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

A view from the EDG

And the birth of a new research network

Hugh Possingham (Director, The EDG)

I have a new acronym to share with you. Yes, I know, like me you hate acronyms so we've done our best to keep it short and simple. It's EDG and stands for the Environmental Decision Group (though we sometimes just call it 'the edge').

The EDG is a group of researchers based here in Australia and overseas who share a common interest in the science of environmental decision making (and specifically decisions surrounding the conservation of biodiversity). It includes some of the world's preeminent scientists working in this field, and if you look at the publishing record of our members, it's easy to justify the claim that we are operating at the cutting edge.

Though the network is new, it didn't come into being overnight. As readers of ***Decision Point*** will appreciate, EDG's antecedents lie in the network known as the Applied Environmental Decision Analysis Hub (also known as AEDA). AEDA was funded under the Australian Government's Commonwealth Environment Research Facility program. That program ended last year however AEDA proved remarkably productive and influential in the four short years it existed. Besides producing many world-first innovations in environmental decision theory and conservation planning (see ***Decision Point #45*** for a summary of highlights), it also provided us with a platform to build an even more effective research network – and that's the EDG. (Okay, now we descend into acronym soup.)

The EDG received funding from two sources: the Australian Government's new National Environmental Research Program (NERP) and the Australian Research Council where we bid and won a Centre of Excellence (ARC CoE). The NERP funding ($11million to run over 4 years, 2011-2012) has enabled us to establish a group called the NERP Environmental Decisions Hub. The ARC funding ($11.9million to run over 7 years, 2011-2017) has created the ARC Centre of Excellence for Environmental Decisions (or CEED).

The EDG network consists of 26 primary researchers (14 in common to both NERP ED and CEED) spread across five Australian universities and CSIRO. The network consists of these researchers, their students, staff and associated research fellows. The universities in question are the University of Queensland, University of Melbourne, Australian National University, University of Western Australia and RMIT. CEED also collaborates with six universities from overseas. All in all it represents some 200 researchers and staff, all united by a deep and professional interest in arresting the catastrophic declines we are witnessing in biodiversity both here and around the world. The details of all these partners and collaborators will be on our website in due course.

Administration for the component parts of the EDG will be shared and, to this end, we appointed Dr Alvin van Niekerk as our Chief Operating Officer last month.

And ***Decision Point*** will remain the primary vehicle for communication to our many stakeholders. This is the first issue of ***Decision Point*** under the banner of EDG and to mark the occasion we're launching a new look – the substance will be the same.

So, what more can I tell you about the EDG? Generally people think that money for science goes to big pieces of equipment and fancy labs. Not so for us. Our money is for people and workshops. Our legacy will be a large body of new science (see the list of themes we're tackling on the next page) and better ways of managing our environment and biodiversity.

A recent CEED workshop at the University of Queensland on the multi-species management. EDG workshops are not talkfests; they are about planning and actual work. (See the workshop report on the next page.).

When the public hear the word 'workshop' they imagine lazy junkets at exotic locales. Our workshops are very different – they are not talkfests, they are planning, modelling and writing. The typical format follows the famous NCEAS model – in 3-5 days we have just one day where we set aside time to make sure everyone knows what everyone else is doing. Days 2-5 are drafting projects for new PhD students and postdocs, plans and even papers. Real work, no fun.

This provides a great opportunity for you, the DP reader. All NERP workshops will involve SEWPaC staff, and people from other government agencies from around Australia. They can involve anyone in the country, scientist, expert, anyone who we think can make a useful contribution, not just members of our centres.

As far as leadership is concerned, while I direct both centres with the capable assistance of Brendan Wintle (NERP ED) and Mick McCarthy (CEED), both centres are more like a bikie gang than a bus tour. A bus trip has one driver and is a fairly dull affair that often degenerates into singing songs and seeing very little of the world through dusty glass.

A bikie gang, by comparison, is a loose conglomeration of individuals determined to raise hell. People can come and go as they wish and

> "If people have a vision of where we should go tomorrow, it is in their power to take us there, if they can convince enough of the other riders"

we expect pub brawls, little heirarchy and divisions. However the key is this – if anyone has a vision of where we should go tomorrow, it is in their power to take us there, if they can convince enough of the other riders. (Of course, this all a metaphor. We don't actually brawl in pubs.)

So there you have it; a view from the EDG. It's not a neat group with well-defined boundaries. Its multiple funding sources, mixed history and cast of characters means there are still many details to be ironed out. This is but the beginning a new network and there are still many unknowns on how it will all unfold. However, given the calibre and passion of its constituent researchers, I guarantee the EDG will deliver on its promise of producing the science that can underpin a profound change in the way we manage our threatened biodiversity. We focus on the pursuit of excellence, cooperation, quality outcomes and making a difference.

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Major research themes for the EDG

NERP ED

Values: Understanding major drivers for maintaining biodiversity

Understanding function/monitoring ecosystem health

Threats: building resilience for evolving threats

Sustainable use of biodiversity and ecosystems

Biodiversity economics and markets

CEED

Spatial Planning for Landscape Restoration & Management

Biodiversity Decisions in Dynamic Systems

Rapidly-transforming Landscapes

Optimal Management of Multiple Threats & species

Decision-making Tools for Complex Environmental Problems

Optimal Monitoring and Evaluation

Biodiversity scenarios and forecasting

CEED Multi-species management workshop

By Yvonne Buckley (University of Queensland)

When managers intervene in natural systems they are either directly managing multiple species or their management of one species has direct and indirect effects on other species in the system. Fishing, control of foxes and cats to reduce threats to native marsupials and the introduction of biocontrol agents to control pests are just a few examples where multi-species management is central to the conservation problem. Species interactions however are not always taken into account which can lead to unforeseen management outcomes.

