DECISION POINT

Connecting conservation policy makers, researchers and practitioners

Issue #79 / June 2014

Connecting People & Nature

Science informing conservation in collaboration with the Wildlife Conservation Society

Allocating ranger patrol effort for better outcomes

Ridge to reef conservation planning

MPAs that work with communities

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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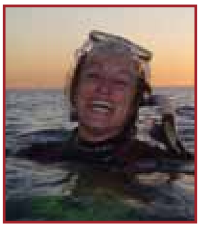
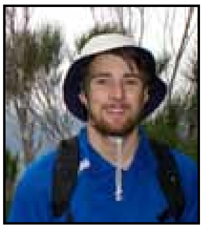


Cover image: A coastal village in PNG lying adjacent to coral ecosystems. Effective conservation at sea requires an acknowledgement of the connection with the land, something that most conservation planning has previously not taken into account. New research collaborations between CEED/NERP and WCS is looking into this particular challenge. This issue of Decision Point presents this and several other examples of the work being done with WCS. (Photo by Viv Tulloch)

On the point

Working with the WCS

Welcome to a special issue of Decision Point that focusses on a range of research collaborations that have developed over recent years between CEED / NERP researchers and the Wildlife Conservation Society (WCS). WCS prides itself as being a science-based 'muddy-boots NGO', meaning it's all about making a difference on the ground. It doesn't have as big a public profile in Australia as some of our own NGOs (like The Wilderness Society or Greening Australia) but WCS is one of the world's biggest and oldest conservation organisations (see the box on page 5). It was established in 1895 and cut its teeth saving the American bison.

The collaboration with WCS, as illustrated by the stories in this issue, is special on a number of levels. First, as James Watson points out (on page 3), NGOs like WCS are making a world of difference to conservation in places where governments often don't have the capacity. And, by partnering research groups like the EDG, these NGOs can be continually informed by the best science.

Carissa Klein then follows up with a perspective from the researcher (page 4) outlining why conservation scientists might want to collaborate with conservation NGOs. She then provides some tips on how this is best done and what's being achieved with CEED/NERP.

The rest of the issue then provides examples of how the research coming out of this collaboration is making real contributions to biodiversity conservation. Topics covered include assessing vulnerability to climate change (page 6); the effectiveness of surrogates (page 7); marine conservation planning that takes into account land use (page 8), and social values (page 9), and map uncertainty (page 11); and the allocation of effort to ranger patrols in Africa (page 13).

What's more, most of this has been achieved over the past four years with the promise of a whole lot more to come in the near future.

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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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Bridging the science-implementation gap

Engaging with conservation NGOs can make the difference

By James Watson (Wildlife Conservation Society & University of Queensland)

As most governments struggle to achieve conservation outcomes when budgets are small, there has been a considerable (though often overlooked) response by the wider community. The substantial growth in the number and size of non-governmental organisations (NGOs) focused on conservation over the past few years is testament to this.

Across the world, conservation NGOs are increasingly engaging in national and international policy development, advocacy and on-the-ground action. Given the formidable threats faced by biodiversity (including those arising from human population growth and climate change) and that all developing nations are trying to fast track their economies by utilizing their natural resources, new forms of conservation activities are required that integrate nature conservation within the goals of economic development. Achieving these 'new age' conservation outcomes increasingly requires NGOs to develop strategies that integrate life sciences with the social, economic and political sciences – a complex challenge, but certainly not impossible.

While there's a broad range of NGOs engaged in an array of conservation activities, each with their own unique mission, most agree that good science lies at the heart of delivering effective outcomes. However, ensuring that the conservation actions, policies and philosophies of NGOs are informed by the best available science is seriously challenging. It takes time and it takes money.

Consider the issue of time. It's extremely difficult for conservation NGOs – regardless of their budget – to keep up with the mass of conservation science papers being pumped out each week. The amount of time most NGO scientists have to spend to keep up with 'best practice' science is extremely limited. Most of their available time is consumed with day-to-day tasks associated with actually 'doing' conservation.

Now add the challenge of money. The funding base for core science within most NGOs is extremely limited and in many cases declining. Consider the case of researchers in WWF International as recently highlighted by Erik Stokstad in *Science* (Stokstad, 2014). WWF has just released approximately two thirds of their Washington DC based scientific workforce. Sustaining long-term science programs in NGOs is becoming increasingly difficult and the days of academic scientists simply jumping ships to join an NGO (and vice versa) are likely over.

Both of the challenges are significant but not impossible to overcome. In this special issue of *Decision Point*, we show how the international conservation NGO that I work for, the Wildlife Conservation Society, is attempting to overcome these challenges by forming strategic collaborations with the applied academic community (in this case, CEED and NERP researchers).

The Wildlife Conservation Society (WCS) is a global non-government organisation dedicated to saving wildlife and wild places (see the box on The Wildlife Conservation Society on page 5). Over the past four years, WCS has developed ties with researchers from CEED and NERP ED to generate science that informs real conservation decisions and policies. There have been a number of different models WCS have explored with the CEED/NERP that has led to the science outlined in this special issue. Initially, these have included consultancies (for example with WCS Fiji, p8) and joint supervision of students (for example, Azusa Makino, p9, and Kendall Jones, p7) and postdoctoral fellows by (for example Joseph Maina, p15).

> "Ensuring that the conservation actions, policies and philosophies of NGOs are informed by the best available science is seriously challenging. It takes time and it takes money."

James Watson *is the Climate Change Director at WCS, a Principal Research Fellow at the University of Queensland and an adunct research fellow at CEED. He is the chair of the IUCN climate change specialist group, a member of the International Panel for Biodiversity and Ecosystem Services and the Data and Knowledge Task Force, and has recently been elected the global president-elect of the Society for Conservation Biology. His current research is focussed on testing different methodologies that assess the impact of landscape change and climate change for biodiversity and ecosystem services.*

Due to the trust that has developed between different people in both organizations, the collaboration has expanded to include co-funded positions and grants (eg, two ARC Linkage Grants and a Science for Nature and People Grant, see page 5). These are models that aid both the university and WCS. What's more, they are a mechanism for ground-breaking science to quickly inform conservation action.

In a recent development, WCS has started to jointly fund positions with the University of Queensland. For example, Dr Joseph Maina joined CEED as a post-doctoral research fellow in November last year and is working on a series of applied science initiatives that will help inform conservation science at WCS sites (see page 15). I also have recently taken up a joint position between WCS and the School of Geography, Planning and Environmental Management at the University of Queensland. In this position, I maintain associate fellowship within CEED which has allowed me to maintain and generate new collaborations with CEED and NERP researchers.

The aim of these joint appointments is to allow WCS to build an applied conservation science group utilising the fantastic resources and brain power that CEED and NERP have to offer, ensuring the science being done is either applied at the local scale in landscapes and seascapes WCS works in, as well as at the policy interface that WCS is increasingly engaged with (for example, policy connected to the institutions of the Convention on Biological Diversity and the Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services). My aim is to engage and collaborate with the different hubs, trying to ensure the great science done by CEED and NERP can be translated for WCS activities and linking interested CEED people to WCS problems. If you are interested in exploring the opportunities, please get in contact.

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Collaborating with NGOs

A perspective from a CEED researcher

By Carissa Klein (University of Queensland)

As with many conservation scientists, I have always wanted my research to be useful. But conducting research that is useful AND novel enough to be published in a good scientific journal is not an easy task. What is useful is often pretty boring in an academic sense, and what is scientifically interesting, is often disconnected from reality. This is a serious issue and often results in a trap of focusing on solving problems that don't actually exist in reality.

In an attempt to overcome this challenge, I made the conscious choice to collaborate with conservation NGOs to help them solve specific, real-world conservation problems in the places they work. Although I have worked with NGOs both small and large, including the world's four biggest conservation NGOs (The Nature Conservancy, Wildlife Conservation Society, World Wildlife Fund, and Conservation International), I will focus on my collaboration with WCS as it has been particularly productive both in terms of science and conservation.

