

Restoring at landscape scales: Interview with Andrew Bennett

By Andrew Bennett and Tein McDonald

Intrigued by the power of science to grapple with questions relevant to management, Victorian landscape ecologist Andrew Bennett has directed his career to investigating how human land-use and landscape change affect native fauna and ecological processes, seeking ways to achieve the ongoing conservation of Australian native fauna.

Key words: agricultural landscapes, habitat restoration, Landcare, landscape ecology, science communication.

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TM: Andrew – your career started at the Victorian government's Arthur Rylah Institute for Environmental Research (ARI). Three decades and two professorships later, you are back playing a Science Leadership role at ARI.



Figure 1. Andrew Bennett maintains a focus on big picture issues while studying their component parts. He has quietly guided and inspired many ecologists over the decades, including beyond his native state of Victoria, through his roles as researcher and science team leadership. [Colour figure can be viewed at wileyonlinelibrary.com]

Is there a sense of coming full circle?

AB: Yes, well I guess there is a sense of coming full circle. I started my professional career at ARI, as part of the wildlife survey team, and that became a springboard for later work in conservation biology and landscape ecology (Fig. 1). My current role at ARI is in working with staff to further build the quality of our research, to enhance the research culture, to provide scientific advice, and to foster research collaboration.

ARI is a unique institution. It has a sense of place, a place in history – and so it's interesting to be back. I'm proud to be a part of that ARI history

and I enjoy contributing to its work in applied ecology and conservation.

TM: And what is that history?

AB: Well, ARI has a long history of applied ecological research in Victoria that sets a foundation for conservation in this State. A wide range of notable people have worked here and have built up extraordinary knowledge and expertise relating to the State's flora and fauna. It's impressive, looking back on the legacy of achievements over the years – achievements in flora and fauna surveys, distributional data bases, spatial modelling, studies of threatened species,

developing new techniques, communicating science, and providing advice and expertise.

TM: How did this special linked role, shared between La Trobe and ARI, come about?

AB: It came about because the Director of ARI and the Head of the School of Life Sciences at La Trobe got their heads together and created this position. It involves a separate role in each institution, but it's also about fostering collaboration as well. The cultures of both institutions are familiar to me because I worked at ARI previously, and I've worked in a university environment for many years previously at Deakin University.

One of the things we've done to build collaboration is to appoint two joint research fellows, who work on projects that span across both La Trobe and ARI. We have some great appointments. Katherine Harrisson is working in landscape and conservation genetics, and Luke Collins is working on fire ecology and modelling. There is also co-supervision of PhD students. And of course, ARI has relationships with other universities as well.

TM: When you first started at ARI, what was your role and who were your stakeholders there in terms of the work that you did?

AB: When I started at ARI, I joined the wildlife survey team; it's how many people started their career there. This mainly involved wildlife surveys in different parts of Victoria to contribute information for land-use planning. A body called the Land Conservation Council (LCC) systematically reviewed and made recommendations about the use of public land across the state. We would carry out surveys in a particular study region and provide information to the LCC to assist it in making recommendations.

It was a great way to start a career – to learn skills and to be part of a team with others who had expertise with birds, reptiles, mammals, plants and so on; and to see different parts of the state. During my time in the wildlife survey team we carried out surveys in north-east Victoria, east Gippsland, then a major survey in the Mallee in north-west Victoria.

And then I became involved in leading projects. The first was working in the Northern Plains of Victoria where we investigated the value of remnant vegetation on both public and private land. It was some the first work in Victoria specifically looking at the conservation values of private land. This was at the time when the *Land for Wildlife* Scheme was starting, so it tied in with that recognition of the role of private land in nature conservation.

Following that, I led a collaborative research project in which we set out to understand more about the woodland ecosystems in north-central Victoria (Figs 2, 3), working with colleagues from Monash University, La Trobe University and the Museum of Victoria. This coincided with an investigation of public land values in the Box and

Ironbark region by the Land Conservation Council, and so our results fed into that land-use planning process.

