Woolgoolga to Ballina Pacific Highway upgrade

Annual Threatened Flora Translocation Monitoring Report 2021

NSW GOVERNMENT

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Woolgoolga to Ballina Threatened Flora Translocation Project

Annual Monitoring Report 2021

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29/6/2022

Contents

Executive Summary

This annual monitoring report describes threatened flora translocations carried out for the Woolgoolga to Ballina (W2B) upgrade of the Pacific Highway, a 155 km section of new highway on the North Coast of NSW. Results are described for Sections 3-11 after 4-5 years or 3.5 – 4 years in the case of unexpected finds. Final results for Sections 1-2, which started one year earlier, were described in last year's report. A total of 21 plant species were translocated on the W2B project, including 18 threatened species, 1 rare species and 2 vines hosting threatened butterfly and moth species:-

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 insects

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

Translocation Strategies for Sections 1-2 and Early Works and Soft Soils Treatment Areas (EWSSTA) and Sections 3-11 were prepared prior to translocation, describing translocation methods, receival sites and evaluation criteria (RMS 2015a &b). Ecos Environmental Pty Ltd implemented the translocations and modified aspects of the Strategy where required. The aims of translocation were to establish new or augmented, self-sustaining populations of the impacted species, utilise translocation to avoid significant net loss to local threatened plant populations, investigate species ecology and translocation methods, and make the best possible use of all plant material with potential conservation value.

Species were introduced to 20 recipient sites, 7 on Sections 1-2 and 13 on Sections 3-11. Four methods were used to translocate species:

- Salvage transplanting.
- Propagation and introduction from cuttings.
- Propagation and introduction from seed.
- Propagation and introduction from the soil seedbank.

The translocations for some species incorporated simple experiments comparing different planting locations, treatments etc. Methods were observational rather than statistical.
Additional trials and investigation went into translocation of Singleton Mint Bush (SMB). There were four phases to translocation of this species that developed as the work progressed:

1. As other options were not viable, a trial using salvaged soil seedbank and fire to propagate this species was carried out, which proved successful.
2. As the aim was to augment an existing population and it was unclear in what parts of the recipient site SMB could be established, seedling tubestock were planted across the whole site and natural selection (i.e. environmental interactions) allowed to indicate where micro-habitat was best suited to the species.
3. Plot-based experimental plantings were used to clarify how microhabitat variation within the recipient site and horticultural factors affected species performance.
4. Monitoring continued after a natural experiment when the site was burnt by bushfire, enabling the response of introduced plants to an infrequent but major agent of disturbance to be recorded.
5. Based on the findings of 2 & 3, remaining tubestock were planted in microhabitat most suited to the species.

Approx. two-thirds of the first introduction of seedlings in March/2017 died of a wilt disease in the first few months. Experimental plantings showed this was related to soil texture and the species preferred sandier soil closer to Tabbimoble Ck. The disease was much less common in a reference site on the opposite side of the highway where most of the SMB population at Tabbimoble Creek is located.

A bushfire burnt the recipient sites for Singleton Mint Bush, Slender Screw Fern and Weeping Paperbark in Nov/2019, during the east coast bushfires of 2019-2020. The bushfire (and preceding drought) caused the first two species to contract to smaller sections of their recipient sites. The distribution of Weeping Paperbark in the three sites where it was planted was unchanged by fire, which killed above ground parts, then plants reshot from roots at the stem base and reached about pre-fire height in only two years.

After the Nov/2019 bushfire, SMB (an obligate seeder) regenerated by resprouting (as fire in the recipient site was low intensity) and from seed as expected. Number of individuals increased in the recipient site after the Nov/2019 fire due to seedling recruitment, although translocated plants produced very few seedlings as they were too young. In 2021, two years after fire, SMB population in the recipient site had thinned to a total of 353 (all sizes, translocated and in situ origin).

It was estimated that approx.10% of the total SMB population present in the recipient site in 2021 originated from translocation and 90% from the in situ (pre-translocation) population, as translocated plants were too young (2.5 years) to have produced much seed before the fire and seedlings (naturally recruited or planted) were susceptible to wilt disease across most of the site. The plot-based experiments showed that:

- Soil texture strongly affects the performance of SMB seedlings
- Older seedlings perform much better than younger seedlings.
- Plants propagated from seed perform better than cuttings.
- Most of the recipient site represented unsuitable habitat for SMB.

Overall, the results of translocation on Sections 3-11 met most aims, objectives and targets for all 16 threatened species translocated, except Lindernia. The translocation was unsuccessful in significantly augmenting the existing population of SMB, but produced new information on its autecology. Results were more mixed for species on Sections 1-2 where several species recorded zero survival or population establishment, including Moonee Quassia, Oberonia, Lindernia, Square-stemmed Spike Rush, Lepidosperma sp. Coaldale and Hairy Joint Grass.

1.0 INTRODUCTION

This monitoring report describes the results of threatened flora translocations carried out for the Woolgoolga to Ballina (W2B) upgrade of the Pacific Highway, a 155 km section of dual carriageway constructed on the North Coast of NSW (Figure 1).

The threatened flora translocations for the W2B project were implemented in two stages:

- *Landmark Ecological Services and Bushland Restoration Services* carried out translocations on Sections 1-2 and EWSSTA (Early Works Soft Soil Treatment Areas) 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 modified to include Early Works Soft Soil Treatment Areas.

- *Ecos Environmental* carried out translocations on Sections 3-11 in 2016-2017. Implementation 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 included several unexpected finds, which were translocated in 2017, as described below.

'Strategy' below refers to the Translocation Strategy set out in RMS (2015 a&b).

A total of 21 plant species were translocated, including 18 threatened species, one rare species (not scheduled) and two species of vine that host threatened butterfly and moth species during their larval stage (Table 1).

Translocations on Sections 1-2 and Early Works Soft Soil Treatment Areas (EWSSTA) started in 2015 and translocations on Sections 3-11 started in 2016. Results of translocations on Sections 1-2 and EWSSTA for the first two years were described in Landmark Ecological Services (2016 and 2017). For years 3-5 they were included in Ecos Environmental (2018-2020).

The final monitoring results for Sections 1-2 and EWSSTA were described in last year's report, completing five-year monitoring requirements. This report describes translocation results for Sections 3-11, which represent 4-5 years since introduction (planting) or 3.5 – 4 years in the case of unexpected finds, to November 2021. Following the Introduction, Part 2 describes the Methods used to translocate species, including selection of recipient sites and a summary of techniques used for salvage and propagation, and monitoring methods. Part 3 is a species-by-species account of translocation implementation and results. Part 4 assesses translocation outcomes in terms of the aims and objectives of the Translocation Strategy. Part 5 identifies actions required in the next 12 months and recommends some measure to complete aspects of experimental translocation work. A photo record of the translocation project is included.

Table 1: Conservation status of the species translocated and whether they were translocated on Sections 1-2 & EWSSTA starting in 2015 and/or on Sections 3-11 starting in 2016

Threatened Species	**EPBC Act status**	**BC Act status**	**Sec.1-2 & EWSSTA start 2015**	**Sec.3-11 Start 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 Birdwing Vine (*Aristolochia pravevenosa*)	-	-		√
Pink Underwing Moth Vine (*Carronia multisepala*)	E			√

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

2.0 METHODS

2.1 Aims and Objectives

The aims of the translocation project set out in the Strategy (RMS 2015 a & b) are to:

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

Objectives to further 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).

Translocation can contribute towards achieving conservation aims and mitigating some of the impact of development on threatened plant species. However, it is recognised that translocation is often experimental and outcomes cannot be guaranteed for a given species. Translocation is therefore not factored into offsetting packages for example, at least not at the current stage of its development as a potential conservation tool.

2.2.1 Sections 3-11

Sections 3-11 extend from Pillar Valley east of Grafton north to the Wardell area south of Ballina. The Strategy (RMS 2015b) identified twelve threatened species requiring translocation in Sections 3-11. Additional threatened plant species were found during pre-clearing surveys (i.e. unexpected finds) and incorporated into the translocation program, including the two species of vine that host threatened invertebrate species, taking the total to 18 species (Table 2).

Table 2: Number of individuals or areas of threatened species cleared during the W2B project on Sections 3-11.

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*)	6350 fronds (0.370ha)	4350 fronds (~0.3ha)	10700 fronds (0.670 ha)

Species	**Translocation Target (RMS 2015a)**	**Unexpected Finds**	**Total number removed/ translocated**
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		28
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*)		10***	10
Species Associated with Threatened Insects	Other		
Richmond Birdwing 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. *** plants previously included from a second donor site, but as they disappeared before clearing they have been omitted.

2.2.2 Sections 1-2 & Early Works Areas

The Translocation Strategy for Sections 1-2 & Early Works Soft Soil Treatment Areas (RMS 2015a) identified nine threatened species requiring translocation, including Rusty Rose Walnut (Table 3). Attempts to protect in situ a single individual of the latter species at the Maclean interchange were unsuccessful and this population has now been included in the translocation program, but under a separate Green-leaved Rose Walnut Rehabilitation Plan (Geolink 2019) and not included in the present monitoring report.

Table 3: Number of individuals or areas of threatened species clreared during the W2B project on Sections 1-2.

Species	**Translocation Target (RMS 2015a) as no. or no./area**	**Early Works Soft Soil Areas 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)
Rusty Green-leaved Rose Walnut (*Endiandra muelleri ssp. bracteata*)		1	1
Lepidosperma sp. 'Coaldale'		35	35

* 18 translocated during early works in 2015 went to a nursery but appear to have died; 11 more were translocated in 2016 by Ecos Environmental as described below.

2.3 Recipient Sites

The success of threatened plant species translocation depends largely on how well the habitat present at the recipient site corresponds with habitat at the donor site, or the habitat requirements of the species being translocated. Plant habitat is determined by a complex of factors including climate, geology, soil profile, topographic position, aspect, hydrology, vegetation structure and species composition, and successional stage (e.g. mature, regrowth, patchy regrowth or cleared).

The recipient sites selected for Sections 3-11 and for Sections 1-2 & EWSSTA are listed in Tables 4 and 5 below. Prior to translocation starting on Sec 3-11, the sites nominated in the Strategy were inspected to assess their suitability in terms of habitat and logistical factors (access, water availability etc.). Site locations for some species were modified (e.g. Tall Knotweed, Weeping Paperbark and rainforest species). This assessment is summarised in Ecos Environmental (2016) "W2B Flora Translocation Project - Site Selection and Validation

Report". Thirteen recipient sites were finally selected on Sections 3-11. The seven used for Section 1-2 & Early Works Areas (see Figs 2 and 3) had already been selected and translocations started in 2015.

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 Birdwing 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)

* More individuals of Rough-shelled Bush are still being propagated to introduce to Lumleys Lane, as well as those already introduced to Coolgardie Rd.

Table 5: Recipient sites for species translocated on Sections 1-2 & 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
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

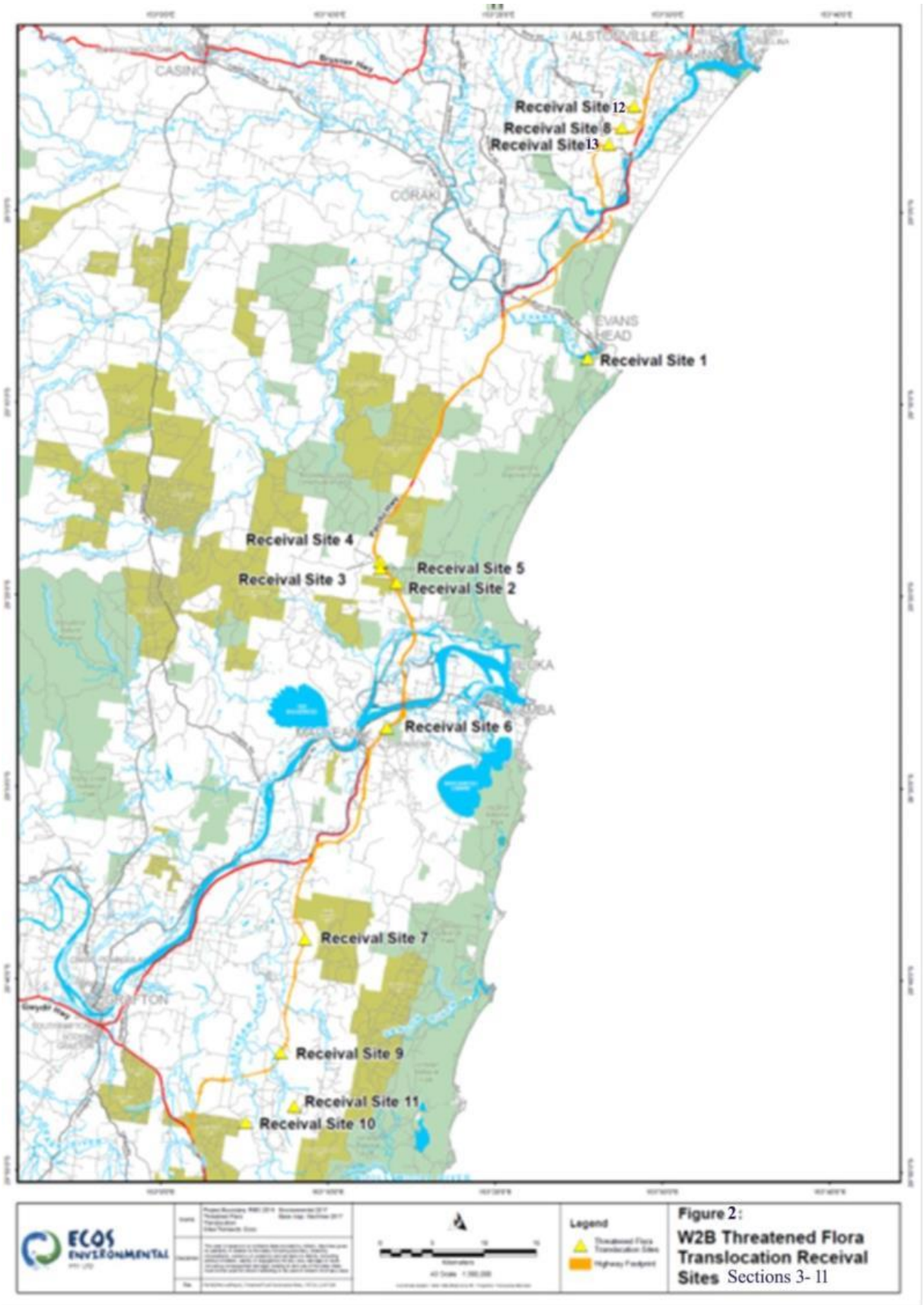
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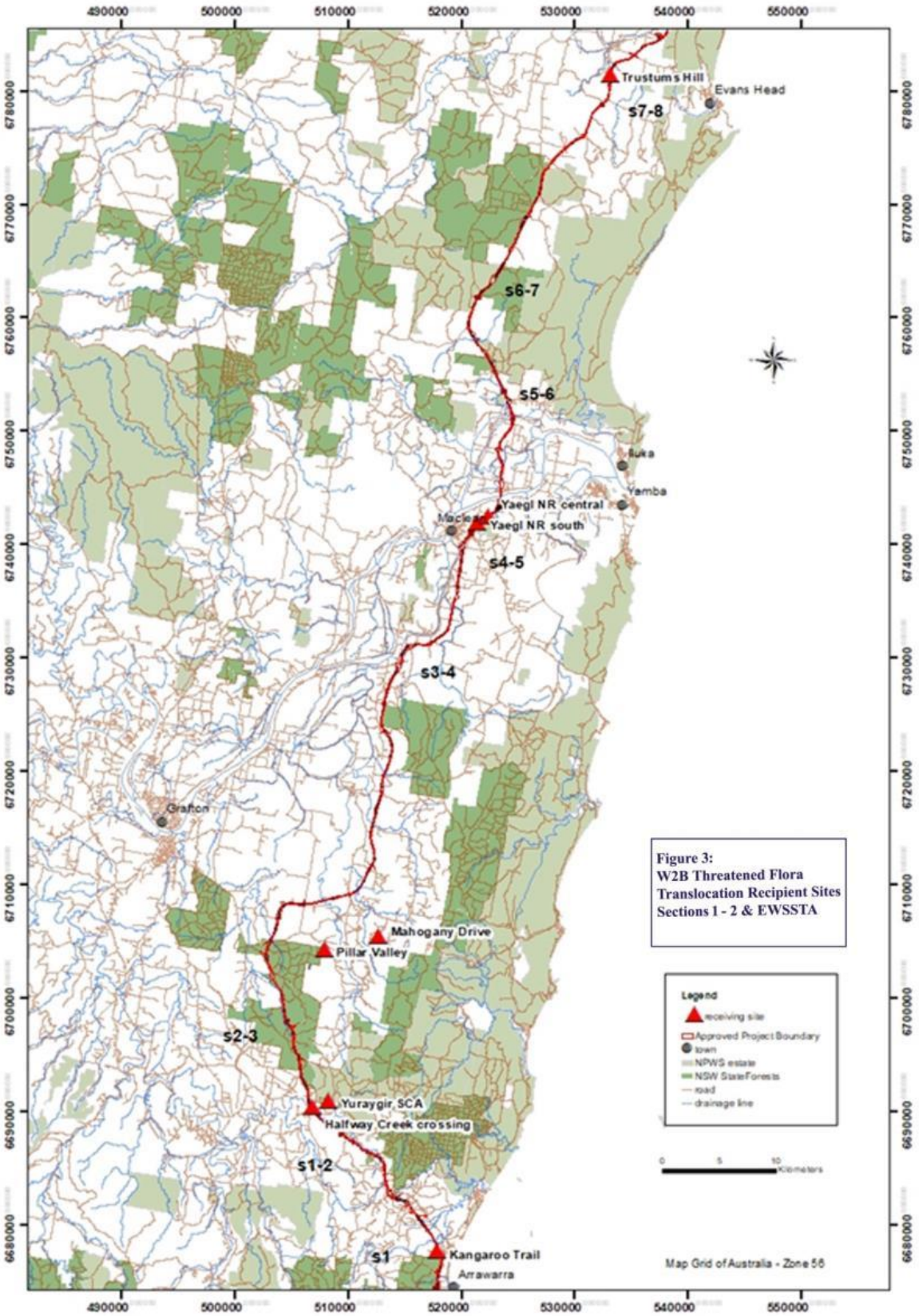
Figure 2:
W2B Threatened Flora Translocation Receival Sites Sections 3- 11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Trustums Hill
Evans Head
s7-8
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s5-6
Iluka
Yamba
Yaegl NR central
Yaegl NR south
s4-5
s3-4
Grafton
Mahogany Drive
Pillar Valley
s2-3
Yuraygir SCA
Halfway Creek crossing
s1-2
s1
Kangaroo Trail
Arrawarra
Figure 3:
W2B Threatened Flora
Translocation Recipient Sites
Sections 1 - 2 & EWSSTA
Legend
receiving site
Approved Project Boundary
town
NPWS estate
NSW StateForests
road
drainage line
0
5
10
Kilometers
Map Grid of Australia - Zone 56

