



ML1124/ML7064 Rehabilitation Monitoring 2021

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Glossary of Terms

Acronym	Description
cm	Centimetres
EA	Environmental Approval
km	Kilometres
m	Metres
ML	Mining Lease
sp.	Species (singular)
spp.	Species (plural)
sub sp.	Sub species

1 Introduction

The Mining Leases (ML) 1124 and 7064 have been mined and rehabilitated progressively since 1975. Between 2018 and 2020, Sibelco has undertaken rehabilitation in the remaining disturbed areas to allow relinquishment in the coming years. To achieve this, the rehabilitation must meet condition F2-1(a) of the Environmental Authority EPML00349813. This is evaluated using monitoring methods detailed in Section 5.2 of Rehabilitation of Disturbed Areas at ML1124, ML1132 and ML7064 North Stradbroke Island (UNIMIN, 2009).

Ausecology Pty Ltd ("Ausecology") was engaged by Sibelco to undertake monitoring of these rehabilitated areas to inform the relinquishment process including the extent of compliance with EA Condition F2-1(a). The primary aim of this monitoring was to compare rehabilitated vegetation to remnant vegetation to assess the progress and quality of the rehabilitation.

2 Methodology

This section details the data collected during the field survey, analysis of the data and limitations of the work.

2.1 Field survey

Field surveys of Glass monitoring survey sites were performed over two days between 13 and 15 July 2021 by two ecologists. A total of three rehabilitation sites were monitored including, G1, G2, and G3 during the 2021 survey. Site G1 was located within rehabilitation that was established in 2018 and was sampled for the third year. Site G2 was in a rehabilitation block which was formed in 2019 and was sampled for a second time, whereas G3 was established during the 2021 monitoring event and is located in a rehabilitation block established in 2020. All rehabilitation plots were in areas mapped as RE 12.2.10 on the Qld Regulated Vegetation Management preclearance mapping. These areas of RE 12.2.10 was dominated by *Eucalyptus planchoniana*, the key diagnostic canopy species for the RE. Three reference sites of RE 12.2.10 were also monitored in 2021 and were compared against the monitoring results of rehabilitation sites G1, G2, G3. Due to variation within regional ecosystem types, it is more appropriate to compare a rehabilitation site to a suite of reference sites to evaluate the success of the rehabilitation (Gravina, McKenna and Glenn, 2011). Therefore, rather than averaging reference site data each rehabilitation site was compared to each reference site.

At each monitoring site a 50 m tape was laid out. Within a 50 m by 2 m area (1 m either side of the tape) a stem count for each species was recorded. Some species are extremely difficult to determine how many individuals are present due to being multi-stemmed or rhizomatous with subterranean stem junctions. Therefore, for species of the sedge and rush families (Cyperaceae, Restionaceae, Hemerocallidaceae, Juncaceae), grass family (Poaceae), and the *Lomandra* (mat-rushes), *Cassytha* (dodder laurels), *Austromyrtus* (midyim) and *Xanthorrhoea* (grass-trees) genera, the foliage projective cover of the individual species was recorded within the 50 m by 2 m area (1 m either side of the tape) instead of a stem count.

Additional flora species were noted within a 10 m by 50 m plot to yield a species list. A 10 m by 50 m plot is standard for measuring the species richness of a site where diversity is highest in the lower strata (Eyre et al., 2015; Neldner et al., 2020). Several of the *Leucopogon* species have been reclassified into the *Styphelia* genus since 2020 and thus have had a name update in the 2021 report.

Start and end points of the 50 m transect was geolocated using a Trimble Geoplotter 7 with photos taken from the start and end points along the transect tape. Each site was demarcated with a star picket at the start and end of the transect to allow for repeated surveys.

Quaternary assessments as per Neldner et al. (2020) were performed at each site, to justify the selection of reference sites and the comparison of rehabilitation sites to reference sites representing a certain RE.

2.2 Analysis

Data analysis was performed as per Section 5.2 of UNIMIN (2009) and included two components: (1) Index of Similarity and (2) Species Percent Comparison.

2.2.1 Species composition

Sorenson's Index of Similarity (SIS) was employed to compare the species richness of rehabilitation sites to reference sites as measured in a 10 m by 50 m plot. It was calculated for each rehabilitation site in comparison to a corresponding reference site using the formula:

$$SIS = \frac{2c}{a + b}$$

Where:

a = species richness of the rehabilitation site

b = species richness of the reference site

c = number of species found at the rehabilitation site and the reference site

The result of this index is a value between 0 and 1, where 0 is completely different and 1 is identical. A rehabilitation site is compliant with the species composition criteria if it records an SIS value of >0.5 with any one of the three reference sites and maintains or increases that SIS value over two additional, consecutive years.

2.2.2 Species abundance

To identify if certain flora species are too sparse or over abundant within rehabilitated areas compared to the reference sites, the percent contribution of dominant species (i.e. those that contribute over 15% of stems to a reference site) are compared with each corresponding rehabilitation site.

The species abundance methodology is stated in Section 5.2 of UNIMIN (2009), and although it compares the percent contribution of species dominant in the reference sites to their percent contribution in rehabilitation sites, it does not indicate which species are dominant in the rehabilitation. Therefore, the analysis was also performed in reverse by identifying species contributing more than 15% to the stem density of rehabilitation sites and comparing that to the percent contribution of those species to each of the reference sites.

3 Results

This section presents descriptive results of the field survey followed by analysis of similarity and species contributions between rehabilitation and reference sites.

3.1 Site descriptions

3.1.1 Rehabilitation sites

There are three rehabilitation sites within the Glass Mine including, G1, G2 and G3. Sites G1 and G2 have been monitored annually since 2018 and 2019, respectively, whereas monitoring of site G3 commenced as part of the 2021 survey. The species composition of all three sites is most similar to regional ecosystem (RE) 12.2.10 which is described by the Queensland Herbarium (2018) as: “Mallee *Eucalyptus planchoniana* +/- *Corymbia gummifera*, *E. racemosa* subsp. *racemosa*, *Banksia aemula* woodland on dunes and sand plans, especially southern sand mass islands. Usually deeply leached soils”.