It was part way through that project that I moved to Deakin University, but continued leading the project; continuing the collaboration with people like Ralph Mac Nally from Monash, Alan Yen from the Museum of Victoria, and Lindy Lumsden and Geoff Brown from ARI. It was a great team of people who worked well together and it also included regional and policy staff from the (then) Department of Natural Resources and Environment. We conducted a wildlife survey across the region in relation to vegetation types; then we had a series of projects looking into a number of broad themes including the effects of forest fragmentation on the avifauna, the effects of forestry practices (by comparing forest stands that had large old trees versus those that did not), and the effect on fauna of changes to the forest ground layer (e.g. from grazing).

Subsequently, I moved into landscape-scale investigations. I was becoming more and more intrigued by questions about the properties of 'whole landscapes' that we need to



Figure 2. Woodland ecosystems of north-central Victoria include the box-ironbark forests, which have been extensively cleared. (Photograph A. Bennett). [Colour figure can be viewed at wileyonlinelibrary.com]



Figure 3. An experimental planned burn in box-ironbark forests; part of a collaborative, landscape-scale fire-study. (Photograph A. Bennett). [Colour figure can be viewed at wileyonlinelibrary.com]

understand and manage for conservation. That's the scale at which conservation planning occurs – landscapes, sub-catchments, catchments. Yet so much of our work was based on individual blocks, individual remnants. I was becoming more conscious that it's really at the scale of the landscape that we need solutions. What should the landscape look like? How much native vegetation should there be? Where should it be located? Does the context matter? What about the representation of different types of vegetation?

We started a major new project in north-central Victoria, the Landscape Pattern Project, that investigated these questions at a landscape scale. Jim Radford, who had been a PhD student with me, moved onto this project as a Research Fellow and has had a critical role in developing this thinking. We selected a series of 24 landscapes, each 10 × 10 km in size, and we chose them to represent different amounts and different configurations of native vegetation. We carried out systematic surveys of birds in these landscapes, and asked 'which properties of these rural landscapes make them better or worse for conserving woodland birds?'

TM: And woodlands birds were recognised at the time as a declining group?

AB: Yes, there had been growing interest and concern about the status of woodland birds – from the work of people like Hugh Ford, Denis Saunders, Doug Robinson and Geoff Barrett. There was known to have been a decline, both in individual species and of whole communities. The region we were working in was part of what has been called the sheep-wheat belt of Australia; the productive part of the Murray-Darling Basin where there has been massive clearing of native vegetation for farming.

TM: And what were the main things you found? Were there surprises or was it a reaffirmation of your existing hunches?

AB: For me, the surprise was the overwhelming importance of the total amount of native vegetation in the landscape. I expected there to be a greater influence of the connectivity and arrangement of the vegetation in the

landscape. But from our analyses, the most important influence on the species richness of woodland birds was the total area of native vegetation in the landscape. We found that there was a threshold relationship. That is, it wasn't a linear relationship where, for example, the number of species smoothly decreases as the amount of native vegetation in the landscape decreases. Rather, once native vegetation cover fell below about 30% of the landscape, we started seeing declines in species; and particularly below around 10% cover there was a marked loss of species in these landscapes. We called it a threshold – a point at which the numbers of species of woodland birds declined dramatically. There was also some influence of the configuration of vegetation, the diversity of vegetation types and the geographic location of the landscape (there tended to be more species to the east than the west). But the dominant influence was the total amount of wooded cover in the landscape.

TM: In a paper you gave at ESA last year you mentioned that even single rows of trees do have some benefits. Even if we can't go from 10% to 30% are there qualitative differences that we can make to improve the situation?

AB: For me, one of the most important lessons from this landscape-scale research is that all the individual 'bits' in the landscape do matter. The individual components are what add up to make the overall landscape structure. And so, if we lose some components, or we restore some components, that modifies the landscape as a whole and influences its conservation value. I think that's a really important point. It also means that what each individual landholder does on their property matters, because it's contributing to the landscape as a whole and its capacity for nature conservation.

