

## **Sharing the environment: Counting the cost of wildlife mortality on roads**

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### **Abstract**

Awareness of fatalities resulting from collisions between wildlife and vehicles, both wildlife and human, is not recent. With the increase in vehicles and our reliance on the road transportation network over the past 30 years, roadkill has taken the interest of many environmentalists, animal welfare agencies and government bodies. Increasing insurance costs, estimated to be around \$21 million annually by the NRMA, and rising injury and death tolls to motorists has also brought this issue to the attention of many. We have a national crisis on our hands. And yet, research efforts have not kept pace with this awareness. We lag seriously behind Europe, the US and Canada in our efforts to understand the implications of our burgeoning transportation system and lifestyle on our wildlife.

Roads have a multitude of effects on the natural environment. In the field of road ecology we talk about the road effect zone, or the virtual footprint the road has on the landscape. Developed countries dedicate around 1 to 2 % of land to roads, with road effects extending to an estimated 15 to 20 % of land. Roads impact on soil structure and chemistry, microclimate, run-off and water flow, noise pollution and the spread of weeds and feral animals. Perhaps the most significant impact of roads is on our native fauna. For wildlife, roads have three major impacts on populations. Roads can form barriers to movement, fragmenting populations and isolating them from resources and mates. They can alter the structure of populations adjacent to roads where road effects lead to avoidance. They can also cause fatality of animals as a result of collisions with the vehicles that travel on them. Research has an important part to play in our efforts to tackle the intricate relationship between wildlife and roads. It is only with comprehensive and reliable data that we can hope to tease apart the complex factors that contribute to this problem.

In this paper I will outline our efforts at UNSW to address the paucity of information on this serious issue. In conjunction with the federal government and industry partners, we are gathering, collating and analysing data on roadkill statistics across NSW. We are also taking a rigorous approach to evaluating existing

preventative measures to mitigate collisions and develop new technologies with the same aim. I will suggest that it is high time this issue was taken seriously, with comprehensive backing from federal and state governments necessary to ensure future road development is conducted in a sensitive and appropriate manner in an ever urbanised landscape.

## **Introduction**

*“The greatness of a nation and its moral progress can be judged by the way its animals are treated” – Mohandas Gandhi.*

We like to think that society today is highly sophisticated and that how we interact with the world is the result of deliberation, debate and reason through logic. In our ever burgeoning Australian cities the requirements to sustain our lifestyle, considered to be in the top 3 % in the world, are continually increasing. And yet in order to maintain this it is necessary to consume more and more resources. We continue to clear land at phenomenal rates, consume unsustainable energy resources and develop transportation systems to improve commuting and distribute resources to satisfy our lifestyle requirements. As we justify this with our stubborn ‘colonial’ attitudes, the conservation of the environment, wildlife and ecosystem functioning comes in a poor second. What happened to reason and logic? Is it that we are unaware of our effect on the environment or is it that we are deluded? Do we not care?

Take a trip along any country road throughout Australia. You might see patches of remnant vegetation in linear corridors along the road side and the occasional koala, wallaby or kookaburra, but perhaps more often you will see evidence of exotic weeds and the carcasses of wildlife killed from collisions with vehicles. At a rough guess, probably 90 % of our experiences of the environment and wildlife are facilitated by roads and yet what sticks in the mind are vast stretches of agricultural land and roadkill. Despite this, little is currently being done to alleviate the carnage. At best, most dollars are spent mimicking strategies and technologies developed and employed, with varying degrees of success, in countries such as the US, Canada and in Europe. What we need are strategies that are tailored to Australian wildlife and our environment.

## **Australian Transportation Systems**

According to the Australian Bureau of Statistics Australia had 810,022 km of road in June 2002 however the effect of the road is further reaching than the road strip itself. Calculations of the 'road effect zone' must take the impacts of chemical and noise pollution, the avoidance response of wildlife and habitat alteration into consideration<sup>i</sup>. For example, willow warblers have been shown to not engage in song within 100 m of a major highway<sup>ii</sup>. The effect zone should vary with the level of urbanisation and landscape differentiation, but as a simplistic measure we can use the figure of 200 m as a safe average when looking at the scale of the Australian continent. Using this figure we can derive a total of 162,004 km<sup>2</sup> of road effect zone in Australia, or 2.12 % of the Australian landscape. In New South Wales there is 182,006 km of road, divided almost equally between bitumen or concrete roads and gravel or crushed-stone roads. We can then predict that just over 4.5 % of land in New South Wales can be considered within this very conservative estimate of effect zone. There is no doubt that if this zone was calculated in a rigorous fashion Australia, and New South Wales, would compare similarly to other countries estimated effect zones of between 15 and 20 %. It is our aim to accurately identify this effect zone in Australia over the coming year.