Rehabilitation site G1 is located within an area rehabilitated in 2018 and was monitored for the third consecutive year (Appendix A; Figure 3-1). Tree species include *Eucalyptus planchoniana*, *E. racemosa*, *Corymbia gummifera* and *Banksia aemula* ranging from 1 m to 4 m in height. The shrub layers are sparse with *Ricinocarpos pinifolius* the most abundant tall shrub species whilst *Acacia ulicifolia* is the most abundant low shrub species. The ground layer is sparse and dominated by *Caustis recurvata*, *Eriachne pallescens* and *Eragrostis* spp. Non-native species include, *Megathyrsus maximus** and *Praxelis clematidea**. New growth of plants was observed, and flowering and fruiting was also evident within the G1 site (Figure 3-2).

The 2019 rehabilitation is represented by site G2 which was monitored for the second consecutive year (Figure 3-3). Tree density remains sparse and is dominated by *Eucalyptus planchoniana* and *Banksia aemula* with a maximum tree height of 2.6 m. The tall shrub layer is yet to form, however there is a moderate density of species which will develop a tall shrub layer in the future, these include *Leptospermum polygalifolium*, *L. trinervium* and *Ricinocarpos pinifolius*. The low shrub layer is dense with *Ochrosperma lineare*, *Acacia ulicifolia* and *Woollsia pungens* – the most abundant low shrub species. The ground layer is sparse and consists of native and exotic grasses and forbs with *Imperata cylindrica*, *Caustis recurvata*, *Praxelis clematidea** observed as the most abundant. Other non-native species include, *Andropogon virginicus** and *Paspalum urvillei**. Flowering and fruiting of tree species were also observed on this site (Figure 3-4).

Rehabilitation site G3 was established during the 2021 monitoring event within vegetation rehabilitated to RE 12.2.10 in 2020. The landform at G3 includes a flat bench top which slopes down towards the west into a valley before flattening out into an ephemeral water body (Figure 3-6). The survey area is located along the southern face of the valley running along contour at the lower half of the slope (Figure 3-5). The tree layer is sparse and low with a maximum height of 1.1 m. Dominant species including, *Eucalyptus planchoniana* and *Banksia aemula* with *Angophora leiocarpa*, *Corymbia gummifera* and *Eucalyptus racemosa* also present. Defined shrub layers are yet to separate, however tall shrub species include, *Leptospermum polygalifolium*, *L. semibaccatum* and *L. trinervium*, whereas, *Acacia ulicifolia*, *Hibbertia linearis* and *Ochrosperma linearis* dominate the low shrub layer. The ground layer is dominated by bare ground however, a high native grass and forb species richness was observed, including, *Laxmannia gracilis*, *Pteridium esculentum*, *Cymbopogon refractus* and *Eriachne pallescens*. Regeneration of non-native species included, *Cynodon dactylon**, *Eleusine indica** and *Melinis repens**. The gully erosion feature caused by water draining towards the ephemeral water to the west of the 2020 rehabilitation area (as noted in the 2020 report) persists directly downslope of the G3 survey site.



Figure 3-1 Stratification of G1 site rehabilitated in 2018



Figure 3-2 Eucalyptus planchoniana fruiting in G1 site



Figure 3-3 G2 site representing 2019 rehabilitation



Figure 3-4 Banksia aemula flowering in G2 site



Figure 3-5 G3 site representing 2020 rehabilitation



Figure 3-6 Looking towards the G3 site and the 2020 rehabilitation area from above the slope

3.1.2 Reference sites

As the target RE for the rehabilitation was RE 12.2.10, three reference sites were monitored to cover the different canopy species composition and community structure of the RE 12.2.10 surrounding the rehabilitation (Table 3-1; Appendix A). No disturbance or substantial differences to the reference vegetation communities were observed in 2021 from the previous monitoring event in 2020.

The reference site - P7, is a woodland co-dominated by *Eucalyptus planchoniana* and *E. racemosa* with scattered *Corymbia gummifera* to 14 m. REF2 reference site is considered more open than P7 and is dominated by a 10 m canopy of mallee *Eucalyptus planchoniana* and *Banksia aemula* with scattered *Eucalyptus racemosa* and *Corymbia gummifera*. REF1 reference site has a similar community structure to REF2 but is co-dominated by *Eucalyptus planchoniana* and *Corymbia gummifera* however, *Eucalyptus racemosa* is absent. A commonality between all reference sites is a low tree layer of *Banksia aemula* at varying densities.

All three reference sites had a tall shrub layer, comprised of *Leptospermum trinervium*, *Ricinocarpos pinifolius* and *Monotoca* sp. (Fraser Island P.Baxter 777), which was mid-dense at P7 and REF1, but very sparse at REF2. *Xanthorrhoea johnsonii* can be considered a tall shrub in mature undisturbed form, however at all three sites was present in a trunkless form in the ground layer. At site P7, *Leptospermum polygalifolium* and *Baeckea frutescens* formed a tall shrub layer over the latter half of the transect.

Each reference site contained a diverse low shrub layer often dominated by the following shrub species: *Ochrosperma linearis*, *Homoranthus virgatus*, *Styphelia leptospermoides*, *Boronia rosmarinifolia*, *Acacia ulicifolia* and *Dillwynia retorta*. Common ground cover species included, *Caustis recurvata*, *Coleocarya gracilis* and *Platysace ericoides*.

