BRUNSWICK HEADS CROWN LAND
BYRON SHIRE CHEMICAL-FREE LANDCARE

Management Plan
and
Monitoring Report 2012-13

BITOU THREAT ABATEMENT PLAN

A Project of
Mullumbimby Centre for Sustainable Living and Environmental Education Inc.

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1. INTRODUCTION

1.1 The Bitou Threat Abatement Program

The NSW Bitou Bush Threat Abatement Plan (2001) is part of a national strategy developed in 2000 for Bitou Bush and Boneseed. Under this plan, high priority plant species, populations and ecological communities were listed. This project seeks to implement the objectives of this plan – to control bitou bush and monitor the effectiveness of the (chemical-free) techniques used.

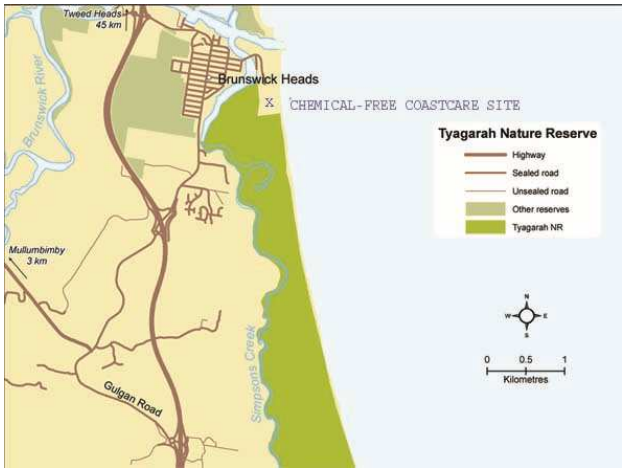
1.2 Management Intent

- **To eradicate Bitou Bush, planted after sandmining, as it forms a climax community which inhibits natural regeneration**
- **To promote the conservation of coastal biodiversity**
- **To demonstrate the cost effectiveness and efficiency of the chemical-free bush regeneration technique**
- **To protect native plants and animals from the effects of toxic pesticides**
- **To monitor the effects of Bitou Bush removal**
- **To create a safe public space for chemically-sensitive residents and citizens concerned with the use of pesticide in our local environment**
- **To provide options and opportunities for chemically-sensitive residents to engage in dunecare and landcare**
- **To work towards chemical-free bush regeneration employment**
- **To remove historic European Cultural Heritage (rubbish)**

2. THE SITE

2.1 Where is it?

The site is a Crown Reserve (DP 428/729272) between the Brunswick Heads Surf Club and the Tyagarah Nature Reserve. The area concerned is about 4.75ha.



Map 1. Brunswick Heads site

2.2 A bit of project history

This group emerged from widespread community concern about the aerial spraying of coastal areas in Byron Shire. We thank then Byron Shire Mayor, Jan Barham, and Councillors for giving us the opportunity to demonstrate the effectiveness of this technique. As it turned out, the section of the area proposed by Byron Shire Landcare Coordinator, Wendy Gibney, was not under Byron Shire Management. Permission to undertake the project was sought and gained from Mr Frank McLeod, Crown Lands, Grafton.

This is a project of Mullumbimby Centre for Sustainable Living and Environmental Education Inc. It began in May 2010 and continued at one day per fortnight (except for Christmas and rain) until July 2013. It now operates at one day per month. The project is coordinated by Nadia de Souza Pietramale. During the first year (2010-11) funding was provided by the Northern Rivers Catchment Management Authority (NRCMA) under the *Caring for our Country* Program. Funding was offered by NRCMA for the 2011-12 year but was rejected because of the extra administrative work involved and constraints imposed on media releases. The program is now reliant on donations.

The project has provided diverse educational opportunities. Volunteers are always eager to learn more about their local environment as well as about this safer technique. Students from Shearwater Steiner School (Mullumbimby) have worked here. In 2011, supervisor Mark Thompson (New Train- National Green Jobs Corps) included this site for land management training of two teams of young people. For the third consecutive year (2011-2013) Lecturer Zan Hammerton and students from Long Island University (USA), engaged in the course 'Australian Coastal Environmental Issues', have attended (and been impressed).

In 2012 Byron Shire Council provided 6 excellent Landcare signs from their Bush Futures Grants Program as well as a fence south of the beach track on the northern boundary to assist in keeping the general public out of the regeneration area.

Under the professional supervision of Nadia de Souza Pietramale, and botanical support and strategy advise from Ellen White, the many volunteers have shared wonderful times learning about country. Thank you all. It has been so exciting to watch the shape of the country emerge from the sea of bitou.

2.3 Summary of the Chemical-free approach to bush regeneration

This approach is very low cost – no planting, watering, chemicals, machinery. It can be a family affair with children learning by doing. School groups may attend work days. It doesn't matter if it rains – in fact, this can only be beneficial – there is nothing to wash off; the last few wet years has seen fantastic germination and growth of native species.

This method considers the environment as a whole – micro-organisms, invertebrates, birds and mammals, orchids, fungi, grass etc. It uses an understanding of the role of

weeds in providing ecological structures and functions to aid regeneration. From an ecological perspective, our approach – like that of organic agriculture – focuses on the importance of the soil – there is no further soil damage, as evidenced by our healthy Endangered Orchid population and the amazing germination rates.

Many independent, peer-reviewed studies have demonstrated the toxic effects of pesticides (including glyphosate and metsulfuron methyl) on terrestrial and aquatic flora and fauna and on soils and gut micro-organisms. In addition, while it has always been assumed that herbicides are time- and cost-effective, there have been no studies to validate this. In particular, the manual technique developed for Bitou Bush is also less time-consuming and less expensive than the cut and paint technique advocated more extensively in '*Current management and control options for bitou bush (Chrysanthemoides monilifera ssp. rotundata) in Australia'* (2008). Recovery would also appear to be faster than when constant herbicide applications are used.

With this technique, there are no herbicides leaching into waterways – remember that these are mostly coastal sands, not clays, so repeated herbicide use is particularly damaging to coastal wetlands and possibly to the littoral zone. There are no surfactants to impact the invertebrate populations. In addition, recent research has demonstrated the damaging effects on mammals – through damage to gut bacteria and fungi and consequent alterations to metabolic pathways which then leads to disease.

Strategies:

a) Work on primary **Bitou Bush** areas during the cooler months and on followup during the warmer months. This is not only **good occupational health and safety practices** for the volunteers to do hard work when is cool and light work when it is hot, it also aids the regeneration process. Why? Because there are often native seedlings under the Bitou Bush and exposure in hot weather on sands can cause seedling loss.
b) Thin out **Coastal Teatree** so that native species can germinate in the space provided
c) Remove **Glory Lily** three times during the growing season (November to May)
d) Remove other non-native tree species as found
e) Remove Potato Vine and Asparagus Fern as found
f) Remove Sporobolus and other non-native clumping grasses
g) Do not remove annual or biennial weeds (to maintain ground cover while soil recovers)

2.4 Initial vegetation condition.

The site was sand-mined during the 1960-70's. The two major weed species and a minor one were planted following sandmining.

At the time the project began, Bitou Bush, *Chrysanthemoides monilifera* dominated much of the northern and eastern dunes (about 70%) while *Leptospermum laevigatum* dominated much of the south-western area and a section in the north (about 30%). *Acacia*

saligna has a few old plants in this area, but is not invasive at this site. The absence of fires in the area is indicated by the maturity of the *Leptospermum laevigatum* and *Acacia saligna*.

