Wildlife Roadkill Mitigation Information Kit

A guide for local government and land managers

Prepared by Zoë Magnus, Environmental Consultant
(for Tasmanian Wildlife Roadkill Collective 2004
convened by the Tasmanian Environment Centre Inc.
trading as Sustainable Living Tasmania)

Edited by Beth Chamberlain, 2006

Sustainable Living Tasmania
First floor, 102 Bathurst St,
Hobart Tasmania 7000
Ph. 03 6234 5566
Fax 03 6234 5543
Email: info@sustainablelivingtasmania.org.au

July 2006

Introduction

Wildlife killed on our roads due to collision with vehicles (roadkill) is an issue that Tasmanians are finding increasingly difficult to ignore. This manual looks at the three causes of roadkill – road design, driver behaviour and roadside attributes – and ways in which these causes can be minimised.

Negative aspects of roadkill include:

- unpleasant aesthetics for Tasmanians and tourists;
- negative impact on visitor experience;
- direct adverse impacts on wildlife tourism businesses (wildlife tourist operators rely on relatively high density accessible populations of wildlife, so that viewing of wildlife is reliable);
- reduction in the availability of hire cars due to repairs associated with wildlife collisions, especially over the summer months;
- human safety;
- conservation issues (local populations have been known to become extinct due to roadkill);
- ethical issues (injured and orphaned wildlife often suffer long, painful deaths);
- community morale (resident Tasmanians are often extremely upset about the roadkill issue).

Many people argue that the large amount of roadkill in Tasmania reflects healthy wildlife populations. This has some truth in it, but roadkill can act as a substantial pressure to populations already under pressure from other threats. The number of animals killed does not actually represent the size of populations as particular species are killed in higher proportions to others (Magnus *et al.*, in prep).

There are several mitigation measures available, which have been designed to decrease the incidence of wildlife roadkill. Some have been modified for Tasmanian species, and others were designed here, especially for our conditions. Some relate to black spots (short section of road where many individual animals are killed or where individuals of a species of special interest are killed), and some to lengths of road or the whole State.

Legislative requirements for wildlife roadkill mitigation
Legislative requirement to mitigate roadkill falls under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) at the Commonwealth level and *Threatened Species Protection Act 1995* (TSP Act) at the State level. All Tasmanian native species are protected under the *Nature Conservation Act 2002*. Some are also listed under the EPBC Act and TSP Act. Therefore, if any road development is likely to cause an impact to native fauna, it is advisable to undertake an Environmental Impact Assessment and seek advice from the Biodiversity Conservation Branch of the Department of Primary Industries, and Water (DPIW).

Each agency complies with legislation by implementing their own Environmental Management Systems. This kit is designed to be readily incorporated into existing agency structures.

This information kit provides:

1. Section 1 – Guidelines for the development of a wildlife roadkill mitigation “code of good practice” for councils, private industry and state government agencies.
2. Section 2 – A flow chart to assist decisions regarding appropriate roadkill mitigation measures.
3. Section 3 – An outline of available mitigation measures, rough cost estimates where possible and basic advice on the application of these measures in different circumstances.
4. Section 4 – Protocol for determining and prioritising black spots for treatment (including proforma for data collection).
5. Section 5 – A list of useful resources for further reading.

Section 1: Good Practice for Wildlife Roadkill Mitigation

The following guidelines are taken from the Department of Infrastructure, Energy & Resources "Code of Practice" for wildlife roadkill mitigation document (DIER 2004). The guidelines were produced to assist in considering and mitigating wildlife roadkill during road planning, design and maintenance. Other Agencies are encouraged to adapt these guidelines to their own needs.

1. Make an assessment of potential wildlife roadkill issues

Consider whether the construction/maintenance and use of the road will result in increased levels of wildlife roadkill. If so, assess the significance of this and implement mitigation measures.

- Which wildlife species occur in the area?
- *Conservation*: Will changes to the roadside impact on threatened species and/or locally rare species in the process of road construction/maintenance? Are there other pressures that might exacerbate roadkill, in this area, for the affected species (eg. fragmented habitat, increasing land clearance)? Consult the DPIW Natural Values Atlas site for distibution information – www.naturalvaluesatlas.tas.gov.au
- *Human safety*: Do any of the species involved have the potential to cause serious damage to humans/vehicles if a collision occurs? (eg. Bennetts wallaby, forester kangaroo, wombat).
- *Aesthetics and tourism*: Is it a tourist route? (A large number of carcasses on the road is likely to have a negative impact on the visitor experience, and therefore on the tourism industry).

2. Identify actual and potential problem zones

It is unlikely that the whole road needs to be considered for wildlife roadkill mitigation. It is therefore necessary to identify sections of the road that are more likely to be affected. Consider the following roadside attributes as areas of high risk:

Aspects of the road design that increase danger to wildlife present on the road/verge:

- areas where natural or artificial barriers occur on the roadsides after construction, which may make animal escape difficult (eg. steep batters, deep drains, guard rails);
- sharp corners;
- high speed zones;
- areas of low visibility.

Features that draw wildlife to the road or encourage lingering:

- areas where different land uses occur on opposite sides of the road (eg. bush and agriculture) – this represents diverse resources for wildlife, and therefore increases the likelihood they will cross or spend time on the road;
- areas where grasses and other herbaceous plants proliferate, especially those that are likely to be slashed or mown –this process creates tender shoots which are attractive to herbivorous wildlife;
- areas where standing water is likely to be present, especially in summer (eg. drains);
- sections of road where vegetation (habitat) is dense right up to the roadsides;
- creeks passing through culverts (platypus and freshwater crayfish issues).

3. Minimise the factors of road design that increase danger to wildlife

Consult the *Outline Framework for Fauna Sensitive Road Design and Management* (Jungalwalla 2003) when considering use of wildlife roadkill mitigation measures.

- barriers: reduce slope of batters where road reserve width allows, or build gravel "escape ramps" to allow animals to move off road when under stress (see cutting diagrams in Section 3);
- consider guard rail design to minimise barrier effect;
- sharp corners: increase visibility for both animal and driver, and ensure barriers are designed to enable wildlife to escape quickly;
- high speed zones: consider wildlife signage, which recommends a night-time speed reduction (refer to example in Section 3);
- creeks passing through culverts: provide suitable access for platypus into culverts, install funnel fencing, 'bio-baffles'* (see Section 3 for explanation) and a dry underpass.

4. Minimise the roadside attributes that increase appeal to wildlife

- diverse resources on opposite sides of the road (crossing danger): create safe wildlife crossing options by using underpasses or overpasses;
- grasses and other palatable plants growing on roadsides: prevent the spread of herbaceous weeds – in high-risk wildlife roadkill areas control herbaceous roadside vegetation by spraying rather than slashing (in areas where threatened species may be present, consult with Sally Bryant – Threatened Species Section, DPIW ph: 03 6233 8759);
- revegetate roadsides with native species (of that area) that are sparse, woody, and unpalatable;
- obtain current advice on odour repellents;
- standing water: minimise by ensuring drains transport water efficiently (without pooling) and consider solutions to eliminate other sources of standing water.