Predicting the outcome of dynamic multi-species systems, even without the addition of management, is difficult. However, the problem we are faced with is how to optimise management strategies and schedules for multi-species systems even in the face of high uncertainty in responses. Sometimes very unexpected interactions can arise, for example mice on Gough Island have turned to eating albatross chicks and it is thought that this is due to the absence of other introduced competitors (such as rats) or predators (such as cats). This should ring alarm bells for rat and cat eradication or control programs if mice are not also targeted.

> "Predicting the outcome of dynamic multi-species systems, even without the addition of management, is difficult."

At a recent workshop at the University of Queensland (4-9 July) we explored the use of different tools for optimising management for suites of multiple interacting species. Throughout CEED's lifetime we will be working on problems such as: **How to predict the impacts of species additions and deletions within interaction networks? How much sampling of interaction networks is needed to make sensible management decisions? What is the value of learning about interactions, optimal management of smaller networks? and What can we learn from island eradication programs?** We have identified several projects suitable for PhD, honours and masters students and post-doctoral researchers, if you would like to discuss any potential research projects please contact Yvonne Buckley <y.buckley@uq.edu.au>.

Hordes of giant mice are devouring endangered seabird chicks on Gough Island in the South Atlantic. Pictured here is a mouse feeding on the carcass of a Tristan albatross (photo by Ross Wanless). They may be pushing some of the birds to extinction. This should ring alarm bells for rat and cat eradication or control programs if mice are not also targeted.

To monitor or not to monitor

And when doesn't it count?

By Eve McDonald-Madden (EDG, University of Queensland)

If you were to ask a room full of managers, policy makers and even scientists if they should be monitoring the outcomes of their conservation actions, the answer from most would be a resounding yes! The argument being that if we don't understand the benefits of our investment how can we possibly know if we are doing the right thing and if our investment is worth it! The logic behind this premise is sound, any business manager will tell you that, but in a resource-constrained world it's worth taking a moment to consider what it is you're hoping to achieve. When we did this and attempted to formalize the logic behind when to monitor it quickly became clear there are many situations where monitoring is not appropriate.

Essentially, we do not have enough money to manage all the threatened biodiversity we care about. We need to make good decisions about where we spend our limited resources. Well, the same is true for monitoring. Also important is the fact that biodiversity loss waits for no man (or in this case no monitoring) – we may not actually have time to gain information to improve our decision-making before we lose what we are trying to protect.

That's not to say that those who answer "yes" to monitoring are not thinking about money. In fact one of the most common questions I get asked is how much of our program budget should we be spending on monitoring? In other words is there a set percentage you can tell us to put aside to monitor our conservation actions? It was these questions that led The Nature Conservancy (TNC), the world's largest conservation NGO, to contact us. Unfortunately, the answer to their question was "no, there is no generic benchmark for monitoring, it's situation-dependent".

Determining how much to spend on monitoring depends heavily on the problem at hand and even with a well-defined problem finding the answer is not trivial. Not a satisfying answer for those, like TNC, making daily decisions about their investment in monitoring. But while we may not be able to give one magic number, we can provide a framework that enables better decision-making about "when to invest in monitoring" and "what type of monitoring to undertake".

So, to flesh out this framework we sat down with some of the TNC's key monitoring scientists and constructed a simple decision tree (see Figure 1) that guides managers through a series of basic questions. The answers lead to an explicit and transparent decision regarding their investment in monitoring to improve management. To illustrate the utility of the decision tree we used it to assess the need for monitoring connected with three conservation problems (see the boxes on killer whales, Florida scrub jays and Tasmanian devils). There are five main elements to the decision tree.

One: **Specifying the objective of the program** (Q1). What are we hoping to achieve in our conservation endeavours? Without an objective we do not have a benchmark by which to evaluate our actions. Indeed, without an objective there can be no metric by which to assess performance, and thus monitoring in any form would have no utility.

> "the most common questions I get asked is how much of our program budget should we be spending on monitoring?"

Threats to killer whales

The killer whale population in the Georgia Basin on Canada's west coast declined significantly between 1995 and 2001 prompting listing under the Species at Risk Act and the development of a recovery strategy (Q1). The causes of killer whale declines are poorly understood (Q2– No), so it is difficult to derive management options for this species and assess the benefits of these alternative actions. As such, it is prudent to implement research (eg, scientific research or an expert elicitation process) to identify threats and uncover management options (Decision 3). Once this is achieved, managers can return to the decision tree to decide whether monitoring is needed to drive state-dependent management or to learn the best management action. While it may seem alarming to postpone management-driven monitoring of a threatened population, it is often more important to identify threats and appropriate management actions than to expend resources on merely confirming a continuing decline. (Image by NOAA)

Two: **Understanding the threat.** Once our objective is defined it's crucial to ask what the threats to the system are. From there we can construct a list of potential conservation actions we might implement (Q2). Without knowledge of the threats to the system it is impossible to plausibly assess the benefits of different management actions, nor the role of monitoring. Although some advances in understanding threats and management actions might emerge serendipitously from untargeted monitoring, this is a long shot and could result in years of wasted effort. A better decision is to invest in a targeted program to understand the threats to the system. The first port of call maybe eliciting valuable information from experts but for highly unknown systems a targeted research program maybe required (Recommendation 3). Management of the Orca in Georgia Basin is an example of this sequence of decisions.

> "while we may not be able to give one magic number, we can provide a framework that enables better decision-making about "when to invest in monitoring" and "what type of monitoring to undertake"

Three: **Assessing our reasons for monitoring.** Once we have a set of plausible management alternatives we can begin to consider whether monitoring to improve management is necessary. That is, do we need to understand the state of the system to implement management (Q4), is it clear what the best management action for each state is (Q5), and do we need to consider learning to find the best management action (Q7)? In essence here we are assessing our reasons for monitoring either to understand our system state to guide management or to adaptively assess the benefits of our management. While it might seem obvious it is essential to highlight that if we know what the best management action is or indeed we only have one management action to choose from, then there is no value gained from monitoring. There is nothing targeted we can learn and spending money on monitoring will just take valuable dollars away from management (or from other conservation endeavours). Management of the Scrub Jay is an example of this sequence of decisions.

