VEGETATION RESTORATION, A STRATEGY FOR MT ETNA CAVES NATIONAL PARK

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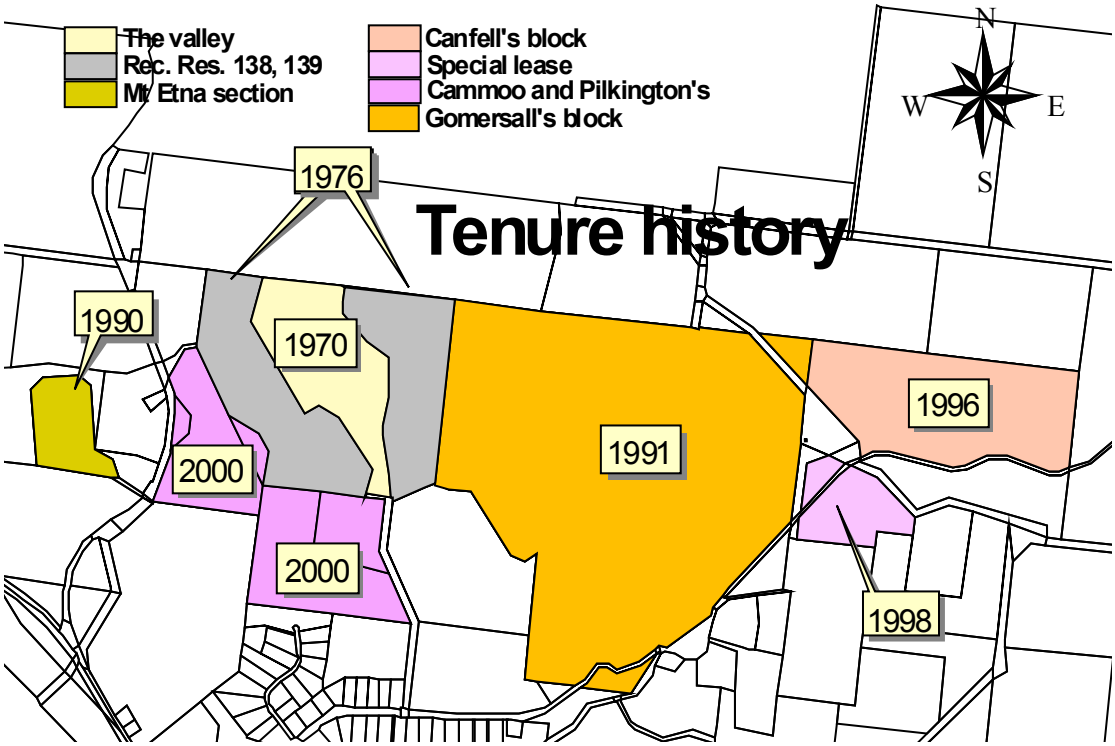
INTRODUCTION

Mt Etna Caves National Park covers 550ha and is 28km north of Rockhampton near the township of The Caves in Livingstone Shire. Mt Etna and Limestone Ridge were declared recreation reserves under the trusteeship of the Department of Lands in 1920 and rescinded on Mount Etna in 1977. The Fitzroy Caves National Park was gazetted over a 116ha section of Limestone Ridge in 1976. In 1988, Mining lease 326 on Mount Etna was surrendered and declared a D & O Reserve for scientific purposes under the trusteeship of the Mines Department and QNPWS. These two areas were declared the Mt Etna Caves National Park in 1990. Two more sections were added to the east, while the recent additions of Pilkington's and Cammoo Caves build the park to its current size (Map 1).

Map 1 Mt Etna Caves National Park - Tenure history by sections



The dry rainforest vegetation, which dominates the park, represents a vegetation type that was once widespread throughout Central Queensland but is now found only in isolated pockets. Limestone karst landform covers a significant part of the park. Karst landform is formed from rock with a high degree of solubility that has been sculpted by natural waters.

VEGETATION

Park vegetation ranges from open forest to dry rainforest. The limestone bedrock, harsh terrain and drier climate create an unusual habitat that is reflected by the composition of vegetation species. The locations of the various vegetation communities found on the park appear in the parks vegetation map.

Significant vegetation features

- semi-evergreen vine thicket or 'dry rainforest'. Few areas of dry rainforest are conserved in central Queensland as this habitat has been subjected to development pressures in the past;
- rare and threatened plant species and plant species which are at their northern or southern limits of distribution. This suggests the park includes an area of biogeographic significance. The rare plants *Graptophyllum excelsum* and *Heterostemma acumin-atum* are found on the park, with G *excelsum* locally common in some areas; *Atalaya rigida*, *Cycas megacarpa*, and more recent specimens believed to be *Pimelea leptospermoides* and *Eucalyptus xanthope*. The Endangered fern *Tectaria devexa* is found nearby and may even occur on the park.

Some past uses that are of historical interest include:

- guano mining in the caves, with some evidence remaining;
- limestone mining, which still occurs on adjacent lands;
- several old home sites, being both permanent residences and seasonal huts
- small crop farming at Pilkington's, Cammoo and Gomersall's

HABITAT THREATS

Weeds

Currently, weed invasion is the most widespread and ongoing threat to the vegetation within the park. Weeds can threaten the diversity and structure of all existing plant communities on the national park. The weed vines have a great potential for this impact type of damage to the park's vegetation while Lantana, already widespread through the park, is now arguably the single most dominant species in the park.

Lantana camara (lantana) and *Rivina humilis* (coral berry) are the most abundant and widespread weed species, while *Cryptostegia grandiflora* (rubbervine), *Parthenium argentum*, *Anredera cordifolia* (Madeira vine) and *Macfadyena unguis-cati* (cat's-claw creeper) are significant weeds requiring attention on a seasonal basis.

The larger grass species like Guinea grass, Green panic and Collar grass are also significant site-specific pests especially as these species create a high fire hazard when they cure off. Where these species occur at the edge of closed forest communities they increase the vulnerability of the communities to fire. Thus protection of the vineforests is often a function of weed and fire management.

Fire is a major threat

Two of the principle objectives of the current fire management strategy (1997) for the Mt Etna Caves National Park (pre Cammoo acquisition) are to maintain the current extent of the closed forest communities and to allow for regeneration/development and expansion of these communities. Fire protection is achieved near or on the park boundary by firebreaks, public roads or by virtue of the 'fire resistant' closed forest at the boundary.

Fire protection for regenerating closed forest vegetation in disturbed areas is particularly important as these species are mostly highly fire sensitive. In any regeneration/restoration area the reduction of the weed population must be a key management consideration in order to minimise or reduce fire risk. Prior to making a decision to embark on a regeneration or restoration program it is critical to identify the strategies and resources necessary to manage fire and weeds. These strategies must be implemented so that the resources put into the regeneration program are not expended in vain.