5. **Plan, design and implement monitoring programs to assess success of mitigation measures**

   For information on monitoring, refer to *Outline Framework for Fauna Sensitive Road Design and Management*, Anahita Junalwalla – August 2003 (DIER document).

6. **Redesign/reroute road to avoid impacts**

   If potentially significant wildlife roadkill issues cannot be mitigated using methods already mentioned, consider redesigning features of the road or rerouting sections to avoid wildlife roadkill impacts.

7. **Research and select methods to achieve "No Net Loss"**

   For impacts that cannot be eliminated or sufficiently mitigated, consider compensatory actions ('offsets').

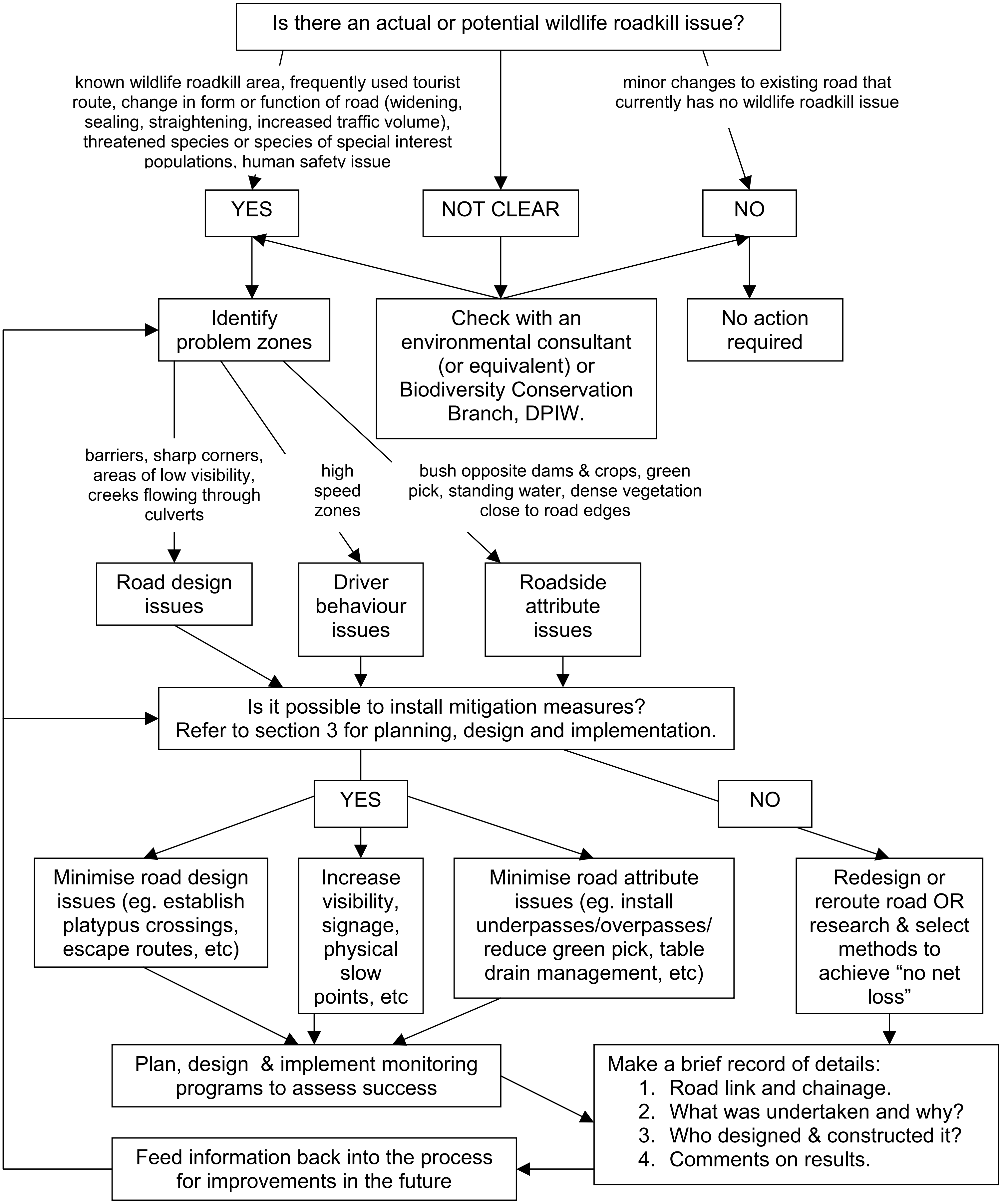
8. **Make a brief record of details**

   The design parameters should be inspected post-construction and comments relayed to project managers and planners for future reference. Make sure at least the following details are on file:

   1. Road link and chainage.
   2. What was undertaken and why?
   3. Who designed and constructed the measure?

9. **Feed information back into the process so improvements can be made in the future**

Section 2: Flow chart to assist in wildlife roadkill mitigation



Section 3: Mitigation measures

The following information has been extracted from the findings of a project undertaken by the University of Tasmania, in conjunction with the Wildlife Roadkill Collective (WRC). The Sustainable Tourism Cooperative Research Centre was the main provider of funding. The full document (Reducing the Incidence of Wildlife Roadkill, Magnus *et al*. 2004) can be ordered from the bookshop at: www.crcst.gov.au or viewed/borrowed from the DPIW Environment library or the Sustainable Living Tasmania library.

Table 1. Summary of potential roadkill mitigation measures and their application.

Action	**Spatial scale for application**	**Application**
Highly recommended (not in order of priority)		
Design and Install Escape Routes	blackspot	Fit all new roads with cut batters, retro-fit old roads in areas where animals are regularly trapped
Table Drain Management	length of road	Minimise green "pick" and water resources on roadside
Install Underpasses	blackspot	Install on all new roads where wildlife crossing problems are predicted
Install Signage	blackspot or length of road	Install on frequently used tourist routes, especially long sections of road (over 100m)
Install Canopy Crossings	blackspot	Install at ringtail possum blackspots / good habitat
Install Platypus Crossings	blackspot	Install at platypus blackspots / good habitat
Design and Install Physical Slow points (chicanes & speed humps)	blackspot	Install in special areas (eg. National Parks or areas with threatened fauna)
Have potential but need further research		
Light Coloured Road Surfacing	length of road or region/state	Potential, especially on long sections of road
"Driving" Lights	region/state	Potential
Odour Repellents	blackspot or length of road	Potential short-term use
Road Markings	blackspot or length of road	Potential
Not recommended at present		
Reflectors	length of road	Unknown. Not recommended at this time.
Lighting	blackspot	Unknown. Prohibitively expensive.
Ultrasonic Whistles	region/state	Not recommended.

