Woolgoolga to Ballina Pacific Highway upgrade

Threatened Flora Translocation Project (Section 1-11)

Annual Monitoring Report (2017-2018)

NSW GOVERNMENT

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Woolgoolga to Ballina Threatened Flora Translocation Project (Sections 1-11)

Annual Monitoring Report (2017-2018)

Prepared for:

Pacific Complete
21 Prince Street, Grafton, NSW 2460

Prepared by:

Dr Andrew Benwell
ECOS Environmental Pty Ltd
PO Box 641 Mullumbimby, NSW 2482
ph 0487050005; email: andrewbenwell@bigpond.com

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Executive Summary

This annual monitoring report documents the implementation and results of threatened flora translocations conducted for the Woolgoolga to Ballina (W2B) Pacific Highway upgrade project, Sections 1- 11, to June 2018. Translocations on Sections 1-2 of W2B and EWSSTA (Early Works Soft Soil Treatment Areas) (2015-2018) started a year earlier than Sections 3-11 (2016-2018) and were guided by separate Translocation Strategies (RMS 2015a & b). This report is a consolidation of the translocation monitoring results for the whole W2B upgrade (ie. Sections 1-11) and includes Year 2 results for Sections 3-11 and Year 3 results for Sections 1-2.

Eighteen threatened plant species, one rare species and two vines that are host plants for threatened invertebrate species were translocated and comprised the following:-
Threatened Species

- Yellow-flowered King of the Fairies (*Oberonia complanata*)
- Slender Screw Fern (*Lindsaea incisa*)
- Singleton Mint Bush (*Prostanthera cineolifera*)
- Weeping Paperbark (*Melaleuca irbyana*)
- Tall Knotweed (*Persicaria elatior*)
- Four-tailed Grevillea (*Grevillea quadricauda*)
- Stinking Cryptocarya (*Cryptocarya foetida*)
- Rusty Green-leaved Rose Walnut (*Endiandra muelleri ssp. bracteata*)
- Red Lilly Pilly (*Syzygium hodgkinsoniae*)
- White Laceflower (*Archidendron hendersonii*)
- Rough-shelled Bush Nut (*Macadamia tetraphylla*)
- Hairy Joint Grass (*Arthraxon hispidus*)
- Square-fruited Ironbark (*Eucalyptus tetrapleura*)
- Hairy Melichrus (*Melichrus hirsutus*)
- Lindernia (*Lindernia alsinoides*)
- Rotala (*Rotala tripartita*)
- Square-stemmed Spike Rush (*Eleocharis tetraquetra*)
- Moonee Quassia (*Quassi*a sp. Moonee)

Rare Species

- *Lepidosperma* sp. Coaldate

Hosts of Threatened Invertebrate

- Richmond Bird Wing Vine (*Aristolochia pravevenosa*)
- Pink Underwing Moth Vine (*Carronia multisepala*)

After two years, current translocation results on Sections 3-11 have met project aims and targets for all 16 species translocated on these sections with the exception of Lindernia and Rough-shelled Bush Nut. The latter species is currently below target as more plants being propagated have not been planted out yet. There should be no problem in reaching the target for this species. Lindernia is the only species likely to fall short of translocation aims and targets.

After 3 years, translocation results on Sections 1-2 & EWSSTA failed to meet project aims and targets for most species translocated with the exception of *Arthraxon hispidus* and *Eucalyptus tetrapleura*. Species that failed to translocate successfully included Moonee Quassia, Oberonia orchid, Lindernia, Square-stemmed Spike Rush, Lepidosperma sp. Coaldale and Tall Knotweed.

1.0 INTRODUCTION

This monitoring report documents the implementation and results of threatened flora translocations carried out on Sections 1-11 of the Woolgoolga to Ballina (W2B) project, a 155 km section of the Pacific Highway upgrade on the NSW North Coast (Figure 1). Monitoring of the translocations is scheduled to continue for a minimum of 3 years with provision for a further 2-year extension if required. The previous monitoring report by Ecos Environmental (2017) described the Year 1 results of the translocations conducted for Sections 3-11, which started in 2016. Translocations on Sections 1-2 and Early Works Soft Soil Treatment Areas (EWSSTA) started a year earlier (2015) and results for the first two years were described in reports by Landmark Ecological Services (2016, 2017). This report is a consolidation of the translocation monitoring results for the complete Section 1-11 of the W2B upgrade and covers Year 2 results for Section 3-11 and Year 3 results for Section 1-2. Also included are unexpected finds that were translocated on Sections 3-11 in 2017.

As stated above, threatened flora translocations for the W2B project were carried out in two stages over almost three years, as follows:

- *Landmark Ecological Services and Bushland Restoration Services* conducted translocations for Sections 1-2 and EWSSTA in 2015-2016. Implementation for these sections was based on RMS (2015a). *Flora Translocation Strategy Pacific Highway Upgrade Sections 1-2 Woolgoolga to Ballina Pacific Highway upgrade – April 2015.* The translocation strategy was subsequently modified to include EWSSTA, as described below.

- *Ecos Environmental* conducted translocations on Sections 3-11 in 2016-2017. Implementation for these sections was based on RMS (2015b) - *Flora Translocation Strategy Pacific Highway Upgrade Sections 3-11 excluding Early Works Soft Soil Treatment Areas Woolgoolga to Ballina – Ver. 2 Nov. 2015.* The translocations planned for this section also required modification to include several unexpected finds, which were translocated in 2017, as described below..

RMS (2015 a & b) constitute the 'Translocation Strategy', as referred to below.

A total of 21 plant species were translocated on Sections 1-11 of the W2B project (Table 1). These included 18 threatened species, one rare species (not scheduled) and two species of vine that are hosts of threatened butterfly and moth species during their larval stage.

Table 1: Species translocated during the first round of translocations for Sections 1-2 and EWSSTA starting in 2015 and the second round of translocations for Sections 3-11 starting in 2016

Threatened Species	**EPBC Act status**	**BC Act status**	**Sec.1-2 & EWSSTA 2015**	**Sec.3-11 2016**
Four-tailed Grevillea (*Grevillea quadricauda*)	V	V		√
Hairy Joint Grass (*Arthraxon hispidus*)	V	V	√	√
Hairy Melichrus (*Melichrus hirsutus*)	E	E		√
Lindernia (*Lindernia alsinoides*)	-	E	√	√
Moonee Quassia (*Quassia* sp. 'Moonee')	E	E	√	
Red Lilly Pilly (*Syzygium hodgkinsoniae*)	V	V		√
Rotala (*Rotala tripartita*)	-	E		√
Rough-shelled Bush Nut (*Macadamia tetraphylla*)	V	V		√
Rusty Green-leaved Rose Walnut (*Endiandra muelleri ssp. bracteata*)	-	E		√
Singleton Mint Bush (*Prostanthera cineolifera*)	V	V		√
Slender Screw Fern (*Lindsaea incisa*)	-	E	√	√
Square-fruited Ironbark (*Eucalyptus tetrapleura*)	V	V	√	
Square-stemmed Spike Rush (*Eleocharis tetraquetra*)	-	E	√	
Stinking Cryptocarya (*Cryptocarya foetida*)	V	V		√
Tall Knotweed (*Persicaria elatior*)	V	V	√	√
Weeping Paperbark (*Melaleuca irbyana*)	-	E		√
White Laceflower (*Archidendron hendersonii*)	-	V		√
Yellow-flowered King of the Fairies (*Oberonia complanata*)	-	E		√
Rare Species				
Lepidosperma sp. 'Coaldale'	na	na	√	
Host Species for Threatened Insects				
*Richmond Bird Wing Vine (*Aristolochia pravevenosa*)	-	-		√
Pink Underwing Moth Vine (*Carronia multisepala*)	E			√

*Listed as threatened in Qld, not in NSW or the Commonwealth

Following this report introduction, Part 2 presents an overview of the translocation methods applied. Parts 3 describes the implementation and results of the translocation program for each species on Sections 3-11, and Sections 1-2 and EWSSTA. Part 4 assesses the outcomes of the translocation project in terms of performance criteria and thresholds set out in the Translocation Strategy. Part 5 identifies any corrective measures considered necessary to achieve the translocation projects aims and objectives. Finally, a photo record documents the progress of the translocation project.

2.0 METHODS

2.1 Aims and Objectives

The aims of the translocation project as defined by the Translocation Strategies include:

- Create self-sustaining populations.
- Maintain or enhance existing demographic function and genetic variability.
- Generate increased knowledge of the threatened plant species.
- Achieve no net loss in local plant populations being impacted by the project.
- Make the best possible use of all plant material with potential conservation value.

Objectives addressing the above aims include:

- Plants improve in condition so that flowering fruiting and regeneration is successful.
- Relevant project results and observations documented.
- Original number of individuals re-established.
- Available cutting material and seed harvested, and plants transplanted to the best extent practical.
- Create or augment small sub-populations with diffuse connectivity to metapopulations conserving existing genetic variability.
- Maintain or create a self-sustaining population (or augment an existing patch).

2.2 Translocation Targets

The translocation target is defined as the number of individuals the translocation project aims to establish to compensate for individuals lost during clearing. Translocation targets for the W2B project were identified in each Translocation Strategy and were based on the number of individuals or area of a species recorded within the clearing area/footprint during pre-clearing surveys. The aim of translocation is to maintain populations at these pre-construction levels by salvage, transplanting and introduction of propagated plants. Despite the potential for translocation to make valuable contributions to conservation objectives and to mitigate some of the impacts of development it is recognised that translocations are generally experimental and success cannot be guaranteed, although every effort is made to maximize the chance of success. Accordingly translocation is not considered a mitigation measure under the EPBC Act and the flora individuals to be removed/translocated are considered to be impacted for the purposes of the EPBC Act. This impact will be compensated for with the provision of suitable offsets in accordance with the EPBC Act Offsets Policy. Translocation targets for Sections 3-11 and Sections 1-2 and EWSSTA are listed in Tables 2 and 3 below.

Generally, targets remain as specified in the translocation, although adjustments may be necessary for some species due to unexpected finds of previously unknown plants, thereby increasing the number of plants removed (Table 2). There were also instances where fewer plants were found on the clearing footprint during translocation than indicated in the Translocation Strategy (e.g. 28 *Cryptocarya foetida* instead of 41), this may have been due to design refinements and efforts to reduce unnecessary clearing. However, the true target for *C.foetida* was about 28, or slightly less as some individuals had been misidentified and others were hybrids with *C. microneura*. It is assumed that if all plants of a species were translocated from the clearing footprint, then the number of plants/clumps/trays salvaged represents the actual number of plants present immediately prior to clearing, and therefore the true target.

2.2.1 Sections 3-11

The Translocation Strategy for Sections 3-11 (RMS 2015b) identified twelve threatened species requiring translocation. Additional threatened plant species were found during pre-clearing surveys (unexpected finds) and included in the translocation program (Table 2). Two species of vine that support threatened invertebrate species were also translocated (Table 2).

Table 2: Threatened species translocated for the W2B project on Sections 3-11 and the translocation targets for each species, including unexpected finds.

Species	**Translocation Target (RMS 2015a)**	**Unexpected Finds**	**Total number removed/ translocated**
Threatened Species – Translocation Strategy			
Yellow-flower King of the Fairies (*Oberonia complanata*)	18 (+11) clumps*	35 clumps	53 clumps
Slender Screw Fern (*Lindsaea incisa*)	6295 fronds (0.370ha)	4350 fronds (~0.3ha)	10645 fronds (0.670 ha)
Singleton Mint Bush (*Prostanthera cineolifera*)	609 (0.424ha)	35**	644 (0.43)
Weeping Paperbark (*Melaleuca irbyana*)	1721 (2.761 ha)	1	1721 (
Tall Knotweed (*Persicaria elatior*)	20	350	370
Four-tailed Grevillea (*Grevillea quadricauda*)	3	15	18
Stinking Cryptocarya (*Cryptocarya foetida*)	41		41
Rusty Green-leaved Rose Walnut (*Endiandra muelleri ssp. bracteata*)	3		3
Red Lilly Pilly (*Syzygium hodgkinsoniae*)	6		6
White Laceflower (*Archidendron hendersonii*)	1		1
Rough-shelled Bush Nut (*Macadamia tetraphylla*)	10		10
Hairy Joint Grass (*Arthraxon hispidus*)	348 (1.3ha)	1000 (~0.1)	1348 (1.4ha)
Threatened Species - Unexpected Finds			
Square-fruited Ironbark (*Eucalyptus tetrapleura*)		5	5
Hairy Melichrus (*Melichrus hirsutus*)		1	1
Lindernia (*Lindernia alsinoides*)		30	30
Rotala (*Rotala tripartita*)		20	20
Species Associated with Threatened Insects	Other		
Richmond Bird Wing Vine (*Aristolochia pravevenosa*)	3		3
Pink Underwing Moth Vine (*Carronia multisepala*)	5		5

* 18 translocated during early works soft soil areas in 2015 went to a nursery but appear to have died; 11 more were translocated in 2016 by Ecos Environmental as described below. **Pacific Complete pers. comm. July 2018

2.2.1 Sections 1-2 and EWSSTA

The translocation strategy for Sections 1-2 and EWSSTA (RMS 2015a) identified nine threatened species requiring translocation. One species, *Endiandra muelleri subsp. bracteata* at the Maclean interchange, originally intended for translocation was later found not to require translocation and protected in situ.

Table 3: Translocation targets for species translocated on Sections 1-2 and EWSSTA as per Table 3 in RMS 2015a (Translocation Strategy) and Table 6 in Landmark Ecological Services 2017 (2017 monitoring report).

Species	**Translocation Target (RMS 2015a) as no. or no./area**	**Early Works Soft Soil LES (2017) No. of plants**	**Total number removed/ translocated**
Threatened Species – Translocation Strategy			
Hairy Joint Grass (*Arthraxon hispidus*)	2	38	40
Lindernia (*Lindernia alsinoides*)	1811		1811
Moonee Quassia (*Quassia* sp. 'Moonee')	73 (0.086 ha)		73 (0.086 ha)
Yellow-flower King of Fairies (*Oberonia complanata*)		18*	18*
Slender Screw Fern (*Lindsaea incisa*)	2820 fronds (0.013ha)		2820 fronds (0.013ha)
Square-fruited Ironbark (*Eucalyptus tetrapleura*)	823 (20.285ha)		823 (20.285ha)
Square-stemmed Spike Rush (*Eleocharis tetraquetra*)	253 (0.815ha)		253 (0.815ha)
Tall Knotweed (*Persicaria elatior*)		37 (44)	37 (44)
Lepidosperma sp. 'Coaldale'		35	35

* 18 translocated during early works soft soil areas in 2015 went to a nursery but appear to have died; 11 more were translocated in 2016 by Ecos Environmental as described below. **Pacific Complete pers. comm. July 2018

2.3 Recipient Sites

The quality of the recipient site or how well it matches the original or donor site is a key factor determining the success of threatened flora translocation. Several characteristics need to be considered in selecting a suitable recipient site including the type of habitat present, ecological requirements of the species being translocated, logistical feasibility, whether threatening processes can be controlled, tenure and prospects for long-term population or stand viability. Many plant species can have quite specific habitat requirements, which may not be immediately obvious, and they are unlikely to persist at a recipient site unless it closely matches the donor site in its habitat attributes, including soil type, hydrology/soil moisture regime, topographic position and geology.

Recipient sites for species translocated on Sections 3-11 and Sections 1-2 and EWSSTA are listed in Tables 4 and 5 respectively. These were identified in the relevant Translocation Strategies (RMS 2015a and b). For Sections 3-11 there was provision for flexibility in the final selection of sites, as two or more alternative sites were suggested for most species. Prior to translocation commencing, inspections of the nominated recipient sites were conducted to assess their suitability in terms of soil type, aspect, vegetation and other environmental and logistical factors likely to affect survival and establishment of the species being translocated. This assessment is summarised in Ecos Environmental (2016) "W2B Flora Translocation Project - Site Selection and Validation Report". Thirteen recipient sites were finally selected for Sections 3-11. For the whole W2B project (Sections 1-11) there were 21 translocation recipient sites, the locations of these are shown on Figures 2 and 3.

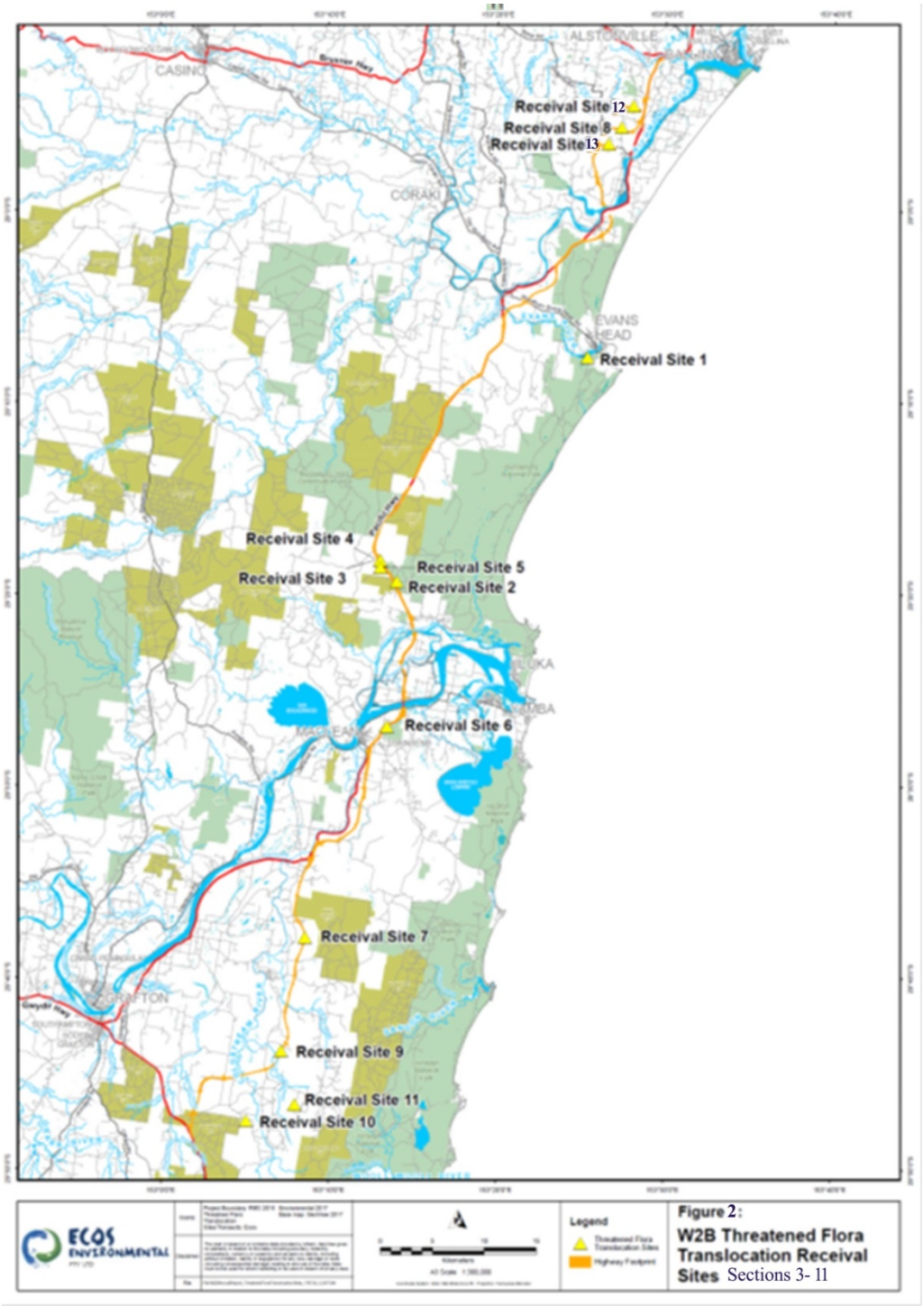
Table 4: Recipient sites for species translocated on Sections 3-11. See Figure 2 below.

Species	**Recipient Site**
Sections 3-11	
Yellow-flowered King of the Fairies (*Oberonia complanata*)	Site 1 - Bundjalung National Park (Evans Head) Site 13 - Lumleys Lane South
Slender Screw Fern (*Lindsaea incisa*)	Site 2 - Bundjalung National Park (Mororo Rd)
Singleton Mint Bush (*Prostanthera cineolifera*)	Site 3 - Tabbimoble Triangle, RMS property at Tabbimoble Ck as per Strategy
Weeping Paperbark (*Melaleuca irbyana*)	Site 3 - Tabbimoble Triangle Site 4 and 5 - RMS offset property at Tabbimoble Ck.
Tall Knotweed (*Persicaria elatior*)	Site 6 - Yaegl Nature Reserve (centre-north)
Four-tailed Grevillea (*Grevillea quadricauda*)	Site 7 - Within project boundary Quarry Rd (Sec.3)
Stinking Cryptocarya (*Cryptocarya foetida*)	Site 8 - Lumley's Lane; Site - 12 Coolgardie Rd
Rusty Green-leaved Rose Walnut (*Endiandra muelleri ssp. bracteata*)	Site 8 - Lumley's Lane; Site - 12 Coolgardie Rd
Red Lilly Pilly (*Syzygium hodgkinsoniae*)	Site 8 - Lumley's Lane; Site - 12 Coolgardie Rd
White Laceflower (*Archidendron hendersonii*)	Site 8 - Lumley's Lane; Site - 12 Coolgardie Rd
Rough-shelled Bush Nut (*Macadamia tetraphylla*)	Site 8 - Lumley's Lane; Site - 12 Coolgardie Rd
Hairy Joint Grass - Section 10 (*Arthraxon hispidus*)	Site 8 - Lumley's Lane
Hairy Joint Grass - Section 3 (*Arthraxon hispidus*)	Site 9 - Within project boundary at Mitchells Rd (Sec.3)
Species Additional to Translocation Strategy	
Richmond Bird Wing Vine (*Aristolochia pravevenosa*)	Site 12 - Coolgardie Rd
Carronia (*Carronia multisepala*)	Site 12 - Coolgardie Rd
Lindernia (*Lindernia alsinoides*)	Site 9 - Within road reserve at Mitchells Rd (Sec.3)
Square-fruited Ironbark (*Eucalyptus tetrapleura*)	Site 10 - Offset land, Sunnyside Rd
Weeping Paperbark (*Melaleuca irbyana*)	Site 10 - Offset land, Sunnyside Rd
Hairy Melichrus (*Melichrus hirsutus*)	Site 11 - Offset land, Pillar Valley (Mahogany Drive)

Table 5: Recipient sites for species translocated on Sections 1-2 and EWSSTA. See Figure 3 below.

