically identified gaps in the bird monitoring network so that we are a step closer to filling them (Tulloch et al. 2013).

With a lot of money already spent on monitoring, and more money clearly needed, we started to wonder whether management decisions should be based on ecological intuition rather than evidence. We found a powerful example of why this would be dangerous by exploring the

"The research projects that were initiated through the collaboration are now being published in international journals, research students are graduating, and new partnerships are emerging."

relationship between fox baiting and the responses of threatened species. Alarmingly, we discovered that current fox baiting programs are ineffective for abating the decline of many species (Tulloch et al. in press), including malleefowl (Walsh et al. 2012). This is despite the malleefowl being one of the best-monitored species of conservation concern in Australia. If we are still uncertain how to cost-effectively manage this species then clearly ongoing research on evaluating conservation outcomes, rather than inputs or outputs is required.

The gap between ecological & social assessments

The third significant outcome was research aimed at bridging the gap between ecological and social assessments. As reported recently in *Decision Point,* we have identified that mismatches in scale between conservation actions and ecological systems can seriously undermine conservation outcomes (Guerrero et al. 2013). We are now analysing the results of interview surveys of stakeholders in Gondwana Link so that we can further explore the structure of the collaboration network and how this aligns with a subset of conservation features of concern.

Angela Guerrero, who is leading this analysis, has already discovered that the complexity surrounding effective implementation in large-scale conservation projects such as Gondwana Link involves multiple interacting aspects, including collaborative processes, the effects of social networks, and the diversity of institutions at play. We'll keep you posted on what she finds.

Partners in research

This is just a taste of the research that has arisen from this project. Ultimately, the research and publications did not emerge from thin air: they emerged from discussions (at times intense) with project partners in relation to prioritisation, decision-making and monitoring. The work of the non-government organisations and dedicated individuals involved in this project provided the fundamental inspiration for this research project and many of our research endeavours.

Gondwana Link provides a particularly rich suite of applied conservation problems, many more than can be tackled in a single project. How best to deal with the interaction of climate change on threats and what that means for biodiversity conservation still eludes us, but we are closer now to knowing how to cost-effectively monitor these changes. We also have a much clearer understanding of the strengths and gaps in the social network.

Our partners are well-positioned to exploit these findings in Gondwana Link. The hope is this work will inform other major conservation projects across Australia as well.

More info: Kerrie Wilson k.wilson2@uq.edu.au

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Guerrero AM, RRJ McAllister, J Corcoran & KA Wilson (2013). Scale Mismatches, Conservation Planning, and the Value of Social-Network Analyses. *Conservation Biology* 27: 35–44. (covered in Decision Point #70)

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Tulloch AIT, K Mustin, HP Possingham, JK Szabo & KA Wilson (2012). To boldly go where no volunteer has gone before: predicting volunteer activity to prioritize surveys at the landscape scale. *Diversity and Distributions*. DOI: 10.1111/j.1472-4642.2012.00947.x. (covered in Decision Point #64)

Tulloch AIT, I Chadès & HP Possingham (in press). Accounting for complementarity to maximize monitoring power for species management. *Conservation Biology*.

Walsh JC, KA Wilson, J Benshemesh & HP Possingham (2012). Unexpected outcomes of invasive predator control: the importance of evaluating conservation management actions. *Animal Conservation* 15: 319-328. (covered in Decision Point #63)

Three perspectives on the Link

A few of the stories we've run on Gondwana Link in *Decision Point* highlighting how different people (and organisations) frame the work being done on GLink. Follow the *Decision Point* links if you'd like to read the whole story.

Big thinking for a big country

Decision Point #26

In this provocative editorial, EDG's Hugh Possingham suggests that proposals for continental-scale connections need to justify the effort that goes into them.

"The case for any single continental-scale corridor does not depend on proving the area is important. The case must depend on the relative merits of expenditure on those areas vs other broad-scale connections or more dispersed habitat restoration."

Planning at Peniup

Decision Point #27

Justin Jonson, who was then with Greening Australia, discusses restoration at the property scale, and lessons they had learned in Gondwana Link.

"The decision making process at Peniup began with the defined objective of re-establishing a self-replicating biologically-diverse plant system, ecologically informed in its design, and consistent with the heterogeneous mosaic of plant associations found in the dryland transition zone of Western Australia "

Bird-guided restoration

Decision Point #28

Angela Sanders and colleagues from Bush Heritage Australia talk about moving revegetation towards habitat restoration in Gondwana Link.

"Piles of rocks, mallee roots and soil within paddocks are now being left in place, whereas previously they were often 'cleaned up' or burnt prior to revegetation."

Strategies to bridge the divide

Mechanisms that help scientists and decision makers work together

By Carly Cook (University of Melbourne), and Hugh Possingham and Richard Fuller (University of Queensland)

There is a growing body of evidence to show that scientists often don't answer the questions most important to managers. It is also increasingly clear that while decision makers value scientific information (see *Decision Point #70*), they do not routinely use science even when it's available.

There are many reasons for this divide between the science and practice of conservation (Cook et al 2013), a separation that is often called the implementation gap. Within the conservation science community there are incentives for publishing research and attracting funding, but not for engaging with decision makers. Furthermore, what is interesting to scientists is not always what is needed by managers.

Then there is the issue of timeliness – journal publications take a long time to appear which can mean that research is perpetually out of sync with the management of urgent or dynamic conservation problems. Funding timeframes generally discourage landscape scale or long-term research projects, and there are disincentives for scientists to engage in multidisciplinary collaborations that develop realistic solutions to conservation problems.

On the other hand, decision makers balance the desire for more information against the lack of funds for data collection and the need to act quickly despite uncertainty. The need to act quickly is reinforced when delaying action may leave only the more expensive management options, such as captive breeding programs.

Managers tell us they find it difficult to access scientific information, and that they are put off when different studies provide conflicting advice. Likewise, operational constraints frequently mean that managers are not able to implement the solutions being proposed because they are too expensive, impractical, politically difficult, or because the research conclusions are vague, uncertain, or riddled with caveats.

