Decision Point

Issue 23 / October 2008

Connecting conservation policy makers, researchers and practioners

Smart science for wise decisions

How much to save Australia's birds?

Optimal investment in saving species

Page 6

Helmeted honeyeater or moneyeater?

What's needed to better protect it? - p7

Save, survey or surrender?

When do we give up on Sumatran tiger? - p4

Last days of the condor (?)

The cost of saving just one threatened species - p8

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

Well endowed - naturally

A new model for national NRM investment?

By Hugh Possingham (Director, AEDA)

As a nation we're failing hopelessly to secure our most precious and unique natural asset – Australia's biodiversity. Since 1990, the Australian Federal Government has announced seven major natural resource programs collectively worth $6.51 billion (Hajkowicz, 2008), and the auditors have consistently pointed out that we have no idea what this investment is achieving.

In 1997 the Australian National Audit Office (ANAO) said "Performance information is not adequate for program managers in DPIE or Environment Australia to determine the quality or the nature of outcomes being achieved" and by 2008 their mood hadn't changed: "Overall, the ANAO considers the information reported in the DAFF and NHT Annual Reports has been insufficient to make an informed judgement as to the progress of the programs towards … outcomes".

Aside from a failure to prove substantive biodiversity outcomes there have been other concerns. First, the Federal Government has struggled to focus the regions on matters of 'National Environmental Significance'. Aside from having a dull name – what are they? They are the biodiversity assets for which the nation assumes duty of care, like World Heritage Areas and listed threatened species and communities (see http://www.environment.gov.au/epbc/protect/index.html). Second the NRM bodies, all 56 of them, have been hamstrung by uncertain funding, bureaucratic mazes and short timelines. How can we harness the talents of our best and brightest in an industry that rarely offers more than twelve months employment?

Is this anyone's fault? Probably not; if anything it reflects a mismatch between the timeframe of politics, years, with the timeframes of delivering credible biodiversity outcomes in a variable climate, decades.

In this editorial I propose a bold new model for delivering biodiversity outcomes by the NRM bodies. I don't expect anyone to take it seriously, however it gives me an ivory tower from which to snipe.

The Possingham proposal has several parts. First, the Federal Government places $200 million dollars, or so, in a trust for every one of the 56 NRM regions (http://www.nrm.gov.au/nrm/region.html). That trust fund is an endowment managed by trustees that releases about 4% per annum to the regional body (hence, ignoring the odd financial crisis, the endowment retains its value in real terms and delivers $8 million per annum for biodiversity conservation for every region forever).

Second, the NRM body has complete power, and responsibility, with respect to how it spends its money – no reports or business plans to be delivered to the Federal Government so they can gather dust in a filing cabinet. They can plan, but only if they think planning is cost-efficient in the context of their task – securing and improving the state of the region's biodiversity asset. The trustees would do normal financial auditing.

Third, from 2010 to 2015, the Federal Government uses the biodiversity parts of the Wentworth Group's new National Environmental Accounts (http://www.wentworthgroup.org/docs/Accounting_For_Nature.pdf) to create and measure baseline indices for the state of each region's biodiversity driven by their matters of National Environmental Significance. During that period we create a composite biodiversity index for each region that is set to a value of 100. Every five years the biodiversity accounting office provides another composite biodiversity index, a measure of real outcomes on the ground. The index will be made up of things like: the abundance or distribution of a population of threatened species, the condition of vegetation in a world heritage area, or counts of waterbirds in a Ramsar wetland. The accounting is paid for by the Federal Government, but carried out by an independent office in cooperation with the states and NRM bodies. Raw data is published on the web within a month of collection.

> "the NRM body has complete power, and responsibility with respect to how it spends its money – no reports or business plans to be delivered to the Federal Government so they can gather dust in a filing cabinet"

Hugh Possingham thinks the Federal Government should place $200 million dollars in a biodiversity trust for every one of the country's 56 NRM regions. "Yes, we have to put some dollars up front," he says "about 2% of the global financial bailout, but I can't think of a cheaper way to secure 5% of the entire globe's biodiversity in perpetuity."

Lastly, we need a mechanism to reward the regional bodies for outcomes; that is, performance in improving the matters of National Environmental Significance. Every five years the endowment is adjusted according to outcome performance in line with agreed rules, something like the following. The composite biodiversity index for each region measured every five years will have a mean value and uncertainty about that value. If the mean value increases, the endowment is augmented by 10 times that increase (a 1% increase in the index will generate $20 million in 2010 dollars). If the index declines the endowment is reduced, but only if we are 90% sure the index has declined more than 1%. If the index falls by 10% the NRM body is dissolved and tenders are sought for a new body. This new NRM body could be a mix of public and private interests, a neighbouring NRM body, maybe the state government or Australian Wildlife Conservancy?

So does this new proposal have any merit? I think so; it provides longevity and stability; it is all about outcomes on the ground and rewards performance; it focuses on the environmental matters the federal government are concerned about; it has minimal transaction costs; and it empowers regional communities. A side benefit is that the National Environmental Accounts will have uses beyond this program.

The Perpetual NRM Endowment Scheme

The problem

• regional NRM bodies are hamstrung by uncertain funding, bureaucratic mazes and short timelines

• they have a poor focus on biodiversity outcomes and little interest in assuming a duty of care for threatened species, World Heritage Areas and other significant biodiversity assets.

• an ongoing failure to report outcomes on NRM investment.

A solution

1. An endowed trust – Government places $200 million dollars in a one-off endowed trust for every NRM region. That trust fund delivers in interest $8 million per annum for biodiversity conservation.

2. Regional autonomy – The NRM body has complete power and responsibility on how it spends its money in securing and improving the state of the region's biodiversity assets.

3. A biodiversity index that allows the measurement of outcomes – The Federal Government creates and measures baseline indices for the state of each region's biodiversity (a composite biodiversity index for each region that is set to a value of 100). Every five years the biodiversity accounting office provides another composite biodiversity index, a measure of real outcomes on the ground.

4. Feedback between outcomes and ongoing investment – Regional bodies are rewarded (or penalised) for outcomes. Every five years the endowment is adjusted according to outcome performance according to agreed rules.

