Converting a dairy farm back to a rainforest water catchment

The Rocky Creek Dam story

By Ralph Woodford

Visitors to Rocky Creek Dam perceive a park-like landscape with picnic areas sculpted into a remnant rainforest backdrop, but the reverse is true. Much of the rainforest backdrop has been encouraged to regenerate by carefully measured restoration interventions undertaken by a 'sole practitioner'.

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The site where I have been working 3 days per week for the past 17 years, Rocky Creek Dam, is located in cleared rainforest country in Australia's northern NSW coastal hinterland. The property would once have been covered with lowland subtropical rainforest such as that occurring in the adjacent 172 ha Big Scrub Flora Reserve (now part of Nightcap National Park).

Initially cleared for grazing, the site was acquired along with several other farms by Rous County Council (now renamed Rous Water) as a site for constructing a public water supply dam for Lismore and the surrounding district. Construction of the dam was completed in 1952. When I commenced employment as a horticulturist with the County Council in 1983, the engineer, Mick O'Keefe, instigated a proposal to plant subtropical rainforest trees at the main entrance to the property to create an attractive public picnic area with a rainforest theme. Prior to this, the entrance site consisted of a toilet block, a few barbecues, the ever-present swing and slide and scattered rainforest trees in a mown Kikuyu (*Pennisetum clandestinum*) lawn.

Rainforest trees were subsequently planted in circular beds around the existing remnant trees in the expanse of lawn (Fig. 1). It was not until some years later that we fully appreciated the fact that planting rainforest trees under isolated remnant trees was unnecessary at this site, given that so many species regenerated naturally over the years from either the soil seed bank or from seed freshly dispersed under perches by birds and bats. Nonetheless, this planting has provided a useful public education and study opportunity and certainly marked the beginning of what has become a more extensive rainforest regeneration programme supported by Rous Water.

At the same time as we undertook the plantings in the picnic area at the entrance, I was undertaking some tentative ecological restoration work in a declining grove of Blackwoods (*Acacia melanoxylon*), itself smothered in the exotic shrub Lantana (*Lantana camara*) (Fig. 2). Forty years previously, this grove had germinated from soil-stored seed after the soil was heavily disturbed by bulldozing for the dam wall. Already, a lot of the dead trees had been pushed into piles and the general assumption was that this approach would continue. However, on the basis that there was a good diversity of rainforest seedlings coming up under the Lantana, I convinced management at Rous Water that better revegetation results would be achieved by removing this suppressing weed in a way that would not damage the natural regeneration that was already occurring. The resulting regeneration could provide a varied and pleasant backdrop for a second picnic area and could supplement the site's existing rainforest vegetation, which was thought to be more valuable for sustaining water quality than was open pasture.

My work proceeded in an orderly progression over the approximately 1 ha Blackwood grove: pulling Lantana and cutting larger specimens of Small-leaved Privet (*Ligustrum sinense*) and Camphor Laurel (*Cinnamomum camphora*) low to the ground and painting the cut stump with glyphosate. Germination of weeds was occurring, but strong germination of

Figure 1. Top: young plantings at Rocky Creek picnic area, photographed in 1987 (photo: T. McDonald). Bottom: a nearby bed (similarly planted) 13 years later. Note that the dominant Acacias and Pencil Cedars (which naturally regenerated on the site within the first 2–3 years after planting) have now overtopped the planted specimens (photo: R. Woodford).

pioneer rainforest species was clearly evident, including species such as Kangaroo Apple (*Solanum aviculare*), Bleeding Heart (*Omalanthus nutans*) and Poison Peach (*Trema aspera*). The faster-growing species of the next successional phase, the 'early secondary' species, were also germinating, including Corkwood (*Duboisia myoporoides*), Celery Wood (*Polyscias elegans*) and Pencil Cedar (*Polyscias murrayi*). The best regeneration was occurring in the areas that had received the most soil disturbance (i.e. the bulldozed sites) but which were neither excessively exposed to high temperatures and desiccation nor completely smothered by Lantana mulch. Ten years after this regeneration began, I counted 40 native species developing in a 0.5-ha section of the Blackwood grove, of which 15 species were 'early-successional' species (a combination of four pioneer species and 11 early secondary species) and 25 species were 'late-successional' species (10 later secondary and 15 mature-phase species). (See box on next page for definitions of successional terms). A list of these species is provided in Table 1, along with information on their successional phase and distribution mode.

