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Design principles and silviculture at the ImLal biorich plantation demonstration site

Refer: www.biorichplantations.com

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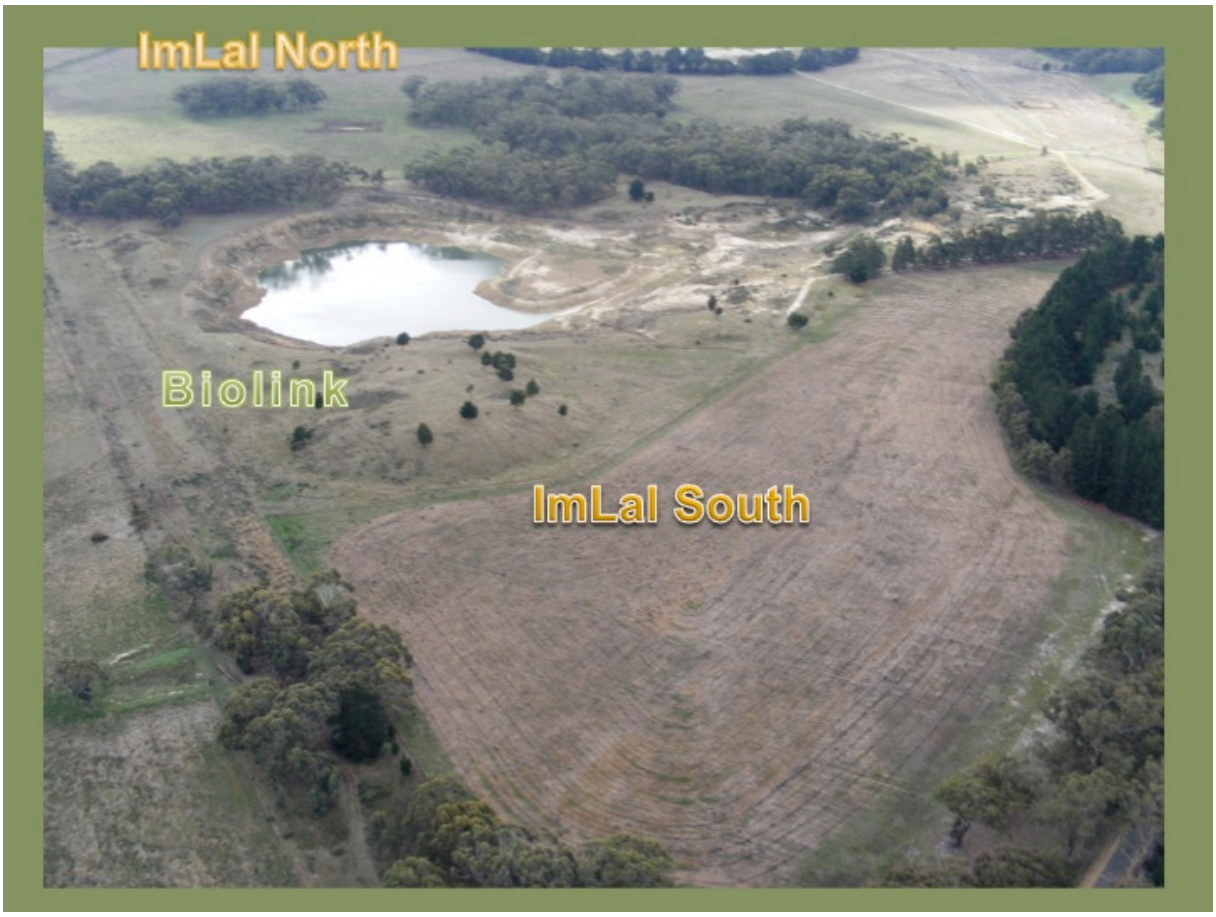
As the display board declares at the entrance to Ballarat Region Treegrowers' (BRT) 15ha biorich demonstration project, a biorich plantation offers a model of revegetation that acts as a bridge between farm forestry and pure environmental plays like Landcare plantings. The answer we believe is to rethink our revegetation strategies so that they mimic the sophistication of the original natural forests' design principles and structures.

