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Can We Have Our Biodiversity and Eat Too?

Hugh P. Possingham
Professor
University of Queensland

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KEYNOTE PRESENTATION

Can We Have Our Biodiversity and Eat Too?

HUGH P. POSSINGHAM

The University of Queensland
Email: h.possingham@uq.edu.au

Australia's isolation from other continents over millions of years led to the evolution of many species that exist nowhere else, so called 'endemic' species. Of the ten megadiverse countries in the world, we are the only one that is labelled as 'developed' so have a global leadership role in getting the balance right. However, European settlement and the introduction of exotic species animals and plants have perturbed ecosystems, leading to changes in the distribution and abundance of many species. Extinctions of species in Australia now occur at 100–1000 times the 'background' rate. Land transformation—the clearing of natural habitat for grazing, cropping and infrastructure—has been a major driver of change and species loss. Overgrazing of native pastures is a particularly widespread problem, compounded by a changing climate and a higher incidence of drought in some areas. Drought also exacerbates damage to wetlands, as river flows are reduced by over-allocation of water to agriculture and other uses. However, recent transformations in the agriculture sector (e.g. water efficiency gains) and government policy (e.g. land clearing legislation) have halted the drivers of biodiversity loss.

Now, agriculture should not be seen as the problem, but rather as the solution. The best chance for many species is persistence in an agricultural matrix, not the national parks system (which is inadequately funded to meet its management objectives). Significant progress can, for example, be made through habitat restoration, wetland creation and modifying grazing and fire management practices, all of which have major benefits through carbon sequestration. Biodiversity conservation areas should be integrated with agricultural land in ways that create almost win–win situations—*I think we can have biodiversity and eat too*. We need to prioritise ecosystems and species for conservation, and allocate resources accordingly. We also need to convince the conservation movement that preservation is only part of the solution—active and aggressive intervention is another way of conserving biodiversity. This will not be achieved easily without education of the Australian people and encouraging their love of the diversity of nature.

Professor Hugh Possingham FAA is an Australian Research Council Federation Fellow, a member of the Wentworth Group of Concerned Scientists, the Director of the Applied Environmental Decision Analysis Centre (AEDA) and the Director of The Ecology Centre at the University of Queensland. He completed applied mathematics at The University of Adelaide before attaining a Rhodes Scholarship to undertake a DPhil at Oxford; an ARC QEII Fellowship at ANU followed. In 1999 he was awarded the POL Eureka Prize for Environmental Research, and subsequently has been honoured with a number of other prestigious awards. He has a variety of broad public roles, and is a member of the Queensland Smart State Council, the Council of the Australian Academy of Science and NGO scientific advisory committees.

Introduction

I'm honoured to be here to day. Based on dinner last night and conversations this morning, probably I know less about food security than most people. I face an esteemed group of people in the audience who know an enormous amount about agriculture and biodiversity.

The first speaker today and Steve Hopper last night [page 92]set the scene. I suspect the conference organisers expected me to tell you now how much biodiversity we've got, how wonderful it is and how if we lose it we are all going to die, and that biodiversity is essential to food security. That is the standard talk, and a good one. Although I've wheeled it out many times, I don't think I com-

pletely believe it any more. I will take a different, and almost certainly unpopular, tack.

I'm going to talk about trade-offs. Both Bob McMullen and Cristián [pages 1 and 5] have already hit this nail on the head with respect to trade-offs. We do have to make choices—food security and biodiversity fight each other. It is lovely to be positive and think about the all the win–win things we can do, but in the end with many things, most things, the hard decisions will not lead to win–win. If there were a lot of win–win actions that increased the happiness of all sectors of society, we would simply do them. This will be the basic tenet of my talk.

Our research centre

I would like to acknowledge the Australian Research Council for providing me with a lot of my research funding, and the Department of Environment, Water, Heritage and the Arts[1] which funds our current research centre, the Centre for Applied Environment and Decision Analysis (AEDA). Both of these agencies have recently provided us with new and substantial support to continue to work on the science of environmental decision-making.