Fire management through revegetation

An ideal manner for minimising the fire hazard in the long term, and to thereby relieve management commitment, is to suppress the more combustible taller grasses to the point that their density is so low that when dry they can no longer sustain a hot and damaging fire. Grazing of fast growing grass species by livestock can reduce the volatile biomass but this maybe undesirable due to the impacts upon other palatable native vegetation.

Another good way to achieve this is to produce canopy cover as quickly as possible so that these grasses are out competed and shaded out. Most shrub and tree species are capable of providing shade when they have established but only a few species can grow fast enough and have the ideal mix of characteristics to be considered as desirable reveg colonising plants. *Euroschinus falcata* (ribbonwood), *Pipturus argenteus* (native mulberry), *Cassia brewsteri* ssp *tomentella*, *Mallotus sp*, *Terminalia porphyrocarpa* (bandicoot plum), *Clerodendrum spp* and *Acacia aulacocarpa* (hickory wattle) are some of the main colonising species suitable for frequent use in the park.

In the Mt Etna area *A. aulacocarpa* is by far the favoured coloniser. It grows fast; the seed is often readily available and stores well; it is a nitrogen fixer and so must assist soil development over time; it is relatively short lived; and the leaf litter suppresses germination.

REVEGETATION SPECIES SELECTION

Localised species bias

There are often localised variations in the composition of the closed forest communities. Because of these local variations in species composition it is sometimes appropriate to consider a bias towards certain species when developing a planting strategy on any particular site within the park. Reasons for such localised variation (or perhaps better said localised species associations) could include degree of exposure to elements and a species capacity to tolerate 'drought' stress, micro climatic variations, soil conditions and proximity to (seed source) parent trees.

The prevalence of *Gyrocarpus americanus* (cotton-wood) at the southern end of the Johannsen's quarry, the abundance of *Ficus opposita* (sandpaper fig), *Melia azederach* (white cedar) and *Nicotiana velutina* (wild tobacco) on the western edge of the quarry bench rubble and the dominance of *Mallotus phillipensis* (red kamala) on the northern end of Johannsen's quarry bench are good examples.

At the vegetation community level the distinction between the drier vine thickets and the more sheltered notophyll rainforest species is marked. Across these communities there is however a lot of blending or overlap of species. Some places in the park would rate as intergrades between these two major rainforest vegetation types. Clearly, however, it is significant that the most exposed sites include higher proportions of some species, usually semi-evergreen vine-thicket

(SEVT), whilst other sites in more sheltered gullies include a greater abundance of taller notophyll dry rainforest species. *Cassia brewsteri ssp tomentella* and *Baloghia inophylla* are good examples of these two diverse habitat types.

Thus it should be noted that the natural species composition near any revegetation site will be a function of the natural elements so it follows that replanting activities should include a dominance of species which are proven to survive readily in that general location.

Lumping of revegetation species in functional groups.

Thus revegetation species are labelled in the following planting groups: (see Appendix 1).

- Planting group 1 Colonising species. Generally fast growing species with the potential to rapidly create closed canopy cover and thus suppress weeds especially grasses and lantana. Other species may also be favoured on basis of seed availability and viability and inherent abundance in the "original" community nearby.
- Planting group 2 Bird and bat attracting species. For long term species diversity where new seed is introduced by natural dispersal means - bird and bat attracted by fruits, eat and spit…)
- Planting group 3 Mixed species. Dry rainforest species for diversity in short term (by planting), generally trees and shrubs.

With the functional process of colonisation under control through initial planting actions, it is now important to consider the potential for future development of a more complex community in this dry rainforest setting. Long term (50 yrs+) development of the recovering dry rainforest will surely be a slow and steady process. Recruitment of species through 'natural' seed dispersion methods will certainly occur over time although it will be desirable in the short term to see or have confidence in a 'faster' rate of recruitment of rainforest species beyond the initial colonising planting activity. Unfortunately in the short term the park management staff believe that it is unlikely that further planting of more seedlings (for both density and diversity) could be feasible in the revegetation sites with current resource levels.

A simple approach to speed short term recruitment of rainforest seed for enhanced diversity and density lies in the use of animals especially birds and bats and their respective behaviours in regards to seed dispersal. By eating fruits of many rainforest species animals can carry undigested seed to another area before excreting or regurgitating such seed possibly in ideal germinating conditions. By deliberately planting fleshy fruited species and other species with palatable fruits which are eaten and carried by animals we can hasten some of the natural processes that disperse rainforest seeds. These fleshy-fruited species will be used in a second planting group as it is important to have mechanisms in place for the long term for enhanced natural recruitment of rainforest species.

A third planting group includes other dry rainforest shrub and tree species for which seed or other regenerative material can be readily obtained. These species will generally be planted in lower densities distributed about the revegetation sites.

Source of revegetative material for enhancing habitat restoration

Seed germination and occasional suckering are the main means by which regeneration or colonisation occurs in any given area. This seed may be stored in the soil or litter or it may be transported to the site. Some seeds are wind blown, others are carried by animal fur, dropped by birds and bats, passed through the digestive system of birds, bats and other animals or carried in water. These and other actions will facilitate natural recruitment of plant species into all the disturbed sites on the park. It is however, necessary or desirable to hasten the regenerative process at times by enhancing and supplementing the natural process.

Enhancing the growth of naturally established seedlings

Seedlings in sites that have established naturally can be assisted substantially by removing competitive weed species and adding a slow release fertiliser. This technique can be applied nearly anywhere provided that the fertiliser has a suitable NPK mix for the species involved.

Direct seeding

Direct seeding is the easiest and potentially the most cost-effective method for enhancing regeneration. There are several techniques for direct seeding. The simplest is to broadcast seed on the site. The seed may be untreated, pre-germinated or even pre-treated to break germination dormancy mechanisms. A more advanced method of direct seeding is to use the clay ball procedure. (see Attachment 1 Clay seed ball preparation) Here seeds are pre-treated if necessary and bound in clay pellets/balls, either as single/mixed species for application in the field. The clay type should be such that it binds the seeds, protects them until rains arrive but does not soften unless a heavy rain event occurs (e.g. >50mm). Seed may be broadcast randomly or planted in prepared seedbeds such as ripped furrows or simply inserted above freshly filled holes. A clay ball fact sheet is provided in attachment 1.

Success rates for direct seeding vary across the country depending upon the site, weather, species etc. Direct seeding with nil - low maintenance returns a very low rate of successful seedling establishment in the Mt Etna area (N. Hoy pers comm). The extremely fast draining (and drying) nature of limestone derived soils is a significant factor likely to influence the survival of any species directly sown on the park. The relatively high level of exposure to the elements at Mt Etna (eastern workings) would add to the stresses placed upon seedlings by the soils.

Cuttings

Direct setting of cuttings may be possible in some soil types in wetter areas however the limestone-derived soils do not lend themselves to low maintenance applications here on the park. *Schefflera actinophylla* (umbrella tree) would be a prime candidate for this type of planting if the soil moisture content were higher for longer periods than it usually is at Mt Etna. Ground or stool layering of other species is also not worth considering for similar reasons. Nursery based propagation by cuttings is recommended for species which are difficult to germinate from seed or which produce few viable seeds. For example it is difficult to obtain fresh viable seed of *Grevillea helmsiae* and almost impossible to find any seed of *Graptophyllum excelsum* while *S. actinophylla* may be generated by cuttings throughout much of the year but the relatively short-lived seed is only available in the early autumn.

