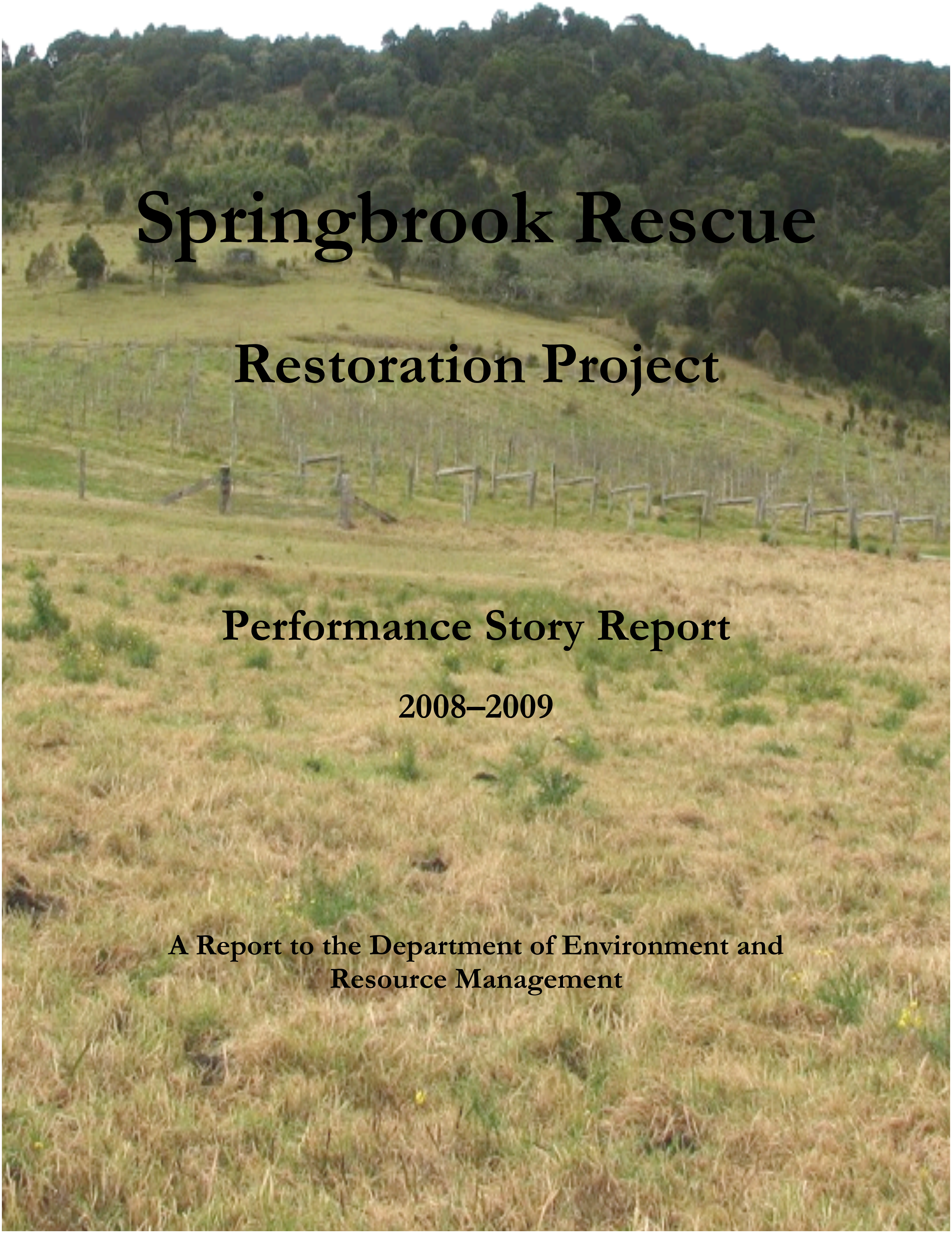
Springbrook Rescue

Restoration Project

Australian Rainforest Conservation Society Inc



Springbrook Rescue

Restoration Project

Performance Story Report

2008–2009

A Report to the Department of Environment and Resource Management

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Report Structure

This Performance Story is structured as far as practicable to meet guidelines indicated by the following sources:

Australian Government (2009). NRM MERI Framework. Australian Government Natural Resource Management, Monitoring, Evaluation, Reporting and Improvement Framework.

Pannell, D.J. (2009) INFFER: Investment Framework for Environmental Resources http://www.inffer.org

SER (2004) The SER International Primer on Ecological Restoration. Society for Ecological Restoration International, Science & Policy Working Group (Version 2: October, 2004)

Part 1: The Project

1. The Project

1.1 Background and overview of the Project

The Queensland Government has allocated major funding to the acquisition of freehold properties in the Springbrook area for the purposes of conservation.

The current national park, the southern section of which is included in the Gondwana Rainforests of Australia World Heritage Area, is small and has boundary configuration inconsistent with long-term conservation.

The overall aim of Springbrook Rescue is to restore rainforest on cleared areas and re-create links between sections of the national park, thus creating a more viable World Heritage Area and one which provides a greater potential for its flora and fauna, especially ancient lineages underlying criteria for listing, to survive the impacts of future climate change.

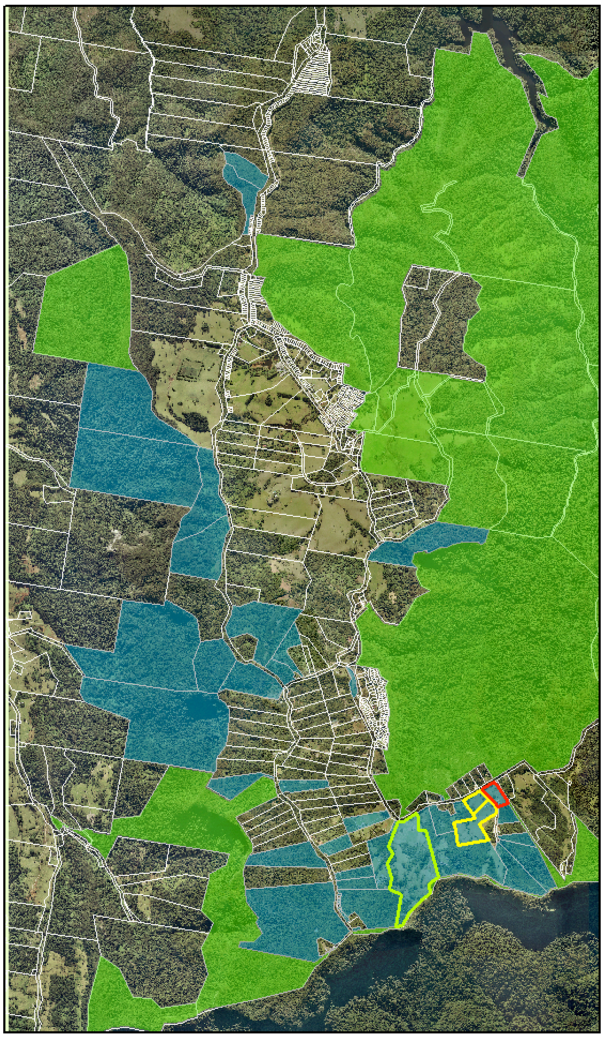

Figure 1.1. The Springbrook Area. Properties purchased by the Queensland Government are shaded blue. Springbrook National Park is shaded green. The three properties that are the main focus of the restoration project at this time are shown outlined.

The Australian Rainforest Conservation Society Inc (ARCS) has enthusiastically accepted responsibility for managing the restoration program for properties purchased by the Queensland Government. This will be done in the overall context of restoring World Heritage values and integrity across the Springbrook Plateau and surrounding areas with a focus on restoring whole catchments wherever possible. This objective coincides with that of the ARCS project, 'Springbrook Rescue'.

Boundaries

Whereas the Springbrook Rescue project encompasses the whole of Springbrook Plateau and adjoining areas, the restoration project is limited to properties purchased by the Queensland Government or owned by the Australian Rainforest Conservation Society and, in the first instance, will focus on those properties that will restore the high-country linkage between sections of the national park that are part of the World Heritage Area.

1.2 The Site

1.2.1 Identification

1.2.1.1 Location

The site is defined broadly as Springbrook, an area of roughly 20 square kilometres (~ 12 km long and 3 km wide at the widest point), located largely on the Springbrook plateau, between 28˚15' S and 28˚08' S, and 153˚14' E and 153˚18' E, and approximately 500 km south of the Tropic of Capricorn and 38 km south of the nearest town, Nerang, Queensland, Australia.

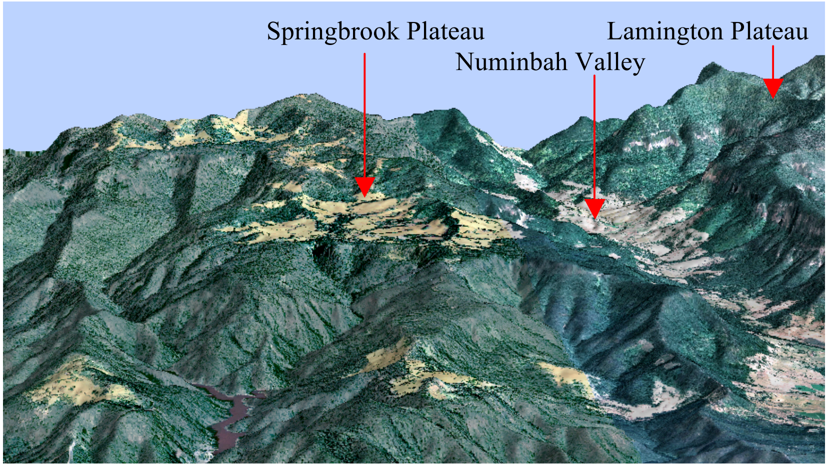

Figure 1.2. The Springbrook area viewed from the north. The southern extent of the view is the Queensland–New South Wales border.