And this endowment proposal provides opportunities for other investors. The Nature Conservancy, or an independent philanthropist, may wish to add to the endowment for a region – or establish a sister endowment with slightly different objectives (eg, regional biodiversity interests). The Federal Government may wish to increase the endowment in an area where there is extra biodiversity – a biodiversity hotspot. States may wish to match the federal investment.

The devil, of course, is in the detail; for example, agreements for changing a regional biodiversity index as we learn about accounting for biodiversity. Fortunately, I am not a detail person.

How much might this all cost? Assuming we endow the auditing – at most $20 billion, but that's a once off payment. It's equivalent to the surplus for just one year, or around $1,000 per Australian. And consider this, as a nation we've spent more than $6.5 billion on major natural resource programs since 1990 (Hajkowicz, 2008) and, based on repeated audit reports, we've got nothing to show for it. The US spent US$3.5 billion on just three environmental programs in 2005 (Hajkowicz, 2008).

Yes, we have to put some dollars up front, but I can't think of a cheaper way to secure 5% of the entire globe's biodiversity. Can you?

Hajkowicz SA (2008) The Evolution of Australia's Natural Resource Management Programs: Towards improved targeting and evaluation of investments. *Land Use Policy*. doi:10.1016/j.landusepol.2008.06.004

DPoint News

Smart women of Queensland: *Once again AEDA featured prominently in Queensland's Smart women – Smart State Awards. This year Josie Carwardine, Carissa Klein and Eve McDonald-Madden were all finalists and highly commended for their achievements in developing and implementing novel decision making approaches for saving biodiversity. Carissa and Eve (the ones with white arrows overhead) are pictured here at the award ceremony (Josie was overseas at the time.)*

CERFs up (again): *The second annual CERF Conference was held in September in Canberra. Whereas the first conference in 2007 was a 'meet-and-greet' session between the newly formed hubs, this time around there was a greater focus on matching up CERF science with DEWHA's policy needs. The two day event staged a number of panel-based workshops in which key policy challenges were laid down for discussion between policy makers and CERF researchers. Workshop topics included biodiversity policy, environmental information, 'Caring for our country', the EPBC Act and climate.*

Decision making underpinned much of the discussion and, as you'd expect, AEDA was a strong voice constantly asking how much and what type of information do you need to make a good decision. Mick McCarthy (arrowed) is pictured here making a point on the EPBC Policy Workshop panel.

KBs first contact: *And while the CERF Hubs were doing a bit of 'group' thinking, the CERF KBs (that's knowledge brokers to the uninitiated) decided it would also be a good opportunity to meet and share notes. And so it was that CERF KBs met (pictured here) for the first time immediately following the CERF conference and discussed their experiences. It quickly became apparent there was a wide diversity of knowledge broking activities and experience across the hubs; from the research-orientated end through to out-put focussed efforts. Now that the KBs have made contact it's hoped we'll maintain the interaction and hopefully generate more cross-hub activities. (See page 11 for an example of an AEDA/Landscape Logic co-production.)*

Save, survey or surrender?

Optimal management of a secretive species

An AEDA info sheet

When the numbers of an endangered species declines to a point where it becomes difficult to find, how do you prioritise your resources? Do you assume the species has gone extinct and reallocate the resources to other endangered species (surrender)? Or do you put more of your resources into monitoring for the species to find out if it's still around (survey)?

But, of course, there's also a third option; you could just assume the species is still present and keep on managing its environment as if it's there. In this third option you could do more management because you're not diverting resources into monitoring (which is resource-intensive and may not successfully detect the species in question anyway, even it is still around). Let's call this third way the 'save' option.

So how do you manage an endangered species that hasn't been seen for a while: Do you save, survey or surrender?

New research led by AEDA suggests the optimal strategy, most of the time, is the save option. That is, conservationists should carry on managing the environment as if a seemingly vanished species is still around rather than rushing to check whether it is extinct. And the researchers have demonstrated the validity of this strategy with an analysis on the endangered Sumatran tiger found in Western Indonesia.

There are many species of threatened animal and plant that have not been seen for some time. These cryptic species present a major intellectual, and in the case of the Ivory-billed Woodpecker (see *AEDA News #8*) a very public, costly and controversial challenge for managers.

"A lot of threatened species are cryptic," says AEDA's Hugh Possingham. "The question is how do you know how to best protect them?"

The research, headed by Dr Iadinè Chades from AEDA's Brisbane node, found that the most cost-effective strategy is to assume the species is still around and manage for it, even though it hasn't been seen for some time. The next big question, then, is how long you apply this strategy.

"Several factors influence just how long conservationists should wait before starting to search for a species," says Possingham. "That includes the value of the species, its detectability and its probability of extinction."

The underlying principle, however, is that money should be spent first in managing the environment to give a threatened species the best chance of survival, rather than engaging in efforts to survey for its presence. The optimal strategy is to invest in active protection.

The researchers illustrated their findings with a case study using parameters based on the critically endangered Sumatran tiger (*Panthera tigris sumatrae*). The tiger had apparently vanished from certain areas, but may or may not have become extinct.

The modelling they carried out suggests that if the Sumatran tiger is detected in the reserve, the optimal strategy is to manage it for 12 years from that time regardless of whether there are subsequent detections or not. If, however, the tiger is not observed at all during that 12-year period, then we should switch from the active management option (save) to an intensive monitoring phase (survey). In other words, all resources should be switched from managing the tiger back to surveying for it.

"I think this was a surprise that was thrown up by our analysis," says Eve McDonald-Madden, a coauthor of the study. "What was counterintuitive was the length of time

The Sumatran tiger, like all the tiger subspecies, has suffered dramatic population declines as a result of a reduction in prey abundance, habitat clearance, and illegal poaching. The researchers asked: What is the optimal management strategy for this highly valued species? When is it best to invest money managing the Sumatran tiger, when should we survey to assess the status of the population, and when, if ever, should we give up?

you should keep managing the environment. We showed that often you should manage for a lot longer without seeing them."

