Springbrook Rescue Restoration Project

Progress Report

2013

Australian Rainforest Conservation Society Inc.

March 2014

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Cover photo: Forty volunteers after four hours digging up Aristea on 'Warblers'

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Introduction

In 2008, a Restoration Agreement was signed between the Queensland Government and Australian Rainforest Conservation Society Inc (ARCS). Under the Agreement, ARCS has undertaken to carry out a restoration project on a number of properties on Springbrook Plateau purchased by Queensland Government for addition to the Protected Area estate and eventually to the Gondwana Rainforests of Australia World Heritage Area. This work is carried out by ARCS for the State Government on an entirely *pro bono* basis.

In early 2010, ARCS provided the Department of Environment and Resource Management (DERM) with a progress report, *Springbrook Rescue Restoration Project — Performance Story Report 2008–2009*. The report was structured to be consistent with the Australian Government's Monitoring, Evaluation, Reporting and Improvement (MERI) framework, and with guidelines established by the International Society for Ecological Restoration (SER).

A third progress report was provided to the Department in March 2013. This present report covers the period to the end of 2013.

The Desired Outcomes defined in the *Performance Story Report 2008–2009* provide the framework for these annual reports.

The *Performance Story Report 2008–2009* defined four stages: Foundational activities, Initial activities and outcomes (0–3 years), Intermediate activities and outcomes (4–9 years) and Longer-term outcomes (≥10 years). This present report applies to the second year of the 'Intermediate activities'.

As appendices to this report, we have included our 3-year Plan, Activities Report for 2013 and Threat Management Plan.

In June 2012, ARCS was awarded a grant of $270,000 over 3 years under the Biodiversity Fund Round One 2011–12 (http://www.environment.gov.au/cleanenergyfuture/biodiversity-fund/projects/pubs/qld-round1.pdf).

The restoration project has been included as one of 12 Case Studies, The Springbrook Rainforest Project: Restoring World Heritage rainforests in Australia, in the IUCN World Commission on Protected Areas publication, *Ecological Restoration for Protected Areas - Principles, Guidelines and Best Practices. Best Practice Protected Area Guidelines Series No. 18*.

The project is comprehensively described on the web site launched in January 2013: http://www.springbrookrescue.org.au.

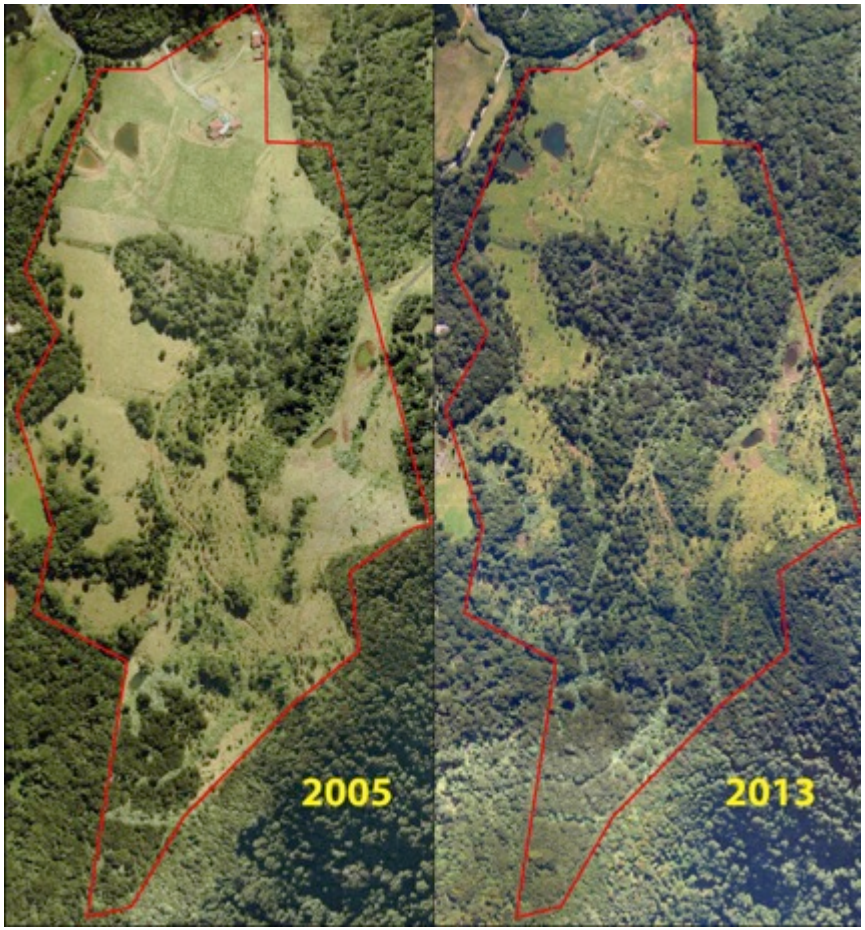
Progress report

Intermediate activities and outcomes

This reporting period represents the second year (2013) of the 'Intermediate activities and outcomes' phase which extends from Year 4 to Year 9 (2012–17).

Desired outcome	Activity reporting
Supplementary planting in selected areas unable to regenerate naturally (by direct seeding, transplanting or growing nursery stock)	As incorporated in the Restoration Agreement, restoration will be based on facilitating natural regeneration. Planting will only be undertaken when it is judged that the particular area is showing no signs of natural regeneration. This approach is fully consistent with the IUCN WCPAs Best Practice Protected Area Guidelines Series No. 18: Ecological Restoration for Protected Areas: Principles, Guidelines and Best Practices (2012). These guidelines formally underpin advice to signatory countries of the International Convention on Biological Diversity for meeting their restoration targets. The Springbrook project is Case Study 11 in these guidelines. In the case of the **Warblers** property, regeneration is occurring naturally across the entire 3-ha area as predicted and no planting is likely to be required. On **Ashmiha**, regeneration is occurring naturally across the major part of the property and no planting is being considered at this stage. Isolated nurse plants are developing in key areas, consistent with the 'nucleation' model of ecological restoration. The 'facilitation' function of even exotic grasses is significant particularly with respect to protection from frost damage. However, it will be necessary to carefully monitor a band across (east-west) the middle of the property which lies between the regeneration to the north (largely *Eucalyptus oreades*, *E. campanulata*,, *Lomatia arborescens* and *Acacia* spp.) and that to the south (*Leptospermum* spp., *Lomatia arborescens* and *Acacia* spp.). This band is dominated by the mat-forming grasses, kikuyu and setaria which have the potential to block regeneration if not controlled strategically. Strategies involve reaching a fine balance between the competition and facilitation processes served by these invasive species. Both function to rehabilitate compacted soils and to create microclimates that facilitate germination and survival of native species during periods of prolonged high evaporative demand. On **Pallida**, natural regeneration is progressing well on the upper and middle slopes and along the western boundary. On the lower flatter section, natural regeneration is limited by the presence of the mat-forming grasses, kikuyu and setaria. As for Ashmiha, this area will require careful monitoring in case active intervention is deemed necessary. To date, intervention has been limited to slashing at appropriate intervals to reduce

Desired outcome	Activity reporting
	competition. The image below shows the regeneration that has occurred naturally over the past eight years. Canopy cover has been estimated using nearmap.com imagery. A 2-metre grid is overlaid on the imagery and canopy cover estimated on each 2 x 2 m cell. The results show an increase in canopy cover from 31 to 60 per cent. **This property is a major and critical part of the Boy-Ull Creek catchment which feeds Twin Falls, a popular attraction in Springbrook National Park.**

Desired outcome	Activity reporting
	 The **Ankuna** property is being monitored but it is considered unlikely that any planting will be necessary. It will, however, be necessary to control and eventually eradicate the aristea occurrence on the southern part of the property. There was an infestation of montbretia in a swampy area south of Little Nerang Creek which flows through the property which appears to have been eradicated by our removals.

Desired outcome	Activity reporting
	Kanimbla has also been monitored and it is considered that natural regeneration will occur with few obstacles. There are plantings of exotic species (large conifers) which may need to be removed in the future. Current advice is that removal of these large trees may be more damaging compared with natural attrition. The **Quolls** property requires little intervention as it is almost entirely remnant or regrowth rainforest. Exotic species around the clearing for the building have been removed. Follow-up will be required to deal with any regeneration of exotics. What has to be remembered is that "year" and "facilitation" effects are critically important, consistent with results reported in the literature, and that "patience" is paramount. To intervene when unnecessary can have seriously counterproductive results on ecosystem resilience in the long term.
Aristea ecklonii declared a Class 2 weed; nurseries cease selling it; local landholders participate in removing it from their land	ARCS made repeated approaches to Biosecurity Queensland in an attempt to have *Aristea ecklonii* declared a Class 2 weed. Biosecurity Queensland carried out and published a risk assessment of the plant. The report is available at http://www.daff.qld.gov.au/documents/Biosecurity_EnvironmentalPests/IPA-Blue-Stars-Risk-Assessment.pdf. The following a is a quote from the risk assessment: *A. ecklonii* has a history as a weed in New Zealand and interstate (New South Wales and Victoria). As such, it is predicted to become a weed within comparable habitat types and climate zones in Queensland. Based on climatic and habitat information from its native range, habitats at risk of invasion appear to be limited to open or otherwise disturbed sites in mesic, upland rainforests in sub-tropical Queensland (open grassy areas/pastures, roadsides, tracks and riparian habitats). Remaining areas of the state are predicted to be either too hot or dry. Even though *A. ecklonii* is listed as a weed interstate and overseas, there is very limited information available on its impact. It is reported to be replacing native vegetation in New Zealand, but the scale of such impacts is poorly described. *A. ecklonii* is in an early stage of invasion in Queensland and could become a significant pest within suitable habitats after its population has had sufficient time to develop. In short, Biosecurity Queensland has declined to list the plant as a pest. It would appear that it is the intention to allow the species to develop to the point where it becomes a significant pest, threatening the viability of a World Heritage area, before taking any action. Many private landholders are now aware of the threat posed by this new class of shade-tolerant weed that is

Desired outcome	Activity reporting
	capable of invading undisturbed forests, and are actively removing it from their properties. This awareness and action is critical as the seeds are now recognised as being bird-dispersed. As previously reported, we have established that application of glyphosate to aristea can be effective even when the plants are fruiting. Plants bearing well developed green fruits were treated with glyphosate and monitored. The fruits dried out and opened up exposing the seeds as the plant died. However, seeds were collected and 200 seeds tested for germination. No germination occurred. We have previously been concerned that glyphosate was not effective on aristea plants with well developed rhizomes. Over the past year, we have observed that plants with rhizomes are being killed by glyphosate application in some instances. We suspect that the effect of glyphosate is dependent on timing — the time of year, growing stage of the plant (not necessarily actively growing). Glyphosate is applied with a rope wick at a concentration of 120 g/L.
More projects using wireless sensor networks for monitoring of restoration	The Springbrook wireless sensor network project is arguably the largest of its kind in the world and won the 2012 Queensland iAwards for Research and Development. This award is acknowledgment of the transformational potential of this technology in environmental monitoring. The project allowed the CSIRO to further develop the technology to improve its performance and affordability. The CSIRO reports on the progressive uptake of this technology on their dedicated web site. Over the past year, the network has had many problems related to maintenance. CSIRO was only committed to setting up the network and has no responsibility for maintaining it. This responsibility apparently lies with the Department of Science, Information Technology, Innovation and the Arts. The underlying issue appears to be a matter of resourcing and government policy. ARCS is progressively working on the means to contribute significantly to ongoing maintenance of this unique and extremely import monitoring system.
Results of monitoring reviewed and incorporated into adaptive management	The process of Monitoring, evaluation, review and improvement in the adaptive management Decision Framework is described in detail in the Springbrook Rescue website: http://www.springbrookrescue.org.au/DecisionFramework.html 1. CONTEXT. The socio-economic context has seen some changes in the past 12 months which is normal during a long-term project that ecological restoration necessarily has to be. However, despite fluctuations in economic uncertainty which affects both business revenue and volunteer availability, risk assessment in our decision framework remains essentially unchanged. The ecological context from the point of view

Desired outcome	Activity reporting
	of climate change worsens, but merely highlights the importance of the project towards helping protect the outstanding universal value of this World Heritage Area. The 'problem' as originally assessed remains valid — loss and impairment of critical habitat and landscape connectivity. Our biodiversity surveys, assessments of fauna and flora most vulnerable to these impacts, and identification of the most pressing bottlenecks to functional connectivity has assisted prioritisation of objectives for the 2012-2015 Restoration Plan. 2. GOAL: The original Goal of the project remains valid and unchanged by results of monitoring and review over the foundation period. The Goal is fundamentally tied to implementing obligations under the World Heritage Convention and its associated Operational Guidelines. 3. OBJECTIVES: The ecological restoration objectives remain unchanged, based as they are on those recommended by the International Society for Ecological Restoration and in the IUCN WCPAs "*Ecological Restoration for Protected Areas: Principles, Guidelines and Best Practices*" (2012). These objectives, and thereby the Goal, are achieved and reported on through time-bound, measurable actions detailed in each 3-year Restoration Plan (Attached). This plan details the baseline, the expected results and how they will be measured. 4. RESOURCES: Our access to material, financial, in-kind, informational and legal resources remains adequate for the viability or sustainability of the project. Our Management Plan and detailed costings allow us to apply for grants in a strategic and targeted way to supplement core funding. These resources are a major in-kind community contribution that helps the Queensland Parks and Wildlife Service, achieve its objective of protecting, managing and restoring Queensland's outstanding biodiversity. 5. RISK ASSESSMENT: Our risk assessment framework provides an integrated systems approach to considering social, economic or ecological barriers to achieving the project's Goals and Outcomes allowing continual improvement as part of adaptive management. 6. MANAGEMENT ACTIVITIES: All management activities are guided by evidence and our ecological and social conceptual models, as well as principles of best practice. These are detailed in our earlier reports and website (http://www.springbrookrescue.org.au/DecisionFramework.html). Key lessons learned to date include: (a) our conceptual models have stood the test of evidence for the past 4 years and give vital guidance (b) "facilitation", as an ecosystem process, is key to the success of ecological restoration in refugia (c) understanding "year" effects for mass seeding events avoids costly financial and ecological mistakes (d) a long-term view & patience are needed for ecological restoration of viable & resilient communities (e) a business model that can provide sustainable long-term funding is vital for ecological restoration

