

**Pacific Highway Sapphire to Woolgoolga Upgrade
Threatened Flora Monitoring
Annual Report 5**



**Prepared for NSW Roads and Maritime Services
Peter Richards
March 2016**

This report, **Pacific Highway Sapphire to Woolgoolga Upgrade Threatened Flora Monitoring Annual Report 5**, was prepared for NSW Roads and Maritime Services in accordance with the NSW *Environmental Planning and Assessment Act 1979*, the NSW *Threatened Species Conservation Act 1995* and the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999*.

The author of this report is Peter Richards, Consultant Ecologist, whose qualifications are B.Sc. (UNE).

Any opinion expressed in this report is the professional, objective opinion of the author.



March 2016

Front Cover Images:

Top: *Lindsaea incisa* fronds – Orara East State Forest translocation site;

Middle: Young *Marsdenia longiloba* plant – Split Solitary Rd *in situ* site;

Bottom: *Quassia* sp. B in fruit – Sapphire North *in situ* site.

All photographs taken February – March 2016 by Peter Richards.

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GLOSSARY

Term	Meaning
ANPC	Australian Network for Plant Conservation
EP&A Act	<i>NSW Environmental Planning and Assessment Act 1979</i>
<i>In situ</i>	Latin term meaning 'in the original place'. In this report, refers to threatened plants that have are being protected where they were found
LGA	Local Government Area
MCoA	Minister's Conditions of Approval
NSW EPA	NSW Environmental Protection Agency
NSW OEH	NSW Office of Environment and Heritage
RMS	NSW Roads and Maritime Services
S2W	Sapphire to Woolgoolga Pacific Highway Upgrade Project
S2W ERG	Sapphire to Woolgoolga Environmental Reference Group
TA	Translocation Area
TSC Act	<i>NSW Threatened Species Conservation Act 1995</i>

INTRODUCTION

Background

The Sapphire to Woolgoolga Pacific Highway Upgrade project (S2W) is a 25 km-long section of the Pacific Highway upgrade located entirely within the Coffs Harbour Local Government Area (LGA). Translocation of three threatened plant species directly impacted by the project was undertaken, with the aim of salvaging impacted individuals and establishing new, self-sustaining populations at alternative sites to compensate for the habitat and/or plants lost due to the highway development (Ecos Environmental 2010, 2011). The three translocated plant species are:

- *Lindsaea incisa*, a small ground fern, listed as Endangered under the NSW *Threatened Species Conservation Act 1995* (TSC Act);
- *Marsdenia longiloba* (Slender Marsdenia), a slender vine, listed as Endangered under the TSC Act; and
- *Niemeyera whitei* (Rusty Plum), a medium-sized rainforest tree, listed as Vulnerable under the TSC Act.

In addition to the translocated specimens, a number of individuals of the same three species were also recorded at various sites within the S2W project boundaries, along with individuals of the threatened plant *Quassia* sp. B. These plants were not directly impacted by the construction works and have been protected *in situ* within areas of native vegetation adjacent to the S2W alignment. **Figure 1** shows the location of the three translocation areas and the sites supporting *in situ* threatened flora species. **Figure 2** shows the same sites in relation to the route of the new S2W alignment.

In accordance with the Minister's Conditions of Approval (MCoA) for the S2W Flora Translocation Plan (Ecos Environmental 2010), an annual monitoring report is to be prepared, addressing the following matters:

- Background and description of the translocation project;
- A description of translocation methods;
- A description of monitoring methods;
- An analysis of monitoring data on a species by species basis;
- An assessment of causes of plant mortality;
- An accurate record of the plants transplanted and propagated;
- A description of the population enhancement program;
- Evaluate the short term success of the translocation in accordance with ANPC Guidelines for the Translocation of Threatened Plants in Australia (Vallee *et al.* 2004).
- An evaluation of the methods and cost-effectiveness of the translocation project; and
- Work plan for monitoring, maintenance and management of the translocation site over the next twelve months.

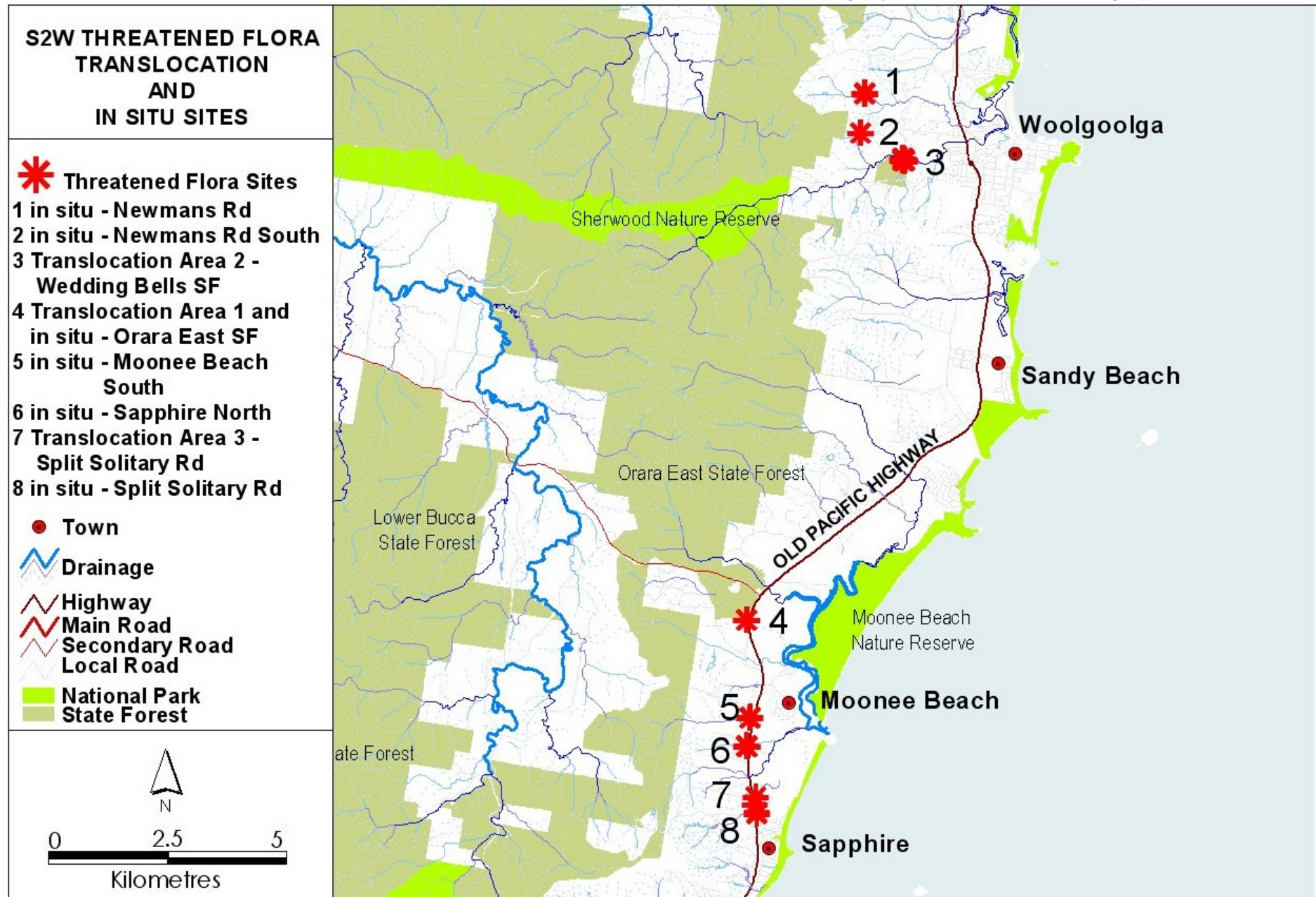


Figure 1: Location of S2W Threatened Flora Translocation Areas and *in situ* Threatened Flora sites.

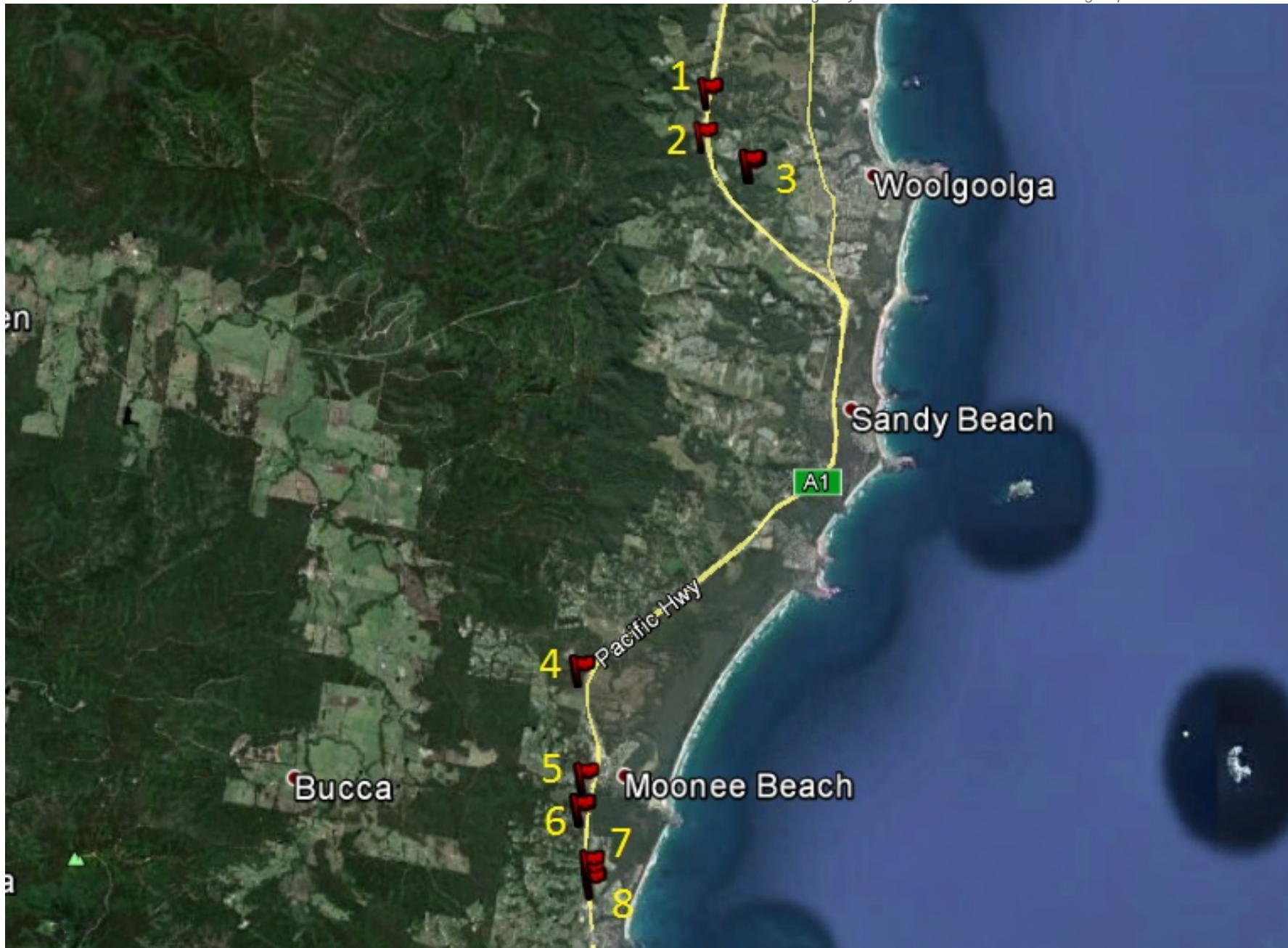


Figure 2: Location of S2W Threatened Flora Translocation Areas and *in situ* Threatened Flora sites in relation to the S2W upgrade route.

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Implementation of the flora translocation program and monitoring of translocated and *in situ* flora is based on the S2W Threatened Flora Translocation Plan (Ecos Environmental 2010) and the approved S2W Ecological Monitoring Program (Benchmark Environmental Management 2009). The first annual monitoring report (Ecos Environmental 2011) covered the period up to June 2011; the second annual reports (Ecos Environmental 2012a & b) provide results up to October 2012 and the third annual report (Richards 2013) accounts for the period up to October 2013.

The results in the third annual report (Richards 2013) revealed that most translocated Slender Marsdenia plants in Translocation Area 2 (TA2) had died back, and many Slender Marsdenia plants protected *in situ* had also died back or were in poor condition. This prompted the approval regulator, the NSW Environment Protection Authority (EPA), to seek further information regarding the possible mortality of the translocated Marsdenia plants. It was suggested by the author that, rather than survey the sites in late spring at the peak of the seasonal dry period, a survey of all translocated and *in situ* plants be undertaken in early autumn 2014, after late spring and summer rains. This proposal was accepted by EPA, and an interim report (Richards 2014a) recorded a general improvement in the condition and number of plants of all target species, including an increase in the number of live translocated Slender Marsdenia recorded at TA2. All data collected in March 2014 were also presented in the fourth annual report (Richards 2014b) which was submitted in November 2014.

This fifth annual monitoring report represents the first report with oversight of ongoing environmental monitoring and maintenance now the responsibility of RMS. This report provides the results of monitoring of translocated and *in situ* threatened flora undertaken in February and March 2016.

METHODS

Maintenance Tasks

Based upon recommendations made in the fourth annual monitoring report (Richards 2014b), a number of maintenance and plant management tasks were undertaken at all sites prior to re-surveying the plants at each site. These actions are listed below in **Table 1**. Refer to the Recommendations section below for further details.