In essence, a biorich plantation aims to deliver high quality, multi-layered habitat suited to a specific location, with the biodiverse habitat bulked out with forestry trees, thereby providing the landholder with timber resources like firewood, posts & poles and future income through sawlog harvest. Such an approach serves to build resilience into both the landscape and the landholders.

After BRT published *Recreating the Country*, BRT President Phil Kinghorn convinced multinational kaolin clay miner Imerys Minerals Ltd to part with 15ha of their mining buffer zone near Lal Lal, south-west of Ballarat. The swampy site was being trampled by cattle, and Imerys Environmental Manager Brad Haywood saw an opportunity to work with the local community to improve the site's biodiversity.

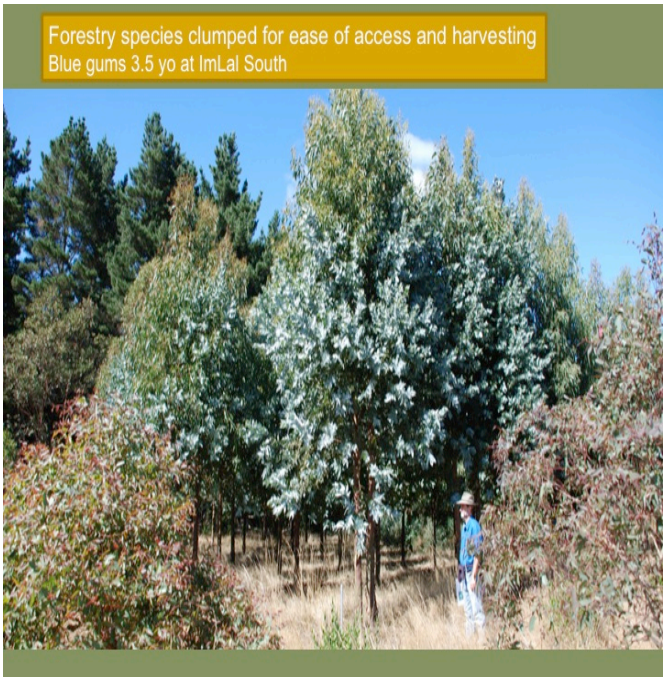
Biorich site plans



The site has three parts to it. The 5ha south site (known as ImLal South) was ripped and mounded in mid-2010. In the centre, an old quarry site has become a large dam. The adjacent hill to the west was created from quarry spoil. To the north is a strip of remnant swamp gum woodland; and further north, another 5ha degraded pasture site, which BRT calls ImLal North.

BRT commissioned *Recreating the Country* author, Stephen Murphy, to design the environmental plantings, with Phil Kinghorn having input on the forestry trees.

In the first 5ha south site to be planted, the 10 forestry tree species were arranged in clumps around the perimeter, easily accessible for later harvesting without damaging the biodiverse core, which consists of over 30 indigenous species of herbs & grasses, shrubs and understorey trees. The second 5ha site in the north has the forestry trees arranged in rows on either side of a central access track.



In both sites, the ratio of environmental to forestry plantings is 80:20. Forestry species selected were drooping sheoak (*Allocasuarina verticillata*), river sheoak (*Casuarina cunninghamiana*), spotted gum (*Corymbia maculata*), river red gum (*Eucalyptus camaldulensis*), sugar gum, (*Eucalyptus cladocalyx*), Tasmanian blue gum (*Eucalyptus globulus*), yellow gum (*Eucalyptus leucoxylon ssp. connata*), shining gum (*Eucalyptus nitens*), Sydney blue gum (*Eucalyptus saligna*) and red ironbark (*Eucalyptus tricarpa*).

For ease of silvicultural treatment and harvesting, the forestry trees – whether clumped or in rows – have been established as pure, single species stands of 40 or more. A trial clump of 67 Californian redwoods (*Sequoia sempervirens*) was planted as one of the forestry trees in the north site.

