DECISION POINT

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Connecting conservation policy makers, researchers and practioners

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DECISION POINT

Decision Point is a monthly magazine presenting news, views and ideas on environmental decision making, biodiversity, conservation planning and monitoring. It is produced by AEDA – the Applied Environmental Decision Analysis CERF Hub. For more info on AEDA, visit our website at www.aeda.edu.au or see the back cover.

Other stories

Climate change and decision theory

How can we help?

By Brendan Wintle (Deputy Directory, AEDA)

Things will happen this year that will have a huge impact on the way the Australian environment is managed. Climate change will be high on the agenda, and almost everybody in conservation and ecological research will be doing or thinking about some aspect of climate change research (Morton et al, 2009). In the coming years, the world will be looking to decision scientists to help prioritise actions on climate adaptation. Researchers have done a good job of convincing the world that climate change is happening; now it's time for the hard part – figuring out what to do about it.

Climate change sceptics are wrong. The people who's opinion matters believe that climate change is happening and those who don't probably still won't even when the ocean is lapping at their letter box. 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 safely getting on with the adaptation process... without looking like we're being too hasty! 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.

Prudent investment in adaptation requires systematic evaluation of potential actions so that we can settle on an efficient and robust strategy for minimising climate change impacts on biodiversity. For this reason, 2009 should be the year of the decision scientist. Here's how I think we can help:

1. Setting clear objectives

Identifying the most efficient and robust climate adaptation strategies will require clarity. What is it that we specifically hope to achieve with investment in climate change adaptation? When thinking about what a specific objective should look like, it's prudent to consider how progress toward the objective might be measured. If a measure of performance cannot be identified, then it is likely that the objective is under-specified.

For example, if the objective was to "maximise the resilience of rural landscapes", a measure of resilience would need to exist in order to be able to discern between management options. We would need to be able to answer the question; "which action will confer the greatest increase in resilience given my limited budget?".

Alternatively, if the objective was to "minimise the predicted number of vertebrate species extinctions in the region over the next 40 years", then a performance measure of the net predicted probability of extinction (across, say, all known vertebrates in the region) could be used to discern between competing strategies of adaptation.

Reducing emphasis on conserving species and increasing emphasis on conserving ecological processes is very popular among scientists and policy makers. The intuitive argument that conserving processes is likely to conserve species (and other ecosystem services) is appealing. However, in order to choose between competing management options, it's necessary to identify which processes are to be emphasised and how they will be measured so that the management option(s) that maximise 'process' can be chosen.

2. Making predictions about the benefits of potential management responses.

Many ecologists argue that climate-proofing biodiversity is probably best achieved by managing known, existing threats such as feral predators, invasion of weeds, habitat destruction, habitat degradation via inappropriate grazing and burning regimes. This might be achieved via a number of general approaches including regulations, incentives, or other public investments. Proactive measures such as translocations (see *DPoint* #17, p2; #22, p22), and habitat and connectivity restoration must also be considered. Moreover, because many species are threatened by more than one threatening process, each of which may be addressed in several different ways, managers and policy makers will be forced to choose between a very large set of possible actions.

There are likely to be many more possible actions than we have enough money to fund, so which actions should be funded? Presumably, we would like to fund the actions that are likely to bring the greatest benefits (in terms of, say, "net persistence of vertebrates in the region") for the lowest cost. However, as Nils Bohr points out: "prediction is hard, especially if it's about the future". Our future includes climate change, and predictions about the efficacy

"Prudent investment in adaptation requires systematic evaluation of potential actions so that we can settle on an efficient and robust strategy for minimising climate change impacts on biodiversity. For this reason, 2009 should be the year of the decision scientist."

Climate change and decision theory (*Cont. from p2*)

of potential biodiversity investments must consider how climate change may interact with existing threats and thwart restorative efforts.

Given the range of synergies, uncertainties and possible actions, it will be very difficult to make good decisions about best approaches to climate adaptation in even the most experienced, expert heads. That's where models come in. Models help us deal with complexity, help us communicate what we're thinking to other people, and ultimately confer transparency and coherency to decisions if they are constructed well and used carefully.

There are very many models out there that attempt to predict the impacts of climate change on aspects of biodiversity, each with its uncertainties and its critics. Indeed, models have been central to the argument that climate change is happening and biodiversity will be extensively affected. However, the models that demonstrate likely impacts of climate change are not necessarily the same as the models that would be most useful in helping us prioritise adaptation actions.

There are a number of things that need to be considered when constructing a model that will allow us to predict the relative benefits of competing climate adaptation actions. First, they should model a dependent variable that is proximal to our objective and performance measure. For example, if the objective of a particular climate adaptation investment is to "minimise the predicted number of vertebrate species extinctions in the region over the next 40 years", then models that predict the extent and distribution of suitable habitat for a range of species only partly address the actual objective. Habitat is only part of the persistence story, albeit an important part!

If the objective is to maximise persistence, then a model that explicitly predicts persistence probabilities under a range of management scenarios will be the most useful decision tool. Of course, it won't be practical to develop detailed persistence models for all species of interest, so there will need to be a number of difficult (social) choices made about which species to focus on.

3. Methods for setting investment priorities

Prioritising actions is complicated. Even simple problems like, "should I go for an uncertain, but possibly large benefit, or a certain but probably small benefit" are not easily addressed without a clearly articulated objective and a formal decision theory. There is literally hundreds of years of decision theory literature to help with such problems(eg, Bernoulli 1738, Pascal 1670, Keynes 1921). Simple cost-efficiency or cost-utility analyses allow us to represent the expected gain arising from an action per dollar spent and could form the basis of a coherent decision strategy for prioritising climate adaptation actions.