Desired outcome	Activity reporting
	(f) management without monitoring is likely to fail as required solutions are often counter-intuitive (g) understanding "social learning" is important for an effective communication & engagement strategy (h) convincing people about the important role of weeds as nurse plants is essential but challenging In summary, the most significant learning from monitoring is that even weeds can serve an ecological function for a time without which restoration can fail under particular circumstances. Plants from old lineages and with conservative traits can fail to germinate or survive in microclimates radically different from their evolutionary past. Any plant, whether native or alien, can serve to ameliorate conditions inimical to regeneration. A scientific approach coupled with monitoring is essential to guide the timing of interventions when the role of weeds shifts from facilitation to competition. Given the historically and generally valid view of weed invasions as one of the most threatening processes known, accepting a constructive role for weeds can require a paradigm shift which is difficult.
Community skills, knowledge and engagement increased; SBL Tool completed	During 2013, 270 volunteers were involved in the project and have gained relevant skills. We continue to attract additional volunteers. The Springbrook Rescue web site (http://www.springbrookrescue.org.au) should considerably increase community understanding and support for the project. A brochure explaining the project and providing the URL for the web site has been distributed to all properties at Springbrook. A reprint was made in October 2013 and this has been provided at all information sessions and is available at the new information centre run by the local community at Springbrook. In parallel with the web site, a Facebook page has been created, launched in February 2013, and is receiving considerable interest. As noted previously, the SBL Tool has not been progressed.
Community understands the project and its significance for World Heritage	There continues to be significant progress in this regard. There are clear indications that a large proportion of the local community supports the program for greater protection of biodiversity generally and World Heritage values specifically. A well-supported local group "Springbrook Wildlife Appreciation Group" (SWAG) has formed, produced web and associated Facebook social networking sites enabling local community members to share experiences and voice support. More articles relating to nature occur in the local newspaper "Springbrook Voices". Almost all accommodation businesses at Springbrook now use World Heritage in their advertising when in 2005 only one did so. The Springbrook Chamber of Commerce increasingly deals positively with World

Desired outcome	Activity reporting
	Heritage and has produced a brochure highlighting World Heritage as the basis of a sustainable local tourism industry. It is distributed to visitors through tourism venues. Events are scheduled to celebrate World Heritage as a means of attracting visitors to the area.
Institutional, organisational and policy change facilitating control of threatening processes	As noted previously, some progress was made earlier in negotiations with the Queensland Government and between The Queensland Government and Gold Coast City Council. Those negotiations stalled.

Appendix 1

Springbrook Restoration Plan (2012–2015)

Mundora, Ee-jung, Boy-ull Restoration Areas

Project description	Springbrook Rescue is a long-term project that aims to restore and enhance critical habitat and functional connectivity, lost over the last century, around the wet heartland of the Gondwana Rainforests World Heritage Area (GRWHA). Assisting natural regeneration of canopy cover and key ecosystem functions catchment-wide will increase carbon storage and resistance and resilience to climate change and other threatening processes. Using alternative stable state theory and wireless sensor networks to evaluate regeneration strategies, the project breaks new ground on more cost-effective methods for restoration of degraded lands. Eradicating new, forest replacing, shade-tolerant weeds that threaten the World Heritage Area is an urgent priority for the 2012–2015 planning phase.
Project outcomes	Between 2005 and 2009, the Queensland Government spent $40 million purchasing land adjoining the Springbrook National Park section of the Gondwana Rainforests of Australia World Heritage Area (GRAWHA). The majority of this land is now gazetted as National Park or National Park (Recovery). Some of this land is cleared and ARCS Inc has entered into a legal agreement with the State of Queensland to restore, pro bono, native vegetation on the land over a period of 10–20 years. The regeneration plan for the National Park (Recovery) areas is accessible electronically at http://www.derm.qld.gov.au/parks/springbrook/pdf/regeneration-plan-web.pdf Springbrook Rescue aims to restore the viability and resilience of one of the planet's most significant World Heritage areas but which has been severely put at risk by clearing and fragmentation over the past 100 years. Through restoration of connectivity and critical habitat integrity, Springbrook National Park will be extended giving this national hotspot of biodiversity and universal significance greater security. To be effective connectivity must consider processes related to ecosystem resistance and resilience at habitat, landscape, ecological and evolutionary scales. The success of interventions in the short- and long-term will be measured against goals (desired ecosystem parameters) published by the International Society for Ecological Restoration. Critical habitat restoration will give priority consideration to a wide range of functional groups amongst ancient plant and animal lineages (to their resource, shelter, and reproductive needs as well as their sensitivity to habitat loss, modification and fragmentation). The approach adopted is to build first on those areas that will establish initial connectivity with the least effort and most effect. Then later build connections between these primary corridors (interlinked landscape matrices) with continuing infilling until all gaps are closed. Thus during the current Project term a specific aim is to improve canopy cover in three primary corridors within the Mundora, Ee-jung and

	Boy-ull Creek catchments that bridge a significant gap between the Queensland and New South Wales sections of the Gondwana Rainforests of Australia World Heritage Area (GRAWHA). This section represents the superwet, core refugium of the GRAWHA where ancient, conservative Gondwanan lineages have the greatest potential to recover and survive climate change. Centred in the highest rainfall zone of the McPherson Range (≥3,500 mm av. annual rainfall), the high country cloud forests of Springbrook Plateau represent the wettest core of the GRAWHA. The area is the closest present-day analogue, outside the Wet Tropics of Queensland, of wetter and more equable palaeo-climates under which the ancestry of the world's songbirds and many other ancient lineages evolved. The most vulnerable bottlenecks in this linkage zone have been identified (Warblers, Ashmiha, Barimbah and Pallida) and are targeted for substantial improvement during the current 3-year period: The Mundora linkage bridges a 1.25 km N–S gap over a 170-m elevational band that is 670 m at its widest and 140 m at its narrowest points. The "**Warblers**" site represents the critical bottle neck in this corridor being an essentially cleared gap 140 m wide and 250 m long on flat land at the base of the elevational gradient. The Ee-jung linkage adjoins the Mundora corridor at the watershed boundary between the Mundora and Ee-Jung Creek catchments. The N–S corridor is 775 m long and, on average, 545 m wide, spanning an elevational gradient of 160 m (790 m to 950 m). The last major clearing was in 1975. The "**Ashmiha"** site is the critical bottleneck at the base of the corridor creating an almost complete break ~530 m long and 250 m wide and extending for more than half the length of the planned primary corridor. A diversity of aspects ranging between east and west, from valley floor to mid-slopes contributes to topographic diversity fundamental to refugia where species have only short distances to move to track climate change. The "**Barimbah"** site forms the upper elevational connection (870 m–940 m) in the corridor spanning a range of aspects from predominantly northwest to to northeast between the watershed boundaries. This is the most intact part of the corridor with a remnant core that escaped all past clearing. The Boy-ull linkage adjoins the Ee-jung Linkage at the watershed boundary of the two catchments. This region is the most heavily impacted of the three priority corridors, experiencing repeated near-complete clearing, the last on the "Pallida" site being in 1992. The "**Pallida"** site spans the full elevational gradient between the two blocks being connected (from 780 m to 935 m) and occurs in the

	eastern half of the Boy-ull Creek catchment with largely a westerly to northerly aspect. Invasive weed eradication is a significant element of Springbrook Rescue and aims to not only prevent invasion of the GRAWHA by the weeds but also remove their inhibiting effects on natural regeneration. In this term the project aims to assist natural regeneration through a concentrated focus on the two most aggressively invasive and ecologically damaging weeds — blue stars and kahili ginger, whilst controlling the impact of other weeds, especially mat-forming exotic pasture grasses, so as to reduce barriers to natural regeneration. Blue stars (*Aristea ecklonii*) and kahili ginger (*Hedychium gardnerianum*) not only inhibit natural regeneration on cleared areas but, being shade-tolerant and bird-dispersed, also have the potential to invade native vegetation including in inaccessible areas and form dense ground cover preventing seedling establishment and threatening long-term survival of the ecosystem. They represent a significant threat to the adjoining World Heritage areas. The most critical intended outcome over the next three years is eradication of blue stars and kahili ginger on the restoration land. Project outputs related to this specific objective are highlighted in green in the table below.

Project Outputs (2012–2015)

Mundora: Warblers	Vegetation description	Current condition	Intended condition in 2015	Method of assessment
Mundora Catchment **Warblers site (3 ha)** **Acquired August 2007**	**A. Exotic grassland** (sown pasture) dominated primarily by the bunch grass *Setaria sphacelata* and the rhizomatous herb *Aristea ecklonii* (blue stars); On the adjoining northern, eastern and southern boundaries of this property is unclassified "High value regrowth vegetation" (mapped by Qld Dept of Environment) that acts as a potential species pool of colonisers for the Warblers site. Canopy species on the eastern and northern boundaries include *Callicoma serratifolia*, *Pittosporum undulatum*, *Leptospermum trinervium*, *Leptospermum polygallifolium*, *Lomatia arborescens*, *Persoonia media*, *Orites excelsa*, and *Acacia* spp. Along the northern boundary is well advanced regrowth of	***1. Recruitment***		
		Assisted natural regeneration since the beginning of the project has resulted in an increase in native plant density to ≥1,000/ha (a spacing of ≥ 3.25m or ≥30 plants/sub-cell) over 89% of the area	Assisted Natural regeneration will have resulted in a native plant density of ≥ 1,800 plants/ha (an av. plant spacing of 2.5 m or 50 plants/sub-cell) on 100% of the area	Plant species assembly (**density**, **richness**) is monitored directly in the field by marking & labelling all new plants in each 16.66m x 16.66m sub-cell, that is part of a continuous grid, annually for most (**Project SS2**), but seasonally in 8 subcells (**Project SP1**). Values are corrected for mortality at each measure. Data are collated and analysed using FileMaker databases.
		2. Plant community composition and structure		
		Plant community composition and structure is maximally divergent from that of reference ecosystems. Species accumulation is mainly restricted to wind-dispersed pioneer and some animal-dispersed early- to mid-successional species In the northern section, "High value regrowth vegetation of Regional Ecosystem 12.8.2 is expanding into the cleared areas with individuals of *Eucalyptus oreades* reaching above 6 m.	A plant community composition and structure that in the southern half includes more animal-dispersed rainforest species from Araliaceae, Elaeocarpaceae, Icacinaceae, Lauraceae, Meliaceae, Myrtaceae, Rutaceae, Sapindaceae, families (which in turn will facilitate recovery of keystone avian frugivores); and in the northern half more animal-dispersed species typical of RE 12.8.2. Along the northern boundary on rhyolite (the northern half of Grid	Trends in plant community ***composition*** *and relative* ***abundance*** are based on annual monitoring of stratified quadrats compared with the previous year's results and with characteristic composition and abundance of indicator species in corresponding Reference Sites **(Project SSP4)** Changes in plant community ***structure*** is monitored in 8 stratified quadrats by comparing changes in height and leaf area index summarised into height-classes differing by 20 cm up to 1 m,

Mundora: Warblers	Vegetation description	Current condition	Intended condition in 2015	Method of assessment
	Regional Ecosystem 12.8.2, *Eucalyptus oreades* tall open forest on Cainozoic igneous rocks (Conservation status 'Of Concern'). Indicator species include: a **canopy** layer of *Eucalyptus oreades* and *E. campanulata*; a **subcanopy** of *Elaeocarpus reticulatus*, *Acacia obtusifolia*, *Litsea reticulata*, *Leptospermum petersonii*; **shrubs** including *Elaeocarpus reticulatus*, *Logania albiflora*, *Cyathea australis*, *Cassinia subtropica*, *Synoum glandulosum*, *Melicope micrococca*, *Prostanthera phylicifolia*, *Pittosporum undulatum*, *Neolitsea dealbata*, *Polyscias sambucifolia*; a **ground layer** of *Dicranopteris linearis*, *Calochlaena dubia*, *Gonocarpus teucrioides*, *Hibbertia dentata*, *Gahnia melanocarpa*, *Dianella caerulea*		Cell A in attached file "BiodiversityPlanGrids&Photopoints.pdf") plant stocking levels expected to exceed 3000–5000 plants/ha within 50 metres of the forest edge. Plant species accumulation will grade inversely with distance from forest edge (50 to 5 species)	and by 50 cm increments thereafter to 6 m **(Project SP1).** Data can be extrapolated to adjoining areas to project expected rates of change. In older communities basal area estimates are made by random or systematic point sampling
		3. Animal community composition and structure		
		Animal community composition and structure reflect disturbance. Bird species common to disturbed areas dominate (ravens, crows, currawongs, magpies);	An increased use of regenerating vegetation is expected for foraging by scrubwrens and bowerbirds (and possibly Albert's Lyrebird), and for nesting by thornbills and gerygones.	Targeted surveys and incidental observations. Acoustic monitoring **(Project SS1)** using an omnidirectional, high-powered microphone (Song Meter, Wildlife Acoustics Inc.). Identification to species and abundance assessment is by analysis of sonograms using specialist software (Songscope, Wildlife Acoustics Inc.).
		4. Habitat for rare, threatened or significant species		

Mundora: Warblers	Vegetation description	Current condition	Intended condition in 2015	Method of assessment
		The regenerating ecosystems can only ever provide extensions of viable habitat for rare, threatened or significant species that occur in contiguous parts of the primary corridor being restored: currently recorded are *Acacia orites* (NT), *Austrobuxus swainii* (NT), *Lenwebbia prominens* (NT), *Rhodamnia maideniana* (NT), *Assa darlingtoni* (NT), *Litoria pearsoniana* (V), *L. revelata* (NT), *Mixophyes fleayi* (E); the highly cryptic Lewin's Rail (NT) is recorded on the site where grass cover is tall; grey goshawk (NT) sighted but has a large range	The population of *Litoria revelata* (NT) is expected to increase Threatened (E, V, NT) or significant plant species increased in both density and extent of occurrence	Acoustic monitoring **(Project SS1)** as above for bird and frog species supplemented by incidental records Plant species monitoring associated with routine marking and monitoring in Growth Plots (**Project SP1**) and in other Grid cells on the site (**Project SS2**)
		5. Non-indigenous species		
		Non-indigenous species levels high; *Aristea* and *Setaria* blanket most of the site potentially producing tonnes of seed heads with billions of highly dispersible seeds in 1.5–3 months if uncontrolled	Aristea, kahili ginger, montbretia absent; fireweed reduced to low levels; setaria kept from forming thick necrotosing mats	Quantitative assessment of plant/plant part removals (by weight and number/subcell) provides confirmation of trends on repeated removals **(Project SD7)** Semi-quantitative assessment of effectiveness of repeated removal effort via inspection (scale of 1–4) and photopoint monitoring of each subcell on the site **(Project SP4)**
		6. Functional Diversity		