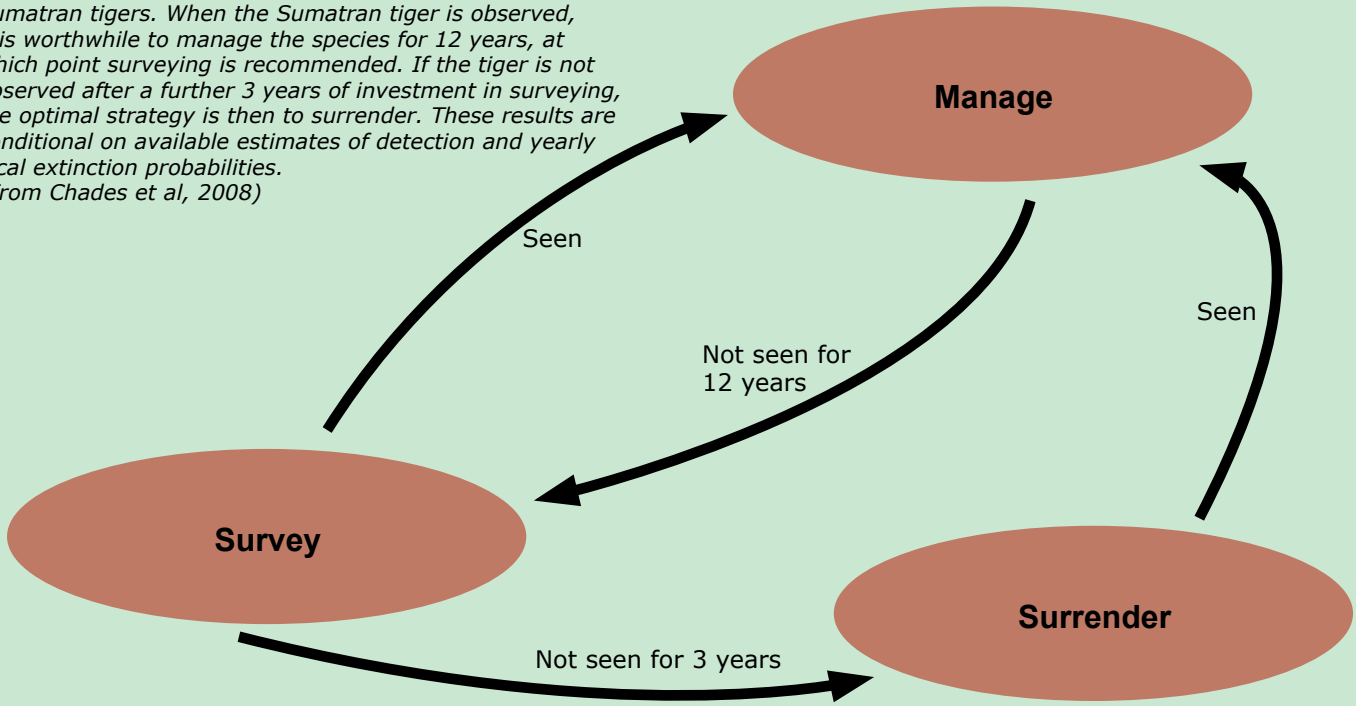
However, if the species remains unobserved for a further 3 years of dedicated surveying, then the optimal strategy is to stop investing resources in conserving this species (surrender). Of course, this sounds a bit fatalistic (though some might say realistic) in that it might be interpreted as we're 'giving up' on a species. A more constructive way of phrasing it is: when surveys have convinced us (with a high degree of certainty) that the species is gone, we surrender resources to other conservation actions (other species, habitats and conservation causes).

Rather than being a form of hard-hearted, soulless ecological rationalisation, decision frameworks arising from analyses such as these aim to assist conservation workers make decisions in the face of seemingly impossible options – how do you prioritise limited resources when species of high value can't even be found any more. You're damned if you do (ie, continue managing for a cryptic species in the hope that it might be around) and damned if you don't (ie, put more resources into looking for the cryptic species thereby possibly losing the species because you weren't managing for it well enough).

This decision framework provides a method for determining how you might best manage this situation. Best management involves actively managing for cryptic species for a period (regardless of whether it's detected or not). If after that period the species hasn't been spotted, switch to intensive monitoring for a further period to assure yourself

> "Analyses such as these aim to assist conservation workers make decisions in the face of seemingly impossible options – how do you prioritise limited resources when species of high value can't even be found any more"

Decision graph representing the optimal strategy for Sumatran tigers. When the Sumatran tiger is observed, it is worthwhile to manage the species for 12 years, at which point surveying is recommended. If the tiger is not observed after a further 3 years of investment in surveying, the optimal strategy is then to surrender. These results are conditional on available estimates of detection and yearly local extinction probabilities.
(From Chades et al, 2008)



the species is not still around. And, finally, if you can't find it during this period, accept that the species is lost and surrender the resources that were available to saving this species to some other conservation target.

And it's easy to see that, without such a decision framework, decisions to manage species that can't be seen (or accepting a species is lost) might be politically difficult to accept. Without the support of such as framework, public sentiment would intuitively swing towards a greater effort to find the cryptic species. And no one wants to admit that a species has been lost, consequently efforts to find a cryptic species sometimes go on for years (even decades, think of the Tasmanian tiger) beyond the point where there is any reasonable chance of finding that species. And the available resources devoted to that search may well have achieved a greater good if they had gone to another species in need.

The time you allow for the save and survey periods depends on a number of factors including the value of the species, its detectability and its probability of extinction. In the case of the Sumatran tiger the researchers determined the save period is best set at 12 years and the survey period at 3 years. Of course these solutions are not perfect and can't be absolutely black and white. The 'value of the species' for example will vary from person to person.

However, applying such frameworks allows the decision to be robust and transparent and allows a clear management plan to be drawn up and implemented. The alternative is to allow *ad hoc* plans to be applied to suit short term interests.

Hugh Possingham believes efforts to save the Tasmanian tiger would have been better served by their approach.

"We probably should have actively managed for them in the wild a lot longer than we did," he says. "In retrospect they should have been making sure nobody was persecuting them for at least another 20 years or so from when they were last seen."