Scientists are expected to take a rigorous approach to answering novel questions but this isn't always compatible with addressing well established conservation problems. When research questions are simplified to suit rigorous scientific methods they become less relevant to decision makers, who must deal with the real complexity of environmental problems. Conversely, highly technical outputs may be unintelligible for decision makers, who do not always need high levels of confidence to act.

The focus on reducing uncertainty can distract from the fact that the acquisition of new knowledge may not materially change what is considered the best course of action. Meanwhile, we can often use existing knowledge to develop rules of thumb that predict the likely outcomes of management with reasonable certainty and without expensive data collection. The obsession with scientific credibility can also lead to different values and perspectives, such as those of stakeholders and experts from other disciplines, being excluded from the research process.

"Managers are not able to implement the solutions being proposed because they are too expensive, impractical, politically difficult, or because the research conclusions are vague, uncertain, or riddled with caveats."

"The most important element is collaboration between decision makers and scientists."

While the impediments to developing science that is used by decision makers (boundary science) are well documented, the solutions have received less attention. David Cash and colleagues (2003) observed that decision makers use research if it is **salient** (relevant to decision-making bodies and provided when it is needed), **credible** (authoritative, believable, and trusted), and **legitimate** (developed via a process that considers the values and perspectives of all actors). They showed that achieving all three elements requires a collaborative process with mechanisms to facilitate communication across the science–management boundary, communication that translates jargon and advocates for the perspectives of both knowledge producers and users. What's more, this collaboration needs to operate throughout the research process, not just at the end.

While this might sound difficult to achieve, conservation professionals (ie, decision makers and scientists) have already developed several innovative approaches. In our recent paper (Cook et al. 2013) we highlight 4 successful approaches: boundary organisations (independent organisations that work at the nexus of science, policy, and practice and facilitate communication

EDG researcher Phil Gibbons (on the right) talking about biodiversity offsets out in the field with a local government conservation manager. Researchers need to work with managers and decision makers as they do their science if they are to bridge the implementation divide.

Four strategies that bridge the divide

Boundary organizations

Dedicated boundary organisations can take on the role of facilitating communication between scientists and decision makers on specific issues. These organisations operate in both the scientific and management spheres but retain distinct lines of accountability to both groups. For example, the Ecosystem-Based Management Tools Network (http://www.ebmtools.org/) provides a wide range of training and outreach activities to connect practitioners with tools that incorporate science into decision making. The independence of boundary organisations can bring together groups that may have had poor relationships in the past and can help attract funding from a wide range of sources.

Research scientists in management agencies

Creating permanent positions for research scientists in management agencies can make sure that high-priority knowledge gaps are filled. These scientists can provide in-house expertise for the design and implementation of research and monitoring programs, can help analyse data collected by agency staff, can provide advice relevant to specific management contexts, and help managers achieve an appropriate compromise between certainty and urgency. When scientists and managers work together, managers can educate scientists about real-world constraints on management. With a more realistic understanding of the management context, scientists can filter, synthesise, and translate the peer-reviewed literature into management approaches and help managers learn from and evaluate their management activities.

Links between researchers and decision makers

When it isn't possible for management agencies to employ scientists there are other ways to benefit from closer ties between these groups. Formal arrangements exist whereby agencies support research-focused institutions to address priority research questions, often using small financial incentives, such as a research stipend or a contribution toward project costs. This approach benefits the agency because it provides scientific expertise from a wide range of disciplines and the enthusiasm and energy of academic staff or research students. The research-focused institutions benefit from an additional source of research funds, and their staff and students get the opportunity to conduct relevant research and better understand conservation problems through their interactions with decision makers.

Training conservation professionals

Existing academic training programs generally fail to capture the skills required by both conservation practitioners and scientists. The next generation of conservation professions needs the skills to operate on both sides of the science-management boundary. The scientific training of conservation professionals should not be compromised, but students need to be taught how to communicate science to decision makers, and how policy is generated and implemented, and how to make decisions under uncertainty (eg, decision theory). Getting the right balance between these skills can be achieved by including both scientists and decision makers in the development of training programs.

EDG researcher Eve Macdonald Madden (standing) with Tara Martin (on the right) discuss structured decision making with Nick Dexter, a Parks Australia manager, to understand real world management issues facing conservation managers. Only by collaborating can researchers learn how to best make their science salient, credible and legitimate.

among them), research scientists working within management agencies, formal links between research-focused institutions and management agencies, and training programs for conservation professionals (see the box on four strategies).

The approaches we highlight here are by no means the only ones that exist and different elements can be mixed and matched depending on the needs and constraints of the organisation. However, the most important element is collaboration between decision makers and scientists. Breaking down the boundaries between different groups of conservation professionals, and different scientific disciplines, requires that these different groups be prepared to engage with one another and to challenge traditional models of knowledge production. While this may require some additional effort, there are many rewards for those willing to invest their time and energy.

More info: Carly Cook carly.cook@unimelb.edu.au

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Cash DW, WC Clark, F Alcock, NM Dickson, N Eckley, DH Guston, J Jager & RB Mitchell (2003). Knowledge systems for sustainable development. *PNAS* 100:8086-8091.

Cook CN, MB Mascia, MW Schwartz, HP Possingham & RA Fuller (2013). Achieving conservation science that bridges the knowledge-action boundary. *Conservation Biology*, 27(4): 669-678.

On being salient, credible & legitimate

We perceive at least three key challenges for those hoping to achieve boundary-spanning conservation science. First, scientific and management audiences can have contrasting perceptions about the salience of research. Second, the pursuit of scientific credibility can come at the cost of salience and the legitimacy of science in the eyes of decision makers, and third, different actors can have conflicting views about what constitutes legitimate information. The key to overcoming all three challenges is through meaningful collaboration between scientists and decision makers, and the four strategies we highlight (see the box on four strategies) are a good place to start.