So what is it that I do? I develop quantitative tools and approaches that can be used to help practitioners decide what and where to protect. I have a strong focus on marine conservation in the tropics.

The collaboration between WCS started with the Fiji country program, directed then by Dr Stacy Jupiter, and expanded to other WCS programs in Africa (see page 13) and Papua New Guinea (page 15). Initially it was just me working on projects but it quickly led to the formation of a small research team comprised of a postdoc (myself), two Honours students (Kendall Jones and Viv Tulloch), and two PhD students (Azusa Makino and Viv Tulloch). Short profiles of all of these people appear in this issue.

In just three years, this team published six papers (and several more are in review) focused on conservation planning in Fiji – and this science has helped WCS improve the network of protected areas in Fiji (see page 8). And we still have not had enough of each other – last year we applied for two research grants to help sustain and grow our collaboration. We were awarded a Science for Nature and People Grant for research integrating land management with marine conservation (see the story on page 5).

There are many other CEED/NERP researchers working with NGOs around the world (eg, Maria Beger, Jessie Wells, Richard Fuller, etc) and I highly encourage others to expand these networks.

Other CEED/NERP researches often ask about my experiences with NGOs – How do I establish the collaborations? What are the benefits/drawbacks? The answers are not clear cut, but I will briefly outline a few tips for researchers interested in setting up and maintaining collaborations with NGOs.

1. **Invest time in building relationships**. Relationships with NGO staff and stakeholders are the key, but like any relationship, they are not formed quickly.
2. **Hone your communication skills**. More time is spent on communication than when doing 'blue-sky' science. From communication focused on ensuring we solve the right problem all the way through to ensuring everyone understands the methods and results. And central to all of this work is training workshops with the end-users of the quantitative tools to help build the capacity of managers and scientists working in these countries.
3. **Be flexible and embrace change**. In any given place, things can change at any time, and NGOs (and the scientists they work with) have to adapt too. Change happens for a variety of reasons – threats to nature change, governments change, change in working teams etc – and your project might need to do a u-turn to keep up and ensure that it is still relevant.
4. **Co-fund projects**. Identify research funds that can be used to leverage funds from an NGO to co-fund projects (eg, ARC Linkage Grants). Long term funding is key as the endpoint to most of these planning projects is far away.

Although I love what I do, it is not as glamorous as it sounds – there are real costs associated with doing applied research. These tips highlight the fact that it is often much more time consuming than most 'blue-sky' science projects as time normally spent on doing science gets spent on building relationships, training stakeholders, and adopting projects to accommodate a change in circumstances. It requires researchers to shift the focus on papers towards other aspects of delivering good science.

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***Carissa Klein** is a conservation scientist at The University of Queensland. Her expertise is in spatial conservation prioritisation, answering questions such as: Should we be investing in marine parks or stopping forest clearing to get the most bang-for-our buck in protecting Indonesia's coral reefs? How can we zone the ocean to meet the needs of multiple stakeholders? In addition to WCS, she is also collaborating with The Nature Conservancy (Melanesia), Conservation International, and the World Wildlife Fund (Malaysia) to apply various spatial conservation prioritisation techniques to support conservation decisions.*

"I have always wanted my research to be useful. But conducting research that is useful AND novel enough to be published in a good scientific journal is not an easy task."

The Wildlife Conservation Society

The Wildlife Conservation Society was founded in 1895. Its mission is to save wildlife and wild places across the globe. It also seeks to educate millions of visitors at five living institutions in New York City on important issues affecting our planet. The parks include the Bronx Zoo, New York Aquarium, Central Park Zoo, Prospect Park Zoo and Queens Zoo.

The WCS Global Conservation Program (GCP) aims to protect 25% of the world's biodiversity. The program oversees the conservation work of the Society in 57 countries around the world. The GCP has approximately 2,500 staff working on over 300 projects with offices in 40 of the countries in which we are active.

The Society is a science-based 'muddy-boots NGO' with work deeply grounded in the field, and staff focusing efforts on conservation action at the scale of land- and sea-scapes. Their conservation strategies recognize that terrestrial and marine protected areas must be integrated into the broader ecological, social and economic spaces that surround them if their biodiversity and productivity are to be sustained.

The WCS helps governments and communities to establish and manage protected areas and reserves, render them more effective, integrate them into the complex land-use matrices that surround them, and ensure the habitat connectivity that meets the ecological requirements of species of conservation concern. The organisation works with resource-extraction industries to reduce their impact on our focal landscapes and seascapes, and the species they contain. The approaches reflect that livelihood and governance issues are integral to conservation success, and that strengthening institutional capacity of those involved in delivering on conservation on the ground is integral to sustainability.

Increasingly, the WCS is a leader in influencing national conservation policy in the countries in which they work by assisting national governments with a variety of issues including park and protected area establishment and management, legislation and legislative review of laws affecting wildlife and natural resource management, training of national parks and wildlife staff, large scale infrastructure and climate change planning, and land tenure issues. The WCS is also one of the co-founders of Science for Nature and People, alongside The Nature Conservancy and NCEAS (see http://www.snap.is).

More info: http://www.wcs.org/

The Ridges to Reef Fisheries Project

A SNAP Working Group

The WCS is one of the founding members of the SNAP collaboration along with The Nature Conservancy and the National Center for Ecological Analysis and Synthesis. SNAP stands for Science for Nature and People. At the heart of SNAP are Working Groups — teams of scientists, practitioners and stakeholders that answer specific critical questions at the conservation/human interface.

Researchers with CEED together with the WCS have recently been awarded funding to investigate the land/sea connection and the impacts of land management on marine conservation. The working group is being led by Carissa Klein, Chris Brown and Hugh Possingham (all CEED people) and includes members from a number of other universities and NGOs.

Population growth and economic development along coasts around the globe are placing increasing pressure on fisheries and marine ecosystems. To date, marine conservation has focused almost exclusively on reducing overfishing — despite the harmful impacts on marine ecosystems from terrestrial activities like farming and logging.

This working group will address these information gaps, allowing conservationists to better address the impact that land-use changes have on fisheries. The group will develop a model that can predict the effects of river run-off on coral reef fisheries and assess how various management actions impact economic development, fisheries management, livelihoods and conservation.

Among other things, the research is expected to answer the following questions:

- Where are the most cost-effective priorities for management intervention, on the land and sea, to secure fisheries and livelihoods?
- Can the positive impacts of traditional fisheries management actions offset the negative impacts from land-based activities, under different climate change and socio-economic scenarios?
- What is the consequence of land- and sea-based policy change on coastal fisheries?

More info: http://www.snap.is/groups/ridges-to-reef-fisheries/

Marine conservation has traditionally focussed on the marine realm, ignoring the impacts from nearby landuse such as run-off resulting from forestry. The SNAP working group on ridges to reef-fisheries is hoping to fill this gap. (Photo by Stacy Jupiter)

Assessing vulnerability and adaptability

Cost-effective conservation incorporates the human dimension

By Nathalie Butt (UQld), James Watson (WCS) and Takuya Iwamura (Stanford Uni)

Until now, most planning assessments of how future climate change will affect our land and seascapes have been incomplete as they haven't properly factored in how those landscapes have already been modified by human activities, such as land clearing. Too often, assessments that have been done on future climate vulnerability have looked at the Earth as a blank slate, assuming that the level of warming a landscape or species faces is the only thing that determines future persistence. In fact, the planet has been modified in vastly different ways wherever humans have settled. We found that when human land-use-change data are combined with future projections of climate changes, the results are very different to previous climate vulnerability assessments.

