

Big Scrub: A cleared landscape in transition back to forest?

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Restoring the rainforests of the Big Scrub is a powerful restoration symbol for the regional communities of far north coast New South Wales, but it is only a partly realized aspiration. What progress has been made in 35 years and to what extent is the aspiration achievable?

Key words: assisted natural regeneration, Big Scrub Landcare, biodiverse plantings, Campbor Laurel, rainforest restoration.

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Figure 1. White Booyong (*Argyrodendron trifoliolatum*) was the main tree dominant in the original Big Scrub, but has limited natural dispersal potential. Restoration of the Big Scrub floristic alliances depends upon active restoration of this other fragmentation-sensitive plants and animals. (Photograph: Courtesy Hugh Nicholson, Terania Rainforest Publishing).

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Introduction

The 'Big Scrub' is the term historically given to the iconic 75 000 ha area of continuous lowland subtropical rainforest that once covered the deep, volcanic soils of the Alstonville Plateau in far north coast New South Wales (NSW), providing habitat to thousands of native rainforest plant and animal species (Fig. 1). By the late 19th century, the rainforest was

reduced by land clearing for agriculture to <1% of its original extent spread across a small number of widely separated remnants (Box 1 and Fig. 2).

With these dramatic changes in the physical landscape came equally dramatic changes in the human and cultural landscape. Indigenous people were displaced and removed from traditional lands, and the remaining forests of the hinterlands came under the management of the State forestry department. In the cleared lands, agriculture dominated, particularly dairy farming. But the demographic rapidly changed in the 1970s and 1980s when

Box 1. Lowland Subtropical Rainforest of the Big Scrub

The Big Scrub is an area of subtropical rainforest (Complex Notophyll Vine Forest) that once covered 75 000 ha of fertile basalt-derived soils between Nightcap Range and Richmond River in north-east NSW. Extensive clearing for (mainly) dairying commenced in the 1840s and was effectively completed for the major rainforest areas by the 1890s (Frith 1977). Some regrowth of secondary rainforest occurred in small patches throughout the area during the 20th century, with regeneration largely made up of early successional rainforest species such as *Mallotus* spp., *Guioa semiglauca* and *Jagera pseudorhus*.

Protection status. 'Lowland Rainforest of the NSW North Coast and Sydney Basin Bioregions' and 'Lowland rainforest on floodplain in the NSW North Coast Bioregion' are listed as an Endangered Ecological Community under the NSW *Threatened Species Conservation Act, 1995* (TSC Act 1995). 'Lowland Rainforest of Subtropical Australia' is also listed as a Critically Endangered Ecological Community under the Federal *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999).

Area remaining. At the time of the nomination of the Big Scrub remnants to the Register of the National Estate in the early 1990s, 33 remnants with a combined area of approximately 320 ha were identified by Mezzatesta (1992). The Border Ranges Management Plan (Department of Environment, Climate Change and Water (DECCW) 2010) estimated that there were about 50 remnants. When taking into account now-maturing regrowth, however, the area of rainforest can be considered somewhat larger. Big Scrub Landcare and its major partner EnviTE Environment (EnviTE), for example, have identified (from GIS mapping and air photo interpretation combined with on-ground knowledge) 68 significant Big Scrub remnants and mature regrowth patches with an aggregate area of at least 642 ha of lowland subtropical rainforest.

A further large (but as yet unquantified) area of rainforest regrowth is slowly developing amongst extensive stands of the introduced tree Camphor Laurel (*Cinnamomum camphora*) which has been gradually dispersed throughout the landscape by native frugivorous birds after the scaling down of the dairy industry in the 1960s (Holmes 1987; Date *et al.* 1991). Such 'camphor regrowth' areas have been shown to be rich in regenerating native rainforest tree species (Gilmore 1999; Neilan *et al.* 2006) and have responded positively to Camphor Laurel conversion treatments by bush regenerators (Lymburner *et al.* 2006; Kanowski & Catterall 2007a).

Floristics and structure. Remnants of the Big Scrub have been classified as belonging to the *Argyrodendron trifoliolata* (White Booyong) floristic Alliance, with four sub-alliances recognized, although others may have existed prior to clearing (Floyd 1990). While high levels of heterogeneity are likely to have occurred and no remnant can be considered 'typical', the community is characteristically dominated by large buttressed trees and woody vines, with epiphytes in the canopy and occasional emergent trees including *Ficus* spp. and Yellow Carabeen (*Sloanea woollsi*); with Blue Quandong associated with watercourses (*Elaeocarpus grandis*); Kooyman 1996). Major species in the canopy of Big Scrub remnants are numerous but often include White Booyong (*Argyrodendron trifoliolatum*), Giant Stinging Tree (*Dendrocnide excelsa*), Black Bean (*Castanospermum australis*), Brown Walnut (*Beilschmiedia elliptica*) and a range of species from many other genera including *Syzygium* spp., *Flindersia* spp., *Cryptocarya* spp and *Ficus* spp. (Floyd 1990).

Size and tenure. Big Scrub remnants and mature regrowth areas range in size from c. 0.4 to 150 ha and include three sites within Nightcap National Park and seven Nature Reserves. Twelve other remnants or mature regrowth areas are on Council or Crown Land managed by a trust. Thus 22 (33%) of the identified remnants/mature regrowth areas are on public land and 38 (66%) are on private land (T. Parkes, Big Scrub Landcare, pers. comm., 2012).

Conservation value. Historically the Big Scrub provided an extremely important and very large resource of lowland rainforest. It is likely to have acted as a major mixing bowl of genetic variation during rainforest expansion and contraction phases related to the mid Miocene to present day climate oscillations (R. Kooyman, pers. comm., 2012). Its fragmentation and reduced area clearly mean that it has reduced habitat values compared to the larger areas of forest still present in the nearby hinterland of the Border Ranges. Big Scrub remnants and regenerating landscape collectively contain, however, very high plant species richness dispersed through the landscape. Furthermore, these areas provide key stepping stones between coastal habitats and the hinterland ranges for many birds and bats that need to move latitudinally, longitudinally and altitudinally to follow food resources as they change with the seasons (Lott & Duggin 1993; Date *et al.* 1991; Kanowski *et al.* 2008a,b; Neilan *et al.* 2006). Such connectivity is likely to become even more important as climate changes.

