# MOVEMENT *of mammals through tunnels under railway lines*

Alison Hunt, Helen J. Dickens
Robert J. Whelan

Biology Department
University of Wollongong
Wollongong, NSW 2500
Australia

*ABSTRACT*

Fragmentation of extensive natural ecosystems by roads, railways and other barriers poses major threats to populations of native animals. Attempts have been made to reduce the magnitude of these threats by constructing "underpasses" designed to permit exchange of animals. We compared mammal use of long-established drainage culverts and newly constructed tunnels under the Maldon-Dombarton rail line, near Wollongong, New South Wales. Small mammals used the established culverts, but use of the new tunnels was predominantly by feral predators. We predict that frequent use by small, native mammals will not occur until native vegetation regenerates around the tunnel entrances, establishing a connection between undisturbed vegetation on the two sides of the track. We also argue that follow-up studies such as this one should be an integral part of the environmental impact study of a proposed development.

*INTRODUCTION*

Fragmentation of natural ecosystems by linear barriers such as roads and railway lines creates several threats to populations of native animals (Robinson 1977); Swihart and Slade 1984; Mader 1984). These threats include: (a) risk of death from traffic and possibly predation whilst crossing the barrier (e.g., Coulson 1982; Hodson 1966; Oxley *et al.* 1974; Whelan 1983); (b) reduction of the genetic diversity within small, subdivided populations (Diamond 1975); (c) increased probability of local extinction caused directly by small population sizes (Diamond 1975; Frankel 1982); (d) reduced likelihood of re-establishment of local populations, after natural declines, because immigration is inhibited by the barriers (Terborgh and Winter 1980).

Observations such as these have led to concern regarding the long-term effects of new roads and railway lines on populations of Australian native mammals (e.g., Whelan 1983; State Rail Authority 1983). It has been suggested that such new developments incorporate tunnels or culverts specifically designed for use by mammals (State Rail Authority 1983; Broadbent and Cranwell 1979).

The Metropolitan Water, Sewerage and Drainage Board catchment area, situated on the escarpment to the west of Wollongong, New South Wales, is one of the last remaining large tracts of undisturbed vegetation in the Illawarra region (Robinson 1977; 1985). Several roads and railway lines already dissect this landscape, and upgrading of a railway line to permit coal transport is currently under way in both the open eucalypt forest of the plateau and also in the tall open forest and subtropical rainforest of the escarpment slopes (Figure 1). At the suggestion of the NSW National Parks and Wildlife Service, seven tunnels were constructed along the 35 km of new railway line. There is currently little information available on whether the native animals in this region will use tunnels such as these and possible problems have not been anticipated. If successful, this technique of facilitating animal movements between

*Table 1:* Trapping information for surveys of mammal movements through culverts (A to E) and tunnels (3, 4 and 5). e represents Elliott traps for small mammals; c represents cage traps for larger mammals.

| Culvert/Tunnel[1] | Trapping Dates | Trap-nights | Other Methods |
|---|---|---|---|
| (a) Culverts | | | |
| A | 23-25/9/84 and 5-8/10/84 | 15e | Sand, scats, tracks |
| B | 23-25/9/84 and 5-8/10/84 | 30e | Sand, scats, tracks |
| C | 23-25/9/84 and 5-8/10/84 | 20e | Sand, scats, tracks, funnelling into traps |
| D | 5-8/10/84 | 60e | Sand, scats, tracks |
| | 26/9/84 and 7/10/84 | 4c | Caging end of culvert |
| E | 23-25/9/84 and 5-8/10/84 | 15e | Sand, scats, tracks |
| (b) Tunnels | | | |
| 3 | 8-15/10/84 and 2-7/1/85 | 220e 17c | Sand, carbonized paper, scats, funnelling, tracks |
| 4 | 8-15/10/84 and 2-7/1/85 | 225e 17c | Sand, carbonized paper, scats, funnelling, hair ID |
| 5 | 8-15/10/84 and 2-7/1/85 | 126e 9c | Sand, carbonized paper, scats, funnelling, tracks |

[1]Dimensions as follows: Culvert A — 0.91 × 0.58 × 5.0 m; Culvert B — double culvert, both 0.66 × 0.94 × 8.0 m; Culvert C — 2.4 × 3.0 × 3.5 m; Culvert D — double culvert, both 1.1 × 1.6 × 5.0 m; Culvert E — 0.83 × 0.10 × 5.0 m. Tunnels — 3.2 × 4.0 × 20.0 m.

otherwise isolated blocks of vegetation would have wide application in road and rail construction in many regions. It is noteworthy that tunnels designed to permit annual breeding movements of both mountain pygmy possums (Steer 1987) in the Victorian alps and toads in England (Walker 1987) have been successful.