Table 1: Maintenance and plant management tasks undertaken February - March 2016.

TASK	COMMENTS
Replace quadrat marker pegs and labelling in <i>Lindsaea incisa</i> transects at Translocation Area 1	89 <i>Lindsaea</i> plots re-located and missing or broken quadrat marker stakes replaced and re-labelled
Re-locate <i>in situ</i> Slender Marsdenia plants at Split Solitary Road site and re-label with new flagging	56 Slender Marsdenia plant points re-located and re-labelled
Re-locate <i>in situ</i> Slender Marsdenia, Rusty Plum and <i>Quassia</i> plants at other <i>in situ</i> sites and re-label with new flagging tape as required	Slender Marsdenia, Rusty Plum and <i>Quassia</i> plants re-located and re-labelled and flagged where necessary; replacement of flagging and labelling undertaken at all <i>in situ</i> sites. Over 40 newly recorded plants also labelled and flagged at several <i>in situ</i> sites
Replace plant protection cages and labels at Translocation Area 2 (TA2)	49 Rusty Plums re-located and wallaby cages replaced where necessary
Weed control / storm damage removal in TA3	Coffs Coast Bush Regeneration (CCBR) undertook weed control and debris removal. Annual follow-up recommended to maintain site
Assess need for supplementary plantings and need for replacement of hessian shading on eastern edge of <i>Lindsaea incisa in situ</i> site; assess need for supplementary plantings on eastern edge of Newmans Road South <i>in situ</i> site	CCBR undertook an assessment of both sites and advised that targeted control of exotic grasses would suffice to reduce competition with the native plants that are regenerating well at both sites. Also agreed that hessian shading is no longer required at <i>Lindsaea incisa</i> site

Translocation Methods

The translocation program was conceived, prepared and implemented by Ecos Environmental, and is described in detail in the S2W Threatened Flora Translocation Plan (Ecos Environmental 2010). The reader is referred to this plan for detailed descriptions of the objectives of the translocation project, the translocation recipient sites, and the methods employed to translocate each plant species.

Monitoring Methods

The methods employed to monitor the translocated plants and the plants protected *in situ* are described in Ecos Environmental (2010) and the approved S2W Ecological Monitoring Program (Benchmark Environmental Management 2009). A brief summary of those methods is provided here.

Plants targeted for translocation and all *in situ* plants to be protected within road reserves were each given a unique field identification code on labelled flagging tape. The labelled flagging was attached directly to each plant, or to a bamboo stake adjacent to the subject plant (in the case of *Lindsaea incisa* clumps) or to wallaby cages protecting individual plants (Rusty Plum enhancement plantings and Slender Marsdenia transplants). The locality of each plant was recorded using GPS, and maps prepared showing the location of plants in each Translocation Area or *in situ* site.

Translocated plants were assessed every three months for the first year, at six-monthly intervals for the following two years, then annually for the duration of the monitoring program. Plants protected *in situ* in road reserves were monitored at six-monthly intervals for the first two years, thence annually. **Table 2** lists the information recorded during each monitoring survey.

Table 2: Data recorded for all translocated and *in situ* plants during the S2W flora monitoring program.
x = data recorded for this species; t = recorded only for translocated specimens. *See below for description of general condition classes.

Data recorded	<i>Marsdenia longiloba</i>	<i>Niemeyera whitei</i>	<i>Lindsaea incisa</i>	<i>Quassia sp. B</i>
Species name	x	x	x	x
Unique ID code	x	x	x	x
Translocation type, date	t	t	t	
Place of origin	t	t	t	
Condition when planted	t	t	t	
Initial height	x	x	x	x
No. of stems, diameter	x	x		x
Bark condition		x		
Insect grazing	x	x	x	x
Mammal grazing	x	x	x	x
Evidence of recruitment	x	x	x	x
Date	x	x	x	x
Location	x	x	x	x
General condition*	x	x	x	x
Height	x	x	x	x
Leaf condition	x	x	x	x
No. of leaves	x			
Flowers / fruits	x	x		x
Sporangia			x	
% Cover			x	
Length of new shoots		x		x
Distance outside quadrat			x	
Evidence of disease	x	x	x	x
Notes	x	x	x	x
SITE DATA:				
Plant community height and cover	x	x	x	x
Weed abundance and composition	x	x	x	x
Unusual climatic events	x	x	x	x
Maintenance undertaken	x	x	x	x
Other ecological impacts	x	x	x	x

Condition Scores

The monitoring surveys recorded a general plant condition score on a scale of 0 to 5, where 0 is dead or died back and 5 is excellent. These condition scores may be defined for each species as follows:

Slender Marsdenia, Rusty Plum and Quassia sp. B condition classes:

0 = dead / died back; 1 = leafless and no sign of re-shooting; 2 = pruned foliage retained, or small amount of re-shooting after defoliating, or foliage sparse/dicoloured; 3 = vigorous re-shooting; 4 = crown recovering, foliage healthy; 5 = crown recovered, growing actively, flowering or seeding recorded.

Lindsaea incisa condition classes:

0 = all dead; 1 = dieback >20%; 2 = >50% yellowing; 3 = slight to <50% yellowing; 4 = very slight yellowing; 5 = all fronds healthy and green.

A leaf condition score was recorded for Rusty Plum and Quassia sp. B (the number of leaves present on Slender Marsdenia plants was recorded, rather than leaf condition). This score was also on a scale of 0 to 5, where 0 is dead and 5 is excellent.

Slender Marsdenia – dead plants

The question of when a Slender Marsdenia plant should be considered dead is especially relevant to translocated individuals, as it is vital to determine outright success or failure of translocation efforts in order to inform future proposals that might include translocation as a mitigation measure. In on-site discussions with members of the S2W Environmental Reference Group (ERG) in February 2014, an arbitrary criterion was agreed whereby if no above-ground material is recorded on an individual Slender Marsdenia plant for four consecutive years then that plant is considered to be dead.

RESULTS

In situ Flora Monitoring

Appendix 1 provides full details of the results of the S2W Year 5 autumn 2016 monitoring of all *in situ* flora. A summary and assessment of the monitoring results for each species is provided below.

Slender Marsdenia

During Year 4 surveys in November 2014 it was discovered that the numbered flagging tape had been removed from about three-quarters of the tagged Slender Marsdenia plants at the Split Solitary Road *in situ* site. This has necessitated the re-commencement of monitoring of the majority of Slender Marsdenia plants at this site from this report onwards. **Table 3** below provides monitoring results for all *in situ* Slender Marsdenia sites.

Table 3: *In situ* Slender Marsdenia monitoring results February – March 2016

CONDITION CLASS	5	4	3	2	1	0 (died back)*	total no. of live plants recorded	total no. of plants, live or died back
NUMBER OF PLANTS	4	212	29	9	0	39	254	293
PERCENTAGE	1.4	72.4	9.9	3.1	0	13.3	86.7	100

* = this category only records plants identifiable by the presence of numbered flagging.

In October 2012, a total of 137 *in situ* Slender Marsdenia individuals were being monitored, with 124 plants recorded as bearing aerial stems and leaves (Ecos Environmental 2012b). In October 2013, the total number of plants had increased to 145, with 57 plants recorded with aerial stems and leaves at that time (Richards 2013). In March 2014 a total of 183 plants (88 bearing aerial stems and leaves) were being monitored, with newly observed plants recorded at all sites, especially at Split Solitary Road, where many apparent 'seedlings' of Slender Marsdenia were recorded (Richards 2014a). In October-November 2014 a total of 140 living plants were recorded across all *in situ* sites, with at least

215 plants being monitored overall (Richards 2014b). It should be noted that the removal of flagging from many plants at Split Solitary Road makes an accurate overall plant count impossible.

The current survey of *in situ* Slender Marsdenia resulted in a total of 293 flagged plants now being monitored across all sites, with 254 plants (86.7%) recorded as alive and bearing aerial stems and leaves. This high proportion of living plants may be due to the fact that any previously flagged plant at Split Solitary Road that had its flagging removed and had died back would not have been counted in the current survey, resulting in an inflated proportion of living plants recorded this year. Of the live plants observed this current survey, over 80% were assessed as in good to excellent condition (condition classes 3 to 5). Two plants at the Split Solitary Road site were in bud (**Figure 8**).

Very dry conditions have characterised the previous four winter-spring periods, with below-average rainfall recorded during that time each year since 2012 (refer to **Appendix 4** for full rainfall statistics). This seasonal drought can induce Slender Marsdenia plants to die back to the subterranean rhizome and lie dormant, potentially for a number of years, according to monitoring data collected during this program.



Figure 3: Slender Marsdenia in bud at the Split Solitary Road *in situ* site, March 2016.

Rusty Plum

Ecos Environmental (2012b) and Richards (2013, 2014a) recorded four Rusty Plums protected *in situ* at the Moonee Beach South site. In November 2014 Richards (2014b), recorded an additional six Rusty Plums, some of which probably occur on private property outside the road reserve boundary. During the current survey, a total of 34 Rusty Plum plants (**Figures 9 and 10**) were recorded at this site (**Appendix 1**). Of these plants, 13 appear to lie within the road reserve and the remaining 21 plants most likely occur on adjacent private property. Just over half of all plants are seedlings up to 60cm high. Plants were, in general, in good health, with a mean condition score of 3.6 and median general condition and leaf condition score of 4. No plants were recorded in flower or fruit during this survey, in contrast to November 2014 when some large plants bore abundant fruits. This is likely due to the

extremely dry winter-spring of 2015 (see **Appendix 4** for rainfall statistics). The two Rusty Plums NW99 and NW100, which occur on the exposed eastern edge of the Moonee Beach South road reserve, continue to display yellowed foliage as a result of exposure. The amount of regenerating shrubs and trees in the road reserve to the east of these plants is now substantial. It is envisaged that protection of these Rusty Plums from exposure will improve over the next few years.



Figures 4 and 5: Two large Rusty Plums, showing the characteristic fluted trunk of mature trees. These plants, along with another 22 Rusty Plums, were newly recorded at the Moonee Beach South *in situ* site in March 2016, and may lie outside the road reserve boundary in adjoining private property.

Quassia sp. B

As stated in the October 2012 monitoring report (Ecos Environmental 2012b) 15 *in situ* plants of *Quassia sp. B* were tagged at two sites for ongoing monitoring. Several of these plants consist of several stems as this species, like Slender Marsdenia, propagates vegetatively from its root system. In October 2013, all but two of these plants were re-located, and an additional five plants were located at the Sapphire North site, bringing the total number of plants to 20, comprising 51 individual stems. In March 2014, all *Quassia* plants recorded in 2013 were re-located, along with an additional two plants, bringing the total number of plants to 22, comprising 60 individual stems. All plants were in very good health, with one plant bearing two fruit. In November 2014, all *Quassia* plants recorded in 2013 were re-located. One plant, at the Moonee Beach South site, had died since March 2014, and an additional plant was recorded, also at the Moonee Beach South site, leaving the total number of living individual stems at 60.

During the current survey a total of 24 *Quassia sp. B* plant sites, supporting 107 stems, was recorded. All but three existing plants, totalling five stems, were re-located, and two plants were recorded as dead (the same plants previously recorded as dead). Of those stems newly recorded in this survey, up to 20 may occur on private property adjacent to the Moonee South road reserve (in the vicinity of

Rusty Plum NW0125). All plants were in good to excellent health (**Table 4**), with five plants at Sapphire North bearing fruit (**Figure 6**) and a number of plants at Moonee Beach South suckering vigorously in response to stem damage by tree fall debris (**Figure 7**).

Table 4: March 2016 *in situ* *Quassia* sp. B results. Number refers to stems.

CONDITION CLASS	NOT FOUND	5	4	3	2	1	0 / DEAD	TOTAL
NUMBER	5	15	90	2	0	0	2	107
PERCENTAGE		14.0	84.1	1.9	0.0	0.0		100



Figure 6 (left): A *Quassia* sp. B plant bearing fruit. **Figure 7 (right):** *Quassia* sp. B plant suckering from beneath tree fall debris at Moonee Beach South site.

Lindsaea incisa

The *in situ* protected site for *Lindsaea incisa* lies within Orara East State Forest adjacent to the S2W road reserve boundary. The *L. incisa* translocation sites are located to the immediate west of the *in situ* site (see **Figure 13** in the translocated plants section below for a description of the *L. incisa* translocation areas). In October 2012 one third of the *Lindsaea incisa* population remaining *in situ* had died off within the previous six months (Ecos Environmental 2012b). The dieback appeared to be a result of habitat changes associated with clearing of vegetation up to the edge of the *L. incisa* patch. In response, a hessian wall was erected along the eastern boundary of the *in situ* population in an attempt to reduce the level of exposure to which the ferns were subject. The October 2013 survey (Richards 2013) indicated that the hessian had a beneficial effect upon the *in situ* population, with 90% of plots now supporting *L. incisa*, and 80% of those plots with *L. incisa* in good or very good condition (class 3 or 4). Fertile fronds bearing sporangia were observed in all patches. This recorded improvement was maintained in subsequent surveys (Richards 2014a, 2014b).

An increase in crown cover, and maintenance of excellent overall plant condition of the *in situ* *L. incisa* was recorded in March 2016 (**Table 5, Figure 8**). **Table 5** below provides comparative mean cover and condition scores since October 2013 (**Appendix 1**). The increase in mean canopy cover from November 2014 to March 2016 was not quite statistically significant ($t = 2.1573$; P value equals 0.0972).