The presence of certain native species indicated that the following vegetation communities would once have been present.

1. Littoral rainforest/Banksia woodland – Bitou occasional, Glory Lily frequent. Coastal Teatree abundant

2. Bitou dominated - recovering littoral rainforest – Glory Lily occasional. Coastal Tea-tree occasional

3. Coastal Tea-tree dominant. Some Leptospermum primary done. Bitou occasional, Glory Lily frequent.

4. Callitris/Banksia woodland on hind dune ridge – Bitou abundant.

5. Callitris/Banksia/littoral rainforest –Bitou abundant, Glory Lily occasional to frequent

6. Coastal sand dune complex – Bitou abundant.

7. Frontal dune vegetation complex is occurring to the seaward side once Bitou Bush is removed.

Map 2. Vegetation distribution

Sections 1,2,3: Recovering Littoral Rainforest. Littoral rainforest is regarded as one of the rarest subformations of rainforest in Australia. It occurs here on Quaternary sand deposits on the sand flats between Simpsons Creek and the barrier and frontal dunes.

Section 1 was lightly invaded by Bitou Bush with moderate to dense cover of Coastal Teatree, Section 2 was heavily invaded and lightly covered by the Teatree, while Section 3 was moderately invaded by Bitou Bush but dominated by the Coastal Teatree. All areas had a scattering of Glory Lily throughout.

Typical species of the canopy of littoral rainforests occurring at the site include Tuckeroo (*Cupaniopsis anacardioides*), Broad-leaved Lilly Pilly (*Acmena hemilampra*), Hard Corkwood (*Endiandra sieberi*). Mid and understorey species include Acronychia (*Acronychia imperforata*), Poison Peach (*Trema tomentosa*) Blue Lillypilly (*Syzygium oleosum*) and Soft Corkwood (*Duboisia myoporoides*). Ground and shrub layer species generally consist of Midjimberry (*Austromyrtus dulcis*), Flax Lily (*Dianella caerulea*), Spiny Matrush (*Lomandra longifolia*) and the Snake Vine (*Stephania japonica*).

Section 4, 5: 'Coastal Cypress Pine Forest in the NSW North Coast Bioregion' has now been registered as an Endangered Ecological Community. This vegetation type is highly restricted and has suffered a large reduction in geographic distribution since European invasion. Here remnants occur immediately inland of the frontal dune on a low rise that represents eroded Pleistocene backbarrier dunes. The sandy soils are generally deep, freely draining podsols. It merges into Littoral Rainforest.

As well as *Callitris columellaris* (Coastal Cypress Pine), canopy species listed in the EEC determination which occur here include *Acacia aulacocarpa (*Hickory Wattle), *Acronychia imperforata* (Beach Acronychia), *Banksia integrifolia* subsp. *integrifolia* (Coast Banksia), *B. serrata* (Old Man Banksia) and *Eucalyptus signata* (Scribbly Gum), *Notelaea longifolia* (Large Mock Olive), *Persoonia adenantha* (Geebung). The shrub layer generally consists of *Monotoca elliptica* (Tree broom-heath) and *Austromyrtus dulcis* (Midjimberry) while groundcover includes *Imperata cylindrica* var. *major* (Blady Grass), *Paspalidium distans* (Shotgrass), *Lomandra longifolia* (Spiny-headed Mat-rush), *Dianella caerulea* (Blue Flax Lily), *Commelina cyanea*, and *Pteridium esculentum* (Bracken). These sections were heavily invaded by Bitou Bush.

Section 4: Coastal Cypress/Banksia woodland on hind dune. This is very similar to Section 5 though rainforest species are less frequent.

Section 5: Coastal Cypress Pine/Banksia Woodland/Littoral rainforest. The Threatened Species *Geodorum densiflorum* (Pink Nodding Orchid) occurs here in association with the Scribbly Gum. This is the largest population of this orchid known in Byron Shire. All ground orchids have mycorrhizal associations. Research indicates that such associations may facilitate the translocation of herbicide to roots thus potentially affecting the host plant if a herbicide spray regime is used (Mukerji, 1996).

Geodorum densiflorum (Orchidaceae) **under Scribbly Gum**

Section 6: The Coastal Sand Dune Complex of the frontal dune was dominated by Bitou Bush (*Chrysanthemoides monilifera* ssp. *rotundata*) with scattered Horsetail Oak (*Casuarina equisitifolia*) and Coastal Teatree (*Leptospermum laevigatum*), all planted after sandmining. The Casuarinas are becoming senescent. A Pink Nodding Orchid was exposed following the removal of Bitou Bush but has not survived without this protection.

Section 7: As the Bitou Bush is removed from the frontal dune, a beach berm is developing with sands trapped by Coastal Spinifex (*Spinifex sericeus*).

2.5 High Priority Species

High priority species and communities documented in the *Invasion of native plant communities by* Chrysanthemoides monilifera *(bitou bush and boneseed) NSW Threat Abatement Plan* (DEC 2008) identified include (some uncovered as work proceeded):

Table 1: Species, populations, or ecological communities contained in the Bitou TAP appendix 3

List all species, populations or ecological communities present from Appendix 3 of TAP	Scientific name/s	Common name/s	Priority
	Stackhousia spathulata	Stackhousia	High
	Acronychia imperforata	Beach Acronychia	Med
	Cryptocarya foetida	Stinking Cryptocarya	Med
	Geodorum densiflorum	Pink Nodding Orchid	Med
	Casuarina equisitifolia	Horsetail Oak	Med
	Cryptocarya foetida	Stinking Cryptocarya	Med
	Hibiscus tiliaceus	Beach Hibiscus	Med
	Cupaniopsis anacardioides	Tuckeroo	Low
	Glochidion sumatranum	Umbrella Cheese Tree	Low
	Acmena hemilampra	Broadleaf Lillypilly	Low
	Acacia sophorae	Coastal Wattle	?
	Banksia serrata	Saw Banksia	?
	Dianella caerulea	Flax Lily	?
	Lomandra longifolia	Spiny Matrush	?
	Monotoca elliptica	Tree Heath	?
	Rhagodia candolleana	Seaberry Saltbush	?
	Spinifex sericeus	Coast Spinifex	?

However, this extensive list includes species which may co-occur with Bitou Bush or which once occurred prior to vegetation damage. For some species, the inappropriate clearing for sandmining was the primary damage, not the Bitou Bush. We have seen some of these germinating under Bitou. For others, like the Pink Nodding Orchid, Bitou Bush provides a protective cover and consideration needs to be given to its protection during bush regeneration. Most importantly, in these highly exposed situations, the Bitou Bush helps to rebuild soil health following severe disturbance. In addition, native seed characteristics are unknown for many species. If, as is common in highly dynamic communities, seed longevity is high, there is a large window of opportunity while soil health is building.

Similarly, other weeds, like Brazilian Cherry, have performed an important role in recovery. It is under this species that a healthy population of the Threatened Species, *Cryptocarya foetida* has been found. Clearly the birds which eat the Cherry, are also distributing the seeds of the Cryptocarya.