2.4 Translocation Methods

Threatened flora were translocated to the recipient sites using four main methods:

(i) Salvage transplanting (i.e. excavation of impacted plants).

(ii) Propagation of plants from cuttings.

(iii) Propagation of plants from seed.

(iv) Propagation of plants from the soil seedbank.

All propagation material came from the construction and clearing footprint. More than one method was applied to several species, as shown in Table 6. Summing the main methods in Table 6, transplanting was applied to 18 species, seed propagation to 8, cutting propagation to 5 and soil seedbank propagation to 3. Different methods applied to the same species provided back-up in case one failed and allowed testing of different propagation methods. Further details of translocation methods applied to each species is provided below.

Propagation from the soil seedbank was used for Singleton Mint Bush (SMB), Tall Knotweed (TK) and Fou**r**-tailed Grevillea (FG), although mainly for the first two species. Topsoil (or mud in the case of Tall Knotweed) was collected under mature plants on the assumption it would contain dormant seed of these species. Litter was burnt on top of the salvage topsoil to simulated bushfire and stimulate germination of Singleton Mint Bush and Fou**r**-tailed Grevillea. This method was successful for SMB but not FG as the latter's winged seed is probably dispersed away from the parent plant. Mud was collected under old Tall Knotweed plants and spread in plots at the recipient site.

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

(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	+	+	-	-

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

(ii) Sections 1-2 & 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

2.5 Monitoring

Monitoring was conducted once every three months for the first year after introduction, every six months in the second year, then once a year thereafter. Monitoring for this report was carried out in November 2021, representing 4.5 – 5 years since the first round of translocations and 3.5 – 4 years for unexpected finds which were translocated a year later (e.g. *Lindsaea incisa*). Time since translocation is given after introduction or planting out and does not include time required for propagation.

The Strategy (RMS 2015b, p. 44) states that "*Monitoring of the translocations would be conducted during and after construction for a minimum of 3 years*, *a total of approximately 5 years*."

The following data were recorded for each tagged individual or plot:

- plant height, width, or crown-cover
- plant condition
- new shoot growth (present/absent)
- flowering, seeding
- recruitment
- evidence of disease, grazing
- soil moisture/recent rainfall
- water depth if flooded and
- exotic species.

Monitoring results were entered in an Excel spreadsheet, saved as "W2B Translocation Monitoring 2016 to 2021 and Monitoring 2016 to 2021_process".

2.6 Maintenance and plant care

Mortality or poor condition in translocated plants is often a result of stressful growing conditions caused by soil dryness, low nutrient availability, weed competition and other factors. Salvaged and propagated plants have a better chance of survival and establishment at the recipient site if regular maintenance is carried out to reduce stressful growing conditions. This is achieved by horticultural interventions such as watering, mulching, shading, spraying to control weeds, removal of competing native species, fencing to exclude native and domestic grazing animals, and use of fertiliser. Application of such methods is usually referred to as maintenance, but more specifically consists of plant care during the establishment phase, which in many species may require five years, sometimes longer.

Maintenance activities carried out during the last 12 months (spring 2020 to winter 2021) on the W2B are shown in Table 7. These varied according to species and recipient sites, and included weed control, grass slashing, removing sapling competition, application of slow release fertiliser, renewing monitoring tags and implementation of habitat restoration at the two rainforest species recipient sites (Lumleys Lane and Coolgardie Rd).

Table 7: Maintenance activities carried out between August 2020 and November 2021

Recipient Sites	Watering	Weed control	Mulching/fertiliser	Fence repair/exclude grazers	Renew monitoring tags	Grub saplings/reduce natives	Biomass reduction	Rainforest restoration
Site 1 - Bundjalung National Park (Evans Head) Oberonia								
Site 2 - Bundjalung National Park (Mororo Rd) Slender Screw Fern					+			
Site 3 - Tabbimoble Triangle Singleton Mint Bush, Weeping Paperbark				+	+			
Site 4 and 5 - RMS offset property at Tabbimoble Ck. Weeping Paperbark, Rotala				+	+			
Site 6 - Yaegl Nature Reserve (centre-north) Tall Knotweed		+			+			
Site 7 - Within project boundary Quarry Rd (Sec.3) Grevillea quadricauda				+				
Site 8 - Lumley's Lane Rainforest species'; Hairy Joint Grass	+	+	+	+	+			+
Site 9 - Within project boundary at Mitchells Rd (Sec.3) Hairy Joint Grass; Lindernia				+	+			
Site 10 - Offset land, Sunnyside Rd Eucalyptus tetrapleura								
Site 11 - Offset land, Pillar Valley (Mahogany Drive) Hairy Melichrus				+				
Site 12 - Coolgardie Rd Rainforest species	+	+	+	+	+			+
Site 13 - Lumleys Lane South Oberonia								
Sites on Section 1-2 and Early Work Areas		+			+		+	

3.0 RESULTS (SECTIONS 1-11)

3.1 Weather Conditions

Monthly and mean monthly rainfall between 2015 and 2021 at Evans Head (www.bom.gov.au/climate/data/) are plotted in Figure 4. This six-year period included droughts, which were defined as three or more consecutive months of below average rainfall, floods and a major bushfire (see Figure 4). Periods of below average monthly rainfall were in winter-spring, except for 2018 & 2019 when drought extended into summer, culminating in the bushfires of 2019-2020. Leaves on species such as *Lindsaea incisa* and *Prostanthera cineolifera* wilted and shrivelled up, indicating severe water stress. Additional watering was carried out to alleviate stress. Heavy rainfall events causing flooding and soil water logging adversely affected some species such as *Lindsaea incisa* and *Persicaria elatior*.

The highest maximum temperature on record for the Far North Coast of NSW was recorded on 11/2/2017 (mid to high 40s). This event caused leaf scorching and mortality to several transplanted *Cryptocarya foetida* at Lumleys Lane. The high temperature occurred during a drought that ended in March 2017 when 800-1000 mm of rain fell from Ballina to Maclean, causing flash floods and prolonged flooding of low lying recipient sites. Wet conditions persisted to the end of June 2017.

An exceptionally long dry period occurred from October 2018 to December 2019 along much of the east coast of Australia and bushfires were widespread. A bushfire burnt from the Richmond Range to the coast, crossing the W2B corridor between Ballina and Maclean, including the recipient sites for *Lindsaea incisa*, *Prostanthera cineolifera* and *Melaleuca irbyana* at Tabbimoble Ck, near the Iluka turnoff in Nov/2019. The bushfire provided an opportunity to record how translocated plants were affected by bushfire, and whether this affected their establishment.

Overall, weather patterns between mid-2015 and mid-2021 were notable for several large deviations from average monthly rainfall. In 6.5 years, there were five drought periods, defined as more than three consecutive months of below average rainfall, and six very high monthly rainfall events (see Figure 4). Intervening periods were about average with respect to rainfall, although higher than average in some months. Exceptionally high temperatures were recorded at the start of 2017, as noted above. The saying “a land of droughts and flooding rains “ is as true for the high rainfall North Coast of NSW as the dry inland.

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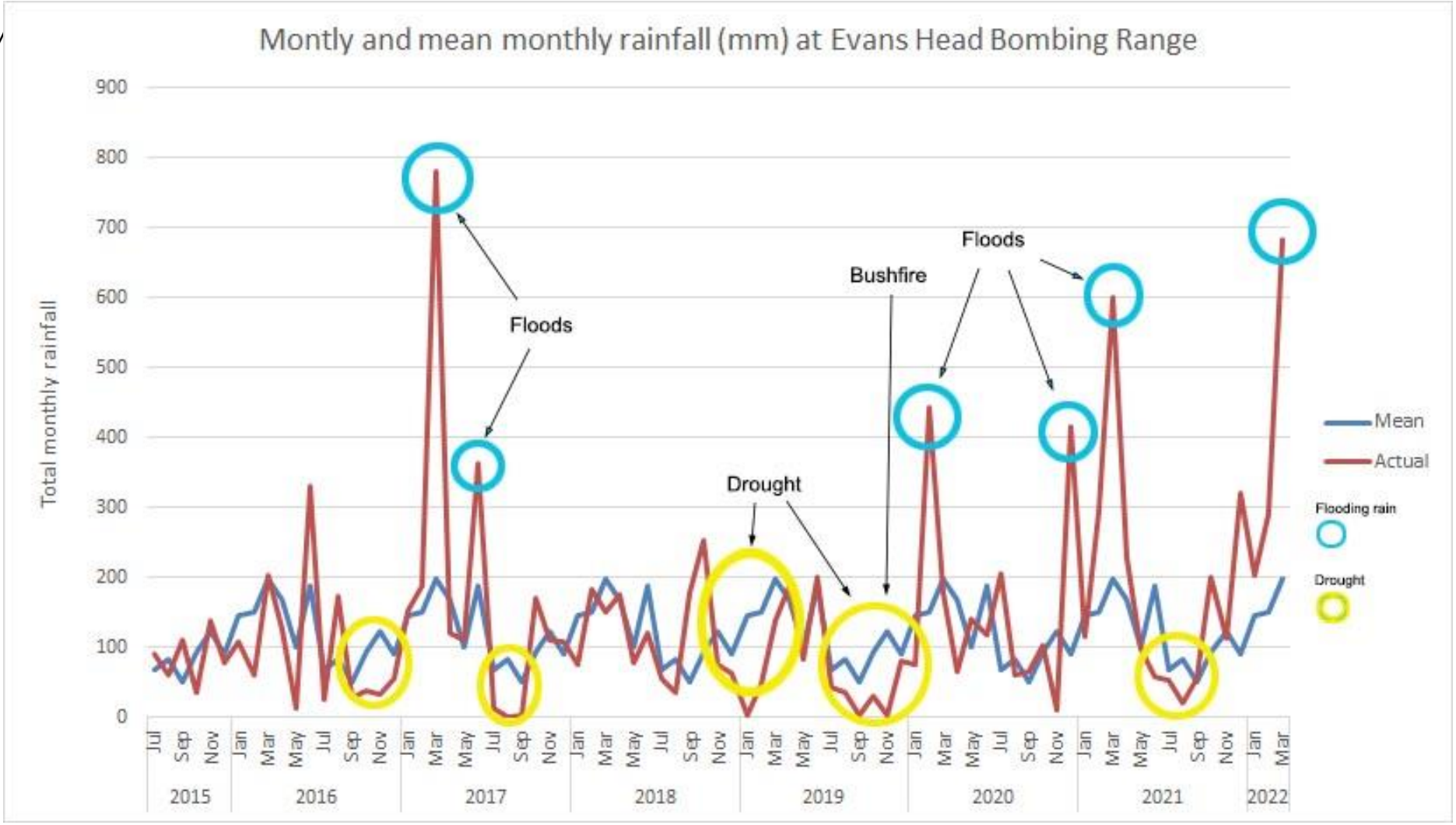

Figure 4: Actual monthly and mean monthly rainfall for Evans Head Bombing Range, representing rainfall on Sections 3-11 from 2015 to 2022. The weather pattern was characterised by high rainfall variability with frequent droughts and floods, and a major bushfire which burnt recipient sites for Singleton Mint Bush, Slender Screw Fern and Weeping Paperbark in the Tabbimoble Creek area north of Illuka turnoff in November 2019.

3.2 Translocation Results

Table 8: Summary of threatened flora translocation results on W2B sections 3-11 after five years (2016-2021) and four years (2017-2021) for unexpected finds. Some species/recipient sites were burnt by bushfire in November 2019, as indicated.
S - survivorship %; CC - mean % crown-cover; Ht - mean height (cm); ~1-4 years - time since transplanting/introduction, or time since seed germination.