Another of the important lessons from this work is that there are particular parts of the landscape that have disproportionate value for nature conservation. In the system we're working in, for example, we found that streamside vegetation has high importance (Fig. 4). Individual sites in streamside vegetation are richer in bird species and have a distinct species composition. As landscapes become more heavily cleared, streamside vegetation contributes disproportionately to the landscape-scale diversity of woodland birds. So, focusing our conservation and restoration work in these streamside systems is a win-win. We know that protecting and maintaining streamside vegetation is important for aquatic habitats, it's important for protecting stream banks and reducing erosion, and it's a productive part of the landscape. And, of course, because streams are connected, it adds to the connectivity of the landscape as well. What's more, it's within the capacity of individual

landholders to protect and restore streamside vegetation; and what each one does, contributes to the wider landscape. So, these are important areas for investment of conservation and revegetation resources.

TM: Underpinning all this insight about landscape connectivity is your interest in fauna. What started your interest in fauna? How did this all start at a personal level?

AB: I grew up on a farm in south-western Victoria, a small family farm. So, I guess I've always been interested in rural landscapes, in farming, and later in how farming and nature conservation can be complementary. My dad was interested in nature. He knew the names of the native plants. At the back of our property was an old railway line that had Silver Banksia (*Banksia marginata*) and some of the herbs and grasses of the original

western plains native grassland. And on the farm, we always had a variety of animals around – budgies, ducks, bantams, guinea pigs, tropical fish and tortoises; the 'works' at various times.

But for me, a fascination has been in asking questions. That's what I enjoy about science, about being involved in research.

My first introduction to biology was in Form 5 – Year 11 now. I went to Hawkesdale High School, at the time the smallest country high school in Victoria. In the 1970s, the Education Department brought in some teachers from the USA, although I'm not sure why. In Form 5 we had an American teacher and this new subject called 'biology', the first time it had been taught at Hawkesdale. I then had to go to Warrnambool High School for Form 6 (Year 12) because Hawkesdale wasn't large enough to have a maths-science course. But looking ahead to university, I was fascinated by this subject I saw in the handbook called 'zoology'. So, I was keen to pursue zoology. In first year at Melbourne University, we all started out with general subjects, maths, physics, biology and chemistry – that was back in 1975 – but then in second year I specialised in zoology.

But I almost became a neurophysiologist! I didn't do the typical stream of zoology and botany; I studied zoology and physiology/biochemistry in second year. In third year, two units in physiology stood out. One, in the medical physiology area, was Brain and Behaviour which intrigued me. There was also a new unit in the Zoology Department on Invertebrate Neurobiology. But it was a field trip and research project we did in third-year ecology that shifted my focus to ecology. It was that whole thing of asking questions in the field about what determines the distribution of organisms, and about how ecosystems work, that really attracted me; and so I followed the ecological pathway (Fig. 5).



Figure 4. Streamside ecosystems in north-central Victoria. As riparian areas are richer in species, protect aquatic habitats and provide natural linkages, they are important areas for investment of conservation and revegetation resources. (Photograph A. Bennett). [Colour figure can be viewed at wileyonlinelibrary.com]



Figure 5. Detailed fieldwork underpins insight into big picture questions. Andrew's fascination with animals is equalled only by his fascination for attempting to answer questions through the scientific process. (Photograph D. Nimmo). [Colour figure can be viewed at wileyonlinelibrary.com]

TM: And did you have mentors during that time?

AB: Not especially at that time. Two particular mentors came later, both international landscape ecologists who fostered my interest in landscape ecology. I did my PhD research on native mammals in forest fragments in south-western Victoria. It was around the time when there was intense interest in MacArthur and Wilson's theory of island biogeography and its application to mainland isolates. I didn't realise at the time that there was this emerging area called 'landscape ecology'. It was only after I'd completed my thesis in 1987 that I came across the text by Forman and Godron called 'Landscape Ecology'. Here was all this stuff that I had been doing; all of this thinking about patterns in the landscape, the size and shape of remnants, and what it means for nature conservation.

My first mentor in terms of landscape ecology was Gray Merriam, in

Ontario, Canada. He was one of the examiners of my PhD thesis. A couple of years later, when I was working at ARI, an opportunity arose for me to spend 6 months at Carleton University in Ottawa, Canada, with Gray and his group. Gray was one of the early leaders in landscape ecology. That time was also influential for another reason; it was the first time I'd been outside Australia and the first time I had experienced the northern hemisphere. As Australian ecologists, we read a lot of literature from the northern hemisphere and so it was a great experience to actually be there, to see a deciduous Beech-Maple forest, to trap and handle some of the small mammals I'd read about, and gain a different perspective on ecology from a Canadian/North American perspective.

