Using log piles to assess reptile habitat development in Donaghy's Corridor

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Abstract

One criterion for measuring restoration project success is the successful establishment of different microhabitats within the restoration area. An important microhabitat for many species is coarse woody debris (CWD), often one of the last microhabitats to develop naturally. To measure utilisation of restored rainforest habitats by CWD-dependant reptiles, we laid out 24 log piles in a 20 year old restored tropical wildlife corridor, sampling the piles after six and 12 months. Four rainforest-dependant skink species were recorded at multiple sites along with one rainforest-dependant frog and one exotic toad, suggesting restored habitat is suitable for a range of forest-dependent species, in addition to the success of log piles as a CWD analogue.

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Introduction

Isolated habitat patches are increasingly becoming the main habitat for species occurring in arable land, with agricultural land accounting for more than 40% of the Earths land surface (Foley *et al*. 2005). Forest fragmentation has myriad corrosive effects (Haddad *et al*. 2015), including local extinctions (Korfanta *et al*. 2012, Neuwald & Templeton 2013). Retention or creation of habitat corridors between patches can mitigate the effects of fragmentation via two main mechanisms, facilitating the exchange of genetic material between populations to increase their genetic diversity and resilience (Christie & Knowles 2015), and by providing a mechanism for re-colonisation following local extinctions (Jackson *et al*. 2016).

North Queensland's Wet Tropics bioregion supports 161 reptiles and 60 amphibians, representing 26% and 30% of Australia's total complement of these groups (Williams 2006). In a north-east and south-east Queensland study, Kanowski *et al*. (2006) examined the response of reptiles to different styles of reforestation ranging from plantation forestry to ecological restoration, comparing these to intact reference forest and areas of natural regeneration. Their study, which included the site detailed in this study, found colonisation was strongly influenced by habitat structure (essentially a temporal influence), and proximity to source populations. Rainforest specialists, e.g., Prickly Forest-skink (*Gnypetoscincus queenslandiae*), Tiger Skink (*Concinnia tigrina*), were found only in reference forest or old (>50 years) plantations abutting reference forest, where specific habitat features (e.g., coarse woody debris [CWD], strangler figs) were present. Whilst present in reference forest, other Scincidae e.g., *Saproscincus* spp. were also found in ecologically restored habitats where more complex structure and higher levels of canopy and litter cover were present.

In ecologically restored areas, an adequate supply of sufficiently large CWD is dependent on the time taken for mortality of planted stems. This can be overcome by placement of larger CWD as ecological furniture at planting (Grove & Tucker 2000, Kanowski et al. 2006), and the use of short-lived pioneer plants to mimic natural disturbance (Tucker & Simmons 2009). Indeed, throughout the corridor, mortality of planted pioneer species has resulted in many fallen logs and CWD >100 mm diameter. However, small size, limited mobility and reliance on CWD suggest rainforest-dependent reptiles and amphibians may be slower to colonise restored habitats when compared to responses by local birds (Freeman *et al*. 2015) and mammals (Paetkau *et al*. 2009).

Donaghy's Corridor (-17.257285, 145.652202) is a 1.2 km restored habitat corridor between the Lake Barrine section of Crater Lakes National Park (498 ha), and the adjacent Wooroonooran National Park (80,000 ha). The corridor follows the course of the perennial Toohey Creek (Tucker & Simmons 2009). Planting was completed over four years (1995–1998) using 16,800 seedlings of 100 species. Small mammal colonisation and movement were intensively surveyed for the first three years post-establishment (1998–2000) throughout the corridor and in the intact forests at either end of the corridor (Paetkau *et al*. 2009). In addition to cage and box traps, these surveys also used pitfall traps; (440 trap nights) which provide some base-line data on reptile and amphibian species present in 2000. Three widespread generalist amphibians, the Northern Stony Creek Frog (*Litoria jungguy* – reported as *L. lesueurii* – 1 individual), Red Tree Frog (*L. rubella* – 2 individuals), and Striped Marsh Frog (*Limnodynastes peronii* – 1 individual), were recorded in planted areas; two reptiles, the endemic Red-throated Skink (*Carlia rubrigularis*) and the widespread Eastern Water Dragon (*Intellagama lesueurii*) were also recorded in planted areas. Two rainforest-dependent skinks, the Pale-lipped Shade Skink (*Saproscincus basiliscus*) and Four-fingered Shade Skink (*S. tetradactylus*) were recorded in the 1.75 ha patches of disturbed regrowth adjacent to the 1995 planting (refer Fig. 1) but not in planted areas (Tucker & Simmons 2009).

