Chapter S8 Plant stock and planting

IN RAINFOREST RESTORATION, DOES WHAT YOU CAN 'GROW' DICTATE WHAT YOU CAN RESTORE?

Maybe. The first question is: **why grow it?** If natural regeneration will provide what is required, then release the ecological brakes and the plants will come up on site for you. If not, then there are many considerations in propagation: cuttings of Blueberry Ash *Elaeocarpus reticulatus* (left) are best because seed is very difficult to germinate, so try direct-seeding. Austral Stork's-bill *Pelargonium australe* (right), if nursery-grown, appears in every pot, while species such as Long-flower Mistletoe *Dendrophthoë vitellina* (below) are best sown and grown on site. See Propagation Manual.

Genetics and sourcing plant propagation material

Introduction

Most restoration projects (except those entirely dependent on the Natural Regeneration Method) will require plant stock at some time. The source of plant propagation material and the genetic and management decisions involved are canvassed in this section. This apparently simple task brings into sharp focus the differences between gardening, revegetation and restoration. These differences are important and are worth discussing because it relates to sourcing propagation material:

- Gardening is a human-centric pursuit where the construction, layout and plant production of the area involved are primarily for the benefit of the gardener or an audience. The plants used can be sourced from oversees, interstate and out of the region: they are rarely local and are usually of limited genetic diversity. There is no compunction on the part of the gardener in not using local genetic stock or to refrain from breeding and selection to change the genetics and character of the original wild species to their needs or desires: indeed it is often the avowed aim of the gardener to do so. Benefits to local indigenous biodiversity are usually incidental rather than intended and ecological or environmental damage may result from the introduction of plants from outside the region. Such endeavours can generate environmental weeds and pollute local gene pools.
- Revegetation is somewhere in between gardening and restoration. Ecological processes are generally not considered, nor are ecological brakes. Once again, the layout and location of the works tends to be human-centric: being primarily for stock or crop shelter and does not seek to recreate or restore the pre-existing natural vegetation. Although increasingly these days it does involve the use of local species, genetic diversity considerations are usually secondary and the subsequent control of weeds is haphazard, *ad hoc* or absent. Landscape assessment and an analysis of landscape support are not carried out. Consequently, the size and orientation of such works is often not large enough to provide sufficient area to allow for the reinstatement of the self-sustaining ecological processes that underpin native ecosystems (i.e. such plantings are usually linear, narrow and often isolated in the landscape). At the end of the day, revegetation such as those of shelter-belts are not self-sustaining and will require renovation and replacement as the species first planted die out and these are not replaced by natural regeneration. Genetic diversity is usually minimal, and biodiversity benefits, although intended, are not as great as those provided by restoration, with revegetation in agricultural areas not supporting the richness or composition of remnant vegetation (Munro *et. al*. 2007, or other indicators such as birds Deakin University 2008).
- Restoration, however, is a complex and sophisticated landscape approach that is based on ***landscape analysis*** and tries not simply to replant particular species, but instead aims to reinstate ecological processes and so to conserve species in a way that allows them to maintain their potential for out-crossing, adaptation, migration and evolution over time periods of thousands of years. To achieve this, restoration sets much higher goals and achieves better biodiversity results through a broader and deeper understanding of ecology, succession and landscape context (see Definitions and Synonymy: Ecological Restoration). Restoration sites are chosen with the restoration of biodiversity and the maintenance of their evolutionary potential as primary-level aims. Restoration aims to create a structurally complex result (one that revegetation does not) and this has demonstrated biodiversity benefits for birds (Deakin University 2008), small native terrestrial mammals, and some invertebrates (litter hoppers Amphipoda) in agricultural areas (Munro *et. al*. 2007) and butterflies (Deakin University 2008). Munro *et al*. (2007) found high levels of richness and good correlations with remnants in agricultural areas: a finding confirmed by studies of birds in rainforest restoration in East Gippsland (Chapter 9). In restoration, the secondary benefits to the landscape and to the human population are not incidental, but are planned by way of multiple benefits and synergies such as improvements in river health, reduction in erosion, rehabilitation of degraded farmland, improvements in recreational fishing, nature study, increased farm productivity, and so on.

If the aims of restoration are to be achieved, the rainforest restorer must be much more careful when dealing with conservation of species and plant communities, maintaining regional genetic integrity and ensuring genetic diversity. This is done by having a broad appreciation of speciation (Figure S301), pollinators, seed dispersal, plant populations and the genetics likely to be involved. If you understand these concepts, then the choices you must make about the sources of your plant propagation material become much clearer.

Genetics

How then do plant propagation material collection, genetics and plant stock fit into the rainforest restoration paradigm, given that you are aiming to facilitate the conservation of rainforest and its constituent species, rather than just preserving them in a garden-like setting over the short term? The landscape, size and contiguity considerations that went into your original restoration site selection (Chapter S5), directly affects your sites' genetics (CSIRO 2008) and the plants that you choose are the other major plank that underpins rainforest evolutionary potential. If your plant propagation material has a narrow genetic base, or is inbred, the chances are that your site will look restored, but will not be sufficiently diverse genetically to have the resilience and potential required to adapt to the climatic and landscape changes that now lay ahead of us (BSLCG 2005; CSIRO 2008) in south-eastern Australia.

It therefore appears that if you want to maintain the vigour of your restored rainforest over time, plants that are inbred are indeed a problem. Remember that you have to be thinking 20 generations ahead if you are to avoid inbreeding (BSLCG 2005). Some local examples serve to illustrate the difference between appearance and heredity and why genetics are an important consideration in rainforest restoration in south-eastern Australia.

Although ***provenance*** is very important (plants have had millennia to adapt to the conditions provided by these habitats), genetic diversity and vigour are also paramount to maintain the genetic (and physical) health of small and/or isolated plant populations (CSIRO 2008) that are typical of rainforest stands throughout much of south-eastern Australia. This is so not only for rare or threatened species, but also for the common species as well (CSIRO 2008). Although we do not have to understand every nuance of these niches, we should respect the evolution and genetic adaptation that have, over time, so neatly fitted these species into the habitat envelope that we see today. This decision is basically: the right plants for the right area: choosing plants from other patches that have good flowering and seed set as well, especially where local sources are from small or isolated patches: in other words high-quality seed is very important (CSIRO 2008). Maintenance of this local genetic signature maintains genetic distinctiveness and gives your plantings an edge (BSLCG 2005) because they are adapted to your site and climate, but must be balanced by genetic vigour considerations as well. When you collect seed, select for quality, size of remnant and connectedness, as well as the analogous landscape niche (based on your reference sites) (CSIRO 2008). If the plant material for your restoration site is correctly matched to the site, and sourced from the right provenance and habitat, the growth rates can be quite phenomenal. On the other hand, poor provenance or genetic material choices can be as detrimental as planting the wrong plant or choosing the incorrect species.

A NEW SPECIES SITTING UNDER OUR VERY NOSES!

Figure S301. Gulaga National Park, New South Wales. Despite their accessibility and high levels of study, even today, new species are being described from the rainforests of south-eastern Australia. The massive woody ***liane*** (red arrow) in this stand of Subtropical Rainforest used to be called Wonga Vine *Pandorea pandorana*. It is currently being described as a new species Giant Wonga Vine *Pandorea* sp. (Ipswich). This ‘new’ species occurs naturally from Queensland to southern New South Wales (in the Bunga district). If rainforest restorers had not respected provenance, the true distribution and ecological relationships of this taxon would have been lost. See Definitions and Synonymy: Cover.

Other things that you can do to assist in maintaining and conserving your local rainforests include: ensuring that your patch is as big as possible (within the habitat constraints of your site); ensuring that it becomes better connected over time; minimising the distance between patches (restoring the missing intervening stepping stones); and maintaining the largest populations that are possible. It has been found that site condition is not as important as previously thought: population size and isolation are more important in reducing genetic prospects. As a consequence, we should be seeking to maintain the meta-population: that is, the population that is connected by dispersal of seed and pollen through 'virtual connections', where physical connections have been lost; in others, manage the whole constellation of remnants in the ecosystem, rather than concentrating on only one site or population (CSIRO 2008). From this you can see that reconnection is absolutely vital to the long-term conservation of species.

Without in-depth genetic studies, how can you be sure that there are any genetic differences between individuals of the same species across different sites in the landscape? The answer is to look for indicators of genetic variation such as differences in appearance. It is easy to assume that plants of the same species from different populations that look different are genetically distinct, but is this necessarily so? It is possible that this disparate appearance is the result of slightly different environmental conditions. If, however, plants of the same species that look different grow true to type from seed, then this is a strong indicator that there are in fact genetic differences, rather than environmental ones, causing the observed variations.

We first noticed this with Forest Clematis *C. glycinoides* from the Lakes Entrance-Lake Tyers district compared with those of the adjacent catchment on the Snowy River. Because the clematis seedlings grown at the same nursery using seed from these two different localities were so strikingly different in appearance and grew to type, a genetic difference is the likely cause. Although this does not necessarily indicate different adaptations to particular niches it does show that the development of new taxa (including species) can occur under our noses. This incident served to reinforce our policy of trying to only source plants from remnants in the same catchment. Until this incident, we had never tried to distinguish between the adults of these two populations (we assumed they were the same) and clearly they are not. Another example from East Gippsland is the difference in leaf dimensions of Coast Banksias *B. integrifolia* growing on dunes along the coast compared with those restricted to riverine cliffs on marine limestone more than 30km inland. The average leaf dimensions for Coast Banksias of the Littoral Rainforest growing on dune trees are 61.4mm length and 17.6mm width compared with the Littoral Rainforests of the riverine cliffs 94.1mm length and 17.2mm width. The differences in adult leaves are graphed in Figure S302 and their habit differences for juvenile leaves in Figure S303 and mature leaves in Figure S304. Salinity ecotypes have also been noticed in East Gippsland for Southern Mahogany *Eucalyptus botryoides* (Figure S305). Other factors that may be important are temperature tolerance ranges and water requirements.

It is possible that many genetic differences, including adaptations to important site factors such as salinity or inundation tolerance, can be hidden in plants that look identical (these are called ***ecotypes***). As a consequence, it is important not to assume one individual plant or a small population is adapted to thrive in all of the niches in which the species occurs throughout your district. This can be tested through trials such as those being conducted during 2006-2007 on the lower Snowy River. In these trials, several distinct populations of Common Reed *Phragmites australis* are being planted in six different habitats: both fringing wetland and bank plantings are planned for populations from the marine estuary, the brackish lower reaches below the Princes Highway Bridge and the freshwater reaches at Bete Belong. This will improve our understanding of any ecotypes that may exist (or are hiding) and will allow us to source plants for appropriate niches. If everything grows everywhere, we retain the maximum flexibility in sourcing this important bank-binding and rainforest gap species; but if some ecotypes are uncovered then our future success will very much depend on matching the right ecotype with the right salinity conditions.

Another example illustrates that plants that appear identical can have different tolerances to a specific site factor which can slow or derail your restoration efforts. Around the Gippsland Lakes, Tertiary marine limestones provide habitat for Littoral Rainforest and Warm Temperate Rainforest. Two important pioneer species for these rainforest ecological vegetation classes are Black Wattle *A. mearnsii* and Kangaroo Apple *Solanum aviculare*. Because limestone soils are very alkaline, many plants are simply unable to cope and do not occur on these soils. One factor that is responsible for this is the restricted uptake of some critical plant nutrients where the pH is high. If the uptake of magnesium is inhibited, the plant cannot make chlorophyll: the green pigment in the leaves necessary for ***photosynthesis***. Plants that are so affected appear chlorotic (have yellow leaves) (www.dse.vic.gov.au/DPI/nreninf.nsf.) Such affected plants fail to thrive and usually die in the same year that they are planted. We have found that individuals of these two pioneer species that look identical have very different tolerances to limestone. We have improved the success of plantings on limestone, by only using seed from populations already thriving on limestone when we are restoring these niches (see also Figure 8.53).

