Accident Analysis and Prevention 40 (2008) 1865–1871

Contents lists available at ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

Road crashes involving animals in Australia

Peter Rowden*, Dale Steinhardt, Mary Sheehan

Centre for Accident Research and Road Safety-Queensland (CARRS-Q), Queensland University of Technology, Beams Rd, Carseldine, Queensland 4034, Australia

ARTICLE INFO

Article history:
Received 23 April 2008
Received in revised form 23 July 2008
Accepted 3 August 2008

Keywords:
Road safety
Injury
Crash
Animal
Motorcycle

ABSTRACT

Each year in Australia many thousands of collisions occur between motor vehicles and animals, resulting in considerable vehicle repair costs, injury to persons, and loss of animal life. This paper reviews animal-related road crashes in Australia and presents data from the in-depth Rural and Remote Road Safety Study in North Queensland for serious casualties ($n = 33$) resulting from direct impact with an animal or swerving to avoid an animal on public roads. These crash types accounted for 5.5% of all eligible on-road serious casualties in the study and, hence, are considered to be an important issue that requires particular attention within rural and remote areas. Kangaroos and wallabies were the predominant species involved in these crashes (44.8%). Consistent with international studies, night-time travel was found to be a significant risk factor when comparing animal-related crashes to other serious injury crashes in the study. There were also a significantly higher proportion of motorcyclists (51.7%) than other vehicle occupants involved in animal-related serious crashes compared to all other serious injury crashes. Data matching to official Government records found underreporting of animal-related crashes to be an issue of concern. These findings are discussed in terms of countermeasures suitable for the Australian context and the need for consistent crash reporting across jurisdictions.

1. Introduction

Each year in Australia many thousands of collisions occur between motor vehicles and animals, resulting in considerable vehicle repair costs, injury to persons, and loss of animal life. The vast nature of the Australian landscape and broad expanse of rural roads often exposes road users to encounters with animals, with the majority of serious collisions occurring in rural areas (Attewell and Glase, 2000). However, in Australia the specific nature of road crashes involving animals has not been rigorously studied in the field of road/traffic safety and, consequently, countermeasures designed to address such crashes have been limited in success and scope. Wild Australian fauna such as the kangaroo, wombat, wallaby, and emu continue to be among the most prevalent road-kill victims reported (NRMA, 2003). Accordingly, it is imperative that countermeasures consider the particular behavioural patterns of these species (Ramp and Croft, 2002) as well as the human factors involved. This paper reviews the prevalence of animal–vehicle crashes in Australia and examines issues such as the consistency of official crash reporting across all Australian States and Territories, and the efficacy of current countermeasures. Additionally, data from the Rural & Remote Road Safety Study in North Queensland is presented for hospitalisations (with a length of stay greater than 24 h) in an endeavour to raise awareness of the human cost associated with animal–vehicle crashes and to identify the unique characteristics of such crashes.

1.1. Animal–vehicle collision reporting in Australia

As stated by Attewell and Glase (2000), there is very little data available on the overall patterns of road crashes involving animals within Australia. One limitation is that official road crash reporting databases only record those crashes that are reported to the police. Furthermore, various agencies and jurisdictions across Australia are not consistent in regard to reporting categories for crashes that: (1) involve swerving to avoid an animal and (2) where animals are actually the first object hit by a vehicle. For instance, whilst the States of Queensland and New South Wales currently include both of the above reporting categories, other jurisdictions such as Victoria and the Northern Territory only report crashes where an animal is the first object hit. Other difficulties in interpreting the data are encountered as some agencies present crash data (number and type of crashes) whilst others present casualty data (number of severity of injury). These inconsistencies in data reporting make collation difficult and almost certainly result in an under-representation of the actual extent of problem. Other sources of data such as hospital records, ambulance records, coroner's reports, and in-depth crash

* Corresponding author. Tel.: +61 7 3138 4753; fax: +61 7 3138 4907.
E-mail addresses: p.rowden@qut.edu.au (P. Rowden), d.steinhardt@qut.edu.au (D. Steinhardt), m.sheehan@qut.edu.au (M. Sheehan).

0001-4575/$ – see front matter © 2008 Elsevier Ltd. All rights reserved.
doi:10.1016/j.aap.2008.08.002

studies may provide valuable insight into the prevalence of human casualties as a result of animal–vehicle collisions. However, such information is rarely disseminated to the public. Further limited information for animal–vehicle collisions is publicly available from motor vehicle insurers (e.g. see AAMI, 2007; NRMA, 2003, 2005) and from wildlife welfare research examining road-kill statistics.

1.2. The prevalence of animal–vehicle road crashes in Australia

The importance of protecting Australian fauna from injury due to vehicular traffic cannot be overstated, however this paper focuses on human casualties from such collisions. Therefore, whilst it is acknowledged that many animals unfortunately die as a result of impact with a motor vehicle, a complete review of the animal welfare literature on this topic is beyond the scope of this paper. The primary focus of this section will therefore be on animal-related crash data rather than road-kill statistics. Accordingly, Attewell and Glase (2000) examined Australian national transport agency data for road crashes involving animals and reported 94 fatal and 1392 hospitalisation crashes from 1990 to 1997. This was inclusive of all States and Territories. Of the fatal crashes 42% involved a vehicle manoeuvring to avoid hitting an animal, 80% occurred in rural areas, and 71% involved stock or a large animal such as a horse. Speed zones were unfortunately not reported in this study; however the above characteristics suggest that the severity of crashes increased with the size of the animal and most likely the speed of the vehicle on rural roads.