Species	**Recipient Site**
Sections 1-2 and EWSSTA	
Hairy Joint Grass (*Arthraxon hispidus*)	Kangaroo Trail, Trustrums Hill
Lindernia (*Lindernia alsinoides*)	Kangaroo Trail, Halfway Ck Crossing, Yuragir NP
Moonee Quassia (*Quassia* sp. 'Moonee')	Dirty Creek Road Reserve
Slender Screw Fern (*Lindsaea incisa*)	Kangaroo Trail

Species	**Recipient Site**
Square-fruited Ironbark (*Eucalyptus tetrapleura*)	Pillar Valley
Square-stemmed Spike Rush (*Eleocharis tetraquetra*)	Halfway Ck Crossing
Tall Knotweed (*Persicaria elatior*)	Yaegl NR
Lepidosperma sp. 'Coaldale'	Mahogany Drive



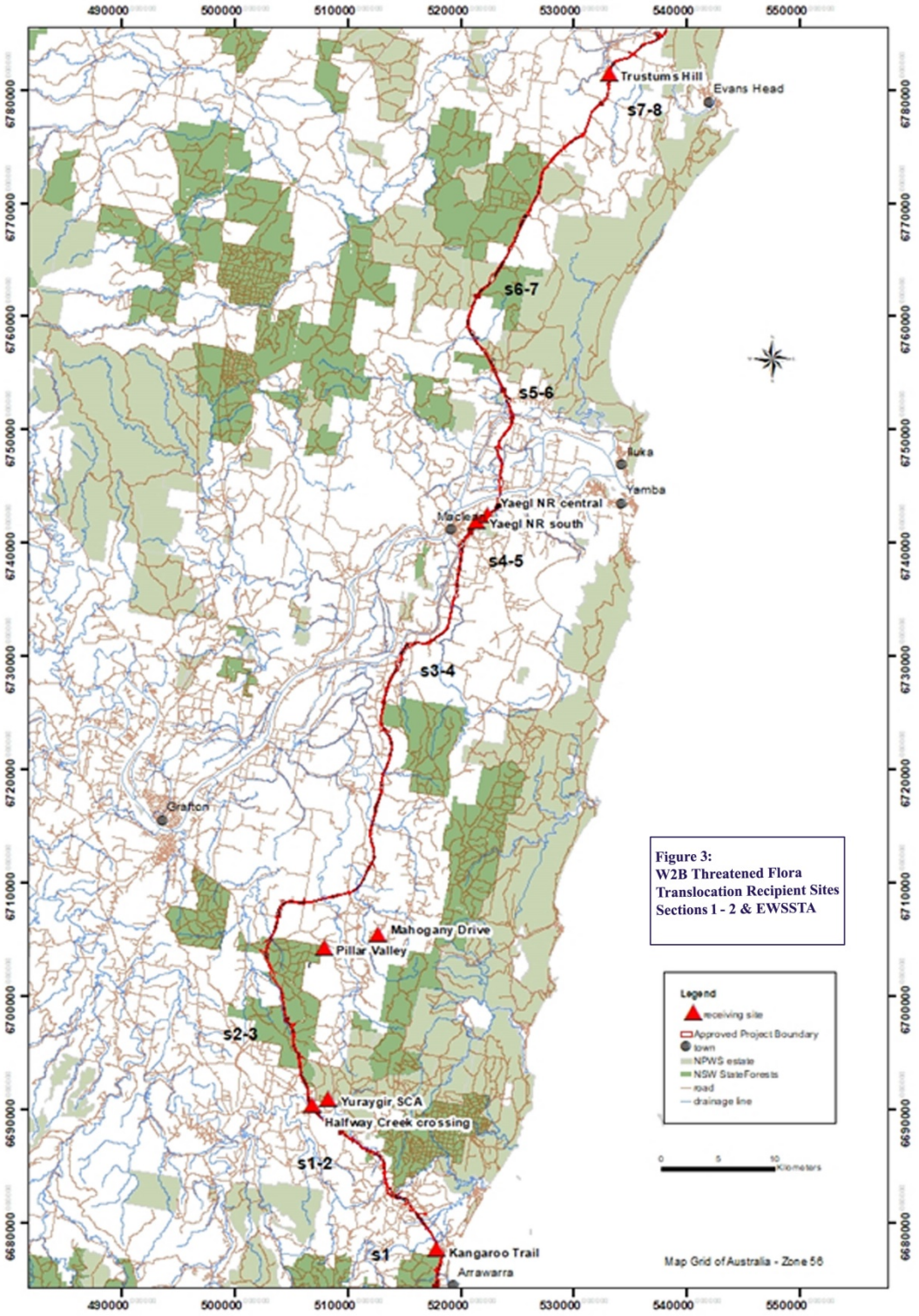


Figure 3:
W2B Threatened Flora Translocation Recipient Sites Sections 1 - 2 & EWSSTA

2.4 Translocation Methods

Four methods were used to translocate species: (i) transplanting (or salvage transplanting), (ii) propagation of cuttings collected from impacted plants, (iii) propagation of seed collected from impacted plants or the local population, and (iv) propagation of soil seedbank collected from under impacted plants. The translocation methods applied to each species are indicated in Table 6. Summing the instances of each type of translocation in Table 6 it can be seen that transplanting was the main translocation method applied (18), followed by seed (8), cutting (5) and soil seedbank propagation (3). More than one method was applied to several species, often as back-up in case one method failed or fell below target.

Some changes were made to translocation methods described in the Translocation Strategy on Sections 3-11 including recipient sites. These changes did not alter the overall translocation strategy only some of the methods. They were detailed in the first monitoring report for Section 3-11 (Ecos Environmental 2017) and have been included in Appendix 1 of this report.

2.4.1 Transplanting

Transplanting from the clearing footprint was limited to small plants up to sapling size as they were able to be transplanted manually (i.e. with spade and mattock). Transplanting of larger individuals with machinery has been effectively applied during past translocation projects, particularly with rainforest species (e.g. the Brunswick Heads to Yelgun and Tintenbar to Ewingsdale projects), but was not applied on the W2B project as this approach was not included in the Translocation Brief and generally discouraged in favour of translocation by cutting or seed propagation.

Larger individuals were replaced with propagated plants. Transplanting can ensure that locally adapted genotypes are preserved and achieve a high survival rate, but propagation may be more cost-effective and appropriate in situations where large numbers of mature individuals require replacement, as in the case of Weeping Paperbark and Singleton Mint Bush on the W2B project.

2.4.2 Seed and Cutting Propagation

For threatened species on Sections 3-11, propagation was carried out from seed if possible, as cutting propagation on previous translocation projects had often resulted in a low cutting strike rate or plants with a sparse root system and lacking in vigour (Ecos Environmental 2011a). Cutting propagation was applied only if a seed source was not available, as in the case of Richmond Bird Wing Vine. Unexpectedly, this species propagated fairly well from thick hardwood stem cuttings when attempts to propagate other vines by stem cuttings in the past had failed.

Translocation was limited to transplanting for the fern *Lindsaea incisa* and the orchid *Oberonia complanata*, as transplanting of these or related species had good results on previous projects (Ecos Environmental 2016 and 2011b), and propagation from spores or very fine orchid seed would have required specialised methods.

Generally, propagation of all species was successful and any problems that arose occurred after planting out. The only species where propagation failed was the attempt to propagate *Quassia* sp. Moonee on Sections 1-2 from cuttings. Seed propagation and transplanting were not attempted. This was unfortunate as the species is known to reproduce clonally/ vegetatively by producing stem shoots off the root system (root suckers), indicating it would transplant successfully.

As well as receival site, horticultural factors also play a key role in the success or failure of translocations. Horticultural factors include choice of translocation method, propagation technique, growing-on and hardening off, soil media, fertilisers and the regime of follow-up plant care and maintenance. Ideally methods should be based on previous experience and proven outcomes but often this information is not available, which underlines the experimental

nature of much threatened plant translocation work and the importance of documenting translocation methods and results.

2.4.3 Soil Seedbank

A different method of propagation using the soil seedbank was used successfully for the Singleton Mint Bush translocation, and also trialled with Four-tailed Grevillea and Tall Knotweed. Topsoil under mature plants was collected on the assumption it contained dormant seed. For the first two species, the soil was placed on sheets of tin then dry leaf litter spread on top and burnt to remove germination inhibitors. The treated soil was placed into trays and the seedbank germinated in a nursery (further details below). This proved to be an effective means of propagation for Singleton Mint Bush, particularly as seed and cuttings were either difficult to propagate, of poor quality or unavailable at the time. Using the same approach, but without fire, mud was collected under old Tall Knotweed plants and spread in plots at the recipient site.

Table 6: Translocation methods applied to impacted threatened species on (i) Sections 3-11 and (ii) Sections 1-2 and EWSSTA of the W2B project. Four methods were applied to species. Totals for each method are indicated at the bottom of the table.

(i) Sections 3-11

Species	**Transplant**	**Propagate Seed**	**Propagate Cuttings**	**Propagate Soil seedbank**
Yellow-flowered King of the Fairies (*Oberonia complanata*)	+	-	-	-
Slender Screw Fern (*Lindsaea incisa*)	+	-	-	-
Singleton Mint Bush (*Prostanthera cineolifera*)	-	-	+	+
Weeping Paperbark (*Melaleuca irbyana*)	-	+	-	-
Tall Knotweed (*Persicaria elatior*)	+	-	-	+
Four-tailed Grevillea (*Grevillea quadricauda*)	+	+	-	+
Stinking Cryptocarya (*Cryptocarya foetida*)	+	+	-	-
Rusty Rose Green Walnut (*Endiandra muelleri ssp. bracteata*)	+	+	-	-
Red Lilly Pilly (*Syzygium hodgkinsoniae*)	+	+	-	-
White Laceflower (*Archidendron hendersonii*)	+	+	-	-
Rough-shelled Bush Nut (*Macadamia tetraphylla*)	-	+	-	-
Hairy Joint Grass - Section 10 (*Arthraxon hispidus*)	+	-	-	-
Hairy Joint Grass - Mitchell Rd Sect 3 (*Arthraxon hispidus*)	+	-	-	-
Additional Species				
Square-fruited Ironbark (*Eucalyptus tetrapleura*)	+	-	-	-
Hairy Melichrus (*Melichrus hirsutus*)	+	-	-	-
Lindernia (*Lindernia alsinoides*)	+	-	-	-

Species	Transplant	Propagate Seed	Propagate Cuttings	Propagate Soil seedbank
Richmond Bird Wing Vine (*Aristolochia pravevenosa*)	-	-	+	-
Carronia (*Carronia multisepala*)	-	-	+	-

(ii) Sections 1-2 and EWSSTA

Species	Transplant	Propagate Seed	Propagate Cuttings	Propagate Soil seedbank
Hairy Joint Grass (*Arthraxon hispidus*)	+	-	-	-
Lindernia (*Lindernia alsinoides*)	-	-	+	-
Moonee Quassia (*Quassia* sp. 'Moonee')	-	-	+	-
Slender Screw Fern (*Lindsaea incisa*)	+	-	-	-
Square-fruited Ironbark (*Eucalyptus tetrapleura*)	-	+	-	-
Square-stemmed Spike Rush (*Eleocharis tetraquetra*)	+	-	-	-
Tall Knotweed (*Persicaria elatior*)	+	-	-	-
*Lepidosperm*a sp. 'Coaldale'	+	-	-	-
Total instances (i) and (ii)	18	8	5	3

2.4.4 Maintenance

Maintenance is an integral part of the translocation strategy. This includes watering of recently introduced plants, checking and repair of exclusion fences and tree guards, spraying of weeds and competing natives, digging out sapling regrowth, brush-cutting and removal of mulch, addition of mulch, replacing monitoring tags, addition of fertiliser, spraying for insect pests and associated sooty mould, and various other maintenance tasks depending on the species and the recipient site. Maintenance is essentially a set of horticultural practices applied to assist introduced plants become sufficiently established on a site that they will continue to survive and grow once the translocation has finished.

Without maintenance, the mortality rate of introduced plants would be much higher. In a completely natural population we know that there are scenarios where after disturbance (e.g. bush fires) enormous numbers of seedlings or vegetative off-shoots are produced but only a minute percentage become established as a growing plant and even fewer reach maturity. If translocation is to be successful, ecological processes causing mortality of plants trying to establish a foothold in a plant community have to be circumvented to give the introduced plant a better chance of becoming established. This is achieved through the application of horticultural techniques as simple as watering and fencing, to complex interventions such as manipulation of mycorrhizae or introduction of pollinators. It is still not clear as to what extent translocation is possible, but it is fairly obvious that without maintenance during the early phase of the species life cycle, individuals have less chance of becoming established and forming part of a functional plant community.

2.5 Monitoring

The Translocation Strategies required monitoring of the translocations 3-monthly in Year 1, 6-monthly in Year 2 and annually from Year 3 onwards. Monitoring on Sections 3-11 from June 2017 to June 2018 represented the second year of the translocation project and monitoring was carried out 6-monthly in spring 2017 and autumn-winter 2018.The translocations on Sections 1-2 were in their third year therefore one monitoring was carried out in 2017-2018 in autumn-winter 2018.

The data collected at each monitoring event included ID no. of individual plant/plot, date, number or abundance of individuals as counts or crown-cover, evidence of disease or grazing, new shoot growth, flowering, seedling, recruitment and physical site conditions (e.g. soil moisture, recent rainfall, water depth when flooded) and overall plant condition. Condition was recorded on a scale of 0 to 5 where '0' is dead and '5' is reproductively mature.

2.6 Data Entry and Analysis

Monitoring results were entered into an Excel spreadsheet after each monitoring event. See the files: titled "W2B Translocation Monitoring Sections 3-11 – Years 1 -2, to June 2018" appended to this report" and "W2B Translocation Monitoring Sections 1-2 and EWSSTA – Year 3, to June 2018" appended to this report"

Summary statistics were calculated using Excel. Some of the data was amenable to more complex statistical analysis, but at this stage of the project, trends rather than formal statistical testing were relied on to interpret the data. Previous experience has shown that because the mean to standard deviation ratio of translocation data is usually high and sample numbers constrained, sample sizes are seldom large enough to demonstrate a statistically significant difference, even though data trends indicate differences in response between species, locations, treatments etc. Most of the analysis in this report is based on interpretation of data trends.

3.0 IMPLEMENTATION AND RESULTS (SECTIONS 1-11)

3.1 Weather Conditions

The start of the translocations on Sections 1-2 and EWSSTA experienced average rainfall conditions between July and December 2015, although October was drier than usual. Between January and April 2016 during the typical rainy season, rainfall was well below average. However, as average rainfall in late summer and autumn is generally more than required to maintain reasonable soil moisture levels, below average rainfall would not have resulted in particularly stressful soil moisture conditions.

The first year of the translocations on Sections 3-11 starting August 2016, coincided with a late spring-early summer dry season and stressful soil moisture conditions. The seasonal drought ended abruptly at the end of February 2017 with heavy rain and flash flooding. Between September 2016 and February 2017 rainfall was well below average (see Figure 4) and temperatures were also above average, necessitating additional watering of the recipient sites. The Far North Coast region recorded the highest maximum daily temperature on record on 11/2/2017 (mid to high 40s), causing leaf damage, wilting and some mortality on the translocation project. A few weeks later at the end of February the rainy season started and low lying sites were hit by flash flooding. Between 27/2/17 and 31/3/17, 800-1000 mm of rain fell from Ballina to Maclean causing flash floods and prolonged flooding of recipient sites located on Sections 3-11 and similar effects on Sections 1-2. Wet conditions persisted to the end of June 2017.

During the last 12 months (June 2017 until June 2018) the usually dry late winter-early spring period was very dry, with a consequent bushfire at one of the receival sites on Sections 1-2. This was followed by a wet late spring, which avoided the usual late spring drought, followed by more or less average rainfall through to June 2018. Unlike the previous year there were no heavy rainfall events and flash flooding.

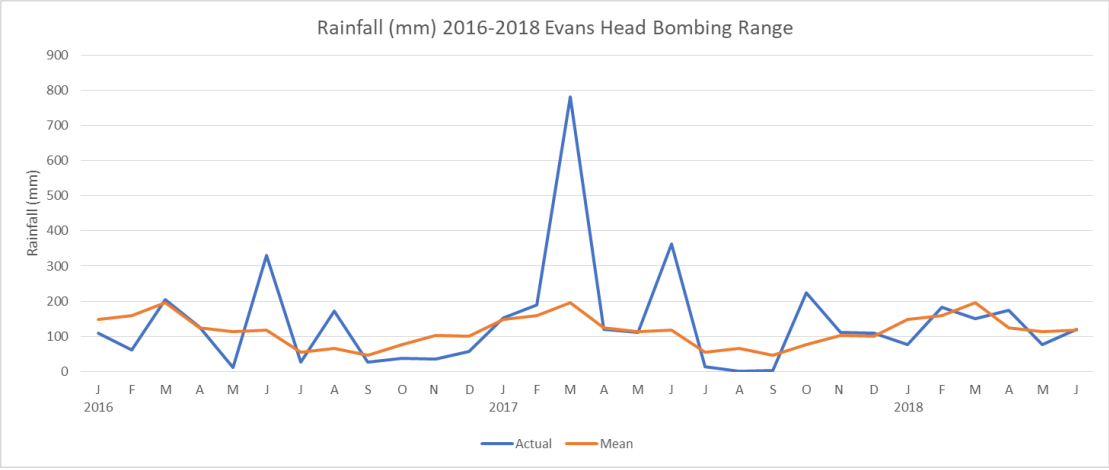


Figure 4: Daily and monthly rainfall in 2016-2018 recorded at Evans Head Bombing Range and representative of W2B.

3.2 Slender Screw Fern (*Lindsaea incisa*)

3.2.1 Translocation Method – Sections 3-11 (2016-18)

First translocation 2016

A total of 127 trays or ~6350 fronds were transplanted to a recipient site 1 in Bundjalung National Park in September 2016. This total is based on an estimate of 50 fern fronds per tray. The number of genetic individuals is unknown as the fronds grow from a network of rhizomes. It is possible that patches represent single clones of hundreds of stems.

Sods containing fern fronds and rhizomes were dug out to a depth of 6-8 cm and placed in 40 cm square trays, watered and transported to the recipient site in Bundjalung National Park. The trays of fern were planted in plots about 2 m apart with the plots laid out in lines roughly parallel with the contour, although the site is in a flat-bottomed valley and the slope angle very small (<1 degree). Each plot received one tray of *L.incisa*. In addition, 5 larger patches were planted with 5 trays/patch. The overall planting layout was as follows:
Lines A-D:
Line A – 25 trays/plots
Line B – 44 trays/plots
Line C – 15 trays/plots
Line D – 18 trays/plots
Patches 1– 5 (5 trays/patch)
Total trays/plots = 127. Total number of fronds based on an av. of ~50 per tray = 6350.

The plots were watered regularly to keep the soil moist; no fertilisers were applied. The plastic trays have an open grid base and were inverted over the plots to protect the fern plants from animal disturbance and to define the plots for monitoring. They also proved useful for catching leaf fall during the dry season and preventing a build-up of leaf litter, which may have smothered *L. incisa*. Leaves were cleared from the trays every few months. Watering was carried out every month to six weeks to the end of February to prevent wilting during hot dry weather.

Second translocation 2017 (unexpected finds)

The same methods were used to translocate Slender Screw Fern in September 2017 one year later. These plants, in similar number, came from the eastern side of the Pacific Highway at Mororo, which had not been surveyed. They were introduced to a second recipient site on the southern side of the swale about 30-40 m away from the first translocation area in Bundjalung National Park. The site was just above the level of flash floods that occurred in autumn 2017 and the soil was grey rather than dark brown, indicating less organic matter or humus. Vegetation in both areas was similar in species composition, structure and topographic position. A third of the plants from the second translocation were planted in Area 1, as suitable habitat was soon used up in Area 2. These were planted in patches just above the flash flood level. Regular watering was carried out to prevent wilting during spring and early summer 2017.
Total trays/plots translocated = 151. Total number of fronds based on an av. of ~30 per tray = 4530. (Note – number of fronds was apparently not recorded in pre-clearing surveys on the eastern side of the highway, but the density of patches appeared to be considerably less, as the eastern side was exposed to the west, hence estimated number of fronds was based on 30 per tray rather than 50.)

3.2.2 Results

First translocation 2016

Survival rate of the first translocation in terms of the number of plots with at least some *L. incisa* fronds was 100% in April 2018 (approx. two years after translocation). Mean percent crown cover of *L. incisa* on the five lines ranged from 11.9% to 41.3% (Table 7). The patches had a mean percent crown cover of 53%. The plots had recovered from being flattened and flooded by several flash floods in autumn-winter 2017. Overall, the total number of fronds was probably about 20% less than the original or target number. On Line C, mean percent crown cover increased from 4.7% to 41.3% over 12 months, while on the other lines crown cover remained roughly the same (Figure 5). This indicates that fine scale habitat on Line C, which is in an intermediate topographic position (between Lines A, B and Lines D, E), is more suited to *L. incisa* than the other lines. The patches maintained high percent crown cover indicating they also represented better habitat for *L. incisa*. These differences in habitat are very subtle and probably related mainly to soil moisture regime and competition. Similar patterns of response to subtle differences in topographic position were recorded during the translocation of this species for the Sapphire to Woolgoolga Pacific Highway upgrade project (Ecos Environmental 2011b).

Second translocation 2017 (unexpected finds)

Similar levels of survivorship and mean crown cover resulted from the second translocation in 2017 (Table 7). This translocation was not subjected to flash flooding, unlike the first translocation. Roughly similar crown cover values between the first and second translocation suggests that plants can recover from flash flooding. Therefore, flash flooding does not appear to bear significant threat to the translocated population. Results are shown in Figure 5 and Table 7.