Species adapt to change all the time, and humans are no different. Indeed, it could be said we're at the forefront, adapting to the changing climate in various ways. And that includes how we undertake natural resource management. People are changing their agricultural activities due to changing rainfall in the mountains of the Albertine Rift and the valleys of the Congo Basin in Africa, while on the islands off Papua New Guinea, local communities are constructing seawalls to slow down the impact of sea-level rise. In the Arctic, mining activities and transport routes are on the increase as sea-ice retreats, and Dutch architecture has evolved in a completely new direction, designing and producing floating homes and other buildings as a way of avoiding flood damage and destruction; a possible solution to flooding in other countries too.

These efforts at human adaptation are of course resulting in significant ecological consequences (Watson, 2014). The increased agricultural production in Africa is causing widespread loss of critical species habitats, including the critically endangered mountain gorillas. The creation of seawalls has led to the wholesale destruction of some of the most biodiverse coral reefs in the world. The increased human access in polar regions is causing havoc for its delicate biodiversity with declines in shorebirds, seabirds and mammals being reported. The large-scale development of floating infrastructure has potentially detrimental impacts on water quality and ecology through eutrophication.

Conservation science has not been strong on planning for how biodiversity can persist under changing and future climates, and almost all assessments discount the fact we are in the midst of a global extinction crisis. Most of the climate oriented conservation science we produce does not consider the fact that many species are already vulnerable due to human activities (past and current). This oversight has serious ramifications: it means that we don't really know where species are most vulnerable, what actions we need to take, and which actions are most cost-effective. Our new vulnerability assessment took this into account. It asks how modified vegetation communities are in different regions, and then considered how stable that ecosystem is expected to be under predictions of future climate change. Using this method, we identified southern and south eastern Asia, western and central Europe, eastern South America, and southern Australia as some of the most vulnerable regions. Previous assessments, based only on climate change exposure, often identify the most vulnerable regions as central Africa, northern South America, and northern Australia.

Building protective sea walls using coral reef that has been blasted is now a common practice in some of the islands off northern Papua New Guinea. (Photo by James Watson)

***Nathalie Butt** is a postdoctoral research fellow in CEED at the University of Queensland. Her work is concerned with the interactions between biodiversity and climate/climate change, previously focussing on forests in tropical South America and temperate Europe. She is currently working on global-scale analyses of climate and human impacts on biodiversity, ecosystem function and processes, and species' and ecosystem vulnerability to climate change.*

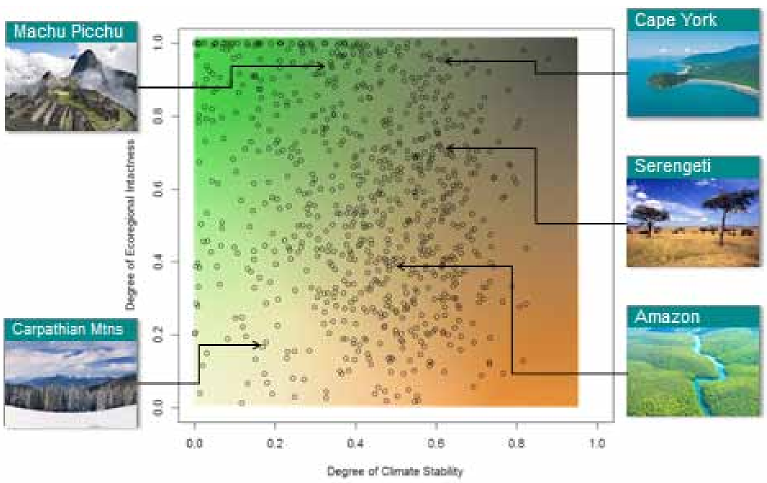

Figure 1: The relationship between ecoregional climate stability (x-axis) and mean ecoregional intactness (y-axis). The most vulnerable ecoregions reside in the lower left-hand quadrant and the least vulnerable ecoregions reside in the top right-hand side. Five iconic landscapes have been identified to show how they vary.

> “This approach has moved WCS away from the assumption that all adaptation actions are suitable everywhere and moves it towards matching actions to target situation.”

By placing vulnerability in a context of future climate change, and past levels of vegetation change, WCS is starting to identify the different management recommendations that can be applied across the different terrestrial regions on earth. This approach has moved WCS away from the assumption that all adaptation actions are suitable everywhere and moves it towards matching actions to target situation. In almost all cases, the most effective adaptation is that which considers interactions between human activity and biodiversity.

For example, ecosystems with highly intact vegetation and high relative climate stability are arguably the best locations for expending money on future protected areas, as these have the best chance of retaining species. In contrast, ecosystems with low levels of vegetation and high relative climate stability could merit efforts at habitat restoration. Ecosystems with low levels of vegetation intactness and low climate stability would be most at risk and would require significant levels of investment to achieve conservation outcomes.

This type of assessment – that takes into account human activity – is crucial but it is really only the beginning. We need to start to acknowledge that humans are going to respond to climate change, and we need to start planning for this. There is no point in investing in conserving a particular species in a particular habitat, for example, if it is on land that is likely to be converted for agriculture (as human food production needs change) or cleared for urbanisation (as human accommodation demands increase or shift). We need to be pragmatic and realistic in terms of financial investment in conservation planning and activity.

As argued by the current IPCC report, the next one to two decades is when we need to put our adaptation actions into place. With regard to our own backyard, southern Australia is one of the most vulnerable regions in the world and it is obvious that there is huge pressure on natural resources and biodiversity from human activity here. Strategic assessment and integrated planning at the landscape scale is the only way to go if we are to effectively protect biodiversity and support human progress and development in the same space and at the same time.

Our global analysis, however, also shows Australia has fantastic opportunities for proactive adaptation as most of the continent is relatively stable and relatively intact (when compared to other continents). Conservation practitioners will have a much greater chance of influencing the intactness of an ecosystem (by reducing land clearance, for example), rather than its robustness to future climatic conditions (which can only be changed through international mitigation efforts), and thus a focus on maintaining ecosystem integrity should always be a primary conservation objective when we think about climate change. Protecting areas such as the Kimberely in north-western Australia, the Great Western Woodlands in WA, and other large intact ecosystems that are features of Australia's great outback, is therefore also an essential adaptation strategy.

What is needed is the recognition that current 'climate-blind' planning is unlikely to be effective and that there is an urgent need to undertake 'climate-smart' assessments. This includes assessing the best places to do conservation activities such as restoration, while recognising that some landscapes may not be a good conservation investment.

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The effectiveness of surrogate species

By Kendall Jones (University of Queensland)

Since conservation practitioners do not have enough funds to conserve all places and all species, they must prioritise where to put their limited resources to work. Setting these priorities requires information about the distribution of species and ecosystems, however our knowledge of Earth's biodiversity is poor, with approximately 86% of land species and 91% of marine species still undiscovered.

To overcome this lack of knowledge, conservation practitioners often use the species which they do have information on as surrogates for other species, with the aim being that conserving surrogate species also acts to conserve other species. One example of a surrogacy-based conservation is the Landscape Species Approach, which was developed by the Wildlife Conservation Society. This approach selects and uses a suite of 'landscape species' as surrogates. These include, for example, the chimpanzee, African elephant and the giant forest hog. Despite being used in many countries across four continents, the effectiveness of landscape species as surrogates has never been tested.

Our research tested the Landscape Species Approach, by setting conservation priorities using landscape species, and using various alternative sets of species, and comparing the location and cost of these priorities. We assumed that if the priorities for landscape species were similar to other sets of species, then landscape species were good surrogates for other species.

We discovered that prioritising for landscape species adequately conserved 35% of species, while prioritising for endemic or threatened species conserved 73% and 69% respectively. We also found that on average, prioritising for a randomly selected group of species conserved 56% of species. From this finding we recommended that WCS supplement the Landscape Species Approach with other, more robust conservation planning approaches.