The biorich concept, we have discovered, fits within analogue forestry principles, first developed in the tropics. Analogue forestry differs from other forestry practices in that it starts from the premise that the original natural forest ought to determine design parameters, such as the number of structural layers and ensuring that revegetation incorporates a wide diversity of site specific, indigenous species. In an analogue forest optimising biodiversity moves front and centre.

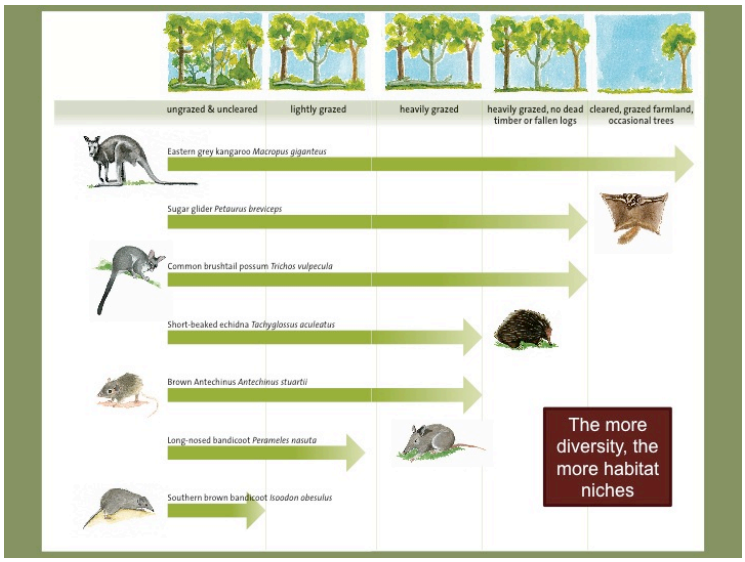
But analogue forestry has another crucial complementary goal. As in farm forestry, the design seeks to offer economic returns, such as timber or some sort of food crop. In replicating the forest, an analogue forest design must incorporate productive resources either for sale or use by the landholder. These, like the redwoods we have planted at ImLal North, need not be indigenous; they just have to slot into the architecture, in ImLal's case, of the original swamp woodland structure.

In developing his revegetation design principles, Stephen Murphy studied 12 woodland and forest reserves in central Victoria. He came up with four principles observed from nature that he regards as critical in maximising biodiversity and ensuring that plant cycles within the biorich plantation become self-perpetuating.

DESIGN PRINCIPLES

First principle: species diversity

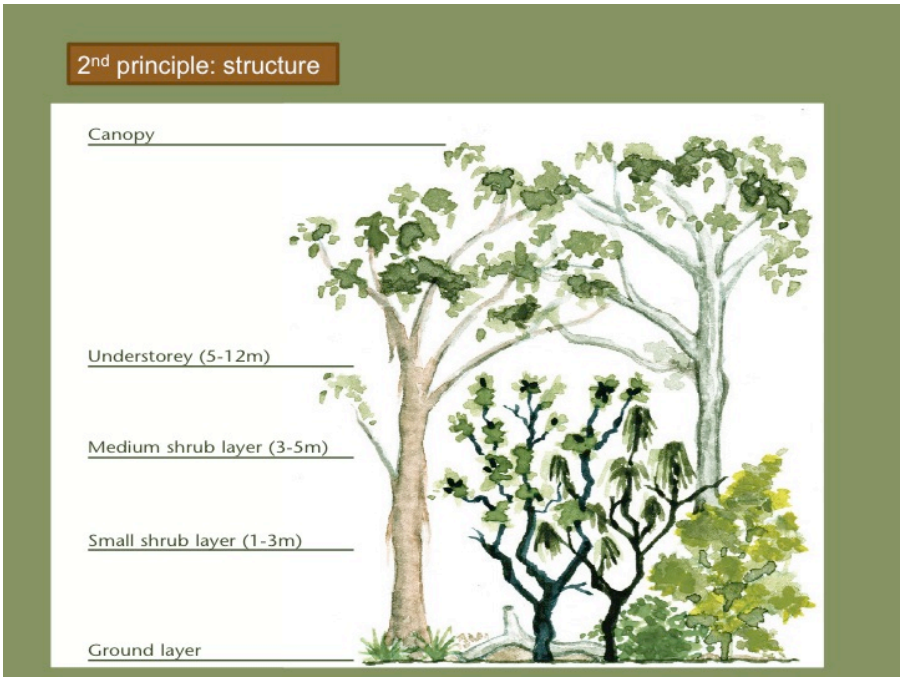
The first of these biorich design principles relates to species diversity. At ImLal, 32 indigenous species selected from 16 genera and 17 families were planted. Diversity optimises habitat niches and therefore biodiversity.