3. THE WEEDS AND THEIR REMOVAL

Unlike in the Bradley method of bush regeneration, we do not remove all weeds. For instance, annuals are left to both provide soil cover and to aid the recovery of soil micro-organisms. It is the health of the soil that is of primary importance in ecological restoration. Weeds that are (or may become) climax communities or which can survive in healthy vegetation communities are our main focus. The exotic plants of chief concern at this site are: Bitou Bush, Glory Lily, and Coastal Teatree. Because infestations can become severe, we also remove Ground Asparagus, and Potato Vine. Brazilian Cherry,

Koda, Umbrella Tree, Climbing Nightshade and Parramatta Grass, although infrequent, are also removed.

The western edge of the site is bounded by an old sand-mining track which passes into Tyagarah Nature Reserve. This has considerable traffic for horses, dogs and people with consequent nutrient enrichment. There is a considerable diversity of weed species along the edges, particularly weed grasses. However, since they are generally confined to the track, they are not the focus of our initial work.

Bitou Bush (*Chrysanthmoides monilifera ssp. rotundata*): Bitou Bush is native to South Africa. This species is a legacy of past sandmining activities and dominates foredune and hind-dune areas. While areas shown as dominant (Map 2) are/were almost entirely Bitou dominated, Bitou is abundant throughout the site. Removal: crowning , pulling seedlings.

Glory Lily (*Gloriosa superba)*: This species is also a common exotic garden escapee. The infestation here is generally under canopy where plants are not yet robust. Glory Lily is the most time consuming and difficult weed. At least three follow-ups are required during its growing period each year for significant reduction.

Bitou bush

Glory Lily

Terry removing Glory Lily

Coastal Teatree (*Leptospermum laevigatum)* was planted after sandmining and is now an aggressive invader. It dominates the hind dune areas here and also further south in the Tyagarah Nature Reserve. Although native to NSW further south, it does not naturally occur here. Removal is being staged with areas where native trees are already established being first released. Removal is by cutting or ring-barking.

Nadia on cut Coastal Teatree

Ring-barked Coastal Teatree

Madeira Vine (Potato Vine) *(Anredra cordifolia)*: Native to South America, this climbing species is particularly threatening to native plant communities on moist sites, particularly littoral rainforest. With sub surface and aerial tubers, this plant if left uncontrolled, can destroy the rainforest canopy. One plant has been removed off site.

Ground Asparagus (A*sparagus aethiopicus*): Native to South America it is a vigorous reproductive species and is also a potentially destructive species if left uncontrolled. A few small plants have been removed and hung in adjacent vegetation.

Golden Wreath Wattle (*Acacia saligna,* endemic to Western Australia) was also planted after sandmining but does not appear to be particularly invasive here. However, an unknown axe-man chopped the tree down in 2012. There were no other individuals of this species.

4. PRESENT SITE CONDITION

Primary work and has been completed for both Bitou Bush and Glory Lily on about 4.5ha of the site. Follow-up has been completed a number of times through this area. Bitou seedlings are now infrequent while Glory Lily has been considerably reduced.

The Threatened Species Stinking Cryptocarya (*Cryptocarya foetida*) has been found here in association with Brazilian Cherry (*Eugenia uniflora*). This illustrates the role that weeds can play in aiding the distribution of native species.

Cryptocarya foetida (Lauraceae)

Two tufts of the Giant Boatlip Orchid (*Cymbidium madidum*) were uncovered on fallen Coastal Tea-tree logs, under bitou. One, however, close to the track to Tyagarah Nature Reserve, was rapidly stolen.

In addition to more intensive monitoring (as below) observations are also made throughout the site for the following:

a) Response of high priority plant species, populations, ecological communities
b) Non-target effects (monitor following any treatment).
a) Other responses of flora or fauna are noted

Regeneration has been spectacular in the past three years, both in species diversity and abundance. This has been aided by the constant rain which has allowed rainforest species to survive and grow well when they may have otherwise been burnt or droughted.

4.1 Species of Concern (Bitou TAP)

Table 2. Condition of species populations or ecological communities contained in the Bitou TAP appendix 3.

Scientific name/s	Abundance and Condition
Stackhousia spathulata	One specimen discovered, to date
Acronychia imperforata	Occasional, mature, many seedlings present
Cryptocarya foetida	Associated with Brazilian Cherry – number of healthy saplings
Geodorum densiflorum	Associated with Scribbly Gum and hind dunal ridge
Casuarina equisitifolia	Planted after sand-mining – no seedlings present
Hibiscus tiliaceus	Few plants in north-west
Cupaniopsis anacardioides	A few adult plants, occasional seedlings
Glochidion sumatranum	Rare at site, small plants present
Acmena hemilampra	Mature plants freely seeding, young plants present
Acacia sophorae	Occasional mature and young plants
Banksia serrata	Occasional mature and young plants
Dianella caerulea	Plants throughout site
Lomandra longifolia	Abundant under Coastal Teatree canopy, but frequent elsewhere
Monotoca elliptica	Frequent mature plants and abundant seedlings
Rhagodia candolleana	Occasional, increasing
Spinifex sericeus	Healthy recovery on frontal dune and berm

Most species of concern are increasing their range and abundance (Table 2).

4.2 Abundance and diversity of native and weed species

It is difficult to know over the whole site how many species were initially present post-germination under the dense Bitou Bush canopy. As at May2011 and 2013, the following numbers were present. There has been a significant increase in native species (Table 3). Of particular note has been the abundance of Celery Wood and of Poison Peach

There has also been an increase in weeds, notably herbs and grasses. Most of the weed grasses occur solely along the track to Tyagarah Nature Reserve. We consider many of the weeds, particularly the herbs and annuals as erosion protection and part of the soil restoration process.

Table 3. Number of native and weed species present on the site as at May 2013

Life Form	Native Species		Weed Species	
	May 2011	May 2013	May 2011	May 2013
Vines	3	8		4
Trees	23	35	4	5
Shrubs	5	7	2	7
Herbs	3	10	2	19
Graminoids	7	15	2	18
Ferns	1	1		
Epiphytes		1		

4.3 Changes in abundance of significant weeds

Table 4 shows changes to abundance of significant weeds. While the focus has been on the removal of Bitou Bush, Glory Lily is pulled out when revealed. It mainly occurs under dense Teatree canopy; there has been considerable reduction and stems are not robust.

Coastal Teatree has seedlings/saplings are removed by pulling. In the dense Teatree in the southern part of the site, Coastal Teatree has been removed by chain-sawing to release established rainforest trees. In both the north and the south, there was considerable blow-down in the autumn storms. This species is easy to remove as removal of leafy canopy causes the death of the tree without further treatment.