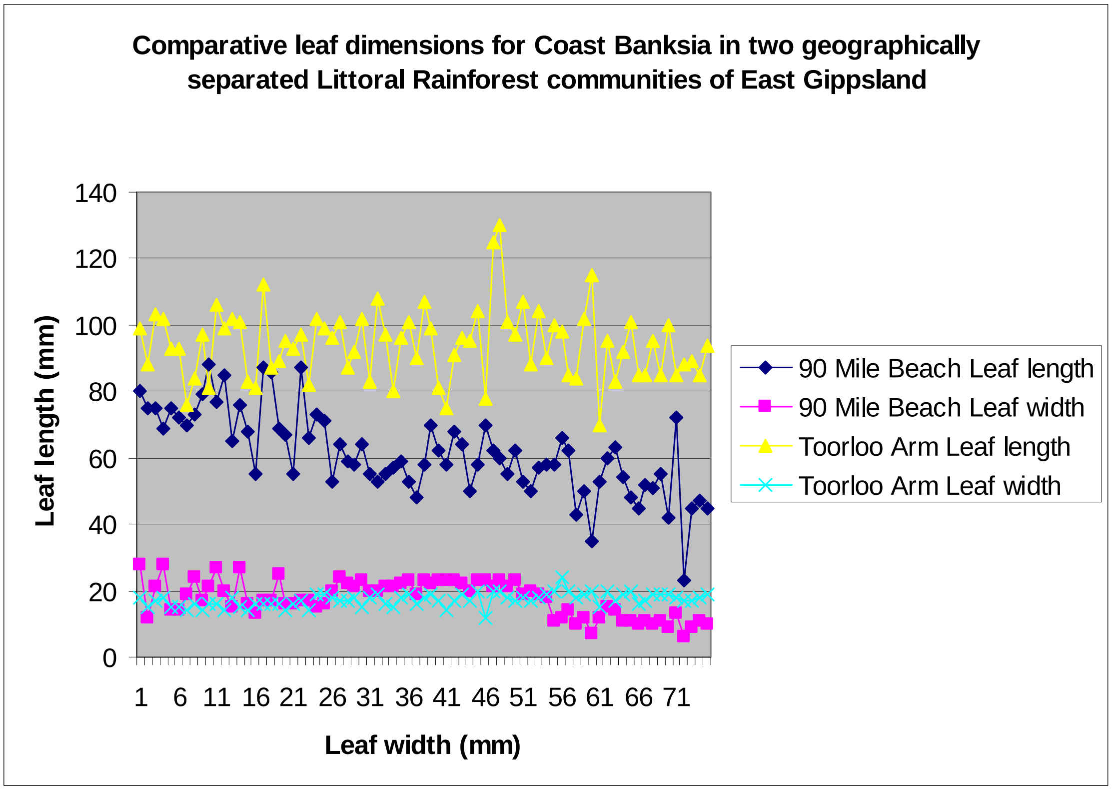

Figure S302. Comparison of leaf dimensions (length and width) between two different Littoral Rainforest populations of Coast Banksia *B. integrifolia*. The 90 Mile Beach population is growing on Pliocene sand dunes, the Toorloo Arm population is growing on Tertiary limestone.

PHENOTYPIC DIFFERENCES IN THE SAME SPECIES IN EAST GIPPSLAND

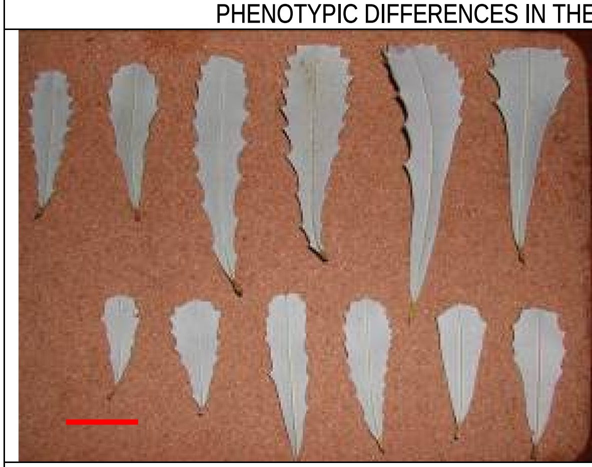

Figure S303. Toorloo Arm (top row) and Lake Bunga (bottom row), Victoria. Juvenile leaves of Coast Banksia *B. integrifolia* randomly selected from 5 individuals from two populations: Toorloo Arm limestone (top row) and the Warm Holes dunes (bottom row). The bar in both Figures 303 and 304 is 2cm.

Figure S304. Toorloo Arm (top row) and Lake Bunga (bottom row), Victoria. Adult leaves of Coast Banksia *B. integrifolia* randomly selected from 5 individuals from the same two populations [Toorloo Arm (top row) and the Warm Holes (bottom row)] as for Figure S303. See graphic representation in Figure S302.

TWO PHENOTYPES THAT MATCH DIFFERENCES IN SALINITY BETWEEN RAINFOREST TYPES

Figure S305. Lower Snowy River, Victoria. Southern Mahogany *Eucalyptus botryoides* seedlings of the same age, grown under the same conditions in Kanooka Eastern Native Flora Nursery in 2006. The multi-branched specimen is from the freshwater river reach in Warm Temperate Rainforest habitat (left) compared with the much more compact plant from Littoral Rainforest habitat on the estuarine reach of the river at Corringle Creek (right). The ***phenotypes*** illustrated are consistent for each seed batch and these two plants are typical. The parent populations are only 2km apart.

Conserving rather than preserving rare or threatened species

Preventing inbreeding should be a major goal when propagating rare or threatened species and introducing them to your rainforest restoration site. If you fail to take reasonable precautions by collecting propagation material from a number of individuals from a number of populations, you are merely preserving the species for as long as it takes for it to stop reproducing as the result of inbreeding depression, rather than conserving it for many generations to come (BSLCG 2005).

A good example of this has come from our conservation efforts for Southern Kurrajong (Blackfellows Hemp) v *Commersonia rossii*: a root-coppicing species found at its biogeographic limit on the Snowy River (Appendix S2: worksheet: Flora at edge of range). We used to have only one colony left at Bete Belong that covered an area of about 1ha. This colony had cuttings taken from it over many years and many plants were produced for the rainforest restoration works on the river. But the newly established colonies on our restoration sites never set seed. In time, the Bete Belong colony flowered and seed-set was eagerly anticipated, but sadly, it never came. This suggested one of a number of problems: the colony was one or several genetically identical sister plants that arose from root-coppicing; the pollinator was not present; or the right weather conditions did not follow for seed set. Several flowerings later, it was clear that no seed was going to come from the Bete Belong population. This suggested that there was insufficient genetic diversity to effect fertilisation.

We began to look for the nearest population from the next catchment (the Bemm River). A population was eventually located one that clearly consisted of many plants separated over several hectares and cutting material was taken and many plants were successfully propagated from these plants. To test our hypothesis that: "lack of seed set in the Snowy population was due to a lack of genetic diversity': we held back a proportion of the propagated plant stock from both populations and allowed them to flower. The result was wonderful: we had lots of seed set. This strongly suggested it was a lack of genetic diversity and not a lack of a pollinator (because the successful fertilisation was effected in the same valley where the sterile population was located). These cutting-propagated plants have now been out on the river for several years and seed set continues.

But what about our wonderful crop of seed? Well, it was sown and we waited, waited and waited: nothing! Then we wondered if the seed set was actually viable. To test this, we took 10 seeds at random and cut them in half to find if there husk contained a viable endosperm (you can do this as well, what you are looking for is a firm often milky-coloured seed, much the same as cutting open a grain of wheat). This indicates a viable seed and we were stumped.

Fortunately for us, the rainforest nurseryman involved (Jurg Hepp of Kanooka Eastern Native Flora Nursery) is a very fastidious and methodical bloke and he kept the remaining seed. Twelve months later (unknown to us), he planted the same seed lot again – and he was rewarded with a fine germination! This taught us a lot about this particular situation: the plants at Bete Belong were inbred (or identical) and the pollinator was not the limiting factor. In addition, these trials showed us that the seed was viable, but that Blackfellows Hemp also requires an ***after-ripening period*** before it will germinate.

Proportions are also important if you want to share (and conserve) the genes of a small population of rare or threatened plants with those of a larger population but, at the same time, not swamp those of the smaller population in the process (BSCLG 2005). You must collect seed and plan the new population carefully. If you collect a bucket of seed from one individual in the larger population and in the same year collect only a few seeds from the rest of the small population and plant them in the same proportions, then you have a problem (BSCLG 2005). You will have significantly increased the population size (good for preservation), but you have increased the likelihood of inbreeding depression of the small isolated population because you have swamped its genes with the genes from the larger population. This will not accommodate evolutionary change (BSLG 2005), which is bad for the long-term conservation of the species on that site. It is best therefore to plant equal numbers from each of your parent populations when establishing a new colony.

In summing up, the advice of Dr. Julia Playford from the 1997 Big Scrub Newsletter, autumn edition (cited as BSLG 2005) above, who was the then Professor of Botany at Queensland University has put it very well:

> "Conservation is a slow process … Doing something about the large areas of land deforested is better than doing nothing, but if you can take the time to do the best possible job it will be worth the effort. We created the conservation mess by being in a hurry, so let's fix it by doing it slowly and properly."

Maintaining regional genetic integrity

The first very clear message from the discussion and examples provided, is to only plant local species that have been sourced from the nearest local rainforest stands on the same (or equivalent) geology and landform. The second message is to conserve local provenances: collect from the nearest stands and preferably in the same catchment as the one in which you are undertaking your rainforest restoration project. Collections from adjacent catchments are acceptable only when no other options exist within the catchment.

To conserve genetic material that is adapted to your site and its particular conditions; try to collect material within 'genetically connected population archipelagos' that are likely to be 'virtually' connected by their dispersal potential. How can you judge whether they are connected? For rainforest species, populations do not have to be growing cheek by jowl to exchange their genes as this occurs both at the time of pollination (out-crossing during breeding) as well as seed transferral between populations.

If a dispersal agent (animal, wind, water or gravity) can transfer a seed from one population to another and the seed germinates and the plant, in turn, produces seed, then interbreeding can occur and genes can be exchanged. Discrete rainforest stands therefore can interact like islands in an archipelago exchanging their plants and genetic material. This is particularly important where dispersal is by wind (orchids, ferns, daisies, and many canopy vines), but also where animals disperse seed (rainforest stand to rainforest stand), either on their fur or feathers or through ingestion of seeds in fruits. The distances over which adjacent populations of plants can interact in this way, can be roughly calculated using a bit of logic combined with some extrapolation of the likely dispersal distances that can be achieved by different dispersal agents. This provides a guide for maintaining local genetic integrity while guarding against inbreeding in fragmented landscapes or where the population numbers of individual species are dangerously low (i.e. less than ten genetically distinct individuals).

So what are the general rules of thumb when forced to use propagation material from adjacent catchments? The following advice relates to what used to occur in intact landscapes where dispersal over distances of 30km may be usual and can still occur in some fragmented landscapes (Neilan *et. al*. 2006), as well as what we have noted locally (Chapter S5: Contiguity, proximity, size and width: helping your restoration site to be the best it can).