Several species within the vine forests at Mt Etna can be grown from root cuttings. *Owenia acidula* is very difficult to grow from seed but reputedly takes well when struck from root cuttings.

The right seed source: where provenance is important

Local genetic pools, the concept of provenance and natural dispersal are essential matters to consider when contemplating the source of seed to be used in a national park revegetation program. The basic rules for sourcing regenerative materials are: to use local seed from many parent trees. The maximum distance for dispersion is a good guide as to the outer limits for collection.

Seed collection protocols

Refer to extract from Code of practice for seed collection. (Attachment 2)

Seed storage – seed bank

An artificial seed bank is of benefit to this program. Fresh seed of many species should be available in most years. However stock of some less reliable species (perhaps *E. falcata* or *Cupaniopsis anacardioides*) will be useful to ensure that there is always a high level of species diversity in the plantings. It is possible that the CQU seedbank could be used provided QPWS supply that project with Mt Etna provenance seed stock in the first place.

An alternative method of 'storing' plants with short-lived seed is to germinate them but delay their rate of growth after germination. This in effect banks the germinated seedlings and can be useful to carry stock over until suitable conditions appear and they are needed. Simply germinate as usual then store the seeding in low light and without fertiliser. The seedlings are potted on as usual when needed and their growth will resume when the light and nutrient levels are more suitable.

Nursery stock- standards and processes

This section specifies a recommended set of 'standards' with respect to the general nature of nursery stock to be used in this revegetation program.

Ideal pot size

50mm square native tube is the main pot style to be used. They are the cheapest options, are simple to pack and transport and convenient to manage in a nursery situation. There should be a high success rate if 'after care' is available until plants have established.
100mm round native pots will be needed on occasion for provision of advanced trees in special sites.

Site preparation

All sites should be free of all 'substantial' weeds within 1 metre of each individual new plant location. The tall grasses and lantana especially should be destroyed in preparation and any regeneration of these weeds suppressed and kept totally under control until the 'new' plants grow taller than any of these weeds and start to close a canopy over them.

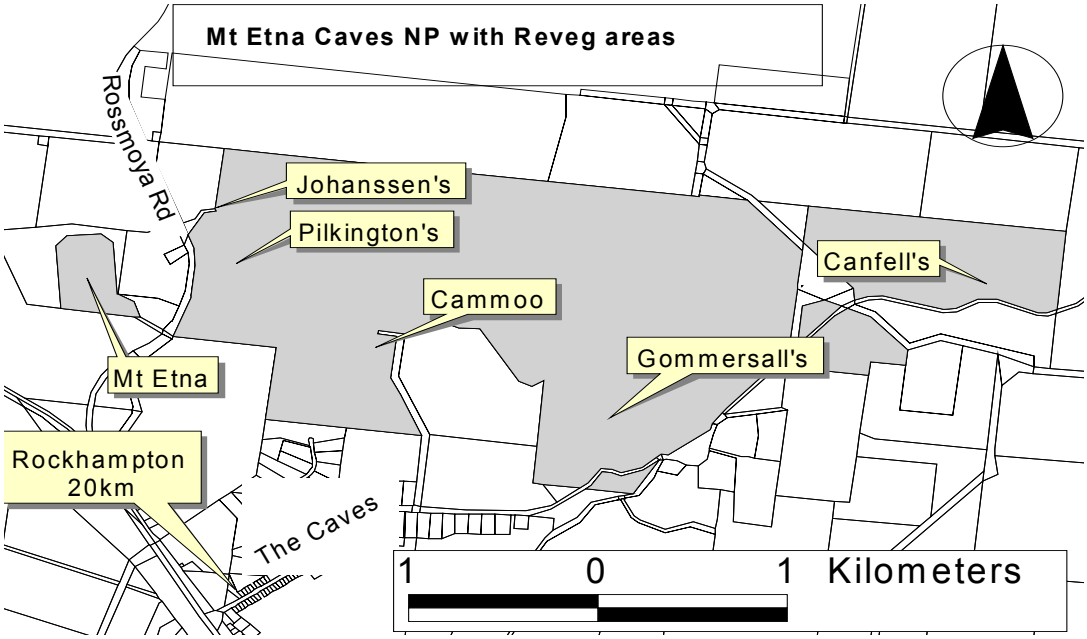
Plantings: spacing

In general a reasonable maximum spacing between plants along rows could be 2m. Rows should also be a maximum 2m apart. This gives a 2m grid. However on-site terrain, remnants, resources and other factors may require some modification to this pattern.

Planting Standards for 100mm native tubes

- **Planting Hole**; minimum dimension; 300mm deep x 50mm width, (100mm width in heavy clays not of limestone origin)
- **Surface 'moat'**: developed in conjunction with the initial planting hole digging. A soil wall or 'moat' should be erected around the new plant to catch water. Approx: 500mm dia. x 75mm depth in centre.
- **Long term fertiliser**: Agriform 21gm 20 – 4.3 – 4.1 slow release fertiliser tablet placed in bottom of hole at 300mm depth
- **Stake**: bamboo 10mm x 900mm. Place beside each plant for visual recognition and for loose tying where necessary.
- **Fertiliser short term boost**: CK88 applied as a few grains in each hole beneath potted plant but not in contact with sensitive roots.
- **Tubestock plant placement**; young plant to be set in hole with surface of plant potting mix level with surface in centre of moat/hole.
- **Mulch**: two full buckets minimum per plant to cover area around young plant to 750mm minimum diameter. Leave stem of plant clear of mulch.
- **Timing**: optimal time for planting is after 100mm of rainfall over a maximum of two days. Planting should occur from January to March annually. Resource opportunities may also allow planting after heavy storms in spring or early summer. In such cases a commitment to watering during any subsequent heat spells must be made before any significant planting event is undertaken.

- **Watering**: The revegetation program and priorities are tailored to make good economical use of the park's watering reticulation system. This includes access to the Pacific Lime's elevated storage tank on Bench 8. The proposed planting events tend to follow the water supply reticulation lines in the short term. Extension of the temporary reticulation system will also be required in the longer term. The water level in Bench 8 tank must be maintained above half to guarantee Pacific Lime reliable water at bench 7 on a daily basis.
- **Hoses**: The revegetation water reticulation system provides tapped outlets at strategic points around the revegetation sites. Each delivery connection point has a valve and matching hose coupling adaptor for the connection of standard 12mm hoses. A 30m hose with adjustable nozzle is needed at each site for watering plants.



DISTURBED SITES AWAITING REHABILITATION AND/OR VEGETATION RESTORATION.