Conservation and collaboration in the Mediterranean Sea

Collaboration can reduces conservation costs in the marine realm

By Tessa Mazor (University of Queensland)

The problem with countries collaborating for conservation is that it takes too much effort. Well, that's a common perception anyway. The truth is that if it's done properly you can get better conservation outcomes. What's more, in some situations collaboration is the only sensible way to go. To demonstrate the possible benefits of collaboration, we modelled different levels of collaboration in conservation planning for the Mediterranean Sea biodiversity hotspot (Mazor et al. 2013).

The Mediterranean Sea biodiversity hotspot is one of the most complex marine regions in the world (see the 'Mediterranean melting pot'). It supports a rich biodiversity concentrated in a small area surrounded by over twenty countries across three continents: Europe, Asia and Africa. Clearly, if conservation efforts are to be fruitful in the Mediterranean Sea, there needs to be some degree of collaboration between these countries. But can collaboration between Mediterranean countries actually improve conservation efficiency – achieving the same conservation outcomes for less cost?

Collaboration and efficiency

To answer this question we compared three collaboration scenarios to examine the efficiencies of coordinating marine conservation. One involved full coordination between Mediterranean countries; another partial coordination (within continents) and the third involved no coordination in which countries act in isolation. We examined each of these scenarios using the decision support tool Marxan to identify good reserve systems that protect all threatened vertebrate species of the Mediterranean Sea while, at the same time, minimising the cost of doing so.

> "Our 'full coordination plan' can reduce conservation costs by more than two-thirds compared to the uncoordinated plan where each country acts independently."

'Cost' data in the Mediterranean Sea is difficult to obtain because of its large area and the high heterogeneity among countries. Consequently, we focussed on basin-wide cost surrogates. These cost layers represent the opportunity cost (fishing income that is lost when an area becomes a marine reserve) of commercial, recreational and subsistence fishers in the Mediterranean Sea.

We found that conservation efficiency can be significantly increased when countries of the Mediterranean Sea coordinate their conservation actions to protect marine species. Our 'full coordination plan' (that assumes all countries of the Mediterranean Sea collaborate together) can reduce conservation costs by more than two-thirds compared to the uncoordinated plan where each country acts independently. The partial coordination scenario also does a good job and reduces costs by more than a half (over the uncoordinated scenario). Given these findings, we suggest that in the Mediterranean Sea it is highly beneficial for countries to collaborate.

The 'Mediterranean melting pot'

The Mediterranean Sea supports a rich biodiversity but faces many threats that have to be dealt with by multiple nations. The Sea is surrounded by over twenty countries spread across three continents. It is visited by around 200 million tourists a year and supports the livelihood of some 150 million people via small-scale subsistence fishing, employment within commercial fisheries and as a food source. In addition, the multiple users of this common resource face very different circumstances. Countries surrounding the Mediterranean Sea show a vast array of cultural values, economic statuses, political systems, religions and languages. All these additional factors can impede successful collaboration (see the box on 'Collaborative potential').

Most conservation efforts in the Mediterranean Sea are uncoordinated and are not protecting the sea's highly threatened biodiversity. With limited conservation measures in place, the sea's native species and ecosystems continue to face threats from both land- and sea-based human activities. Existing marine protected areas (MPAs) are relatively small and are not based on coordinated legislation or criteria for establishment; each country has its own guidelines for administering MPAs. While the implementation of protected areas has raised conservation awareness, limited structural integrity and cross-country collaboration challenge the ability of these areas to protect and sustain the biodiversity of the Mediterranean Sea.

The Mediterranean Sea supports the livelihood of some 150 million people. (Photo by Tessa Mazor)

Land vs sea

Our study is the first to examine the potential benefits of countries collaborating for conservation in the marine realm. Several other studies have examined what's possible on land. One study examined what was possible if Mediterranean countries were to collaborate in setting up terrestrial reserves (Kark et al. 2009). It showed that collaboration can save up to 45% of the conservation costs. Our coordinated marine plan delivered even greater savings, up to three quarters. The difference can be explained by the different factors at work in the terrestrial and the marine realm.

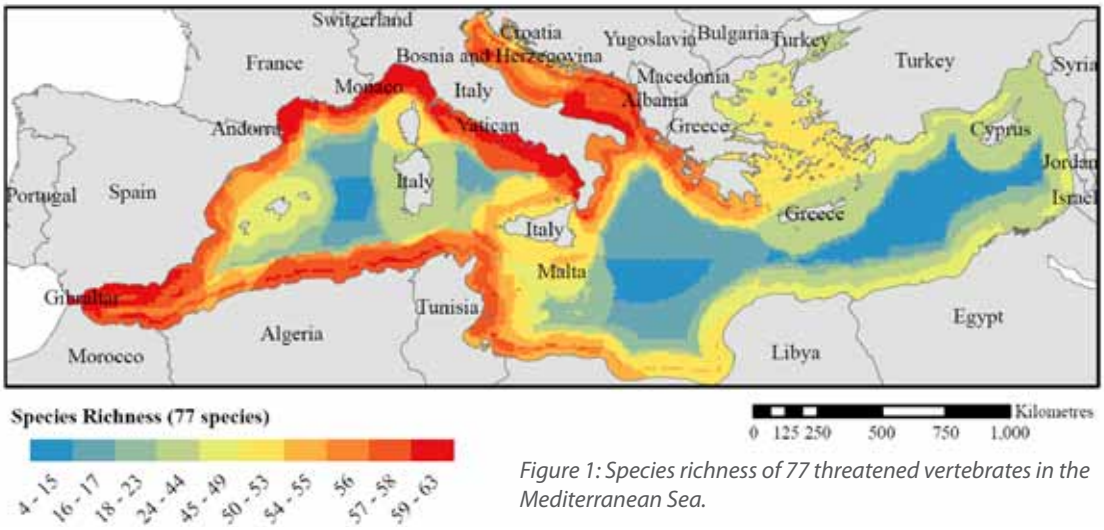

Figure 1: Species richness of 77 threatened vertebrates in the Mediterranean Sea.

