WHAT CONNECTS YOUR SITE TO THE REST OF THE LANDSCAPE AND OTHER RAINFOREST STANDS?

Princes Highway, Tibla Tilba New South Wales. In fragmented landscapes, can there be ***virtual connectivity*** between your rainforest site and other rainforest stands in your district when there is no physical connection? How would you know? The following is a worked example to help you find this answer for yourself. This Blackwood *Acacia melanoxylon* (left) that sits on the highway reserve is heavily laden with Variable Mistletoe *Amyema congener*, and is 0.25km from the Subtropical and Dry Rainforest stands at Natchanuka (Little Dromedary) (right) and it is a further 1.45km from Gulaga (Mt. Dromedary). Given their current isolation in cleared paddocks, can these two important rainforest stands still be connected in any way? If so, how could they be connected via this Blackwood? What bird species could connect them genetically? Let's look at which plant produces what resources, then what bird species are recorded using their fruits (in eastern Australia, 17 bird species are so far recorded* as doing so) and, lastly, would they normally cross open ground and thereby possibly link these two stands through this tree and its luscious cargo of long-flowering, long-fruiting mistletoe? See the analysis we have done below to try to quantify this relationship for this site. Note the difference in bird guilds visiting each plant species and that those using the mistletoe fruit are not constrained by crossing open ground, nor are any seed predators.

Local bird species that eat Blackwood seeds with arils*: **Olive-backed Oriole**, **White-bellied Cuckoo-shrike**, Pilotbird, Lewins Honeyeater, **Satin Bowerbird**, **Pied Currawong**, **Silvereye**, **Yellow-faced Honeyeater**, Common Bronzewing, Brown Cuckoo Dove, Wonga Pigeon, Emerald Dove.	Local species that feed on Variable Mistletoe nectar or fruits*: **Red Wattlebird**, **Brush Wattlebird**, **Lewins Honeyeater**, **Scarlet Honeyeater**, **Channel-billed Cuckoo**, **Koel**, **White-bellied Cuckoo-shrike**, **Black-faced Cuckoo-shrike**, **Pied Currawong**, **Mistletoebird**, **Satin Bowerbird**.
Number of birds will cross open areas: 9.	Number of birds will cross open areas: 8.
Number of birds less likely to cross open areas: 3.	Number of birds less likely to cross open areas: 0.
Potential bird connections: Likely: 6 seed dispersers. Unlikely: 3 seed predators+3 unlikely to cross open ground. Total: 12.	Potential bird connections: Likely: 8 seed dispersers. Unlikely: 0. Total: 8.
Total number of plants species consumed by this *guild**: 83	Total number of plant species consumed by this guild*: 66

Total potential ***genetic transactions*** through all bird species that could potentially use this one tree and its mistletoe colonies is 149: i.e. 83 (potentially using the tree for Blackwood seed) +66 (potentially using the tree for the Variable mistletoe seed).

Conclusion: through 19 birds potentially being attracted to feed on this one tree and its mistletoes, there could be at least 149 ***potential vector transactions*** involved in the dispersal of as many as 82 rainforest plant species between stands through this tree across open country (Appendix S6: worksheet: Single tree connections). This ***hypothesis*** is corroborated by the presence of several fruiting rainforest species (Tree Violet *Melicytus dentatus* and Sweet Pittosporum *P. undulatum*) that have arrived from these nearby rainforest remnants and established in the deep Kikuyu under the tree on the highway. These are ***realised vector transactions***. It appears then that this single tree does connect the Subtropical, Warm Temperate and Dry rainforest remnants of Tilba Tilba district across its open agricultural country!

Bird species in **bold** are rainforest *seed dispersers*, those underlined are seed predators (their gut or gizzard destroys the seed's endosperm and the defecated material is not viable), while the status of those in plain font is unknown *Data source: Appendix S6 Planting guide all species: worksheet All species+FCs. For the compiled species list see: Appendix S6 Planting guide all species: worksheet: Single tree connections.

Landscape context

Introduction

Why is landscape an important consideration for the rainforest restorer? The answer lies in the fact that rainforests are fire sensitive islands in a sea of vegetation that is dependent on fire. The survival of rainforests is dependent on topographic, and occasionally vegetation, protection from fire and an ability to remain genetically connected through the dispersal of genes between stands. There is evidence that Kooris protected some rainforest stands from fire by regular burning of the adjacent bush (this publication; Bowman 2000). The stands' continued evolution and development is dependent on seed or pollen that travel across this hostile sea to arrive on these small islands where they exchange their precious genetic cargo with the rainforest stand's other residents. This genetic interchange that is brought about by wind, water and animals maintains individual populations of plants and their adaptability in the face of an ever-changing climate. Knowing the position of your restoration site in the landscape helps you to appreciate its role as a stepping stone, and therefore how vital is your particular task of rainforest restoration.

Your site in the landscape

The context of your restoration site in the landscape is an important factor in the rainforest's short- to medium-term development and its long-term survival, as well as for its prospects of colonisation, at least by rainforest birds, and probably other species as well (see Additional Reading: Bird breeding censuses). The position of your site will determine the method of restoration to be used (Chapter 5) as well as helping you to plan what works you need to do, such as weed control, assisting natural regeneration or starting from scratch. So, for example, if your site is on a stream, you should not need to plant semi-aquatics to stop bank erosion; instead, look for the ecological brake that explains why natural regeneration may not be occurring (Figure S190).

Restored sites that are adjacent to existing remnants will support rainforest animals much more quickly than those that are isolated from existing areas of bushland. This is thought to be partly because of their physical attachment to existing rainforest, which allows these species to 'trip through' younger, less ideal restored areas and to return to the core habitat that provides a wider range of more critical resources over a longer period. In other words, "all critical resources must be continually available in either home range size packages if breeding units are not to become extinct; or locally or regional-sized packages for migratory populations" (Gilmore 1999).

If the remnants are connected, then your species will be able to get there more easily in the first instance, and be able to use the resources of the adjacent bushland when these are in short supply or absent within the restoration site. Work done at a restoration site in Lakes Entrance that was at least 2 kilometres from the nearest bushland (and 4 kilometres from the nearest rainforest stands), showed that it took 10-16 years to attract rainforest-dependent birds such as Lewins Honeyeaters *Meliphaga lewinii*, Wonga Pigeons *Leucosarcia melanoleuca*, Black-faced Monarchs *Monarcha melanopsis* and Rufous Fantails *Riphidura rufifrons* (Peel 2002 unpublished). In marked contrast, restoration works along the Snowy River attracted rainforest birds such as Wonga Pigeons, Bell Miners *Manorina melanophrys* and Bassian Thrushes *Zoothera lunulata* within two years of the plantings (Peel 2004 unpublished). Residence times of some birds that occur locally in rainforest, such as Golden Whistlers, may be dependent on the ***proximity*** to remnants, as well as their complexity. This species is still only a winter visitor to the Framework Restoration site at Kinkuna in Lakes Entrance 17 years after its establishment. In contrast, these whistlers are resident in Maximum Diversity Restoration work sites along the lower Snowy River that were only 2 years old (these are only 200m from a rainforest remnant, as well as being more structurally and compositionally more complex). The birds are breeding there as well. So, you can see that the site's context as well as the Restoration Method (and result) are important for Golden Whistlers. This is not to say that Framework Restoration does not work, but it works more quickly if one of the remnants is connected to it. Such is the case at Maringa Creek where the restoration site encloses the remnant, where Golden Whistlers were present and breeding after 4 year of restoration (Appendix 1: worksheet Maringa Creek bird census).

In addition, several rainforest-dependent birds are likely to arrive earlier and use younger sites if they are connected to existing remnants and are larger in area (see Additional Reading: Bird breeding censuses). The width of a site may also play a role as well, with several rainforest species arriving in sites that are both better connected and wider (see Chapter 9).

SOMETIMES REMOVING JUST ONE WEED CAN PRODUCE SWATHES OF NATURAL REGENERATION

Figure S190. Site 70f Marlo Road, lower Snowy River Victoria. Here, willows have been culled and there has been extensive Riverine Wetland colonisation without any need to plant. On this site, the bank was previously bare beneath the living willows 12 months before it was stem injected and killed. Following this treatment, Australian Gypsywort *Lycopus australis* (the leafy plant to the left) and River Club-sedge *Schoenoplectus tabernaemontani* (to the right) appeared. Smaller amounts of Marsh Club-sedge *Bolboschoenus medianus* are also present (far right of the semi-aquatics).

Why proximity to existing bush is important

The genetic interchange between rainforest stands from seeds and cross pollination brought in by animals, wind or water is very important for the long-term survival of your restored remnant over time. In reality, the seed collected for most nursery-grown stock is of very limited genetic diversity for entirely reconstructed sites. The broader the genetic base, the better adapted your site will be to deal with changes in climate or circumstance, so dispersal will always be important. So, you can appreciate the importance of both the physical connection of your site to bush that facilitates dispersal and the 'virtual connections' brought about by seed and pollen dispersal mechanisms (less easily seen) that together increase the genetic diversity of your restoration site.

Two studies in south-eastern Australia, Peel (2001) and this publication, have shown that the rate of noticeable natural regeneration of rainforest via seed dispersed by fruit-eating birds is limited in fragmented (cleared) landscapes to 1-2.5km (when measured over a 15 year period), but that site context is also important (mediated by distance to, and number of, rainforest stands, as well the proximity of continuous bush) (see Landscape context: proximity and contiguity below). This is in marked contrast to a much more comprehensive study of ***oldfield regrowth*** of Camphor Laurel **Cinnamomum camphora* in the Big Scrub in the subtropics of northern New South Wales by Neilan *et al*. (2006). The authors found considerable diversity and quantity of fruit dispersal by frugivorous birds, with a high potential for dispersal (species with a large gape (>15mm) that regularly consume fruit; or a medium gape (10-15mm) with fruit as a major part of their diet) occurs over distances of 20-30km. In addition, Neilan *et al*. (2006) found that frugivore abundance and recruitment of rainforest fruiting species was not related to distance from the seed source. Many of these frugivores are common or regular visitors to south-eastern Australia and include: Topknot Pigeon

Lopholaimus antarcticus, Pied Currawong *Strepera graculina*, Lewins Honeyeater *Meliphaga lewinii*, Satin Bowerbird *Ptilonorhyncus violaceus* and Silvereye *Zosterops lateralis*.

Explanations for the differences between the findings of the studies cited above and our results on the lower Snowy and Brodribb Rivers may include: the young age of the restored sites (15 years) compared with more than 80 years for some Camphor thickets in the Big Scrub; extent (the sites studied on the lower Snowy were generally less than 1ha, narrow: rarely wider than 20m); and occurrence in highly fragmented landscapes, often next to a busy road, which may have deterred some species and only one valley was studied. In addition, the return of large fruit pigeons to the far south-east of Australia is still sporadic, involving relatively low numbers, and has only just begun in the last 10-20 years as their recovery (facilitated by a conversion to a diet that now includes the fruits of Camphor Laurel and Privets) has allowed them to recolonise their former southern range. In addition, the Big Scrub Study area has greater fruiting species connections (albeit weed species) across the landscape. We conclude that dispersal over distances larger than 2.5km and at higher rates than those observed on the Snowy is likely and our results may have been confounded by the isolated landscape context of our study sites as well as the previously listed differences. So read on.

But what about intact landscapes, measured over longer periods: would they provide a better guide for the lower Snowy? How could this be judged? One way is to look at isolated large populations and their satellite (smaller) outlying populations.

A good example of this is the distribution of Cabbage Fan Palms *Livistona australis* in Victoria that are associated with the lower Snowy and Brodribb Rivers. There is only one large population (on the lower reaches of Cabbage Tree Creek). There are two extant and one extinct (but recorded) populations known outside the Cabbage Tree Creek stand. These are Tabbarra Landing (a juvenile plant) 4km away (showing that dispersal is still occurring); 2-3 mature but youngish (20-40 year old sub-canopy individuals) in the Brodribb Flora Reserve (8km distant) and the historic record from Corringle (14km distant), with the size and extent of that population unknown to this day. The key thing about the palms' disposition in the landscape is that they are in a line of large rainforest stands: the Palms Reserve itself (the core population), the Brodribb Flora Reserve (extant), the banks of the lower Brodribb River (whose rainforest is now extinct), then Bream Point (also now extinct), First and Second Islands (extant) and then Corringle (largely extinct). Cabbage Fan Palms are known to be water-dispersed (an important process for a population on the floodplain of a large creek, and whose satellite populations are all downstream) on the floodplains of other water bodies. However, to date, the seeds are not known to be buoyant and are dispersed in the fashion of small pebbles bumping along the bottom of the stream's bed and are deposited wherever this debris accumulates.

