DECISION POINT

Connecting conservation policy makers, researchers and practitioners

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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://ceed.edu.au/dpoint-news/

Other Stories

Sufficiency vs efficiency

Two faces of the same coin?

Hugh Possingham (Director, EDG)

During a review of the Applied Environmental Decision Analysis network (the predecessor of the Environmental Decision Group) I was pulled up about our focus on efficiency. The challenge came from Greening Australia's David Freudenberger who exclaimed: "While all this research on efficiency is great, I wish you would do some more research on sufficiency" – or words to that effect. It took somewhere between five minutes and five months for me to fully understand exactly what he was saying.

One of the important contributions of much of our research over the past ten years is to ask conservation researchers to include money in their thinking. It's a notion that probably seems fairly pedestrian to most economists yet it's a major stumbling block for a lot of conservation science. It is hard to be credible when you spend public funds and ignore the cost of actions.

For example, by the end of the last century there were innumerable processes and decision support tools to choose where to place national parks and marine reserves. But most of these frameworks concentrated on optimising biodiversity value (however you wanted to define it). The cost of the various options was often not factored in despite the fact that cost was more often than not the key factor in determining the best option.

The conservation planning tool I helped develop with Ian Ball and Matt Watts placed the importance of including cost front and centre. It was called Marxan. Once the conservation targets are set – for example, get me 20% of every kind of habitat or species for which we have a map – then Marxan helped achieve that as efficiently as possible with respect to cost. In this case cost can be a combination of many things: cost to the taxpayer, forgone revenue from fisheries or forestry, or a combination of many other things that implies making any parcel of land or sea into a reserve and a loss to a member of the voting pubic. If you want to see the many ways it can do this, take a look at our *Decision Point* special issue on Marxan where we explore its many permutations (see the October 2010 issue at the *DPoint* archive on our website).

Some of our other research asks the related question, how can I allocate limited funds to deliver the greatest biodiversity return on investment from actions? For example, how can I use a state's budget to minimize the loss of species (see *DPoint #29*) or achieve carbon and biodiversity benefits simultaneously (see *DPoint #35* for tropical forests and *#53* for rangelands) or determine which subpopulation to monitor or manage (*DPoint #54*).

And finally, in our quest to drive even more efficiency we have asked questions that many people would prefer us not to have asked. For example: Should we be wasting money on monitoring that is unlikely to deliver outcomes cost-effectively (*DPoint #52*)? Should be selling some national parks that are not cost-effective (*DPoint #51*)? When can we declare a species extinct (*DPoint#38*)?

> "Being sufficient, as opposed to efficient, is posing the same type of analysis in a different framing. What is a sufficient investment to ensure a certain conservation outcome (with a specified level of confidence)?"

All these stories revolve around being efficient with our conservation investments. And that's good and proper when funds (usually public funds) are limited. Indeed we have recently argued that the case for more funding for threatened species is best made if you can show what little funds you have are being used prudently (Joseph et al 2011).

And in this issue of *Decision Point*, Brendan Wintle shows how to allocate investment between reserve acquisition and fire management depending on the size of the budget while Geoff Park and colleagues explain how an environmental investment framework called INFFER can improve the effectiveness of our NRM choices.

However none of this tells us what the budget should be! Are we afraid of telling government what is enough to stop the world's sixth mass extinction event?

Being sufficient, as opposed to efficient, is posing the same type of analysis in a different framing. How much money to we need to ensure a certain conservation outcome (with a specified level of confidence)? This sort of analysis does not presuppose the budget, but determines the budget. Carwardine et al (*DPoint #47*) showed what investment would be needed to secure biodiversity in the Kimberley, the last place in Australia with an intact mammal fauna. Surely that is a good idea? Can we have $40 million per annum?

Garrad et al 2008 et al (*DPoint #38*) found out what we would need to have a very high chance of finding a threatened species while surveying areas for an environmental impact study.

Of our few sufficiency studies I think my favourite is that by McCarthy et al (2009) (*DPoint #23*) on what investment is sufficient to safeguard our birds. Their analysis found that an annual budget of $10 million (that's an average of $37,000 per species of conservation concern) can be expected to reduce the number of threatened species in 80 years time by approximately 15% while limiting the number of extinct species to one. It should be noted that this level of spending is approximately three times what is being spent at the moment. This seems like a trivial amount to secure Australia's avifauna which is currently disappearing at about 100 times the 'background rate'. It seems remarkable that so little action is taken even when we can tell government what is enough.

PS: As noted in the introduction, this commentary on an important idea was sparked by an external review. Who said external reviews are a waste of time? Ideas from outside one's comfort zone invariably emerge if a research program is subjected to free-flowing inspection by people with lateral thoughts – another lesson for universities and government agencies alike.

References

Joseph LN, RF Maloney, JEM Watson and HP Possingham (2011). Securing nonflagship species from extinction. *Conservation Letters* 4: 324-325.

Discussions on other papers mentioned in this editorial are available free at the *Decision Point* archive: http://ceed.edu.au/dpoint-news/

Avoiding extinctions under climate change

Ecological optimisation of conservation investment in the Fynbos

By Brendan Wintle (EDG, University of Melbourne)

Climate change is real and we need to start making decisions about how to prevent an increase in the rate of species extinctions. Climate change brings a suite of challenges for biodiversity management because it provides new direct threats and exacerbates existing ones. As a result, many species are now at an increased risk of becoming extinct. No ecologist I know disputes any of this. This makes decisions about how to spend limited conservation budgets even more important.

We have limited control over global warming, we have little money with which to protect species and we have many possible courses of action, only a portion of which can we afford to try. Under such circumstances, how do you approach making a decision? From the perspective of conservation scientists and practitioners, the question is how best to invest limited conservation and climate adaptation resources to minimise the number of species going extinct.