Reference

Chades I, McDonald-Madden E, McCarthy MA, Wintle B, Linkie M, and Possingham HP (2008), When to stop managing or surveying cryptic threatened species, *PNAS*, 105: 13936-13940.

The tale of the tiger

The Sumatran tiger is only found naturally in Sumatra, a large island in western Indonesia. It lives anywhere from lowland forests to mountain forest and inhabits many unprotected areas. Only about 400 live in game reserves and national parks and the rest are spread out in areas that are quickly being lost to agriculture. The reserves are not safe because, despite conservation efforts, many tigers are killed by poachers each year.

The Sumatran tiger is the smallest of all still existing tiger subspecies. Male Sumatran tigers average 2.3 metres in length and weigh about 135 kg. Females average 2 metres in length and weigh about 90 kg. Its stripes are narrower than those in other subspecies, and it has a more bearded and maned appearance, especially the males. It has webbing between its toes that, when spread, makes Sumatran tigers very fast swimmers, and it has been known to drive hoofed prey into the water, especially if the prey animal is a slow swimmer. Sumatran Tigers commonly prey on wild boar, tapir, deer, fowl and fish and orangutans.

Source: Wikipedia

How much to save Australia's birds?

Optimal investment in saving species

By Mick McCarthy (Uni Melb, Melbourne Node, AEDA)

Are we wasting scarce conservation resources by trying to manage the world's most endangered species? Should that money be spent on species with greater prospects for survival? Or are humans obliged to try to save the most endangered species because our actions have caused their decline? These questions polarise 'the triage debate', which more generally considers how best to allocate a finite budget for the conservation of threatened species.

We recently examined these questions by determining the relationship between the amount of money invested and the change in conservation status of threatened Australian birds (Fig. 1). The analysis was carried out by myself, Colin Thompson (Melbourne University) and Stephen Garnett (Charles Darwin University), and the results of our study were recently published in the *Journal of Applied Ecology*.

We demonstrated that the best course of action depends on the efficiency of management, the exact objective we are trying to achieve, and how much money there is to spend.

We specifically examined the influence of different investments on changes in conservation class (IUCN Red List categories) of a bird species (over the period 1992-2000). Our analysis showed that the chance of a species becoming more threatened is reduced quite efficiently by spending money. In contrast, improving the conservation status of a species requires a large investment. This study is the first to demonstrate how the conservation status of species can be changed by spending money.

So what's the best or most optimal way to invest your money? Well, that depends very much on what you're trying to achieve (your objective) and how much you have to spend (the budget).

Possible management objectives include minimising the number of extinct species, minimising the number of threatened species (perhaps weighted by the level of threat), maximising the number of species that are removed from the list of threatened species, or some combination of these or other objectives. We show that the optimal level of investment in different species depends on which objective is chosen.

The optimal level of investment in different species did not necessarily reflect the level of threat, with more threatened species receiving more resources in some cases and less in others. The analysis showed that the most endangered species should only receive the most funding when the

> "We demonstrated that the best course of action depends on the efficiency of management, the exact objective we are trying to achieve, and the size of the budget."

Threatened birds of Australia

Around 770 bird species occur in Australia and its territories (of which approximately 600 breed). Of these species, 180 taxa (mainly species but some subspecies) are threatened, with a further 81 taxa of conservation concern. Examples of these are presented over the next couple of pages.

Major threats to Australian birds include the destruction and fragmentation of native vegetation, grazing, inappropriate fire regimes, intensification of agriculture, changes in hydrology, reduction in coarse woody debris, introduced animals, longline fishing and climate change.

Conservation actions undertaken in Australia have aimed to mitigate the impact of these threats. These actions include, among other measures, captive breeding programs, controlling competitors and exotic predators, provision of supplementary food, and the protection and enhancement of habitat.

Our analysis indicates that an annual budget of $10 million (that's an average of $37,000 per species of conservation concern) can be expected to reduce the number of threatened species in 80 years time by approximately 15% while limiting the number of extinct species to one. It should be noted that this level of spending is approximately three times what is being spent at the moment.

The brown treecreeper

The brown treecreeper is not listed as a nationally threatened species, but the eastern subspecies is listed as vulnerable in New South Wales. As with many woodland birds, its numbers have been declining in recent times, particularly in smaller and more isolated patches of remnant vegetation. Its decline is partly attributed to the decline of tree hollows in both live and dead trees, which it uses for nesting. Tree hollows take a century or more to develop, but can be lost in an instant. The protection of this resource, and managing grazing to promote regeneration of understorey plants, would benefit this and other woodland bird species.

Photo: copyright Julian Robinson

> "the most endangered species should only receive the most funding when the budget is large, or when we are aiming to minimise extinctions rather than the number of threatened species."

budget is large, or when we are aiming to minimise extinctions rather than the number of threatened species.

The relationship between conservation outcome and expenditure can predict how different budgets can achieve particular conservation outcomes. Extinctions of Australian birds can be largely avoided over the next 80 years given current expenditure, but greater investment in conservation is required to reduce the number of threatened species. For example, tripling the annual budget to $10 million can reduce the number of Australia's threatened bird species in 80 years by approximately 15%, with only one extinction expected in that time.

The most efficient allocation of resources to conserve species is difficult to determine intuitively. This allocation requires formal decision theory, an approach being explored all across AEDA's activities. The influence of the particular management objective on the optimal decision means that managers, and society in general, need to consider more carefully what they are trying to achieve in conservation programs.