There are numerous heavily disturbed sites (Table 1) throughout the park where the original vegetation was cleared. In other sites the habitat has been significantly altered as a result of severe fires. Although it is desirable to 'restore' the vegetation on all of these sites, the scale of effort required for these tasks is well beyond the likely level of resources available to the park's management in the short to medium term.

Table 1 Revegetation sites – Ordered by 'draft' priority

Priority	Site	Proposed timeframe for action
1a.	Bench 9 Mt Etna.	Commenced Feb 1999, Planting finalised Oct 2000, Maintenance commitment released Mar 2002
1b.	Johannsen's Cave/Quarry area	Commenced Oct 1999, Planting finalised Oct 2000, Maintenance commitment released Mar 2002
1c.	Bench 10	Planting to start Sept 2000, Planting finalised Mar 2001, Maintenance commitment eased Mar 2002
2a.	Cammoo Caves, general vicinity of mown lawn areas and surrounds	Commenced Oct 1999, Planting finalised Mar 2001, Maintenance commitment released Mar 2002
2b.	Pilkington's Quarry area scrub fringes along Limestone Ridge slopes	Planting/lantana removal by WFTD or Greencorps Summer 2000/2001 Planting complete Stage 1 (northern) Mar 2001, Stage 2 (Central) Mar 2002, Stage 3 (southern?) Mar 2002 or 2003
3a.	Bench 8	Rehab required see MEMRAC. Commence 2001??, Planting finalised later, Maintenance commitment eased Mar 18 months later
3b.	Pilkington's quarry – lantana fire scar	Planting/lantana removal by volunteers and WFTD or Greencorps Summer 2001/2002 Planting complete Stage 1 (northern) Mar 2002, Stage 2 (Central) Mar 2003, Stage 3 (south?) Mar 2003/4
4.	Pilkington's block generally between Limestone Ridge and Rossmoya Rd	Fringing forest border planting a.s.a.p. Internal reveg. by natural process over time.
5.	Cammoo generally including 'paddocks' and Cammoo hill	Fringing forest border planting a.s.a.p. Internal reveg. by natural process over time
6.	Canfell's house site	Weed management in short term, natural recruitment over

		time.
7.	Canfell's block quarry	Weed management, natural recruitment over time.
8.	Gommersall's house site	Firstly find the site then – implement weed management, natural recruitment over time.
9.	Hidden Valley hut	Weed management a short term issue, natural recruitment over time.
10.	Dodd's Lane section	Weed and fire management, natural recruitment over time.

REHABILITATION ACTIONS

This section identifies significant elements of the key revegetation sites currently being considered. *Operational notes for ranger management action are also included in some instances.*

Mining benches on Mt Etna section

Bench 8 A mining platform heavily benched for extraction of limestone. The site is very hard, has skeletal soils and includes a tall vertical face. Restoration of this site is to be considered in the Mount Etna Mine Rehabilitation Advisory Committee (MEMRAC) forum. The current MEMRAC preferred quarry rehabilitation proposal for bench 8 includes rock breaking along the upper edges of the vertical faces and thence filling the flat areas with appropriate soils and occasional finer breccia. The replacement of soil material on these areas will enable the above-mentioned replanting procedure to occur here.

Bench 9 An elongated benched mining platform with a backdrop of vertical faces. The southern part of the bench is stable and moderately well covered in soil. The lower eastern slopes of bench 9 slope steeply down onto bench 8. These slopes are well covered with collar (fountain) grass and are fully exposed to any easterly wind and all but afternoon sun. Despite a reasonable soil depth revegetation on this area must address these issues. A species list specific to this area is not yet finalised but considers the use of colonising species that are able to cope with the exposure and will develop a low closed windswept canopy within which other revegetation species can 'shelter' and later emerge from.

The upper flat section of bench 9 is a relatively straight forward site to rehabilitate. Collar grass occupies most of the site and when removed other weeds emerge in abundance. Two methods of planting will be trialed here. Firstly all the grass and weeds will be killed, the site will be planted and then the site mulched. Later weeds will be managed as required. This will become a drain on staff resources especially as the labour market labour complement diminishes. Secondly, there will be additional planting between the collar grass. The grass will be kept to 1 metre from the revegetation trees until the trees gain size. Over time management on this site should 'push' the collar grass out further from each tree as they develop a canopy. The level of competition in the soil from the collar grass on the new plants is unknown and will require monitoring to evaluate the merits of this approach to planting site management.

Planting has occurred here in the past and each time has suffered severely from the combined effects of the elements. Water is now available on site and should provide relief for plants in this area during stressful dry and windy times. A tank using water pumped from the Pacific Lime mine, and an associated reticulation system will increase the chances of success. The current Labour market program is likely to use a dripper system in this site for enhancing growth rates. It is unlikely that resources will support this level of care in other locations in the short term.

The ground surface at the northern end of bench 9 is considerably hard, has little soil cover, few remnants and includes sections requiring stabilisation and or geomorphological restoration. The loose boulders and other material on this northern end are proposed for rock-breaking treatment and will subsequently be dragged down to a safer level. Again recommendations for remedial action in relation to these issues is expected through the MEMRAC forum.

Bench 10 Predominantly a site with light surface disturbances and thus requiring little to no earth works before revegetation. There is considerable remnant vegetation here so restoration plantings are both a supplementary enhancement and a replacement of the weed species. Lantana, some cacti and collar grass comprise most of the main weed problem on this site. A planting formula similar to bench 9 is preferred. Significantly this site is less exposed to the wind than bench 9.

Johannsen's Cave entrance, Quarry and adjoining area

This area includes the mining platform and vertical face of the Johannsen's Quarry. A rubble slope and discarded spoil exist on the south and west edges of the platform. There is some established regeneration and it is not the desire of park management to modify or restore any shape or landform to these areas. The general surrounds of the Johannsen's site include up to two hectares of light surface disturbance with a lot of weed cover. Lantana, green panic and Guinea grass are the more common and significant weeds present. The fire risk posed by the grasses is the greatest concern for the remnant and newly planted vegetation on this site. Suppression of this fire threat is a principle objective for this habitat restoration program.

This area has been the site of several summer attempts at revegetation over the past dozen or more years. Of the hundred or more trees planted over this time, very few have survived the dry weather spells, defoliation by bugs, browsing by wallabies and abuse by humans to reach maturity. These factors will surely persist into the future and so this site in particular will require periodic monitoring and attention to maintain a satisfactory level of health of the 'new' plants. Revegetation here is

otherwise straight forward and the planting list is considerate of localised species biases and the drier nature of the site. Management of weeds and the fire risk after planting will be an ongoing matter for attention.

Pilkington's block - scrub fringes along Limestone Ridge slopes and the quarry

Three sections with different management aspects. Edge of scrub along break over the rise to Johanssen's. Simple site as a scrub against the firebreak. The disturbance exists as historic fire scarring off the track edge and into the scrub. Depth ranges from a metre to 30 metres in two places. Lantana and guinea grass are common throughout. Some areas still lightly grassed with natives and minor weeds as such are not a significant threat like the guinea grass patches. Rehab. here is similar as for Johannsen's site, where a modernised application of the Bradley technique of weed removal and direct reveg. planting can enhance the rate of habitat recovery. Weed and thus fire management over time are of course crucial to long term success.