Four: **Assessing our ability to implement adaptive management.** If it is not clear what management action is the best to implement we will need to assess our ability to implement adaptive management (see box 1 for more detail). Conservation science is a crisis discipline and it is essential here to consider the urgency of the problem when making decisions regarding monitoring (Q9). Urgency might relate to the risk of extinction of a species, the rate of decline of a species or the rate of clearing of a plant community. Questions regarding time constraints that we must consider include:

- Do we have enough time before our species is lost to implement a program of adaptive management?
- Can we observe the response of the system relative to the

Continued on page 6

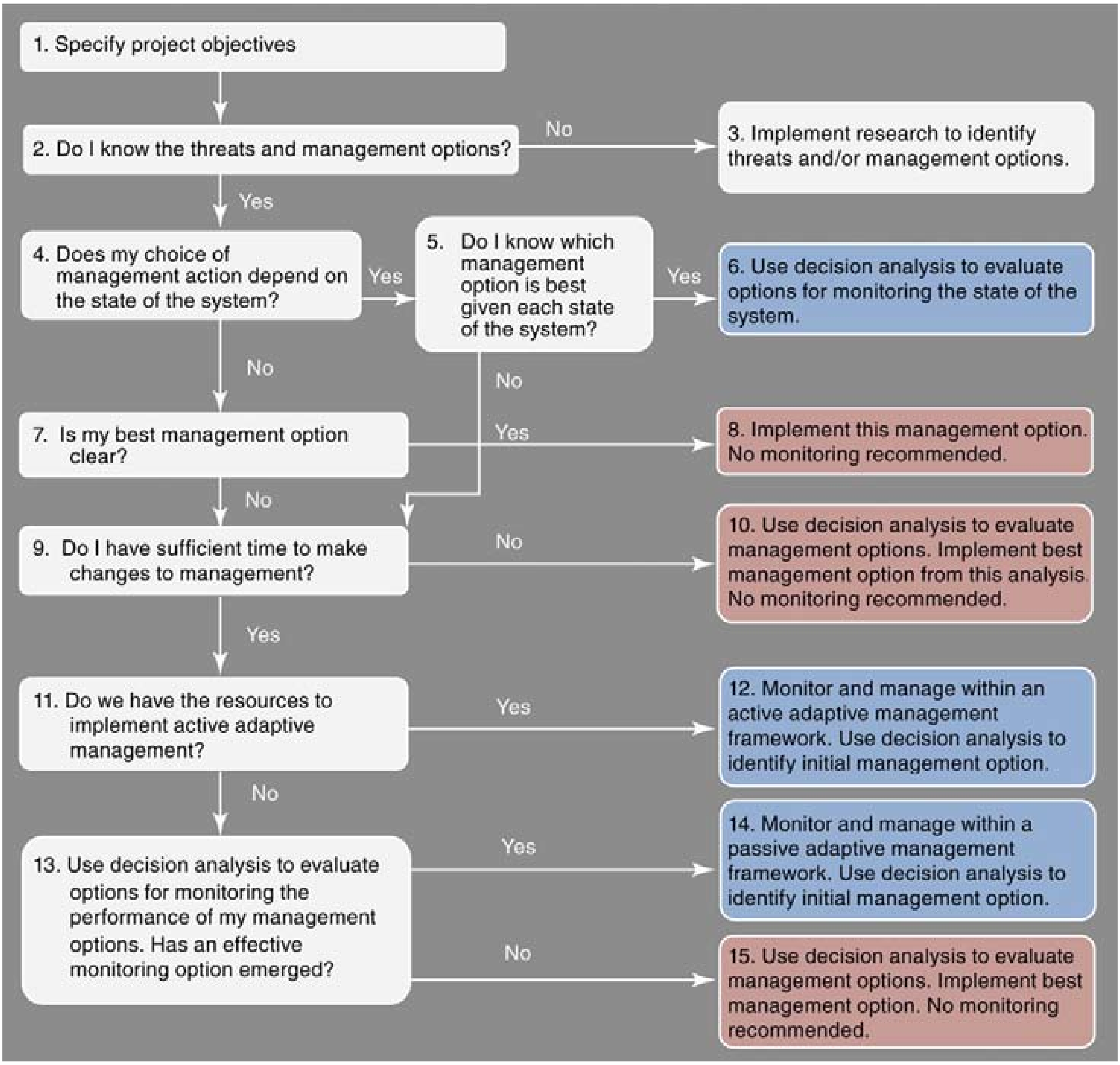

Figure 1: A decision tree for deciding when to implement monitoring to improve conservation managment (and when not too). From Macdonald-Madden et al, 2010.

To monitor or not to monitor

Continued from page 5

objective of the conservation within the project timeframe? For example if the objective requires us to demonstrate increased forest growth in response to a management intervention, and this increase can only be observed in 50 year timeframe, then this project may not be a suitable candidate for learning through adaptive management.

• And, finally, do we have an adequate funding period to allow the iteration of management and thus knowledge accrual required for adaptive management to be successful.

Not having the time to successfully implement adaptive management does not mean we avoid decisions regarding the best management action; however it does mean that we should avoid expending resource on monitoring to learn (Recommendation 10). If we do have time then we can implement an adaptive approach. How we go about this however will be governed by that omnipresent limiting force in conservation – funding (Q11).