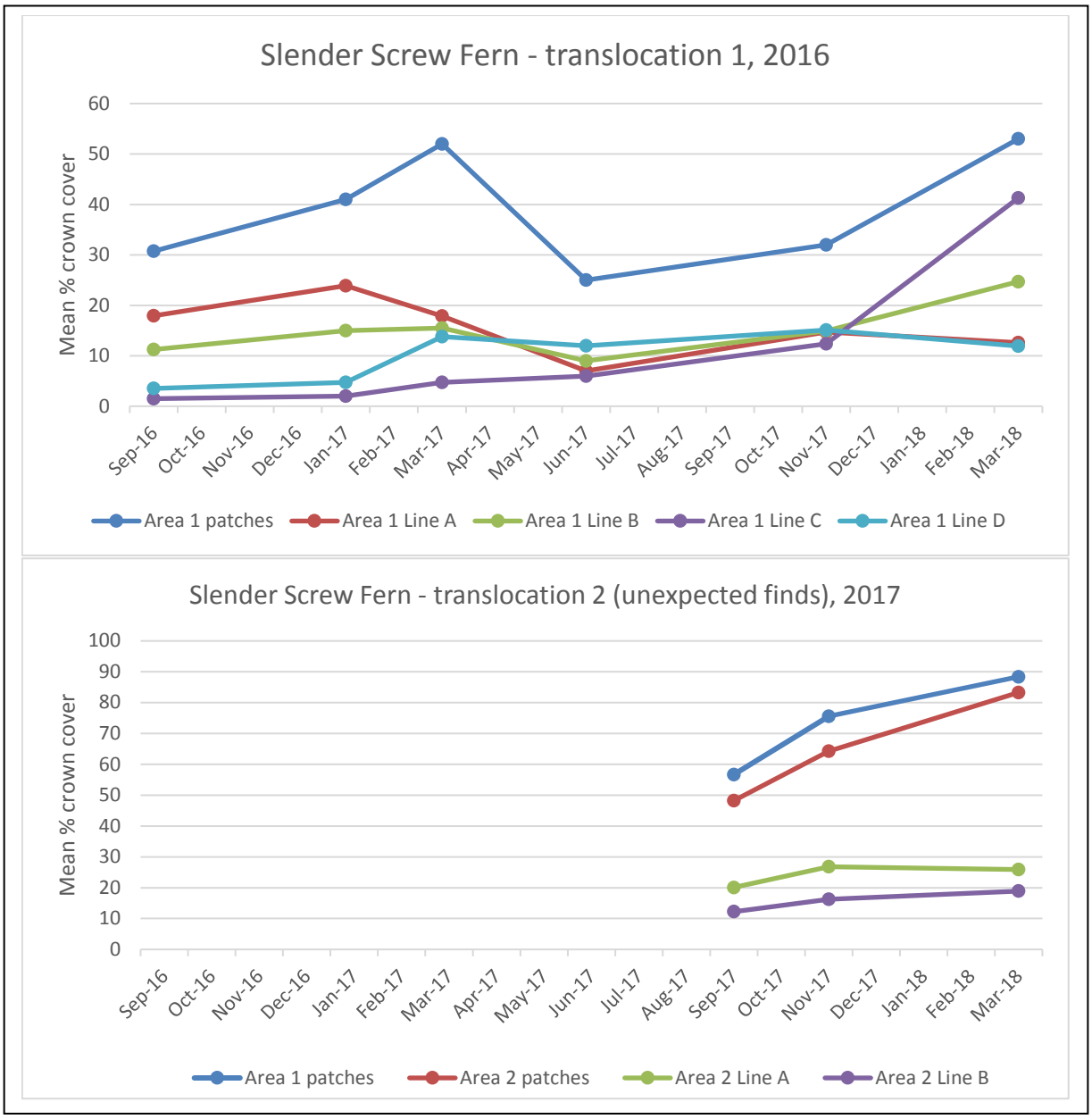


Figure 5: Results of Slender Screw Fern translocations on Section 3-11 in terms of changes in mean percent crown cover. The first translocation was carried out in September 2016 and the second for unexpected finds in September 2017. The dip on some lines in the upper graph is due to flooding.

3.2.2 Translocation Method and Results – Section 1-2 and EWSSTA (2015-18)

Results of the Slender Screw Fern translocation on Sections 1-2 and EWSSTA were not as successful. Only 3 of the original 45 slabs transplanted (equivalent to plots) survived after 2.5 years, although near 100% of 17 additional potted plants introduced in autumn 2017 were surviving after one year (Table 8). The second planting consisted of plants grown in a nursery. High mortality in the initial translocation was attributed by LES (2016, 2017) to kangaroo grazing and flash flooding.

3.3 Yellow-flowered Oberonia (*Oberonia complanata*)

3.3.1 Translocation Method

Orchid plants constituting the 18 plant target specified in the Translocation Strategy were apparently salvaged during the early works period in 2015 and sent to a nursery for stabilisation or growing-on, but died for reasons unknown. Plants translocated by Ecos Environmental from Woodburn – Evans Head Rd donor site in August 2016 were growing on a dead Casuarina tree at the edge of clearing. As the host tree was in an advanced state of decay and likely to collapse, these plants were also translocated. Eleven plants or clumps were translocated from the dead tree to a recipient site in Bundjalung National Park near Evans Head.

Rather than prising the orchid away from the tree as described in the Translocation Strategy, the orchid plants were translocated still attached to the bark substrate. A hand saw and chisel were used to remove sections of dead bark from the tree supporting the orchids so there was minimal disturbance of the orchid roots, which grow mainly on the surface of the bark. Bark with orchids was then attached to a host tree in a sheltered position at the recipient site with ribbon or wire.

Twenty small orchid recruits (1-2 cm long) growing under one of the larger plants were separated and placed on small pots of ground up bark from the host Casuarina tree in an attempt to propagate more plants of this species. All plantlets died over the next six months. They died from a fungal wilt and appeared to be very sensitive to substrate moisture. The few plantlets that produced growth arched downward as if growing on a vertical face, indicating they should have been attached to a vertical surface in a fully aerated position rather than attempting to grow them upright on pots of damp bark fines.

Further plants of this species were found on a *Melaleuca linariifolia* tree south of Lumleys Lane in the clearing footprint in 2017. A total of 14 small branch sections containing approximately 35 plants or clumps of plants were removed from the tree and attached to trees in an adjoining swamp sclerophyll forest margin about 30 metres away in August 2017.

3.3.2 Results

Only one plant from the first translocation by Ecos Environmental in 2016 has died (not including the plantlets that died in the pots). Tree moss was packed in behind some of the bark pieces to maintain moisture, and the plant that died was the only one that came into contact with the moss, again showing how sensitive the species is to moisture. Generally, clumps of orchid plants continued to flower and produce seed without apparent interruption of their normal growth rhythm.

In the second translocation of unexpected finds in 2017, out of the fourteen branchlets supporting approximately 35 plants or clumps of plants, all survived to June 2018 and the majority of clumps continued to produce flowers and seeds.

3.4 Singleton Mint Bush (*Prostanthera cineolifera*)

3.4.1 Translocation Method

Singleton Mint Bush has a single stemmed growth form typical of sclerophyll shrubs with an obligate seeder life history. Obligate seeders are killed by fire, regenerate only from seed, tend to be short-lived (<20yrs) and often persist by soil-stored seed if a long period without bushfire occurs. Seeders with soil stored seed (some have canopy seedbanks) build up a store of dormant seed in the soil between fires and regenerate from this seed when a fire goes through. In August 2016, the Tabbimoble population consisted of over-mature and senescent individuals and most were collapsing as they neared the end of their life-span. As cuttings and seed were of poor quality or not available until later in the year, it was decided to trial a different method of propagation using the soil seedbank.

Topsoil was collected to a depth of 1-3 cm from under *P. cineolifera* bushes within the clearing footprint. The soil was spread on sheets of tin and covered by a 5 cm layer of dry leaves and twigs which was burnt to simulate the effects of bushfire, including heating of the topsoil and release of combustion compounds that trigger germination of dormant seed. The burnt soil was placed in trays and germinated in a nursery.

To clarify the effect of the fire treatment on seed germination, topsoil was divided into three lots and subjected to three treatments: (i) high fire, (ii) low fire and (iii) no fire (control). High fire was simulated by doubling the amount of fuel. Species and numbers of seedlings were recorded three months after the treatments. Seedling density and species diversity was much higher in the high fire treatment and much lower in the control. Ten trays were selected at random from the high fire and control treatments and counts made of the number of seedlings of each species, including Singleton Mint Bush.

Seedlings of *P. cineolifera* were potted into native tubes in October 2016 after recording the soil treatment results. Standard nursery potting mix for natives was used and Seasol liquid fertiliser applied at intervals as the potting mix had no added fertiliser. There were no disease problems and only minor grazing by caterpillars in the nursery. Tubestock were >30 cm in height and hardened off before planting out. A series of plantings were carried out at the 'Tabbimoble Triangle' recipient site over 11 months in 2017 – firstly in March, followed by three additional plantings in April and November. See below for details.

The site was about 80 metres long (N-S) by 60 metres wide (E-W) and was fenced to exclude grazers. Vegetation structure varied from forest in the south to woodland in the north. A soil texture and drainage gradient extended north-south across the site with increasing sand content and better drainage towards Tabbimoble Creek at the southern end, and increased clay content and poorer drainage to the north. Sand is transported by Tabbimoble Creek from sandstone hills upstream and during floods spills out on the edge of the clay soil floodplain.

In the first planting (23/3/2017) 600 tubestock were planted across the whole recipient site at roughly even spacing (a few metres apart). An inspection of the site three weeks after planting found that most tubestock in the northern half to two-thirds of the site were dead or dying from a wilt disease (probably a root fungus), whereas plants in the southern half to one third of the site were still healthy. As soil texture became sandier towards the creek, this result indicated that *P. cineolifera* was sensitive to soil texture and more likely to establish on soil with a higher sand content closer to Tabbimoble Creek.

<u>Planting Experiment 1</u>

To clarify the effect of difference in soil texture within the site on the performance of *P. cineolifera* (apparent in the early results of the first planting), and to discount possible effects due to flash flooding and pre-planting herbicide, a controlled experimental planting was carried out three weeks after the first planting (12/4/2017). Five transects were laid out at different points relative to the north-south soil texture gradient within the fenced site.

Transects were placed at approx. right angles to the soil texture gradient so soil texture on a transect would be roughly the same. Three 2 m x 2 m plots were placed 510 m apart along each transect. The plots were divided into quarters and each quarter planted with four tubestock (16 plants per plot). The two quarters closest to the creek received a 12-month slow release fertiliser and the other two quarters received no fertiliser.

Two months after the start of the experiment, plants on the two transects furthest from the creek at the northern end of the site (transects A and B) were showing the same wilt symptoms as the first planting, whereas plants in transect plots closest to the creek (transect E) and in the side gully (transect C) were healthy. On the transect in an intermediate position (transect D), about half the plants were healthy and half were wilting. There was no discernible difference in performance due to the fertiliser treatment. These results confirmed the initial observations that *P. cineolifera* is sensitive to soil texture and drainage and requires soil with visible sand content. Further flash flooding occurred which did not affect survival on the sandier transects.

Based on the results of this experiment, the recipient site was extended further south into the sandy belt closer to Tabbimoble Creek, fenced and planted with another 200 tubestock at the start of July 2017.

Planting Experiment 2

Cutting propagation of *P. cineolifera* was carried out during the early works period in 2015-2016 from a few young plants growing on the edge of forest at the Tabbimoble Creek bridge (Only a small amount of good quality cutting material was present on these plants when inspected in August 2016 so the decision was made to propagate from the soil seedbank.) Cutting propagation was successful and plants were transferred to Ecos Environmental's nursery where they were grown on in super tubes for later planting out.

A second experiment was carried out to determine if there was any difference in the performance of plants propagated from seed and cuttings . The effect of fertiliser was also incorporated into the experiment by planting half with 12 month slow release fertiliser and half without. As well as investigating the effect of propagation type and fertiliser on performance, this experiment augmented the number of translocated Mint Bush, to keep the total number of surviving or established plants near the target number specified by the Translocation Strategy (ie 609).

Outline of experimental design 2 comparing the growth rate (plant height) of Singleton Mint Bush propagated from seed and cuttings, and planted with and without fertiliser:-

	Propagation Type	
Fert Treatment	Seedlings	Cuttings
No Fert	X	X
Fert	X	X

Planting Experiment 3

Tubestock introduced in the first planting and in Experiment 1 were approximately 6 months old. They were relatively young but large enough according to usual standards (i.e. >30cm tall) for planting out.
Tubestock introduced in Experiment 2 were one year old, meaning they had been growing in the plant tubes for 12 months since being transferred from the germination trays.

A third experiment was carried out to test if the now one year old tubestock would still be affected by disease to the same extent if planted into areas of the soil gradient where all plants had died in Experiment 1. Time and resources were limited, so only two plots were replanted. These were planted in Nov/2017.

3.5.2 Results

First planting

Survivorship was ~40% after two years. Most mortality occurred in the two months after planting and the main cause appeared to be fungal infection (fungal wilt). Of the plants that survived, mean height in July 2018 was 91.4 cm, increasing from 31.3 cm in November 2017, a three-fold increase in height in less than a year. The tallest plant was 182 cm (approx. 2 years since germination, 1 year since planting out). A few other plants were taller than 1.5 m.

Experiment 1
Experimental layout planted with 6 month old tubestock (age since potting on to native tubes). Survivorship varied from 0% to 100% depending on where plants were introduced relative to the soil texture gradient, within the 80m long site. Addition of 12 month slow release fertiliser at planting had no effect on growth. This is possibly because all tubestock still carried fertiliser applied in the nursery.

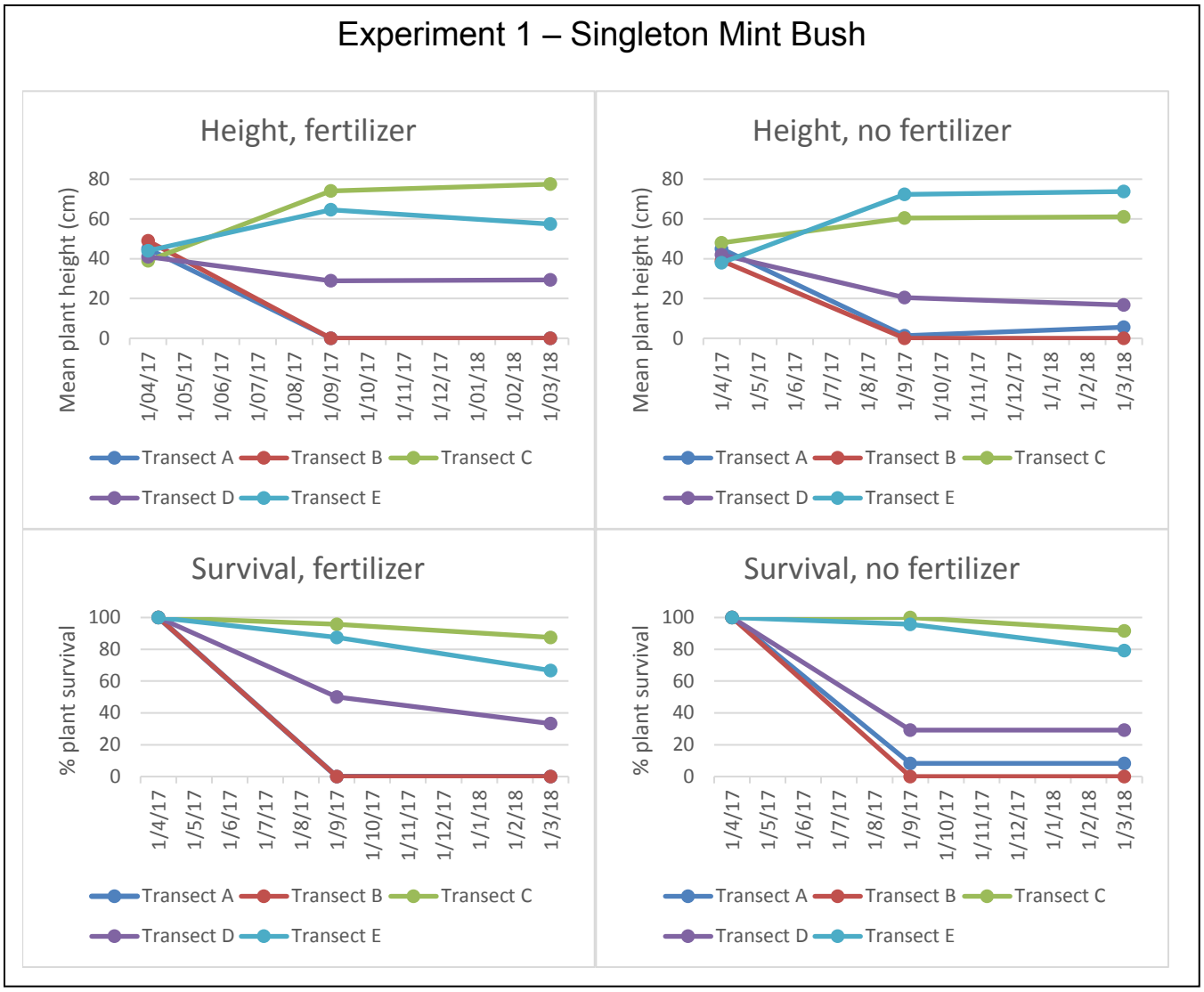


Figure 6: Experimental planting of Mint Bush comparing growth rate (Height in cm) and survival on five transects in a receival site 80m wide with variable soil texture (sand content). Mean height and survivorship were much higher on Transect C and E which were in parts of the site with higher sand content. Planting with or without fertiliser had nt noticeable effect, probably because of fertiliser carried over from the nursery.

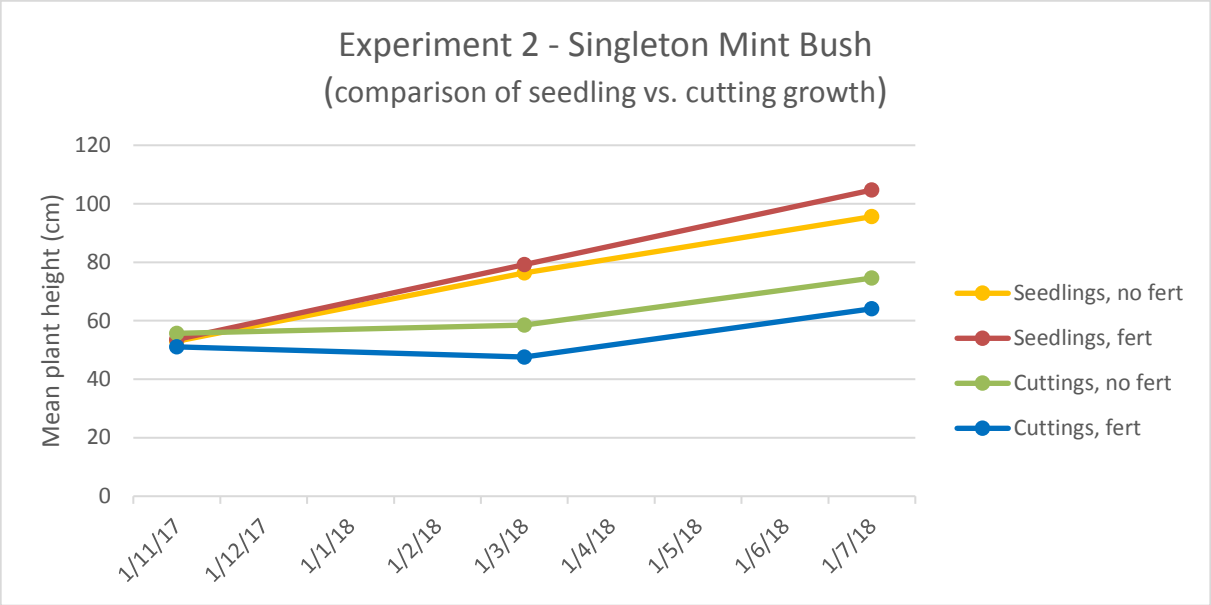


Figure 7: Experiment 2 comparing the growth rate of introduced Singleton Mint Bush propagated from seed and from cuttings. Growth of the seedlings is noticeably faster than the cuttings. Again, planting with or without fertiliser had no noticeable effect, probably because of fertiliser carried over from the nursery.

Experiment 2

Experimental layout planted with 12 month old tubestock. Seed propagated plants grew taller and more vigorously (ie. with more leaf) than cutting grown plants, even though cuttings were about 6 months older. Fertiliser again had no discernible effect on growth rate, possibly because of fertiliser carried from the nursery.

Experiment 3

The most interesting result came from Experiment 3. Two plots (B5 and B6) where all plants had died in Experiment 1 were replanted with 12 month old tubestock. Survivorship in plots B5 and B6 after 6 months was 100%, compared with zero in experiment 1.

As well as soil texture, or sand/clay content, age of tubestock (a horticultural factor) appears to be important in determining plant performance. Possible mechanisms for this effect could be (i) greater disease resistance as seedlings grow older, (ii) changes in the microflora of sterilised soil as the soil medium is recolonised by soil biota (fungi, bacteria, protozoans and myriad other organisms). These may condition the seedlings, particularly the root system, so they are better able to resist the impact of soil biota when introduced to the wild. This effect is due not so much to the age of seedlings, but to age of the commercial soil medium since it was sterilised, although both may be relevant.

The total or net number of plants surviving in July 2018 was 584, or roughly equal to the target of 609.

3.5 Weeping Paperbark (*Melaleuca irbyana*)

3.5.1 Translocation Method

Seed capsules were collected in August 2016 from trees on a 100 metre transect in the New Italy population (see Excel spreadsheet, donor tab). Weeping Paperbark stores seed in persistent capsules on its branchlets so seed is always available. Seedlings were grown in a commercial, sterilised soil mix for natives and given applications of dilute Seasol liquid fertiliser. The tubestock were planted out after reaching an average height of 30cm and after hardening off for two weeks. Seed propagation took 8 months to complete.

Two recipient sites were selected for Weeping Paperbark: RMS offset land south of Tabbimoble Creek and 'Tabbimoble Triangle', also RMS property, on the northern side of Tabbimoble Creek. At the first site two planting areas were marked out in grassy open woodland dominated by Forest Red Gum, Swamp Oak, Paperbark and Swamp Box. Planting areas were fenced to exclude domestic and native grazing animals. The two areas were on a flat floodplain on heavy clay soil typical of most Weeping Paperbark habitat. The vegetation was relatively open with low tree density allowing for better tubestock establishment, but native tree regrowth would need to be controlled during the establishment period.