AEDA researchers Liana Joseph and Hugh Possingham, in collaboration with conservation practitioners in New Zealand, have utilised cost/benefit analysis to prioritise spending on threatened species recovery projects. The structure of the decision process could be generalised to

Modellers and their models

Modellers and their models will be important in the process of managing ongoing impacts on biodiversity, however, they (we) should be cognisant that the model and its predictions are not the decision in and of themselves; they are part of a bigger decision process. Models that are built in isolation or at arms length from the decision makers are likely to be at worst irrelevant, or at best much less useful than they could have been.

> "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!"

prioritise climate adaptation investments by calculating the efficiency of each option as:

$$E_i = \frac{\sum (b_j * p_j)}{c_i}$$

where E_i is the efficiency of action i, b_j is the expected benefit to species j of action i (in terms of, say, change in expected minimum population size over the next 40 years, compared with doing nothing), and p_j is the probability that this benefit will accrue, and c_i is the cost of action i.

Simple cost-efficiency approaches to prioritising climate adaptation actions could provide increased rigour and transparency without requiring overly complicated analysis and modelling.

4. Coping with uncertainty

All of the models we use to predict the impacts of climate change (and the mitigating benefits of management actions) will be subject to substantial uncertainty. Uncertainty is pervasive and much of it is irreducible – that's just the way it is.

Models provide an excellent format for exploring the magnitude and importance of various sources of uncertainty. By expressing uncertainty about all of the assumptions underlying a model prediction, we are able to explore both the extent to which particular assumptions influence model predictions and the extent to which that uncertainty impacts on the choice of best course of action.

Simple sensitivity analyses can be used for this process. Assumptions that are shown to be highly influential on model predictions and the decision process represent ideal research priorities and should be the focus of monitoring efforts aimed at reducing uncertainty. Irreducible uncertainty cannot be resolved by research or monitoring. The challenge facing decision makers is to find a way to make decisions that are robust to such uncertainty. This is a space in which decision theorists can most effectively contribute to policy on adapting to climate change.

An appropriate new years resolution for AEDA researchers would be to make a greater effort to simplify our decision tools and make them more accessible to the broader community of managers, policy makers and conservation scientists so that they're actually used in climate change adaptation.

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Measuring 'true' conservation progress

Injecting a little 'honesty' into environmental reporting

If you were deciding whether to buy a business, would you be more interested in knowing its revenue or its net profit? It sounds like a dumb question because revenue tells you little about the value of the business if you have no idea about its costs. And yet this is exactly how we report on the outcomes of conservation policy where only the gains in reserves are reported and losses are seldom mentioned. AEDA researchers have been examining this issue and their investigation recently appeared in the journal *Science*.

"Reporting both gains and losses is a basic requirement of 'honest' conservation accounting," says Dr Eve McDonald-Madden, lead author on the report. "The current global standard of reporting gains but not losses is unjustified and potentially misleading.

"Given the increasing public awareness of conservation issues and the need for ongoing investment in environmental management, it's worrying that little attention has been given to deriving rigorous metrics for reporting on conservation investments," says McDonald-Madden.

Credible performance measures should connect conservation outcomes to goals for public investment in conservation. Gains and losses must both be presented as an auditable conservation balance sheet, revealing the net benefit of conservation actions and policies reported against losses.

Well known economic indicators - like GDP, unemployment rates, our terms of trade, and interest rates - are readily available to politicians, national economic managers and the public. Surely the environment needs equally well-known indicators of performance, otherwise policy proceeds in a vacuum.

Lead researcher on the analysis, Eve McDonald-Madden: "Governments around Australia, and all over the world, need to get their environmental accounts cleaned up."

The Wentworth Group's document: *Accounting for Nature* represents a national push to gather such credible, transparent and repeatable metrics for environmental management and reporting (See *Decision Point #21, p2*). Given AEDA's obsession with monitoring, it is perhaps not surprising that two AEDA core researchers are also members of The Wentworth Group.

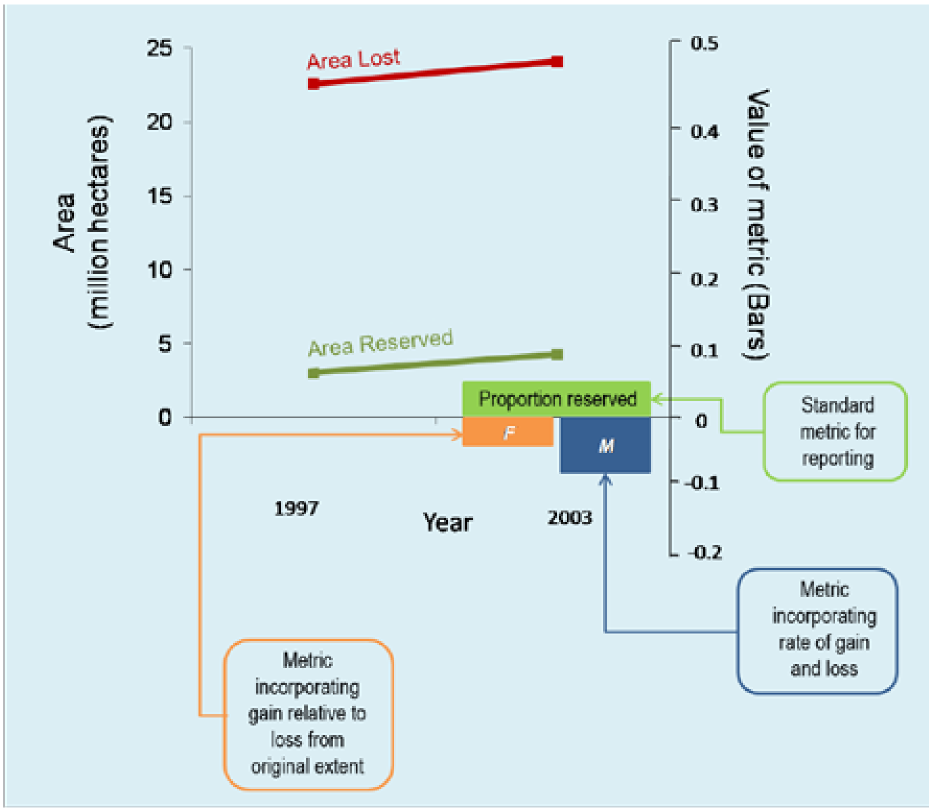
A major performance measurement on conservation in government state-of-the-environment reports is the size of the physical area protected, or the change in area protected. For example, South Africa reported that 6% of terrestrial habitat was contained within protected areas in 1999; in 2001, North America reported an increase in land within reserves over time. However, these numbers provide no information on loss of habitat outside (or inside) reserved areas, or conservation opportunity costs of securing areas for conservation. Even when habitat loss is reported it is rarely possible to evaluate net conservation outcomes.