The edge of the remnant scrub outside old firebreak behind Pilkington's mine site, northern and southern sides.

Northern side is similar to the edge over the rise discussed above with the significant addition of lots and lots of lantana, but less guinea grass. The site is relatively well protected with a SW aspect. Repatriation of this site will be labour intensive to prepare yet is potentially very rewarding given the protected nature of the site for young plants. Again the modernised Bradley technique with a localised bias in the planting list and an ongoing commitment to maintenance is necessary. The southern side is much more difficult to address. There is a real lot of lantana, it is far more exposed with a drier NW aspect and much of the access is so far overgrown that it is hard to find now. With a lot of resources the habitat can be recovered here but it may be that resource limitations suggest this site requires an approach focusing upon low maintenance fire protection and allowing for an opportunistic reactive response to the weed threat.

General area within tracks and breaks at Pilkington's Quarry site

Heavily infested with weeds although this is mostly guinea grass, collar grass and lantana. Some scattered remnants are present, both as clumps and as patches. A potentially high profile site when considered with the associated heritage values of the lime kilns. Short-term attention should be directed to managing the fire threat with some opportunistic weed control. A special weed management effort that is directed at fire protecting remnants is ideal in this site. Long-term options could eventually include enhanced habitat restoration and reveg. planting. Given the scale of resources required in this site it is likely that natural recovery of the closed forests will occur over time.

Pilkington's quarry – lantana fire scar

A series of severe wildfire events in the 1980's and early 1990's trashed a path through the dry vineforest on the side of Limestone ridge above Pilkington's quarry. This fire scar is heavily infested with lantana and is thus the focus of many people's attention for restoration. The local caving club in particular sees this area as a priority rehabilitation site.

Removal of lantana, soil stabilisation, mulching and reveg. planting will require a deliberate application of committed resources to effectively succeed in the rehabilitation of this site. The key issue requiring more detailed planning that is not attempted here addresses stabilisation of the soil on this site. A planting list can be prepared following the principles noted above for the Johannsen's site.

Pilkington's block generally - between Limestone Ridge and Rossmoya Road

Two distinct management zones over several parts:

Rossmoya Road frontages. As proposed in the rehabilitation program for the previous owners Pacific Lime (Kershaw 1993), these road frontages can be used as firstly a fire buffer (as is currently the case) and with additional reveg. plantings can be a visual screen and, over time, a 'natural' vegetated fire protection strip. This would require the planting of a strip 6 to 8 metre wide within a parallel firebreak, set inside the road frontage fire buffer zone. There is little remnant left in this strip and this would be the greatest single piece of planting undertaken in this rehab. program. The benefits of this activity will show over time when the vegetation has reached 2m or more in height and the young canopy started to close in. The right year with a good wet season is probably the secret to this site's success. Perhaps it is an area that is considered opportunistically for redirected attention should the seasons turn for the better. A rain event of 8 inches in the old scale (200mm) over a few days would be the trigger to seriously consider taking this area on. Reactive concentration of district and other resources to plant 5000+ plants along this site would be well and truly worthwhile.

General core of blocks with scattered remnants. The largest central disturbed areas around Johannsen's and Pilkington's are not suitable for direct reveg. planting within contemporary resourcing levels. These areas however can be fire protected with a practical fire break network dividing the blocks into smaller separate pieces. Further localised fire protection should be considered for remnant pockets within, usually by applying a herbicide (Glyphosphate 360) to the fire threatening grasses surrounding these remnants. Regeneration of the rainforest community in these sites can thus be left in the hands of the slow natural processes allowing for the essential management commitment to minimise the fire hazards annually. Some parts of these areas should be considered as sacrificial protection zones and thus burnt annually with this purpose in mind.

Cammoo Caves site, immediate vicinity of lawn areas and major infrastructure

The two gullies to the immediate south east of the Cammoo carpark include areas ideal for high profile reveg works. These areas are to be addressed in the autumn of 2000. More work needs to be done in planning rehabilitation on this site in late 2000. This

planning may await the outcomes of the management planning process and the development of the recreation management strategy for the park.

Cammoo generally including 'farmed paddocks' and the lookout hill.

Needs to be looked into in 2001 for future planning works. Some fire protection around remnants should be undertaken annually to reduce the threat to the fire sensitive species.

'The Valley' hut, Canfell's sites, Gommersall's sites.

Vegetation restoration on these sites will principally include weed management in the short term while allowing for natural forest recovery. Low maintenance supplementary planting may be feasible in ideal weather conditions to accelerate recruitment of colonising and/or 'signature' species (characteristic of that site).

Weed management - post planting

Weeds shall be removed from each site as required and prior to planting events. Consistent with the fire management strategy and this rehabilitation program, all the greater grasses and lantana shall be treated on site prior to planting as a matter of great importance.

As weed infestations often support severe fire conditions they can increase the risk of fire damage occurring in many of the park's closed forest ecosystems including direct competition for water, nutrients and other basic resources.

Although implementation of this program commenced nine months ago, it is still unclear as to what the composition and scale of the weed problems at each site may be.

Early observations from the Johannsen's Cave site suggest that the removal of the fast growing grasses (fire hazards) results in rapid development of the herbaceous environmental weeds especially where glyphosphate is used.

Euphorbia sp (painted spurge), *Rivina humilis* (coral berry), *Bidens pilosa* (cobblers peg), snake weed, blue billy goat's weed and several thistles and daisies have attempted to dominate the disturbed and bared soils on the Johannsen's site.

Painted spurge in particular is rapidly developing as the dominant species in the Pilkington ridge strip which we have recently treated with glyphosphate for grass control.

Further assessment and consideration is required to develop an effective and cost efficient strategy for controlling these pests and maintain the integrity of revegetation sites in the short term.

All weed control treatments applied to revegetation site maintenance shall be consistent with recommended treatments identified in the park pest management strategy. A draft pest plan is planned for December 2000.

Watering - post planting

In the past we have planted trees in most months of the year, usually at the convenience of our limiting manpower resources. On occasion a team of trainees or volunteers may become available and put to good use clearing and hastily planting trees to help fill in a work or training program. On this park planting trees at any time of the year is only going to be viable where the trees have adequate soil moisture to enable them to develop necessary traits to withstand the hot and dry spring and summer seasons. Dry season plantings are marginally successful even if watered heavily at planting and where frequent deep watering is provided through the dry season.

Wet season planting (e.g. after 150mm + rainfall events) is ideal. These trees require a reasonable watering at planting then may be a week later and they are off. The Nov 2000 sites we have on the park and a matching 1998 site Ann showed me at Augusteyn's Capricorn Caverns have many reveg. species with growth rates of over 500mm per year. We are in little doubt now that successful reveg. planting on the Mt Etna Caves National Park is achieved under optimal climatic conditions and that revegetation planning should allow for reactive response to heavy rainfall events and/or be able to stall trees in a dormant state in darker nurseries until suitable weather arrives.