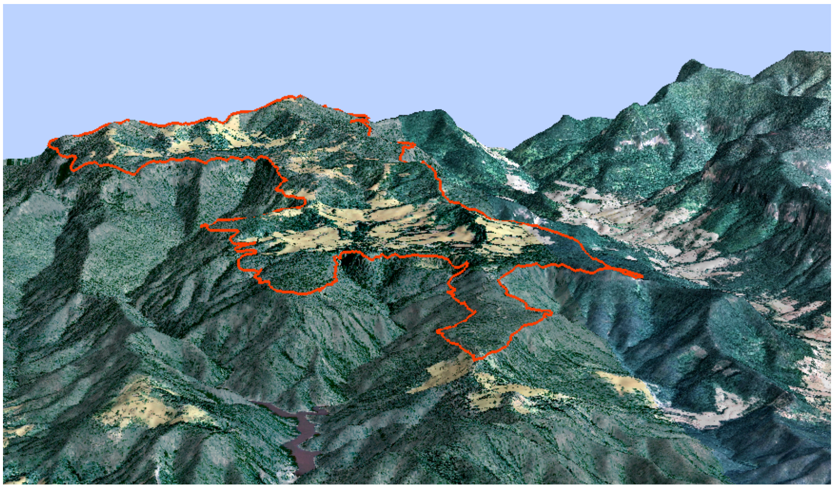

Figure 1.3. Springbrook Plateau is outlined in red.

1.2.1.2 Ownership

A major part of the Springbrook area is owned by the Queensland Government within protected area and Crown freehold tenures. The remainder includes conservation areas owned by Gold Coast City Council and privately owned freehold land.

Restoration activities will be undertaken on land owned by the Queensland Government and property owned by the Australian Rainforest Conservation Society.

1.2.1.3 Brief description

Topography

Springbrook lies on the northern flanks of the Tweed Volcano which, with its well-developed radial drainage, is easily recognizable as a shield volcano, despite its age (23.5–20.5 million years). Erosion has left a core, Mt Warning, isolated from a horseshoe-shaped arc of precipitous cliffs — the Mt Warning or Tweed Caldera. This erosion caldera, about 30 km across, is one of the major examples of this landform in the world, notable for its size and central mountain mass (Figure 1.4).

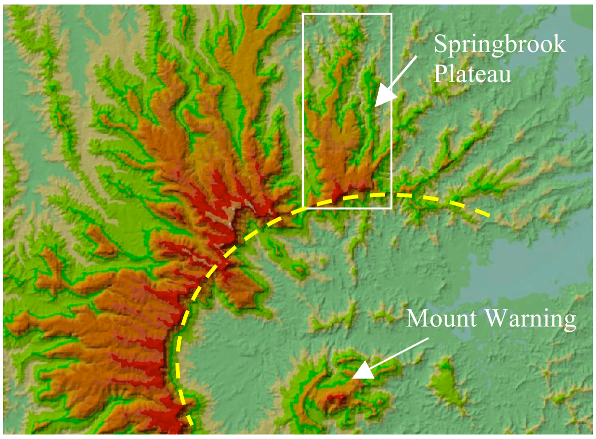

Figure 1.4. The Tweed Caldera. The rim of the erosion caldera is indicated by the dashed line.

The Springbook precinct is effectively a biogeographic island isolated by fluvial processes typically associated with volcanic landforms, preserving extremely compressed environmental gradients (climatic, hydrological, physiographic, historical) including the wettest, most nutrient rich environments nationally outside its sister area, the Wet Tropics.

Altitudinal gradients encompass lowlands (less than 400 m), through uplands (400–800 m) to highlands (800–1051 m)(See Figure 1.5.). Each altitudinal zone shows further segmentation of microenvironments on the basis of altitude, geology, rainfall and aspect — these are the key present-day determinants of plant and animal distributions, abundances and movements since they determine availability of energy, moisture, nutrients, the essential factors for life.

The highest points in the area are Mt Mumdjin (1010 m) in the south-west corner of the plateau and Mt Bilbrough (960 m) 2 km to the east along the McPherson Range. The lower limit of the plateau's elevation gradient was set at ~600 m, as this generally marks the transition between the flatter topography of the plateau and the near vertical, rhyolite-derived cliff faces.

Over the past 23 million years geomorphological processes have isolated the Springbrook plateau biogeographically from the rest of the Caldera precinct and the McPherson Range to the west. Erosion reduced the crater from a maximum height of 2000 m to 1150 m, with typical radial drainage reducing the conical surface to complex, stepped valleys and more erosion resistant scarps and cliff lines. Currumbin and Tallebudgera valleys drain the plateau to the north east, and Numinbah/Nerang to the north and north west.

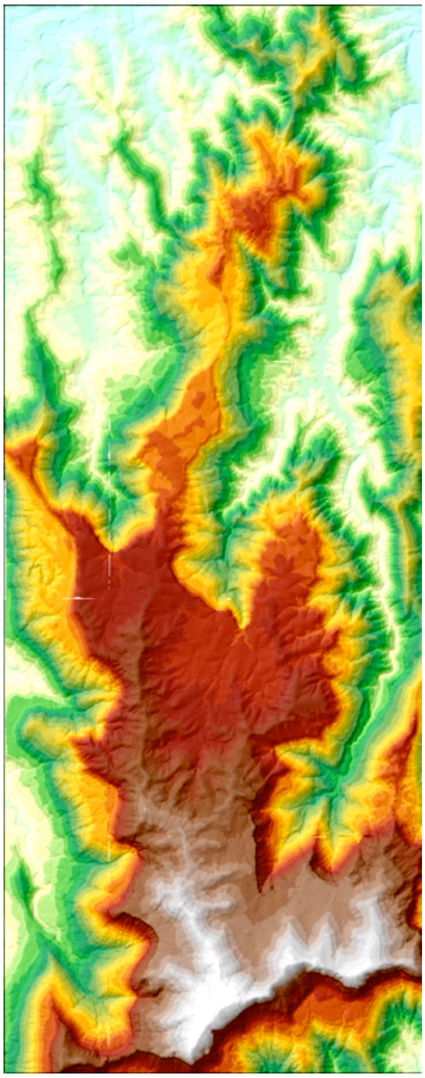
Figure 1.5. Springbrook Plateau terrain

Catchments are the basic unit of management on any scale (Magnusson 2001; Margules and Pressey 2000) since it is almost impossible to effectively protect parts of a catchment if threats spread from ridgelines or watershed regions. Most ridgelines on the Springbrook plateau are roaded, facilitating urbanization and associated infrastructure development which fragment ecosystems and act as conduits for alien invasions, aiding the spread of weeds and feral animals. Riparian areas with their dendritic structure and connectivity throughout the landscape reinforce the need for a catchment approach to management.

The plateau proper (above ~600 m) comprises 10 subcatchments flowing into the Nerang River and Little Nerang Creek (both East and West branches), which supply water to the Hinze and Little Nerang dams that service the needs of the Gold Coast. The subcatchments vary in size between 20 and 290 hectares each, as well as in altitude, topographic diversity, aspect, radiation and rainfall regimes, soils and geological substrates.

Lower plateau (600–750 m) catchments with a combined area on the plateau of 422 hectares, are drained by Camp, Kuralboo, Purling Brook and Carrick Creeks via spectacular waterfalls (Purling Brook Falls) over steep rhyolite cliffs into Little Nerang Creek (West Branch). Cleared areas within these catchments are virtually contiguous and total about 150 hectares. Purling Brook catchment is the only meso-scale catchment on the lower plateau.

The higher plateau (750–1010 m) catchments with a combined area on the plateau of about 350 ha are comprised of Mundora, Ee-jung, Boy-ull and Rush Creeks draining northwards into Little Nerang Creek (East Branch). Boy-ull Creek Catchment is the only meso-scale catchment on the higher plateau, and the second largest on the entire plateau.

Geology

The area represents the northern flank of the now extinct Tweed Shield Volcano, active between about 23 and 20 Million years ago. It is the best preserved of its kind and size in the world. Five major eruption episodes of varying intensities and durations produced as many lava flows differing in composition, density, areal extent and depth. The oldest and most extensive flows (Beechmont Basalts) range in thickness from 300 m to 150 m, south to north. The two succeeding basalt flows are interleaved by harder, less erodible rhyolites (Binna Burra Rhyolite and Springbrook Rhyolite), with Hobwee Basalts the last overtopping layer restricted to the highest, southernmost parts of the plateau. Springbrook Rhyolite forms the upper cliff line of this plateau (Figure 1.6).

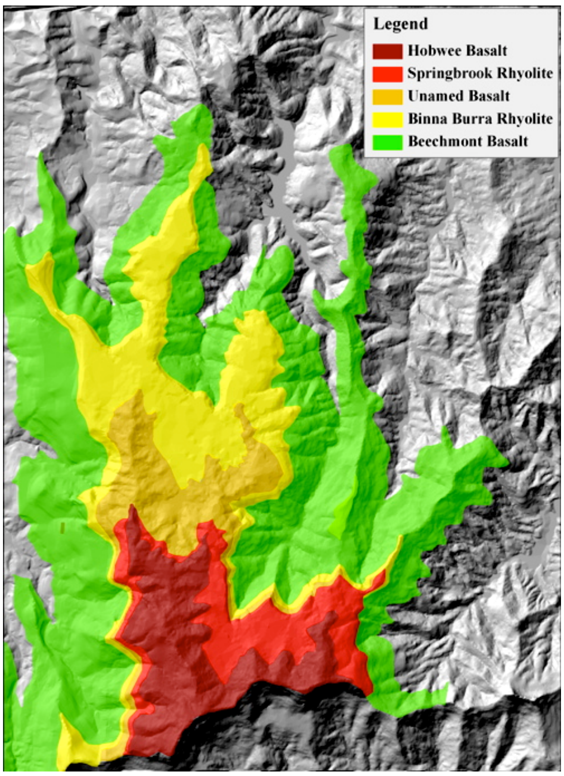

Figure 1.6. Geology of Springbrook Plateau (based on Willmott & Hayne 2001)

Climate

The climate is subtropical, moist maritime, characterized by hot, wet summers and cool dry winters. The climate is strongly seasonal with two main air masses alternating during the year. Dominant influences are unstable moist air masses flowing from the east in summer and dry westerlies in winter.

Mean annual temperature is ~ 15 ˚C. Seasonal variation in air temperatures is high. The monthly average maximum temperature is ~ 27 °C and the monthly average minimum temperature is ~ 3 °C. January is the hottest month and August the coldest month. Daily temperatures fluctuate enough to make frosts possible at any time of the year.

On the slopes of plateau, temperature decreases an average of 0.65 ˚C per 100 m increase in elevation. Occasional snow has been recorded on the plateau in 1948 and 1985 (Hall 1990). Hailstorms are an annual occurrence.