Species/Recipient Sites	Method/Start Date	No. of Plants Translocated (Transplanted/Propagated)	Survival %/Cover-abundance/ No. of plants June/2017	Survival %/Cover-abundance/ No. of plants July/2019	Survival%/Cover-abundance/ No. of plants Aug/2020	Survival%/Cover-abundance/ No. of plants Nov/2021
Yellow-flowered Oberonia (*Oberonia complanata*)						
Bundjalung NP Gumma Gurra	Transplanted Aug/2016	Transplanted - 11	~1 year S = 91% (10/11)	~3 years S = 91%	~4 years S = 91%	~5 years S = 91%
Unexpected finds Lumleys Lane Sth	Transplanted Aug/2017	Transplanted – 12 small branches with orchid clumps	n/a	~2 years S = 100%	~3 years orchids taken by collectors	
Slender Screw Fern (*Lindsaea incisa*)					Bushfire Nov/2019	
First Translocation Area 1 - Bundjalung NP	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% All S=95%; cc=16%	~3 years Line A –S=100%; CC=30% Line B – S=100%; CC=25.5% Line C – S=100%; CC=40.9% Line D – S=100%; CC=25% patches – S=100%; CC=36% All S=100%; cc=35%	~4 years; 9 months post-fire Line A –S=0% Line B – S=8%; CC=2% Line C – S=75%; CC=18% Line D – S=0%; patches – S=20%; CC=1% All S=25%; cc=3.4%	~5 years; 2 years post-fire Line A –S=0% Line B – S=25%; CC=3.2% Line C – S=80%; CC=29% Line D – S=0%; patches – S=20%; CC=0.5% All S=25%; cc=5.8%
Second Translocation Unexpected finds. Area 1 & 2 - Bundjalung NP	Transplanted Sept, Oct 2017	Transplanted Area 2: Line A – 29 trays/plots Line B – 30 trays/plots Patches Area 2 = 7 Transplanted Area 1: Patches Area 1 =16 @ 25 fronds/tray Total fronds=~4350	n/a	~2 years Transplanted Area 2 Line A – S=97%; CC=6.8% Line B – S=94%; CC=16.3% Patches–S=100%; CC=68.5% Transplanted Area 1 Patches–S=100% CC= 80%	~3 years Transplanted Area 2 Line A – S=36.6%, CC=6.3% Line B – S=30%; CC=10.7% Patches – S=12% CC= 1% Transplanted Area 1 Patches–S=73%, CC=30%	~4 years; 2 years post-fire Transplanted Area 2 Line A – S=44%, CC=13% Line B – S=30%; CC=10.7% Patches – S=12% CC= 1% Transplanted Area 1 Patches–S=73%, CC=34%
Singleton Mint Bush (*Prostanthera cineolifera*)					Bushfire Nov/2019	
Tabbimoble Triangle	Soil seedbank collected Aug/2016 1st tubestock planted 23/3/2017 when seedlings ~6 month old	First (blanket) planting - 700 tubestock	~3 months 1st planting ~30% survival 1st planting mean ht 31.4cm	2.5 years Total number surviving - 520 1st planting mean ht 121.1cm	3.5 years, 6 months post-fire Total number surviving - 400 Small percentage resprouted indicating low fire intensity; very low	4.years, 2 years post-fire Total number surviving - 350

Species/Recipient Sites	**Method/Start Date**	**No. of Plants Translocated (Transplanted/Propagated)**	**Survival %/Cover-abundance/ No. of plants June/2017**	**Survival %/Cover-abundance/ No. of plants July/2019**	**Survival%/Cover-abundance/ No. of plants Aug/2020**	**Survival%/Cover-abundance/ No. of plants Nov/2021**
					density of seedlings across site, more towards Tabbimoble Ck	
Experiment 1 (effect of soil texture gradient and fertiliser on survival and growth) Tabbimoble Triangle	Exp.1 planted 12/4/2017 when seedlings ~7 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. 4 plants/quarter, 16 plants/plot Total 240 plants in experiment	~3 months Start height 35-45cm T1 – 97.9% wilted T2 – 91.7% wilted T3 – 4.2% wilted T4 – 62.5% wilted T5 – 14.8% wilted T2 all dead Sept/2017	~ 2 years Mean Ht of plants (cm) zeros included (NF-no fert; F – fertiliser) T1 T2 T3 T4 T5 NF 5.7 0 84.4 19.8 79.6 F 0 0 91.8 39.2 59.3 Survival 4% 0% 77.1% 31.3% 58.3% (NF+F)	~ 0.5 years post-fire T1 – no resprouts or seedlings T2 – no resprouts or seedlings T3 – few resprouts & seedlings T4 -- no resprouts or seedlings T5 -- few resprouts & seedlings	~ 2 years post-fire T1 – no resprouts or seedlings T2 – no resprouts or seedlings T3 – few resprouts & seedlings T4 -- no resprouts or seedlings T5 -- few resprouts & seedlings
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 months old	Six plots, each plot divided into quarters, two quarters with seedlings, two with cuttings, half plots with Fert, half No fert. 3 plants/quarter, 12 plants/plot Total 72 plants in experiment	n/a	~1.5 years Seedlings Cuttings NF Ht=155.2cm Ht=116.1cm F Ht=142.4cm Ht=94.5cm Survival 94.5% No sig diff between cuttings vs seedling & fer vs no fert	~0.5 years post-fire A few sdlgs, some resprouts A B C D E F Resp 0 33 41 8 12 0 (%) Seedlings total 3	~2 years post-fire No sdgs, a few resprouts A B C D E F Resp 0 8 0 8 8 0 (%) Seedlings total 0
Experiment 3 (effect of seedling age – two plots on T2 replanted) Tabbimoble Triangle	Exp 3 planted 17/11/2017 with ~12 month old seedlings	Two plots from Experiment 1 (T2-5 and T2-6) replanted with 12 mth old seedlings, 4 plants/quarter, 16 plants/plot Total 32 plants in experiment	n/a	~1.5 years T2-5 mean ht = 141.6 cm T2-6 mean ht = 165.5 cm Survivorship – 100%	~0.5 years post-fire T2-5 & 6 – no resprouts or seedlings Survivorship – 0, no regen.	n/a
Weeping Paperbark (*Melaleuca irbyana*)					Bushfire Nov/2019	
Tabbimoble Offset Land (Sites 1 & 2) Tabbimoble Triangle (Site 3)	Seed collected and sown in Aug/2016, tubestock planted early 2017	Planted at the 3 sites: 1. 600 tubestock 2. 500 tubestock 3. 400 tubestock	6 months 1. S ~80% 2. S ~80% 3 – recently planted	~2.5 years Total number of plants approx. 1300	~3.5 years since introduction, 0.5 year since fire Total number of plants approx. 900	~4.5 years since introduction, 2 years since fire Total number of plants approx. 900
		Fertiliser comparison: No fert – 2 plots of 9 Fert – 1 plot of 18		~3 years No fert mean ht = 121.2 cm Fert mean ht = 211.0 cm	~4 years since introduction, 0.5 years since fire– new plots (2) At fire - 225 cm 0.5 years post-fire – 103 cm	~5 years since introduction, 2 years since fire– new plots (2) When burnt - 225 cm 2 years post-fire – 197 cm
Tall Knotweed (*Persicaria elatior*)						
Translocation No. 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.	% of plots with Tall Knotweed: Oct/16 - 51.9%, Jan/17 - 29.6%, April/17 - 22..2%, June/17 – 0%	~ 3 years 19% of plots with live sdlgs or recently dead mature Tall Knotweed. Total number of plants ~ 37	~ 4 years 51% of plots with TK plants, most mature Total number of plants ~ 25	~ 5 years 7/26 of plots with TK plants, most mature Total number of plants ~ 22
Translocation No. 2 (transplant young plants (0.5-0.7m) Yaegl Nature Reserve	Young plants transplanted Nov/2016	Transplants - 27 clumps/plots 48 plants	% of plots with Tall Knotweed April/17 - 66.7% June/17 – 11.1%	~ 2.5 years No plots with Tall Knotweed – there was some when inspected in March/19	~ 3.5 years 4 plots with TK plants, most mature	~ 4.5 years 2 plots with TK plants, most mature

Species/Recipient Sites	**Method/Start Date**	**No. of Plants Translocated (Transplanted/Propagated)**	**Survival %/Cover-abundance/ No. of plants June/2017**	**Survival %/Cover-abundance/ No. of plants July/2019**	**Survival%/Cover-abundance/ No. of plants Aug/2020**	**Survival%/Cover-abundance/ No. of plants Nov/2021**
Centre-north				Total number of plants = 0	Total number of plants = 9	Total number of plants = 5
Translocation No. 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	~4 months % of plots with Tall Knotweed: April/17 – 100% June/17 – 86.6%	~2 years 33% of plots with live sdlgs or recently dead mature Tall Knotweed. Total number of plants ~ 33 (mainly dead matures)	~3 years 27% of plots with TK plants, most mature Total number of plants ~ 21	~4 years 7/15 of plots with TK plants, most mature Total number of plants ~ 139
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.	~ 0.5 year 85% survived transplanting to pots; 100% survived after planting out. Mean ht – 60.8cm	~ 1.5 years Survivorship - 93% Mean height – 155.9cm Mean width – 146.2cm Total number of plants 14	~ 2.5 years Survivorship - 93% Mean height – 163.7.6cm Total number of plants 14	~ 3.5 years Survivorship - 93% Mean height – 163.7.6cm Total number of plants 14
Stinking Cryptocarya (*Cryptocarya foetida*)						
Lumleys Lane - transplanted	Transplanted Sept-Oct/16	Transplanted – 24 saplings	Jan/17 - 62.5% survived Mar/17 - 26.9% June/17 – 26.9%	~ 3 years Survivorship – 25% Number of plants 6	~ 4 years Survivorship – 25% Total number of plants 6	~ 5 years Survivorship – 25% Total number of plants 6
Coolgardie Rd - propagated	Propagated - seed collected Aug-Sept/16 Planted Feb/18	28 plants in 5 inch pots	n/a	~1.5 yrs Mean Ht – 42.9cm Survivorship – 89.3% Total number of plants 25	~2.5 years Mean Ht – 66.9cm Survivorship – 89.3% Total number of plants 25	~3.5 years Mean Ht – 85.5cm Survivorship – 89.3% Total number of plants 25
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%	~ 3 years Survivorship – 33.3% Total number of plants 1	~ 4 years Survivorship – 33.3% Total number of plants 1	~ 5 years Survivorship – 33.3% Total number of plants 1
Propagated – Coolgardie Rd	Propagated - seed collected Aug-Sept/16 Planted Feb/18	19 plants in 5 inch pots	n/a	~1.5 yrs Mean Ht – 35.6cm Survivorship – 100% Total number of plants 19	~2.5 yrs Mean Ht – 68.5 cm Survivorship – 100% Total number of plants 19	~3.5 yrs Mean Ht –98.0 cm Survivorship – 94.7% Total number of plants 18
Red Lilly Pilly (*Syzygium hodgkinsoniae*)						
Lumleys Lane – propagated seedlings	Transplanted and propagated - juveniles transplanted to pots (6) Oct/16; seed collected	13 propagated plants (supertubes)	n/a	~ 2 years Mean Ht – 59.5cm Survivorship – 92% Total number of plants 12	~ 3 years Mean Ht – 81.3cm Survivorship – 92% Total number of plants 12	~ 4 years Mean Ht – 83.4 cm Survivorship – 85% Total number of plants 10

Species/Recipient Sites	**Method/Start Date**	**No. of Plants Translocated (Transplanted/Propagated)**	**Survival %/Cover-abundance/ No. of plants June/2017**	**Survival %/Cover-abundance/ No. of plants July/2019**	**Survival%/Cover-abundance/ No. of plants Aug/2020**	**Survival%/Cover-abundance/ No. of plants Nov/2021**
	Aug-Sept/16. Planted June/17					
Coolgardie Rd – propagated and transplanted seedlings	Propagated - seed collected Aug-Sept/16.Planted Feb/18	30 propagated plants including transplants (supertubes)	n/a	~ 18 mths Mean Ht – 49.2 cm Survivorship – 46.7% Total number of plants 14	~ 30 mths Mean Ht – 22.2 cm Survivorship – 34% Total number of plants 10	~ 3.5 years Mean Ht – 12.9 cm Survivorship – 17% Total number of plants 5
White Laceflower (*Archidendron hendersonii*)						
Lumleys Lane	Transplanted Oct/16 Saplings directly transplanted	2 saplings transplanted;	~ 1 year 100% survival transplants	~ 3 years Survivorship – 100% Total number of plants 2	~ 4 years Survivorship – 100% Total number of plants 2	~ 5 years Survivorship – 100% Total number of plants 2
Coolgardie Rd	Juveniles transplanted to pots, grown on and planted out	6 potted juveniles (6) introduced Feb/18	n/a	~ 1.5 years Mean Ht – 152.7cm Survivorship – 100% Total number of plants 6	~ 2.5 years Mean Ht – 217.6cm Survivorship – 100% Total number of plants 6	~ 3.5 years Mean Ht – 282.5cm 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	~ 1.5 years Mean Ht – 55.2cm Survivorship – 100% Total number of plants 5	~ 2.5 years Mean Ht – 124.3cm Survivorship – 80% Total number of plants 4 + 3 more planted = 7	~ 3.5 years Mean Ht – 124.3cm Survivorship – 80% Total number of plants 4 + 3 more planted = 7
Square-fruited Ironbark (*Eucalyptus tetrapleura*)						
Sunnyside Rd Offset property, Glenugie	Transplanted Oct/2016	Transplanted – 8	~ 1 year Survivorship – 75% Total number of plants 6	~ 3 years Survivorship – 75% Total number of plants 6	~ 4 years Survivorship – 75% Not all E. tetrapleura Total number of plants 6	800 more tubestock planted in 2021 to meet target in Strategy
Hairy Melichrus (*Melichrus hirsutus*)						
Mahogany Dv Offset property, Pillar Valley	Transplanted Oct/2016	Transplanted – 1 (divided into 2 plants)	~ 1 year Survivorship – 100% Total number of plants 2	~ 3 years Survivorship – 100% Total number of plants 2	~ 4 years Survivorship – 100% Total number of plants 2	~ 5 years Survivorship – 100% Total number of plants 2
Hairy Joint Grass (*Arthraxon hispidus*)						
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	~ 3 years Recently germinated seedlings present	~ 4 years Recently germinated seedlings present	~ 5 years Recently germinated seedlings present
Lumleys Lane, Section 10	Transplanted Nov/2016	Transplanted - 43 trays/plots (~2150 plants)	~ 1 year Survivorship –100% of plots. Total number of plants ~1000	~ 3 years Survivorship –100% of plots, Total number of plants ~2000	~ 4 years Survivorship –100% of plots. Total number of plants ~500	~ 5 years Survivorship –10% of plots. Total number of plants ~50

Species/Recipient Sites	Method/Start Date	No. of Plants Translocated (Transplanted/Propagated)	Survival %/Cover-abundance/ No. of plants June/2017	Survival %/Cover-abundance/ No. of plants July/2019	Survival%/Cover-abundance/ No. of plants Aug/2020	Survival%/Cover-abundance/ No. of plants Nov/2021
Lumleys Lane, Section 10	In situ population managed by annual slashing					~ 5 years Large in situ population present, dense in lowest part of paddock adjoining highway, covering over 1 ha.
Lindernia (*Lindernia alsinoides*)						
Mitchell Rd	Transplanted Dec/2016	Transplanted - 5 plots containing 30 sods	~6 months April/17 – 50% of sods June/17 – 0%	~2.5 years Survivorship – ? Need to monitor in summer	3.5 years No plants seen (better to monitor in summer when flowering)	4.5 years No plants seen (better to monitor in summer when flowering)
Rotala (*Rotala semipatita*)					Bushfire Nov/2019	
Tabbimoble Offset land	Transplanted to pots Sept/2017. Pots planted out in Feb/18	About 10 plants salvaged and propagated by division, 50 plants introduced	n/a	~1.5 years Survivorship – 37.8% Total number of plants 17	~2.5 yeas Survivorship – 30% Total number of plants 15	~3.5 years Survivorship – 40% Total number of plants 20
Richmond Birdwing Vine (*Aristolochia pravevenosa*)						
Coolgardie Rd	Propagated - cuttings collected Oct, Nov/2016, Planted Oct/2017	Propagated - 11 in 6 inch pots	100%	~ 2 years Mean Ht – 89.6cm Survivorship – 100% Total number of plants 11	~ 3 years Mean Ht – 88.5cm Survivorship – 91% Total number of plants 10	~ 4 years Mean Ht – 110.8cm Survivorship – 100 % Total number of plants 1q
Pink Underwing Moth Vine (*Carronia multisepala*)						
Coolgardie Rd	Propagated - cuttings collected in June/2017; Planted June/18	6 planted out June/18	n/a	~ 1 years Mean Ht – 8.3cm Survivorship – 83.3% Total number of plants 5	~ 2 years Mean Ht – 10 cm Survivorship – 40% Total number of plants 2	~ 3 years Mean Ht – 10 cm Survivorship – 40% Total number of plants 2

Table 9: Results of threatened flora translocations on W2B Sections 1-2 & EWSSTA after five years (2015-2020)