Table 3-1 Description of rehabilitation and reference sites sampled during 2021 monitoring event

Site	Description	Transect Start	Transect End
Rehabilitation Sites			
G1	Tree layer beginning to form with <i>Eucalyptus planchoniana</i> , <i>Corymbia gummifera</i> and <i>E. racemosa</i> reaching up to 4 m in height. Heath understorey dominated by tall and low shrub species. Rehabilitation established in 2018.		
G2	Shrubland of <i>Eucalyptus planchoniana</i> , <i>Corymbia gummifera</i> , <i>Banksia aemula</i> and <i>E. racemosa</i> to a height of 2.6 m. Diverse tall and low shrub species dominated by <i>Ochrosperma lineare</i> , <i>Acacia ulicifolia</i> and <i>Aotus lanigera</i> . Rehabilitation established in 2019.		

Site	Description	Transect Start	Transect End
G3	Very sparse dwarf shrubland with tree species at a maximum 1.1 m. <i>Eucalyptus planchoniana</i> is the dominant tree, with <i>Corymbia gummifera</i> and <i>Angophora leiocarpa</i> subdominant. Diverse shrub species dominated by <i>Acacia ulicifolia</i> , <i>Hibbertia linearis</i> and <i>Ochrosperma lineare</i> .		
Reference Sites			
P7	Woodland to 14 m of <i>E. planchoniana</i> and <i>Eucalyptus racemosa</i> , with <i>Corymbia gummifera</i> and a subcanopy of <i>Banksia aemula</i> to 8 m and a dense ground layer of native tall and low shrubs.		

Site	Description	Transect Start	Transect End
REF1	Low open forest of mallee <i>Eucalyptus planchoniana</i> and <i>Corymbia gummifera</i> to 10 m with a <i>Banksia aemula</i> subcanopy to 6 m. Absence of recent fire likely resulting in a particularly high cover of tall shrubs species.		
REF2	Low open forest of mallee <i>Eucalyptus planchoniana</i> with <i>Banksia aemula</i> and scattered <i>Eucalyptus racemosa</i> and <i>Corymbia gummifera</i> to 10 m. A subcanopy of <i>Banksia aemula</i> present to 6 m.		

3.2 Species composition

A total of 85 native flora species were identified across the three reference and three rehabilitation sites during the 2021 monitoring event (Appendix B). Native species richness ranged from 34 species (REF1) to 46 species (P7). The mean native species richness across reference sites was 40 whilst the three rehabilitation sites recorded a mean of 36.3 species. A total of 26 native flora species were common to all reference sites, of which, 6 of these species were recorded at each of the three rehabilitation sites including, *Eucalyptus planchoniana* and *Banksia aemula* (i.e. the characteristics species of RE 12.2.10).

Results of the Sorenson's Index of Similarity (SIS) showed the reference sites had an average SIS value of 0.76 (Table 3-2). The species of all rehabilitation sites were most similar to P7 which recorded with a mean SIS score of 0.56 compared to the overall mean of 0.54 (Table 3-2).

Table 3-2 Results of SIS comparing the species composition of reference and rehabilitation sites

		Species Richness	Reference Sites			Mean
			P7	REF1	REF2	
Reference Sites	P7	46	-			
	REF1	34	0.73			
	REF2	40	0.81	0.73	-	
Rehabilitation Sites	G1	37	0.55	0.54	0.55	0.54
	G2	37	0.59	0.51	0.55	0.55
	G3	35	0.55	0.53	0.49	0.52

Table 3-3 compares the mean SIS values recorded from 2019 to 2021 and shows rehabilitation site G1 has decreased from the previous year, however, remains higher than the 2019 value. Rehabilitation site G2 has also decreased from the previous year whilst site G1 had not been previously monitored.

Table 3-3 Year-on-year comparison of mean Sorenson's Index of Similarity (SIS) recorded at rehabilitation sites

Rehabilitation Site	Comparable Reference Site	Establishment Year	SIS		
			2019	2020	2021
G1	P7, REF1, REF2	2018	0.50	0.69	0.54
G2	P7, REF1, REF2	2019		0.67	0.55
G3	P7, REF1, REF2	2020			0.52

3.3 Species abundance

Total stem counts were conducted within a 2 m by 50 m plots. The three reference sites recorded an average of 300.7 stems and ranged from 99 at REF1 to 539 at REF2, with P7 having 355 stems in the same sized plot (Table 3-4). Stem density was lower on the rehabilitation sites which recorded an average of 164.7 stems and ranged from 77 on G1 to 182 on G2. A total of 168 stems were recorded on the newly established rehabilitation site G3.

Table 3-4 Stem count (n) and proportion of site total (%) for reference and rehabilitation sites with dominant species highlighted blue

Species	Reference								Rehabilitation							
	P7		REF1		REF2		Mean		G1		G2		G3		Mean	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
<i>Acacia concurrens</i>	0	0.0%	0	0	1	0.2%	0.3	0.1%	0	0	0	0.0%	0	0.0%	0.0	0.0%
<i>Acacia suaveolens</i>	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	1	0.4%	4	2.4%	1.7	0.9%
<i>Acacia ulicifolia</i>	48	13.5%	2	2.0%	4	0.7%	18.0	5.5%	32	47.1%	54	20.9%	84	50.0%	56.7	39.3%
<i>Allocasuarina littoralis</i>	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%	1	1.5%	0	0.0%	0	0.0%	0.3	0.5%
<i>Aotus lanigera</i>	6	1.7%	0	0.0%	1	0.2%	2.3	0.6%	0	0.0%	7	2.7%	0	0.0%	2.3	0.9%
<i>Baeckea frutescens</i>	31	8.7%	0	0.0%	0	0.0%	10.3	2.9%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
<i>Banksia aemula</i>	18	5.1%	0	0.0%	10	1.9%	9.3	2.4%	5	7.4%	3	1.2%	5	3.0%	4.3	3.8%
<i>Boronia rosmarinifolia</i>	7	2.0%	15	15.2%	16	3.0%	12.7	6.9%	1	1.5%	0	0.0%	0	0.0%	0.3	0.5%
<i>Boronia saffrolifera</i>	0	0.0%	0	0.0%	2	0.4%	0.7	0.1%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
<i>Bossiaea heterophylla</i>	7	2.0%	0	0.0%	2	0.4%	3.0	0.8%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
<i>Brachyloma scortechinii</i>	6	1.7%	0	0.0%	7	1.3%	4.3	1.1%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
<i>Conospermum taxifolium</i>	1	0.3%	0	0.0%	12	2.2%	4.3	1.0%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
<i>Corymbia gummifera</i>	2	0.6%	6	6.1%	0	0.0%	2.7	2.2%	4	5.9%	0	0.0%	1	0.6%	1.7	2.2%
<i>Dillwynia retorta</i>	15	4.2%	0	0.0%	41	7.6%	18.7	4.5%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
<i>Dodonaea triquetra</i>	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	1	0.4%	1	0.6%	0.7	0.3%
<i>Epacris pulchella</i>	2	0.6%	0	0.0%	33	6.1%	11.7	2.6%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
<i>Eucalyptus planchoniana</i>	3	0.8%	6	6.1%	0	0.0%	3.0	2.3%	10	14.7%	5	1.9%	3	1.8%	6.0	6.1%
<i>Eucalyptus racemosa</i>	1	0.3%	0	0.0%	0	0.0%	0.3	0.1%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
<i>Hardenbergia violacea</i>	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%	1	1.5%	0	0.0%	1	0.6%	0.7	0.7%
<i>Hibbertia linearis</i>	7	2.0%	0	0.0%	19	3.5%	8.7	2.1%	0	0.0%	6	2.3%	25	14.9%	10.3	5.7%

