The Evolution of Wildlife Crossings in Eastern Australia and a Guide to 57 Iconic Sites

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By

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TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

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INTRODUCTION

Have you ever driven along the Pacific Highway (or the Hume or the Bruce Highway) and wondered "what's that strange rope net suspended across road?" Or "why did they build a bridge over the highway with trees and shrubs on it?" Or "what is that tall, floppy-looking fence along the roadside for?"

Well, this book is for you. It explains the how, what, when and why of these innovative pieces of engineering. It's also the book that tells you the 'where'–so you can plan your own journey to drive under and over them. What better excuse for a road trip.

So, what are these curious structures? Road ecologists–the people who study the interaction between roads and the natural environment–commonly refer to them as wildlife crossing structures or *wildlife crossings*. Wildlife crossings have been around in various forms for decades. In fact, they've existed since the early stages of road building in the form of drainage pipes, box culverts and bridges over waterways. In a nutshell, they're structures that wildlife can use to get from one side of the road to the other, without taking on the traffic.

In more recent times, as our understanding of the impact of roads on wildlife has grown, road authorities started installing purpose-built structures such as culverts with timber railings through them for some of our ground-dwelling wildlife and rope canopy bridges over the road for some of our tree-dwelling wildlife. As you'll discover in this book, the wildlife crossings family is a pretty diverse group.

My interest in wildlife crossings started in 1999 when I drove along the recently upgraded Pacific Highway at Brunswick Heads in northern New South Wales. The new section of highway was lined by strange looking floppy-top fencing which occasionally rose above what appeared to be large box culverts. An enthusiastic local told me the box culverts were put there for koalas so they could cross under the highway and the funny looking floppy-top fence, which he reckoned they couldn't climb, was to stop them wandering out onto the road and getting hit by cars. "Bloody great idea," he said, "they can cross the road without worrying about being run over by us idiots."

I agreed with him–*it was a bloody great idea*. Allowing animals to cross the road without having to set foot on the road surface. Permeable road

corridors without the roadkill. It was an elegant, obvious, and simple solution. But did they work?

I've spent the best part of the last 20 years radio-tracking, translocating, camera monitoring, sand tracking and analysing data to answer this question. And I'm just one of a growing band of dedicated road ecologists trying to better understand how wildlife crossings affect the viability of local populations, or how the width of the road, or traffic volume, or noise or light from the road affects wildlife or plant communities. There is even growing interest in potential impacts on microbat movement and insect abundance.

Importantly, the basis for much of this work is the fundamental ecological concept of connectivity. Connectivity is critical to functioning ecosystems and to functioning wildlife populations. That's what wildlife crossings strive to enable–connectivity across roads and highways for a wide range of wildlife. Indeed, for many animals, wildlife crossings provide a critical link to food resources or mates on the other side of the road or even an escape route from a raging bushfire. In some places, like along the Great Alpine Road in Victoria's high country, wildlife crossings are vital for the tiny population of the exceptionally tiny mountain pygmy possum to cling on to existence.

And it's this crucial role that wildlife crossings perform that this book aims to celebrate. In doing so, I have structured the book around the theme of *a journey*–a journey through the evolution of wildlife crossings in eastern Australia, and a journey along the roads and highways that feature these spectacular structures. But every great journey requires a bit of background reading, so the guide begins with an explanation of how and why roads are so bad for our wildlife. From road-effect zone to metapopulation theory, you'll be a fully-fledged road ecologist by the time you finish this chapter.

The guide then changes gear and introduces you to the *UNDERS* (under-road wildlife crossings) and the *OVERS* (over-road wildlife crossings). The UNDERS have been around in various forms for many decades whereas the OVERS have largely emerged during the last 20 odd years. Some, like glide poles, are uniquely Australian innovations for some of our uniquely Australian wildlife–the gliding possums. Others, like land bridges, have been copy-and-pasted from the USA and Europe and target a broad range of wildlife.