Mundora: Warblers	Vegetation description	Current condition	Intended condition in 2015	Method of assessment
		Functional diversity of regenerating native plant species characteristic of 5-year old regrowth All trophic levels of fauna are represented but restricted to occasional use for non-breeding activities	Each functional group characteristic of the stage of succession is represented with increased 'redundancy'	The biodiversity surveys (**Projects SBD1-7**) provide the basic information for assessing functional groups integrity. Functional groups are defined by taxonomic, morphological, & trophic classes; with subsets relating to niche specialization (resource, habitat, reproduction); as well as to fragmentation sensitivity (area- and barrier-sensitive; habitat specialist; dispersal-limited; metapopulation-dependent, otherwise ecologically important or phylogenetically significant) **(Project SBD9).** Surveys of birds and frogs at this site are restricted to incidental records and acoustic monitoring using omnidirectional, high-powered microphones (Song Meter, Wildlife Acoustics Inc.). Identification to species is by analysis of sonograms using specialist software (Songscope, Wildlife Acoustics Inc.) **(Project SS1)**
		7. Canopy Cover		
		Canopy cover exists on 18% of the site; regeneration nodes with canopy closure act as stepping stones for some frugivorous birds (e.g. bowerbirds) and ground-dwelling invertebrativores (e.g. logrunners);	An east–west corridor linking the central regeneration node on outcropping rhyolite to that at the eastern boundary is advanced to either canopy closure or high plant	Aerial photography (NearMap) and GIS-based quantitative, grid-based assessment of canopy cover to determine extent (See attached file warblers_14Jun2012.jpg)

Mundora: Warblers	Vegetation description	Current condition	Intended condition in 2015	Method of assessment
		otherwise the site remains a bottleneck in the corridor	density capable of closure in the near term	Estimates of Leaf Area Index (LAI) and effective plant biomass outside the WSN nodes using a portable ceptometer (AccuPAR, LP-80, Decagon Devices, Inc.) provides a measure of canopy density. Alternatively, finer-scale assessments are carried out using point sampling with a Spherical Crown Densitometer or line-point transect sampling with a GRS Densitometer. The latter method allows greater characterisation of forest structure in addition to canopy closure levels
		8. Abiotic conditions — Microclimate		
		Microclimate over most of the area deviates maximally from the optimal buffered condition characteristic of climate refugia.	Microclimate is significantly moderated through shading by advancing regeneration	Three micrometeorological nodes **(Project SRC1)** sample at 15 min intervals: rainfall, PAR, air RH & T, leaf wetness, soil moisture and soil water potential; a further two only sample PAR as a function of distance from forest edge to assess the impact of shading. Monitoring elsewhere as required using a Kestrel 4500 Pocket Weather Meter with comparisons

Mundora: Warblers	Vegetation description	Current condition	Intended condition in 2015	Method of assessment
				to adjacent cleared areas and the formal weather stations on the site.
		9. Abiotic conditions — Soil health		
		Soil health is still generally poor (high compaction levels and low water holding capacity); thin skeletal soils devoid of leaf litter render new regeneration highly frost prone	Soil compaction continues to be significantly reduced, on average, across the site. Earthworm activity and density in soils increasing Leaf litter levels improving in areas of advanced regeneration	Soil health assessments are conducted as part of **Project SRC3**. Soil compaction and moisture levels are considered a minimal set of surrogate indicators of soil health at a broad scale (other physical parameters measured on more limited stratified quadrats include depth, texture, pH, dispersion and colour). Transect-based measure of soil compaction is done using a drop-cone penetrometer; soil moisture other than at micrometeorological stations is measured using an MPKit (ICT International) Earthworm activity (a key bioindicator including of soil organic matter) is semi-quantitative (counts per unit area dug) but non-lethal, non-invasive soil imaging methods are being investigated Leaf litter levels measured by steel prong capture method
		10. Successional processes		

Mundora: Warblers	Vegetation description	Current condition	Intended condition in 2015	Method of assessment
		Successional processes likely to flip to undesired Alternative Stable State (ASS) in the absence of active intervention to control the key drivers of phase shifts (Aristea, setaria & Kahili Ginger)	Successional processes less prone to ASS; the need for active intervention re. 2 of the 3 critical biotic drivers of phase shifts removed	Our broad- and fine-scale ecological conceptual models provide the basis for assessing emergent system dynamics that consider the drivers of environmental change (species pool characteristics, climate, resource fluxes, disturbance regimes), state response variables (ecosystem structure and processes, including feedbacks that stabilise/destabilise alternative stable states) **(Project SS3)**.
	B. Unclassified regrowth vegetation on outcropping rhyolite with emergent *Leptospermum polygalifolium* var. *montanum*, *Lomatia arborescens*, *Orites excelsa*, *Persoonia media*, *Acacia* spp., *Pittosporum undulatum*, *Tasmannia insipida* etc.	**1. Recruitment**		
		Edges have expanded (through control of competition from setaria) at least 16–20 m into adjoining cleared area on rhyolite around the southern half with a density ≥5000 plants/ha; (the core regrowth area has significant infestations of kahili ginger)	Further increasing density and extent of the leading edge to south, east and west	Aerial photography (NearMap) and GIS-based quantitative, grid-based assessment of increase in vegetation extent Plant density estimated from number of individuals per marked grid cell
		2. Plant community composition and structure		
		Plant community composition is dominated by Leptospermum polygalifolium var. montanum with minor presence of Lomatia	Plant community composition is likely to increase and include more bird-dispersed species as canopy	Plant species assembly (**richness**) is monitored directly in the field by marking/labelling new plants

Mundora: Warblers	Vegetation description	Current condition	Intended condition in 2015	Method of assessment
		arborescens	cover increases	annually in 16.66m x 16.66m sub-cells, that are part of a continuous grid (**Project SS2**). Values are corrected for mortality at each recording. Data are collated and analysed using FileMaker databases.
		3. Animal community composition and structure		
		Animal community composition reflects the currently small size and quality of the fragment but logrunners, bowerbirds, pheasant coucals use the area occasionally; unidentified birds nests have been found in the regeneration area	Improvements in animal community composition are expected as the canopy and plant species composition develops further; and linkages to more mature vegetation consolidates	Ad hoc sightings are useful due to the frequent presence of regenerators on the site including volunteers from Birds Queensland; Project SS2 and Project SBD6
		4. Habitat for threatened or significant species		
		Viable habitat extensions for rare and threatened animal species is unlikely until greater connectivity is achieved	No change in representation of threatened species is expected	Acoustic monitoring of bird and frog species (Project SS1) allows detection of rare, threatened or significant species and their abundances
		5. Non-indigenous species		
		The vegetation on this outcropping rhyolite is extensively infested with kahili ginger (rising up into the trees) and aristea	Kahili ginger and aristea absent; Setaria prevented from seeding and necrotising mat-formation	Quantitative and semi-quantitative methods (subjective rating scale and photographic records) for assessing effectiveness and efficiency of removals as above (Project SD7) Setaria controlled by mowing where interference with natural

Mundora: Warblers	Vegetation description	Current condition	Intended condition in 2015	Method of assessment
				regeneration is not compromised, and hand-shearing otherwise
		6. Functional diversity		
		Functional diversity is at a low level	Functional diversity slightly improved	Functional group analysis (Projects SBD1-9) as above based on data from targeted surveys and incidental recordings
		7. Canopy cover		
		Canopy cover is broken by windthrow of two structure-forming canopy trees	Canopy cover improved by lateral expansion of existing tree canopies; canopy closure increasing in expanding margins and along newly emerging/facilitated linkages to the eastern and southern boundaries	Aerial photography (NearMap) and GIS-based quantitative, grid-based assessment of canopy cover to determine extent (See attached file warblers_14Jun2012.jpg) Estimates of Leaf Area Index (LAI) and effective plant biomass outside the WSN nodes using a portable ceptometer (AccuPAR, LP-80, Decagon Devices, Inc.) provides a measure of canopy density. Point- or line-point transect sampling with spherical crown or GRS densitometers.
		8. Abiotic condition — microclimate		
		Microclimate is suboptimal in the remnant core because of its small size and edge effects; vegetation is exposed to drying and strong winds causing loosening or uprooting of trees growing on almost bare rock	Microclimate improved due to expanding edge with canopy closure	Monitoring as required using a Kestrel 4500 Pocket Weather Meter with comparisons to adjacent cleared areas and formal weather stations on the site.
		9. Abiotic condition — soil health		

Mundora: Warblers	Vegetation description	Current condition	Intended condition in 2015	Method of assessment
		Soil health difficult to assess on outcropping rhyolite where soil development is minimal; trees form thick root mats covering rock for anchorage and nutrient & water extraction Soil health in adjoining areas with expanding regeneration recovering from past heavy vehicle impacts. Litter development low	Soil health continuing to improve	Soil health assessments are conducted as part of Project SRC3. Soil compaction and moisture levels are considered a minimal set of surrogate indicators of soil health at a broad scale (other physical parameters measured at more limited sites include depth, texture, pH, dispersion and colour). Transect-based measure of soil compaction is done using a drop-cone penetrometer; soil moisture other than at micrometeorological stations is measured using an MPKit (ICT International) Earthworm activity (a key bioindicator including of soil organic matter) is semi-quantitative (counts per unit area dug) but non-lethal, non-invasive soil imaging methods are being investigated Leaf litter levels measured by steel prong capture method The method chosen depends on the nature of the substrate
		10. Successional processes		
		Successional processes maintained through active intervention balancing competitive/facilitative	Succession progress maintained through active intervention to remove competing setaria	Resilience model based on assessing drivers and response variables affecting ecosystem

Mundora: Warblers	Vegetation description	Current condition	Intended condition in 2015	Method of assessment
		interactions between weeds and native species		dynamics and potential for sudden, essentially irreversible change in ecosystem states (Project SS3)

Ee-jung ASH–PUM	Vegetation description	Current condition	Intended condition in 2015	Method of assessment
Ee-jung catchment: **Ashmiha site (12 ha)** **Pumilo site pt (6 ha)**	A. Exotic grassland (sown pasture) dominated primarily by the bunch grass *Setaria sphacelata*, kikuyu and paspalum. Grazing ceased in 2008. Just prior to being acquired by the Queensland Government, regeneration along the south-western boundary was killed with the persistent herbicide Grazon. The property consists of two lots. Southern lot: Immediately adjoining the southern and western boundaries is advanced regrowth of Regional Ecosystem 12.8.5 (Complex notophyll vine forest on Cainozoic igneous rocks >600 m altitude), mapped by Qld Dept of Environment as "High value regrowth vegetation". Near the south-eastern boundary is a small remnant patch of Regional Ecosystem 12.8.5 which survived more than 100 years clearing on the plateau. These areas provide the	**1. Recruitment**		
		Natural regeneration in the Southern lot and part of the Northern lot (trial areas testing both capacity for unassisted regeneration and recovery of soil health under the respective covers of kikuyu, paspalum and setaria) has largely failed in the absence of active intervention to control necrotosing mat-forming exotic grasses (setaria, kikuyu and paspalum). Isolated *Leptospermum polygalifolium* present from the end of cattle grazing when grass canopies were low. Assisted natural regeneration near forest edges of the Northern lot since the beginning of the project has resulted in an increase in native species recruitment with an average current density of 5,560 plants/ha	Density of assisted natural regeneration greatly increased, via control of mat-forming grasses, with pant densities within 35 m of forest edges approaching 5000 plants/ha, decreasing with distance from forest edge	Plant species assembly (density) is monitored directly in the field by marking/labelling all new plants in each 16.66m x 16.66m sub-cell, that is part of a continuous grid, annually for most (Project SS2), but seasonally in 4 subcells associated with productivity assessment (Project SP1). Values are corrected for mortality at each measure. Data are collated and analysed using FileMaker databases.
		2. Plant composition and structure		
		Plant community richness, composition and structure over most of the area is dominated by pasture grasses and isolated shrubs of mainly orites, lomatia and acacia species especially at the highest altitudes. The Northern boundary in the Northern lot contains a greater	Plant community richness, composition and structure are likely to increase with increased representation of plant families and genera, as well as of animal dispersed species as regenerating species provide perching opportunities for birds from the forest blocks being connected.	Grid-based marking/labeling as above for monitoring trends Four stratified quadrats for monitoring and predicting changes in productivity and structure as above (Project SP1).