Conservatively, we suggest that you select:

- Bird-dispersed seed from within 5-14 kilometres of your site
- Large wind-dispersed seed (Coast Banksia, Forest Clematis, White Milk-vine and Wonga Vine as examples) from metres to kilometres of your site depending on:
    - o Seed weight
    - o Elevation at the time of release (those in canopies going further than those of the sub-canopy)
    - o Lighter seeds going further
    - o Those that remain attached to their floatation device going further (e.g. *Banksia*, *Clematis*, *Hakea* etc.) compared with those that are dislodged from their floatation device going less far (e.g. *Mardsenia*).
- Grey-headed Flying Fox-dispersed seed from sites between 5-17 kilometres from your restoration project
- It seems likely that small-seeded wind-dispersed species (such as daisies) have no meaningful dispersal distance limits in the rainforest restoration context and the catchment imperative is irrelevant;
- Spores of orchids (Figure S238) and ferns behave in a similar manner, however, the caveat on within-catchment sourcing may still apply because many are also likely to be water-dispersed as well (Appendix S5).

In any case, if you do choose to collect from the adjacent catchment, you should obtain your propagation material from the same elevation, landform and geology, especially as these factors seem to influence morphology and speciation. This relationship is especially marked where limestone geology is involved. In East Gippsland, there are four described taxa that occur in Littoral Rainforest that are limited to limestone geology: Limestone Blue Wattle *Acacia caerulescens*, Common Spleenwort *Asplenium trichomanes* ssp. *quadrivalens*, Sticky Daisy-bush *Olearia viscosa* and Limestone Pomaderris *P*. *oraria* ssp. *calcicola*.

Water dispersal is another matter altogether because it involves both seeds and fragments and these can travel rapidly, especially during flood events. The key constraint here is that the dispersed material can survive inundation and is delivered to a suitable niche when it reaches land once more. Riverine or estuarine water-dispersed seeds or fragments can have long periods of buoyancy (Chapter S4: Figure S189) and can potentially travel tens or even hundreds of kilometres, so, for such species, propagation material sourced from anywhere in the catchment (provided it is within the same altitudinal range i.e. foothills versus lowlands) is acceptable.

Oceanic-dispersed plants of rainforest (New Zealand Spinach *Tetragonia tetragonioides* and Scurvy-weed *Commelina diffusa* as examples) are transported over distances that are likely to be of the same order as that for rivers, but there are no catchments with directional flows involved. To avoid mixing genetically distinct populations of Littoral Rainforest plants, simply match the seed set or fragment availability with the time of year to get your dispersal direction via the sea's currents (because these can vary or even reverse according to the season). So, for plant material in New South Wales that is ready for dispersal in summer (and will be dispersed by the East Australian Current), source populations to the north are acceptable. For those species and their populations that occur south of Eden (and will be dispersed by the Circum-Antarctic Western Current) that have plant material ready for dispersal in winter, source populations from the south (including Victoria) are acceptable. In Victoria: summer-set dispersal material should be sourced from the east of your site (the East Australian Current again), while winter-ready material should only be sourced from the west of your site (Circum-Antarctic Westerly Current).

Ensuring genetic diversity

These examples serve to underline that it is best to be very careful and considered when selecting plant propagation material: always collect from as many different individual plants from as many different stands (populations) on the same landform and geology as are available to you (a suggested minimum of ten). If the number of plants setting viable seed is less then ten, then collect from a number of populations, which in some instances may include the adjacent catchment, to avoid inbreeding (BSLCG 2005; Lindenmayer and Burgman 2005). Apart from avoiding the pitfalls already outlined, this approach is necessary to prevent inbreeding that can occur where there are either small and/or isolated populations. This produces inbreeding depression that results from closely related plants breeding only with each other. Inbreeding depression means plants are much less likely to survive in the long-term; will be smaller, and will produce less viable seed (BSLCG 2005) and this is not likely to conserve the population.

If your population sizes are small or isolated, then it is important to mix these seed batches before sowing, so that the new populations you create are genetically diverse (BSLCG 2005). Another way of selecting for diversity and adaptability in small populations is to ensure that you collect seed during drought and good years (Lindenmayer and Burgman 2005). Provided the caveats regarding collection from the same geology and landform are followed, and the proportions of rare and threatened plant seeds are kept the same, then the new populations you create will be well adapted to the niche upon which you are doing your restoration works (irrespective of climate variations). And remember, even if it is not obvious, genetic diversity is out there and should be accommodated in your planning (Figure S306).

GENETIC DIVERSITY IS NOT ALWAYS OBVIOUS: SO ENSURE THAT PROPAGATION USES LOCAL SOURCES

Figure S306. West Cann Bridge, Cann River Victoria. The genetic diversity hidden in this population of Drooping Mistletoe *Amyema pendula* was not evident until it flowered: the normal colour is red (background right). This colour variant is not known to the author from any other site in the study area. Though there is no need to plant it at this site, this example serves to illustrate the need to use local populations when sourcing seed to conserve genetic variation.

Propagation

The decisions you make when choosing which method of propagation to use, will often be dictated to you by factors other than your free will in the matter. Each propagation technique has its advantages and disadvantages: it is species-dependent, propagation material dependent, situation dependent and urgency dependent. So, once you decide what species you need, by when and in what numbers, you have probably already built in the choices that the nurseries will have to make on your behalf in order to fill your plant order.

There are, however, some important features of each propagation method that need to be fleshed out and some significant caveats as well. These may help you to anticipate certain problems and, through better planning and forethought, you may wish to direct nurseries towards specific techniques on some species, especially rare or threatened plants. To help you make these decisions, each propagation technique is examined in turn. More detailed data on how to propagate each individual species is provided in the Propagation Manual.

Seed

Seed is the preferred propagation technique because of the multitude of advantages that these propagules possess.

Advantages:

- It is usually abundant
- Usually reliable
- Easily collected
- Often easily transportable (durable and sufficiently long-lived so as not to require specialist care in transit to the nursery)
- Can usually be stored for a period before sowing is required
- Small amounts (bulk and weight) produce large numbers of plants
- The plants produced are genetically diverse.

Disadvantages:

- Some species produce low viability seed
- Some species only rarely produce seed or do so on irregular (and often unpredictable) occasions
- Some species, we have yet to propagate from seed (Propagation Manual)
- Some species require tedious or long-winded treatments to ensure germination (or triggers are not yet fully understood; Figure S307)
- Plants produced are juvenile and may take many years to set seed.

When to use seed:

- For most restoration needs (except for those situations where cuttings or *division* are more appropriate) but may be limited by:
  - When it is available
  - When it is abundant
  - If it is cheap
  - When its viability is still sufficient at the time of sowing
  - If the propagation times meet your intended planting times.

Spore

Spore-based propagation has some drawbacks, but for many fern species there is no alternative.

Advantages:

- It is usually abundant
- Easily collected
- Easily transportable (durable and sufficiently long-lived)
- Can usually be stored for a period before sowing is required
- Small amounts (bulk and weight) can (if you crack the code): produce large numbers of plants
- The plants produced are genetically diverse.

Disadvantages:

- Not always reliable (sometimes hard to be sure that it is ripe)
- Some species may produce low viability spore
- Some species, we have yet to propagate from spore
- Some species require tedious or long-winded treatments to get germination
- Propagation is a specialist task
- Propagation times usually exceed a year (making ordering and planning for funding and planting problematic for some projects and funding organisations)
- Plants produced from spore usually have to be provided in larger pots
- Given the time, effort and pot size considerations, plants grown from spore are often expensive.

When to use spore:

- When ferns cannot be propagated by division;
- For species which can be divided, but which take a long time to recover (Black Stem *Adiantum formosum*) or fail to establish; and
- For rare or threatened species, where subdivision is inappropriate.

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PROPAGATION FROM SEED: SOME GERMINATION TRIGGERS AREN'T OBVIOUS

Figure S307. Site 70f Marlo Road lower Snowy River, Victoria. The seed of Red Passion-flower *Passiflora cinnabarina* appears to enter a period of dormancy: one which we are yet to fully understand. This picture was taken on a site where adult plants had died out 2 years earlier, but there had been no previous germination. Then, when the drought broke in March 2007, the germination went ballistic, so what could be the explanation? In discussions with the widely respected agronomist Leo Hamilton, he suggested a possible mechanism. During drought, the nitrogen stored in dead plant material is not released due to a lack of moisture. When the drought breaks, there is a massive pulse of nitrogen released. Perhaps it is this nitrogen pulse that broke the dormancy in the passion-flower's seed. We will follow up this possibility up in a trial conducted by one of our local rainforest nurserymen.

Cuttings

Propagation from cuttings (including *layering*) is usually a technique of last resort because of the inherent disadvantages of cuttings over seed, spore or division. The advantages and disadvantages are listed below. Take note, however, of the times when cuttings are exactly what you require, especially when other techniques will not meet your needs.

Advantages:

- The plants produced are limited in their genetic diversity by the number of stock plants used
- Large numbers of some species can be grown in short periods (2-3 months), compared with. 6-12 months for seed
- Stock plants can be kept in nurseries to increase efficiency of cutting collection but should be regularly replaced to ensure genetic diversity
- Large numbers can be grown if the propagated plants are again 'taxed' for cuttings while still in the nursery.

Disadvantages:

- Not as easily collected as seed
- Not as easily transported (usually requires eskies plastic bags, etc.) as seed
- Cutting material is not durable (allow a maximum of a couple of hours from collection to treatment)
- Cutting material is bulky and difficult to handle in the field compared with spore or seed
- Cutting material suitable for rapid and reliable propagation often only appears once or twice a year (and for some in drought years: not at all)
- Not always reliable
- Some species cannot be propagated reliably or at all using this method
- Some species require tedious or long-winded treatments to get root formation

- Cutting propagation of native species (with few exceptions) is a specialist task
- Cutting propagation usually requires hot houses, heat beds and misters to be able to supply plants
- Cuttings have low genetic diversity and are identical to the parent plant.

When to use cuttings:

- In an emergency, to cover short-falls in plants (but remember not to swamp your site with genetically identical plants: leave some room for seed-derived plants in following years)
- When a species or population is on its last legs and large numbers are needed to be propagated to save it
- When a species or population is on its last legs and large numbers are needed to import genes into a larger and genetically more diverse population of the same species
- If seed viability or seed set is rare or intermittent.

Translocation, division and transplanting

Now that the principles of provenance, maintaining regional genetic integrity and ensuring genetic diversity have been established and are understood, the issue of how to get your plants comes to mind. Fortunately, plants are very adaptable organisms and can put up with a lot of rough treatment, provided you know how to handle individual species, the time of year to do the propagation and the time to plant them out. The various methods are outlined, as are the ethics associated with each method.

Plant division and translocation are very useful tools in restoration in general, and in rainforest restoration in particular. There are two scenarios for translocation. The first scenario is where there is a problem with the plants being rare or threatened, the seed is difficult to obtain (Figures S308, S309, S310 and S311) and/or the plant is under immediate threat (Figures S309-S311, S312 and S313).

TRANSLOCATION: IDENTIFY THE THREATENING PROCESS, ALERT AUTHORITIES AND ACT

Figure S308. Wood Point, Snowy River Victoria. Chris Coulton illustrates the browsing height on a mature Buff Hazelwood *Symplocus thwaitesii* browsed by Sambar to 2.5m. Chris is 2m high and with his reach the browsing e is about 2.4m up the tree.

Figure S309. Wood Point, Snowy River Victoria. Ned Rickard pointing out Sambar antler rubbing on Buff Hazelwood *Symplocus thwaitesii* sapling.

It is important to be very clear about the purpose and effectiveness of your translocation efforts when applied to rare or threatened species. You do not want to become an additional threat to the embattled plant on top of everything else it has to deal with to survive (Figures S314 and S315). It is well worth experimenting with translocation and division. Experiments with the Victorian endangered Maidens Wattle *A. maidenii* has shown that about 75% of the translocated root suckers survive in the nursery to a point where they can be planted out. Similar experimentation on Buff Hazelwood showed that only 50% translocation success was achieved with autumn translocation, but 100% with spring translocation. This is not surprising in retrospect because this is a subtropical climate zone plant that actively grows during the warmer months (Figure S315).