Continued on page 8

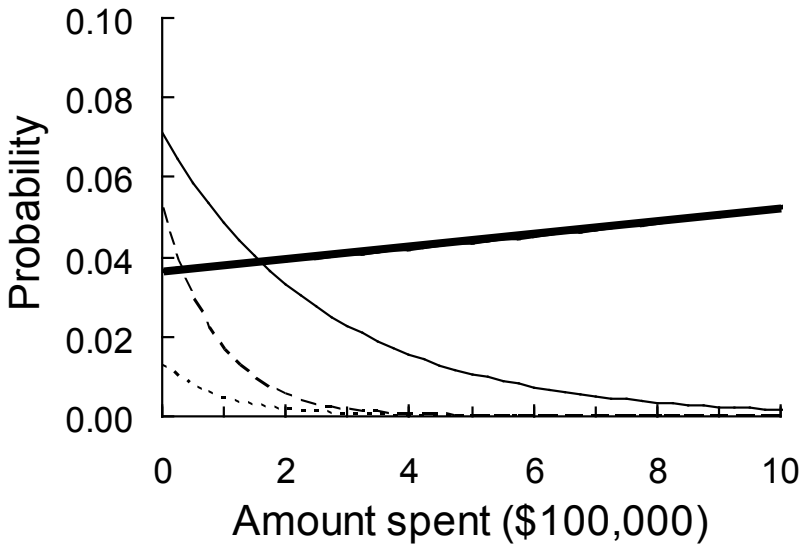


Figure 1. The probability of changing IUCN category versus the amount of money spent on Australian birds for the period 1992-2000 (based on data in Garnett et al, 2003).

For threatened species, results are shown for declines of one (thin line) and two (dashed line) IUCN categories. In other words what's the probability of a threatened species moving to a more threatened category as the amount of money spent increases.

The thick line is likelihood of threatened species moving to a less threatened conservation category (as more money is spent.)

The dotted line is the probability of non-threatened species becoming vulnerable.

The superb parrot

Listed nationally as vulnerable to extinction, the superb parrot is large and brightly coloured. It is found in inland woodlands of New South Wales and Victoria. This parrot requires tree hollows for breeding, so its persistence is threatened by the loss of this resource and the woodlands in which it forages. Conservation actions focus particularly on protection and enhancement of woodland habitats. Superb parrots are killed by vehicle collisions when they are attracted to spilled grain on roads. Removal of this grain will also contribute to the survival of the species.

The helmeted honeyeater

The helmeted honeyeater (a subspecies of the yellow-tufted honeyeater, a common species) has the unfortunate nickname of "helmeted moneyeater" because it receives more funding than many other Australian birds. However, it is one of Australia's most threatened birds, with less than 100 individuals in the wild, and it is valued highly by society, in part because it is one of Victoria's faunal emblems. Threatened by loss and degradation of habitat, and from competition with bell miners, conservation actions such as captive breeding and release, control of competitors, and protection of nests from predators have helped to prevent its extinction. Our analysis suggests that increased investments in this and other birds would be required to substantially reduce the number of threatened Australian bird species.

The powerful owl

Powerful owls are not listed nationally as threatened, but they are considered vulnerable to extinction in Victoria and New South Wales. Australia's largest owl, it occupies a wide range of habitats, including forests, woodlands and urban areas. Sightings in cities can be reasonably common, but breeding in these areas is uncommon because the large tree hollows that are required for nesting are rare, and nests are often abandoned in the presence of frequent human activities. The photo below was taken when this owl visited the Australian Botanic Garden in Canberra for 6 months in 2007. It fed extensively on the populations of arboreal marsupials in the vicinity.

Photo: copyright Julian Robinson

The wedge-tailed eagle

The wedge-tailed eagle is common and widespread, but the Tasmanian sub-species is endangered with less than 1000 individuals. Wedge-tailed eagles build large nests of sticks in trees or on cliff ledges. Their diet is diverse, depending on local availability of prey, but rabbits and hares are important food sources where these introduced mammals are common. Wedge-tailed eagles hunt live prey, but they also feed on carrion including that of domestic stock. Because of this, some land owners believe they kill domestic animals, leading to the establishment of poisoning and shooting programs. In reality, wedge-tailed eagles rarely kill healthy livestock. In addition to human persecution, the major threats are loss of nesting habitat and disturbance of nests.

Photo: copyright Julian Robinson

Optimal investment in saving species

Continued from page 7

Overall, our analysis suggests that, for greatest efficiency in the allocation of resources to species conservation, governments need to make overt decisions about their conservation objectives. Currently this is something that is at best simply implied in legislation, and is usually ambiguous in either statutes or in policy.

As it is, decisions are being made in the triage debate by default without a strategy for achieving long-term objectives that have been open to public debate. The allocation of resources should also be undertaken in a considered way across all species, taking into account the diverse values placed on species by society, not piecemeal across various levels of legislature as is the case within most jurisdictions.

Finally our analysis suggests that allocating resources today based on agreed objectives is likely to have the desired benefit for a substantial period into the future.

More info: Mick McCarthy <mamcca@unimelb.edu.au>

References

McCarthy MA, Thompson CJ, and Garnett ST (2008) Optimal investment in conservation of species. *Journal of Applied Ecology* 45: 1428-1435.

Garnett ST, Crowley GM, and Balmford A (2003) The costs and effectiveness of funding the conservation of Australian threatened birds. *BioScience* 53: 658-664.

Last days of the condor (?)

And while we're on the topic of endangered birds, the American Ornithologists' Union (AOU) has just released a review on efforts to save the Californian condor. Their findings make sobering reading and underline the high costs of saving critically endangered species.

The condor, the largest soaring bird in North America , was the first animal for which a recovery program was created in the US (in 1975) but initial efforts failed to stem the decline in numbers. In 1986 the last three birds left in the wild were captured and put into a breeding program.

However, with much money spent and a sustained effort by many groups, condor numbers increased. Now their population sits at 300 birds, 150 of which are living in the wild. But these 'free' condors can only stay in the wild if they're regularly trapped and treated for lead poisoning (the lead comes from shot gun pellets in carrion that they feed on). It's argued that the wild population is really little more than an outdoor zoo population.

Currently, the US spends $US5 million per year on the combined condor program.

To read the report yourself visit the AOU at http://www.aou.org/

Ignorance and uncertainty: academic orphans

by Gabriele Bammer and Michael Smithson

Donald Rumsfeld's remarks on unknown unknowns still lead people to chuckle. But he was right. The challenges we should be most worried about are the ones we don't know we don't know.