Table 4. Changes to significant weed species following control

Significant weed species	Initial density	Regeneration situation
Bitou Bush (Chrysanthemoides monilifera ssp rotundata	Dominant through half the area	Removed from about 4.5ha of initial 4.75ha infestation with follow-up completed over all of this area. More frequent follow-up in frontal dune were Bitou germination prolific.
Coastal Tea Tree (*Leptospermum laevigatum*)	Dominant in approximately half the area.	Removed from sections particularly within the dense southern section to allow space for native tree growth. March storms have blown down many. They are beginning to senesce.
Glory Lily (*Gloriosa superba*)	Scattered throughout under canopy. Not robust (i.e. tuber is not large)	Pulled. Is not in sufficient abundance to inhibit regeneration of native species
Ground Asparagus *(Asparagus aethiopicus)*	Few small plants	Removed and hung
Madiera Vine *(Anredra cordifolia)*	One plant	Removed off site
Brazilian Cherry (*Eugenia uniflora*), Koda (*Ochna serrulata*), Umbrella tree (*Schefflera actinophylla*)	Few plants of each, small	Removed by leverage as found. Larger Brazilian Cherry cut and shoots removed. It is to be noted that the avian disperser of Brazilian Cherry appears to also disperse the seed of Stinking Cryptocarya, a Threatened Species
Grasses, particularly Parramatta Grass *(Sporobolus africanus)*, Molasses Grass (*Melinus minutiflora*)	On the whole, weed grasses are confined to tracks	Parramatta Grass plants from within the site have been removed

4.3 Non-target effects

Soil disturbance, so often discussed as a drawback of manual control, is considerably less than that of the bandicoots and swamp wallabies and the excellent regeneration would also indicate this is not a problem. In addition, the light soil disturbance on removal of the Bitou Bush crown may bring buried seed to the surface.

However, one unfortunate effect of the removal of Bitou Bush has been the easy access to the site of dogs which chase Swamp Wallabies and other native species. At least one wallaby death has occurred. There has also been occasional camping. A great deal of rubbish has been removed from the site.

5. MONITORING – Bitou Bush Quadrats

5.1 Monitoring quadrats

Four monitoring quadrats have been set up in two vegetation community types (recovering littoral rainforest and frontal dune) to assess the following:

- Response of Bitou Bush (adult and seedlings) to the control program
- Response of high priority plant species, populations, ecological communities
- Response of other weed species

- Response of native species – plants and animals
- Recruitment: seedling density over time
    - In relation to canopy cover
    - In relation to original Bitou density
    - In relation to distance from frontal dune

Monitoring is completed at approximately 6-monthly intervals. Bitou seedlings are removed at this time.

5.2 Data collection

Quadrat identifier *Quadrat location* (geology/soil type) *Date of sampling*
Quadrat *AMG* – co-ordinates recorded with hand-held GPS
Photograph: across diagonal of quadrat
Treatment: Manual removal
*Floristic*s: all vascular plant species present in each quadrat
Percent crown cover: estimated visually to nearest 5% for species with greater than 10% crown cover and to the nearest 1% for species with less than 10% crown cover. These values convert to the Braun-Blanquet scale of cover abundance (DAFOR scale in brackets) as follows:

1 = less than 5% cover, ≤5 individuals (Rare) R
2 = less than 5% cover, >5 individuals (not rare) R
3 = 5-25% (O) ; 4 = 25-50% (F)
5 = 50-75% (A) ; 6 = > 75% (D)

Seedling density – number of seedlings of all species, unknowns also being counted
Seedling height – maximum height of seedlings of each species.

5.3 Results and Discussion

Monitoring has been carried out on approximately six monthly basis. The hind dune quadrats were begun in June 2010, while the frontal dune quadrats started in March 2011.

Temperatures were in the high 30's in January 2013 and this is likely to have impacted negatively on seedling survival. These impacts may have been most felt in the more open quadrats, 1 and 3. The storms of March 2013 also illustrate the importance of extreme events in these dynamic environments. It is likely that when ground cover increases it will provide a protection for other species from extremes of temperature and the drying effect of winds.

Geebung seedling protected by Bladey Grass.

5.3.1 Diversity & cover: Response of native species

There was a rapid and significant increase in the number of native species in the recovering Littoral Rainforest quadrats with a number of rainforest species amongst them (Table 5). Quadrat 2 has had a more protective ground cover, largely the vine, *Stephania japonica*. Geebung (*Persoonia adenantha)* and Tree Heath (*Monotoca ellipticaI)* have germinated particularly abundantly, though there is considerable seedling loss as well. While this may be due to extreme weather events, there may also be significant predation by Swamp Wallabies - predation has been observed in the quadrats on *Acronychia imperforata*, *Commersonia bartramia*, and *Dianella caerulea*. For Quadrat 1, now that Bitou Bush has been removed, it has more frequent foot traffic which also impacts survival.

Table 5: Native species present in quadrats over time (Littoral Rainforest/Banksia)

	0 mths Jun 2010	c.6 mths Dec 2010	c.12 mths Jun 2011	c.18 mths Nov 2011	c.24 mths July 2012	c.30 mths Jan 2013
Quadrat 2						
Total No.Trees & Shrubs	3	6	6	7	9	6
Total No. Herbs and Grasses	2	5	7	9	10	7
Total No. Vines	1	3	3	3	2	2
TOTAL NO. SPECIES	**6**	**14**	**15**	**19**	**21**	**15**
Quadrat 2						
Total Trees & Shrubs	1	5	4	5	6	4
Total Herbs and Grasses	1	2	4	6	8	3
Total Vines	1	1	1	1	1	1
TOTAL SPECIES	**3**	**8**	**9**	**12**	**15**	**8**

June 2011 July 2012

Growth rate of *Polyscias elegans* – from 30cm to 2m in a year!

While most tree and shrub species have relatively slow growth rates, Celerywood (*Polyscias elegans*) has been remarkable. In Quadrat 1, it was first recorded at 15cm in December 2010, by January 2013, it had reached 2.5m; in Quadrat 2, first recorded at 40 cm in 23 July 2011, it reached 2m by January 2013 (see Appendix 1). Similarly, a shrub (*Trema* tomentosa) just outside Quadrat 2 reached 4m within this time period.

Table 6: Native species present in quadrats over time (Frontal Dune)

	0 mths Mar 2011	c.6 mths Sept 2011	c.12 mths Apr 2012	c.18 mths Oct 2012	c.24mths Mar 2013
Quadrat 3					
Total Trees & Shrubs	3	3	4	3	
Total Herbs and Grasses	2	2	4	2	2
Total Vines		1	1	1	1
TOTAL SPECIES	**5**	**6**	**9**	**6**	**3**

Quadrat 4					
Total Trees & Shrubs	3	4	5	2	2
Total Herbs and Grasses	5	6	6	5	6
Total Vines		2	3	1	1
TOTAL SPECIES	**8**	**12**	**14**	**8**	**9**

As expected, the frontal dunes are less species rich (Table 6). While Quadrat 4 revegetated rapidly, Quadrat 3 remains very sparsely vegetated and thus more affected by weather extremes.

Most species in all quadrats have <5% cover (Table 7). The sedge, *Cyperus imbecilis* is abundant in Quadrat 1, with Snake Vine (*Stephania japonica var discolor*) and Salt Couch (*Zoysia macrantha*) common. In Quadrat 2, the Snake Vine dominates with *Cyperus imbecilis* common. In Quadrat 3, which remains relatively bare, sedges provide cover but are adversely affected by high temperatures. Quadrat 4 is well covered by Bladey Grass and Salt Couch. It was noted that Love Grass (*Eragrostis interrupta*) was

also very adversely affected by high temperatures, disappearing entirely from all plots following the high temperatures in January 2013.