Where was the seed coming from?

Seed of some of the initial pioneer species under the blackwoods may have been stored in the soil given the longer soil persistence of pioneer species (Whitmore 1991). We assume, however, that much of the more diverse regeneration is likely to have arisen from seed recently dispersed from the nearby rainforest remnant by fauna, because the longer-lived species do not usually form a persistent soil seed bank (Whitmore 1991). Also, seed-dispersing bird species such as the Topknot Pigeon (*Lopholaimus antarcticus*), Green Catbird (*Ailuroedus crassirostris*), Lewin's Honeyeater (*Meliphaga lewinii*), Figbird (*Sphecotheres viridis*), Regent Bowerbird (*Ptilonorhynchus chrysocephalus*) and Satin Bowerbird (*Ptilonorhynchus violaceus*) are commonly observed perching in the grove. The importance of trees in facilitating the dispersal of seed by birds into otherwise cleared areas that are close to stands of native vegetation is now well documented (McClanahan 1986; McClanahan & Wolfe 1987, 1993; Robinson *et al.* 1992; Robinson & Handel 1993). Our awareness of the role of perches in triggering regeneration, however, occurred gradually, along with the subtly expanding results of our regeneration work.

Expansion into new areas

Released from weed competition, the rainforest species in the Blackwood grove put on rapid growth, soon out-competing further weed regeneration and exponentially reducing my workload. This allowed me to take on a corresponding amount of work in a new area each season. When I realized that hand-weeding was limiting the area I could manage, I began using herbicide judiciously.

In 1989, with management's support, I started weeding a new 25 ha area beyond the Blackwood grove (Fig. 2) that contained patches of rainforest regrowth struggling in competition with Lantana, Camphor Laurel and Small-Leaved Privet (*Ligustrum sinense*). The same approach that was adopted in the Blackwood grove worked well in these new areas to rapidly consolidate the native regeneration and tip the