Table 5: *In situ* *Lindsaea incisa* monitoring results 2013 to 2016 – mean canopy cover and condition.

Date	Mean % canopy cover	Mean condition score
October 2013	29%	3.1
March 2014	46%	4.7
November 2014	45%	5
March 2016	56%	5



Figure 8: Stand of healthy, fertile *Lindsaea incisa* fronds at Orara East SF *in situ* site March 2016.

Translocated Flora Monitoring

Slender Marsdenia

In October 2012 two Slender Marsdenia plants were recorded as bearing living aerial material. In October 2013 only one translocated Slender Marsdenia plant, ML143_1 (ML6), was observed to have above-ground vegetative growth. In March 2014, after below-average spring-summer rains, three translocated Marsdenia plants were recorded with vegetative growth. In October-November 2014 the same three plants remained alive and all had grown since March 2014. The current survey recorded only plant, ML6, with aerial stems (**Figure 9; Table 6**).



Figure 9: Slender Marsdenia transplant ML6 growing on White Cedar and Sandpaper Fig at Translocation Area 2, Wedding Bells State Forest, February 2016.

Table 6: Slender Marsdenia translocation monitoring results 2011 – 2016. Plants shaded in gold were last recorded with aerial growth in May 2011. Plants shaded green were last recorded with aerial growth in October 2012.

Transplant No.	Height and number of leaves pre-transplant March 2011	Height and number of leaves May 2011	Height and number of leaves Oct 2012	Height and number of leaves Oct 2013	Height and number of leaves Mar 2014	Height and number of leaves Oct-Nov 2014	Height and number of leaves Feb – Mar 2016
ML160 (ML1)	100cm, 16 leaves	25cm, 5 leaves	28cm, 2 leaves	died back	110cm, 12 leaves	140cm, 12 leaves	died back
ML161 (ML2)	40cm, 6 leaves	80cm, 3 leaves	died back	died back	5cm, 3 leaves	30cm, 4 leaves	died back
ML162 (ML3)	50cm, 8 leaves	120cm, 7 leaves	died back	died back	died back	died back	died back
ML163 (ML4)	10cm, 6 leaves	130cm, 2 leaves	stem died back, base green under bark	died back	died back	died back	died back
ML143 (ML5)	150cm, 25 leaves	130cm, 8 leaves	stem died back, 4cm at base still green	died back	died back	died back	died back
ML143_1 (ML6)	rhizome	10cm, 4 leaves	180cm, 16 leaves active growing tip	230cm, 9 leaves	200cm, 2 leaves	240cm, 16 leaves	240cm, 18 leaves
ML143_2 (ML7)	rhizome	130cm, 11 leaves	died back	died back	died back	died back	died back
ML143_3 (ML8)	rhizome	8cm, 3 leaves	died back	died back	died back	died back	died back

As discussed above, it is difficult to tell when a plant of Slender Marsdenia might have died or has simply died back to its subterranean rhizome, hence the decision to consider as dead any plant that has not shown above-ground growth for four consecutive years. With regard to the translocated individuals listed above, all were last recorded as bearing aerial stems and leaves in May 2011. Since that time, three plants, ML3, ML7 and ML8, have not been recorded as bearing living above-ground parts, and should now be considered to have died. Two other plants, ML4 and ML5, were recorded as having died back in October 2012, but still bearing remnant aerial stems that were green at the base. Since all of these plants were recorded as having died back in the current survey, they too must now be considered dead. To date, the Slender Marsdenia translocation effort has resulted in one plant (12.5% of the total) bearing aerial growth since translocation, and three of eight plants (ML1, ML2, ML6) possibly remaining alive since translocation - a success rate of 37.5%.

Rusty Plum Transplants

A total of nineteen (19) Rusty Plum trees, saplings and natural seedlings were transplanted to Translocation Area 2 (TA2) in Wedding Bells State Forest (15 plants) and TA3 at Split Solitary Road (four plants). By October 2013 the survival rate of transplanted Rusty Plums was 68% (Richards 2013). Six individuals had (most likely) died or could not be re-located. 12 individuals (80%) at TA2 were

surviving and most were in good condition although some plants had been damaged by tree fall and wind-blown debris at the site. At TA3, three plants were thought to have died and one plant was still alive and in good condition. The March 2014 survey (Richards 2014a) revealed that no translocated Rusty Plums were lost since the previous survey. A general improvement in the condition of plants in TA2 was noted, and a previously lost plant, NW126 at TA3, was re-located. The October-November 2014 survey (Richards 2014b) recorded all existing Rusty Plums were alive and showing a general improvement in condition, including several plants at TA2 in excellent condition, and one plant, NW61, in flower.

The current survey re-located all but one transplant (NW58_2) in TA2, and both living transplants in TA3. Transplant NW69_6, which had not been recorded since October 2012, was re-located in TA2 (**Table 7**). General condition of transplants was good to excellent, with transplant NW130 in TA3 showing a significant improvement in health since the previous survey. Overall survival of translocated Rusty Plums stands at 74% as at March 2016.

Table 7: Rusty Plum individuals transplanted to TA2 and TA3 showing height and diameter at breast height (dbh) before transplanting, and their height and condition from May 2011 to February 2016.

Site	Id No.	Height & dbh before transplanting	Height May 2011	Cond May 2011	Height Oct 2012	Cond Oct 2012	Height Oct 2013	Cond Oct 2013	Height Mar 2014	Cond Mar 2014	Height Nov 2014	Cond Nov 2014	Height Feb 2016	Cond Feb 2016
TA2	NW58	2 stems joined at base, 8m, 10cm dbh	2 stems, 1.1m	3	1.8m	3	2.1m	3	2.2m	4	2.4m	5	2.9	5
	NW59	7m, 10cm dbh	3.2m	3	3.7m	3	4m	3	4.1m	4	4.5m	5	5	5
	NW60	6m, 6cm dbh	2m	3	2.4m	3	2.8m	4	3.0m	5	3.5m	5	4	5
	NW61	9m, 12cm dbh	4.8m	3	5.1m	3	5.5m	3	5.7m	5 in flower	6m	5	6.5	5
	NW62	3m, 3cm dbh	0.8m	3	0.8m	3	0.7m	3	0.8m	4	1m	5	1.1	5
	NW63	8.5m, 10cm dbh	2.2m	3	2.9m	3	3.2m	2	1.2m	3	1.8m	4	2.1	4
	NW64	3 stems, 6m, 6cm dbh	0.6m	3	0.9m	3	Dead	0	-	0	-	Dead	-	Dead
	NW64_1	part of NW64	0.5m	3	0.7m	3	Dead	0	-	0	-	Dead	-	Dead
	NW69	2 stems joined at base, 8m, 10cm dbh	2 stems, 2m, 0.9m	3	2.5m, 1.1m	3	2.2m	3	3.0m	4	2.4m	5	2.7	5
	NW58_1 (T1)	seedling	40cm	3	62cm	3	50cm	3	50cm	4	60cm	5	0.7	5
	NW58_2 (T2)	seedling	10cm	3	10cm	3	25cm	3	30cm	4	30cm	4	-	Not found
	NW58_3 (T3)	seedling	28cm	3	35cm	3	30cm	2	30cm	3	40cm	3	0.4	3
	NW58_4 (T4)	seedling	42cm	3	60cm	3	45cm	3	55cm	4	55cm	4	0.55	4
	NW58_5 (T5)	seedling	50cm	3	62cm	3	28cm	3	35cm	4	45cm	5	1	2
NW69_6 addendum	3m, 6cm dbh	1.6cm	3	1.8m	3	Not found	0	-	0	-	Dead	3.3	5	
TA3	NW128	6m (transplanted Sept 2011)		2	1.7m	3	1.7m	0	-	0		Dead	0	Dead
	NW129	7m (transplanted Sept 2011)		2	1.8m	3	1.8m	0	-	0		Dead	0	Dead
	NW130	5m (transplanted Sept 2011)		2	1.8m	3	1.8m	3	1.5m	2	1.5m	2	1.6	3
	NW126	1.8m	0.2m	0		0	0	0	1m	3	1m	3	1.1	3

Rusty Plum Enhancement Plantings

Direct-seeding

Of the 68 Rusty Plum seeds sown into TA2 in November 2010, 29 (42.6%) were recorded as surviving in October 2013, compared to a survival rate of 51 (75%) in 2012. This reduction in survival of Rusty Plum seeds was apparently due mainly to difficulty in re-locating some of the seedlings, as in March 2014 43 living seedlings (63.2%) were re-located and in October-November 2014 44 living seedlings (65% of the original number) were re-located. The current survey re-located 36 (53%) seedlings, and mean seedling height had increased substantially (**Table 8**). For individual seedling height and condition details refer to **Appendix 2a**.

Table 8: Monitoring Results - Rusty Plum Seeds (68 seeds originally direct-seeded into TA2 in November 2010)

YEAR	2012	2013	Mar 2014	Nov 2014	Feb 2016
SEED STATUS	NO. (%)	NO. (%)	NO. (%)	NO. (%)	No. (%)
Seed germinated	51 (75)	29 (42.6)	43 (63.2)	44 (65)	36 (53)
Seed gone	17 (25)	39 (57.4)	25 (36.8)	24 (35)	32 (47)
Mean seedling height (cm)	31.2	35.0	34.6	37.5	49.9

Pot-germinated seeds

The 20 Rusty Plum seedlings that were germinated from seed then planted out into TA2 in March 2011 have fared similarly to the direct-seeding trial, with 70% survival and growth recorded for all 2013 and 2014 surveys. The results of the current survey were similar, with 13 (65%) of pot-germinated seedlings re-located (**Table 9**). Refer to **Appendix 2b** for individual seedling height and condition details.

The decrease in numbers of seedlings re-located is most likely due to the presence of considerable amounts of ground debris from tree and stag falls in TA2 since the previous survey. At least some of the lost seedlings are most likely alive but concealed by ground debris. Similarly, natural regeneration at TA2 has obscured some areas of the understorey.

Table 9: Monitoring Results - Rusty Plum Seedlings (20 seedlings originally planted at TA2 in March 2011)

YEAR	2012	2013	Mar 2014	Nov 2014	Feb 2016
SEED STATUS	NO. (%)	NO. (%)	NO. (%)	NO. (%)	No. (%)
Seedling alive	17 (85)	14 (70)	14 (70)	14 (70)	13 (65)
Seedling gone	3 (15)	6 (30)	6 (30)	6 (30)	7 (35)
Mean seedling height (cm)	30.6	35.1	40.4	45	66

As described above, during the current survey of TA2 the original wire wallaby guards, which had started restricting the growth of many Rusty Plum enhancement plantings, were removed and replaced with 1.2m high by 40cm wide plastic mesh guards supported by hardwood stakes (**Figures 10 and 11**).

The enhancement planting program for Rusty Plum, utilising both direct-seeding and planting of pot-germinated seedlings, has been successful to date, with at least 49 plants established and growing within TA2, in addition to the original translocated plants. Overall, the plants are in fair to excellent condition (**Figure 12**). The new wallaby guards will ensure ongoing protection of these enhancement plantings until the plants are tall enough to be out of reach of browsing macropods.



Figure 10 (left): Rusty Plum D20, a direct-seeded transplant, in original wire wallaby guard. **Figure 11 (right):** a replacement 1.2m high plastic mesh guard.



Figure 12: Rusty Plum P16, a pot-germinated transplant, showing excellent growth and vigour in a new mesh wallaby guard.

Lindsaea incisa

A description of the layout of the *L. incisa* translocation area is provided below (Figure 13).

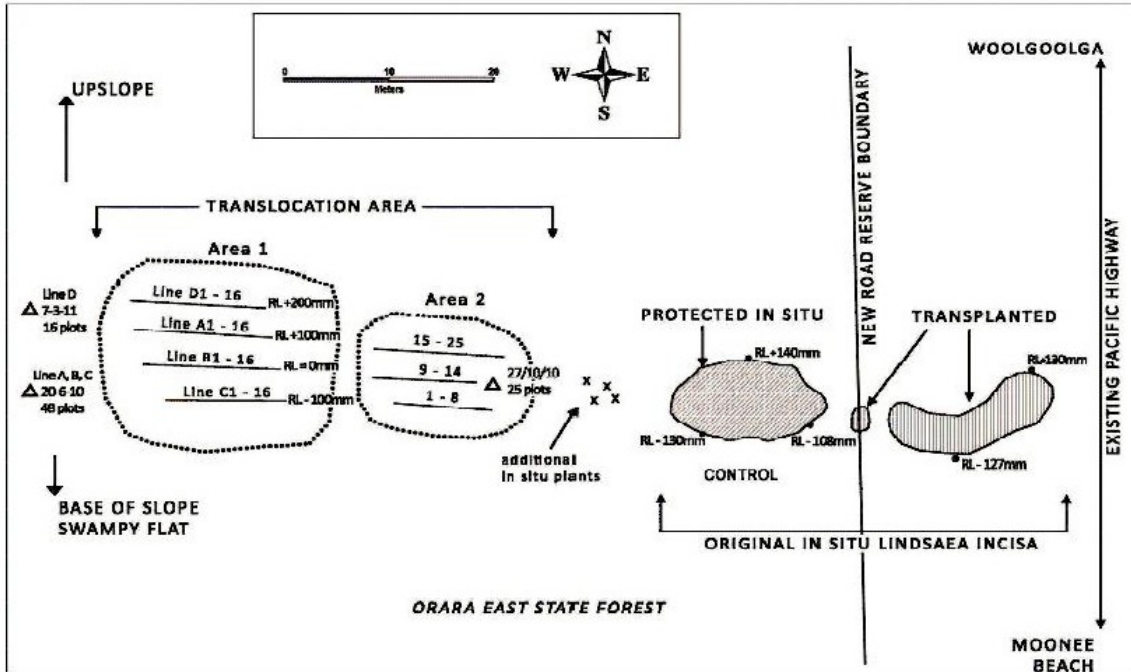


Figure 13: Diagram of *Lindsaea incisa* in situ and translocation sites in Orara East State Forest (from Ecos Environmental 2012a)

Area 1

Area 1 comprises three lines of 16 quadrats and one line (Line D) of 10 quadrats, each 0.5m square and containing *L. incisa* transplants (Figure 14). Each line follows a contour relative to a surveyed elevation point, with Line D the highest, then Lines A, B and C each 100mm lower respectively.



