Informal trails fragmenting endangered remnant vegetation in Australia

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Natural areas attract a range of recreational users across a broad spectrum of land uses including rural and urban settings. Recreational impacts are often controlled by restricting access through the use of zonation schemes, designated access routes, and hardened sites (Newsome et al. 2002). Despite this, these areas continue to be impacted by informal trails. Informal trails created by hikers and other visitors within natural environments can degrade high conservation value rare plant communities (Newsome and Davies, 2009; Pickering et al. 2010). Direct impacts of trails include reduced vegetation cover, compacted soils and soil erosion. There are also numerous edge effects including increased light, the spread of feral animals and weeds and reduced habitat quality for native animals (Liddle, 1997). As a result, networks of informal trails can internally fragment vegetation into smaller and smaller functional patches each exposed to proportionally greater edge effects. We assessed how these trail networks have degraded remnants of an endangered urban forest community within the seventh largest city in Australia, the Gold Coast in Queensland.

Tall open Blackbutt forest is an endangered regional ecosystem with high conservation value that is dominated by the large evergreen hardwood *Eucalyptus pilularis* (EPA 2007). It provide habitat for native animals including threatened species such as the green-thighed frog (*Litoria brevipalmata*), wallum froglet (*Crinia tinnula*), and koala (*Phascolarctos cinereus*), as well as regionally significant populations of the native yellow-footed antechinus (*Antechinus flavipes*), squirrel glider (*Petaurus norfolcensis*) and swamp rat (*Rattus lutreolus*). Within Queensland, the majority of remaining Blackbutt forest occur within the rapidly developing urban area of the Gold Coast. Although it once covered 7757 ha (5.6%) on the Gold Coast, by 2003 there was only 767 ha left (0.6%) due to ongoing clearing, mostly for urban development and agricultural use (EPA 2007). In addition to the direct threat arising from loss through urban development many remnants are easily accessible by locals and are extensively used for a range of recreational activities resulting in the formation of extensive trail networks (Pickering et al. 2010).

We assessed the effects of trail networks on eight Blackbutt remnants on the Gold Coast with a total area of 37 ha. The ArcPad (ESRI, ver 7.0) interface on a Trimble Juno ST handheld GPS unit was used to survey the perimeter of each remnant and all trails within it. Trails were broadly categorized as narrow, single person, two person, three person, or proper roads based on the width and nature of the trail. At 91 evenly spaced points along the trails, transects set at right angles to the trail were used to the measure trail width, width to nearest vegetation (ground cover), width to shrub layer and width to tree trunks. Following field data capture, all trail attributes (i.e. width and distance measures) were linked using the spatial join function in ArcMap. The areas of bare soil, and areas without ground cover, shrubs or trees were calculated by buffering all linear trail features by the mean width of each disturbance type for each trail type. Overlapping buffer areas were dissolved to determine the overall impact area. These data were then used to calculate the reduction in the area of each fragment, the number of subpatches created and the average size of subpatches created due to trails. Similar analyses were then completed to determine the areal reductions within subpatches associated with increasing levels of impact resulting from the loss of ground cover, shrubs and trees on the trail verges.

The eight remnants surveyed averaged 4.6 ha, with the smallest 0.72 ha and the largest 12 ha (Table 1). There were just over 9 km of trails within these remnants, 1.7 km of which was formal tracks and 7.4 km of which was informal trails. These trails resulted in the loss of 2.8 ha of forest overall, and the fragmentation of the 8 remnants into 101 subpatches with an average size of 0.39 ha, the largest of which was only 3.8 ha. When the loss of ground cover associated with the trails and their verges was calculated, a total of 3.8 ha of forest no longer had ground cover, and the average size of subpatches was further reduced to 0.36 ha. When the reduction in shrub cover was assessed, the estimated extent of trail impacts increased to 5 ha, and the average subpatch size was only 0.34 ha. When the area where there were no tree trunks was calculated, the extent of trail impacts increased even further to 6.4 ha. At this resolution the extent of remnant fragmentation is most severe with 109 subpatches averaging 3.5 ha, being recorded. Of these only 15 were >0.5 ha in size. While the full extent of edge effects in urban remnants is yet to be determined, if we assume that trail effects could potentially penetrate up to 5 m from the edge of trails then the cumulative loss in remnant area would be 9 ha. This amounts to the potential functional loss of almost 25% of this endangered community.