Introduction

The objective of the University of Tasmania project was to evaluate techniques to reduce wildlife roadkill and to discuss suitability and implementation of these methods in Tasmania. A number of techniques were not evaluated, but are covered briefly. The following techniques were evaluated:

- *ultrasonic whistles*: attached to vehicles to warn wildlife of oncoming traffic;
- *overpasses*: consisting of rope tied between trees or other structures to allow ringtail possums to cross over the road without coming down to the ground;
- *escape routes*: moderating obstacles such as batters (roadside 'cuttings') to allow animals to move off the road quickly, even when panicked;
- *table drain management*: reduction of roadside grass and water aiming to reduce the number of animals attracted to the roadside to feed and drink;
- *platypus crossings*: increasing the attractiveness to platypuses to travel through the culvert underneath roads rather than crossing over the road surface;
- *signage* (with night-time speed limits): advisory speed limits at least 20 km ph slower than the normal speed limit between dusk and dawn; and
- *public education*: informing people of the negative and dangerous aspects of wildlife roadkill and aiming for fauna-friendly driving attitudes.

The following techniques were not evaluated but are discussed briefly:

- *underpasses*: a variety of structures passing underneath the road to provide an alternate route for wildlife, ranging from small concrete culverts to large bridges spanning gullies. Usually used in conjunction with wing fencing;
- *reflectors*: plastic prisms attached to guideposts, which reflect headlights to prevent wildlife from moving onto roads and to scare wildlife off roads;
- *roadside lighting*: to produce increased visibility which may discourage wildlife from spending time on the road or roadside and/or improve visibility for drivers;
- *light-coloured road surfacing*: to produce a contrast in colour between dark animals and a light-coloured road, which may discourage wildlife from spending time on the road or roadside and/or improve visibility for drivers; and
- *odour repellents*: synthetic substance manufactured to mimic canine urine to discourage wildlife from roadsides.

Several measures were identified as being likely to reduce wildlife roadkill and/or decrease distress on account of roadkill. These include: wildlife signage, escape routes, table drain (ditch) management, platypus crossings, underpasses and potentially odour repellents.

Ultrasonic whistles, wildlife reflectors and lighting have doubtful application, at least in Tasmania, although managers should follow up on current research in these areas. Light-coloured road surfacing and use of "driving lights" (long-range headlights) remain as possibilities for further trials.

Spatial Scales and Categories of Roadkill Mitigation

There are three **spatial scales** of roadkill mitigation:

1. A black spot (short section of road where many individual animals are killed or where individuals of a species of special interest are killed).
2. A length of road.
3. A whole region or state.

Regardless of the spatial scale at which the mitigation measure is applied, there are two main **mechanisms** to mitigate roadkill:

1. Changing driver behaviour:
    a) Changing driver attitude (by increasing public awareness and helping people understand that preventing roadkill will benefit their community);
    b) Making people aware of black spots (signage, rumble-strips and/or lighting);
    c) Physically or psychologically slowing traffic (traffic-calming devices (chicanes or speed humps) or road markings to increase apparent speed).

2. Changing wildlife behaviour:
    a) Discouraging wildlife from lingering on roadsides (by reducing food and water resources or making the road surfaces lighter in colour which may make wildlife feel more exposed on the road);
    b) Preventing/discouraging wildlife from crossing roads, at least when cars are present (ultrasonic whistles, reflectors, fencing);
    c) Providing safe crossings (overpasses, underpasses and escape routes).

Highly Recommended Measures

Escape Routes

Spatial scale: black spot,
Mechanism: change wildlife behaviour by providing safe crossing

Shaw *et al.* (In prep. 2004) has recently confirmed that banks, cuttings and fences that trap animals on the road are associated with roadkill.

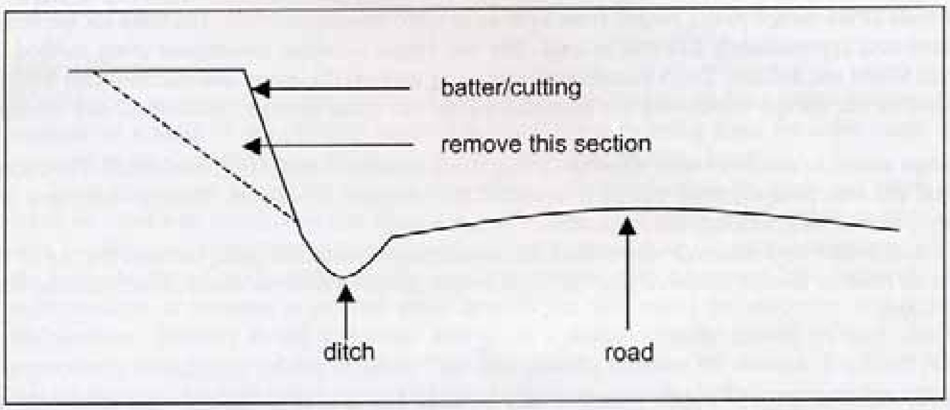
In order to increase the likelihood of escape from the road, escape routes have been constructed on the access road to Cradle Mountain National Park (Jones 2000). These escape routes span deep, steep drainage ditches on the roadside. The gaps have been spanned by placing a 2 m section of 300 mm culvert pipe in the drain, parallel to the road, and constructing a gravel ramp over the culvert, to create access to the bush. The escape routes were constructed at approximately 25 m intervals. The escape routes were not trailed independently as part of Jones' (2000) study, as several measures were installed simultaneously in an urgent effort to slow the significant increase in roadkill after the road was widened and sealed. However, although it is not known whether the escape routes are being used in emergencies, or whether they are effective in reducing roadkill, it is known that animals are using the escape routes, possibly as part of their daily movement (M. Jones, pers. obs.).

DIER constructed three escape routes on the Arthur Highway in south-east Tasmania, using two of the three possible methods - method (a) and method (b) (concept designs illustrated in Figure 2). Theses were not monitored due to budget and time restrictions of the project. However, this project was able to provide information about:

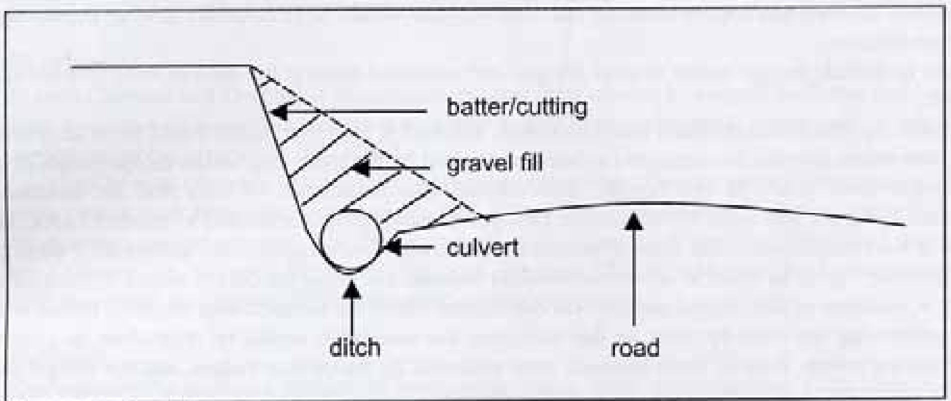
- the costs of different types of escape routes;
- difficulties encountered in allocating space for escape routes;
- difficulties encountered in construction of escape routes.