Table 7a: No. of Native species within each cover class at each quadrat over time

Habitat	Initial				c.6 months			
	R1/R2	R3	R4	R5	R1/R2	R3	R4	R5
Lit. Rainforest/Banksia Woodland 1	6				14	1		
Lit. Rainforest/Banksia Woodland 2	3				7	1		
Frontal Dune 3	5				5	1		
Frontal Dune 4	8				10	2		

Table 7b: No. of Native species within each cover class at each quadrat over time

Habitat	c.12 months				c.18 months			
	R1/R2	R3	R4	R5	R1/R2	R3	R4	R5
Lit. Rainforest/Banksia Woodland 1	11	5			14	5		
Lit. Rainforest/Banksia Woodland 2	8	1			10	1		1
Frontal Dune 3	8		1		5		1	
Frontal Dune 4	11	2	1		6		2	

Table 7c: No. of Native species within each cover class at each quadrat over time

Habitat	c.24 months				c.30 months			
	R1/R2	R3	R4	R5	R1/R2	R3	R4	R5
Lit. Rainforest/Banksia Woodland 1	17	4			12	2	1	
Lit. Rainforest/Banksia Woodland 2	14	1		1	6	1		1
Frontal Dune 3	3	2			n.a.			
Frontal Dune 4	7		2		n.a.			

R1/R2=<5%; R3=6-25%; R4=26-50%; R5=51-75%

5.3.2 Diversity & cover: Response of weeds

Some weeds, e.g. the annuals, are considered to be more of an indicator of the underlying soil conditions, community health and disturbance, while others, e.g. Bitou Bush and Coastal Tea Tree, actively inhibit the regeneration of native plants. As expected, weed diversity significantly increases following Bitou Bush removal.

Species richness is most rich in the regenerating rainforest site (Table 8). However, the number of weed species is reducing with time in all quadrats

Table 8: Number of weed species (excluding Bitou Bush) present at each site over time

Habitat	Monitoring Period					
	Initial	c.6mths	c. 12mths	c. 18mths	c. 24mths	c. 30mths
Littoral Rainforest/Banksia Woodland 1	0	10	9	9	7	4
Littoral Rainforest/Banksia Woodland 2	0	8	8	12	9	4
Frontal Dune 3	1	4	6	2	2	n.a.
Frontal Dune 4	2	4	4	1	2	n.a.

. All weeds are now of low abundance within the quadrats (Table 9). Weed species present are provided in Appendix 2.

Table 9: No. of weed species (excluding Bitou Bush) within each cover class at each Quadrat over time

Habitat	Initial				6 months			
	R1/R2	R3	R4	R6	R1/R2	R3	R4	R5
Lit. Rainforest/Banksia Woodland 1					10			
Lit. Rainforest/Banksia Woodland 2					8			
Frontal Dune 3	1				4			
Frontal Dune 4	1	1			4			

Table 9b: No. of Weed species within each cover class at each Quadrat over time

Habitat	c.12mths				c.18mths			
	R1/R2	R3	R4	R5	R1/R2	R3	R4	R5
Lit. Rainforest/Banksia Woodland 1	9				9			
Lit. Rainforest/Banksia Woodland 2	8				12			
Frontal Dune 3	6				2			
Frontal Dune 4	4				1			

Table 9c: No. of Weed species within each cover class at each Quadrat over time

Habitat	c.24 months				c.30 months			
	R1/R2	R3	R4	R5	R1/R2	R3	R4	R5
Lit. Rainforest/Banksia Woodland 1	7				4			
Lit. Rainforest/Banksia Woodland 2	9				4			
Frontal Dune 3	2				n.a.			
Frontal Dune 4	2				n.a.			

R1/R2=<5%; R3=6-25%; R4=26-50%; R5=51-75%; R6=100%

5.3.3 Response of Bitou Bush

Bitou Bush initially dominated all of the quadrats and there was rapid and abundant Bitou seedling regeneration (Table 10).

Table10: No. of Bitou/m^2 at each Quadrat over time. Removal follows count at 6-monthly intervals

Habitat	Density per m2 (months)					
	Initial %	c.6mths	c.12mths	c.18mths	c.24mths	c.30mths
Lit. Rainforest/Banksia Woodland 1	100	21.28	2.3	0.42	0.43	0.04
Lit. Rainforest/Banksia Woodland 2	100	8.77	1.99	1.13	0.28	0.45
Frontal Dune 3	100	8.95	0.59	0.05	0.02	n.a.
Frontal Dune 4	100	17.81	1.98	0.62	0.12	n.a.

It was expected that Bitou Bush regeneration would initially be higher in the frontal dune as these areas have a higher nutrient input from cyclic marine salts coupled with lower competition from a less diverse native species assemblage. However, this was not borne out by the data (Table 10). From our data, it seems that the density of Bitou germination

is a function of soil conditions as the highest rates for both hind (Quadrat 1) and frontal dune (Quadrat 4) were in the quadrats which also had the highest numbers of native species regenerating. This indicates the importance of Bitou control in regaining species diversity. Nevertheless, at all sites, Bitou Bush was controlled within 2 years though further followup is required. As competition and cover from native species becomes more intense, Bitou Bush is less likely to germinate.

Bitou seedling regeneration after 6 months, Quadrat 1

6. GLORY LILY

6.1 Weed Control with herbicide – trials & observations

IT IS NOTEWORTHY THAT NONE OF THE FUNDED TRIALS TO DATE INVESTIGATED MANUAL REMOVAL AS A TREATMENT

6.1.1 Yuraygir National Park, N.S.W. (Thomas 2000)

Six herbicide treatments were used. Trial 1 was conducted between 20/1/97 and 26/1/97. Glory Lily was in flowering and early fruiting stage. Trial 2 was conducted on 5/12/97 prior to Glory Lily flowering. Each 3m x 3m plot contained a minimum of 10 stems. Stem densities were observed from $1/m^2$ to $67/m^2$. Each plot was monitored for the results of treatments at 2, 4, 6 and 8 weeks. 11 months later, stems emerging in the plots were counted.

From these trials, the most effective treatments appeared to be Glyphosate and Glyphosate + LI-700 applied before flowering. However, **the Glyphosate treatments caused high native plant mortality** even though no plants were deliberately treated. Thomas also noted that the **death rate at 8 weeks does not give a reliable indication of the effectiveness of many of the treatments** as measured by the regrowth next year.

Some comments (White, 2013):

- trials were established late in the growing season when tubers are well developed.
- Death rate on native species high with effective Glory Lily treatment – unacceptable in unstable dunal situation where Glory Lily density very high and therefore all plants present would be affected.
- Trial period far too short

6.1.2 Brunswick Heads, NSW (R.Joseph)

'R.Joseph maintains that herbicide does work on Glory Lily if you **time the application to precisely that window when the plants are emerging in Oct-.Nov** (about 6" high). She says there are a number of areas at Brunswick Nature Reserve that were thick glory lily and where it is now absent, after using this method. '(T.McDonald pers. comm.2004). However, this is only likely to work on young plants where the tuber is not well developed and, as mentioned, seeds germinate for much of the year.

6.1.3 Hastings Point, NSW (R.James to T.McDonald, March 2004)

'We have been treating at Hastings Point for around 5 years and where there was dense glory lily it is now just scattered plants. I am not sure about the critical window of Oct/Nov. **….Our spraying is generally later as we wait for the stems to grow to around 10 cms and then spray. This year for the first time we have only done one spray run.**

6.1.4 Moreton District, Queensland. (Sparkes, Grace & Panetta 2003)

A herbicide screening trial was conducted at Warana on the Sunshine Coast. Sixteen treatments and a control were set up in pot trials. Treatments were applied on 22 March 1999 and the state of plants assessed on three occasions up to 29th October 1999. The

underground rhizomes were persistent and relatively undamaged in the majority of the treatments. While a **mix of 2,4-D (200g a.i. 100 L-1) and metsulfuron-methyl (6 g a.i. 100 L-1) proved the most effective**, it was noticed that a **distinct abscission layer was present in the underground stem**, such that decomposing tissue occurred adjacent to unaffected rhizome tissue.