Unfortunately a search for publicly available information relating to animal–vehicle crashes from road safety agencies in each State and Territory of Australia provided only limited data with scant consistency as summarised in Table 1.

A breakdown of the New South Wales data reveals that from 2001 to 2005 there were 11 fatal crashes, 1399 injury crashes, and 2532 non-casualty crashes attributed to swerving to avoid an animal within that State. Additionally, during the same 5-year period there were 14 fatal crashes, 716 injury crashes and 1751 non-casualty crashes where an animal was actually the first object hit (RTA, 2002, 2003, 2004, 2005, 2006). Forty-seven percent of the 'hit-animal' crashes involved kangaroos and wallabies whilst 32% involved stock animals.

In the State of Victoria there was a total of 632 casualty crashes recorded from direct animal–vehicle collisions during the 5-year period 2001–2005 (VicRoads, 2008). When examining the pattern of animal-related crashes from other jurisdictions it is evident that beyond these direct animal collisions there would also be a considerable number of crashes that involved a vehicle swerving to avoid an animal. Unfortunately there is no reporting category for such crashes found within the Victorian database. Of the recorded casualty crashes, 85% were classified as being in 'non-residential' areas, 66% occurred at dawn, dusk, or night time, and 39% involved motorcyclists.

In comparison, within the State of Queensland there were 3197 total reported crashes involving animals for the 5-year period 2001–2005 with a total social cost of $142,524,000 as estimated by Queensland Transport (2007). Particular attention is afforded to the Queensland data in this paper as it is the State in which the Rural and Remote Road Safety Study was undertaken and access to detailed follow-up data for individual cases was available to the researchers. The crash figures presented below in Table 2 as a function of crash severity and speed zone include both 'hit-animal' crashes and those where an uncontrolled animal on the road was a contributing factor.

Of note in Queensland is the high percentage of crashes in 100 km/hr or greater zones, which included 81% of fatalities, 67% of hospitalisations, and 64% of total crashes. It is also worth noting that a substantial proportion of all animal-related crashes above resulted in a fatality or casualty (51%) and not merely property damage. Just less than 62% of all animal-related crashes did not involve the vehicle actually striking an animal, but rather from the vehicle swerving to miss an animal and resulting in another subsequent action (e.g. vehicle overturned or hit another object). However, 11 of the 16 fatal crashes (68.8%) were directly attributable to 'hit-animal'. Temporal factors are also commonly reported relating to animal–vehicle collisions as animal movements and traffic flow in rural areas fluctuate considerably in terms of time of day. Fig. 1 below presents the temporal distribution of the above serious (fatality and hospitalisation) Queensland crashes in 6 h periods. A substantial peak in animal-related crashes is evident each day in Queensland in the 6 p.m.—mid-night period. In comparison to all recorded serious crashes, animal-related crashes are just over twice as likely to occur during this 6-h time period (QT, 2007). Lack of driver visibility, particularly in curved road sections has been highlighted previously as a reason behind this night time increase as well as the nocturnal nature of many wildlife species (Klöcker et al., 2006).

Apart from the road crash statistics from Government road safety agencies there has been very little information published regarding the human cost of animal–vehicle collisions in Australia. One exception is Western Australian hospitalisation data reported by Abu-Zidan et al. (2002) for patients who presented to Royal Perth Hospital as a result of motor vehicle crashes involving kangaroos. They reported 46 patients (one fatally injured) between July 1994 and June 2000, with 67.4% of these being car occupants and 32.6% motorcyclists. Ninety percent of all crashes were at night and 74% in 'countryside' (rural) areas. Forty-one percent of the reported crashes involved a direct hit with the animal.

Insurance companies have also drawn attention to the amount of motor vehicle insurance claims associated with animal strikes in Australia. During 2002 the NRMA (2003) recorded approximately 11,000 claims nationally for crashes involving collisions with animals. This figure has however been steadily rising, with a 13% increase to 12,549 claims in 2003 and a further 41% increase in 2004 to 17,748 claims (NRMA, 2005). Similarly, AAMI (2007) reported a 25% increase in animal-related crash claims from 2005 to 2006. This was accompanied by a 50% rise in the cost of vehicle repairs for these incidents from $10.2 million in 2005 to $15.3 million in 2006, with an average claim amount of $2260.