Australia's population is not expected to increase dramatically over the next few years, however there is concern that our dependence on vehicle transportation is on the rise. Australian Bureau of Statistics figures show that new motor vehicles sales have jumped by an additional 10,000 per month in the last year, to roughly 80,000 per month, and rising by 30,000 per month in the last 10 years. As we reach 20 million people in Australia, the fleet of vehicles in the population has reached somewhere in the vicinity of 12 million. In every state there has been an increase in the number of motor vehicles per 1,000 people in the last 30 years. As such, we can expect that the situation of wildlife being threatened by our transportation system will only worsen.

## **Road Impacts on Wildlife and Habitat**

Briefly, mortality of wildlife killed from collisions with vehicles is not the only impact roads have as the effect of roads and traffic on habitat and wildlife is far-reaching. Community perception of this issue is not new, but consideration of roads as "driving" forces in ecology has only recently gained a focussed international

awareness. Roads have a multitude of effects on the natural environment. Roads impact on microclimate, wind flow, run-off and water flow, they cause noise pollution and facilitate the dispersal of both plants and animals, including weeds, feral animals and native species. For wildlife, roads have three major impacts on populations. Roads can form barriers to movement, fragmenting populations and isolating them from resources and mates. They can alter the structure of populations adjacent to roads where road effects lead to avoidance. They can also cause mortality of animals as a result of collisions with the vehicles that travel on them.

Assigning priority to the different components of road effects has varied considerably world wide. In essence, politics and available money tends to have a large impact on the direction research takes. This is not such a bad thing, but care must be taken to make sure appropriate and rigorous questions are asked rather than conducting research that will have the most 'visible' outcome. Often money will be spent on high profile projects focussing on localised areas, as opposed to projects that offer broader solutions. There are also differing opinions of what effects of roads are more deleterious than others. For example, many landscape ecologists see the big impact of roads as habitat fragmentation and the isolation of populations. They suggest that genetic degradation resulting from isolation is the biggest threat to the sustainability of populations. Richard Forman, the 'father' of road ecology has written:

*“Degraded habitat surrounding roads is a bigger problem, ironically nearly invisible to the driver speeding along the highway.”<sup>iii</sup>*

For species with large home ranges, migratory habits or those that actively engage in dispersal, habitat fragmentation can play havoc on populations. The isolation of resources or mates via roads has been shown to impact on a number of species. However it is often contended that the most serious effect of habitat fragmentation is on the genetic diversity of populations, with significant conservation concerns. This is despite no evidence of genetic isolation caused by roads resulting in the decline of a population of any species. This is not to say that roads do not have the potential to cause population decline, but to date few studies have been conducted that have been specifically designed to address this question. For example, genetic drift among vole populations separated by a large highway has been proven but not whether the populations were in decline as a result of this drift.<sup>iv</sup>

Richard Forman then went on to say,

*“Fortunately, however, except for large predator and reptile and amphibian cases, roadkill is arguably of little overall ecological significance. In essence, most animals reproduce faster than vehicles hit them.”<sup>v</sup>*

There are a number of ways to interpret this. For very common species, such as deer or kangaroos, no studies to date have shown that mortality from collisions on roads has severely impacted on the local population of a species. For some species though, road mortality has been directly linked to the survival of local populations (e.g. quolls and bandicoots), and we at UNSW have data that suggests many more species may be affected. But this approach focuses on a species-level concern. What about the rights and welfare of individual animals? From a legislative point of view, the presence of a few individuals of an endangered skink is enough to make engineers rethink their road location and design, but the likelihood of more abundant species being killed does not have any legislative protection in Australia. So most thinking about the protection of animals is concerned with the protection of species and not individuals. While this has some merit, it is hard to write off the millions of animals killed on roads in NSW alone each year on the basis that most are not endangered species. These animals deserve a fair go!

### **The Roadkill Story in NSW**

The most obvious and serious effect of roads on wildlife has to do with the mortality of wildlife killed in collisions with vehicles. A range of small-scale studies have been conducted in Australia that attempt to quantify the roadkill problem, and NSW WIRES should be applauded for their efforts in this area. The most widely publicised figure of roadkill within NSW is that produced by NSW WIRES in conjunction with Macquarie University. Their figure of 7,000 animals per day in NSW (or 2.55 million animals per year) was derived from six weeks of data collection over 199 km of road. It is likely that this figure is a good rough estimate as data we have recently collected puts it in the same ball park, although for some ‘hot spots’ like the Snowy Mountain Highway between Tumut and Talbingo, our figures for this area are double. Given the large degree of spatial and temporal error that must be associated with estimating state-wide or even nation-wide totals from these small

amounts of data it is clear we must obtain more high quality spatial and temporal data of collisions before we can be confident of our predictions. We really must strive to improve our knowledge of roadkill if we are going to take serious steps towards reducing the carnage. It is imperative that we collect information throughout Australia, in a range of environments and road systems.