This is the question we set out to tackle in a recent climate adaptation research project funded by NERP and CEED. We approached it using a combination of ecological and economic models that help us to:

1) predict the probability that a species will go extinct under a set of climate change scenarios;

2) predict how much extinction risk can be reduced by implementing particular conservation actions;

3) estimate the cost of implementing those actions;

4) figure out the most cost-effective portfolio of conservation actions for a given budget, based on the above estimates of extinction risk reduction and cost.

In short, we figure out how to provide the "best bang for our conservation buck".

While this sounds fairly logical, the primary challenge is coming up with the best possible estimates of conservation benefit (reduced extinction risk across multiple species), and management costs. And there are a number of factors in doing this that make it a significant challenge.

To begin with, global warming scenarios are inherently uncertain. We don't know, for example, exactly how global change will influence local weather patterns.

On top of this, we have a relatively poor understanding of ecological processes that mediate the extinction risk of particular species. What's more, the number of species at risk is huge.

To cap it all off, we don't know enough about the effectiveness of management in influencing ecological processes and reducing species loss.

Actions in the Fynbos

Despite this level of uncertainty, we have shown in the journal *Nature Climate Change* that ecological-economic models can be applied to help make better conservation investment decisions. In this case we showed how it can be used to help conserve species in the South African Fynbos Biome – a global biodiversity hotspot of phenomenal beauty.

The fynbos ecosystem supports more than 6,200 endemic plant species in an area less than the size of Tasmania. Many of those species are highly threatened by the direct and indirect impacts of climate change, particularly through the increased frequency and intensity of fires that climate change is predicted to bring about.

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Threats in the fynbos

The fynbos is a centre of endemism, containing over 6,200 endemic plant species that are highly dependent on local fire regimes. Climate change is likely to increase fire risk in Mediterranean ecosystems, posing a significant threat to shrubland species worldwide. A large portion of fynbos shrub flora are known as 'obligate seeders' because standing plants are killed by fire and they can regenerate only from seed. Increasing fire frequency (decreasing fire return interval) may lead to the destruction of adult plants before they reach sexual maturity, and hence local extinction. Exacerbating these impacts is the rapid loss and fragmentation of the Fynbos under urban and agricultural development, and invasion by exotic plant species. Given an objective to maximize net species' persistence in the Fynbos over the next 50 years, how should a limited adaptation investment budget be most efficiently invested?

"Under a no-extra-investment scenario, the average risk of extinction by 2050 is more than 90% for many species. Business as usual, therefore, has dire consequences."

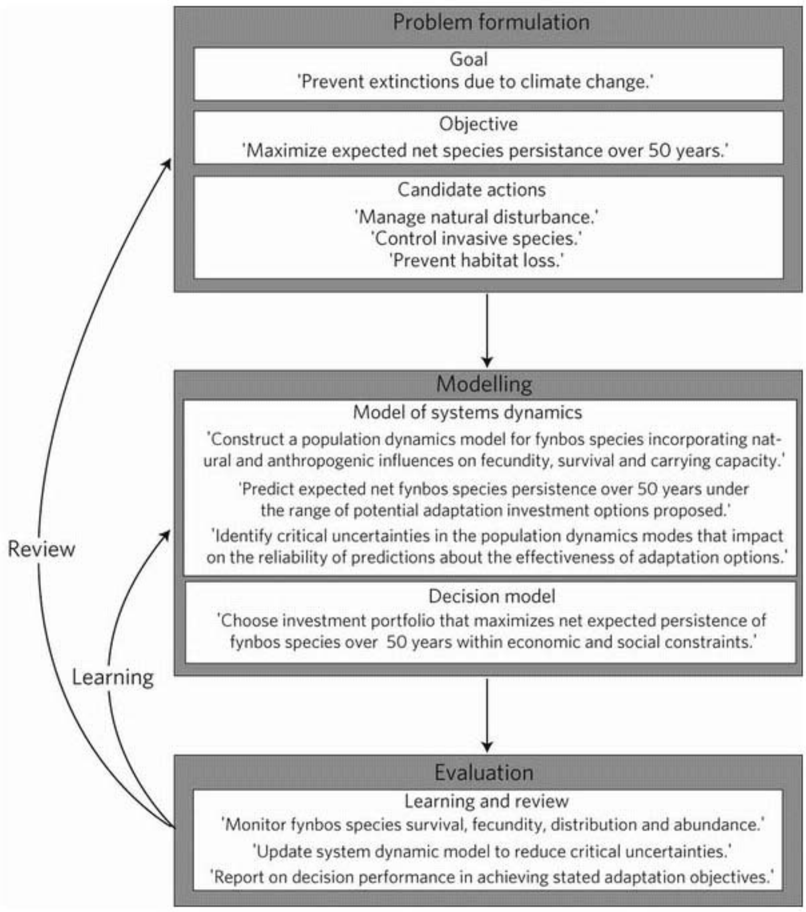


Figure 1: The six headings in the white boxes define the steps of a general framework for prioritizing climate adaptation investment options. By way of example, activities relevant to the fynbos case study are included in inverted commas.

Decision making in a changing climate

Continued from page 4

These threats compound the already severe impacts of habitat loss (land clearing) and weed invasion.

In collaboration with Brian van Wilgen from CSIR South Africa and David Keith from the NSW Department of Environment and Conservation, we developed mathematical models to predict the risk of extinction (by 2050) for a set of fynbos flowering shrubs (proteas and leucadendrons) using the IPCC's A1FI climate change projection. We then considered these extinction risks under a range of conservation investment scenarios involving differing allocations to fire suppression, weed control and habitat preservation. Using these models, we identified the most cost-effective portfolio of conservation investment for reducing extinction risk for a subset of the threatened fynbos flora.

So, what did we find?

Under a no-extra-investment scenario, with current habitat loss rates and 'best-bet' climate change projections, the average risk of extinction by 2050 was more than 90% for many species. Business as usual, therefore, is predicted to have dire consequences.

We found that if conservation budgets were increased by around US$60 million per year, mostly allocated to early-strike fire suppression, we could reduce the average extinction risk to below 20% – a significant reduction.