Species	Reference								Rehabilitation							
	P7		REF1		REF2		Mean		G1		G2		G3		Mean	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
<i>Homoranthus virgatus</i>	9	2.5%	0	0.0%	19	3.5%	9.3	2.3%	1	1.5%	3	1.2%	0	0.0%	1.3	0.9%
<i>Jacksonia stackhousei</i>	0	0.0%	0	0.0%	3	0.6%	1.0	0.2%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
<i>Laxmannia gracilis</i>	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	12	4.7%	19	11.3%	10.3	5.3%
<i>Leptospermum polygalifolium</i>	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	2	0.8%	0	0.0%	0.7	0.3%
<i>Leptospermum semibaccatum</i>	0	0.0%	0	0.0%	32	5.9%	10.7	2.4%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
<i>Leptospermum trinervium</i>	1	0.3%	20	20.2%	3	0.6%	8.0	7.1%	0	0.0%	3	1.2%	0	0.0%	1.0	0.4%
<i>Styphelia deformis</i>	0	0.0%	0	0.0%	6	1.1%	2.0	0.4%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
<i>Styphelia ericoides</i>	9	2.5%	0	0.0%	5	0.9%	4.7	1.2%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
<i>Styphelia leptospermoides</i>	12	3.4%	0	0.0%	41	7.6%	17.7	4.2%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
<i>Lomatia silaifolia</i>	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	1	0.6%	0.3	0.2%
<i>Monotoca scoparia</i>	16	4.5%	0	0.0%	24	4.5%	13.3	3.3%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
<i>Monotoca sp. (Fraser Island P.Baxter 777)</i>	8	2.3%	12	12.1%	4	0.7%	8.0	5.1%	1	1.5%	0	0.0%	0	0.0%	0.3	0.5%
<i>Ochrosperma lineare</i>	34	9.6%	11	11.1%	22	4.1%	22.3	8.5%	2	2.9%	112	43.4%	11	6.5%	41.7	17.6%
<i>Persoonia virgata</i>	6	1.7%	0	0.0%	16	3.0%	7.3	1.8%	0	0.0%	4	1.6%	5	3.0%	3.0	1.5%
<i>Petrophile canescens</i>	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%	1	1.5%	1	0.4%	0	0.0%	0.7	0.6%
<i>Phyllota phyllicoides</i>	0	0.0%	0	0.0%	7	1.3%	2.3	0.5%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
<i>Pimelea linifolia</i>	2	0.6%	0	0.0%	8	1.5%	3.3	0.8%	0	0.0%	1	0.4%	1	0.6%	0.7	0.3%
<i>Platysace ericoides</i>	3	0.8%	0	0.0%	6	1.1%	3.0	0.7%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
<i>Pseudanthus orientalis</i>	0	0.0%	0	0.0%	3	0.6%	1.0	0.2%	1	1.5%	0	0.0%	0	0.0%	0.3	0.5%

Species	Reference								Rehabilitation							
	P7		REF1		REF2		Mean		G1		G2		G3		Mean	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
<i>Ricinocarpos pinifolius</i>	27	7.6%	1	1.0%	6	1.1%	11.3	3.3%	8	11.8%	9	3.5%	3	1.8%	6.7	5.7%
<i>Scoparia dulcis</i>	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
<i>Strangea linearis</i>	4	1.1%	10	10.1%	23	4.3%	12.3	5.5%	0	0.0%	1	0.4%	1	0.6%	0.7	0.3%
<i>Styphelia viridis subsp. breviflora</i>	0	0.0%	0	0.0%	3	0.6%	1.0	0.2%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0%
<i>Woollisia pungens</i>	63	17.7%	16	16.2%	156	28.9%	48.0	16.1%	0	0.0%	33	12.8%	0	0.0%	11.0	4.3%
<i>Zieria laxiflora</i>	7	2.0%	0	0.0%	4	0.7%	3.7	1.0%	0	0.0%	0	0.0%	3	1.8%	1.0	0.6%
Total	355	100%	99	100%	539	100%	300.7	100%	68	100%	258	100%	168	100%	164.7	100%

There are three species regarded as dominant (>15% of the total stem count) across the three reference sites, *Woollisia pungens*, *Boronia rosmarinifolia* and *Leptospermum trinervium*. In comparison, two species were recorded as dominant across the three rehabilitation sites, *Acacia ulicifolia* and *Ochrosperma lineare*.

The heath shrub *Woollisia pungens* was a dominant species at all three reference sites with a mean stem count of 48 and 16.1% of all stems. In comparison, *Woollisia pungens* was only detected on one of the rehabilitation sites at 33 stems which equals 12.8% of all stems recorded on G2.