Many threatened plant and animal species occur in Big Scrub remnants, with some of those confined to very small, isolated remnants now being perilously close to local extinction (DECCW 2010). While the size of remnants is a conservation issue, this does not mean that small sites are less valuable. Rather, it points to a need for their expansion and linkage to other habitats through regrowth and planting in corridors.

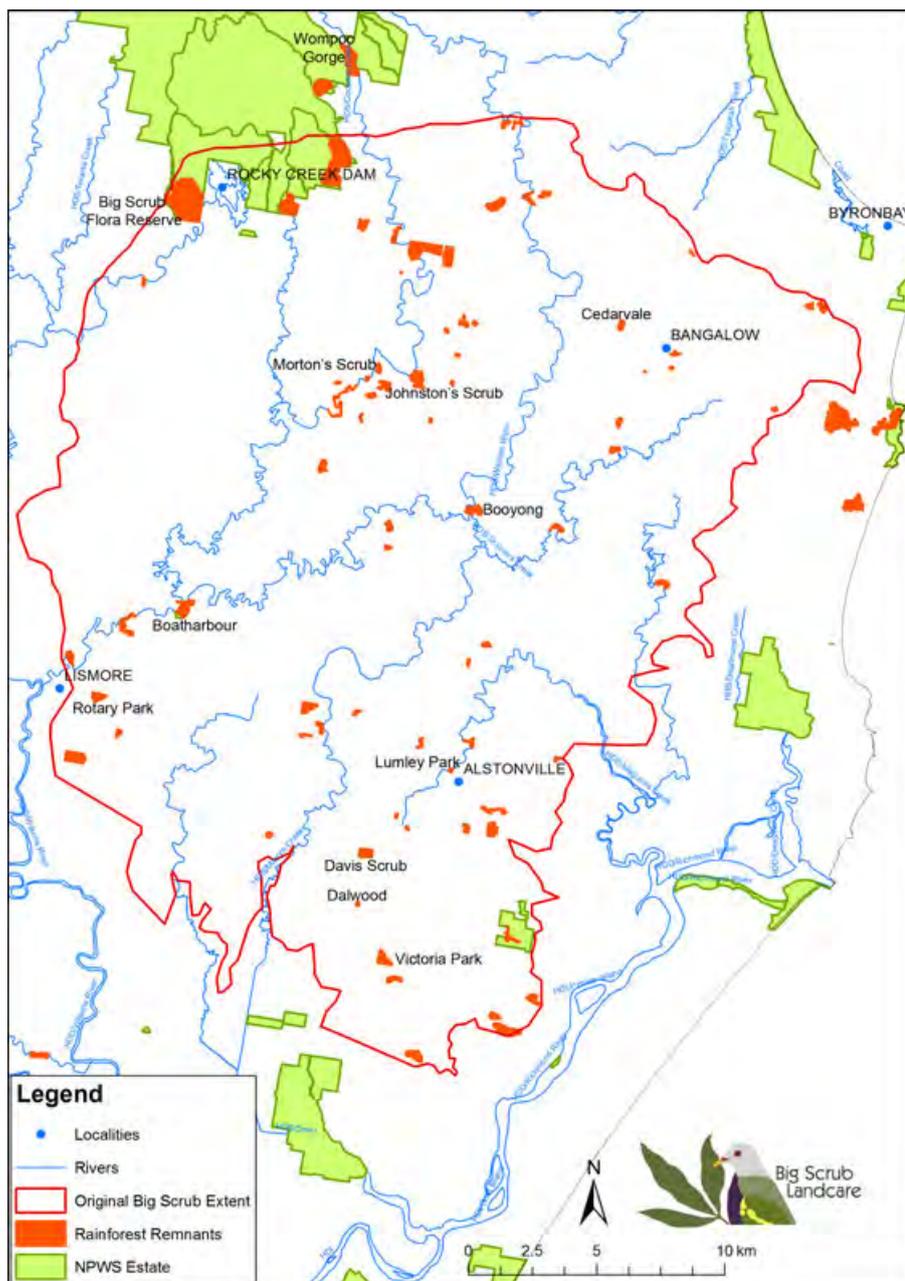


Figure 2. Indicative Boundary of Original Big Scrub and the location of major rainforest remnants, national parks and nature reserves, estimated from broad geological patterns and local knowledge (Copyright 2012 Big Scrub Landcare. This map is not guaranteed to be free from error or omission).

many struggling older farmers sold their land to 'new settler' immigrants, many of whom had an interest in rehabilitating the transformed landscape. This coincided with a rising consciousness about rainforest conservation in general and often involved activism to preserve large rainforest tracts. This and subsequent waves of recent

arrivals included botanists, biologists, ecologists, conservation activists, field restoration practitioners, nursery people and others with a strong environmental ethic. These people contributed over the decades to support the process of conservation and recovery of the Big Scrub rainforest landscape.

Forty years on, it is timely for some of those involved in the process to take stock and ask some of the difficult questions such as: How far have we come? Will our efforts make a difference at landscape scale? What more can be done to better secure outcomes for conserving and restoring these rainforest areas? What priorities are needed to achieve that vision?

This article puts these and other questions to some of the main players involved in the restoration of Big Scrub area rainforests while tracing the history of the movement to restore the forests of the Big Scrub.

Early History

As early as 1936, dairy farmer Ambrose Crawford commenced a rainforest regeneration and planting project at the Lumley Park rainforest remnant at Alstonville (Fig. 2). But this was a project ahead of its time. Ambrose and his group continued the work until he handed it over to Council in 1976 (McDonald 2008), and it was not until the influx of conservation-minded settlers in the mid-to-late 1970s that interest in conservation was rekindled and other north coast NSW projects commenced (Table 1).