1.3. The international perspective

In the United States considerable interest has been generated into preventing animal-related crashes due to over a billion dollars of vehicle damage annually (Hedlund et al., 2004). Of note is the high proportion of hospitalisation crashes (44.8%) found to involve drivers swerving to avoid an animal, resulting in the vehicle leaving the road, hitting a tree, pole, guardrail, and/or rolling over (Conn et al., 2004). Langley et al. (2006) examined risk factors involved with fatal animal–vehicle collisions in the United States from 1995 to 2004 and found that 89.5% occurred on rural roads, 64.8% in darkness, 85.4% on straight sections of road, 91.1% occurred in dry weather conditions, and 28% of the victims were motorcyclists. A large proportion of injuries from animal–vehicle collisions in the United States involve deer (Sullivan et al., 2004; Williams and Wells, 2005). Similarly, in Europe and Canada moose and deer have been shown to be a considerable problem on the road (Haikonen and Summala, 2001; Pynn and Pynn, 2004). In Saudi Arabia collisions with camels are more prominent (Al-Sebai and Al-Zahrani, 1997; Ansari and Ashraf, 1998). However, whilst many countermeasures to prevent animals from entering the roadway or to change driver behaviour have been trialled, the majority have been found

Table 1
Animal-related crash data from road safety agencies in all Australian states and territories: brief summary

State/Territory	Time period	Crashes/casualty type	Number	Reporting categories
New South Wales	5 years (2001–2005)	Fatal crash Injury crash Non-injury	25 2115 4283	Hit animal 1st impact, Swerve to avoid
Victoria	5 years (2001–2005)	Fatal crash Serious injury crash Other injury crash	9 215 408	Hit animal
Queensland	5 years (2001–2005)	Fatal crash Hospitalisation crash Medical attn/minor injury crash Property damage crash	16 649 981 1551	Hit animal, Animal uncontrolled on road
Northern Territory	5 years (2001–2005)	Fatal crash Serious injury crash	4 32	Hit animal
Western Australia	5 years (2001–2005)	Fatal crash Hospitalisation crash	7 101	Hit animal (single vehicle)
Australian Capital Territory	3 years (2001–2003)	Fatal crash Injury crash Property damage crash	0 13 697	Struck animal (not ridden)
Tasmania	2 years (2006–2007)	Serious casualties	11	Animal on road
South Australia	1-year (2003)	Fatal crash Casualty crash All crashes	0 41 478	Hit animal

Sources: Roads & Traffic Authority of New South Wales (2002, 2003, 2004, 2005, 2006); VicRoads (2008); QT (2007); NTDIPE (2005, 2007); Western Australian Office of Road Safety (2004, 2005, 2006, 2007a,b); ACTDTMS (2002, 2003, 2004); TDIER (2007a,b); SADTEI (2006).

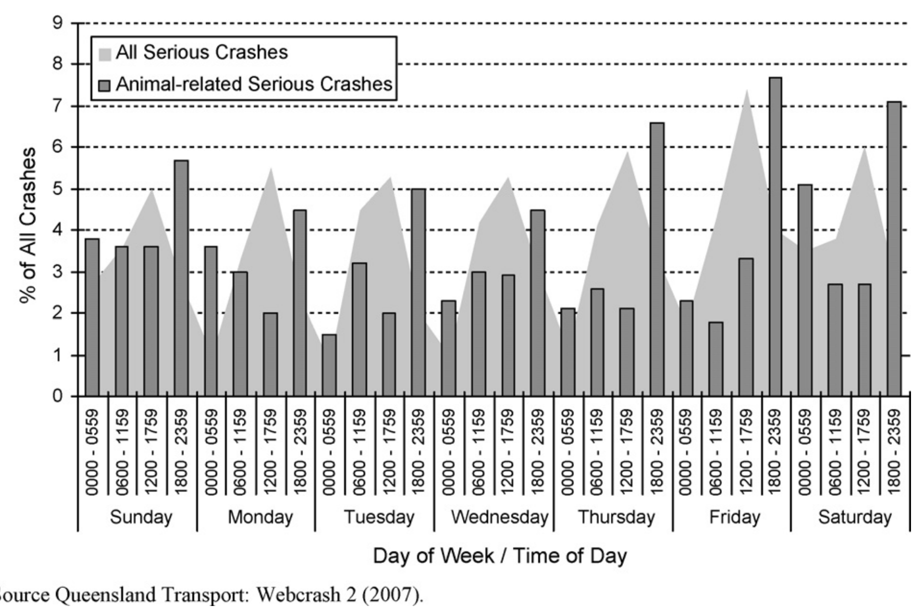

Fig. 1. Proportion of all serious crashes and animal-related crashes in Queensland, 2001–2005, by day of week and time of day.

Table 2
Animal-related crashes in Queensland, 2001–2005, by prevailing speed limit and crash severity

Speed zone (km h)	[a]Fatal (%)	[b]Hos (%)	[c]Med/inj (%)	[d]Prop (%)	Total (%)
≤60	1 (6.3)	120 (18.5)	240 (24.5)	324 (20.9)	685 (21.4)
70–90	2 (12.5)	89 (13.7)	154 (15.7)	209 (13.5)	454 (14.2)
100–110	13 (81.3)	440 (67.8)	587 (59.8)	1018 (65.6)	2058 (64.4)
Total	16 (0.5)	649 (20.3)	981 (30.7)	1551 (48.5)	3197 (100.0)

Source: Queensland Transport Webcrash 2 (2007).
[a] Fatal crash.
[b] Hospitalisation required.
[c] Medical treatment administered/Minor injury.
[d] Property damage only.

to generally have very limited effect, particularly for deer in the United States (Hedlund et al., 2004). Such countermeasures include driver education, warning signs, roadside reflectors, deer repellents, lower speed limits, and deer whistles. However, some studies have found positive results. For example, Sullivan et al. (2004) found that temporary warning signs that were well lit at night during deer migration periods reduced the number of deer road-kills at experimental sites compared to control sites. The study did not however report human casualties during the trial.