I was first trained as an applied mathematician and bio-chemist; I wandered into ecology and now I'm an aspiring economist (although I am not sure the economists want me). I'm very interested in making decisions and solving problems, not merely science—which means I have had to embrace economics. I have also been very interested in forming policy ever since I wrote my first letter to the newspaper objecting to the land-clearing that had destroyed our favourite birding spot, when I was eighteen. As I've been trying to influence decisions all my life I've drifted towards economic things, and I have found that knowing a bit of maths has made it a lot easier. I have been known to proclaim that economics is just applied mathematics with lots of jargon.

Before I get to the meat of the talk, I also point out that behind me is a vast lab of young people who are smarter and more energetic than I am. They do all the work and write all the papers. We also have a huge suite of colleagues. In summary, I am good at taking a lot of credit for the ideas and labours of others in other universities.

[1] Now Department of Sustainability, Environment, Water, Population and Communities, SEWPAC

It is pleasing to see that universities like The University of Queensland, the ANU and The University of Melbourne have become global hotspots for biodiversity conservation research. Indeed, if you were to pick a research area where Australia was the strongest in the world, conservation and agriculture would have to fight it out.

Choices are inevitable

So what is the punch line? It is very popular to seek win–win solutions. About ten years ago, Steve Morton, myself, the late Peter Cullen and several others were asked to deliver a Prime Ministers Science, Energy and Engineering Innovation Committee (PMSEIC) report. PMSEIC was a great innovation of the Howard government. We told the Howard government about biodiversity—what we've heard this morning, that biodiversity is very important for ecosystem services. The millennium assessment has clarified all those issues, and therefore we tried to build a case that there are win–wins: if we secure the ten million species on the planet, that will help us secure all these other things that we need—food, water and so on—for us.

But I don't think that's generally true. We are going to have to sacrifice land for biodiversity, or take land away from food if we want to maintain all our biodiversity. There are fundamental trade-offs; there are a few win–wins. I'm going to talk about what that trade-off curve looks like. Can we move the shape of the trade-off curve? Furthermore, we have to make choices between biodiversity and ecosystem services. In particular, if we want to maximise water availability or carbon sequestration, that won't maximise biodiversity. Many people think the reduction in deforestation that occurs where we buy carbon credits through tropical countries is the best action for saving biodiversity. I will show you that it is not optimal—maximising carbon retention is not the same as maximising biodiversity. In the end people, the world, have got to decide whether they actually like biodiversity and how much are they willing to pay for it. If we walk away from that fundamental trade-off, like so many other fundamental trade-offs—e.g. health vs security—we are deluding ourselves.

The world's, and Australia's, biodiversity is a mess, but I don't think most Australians know how big a mess it is. We have stopped land clearing relatively recently, thanks a lot to the Wentworth Group and many others—but in fact

biodiversity is declining here just as fast as anywhere else in the world, if not faster. Aside from that depressing fact, I'm going to talk about what I think we need to do to get *almost* win–win solutions to the biodiversity crisis. We can get really good solutions—not win–win, but almost win—and I will explain what do we have to do. This will mean that the conservation movement needs to be far less conservative, and Australians need to recognise the billions that this country makes from biodiversity. For example, birdwatching in the USA in 2006 was a $36 billion dollar industry that generated over $80 billion dollars of growth.

Identifying critical issues

The fact that biodiversity is in rapid decline was highlighted in an excellent paper in *Nature* in 2009 by Rockstrom *et al.* that pushes us ahead from where the Millennium Ecosystem Assessment report was. It identified a raft of fundamental global biological processes and subsystems and assessed whether we had pushed those systems beyond acceptable thresholds (see Fig. 1). The green circle in the middle is where they consider the acceptable threshold is for each process. The red wedges show far we have pushed processes or systems like ozone depletion or freshwater use at a global scale. Freshwater use is not too bad yet but getting worse fast. Two problems stand out—disruption of the nitrogen cycle and biodiversity loss. Specifically, they argue that if we kept biodiversity loss at about 10 times background rates it is vaguely acceptable (inside the green circle)—but we now think it is 100–1000 times background rates, way beyond an acceptable threshold. I recommend that paper wholeheartedly.