The second scenario is where there is an abundance of plant material for species that are difficult or slow to propagate. To be time efficient, species used in this way must grow vegetatively so that they can be translocated using the process of division. These species are usually ***rhizomatous plants*** and so lend themselves to translocation. Species include: Large Bindweed Calystegia sepium and many ferns: Black-stem Maidenhair *Adiantum formosum*, ground-ferns: *Hypolepis* spp. (including *H. muelleri*, *H. glandulifera* and Sickle-fern *Pellaea falcata* (Figure S316).

THIS DOCUMENTED THREAT LED TO SEEDLING TRANSLOCATION AND FENCING OUT OF SAMBAR

Figure S310. Wood Point, Snowy River Victoria. Chris Coulton pointing out the early stages of Sambar browsing of Buff Hazelwood *Symplocus thwaitesii*.

Figure S311. Wood Point, Snowy River Victoria. The later stages of browsing causing death of Buff Hazelwood *Symplocus thwaitesii* .

Ethical and legal guidelines for species translocation

Irrespective of the scenario, some important ethical rules need to be followed. Never use translocation if cuttings or seed is available and either are a viable alternative for propagation of the species involved.

The ethical and legal guidelines for rare or threatened species are:

- Ensure that you have the relevant permits for collection of native flora and that they are current
- Only act with the relevant authorities' explicit consent
- Only act to translocate if the threat is immediate
- Translocation may be justified if seed set is rare or infrequent (e.g. in Victoria: Buff Hazelwood and Southern Kurrajong or Blackfellows Hemp *Commersonia rossii*
- Disturbance of a rare or threatened species produces a prolific vegetative response (e.g. suckering) but the regeneration is itself threatened (e.g. Maidens Wattle *A. maidenii*, suckering onto the gravel verge following fire: Figure S312 and Figure S313)
- Never take more than 10% of any one cohort in any given year, unless the loss of most or all of the population is imminent.

The ethical and legal guidelines for rare species, or those that are uncommon, are:

- Ensure that you have the relevant permits for collection of native flora and that these are current
- Only act with the relevant authorities' explicit consent
- Translocation is justified if there is seed set, but that this is difficult to access (particularly where specific provenances are required) for example Gippsland Waratah and restocking the lower Snowy River floodplain (Figures S317 and S318)
- Individual populations may not set viable seed and require the bringing together of genetically distinct, but geographically close, populations to encourage seed set (e.g. Blackfellows Hemp on the lower Snowy River).

TRANSLOCATION OF THREATENED SPECIES SHOULD FOLLOW STRICT ETHICAL AND LEGAL PROTOCOLS

Figure S312. Burns Road, Newmerella Victoria. The endangered Maidens Wattle *Acacia maidenii* being translocated from the gravel verge of Burn's Road. The rescuer is Jurg Hepp of Kanooka Eastern Native Flora Nursery. Note the methylated spirits that is used to reduce the risk of disease transmission when collecting the root suckers.

Figure S313. Kanooka Eastern Native Flora Nursery, Orbost Victoria. Potted up to allow root development in preparation for translocation, about 75% of these rescued plants survived. They are kept in the nursery for 12 months then transported to their new home. On site, they are removed from their boxes, separated and planted as bare-rooted plants.

For the translocation of common species the ethical and legal guidelines are:

- Ensure that you have the relevant permits for collection of native flora and that these are current
- Only act with the relevant authorities' explicit consent
- Translocation should only occur if damage to the source population is negligible (Figure S319) and it can recover within a year
- Translocation should be restricted to species that:
    - Are difficult to propagate because seed has low viability (some populations of Common Reed *Phragmites australis*)
    - Have erratic or sparse seed-set (e.g. Common Ground-fern *Calochlaena dubia*)
    - Take a long time to be ready to plant out and your project will not succeed if such plants are not available (Downy Ground-fern *Hypolepis glandulifera* and the Willows to Natives Trial on the lower Snowy River in 2004-05; Figure S316)
- Translocation material (e.g. Common Reed *Phragmites australis*) should not be sourced from plant communities that are themselves rare or threatened (e.g. Floodplain Reedbed Wetlands in East Gippsland).

Division is also very useful and can be achieved through hand planting (Figure S320) or the use of machines (Figure S321). Species that lend themselves to division are generally colonial and establish quickly, provided the work is done in the right season, and the right niches are identified for transplantation. This provides rapid native plant cover that can outcompete weed species (Figure S322). This form of translocation is used for protection of both restoration sites (Figure S322) or rainforest remnants that are under threat (Figure S321, S323 and S324). Club-rushes *Bolboschoenus* spp. and Common Reed *Phragmites australis* (Figures S320, S321) are useful; the latter species is a plant of Warm Temperate and Littoral Rainforest gaps along rivers and estuaries (Figure S146).

There are some significant advantages to this technique: rare or threatened species can be saved and populations multiplied and translocated into a number of safer locations, as we have done in Victoria with Buff Hazelwood. This fact also allows threatened species to be used to gain publicity and important supporters for your works (Figure S325).

TAKE GREAT CARE IN TRANSLOCATION OF THREATENED SPECIES: YOU DON'T WANT TO BE THE THREAT

Figure S314. Wood Point, Snowy River Victoria. Careful removal of seedlings of the *FFG Act*-listed Buff Hazelwood *Symplocus thwaitesii* for translocation to sites free of Sambar. Part of this site has been subsequently fenced by Parks Victoria to help exclude this pest species.

Figure S315. Site 70b Marlo Road Snowy River Victoria. Successful arrival of rescued endangered plants to a 'safe site' is something to be shared and celebrated.

COLONIAL FERNS ARE GREAT CANDIDATES FOR TRANSLOCATION (ESPECIALLY UNDER WILLOWS)

Figure S316. Site 41, Lower Snowy River Victoria. Downy Ground-fern *Hypolepis glandulifera* is well suited to translocation. These plants were transplanted two years ago and planted beneath Willows in order to replace their bank-binding role in preparation for the time when they could be safely culled (as they now have been). The original transplants were no more than 20cm x 20cm.

TRANSLOCATION TO RETURN GIPPSLAND WARATAH TO HITS FORMER HOME ON THE LOWER SNOWY

Figure S317. Martins Creek, Victoria. Gippsland Waratah *Telopea oreades* produces abundant seedling regeneration (red arrow) on gravel shoals along the creek. These Gippsland Waratah germinants were used in translocation because the seed is difficult to collect and these seedlings are washed away each year by floods. Germinants were grown on in the nursery for 12 months.

Figure S318. Site 70f Marlo Road, lower Snowy River Victoria. Chris Coulton with a Gippsland Waratah that was collected as a germinant from the Martins Creek Scenic Reserve because the Orbost population has been extinct for over a century. It was planted out on the lower Snowy River adjacent to a picnic area to display its floral beauty, but it was subsequently poached.

TRANSLOCATION CAN BE AS SIMPLE AS DROPPING A BULB ONTO THE GROUND AND STAMPING IT IN

Figure S319. Frenchman's Gully, Victoria. Vegetative transplantation need not involve large amounts of material: a single bulbil of Marsh Club-sedge *Bolboschoenus medianus* was stamped into the soft mud with a boot and this is the plant that resulted 4 months later.

Disadvantages of translocation

Be careful when considering translocation because there are several disadvantages that could have dire consequences for the sites that will host your transplanted species. For plants that are to be divided, be as sure as you can that the parent stock from which you are obtaining your material is free of disease (primarily fungi). This is best judged by examining the parent plants, which should be vigorous, have good leaf colour and show no signs of dieback. For seedling transplantation, similar caution is also warranted because soil borne diseases (particularly dieback caused by Cinnamon Fungus *Phytophthora cinnamomi*) can spread across your host site and may cause havoc. Although dieback in rainforest in south-eastern Australia may not have been linked to this pathogen, caution is still advised.

Transplantation in particular can also lead to other problems for your site. Weeds are often present in translocated material and those with transforming weed species must be managed after planting, or alternatively you will have to choose sites where they do not occur. Species to be particularly wary of include: Cape Ivy **Delairea odorata*, Wandering Jew **Tradescantia fluminensis* and Blue Periwinkle **Vinca major*. Where possible, transplanted material should not be weedier than the site to which it is to be translocated. Ensure that all translocated material is weed free.

TRANSLOCATION CAN BE ACHIEVED BY HAND OR BY MACHINE	
	
Figure S320. Frenchmans Gully, Lakes Entrance Victoria. Clod translocation of Common Reed *Phragmites australis* and Marsh Club-sedge *Bolboschoenus medianus*.	**Figure S321. Lochend Jungle, lower Snowy River Victoria**. Common Reeds *Phragmites australis* translocation following rocking. Note that 6 years later, the reeds have completely covered the rocks({) and have grown into the river, once more building a silt-based bank ({).

The translocated plant material **should never be transferred between catchments.** The reason for this is that it could contain pathogens or pests not present in the catchment to which the material is being transferred. This is especially the case where wetland species are being translocated and the pest species European Carp *Cyprinus carpio* are present, because small fish and/or eggs may be relocated to carp-free catchments.

The last disadvantage of translocation is the damage that you may cause to the parent colony plants when you take the stock that you intend to transplant to another site. This is generally only an issue where the translocation is on a large (industrial scale) or the same site is used frequently. The damage you may be causing to the habitat from which you are 'mining' your parent material may be unacceptable to the land manager; or the recovery time may be longer than you expect (Figure S326). Such sustainability issues may to some degree be minimised if the translocated material is sourced from highly disturbed or fragmented sites of limited habitat value (compare Figure S326 and S327). It is better that the plants be used for a greater benefit and the development of improved habitat that is protected by the translocation. This is especially so on sites that are gradually being eliminated by ongoing poor management (such as is often the case on road reserves) (Figures S326 and S327).

Plant stock

Introduction

The choice of container size (and therefore plant size) is as important, as are your choices of propagation techniques discussed earlier. In the rainforest restoration work undertaken in East Gippsland by the East Gippsland Catchment Management Authority, the vast majority of plants used have been provided as 15cm (6") deep forestry tubes. In contrast, most plantings of Subtropical Rainforest in northern New South Wales are based on advanced plants (Figures 8.30 and 8.32). Basically, the choice of container size is a balance between cost, utility and the establishment success of plants on the restoration site. It is likely that the choice of container type and propagation techniques are going to be budget, site and climate specific, so no absolute dictums can be issued on these subjects. Instead we will relate our experiences and let you decide.

COLONIAL SPECIES ARE USEFUL TRANSPLANT SUBJECTS AND PROVIDE QUICK COVER

Figure S322. Site 70b Marlo Road, lower Snowy River Victoria. Here, two colonial species, Sword Tussock-grass *Poa ensiformis* (foreground) and Common Reed (R background), show the potential for site control using transplantation as a propagation technique.

Hikos

These are generally used where large numbers of plants are required at a low cost, but where the cost or availability of labour is no object and the project has good weed control (because the plants are very small: usually 10-15cm high and easily lost if weeds get out of control). The congruence of these factors is rarely the case for rainforest restoration using the Framework Restoration Method, because most rainforest restoration sites are on fertile soils and weed growth and regrowth is prolific. The large number planted and their small size means that finding them during maintenance in the early stages of restoration is a nightmare and the cost of maintenance is prohibitive. For this reason, it is recommended that only wattles (that are fast growing) be used in areas where weed control is not ideal. These cell-stocks are planted with Pottiputki and large areas can be covered in a short time.