This is an important distinction in the context of the following discussion, because two of these sites (Tabbarra Landing and Corringle) are not in the alluvial flood depositional zones of Cabbage Tree Creek or its point of discharge onto the lower Snowy-Brodribb Floodplain) and so must have reached there by another mode of dispersal. The assumption here is, therefore, that the dispersal (at the 4 and 14km distance) is the result of birds and/or mammals (Appendix 6: worksheet: All species+FCs) that are locally abundant and have a large gape that allows their consumption of Cabbage Fan Palm fruits. These include: Satin Bowerbird, Pied Currawong, Topknot Pigeon and Grey-headed Flying Fox *Pteropus poliocephalus*). So, the potential vectors are known, their ability to successfully disperse the seed over the distances involved is also known (Neilson *et. al*. 2006), the draw-cards are in place (large stands of rainforest that are lined up) and at least one dispersal agent is known to move in the required direction to effect dispersal. Together, these observations provide a plausible dispersal scenario over longer periods of time and over greater distances between larger intact rainforest stands in a connected landscape.

However, care must be taken when suggesting dispersal modes and linking these to the distribution of rainforest plants in the landscape. For example, one of these vectors, Grey-headed Flying Fox, is known to roost in the Palms Reserve and to also feed out on the Snowy floodplain. At first this appears to be a very likely mechanism, but other elements of the bat's feeding ecology suggest it is not one of the agents responsible, because it takes these large fruits only a short distance from the fruiting tree to consume the flesh, after which it drops the large seed before returning for further fruit and repeating the feeding process. Another caveat involves dispersal agents that are unlikely to fly large distances between stands (or to do so only rarely), such as Lewins Honeyeater *Meliphaga lewenii*) and so their involvement in the dispersal of Cabbage Fan Palms widely across the landscape is also going to be severely curtailed.

Dispersal of seed by flying foxes over long distances does occur provided the seeds are small and ingested (e.g. Figs *Ficus* spp. and Austral Mulberry *Hedycarya angustifolia*), with records from south-eastern Australia showing that Grey-headed Flying Foxes are fundamental to the dispersal and natural regeneration of many rainforest plants. Other species, such as Swamp Wallabies, are proving important in this role even though the literature does not show them to be fruit-eaters (Figure S176). Viable seed has been recovered from the dung of this species on pilot restoration sites (Appendix S10).

Humans also had, and continue to have, a unique role to play. We have long gut residence times (meaning the distance we move in the next 8-12 hours is the potential dispersal distance for voiding seed: when was the last time you ate a tomato sandwich and had to defecate in the bush some kilometres distant?. You dispersed the seed. The reason being that our gut is not very destructive when it comes to seed because (it is theorised) we have increased our nutrient uptake and calorific yield from food by cooking it (ABC 2009). So, for those things that we do not cook (including fruit), if we did not chew it, it does go straight through. Just look at any bush campground and you will see a variety of fruits around that we have dispersed, either through defecation or disposal of fruit: ones that the author has noticed include: apples, avocadoes, plums, peaches, potatoes, tomatoes and passion-fruit. The list should also probably include blackberries. We also carry fruit (and seeds) with us when we move throughout the landscape, and in the past that would have been at about 4km hr^{-1} on foot over an 8 hour walking day: a potential distance of 32km. But today we move much further in motorised transport, so the potential for dispersal is even greater.

There are many factors other than distance or habitat fragmentation that are likely to be mediating the effectiveness of dispersal and establishment including: the frequency of dispersal events (the more there are, the greater the chance of establishment); the amount of viable seed produced in the source area; the amount dropped (more is better than less); the size of the target area (this governs the number of suitable niches); and other habitat features that are likely to attract the dispersing agent to the dispersal target site. Germination is not guaranteed simply because a seed has been dispersed. Some, or all, of the following conditions must also be met: the climatic suitability of the seasons following seed delivery (helps establishment), the extent or multiplicity of suitable niches (seed dropped on a bitumen road will not germinate, though the chances of it being dropped there in the context of the whole landscape are slim), the security of the site into which the seed is dropped (because it must be a long-standing refuge where a chance establishment will persist over time), and the duration of the dispersal journey, since the vector has to deliver a viable seed to its new home. All of these things have to line up as well as having a favourable rainfall event, the right temperature, low predation and follow-up rains, and so on: seeing a mature plant in front of you really is the culmination of an amazingly long chain of events!

The results of the time-constrained studies in fragmented landscapes on the lower Snowy River (Peel 2001 and this publication) does give rise to depressingly short dispersal distances. However, other pointers in the same landscape (the Cabbage Fan Palm example) does give us hope that there is dispersal over larger distances and in longer than human-constrained time scales. The last example that we present to you is designed to cement this concept in your minds. The success of dispersal events is clearly perpetuated over longer time periods and longer distances: to a level that defies belief (Figure S191).

These processes on Lord Howe Island have taken 6.4 million years (Hutton 1999), and this oceanic island has probably been a rainforest refuge for much of that time. Nine of the 10 species listed in Figure S191, have their nearest relatives on the Australian mainland: a current-day dispersal distance of around 700km (Hutton 1999), which represents a truly a remarkable feat of nature. Of these original Australian species: 2 are wind-dispersed, 3 are water dispersed and 4 are animal dispersed (3 as fruit, one on fur or feathers). According to Hutton (1999), the most efficient dispersal mechanism is animals, so don't give up: some dispersal will happen (perhaps not from Lord Howe!), but some species will reach your restoration site sooner or later. There seems no doubt: if a species can get there, it will.

Before leaving the issue of dispersal entirely, examining the role of a suitable niche for establishment is worthwhile, as illustrated by a study of a Littoral Rainforest community on the 90 Mile Beach in Victoria (Figure S192). A bluff system between Lake Bunga and the Red Bluff supports a range of vegetation types, including *Bung Yarnda* Littoral Rainforest, the position of the various vegetation types being dependent upon the age of the bluff since the last land slip event: the Littoral Rainforest being restricted to the more stable sections to the west on the less erosion-active marginal bluff near Lake Bunga (Figures S193 to S196). To the south lies a parallel dune sequence that supports a range of vegetation types including *Bung Yarnda* Littoral Rainforest: their relative positions in the sequence are dependent on dune age.

Figure S191. Lord Howe Island. Eight rainforest species and two genera from the 6.9 million year old oceanic volcanic remnant of Lord Howe island (Hutton 2002) are shared with the Littoral Rainforests of the South East Corner Bioregion. Top left: *Alyxia spicata,* a genus-level link with *Alyxia buxifolia*; Middle left: *Microsorium pustulatum*; Bottom left: *Dodonea viscosa*; Top right: *Geitonoplesium cymosum*, Australian Basket Grass *Oplismenus hirtellus* and Scurvy Weed *Commelina diffusa*; Middle right: Knobby Club-rush *Ficinia nodosa*; Bottom left: Austral Sarsaparilla *Smilax australis*; Middle (top left): Kangaroo Fern *Microsorium pustulatum* and New Zealand Spinach *Tetragonia tetragonioides*; Middle (top right): *Meuhlenbeckia complexa,* a genus-level link with Twining Lignum *Meuhlenbeckia australis*. Plant dispersal of the island's flora to this oceanic Island comprises 40% animal-based dispersal of fruits, 17%; by sea and 10% by wind (Hutton 1999).

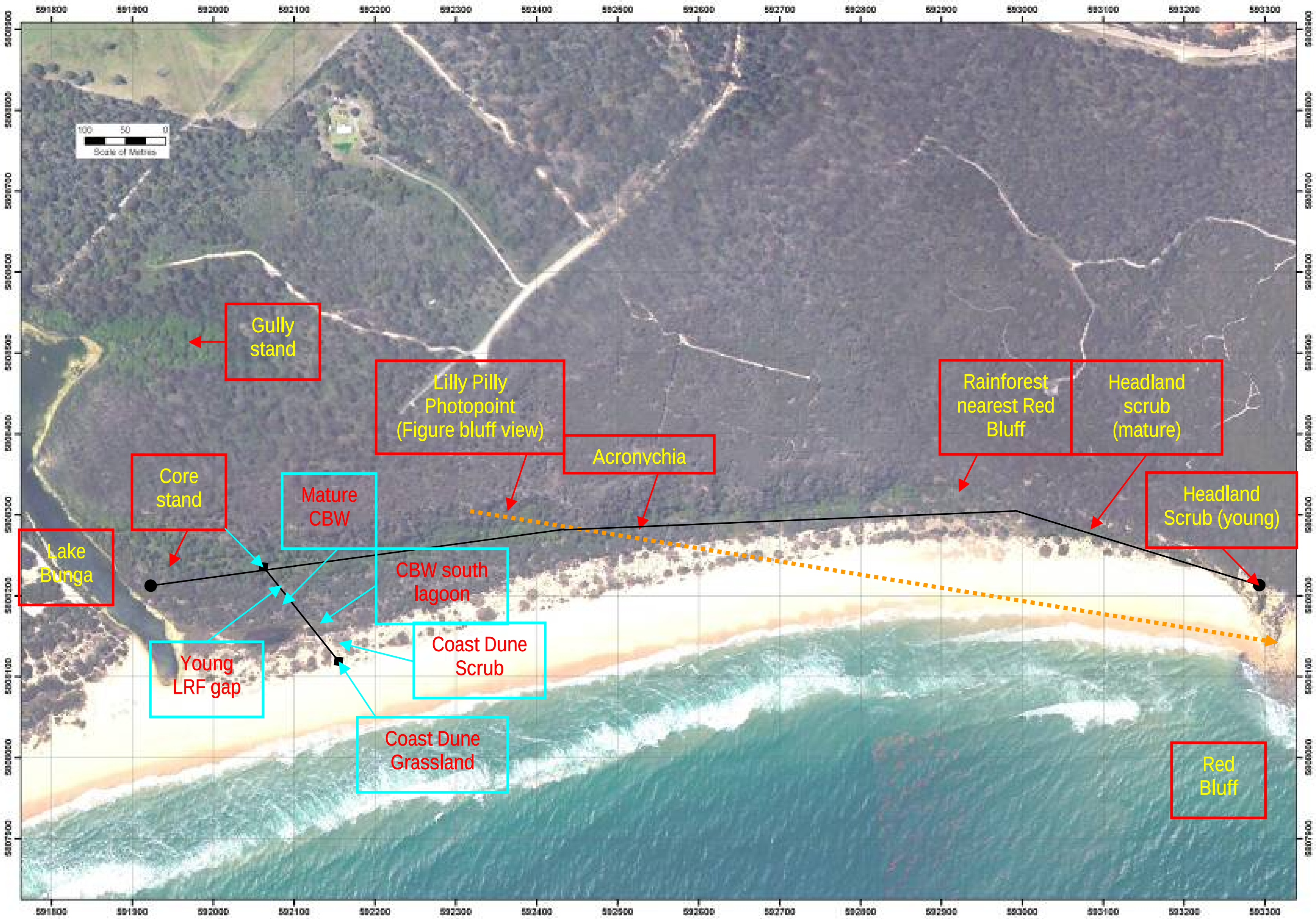


Figure S192. 90 Mile Beach, Victoria. The spatial relationships between dunes, bluffs and sea cliffs described in the text as well as the transects (Figure S197 and Figure S198). (···►)photo point view line for Figure S199. Photograph: East Gippsland Landcare Network.

Figure S193. 90 Mile Beach, Victoria. The core stand of Littoral Rainforest on the oldest and most stable section of the cliff system. Aeons of landslips have changed the cliff to a more stable landform (see slope angle below). The talus slopes and most stable sections of cliff are now occupied by *Bung Yarnda* Littoral Rainforest. The older sections of secondary dune at the base of the cliffs also support *Bunga Yarnda* Littoral Rainforest.

VERY RARE LANDSLIPS
Slope: 20-45º: mostly soil, some rock

Figure S194. 90 Mile Beach, Victoria. Now a marginal bluff, this slope has been protected for many decades from undercutting by the sea by a primary dune (bottom left) vegetated with Coast Dune Scrub. Landslips are now irregular and the result of high rainfall events: recent slips are recolonised by Headland Scrub; older sites are clothed in Coast Banksia Woodland. Talus slopes are now beginning to develop.

RARE LANDSLIPS
Slope: 45-90º rock and soil

Figure S195. 90 Mile Beach, Victoria. A narrow waxing and waning sandy beach only partially protects the sea cliff behind from oceanic wave action. Storm waves remove the beach from time to time, which directs their power to undermining the cliff's base. Consequently, landslips are common (and recent): Here the cliff is vertical. Headland Scrub present on older landslips and benches, no vegetation on the most recent land slips.