An example: Australian birds

You might think Australia is fine—a green nation. About ten percent of the Australian population voted for the green party, an increasing number—surely that is enough political support to secure the environment? The reality is otherwise. Professor Stephen Garnett, Dr Judit Szabo, myself and others have a grant to re-analyse all the data on Australia's threatened birds. We have only about 800 bird species; we are losing one a decade. At the sub-specific level (down to sub-species and races) we have 2400, and we are losing one every four years. Who can name the six taxa of birds we lost in the last 25 years? None of you can! The Mt Lofty Rangers spotted quailhrush has disappeared,

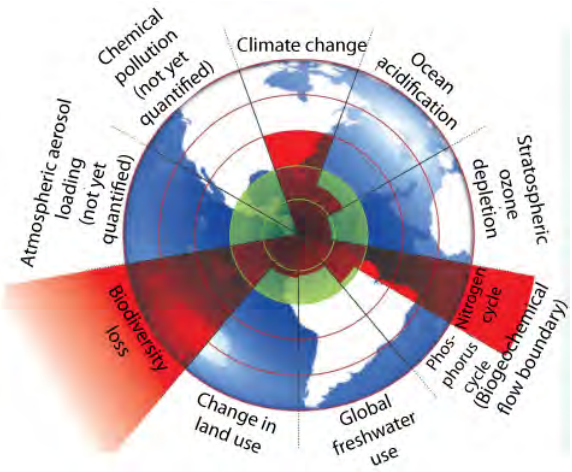

Figure 1. Biodiversity: the state of the world's biophysical processes/subsystems (Rockstrom *et al.* 2009)—we say that biodiversity is essential because …

it was last seen in 1983. Did anybody see the press release! This bird is gone. The Tiwi Islands hooded robin has disappeared, the southern subspecies of the star finch has disappeared. All have vanished in the last 10–20 years, mostly without a single dollar being spent on their conservation other than for the odd biologist going to look and exclaim 'they're not there anymore!'. That has been the extent of the expenditure.

This is a global embarrassment that would not happen in Europe or North America—they would be spending tens of millions of dollars on each of these birds. Obviously those places have huge economies and could afford to do those things. The current rate of expenditure on bird conservation here (for example) is roughly $12 million per year, about 1/1000th of defence expenditure. Maybe it is not surprising that we are losing a bird species every decade (and if maintained that means we would have none in 8000 years time). Of course we won't lose every species, we will have still have magpies and crows. But it is embarrassing, and from an economic perspective the infrastructure that underpins tourism and our culture is being squandered. No smart industry allows its capital assets and infrastructure to decline.

What is really going to happen? Probably in a few hundred years we will lose a couple of hundred bird taxa. Do we need those bird species to live, to eat, for food security? The short answer is no. Consider other aspects of biodiversity. There are a thousand species of terrestrial orchid in southern Australia. They could all go and ecosystem func-

tion would not change one iota. Our cultural heritage would be irreversibly diminished, but we would continue to live. So why should we care about species loss?

I care about biodiversity loss because it will take 2–5 million years for these losses to be recovered. This is the most irreversible of our environmental woes (something that is not accounted for in Fig. 1). We can sort out problems of air quality, water supply and food security in 10–100 years. Indeed we could solve the global food security problem—just stop feeding grain to animals—*don't eat something that ate something that you could have eaten*! It is simple. We can probably even sort out climate change in 200–300 years, *but if you lose biodiversity then 20 000 times as many people as has ever lived will suffer the consequences*. If only 5% of these are bird watchers, this issue is 1000 times more important than almost any other environmental change that we can currently recognise. In civilised developed countries 10–20% of people are avid natural historians. This is what people want to do with their time and money, and that fraction of the world deserves the right to keep those species just as we all also deserve the right to have things like food and liberty.

Food security and biodiversity

I believe that the world has plenty of food, partly because of efforts of people like those in this room and because there is space for the green revolution to progress. A small fraction (perhaps 5% or 10%) of the world's biodiversity is essential for fuelling that. But how much of the remainder do we really need? What's the evidence that it is essential for food security?

We've probably got about 10 million species of organism; a quarter of them are beetles, a quarter of them are fungi. Many have put the argument that you can't lose any of these species because everything is going to collapse. However, there is no evidence that this will happen. We have many interesting stories about how loss of biodiversity causes little wrinkles in the food production system and other aspects of life—honeybees come to mind. But these are really very small wrinkles. They may affect options for biological control: if you lose half the predatory insects in the world, then you are going to halve those options for biological control. That's bad, but you will still have some options. Bottom line, an unpopular bottom line: we can lose a lot of biological diversity without jeopardising food security. Why do I think that?