Figure 14: *Lindsaea incisa* transplant quadrats – Area 1, Line C. March 2016.

Between 2012 and 2013, the mean percent crown cover of *L. incisa* in Area 1 decreased highly significantly on Line A, decreased significantly on Line B, increased non-significantly on Line C and decreased highly significantly on Line D. A significant increase in mean cover was recorded in Lines A and B in March 2014 compared to October 2013, and non-significant decreases in mean cover in Lines C and D were recorded for the same period. The November 2014 survey, in comparison to March 2014 revealed a significant increase in mean cover on Line A and a very significant increase in mean cover on Line D. Increases in mean cover on Lines B and C were not statistically significant (refer to **Figure 15** and **Table 10** below).

Results from the February 2016 survey revealed a significant increase in mean cover on Line A compared to November 2014, a non-significant increase on Line C, and non-significant decreases in mean cover on Lines B and D (**Figure 15, Table 10**). **Appendix 3a** provides individual quadrat details for Feb-Mar 2016 and **Appendix 3b** provides full results of the paired t-tests of significance.

The general condition of *L. incisa* plants in terms of foliage vigour was generally high across the site, with healthy fronds bearing sporangia present in all quadrats that supported plants of *L. incisa*. However, as in previous surveys, Lines A and D consistently supported good plant cover in all quadrats as well as vigorous growth of plants beyond quadrat boundaries. The *L. incisa* in quadrats 1 to 11 on Line A have expanded to the point where there is now almost contiguous cover of *L. incisa* across the extent of those quadrats. Most plants appear to have died on Line C, with only two quadrats still containing plants as of February 2016. Line B had plants present in 10 of 16 quadrats. Overall survival of *L. incisa*, based upon quadrats still supporting *L. incisa* in Area 1, is 76%.

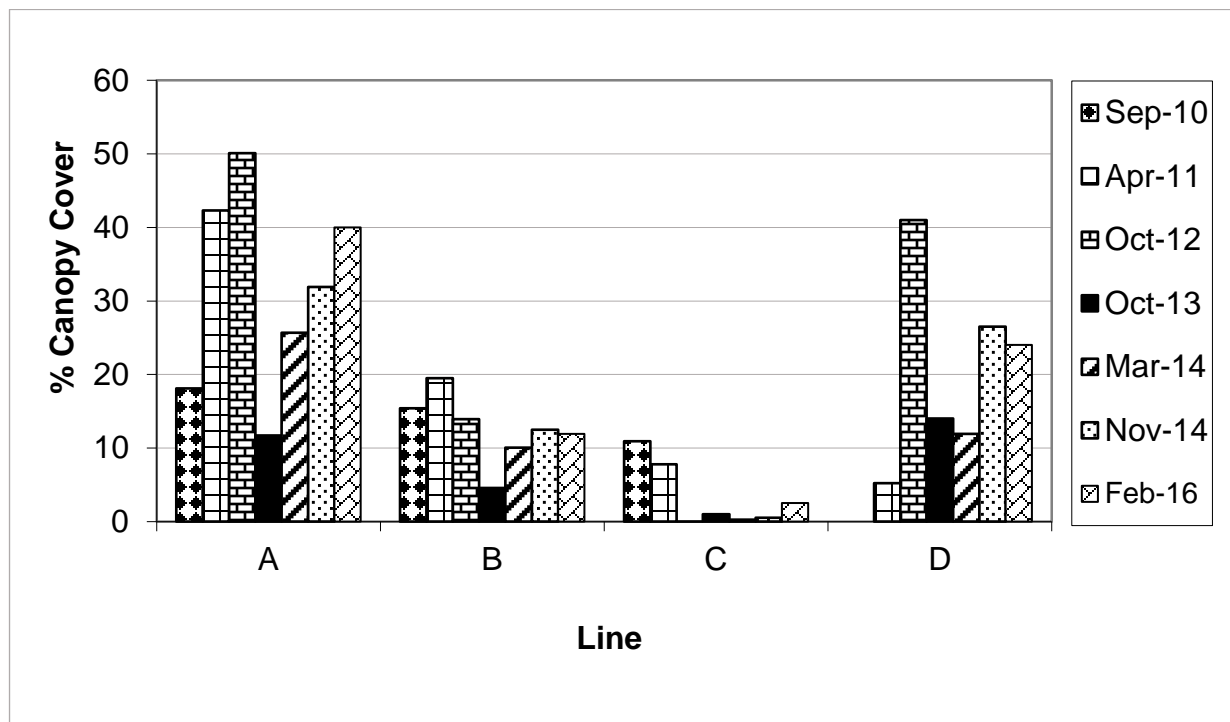


Figure 15: Mean percent crown cover of *Lindsaea incisa* on lines A, B, C and D (Area 1) between Sep 2010 and Feb 2016.

Table 10: Mean percent crown cover of *Lindsaea incisa* (\pm standard error) on transect lines A, B, C and D (Area 1) Sep 2010 to Feb 2016. The results of paired t-tests comparing mean canopy cover data for Nov 2014 with data from Feb 2016 are provided. Sig = significant; NS = not significant.

Area 1 Line	Sep-10	Apr-11	Oct-12	Oct-13	Mar-14	Nov-14	Feb-16	T-value	P-value
Line A (n=16)	18.1 (± 2.8)	42.3 (± 6.2)	50.1 (± 7.9)	11.69 (± 2.5)	25.7 (± 3.6)	31.9 (± 4)	40.0 (± 3.16)	2.263	0.0389 (Sig)
Line B (n=16)	15.4 (± 3.2)	19.5 (± 4.9)	13.9 (± 4.8)	4.56 (± 1.6)	10.1 (± 3.1)	12.5 (± 3.4)	11.9 (± 3.3)	0.2863	0.7786 (NS)
Line C (n=16)	10.9 (± 0.9)	7.8 (± 2.7)	0.1 (± 0.1)	1.0 (± 0.9)	0.25 (± 0.19)	0.5 (± 0.3)	2.5 (± 1.71)	1.1579	0.265 (NS)
Line D (n=10)	NA	5.2 (± 1.1)	41.0 (± 5.7)	14 (± 2.6)	11.9 (± 5)	26.5 (± 4.3)	24 (± 2.33)	0.5423	0.6008 (NS)

Area 2

Area 2 is an additional set of three lines, with Line 1 the highest elevation and Lines 2 and 3 each 100mm lower respectively (**Figure 13**). Area 2 was established to transplant fragments of *L. incisa* that had been grown on in pots after the initial translocation into Area 1 had occurred (Ecos Environmental 2012a).

Of the 27 quadrats placed over three lines in Area 2, nine (33.3%) were recorded as supporting *L. incisa* in February 2016 and, of those nine quadrats, six were on Line 1 and three were on Line 2. These findings are similar to those reported by Ecos Environmental (2012a) and Richards (2013 & 2014a & b). **Table 11** below provides a summary of comparative crown cover of *L. incisa* over time in Area 2. All plants recorded in February 2016 bore sporangia and were in very good to excellent condition (**Figure 16**). Full details and tests of significance for Area 2 are provided in **Appendix 3a** and **Appendix 3b** respectively.

Table 11: Mean percent crown cover of *Lindsaea incisa* (\pm standard error) on transect lines 1, 2 and 3 (Area 2) Oct 2010 to Feb 2016. The results of paired t-tests comparing data for November 2014 and Feb 2016 are provided. NS = not significant.

Area 2 Line	Oct-10	Apr-11	Oct-12	Oct-13	Mar-14	Nov-14	Feb-16	T-value	P-value
Line 1 (n=9)	13.3 (± 2.5)	42.4 (± 9.1)	20.1 (± 7.7)	7.0 (± 2.7)	15.6 (± 6.4)	22.2 (± 5.7)	33.3 (± 8.7)	2.1693	0.0619 (NS)
Line 2 (n=12)	8.6 (± 1.8)	19.0 (± 7.4)	1.4 (± 1.2)	1.33 (± 0.9)	2.9 (± 1.8)	7.5 (± 4.1)	10.83 (± 5.7)	1.7728	0.1039 (NS)
Line 3 (n=6)	11.2 (± 2.1)	17.3 (± 2.1)	0	0	0	0	0	n/a	n/a

The translocated *L. incisa* is now reaching what might be considered to be 'natural' levels of canopy cover, particularly in Area 1 where *L. incisa* cover is, in places, approaching that measured at the *in situ* quadrats. It is expected that cover of *L. incisa* transplants will tend to level off from now on, in response to natural processes operating at the site, e.g., seasonal variation in hydrology, and

competition from other ground cover species including *Hibbertia aspera*, *Entolasia marginata*, *Ptilothrix deusta* and *Chorizandra cymbaria*.



Figure 16: *Lindsaea incisa* transplant growing vigorously and extending beyond Quadrat 7 on Line 1 of Area 2, March 2016.

SITE CONDITIONS

Plant community canopy height and cover

Split Solitary Road (Slender Marsdenia *in situ* site and TA3 for Rusty Plum – mature moist open Tallowwood – Grey Gum – Grey Ironbark forest with good forest structure; height 20-30m, crown cover 60%

Orara East SF (*Lindsaea incisa* TA1 and *in situ* site) – mature open heathy Needlebark – Red Mahogany – Sieber’s Paperbark woodland/forest with good forest structure; height 15-20m, crown cover 40%

Sapphire North – mature moist open Grey Gum – Ironbark – Turpentine forest with good forest structure; height 25-30m, crown cover 60%

Newmans Rd South – mature moist open Grey Gum – Tallowwood - Ironbark forest with good forest structure; height 25-28m, crown cover 60%, except near edge where canopy is more open

Moonee Beach South – mature wet open Tallowwood – Brush Box – Flooded Gum - Grey Gum forest with good forest structure and mesic mid-stratum; height 25-35m, crown cover 60%

Newmans Rd – mature moist open Tallowwood – Ironbark – Pink Bloodwood forest with good forest structure and mesic mid-stratum; height 20-30m, crown cover 60% apart from edge on roadside which remains more open and supports a ferny / grassy understorey. Some formerly open gaps are regenerating naturally.

Wedding Bells State Forest (TA2 for Rusty Plum and Slender Marsdenia) – Regenerating *Eucalyptus grandis* (Flooded Gum) very tall wet sclerophyll forest 25-35m, crown cover 60% where canopy exists,

with an open to dense mid-stratum of rainforest species under the canopy and open weedy understorey where substantial crown gaps exist. Good canopy cover and structure where canopy is intact, regeneration slow but advancing where canopy is absent. Native species such as White Cedar and Sandpaper Fig are starting to colonise the open areas.

Weed abundance and composition

Split Solitary Road / TA3 – Moderate, in places heavy, infestations of *Lantana camara* (Lantana) and *Senna pendula* (Winter Senna), although these species often support plants of Slender Marsdenia. Small trees and seedlings of *Cinnamomum camphora* (Camphor Laurel) are also present at low frequency.

Orara East State Forest / TA1 – more or less weed free.

Sapphire North – more or less weed free, apart from a little *Lantana camara*.

Newmans Road South - light to moderate infestation of *Lantana camara*.

Moonee Beach South – light to moderate infestation of *Lantana camara*, *Senna pendula* and *Ochna serrulata* (Mickey Mouse Plant).

Newmans Road - light to moderate infestation of *Lantana camara* and *Senna pendula*.

Wedding Bells State Forest / TA2 – fairly heavy infestations of *Ageratum houstonianum* (Blue Billygoat Weed) and *Paspalum mandiocanum* (Broad-leaf Paspalum); moderate level *Caesalpinia decapetala* (Mysore Thorn), *Lantana camara* and *Bidens pilosa* (Cobblers Pegs); significant numbers of young *Erythrina vespertilio* (Bat-Wing Coral Tree) and *Melicope elleryana* (Pink Doughwood). *Solanum mauritianum* (Wild Tobacco) is currently providing beneficial shade in the open regenerating areas. It is dying off and being replaced in some places by natives such as *Melia azedarach* (White Cedar) and *Ficus coronata* (Creek Sandpaper Fig). The many seedlings of Bat-Wing Coral Tree and Mysore Thorn originate from large naturalised specimens in the vegetated areas adjacent to TA2. These plants require removal in order to prevent constant re-infestation of TA2 by these species.