In-vehicle longwave infrared imaging and thermal imaging are new intelligent transport system (ITS) devices for night-time driving that may assist to reduce deer–vehicle collisions in the near future by alerting the driver to the presence of animals on the road (Hirota et al., 2004; Rigney and Mitchell, 2000). Additionally, Hedlund et al. (2004) reported that reducing wildlife populations in specific areas shows some promise in reducing the amount of animal–vehicle collisions. Fences combined with animal underpasses or overpasses have been found to have some success in preventing animal–vehicle collisions but are amongst the most expensive of the countermeasures to implement (Conn et al., 2004).

1.4. Countermeasures for Australia

Within Australia fencing and underpasses have been recently incorporated into many road systems (for reviews see, Magnus, 2006; Queensland Department of Main Roads, 2000; Goosem et al., 2004). However, no rigorous evaluation has been published to date in relation to the effectiveness of these underpasses for reducing road trauma in the Australian context. Of particular interest for road safety is the potential efficacy of underpasses regarding large mammals such as kangaroos as collisions with these animals are more likely to result in serious injury to vehicle occupants. The available information suggests that fencing is required as an integral part of the design of such treatments (Magnus, 2006; Queensland Department of Main Roads, 2000). Unfortunately the extensive network of rural roads throughout Australia dictates that the cost of widespread implementation would be prohibitive. Broad-scale research into road-kill “hotspots” and the behaviour of the particular species involved is therefore required to identify where resources are best deployed in regard to countermeasures such as animal underpasses and overpasses (personal communication, Ramp, 2004).

Other countermeasures that have been trialled in Australia are the Shu Roo device, roadside reflectors, ‘slow zones’, canopy crossings, and more recently predator scents. The Shu Roo product was posited to repel kangaroos using an ultrasonic tone, however an evaluation by Bender (2001) found that Shu Roo resulted in no difference to kangaroo vigilance response, flight response, or the number of animals actually hit when compared to control vehicles not fitted with the device. The effectiveness of Swareflex wildlife reflectors for kangaroos was reviewed by Lintermans (1997) who stated that most studies were methodologically flawed and that generally the results had been “disappointing”. Subsequently, further controlled research into the behavioural responses of red kangaroos and red-necked wallabies to roadside reflectors has been undertaken to determine their merit (Ramp and Croft, 2002, 2006). Results indicate a minimal increase (10%) in flight response for both species for Swareflex reflectors, with no change exhibited for Strieter-Lite reflectors. It must be mentioned though that the human response to these roadside reflectors has not been evaluated and that, speculatively, they may serve as a warning device that influences driver behaviour.

Another countermeasure trialled in Australia has been reduced speed limits. An evaluation of the use of reduced speed limits in koala habitat in south-east Queensland found no reduction in the number of koalas hit by vehicles during a 5-year trial period compared to a control period, nor was there any significant difference in actual vehicle speeds measured by police between trial sites and control sites (Dique et al., 2003). Other combinations of countermeasures have been implemented and assessed on an ad hoc basis. For example, Jones (2000) examined the impact on population numbers of eastern quolls and Tasmanian devils following a road upgrade in the Lake St Clair National Park in Tasmania. Increased traffic volume and speed on the road upgrade were posited as the main reasons for a dramatic decrease in the population of each species. Subsequently several countermeasures were trialled concurrently. This included driver education, slow points where the road was deliberately narrowed and signposted, roadside reflectors, escape ramps, and roadside pipes for shelter. It was found that the eastern quoll population increased 50% in the 2 years following the introduction of the countermeasures, with Tasmanian devil numbers unknown. However due to the design of the study it cannot be categorically stated that decline of animal numbers could be attributed solely to the new road, nor that their subsequent reinstatement could be attributed to any or all of the countermeasures. This highlights the need for specific rigorous studies to be conducted into the nature of animal–vehicle collisions.

Predator scent has been trialled for several species on the rationale that many animals that are hit by motor vehicles have been attracted to the roadside to feed at grassy clearings. By spraying roadside verges with predator scent, it has been envisaged that animals will avoid feeding at these areas. Ramp and Croft (2002) trialled a synthetic canine urine product Plant Plus to determine aversion responses for parma wallabies and red-necked pademelons. It was found that whilst parma wallabies exhibited an aversion response, red-necked pademelons were actually attracted to the scent. Unfortunately, the limited research in the area of predator scents for Australian wildlife means that this is not a viable practical option at this stage as a preventative measure for animal–vehicle collisions. Research into the possible habituation of animals to synthetic scents is required before this measure can be validated.