Our study aimed to determine which species of log-dwelling reptiles had colonised the corridor over a 20-year period. We avoided disturbing existing CWD and instead used constructed log piles of consistent dimensions to provide habitat suitable to reptiles,

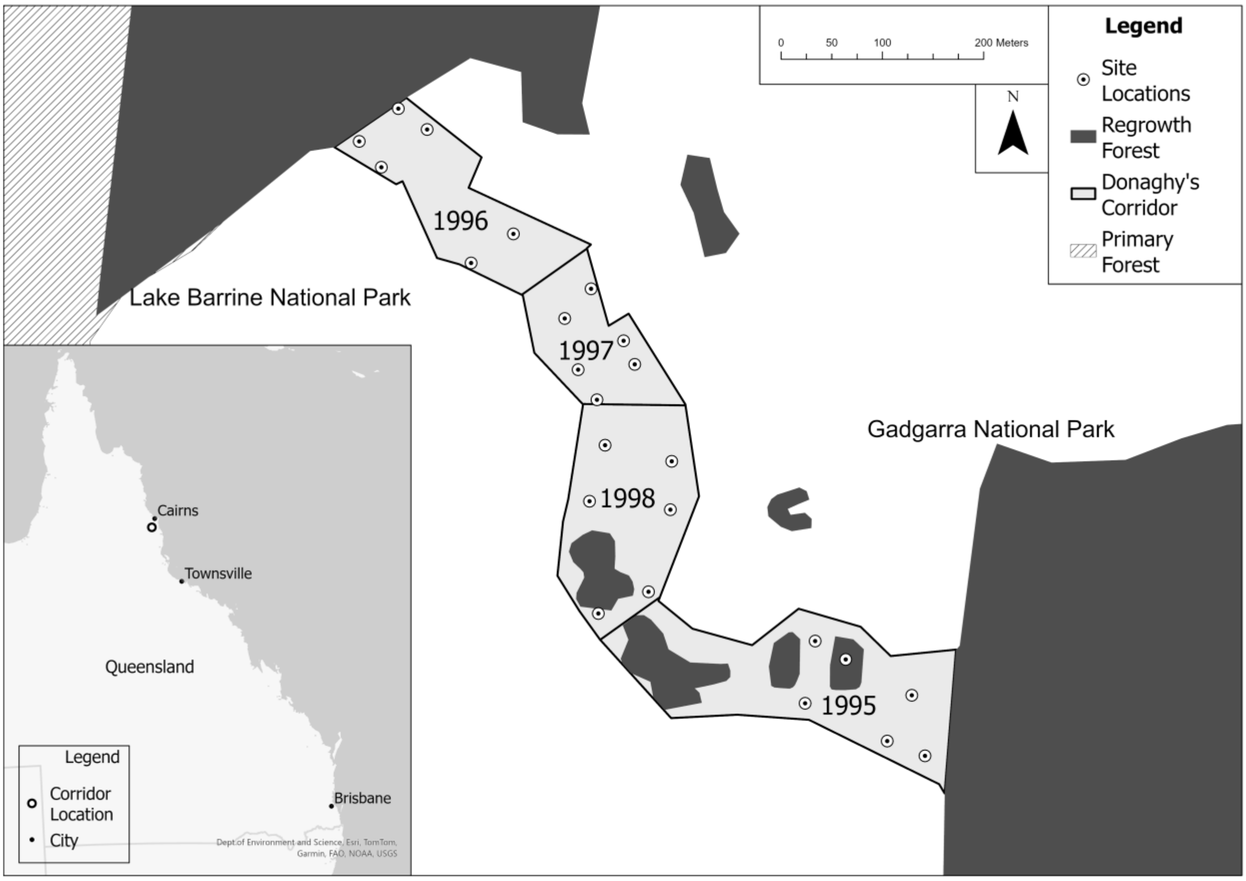

Figure 1. Log pile locations at Donaghy's Corridor.

in an arrangement which could be easily sampled. Log piles constructed of old fence posts were selected as they provide a more reliable, longer-lived analogue for CWD (Freeman *et al*. 2021).

Methods

In December 2021, 24 log piles were laid out within the corridor (refer Figure 1). Each pile consisted of 6–8 old timber fence posts, 1–1.5 m in length, and 15–25 cm in diameter arranged in a pyramid. Piles were placed 20 m inside the fenced outer edge of the planted corridor, with six piles in each yearly planting.

Log piles were surveyed in early July 2022 and December 2022. Each pile was visually searched prior to disturbance and carefully dismantled to ensure a low risk of injury and a high chance of capture/identification. Both species of shade skink (*Saproscincus* spp.) were captured by hand to confirm identification. Remaining species were sufficiently distinctive to allow visual identification and no handling was required. Gloves were worn at all times when handling fauna. After each pile was surveyed, logs were replaced in the pre-disturbance configuration and captured individuals released at the point of capture. Numbers of captures in each of six sites in each planting year were summed.

This sampling method provides a standardised measure of species utilising the corridor as opposed to sampling existing CWD that is not uniformly sized or distributed, potentially resulting in biased distribution and results. Sampling is however biased towards skinks reliant on dead wood; the response of litter and many arboreal skink species remains unknown.