Springbrook Plateau is the wettest area on the Australian mainland outside the Wet Tropics. Mean annual precipitation exceeds 3500 mm at higher altitudes, with marked interannual variation both in seasonal and annual levels corresponding to El Niño Southern Oscillation (ENSO) events. Most of the rain falls between December and April with February the wettest month, with an average of 475 mm of precipitation, and August/September are the driest, with generally less than 100 mm of precipitation per month. In 1974, Springbrook Forestry Station received 5648 mm with 2323 mm falling in January. With respect to rainfall, the significance of Springbrook in the Tweed Caldera region can be seen in Figure 1.7.

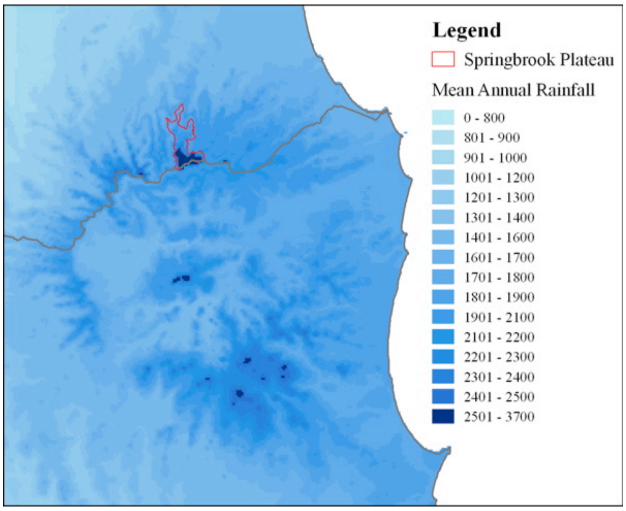

Figure 1.7. Mean annual rainfall in the Caldera region.

The annual 1600-mm isohyet skirts the base of the plateau, while precipitation reaches >3100 mm at higher altitudes. Dry season length (number of months with <100 mm of rain) (Ter Steege *et al.* 2003) is a strong predictor of tree density and maximum tree alpha-diversity. Rainfall seasonality regulates diversity and density by affecting shade tolerance and subsequently the number of different functional types of trees that can persist in an area. High constant moisture increases shade tolerance, higher densities, higher numbers of functional guilds in the understorey (Huston 1994).

Vegetation

Vegetation on the Plateau includes cool temperate, warm temperate and subtropical rainforest, tall open forest and small areas of montane heath.

Mapped Regional Ecosystems prior to clearing (pre-1906) and at 2006 are shown in Figures 1.8 and 1.9, respectively. Of the regional ecosystems occurring on the Plateau, four are classified as 'Of Concern' with respect to their conservation status and/or biodiversity status: 12.8.2 — *Eucalyptus oreades* tall open forest, 12.8.6 — Simple microphyll fern forest with *Nothofagus moorei*, 12.8.8 — *Eucalyptus saligna* or *E. grandis* tall open forest and 12.8.9 — *Lophostemon confertus* open forest.

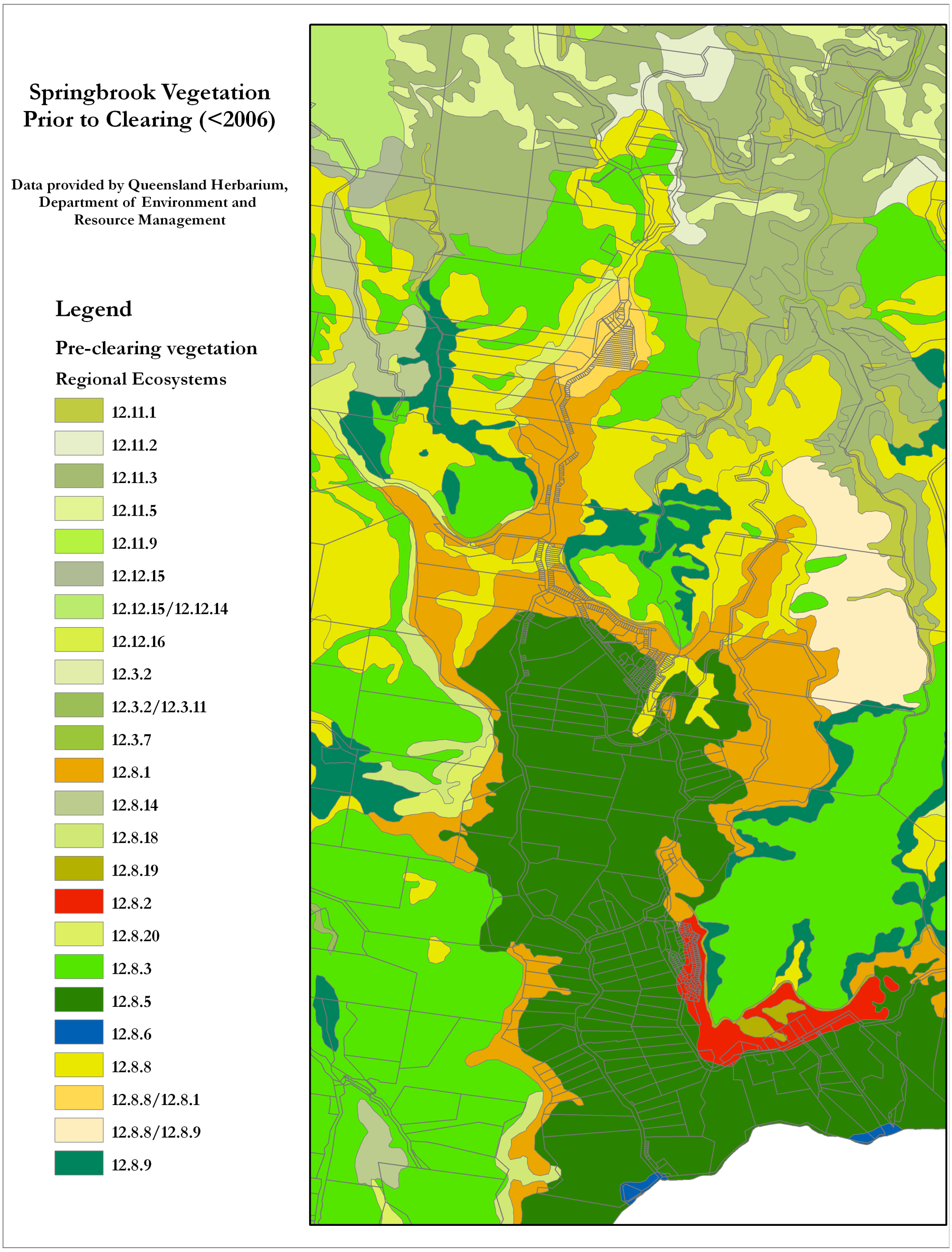

Figure 1.8. Pre-clearing (pre-1906) Regional Ecosystem mapping by Queensland Herbarium. Regional Ecosystems relevant to the restoration project are —

12.8.1 Eucalyptus campanulata tall open forest on Cainozoic igneous rocks
12.8.2 Eucalyptus oreades tall open forest on Cainozoic igneous rocks
12.8.3 Complex notophyll vine forest on Cainozoic igneous rocks. Altitude <600m
12.8.5 Complex notophyll vine forest on Cainozoic igneous rocks. Altitude usually >600m
12.8.6 Simple microphyll fern forest with Nothofagus moorei on Cainozoic igneous rocks
12.8.8 Eucalyptus saligna or E. grandis tall open forest on Cainozoic igneous rocks
12.8.9 Lophostemon confertus open forest on Cainozoic igneous rocks

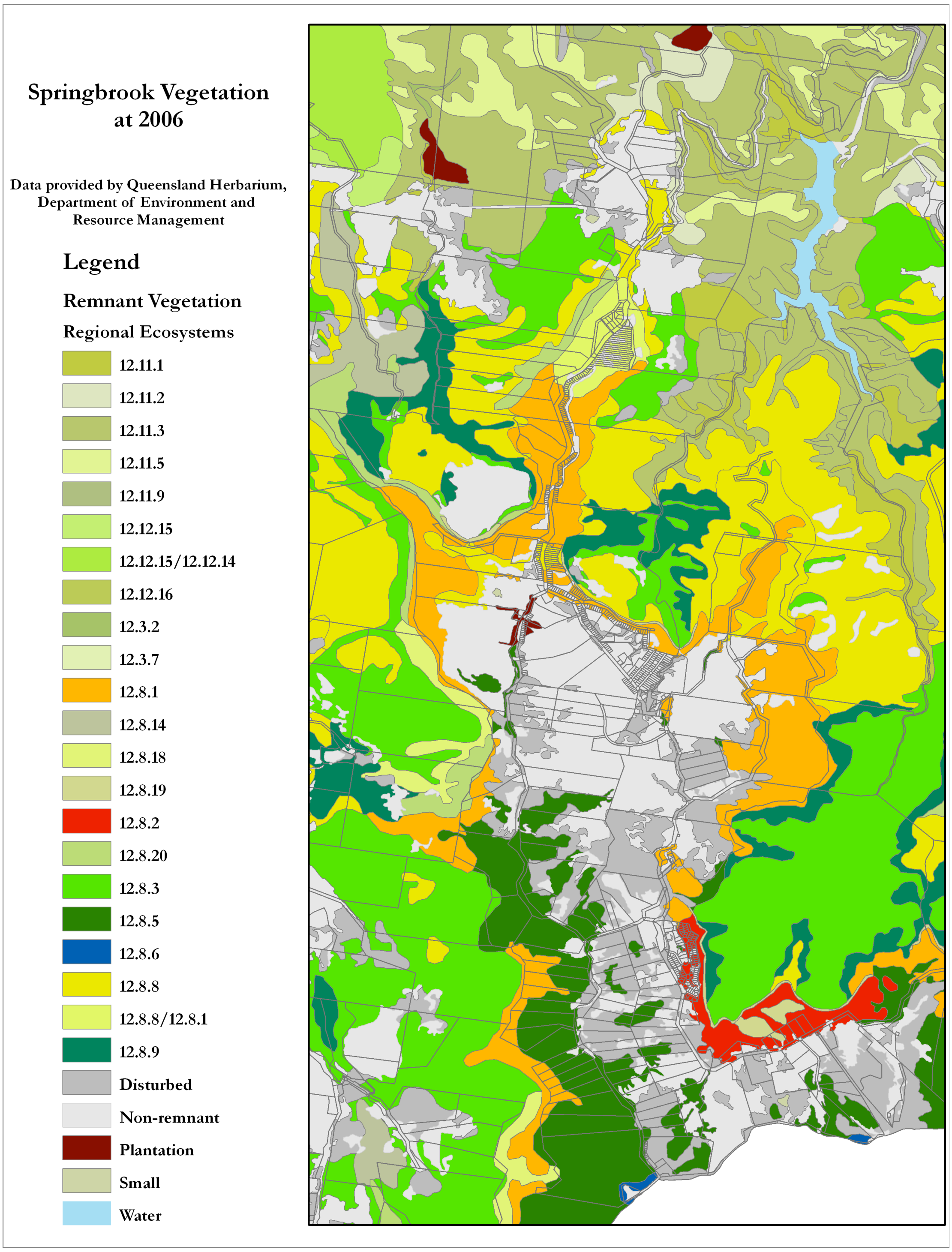

Figure 1.9. Remnant (2006) Regional Ecosystem mapping by Queensland Herbarium. Regional Ecosystems relevant to the restoration project are —