Both *Boronia rosmarinifolia* at 15.2% and *Leptospermum trinervium* at 20.2% were dominant at REF1 however were not recorded as dominant in any of the other reference or rehabilitation sites.

Acacia ulicifolia was a dominant species in high abundance at all three rehabilitation sites with a mean of 56.7 stems and 39.3% of the total stem density count per site. Many reproductive individuals were observed with flowers and fruit amongst the rehabilitation sites (Figure 3-7). The species also occurred on each of the three reference sites, although not at a dominant density with a mean of 18 stems and 5.5% of the total stem count.

Ochrosperma lineare occurred on every reference and rehabilitation site however was only at a dominant density at G2 where a high number of young recruiting stems (Figure 3-8) were recorded at 112 and 43.4% of the total and increased the mean number of stems to 41.7 and 17.6% across all rehabilitation sites. In comparison, the mean number of stems recorded across the reference sites was 22.3 equalling 8.5% of the total.



Figure 3-7 Acacia ulicifolia flowering on rehabilitation site G2

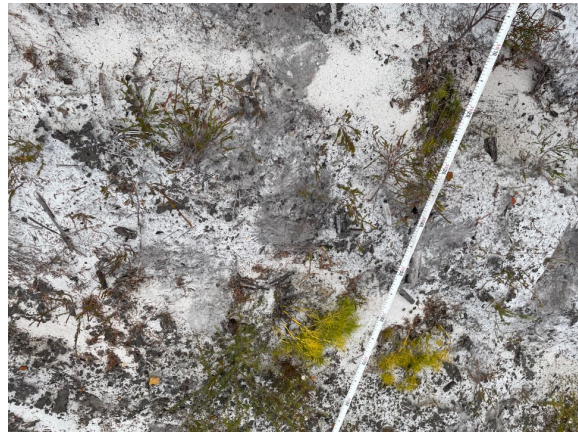


Figure 3-8 Many Ochrosperma lineare recruits on rehabilitation G2

4 Discussion

The objective of the survey was to assess rehabilitation established in 2018, 2019 and 2020 on ML1124 and ML7064 against success criteria to fulfil condition F2-1(a) of the Environmental Authority EPML00349813 using methodology detailed in Section 5.2 of Rehabilitation of Disturbed Areas at ML1124, ML1132 and ML7064 North Stradbroke Island (UNIMIN, 2009). A summary of the two criteria is presented below.

The criteria for species composition presented in section 2.2.1 states each rehabilitation site must achieve a minimum SIS value for three consecutive years; and cannot decrease in value throughout the three years. Therefore, the baseline target SIS value is 0.5 for the first year and then increases the following two years according to the previous year's SIS scores. This second condition has prevented G1 and G2 from achieving species composition compliance in 2021 as they did not record the relatively high minimum SIS value set in 2020. However, all three rehabilitation sites achieved the baseline minimum SIS value of 0.5 and will therefore need to meet the relevant minimum compliant SIS score in 2022- G1- 0.54, G2- 0.51, G3- 0.53.

The species abundance criteria is presented in section 2.2.2 and compares the abundance of dominant species within the reference and rehabilitation vegetation communities. A species is considered dominant when it represents 15% of the total stem count. As none of the rehabilitation communities shared the same dominant species as the reference counterparts, they did not achieve compliance in the species abundance criteria.

4.1 Species composition

The species richness of rehabilitation sites is high with an average of 36.3 and comparable to the reference sites which recorded an average of 40. However, the Sorensen's Index of Similarity (SIS) shows the species composition differs substantially between the rehabilitation and reference sites. This is likely due to two factors. Firstly, the tube stock and seed mixes used to rehabilitate the areas does not include a considerable amount of reference site species. Therefore, these species will only occur if they are present within the topsoil and successfully germinate from the seed bank and survive. This is the case for one of the common pioneer species- *Acacia ulicifolia*, which has naturally regenerated across all three rehabilitation sites. However, there are other shrub species common throughout all three reference sites including *Austromyrtus dulcis*, *Monotoca scoparia* and *Styphelia leptospermoides* (previously *Leucopogon leptospermoides*) which are not present on any rehabilitation site. Other common species only occurring on one rehabilitation site include *Dillwynia retorta*, *Monotoca* sp. (Fraser Island P.Baxter 777), *Cassytha pubescens* and *Leptospermum trinervium*. Due to the relative abundance of these species throughout nearby areas, it is likely most will inhabit the rehabilitation sites in the future. However, the time frame for natural regeneration of these species is uncertain and therefore presents a risk to the short to medium-term compliance of the species composition criteria. Secondly, the difference in species composition may also be due to the relatively early development stage of the rehabilitation which has a low, sparse canopy and understory cover compared to the reference sites and therefore encourages native and exotic grass and forb species richness and cover. This should balance out in the future as the canopy and understory cover increases but again, poses a short to medium- term risk of non-compliance whilst the structure of the rehabilitation communities develops.

Neither rehabilitation sites G1 or G2 equalled the SIS value recorded in 2020 and will therefore need to meet the 2021 SIS scores of 0.54 and 0.51 respectively in the 2022 monitoring event. In the G1 site, there were six species not detected in 2021 that were present in 2020 including *Acacia suaveolens*, *Acacia baueri* subsp. *Baueri* and *Entolasia marginata* whilst seven species were detected in 2021 that were not present in 2020, including *Leptospermum semibaccatum*, *Strangea linearis* and *Styphelia margarodes*. Similarly so, there were 10 species detected in G2 in 2020 that were no longer present in 2021 including *Hardenbergia violacea*, *Boronia rosmarinifolia* and *Eragrostis brownii* whilst 13 species were present in 2021 that weren't found in 2020 including *Andropogon virginicus*, *Brachyloma scortechinii* and *Gahnia sieberiana*. This highlights the dynamic nature of the

rehabilitation areas during early development with several species likely to recruit and die back each year until a resilient population of species occupies each niche.