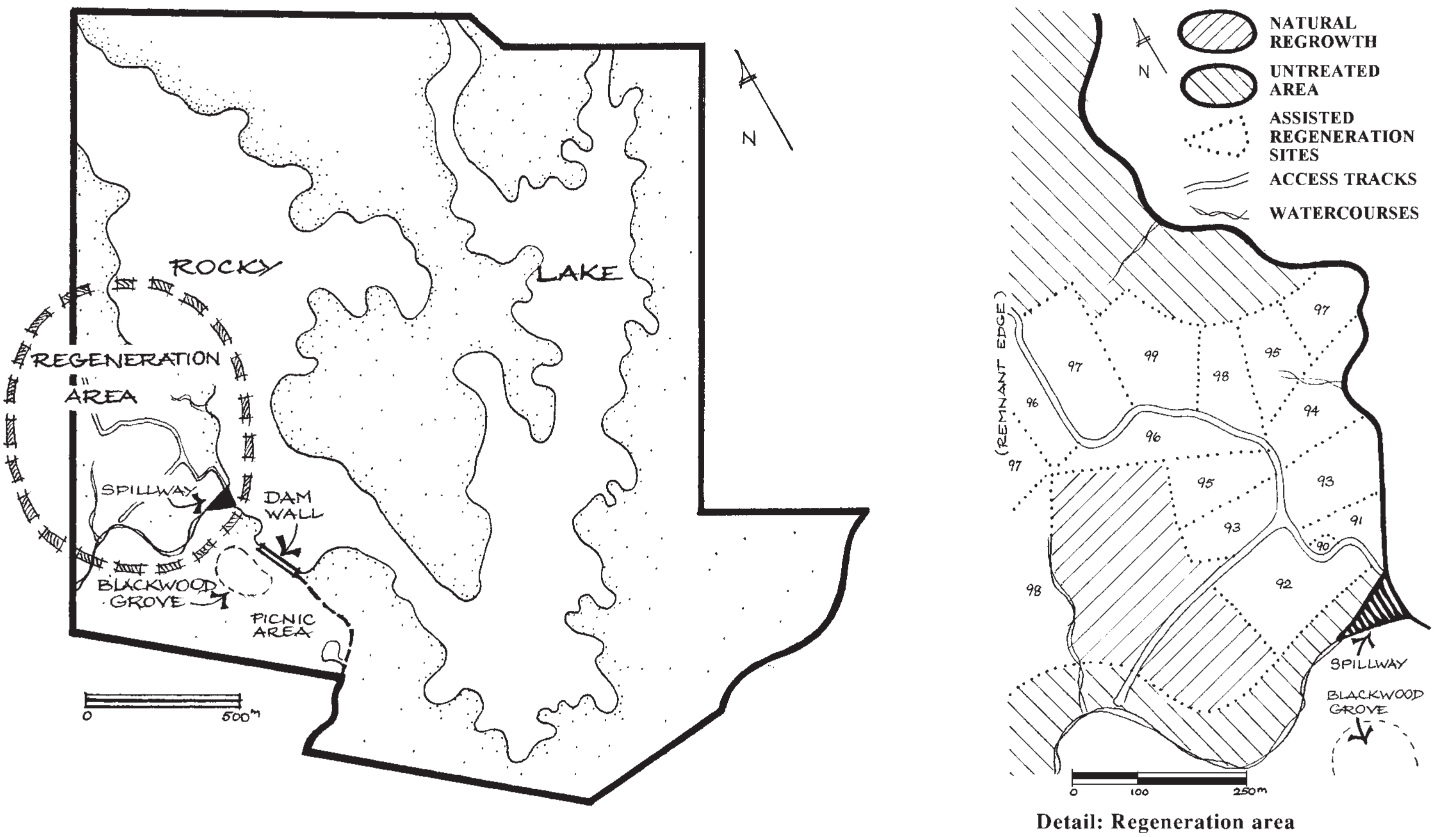

Figure 2. Left: map of the entire Rocky Creek Dam site, showing the dam wall and location of Blackwood grove, natural regrowth area and the 'regeneration area'. Right: detail of the 'regeneration area', showing the location of the adjacent remnant edge and areas worked in sequence from 1983 to 1999.

Terms used to describe successional phases

A number of models have been devised to describe and predict subtropical rainforest development on cleared land. Invariably they describe a process where 'earlier' successional phase species are replaced over time by 'later' successional phase species (Hopkins *et al.* 1977; Winter *et al.* 1991; Floyd 1999). All are more or less based on the following categorization of species into successional groups (Hopkins *et al.* 1977):

Earlier successional phase

A1 Herbs and soft-wooded shrubs

A2 Pioneers

B Early secondary species

Later successional phase

C Late secondary species

D Mature phase ('primary') species

Table 1. Species recorded in 1985 regenerating under the Blackwood grove, Rocky Creek Dam. *Data from McDonald (1996).