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***Kendall Jones** is now working as a research assistant at CEED, funded by the WCS and The University of Queensland. The research discussed above formed the basis of Kendall's Honours thesis at UQ, which he completed in 2013. Kendall's current work with WCS and UQ is focused on creating a spatial planning framework for coral reef conservation in a high CO_2 world. He will commence a PhD project later this year looking at how land-use and climate change will affect coral reef fisheries in Melanesia.*

Managing across the land-sea divide is never easy

But a Fiji case study shows it is possible

By Stacy Jupiter (Wildlife Conservation Society)

Most managers understand how 'downstream' ecosystems such as coral reefs can be impacted by activities on the land. Forestry and agriculture, for example, can increase runoff, turbidity, nutrients and chemicals, all of which can have adverse impacts on coral ecosystems. Yet, despite this appreciation, there are very few examples where protected area networks have been designed using truly integrated planning to minimize such threats. Well, I'm happy to report that just such an approach is being applied in Fiji. Not bad for a small-island developing state.

In the past the selection of terrestrial protected areas in Fiji has mostly been ad hoc. It's been based more on the cultural or timber value of forests than on any commitment to biodiversity conservation. Fiji's current terrestrial protected areas, which cover less than 3% of the land, are inadequate in protecting Fiji's sensitive island habitats, and do little to minimize runoff to adjacent coral reefs.

In 2008, a national Protected Area Committee (PAC) was created by the Fiji Government. This was done in part to achieve the goals of protecting 20% of the country's land and 30% of its coastal waters by the year 2020. The PAC began its work by identifying gaps in the existing protected area network and then prioritising areas for addition to the protected area estate.

To support this prioritisation process, we developed a model to identify where Fiji could get the best return on investment for forest conservation to minimize downstream runoff to coral reefs (Klein et al. 2012; the model was developed as part of an NCEAS working group on Decision-Making in the Coral Triangle, see *Decision Point #44*). In other words, where were the cheapest places to protect forests that influence water quality on the greatest amount of adjacent coral reef. This was not just an academic exercise as I serve as an NGO member on the PAC and can directly input into PAC decision-making processes.

The work was done as a collaboration with colleagues from the University of Queensland, the National Center for Ecological Analysis and Synthesis (NCEAS) and Conservation International

After presenting the results of our initial land-sea model to the PAC, the general feedback was along the lines of: "That's nice for the marine systems, but what about our terrestrial habitat targets?"

So we went back to work. We systematically analyzed six scenarios for expanding Fiji's network of terrestrial protected area networks, with the aim to uncover how well each approach did to protect different target vegetation types and minimize land-based runoff to downstream coral reefs. One scenario evaluated included priority forests for conservation that the PAC had already identified based on field data and rules of thumb.

We were pleased to find that the forests that the PAC was considering for protection offered substantial downstream benefits to coral reefs. However, we were surprised to see that these priority forests for conservation actually did a very poor job at representing key threatened vegetation types (Klein et al. 2014a and 2014b).

I took these results back to the PAC with the recommendation to add some additional forests to the priority list in places of notable terrestrial biodiversity that also conferred benefits to downstream reefs. Of course, adding forest to the reserve network comes with a cost so there was every chance that this recommendation might have been knocked back. However, in this case the advice was accepted and a revised list of priority forest sites for conservation was endorsed by Fiji's National Environment Council in October 2013.

At the end of the day, governments only have a limited amount of resources available for conservation. Thus, there will always be trade-offs associated with any location chosen for management. CEED's Director, and a collaborator on this work, Hugh Possingham puts it like this: "The trick is to identify areas that maximize benefits, such as biodiversity conservation and fisheries production, while upsetting the fewest number of people. It's a balancing act, and before now, we had few tools to help us span the divide between land and sea planning."

> "The trick is to identify areas that maximize benefits, such as biodiversity conservation and fisheries production, while upsetting the fewest number of people."

It's true. Identifying an effective reserve network is a balancing act between science and a broad range of stakeholders. In this instance there's every reason to hope a good balance has been reached.

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Stacy Jupiter *is presently the Wildlife Conservation Society's Fiji Country Program Director. Since 2010, she has collaborated with UQ CEED researchers to develop models and options for integrated land-sea planning and marine zoning in Fiji. She is currently part of a SNAP (Science for Nature and People) working group led by Carissa Klein, Chris Brown and Hugh Possingham to develop decision-support tools to incorporate land-based impacts to coastal fisheries into coastal planning in Melanesia.*

Making more of our MPAs

Zone effectiveness and connecting land and sea

By Azusa Makino (University of Queensland)

The aim of my research has been to provide decision-support information that can be used in conjunction with local community expertise when developing conservation plans. The testing ground for my ideas has been Fiji, with the specific projects I ended up working on being heavily influenced by discussions with Stacy Jupiter, the Director of WCS Fiji.

A cornerstone of conservation planning at sea is the marine protected area or MPA. MPAs these days can have multiple zones in which different activities are allowed (or not allowed). For example, these zones might include no-take zones, partial protection zone, or no-commercial-fishing zones. Zoning is the spatial distribution of various types of management areas and they have been used to great effect all around the world, for example marine zoning has been applied in the Great Barrier Reef Marine Park in Australia, California in the United States and Raja Ampat in Indonesia.

Zone effectiveness

Zone effectiveness relates to how much one zone contributes to reaching the overall conservation goals. Management regulations across zones have differing levels of zone effectiveness for biodiversity protection. For example, if the conservation goal is to protect 30% of the fringing reef habitat, the no-take zone will contribute more than the partial-protection zone to achieve the goal. However, if we do not take into account zone effectiveness, it might be assumed that a similar area of the partial-protection zone and the no-take zone will contribute the same to achieving this goal. Unfortunately, little attention has been given to the zone effectiveness in spatial prioritisation. Thus, our first project was to explore how priority areas might change if we take into account the zone effectiveness of different zones (Makino et al., 2013a).

Our study area was the Vatu-i-Ra seascape. This seascape lies between Fiji's two main islands Viti Levu and Vanua Levu, and in this region the local people were developing a conservation plan with support from WCS.

Vatu-i-Ra is believed to be a high priority for conservation because it was identified as an important area for endemic fish and coral reefs. What's more, it's believed to be an area with high resilience having the ability to recover from severe bleaching events.

Zone effectiveness scores were previously estimated by experts. The effectiveness score ranges from 0 to 1, where 0 is completely ineffective and 1 is 100% effective. In this project, we considered three zones: (1) permanent closure (2) partial protection, and (3) open. We assumed that permanent closure zones are fully effective at protecting biodiversity, whereas open zones do not contribute towards the conservation goals. Partial protection zones lie somewhere in between.

We found that when zone effectiveness for different zones were the same, high priority areas for some zones were dismissed. We also tried to distribute the loss of fishing opportunity equitably among local communities. As a result, we found that 84–88% of each traditional fishing ground can be left open for fishing while still meeting conservation goals. These results suggest that it is important to consider the zone effectiveness so that we will not miss high priority areas which could be important in achieving conservation goals. Furthermore, it is still possible to have almost the same areas of conservation zones between local communities. In addition, conservation goals can still be achieved while still leaving large open areas.

> "We also demonstrated that integrated planning can be facilitated with very little difference in costs compared to a plan that ignored connections."

Different zones in marine protected areas help enable effective conservation without significantly compromising local fisheries. (Photo by Natalie Askew)

We also proposed guidelines to consider zone effectiveness when developing a marine zoning that: (1) list activities allowed in each zone, (2) decide which zones should be included, (3) assess the zone effectiveness, (4) decide how much of each feature should be represented in each type of zone, and (5) calculate or estimate the cost of zones.

Connecting land and sea

The second project I worked on aimed to describe an integrated approach for coral reef conservation that considers the connections between the land and the sea. Coral reefs are threatened not only by sea-based activities such as fishing, but also by land-based activities such as deforestation. Therefore, placing coral reefs inside a reserve is not necessarily enough to save it. Unfortunately, spatial prioritisation rarely considers connections between ecosystems.