The major aim of the study described here was to determine whether tunnels facilitated movement of mammals between sites separated by the railway line. Because the tunnels designed for this purpose have been constructed so recently, and no equivalent, well-established tunnels were available for comparison, we included some older culverts in the study as an indication of the potential usage once revegetation of the surroundings has occurred.

## METHODS

The existing railway line crosses several watercourses. Five culverts designed to facilitate water drainage were selected for study of mammal movements because they have been in place for many decades, the vegetation surrounding them was dense and close to the culvert openings and water levels were low. Sizes of these culverts ranged from 15 × 90 cm to 240 × 300 cm (see Table 1). The vegetation of this area was tall open eucalypt forest interspersed with patches of sub-tropical rainforest (Fuller 1980). These culverts were both smaller and also in a different type of vegetation than their newly-constructed counterparts.

During construction of the new section of railway line in 1984, several tunnels were incorporated specifically for use by animals. These tunnels are much larger than the culverts described above, about 3 m diameter and 15 to 20 m in length. The tunnels have a sandy floor, continuous with the approaches, which were still bare of vegetation at the time of the study (Figure 2). The cleared strip between each side of the railway line and the surrounding vegetation was from 20 to 50 m wide. The vegetation of this area is open eucalypt woodland typical of the Hawkesbury Sandstone vegetation surrounding Sydney (Burrough *et al.* 1977).

Elliott traps (type A, aluminium), baited with a standard mixture of oats and peanut butter, were used

to trap small mammals. Cage traps were used to trap medium-sized mammals. These were baited with bread/honey/peanut butter or with commercial dog food. Elliott and cage traps were set inside all tunnels. Elliott traps were set at all culverts, but cage traps were used only for culvert D. These traps were set at the culvert mouth, opening into the culvert. Indirect evidence of mammal movements was obtained by identifying scats (Triggs 1984) and also by identifying footprints left both in patches of soft sand we smoothed over within the tunnels and also on strips of soot-coated paper placed across the passage within tunnels.

Mammal surveys were conducted at the culverts for five nights in September 1984 and for three nights in October 1984. For the tunnels, surveys were for seven nights in October 1984 and for five nights in January 1985. A summary of trapping appears in Table. 1.

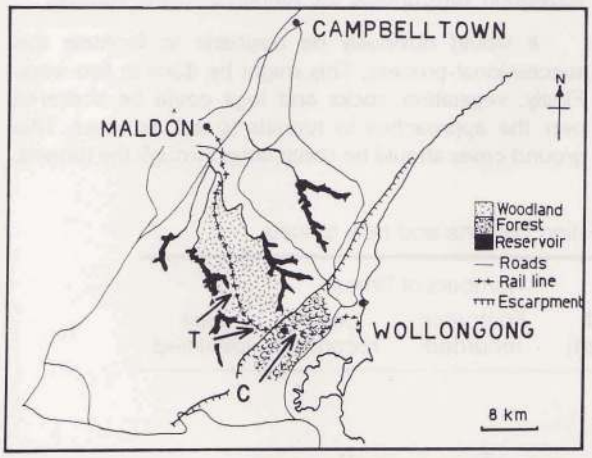


*Figure 1: Map of the study area within the Illawarra region. Tunnels and culverts are indicated by "T" and "C" respectively.*

## RESULTS

Mammal activity was evident in all five of the existing culverts (Table 2). Three species of mammals were recorded, *Rattus fuscipes* (bush rat) being the most common. The feral cat, *Felis catus*, was also recorded in two of the culverts. Culvert C was considered large enough to be suitable for use by larger mammals such as wombats and macropods (which were both present in the surrounding vegetation), yet only *R. fuscipes* tracks were found in this culvert. *Perameles nasuta* (long-nosed bandicoot) was recorded using Culvert D and this animal was subsequently trapped inside the culvert. This observation is of particular interest because the animal travelled 15 m further to cross through the culvert than if it had travelled directly over the track. It was possible to measure this distance because the animal used a well worn runway through the surrounding vegetation.

In contrast to the existing culverts, indications of mammal activity were much less frequent in the tunnels. Most of the activity recorded was attributable to feral animals. One of the cage-traps set in tunnel 4 in October had been broken into, several of the Elliott traps were overturned and bait was taken. Hairs found caught in the outside of cage traps were identified (Brunner and Coman 1974) as those of dog and fox. *Wallabia bicolor* (swamp wallaby) tracks were recorded on one occasion in tunnel 3, during October 1984. An unidentified track in tunnel 4 was the only indication of any small mammal movement through the tunnels. No indication of mammal use was found during January 1985.

## DISCUSSION

This study shows clearly that various mammal species regularly use culverts installed for water drainage. Although our sample sizes were limited, the species using a particular culvert appeared to be related to the characteristics of the culvert, i.e., size and degree of cover at the entrance. For example, *Rattus fuscipes* was the sole user of the smallest culverts; the larger mammals were recorded in intermediate-sized culverts but not in the one large culvert which also lacked vegetation cover over its entrance. Swamp wallabies, which were present in the surrounding area, failed to use these culverts.