	potential species pool of colonisers for the southern lot of Ashmiha. Indicator species include: **emergent** *Ficus watkinsiana*; a canopy *Argyrodendron actinophyllum*, *A. trifoliolatum*, *Sloanea australis*, *Acmena ingens*, *Syzygium crebrinerve*, *Caldcluvia paniculosa*, *Geissois benthamii*, *Aronychia octandra*, *Acronychia suberosa*, *Doryphora sassafras*, *Orites excelsa*, *Cryptocarya erythroxylon*; **Subcanopy** *Daphnandra tenuipes*, capparis arborea, Sloanea australis, Quintinia verdonii, Baloghia inophylla, Scolopia braunii, Geliotropium glabellum, Alangium villosum; **Shrubs** *Cyathea leichhardtiana*, *Linospadix monostachya*, *Ardisia bakeri*, *Capparis arborea*, *Rhodamnia maideniana*, *Harpullia alata*, *Wilkiea austraoqueenslandica*, *Wilkiea huegeliana*, *Psychotria simmondsiana*, *Cryptocarya meisneriana*, *Citrus australasica*; **Ground layer** *Lastreopsis marginans*, *L. decomposita*, *Lomandra spicata*, *Pellaea falcata*	diversity of species as measured in the formal growth plots. Twenty-five plant species in 15 families and 22 genera comprise the recruited pool (c.f. 63 species in 31 families & 51 genera in the source pool) representing significant phylogenetic diversity. Plant functional types (plant form) include trees, shrubs, herbs, vines, ground ferns and orchids. Large tree species, e.g. *Eucalyptus oreades* and *E. campanulata* now reach ≥6 m in height. Wind-dispersed propagules dominate over animal dispersed ones ~ 2:1 (c.f. 1:3 in the total species pool)		
		3. Animal composition and structure		
		Animal community richness, composition reflects the high level of disturbance and fragmentation; birds include ravens, crows, butcherbirds, currawongs and generally a pair of masked lapwings. Raptors are frequently recorded. Forest edges frequently utilised by bowerbirds (satin bowerbird), pardalotes (both spotted and striated), white-browed treecreepers and occasionally Victoria's Riflebird.	Changes in animal community composition are likely to remain relatively unchanged.	Targeted surveys and incidental records associated with routine management activities as above
		4. Habitat for threatened or significant species		
		The site does not necessarily provide viable habitat for rare, threatened or significant species, but two of the four rare species known to occur on	No major progress is expected in three years, and until canopy closure is reached; however an increase expected in population numbers of	Plant monitoring/marking associated other restoration activities (prior to slashing or other means of weed control)

	Northern lot: Along the northern boundary of the lot is well advanced regrowth of Regional Ecosystem 12.8.2, *Eucalyptus oreades* tall open forest on Cainozoic igneous rocks (Conservation status 'Of Concern'). Mapped by Qld Dept of Environment as "High value regrowth vegetation" Detailed description above for this species pool.	Ashmiha (*Acacia orites* (NT) and *Lenwebbia prominens* (NT)) are dispersing onto the site.	*Correa lawrenciana* var. *glandulifera* (significant species)	Incidental records of fauna by experienced observers
		5. Non-indigenous species		
		Non-indigenous species levels high; setaria, kikuyu, paspalum blanket most of the site; fireweed is common; Aristea has invaded the eastern and northern boundaries the likely source being from Warblers and the road reserve) Kahili ginger infestation minimal. Yorkshire Fog in wetter areas with poor drainage	Aristea, kahili ginger absent. Fireweed reduced but not eradicated due to continuing re-infestation from neighbouring private land; Setaria, kikuyu, paspalum prevented from forming thick necrotosing mats that inhibit natural regeneration	Quantitative estimates of aristea removals as above Photopoint monitoring where relevant
		6. Functional diversity		
		Functional diversity of plants very low over much of the site but relative high close to forest edges (all morphological groups present). Bird functional diversity associated with exotic pastures comprises mainly omnivore/carnivore classes.	Functional diversity is not expected to change dramatically overall in 3 years	Analysis of selected functional groups recorded by targeted surveys (Projects SBD1–8) as described above
		7. Canopy cover		
		Canopy cover minimally contributes to improved connectivity	Improvements in connectivity are not expected within 3 years but edge expansion continues consistent with growth plot data	Aerial photography (NearMap) and GIS-based quantitative, grid-based assessment of canopy cover to determine extent (See attached file ashmiha_14Jun2012.jpg) Estimates of Leaf Area Index (LAI) and effective plant biomass outside the WSN nodes using a portable ceptometer (AccuPAR, LP-80,

				Decagon Devices, Inc.) provides a measure of canopy density. Photomonitoring where relevant
		8. Abiotic condition — microclimate		
		Microclimate deviates maximally from the optimal buffered condition in reference sites	Microclimate changes at expanding forest edges mainly related to effects of shading	Extrapolation of micrometeorological monitoring on analogous environments on the Warblers site in the Mundora Creek catchment
		9. Abiotic condition — soil health		
		Soil health generally improved by utilising principle of "ley" pasture management (high compaction levels and low water holding capacity originally due to impact of cattle grazing and heavy machinery ameliorated by certain pasture grasses during a sufficiently long fallow period); Soil nutrient levels still elevated patchily from past cattle grazing; Erosion significant along Ee-jung Creek due to removal of vegetation and cattle trampling up to 2007; Erosion along a deep artificial trench (40 m long, 1.5 m deep and 5 m wide on average in the worst parts); established in past to divert overland flow from the former house site	Soil health, 7 years after grazing ceased & ley pasture type management, has returned to ~ normal (re compaction, aggregate stability, hydraulic conductivity) — essential for overcoming major abiotic barrier to effective regeneration Residual levels of Grazon (persistent herbicide) likely to be negligible 5-7 years after original application by previous private owners Hydrological improvements as a result of in-filling of artificial trenches previously diverting overland flow, and increased native plant cover along riparian areas	Soil health assessments are conducted as part of Project SRC3. Soil compaction and moisture levels are considered a minimal set of surrogate indicators of soil health at a broad scale (other physical parameters measured on more limited stratified quadrats include depth, texture, pH, dispersion and colour). Transect-based measure of soil compaction is done using a drop-cone penetrometer; soil moisture other than at micrometeorological stations is measured using an MPKit (ICT International) Earthworm activity (a key bioindicator including of soil organic matter) is semi-quantitative (counts per unit area dug) but non-lethal, non-invasive soil imaging methods are being investigated

				Leaf litter levels measured by steel prong capture method Soil nutrient levels qualitatively inferred by quality of grass patches affected by cow dung and urine (still visible 4 years after grazing stopped) Macrofungi surveys in stratified quadrats (Project SBD2) indicative of soil health and successional development.
		10. Successional processes		
		Successional processes unstable with formation of undesired Alternative Stable State (ASS) likely in the absence of active interventions to control the key drivers of phase shift by setaria, kikuyu, paspalum and potentially aristea.	Succession favouring native trajectory only if controlled disturbance to mat-forming grasses maintained until natural shading by emerging canopies effective	Our resilience-based conceptual model incorporating drivers and response variables associated with ecosystem dynamics assists determination if and when interventions are required to avert negative phase shifts or accelerate regeneration
	B. Advanced regrowth of montane heath on outcropping rhyolite along the south-western boundary of the northern lot, mapped as Regional Ecosystem 12.8.19. The canopy is dominated by *Leptospermun polygalifolium*	**1. Recruitment**		
		Native plant recruitment is limited but existing canopies are coalescing	Recruitment density continuing unassisted; extent increasing to within 20 m	Plant species assembly (density) is monitored annually by marking new plants in stratified 16.66 m x 16.66 m sub-cells, that are part of a continuous grid system (Project SS2)

	var. *montanum*. The vegetation was largely cleared by 1930, recovered canopy integrity by 1961, half was re-cleared in 1975, clearing completed by 1989, remaining so until 1993. At most regrowth is ~20 years old. At Springbrook, these heaths and rock pavements may provide habitat for rare and threatened plant species including: *Callitris monticola* (NT), *Gahnia insignis* (NT), *Plectranthus torrenticola* (E), *Westringia blakeana* (NT), *W. rupicola* (V), *Eucalyptus codonocarpa* (NT), *Leptospermum oreophilum* (V), *Arundinella montana* (NT), *Comesperma esulifolium*, *Leionema elatius* subsp. *beckleri* (E)	**2. Plant community composition and structure**		
		Plant community richness, composition and structure are consistent with 20-year regrowth. *Callistemon pallida*, *Leptospermum polygalifolium* var. *montanum*, *Acacia obtusifolia* and *Callicoma serratifolia* the main emergent canopy trees. Opportunities for expansion of the community are limited by the size of the rhyolite outcropping.	Slight improvement in plant community richness, composition and species relative abundance	Trends in plant community richness, composition and relative abundance are based on annual monitoring of stratified quadrats compared with the previous year's results (Project SS2) and with characteristic composition and abundance of indicator species in corresponding Reference Sites (Project SSP4)
		3. Animal community composition and structure		
		Animal community richness and composition: comprehensive surveys have not yet been conducted; grey goshawks (NT) use emergent trees as perches; *Crinia signifera* and *Limnodynastes peronii* main amphibians	Animal community richness, composition and relative species abundance consistent with 22-year old regrowth	Targeted surveys and incidental observations (Projects 4-6). Acoustic monitoring of fauna (Project SS1) using an omnidirectional, high-powered microphone (Song Meter, Wildlife Acoustics Inc.). Identification to species and abundance assessment is by analysis of sonograms using specialist software (Songscope, Wildlife Acoustics Inc.).
		4. Habitat for threatened and/or significant species		
		Viable habitat extensions for threatened (E, V, NT) or significant species is likely to be restricted to frog species in the marshy conditions surrounding the outcropping rhyolite. The grey goshawk (NT) is	Situation unchanged	Acoustic monitoring (Project SS1) as above for bird and frog species supplemented by incidental records

		regularly observed		
		5. Non-indigenous species		
		Non-indigenous species levels mainly kahili ginger and mistflower	Kahili Ginger removed; mistflower absent	Quantitative assessment of plant/plant part removals (by weight and number/subcell) provides confirmation of trends on repeated removals (Project SD7) Semi-quantitative assessment of effectiveness of repeated removal effort via inspection (scale of 1–4) and photopoint monitoring of each subcell on the site (Project SP4)
		6. Functional diversity		
		Functional diversity not yet assessed comprehensively	Functional diversity assessed c.f. reference sites	Biodiversity surveys (Projects SBD1-7) underpin functional group integrity assessments defined as above (**Project SBD9**)
		7. Canopy cover		
		Canopy cover over at least 50% of the rock surfaces	Canopy extent continually improving but natural wind-throws create periodic gaps	Aerial photography (NearMap) and GIS-based quantitative, grid-based coarse assessment of canopy cover to determine extent (See attached file ashmiha_14Jun2012.jpg) Finer-level point and line-point transect sampling of Leaf Area Index (LAI) and effective plant biomass outside the WSN nodes using a portable ceptometer (AccuPAR, LP-80, Decagon Devices, Inc.) provides an indirect measure of canopy density. Spherical Crown Densitometer and GRS

				Densitometer assessments allow greater definition of canopy and forest structure. Where relevant, additional photomonitoring.
		8. Abiotic condition — microclimate		
		Microclimate not measured	Microclimate not measured but inferred to be consistent with 20-year regrowth	Inference supplemented with a Kestrel 4500 Pocket Weather Meter readings
		9. Abiotic condition — soil health		
		Soil health not assessed quantitatively; soils are skeletal on rock surfaces with thick fibrous root-mat and litter development; polluted by cattle dung from previous grazing history	Soil/substrate health improving; largely because litter levels increasing and cow pads absent	The following methods apply only where soil depth is sufficiently developed: Soil health assessments are conducted as part of Project SRC3. Soil compaction and moisture levels are considered a minimal set of surrogate indicators of soil health at a broad scale (other physical parameters measured on more limited stratified quadrats include depth, texture, pH, dispersion and colour). Transect-based measure of soil compaction is done using a drop-cone penetrometer; soil moisture other than at micrometeorological stations is measured using an MPKit (ICT International) Earthworm activity where relevant and possible (a key bioindicator

				including of soil organic matter) is semi-quantitative (counts per unit area dug) but non-lethal, non-invasive soil imaging methods are being investigated Leaf litter levels measured by steel prong capture method Cow pad residuals: semi-quantitative scale of 1–4 based on visual inspections) Macrofungi surveys in stratified quadrats (Project SBD2) indicative of soil health and successional development
		10. Successional processes		
		Successional processes normal and unaided for 20-year regrowth	Successional processes remain normal and unaided	Resilience model guides assessment of drivers and response variables affecting ecosystem dynamics and potential for sudden, essentially irreversible changes in ecosystem states (Project SS3)

Ee-jung - Barimbah	Vegetation description	Current condition	Intended Condition in 2015	Method of Assessment
Ee-jung catchment — Barimbah (28 ha)	**A. Regional Ecosystem 12.8.5**, complex notophyll vine forest on Cainozoic igneous rocks >600 m altitude (mainly advanced regrowth surrounding a remnant patch of not greater than ~80 m^2 representing one of the few remaining relicts of the original forest on the Springbrook plateau) The surrounding regrowth is mapped by Qld Dept of Environment as "High value regrowth vegetation". Detailed description of Indicator species above in **Ee-jung — Ashmiha** The remnant and regrowth patches in the Barimbah corridor provides confidence that recovery of all historically occurring species can be recovered. Four "stepping stones" have persisted since (and likely before 1930) in P', Q' and N' grids but were separated by clearing in ~1975. The link between P' and Q'	**1. Recruitment**		
		Native plant recruitment is unassisted with high densities (≥5000 plants/ha) at forest edges attenuating rapidly with distance from edge	Native plant density increasing with distance from forest edges and around existing regeneration nodes acting as "nurseries"	Plant species assembly (density distribution) is monitored annually by marking new plants in stratified 16.66 m x 16.66 m sub-cells, that are part of a continuous grid system (**Project SS2**)
		2. Plant community composition and structure		
		Plant community richness, composition & structure: flora surveys are incomplete but to date comprise 101 native species in 87 genera within 57 families; basal lineages well represented	Flora surveys indicate greater species richness and composition than indicated by ARCS surveys in late 2005	Trends in plant community **richness**, ***composition*** *and relative* ***abundance*** are based on monitoring of stratified quadrats and transects compared with the previous year's results and with characteristic richness, composition and abundance of indicator species in corresponding Reference Sites **(Project SSP4)**
		3. Animal community composition and structure		
		Animal community richness, composition & structure is incompletely documented but ARCS bird surveys under adverse weather conditions in 2006 recorded 25 species in 17 families and 23 genera.	Richness, composition and structure more comprehensively inventoried	Targeted surveys and incidental observations. Acoustic monitoring in reference site Q' **(Project SS1)** using an omnidirectional, high-powered microphone (Song Meter, Wildlife Acoustics Inc.). Identification to species and abundance assessment is by analysis of sonograms using specialist software (Songscope,

	cores is ~37 years old, that between Q' and N' 25-27 years. The uppermost elevations are directly in contact with the NSW Nature Reserve (maximum naturalness) via a low saddle bridging the otherwise cliff-lined caldera edge with a sufficient low gradient to facilitate movement of fauna and flora from "source" populations. Forest in Grid K' (Barimbah) providing seed sources to the adjoining Ashmiha site is 35–40 years old. Forest in Grid C" has a minimum age of 40 years.			Wildlife Acoustics Inc.). SWAG annual Lyrebird surveys (triangulation methods allows some assessment of abundance)
		4. Habitat for threatened and/or significant species		
		Viable habitat extension for threatened (E, V, NT) or significant species recorded for 8 plant species, the Australian Logrunner and the Albert's Lyrebird. Six calling males were recorded in July 2012. ARCS records also include sightings for 5 frog species including *Litoria revelata* (NT) and *Assa darlingtoni* (NT); 3 significant reptile species including eastern tiger snake, red-bellied black snake and rough-scaled snake	Comprehensive surveys more accurately reflect the numbers of threatened and significant species	Targeted surveys, incidental records and Song Meter records from the Q' reference site (Project SS1) SWAG annual Lyrebird surveys as above
		5. Non-indigenous species		
		Non-indigenous species levels are comparatively low in regrowth forest and comprise mainly mistflower and kahili ginger in gullies	Kahili ginger removed from Rolfe Creek (small tributary) and from most of the remaining area	Quantitative assessment of plant/plant part removals (by weight and/or number/subcell or other fixed unit area) provides confirmation of trends on repeated removals **(Project SD7)** Semi-qualitative assessment of effectiveness of repeated removal effort via inspection and photopoint monitoring of infested sites **(Project SP4)**