The mid-to-late 1970s saw a growing climate of community support for rainforest protection in a landscape that had been extensively cleared for forestry and dairying – culminating in a series of campaigns in the Border Ranges advocating for the cessation of rainforest logging in NSW. The most highly publicized and influential of these was the Terania Creek rainforest blockade of 1979, which took place in a rainforest area located at the edge of the Big Scrub. This protest was highly charged and affected the entire regional community and beyond, ultimately leading to the cessation of rainforest logging in the whole of NSW and the addition of publicly owned rainforest areas to the National Parks estate.

Not content to only stop further destruction, many new settlers responded to opportunities to gain

Table 1. Key dates in Big Scrub restoration

1936	First rainforest restoration project, Lumley Park Alstonville (ongoing)
1977	Rainforest restoration recommendations made for Victoria Park Nature Reserve
1978	On-ground works start at Victoria Park (camphor poisoning and pioneer planting)
1979	Terania Creek rainforest blockade (anti-logging protest)
1979	UNE Continuing Education rainforest plant identification and ecology courses start
1980	Wingham Brush rainforest regeneration project starts
1982	Australian Year of the Tree 'Trees for Tomorrow' conference, Lismore, focuses on ecological restoration
1983	Rainforest plantings commence at Rocky Creek Dam, and later at Myocum and Boatharbour
1985	Rotary Park regeneration programme starts
1988	TAFE bush regeneration certificate course starts Wollongbar TAFE
1988	NPWS-sponsored Workshop on Rainforest Rehabilitation (Proceedings 1991)
1992	Big Scrub Landcare (BSL) formed
1993	BSL's first field day at Hayters Hill in 1993
1995	Regeneration plans commissioned by NPWS for all its rainforest Nature Reserves
1997	First Hunter review of NPWS rainforest regeneration programme
1998	NPWS-sponsored Conference 'Rainforest Remnants: A Decade of Growth', Lismore. (Proceedings 1999)
1998	BSL's first of nine successful NSW Environmental Trust Grants for remnant rehabilitation
1999	First annual Big Scrub Rainforest Day
2001	Second Hunter review of NPWS rainforest remnant regeneration programme
2006	Listing of Lowland Rainforest as a State EEC after nomination by BSL
2009	BSL received Commonwealth Govt Caring for our Country grant matched by 12 partners for the largest recorded Lowland Rainforest remnant project
2011	Listing of Lowland Rainforest as a Federal CEEC after nomination by BSL
2012	BSL awarded a 6 year NSW Govt Environmental Trust grant

knowledge that might help them carry out active restoration of rainforests. In the late 1970s and early 1980s, scores of rainforest enthusiasts enrolled in courses put on by the University of New England's (UNE) Continuing Education Unit, taught by UNE botanists John Williams, Gwen Harden and Bill McDonald. Plant keys used during laboratory and field work were based on vegetative characters (in contrast to the existing keys based on the rarely available flowers and fruits). These keys, which later evolved into the 'Red book' (Williams *et al.* 1984), empowered many individuals to gain high levels of field skills upon which a rainforest restoration industry would later develop.

The participants in these workshops were also treated to tutoring from renowned Australian rainforest ecologist Len Webb (from Queensland) and rainforest botanist Alex Floyd (from NSW). During lectures and field trips to local remnants, both conveyed a passion for rainforest ecology and pointed to potential

for ecological restoration. Strategies proposed included planting pioneer species and poisoning weed trees to attract natural seed dispersal agents, as well as the creation of habitat islands and habitat connections using high-diversity closely spaced plantings in open areas. Inspired by these and other ecological restoration ideas, a number of participants in the courses became actively involved in tree planting and/or assisted natural regeneration activities, themselves subsequently influencing and inspiring further cohorts of on-ground restoration practitioners.

Replanting – early programmes

In 1978, National Parks and Wildlife Service (NPWS) and the Richmond Valley Naturalists Club commenced poisoning grass, mulching and planting pioneer species in the paddocks surrounding the rainforest remnant at Victoria Park Nature Reserve, Alstonville (Hunter, unpubl. data, 1997). This work was based on the advice (A.

Floyd, NPWS, unpubl. correspondence, 1977) that planting pioneers followed by early secondary species would attract bird dispersal of plant species from a range of successional phases. Similar plantings were carried out at Boatharbour near Lismore, with work ongoing at both sites until the 1990s.

Other plantings carried out in the early 1980s were modelled on the idea of starting with closely spaced mixes of tree species from all successional phases. One of the first was carried out through a labour market programme by Rous Water at Rocky Creek Dam, with others established on private property. Notable among these were the plantations established by Rob Kooyman at Myocum, which were subsequently used to demonstrate the close-spacing, mixed species model for broader application in rainforest restoration in the region (Kooyman 1996).

Unfortunately, private property landholders during this period were still being advised by the state forestry agency to plant nonlocal eucalypts (*Eucalyptus* spp.) and slash pine (*Pinus elliotii*) for soil conservation and farm amenity purposes. Advocates for local rainforest restoration, however, joined the committee of the Richmond Valley Reforestation Association to guide a more ecologically informed approach. The committee successfully put together 'rainforest kits' for distribution to landholders. While a short-lived exercise, the rainforest kits proved to landholders that rainforest plants could be successfully grown in the open and that a diverse range of species could be produced in commercial quantities, from locally collected seed.

Remnant regeneration – early programmes

Weed management projects designed to achieve natural regeneration of rainforest species were carried out at Ukerabagh Island and Stotts Island in the Tweed River in the early 1980s, but the Wingham Brush project on the

lower north coast of NSW, commencing in 1980, was a turning point in the professionalization of restoration practice. This project, through the leadership of John Stockard (Stockard 1991, 1999), pioneered highly successful techniques of weed control using a range of herbicide methods. This set the scene for the Rotary Park regeneration project that commenced in Lismore in 1985 and provided experience for many of the area's early practitioners.