Another issue that may affect the severity of animal–vehicle crashes is bullbars (also known as roo-bars). These are crash bars fitted to the front of the vehicle specifically for animal impacts. Whilst it has been argued that bullbars are an essential safety feature that protect occupants in the event of a collision with an animal in rural areas, there has been much emotive debate about their use in urban areas (New South Wales Legislative Assembly, 2001). The ambivalence shown by governments in regard to bullbars is justified. On one hand they can be seen as an important road safety countermeasure against potential injury in animal–vehicle collisions and, alternately, they can be seen as a potential harm agent for pedestrians and cyclists. Attewell and Glase (2000) examined the benefits and disadvantages of bullbars and found that only 19% of vehicles involved in fatal animal–vehicle collisions were fitted with bullbars. Furthermore, the specific protective benefits of the bullbars in these crashes could not be quantified as many vehicles that hit an animal subsequently hit another object (e.g. tree) or overturned. Accordingly, further study into the severity of animal–vehicle crashes for vehicles with and without bullbars is required to establish whether the protective benefits in rural areas is comparable to the harm directly caused by bullbars to other road users.

1.5. Other influences on mitigation

Further factors may also influence collision rates and the evaluation of countermeasures. Trends in road-related mortality rates for native animals such as the eastern grey kangaroo have been shown to be influenced by the occurrence of drought and other seasonal factors (Ramp and Croft, 2002). Kangaroos are drawn to roadside verge clearings to feed particularly during drought where the abundance of other vegetation is scarce. Other risk factors such as time of day (dawn and dusk) must also be considered (Haikonen and Summala, 2001). Additionally, as evident in QT (2007) data in Section 1.2 most crashes involving animals occur in higher speed zones (particularly 100 km or above). This could be as a result of decreased reaction times when travelling at higher speeds, a lack of driver alertness, or simply that the population density of animals is highest in these zones. For example, Ramp and Croft (2002) reported 127 kangaroos hit by motor vehicles in a 6-month period on a remote 21 km stretch of rural highway in western New South Wales. This equated to one kangaroo killed for each 30 km of road per day. However, it must be noted that heavy vehicles may account for a large percentage of actual road-kills, with no resultant damage to the vehicle or persons.

2. Further evidence: the rural and remote road safety study

The broad aim of the study was to identify the human, vehicular, and environmental factors that contribute to serious road casualties in rural and remote North Queensland and to develop tailored interventions to address these issues. The data presented in this section specifically examines animal-related crash characteristics found in the study. This serves to supplement the existing known evidence for animal-related crashes in Australia.

2.1. Method

The study was conducted from March 2004 to June 2007 in Northern Queensland, Australia (see Sheehan et al., 2008). It encompassed an area of over 660,000 km^2 north and west from Bowen, excluding the mainly urban centres of Thuringowa, Townsville and Cairns (as defined by Australian Bureau of Statistics 'Part A' Statistical Local Areas). To be eligible for the study, crashes needed to result in at least one person 16 years or older being killed or admitted to hospital for 24 h or greater as a direct result of the crash. Data was gathered from five hospitals within the study area, generally within a week of the crash.

A total of 532 serious road crashes, resulting in 600 human casualties, were recorded during the study period. From this larger group, 383 patients (298 male, 83 female, 2 unknown gender) agreed to be interviewed. Each interview utilised a standardised survey taking approximately 45 min to complete. This included crash circumstances and information such as attitudes to road safety and enforcement, alcohol and drug consumption, and demographic details. Additionally, patients were encouraged to describe the crash in their own words as a narrative of the event. Where interview data was not available, hospital admission records were used to compile an overall profile of each crash.

2.2. Results

Of the total 532 serious road crashes, 29 (3 fatal, 26 hospitalisation) were identified where animals were involved, accounting for 33 human casualties (3 fatalities and 30 hospitalisations). An attempt was made to match each of these cases to official Queensland Transport crash data. Of the 29 crashes, 20 were matched; however two of these did not mention the contribution of animals. Thus, 11 of the 29 reportable animal-related crashes were either

Table 3
Crash characteristics for animal-related road crashes compared to all other crash types from the Rural and Remote Road Safety Study

	Animal-related		All other		
Variable	*n* (29)	%	*n* (503)	%	*p*-Value[a]
Time of day					
Night (1800–0559)	17	58.6	175	35.3	0.01*
Day (0600–1758)	12	41.4	321	64.7	
Day of week					
Weekend	11	37.9	196	39.0	0.91
Weekday	18	62.1	307	61.0	
Road status					
Highway	8	72.4	359	71.4	0.90
Other road	21	27.6	144	28.6	
Vehicle type					
Motorcycle	15	51.7	138	30.7	0.02*
Car or derivative	14	48.3	311	69.3	
Speed zone (km/h)[b]					
≥100	14	77.8	233	60.1	0.32
80	2	11.1	68	17.5	
60	2	11.1	87	22.4	
Season					
Summer	3	10.3	107	21.3	0.52
Autumn	7	24.1	125	24.9	
Winter	9	31.0	132	26.2	
Spring	10	34.5	139	27.6	
Crash type					
Hit animal	18	62.1	–	–	–
Swerve/avoidance	11	37.9	–	–	
Animal type					
Kangaroo/wallaby	13	44.8	–	–	–
Other	16	55.2	–	–	

[a] Based on χ^2 statistics.
[b] As recorded by available police crash reports.
* Statistical significance at $p < .05$.

not found to be recorded in the Government database or did not record the involvement of animals.