In the early 1980s, before the AIDS epidemic took hold, there were confident predictions that communicable diseases would no longer be a significant threat to population health. But AIDS was a new kind of infectious disease which caught us unawares killing millions of people. Unknown unknowns are amongst the hardest kinds of uncertainty to deal with. They are most easily recognised in hindsight – but that can be too late.

Unknown unknowns are not the only kind of uncertainty we find it hard to get our heads around. Indeed the notion that there are different kinds of uncertainty is foreign to most of us. But real world problems contain different types of uncertainty and that's a large part of their challenge.

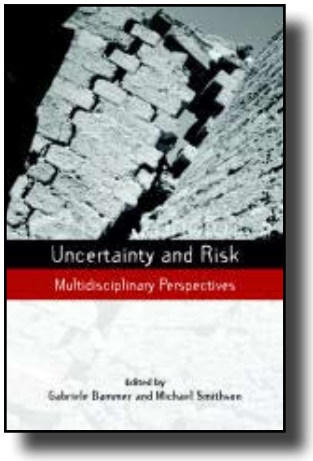
Take the problem of global climate change. If we want to discuss the existing predictions, the first kind of uncertainty we encounter is 'taboo' – the reluctance to open the topic up for debate because of the necessity, if the figures are correct, to get strong political action taken without delay. Some aspects of the estimates are imprecise, others are conflicting – two further kinds of uncertainty. Politicians will be lobbied on the topic by various interest groups, some of whom will selectively ignore or otherwise distort information. This may be to simplify it for ease of communication or for less benign ends. In any case, distortion is another kind of uncertainty. None of these kinds of uncertainty relates to probability, which is the form of uncertainty we tend to be most familiar with. Probability will enable the chance of various events occurring to be calculated, but it does not encompass concepts such as taboo or distortion.

Each of these different forms of uncertainty requires a different response, which may have significant additional ramifications. For example, removing the taboo on debate about global climate change will allow the evidence to be further scrutinised and most likely improved, but may well delay political action, which is likely to be more important and urgent. Obtaining more precise estimates may be costly and divert resources from other important research areas. Recognising the likelihood of distortion and seeking to provide countervailing evidence may lead to information overload for the recipient. Moreover, increasing certainty about global climate change trends may be of little use for making decisions in specific regions because uncertainties about local consequences of climate change and their political and social fallout generally are not resolved by global models.

No discipline or practice area covers more than a fraction of the terrain of ignorance and uncertainty, and most disciplines reduce unknowns to one kind. Thus, the discipline of statistics concentrates on uncertainties that can be managed with probability theory. While that's been hugely important in many spheres of our life, it's not much use to the intelligence community which suffers from either gaps in information or reams of sometimes conflicting data. Different techniques are required to make decisions when critical pieces of information are missing, from when there are truckloads to sift through and assess.

Interestingly, the uncertainty challenges which confront historians are much the same as those which intelligence officers have to contend with. Lawyers on the other hand, face a different set of challenges. People having their day in court don't want to be told that they are probably innocent. They want the judge to make a determination to settle the matter once and for all. Knowing judges can't get it right all the time, the law tries to set in place a range of safeguards against the uncertainties judges face, including rules of evidence and trial by jury.

> "The challenges we should be most worried about are the ones we don't know we don't know"



The problem is that it's no-one's job to pull together these understandings about different kinds of uncertainty. No discipline or practice area has the mandate to take such a big picture view. And it matters precisely because real world problems don't confine themselves to single well-understood kinds of uncertainty.

It also matters because uncertainties can be beneficial as well as detrimental. Freedom is positively badged uncertainty; without uncertainty there is no liberty. Likewise, a climate favouring innovation and entrepreneurship requires tolerating some uncertainties and risks. The absence of a big picture view of uncertainty can blind us to these important tradeoffs.

As a society, we've realised the importance of bringing together knowledge from different disciplines and stakeholder groups in tackling problems like global climate change, ageing, obesity and biosecurity. But what we know is only half the picture. In fact it's usually less than half. There's generally much more that we don't know or can't be certain about. We need a complementary effort to bring together different perspectives on what we don't know – to better understand the unknowns and to develop good management strategies.

Universities and other research institutions are starting to develop effective ways to bring different kinds of knowledge together, but attention to different kinds of uncertainty is sorely lacking. When dealing with uncertainty, society is poorly served by current academic arrangements. More attention needs to be focused on uncertainty, both in researching real-world problems and in educating the next generation of decision-makers, researchers and informed citizens.

In our research we've seen numerous 'ah ha' experiences when we have brought together proponents from fields as diverse as art history and economics, emergency management and philosophy, music and theology. We're working on untangling the types of uncertainty involved in three fields: environmental management, communicable diseases and illicit drugs. We've started to lay out major conceptual strands in uncertainty thinking and to develop an integrated view of the nature of uncertainty, uncertainty as a motivating or de-motivating force, and strategies for coping and managing under uncertainty.

We don't see the lack of sophistication in current methods for understanding and dealing with uncertainty as a cause for pessimism or nihilism. On the contrary, it has never been more important to bring this vital topic into the mainstream of academic enquiry.

Making decisions in the face of uncertainty is a major theme across all of AEDA's activities, and Decision Point *welcomes all contributions on this topic. Gabriele Bammer is a Professor at the National Centre for Epidemiology and Population Health and Michael Smithson is a Professor in the School of Psychology, both at The Australian National University. Their book is* Uncertainty and Risk: Multidisciplinary Perspectives*, (London: Earthscan, 2008).*

Shakespeare, Wald and decision making under uncertainty

by Mark Burgman (UMelb, Melboune Node, AEDA)

It was difficult for me to know whether to respond to the opinion piece by Sniedovich (2008). There's not much to disagree with in the historical account that makes up the first part, but in the second part Sniedovich misrepresents decision problems in the conservation biology and applied ecology literature, and this should not go unchallenged.

The piece spends the best part of a page noting the worthy contribution to decision theory expressed by Wald's Maximin Principle which, as Sniedovich points out, dates back at least to Shakespeare and almost certainly as far back as people have been making sensible choices when confronted by an uncertain and dangerous world. Against this backdrop, Sniedovich (2008) provides a critique of Info-gap theory, claiming it is an instance of Wald's Maximin Principle, and that it doesn't deal with severe uncertainty (Sniedovich's definition of which is too narrow to be useful).