Rehabilitation site G3 achieved the minimal compliant SIS value of 0.5 as it recorded a mean of 0.52 (range of 0.49 to 0.55) in its first year of monitoring. This site will be required to meet the minimum compliant SIS value of 0.53 in 2022.

4.2 Species abundance

There was a large increase in overall stem density in rehabilitation site G2 which increased from 182 to 258 stems. Site G1 recorded a slight decrease from 77 to 68 stems whilst a total of 168 stems were recorded throughout the G3 plot. *Woollisia pungens* remains the only species to contribute more than 15% of stems to all three reference sites, whilst *Acacia ulicifolia* is the only species classified as dominant throughout all three rehabilitation sites. It is likely *Acacia ulicifolia* is more dominant in the rehabilitation sites as it is suited to sites with an open canopy and understory typical of a recently disturbed community. As the rehabilitation sites remain sparse with a high proportion of bare ground, there is potential to increase the abundance of *Woollisia pungens* in the rehabilitation areas to a level of dominance. This is highlighted by the recruitment of 33 *Woollisia pungens* stems in site G2 which increased from 0% to 12.8% of the total stem density since the previous monitoring event. Several species were successfully reproducing with seeds observed on trees, shrubs, grass and forbs and overall stem density is expected to increase as a result. The introduction of *Woollisia pungens* to the rehabilitation sites will have a greater impact towards reaching a dominant level whilst the vegetation remains sparse.

5 References

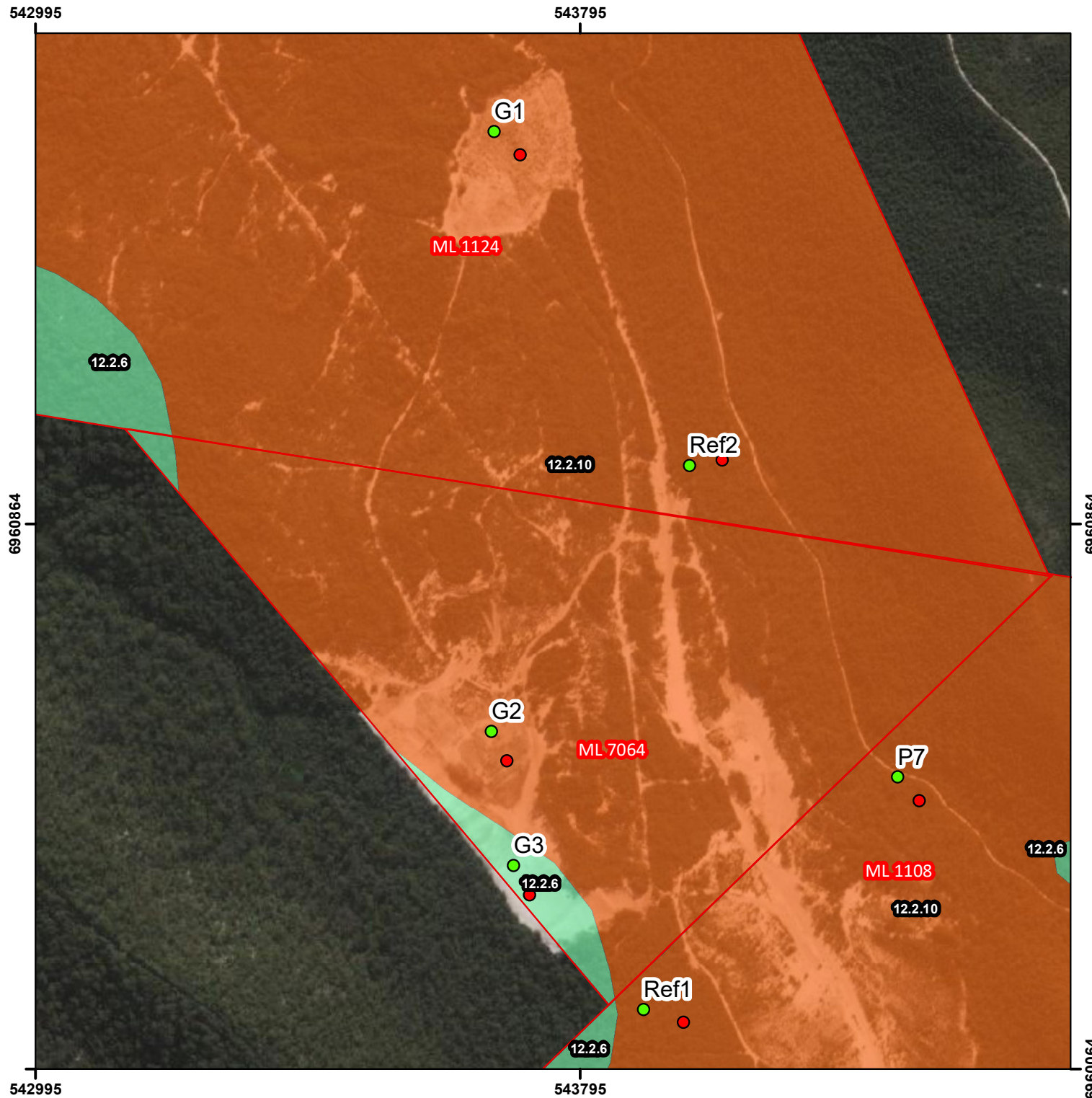
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Appendix A – Mapping



Appendix A:

Vegetation Monitoring Sites
Glass Mining Lease
North Stradbroke Island 2021



0 200 400
Meters

Scale: 1:8000

Coordinate System: GDA 1994 MGA Zone 56
Datum: GDA 1994

Legend

Transect Position

- End
- Start

Mining Leases

Pre-Clear Regional Ecosystems

- Pre-clearing area containing Of Concern RE
- Pre-clearing area that is a Least Concern RE