However, in the third year using the Maximum Diversity Restoration Method conditions are just right for the use of ***hikos*** and this enables you to establish large numbers of grasses and sedges. Similarly, enrichment plantings of older Framework Restoration sites can benefit from plants provided in these containers.

Hikos also provide a very useful technique where there is severe browsing or grazing pressure for planting sites with non-sward forming pastures that lend themselves to establishment of small plants. Their small size allows them to be hidden in herbicide-treated grass and to establish before being nibbled. This ensures that by the time that they are discovered: this feeding behaviour does not see them reefed out.

Tubestock

These provide plants at 15-30cm in height, which gives you the option of holding plants over (pruning may be required) should the planting season be unfavourable (Propagation Manual: worksheet: Nursery hold-over Solanum trial). Other plant container sizes have been used for specialist needs on some occasions (Table S28).

PROTECTING BANKS WITH RIVERINE WETLAND CONSERVES RESTORATION SITES AND REMNANTS

Figure S323. Mitchell River, Bairnsdale Victoria. Mixed plantings of Common Reed and Club-rush transplanted onto rock-beaching that is protecting undercut banks on the river. Note the density of the regeneration and its colonisation onto the bank. This site was treated 4 years ago.

Figure S324. Lochend Jungle, lower Snowy River Victoria. This important rainforest reference site saved by rocking and the translocation of Common Reeds. The logs have been placed as fish habitat and have been tied into the banks with cables.

PLANT RESCUE CAN ATTRACT IMPORTANT SUPPORTERS

Figure S325. Site 70f Marlo Road, lower Snowy River Victoria. One of the same plants of Maidens Wattle *Acacia maidenii* rescued (Figure S312) being planted by the Honourable John Thwaites the then Deputy Premier and Minister for Environment with Craig Ingram Independent MP for East Gippsland and his son Will. The tree was planted on the occasion of the Minister's announcement of further State Government financial support for the Rainforest and Riparian Vegetation Restoration Trial. The announcement was made in 2003 and totalled $700,000 over 3 years. This specimen flowered 4 years later in 2007.

Table S28. Plant container size, features of plants grown and application in the field.

Container names	Container size (plant size)	Use
Very small plants		
Hikos	Variable say: 7cm (15cm)	Specialised where weed control is good
Medium plants		
Forestry tubes	12cm (15-30cm)	Most favoured for general use, good hold-over option. Held over plants used for long-stem plantings.
Large plants		
Super tubes	16cm high x 6.5cm wide (up to 1m)	Lilies or other species with slow or poor root mass development; useful as cheaper advanced plants; worthwhile for rare, threatened or special plants.
Very large plants		
Advanced plants	30cm (up to 2.5m)	High cost means last resort use (severe browsing) and for rare or threatened species or other highly valued plants (those that rarely set seed, etc.).
Rocket pots	26cm highx20cm wide (up to 50cm) Other sizes available	

TRANSLOCATION SHOULD NOT CAUSE SIGNIFICANT OR LASTING DAMAGE TO PARENT PLANTS

Figure S326. Marlo Road causeway, Brodribb River Victoria. This colony of Common Reed *Phragmites australis* on a narrow and weed-infested road reserve (right) was used to collect transplant material using an excavator, loaded onto trucks and then onto river barges for placement on the rocking that saved Lochend Jungle – a State Site of Significance for rainforest (Peel 1999) – from bank collapse (Figures S321 and S324).

Figure S327. Marlo Road causeway, Brodribb River Victoria. Clearly, 5 years after the reed rhizomes were removed, the colony in Figure S326 has not yet fully recovered (i.e. the remainder of stand is taller. Alternatives such as nursery propagation of reeds from seed are now used in full-scale restoration on the river. This reduces our reliance on these bioregionally threatened Floodplain Reedbed Wetlands (EGCMA 2000).

Advanced plants

Advanced plants are very useful where browsing is concentrated on palatable tree species and therefore prevents establishment of tube-stock. Because advanced plants are expensive (in the order of $15-25.00: a total of $2,000 a hectare at 10m spacings) and slow to plant, they should only be used where all other strategies to ensure establishment have failed. This cost does compare favourably with tube-stock, where up to 10,000 are planted in a hectare at a cost of $11,000 especially if a significant proportion of these will be lost to browsing during seasons of scarcity. The downside is that each advanced plant generally requires a larger hole, staking and tying: all of which are very time-consuming, but nevertheless worthwhile in the right circumstances, particularly where they have the additional role of protecting your planting from such all-pervasive threats as frost (Chapter S7: Warming frost-prone sites by planting).

Fortunately, because of the large size of these species at maturity and rapid growth rate, they can be planted at wide spacings and the numbers per hectare are relatively small. For example eucalypts: 25 per ha (20m spacing) for a cost of $500, Wattles *Acacia* spp. 100 per ha (10m spacing) at a cost of $2000. Advanced trees are used where rapid establishment of overstorey structure is required. Advanced plants are used for frost protection (including eucalypts and wattles), nitrogen fixation (wattles and sheoaks), replenishment of soil-stored seed (wattles, daisies) and biodiversity (primary canopy species such as Muttonwood *Myrsine howittiana* and Lilly Pilly *Syzygium smithii*).

The other scenario for the use of advanced plants relates to plant rescue and plant translocation. This is usually reserved for rare or threatened species or those of high value.

Ordering plants from nurseries

Introduction

Ordering plants is a complex task that takes a lot of planning, thought and flexibility: both on the part of those ordering the plants and those growing them. Even with the best of intentions, the number of variables that influence the process – calculating numbers, matching this to supply of seed, germination/growing, weather during propagation; nursery care, site preparation, marshalling of planters and delivery – rarely allows your initial order to exactly reflect the final order. In fact, nature always has the last laugh (Figure S328). Holdovers are another option, but require more work and will cost you more for pruning and additional hand watering (Propagation Manual: Nursery holdover Solanum trials).

Flexibility and communication between grower and buyer: plant substitutions and speculation plants

At the outset, be focused on why you need a particular species and in what numbers. Although it is always tempting, as far as possible avoid having your plant order swamped by species that are easy to grow and available in huge numbers for that year. If this is unavoidable, redress the imbalance in the following year's order. Each year or season's order will invariably require species substitutions for one or more of the following reasons: seed cannot be found, seed is found but fails to germinate, or unexpected events in the nursery cause losses. Clear and frequent communication between the nursery and the buyer are therefore essential so that there are no surprises to be sprung on either party, at a time when little choice remains for substitutions. Essentially, your first order is a wish list: and if you treat it that way then everyone can relax and get on with the job of supplying a diverse array of plants that meet your needs when it comes to planting.

Good nurseries usually grow more than is ordered, and often grow species and numbers above contract requirements as speculation plants. These 'spec. plants' are very useful to buyers and project managers because they allow flexibility in substitutions and permit short-term money or unexpected projects with tight timelines to be implemented. It is also a necessary part of rainforest plant propagation, mainly because there are a fair number of species that cannot be sown and grown over a 12 month period (Propagation Manual).

The other reason for this practice is the fact that many mature phase species have seed which sets irregularly (in other words if you see it: you should collect it). This may occur when there is no money for these species or a suitable project at the time. In addition, many of these species, as well as the more regular fruiting species (e.g. Lilly Pilly), have seed that dies within a week if not sown immediately. Although such plants fall outside contracted orders, there is a benefit to both parties if substitutions are made from this pool of species that must be grown on speculation. It satisfies both parties' needs and provides a considerable amount of flexibility to rainforest restoration projects and often adds an element of diversity that is hard to plan for in big projects. Although project managers generally cannot commit to buying such plants; common courtesy dictates that these spec. plants should be the first on the list for new money or unexpected windfalls as recognition of the risk taken by the grower (effectively on your behalf).

In short, work cooperatively, maintain regular and clear communication about your orders and do not be absolutely wedded to x number of plants of y species. Experience shows that where communications are good between buyer and nursery, it is reasonable to expect a 5-10% variation between the initial order and the final delivery: seasonal, pest or weather disasters notwithstanding.

Nursery order cut-off dates for seasonal delivery and planting

Each species of plant has its own particular germination, growing and nursery care requirements (Propagation Manual). Some species are summer growing and are sown in late winter (Kangaroo Apple *Solanum aviculare*); others are winter growing and can be sown in summer and autumn (Hazel Pomaderris *Pomaderris aspera*); while others require more than 12 months to be of a size to plant out (Jasmine Morinda *Morinda jasminoides,* Muttonwood *Myrsine howittiana* etc.). Because of these differing growth requirements of plants seed collection, propagation and delivery times will be species-dependent. These growth requirements, container size and seed collection times have been combined into a yearly planner for your reference in Table S29. This table should enable you to coordinate your seed collection based on the types of plants that you require, when they are best sown and when your project will need them on site. If there is any doubt, good communications with your nursery will sort out any problems that can crop up.

SOME THINGS YOU JUST CAN'T BELIEVE!

Figure S328. They say that 'time and tide wait for no man;: well neither do plants. Matching plants grown with planting cycles, climate, money, a site and planters, sometimes just does not come together! Here Blady-grass *Imperata cylindrica* poses an interesting problem for the planters next season. This species is useful for northern or western edges and sunny gap plantings for Warm Temperate and Littoral Rainforest with sandy soils on flood plains, riverine cliffs, coastal dunes and cheniers. These were planted horizontally and seemed just fine: though the look on the planter's faces when they were unpacked was priceless!

Table S29. Nursery order cut-off dates for south-eastern Australia, calculated from likely planting season.

Season	Summer			Autumn			Winter			Spring		
Scenario	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Frost restricts planting												
Frost-sensitive (fast) plants												
Frost-sensitive (slow) plants*												
Autumn planting												
Winter planting												
Spring planting												
Advanced plants (fast)**	pot up	pot up										
Advanced plants (slow)*												
Vernalised plants												
Winter sown species**												
Spring sown species**												
Summer sown species**				fast	fast	fast				slow	slow	slow

LEGEND	
Seed collection	(red)
Sowing	(purple)
Growing period***	(yellow)
Planting season	(green)

NOTES (see notes below and in the text):
*These species take more than a year to grow: seed collection is species-specific (this includes ferns) as are growing and production times (usually >12 months).
**Seed collection is species-specific.
***For advanced plants, time your planting to their production. The timing of the transfer of tubestock to the larger pot gives you some control over this.
If you have trouble working out this Table (even with the explanation in the text), show it to your grower. They will be able to assist you in planning your order and the options available based on of plants, their growing requirements and delivery times.

The supply and delivery dates are negotiated between you (project manager, landholder, community group etc.) and the nursery **every** time. Plant ordering is a big and complex task, but, with practice, organising orders will become second nature to you. Some explanatory notes for Table S29 are as follows:

- **Advanced plants (fast)**: seed sown August-September, potted into large pots in December January for pickup in following spring (September); suitable species: wattles, eucalypts, boobiallas
- **Advanced plants (slow)**: uses tube-stock that was sown in the previous year and grown as forestry tubes and then potted up when they are 30-45cm high. Potting up into larger containers occurs in October for delivery in following spring; suitable species include Muttonwood *Myrsine howittiana*, Lilly Pilly *Syzygium smithii*, and Kanooka *Tristaniopsis laurina* .
- **Winter** sowing is only for species needing vernalisation (Tree Violet *Melicytus dentata*) and active winter growing species: Flax Lilies *Dianella* spp., Tussock Grasses *Poa* spp., Hazel Pomaderris *P. aspera*, Fireweed Groundsel *Senecio linearifolius* etc.; or fast growing frost-sensitive species such as Kangaroo Apple that are kept in hot houses until spring
- **Warm-season growing species** (coincidently often with small seed) are sown in spring and summer. Slower growing species that would be ready for winter-spring pickup include: Spiny-headed Mat-rush *Lomandra longifolia*, eucalypts, wattles, Leptospermums and Callistemons, Melaleucas, etc. These species take a longer time to reach a size where they can be pricked out. This can be accelerated by fertiliser applications but this significantly increases the risk of damping off (Jurg Hepp pers. comm.)
- **Warm-season growing species** are sown in spring and summer. Fast growing species that would be ready for collection in the following autumn include: Hops Goodenia *G. ovata*, Shade Pellitory *Parietaria debilis*, Cockspur Flower *Plectranthus parviflorus*, Indianweed *Sigesbeckia orientalis*, Shade Plantain *Plantago debilis,* Golden Everlasting *Xerochrysum bracteatum*
- **Slow growing plants.** These species take more than a year to produce specimens suitable for planting out. These include: Wombat Berry *Eustrephus latifolius*, Scrambling Lily *Geitonoplesium cymosum*, Jasmine Morinda *M. jasminoides*, Muttonwood *Myrsine howittiana*, Buff Hazelwood *Symplocus thwaitesii* and Lilly Pilly *Syzygium smithii*. Such species are either slow to attain a height suitable for planting and/or root development is slow
- **Ferns** are in a class of their own. An additional reproductive cycle must occur before a plant appears that can be potted up. Ferns usually take at least 18 months and up to two years to be ready for collection.