Climatic events

The local climate since 2010 has been characterised by four years of above average summer rainfall (2010-2013) but below average rainfall over winter and spring each year from 2012 to 2015. The summer of 2015-2016 has been one of the hottest and driest on record. It is likely that sites on the western side of the highway experienced frosts in winter 2012, 2013 and 2014. Refer to **Appendix 4** for monthly rainfall statistics covering the duration of the translocation and monitoring program to date.

Site Maintenance

Split Solitary Rd / TA3 – Mar 2016 - Re-location and re-flagging and numbering of Slender Marsdenia plants.

Orara East State Forest / TA1 – 2014 - mesh boundary fencing replaced with flagged ropes to allow macropods to more easily traverse the site. Feb-Mar 2016 – replacement of bamboo marker stakes and numbered flagging at all *Lindsaea incisa* transplant quadrats; replacement of marker stakes and numbered flagging at all *in situ* *Lindsaea incisa* quadrats. Feb 2016 the eastern side of the *in situ* *Lindsaea incisa* site was assessed by the author and Brent Hely (CCBR). Confirmed that hessian shade screen is no longer required as regeneration is excellent. Targeted removal of exotic grasses here would reduce competition and further enhance natural regeneration at this site.

Sapphire North – Mar 2016 – Some flagging and marker stakes replaced.

Newmans Road South - Mar 2016 – Some flagging and marker stakes replaced. The eastern edge of this site was assessed by the author and Brent Hely of CCBR. Noted that natural regeneration is very good, but targeted spraying of exotic grasses would enhance regeneration by reducing competition.

Moonee Beach South - Mar 2016 – Flagging and marker stakes replaced.

Newmans Road – Mar 2016 – Some flagging and marker stakes replaced.

Wedding Bells State Forest / TA2 – Late 2013 – early 2014 - CCBR undertook weeding and removal of dead Coral Tree wood. March 2014 – hand-weeding around a number of Rusty Plum seedlings, further opening of wallaby cages to allow seedling growth. October/November 2014 – weeding and removal of native vines from numbers of Rusty Plums; opening of remaining wallaby cages to enable unimpeded growth of seedlings. February-March 2016 – CCBR undertook weed control, removal of fallen tree debris from Rusty Plum transplant, and along with the author replaced the wire wallaby cages on most Rusty Plum enhancement plantings with larger mesh guards.

Other ecological impacts

No other ecological impacts such as outbreaks of disease, insect infestations or excessive dust deposition on foliage were observed.

DISCUSSION

Evaluation of Translocation Program

In accordance with the Minister's Conditions of Approval, an evaluation of the short-term success of the S2W flora translocation program against criteria outlined in *ANPC Guidelines for the Translocation of Threatened Plants in Australia* (Vallee *et al.* 2004) is required. A summary evaluation against those criteria is provided in **Table 12** below.

Table 12: Evaluation of short-term success of S2W translocation program, using criteria in Vallee *et al.* (2004).

Short-term criterion (Vallee <i>et al.</i> 2004)	Slender Marsdenia	<i>Lindsaea incisa</i>	Rusty Plum
>70% of transplants are surviving, with representatives from the range of genetic individuals planted	No	Yes	Yes
New populations have similar characteristics to natural populations	No	Yes	?
Survival of transplants to reproductive stage (producing flowers and fruit)	No	Yes	Yes
Reproduction of transplants is at levels consistent with naturally occurring plants,	No	Yes	?

Short-term criterion (Vallee <i>et al.</i> 2004)	Slender Marsdenia	<i>Lindsaea incisa</i>	Rusty Plum
including seed viability			
Translocation success?	No	Yes	Yes, to date

Slender Marsdenia

It is clear that, by all criteria, the translocation of *Slender Marsdenia* has failed in the short-term. It should be noted, however, that this assessment is based upon the decision to deem as dead those plants that have not produced aerial stems for four consecutive years. **Table 6** above shows that the longest a transplanted *Slender Marsdenia* has died back before resprouting is two years. It is possible that some rhizomes now classed as dead could resprout in the future, but in order to evaluate the success or otherwise of a translocation effort there must be a point at which a plant can be assessed as dead. In the case of *Slender Marsdenia*, four years without above-ground growth seems a reasonable, albeit arbitrary, length of time. A possible cause of translocation failure is alluded to by Ecos Environmental (2012a), which reports that *Slender Marsdenia* thrives in the absence of competition for available soil nutrients and water. The *Slender Marsdenia* translocation site at Wedding Bells State Forest has shown significant regeneration of native trees, shrubs and ground cover species since being prepared as a recipient site in October 2010. This regeneration, coupled with moderate to dense infestations of weeds such as Broad-leaf Paspalum and Blue Billygoat Weed, has most likely increased competition for available nutrients and moisture at the site. It is possible that *Slender Marsdenia* plants have succumbed to this increase in competition.

Lindsaea incisa

The translocation of *Lindsaea incisa* has been successful, with 76% of transplants in Area 1 surviving and healthy and spreading beyond the original quadrats. In addition, the experimental nature of the transplants has provided valuable information regarding specific habitat requirements of *L. incisa*, with the majority of surviving transplants occurring along the highest elevation transects in Area 1. Whilst it is a simple matter to examine the fronds of this species for the presence of sporangia and spores, it is not possible to determine whether any propagation has resulted from spores (i.e., sexual reproduction) in the transplanted colonies, rather than vegetative propagation. Whatever its method of spreading, the translocated *L. incisa* in Area 1 is, in places, approaching the canopy cover measured at the *in situ* quadrats, and cover may be expected to remain more or less the same from now on, in response to natural processes operating at the site, such as seasonal variation in hydrology, and competition from other ground cover species.

Rusty Plum

The translocation of *Rusty Plum* should be considered a success at this stage, with 74% of translocated plants surviving. Being long-lived trees, it is difficult to assess short-term criteria such as population structure and reproductive levels when it may take decades for some translocated *Rusty Plum* plants to become reproductive. As suggested by Vallee *et al.* (2004), it is recommended that for long-lived taxa the short-term criteria be limited to survival of plants, with other criteria being assessed in the long term.

Evaluation of Methods and Cost-effectiveness of the Translocation Program

At this stage in the translocation program, a few comments can be made in relation to the efficacy and cost-effectiveness of the different methods employed.

Slender Marsdenia

Although the method employed for the translocation of *Slender Marsdenia* is relatively inexpensive (apart from the cost of preparing a suitable recipient site), the poor results to date would suggest that there is no point in attempting future translocations with this species.

Lindsaea incisa

The method employed for the translocation of *L. incisa* is relatively inexpensive and simple, as long as suitable habitat is available as a recipient site. The success of this translocation program to date suggests that *L. incisa* is a suitable subject for translocation in the future if other mitigation measures are not available.

Rusty Plum

The translocation of large Rusty Plum specimens, and the acquisition, preparation and ongoing management of a suitable recipient site, is the most expensive translocation methodology employed during the S2W translocation program. The high success rate of this method for this species would suggest that it is an appropriate strategy for future projects, in the absence of other mitigation measures. However, the relatively simple and inexpensive enhancement planting method, which involves direct-seeding and planting pot-grown seedlings into the recipient site, has proved to be almost as successful as tree translocation at this stage in the program, having contributed at least 49 extra plants to date. Consideration should be given to employing the latter methodology in preference to translocation of large trees in the future.

RECOMMENDATIONS / WORK PLAN

Weed Control – TA2

Weed control will be necessary at least annually (preferably twice annually), in order to effectively suppress infestations of weeds in TA2. Brent Hely (CCBR), who undertook weed control in TA2 in February 2016, recommends a follow-up weeding in TA2 in early December 2016, in order to minimise the production of seed by Broad-leaf Paspalum. Ongoing control of Broad-leaf Paspalum, Mysore Thorn and Bat-Wing Coral Tree in TA2 is very important, as these species can suppress regeneration and quickly invade disturbed native vegetation. Mysore Thorn is listed as a Class 3 Noxious Weed under the *NSW Noxious Weeds Act* and, as such, it is a legal requirement that the plant must be fully and continuously suppressed and destroyed. As the principal source of seed of Mysore Thorn and Bat-Wing Coral Tree lies outside TA2 in the adjacent area of State Forest, it will be necessary to remove those mature plants as well. The following weed management recommendations are made for TA2:

1. A weed control program is conducted twice annually, targeting infestations of Broad-leaf Paspalum, Mysore Thorn, Bat-Wing Coral Tree, Blue Billygoat Weed and Lantana. The next program should be undertaken in early December 2016.
2. Discuss with Forestry Corporation NSW the potential for a cooperative weed removal and control program in areas of the State Forest adjoining TA2. Target weeds are the listed Noxious Weeds Mysore Thorn and Lantana. Other target species include adult Bat-Wing Coral Tree and Winter Senna.

Weed Control – Split Solitary Road

Moderate to dense infestations of Lantana and Winter Senna occur at the Split Solitary Road *in situ* site. In the course of the current monitoring program, all Slender Marsdenia plants observed at this site have been freshly numbered and flagged. It is therefore recommended that:

3. A weed control program be undertaken at Split Solitary Road by a bush regeneration team who are familiar with Slender Marsdenia or have been trained to recognise the species by an experienced botanist. Target species are Lantana, Winter Senna and Camphor Laurel.

Protective plantings – TA1 and Newmans Road South

The author and Brent Hely of CCBR assessed roadside plantings adjacent to TA1, the *Lindsaea incisa in situ* and translocation site, and Newmans Road South, a Slender Marsdenia *in situ* site, where CCBR advice was sought in regard to supplementary plantings in the road reserve to protect the adjacent threatened plants from exposure at the forest edge - CCBR advice at both sites was not to undertake supplementary planting, as there is a good cohort of young native shrubs and trees present at both sites, albeit infested with dense exotic grasses. CCBR recommends for these sites:

4. Undertake targeted control of exotic grasses at TA1 and Newmans Road South road reserve edges in order to reduce competition and promote regeneration of native shrubs and trees at

both sites. Target species are Rhodes Grass, Setaria and Giant Paspalum. Estimated effort is one person for two hours at each site.

Hessian Shade Screen – TA1

A large hessian screen, erected along the edge of the road reserve at TA1, has been protecting *in situ* *L. incisa* plants from exposure since 2012. At some time after November 2014, the screen was removed. In spite of this, the *L. incisa* is healthy and appears to be flourishing, even in the very hot and dry summer of 2015-16. It is therefore recommended that:

5. The hessian screen at TA1 not be re-installed, but that targeted weed control as per Recommendation 4 above be undertaken.

Newly recorded Rusty Plums and Quassia sp. B at Moonee Beach South site

Accurate locality information should be obtained for the newly recorded Rusty Plums and *Quassia* sp. B plants at Moonee Beach South to determine whether they are within or outside the road reserve boundary. If, as suspected, many of these plants are outside the road reserve, then it is recommended that:

6. Consideration should be given to initiating discussions with CHCC and relevant landholders about appropriate management / zoning of this area with a view to ensuring protection of the native vegetation and threatened species that occur there.

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APPENDIX 1: Monitoring Results – all *in situ* flora February - March 2016