Data sources:
Mining Lease Boundaries
© State of Queensland (Department of Natural Resources and Mines) 2016

Document History:

Rev	Reason for Issue	Author	Reviewer	Approver	Date
A	Internal Draft	NC	AD	RR	21/07/2021
1	Issue for information	JS	RE	RR	06/08/2021

Appendix B – Species List

Scientific Name	P7	Ref1	Ref2	G1	G2	G3
<i>Acacia baueri</i> subsp. <i>baueri</i>	1					
<i>Acacia suaveolens</i>	1		1		1	1
<i>Acacia ulicifolia</i>	1	1	1	1	1	1
<i>Andropogon virginicus</i>					1	
<i>Angophora leiocarpa</i>				1		1
<i>Anthelepis paludosa</i>			1			
<i>Aotus lanigera</i>	1	1	1		1	1
<i>Aristida jerichoensis</i>				1	1	
<i>Austromyrtus dulcis</i>	1	1	1			
<i>Baeckea frutescens</i>	1					
<i>Baloskion pallens</i>	1					
<i>Banksia aemula</i>	1	1	1	1	1	1
<i>Boronia rosmarinifolia</i>	1	1	1	1		
<i>Boronia saffrolifera</i>			1			
<i>Bossiaea heterophylla</i>	1		1	1	1	
<i>Brachyloma scortechinii</i>	1	1	1	1	1	1
<i>Cassytha pubescens</i>	1	1	1			1
<i>Caustis recurvata</i>	1	1	1	1	1	1
<i>Cenchrus echinatus</i>						1
<i>Coleocarya gracilis</i>	1	1	1	1		1
<i>Conospermum taxifolium</i>	1		1			
<i>Corymbia gummifera</i>	1	1		1		1
<i>Cymbopogon refractus</i>						1
<i>Cynodon dactylon</i>						1
<i>Cyperus polystachyos</i>					1	
<i>Dianella caerulea</i>				1		

Scientific Name	P7	Ref1	Ref2	G1	G2	G3
<i>Dillwynia retorta</i>	1	1	1		1	
<i>Dodonaea triquetra</i>				1	1	1
<i>Drosera</i> sp.					1	
<i>Elaeocarpus reticulatus</i>		1				
<i>Eleusine indica</i>						1
<i>Entolasia marginata</i>	1	1			1	1
<i>Epacris pulchella</i>	1		1			
<i>Eragrostis interrupta</i>				1	1	1
<i>Eragrostis parviflora</i>				1		
<i>Eriachne pallescens</i>				1	1	1
<i>Eucalyptus planchoniana</i>	1	1	1	1	1	1
<i>Eucalyptus racemosa</i>	1		1	1		1
<i>Gahnia sieberiana</i>					1	1
<i>Gompholobium virgatum</i>				1		
<i>Hardenbergia violacea</i>				1		1
<i>Hibbertia acicularis</i>	1					
<i>Hibbertia linearis</i>	1		1	1	1	1
<i>Homoranthus virgatus</i>	1	1	1	1	1	1
<i>Imperata cylindrica</i>					1	
<i>Jacksonia stackhousei</i>	1		1			
<i>Juncus</i> sp.				1		
<i>Laxmannia gracilis</i>	1			1	1	1
<i>Leptospermum polygalifolium</i>	1				1	1
<i>Leptospermum semibaccatum</i>			1	1		
<i>Leptospermum trinervium</i>	1	1	1		1	
<i>Leucopogon virgatus</i>	1					

Scientific Name	P7	Ref1	Ref2	G1	G2	G3
<i>Lomandra elongata</i>		1		1		
<i>Lomandra laxa</i>	1					
<i>Lomandra longifolia</i>		1				1
<i>Lomatia silaifolia</i>						1
<i>Megathyrsus maximus</i>				1		
<i>Melinis repens</i>						1
<i>Monotoca scoparia</i>	1	1	1			
<i>Monotoca</i> sp. (Fraser Island P.Baxter 777)	1	1	1	1		
<i>Ochrosperma lineare</i>	1	1	1	1	1	1
<i>Paspalum scrobiculatum</i>					1	
<i>Paspalum urvillei</i>					1	
<i>Patersonia sericea</i>	1	1		1		
<i>Persoonia virgata</i>	1	1	1		1	1
<i>Petrophile canescens</i>				1	1	1
<i>Phyllota phyllicoides</i>		1	1			
<i>Pimelea linifolia</i>	1	1	1		1	1
<i>Platysace ericoides</i>	1	1	1	1		
<i>Praxelis clematidea</i>				1	1	
<i>Pseudanthus orientalis</i>	1		1	1	1	
<i>Pteridium esculentum</i>					1	1
<i>Ricinocarpos pinifolius</i>	1	1	1	1	1	1
<i>Schizaea dichotoma</i>		1				
<i>Sorghum</i> sp.	1				1	
<i>Strangea linearis</i>	1	1	1	1	1	1
<i>Styphelia deformis</i>	1		1			
<i>Styphelia ericoides</i>	1	1	1	1		

Scientific Name	P7	Ref1	Ref2	G1	G2	G3
<i>Styphelia leptospermoides</i>	1	1	1			
<i>Styphelia margarodes</i>				1		
<i>Styphelia viridis</i> subsp. <i>breviflora</i>			1			
<i>Utricularia lateriflora</i>					1	
<i>Woollsia pungens</i>	1	1	1		1	
<i>Xanthorrhoea johnsonii</i>	1	1	1	1	1	
<i>Zieria laxiflora</i>	1	1	1	1	1	1