And it's not that it's too difficult to devise a measure of performance that takes into account gains and losses. The researchers demonstrated this by proposing their own metric and then compared it with traditional reporting methods. They used a case study of land clearing in Queensland from 1997 to 2003 (see Figure 1) and found, with traditional reporting methods, the conservation gains would appear to be small but positive.

"However, when metrics are used that account for both loss and reservation, they tell a markedly different story" says Hugh Possingham, a coauthor on the paper. "They reveal that overall in that period Queensland lost habitats far faster than they were being conserved. Hopefully changes to land clearing laws and a government commitment to expanding the reserve system will show better performance in the next period."

"We're not claiming ours to be the best or only metric that could be developed," says McDonald-Madden. "We

(Above and bottom right of the next page) Land clearing in Queensland: A major performance measurement on conservation in government 'state-of-the-environment' reports is the size of the physical area protected, or the change in area protected. However, these numbers provide no information on loss of habitat outside (or inside) reserved areas.
(Photos courtesy of The Wilderness Society Collection and Barry Traill.)



"GDP, unemployment rates, our terms of trade, and interest rates, are readily available to politicians, national economic managers and the public – surely the environment needs equally well-known indicators of performance, otherwise policy proceeds in a vacuum."

Figure 1: A simple plot showing land reserved and land cleared in Queensland from 1997 to 2003. With traditional reporting methods, the conservation gains would appear to be small but positive. However, when metrics are used that account for both loss and reservation, they reveal that overall in that period Queensland lost habitats far faster than they were being conserved.

"True" conservation progress

(Continued from p4)

merely aim to demonstrate that honest reporting is possible, and can be simple and informative. We also show that the current global standard of reporting gains, but not losses, is unjustified and potentially misleading.

"In failing to mention the losses and opportunity costs of conservation investments, agencies reporting on conservation achievements are disclosing revenue rather than net profit, and are being economical with the truth. An auditor from the financial sector would be appalled. Governments around Australia, and all over the world, need to get their environmental accounts cleaned up."

This research emerged from an AEDA workshop in 2007 that joined AEDA staff with scientists from the New Zealand Department of Conservation. It has far-reaching implications for state of environment reporting in Australia and around the world.

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Eradicating invasive species

Smart decisions using scarce data

By Tracy Rout (Melbourne Uni, AEDA)

Invasive species are a major threat to biodiversity, and if eradication of the pest or weed is possible it's a preferable way to go. But when is an eradication program deemed to be successful? Is it when you simply stop seeing the invasive species?

Of course, our confidence that eradication has been successful increases with each successive survey where the target species is not detected, but that doesn't prove that it's absent. The question is: how confident do we need to be to declare the species successfully eradicated? Making management decisions based on a false assumption of successful eradication can be costly (see the box below and the story on the back page), and such mistakes can have severe environmental impacts. On the other hand, surveys are expensive and you have to stop looking at some point.

Regan et al (2006) recently proposed a way to solve this dilemma: declare eradication when the total expected cost is minimised. They found the stopping time (based on the number of previous consecutive surveys in which the species is not found) that minimises the net expected cost. This is essentially a trade-off between the cost of continued surveying and the cost if eradication is declared when the species is still present (ie, the expected cost of falsely declaring eradication). It's a revolutionary approach, and

Getting it wrong can be a bitter pill to swallow

How might this work in the real world? We applied the method to the eradication of *Helenium amarum* (bitterweed) in Queensland, the same case study used by Regan et al (2006). Bitterweed is toxic to stock, and if ingested causes vomiting, diarrhoea, and production of bitter undrinkable milk. It was first found in Queensland in 1953, and an eradication program began in the same year.

After 3 years of herbicide and manual removal, only isolated patches of plants remained. The 9 surveys carried out between 1988 and 1992 did not detect any plants, and the weed was declared eradicated. Regular surveys for the weed were stopped.

Years later, in March 2007, a small infestation of bitterweed was discovered at the site of original occupancy, and control activities were re-instigated (and are still being applied).

