Restoring habitat connectivity over the road: vegetation on a fauna land-bridge in south-east Queensland

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Introduction

Roads represent one of the most pervasive and influential sources of habitat fragmentation, isolation and degradation. The ‘road barrier’ effect, a central concept within road ecology, suggests that roads may present a partial or complete barrier to the movement of animals between habitat patches (Forman *et al.* 2003). Different taxa respond variously to roads with some groups avoiding the road entirely (Eigenbrod *et al.* 2009). To counter the isolating influences of roads, a variety of structures have been developed to facilitate the safe passage of animals, the largest being land-bridges or fauna overpasses. Europe now has over 200 established in 13 countries (Corlatti *et al.* 2009). The form of vegetation used on these structures varies greatly, though most tend to have only minimal habitat.

In Australia, four fauna overpasses have now been established, primarily in northern New South Wales and south-east Queensland. The overpass spanning Compton Road in southern Brisbane is by far the best studied in Australia (Veage & Jones 2007, Bond & Jones 2008). This structure, constructed in 2004-5 as part of an upgrade of a major arterial road, aimed to provide safe passage for animals moving between two large conservation reserves.

Fauna overpasses such as that at Compton Road have traditionally been designed to act as animal movement corridors for larger mammals (in this case, for the passage of three local macropods) by providing a physical link between forested areas either side of the road barrier. As such, the surface of most overpasses typically have little structural vegetation so as not to impede animal movement. Recently, however, interest in the potential use of these structures by a much broader set of taxa including small mammals, birds and reptiles and amphibians has resulted in suggestions that habitat ‘continuity’ be regarded as a crucial element of the design (Bissonette & Adair 2008). The Compton Road overpass represents an

Australian example of this approach with the plantings used on the structure intentionally being designed to match the forest on either side of the road (Brisbane City Council 2004).

The aim of this paper is to describe the vegetation that now exists on the Compton Road overpass after four years of growth, given that the vegetation has now been shown to be providing habitat for numerous birds, reptiles and amphibians (Veage & Jones 2007, Jones & Bond 2010). We compared plant abundance and species richness established on the structure with that in the adjacent forest. We also compared the plant species actually planted with those currently present to assess levels of survival as well as levels of native plant recruitment and invasions of weeds.

Method

Study area

Compton Road is a major east-west arterial road located in the southern suburbs of Brisbane, Queensland, separating two significant areas of bushland: Karawatha Forest (950 ha), and Kuraby Bushland (150 ha) to the north. The vegetation is mainly dry eucalypt forest and woodland with heath understoreys and contains 324 plant species and a wide range of native vertebrates (Veage & Jones 2007).

The overpass and initial vegetation establishment

The Compton Road overpass is hourglass-shaped, 15 m wide at the waist of the flat top and expanding to a base width of 20 m. The overall length is 70 m. The slope of batters on either side is 1:3 but is steeper on the slopes leading toward the road. The surface of the overpass is 8 m above the road and both tunnels have a clearance of 5.4 m.

A layer of 30 cm to 1.8 m of topsoil was placed on the soil fill, along with a full covering of hydromulch containing seed of sterile exotic grasses. The topsoil was carefully collected from the forest cleared for the road construction, and applied after four months storage. The landscaping contractors were provided with generalised instructions as to the aims of the revegetation, the intent being to “provide a well vegetated, low-maintenance habitat, in keeping with the character of the surrounding area” (Brisbane City Council 2004: 34). Native vegetation was to be planted at a density of 70 shrubs and 6 trees per 100 m², although 30% of the total surface area was to be left open to facilitate the movement of larger mammals such as macropods.

Most of the planting was undertaken between February and May 2005 (Figure 2). To facilitate the survival of the plantings, a trickle-irrigation network was established over the surface of the overpass. Discounting vandalism, informal surveys of the survival of plants indicate less than 4% mortality of all plantings to date (D. Jones unpublished data).

Vegetation surveys after four years

To assess the structure and diversity of the vegetation now established on the overpass, all plants present in five 15 x 5 m quadrats were counted and identified using Ryan (2003). Using the species lists provided to the contractors and vegetation information from the site, we ascertained the likely origins of each species as either intentionally planted or as self-sown. In addition, we classed each species as either local native, non-local native, or introduced to Australia.

To compare the habitat of the overpass with that of the nearby bushland, a total of 20 randomly located 15 x 5 m quadrats were surveyed on both sides of the road. On each side, five quadrats were situated randomly within 20 m of the base of the overpass ('edge' sites) and a further five transects at least 70 m from the base of the overpass ('interior' sites).