Eucalypts and acacia are considered an important component of the mix.

Second principle: structure

A biorich plantation aims to develop five structural layers composed of canopy trees, understorey trees, medium shrubs, small shrubs and a ground layer of grasses & native herbs.



Scale is integral to structure. Studies of remnant vegetation on farms have found that 10ha, at least 50m wide, is a critical minimum size for supporting a variety of forest and woodland birds. Associating farm forestry with native forest remnants can have significant benefits for fauna.

Thick young plantations can, for instance, substitute for protective understorey. Linkages between plantations and native forest patches can act as ‘stepping stones’, particularly for highly mobile species.

The planting at the southern site at ImLal varies between 90m and 200m wide. By placing Imlal North and South on either side of a remnant patch of woodland and wetland, we are transforming the total site area of 15ha into diverse wildlife habitat.

Third principle: ensuring long term survival

Planting in single species clumps of 10 or more ensures good pollination and provides efficient foraging for wildlife. Single species grouping is often seen in nature and also lends itself to commercial harvesting.
It is particularly important for the smaller plants and was done extensively at ImLal.

Moreover, diverse genetics acts as a keystone principle for plantations to become sustainable in the long term.

Fourth principle: connectivity

Linking with remnant vegetation in reserves or roadsides fosters migration of flora and fauna and supplements species diversity. The presence of water is a bonus as it will support more fauna of greater diversity. We have grant funds to link the northern and southern sites next year with a 50m wide biorich corridor around the west flank of the central dam.

SILVICULTURE

Establishment

While tubestock is the most reliable of revegetation options, it is labour intensive and therefore potentially expensive. We get around this by holding community planting days, where equipment, such as Hamilton planters and trays, are borrowed from Landcare groups, and the voluntary labour comes free.

We have found that by having a primary aim of putting habitat back into landscape, we can tap into a large constituency of the population who are concerned about nature and its continual destruction and degradation as a result of all forms of 'progress' and development. We have promoted our three community planting days through Landcare networks, local media and to neighbours, broadening the pool of involvement from those simply focused on farm forestry.

As the design of the ImLal north and south sites sets out to recreate indigenous shrubby woodlands similar to remnant vegetation found locally, it stands to reason that it should have the look and feel of a natural forest. At ImLal South, we diverted from the usual regimented rows and planted at 3m X 3m in a spiral, snail-like pattern.

To add another random element, Stephen Murphy devised an innovative planting pattern. On planting days each tray of trees and shrubs was colour coded. Red for canopy trees; green for understorey trees; white for small and medium shrubs. Volunteers then took a tray with a handful of colour-coded bamboo stakes keyed to the tray's type of tubestock. They were instructed to clump the tray's tubestock in a same species group, with the assigned colour-coded stakes beside each shrub or tree. This indicated to the next planter that they needed to choose a same species clump of a different colour.

If, for instance, they were planting shrubs (white stakes), they looked out for clumps with either green (understorey) or red stakes (canopy). By always varying the colours and planting in groups, the vegetation automatically combined to create structural layers.

Weed control

Excellent weed control is critical to a satisfactory result and this was brought home as a result of our starkly contrasting experiences between establishment on ImLal's south and north sites.

Research has shown that August/ September are the best months to plant in south-east Australia. So in autumn we spray 1.5m wide planting strips with a knock down glyphosate. Then a month prior to planting, the planting strips are given another dose of glyphosate and a residual (simazine).