### **Research is the Answer**

Research has an important part to play in our efforts to tackle the intricate relationship between wildlife and roads. It is only with comprehensive and reliable data that we can hope to tease apart the complex factors that contribute to this problem. In order to plug this large hole in our understanding of the issue, the University of New South Wales and the International Fund for Animal Welfare, in conjunction with NSW WIRES and the NSW RTA put together a proposal to address this issue. The ‘Saving Wildlife: Saving People on our Roads’ project began in 2001 and is headed by Dr David Croft and myself, Dr Daniel Ramp, of the University of New South Wales. In 2003 we received further support from the Australian Research Council, IFAW, NSW NPWS, NSW WIRES and Roe Koh & Associates. The project is currently funded until the end of 2005. We have set up the Road Ecology Research Group in order to provide a focus and stimulus for research that encompasses both roadkill and more general effects of roads on the environment. We have taken on numerous honours students and have postgraduate students enrolled both here and overseas actively engaged in the project. We have set ourselves a mandate – develop protocol to enable roads to be designed to reduce their impact on the environment, make them permeable to Australian wildlife and at the same time allow for safe and efficient transportation.

### **Quantifying Roadkill in NSW**

Our goal was to start at the beginning. We decided to quantify the what, why, where and how of animals killed on roads in NSW. As we cannot expect to be able to prevent collisions along every stretch of road, we need to have quantifiable and rigorous means for targeting those areas of most concern. To do this we will be developing models that will inform us of where collision ‘hotspots’ occur. There is likely to be both spatial and temporal variation in the location of these hotspots, but it

is hoped that these hotspots will provide road managers with the ability to target those areas of most concern with mitigation strategies.

In order to quantify collisions between wildlife and vehicles we have taken both a broad and small-scale approach. As it is impractical and expensive to have someone constantly driving around the state of NSW recording roadkill, we developed a system that uses expert volunteers to assist with data collection. This system is especially potent as we not only get information on the location of roadkill but we also know where roadkill does not occur. We achieve this by tracking the path of the volunteer vehicles, taking readings every ten seconds. The use of presence/absence data makes the modelling of this roadkill information particularly powerful and has not been attempted anywhere else in the world. The idea is simple. Based on the data we collect we can determine which attributes are associated with roadkill hotspots (e.g. road type, proximity to habitat, traffic volume). We can then predict the likely location of a roadkill hotspot for any road in NSW, whether we have driven on it or not. There is always some degree of uncertainty inherent in these predictive models but without them we would have to drive every road multiple times a year.

Small-scale studies are incredibly important for validating the information provided by the state-wide approach. These studies attempt to obtain fine-grained information on the spatial and temporal distribution of roadkill in order to explore just what influences collision frequency. We have been running sophisticated modelling procedures using geographical information systems programs (GIS) to explore these patterns. In addition, we have been attempting to obtain information on the populations of animals adjacent to roads, in order to quantify the populations at risk. This information is lacking from most studies and is vital for assessing the viability of wildlife populations.

### **Roadkill Mitigation**

The second aim of the project is to investigate ways to prevent collisions from occurring once hotspots are identified. A major focus of our research investigating roadkill prevention has been on understanding the animals themselves. We are exploring how the behaviour of animals can be exploited to reduce the amount of time animals spend on roadsides, or at least when a vehicle approaches. To do this we are exploring the applicability of technologies developed overseas, as well as

investigating the development of our own novel technologies. Focussing on macropodids, our approach has been to evaluate how these species respond to visual, olfactory and aural stimuli. We have taken a rigorous scientific approach, by running extensive captive trials before undertaking any field experiments.

Wildlife reflectors are devices that have been developed for reducing collisions with deer, elk and moose in Europe and the US. The reflectors are stationed along the roadsides, and with the headlights of an oncoming vehicle, light is reflected perpendicular to the road and into the eyes of animals adjacent to the road (and potential roadkill). There are two main manufacturers of the reflectors, and they come in a variety of colours. Evidence for their effectiveness in reducing collisions with deer is ambiguous. Some testing of their applicability to macropodids in Australia has been done with little success, and most trials have been poorly designed. We built an artificial road in a paddock containing red kangaroos and eastern grey kangaroos. We set up pairs of headlights every ten metres and wrote a computer program to switch the headlights on to mimic the passing of a car. With infra-red video we have been assessing the reactions of the kangaroos to the headlights and different combinations of wildlife reflectors. Our research is ongoing but results so far suggest these devices have limited applicability to Australian wildlife.