12.8.1 Eucalyptus campanulata tall open forest on Cainozoic igneous rocks
12.8.2 Eucalyptus oreades tall open forest on Cainozoic igneous rocks
12.8.3 Complex notophyll vine forest on Cainozoic igneous rocks. Altitude <600m
12.8.5 Complex notophyll vine forest on Cainozoic igneous rocks. Altitude usually >600m
12.8.6 Simple microphyll fern forest with Nothofagus moorei on Cainozoic igneous rocks
12.8.8 Eucalyptus saligna or E. grandis tall open forest on Cainozoic igneous rocks
12.8.9 Lophostemon confertus open forest on Cainozoic igneous rocks
'Disturbed' ecosystems are generally rainforest regenerating after clearing
'Non-remnant' ecosystems are generally introduced pasture grasses

Table 1.1 provides more details of the Regional Ecosystems as described by the Queensland Herbarium.

Table 1.1. Regional Ecosystem descriptions and special values. Species highlighted in bold have been recorded at Springbrook.

RE	Description	Special values
12.8.1	Eucalyptus campanulata tall open-forest with shrubby to grassy understorey. Other canopy species include Eucalyptus microcorys, Syncarpia glomulifera subsp. glomulifera, E. acmenoides, Corymbia intermedia, E. carnea and E. resinifera. Patches of Eucalyptus pilularis sometimes present on ridges and crests. Occurs in high rainfall areas above 580 metres altitude on Cainozoic igneous rocks especially rhyolite.	Habitat for rare and threatened flora species including Acacia acrionastes, A. saxicola, Arundinella montana, Gahnia insignis, Hibbertia hexandra, H. monticola, Pandorea baileyana and Rulingia salviifolia.
12.8.2	Eucalyptus oreades ± E. campanulata tall open-forest. Occurs on Cainozoic igneous rocks	Habitat for rare and threatened flora species including Hibbertia monticola, Olearia heterocarpa, Petermannia cirrosa , Banksia spinulosa var. cunninghamii and Prostanthera phylicifolia
12.8.3	Complex notophyll vine forest. Characteristic species include Argyrodendron trifoliolatum, Argyrodendron sp. (Kin Kin W.D.Francis AQ81198), Olea paniculata, Castanospermum australe, Cryptocarya obovata, Ficus macrophylla forma macrophylla, Syzygium francisii, Diploglottis australis, Pseudoweinmannia lachnocarpa, Podocarpus elatus, Beilschmiedia obtusifolia, Neolitsea dealbata and Archontophoenix cunninghamiana. Occurs on Cainozoic igneous rocks, especially basalt <600m altitude.	Habitat for endemic and rare and threatened flora species including Niemeyera whitei, Austromyrtus fragrantissima, A. inophloia, Baloghia marmorata, Cassia brewsteri var. marksiana, Choricarpia subargentea, Corynocarpus rupestris subsp. arborescens, Cupaniopsis newmanii, Davidsonia johnsonii, Dendrobium schneiderae, Diploglottis campbellii, Endiandra globosa, Floydia praealta, Lepiderema pulchella, Macadamia integrifolia, M. tetraphylla, Muellerina myrtifolia, Ochrosia moorei, Owenia cepiodora, Pandorea baileyana, Papillilabium beckleri, Plectranthus nitidus (rocky outcrops), Pouteria eerwah, Randia moorei, Rhodamnia maideniana, Romnalda strobilacea, Sarcochilus dilatatus, S. weinthalii, S. fitzgeraldii, S. hartmannii, Syzygium hodgkinsoniae, S. moorei, Marsdenia hemiptera and Triunia robusta.
12.8.5	Complex notophyll vine forest. Characteristic species include Argyrodendron actinophyllum, Sloanea australis, S. woollsii, Cryptocarya erythroxylon, Ficus watkinsiana, Dysoxylum fraserianum, Caldcluvia paniculosa, Geissois benthamii, Orites excelsus, Acmena ingens, Syzygium corynanthum, S. crebrinerve and Citronella moorei. Occurs on Cainozoic igneous rocks especially basalt and laterised basalt usually >600m altitude.	Habitat for endemic and rare and threatened flora species including Acacia orites, Acronychia baeuerlenii, Austromyrtus inophloia, Austrobuxus swainii, Clematis fawcettii, Cordyline congesta, Cyathea cunninghamii, Dendrobium schneiderae, Euphrasia bella, Helmholtzia glaberrima, Lastreopsis silvestris, Muellerina myrtifolia, Nothoalsomitra suberosa, Pandorea baileyana, Pittosporum oreillyanum, Sarcochilus fitzgeraldii, S. hartmannii, S. weinthalii, Solanum callium, Symplocos baeuerlenii and Uromyrtus sp. (McPherson Range G.P. Guymer

RE	Description	Special values
		2000), and cool subtropical species at limits of climatic range.

Table 1.1. (Cont.) Regional Ecosystem descriptions and special values. Species highlighted in bold have been recorded at Springbrook.

RE	Description	Special values
12.8.6	Simple microphyll fern forest with Nothofagus moorei and/or Doryphora sassafras, Caldcluvia paniculosa, Orites excelsus. Occurs on Cainozoic igneous rocks at high altitudes	Habitat for rare and threatened flora species including Pararistolochia laheyana and Parsonsia tenuis, and range limits of temperate adapted species
12.8.8	Eucalyptus saligna or E. grandis tall open-forest often with vine forest understorey ('wet sclerophyll'). Other species include Eucalyptus microcorys, E. acmenoides, Lophostemon confertus, Syncarpia glomulifera subsp. glomulifera. Occurs on Cainozoic igneous rocks and areas subject to local enrichment from Cainozoic igneous rocks.	Habitat for rare and threatened flora species including Lepidozamia peroffskyana
12.8.9	Lophostemon confertus open-forest often with vine forest understorey ('wet sclerophyll') Occurs on Cainozoic igneous rocks. Tends to occur mostly in gullies and on exposed ridges on basalt.	

The standard descriptions of 12.8.3 and 12.8.5 include as characteristic species *Argyrodendron trifoliolatum* below 600 m (12.8.3) and *A. actinophyllum* above 600 m (12.8.5). At Springbrook, however, RE 12.8.5 is unusual in that *A. trifoliolatum* is more common than *A. actinophyllum* above 600 m.

RE 12.8.2, *Eucalyptus oreades* tall open forest on Cainozoic igneous rocks, is 'Of Concern' being a very rare ecosystem having a pre-clearing extent of <1000 ha and recorded only from Springbrook and Mt Barney. It is confined to areas with shallow soil over rhyolite in areas with very high peak summer rainfall (Williams and Woinarski 1997, Brooker and Kleinig 2006). It provides habitat for endemic, rare or threatened flora. Understorey species characteristic of this forest type only at Springbrook include *Austrobuxus swainii* (r), *Ardisia bakeri* (r) and *Cryptocarya meisneriana*.

Two other 'Of Concern' regional ecosystems that occur in the restoration area but are too small to map are simple notophyll vine forest with *Ceratopetalum apetalum* on Cainozoic igneous rocks (12.8.18) and montane heath and rock pavement on Cainozoic igneous rocks (12.8.19). RE 12.8.18 is a very rare ecosystem with a pre-clearing area of <1000 ha occurring in just a few localities in the Gold Coast Hinterland. RE 12.8.19 provides habitat for numerous rare or threatened flora species.

The area is now a complex mosaic of primary, secondary or regrowth forest, agricultural land and active and abandoned pastures over a range of environmental gradients.

Vegetation cover and successional status vary both within and between subcatchments.

1.3 Ecological restoration

1.3.1 The Springbrook Rescue context

Springbrook Rescue is a broad project that incorporates acquisition, protection and restoration of land at Springbrook with the overall objective of providing secure, long-term habitat for flora and fauna contributing to World Heritage values.

There remains a range of policies and management practices that need to be aligned with the vision of Springbrook as a World Heritage precinct. This matter is addressed in the Program Logic for the overall project.

Within the overall project, restoration of rainforest habitat is a central component, with the initial focus being restoration of habitat linkage in the high country at the southern end of the plateau (Figure 1.10).

