Use of badger tunnels by mammals on Highways Agency schemes in England

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SUMMARY

Monitoring of badger tunnels using clay mats on nine Highways Agency road schemes was undertaken to establish their effectiveness in terms of use by large mammals (primarily European badger *Meles meles*), as well as the efficacy of tunnel design advice provided by the agency. The results indicate that tunnels are an effective means of mitigating the effects of all types of new road schemes on badgers; 89% of the tunnels monitored were used. The results suggest that no one factor is of over-riding importance in tunnel design; however, design features that appeared to be associated with the use of tunnels were good vegetation cover, habitat connectivity, good drainage and a tunnel width of at least 600 mm.

BACKGROUND

In the UK, the Highways Agency routinely evaluates the efficacy of conservation initiatives to assess the extent to which objectives have been met. In 2010, the Post Opening Project Evaluation, identified badger tunnels (culverts installed under roads to allow safe passage) as an intervention that merited further investigation to establish effectiveness in terms of use by large mammals (primarily European badger *Meles meles*), as well as the efficacy of tunnel design advice provided within the Highway Agency's *Design Manual for Roads and Bridges* (DMRB; HA 2001).

The primary reason for incorporating tunnels beneath highways during construction is to reduce habitat fragmentation impacts on mammals, and to minimise the risk of road traffic accidents caused by animals attempting to cross a road. When installing badger tunnels, the Highway Agency's manual recommends a number of design features to guide mammals through culverts or overpasses to prevent them from directly crossing a road. Badger tunnels should be made using 600 mm diameter concrete pipes. Appropriate landscape planting should be carried out to soften the approach to the tunnel, while fencing should be installed to direct mammals to the tunnel entrance and prevent them from accessing the road. The location of badger crossings is crucial to success; it is preferable if a crossing can be located on, or as near as possible to, the site of an active badger path. The manual does not provide guidance on optimal length of a badger tunnel (DMRB; HA 2001). As badgers are one of the species most commonly killed on roads in the UK, this study focuses primarily upon the use of tunnels by badgers, although other mammal species are also considered.

The monitoring method used in this study follows that developed by Baker, Knowles & Latham (2007). This involved using clay mats to record the imprint of mammal tracks; a simple and low-cost technique (Figure 1). The present study had two aims, firstly to establish whether badgers use crossings, and secondly, to identify any specific problems or factors associated with tunnel design that reduce or increase the likelihood of use by mammals.

Figure 1. A clay mat installed at the entrance of a badger tunnel to monitor use by mammals.

ACTION

Study sites: Nine major road schemes (dual carriageway or motorway) throughout England were chosen for study. These roads incorporated 38 mammal tunnels installed between 2003 and 2007 (Table 1). The tunnels varied in design in terms of materials, width and length. The 38 tunnels included both concrete and corrugated iron tunnels and were an average length of 44 m (minimum 20 m, maximum 120 m). Tunnel diameters were 300 mm, 450 mm, 600 mm, 700 mm or 1,000 mm, with the modal diameter being 600 mm (the 'standard' width). (Note, diameters given in mm as per industry standard).

Monitoring: Monitoring was undertaken from 24 August to 26 October 2010. The autumn was chosen as a suitable time (as in the 2007 study) as it was considered that the clay mats would remain moist and soft enough to record mammal footprints over about a week's duration (interval between each visit). It is also the time when mammal activity tends to be high (post-breeding dispersal of young animals). At each study tunnel, a clay mat (45 x 45 cm x 0.5 cm thick) was placed just inside the tunnel entrance in late August. Tunnel design (diameter, construction material, visibility of light through the concrete pipe), the condition of the tunnel and associated fencing were recorded. The amount of vegetation cover around the tunnel entrance and habitat connectivity was assessed, describing how the tunnel entrance linked to adjacent habitat features such as hedges and highway (roadside) planting.