FREQUENT LANDSLIPS
Slope: 90º mostly rock, some soil

Figure S196. 90 Mile Beach, Victoria. Here the Red Bluff illustrates an active sea cliff, where the fallen talus slope material consists only of rocks because wave action has washed out the soil from the talus' interstices. This part of the cliff system is subjected to very frequent landslips because there is no sandy beach to dissipate the wave's energy before their full force is directed at the cliff itself. Consequently, there is no vegetation on this, the most active part of the whole cliff system.

VERY FREQUENT LANDSLIPS
Slope: 90º: all rock, no soil

All EVCs along two transect lines – one running parallel with the coast along the cliff system; the other perpendicular across the dune sequence from the base of the cliff to the seaward edge of the dunes (Figure S192 and Figures S193-S196) – were surveyed for their rainforest species diversity (those with high fidelity that are largely restricted to rainforest receive a score of 10 or 15 (see Appendix S6 for rainforest fidelity and scoring system). The results are graphed in Figure S197 and Figure S198. How can rainforest species that can disperse more than 1.5km over the several thousand years that the cliff system has been present, not disperse across 120m of dune and what does this have to do with rainforest restoration? The answer is twofold: a suitable niche for germination (in both cases), and the persistence of the habitat in one instance. What do we mean?

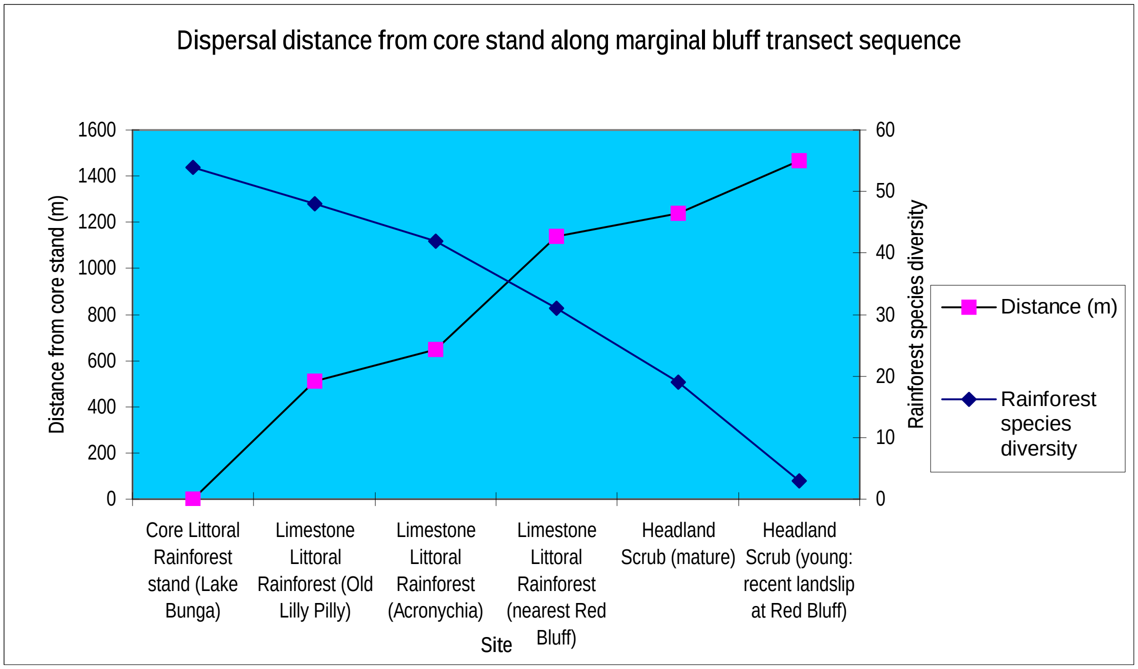


Figure S197. Species diversity along the marginal bluff between Lake Bunga and Red Bluff (yellow text Figure S192).

In the case of the cliff system, rainforest takes quite a while to establish: its species are not pioneers suited to frequently disturbed sites such as steep cliffs where land slips are frequent and new soils are exposed during every such event. However, to the west the story is very different: the cliff system has stabilised, morphing into a marginal bluff because the frontal dune has protected it from frequent undercutting action and erosion from the sea. Through a process of occasional land slips, it has sloughed off resulting in a slope of 20-45^{o} instead of the 90^{o} where the sea cliff is still actively and frequently eroded by the ocean's waves (Figures S195 and S196). This stability has allowed the core stand of rainforest to establish and remain intact for the longest (Figure S193). Consequently, it has the greatest diversity of rainforest species present. Moving to the east along the beach, the species diversity of rainforest stands decline (Figure S197), which is mirrored by the stability of the cliff system and its proximity to the sea (Figures S193-S196).

From a rainforest restoration perspective, this teaches us that habitat selection for your restoration site is very important, and that distance alone may not be the only factor that mediates when and how much seed disperses onto your site from other stands (Figures S198 and S199).

Despite this core stand on the marginal bluff being immediately adjacent to the widest section of dune and the subtending sandy flat, rainforest plant diversity has dropped away to nothing within 120m! (Figure S198). The reasons for this are two-fold. Dune sands are extremely droughty (they lose water like a sieve and put their plants under drought-stress), and although Littoral Rainforest plants are drought-adapted, they cannot live on pure beach sand. There are a number of reasons for this, which are associated with the level of organic matter in the sand. Therein lays the first factor restricting dispersal distance from the core rainforest: there is a geographic limit to dispersal based on the age of the dune, and consequently the organic content of its soils. The second factor relates to the germination niche required by rainforest plants (Figures S200-S203). They will not germinate and persist on bare sand, which is related to the first factor. As importantly, even when the soil organic matter exceeds the 27% minimum requirement for Littoral Rainforest establishment, germination only occurs in leaf litter. Such conditions only exist in certain localities (deep shade), while the gaps found elsewhere in adjacent vegetation are entirely dominated by ***duricrusts*** of mosses and lichens (see also Epiphytes and moisture-dependent plants: *Mosses and ferns: when and how they arrive)*. These duricrusts appear to stifle germination of rainforest species (compare Figure S202 with Figure S203).

Each EVC (Figure S204) has its own soils (Figures S205-S208) and species fidelities are very closely aligned to the niches in each of the habitats (Figure S209). The lesson here, especially for those intending to undertake Littoral Rainforest restoration, is to be absolutely sure that your landform is appropriate, that the soils are right and that suitable nursery crop species are planted first because they provide both shade and leaf litter, which firstly limits the development of duricrusts of mosses and lichens and secondly improves soil organic matter. This simple act thereby ensures suitable habitat for rainforest seedling establishment, and ultimately rainforest succession. Nursery crop species include exposure-tolerant wattles and Coast Banksia *B. integrifolia*. Each of these processes is intimately related to landform, soils, soil age and the level of organic matter provided by the vegetation succession that has preceded the current vegetation, as well as that which grows there today. Interestingly, the adjacent marginal bluff also produces sandy soils and the Littoral Rainforest is much older having produced soil organic content of 45.56% (Figure S199 and Figures S205-S208).

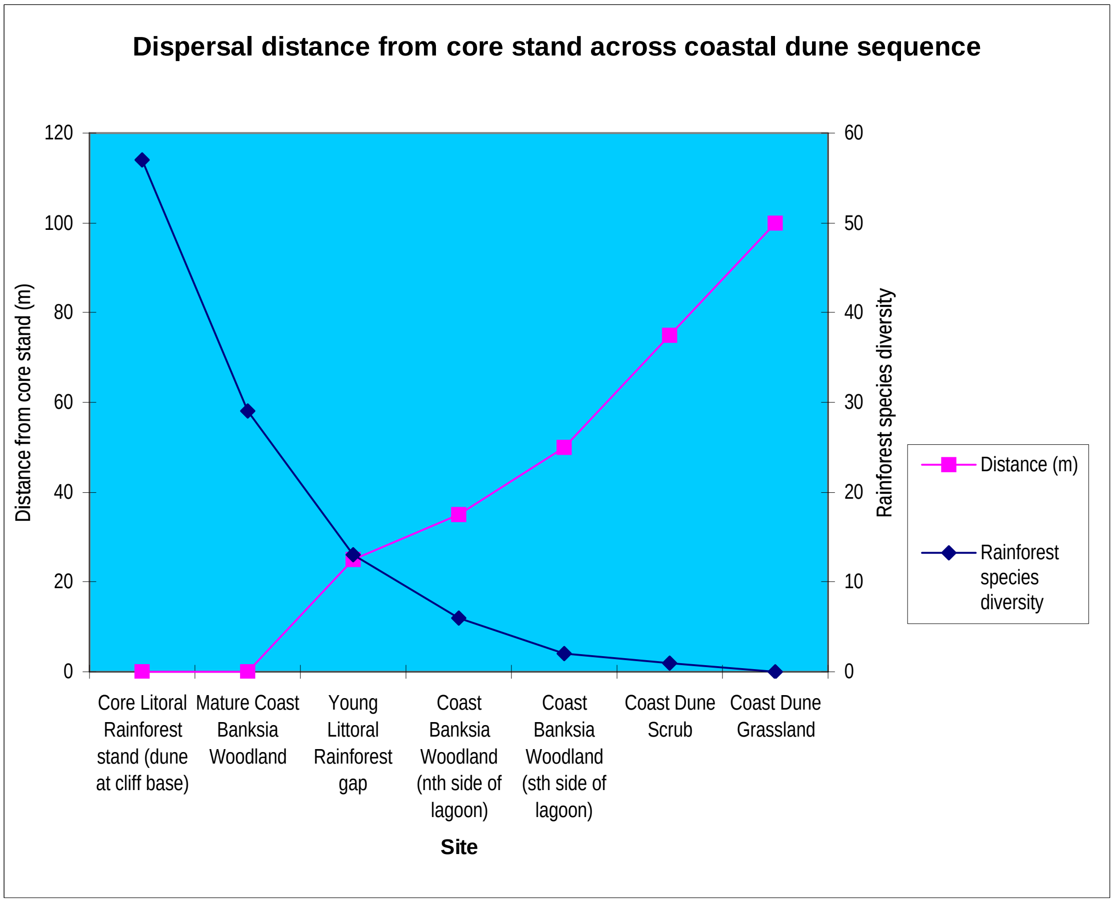


Figure S198. Species diversity versus distance from the core stand on Pliocene dune sequence (red text Figure S192).

UNDERSTAND YOUR SITE: ARE THE LANDFORMS, SOILS, NICHE AND HABITAT RIGHT FOR RESTORATION?

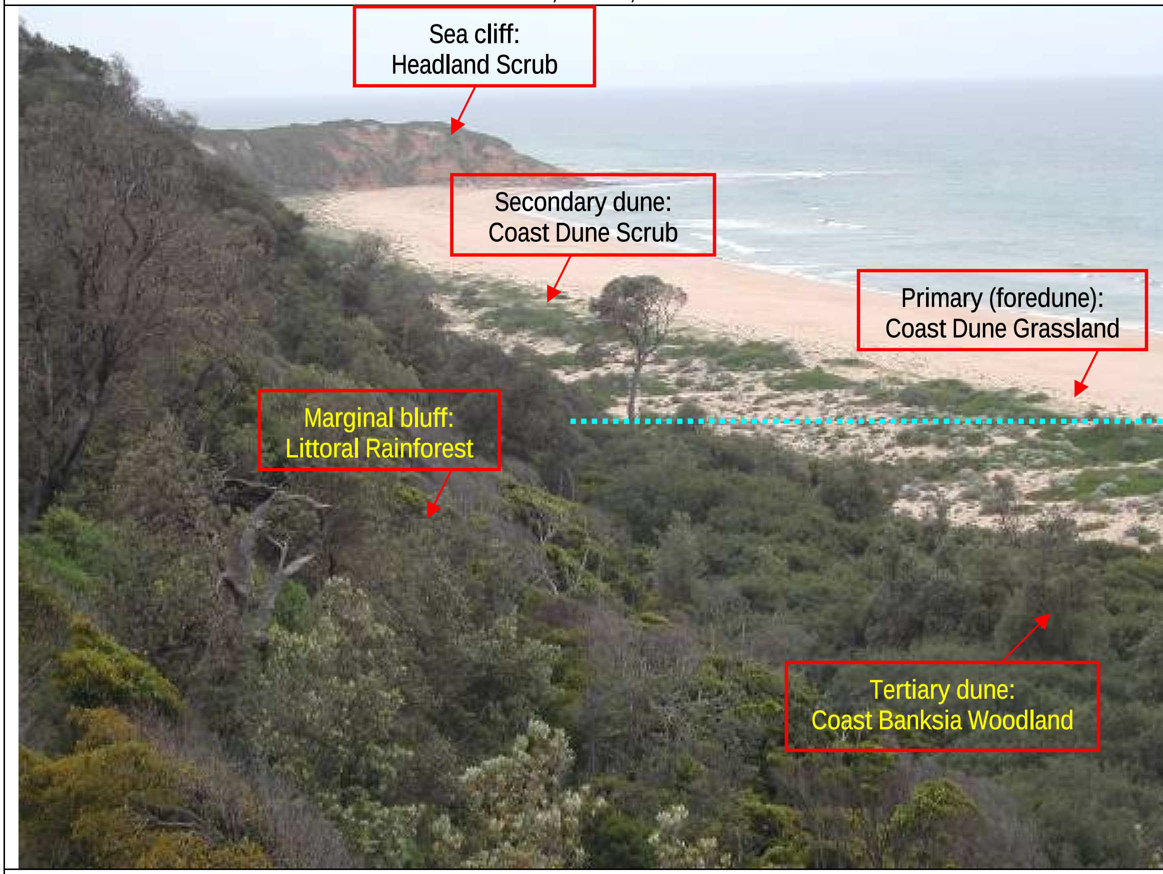


Figure S199. 90 Mile Beach, Victoria. The active sea cliff at the Bluff (background) and young primary dunes only supports shrubs, the foredunes only grassland, and the secondary dunes Coast Banksia Woodland. The oldest tertiary dunes support Littoral Rainforest as do the old sections of the cliff system. Note the emergent Banksia (centre) which indicates the stature of the vegetation prior to winter storms in 1977, which removed much of the tertiary dune.
(......)= seed establishment habitat sampling transect Figure S204 and soils Figures S205-8.