Tubestock were planted at the offset site south of Tabbimoble Ck in March/17 and at the Tabbimoble Triangle in July/17. On the offset land tubestock were planted with 12 month slow release fertiliser. To assess how fertiliser affected the performance of introduced *M. irbyana*, two plots of 10 plants received no fertiliser and tubestock in the Tabbimoble Triangle were also planted without fertiliser. As it soon became apparent that fertiliser was stimulating growth, fertiliser was applied at the Tabbimoble Triangle site.

More tubestock were planted in April 2018 in the northern part of the Tabbimoble Triangle to increase numbers to around the target of 1700.

The total or net number of plants surviving in July 2018 was approximately 1500, or within 80% of the target of 1700 as required by the performance criteria.

3.5.2 Survival and Growth

Percent survival of seedlings planted-out in March and July 2017 was approximately 80% after two years.

Mean seedling height of plants introduced in March 2017 with fertiliser increased from 42.3cm in June 2017 to 109.3cm in April 2018. In plots with no added fertiliser, growth rate was 25-30% less (see Table below).

Mean height of seedlings (cm) at the end of Year 1 and Year 2:

	no Fert	Fert
Mar-17	31.4	42.3
Apr-18	68.9	109.3

3.6 Tall Knotweed (*Persicaria elatior*)

3.6.1 Staging

Tall Knotweed was translocated by different practitioners in 2015 and in 2016-2017. Donor and recipient sites for all the translocations were located in the same area of low lying swamp and swamp sclerophyll forest between the Maclean interchange and Harwood bridge. Results of the first round of translocation by Landmark Ecological Services (LES) and Bushland Restoration Services (BRS) were described in two monitoring reports (LES 2016, 2017).

Results up to the end of Year-3 are described below. A second round of translocation was conducted by Ecos Environmental in 2016-17. Results after one year were documented in Ecos Environmental (2017). Results up to the end of Year-2 are described below.

3.6.2 Translocation Method – Second Round (2016-18)

Translocation demonstrated that Tall Knotweed is an annual to biennial plant and that to maintain an above ground population (ie ignoring the soil seedbank), recruitment from seed needs to occur each year. Lack of follow-up recruitment after the first translocation in Yaegl Nature Reserve indicated that conditions in the paperbark forest recipient site were not suitable for Tall Knotweed, particularly as this species is usually found in more open habitat.

For the second round of translocations carried out by Ecos Environmental in 2016/2017, a recipient site in Yaegl Nature Reserve was selected a few hundred metres north in a more open situation on the edge of paperbark forest. Three translocations of a total 350 Tall Knotweed plants were carried out. All plants came from the swampy area north of Goodwood St adjacent to the Pacific Highway at the Maclean interchange construction area. Translocation methods evolved as more plants were found during pre-clearing surveys and added to the translocation project. The three translocations were conducted using slightly different methods according to the age and size of Tall Knotweed plants being salvaged and environmental conditions at the time, as indicated in the table below.

Translocations 1-3	Number
(1) old plants and soil seedbank (Aug/16)	7 old plants and soil seedbank (26 plots)
(2) young plants (0.5-0.7m tall) (Nov/16)	27 clumps of plants/~48 individuals.
(3) salvaged field seedlings, grown-on in nursery until mature, plant-out (Feb/17)	300 tubestock, mature plants in flower/seed

For the first translocation in August 2016, old Tall Knotweed plants (from the previous year's cohort) and soil seedbank were translocated to the new recipient site in Yaegal Nature Reserve. Seven old Tall Knotweed plants were transplanted (one per plot) and 20 plots were seeded with soil seedbank collected around the old plants at the Goodwood St donor site.

The plants were relocated to shallow standing water at the recipient site, similar to hydric conditions at Goodwood St. Several bins of muddy substrate were collected likely to contain Tall Knotweed seed. The mud was spread in 1m x 1m cleared plots on the north facing margin of paperbark forest where the paperbark trees were widely spaced and the ground layer consisted of wetland grasses and sedges. More than half the plots were in shallow standing water 1-10cm deep and were dug over with a spade to reduce sedges and grass (mainly *Eleocharis acuta* and *Paspalum distichum*) and make gaps for germination of Tall Knotweed seed (if present). The mud seedbank plots were placed at slightly different elevations in the Couch Grass zone (higher – no standing water) and the Water Couch zone (lower – shallow standing water) along about 150 metres of swamp edge. The plots were tagged for monitoring.

In November 2016 more Tall Knotweed plants were found during pre-clearing surveys north of Goodwood St and translocated to the recipient site. These plants had grown from seed during recent months and were 0.5-0.7m tall. The plants were dug up and transported to the recipient site in Yaegl National Park where they were planted further into the swamp as conditions were drying out. Twenty seven clumps containing approximately 48 plants were transplanted and tagged for monitoring.

While conducting the second translocation in Nov/16, several hundred recently germinated Tall Knotweed seedlings were also collected. The seedlings were grown in pots at the nursery before introduction to the recipient site. Tall Knotweed is very fast growing and plants had to be pruned back twice while at the nursery to keep them less than a meter in height. Planting was delayed until late February/17 due to hot, dry conditions. Three hundred tubestock were planted in fifteen 4m x 4m plots, 20 plants per plot. All plants were flowering and seeding when planted.

3.6.3 Results - Second Round (2016-18)

Translocation 1- transplanted old plants and soil (mud) seedbank
The old plants survived for ~about 2 months and continued to flower sparingly, producing a small amount of seed, then died off as the swamp dried out.

Tall Knotweed seedling recruitment was recorded in some mud seedbank plots. Most seedling recruitment occurred in cleared plots in the Couch Grass (*Cynodon dactylon*) zone which is slightly higher than the Water Couch (*Paspalum distichum*) zone. Tall Knotweed seedlings were identified by their sticky, scented first true leaves.

Most seedlings died during the dry spring- early summer period, some persisted in slightly damper microsites where they grew to maturity and set seed. Nearly all plants were dead by June 2017, showing Tall Knotweed has an annual life cycle. A few plants grew into the second year (like the old plants salvaged in August 2016).

29% of the 27 plots in Translocation 1 had Tall Knotweed plants in autumn 2018, usually one or two, sometimes more, most flowering and seeding, tallest 130cm, average height about 70 cm.

Translocation 2 – transplanted young plants (0.5-0.7m)
Most of these plants moved in Nov/16 survived and reached reproductive maturity. The site dried out in the first few months after transplanting and additional watering was necessary to prevent die-off. Although the plants were fairly large, flowering and seeding did not start until the wet season (Feb/17). A few plants were still alive at the end of June 2017. These had grown to a large size by producing branches and roots underwater. They appeared to be growing as floating aquatic plants with little attachment to substrate and were still producing flowers and seed.

A total 23 plants were counted at 8 of the 27 labelled plant points March 2018. The plants were mature and still in flower. These plants had grown from seed produced by plants translocated in Nov/16.

Translocation 2 - changing numbers of Tall Knotweed over two years:

Date	No. of plants
02-03-18	23
03-07-17	3
04-04-17	48
Start date Nov/16	

Translocation 3 - field seedling grown-on in nursery then introduced
Translocation 3 plots were located on the boundary of the low lying paperbark forest and open pasture on slightly higher ground, where the soil type, low competition from other plants and open unshaded conditions were considered most suitable for Tall Knotweed seedling establishment and growth.

The 15 plots planted with tubestock were flooded about a week after introduction at the end of February 2017. More than half the plants were submerged by flood water and died (at least some leaves must remain above water for plants to survive). All plants were in flower and producing seed when planted out so the plots were seeded. By June 2017, 87% of plots still had at least three live plants and where the water had receded recently germinated seedlings were recorded. The seedlings were 5-10cm tall and being grazed by kangaroos.

In March 2018, 87% of the plots had mature Tall Knotweed plants. Several plots had high densities and a crown cover of Tall Knotweed >50% (100% in one plot). These plants had all recruited naturally from seed produced by the plants introduced in February 2017.

Weeding was carried out in autumn 2018 to increase open site, stimulate seedling recruitment and thereby maintain population levels at or above target. However, on-going recruitment from year to year in this annual species will depend on soil moisture conditions not becoming too dry during the critical spring-early summer period, when very dry conditions can result in high seedling mortality.

Population Ecology

Monitoring of the translocations showed that germination of Tall Knotweed seed can occur virtually all year round if seed is present and germination conditions favourable. Germination requires a damp substrate exposed to the air.There was no evidence that Tall Knotweed seed can germinate under water even though mature, seeding plants were often growing in standing water. Germination occurred when the water receded, leaving damp ground exposed to the air. Observations indicated that seed can germinate within a few months after being shed from the parent plant, depending on water level. Tall Knotweed seed does not appear to have a dormancy mechanism that requires an 'after-ripening' period, rather dormancy is temporarily enforced by current environmental conditions such as standing water (submergence) or dry soil conditions.

Survival of seedlings recruited in autumn or winter requires that the substrate remains moist during the dry season, up the start of the next rainy season. Sites that appear to be suitable for Tall Knotweed in the wet season may completely dry out in spring-summer so that seedlings die. Open habitat conditions with low competition from trees and herbaceous understory plants appear to be necessary for Tall Knotweed to thrive.

The translocations and follow-up monitoring showed that Tall Knotweed is essentially an annual plant and exceptionally fast growing. In a few months it can grow from seed to a height well over a metre and start flowering, given suitable conditions.

3.6.4 Translocation Method and Results – First Round (2015-2018)

Two recipient sites in Yaegl Nature Reserve were used for the first round of translocation in 2015. Nearly all of the plants were translocated to the Yaegl South site. The habitat consisted of young paperbark swamp forest with a sparse ground cover of swamp grass and sedge. Tall Knotweed plants were relocated by direct transplanting in September and November 2015. Fifty five plants were planted in several plots about 10-20 metres inside the edge of the swamp forest. From the stem diameter of dead plants observed in Aug/2016 they were about 50-100cm tall and they were pruned at introduction.

Only three were alive in Autumn 2016 so it appears that conditions were unfavourable at the recipient site. Some were already flowering when transplanted in Nov/15 and some seeding of the recipient site occurred. Seedlings were subsequently observed at several of the marked planting points in spring 2016, but these did not grow and establish. This was due partly to the dry spring-early summer in 2016-2017 and also the relatively high density of paperbark (*Melaleuca quinquenervia*) at the recipient site. This is a very competitive species when young and inhibits the growth of herbaceous understorey plants. No Tall Knotweed plants were recorded at the recipient site in April 2018, approx. three years after translocation. As Tall Knotweed plants failed to recruit another cohort after introduction in 2015 and produce more seed, habitat at the recipient site appears to be unsuitable for the species.

3.7 Four-tailed Grevillea (*Grevillea quadricauda*)

3.7.1 Translocation Method

Grevillea quadricauda is a shrub with a single-stemmed growth form characteristic of seeder species. Generally, large or adult specimens of seeder plants are not suited to direct transplanting, as they do not regenerate well after root disturbance and pruning, unlike resprouter species which can recover from damage to root and stem systems. This is

because resprouter species possess protected, dormant buds and food reserves adapted for regeneration after damage caused by natural disturbance. Transplanting of this species was therefore limited to small, juvenile plants <30 cm in height. These were grown-on in pots in the nursery before planting out. Large pots were used so there was less disturbance of the root system during transplanting. The plants were grown in soil from the donor site and care taken not to over-water the pots.

Fifteen plants were grown in pots for six months to a size suitable for planting out. Salvage of these plants compensated for the loss of large mature individuals due to clearing (target number 3 – Table 2)

An attempt was made to propagate more plants using the soil seedbank method applied to Singleton Mint Bush and by seed collection. Very little seed could be found and the soil seedbank method yielded few seedlings. One reason for this may be that *G. quadricauda* produces winged seed, which disperses away from parent plant so that little seed is found under bushes, unlike Singleton Mint Bush.

3.7.2 Results

The juvenile plants transplanted to pots grew rapidly in pots of the infertile sandy soil from the donor site and after planting out at the recipient site. No fertiliser was applied except a few pellets of organic fertiliser in the nursery. Three months after planting out in March/17 all plants were producing flowers.

By March 2018, the plants had doubled in height in 12 months and only one plant died during introduction. Some plants were in flower.

Survivorship and mean height of transplanted Grevillea quadricauda juveniles:

	Surviv %	Mean Height (cm)
Mar-18	93.3	115.8
Mar-17	100	60.8

3.8 Stinking Cryptocarya (*Cryptocarya foetida*)

3.8.1 Translocation Method

The target number of 41 *Cryptocarya foetida* appeared to be a mistake, as only 28 individuals were found within the footprint during transplanting. Twenty-four (24) sapling sized individuals (1-4m tall) were transplanted manually and four trees were too large to transplant. Some individuals had been misidentified and were actually *C. microneura* or *C. triplinervis*. All came from the Randles Creek area adjacent to Coolgardie Rd.

Two recipient sites were used for this species. Transplanting was carried out to offset land at Lumleys Lane referred to as BOS 22, as per the Translocation Strategy. Habitat consisted of cleared pasture and hillside rainforest regrowth dominated by broad-leaved privet and camphor laurel. An area near the only dam on the land was the obvious choice for a recipient site, as a water source is a key requirement for cost-effective and successful translocation (trucking water for translocated plants is logistically more complicated and expensive). Most of the hillside forest was very rocky, so open pasture immediately below the forest closer to the dam was selected as the recipient site. The soil type consisted of heavy yellow clay with minimal topsoil formed on metasediment, not ideal but acceptable.

Sapling sized individuals were translocated by direct transplanting. Most of the 24 saplings were dug out with an intact soil-root ball. Pruning was carried out to reduce foliage area. Conditions at the recipient site were exposed with little shade from existing trees except around the forest edge. After transplanting, saplings were mulched and fertilised and watered regularly to maintain high soil moisture.

Additional plants were propagated from seed and introduced to a second rainforest species translocation receival site, as described below.

3.8.2 Results

The transplants at Lumleys Lane started to reshoot four weeks after transplanting. Short leafy shoots grew from dormant buds on the main stem and pruned branches. No root suckers or basal stem shoots were produced. Regrowth was slow and organic pelleted fertiliser and Seasol were applied to stimulate growth. By January 2017, ~6 months after transplanting, 62.5% (15/24) of the transplants had reshot and were alive. Two more had reshot, but died soon after. Although regeneration was slow, it appeared to be progressing satisfactorily until two extremely hot days in Feb/2017 which caused leaf scorching, tissue damage and consequent die-off of half the transplants. One of the days was the hottest on record for most of the Far North Coast. At the end of Year-1 survival rate had dropped to 26.9%. Basal reshooting occurred in two individuals that had died back after the heat event.

The response of *Cryptocarya foetida* at the Lumley's Lane recipient site contrasted with common rainforest species as well as two other threatened species transplanted to the site which survived and grew reasonably well. Both donor and recipient sites had heavy clay soil, although the donor site on Randles Creek (North of Coolgardie Rd) included a narrow strip of alluvium, close to the creek. No vigorous saplings or regrowth trees of *C. foetida* have been observed during other survey work on the Blackwall Range, only the occasional seedling or small sapling, which indicates that hill slopes similar to the recipient site represent marginal habitat for *C. foetida*.

For this reason, a second recipient site with soil type closer to the donor site was established north of Coolgardie Rd, in an island of natural vegetation retained within a wide section of the road reserve (project boundary). This site is on Randles Creek and adjoins the donor site. Work on the second rainforest species translocation site began in late 2017 and early 2018. Propagated plants of threatened rainforest species would be introduced to this site.

Thirty *C. foetida* propagated from seed were introduced to the site in Feb/18. By June/18, there were no mortalities and plants showed a small amount of new shoot growth. Additional watering was carried out during dry periods.

3.9 Rusty Green-leaved Rose Walnut (*Endiandra muelleri ssp. bracteata*)

3.9.1 Translocation Method

Three saplings were transplanted directly to the recipient site and three juveniles were transplanted to pots for growing-on at the nursery.

Saplings were dug out manually as described for *C. foetida.*

Approximately 30 plants were propagated from seed collected in Aug-Sept/16. Nineteen plants approximately 15 months old were planted in Feb/18.

3.9.2 Results

Only one of the three transplanted saplings reshot. This individual survived after two years. The three juveniles in pots all survived and grew very slowly.

No losses of seed propagated plants occurred to June/2018. A small amount of new shoot growth was recorded on most plants.

3.10 Red Lilly Pilly (Syzygium hodgkinsoniae)

3.10.1 Translocation Method

A total of 42 Red Lilly Pilly have been translocated to the rainforest recipient sites at Lumleys Lane and Coolgardie Road

Six juveniles were salvaged from under a large tree located on the clearing footprint north of Lumleys Lane in Oct/2016. These plants were grown on in pots for approx. 12 months before planting out with propagated tubestock in Rainforest Restoration Area No. 2 (Coolgardie Rd) in Dec/2017.

About 50 Red Lilly Pilly were propagated from seed collected in August 2016. Twelve were planted out in Rainforest Restoration Area No. 1 on 1/6/2017 and the remainder grown on for another six months. Thirty were subsequently introduced to Rainforest Restoration Area No. 2 in December 2017 (including the small potted transplants). 1.2m chicken wire tree guards were installed to prevent grazing by wallabies and 12 month slow release fertiliser applied.

3.10.2 Results

Rainforest Translocation Area 1

Mean height of first planting of propagated plants (12):

Date	Mean Height (cm)
Jun-18	58.9
Mar-18	58.4
Planted out June-17	

Rainforest Translocation Area 2

Mean height of second planting of propagated plants and transplants (30):

Date	Mean Height (cm)
Jun-18	47.3
Planted out Dec-17	

3.11 White Laceflower (*Archidendron hendersonii*)

3.11.1 Translocation Method

Two saplings were transplanted directly to the recipient site at Lumleys Lane and six juveniles were transplanted to pots for growing-on at the nursery. Saplings were dug out manually as described for *C. foetida.*

3.11.2 Results

All transplants survived and are in good condition. Mean height of the two plants in Area 1 nearly doubled between June 2017 and June 2018.

Mean height of translocated White Laceflower at rainforest translocation areas 1 & 2:

	Rainforest Translocation Area 1	Rainforest Translocation Area 2
Jun-18	134	92.5
Jun-17	72	nursery
transplanted Oct-16		

3.12 Rough-shelled Bush Nut (*Macadamia tetraphylla*)

3.12.1 Translocation Method

Rough-shelled Bush Nut is being translocated by seed propagation. Seeds were collected on the Blackwall Range adjacent to the highway footprint and from a group of six trees with a densely coppice growth form growing in a paddock at the end of Whytes Rd, Pimlico. These trees have the same unusual (unique?) growth form of old trees cleared from the footprint at Coolgardie Road, therefore are likely to preserve the same genotype as the cleared trees. Approximately 50 seeds were collected and five individuals were planted in Feb/18. The other plants are still too small to plant out.

3.12.2 Results

After 6 months, the five introduced plants were in good condition.

3.13 Square-fruited Ironbark (*Eucalyptus tetrapleura*)

3.13.1 Translocation Method

Eight saplings were transplanted from the crown land site to the Sunnyside Rd offset property in Oct/16.

79 tubestock propagated from seed were planted at Sunnyside Rd in autumn 2017.

3.13.2 Results

Two of the eight transplants died over two years.

There was 5% mortality of the planted tubestock between 2017-2018 and mean height in autumn 2018 was 55.3cm.

3.14 Hairy Melichrus (*Melichrus hirsutus*)

One individual transplanted and divided into two. Survivorship 100% after two years. Flower buds in June/2017.

3.15 Hairy Joint Grass (*Arthraxon hispidus*)

3.15.1 Translocation Method

Hairy Joint Grass (HJG) was translocated on Sections 3-11 in 2016 and on Sections 1-2 and EWSSTA's in 2015. All translocations were carried out by direct transplanting of sods containing plants or thought to contain seed.

On Sections 3-11, populations were translocated on Section 10 (Coolgardie Rd – Lumleys Lane) and Section 3 (Mitchell Rd). Plants on Section 10 went to a recipient site on offset land at Lumleys Lane and those on Section 3 went to the adjoining road reserve. Fifty trays of plants from the Coolgardie Rd south and Lumley's Lane west areas of the alignment were planted into 43 plots at Lumley's Lane recipient site, approximately 50 plants per plot (43 x 50

= 2150 plants), in Nov/16. Approximately 1000 plants were translocated to 20 plots at Mitchell Rd in Sept/16. The plants consisted of seedlings.

On Sections 1-2 and EWSSTA there were also two translocations, one at Kangaroo Trail on Section 1 in Sept/15 and one at Trustrums Hill in a SSTA in July-Aug/15. Trustrum's Hill had two planting areas – Site 1, a low lying area with 3 plots and Site 2 on higher ground with eight plots (Table 8)

3.15.2 Results

Sections 3-11

Plants in both translocations on Sections 3-11 grew to maturity and seeded prolifically in 2016-2017 and then again in 2017-2018. Biomass reduction was carried out in June each year to create low, open conditions favourable for HJG seed germination and seedling establishment. HJG is an annual grass and must recruit a new cohort of seedlings each year to maintain a population at a location. On grazing land (grassland) biomass reduction either by grazing or slashing (and mulch removal if the mulch is thick) is necessary for a population to persist at a location. A small proportion of the seed produced appears to have a dormancy mechanism but most seed is non-dormant in populations adapted to agricultural grazing land (Ecos Environmental 2015).

Sections 1-2 and EWSSTA

On Sections 1-2 & EWSSTA, where there were also two translocations, both translocations appear to have failed to establish a persistent population at the respective recipient sites (Table 8). The 2017 monitoring report by LES stated "no plants observed" in autumn 2016 or autumn 2017 at the Kangaroo Trail recipient site. However, monitoring the site in autumn 2018, Ecos Environmental recorded 11 clumps of HJG in seed and some of these had tags with 'A.h.' on them (*Arthraxon hispidus*). These plants appear to have been tagged in last 12 months, but the origin of the HJG plants when none were recorded the previous two years (after translocation in Sept/15) is unclear. Perhaps they were accidently introduced in soil on people's boots.