Figure 1: Escape Route Built by DIER on the Arthur Highway. (Taryn Laird)

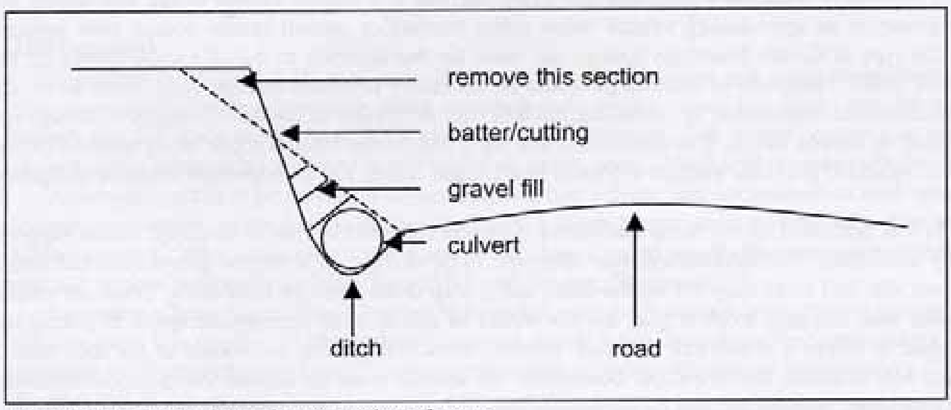
Figure 2: Concept Designs of three potential cut batter treatments *(from "Reducing the Incidence of Wildlife Roadkill: Improving the Visitor Experience in Tasmania", Magnus et al. 2004).*



(a) removal of material



(b) construction of ramp



(c) removal of material and construction of ramp.

Two escape routes were constructed using method (a) - removal of hard material. Both of these escape routes were 75m in length. An adequate amount of space between the top of the batter and the edge of the road reserve was required for this method. From a maintenance perspective, this method may be preferable as continuous table drains are easier to maintain than culverts which can become blocked and require cleaning out.

The escape route constructed using method (b) - construction of a ramp using a culvert, concrete endplates and gravel, was 3m long. Escape routes of this type were only practical where the distance between the road edge and batter was not too small.

Cost

The estimated costs of the escape routes constructed by DIER in 2002 ranged from $750 to $11 246 (average $3985). The three escape routes that were actually constructed cost approximately $21 600 in total. The two longer sections, constructed using method (a) (laying back the batters), cost $7410 and $10296. The 3 m section treated using method (b) (ramp construction) cost $3926.

Proposed sites will require an assessment to determine which of the above mentioned methods are most appropriate.

Variations to these escape routes for consideration include:

- producing several short type (b) escape routes (which only need to be 500 mm wide) over a 50 metre distance;
- constructing several shorter type (a) escape routes over a larger distance.

It is much more efficient to include escape routes in road designs and construct them at the time of road construction when all equipment is on site.

Recommendation

- Escape routes should be considered as one of the most useful and imperative measures, especially when new roads are being built or roads are being upgraded, widened or sealed.

Table Drain Management

Spatial scale: length of road
Mechanism: change wildlife behaviour by discouraging wildlife from lingering on the roads

Wildlife is attracted to the road by water in roadside drains (ditches) and/or by herbaceous vegetation growing on roadsides as a result of run-off from roads. It is thought that managing these resources effectively could reduce the wildlife attracted to the road. However, threatened flora issues need to be considered as road reserves often contain remnant patches of grassland and threatened plants.

Figure 3: Table drain management at this site would minimise the risk of wildlife crossing for food and water. This is a high risk site because of the steep batter and sharp corner.
(Zoë Magnus)

There are several potential means of achieving a reduction in roadside water and green pick. To reduce water, drains could be lined with concrete to prevent pooling, or they could be filled with boulders to prevent access to water whilst still allowing flow.

To reduce vegetation, herbaceous weeds could be sprayed using a herbicide that has minimal environmental impact (eg. Weedmaster® Duo). An holistic and strategic approach is needed to treat weeds effectively. Again, threatened flora issues need to be considered.

The roadsides could be lined with concrete or bitumen to prevent plant growth, but this would be expensive and would also require cleaning and maintenance.

Slashing should be minimised, as it encourages the growth of new shoots, which are particularly attractive to grazing wildlife. Where slashing is unavoidable, the timing of this should be considered. It may present less risk if carried out in winter - a slow growth period.

Again, proposed sites will require an assessment to determine which of the above mentioned methods are most appropriate.

Cost
To treat one hectare of herbaceous weeds costs approximately $110. One hectare equates to a 2 m strip approximately 5 km long, so to treat a 10 km section of road on both sides (2 m width) would cost approximately $440.

Recommendations

- In areas where roadkill of herbivores is an issue, slashing of roadside vegetation should be minimised, as this creates new growth which is attractive to herbivores.
- Table drain management should be considered where the roadkill problem is related to wildlife being attracted for food and water resources which are present due to the road design (eg. water in table drains and associated fodder).
- This type of mitigation measure should be dismissed in cases where it impacts upon threatened plants or communities existing in the area. Wildlife behaviour and threatened flora experts should be consulted (Sally Bryant - Threatened Species Section, DPIW).

Underpasses

Spatial scale: blackspot
Mechanism: change wildlife behaviour by providing safe crossings

Underpasses for wildlife continue to be studied in Australia and overseas, with some record of success (eg. Mansergh & Scotts 1989, Goosem *et al.* 2001, Clevenger *et al.* 2001). Underpasses can be of varying types and sizes, from bridges spanning dozens of metres over gullies, to 30 mm diameter culverts underneath roads.

Figure 4: Underpass on the Arthur River Road. (Daryl Polzin)

Generally fencing in conjunction with the underpass is necessary to guide animals through, particularly for the smaller underpasses which have narrow entrances. Funnel fencing (constructed at an angle leading away from the road) is preferred because fencing constructed along the roadside can trap animals on the road. A range of one-way gates have been designed to let animals off the road when they become trapped by fencing (eg. Reed *et al.* 1974), however these have not been widely adopted in Australia. Refuge culverts are being trailed on the outside of such fences at several underpass sites in Tasmania (work in progress, Nick Mooney, DPIW).

Several studies have shown that a wide range of species will travel through underpasses (eg. Clevenger *et al.* 2001, O'Donnell 2003 in Austroads 2003). Tasmanian Devils are known to use underpasses even before fences have been constructed (N. Mooney, pers. obs.). There has been little research undertaken, however, on the number of individuals of each species that use each underpass, and whether underpasses have any impact at the population level (van der Ree, In prep.). Underpasses may also be beneficial for maintaining animal movements and gene flow on either side of large roads.

More research needs to be undertaken into whether wildlife use of underpasses and the associated decrease in road mortality is effective on whole populations, or just individuals. Underpasses do seem to be successful at least at the individual level, and can be relatively cost-effective to install.

Small culverts are very cost-effective, especially if installation occurs at the road building or upgrading stage. Underpasses are more likely to be useful for the smaller Tasmanian mammals and those that use burrows (Tasmanian devils, quolls, bandicoots, wombats etc). Larger animals (such as wallabies and kangaroos) are unlikely to use underpasses unless the underpass is very large (eg. a bridge spanning a gully), as a tunnel may represent a predator trap (Hunt *et al.* 1987).