Figure 1 shows the net expected cost (NEC) of declaring bitterweed eradicated as a function of the number of consecutive surveys without detection (d). As you can see, declaring bitterweed eradicated after only a few surveys has a very high expected cost. This is driven by the cost of falsely declaring eradication, which is the cost of impact of the species. However, declaring bitterweed eradicated after many surveys also has a high cost, due to the cost of surveying. Using only the sighting data of bitterweed, we found that declaring it eradicated after 13 surveys without detection gives the lowest expected cost. This is more than the 9 surveys that occurred before eradication was declared in 1992.

So how do our results, which use only sighting data, compare with the results of Regan et al (2006), which used a more complex model? They're a little hard to compare directly because of different assumptions: Regan et al (2006) assumed surveys occurred annually. They found that the optimal time to declare bitterweed eradicated was after 3 years without detection, which is less than the 5 years without detection before eradication was declared.

Figure 2 shows the probability that bitterweed is still extant as a function of the number of surveys without detection (d). The solid grey line and dotted line are calculated using the methods from Regan et al (2006), where the grey line is from the rule of thumb and the dotted line is from the more precise stochastic dynamic program. Both of these methods assume surveys are conducted annually, so d surveys without detection is the same as d years without detection. The solid black line and dashed line are calculated with sighting data methods, with different assumptions about population trends. The solid black line assumes the bitterweed population is constant throughout the sighting period, whereas the dashed line assumes the population is declining. As you can see, the methods using sighting data generate much higher probabilities than the methods used by Regan et al (2006), which explains the difference in optimal decisions.

So the results are different, but which one is right? The large difference in results is most likely driven by the assumption of annual surveys. For bitterweed, the assumption of annual surveys doesn't hold true, which makes the sighting data method more appropriate for this species. The sighting data method is also the best option for species where data on detectability and seed bank persistence is either unavailable or unreliable. For species where this data is available, a more detailed model (either that of Regan et al or a custom model) could be used to calculate the probability of presence, and then find the decision with the lowest expected cost.

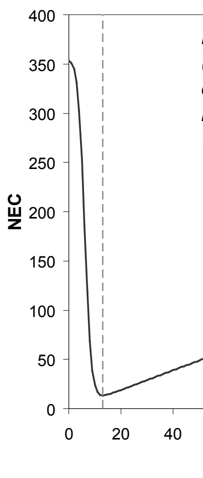

Figure 1. The net expected cost (NEC) of declaring bitterweed eradicated as a function of the number of consecutive surveys without detection (d).

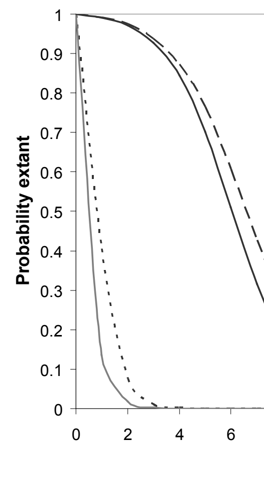

Figure 2. The probability that bitterweed is still extant as a function of the number of surveys without detection (d), calculated with four different methods.

A bitter bouquet: Bitterweed (also known as bitter sneezeweed) has been a noxious weed in Queensland for over fifty years. After many years of attempting to eliminate it followed by several years of monitoring, in which it was not detected, the weed was declared eradicated – only to turn up several years later (see the box on page 6). Another example of premature eradication is on the back cover of this issue.

Eradicating invasive species

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the first decision-theoretic method for determining when to declare eradication of an invasive species. But it has a weakness: the model they created requires parameter estimates that may not be available (or reliable) for many invasive species.

So, how can we make decisions about declaring eradication when we don't have this detailed information? Working with Yacov Salomon and Mick McCarthy (both from Melbourne University), I set out to answer this question by adapting the method set out in Regan et al (2006) and applying it to cases when the only data available is the presence-absence sighting record of the species. The paper arising from this research is currently in press in the *Journal of Applied Ecology*.

We used methods previously applied to rare threatened species (Solow 1993) to calculate the probability that the invasive species is still present from its sighting record. We trialled two different ways of modelling the sighting record: assuming the invasive species population is constant throughout the sighting period, and assuming it is declining. These assumptions only made a big difference to the best decision when the decline was severe.

We also compared methods of finding the best decision that traded off accuracy and accessibility. The most

"This is essentially a trade-off between the cost of continued surveying and the cost if eradication is declared when the species is still present"

accurate method was stochastic dynamic programming. Unfortunately, this requires mathematical and computer programming skills to implement. However, we compared this with an approximation, which is a simple calculation that can be performed on a hand-held calculator, and we found that the approximation performed well under most circumstances. Therefore the approximation is an accessible tool that can be easily applied by managers running eradication programs of invasive species.

So, it is possible to make systematic decisions on complex problems such as when to declare the end of an eradication program, even with sparse data. In so doing, decisions can be made that are scientific, transparent, and justifiable – everyone's a winner.

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Tracy at work taking measurements in an experimental plot of thistles at Penn State University last year. The seed heads have been bagged so they the seeds can be counted. Thistles are a major invasive weed in many agricultural landscapes.

Desperately seeking engagement

So, you want to inform policy?

We've all heard policy-makers in environment organisations accuse researchers as out of touch, impractical and irrelevant. And then, on the other side of the fence, we've all seen environment management agencies being criticised by researchers in the media, in scientific journals, or in the tea room for ignoring, under-utilising or misrepresenting research findings when formulating or implementing policy. It's been suggested that the criticism of policy-makers by researchers and vice versa is an acknowledgement of their mutual dependence.