Scientific name	Common name	Successional phase*	Dispersal mechanism*
Acacia melanoxylon	Blackwood	A	Ants; birds
Acacia orites	Nightcap Wattle	A	Ants; birds
Achronychia pubescens	Hairy Achronychia	C	Flying frugivores
Alphitonia excelsa	Red Ash	B	Flying frugivores
Anthocarapa nitidula	Incense Cedar	D	Flying frugivores
Archontophoenix cunninghamiana	Bangalow Palm	C	Flying frugivores
Arytera divaricarta	Coogera	D	Flying frugivores
Beilschmedia obtusifolia	Blush Walnut	D	Flying frugivores
Cinnamomum oliveri	Oliver's Sassafras	D	Flying frugivores
Cryptocarya obovata	Pepperberry	D	Flying frugivores
Cyathea cooperi	Straw Treefern	C	Wind/water
Cyathea leichhardtiana	Prickly Treefern	C	Wind/water
Daphnandra micrantha	Socketwood	D	Wind
Dendrocnide excelsa	Giant Stinging Tree	C	Flying frugivores
Diploglottis australis	Native Tamarind	C	Flying frugivores
Duboisia myoporoides	Corkwood	A	Flying frugivores
Dysoxylum mollissimum	Red Bean	C	Flying frugivores
Dysoxylon rufum	Hairy Rosewood	C	Flying frugivores
Elaeocarpus eumundi	Eumundi Quandong	D	Flying frugivores
Ficus coronata	Creek Sandpaper Fig	B	Flying frugivores
Flindersia schottiana	Cudgerie	C	Wind
Glochidion ferdinandi	Cheese Tree	B	Flying frugivores
Guioa semiglauca	Guioa	B	Flying frugivores
Heritiera trifoliolata	White Booyong	D	Wind
Jagera pseudorhus	Foambark Tree	B	Flying frugivores
Litsea australis	Brown Bolly Gum	D	Flying frugivores
Litsea reticulata	Bolly Gum	D	Flying frugivores
Melicope micrococca	White Euodia	B	Flying frugivores
Melicope octandra	Doughwood	D	Flying frugivores
Neolitsea australiensis	Green Bolly Gum	C	Flying frugivores
Neolitsea dealbata	White Bolly Gum	B	Flying frugivores
Omalanthus populifolius	Bleeding Heart	A	Flying frugivores and ants
Pittosporum undulatum	Sweet Pittosporum	B	Flying frugivores
Polyscias elegans	Celerywood	B	Flying frugivores
Polyscias murrayi	Pencil Cedar	B	Flying frugivores
Sarcopteryx stipata	Steelwood	C	Flying frugivores
Schizomeria ovata	Crabapple	D	Flying frugivores
Sloanea australis	Maiden's Blush	D	Flying frugivores
Sloanea woolsii	Yellow Carabeen	D	Flying frugivores
Wilkiea huegeliana	Veiny Wilkiea	D	Flying frugivores

successional battle in favour of the natives and away from the weeds. In this site, Blackwood was also the major pioneer species and because the level of Lantana germination under the consolidating canopy was low, Lantana did not persist on this site after a small amount of follow-up weeding. Today, these patches have coalesced into large clusters of regrowth rainforest, surrounding declining Blackwoods.

Lantana swathes

As the native regeneration became consolidated in the regrowth area, I was able to work in land that had been completely cleared for pasture and, after the removal of dairy cattle, had subsequently become dominated by Lantana.

Over many years of trial and error, I have formulated a method that works most favourably in Lantana swathes on the Rocky Creek Dam site and which results in very high levels of regeneration by rainforest pioneer species (Woodford 1994, 1999). The method involves carrying out primary clearing of the Lantana in the driest part of the year, late winter/early spring, when Lantana is at its weakest. I use a tractor to initially flatten the Lantana and then undertake several slashings over approximately a month, during which time most of the Lantana is killed, leaving a fairly coarse mulch 2–5 cm deep over the ground (Fig. 3). Depending on time, I pull the remaining live Lantana stumps to create disturbed patches and bring some of the buried pioneer seed bank to the surface. Lantana found to be climbing trees is cut with a brush cutter and pulled out.

When the wet season begins in summer, increasing soil moisture levels initiate fungal activity and the decomposition of mulch. The resulting bare soil warms up and creates conditions suitable for the germination of annual weeds. These are sprayed with dilute

Figure 3. Top: an example of the typical density of Lantana on previously cleared paddocks. Middle: Lantana reduced to the ground by driving over it with the tractor during the dry season (note Lantana and vines still covering regrowth trees in the background). Bottom: same site after the slashing of Lantana and the cutting ('skirting') of vines and Lantana around a regrowth patch (photos: R. Woodford).

glyphosate before they set seed, thereby allowing a competition-free seed bed in which the rainforest pioneers can germinate. By then, the mulch layer and weeds have diminished considerably and, in good years, soil moisture levels are high and constant. In late summer and early autumn, the days are often cloudy and getting cooler. A mass germination of pioneers occurs, particularly under the dripline of any residual trees left in the cleared area. Hand-weeding among these pioneers (rather than spraying) then becomes the major task. By mid-winter, the pioneers are 1–2 m high and already forming a closed canopy, suppressing the weed problem and releasing my time and labour for other work in other areas, with regular, but diminishing, revisits to the original areas for follow-up weed control.