SUCCESSFUL RAINFOREST PLANT ESTABLISHMENT REQUIRES THE RIGHT NICHE

Figure S200. 90 Mile Beach, Victoria. Bare sand in Coast Dune Grassland with Dune Thistle *Actites megalocarpa*, Hairy Spinifex *S. sericeus* and Cushion Bush *Leucophyta brownii*.

Figure S201. 90 Mile Beach, Victoria. Scant leaf litter in Coast Dune Scrub: created by the autumnal leaf-fall from Coast Wattle *Acacia longifolia* ssp. *sophorae*.

Figure S202. 90 Mile Beach, Victoria. Duricrust in Coast Banksia Woodland, which prevents germination of rainforest plants even though soil organic levels are may be adequate.

Figure S203. 90 Mile Beach, Victoria. Emerging young Littoral Rainforest in old Coast Banksia Woodland: deep leaf litter and shade are colonised by Littoral Rainforest plants: Snowy Daisy-bush *Olearia lirata*, Sticky Daisy-bush *O. viscosa*, Sickle Fern *Pellaea falcata*, Sweet Pittosporum *P. undulatum*, Greenhood Orchids Pterostylis spp. and Ivy-leaf Violet *Viola hederacea*.

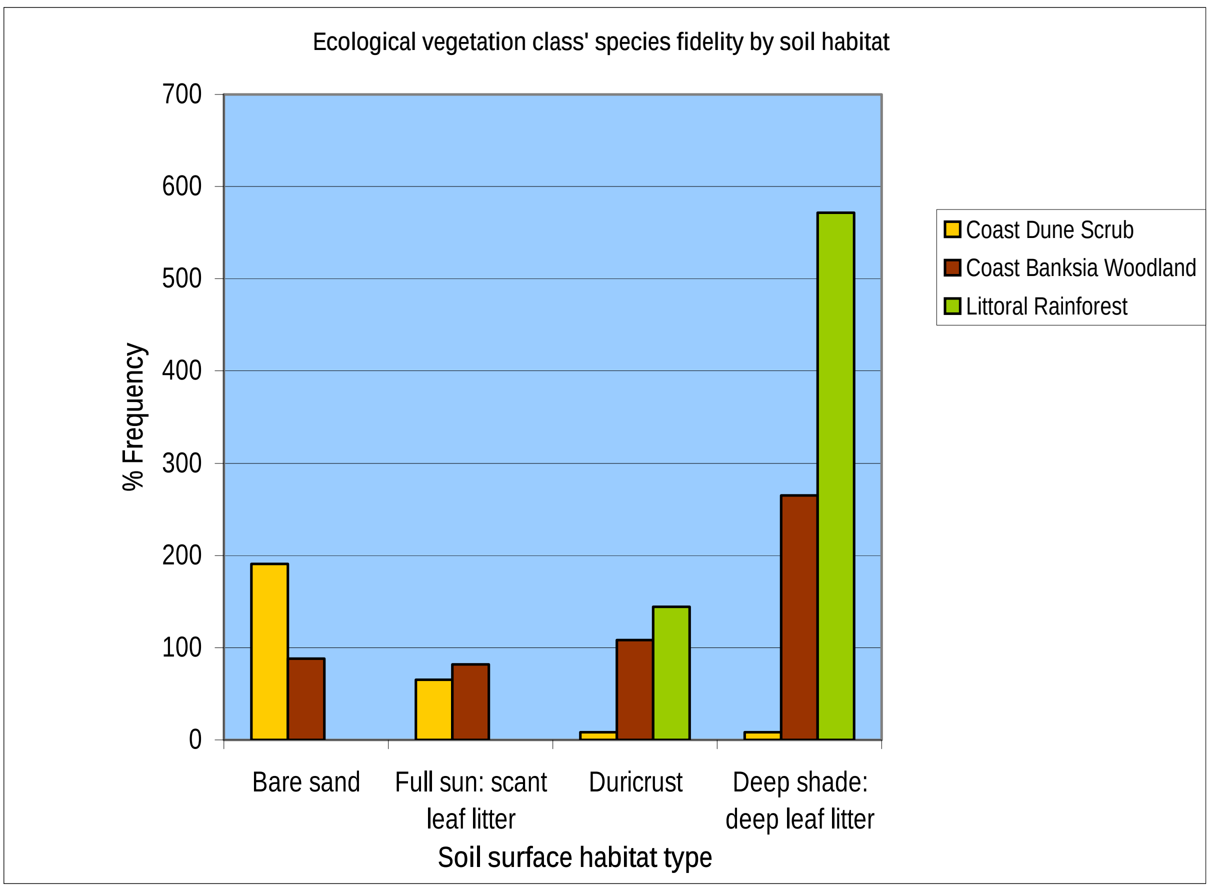


Figure S204. Species of three EVCs and their germination[1] on soil surface habitat types on contiguous dunes.

[1] *Data collected from contiguous and adjacent dunes on the 90 Mile Beach between Red Bluff and Lake Bunga, Victoria (dotted blue line in Figure S199).

ONE DUNE SYSTEM, FOUR SOILS: FOUR ECOLOGICAL VEGETATION CLASSES

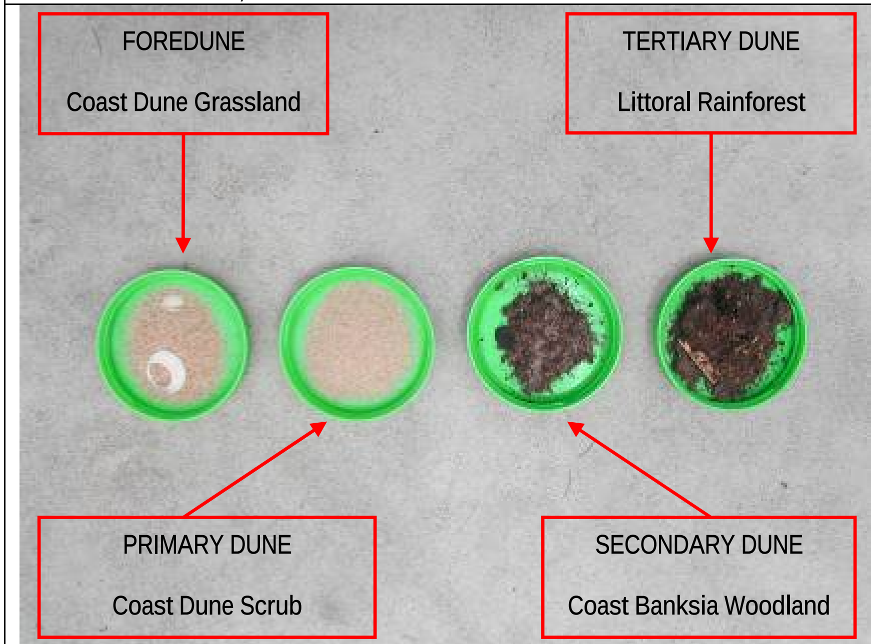


Figure S205. 90 Mile Beach, Victoria. EVC: Coast Dune Grassland. **Soils**: sands with 0% organic matter. **Soil dry weight**: 1.524 kg l^{-1} volume. Note: shells.

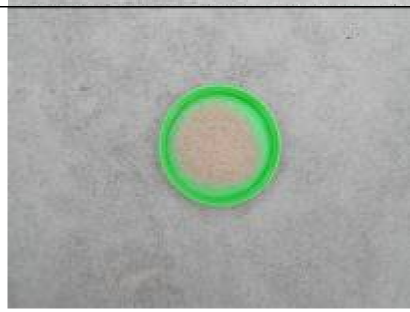


Figure S206. 90 Mile Beach, Victoria. EVC: Coast Dune Scrub. **Soils**: sands with 1.69% organic matter. **Soil dry weight**: 1.506kg l^{-1} volume. Note lack of organic matter and colour.

Figure S207. 90 Mile Beach, Victoria. EVC: Young Littoral Rainforest starting in Coast Banksia Woodland. **Soils:** sands with 26.82% by vol. organic matter. **Soil dry weight**: 1.121kg l^{-1} volume. Note colour.

Figure S208. 90 Mile Beach, Victoria. EVC: Littoral Rainforest. **Soils:** sands with 29.30% organic matter. **Soil dry weight**: 1.083kg l^{-1} volume. Note pedal structure from organic material.

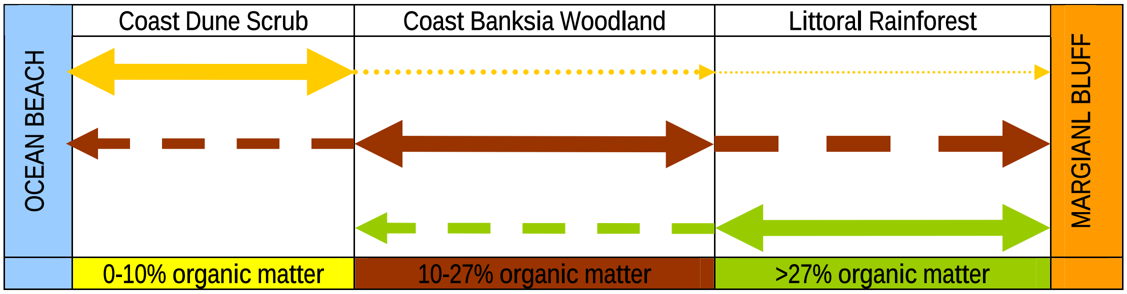


Figure S209. Schematic representation of rainforest succession mediated by soils and species' mobility across ecological vegetation class boundaries on Pliocene dunes on the 90 Mile Beach Victoria (based on data and colour code of Figure S204.

If you do get all of that right, then you will have set in train the sequence for rainforest succession from Coast Dune Grassland, Coast Dune Scrub, Coast Banksia Woodland and ultimately Littoral Rainforest. Once Littoral Rainforest is established, restored or repaired, then rainforest dynamics and gap succession can then proceed in the mature rainforest stand (Figure S210).

RAINFOREST DYNAMICS: GAP SUCCESSION IN LITTORAL RAINFOREST

Figure S210.. Saltwater Creek Ben Boyd National Park, New South Wales. Disturbance and succession in an ancient Littoral Rainforest stand in a small gap, formed when a mature Coast Banksia *B. integrifolia* fell into the rainforest (logs foreground and middle-ground) triggered a gap regeneration sequence:

1. The pre-existing emergent Coast Banksia was undamaged (yellow arrow)
2. The pre-existing Muttonwood *Myrsine howittiana* crown was damaged but re-sprouted (red arrow)
3. A Sweet Pittosporum *P. undulatum* seedling germinated and established on the fallen the Banksia trunk (green arrow).

Pollination

Ecosystem resilience is dependent on genetic diversity, which is partly accommodated by seed dispersal between stands and partly dependent upon gene transfer through pollen dispersal and the out-crossing between plants that is the end result of these interactions. The great long-distance pollinators in rainforests are the flying foxes. These animals are effectively one big pollen brush and, unlike many of our honeyeaters, they move between trees when feeding (and thereby spreading the flowering plant's genes around the district). In fact, they are the major out-crossing agent for eucalypts in eastern Australia and, as such, provide a pivotal and vital service to the wider forested landscape that ensures genetic diversity in our hardwood eucalypt forests. The service that Grey-headed Flying Foxes provide in that regard is in no short measure dependent on rainforests because of the abundant resources that they supply to this species. The other great guild of rainforest pollinators are the insects (Figure S66) (Big Scrub Landcare Group 2005). They are, by comparison, much weaker fliers than either the bats or the birds with most movements likely to be between 50-100m (Big Scrub Landcare Group 2005). As a consequence, much of the advice to rainforest restorers regarding maintaining optimal habitat for insect pollinators relates to maintaining or reconnecting remnants to existing areas of bush and retaining vegetation buffers around rainforests (Big Scrub Landcare Group 2005).

