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Fire, Fauna & Ferals
from backyards to bush

Conference Proceedings – Speaker Transcript
Keynote Address

Managing fire for fauna conservation: what have we learnt and where to next?

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Link to Slides

Thanks to the organising committee for inviting me to come along and talk to you today. I think it's worth reflecting that fire ecology in Australia as a discipline is actually quite young. Malcolm Gill gave us a framework to structure our research in 1975 (Slide 2), where he consolidated some ideas around disturbance regimes by describing a fire regime to us. He explained how various attributes of plants, their vital attributes, particularly whether they were seeders or re-sprouters, might give us some guidance about how plants might respond to aspects of the fire regime (Slide 3). He put it in a management context to say that we could use this, use these tools, to guide management of our ecosystems.

We understand that there are components of the fire regime at a point in space, intensity, frequency and season, and that there are spatial and temporal components to that and all those combine to determine the outcomes of individual fires and subsequent fires on our biota. A few years later, Noble and Slatyer provided us with some tools within that framework, particularly around plants (Slide 4). That viable attribute model guides our fire ecology management as you know across our landscapes, guiding tolerable fire intervals in particular. Do we have similar tools for fauna? Well, the answer is it's a work in progress. We haven't achieved those goals as yet. It's not as if we haven't tried. There's plenty of science out there. This is a fraction of the stuff I waded through while I was reflecting on this talk today (Slide 5).

There's been lots of summaries done over the years based on locations in the landscape or particular animal groups, so there is no way I can cover this. What I thought I'd do is work backwards to some extent. A few years ago, a group of fire ecologists from all over Australia got together to think about what the challenges were. I'd like to use these three themes (Slide 6) to look backwards a little bit at some of the work that we have done and then reflect forward as to

where we're going in this area. The first of these themes is developing mechanistic models (Slide 7) and by that I mean if there's a fire and some animals what's the outcome? Can we describe a process and can we understand how that process occurs by reflecting on characteristics of the animal populations and characteristics of the fire? There's been an awful lot of work done in that space.

One of the earliest and most interesting pieces of work was a complete accident. There was a group of scientists from CSIRO working in the Nadgee Nature Reserve on the south coast modelling how dingo predation might impact upon mammal communities. There was a substantive wildfire, so overnight they became fire ecologists. It's happened to so many people over the years. They made some observations which were very insightful at the time. This graph (Slide 8) represents the response of a number of small mammal species at two sites over a time period and you can see the fire mark there. They noticed that the effects were spatially variable and they noticed that even wildfires could be patchy and they raised the idea of refuges within fire landscapes. They noticed that the impacts varied between species. Some things went locally extinct but other things seemed to benefit from the fire and increased in their level of activity.

They raised the ideas around predation and in this case that dingos may be interacting with the fire effects. They speculated about long-term successional changes and the science around post-fire succession in Australia was quite young then and there were some models in the US about how it might work. So, these guys thought, well, it would be interesting to see what happens over time. Perhaps most interesting and almost amusingly there was a debate raging at the time about the use of prescribed fire in State Forests and in National Parks and they concluded at the time that fire science was too young to make any definitive statements about this. I'd like to think that 40-odd years on we've resolved that issue but we haven't completely.

A few years later, Barry Fox, as part of his PhD work in heathlands on the north coast of New South Wales, described changes in the abundance of a number of mammal species over time (Slide 9). He described this as a replacement of species and this graph represents the abundance of a number of small mammal species. There was a replacement or a succession over time as the habitat became suitable for the different component species. Barry did something a lot of others hadn't done. He measured the environment at the time and so he could draw direct parallels to those changes with what was going on in the heath at the time. He later experimented and described this as the Habitat Accommodation Model and this model drives a lot of our understanding of fauna responses to fire. He also speculated and quite logically that if we wanted to conserve animal populations at the landscape level that we would need a patchwork or a mosaic of different age classes across the landscape to facilitate this. This was way ahead of his time,

really, because formal concepts about pyrodiversity and biodiversity weren't developed until 10 years later.