Forward ordering of plants

Many organisations that undertake large-scale restoration or revegetation works find it difficult to fit funding, budgeting and project implementation cycles in with the natural cycles of seed set, plant germination, growth and planting season. The reason for the problem is that funding cycles rarely extend beyond one year and once the project planning is complete, the time available to complete the project is often less than 12 months.

Where large numbers of plants are required, it is not fair for small commercial nurseries to bear the risk of growing plants on speculation. What can be done in such situations? For the reasons outlined in the explanatory notes for Table S29, we have found it beneficial to forward order plants (provide an order number to the nursery for a specified amount and to have a range of plants on hand at a specified time). This makes plants available for projects in the coming year for which the location or monies have yet to be finally determined. We have forward ordered 20% of our plant needs and have found this to be satisfactory and to the mutual benefit of both the agency and the nurseries involved. We have used the following rationale (that you may find useful), to pre-order plants for rainforest restoration in East Gippsland under this arrangement:

- Permits a spring planting within contract cycles
- Expands the planting season by having mature plants on hand when climatic conditions allow for their planting
- Allows greater flexibility to have utility plants on hand (those widely used as pioneer species in rainforest restoration as well as for river revegetation) to deal with unexpected or emergency projects. For East Gippsland these include: Silver Wattle *Acacia dealbata*, White Sallow Wattle *A. floribunda*, Blackwood *A. melanoxylon*, Bottlebrushes *Callistemon* spp., Tasman Flax Lily *Dianella tasmanica*, Kunzeas *Kunzea* spp., Tea-trees *Leptospermum* spp, Spiny-headed Mat-rush *Lomandra longifolia*, Paperbarks/Honey Myrtles *Melaleuca* spp. and Kanooka *Tristaniopsis laurina*.
- If the woody species that are utility plants are not taken up, they can be held over in the nursery for a year to be converted into long-stem plants that are integral to the revegetation of sand bars and rapidly eroding banks on rivers.
- Allows for the use of plants that take more than 12 months to grow (Propagation Manual) to be included in orders (mostly rainforest plants). For East Gippsland these include: Yellowwood *Acronychia oblongifolia*, Blackstem Maidenhair *Adiantum formosum*, Wallaby Bush *Beyeria lasiocarpa*, Pinkwood *Beyeria viscosa*, Common Ground-fern *Calochlaena dubia*, Prickly Currant-bush *Coprosma quadrifida*, Prickly Tree-fern *Cyathea australis*, Lacy Ground-fern *Dennstaedtia davallioides*, Paroo Lily *Dianella caerulea*, Tasman Flax Lily *Dianella tasmanica*, Austral Lady Fern *Diplazium australe*, Bolwarra *Eupomatia laurina*, Wombat Berry *Eustrephus latifolius*, Scrambling Lily *Geitonoplesium cymosum*, Downy Ground-fern *Hypolepis glandulifera*, Spiny-headed Mat-rush *Lomandra longifolia*, Jasmine Morinda *M. jasminoides*, Sickle Fern *Pellaea falcata*, Rough-fruit Pittosporum *P. revolutum*, Sweet Pittosporum *P. undulatum*, White Supplejack *Ripogonum album*, Muttonwood *Myrsine howittiana,* Austral Sarsaparilla *Smilax australis* and Lilly Pilly *Syzygium smithii*.
- Allows for the use of summer growing species that must be sown in late winter (at the end of the contract cycle) or early spring (before contracts are normally finalised). For East Gippsland these species include: Large Bindweed *Calystegia sepium*, Jungle Grape *Cissus hypoglauca*, Staff Climber *Celastrus australis*, Jasmine Morinda *M. jasminoides*, Common Boobialla *Myoporum insulare*, Kangaroo Apple *Solanum aviculare*, Large Kangaroo Apple *Solanum laciniatum*, Green-berry *Solanum opacum*, Forest Nightshade *Solanum prinophyllum,* Eastern Nightshade *Solanum pungetium* and Gunyang *Solanum vescum.*

Planting seasons across south-eastern Australia

Planting seasons are as critical to the rainforest restoration process as are nursery growing periods. The objective in south-eastern Australia is to plant without watering-in or follow-up watering. This is in contrast to the Big Scrub around Lismore where they both water in and do follow-up watering.

Both the start and duration of the planting season is regionally set. The start of the planting season is marked by a combination of deep and even soil moisture into which you can plant and a favourable temperature outlook for the next 2-3 months (i.e. limited frosts for a majority of that period). For climatically benign sites with only a few light frosts (subtropical climate zone north of Bermagui and coastal sites throughout south-eastern Australia), planting can start in autumn. On frosty or cool temperate climate zone sites, planting is limited to spring if winter temperatures regularly fall below -4 to -5^{o}C.

Moderate temperatures allow root growth and do not damage the leafy portion of the plant. Plant survival going into winter is therefore more often governed by a drop in temperature than moisture stress, because the days are becoming shorter, temperatures are dropping and dews are common: even under low a diminished rainfall regime. All of these factors combine to reduce water stress. Planting seasons for cooler (i.e. not frosty sites) can be extended by using mostly winter growing species (mentioned above).

On the spring side of winter, using the end of the planting season is always a gamble: days are lengthening, temperatures are increasing and the loss of plants is more likely to be related to moisture stress, not low temperatures. This end of the planting season therefore holds much less certainty because you are relying on good follow-up rains at strategic intervals to ensure establishment (except in the subtropics where there is a greater chance of summer rainfall. The same starting principle of deep and even soil moisture at the time of planting still holds as it did for autumn plantings.

Planting times by region, landscape unit and climatic cycle

You will note by consulting Table S30 that there are very distinct difference between the Victorian end of the South East Corner Bioregion and the New South Wales section (particularly during drought) with regard to the planting season duration. Although drought can be severe in both regions, Victoria's more southerly position usually allows for at least some planting over winter as some (though reduced) frontal rain does occur during *El Niño* years. Note ,however (for both regions), that the frost limitations during droughts are both extended and more severe. Advice on the New South Wales section of the region was primarily sourced from Jackie Miles and Stuart Cameron and some observations of the author.

Successional planting on frosty sites or during droughts is greatly enhanced by using the frost cover afforded by hardy pioneer and secondary species. Although you may get away with planting frost-sensitive species in non-drought (*La Niña*) years) in open situations without such cover when cloud cover is frequent and moisture levels are high overnight, it is a significant risk. If you do not use these protective species during drought periods when frosts are on average: more frequent, longer in duration and colder; then you will end up with a site that looks like Figure S288 where the average number of frosts jumped from 18 (DSE 2008) to 45 (Jurg Hepp pers. comm.).

Timelines: a rainforest by when?

How long does it take to produce a functioning rainforest? What are the *ecosystem processes* that produce and/or maintain a rainforest? What are the ecological processes we are trying to reinstate and, if they were reinstated, what would they look like? If you can list some of these at the outset then you can get some idea of what you are aiming to do. Perhaps as importantly, it focuses your mind on what components of the ecosystem that you must reappear before you can conclude that there has been some degree of rainforest restoration success (Table S31). Figures S319, S330 and S331 illustrate some correlations with rainforest restoration success (we know of) in south-eastern Australia.

Another example is that of Gippsland Water Dragons *Physignathus lesueurii howittii* (Figure S250), which are largely restricted to the river margin where sites are infested by Kikuyu **Pennisetum clandestinum*. Once rainforest is restored, food resources (fruit and other foods) become available; the more open ground layer provides easier access to the restored rainforest and this species responds by using more of the levee many tens of meters further from the river itself. On the other hand, Tiger Snake *Notechis scutatus* populations decline markedly under the same regime, possibly because Swamp Rat *Rattus lutreolus* populations initially crash as the weed-based cover and food items are lost during weed control. Once the rainforest is established, new non-weed foods are available for prey species. This is the time when Tiger Snake populations are likely to recover to some extent as the other habitat requirement for the snakes (groundcover) also increases. Unpopular as that may seem, we regard Tiger Snakes as a part of a healthy ecosystem, because they help to keep rodents (amongst other species) to appropriate levels.

Sometimes the stages of restoration can be tracked through the behaviour of animals using your site and these can have unexpected benefits. Blanket-leaf *Bedfordia arborescens* is a late secondary species and cannot be established until the shade of pioneer species plantings has developed (it hates hot feet and full sun in the lowlands). This had an unexpected benefit for Bellbirds *Manorina melanophrys* on the site. Prior to the planting of Blanket-leaf, their nests were only lined with rootlets. Given that they begin nesting in mid-winter (Pizzey and Knight 2003), the 'plant-down doona' obtained from the undersides of the Blanket-leaf probably helped to insulate the eggs better to allow more young fledge (Figure S330).

Planting prescriptions

Introduction

In some situations planting prescriptions are useful. These involve sets of 'recipes' that save practitioners from particular pitfalls, such as not planting vines along electric fences. A couple of useful prescriptions are provided below while Appendix S21 provides an edge species planting guide so that your plantings will not interfere with fences, paths or roads. In the long term, this means that your plantings will not be interfered with by other authorities who have to remove your plantings in order to protect their infrastructure (Figure S332).

Table S30. Planting seasons for rainforest restoration by region across south-eastern Australia.

Catchment or situation	Victoria: Otways, Central Highlands, Strzeleckis, Wilsons Promontory, Mitchell-Nicholson-Tambo (including Gippsland Lakes)			Victoria/New South Wales (cool temperate and warm temperate climate zones): Central Highlands, Lake Mountain, Donna Buang, Baw Baws, Snowy, Buchan, Murrindal, Brodribb, Bemm, Cann, Genoa, north to Eden				New South Wales (cool temperate, warm temperate and sub-tropical climate zones): north from Merimbula to Batemans Bay			
Planting season	Lowlands	Mountains, foothills or frosty gullies	Drought years	Lowlands	Mountains, foothills or frosty gullies	Peaks and montane plateaus**	Drought years	Lowlands	Foothills or frosty gullies	Peaks and montane plateaus**	Drought years
December	*		*								*
January	*		*								*
February	*		*								*
March											*
April											
May											
June											
July											
August											
September											
October	*		*				*	*			*
November	*		*				*	*			*

LEGEND	NOTES
	Not recommended (primarily due to predictable water and temperature stress on plantings).
	Exceptional seasons (when they occur) or moist niches that persist for extended periods (toes of banks, gully floors, etc.).
	Drought years (limited by moisture and extended period and intensity of frosts): plant in moist niches or if soil moisture permits as the result of deep soaking rain.
	Planting season optimal (for moisture and temperature).
	Refers to Cool Temperate Rainforest in the cool temperate climate zone.
	Frost limited (even with frost-hardy nursery crop species or winter growing species): plant in sheltered or warm niches only, or in more appropriate season.
	Plant (in frost shelters) if there is good soil moisture: take the risk that even if the drought has not broken, there will be sufficient follow-up rain to ensure establishment.