At the Trustrums Hill recipient site, two areas received slabs in July-Aug/15 during the species annual short dormancy or early germination phase. A total of 25 slabs were planted into 3 plots in Site 1 and 8 plots in Site 2. The slabs transplanted on July-Aug/15 had no plants but were thought to contain seed. Based on our research, in July-August, HJG seed was if present it should have germinated and been present as very small seedlings. HJG seedlings are distinctive by the width of the first leaf which is relatively broad compared to other grasses.

The 2017 monitoring report states that In the first area (Site 1), one plant was observed by bush regenerators in February 2016, and none were observed during monitoring in autumn 2016 and autumn 2017 (Table 8). The slabs were overgrown by dense Setaria grass. Attempts were made to clear biomass but no further plants were recorded. In the other area with eight plots, dead plants were recorded in autumn 2016 and 2017 indicating that HJG plants had recruited from seed in this area, but no dead plants were observed in June 2018. This area located on slightly higher ground had dense ground fern. Overall, the translocation of HJG at Trustrums Hill appears to have been unsuccessful in maintaining a population of HJG in the translocation areas. Biomass reduction may have been applied at the wrong time, or inconsistently. The hydrological regime in low lying Site 1 may have been too wet for HJG, which only grows on the fringes of wetlands, not in standing water for any length of time.

Despite the apparent failure of the two translocation sites at Trustrum's Hill, in situ HJG is the power line easement next to the sites has persisted. Fifty points with dead HJG were recorded and tagged in June 2018 in the power line easement. Biomass reduction was carried out by Ecos Environmental in June 2018 to assist in maintaining the local population. Some, recently germinated HJG seedlings were observed in this area.

HJG is not a difficult species to translocate. All that is required is an understanding of the species' habitat requirements and life history/cycle, and how to manipulate site conditions to maintain favourable conditions for seed germination each year, which typically occurs in late winter when soil conditions are still damp.

3.16 Lindernia (*Lindernia alsinoides*)

3.16.1 Translocation Methods

Lindernia was one of two threatened species on the W2B project for which translocation attempts were largely a failure (on Section 3-11 and Section 1-2). The primary reason for this outcome appears to be the quality of the recipient sites, as described below. The specific habitat requirements of Lindernia are clearer after monitoring its survival response to translocation at the four receival sites where translocation was attempted. The natural habitat of Lindernia appears to consist of seepage areas on lower slopes and drainage lines in sandstone or sandy soil terrain. These seepage zones are more-or-less perennial and consequently often have peat soil overlying sand. At Mitchell Rd (Section 3-11) the peat was 20-30cm deep. Vegetation growing on the seepage at this site consisted of wetland sedges and herbs, and sphagnum moss, with an open woodland canopy of trees such as *E. robusta* and *Melaleuca spp*. Generally there are no grasses present in the immediate vicinity of Lindernia that together with the dominance of sedges indicates low pH and nutrient levels.

Three recipient sites were selected for Lindernia on Sections 1-2 & EWSSTA and one on Sections 3-11. Translocation methods applied on Sections 1-2 included transplanting sods/clumps of plants, soil slabs thought to contain seed and introduction of plants propagated from cuttings. None of these methods produced positive results, which appears to be have been due to the type of receival site, or possibly horticultural factors. Large numbers of propagated plants were introduced to two receival sites (Kangaroo Trail and Halfway Ck Crossing) but very few survived after six months. At Kangaroo Trail, a planting of 350 nursery plants in Jan/16 died out in six months then a second large planting was carried out in autumn 2017 (428 plants Table 7), but nearly all plants died again after 12 months. The site had been fenced to exclude kangaroo grazing but this was clearly not the cause plant death as the same result occurred.

Translocation of Lindernia on Sections 3-11 was limited to transplanting. Thirty (30) spade sized sods of Lindernia plants growing in black peat over sand were transplanted. The recipient site was located on the same drainage line as the donor site on the opposite (downstream) side of the highway. The site turned out to be unsuitable, as run-off from the earthworks during periods of high rainfall, deposited thick, flocculated leachate on the translocated plants. Water depth and length of inundation at the recipient site also increased and the plants should have been 1-2 m closer to the base of the slope, but this was constrained by the project boundary and planting of HJG all in a narrow zone, not an ideal situation. As the Lindernia plants were found in a pre-clearing survey with clearing to take place the same week, there was no time to search for other potential receival sites.

Generally, the receival sites selected for Lindernia did not meet the species habitat requirements in terms of soil properties, hydrology and the species composition of vegetation. The recipient sites selected were poor matches for the donor sites, which only became clear with the results of the translocations. The type of habitat present at the receival sites on Sections 1-2 appears to have been unsuitable, as indicated by the poor performance of introduced plants. Vegetation may have been too dense, particularly the ground layer vegetation, which at Halfway Crossing was covered in dense ground fern and other herbaceous plants; soil texture at both sites had a clay-silt texture rather than peat on sand that appears to be required by Lindernia; and receival sites were not on lower slope seepage zones or channel wetland.

3.16.2 Results

Survivorship:

Mitchell Road – all plants in 30 sods were dead after two years (June/18).

Halfway Ck Crossing – 12 plants out of 500 propagated plants survived after one year (June/18)

Kangaroo Trail – one plant out of 428 propagated plants survived after one year (June/18)

Yuraygir SCA – no plants since spring 2016 (Table 8).

The Lindernia translocations although failing to establish stands or populations of this species, have been useful in clarifying the specific, narrow habitat niche of this species. If carried out again, translocation would have a much better chance of success as the habitat requirements of the species are now better understood.

3.17 Rotala (*Rotala tripartita*)

3.17.1 Translocation Method

Approximately 10 plants growing in a linear drainage depression on the eastern side of the highway were salvaged in Sept/17 and grown-on in pots at Ecos Environmental's nursery for planting out closer to the wet season. Habitat at the donor site consisted of a linear wetland depression in a cleared paddock, which held shallow standing water for most of the rainy season (DecJune) and dried out from a month or two during the spring. Rotala appears to be a perennial, shallow-water, herb although monitoring is required to confirm its life cycle.

No matching wetland habitat was found at potential recipient sites, so similar habitat was engineered at a site with suitable landform and soil type. Two pond depressions were dug with an excavator on a shallow drainage line in open woodland on heavy clay soil. Lowering of the ground surface aimed to create a permanently flooded or damp area suitable for Rotala. Before introducing plants, the ponds were filled by pumping water from a nearby creek. Natural run-off would then maintain suitable hydrological conditions in later years.

Rotala is a stoloniferous herb and is readily propagated by division. About seventy plants were propagated by this method from plants salvaged from the donor site. These were introduced to the receival site in the pots they were growing in, by sinking the pots into the ground. In this way it was possible to adjust the level of plants and move them around with minimal damage to the plants. Hydrological conditions are critical for the survival of wetland plants, particularly those that grow on the edge of wetlands. It was unclear where the best planting position for Rotala plants relative to the variable hydrological surface created by the new pond depressions would be located. Two adjustments to pot position were subsequently made and about twenty plants were lost during this process by planting them too high. Plants were moved down closer to the water as the water level dropped. The number of plants and survivorship values given in Table 7 represent plants at the final planting position after carry out this adjustment process. Organic fertiliser pellets were added to pots to simulate growth. Plantings at the two ponds were fenced in March/18 due to disturbance by wild pigs.

3.17.2 Results

Survivorship – 90% after approximately 6 months (Feb to July/18). Stolons grew up to 10cm beyond some pots taking root in the damp substrate.

3.18 Lepidosperma sp. Coaldale

3.18.1 Translocation Method

Lepidosperma sp. Coaldale is a sedge growing to about 1 metre in height. It has a short, almost woody horizontal rhizome from which upright stems grow. Habitat at the donor site at Wells Crossing consisted of an open woodland dominated by Scribbly Gum with a dense shrub understorey (Leptospermum, Banksia, Xanthorrhoea), growing on shallow sandy soil overlying sandstone. The site was on a lower slope next to a swampy drainage line.

Thirty five Lepidosperma sp. Coaldale were transplanted to pots in August 2015 and kept at a nursery for before planting out at a recipient site on RMS offset land at Pillar Valley (Mahogany Drive) in Spring 2016 (Table 8). This site has broadly similar habitat to the donor site at Wells Crossing, including sandstone geology and lower slope position, although there are differences in species composition and probably soil hydrology, as the soil at Pillar Valley is a deep sand. Thirty five individuals were planted in Spring/2016 in four plots located on two drainage lines. A year later in August 2017 the offset land was burnt by a fire, including the translocation plots. The plastic monitoring tags were burnt in the fire and have been replaced.

3.18.2 Results

Survivorship in June/2018, approximately three years after salvage from the construction footprint was 43%. Some of the plots were becoming overgrown with Common Ground Fern (*Calochlaena dubia*), which overtops and smothers Lepidosperma sp. Coaldale. This fern was not present at the donor site.

3.19 Richmond Bird Wing Vine (*Aristolochia pravevenosa*)

Propagated from 1-2 cm thick hardwood stem cuttings collected in Oct/16. Eleven plants introduced to the Coolgardie Rd rainforest species translocation area in Oct/17

Survivorship - 100% after 1 year (to June/18)

3.20 Carronia (*Carronia multisepala*)

Propagated from stem cuttings collected Nov/17. Six plants introduced to the Coolgardie Rd rainforest species translocation area in June/18 and further plants being grown-on.

3.21 Summary of Translocation Monitoring

Table 7: Results of threatened flora translocations after two years (2016-2018) for W2B sections 3-11.

S - survivorship %; CC - mean % crown cover; Ht - mean height (cm); ~1 year, ~2 years - time since transplanting/introduction, or time since seed germination.

Species	Receival Site	Method/Start Date	No. of Plants Translocated (Transplanted/Propagated)	Survival %/Cover-abundance/ No. of plants June/2017	Survival %/Cover-abundance/ No. of plants March-June/2018
Yellow-flowered Oberonia (*Oberonia complanata*)	Bundjalung NP Gumma Gurra	Transplanted Aug/2016	Transplanted - 11	~1 year S = 91% (10/11)	~2 years S = 91%
Unexpected finds	Lumleys Lane Sth	Transplanted Aug/2017	Transplanted – 12 branches with 35 clumps	n/a	~1 year S = 100%
Slender Screw Fern (*Lindsaea incisa*)	Bundjalung NP Area 1	Transplanted Sept (most), Nov, Dec 2016	Transplanted: Line A – 25 trays/plots Line B – 44 trays/plots Line C – 15 trays/plots Line D – 18 trays/plots Patches = 5 (5 trays/plot) @ 50 fronds/tray Total fronds=~6350	~1 year Line A – S=100%; CC=17.9% Line B – S=100%; CC=15.5% Line C – S=100%; CC=4.7% Line D – S=89%; CC=13.8% patches – S=100%; CC=52%	~2 years Line A –S=100%; CC=12.6% Line B – S=100%; CC=24.7% Line C – S=100%; CC=41.3% Line D – S=100%; CC=11.9% patches – S=100%; CC=53%
Unexpected finds	Bundjalung NP Area 2	Transplanted Sept, Oct 2017	Transplanted: Line A – 29 trays/plots Line B – 30 trays/plots Patches Area 1 =16 Patches Area 2 = 7 @ 50 fronds/tray Total fronds=~4350	n/a	~1 year Line A – S=100%; CC=25.9% Line B – S=100%; CC=18.9% patches–S=100%; CC=88.4% &83.3%
Singleton Mint Bush (*Prostanthera cineolifera*) Overall	Tabbimoble Triangle	Soil seedbank collected Aug/2016 1st tubestock planted 23/3/2017 when seedlings ~6 month old	Propagated (soil seedbank) Number planted: 1 - 700 tubestock 2 - experiment 1 & tubestock (300) 3 - experiment 2 & tubestock (200)	~3 months 1 (1st planting) = ~40%	~2 years Total number surviving - 584
Experiment 1 (effect of soil texture gradient and fertiliser on survival and growth)	Tabbimoble Triangle	Soil seedbank collected Aug/2016 Exp.1 planted 12/4/2017 when seedlings ~6 month old	5 transects at different locations relative to soil texture gradient, 3 plots per transect, 2 treatments per plot (Fert and No Fert), 8 plants per treatment. 16 plants/plot Total 240 plants in experiment	~3 months S = 100% Start height 35-45cm	~ 1 year Ht of plants (cm) A B C D E NF 5.5 0 61.1 16.7 73.8 F 0 0 77.5 7 57.4 Total 2.7 0 66.1 21.7 66.5 Survival 95-100%

Species	**Receival Site**	**Method/Start Date**	**No. of Plants Translocated (Transplanted/Propagated)**	**Survival %/Cover-abundance/ No. of plants June/2017**	**Survival %/Cover-abundance/ No. of plants March-June/2018**
Experiment 2 (effect of propagation type – cutting vs.seedling - and fertiliser on survival and growth)	Tabbimoble Triangle	Soil seedbank collected Aug/2016; cuttings collected 2015 Exp.2 planted 9 & 17/11/2017 Seedlings ~12 months old; cuttings ~18 mths	Six plots, each plot divided into quarters, two quarters with seedlings, two with cuttings, half plots with Fert, half No fert. 12 plants/plot Total 72 plants in experiment	n/a	~6 months Seedlings Cuttings NF Ht=95.6cm Ht=74.6cm F Ht=104.7cm Ht=64.1cm Survival 95-100%
Weeping Paperbark (*Melaleuca irbyana*)	Tabbimoble Offset Land Tabbimoble Triangle	Seed propagation, seed collected Aug/2016	Propagated (seed) No.planted (different sites) 1. 700 tubestock 2. 500 tubestock 3. 500 tubestock	1. S ~80% 2. S ~80% 3 – recently planted	~2 years Total number of plants approx. 1500
Tall Knotweed - translocation 1 (old plants and soil seedbank)	Yaegl Nature Reserve Centre-north	Old plants (7) transplanted & soil seedbank collected Aug/Sept 2016	Transplants (7) & soil seedbank (SSB) applied to 27 plots.	transplants – 0% % of plots with Tall Knotweed: Oct/16 51.9%, Jan/17 - 29.6%, April/17 - 22..2%, June/17 – 0%	~ 2 years 29.6% of plots with at least one mature Tall Knotweed. Total number of plants ~12
Tall Knotweed - translocation 2 (transplant young plants (0.5-0.7m)	Yaegl Nature Reserve Centre-north	Young plants transplanted Nov/2016	Transplants - 27 clumps/plots 48 plants	% of plots with Tall Knotweed April/17 - 66.7% June/17 – 11.1%	~ 1.5 years 30% of plots with at least one mature Tall Knotweed. Total number of plants ~24
Tall Knotweed - translocation 3 (salvage field seedlings grow-on in nursery, introduce)	Yaegl Nature Reserve Centre-north	Field seedlings collected Nov/16, grown in pots in nursery introduced Feb/17	300 plants - 15 plots with 20 plants per plot	% of plots with Tall Knotweed: April/17 – 100% June/17 – 86.6%	~1 year since introduction 87% of plots with mature Tall Knotweed plants, several with a crown cover of Tall Knotweed >50%. These plants were recruited naturally from seed produced by plants introduced in Feb/17. Total number of plants 300+
Four-tailed Grevillea (*Grevillea quadricauda*)	Road Reserve south of Quarry Rd, Section 3	Transplanted - juvenile plants transplanted to pots Aug-Sept/16 and grown in nursery for ~6 months. Soil seedbank collected Aug-Sept/16	15 potted plants introduced to recipient site I n March/17.	~ 1 year 85% survived transplanting to pots; 100% survived after planting out. Mean ht – 60.8cm	~ 2 years Survivorship - 93% Mean height – 115.8cm Total number of plants 14
Stinking Cryptocarya	Lumleys Lane	Transplanted Sept-	Transplanted – 24 saplings	Jan/17 - 62.5% survived	~ 2 years

Species	**Receival Site**	**Method/Start Date**	**No. of Plants Translocated (Transplanted/Propagated)**	**Survival %/Cover-abundance/ No. of plants June/2017**	**Survival %/Cover-abundance/ No. of plants March-June/2018**
(*Cryptocarya foetida*)		Oct/16		Mar/17 - 26.9% June/17 – 26.9%	Survivorship – 26.9% Total number of plants 7
	Coolgardie Rd	Propagated - seed collected Aug-Sept/16 Planted Feb/18	28 plants in 5 inch pots	n/a	~6 months Survivorship – 100% Total number of plants 28
Rusty Rose Green Walnut (*Endiandra muelleri ssp. bracteata*)	Lumleys Lane	Transplanted Sept-Oct/16	Transplanted – 3 saplings; (3 seedlings to pots)	Jan/17 - 33.3% survived Mar/17 - 33.3% June/17 – 33.3%	~ 2 years Survivorship – 33.3% Total number of plants 1
Propagated		Propagated - seed collected Aug-Sept/16 Planted Feb/18	19 plants in 5 inch pots	n/a	~6 months Survivorship – 100% Total number of plants 19
Red Lilly Pilly (*Syzygium hodgkinsoniae*)	Lumleys Lane	Transplanted and propagated - juveniles transplanted to pots (6) Oct/16; seed collected Aug-Sept/16. Planted June/17	12 propagated plants (supertubes)	n/a	~ 1 year Survivorship – 100% Total number of plants 12
	Coolgardie Rd	Propagated - seed collected Aug-Sept/16.Planted Feb/18	30 propagated plants including transplants (supertubes)	n/a	~ 6 mths Survivorship – 100% Total number of plants 30
White Laceflower (*Archidendron hendersonii*)	Lumleys Lane	Transplanted Oct/16 Saplings directly transplanted, juveniles to pots	2 saplings transplanted; (6 seedlings to pots)	~ 1 year 100% survival transplants and pots	~ 2 years Survivorship – 100% Total number of plants 2
	Coolgardie Rd		6 potted juveniles (6) introduced Feb/18	n/a	~ 6 mths Survivorship – 100% Total number of plants 6
Rough-shelled Bush Nut (*Macadamia tetraphylla*)	Coolgardie Rd	Propagation - seed collected Jan–Feb/2017	Most seed eaten by rats during propagation; 5 plants introduced in Feb/18	n/a	~ 6 mths Survivorship – 100% Total number of plants 5
Square-fruited Ironbark (*Eucalyptus tetrapleura*)	Sunnyside Rd Offset property, Glenugie	Transplanted Oct/2016	Transplanted – 8	~ 1 year Survivorship – 75% Total number of plants 6	~ 2 years Survivorship – 75% Total number of plants 6
Hairy Melichrus (*Melichrus hirsutus*)	Mahogany Dv Offset property, Pillar Valley	Transplanted Oct/2016	Transplanted – 1 (divided into 2 plants)	~ 1 year Survivorship – 100%	~ 2 years Survivorship – 100%

Species	**Receival Site**	**Method/Start Date**	**No. of Plants Translocated (Transplanted/Propagated)**	**Survival %/Cover-abundance/ No. of plants June/2017**	**Survival %/Cover-abundance/ No. of plants March-June/2018**
				Total number of plants 2	Total number of plants 2
Hairy Joint Grass (*Arthraxon hispidus*) Section 3	Mitchell Rd, Section 3	Placed in trays Sept/2016, planted out in Dec/2016	Transplanted – 20 trays/plots (~1000 plants)	~ 1 year Survivorship – 100% Total number of plants ~1000	~ 2 years Survivorship – 100% Total number of plants ~1000
	Lumleys Lane, Section 10	Transplanted Nov/2016	Transplanted - 43 trays/plots (~2150 plants)	~ 1 year Survivorship – HJG at 100% of plots, Total number of plants ~1000	~ 2 years Survivorship – HJG at 100% of plots Total number of plants ~2000
Lindernia (*Lindernia alsinoides*)	Mitchell Rd	Transplanted Dec/2016	Transplanted - 5 plots containing 30 sods	~6 months April/17 – 50% of sods June/17 – 0%	~1.5 years Survivorship – 3% of sods Total number of plants 1
Rotala (*Rotala semipatita*)	Tabbimoble Offset land	Transplanted to pots Sept/2017. Pots planted out in Feb/18	About 10 plants salvaged and propagated by division to yield about 70 plants. After adjustments, final planting of 50 plants	n/a	~6 months Survivorship – 90% Total number of plants 45
Richmond Bird Wing Vine (*Aristolochia pravevenosa*)	Coolgardie Rd	Propagated - cuttings collected Oct, Nov/2016, Planted Oct/2017	Propagated - 11 in 6 inch pots	100%	~ 1 year Survivorship – 100% Total number of plants 11
Pink Underwing Moth Vine (*Carronia multisepala*)	Coolgardie Rd	Propagated - cuttings collected in June/2017; Planted June/18	6 planted out 20 more under propagation	n/a	n/a

Table 8: Results of threatened flora translocations after three years (2015-2018) W2B Sections 1-2 and EWSSTA

Species	Recipient Site	Methods/Start Date	No. of plants translocated	Autumn 2016	Spring 2016	Autumn 2017	Autumn 2018
SECTION 1							
Lindernia	1. Yuraygir SCA	Slabs/clumps (15/8/15)	22 clumps/plants	6 clumps/plants (flowers on 2 plants, seed capsules on 1) (9 mths)	3 clumps/plants	no plants observed	~ 3 years Survivorship – 0 Total no plants – 0
	2. Halfway Creek crossing	Soil slabs stored (31/8/15)	8 slabs	no plants observed (9 mths)	no plants observed (1 yr)	no plants observed (1.5 yr)	~ 3 years Survivorship – 0 Total no plants – 0
	2. Halfway Creek crossing	Nursery plants		n/a, not yet planted out	n/a, not yet planted out	~ 500 plants newly planted	~ 1 year Survivorship – 2% Total no plants – 12
	3. Kangaroo Trail	Nursery plants 28/1/16	350	30 (3 mths) (flowers on 17 plants, seed capsules on 11)	1 (6 mths)	no plants observed (1 yr)	~ 3 years Survivorship – 0 Total no plants – 0
	3. Kangaroo Trail	Nursery plants	2nd planting May/17			428 plants newly planted (30/5/17) 1-50 monitored	~ 1 year Survivorship – 0.2% Total no plants – 1
Slender screw-fern	3. Kangaroo Trail	Slabs/planting pts (10/9/2015)	45	17 (8 mths)	10 (1 yr)	4-6 (1.5yr) (+17 planted May/17) = 21	~ 3 years Survivorship – 7%? Total no plants – 3 Net no. = 20
Hairy joint-grass	3. Kangaroo Trail	Slabs - stored soil (10/9/2015)	8 slabs	no plants observed	no plants observed	no plants observed	~ 3 years Survivorship – 0 Total no plants – 0
Square-stemmed spikerush	2. Halfway Creek Crossing	Soil slabs stored (31/8/2015)	75 slabs/clumps on 3 transects	no plants observed	no plants observed	no plants observed	~ 3 years Survivorship – 0 Total no plants – 0
Moonee Quassia	(Dirty Creek road reserve)	Nursery cuttings		No strike			
SECTION 2						A	
Lepidosperma "Coaldale"	4. Mahogany Drive	Nursery, plants		n/a, not yet planted out	35 planted out	20 (didn't look under ferns?)	