So, there have been a lot of people who have taken the Habitat Accommodation Model. They have looked at what they know about species and they predicted what their response might be. Then they have conducted an experiment. The group of scientists here, working in the Mallee with reptiles (Slide 10), took the knowledge that they had about reptiles and they said given the life history strategies of these animals they might do one of these four or five different things. So, they went out there and they measured and collected data and they didn't do any of those things. They did a whole lot of other things. They could define responses of these reptiles and 11 species (there are 9 shown here) showed responses that you could describe as trends over time (Slide 11). The shape of the response was very difficult to predict from a knowledge of the animals themselves. The response varied between regions.

The Mallee Dragon showed a different response in the north and south end of its ranges. Even for a single species that was very difficult to predict what was going to happen. Birds showed a very similar pattern in that landscape.

Pseudomys as a genus is often described as an early-sessional species (Slide 12) and a group working in the south coast of New South Wales developed this rather complex model that I won't go into. The take-home message is that these native rodents like large areas of a particular vegetation type. After fire, they benefit from the opening up of this area because it frees up resources, food resources, but also the dead shrubs that are responding to the fire provide shelter. They are the two fundamental resources it needs. It needs open space to operate and shelter. That happens at the early stage of the post-fire succession, so that's why we see them as benefiting from fire in that regard. In Victoria, a close relative, a different *Pseudomys* species, also responds to that shelter requirement but it responds to the dead skirt around the base of *Xanthorrhoea*s which are the dominant persistent shrub with fire. That skirt is burnt off and then develops with time. This species is actually most abundant in mid and late successional stages. We thought we could predict the way that this species would behave because of the way the genus behaves but it's all about habitat. It's not about time since fire, a recurring theme.

Here's a heritage document (Slide 13) and those of you who understand what a dot matrix printer is will understand why the text is a bit hard to see. Barry Fox and I posed the question that if these small communities of three or four or five species had predictable responses, what about megadiverse communities? So, we looked at ant communities and we have a group of ants that do show successional responses with time since fire. They come and go out of the succession. There's another group which make up about a third of them that don't show those responses. The current

wisdom in these communities is that competition rather than habitat, resource availability, is driving community structure. Here's another factor coming in that I will come back to later on, competition determining some of the outcomes that we observe.

I'm sure Chris will talk about these sorts of models later on but this is a model that's not based upon succession at all (Slide 14). In these desert landscapes these researchers found that lizards did respond in a successional trajectory but the mammals didn't. What they found was species bouncing around between three states based upon rainfall events, subsequent growth of vegetation and provision of resources, moving between those different states over time. Then when there was a dramatic event, major flooding rains, the state moved to a different condition altogether, where there was lots of vegetation, lots of resources. If there was a subsequent fire, if there was a severe fire, it would move back to another state. These are called State and Transition Models and they seem to be quite widespread in our arid zone environments, so an alternative description to common successional models.

If some species show mechanistic and predictable responses, and Barry was right, that if we create patches of habitat at different successional stages in the landscape, we should facilitate the persistence of those species (Slide 15). What should this mosaic look like? A number of people have reflected on that. What pattern, what shape, how should it configure in the landscape (Slide 16)? Where should the refuges be? This is an ongoing question in fire ecology. We undertook some research a number of years ago in the Otway Ranges where we established a number of 100-hectare sites, mosaics, varying from very simple mosaics of single vegetation to complex mosaics of different vegetation types and different fire histories and there are the two extremes there (Slide 17). We asked some simple questions of that. Is there a relationship between environmental variability, heterogeneity, and biodiversity? When it's caused by fire we term that the pyrodiversity-biodiversity hypothesis (Slide 18), as I said before. For birds, the answer is yes. As you can see, there is a positive linear relationship there. The more complex the landscape, the more birds it supports. The hypothesis is accepted. As you can see, there is a lot of scatter around that line and so we delved into why that might be. What this graph shows is the results for two bird species (Slide 19). At the top, you can see that there's a positive response to time since fire, irrespective of vegetation type. It's time since fire that's driving the response for the eastern yellow robin. But when we look at the golden whistler at the bottom, the whistler doesn't care at all about time since fire. It cares about structural attributes within the different veg types. That's what drives its abundance.