There are two recognised ways that adaptive management can be implemented, either actively or passively. Active adaptive management is seen as the panacea for managing biodiversity in the face of our many uncertainties but in reality being an active adaptive manager can be costly. If there are significant resources available to a conservation program then this is indeed the ideal approach to learning and managing (Recommendation 12). Where resources are slim the best approach may be one where we still repeatedly evaluated the performance of our management endeavours but we do not impose management actions with the intention of learning (Recommendation 14). What is important here is that we can find a monitoring strategy that will enable us to decide when our actions are no longer successful (Q13). If an effective monitoring option does not exist then we should not implement monitoring – the message being that ineffective monitoring is a waste of money. It is still important that a good decision is made about management and the best management option based on our current knowledge should be implemented (Recommendation 15 and see box on decision analysis). The novel impact of the Facial Tumour Disease on the Tasmanian devil lends itself to the concept to learning whilst managing (see the box on learning about devils to see how the decision tree could be used to assess adaptive approaches for this problem).

Five: **Other reasons to monitor.** Of course, there other reasons to monitor where the purpose is not to improve outcomes. It might be a legal or audit requirement, or it might be for publicity. The limitation of time and money, however, often plays less of a part in such monitoring endeavors. If a decision to monitor based on our decision tree suggests no monitoring is required to improve management outcomes, it is important that managers assess their legislative requirements to monitor or their need to monitor to inform donors and implement a decision analysis to determine how to monitor to this end. Similarly, if monitoring is required to improve management, managers should assess if the monitoring strategy implemented is satisfactory to fulfill these other monitoring requirements and thus avoid additional expenditure.

Adaptive management

Adaptive management has a lot in common with the scientific experimental technique but recognises that ecosystem managers do not always have the luxury of extensive spatial and temporal replication before having to make a decision. Instead, adaptive management is a process by which we manage a unique system without delay and learn as we go – learning while doing.

There are four key facets to an adaptive management process:

1. **Clear specification of the management objective.** This enables assessment of the performance of an action towards management goals.

2. **Articulation of all the different hypotheses** of how the system may function in response to management actions and weighting of their plausibility;

3. Information gain through monitoring to **identify system response to management.** This allows feedback on the performance of management actions;

4. **Updating our understanding** of how the system functions in response to management based on this new knowledge and adaption of management if appropriate.

Burning for scrub jays

The Florida scrub jay is listed as threatened under the US Endangered Species Act. Florida scrub jays are cooperative breeders with limited dispersal ability, requiring a set of well-documented habitat conditions to raise successful offspring. Prescribed burning is needed to maintain suitable scrub-oak habitat, as the key objective is to maintain the shrub layer at less than 2 metres high (Q1). The major threat is scrub oak habitat loss due to fire suppression (Q2-Yes). Management is dependent on the state of the system, namely the height of the shrub layer (Q4-Yes). If managers were unclear which habitat management option was best given the habitat state (Q5-No), they would need to address questions regarding monitoring for adaptive management (Q9-15) before assessing methods to monitor the state of the system. In this case, however, the conservation activity for each state is known. For example, if the shrub layer is 1.5 metres and other conditions are met, the habitat is considered adequate and no action is required. Alternatively, if shrub layer is 2.5 metres, prescribed burning is required even if other conditions are met (Q5-Yes). After answering questions 1, 2, 4, and 5, the manager must decide how to monitor the vegetation and thus the state of the scrub oak habitat (Decision 6). To make this choice, a manager should employ decision analysis based on the adequacy of habitat information delivered by different monitoring techniques and the cost of each monitoring technique.
(Image by Andromedav)

Is it justified?

Monitoring is generally perceived as a rational and defensible activity in the pursuit of improved conservation outcomes. However, when we explicitly ask: "Is spending money on monitoring justified relative to other actions?", we must be prepared that sometimes the answer is "no"! In other words, in some cases it is not appropriate to monitor. Importantly, within the framework presented here, a decision to direct resources away from monitoring is not driven by lack of confidence in the effectiveness of monitoring nor by reluctance to evaluate our conservation investments. Instead, this decision is driven by a desire to maximise expected conservation outcomes given limited resources.

There has been a surge in research looking at the design of monitoring programs in recent years, as well as a growing number of calls for the establishment of long-term biodiversity monitoring (see *Decision Point #48*). At its heart, however, good monitoring rests fundamentally on a clear justification for acquiring information in the first place. In other words, what we strive to know should be driven by what we need to know.

And, if we take a structured approach to decisions about monitoring, as we have set out here, we find that the answer to whether we should monitor is not always yes – there are actually times when monitoring is a waste of time and money.

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Reference

McDonald-Madden E, PWJ Baxter, RA Fuller, TG Martin, ET Game, J Montambault & HP Possingham (2010). Monitoring does not always count. ***Trends in Ecology and Evolution*** 25: 547-550.

Decision analysis

Decision analysis is a procedure for discriminating between suitable courses of action; in our case, to select the most appropriate regime for monitoring (Decision 6, Question 13) or management (Decisions 10, 14, 15). Decision analysis involves a structured enquiry into the different options available to manage or monitor, along with their costs, benefits and constraints. A simple form of decision analysis ranks options according to their expected cost effectiveness, or expected benefit divided by expected cost.

When deciding which **management option** is best, one must consider the benefit of each possible action in terms of reaching the overall program objective, the probability of success of that action, and of course the cost of implementing that action.

To select the best **monitoring regime** we include the same components, but the benefits now relate to the quality of information needed to make a decision based on the reason for monitoring (eg, track system state to guide state-dependent management, or track performance to guide adaptive management). Furthermore, adequate monitoring must consider the ability of the strategy to detect changes in the system.

Acquiring **information** on benefits and costs for a decision analysis can be achieved through expert elicitation or through more detailed scenario modelling. Options for implementing decision analysis range from a simple calculation of the combined benefits relative to the total costs incurred (e.g. Benefit x Probability of success / Cost) to a more complex optimization (eg, stochastic dynamic programming or reinforcement learning). Methods of obtaining data and implementing decision analysis vary in their cost and their ability to provide rigorous results.