It was a formative experience for me to see how Gray worked with his lab group, his model of supervision. I hadn't had that experience of being part of a lab group in which

an academic, postgrad students and research fellows all worked closely together. That's something that I've sought to follow, this model of working as a collaborative research group. And I'm thankful for an extraordinary group of research students and research fellows who have worked with me over the years.

Later, I met Richard Forman, from Harvard University, a leader in landscape ecology, who's been an important influence on my thinking. We interacted when he visited Australia on two periods of sabbatical leave; and then, in 2012, I had the opportunity to spend 6 months at Harvard Forest in Massachusetts, New England. We've been in touch for many years and he's been very supportive of my career.

TM: Your interest in landscape ecology is also heightened by the fact that fauna, your initial area of interest, often need large home ranges or operate as meta-populations. And big picture planning requires information on the ecology of individual species. Can you tell us a little about your interest in fauna when you entered zoology?

AB: I was initially very interested in native mammals. My PhD was on the conservation of native mammals in a fragmented forest system in south-western Victoria. I carried out surveys to examine the species richness and composition of native mammals in forest remnants amongst farmland. I also investigated the ecology of the Long-nosed Potoroo (*Potorous tridactylus*), a small member of the macropod family. They have this fascinating diet, mainly feeding on hypogaeal (underground-fruited) fungi. There is an intriguing three-way relationship between the fungi, the potoroos and forest trees. The potoroos feed on the fungi, they then disperse the

spores of the fungi through the forest in their droppings, and the fungi form a symbiotic relationship with the forest trees.

I was also studying the population ecology of the potoroos and why they were able to persist in this highly fragmented system. One reason for this was their ability to move along linear strips of roadside vegetation between forest patches. So, that's where I developed an interest in connectivity, as their ability to disperse meant they were able to function as a meta-population in that system.

Later on, as a research group, we studied other mammals as well. For example, Rodney van der Ree studied the Squirrel Glider (*Petaurus norfolcensis*) and the Brush-tailed Phascogale (*Phascogale tapoatafa*); and Greg Holland examined the population dynamics of the Bush Rat (*Rattus fuscipes*) in forest fragments. Lindy Lumsden has done great work on the ecology of microbats, their movements in the landscape, and their selection of roost sites. But then I moved more into working on woodland bird communities. In part, that's because when you're asking questions about landscape change you can get a lot more information when you're dealing with, say, 80 species of birds compared to a dozen mammal species. It's also because woodland birds are more visible, they are what people can see and can relate to.

TM: Is the response quicker?

AB: Potentially – because they are more mobile and so they can respond to landscape pattern more directly. But I think it's more to do with the fact that you can detect patterns and change more readily with larger numbers of species, and bird surveys require less overall effort than intensive surveys of native mammals. And in some of these areas that we're dealing with, many of the native mammals have been lost from the region.

TM: The potoroos you looked at initially – how were they going at the time and how do you think they are going now?

AB: At the time, they were surviving in that system among farmland in SW Victoria because it was a connected network of habitat and there were forest remnants that provided dense, high quality habitat. The Ash Wednesday wildfires went through in 1983 and incinerated most forest patches. Later, in about 2002, we were able to go back and survey most of the forest patches again and the metapopulation had declined. They had disappeared from a number of patches that I had originally surveyed but there was no evidence of colonizing new patches. The concern is that there seems to be a gradual attrition over time. It's 15 years since we last did surveys there, and while potoroos are still present in the local area it may be difficult for them to survive in such a fragmented forest environment amongst intensive farmland into the future. I remain optimistic but the warning bells are sounding.

TM: Is there much activity going on in those landscapes to increase the connectivity?