6.1.5 Sunshine Coast Council (Gilles & Milner 2010)

Following on from the recommendations of Sparkes and Rogers a further trial was established by Sunshine Coast Council to:

- Field test the recommended chemical application of 200mL *625g/L 2,4-D Amine + 5g Metsulfuron-methyl [600 g / kg] + 100mL BS1000 / 100 L* water;
- Evaluate the required application frequency to ensure that the use frequency is effective but not excessive; and
- Determine whether there are any effects on non-target species

The herbicide was applied 'to the point of runoff' (which means: to thoroughly wet the foliage with minimal herbicide dripping off onto the ground). The application technique required the operators to employ a deliberately slow and meticulous approach while ensuring to wet the foliage sufficiently without allowing runoff to hit the ground.

Treatments were:

1. Dec 2007 2. Dec 2007 + Feb 21008 3.Feb 2008 only
4. Dec 2007 + Dec 2008 5. Dec 2007 + Feb 2008 + Dec 2008 + Feb 2009
6 Feb 2008 + Feb 2009

- **Treatment targeting initial stages of growth for two years was the most effective (Trt, 5,4); with treatment 5 (two treatments/annum) the most effective.**
- Even with the adoption of a deliberately slow and methodical application technique, **some off target damage is to be expected** because of the high levels of infestations of *G. superba* and the intertwined nature of *G. superba* and native plant species.
- Over the duration of the trial it was observed that treatment 5 did stop *G. superba* from sexual and asexual reproduction, and thus spread. In order to achieve the greatest reduction of *G. superba* it is expected that **the treatment regime may need to be followed for up to 5 years** depending on the viability of the seed.
- This treatment is now currently recommended to only **strategically undertake control of small incursions of *G. superba* no larger than 10 x 10 meters in area**. Treatment of *G. superba* on a larger scale using this treatment is currently not recommended as it is not known if there are any cumulative impacts associated to a dunal system of this size.

Table 11: Sunshine Coast Council trials Dec 07-Dec 09: % stem reduction

SITE	A			B			C		
Treatment	**Init**	**Final**	**% red**	**Init**	**Final**	**% red**	**Init**	**Final**	**% red**
1	60	10	83%	30	20	33%	20	5	75%
2	40	15	63%	40	40	0%	5	1	80%
3	90	25	72%	30	20	33%	35	10	71%
4	50	10	80%	25	1	96%	15	3	83%
5	80	5	94%	20	3	88%	50	3	94%
6	10	3	70%	50	20	60%	15	1	93%

Comments (White, 2013)

- The slow and careful method used is unlikely to be done in the field.
- They suggest that the technique is only used for small infestations because of the potential for damage.
- Trial was for a very short period
- Measurement was subjective – Glory Lily cover estimation.
- Plots in Site A were mainly rainforest species; Site B plots were extremely variable, Banksia woodland, swamp forest, rainforest; Site C were mainly dunal (deduced from species composition). It was not possible from the report data to deduce actual canopy covers)
- Note the variability of results of plots in Site B, in particular that for treatment 2 needs explanation.

6.1.6 Bongil Bongil, NSW (Tim Scanlon, NPWS 2007-2011 ongoing)

Trial begun December 2007. For the first two years control treatments were undertaken in late spring/early summer and again in late summer. Since then, in the following two years, control treatments have only been undertaken annually in mid summer. Initially results (no. of stems and canopy cover) were reviewed in March 2008 but then annually in summer. (data we have is to Jan 2011)

Four different control treatments

1. No control
2. Glyphosate 1:75 + Metsulfuron methyl 1g/10L
3. Glyphosate 1:200 + Metsulfuron methyl 1g/10L
4. Glyphosate 1:500 + Metsulfuron methyl 1g/10L
5. 200 mL 2,4-D amine + 5 g Metsulfuron-methyl + 100 mL BS 1000 per 100 L water

Each treatment is being carried out in: a) littoral rainforest, b) sandy hind dunes.

The study commenced in December Each trial quadrat is 2m by 2m . As glory lily can grow into the quadrats from the sides, all treatments have been applied over an area of 4m by 4m.

Overall summary of results to January 2011

- Although there have been significant reductions in glory lily during the trials, there will still need to be at least several more years of treatment in order to control the species at the site, and on-going follow up of new seedlings will be required.
- The **results highlight the effects of spring rains**. When there is a wet spring there is more significant growth of glory lily over the following summer months. Despite five previous treatments there has been increased growth of glory lily across the trial plots this summer – particularly in the more open trial plots.
- Control of glory lily has been much **more effective in the littoral rainforest** plots compared with plots in the more open hind dunes.
- The technique **"Foliar spraying with 1 part Glyphosate to 75 parts water PLUS 1g of Metsulfuron methyl in 10L of water PLUS 20mL of Pulse® penetrant per 10L of water" is so far providing the most effective control,** although several of the techniques have shown good results (e.g "200 mL 2,4-D amine + 5 g Metsulfuron-methyl + 100 mL BS 1000 per 100 L water" in the rainforest plot).
- The majority of native species growth within the trial plots has been in the form of groundcovers. Only a small percentage increase of native trees has occurred within the trials (and a slight reduction for the 2,4-D amine etc. technique)

Table 12: % reduction of Glory Lily stems with different treatments

RAINFOREST	2. Glyphosate 1:75 + Metsulfuron methyl 1g/10L		3. Glyphosate 1:200 + Metsulfuron methyl 1g/10L		5. 200 mL 2,4-D amine + 5 g Metsulfuron-methyl + 100 mL BS 1000 per 100 L water	
	No. plants	% reduction from initial	No. plants	% reduction from initial	No. plants	% reduction from initial
2007 Dec	81		46		52	
2008 Mar	2	98%			1	
2008 Nov	14	83%	9	80%	6	88%
2009 Dec	5	94%	6	87%	1	98%
2011 Jan	1	99%	4	91%	2	96%

HIND DUNE	2. Glyphosate 1:75 + Metsulfuron methyl 1g/10L		3. Glyphosate 1:200 + Metsulfuron methyl 1g/10L		5. 200 mL 2,4-D amine + 5 g Metsulfuron-methyl + 100 mL BS 1000 per 100 L water	
	No. plants	% reduction from initial	No. plants	% reduction from initial	No. plants	% reduction from initial
2007 Dec	304		327		359	
2008 Mar	75	75%	72	78%	143	60%
2008 Nov	54	82%	32	90%	46	87%
2009 Dec	42	86%	56	83%	85	76%
2011 Jan	89	71%	91	72%	157	56%

Comments (White, 2013)

- The most effective treatment in these results is contrary to the Sunshine Coast findings
- These results illustrate that the results of short-term trials are unreliable
- These trials continued past Jan 2011 and further information on results has been sought.

6.2 Manual Control - Brunswick Heads Site

The bulk of the Glory Lily infestation here is found under dense canopy of Coastal Teatree (*Leptospermum laevigatum)* on the coastal dunes. There are also scattered plants in swale areas including those dominated by Bladey Grass.