Recommendations

- Small underpasses (consisting of 300-450 mm diameter culverts and wing fencing) should be installed in areas where roadkill of smaller mammals (eg. Tasmanian devils and smaller) is a problem. It is not practical to use underpasses for larger wildlife in Tasmania due to the expense of constructing large underpasses.
- Installation of underpasses is best done during road upgrade or construction rather than as a retrofitting activity, except in exceptional circumstances.

Signage

Spatial scale: black spot or length of road
Mechanism: change human behaviour by making people aware of blackspots

The purpose of wildlife warning signs is to inform drivers that there is a danger of their vehicle colliding with an animal, and to encourage them to be particularly alert, and slow down when travelling dangerous sections of road at night time.

A new wildlife sign has been produced by DIER in conjunction with the WRC. The sign gives a recommended night time speed limit, which is calculated as 35 km/h lower than the normal speed limit of the road being signposted.

Figure 5: Wildlife signage currently in use in Tasmania at trial sites. (DIER)

It is not known how effective the signs are, but it is important to consider that even if the signs do not reduce vehicle speed or collision rate *significantly*, they almost certainly have an effect on some individuals, and are therefore worthwhile.

Signs are important in improving public awareness, and are therefore an important part of the overall roadkill package. Signage can also be regarded as "duty of care".

One of the main problems with signage to date has been the lack of clear guidelines as to placement of signs. They are most often installed due to requests from the public. In Tasmania, these requests go to numerous government departments and local councils and there is no one person or process that deals with the requests.

In most cases, it is not clear to the person who receives the request whether or not the site in question is a genuine black spot, and if it is, whether it should be prioritised over other black spots. Even if the black spot is a genuine priority, signage is not necessarily the best method of mitigating roadkill at that site.

A *Protocol for Determining and Prioritising Black Spots for Treatment* has been established (see Section 4), which will assist those who deal with signage requests and other black spot information from the public.

A suggestion has been made that seasonal signage may be appropriate in some areas where roadkill is only frequent at particular times of year. This is a good idea, but may be unrealistic due to the added work in having to erect and remove the sign at appropriate times. Therefore each organisation should decide on a method most applicable to them.

Cost
Two signs erected at Bruny Island cost $1753 to produce and erect, and five signs at Coles Bay cost $2976 to produce and erect.

Recommendations

- Signage should be adopted as a roadkill mitigation measure by state and local government as their "duty of care".
- Locations for signage should be designated sparingly to avoid habituation, and should be assessed using the *Draft Protocol for Determining and Prioritising Black Spots for Treatment* (see Section 4).

Canopy Crossings

Spatial scale: black spot
Mechanism: change wildlife behaviour by providing safe crossings

The removal of trees associated with road construction produces a gap in the forest canopy that forces arboreal (tree-dwelling) species to come to the ground to travel across the gap. Animals are then forced to cross the road, where they are in danger of being hit by passing traffic. Canopy crossings have been constructed for red squirrels in Great Britain (Norwood 1999), Colobus monkeys in Kenya (Colobus Trust 2002) and ringtail possums in Far North Queensland, Australia (Weston 2000, 2003). The crossings have two purposes: to ensure that roads do not restrict movement of animals and also to reduce roadkill.

Figure 6: Canopy crossings can be as simple as a rope between power poles or trees. (Zoë Magnus)

Although ringtail possums were not observed using the canopy bridges constructed in 2003 (Magnus *et al.* 2004), it is quite likely that bridges of this design will be used by possums if they are placed in suitable locations.

Ringtail possums are known to balance on fencing wire when pulled reasonably taut (Anna Court, wildlife carer, pers. comm., 2002), and on 8mm wide, 50m long aerial stay wires which are used between power poles across roadways (Simon Burgess, Aurora Energy, pers. comm. 2002).

The crossings we put in place were much longer than the ones found to be successful elsewhere, which may have increased exposure to predators, however ringtails have been observed crossing exposed power lines on several occasions (M. Jones, pers. obs.). Increased instability from a longer bridge is unlikely to be an issue for this species due to their ability to use long sections of 8 mm power lines.

The trial site was not conducive to crossings. The overpass was installed between power poles and a pine tree as there were few trees on one side of the road. Sites where the vegetation provides habitat and food should be chosen to ensure success. Only a small amount of monitoring was undertaken due to lack of time and resources.

Ringtail possums are habitual animals and tend to follow the same route for long periods (Sarah Munks, University of Tasmania, pers. comm. 2002). It has been suggested (Yvonne Hill, pers. comm., DPIW, 2002) that scenting the rope with ringtail possum urine may attract the possums to the crossings, which may then become part of their established route. This was not found to be necessary in Queensland (Nigel Weston, pers. comm. 2002).

Cost
For five crossings, approximately 200 metres of rope was used, which cost $495. The tree-climber was paid $400 (5 hours work) and Aurora contributed $480 in use of the elevating work platform truck and two staff for 3 hours work. The hardware for the scat nets cost $57. In total, $1427 was expended.

Recommendations

- Installation of the canopy crossings was relatively quick and cheap, and it is recommended that they are installed at other locations where ringtail possum roadkill is frequent, particularly if the site is more conducive to such a construction.
- When other canopy crossings are installed, monitoring should take place in order to gain information on favourable conditions for success of these structures.

Platypus Crossings

Spatial scale: black spot
Mechanism: change wildlife behaviour by providing safe crossings

Platypuses in Tasmania often avoid using culverts to cross underneath roads, preferring to leave the watercourse and cross over the road (Mooney & Spencer 2000). Thus, platypus mortality on Tasmanian roads, while reported less frequently than many other terrestrial mammals, could be quite significant at a local level.

The platypus home range is at least 4-5 km of stream length, and they are known to forage over several kilometres per day (Grant 1991). Thus, many platypuses may have to negotiate several road crossings each day, perhaps resulting in a significant percentage of particular populations being killed on roads (Grant & Denny 1991). Otley & Le Mar (1998) suggest that in water systems with a large number of culverts, local extinctions of platypuses may occur.

Although little research has been undertaken in this field, a workshop held in 2003 (attended by zoological and transport experts) resulted in four measures being proposed to ameliorate Platypus roadkills at new culvert sites:

• installation of 'bio-baffles'* to assist passage through the culvert;
• provision of suitable access to culverts;
• provision of an alternative dry passage culvert; and
• installation of funnel fencing to encourage the Platypus to use the culvert rather than to go up and over the road.

The full workshop report (Tanner 2003) is included as an appendix in Magnus *et al.* (2004) and is also available through SLT or DPIW Environment libraries.

Recommendation

- All road-building agencies should include recommendations of the platypus roadkill report in their road-building policies.

*bio-baffles (Peter Davies, University of Tasmania) are a synthetic obstruction bolted to the inside of culverts to alter the flow of water. They were initially developed to assist fish passage.