Appendix C – Stem Count Data

			Reference Sites			Rehabilitation Sites		
Species	Life Form	NC Act Status	P7	REF1	REF2	G1	G2	G3
Area								
<i>Baloskion pallens</i>	Forb		10	0	0	0	0	0
<i>Cassytha pubescens</i>	Forb		0	0	1	0	0	0
<i>Caustis recurvata</i>	Forb		3	0	3	0	0.03	0
<i>Coleocarya gracilis</i>	Forb		3	0	2	0	0	0
<i>Gahnia sieberiana</i>	Forb		0	0	0	0	1	0
<i>Laxmannia gracilis</i>	Forb		1	0	0	0	0	0
<i>Lomandra laxa</i>	Forb		1	0	0	0	0	0
<i>Paspalum urvillei</i>	Grass	*	0	0	0	0	1	0
<i>Patersonia sericea</i>	Forb		4	0	0	0	0	0
<i>Praxelis clematidea</i>	Forb	*	0	0	0	0	3	0
<i>Schoenus paludosus</i>	Forb		0	0	2	0	0	0
<i>Xanthorrhoea johnsonii</i>	Shrub		3	0	2	0	0	0
Stem count								
<i>Acacia baueri</i> subsp. <i>baueri</i>	Forb	V	0	0	0	0	0	0
<i>Acacia complanata</i>	Shrub		0	0	0	0	0	0
<i>Acacia concurrens</i>	Shrub		0	0	1	0	0	0
<i>Acacia suaveolens</i>	Shrub		0	0	0	0	1	4
<i>Acacia ulicifolia</i>	Shrub		48	2	4	32	54	84
<i>Allocasuarina littoralis</i>	Tree		0	0	0	1	0	0
<i>Andropogon virginicus</i>	Grass	*	0	0	0	0	2	0
<i>Aotus lanigera</i>	Shrub		6	0	1	0	7	0
<i>Baeckea frutescens</i>	Shrub		31	0	0	0	0	0
<i>Banksia aemula</i>	Tree		18	0	10	5	3	5
<i>Boronia rosmarinifolia</i>	Shrub		7	15	16	1	0	0

Species	Life Form	NC Act Status	Reference Sites			Rehabilitation Sites		
			P7	REF1	REF2	G1	G2	G3
<i>Boronia saffrolifera</i>	Shrub		0	0	2	0	0	0
<i>Bossiaea heterophylla</i>	Forb		7	0	2	0	0	0
<i>Brachyloma scortechinii</i>	Shrub		6	0	7	0	0	0
<i>Cassytha pubescens</i>	Forb		0	0	0	0	0	1
<i>Conospermum taxifolium</i>	Shrub		1	0	12	0	0	0
<i>Corunastylis psammophila</i>	Forb		0	0	0	0	0	0
<i>Corymbia gummifera</i>	Tree		2	6	0	4	0	1
<i>Cymbopogon refractus</i>	Grass		0	0	0	0	0	1
<i>Cyperus polystachyos</i>	Forb		0	0	0	0	2	0
<i>Dillwynia retorta</i>	Shrub		15	0	41	0	0	0
<i>Dodonaea triquetra</i>	Shrub		0	0	0	0	1	1
<i>Epacris pulchella</i>	Shrub		2	0	33	0	0	0
<i>Eriachne pallescens</i>	Grass		0	0	0	0	5	0
<i>Eucalyptus planchoniana</i>	Tree		3	6	0	10	5	3
<i>Eucalyptus racemosa</i>	Tree		1	0	0	0	0	0
<i>Hardenbergia violacea</i>	Forb		0	0	0	1	0	1
<i>Hibbertia acicularis</i>	Forb		0	0	0	0	0	0
<i>Hibbertia linearis</i>	Shrub		7	0	19	0	6	25
<i>Homoranthus virgatus</i>	Shrub		9	0	19	1	3	0
<i>Imperata cylindrica</i>	Grass		0	0	0	0	4	0
<i>Jacksonia stackhousei</i>	Shrub		0	0	3	0	0	0
<i>Laxmannia gracilis</i>	Forb		0	0	0	0	12	19
<i>Leptospermum polygalifolium</i>	Shrub		0	0	0	0	2	0
<i>Leptospermum semibaccatum</i>	Shrub		0	0	32	0	0	0
<i>Leptospermum trinervium</i>	Shrub		1	20	3	0	3	0

Species	Life Form	NC Act Status	Reference Sites			Rehabilitation Sites		
			P7	REF1	REF2	G1	G2	G3
<i>Leucopogon virgatus</i>	Shrub		0	0	0	0	0	0
<i>Lomatia silaifolia</i>	Shrub		0	0	0	0	0	1
<i>Melinis repens</i>	Grass	*	0	0	0	0	0	1
<i>Monotoca scoparia</i>	Shrub		16	0	24	0	0	0
<i>Monotoca</i> sp. (Fraser Island P.Baxter 777)	Shrub		8	12	4	1	0	0
<i>Ochrosperma lineare</i>	Shrub		34	11	22	2	112	11
<i>Persoonia virgata</i>	Shrub		8	0	16	0	4	5
<i>Petrophile canescens</i>	Shrub		0	0	0	1	1	0
<i>Phyllota phyllicoides</i>	Shrub		0	0	7	0	0	0
<i>Pimelea linifolia</i>	Shrub		3	0	8	0	1	1
<i>Platysace ericoides</i>	Forb		3	0	6	0	0	0
<i>Pseudanthus orientalis</i>	Shrub		0	0	3	1	0	0
<i>Ricinocarpos pinifolius</i>	Shrub		27	1	6	8	9	3
<i>Scoparia dulcis</i>	Forb		0	0	0	0	0	0
<i>Strangea linearis</i>	Shrub		4	10	23	0	1	1
<i>Styphelia deformis</i>	Shrub		0	0	6	0	0	0
<i>Styphelia ericoides</i>	Shrub		9	0	5	0	0	0
<i>Styphelia leptospermoides</i>	Shrub		12	0	41	0	0	0
<i>Styphelia leptospermum</i>	Shrub		0	21	0	0	0	0
<i>Styphelia viridis</i> subsp. <i>breviflora</i>	Shrub		0	0	3	0	0	0
<i>Woollsia pungens</i>	Shrub		63	16	120	0	33	0
<i>Zieria laxiflora</i>	Shrub		7	0	4	0	0	3