On land, high priority conservation areas tended to be clustered in Europe. In the Mediterranean Sea, however, we found that priorities were more evenly distributed in space. In the sea, huge cost efficiencies are realised by choosing to take conservation action (set up reserves) in the cheapest places. There wasn't the same choice on land. To meet terrestrial conservation objectives required the inclusion of higher value land.

Within this complex part of the world, we suggest that collaborative conservation efforts may be even more mutually beneficial and feasible in the marine realm.

Country vs country

The overall savings from collaboration in the marine realm are substantial yet the cost is not equally shared between countries. We found that, on the whole, most countries benefit by engaging in a collaborative plan. But, for some countries, the costs remained high despite collaboration.

We believe that plans for collaboration like this may require between-country compensation or subsidies as incentives to encourage countries which carry greater costs. This finding relates to the high spatial heterogeneity of cost and species in the Mediterranean Sea, and is perhaps a likely outcome for complex regions where there is high diversity between countries.

Continued on page 10

Collaborative potential

International collaboration has been shown to be a key to success in tackling a range of environmental problems. Furthermore, it has been found that collaboration in conservation has the potential to substantially reduce costs. While these factors may be enough to encourage some countries to engage in conservation, for others there are large cultural differences, political histories and language barriers that may be too difficult to overcome. For establishing collaborative conservation initiatives where do we begin? How can we identify countries which have the potential to collaborate successfully in conservation?

To address this, we have developed a framework for including collaborative potential into conservation planning (Levin et al. 2013). Because there is no way of calculating the success of future collaborations, we assessed current connections and linkages between countries and used these as surrogates. The surrogates we used included demographics, socioeconomic (eg, trade and tourism), political (eg, history of conflicts) and historical features.

Given the large heterogeneity among countries surrounding the Mediterranean Sea (and the fact that collaboration for marine conservation is necessary within this shared environment), it makes a good region to use as a case study for our method. However, the findings from this study could be applied to any area where collaboration for conservation is needed.

> "How can we identify countries which have the potential to collaborate successfully in conservation?"

Priority areas for conservation may look promising on paper, but they may not be actually achievable. By incorporating collaborative potential we found that our spatial priorities for marine conservation in the Mediterranean Sea shifted to the northern part of the Mediterranean Sea, where collaboration between countries (and especially within the European Union) is well established.

This type of analysis allows planners and decision makers to incorporate feasibility when setting up marine or terrestrial trans-boundary park and international conservation projects. Besides this, it can help us realise which areas may need extra resources and time for facilitating collaborative conservation.

Reference

Levin N, A Tulloch, A Gordon, T Mazor, N Bunnefeld & S Kark (2013). Incorporating Socioeconomic and Political Drivers of International Collaboration into Marine Conservation Planning. *BioScience* 63: 547 – 563.

Collaboration in the marine realm

Continued from page 9

Of course, collaboration between countries presents many challenges; it's not just about accounting for costs and conservation benefits. While collaboration might deliver effective and efficient conservation, whether countries actually collaborate often relates to a whole host of other factors like history and culture that have little or nothing to do with biodiversity (see the box on 'Collaborative potential').

However, evaluating the costs and benefits of such collaborations is an important step in the process of making it happen. Such knowledge may provide incentives for countries to consider undertaking such action. Consequently, we believe that it's important that future collaborations in the marine realm quantify the benefits of between-country collaboration as it is an important step towards delivering geographically applicable and efficient conservation outcomes.

The approach that we applied to the Mediterranean Sea has relevance to other regions where many countries (or geopolitical divisions within a country such as states) share marine waters and collaborative conservation has benefits. This type of analysis is particularly valuable for those regions considering the implementation of trans-boundary marine parks, marine peace parks or multinational marine reserves.

Given the need for more effective conservation in the marine realm, and the clear benefits that exist in countries collaborating, surely the time for meaningful collaborative conservation has arrived.

More info: Tessa Mazor t.mazor@uq.edu.au

Reference

Kark S, N Levin, HS Grantham & HP Possingham (2009). Between-country collaboration and consideration of costs increase conservation planning efficiency in the Mediterranean Basin. *PNAS* 106: 15368–15373. http://www.pnas.org/content/106/36/15368.full (or See *Decision Point #34*)

Giakoumi S, T Mazor, S Fraschetti, S Kark, M Portman, M Coll, J Steenbeek & H Possingham (2012). Advancing marine conservation planning in the Mediterranean Sea. *Reviews in Fish Biology and Fisheries* 22: 943-949.

Mazor T, HP Possingham & S Kark (2013). Collaboration among countries in marine conservation can achieve substantial efficiencies. *Diversity and Distributions* doi: 10.1111/ddi.12095

Collaboration makes sense underwater

Lines on maps seem to work better above sea level. Maybe they're easier to envisage or measure and can be referenced against landmarks and things that are familiar to us. Move underwater and things become murkier. Marine systems are often characterised by rapidly changing conditions and high connectivity. National borders still exist in the marine realm but the high connectivity of marine waters means that countries share many marine species and conservation challenges. This relationship is especially evident in environments that have a common sea or ocean, and this includes places such as the Caribbean, the Coral Triangle, the Baltic Sea and the Mediterranean Sea. Given the important biodiversity present in these places, a little country-to-country collaboration simply makes good conservation sense.

Advancing conservation planning in the Mediterranean Sea

Given the complexity of the Mediterranean Sea and it's surrounding countries, developing the science that could underpin conservation planning in this region has taken a significant effort by many scientists. In the past couple of years there have been two key workshops that have worked through the issues and enabled the science discussed in this article. CEED was one of the sponsors of these meetings.

Workshop 1: Santorini, Greece, April 2012

The Santorini workshop (pictured below) bought together experts involved with conservation planning of the Mediterranean Sea. Due to the novelty of conservation planning in this area and importance of implementing conservation measures, this workshop provided an opportunity to collaborate and advance current conservation research efforts and programs. The workshop sought to enhance cooperation between researchers and countries surrounding the Mediterranean Sea, and establish goals for future projects and partnerships.