		6. Functional diversity		
		Functional diversity amongst bird guilds is comparable to that on the plateau as a whole	Functional diversity encompassing a broader range of taxa assessed. The Barimbah Reference site more fully documented	Functional group analysis (**Projects SBD1-9)** as above based on data from targeted surveys and incidental recordings
		7. Canopy cover		
		Canopy cover is complete over 75% of the site	Canopy cover greater than 75% for the site	Aerial photography (NearMap) and GIS-based quantitative, grid-based assessment of canopy cover to determine extent (See attached file barimbah_14Jun2012.jpg) Estimates of Leaf Area Index (LAI) and effective plant biomass outside the WSN nodes using a portable ceptometer (AccuPAR, LP-80, Decagon Devices, Inc.) provides a measure of canopy density. Point- or line-point transect sampling with spherical crown or GRS densitometers provides fine-scale descriptors of canopy structure and vertical complexity. Basal area assessment by random or systematic point sampling using a wedge prism relascope (or Haglöf Factor Gauge) to complement site data obtained for canopy structure. Where relevant, additional photomonitoring.

		8. Abiotic condition — microclimate		
		Microclimates are highly buffered by the intact and mostly contiguous forest canopies	Microclimate parameters measured quantitatively for the reference site in remnant forest	Monitoring using a Kestrel 4500 Pocket Weather Meter with comparisons to adjacent cleared areas and the formal weather stations on the adjoining Boy-ull Creek - Pallida site.
		9. Abiotic condition — soil health		
		Soil health, although unmeasured is likely to be high in areas undisturbed since 1961 or longer; In other areas the long legacy of repeated clearing is likely to have long-term impacts due to the known vulnerability of kraznozems (red ferrosols) to degradation from clearing	Soil moisture, leaf litter development, and other parameters measured in Reference site Q' Soil moisture and pH outside the reference site in different parts of the chronosequence recorded	Soil health assessments are conducted as part of **Project SRC3**. Soil compaction and moisture levels are considered a minimal set of surrogate indicators of soil health at a broad scale(other physical parameters measured on more limited stratified quadrats include depth, texture, pH, dispersion and colour). Transect-based measure of soil compaction is done using a drop-cone penetrometer; soil moisture other than at micrometeorological stations is measured using an MPKit (ICT International) Earthworm activity (a key bioindicator including of soil organic matter) is semi-quantitative (counts per unit area dug) but non-lethal, non-invasive soil imaging methods are being investigated

				Macrofungi surveys in stratified quadrat associated with Reference site Q' (**Project SBD2**) indicative of soil health and successional development Leaf litter levels measured by steel prong capture method
		10. Successional processes		
		Successional processes appear to be trending normally towards the reference condition unaided	Successional processes continue trending normally towards the reference condition unaided	Resilience model based on assessing drivers and response variables affecting ecosystem dynamics and potential for sudden, essentially irreversible change in ecosystem states (**Project SS3**)
Ee-jung catchment — Barimbah (28 ha) **(Continued)**	**B. Cleared land** dominated by kikuyu and in parts by setaria remain, as a result of past slashing and other management practices, as relatively small residues of old historical clearings: (1) **a 2.6 ha patch** associated with a recently demolished house and bitumen access road, and equally split along the watershed boundary between Ee-jung and Boy-ull Creek catchments — dominated by kikuyu and	**1. Recruitment**		
		Recruitment of pioneer species into clearings proceeding naturally but hindered by mat-forming exotic grasses	Recruitment density accelerated by controlling mat-forming exotic grasses	Plant species assembly (density distribution) is monitored annually by marking new plants in stratified 16.66 m x 16.66 m sub-cells (part of a continuous grid-based monitoring system), located in high priority areas that are critical linkage bottlenecks (J'part, P', M'part) (**Project SS2**)
		2. Plant community composition and structure		
		Richness and composition of plant communities limited in expanding	Richness and composition improving as a result of active control of	Results of targeted transect/quadrat based plant

	setaria; (2) **a 0.2 ha clearing** at the summit of Mt Springbrook dominated by setaria; (3) **a 0.92 ha clearing** dominated by setaria at lowest altitudes (<800 m), surrounded by 50–55 year-old regrowth (4) **An 0.35 ha clearing** at the caldera edge, surrounded by 30–35 year-old regrowth (5) **An 0.8 ha clearing**, surrounded by 30–35 year old regrowth, along the watershed dominated by kikuyu and setaria as well as patches of lantana (6) **part of a 2.5 ha clearing** maintained since 1930, surrounded by 35-year old regrowth, dominated mainly by kikuyu and lantana in parts, 75% of the clearing being in the Mundora catchment. The whole clearing will be managed as a unit.	edges mainly to wind-dispersed species in the east; isolated trees and advanced shrubs of *Lomatia*, *Callicoma* with occasional relict trees such as *Acronychia suberosa*, *Syzygium crebrinerve* occur	competing mat-forming exotic grasses	surveys and incidental records analysed in terms of changes in species richness, composition and relative abundance **(Project SS2)**
		3. Animal community composition and structure		
		Richness and composition of animal communities characteristic of disturbed areas; red-bellied black snakes abound	Little change is expected in 3 years	Transect-based monitoring (**Projects SBD4-7)** supplemented by incidental records associated with routine management activities analysed re richness, taxonomic composition and relative abundance (**Project SS2**)
		4. Habitat for threatened and/or significant species		
		Viable habitat extension for threatened and significant species unlikely until native species canopy closure	No change expected in 3 years	Records from plant and animal monitoring as above
		5. Non-indigenous species		
		Non-indigenous species include mainly kikuyu, setaria, lantana, montbretia, and expanding populations of Formosan lily	Kikuyu and setaria prevented from seeding by preventing necrotosing, light-blocking mats Montbretia, kahili ginger (if it is found), Formosa lily absent Lantana occurrence reduced by half	Quantitative assessment of plant/plant part removals (by weight and/or number/subcell or other fixed unit area) provides confirmation of trends on repeated removals **(Project SD7)** Semi-qualitative assessment of effectiveness of repeated removal effort via inspection and photopoint monitoring of infested sites **(Project SP4)**

		6. Functional diversity		
		Functional diversity of native species limited	Functional diversity of native species present increasing	Functional group analysis (**Project SBD09**) based on results of plant and animal surveys above (**Projects SBD1-7**)
		7. Canopy cover		
		Canopy cover limited to that of isolated regenerating plants (mainly *Lomatia arborescens*)	Canopy cover expanding at edges at the expense of grass cover in cleared areas	Aerial photography (NearMap) and GIS-based quantitative, grid-based assessment of canopy cover to determine extent (See attached file photomonitoring.barimbah_14Jun2012.jpg) Finer-scale estimates of Leaf Area Index (LAI) and effective plant biomass outside the WSN nodes using a portable ceptometer (AccuPAR, LP-80, Decagon Devices, Inc.) provides one measure of canopy density. Point and line-point transect sampling using a Spherical Crown Densitometer and GRS Densitometer allow greater definition of canopy and forest structure. Basal area point sampling using a wedge prism relascope (or Haglöf Factor Gauge) to complement site data associated with the above

				measures. Where relevant, photomonitoring additional
		8. Abiotic condition — microclimate		
		Microclimate characteristic of cleared areas	Changes in microclimate only expected at expanding edges and isolated regenerating clumps	Monitoring using a Kestrel 4500 Pocket Weather Meter with comparisons to data from the formal weather stations at Nodes 210, 211, 213, 214, 216 on the Barimbah site (Grids J', M' on Attached file "BiodiversityPlanGrids&Photopoints .pdf) and corresponding nodes on the adjoining Boy-ull Creek - Pallida site (Project SRC2). Weather station data as part of Project SRC2 are publicly available on http://www.sensornets.csiro.au/deployments/63
		9. Abiotic condition — soil health		
		Soil health impacted by long history of clearing and compaction from cattle and machinery	Soil health improving steadily based on 2012-13 baseline (earlier for the broad long-term project)	Soil health assessments are conducted as part of **Projects SRC2** and **SRC3**. Soil compaction and moisture levels are considered a minimal set of surrogate indicators of soil health at a broad scale(other physical parameters measured on more limited stratified quadrats include depth, texture, pH,

				dispersion and colour). Transect-based measure of soil compaction is done using a drop-cone penetrometer; soil moisture other than at micrometeorological stations is measured using an MPKit (ICT International) Soil moisture and soil water potential data obtained from the Wireless Sensor Network nodes 210, 211, 213, 214, 216 as above. Earthworm activity (a key bioindicator including of soil organic matter) is semi-quantitative (counts per unit area dug) but non-lethal, non-invasive soil imaging methods are being investigated Presence of indicator species of macrofungi in regenerating areas (**Project SBD2**) indicative of soil health and normal successional development Leaf litter levels measured by steel prong capture method
		10. Successional processes		
		Successional processes still capable of transitioning to Alternative Stable	Control of necrotising, light-blocking exotic grasses allowing assisted	Resilience model of drivers and response variables affecting

		State of kikuyu/setaria dominated exotic grassland in absence of active interventions	natural regeneration to continue more effectively	ecosystem dynamics and potential for sudden, essentially irreversible change in ecosystem states drive decisions on appropriate type and timing of interventions (**Project SS3**)
Boy-ull catchment **Pallida (33 ha)** **Acquired 2004**	**A. Regrowth Regional Ecosystem 12.8.5** Approximately half of the property is advanced regrowth (of varying ages) of Regional Ecosystem 12.8.5, complex notophyll vine forest on Cainozoic igneous rocks >600 m altitude Mapped by Qld Dept of Environment as "High value regrowth vegetation" Some kahili ginger present Detailed description of Indicator species above in **Ee-jung — Ashmiha** Almost complete clearing occurred by 1930, again between 1961–1975, and yet again in 1992, the latter being accompanied by major landscape-wide erosion. Only small patches survived the repeated clearing since	**1. Recruitment**		
		Ongoing high *densities* of native plant recruitment within older regrowth and newer regrowth into adjoining cleared areas involves both wind- and animal dispersed species within a large proportion of plant families represented in old-growth reference sites	High levels of natural recruitment continue (≥5000 plants/ha) over the upper half the 33 ha Pallida site with the exception of setaria-dominated parts of Grid cell L". further increased around established growth nodes	Recruitment *densities* in advanced regeneration within the primary corridor are determined quadrats located at point intersects every 50 m along 4 x 350-m transects (a) following the 820- and 850-m contours (Lower Forest Track and Middle Forest Track respectively) as well as (b) along a 350-m transect traversing a 70-m gradient between 800-870 m (the Rolfe Track). Forest patch age is inferred from 1930, 1961, 1975, 1989, 1993 and 2005 mostly high-resolution air photos.
		2. Plant community composition and structure		
		Plant community richness, composition and structure is relatively simple in younger regrowth as expected, for the majority of the area; wind-dispersed species >> animal dispersed species.	Plant richness and diversity in plant composition continues to increase in regenerating areas with increasing proportions of drupe- or berry-bearing species	Plant community richness, composition, and structure (**Project SS2)** is recorded along 6 x 350-metre transects through regenerating forest in the primary corridor (See above.), stratified by

	1930 — in H", J", M", N" Grid cells. Additional regenerated patches occur in Q" (intact since 1975) and K" (intact since 1990). These form the oldest nodes in the developing corridor. The main bottlenecks in corridor connectivity requiring priority attention occur in Grid cells X" (link associated with Rolfe Creek to the World Heritage area in Queensland and D" (linking the eastern half of the catchment to the main trunk of Boy-ull Creek)	Monocultures of either wind-dispersed *Lomatia arborescens* or *Callicoma serratifolia* are frequent Richness and composition in older regrowth or small relict patches of original vegetation not comprehensively surveyed but 56 of the plant 126 species encountered to date are bird or other animal dispersed, including the phylogenetically significant species *Berberidopsis beckleri*		age and compared with previous years' results and characteristic indicator species lists from corresponding Reference Sites (**Project SSP4**) Each transect is measured every 2 years. Recruitment projections for wind-dispersed species are inferred from typical dispersal kernels of individual species and distribution of reproductively mature individuals (**Project SSP2 & SSP3**) Literature values are used to infer likely age/size at reproductive maturity for fleshy-fruited species (**Project SSP1**)
		3. Animal community composition and structure		
		Animal community richness, composition and structure: 40 species of birds in 28 families and 38 genera have been recorded across all environments and include basal lineages (representing considerable phylogenetic diversity) Frog species recorded in association with Boy-ull Creek and marsh habitats: 10 species in 3 families and 4 genera including 2 threatened	A higher proportion of forest inhabiting birds including Scrubwrens are expected to be recorded in advancing and established regeneration. Increased diversity of frogs and reptiles recorded (including geckoes, agamids and skinks)	Baseline monitoring of avifauna was conducted for the lower half of Pallida in March 2007 by Dr Gayle Johnson. Incidental records of birds, reptiles, frogs, mammals, during routine project management activities at any time of the year contribute significantly (doubling of bird species recorded over targeted surveys).