Azusa Makino *was a PhD student at University of Queensland, supervised by Hugh Possingham, Maria Beger, and Carissa Klein. She also advanced methods for spatial prioritisation by addressing connections in space (ie, between land and sea) and time (ie, between the present and future). The integrated planning considered connections between the land and the sea was also conducted in Fiji, collaborating with the Wildlife Conservation Society Fiji.*

In this project, we demonstrated an integrated approach for coral reef conservation with the objective of prioritising MPAs close to catchments with high forest cover (Makino et al., 2013b). Our aim was to facilitate ecological processes that rely on an intact land-sea protected area connection thereby minimising negative impacts of land-based runoff onto coral reefs.

Our study region was Vanua Levu, where comprehensive data for land-sea connections do not exist. To deal with this we developed and applied simple models of connections between terrestrial and marine ecosystems that require little data. In addition, we incorporated different types of connectivity models into spatial prioritisation that represent: (1) adjacent connections in the sea, (2) land-sea connections in both directions (ie, the land to the sea, the sea to the land), and (3) land-sea connections with one direction from the land to the sea. We then calculated the opportunity costs for the land and the sea, separately.

What we found was that priority areas change when the land-sea connections are considered as compared with a plan that ignored the connections. We also demonstrated that integrated planning can be facilitated with very little difference in costs compared to a plan that ignored connections.

Our results showed that integrated planning is not necessarily expensive compared to a plan for a single ecosystem. In addition, if the conservation features (eg, species) are influenced by multiple ecosystems, a conservation plan needs to consider them and not just focus on a single ecosystem. Our approaches were simple, but they can be easily applied at different scales and locations.

The research was done at the University of Queensland in Brisbane. Of course, this is quite distant from Fiji. Stacy Jupiter provided us with a lot of information and opinions to reflect the values of local Fijians. This was important to our analysis. It was a great opportunity to work with a local NGO. We could not have done these studies without them providing us data and local information.

Our projects did not directly influence the Fiji's conservation plans, it was more of a theoretical exercise designed to demonstrate what was possible. However, I still remember that when I presented our results to a stakeholders meeting, local people were listening carefully and some people came to me after the talk to say thank you. While our projects were somewhat theoretical, they also demonstrated the importance of factoring in different dimensions of the conservation problem. I'm hopeful that they will contribute to better biodiversity outcomes in Fiji.

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Resilient Island Ecosystems and Communities

Society for Conservation Biology Oceania Fiji 2014 Conference

As conservationists continue to make headway into improving our understanding of the science and practice of conserving the Earth's biological diversity, a great challenge lies in being able to effectively disseminate and implement best practice guidance to a broad spectrum of professionals across the biological and social sciences, management practitioners and policy makers.

To respond to this challenge, the Society for Conservation Biology Oceania is proud to co-host its 2014 section conference with the University of the South Pacific in Suva, Fiji, between July 7-11, 2014. The conference will feature five days of interactive workshops and presentations, providing a tangible conduit for presenting and discussing new research and developments in conservation science and practice. During this time, the conference attendees will hear from world renowned guest speakers who are leaders in their respective fields and will also provide an excellent opportunity for young career researchers and university students in the Oceania region to link up and network with other conservationists.

Sub-themes for the conference include:

- Vulnerable Ecosystems, Communities and Species
- Adaptive & Community Based Management of Socio-Ecological Systems
- Conservation in a Changing Oceania

The conference is expected to attract at least 200 attendees from across the Oceania region including Australia, New Zealand, Melanesia, Micronesia, and Polynesia.

The Wildlife Conservation Society will be playing a major role in the conference and CEED will have over 20 researchers in attendance. Dr Stacy Jupiter, WCS Fiji Program Director, is a recent board member of the SCB Oceania section and is chair of the Local Organizing Committee for the conference. She and her staff are closely liaising with the University of the South Pacific on conference planning and design of the scientific program.

More info: http://www.scbo2014.usp.ac.fj/

How does map error impact priorities

How do we effectively protect biodiversity if the maps we are using are inaccurate?

By Vivitskaia Tulloch (University of Queensland)

Reserves are one of the most successful systematic conservation planning tools used to protect biodiversity. But choosing the best location for a reserve is never easy. Reserve placement relies on ecological data, such as the distribution of species or habitats. But field data is expensive and difficult to obtain, so cheaper data options such as habitat maps are often used instead. For planning involving the conservation of coral reefs, remotely-sensed habitat maps are one of the most commonly used data sets, usually because of the remoteness or extent of these marine systems. Using these types of habitat maps, however, can cause big problems. Most people assume habitat data is accurate – but it never is! There are all types of errors associated with the making and using of habitat maps, and almost never is this error accounted for in conservation planning.

Why does this matter? Well, ignoring data uncertainty can cause all sorts of problems when this data is used to plan marine reserves. We might end up placing the reserve in the wrong location if we assume the data is right, when it is actually wrong. Planners however are forced to use inaccurate data regularly, which could be leading to misinformed management decisions. We might not be protecting the right areas, and it also might lead to us to spending our already stretched conservation budgets unwisely.

Making decisions with what we have

To avoid issues of error in our data, some suggest we should collect MORE data (through field surveys for example). However, besides being very costly, such efforts also take time meaning delays in protecting biodiversity that might be under considerable threat. Many coral reef regions, for example, are already facing significant losses from activities connected to human activities. We simply can't delay our conservation effort. Consequently, we need ways to include data uncertainty in our planning processes now.

And that's where my work comes in. Working with colleagues at CEED at UQ, I have recently developed a new method of accounting for data errors in conservation planning, using a modified version of the decision-support tool Marxan. In a nutshell, we are seeking to minimise the risk of using inaccurate data in order to be confident in conservation decisions.

To do this, we designed a series of marine reserve networks that included or ignored habitat-mapping error. We used a case study of the Kubulau traditional fishing grounds, or 'qoliqoli', in Fiji. The Kubulau qoliqoli is located in the South-West of the island Vanua Levu, and covers an area of around 260 square kilometres. The researchers worked closely with the Wildlife Conservation Society (WCS) in Fiji, a non-government organization working with communities in Kubulau to initiate marine management projects.

WCS has been working with local stakeholders in the region to build a resilient MPA network design that protects 30% of all coral reef habitat types. The collaboration between UQ and WCS has enabled researchers to obtain detailed knowledge of the cultural and socio-economic needs of local stakeholders in the Kubulau qoliqoli, which were integrated into the new reserve design methods.

How good's the map?

A number of coral reef habitat maps at different scales have been developed for the region. These have been derived from high spatial resolution satellite imagery using hierarchical object-based image analysis and segmentation. For the spatial prioritization they used a fine-scale benthic habitat map describing coral, reef, algal, seagrass and sediment habitats.

So, a habitat map exists for this area. But planners also needed information on the accuracy of this map to include in the spatial prioritization. Errors in map classification are common, due to detection issues and spectral mixing. These values were obtained using an error matrix, also called a confusion matrix, which basically tells you how many pixels in the map were classified correctly by comparing the map to reference images, and how many pixels were inaccurately assigned to the wrong habitat class.

Using this error matrix, the accuracy of each habitat classification was determined (Figure 1), which was just the number of times a pixel was correctly classified divided by the sum of all reference images for that class. For instance, a habitat type called 'coral' was correctly classified 34 times. This number was then divided by the total number of reference images (66 for coral), giving an accuracy of 51.5% for that habitat type.

These accuracy values were included in a new approach to spatial prioritization using Marxan with Probability (or MarProb for short). The traditional version of Marxan aims to achieve biodiversity objectives for the lowest cost. This new modified version of Marxan, MarProb, solves the same problem but is also able to maximise the probability of protecting every conservation feature, given inaccurate data. It does this by applying a penalty to those habitats that do not meet a target certainty, and so is less likely to include them in the final solution as doing so will increase the objective function score.