Sniedovich (2008) asserts that the conservation biology and applied ecology literatures are spotted with assertions that Info-Gap's robustness model addresses the following question: how wrong can I be, yet get an acceptable level of performance? But this question wasn't asked in the first place. Rather, the question asked in various applications of Info-gap has been the following: How wrong can this model be, without jeopardizing an acceptable level of performance? While the two questions might appear the same, there are important differences. In Sniedovich's (2008) words, the latter question asks; how much can I deviate from the given estimate so that the performance requirement is satisfied throughout the region of uncertainty?

Sniedovich (2008) correctly points out that Info-gap's robustness model guarantees that the performance constraint will be satisfied if the true value is in the 'safe' sub-region of uncertainty determined by the robustness analysis. The reason why this question matters in a world of real decisions is that there comes a time when a specific decision (a single model from among the universe of possibilities) has to be accepted, when the reserve system has to be selected and purchased, when the investment has to be made to build a fence rather than translocate a population. This decision becomes the focal point for thinking.

When that time comes, and irrespective of how we arrived there, we want to know how much can we deviate from the given estimate (the model for the thing we are actually going to do) so that the performance requirement is satisfied throughout the region of uncertainty around the nominal estimate. It's understood that there is no absolute guarantee that the true value is in this 'safe' sub-region. No method can guarantee this.

Sniedovich (2008) says that this is not so interesting a question. In the large world of mathematics, he may be right. In the small, applied world of environmental decision-making, it's life-and-death.

A very small measure of experience tells us that neither Laplace nor the Maximin Principle are sufficient for decision-making under uncertainty. In some situations, it's not possible to say what the 'worst' case is for a given model, a problem akin to specifying 'sure' bounds on a highly uncertain quantity. In other decision contexts, several alternatives may present 'worst' outcomes that are tolerable. What would Wald (or Shakespeare) suggest we do? If they are sensible, they might suggest we look for the alternative among a satisfactory set that promises the best expected outcome. After all, who doesn't like a windfall gain, especially if you can't lose too badly.

Of course, decision theorists have been thinking about these issues for a while (eg, Simon 1956, Rosenhead et al 1972, Gupta and Rosenhead 1972, Mulvey et al 1994, Kouvelis and Yu 1997, Ballestero 2002). We can again claim Shakespeare's credentials as a decision theorist. He tells us that it is better to be safe than sorry, that *The better part of valour is discretion...,* (Henry The Fourth, Part 1 Act 5, scene 4).

The strategy you choose should depend on your personal circumstances, your attitude to the outcomes, how many such games you intend to play, and so on. Info-gap has a role to play in decision making under uncertainty, partial ignorance, severe uncertainty, non-probabilistic uncertainty or whatever one chooses to call it. Once we've settled on a (tentative) choice, the question invariably arises, how robust is THIS choice, how far wrong can I be in the choice of parameters and assumptions for THIS model, before the outcome would be unacceptably bad. Info-gap can help.

My view is that the complaints raised by Sniedovich (2008) are semantic and tangential to the real business of making better decisions. I'm sure that operations research and the community of mathematicians involved in it offer fantastic opportunities to improve decision making. I'd like us to move away from the semantic debate, towards one that concentrates on building and improving tools for problems that matter.

References

Ballestero E (2002) Strict uncertainty: a criterion for moderately pessimistic decision makers. *Decision Sciences* 33, 87–108.

Gupta SK and Rosenhead MJ (1972) Robustness in sequential investment decisions. *Management Science* 15, 18-29.

Kouvelis P and Yu G (1997) *Robust discrete optimization and its applications.* Kluwer Academic, Dordrecht.

Mulvey JM, Vanderbei RJ and Zenios SA (1995) Robust optimization of large-scale systems under uncertainty. *Operations Research* 43, 264-281.

Rosenhead MJ, Elton M and Gupta SK (1972) Robustness and optimality as criteria for strategic decisions. *Operational Research Quarterly* 23, 413-430.

Simon H (1956) Rational choice and the structure of the environment. *Psychological Review* 63, 129-138.

Sniedovich M (2008) From Shakespeare to Wald: Modelling worst-case analysis in the face of severe uncertainty. *Decision Point* 22, 8-9.

"Once we've settled on a (tentative) choice, the question invariably arises, how robust is THIS choice, how far wrong can I be in the choice of parameters and assumptions for THIS model, before the outcome would be unacceptably bad. Info-gap can help."

The art & science of good environmental decision making

The Fenner Conference on the Environment 2009

Australia invests billions of dollars on restoring its landscapes, protecting its biodiversity and managing invading weeds and pests. Do we get good environmental returns on this investment? Are the decisions we make for the environment transparent, accountable and defensible? Could we do better? How do we make decisions in the face of growing uncertainty?

These are big questions addressing big issues and they lie at the heart of the 2009 Fenner Conference on the Environment. Running over two days at the Shine Dome in Canberra in March next year, this Fenner Conference will bring together a galaxy of decision-making stars from the research, management and policy arenas.

If you have any interest or responsibility for environmental decision making in your organisation then this is one conference you can't afford to miss. You'll hear from some of the world's top researchers working in decision theory and have the opportunity to network with Australia's finest scientists and environmental managers. Numbers are strictly limited (to just over 200) so you should get several opportunities to discuss your area of interest with the relevant researcher or policy maker. However, because of the number limit, you don't want to leave your registration to the last month because you may miss the opportunity.

The 2009 Fenner Conference on the Environment is being jointly run by the Landscape Logic and the Applied Environmental Decision Analysis (AEDA) CERF* research hubs. The Fenner Conference is an annual event run by the Australian Academy of Science and is the country's leading environmental science gathering.

*The CERF programme is a $100 million initiative of the Australian Government to improve Australia's capacity to understand and respond to priority environmental concerns. The CERF program is administered by the Australian Government Department of the Environment, Water, Heritage and the Arts.