Tim Scanlon (NPS) commenced Glory Lily control trials in December 2007. Our monitoring design seeks to replicate his research in quadrat size. We began in February 2011. Unfortunately we had already done almost all initial work on Glory Lily at the time we were informed of Mr. Scanlon's trial. The only areas remaining were relatively sparse under dense Coastal Teatree canopy in the southern section of the site. We set up two quadrats each $4m^2$ there.

Manual control involves removing stems at each monitoring period. Monitoring is completed at approx 2-3 monthly intervals during the Spring to Autumn periods of Glory Lily growth.

6.2.1 Data collection

The cover and abundance of species is noted as above and Glory Lily and Bitou Bush removed.

6.2.2 Results at Brunswick Heads

Glory Lily plants were small under the dense Coastal Teatree cover. Quadrat 1 has little ground cover – Lomandra is about 1%. In Quadrat 2, with a Lomandra cover of c.40%, Glory Lily was both more abundant and larger. It would seem that neither of these plants inhibit the growth of the other.

First and second growing period (Oct-May) saw a rapid reduction so that by the beginning of the 3rd growing season, stems had been reduced by 67% and 74% (Table 13). However, for the 2012-13 growing period monitoring in mid-summer and late autumn has seen no further reduction from this density.

Table 13: Beginning of each growth period ($4m^2$)

Quadrat	Initial density	Start of growing season Nov 2011	Start of growing season Nov 2012
Dense Lomandra ≥40%	111	82	21
Bare, Lomandra ≤5%	86	75	31

Although both quadrats had little regeneration after 2 months in the first half of 2011, glory lily was again abundant in both plots at the beginning of the 2011 growth period in October, though somewhat reduced. (Illustrated in Table 14 for the quadrat with the greater density) This would indicate that the optimal growth period is in the first three months. To significantly reduce growth, given that there are three growth points on the Glory Lily tuber, three follow-ups should be completed. A regime of late October/early November, late December/early January, late April/early May.

Table 14: Glory Lily regeneration over time, (No./m^2). Removal follows count

Growth Period 1			Growth Period 2			Growth Period 3		
Feb 2011	**April 2011**	**May 2011**	**Nov 2011**	**Mar 2012**	**May 2012**	**Nov 2012**	**Jan 2013**	**May 2013**
27.75	0.5	0	20.5	18.25	0	5.25	7.25	7.25

Glory Lily also occurred in 3 of the 4 Bitou Bush monitoring quadrats (Table 15)

Table15: No. Glory Lily at each Bitou Monitoring Quadrat (100m2) over time. Removal follows count at 6-monthly intervals

Habitat	Density per m2 (months)					
	Initial	**c.6mths**	**c.12mths**	**c.18mths**	**c.24mths**	**c.30mths**
Lit. Rainforest/Banksia Woodland 1	0	0.18	0.03	0.09	0	0
Lit. Rainforest/Banksia Woodland 2	0	0.07	0	0.01	0	0
Frontal Dune 3		(Sept)		(Oct)		n.a.
Frontal Dune 4	0.03	(Sept)	0.20	(Oct)	0.06	n.a.

At the quadrat sites, Glory Lily densities are low and reducing over time.

7. CONCLUSION

About 5% of the site (mainly frontal dune)still requires primary work for Bitou Bush. Bitou Bush germination has significantly reduced in all areas cleared to date. Native species have regenerated extremely well. Some areas take longer to recover than others and it would be interesting to investigate soil and hydrological characteristics.

Primary work and a number of follow-ups have been completed for Glory Lily. Some primary removal of Coastal Tea-tree has been completed. Additionally many Teatree were blown down in the storms of March 2013.

7.1 Some Final Thoughts

- Vegetation recovery may be more rapid following Bitou Bush removal by manual methods than with herbicide use
- Manual control may be at least as effective as herbicide use for Glory Lily
- Where landcare groups are well supervised, there are no obvious off-target effects to soil or native species
- The influence of weather conditions on germination, continuance of germinants, and growth could be investigated
- Projected canopy cover and other habitat characteristics need to be taken into account with regard to Glory Lily.

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Appendix 1

BRUNSWICK HEADS CHEMICAL-FREE DUNECARE

Monitoring Photographs

Quadrat identifier: 1
Quadrat location: Rear of hind dune, Littoral Rainforest
Site Characteristics: Pleistocene sand
Quadrat AMG : Brunswick Heads 9640-4-N 56J 055(4243) 684(2262)
Structure: Height of initial dominant stratum 1.5-2m (Bitou)
Primary Clearing Date: 19 June 2010

June 2010 Before we started, from the track.

6 months December 2010

2 years July 2012

Quadrat identifier: 2
Quadrat location: Rear of hind dune, Littoral Rainforest
Site Characteristics: Pleistocene sand
Quadrat AMG : Brunswick Heads 9640-4-N 56J 055(4243) 684(2262)
Structure: Height of initial dominant stratum 1.5-2m (Bitou)
Primary Clearing Date: 31 July 2010

July 2010

6 months December 2010

2 years July 2012

Quadrat identifier: 3
Quadrat location: Frontal Dune
Site Characteristics: Pleistocene sand
Quadrat AMG : Brunswick Heads 9640-4-N 56J 055(4338) 684(2231)
Structure: Height of initial dominant stratum 1.5-2m (Bitou)
Primary Clearing Date: 3 March 2011

March 2011: before

March 2011: after

6 months September 2011 2 years March 2013

Quadrat identifier: 4
Quadrat location: Frontal Dune
Site Characteristics: Pleistocene sand
Quadrat AMG : Brunswick Heads 9640-4-N 56J 055(4239) 684(2406)
Structure: Height of initial dominant stratum 1.5-2m (Bitou)
Primary Clearing Date: 5 March 2011

March 2011: before

March 2011: after

6 months September 2011

2 years March 2013

GLORY LILY – Plot 1

November 2011

March 2012

November 2012

May 2013

GLORY LILY – Plot 2

November 2011

March 2012

November 2012

May 2013

APPENDIX 2
Species present in bitou monitoring quadrats

Table 1: Native species present in quadrats over time (Littoral Rainforest/Banksia)

Species present	Quadrat 1					
Trees and Shrubs	**0 mths Jun 2010**	**c.6 mths Dec 2010**	**c.12 mths Jun 2011**	**c.18 mths Nov 2011**	**c.24 mths July 2012**	**c.30 mths Jan 2013**
Acacia seedling	1	2	1	2	2	1
Acronychia imperforata		3	3	3	1	2
Austromyrtus dulcis					1	
Banksia integrifolia					1	
Commersonia bartramia				1	3	1
Dubosia myoporoides		4	1	1		
Elaeocarpus reticulatus		1			1	
Monotoca elliptica	1	28	3	5	10	3
Persoonia adenantha	1	24	45	28	17	5
Polyscias elegans		1	1	1	3	2
Herbs and Grasses						
Cyperus eglobosus			x	x	x	x
Cyperus eragrostis			x	x		
Cyperus imbecilis		x	x	x	x	x
Dianella caerulea	x	x	x	x	x	x
Eragrostis interrupta			x	x	x	
Eragrostis leptostachya?			x			
Ficinia nodosa				x	x	x
Hydrocotyl acutiloba					x	
Ischaemum australe		x				
Lomandra longifolia	x	x	x	x	x	x
Paspalidium distans		x		x	x	x
Pterostylis nutans					x	
Zoysia macrantha				x	x	x
Vines						
Hibbertia scandens		x	x	x		
Smilax australe		x	x	x	x	x
Stephania japonica	x	x	x	x	x	x
Total No.Trees & Shrubs	**3**	**6**	**6**	**7**	**9**	**6**
Total No. Herbs and Grasses	**2**	**5**	**7**	**9**	**10**	**7**
Total No. Vines	**1**	**3**	**3**	**3**	**2**	**2**
TOTAL NO. SPECIES	**6**	**14**	**15**	**19**	**21**	**15**

