Conference Proceedings – Speaker Transcript
Keynote address

Fire, feral and native animal interactions: perspectives from central Australia

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Link to slides

Thanks for the opportunity to be here today to talk about a perspective that may be slightly different from some of the talks that have been given earlier today and yesterday. I'll be switching the focus to arid Australia and I'll be making perhaps the slightly controversial point that in that region, fires per se are not so much the problem as compared with feral animals. The fire/feral animal interaction is probably the most important thing that we need to be thinking about for many of the inland regions.

First I'd like to describe some of the background biology that characterises the inland environment (Slide 2), particularly the boom and bust dynamic that is driven by big rainfall events and the intervening droughts. I'll talk about some of the opportunities and hazards that arise from these big events, called 'pulses of food' and 'pulses of fear'; fear coming from the predators that move in. I'll explore some of the patterns and the processes that operate in these environments, focusing firstly on rainfall as the big driver of the boom events, then the effects of wildfire. Wildfire often comes within a year or so of big rainfall events. Big rainfall drives bursts of productivity; a year later it's all dried off and it's then subject to lightning ignition over large areas. The interactions between these events and introduced predators can be very important. I'll also talk a little bit about management possibilities and some of the challenges posed by climate change.

Arid Australia covers around 70% of the continent (Slide 3). The work that I'll be talking about is carried out in the hummock grasslands. One of the biggest biomes on the continent, it covers around 40% of Australia. The area that I'll be talking about is the Simpson Desert, marked by the red star. This particular spinifex-dominated area is characterised by long red linear sand dunes that run for many kilometres (Slide 4). It's pretty arid, as you can see from the rainfall figures, usually receiving no more than 200 mm a year. It is very variable in terms of other aspects of climate; it's often very windy, and either very hot or very cold.

Historically, the fire return interval was 25 - 26 years, but we've seen some evidence that the fires are becoming more frequent in the last 20 - 25 years. I'll be talking about some long-term data that we've been able to gather over the years since 1990. We operate around 12 sites in the Simpson Desert, covering an area of around 8,000 km^2 (Slide 5). There are several sampling plots per site, at which we monitor a variety of small vertebrates, invertebrates, vegetation cover and composition, as well as weather data. We've tried to get out there between three to six times a year; it's currently around three times a year.

I'll talk particularly about the series of sites that are encompassed within the red circle. The area is subject to the vagaries of climate and to this boom/bust dynamic. The pictures on the left of the slide (Slide 6) show two examples of the area in drought, and two on the right show what's happened after big rainfall events in 2010-11. These were big rainfall events, with falls in the order of 150-200 mm over a weekend - a year's annual rainfall in a weekend.

Some of the study species that we look at are ground-dwelling vertebrates (Slide 7). These include small mammals: the Spinifex Hopping Mouse, Sandy Inland Mouse, and the Mulgara, one of the medium sized carnivorous marsupials. There's a big variety of lizards too. They're caught in pitfall traps on each of the sites. The boom/bust dynamic is one that's characterised by these dramatic ups and downs in populations of various consumer species (Slide 8). Big rainfall events generate big pulses of productivity and the consumer organisms, of which the rodents are one, respond accordingly. This is a standard metric of captures per grid night and, as you can see, there are several periods when the numbers erupted from a baseline of zero or near zero to quite large peaks before declining again.

To illustrate the importance of rainfall (Slide 9), this is the same plot for the Sandy Inland Mouse, compared with the rainfall that occurred over the time period from 1990, and you can see that the big rainfall events that occurred early in the study were all followed by large eruptions in the numbers of this particular species. If you do a simple correlation, lagging the numbers of the rodents by 6 months, you get a very strong correlation. Within 6 months of a big rainfall event, you can expect an eruption of these consumer organisms (the Sandy Inland Mouse in this case).

There is a similar pattern for the Mulgara (Slide 10). This is the largest of the carnivorous marsupials, it feeds on rodents. Its numbers show a similar correlation with rainfall, but with a slightly longer lag. This is because Mulgaras do particularly well after rainfall events have generated pulses of rodents, which the Mulgaras then eat. Their peak numbers tend to come a little later than those of the rodents, with a 10 month lag producing the strongest correlations. The correlation is not quite as strong, but nonetheless, rainfall drives the numbers of these species through the effect on the rodents. Rainfall has dramatic effects on these two species.