Animal-related crashes accounted for 5.5% of all on-road serious casualties in the study and, hence, are considered to be an important issue that requires attention within rural areas. Table 3 presents some brief details regarding the circumstances of the on-road animal-related crashes identified in the study for both direct animal hits and crashes that involved the controller swerving to avoid an animal.

Night-time travel is a notable risk factor that showed a significant difference between animal-related crashes and all other on-road crashes, χ^2 (1, N = 532) = 6.43, p < .05. The high proportion of motorcyclists involved is of concern, highlighting their inherent vulnerability to injury from such crashes. There was a significantly higher proportion of motorcyclists involved in animal-related crashes than all other on-road crashes in the study, χ^2 (1, N = 532) = 5.51, p = < .05. The proportion of swerve and avoidance crashes suggests that official crash reporting regarding animal crashes should not overlook this category. The high proportion of kangaroos/wallabies involved in these crashes also points to the need for interventions specific to the Australian driving context.

3. Crash narratives

A number of the patients reported that there was little or no warning of a crash, with an animal crossing into the path of a vehicle just prior to the accident. Ten interviewees specifically reported that the animal was either first perceived when in the middle of the road as they came towards it, or that the animal jumped or ran directly in front of the vehicle at close range. Two quotes from patient narratives are presented below.

> "Driving along dirt road a kangaroo jumped onto road in path of car. Swerved to miss Kangaroo went into skid. Attempted to correct skid. Vehicle regained grip to a point on corrugations and then overturned." [Car occupant - Male, 36 years, 4 injured]

> "Before this I have excellent vision to the left and from here I have excellent vision along the straight as I pull out of the bend. This is where the wallaby got me. It just jumped straight out and hit me. The camber of the wheel meant I couldn't steady the bike and it's the type of corner that you can see everything on the left side of the road and it's also fenced. I've never seen any wallabies just there. It was a full moon and my vision was good." [Motorcycle rider - Male, 54 years, rider injured]

4. Discussion

The data presented above from the Rural and Remote Road Safety Study is one of the few attempts to document the nature of animal–vehicle collisions in Australia from a public health/road safety perspective. The incidence of serious injury from these crashes (5.5% of the sample) demonstrates that far more recognition should be afforded to this issue by road safety researchers, practitioners and funding bodies in an attempt to reduce the injuries to persons and the associated social costs within rural and remote Australia. The matching of cases in the study to official Government crash data (whilst limited in number) found evidence of underreporting, although some factors need to be kept in mind. The base rate of underreporting across all crashes is difficult to estimate, and thus the level of underreporting of animal-related crashes may be consistent with the entire set of crashes. It is also possible that there may also be a bias in terms of participants of the study attributing causation for the crash to an animal rather than acknowledging the contribution of their own behaviour. Further continued investigation matching such data needs to be undertaken to clarify the issue of underreporting. Additionally, as highlighted in Section 1.2, there appears to be no standardised reporting categories for animal-related crashes across various jurisdictions in Australia.

Huijser et al. (2007) also highlighted data reporting problems for animal–vehicle collisions across government agencies in the United States and Canada. They recommended that standardised reporting procedures be developed across agencies and that this data should be shared to highlight the magnitude of the problem, analyse trends, and to prioritise road sections for targeted intervention. They also recommended that data collection should focus on collisions involving species that are endangered from a conservation perspective and/or those involving large animals likely to cause human injury. As many serious casualty crashes in rural areas of Australia involve kangaroos, particular attention should be directed towards detailed data collection of such crashes and development of specific interventions. Measures to ensure large stock animals and horses do not enter the roadway also require attention within the agricultural sector.

Elevated crash counts in higher speed zones suggest that drivers/riders need to be particularly vigilant in these areas, especially at the high risk times of dawn, dusk, and darkness. To this end, research into actual travel speeds in rural and remote areas is required to establish whether adherence to existing speed limits may mitigate the frequency or severity of animal-related crashes. Research into other human factors that may contribute to or mitigate the problem is also required. For instance, the promotion of trip planning to avoid travelling at night in rural and remote areas of Australia deserves consideration and may have possible secondary benefits for road safety in terms of reducing fatigue-related incidents that are predominant during the same time of day.

No broad-scale effective countermeasure has been identified to date that reduces the occurrence or severity of animal-related crashes, highlighting the need for a multifaceted approach to the problem with regard to driver behaviour, road design, animal behaviour, and related environmental influences. Furthermore, the identification of specific collision 'hotspots' would be expected to assist in the implementation of tailored interventions that consider all relevant influences (Huijser et al., 2007; Ramp et al., 2005). Key factors that appear to be consistently identified in studies are time of day (dusk, dawn, night), higher speed zones, and the over-representation of motorcyclists due to their vulnerability. Accordingly, future development of effective ITS devices and animal repellents in combination with driver education and proficient road design is required to reduce crash counts for animal–vehicle collisions in rural and remote Australia.