The rainforest regeneration industry snowballed from that point, with numerous projects mushrooming across the Big Scrub area, including at Rocky Creek Dam (Woodford 2000) and many of the rainforest remnants in the NPWS estate such as Victoria Park, Davis Scrub and Boat Harbour (Fig. 2; Hunter, Unpub. data, 1997). Practitioners involved in those programmes mentored others, and a course in rainforest regeneration was established at the Wollongbar campus of the North Coast Institute of Technical and Further Education (TAFE) in the heart of Big Scrub country. Taught by experienced rainforest regenerators, this ongoing course is run now at other campuses and by other training organizations. It has contributed substantially over the decades to raising the standard of practice by both paid and volunteer rainforest regenerators in the Big Scrub area.

The works in the NPWS estate are arguably the jewel in the crown of the Big Scrub regeneration movement as they have achieved substantial conversion of many rainforest remnants from a highly degraded state to functional rainforest patches. In 1995, NPWS commissioned plans for long-term rainforest regeneration works at most of the nature reserves (Joseph 1995) and commissioned a review of the programmes, which concluded that, 'despite some problems identified, the program has been an outstanding success' (Hunter, Unpub. data, 1997, p. 7). Thirty-two areas in the Northern Directorate of NPWS (including the Big Scrub remnants) were further



Figure 3. Restoration in the Big Scrub is highly dependent on participation by private landholders, as well as agencies. Providing information to landholders through various publications and field has been a key to success to date. Big Scrub Landcare's annual Rainforest Day has now been running for 14 years, with a cumulative total attendance of over 20 000 visitors.

reviewed in 2001. Hunter (2001) concluded: 'In all cases, the fully treated sections (that is, those sections which have received both primary and follow-up treatment) of the mature rainforest in these areas are now in good condition and the desired endpoint has been achieved.'

Big Scrub Landcare

A key event in the movement to restore the Big Scrub was the formation of the Big Scrub Rainforest Landcare Group (Big Scrub Landcare) in 1992. The group evolved from a Big Scrub Remnant Owners group facilitated by NPWS and was largely the brainchild of several newly settled landholders including Berkeley Wiles and Tony Parkes, along with rainforest restoration practitioners Mark Dunphy, John Nagle, Sue Bower and Hank Bower. Motivated by the need to get private landholders to weed their remnants and connect them with plantings so that the Big Scrub rainforest could become functional again, the group adopted a strategy quite different to other Landcare groups. Rather than actually getting together to work on members' sites, the group saw its role as providing information to landholders through various publications, field days and the establishment of an

annual Rainforest Day held at Rocky Creek Dam (Fig. 3). More recently, it has successfully sourced grants and attracted skilled helpers that have made it one of the most successful Landcare groups in Australia.

In terms of its primary role of providing information, Big Scrub Landcare has published two highly popular publications: the Rainforest Restoration Manual (BSRLG 2005) and the Weeds Manual (BSRLG 2008). These publications provide information on the two main planks of work within the Big Scrub: assisting natural regeneration of rainforest and replanting. The group's annual Rainforest Day has now been running for 14 years, with a cumulative total attendance of over 20 000 people, with 4000 people passing through the gates in 1 year. Financial support for these activities came from Rainforest Rescue, a rainforest restoration foundation co-founded by Big Scrub Landcare's President Tony Parkes and Kelvin Davies, set up to support rainforest conservation programmes in the Big Scrub and around the world (<http://www.rainforestrescue.org.au/s>).

Over the years, however, Big Scrub Landcare has greatly expanded the scope of its restoration activities; involving both works on the ground and conservation advocacy. Alongside

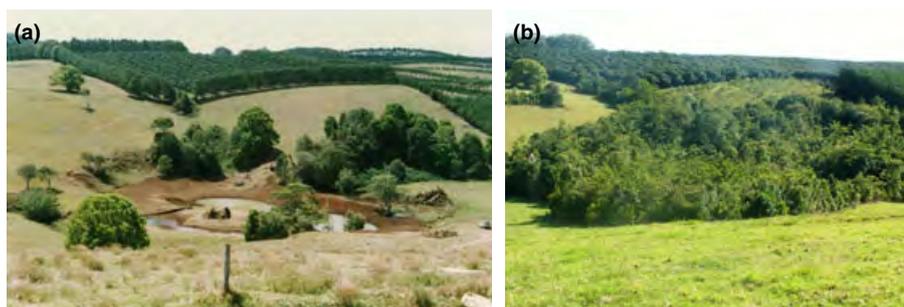


Figure 4. (a) 'Before' and (b) 'after' photograph-monitoring of plantings at the Big Scrub private property 'Jephcott's' at Brooklet in the Big Scrub. Potential exists for mixed species plantings to abut Macadamia plantations, enhancing connectivity across the Big Scrub landscape (Photos courtesy Mark Dunphy).

allow Big Scrub Landcare to continue its work on private land and seven NPWS Nature Reserves. In addition, it will be able to fund long-term rehabilitation works in two large areas of remnant lowland rainforest in Nightcap National Park and the adjacent area of Rocky Creek Dam catchment where exemplary works by Rous Water over the last two decades have already secured regeneration of extensive areas (Woodford 2000).

How Far Have We Come?

Are our efforts making a difference including at a landscape scale?

One of the greatest frustrations of those working in the Big Scrub is a lack of monitoring that can demonstrate the success of the projects. In his review of the earlier NPWS remnant regeneration projects, Hunter (2001) pointed out that lack of formal monitoring was a major shortcoming of the programme, with the exception of Wingham Brush and the North Washpool Rehabilitation. Pointing out that lack of monitoring limits the ability of the discipline to demonstrate scientifically that it is achieving the results it claims, Hunter (2001) recommended that the NPWS 'allocate funding to implement quantitative monitoring in several selected reserves or seek to obtain cooperative links with universities or other research bodies to do monitoring research'. Funding was not made available, however, to carry out this work. This has meant that information to evaluate the outcomes of most of the past two decades has depended on record keeping associated with grants; although more recently a monitoring programme called Monitoring and Evaluating Restoration of Vegetation (MERV) has been developed by EnviTE, with initial assistance from Big Scrub Landcare. This is now being applied across Big Scrub Landcare contract sites.