Deer and the pitfalls for restoration sites that are next to existing remnants

This genetic interchange is best conferred by having your restoration site near to, or attached to, an existing bush remnant. Although the conventional wisdom is that connection to existing remnants is beneficial for the restored rainforest, in south-eastern Australia it does present some major hurdles for the restoration practitioner, some of which are listed below:

- Increased levels of browsing from feral species (particularly Hog Deer and Sambar)
- Increased levels of browsing are likely from native species such as Swamp Wallabies.

To date, there have been only four methods devised for dealing with Hog Deer infestations populations on restoration sites, and each of these has its limitations:

1. Use of non-palatable species; although this is effective, it does not permit the full restoration of any given site because most of the mature canopy, shrub and vine species are rapidly browsed out and fail to establish (as happens with Sambar: Figures 8.107 and, 8.109-8.111). In addition it does not prevent antler damage, which can be extensive
2. Hiding palatable species within copses of non-palatable species (there are only so many opportunities to do this on any given site), and its long term success is yet to be tested
3. Exclusion (8-strand-electric) fencing is only partially effective, it is extremely expensive and it is very hard to eliminate the pest from your site before you close the gate (Figure AM5-1)
4. Culling, has been sought as a last resort because it is very difficult to cull this currently protected game species in Victoria because of legislative, regulatory or institutional constraints. After four years of trying to obtain the necessary permissions at one restoration site in Victoria (where more than 25 individuals were present), only one animal has been shot! In other words, it is sport, not culling.

Sambar in particular are devastating otherwise intact rainforest throughout eastern Victoria and southern New South Wales. To date, there have been no effective methods devised for the ongoing protection of restoration sites from Sambar, which are larger animals than Hog Deer and able to jump most fences. Limited exclusion has been achieved over a short time-period (3 years) within dense plantings of Kangaroo Apple *Solanum aviculare* on the Cann River in East Gippsland. At these sites, where browsing by Sambar of Victoria's critically endangered Slender Lignum *Muehlenbeckia gracillima* and riparian plantings has been severe in the past, this method of exclusion has only lasted a short time and it is expected that within 2 years the other dense plantings of Tree Everlasting *Ozothamnus ferrugineus* will also break down to the point where the deer will once more have full access to the more palatable vegetation (which constitutes the balance of the rainforest restoration planting). Already, they are targeting Muttonwood *Myrsine howittiana* within the planting as the Kangaroo Apple senesces.

In Victoria, a regulatory approach has also been tried with a nomination (in 2004) under the *Flora and Fauna Guarantee Act 1988* for deer to be listed as a potentially threatening process. The Scientific Advisory Committee (SAC) made a preliminary recommendation in support of this nomination, calling for more information during the public consultation period. This approach has already succeeded with the New South Wales Scientific Committee set up under the *Threatened Species Conservation Act 1995* having provided their final determination to list: 'Herbivory and environmental degradation caused by feral deer' as a key threatening process in schedule 3 of the Act (SC 2005). Unfortunately, the SAC recalled the nomination until more data could be provided in support of a listing for all species across the state. In 2006, another nomination specifically based on Sambar was submitted and was listed in November 2007 as a Potentially Threatening Process (DSE 2007c). So, for the time being, all of Victoria's feral deer species continues to expand inexorably while we try to find a solution to this rising plague.

Browsing by Swamp Wallabies is a part of rainforest dynamics in south-eastern Australia and this species is an adept disperser of a range of rainforest species. Wallaby browsing is easily dealt with through the use of one or a number of successfully implemented and scientifically trialled techniques. Swamp Wallaby browsing is not a serious impediment for the rainforest restorer in the region, but should it be apparent that your site is being browsed by this species then one or a combination of the following methods will deal with the issue:

- Planting palatable species as advanced plants (>2m high)
- Mass plantings of un-palatable species (Appendix S11) that, fortunately for us, are locally abundant as pioneer species
- Hiding palatable species within copses of non-palatable or camouflage species.

Contiguity, proximity, size and width: helping your restoration site to be the best it can

Introduction

What do these four things have to do with rainforest restoration and how do they help? The short answer is everything: without an understanding of these ecological landscape terms and their importance in your restoration work you will spend a lot of wasted time and resources on your project. This is because many processes that are important in remnants are linked to the wider landscape and so landscape context is very important, as related by the ***island biogeography theory*** (MacArthur and Wilson 1967). Responses by plants and animals in your patch to this landscape context are group or species-specific. Such landscape analysis leads to an appreciation of both connections and condition of other remnants that might be able to help.

But first let us begin with some explanations:

Contiguity: How connected is your site (by bush) to the nearest bush? Many native animals of the forest do not like crossing open (cleared) or urban land. If there is a bush corridor directly linking your restoration site to existing bush then natural processes such as insect control from birds and other groups will be reinforced. Natural dispersal of rainforest seed by birds, small mammals and wind will be higher the closer to the remnants your restoration site is, indicating a benefit both for plants and animals (Munro *et. al*. 2007). This leads to higher rates of germination establishment and persistence of rainforest plants (Peel 2001 unpublished). Contiguity also supplies big advantages by insulating your rainforest stand from the severe impacts of edge effects (see Width below). Contiguity ensures that your site is connected and consequently stronger and healthier

Proximity: How close is your restoration site to the nearest rainforest or the nearest bush? The nearer your restoration site is to existing bush, the higher the number of native animals that will visit your site and help maintain your rainforest. The nearer to another rainforest stand, then the higher is the likelihood that wind and animal-dispersed seed will reach your site (Peel 2001 unpublished; Munro *et. al*. 2007). If it is close to rainforest, then there will be 'seed rain' from the adjacent remnant onto your site. The closer your site is to another rainforest stand, the greater the genetic interchange between the species of the two stands: the more resilient and self-sustaining your restoration site is likely to become

Size: The larger the size of the rainforest stand, the greater the number of plant species it will hold and support. In turn, this provides habitat and diversity of opportunity for rainforest animals, which therefore means that the site will support larger populations, more species, and for longer periods. So for example a 12-month survey of a 3-year-old restoration site of 1ha on the Snowy River produced 44 bird species, whereas a shorter 7-month census (missing winter) at Maringa Creek of a 4-year -old restoration site with a larger area (11ha) produced 39 species. A very rough rule of thumb would be: if size were the only factor that differed, then for this shorter period, it would be expected that only 26 species would have been recorded for a 7 month census. For straight revegetation (note: not restoration) in agricultural areas, Munro *et. al.* (2007) report that patch size benefits are group dependent: being beneficial for birds and arboreal mammals, but because it is poorly researched, the relationships for other groups are poorly known. Larger sites are more stable and so are their plant and animal populations. The larger the stand, the more resilient it is likely to be in the face of severe stresses such as drought, fire or climate change; larger sites make better refuges

Width: Narrow stands suffer from edge effects; they have less structural and floristic integrity and important ***homeostatic*** (self-regulating) functions such as maintenance of shade and high humidity levels are impaired (Lindenmayer and Burgman 2005) (Additional Reading: Edges). Studies of revegetation in agricultural landscapes show birds have a higher richness (in a variety of landscapes from the tropics to cool temperate climate zones; as well as for a variety of vegetation types from rainforests to grassy woodlands) (Munro *et. al.* 2007 and Deakin University 2008); whereas frogs, bats, arboreal marsupials and reptiles appear to show no consistent response (Munro *et. al*. 2007). Many rainforest stands in the region are naturally narrow: being inherently constrained by topography; however, the surrounding slopes, aspect and fringing bush significantly reduce the edge effects in these narrow stands. The problem for the rainforest restorer is that where stands were once more extensive and/or the surrounding land has been cleared, contiguity is lost and that supportive role of a large rainforest stand or its fringing bush has been lost. This places significant limitations on the restoration process, especially where restoration is constrained by linear reserves or fencing arrangements. This is especially so along rivers (see Case Study S2 and S3 below).

Width is very important: always negotiate or find sites that accommodate as much as possible of the original extent of the rainforest and its ecotone so as to minimise the edge effects. You should aim to maximise circumference to volume ratios (larger and rounder is better than small or narrow).

Landscape context can be obtained graphically for your area (in Victoria at least) by going to the DSE website <http://www.dse.vic.gov.au> and clicking the Interactive Maps icon and using Biodiversity Interactive Map 2.0 and switching on the Modelled Native Vegetation layers which will give you: extent, quality and condition. Rainforest regenerators and planners always need to be on the lookout for opportunities to reconnect sites (Figure S211) and to reduce the circumference to area ratio of their restoration projects. In such situations, look for blocks rather than strips. On river flats, this is always likely to be a difficult task because the land is so fertile and consequently very valuable (everyone wants a piece). There are several ways of dealing with this: aggregate multiple uses and values to which such a restoration site can be put, solving a vexing problem at the same time; or target less valuable parts of the landscape such as islands, cliffs or steep slopes (see Case Study S2 and S3 below) and Figures S214 and S215. The aim is to find as many synergies as you can, to get off the thin narrow line (Map S2) as we show in these Case Studies. A classic example is the incorporation of a road underpass for rainforest mammals on the Atherton Tableland (Goosem *et. al*. 2001) with many species, (not just mammals) recorded using such structures (Australian Museum Business Services 2001a, b, c, d). We eagerly await the results!

COMPLEX AND VAULTED CANOPIES TAKE TIME TO PRODUCE: SO SOME WILL TAKE DECADES TO ARRIVE

Figure S211. Goldsmith's Gully, Colquhoun Forest Victoria. In East Gippsland, Rose Robin *Petroica rosea* has not been recorded in restoration sites unless they are connected to remnant bush. This one is in stand of mature Hazel Pomaderris *P. aspera* that is part of a late secondary species-dominated gap in Warm Temperate Rainforest. Note the presence of lichens used in nesting (Figure S151) and the vaulted canopy (i.e. no dense understorey) that enables the species to forage for insects in the high canopy and sally after them in the vaulted space below. Photo: Les Goldsmith.

CASE STUDY S2: THE BILLABONG AT ORBOST

Existing situation: The Billabong at Orbost on the Snowy River represents an overflow channel for the river during major flooding events and runs from the Orbost Caravan Park, behind the football oval, beneath the highway bridge and out onto the floodplain around Snaggers Lane (Figure S212).

Existing conflicts/problems:

- The billabong is a significant crevasse *avulsion* risk for the Snowy River during major floods
- It expands in size after every flood event
- It has a high erosion risk because:
    - Its banks are largely grassed, which provides minimal erosion protection
    - For much of the time, its surrounds are ploughed for crops; increasing the risk of an avulsion.

Existing risks:

- Should the river change course during such an event, the hardship caused and financial costs could be enormous for:
    - Floodplain farmers
    - Currently contiguous land holdings would be separated by one of the largest rivers in Victoria
    - The community of Orbost
    - The state in general (roads would have to be re-routed, new bridges would be required.
- The existing exotic trees on the site east of the highway bridge are old and need management (replacement/or renewal).

Rainforest Ecological Vegetation Class/Floristic Community to be restored:

- *Perennial Streams* Gallery Rainforest
- *Alluvial Terraces* Warm Temperate Rainforest.

Conservation Significance:

- *FFG Act*-listed and vulnerable White-bellied Sea Eagle *Haliaeetus leucogaster* uses the site
- Grey-headed Flying Foxes are listed under the Commonwealth *Environment and Biodiversity Conservation Act 1999* as nationally Vulnerable (the relevant primary threats at this site are loss and degradation of roosting and feeding habitat). Experience elsewhere (Hall and Richards 2000) and on the Snowy indicates restoration plantings can be used for roosting within 5 years
- *Alluvial Terraces* Warm Temperate Rainforest is listed as threatened under the Flora and Fauna Guarantee Act *1988*
- *Alluvial Terraces* Warm Temperate Rainforest provides habitat for 16 rare or threatened plants and 7 rare or threatened animals including two that are nationally threatened.