Learning how to manage Tasmanian devils

The Tasmanian devil has declined rapidly in the last decade due to a fatal facial tumour disease (an example is pictured here), and a vigorous conservation initiative has been launched in response. There are many potential objectives for this initiative. For this discussion we specify an objective to minimise disease prevalence (Q1). Here the cause of decline is known and potential actions have been described (Q2-Yes). The state of the system (eg, total devil population or number of infected animals) does not affect the management decision (Q4-No) but the novelty of the disease has led to multiple hypotheses about disease behaviour and thus to multiple management options, for example removing only diseased individuals, removing all adults or removing no individuals (Q7-No). Given multiple theories on how to intervene, the reason for monitoring here is for adaptive management. Funding is committed over the next five years, so several iterations of removing individuals and tracking disease prevalence could occur during the conservation program (Q9-Yes). The decline of this iconic Australian species has drawn over A$13 million from state and federal government bodies (Q 11-Yes). Given this high level of resourcing, active adaptive management is a feasible option for understanding how to manage the impact of the facial tumour disease (Decision 12). However if sufficient resources (both financial and institutional) were not committed to an active adaptive strategy (Q 11- No), then it is essential to decide if an effective monitoring strategy for observing change in disease prevalence is possible with the funding available (Q 13). If there is a cost effective monitoring strategy, a passive adaptive management approach may be implemented (Q 13 - Yes), but if no effective monitoring strategy exists (Q 13 - No), then the benefits of monitoring to inform management are negligible and monitoring should not be implemented. Managers should instead make an informed decision regarding the best management action and proceed with implementation (Decision 15). Threatened species managers often have very limited funds, and as such, many will reach this final suite of questions. (Image by Menna Jones)

"When we explicitly ask: "Is spending money on monitoring justified relative to other actions?", we must be prepared that sometimes the answer is "no""

Biodiversity *AND* climate change

Priorities in policy and management

Epicormic regrowth in mixed a species forest (stringybark, messmate & peppermint) in Victoria following the Black Saturday fires in 2009. Climate change is expected to change fire regimes and the frequency of large-scale events like Black Saturday. These climate-change driven effects will interact with resource exploitation, such as salvage logging, magnifying the the impacts on biodiversity. Taking action to reduce the interactions between traditional drivers of biodiversity decline with new impacts of climate change is essential for effective adaptation to climate change. (Photo by David Blair)

Biodiversity is in crisis. That's not news. It's something that is widely acknowledged and governments at all levels are responding to the traditional threats of habitat loss, invasive species and resource extraction in a variety of ways. Climate change is adding to the problem of declining biodiversity as it brings with it a range of additional threats (higher temperatures, higher ocean acidity etc). The science on these threats has firmed over the last decade and there is a growing response to deal with them. But there's a third area that hasn't received as much attention until now – the interactions between the traditional drivers of biodiversity decline and the new drivers of decline associated with climate change. A new review in the international journal Climatic Change led by EDG scientists at the ANU has shown that the combined effects of changing climate and existing threats to biodiversity will multiply the impacts that those processes would have alone, thereby significantly magnifying the biodiversity crisis.

"While much effort is already expended countering existing threats to biodiversity, climate-change adaptation now demands new and more efficient approaches, because current efforts in many cases are inadequate," says Dr Don Driscoll, the lead scientist in the review. "In our analysis, we first reviewed the extent of interaction of climate change with three globally important causes of biodiversity loss: native vegetation loss and fragmentation, invasive species, and resource exploitation.

"We then collated well-substantiated and empirically based recommendations from the scientific literature to identify a concise list of the most important actions, policy changes, and players needed to support climate-change adaptation. In doing so, we found substantial shortcomings in international, national and regional policy that require urgent attention, in addition to challenges that must be overcome for new scientific approaches to transfer to the policy and decision-making realm."

As just one example of the synergies between traditional drivers of biodiversity decline and climate change interact, consider land clearing. Land clearing by itself is one of the world's biggest threats to biodiversity. However, the clearing of native vegetation is also expected to exacerbate climate-change and therefore increase the impacts of climate change on biodiversity so it brings with it a double whammy. There are three ways this happens: First, clearing native vegetation for agriculture or forestry exacerbates climate-change because it is a major source of greenhouse gas emissions world-wide. Second, land clearing can increase regional temperature, reduce rainfall and increase weather variability compounding similar trends that are predicted to result from increased atmospheric greenhouse gases. And third, a dangerous interaction between fragmentation and climate-change may arise when a fragmented landscape (a) hinders dispersal, preventing species from tracking their climatic niche, (b) offers a reduced availability of habitat situated in suitable climate space, and (c) harbours small populations which generally possess lower genetic diversity, limiting the potential for adaptation to changing climate.

Similar interactions with climate change have been noted with other areas of concern such as management of invasive species and resource extraction (for example, water management).

"Climate-change adaptation is intrinsically linked to reducing threats to biodiversity," says Driscoll. "It's not enough to simply address biodiversity decline and impacts of climate change in isolation of each other. Climate change mitigation and biodiversity preservation is not an either/or trade-off, nor should we hide behind uncertainty as a reason for delaying action."

To help guide appropriate response, the researchers summarised critical policy and management actions that represent the front line of a thorough climate-change adaptation response. These are outlined in Table 1.

"When we summarised policy and management responses outlined in the scientific literature, three key trends emerged," observes Driscoll.

First, there are many policy and management actions that can be taken now and would result in a rapid reduction in the threats to biodiversity. These are principally actions that circumvent further impacts such as avoiding the introduction of new invasive species and preventing further habitat loss or degradation. Nevertheless, actions that pay off in the medium and long-term remain essential for an effective program of adaptation to climate change.