Fire protection

Fire protection of the dry rainforest species is most important for these species to maintain their current distribution. For the dry rainforest communities to recover in disturbed sites, fire management actions need be recognised and given high priority.

The fire management strategy for the park also considers the use and control of fire as a management tool for ecological and/or hazard reduction burns.

SITE MONITORING PROGRAM

Site photos may be taken on each major vegetation recovery site before any clearing of weeds and/or landscape rehabilitation works. Post treatment photo recording and matching data can provide future management details on many aspects of the process. In particular the comparison of before/after images is often an effective tool in illustrating the benefits of active vegetation restoration and/or particular techniques or events.

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Acknowledgment for technical support and quality advice to:
S. Elson (EPA) , S. Edwards (EPA), N Hoy (DME), A. Rogers (QNPWS), J McCabe (QNPWS), J. Vavryn (QNPWS volunteer), D. Vavryn (QNPWS), J. Augusteyn (QNPWS & Capricorn Caverns), Ann Augusteyn (Capricorn Caverns), C. Unger (DME), Mr Ian Herbert

Appendix 1. Revegetation planting list

Planting group	*Genus*	*species*	Common name	No. required 2000/2001	Description
0.5	**Total annual requirement for plantings**			**6152**	
1	*Acacia*	*aulacocarpa*	Hickory wattle	1000	Medium sized tree to 4m. Highly perfumed, yellow flowers.
1	*Alphitonia*	*excelsa*	Red ash, soap bush	80	
1	*Breynia*	*oblongifolia*	Coffee bush	80	Small tree to 3m with attractive red fruit changing to black when ripe. Hardy plant for all locations. Leaves ovate pseudo-pinnate in sets of 4 - 10 on short lateral branchlets.
1	*Cassia*	*brewsteri var. tomentella*	Velvet cassia	200	Small to medium semi-deciduous tree to 5m. Leaves with 8 - 12 leaflets, obovate with hairy underside. Attractive yellow flowers. Hardy tree but slow to get started.
1	*Citriobatus*	*spinescens*	Wallaby apple	100	Attractive small tree to 3m. Shoots mostly ending in spines, axillary spines rare. Leaves small, obovate or oblanceolate to 2 cm. Yellow-green berry fruit to 3cm across. Good small bird habitat.
1	*Clerodendrun*	*volubile*	Lolly bush	10	
1	*Clerodendrum*	*floribundum*	Lolly bush	40	Small tree to 4m. Leaves elliptical to 12 cm. Flowers white, tubular with protruding stamens. Fruits blue-purple in enlarged red calyx. Good for new ground. Suitable for most soils and aspects.
1	*Cupaniopsis*	*anacardioides*	Tuckeroo	5	Medium sized tree to 10m. Shiny pinnate leaves with leaflets elliptical-oblong to 12cm. Flowers insignificant but attractive orange fruit. Excellent shade and street tree and handles most situations.
1	*Eucalyptus*	*crebra*	Narrow leaf ironbark	10	
1	*Euroschinus*	*falcata*	Ribbonwood, Pink poplar	40	Medium to large shade tree to 20m. Very attractive foliage with pinnate leaves having 4 - 10 elliptical leaflets.. Partly deciduous. Small pink flowers in large sprays. Small (5mm) mango -like fruit. Superb shade/street tree.
1	*Ficus*	*obliqua var petiolaris*	Small-leaved fig	40	Large spreading shade tree to 15m.
1	*Ficus*	*opposita*	Sandpaper fig	200	Small tree to 4m. Large fruit. Quick growing and early fruiting.
1	*Harpullia*	*pendula*	Tulipwood	120	Large tree to 10m. Very attractive shade tree.
1	*Jagera*	*pseudorhus*	Pink foambark	40	Medium sized tree.
1	*Lophostemon*	*confertus*	Supplejack	10	
1	*Lysiphyllum*	*carronii*	Red bauhinia	100	Medium sized tree to 8m. Semi-deciduous 2-lobed leaves. Flowers white to 7cm. Good shade tree.
1	*Mallotus*	*claoxyloides*		10	Small tree/shrub. Leaves 8-17 cm long, broad-elliptic to obovate, shallow toothed. Fruit an angular grey-brown capsule with a rough surface. Very hardy plant.
1	*Mallotus*	*phillipensis*	Red Kamala	200	Small to medium tree to 10m. Leaves ovate, stiff to 15cm. Flowers insignificant. Fruit red, dry in attractive clusters.
1	*Melia*	*azederach var australasica*	White cedar	200	Medium to large shade tree to 6m.
1	*Nicotiana*	*velutina*		10	
1	*Notelaea*	*microcarpa var microcarpa*	Mock olive	20	Small tree to 10 m. Leaves narrow-lanceolate to 10cm. Insignificant flowers and small blue-black fruits.
1	*Pipturus*	*argenteus*	Native mulberry, false stinger	80	Small fast growing tree to 6 m. Leaves elliptical to 12cm, toothed, and white underneath. Flowers insignificant. Translucent mulberry-like fruits.