Regeneration after Lantana removal

With the help of friends and students from TAFE, I have been able to monitor the progress of regeneration after Lantana removal on one 0.2-ha subsite within 100 m from the edge of the uncleared Big Scrub Flora Reserve (Fig. 4). Preliminary results from 12 (each 25 m^2) random quadrats show that a total of 38 native species had regenerated in high densities 3 months after clearing. These included 23 trees or shrubs; six vines and nine herbaceous species. Five years after clearing, 71 species were recorded at the same site within similarly located random quadrats of the same size, adding 11 climbers and 20 trees and shrubs to the list of plants occurring. One colonizing shrub species, White Dogwood (*Ozothamnus diosmifolius*), had senesced by the time of the second count.

Even at our first reading, 3 years after clearing, it was very obvious that a higher number of bird- and bat-dispersed species were regenerating on site, compared to species dispersed by wind or other means (Table 2), a phenomenon that also occurs in

Figure 4. Top: forest edge subsite at Rocky Creek Dam 3 months after clearing dense Lantana with a tractor. Lantana mulch has all but decomposed and seedlings of pioneers and early secondary species have germinated. Note the cluster of remnant and regrowth trees in the right foreground. Middle: a closer shot of the base of the same cluster of trees, 5 years after Lantana clearing, showing the vigorous development of saplings around the base of the tree. Bottom: the view looking up into the young canopy of Giant Stinging Trees, Corkwood and Pencil Cedars in the previously 'open' Lantana-dominated areas between the remnant trees (photos: T. McDonald).

healthy rainforests (Jones & Crome 1990). A breakdown of trees and shrubs into their 'successional groupings' (Table 2) also shows that increasing numbers of later successional species (particularly late secondary species) are colonizing the site relative to earlier-phase species.

The height of the regenerating canopy at 3 months after clearing was generally below 50 cm, but after 5 years, the heights of the plants represented a range of different height classes. Considerable numbers of the early secondary species that had germinated during the initial flush had reached 2.5–10 m in height by our second reading, 5 years after clearing. Some of these, notably Corkwood, Celerywood, Pencil Cedar and Red Cedar (*Toona ciliata*), were already taller than 10 m after 5 years. Furthermore, we noticed that at our first reading, significantly more later successional-phase species regenerated in the quadrats under isolated remnant trees relative to the 'open' ex-Lantana swathes (McDonald 1996). This difference is consistent with other observations of higher diversity and density of bird- and bat-dispersed species under perches relative to open sites (McClanahan & Wolfe 1993; Robinson & Handel 1993). This difference had reduced 5 years after treatment, however, when we found that later successional-phase species were somewhat more evenly dispersed across the site (R. Woodford, M. McDonald and D. Bailey, unpubl. data, 2000).

Faunal herbivory: A potential research question?

Watching the changes on the various sites over the years, native species have continued to germinate after Lantana clearing but I have certainly noticed a considerable reduction in the density and number of pioneers surviving

Table 2. Breakdown of species according to successional and dispersal categories 3 months and 5 years after Lantana clearing at Rocky Creek Dam forest edge

Time since Lantana clearing	Total species (trees/shrubs)	Bird- or bat-dispersed	Wind (or otherwise) dispersed	Earlier successional (A + B groups)	Later successional (C + D groups)
3 Months	23	20 (87%)	2 (8.5%)	14 (61%)	9 (39%)
5 Years	42	37 (88%)	5 (12%)	18 (43%)	24 (57%)

and establishing on site. I tentatively attribute this reduction to a recent increase in resident populations of Pademelon (*Thylogale* spp.) species that I have observed browsing on seedlings and saplings.