AB: Much of the forested roadside vegetation and the forested creeklines are still there, but my observations are that some of the connections are becoming degraded by weeds such as Blackberry (*Rubus fruticosus*). The fragments of forest are small and all but one or two are privately owned, and so their future depends on how people manage them. If they become grazed by stock then that's not compatible with the potoroos, because they need patchy dense undergrowth – shrubby vegetation, with dense *Lepidosperma* (*Lepidosperma laterale*) and sedges – as cover and protection from predators like foxes. They use a fine-scale, local mosaic of dense cover for shelter and refuge – you can see their runways through this dense vegetation – and then foraging in adjacent, slightly more open vegetation. It's an interesting example of a species using a fine scale habitat mosaic to meet their requirements.



Figure 6. Scattered old trees in farmland near Heathcote, Victoria, many dying and lacking replacement. This is an example of the time lag effect of past land-use practices – a debt we are still to pay. (Photograph A. Bennett). [Colour figure can be viewed at wileyonlinelibrary.com]

I think the mammal fauna in that study area is experiencing what we refer to as 'extinction debt', a time lag in experiencing the full effects of past changes (Fig. 6). I expect we will see – and are seeing – gradual loss of species over time in that highly fragmented system amongst dairying country in south-western Victoria. Back in the early 1980s, there were two species of bandicoot present; the Long-nosed Bandicoot (*Perameles nasuta*) and Southern Brown Bandicoot (*Isodon obesulus*). I suspect they may have disappeared by now, as they were quite scarce then.

TM: But the damage was done long before?

AB: Yes, due to clearing of 80–90% of the native vegetation. That puts in train long-term changes, and then when the system is hit by a wildfire, for example, or there is grazing by cattle in the remaining forest vegetation, it can push it over the edge. Long-term change and time-lag effects are important conservation and management issues that largely go unnoticed. Often we're not actually aware of the long-term changes happening around us, and we're almost certainly underestimating them. It can take decades for the full consequences of past change to work through.

TM: That must make it doubly hard for ecologists to work out what is reversible – i.e. whether something is happening now or it is a lag – and what might be yet to come in the future

AB: That's right, it is difficult. But we can see it in some situations. In relation to old scattered trees in farmland, for example, we can see that there is no regeneration and so we can say, yes, unless there is regeneration of new trees we'll eventually lose these scattered tree populations across large areas. But it is harder to see and detect with animal

populations. We have to pay attention to time-series trajectories... and that's the value of long-term studies that can demonstrate changes over time and assist us to project into the future.

TM: So, looking at the big picture is not only looking at space but also time. And this extension into landscape ecology from a more detailed study of zoology is a logical progression

AB: Yes, I found it a logical progression to think about the pattern and the process in the overall landscape. It's not just about the animals, it's also about the native vegetation, the soils, the landform, and the people living there, the human land-use and how that affects conservation. I find this more holistic framework helpful for thinking about conservation.

The importance of patterns through time, as well as space, has been brought home to me in the last decade in a series of projects in fire

ecology that Mike Clarke and I have led. In the 'Mallee Fire and Biodiversity Project', our team of PhD students investigated how spatial and temporal mosaics created by fire affect birds, reptiles, small mammals, invertebrates and vegetation (Figs 7, 8). In semi-arid mallee vegetation, fire modifies the suitability of habitat for some species for over a century or more. So, time is a critical dimension in understanding these fire-prone landscapes. Importantly, it also means that the way in which we manage fire now will have implications for nature conservation for decades to come.

TM: Your appreciation of this 'big picture' view must have been enhanced by the opportunities you have had to work overseas?

AB: Yes, I've had the opportunity to spend three periods of time overseas, each of which has been a formative experience. I had 6 months in Ottawa, Canada in 1989; then



Figure 7. Andrew Bennett, Mike Clarke and Kate Callister planning fieldwork in the Sunset Country, Victoria, as part of the Mallee Fire and Biodiversity Project (Photograph A. Clarke). [Colour figure can be viewed at wileyonlinelibrary.com]



Figure 8. Triodia Mallee vegetation is a fire-prone ecosystem. Conservation management solutions require understanding how plants and animals respond to fire over many decades. (Photograph A.Bennett). [Colour figure can be viewed at wileyonlinelibrary.com]

6 months in the UK at Monks Wood Research Station in the year 2000; and then 6 months at Harvard Forest in New England, USA in 2012.