Chicanes and speed humps (traffic slowing devices)

Spatial scale: black spot
Mechanism: change human behaviour by physically slowing traffic

These measures were not evaluated by Magnus *et al.* (2004). Chicanes appear to be contributing to the success of the Cradle Mountain wildlife recovery (Jones 2000).

Figure 7: A Chicane Installed by DIER at Cradle Mountain National Park. (Russell Bauer)

Traffic speed was found by Shaw *et al.* (in prep.) to be the primary factor in wildlife roadkill in Tasmania. There is no doubt that slowing traffic down will reduce roadkill, in fact, it is probable that traffic slowing devices are the most effective way of reducing roadkill, although in many places are not practical or safe. Due to state government regulations, there are very few places on state roads where it is possible to install traffic slowing devices.

Recommendation

- Traffic slowing devices are probably most appropriate when the roadkill issue is devastating, and are probably most practical in situations such as National Parks and roads where roadkill of threatened species is frequent.

Measures which merit consideration

Light-coloured Road Surfacing

Spatial scale: length of road or region/state
Mechanism: change human behaviour by improving driver's chance of seeing wildlife and change wildlife behaviour by discouraging wildlife from lingering on the road.

Sealed roads around most of Tasmania are typically surfaced with dark coloured rock such as basalt or dolerite. However, some roads are sealed with locally available material that is of a different colour, for example, quartzite on the Lyell Highway in the west of Tasmania.

It is thought that light-coloured road surfaces may decrease roadkill (Jones 2000). Wildlife are likely to feel uncomfortable spending time on the road, due to their increased visibility; and drivers are likely to see an animal sooner against the light surface of the road, as most Tasmanian wildlife is dark in colour. Personal observations (N. Mooney) suggest that this may be one reason why less roadkill occurs on gravel roads in Tasmania, as the gravel used is usually pale in colour.

At the planning stage of the current project, DIER's position was that the light-coloured road surfacing was being 'phased out' in favour of the typical black surfacing. Therefore it was likely to become too expensive in the future to seal a road with a different coloured material.

It should be noted that the selection of stone relates to durability and degree of polishing, which has impact on the friction and skid resistance of the surface. Another consideration is that light-coloured aggregate is more visible and so some people consider that it is not desirable in wilderness areas.

Recommendation

- Trials would be useful and should be undertaken using existing roads. If results are convincing, this method should be financially practical as a roadkill mitigation measure in some circumstances (eg. National Parks, other special projects etc).

"Driving" lights

Spatial scale: region/state
Mechanism: change human behaviour by improving driver's chance of seeing wildlife and change wildlife behaviour by providing more warning of a vehicle's approach

This method was not evaluated by Magnus *et al.* (2004), but is mentioned as having merit for further study. Professional drivers who assisted with the ultrasonic whistle study suggested that the 'driving lights' used on their vehicles appear to result in fewer animals being hit.

Recommendation

- Driving lights could be adopted by agencies for use on agency vehicles.

Odour Repellents

Spatial scale: black spot or length of road
Mechanism: change wildlife behaviour by discouraging wildlife from lingering on the roadsides and possibly preventing wildlife from crossing roads.

This mitigation measure is focused on medium to large herbivores, and aims to repel them from spending time foraging on the roadsides. In this respect, it is a comparable measure to table drain management. Odour repellents are based on a synthetic substance which has elements of the odour of canine urine. Ramp & Croft (2002) have begun experiments on the effectiveness of odour repellents, and have had some encouraging results (Daniel Ramp, pers. comm. 2003). More trials need to be completed before confirming efficacy of this mitigation measure. They also intend to investigate the possibility of animals habituating to the odour repellent.

If wildlife did habituate to the odour repellents (thus recognising that the odour repellent presented no danger to them), it is possible that the habituation would extend to genuine dog urine, lowering wildlife wariness to feral and domestic dogs and other exotic predators. This effect would be hard to study, but even if found to present, would be minimal as odour repellents would be used in localised areas for short times.

It is important to recognise that if a strong effect is found, this measure might discourage animals from crossing roads, and could therefore act in a similar way to fencing, preventing animals from moving about the landscape freely. This may inhibit access to new habitat and restrict breeding, which could cause population decline (eg. Mansergh & Scotts 1989).

For multi-lane roads with high traffic volumes, this is not an issue, as the road itself creates a barrier (i.e. if animals get onto the road, they are unlikely to survive). However, most Tasmanian roads are small with comparatively low traffic volumes. Therefore any animal on the road has a much greater chance of being successful at crossing.

Thus, the advantage of reducing roadkill by using odour repellents would have to be weighed up against possible constraints that might occur at the population level. If odour repellents are found to be effective, they may be useful for short-term mitigation of mortality along specific sections of road.

Recommendation

- It would be advisable to follow-up on the current study (Ramp and Croft, 2002), and make decisions about use of odour repellents based on those results and specific sites.

Road markings

Spatial scale: black spot or length of road
Mechanism: change human behaviour by psychologically slowing traffic

These are markings painted on the road to give the driver the feeling of apparent speed, in order to discourage fast driving. One technique is to make the driving lanes narrower, another is to make center lines shorter and closer together. Road markings were not evaluated by Magnus *et al.* (2004). Queensland Main Roads has used them with equivocal results.

Recommendation

- These techniques could be useful, particularly in the form of a trial.

Measures that are not recommended at this time

Reflectors

Spatial scale: length of road
Mechanism: change wildlife behaviour by discouraging wildlife from crossing the road while the vehicle is present

Wildlife reflectors are small plastic prisms attached to guideposts on the roadside. Because of their triangular cross-section, they reflect vehicles' headlights onto the roadsides, creating an optical barrier to wildlife. This should either scare wildlife away from the lights, or prevent them from crossing the optical barrier created by the reflected light. Swareflex reflectors were developed in Austria for mitigation of deer roadkill, and have since been adopted by an American company, Strieter-Lite, which uses a different design (reflectors face into the middle of the road, and are designed to scare animals off the road surface).

Two US studies on the Swareflex reflector's effects on deer produced conflicting results - one found that the reflectors reduced roadkill dramatically (Schafer & Penland 1985) and the other found no effect (Reeve & Anderson 1993).

The reflectors have been adopted by some Australian road managers in the hope that they will be effective on kangaroos and other Australian wildlife. There have been several studies undertaken in Australia, which have had equivocal results (eg. Sheridan 1991). Reflectors are currently being trailed by the University of New South Wales (Dr Daniel Ramp and Dr David Croft). To date, they have undertaken preliminary trials with conflicting results (Ramp & Croft 2002).

Swareflex reflectors were designed to work by stopping animals from approaching the roadside. Therefore they cannot be effective on animals that are already on the verge or road itself. In Tasmania, it is likely that most wildlife is already on the road or verge when the car approaches (Z. Magnus, pers. obs.). Tasmanian devils and quolls are often on the road scavenging on carcasses, and herbivores are often attracted to the roadsides by the green grass growing there due to run-off from the road (N. Mooney, pers. obs.). The exception may be some forester kangaroos and Bennetts wallabies, which may be traversing the countryside. In comparison, deer migrate hundreds of kilometres, crossing roads en route, so they may actually be far away enough from the roadside to be halted by the "light fence". The same might apply to the large kangaroo species, and perhaps emus and cattle, on the mainland of Australia.