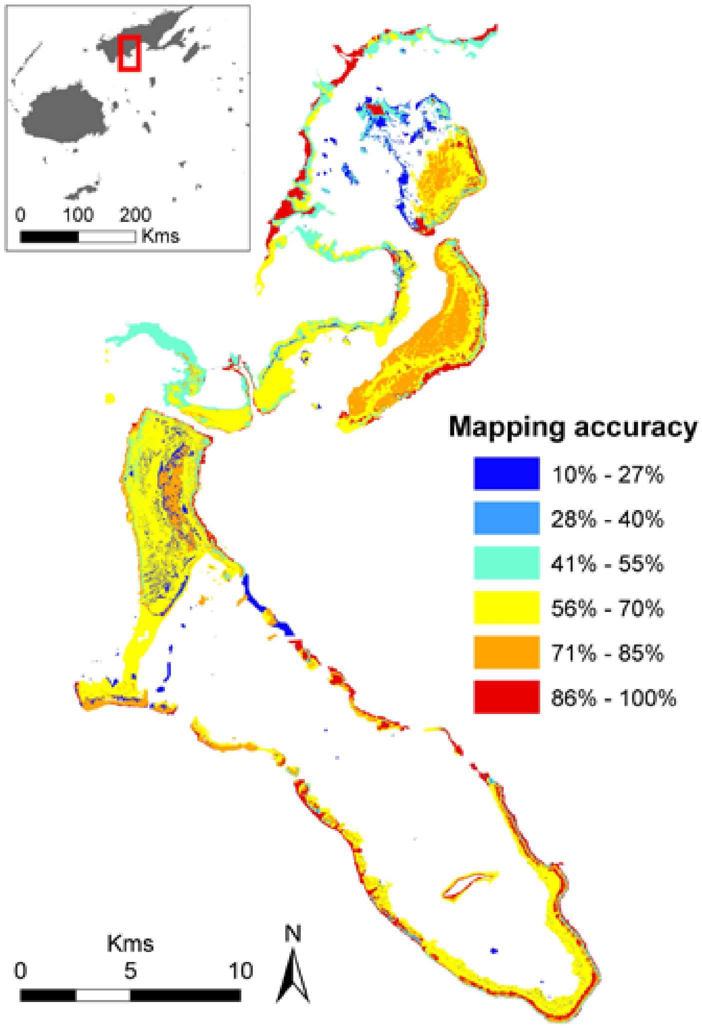

Figure 1: Accuracy values for a map of marine ecosytems derived from remote-sensing imagery of the Kubulau Fiji fisheries management area (qoliqoli).

Mapping the options

To investigate how priority reserve areas change once habitat-mapping error was accounted for, we ran a number of different reserve design scenarios using the traditional version of Marxan, where we assume habitat occurrence is 100% certain. We compared these reserve designs with those using the probabilistic method, MarProb, which included the habitat-mapping accuracy data, to determine what if any changes occurred by using probability data. By varying the conservation representation targets from 10% to 100%, we also aimed to evaluate trade-offs in marine reserve design between representation and cost.

When we compared the results from the standard and probabilistic scenarios, we found that many areas that were a high priority for meeting targets in one scenario could be a low priority in another scenario, and vice versa. Areas important to achieving representation targets for habitats in probabilistic scenarios were largely excluded or considered unimportant in the standard scenarios.

We also found reserve networks that accounted for mapping error were up to 50% larger than those designed using the standard approach. We wanted to look into what was driving these differences, and found that larger amounts of habitats with low mapping accuracy were represented in reserve networks created through the probabilistic approach. When we locked in the priority planning units from the standard approach into a run using the probabilistic method, most habitats failed to achieve their representation targets, and habitats with accuracy values less than 90% would actually never achieve their targets.

Importantly, existing reserves do not meet national conservation targets (30%) once mapping error was accounted for. Six habitats were under-represented including coral and seagrass, which are really important habitats supporting large amounts of biodiversity.

The consequences of a poor map

This study is important as it shows that conservation schemes based solely on the distribution of habitats that don't have information on mapping accuracy may fail to achieve adequate conservation outcomes. This is because they risk either under-representing conservation features by missing out on protecting high priority areas, or over-representing conservation features by including areas in the reserve network that are of low importance to meeting conservation goals.

Given that we have so little money to invest in conservation actions as it is, we could really be reducing the efficiency of conservation investments if we don't start accounting for uncertainty. The results from this study show that serious consequences might result by not accounting for mapping error in marine spatial planning. That's in terms of the benefits for conservation and the cost of management.

Even though larger reserve networks that account for mapping accuracy could be more costly to manage, they are more robust to uncertainty than those that do not consider mapping accuracy. Even though they were larger, the key advantage of the probabilistic solutions with high certainty targets is that they increase confidence in achievement of conservation outcomes, making decisions more robust and less risky.

There is a growing call for decision-support tools to explicitly incorporate uncertainty associated with the data in conservation planning. This new probabilistic approach allows planners to quantify how often targets might be missed when uncertainties are not considered, enabling them to evaluate necessary trade-offs, and understand the implications of not including uncertainty information in the planning process.

If uncertainty data are not readily available, planners have several options to ensure they are not ignoring the error inherent in their habitat maps. First, planners could try to source more information about the habitat information that is often just assumed to be correct. For instance, how were the maps produced? Was there any validation? Which habitats may have been problematic and/or under-sampled?

Second, planners could set different targets for each habitat, with higher targets set for habitats suspected to be uncertain. For example, some habitats are known to be commonly confused when mapped (eg, because their spectral signatures or textural characteristics are very close or because they tend to occur in the same geomorphic zone in patchy habitats), so planners could set higher representation targets and/or higher certainty targets for these habitats.

> "Serious consequences might result by not accounting for mapping error in marine spatial planning. That's in terms of the benefits for conservation and the cost of management."

Embracing uncertainty in conservation planning and reserve design is important in our search for more robust and defensible conservation decisions – so let's start doing it! Our challenge now is to ensure data accuracy assessments or uncertainty information is more readily available, and find new methods of dealing with these uncertainties to allow the design of reserve networks that adequately and efficiently represent biodiversity.

Importantly, this research provides an avenue for applied conservation management, as it was done in collaboration with WCS-Fiji, an influential organisation in making conservation decisions in this region. The new methodology provides a potentially useful and cost-effective reserve planning decision-making tool for scale-up to a national level in Fiji. The collaboration with WCS, and in particular WCS-Fiji Director Stacy Jupiter, is ongoing, with current research investigating trade-offs between socio-economic costs and data accuracy in coral reef marine spatial planning.

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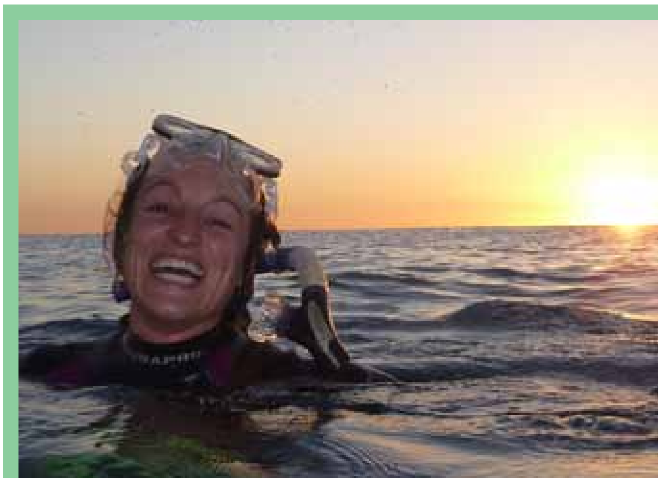

Vivitskaia Tulloch *completed this project as part of her Honours thesis at UQ. She is currently a PhD student at the Centre for Biodiversity and Conservation Science (CBCS), jointly funded by the Wildlife Conservation Society and CSIRO. Her collaborative project with WCS involves modelling catchment run-off to coastal waters in Papua New Guinea to investigate the impacts of oil palm on coral reef habitats, and to optimally plan for conservation and sustainable resource development in the region.*

Allocating ranger patrol effort

using conservation planning tools

By Andrew Plumptre (Wildlife Conservation Society Albertine Rift Program)

Ranger patrolling is one of the key tools used by conservation managers, particularly in tropical countries, to ensure law enforcement occurs in protected areas and that poaching is minimized. Several recent assessments of the effectiveness of protected areas have shown that supporting law enforcement at a site is one of the most important factors for ensuring the maintenance of the integrity of the site. Yet very little research has looked at how best to allocate patrol effort to deter illegal activities within a protected area and to maximize efficiency of law enforcement.