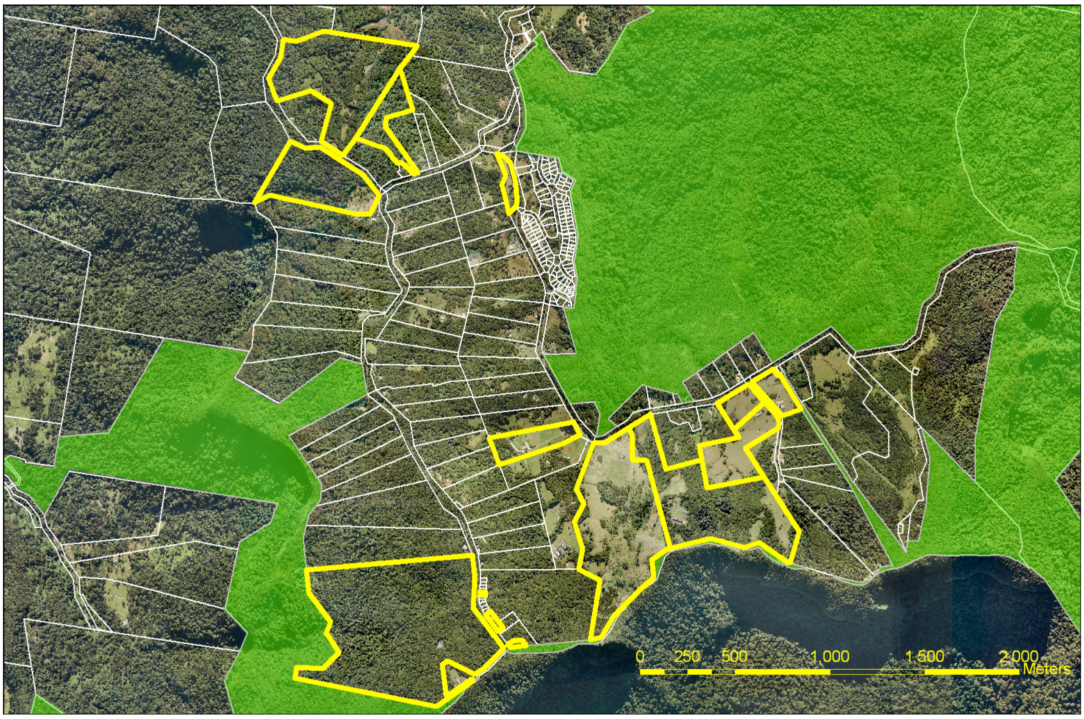

Figure 1.10. Restoration properties (outlined in yellow) in the high country towards the southern end of Springbrook Plateau. The national park is shaded green.

1.3.2 Restoration goals

1.3.2.1 Overall goal

The overall restoration goal is stated as follows:

An expanded, protected and self-sustaining World Heritage rainforest ecosystem providing secure habitat for flora and fauna contributing to World Heritage values.

1.3.2.2 Sub-goals

The sub-goals or desired attributes for the restored ecosystems are listed below.

1. The restored ecosystem contains the characteristic assemblage of species with community composition, structure and functions analogous with reference ecosystems
2. The restored ecosystem provides habitat for rare, threatened and significant species
3. The restored ecosystem comprises only indigenous species
4. All functional groups necessary for continued development, viability, health, resilience and evolutionary capacity, are present or able to colonize naturally.
5. The abiotic environment can sustain reproductively viable populations of those species required for stability and resilience and continued ecosystem development along the desired trajectory.
6. The restored ecosystems are suitably integrated into a larger ecological matrix or landscape with which it interacts through abiotic and biotic flows and exchanges.
7. Potential threats to the health and integrity of the restored ecosystems from the surrounding landscape have been eliminated or reduced as much as possible.
8. The restored ecosystems are sufficiently resilient to endure the normal periodic stress events in the local environment that serve to maintain the integrity of the ecosystem.
9. The restored ecosystems are self-sustaining to the same degree as their reference ecosystems and have the potential to persist indefinitely under existing environmental conditions. Nevertheless, aspects of their biodiversity, structure and functioning may change as part of normal ecosystem development and may fluctuate in response to normal periodic stress and occasional disturbance events of greater consequence. As in any intact ecosystem, the species composition and other attributes of a restored ecosystem may evolve as environmental conditions change.
10. The restored ecosystems are self-sustaining to the same degree as their reference ecosystems and have the potential to persist indefinitely under existing environmental conditions.

Note: In regard to Subgoal 9 in particular:

(a) aspects of the biodiversity, structure and function will change during normal ecosystem development (succession), and may fluctuate in response to normal periodic stress and disturbance regimes;

(b) the species composition and other ecosystem attributes may evolve as environmental conditions change, e.g. under predicted climate change, to produce novel or "no-analog" communities that are compositionally unlike any found today (Jump and Penuelas 2005; Williams and Jackson 2007)

1.3.3 Need for ecological restoration

1.3.3.1 Significance of the restoration sites

Springbrook is the central core for values underpinning the Gondwana Rainforests of Australia World Heritage Area which was listed in 1995. It is part of 15 nationally proclaimed Biodiversity Hotspots representing "the most threatened and biodiverse centres in Australia" (Commonwealth of Australia 2003) and part of the scientifically famous "Macleay–McPherson Overlap" (Burbidge 1960).

As part of the Tweed volcanic province Springbrook is a recognised refugium and contains outstanding levels of biodiversity, narrow-range endemism and relict disjunctions of phylogenetically significant lineages. It is home to nearly 1100 species of native plants contained within 537 genera in 159 families, and more than 220 species of native animals including 20 species of frogs, 30 reptiles, 148 birds and 24 mammals.

The current National Park is too small (2,500 ha at the time of World Heritage Listing in 1995), unrepresentative, fragmented and dysfunctionally configured to viably protect the region's biodiversity and World Heritage values. The current National Park fails to represent the core World Heritage values that occur on the plateau, very little of which is included within the park estate (Figure 1.11).

The World Heritage Area is currently too small, fragmented, unrepresentative and poorly configured to be viable or resilient against climate change, with the largest area of cloud forests in subtropical Australia critically threatened.

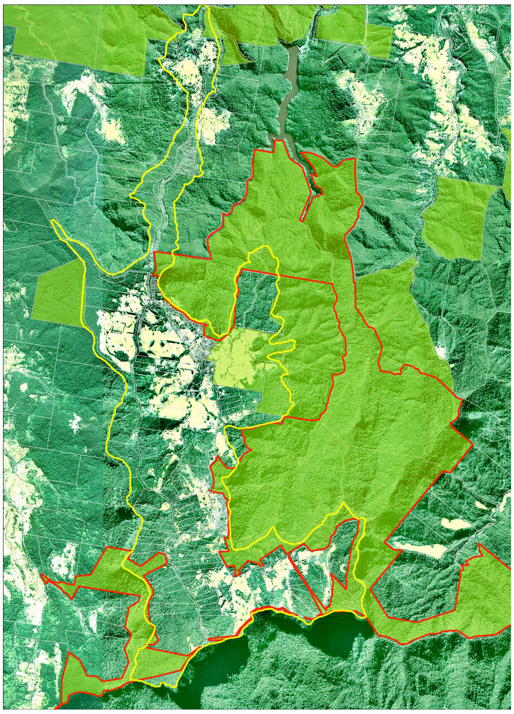

Figure 1.11. Springbrook Plateau is outlined in yellow, the World Heritage Area in red and the national park shaded green

1.3.3.2 Current condition

As can be seen from Figure 1.9, the plateau area has been strongly affected by humans. Over the past 100 years, settlement, encouraged by official government settlement programs, resulted in forests being selectively logged for timber and cleared for farmland and, more recently, for urban development to meet increasing population demands (Hall 1990). Most of the area was cleared prior to the 1930s, including almost all of the plateau area above 600 m totalling nearly 2000 hectares. Historical aerial photography shows extensive rainforest regeneration since the 1930s as various farming ventures failed. Clearing, however, continued and continues today for residential purposes. Whilst about 65 per cent of the originally cleared area is in varying stages of regeneration, population pressures are escalating and current planning and management guidelines and practices are not consistent with obligations under the World Heritage Convention for "protection, conservation, presentation and transmission to future generations" of areas of outstanding universal value wherever they occur.

The areas of regeneration can be seen in Figure 1.9 where they are mapped as 'disturbed' ecosystems.

The Queensland Government has purchased about 57 parcels of land between 2004 and 2009 comprising a total area of almost 840 hectares, including about 120 hectares (14 per cent) in need of ecological restoration. The remainder of the purchased land is in varying stages of natural regeneration requiring little or no active intervention. Of the 840 hectares purchased 444 ha (53 per cent) occur on the Springbrook plateau with the balance on the western escarpment.

There remain over 720 hectares of land within private ownership or within National Park on the Springbrook plateau, outside the Springbrook Rescue program, but in urgent need of ecological restoration. These lands occur primarily on the lower plateau within the Purling Brook, Camp, Kuralboo and Carrick Creek catchments.

The primary industries such as dairying, grazing and banana growing for which clearing originally occurred have all declined leaving ecotourism virtually the sole economic base for the small local community. However, significant areas of the plateau remain cleared for rural activities which, whilst not economically viable in their own right, provide tax benefits for some of the large landholders. Existing planning instruments such as the South East Queensland Regional Plan at the State level, and the Gold Coast City Council's Local Area Plan, contain many deficiencies and loopholes, are essentially static conceptually, and entrench the status quo. Much of the land is still formally classified as "Good Quality Agricultural Land" legally binding local government planning instruments to consistency with this obsolete objective. The protection, presentation and restoration of World Heritage Values is not provided for by any existing statutory or policy instruments. It is noted that responsibilities of State Parties under the World Heritage Convention include "adopt general policies to give the heritage a function in the life of the community" and "integrate heritage protection into comprehensive planning programmes".

Impacts

The cumulative legacy from past agricultural and settlement activities include habitat loss, modification and fragmentation, invasions by feral animals and weeds, abnormal fire regimes, altered hydrological regimes and altered bio-geochemical cycles including significant soil erosion and degradation, such that the viability of biodiversity and World Heritage values are now critically threatened by these impacts.

Superimposed on threatening processes associated with land-use change, global warming is emerging as the most serious and pervasive of all the threats to the planet's biodiversity given its potential to affect even areas far from human habitation. Cloud forests and restricted-range endemic species in "hotspots" are especially vulnerable to climate change impacts (Malcolm *et al.* 2006).

A recent report on the implications of climate change for Australia's World Heritage Properties summarised threats and impacts for the Gondwana Rainforests of Australia World Heritage Area (Australian National University 2009). They are listed in Table 1.2.