		species) Reptiles: records restricted to diurnal snakes: 3 species Mammal species restricted to pademelons and		Targeted monitoring of frog species in different habitat types, during and after dusk, using both omnidirectional (Edirol R09, Zoom H2n pocket recorders) and directional (Sennheiser ME67/K6 or MKH70) microphones with a high-capacity portable field recorder (Sound Devices 722). Ongoing traditional field monitoring of avifauna and reptiles along a 1000-m transect in the primary corridor (combined Lower- and Middle-Forest Tracks) conducted twice-annually (Spring, Autumn). Autonomous acoustic monitoring (1 Song Meter node, 7 hrs/day) is located adjacent to WSN Node #46 which is close to a creek line and relict remnant (in Grid H") within the primary corridor being restored. Diversity and abundance of both bird and frog species is assessed using analytical software (Songscope, Wildlife Acoustics Inc.).
		4. Habitat for threatened and/or significant species		
		Viable habitat extensions for threatened or significant species (basal lineages, palaeo-endemic and keystone species) of uncertain	Albert's Lyrebird is extending its range further into regrowth; logrunners able to migrate along the full length of the corridor but only 1–	Results of transect surveys, incidental records contribute to monitoring progress in restoration of habitat viability

		quality due to the young age of most of the regrowth (7 to 20 yrs). However, populations of logrunners may survive for at least one generation within the primary corridor until habitat quality improved sufficiently for reproductive viability. Lyrebirds are not known to extend into the current primary corridor but utilise more mature forest adjoining the site. *Litoria revelata* (NT), *L. pearsoniana* (V), and *L. brevipalmata* (NT) are recorded but status of their habitat for reproductive viability is unknown	2 breeding pairs likely to be supported. *Assa darlingtoni* (NT) is expected to be recorded.	Autonomous acoustic monitoring (1 Song Meter, as above) as described for Mundora – Warblers and above Suitability of habitat analysed through knowledge of life history traits and niche specificity and requirements of indicator species Corridor integrity re required habitat parameters is deduced from other assessments (canopy, microclimate, soil parameters, functional/trophic diversity)
		5. Non-indigenous species		
		Non-indigenous species levels are mainly restricted to kahili ginger, mistflower, lantana , wild tobacco, & setaria along old tracks	Kahili ginger absent; lantana & wild tobacco removed; setaria controlled on tracks	Where feasible, quantitative assessment of plant/plant part removals (by weight and/or number/subcell or other fixed unit area) provides confirmation of trends on repeated removals **(Project SD7)** Semi-quantitative assessment of effectiveness of repeated removal effort via inspection and photopoint monitoring of infested sites **(Project SP4)**
		6. Functional diversity		

		Functional diversity in bird species overall is high covering all trophic groups but with low redundancy. Functional diversity of plants is low to moderate, varying according to age of nodal areas that escaped clearing: probably nil for most habitat- and area-specialists, dispersal-limited species	Functional diversity incrementally increasing associated with improvements in plant community richness, composition and structure	Biodiversity surveys (**Projects SBD1–7**) as previously described provide the primary data for functional diversity assessment. Functional groups defined in earlier sections (**Project SBD9**)
		7. Canopy cover		
		Canopy cover now almost continuous for the entire length of the corridor but only 44 m wide at its narrowest and of relatively poor quality at the northern end comprising low monoculture of *Lomatia arborescens*; a significant advance has occurred since November 2011 associated with La Nina conditions	Canopy cover continuous with at least a 150-m width over the core corridor length Forest edges expanded by 20–30 m in priority bottleneck areas	Aerial photography (NearMap) and GIS-based quantitative, grid-based assessment of canopy cover to determine extent at a coarse scale (See attached file pallida_14Jun2012.jpg) Indirect measures of canopy development from the WSN data for Total Radiation Flux, PAR, Relative Humidity and leaf wetness located at 175 nodes distributed 50 m apart along 10-m contours over the entire Pallida site. Data have been logged at 15-sec intervals since 2008 (10 nodes), 2010 (49) and finally 175 by 2011. The majority of nodes fall within the primary corridor or immediately on its edges. Ten nodes occur directly on the Lower Forest Track and Middle Forest Track 350-m transects.

				Estimates of Leaf Area Index (LAI), thus effective leaf biomass, outside the WSN nodes are carried out along 350-m transects using a portable ceptometer (AccuPAR, LP-80, Decagon Devices, Inc.) provides a measure of canopy density. Finer-scale assessments are carried out along the 350-m transects as above using point sampling with a Spherical Crown Densitometer or line-point transect sampling with a GRS Densitometer. The latter method allows greater characterisation of vertical and horizontal forest structure in addition to canopy closure levels (**Project SS2**) Photomonitoring supplements the above assessments where significant differences need to be highlighted (**Project SP4**). Trend predictions can be made based on (a) quantitation of past changes over fixed periods visible in aerial photography and (b) from productivity measurements on growth Plots (**Project SP1**)

		8. Abiotic condition — microclimate		
		Microclimate is variable depending on the vertical and horizontal density of forest cover in the primary corridor as a function of the age of regrowth. The trends in buffering by canopies against extremes of temperature, humidity and sunlight exposure, are positive and significant.	Microclimate buffering over larger areas of the corridor continues to increase significantly	Micrometeorological monitoring (**Project SRC2**) based on a network of 175 nodes at 50-m intervals along the 10-m contours, sampling at 15-second intervals a broad range of parameters encompassing rainfall, both PAR and total radiation, air RH & T, leaf wetness, and associated impacts on soil (soil moisture, soil water potential). One third of all nodes are located in regrowth of RE 12.8.5 (65 of 175) along the full altitudinal gradient. Daily differences in environmental parameters are compared with analogous sites in cleared areas as a measure of progress to re-establishing refugial conditions.
		9. Abiotic condition — soil health		
		Soil health estimates in regrowth areas is based on recovery of normal values for soil water potential. It is likely that pre-clearing soil nutrient levels will never be recovered given the combined impacts of repeated and extensive clearing, erosion and compaction from cattle grazing. The history of fertilizer use is unknown	Erosion along old cattle tracks is stabilised by native vegetation cover. Soil water potential in regrowth areas continually improves.	Soil Water Potential sensors (MPS-1), as part of the wireless sensor network (Project SRC2) measure water availability for plant growth, water flow, and soil stability. Twenty-six are distributed in cleared (18), canopied (2) and edge (6) environments across part of the altitudinal environment. Soil Health aspects are part of **Project SRC3** as

				in previous sections.
		10. Successional processes		
		Successional processes in regrowth areas appear to functional normally for their age of development except in limited areas where dense lantana blocks succession	Successional processes normal with no signs of dysfunction Where lantana removed, improvements in native species recruitment occur rapidly	Our resilience-based conceptual model incorporating drivers and response variables associated with ecosystem dynamics assists determination if and when interventions are required to avert negative phase shifts or accelerate regeneration
	B. Advanced regrowth of montane heath on outcropping rhyolite — Regional Ecosystem 12.8.19 The vegetation (except for riparian corridors) was cleared by 1930. Regrowth is visible around the margins of the outcrop by 1961. Capacity for expansion is limited by the size and extent of the outcropping rhyolite.	**1. Recruitment**		
		Recruitment is limited to the small in-situ species pool because of the small size and relative isolation of these areas	The local species pool is reproductively mature, producing most of the new recruits in the area	Density of new regeneration is determined by plot-based survey of plant species, with the presence of young seedlings produced *in situ* indicative of a self-organising community
		2. Plant community composition and structure		
		Community richness and composition is limited by the size, age and isolation of this forest type	Surveys provide an improved record of species richness, composition and structure	Results of plant surveys analysed for changes in species richness, composition and phylogenetic structure
		3. Animal community composition and structure		
		Animal richness, and composition have not been systematically assessed.	No significant change in the situation expected over the 3-year period	Incidental records associated with routine management activities is the main source of data analysed

		Incidental records indicate frequent present of a grey goshawk (white morph) (NT) Soil disturbance is indicative of the present of either bandicoots or potoroos	A more accurate faunal richness, composition and phylogenetic structure obtained	Camera trapping, equipped with motion detection sensors, of sites with soil disturbance to identify animals responsible Temporary acoustic monitoring with a Song Meter (Project SS1) to augment fauna records
		4. Habitat for threatened and/or significant species		
		Viable habitat for habitat specialists associated with this ecosystem alone is unlikely, unless for basal lineages of invertebrates with limited dispersal ability (e.g. dung beetles) The montane heath is likely to contribute additional habitat diversity to species that utilise riparian corridors that pass through this patch	Habitat quality is likely to be improved but without adequate baselines conclusions will only deal with trends	Surveys of flora and fauna provide the base data for analysis
		5. Non-indigenous species		
		Non-indigenous plant species occurring in this vegetation type include kahili ginger, lantana, mistflower and some crofton weed.	Kahili ginger and lantana eliminated. Mistflower appears to be successfully controlled progressively by the bio-control agent white smut fungus (*Entoloma ageratinae*), accidently introduced from New Zealand by bushwalkers	Quantitative assessment of plant/plant part removals (by weight and/or number/subcell or other fixed unit area) provides confirmation of trends on repeated removals **(Project SD7)** Semi-qualitative assessment of effectiveness of repeated removal effort via inspection and photopoint monitoring of infested sites **(Project**

				SP4)
		6. Functional diversity		
		Plant functional diversity is likely to be moderate	Functional diversity baselines for ongoing monitoring determined	Biodiversity surveys as indicated above provide the primary data for functional groups analysis, functional groups being defined above (**Project SP4**).
		7. Canopy cover		
		Canopy cover has increased to ~ 70% of the potential habitat area since last clearing	Canopy closure further increased	Aerial photography (NearMap) and GIS-based quantitative, grid-based assessment of canopy cover to determine extent (See attached file pallida_14Jun2012.jpg)
		8. Abiotic condition — microclimate		
		Microclimate is moderated compared with adjoining cleared areas	Microclimate, as measured by the WSN sensors continues to improve with increasing canopy closure	WSN Nodes 18, 19, 20, 30, 31, 32 occur within this forest type and provide data on microclimate parameters as described above (Project SRC2) WSN Nodes 19, 20 and 32 contain sensors measuring wind speed and direction (MetOne) to evaluate the extent of edge effects.
		9. Abiotic condition — soil health		
		Soil health status based on soil moisture levels recorded but not yet analysed	Soil health status assessed in comparison with 2012-13 levels, together with data on litter	Soil Water Potential sensors (MPS-1), as part of the wireless sensor network (Project SRC2) measure

			development	water availability for plant growth, water flow, and soil stability. Twenty-six are distributed in cleared (18), canopied (2) and edge (6) environments across part of the altitudinal environment. Soil Health aspects are part of Project SRC3 as in previous sections.
		10. Successional processes		
		Unaided successional processes appear to be normal except in those areas with heavy infestations of lantana occur	Successional processes accelerated by removal of competition from lantana and other weed invasions	Rectified images from Aerial Photographs in 1930, 1961, 1975, 1989, 1993, 1998, 2005 (and thereafter using NearMap) (Project SSP4) provide coarse-level information on trends. The absence of non-indigenous species capable of outcompeting native species provides another indicator of ecosystem health. However, few areas if any escaped clearing (repeated in many cases) thus analogous undisturbed reference sites in close proximity are not available. Permission to access private land for surveys will be sought to provide data relating to mid-successional ecosystems.
	C. Cleared land with dense	**1. Recruitment**		
		Recruitment density of native	Recruitment substantially increased	Recruitment densities at lower

	cover of introduced pasture grass (kikuyu, setaria, cocksfoot), and, in west-facing upper elevations, whiskey grass and large-leaved paspalum Grazing ceased in 2005, which prior to that, significantly impeded natural regeneration.	species is especially poor in frost-prone areas with a dense cover of introduced mat-forming stoloniferous and rhizomatous pasture grasses. These areas occur in Grid cells A", B", C" (part), D", E", G"(part), J"(part) (See in Attached File"BiodiversityPlanGrids&Photopoints.pdf" Forest edges (western edge in Grids G", J" and those further south) are expanding effectively with recruitment levels ≥ 5000 plants/ha	by better management of the balance between competition and facilitation amongst weed and native species (the former can act as nurse plants for palaeoendemic species at the vulnerable seedling stage) Direct seeding in areas greater than 50 from forest edges providing more regeneration nodes	altitudes (790 m – 825 m) monitored quantitatively in Growth Plots G361, G367 and A689 (**Project SP1**), and by marking of new plants in remaining 16.66 m x 16.66 m sub-cells within this altitudinal zone (as previously described) Priority assessments are given to areas identified as critical bottlenecks within the defined primary corridor (cleared areas in Grids C", W" and X") associated with Rolfe Creek; riparian corridors in Grids D", G" and J") At higher altitudes, where regeneration >> 5000 plants/ha it is impractical to mark all grid cells. Plant species within 5 metres of the 300-m Top Track transect along the 900-m contour are identified to allow analysis of developing richness, composition and structure. In addition, one 16.66 m x 16.66 m sub-cell will be established late in 2012 near WSN Node 176 and the north-facing ARCS meteorological station (PALTOPN) on the 910-m contour.
		2. Plant community composition and structure		