Big Scrub Landcare records show that over the past 20 years, most of



Figure 5. (a) Isolated giant stinging tree (*Dendrocnide excelsa*) in a weedy gully at 'Jephcott's' property and (b) the same site after 10 years, showing regeneration of a range of rainforest plant species and the creation of more typical rainforest conditions (Photos courtesy Mark Dunphy).

substantial funds that have been invested by private landholders (Figs 4,5), Big Scrub Landcare has been successful in gaining grants and has invested a total of \$2 M over the past 18 years to 2012, with \$1.8 M of this going to on-ground restoration works including remnants within the NPWS estate. Supported by dedicated professionals working on a pro-bono basis, the group also prepared successful nominations for the listing of lowland subtropical rainforest as Endangered (under State legislation) in 2006 and as Critically Endangered (under Federal legislation) in 2011

(see protection status, Box 1). These listings have assisted in having State and Federal funding bodies recognize the priority importance of works in the Big Scrub.

More recently, the group's aspirations broadened to include the rehabilitation of critically endangered lowland rainforest beyond the immediate confines of the Big Scrub. Relationships have expanded to include 12 major institutional partners, 60 landholders, 90 different properties containing remnant or regrowth vegetation and over 100 replanting sites. The group's current grant will

Box 2. Some Useful Terms Used in Bush Regeneration

'Primary treatment' is the first weeding treatment at a site, the one that removes the 'parent' generation of weed. As removal of the parent weed creates new gaps for emergence of weed stored as seed in the soil, multiple follow up treatments are required.

'Secondary treatment' is the generic term for the multiple 'follow-up' treatments required before weed will deplete weed sufficiently to secure the site for the natives. Natives can start to regenerate, along with weeds, immediately after primary treatment if their seed is present – although it often takes time for natives to recolonise.

'Maintenance' describes the low level of follow up required after natives have regenerated and weed is a very low and stable level.

(Adapted from McDonald 2006.)

the significant Big Scrub remnants (Box 1) have been subjected to systematic rainforest regeneration treatments, involving the gradual control of weeds. They are by no means 'finished' but many are well advanced in their recovery. Weed control is at the 'maintenance' stage (see Box 2 for definitions) at 31 remnants (46% of the total number of identified remnants) with an estimated total area of 174 ha (27% of the total area of remnants). Primary and follow-up weed control has been undertaken in an estimated area of 156 ha at a further 28 sites. Thus, invasive weeds, the major immediate threat to lowland subtropical rainforest vegetation, are being managed on an estimated 330 ha of remnants (51% of their total estimated area) in 59 Big Scrub remnants (87% of the 68 remnants; Box 1).

Across the remnants, daily record sheets kept by contractors show that the most widespread weeds that were treated consisted of Camphor Laurel, Lantana (*Lantana camara*), Large-leaved Privet (*Ligustrum lucidum*), Climbing Asparagus (*Asparagus plumosus*), Ochna (*Ochna serrulata*), Wandering Creeper (*Tradescantia fluminensis*), Madeira Vine (*Anredera cordifolia*), Tobacco Bush (*Solanum mauritianum*) and White Passionflower (*Passiflora subpeltata*). Exotic grasses and a raft of other weed species are encountered less often across the landscape (Big Scrub Landcare 2011).

Increased area of rainforest due to regeneration

Big Scrub regeneration contractors report edges are expanding as a result of weed control works at a range of remnants where adjacent land use allows. Examples include Johnston's Scrub NR (Figs 6,7), Emery Scrub and Cedarvale. While the area has not been calculated separately from the area of remnants and mature regrowth, expansion from regeneration is likely

to explain some of the c. 200 ha or so (c. 33%) gains in rainforest regrowth estimated in 2012 by Big Scrub Landcare and EnviTE compared with earlier assessments (Box 1).

Increased area of rainforest due to replanting

It is not possible to ascertain the precise area that has been replanted in the Big Scrub because, apart from works carried out by Big Scrub Landcare, many landholders have gained grants directly from the Catchment Management Authority (CMA) and/or paid for works out of their own pockets. An informed estimate is that commercial nurseries have sold 1.5 million trees to Big Scrub landholders in the last twenty years (M. Dunphy, BSL, unpubl. data, 2012). Assuming that 20% of these trees did not establish and that a further 20% were used for understory and other enhancement plantings, 900 000 trees are likely to have been established on Big Scrub sites. Based on an average spacing of 1.8 m, which is the recommended



Figure 6. Work area at the Johnston's Scrub remnant showing primary and/or follow-up work and location monitoring points using the recently developed monitoring system, MERV. Potential for expansion and linkage to adjacent vegetation is often enhanced by the presence of Camphor Laurel regrowth such as in the lower left of this photograph (Photomap courtesy EnviTE Inc).



Figure 7. Quadrat 6 Johnston's Scrub (a) before weed treatment when the quadrat contained three native species and seven exotic species; (b) just after primary weed treatment; and (c) after treatment, showing ten native species (including seedlings of four rainforest trees, one shrub, three scramblers/climbers, one fern and one grass species) (Photos Darren Bailey).

(and most commonly used) spacing, this may have expanded the area of lowland subtropical rainforest in the Big Scrub by approximately 250 ha.

Many of the plantings include a wide diversity of trees species, except on riparian zones or flats where frost limits the number of species that can initially survive. A number of demonstration sites of varying ages and floristic associations and planting styles are now developing in the local area (Big Scrub Rainforest Landcare Group 2005).

Improvements in connectivity

Continuous linkages due to plantings and assisted natural regeneration of rainforests are increasing as a result of restoration work being carried out in the Big Scrub area. Some outstanding examples of continuous linkages created by assisted natural regeneration include work at Rocky Creek Dam (Woodford 2000) and Brockley (Lymburner *et al.* 2006) – with regeneration at Wompoo Gorge, a property just outside the Big Scrub, aiming to connect Nightcap and Goonengerry National Parks (<http://site.emrproject-summaries.org>).

It is hard to envisage, however, achieving a continuous corridor in any direction across the entire Big Scrub, mainly because recruiting the private landholders is an extremely difficult challenge. While continuous linkage is still the dream of Big Scrub Landcare and is represented by a corridor

framework developed by the group in collaboration with EnviTE (Fig. 8), the more pragmatic approach adopted by the group is to focus on two things: opportunistic works to create linkages between close sites; and, continuing works to create stepping stone habitats.

