Eco-Link@BKE: A Safe Corridor for our Biodiversity

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Images as credited

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Commuters rushing through Bukit Timah Expressway (BKE) everyday may not notice the green lungs situated along the way between the Dairy Farm exit and the Pan Island Expressway (PIE) exit. While the BKE has eased traffic congestion for residents in northern Singapore, its construction divided a once continuous patch of rainforest into two, creating ramifications for the wildlife within.

The 11-kilometre BKE cuts through the centre of Singapore, linking the PIE to Woodlands and providing a vehicular passage straight to the north of the island. At the southern end of the expressway, the Bukit Timah Nature Reserve (BTNR) and Central Catchment Nature Reserve (CCNR) flank the road on either side.

The expressway creates a physical barrier for the movement of native wildlife between the BTNR and the CCNR. The most direct and easily-noticed impact of a major road adjacent to the forest is vehicular-wildlife collision. From 1994 to 2014, there were two Sunda Pangolin (*Manis javanica*) deaths per year on the major roads around the nature reserves. This species is classified as critically endangered on the International Union for Conservation of Nature Red List of Threatened Species. Other common roadkill victims are the Common Palm Civet (*Paradoxurus hermaphroditus*), Long-tailed Macaque, and a number of reptiles.

The expressway also affects wildlife by altering the movement patterns of wildlife, and by isolating habitats and populations. Most of the endangered forest species in Singapore are elusive wildlife which avoid human disturbances, such as major roads. The six-lane BKE reduces the chances of interaction between the wildlife across the road, hence, restricting the gene pool of the wildlife populations. Under such conditions, inbreeding depression, the reduced biological fitness in a population as a result of breeding of related individuals, will occur. This could potentially cause local extinction of a species. Even one of the most common wild mammals—the Long-tailed Macaque—was shown to be separated into two sub-populations, which is an early sign of inbreeding depression.

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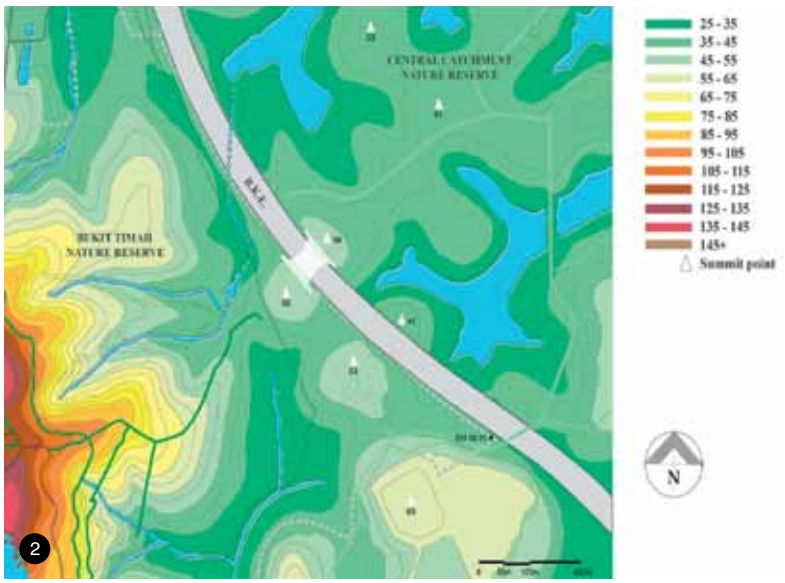
In 2005, an idea of a facility which would enable wildlife to travel between the two nature reserves was proposed during public consultations for the Singapore Green Plan 2012. In the same year, the feasibility of the wildlife road crossing project was conducted. Some of the most important outcomes of the study were the possible locations and the concept design of the link between two reserves. By taking into consideration knowledge of the wildlife in the vicinity and the natural landscape of the potential locations, the decision of a wildlife bridge overpass built over the expressway was made. Compared to other options, such as a wildlife viaduct, the wildlife overpass was cheaper, caused less impact on traffic flow, caused less unmitigated noise, and produced a smaller environmental footprint. The overpass is known as the Eco-Link@BKE today.

The key target species for the Eco-Link@BKE are the terrestrial mammals which mostly have restricted home range, species that have more



roadkill victims, and threatened species, such as the Common Palm Civet, Sunda Pangolin, and Lesser Mousedeer (*Tragulus kanchil*). In addition, disturbance-sensitive forest birds, insectivorous bats, and other invertebrates are also projected to benefit from the wildlife bridge. In order to assess the effectiveness of the Eco-Link@BKE, nature groups, tertiary institutions, and government agencies worked closely with the National Parks Board (NParks) to conduct biodiversity monitoring surveys. The targeted taxonomic groups for the surveys include mammals, birds, and insects (mainly orthopterans, the order of insects which includes grasshoppers and crickets).

Before construction began, monitoring surveys were planned and conducted to collect baseline data for future comparison as well as assessment. Through numerous monitoring surveys, new species were discovered together with the documentation of rare and geographically restricted fauna. Five new species of orthopterans —*Cardiodactylus singapura*, *Tremellia timah*, *Singapuriola separate*, *Micrornebius kopisua*, and *Asiophlugis thaumasia*—were discovered.

From camera traps and nocturnal faunal surveys, we also recorded several rare and geographically restricted mammals, such as the Lesser Mousedeer and Sunda Pangolin. Forest birds, such as babblers, barbets, and bulbuls, were observed in the vicinity of the Eco-Link@BKE. These species are vulnerable to local extinction and would rarely traverse the expressway in the absence of an ecological corridor.