Certainly, Pademelon browsing has been found elsewhere to reduce regeneration on forest edges (Wahungu *et al.* 1999) and I am concerned that excessive Pademelon browsing at the Rocky Creek Dam site may be causing a floristic shift toward the species that are not browsed by Pademelons to the same extent. In turn, these plant species (Celerywood, Kangaroo Apple and Corkwood) are shorter-lived than many of the browsed species. Being susceptible to defoliation by insects, they, in turn, produce a considerably thinner canopy than might occur without the Pademelon browsing. Furthermore, the recent proliferation in the regeneration area of dense thickets of Native Raspberry (*Rubus rosifolius*) may be a direct consequence of this insect defoliation of the canopy. The question needs to be asked whether the combined effect of the defoliation, shorter-lived pioneers and competition from Native Raspberry could represent a 'short circuiting' of the successional process, which could be avoided with some timely restoration intervention in the early treatment stage. This question could be put to the test by experimentally comparing current treatments with experimental treatments designed to protect young regeneration sites from Pademelon browsing as well as experimental thinning of Native Raspberry. This question is an example of one of the many questions that could potentially be asked by students using Rocky Creek Dam as a formal rainforest regeneration research site in the future.

Camphor Laurel groves

Concurrent with my ongoing work in Lantana areas, I have been able to undertake some work each year in some of the many groves of Camphor Laurel and Privet scattered about the property (Fig. 5). In these stands (or where these species occur within the Lantana areas), the taller specimens are stem-injected with glyphosate herbicide. The smaller specimens are treated by the cut and paint herbicide application method.

At the time of poisoning, I usually find at least some native species suppressed under the tall Camphor or Privet canopy, and even mature-phase species (particularly those belonging to the Meliacae and Lauraceae families) if the weed canopy has been dense enough to exclude Lantana. The regeneration response after weed removal and the first germination season is invariably explosive. Once the Camphor Laurels are killed, the dormant soil seed bank of pioneers is activated and the existing mature-phase species put on good growth before being overtopped by the pioneers. Regrowth of natives of mixed successional phases is usually dense a few years after treatment. In a 100-m^2 area of one of these groves, for example, I counted 19 species 4 years after treatment. These included 10 later-phase species and nine earlier-phase species. The grove was approximately 1.5 km from the Big Scrub Flora Reserve, approximately 750 m from a smaller remnant/regrowth patch and 200 m from scattered remnant or regrowth rainforest trees, all within flying distances of a range of seed dispersers, including both birds and bats (Holmes 1987; Eby & Palmer 1991; Green 1993).

The very high regeneration under tall, dead Camphor Laurels within dispersal distance of seed sources may be explained by a number of factors. The fundamental one is that Camphor Laurel fruits attract at least nine fruit-dispersing birds including Rose-crowned Fruit-Dove (*Ptilinopus regina*), Topknot Pigeon, White-headed Pigeon (*Columba leucomela*), Lewin's Honeyeater, Figbird, and Pied Currawong (*Strepera graculina*) (Holmes 1987; Date *et al.* 1991b). Camphor Laurel fruits are also a major food source for Topknot Pigeons (a species I often observe feeding at the Rocky Creek sites), which can transport undamaged seeds of rainforest species between sites many kilometres apart (Date *et al.* 1991b). This means that, as the Camphor Laurels will be functioning as seed-attractants (or 'seed sinks') prior to poisoning, there can be some build-up of a seed and seedling bank underneath the live perch. In addition, the poisoned trees continue to function as perches for seed dispersing birds, possibly even as preferred perches, given the lack of visually obstructive foliage. Growth of the recruits can also be more rapid than under a live perch, as a dead perch does not compete with the recruits for light, nutrients and moisture and when the dead trees eventually fall, they create a gap for the waiting late secondaries and mature-phase species. These observations should give some cause for optimism for land managers elsewhere who have Camphor Laurel groves within dispersal distance of rainforest seed sources, either planted or naturally occurring.

Interestingly, I have observed that the recruitment under pure stands of Camphor Laurel canopy is not as dense as under a Blackwood canopy. I suggest this may be because of the action of the Brush Turkey (*Alectura lathami*), a seed predator that scratches for Camphor Laurel seeds. Where the Brush Turkeys are absent, I have found that seedling density under Camphor Laurels is similar to that found under Blackwoods. Once the Camphor Laurels have been treated and are no longer dropping seed, however, Brush Turkey scratching ceases and seedlings are able to establish.