1	*Polyscias*	*elegans*	Celerywood	40	Medium sized tree to 15m, often slender. Leaves very large to 60cm, bipinnate with ovate leaflets to 12cm. Flowers insignificant. Fruit in terminal clusters changing green to black. Needs well drained soil and good moisture.
1	*Streblus*	*brunonianus*		10	Small tree to 10m. Adult leaves ovate to lanceolate 1 - 7 cm long. Flowers insignificant. Useful shade and street tree.
1	*Trema*	*aspera*	Poison peach	40	Fast growing small tree. (Poisonous to stock)
1.1		***Total class 1***	***2685***		
2	*Cordia*	*dichotoma*	Cordia, Pink pearl	80	Medium sized tree to 8m. Large pink fruit.
2	*Dendrochnide*	*photinophylla*	Shiny-leaved stinging tree	40	
2	*Diospyros*	*australis*	Ebony	10	
2	*Diospyros*	*fasciculosa*	Grey ebony	10	
2	*Diospyros*	*geminata*	Scaly ebony	40	Medium sized tree to 7m. Leaves elliptic to ovate, glossy to 6cm. Fruit ovoid yellow-orange to 12mm.
2	*Diospyros*	*humilis*	Small leaved ebony	40	Medium sized tree to 5m. Leaves elliptic to ovate, glossy to 3cm. Fruit ovoid yellow-orange to 10mm.
2	*Drypetes*	*deplanchei*	Yellow tulip	80	Attractive medium sized tree to 10m. Leaves elliptical with undulate margins, toothed, glossy. Slow growing. Semi-shade. Red egg-shaped fruit to 1.2cm.
2	*Ficus*	*fraseri*	White fig	80	
2	*Ficus*	*microcarpa*	Small-fruited fig	40	
2	*Ficus*	*platypoda*	Rock fig	80	Large spreading shade tree to 15m.
2	*Ficus*	*racemosa*	Cluster fig	40	Large spreading shade tree to 15m.
2	*Ficus*	*virens var sublanceolata*	White fig	80	Large spreading shade tree to 15m.
2	*Jasminium*	*didymum ssp lineare*		40	
2	*Micromelum*	*minutum*	Lime berry	40	Small understorey shrubby tree to 5m. Leaves pinnate with elliptical leaflets to 7cm. Small white fragrant flowers. Yellow fruit changing to bright red in attractive showers. Plant in semi-shade.
2	*Murraya*	*ovatifoliolata*	native murraya	40	Small understorey shrubby tree to 4m. Dark green pinnate leaves with ovate leaflets. Fragrant white flowers to 2cm. Red fleshy fruits.
2	*Pleiogynium*	*timorense*	Burdekin plum	60	Large shade tree to 15m.
2	*Schefflera*	*actinophylla*	Umbrella tree	200	Multi-trunked tree to 10m with light green elliptical leaflets to 30cm radiating from a single point. red leaf stalks. Terminal inflorescence of radiating spikes of flowers followed by red fruits turning soft and black. Bird attractant.
2	*Terminalia*	*porphyrocarpa*	Bandicoot plum	200	Medium sized tree to 20m. Leaves obovate to 10cm. Terminal flower spikes, cream. Red oblong edible fruit to 3cm. Very good shade tree.
2	*Vitex*	*acuminata*	Vitex	40	
2.1		***Total class 2***	***1240***		
3	*Acronychia*	*laevis*	Glossy acronychia	20	Small to medium sized tree with obovate leaves to 10cm. Bears small white flowers followed by blue/purple fruits which area edible but not palatable. Prefers part shade and good soil.
3	*Aidia*	*racemosa*	Archer Cherry	10	
3	*Ailanthus*	*triphysa*	White Bean	40	Very attractive tall shade tree to 15m.

3	*Alangium*	*villosum ssp tomentosum*	Hairy muskwood	10	
3	*Alchornea*	*ilicifolia*	Holly bush	20	Small tree/shrub to 3m by 2m across. Shiny holly-like leaves 9cm long with reddish new growth and insignificant flowers. Needs a shady position in good soil.
3	*Alectryon*	*connatus*	alectryon	40	Medium sized dry rainforest tree to 8m. Distinctive fruit with bright red (edible) aril on seed. Attractive small to medium tree. Bush tucker.
3	*Alectryon*	*diversifolius*	Scrub Boonaree	10	Attractive small shrubby tree. Bush tucker, bird habitat.
3	*Alectryon*	*subdentatus*	Holly	10	
3	*Alectryon*	*tomentosus*	Hairy alectryon	10	
3	*Alyxia*	*ruscifolia var. ruscifolia*	Chainfruit	40	Small tree/shrub to 3m. Dark glossy leaves, triangular and sessile with a sharp point. Leaf size highly variable. Bears white perfumed flowers in summers/autumn followed by orange fruit. Very hardy attractive plant but slow growing.
3	*Arytera*	*divaricata*	Coogera	40	Medium sized tree to 12m. Shiny pinnate leaves with 2 - 7 oblong dark green leaflets. Young growth dark pink. Very attractive shade/park tree. Flowers and fruit insignificant.
3	*Atalaya*	*multiflora*	Broad-leaved whitewood	400	Small to medium tree. Pinnate leaves with 1 - 2 pairs of elliptical leaflets to 9cm. White flowers and winged seeds.
3	*Atalaya*	*salicifolia*	Whitewood	40	
Austromyrtus		*bidwillii*	Python tree	40	Small tree to 6m. Trunk blotched brown and green (similar to guava). Shiny leaves ovate to elliptical to 10cm. White flowers with tuft of yellow stamens. Globular black fruit about 6 mm. Very attractive tree but slow growing. Handles full sun.
Baloghia		*inophylla*	Scrub bloodwood	40	Medium sized tree. Attractive deep green heavy foliage.
Bridelia		*exalta*		10	
Bridelia		*leichhardtii*	Scrub ironbark	10	Small tree to 4m with attractive red fruit changing to black when ripe. Leaves ovate to oblong-ovate 2 - 6cm long.
Canthium		*buxifolium*		40	
Canthium		*coprosmoides*	Beach canthium	40	Small to medium sized tree to 4m. Attractive foliage with elliptical leaves to 10cm. White fragrant flowers in clusters. Red globular, edible fruit.
Canthium		*lamphrophylum*		40	
Canthium		*odoratum*	Shiny-leaved canthium	40	Small to medium sized tree to 6m. Attractive foliage. Leathery shiny elliptical leaves to 8cm. Fragrant white flowers in clusters. Black fruit to 7 mm.
Carissa		*ovata*	Currant bush	40	Spiky small bush. OK if pruned
Cassine		*australis*	Red olive plum	10	Small tree to 5m. Glossy elliptical leaves to 8 cm. Flowers insignificant. Attractive foliage and orange fruit.
Cassine		*melanocarpa*	Black olive plum	10	Small tree to 5m. Glossy elliptical leaves to 10 cm. Flowers insignificant. Attractive foliage and black fruit.
Cissus		*opaca*	Native grape	10	Vigorous climber with three to five leaflets per leaf. Small flowers and black fruit to 2cm. Useful in part shade or full sun.
Claoxylon		*tenerifolium*		20	
Clerodendron		*inerme*		40	
Clerodendron		*tomentosum*	Lolly bush	10	Small tree to 4m. Leaves elliptical to 12cm and hairy. Flowers white, tubular with protruding stamens. Fruits blue-purple in enlarged red calyx. Good for new ground. Suitable for most soils and