Square-fruited ironbark	5. Pillar Valley	Nursery, seed		80 plants in nursery	80 plants in nursery	79 planted	~ 1 year Survivorship – 95% Total no plants – 75
SOFT SOILS							
Tall Knotweed summary	6. Yaegl NR (south 8 plots and central 2 plots and 4 controls)	Slabs/clumps/ plants (9/9/15, 29/11/15)	55 south (44?) 2 central	3	1 + 4 seedlings observed but did not establish.	All plants died back, including controls Occasional seedlings (cotyledon stage) present.	~ 3 years Survivorship – 0 Total no plants – 0
Green-leaved rose-walnut	(Maclean Interchange road reserve?)	Single small tree has been prepared for translocation		Uncertain if translocation is required	Translocation not required		
Hairy joint-grass	Trustrums Hill road reserve Site 1	Slabs/plants (29/7/15, 6/8/15)	25 slabs in total (Sites 1 and 2) Site 1 - 3 plots	Though one plant was observed by bush regenerators in February, none was observed during monitoring	Non observed, biomass high	Non observed (biomass under management)	~ 3 years Survivorship – 0 Total no plants – 0
	Trustrums Hill road reserve Site 2	Slabs/plants (29/7/15, 6/8/15)	Site 2 – 8 plots		Dead transplants observed, no retained seed observed, probably shed	Dead material still present. (Live material not expected in autumn.)	~ 3 years Survivorship – 0 Total no plants – 0

4.0 Assessment of Translocation Outcomes

4.1 Translocation Results Summary

Translocation results on Sections 3-11 met short-term project aims and objectives for all 16 species translocated except Lindernia and Rough-shelled Bush Nut (Table 9). The latter species is currently below target but more plants are being propagated and major problems are unlikely in reaching the target for this species.

Translocation outcomes were generally poor on Sections 1-2 and EWSSTA. Only one or two species are on track to meet translocation aims and objectives (Table 10). Even these were questionable as it was unclear how many E. tetrapleura will be propagated to reach the target of over 800, and the assumption that seedbanks are in place for some species is doubtful given poor growth response after translocation. Translocations were unsuccessful or below target for Moonee Quassi, Lindernia, Square-stemmed Spike Rush, Hairy Joint Grass and Tall Knotweed. Monitoring tags for Lepidosperma sp. Coaldale were destroyed by a bushfire and replaced but some plants may have been missed so it is unclear how many are currently surviving.

Table 9: Translocation Results Summary Sections 3-11. Each recipient site is treated as a separate translocation. Target is according to RMS (2015b) or the actual number found within footprint during translocation. If these differ the original RMS target is shown in brackets. Net Number Abundance Mar-Jun 2018 gives the total number or amount alive in June 2018 (i.e. after mortalities). Satisfactory Failure Equivocal is an overall assessment of the progress of translocations in meeting targets.

W2B Sections 3-11: Overall results after 2 Years

Species	Recipient Site	Method	Target	Net Number Abundance Mar-Jun 2018	Satisfactory Failure Equivocal
Yellow-flowered King of the Fairies	Bundjalung Nat Pk (Evans Hd)	Transplanted	(18) 11	10	S
Unexpected finds	Lumleys Lane Sth	Transplanted	35	35	S
Slender Screw Fern	Bundjalung Nat Pk Area 1 (Mororo Rd)	Transplanted	6295 fronds/ 127 trays	tray survivorship 100%; mean crown cover 11.4% - 53%	S
Unexpected finds	Bundjalung Nat Pk Area 2 (Mororo Rd)	Transplanted	8500 fronds/ 151 trays	tray survivorship 100%;; mean crown cover 25.9% - 88.4%	S
Singleton Mint Bush	Tabbimoble Triangle	Soil seedbank	609	584	S
Weeping Paperbark	Offset property Tabbimoble Ck.	Seed	1700	1500	S
	Tabbimoble Triangle	Seed			S
Tall Knotweed (incl. unexpected finds)	Yaegl Nat. Res. (centre-north)	Transplanted Soil Seedbank	(20) 350	336	S
Four-tailed Grevillea	Quarry Rd (Sec.3)	Seed	(3) 15	14	S
Stinking Cryptocarya	Lumley's Lane	Transplanted	(41) 24	7	F (overall S)
	Coolgardie Rd	Seed		28	S
Rusty Green-leaved Rose Walnut	Lumley's Lane	Transplanted	(3) 6	1	F (overall S)
	Coolgardie Rd	Seed		19	S
Red Lilly Pilly	Lumley's Lane	Seed	6	12	S
	Coolgardie Rd	Seed Transplanted		30	S
White Laceflower	Lumley's Lane	Transplanted	(1) 8	2	S
	Coolgardie Rd	Transplanted		6	S
Rough-shelled Bush Nut	Coolgardie Rd	Seed	10	5	F
Hairy Joint Grass - Section 10	Lumley's Lane	Transplanted	348 (1.3ha)	41 plots	S
Hairy Joint Grass - Section 3	Mitchells Rd	Transplanted	1000	20 plots	S
Species Unexpected			Target= no.		

and Additional to the Translocation Strategy			impacted		
Richmond Bird Wing Vine	Coolgardie Rd	Cuttings	5	11	S
Lindernia	Mitchells Rd (Sec.3)	Transplanted	30	0	F
Square-fruited Ironbark	Offset land, Sunnyside Rd	Transplanted	8	6	S
Weeping Paperbark	Offset land, Sunnyside Rd	Transplanted	1	1	S
Hairy Melichrus	Offset land, Pillar Valley (Mahogany Drive)	Transplanted	1	1	S
Rotala	Offset land Tabbimoble Ck	Transplanted Division	20	45	S

Table 10: Translocation Results Summary Sections 1-2 and EWSSTA. Each recipient site is treated as a separate translocation. Target is according to RMS (2015a) or the actual number found within footprint during translocation. If these differ the original RMS target is shown in brackets. Net Number Abundance Mar-Jun 2018 gives the total number or amount alive in June 2018 (i.e. after mortalities). Satisfactory Failure Equivocal is an overall assessment of the progress of translocations in meeting targets.

W2B Sections 1-2 and EWSSTA: Overall results after 3 Years

Species	**Recipient Site**	**Method**	**Target**	**Net Number Abundance Mar-Jun 2018**	**Satisfactory Failure Equivocal**
Hairy Joint Grass	Kangaroo Trail	Transpl/Soil Seed	2	11	S
	Trustrums Hill	Transpl/Soil Seed	38	0 (in 11 plots)	F
Lindernia	Kangaroo Trail	Cuttings	1811	1	F
	Halfway Ck Crossing	Cuttings		12	F
	Yuragir NP	Transpl/Soil Seed		`0	F
Moonee Quassia	Dirty Creek Road Reserve	Cuttings	73	0	F
Slender Screw Fern	Kangaroo Trail	Tranplanted	2820 45 slabs	3 (20)	F
Square-fruited Ironbark	Pillar Valley	Pillar Valley	823	79	E
Square-stemmed Spike Rush	Halfway Ck Crossing	Halfway Ck Crossing	253	0	F
Tall Knotweed	Yaegl NR	Yaegl NR	37	0 Seedbank?	E
*Lepidosperm*a sp. 'Coaldale'	Mahogany Drive	Mahogany Drive	35	15	E

4.2 Performance Criteria

An assessment of the extent to which the translocation project has so far met the Performance Criterial set out in the Translocation Strategies is presented in Tables 11 and 12 below.

A key aim of both Translocation Strategies is for 'no net loss' to the size and condition of threatened flora populations to occur as a result of construction of the W2B project. A range of measures are being implemented to reach this aim including construction-related mitigation measures, offsetting and translocation. Specifically, translocation aims to minimise loss to local threatened species populations by conducting salvage transplanting, propagation and introduction of additional individuals to maintain local population numbers and by restoring and maintaining habitat conditions conducive to the viability of translocated plants at the recipient sites.

A brief overall assessment of the extent to which the translocation project has complied with performance criteria as well as translocation aims and objectives is provided below.

Table 11: Evaluation of Translocation Outcomes on Sections 3-11 (year 2) as per Table 6 of the Translocation Strategy (RMS 2015b)

Evaluation – Sections 3-11

	Four-tailed Grevillea	Green-leaved Rose Walnut	Hairy Joint-grass	Red Lilly Pilly	Rough-Shelled Bush Nut	Singleton Mintbush
Aim	Maintain or improve the functioning and condition of existing populations	Maintain or enhance existing demographic function and genetic variability	Create a self-sustaining population (Kangaroo Trail) or augment existing populations (Coolgardie-Wardell sites)	Maintain or enhance existing demographic function and genetic variability	Maintain or enhance existing demographic function and genetic variability	Maintain a self-sustaining population adjacent to and in the vicinity of the Tabbimobile Creek donor population.
Objectives	Plants improve in condition so that flowering fruiting and regeneration is successful.	Create or augment small sub-populations with diffuse connectivity to meta population in the Coolgardie-Wardell area conserving existing genetic variability	Plants complete their lifecycle and regenerate successfully	Create or augment small sub-populations with diffuse connectivity to meta population in the Coolgardie-Wardell area conserving existing genetic variability	Create or augment small sub-populations with diffuse connectivity to meta population in the Coolgardie-Wardell area conserving existing genetic variability	Translocated plants complete their lifecycle and regenerate successfully
Performance criteria	Threats identified and addressed. New growth documented on 80% of existing plants flowers and fruit observed by Year 3. Improvement maintained to Year 5.	Clumps of plants established numerically sufficient to replace or augment the number of affected individuals or sub-populations. Progeny from all translocated individuals is established by Year 3 and maintained to Year 5.	At least 50 plants germinate and set seed each year	Clumps of plants established numerically sufficient to replace or augment the number of affected individuals or sub-populations. Progeny from all translocated individuals is established by Year 3 and maintained through to Year 5.	Clumps of plants established numerically sufficient to replace or augment the number of affected individuals or sub-populations. Progeny from all translocated individuals is established.	At least 30 plants establish and set seed each year from Year 3
Threshold	New growth on <50% of existing plants no flowers nor fruit by Year 3. Improvement not maintained to Year 5.*	Less than 80% of no of original clumps or individuals are established. Less than 80% of impacted plants represented by established progeny.*	Less than 30 plants germinate and set seed in any one year*	Less than 80% of no of original clumps or individuals are established. Less than 80% of impacted plants represented by established progeny.*	Less than 80% of no of original clumps or individuals are established. Less than 80% of impacted plants represented by established progeny.*	Less than 20 plants establish and set seed in any one year from Year 2*
Corrective action	Re-assess threats and address. Consider augmentation from seed propagated plants from alternative donor sites.	Augment with nursery stock from (likely cutting grown) back up stock.	Undertake searches for suitable local donor populations (in case of isolated southern occurrence) or source from	Augment with nursery stock from (likely cutting grown) back up stock.	Augment with nursery stock from (likely cutting grown) back up stock.	Augment with nursery back up stock and if required collect additional seed and cuttings from seed; nursery propagate and plant out.

	Four-tailed Grevillea	Green-leaved Rose Walnut	Hairy Joint-grass	Red Lilly Pilly	Rough-Shelled Bush Nut	Singleton Mintbush
			receiving site populations. Collect seed nursery propagate or clump transplant. Re-evaluate site moisture gradients to best target suitable planting sites.			
Evaluation and actions	Performance criteria met. Salvaged plants in good condition, more than tripled in size since introduction, flowering.	Performance criteria met. Population numbers and putative genetic diversity maintained by salvage from footprint and propagation. Total number translocated is above target.	Performance criteria met. Existing population augmented. Species life cycle completed in Year 1 and 2. Stand expected to be self-perpetuating with recruitment occurring in winter as expected.	Performance criteria met. Additional plants have been propagated from seed. Total number translocated is above target.	Performance criteria met. Some introducted, Propation progressing. Seed collected locally to maintain population level and genetic integrity	Performance criteria met. Adequate number of seedling tubestock plants introduced and in healthy condition.
Aim	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species
Objectives	Relevant project results and observations documented.	Relevant project results and observations documented.	Relevant project results and observations documented.	Relevant project results and observations documented.	Relevant project results and observations documented.	Relevant project results and observations documented.
Performance criteria	Reporting to Include e.g. threat identification and amelioration detail of growth and seeding periods and results of nursery tasks.	Reporting to Include observations of new growth on translocated trees results of nursery tasks. progress of seedling establishment as relevant.	Reporting to Include e.g. detail of growth and seeding periods and results of nursery tasks.	Reporting to Include observations of new growth on translocated trees results of nursery tasks. progress of seedling establishment as relevant.	Reporting to Include observations of new growth on translocated trees results of nursery tasks. progress of seedling establishment as relevant.	Reporting to Include e.g. detail of growth and seeding periods and results of nursery tasks.
Threshold	Reporting incomplete	Reporting incomplete	Reporting incomplete	Reporting incomplete	Reporting incomplete	Reporting incomplete
Corrective action	Project manager to address with sub-contractors	Project manager to address with sub-contractors	Project manager to address with sub-contractors	Project manager to address with sub-contractors	Project manager to address with sub-contractors	Project manager to address with sub-contractors
Evaluation and actions	Performance criteria met. Knowledge of species life cycle and translocation potential increased – e.g. obligate seeder, low seed output, low soil seedbank, young plants can be transplanted, capable of rapid growth in infertile soil, horticultural potential	Performance criteria met. Knowledge of species life cycle and translocation potential increased – e.g. persistent species, increases in degraded habitat. Seed have high viability by difficult to find and slow growing.	Performance criteria met. Knowledge of species increased – e.g. species life cycle confirmed as annual. Sensitive to dominance by tall exotic grasses. Co-exists with native Foxtail Grass, a possible original plant community.	Performance criteria met. Knowledge of species life cycle and translocation potential increased	Performance criteria met. Knowledge of species life cycle and translocation potential increased	Performance criteria met. Knowledge of species life cycle and translocation potential increased

	Four-tailed Grevillea	Green-leaved Rose Walnut	Hairy Joint-grass	Red Lilly Pilly	Rough-Shelled Bush Nut	Singleton Mintbush
Aim	Achieve no net loss in local plant populations being impacted by the project	Achieve no net loss in local plant populations being impacted by the project	Achieve no net loss in local plant populations being impacted by the project	Achieve no net loss in local plant populations being impacted by the project	Achieve no net loss in local plant populations being impacted by the project	Achieve no net loss in local plant populations being impacted by the project
Objectives	Original number of individuals and area re-established	Equivalent original number of individuals re-established. following guidelines for replacement of mature trees by seedlings/cuttings i.e ten seedlings established for any mature trees lost five seedlings established for any saplings lost.	Original number of individuals and area re-established	Equivalent original number of individuals re-established. following guidelines for replacement of mature trees by seedlings/cuttings i.e ten seedlings established for any mature trees lost five seedlings established for any saplings lost.	Equivalent original number of individuals re-established. following guidelines for replacement of mature trees by seedlings/cuttings i.e ten seedlings established for any mature trees lost five seedlings established for any saplings lost.	Original number of individuals re-established
Performance criteria	Compare with donor site. 70% of original number of plants established in Year 1 increasing to 100% minimum by Year 5	Compare with donor site. 70% of original number of plants established in Year 2 increasing to 100% minimum by Year 5	Compare with donor site. 70% of original cover of plants established over an area equivalent to original in Year 1 increasing to 100% cover by Year 5	Compare with donor site. 70% of original number of plants established in Year 2 increasing to 100% minimum by Year 5	Compare with donor site. 70% of original number of plants established in Year 2 increasing to 100% minimum by Year 5	Compare with donor site. 70% of original number of plants established in Year 2 increasing to 100% minimum by Year 5
Threshold	>50% of original number of plants established in Year 1 or similar levels below target in subsequent years*	>50% of original number of plants established in Year 2 or similar levels below target in subsequent years*	>50% of original cover of plants established over an area equivalent to original in Year 1 or similar levels below target in subsequent years*	>50% of original number of plants established in Year 2 or similar levels below target in subsequent years*	>50% of original number of plants established in Year 2 or similar levels below target in subsequent years*	>50% of original number of plants established in Year 2 or similar levels below target in subsequent year*
Corrective action	Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling	Replace with nursery back up stock. Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling	Undertake searches for suitable local donor populations collect seed nursery propagate or clump transplant.	Replace with nursery back up stock. Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling	Replace with nursery back up stock. Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling	Replace with nursery back up stock. Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed/cuttings following guidelines for sampling
Evaluation and actions	Performance criteria met. Translocated number currently equal to or greater than target/impact number.	Performance criteria met. Total number translocated is above target.	Performance criteria met. Translocated number currently equal to or greater than target/impact number.	Performance criteria met. Total number translocated is above target.	Performance criteria met. Translocated number currently equal to or greater than target/impact number.	Performance criteria met. Translocated number currently equal to or greater than target/impact number.
Aim	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value

	Four-tailed Grevillea	Green-leaved Rose Walnut	Hairy Joint-grass	Red Lilly Pilly	Rough-Shelled Bush Nut	Singleton Mintbush
Objectives	All available cutting material and seed harvested and grown on for transplant to best extent practical.	Trees and saplings is transplanted. All potential cutting material (and seeds if available) harvested for nursery propagation.	Soil associated with above-ground plants transplanted	Trees and saplings is transplanted. All potential cutting material (and seeds if available) harvested for nursery propagation.	Trees and saplings is transplanted. All potential cutting material (and seeds if available) harvested for nursery propagation.	All available seed collected cutting material harvested to an extent predicted to cover predicted requirements x 2.
Performance criteria	No unsalvaged material present on ground inspection	Trees translocated and cutting material collected to best extent practical for nursery propagation	No unsalvaged material present on ground inspection	Trees translocated and cutting material collected to best extent practical for nursery propagation	Trees translocated and cutting material collected to best extent practical for nursery propagation	No seed present on ground inspection
Threshold	More than 10% of the original material present	Tree not translocated. Less than 15 cuttings transferred to nursery facilities	More than 10% of the original material present.	Tree not translocated. Less than 15 cuttings transferred to nursery facilities	Tree not translocated. Less than 15 cuttings transferred to nursery facilities	Uncollected seed present on 10 or more plants
Corrective action	Project manager to address with contractors	Project manager to address with contractors	Project manager to address with contractors	Project manager to address with contractors	Project manager to address with contractors	Project manager to address with contractors
Evaluation and actions	Performance criteria met. All small plants salvaged. Target number equalled.	Performance criteria met. Saplings and juveniles transplanted. Cutting propagation not undertaken as past results poor. Seed collected and propagated.	Performance criteria met. Target number well exceeded. BOS22 offset site captures impacted HJG habitat area.	Performance criteria met. Available seed used, cutting material unsuitable for propagation.	Performance criteria met. Available seed used.	Performance criteria met. Soil seedbank used as source of seedlings. Number propagated adequate to achieve translocation target

	Slender Screw Fern	Stinking Cryptocarya	Tall Knotweed	Weeping Paperbark	White Laceflower	Yellow-flowered King of the Fairies
Aim	Create a self-sustaining population	Maintain or enhance existing demographic function and genetic variability	Maintain a self-sustaining population.	Create self-sustaining populations (two sites)	Maintain or enhance existing demographic function and genetic variability	Maintain a self-sustaining population.
Objectives	Maintain or create a self-sustaining population (augment an existing patch)	Create or augment small sub-populations with diffuse connectivity to meta population in the Coolgardie-Wardell area conserving existing genetic variability	Plants complete their lifecycle and regenerate successfully	Plants complete their lifecycle and regenerate successfully	Create or augment small sub-populations with diffuse connectivity to meta population in the Coolgardie-Wardell area conserving existing genetic variability	Translocated clumps and individuals establish on new hosts flower set seed.
Performance criteria	Plants complete their lifecycle and regenerate	Clumps of plants established numerically sufficient to replace or	At least 30 plants germinate and set seed each year	At least 50 plants germinate and set seed each year from	Clumps of plants established numerically sufficient to replace or	At least 20 plants establish flower and set seed each

	Slender Screw Fern	Stinking Cryptocarya	Tall Knotweed	Weeping Paperbark	White Laceflower	Yellow-flowered King of the Fairies
	successfully	augment the number of affected individuals or sub-populations. Progeny from all translocated individuals is established by Year 3 and maintained through to Year 5.		Year 2	augment the number of affected individuals or sub-populations. Progeny from all translocated individuals is established.	year from Year 2
Threshold	Spore production observed each year (compare with control populations). Lateral vegetative growth observed from all transplants.	Less than 80% of no of original clumps or individuals are established. Less than 80% of impacted plants represented by established progeny.*	Less than 20 plants germinate and set seed in any one year.*	Less than 30 plants germinate and set seed in any one year from Year 2*	Less than 80% of no of original clumps or individuals are established. Less than 80% of impacted plants represented by established progeny.*	Less than 15 plants establish and set seed in any one year from Year 2*
Corrective action	No spore production lateral growth from <50% of transplants	Augment with nursery stock from (seed or cutting grown) back up stock.	Undertake searches for suitable local donor populations collect seed nursery propagate or clump transplant. Re-evaluate site moisture gradients to best target suitable planting sites.	Use stored seed or collect additional seed from remaining source population nursery propagate and plant out. Re-evaluate site conditions to best target suitable planting sites.	Augment with nursery stock from (likely cutting grown) back up stock.	Evaluate host sites of any plants not functioning as required and assess benefits of re-location.
Evaluation and actions	Performance criteria met. Large populations established approximating original population, number maintained over 2-3 years.	Performance criteria met. Poor transplanting results augmented by propagated plants. Total number translocated is above target.	Performance criteria met. Population shows initial evidence of self-perpetuation. Numbers equal to or above target.	Performance criteria met. Performance criteria and threshold inappropriate to species.	Performance criteria met. No loss of transplants, small amount of propagation achieved	Performance criteria met. Loss of only one plant from those translocated. Some plants flowered in Year 1
Aim	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species
Objectives	Relevant project results and observations documented.	Relevant project results and observations documented.	Relevant project results and observations documented.	Relevant project results and observations documented.	Relevant project results and observations documented.	Relevant project results and observations documented.
Performance criteria	Reporting to Include e.g. detail of growth and spore production.	Reporting to include observations of new growth on translocated trees results of nursery tasks. Progress of seedling	Reporting to Include e.g. detail of growth and seeding periods and results of nursery tasks.	Reporting to Include e.g. results of nursery tasks records of establishment and development.	Reporting to Include observations of new growth on translocated trees results of nursery tasks. progress of seedling	Reporting to Include e.g. detail of growth and seeding periods and results of nursery tasks.