It is unclear how the Strieter-Lite's inward-facing reflectors might work. If they were found to be effective, this would provide a better solution for the Tasmanian situation. Ramp & Croft (2002) are currently undertaking trials.

Reflectors need to be attached to wooden guideposts rather than the more modern pressed metal or plastic guideposts, as they are attached to the side rather than the face of the post.

Depending on the terrain, reflectors need to be placed 20-30 m apart, so installation of extra guideposts is required. Costs will be incurred for additional guideposts and for their maintenance. The reflectors will also require maintenance, and are prone to being vandalised and/or stolen (Z. Magnus, pers. obs.).

As Ramp & Croft (2002) have highlighted, the reflectors were designed for large animals (deer), the eyes of which are higher above the ground than the eyes of most Australian wildlife (and Tasmanian wildlife). If the reflectors are to be successful, it may be necessary to lower the height at which the reflectors are attached to the guideposts. Ramp & Croft (2002) are currently investigating the effectiveness of this approach.

Recommendations

- At this time, wildlife reflectors should not be considered for use in Tasmania, considering their expense, the high maintenance required and the fact that their efficacy is as yet unknown.
- If wildlife reflectors are shown to be highly effective, their use could be considered in Tasmania, but probably only in areas used by the larger macropods (eg. Bennetts wallabies and forester kangaroos). Such decisions would best be made in conjunction with a wildlife expert.
- If wildlife reflectors are shown to be highly effective for kangaroos, research into the effectiveness of reflectors for smaller macropods and other mammals could be considered.

Roadside Lighting

Spatial scale: black spot
Mechanism: change wildlife behaviour by discouraging wildlife from lingering on the roadsides

Roadside lighting as a deterrent to roadkill has been studied in the United States of America (Reed 1981). Lighting the road surface is thought to discourage wildlife from lingering on the road or roadside due to their increased visibility to predators. It is also thought to increase driver awareness, and increase driver visibility. A quote was obtained for setting up an equivalent system in Tasmania. The quote, for 1.2 km of road to be lit up, using 26 lights was $44251.

It was also considered possible that lighting could have the opposite effect to that required, by attracting insects, which would in turn attract insectivorous vertebrates (eg. quolls) to the roadsides, possibly creating more roadkill.

Recommendation

- Due to the expense and unknown consequences, it is not recommended that lighting is used as a roadkill mitigation measure in Tasmania at this time.

Ultrasonic animal alerts

Spatial scale: region/state
Mechanism: change wildlife behaviour by preventing/discouraging wildlife from crossing the road while a vehicle is present

These come in two forms: small air-driven whistles which stick to the outside of the vehicle or electronic units attached to the car battery. Despite some positive anecdotal evidence, there is no scientific evidence that they are effective (Magnus *et al.* in prep., Bender 2004, Scheifele *et al.* 2003, Bender 2001, Romin & Dalton 1992).

Recommendation

- Ultrasonic whistles should not be considered as a genuine roadkill reduction method.

Conclusions

Several measures were identified as being likely to reduce wildlife roadkill and/or decreasing visitor distress on account of roadkill.

These are: escape routes, table drain (ditch) management, underpasses, wildlife signage, canopy crossings, platypus crossings, chicanes and speed humps, and potentially odour repellents.

Ultrasonic whistles, wildlife reflectors and lighting have doubtful application, at least in Tasmania.

Light-coloured road surfacing, the use of "driving lights", and road markings remain as possibilities for further trials.

In terms of further research, priority should be given to research and monitoring to further our understanding of roadkill events and sites, and wildlife behaviour in reaction to oncoming traffic. This information will better equip research into wildlife roadkill mitigation measures.

Section 4: Protocol for Determining and Prioritising Black Spots for Treatment (including proforma for data collection)

Adapted from an earlier document developed in conjunction with the Wildlife Management Branch, Department of Primary Industries and Water (DPIW) and the Department of Infrastructure, Energy and Resources (DIER).

Background

Wildlife roadkill black spots are areas where the number of animals killed on a certain length of road is high, or where a species of special interest is killed frequently (eg. threatened species).

Road managers need to address the following three questions in response to reported black spots:

- How can we decide which reported black spots are genuine?
- How can we decide which known black spots to treat?
- How can we decide which method(s) is/are appropriate?

Determining black spots

Some initial questions must be answered:

- Was the black spot observed in a drought year?
- Have there been roadside habitat changes in the last 12 months?

If the answer to either of these questions is yes, information from a period of less extreme conditions must be sought before the significance of the black spot can be properly considered (unless it is possible to use a temporary or cost-effective measure to reduce roadkill in this zone).

Generally, more roadkill occurs during summer as there are more animals around due to young leaving pouches and dens and later dispersing. Also in summer less green pick is available for grazing throughout the general landscape so larger distances must be travelled to find food. Water runoff from roads and the consequent green grass alongside roads can also attract herbivores in summer when less food is available elsewhere. For the same reasons, roadkill rates increase in years of drought, and decrease in wet summers. Drastic local habitat changes such as vegetation clearing or wildfire can cause dislocation of animals and increase roadkill events.

Prioritising black spots
Several factors need to be considered in prioritising black spots to be treated:

- Which species are involved?
- Is there a threatened or unusual species or species of special interest involved (eg. Tasmanian devils, platypuses)?
- Is/are the species involved endemic?
- Is there a particularly large number of low-priority animals affected?
- Is the black spot on a tourist route?

Making a decision on which black spots should be prioritised is not simple; many factors must be taken into account. Roadkill rates can change depending on season (eg. grass establishing, water availability) and stochastic events (eg. drought, fire), which both produce changes in roadside habitat. These factors must be considered when assessing black spot information.

Which mitigation method is appropriate?
Roadkill mitigation measures that are recommended include: escape routes, table drain management, signage, underpasses, canopy crossings, platypus crossings, chicanes and speed humps and public education. (See Section 3 for more details).

How to use the attached proforma:
This proforma has been developed in conjunction with the Wildlife Management Branch, Department of Primary Industries and Water (DPIW) and the Department of Infrastructure, Energy and Resources (DIER).

It has been designed to assist in the collection of data to determine and prioritise black spots.

The data collected needs to be accurate and relevant. To ensure this:

- Reports are best filled out by someone who is travelling the section of road, where the roadkill occurs, frequently;
- Records should be taken from the beginning of January to the end of March (or whatever period most roadkill events occur);
- Locations must be recorded accurately - either as grid references or numbers marked on a map;
- Dates when no roadkill was seen should be included.

The information can be sent to DPIW to be recorded on the Natural Values Atlas Site (the Department's flora and fauna Geographic Information System) – www.naturalvaluesatlas.dpiw.tas.gov.au

Wildlife roadkill black spot assessment

Name of reporter:…………………………………..
Organisation:……………………………………….
Address…………………………………………….
…………………………………………………..
Postcode…………………………………………….
Contact numbers: BH…………………………….
AH………………………………………………..
Email……………………………………………..