Workshop 2: Nahsholim, Israel, April 2013

The Nahsholim workshop (pictured below) followed on from Santorini. Its focus was on planning within and between Exclusive Economic Zones (EEZs) – tentative marine borders that a country has economic rights to — in the Mediterranean Sea. Countries of the Mediterranean Sea are currently defining these marine boundaries (EEZs), mainly driven by the discovery of offshore oil and gas. These borders (and subsequent political disputes or positive collaborations) will have a significant influence on collaboration for marine conservation in the Mediterranean Sea.

Weighing up the costs of collaboration

Multiple actors working together in the landscape

By Ascelin Gordon & Sarah Bekessy (RMIT University)

Prioritising conservation actions is a challenging task even when it's a simple comparison between two options – for example, do you buy land and put it in a reserve or restore degraded land if you want to reduce the loss of habitat? However, the task of prioritisation becomes considerably more complex when you try to factor in multiple parties undertaking the actions.

In the real world many groups – individuals, NGOs, government agencies and so forth – are all attempting to conserve biodiversity. Often multiple groups will be working in the same landscape and the objectives of the groups may range from significantly overlapping to mostly diverging. If some of these groups were to collaborate in their conservation actions (eg, share the costs of buying land for a reserve), there could be significant benefits. But such collaboration has associated costs such as funds spent on travel and administration for collaborative meetings. And it often causes delays in being able to implement actions. Is collaboration worth the effort? We modeled a few scenarios involving collaboration (Gordon et al. 2013) to explore this question, and the short answer is: sometimes.

Different groups often vary in their focus, available resources and geographic extent. They can include a range of organisations including governments, private individuals and NGOs such as land trusts and charities. In these types of investigations, the different groups (be they individuals or organisations) are referred to as actors (or agents). As the actions of one actor may contribute to (or detract from) the aims of another, strategic collaboration could increase the efficiency of planning efforts and actions for both actors.

However, collaboration is only worthwhile if the benefits outweigh the costs, and assessing the various costs of collaboration is rarely straightforward. Some factors, such as administrative burden or dilution of an agency's perceived achievement, may be relatively easy to quantify. Others, such as mistrust and mission conflict, are more subjective.

We started examining this problem by exploring the potential cost savings that can occur when two actors collaborate in undertaking conservation actions for multiple species. Although we were fairly certain there would be situations where collaboration would involve a significant increase in the cost effectiveness of funds spent on conservation, we wondered whether there were situations where the transaction costs of collaboration would result in collaboration being an inefficient use of funds.

To clarify thinking around this issue we built a model where two actors, having differing objectives, attempt to create a multi-species reserve network. This played out as a 'conservation game' where each actor had a 'turn' at implementing their conservation actions (see box 'the game of conservation'.) The idea is to quantify the cost savings for the actors to achieve their objectives under different types of collaboration. This analysis allows us to determine the range of transaction costs that would make collaboration a cost-effective activity for conservation.

> "The cost savings from collaboration could vary significantly in different situations, ranging from a given actor making almost no savings through to saving almost 40% of the cost of achieving their objectives in isolation."

We modeled two scenarios. The first involved both actors representing non-government organisations (NGOs), with each purchasing parcels of land for separate lists of rare and threatened species. The second had one actor representing the government trying to establish a reserve network representative of all species while the other actor, representing an NGO, was interested in increasing the representation of the rarest species. For each of these scenarios we examined the cost savings when the agents moved from *acting in isolation* (where they ignore the actions of the other actor) to:

- *sharing information*, where each actor is aware of the species representation achieved within the other actor's conservation network and counts these gains towards their own targets, or
- *pooling resources*, where actors combine resources and undertake conservation actions as a single entity.

Our results suggest that in some situations collaboration can make a big difference. We found that the cost savings from collaboration could vary significantly in different situations, ranging from a given actor making no savings through to saving almost 40% of the cost of achieving their objectives in isolation. In our model, the largest potential gains from collaboration occur when the conservation objectives of the two actors involved non-overlapping sets of species.

We also explored a range of additional complications. This included understanding consequences of the order in which each actor undertook their actions. We also looked at the issue of negotiating multiple ways for actors to share the total cost when they combine to act as a single entity. We plan to extend this work within CEED to explore more complex and realistic situations such as where the actors anticipate each others' actions and when they have uncertainties in the information on which they base their decisions.

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Reference

Gordon A, WT Langford, L Bastin, AM Lachner & SA Bekessy (2013). Simulating the value of collaboration in multi-actor conservation planning. *Ecological Modelling* 249: 19-25.

The game of conservation

Collaborating in conservation (or in any field) has a lot to do with anticipating what the other party will do in response to your action. Given the importance of cost-balancing and knowledge, a useful approach to these multi-actor interactions may be to model them as 'games' which allows them to be analysed using techniques from the field of game theory. What game theory brings to the debate is a systematic way of structuring such cooperation problems in order to illuminate the core issues.

There are no easy solutions to the environmental problems we face. But whichever way we turn we will need to seek cooperative solutions and guard against undesirable unintended flow-on effects. On both counts, game theory is the tool of choice.

Reference

Colyvan M, J Justus & HM Regan (2011). The Conservation Game. *Biological Conservation* 144: 246-253.
(Or see the story on this article in *Decision Point #51*)

Citizens in the woodwork

If you go down to the woods today, will the data collected give you a big surprise?

By Nathalie Butt (University of Queensland)

The ultimate act of environmental collaboration might involve getting the general public to go out and collect environmental data that feeds into our efforts at sustainable environmental management. Actually, there's a name for this type of activity – citizen science. It's an attractive idea on so many levels. Besides engaging more people in issues of environment and sustainability, it also potentially enables the collection of large quantities of data over vast areas; data that might be too expensive to collect any other way. But how good are those data? That's a question that has often dogged efforts at citizen science in the past. Recently, I was involved in an investigation that had bank workers out in the woods measuring trees as an exercise in citizen science. And the data they collected weren't half bad.