How can researchers and policy-makers work together more effectively to narrow the gap between science and policy in NRM? Influencing policy is not a process as easily definable as, say, publishing a scientific paper. Policy outputs appear in a number of forms over a variety of timeframes, and are rarely tracked back to single meetings or workshops. The very process of influencing policy makers is difficult to define. Anyone who thinks it's a rational, linear process probably hasn't tried it.

It's not clear to the researchers which buttons you need to push to best inform policy. It's also not clear to policy makers how to access the best information emerging from the latest research. Back when AEDA was just getting started, our Advisory Board asked that we consider the research/policy nexus and make an effort to answer a number of questions. How can we communicate research discoveries to policy makers and managers at minimal cost? How can we find out what research questions may deliver answers needed by policy makers and managers? What kinds of forum will enable us to engage with each other?

In an effort to explore these issues, AEDA ran a Policy/Research Nexus workshop in February 2008. Policy makers from DEWHA and other organisations spent a morning with a range of AEDA researchers discussing how they each saw the process working. The discussions revealed both common ground and significant differences.

It was agreed that personal relationships and networks were key to effectively influencing the development of policy. Activities that would serve to help foster effective relationships and networks include the creation of policy buddies (ie, researchers nominating policy people they need to interact with on specific topics), having AEDA staff sit in DEWHA and vice-versa, reviewing rewards to researchers for making the extra effort to influence policy (currently there are few), creating mechanisms by which policy makers can alert AEDA researchers to their specific concerns, and contact mapping (ie, figuring out just who is in whose network).

These discussions have now been summarised in a commentary appearing in *Ecological Management and Restoration* (see Gibbons et al, 2008) so everyone can read for themselves what was discussed. Phil Gibbons, lead author on the editorial, has pledged that in future he'll send a copy of the paper to all potential policy collaborators in the hope that they too might make research/policy engagement an important outcome of the collaboration.

If influencing policy is important to you, what are you going to change to be more effective in this arena in 2009 and beyond?

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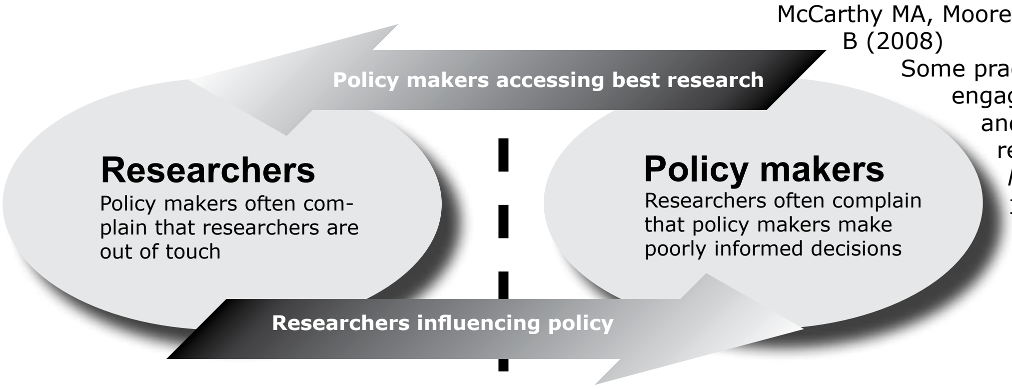


Researchers are motivated by policy activities that:

- generate information they can publish
- generate long-term research activities (eg, post-graduate scholarships)
- have a teaching spin-off (eg, guest lectureship)
- raise their profile (eg, in the media)
- have a demonstrable impact on public policy (eg, they are formally acknowledged in a policy document)
- seek objective knowledge rather than support for an existing position

Policy makers are motivated by research that:

- is relevant for a contemporary issue
- is acceptable to the current government
- identifies practical solutions
- can be used to identify policy options
- is demonstrated to work
- does not attract controversy
- is effectively communicated (eg, succinctly)

A tale of two cultures. Researchers and policy-makers have different reward systems, and this needs to be considered when seeking engagement from one another (from Gibbons et al, 2008).

> "We challenge every researcher, policy-maker and manager in NRM to build one new cross-cultural relationship each year."

A bioregionalisation for the Southern Ocean

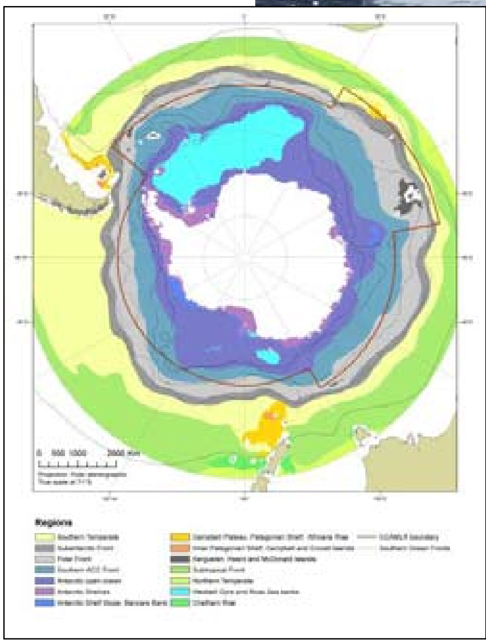
Conservation planning down south

The vast Southern Ocean hosts an enormous and complex marine ecosystem that supports the fisheries of Australia and several other nations. It's also home to many of the major vertebrate species of the Antarctic region (such as whales, seals and penguins), species that depend on the vast Antarctic krill population for food.