Species	Recipient Site	Methods/Start Date	No. of plants translocated	Spring 2016	Autumn 2017	July 2019	Aug 2020
SECTION 1							
Lindernia	1. Yuraygir SCA	Slabs/clumps (15/8/15)	22 clumps/plants	3 clumps/plants	no plants observed	~ 4 years Survivorship – 0 Total no plants – 0	~ 5 years Survivorship – 0 Total no plants – 0
	2. Halfway Creek crossing	Soil slabs stored (31/8/15)	8 slabs	no plants observed (1 yr)	no plants observed (1.5 yr)	~ 4 years Survivorship – 0 Total no plants – 0	~ 5 years Survivorship – 0 Total no plants – 0
	2. Halfway Creek crossing	Nursery plants		n/a, not yet planted out	~ 500 plants newly planted	~ 2 years Survivorship – 1%	~ 5 years Survivorship – 0

						Total no plants – 6	Total no plants – 0
	3. Kangaroo Trail	Nursery plants 28/1/16	350	1 (6 mths)	no plants observed (1 yr)	~ 4 years Survivorship – 0 Total no plants – 0	~ 5 years Survivorship – 0 Total no plants – 0
	3. Kangaroo Trail	Nursery plants 30/5/17	428		428 plants newly planted (30/5/17) 1-50 monitored	~ 2 years Survivorship – 0% Total no plants – 0	~ 5 years Survivorship – 0 Total no plants – 0
Slender screw-fern	3. Kangaroo Trail	Slabs (10/9/2015) and nursery plants (2016-17)	45 slabs	10 (1 yr)	4 (1.5yr) (+17 grown-on in nursery and planted May/17) = 21	~ 2 or 4 years Survivorship – 15.8% Total no plants – 9 Total no of tags - 57	~ 2 or 4 years Survivorship – 14% Total no plants – 8 Total no of tags - 57
Hairy joint-grass	3. Kangaroo Trail	Slabs - stored soil (10/9/2015)	8 slabs	no plants observed	no plants observed	~ 4 years Survivorship – 0 Total no plants – 0	~ 5 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	~ 4 years Survivorship – 0 Total no plants – 0	~ 5 years Survivorship – 0 Total no plants – 0
Moonee Quassia	(Dirty Creek road reserve)	Nursery cuttings	Zero – failed to strike				
SECTION 2					A		
Lepidosperma "Coaldale"	4. Mahogany Drive	Nursery, plants		35 planted out	20 (didn't look under ferns?)	~ 3 years Survivorship – 31.4% Total no plants – 11	~ 5 years Survivorship – 0 Total no plants – 0
Square-fruited ironbark	5. Pillar Valley	Nursery, seed		80 plants in nursery	79 planted	~ 2 year Survivorship – 92% Total no plants – 71	~ 3 year Survivorship – 90% (900 tubestock to be planted Oct/20)
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	1 + 4 seedlings observed but did not establish.	All plants died back, including controls Occasional seedlings (cotyledon stage) present.	~ 4 years Survivorship – 0 Total no plants – 0	~ 5 years One clump of healthy, mature plants 20m north of tagged points
Green-leaved rose-walnut	Adjacent to Maclean Interchange	Single small tree, root-pruned in prep for translocation		Translocation not required, to be protected in situ.		Translocation now required as the in situ tree died. Seed collection and propagation underway.	No suckers or recruitment at site of dead in situ tree. Propagated plants (10) to be introduced in Dec 2020. Note – this species is monitored and reported on separately
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	Not observed, biomass high	Not observed (biomass under management)	~ 4 years	~ 5 years

						Total no plants – 0, but monitored in winter when only very small seedlings active	Total no plants – 0, but monitored in winter when only very small seedlings active
	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.)	~ 4 years Total no plants – 0, but monitored in winter when only very small seedlings active	~ 5 years Total no plants – 0, but monitored in winter when only very small seedlings active

3.3 Slender Screw Fern (*Lindsaea incisa*)

3.3.1 Translocation Method – Sections 3-11

There were two translocations of Slender Screw Fern (*L. incisa*) on Sections 3-11: - plants identified in the Strategy translocated in 2016, and unexpected finds translocated in 2017.

First translocation 2016

In the first translocation 127 trays (40 cm x 40 cm) of *L. incisa* were transplanted to the recipient site in Bundjalung National Park in September 2016 (i.e. Area 1 - Table 8). Sods containing fronds and rhizomes were dug out to a depth of 6-8 cm, placed in trays, watered and transported to the recipient site about 0.5 km away. These were planted in plots the size of the tray about 2 m apart in five lines, the lines at slightly different elevation, at the base of a slight hill slope (~1 degree). The aim was to record how microtopography affected survival and growth. As well as the single tray plots, the sods were planted in larger plots/patches of four trays (ie approx. 80 cm x 80 cm square).

Plots and patches were watered to keep soil moist and no fertilisers were applied. The plastic trays with a wide grid base were inverted to protect *L. incisa* from possible animal grazing and digging, and to define the plots for monitoring. They also caught falling leaves and bark which were removed to prevent shading/smothering *L. incisa*. Additional watering was carried out during drought periods in 2016 and 2017.

Second translocation 2017 (unexpected finds) Area 1 and 2

The second translocation of Slender Screw Fern was carried out one year later in September 2017, to the same recipient site in Bundjalung National Park. About half the plants were planted in two lines of one-tray plots on the opposite side of the flat-bottomed valley to the first batch, 50 m to south (Area 2). The other half were planted in patches (i.e. 4 trays to a patch), 16 in Area 1 and 7 in Area 2 (see Table 8). A total of 59 tray-sized plots and 23 patches were transplanted. Planting sites in Area 1 and 2 were positioned above the level of flash floods that occurred in autumn 2017. Habitat in Area 2 was similar to Area 1, but there were differences in soil type and understorey. The soil consisted of a pale grey (higher content of fine sand) clay loam rather than dark brown, humic clay loam in Area 1, and the understory was dominated by Common Tea Tree (*Leptospermum polygalifolium*).

3.3.2 Results

Over the first three years, *L. incisa* crown cover fluctuated with flood and drought events, but the salvaged plants recovered from these disturbance events and overall established successfully at the recipient the site in Bundalung NP. At the July/19 monitoring (before the Nov/19 bushfire), *L. incisa* had recovered from frond die-off during drought at the start of 2019 (see Fig 4). Crown cover was 25% - 35% in most plots and patches in Areas 1 and 2. After the bushfire, monitoring in Aug 2020 recorded a substantial contraction of the translocated population, almost certainly due to mortality caused by drought and/or bushfire in the latter half of 2019 (note - monitoring was conducted once a year in winter-spring).

Effect of the Nov/2019 bushfire

After the fire *L. incisa* regenerated by resprouting from rhizomes in 32% of the plots/patches, as indicated by 60 regenerating, discrete clumps/patches of Lindsaea out of an original 189 plots or patches. Overall there was a decrease in crown cover and contraction of distribution

across the recipient site. In Area 1 *L. incisa* contracted to the eastern part of site (eastern end of transects B and C). Patches (part of the second translocation) which were adjacent to and at the same micro-elevation as transect C regenerated well, but plots (first translocation) declined markedly on transect A (the lowest transect), the western half of Transect B and all of Transect D. Declines were either in the western part of the site or at a lower elevation. In Area 2, the patches have almost disappeared, but the plots have recovered fairly well. In Aug/20, mean crown cover was down from 35% before the fire to 3.4% (all plots including zeros) in Area 1. Mean crown cover increased to 5.8% in 2021.

A similar increase in crown cover to Area 1 was recorded in Area 2 in 2021. In Area 2, Line A crown cover was higher than it was before the fire, indicating fire in this microhabitat (parameters unknown) stimulated expansion of *L. incisa.* Crown cover on all other Lines in Area 2 (and Area 1) in 2021 was less than before the fire, but not greatly so on some Lines including Translocation 1- Area 1 - Line B and Translocation 2-Area 1-patches. Overall, the second translocation responded better to fire. As Lines were performing better in Area 1 compared to Area 2 before the fire, but are now performing poorer, performance is not correlated with time since introduction. Subtle and complex variation in microhabitat appears to be the operative factor.

Bushfire appears to have culled fern plants from habitat where they were able to establish in the short-term in absence of bushfire. The fire was of medium to high intensity, burning the canopy as well as the ground layer. The micro-habitat factors involved and why plants survived at some points within the site and not others are unclear. Whether a similar response to fire, with some sections of a population contracting and other recovering, would have occurred in a natural or untranslocated population is unclear, as no reference or control sites were included in the Translocation Strategy.

In previous years the translocated population recovered from flood and drought dieback by reshooting from rhizomes. The population contraction after the bushfire indicates that rhizomes were killed by the fire or drought preceding the fire. It is unlikely fern regeneration was suppressed by the dense ground layer regrowth after fire, as this was also present at places where the fern has regenerated. The rhizomes of *L. incisa* are horizontal, thin (one or a few mm in diameter) and usually close to the surface, but clearly have some fire resistance.

In Area 1 prior to the fire, mean cover-abundance was highest on Line C and less on the other lines (see Fig 5; Table 8), suggesting that factors associated with micro-elevation affect *L. incisa* growth and survival. Of the four lines in Area 1, Line A was lowest in elevation and Line D the highest. Small differences in elevation may be related to gradients of soil moisture or species composition/competition. Similar sensitivity to micro-elevation was recorded during the translocation of *L. incisa* on the Sapphire to Woolgoolga Project (Ecos Environmental 2011b).

Overall, the bushfire substantially reduced extent of the translocated population but a healthy population still survives in a reduced area.

Monitoring post-fire (Year 4 – July 2020)

As plot markers were burnt and we were unable to determine the exact location of many plots and patches, clumps of regenerated *L. incisa* were re-tagged and re-numbered in Aug/20 for on-going monitoring. In Area 1, 38 discrete clumps of Slender Screw Fern with a mean percentage crown cover of 12.8% (i.e. clump area/plot area x 100) were marked and given a new number for monitoring. In area 2, 21 discrete clumps of Slender Screw Fern with a mean percentage crown cover of 6.1% were tagged and numbered. There were also other tagged but unnumbered clumps (not monitored). The renumbered clumps were

equated approximately with the lines and patches recorded the previous year (pre-fire) for purposes of extending the graphs below (see Figs 5 & 6).

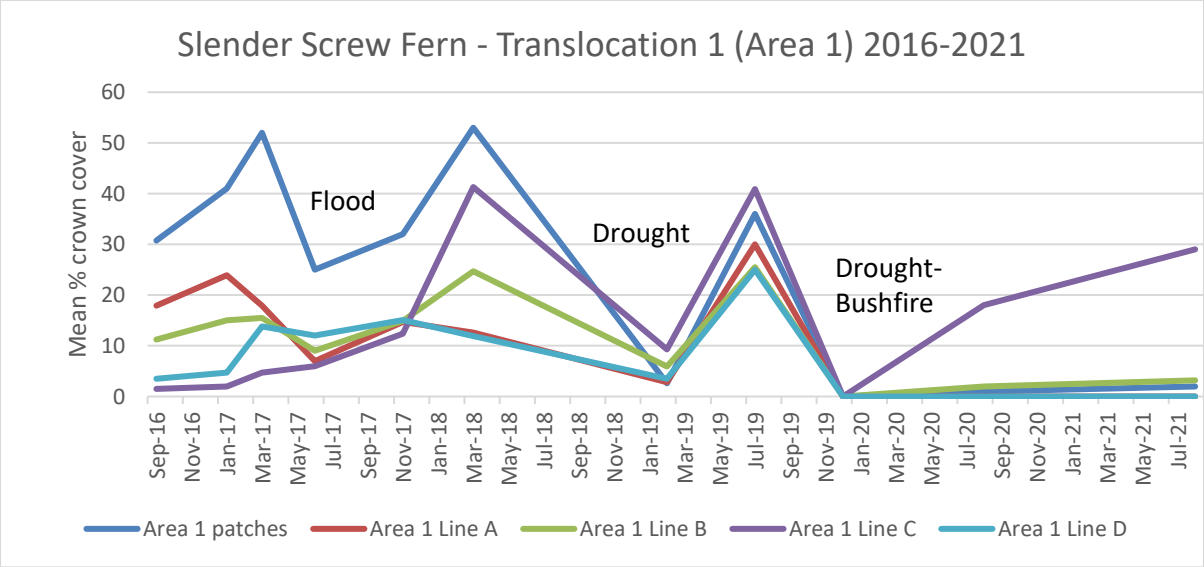

Figure 5: Slender Screw Fern - Translocation 1, Area 1, 2016-2021. Dips or declines in crown-cover relate to environmental disturbance events, the first (on the left) to flash flooding and prolonged inundation, the second to unseasonal drought and the most recent to drought and bushfire. After this event, Slender Screw Fern recovered to near pre-disturbance abundance only on Line C. (Note that monitoring was only carried out frequently enough to pick up some of the drought and flood events in Figure 4.)

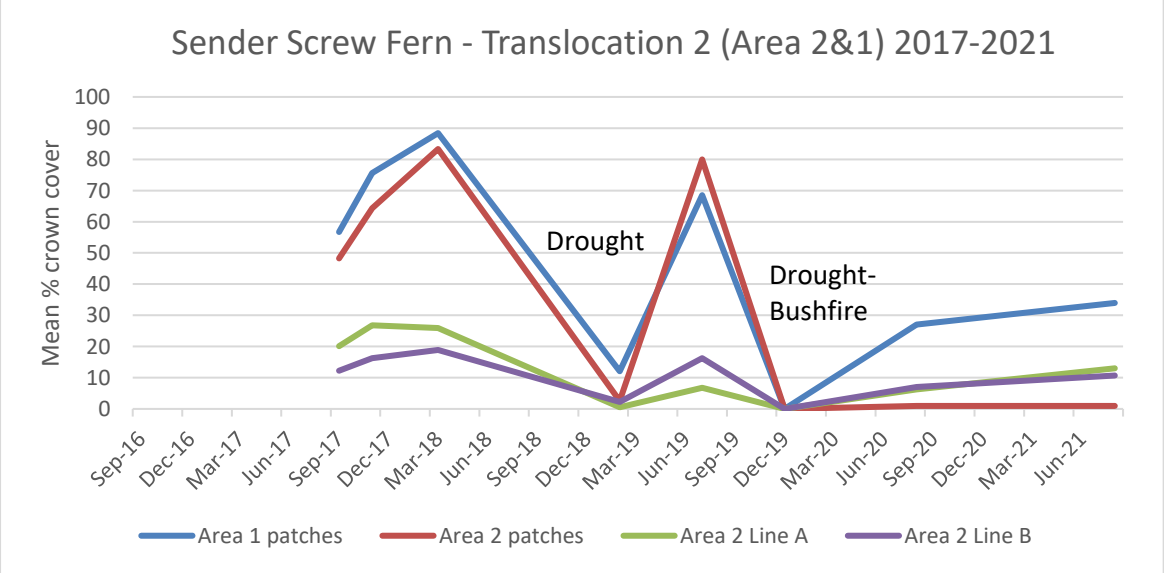

Figure 6: Slender Screw Fern - Translocation 2, Area 2 & 1, 2017-2021. Declines in crown-cover relate to drought (left hand side), also seen in the graph above and most recently, to drought and bushfire (see also with Fig 5). Overall, post-fire recovery of Slender Screw Fern was better on Translocation 2, particularly Area 1 patches that happen to be in the same part of Area 1 as Line C (Figure 5) which also performed well. This is probably due to favourable micro-habitat parameters including soil moisture and water table dynamics.

3.2.3 Results of Slender Screw Fern on Section 1-2 & EWSSTA

Monitoring of Slender Screw Fern on Sections 1-2 finished in 2020 after 5 years (initial translocation was carried out a year earlier in 2015). Monitoring by Ecos Environmental over the last three years recorded that out of 57 tagged points present at the site, 35.1% had surviving plants in 2018, 15.8% in 2019 and 9.3 % in 2020. These results omit plants that had died previously, so survival rates were at least half those given. Surviving plants in 2020 were healthy and there was some lateral expansion of clumps but as the figures show, the translocated population at Kangaroo Trail Rd was in decline. The main threats were drought and smothering by the exotic grass Broad-leaved Paspalum (*Paspalum mandiocanum*).

3.4 Yellow-flowered Oberonia (*Oberonia complanata*)

3.4.1 Translocation Method

The 18 plants identified in the Strategy were salvaged from the donor site on the Woodburn-Evans Head Rd during early works in 2015 and sent to a nursery for growing-on, but all apparently died.