These results highlight how recreational trail networks can degrade forest remnants from the interior, particularly when they occur as remnants surrounded by urban development. This degradation is important as there was not only a loss of 17% of the forest directly, and potentially 25% indirectly, but also the proliferation of very small patches within the remnants. Therefore the capacity for these remnants to persist as functional ecosystems is likely to be compromised with only those subpatches that exceed minimum area thresholds being able to maintain recruitment, harbor faunal species and support habitat values. The determination of such threshold values, however, requires further analysis of the life history traits of both the flora and fauna in these habitat remnants. Furthermore, these trail networks also facilitate the influx of additional threat agents, including weeds, feral animals and fires, further exacerbating the po-

Table 1. Effects of fragmentation by formal and informal traits on eight remnants of the endangered Blackbutt forest, Queensland, Australia. Reduction in area and effect on subpatch size and number are assessed based on just the trails surface, and on its effect on ground cover, shrubs and trees as well as the area left unaffected by a 5 m buffer on each side of the trails.

Remnants	Original	Trails	Ground cover	Shrubs	Trees	5m buffer
Area remaining (ha)						
1	3.9	3.8	3.7	3.7	3.6	3.5
2	3.5	3.3	3.2	3.2	3.1	2.8
3	3.6	3.4	3.4	3.3	3.3	3.1
4	4.9	4.7	4.6	4.5	4.3	4.0
5	0.7	0.6	0.5	0.5	0.4	0.3
6	3.3	2.9	2.8	2.7	2.4	2.0
7	5.0	4.3	3.9	3.6	3.4	2.9
8	12.0	11.2	11.0	10.5	10.1	9.3
Total	37.0	34.2	33.2	32.0	30.6	28.0
Number of subpatches						
1		6	8	7	4	2
2		14	12	12	10	7
3		5	5	6	8	4
4		8	8	9	9	5
5		10	8	8	8	0
6		17	17	16	23	19
7		19	20	21	22	19
8		22	22	21	25	23
Total		101	100	100	109	79
Mean area of subpatchs						
1		0.63	0.47	0.53	0.91	1.75
2		0.23	0.27	0.26	0.31	0.40
3		0.68	0.67	0.55	0.41	0.78
4		0.59	0.57	0.50	0.48	0.80
5		0.06	0.07	0.07	0.05	0.03
6		0.17	0.17	0.17	0.11	0.11
7		0.22	0.19	0.17	0.15	0.16
8		0.51	0.50	0.50	0.40	0.40
Average		0.39	0.36	0.34	0.35	0.55

tential for degradation. What this study has clear demonstrated is that fragmentation associated with networks of informal trails for recreational use are an important threat to remnant vegetation.

Environmental Protection Agency [EPA], 2007. *Regional Ecosystem Description Database (REDD)*. Version 5.2. Environmental Protection Agency, Brisbane.

Liddle, M.J. 1997. *Recreation Ecology*. Chapman and Hall, London.

Newsome, D., Davis, C., 2009. A case study in estimating the area of informal trail development and associated impacts caused by mountain bike activity in John Forrest National Park, Western Australia. *Journal of Ecotourism* 8, 237–253.

Newsome, D., Moore, S.A., and Dowling, R.K. 2002. *Natural Area Tourism: Ecology, Impacts and Management*. Channel View Publications, Sydney.

Pickering, C.M., Castley, J.G., Newsome, D. and Hill, W. (2010). Environmental, safety and management issues of unauthorised trail technical features for mountain bicycling. *Landscape and Urban Planning* 97, 58–67.