Second, is the importance of international agreements in driving or resolving threats to biodiversity. Climate change adaptation is intrinsically linked, not just to international climate change conventions, but also to international trade and conservation conventions. National effort to combat the effects of climate change must include engagement in such international negotiations, particularly those associated with international trade.

Third, is the importance of developing new collaborations between government, NGOs, industry, land managers and scientists to ensure better knowledge transfer, better policies and better on-ground delivery of programs. We have identified specific areas where particular groups must work together to transfer knowledge into practice via policy.

An unfortunate by-product of the complex interaction between climate change and biodiversity loss, is the potential that key responses will be delayed. This is based on the assumption that many impacts and outcomes are uncertain and greater efficiencies will be achieved as our understanding improves. It is much easier to delay decisions under the justification of "inadequate information"

Broad goal	Recommended action	Acting Agency	Time
Reduce land clearing	Address fundamental drivers of clearing (per-capita consump & pop growth;	International/ nat/reg policy	slow
	Support strong governance	Intern/ national/regional policy	med
	Remove taxation and other financial incentives to clear land	National/regional policy	fast
	Eliminate carbon-account rules that promote forest clearance for plantations	Intern/ national/regional policy	fast
	Improve access to technol for higher agricultur productn in a smaller area[a].	Intern/ national/regional policy	med
	International carbon market and REDD+	Bilat nat agree, intern conventn	fast
	Applic of regional market-based instr, includ offsets for no net biodiver loss.	National/regional policy	fast
Restore nat veg to create carbon sinks & enhance biod	Identify priority areas for restoration	Scient/policy maker collaboratn	slow[b]
	Create guidelines to choose species for restoration	Scient/pol maker collaboratn	slow[b]
	Use carbon pricing schemes to fund revegetation	Internat/nat/reg policy, local implementn	slow[b]
	Guard against perverse outcomes, esp invasive species risk in new plantings.	Nat/reg policy & enforcement	fast
Prevent new introductions of potentially invasive species	Urgent modification to WTO international agreements	International policy	fast
	Remove incentives for imports with high risk of accidental introductions	International & national policy	fast
	Improve quarantine and other national policies	National/regional policy	fast
Manage established alien invasive species	Identify potentially invasive species before they escape captivity and implement policy to support education and regulation	Scient/ government collaboratn, Nat/reg policy	fast
	Create new policies to regulate sales of potentially invasive garden plants	National/regional policy	fast
	Apply new and existing technology	Scientist/NGO/gov collab, Nat/ reg policy	fast-med
Detect range changes of concern	Establish targeted monitoring programs using both scientists and citizens as primary data collectors	Scient/NGO/ gov collab, Internt conventns, Nat/reg polic	med-long
Alter manag of nat resourc incl:			
Water management	Ensure environmental flows are adequate	Scientist/gov collab, Nat/ regional policy	fast-m
	Provide internat framework to support water management for biodiversity	Internat conventions, Nat/ regional policy	fast-m
	Regulate and police water extraction	National/regional policy	fast-m
	Reduce demand	National/regional policy	fast-m
Livestock grazing	Implement conservative not opportunistic stocking rates	Nat/reg policy, land managers	fast-m
	Exclude stock from land set aside for conserv, especially during drought	Nat/reg policy, land managers	fast
	Use outreach programs to educate land owners about ecosystem services	Scient/pol maker/lnd mnger collaboratn	med
	Financial incentive schemes for stewardship	Nat/reg policy, land managers	fast
	Off-farm income support	National/regional policy	fast-m
Forest Logging	Retain habitat features to provide native species with resilience to disturbance	Scient/poli maker collaboratn, Nat/region policy, lnd mngers	fast-slow[c]
	Reduce and regulate post-disturbance logging	Nat/reg policy, land managers	fast
	Use indigenous species in reafforestation	Nat/reg policy, land managers	fast-s[d]

than to embark on the difficult processes of informed decision making.

We have shown, however, that for the vast majority of major threatening processes to biodiversity, sufficient ecological knowledge and policy options currently exist for effective adaptation efforts to be implemented or improved upon, today. Policy makers and land managers can take practical action now to reduce the impacts of climate change on biodiversity. Such actions will critically determine the trajectory that the biodiversity crisis will take over coming decades.

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Reference

Driscoll DA, A Felton, P Gibbons, AM Felton, NT Munro & DB Lindenmayer (2011). Priorities in policy and management when existing biodiversity stressors interact with climate-change. ***Climatic Change***. DOI or ref still to come.

Table 1. A summary of key climate change adaptation responses that are likely to result in biodiversity benefits. The fourth column (Time) lists the approximate potential timeframe within which resultant biodiversity benefits would begin to accrue once the action has been enacted: fast: *immediate to a few years;* medium: *a few years to a few decades;* slow: *decades to centuries.*

(Notes a. *This approach has risks of perverse outcomes because it does not always lead to increased land sparing. The conditions under which this approach may be beneficial must be carefully assessed.* b. *Although changes in revegetation may be fast, the benefits to biodiversity of revegetation are likely to be slow to accrue because forest communities will take decades or longer to re-establish.* c. *Species specific; invertebrates may use retained habitat immediately, old-growth specialists may use retained habitat only after the surrounding logged forest has substantially matured.* d. *Fast for avoided introduction of invasive species, slow for the time it takes for revegetation to establish.*

Behind the paper

In June, the journal *Nature* published a provocative commentary piece on perceptions about 'invading' organisms (Davis et al, 2011). It suggested managers and researchers may be placing too great an emphasis on the origin of the invader, and that rather than focussing on whether the problem species is native or non-native, we should be looking at its impact first. The authors urged "conservationists and land managers to organize priorities around whether species are producing benefits or harm to biodiversity, human health, ecological services, and economies." Richard Hobbs, an EDG researcher from the University of Western Australia, was one of the co-authors on that commentary piece. Here, Yvonne Buckley (another EDG scientist, from the University of Queensland) reflects on the vexed issue of the native/non-native divide. (She's joined by colleagues Jennifer Firn, Queensland University of Technology and Justine Shaw, Australian Antarctic Division, DSEWPaC)

Species' origin is not everything

But it still matters

By Yvonne Buckley, Jennifer Firn and Justine Shaw

In their *Nature* commentary 'Don't judge species on their origins' Davis et al. (2011) urge us to disregard native or non-native origin as a motivator for eradication or control of particular species in an ecosystem. They advocate judging species' negative or positive impacts based on "sound empirical evidence and not on unfounded claims of harm caused by non-natives".