Any evidence of animal tracks was recorded and species identified (Bullion, Strachan & Troughton 2001). The clay mat was then thoroughly wetted and smoothed over, leaving a clean surface to record future tracks. In addition to clay mats, passive infra-red motion activated cameras were set up at two tunnel entrances (A5 Nescliffe Bypass and A590 High and Low Newton Bypass) for one week to further assess suitability of monitoring using clay mats and to highlight any unexpected limitations associated with this technique.

Table 1. Road scheme, tunnel numbers and known design issues potentially affecting use by badgers.

Scheme name and location	Scheme type and length	Mammal tunnels	Known design issues
A590 High and Low Newton Bypass, Cumbria, northwest England	3.8 km 2-lane dual carriageway	4 badger tunnels; 1 badger/otter tunnel	1 tunnel 450 mm width i.e. less than standard 600 mm
A66 Temple Sowerby (northwest England)	5 km 2-lane dual carriageway	1 badger tunnel	Tunnel longer than average at 60 m
A1(M) Wetherby to Walshford, North Yorkshire, northeast England	5.3 km 3-lane motorway	1 badger tunnel	Tunnel longer than average at 60 m and with plank bridge crossing to access tunnel
A63 Selby Bypass, North Yorkshire, northeast England	10 km single carriageway	3 badger tunnels	1 tunnel 300 mm i.e. less than standard width
A5 Nesscliffe Bypass, West Midlands, central England	4.5 km 2-lane dual carriageway	4 badger tunnels	2 tunnels larger than standard width (i.e. 700 mm and 1,000 mm); 1 tunnel longer than average at 70 m
A6 Rothwell Bypass, East Midlands, central England	6 km single carriageway	13 badger tunnels	Some tunnels deep beneath carriageway, therefore possible restricted air flow; close to public footpaths
A428 Caxton to Hardwick, Cambridgeshire, eastern England	7.7. km 2-lane dual carriageway	4 badger tunnels	1 tunnel with poor drainage
A120 Stansted to Braintree, Essex, southeast England	14 km 2-lane dual carriageway	6 badger tunnels	3 tunnels longer than average at around 70 m
A34/M34 Chieveley Junction South, Berkshire, southern England	Junction	1 badger tunnel	Tunnel longer than average at 120 m

CONSEQUENCES

Mammal use: Overall, 35 of the 38 tunnels (92%) were used by large mammals, with 89% used by badgers during the autumn 2010 monitoring period. Species recorded were badger, Eurasian otter *Lutra lutra*, red fox *Vulpes vulpes*, European hedgehog *Erinaceus europaeus*, brown rat *Rattus rattus*, domestic cat *Felis catus* and domestic dog *Canis lupus familiaris*. Use of the tunnels by badgers was greater than any other species. In terms of the regularity of use, 37% of the tunnels were used frequently by badgers (i.e. footprints recorded on 7 or 8 of the monitoring visits), 29% showed moderate levels of use (i.e. prints recorded on 4-6 monitoring visits) and 23% were used infrequently (i.e. prints recorded on only 1-3 monitoring visits). Figure 2 shows prints on one of the clay mats. These results indicate that the tunnels installed under both dual carriageways and motorways are being used on a regular basis.

Figure 2. Badger prints on a clay mat within a badger tunnel.

Tunnel design: The results emphasise the importance of some elements of tunnel design that may encourage use by badgers. The key features that appear to be associated with more frequent use were:

1) Good habitat connectivity with existing landscape features such as hedges and ditches. Figure 3 suggests that good and moderate habitat connectivity is more likely to result in a tunnel being used than those with poor connectivity to such features;

2) Good vegetation cover around the tunnel entrance. Figure 4 indicates more frequent use by badgers of tunnels with good cover;

3) Good drainage; tunnels with poor drainage were never or infrequently used;

4) A tunnel width of at least 600 mm. Tunnels wider than 600 mm were regularly used. The two tunnels of 300 mm and 450 mm were never used or infrequently used by badgers (it is acknowledged that the small sample size precludes a definitive conclusion).

It was found that use of the tunnels was not significantly influenced by tunnel construction material (concrete or corrugated steel), whether light was visible through the tunnel, or tunnel length. The lack of a relationship with tunnel length Figure 5 was surprising (there is anecdotal evidence that badgers tend not to use long tunnels, particularly if light is not visible through the tunnel).