To illustrate the point that it's not uniformly good for all consumer organisms, this is one of the smaller insectivorous marsupials (Slide 11), the Lesser Hairy-Footed Dunnart. This tends to show negative effects from big rainfall events and the correlation, with a 2-6 month lag, is actually negative. This appears to be because these small species don't dig their own burrows; they're critically dependent on the burrows of other species. When it rains these burrows fill up, the Dunnarts are unable to find other alternatives or to dig their own and their numbers go down. But for the most part, big rainfall events herald these pulses of great productivity that are used by many of the consumer organisms.

One of the other consequences of having big rainfall events is that the pulse of productivity translates not just into green growth and the production of flowers and seeds, but within a year or so there is a large amount of fuel that has been generated and this is subject to lightning ignition (Slide 12). These are rainfall traces from stations to the north of the desert and they indicate that, after big rainfall events, there were fires of considerable extent in 1917, 1951, 1974 and 2001. There have been more recent fires in 2010. The 2001 fire was quite a large wildfire (Slide 13); it burnt around a quarter of a million hectares of the immediate study region. Elsewhere, further to the south and to the west in arid Australia, around 3 million hectares of spinifex were burnt. Wildfires have burnt smaller areas more recently, in 2011 around 25,000 hectares were burnt.

The historic fire return interval of 25-26 years appears to be declining. There have been smaller fires in the last year, again after big rains. The shaded area here (Slide 13) represents the area that was burnt. This was very convenient as we had sampling plots all through the burnt and unburnt areas. This gave us a readymade BACI (Before-After-Control-Impact) design. The wildfire burnt for months. There was no real attempt to put it out as there was not a great deal of infrastructure, no human life, very few livestock at risk in this region. It was patchy in parts, as shown by the top figure in the middle (Slide 14), but for the most part all aboveground vegetation was removed, as the figure on the top right shows. This contrasts quite dramatically with attempts that are sometimes made by land managers to carry out small-scale prescribed burns, as shown at the bottom. The top right photo was how much of the desert looked, and did so for about 5 years until it rained again.

As you might expect from the preceding figure, much of the vegetation - if not all of the above-ground vegetation - over large areas was removed. This is a plot (Slide 15) showing the mean percentage of spinifex cover before and after the fire in the burnt and unburnt grids. The approximate 35% cover before the wildfire, crashes to very low levels once the fire has passed through. Spinifex remained at very low levels for several years afterwards until it rained. There was a general decline in the cover of spinifex in the unburnt areas, probably a consequence of the ongoing drought.

The effect of the wildfire on small mammals was equally interesting and quite dramatic (Slide 16). You can see the peak just before the wildfire that had been stimulated by rainfall around 2010-11. There was a big eruption in rodents, particularly in the sites that were later to be burnt. After the wildfire, these numbers crashed to zero for a number of time periods and then stayed at low levels for a long time. The numbers in the unburnt sites tended to be higher than in the burnt areas for most of this period, even though they were still low due to the ongoing drought. The fire appeared to have this effect on their numbers, but was it just the fire?

Our measurements of invertebrate resources for the insectivorous marsupials and seed resources for the rodents showed that there hadn't been a great reduction in their abundances as a consequence of the wildfire. So, in terms of food resources we might have expected their numbers to remain reasonably high.

While monitoring the populations of small native species, we also monitor the introduced predators, particularly the introduced feral cat and red fox (Slide 17). Numbers fluctuate dramatically over time. To put that into the context of the dynamics of the native species (Slide 18), we've got the trace of feral cat and fox activity in the top since 1990, and the capture rate of the Sandy Inland Mouse as a representative native rodent. The numbers of predators tend to be relatively low as the native rodents are increasing, and they build up at about the time the native rodents are decreasing to low numbers. That has happened in the three separate eruption events and has also happened in one that we finished measuring over the last couple of years. There seems to be a slight offsetting: predators increase to their maximum activity at a time when the native species are declining.

To help understand if there is a causal link here rather than coincidence, if you break up the time period into different phases (Slide 19), bust is the long phase when there's not much happening: no rainfall, very little productivity - the increase happens after rainfall. Peak numbers are there for a very brief period before the decrease phase of small mammal populations occurs. Looking at the diet of the fox and the cat from their scats at those times, you can see that small mammals feature in the diets of the predators at all times. They are present during the bust, they tend to increase in representation during the population increase phase. But particularly during the peak and the decline phases of the small mammal populations, virtually every predator scat contains small mammal fur, which suggests that at these times there is intense per capita predation by the introduced predators.