Over the last 200 years, animals that harvest krill (such as Antarctic fur seals, humpback and blue whales) have been hunted almost to extinction – which has substantially altered Antarctic marine ecosystems. But compared to other oceans around the globe, this important region remains relatively under-sampled and poorly understood, even through it's internationally acknowledged as a region of great ecological importance.

The Antarctic Climate & Ecosystems Cooperative Research Centre (ACE CRC) Marine Ecosystems Program is exploring relationships among the biological patterns and processes of the marine ecosystem around East Antarctica and relating them to physical oceanographic processes. Its goal is to help guide Australian government and industry decision-makers formulate policy and management strategies concerned with the harvesting of krill and the impacts of future climate change.

Human activities in the Southern Ocean are largely managed through a regional agreement called the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR). It provides a precautionary approach that is ecosystem-based. According to ACE CRC program leader Dr Andrew Constable, our present inability to predict the effects of environmental changes on the Antarctic and Southern Ocean populations makes it difficult for regulatory bodies such as CCAMLR and the International Whaling Commission, to establish sound long-term conservation strategies.



Bioregional map from the report: Grant S, Constable A, Raymond B, Doust S (2006). Bioregionalisation of the Southern Ocean: report of the Experts Workshop, Hobart, 2006. WWF-Australia and ACE CRC.

"We need models that can integrate the small-scale ecological interactions at the level of krill swarms, for example primary and secondary production, and larger-scale regional patterns of key predators such as whales, seals and penguins, with the spatial and temporal dynamics of the sea ice and ocean," says Andrew Constable.

"Without this sort of integration, we're unable to forecast the effects of climate-driven changes to the ocean and sea ice systems on the ecology of the Antarctic marine ecosystems. Nor are we able to predict what the consequences of fisheries might be to the structure and function of those ecosystems."

"For example, while some of the management approaches have taken account of the relationships amongst species (predators and prey) in determining catch limits for Antarctic krill and mackerel icefish, the impacts of climate change remain to be factored into these strategies."

The Scientific Committee of CCAMLR has also recognised that the process of setting catch limits needs to take better account of the smaller-scale requirements of predators of these species, particularly at the scale of important foraging locations, as well as taking account of the potential effects of climate change.

"But adequate computer simulation tools are yet to be developed that predict these effects and for designing fishery management strategies and field monitoring programs that can appropriately disentangle the impacts of fishing from the impacts of climate change and natural processes of change."

In 2005 CCAMLR identified a series of key tasks in developing a representative system of marine protected areas as part of a tool box for conserving marine biodiversity in the region. The critical launching pad for this was a bioregionalisation of the Southern Ocean. In response, the ACE CRC and the WWF-Australia, with sponsorship from Peregrine Adventures, hosted an Experts Workshop on Bioregionalisation in 2006 to explore the best way to develop a method to divide the immense Southern Ocean into a series of smaller 'bioregions' based on unifying physical and biological properties.

The result was a 'proof of concept' for a bioregionalisation for the Southern Ocean that paved the way for the bioregionalisation adopted by CCAMLR in 2007, which is now being used as the basis for planning the reserve system.

In developing the longer term management strategies in CCAMLR, Andrew Constable says the next step is establishing programs to quantify the rates and magnitudes of change – an important prerequisite to planning adaptation strategies to respond to climate change.

A workshop is planned for April 2009 (see www.aad.gov.au/sentinel). It provides a timely interdisciplinary forum for scientists, policy and decision-makers and representatives of NGOs. Participants will address important issues in measuring, assessing and providing early-warning detection of climate change impacts on marine ecosystems and biodiversity in the Southern Ocean.

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This story was prepared by Jess Tyler, the Communications Manager for the ACE CRC. The ACE CRC is a collaborative partnership dedicated to the study of atmospheric and oceanic processes of the Southern Ocean, their role in global and regional climate change, and their impact on sustainable management of Antarctic marine ecosystems. The ACE CRC's core partners are the Australian Antarctic Division, the Australian Bureau of Meteorology, CSIRO Marine and Atmospheric Research, and the University of Tasmania.

Gondwana Link meets decision theory

Getting a GRIPP on what's important

It's bigger than Ben Hur and if you've had any involvement in the Australian conservation scene in recent years it's likely you will have heard of it. It's Gondwana Link, a massive, multi-organisation, on-ground conservation project transforming vast swathes of land in the south west corner of the Australian continent. It hopes to link up several of Western Australia's conservation icons including the Karri forests, the Stirling Ranges and the Great Western Woodland through land restoration, protection and management. Now an innovative and wide ranging research investigation known as GLink's Research on Identifying Priorities Project (or GRIPP) has been established to explore how environmental decision making and spatial prioritisation might contribute to improving the conservation outcomes of Gondwana Link. GRIPP's lead investigators are Dr Kerrie Wilson and AEDA's Professor Hugh Possingham (both based at the University of Queensland). Here Kerrie provides some background.

AEDA researchers and their collaborators are involved in solving a diverse array of applied conservation problems ranging from optimal monitoring to spatial planning. Advances and breakthroughs in the research have been plentiful, but applying them in the real world remains a major challenge.

While identifying broad priority areas for biodiversity conservation is an important first step, it is widely recognised that we need to work at a fine spatial scale in order to achieve conservation outcomes on the ground. To do this we require a spatially-explicit planning process to improve decisions made across complex social and ecological landscapes.

At the same time we require efficient and effective ways of collating information to inform decisions on investment and then evaluate their impact. And as we do this we need to account for synergistic interactions between land cover changes and climate change.