The time in the UK exposed me to seeing the long history of 'cultural' landscapes. It was fascinating to think about and appreciate the way in which cultural land-use has shaped the landscape. Almost everything you see is there because it's a product of the cultural use of the landscape. Woods have been cut down, coppiced, regrown and cut down again over centuries. What's also interesting is that many species of concern are associated with the long history of human use of the landscape; plants that may be associated with ditches or particular intensive agricultural practices.

Of course, we have a long human history in Australia too, and live in cultural landscapes that have been shaped by Aboriginal people over millennia. It makes me think about what the cultural landscapes of the future will be in Australia. What is the legacy

we're creating now? I see that the 'scattered trees in farmland' is a kind of cultural landscape, but will these persist?

Land-use history was also a feature of the time at Harvard Forest. Forest cover in Massachusetts was reduced to around 30% but then land abandonment in the mid-19th C resulted in forests regenerating to cover more than 60% of the state. At Harvard Forest, there are old stone walls through the forest, a reminder of the past farmland. It's one of the US LTER sites (Long Term Ecological Research) and there is an array of long-term plots and experimental manipulations. It's also amazing to experience a northern hemisphere 'fall', and to ponder the sheer biomass of canopy foliage that is grown and falls each year.

It's been wonderful to have the opportunity to work overseas, so my advice to anyone who has the chance to do it is – just do it! It's extraordinarily valuable professionally, but it is also valuable personally

and as a family, to go and live in another place.

TM: I was struck by a conference presentation a couple of years ago by a North American landscape ecologist who was talking about some very impressive proactive planning for conservation by the State, particularly corridors. It seems quite radical compared to the reactive decision-making that seems to be happening in Australia. Do you think this sort of proactive planning can occur here?

AB: To some extent it is happening. In Victoria, public land has been set aside for parks in a number of locations in a way that increases connectivity – such as in the Alpine National Park, in the Central Highlands and in the Mallee region. So, that principle has certainly been recognised in planning for conservation reserves. But it's much harder in our already more fragmented systems where large connections do not exist. What we are seeing in some of those areas are more 'bottom up' opportunities. For example, the Central Victorian Biolinks Alliance is a group bringing together a number of conservation and community groups in north-central Victoria. They are asking, 'how can we work towards better connected landscapes'? But bottom up approaches involve mostly smaller projects – so the challenge is how to integrate these for a large scale coordinated outcome.

There is a major challenge here. We have lots of revegetation and restoration, but it is hard to do it at a large enough scale to make a big difference. I think of the massive effort by various groups to revegetate to counter salinity in the Tammin area in the WA wheat belt region. After something like 15 years of intensive sustained work, there was an increase in vegetation cover by about 3-5% of the landscape. And in the Holbrook area of NSW, after

a huge effort, it was about 2% increase in the landscape. But change is occurring, even if slowly. It's great when you look around a landscape and see areas where gullies and streamlines are fenced and revegetation is occurring – and widening of roadside vegetation in areas where the Grey-crowned Babbler (*Pomatostomus temporalis*) occurs. It's incremental and positive, but there is a long way to go.

TM: And do you think the non-profit organisations, along with Landcare and catchment groups, are taking more of a landscape approach, more of a strategic approach in the location of plantings?

AB: I think we're seeing that more and more. When putting vegetation back, we do need to plan for the landscape as a whole, and for the long term. We need to make sure that the vegetation is typical of the ecosystems of a local area – e.g. River Red Gums (*Eucalyptus camaldulensis*) if it is along a creekline in many areas, or eucalypts appropriate to the landform if it is just back from the creekline. We also need to think about how the restoration and revegetation fit into the other blocks of forest and connections that are there. The goal is an overall network of habitat, not just connectivity on its own. That's why I strongly support creeks and streams as a focus for conservation and restoration, because those areas provide habitats and are naturally connected as drainage lines through the landscape.

TM: So the more knowledge the local person has of the fauna and the quality and characteristics of the local vegetation communities the better?