Species	Id No.	Location	General Condition	Height	Leaf Condition	Flower /fruit	Length of new shoots	Evidence of disease	Note	No. plants per site
Marsdenia longiloba	ML1	Split Solitary Rd	3	20cm	3				On ground log	1
Marsdenia longiloba	ML5d	Split Solitary Rd	3	40cm	2				on Dianella caerulea	1
Marsdenia longiloba	ML5e	Split Solitary Rd	0						Died back	0
Marsdenia longiloba	ML8b	Split Solitary Rd	0						Died back	0
Marsdenia longiloba	ML13	Split Solitary Rd	4	50cm	7				On leaf litter. One other plant near old flagging	2
Marsdenia longiloba	ML16	Split Solitary Rd	4	1m	14				On Cryptocarya rigida downslope of ground layer ML16s recorded Nov 2014. 3 seedlings adjacent	4
Marsdenia longiloba	ML16a-c	Split Solitary Rd	4	20cm	8 to 12				Three plants on litter plus 2 seedlings	5
Marsdenia longiloba	ML19	Split Solitary Rd	4	1.9m	12				On Jagera pseudorhus. Note: hairy stems and petioles = T. woollsii	1
Marsdenia longiloba	MLseedlings	Split Solitary Rd	4	<40cm	2 to 6				Same site as WPT067 from Nov 2014. 49 'seedlings' in area bounded by pink-flagged bamboo stakes on NE, NW, SE and SW corners. Plot c. 6m X 20m (long axis N-S). All adult plants within this plot have been individually flagged and numbered.	49
Marsdenia longiloba	WPT089	Split Solitary Rd	3	1m	6				Beneath Cryptocarya rigida on stick. Flagged Oct '13. One other plant 30cm 12lvs on Lomandra longifolia to S.	2
Marsdenia longiloba	WPT091	Split Solitary Rd	2	1m	1				Dying back; stem green	1
Marsdenia longiloba	ML001	Split Solitary Rd	5	70cm	12				On broken Turpentine branch nr highway edge. Northernmost plants. Plus 3 seedlings	4
Marsdenia longiloba	ML002	Split Solitary Rd	5	2.5m	22	Old in flor.			On small Turpentine adjacent to ML001.	1
Marsdenia longiloba	ML003	Split Solitary Rd	4	5cm	8				In litter b/w Tallowwood and Grey Gum. Flagging on Notelaea longifolia 1m to W	1
Marsdenia longiloba	ML004	Split Solitary Rd	4	60cm	17				In MLseedlings plot. On Senna pendula	1
Marsdenia longiloba	ML005	Split Solitary Rd	4	40cm	7				In MLseedlings plot. On Smilax australis, base of Turpentine	1
Marsdenia longiloba	ML006	Split Solitary Rd	4	1.1m	12				In MLseedlings plot. On Notelaea longifolia	1
Marsdenia longiloba	ML007	Split Solitary Rd	4	1m	19				In MLseedlings plot. On Senna pendula, near large Bloodwood	1
Marsdenia longiloba	ML008	Split Solitary Rd	4	1.8m	30				In MLseedlings plot. On Pittosporum undulatum and Smilax australis	1
Marsdenia longiloba	ML009	Split Solitary Rd	4	60cm	6				In MLseedlings plot. On Blackbutt branch on ground adjacent to stag	1
Marsdenia longiloba	ML010	Split Solitary Rd	4	40cm	7				In MLseedlings plot. On Blackbutt branch on ground adjacent to stag	1
Marsdenia longiloba	ML011	Split Solitary Rd	4	50cm	12				In MLseedlings plot. On dead Lantana camara	1
Marsdenia longiloba	ML012	Split Solitary Rd	4	40cm	14				On Blady Grass / Blechnum cartilagineum. Lus 3 seedlings. S of seedlings plot	4
Marsdenia longiloba	ML013	Split Solitary Rd	4	80cm	12				On Senna pendula W od seedlings plot near star picket. Plus 8 seedlings	9
Marsdenia longiloba	ML014	Split Solitary Rd	4	2m	30				On Glochidion ferdinandi adjacent to Blackbutt 3m S of ML013. 2 stems counted as one plant	1
Marsdenia longiloba	ML015	Split Solitary Rd	4	2m	20				On Guioa semiglauca next to ML014	1
Marsdenia longiloba	ML016	Split Solitary Rd	4	1.5m	8				On Notelaea longifolia on W edge of seedling plot. Plus 4 seedlings beneath	5
Marsdenia longiloba	ML017	Split Solitary Rd	4	1.8m	25	In bud			On Guioa semiglauca 2m SE of Blackbutt. Plus 4 seedlings beneath	4
Marsdenia longiloba	ML018	Split Solitary Rd	4	2m	13				On Guioa semiglauca adjacent to SW corner of seedling plot. Plus 2 seedlings	3
Marsdenia longiloba	ML019	Split Solitary Rd	4	50cm	6				On Blady Grass 1m NNE of large stump. Flagging on Guioa 1m E	1
Marsdenia longiloba	ML020	Split Solitary Rd	4	1.1m	20				On dead Senna pendula, second stem on Blady Grass. Plus 4 seedlings in grass	5
Marsdenia longiloba	ML021	Split Solitary Rd	4	70cm	13				On branch of small Turpentine	1
Marsdenia longiloba	ML022	Split Solitary Rd	3	1.2m	8				On Maclura cochinchinensis SE of seedling plot	1
Marsdenia longiloba	ML023	Split Solitary Rd	4	1.2m	16				On Lantana camara / Smilax australis	1
Marsdenia longiloba	ML024	Split Solitary Rd	4	1.1m	14				On Lantana camara / Smilax australis	1
Marsdenia longiloba	ML025	Split Solitary Rd	3	1.7m	7				On sick Rhodamnia rubescens - unhealthy vine	1
Marsdenia longiloba	ML026	Split Solitary Rd	4	1.1m	10				On small Cryptocarya triplinervis adjacent to little Turpentine. Plus 4 seedlings between ML025 and ML026	4
Marsdenia longiloba	ML027	Split Solitary Rd	4	1.6m	21				On Senna pendula. Marsdenia rostrata on same plant. Plus 2 seedlings	3
Marsdenia longiloba	ML028	Split Solitary Rd	4	50cm	15				In Blady Grass 1m S of flagging. Plus 5 seedlings	6
Marsdenia longiloba	ML029	Split Solitary Rd	4	1m	20				On branches in litter amongst fallen Tallowwood limbs	1
Marsdenia longiloba	ML030	Split Solitary Rd	4	10cm	3				Scrambling on ground at base of large Tallowwood	1
Marsdenia longiloba	ML031	Split Solitary Rd	4	1.1m	9				On Senna pendula at base of Elaeocarpus obovatus	1
Marsdenia longiloba	ML032	Split Solitary Rd	3	60cm	6				On root sucker of Elaeocarpus obovatus	1
Marsdenia longiloba	ML033	Split Solitary Rd	4	up to 10cm	2 to 6				15 seedlings between large Eucalyptus propinqua to N and 2m X 2m pit to S. A lot of M. rostrata here as well	15
Marsdenia longiloba	ML034	Split Solitary Rd	4	1.7m	13				On Guioa semiglauca. Lots of Smilax australis and Marsdenia rostrata	1

Species	Id No.	Location	General Condition	Height	Leaf Condition	Flower /fruit	Length of new shoots	Evidence of disease	Note	No. plants per site
Marsdenia longiloba	ML035	Split Solitary Rd	4	2.1m	23				Climbing on Smilax australis into Turpentine	1
Marsdenia longiloba	ML036	Split Solitary Rd	2	2m	1				Dying back - stem still green. On dead sapling.	1
Marsdenia longiloba	ML037	Split Solitary Rd	4	70cm	5				Climbing onto Cryptocarya triplinervis	1
Marsdenia longiloba	ML038	Split Solitary Rd	4	60cm	6				On fallen limb at base of Tallowwood	1
Marsdenia longiloba	ML039	Split Solitary Rd	3	1.1m	8				On dead Senna pendula adjacent to Ironbark sapling	1
Marsdenia longiloba	ML040	Split Solitary Rd	3	1m	11				On Senna pendula near tall Ironbark	1
Marsdenia longiloba	ML041	Split Solitary Rd	3	40cm	3				On Blechnum cartilagineum at base of Ironbark	1
Marsdenia longiloba	ML042	Split Solitary Rd	4	40cm	16				Scrambling on tree fall debris adjacent to ML13	1
Marsdenia longiloba	ML043	Split Solitary Rd	4	1.3m	20				On Senna pendula	1
Marsdenia longiloba	ML044	Split Solitary Rd	4	1m	11				On Lantana camara beside Ironbark. Plus 2 seedlings	3
Marsdenia longiloba	ML045	Split Solitary Rd	4	30cm	16				Scrambling over ground debris downslope of Ironbark	1
Marsdenia longiloba	ML046	Split Solitary Rd	4	30cm	14				On litter and small Cryptocarya triplinervis	1
Marsdenia longiloba	ML047	Split Solitary Rd	5	1.8m	48	In bud			On Pittosporum undulatum near W edge of reserve	1
Marsdenia longiloba	ML048	Split Solitary Rd	4	1.1m	24				On Cyclophyllum longipetalum and Notelaea longifolia. Note: hairy stems, could be Tylophora woollsii	1
Marsdenia longiloba	ML049	Split Solitary Rd	4	30cm	10				On Blady Grass at foot of small slope	1
Marsdenia longiloba	ML050	Split Solitary Rd	4	20cm	29				Sprawling over litter on slope	1
Marsdenia longiloba	ML051	Split Solitary Rd	3	1.2m	7				On Jagera pseudorhus. Yellowing	1
Marsdenia longiloba	ML052	Split Solitary Rd	3	30cm	5				On litter adjacent to Blackbutt near large stump near W edge	1
Marsdenia longiloba	ML053	Split Solitary Rd	4	2.2m	33				In wet gully to SE of other plants - on Smilax australis	1
Marsdenia longiloba	ML054	Split Solitary Rd	4	1.1m	22				On Notelaea longifolia with ML053	1
Marsdenia longiloba	ML055	Split Solitary Rd	4	1.8m	50+				Very healthy plant on Trochocarpa laurina	1
Marsdenia longiloba	ML71	Newmans Rd Sth	0							0
Marsdenia longiloba	ML72	Newmans Rd Sth	0							0
Marsdenia longiloba	ML72a	Newmans Rd Sth	2	30cm	3				In litter 1m S of Wilkiea heugeliana with flagging	1
Marsdenia longiloba	ML73	Newmans Rd Sth	0							0
Marsdenia longiloba	ML73a	Newmans Rd Sth	0							0
Marsdenia longiloba	ML74	Newmans Rd Sth	0						One seedling 1m W of Trochocarpa laurina	1
Marsdenia longiloba	ML74a	Newmans Rd Sth	2	10cm	2				At base of small Eucalyptus propinqua	1
Marsdenia longiloba	ML74b	Newmans Rd Sth	0						Died back. On ground 2m S of large Eucalyptus propinqua	0
Marsdenia longiloba	ML75	Newmans Rd Sth	0							0
Marsdenia longiloba	ML75a	Newmans Rd Sth	0							0
Marsdenia longiloba	ML75b	Newmans Rd Sth	0							0
Marsdenia longiloba	ML76	Newmans Rd Sth	4	1.1m	18				Healthy plant on Pittosporum multiflorum	1
Marsdenia longiloba	ML76a	Newmans Rd Sth	3	60cm	4				On Pittosporum multiflorum	1
Marsdenia longiloba	ML077	Newmans Rd Sth	2	10cm	3				Weakly climbing over fallen log 2m E of fence where 75b/c flagging is located	1
Marsdenia longiloba	ML078	Newmans Rd Sth	2	20cm	4				At base of 30cm dbh Turpentine	1
Marsdenia longiloba	ML079	Newmans Rd Sth	3	25cm	3				On Lepidosperma laterale 2m N of ML078	1
Marsdenia longiloba	ML080	Newmans Rd Sth	4	1.2m	14				On Lantana camara 10m SW of ML76	1
Marsdenia longiloba	ML080a	Newmans Rd Sth	3	70cm	15				On Lantana camara 1m W of ML080	1
Marsdenia longiloba	ML080b	Newmans Rd Sth	4	2m	16				On Lantana camara and Trochocarpa laurina 4m S of ML080	1
Marsdenia longiloba	ML102	Moonee Beach Sth	0						Died back	0
Marsdenia longiloba	ML104	Moonee Beach Sth	3	0.2m	6				Beside small Quassia. Plus 3 plants adjacent	4
Marsdenia longiloba	ML105a	Moonee Beach Sth	0						Died back.	0
Marsdenia longiloba	ML111	Moonee Beach Sth	3	0.2m	7				At base of Cordyline stricta	1
Marsdenia longiloba	ML112	Moonee Beach Sth	0						Died back. Plus 3 plants to N.	3
Marsdenia longiloba	ML119	Moonee Beach Sth	0						Died back. On Choricarpia leptopetala	0
Marsdenia longiloba	ML120	Moonee Beach Sth	0							0
Marsdenia longiloba	ML120a	Moonee Beach Sth	4	0.7m	6				1m from ML120 flagging	1
Marsdenia longiloba	ML121	Moonee Beach Sth	2	0.6m	5				Dying back. Plus 3 seedlings.	4
Marsdenia longiloba	ML122	Moonee Beach Sth	4	0.6m	8				On fallen Notelaea longifolia between two Brush Box	1
Marsdenia longiloba	ML123	Moonee Beach Sth	4	1m	8				On Croton verrauxii 1m from old flagging. Plus one seedling	2