A further 11 plants were translocated from the same donor site by Ecos Environmental in August 2016. These plants were growing on a dead casuarina tree about to fall over. As the orchid plants were unlikely to survive on the ground, 11 clumps of orchid were salvaged from the tree and relocated to a recipient site near Evans Head, in Bundjalung National Park.

Rather than prising the orchid and roots away from the tree as described in the Strategy, a handsaw and chisel were used to remove sections of dead bark on which the orchid was growing so there was minimal disturbance of its roots. The pieces of bark supporting whole orchid plants were attached to suitable trees at the recipient site with cloth ribbon or wire.

A second translocation of this species was carried out after an unexpected find of additional plants was made during a pre-clearing survey south of Lumleys Lane (Section 10) in 2017. Twelve small sections of branch with clusters of the orchid were removed from a *Melaleuca linariifolia* tree to adjoining swamp sclerophyll forest about 30 metres away and attached to the branches of paperbarks in August 2017.

3.4.2 Results

One of the 11 plants translocated in 2016 died after relocation to the recipient site due to moss placed for water retention that instead caused the orchids to rot. The other ten orchid clumps (without moss) were all looking healthy in Aug/2021, after 5 years. Some had dried racemes of seed pods.

Plants in the second translocation grew well and flowered during the first two years, but in 2020 all the orchid plants had disappeared and appear to have been stolen by orchid collectors, even though this species does not have colourful flowers. A few juvenile orchid plants were noted on trees nearby and may have recruited from seed produced by the translocated plants.

3.5 Singleton Mint Bush (*Prostanthera cineolifera*)

3.5.1 Translocation Methods

Soil Seedbank Propagation

Topsoil was collected to a depth of 1-3 cm from under SMB on the highway footprint at Tabbimoble Creek and divided into three lots. Two were spread on sheets of tin to a depth of 6-8 cm and covered with dry eucalypt leaves and twigs of different amounts and ignited to simulate bushfire of different intensity. Three treatments were applied: a 10 cm thick layer of litter for higher fire intensity, 5 cm for lower fire intensity and no litter (or fire). The cooled soil was placed in plastic trays and placed under sprinklers in a shade house. Twenty trays of each treatment were prepared. Singleton Mint Bush seedlings were identified after 3-4 weeks and at 12 weeks, 10 trays from each treatment were selected at random and counts made of SMB seedlings and those of other species. SMB seedlings were potted-up and grown in standard, sterilised nursery soil mix for natives.

Recipient Site

The recipient site was selected in the Strategy and consisted of a block owned by TfNSW on the eastern side of the highway at Tabbimoble Creek referred to as the 'Tabbimoble Triangle'. An area about 100 metres square fronting onto Tabbimoble Creek was used as the recipient site. This site is on the coastal floodplain 3 km north of the Clarence River and supports grassy, layered, dry sclerophyll forest dominated by Swamp Box (*Lophostemon suaveolens*), White Stringybark (*E. eugenoides*), Blackbutt (*E. pilularis*) and Pink Bloodwood (*Corymbia intermedia*) with a mid-stratum of small trees, mainly *Acacia* and *Melaleuca* spp. and a diverse ground layer of grasses, herbs, and sedges. The site was fenced to exclude macropod grazing.

Planting Trials

Initial site-wide planting - 6 month old tubestock

Approximately 700 tubestock were planted across the recipient site at an average spacing of one per 4 m2 in March 2017 and natural selection left to indicate parts of the site best suited to the species. The seedlings were 6 months old and 35-45 cm high. An inspection three weeks later, after heavy rain and flash flooding, found that nearly all tubestock in the northern two-thirds of the site further away from the creek were dead or dying from a wilt disease, whereas plants in the southern one third, closer to the creek, were still healthy. Soil ribbon tests indicated that soil texture varied within the recipient site, with increasing sand closer to Tabbimoble Creek and heavy clay further away. To examine the effect of soil texture more closely, and to discount possible effects due to flash flooding and application of herbicide during site preparation, experimental trials were designed to examine survival and growth in relation to the local soil texture gradient and horticultural factors, as follows:

Experiment 1 - effect of soil texture

To examine the effect of soil texture on species performance, five transects (T1-T5) were positioned at increasing distance from Tabbimoble Creek and in a small gully running into the creek. Transects ran at right angles to the putative soil texture gradient so soil texture on each transect would be roughly the same. Three 2 m x 2 m plots were placed on each transect 10-20 m apart. The plots were divided into quarters and each quarter planted with four tubestock (16 plants per plot). Experiment 1 was planted 3 weeks after the initial planting, on 12/4/2017,

so seedlings were only a month older. Soil samples were collected from each plot and soil chemistry and particle size analysed by EAL at Southern Cross University, Lismore.

Experiment 2 - effect of propagation type (seedlings vs cuttings) and fertiliser

The second experiment was carried out to examine if plants propagated from cuttings from established in situ plants would perform any better than plants propagated from the soil seedbank. The effect of fertiliser was also included in this experiment by planting half with 12-month slow-release fertiliser and half without. A small quantity of cuttings had been propagated during early works for the highway from a few young plants that grew where soil had been disturbed by geotechnical investigations. These were potted into larger tubes and grown on. The seedlings were 12 months old and the cuttings 18 months old when planted. The experiment was situated on sandier soil closer to Tabbimoble Creek and planted 17/11/2017.

Experiment 3 - effect of tubestock age

Nearly all of the 6 month old seedlings died on transects further from Tabbimoble Ck where the soil sand content appeared to be low. To test whether older seedlings would perform any better, 12 month old seedlings were planted in two of the three plots on T2 where all 6 month old seedlings had died. The same planting layout was used with 16 tubestock per plot and planted 17/11/2017.

Fire Response – translocation site vs reference area

The fire response of SMB after the Nov/2019 wildfire was compared in the recipient site and the reference area next to Tabbimoble Creek on the western side of the highway, where most of the SMB population is located. Fire intensity was low in the recipient site and moderate in the reference area, as indicated by flame scorch height (2-4 metres vs 6-10 metres). The fire response of SMB in the experimental plots (n = 23) was recorded in terms of mode of regeneration, seedling density, height and resprouter density, and the same observations made in surrounding parts of the recipient site. Four plots were established in the reference area and the same data recorded. Data were recorded, 6 months and 2 years after fire.

Soil Analysis

To examine relationship between SMB performance and soil physical and chemical properties variation in soil texture and chemistry, soil samples were collected at the experimental plot and other points around the recipient site, and from the reference area on the western side of the highway. Soil was collected to a depth of 8 cm at each plot then bulked for each Line. Separate samples were taken from Line C as this ran parallel rather than at right angles to the putative soil gradient. Four samples were taken from plots in the reference area making a total of thirteen samples, which were analysed for major nutrients and percentage sand, silt and clay at Environmental Analysis Laboratory, Southern Cross University, Lismore.

3 Results

Propagation - soil seedbank treatments

The soil seedbank-and-fire method of propagating this obligate seeder species was shown to be simple to apply, cost-effective and fast. Comparison of the different treatments showed that seedling density and number of species germinating from the seedbank were much higher in

the high fire intensity treatment, significantly less with low fire intensity and very low in the no burn treatment. No SMB seedlings germinated in the no burn treatment, very few in the low intensity treatment and many in the high intensity treatment.

First planting of Singleton Mint Bush

Seedlings planted closer to Tabbimoble Ck survived but nearly all further away died from a wilt disease, possibly caused by *Phytophthora*, a microscopic water mould that infects root hairs, preventing water uptake. The mean height of plants that survived the wilt disease was 31.3 cm in November 2017, 91.4 cm in July 2018 and 121.1 cm in July 2019. Survivorship of these was 84.3% after 3 years. The tallest plant in July 2019 before the fire was 268 cm. Some flowering occurred in spring 2019 but seed may not have been fully mature when the fire occurred in Nov/2019.

Experiment 1 - effect of soil texture

Two months after planting, Transects 1 & 2 furthest from the creek at the northern end of the site showed the same wilt symptoms as the first planting. Most plants were healthy on Transect 5, closest to the creek and Transect 3, the side gully. On Transect 4 in an intermediate position, half the plants were healthy and half were wilting. Survivorship varied from 0% to 77.1% depending on the position of transects relative to the soil texture gradient. Survivorship increased toward the creek as the topsoil became sandier (Figure 7). Soil analysis confirmed a gradient in soil texture with sand content increasing towards Tabbimoble Creek (see Figure 8).

Experiment 2 – effect of tubestock age

In Experiment 2, two plots on Transect 2 from Experiment 1 where all the 6-month old tubestock had died were replanted with 12-month old tubestock. Surprisingly, none of the 12-month old seedlings succumbed to the wilt disease, and survival remained at 100% after 2 years, directly before the fire (see Figure 7). This result implies that the age of tubestock at introduction also has a major effect on survival.

See 2020 and previous reports for further description of these experiments.

Response to bushfire in translocation area and reference site

As typical of obligate seeders, all SMB plants in the reference area where fire intensity was moderate were killed by fire and regeneration was only from seed. The dead frames of SMB showed all plants were old and senescent as observed before the fire. Seedling density of SMB in the reference site was high. In the translocation area where fire intensity was low, not all plants were killed by fire, and seedling density was much lower. Approximately 11% of plants were defoliated then resprouted from stems and branches. Although generally killed by fire, obligate seeders can show some resprouting after low intensity fire when they resprout from stem and branches rather than below ground. Seedlings were only recorded near the eastern margin of the recipient site in a few plots in Experiment 1 and 3, close to Tabbimoble Creek. SMB plants were approximately 2.5 years old when burnt by the fire. Flowering occurred in years 2 and 3. Overall, regeneration was poor in the translocated population, but vigorous in the naturally occurring population.

Table 10: Fire response of SMB combining data from plots on each experiment transect and in the reference area, showing percentage resprouted plants and number of seedlings per m2 in 2020 and 2021. N = total number of plants.

	2020		**2021**	
	Resprouting	**Seedlings (no./m2)**	**Resprouting**	**Seedlings (no./m2)**
Experiment 1 (n=240)				
Transect 1	0	0	0	0
Transect 2	0	0	0	0
Transect 3	0	0.9	0	0
Transect 4	0	0	0	0
Transect 5	0	0	0	0
Experiment 2 (n=32)				
Transect 2a	0	0	0	0
Experiment 3 (n=72)				
	16.6%	0.6	4.6%	0.3
Reference Site				
	0	42.2	0	25.5

From 344 plants introduced in the experiment plots and survivorship over 80% in mid 2019, before the bushfire, numbers plummeted to less than 20 in 2020 and less than 10 in 2021 (only 3% survivorship since introduction in 2017). Additional introduced plants survived and resprouted after the fire outside the experiment plots, but overall, post-fire, more than 95% of SMB plants were derived from the existing, pre-translocation SMB population (i.e. extant plants and soil seedbank), and < 5% were of translocated origin. This was partly due to introduced plants not reaching reproductive maturity and setting seed before the fire (they were 2.5 years old), but also because much of the site is unsuitable habitat for SMB due to heavy soil texture which produces wilt disease in seedlings of this species. Very low numbers of seedlings were recorded post-fire in the experimental plots where SMB had been planted, whereas high densities of seedlings were present in the reference area (Table 10).

Table 11: Estimated numbers of SMB in the recipient site between 2016-2021 as contributed by translocation and the (pre-translocation) in situ population. Resp. = resprouting; I and T indicate whether of In-situ or Translocated origin. (To explain as an example, in 2020 (6 mths post fire), approx. 30 of the original in situ population survived fire by resprouting and about 500 seedlings germinated from the soil seedbank probably from the in-situ population (as gauged by numbers in experiment plots). Of the introduced (translocated) plants, about 50 of the first site-wide planting and 12 in the experiment plots survived fire by resprouting and there was very small amount of seedling recruitment.)

	Original in-situ plants (pre-translocation)	Introduced: Site-wide planting	Introduced: Experiments 1-3	Post-Fire Seedling Recruitment – in situ origin	Post-Fire Seedling Recruitment – translocated origin	Total Site Population
	I	T	T	I	T	
2016	80					80
2017	100	700	344			1144
2018	100	200	180			480
2019	80	150	173			403
2020 – 6 mths post-fire	30 (resp.)	50 (resp.)	12 (resp.)	500	30	622
2021 – 2 yrs post-fire	30 (resp.)	40 (resp.)	3 (resp.)	280	0	353
2021 – 2 yrs %	8.4%	11.3%	0.9%	79.3%)	0	353

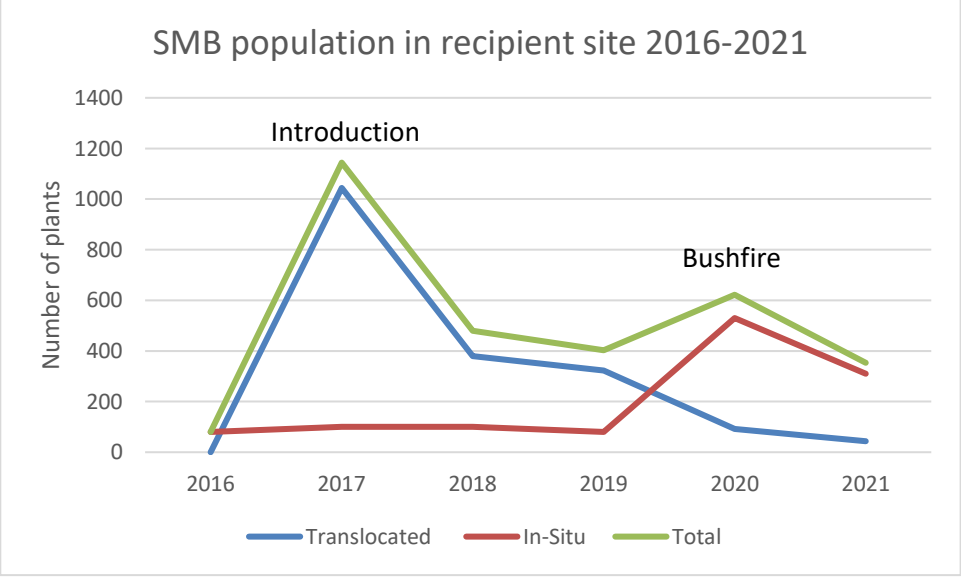

Figure 7: SMB population in the recipient site between 2016-2021 indicating numbers originating from translocation and the in situ population. The aim of this translocation was to augment and extend the original population. As the graph indicates, only minor augmentation was achieved by 2021. The graph does not include an additional 100 plants introduced to the part of the site most suited to SMB in 2021.

Soil Analysis

Results of soil particle size analysis were consistent with the interpretation of a soil texture gradient across the site, at right angles to Tabbimoble Creek, probably the main source of sand in the soil. Analysis showed a clear gradient from sandy clay on the banks of the creek, to loam and then clay loam further from the creek. Soil chemical analysis showed subtle differences in soil nutrient levels consistent with the changes in soil texture. T1 & T2 (further from the creek, higher clay content) had higher CEC, Mg, K and Na, Total Carbon% and Total Nitrogen%, but not Ca, than T 4 & 5 closer to the creek (Table 12). P content was the same and pH slightly more acid in T 4 & 5, predictable from higher sand content. C:N ratio was also higher in T 4 & 5, as reflected by a slightly more sclerophyll flora composition on the creek levee, including presence of SMB.

Table 12: Results of soil chemical and particle size analysis of samples taken from experimental plots, elsewhere in the site and reference plots. Transects 1 & 2 were far from the creek; Lines 4 & 5 were close to the creek.