Effectiveness of clay mats as a monitoring method: The clay mats were effective as a means of monitoring mammal tracks. The technique does however have limitations, which include drying out and cracking in hot weather, or water logging in wet conditions. Where water logging occurred there was evidence that badgers tried to avoid walking on the mats (partial prints on mat edges suggested that badgers had tried to walk around them). A few simple measures could be taken to reduce these limitations, such as the use of larger clay mats (thus animals cannot pass without treading on them, placing mats further in the tunnel entrance (out of direct sunlight or precipitation), and more regular monitoring and maintenance (e.g. every 3 to 5 days instead of every 7 days).

The use of motion-activated cameras at two sites did not pick-up any additional species to those identified by the clay mats.

Other observations: A number of other interesting observations were made. In some tunnels, prints were sometimes recorded in one direction only. This suggests that badgers use tunnels to access feeding grounds, subsidiary or outlier setts; consequently, they may not return the same night (or for several nights). Alternatively, badgers may be using other means of returning, such as other tunnels or bridges, or traversing directly over the road. At three locations (on the A5 and A6), badgers had pulled bedding into the tunnels. This suggests they use tunnels as resting sites as well as underpasses. In one case, the tunnel was blocked at one end by a large boulder making it impassable to badgers, but prints were recorded regularly at the open end of the tunnel and badgers appeared to be using the tunnel as a sett.

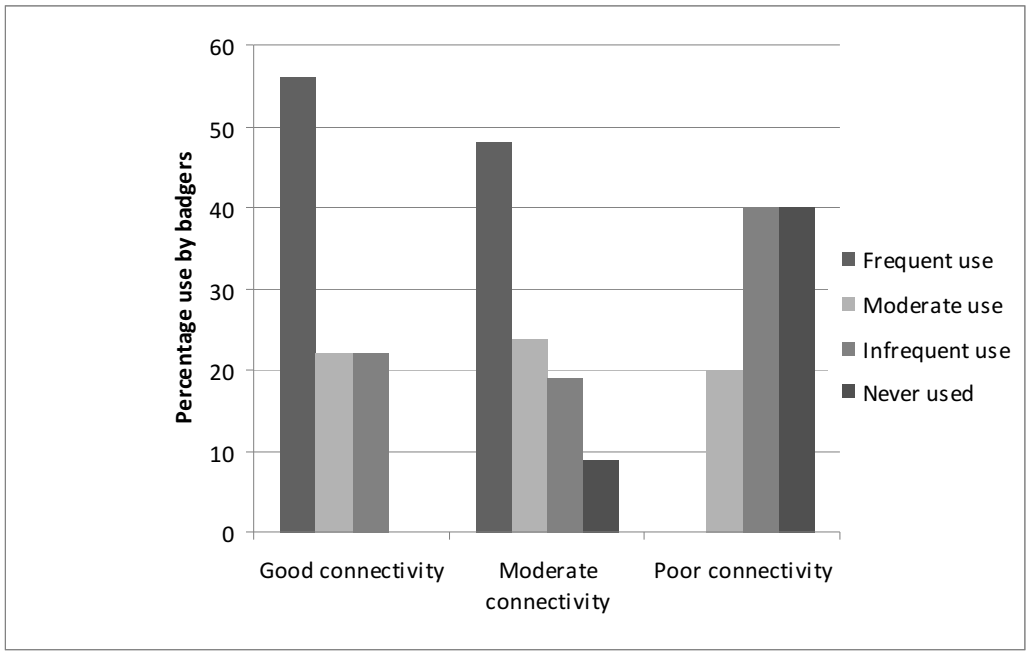

Figure 3. Tunnel use by badgers in relation to habitat connectivity.