Dimensions of biodiversity

Biodiversity operates at three levels: alpha, beta and gamma. Alpha diversity is what's in a single locality. Beta diversity is the diversity of species between habitats—say from heathland to forest, in a single area. Gamma diversity is the diversity you get by moving to different regions: the diversity between England and New Zealand, which basically shared few or no species even though effectively they had similar environments and habitats. Gamma diversity explains most global diversity. The biodiversity of New Zealand could be replaced by the diversity of England (or New England) and it would still function: and that has already partly occurred. Go to the Canterbury Plains, the most productive irrigated agricultural system in New Zealand, and you see hedgehogs, stoats, chaffinches, blackbirds, European earthworms and snails: an enormous amount of European biodiversity that inadvertently or deliberately was transported by us. It is a functioning system. It is nowhere near natural: most of the local diversity has entirely gone, but the system is still functioning well. So, unfortunately, we can lose most of the gamma diversity, which is the biggest contributor to global biodiversity, without affecting the ways ecosystems function. I wish this wasn't true, as it would be nice to say that the loss of species is a large and immediate threat to our survival and economy.

The trade-offs

If Australians want to save biodiversity we've got to move away from the false, selfish utilitarian argument that biodiversity is essential—we have just got to say we like biodiversity and we want to keep it, and there are enough of us who want to keep it, now and in the future, that keeping it is worthwhile. We should spend more than $12 million a year on all bird conservation and stop losing a bird a decade. Our research centre has calculated that by spending $50 million a year on bird conservation we could basically stop Australian bird extinctions: we would have one species extinction in the next 100 years instead of ten.

This is where we get to the trade-offs. Why are we spending so much money on all other things and spending such a tiny amount on biodiversity? If anything, the trend has been for environmental

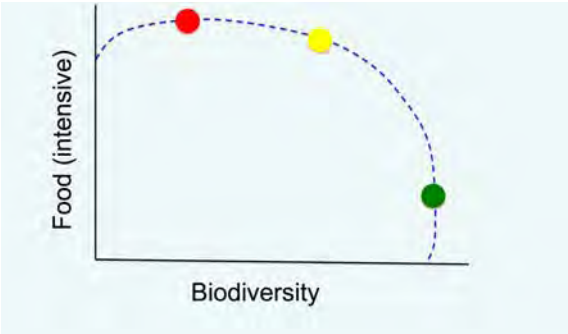

Figure 2. Trade-offs between biodiversity and intensive food production—not cost-benefit analysis. See text for explanation of dots.

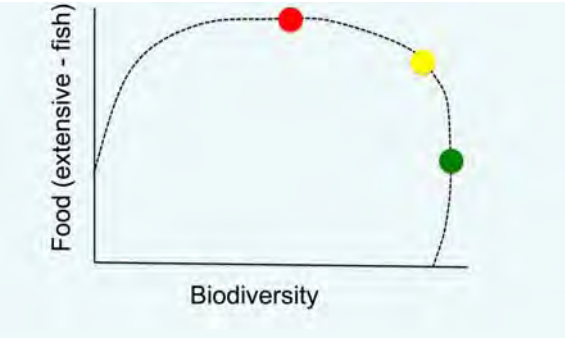

Figure 3. Trade-offs between biodiversity and extensive food production. See text for explanation of dots.

spending to move from biodiversity conservation to ecosystem services conservation, because people think, for example, 'water is good for me'. We've become extremely utilitarian and greedy—it appears that we believe that if an action doesn't do something for me here and now, it isn't worth my money and time. Although we actually have more wealth than any group of people have ever had in humanity's history, at any time in any place, we seem to be more depressingly utilitarian, greedy and self-centred than ever before. So what can we do about biodiversity and food production—is there a way forward for these two superficially competing demands?

To understand the relationship between biodiversity and food security we will look at some trade-off curves: Figure 2 is a hypothetical example. In this figure I show that to maximise food production in systems with intensive agriculture (e.g. monoculture crops) one would have little biodiversity in the long term: the red dot in Figure 2. To maximise biodiversity we would not have much intensive agriculture and make little food, the green dot. However, the yellow dot in Figure 2 is perhaps a reasonable compromise. It is a dot that includes a subdivision on the landscape into some conservation land and some intensive agriculture. When we are looking at the land of Australia we've ultimately got to decide how to allocate it. In the curves I have assume a small fraction of biodiversity is essential (food production goes down if there is very little biodiversity). Despite this, there is no obvious win–win. The compromise solution is not optimal for either sector.