Solutions and advantages provided by a block of rainforest restoration at the Orbost Billabong:

- Restoration would replace existing high-risk grassed banks with a broad suite of erosion-protective vegetation that would slow water velocity to reduce the erosion risk and avulsion potential at the site
- The habitat of an existing roosting colony of Cattle Egrets *Ardea ibis*, Straw-necked Ibis *Threskiornis spinicollis* and Australian White Ibis *T. molucca* (all major pasture and pest control agents on farms in the valley) could be enhanced, expanded and its long-term security assured
- The new habitat would support a larger population of rainforest birds than the linear plantings along the river (Map S2). This would ensure more natural regeneration, as well as supporting agriculturally useful species such as Australian Ravens and Pied Currawongs that feed on pasture pests at the time of ploughing
- The high-risk cropping use of the site would be converted to river/land protection and nature conservation
- The restoration site could become a great recreation asset to the town for nature appreciation, as well as increasing contiguity with the existing rainforest restoration works on the river and those of the nearby Orbost Rainforest Centre on Lochiel Street, which was established in 1989 by the then Department of Conservation Forests and Lands and community assistance with funds from the Federal National Rainforest Conservation Program (G. Box pers. comm.)
- Management of the Orbost Caravan Park might be sympathetically adjusted over time to increase the effective area of the restoration works by gradually replacing existing plantings with rainforest plantings (as it has been noted has been done on their boundary along Marlo Road over the last year).

CASE STUDY S3: THE GREY-HEADED FLYING FOX COLONY AT BAIRNSDALE

Existing situation:

A maternal camp of the nationally threatened and *EPBC Act*-listed Grey-headed Flying Fox regularly establishes in a small stand of senescing Grey Poplars and other native and exotic species between Riverine Road and the Mitchell River at Bairnsdale in Victoria. The camp size varies from a few hundred individuals to more than 30,000 animals. This roosting habitat qualifies as habitat critical to the survival of this EPBC Act-listed species because:

- It has been used at least once in the last ten years (beginning in 1995) and is known to have contained >10,000 individuals
- It has been used at least once in the last ten years (beginning in 1995) and is known to have contained >5,000 individuals (>30,000 in May 2006), including reproductive females during the final stages of pregnancy, lactation or the period of conception (Eby 2005), as occurred between September-May in 2004 and May-June in 2006.

Existing conflicts/problems:

- The colony is adjacent to residential properties and sometimes includes their gardens as well
- The camp hangs over a popular walking, running and bicycling track for town residents
- The poplars are weed, that everywhere else on the river are being removed
- The poplars are getting old and beginning to collapse, representing a threat to life and limb
- The camp has no room for expansion
- Residential and camp conflict will continue while the Flying Foxes occupy the current roost
- The site is earmarked for weed control (poplar and exotic tree removal) and rainforest restoration.

Existing risks:

- The roost and its flying foxes will continue to get bad press while it remains at its current site
- Residential discomfort will continue
- The conservation of this species in Bairnsdale will suffer whilst the current site is occupied
- The colony's tree structure is beginning to break down and will continue to do so over the next decade, leaving the flying foxes without a roost at this site
- There is a risk that the colony will seek a new roost site in an even more contentious location (perhaps moving back to a previous roost that was in the Bairnsdale Botanic Gardens, which is now the outdoor swimming complex)

Rainforest Ecological Vegetation Class/Floristic Community to be restored:

- On the slope: *Limestone* Littoral Rainforest, on the river flat: *Alluvial Terraces* Warm Temperate Rainforest.

Conservation Significance:

- Grey-headed Flying Foxes are listed under the Commonwealth *Environment and Biodiversity Conservation Act* 1999 as nationally Vulnerable (the relevant primary threats at this site are loss and degradation of roosting and feeding habitat). Experience elsewhere (Hall and Richards 2000) and on the Snowy indicates restoration plantings can be utilised for roosting within 5 years;
- *Alluvial Terraces* Warm Temperate Rainforest is listed as threatened under the Flora and Fauna Guarantee Act (1988)
- *Alluvial Terraces* Warm Temperate Rainforest provides habitat for 5 rare or threatened plants (e, v, r,) and
- 4 rare or threatened animals including one that is nationally threatened.

Solutions provided by a block of rainforest restoration on the Mitchell River flats (Figure S213):

- Rainforest restoration would be reinstating Victorian threatened and listed community of Warm Temperate Rainforest that once used to occur on the riverine floodplain reach of the Mitchell River; (the proposed site does not have habitat for the Littoral Rainforest)
- A rainforest restoration site that was more than 300m distant from existing or likely residential land would, if chosen as an alternative camp site by the flying foxes act to effectively minimise impacts to the nearest residents (Eby 2005)
- An appropriately chosen site could be a tourist attraction in its own right, which, if it became a roost site, would allow full visitor access when the colony is not breeding or absent but limited public access to view the site whilst the colony is breeding (as is the case at the exemplary Wingham Brush in NSW)
- The maternal colony could function with minimal human interference
- The bad press regarding the existing camp should abate.

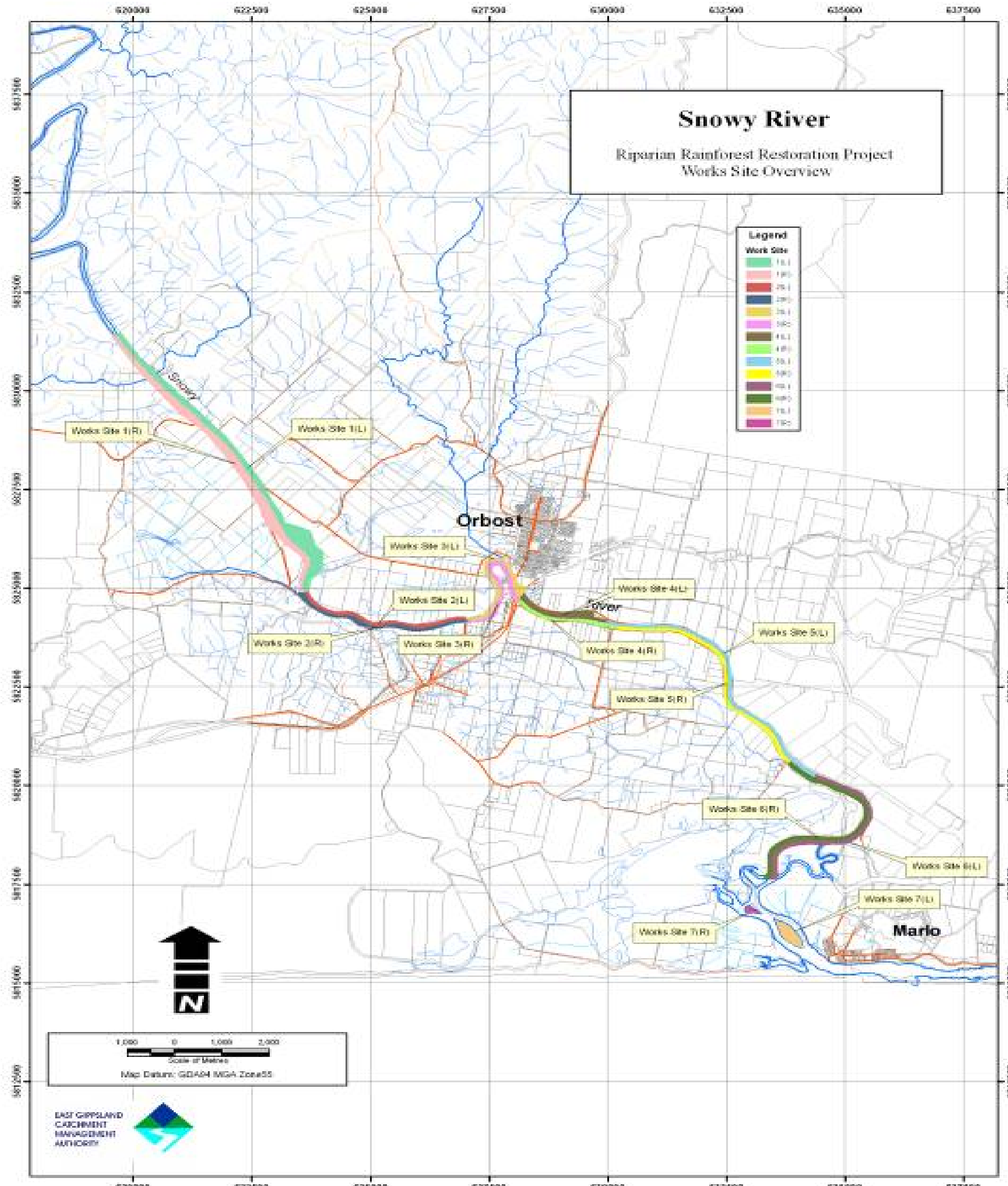
Having said all of this, do not lose heart if your restoration site is isolated from other areas of bush, because a number of adaptable and hardy animals species, particularly birds, are very good at 'stumbling over' restoration sites and using them as stepping stones for movement across the landscape and your restoration efforts will produce greater bird diversity than open paddocks by a factor of six and a half (Appendix 1.1: worksheet: two-way table) comparing favourably with woodland birds elsewhere in Victoria where the factor was five (Deakin University 2008). In so doing, they bring with them a cargo of other genetic material: the pollen they carry and the seed that they have ingested. As well as this, we are fortunate in this country that a number of animals that use rainforests and spread seed are also generalists that are prepared fly high and bold (Pied Currawongs *Strepera fuliginosa*) or to tree-hop across cleared land (Satin Bowerbirds *Ptilonorhynchus violaceus*) to reach isolated rainforest patches. It is also worth noting that your patch of restored rainforest may not always remain isolated: its very presence is a good argument to planners and the community to ensure that it can be connected at some time in the future. 'Reconnection also has several forms: many rainforest animals are altitudinal, regional, national or international migrants (Gilmour 1999; Additional Reading: Avian migration patterns; Chapter M9: Habitat value for birds: How well have you done and is your site rainforest yet?). If your restoration site is a reasonable size, is well planted and in the right place, many of these species will, in time, visit and stay and, if you are lucky, breed. Connections are not necessarily about bush connecting bush, especially because rivers deposit more than silt during a flood and many animals (and plants) also arrive in floods.

<table>
<tr><th colspan="2">TWO SCENARIOS THAT COULD SUPPORT CLIMATE CHANGE CORRIDORS AND RAINFOREST RESTORATION</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Figure S212. Snowy River, Orbost Victoria. This aerial perspective shows the billabong site described in the Orbost Case Study S2 (red arrow) and its landscape context that could form a rainforest node attached to the linear restoration site on the Orbost Bike Track (green arrow). Gilbert's Gulch (foreground) became active during the major June 2007 floods (29 June 2007 10.20am): its waters replenishing and nourishing the back swamps and billabongs of the plain.</td><td>Figure S213. Mitchell River, Victoria. An example of a prospective restoration site more suited to a Flying Fox camp (Case Study S3) because of its distance from dwellings, which meets the criteria for such camps in urban areas under the EPBC Act's Draft Recovery Plan for this species (Eby 2005)] as compared with the existing sub-optimal camp location abutting houses nearby (Figures S214 and S215).</td></tr>
</table>

Landscape context: proximity and contiguity

Proximity is important for rainforest restoration because it has a large bearing on the rate of natural regeneration that will occur on your restoration site and when it will occur, as is predicted by the island biogeography theory (MacArthur and Wislon 1967). This regeneration is initiated by seed-dispersing animals, wind or water. Other factors in cleared areas come into play however, including: size, shape and position in the landscape and these in turn will influence impacts of the cleared land on species resident in your fragments (Saunders *et. al*. 1995) or restoration sites. For example, who gets there, how often and do they want to stay a short while, a long while and can they manage to breed?

Research within the study area in the fragmented landscape of one river valley (the lower Snowy, with two rivers: the Snowy and Brodribb), indicates that if your restoration site is more than 1.2-2.5km distant from the nearest healthy rainforest remnant, then the rate of colonisation from that remnant will be relatively slow, as well as being mediated by site context. At the time-scales measured (15 years) the rate of off-site colonisation by rainforest plants to planted sites is slow, but measurable (Peel 2001 unpublished), but only on those sites nearer to bush that includes other rainforest stands. For example, a 15-year-old restoration site on the Brodribb River showed excellent diversity and numbers of off-site species colonisation with a site context that included: 4 rainforest stands within 2.5km, (one at 1km, one at 1.2km, and two at 2.3kms) and continuous bush 1.2km distant. In contrast, another restoration site on the Snowy River of the same age (but with no offsite recruitment) had only two rainforest stands (one at 2.3km and another at 6.5km distance) and the nearest continuous bush was 5.4 and 6.2km away. The percentage of cleared land in the neighbourhood of each of these restoration sites (until continuous bushland is reached) is 4% for the Brodribb compared with 0% for the Snowy site.



Map S2 Colour coded Work Sites for the Snowy River Riparian and Rainforest Restoration. Project.