References

AAMI, 2007. Look left, look right, look 'roo. <http://www.aami.com.au/about_aami_insurance/aami_news_centre/pdf/press_releases/AnimalCrashesNationalFinal.pdf> (retrieved 11.02.08).

Abu-Zidan, F., Parmar, K., Rao, S., 2002. Kangaroo-related motor vehicle collisions. Journal of Trauma-Injury Infection & Critical Care 53 (2), 360–363.

Al-Sebai, M.W., Al-Zahrani, S., 1997. Cervical spinal injuries caused by collisions of cars with camels. Injury 28, 191–194.

Ansari, S., Ashraf, A., 1998. Camel collision as a major cause of low cervical spinal cord injury. Spinal Cord 36, 415–417.

Attewell, R., Glase, K., 2000. Bull bars and road trauma. Report CR200. Australian Transport Safety Bureau, Canberra.

Australian Capital Territory Department of Territory and Municipal Services, 2002. 2001 Road crash statistics. <http://www.tams.act.gov.au/__data/assets/file/0020/12629/trafficcrashes2001.zip> (retrieved 11.02.08).

Australian Capital Territory Department of Territory and Municipal Services, 2003. 2002 Road crash statistics. <http://www.tams.act.gov.au/__data/assets/pdf_file/0011/13997/acttrafficaccidentdataanalysisreportfor2002.pdf> (retrieved 11.02.08).

Australian Capital Territory Department of Territory and Municipal Services. 2004. 2003 Road crash statistics. <http://www.tams.act.gov.au/__data/assets/word_doc/0005/14468/2003crashstats.doc> (retrieved 11.02.08).

Bender, H., 2001. Deterrence of Kangaroos from Roadways using Ultrasonic Frequencies—Efficacy of the Shu Roo. University of Melbourne, Melbourne.

Conn, J.M., Annest, J.L., Dellinger, A., 2004. Nonfatal motor-vehicle animal crash-related injuries – United States, 2001–2002. Journal of Safety Research 35, 571–574.

Dique, D.S., Thompson, J., Preece, H.J., Penfold, G.C., de Villiers, D.L., Leslie, R.S., 2003. Koala mortality on roads in south-east Queensland: the koala speed-zone trial. Wildlife Research 30, 419–426.

Goosem, M., Harriss, C., Chester, G., Tucker, N., 2004. Kuranda Range: Applying Research to Planning and Design Review. Rainforest CRC, Cairns.

Haikonen, H., Summala, H., 2001. Deer–vehicle crashes: extensive peak at 1 hour after sunset. American Journal of Preventative Medicine 21 (3), 209–213.

Hedlund, J.H., Curtis, P.D., Curtis, G., Williams, A.F., 2004. Methods to reduce traffic crashes involving deer: what works and what does not. Traffic Injury Prevention 5 (2), 122–131.

Hirota, M., Nakajima, Y., Saito, M., Uchiyama, M., 2004. Low-cost infrared imaging sensors for automotive applications. In: Valldorf, J., Gessner, W. (Eds.), Advanced Microsystems For Automotive Applications. Springer, Berlin, pp. 63–84.

Huijser, M.P., Fuller, J., Wagner, M.E., Hardy, A., Clevenger, A.P., 2007. Animal–vehicle Collision Data Collection: A Synthesis of Highway Practice. Transportation Research Board, Washington, DC.

Jones, M.E., 2000. Road upgrade, road mortality and remedial measures: impacts on a population of eastern quolls and Tasmanian devils. Wildlife Research 27, 289–296.

Klöcker, U., Croft, D.B., Ramp, D., 2006. Frequency and causes of kangaroo–vehicle collisions on an Australian outback highway. Wildlife Research 33, 5–15.

Langley, R.L., Higgins, S.A., Herrin, K.B., 2006. Risk factors associated with fatal animal–vehicle collisions in the United States 1995–2004. Wilderness and Environmental Medicine 17 (4), 229–239.

Lintermans, M., 1997. A review of the use of swareflex wildlife reflectors to reduce the incidence of road-kills in native fauna. <http://www.newcastle.edu.au/discipline/biology/marsupialcrc/actkanga3/appd.html> (retrieved 03.11.04).

Magnus, Z., 2006. Wildlife Roadkill Mitigation Information Kit. Sustainable Living Tasmania, Hobart.

New South Wales Legislative Assembly, 2001. Bullbars in country areas. <http://www.parliament.nsw.gov.au/prod/parlment/hansart.nsf> (retrieved 01.12.05).

New South Wales Roads and Traffic Authority, 2002. Road Traffic Accidents in New South Wales 2006. RTA, Sydney.

New South Wales Roads and Traffic Authority, 2003. Road Traffic Accidents in New South Wales 2007. RTA, Sydney.

New South Wales Roads and Traffic Authority, 2004. Road Traffic Accidents in New South Wales 2003. RTA, Sydney.

New South Wales Roads and Traffic Authority, 2005. Road Traffic Accidents in New South Wales 2004. RTA, Sydney.