1. North-south aligned Bukit Timah Expressway (BKE) cut through the BTNR and CCNR, seen on the left and right sides of the road respectively (Photo: National Parks Board and Land Transport Authority).
2. Location of the Eco-Link@BKE on two oppposing natural hills by the BKE (Image: Stephen Caffyn Landscape Design & Eng Lee Pte Ltd).
3. Artist's impression of the Eco-Link@BKE (Image: Stephen Caffyn Landscape Design & Eng Lee Pte Ltd).
4. The Short-tailed Babbler (*Malacocincla malaccensis*), a species found in the vicinity of the Eco-Link@BKE, is one of the truly forest-dependent species. It is known to only disperse through contiguous forest patches (Photo: Chung Yi Fei).
5. One of the common roadkill victims, the Common Palm Civet, is a key target species in the assessment of the effectiveness of the Eco-Link@BKE project (Photo: Chung Yi Fei).

6. Traffic flow along the BKE continued as usual throughout the construction phase. The inconvenience for the commuters along BKE was minimised (Photo: National Parks Board and Land Transport Authority).
7 – 12. Aerial photographs show the progression of construction of Eco-Link@BKE. The photographs were taken in March 2011, April 2013, August 2013, November 2013, June 2014, and October 2015 respectively. (Photos: National Parks Board, Land Transport Authority, and NParks Drone Team).
13. Series of continuous photographs taken by camera traps, showing the Sunda Pangolin moving across and utilising the landscape on Eco-Link@BKE (Photo: National Parks Board).
14. Former Minister of State for National Development, Mr Desmond Lee and National Parks Board Conservation Director, Mr Wong Tuan Wah, planted the Singapore Kopsia (*Kopsia singaporensis*) and Seashore Mangosteen (*Garcinia hombroniana*) during the greening event (Photo: National Parks Board).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Shaped like an hourglass, the Eco-Link@BKE is the first overhead ecological corridor in Southeast Asia. Extra effort was made to ensure undisrupted traffic flow along the expressway, while keeping the environmental footprint of the construction to a minimum.

On 5 October 2013, some 100 representatives from various agencies and organisations planted 50 native trees on Eco-Link@BKE to kick start the greening of the overpass. The guest-of-honour at the event, former Minister of State for National Development, Mr Desmond Lee, said: "I think this represents, at the symbolic level, a commitment by Singapore and Singaporeans to preserve what is precious about our biodiversity, because of itself and because of the importance of nature."

Subsequently, more than 3,000 native plants were used to lay the foundations of the connection between the two nature reserves. The bridge boasts a soil depth of 2 metres, which consists of 10 layers of different materials. The top soil and the loamy soil are the major components of the backfilling materials. Before the establishment of the greenery, the weather condition on the bridge was very harsh with high sunlight intensity, high wind speed, low humidity, and high ambient temperature. Native plants, which could tolerate the extreme conditions on the bridge, yet provide minimal food source and shelter, were selected as the pioneer. Some of the species which have been successfully established on the bridge are Elephant Apple (*Dillenia indica*), Petai (*Parkia speciosa*), Sandy-leafed Fig (*Ficus heteropleura*), Singapore Rhododendron (*Melastoma malabathricum*), Campanula Orchid (*Dianella ensifolia*), and Cane Reed (*Cheilocostus speciosus*). More shrubs were planted at the edge to create a barrier between the interior and the disturbances, and most of the trees were planted in the middle to form the backbone of the landscape.


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With the completion of the Eco-Link@BKE, monitoring surveys resumed, both on the bridge and the adjacent forest. Preliminary camera trapping results showed occurrences of Sunda Pangolins and Common Palm Civets on the bridge. The first detection of the pangolin and palm civet by camera traps on the bridge of in April 2014, just as most of the tree planting had completed. Subsequently, observations of the two species were relatively low yet consistent.

The Emerald Dove (*Chalcophaps indica*), a common bird species usually found foraging on the forest floor, was caught in the mist net survey on the bridge. These preliminary results suggest that some wildlife have begun occupancy of the newly created landscape.

As the vegetation on and around the bridge matures, the bridge might be utilised by more shy and elusive species, such as the Banded Leaf Monkey (*Presbytis femoralis*), and Malayan Colugo (*Galeopterus variegatus*). Recently, there were records of the Lesser Mousedeer, used to be found only in CCNR, in BTNR. It was hypothesised that the Lesser Mousedeer crossed the BKE through the Eco-Link@BKE. However, further research is needed to test the hypothesis and the establishment of viable mousedeer populations in BTNR.

With wildlife crossing the expressway from one nature reserve to another, the chances of pollination and dispersion of rare native plants could greatly increase. For example, the Singapore Durian (*Durio singaporensis*) and Singapore Walking Stick Palm (*Rhopaloblaste singaporensis*) are pollinated by bats and insects respectively; the Rusty Oil Fruit (*Elaeocarpus ferrugineus*) is dispersed by animals.

Transforming Eco-Link@BKE into a forested bridge not only demonstrates Singapore's commitment to conserve biodiversity, but also provides motorists with a pleasant driving experience.

Wildlife road crossing structures, such as Eco-Link@BKE, while not able to reverse the effect of forest fragmentation, could become an effective mitigation method for fragmented forests. CG