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Establishing native vegetation on the Mount Owen Mine Model Site

Biorich plantations: integrated commercial and environmental treescapes

Better bush for your buck: targeting restoration efforts and exploring restoration methods in the lower Hunter Valley, NSW

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SPECIAL THEME: LANDSCAPE RESTORATION

achieved with use of small planting hole with compost, slow release fertilisers and water crystals and has been adopted as the model for the majority of the former sites rehabilitation project. This site was completed in 2008 and currently has trees well over 12 metres in height and has essentially been integrated into the montane ecosystem of KNP.

Conclusion

To date the team have rehabilitated in excess of 150 sites in KNP with an altitudinal range between 600 m to 2000 m. Over 700,000 tubestock have been planted with an average of 90% survival and work is currently underway to create habitat for the Southern Corroborree Frog, Spotted Tree Frog and Mountain Pygmy Possum within some of the recently rehabilitated sites. In addition to the planting program, woody weed management in the higher reaches of Australia's largest catchment has been carried out with the intent of eradication or at least control of willows (*Salix* spp.), blackberries (*Rubus* sp.) and Scotch Broom (*Cytisus scoparius*).

The techniques developed in the rehabilitation of the Former Snowy Scheme Sites project potentially have application to multiple landscapes that are in need of ecological repair. The project was recently acknowledged for its contribution to land restoration by the Institute of Engineers Australia and was awarded the National Environmental Engineering Excellence prize in 2011.

Restoring patches: landscape restoration in practice

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Positive thresholds

Current discussions on ecological thresholds often focus on examples of biological systems at risk of collapse. Ongoing decline and degradation of natural systems is the trend. However as we seek to restore our environments through the process of 'landscape restoration' we are required to shift our minds away from the negatives of degradation, toward more progressive paradigms which focus on the return of self-sustaining ecosystems.

Fire triggered serotinous burn piles in flame within contour graded seams. Photo: Justin Jonson

While we cannot know for certain at what point such positive ecological thresholds will be crossed, we can have confidence that natural systems will respond with their characteristic self organisational properties when seeded appropriately. In practice, the restoration of landscapes is supported by the cumulative gains achieved through many on-ground projects. However the capacity of each individual site to contribute to the whole is dependent on the quality of works undertaken. In this way, there is a strong dependence on the initial conditions we set through our restoration treatments. Sites which re-establish plant populations that can directly contribute to ecological function at the patch scale, are central to achieving broader successes at the landscape scale.

Ecological restoration

Landscapes are diverse in abiotic conditions. As one moves spatially across a landscape there are many differences in soil types and landscape positions, and this is reflected in the plant communities within them. Tens of thousands of years of selective pressure have resulted in the mosaic of different vegetation associations and plant species distributions that we see today. This is nature's model, which demonstrates the physical conditions that best enable plant species presence and persistence. It is also a primary argument for why ecological restoration is the best approached to follow when replanting a given area of land (SER, 2004).

Function and resilience

When discussing goals for landscape restoration, terms like ecological function and ecological resilience are used to provide conceptual benchmarks for success. However little information is available to define what specifically this terminology means in practice. This becomes increasingly difficult as delivery organisations are faced with the challenge of applying conservation theory to their on-ground works (Fazey and McQuie, 2005). To bridge this gap between theory and practice, basic techniques of ecological restoration can be applied. The process begins with a goal of re-establishing the appropriate suite of plant communities, matched to their preferred soil type and landscape position, where species mixes are diverse and include a mix of different plant height strata. As this approach is continued over time, a greater familiarity develops with the individual characteristics of each species used. Through this process, a myriad of functions are revealed.

Genetically viable populations

Broadly speaking, ecological resilience across the greater landscape is expressed through the diversity of plant communities, the species within them, and their collective capacity to respond to disturbance, be it fire, disease, drought, flood, or clearing. Through restoration, we seek to support metapopulations through the re-establishment of well-placed genetically viable subpopulations. Operationally, this requires rigorous thinking and planning about how to utilize precious available seed resources. This includes considering when to include a certain species in a direct seeding mix applied at the broad-acre scale, when to grow small batches of seedlings, or hand broadcast small quantities of seed to re-establish or support subpopulations. Background information is also required to inform appropriate direct seeding rates for different species, so representative densities are achieved and highly viable species do not dominate the newly forming community. Across any landscape, one can find both common ubiquitous species and uncommon rare species. While common species are often easiest to establish, less common species often provide the unique signature of place, and associated functional diversity.