This risk could be reduced to less than 10% with a further increase to US$120 million per year, spread fairly evenly across habitat protection and fire suppression.

This is an all too rare attempt to quantify the marginal benefits of increasing spending in terms of reducing extinction risk; something we believe to be a very powerful policy tool.

The best mix depends on the total investment

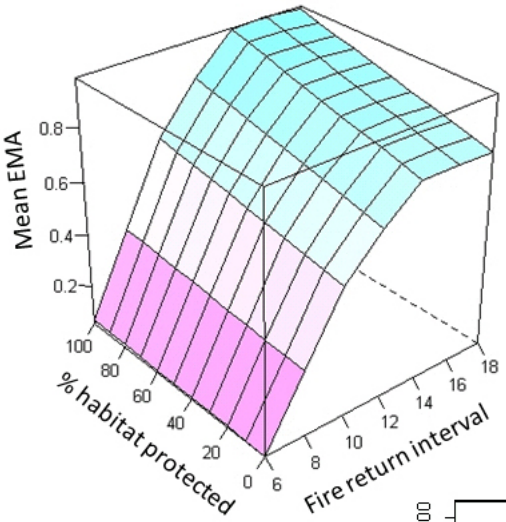
Our analysis indicates that if climate change drives fire return interval to low levels (<8 years), there is a high probability of extinction for the species modelled in this system. Under relatively conservative climate change scenarios, and in the absence of investment in fire protection, this is a real possibility. Consequently, it was most efficient to invest almost solely in fire management, especially when available budgets are small.

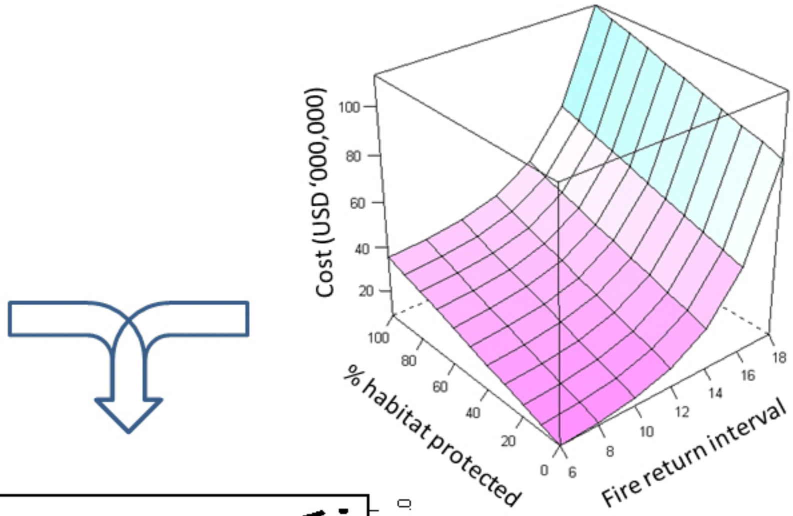
When the available budget exceeds US$43 mill, marginal returns from fire management decrease relative to habitat protection, leading to a mixed investment strategy. At around US$105 mill no further gains in expected minimum abundance can be made with further investment in habitat protection, after which the remaining budget goes into fire management. This illustrates a key result; that the optimal investment strategy depends on the available budget, in this case in a highly nonlinear fashion.

The preference for fire management at low budgets arises because every dollar invested in fire management delivers a relatively large increase in fire return interval and therefore population persistence. However, if the fire return intervals are too low to maintain species, habitat protection is irrelevant.

At higher budgets, the switch to habitat management and then back to fire management simply reflects diminishing returns from each activity as the total available budget increases. These results have important implications for climate adaptation investors.

First, investing in just one type of adaptation action (for example increasing habitat connectivity) irrespective of available resources is unlikely to be an optimal strategy; a careful evaluation of the optimal strategy, given the resources available, is necessary. Second, analytical methods such as those used here can be used to quantify how much extra conservation benefit can be obtained for a given increase in budget, providing a powerful tool for guiding policy.





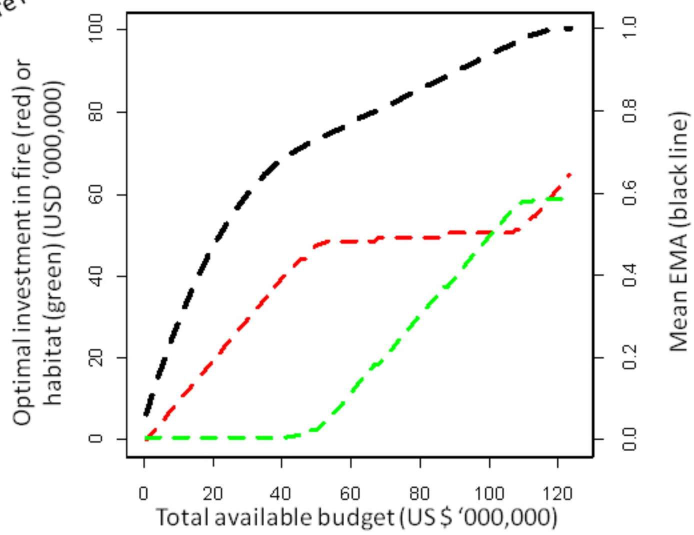


Figure 2: The top left plot shows how the species' expected minimum abundances (EMA) varies with the proportion of habitat protected and fire return interval (FRI). The top right plot shows how overall conservation cost varies with habitat protected and FRI. The central plot shows the optimal investment allocation between fire management (red line) and habitat protection (green line) as a function of available budget (axis on the left). The black line on the central plot shows how species' mean EMA (axis on the right) increases as the budget increases.

But will it work in Australia?

So, what does this all mean for Australian species and how we should be managing ecosystems in order to reduce climate-change driven extinctions?

The first point to make is that conservation investment questions faced by managers of the Fynbos are very similar to those faced in Australia and in other parts of the globe. Namely, how should I allocate my limited budget across a set of possible management actions to achieve the best conservation outcome?