After exploring the UNDERS and OVERS we take a look at fencing. Now, I can hear you thinking–"Why include fencing? It's not a type of wildlife crossing." And you'd be right–it's not a type of crossing; but it is integral to their effectiveness. Fencing is the thing that stitches it all together. Fencing keeps wildlife off the road. Fencing directs or funnels

wildlife to the wildlife crossing. Fencing also comes in many shapes, types, and colours and features interesting add-ons like escape ramps, up-and-overs and drop-downs. Hopefully, after reading this section, you'll have a whole new appreciation for the humble fence.

Then it's time to travel! You've done the essential background reading; it's time to plot your path. Pick some wildlife crossings in your favourite part of eastern Australia and plan your route. Or, perhaps, go somewhere unfamiliar. Make visiting a particular crossing an excuse for journeying to a part of the country you haven't seen. Then hit the road and tick them off as you see them. Show your kids. Post them on your socials. Spruik to your friends that you've seen three types of glide pole in three different states or that you've driven under the land-bridge that wallabies, goannas, whip birds and the occasional koala use to safely cross the road.

The guide is organised into eight regional clusters, beginning in north Queensland and ending in central Victoria. There's a map for each cluster which shows the location of iconic structures. Each site features location and access details as well as information about the structure and the native wildlife that we know use it, or are likely to use it. There are also detailed facts (*ANIMAL INFO* boxes) about iconic users of the structures. And, of course, there's information on how to do it safely and not become a road statistic yourself or add to the wildlife road statistics. It would be a sad thing indeed if while journeying to some of eastern Australia's most iconic wildlife crossings you hit one of the target species.

You may be thinking at this point–"What about the rest of Australia?"–which is a fair question. Well, the east is where Australia's wildlife crossings story began and evolved. It's also where most of Australia's wildlife crossings are located. The other states feature far fewer crossings and very few above road crossings. Wildlife crossings in the east are also where I've conducted all my research and monitoring work over the last 20 years and where I've travelled extensively to visit sites. The west is a story for another time.

So, to begin our journey, let's start at the beginning–*why are roads so bad for our wildlife?*

CHAPTER ONE

WHY ARE ROADS SO BAD FOR OUR WILDLIFE?

In the beginning …

Before roads and before humans started carving up the landscape, our forest-dwelling wildlife generally lived in largely continuous forest habitat. There would have been natural barriers and breaks–like rivers and cliffs and swamps–but, by and large, animals that lived in forest habitat would have been able to move around the landscape relatively unimpeded.

That all changed when modern humans appeared on the scene and started burning, clearing and, eventually … building roads. Forest landscapes, like that which existed all the way down the east coast of Australia, became increasingly fragmented and tree cover became progressively patchy. David Quammen, in his seminal book the *Song of the Dodo* (Quammen 1997), portrayed the process of landscape fragmentation using the analogy of cutting up a priceless Persian rug into 36 pieces with a hunting knife. It was a powerful analogy and I recall reading it and feeling a bit shaken as the gravity of the analogy sank in.

But *Song of the Dodo* was written in the 1990s. Things have gotten a lot worse since then. The 2020's version of the analogy is more like: hack the Persian rug into numerous random sizes, throw half of them away, and live with what's left. Perhaps not as eloquent as Quammen's portrayal but the take home message is this: fragmentation and modification of large parts of our global landscape has been disastrous for the functioning of our forest ecosystems.

Fig. 1-1. Roads have transformed much of our natural landscapes into built landscapes. *Photo: Unsplash.*

How has this affected our forest-dwelling wildlife? Well, imagine for a moment you're a koala or a yellow-bellied glider or a pouched frog or a superb lyrebird. You've evolved over millions of years in largely continuous forest landscapes. Now you have to function in a patchy forest landscape with lots of gaps in it; with dogs and cats and foxes in it; with people and buildings in it; and with roads and cars in it. It's a daunting prospect. Throw in the odd bushfire, drought, flood, disease outbreak and climate change and you can see why much of our forest-dwelling wildlife are struggling.