Successional phases and patterns at Rocky Creek Dam

Over the 11 years that I have been working beyond the spillway at Rocky Creek Dam, both the yearly seasonal conditions and the response of the new sites have varied. No year has been the same and the conditions (including the species) on each site are always different. Consequently, regeneration has happened differently on each site. Past farming practices may also have had a bearing on the different restoration responses in different areas. Invariably,

Figure 5. Top left: Camphor Laurel trees prior to poisoning. Bottom left: distance view of the same site, 9 months later, showing high levels of native species regenerating. Top right: distance view of the same site and regenerating natives, 9 months later. Bottom right: a nearby Camphor Laurel grove, 4 years after a similar treatment. Nineteen species of trees and shrubs were counted regenerating on this site, approximately half of which were earlier-successional species and half were later-successional species (photos: R. Woodford).

however, as soon as weed clearing introduces light onto a site, a suite of pioneer seedlings emerges. How soon the late-secondary and mature-phase species appear, however, seems to depend on a variety of factors including: (i) the weed species on the site prior to clearing; (ii) the proximity of native seed source species; and (iii) the particular climatic and seasonal conditions at the time of clearing. Another factor to consider is herbivory by browsing mammals.

The sequence of regeneration at Rocky Creek Dam does not easily fit the six-phase model proposed for subtropical rainforest succession by Hopkins *et al.* (1977) in that later-secondary species are more prevalent much earlier in the succession at Rocky Creek. This may be explained by the proximity of seed sources from scattered later-secondary trees, the proximity of the remnant and perhaps the dispersal of relatively fresh seed into the pre-existing Lantana and Camphor Laurel sites just prior to clearing. The site's response is more consistent with the four-phase description proposed by Floyd (1999) that combines early and late secondary species in a general and prolonged secondary phase, with less strict sequencing of the order of appearance of the secondary- and mature-phase species.

To elaborate on the successional pattern in the Rocky Creek regeneration areas after clearing dense Lantana, the germination of pioneers and early secondary species often occurs simultaneously, although the tougher pioneers may, initially, grow more rapidly. A suite of pioneers occurs on each site, with each filling different niches that are related to exposure and ability to withstand radiant heat. Kangaroo Apple, Poison Peach, Corkwood and Blackwood are the 'tough nuts', germinating in full sun in the Lantana mulch. They grow rapidly and create the niches for the less hardy pioneers (such as Bleeding Heart) and the early secondary species such as Pencil Cedar, Celerywood, White Euodia (*Melicope micrococca*) and Red Ash (*Alphitonia excelsa*), species that can germinate at the same time as the pioneers. While the early secondary species may be slower to take off than the pioneers, they need high light levels to germinate and grow and so they soon develop well. A need for high light levels also seems to apply to the late secondary species such as Red Cedar and Cudgerie (*Flindersia schottiana*), which can also germinate immediately after clearing if the disturbance from Lantana clearing, seed production and suitable germination conditions all happen to coincide. Consequently, because there have been several large, isolated specimens of

Red Cedar and Cudgerie scattered over the Rocky Creek Dam site (and because weed clearing has spanned a range of seasonal conditions), these wind-dispersed species are very well represented in large sections of the regeneration areas.

I have observed that mature-phase species generally germinate in dappled light situations created by the pioneer and secondary canopy. At Rocky Creek Dam, mature-phase species are appearing 4–5 years after clearing Lantana, when the developing canopy is approximately 10 m high. At this height, the canopy offers plenty of perches for birds, a more suitable microclimate is achieved and the earlier-phase species have begun seeding, thus providing fruits to attract seed-dispersing birds. Blackwood- and Camphor Laurel-dominated groves, on the other hand, can often be one step ahead of the Lantana areas in terms of successional development. This is because, as mentioned earlier, they can provide conditions suitable for the advanced regeneration of mature-phase species, which can 'take off' and make some growth before being overtopped by early-phase species. Furthermore, these taller, more predominant stands may attract higher levels of dispersal by birds, particularly fruit pigeons, which feed on a range of later-phase species, including native laurels (Holmes 1987; 1991b; Date *et al.* 1991a).