Table 1.2. Implications of climate change for the Gondwana Rainforest of Australia World Heritage Area (from Australian National University 2009)

Potential climate threats	Potential impacts
• Higher temperatures • Increased carbon dioxide concentrations • Periods of prolonged drought • A rise in the orographic cloud layer • Exacerbation of fire regimes that are inappropriate to maintenance of rainforest species	• Further habitat fragmentation • Frequent fires may threaten fauna and flora populations and result in habitat loss • The cool upland subtropical rainforest are at greatest risk from higher temperatures and lower rainfall • There are two groups of Gondwanan rainforests under threat from climate change: the microphyll fern forests, typically dominated by Nothofagus moorei (Antarctic Beech); and the simple notophyll evergreen vine forests, generally dominated by Ceratopetalum apetalum (coachwood) • Loss of species with low dispersal ability and/or specific habitat preferences

Fragmentation from clearing alters critical genetic and demographic processes potentially threatening long-term persistence of both rare and common and widespread species (Broadhurst and Young 2007). All aspects of the plant reproductive cycle may be impacted including flowering, pollination, fertilisation, seed set and quality and probability of reaching reproductive adulthood.

Clearing destroys the buffering conditions created by intact forest canopies critical for the persistence of palaeo-climatic refugia (Fjeldsa and Lovett 1997a,b; Fjeldsa *et al.* 1997). The high concentrations of phylogenetically significant endemic species (old or basal lineages) are especially at risk from the combined effects of fragmentation and climate change. Biomass that accumulates in these refugial areas normally buffers extrinsic changes in the physical environment through feedback loops with soil, water and climate. Intact, extensive forest canopies increase the frequency of cloud immersion in high altitude forests which may be critical to the survival of many of the relictual species.

1.3.3.3 Benefits from restoration

Ecological benefits

Biodiversity representing major stages of the earth's evolutionary history and formally recognised as having outstanding universal value will receive greater protection with improved prospects for viability, resilience and capacity for ongoing evolution.

Specifically, the area when restored will contribute to:

(a) protecting biodiversity — a hotspot for species richness, rarity, ad endemism;
(b) conserving phylogenetic diversity — habitat for ancient plant and animal lineages representing major changes in the earth's evolutionary history, that contribute to viability and resilience of World Heritage values significantly threatened by climate change

Economic benefits

Economic benefits are three-fold. Benefits can be predicted to accrue from increased quality and sustainability of (1) ecotourism, (2) water catchment values, and (3) restoration practice.

Long-term sustainability of ecotourism will depend on the availability of increasingly rare experiences of "overwhelming" naturalness, outstanding natural beauty, grandeur and intrinsic curiosity in a "living museum".

The Project area is part of the water source for the Hinze Dam, a vital water supply for the Gold Coast City. Restoration of forest cover is likely to improve the quality of water and the evenness of water flows.

Improved cost-effectiveness of restoration techniques will enable restoration to be carried out at more ecologically meaningful scales at a range of other biologically significant areas.

To 2006, less than 0.5 per cent of previously cleared rainforest in the Wet Tropics or 0.3 per cent in the subtropics had been restored at a cost of $525 Million (Catterall and Harrison 2006). The cost of restoring previously rainforested land on the Springbrook plateau (800 hectares) could therefore be projected to be $40–80 million. Clearly, traditional restoration practices are not tenable at ecologically meaningful scales.

If land is to be reforested at ecologically meaningful scales, revolutionary changes are needed (Catterall and Harrison 2006): either (a) there is greater financial commitment by governments and the community, or (b) methods are developed enabling restoration of greater areas at lower unit cost. Calls have been made for more case studies enabling restorationists to reduce costs, time and effort by avoiding mistakes of others, and implement proven strategies or generic decision rules (Jenkinson *et al.* 2006).
Clearly, better, more cost-effective restoration practices would be of immense economic benefits to society, enabling biodiversity conservation and restoration at meaningful scales so critically needed today.

Cultural benefits

World Heritage obligations include ensuring that World Heritage plays a meaningful role in the community (Bentrupperbäumer and Reser 2006).

Environmental degradation is both caused by human behaviour and affects human health and wellbeing. There is mounting concern over unparalleled threats to the world's biodiversity and human welfare (World Commission on Environment and Development 1987; Union of Concerned Scientists 1992, 1997; World Resources Institute 2002, Millennium Ecosystem Assessment 2003, Kennedy 2006; World Wildlife Fund 2006). The natural environment is a defining and formative part of the Australian character, lifestyle and sense of place (Australian Psychologists Society Position Statement on Psychology and the Natural Environment, April 2007). Australia is richly endowed with World Heritage Areas (15) listed for their outstanding universal values to all current and future human generations. Their protection, restoration and presentation, is clearly of immense cultural benefit both locally and globally.

Springbrook has been selected as a State Icon. This year, Queensland's 150th, the State Government wished to celebrate the people, places and stories that define the State. All Queenslanders had the opportunity to vote for their favourite icons from a short-list of 300 between 2 March and 30 April 2009. These votes ultimately made up the list of Queensland's top 150 icons. Springbrook National Park was voted as one of the 15 top icons in the 'Natural Attractions' category. Hence there are significant cultural benefits in ensuring the ongoing viability of the area.

Educational and scientific benefits

Ecological restoration is increasingly considered an "acid test for ecology". It provides ideal experimental settings for tests of ecological theory (Lake 2001, Young *et al.* 2005, Halle 2007, Temperton 2007), but equally the practice of restoration is becoming critically dependent on the scientific understanding of ecosystem processes. Springbrook provides exceptional opportunities for restoration informing ecological theory because of the compressed nature of ecological gradients within a relatively small, readily accessible area.

1.3.3.4 Ecosystems to be restored

Figure 1.12 shows regional ecosystems and other vegetation on the properties that are the main focus of restoration.

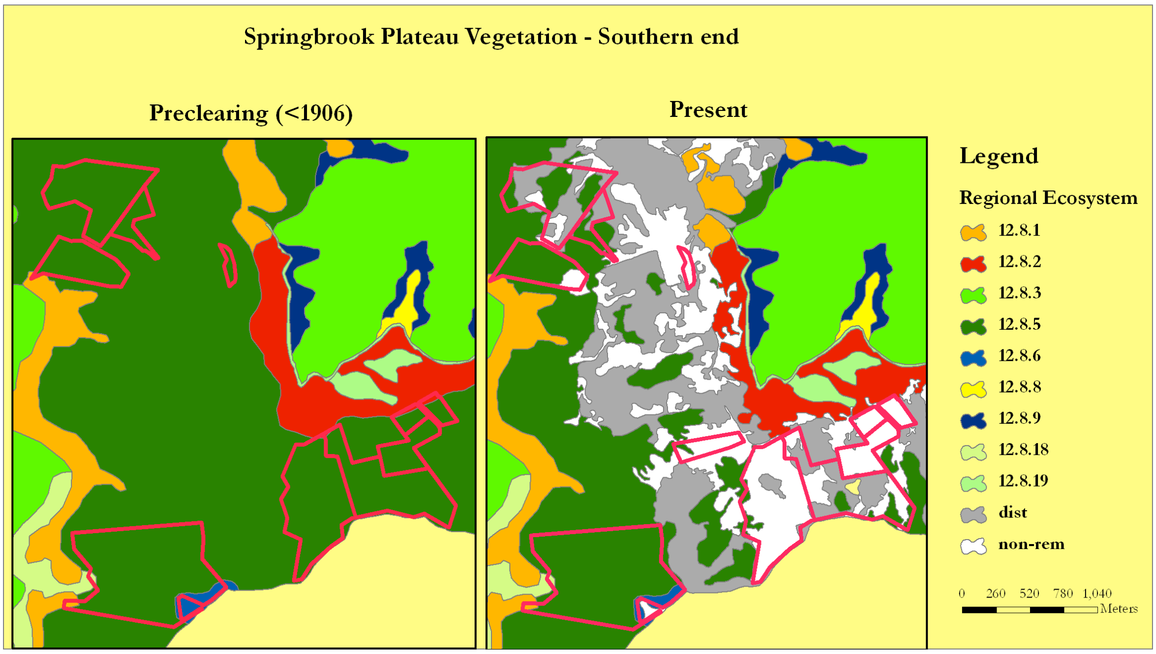

Figure 1.12. Vegetation map of restoration areas. The properties to be restored are outlined in red.

The required restoration falls mainly in the category of creation of a new ecosystem to replace the existing ecosystem dominated by grasses. There may also be some repair of damaged ecosystems where regenerating rainforest has been invaded by shade-tolerant weeds.

The preclearing vegetation map (Figure 1.12) suggests that the original ecosystem over virtually all of the restoration properties was subtropical rainforest — complex notophyll vine forest (>600 metres)(RE 12.8.5). However, there are indications that the *Eucalyptus oreades* tall open forest (RE 12.8.2) may have extended further south than is shown on the preclearing map and may have covered the northern parts of two of the properties.

Because of the scale of regional ecosystem mapping, some smaller occurrences of other vegetation types are not shown. Figure 1.13 shows occurrences of outcrops of rock which in some cases support montane heath vegetation. Where these outcrops occur, there is often evidence of extensive occurrence of rock beneath a very thin soil cover.

The regenerating rainforest has generally not yet regained the original species composition as judged by the composition of appropriate reference ecosystems.

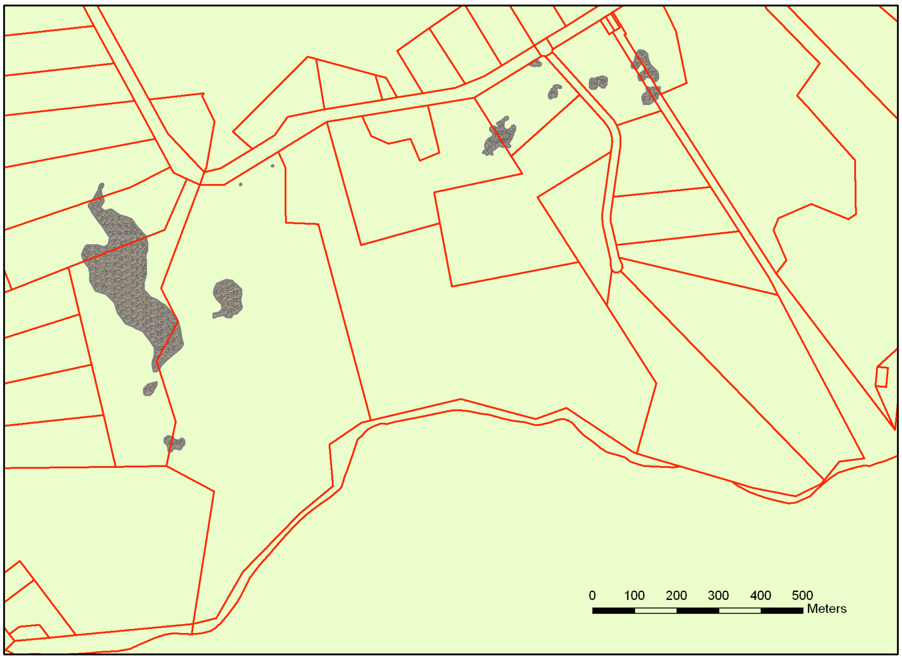

Figure 1.13. Outcrops of rock on restoration properties commonly support heath vegetation

1.3.4 Key threats and barriers to ecological restoration at Springbrook

The main threatening processes occurring on the asset are listed in Table 1.3. Those threats considered to be most likely to occur are highlighted.