Holly Sitters, our PhD student, found that for most of the birds she looked at it was again habitat structure that was determining the response over time after fire. Matt Swan, who will be speaking later this morning, looked at some terrestrial mammals in this situation and found no response to

the mosaic at all (Slide 20). The mammals were responding to small scale charges in habitat structure. There were periods at which there would appear to be thresholds when certain habitat elements had recovered after fire and then could support those mammal communities. Sometimes, those thresholds varied between vegetation types, as we found with the birds. Matt's conclusion, and this has been supported by a lot of other work, was that it is habitat structure again driving it for this group of animals.

There are other landscapes where pyrodiversity isn't important at all. Back to the Mallee and bird species again (Slide 21), work from Deakin and Latrobe Universities, this is the relationship between species richness and complexity there and there's no relationship. Where there is the relationship is the proportion of the landscape that has long unburnt patches in it. So, why is that happening? In this landscape there are a number of specialists that live only in long unburnt vegetation. You need to include those patches in the mosaic in order to maximise the diversity of species that are there.

So, we have models that are imperfect. We're applying them at landscape scales in a mosaic framework and the answer isn't simple. It's quite logical that there must be something else going on (Slide 22). It's not just fire. As I said, the guys from CSIRO hinted on this 35 years ago. Back to the Nadgee experiment, at the same time Harry Recher was working in Nadgee and subsequently Dan Lunney and others from National Parks have been working on that, and this is a long-term data set now, and these three graphs (Slide 23) for three different small mammals show the original fire and then a subsequent fire of lower severity.

Harry and Dan and others have been studying this system for a number of years. I spoke to Dan on the weekend and they are still down there collecting data. They have found as the guys from CSIRO had that after the original fire there were extinctions and then recolonization. The second fire wasn't as severe and so there was survival in situ and recovery. But there are other drivers here and the bumpiness of those graphs, you can see that for some species fire wasn't causing changes in population sizes at all. It's drought or rain that causes eruptions in their resources and therefore facilitates changes in their population sizes. So, these species are responding as much to changes in rainfall and climatic changes as they are to fire.

Time for some melodrama (Slide 24), to lighten things up. Here we have a lady wasp who is flightless sitting on the top of a grass stalk waiting for her lover to come and sweep her off her feet and take her away. But he's down the road having it off with an orchid who has disguised itself as a lady wasp by its morphology and by its scent. I had a student working in this area. The orchids flower in the first years after fire. There's an obligate relationship. These wasps only pollinate these orchids and the orchids need to be pollinated by these wasps.

You would expect maybe that the amount of orchids or the amount of recently burnt vegetation would determine the rates of pollination. In fact, the rates of pollination in these recently burnt areas are best predicted by the amounts of long unburnt vegetation nearby, within 800 metres, because that's as far as the Thynnine wasp can fly on a good day. The reason that is, is because they go to the orchid for sex but they need to eat. These long unburnt areas provide the food resources and the other habitat. This is a complex interaction here where the ongoing persistence of the orchid and the survival of the wasp results from an interaction between two processes, fire and pollination. In this landscape, we need fine-scale mosaics to allow those two processes to work together so that the organisms can survive. The good news is in this story that he learnt his lesson. She forgave him and they got back together and everybody lived happily ever after.

These are small-scale interactions, so I'd like briefly to reflect on large-scale interactions (Slide 25). A number of us in Victoria pooled our data sets across Foothill Forest, across the landscape. These two graphs, the y-axis shows, is just the amount of information that was explained by the variables on the bottom axis and they are colour coded by the types of variables that are there. The blue-green coloured ones in the middle are our landscape variables. Most of the information about the way species occupy the landscape is as we all know explained by vegetation type which is a response to rainfall and soils and topography, etcetera. Fire actually at the landscape scale plays a lesser role. It's still significant. Amongst the three fire variables that we looked at, it was inter-fire interval that was the greatest predictor for both plants and animals. When you dug down in the animal groups, again, the groups that showed response to fire as well as response to landscape are those whose habitat was influenced by fire and those that have a strong relationship with habitat, this word keeps coming up.