Figure 2 is quite hypothetical. We don't know what this curve looks like and we do need to understand it more to make wise land use decisions.

In contrast to intensive agriculture, with extensive agriculture or extensive harvesting, like fisheries or grazing, you can get closer to a win–win outcome because of the diverse nature of the systems that are producing the food, although if you plundered them too much you'd lose biodiversity. Figure 3 is how I think food production in extensive landscapes relates to biodiversity. Again, biodiversity at some level is essential for maximum food production, and given these systems are complex we need quite a bit of biodiversity. There is still no win–win, but there are solutions that are close to win–win. While I don't know what these curves look like for the food–biodiversity trade-off, we have calculated them for the carbon–biodiversity trade-off.

Last year we published a paper in *Science* (Venter *et al.* 2009) in which we asked a question that the Norwegians have asked several times and acted on: if I have a heap of money and I want to store as much carbon as possible while also stopping people chopping down trees in tropical countries, where should I spend it? If a decision is based on land prices, you would spend most of your money in Brazil. In this case you would also save nine or ten threatened birds. (If I were interested in beetles, multiply that number by a thousand. We are talking about saving a lot of species.) That's good. This is why most people think 'Great. Payments for reduced deforestation and degradation will save biodiversity'.

If in fact I spent that same money to save as many species as possible and didn't care about carbon any more, I would get half as much carbon but four times as many species: so there is a clear trade-off. You can't have your carbon and save your species too: the bottom line is that you've got to accept these trade-offs, although nobody wants to talk about them, even in this case where we have two environmental objectives, there is conflict. In this case we've calculated there is an