The Fynbos Biome is known as a 'Mediterranean' climate ecosystem, similar to ecosystems in Australia, including the biodiversity hotspots in south-western Australia. The impacts of climate change on fire dynamics and how those changes will impact Australian species are important questions that are currently being addressed by a number of Australian scientists. We hope to be able to work with these experts to implement the sort of ecological-economic analyses described above.

Although ecological-economic analyses such as ours provide just one of many inputs to real-world decision-making, more widespread application of these approaches will help reduce the politicisation of conservation decisions, thereby enhancing the credibility of those who make them.

More info: Brendan Wintle b.wintle@unimelb.edu.au

Reference

Wintle BA, SA Bekessy, DA Keith, BW vanWilgen, M Cabeza, B Schröder, SB Carvalho, A Falcucci, L Maiorano, TJ Regan, C Rondinini, L Boitani & HP Possingham (2011). Ecological–economic optimization of biodiversity conservation under climate change. *Nature Climate Change* doi:10.1038/nclimate1227

" More widespread application of these approaches will help reduce the politicisation of conservation decisions, thereby enhancing the credibility of those who make them. "

Is climate change really for real?

"The 2007 IPCC report identifies 28,586 independent lines of confirmatory evidence linking recent climate changes to changes in ecological processes and functioning of individual species. Ecologists, biologists, meteorologists, modellers, geographers, social scientists, and geologists have provided more than enough evidence for us to be getting on with the adaptation process. Given that agricultural harvests are likely to decline, birds are changing their ranges, pygmy possums are dying of thirst on hot dry mountain tops, we need to act quickly to identify and examine potential solutions.

Don't be the 28,587th person to confirm the likely impacts of climate change on biodiversity – be one of the first to identify robust and efficient solutions to the problem."

Brendan Wintle, *Decision Point #25,* in an editorial on what environmental decision theory has to offer conservation in a time of climate change. (Good background reading on the study he's presented in this issue.)

INFFER – seven steps to better decisions

A better bang for your environmental buck

INFFER team members discuss the protection of environmental assets with landholders in North Central Victoria . (Photo by Geoff Park)

By Geoff Park, Jennifer Alexander, Anna Roberts and David Pannell

It's a challenge faced by environmental organisations around the world: How do you get the best and most needed results from the limited resources available? At the same time, governments that provide most of the funds to these organisations want to know which projects will deliver the most valuable environmental outcomes. Usually they lack the information needed to make these decisions.

This is why INFFER (Investment Framework for Environmental Resources) was created. It enables environmental managers to set clear priorities and develop robust, compelling project proposals; and investors to assess project proposals based on effective, relevant criteria that simplify decision making.

Everyone involved in protecting the environment wants to make the best use of the money that's available, but the issues involved in this decision process are complex and multi faceted. What does 'best' actually mean? The development of INFFER was motivated by a belief that we could achieve a lot more with the available resources if projects are well designed prior to the allocation of investment.

So how does it work? INFFER consists of a seven-step process which begins by identifying the things you want to invest in.

Step 1: **Identify significant assets:** A list of significant natural assets that are candidates for investment is prepared. These assets can be drawn from existing documents or lists, from community workshops, from relevant experts, or from analytical processes, such as systematic conservation planning.

"The development of INFFER was motivated by a belief that we could achieve a lot more with the available resources if projects are well designed prior to the allocation of investment."

Step 2: **Filter the list:** Using a simple set of criteria, the list of significant assets is filtered down to around 20-40 assets. Our suggested approach is to identify assets of high significance that are currently under threat or are suspected to become under threat in the future.

Step 3: **Develop projects for each asset:** Using the INFFER Project Assessment Form, develop an internally consistent project for each asset on the reduced list. This process draws together readily available information (publications and reports), and involves consultation with the community and with relevant experts. It may also draw on purpose-conducted modelling, if available. Information required includes: asset significance, threats, project goal, works and actions, time lags, effectiveness of works, private adoption of actions, delivery mechanisms and costs.

Step 4: **Select priority projects:** Select a short list of priority assets/projects based on the information in step 3 with other relevant considerations.

Step 5: **Create investment plans or funding proposals**: Develop investment plans or proposals for external funding.

Step 6: **Implement funded projects:** Implement those projects that receive funding. In many cases, the first stage of a project should consist of a detailed feasibility investment, involving targeted collection of additional information to strengthen the assessment done in step 3.

Step 7: **Adaptively manage:** Monitor, evaluate and adaptively manage projects. After feasibility assessment, and at regular intervals thereafter (say every two years), the data in the original Project Assessment Form for each funded asset/project should be updated to reflect lessons learned, progress towards outcomes, and any new data or analysis that has become available.

The first version of INFFER was completed in 2008. Since then, many regional environmental groups, state agencies, conservation organisations and researchers have trialled and/or used it, with the list continuing to grow steadily. Of Australia's 56 regional environmental management bodies, 21 have used or trialled INFFER, or are currently trialling it. Some have just done some training and a quick trial, completing a small number of Project Assessment Forms, while others have adopted INFFER comprehensively.

Internationally INFFER and its components have been applied in Canada, Italy and The Netherlands, with interest from other countries, including China and New Zealand.

How is INFFER different?

INFFER has some similarities to other decision processes being used by landscape managers. However, INFFER includes a number of important elements that generally are not included in most commonly used environmental decision frameworks. Our experience (and analysis) shows how these additional elements make an enormous difference to environmental outcomes.