The myriad of ill-effects roads and traffic inflict on natural landscapes and the wildlife living in them, can largely be grouped into three primary impacts:

1. Wildlife road mortality or *roadkill*
2. Loss of habitat
3. Fragmentation of remaining habitat

1. Wildlife road mortality–*Roadkill*

As a road user, wildlife road mortality–or *roadkill*–is probably the most obvious impact of roads on wildlife. It begins with the little things we barely notice–like the myriad of insects your car wipes out on a warm, spring evening, or the countless frogs you squash driving around on a wet, summer night. Then there are the things we do notice–like a magpie, or carpet snake, or echidna, or large kangaroo.

Apart from the potential damage to you and the vehicle, we seem to be more affected by hitting larger animals–at least I certainly do. I still recall running over a perentie–Australia's largest goanna-like lizard–on a track near Alice Springs. I was devastated. And, like many of us, that was just one of the countless things I've hit during 40 years of driving.

Fig. 1-2. Iconic species, such as echidnas, are common casualties on Australian roads. *Photo: Author.*

But I'm just one driver. When you start scaling this up to the 20.1 million cars on the road in Australia (ABS 2021) and the 1 billion plus cars globally (OICA 2016) you start to get a sense of the scale of the tragedy. And the scale is big. Estimates include anywhere between 89-340 million birds killed each year by cars in the US (Loss et al. 2014) and 29 million mammals per year in Europe (Grilo et al. 2020).

Estimates for Australia are limited but published studies have reported such figures as: over nine million kangaroos and wallabies struck on Australian roads each year (Burgin and Brainwood 2008); over 300 koalas killed annually on roads in southeast Queensland (QDES 2022); and over 40,000 frogs run over annually on one road in northern NSW (Goldingay and Taylor 2006). I think you get the picture.

Hidden within these monumental roadkill statistics is the story that different species are impacted very differently. For some relatively common species, like swamp wallabies, roadkill, generally, does not threaten the viability of local populations. But for other species, particularly some of our threatened species, roadkill can be the straw that breaks the camel's back. It can be the thing that tips an already vulnerable species closer to the precipice. This is particularly the case for species like koalas, Tasmanian devils and cassowaries. Roadkill is additive. It adds to an already long list of threatening processes or pressures on many of our iconic species. And a primary one of these processes is loss of habitat.

Fig. 1-3. Seasonal koala warning signs on the Pacific Highway, NSW. *Photo: Author.*

2. Loss of habitat

Roads convert enormous amounts of our natural landscape into bitumen corridors. In fact, the global road network is regarded as the largest human artifact on the planet (Forman et al. 2003). The International Road Federation reported that in 2019, globally, there were over 33 million km of roads (International Road Federation 2022), which is a breathtaking figure. In Australia, the figure is a sobering 825,000 km and counting (International Road Federation 2022). It won't be long till we crack the million mark.

If we consider that a typical road lane in Australia is 3.5m wide (3.7m in the US) plus a similar width road shoulder, we soon discover that the typical two-lane road is about 15m-wide. If we conservatively push this figure to 20m to account for all the three and four (and more) lane highways and motorways across Australia and then multiply this by 825,000 km of road length we end up with a figure of approximately 16,500 km^2 or 1.65 million hectares. But this is a very conservative figure and, as you'll see below, the impact of roads extends well beyond the footprint of the road corridor.

Fig. 1-4. Construction of highways through natural areas involves clearing and re-shaping the landscape. *Photo: Author/Sandpiper Ecological.*

What does all this mean in terms of loss of habitat? It means precisely that–you lose habitat. You lose food and shelter resources for wildlife and other organisms; you lose the ecosystem services that forests provide; and you lose parts of the integrity of a functioning natural system. You've lost patches of the priceless Persian rug. And this cutting out and transforming parts of the natural landscape for roads leads to the next dilemma–landscape fragmentation.