					aspects.
	Croton	*acronychioides*	Thick-leaved croton	10	Small tree to 5m Leaves elliptic to 13cm, bright green and glossy above and below. Flowers insignificant. Fruit reddish-brown, scaly, 3-lobed capsule.
	Croton	*insularis*	Qld cascarilla bark	10	Small tree to 5m with fragrant bark.. Leaves ovate to lanceolate to 8cm, silvery below. Flowers insignificant.
	Cryptocarya	*bidwillii*		10	
	Cryptocarya	*hypospodia*	Purple laurel	10	
	Cupaniopsis	*wadsworthii*	Tuckeroo	40	Small tree/shrub to 3m. Leaves obovate with two lobes at apex. Attractive foliage and seeds.
	Denhamia	*oleaster*		40	Small tree to 7m. Juvenile leaves elliptica, toothed. Adult leaves entire to 8cm. Small flowers. Large orange ovoid fruits.
	Dioscorea	*transversa*	Common yam vine	10	Climber with annual twining stems and perennial edible underground tubers. Leaves heart-shaped to 10cm with prominent veins. Flowers insignificant. Three-winged brown fruits. Male and female plants.
	Dodonaea	*viscosa*	sticky hopbush	40	Bushy shrub to 3m. Oblanceolate leaves shiny and sticky. Flowers insignificant. Fruits yellow four angled. Very hardy.
	Ehretia	*membranifolia*	Peach bush	20	Small tree to 5m. Leaves thin, soft, lanceolate to oblong-ovate, 4 - 10cm long. Fruit a small blackish drupe 3 - 4mm across and red when young.
	Ehretia	*sp. Nov.*		10	
	Elaeocarpus	*obovatus*	Hard quandong	10	Medium sized tree to 20m. Leaves elliptical to 7 cm, sparsely toothed. Profuse fringed white flowers. Dark blue fruits approx. 6mm diameter. Good shade tree.
3	*Elattostachys*	*xylocarpa*	White tamarind	5	Small tree to 10 m. Pinnate leaves with elliptical toothed leaflets. Red young growth. Pear shaped woody fruits to 2cm long.
3	*Erythrina*	*vespertilio*	Bat's wing coral tree	40	Medium to large tree
3	*Erythroxylum*	*australe*	Erythoxylum	40	Shrub or small tree to 4m. Leaves small thin elliptic to obovate. Fruit a red drupe. A plant with much potential but unknown propagation.
3	*Eustrephus*	*latifolius*	Wombat berry	10	Small vine with shiny lanceolate leaves to 10 cm and distinctive parallel veins. White flowers to 1cm and globular orange fruits to 1.5cm. Hardy but likes part shade. Good in pots.
3	*Geijera*	*paniculata*	Axe breaker	40	
3	*Geijera*	*salicifolia var. latifolia*	Scrub wilga	40	Medium sized tree to 12 m. Leaves firm, tough, glossy, ovate-lanceolate to broadly elliptic 5 - 15cm long. Fruit dry with 1 - 4 segments containing one seed each. Superb shade tree.
3	*Geitonoplesium*	*cymosum*	Scrambling lily	40	Vigorous twisting climber with lanceolate leaves to 8cm with distinctive parallel veining. Flowers white, green or purplish and fruits dark blue/black to 1.2cm.
3	*Glochidion*	*lobocarpum*	Buttonwood	40	Medium tree to 12 m. Lanceolate trees to 10cm arranged in two rows to appear pinnate. Flowers insignificant. Fruit lobed disc-like to 2cm. Fast growing.
3	*Graptophyllum*	*excelsum*	Red native fuschia	40	Attractive shrub to 2m. Obovate glossy leaves to 3cm. Red flowers. Woody fruit to 3 cm.
3	*Grevillea*	*helmsii*		40	Medium tree to 8m.
3	*Guettardella*	*putaminosa*		10	
3	*Gyrocarpus*	*americanus ssp americanus*	Twirly whirly tree	10	
3	*Harpullia*	*hillii*	Tulipwood	10	
3	*Heterodendron*	*diversifolium*	Scrub boonaree	10	

3	*Homalium*	*alnifolium*	Homalium	10	
3	*Hymenosporum*	*flavum*	Native frangipanni	20	
3	*Jasminium*	*didymum ssp racemosum*	small-leaf jasmine	10	Small shrubby vine with trifoliate leaves. Leaflets variable, ovate to linear to 10cm long. Small white flowers. Black fruit to 3mm dia.
3	*Jasminium*	*simplicifolium ssp australiense*	Native jasmine	10	Shrubby vine with linear-lanceolate glossy leaves to 5cm. White fragrant flowers to 2 cm. Black fruit to 10 mm dia.
3	*Jasminium*	*volubile*		10	
3	*Mallotus*	*discolor*	White kamala	40	Medium tree to 10m. Leaves ovate on long stalks, green on top and silvery on underside. Flowers insignificant. Fruit fleshy yellow to 6 mm dia. Good feature tree
3	*Maytenus*	*disperma*	Orangebark	40	Small to medium tree. Leaves oblanceolate or narrow-elliptic, 5 - 10cm long, yellowish-green, glossy. Fruit an ovoid yellow capsule opening in two valves. Very attractive tree but propagation method unknown.
3	*Melaleuca*	*leucadendron*	Weeping tea tree	10	Large tree to 15m.
3	*Melicope*	*erythrococca*		10	Large shade tree to 6m.
3	*Melodorum*	*leichhardtii*	Zigzag vine	40	Twining climber or shrub with spreading habit. Glossy green elliptical leaves to 15cm. Fragrant brown flowers. Yellow-orange irregular shaped fleshy fruit. Fruit salad aroma in leaves and fruit. Good ground cover or clip to shrub. Slow to start.
3	*Owenia*	*venulosa*	Crow apple	10	Medium sized tree to 12m. Bark greyish and very scaly. Leaves with 6-8 leaflets with winged rachis and petiole in juvenile leaves. Fruit a reddish globular drupe 2-3cm dia with hard stone. Superb shade or feature tree but slow growing
3	*Peperomia*	*tetraphylla*		10	
3	*Pittosporum*	*rhombifolium*	Hollywood, Diamond pittosporum	80	Medium sized tree to 15 m. Glossy green, ovate to rhomboid leaves to 11cm. Creamy white flowers in dense terminal clusters. Orange globular fruits to 5mm. Very attractive foliage and spectacular apricot coloured fruit.
3	*Planchonella*	*cotinifolia*	Small-leaved coondoo	20	Medium to large rainforest tree
3	*Planchonia*	*careya*	Cocky apple	20	
3	*Pogonolobus*	*reticulatus*	Medicine bush	20	
3	*Polyalthia*	*nitidissima*	Canary beech	10	Very attractive dry rainforest tree
3	*Psychotria*	*daphnoides*		10	
3	*Scolopia*	*braunii*	Flintwood	10	Shapely tree to 10m with dense rounded crown. Glossy narrow-ovate leaves to 7cm. Scented flowers. Good shade tree.
3	*Siphonodon*	*australis*	Ivorywood	1	
3	*Solanum*	*shanesii*		10	
3	*Sterculia*	*quadrifolia*	Peanut tree	20	Medium sized tree to 12m. Semi-deciduous. Leaves heart shaped to 12cm. Dull yellow hairy, bell-shaped flowers 1cm long. Fruits orange-red woody, boat like with edible black seeds. Spectacular when in fruit.
3	*Strychnos*	*psilosperma*	Strychnine tree	10	
3	*Tetrastigma*	*nitens*	Native grape, Three leaf vine	10	Vigorous tendril climber. Shiny trifoliate leaves. Small flowers and edible black fruit. Good indoors.
3	***Toona***	***australis***	**Red cedar**	**1**	

3	*Turraea*	*pubescens*	Native witch hazel	80	Open deciduous shrub to 3m. Leaves elliptical. Fragrant white-yellow flowers occur when leafless. Needs good drainage.
3	*Vitex*	*melicopea*	Vitex	10	
3	*Xanthoxylum*	*brachyacanthum*	Thorny yellowwood	20	
3.1		***Total class 3***	***2227***		

Map 2 Mt Etna Caves National Park Vegetation Communities