To begin with, INFFER includes a much broader range of information than most environmental decision processes. We have found that decisions are often made without accounting for crucially important information. For example, two of the most important determinants of the cost-effectiveness of an environmental project are (a) the effectiveness of the on-ground works and actions (ie, the cause and effect relationship between actions and outcomes) and (b) the adoptability of the required works and actions for relevant land and water managers (ie, to what extent will the required works and actions be adopted?). Both of these things are commonly left out or included in a weak way. If effectiveness and adoptability are

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One of the swamps making up the the Moolort Plains wetlands. (Photo by Geoff Park)

INFFER delivers to the Moolort Plains wetlands

This complex of around 50 ephemeral wetlands is located in the Victorian Volcanic Plain bioregion in the North Central CMA region. Almost exclusively on private land these magnificent wetlands have been identified as one of the most significant environmental assets in the North Central CMA Region. An INFFER assessment was conducted using the Project Assessment Form prior to submission for funding to examine if a robust and cost-effective project could be developed.

The assessment led to a management and restoration strategy using buffer fencing; invasive plant and animal control; facilitated regeneration and revegetation; and the development of in-perpetuity management agreements. Along with the North Central CMA, a number of key stakeholders were consulted and agreed to be involved including the Moolort Landcare Group, Trust for Nature, Birds Australia and the Shires of Mount Alexander and Central Goldfields.

In September, the Australian Government announced funding of $919,000 for the project as part of the Australian Government's Caring for our Country initiative. This makes it the third largest single investment nationally from this funding round.

Damian Wells, CEO of the North Central Catchment Management Authority, had this to say about the process: "INFFER has helped the North Central CMA move to investing in spatially explicit assets. It has encouraged a culture of being explicit about what we value and why we value it. More importantly it has forced us to be more disciplined about the threats at play and be 'hard-nosed' in our assessment as to whether we can mitigate these threats. It has helped us to develop more considered business cases and it has enhanced our 'due-diligence' in relation to investment decisions."

INFFER - seven steps to better decisions

Continued from page 7

not properly considered, then the results of the prioritisation will be essentially random.

It is one thing to collect the relevant information to assess a project, but it is also necessary to combine the information in a way that provides an accurate picture of the relative merits of different projects. The INFFER approach is based on the calculation of the benefit: cost ratio for each project that is assessed in detail (see the box on the toolbox). Most other processes that prioritise environmental projects do not achieve this. They rely on a weighted additive formula that is not consistent with economic theory and logic.

INFFER allows systematic comparison of investment options across all types of environmental and natural resource issues, not just within any one category (such as biodiversity). It also allows comparison of large and small projects, and of short-term versus long-term projects. All of these comparisons are made in terms of the benefits generated per dollar invested. Other systems are not designed in a way to validly allow this degree of flexibility.

We have observed that many projects are hampered by the use of inappropriate policy mechanisms, so we developed a unique tool called the Public: Private Benefits Framework. INFFER includes this tool to provide guidance on the most appropriate class of policy mechanism to use in the project being assessed (positive incentives, negative incentives, extension/information, technology development, or no action).

And INFFER embeds all the above elements in a well-structured seven-step process. The early stages are designed to ensure that the process is efficient – they identify a large number of potential projects, and filter them using relatively simple criteria. This avoids the need to do time-consuming evaluations of a large number of projects. The middle stages are about detailed assessment and decision making, and the latter stages are about implementation, monitoring and adaptive management.

Training and support

Training in the use of INFFER is recommended so that users can get the maximum benefits from the framework with the least effort. A comprehensive training program was developed in partnership with the New South Wales Department of Industry and Investment, and funded by the Future Farm Industries Co-operative Research Centre. The training can be tailored to different audiences and organisational requirements.

A key feature of INFFER is the 'help-desk' support provided to users by a small interdisciplinary team. The team is dedicated to providing comprehensive support in the form of review and feedback on project assessments as well as advice and assistance with asset identification and filtering.

While INFFER is a comprehensive and rigorous process, its structured and systematic approach mean that it is an efficient investment of time. It can, in fact, save time when users become familiar and confident with the process.

The INFFER website www.inffer.org provides access to all aspects of the Framework including relevant tools (PAF, BCR, etc), publications and case studies.

More info: Geoff Park Geoff.Park@nccma.vic.gov.au

Reference

Pannell DJ, AM Roberts, G Park, J Alexander, A Curatolo, & S Marsh (2012). Integrated assessment of public investment in land-use change to protect environmental assets in Australia. *Land Use Policy* 29: 377-387.

The INFFER Toolbox

Central to INFFER are the following three tools

Project Assessment Form (PAF)

The PAF is an on-line web-based application. In the PAF, a specific project is developed and assessed in detail. Users enter information about the changes or improvements they plan to achieve for the natural asset in question, the works that need to happen to create those changes, the people who need to be involved, what the anticipated levels of stakeholder support for the project are, the types of delivery mechanisms that will be used to garner the needed levels of participation, and how much the project will cost.

Public: Private Benefits Framework

This is a simple framework to guide the choice between policy mechanisms. The policy mechanisms are in five categories:

- **positive incentives** (financial or regulatory instruments to encourage change)
- **negative incentives** (financial or regulatory instruments to inhibit change)
- **extension** (technology transfer, education, communication, demonstrations, support for community network)
- **technology change** (development of improved land management options, such as through strategic R&D, participatory R&D with landholders, provision of infrastructure to support a new management option), and
- **no action**

The choice among these mechanisms depends on the levels of public net benefits and private net benefits from the land-use changes being proposed.

The Benefit Cost Ratio (BCR)

Comparing the relative merits of projects of different scales, durations and asset types has always been a challenge for managers of natural assets. INFFER's Benefit: Cost Ratio (BCR) has been designed specifically to solve this problem. It reveals which environmental projects would produce the most valuable outcomes per dollar spent. In the formula for the Benefit: Cost Ratio, the benefits index is divided by total project costs (including subsequent maintenance costs, if relevant) to calculate the expected level of benefits per dollar spent. This allows us to compare the merits of projects of different scales and structure. The BCR is broadly consistent with the "Project Prioritisation Protocol" devised to help allocate funds for the management of threatened species (see *DPoint #29*) although the BCR is more detailed and includes more elements.