*Use of long-stems (for suitable species) allows planting in any season where frost is not a limiting factor

** No direct experience available: planting opportunities may be more or less than indicated (depending on the frequency and persistence of autumn, winter and spring cloud cover) that mitigates frosts..

Table S31. Some criteria for assessing rainforest restoration success based on East Gippsland restoration sites.

Rainforest process	Criterion	Time taken to achieve criterion
Structural (see Appendix S16)	1. Pioneer species canopy closure (Figures S100, S120) 2. Secondary species canopy closure (Figure S119) 3. Mature species canopy closure (Figure AS16-4).	• 0.5-1 year • 2-5 years • 10-15 years
Natural regeneration*	1. Soil seed bank regeneration (Chapter Opener; Figure S277) 2. Pioneer (gap) species regenerate (Figure S272) 3. Secondary species regenerate (Figures AS18-8, AS18-9) 4. Primary species regenerate (Figure AR31) 5. Off-site recruitment (Figure AR32) 6. Lichens and mosses colonise (Figures S147-S152) 7. Vascular epiphytes colonise (still waiting)	• 1 year • 1-2 years • 3-5 years • 2-5 years • 2-3 years • 5-[10-15] years* • ??many decades
Bird colonisation**	1. Open country species present 2. Open country species decline 3. Generalists arrive 4. Generalists that live in rainforest arrive 5. Azure Kingfishers excavate nest burrows (Figure S249) 6. Boobook Owls roost in rainforest plantings 7. ***Rainforest-dependent*** species arrive (some breed) 8. Increasing numbers of rainforest-dependent species breed 9. Rufous Fantails breed when vaulted canopies form 10. Powerful Owls visit (Figure S82) 11. All rainforest-dependent species stay: rainforest is mature.	• 0 year • 1-3 years • 1-2 years • 1-5 years • 2-3 years • 4 years • 2-15 years • 4 years-decades • 20-22 years • 40 years • ??Decades
Mammal colonisation***	1. Wombat 2. Swamp Wallaby 3. Ringtail Possum, Echidna 4. Antechinus.	• 2 years • 1-3 years • 3-5 years • 10-15 years
Reptiles****	1. Blue-tongues (Figure S68) 2. Gippsland Water Dragons (Figure S250).	• 3 years • 3 years
Pest animals	1. Fox (den-making for breeding) 2. Sambar.	• 2 years • 4 years

*Speed of lichen colonisation is site-dependent and apparently linked to relative humidity (with river plantings obtaining their first lichens in five years, but drier more exposed sites, such as Littoral Rainforest requiring 10-15 years)

**Bird colonisation varies according to climate and landscape context (e.g. Rufous Fantail *Riphidura rufifrons* will use restoration sites as young as four years old during drought when mature remnant abuts the restoration works); however, will only breed in older sites with vaulted canopies

***Mammal colonisation is dependent in part on the quality and stage of the restoration site, but is also influenced by the proximity and contiguity of the site to existing remnants

****Reptile colonisation and abundance changes rapidly in response to food availability, nesting sites (leaf litter, warm sands, etc.), cover and sunlight for basking; and in time rainforest dependent species that need less sun will arrive.

In other situations, rainforest restoration is not necessarily the primary aim of the works to be done on a particular site. The Mitchell River Walk in Bairnsdale is a prime example. Even though vegetation restoration is a primary aim, the locals have determined that a variety of recreation pursuits should be available along the river: fishing, walking, sunbaking, river views, and so on. If rainforest restoration was to get a hearing in this scenario, rainforest restorers and planners had to be flexible. It is better to accept some role rather than none, but this requires you to know when to push a point and when not to do so.

As a consequence of this approach, a number of sites are being restored with rainforest and the balance is being restored with Dry Valley Forest (a much more open vegetation type) that facilitates a less ‘gloomy and claustrophobic’ restoration result that is preferred by the locals at this stage. It is the responsibility of those that undertake rainforest restoration to be flexible and to do this you must know the growth habits and best features of the plants that you use in rainforest restoration. This will allow you to participate in the debate and still be at the table when works are being undertaken and an opportunity to do rainforest restoration presents itself. Alternatively, it also allows you to offer individual rainforest species for landscaping use when a more horticultural planting is needed. Let’s face it, many of the rainforest plants of south-eastern Australia have outstanding horticultural features (Figure S333) and should be used in that role on sites that once used to carry rainforest, but for whatever reason are not likely to be fully restored.

By not being dogmatic about rainforest plantings in every situation, you can at least supply local species that are visually attractive and provide at least some benefit as habitat value in a horticultural setting.

ECOSYSTEM FUNCTION CAN BE SEEN IN MANY WAYS: SOMETIMES MANY AT ONE SPOT!

Figure S329. Site 70b Marlo Road, lower Snowy River Victoria. Now a year old, this Satin Bowerbird *Ptilonorhynchus violaceus* bower was built on a 3-year-old restoration site and they left Sweet Pittosporum *P. undulatum* germinating in their droppings. The surrogates that show ecological processes returning are: the seedlings suggest site maturity, the bower says habitat, food, cover and the site is structurally and compositionally diverse, leading to courting; and other birds have provided bower decorations (Crimson Rosellas *Platycercus elegans*).

Edge closure

Edge closure of plantings from the rainforest perspective is very important because it reduces the likelihood of sun weed invasion and reduces light and wind exposure for the rainforest stand (Figure S334) and failure to maintain a closed edge leads to weed invasion (Figure S216). It can also be critical in some rainforest types (e.g. Littoral Rainforest) where ***frontline species*** (Appendix S6: worksheet: Frontline species) are essential to develop and maintain storm shutters. On the other hand, planting visually attractive species is a good idea (Figures S217 and S334). It is also important at the outset to consider the adjacent land use (Figure S332) and whether your edge species (which may want to stray onto that land) are manageable. For example, using species that may be toxic to stock if farming is the adjacent land use is not appropriate, nor are suckering woody species near mown areas (Appendix S6: workshop: All species+FCs, 'OTHER' column).

Ideally, rainforest restoration should involve planting a sclerophyll ecotone (broad-leaved fire-suppressant secondary plant species of the adjacent eucalypt forest). However, in many situations (along roads, amenity plantings or where the normal ecotone habitat is missing, edge-closing species need to be employed. In general, they are exposure hardy bushy species that retain foliage right to the ground that can provide a barrier against light and wind. Combinations apart from shrubs or trees that are bushy to the ground include mixed plantings of one or more of the following life-forms: vines, ferns and grasses. A list of useful edge-closing species is provided in Appendix S12. In addition, root suckering species of shrubs and trees should be avoided if the damage that they do to fencing and paths (Figure S332) is an issue, while rhizomatous ferns or herbs may be quite useful in providing a soft edge to the restored rainforest.

Frontline species

We have provided a list of frontline species (Appendix S6: worksheet: Frontline species) that are essential for Littoral Rainforest restoration and ecological maintenance. The species have been arranged by height so that you know which spatial sequence to plant them on your site: the smallest in stature at the front, the largest towards the rear. Remember your successional planting, because it is no good planting something that requires high soil carbon levels before the carbon has been accrued in the soil (see also Chapter 8: Generalised planting prescriptions by ecological vegetation class: Littoral Rainforest). Some species have a wide range of stature (from 0m to 10m or more): these include trees that can begin as ground cover and end up as canopy species (Figure AR16); Rusty Fig *Ficus rubiginosa* is the classic example (but there are many more) that produces that classic wind-sheared wedge-shaped cross-section of an intact storm shutter (Figure AR19).

3 YEARS AND NEW LIFE JUST APPEARS!

Figure S330. Site 70b Marlo Road, lower Snowy River Victoria. Bell Miners *Manorina melanophrys* nesting on a 3-year-old Maximum Diversity Method restoration site: the nest is in 3-year-old Sweet Pittosporum that established under Kangaroo Apple that germinated from Ian McKeown's experiment 4 years before. It is lined with plant down from the undersides of Blanket-leaf *Bedfordia arborescens* planted 2 years previously. Lewins Honeyeater *Meliphaga lewinii* also lines its nest with this plant down (Max James pers. comm.).

Figure S331. Site 70b Marlo Road, lower Snowy River Victoria. The same nest with two young that are about to successfully fledge, no doubt assisted by that year's addition of Blanket-leaf *Bedfordia arborescens* down. Mistletoe Birds *Dicaeum hirundinaceum* go even further and use Blanket-leaf down to construct the whole 'babies bootie' shaped nest from it, bind it with spider's web and then adorn it in wattle blossom: a wonderful sight.

Electric fences

For the efficient functioning of these fences, they should be kept clear of any vegetation. As such, vines should not be planted near to them, nor should species that are likely to grow through them or fall on them. Management of electric fencing surrounding plantings may include planting palatable herbaceous species that can be periodically grazed through the fence by stock. This can be achieved by turning off the fence for short periods.

KNOWING THE FEATURES OF YOUR RAINFOREST SPECIES ENSURES THEY ARE USED APPROPRIATELY

Figure S332. Centrepoint Plaza car park, Lakes Entrance Victoria. A Blackwood was inappropriately planted in a small garden bed at a shopping development at Lakes Entrance. This species is a strongly surface-rooted species that is inclined to sucker as well. The poor choice made by the landscape architect has seen the tree removed because of the inappropriate planting.

Figure S333. Swan Reach-Bruthen Road, East Gippsland Victoria. Rainforest species from the region have stunning horticultural values. Use them along paths with great effect while still providing good rainforest habitat values. Pictured here are in the foreground: Sweet Pittosporum *P. undulatum* (foliage, fragrant flowers and bright orange fruits) and Eastern Bitter Bush *Adriana glabrata* with the maroon foliage.

SEALING THE EDGES OF PLANTINGS WILL REDUCE THE AMOUNT OF MAINTENANCE REQUIRED

Figure S334. Site 70f Marlo Road, lower Snowy River Victoria. Efficient edge closure reduces the weed maintenance of the edge and if you choose your species well: a visually stunning public face to your restoration works. These species is Forest Clematis *C. glycinoides*. Such treatments avoid the edge effects shown in Figure S216.

Barbed wire fences

For the protection of rainforest restoration sites, the use of barbed wire fences should be minimised wherever possible and used only where there is no other economic or practical alternative. The reason for this is their hazard to wildlife (especially mammals) with gliders and Grey-headed Flying Foxes frequently dying a painful death in their barbs.

Having said this, in areas where their use is necessary, there are a number of species that are very good at reducing the impact of the barbs. These include the edge closing species (mentioned above), as well as a range of vines and shrubs (Figure S217). It is important to avoid using species that have fruits (e.g. Red Passion-flower *Passiflora cinnabarina*) that are attractive to Grey-headed Flying Foxes (Appendix S12) because these plants increase the risk to this threatened species. In situations where Kangaroo Apple (also palatable to flying foxes) is used as an edge-closure species, plant vines that are not attractive to these species (such as Wonga Vine).

Paths and roads

Most restoration sites must fit in with existing infrastructure such as paths and roads. It is important that the requirements of these infrastructures are not compromised by the works that you do now or in the future. Failure to heed this advice will see a lot of damage caused to your rainforest as the relevant authorities seek to maintain (or is that find?) their infrastructure assets.