Mean values	**Transects 1 & 2** (far from ck)	**Transects 4 & 5** (close to creek)	**Reference plots**
CEC (cmol./kg)	8.4	6.0	4.0
% Ca	41.7	63.9	37.2
% Mg	49.8	32.1	52.8
% K	6.6	3.0	7.2
% Na	1.9	0.9	2.8
Total C %	4.5	0.7	3.1
Total N %	0.3	0.1	0.2
C:N ratio	15.3	26.1	20.9
P	2.7	2.8	2.9
pH	5.4	5.8	5.3

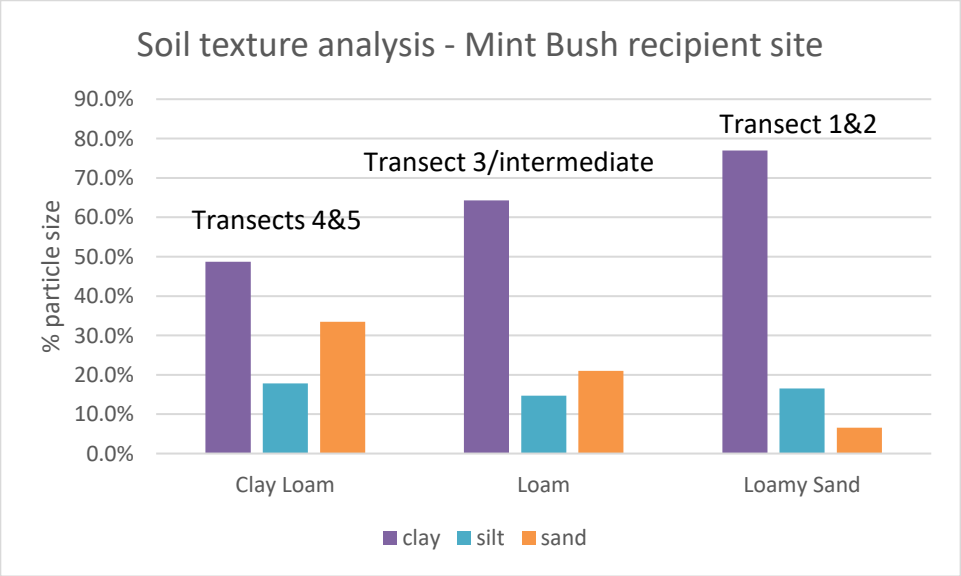

Figure 8: Soil textural classification at the Singleton Mint Bush recipient site as determined by EAL, consisted of clay loam over most of the site, grading into loam and loamy sand close to the main creek and along small tributary gullies, confirming initial observations.

Wilt Disease

SMB plants have been affected by an apparent disease during translocation that causes foliage and growing tips to wilt (see Plate 24), and death of young seedlings. These symptoms were common in seedlings introduced in autumn 2017, then again after floods in summer 2021/2022, but this time in older plants, up to 2 m high. Some 50-75% of SMB plants in the recipient site were affected in March/2022, and only a small number in the reference area (<5 %). The condition was defoliating rather than killing older plants, as stems were still green and likely to resprout.

The wilt symptoms occurred in the wet season during periods of high rainfall and soil saturation, so are different from wilting caused by drought, which is common in SMB in the dry season. The leaves of SMB are soft and wilt easily during hot, dry weather, plants often defoliating to conserve moisture. The wet season wilt symptoms may be caused by *Phytophthora*, a microscopic water mould that infects via root hairs. *P. cinnamomi* is reported to be indigenous to wet forests of the North Coast of NSW but is rarely associated with disease in natural vegetation of the region, unlike southern Australia (Pratt and Heather 1973; Weste 1994).

Summary

In summary, translocation efforts augmented the SMB population by about 12% after 4.5 years (Table 11), a minor increase, which was partly due to the fire occurring before translocated plants had produced seed in any significant amount. The seedlings were 2.5 years old in Nov/19 and seed produced by flowering in September may not have ripened fully or been incorporated into the topsoil. It appears that only the southern end of the site closest to Tabbimoble Creek with sandier soil was suitable habitat for SMB, which limited any potential to significantly increase the population size. The translocation was not successful in increasing population size, but significantly advanced understanding of this species' ecology.

3.6 Weeping Paperbark (*Melaleuca irbyana*)

3.6.1 Translocation Method

Seed capsules were collected from a cross-section of trees in the New Italy donor population in August 2016 (see Table 8). After germination, seedlings were grown in native tubes in a standard, pine-bark based, sterilised soil mix for natives and dilute Seasol liquid fertiliser applied. Tubestock were 6-months old, 35-45 cm high and well hardened-off when planted. From seed collection to planting out took 8 months to complete.

Weeping Paperbark was introduced to three recipient sites: two on TfNSW offset land south of Tabbimoble Creek and the northern end of 'Tabbimoble Triangle' on the other side of Tabbimoble Creek, also RMS property. At the offset site in grassy, open woodland dominated by Forest Red Gum, Swamp Oak, Paperbark and Swamp Box, two planting areas were marked out in open sections where trees had been cleared. These were fenced to exclude domestic and native grazing animals. Both areas are on a floodplain with heavy clay soil, typical of Weeping Paperbark habitat. The areas were open with few trees allowing for better tubestock establishment, although sapling regrowth needed control during the establishment period.

Tubestock were planted on the offset land south of Tabbimoble Ck in March/2017 and in the Tabbimoble Triangle in July/2017. All tubestock were planted with 12 month slow release fertiliser. To assess how fertiliser affected performance, two plots of plants received no fertiliser. Tubestock in the Tabbimoble Triangle were planted without fertiliser. Tubestock were planted in the northern part of the Tabbimoble Triangle in April 2018.

3.6.2 Survival and Growth

Mean plant height tripled between 2017 and 2019. Addition of 12 months slow release fertiliser resulted in a doubling of mean plant height, to 211.0 cm in 2019 before the fire. Fertiliser was the standard treatment applied to plants following the first results of the fertiliser trial.

Mean height of seedlings (cm) over three years:

	no Fert	Fert
Mar-2017	31.4	42.3
Apr-2018	68.9	109.3
Jul-2019	108.9	211.0

Bush fire Nov 2019

Recipient sites at the Tabbimoble Ck offset land (Sites 1 & 2) and Tabbimoble Triangle (Site 3) were burnt in the Nov 2019. Translocated plants on the offset land were approximately 3 years old and most plants 1.5 – 2 m high. Fire intensity at Tabbimoble Triangle was low and medium to high at the offset land. Above ground stems were killed by the fire and nearly all plants regenerated by coppicing from roots near from the stem base. Six months post-fire, the plants were about half their pre-fire height and after 1.5 years only slightly less than height before fire – see table below. No flowering has been recorded yet.

Height (M)	2019 6 months pre-fire	2020 Approx. 6 months post-fire	2021 Approx. 1.5 years post-fire
Plot 1	2.3	1.0	2.1
Plot 2	2.5	1.1	1.9

In November 2021, the total translocated population of M. irbyana was approx. 700 and plants over the three sites covered a similar total area to the rescue site, approximately 2 ha.

3.7 Tall Knotweed (*Persicaria elatior*)

3.7.1 Background

All Tall Knotweed were translocated from the same, swampy area next to the Maclean south turnoff to Yaegl Nature Reserve, 0.5 km to the north, to sites on the north western boundary of the reserve next to the highway: Yaegl South in 2015 and Yaegl North in 2016 -17. The Yaegl South translocation was carried out during Early Works and the results are described in Landmark Ecological Services 2016 and 2017. Results of the second round of translocation are reported in Ecos Environmental 2017, 2018 and 2019, and this report (2020). In effect there were at least four translocations, one (or two) implemented in 2015 and three in 2016-7.

3.7.2 Early Works – Yaegl South (2015)

Plants were translocated to the Yaegl South site in Sept and Nov/2015. The habitat consisted of paperbark swamp forest with a sparse ground cover of grass and sedge. Tall Knotweed plants were relocated by direct transplanting. Fifty five plants were planted at separate, labelled points about 10-20 metres inside the edge of the swamp forest. From the stem thickness of dead plants observed in Aug/2016 they were about one metre high when transplanted and were pruned at introduction. Some flowered and seeded at the planting points.

In Autumn 2016 three were alive and seedlings were observed at the tagged points in Spring 2016, but due to the dry spring-early summer in 2016 (Fig 4) the seedlings died off. The relatively high density of paperbark (*Melaleuca quinquenervia*) and sparse herbaceous ground layer may not have been conducive to Tall Knotweed establishment, but performance of this species is difficult to predict. No Tall Knotweed plants were recorded at the Yaegl South in April 2018, approx. three years after translocation.

In Aug/2020, one patch of vigorous Tall Knotweed plants about 1.5 m wide was observed about 20 m north of the tagged points, within the Paperbark forest. The site was wet and boggy, but otherwise there was nothing in particular to suggest why this small patch of plants was thriving at this particular point, or where the seed had come from.

3.7.3 Main Construction Phase – Yaegl North (plants salvaged Aug 2016 – 17)

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 att nursery until mature, introduced (Feb/17)	300 tubestock, mature plants in flower/seed

A new recipient site was established at Yaegl North due to apparent poor establishment at the Yaegl South site. This is 150-250 metre north of the first site. Three introductions were carried out in 2016-17. The site was more open and on the edge of paperbark forest. Hydrological conditions (e.g. duration of flooding) were probably still similar to the Yaegl South site.

Reduction of ground layer vegetation was carried out by hand weeding in 2018 and herbicide spraying in 2019 and 2020 to stimulate seedling recruitment. This treatment was limited to the vicinity of plots, being careful avoid any Tall Knotweed plants.

1. In the first translocation (August 2016), seven old Tall Knotweed plants (found to be prostrate and up to 3.5 m long) were transplanted and 20 plots were seeded with mud assumed to contain seedbank collected from around the old plants (see Table 8). The old plants were planted in shallow water. Several more bins of muddy substrate were collected assuming it would contain Tall Knotweed seed. The mud was spread in 1m x 1m cleared plots on the margin of paperbark forest where paperbark trees were more widely spaced and the ground layer consisted of grasses and sedges. Half the plots were in shallow standing water 1-10cm deep and were dug over with a spade to reduce sedge and grass competition (mainly *Eleocharis acuta* and *Paspalum distichum*). Plots were also placed in the Couch Grass zone (higher – no standing water) and the Water Couch zone (lower – shallow standing water) and spread out along about 150 metres of swamp edge. The plots were marked with an identification tag for monitoring.

2. In November 2016 more Tall Knotweed plants were found during pre-clearing surveys and translocated to the recipient site. These had grown from seed and were 0.5-0.7 m tall. The plants were dug up and transported to the recipient site 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.

3. While carrying out the second translocation in Nov/16, several hundred recently germinated Tall Knotweed seedlings were found. These were salvaged and grown on in pots at ECOS' nursery. Tall Knotweed is fast growing and they had to be pruned twice at the nursery to keep them at a manageable height (~1m). Planting was delayed until February/17 due to hot, dry conditions. Three hundred tubestock were planted in fifteen 4 m x 4 m plots, 20 plants per plot, in mid-February in anticipation of rain that came as a flood one week later. All plants were flowering and seeding when planted.

3.7.4 Results – Yaegl North (Aug 2016 to Nov 2021)

Translocation 1- salvaged old plants and soil (mud) seedbank

The old plants survived for about 2 months, producing a small amount of seed, then died off as the swamp dried out in spring-early summer 2016. Seedling recruitment from the mud seedbank plots was sparse. It was recorded mainly 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 in 2016 during the dry spring- early summer period. Some persisted in slightly damper microsites where they grew to maturity and set seed. A few plants survived to winter 2017 (like the old plants salvaged in August 2016).

In March 2018, 29% of the 27 seedbank plots had new Tall Knotweed plants.

In July 2019, 19% of plots had seedlings, and one or two had live or recently dead medium sized plants.

In August 2020, 51% of plots had new plants (total 25), height 20-60 cm, the majority with flowers.

In November 2021, 27% of plots had plants (22), height 20-60 cm, the majority with flowers.

Translocation 2 – salvaged young plants (0.5-0.7m high)

Most of these plant translocated in in Nov/16 survived and reached reproductive maturity. The site dried out soon after transplanting and additional watering was carried out to prevent die-off. After flooding rain in late Feb-March/17 they grew in standing water a metre deep and produced stems and roots underwater with little attachment to substrate. They flowered and seeded. A few plants were still alive at the end of June 2017.

In March 2018, a total new 23 plants were present at 8 of the 27 labelled plant points.

In July 2019, there were no seedlings or evidence of dead plants. The surface soil was dry.

In August 2020, new plants were present at four points (total 9 plants)

In November 2021, plants were present at two points (total 5 plants)

Translocation 3 - field seedling grown-on in nursery then introduced

The 15 plots for Translocation 3 plots were located along the boundary between low lying paperbark forest and open pasture on slightly higher ground, where soil type, low competition from trees, and open unshaded conditions might favour Tall Knotweed.

A week after planting the tubestock in late February 2017 there was a major flood. More than half the 1 m tall plants were fully submerged and died (at least some leaves must remain above water for plants to survive). All plants were in flower and producing seed when planted. In June 2017, 87% of the 15 plots had at least three live plants and where the water had receded small numbers of recently germinated seedlings were recorded. The seedlings were 5-10cm high and being grazed by kangaroos.

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

In July 2019, 33% of plots had TK plants (total 33), most recently dead).

In Aug 2020, 27% of plots had TK plants (total 21), 30-60 cm high, flowering.

In Aug 2020, 27% of plots had TK plants (total 21), 30-60 cm high, flowering.

In Nov 2021, 47% of plots had TK plants (total 139), 70-150 cm high, most flowering.

Population Ecology

Monitoring of the translocations showed that Tall Knotweed is a fast growing, annual plant, not a perennial. Most plants in the nursery grew from seed to over a metre high and flowering in 3 months. Similar rapid growth was observed in the field at some sites. Tall Knotweed seed germinated in the field on damp substrate where surface water had retreated. There was no evidence of underwater germination although large mature plants could grow like aquatic plants in water a metre or more deep, if some leaf was out of the water. Seeds germinated when high water levels receded leaving damp ground. Tall Knotweed seed is black and has a hard, shiny, seed coat indicating it can lie dormant when conditions are unsuitable.

Field observations indicated that seed germinates mostly as annual high water level in the Yaegl Swamp recedes leaving damp ground, but germination may occur any time of year as long as the ground substrate is damp. Survival of seedlings and young plants through the dry spring and early summer period requires the substrate to retain some moisture and not dry out completely. However, more seedlings germinate when rain returns if other conditions are right. Tall Knotweed prefers open, seasonally swampy ground with few trees. Disturbance events that reduce herbaceous biomass on swampy or marshy ground favour Tall Knotweed, including flooding, grazing, slashing, or carefully targeted herbicide spraying. Locally, flooding is the main disturbance agent supressing ground layer vegetation and creating open sites where Tall Knotweed seed can germinate. Prolonged inundation kills herbaceous vegetation leaving a bare muddy substrate to be recolonised again by marsh and swamp plants including Tall Knotweed. Previously, disturbance would have included fire in the dry season.

It was not possible to maintain the large numbers of Tall Knotweed plants recorded at the impact site (opposite the southern Maclean exit) at the recipient site, although the impacted population was largely artificial and a result of clearing and heavy soil disturbance at the site concerned. The translocation established a low-density population, with yearly recruitment and growth to maturity taking place naturally for four successive years (with a bit of help by spraying out dense herbaceous ground layer to create open sites). On-going recruitment from year to year depends on the ground layer vegetation not becoming too dense and soil conditions not becoming too dry during the spring-early summer dry season. Tall Knotweed appears to be favoured by a wet spring and above average annual rainfall. This year numbers increased after declining in previous drought years (see Figure 9).