Data you can bank on

In situations where large amounts of data need to be collected over big areas to provide both baseline data (for example, for national forest inventories) and repeated survey data (recensus data to estimate change), and governments don't have adequate financial resources for this collection, citizen science can play a valuable role. Indeed, in the type of ecological research that is usually costly, time consuming and labour intensive, citizen science might be the only way to acquire this information.

Currently there is great interest in forests as carbon stocks. And where carbon storage equals money (eg, the UN programme for Reducing Emissions from Deforestation and forest Degradation, REDD+), it is vital for measurements, and thus carbon stock estimates, to be as accurate as possible. However, there are concerns over the reliability of data collected by unskilled volunteers. In such cases data validation – establishing the range of uncertainty or bias in volunteer measurements – has a crucial role to play.

A four-year forest monitoring program based in Wytham Woods, Oxford (in the UK), has generated a large amount of measurement data collected by volunteers funded by HSBC bank through an Earthwatch program (http://www.earthwatch.org/europe/our_work/corporate/hcp). The program provided the perfect opportunity to 1) compare volunteer and expert sampling error in tree measurement data in order to assess the quality of volunteer data, and 2) apply these sampling errors to tree biomass and carbon storage estimates, and to calculate the range of uncertainty values in order to establish how sensitive these estimates are to measurement sampling errors.

The woodland lab

Wytham Woods has been owned by Oxford University since 1943. It is one of the most researched woodlands in Europe, and wherever you venture in its leafy spaces you are never far from a marker tag, transect line, moth trap, bird or bat box. In 2008 the woods became the location for the European Regional Climate Centre of the Earthwatch program's global network of forest plots (http://www.earthwatch.org/europe/rcc_europe and see Shetty 2011). Ten Earthwatch monitoring plots, each approximately 1 ha in size, were set up around Wytham Woods representing forest 'edge', 'fragment' and 'core' woodland habitats.

During the four year period, 260 volunteers collected above-ground carbon-stock measurement data: tree diameters, tree heights, and stem growth data using dendrometer bands (they also carried out fieldwork activities that provided data on woodland productivity and phenology). The volunteers were HSBC bank employees, from UK and international branches, engaged in the Climate Champion Program. They spent one or two weeks at the Regional Climate Centre learning about climate change and environmental science and working with scientists to collect forest monitoring data. The data provided a baseline for long-term monitoring of changes in carbon stocks and enabled comparisons among tree species, sites, seasons and years.

Diameter-at-breast-height (dbh) was measured to the nearest 0.05 cm using diameter tape for all tree stems greater than 5 cm in diameter in the 1 ha plots. These diameter measurements were then used to calculate the standing stocks. We assessed the difference between repeated measurements, but as we do not know the 'correct' measurements for each tree, because we have no information other than two measurements for each stem, we cannot calculate the absolute error in the measurements. Instead we calculate the 'sampling error', or variation in observations.

Climate Champions monitoring dendrometers for growth data in the Wytham Woods, Oxfordshire. (Photo by Earthwatch Field Team)

To assess the effect of the measurement uncertainty on forest carbon stocks, the above-ground (standing) biomass was calculated per hectare and the resultant sampling error applied to a large, previously collected dataset (see Butt et al. 2009 and http://www.sigeo.si.edu/about/). This gave a plus-or-minus carbon and biomass estimate per hectare, designated the 'range of uncertainty', where that uncertainty is a function of the lack of a known 'correct' diameter measurement.

Volunteer vs expert

Diameter measurements had a sampling error of 9.9 mm for volunteers and 1.8 mm for experts. The volunteer range of uncertainty for biomass calculated using diameter measurement data was ±7%; the equivalent expert value was ±1%.

"There's growing interest in mapping the world's forests for carbon. Unfortunately, we lack the funding and experts to achieve it at scale. Using the large base of citizen scientists may be one way to fill this critical data gap."

Climate Champions undertaking a range of measurements in the Wytham Woods: using canopy scopes to estimate canopy cover (top), taking tree dbh measurements (lower left) and collecting leaf litter from a litter trap (lower right). (Photos by Earthwatch Field Team)

In general, the tree census carried out by volunteers provides good quality data: the sampling errors, as translated into ranges of uncertainty, did not make a biologically significant difference to estimates of biomass or carbon stocks. We can think of the situation in terms of a trade-off between obtaining large amounts of data over a large area and potentially more frequently, or having data always collected by 'experts' who are more accurate but also expensive and able to complete field measurements less frequently and over a smaller area.

In terms of observer quality, expert measurements are of better quality than volunteer measurements, but the results show that volunteers can collect useful data. The volunteers in this study received training both before the fieldwork and further training and supervision during it, and they all spent at least two days collecting data, underlining the importance of effective training and in-field supervision.

Volunteers are generally not as efficient as an expert in terms of time, but teams of volunteers may compensate for lack of experience and speed by increasing effort through increased numbers of people collecting data. The volunteers in this project collected tree diameter, height and growth data from ten plots on a regular basis over four years, enabling re-censussing of all the plots and monthly growth monitoring. The collection of this quantity of data at such a high temporal resolution would have been difficult (if not impossible) to achieve without their contribution.

Citizens in the forest

Forest-monitoring research is an ideal area for the participation of citizen scientists as it involves the collection of large amounts of easy-to-collect data over large spatial and temporal scales. Although the data collected by volunteers are of a slightly lower quality than that of experts, they fall within an acceptable range. The volumes of data that can be collected using teams of volunteers more than compensates for these small inaccuracies.

With the rise of schemes such as REDD+, there's growing interest in mapping the world's forests for carbon. Unfortunately, we lack the funding and experts to achieve it at scale. We suggest that using the large base of citizen scientists may be one way to fill this critical data gap. The advantage of this approach is that it also provides opportunities for the education and engagement of the public in science, and its use in policy.

So, maybe we should be inviting more citizens out into our woodlands and forests to engage in a little data collection. Clearly they measure up well.

More info: Nathalie Butt n.butt@uq.edu.au

Reference

Butt N, E Slade, J Thompson, Y Malhi & T Riutta (2013). Quantifying the sampling error in tree census measurements by volunteers and its effect on carbon stock estimates. *Ecological Applications* 23: 936-943.