Finally, while conservation decision making benefits from strategic planning, how do we ensure plans are flexible enough to accommodate new opportunities – events or knowledge that often emerge unexpectedly? For example, how do we incorporate a new restoration technique, or improved ecological understanding, or acquire an important property coming on the market, or make the most of a commercial opportunity to subsidise the restoration of cleared habitat?

> "It is rare for such a range of activities to be undertaken concurrently in an integrated fashion over such a large area"

So, here are three massive challenges:

1. Fine-scale spatially-explicit planning across complex landscapes

2. Factoring in specific impacts of climate change and the potential synergistic effects of climate change and other land cover changes

3. Accommodating unforeseen emerging opportunities

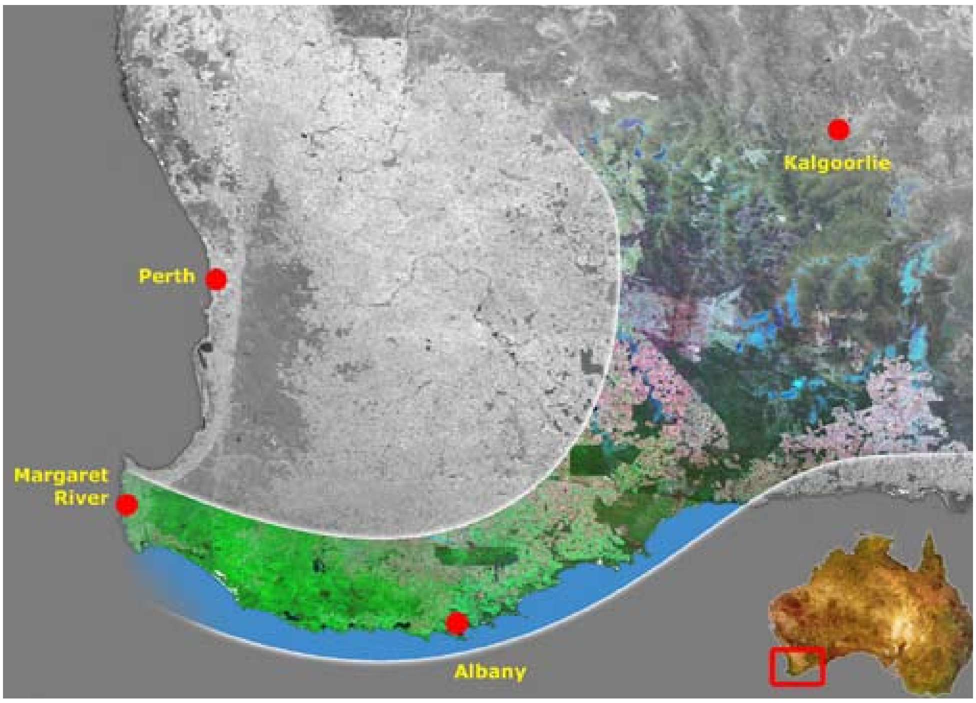
These are enormous challenges for conservation planning but if we can meet them we will be much better placed in supporting on-ground conservation works. And when it comes to landscape-scale conservation works in Australia, it's difficult not to think of Gondwana Link in Western Australia. Indeed, the formulation of these challenges was specifically motivated by the goal of improving the scientific and strategic planning in Gondwana Link.

A unique test bed

Gondwana Link is a landscape-scale conservation project in the ecologically significant south west corner of Western Australia. GLink, as it's commonly called, extends from the Western edge of the Nullarbor Plain to the wet forests of the Margaret River region (see map). The aim of the Gondwana Link project is to reconnect fragmented ecosystems, and to protect, restore and maintain the fundamental ecological processes that underpin these ecosystems. This is being achieved through a range of activities including:

- developing the case for stronger protection of the public land estate;
- providing incentives for better land management, such as fencing and restoring bushland;
- purchasing bushland to protect and manage;
- purchasing and revegetating large areas of cleared land;
- developing ecologically supportive industries, such as commercial plantings of local species; and
- working to achieve social, cultural, and economic change where this strengthens support for ecological values.

The project has been built through an initial focus on reconnecting ecosystems between the Fitzgerald River and Stirling Range National Parks, and presenting the scientific



The Gondwana Link project area in south west Western Australia.

GRIPP's advisory team:

Back Row (from the left): Ayesha Tulloch (UQ PhD Candidate), Dr Nicola Markus (Bush Heritage Australia), Dr David Freudenberger (Greening Australia), Dr Robert Lambeck (Greening Australia), Keith Bradby (Gondwana Link Coordination Unit), Professor Hugh Possingham (UQ)

Front Row: Dr Michael Looker (The Nature Conservancy); Dr Trudy O'Connor (The Wilderness Society); Paula Deegan (UQ); Dr Kerrie Wilson (UQ).

GLink meets decision theory

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case for holistic conservation protection and management of the vast Great Western Woodlands area (See *DPoint* #20 for background on the Woodlands). Critical planning is underway to extend the program into other parts of Gondwana Link.

While elements of the Gondwana Link project are occurring elsewhere in Australia (collectively they are often referred to as biolinks), it is rare for such a range of activities to be undertaken concurrently in an integrated fashion over such a large area. GLink represents an outstanding example of a landscape-scale conservation project in Australia, and the project is recognised locally and internationally for its grand vision, integrated approach, and focus on ecological resilience.

Getting a GRIPP on the system

All of this means that GLink provides a unique test bed to facilitate the research and development of conservation theory, and its application to on-ground conservation in a real world situation. And the opportunity has been seized by the organisations involved in GLink together with conservation research institutions from around Australia (including AEDA). Together they have created the GLink Research on Identifying Priorities Project (or GRIPP) which seeks to address the three planning challenges outlined on page 10. GRIPP recently received funding by the Australian Research Council (with generous support from GLink organisations).