About the authors: *Geoff Park is a knowledge broker with the North Central CMA, Anna Roberts and Jennifer Alexander are based in the Victorian Department of Primary Industries and David Pannell is Professor and Director of the Centre for Environmental Economics and Policy at the University of Western Australia. All four are passionate about empowering NRM policy makers and managers to make better decisions, which motivated them to develop INFFER in association with the Future Farms Industries CRC. Geoff and David are also now working with the EDG.*

Conservation, in theory

(What about in practice?)

By Don Driscoll (EDG, ANU)

Since its emergence as a distinct field in the 1980s, conservation biology has developed a profound and debilitating paradox. On the one hand, ecological theory is deeply embedded within the field, and is applied directly or indirectly in conservation decision-making. On the other hand, most papers published in conservation journals make little or no use of theory. Ecological theory is being used for making resource-management decisions, but applied ecologists most often report research as though theory does not exist.

This is a problem. If only a few applied ecologists are working to develop theory, then the theory supporting decision-making will improve at a slow pace, if at all. At the same time, conservation challenges facing land managers continue to increase. Decisions must be made in the context of the global biodiversity crisis, made worse by climate change, increasing population and demand for resources.

For ecologists to provide information and guidance we need theory to perform three critical functions:

- **to predict** the consequences of management interventions,
- **to plan and frame** research that addresses the most important conservation and ecological questions, and
- **to communicate** our research results to one another effectively.

Unfortunately, theory is currently failing in all three of these areas.

On being predictive

While theory can be used effectively in empirically verified, local case studies, substantial evidence spanning two decades demonstrates that ecological theory has very limited general predictive capacity.

Predictions based on popular theories such as metapopulations, metacommunities, island biogeography and the intermediate disturbance hypothesis have been found wanting when challenged with field data. Despite this lack of predictive capacity, theory is frequently applied in conservation and land management with the implicit assumption that predictions from theory provide a reasonable guide for management. Assumptions about connectivity, metapopulation dynamics, and patch-matrix landscapes are common in tools for landscape planning and reserve design. Ecological theory also underlies many scenario-planning approaches in ecology, and these are widely applied in environmental planning.

Don Driscoll (on the left) questions the value of conservation theory in guiding management.

With weak predictive capacity, the application of theory in conservation can lead to management mistakes. A classic example of this comes from north-western USA, where forest logging options were identified on the basis of population viability analysis (PVA) of the Northern spotted owl *Strix occidentalis caurina*. Subsequent scrutiny of the models in court revealed the metapopulation assumptions of the PVA were poorly supported. Management based on theory was deemed to be a substantial threat to the Northern spotted owl.

In Australia, things are no better. Proposed use of the intermediate disturbance hypothesis to guide fire management in Booderee National Park would not have increased species richness. Forest management in Australia has used indicator species concepts but these often fail to accommodate most other species requirements. Development planning in already fragmented landscapes have used island biogeography principles to assess the value of remnant vegetation. Such applications of theory have lead to clearing of small remnants, even though small remnants maintain elements of biodiversity that large remnants do not. No doubt there are other cases of policy development based on theory that have a high risk of failure because the assumptions built into the theory do not apply to the system that is subject to the policy.

On framing research

Ecological theory should also play a pivotal role in setting up research questions. Research framing and planning is a useful role for theory and there are many examples in the literature attesting to the useful role of, for example, metapopulation theory in guiding research questions. However, such an approach can also have a dark side. Much theory is conceptually narrow, and this constrains the design of experiments, limiting the scope of questions that are asked and the approaches that are taken.

For example, the popularity of island biogeography theory constrained much research to questions about the influence of patch size on species richness, but these questions often have limited relevance in conservation. Working within the conceptual domain of island biogeography prevented a focus on other questions that are important for conservation, particularly about how species use the matrix, habitat loss, fragmentation and causes of extinction. More rapid research progress is likely when a broad conceptual framework is used for guiding and interpreting research rather than a narrow focus on particular theory.

And on communication

While theory can fail in its predictive and planning roles at the beginning of the research cycle, theory should nevertheless be useful towards the end of the cycle as a communications tool. But theory performs poorly here as well for two key reasons.

First, effective communication can be confounded by poorly defined terms or conflicting definitions. One example is the indicator species concept which can refer to using particular taxa as surrogates for environmental change, but can also simply refer to the species that is measured without assuming that the species provides additional insight into the state of the ecosystem.

A second reason that theory struggles to serve an ideal communications role is that there is massive redundancy, with multiple theories that describe the same phenomenon. Different streams of theory can develop in isolated 'ivory publishing towers', insulated by separate sets of key-words and particular applications.

Conservation, in theory

Continued from page 9

Among the most gob-smacking examples of reinventing the wheel are ecological stability concepts; there are only six different stability phenomena, but Grimm and Wissel (1997, Oecologia 109: 323-334) nevertheless identified 163 definitions for 70 different stability terms. Instead of standing on the shoulders of giants, this redundancy in ecological theory provides small opportunity for gaining a vantage point from previous research.

Being of value

What are the solutions to these failings of ecological theory in conservation? We suggest three important steps should be considered:

1. Better define the predictive capacity of theory, and therefore better identify appropriate applications by: publishing reviews that define contingent theory, refining existing theory and providing support for decision-making.

2. Guide research planning and framing by: encouraging applied ecologists to use a broad checklist of phenomena when planning new research to avoid the narrow heuristic value of individual theories.

3. Enhance communication among scientists by: developing and updating a stream-lined set of theory from which redundant theory has been purged, and for which a set of key-word definitions are developed.

The latter point is only likely to come about with the development of a new global collaborative institute that can provide a centralized and authoritative repository and access point for peer reviewed definitions and theory purged of redundancy. Models for this kind of international cooperation among scientists exist in the International Nucleotide Sequence Database Collaboration or the Collaboration for Environmental Evidence.

An international collaboration would enable existing theory to be elaborated, refined, or overthrown where necessary, and ensure that only truly new ideas made it into the revised and rationalized theory. It could provide a forum for debating and updating definitions of ecological terms.