Law enforcement using ranger patrols is effective where the level of deterrence is sufficient to make it difficult for poachers (of wildlife, timber and non-timber products) to gain from illegal activities. In the case of ivory from elephants and rhino horn, the incentives to poach can be huge and providing sufficient deterrence is very difficult. However for the other species (and products) the incentives are a lot lower and ranger patrolling can be an effective deterrence if planned well. But how much is enough? There is a need to better understand what level of re-visitation to an area provides an effective deterrence.

For the most part ranger patrols are focussed on zones within protected areas where it is believed illegal activities are most abundant. This is very much influenced by the ability to detect

Ranger patrols are one of the most important factors for ensuring the integrity of protected areas. (Photo by Andrew Plumptre)

illegal activities, and also the fact that as patrolling effort in one area increases then poachers adapt and move to other areas. Frequently, managers do not have the time to coordinate all the daily patrols from several ranger stations. Consequently, the patrolling effort is sometimes haphazard and often re-visits areas near the posts while leaving other areas rarely visited.

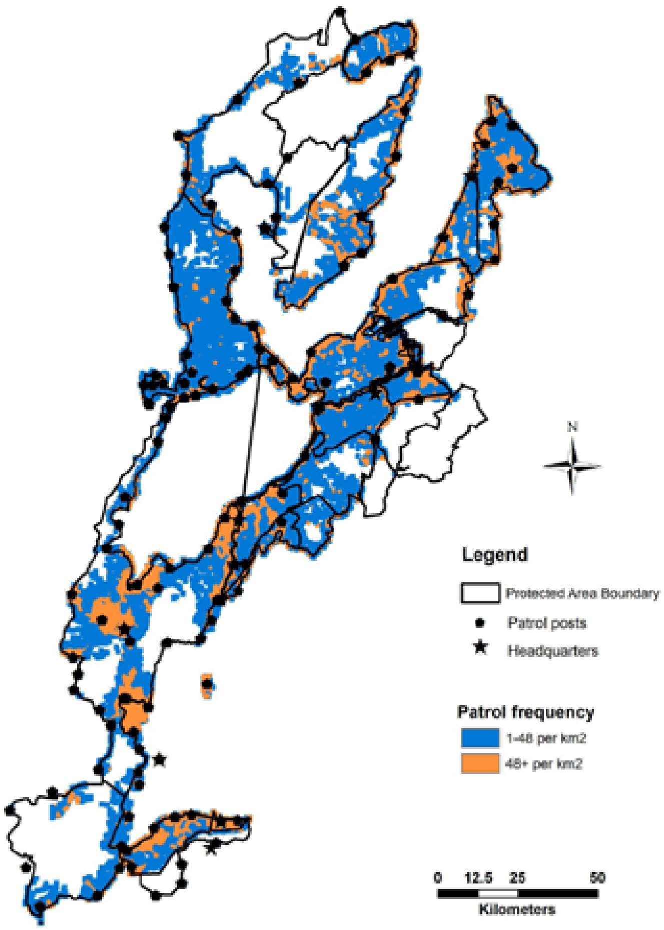

Figure 1: Frequency of patrolling within the GVL. Number of locations records per month are plotted per km² and four locations (2 hrs) were deemed necessary to sufficiently search a cell. Therefore observations with more than an average of 48 locations per month were deemed to be searched sufficiently intensively to act as a deterrence.

The Greater Virunga Landscape (GVL) is one of the most biodiverse pieces of real estate in the world. Straddling the borders of Uganda, Rwanda and the Democratic Republic of Congo, it is made up of 13 protected areas including three World Heritage sites, one Ramsar site and one Man and Biosphere reserve. Since the early 2000s the Wildlife Conservation Society (WCS) has been supporting the protected area authorities of these three countries to implement a law enforcement monitoring program using the software MIST and more recently SMART (www.smartconservationsoftware.org). We examined the existing data on patrol effort in the parks of the Greater Virunga Landscape and showed that while about 60% of the landscape was visited between 2000-2010, only 22% had been visited at a frequency of at least once each month over this period (figure 1). Assuming that a visitation rate of once per month provides sufficient deterrence to poachers, this meant that poaching was not being effectively tackled.

Analysis of the distances that ranger patrols travel from the 125 patrol posts in the landscape also show that most patrol effort was within 5 km of a patrol post (75% of patrol locations) and 50% were within 3 km of the patrol post. As the area that requires patrolling increases with the radial distance from a patrol post this means that the funding for law enforcement per unit area of the landscape is mostly expended within 2-3 km of a patrol post (figure 2). These scarce resources are therefore being used very inefficiently at present and we therefore investigated whether patrolling could be better planned and implemented for similar costs.

Conservation planning methods generally target where to conserve a suite of conservation targets. In this study we developed a novel

> “We developed a novel way of using Marxan to more efficiently target patrol effort to ensure the conservation of the key species and habitats in the GVL.”

way of using Marxan to more efficiently target patrol effort to ensure the conservation of the key species and habitats in the GVL (Plumptre et al., 2014).

Using a habitat map developed by WCS and a suite of landscape species for the GVL, we set target levels for each habitat based on their size and conservation importance. We also set targets for each species based on its population size. A cost layer was developed using the predicted costs of patrolling in the GVL correcting for the time it takes to travel through different habitats and terrain and incorporating additional costs for overnight patrolling. Costs were based on the current expenditures for these activities made by the Uganda Wildlife Authority and Institut Congolais pour la Conservation de la Nature. A separate cost layer was similarly developed for mobile patrolling where a vehicle can transport a team of rangers to a site before they move off on foot. A third cost layer identified which of these two patrol methods was cheapest for any site within the landscape.

Using these three cost layers we were able to show that the cost of patrolling the whole landscape at a frequency of once per month would absorb the total budgets for park operations. If however, patrols targeted those areas where illegal activities were most common (77% of all activities) then the costs could be brought down to about 57% of these total costs. But if patrolling targets those areas which are critical for the conservation of the key species and habitats identified, rather than trying to patrol the whole landscape, costs could be brought down to 38% of these total costs and as low as 16% of the total costs if patrolling focused in the areas where threats were most common within the Marxan selected areas (Table 1).

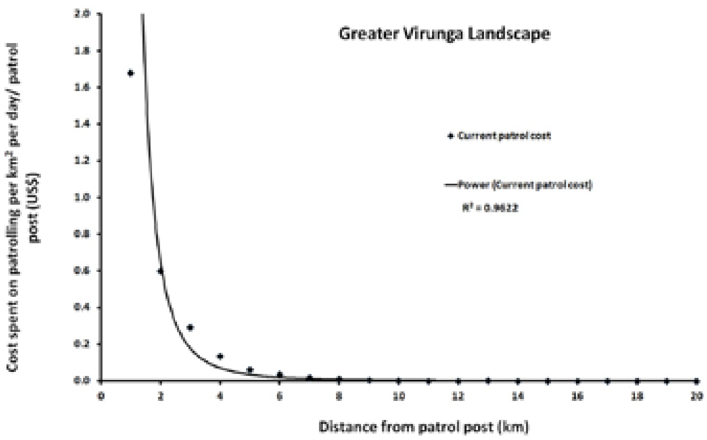

Figure 2. The current expenditure of park law enforcement budgets in relation to distance from the 125 patrol posts in the landscape.