Cutting back long grass on bare paddock sites, such as at ImLal, forms the difference between life and death for tubestock and direct seeding – both revegetation options we have implemented. On ImLal South, a local farmer was drafted to rip and mound, and we had an excellent result. Four years after planting, the forestry trees on the ImLal South biorich site are growing particularly vigorously. Plant monitoring by students from Federation University at Ballarat recorded an overall plant survival rate of 88% after the 1st year. The university's landscape restoration course has set up 16 plots to monitor plant growth rates and mortality.

Establishment at ImLal North was not as successful. Planted a year later than ImLal South in the year the drought broke, it was too wet prior to planting to effectively slash the long grass on this more waterlogged paddock. The herbicides failed to adequately kill the heavy bent grass cover, which overwhelmed many of the seedlings planted. Consequently, establishment has proven extremely disappointing – probably less than 50%, with whole rows to the rear of the paddock showing few signs of survival. We'll keep trying!

Ongoing annual spraying is required to keep gorse and blackberries at bay. Imerys patrols the borders of the biorich plantation, maintains fences and provides support, such as carrying out the weed control prior to planting the biorich corridor. BRT has purchased a 250L spray unit with two

long hoses, which can be attached to the tray of a flat bed ute. The spray unit is kept at a BRT member's nearby farm. We regularly spray weeds growing within the biorich site.

Ratio of commercial to biodiverse

Stephen Murphy gathers research in *Recreating the Country* to demonstrate that the proportion of canopy species in mature natural forest is low at only 20%. Given that forestry species, such as eucalypts, generally fall within the category of canopy species, this has ramifications for the proportion of commercial trees planted in a biorich site.

This is not an issue in the tropics. In Sri Lanka, the birthplace of analogue forestry (AF), an extraordinary array of indigenous tropical fruit, nut, spice and essential oil species can be introduced into the AF mix. So much so that it can tip the proportion of 'useful' species planted in the other direction, with the result that an AF site can have a ratio of 80% commercial to 20% biodiverse.

In Australia's temperate zones, far less indigenous fruit and nut trees are available to slot into a woodland's structural layers. While there is some latitude to introduce exotics species as substitutes within the layers (e.g. redwoods as part of the 20% canopy), we are going to have to become more creative in our species selection. Seed collecting from shrubs and understorey species is one opportunity. A local nurseryman has suggested we could become an ark for growing seed from locally endangered plants, like *Banksia marginata* and *Hakea decurrens*, which attract prices of $1,500 -1,600/kg.

In commercial terms, the single species clumping innovation introduced by Stephen Murphy holds the potential to deliver advantages in economies of scale for the harvesting of wood, flowers, nuts, seeds or foliage. Clumping provides an added benefit where the commercial species are sited next to access tracks for harvesting, as in both ImLal South and North.

Moreover, understorey species such as the wattles – decreed as so important under the biorich first principle – could be selectively harvested for timber where form pruned. Under these scenarios, the ratio of commercial to biodiverse becomes porous, with species planted to aid habitat also offering opportunities to the landholder for resources like firewood, posts or poles; or for making income from seed collection, bush tucker, medicinal plants, foliage or essential oils.

Thinning

Natural regeneration is proceeding apace at ImLal. It's not only the cheapest way to put trees back, but as Stephen Murphy writes, they "are inherently the most appropriate as they are the correct provenance with a proven ability to thrive in the soil and the aspect where they will germinate."

Eucalypt and acacia species are proving particularly effective invaders. Swamp gum (*Eucalyptus ovata*) is advancing on several fronts from remnants on both ImLal sites. Manna gum (*Eucalyptus viminalis*) is encroaching along a central shelterbelt edge. The indigenous silver wattle (*Acacia dealbata*) is spreading and growing in dense thickets. Another 'volunteer' wattle that is flourishing on-site is that king of cabinet making, blackwood (*Acacia melanoxyon)*.

In these initial years, the dense cover provided by the volunteers acts as a bonus, offering shelter on what is an exposed, cold and windy site, to both neighbouring plants and small birds, such as thornbills and honeyeaters. But if the volunteers' spread continues unhindered, the tree-dominated invasion threatens to overwhelm the other shrub layers.

