Ecological Success of Post-mining Rehabilitation

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The field of ecosystem restoration is currently in its infancy, something like the state of medical practice in the eighteenth century – attempts are being made which vary in their success, but whose outcomes have not been subject to the kind of scientific scrutiny that is needed in order to be even moderately confident of a successful outcome. Furthermore, even in the most promising of situations, there is an extremely high risk that restoration will fail to produce the hoped-for outcomes within the expected time frame (i.e. within a decade or two). Over longer periods, we simply don't know as the work has not been done.

For example, early revegetation of sand-mined areas in eastern Australia involved the widespread planting of Bitou Bush, which then became a significant weed species invading natural areas along much of the east coast. Thankfully, post-mining practices have improved during the past three decades (for example, they focus on establishing locally native rather than introduced plant species), but they would still fall a long way short of being able to replace the ecosystems that were present before mining.

Restoring an ecosystem requires the reinstatement of the full complement of pre-impact biodiversity. This encompasses both species diversity (including species of plants, worms, insects, birds, mammals, etc.) and the ecological processes which enable these species to persist in the longer term while maintaining resilience to natural disturbances (such as fire, storms and climate variation). Such processes include dispersal, nutrient cycling, pollination, food-chain maintenance and many others.

A scientific review of past attempts at restoring biodiversity and ecosystems (Hilderbrand *et al*. 2005) concluded that there is a very high risk that restoration projects will fail to achieve their objectives.

Common reasons for this include the following:

1. **The 'field of dreams' fallacy.** For example, it is incorrect to assume that initial success in growing a limited number of plant species will eventually result in colonisation of the area by most of the other desired species (the plants, animals and microbes of the original ecosystem). Many species lack the movement and dispersal capabilities to move to these areas in sufficient numbers for restoration of their populations.

2. **The 'carbon copy' myth.** For example, it is not possible to copy an original ecosystem in situations where the physical properties of an area have changes (e.g. where soil nutrients or hydrological processes have been altered, as is the case in sand mining).

3. **The 'fast forward' myth.** For example, natural forest ecosystems take centuries to redevelop after large-scale disturbance, and there is no proof that restoration actions will be able to significantly accelerate this.

My own research into the use of replanted rainforest sites by birds, reptiles and insects has shown that, while ecological development looks encouraging in the first decade (with apparently 50% recovery after 10 years), there is substantial risk that many sites may never regain the other 50% of biodiversity, and at best it will require many further decades (see Catterall *et al.* 2008).

In the case of post-mining restoration of natural ecosystems to sand deposits of coastal Southeast Queensland, the failure risk is far higher, due to the unusual soil nutrient requirements of many plant species and the relatively poor ecological understanding of the fauna and flora. If the restored ecosystem only partially resembles the original, there is a further risk that it may lack resilience to fire, storms and climate change.

Rehabilitated ecosystems are much less resilient to disturbance events such as fire (PD)

In mainland regions, where large areas of land are currently degraded as a result of previous land uses, there are various useful attempts currently underway at restoration, and these are likely to produce a net ecological benefit in spite of their uncertainty of full success. However, in areas which currently support important natural or near-natural vegetation, the most likely outcome from removing the vegetation and soil structure, and then attempting to restore them, is a large net loss of ecological value, because this restoration will fall short of the previous natural community.

With respect to North Stradbroke Island in particular, there is currently a spatial mix of substantial areas of intact native habitat with other areas that were previously sand-mined and partially restored. This mix retains the potential to sustain the Island's biodiversity in the longer term: the large intact areas can provide a source of species to progressively recolonise partly-restored areas. However, if the total area of intact vegetation is reduced, together with further mining of other areas, there is a considerably greater risk that the Island's ecological values will be irreversibly degraded over time.

Catterall CP et al. 2008. Biodiversity and new forests: Interacting processes, prospects and pitfalls of rainforest regeneration. Pp 510-525 in: Stork N and Turton S (eds.) *Living in a Dynamic Tropical Forest landscape*. Wiley-Blackwell, Oxford.

Hilderbrand RH et al. 2003. The myths of restoration ecology. *Ecology and Society* 10: 19.