GRIPP builds on the productive collaborations between Dr Kerrie Wilson and Professor Hugh Possingham at the University of Queensland (and partner organisations), the strong technical and financial support provided by The Nature Conservancy (Dr Michael Looker) and engagement of key GLink organisations Greening Australia (Dr David Freudenberger and Dr Robert Lambeck), The Wilderness Society (Dr Trudy O'Connor), Bush Heritage Australia

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Prioritising conservation actions

One of the major tasks of the GLink's Investigating Priorities Project is to develop a fine scale spatial prioritisation process that allows multiple conservation actions to be prioritised. That's not to say that effective prioritisation isn't already happening in GLink or that any new prioritisation frameworks arising from GRIPP will simply displace what's being done at the moment.

Indeed, the current planning approach being used in Gondwana Link is Conservation Action Planning (or CAP) and is highly regarded in Australia and overseas. It was devised by The Nature Conservancy (TNC) and has been applied by TNC and other major conservation organisations around the world. CAP involves indentifying a series of ecological targets together with indicators of their condition and threats to their persistence. These indicators are then strategically used as the basis of on-going management and monitoring.

CAP is valuable in extracting expert information and bringing together information from disparate sources. And it has already been applied in one region (the Fitz-Stirling operational area) of Gondwana Link. CAP will be employed and extended in GRIPP by more closely linking the process with spatial ecological and social data and melding the planning process with a return-on-investment framework that includes the cost and likelihood of success of the planned conservation action. The goal is to enable fine-scale decisions to be made about the relative importance of investing in diverse conservation actions and across areas with variable ecological and socio-economic characteristics. This is particularly relevant to this project as GLink covers such a varied landscape.

Hugh Pringle, an ecologist with Bush Heritage Australia, measuring a vegetation transect in a GLink restoration planting. (Photo Chinch Gryniewicz) the sad end bit

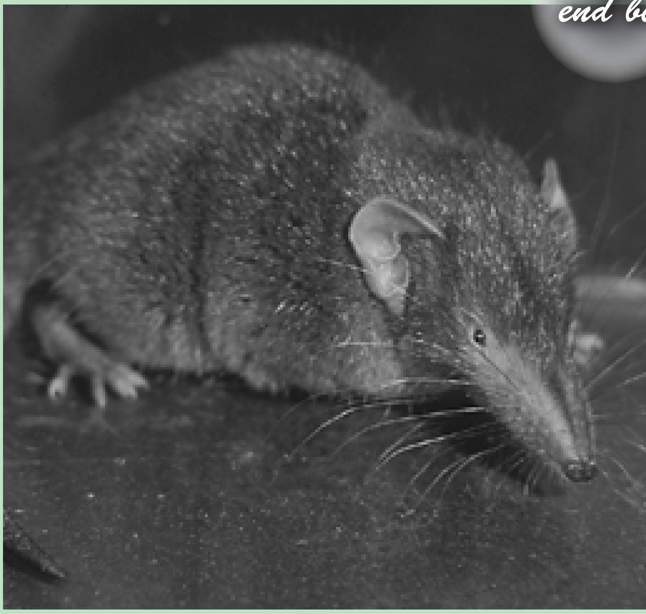
Premature eradication

Imagine what is jeopardised by declaring successful eradication too soon? Consider the case of the eradication of Asian musk shrews (*Suncus murinus*), an invasive predator, from the Mauritian island of Ile aux Aigrettes. The island is a nature reserve where conservationists hope to restore native vegetation and reintroduce endemic pink pigeons. Cats and rats have already been eradicated from the island, and the eradication of the Asian musk shrew was the last step before this reintroduction could commence.

This eradication program began in July 1999, and animals were trapped for the following 49 days. Then after only 8 days where no individuals were found, the program was scaled back. This was later recognised as premature: the number of animals captured increased again until the program was abandoned in February 2000. A later study by Solow et al (2008) estimated that the probability of successful eradication after those 8 days without detection was only 0.27. Despite failures such as this there are still no formal guidelines for declaring eradication. (See the story on p6 on making smart decisions on eradication.)

References

Solow A, Seymour A, Beet A, & Harris S (2008) The untamed shrew: on the termination of an eradication programme for an introduced species. *Journal of Applied Ecology*, 45, 424-427.



The Asian musk shrew is an invasive predator that has had significant impacts on biodiversity in its introduced range.

GLink meets decision theory

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(Dr Nicki Markus) and the Gondwana Link Coordination Unit (Keith Bradby). Paula Deegan, who has worked with Gondwana Link on its early conservation planning, is now employed through the University of Queensland (though she's based in Western Australia).

It's anticipated that the knowledge gained through this research project will help maximise conservation outcomes in Gondwana Link. However, the results will also be applicable elsewhere in Australia and overseas. The Gondwana Link project is by its nature a collaborative undertaking involving many people and institutions. If GRIPP demonstrates its value to GLink then it's expected the lessons learned will be transmitted far and wide by its many partners.

This is but an entrée to GRIPP. Its many facets will be featured in forthcoming issues of *Decision Point*. Future articles will provide details of each of the specific research aims and outline how the science will inform conservation in Gondwana Link and elsewhere.

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Volunteers planting trees on Yarrabee, a Gondwana Link property. (Photo Amanda Keesing)

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A Commonwealth Environment Research Facility

Smart science for wise decisions

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