Although mammals did use the new tunnels, the pattern of use was different from that observed for the culverts. There was no overlap in the species recorded using the two types of passage under the railway line. Although swamp wallabies were recorded using the tunnels but not the culverts, fewer animals in total were recorded using the tunnels. The habitat surrounding the tunnels could explain this result, because it is known that open eucalypt woodland supports lower densities of small mammals than other vegetation types (Robinson 1985). Nevertheless, *Rattus fuscipes* would be expected in the adjacent vegetation, but was absent from the tunnels. The large diameter of the tunnels, their lengths (about 20 m) and their exposed entrances devoid of vegetation probably contribute to this result. Thirdly, feral animals, notably pedators, predominated in the tunnels.

Small, native animals avoid open spaces for many reasons, perhaps principally due to the risk of predation. These animals may therefore avoid large tunnels and also culverts and tunnels devoid of surrounding vegetation. Larger mammals may also be excluded from large, exposed tunnels through fear of predation and they

*Figure 2: Photograph of the entrance to Tunnel 3. Note the size of the tunnel and the expanse of cleared ground at the tunnel entrance.*

would be excluded from small culverts simply because of size. In addition to these interpretations, our study has brought to light a potential problem that has not been widely recognized, namely the possibility that feral, predatory mammals such as foxes, dogs and cats may focus their activities on tunnels which act as funnels for prey. This effect would probably be more extreme in tunnels that lack "obstacles" such as vegetation cover, both inside and adjacent to the entrances.

On the basis of our results and general observations in the area, we speculate that a concentration of feral predators will be possible soon after construction, while the site is still seriously disturbed. In the absence of high predator activity, this phase may be followed closely by usage of tunnels by larger native mammals such as swamp wallabies and wombats, which have relatively large home ranges and do not depend heavily on ground cover. Appearance of introduced rodent species may occur because exotic plants such as clover and grasses have been sown on the cleared margins of the railway line as a means of stabilizing the soil. Finally, native small mammals might be expected to appear as the cover and vegetation surrounding the tunnels become suitable.

It would obviously be desirable to facilitate this successional process. This might be done in two ways. Firstly, vegetation, rocks and logs could be scattered over the approaches to tunnels to act as cover. This ground cover should be continuous through the tunnels.

*Table 2:* Results of surveys for mammals in existing culverts and new tunnels.

| | Species | Numbers of Times: Trapped (recaptured) | Footprints recorded | Scats recorded | Hair identified |
|---|---|---|---|---|---|
| (a) Culverts | | | | | |
| A | *Rattus fuscipes* | 1(1) | 3 | 0 | – |
| B | *R. fuscipes* | 6(6) | 0 | 0 | – |
| C | *R. fuscipes* | 0 | 6 | 0 | – |
| D | *R. fuscipes* | 1(1) | 1 | 0 | – |
| | *Perameles nasuta* | 1(0) | 1 | 0 | – |
| | *Felis catus* | 1(0) | 1 | 0 | – |
| E | *R. fuscipes* | 0 | 1 | 0 | – |
| | *F. catus* | 0 | 1 | 0 | – |
| (b) Tunnels | | | | | |
| 3 | *Canis familiaris* | 0 | 3 | 3 | – |
| | *Vulpes vulpes* | 0 | 1 | 0 | – |
| | *Wallabia bicolor* | 0 | 1 | 0 | – |
| 4 | *C. familiaris* | 0 | 3 | 0 | 1 |
| | *V. vulpes* | 0 | 3 | 1 | 1 |
| 5 | *C. familiaris* | 0 | 1 | 0 | – |
| | *V. vulpes* | 0 | 2 | 1 | – |

N.B. Records of animals using these different detection techniques were independent, i.e., records of trapped *R. fuscipes* did not coincide with records of their footprints in a given tunnel.

Secondly, the approaches to the tunnels should be revegetated with native plant species from the local area to return the rail verge to a natural condition as soon as possible.

Further research is required to provide ways of facilitating use of tunnels such as these by native mammals. The incorporation in a new development of an untested potential solution to a real environmental problem is not adequate in itself. We suggest that such potential solutions to environmental problems must be monitored for some time after construction, as an integral part of the construction project, to determine how well its aims are being achieved.

## *ACKNOWLEDGEMENTS*

We thank the State Rail Authority of New South Wales for support in conducting this study. In particular, Mr P. Treffry and Mr Lane of the SRA provided support which made the study possible. The Metropolitan Water Sewerage and Drainage Board provided permission to work in areas under their control; we thank their rangers for assistance. J. Howard, E. Hunt, J. Hunt, L. Popa and C. Stephenson provided field assistance and D. Ayre, S. Carthew, R. Goldingay and P. Tap and two referees provided valuable comments on the manuscript.

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