Importantly, with a single repository for theory, all ecologists would know where to access the most up-to-date ecological theory and definitions, and would have a framework for selecting an appropriate theory that describes their case study. Case studies would subsequently be readily discoverable in science data-bases through shared key words, accelerating our global capacity to develop contingent theory.

A central repository for theory and definitions would also be a valuable new source of credible and salient information for application in conservation policy development and land management. No longer would land managers have to draw on their (perhaps long past) undergraduate training for digging out concepts that might help them make decisions. The most up to date thinking would be available, including the latest insights into when ecological theory might apply in practice.

Implementing the framework we've detailed in *Ecological Monographs* (Driscoll & Lindenmayer, 2011) would help to avoid management mistakes and increase the capacity of ecologists, policy makers and land managers to rise to the challenges of biodiversity conservation in the face of global change.

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Reference

Driscoll D & DB Lindenmayer (2011). Theory in ecology and conservation, a framework to improve the application of theory in ecology and conservation. *Ecological Monographs* DOI: 10.1890/11-0916.1

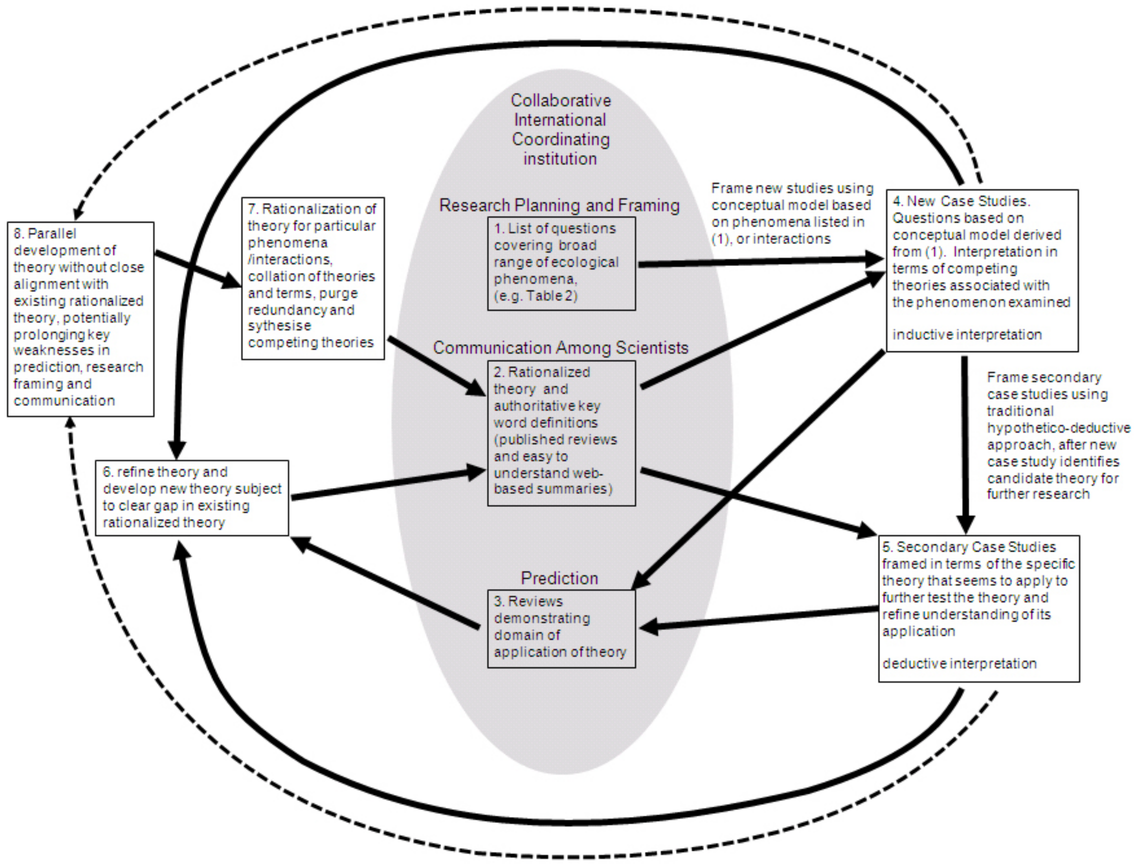

Figure 1. Model of how solutions to the three key areas in which theory often fails can be incorporated into research.

> "Despite this lack of predictive capacity, theory is frequently applied in conservation and land management with the implicit assumption that predictions from theory provide a reasonable guide for manage-ment."

Behind the paper

It's a funny thing but sometimes a good idea doesn't have scientific validity until it's appeared in a scientific journal. Well, maybe it's not funny because going through a rigorous peer-review process means the idea has been tested and judged worthy by people who should have expertise to know. It can also sharpen the thinking behind the idea and improve the product. But, as everyone who has submitted papers for review would attest, it's often a frustrating and time-consuming process. Take the paper on INFFER in the journal *Land Use Policy* (the paper and the INFFER framework is described on page 6). It's being used around the country and overseas with demonstrable success but it took three years to get into the journal of the author's choice. Was it worth the effort? According to David Pannell, its lead author, it was.

Publishing persistence

If it's important, it's worth the effort

By David Pannell (EDG, University of Western Australia)

Sometimes getting a research article published in a peer-reviewed journal requires a high degree of persistence. I've found this to be particularly the case for some papers that are a bit outside the mainstream.

When trying to publish a research paper, the best one can usually hope for is for the editor to require changes to the paper in response to reviewer comments, which one duly makes, and, after some further too-ing and fro-ing, the paper gets accepted. The reviewers' comments might be anything from insightful and helpful to annoying and irrelevant, but whatever they are, we aim to go through this process.

But some papers are much harder to get accepted. I've just had this experience with the paper that describes the work we've done developing and applying INFFER (the Investment Framework for Environmental Resources). This is a really important paper to me – one I've got a lot more staked on than most. I think it's the most important and valuable work I've ever been involved in.