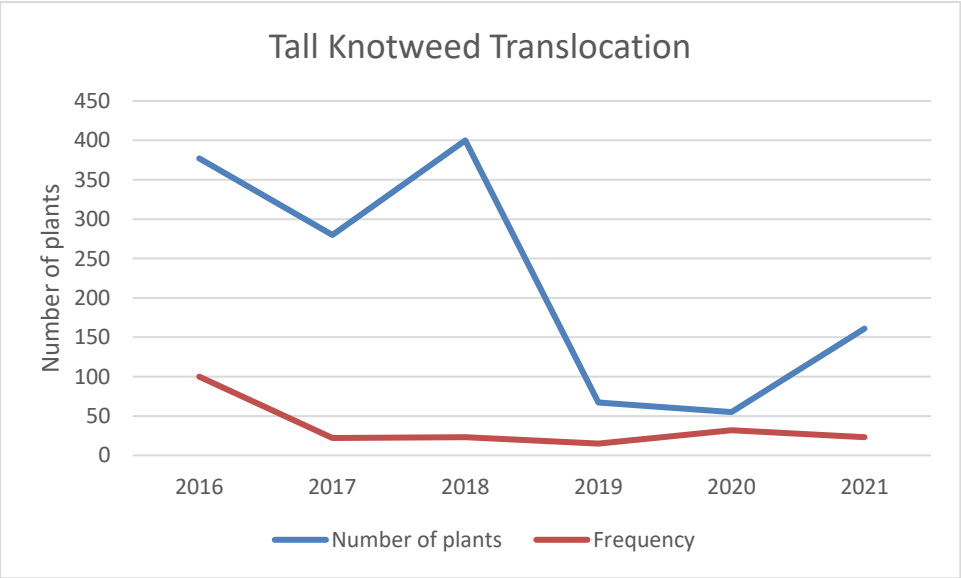

Figure 9: Changes in Tall Knotweed abundance after translocation over five years, combining results of the three translocations. The frequency curve gives the number of plots with Tall Knotweed present after translocation as a percentage (i.e. 0-100 on vertical axis). It can be seen that frequency has remained about constant at around 25% while abundance in terms of number of plants fluctuated, declining steeply in the strong drought year 2019. The previous dip largely reflects earlier below average spring-summer rainfall.

3.8 Four-tailed Grevillea (*Grevillea quadricauda*)

3.8.1 Translocation Method

Grevillea quadricauda is a shrub with a single-stemmed growth form typical of plants with an obligate seeder life cycle. Adult specimens of seeder species are not suited to direct transplanting, as they do not respond well to root disturbance and pruning, unlike resprouter species which can generally recover from transplanting and damage to their stem and/or root systems. (This is because resprouter species have dormant buds on stems, and roots, which enable regeneration after damage caused by natural disturbances such as fire and storm.)

As adult seeder species often transplant poorly, salvage was limited to small, juvenile plants on the highway footprint <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. Fifteen plants were grown in pots for about six months before planting out.

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

3.8.2 Results

The juvenile plants transplanted to pots grew rapidly in the infertile sandy soil used from the donor site. They continued to grow rapidly after planting-out despite competition from plants

in the intact plant community at the recipient site. No fertiliser was applied except a few pellets of organic fertiliser in the nursery. All plants 'started to flower in 2017 and have had flowers and/seed pods at every monitoring to Aug 2020.

In the last 12 months to Aug 2020, mean height increased slightly to 163.7 cm and there were no mortalities. The shrubs were flowering and seeding when monitored in Aug 2020.

Survivorship and mean height of translocated *Grevillea quadricauda*:

Monitoring Date	Surviv %	Mean Height (cm)
Nov-21	93.3	165.2
Aug-20	93.3	163.7
Jul-19	93.3	155.9
Mar-18	93.3	115.8
Introduced Mar-17	100	60.8

3.9 Stinking Cryptocarya (*Cryptocarya foetida*)

3.9.1 Translocation Method

The target for *Cryptocarya foetida* in the Strategy (RMS 2015) was revised down from 41 to 28 individuals based on the number found on the footprint during transplanting. Twenty-four (24) sapling sized individuals (1-4m tall) were transplanted manually. Some individuals were misidentified and were actually *C. microneura* or *C. triplinervis*. All came from the Randles Creek area in Section 10 adjacent to Coolgardie Rd. Four trees were too large to transplant given constraints with organising machinery through the Principal Contractor.

Two recipient sites were used for this species - Lumleys Lane and Coolgardie Rd. All rescued sapling size plants were introduced to the Lumleys Lane site as per the Strategy (referred to as BOS 22). Habitat consisted of a lower south-facing hillside covered by pasture with a few trees, next to rainforest regrowth dominated by broad-leaved privet and camphor laurel. Most of the hillside forest was very rocky. An area lower down on the edge of forest in pasture next to a dam (for watering) was selected as the recipient site. The soil type consisted of a heavy clay, yellow podzol with minimal topsoil and small surface rock, formed on metasediment with basalt colluvial influence from top of range.

Sapling sized individuals were translocated by direct transplanting carried out manually. The 24 saplings were dug out with an intact soil-root ball about 50 cm in diameter and pruned to reduce evapotranspiration stress. Conditions at the recipient site were exposed with few existing trees. After transplanting, the saplings were mulched and watered regularly to maintain moist soil conditions. Organic pelleted fertiliser and Seasol were applied to stimulate growth.

The second recipient site was located near Coolgardie Rd adjacent to the area where most of the saplings had come from. This area wasn't used initially as the nominated site was at Lumleys Lane and use of Coolgardie Rd area had to be approved. Propagated plants were introduced later to this site because of the high mortality amongst the salvaged saplings Lumleys Lane, which was attributed to soil conditions. Soil conditions were considered better at the Coolgardie Rd site, which included some alluvium along Randles Ck and general habitat more closely matched the rescue site on the highway footprint.

Twenty-eight (28) *C. foetida* propagated from seed were introduced to Coolgardie Rd in Feb/18. Additional watering was carried out during dry periods. The plants were kept mulched,

organic fertiliser applied and weed control carried out. Habitat rehabilitation was carried out in adjoining rainforest and additional plantings carried out. Exotic trees including a few Camphor Laurel and one large Ficus benjamina were not removed as they were facilitating natural rainforest regrowth.

At Lumleys Lane, to provide better quality habitat, intensive habitat rehabilitation was carried out in about 1 ha of adjoining rainforest regrowth dominated by Broad-leaved Privet and Camphor Laurel. The latter species were poisoned with the aim of releasing supressed native rainforest species growing with the exotics.

3.9.2 Results

Transplanted saplings at Lumleys Lane started to reshoot after about 4 weeks. Epicormic shoots grew from the main stem and pruned branches. By January 2017 (~6 months after transplanting) 62.5% (15/24) of the saplings had reshot and were alive. Two more had reshot then died. Regeneration was slow but satisfactory until two extremely hot days in Feb/2017 (hottest on record for most of the Far North Coast), which caused leaf scorching and die-off in about half the transplants, reducing survival rate at the end of Year 1 to 26.9%. Two individuals defoliated during the heat wave reshot. No more mortalities occurred and survival leveledof at about 25%. By 2021 the tallest of six transplanted individual at Lumleys Lane was 3.7 m.

At Coolgardie Rd, the survival rate of 28 seedlings 18 months after planting out (July 2019), was 89.3% and mean height was 42.9 cm. A year later (Aug 2020), survival rate was unchanged and mean height increased to 66.9 cm. This was despite drought conditions in 2019. In 2021, mean height of propagated seedlings after 3.5 years had increased to 85.5 cm and survival was still 89.3%

Habitat rehabilitation work carried out at both sites from 2016 to 2021, included spraying of herbaceous weeds, injecting exotic trees, planting of local rainforest species and removal of exotics from adjoining natural rainforest and regrowth, as described above. Results have been positive although very slow on the poor metasediment soil.

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

3.10.1 Translocation Method

Three saplings were transplanted to the Lumleys Lane 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 at the Coolgardie Rd recipient site in Feb/18.

More seed was collected from Section 10 and propagated for the site near the Maclean interchange (Section 4) where one tree inside the project boundary was accidently cleared. This work is being done in accordance with the Green-leaved Rose Walnut Rehabilitation Plan which is reported on separately.

3.10.2 Results

Only one of the three transplanted saplings at Lumley's Lane reshot. The height of this individual increased from 194 cm to 320 cm between 2020 and 2021.

Survival of seed propagated plants remained high after 3.5 years at 94.7% (2021). Mean height increased from 68.5 cm to 98.0 cm between 2020 and 2021 (Table 8).

3.11 Red Lilly Pilly (*Syzygium hodgkinsoniae*)

3.11.1 Translocation Method

A total of 42 Red Lilly Pilly were introduced to the rainforest recipient sites at Lumleys Lane and Coolgardie Road, including six juveniles salvaged from under a large tree (cleared) north of Lumleys Lane in Oct/2016. About 50 Red Lilly Pilly were propagated from seed collected in August 2016. Twelve were planted out at the Lumleys Lane recipient site on 1/6/2017 and the remainder grown-on for another six months. Thirty were introduced to the Coolgardie Rd recipient site in December 2017, including the small potted transplants. The plants received fairly intensive care, including additional watering during dry periods, mulching, shielding from direct sunlight and addition of fertiliser. Wire tree guards (1.2 m high) were installed to reduce grazing by wallabies.

3.11.2 Results

Propagated seedlings introduced to Coolgardie Rd showed very slow growth, susceptibility to disease and have slowly been dying out. Survival of 29 seedlings after 3.5 years (2021) was 17% with 5 surviving. Mean height averaged over all seedlings including zeros was 12 cm (see Tables below). The tallest plant was 1.4 m, but it had red tip and few leaves. Soil over most of the Coolgardie Rd site was an alluvial clay derived from metasediment and possibly too heavy textured for this species. The species grows naturally nearby on gravelly sand in the channel of Randles Creek and one tree grew on coastal sand-colluvium at the base of the range. These soil conditions were approximated closer to the creek, but seedling planted as these points grew only marginally better.

This species has proven difficult to establish on other translocation projects due to lack of vigour and infection of growing tips with red witches broom, even on basaltic krasnozem (e.g. T2E). Nurseries don't grow the species because witches broom stunts or completely stops growth. Mature trees have been transplanted successfully and they don't develop the witches broom problem (e.g. BH2Y) so it is a pity effort wasn't made to salvage a single large tree cleared at Lumleys Lane.

It was observed that if the witches broom is left on the plant rather than picking the scab of hardened tissue off, healthy leaves often emerged from the hard cap of diseased tissue and picking it off appeared to worsen the problem as this removed apical buds still functional inside the witches broom, so no growth occurred. Sometimes shoots were produced from the stem below the red tip infection, but then became infected too.

Red Lilly performed better at Lumleys Lane than Coolgardie Rd. Survival of 13 seedlings after 3.5 years was 85% and mean height averaged over all seedlings including zeros was 83.4 cm. The tallest plant was 1.4 m with new leaf growth. However, the condition of most plants was fairly poor. The soil was a similar hard clay formed on metasediment on a lower slope, but the site was sloping and better drained. Initially the site was open with few shade trees. Although growth was better, plants were susceptible to red tip and dieback. This species

appears to be susceptible to three different diseases, sometimes all present on one plant. I have called these red tip, leaf decline and brown spot. Plants at Lumleys Lane received more mulch, competition from existing trees was less and seedlings were planted 6 months earlier than at Coolgardie Rd.

Lumleys Lane recipient site (Area 1) – 13 plants introduced

Date	Mean Height (cm)	%Survival
Nov-21	83.4	85%
Aug-20	81.3	92%
Jul-19	59.5	92%
Jun-18	58.9	92%
Mar-18	58.4	100%
Planted out June-17		

Coolgardie Road recipient site (Area 2) – 30 plants introduced

Date	Mean Height (cm)	%Survival
Nov-21	12.9	17%
Aug-20	22.2	34%
Jul-19	49.2	47%
Jun-18	47.3	100%
Planted out Dec-17		

3.12 White Laceflower (*Archidendron hendersonii*)

3.12.1 Translocation Method

Two saplings were transplanted directly to the recipient site at Lumleys Lane in 2016 and six juveniles were transplanted to pots, grow-on at the Ecos nursery then planted at Coolgardie Rd in 2017. Plants were dug out manually as described for *C. foetida.*

3.12.2 Results

Lumleys Lane recipient site - The two direct transplants were in good condition in 2021 after fire years. Mean height was 346 cm.

Coolgardie Rd recipient site – The six juveniles transplant to pots, grown-on and planted all survived and were in good condition in 2021. Mean height after 3.5 years after planting was 283 cm (see table below).

Mean height of translocated White Laceflower at the rainforest species translocation sites

	Mean Height (cm) Lumleys Lane	Mean Height (cm) Coolgardie Rd- Area
Nov-21	345.8	282.5

Aug-20	279.5	217.7
Jul-19	208.5	152.7
Jun-18	134	92.5
Jun-17	72	In nursery
transplanted Oct-16		

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

3.13.1 Translocation Method

Rough-shelled Bush Nut was translocated using seedlings propagated from locally collected seed and introduced to the Coolgardie site which is close to the locations impacted on the footprint. Seeds were collected from rainforest regrowth on the lower slopes of the Blackwall Range adjacent to the highway footprint and a group of trees on a property at the end of Whytes Rd, Pimlico. The latter trees growing on the inland edge of the ancient Pleistocene sandplain, and sandy soil, have an unusual densely coppiced growth form, similar to the tree that grew next to Coolgardie Road and may preserve a similar genotype. From approximately 50 seeds collected, eight seedlings were planted out.

3.13.2 Results

Of the first seedlings planted in Feb 2018 (Table 8), survival after 3.5 years (2021) was 80% and mean height 192.5 cm. This species performed well on the poor metasediment soil at Coolgardie Rd. Three more seedlings propagated from locally collected seed have been planted, taking the net population to 7.

Rainforest Translocation Area 2 (Coolgardie Rd)

Mean height of first planting of propagated plants:

Date	Mean Height (cm)
Nov-21	192.5
Aug-20	124.3
Jul-19	55.2
Jun-18	31.2
Planted out June-17	

3.14 Square-fruited Ironbark (*Eucalyptus tetrapleura*)

3.14.1Translocation Method

Eight saplings were transplanted from a crown land site on the footprint where Square-fruited Ironbark was was planted during a special occasion, to the Sunnyside Rd offset property in Oct/16.

In addition, 79 tubestock propagated from seed were planted at Sunnyside Rd in autumn 2017 as part of the first round of translocations (Sect 1&2).

Square-fruited Ironbark seed was collected by Ecos Environmental at Glenugie in 2014 and stored in a fridge at about 5 degrees C for 5 years. At the request of TfNSW, Ecos Environmental propagated 800 tubestock from this seed and planted them at the Sunnyside Rd offset site in Oct 2020. Apparently, they are growing satisfactorily (S. Walker pers. comm.).

3.14.2 Results

Three saplings from the crown land site turned out to be Square-fruited Ironbark. The others were different species.

The first round of tubestock planting grew fairly poorly for some reason. Natural recruitment of Square-fruited Ironbark also occurred at the site and these trees are much taller and more vigorous than the propagated ones, growing alongside. The natural recruitment may have been from suppressed lignotubers in the paddock when the property was purchased by TfNSW and cattle removed.

The 800 tubestock planted in 2020 were reported to be growing satisfactorily (S. Walker pers. comm.).

3.15 Hairy Melichrus (*Melichrus hirsutus*)

The two plants transplanted from the footprint in 2016 have survived and flowered each year from 2017 to 2021.

3.16 Hairy Joint Grass (*Arthraxon hispidus*)

3.16.1 Translocation Method

Hairy Joint Grass (HJG) was translocated on Sections 1-2 & EWSSTA's in 2015 and Sections 3-11 in 2016, by different translocation practitioners. Both translocations were carried out by transplanting sods containing live plants or thought to contain seed.

Hairy Joint Grass was translocated on Sections 1-2 & EWSSTA to Kangaroo Trail on Section 1 in Sept/15 and to a site on the southern outskirts of Woodburn (also referred to as Trustrums Hill, but on the floodplain, not a hill) in July-Aug/15. The Trustrum's Hill recipient site had two planting areas – Site 1, a low-lying area with 3 plots and Site 2 on higher ground with eight plots (Table 8)

On Sections 3-11, populations were translocated from Section 10 between Coolgardie Rd and Lumleys Lane, and from Section 3, Mitchell Rd. Plants on Section 10, to a recipient site at Lumleys Lane and from Section 3 SE of Tucabia to the adjoining road reserve at Michell Rd. Fifty trays of plants were salvaged from Section 10 and planted into 43 plots at Lumley's Lane recipient site in Nov/16. Each plot had approximately 50 plants (43 x 50 = 2150 plants). at At Mitchell Rd, approximately 1000 plants were translocated to 20 plots in Sept/16. All plants consisted of young seedlings of this annual species which flower and seeds in autumn.