To compare the habitat present on the overpass within forests on either side we employed Sørensen's Index to assess species richness data. An index was obtained of the level of similarity based on the number of species common to both sites, with a range from 0 (no similarity) to 1.0 (exact similarity).

Results

A total of 45 species of plants were detected growing on the overpass (Table 1). Of these, it appears that 26 (57.8%) were intentionally planted with most of the remaining species almost certainly germinating from seed within the topsoil (Table 1). Specimens of two species may have been planted as well as recruiting naturally. Of these non-planted species, 22 species include 11 shrubs and trees almost all of which exist locally. Only eight species, all of which were either grasses, small weeds or climbers, were introduced species; no species of shrub or tree present on the overpass was exotic and only one – *Leptospermum luehmanii* – did not occur naturally within the local area.

Sørensen's Index of similarity indicated that the ground layer vegetation on the land-bridge was only moderately similar to the forest sites with a range of 0.24 to 0.55 compared to 0.60 to 0.94 for within-forest comparisons. The indices for the shrub and creepers were similarly low (0.25-0.36) compared to the within-forest sites (0.57-0.78). In contrast, the similarity analyses for tree species indicated remarkably high indices, with overpass and forest indices (0.54-0.67) being directly comparable to within-forest sites (0.50-0.82). In other words, the range of the similarity measures for trees was very similar for almost all sites, overpass and forest.

When the density of those species that were originally on the planting list compared with their current densities established, the rates of survival appear to have been extremely high, with a survival rate of around 95%. Weed density was observed to be minimal and

limited to a few well dispersed clumps. The resulting habitat, four years later, now appears similar to a typical coastal eucalypt forest secondary succession.

Discussion

The list of 45 plant species growing on the land-bridge indicates that the range of plants used was relatively extensive and composed almost entirely of locally occurring species. Interestingly, almost half of the species detected were not planted and so appear to have germinated on-site from the topsoil, although some may have been naturally dispersed. This shows that, by careful sourcing mainly local species and using local topsoil, the construction of habitat has resulted in a developing version of the nearby bushland - at least in terms of the tree species used. Should levels of weed infestation remain moderate, it is possible that the similarity of the shrub layer to the surrounding forest may increase with time, resulting either from some germination from the soil or from natural colonisation.

The relevance of understanding the structural development of the planted vegetation on the land-bridge is most pertinent with regard to the recent discovery of significant numbers of birds moving through the vegetation (Jones & Bond 2010). This appeared to be directly related to the provision of a dense mid-layer of small trees and shrubs allowing even the edge-avoiding species to cross the road. In the majority of fauna overpasses in North America and Europe, the main aim has explicitly been the facilitation of movements over roads of larger mammals, principally for human safety reasons (Corlatti *et al.* 2009). For most such species, the optimal design of the passageway has been a relatively open structure with a minimum of structural impediments such as trees and, particularly shrubs. Yet, especially in Europe (e.g. Holzgang *et al.* 2001) the appropriateness of a sole focus on large animal passage is being reassessed and habitat corridors are more recently also being considered as a means of reducing or removing the major influence of the road barrier effect for other faunal groups (Corlatti *et al.* 2009).

As most of the plants comprising the constructed vegetation are only a few years of age and the structure of the vegetation is continue to change; on-going investigation of these changes and the changing responses of the birds and other taxa will be an important contribution to understanding the functionality of such crossing structures. The presence of significant numbers of such species appears to be closely associated with the apparent continuity of the habitat present on the overpass, itself the result of careful selection of local plant species along with the use of locally native local top soil and adequate establishment watering regimes.

References

- Bissonette J. A. and Adair W. (2008) Restoring habitat permeability to roaded landscapes with isometrically-scaled wildlife crossings. *Biological Conservation* **141**, 482-488.
- Bond A. R. and Jones D. N. (2008) Temporal trends in use of fauna-friendly underpasses and overpasses. *Wildlife Research* **35**, 103-112.
- Brisbane City Council (2004) *Compton Road: Principals Project Requirements*. Brisbane City Council, Brisbane.
- Corlatti L., Hackländer K. and Frey-Roos F. (2008) Ability of wildlife overpasses to provide connectivity and prevent genetic isolation. *Conservation Biology* **23**, 548-556.
- Eigenbrod F., Hecner S. J. and Fahrig L. (2009) Quantifying the road-effect zone: threshold effects of a motorway on Anuran populations in Ontario, Canada. *Ecology and Society* **14**, 24 (<http://www.ecologyandsociety.org/vol14/iss1/art24/>)
- Forman R. T. T., Sperling D., Bissonette J. A., Clevenger A. P., Cutshall C. D., Dale V. H., Fargione L., France R., Goldman C. R., Heaney K., Jones J. A., Swanson F. J., Turrentine T. and Winter T. C. (2003) *Road Ecology: Science and Solutions*. Island Press, Washington D.C.
- Holzgang O., Pfister H. P., Heynen D., Blant M., Righetti A., Berthoud B., Marchese P., Maddalena M., Müri H., Wendelspiess M., Dandlker G., Mollet P. and Bornhauser-Sieber U. (2001) *Korridore für Wildtiere in der Schweiz*. Schweizerische Vogelwarte Sempach, Bern.
- Jones D. N. and Bond A. R. (2010) Road barrier effect on small birds removed by vegetated overpass in South East Queensland. *Ecological Management and Restoration* **11**, 65-67.
- Ryan, M. (ed). *Wild Plants of Greater Brisbane*. Queensland Museum, Brisbane.
- Veage L-A. and Jones D. N. (2007) *Breaking the Barrier: Assessing the Value of Fauna-friendly Crossing Structures at Compton Road*. Brisbane City Council and Centre for Innovative Conservation Strategies, Griffith University, Brisbane, Qld.