For the most isolated sites, the only other alternative seed source will be what you plant and this relies on maturation and seed set times (Appendix S7) of the species that you have used. Rainforest plant species can take from several months to many years, or even decades, to mature. The value of restoration though is profoundly illustrated by the results of 4-year Maximum Diversity Restoration project on the Snowy that has connected the low recruitment site mentioned above to Lochend Jungle. In these restoration sites, the amount of recruitment has risen from nil to 22 (depending on the site) to reach 115 plant species in 5 years (Chapter 9: Natural regeneration)! These amazing statistics includes both the progeny of the species established by the *bush regenerators*, as well as those brought onto the site. So you can see that reconnection through rainforest restoration that re-establishes contiguity can also have a profound effect, because this colonisation of rainforest plants is happening as much as 2.3km away from the reconnected rainforest remnant at Lochend Jungle.

These maxims regarding contiguity and connection hold true except in some exceptional circumstances. Specifically these involve the movement by Australian Ravens *Corvus coronoides* and (a narrower selection) via Musk Lorikeets *Glossopsitta concinna* of a broad range of coastal plant species into Littoral Rainforest niches. These animals regularly move 5-8 kilometres from feeding sites on coastal dunes across fragmented landscapes into the hinterland rainforests where they drop their precious cargo of seed (Coast Beard-heath *Leucopogon parviflorus*, Coast Wattle *Acacia longifolia* ssp. *sophorae*, Common Boobialla *Myoporum insulare* and Sea-box *Alyxia buxifolia*).

Therein lies a lesson to us all: that without local knowledge, its systematic collection, recording and dissemination, we will never really know the importance of what we do when we restore rainforest and how our actions can assist those plants and animals that rely on our efforts. Conversely, nor will we know the extent of damage we have done when we remove a tree, clear some bush or allow a weed to take over.

LIVING UP CLOSE AND PERSONAL WITH SOME RAINFOREST RESIDENTS CAN BE A HARDSHIP

Figure S214. Riverine Road, Bairnsdale Victoria. Too close for comfort: this maternal colony of Grey-headed Flying Foxes containing more then 10,000 individuals was, when it was smaller, only found in Grey Poplars *Populus* x *canescens* along the river (red arrow), but now some are occupying adjacent domestic gardens (green arrow). The smell is so overwhelming to local residents who are frequently nauseated if the wind direction is from the east. Clearly this is not a sustainable situation in the long term. It is for this reason that the Draft National Recovery Plan for Grey-headed Flying Foxes (Eby 2005) recommends a buffer of 300m from dwellings. To get people thinking of solutions for this conflict Case Study S3 deals with the issues.

Figure S215. Riverine Road, Bairnsdale Victoria. This maternal camp of Grey-headed Flying Foxes numbered more than 10,000 individuals (Tony Mitchell pers. comm.) at the time of this shot in May 2006. Clearly the colony is not dependent on native species to provide suitable roosting conditions. From observations of this and other camps in East Gippsland the most important site features seem to include:

- Shelter from cold westerly and southerly winds
- Warm sun-drenched aspects for warmth during cold-weather
- Exposure to a cooling sea breeze on hot days
- A freshwater stream nearby for water
- Abundant food resources: variously eucalypt and/or Banksia nectar, rainforest fruits and/or domestic fruits within 30km.

Contiguity is also important to some species such as Satin Bowerbirds *Ptilonorhynchus violaceus* that will cross small gaps in tree cover, but are reluctant to cross over long distances. Many animals dependent on rainforest are also seed dispersing species, but some of these (e.g. Lewins Honeyeater) can be reluctant to travel over open ground (Opener). Some larger generalist species (such as Australian Ravens, Pied Currawongs. and Grey-headed Flying Foxes) will do so, but if the distance exceeds several kilometres, then by the time they arrive, much of what they have consumed may have already been voided and does not land in your restoration site (Chapter 3: Opener). As you will have gathered by now; rainforest seed that falls on house roofs, roads or paddocks is of no use to you or your restoration site. The converse, however, is also true: because these species are seeking more of the same food in rainforest habitat and for those that do not move outside rainforest, they will travel along linear corridors such as river banks reinforcing the character of these restoration efforts (Appendix M1: worksheet: Two way table).

As a consequence, it is very important to attract seed dispersing animals to your restoration site. It is important to encourage these animals to stay as long as possible by reinstating the appropriate resources that enable them to live there and prosper. It can be very beneficial therefore, to understand the diet of the rainforest animals of your district and the fruiting times of the plants that they consume (Appendix S10). To increase the rate of visitation, the length of stay and the diversity of the visitors to your site, you must plant as wide a range of food plants as possible for the floristic community relevant to your site. Important features of these fruiting plants include: those that have long fruiting seasons, those whose fruiting periods overlap or those whose fruiting is regular and or abundant. Recording what birds use your site can help to determine whether your efforts have been successful: those that stay and breed obviously think that you have succeeded. There are few species in south-eastern Australia that exist on fruit alone. Those that do, such as Topknot Pigeons, tend to be nomads that magically appear when the fruit is ripe. All the rest rely on other resources such as nectar (flying foxes, many honeyeaters and lorikeets) or insects (honeyeaters, silvereyes) honeydew (honeyeaters), browse (Satin Bowerbirds), meat (Pied Currawongs and Australian Ravens) or the nests of others (Channel-billed Cuckoos).

Although the major seed dispersers of rainforest seed in south-eastern Australia are birds (both in terms of diversity and quantity of seed dispersed), some mammals are seasonally or periodically important. Grey-headed Flying Foxes are perhaps the best example, even though relatively little is known of their feeding habits in the lowland rainforests of this region (Eby pers. comm.). This lack of knowledge represents an enormous opportunities for anyone interested in rainforest restoration and species ecology to increase our collective knowledge of these threatened species and a wide range of other animals (see When does it fruit and who eats what?).

The '***virtual connections'*** between rainforest stands are dependent on a number of factors. Calculating the dispersal distance is easy if certain information is available. For instance, the fruit ingestion time in Grey-headed Flying Foxes (Law 1992) is between 12 and 34 minutes. We also know that their flight speed 25-30km hr^{-1} (Hall and Richards 2000). The possible dispersal distance for small ingested seeds carried by these fruit bats (Red Passionfruit *Passiflora cinnabarina*, Rose-leaf Bramble *Rubus rosifolius*, Yellow Elderberry *Sambucus australasica* and Seaberry Saltbush *Rhagodia candolleana*) therefore ranges from 5-17km.

Ecotones

The other major consideration regarding contiguity is the presence (or absence), health and extent of ecotones, which are a vital protective mechanism for the rainforests of south-eastern Australia. Ecotones reduce the impacts of edge effects (Additional Reading: Edges), but also do a lot more. They are the natural cross-over zones between different ecological vegetation classes. As might be reasonably expected from the use of the term 'cross-over', they are comprised of a mixture of environmental conditions from each of the adjacent ecological vegetation classes, with a complement of plant species from each to match. They have four very important aspects.

The first is that they are comprised of a range of rainforest secondary species that dampen down fire intensity and frequency, partially because they occupy intermediate landscape positions where fuels are damper and fire behaviour is usually less severe, but also because many of the dominant species of this zone have lower flammability than their sclerophyll brothers and species of the adjacent EVC (Additional Reading: Ignition times). This is an important point: our data suggests that position (exposure) has a bearing on flammability, which is perhaps not surprising because fuels must be reduced to 20% moisture before they will ignite (Greg McCarthy pers. comm.). So, the same species growing on a ridge nearby will be more flammable than its counterpart growing in the gully below within the rainforest ecotone.

The second component relies on the fact that the ecotones between rainforest and the adjacent sclerophyll forests have higher light levels than the rainforest, lower frequency and lower intensity fire regimes than the adjacent sclerophyll community. This provides a very important crucible for a range of species that require such a niche (species that often turn up as gap species in rainforest as well). In south-eastern Australia, these include a range of species that may also be found in other environments with similar conditions or fire regimes to rainforest ecotones. These are denoted by: rock outcrops (<u>underlined</u>), lakeshores (in **bold**) and grassy woodlands (<u>**bold**</u> and underlined) and include:

> <u>Lightwood *Acacia implexa*</u>, <u>Hop Bush *Dodonaea viscosa*</u>, <u>Chef's-cap Correa *C. bauerulenii*</u>, Mountain Correa *C. lawrenciana*, Tall Everlasting *Helichrysum elatum*, **Sticky Everlasting *Olearia viscosa***, **Spicy Everlasting *Ozothamnus argophyllus***, Slender Tussock-grass *Poa tenera* (hairy form), Bootlace Bush *Pimelea axiflora*, <u>Limestone Pomaderris *P. oraria* ssp. *calcicola*</u>, <u>Blunt Sandalwood *Santalum obtusifolium*</u>, Sandfly Zieria *Z. smithii*, <u>Dromedary Zieria *Z. tuberculata*</u>.

The third aspect of ecotones is that they allow the extent of each of the adjacent ecological vegetation classes to wax and wane according to the prevailing environmental conditions for the site. In other words, ecotones allow rainforests room to 'breathe': expanding during favourable periods and contracting during unfavourable periods (while still protected by the ecotone itself).

The fourth aspect relates to the diversity of fauna that occupy ecotones. This is usually greater than for either of the adjacent ecological vegetation classes. A similar scenario also operates with regard to the permeability and dynamic status of the ecotones for animals (as it does for plants). Species from both adjacent ecological vegetation classes use them and that use increases and decreases over time according, to season, resources and environmental conditions.

Edge effects: site size and width
Edge effects are a major component of site planning in restoration projects. Edge effects occur along the boundaries between radically different land uses, vegetation types or landforms (such as rivers and their banks) (Additional Reading: Edges). A common example for the rainforest restorer is the boundary between a paddock (or road) and your restored rainforest, which produce big differences in temperature, light and moisture that are the result of exposure to wind and sun along the edge (Figure S216). Where possible, rainforest restoration should include the full extent of the original rainforest habitat plus a buffer zone of the adjacent vegetation (the ecotone and adjacent EVC). Although this is the ideal, it is often not possible. In such situations, where the restoration site cannot include a non-rainforest buffer, the edges should be sealed by plantings of species that can withstand more exposure from both the more changeable and more severe conditions on the edge of the site.

These edge-closing species (Appendix S12), either individually or collectively, develop a dense and continuous canopy cover to ground level that will help provide a physical barrier to the invasion of weeds (especially wind-borne species), reduce wind intrusion and the effects of sun, as well as presenting the public face of your restoration effort (Figures S217 and S218). Such species, while retaining leaves on lower branches, also often root sucker. If such species with this combination of features are not available to you, plant a range of species that together have the same effect, such as bushes and colonial species (Figures S146, S219, S220 and S221). Remember to include the showier species of your restoration species lists (Appendix S12) in these edge locations (e.g. Figure S73).

Corridor design and rainforest restoration: balancing what you have and managing edge effects
Not all species benefit from corridors and these are characterised as those that are colonial and/or have widely dispersed food (Lindenmayer and Burgman 2005). However, there are many that are likely to benefit and these include: species that avoid open space (such as forest-dependent and, in our case, many rainforest species); those with ubiquitous or generalist food needs; and those that live in singles and pairs (Lindenmayer and Burgman 2005). Conversely, we would add from our experience that size also matters: small flocking insectivores (such as thornbills, fantails and fairy wrens) are all common in our rainforest corridors, as are the colonially breeding summer migrants: Tree Martins.

Corridors are believed to provide many benefits. The benefits listed by Lindenmayer and Burgman (2005) follow and have been augmented (in parentheses) with some relevant examples of our experience from south-eastern Australia in our restored rainforest corridors:

- Help movement of animals through sub-optimal habitat (such as cleared land, urban areas, landscapes rapidly evolving or disturbed by climate change and its consequences, etc.)
- Provide habitat to resident populations (those that find sufficient resources within or adjacent to the corridor)
- Provide access to unexploited habitat, such as an isolated remnant for which, migration barriers (open land) have prevented its full occupancy
- Enhance dispersal by reducing mortality during dispersal: open country raptors find it difficult to hunt in treed corridors and many bird species fly along them ready to dive into your restored bush when challenged by a predator (Figure M28)
- Prevent and reverse local extinctions by allowing empty patches to be colonised
- Promote gene flow between populations by increasing effective population size; i.e. the number of sexual encounters and the gene flow that results.

