Letting nature take its course

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Our exploitation of the earth's resources inevitably comes at a cost to the environment in which those resources are situated or processed. When the scale of operations was small the disturbance to the environment was not a major concern. The industrial revolution brought a change in scale and geographical extent of disturbance as industrial conurbations were developed, and the raw materials to feed industrial demand came from the around the world. Some limited measures to control air and water pollution were introduced in the late nineteenth century but for the most part widespread environmental damage was accepted as the inevitable price of progress. This view prevailed until the 1960s when restoration of derelict sites became a major priority.

The first steps in the remediation of these brown field sites was to make them safe and to remove or contain contaminants. Urban sites were often redeveloped for housing or cleaner industries, sporting facilities (a common objective for former waste fill sites, both internationally and in Australia), or open space parklands; for rural sites conversion to productive agricultural lands was frequent. Only rarely were outcomes favourable to nature conservation the primary, or even secondary, objective.

In the west much of the historic legacy has now been addressed, but that is still far from the case in parts of eastern Europe and the former USSR, and in the developing world.

While new factories have to satisfy increasingly strict pollution controls from the outset, resource extraction continues apace, with modern mines being developed to a scale previously unimaginable. However, in most of the world rehabilitation of mine sites is no longer something which might be thought about at the end of a mine's life, but is a matter to be addressed during the approval process, and both the objectives of restoration and aspects of the processes to achieve these objectives may be specified by the permission granting authorities.

Increasingly the objectives include re-establishment of 'natural' vegetation cover and conservation of biodiversity which is required for one or both of two reasons – increasing the natural value of the sites and reinstating ecosystem functions and services, which could include productivity, protection of hydrological regimes or protection of the land surface against erosion (see Hobbs and Norton 1996). While maintenance of ecosystem functions and services is one of the prime justifications for biodiversity conservation, it is difficult with present knowledge to set quantitative targets for restoration projects. Goals will frequently be aspirational rather than closely defined, but increasing natural values may relate to components of biodiversity (such as individual rare species) which can be addressed through specified conditions.

Where the site to be restored contains extensive areas of bare substrate, as is the case with quarries and open cut mines, or some of the extensive coastal wetland rehabilitation projects in the northern hemisphere, there has been a dichotomy of approach between the use of technical measures (which involve planting) and reliance on spontaneous succession, (Prach and Hobbs 2008), although the division is not absolute, but rather there is a continuum.

Taking a historical perspective it is clear that 'natural' successional processes have lead to the creation of sites which are now regarded as being of high, and in some cases, exceptional, conservation value. For example the Broadland region of East Anglia in the UK developed by the recolonisation of Medieval peat mines (George 1992), and across Europe there are numerous flooded gravel pits, many of which provide venues for a range of aquatic recreational pursuits, which also support species and communities of conservation interest (Řehounková and Prach 2008).

However, over the last few decades technical restoration has been the predominant approach. There may be several reasons for this, but a major one is that consent and regulatory authorities like certainty, and specifying an end point to restoration to be achieved by planting and other measures is, if successful, a way of satisfying this need. Additionally technical restoration provides employment for consultants, nurseries and field staff.

Nevertheless, there is increasing evidence that in some circumstances spontaneous succession may be successful in achieving restoration goals and has the advantage of being low cost (Prach and Hobbs 2008). Tropek *et al.* (2010) have recently shown that in limestone quarries in the Czech Republic sites subject to technical restoration did not differ in species richness from those that had undergone spontaneous succession, but that the latter sites had more rare species, both plants and arthropods. The study is notable not only for its finding but also because it included assessment of habitat value for arthropods – while objectives often include provision of habitat for fauna, success is rarely measured.

Allowing regeneration to occur by spontaneous succession does not rule out the need for intervention. Some weeds, particularly woody weeds, and feral animals may need to be controlled (Řehounková and Prach 2008). Grazing regimes may be managed, and particularly in the Australian context, fire management may be necessary.

Relying on spontaneous succession will not be appropriate in all circumstances. Some sites may require extensive remediation before any growth is possible, for example, landfill sites (Gray 2010). The likelihood of desirable propagules dispersing to, and establishing in, sites will be influenced by the size of the site, the nature of the matrix in which the site is set (i.e., surrounded by natural/seminatural vegetation or in an agricultural or urban context). In other cases the biodiversity benefit objectives may be so specific that considerable intervention is required.

In Australia the area of mine and quarry sites available for restoration at the end of its working life will be considerable. Spontaneous succession may often be an appropriate approach to regeneration, but it will be important that all sites, whether subject to technical restoration or spontaneous succession, be appropriately monitored, and that the objectives and desired end points be defined so that the success of different approaches can be determined. Clear setting of objectives and implementation of monitoring has frequently not occurred, or monitoring has been poorly planned and executed. To have any value it is also necessary for the findings of monitoring to be fed back into the management regime. Ideally adaptive management should be practised, although consent authorities and proponents are reluctant to engage the concept because of fears of uncertainty and potentially open-ended financial commitments.

The public who make submissions to consent authorities may also be reluctant to embrace spontaneous succession because of uncertainty about success, and because it is perceived as being a lesser cost to developers.

Technical restoration will continue to have a large possibly major role in restoration but there needs to be greater recognition of the potential role of spontaneous succession, and increased public reporting of the outcomes of both technical restoration and spontaneous succession so that better informed decisions can be made. We can draw on the long history of ecological investigation into natural succession, but academic ecology should also seize the opportunity that restoration sites afford to carry out both observational and manipulative studies at spatial and temporal scales which are increasingly difficult to conduct in the wild (Young *et al.* 2005).

References

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