Table 2: Native species present in quadrats over time (Littoral Rainforest/Banksia)

Species present	Quadrat 2					
	0 mths Jul 2010	**c.6 mths Jan 2011**	**c.12 mths July 2011**	**c.18 mths Mar 2012**	**c.24 mths July 2012**	**c.30 mths Jan 2013**
Trees and Shrubs						
Acacia seedling		2	3	3	1	
Acronychia imperforata		2				
Banksia integrifolia					1	1
Commersonia bartramia		2	1			
Cupaniopsis anacardioides		1		1	1	
Monotoca elliptica				6	6	1
Persoonia adenantha	1	10	20	14	7	1
Polyscias elegans			1	1	1	2
Herbs and Grasses						
Commelina cyanea		x	x	x	x	
Cyperus eglobosus					x	x
Cyperus imbecilis	x	x	x	x	x	x
Eragrostis interruptus					x	
Hydrocotyl acutiloba				x	x	
Oplismenus imbecillis			x	x	x	
Oxalis exilis				x	x	
Rhagodia candolleana			x	x	x	x
Vines						
Stephania japonica	x	x	x	x	x	x
Total Trees & Shrubs	**1**	**5**	**4**	**5**	**6**	**4**
Total Herbs and Grasses	**1**	**2**	**4**	**6**	**8**	**3**
Total Vines	**1**	**1**	**1**	**1**	**1**	**1**
TOTAL SPECIES	**3**	**8**	**9**	**12**	**15**	**8**

Table 3: Native species present in quadrats over time (Frontal Dune)

Species present	Quadrat 3				
Trees and Shrubs	**0 mths Mar 2011**	**c.6 mths Sept 2011**	**c.12 mths Apr 2012**	**c.18 mths Oct 2012**	**c.24mths Mar 2013**
Acacia seedling					1
Casuarina equisitifolia			**1**	**1**	
Cupaniopsis anacardioides	**1**			**1**	
Dubosia myoporoides		2	1		
Macaranga tanarius	1	1			
Monotoca elliptica			1		
Persoonia adenantha	1	22	1	4	
Herbs and Grasses					
Cyperus eglobosus	X	X	X	X	X
Cyperus enervis			X		
Cyperus imbecilis					X
Hydrocotyl acutiloba			X		
Eragrostis interruptus	X	X	X	X	
Vines					
Stephania japonica		X	X	X	X
Total Trees & Shrubs	**3**	**3**	**4**	**3**	
Total Herbs and Grasses	**2**	**2**	**4**	**2**	**2**
Total Vines		**1**	**1**	**1**	**1**
TOTAL SPECIES	**5**	**6**	**9**	**6**	**3**

Table 4: Native species present in quadrats over time (Frontal Dune)

Species present	Quadrat 4				
Trees and Shrubs	**0 mths Mar 2011**	**c.6 mths Sept 2011**	**c.12 mths Apr 2012**	**c.18 mths Oct 2012**	**c.24mths Mar 2013**
Acacia seedling	2	4	6	6	2
Commersonia bartramia	**1**	**5**	**1**		
Cupaniopsis anacardioides	**4**	**2**	**2**		
Mallotus philipennsis			1		
Persoonia adenantha		2	5	2	1
Herbs and Grasses					
Commelina cyanea					X
Cyperus eglobosus	X	X	X	X	X
Cyperus imbecilis	**X**	X	X	X	
Oxalis exilis	X	X	X	X	X
Eragrostis interruptus					X
Imperata cylindrica	X	X	X	X	X
Sesuvium portulacastrum			X		
Zoysia macrantha	X	X	X	X	X
Sedge sp.		X			
Vines					
Diplocus palmatus		X	X		
Parsonsia straminea			X		
Stephania japonica		X	X	X	X
Total Trees & Shrubs	**3**	**4**	**5**	**2**	**2**
Total Herbs and Grasses	**5**	**6**	**6**	**5**	**6**
Total Vines	**8**	**2**	**3**	**1**	**1**
TOTAL SPECIES		**12**	**14**	**8**	**9**

Table 5: Weed species present in Recovering Rainforest quadrats over time

Species present	Lit. Rf/Banksia (months)					
	INITIAL	c.6mths	c.12mths	c.18mths	c.24mths	c.30mths
Perennials						
*Chrysanthemoides monilifera	x	x	x	x	x	x
*Leptospermum laevigatum	x	x	x	x	x	x
*Ochna serrulata			x	x	x	x
*Solanum mauritianum		x	x	x		
Total No. perennial shrubs	**2**	**3**	**4**	**4**	**3**	**3**
Grasses, etc						
*Axonopus fissifolius		x	x	x		x
*Cynodon dactylon				x	x	
*Digitaria ap				x		
* Gloriosa superba		x	x	x		
*Sporobolus africanus		x	x		x	x
Total No. Graminoids		**3**	**3**	**4**	**2**	**2**
Vines						
*Ipomoea cairica		x	x	x	x	
*Solanum seaforthianum						x
Total No. Vines		**1**	**1**	**1**	**1**	**1**
Herbs, small shrubs						
*Bidens pilosa		x				
*Cirsioum vulgare					x	
*Conyza albida		x	x	x	x	x
*Conyza parva		x		x		
*Gamochaeta coarctata		x				
*Gomphocarpus sp			x			
*Senecio madagascariensis		x	x	x	x	
*Solanum lycopersicuam		x				
*Solanum nigrum		x	x	x	x	
*Sonchus oleraceus		x			x	
Total No. Herbs		**8**	**4**	**4**	**5**	**1**
Total No. Weeds	**2**	**15**	**12**	**13**	**11**	**7**

Table 6: Weed species present in quadrats at Frontal Dune over time

Species present	Frontal Dune (months)				
	INITIAL	c.6mths	c.12mths	c.18mths	c.24mths
Perennials					
*Chrysanthemoides monilifera	x	x	x	x	x
*Leptospermum laevigatum		x	**x**		
*Solanum mauritianum		x			
Total No. perennial shrubs	**1**	**3**	**2**	**1**	**1**
Grasses, etc					
*Eleusine indica			x		x
*Gloriosa superba	x		x		x
*Sporobolus africanus	x	x	x	x	x
Total No. Graminoids	**2**	**1**	**3**	**1**	**3**
Herbs, small shrubs					
*Asparagus aethiopicus		x			
*Ageratina riparia			x		
*Crassocephalum crepidioides		x	x		
*Solanum nigrum		x	x	x	x
*Conyza albida		x			
*Lantana camara			x		
*Senecio madagascariensis		x			
Total No. Herbs		**5**	**4**	**1**	**1**
Total No. Weeds	**3**	**9**	**9**	**3**	**5**