		Richness, composition and abundance of native plant species varies considerably away from forest edges	Increasing diversity (richness, composition and relative abundances) of native species in all areas being monitored	Data from stratified plots and transects (above) are analysed for changes in species richness, composition, relative abundance, and phylogenetic structure
		3. Animal community composition and structure		
		Richness, composition and abundance of fauna has not been measured systematically, but incidental records show sharp transitions away from forest edges to disturbance-tolerating bird species (currawongs, magpies, ravens, crows, butcherbirds, kookaburras Reptiles recorded to date include 3 venomous Elapid snake species: red-bellied black snake, eastern tiger snake and rough-scaled snake Mammals include pademelons and feral foxes and wild dogs	Changes are not likely to be significant over the next 3 year period	Incidental records associated with routine management activities the main source of information
		4. Habitat for threatened and/or significant species		
		Viable habitat extensions for threatened and significant species are unlikely at these early stages of regeneration post-2005.	Changes unlikely in 3 years.	
		5. Non-indigenous species		
		At lowest altitudes some lantana, cobbler's pegs, mistflower, rubus and wild tobacco present around forest edges potentially impeding	Lantana, cobbler's pegs, wild tobacco removed. Mistflower removed where	Where feasible quantitative assessment of plant/plant part removals (by weight and/or number/subcell or other fixed unit

		natural regeneration Aristea removed from the property but infestations on the adjoining road reserve not completely controlled Other species in Grids A", B", C", D" and E" include limited but spreading occurrences of Agapanthus, American Elder, Camphor Laurel, common fireweed, crofton weed, Formosan lily, groundsel, inkweed, passionfruit, spear thistle, thickhead, tibouchina, tradescantia, white arum lily, Yorkshire Fog. At all altitudes, setaria and kikuyu occur where soil moisture and nutrients are not limiting. Yorkshire fog occurs in wetter areas with impeded drainage, and broad-leaved paspalum is a problem at mid- and higher altitudes. Whiskey grass is not considered a threat at this stage and in fact acts as a vital nurse plant in many areas;	inhibiting regeneration and not naturally killed by introduced biocontrol agent (white smut fungus) Presence of aristea monitored and all new emergence from rhizomes or soils seed stores on the road reserve removed Agapanthus, American elder, camphor laurel, crofton weed, Formosan lily, groundsel, tibouchina, white arum lily removed Other weed species under active control towards elimination where possible. Exotic grasses unlikely to be eliminated until full canopy cover established beyond the current 3-year project Whiskey grass is naturally controlled by shading from developing canopies of pioneer native species A priority focus of controlling biotic barriers includes key corridor bottleneck areas in Grids D" and X".	area) provides confirmation of trends on repeated removals **(Project SD7)** Semi-qualitative assessment of effectiveness of repeated removal effort via visual inspection and photopoint monitoring of infested sites **(Project SP4)** Otherwise, repeated visual inspection of areas allows classification of sub-cells within the Grid-based monitoring system as free of weeds
		6. Functional diversity		
		Functional diversity is dominated by exotic C3 and C4 grasses (monocotyledonous herbs)	Functional diversity expected to improve by control of smothering	Functional group diversity is derived from analysis of data from

			exotic grasses	biodiversity monitoring projects as outlined above
		7. Canopy cover		
		Canopy development is least in Grid cells A", B", C"(part), D", E", G", J" and X" at lower altitudes At higher altitudes north-facing aspects of Grids L" and O" have minimal canopy development	Canopy extending out from existing forest edges and regeneration nodes	Aerial photography (NearMap) and GIS-based quantitative, grid-based assessment of canopy cover to determine extent (See attached file pallida_14Jun2012.jpg) Photopoint monitoring at locations in Grids E" and G". Additional photopoints to be established in Grid X" associated with Rolfe Creek
		8. Abiotic condition — microclimate		
		Microclimates typical of open pastures	No major changes until native species canopy closure achieved; significant improvements expected closer to 5 years from 2012	57 of the 175-node WSN network nodes occur in cleared areas within this project site in the Boy-ull Creek catchment. They are distributes at all altitudes from 790 m to 910 m and are equipped with sensors directly related to measurement of microclimate parameters. An additional 3 non-networked meteorological stations established by ARCS (PALEAST, PALTOPN and PALTOPW) measure PAR, rainfall, air relative humidity and temperature, leaf wetness and soil moisture levels at 15 min intervals

				since the beginning of 2010.
		9. Abiotic condition — soil health		
		Soil health improved following grazing and frequent use of heavy machinery ceased in late 2005	Continuing improvement in soil health indicators	Soil Health aspects are part of Project SRC3 as in previous sections. Soil Water Potential sensors (MPS-1), as part of the wireless sensor network (Project SRC2) measure water availability for plant growth, water flow, and soil stability. Twenty-six such sensors in the network are distributed in cleared (18), canopied (2) and edge (6) environments across the altitudinal gradient (790–900 m). All nodes also have soil moisture sensors as do the three ARCS nodes referred to above. Microtopographic variation in soil moisture levels across Grid A" measured using an MPKit portable soils moisture probe (ICT International) Transect-based measure of soil compaction is done using a drop-cone penetrometer Earthworm activity (a key bioindicator including of soil organic matter) is semi-quantitative (counts per unit area dug) at limited sites

				but non-lethal, non-invasive soil imaging methods are being investigated Leaf litter levels measured by steel prong capture method Macrofungi surveys in stratified quadrats (**Project SBD2**) indicative of soil health and successional development
		10. Successional processes		
		Succession likely to revert to Alternative Stable States (ASS) dominated by exotic pasture grasses without their active control	Successional dynamics will still be vulnerable to ASS transitions without continuing control of mass-seeding, microclimate controlling, mat-forming exotic pasture grasses	A resilience-based conceptual model incorporating drivers and response variables associated with ecosystem dynamics assists determination if and when interventions are required to avert negative phase shifts or accelerate regeneration Macrofungi provide key bioindicators successional development

Appendix 2

Activity Report

Scheduled Activity planned	Scheduled activity undertaken	(i) Progress achieved (ii) If scheduled activity not completed, report on delays & impacts on the project and how these are managed
Activity 1: *Aristea ecklonii* controlled on Warblers, Ashmiha, Pallida and Ankuna sites by: (i) herbicide treatment (ii) digging out whole plants; (iii) culling flower or seed heads; or (iv) mowing &/or hand shearing	☒Yes ☐No	During 2013 the following treatments were completed: **Warblers** ***Herbicide***: 25 cells (Each cell has an area of 0.029 ha.)); 59 person hrs ***Digging:*** 36 cells; 4.15 tonnes removed; 1269 person hrs ***Culling:*** 35 cells; 240 person hrs ***Mowing:*** (setting back growth to buy time): 15 cells ; 8 person hrs (repeated mowing events) During 2013, aristea was treated over more than 95% of the property by digging, herbicide application or culling, or a combination of treatments. During 2013, an additional method of culling of aristea was applied. A brushcutter fitted with a blade (rather than a line) is used to cut off the whole plant at ground level. It was found that this does not damage the fruits and the cut off plants can be picked up and piled on mats. The method has the added advantage of buying more time before next fruiting. **Ashmiha** ***Culling:*** flower or seed heads were removed in the north-east corner of the property where the major infestation occurs. **Pallida** No work required **Ankuna** No work has been carried out on this small property (1.6 ha) during 2013. Results of previous trials including digging and herbicide treatment at a range of concentrations indicated that digging out whole plants, despite being labour-intensive, was the most effective way to eradicate *Aristea ecklonii*, particularly close to water courses and habitat of endangered frogs. Thus, in an attempt to ensure plants did not go to seed, a number of treatments were instituted to control flowering and fruiting while the slow process of digging out of whole plants continued. The success of this strategy was affected by climate conditions which in turn affected the ability to work under suitable conditions. Exceptional weather conditions during 2011–2012 resulted in prolific flowering and fruiting of Aristea throughout the year. To deal with this, a grant was successfully sought from the

Scheduled Activity planned	Scheduled activity undertaken	(i) Progress achieved (ii) If scheduled activity not completed, report on delays & impacts on the project and how these are managed
		Australian government's Biodiversity Fund to increase the number of volunteers. Clearly, we have now had to supplement treatment with a new approach, after many trials, using a new method of application with changed dosages of herbicide that prevent collateral impacts on both regenerating plants and threatened fauna. The timing of *Aristea* control is also complicated by the need to retain these plants as protection of new native seedlings from frost. This is discussed in the Restoration Plan, and highlights the critical role of "facilitation" or nurse plants in successful restoration. Note: Herbicide treatment was re-instigated in 2012 given the disruption to normal control measures by poor weather that resulted in cancellation of several volunteer activities. We trialed the use of rope wicks (Silvan) with monitoring and follow-up over a 4-month period. An experiment testing the viability of seed on treated plants (200 seeds were tested in a germination trial under controlled conditions) and all seeds were shown to be non-viable. Thus this is a promising adjunct to control methods, when previous interventions with herbicide appeared to fail. A very thin film of more concentrated herbicide is applied without any splash or spray affecting sensitive plants. Herbicide treatment has continued in 2013.
36Activity 2: Kahili Ginger controlled on Warblers, Ashmiha, Barimbah & Pallida by (i) herbicide (ii) Cull flowering/fruiting heads	☒Yes ☐No	Overall, 25 person hours were involved in Kahili Ginger control in 2013 (excluding preparation and travel time) **Warblers:** There was a significant population of Kahili Ginger within a patch of native vegetation on the Warblers property. Initially, flower heads and fruits were removed. All plants were then lopped at ground level and glyphosate (120 g/L) applied to the cut stem and injected into the root mass. **Ashmiha:** Kahili Ginger was cut back to ground level in major infestations in 2012. Follow-up is still to occur. **Barimbah:** A few isolated plants have been identified along the edge of the access road. Fruits were removed during 2013. Removal of the plants will be carried out in 2014. **Pallida:** Previously dug out along part of Boy-ull Creek – no regeneration has been observed. A few plants were found near the road frontage towards the southern boundary. They were lopped and treated with glyphosate. No regeneration has occurred.
Activity 3:	☒Yes ☐No	All **Montbretia** on Warblers (along northern and western

Scheduled Activity planned	Scheduled activity undertaken	(i) Progress achieved (ii) If scheduled activity not completed, report on delays & impacts on the project and how these are managed
Montbretia/Formosan Lily/ *Plectranthus ciliatus* controlled on Warblers, Ashmiha, Barimbah, Pallida, Ankuna.		boundaries and associated with an isolated clump of regeneration in Cell A576) was successfully treated with herbicide using rope wick applicators during 2012. A few plants have re-appeared in 2013 and have been treated again with glyphosate. Monitoring and treatment appears likely to be a continuing requirement. Whereas generally available information about this species suggests that is spread by mechanical spread of corms, the 'spotting' that is occurring at Springbrook including along roadsides strongly suggest dispersal by seeds. **Formosan Lily** was removed from the upper slopes of Mt Springbrook in 2012 associated with the demolition process commissioned by the State Government. It occurs on many of the restoration properties but it's invasive potential and ecological threat is not as great as that of *Aristea ecklonii*, Kahili Ginger or *Plectranthus ciliatus*. It can readily be eradicated in the 2013–2015 period. Removal requires careful digging to ensure complete removal of bulbs. ***Plectranthus ciliatus*** as yet does not occur on any of the restoration properties but is spreading rapidly along road verges by poor management practices of the Gold Coast City council and the Main Roads Department.
Activity 4: Wild Tobacco, Lantana & Japanese honeysuckle controlled	☒Yes ☐No	**Wild tobacco** was found on Barimbah, mainly along the access road. In October 2013, a team of volunteers spent two days (80 person hours) chainsawing or lopping plants and treating the cut stump with glyphosate (120 g/L). Virtually all plants were removed and killed with the herbicide. However, follow up will be required to treat new plants developing from seed sources. At the same time, about a dozen planted exotic conifers were removed from around the entry to the property. During Spring 2013, wild tobacco around the entry and access road on Pallida was removed by chainsawing and treatment of the cut stump with glyphosate. At the same time, co-occurring American elder and *Tibouchina urvilleana* as well as planted magnolia trees were removed by chainsawing. Cut stems were treated with glyphosate (120 g/L). All removed stems were chipped using a recently purchased Hansa C21 chipper and chips retained on site. This chipper is mounted on a registered trailer allowing it to be readily transported between properties.

Scheduled Activity planned	Scheduled activity undertaken	(i) Progress achieved (ii) If scheduled activity not completed, report on delays & impacts on the project and how these are managed
		 Tibouchina urvilleana Whereas the wild tobacco was killed, the elder and tibouchina are regenerating, apparently from underground roots, indicating that glyphosate treatment was not effective. The issue will be further investigated and follow-up treatment applied in 2014. Wild tobacco (*Solanum mauritianum*) retards natural regeneration, is highly invasive (copious seed production throughout the year, high seedling recruitment from soil seed stores, dispersed by birds, and allelopathic). Lantana and Japanese honeysuckle (very localized) are not spreading at the high altitudes; work delayed until 2014 without detriment.
Activity 5: Fireweed, crofton weed, mistflower controlled by:	☒Yes ☐No	**Fireweed** has been reduced to low numbers on Warblers as a result of intensive eradication effort in previous years (hand pulling). Only minimal ongoing effort is required (Regeneration is primarily from wind-blown seed from off-site sources). Plant numbers are progressively decreasing on Ashmiha and Pallida at each cull. Re-colonisation will only be controlled fully when complete canopy cover is reached. **Crofton weed** cannot be controlled effectively until canopy closure is achieved. Areas have been prioritized. The Rolfe Creek corridor has been identified as a key connectivity bottleneck; removals in lower reaches were continued in 2013 as planned. **Mistflower** now appears to be successfully controlled by the bio-control white smut fungus (*Entyloma ageratinae*) and no longer requires our active intervention. Mistflower (*Ageratina riparia*) has been confirmed as progressively dying out in most of the restoration areas surveyed.
Activity 6: Mat-forming grasses	☒Yes ☐No	As reported previously, a new tractor/slasher was delivered in mid-August 2012 costing $23,000. Slashing of

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controlled by: Brushing, mowing, slashing		mat-forming grasses at Pallida was carried out in Spring 2013.
Activity 7: Web site developed & launched	☒Yes ☐No	The web site was completed and launched in November 2012. The site comprises 104 pages and took 2 years to develop part time and cost ~$50,000 including in-kind contributions. A Facebook page was set up in February 2013 and now has 2951 likes.
Activity 8: Web site review & maintenance	☒Yes ☐No	Ongoing review and maintenance is occurring as planned — includes editing, additional content, search engine optimization (SEO). Regular posts are made to the Facebook page.
Activity 9: Volunteer recruitment plan	☒Yes ☐No	Volunteer Coordinator appointed 10/9/2012 initially for 3 days/week (funded from Biodiversity Fund Grant) Volunteer Recruitment Plan completed on time and implemented by the Volunteer Coordinator during 2013. Many new volunteer groups were recruited and a total of 220 volunteers assisted the project during 2013. Many of these assisted on several occasions.
Activity 10: Brochure/display/talks prep	☒Yes ☐No	The brochure detailing the Springbrook Rescue project with a focus on World Heritage which was produced in 2012 was reprinted in October 2013. It has been provided to attendees at several talks given to potential volunteer groups. It is also available at the new information centre opened in July 2013 at Springbrook.
Activity 11: Hold information nights	☒Yes ☐No	Information nights were held 30 times during the year to community groups.. Information covered includes rationale for the project, its scope, and results from restoration and scientific research projects. World Heritage and the significance of Springbrook are always covered.
Activity 12: Open or special days/plan, hold	☐Yes ☒No	Open days will of necessity be restricted because of limited parking space, unpredictable weather and operational challenges relating to reducing the risk of spreading plant and animal pathogens such as Myrtle Rust, Phythopthera and Chytrid Fungus. The idea of open days in our original Foundation document was conceived prior to the building demolition program. The most suitable site for open days was considered to be Pallida given the significance of the restoration site, and occurrence of the Wireless Sensor Network and growth monitoring plots. However following demolition of all buildings with the necessary toilet facilities, holding and siting open days becomes problematic. No current site has the combination of suitable parking facilities, shelter and toilets. We are investigating the possibility of obtaining a bus to help solve the dilemma. An alternative involves registration of interested participants and restricting numbers so that conventional vehicles can be used to ferry visitors.