The difference between a Landcare site and one managed by farm foresters is the latter's willingness to intervene to achieve a desired result, rather than leaving it to nature to sort it out – or not, as is so often the case with pure environmental plays. Our resident BRT foresters expect we will need to start thinning at year 6 in two years time.

Pruning

Australian explorers and pioneering settlers regularly described the countryside they first encountered as beautiful and as fine as any nobleman's estate back home in England. Mature canopy trees in woodland valleys were wide-spaced: environmental scientist Erica Nathan argues there were as few as 1-2 red gums per hectare in Victoria's Western District.

In his illuminating magnum opus, *The Biggest Estate on Earth*, environmental historian Bill Gammage asserts that this was not – as originally thought – simply a freak of nature. The open-spaced woodland valleys of *Australia Felix* with their thigh high grasses and pleasing prospects were, rather, the product of tens of thousands of years of fine-grained, purposeful management by Australia's first custodians, the Aboriginal people of this continent.

As farm foresters we have the ability to intervene and achieve the same effects where a biorich plantation is put in place. While Aboriginal peoples' major tool was the skilful application of fire on a mosaic basis, a farm forester's specific silvicultural tools are thinning and pruning – although prescribed burning is an option retained in our toolbox.

At ImLal South, pruning of Sydney and Otway blue gums commenced in year 2. This autumn/winter (year 3.5), we have begun pruning in earnest across ImLal South of clumps of canopy and understorey trees, particularly where they are of good form. Clumps are also left unpruned at regular intervals to provide dense habitat.

The pruning serves two purposes. First, the standard silvicultural purpose of removing double leaders and form pruning in general for timber purposes. But, second, in one of those epiphanies, we are discovering that removing branches to 4m is delivering what the first settlers would have regarded as pleasing prospects. On site tours, we are finding that visitors naturally gravitate towards the clumps of pruned trees, which offer long views through to ImLal's hill and surrounds.

Striking a balance between pruned and unpruned is still a work in progress.

Fire and grazing

As site visitors have pointed out, the heavy grass growth we have at ImLal is clearly a fire hazard.

A neighbour is being paid by Imerys to slash a firebreak around the edge of the biorich plantation. Within both sites, we have a resident mob of kangaroos plus some wallabies. Although they aid grass control, the kangaroos have extensively trampled plants, particularly in the more isolated ImLal North.

Research is increasingly demonstrating that prescribed burning is necessary to maintain ecosystem processes that rely on fire. When the biorich plantation is better established, BRT intends to introduce mosaic patch burning and undertake trials of crash grazing with sheep.

Happenstance

Over time, the best laid plans are modified by happenstance. This is particularly so when a large range of species are mixed together providing opportunities for interaction. One of the most obvious changes are the dense thickets of silver wattle, even spreading under the pruned blue gum. Leguminous, they'll fix nitrogen, remarked forester Gary Featherston.

Another change is the creation of clearings where clumps of frost intolerant species such as spotted gum and sugar gum have died. There is some robust discussion among the ImLal group as to whether or nor we leave the clearings or replant. My preference is to leave them: clearings naturally occur in forests, and can not only be aesthetically pleasing, but as Stephen Pyne and Bill Gammage have highlighted, they are the place where fauna gather to graze and forage.

Regular bimonthly bird surveys, led for three and a half years by ornithologist Tanya Loos, have been checking to see if species richness and abundance have increased. Nineteen surveys have been carried out on site, with a total of 77 species having been observed. The first bird seen using the south site was a yellow-faced honeyeater. This was in October 2011, a year after planting. A flock of about eight birds were foraging on healthy young blue gum seedlings, which were about waist height. By the June 2013 survey, a number of species were observed foraging among the wattles and young eucalypts in ImLal South.

Birds have been seen darting in and out of the biorich plantation at every survey since. We are delivering on the promise of our display board to bring back the splendor of what was once swamp woodland, while at the same time offering the resources and future source of income so that 21st century land managers can too become custodians, caring for their country. #