Species	Id No.	Location	General Condition	Height	Leaf Condition	Flower /fruit	Length of new shoots	Evidence of disease	Note	No. plants per site
Marsdenia longiloba	ML124	Moonee Beach Sth	0						Died back	0
Marsdenia longiloba	WPT003	Moonee Beach Sth	0						Died back (first recorded Mar 2014)	0
Marsdenia longiloba	WPT004	Moonee Beach Sth	5	1.6m	24				On Lantana camara. Very healthy. Adjacent to QB101	1
Marsdenia longiloba	WPT005	Moonee Beach Sth	0						Died back	0
Marsdenia longiloba	WPT007	Moonee Beach Sth	0						Died Back	0
Marsdenia longiloba	WPT007	Moonee Beach Sth	0						Died Back	0
Marsdenia longiloba	WPT007	Moonee Beach Sth	0						Died Back	0
Marsdenia longiloba	WPT060	Moonee Beach Sth	0						Died back	0
Marsdenia longiloba	WPT060a	Moonee Beach Sth	0						Between above plant (WPT060) and old fence. Died back Mar2016	0
Marsdenia longiloba	WPT060b	Moonee Beach Sth	0						Between above plant (WPT060) and old fence. Died back Mar2016	0
Marsdenia longiloba	WPT060c	Moonee Beach Sth	0						Between above plant (WPT060) and old fence. Died back Mar2016	0
Marsdenia longiloba	WPT060d	Moonee Beach Sth	0						Between above plant (WPT060) and old fence. Died back Mar2016	0
Marsdenia longiloba	ML0126	Moonee Beach Sth	3	0.3m	3				At base of Croton verrauxii just W of QB0104. Plus 3 other plants nearby	4
Marsdenia longiloba	ML0127	Moonee Beach Sth	4	1.9m	51				Robust plant on Synoum glandulosum at N edge of forest	1
Marsdenia longiloba	ML0128	Moonee Beach Sth	4	1.1m	12				On Cissus hypoglaucula and Lantana camara	1
Marsdenia longiloba	ML0129	Moonee Beach Sth	4	0.7m	14				On ground debris near NW adults and seedlings (NW WPT063)	1
Marsdenia longiloba	ML0130	Moonee Beach Sth	4	1.3m	11				On Cryptocarya rigida next to NW0140	1
Marsdenia longiloba	ML0131	Moonee Beach Sth	3	1.6m	15				On Pararchidendron pruinosum and Aphanopetalum resinosum. Plus 2 seedlings. Near NW0141	3
Marsdenia longiloba	ML137	Newmans Rd	4	2m	16				On Jagera pseudorhus with Morinda jasminoides	1
Marsdenia longiloba	ML138	Newmans Rd	0						Died back. Plus 2 seedlings present	2
Marsdenia longiloba	ML138a	Newmans Rd	3	20cm	4				At base of small Acacia maidenii amongst Calochlaena dubia	1
Marsdenia longiloba	ML138b	Newmans Rd	4	1m	19				New stem climbing from base of Olea paniculata. Plus 4 seedlings beneath	5
Marsdenia longiloba	ML141	Newmans Rd	0							0
Marsdenia longiloba	ML141a	Newmans Rd	0							0
Marsdenia longiloba	ML141b	Newmans Rd	0						Only Echinostephia aculeata present	0
Marsdenia longiloba	ML142	Newmans Rd	0						On creek bank at W end of site	0
Marsdenia longiloba	ML150	Newmans Rd	0						Near base of slender Spotted Gum. WPT074	0
Marsdenia longiloba	ML151	Newmans Rd	4	1.2m and 50cm	21 and 6				2 stems on dense Calochlaena dubia	2
Marsdenia longiloba	ML157	Newmans Rd	0						Died back, on Cheese tree. 1 seedling present at base of tree.	1
Marsdenia longiloba	ML165b	Newmans Rd	0							0
Marsdenia longiloba	ML166b	Newmans Rd	0							0
Marsdenia longiloba	ML166c	Newmans Rd	0							0
Marsdenia longiloba	ML166i	Newmans Rd	2	10cm	6				Sick 'seedling' beneath dead shrub	1
Marsdenia longiloba	ML167	Newmans Rd	0						On Calochlaena / Lantana	0
Marsdenia longiloba	ML168	Newmans Rd	4	90cm	14				2 stems amongst Calochlaena	1
Marsdenia longiloba	WPT097	Newmans Rd	0						On Trochocarpa laurina - died back	0
Marsdenia longiloba	MLplot	Newmans Rd	4	5 to 15cm	2 to 4				9 'seedlings' in plot bounded by orange-flagged bamboo stakes in vicinity of ML165 - ML166 W of Forest Oak. Adult plants in plot are individually flagged and numbered	9
Marsdenia longiloba	ML0169	Newmans Rd	3	40cm	4				Scrambling in Blady Grass near SW stake of MLplot	1
Marsdenia longiloba	ML0170	Newmans Rd	4	30cm	19				3 stems in Calochlaena dubia near NW corner of MLplot	3
Marsdenia longiloba	ML0171	Newmans Rd	4	50cm	20				3 stems in Calochlaena dubia near NW corner of MLplot	3
Marsdenia longiloba	ML0172	Newmans Rd	2	50cm	3				1 stem, yellowed leaves	1
Marsdenia longiloba	ML0173	Newmans Rd	4	1m	16				1 stem scrambling over Calochlaena dubia c. 2m SW of large Corymbia intermedia	1
Marsdenia longiloba	ML0174	Newmans Rd	4	70cm	17				2 stems on ferns at bae of large Corymbia intermedia	2
Marsdenia longiloba	ML0175	Newmans Rd	4	1m	13				On Calochlaena dubia beneath Psychotria Ioniceroides c. 3m SW of large Corymbia intermedia	1
Marsdenia longiloba	ML0176	Newmans Rd	4	20cm	2 to 5				3 seedlings at base of large Eucalyptus acmenoides	3
Marsdenia longiloba	ML0177	Newmans Rd	4	40cm	13				On Calochlaena dubia 3m NE of slender Corymbia variegata	1
Quassia sp. B	QB101	Moonee Beach Sth	4	1.1m	5	old buds			Very healthy	1
Quassia sp. B	QB101a	Moonee Beach Sth	4	0.7m	5	old buds			Very healthy	1

Species	Id No.	Location	General Condition	Height	Leaf Condition	Flower /fruit	Length of new shoots	Evidence of disease	Note	No. plants per site
Quassia sp. B	QB102	Moonee Beach Sth	4	0.8m	5					1
Quassia sp. B	QB103	Moonee Beach Sth	4	0.9m	4				Plus 2 stems adjacent - one looks new, the other recorded previously	3
Quassia sp. B	QB112a	Moonee Beach Sth	0						Dead	0
Quassia sp. B	QB125a	Moonee Beach Sth	0						Not found	0
Quassia sp. B	WPT062	Moonee Beach Sth	4	0.4m	4	buds				1
Quassia sp. B	QB0104	Moonee Beach Sth	4	0.3m	5				50m due W of Highway culvert	1
Quassia sp. B	QB0105	Moonee Beach Sth	4	0.4m	5				On W bank of N-S creekline with Choricarpia leptopetala	1
Quassia sp. B	QB0106	Moonee Beach Sth	4	0.25m to 1.5m	4				3 stems on E side of N-S creekline. 0.25m, 1m and 1.5m tall.	3
Quassia sp. B	QB0107	Moonee Beach Sth	4	0.2m to 0.6m	4				4 stems uphill from QB0106. 0.2m, 0.4m, 0.4m, 0.6m tall, spread over 2m X 2m.	4
Quassia sp. B	QB0108	Moonee Beach Sth	4	0.2m to 0.5m	4				15 stems on W reserve boundary (ridge between two N-S creeklines). Spread over 3m X 3m area.	15
Quassia sp. B	QB0109	Moonee Beach Sth	4	0.1m to 1m	4				At least 20 stems in vicinity of NW 0125 on W side of N-S creekline (could be private property). All plants very healthy, no buds, flowers or fruits. Some plants damaged by recent tree fall but all are stem suckering in response.	20
Quassia sp. B	QB41	Sapphire Nth	0						Not found – tree fall debris	0
Quassia sp. B	QB41a	Sapphire Nth	5	90	5	11 fruits	n/a		Plant healthy but damaged by tree fall. All fruits on broken branch	1
Quassia sp. B	QB42	Sapphire Nth	4	10 to 60	4	n/a	20-50mm		Healthy. 11 stems	11
Quassia sp. B	QB42a	Sapphire Nth	4	35 and 45	5	n/a	40-80mm		Healthy - beside concrete fence post on E edge	2
Quassia sp. B	QB42b	Sapphire Nth	0						Dead – not recorded since 2012	0
Quassia sp. B	QB43	Sapphire Nth	4	20 to 40	4	4 fruit on small plant	10-30mm		Healthy. Some yellowed leaves on all plants	4
Quassia sp. B	QB43a	Sapphire Nth	4	10 to 40	4	Old fruit bases on large plant	10-40mm		3 stems (one new 'seedling')	3
Quassia sp. B	QB44	Sapphire Nth	4	15 to 50	5	buds on 2	20-50mm		Healthy	8
Quassia sp. B	QB44a	Sapphire Nth	4	40	4	n/a	30mm		Healthy. 1 stem in Gahnia on creek edge at E bndry	1
Quassia sp. B	QB45	Sapphire Nth	5	5 to 65	5	Fruits on 2 larger plants	10-80mm		Good health. 9 stems plus 2 'seedlings'	11
Quassia sp. B	QB46	Sapphire Nth	5	10 and 30	4	Fruit on large plant	10mm		1 new 'seedling' 1m uphill from flagged plant	2
Quassia sp. B	QB47	Sapphire Nth	5	45	5	buds	75mm		Healthy	1
Quassia sp. B	QB48	Sapphire Nth	4	15 to 35	4	buds on 1	10-40mm		Healthy	3
Quassia sp. B	QB49	Sapphire Nth	4	20 to 35	4	old buds on 3 plants	10-30mm		4 stems plus 3 'seedlings' (root suckers?)	7
Quassia sp. B	QB50	Sapphire Nth	0						Not found	0
Quassia sp. B	WPT002	Sapphire Nth	3	15 and 60	4	old buds on large plant	n/a		2 stems under tree fall but not damaged	2
Niemeyera whitei	NW99	Moonee Beach Sth	3	4m	2		40mm		Leaves yellowed due to exposure. Same condition as last survey. Regeneration to the E is substantial, and should improve over next few years.	1
Niemeyera whitei	NW100	Moonee Beach Sth	3	2.3m	2		40mm		Leaves yellowed due to exposure. Same condition as last survey. Regeneration to the E is substantial, and should improve over next few years.	1
Niemeyera whitei	NW105	Moonee Beach Sth	4	2.5m	3				Foliage in poor health	1
Niemeyera whitei	NW124	Moonee Beach Sth	4	0.8m	5				Tree fall has flattened old leader, new leader very healthy	1
Niemeyera whitei	NW109	Moonee Beach Sth	4	1.2m	3				Leaves unhealthy	1
Niemeyera whitei	NW109a	Moonee Beach Sth	3	0.4m	3				Seedling 1.5m downhill from NW109	1
Niemeyera whitei	WPT063	Moonee Beach Sth	3	7m	3				Double-stemmed small tree on creek bank beside large Brush Box. Looking stressed - drought?	1
Niemeyera whitei	WPT064	Moonee Beach Sth	2	0.3m	2				1 seedling in poor health. Other seedling recorded last survey gone	1

Species	Id No.	Location	General Condition	Height	Leaf Condition	Flower /fruit	Length of new shoots	Evidence of disease	Note	No. plants per site
Niemeyera whitei	NW0125	Moonee Beach Sth	4	9m	4				Recorded as WPT067 last survey. Large tree on W side of N-S creekline	1
Niemeyera whitei	WPT068	Moonee Beach Sth	0						Young plant at S of site near creek. Not found	0
Niemeyera whitei	NW0126	Moonee Beach Sth	5	8m	5				On S bank of creek - (probably on private property S of reserve). DBH 15cm and 9cm double leader. Plus 2 seedlings beneath	3
Niemeyera whitei	NW0127	Moonee Beach Sth	4	7m	4				On S bank of creek - (probably on private property S of reserve). 15cm dbh 8m SW of NW0126 - slightly exposed to W	1
Niemeyera whitei	NW0128	Moonee Beach Sth	4	9m	4				On S bank of creek - (probably on private property S of reserve). On creek edge 5m W of NW0126. 8cm dbh	1
Niemeyera whitei	NW0129	Moonee Beach Sth	4	6m	4				On S bank of creek - (probably on private property S of reserve). On creek edge 2m E of NW0128. 8cm dbh	1
Niemeyera whitei	NW0130	Moonee Beach Sth	5	9m	5				On S bank of creek - (probably on private property S of reserve). 20cm dbh. 6m E of NW 0126 between two Eucalyptus grandis	1
Niemeyera whitei	NW0131	Moonee Beach Sth	4	4m	5				On S bank of creek - (probably on private property S of reserve). Young tree 3cm dbh on edge of dense Lantana infestation. 8m NW of NW0132. 1 seedling beneath	2
Niemeyera whitei	NW0132	Moonee Beach Sth	5	15m	5				Recorded last survey as WPT069. Large, 40cm dbh easternmost tree on S bank of creek (probably on private property S of reserve). 6+ seedlings beneath crown	7
Niemeyera whitei	NW0133	Moonee Beach Sth	4	0.6m	4				4m N of creekline	1
Niemeyera whitei	NW0134	Moonee Beach Sth	3	0.5m	3				Seedling in western branch of N-S creekline c. 20m N of main creek	1
Niemeyera whitei	NW0135	Moonee Beach Sth	3	0.6m	3				Seedling, near NW0134	1
Niemeyera whitei	NW0136	Moonee Beach Sth	4	0.3m	4				Seedling, near NW0134	1
Niemeyera whitei	NW0137	Moonee Beach Sth	4	1.6m	4				Sapling on E side of N-S creekline	1
Niemeyera whitei	NW0138	Moonee Beach Sth	3	0.3m	3				Seedling near NW0137	1
Niemeyera whitei	NW0139	Moonee Beach Sth	3	0.3m	3				Seedling near NW0137	1
Niemeyera whitei	NW0140	Moonee Beach Sth	4	7m	4				20cm dbh beside 40cm Tallowwood at QB0108	1
Niemeyera whitei	NW0141	Moonee Beach Sth	4	0.3m	4				Seedling amongst Lastreopsis sp.	1
			General Condition	Height	Fronnd Condition	Reproduction	Crown cover (%)		Notes	
Lindsaea incisa	LI27	Orara East SF	5	30	5	Spores	40		Very healthy patch (1m X 1m)	
Lindsaea incisa	LI28	Orara East SF	5	60	5	Spores	60		Very healthy patch (1m X 1m)	
Lindsaea incisa	LI29	Orara East SF	not found						These plots have been re-marked as quadrats LI01 to LI05	
Lindsaea incisa	LI30	Orara East SF	not found							
Lindsaea incisa	LI31	Orara East SF	not found							
Lindsaea incisa	LI32	Orara East SF	not found							
Lindsaea incisa	LI33	Orara East SF	not found							
Lindsaea incisa	LI34	Orara East SF	not found							
Lindsaea incisa	LI35	Orara East SF	not found							
Lindsaea incisa	LI36	Orara East SF	not found							
Lindsaea incisa	LI01	Orara East SF	5	40	5	Spores	70		6 stakes in NE corner of site. Previously recorded as WPT082	
Lindsaea incisa	LI02	Orara East SF	5	50	5	Spores	50		4 stakes in central E section of site c. 3m WSW of large Needlebark (E. planchoniana). Previously recorded as WPT083	
Lindsaea incisa	LI03	Orara East SF	5	70	5	Spores	60		7 stakes in central W section of site, immediately S of Angophora costata. Previously recorded as WPT084	
Lindsaea incisa	LI04	Orara East SF	5	50	5	Spores	50		2 stakes in centre of site, c. 3.5 m SE of Angophora costata. Previously recorded as WPT085	
Lindsaea incisa	LI05	Orara East SF	5	40	5	Spores	50		3 stakes due E of Angophora costata in N central part of site. Plants sparser than other sites. Drier here. Previously recorded as WPT086	

APPENDIX 2a: Results – Direct-seeded Rusty Plum

Results of direct-seeding 68 Rusty Plum seeds into Translocation Area 2, showing seedling height (cm) or the fate of un-germinated seeds from April 2011 (five months after sowing) to February 2016.