On ground treatments used in southwest WA

In the biodiversity hotspot of southwest WA, within the Fitz-Stirling operational area of Gondwana Link, efforts have been made to put theory into practice. The following are some of the approaches currently applied:

Go for heterogeneity

Landscapes are composed of different land units and associated ecosystems. The greater the diversity of such land units, the more diversity of ecological niches is expected. In restoration, we seek to cultivate the re-establishment of this natural heterogeneity. We attempt to do this through 'stacking' our treatments.

Broad acre direct seeding using a seven meter wide modified agricultural seeder. Each pass seeds five rows at 1.4m spacing. Photo: Lien Imbrechts

Stacking treatments

To support a high measure of ecological productivity, we aim to implement as many treatments as possible in our on ground restoration works. Using this terminology, a treatment can be considered as:

- Direct seeding of one of several seed mixes, specific to soil type, within a given land unit.
- Hand planting seedlings of ubiquitous species in a wide-spaced planting 'grid'.
- In situ 'cut and burn' approach, where serotinous plant material, species that release seed in response to a fire trigger (eg *Banksia* spp.), are lit on site.
- Transplanting sedges or grasses across the site to encourage new patches through stoloniferous or rhizomatous propagation.
- Planting seedlings of a targeted species in spatially discrete dense patches ('nodes') strategically distributed across site (Jonson, 2010).

Thinking across scales

Restoration at the patch scale contributes to a relatively small area. However, across the greater landscape, the cumulative contribution of these small localities of restoration can build on existing remnants to increase ecological structure, function, and resilience. Equally, yet at the finer spatial scale, each sub-system re-established within a restoration site makes a cumulative contribution to the site's overall ecological productivity. Where soils are shallow and hard, these values may be low, while areas of deeper friable soil types may turn out to be of higher productivity. Noting how this 'sum-of-the-parts make the whole' phenomenon occurs at multiple scales, the importance of each project is highlighted. It also highlights the genuine need for detailed restoration planning supported by hard data collected on-site to guide and inform on-ground works.

Conclusion

Ecological restoration is an information rich field of practice in which attention to detail and strong work ethic contribute significantly to project outcomes. There is no upper limit of effort when restoring at the paddock scale (greater than 100 ha). For each project, many opportunities exist to make incremental gains toward improving the ecological function of the local area. Ongoing review of ecological principals, and ongoing development of innovative approaches to apply them, is best practice restoration.

References

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Buffer zones for aquatic biodiversity conservation

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Buffer zones are used worldwide as an approach to protect and manage sensitive ecological areas (Boyd 2001). The function and viability of terrestrial and aquatic communities can be improved through the application of buffer zones, by minimising external threats and encouraging land-use management in adjacent areas. The application of buffer zones offers a practical, cost-effective approach to significantly enhance conservation efforts for aquatic habitats and biodiversity.

Definitions and descriptions

A buffer zone is an area lying between two or more others that serves to reduce the possibility of damaging interactions between or through them (Ebregt and De Greve 2000). It generally refers to the area of land adjacent to a sensitive or 'protected' core area of natural habitat of either terrestrial vegetation or some form of water body (or both).

Wetland of Murray River in SA. Photo: South Australian Murray-Darling Basin NRM Board

A buffer zone also often constitutes or overlaps with an ecotone – a zone of transition between two different ecosystems such as the terrestrial habitat surrounding wetlands or adjacent to rivers (Winning 1997). Ecotones are often species diverse, providing critical habitat for fauna that are dependent on both ecosystem types. Research demonstrates that large areas of terrestrial habitat surrounding wetlands may be critical for maintaining biodiversity, and that both habitats must be managed as an integral unit to protect biodiversity (e.g. Boyd 2001; Semlitsch and Bodie 2003).

Benefits of buffers

A common method for reducing or eliminating impacts to aquatic resources from adjacent land uses and other pressures is to maintain buffers around the resources. For example, there is now sound evidence that providing riparian buffers of sufficient width protects and improves water quality by intercepting and trapping non-point source pollutants and sediments in surface and shallow subsurface water flow (Wenger 1999; Fischer *et al*. 2000). Table 1 provides an overview of the varied specific benefits of using buffers. Some higher level benefits include:

Maintaining ecological integrity - maintaining the structure, composition, function, and therefore the integrity and viability of aquatic systems, which are often subject to disturbances originating in adjacent or upland areas.

Minimising edge-effects - an edge-effect is an 'artificial' ecotone between the remnant natural ecosystem and the adjacent, often anthropogenically changed ecosystem