The major issue with roads is that the plantings do not obscure sight lines or present a hazard to the traffic. The advice that we have is that B and C class roads require a setback of 7m from the road tarmac, and this should be greater where visibility is required on bends. To be sure of these requirements, check with your local Vicroads, Roads and Traffic Authority or council office before you begin planning your planting.

Rainforest restoration planting beside paths needs to fulfil both a practical (edge-closing) and an aesthetic role for the public that use the path. The latter point may seem a little precious, but remember: it is your public that will praise or damn your efforts and it is most important for your restoration site to be seen as an asset not a problem. Having said that, rainforest species can, if chosen carefully help define paths (Figure S335). The use of other species can provide stunning horticultural elements to rainforest plantings beside paths (Figures S333 and S334).

USEFUL PATH EDGING SPECIES GIVE RAINFOREST A PURPOSE-BUILT ROLE IN PUBLIC AREAS

Figure S335. Mitchell River Walk, Victoria. At this site, Seaberry Saltbush *Rhagodia candolleana* has been used as a soft edge to keep people on the path and prevent them from stumbling down the cliff (blue arrow). This effect is accentuated by the frequent appearance of Tiger Snakes basking on the top of the bushes! The saltbush has several advantages that include its ability to compartmentalise herbicide by dying back only where sprayed (green arrow). This allows maintenance crews to keep an edge but not destroy the whole plant (red arrow).

Views

Views are a significant part of the cultural landscapes in which you work: people feel that they own what they can see. If you haven't talked with them first and managed to put them at ease with what you want to do and why you want to do it; then if you go onto a new restoration site and radically change the landscape overnight (and lets face it, with the techniques we are using, that is quite possible): you will face a backlash from the community or the resident. You and your group would do well to acknowledge this cultural reality from the very beginning and be aware of the existing vistas on your site and who 'owns' them.

Although you may think that this is entirely an urban issue, our experience strongly suggests that it is not. The view not only consists of the visual access across your site (i.e. what an observer can see by looking through and across your site to the other side of it) but also what is on your restoration site. A classic example of this is where there will be extensive works to remove woody weeds such as poplars and willows on rural reaches of rivers. The local people have become very attached to their landscape (as we all do: we all assume that what we see today, will be there tomorrow: it gives us a sense of stability and security). Making way for traditional uses on such sites and accommodating them may help (Figure S336).

Given that context, you can imagine the outrage that you can create if you just march onto your restoration site unannounced (and yes it may be public land, but remember who your public is) and start rearranging or demolishing the view. It does not matter how well thought out your project is from the river health or nature conservation perspective; if you haven't talked your proposals through with the community first, all they will see is red! Views can be altered, but this takes careful and considered negotiation with your cultural constituency beforehand and persuasion that you can achieve what you say you can and that the end result will have improved amenity for the community that use your sites or pass by them. Good persuasive tools in this regard include the provision of public amenities such as formalised access to rivers (picnic areas, fishing platforms) walking and/or cycling paths (Figure S337).

Whatever views exist should be maintained or enhanced (Figure S337), and should only be altered after consultation with the neighbours (even if you are operating on public land). Plantings of rainforest species can conserve existing views provided you know the growth habits of the species that you use (Figure S338). If you do not know their growth habits (deciduous, thick foliage, height, rate of growth, etc.) you may run foul of the neighbours, but knowing the species' size and shape can produce excellent results that get rainforest on site and please those with the view (Figure 339).

Destruction of native vegetation to obtain views (usually on public land by neighbours who expect to be able see water from every vantage point of their property) is not to be tolerated. This is doubly-so where the vegetation involved has a high conservation value (often rainforests) and helps stabilise erosion-prone landforms. Many examples exist of Littoral Rainforest being destroyed to obtain ocean or coastal views on sea cliffs or marginal bluffs that, through this destruction, led to increased erosion (Figure 340). Such erosion often threatens public assets such as roads and, on occasions, even the properties of the residents destroying the vegetation to gain a view!

Strong action by councils to erect view screens while reinstating the vegetation and signage warning of fines help to repair the damage and cause people to think twice about doing it again (Figure S341). Failure by local government to act leads to ongoing rainforest destruction. The enforcement part of this widespread problem is something to be left entirely to the local authorities, passions and tempers run high on the issue of views and assaults are not unknown.

IMPROVING PUBLIC AMENITY IN CONJUNCTION WITH RAINFOREST RESTORATION INCREASES TOURISM

Figure S336. The Seed Orchard Picnic Area Marlo Road, lower Snowy River Victoria. This public access to the river was retained and enhanced as a part of rainforest restoration works on the river. It has led to increased use of the site and public appreciation of the restoration works that we have done. The site has extensive signage and access to the new rainforest itself to allow for fishing and nature appreciation. On this evening, three campervans had set up and these included international visitors, who had picked up everyone else's rubbish and were enjoying a quiet drink in the evening light before dinner. They had read the signage, had a good understanding of the restoration works that we had undertaken and were spending money in both Marlo (previous night's stay in the caravan park) and had brought provisions from Orbost.

Powerlines and telecommunications infrastructure

These are often overlooked, but are very important. Look up when planting near powerlines, especially where plantings occur in gullies: the lines may be more than 50m above your site. Never plant eucalypts beneath such infrastructure because it will require their felling in the years to come. Always plant appropriately sized plants beneath powerlines. If you are unsure, check with your local power grid company. If the get too close, they will cause an electric arc and cause a fire.

It is a matter of fact that from time to time, renewal of telecommunications conduit will require some damage to your restoration site. But it is your primary responsibility in the first instance is not to damage these cables. Consult your local telecommunications office before planting to locate cables by phoning 1100 before you dig.

RESPECT VIEWS AND PLANT ACCORDINGLY

Figure S337. Mitchell River Walk, Bairnsdale Victoria. This planting was designed to conserve river and foothill views. The picture was taken at one of the Grey-headed Flying Fox *Pteropus poliocephalus* census sites used to count the fly out from the Bairnsdale camp. Part of the camp can be seen at the top left, which numbered 25,000 breeding animals on this day.

VIEWS ARE TWO WAY: PLANT TO ENHANCE VIEWS

Figure S338. North Arm Kalimna, Lakes Entrance Victoria. This is the view from the North Arm of Déjà Vu Bed and Breakfast. The headland upon which it sits was at the time of the complex’s construction a weed infested mess. Gerard and Bev Goris have slaved to eliminate the weeds and foster the development of both *Bung Yarnda* Littoral Rainforest and *Limestone* Littoral Rainforest. The complex has now merged back into the headland and caters to people who like having Lewin’s Honeyeaters to breakfast, something Gerard and Bev guarantee!

MAKE VIEWS WITH RAINFORESTS

Figure S339. Merrangbaur, Lakes Entrance Victoria. This rainforest planting was carefully planned by the author when the house (behind the photographer) was built. The planting screened out suburbia and caught dust from an unmade road below the marginal bluff, but had to (at the same time), conserve the sea and lake views.

VEGETATION REMOVAL IS OFTEN SUBTLY DONE

Figure S340. Marlo Foreshore, Marlo Victoria. On this public land, the rare and threatened community *Damp Sands* Littoral Rainforest is steadily (and stealthily) being destroyed by private landholders from across the road seeking to get a view of Bass Strait and the Marlo Estuary. Here herbicide has been applied through drill holes.

VEGETATION DESTRUCTION CREATING NEW VIEWS SHOULD NOT BE TOLERATED

Figure S341. Pacific Drive Flynns Beach, Port Macquarie New South Wales. Vegetation destruction in this Littoral Rainforest was not tolerated and prompt reafforestation action by the Hastings Council along with the risk of heavy fines for further infringements has reigned in the practice in this local government area.

Plant toxicity: domestic stock and people

Plant toxicity is an important consideration for rainforest restoration because of the possible risk from some species to stock and humans. Some plants, however, are always dangerous if consumed (especially by children): Cunjevoi *Alocasia macrorrhyza* and White Cedar *Melia azaderach*. However, the actual toxicity of individual plants can be highly variable, depending on the condition of the plant (based on district, individual plants within one species, populations of single species, time of year, season and climatic variability, stage of growth), the animal involved, the animal's routine and its previous history, even for species known to have toxic compounds present in their tissues. The other variables related to animals that mediate the plant's impact include: condition of the stock, availability of other feed, whether the stock has grown up with exposure to the plant in question, whether they are otherwise stressed (Everist 1974), and so on.

An example of the conundrum that this presents the rainforest restorer is a local one, where Kangaroo Apple *Solanum aviculare,* which is known to have physiologically active compounds present including solasonine with the highest levels present in unripe fruits (Everist 1974), has been planted. Because of its ecological importance, it has been widely planted along fence lines in eastern Victoria as a part of the rainforest restoration efforts on at least 3 rivers where cattle have access to it. They do browse it, but there is abundant and high quality pasture in the adjacent paddocks as well. As far as is known, there has not been any adverse impact on these cattle.

Some plants are not recommended for edge planting or fence lines where there is a known or suspected risk of toxicity. A recent example was at Nicholson River in East Gippsland, where more than 22 cattle died (to date) after grazing a bush block and eating both Kangaroo Apple *Solanum aviculare* and White Milk Vine *Marsdenia rostrata.* Both have toxic compounds (. However, based on the symptoms observed, Milk Vine is the suspect (Dianne Phillips pers. comm.), with the cattle showing an unsteady gait, followed by collapse, the animal lying down (struggling at intervals), laboured respiration, racing pulse, violent struggling if disturbed, coma and death. It takes as little as 680g of leaf matter converted into a watery extract to kill a cow (Everist (1974). Sadly, this is perhaps the strongest agricultural argument to the farming community to take up current financial incentives that are on offer to fence out rainforest remnants.

Based on (Everist 1974), we have listed the species that may pose a risk to stock and/or people (though the quality of such evidence is highly variable, ranging from direct evidence to suspicion or uncertain taxonomy. This information is conveyed in all planting species lists (Appendices: S6, S17, 5.2 and 5.3) located in the gap and edge plants column (highlighted in red with stippling) and annotated in Appendix S3 in the notes column. This notation is not proof positive of a known poisonous principle in your local example of that species, but it is a warning: one that you would do well to heed in your planting and maintenance of rainforest sites in agricultural landscapes and places where people congregate or recreate. For more definitive local advice, talk to your local vet or district veterinary officer regarding any local examples of poisoning.

<table>
<tr><th colspan="2">SUMMARY</th></tr>
<tr><td>COMPREHENSION:
STOP</td><td>Genetics underpin the whole success of your rainforest restoration efforts.
How you collect your propagating material is fundamental to getting this step right.
Ecological restoration of rainforests is not gardening and it is definitely not revegetation.</td></tr>
<tr><td>KNOWLEDGE:
THINK</td><td>You need now to understand how genetics can impact on your works.
Different plant propagation techniques capture different levels of genetic diversity.
Once the plants are propagated, you need to know how and when to plant out.
You then to understand the various planting prescriptions that apply to each rainforest ecological vegetation class.</td></tr>
<tr><td>WHAT TO DO?:
ACTION</td><td>Know your site and what species do or did used to grow there.
Identify reference sites and list the species that grow there.
Look up their flowering and seeding so that you know when and where to go to monitor flowering and seeding in your local remnants.

But, before you proceed any further, you need to consult the rainforest Restoration Manual to:
o Plan your project
o Obtain the funds
o Put together a project plan and a works calendar.
• Decide on a likely species list and start talking with your local rainforest nursery
• Consult your nursery regarding plant supply timelines
• Then, and only then, can you collect your seed, send it off to the nursery and get your full-scale rainforest restoration project underway!</td></tr>
<tr><td>WHAT NEXT?</td><td>LOOK IN THE NEXT CHAPTER ON DEPLETION THEN USE THE RESTORATION MANUAL, GET THE SHOW ON THE ROAD!</td></tr>
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