Another interaction that you will hear more about this afternoon is around competition and predation (Slide 26). This graph shows some work in Cape York with cats. This shows a dramatic decline in the activity of cats at recently burnt sites at the first scar over a very short period of time. What they found is that feral cats were travelling large distances to fires and they were more active in the areas of the fire scar in the first one to two months and then that activity declined quite quickly to the sort of base levels that were in the landscape. You will hear later about cat predations.

Cats can have a dramatic impact. Should we worry about that? Well, recent estimates showed between two and six million cats that we don't want in the landscape. This is an interaction with fire that we need to know a whole lot more about. (Slide 27) For people who might be interested, there's a symposium from the Royal Zoological Society later on this year thinking about the issues of how do we manage feral cats, how do we overcome some of the social limitations of telling

people we want to kill cats, what are the challenges, how do we deal with them? It's illegal to kill cats in Victoria.

Foxes are another major predator (Slide 28). Bronwyn Hradsky is going to talk about her fox work later on today. This is just a quick reference to some of the work at the Arthur Rylah Institute. Again, similar to the cats, foxes increase their activity shortly after the fire. Then it declines and it varies in space. So, this is an interaction with fire that we need to consider. It might explain some of the responses that we see in our mechanistic models.

What have we learnt (Slides 29-30)? We know a lot more about the direct effects of fire. We know that some animals are more vulnerable because of their mobility or their fidelity to their site, where they live. We know that other animals can avoid fire and move around. We know that some take shelter and are safe in that regard. We know that some animals are dormant during the time of the year when fires are most prevalent. Frogs in particular, but the Mallee Moth has a strategy where it lays its eggs in leaf litter at a time of the year when historically fires were not part of the system. Now, we are changing the window at which we apply prescribed fire. In southern Queensland in particular there's some concern and particularly because the larvae of this moth are involved in decomposing the leaf litter, so we're seeing increases in rates of leaf litter accumulation because of changes in the season of fire.

There are longer term indirect effects that we are starting to understand. We know that animals can move out of the fire. If they decide to stay and persist they have to face a lack of resources, predation and competition. They may recolonise or they may stay in situ and then they have to find mates and reproduce. Their ability to achieve all of this will depend on the resources that are available to them and their particular life history strategies.

We can describe aspects of their life history strategies as we have with plants by describing traits, morphological, eco-physiological and behavioural traits. Those traits are shaped not by single fires but they are shaped over evolutionary time by the fire regime. Is this the way forward (Slide 31)? There has been a number of people that have reflected around traits and thought about the sorts of traits that we might consider. Some of that's been consolidated down into a smaller set of functional traits that we might experiment with. So, there has been some work done in that space.

Martin Westgate looked at frogs, looking at three different ways that frogs might respond, burrowing, climbing or staying on the surface, and he found that those traits were of no use in describing the survival and persistence of frogs in a fire prone landscape. A group from Latrobe used cockroaches. They measured a whole lot of attributes of cockroaches. Again, these traits were not helpful in predicting the outcomes. A more successful approach in Western Australia,

Peter Langlands (Slide 32), looked at multiple traits of spider and he found that when you considered a range of traits you could better understand the response of spiders to fire. That's not surprising because selection operates on a range of traits, not just single traits. A more productive way forward might be to look at suites of traits and one our students looked at functional diversity, the range of traits that are on the screen here for a range of bird species (Slide 33).

This graph shows bird species richness over time and there's no changes in bird species richness at these three veg types that I described earlier but there were changes in functional trait diversity. In this landscape, patchy low severity fires were creating a greater range of niches or spaces and more birds using different approaches were inhabiting those areas and so creating greater functional diversity. Thinking about functional traits in this regard gave us a bit more insight into what was happening post fire.

We heard a little bit yesterday about mosaics and even though we're very much involved in this work I've decided not to talk about it because of time (Slide 34). There's a lot of work going on in Victoria around using growth stages to predict outcomes and growth stage models and geometric mean abundance as a diversity index is now enshrined in our fire management in Victoria. There's a project just started. Luke Kelly from Melbourne Uni and a group from Latrobe are looking at can you take large data sets, can you use fire prediction modelling, such as Phoenix and other models, to examine how species might respond. Then can you create a decision system to help managers develop scenarios. If we do this, what would be the outcome? Luke has just started on that project.