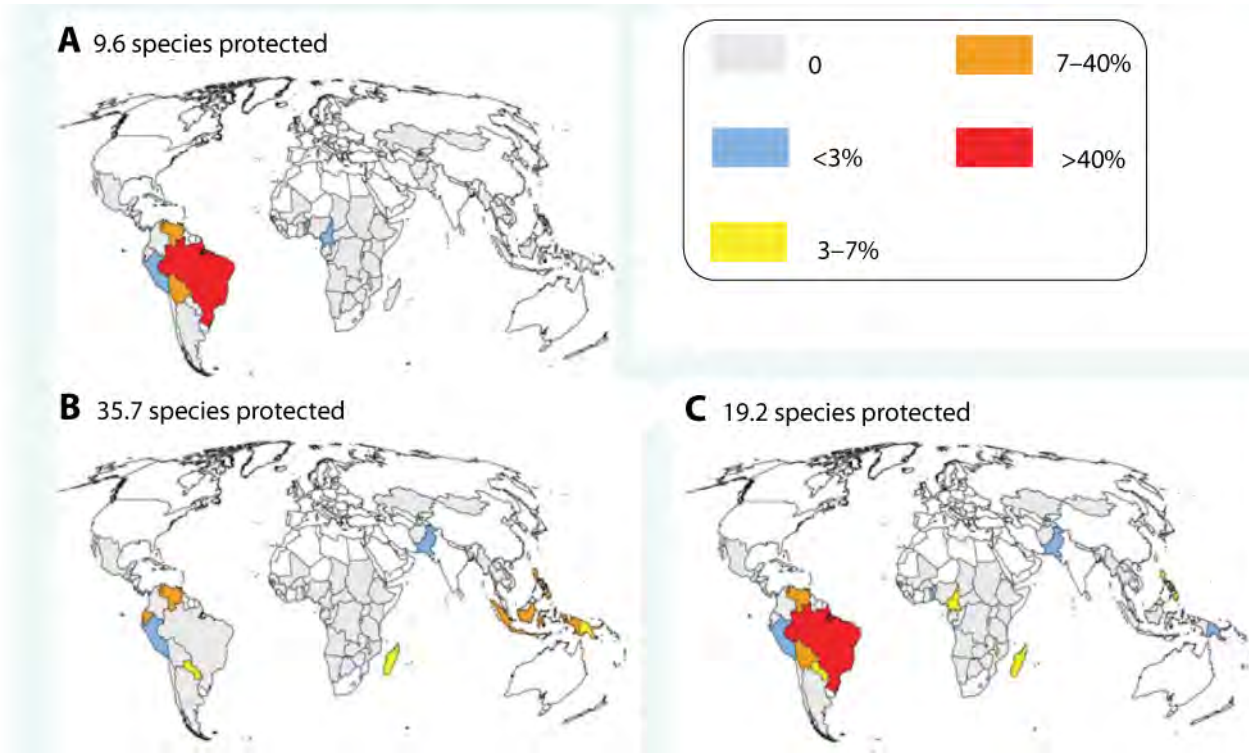

Figure 4. Unexpected trade-offs: for example, between carbon and biodiversity (Venter *et al.* 2009). See text for explanation.

almost win–win. We can save half as many species, so that's not really that good, and we get 96% of the carbon that we got in the plan, that was the optimised carbon plan. So for a tiny reduction (say a 4% reduction) in carbon storage we can save twice as many species (Fig. 4). I would say the same curves could be done roughly for the food–biodiversity trade-off: an optimum trade-off may result in some sacrifice; almost win–win. Better solutions will be found by thinking outside the box and shifting the shape of the trade-off curve.

Solutions

So far I have been deliberately depressing. Biodiversity is in rapid decline and there are no easy win–win solutions. Can I bring any light to bear on this problem, or have the conference organisers wasted their money?

I believe we need to take generally a far more aggressive and honest approach in dealing with these problems, and we need to be much more honest with the Australian public about biodiversity.

First of all there are a few win–wins, although later speakers will describe some interesting, albeit rare, win–wins that do give both better productivity and better biodiversity.

Biosecurity is the greatest win–win of all. If it wasn't for agricultural biosecurity Australian biodiversity would be in a serious mess. I wholeheartedly applaud people working in the area and I lobby continuously for more investment in it, because it is a real win–win economically from both food security and biodiversity perspectives.

There are two reasons, however, why we are not getting really good solutions to the food production – biodiversity nexus in a lot of cases. Firstly, we don't have decent planning tools and we don't stick to our planning. Queensland has just released a map that shows that just 4% of Queensland has soils that are incredibly good for agriculture. There is now an enormous fight with the mining and urban expansion industries. This planning should have happened years ago. This tiny area could probably feed Australia: don't turn it into a mine; don't put a house on top of it. Why didn't we isolate those areas decades ago and take a much more authoritarian approach to land-use planning? I'm sure people in this room have lobbied for such planning. One of our problems is that Australian land-use planning has never been sufficiently decisive nor authoritative. Govern-

ments are frightened of providing guidance on prudent land-use for the benefit of all Australians (existing or unborn), in case they tread on the 'rights' of land developers and landowners.

The second reason is lack of innovation. The conservation movement is obsessed with setting the continental clock back to 1750. Many things could be done in Australia in diverse semi-agricultural systems that cater for biodiversity, and there are many aggressive interventions we could try. For example, how many diverse, constructive, managed wetlands for biodiversity do you know of in Australia? Places where a piece of degraded agricultural land or a mine site has been turned into a wetland managed for diversity? The Europeans and North Americans have hundreds of them. They get much out of small areas by investing in biodiversity and actively managing it. We don't do that because we are obsessed with putting everything back the way it was, something which is often expensive, even impossible. In many cases we can take degraded land and create more interesting biodiversity more cheaply by NOT trying to put things back the way they were in 1750. We seal up areas, like national parks, say nobody can go there, nobody can use them, and then expect them to be really good. The world will never be the way it was because we've got climate change, we've got invasive species, we've lost most of our native top predators and we've got 20 million people.

We need another green revolution: getting more species packed into the small areas that are left purely for conservation. We need to give people plans that invest in intensive biodiversity management. We need to make tough decisions. We probably have to let some species go. We have spent an enormous amount of money propping up species that are completely dysfunctional and will disappear in the next one or two hundred years regardless of what we do. We need to be much more innovative.

Where are we now?

Because of poor planning we are not getting anywhere near as much food or biodiversity as we could get. We could emulate for biodiversity some of the innovations that agriculture has used to increase productivity—there is no discussion of how we could get more biodiversity by really investing in intensive biodiversity and getting more per unit area. Organisations like the Australian Wildlife Conservancy and Bush Heritage Trust are exceptions to this rule.

What are we going to do to improve the present position?