Table 1. Plant species present on the Compton Road overpass, November 2009 and probable origins. *Introduced species, ^Ψnon-local species

Species name	Common name	Planted	Self-sown
Herbs, grasses, ground cover			
* <i>Cirsium vulgare</i>	Scotch Thistle		√
* <i>Crassocephalum crepidioides</i>	Thickheads		√
<i>Cymbopogon refractus</i>	Barbwire Grass	√	√
<i>Cynodon dactylon</i>	Green Couch		√
* <i>Emilia sonchifolia</i>	Emilia		√
<i>Entolasia stricta</i>	Wiry Panic		√
<i>Gahnia aspera</i>	Sword Grass	√	
<i>Lomandra longifolia</i>	Mat Rush	√	
<i>Juncus usitatus</i>	Common Rush	√	
* <i>Panicum maximum</i>	Guinea Grass		√
* <i>Paspalum dilatatum</i>	Paspalum		√
* <i>Setaria verticillata</i>	Whorled Pigeon Grass		√
<i>Themeda triandra</i>	Kangaroo Grass	√	
Climbers			
<i>Hardenbergia violacea</i>	Native Sarsaparilla	√	
* <i>Macropitium atropurpureum</i>	Siratro		√
* <i>Macropitium lathyroides</i>	Phasey Bean		√
Shrubs and small trees			
^Ψ <i>Acacia aulacocarpa</i>	Golden Salwood	√	
<i>Acacia concurrens</i>	Curracabah		√
<i>Acacia disparrima</i> subsp. <i>disparrima</i>	Hickory Wattle		√
<i>Acacia fimbriata</i>	Brisbane Golden Wattle	√	√
<i>Allocasuarina torulosa</i>	Forest She-oak	√	
<i>Alphitonia excelsa</i>	Red Ash	√	√
<i>Bursaria spinosa</i>	Prickly Pine		√
<i>Davesia ulicifolia</i>	Native Gorse		√
<i>Dodonaea triquetra</i>	Hopbush	√	√
^Ψ <i>Hakea actites</i>	Wallum Hakea	√	
<i>Jacksonia scoparia</i>	Dogwood		√
<i>Leptospermum microcarpum</i>	a Wild May	√	
^Ψ <i>Leptospermum petersonii</i>	Lemon-scented Tea-tree		√
<i>Leptospermum polygalifolium</i>	a Wild May		√
^Ψ <i>Leptospermum luehmannii</i>	a Wild May		√
<i>Melaleuca nodosa</i>	Prickly Leaf Paperbark	√	
<i>Melaleuca thymifolia</i>	Thyme Honeymyrtle	√	
<i>Melaleuca quinquenervia</i>	Paperbark Tea-tree	√	
^Ψ <i>Melaleuca viminalis</i>	Weeping Bottlebrush	√	
<i>Petalostigma triloculare</i>	Long-leaf Bitter Bark	√	
<i>Pultenaea villosa</i>	Kerosene Bush		√
Trees			
<i>Corymbia citriodora</i> subsp. <i>variegata</i>	Spotted Gum	√	
<i>Corymbia intermedia</i>	Pink Bloodwood	√	
<i>Eucalyptus microcorys</i>	Tallowwood		√
^Ψ <i>Eucalyptus saligna</i>	Sydney Blue Gum	√	
<i>Eucalyptus seeana</i>	Tumbledown Forest Red Gum	√	
<i>Eucalyptus siderophloia</i>	Grey Ironbark	√	
<i>Eucalyptus tereticornis</i>	Forest Red Gum	√	
<i>Lophostemon confertus</i>	Brush Box		√
<i>Lophostemon suaveolens</i>	Swamp Box		