New South Wales Roads and Traffic Authority, 2006. Road Traffic Accidents in New South Wales 2005. RTA, Sydney.

Northern Territory Department of Infrastructure, Planning and Environment, 2005. Territory road trauma overview. October–December 2004. <http://www.nt.gov.au/transport/safety/road/stats/index.shtml> (retrieved 11.02.08).

Northern Territory Department of Infrastructure, Planning and Environment, 2007. Territory road crash overview. Quarterley Statistics October–December 2006. <http://www.nt.gov.au/transport/safety/road/stats/index.shtml> (retrieved 11.02.08).

NRMA Insurance, 2003. Animals on a collision course. <http://www.nrma.com.au/pub/nrma/about_us/media_releases/20030801b.shtml> (retrieved 16.11.04).

NRMA Insurance, 2005. Safety alert: drivers approach riskiest time for animal smashes—NSW. <http://www.nrma.com.au/pub/nrma/about_us/media_releases/20050629a.shtml> (retrieved 24.08.06).

Pynn, T.P., Pynn, B.R., 2004. Moose and other large animal wildlife vehicle collisions: implications for prevention and emergency care. Journal of Emergency Nursing 30 (6), 542–547.

Queensland Department of Main Roads, 2000. Fauna Sensitive Road Design. vol. 1—Past and Existing Practices. Queensland Department of Main Roads, Planning, Design and Envoronment Division, Brisbane.

Queensland Transport, 2007. Webcrash 2 data. <https://www.webcrash.transport.qld.gov.au/webcrash2> (retrieved 16.11.07).

Ramp, D., Caldwell, J., Edwards, K.A., Warton, D., Croft, D.B., 2005. Modelling of wildlife fatality hotspots along the Snowy Mountain highway in New South Wales Australia. Biological Conservation 126, 474–490.

Ramp, D., Croft, D., 2002. Saving Wildlife: Saving People on our Roads. Annual Report. University of New South Wales, Sydney.

Ramp, D., Croft, D., 2006. Do wildlife warning reflectors elicit aversion in captive macropods? Wildlife Research 33, 583–590.

Rigney, M.P., Mitchell, J.N., 2000. Investigation of Animal detection for traffic accident mitigation, 10-9193. <http://www.swri.org/3pubs/IRD2000/10-9193.htm> (retrieved 18.10.04).

Sheehan, M., Siskind, V., Turner, R., Veitch, C., O'Connor, T., Steinhardt, D., Blackman, R., Edmonston, C., Sticher, G. 2008. Rural and remote road safety research project – final report (Monograph 4). CARRS-Q, Brisbane.

South Australian Department of Transport, Energy and Infrastructure, 2006. Road crashes 2003 for South Australia. <http://www.transport.sa.gov.au/safety/road/road_use/roadcrash.asp> (retrieved 11.02.08).

Sullivan, T.L., Williams, A.F., Messmer, T.A., Hellinga, L.A., Kyrychenko, S.Y., 2004. Effectiveness of temporary warning signs in reducing deer–vehicle collisions during mule deer migrations. Wildlife Society Bulletin 32 (3), 907–915.

Tasmanian Department of Infrastructure, Energy and Resources, 2007a. Tasmanian serious casualties—2006. <http://www.transport.tas.gov.au/pdf/safety/crash_statistics/2006_Tasmanian_Serious_Casualties.pdf> (retrieved 11.02.08).

Tasmanian Department of Infrastructure, Energy and Resources, 2007b. Tasmanian serious casualties—2007. <http://www.transport.tas.gov.au/__data/assets/pdf_file/0005/21011/2007_Tasmanian_Serious_Casualties.pdf> (retrieved 11.02.08).

VicRoads, 2008. Internet crashstats. <http://crashstat1.roads.vic.gov.au/crashstats/crash.htm> (retrieved 11.02.08).

Western Australian Office of Road Safety, 2004. Reported road crashes in Western Australia 2001. <http://www.officeofroadsafety.wa.gov.au/documents/2001_crash_stats.pdf> (retrieved 13.02.08).

Western Australian Office of Road Safety, 2005. Reported road crashes in Western Australia 2002. <http://www.officeofroadsafety.wa.gov.au/documents/2002_crash_stats.pdf> (retrieved 13.02.08).

Western Australian Office of Road Safety, 2006. Reported road crashes in Western Australia 2003. <http://www.officeofroadsafety.wa.gov.au/documents/crashstats2003.pdf> (retrieved 13.02.08).

Western Australian Office of Road Safety, 2007a. Reported road crashes in Western Australia 2005. <http://www.officeofroadsafety.wa.gov.au/documents/Annualcrashbook_2005.pdf> (retrieved 13.02.08).

Western Australian Office of Road Safety, 2007b. Reported road crashes in Western Australia 2004. <http://www.officeofroadsafety.wa.gov.au/documents/crashstats2004.pdf> (retrieved 13.02.08).

Williams, A.F., Wells, J.K., 2005. Characteristics of vehicle–animal crashes in which vehicle occupants are killed. Traffic Injury Prevention 6 (1), 56–59.