We are concerned that Davis et al. are promoting a false dichotomy between an ideal of assessing each species and its function based on empirical information as opposed to making a judgement based on a species' origin. We agree that management decisions should be based on the best information available. Indeed, managers already prioritise which invasive species to manage from among the much broader pool of non-natives and natives due to their predicted or actual negative impacts. However, to disregard species' origins is to lose valuable information.

Scotch broom is a damaging invader worldwide, where it's introduced it lacks many natural enemies which may contribute to its negative impacts on agriculture and biodiversity (photo by Yvonne Buckley, Scotch Broom, Banks Peninsula, New Zealand).

To begin with, detailed empirical evidence on the impacts of introducing a novel species into an ecosystem aren't easy to come by. The absence of such information is the norm. We argue that the disjunct evolutionary history of non-natives from the ecosystem into which they are being introduced is useful *a priori* information.

This disjunct evolutionary history can lead to potentially novel traits, changes in ecosystem function, lack of integration into existing food-webs and lack of population regulation by natural enemies. Moreover, these qualities of non-natives may make them desirable for introduction and also increase the likelihood they become problematic due to alterations to nutrient cycling, primary production, fire regimes, and competition with native wildlife.

Pre-border control has been repeatedly shown to be the most cost-effective way of preventing harmful consequences from novel species (Yokomizo et al, 2009). Both native and non-native species are assessed for import risk, albeit using different systems. If we were to go to an "origin-blind" system we would lose valuable information on the different risks posed by imports of both native and non-native species.

Prior to introduction or before an invader builds up to troublesome densities its impacts can be very unpredictable. A precautionary approach to managing this unpredictability is to simply "nip it in the bud" before a problem arises. This is particularly relevant for areas of high conservation value, with low occurrences of non-native species and low levels of human modification.

> "don't throw out useful information on origins which can help guide prioritisation of management actions."

The replacement of native species with non-natives driven by anthropogenic needs and disturbances has resulted in the global homogenisation of plant, insect and animal assemblages. The labelling of species origin as native or non-native acknowledges human influence in creating novel ecosystems. Species origin does still matter.

Wherever land managers or politicians face budgetary constraints or potential stakeholder conflict arises, Davis et al.'s argument provides a justification for abandoning eradication or control of newly detected introductions. A precautionary approach, which uses species origins ***in lieu*** of detailed assessment of potential impacts, might in fact help avoid large future economic or environmental costs which would be the result of pragmatic management of future invasive populations only when their impacts become apparent (Yokomizo et al, 2009).

We need to move towards better predictions of which non-native species will ultimately become problematic, but in the mean time don't throw out useful information on origins which can help guide prioritisation of management actions.

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Davis MA, MK Chew, RJ Hobbs, AE Lugo, JJ Ewel, GJ Vermeij, JH Brown, ML Rosenzweig, MR Gardener, SP Carroll, K Thompson, STA Pickett, JC Stromberg, P Del Tredici, KN Suding, JG Ehrenfeld, JP Grime, J Mascaro & JC Briggs. (2011). ***Nature*** 474: 153-154.

Yokomizo, H., Possingham, H., Thomas, M. & Buckley, Y (2009). Managing the impact of invasive species: the value of knowing the density-impact curve. ***Ecological Applications*** 19, 376-386.

Biodiversity basics in the brigalow

A new guide for land managers

Old trees and logs provide critical habitat for many species such as this golden-tailed gecko. (Main image by Clive McAlpine. Gecko by Will Goulding)

How times change. Up until the Second World War brigalow woodland was seen as a curse and an obstacle to the development of productive farmland. Cutting it down was difficult, and what was the point as it would only grow back. Then, technology gave land managers the upper hand and today less than 10% of it is left and it's listed as nationally threatened (under the EPBC Act). Now the emphasis is on saving it. And it's not just about preserving a landscape that was once abundant. Brigalow's one important advantage is its capacity for natural regeneration on formerly cleared land. That makes it a low-cost and highly efficient way to restore habitat, as well as having enormous potential as a carbon sink. But preserving this asset is about understanding how to protect its natural values.

Brigalow itself is a species of wattle. It occurs mostly on deep cracking clay soils but its name is also used to define the woodland ecosystems of which it is a part. Today, only tiny fragments of the once extensive* brigalow woodland are left; mostly in small patches, shade-lines and roadside strips. (Brigalow woodland once stretched north almost to Townsville, south to Narrabri and west to Bourke). How do you best manage a relictual system in order to nurture and sustain its biodiversity? Scientists at the University of Queensland, including EDG's Clive MacAplpine, have spent most of the past decade investigating this very question. The essence of their research has now been distilled into 28 page booklet available for free download. It's all about how to manage brigalow vegetation for conserving and restoring wildlife in the region. Here's a taste.

How much vegetation is enough? Patches of all sizes contribute to habitat for wildlife. Even small patches and individual trees are stepping stones through the landscape for wildlife. At the scale of an entire landscape, the size of the patches is less important – simply, the more vegetation the better, especially in heavily cleared landscapes. In such landscapes, every bit of extra vegetation contributes to the number of species the landscape can support. Retaining at least 20–30 % natural vegetation in the landscape will result in high faunal biodiversity.