Catchment stakeholders draw up a list of environmental assets for consideration in the INFFER process. INFFER is scoring well on the ground but its creators wanted the framework to be available in the scientific literature - easier said than done. (Photo by Geoff Park)

"When it comes to publishing, persistence is crucial, but obstinacy is foolish."

But the paper is a bit unusual. It doesn't quite fit the mould of a standard environmental economics or policy paper. We set out to describe the framework in detail, in much the same way as computer models are often described in journals like *Agricultural Systems*. But this proved to conflict with the expectations of reviewers in the journals to which we submitted the paper.

We first submitted it to *Land Use Policy*. The first comment of reviewer 1, in response to the question, "Does the paper represent a contribution to knowledge?", was "Not particularly"! Not surprisingly, the paper was rejected.

So we tried a different journal: *Environmental Science and Policy*. The editor there didn't even want to send the paper out to reviewers. He was interested in the topic, but not in a paper of this style.

Next we went to Journal of *Environmental Management*. Again the reviewers didn't like it. Reviewer 2 started by saying "I am not sure how to review this paper" and later said "this paper doesn't really belong in the scientific literature".

By now, we were getting the message! There was nothing in any of the reviews saying that there were problems with INFFER, but the style of the paper was clearly a problem.

So we re-wrote it from scratch, putting more emphasis on the results of applying the framework, while still including enough description of INFFER for the paper to serve as its main reference. We sent this new paper to *Land Use Policy*, which is where we wanted to publish INFFER in the first place.

I was happy and relieved when, after some positive reviews and minor revisions, the new version of the paper (Pannell et al., 2012; see page 6 in this issue of *Decision Point*) was accepted.

This all shows that, when it comes to publishing, persistence is crucial (Pannell, 2002), but obstinacy is foolish. You have to be prepared to adapt a paper to suit the preferences of reviewers and editors. In this case, I'm even willing to concede that the modified paper is better than the one we started with.

We started writing the original paper in November 2008, so it took almost three years from go to whoa. That's plenty long enough, but it's only about half as long as one of my other papers on perspectives on risk in farm modelling. See Pannell (2002) for the full, sorry story of that one. And yet that problematic risk modelling paper ended up being widely read and highly cited. Hopefully the new paper on INFFER will turn the tables on reviewer negativity in a similar way.

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References

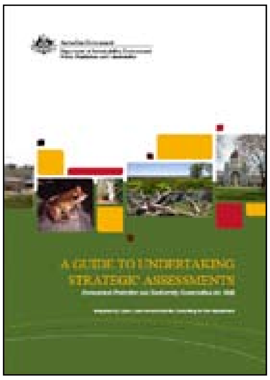
Pannell DJ (2002). Prose, psychopaths and persistence: Personal perspectives on publishing. *Canadian Journal of Agricultural Economics* 50: 101-116.

Pannell DJ, AM Roberts, G Park, J Alexander, A Curatolo, & S Marsh (2012). Integrated assessment of public investment in land-use change to protect environmental assets in Australia. *Land Use Policy* 29: 377-387.

Dbytes

Infomation, resources & opportunities for decision makers

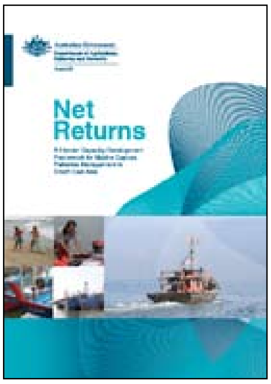
A guide to strategic sssessments



Released by SEWPaC, this guide explains the process of strategic assessments (undertaken at a landscape scale).

http://www.environment.gov.au/epbc/publications/pubs/guide-to-strategic-assessments.pdf

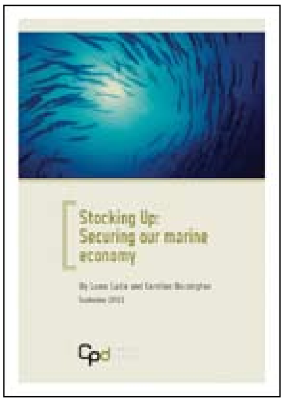
Net returns - marine capture fisheries management



DAFF released a report to help guide future strategies to fight illegal, unreported and unregulated fishing in South East Asia.

http://www.daff.gov.au/fisheries/international/cooperation/issues

Stocking Up: Securing Our Marine Economy



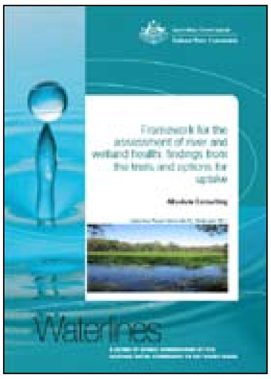
Stocking Up assesses the economic value of Australia's oceans and finds:

-Our oceans provide an unrecognised $25 billion in value every year to our national economy

-The value of sustainably managed Australian fisheries could increase by 42% over 20 years if global fish stocks collapse.

http://cpd.org.au/2011/09/stocking-up/

Framework for river & wetland health



This framework can be used to compile a consistent and comparative picture of river and wetland health across Australia.

http://www.nwc.gov.au/www/html/3142-waterlines-58.asp?intSiteID=1

What's the point?

Nestlings of Newstead

A clutch of six baby eastern rosellas in a tree hollow near the Newstead Racecourse near Bendigo, Victoria, in October. Photo by EDG member Geoff Park, and spotted by Newsteadians Ros Hart and Dave Stratton. It's part of the blog called *Natural Newstead* that follows the natural history of this region and is highly recommended for it's superb bird photography. Check it out for yourself at http://geoffpark.wordpress.com/

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.

Decision Point is written and produced by David Salt. If you have news or views relating to anything you see in ***Decision Point*** or of interest to EDG members, please send them to David at David.Salt@anu.edu.au

Decision Point is available free from: http://ceed.edu.au/dpoint-news/

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