Seven big themes

1. Environmental decision making
How groups of people make decisions, the place of science in environmental decision making, lessons from recent experiences in environmental management including target setting and planning initiatives.
Keynote speaker: Professor Marc Mangel (USA)

2. The art and science of prioritisation
How resources are best applied to specific issues including designing reserves, allocating funds for threatened species management, and investing in water quality and vegetation condition.
Keynote speaker: Professor Bob Pressey (JCU)

3. Adaptive Management
Case studies from Australia and overseas.
Keynote speaker: Prof David Lindenmayer (ANU)

4. Monitoring design for biodiversity conservation
Characteristics of monitoring programs capable of tracking change in the status of viability of populations.
Keynote speaker: Dr Jim Nichols (USA)

5. Monitoring design for soil and water quality
Characteristics of monitoring programs capable of tracking change in environmental condition.
Keynote speaker: Dr Hamish Cresswell (CSIRO)

6. Tools & techniques for environmental decision making
Spatial and non-spatial techniques to aid decision making, accommodate uncertainty and establish links between investment and environmental condition.
Keynote speaker: Professor Tony Jakeman (ANU)

LANDSCAPE LOGIC

αεδα
Applied Environmental Decision Analysis

The art & science of good environmental decision making

The Fenner Conference on the Environment

Tues, 10 March – Thurs, 12 March 2009

Shine Science Science, Canberra

www.conferenceplus.com.au/fennerconf/2009/

Australian Academy of Science

Key decisions you need to make today

1. Can you afford to miss this Fenner Conference?
2. Have you kept the 11/12 March 2009 free?
3. Have you registered? (Keep in mind numbers are strictly limited.)

To register visit the website site today.

www.conferenceplus.com.au/fennerconf/2009/

MPAs in 10 years time

Last month the international not-for-profit conservation newsletter *MPA News* published its 100th issue making it 10 years old. MPA stands for 'Marine Protected Area' and the newsletter provides news, views, analysis and tips on marine planning and conservation. It has thousands of readers based in more than 100 countries. Congratulations *MPA News*.

To mark the occasion, their 100th issue carried forecasts from leading conservation planners and researchers (including AEDA's Hugh Possingham) on what MPAs might be 10 years into the future. Here are some excerpts. For the full commentaries, go to http://depts.washington.edu/mpanews/

MPAs will be 'nimble'
Kristina Gjerde, coordinator of the High Seas MPA Task Force for the World Commission on Protected Areas

Between now and 2018, world leaders will have realised that declines in ocean health and productivity caused by poor management, and exacerbated by climate change, can no longer be tolerated. Fisheries depletions and jellyfish invasions, harmful algal blooms and dead zones will have threatened so many areas and species - including humans - that priority will be placed on protecting and restoring the ocean's integrity and resilience. A 'nimble' system of oceans management and governance will operate at local, national, regional and global levels to deliver ecosystem-based management in an open, equitable and adaptive manner.

MPAs will be accountable and performance-based
Hugh Possingham, Director, AEDA

In ten years' time, all MPA planning and management will be done using decision support tools. The ad hoc planning and management of huge natural assets will be seen as inappropriate - as ridiculous as running an engineering firm without modeling and economic software. Some of the more enlightened marine reserve networks will have public and auditable biodiversity accounts that inform us transparently and credibly about their state. These accounts will be derived from cost-effective long-term monitoring regimes. Monitoring with no apparent purpose will be a thing of the past.

A Norwegian perspective

Alf Håkon Hoel, a political scientist at the University of Troms, Norway

MPAs in ten years' time will become more common and more diverse in terms of what they protect. The number of MPAs is set to increase considerably. And there is a need to design MPAs so that they match the biological, legal, economic and political circumstances in various regions. I think we also will see a stronger temporal element, with the level of regulation varying through the year.

Greater recognition of the need for strict protection
Callum Roberts, author of "The Unnatural History of the Sea

We will see little benefit from most MPAs while they remain lightly protected. Ten years from now, I hope that managers will recognize more willingly the need for high-level protection from human impact to redress past losses, recover ecosystems, and rebuild their resilience. I also hope that the scale of our ambitions for coverage of highly protected MPAs will have risen in tandem.

MPA news

On the toss of a coin

the funny end bit

You toss a coin 40 times and it comes up heads every time. What's the chance of it coming up heads the 41st time?

This is a problem posed by probability-expert Nassim Nicholas Taleb to get people thinking about maths and the real world. To answer it he creates two characters – the academic Dr John and streetwise Fat Tony.

Dr John answers with what every statistics student knows: "It's a 50/50 chance."

Fat Tony shakes his head and says the chances are no more than one per cent: "The coin's gotta be loaded."

The chances of the coin coming up heads 41 times are so small as to be effectively impossible. It's far more likely that somebody is cheating. Fat Tony wins, Dr John is the sucker. According to Taleb, Dr John is the economist or banker who thinks he can manage risk through maths. Fat Tony relies on what happens in the real world.

Taleb, Nassim Nicholas (2007)
The Black Swan: The Impact of the Highly Improbable.
New York: Random House

αεδα
Applied **E**nvironmental **D**ecision **A**nalysis
A Commonwealth Environment Research Facility

Smart science for wise decisions

AEDA stands for Applied Environmental Decision Analysis, a research hub of the Commonwealth Environment Research Facility program. The CERF program is funded by the Australian Government's Department of the Environment, Water, Heritage and the Arts.

AEDA's members are primarily based at the University of Queensland, the Australian National University, the University of Melbourne and RMIT.

Decision Point is the monthly magazine of AEDA. It is available free from the AEDA website <www.aeda.edu.au>. If you would like to receive an email alerting you to new issues as they are released, please visit http://www.aeda.edu.au/news

Decision Point is written and produced by David Salt. If you have news or views relating to AEDA or of interest to AEDA members, please send it to David at David.Salt@anu.edu.au

Decision Point is printed on recycled stock.

The University of Queensland AUSTRALIA
The University of Sydney
The University of Melbourne
Australian Government
Department of the Environment, Water, Heritage and the Arts
ANU THE AUSTRALIAN NATIONAL UNIVERSITY
RMIT UNIVERSITY