Name of road……………………………………..
Location of black spot: Please attach a map. If this is not possible, describe in enough detail for location to be found on a map
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
Length of black spot ………………………………………………………………………..
Number of days on which black spot was surveyed…………………………………….
Number of roadkill animals recorded…………………………………………………
Extra information (eg. has the area recently been under stress through drought, major vegetation clearing, wildfire etc?)…...……………………………………………………

Date	Approx time	Species/type of animal	Grid reference or number on map
4/1/03(sample)	8am	Unidentified mammal	E: 534280 N: 5249460 or #1 on map
6/1/03 (sample)	8am-8:15am	No roadkill this morning	N/A

Please attach extra sheets as necessary.

Section 5: Further reading

Mitigation measures
(See reference list for more detail)

Magnus, Z., Kriwoken, K., Mooney, N.J. & Jones, M.E. (2004) Reducing the Incidence of Wildlife Roadkill: improving the visitor experience in Tasmania. Technical Report, Cooperative Research Centre for Sustainable Tourism, Gold Coast.

Queensland Department of Main Roads (2000). Fauna sensitive road design. Volume 1 - past and existing practices. Queensland Department of Main Roads, Technology and Environment Division. Brisbane.

Predicting blackspots

Magnus, Z., Jones, M.E., Mooney, N.J., Kriwoken, L.K. and Barmuta, L.A. (2004). Differential susceptibility of several Tasmanian wildlife species to road mortality and behaviours that affect it. (In prep).

Shaw, R. A., Jones, M. E. and Richardson, A.M.M. (2004). Predicting the location of wildlife roadkill in Tasmania (In prep).

Assessing effectiveness of roadkill mitigation

Jungalwalla, A. (2003). Outline Framework for Fauna Sensitive Road Design and Management. Department of Infrastructure, Energy and Resources. Hobart.

van der Ree (2004). Assessing the effectiveness of wildlife crossing structures: a need for a rigorous and standardised approach. (In prep.) Email: rvdr@unimelb.edu.au

References

Austroads (2003). Fauna Sensitive Road Design & Management Workshop: Workshop Outcomes Report. Austroads Technology and Environment Programme.
Bender, H. (2001). Deterrence of Kangaroos From Roadways Using Ultrasonic Frequencies – efficacy of the Shu Roo. University of Melbourne, Department of Zoology.
Clevenger, A.P., Chruszcz, B. and Gunson, K. (2001). Drainage culverts as habitat linkages and factors affecting passage by mammals. Journal of Applied Ecology 38: 1340-1349.
Colobus Trust (2002) New bridges for Colobus road safety. http://www.bornfree.org.uk/colobus/. Held by Wakuluzu, Friends of the Colobus Trust, PO Box 5380 Diani Kenya.
DIER (2004). Good practice for wildlife roadkill mitigation. Codes of good environmental practice and revegetation guidance number 1.6, internal unpublished document, Department of Infrastructure, Energy and Resources, Tasmania.
Goosem, M.W., Izumi, Y. and Turton, S. (2001). Efforts to restore habitat connectivity for an upland tropical rainforest fauna: A trial of underpasses below roads. Ecological Management and Restoration 2:96-202.
Goosem, M.W. and Weston, N. (2002). Under and Over. Wildlife Australia Spring 2002: 34-37.
Grant, T.R. (1991). The biology and management of the platypus (Ornithorhynchus anatinus) in NSW. NSW National Parks and Wildlife Service, Hurstville, NSW.
Grant, T. R. and M.J.S. Denny (1991). Distribution of the platypus in Australia with guidelines for management. Mt King Ecological Surveys, Oberon, NSW.
Hunt, A., Dickens, H.J. and Whelan, R.J. (1987). Movement of small mammals through tunnels under railway lines. Australian Zoologist 24:89-93.
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.
Magnus, Z., Jones, M.E., Wilson, C.W., Mooney, N.J., Kriwoken, L.K. and Barmuta, L.A. (2004). In prep.
Magnus, Z., Kriwoken, K., Mooney, N.J. & Jones, M.E. (2004) Reducing the Incidence of Wildlife Roadkill: improving the visitor experience in Tasmania. Technical Report, Cooperative Research Centre for Sustainable Tourism, Gold Coast.
Mansergh, I.M. and Scotts, D.J. (1989). Habitat continuity and social organisation of the mountain pygmy-possum restored by tunnel. Journal of Wildlife Management 53(3):701-707.
Mooney, N. and Spencer, C. (2000). Why did the platypus cross the road? Australian Mammalogy 21(2):264-267.
Norwood, C. (1999). Book Review: Linkages in the landscape: The role of corridors and connectivity in wildlife conservation. Pacific Conservation Biology 5: 158.
Otley, H.M. and Le Mar, K. (1998). Observations on the avoidance of culverts by platypus. The Tasmanian Naturalist 120:48-50.
Ramp, D. and Croft, D. (2002). Saving Wildlife: Saving people on our roads. Annual Report 2002. University of New South Wales.
Reed, D.F. (1981). Effectiveness of highway lighting in reducing deer-vehicle accidents. Journal of Wildlife Management 45(3):1981.
Reed, D.F., Pojar, T.M. and Woodard, T.N. (1974). Use of one-way gates by mule deer. Journal of Wildlife Management 38(1):9-13.
Reeve, A.F. and Anderson, S.H. (1993). Ineffectiveness of Swareflex reflectors at reducing deer-vehicle collisions. Wildlife Society Bulletin 21:127-132.
Romin. L.A. and Dalton, L.B. (1992). Lack of response by mule deer to wildlife warning whistles. Wildlife Society Bulletin 20:382-384.
Schafer, J.A. and Penland, S.T. (1985). Effectiveness of Swareflex reflectors in reducing deer-vehicle accidents. Journal of Wildlife Management 49(3):774-776.
Shaw, R. A., Jones, M. E. and Richardson, A.M.M. (2004). Predicting the location of wildlife roadkill in Tasmania (In prep).
Scheifele. P.M., Browning, D.G. and Collins-Scheifele, L.M. (2003). Analysis and effectiveness of deer whistles for motor vehicles: frequencies, levels and animal threshold responses. Acoustical Research Letters Online 4, 71.
Sheridan, G.J. (1991). The effectiveness of Swareflex and Wegu brand wildlife reflectors in deterring Perameles gunnii (barred bandicoot) from crossing a section of roadway. Ballarat University, Victoria.
van der Ree (In prep.) Assessing the effectiveness of wildlife crossing structures: a need for a rigorous and standardised approach.
Tanner, Z. (2003) Culvert avoidance by platypuses and subsequent road deaths: workshop aims and outcomes. Tasmanian Environment Centre, Hobart.
Weston, N. (2000/2001) Bridging the Rainforest Gap. Wildlife Australia Magazine summer 2000/2001.
Weston, N.G. 2003. The provision of canopy bridges for arboreal mammals: a technique for reducing the adverse effects of linear barriers, with case studies from the Wet Tropics region of north-eastern Queensland. Unpublished MSc Thesis, JCU, Cairns.