AB: That's right and that's where there's also a role for scientists to work to provide the knowledge base to assist and inform on-ground actions. As ecologists, we need to do our best to ensure

the knowledge we have is communicated to people working in policy and on the ground – including Government agencies, CMAs and local communities. In several of our major research projects, for example, we've produced colour booklets setting out the main findings, to hand out to people. The reality is that few managers will read scientific papers. We need to be prepared to give talks, to put our ideas forward, and to provide advice when we can, on the most effective ways to achieve long-term conservation. It's about accepting responsibility for communicating what we do in ways that can be meaningful. I recall Denis Saunders, years ago, talking about 'ecological tithing' – that we should set aside a proportion of our time as scientists to contribute to more effective communication of knowledge.

TM: Yet that is not yet recognised as part of the funding criteria for universities, is it?

AB: No, it's not. In the university system, recognition is largely around journal publications, the quality of journals and citations. But there's a sense of achievement and satisfaction when the work you do is useful and valuable to people. Ultimately, that's what motivates many scientists in the nature conservation area – that we want our science to help make the world a better place.

But it's interesting that we're now seeing a move towards assessing the impact of research. The ARC is carrying out a pilot assessment of 'engagement and impact'. Measuring impact is difficult, but I suspect it will become increasingly important. The pilot is based on universities putting forward case study examples of research, how it involves engagement with industry partners and others who may use the outcomes. La Trobe has put forward as a case study the large 'Mallee Fire and Biodiversity Project' led by Mike Clarke and myself. In this research, we worked with a range of industry partners – conservation agencies in

Victoria, NSW and South Australia and non-government agencies such as Birdlife Australia, the Australian Wildlife Conservancy and the Mallee CMA. I'm not sure how that case study process will work out, we'll wait and see.

TM: Ultimately, though, conveying the outcomes of research will hopefully contribute to the broader goal of helping Australians to become more ecologically literate as time goes on..

AB: I hope so. One of the issues facing society is that we're becoming increasingly divorced from nature. Australia is one of the most highly urbanised countries on Earth. It concerns me that a substantial proportion of the population have little experience of natural ecosystems. The perception of nature that more and more of the next generation will have is a limited perspective from semi-natural 'green' areas in the urban environment. So, that's a big issue – how to connect people with nature. It's interesting that in Victoria, the State Government's recently released Biodiversity Plan 'Protecting Victoria's Environment – Biodiversity 2037', has a major plank around people valuing nature. The aim is to find ways to better connect people with nature. It will likely also involve an increased focus on citizen science, as a way in which people can become involved.

The more people are connected and involved with nature, the more they will have an affinity with it and want to protect it.

TM: What would give you reassurance that our population is on a better trajectory to improving the quality of nature and our connection with it? What milestones or indicators for the changes do are needed

AB: An indicator for me would be a much higher recognition of the environment in the public discourse. For

example, with the Commonwealth budget there is much commentary on how funds will be allocated towards defence, education, hospitals and roads; but often it's lacking in relation to the environment. The environment should be among the headline indicators of what we're doing and what our priorities are in Australia.

I'd like to see greater reporting on national indicators for the health of Australian ecosystems. In Britain, for example, they have the 'UK Farmland Bird Indicator' as a national indicator of long term trends in the health of farmland environments. In reality, we're all absolutely dependent on the environment. As the saying goes, the economy is a wholly owned subsidiary of the environment. We all depend on clean water, clean air,

healthy soils that grow our food. When we go on holidays, we like to go to the coast, to rivers, and national parks. A healthy environment, including local indigenous ecosystems, is fundamentally important for our quality of life as Australian people. Yet we take it for granted.

TM: I am interested in the fact that, as a scientist, you seek to expand your vision and perspective. Some scientists go in the other direction and focus more closely on the minutiae. After all, the big picture can also be pretty depressing

AB: Ah – it's about how we approach it. I'm idealistic enough to

think we can change the world. I want to make my small contribution to making the world a better place. We must have hope. That's something I feel strongly about. When we're teaching and working with the next generation, it's very easy to focus on the negatives, what's going wrong. But that doesn't help them or help us. We must give people hope for the future. We must be careful that we don't sell a message of gloom and doom.

I'm not shying away from the fact that there are major environmental issues and changes that are detrimental. But it doesn't help if we wallow in despair. We need to ask 'what can we do, what are the positive things that can be done, and how can we make a positive contribution?'