It is noted that a recent report (Australian National University 2009) has identified implications of climate change for the Gondwana Rainforests of Australia World Heritage Area.

Table 1.3. Threatening processes affecting the Springbrook restoration properties

Threat category		Threatening/key processes	Details of key process if required
Altered biogeochemical processes	☒	Hydrological processes (eg acidification, inappropriate hydroperiod, salinisation, sedimentation, diversion, soil erosion, compaction)	Clearing changes water balances, soil organic matter and porosity affecting plant water availability; dams and diversions alter normal land surface flows; compaction of thin soils from machinery and cattle increases compaction, reduces macroporosity, hydraulic conductivity and increases overland flows and erosion
	☒	Altered nutrient cycles o linked to soil moisture availability o impacts on photosynthesis, biomass accumulation and competitive abilities	Nutrient enrichment (past fertilizer use; cattle grazing), changed soil organic content and microorganisms, may significantly influence productivity and competitive interactions that affect likely achievement of the long-term goal
	☒	Altered climate processes — Rainfall, cloud immersion, temperature, wind regimes, incident radiation	Altered evapotranspiration levels, microclimate loss from clearing and edge effects
Detrimental regimes of physical disturbance events	☒	Fire regimes — dependent on climate or weather conditions and ecosystem type and condition	Triggers include arson, arcing of electric fencing, lightning strikes (less probable; normally associated with rain events, but underground rhizomes of grasses can catalyse delayed fire response)
	☒	Cyclone or wind storm regimes — changes in regimes related to climate change — impact intensity affected by aerodynamic texture of sites (cleared, modified, canopy architecture) and topographic location	Increased exposure to high intensity winds causing windthrow of remnant, regrowth or biological legacies in exposed areas. Fragmented forests and forest edges inherently vulnerable to wind damage (Laurance and Curran 2008)
	☒	Drought regimes — changes related to climate change, altered hydrological processes — impacts related to intensity/duration of soil water and vapour pressure deficits	Duration of conditions where evapotranspiration exceeds precipitation or biologically available soil water for long enough to cause carbon starvation or cavitation (Dyer 2009)
	☒	Erosion (caused by wind, water) — exacerbated by loss of vegetation cover, soil compaction, slope, associated fire regimes, intensity, duration and frequency of rain events	High erosion proneness (sheet, gully) due to thin compacted soils with diminished infiltration rates and increased overland flows

	☒	Flood	High overland flows in high rainfall zone and waterlogging impacting on land substrate and natural regenerative capacity
	☒	Frost and hail events	Frequent or long-lasting frost: differential mortality of frost-sensitive plants in exposed areas
	☒	Lightning strikes — affected by topographic position and exposure; especially relevant where few relict trees remain as biological legacies	Vulnerability higher in regions with few tall trees in lightning prone areas
Impacts of introduced plants and animals	☒	**Environmental weed invasion**	Competitive exclusion from *Aristea ecklonii*, Kahili Ginger, *Plectranthus ciliatus*, Montbretia, pasture grasses, exotic cypress and smothering vines (major problem invasives)
	☒	Predation/herbivory by introduced species	Domestic dogs and cats, feral dogs, cats, foxes, cane toads killing wildlife
	☒	Habitat destruction/damage/competition	Large domestic dogs damaging regeneration; exotic ants competing with native species (key roles in ecosystem processes)
Impacts of problem natives	☒	Expansion of native plant species or fauna (e.g. Bell Miner associated dieback)	Hoop Pine, and garden escapees not indigenous to the asset
		Expansion of native fauna species	Expansion of disturbance-loving species (increasers) at the expense of those typifying low-disturbance regimes
	☒	Predation/herbivory by native species	Pademelon & insect herbivory; predation of native fauna by elevated numbers of dingoes
Impacts of disease	☒	Dieback (e.g. *Phytophthora* spp., *Favolachia calocera, Armillaria luteobubalina, Puccina psidii* (Eucalypt Rust) and other wood-, root- or shoot-rot fungi)	Fungal pathogens affecting live wood, roots or shoots with potential lethal imacts. Both *Phytophthora* and *Favolachia* have been recorded at Springbrook
	☒	Viral wildlife diseases (e.g. IBD, Inclusion Body Disease)	Recent unconfirmed reports at Springbrook of IBD, lethal to carpet pythons, a key component of the food chain; tests are being carried out
	☒	Fungal animal pathogens (e.g. Chytrid fungus)	Unconfirmed but possible risk of infection to frogs
Insufficient ecological resources to restore and maintain viable populations	☒	**Flora** — Decreasing (or loss of) species pool, pollinators, dispersal agents, or other vital mutualists **Fauna —** Decreasing food, water, shelter, oxygen, 'nest' sites, access to mates (eg from vegetation clearing, urban development, other habitat degradation)	Loss of biological legacy including coarse woody debris, rocks for thermal mass, inadequate species pool, lowered propagule availability, disrupted, diminished or destroyed mutualisms (mycorrhizal associations, pollinators, dispersers)
Impacts of pollution	☒	Chemical — herbicide/pesticide use and direct impacts	persistent herbicides/pesticides — impacting on rare herpetofauna, aquatic biota, residual effects on plants and soil microorganisms

	☒	Chemical/physical — spillage of oil and other chemical spills	
	☒	Physical — entanglement in, collision with or ingestion of anthropic structures or debris	Discarded barbed wire, plastic bags. Physical hazards capable of endangering or injuring wildlife, e.g. Barbed-wire fencing, electric fencing, large glass reflective panels resulting in bird kills
	☒	Photopollution (polarized light pollution) — linear polarization by reflection off smooth, dark buildings, or other human-made objects or by scattering in the atmosphere or hydrosphere at unnatural times or locations (Stratford & Robinson 2005, Horvath *et al*. 2009)	Maladaptive responses in polarization-sensitive taxa and ecological interactions — increased mortality and reproductive failure; understorey birds adapted to low light conditions (lyrebirds, logrunners) especially sensitive
	☒	Noise pollution — detrimental impacts on faunal survival and reproduction (Buckley and Pannell 1989, Patricelli and Blickley 2006); examples: motor vehicles, helicopters, gun firing ranges, high-decibel music, persistent dog barking etc	Acoustic communication a key role in avian sexual selection and social integration — noisy environments result in severe energetic costs and behavioural penalties to animals
Impacts of competing uses	☒	Recreation management — impacts on native fauna include loss of fitness (Amo *et al*. 2006); impacts on flora from trampling, compaction (Komatsu *et al*. 2007)	Car parks and associated landscaping with exotic garden plants (altered food, shelter, habitat, "perceived threat", acoustic environments); introduction of pathogens
	☒	Urbanization impacts	Increased access corridors (fragmentation impacts, road kills, alteration of hydrology, loss of rare ridge habitats); increased weed invasions from road conduits and exotic gardens; exotic fish escape into streams; light and sound pollution; altered fire regimes favouring protection of life and property at the expense of biodiversity; clearing, waste disposal
	☒	Agricultural impacts (other than as already dealt with above)	Use of fertilizers/chemicals associated with cattle dips may have occurred on the properties prior to government acquisition with potential residual contamination
	☒	Consumptive uses (water extraction); domestic and commercial very prevalent	Water extraction from aquifers changing recharge, flow and discharge rates affecting soil water availability to dependent flora and soil fauna (flow on effects to ground-dwelling avian insectivores)
	☒	Illegal activities	Trespass for vandalism, poaching (of native orchids, rare plants, fungi, seeds, foliage, rare butterflies, frogs), firewood collection, tree harvesting, dumping of refuse
	☒	Mining and quarrying (including exploration)	Legal quarry for ilmenite on western escarpment of plateau; dust, noise pollution; nucleus for weed invasions, fragmentation impacts

	☒	Hunting and collecting	Firewood collection leading to loss of natural coarse woody debris as critical habitat component
	☒	Harvesting of native species for production or consumption	Native edible fruits and fungi
	☒	Infrastructure management (powerlines, roads)	Overhead powerlines traverse properties and if retained will cause fragmentation, edge effects, impairment of restoration, weed invasions Roads are conduits for weeds and feral animals (especially toads)
Socio-political processes	☒	Impacts of community values	Opposition from local minority groups impacting broader support for restoration and underlying acquisition program, vandalism, poaching
Other	☒	Climate change	Atmospheric CO_2 levels the highest in more than 650,000 years (preceding the last ice ages) (Bradley and Pretziger 2007). A predicted 2°C temperature change results in latitudinal range shifts of ~ 300 km or altitudinal range shifts of ~ 300 m; other multidimensional, simultaneous changes expected including degree day length or photoperiod, water balance, phenological changes, species interactions, nutrient cycling (Alzinga *et al.* 2007, Jump and Penuelas 2005, Memmott *et al.* 2007, Pinay *et al.* 2007) High-altitude assemblages, particularly associated with cloud forests, are especially vulnerable (Benzing 1998, Wilson *et al.* 2007, Warman and Moles 2009)

The incidence or significance of each threat varies across the various sites. For example, *Aristea ecklonii* is a major barrier to natural regeneration on Warblers whereas Kikuyu is the major barrier on Pallida.

1.3.4.1 Probability of success in reaching Biodiversity Goals

Table 1.4 lists barriers to achieving goals and corresponding mitigation measures. These correlate with the identified threatening processes listed in the Table 1.3.