We could form a partnership with a regional body and develop, for each region, a multi-objective plan that involves food, biodiversity, carbon storage and water. That plan would include biodiversity investment—not lock-it-up and throw-away-the-key conservation.

Who has seen a plan like this for a region anywhere in Australia? One that tries to define that trade-off curve and suggest an optimal allocation of land in the region to maximise the benefits from different uses—forestry, sheep, intensive agriculture, national park and maybe intensive biodiversity management that might entail growing grain for finches and tubers for brolgas. This would be a solution with both good planning and innovation that actually moved the trade-off curve (Fig. 5). Who's seen that map? What has government been doing for two hundred years in the area of land-use planning? I have no idea.

We are going to make some of those maps. We will define that trade-off curve and point out that people can not only work out where the best land-use solutions are, but we can move the trade-off curves by innovative management—like managed wetlands and woodlands. There will be a minor sacrifice. It is impossible to maximise four things (biodiversity, food, carbon, water) simultaneously—if you maximise one thing the others will suffer—but we can get very close to having all of those issues very high on the agenda. If we had that plan, of course, the devil is in the detail. Economists will ask this 'How do you get to do it?' If we were Russia in 1960, we would just say 'Do it.'

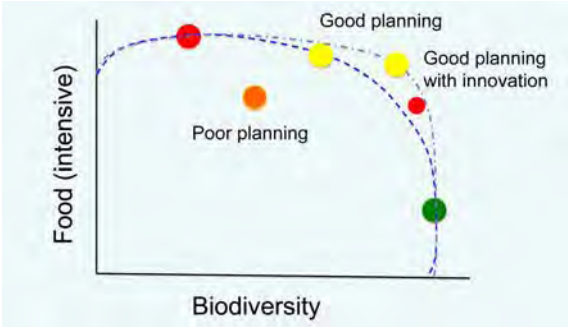

Figure 5. Opportunities for better planning and innovative solutions. See text for explanation.

So how can we move Australia closer to a land-use system that delivers more for everyone, now and in the future? We could legislate, take a heavy-handed top-down approach, but legislation is not palatable for a lot of politicians. We could push down the EU agricultural subsidies route, requiring for example that 20-m strips be left for flowers and forests beside fields of wheat or barley. We could actually say 'you're going to have to farm some biodiversity, and we will pay you to do it'. We could use some of the more innovative solutions like biodiversity trading, insurance mechanisms, providing people a safety net if they are going to do innovative things, and reverse auctions which pay people for biodiversity outcomes through a competitive marketing mechanism. Australia, in some respects, leads the world in some of these innovative areas. We haven't started biodiversity trading yet, but we have to do it and we have to have the plan first. Then we've got to work with smart economists and political scientists and social scientists how we can actually get it done in a particular region.

To demonstrate that such plans can be done, the piece of software that my research group has developed over the past 15 years is actually being used to build the world's entire marine reserve systems in over 100 countries. It is changing the face of 5% of the world's oceans and some of the land. We've adapted it, with the Nature Conservatory, to deliver land use plans too in part of Kalimantan—why not Australia? The technical tools exist, now we need leadership.

Conclusion

I work with many colleagues as part of two new national centres for environmental decision-making. We try to communicate effectively with policy makers. We have a monthly magazine that we send to as many state managers and politicians as are willing to sign up to it, and about 2000 people read it every month. It's called *Decision Point* [http://ceed.edu.au/dpoint-news], not 'save the world's biodiversity'. It has a name reflecting precisely what Bob McMullen talked about—making decisions and hard choices is an issue of trade-offs and leadership. Academics need to get out of our ivory towers, and politicians and the senior bureaucrats need to invite us into theirs.

A final message is to thank my many colleagues, none of whom would admit to agreeing with any of this rant, and other people who have contributed to work described in this presentation.

References

Rockstrom, J., Steffen, W. *et al.* (2009) A safe operating space for humanity. *Nature* **461**(7263)**,** 472–475. http://www.nature.com/nature/journal/v461/n7263/fig_tab/461472a_F1.html

Venter, O., Laurance, W.F., Iwamura, T., Wilson, K.A., Fuller, R.A. and Possingham, H.P. (2009) Harnessing carbon payments to protect biodiversity. *Science* **326,** 1368–1369 DOI: 10.1126/science.1180289