***Andy Plumptre** received a Fairfield Osborne Memorial Fund grant from Wildlife Conservation Society to spend a three month sabbatical at University of Queensland to learn Marxan and to analyse data that had been collected in his eleven years in the Albertine Rift region of central Africa. Supervised by Richard Fuller and Hugh Possingham he used a novel approach of using Marxan to assess ways of improving ranger patrolling strategies to maximise their conservation impact in the Greater Virunga Landscape.*

Combining a conservation planning approach that selects areas in the landscape critical for the conservation of the key species and habitats and focusing patrol effort in these areas will ensure the protection of the conservation features of a site provided the target levels selected are appropriate. The method accepts that it is not possible to fully patrol the whole landscape effectively but at present this is clearly the case for the GVL where illegal activities remain high despite large resources being invested in ranger patrolling. The method requires testing but we believe that it has the potential to significantly reduce the impacts of illegal activities on the key species and habitats in the GVL.

More info: Andy Plumptre aplumptre@wcs.org

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Table 1. Costs of patrolling a) whole landscape effectively, b) areas where threats are abundant in landscape, c) area selected under the Marxan best scenario to minimize costs to protect conservation features and d) areas where threats are abundant within the Marxan best scenario for conservation targets. The percentage of the total costs for patrolling the whole landscape is given in brackets.

Three cost layers	1. Patrol post cost (US$)	2. Mobile Patrol cost (US$)	3. Patrol post and mobile patrols combined (US$)
Patrolling whole Landscape	6,152,170	9,139,850	5,892,120
Patrolling Landscape where threats are abundant (77%)	3,505,020 (57%)	5,324,400 (58%)	3,334,030 (57%)
Focus on conservation features			
Patrolling Marxan best case scenario	2,266,720 (37%)	3,463,280 (38%)	2,223,810 (38%)
Patrolling Marxan best case scenario where threats are abundant (77%)	964,560 (16%)	1,653,600 (18%)	944,380 (16%)

Measuring socio-ecological vulnerability in PNG

Integrating adaptive capacity and climate modelling

By Joseph Maina and James Watson (Wildlife Conservation Society & University of Queensland)

Human societies, species and ecosystems across Papua New Guinea (PNG) are already feeling the effects of climate change. Consequently, addressing the impacts of climate change is becoming an urgent priority for central and provincial governments, NGOs and local communities. One way to address these impacts is by first assessing the vulnerability of the socio-ecological systems to climate-related disruptions. This would then inform decisions concerning climate-smart planning and help facilitate the implementation of adaptation strategies.

A key issue is scale – at the end of the day, all adaptation actions need to be conducted at the local (site) scale. But almost all socio-ecological vulnerability analyses that incorporate future climate information to date have been conducted at regional scales or above. This makes them of little value when considering different local adaptation strategies.

In an ongoing study funded by AusAID, researchers from CEED and WCS have developed a methodology that allows for the integration of top-down climate modeling with bottom-up social adaptive capacity assessments. We then used this to undertake a vulnerability assessment in five villages across Manus island, (PNG). The steps of this methodology include: (i) assessing the adaptive capacity of artisanal and subsistence reef-based fisher communities via questionnaires undertaken by WCS local community facilitators; (ii) generating a model of the relative environmental exposure of coral reefs that these communities depend on by combining satellite observations of wind velocity, sea surface temperature, UV radiation, photosynthetically active radiation, and suspended sediment; and, (iii) assessing the exposure of ecosystems and human population to extreme climate events based on future predictions of temperature and rainfall.

We found that corals reefs in PNG are highly exposed, with the reefs off the mainland being relatively more threatened than those offshore (in Andra and Ponam islands). We also found that the social adaptive capacity differed among the five villages, with fisher communities on the island villages having a relatively high social adaptive capacity compared with those on the mainland.

“We also found that the social adaptive capacity differed among the five villages, with fisher communities on the island villages having a relatively high social adaptive capacity compared with those on the mainland.”

Figure 1. Manus island of PNG and locations of the five village communities studied.

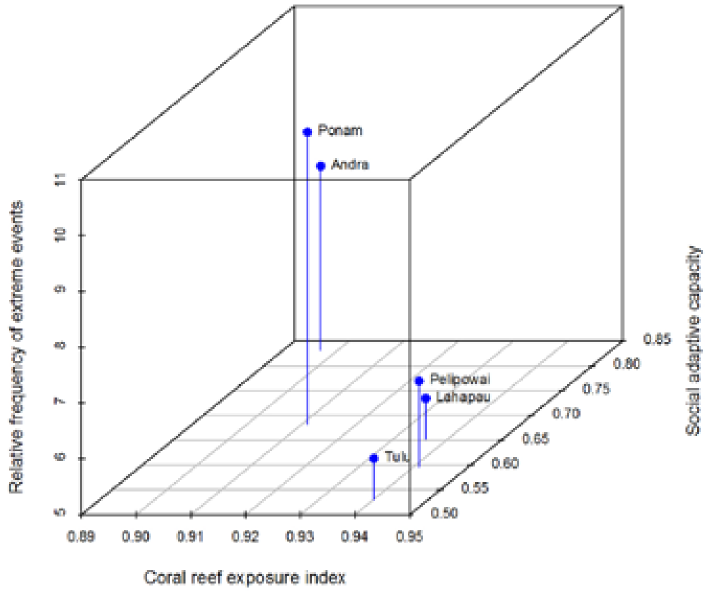

Figure 2. Intersection of three axes of the vulnerability components considered for each village, and the relative position of the villages along each of the three axes on a 3D plot.

We also found that these villages were differentially exposed to extreme events. Consequently, when these three factors were combined, these villages vary in their overall vulnerability. By integrating these different data sets, we have been able to develop an overall analysis that allows us to assess how socio-ecological vulnerability varies among villages. This is being used to inform future adaptation planning.

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***Joseph Maina** completed a BSc. (Hons) in natural sciences at the Egerton University in Kenya. Following this, he worked for several years on the Wildlife Conservation Society's Coral Reefs Conservation Project in Mombasa. Joseph then completed a MSc. in geo-information science for environmental modeling. Having recently completed his PhD at Macquarie University in Sydney, Joseph has since moved to the University of Queensland, where he is currently a WCS/CEED postdoctoral research fellow.*

Picture this

This issue of *Decision Point* focusses on the research coming out of the collaboration between the Wildlife Conservation Society and CEED. Here's a sampler.

Thanks to the innovative application of the conservation planning software Marxan, ranger patrols in the Greater Virunga Landscape in Africa can be more efficiently scheduled to ensure poaching operations are stopped in their tracks. That means there is less chance of poachers killing iconic wildlife like the elephant (see the full story on page 13). Who said Marxan was only about drawing up reserve networks. (Photo by Andrew Plumptre)

Understanding how effective each type of marine management zone is at protecting each aspect of biodiversity will help us plan for multiple management zones, better enabling local communities to access the marine resources they have traditionally harvested. See page 9. (Photo by Stacy Jupiter)

This lion is one of the animals used as a surrogate species to plan for the management of a range of other species. It's known as the Landscape Species Approach but how good is it compared to other prioritisation approaches? See page 7 to find out. (Photo by Andrew Plumptre)

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 Australian National University, the University of Melbourne, the University of Western Australia, RMIT and CSIRO.

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

Decision Point is the monthly magazine of the EDG.
The funding of the research presented in this issue of *Decision Point*, like most research, comes from multiple sources and is identified in the original papers on which the stories are based (references are provided in each story).

To contact the EDG please visit our websites at:
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