Results

Five reptile species from two families (Scincidae, Agamidae) were recorded in log piles, in addition to two amphibians, the feral Cane Toad (*Rhinella marina*: Bufonidae) and the Australian Lace-lid Frog (*Litoria dayi*: Hylidae). Apart from the widespread Eastern Water Dragon and the Cane Toad, all detected species are north Queensland endemics, and rainforest or rainforest-ecotone dependent (Williams 2006). Prickly Forest Skinks and Pale-lipped Shade Skinks were the most common, each occupying 14 of 24 log piles, with up to four individuals of either species present in five log piles. Cane Toads were present in six log piles, co-habiting with the three skinks in four of those piles. The Australian Lace-lid (1 site) and Tiger Skink (2 sites) were the least common species (refer Table 1).

Some seasonal variation was observed. Eastern Water Dragons were only recorded in December and all four animals were juveniles (<150 mm total length). Other species displayed similar variation; Cane Toads and Australian Lace-lids were only recorded in July, as were 90% of Pale-lipped Shade Skinks and Four-fingered Shade Skinks. Tiger Skinks were recorded only in December along with 13 of the 19 Prickly Forest Skinks. In July, only four piles were unoccupied and 40 animals were recorded, but in December vacancy rates increased to 10 piles with 23 records.

Discussion

Our study demonstrates that log pile structures within the corridor have been colonised by a range of species for which the restored forest provides suitable habitat. Although not able to be quantitatively proven, colonisation of artificial log-piles by four rainforest-dependent reptile species

Table 1. Reptiles and amphibians recorded in each yearly planting at Donaghy's Corridor in 2022.

Species	1995	1996	1997	1998	# piles occupied
Concinnia tigrina	0	1	1	0	2
Gnypetoscincus queenslandiae	6	3	8	2	14
Intellagama lesueurii	2	1	1	0	4
Litoria dayi	0	0	2	0	1
Rhinella marina	1	1	3	1	6
Saproscincus basiliscus	8	1	8	8	14
Saproscincus tetradactylus	2	0	1	2	5

and the Australian Lace-lid Frog appears to reflect two factors, (i) proximity to intact forest habitat and (ii) the naturally developed structural complexity of the restored habitat. Our results suggest that over this 20 year period, three species typical of mature forest, the Prickly Forest Skink, Tiger Skink and Australian Lace-lid Frog (Vulnerable: EPBC Act, Nature Conservation Act) appear to have moved from adjacent intact habitats into the corridor, and two skink species known to be present prior to planting have radiated throughout the corridor. Colonisation has likely been facilitated by the development of complex cover at both canopy and ground level. In a parallel study of vegetation at the study site in 2021, stem basal area, density of stems <1 cm DBH, along with canopy height and canopy cover was similar to adjacent reference forest (Tng *et al*. 2023). This similarity, along with CWD created by the natural mortality of pioneer species planted to provide dead wood (Grove & Tucker 2000), has provided the structural connectivity to allow colonisation and the progressive development of functional connectivity. Reptiles and amphibians are both predators and the prey of larger animals; their presence is indicative of habitat suitability for a wider range of species.

Tucker and Simmons (2009) recorded three other CWD-dependent reptiles in adjacent reference forest that were not seen in this study. Northern Dwarf-crowned Snake (*Cacophis churchilli*), Grey-tailed Skink (*Glaphyromorphus fuscicaudis*) and a blind snake (Typhlopidae) were not recorded in this study, although the Northern Dwarf-crowned Snake has been observed in incidental fauna surveys. However, the Red-throated Skink, commonly captured in the corridor between 1998 and 2000, and found in mixed, non-rainforest habitats (Kanowski *et al*. 2006), was not recorded in the current study. Moreover, the CWD-dependent reptile community recorded in these logs more closely resembles the group seen in the forest reference and old plantation sites of Kanowski *et al.* (2006), which were all comprised of species typically associated with intact forest habitats.

These CWD-dependent species were not recorded within any pitfall traps sampled between 1998 and 2000, including traps placed within the regrowth patches. It therefore seems likely that at least two reptiles recorded within the corridor have migrated from rainforests outside the planted area. Given that the two populations of forest and CWD-dependent reptiles were separated by 900 m of pasture for *c.* 50 years, their re-connection within 20 years suggests they will readily colonise planted areas where primary forest source populations remain in close proximity and continuous cover is in place. Such movement and colonisation have been facilitated by the increasing complexity of restored vegetation over time. Proximity to primary forest and the age of restoration are clearly the main factors influencing colonisation.

One site with unique physical characteristics limits wider reliable conclusions regarding wildlife corridor efficiency or wider conservation benefit. Despite this limitation, this study has positive lessons in terms of demonstrating the value of (i) base-line data to determine changes over time, (ii) proximal populations of target animals to provide a colonising source and (iii) using log piles as a means to sample reptile populations in restored areas. To enhance habitat value, landholders and restoration practitioners should aim to (i) preserve any proximal native vegetation, (ii) retain any pre-existing CWD in restoration sites, and (iii) plan the strategic placement of CWD prior to site planting.

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