This slide pulls all this information together (Slide 20). The bottom line shows the population trace for the Sandy Inland Mouse from the early years of the study, heavy summer rains prompt the increases in their numbers, as we've seen. The black arrows indicate periods of the most intense predation, and these tend to occur when the predator numbers are built up and when the small mammals and other consumers are coming down. These appear to be the critical periods and virtually every predator scat that you find during these periods contains small native prey. Due to this intense predation, there are periods with very few, or sometimes no, native mammals that are detectable, and this can be for periods of several years. There are some refuges where these animals may retreat to.

There is also an interaction between wildfires and predators (Slide 21) that is of some concern. This slide shows data collected after the fire that we've just seen, from 2005-08. The data here represents footprints of foxes and cats on transects at the ecotone where the fire burnt. The left-hand side of the figure shows unburnt areas of spinifex, and the right shows areas that were burnt, where the vegetation was removed. Activity of both predators (feral cats in the top figure, foxes in the bottom) is intense at the ecotone. They are taking animals that are perhaps using the spinifex as cover, moving out into the open to forage. The ecotone appears to be the area of most intense activity.

What can you do about this? If wildfires result in the removal of cover and the subsequent arrival of predators have these effects, what can you do? One thing we've tried is to provide experimental small artificial refuges and see if the native animals are able to recognise and use these (Slides 22-24). To do this, we've used a technique called the 'giving up density', which measures the trade-off between the provision of food and the assessment by native animals of predation risk. Results indicate that these refuges are recognised as being a place in the landscape where they can escape predators. We've scaled up to build larger refuges now, covering around 250 m^2 in our 1 hectare study plots.

Rainfall is predicted to increase in the future. This (Slide 25) is the 100 year plot from several stations surrounding the desert. Rainfall has increased over the last 100 years and it is predicted to do so increasingly in the future, meaning that the big boom and bust events that drive the wildfire × predator interaction are likely to increase.

Summing up (Slide 26), we need to be strategic about the time and place where we either attempt to reduce the impacts of invasive predators, or think a little more laterally about the provision of additional refuge for vulnerable prey species that we value and wish to maintain in the broader landscape, and think about whether these might be used more broadly in fire-prone landscapes. I'll leave it there with acknowledgements to co-authors and lots of others (Slide 27). Thank you very much.

Questions from audience

Question: Your study period included the time when calicivirus went through the arid zone rabbits. Did that show up in your conclusions and data?

Prof. Chris Dickman: It didn't in any data that I showed just now because, interestingly, the rabbit line was at the homestead at one of the properties where we worked, but we worked primarily north of there. We did do some sampling with rabbits and the predator dynamic, and it seemed that the predators were showing a classic type 2 response; that is, as the rabbits became increasingly scarce when calicivirus moved through, predators were still focusing on the rabbits. We couldn't find the rabbits, but the predators could, and we were still finding rabbit fur in their scats.

Question: Sam Lloyd from Fire and Biodiversity Consortium in south-east Queensland. You implied that the refuges had been quite successful with the small mammals using them. How realistic is that to implement that as part of a plan? For example if an NGO such as Bush Heritage Trust is looking after a property, is that realistic? Do you think it's a real option with lack of other options coming through in terms of cat and feral fox management?

Prof. Chris Dickman: I think it's probably sort of a holding method, like many of the other techniques that we currently have. We know that we can't do much to reduce fox and cat activity over broader landscapes, but the technique may have value if there are small populations of vulnerable species that are known to be at risk of fox and cat predation. If the idea works it may be possible to manufacture them on a scale such that they can be put on the bed of a flatbed truck and dropped off the back of a truck easily with relatively little cost. One of the values of them is that they don't stop predation, but they do provide reduced predation. So it does allow for learning and natural selection to take place.

Question: Andy Baker from Southern Cross University. I'm looking at other management strategies. I know that these predators sometimes travel long distances to come and utilise the ecotone area, so it tends to concentrate those predators. Do you know if anyone's looking at targeting control or trapping or baiting in those areas and seeing the fire as potentially an advantage to gather those predators for control?

Prof. Chris Dickman: There is a little bit of thinking around that. There's a trap called a cat assassin trap that's been suggested for use in local situations like that. Essentially if a cat walks past, it breaks some sensors, it gets a spray of toxin onto its flanks or shoulders and, being a fastidious creature, it turns around and licks it off and gets knocked out as a consequence. But in terms of ecological traps more broadly, I think where these predators are confined to the landscape for longer periods could also be a really good way to go.