Table 1.4. Barriers to achieving goals and corresponding mitigation measures

Goal	Goal description	Barrier to achieving Goal	Mitigation measures
1	*The restored ecosystems contain the characteristic assemblage of species with community composition, structure and functions analogous with reference ecosystems*	(1) Almost complete clearing of the plateau in the last 100 years may have resulted in species extinctions. The extent is unknowable. (2) Abiotic conditions may have changed irreversibly as a result of past land use practices (nutrient loss from clearing, nutrient enrichment as a result of grazing and fertilizer applications, stream diversions impacting on hydroecology, loss of microhabitats, e.g., stones providing critical thermal mass for fauna that are food resources for Albert's Lyrebird (past farming practices involved systematic removal of "floaters") (3) Natural pollinators and dispersers may have declined or been replaced by less efficient or ineffectual exotic species, e.g. domestic bees; (4) Genetic diversity may be impoverished by reduction of remnant populations below critical levels or by having to rely on mass plantings instead of natural regeneration (Jump and Penuelas 2005). (5) Climate change may make it impossible for some species to establish successfully and survive (Harris *et al.* 2006)	
2	*The restored ecosystems comprise only indigenous species*	(1) The likelihood of meeting this goal will depend on the effectiveness of policy, planning and on-ground management practices within and outside the immediate project area (2) Alien species invasions are unlikely to be prevented if populations are continually re-introduced or rejuvenated through slashing practices along access or essential service corridors, through garden escapes or failure to eliminate source populations elsewhere in Springbrook for those species spread by wind, overland flow or animal vectors (Macleay 2004, Hierro *et al.* 2005) (3) Success will depend on an understanding of the underlying ecological processes associated with invasive species (Hierro *et al.* 2005)	Land-use practices on private land changed through public education and assistance with funding Policy deficiencies at an institutional level that allows continuing threatening processes along road verges and power-line easements rectified Landscape-scale change through ensuring appropriate infrastructure policies, Local Area and Regional Plans Science-based elimination of non-indigenous species within the project area prioritised on basis of threat and effected through intervention or services of nature

<table>
<tr><th>Goal</th><th>Goal description</th><th>Barrier to achieving Goal</th><th>Mitigation measures</th></tr>
<tr><td>3</td><td>The restored ecosystem provides habitat for rare, threatened and significant species</td><td>(1) There are 10 endangered, 21 vulnerable and 40 rare pant species recorded from the Project area
<table>
<tr><td>Group</td><td>E</td><td>V</td><td>R</td><td>Total</td></tr>
<tr><td>Plants</td><td>10</td><td>21</td><td>40</td><td>71</td></tr>
<tr><td>Frogs</td><td>2</td><td>1</td><td>4</td><td>7</td></tr>
<tr><td>Reptiles</td><td></td><td>1</td><td>3</td><td>4</td></tr>
<tr><td>Birds</td><td></td><td>5</td><td>5</td><td>10</td></tr>
<tr><td>Mammals</td><td></td><td>3</td><td></td><td>3</td></tr>
</table></td><td></td></tr>
<tr><td>(3 cont.)</td><td>The restored ecosystem provides habitat for rare, threatened and significant species</td><td>(2) “Habitat” not synonymous with “native vegetation”; resources and conditions for restoring or maintaining occupancy and dispersal capacity of species, populations or individuals (Lindenmayer and Fischer 2006, Miller and Hobbs 2007) may not be known or possible because of lack of data or irreversible changes in abiotic or biotic environment.
(3) Lack of functional landscape connectivity (Chetkiewicz et al. 2006, Awade and Metzger 2008)
(4) Lack of knowledge of different ecological habitat preferences for different life stages of plants or animals (Comita et al. 2007)
(5) Land management practices in adjoining lands non-conducive to habitat restoration at scale required, e.g. National Parks management retain high-usage, high-profile visitor walking tracks through prime Rufous Scrub-bird habitat where understorey managed for visitor comfort and visibility rather than habitat retention
(6) Lack of community understanding of the significance of habitat components, e.g. vines seen as undesirable, to be eradicated elements, but Pale-yellow Robins’ nests built almost exclusively in lawyer-vine (Hindwood 1966)</td><td>Improve autecological data, life history attributes, understanding of natural disturbance regimes and resource fluxes across multiple temporal and spatial scales
Restore functional landscape connectivity</td></tr>
<tr><td>4</td><td>All functional groups necessary for continued development, stability and resilience are present or able to colonize naturally</td><td>(1) Widespread clearing and fragmentation on Springbrook Plateau may have resulted in irreversible loss or severe depletion of whole functional groups (e.g. specialized pollinators and dispersal vectors, avian frugivores, mycorrhizal symbionts, soil microorganisms)
(2) Changed abiotic conditions (e.g. climate, hydrological regimes, nutrient cycling) may be inimical to recovery of particular functional groups (e.g. epiphytes with keystone role in hydrological fluxes)
Functional diversity and ecosystem processes are closely linked (Ernst et al. 2006, Thuiller et al. 2006). Functional diversity is positively correlated with productivity (efficient resource capture conferring invasion resistance), complex trophic structures and feedback interactions fundamental to stabilizing ecosystem structure and function within narrow, historical bounds (Hosack et al. 2009)</td><td>Restore canopy cover and vegetation structure and composition (restore microclimates, biogeochemical cycling)
Monitor recovery of key functional groups that include foundation and keystone species
Assist recovery where naturally inadequate (through comparison with reference sites) by direct seeding or replanting from ex situ stock maximising local genetic diversity</td></tr>
</table>

Goal	Goal description	Barrier to achieving Goal	Mitigation measures
5	*The abiotic environment can sustain reproductively viable populations of those species required for stability and resilience and continued ecosystem development along the desired trajectory*	Normal biogeochemical processes and disturbance regimes may have been changed beyond historical limits of variation such that biotic interactions and positive feedback cycles necessary for normal successional processes and negative feedback cycles for stability and resilience of restored ecosystems may not be achievable (Halpern *et al.* 2007, Jentsch 2007)	Cattle grazing ceased on all acquired properties potentially allowing autogenic recovery in the long-term Routine slashing of exotic pasture grasses ceased to allow natural regeneration processes (where possible) to re-establish Observe/monitor adequacy of natural recovery processes for initial years of project
6	*The restored ecosystems function normally for their ecological stage of development; signs of dysfunction absent*	(1) Inability to distinguish between a normal successional trajectory and shifts via threshold dynamics to alternative stable states (Hobbs and Norton 1996)	Develop indicators able to distinguish between normal successional (linear) and threshold dynamics Compare type, intensity, extent and frequency of disturbance regimes and resource fluxes with reference sites and selected chronosequence sites and other historical records Project likely forest structure using an ecosystem growth model (EDS)
7	*The restored ecosystems are integrated into the larger ecological matrix or landscape with which it interacts through abiotic and biotic flows and exchanges*	Lack of a regional management plan, strategies and controls directed at restoring landscape-wide health and integrity to a World Heritage Precinct, the deficiency allowing: (1) local opposition to acquisition strategy designed to restore landscape integrity (2) land-use practices on private land (clearing, slashing, cattle grazing, forestry, water extraction, fencing, light and noise pollution) (3) institutional policies and practices responsible for ongoing threatening processes (infrastructure management, inadequate development controls)	Identify policy deficiencies Seek institutional, organisational and policy change to rectify policy deficiencies and facilitate control of landscape-wide threatening processes

Goal	Goal description	Barrier to achieving Goal	Mitigation measures
8	*Potential threats to the stability and resilience of the restored ecosystems from the surrounding landscape have been eliminated*	(1) local opposition to acquisition strategy designed to restore landscape integrity (2) land-use practices on private land (clearing, slashing, cattle grazing, forestry, water extraction, fencing, light and noise pollution) (3) institutional policies and practices responsible for ongoing threatening processes (infrastructure management, inadequate development controls) (4) inadequate funding allocated to acquisition of land for ensuring landscape integrity of the expanded National Park	(1) A community support strategy that encompasses: • extension (website, field days, brochures and displays, Scenario Based Learning (SBL) aimed at improved understanding of World Heritage Values and vulnerabilities resulting from land-use and climate change; • financial assistance to facilitate better land-use practices (2) Identification of policy, strategic and coordination deficiencies at the institutional level aimed at threat mitigation and facilitation of restoration (3) Seek additional funding for strategic acquisition of land consistent with the regional and local planning framework
9	*The restored ecosystems are sufficiently resilient to endure normal periodic stress events in the local environment that serve to maintain integrity of the ecosystem*	(1) Alternative stable states are more intractable (stable and resilient) than expected or resources allow (2) Key functional groups missing (e.g. large trees capable of hydraulic redistribution to maintain soil moisture during dry periods) (3) Genetic fitness adapted to local conditions insufficient to maintain resilience (Risk increases where intervention planting carried out to initiate succession — "year effects" can be important	Secure additional resources to ensure essential science-based interventions restart autogenic succession at the expense of alternative stable states Focus on reversing the more intractable effects of stressors on the resource base and ability of biota to capture these resources (Hobbs and Norton 1996) Last resort interventions include direct seeding or planting of genetically diverse stock of missing canopy species (*Argyrodendron*, *Sloanea*, *Syzygium* etc)
10	*The restored ecosystems are self-sustaining to the same degree as their reference ecosystems and have the potential to persist indefinitely under existing environmental conditions*	(1) Functional diversity inadequate to ensure required feedback loops and species interactions that dampen oscillations in ecosystem structure, function and productivity	Assess diversity of functional groups associated with recovery trajectory against reference and chronosequence sites Intervene where necessary with direct seeding/planting of required genetically diverse stock likely to engender resilience

1.3.5 Reference sites

Reference sites will be determined by a combination of visual inspection of historical aerial photography (back to 1930) and on-the-ground assessments. The intention is to establish a chronosequence of reference sites covering a timescale from preclearing to recent clearing and therefore a sequence of ecosystem development from 'original' rainforest ecosystem through various stages of regeneration to recent regeneration.

The location of reference sites will take account of altitude, aspect, slope, rainfall and geology in order to match, as far as practicable, the range of these attributes on the restoration properties.

1.3.6 Timeframe

Springbrook Rescue is a long-term project with an initial timeframe of 10 years. Provision has been made in the Restoration Agreement between the Queensland Government and the Australian Rainforest Conservation Society for an extension for a further 10 years.

Because of this timeframe, restoration will rely as far as possible on natural regeneration. This factor, together with the dependence on volunteer labour which in turn is more readily achievable over a longer timeframe, is expected to make the project significantly more cost-effective.