Field tag	Seedling height Apr 2011	Seedling height Oct 2012	Seedling height Oct 2013	Seedling height Mar 2014	Seedling height Nov 2014	Seedling height Feb 2016	Notes Feb 2016
D1	16cm	20	20	20	25		
D2	18cm	33		25	25		
D3	seed rotted						
D4	seed intact						
D5	grazed, reshot 6cm	44	45	60	70	160	v. healthy - not caged
D6	10cm	36	45	50	45	50	
D7	grazed, reshot 3cm	21					
D8	grazed, reshot 11cm	33		25	30	35	
D9	12cm	28		30	33	65	Labelled as Dsn - no flagging present. Good cond
D10	10cm	41	50	45	50	50	browsed
D11	seed intact						
D12	seed rotted						
D13	22cm	30	36	40	40	45	
D14	14cm	35					
D15	seed rotted						
D16	15cm	17				30	re-found
D17	grazed, reshot 9cm	18	25	25	30	40	
D18	grazed, reshot 10cm	28	28	30	30	30	
D19	grazed, reshot 11cm	22	40	40	42	45	
D20	grazed, reshot 14cm	26	20	25	30	30	
D21	16cm	15	15	20	20		
D22	12cm	38	37	40	40	45	
D23	8cm	25	27	27	25	30	
D24	15cm	24	30	30	30	40	
D25	seed rotted						
D26	seed gone						
D27	seed rotted						
D28	14cm	58		70	110		
D29	6cm	28		25	35	40	poor health - overgrown with Alpinia
D30	seed gone						
D31	7cm	42	28	28	30	40	
D32	grazed, reshot 9cm	39	32	40	30	33	
D33	15cm	42		25	35	30	overgrown with vines
D34	grazed, reshot 10cm	43		45	45	60	
D35	20cm	31	24	25	25		
D36	grazed, reshot 12cm	65	70	70	75	100	exc. cond. Not caged

Field tag	Seedling height Apr 2011	Seedling height Oct 2012	Seedling height Oct 2013	Seedling height Mar 2014	Seedling height Nov 2014	Seedling height Feb 2016	Notes Feb 2016
D37	grazed, reshot 15cm	41		40	40	45	
D38	14cm	37	34	30	36	45	exc cond
D39	13cm	22					
D40	14cm	43	65	40	40	90	exc cond - taller than dense maidenhair
D41	grazed, reshot 17cm	46	55	60	65	80	
D42	grazed, reshot 4cm	14		10	15		
D43	grazed, reshot 4cm	8			10	15	
D44	13cm	22	26	30	32	40	
D45	grazed, reshot 1cm	14					
D46	22cm	35	35	40	42	45	
D47	grazed, reshot 1cm						
D48	13cm	18		15	20		
D49	10cm						
D50	18cm	24					
D51	grazed, reshot 7cm	33	33	33	35	60	v healthy - slightly browsed
D52	32cm	41	43	40	42		
D53	19cm	42	46	40	42		
D54	gone						
D55	seed intact						
D56	15cm	25		30	30	40	
D57	12cm			20	25	25	
D58	seed rotted						
D59	seed intact						
D60	10cm	16	15	15	20	15	poor cond
D61	seed gone						
D62	seed rotted						
D63	seed intact		20	25	25	25	poor cond
D64	18cm	36	39	40	45	80	
D65	17cm	45		50	55	90	good cond
D66	10cm	29	31	35	40	50	
D67	11cm	23		35	40	55	
D68	seed rotted						

APPENDIX 2b: Results – Transplanted Rusty Plum Seedlings

Seedlings of Rusty Plum introduced to Translocation Area 2 showing height (cm) from April 2011 to February 2016.

Field tag	Seedling height Apr 2011 (cm)	Seedling height Oct 2012	Seedling height Oct 2013	Seedling height Mar 2014	Seedling height Nov 2014	Seedling height Feb 2016	Notes Feb 2016
P1	10	42	45	40	40	45	
P2	28	39	40	40	45	110	v healthy
P3	16	32	50	45	40	0	
P4	14					0	
P5	15	43				0	
P6	14	36	35	35	40	65	
P7	8	10	15	17	20	25	
P8	14	47	45	50	55	70	Rescued from beneath fallen stag
P9	13	33	36	36	36	45	
P10	20	34	45	70	70	100	
P11	8	32				0	
P12	15	35	35	35	35	45	
P13	10					0	
P14	17	46	62	90	100	150	spider mite affected
P15	15	21	30	35	35	80	
P16	13	37		30	40	110	v healthy
P17	8	15	27	27	35	55	
P18	10	10	12	15	17	20	
P19	21		15			0	
P20	6	8				0	

APPENDIX 3a: Results – *Lindsaea incisa* translocation quadrats, February 2016. Measured canopy cover (%), condition and distance of growth beyond quadrat (estimated in cm).

Condition Scores

Foliage Condition	Score
All healthy, green	5
Very slight yellowing	4
Slight to <50% yellowing	3
>50% yellowing	2
Dieback >20%	1
All dead	0

Area 1 Feb 2016

Quadrat No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Line A %CC	30	30	40	50	40	60	40	20	30	30	30	60	40	50	30	60
Line B %CC	0	20	30	5	5	20	20	10	0	0	10	0	30	40	0	0
Line C %CC	0	0	0	0	0	0	0	0	0	0	20	0	20	0	0	0
Line D %CC	20	20	40	20	20	30	25	15	30	20						
Line A condition	4	5	4	5	5	4	4	5	4	5	5	4	5	5	4	5
Line B condition	-	4	4	4	4	4	4	4	-	-	5	-	5	5	-	-
Line C condition	-	-	-	-	-	-	-	-	-	-	3	-	5	-	-	-
Line D condition	4	4	4	4	4	4	4	4	3	4						
Line A distance	50	40	40	100	100	100	100	60	100	60	40	30	40	40	40	50
Line B distance	-	30	30	0	20	20	0	15	-	-	0	-	0	-	-	-
Line C distance	-	-	-	-	-	-	-	-	-	-	0	-	0	-	-	-
Line D distance	10	20	20	30	20	40	30	20	30	30						

Area 2 Feb 2016

Quadrat No.	1	2	3	4	5	5a	6	7	8	9	10	11	12	12a	13	14	15	16	17	18	19	20	21	22	23	24	25
%CC	0	0	60	40	0	50	40	60	50	0	0	0	0	0	0	0	50	40	0	40	0	0	0	0	0	0	0
Condition			5	5		5	5	5	5								5	5		5							
Distance			40	60		80	30	90	100								30	20		25							

APPENDIX 3b: Results of paired t-tests of significance of % canopy cover change of translocated *Lindsaea incisa* between monitoring surveys November 2014 and February 2016.

Note: SD = Standard Deviation; SEM = Standard Error of the Mean; N = Number of samples (Online analysis using Graphpad t-test calculator at <http://graphpad.com/quickcalcs/ttest1/>)

Line A Nov14 – Feb16

P value and statistical significance:

The two-tailed P value equals 0.0389
By conventional criteria, this difference is considered to be statistically significant.

Confidence interval:

The mean of Group One minus Group Two equals -8.13
95% confidence interval of this difference: From -15.78 to -0.47

Intermediate values used in calculations:

t = 2.2630
df = 15
standard error of difference = 3.590

Group	Group One	Group Two
Mean	31.88	40.00
SD	15.90	12.65
SEM	3.98	3.16
N	16	16

Line B Nov14 – Feb16

P value and statistical significance:

The two-tailed P value equals 0.7786
By conventional criteria, this difference is considered to be not statistically significant.

Confidence interval:

The mean of Group One minus Group Two equals 0.63
95% confidence interval of this difference: From -4.03 to 5.28

Intermediate values used in calculations:

t = 0.2863
df = 15
standard error of difference = 2.183

Group	Group One	Group Two
Mean	12.50	11.88
SD	13.78	13.15
SEM	3.45	3.29
N	16	16

Line C Nov14 – Feb16

P value and statistical significance:

The two-tailed P value equals 0.2650
By conventional criteria, this difference is considered to be not statistically significant.

Confidence interval:

The mean of Group One minus Group Two equals -2.00
95% confidence interval of this difference: From -5.68 to 1.68

Intermediate values used in calculations:

t = 1.1579
df = 15
standard error of difference = 1.727

Group	Group One	Group Two
Mean	0.50	2.50
SD	1.03	6.83
SEM	0.26	1.71

Group	Group One	Group Two
N	16	16

Line D Nov14 – Feb16

P value and statistical significance:

The two-tailed P value equals 0.6008

By conventional criteria, this difference is considered to be not statistically significant.

Confidence interval:

The mean of Group One minus Group Two equals 2.50

95% confidence interval of this difference: From -7.93 to 12.93

Intermediate values used in calculations:

t = 0.5423

df = 9

standard error of difference = 4.610

Group	Group One	Group Two
Mean	26.50	24.00
SD	13.75	7.38
SEM	4.35	2.33
N	10	10

Area 2 Line 1 Nov14 – Feb16

P value and statistical significance:

The two-tailed P value equals 0.0619

By conventional criteria, this difference is considered to be not quite statistically significant.

Confidence interval:

The mean of Group One minus Group Two equals -11.11

95% confidence interval of this difference: From -22.92 to 0.70

Intermediate values used in calculations:

t = 2.1693

df = 8

standard error of difference = 5.122

Group	Group One	Group Two
Mean	22.22	33.33
SD	17.16	25.98
SEM	5.72	8.66
N	9	9

Area 2 Line 2 Nov14 – Feb16

P value and statistical significance:

The two-tailed P value equals 0.1039

By conventional criteria, this difference is considered to be not statistically significant.

Confidence interval:

The mean of Group One minus Group Two equals -3.33

95% confidence interval of this difference: From -7.47 to 0.81

Intermediate values used in calculations:

t = 1.7728

df = 11

standard error of difference = 1.880

Group	Group One	Group Two
Mean	7.50	10.83
SD	14.22	19.75
SEM	4.11	5.70
N	12	12

APPENDIX 4: Rainfall Statistics

Actual and mean rainfall recorded at Coffs Harbour during the S2W threatened flora project (note that the January 2015 total is from the Woolgoolga weather station, as the Coffs Harbour station was not operational). Source: Australian Government Bureau of Meteorology – available online at http://www.bom.gov.au/nsw/coffs_harbour/

Year	Month	Actual Rainfall (mm)	Mean Rainfall (mm)
2010	June	129.6	123.15
	July	159.4	84.15
	August	20.6	79.7
	September	55.6	65.1
	October	424.8	96.9
	November	215.2	122.7
	December	391.4	141.05
	Total	1396.6	712.75
2011	January	263.6	175.5
	February	125.8	212.75
	March	168.4	234.65
	April	469	183.85
	May	91.8	148.9
	June	419.2	123.15
	July	54.2	84.15
	August	163.2	79.7
	September	29.2	65.1
	October	180.6	96.9
	November	158	122.7
	December	170.8	141.05
	Total	2293.8	1668.4
2012	January	357.8	175.5
	February	311.6	212.75
	March	142	234.65
	April	264.2	183.85
	May	55.2	148.9
	June	272.4	123.15
	July	54.3	84.15
	August	11.7	79.7
	September	33.2	65.1
	October	24.8	96.9
	November	232	122.7
	December	79.6	141.05
	Total	1838.8	1668.4
2013	January	480.8	175.5
	February	379.3	212.75
	March	126.3	234.65
	April	168	183.85
	May	306.2	148.9
	June	90	123.15
	July	97.6	84.15
	August	2.8	79.7
	September	16.4	65.1
	October	54	96.9
	November	290.4	122.7
	December	32.6	141.05
	Total	2044.4	1668.4
2014	January	43	175.5

Year	Month	Actual Rainfall (mm)	Mean Rainfall (mm)
2014	February	64.2	212.75
	March	211.7	234.65
	April	146	183.85
	May	56	148.9
	June	40.7	123.15
	July	5	84.15
	August	275	79.7
	September	28	65.1
	October	11.6	96.9
	November	119.6	122.7
	December	245.2	141.05
		Total	1246.0
2015	January*	210.4	175.5
	February	494.5	212.75
	March	244.6	234.65
	April	176.1	183.85
	May	280.6	148.9
	June	52	123.15
	July	29	84.15
	August	25.5	79.7
	September	81.5	65.1
	October	35.9	96.9
	November	153.3	122.7
	December	184.9	141.05
	Total	1968.3	1668.4
2016	January	82	175.5
	February	32.2	212.75
	March	71.4	234.65