Butt N, G Campbell, Y Malhi, M Morecroft, K Fenn, & M Thomas (2009). *Initial results from establishment of a long-term broadleaf monitoring plot at Wytham Woods*, Oxford, UK. University of Oxford Report.

Shetty P (2011). Citizen scientists' climate-impact survey wraps up. *Nature News* doi:10.1038/nature.2011.9697

From woods to birds

Is volunteer-collected data as good as expert-collected data? Not really, but the differences are often slight and the quantity of data that can be collected by an army of citizens can often more than make up for those differences. That's the finding of this study in the Wytham Woods with tree measurements but it was also the finding of volunteer-collected bird data in the Mount Lofty Ranges near Adelaide (Szabo et al. 2012 and *Decision Point #64*). Indeed, the citizen data collected from the Mt Lofty Ranges enabled one of the first regional estimates of the abundance of many bird species for any part of Australia.

Reference

Szabo JK, Fuller RA, Possingham HP (2012). A comparison of estimates of relative abundance from a weakly structured mass-participation bird atlas survey and a robustly designed monitoring scheme. *Ibis* 154: 468-479.

Of actors, weeds and fence lines

Multiple decision makers and effective weed control

By Shaun Coutts (University of Queensland)

Weeds can cross property boundaries but weed management often cannot. Controlling invasive species across the landscape, therefore, is not only about the effectiveness of control strategies, it's also how, when and where those strategies are employed. And these factors are all the result of human behaviour. We recently modelled the impact of different types of human behaviour together with our ecological understanding of two significant weeds and discovered that human behaviour plays an enormous role in the spread or control of those invasive species (Coutts et al. 2013).

Our modelling approach makes an important contribution to this field because the vast majority of research papers on the management of weeds (and other damaging invasive species) assume that a hypothetical manager has access to all parts of the invasive population and can coordinate control strategies perfectly across the landscape. In reality, however, invasive species can easily cross property boundaries, whereas control efforts often don't make it past the fence line for a range of reasons (including legal restrictions and social norms). As a result, control is undertaken by multiple people, but each only has access to a small part of the entire invasive population.

Modelling over time and space

We wanted to know how the collective decisions of many property managers affected the spread of two damaging weeds: serrated tussock and African love grass. We wanted to look at the spread of these two weeds at a large scale and over a longer time period (50 years), and the only practical way to do this was to build a model.

In our model there were 4096 decision makers (sometimes referred to as actors or agents) who all decided whether or not to control the weed based on a simple rule: if the benefit of controlling the weed was higher than the cost then that decision maker was more likely to undertake control. If the reverse was true then they were less likely to control.

Invasive species can easily cross property boundaries, whereas control efforts often don't make it past the fence line. As a result, control is undertaken by multiple people, but each only has access to a small part of the entire invasive population.

Using this model we could change aspects of the behavior of the decision makers, like how much each one cared about the invader and how strongly they could respond to the presence of weed. The model enabled us to see how each aspect changed the spread of serrated tussock and African love grass, and how those human traits interacted with the ecology of the weed.

Of course, our model wasn't perfect as it simplified many processes; that's what models do. However, it was detailed enough to give us an idea of how the behavior of multiple land managers might affect the spread of weeds and which aspect of the land managers' behavior might be important.

Different weeds

Difference in the impact and ease of control between serrated tussock and African lovegrass highlighted an important point about which types of weeds are likely to become wide spread. Serrated tussock is very damaging to graziers, in some cases halving stocking rates, but there are some practical steps land managers can take to reduce it density and impact. African lovegrass, on the other hand, is slightly less damaging but is very hard to control. This meant the decision to control serrated tussock was very obvious, while the decision to control African love grass was more ambiguous.

> "For concern about a weed to have a large effect on its spread, that concern must be present while the weed is still rare (ie, early in the invasion)."

As a result, most of our modelled decision makers controlled serrated tussock straight away and its spread was greatly reduced. African love grass, by comparison, very often took over the entire modelled landscape because there was always a pool of infested areas available to spread it. This suggests that weeds which go on to become wide spread might be species which have a medium impact – a bit of a 'Goldilocks' weed : not so large that everyone controls them and their spread is restricted, nor so mild that they are not considered weeds.

The modelled outcome for serrated tussock, however, does not tally with the reality we see around us. Serrated tussock is widespread in Australia. However, a lot of the spread of serrated tussock happened before systematic efforts were targeted at controlling it. More recently there has been some success at reducing its prevalence in infested areas, largely because private landholders bought into regionally coordinated control drives.

This highlights another important finding of our model. For concern about a weed to have a large effect on its spread, that concern must be present while the weed is still rare (ie, early in the invasion). If concern only grows as the species becomes widespread, by the time there is enough concern that everybody acts, the weed is already so well established that landscape-wide control is very difficult. Local government has an important role in this regard, publicising potentially damaging species before they become common.

Different actors

A further complication when thinking about multiple actors is that not all of those deciding whether to control or not have the same goals or resources. Some might be operating large commercial properties, others small (non-profit) hobby farms. Some may not be farms at all such as government organizations that look after the roads or parks.

Some of these land managers may not even want to control invasive species at all. We included this in the model by making some decision makers needing extra benefit to control weeds. We called these decision makers 'unmotivated', and in our model they very rarely controlled the weed.

Because unmotivated decision makers act as a constant source of invading weed, they have an especially large effect on the rest of the landscape when there is lots of long-distance dispersal (such as accidental movement of seeds by road). We found that a few unmotivated land managers (1 or 2%) didn't make much difference, but if they made up about 10% of all the land managers then they could cause the weed (especially African love grass) to spread across the whole landscape.

The reason such a small change in the proportion of unmotivated land managers could have such a large effect on the outcome was the result of a feedback. Unmotivated land managers are only a problem if the land they are responsible for gets infested in the first place. When there are more unmotivated mangers in the landscape acting as a constant source of infestation, then it is more likely that other unmotivated managers will get infested and become sources themselves.