What has been learned and implications for other areas

It is interesting to look at the current canopy composition of the original circular beds that were planted 16 years ago at the entrance to the site. These beds were planted with secondary and mature-phase species but were quickly overtopped by the earlier-phase Blackwood and Pencil Cedar, presumably arising from the soil seed bank. Twelve years after the planting, I counted approximately 20 naturally regenerating species in each of two of the beds, about half of which were earlier-phase and the other half, later-phase species. Naturally regenerating early secondary species now dominate the canopy and will presumably do so until they senesce (or are removed) as the islands are allowed to expand outwards, providing an interior forest environment more favourable to the later-phase species.

To date, my work has been based on a series of 5-year plans involving clearing areas of approximately 2 ha per year. It would be good, however, to have an overall long-term plan of management for the restoration of the rest of the site. Such a plan would, ideally, accommodate ecological restoration research conducted by the local university so that reciprocal benefits can flow from both our site treatments and the university's experimental design expertise. The appointment of a catchment manager has been approved to prepare plans for the long-term restoration of the dam catchment, including recent land acquisitions and to further the process of the control of Camphor Laurel (which has been recently declared noxious) so it is likely that such a plan will not be too far off.

The results of work throughout the site have demonstrated the very high natural regeneration capacity of the Rocky Creek Dam site. Adjoining and continuous with the largest rainforest remnant in the area, it is used by many birds and mammals that, together with me, create suitable conditions for successful restoration. Moreover, the weed trees and shrubs act as regeneration 'starters' by providing perching and feeding resources resulting in a seed 'sink' (McDonald 1999), without which the open pasture sites would be much harder to convert to native vegetation. As a result, only eight of the 71 trees and shrubs recorded in the Big Scrub Flora Reserve in the 1970s (NSW Forestry Commission, unpubl. data, undated) are not represented at all on the site (five of which are not commonly found in the healthy remnant). A further 10 species (mainly mature-phase) are only represented as remnant or regrowth trees on the site, while all the remaining 53 species have been recorded as seedlings regenerating on the site, some prolifically.

Similar results could be expected on other sites close to rich sources of native seed and where dispersers are active. But to use the same restoration method I have described on sites without these characteristics would not produce such high regeneration results in a similar time frame. Sites consisting predominantly of weed species or which are isolated from native vegetation can be constantly threatened by weeds. To turn these sites around takes a lot longer and often involves slower rates of canopy clearing, additional planting of less well-represented seed-source species and the planting or natural regeneration of frugivore-attracting perches to hasten the process of dispersal. Partial culling of earlier-phase species on such sites may also be advantageous where delays in seed production of later-phase species are an issue. Nonetheless, planting trees is an expensive and often unnecessary exercise, so treatments, including soil disturbance, to optimize the germination of buried pioneer seed banks and the retention of poisoned weed perches should be tried on all sites to assess the site's natural regeneration capacity. In my experience, the tree that grows in situ from local seed, when and where it wants to, always performs better than the planted equivalent.

The major things I have learnt in the process of my work are: (i) to follow a seasonal approach; (ii) to continue to observe the areas of natural regeneration and use these observations in my work practices; and (iii) to be able to change my practices to suit the variability in season or site. Having an ongoing input on the site is also important and being able to carry out the appropriate work practice in the relevant season saves a lot of wasted time and energy. If any historical data can be gleaned as to the past land-use practices, then one has a better insight into a potential regeneration response in that particular area. Regularly walking over the site provides a regular update on what is happening, as well as a more intimate understanding and connection to the site.

Restoration is a healing of the land as well as a healing of the person involved in the process. It has allowed me to make some real connections with the environment and find a positive place in the natural world. It is an empowering process and hopefully, through seeing the response at my site, other people will be encouraged to become involved in the restoration process at their own sites.

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