Odour deterrents have been given some attention of late, and are a relatively new and prosperous area of research. Of the many varieties of repellents that have been explored, we have opted for examining ones that utilise the innate aversion of predators by prey species, as this is the most ethically acceptable means of warding animals away from a specified area. We have been running captive trials of the responses of different macropodid species to predator odour, either as synthetic dog urine (provided generously by Roe Koh & Associates) or as real dog urine. There are a multitude of reasons why an individual animal may respond to threat in a certain way, and untangling these complexities is tricky work. With testing on a variety of wallaby species our results so far are encouraging. Whether or not this leads to the development of a means of warding animals from roads requires substantial field trials and we will continue to explore this in 2004/5.

One area of reduction technologies that requires considerable attention is that of physical structures designed to assist with, or prevent, animal movement across roads. There is a lack of data on the effectiveness and suitability of wildlife crossings for

different species in different environments. One pivotal question that remains unclear is whether wildlife crossings are meant to prevent collisions or to facilitate road permeability for wildlife, or both? Monitoring of these issues is crucial if the costs associated with these structures are to be justified. If the aim is roadkill prevention, surveys of the change in roadkill adjacent to the crossing must be gauged prior to, and post construction, or else measured at control locations. If the aim is the facilitation of animal movement, surveys of the change in animal crossings adjacent to the crossing structure must also be gauged prior to, and post construction. For both of these issues it is vital that the population structure of animals surrounding the crossing is examined to evaluate what changes occur as a result of the crossing being constructed, both in terms of spatial aggregation and in demography. Before we can take these structures as serious mitigation technologies, hard data of this sort must be obtained.

### **Community Perceptions**

Lastly, but certainly not least, we must address community and driver attitudes to roadkill, and transportation in general. There is undoubtedly a broad spectrum of views in the community regarding this issue. Modifying our own behaviour is perhaps the most simple and significant way we can minimise the effect of roads on wildlife. We engaged in a driver survey in the Royal National Park in 2003, with some extremely interesting findings. One hundred and fifty-six people were surveyed and almost 50 % had been involved with collisions with wildlife. While 83 % of people stated that they did modify their driving behaviour when and where animals were most likely to be found, our traffic volume counters told a slightly different story with average speeds consistently over the speed limit, peaking at night or in the early morning. Most people do not intend to collide with wildlife, but animals do get hit and driver speed is highly correlated with collisions. The answer to this problem is quite straightforward: drive slower and less often and fewer animals will be hit. We need more sociological research to examine why this does not occur, at least in areas deemed to be hotspots. And in these hotspot areas, how can we best encourage drivers to slow down?

### **Counting the Cost**

The cost of collisions between wildlife and vehicles is both social and economic, not to mention the effect on individual animals and populations. Often animals die in

inhumane circumstances especially when they are not killed outright on impact. Are we happy to abide by the pervasive attitude that roadkill is ‘no big deal’ because most species killed are not endangered or are fast breeders? I would hope not. I am in no doubt that it is possible to design roads that reduce their impact on the environment, that are permeable to Australian wildlife and at the same time allow for safe and efficient transportation. These are not mutually exclusive outcomes!

It is crucial that we conduct more research to plug the gaps in our knowledge, but it is also vital that we then integrate this knowledge into management actions and government policy. We must obtain information on roadkill that is reliable and includes temporal variation. We must establish powerful predictive models of hotspot locations that can be used by regulating bodies. We must develop deterrents that are effective and tailored to Australian wildlife, providing recommendations for how, when and where they should be implemented. We need community discussion of policy designed to control road density at sustainable levels, integrating our understanding of ecosystem processes. We need to address the issue of roads and their effects as a community. Ultimately the question is: how much do we value our lifestyle above our wildlife?

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<sup>i</sup> After R.T.T. Forman (2000). Estimate of the area affected ecologically by the road system in the United States. *Conservation Biology* 14: 31-35.

<sup>ii</sup> Reijnen, R. and Foppen, R. (1994). The Effects of Car Traffic on Breeding Bird Populations in Woodland .1. Evidence of reduced habitat quality for willow warblers (*Phylloscopus trochilus*) breeding close to a highway. *Journal of Applied Ecology* 31: 85-94.

<sup>iii</sup> R.T.T. Forman. “Road ecology’s promise: What’s around the bend?” Story in RedNova May 22 2004.

<sup>iv</sup> G. Gerlach and K. Musolf (2000). Fragmentation of landscape as a cause for genetic subdivision in bank voles. *Conservation Biology* 14: 1066-1074.

<sup>v</sup> R.T.T. Forman. “Road ecology’s promise: What’s around the bend?” Story in RedNova May 22 2004.