	Slender Screw Fern	Stinking Cryptocarya	Tall Knotweed	Weeping Paperbark	White Laceflower	Yellow-flowered King of the Fairies
		establishment as relevant.			establishment as relevant.	
Threshold	Reporting incomplete	Reporting incomplete	Reporting incomplete	Reporting incomplete	Reporting incomplete	Reporting incomplete
Corrective action	Project manager to address with sub-contractors	Project manager to address with sub-contractors	Project manager to address with sub-contractors	Project manager to address with sub-contractors	Project manager to address with sub-contractors	Project manager to address with sub-contractors
Evaluation and actions	Performance criteria met. Knowledge of species life cycle and translocation potential increased	Performance criteria met. Knowledge of species life cycle and translocation potential increased	Performance criteria met. Knowledge of species life cycle and translocation potential increased	Performance criteria met. Knowledge of species life cycle and translocation potential increased	Performance criteria met. Knowledge of species life cycle and translocation potential increased	Performance criteria met. Knowledge of species life cycle and translocation potential increased
Aim	Achieve no net loss in local plant populations being impacted by the project	Achieve no net loss in local plant populations being impacted by the project	Achieve no net loss in local plant populations being impacted by the project	Achieve no net loss in local plant populations being impacted by the project	Achieve no net loss in local plant populations being impacted by the project	Improve options for augmentation through seedling production
Objectives	Original number of individuals and area re-established	Equivalent original number of individuals re-established. following guidelines for replacement of mature trees by seedlings/cuttings i.e ten seedlings established for any mature trees lost five seedlings established for any saplings lost.	Original number of individuals and area re-established	Original number of individuals re-established	Equivalent original number of individuals re-established. following guidelines for replacement of mature trees by seedlings/cuttings i.e ten seedlings established for any mature trees lost five seedlings established for any saplings lost.	Research program for seed propagation established and propagation underway.
Performance criteria	Compare with donor site: 70% of original cover of plants established over an area equivalent to original in Year 1 increasing to 100% cover by Year 5	Compare with donor site. 70% of original number of plants established in Year 2 increasing to 100% minimum by Year 5	Compare with donor site. 70% of original cover of plants established over an area equivalent to original in Year 1 increasing to 100% cover by Year 5	Compare with donor site. 70% of original number of plants established in Year 2 increasing to 100% minimum by Year 5	Compare with donor site. 70% of original number of plants established in Year 2 increasing to 100% minimum by Year 5	Specialist propagation facility engaged and liaison with field personnel established. Consultation with OEH SOS program.
Threshold	>50% of original cover of plants established over an area equivalent to original in Year 1 or similar levels below target in subsequent year.*	>50% of original number of plants established in Year 2 or similar levels below target in subsequent years.*	>50% of original cover of plants established over an area equivalent to original in Year 1 or similar levels below target in subsequent year.*	>50% of original number of plants established in Year 2 or similar levels below target in subsequent years*	>50% of original number of plants established in Year 2 or similar levels below target in subsequent years*	Insufficient understanding of seedling production techniques achieved by Year 3 production not underway
Corrective action	Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling	Replace with nursery back up stock. Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed	Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling	Replace with nursery back up stock. Evaluate options for sourcing more propagation material from remaining plants adjacent to donor population collect additional	Replace with nursery back up stock. Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed	Consider options for alternative research partners

	Slender Screw Fern	Stinking Cryptocarya	Tall Knotweed	Weeping Paperbark	White Laceflower	Yellow-flowered King of the Fairies
		following guidelines for sampling		seed following guidelines for sampling	following guidelines for sampling	
Evaluation and actions	Performance criteria met. Translocated number currently equal to or greater than target/impact number.	Performance criteria met. Translocated number currently equal to or greater than target/impact number.	Performance criteria met. Translocated number currently equal to or greater than target/impact number.	Performance criteria met. On track to achieve no net loss. Suggest recount of impacted individuals before clearing.	Performance criteria met. On track to achieve no net loss.	Performance criteria met. Very few plants lost in clumps, no clump loss. Seed production occurring.
Aim	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value
Objectives	All available plants and associated soil harvested and transplanted to best extent practical	Trees and saplings transplanted. Suitable cutting material for predicted requirements x 2 harvested seeds if available for nursery propagation.	All available plants and associated soil harvested and transplanted to best extent practical	Available seed is harvested for nursery propagation.	Trees and saplings are transplanted. All potential cutting material (and seeds if available) harvested for nursery propagation.	All available plants translocated to new hosts
Performance criteria	No unsalvaged material present on ground inspection	Trees translocated no seed left unharvested.	No unsalvaged material present on ground inspection	Trees translocated and cutting material collected to best extent practical for nursery propagation (at least 20 cuttings)	Trees and saplings translocated and cutting material collected to best extent practical for nursery propagation	No unsalvaged material present on field inspection
Threshold	More than 10% of the original material present	Trees not translocated. Less than 15 cuttings transferred to nursery facilities	More than 10% of the original material present	Tree not translocated. Less than 15 cuttings transferred to nursery facilities	Tree and saplings not translocated. Less than 15 cuttings transferred to nursery facilities	Plants remain on host trees
Corrective action	Project manager to address with contractors	Project manager to address with contractors	Project manager to address with contractors	Project manager to address with contractors	Project manager to address with contractors	Project manager to address with contractors
Evaluation and actions	Performance criteria met. No propagation to be undertaken.	Performance criteria met. Propagated plants introduced.	Performance criteria met. Seedlings salvaged, grown on in nursery and introduced.	Performance criteria met. More than adequate quantity of seed collected from cross-section of population.	Performance criteria met. Some seed collected.	Performance criteria met. No propagation planned at this stage, although seed available.

Table 12: Evaluation of Translocation Outcomes on Sections 1-2 & EWSSTA, as reported in Landmark Ecological Services 2017 (year 2) monitoring report

Evaluation – Sections 1 and 2

Species	Hairy joint-grass	Moonee Creek Quassia	Noah's false chickweed	Slender screw-fern	Square-fruited ironbark	Square-stemmed spike-rush
Aim	Create a self-sustaining population	Maintain an self-sustaining population (augment remainder of an existing self-sustaining population by expanding and linking existing patches)	Create a self-sustaining population	Maintain or create a self-sustaining population (augment an existing patch)	Maintain a self-sustaining population (expand existing population)	Maintain or create a self-sustaining population (augment existing small patch or create new population)
Objectives	Plants complete their lifecycle and regenerate successfully	Patches are expanded and linked	Plants complete their lifecycle and regenerate successfully	Plants complete their lifecycle and regenerate successfully	Cleared land adjacent to existing forest is vegetated	Plants complete their lifecycle and regenerate successfully
Performance criteria	At least 50 plants germinate and set seed each year	At least 20 plants are established in each identified section of the receiving sites	At least 100 plants germinate and set seed each year	Spore production observed each year (compare with control populations). Lateral vegetative growth observed from all transplants.	At least 500 plants are established	At least 20 plants germinate and set seed each year
Threshold	Less than 30 plants germinate and set seed in any one year	>10 plants are established in any identified section of the receiving sites	Less than 50 plants germinate and set seed in any one year	No spore production, lateral growth from <50% of transplants	< 300 plants are established by Year 3, similar lack of progress towards targets in subsequent years	Less than 10 plants germinate and set seed in any one year
Corrective action	Undertake searches for suitable local donor populations, collect seed, nursery propagate or clump transplant. Re-evaluate site moisture gradients to best target suitable planting sites.	Transplant additional specimens from seed collected in later years of the project.	Undertake searches for suitable local donor populations, collect seed, nursery propagate or clump transplant. Re-evaluate site moisture gradients to best target suitable planting sites.	Undertake searches for suitable local donor populations, clump/slab transplant. Re-evaluate site moisture gradients to best target suitable planting sites.	Propagate additional seedlings from stored seed	Undertake searches for suitable local donor populations, clump transplant. Re-evaluate site hydrology for best planting site selection or modify hydrology..
Evaluation and actions	Reasonable attempts to translocate soil stored seed (questionable density). No further action feasible..	No strike from cuttings, no alternative sources of propagation material. Corrective actions not possible.	Flowers and fruit observed, though no seedlings to date. Original plantings now died back or damaged. New plantings from nursery-sourced cuttings now planted.	Reasonable survivorship from transplants and limited lateral expansion. Sori not observed. Further transplant of local material is likely to result in unacceptable impacts to source populations, corrective actions not recommended.	~ 80 plants established, seed collection and propagation ongoing.	Translocations undertaken as best possible with material of questionable value– no plants established. Corrective actions unlikely as propagation material is limited.

Species	**Hairy joint-grass**	**Moonee Creek Quassia**	**Noah's false chickweed**	**Slender screw-fern**	**Square-fruited ironbark**	**Square-stemmed spike-rush**
Aim	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species
Objectives	Relevant project results and observations documented.	Relevant project results and observations documented.	Relevant project results and observations documented.	Relevant project results and observations documented.	Relevant project results and observations documented.	Relevant project results and observations documented.
Performance criteria	Reporting to Include e.g. detail of growth and seeding periods and results of nursery tasks.	Reporting to Include e.g. detail of growth and seeding periods and results of nursery tasks.	Reporting to Include e.g. detail of growth and seeding periods and results of nursery tasks.	Reporting to Include e.g. detail of growth and seeding periods and results of nursery tasks.	Reporting to Include e.g. detail of growth and seeding periods and results of nursery tasks.	Reporting to Include e.g. detail of growth and seeding periods and results of nursery tasks.
Threshold	Reporting incomplete	Reporting incomplete	Reporting incomplete	Reporting incomplete	Reporting incomplete	Reporting incomplete
Corrective action	Project manager to address with sub-contractors	Project manager to address with sub-contractors	Project manager to address with sub-contractors	Project manager to address with sub-contractors	Project manager to address with sub-contractors	Project manager to address with sub-contractors
Evaluation and actions	Reported in 2016 and current annual reports	Reported in 2016 and current annual reports	Reported in 2016 and current annual reports	Reported in 2016 and current annual reports	Reported in 2016 and current annual reports	Reported in 2016 and current annual reports

Aim	Development of new management techniques
Objectives	Stem and root cutting trials conducted with at least 10 cuttings x 2 types (root/stem) x 3 treatments (2 hormone treatments, I control)
Performance criteria	Sufficient material collected, treated and set up in specialist nursery facilities
Threshold	Less than 60 cuttings set up
Corrective action	Re-collect if practical
Evaluation and actions	No strike from cuttings, re-collection not practical

Species	Hairy joint-grass	Moonee Creek Quassia	Noah's false chickweed	Slender screw-fern	Square-fruited ironbark	Square-stemmed spike-rush
Aim	Achieve no net loss in local plant populations being impacted by the project	Achieve no net loss in local plant populations being impacted by the project	Achieve no net loss in local plant populations being impacted by the project	Achieve no net loss in local plant populations being impacted by the project	Achieve no net loss in local plant populations being impacted by the project	Achieve no net loss in local plant populations being impacted by the project
Objectives	Original number of individuals and area re-established	Original number of individuals and area re-established	Original number of individuals and area re-established	Original number of individuals and area re-established	Original number of individuals and area re-established	Original number of individuals and area re-established
Performance criteria	Compare with donor site: 70% of original cover of plants established over an area equivalent to original in Year 1, increasing to 100% cover by Year 5	Compare with donor site: 70% of original number planted out and established by year 4, 100% by Year 5	Compare with donor site: 70% of original cover of plants established over an area equivalent to original in Year 1, increasing to 100% cover by Year 5	Compare with donor site: 70% of original cover of plants established over an area equivalent to original in Year 1, increasing to 100% cover by Year 5	Compare with donor site: 70% of original number planted out and established by year 4, 100% by Year 5	5
Threshold	>50% of original cover of plants established over an area equivalent to original in Year 1 or similar levels below target in subsequent year	>50% individuals planted out and established by year 4 or similar levels below target in subsequent year	>50% of original cover of plants established over an area equivalent to original in Year 1 or similar levels below target in subsequent year	>50% of original cover of plants established over an area equivalent to original in Year 1 or similar levels below target in subsequent year	>50% individuals planted out and established by year 4 or similar levels below target in subsequent year	>50% of original cover of plants established over an area equivalent to original in Year 1 or similar levels below target in subsequent year
Corrective action	Undertake searches for suitable local donor populations, collect seed, nursery propagate or clump transplant.	Evaluate options for sourcing more propagation material from neighbouring patches, collect additional seed, following guidelines for sampling	Evaluate options for sourcing more propagation material from neighbouring patches, collect additional seed, following guidelines for sampling	Evaluate options for sourcing more propagation material from neighbouring patches, collect additional seed, following guidelines for sampling	Evaluate options for sourcing more propagation material from neighbouring patches, collect additional seed, following guidelines for sampling	Evaluate options for sourcing more propagation material from neighbouring patches, collect additional seed, following guidelines for sampling
Evaluation and actions	Reasonable attempts to translocate soil stored seed (questionable density). No further action feasible.	No strike from cuttings, no alternative sources of propagation material. Corrective actions not possible.	Less than 70% cover has been achieved. The recently planted ~ 1000 plants require time to spread and layer to increase both the number of plants and their cover.	Low cover has been achieved. This species is known to be difficult to transplant and slow growing and there are no practical options for supplementary collection.	~ 80 plants established. Translocation actions for Square-fruited ironbark remain incomplete, as a result of difficulties in obtaining seed. Low levels of seed production, and the limited proportion of fertile seed found within the chaff, may contribute to the threatened status of Square-fruited ironbark.	Translocations undertaken as best possible with material of questionable value– no plants established. Corrective actions unlikely as propagation material is limited.

Species	Hairy joint-grass	Moonee Creek Quassia	Noah's false chickweed	Slender screw-fern	Square-fruited ironbark	Square-stemmed spike-rush
Aim	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value		
Objectives	Soil associated with above-ground plants transplanted.	All available seeds collected, stems harvested and roots excavated to best extent practical	Above-ground plants transplanted together with associated soil likely to contain soil-stored seeds.	All available plants harvested and transplanted to best extent practical		
Performance criteria	No unsalvaged material present on ground inspection	No unsalvaged material present on ground inspection	No unsalvaged material present on ground inspection	No unsalvaged material present on ground inspection		
Threshold	More than 10% of the original material present.	More than 10% of the original material present.	More than 10% of the original material present.	More than 10% of the original material present.		
Corrective action	Project manager to address with contractors	Project manager to address with contractors	Project manager to address with contractors	Project manager to address with contractors		
Evaluation and actions	No further action feasible	No seeds present, all stems were collected for cuttings	All material collected bar small fragments	All material collected bar small fragments		

Evaluation – Soft Soils

Species	Hairy joint-grass	Tall knotweed
Aim	Create a self-sustaining population	Maintain a self-sustaining population.
Objectives	Plants complete their lifecycle and regenerate successfully	Plants complete their lifecycle and regenerate successfully
Performance criteria	At least 50 plants germinate and set seed each year	At least 30 plants germinate and set seed each year
Threshold	Less than 30 plants germinate and set seed in any one year	Less than 20 plants germinate and set seed in any one year
Corrective action	Undertake searches for suitable local donor populations, collect seed, nursery propagate or clump transplant. Re-evaluate site moisture gradients to best target suitable planting sites.	Undertake searches for suitable local donor populations, collect seed, nursery propagate or clump transplant. Re-evaluate site moisture gradients to best target suitable planting sites.
Evaluation and actions	Site 1 No germination observed as biomass management is required to re-instate suitable conditions for germination Site 2 New plants have developed, difficult to count germinants but judged as meeting performance criterion in Year 2.	Plants have died back and two short-lived seedlings observed. Findings are difficult to interpret since the translocation augments an existing population. The species is ephemeral and control plants have also died back. The addition of substantial amounts of seed to the system has been documented and is likely to have positive medium to long term impacts on the population. Further observation during the coming growing season is recommended before any corrective actions are considered.
Aim	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species
Objectives	Relevant project results and observations documented.	Relevant project results and observations documented.
Performance criteria	Reporting to Include e.g. detail of growth and seeding periods and results of nursery tasks.	Reporting to Include e.g. detail of growth and seeding periods and results of nursery tasks.
Threshold	Reporting incomplete	Reporting incomplete
Corrective action	Project manager to address with sub-contractors	Project manager to address with sub-contractors

Evaluation and actions	Reported in 2016 and current annual reports	Reported in 2016 and current annual reports
Aim	Achieve no net loss in local plant populations being impacted by the project	Achieve no net loss in local plant populations being impacted by the project
Objectives	Original number of individuals and area re-established	Original number of individuals and area re-established
Performance criteria	Compare with donor site. 70% of original cover of plants established over an area equivalent to original in Year 1, increasing to 100% cover by Year 5	Compare with donor site. 70% of original cover of plants established over an area equivalent to original in Year 1, increasing to 100% cover by Year 5
Threshold	>50% of original cover of plants established over an area equivalent to original in Year 1 or similar levels below target in subsequent year	>50% of original cover of plants established over an area equivalent to original in Year 1 or similar levels below target in subsequent year
Corrective action	Undertake searches for suitable local donor populations, collect seed, nursery propagate or clump transplant.	Evaluate options for sourcing more propagation material from neighbouring patches, collect additional seed, following guidelines for sampling
Evaluation and actions	Site 1 Plants not established but biomass has been reduced and may stimulate germination. A further season of observation is recommended before corrective actions are considered. Site 2 Plants well established and approaching threshold. A further season's observation is recommended before considering corrective actions.	Plants have died back, observations difficult to interpret (see above). Further observation during the coming growing season is recommended before any corrective actions are considered.
Aim	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value
Objectives	Soil associated with above-ground plants transplanted	All available plants and associated soil harvested and transplanted to best extent practical
Performance criteria	No unsalvaged material present on ground inspection	No unsalvaged material present on ground inspection
Threshold	More than 10% of the original material present.	More than 10% of the original material present
Corrective action	Project manager to address with contractors	Project manager to address with contractors
Evaluation and actions	All large clumps of plants transplanted, together with associated soil. Plants sparsely dispersed within exotic grasslands were not completely recovered – these constituted a small proportion of the total plant material.	All plants and associated soil translocated.

5.0 Corrective Actions

Corrective actions were applied for some of the species translocated on Sections 3-11. These included adjustments to recipient sites, translocation methods and maintenance regimes.

Appendix 1 presents a summary of changes to methodology that were implemented on Sections 3-11 to increase likelihood of achieving the performance aims and objectives in the Translocation Strategy (RMS 2015).

A second rainforest species translocation area was established at Coolgardie Rd on Sections 3-11 in 2017/2018 to improve prospects for successful translocation of rainforest species, particularly Stinking Cryptocarya which performed poorly at the Lumleys Lane recipient site in Year 1.

Corrective actions were also applied on Sections 1-2 and EWSSTA, as described in Landmark (2016 & 2017), including repeated attempts at translocation by propagation and planting out applied in the case of Lindernia and Slender Screw Fern.

A total of 79 Square-fruited Ironbark have been introduced to the receival site for this species on Sections 1-2 but the target is over 823. These plants still have to be translocated (propagated and introduced), but this is not a corrective action.

No further corrective actions are currently proposed for Sections 3-11 or Section 1-2 and EWSSTA for the year just starting (July 2018 to June 2019).

6.0 References

Ecos Environmental P/L (2011a). *Tintenbar to Ewingsdale Upgrade Threatened Plant Minimisation Strategey.* Report to the NSW Roads and Traffic Authority.

Ecos Environmental P/L (2011b). Sapphire to Woolgoolga Upgrade Threatened Flora Translocation Monitoring Report Year 1. Report to the NSW Roads and Traffic Authority.

Ecos Environmental P/L (2015). Tintenbar to Ewingsdale Upgrade of the Pacific Highway *Arthraxon hispidus* (Hairy Joint Grass) Translocation Project: Year 5 Monitoring Report. Report to the NSW Roads and Traffic Authority.

ECOS Environmental (2016). Nambucca Heads to Urunga Threatened Flora Translocation Project – Annual Monitoring Report Year-3. Report prepared for Lend Lease Infrastructure.

ECOS Environmental (2017). Woodburn to Ballina Threatened Flora Translocation Project (Sections 3-11) Annual Monitoring Report – Year 1. Report to Roads and Maritime Services.

Roads and Maritime Services (2015a). Flora Translocation Strategy, Pacific Highway Upgrade, Sections 1 and 2, Woolgoolga to Ballina, Version 2.

Roads and Maritime Services (2015b). Flora Translocation Strategy Pacific Highway Upgrade Sections 3-11 excluding Early Works Soft Soil Treatment Areas Woolgoolga to Ballina, Version 2 November 2015.

Landmark Ecological Services (2016).Translocation monitoring Sections 1 and 2 and Early Works Soft Soil Treatment Areas. Monitoring Results and Status Report as at June 2016. Woolgoolga to Ballina Pacific Highway Upgrade. Report to Roads and Maritime Services

Landmark Ecological Services (2017).Translocation monitoring Sections 1 and 2 and Early Works Soft Soil Treatment Areas. Annual Report 2017. Woolgoolga to Ballina Pacific Highway Upgrade. Report to Roads and Maritime Services.