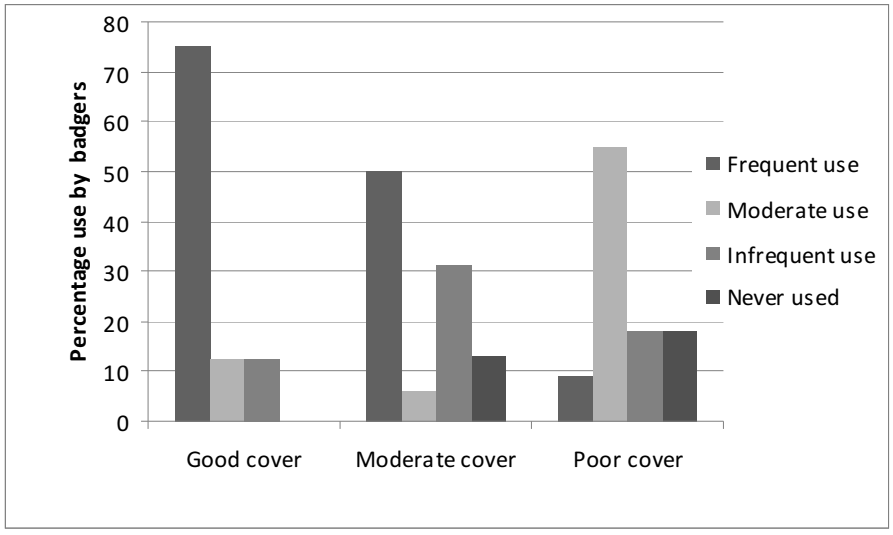

Figure 4. Tunnel use by badgers in relation to vegetation cover at tunnel entrance.

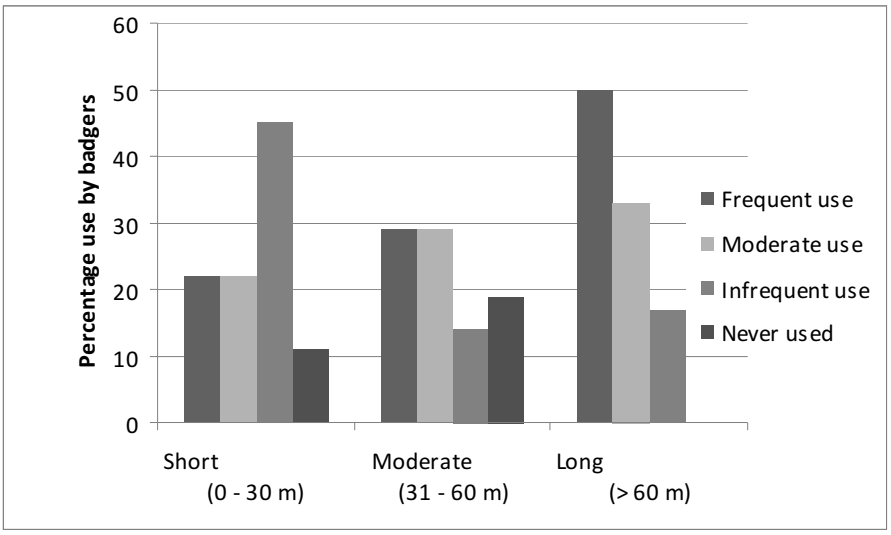

Figure 5. Tunnel use by badgers in relation to tunnel length.

Conclusions: The results indicate that badger tunnels installed under the study roads help mitigate the effects of habitat fragmentation resulting from new road developments. Tunnels provided safe passage under the roads for several large mammal species, particularly badgers; 89% of tunnels monitored were used by badgers and 92% were used by a wider range of large mammals. Clay mats were an efficient and low-cost means of monitoring mammal use of tunnels. It is acknowledged that this method has some limitations such as mats drying out in hot weather thus becoming too hard to record tracks but regular maintenance should avoid such problems, and they cannot be used to assess actual numbers of individual crossings through a tunnel over a given time period.

In terms of enhancing use by badgers, good tunnel design should incorporate adequate drainage and the tunnel width should be 600 mm (results suggest that a tunnel of smaller width is less likely to be used). Tunnels should ideally be located where existing habitat connectivity is good, and with vegetation providing some cover around tunnel entrances in order to increase their suitability for use by mammals as road crossing structures.

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