We've just started a very similar project, only looking at fragmented landscapes (Slide 35). Fragmented landscapes are obviously quite different because as well as habitat suitability which can be influenced by fire, you're looking at connectivity. Can organisms move around between the different parts of the landscape? We're using some Stringy-Bark Woodlands in southwest Victoria and in South Australia, in collaboration with our colleagues there, and using some genetic tools to look at gene flow or how genetic information flows across the landscape, which tells us about connectivity, and again using fire simulation modelling to make predictions.

Are there unifying principles (Slide 36)? Well, yes and no. It's a challenging area with fauna that we need to work on. There's a lot of stuff going on. There's an intrinsic variability across the landscape. I think what we're learning in fire and fauna studies is that there's not a one size fits all approach and that managers should be looking at spatial scales that are relevant to the biodiversity objective that they're setting. There might be small scale objectives with small scale approaches or there might be landscape scales. I heard yesterday, quite encouragingly, that people are using

experiments using adaptive management to address some of these questions and I would say, as others have, that that's the best way forward.

We need to know a lot more about the vulnerabilities of our animal species (Slide 37). How does patchiness provide refuges for them? How does it allow them to recolonise and persist? As I usually conclude by banging on about long-term studies, there's a decline in long-term fire studies in Australia. Forestry agencies are no longer committing to these. There are very few of them happening. What will it take for us to bring them back into our management because that's the only way we will really understand how some of these interacting factors work with fire to determine the outcomes that we see. Thank you for your time.

Questions from audience

Question: Bruce Thompson, OEH. Alan, you mentioned fragmented landscapes. I assume there's a vast difference between patch burning in a continuous landscape and burning of remnants in a heavily fragmented landscape. Do you have any comments on that?

Alan: The reason the study came about is trying to get different growth stages in your management unit is relatively straightforward if you have got a big continuous management unit. However, when you have a small patch do you try and have all the growth stages packed in there, but that's probably not feasible, or will there be some arrangement of patches close by and each can have a different growth stage, so as a unit, a larger unit, they're achieving your management objective. It's a question. That's the hypothesis and the answer is yet to come. That's what we're working on at the moment and as I think your question alludes to, there are real challenges in having patch mosaic burning in small patches and as we heard yesterday, particularly if they are adjacent to urban areas, you might spend most of your life trying to achieve it. I hope that sort of answered your question.

Question: Simon Heemstra RFS. Just thinking about this challenge of long-term studies and particularly how the workforce is changing nowadays and people used to be in one place for a lot longer to be able to continue that. Have you got some ideas as to how we can use other ways to try and get long-term ecological studies happening?

Alan: You're right, Simon. From my observation, there are champions that drive long-term research, so the Harry Recher's of this world, even though he is retired. He's still involved in Nadgee. Encourage champions, encourage people who have moved on or changed their jobs to still be involved and provide mentoring or guidance. The other solution is the agency has to take ownership of it, not rely on individuals. We need OEH, DELWP (Victoria), the various agencies, to own these things and to be proud of them and to provide sufficient resources to allow them to

continue. The same problems that we hear about long-term monitoring exist in this area, in that people come and go and the data is in a poor shape and nobody knows what it means. We know the problems and know the solutions. We just need the motivation to do it and you're our man, Simon.

Question: I was wondering if timber harvesting in working forests, logged forests, creates those mosaics of different life or age classes of forests that you were talking about.

Alan: The graph I showed towards the end of the different response curves was actually developed in harvested forest. The original work by Rod Kavanagh and Richard Loyn and others, and that's been adapted to fire responses. But there are fundamental differences between the disturbance of harvesting and fire of course. David Lindenmayer's group, as you may have been aware, has looked at the interaction between fire and salvage harvesting in Victoria and has concluded that it's problematic. It creates these fire traps where the vegetation becomes almost dependent on a changed fire interval and that that's not what we wanted. So, I think the model behind it all is consistent, one of recovery after disturbance, but there are unique factors depending on the type of disturbance that you're talking about. After cyclones, for example, we see similar response patterns but the initial disturbance is much greater. So, the patterns of response are different.