What are the priority areas to restore? The answer varies. When landscapes have high amounts of remnant woodlands (> 70%), increasing vegetation cover is less important than controlling grazing and exotic species disturbance to maintain high quality habitat. In moderate cover landscapes (30–70%) maintaining habitat condition and also buffering small patches by increasing their size are the most effective activities. In landscapes with low native vegetation cover (<30 %), increasing the total amount of native vegetation through the retention of large areas of regrowth is the thing to focus on.

How important are linear patches? Linear patches like roadside vegetation and shelterbelts are very important habitat and movement corridors in brigalow landscapes. Linear patches often have high mistletoe density, which makes them especially valuable for birds. While narrow (e.g., < 50 m) patches support many animals, wider patches provide better habitat and are more likely to withstand the effects of exposure to wind and storm damage. The key to maintaining the values of narrow patches in the long-term is to avoid damage to the woodland edges and ensure healthy regeneration of young trees to replace older trees as they age. This requires careful management of grazing and herbicide control in and around narrow patches.

How important is connectivity among patches? The single most important thing that can be done for wildlife in cleared landscapes is to increase the amount of native vegetation they can use as habitat. However, connectivity among patches is also important for many reasons, including animal dispersal and access to resources. Scattered trees and small patches can act as stepping stones through cleared areas, as can fence-line vegetation. Connectivity is probably most important in landscapes with little vegetation cover (< 30%) and many small isolated patches. However, improved connectivity cannot make up for less habitat overall.

How important is regrowth of different ages? Regrowth vegetation changes as it ages and this means that it provides different habitat resources throughout its regeneration. Animals differ in their ability to use regrowth and so it is important to have a range of ages of regrowth in the landscape. However, a general rule to follow is that the older the regrowth vegetation is, the more species it can provide habitat for. This is because it takes many decades for important habitat features like fallen timber, tree hollows and leaf litter to develop. The structural complexity of regrowth also improves with age. Regrowth older than 30 years (as depicted above) provides the best value habitat for most wildlife.

What management actions would help to increase the diversity of animal species and their abundance? Animals vary considerably in their habitat needs – diversity is the key to ensuring a range of animals can be accommodated. Actions that will benefit many animals include: retain fallen timber and leaf litter for small mammals and reptiles; retain standing dead trees or old trees with hollow limbs for nesting sites for birds, mammals and reptiles; discourage problem species like noisy miners and introduced predators by maintaining large patches of woodland with complex structure; avoid clearing remnant vegetation; and retain areas of brigalow regrowth for more than 30 years.

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Reference

McAlpine C, M Maron, M Bowen & G Smith (2011). ***Conserving Biodiversity in Brigalow Landscapes***. Uni of Queensland.

A copy of the Booklet may be downloaded from:
http://www.gpem.uq.edu.au/brigalow

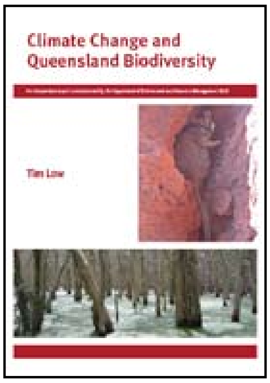
Dbytes

Infomation, resources & opportunities for decision makers

Climate change and Qld Biodiversity

This report is one of the first detailed considerations of how Queensland biodiversity may be impacted by climate change.

http://www.derm.qld.gov.au/wildlife-ecosystems/biodiversity/climate-change-report.html



Threat abatement plan for cane toads

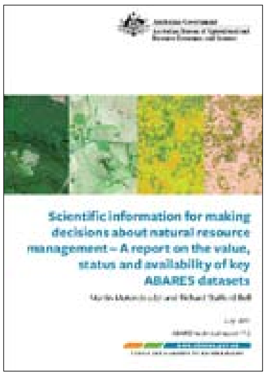
from SEWPaC

http://www.environment.gov.au/biodiversity/threatened/publications/tap/cane-toads.html

Scientific information for making decisions about natural resource management

A report on the value, status and availability of key ABARES datasets.

http://adl.brs.gov.au/data/warehouse/pe_abares99010701/TR11.2ScienceInfoNRM_lowres.pdf



Welcome to the new look *Decision Point*!

"When you're finished changing, you're finished," or so Benjamin Franklin is reputed to have said. Well, even though ***Decision Point*** has been soldiering on for three plus years, we're not finished yet so we thought a change was in order (to coincide with our new funding arrangements). To that end, we redesigned our look, and this issue marks the launch of a fresher, cleaner version of ***Decision Point***. Mindful of the feedback we received at the end of last year, we've kept all the things that readers said they enjoyed and valued, hopefully it'll all be just a bit easier to get at.

Many thanks to Simon, Joss and Tara at Graphic Ark who built the template of our new look. Check them out at http://www.graphicark.com.au/

David Salt

What's the point?

Games people play

It's said that playing games is the best way to learn. Scientists at the University of Washington's Center for Game Science have taken that a step further and are designing games that are helping researchers solve some of the world's really hard problems. The idea is that people's combined intuition can solve problems even super computers can't crack. A few years ago they developed a computer game called ***Foldit*** which allowed players to manipulate a protein's components. ***Foldit*** players create new configurations of known proteins (though with unknown foldings such as the structure of the monkey virus protein, pictured) and the result is assessed by computers. So far, ***Foldit*** has attracted more than 100,000 players from around the world, most of whom have no background in biochemistry, and, according to an August 2010 paper published in the journal ***Nature***, has shown that in certain instances—particularly those where intuitive leaps or major shifts in strategy are called for—the game and its group mind actually outperforms the super computers.

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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