All of which demonstrates that to really appreciate how weed control works over multiple properties, factoring in the behavior of multiple land managers is essential.

More info: Shaun Coutts s.raymond@uq.edu.au

Reference

Coutts SR, H Yokomizo & YM Buckley(2013). The behavior of multiple independent managers and ecological traits interact to determine prevalence of weeds. *Ecological Applications* 23:523-536. http://www.esajournals.org/doi/abs/10.1890/12-0599.1?af=R

Dbytes

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

1. Threatened spp protection in Australia

Effectiveness of threatened species and ecological communities' protection in Australia: This Australian Government Senate Committee report is dry and bureaucratic but details a review of how the Australian Government approaches the management of threatened species and a range of related issues. Mick McCarthy and several other EDG researchers made significant contributions to the review which is reflected in the report's recommendations.

http://www.aph.gov.au/parliamentary_business/committees/senate_committees?url=ec_ctte/completed_inquiries/2010-13/threatened_species/report/index.htm

2. National park needed for Leadbeater's possum

EDG's David Lindenmayer was interviewed on ABC Radio about the plight of the Leadbeater's Possum (Victoria's faunal emblem) and the need for urgent action. Forestry management, against strong scientific evidence, has put the possum on a trajectory for extinction. What makes the interview so revealing are the quotes from an earlier current affairs program back in 1991 (22 years ago) in which Lindenmayer and leaders of the forestry industry talk about the future of possum and the impact of forestry.

http://www.abc.net.au/pm/content/2013/s3824786.htm

3. Reef Plan 2013 & Reef Report Card 2011

The Australian and Queensland Governments endorsed the Reef Water Quality Protection Plan 2013 at the Great Barrier Reef Ministerial Forum in July. Reef Plan's primary focus continues to be addressing diffuse source pollution from broadscale land use. The Great Barrier Reef Report Card 2011 measures progress from 2009 towards Reef Plan's goals.

http://www.reefplan.qld.gov.au/index.aspx

4. Climate-change-vulnerable species

Foden WB, Butchart SHM, Stuart SN, Vié J-C, Akçakaya HR, et al. (2013). Identifying the World's Most Climate Change Vulnerable Species: A Systematic Trait-Based Assessment of all Birds, Amphibians and Corals.
PLoS ONE 8(6): e65427. doi:10.1371/journal.pone.0065427

http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0065427

5. The critical decade

The critical decade 2013: climate change science, risks and responses. By Will Steffen and Professor Lesley Hughes.

Two years ago in its report 'The Critical Decade: Climate science, risks and responses', the Climate Commission stated that this decade, 2011-2020, is the decade to decisively begin the journey to decarbonise our economy, thereby reducing the risks posed by climate change. One quarter of the way through the critical decade they present an update.

http://climatecommission.gov.au/wp-content/uploads/The-Critical-Decade-2013_medres_web.pdf

The researcher, the policy guy & the manager

EDG researcher Phil Gibbons (pictured here on the left) was one of the key scientists behind the NSW Government's decision support system called BioMetric. It codified the rules for when native vegetation could be cleared by setting out what kind of offset would be required to compensate for the clearing (see Decision Point #18). Several years later Phil was instrumental in designing SEWPaC's Offsets Calculator, the mechanism by which offset proposals could be judged. Biodiversity offsetting involves compensating for environmental damage at one location by generating ecologically equivalent gains at another, so that there is 'no net loss' (see Decision Point #69). The trick is being able to measure the damage and the compensating offset in a consistent manner that all stakeholders can work with.

Pictured above with Phil is James Tresize (centre) from DSEWPaC, one of the policy officers tasked with operationalizing the Offsets Calculator. On his right is Michael Mulvaney, an NRM Manager with the ACT Government. His job is to actually use the calculator. The trio are leading a Biodiversity Offsets field class for students from the ANU – a practical, hands-on session of how you might calculate an offset for a proposed development of habitat for the threatened striped legless lizard.

Exercises like this are a great way for ideas to cross the research/policy divide. You can read about a range of strategies like this for bridging this divide on page 6.

What's the point?

There is no bad publicity

"Oh God! I've just heard my latest paper has resulted in several 'comment' articles responding to my finidings! I think I'm in trouble." If this is your situation, fear not. Recent research suggests those comment pieces will only do you good.

Comments are special types of publications whose aim is to correct or criticize previously published papers. Comments are commonly perceived to make commented papers less worthy or credible to the eyes of the scientific community, and thus predestined to have low scientific impact.

But Filippo Radicchi says the empirical evidence suggests otherwise. He analysed thirteen major publication outlets in science, and found (i) commented papers are, on average, much more cited than non commented papers, and (ii) commented papers are more likely to be among the most cited papers of a journal. Indeed, since comments are published soon after criticized papers, comments should be viewed as early indicators of the future impact of criticized papers.

Reference

Radicchi F (2012). In science "there is no bad publicity": Papers criticized in comments have high scientific impact. *Scientific Reports* 2: 815 doi:10.1038/srep00815 http://www.nature.com/srep/2012/121108/srep00815/full/srep00815.html

EDG

ENVIRONMENTAL DECISIONS GROUP

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

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

Decision Point is the monthly magazine of the EDG.
It is available free at: http://www.decision-point.com.au/

The funding of the research presented in this issue of *Decision Point*, like most research, comes from multiple sources and is identified in the original papers on which the stories are based (references are provided in each story). In terms of CEED and NERP ED, the work on bridging the knowledge-action boundary (p6,7) was supported by CEED and NERP ED; research on collaboration in the Mediterranean Sea (pages 8-10) was supported by CEED; and the modelling of the costs of multi-actor collaboration (page 11) was funded by CEED. The Glink story (p4,5) was primarily funded by an ARC linkage grant, however extension and ongoing work is partially supported by CEED and NERP.

To contact the EDG please visit our websites at:
http://ceed.edu.au/ or http://www.nerpdecisions.edu.au/

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