Contribution by Camphor Laurel

The greatest contribution to improvements in connectivity (whether continuous or stepping stones), however, has been made by 'camphor regrowth' – that is, regrowth containing both the tree weed Camphor Laurel and native rainforest species regenerating in tandem. This regrowth has spontaneously occurred on much of the undulating or rocky land farmers find less productive (Fig. 9 and Fig. S1). The process commences with the weed's colonization into these sites, due to dispersal of its seed by frugivorous birds. Once mature, this species continues to attract birds that also disperse seeds of native rainforest species into the weed stands (Holmes 1987; Date *et al.* 1991; Gilmore 1999). This process has been shown to gradually increase rainforest tree species richness at many sites (Neilan *et al.* 2006; Kanowski & Catterall 2007a), and the progressive conversion of these stands from weed to native rainforest regrowth can be accelerated with skilled intervention by on-ground restoration practitioners

(Lymburner *et al.* 2006; Kanowski & Catterall 2007a).

What More Can Be Done?

There is no doubt that a gradual transformation from cleared agricultural lands to something more ecologically diverse and functional is occurring in the Big Scrub landscape. The landscape is increasingly containing elements of the original rainforest within a matrix of production horticulture. This is due to a mix of remnant regeneration work, regrowth (particularly where initiated by Camphor Laurel), rainforest planting and conversion of much of the landscape matrix from grazing to horticulture. A number of issues, however, remain.

Formalizing landscape level planning

There is currently no formal landscape level plan for restoration in the Big Scrub. The current approach by Big Scrub Landcare is partially strategic and partially opportunistic, due to constraints in finances and landholder recruitment. There is no doubt, however, that a formal strategic plan could potentially win greater support from stakeholders and funding bodies as it could devise ways to optimize value for money and achieve outcomes within shorter time frames.

Some of the conceptual planning has already been done. Figures 8 and 9,

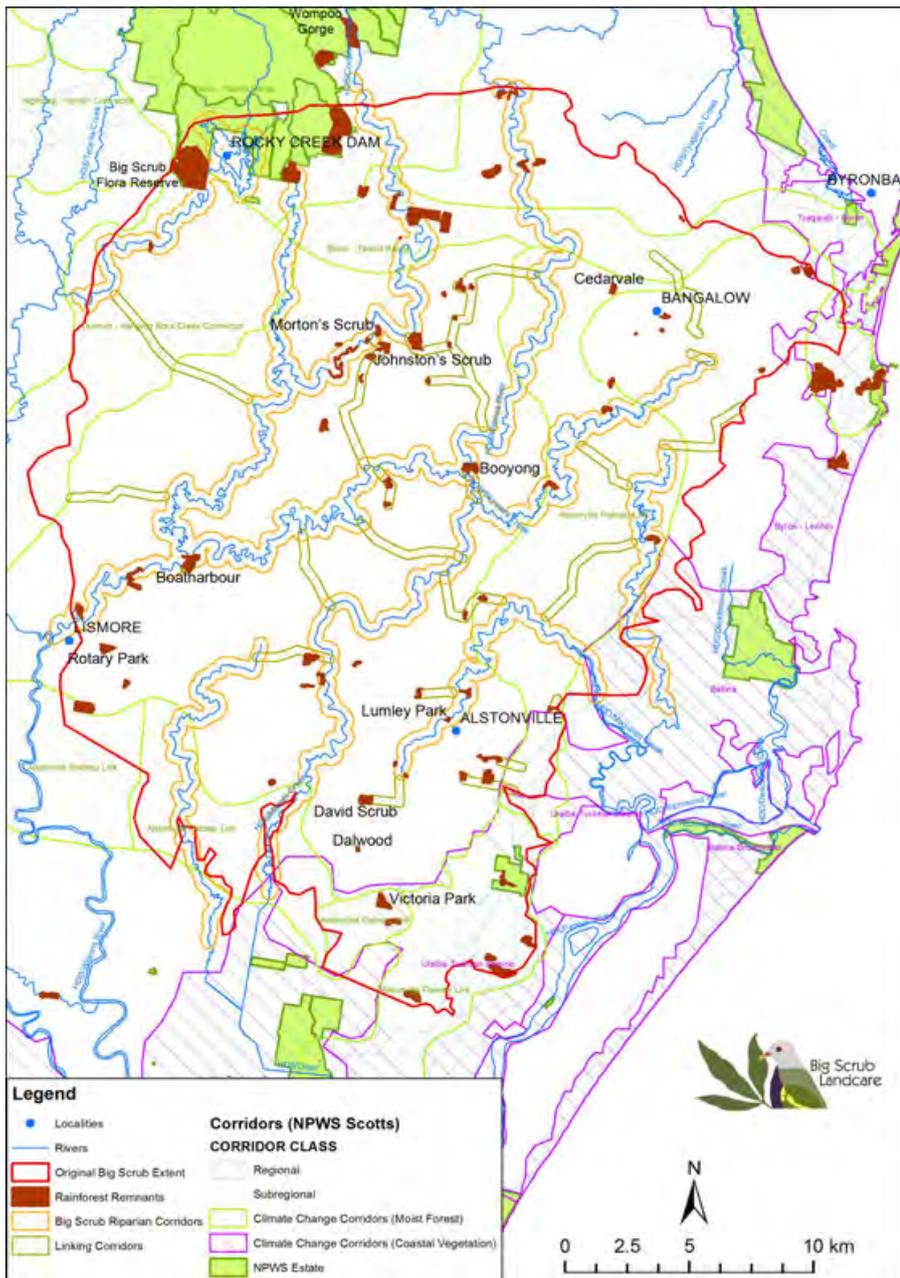


Figure 8. Diagrammatic representation of proposed Big Scrub corridors incorporating regional and local corridors (Map: Copyright 2012 Big Scrub Landcare. This map is not guaranteed to be free from error or omission).

developed by EnviTE and Big Scrub Landcare, for example, propose a framework of potential restoration corridors to link remnants, rainforest regrowth, Camphor regrowth, and rainforest, eucalypt and macadamia plantations. This framework takes into account the broad scale corridors identified by NPWS and other agencies (Scotts 2003, DECC 2007, Byron Shire

Council 2004, Bushland Restoration Services and Landmark Ecological Services 2009).