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		We remain committed to holding an open day(s) when the current constraints are overcome.
Activity 13: Plant surveys/prep/analysis	☒Yes ☐No	Properties in the Mundora, Ee-Jung and Boy-Ull Creek catchments were well surveyed in 2012. Further surveys were carried out during 2013 on the upper slopes of Mt Springbrook on the Barimbah property and on the southern boundary of the Warblers property.
Activity 14: Fungi surveys/prep/analysis	☒Yes ☐No	As reported previously, ad hoc surveys are conducted throughout the year to capture cryptic and sporadically fruiting species. A number of those recorded, at first analysis, appear to be new records for Springbrook. More details are available on our website: http://www.springbrookrescue.org.au/Fungi.html http://www.springbrookrescue.org.au/TheScienceProjectsFungi.html
Activity 15: Invertebrate surveys/analysis	☒Yes ☐No	Target species, including dung beetles, stick insects and weevils, have been monitored as scheduled. Results in reference sites reflect healthy populations of Gondwanic species.
Activity 16: Frog & reptile survey/analysis	☒Yes ☐No	As previously reported, on-ground surveys by researchers at Griffith University confirmed the results of our automated Song Meter monitoring which revealed the presence of *Mixophyes fleayi* in the Mundora Creek Catchment representing the first record in 40 years at these high altitudes. We have completed a detailed spectrogram analysis using Song Scope software from Wildlife Acoustics. These results are significant given Fleay's Barred Frog has disappeared completely from neighbouring Mt Tamborine and Bunya Mountains further west. http://blogs.abc.net.au/queensland/2012/02/endangered-frog-found-at-springbrook.html?site=goldcoast&program=gold_coast_weekends During 2013, ARCS hosted a group of Japanese frog researchers associated with Dr Jean-Marc Hero (Griffith University) who trialled specialised recording equipment on the Warblers property.
Activity 17: Bird surveys (AM/PM) at 5	☒Yes ☐No	Formal seasonal bird surveys were carried out for the third year running, in April, July, and October each

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sites seasonally		involving (on average) 48 person hours excluding travel time. The survey scheduled for January was abandoned because of torrential rain on the Australia Day weekend. Details of methods including a map of transect sites are reported on the website: http://www.springbrookrescue.org.au/Birds.html Results are consistent with altitudinal gradients, successional status, forest type and age and provide baseline chronosequence data for comparison with actively managed restoration sites. A new transect has been added on the Barimbah property, replacing that on The Lodge property. Tree falls following severe weather events in January 2013 made The Lodge track difficult and unsafe to negotiate.
Activity 18: Download/analyse WSN data	☒Yes ☐No	Data downloads from the CSIRO data storage has progressed in 2013 to the point where data download from half the sensors is current to June 2013, included key ones for analyzing data from ground temperature sensors directed at identifying the extent, duration and intensity of frost as a threatening process. Other downloads assisted in monitoring evaporative demand and soils water availability – key drivers of plant productivity and other ecosystem processes.
Activity 19: Download/analyse TREON data	☒Yes ☐No	Data loggers continue to be downloaded on a monthly basis; data is entered into databases; maintenance is carried out as required. Replacements were not required in 2013 except for one node
Activity 20: Measure soil condition trends	☒Yes ☐No	During 2013, soil condition monitoring was associated with the WSN network and the TREON.
Activity 21: Measurement of plant growth, recruitment, mortality, health, herbivory seasonally	☒Yes ☐No	During 2013, measurements on 12 growth plots involved 258 person hours with a further 62.5 person hours for data entry. Wet weather prevented measurements in March and June. Pallida plots (3) were not measured owing to time constraints and weather. Mortality rates were overall similar to those previously recorded. Recruitment has been significant with an 18% increase in number of plants during Spring. Canopy closure is occurring in many parts of the plots resulting in suppression of grass. Leptospermum are reaching reproductive maturity so there is likely to be an exponential increase in recruitment in future years.
Activity 22: Measure resource-use efficiency	☐Yes ☒No	The equipment is jointly owned by ICT International and ARCS. During 2013, ICT provided *pro bono* training in the use of the equipment. New purchases, involving imports

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		from the USA, have involved adaptors to control light intensity to enable accurate determination of light compensation points for Aristea and other weed species. This is essential for determining shade tolerance, thereby obtaining quantitative data on the risk of invasion for undisturbed forests. The equipment has not yet been used on the restoration properties but is scheduled for April 2014; the delay has no material impact on the project as it's completion is not time-critical; key information to be delivered relates to relative shade tolerance data for target plants.
Activity 23: Photopoint monitoring	☒Yes ☐No	Further photopoint monitoring was carried out in 2013. The following images show the effective removal of aristea from a section of the Warblers property. Removal resulted from digging up plants by teams of volunteers devoted to the Springbrook Rescue project.
Activity 24: Repeat aerial photography	☒Yes ☐No	Freely available aerial photography by NearMap was relied upon during 2012 for monitoring trends in vegetation cover development on all restoration

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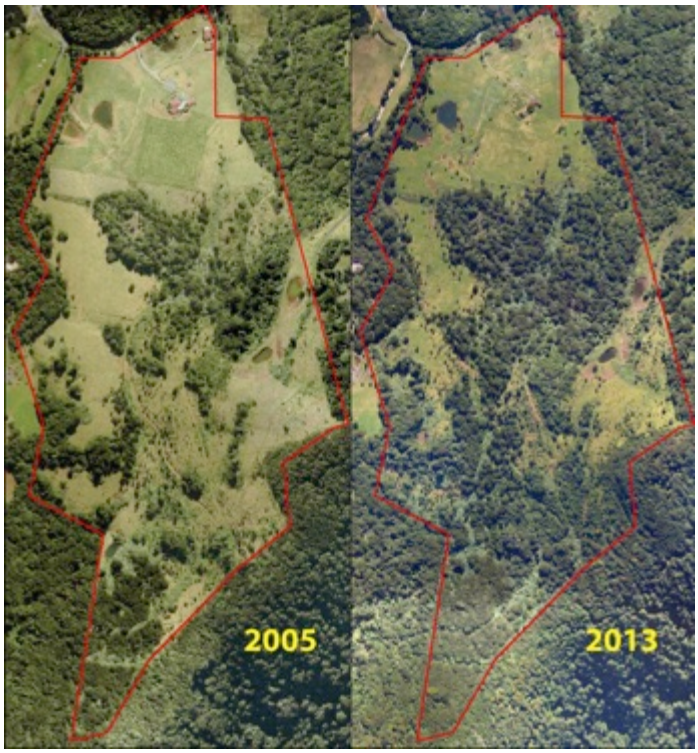
		properties. A policy change by the company late in 2012 meant that ARCS was forced to purchase an annual license costing $4,500, which would be difficult to sustain over the long-term. During 2013, ARCS successfully negotiated a 3-year agreement with NearMap to provide use of imagery at a cost of $2400 per year. Imagery from 2013 was used to assess the regeneration in the critical corridor on the Pallida property. A comparison with 2005 imagery is shown below. 
Activity 25: Install audio recorders (Song Meters), on Ashmiha in montane heath, and on Barimbah in old growth reference site A'	☒Yes ☐No	Three additional Song Meters were installed, at a cost of over AU$1,000 each with battery replacements costing $96/year/unit bringing the total number of units installed to 12. Given the exceptional value of this technology for monitoring critical habitat recovery for wildlife a further 3 have been purchased for installation in 2014.
Activity 26: Download data monthly from audio-recorders at WAR, ASH, BAR, ROC, LOD, LOG, QUO, ANK (2)	☒Yes ☐No	(i) All data downloads have been carried out according to the monthly schedule. (ii) SoundID software and the hardware for its operation have been purchased to enable accurate, fast processing of terrabytes of data.
Activity 27: Download images monthly from Reconyx Hyperfire HC609 Trail Surveillance camera	☒Yes ☐No	As reported previously, a trail camera was set up to monitor ground fauna along Rolfe Creek – a key connectivity bottleneck: Foxes, pademelons, mountain brushtails, brush turkeys are the main species detected to date. The technology has now been tested for a sufficient time to prove its worth and a further camera

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		has been purchased. The camera at Rolfe Creek has served its purpose and the two cameras now in hand will be installed in new locations in 2014. It is intended to install the cameras in habitats likely to detect presence of the Spotted-tailed Quoll, Rufous Scrub-bird and Long-nosed Potoroo.
Activity 28: Conduct periodic review and improve/modify overall program	☒Yes ☐No	Evaluation, review and improvement of program activities: This has been carried out with improvements noted in the individual activity statements.
Activity 29: Report preparation and submission	☒Yes ☐No	All reporting has been carried out and the annual report submitted within the specified timeframe.
Activity 30: Administration including steering and scientific committee meetings, book keeping/accounting, property and staff management	☒Yes ☐No	Administration The Queensland government has not continued the process of Steering and Scientific Committee arrangements as proscribed in the Restoration Agreement. Book keeping/accounting is up to date. The audit report has been forwarded. Property and staff management has been reviewed. The person appointed to the position of Volunteer Recruitment Officer resigned at the end of November 2013. As she was very successful in recruiting volunteers, both individuals and groups, we have not replaced her at this stage. We are considering whether funds (from the Biodiversity Fund grant) would be better spent in another way.
Activity 31 Maintenance of equipment, volunteer accommodation buildings, monitoring systems and access tracks	☒Yes ☐No	All restoration equipment (mowers, tractor, slasher, brushcutters, chainsaws, pole saw, loppers, shears, secateurs etc.) are maintained in working order. Volunteer accommodation buildings have been maintained in acceptable condition. Volunteers provide considerable assistance. We have contacted one of the local Men's Shed centres for assistance with property management over and above normal maintenance activities such as repairs to or replacement of windows, leaking decks, painting etc. After an initially positive response, no further progress has been made. Volunteers with expertise in tiling are scheduled to assist with repairs at the Lodge in 2014. Some monitoring equipment has needed to be replaced due to damage from the severe conditions at super-wet, high altitudes.

Appendix 3

THREAT MANAGEMENT PLAN

Threat[1] *Description of each threat and its sources and impacts*	**Controls/contingency** *Actions to reduce or manage the threat*
1. **frost** causing differential mortality of frost-sensitive plants in exposed areas (especially in corridor bottleneck areas) [DISTURBANCE Driver]	Utilise natural ecosystem processes of 'facilitation' by maintaining protective ("nurse") plant cover (including weeds and grass) around seedlings until frost period has passed; time grass and weed control carefully to maximise facilitation processes when needed and minimise competition processes that threaten native plant viability At a limited scale, such as regeneration nodes, if no nurse plants are available, either (a) maximise water availability to the plants through mulching, or (b) try reducing water loss via transpiration using foliar anti-transpirants
2. **fire** caused by accident, arson, or natural causes [DISTURBANCE Driver]	Implement a Fire Plan that (a) monitors fire risk; (b) identifies high risk ignition points; (b) utilises natural fire-breaks (riparian areas, remnant or advanced regrowth of rainforest and wet sclerophyll forest); (c) reduces risk of trespass through signage; (d) reduces risk of ignition from carelessness though education of volunteers; (e) maintains high-risk grass cover (kikuyu, setaria) at low heights optimal for both facilitating regeneration and reducing fire risk
3. natural regeneration (**recruitment) failure** due to abiotic and biotic barriers (a) [SPECIES POOL Driver] (b) [BIODIVERSITY Driver – species interactions: "herbivory"] (c) [RESOURCES & CLIMATE Driver]	Assess likely cause(s) and mitigation measures: (a) **species pool** deficiency or dispersal failures — supplement by direct seeding, transplanting or biodiverse plantings; (b) Establishment failure due to unnaturally high population levels of mammalian herbivores (pademelons) (**species interactions)** — try establishing exclusion fences in critical areas (corridor bottlenecks and potential critical habitat) (c) weed control of the most ecologically damaging, near-intractable weeds failing with current resources (**project resources)** — seek additional resources and support to combat the most serious threats (e.g. *Aristea ecklonii*) (c) environmental barriers (soil damage; adverse microclimates)(**resources & climate)** — address by monitoring and improving soil health (retain grass cover of species with high soil remediation potential, e.g. kikuyu, for periods required by monitoring data; improve microclimate for vulnerable seedling life stage through careful timing of facilitation by nurse plants (these may even be weed species)
4. Increased mortality from **pests and disease**	(1) Monitor leaf and stem herbivore populations and control by the most effective, efficient and safe means available if necessary (2) Monitor disease incidence (e.g. Myrtle Rust in susceptible plants; chytrid fungus in frogs; other known or emerging fungal/viral pathologies — monitor/ report/ institute appropriate hygiene protocols to mitigate spread and impacts
5. failure to recruit volunteer **resources**	Assess effectiveness of recruitment strategies, review and improve the Volunteer Recruitment Plan
6. failure to generate sufficient **resources** to support the project	(a) Find additional sources (grants, donations, bequest); (b) rationalise program activities to the most time-critical

[1] Threats are categorized in terms of 'drivers' identified in our ecological conceptual model