Here are some other questions posed by Lindenmayer and Burgman (2005) that you may wish to consider when designing your rainforest corridor:

- Which species move between habitat patches using corridors versus those that move between them without corridors? That one is easy: open country birds (think the black and white ones: crows, magpies, wagtails etc.) will, but most of your rainforest birds will not. Conclusion: the corridor is worth doing
- How is corridor use influenced by surrounding habitat use? For example, wallabies use your corridor (as they have on the Snowy), but often there is a busy road nearby: the life expectancy of the wallaby is (and was) short
- What is the corridor's value in the landscape context? That is, where is your corridor heading (will it actually connect with other bush or habitat)? Hence the suggestion of attaching nodes to augment its value as a conduit (see Case Studies S2 and S3); and suggestions of using other mechanisms to connect your corridor with existing remnants (e.g. if the Orbost Caravan Park undertook rainforest plantings it would connect our restoration works along the river with the Orbost Rainforest Centre on Lochiel Street)
- Is the corridor also habitat? What you do or allow in your corridor is directly relevant to how well it will act as a conduit for rainforest species (both plants and animals). Hence our findings locally, that if the corridor is:
    - Grazed, then natural regeneration is non-existent and so the corridor is not self-sustaining
    - Similarly, if it is weed invaded, a variety of characteristic rainforest-dependent birds are excluded (see Chapter 9: Habitat value for birds: How well have you done and is your site rainforest yet?)
    - If firewood collection of fallen woody debris is allowed, then the habitat value for Eastern Whipbirds *Psophodes olivaceus* habitat is reduced, because much of their foraging time is spent around and beneath fallen rotting logs
    - Corridors need to have quiet areas suited to species that do not like exposure to other uses or features that may threaten them. For example, Tiger Snakes use riparian rainforest corridors successfully because there is food, cover and breeding opportunities (largely out of the sight of predators, including us)
- How suitable is the habitat destination that you are connecting to your corridor? In other words, if you've made a rainforest corridor that leads to a paddock or a heathland: then under this scenario, it is just a dead end for rainforest birds (if the corridor or node is not wide to act as rainforest habitat in its own right).

<table>
<tr><td colspan="2">EDGE CLOSING SPECIES: BE PRACTICAL AND USE ATTRACTIVE SPECIES</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Figure S216. Site 70b Marlo Road, Lower Snowy River Victoria. The failure to use good edge closing species at this point on this site has led to the invasion of the edge by Prairie Grass *Bromus catharticus when the Kangaroo Apple Solanum aviculare died. Edges are subject to change: what is not clear from the photograph is that there are young germinants of Kangaroo Apple and Sweet Pittosporum P. undulatum in the grass. Because the Prairie Grass is not a transforming species, these natives will establish and will probably close the gap.</td><td>Figure S217. Site 70f Marlo Road, lower Snowy River Victoria. This edge is along the Marlo Road on the lower Snowy River. Showy species include the white-flowered Forest Clematis C. glycinoides and the purple-flowered Round-leaf Mint-bush Prostanthera rotundiofolia, which have been used to both close the edge from hot sun and drying winds, as well prevent the barbed wire fence from killing wildlife. Species previously caught on this fence before edge-closing species were used included the EPBC Act-listed Grey-headed Flying Foxes and Sugar Gliders that are also present on the site.</td></tr>
</table>

The benefits of corridors can be eroded by edge effects. This is especially relevant to rainforest as a vegetation type, because wind and light penetrate edges and interfere with the internal *homeostasis* (stable temperature, light and humidity) that maintain rainforest diversity and health. So what can be done to reduce edge effects?

FRINGING ECOTONES TO RAINFOREST ADD BUFFERS AND ESSENTIAL RESOURCES

Figure S218. Snowy River, Victoria. River Bottlebrush *Callistemon sieberi* occurs as a dominant species in Riparian Shrubland a fringing EVC for Warm Temperate Rainforest (regenerating on bank slumps) and is a late secondary species that (with other shrub species) forms a nursery crop for Gallery Rainforest. It provides huge crops of nectar-rich flowers visited by a range of honeyeaters including rainforest species. Flower study photograph: Sean Phillipson.

Here are some of the questions that have been posed in Lindenmayer and Burgman (2005) that may improve the value of your corridor with our tried or suggested solutions for rainforest corridors in parentheses:

- What forces that are external to your corridor have an edge effect? For rainforest corridors these are primarily to do with sunlight and wind (both reduce humidity and shade: essential features of mature rainforest that can reduce what species, plants and animals, that you can reasonably expect to have in or use your corridor). Useful solutions: plant edge-closing species (see Chapter S8: Edge closure); maximise the width of your corridor; if the corridor is on a river, ensure that both sides are corridors and are planted densely
- How far will the external force penetrate? (Depending on the force and its affect, the impact may be as little as 10m and as much as 250m.) Useful solutions: be pragmatic, your corridor will not be everything to every species and there are some limits when it comes to rainforest corridors (but once again look for ingenious ways of overcoming these external forces)
- Can forces be ranked to support buffer requirements (particularly important when buffering rainforest from adjacent land use, such as logging operations) such as those recommended by Burgman and Furguson (1995) to protect Cool Temperate Rainforest from the deleterious edge effects of logging in Victoria? This is a good example of a corridor in a treed landscape (note that the habitat context is logging disturbance);
- Are the potentially negative forces on your corridor testable (for example does an open edge admit weeds)?
- How or what data can be collected to test this perceived negative force? (Are weeds present or absent? Are the weed species from the exterior of the corridor and do they require something provided by an edge effect? A local example is Brome Grass **Bromus catharticus*: a common component of roadside verges along the lower Snowy River.)
- How can the exterior forces be mitigated? (Close the edge, thereby preventing weed seed entry through wind or mower chute-throw, use edge closure species to cast shade and to make the edge unsuitable for colonisation by these weeds (Figures S216 and S217).

Remember that a corridor or a stand-level rainforest restoration project can be two very different endeavours, wherein may lie fundamental differences in goals between the restoration of a corridor (where edge effects are inevitable) compared with that of restoring a remnant where ecotones and surrounding bushland are still present. What you can achieve under both scenarios is very much determined by your restoration site's landscape context. The results of our work on the lower Snowy River that are presented in Chapter 9: Habitat value for birds: How well have you done and is your site rainforest yet?, strongly suggest that the restoration of rainforest corridors in south-eastern Australia is both valid and definitely worthwhile in terms of their use by rainforest species. The end point of such restoration, though, is almost certainly unlikely to reach the lofty goals of what can be achieved in a well connected remnant restoration. Both are important however, and each has its respective role to play in landscape-scale restoration and conservation of rainforests in our region.

If your restoration project is to be a corridor, here then are some design features to keep in mind (based on what the literature says and what we have learnt) when planning your rainforest restoration site:

- Know where your corridor is going (both literally and where it begins and ends: match EVC with habitat)
- Look for landscape synergies (attaching it to other projects, policies, or remnant vegetation)
- Try to ensure that it fulfils other landscape uses (erosion protection, river health, recreational needs, etc.)
- Think fat not thin
- Add or join up with patches or nodes of bush wherever possible
- Try to make it continuous between isolated remnants. If this is not possible, then reduce the size or hostility of the gap: e.g. plant specimen trees in the gap rather than have it completely open, or low cover below the view lines (see Chapter S8: Plant prescriptions: Views Figures S336 and S339)
- Add landscape value and corridor utility by trying to connect up with remnants, previous restoration sites or proposed future sites
- Ensure that your corridor has the maximum amount of structural complexity (groundcovers, shrubs, trees, vines, small gaps, fallen logs, permanent water, etc.): this will increase its value, particularly for birds, reptiles and invertebrates
- Do not be too rainforest-centric: your corridor may need to have sections of Riparian Forest, Riparian Shrubland or other vegetation because the landform or disturbance regime dictates this. This all adds value (Figure S218)
- Incorporate the maximum diversity of plants appropriate to the site (more species will live in and use it)
- Incorporate ecotones wherever possible: Riparian Shrublands, Riverine Wetlands, etc. Remember that species from other environments will often need your rainforest corridor as essential habitat for roosting and/or breeding (e.g. waterbirds such as herons and ibis).

Structural complexity and biodiversity: one reason why restoration is better than revegetation

Although all of this information, and what it means to the restorer ,may seem a bit mixed, it is very important to note that the most recent Australian reviews of these factors (Munro *et. al*. 2007) shows us three things:

1. Monitoring of replanted areas in Australia is pretty scant and, because ecologically restoration is relatively new, monitoring of such works is even worse.
2. A major influence (other than contiguity, proximity, size and width) on the diversity and composition of fauna groups using replanted areas is its structural complexity with ecological restoration consistently performing better than revegetation
3. Some aspects of this structural complexity are particularly important for some groups:
    a. Groundlayer complexity is important for reptiles (logs and rocks)
    b. Understorey and mid-layer complexity is important for small terrestrial mammals
    c. The presence of old trees on sites significantly increases the bird diversity and abundance (and we have found this to be the case for both emergent trees and canopy trees)
    d. Structural complexity overrides stand age for bird diversity
    e. For the full suite of rainforest-dependent birds to be present and breeding, stand age and development are also important (Chapter 9: How to measure success).

Similar results are noted by French *et. al*. (2008) with regard to Bitou **Chrysanthemoides monolifera* ssp. *rotundata* control and ecosystem recovery (see Appendix S3 Weed management: Worksheet: Example Bitou impacts).

Integrating landscape theory, ecological theory and social philosophy

Rainforest restoration is an art as much as a science and it may seem strange that philosophy is considered an important part of the process. It is important, because, to do ecological restoration successfully, you need to be able to integrate landscape context, ecological theory, social theory and human philosophies. Start on your site by engaging all of your senses to capture your full potential to practice the art of rainforest restoration (Table S15).

EDGE EFFECTS HAVE IMMEDIATE AND LONG-TERM IMPACTS ON RAINFOREST RESTORATION: SO PLAN TO MINIMISE THEM

Figure S219. Marlo Road, Snowy River Victoria. Inappropriate edge species (Black Wattle *Acacia mearnsii* and pruning for road sight-lines) produced an **8m weed edge.** Native regeneration will seal this edge.

Figure S220. Marlo Road, Snowy River Victoria. Pruning for road sight-lines of appropriate edge species (Blackwood *Acacia melanoxylon*), but planted too close to road produced **sun weed edge of 5m.**

Figure S221. Marlo Road, Snowy River Victoria. Appropriate edge species (Blackwood *Acacia melanoxylon*) and distance from road); **minimal weeds edge: <1m.**

Table S15. Integration of social and ecological philosophies for rainforest restoration: engage your senses.

Subject area	Philosophy	Result
Observation	Always observe, but be careful about your conclusions.	An incorrect conclusion can cost you dearly in rainforest restoration.
	Do not be too proud to change your conclusions when your deductions are in error.	Improving your knowledge saves time, effort and resources: accept your mistakes, learn and move on.
	Take a quiet break in your surroundings: it provides invaluable information about what you are doing and how it is going. Use your senses to determine what is going on!	Feel: • The temperature (is the canopy there yet, is it a hot or shaded gap?) • The humidity (will things survive the drought, is it time for epiphytes, is this a refuge from the heat and sun?) • Light and shade (what to plant where) • The wind, breeze or stillness (edge, interior or failure because the wind still rips through) • The soil (is it sandy, moist, peaty, clayey, compacted or ready to plant?). Listen: • Know your animals by their sounds (often you will not see those that you work for and must find them through your ears first) • Is there a busy road nearby: know that your works will cut down on traffic noise (a point of persuasion to nearby residents) • For your community's opinion of your efforts (track down allies and forge partnerships; seek out detractors and listen to their fears or ignorance) Smell: • The flowers (and appreciate their purpose) • The Flying Foxes (they indicate your success) • The ripe rainforest fruit (knowing that the mammals on your site will feast well tonight). See: • The relationships you build • Your success, failures and improvements.
h	Be humble.	You learn more that way.
	Listen carefully to the views of others.	You cannot learn without listening. If you are constantly talking you can't learn because you are not hearing.
	Do not assume people don't know: they often do, but they may just say it or see it in a different way to you.	Knowledge is vital and comes from surprising sources: be open to all of them.
	Everyone has a story and time spent talking is never wasted.	This is the essence of networking.

SUMMARY	
COMPREHENSION: STOP	Landscape factors and processes are fundamental to restoration tasks as they provide: • Insight into what rainforests persist in a hostile fire-ridden landscape and how • A context for what your rainforest restoration site is/was and can be • Allows you to view wider landscape activities and threats and how this might impact on your site.
KNOWLEDGE: THINK	Understand your community and communicate regularly, clearly and well with them. Understand your target rainforest type's ecology (find reference sites) and compare them to your restoration site. Rainforest restoration is not a series of isolated actions: it has ecological and social impacts.
WHAT TO DO?: ACTION	Get out and find out what it means to have your rainforest restoration site where it is: Is it connected? Is it a stepping stone? Is it in the start, middle or end of series of rainforest stepping stones? Can it provide a connection? Will it act as a refuge during climate change? How does it connect with your neighbours and community?
WHAT NEXT?	There is a whole kit of information and tools that you will need to be across before you set out and start a rainforest restoration project. The next chapter supplies your rainforest restoration kit.