A more detailed level of planning is needed, however, to identify priorities for implementation between and within specific corridors. This should draw on the extensive and detailed knowledge of local ecologists and rainforest restoration practitioners to

ensure: (i) ongoing management of all remnants so they continue to function as habitats and seed sources; (ii) strategically important new plantations to link habitats and provide new seed sources; and (iii) manipulation of key camphor regrowth stands to accelerate their successional development to native rainforest.

Because implementation is likely to continue to involve Big Scrub Landcare and its local, regional, state and commonwealth partners, the planning should be participatory, involving those partners from the outset. Implementation success, however, would also depend upon improvements in the three further issues touched on below.

Better focusing on ecological process and the needs of individual species

Rainforest recovery, whether by planting or regrowth, is a highly unruly process, difficult to direct to successional endpoints, particularly on a large scale or a shorter term. Nonetheless, it is important that restoration planners and practitioners think through the likely regression and successional pathways of planted or recovering vegetation stands. This would allow us to better design our works to ensure that the plant and animal species that might be characteristic of various areas of the Big Scrub have an opportunity to develop and persist in the longer term. Some plant species that were much better represented in the past (particularly dispersal-limited species, some dioecious species and species with short distance pollination), for example, have lower capacity to recover in large gaps and need more assistance than others in terms of direct seeding, planting or the culling of competition at critical stages. Some animal species are found only in few locations and are isolated, potentially exposed to local extirpation if their particular needs are not met. Many of these require special consideration prior to extensive weed bank or native vine removal and may require particular habitats to be fostered.

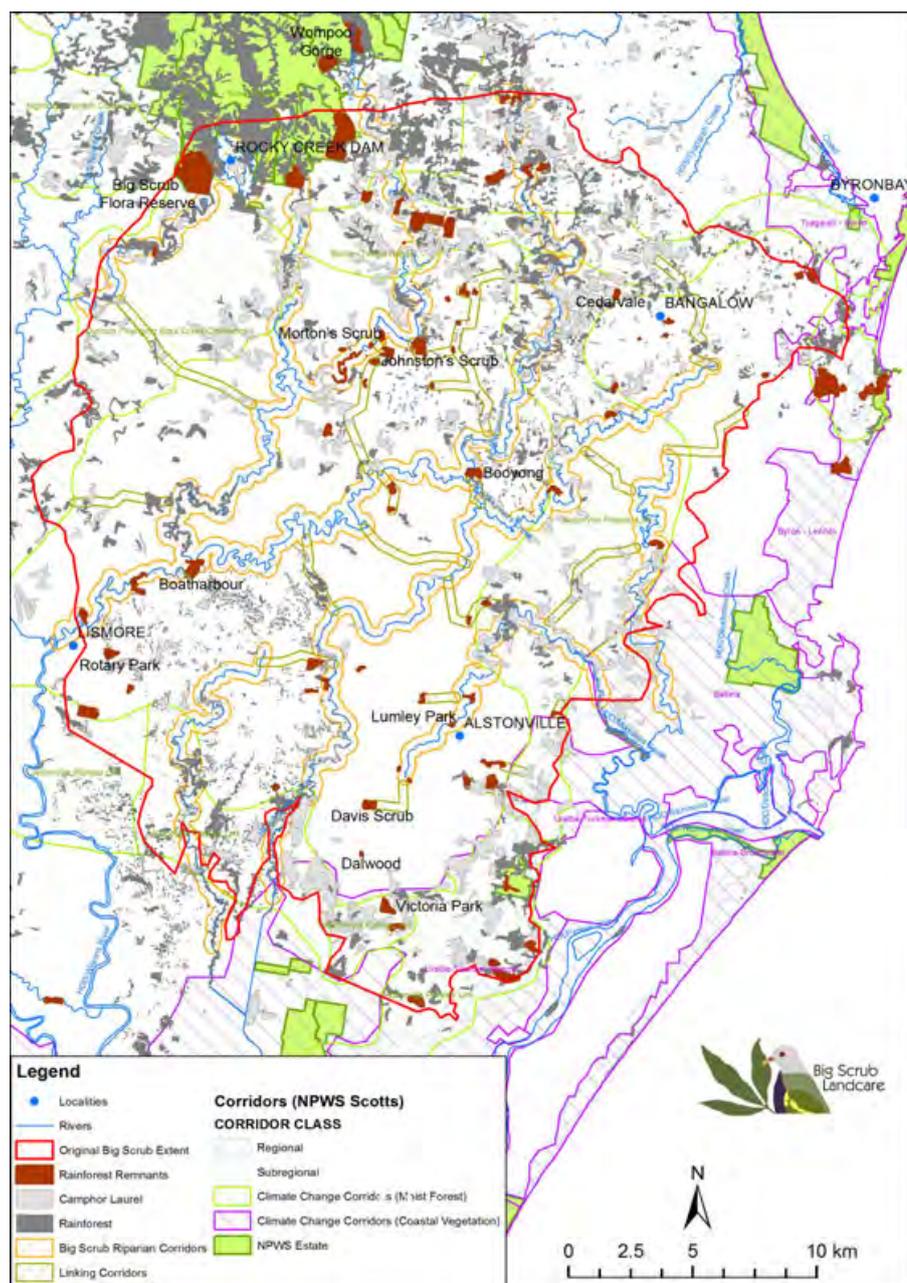


Figure 9. Location of remnants and Camphor regrowth in the Big Scrub area, overlain with the Big Scrub/EnvITE corridor framework (Map: Copyright 2012 Big Scrub Landcare. This map is not guaranteed to be free from error or omission).