3. Fragmentation of the remaining habitat & the "road-effect zone"

Roads have been a key driver of global landscape transformation and habitat fragmentation. Staying with my version of the Persian rug analogy, habitat loss is the cut-out pieces of rug; habitat fragmentation is the effect on what remains of the rug. The east coast of Australia is a vivid example of this. Before we started carving it up, forests stretched almost continuously from the coastal fringe up to the Great Dividing Range. Now it is a landscape transformed into a mosaic of different land types–urban sprawl; agricultural systems; variously sized patches of National Parks, State Forests and forests on private land; and a network of tracks, roads and highways weaving amongst it all.

When we fragment forests, we fragment the populations of wildlife that live in these forest ecosystems. The process of removing and chopping up forest landscapes effectively separates populations into a series of smaller, isolated populations referred to as *metapopulations*. While many wildlife populations already existed as a series of patchy, loosely connected populations, the process of fragmentation takes this to a whole new level. It means that formerly large and loosely connected populations of potoroos or squirrel gliders or lace monitors now exist in even smaller, more isolated patches surrounded by non-habitat areas such as urban sprawl and agricultural land. These small, isolated populations are then increasingly vulnerable to being wiped out by wildfire, or disease, or changes in living conditions driven by climate change. Indeed, the process of isolation reduces a species resilience and capacity to adapt to change.

Another somewhat insidious effect of roads–described by American landscape ecologist Richard Forman–is the 'road-effect zone' (Forman 2000). The road-effect zone refers to the area of land affected by the many indirect ecological impacts of roads and traffic, such as pollutant run off, reduced air and water quality, noise, etc. etc. Forman estimated that about one-fifth of the entire US landmass was affected ecologically by roads–a somewhat astounding figure.

Fig. 1-5. The impact of roads extends well beyond the bitumen, known as the 'road effect zone'. *Photo: Author.*

The road-effect zone applies to wildlife in a variety of ways and can be very species-specific. One especially problematic effect is that it creates a barrier or filter to movement thereby further isolating some already fragmented populations. For some species, the noise, light, width of the road corridor, lack of tree cover, or a combination of the above inhibits or reduces their willingness to go near roads or their ability to cross roads. In Australia, barrier effects have been demonstrated for such things as small forest birds (Jones and Pickvance 2013), microbats (Bhardwaj 2021) and squirrel gliders (Taylor and Goldingay 2012).

Now, I can hear you thinking–"Isn't avoiding roads a good thing? Wouldn't koalas be much better off if they avoided roads?" In part, you would be correct–fewer koalas would become roadkill if they avoided roads. However, avoiding roads in the heavily roaded and fragmented east coast landscape (prime koala habitat) means they would run the risk of becoming very isolated very quickly. Which means they would lose access to other food resources and mates; they would lose movement of individuals into and out of a population and suffer from inbreeding, or genetic drift; and they would become increasingly vulnerable to being wiped out by fire or

disease. In wildlife ecology–small, isolated populations are vulnerable populations.

Combating road impacts and re-connecting landscapes

Hopefully, the tour of the road impacts has given you a heightened appreciation of the uphill battle wildlife faces negotiating our roaded landscapes. This uphill battle brings us back to the importance of wildlife crossings. They're not a panacea to the problems of habitat loss and landscape fragmentation and the countless wildlife road mortalities. However, when combined with wildlife fencing, they reduce roadkill and enable wildlife populations to connect across road corridors that may otherwise be a barrier. In essence, they make roads more permeable to animal movement.

This re-connecting helps to build species' resilience or the ability of a population to absorb and withstand shocks. Think of it as a form of insurance for occasions when a population on one side of the road gets wiped out by something like wildfire and can be re-populated by individuals from the other side of the road. Or they simply enable wildlife populations to better move across the landscape and adapt as the climate changes. Without them, isolated populations can become even more isolated.

With this in mind, let's now meet the structures; beginning with those built under the road–the UNDERS.

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