Appendix 1: Changes to methodology implemented on Sections 3-11 to increase likelihood of achieving the performance aims and objectives in the Translocation Strategy (RMS 2015).

Species	Alternative Methods	Alternative Locations
Yellow-flowered King of the Fairies (*Oberonia complanata*)	Rather than prising the orchid plant and roots away from the bark substrate of the host tree, as described in the Strategy, the substrate was cut away in a slab using a saw and chisel, so plant was moved intact with its bark substrate. The bark and plant was reattached to a host tree at the recipient site.	Proposed host Casuarina trees on Gummigurrah Walk were too exposed; replaced with other rainforest understorey trees in denser bush closer to Evans Head, still in Bundjalung National Park.
Singleton Mint Bush (*Prostanthera cineolifera*)	As (i) species not expected to seed for several months, (ii) seed likely to be of poor quality due to senescent population; and (iii) cuttings of poor quality, species propagation was trialled using the soil seedbank salvaged from underneath bushes on the footprint. Fire was applied to stimulate germination. Experiments/trial planting were also conducted to find the most suitable location for species within preferred recipient site, given sensitivity to soil texture/ drainage.	Two of the three recipient sites proposed in Strategy were assessed as unsuitable habitat due to soil type, dryness and indicator species. Tabbimoble Triangle selected as only suitable site.
Weeping Paperbark (*Melaleuca irbyana*)	Species propagated from seed only, as seed was readily available from capsules on tree branchlets and seed propagation was simpler to implement than cuttings, with fewer potential problems.	Proposed recipient sites either with unsuitable habitat or access impractical due to flooding. Alternative site found on RMS offset land south of Tabbimoble Creek western side of highway. Propagated plants also introduced to Tabbimoble Triangle recipient site used for Mint Bush.
Tall Knotweed (*Persicaria elatior*)	Three methods trialled – (i) translocation using mud seedbank from donor/impact site salvaged and spread directly at the recipient site, (ii) direct transplanting/salvage of large plants and (iii) salvage of seedlings grown on to an established size in pots before planting into the recipient site.	Recipient site used for early works translocation assessed as unsuitable, as inside Paperbark forest where translocation plants grew poorly before dying. Alternative recipient site on edge of Paperbark forest found further north, also in Yaegal Nature Res.
Four-tailed Grevillea (*Grevillea quadricauda*)	Translocation trialled using the soil seedbank collected from underneath large bushes, too large to transplant. Juvenile plants were salvaged to pots and grown-on at the nursery before planting out, as weather conditions in spring-summer were hot and dry.	
Stinking Cryptocarya (*Cryptocarya foetida*)	Saplings were translocated manually by direct transplanting. Juvenile plants were transplanted to pots and grown-on for 10 months before planting out, to improve resilience and survival rate. Transplanting of larger trees not carried as not specified in Brief, discouraged in Strategy and difficult to organise retrospectively with management.	BOS 22 recipient site on RMS land was the only practical recipient site (ie. with available water source) and with reasonable, looking habitat proposed in the Strategy. Translocations implemented to this site in Year 1 performed poorly for four of the five species due to shallow, heavy clay soil. A second recipient site for rainforest threatened species was selected at Randles Creek near Coolgardie Rd and translocations using propagated plants are currently underway.
Rusty Rose Green Walnut (*Endiandra muelleri ssp. bracteata*)		
Red Lilly Pilly (*Syzygium hodgkinsoniae*)		
White Laceflower (*Archidendron hendersonii*)		
Rough-shelled Bush Nut (*Macadamia tetraphylla*)		

Species	**Alternative Methods**	**Alternative Locations**
Hairy Joint Grass Section 10 (*Arthraxon hispidus*)	Hairy Joint was transplanted from the Coolgardie South and Lumleys Lane south donor sites to the BOS 22 recipient site at Lumleys Lane. Well in excess of the 348 individuals that required translocation in the Flora Translocation Strategy were translocated. A total of forty three (43) plots of translocated Hairy Joint Grass were established at the BOS 22 recipient site at Lumleys Lane. A section of this site with very few existing Hairy Joint Grass plants was selected as the recipient site. Approximately 500 individuals were transplanted.	Proposed recipient site unsuitable as too low lying and inundated for long periods during rainy season. Replacement site found in section of BOS22 land with low number of HJG.
Hairy Joint Grass Mitchell Rd Sect 3 (*Arthraxon hispidus*)	Large population found to be present at site when only one point mapped in Strategy. 20 trays of approx. 1000 plants translocated to recipient site in road reserve next to the recipient site.	Recipient site on Section 1-2 proposed in Strategy considered too far away (~50km)
Additional Species		
Square-fruited Ironbark (*Eucalyptus tetrapleura*)	Direct transplanting to recipient site at Sunnyside Rd, Glenugie, RMS offset property.	
Hairy Melichrus (*Melichrus hirsutus*)	Direct transplanting to recipient site at Tallowwood Dv, Pillar Valley, RMS offset property.	
Lindernia (*Lindernia alsinoides*)	Direct transplanting to recipient site in Road Reserve opposite the donor site, south of Mitchell Rd.	
Rotala (*Rotala semipartita*)	Salvage transplanting to pots and propagation	
Richmond Bird Wing Vine (*Aristolochia pravevenosa*)	Propagated from cuttings.	
Carronia (*Carronia multisepala*)	Propagated from cuttings.	

7.0 Photographs Sections 3-11

Plates 1- 39

Slender Screw Fern (*Lindsaea incisa*)

Plate 1: Transplanted Slender Screw Fern from unexpected find area eastern side of the Pacific Highway. Some was growing in relatively dry, conditions under Blackbutt. Sept 2017

Plate 2: Trays of Slender Screw Fern ready for transport to recipients site in Bundjalung National Park. The soil was dry and trays were watered to prevent transplanting shock. Sept 2017

Plate 3: Slender Screw Fern plot in recipient site 2 Bundjalung National Park, six months after transplanting. Inverted nursery trays were used to protect and as plots markers March 2018.

Plate 4: Slender Screw Fern plot in recipient site 2 Bundjalung National Park, six months after transplanting. March 2018.

Yellow-flowered King of the Fairies (*Oberonia complanata*)

Plate 5: Unexpected find of Oberonia complanata introduced to recipient site at Lumleys Lane South in Aug/2017.

Plate 6: Unexpected find of Oberonia complanata introduced to recipient site at Lumleys Lane South in Aug/2017. A branch with several clumps of orchids has been wired onto the branch of a paperbark tree at the recipient site.

Singleton Mint Bush (*Prostanthera cineolifera*)

Plate 7: Singleton Mint Bush propagated from soil seedbank, tubestock planted in March 2017. Plants well over a metre in height. Watering was carried out during dry spells. July 2018

Plate 8: March 2018. A plot in Experiment 1 looking at effect of soil texture on tubestock survival and growth. Sixteen tubestock planted per plot. Conditions were ideal for growth between spring 2017 and autumn 2018.

Plate 9: A plot in Experiment 2 planted November 2017, looking at performance of seed and cutting propagated plants. Twelve tubestock per plot. March 2018.

Plate 10: Experiment 2 planted November 2017, looking at performance of seed and cutting propagated plants. A seed propagated plant, typically these were taller, upright and symmetrically branching. March 2018.

Plate 11: Experiment 2 planted November 2017, looking at performance of seed and cutting propagated plants. A cutting propagated plant, typically these were shorter and tended to grow sideways like a branch rather than upright. March 2018.

Plate 12: March 2018. Large Singleton Mint Bush one year after planting in March 2017.

Tall Knotweed (Persicaria elatior)

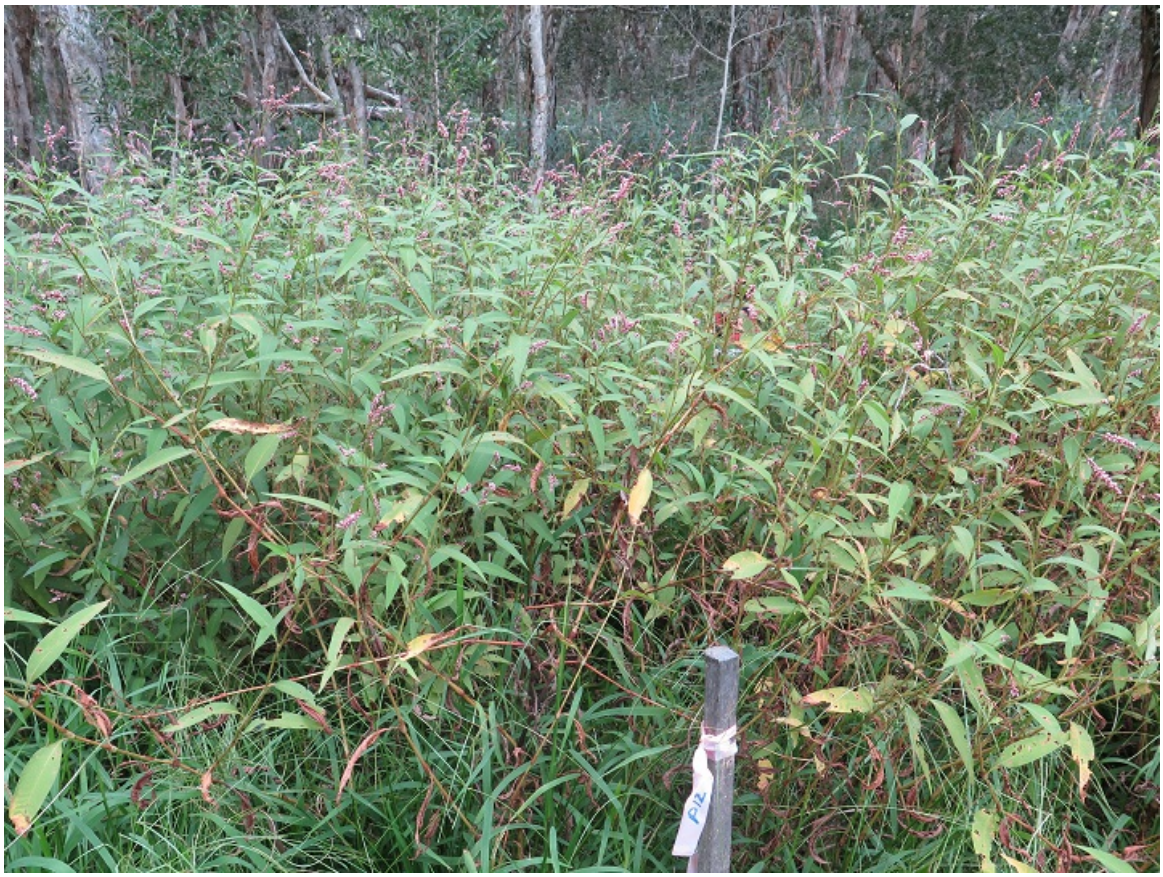


Plate 13: Tall Knotweed plot in March 2018. This annual species has grown naturally from seed produced by nursery grown plants (seedlings salvaged) introduced in Feb/17.

Plate 14: Another Tall Knotweed plot in March 2018. These plants have also grown naturally from seed produced by nursery grown plants introduced in Feb/17. They died in winter 2017 and were followed by another cohort of seedlings that grew into the plants shown in the photograph.

Plate 15: March 2018. This plant is growing on one of the plots from the first translocation of old plants and mud seedbank introduced the Tall Knotweed recipient site in Yaegl Nature Reserve in August 2016.

Four-tailed Grevillea (*Grevillea quadricauda*)

Plate 16: *Grevillea quadricauda* recipient site in road reserve south of Quarry Rd Section 3 in March 2018. Grevillea plants on left hand side.

Plate 17: Grevillea quadricauda in the recipient site south of Quarry Rd Section 3 in March 2018.

Plate 18: March 2018. *Grevillea quadricauda* with flowers at the recipient site south of Quarry Rd Section 3. Not many flowers have been produced so far. Small plants were salvaged in Aug-Sept/16, and introduced to the recipient site in March/2017.

Stinking Cryptocarya (*Cryptocarya foetida*)

Plate 19: One of relatively few transplanted Stinking Cryptocarya still surviving and growing reasonable well 2 years after salvage. June 2018

Plate 19: Rainforest species recipient site no. 1 at Lumleys Lane. Four threatened rainforest species were translocated to this site which is being restored to subtropical rainforest. Plantings are approx. 2 years old. June 2018

Plate 20: The Lumleys Lane rainforest species receival site backs on to rocky hillslopes supporting regrowth rainforest densely infested with broad-leaved privet and camphor laurel. These exotic species have been poisoned, freeing up native rainforest species which are scattered through the regrowth as canopy trees, saplings and seedlings. This intensive, highly skilled ecological restoration work if being implemented by Darren Bailey. June 2018

Rusty Green-leaved Rose Walnut (*Endiandra muelleri ssp. bracteata*)

Red Lilly Pilly (*Syzygium hodgkinsoniae*)

Plate 21: *Endiandra muelleri ssp. bracteata* two years after transplanting. June 2018

Plate 22: Second rainforest species recipient site at Coolgardie Rd. Exotics are being removed before planting out propagated plants of threatened rainforest species. November 2017

Plate 23: Second rainforest species recipient site at Coolgardie Rd. Propagated threatened rainforest species have been planted in the wire tree guards. June 2018

Plate 24: A dozen propagated Red Lilly Pilly (*Syzygium hodgkinsoniae*) were planted in the rainforest species recipient site at Lumleys Lane in June/2017. Typically plants such as this one have survived but grown very slowly, which is a typical response of this species and a reason why it is seldom used in rainforest planting projects even though it is one of the most attractive rainforest trees. Another 30 were planted at the rainforest species translocation site at Coolgardie Road in Feb/18. June 2018

White Laceflower (*Archidendron hendersonii*)

Plate 25: White Laceflower (*Archidendron hendersonii)* at the Lumleys Lane rainforest species translocation area, approx. 20 years after salvage transplanting. June 2018

Hairy Melichrus (*Melichrus hirsutus*)

Plate 26: Hairy Melichrus (*Melichrus hirsutus*) approx.. two years after transplanting to the Mahogany Dv recipient site at Pillar Valley. September 2017

Plate 27: Most of the Mahogany Dv recipient site was burnt about one month prior to these photographs being taken in September 2017, but a small patch with the transplanted Melichrus escaped the burn.

Hairy Joint Grass (*Arthraxon hispidus*)

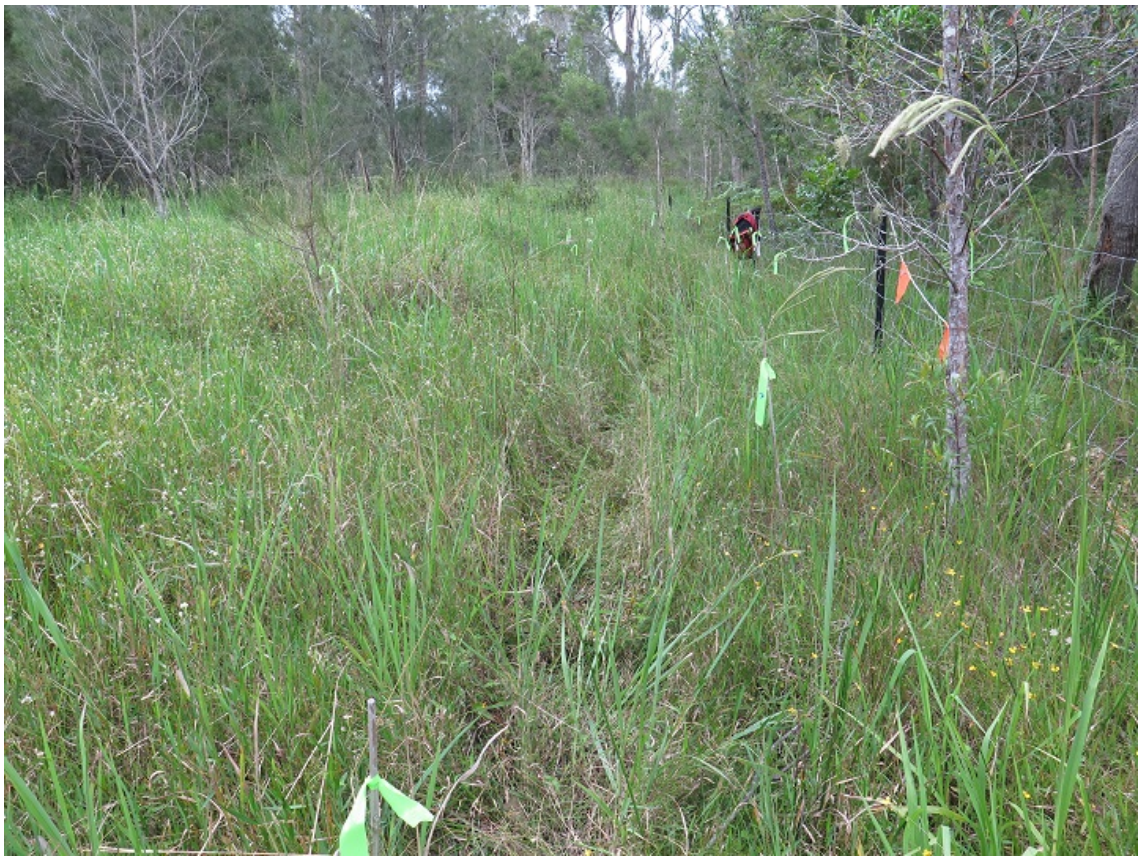


Plate 28: Hairy Joint Grass translocation area at Mitchell Rd, Section 3. Salvaged to trays Sept/16, planted out Dec/16. The tags mark plots. March 2018

Plate 29: Hairy Joint Grass translocation area at Mitchell Rd, Section 3. The same view as above. The site has been treated for biomass removal. It was flooded and turned to mud, but HJG, an annual grass dead at this time, is predicted to regenerate. July 2018

Plate 30: Hairy Joint Grass in the Mitchell Rd translocation area in March 2018, just before the start of flowering. March 2018.

Plate 31: Hairy Joint Grass in the Mitchell Rd translocation area in March 2018. Taken same time as Plate 28 looking in the other direction. Tags mark HJG plots.

Rotala (*Rotala tripartita*)

Plate 32: Rotala donor site, eastern side of the Pacific Hwy. November 2017

Plate 33: Transplanting a sod containing Rotala plants in November 2017.

Plate 34: Transplants were divided and grown on in pots at the nursery then planted out in Dec 2017

Plate 35: Close up of a Rotala plant showing opposite, pointed leaves and red flowers. March 2018

Plate 36: Filling one of the two depressions dug along a minor drainage line at the offset property south of Tabbimoble Ck. November 2017

Plate 37: Planting-out Rotala in depression no. 1 in December 2017. Water was pumped from a nearby creek to flood the receival site.

Plate 38: Depression no. 2 in April 2018. The stakes mark where Rotala has been planted.

Plate 39: Close-up of a Rotala plant at site no. 2 in April 2018. The plants were kept in pots so they could be moved around to find the best position relative to the water level in the basin.

8.0 Photographs Sections 1-2 and EWSSTA

Plates 40 - 55

Slender Screw Fern (*Lindsaea incisa*)

Plate 40: Kangaroo Trail translocation area in April 2018. Three species were translocated to this site – Slender Screw Fern, Lindernia and Hairy Joint Grass.

Plate 41: Slender Screw Fern monitoring tags. Most plants from the first translocation in Sept15 three years ago were dead. Live plants are from a second planting in May/17 one year ago. April 2018.

Plate 42: Slender Screw Fern, Kangaroo Trail translocation area. Most plants translocated in Sept15 three years ago were dead (LES 2017). April 2018.

Plate 43: Slender Screw Fern, Kangaroo Trail translocation area. This plant is apparently from the second planting in May/17. Label can be seen Plate 41. April 2018.

Lindernia (*Lindernia alsinoides*)

Plate 44: Lindernia at Kangaroo Trail translocation area, April 2018. The only plant seen out of approximately 900 introduced to the recipient site in two plantings in Jan/16 and autumn/17.

Plate 45: Lindernia at Halfway Creek Crossing translocation area, April 2018. Twelve plants surviving out 500 introduced in autumn 2017.

Plate 46: Halfway Creek Crossing receival site. The plants present at these monitoring tags were all the small herbaceous plant Stylidium debile. April 2018

Plate 47: Habitat at the Halfway Creek Crossing translocation area. April 2018. Aspects of this habitat did not match the habitat requirements of *Lindernia alsinoides* including soil type, hydrology, topographic position, vegetation structure and plant species composition.

Hairy Joint Grass (*Arthraxon hispidus*)

Plate 48: Kangaroo Trail translocation area. The LES (2017) stated that no HJG regeneration was recorded at the recipient site after slab translocation in Sept/15, yet HJG plants were present in April 2018. The plants were dying after having set seed and the label was also present.

Plate 49: Kangaroo Trail translocation area. HJG was present in April 2018 at several points on the boundary of the low and tall herbaceous vegetation, in line with the star picket.

Plate 50: Hairy Joint Grass recipient site at Trustrums Hill. No HJG was found at Site 1 in this photo overgrown with Setaria grass, at Site 2. June 2018

Plate 51: Powerline easement adjacent to recipient sites 1 and 2 at Trustrums Hill. Site 1 is past the first power pole and Site 2 is alongside the operator on left side of photo. HJG was recorded here in 2015 and was still present in June 2018. Biomass was reduced with a brushcutter to promote HJG seed germination.

Square-fruited Ironbark (*Eucalyptus tetrapleura*)

Plate 52: Square-fruited Ironbark (*Eucalyptus tetrapleura*) planted in Autumn 2017 at a recipient site on the Sunnyside Rd offset land at Glenugie. April 2018.

Plate 53: Square-fruited Ironbark planted Autumn 2017 at the Sunnyside Rd offset land, Glenugie. April 2018. The small tree regrowth in the background appears to be mainly naturally regenerating Square-fruited Ironbark.

Lepidosperma sp. Coaldale

Plate 54: White tags mark Lepidosperma sp. Coaldale at the recipient site on offset land at Mahogany Dv. Pillar Valley, July 2018. Plants were salvaged in August/15, kept at a nursery then planted in spring/16 in four plots. The land was burnt in August 2017

Plate 55: White tags mark *Lepidosperma* sp. Coaldale at the recipient site on offset land at Mahogany Dv. Pillar Valley, July 2018. This plot is becoming overgrown with Common Ground Fern (*Calochlaena dubia*)