Ecological information on the needs of such species would of course, need to be included in any Big Scrub planning. Until then, however, more can be done by landholders and contractors working at the level of an individual site. Sharing knowledge is a key to this. Forums such as the Big Scrub Rainforest Days, field days and newsletters, are

important conduits for empowering the individual landholder to think in terms of how works in or near their remnant or regrowth can better address the needs of isolated species. There is also a vital subculture of sharing knowledge among contractors that has fostered improvements in techniques, skills and understanding over the years and which can be

tapped into for this purpose. Up to 50 of the restoration practitioners working in the Big Scrub are contractors who move around, working for each other. New ideas are developed and spread rapidly in this environment, and it is likely that solutions for better addressing the needs of less well-represented species will come from this quarter, particularly if supported by information provided by ecologists and ecological planners.

Finally, stronger links are needed between TAFE, field practitioners and the local university to ensure that opportunities to study such questions can be fostered – and to ensure that the knowledge gained can be fed back into the content of the relevant TAFE and university courses and through Rainforest Day workshops.

Improvements in monitoring

State and Commonwealth grant recipients are now required to undertake photopoint monitoring and collect some data demonstrating changes at their sites over time. Big Scrub Landcare undertakes photopoint monitoring to convey changes since treatment, although impressive before and after photography is rarely achieved due to the regenerating plants obscuring a vista. A toolkit for rainforest restoration monitoring has been prepared by researchers from Griffith University (Kanowski & Catterall 2007b), which has assisted groups in designing some monitoring. Quadrat monitoring using the MERV system has been applied by Big Scrub's main contractor, EnviTE, over the past 5 years. It is clear, however, that monitoring which is expected to come out of the same budget as on-ground works will always come second; and short term analyses for funding bodies will always take precedence over the analysis of data collected over longer time periods. More dedicated funding for monitoring is therefore needed.

Greater involvement by local universities would also assist. A dearth of interest by researchers has been alleviated in recent years by a number of

high-quality research projects conducted by Queensland's Griffith University, which have substantially advanced communication of knowledge about big Scrub restoration. But there is still more untapped potential for mutually beneficial collaborations between Big Scrub Landcare and northern NSW research and teaching institutions. Obvious projects that could be undertaken include: assisting Big Scrub Landcare with analysing their longer term data; post hoc comparisons of methods; air photograph interpretation to quantify landscape-wide changes in rainforest and Camphor regrowth over time; and, conducting surveys of landholders registered with Big Scrub Landcare to identify works undertaken to date and their results.

Greater security of funding

Funding gained by Big Scrub Landcare has been impressive. Even with excellent grant funding, however, a vision for landscape scale restoration will still be largely limited by lack of *secure* implementation funding.

That is, a repeated concern for the management of remnants is not just the size of the funding but its long-term security. Restoration practitioners have learned to develop strategies to minimize the effect of interruptions to funding. These included breaking up a site up into zones that are treated consecutively so there is always a strong core with the lowest length of edge, consolidating a treated area behind while moving forward (Joseph 1999). Despite this, gaps in funding mean that the condition of the site goes backwards and a proportion of the next much funding has to go to re-treat the site. As a result, some practitioners argue that it would be more cost-effective to have smaller amounts secured over longer time frames than higher amounts in a short period as the growth rates of weeds in subtropical climates mean that much good work can easily be lost with just 1 year without follow-up.

Improving incentives to landholders

The Northern Rivers Catchment Management Authority (Northern Rivers CMA) provides funding for skilled restoration practitioner to commence restoration on private lands on the understanding that landholders will follow up with the work over a 10-year period. The quality of such follow-up work, however, is questionable because very few landholders have the plant identification and detailed herbicide application skills necessary to avoid off target damage when carrying out follow-up and maintenance weed control. Paying regenerators is therefore needed on an ongoing basis.

Currently, primary producers can pay skilled regenerators and claim landcare tax deductions for 'expenditures combating land degradation' including the degradation of native vegetation (Big Scrub Rainforest Landcare Group 2005); some of the larger Macadamia growers claim remnant management as a tax deduction due to the integrated pest management contribution of remnants; and, it is also possible that some remnant maintenance could be financed from rate rebates achieved from covenanting land through voluntary conservation. For landholders less motivated or who have not high taxable incomes, however, more serious incentives that offer real financial gains are needed.

The introduction of market-based instruments such as stewardship payments, biodiversity credits or schemes that involve carbon-biodiversity co-benefits have potential to provide for significant incentives. However, these schemes appear to be insufficiently well tailored to provide appropriate conditions to provide true biodiversity gains. Recognition criteria and registration processes for qualifying projects, for example, need to contain a capacity to reward projects that offer multiple biodiversity gains (such as supporting higher numbers of species or meeting regional benchmarks)

rather than simply ticking a box based on one or a few species or habitat attributes. This is particularly important for supporting skilled conservation management in key corridors for subtropical rainforest and other critically endangered ecosystems.

Renewal of the Vision

Certainly, restoration cannot be applied to the whole landscape and the 75 000 ha extent of Big Scrub rainforest will never be reinstated. But rainforest recovery is a dynamic and long-term process. The positive feedback processes driven by frugivore dispersal via camphor regrowth lend a degree of optimism that the Big Scrub landscape may have potential to continually increase in similarity to the original forest over time in terms of its character, structure and function. This will only occur, however, if the vision of restoration is backed by governments and the community.

The Big Scrub restoration vision needs to be continually renewed in the community. Each generation needs to take stock of and being inspired by the outcomes already achieved by previous generations. We need to be optimistic. So much has been done over the past 30 years because of subtropical rainforest's own recovery capacity combined with the vision of a relatively small number of people. Larger numbers of people can now start to imagine where this restoration process might go in the next 30- or 300-years.

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Supporting Information

Additional Supporting Information may be found in the online version of this article.

Figure S1. Indicative Boundary of Original Big Scrub, major Rainforest Remnants, National Parks and Nature Reserves and 2009 Aerial Photography. (Note indicative Original Big Scrub boundary is that estimated by broad geological patterns and local knowledge. Copyright 2012 Big Scrub Landcare. This map is not guaranteed to be free from error or omission. Big Scrub Landcare and its members disclaim liability for any act performed on the information in the map and any consequences of such acts or omission.)

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