3.16.2 Results

<u>Sections 1-2 & EWSSTA</u>

The populations translocated on Sections 1-2 & EWSSTA declined or died out, due to lack of biomass reduction. Landmark (2017) stated “no plants observed” in autumn 2016 or autumn 2017 at the Kangaroo Trail recipient site. However, on monitoring this site in autumn 2018, Ecos Environmental recorded 11 clumps of HJG in seed and some were near tags with ‘A.h.’ (*Arthraxon hispidus*). The origin of these HJG plants when none were recorded in the previous two years (after translocation in Sept/15) is unclear.

Slabs were salvaged at Trustrums Hill (Woodburn south) in 2015 in July-Aug when the species is dormant or present as very small seedlings. A total of 25 slabs were planted in 3 plots at Site 1 and 8 plots at Site 2 at Trustrums Hill/Woodburn south. The slabs had no HJG plants but were thought to contain seed of this species. Based on research carried out by ECOS don the Tintenbar to Ewingsdale project, HJG seed should have germinated in July-August and tiny seedlings would have been present. (Although minute, HJG seedlings can be distinguished by the relatively wide first leaf which is much broader than other grasses, but not mention is made of this.)

The 2017 monitoring report by Landmark stated that at Trustrums Hill (not a hill, but a floodplain) one plant was observed by bush regenerators at Site 1 in February 2016, and none were observed during monitoring in autumn 2016 and autumn 2017 (Table 8) and the slabs were overgrown with dense Setaria grass (Setaria sphacelate). Attempts were made to reduce biomass (by slashing?), but no further plants were recorded. At site 2 with eight plots, dead plants were recorded in autumn 2016 and 2017 indicating that HJG (an annual) had recruited from seed, but no dead plants were observed in June 2018. No evidence of HJG plants was observed at the plots at Trustrums Hill in Aug 2020 when monitoring finished.

Overall, the translocation of HJG at Trustrums Hill was unsuccessful in maintaining a population in the recipient site plots, as biomass reduction was not carried out, or applied at the wrong time of year. The hydrological regime in low lying Site 1 may have been too wet for HJG, which prefers the edge of wetlands, but not standing water.

Sections 3-11

HJG translocated to recipient sites on Sections 3 and 10 (Mitchell Rd and Lumleys Lane), produced new annual plants each year from 2016 to 2021, although overall crown cover decreased due to build-up of perennial grass, as slashing with brush cutter or tractor was only carried out once a year. However, this was sufficient to maintain HJG population at each site during the monitoring period. Biomass reduction was carried out in spring each year when seedlings were very small and created low, open conditions favourable for growth of HJG seedlings. HJG is an annual grass so a new cohort of seedlings must germinate each year for a population of living plants (rather than dormant seed) to persist at a location. It is unclear if HJG has a mechanism for prolonged seed dormancy when habitat conditions become unfavourable, but this seems likely given its annual life cycle (Ecos Environmental 2016).

HJG requires an open site where the ground layer vegetation is not too dense, so there are gaps between perennial grass plants where seedlings can germinate and begin their annual life cycle. In its present habitat on agricultural land, these conditions are maintained by cattle grazing and trampling. Slashing can be used as a substitute for grazing (to reduce biomass) if cattle or stock are removed.

At Lumleys Lane on Section 10, the extensive population of HJG existing in the paddock at the offset site referred to as BOS 22, contracted in 2020 and 2021, but a large population HJG remained in 2021 in the lower half of the paddock next to the highway. This part of the paddock appears to have been slashed more often by the contractor while maintaining koala tree plantings which are located at the bottom of the paddock next to the highway. The damper soil conditions appear to inhibit Broad-leaved Paspalum which smothers HJG.

3.17 Lindernia (*Lindernia alsinoides*)

3.17.1 Methods and Results Section 3

Transplanting of Lindernia on Sections 3-11 was carried out after an unexpected find in December 2016. Thirty spade sized sods (20-30 cm thick) of Lindernia plants growing in black peat were transplanted to the recipient site on the opposite side of the highway on the same drainage line, downstream about 100 metres from the rescue site.

After transplanting at Mitchell Rd on Section 3 in December 2016, run-off from earthworks deposited iron leachate at the recipient site in autumn 2017, blanketing plants with sludge (being on the downstream side). In July 2019, water quality was much improved, and it seemed possible some plants could regenerate from seed or runners from the transplanted sods. In Aug 2020, iron leachate deposit was present again, and therefore unlikely any plants would reappear. No plant were present when inspected in Nov 2021.

A few plants persist at the donor site on the upstream side of the highway where the drainage line crosses the project boundary fence.

Survivorship:

Mitchell Road – all plants in 30 sods appeared dead after two years (June/18). No Lindernia plants have been recorded since. A few plants have persisted in the road reserve in the drainage swamp on the opposite side of the highway, in what remains of the original seepage swamp (November 2021).

All in situ Linderna monitoring sites for W2B, including control sites had considerable loss of plants during the 2018-19 drought, and have been recorded as absent at all sites, suggesting the very dry conditions did not favour this species (C. Thomson pers. comm.). However, the drainage line at the Lindernia translocation site at Mitchell Road remained dam to boggy during this period, although without surface water, and the few remaining in situ plants were still present on the upstream side of the highway.

The Lindernia translocations were useful in clarifying the narrow habitat niche of this species. Lindernia is a perennial, rhizomatous, semi-aquatic herb that requires a highly restricted habitat consisting of small seepage swamps (springs) along drainage lines in hilly sandstone terrain. The seepage zone is active in the rainy season, but subsurface moisture keeps the soil damp so that a peaty soil develops over sand. At Mitchell Rd (Section 3-11) the peat layer was 20-30 cm deep. Natural vegetation consists of sedges and herbs of marshy ground, and sphagnum moss, under an open woodland canopy of swamp tolerant trees including Swamp Mahogany (*Eucalyptus robusta*) and Paperbarks (*Melaleuca spp*.).

With clearer understanding of the habitat of this species, translocation of the species may be more successful if it has to carried out again.

3.17.2 Methods and Results Sections 1-2

Three recipient sites were used for translocating Lindernia on Sections 1-2 & EWSSTA (see Table 9). Translocation methods included (i) transplanting sods/clumps of plants, (ii) removal of soil slabs thought to contain seed and (iii) introduction of plants propagated from cuttings. These sites were monitored by Landmark and then by Ecos Environmental. All methods were

unsuccessful, which appeared to be due to selection of recipient sites with unsuitable habitat. Soil texture at all sites had a clay-silt texture rather than the peat overlying sand soil profile that appears to be required by Lindernia (see below). The recipient site at Kangaroo Trail was fenced to exclude kangaroo grazing but this was not the cause of plant death as the same result occurred at Kangaroo Trail (fenced) and Halfway Ck Crossing (unfenced).

Large numbers of propagated plants were introduced to two recipient sites (Kangaroo Trail and Halfway Ck Crossing). A handful survived at Halfway Creek by July 2019 and none were present by Aug 2020. At Kangaroo Trail, a planting of 350 nursery plants in Jan/16 died out in six months. A second large planting was carried out in autumn 2017 (428 plants Table 9), but nearly all plants died again after 12 months. The habitat selected was clearly unsuitable for Lindernia.

Survivorship:

Halfway Ck Crossing – 12 out of 500 propagated plants survived after one year (June/18). Six plants surviving July 2019. No plants observed Aug 2020.

Kangaroo Trail – one plant out of 428 propagated plants survived after two years to July 2019. No plants observed Aug 2020.

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

3.18 Rotala (*Rotala tripartita*)

3.18.1 Translocation Method

Approximately 10 plants growing in a man-made drainage depression on the eastern side of the highway opposite Tullymorgan Road were salvaged in Sept/17 and grown-on in pots at Ecos Environmental's nursery before planting out the following wet season (early 2018). Habitat at the rescue site consisted of a linear, marshy depression in a cleared paddock grazed by cattle which held shallow standing water in the rainy season and dried out during spring.

No matching wetland habitat could be found at available sites, so habitat was engineered at a site on the Tabbimoble Creek floodplain about 0.5 km to the south of the rescue site, a TfNSW offset property. Two ponds were dug with an excavator on a minor drainage line in open woodland on heavy clay soil, that aimed to create a permanent pond or damp area suitable for Rotala. Before introducing Rotala plants, the ponds were filled with water by pumping from a nearby creek. Natural run-off would then be relied on to maintain suitable hydrological conditions.

Rotala is a stoloniferous herb (ie. with surface runners) and can be propagated by cuttings or division. About 50 plants were propagated from plants salvaged from the donor site. These were planted into the recipient site in pots by burying the pots, so they could be dug up and their position adjusted with respect to water level. Hydrological regime can be critical for wetland plants that grow in shallow water or on the edge of wetlands.

Two adjustments were made to the position of pots as water fell in the pond during dry weather. Stolon runners had already been produced extending out from the pots, so some of the plant was left behind when a pot was moved. Pots were moved lower down closer to the water as the water level dropped. Organic fertiliser pellets were added to pots to simulate

growth. Plantings at the two ponds were fenced in March/18 due to site disturbance by wild pigs.

3.18.2 Results

Survivorship was 90% after approximately 6 months (July/18) and stolons grew up to 10cm from pots taking root in the damp substrate. After 18 months, survivorship fell to 38% or 17 plants (both ponds combined). After 30 months (Aug 2020), all the plants in pots had died at both ponds, but runners outside pots in Pond 1 were still alive and fifteen discrete clumps representing original pot positions were counted, equivalent to a survival rate of 30%. The Surviving plants were relatively high up on the edge of the pond, suggesting that this species cannot survive submersion for any length of time (as would have occurred to pots placed lower down in the pond basin) and it can survive in seasonally dry ground, probably as a dormant runner, then reshoot again with a return to wet conditions.

Rotala plants were present at the same positions in 2021 as 2020, along the eastern side of Pond 1 (the northern pond) over a distance of 17 m. The number of plants/clumps had increased to approximately 20. At Pond 2 (the southern pond on same drainage line), three clumps were recorded. None were recorded the year before, possibly because they were leafless and unobserved, or they may have been recruited from seed.

No definite seedlings or small plants were observed.

3.19 Richmond Birdwing Vine (*Aristolochia pravevenosa*)

This vine was propagated from hardwood stem cuttings collected from the clearing footprint on Randles Creek in Section 10 in Oct/16. Eleven plants were propagated and introduced to the Coolgardie Rd rainforest species translocation area in Oct/17

In 2021, survivorship of 11 plants remained at 100% 4 years after planting out and mean height remained constant at 110 cm. A few plants had grown up into trees above, and others had died back so the net result was about constant mean height.

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. Survival to Aug/2020 was 40%. Very little growth had occurred.

4.0 Assessment of Translocation Outcomes

4.1 Performance Criteria

Translocation implemented in a developmental context aims to minimise loss or impact to local threatened species populations by carrying out salvage transplanting, propagation and introduction of additional plants to maintain local population numbers, and maintaining habitat conditions adjacent to the development that are conducive to a healthy, self-sustaining population of the subject species.

Towards this general aim, several performance criteria were set out in the Translocation Strategy (RMS 2015b, p. 46), as follows:-

Short Term Criteria (to 5 years)
The translocation of each species:
· at least 70% of the transplants and enhancement introductions are surviving after the first year and 60% after five years (and arrangements for replacement from backup stock are underway in case of failure to meet this target);
· germination from freshly shed or soil-stored seed of Hairy joint-grass and Tall knotweed occurs following suitable seasonal rainfall
· flowering and seed production (or spore production) occurs in transplanted individuals (if appropriate to species timeframe and maturity of transplanted material)
· the translocated populations display similar growth development and vigour to naturally occurring populations
· regeneration occurs in transplanted individuals (if appropriate to species timeframe and maturity of transplanted material)
Habitat and threat management:
· good quality habitat restored in and surrounding the recipient site;
· maintenance carried out at suitable intervals; and
· threatening processes including weed invasion controlled or eradicated.
Long Term Criteria (decades)
The timeframe of the current project will not permit the development of slow-growing species i.e. Green-leaved rose walnut to be followed to reproductive maturity. Annual plants however will complete many life cycles in timeframes of a decade or more. Details of long-term criteria are provided for information and adoption where feasible.
· translocated individuals survive to reproductive maturity;
· new seedlings or vegetative offspring are established;
· the number of individuals in the population is sustained or increased by natural recruitment;
· adequate levels of genetic fitness are maintained through generations
· reproduction including the production of flowers and fruit (or spores) and seed viability (spore viability) is consistent with levels in naturally occurring plants;
· natural habitat conditions are restored or maintained at the recipient site.

Generally, the short-term criteria that would apply during the time-frame of the translocation monitoring allow for a decrease of 30% of translocated/introduced plants after one year and 40% after five years (RMS 2015 b, p. 46).

4.2 Achieving Aims and Objectives

As well as the Performance Criteria listed above, the Strategy presents a method for assessing outcomes in terms of whether Aims and Objectives defined in Strategy were attained or satisfied (RMS 2015b, p.25 Table 6).

For example, there is a general aim of no net loss of threatened flora populations as a result of the development and populations to be functional, self-sustaining and viable at least in the short to medium term.

An assessment of how well the translocation project has met the Aims and Objectives, according to the method set out in the Strategy is presented in Tables 12 and 13 below.

4.3 Translocation Outcomes

As Tables 12 & 13 from the Strategy are very long, an attempt was made present an overall assessment of outcomes in a more succinct format, which is presented in Tables 10 and 11. Results of each translocation (i.e. a species at a site) was ranked as Good, Fair, Poor or Failed, based on target attainment and likelihood the translocated population will persist. For a Good ranking the number of plants must be above the 30-40% threshold for net population loss set in the Strategy. To persist the population would need to survive and remain ecological function – ie growing or producing seed – over the short to medium terms.

The results on Sections 3-11 after 3- 4 years met most of the translocation aims, objectives and performance criteria were overall results were assessed as Good for 16 translocations, Fair for 7 and Failed for 2. The failures were Lindernia and one of the orchid translocation sites (Table 10).

The results for Sections 1-2 & EWSSTA failed to meet project aims, objectives and performance criteria for most species. Failed translocations included Moonee Quassia, Lindernia, Square-stemmed Spike Rush, Hairy Joint Grass, Tall Knotweed and Lepidosperma sp. (Table 11). Little was learnt about the life cycle of Lindernia, but it is possible this species is annual and a seedbank may have formed and then the plants died off. However, no plants appeared in subsequent years.

The short-fall in Square-fruited Ironbark has been addressed with the introduction of another 900 tubestock to the Sunnyside Rd offset site in Sept 2020. (These plants were propagated from seed collected in 2010 on the Glenugie Section of the highway upgrade and stored in a fridge at about 6° C. The seed remained viable after 10 years, despite numerous short periods when the fridge was switched off.)

In addition to the translocation efforts for Square-stemmed Spike Rush, TfNSW has agreed to contribute funds to a DPIE (Save Our Species) proposal for the collection of Seed (and vegetative material, if necessary) from multiple populations within two active SoS sites located in the Clarence Valley. Consultation has been undertaken with NPWS who have provided written agreement to the translocation site within Bongil Bongil NP.

Table 13: Summary of translocation outcomes on Sections 3-11, after four years, or three years (unexpected finds). Overall establshment was ranked at Good, Fair, Poor and Failed in terms of target attainment, plant growth and likelihood the translocated population will persist.

Species	Recipient Site	Source of plants	Target	Number surviving Nov 2021	Establishment: Good, Fair Poor, Failed	Comment
Yellow-flowered King of the Fairies	Bundjalung Nat Pk (Evans Hd)	Transplanted	(18) 11	10	**Good**	
Unexpected finds	Lumleys Lane Sth	Transplanted	35	2	**Failed**	Plants taken by orchid collector?
Slender Screw Fern	Bundjalung Nat Pk Area 1 (Mororo Rd)	Transplanted	6350 fronds 127 trays 0.37 ha	Survival and crown cover good on Line C only (note - point of planting layout was to spread planting out to maximise intersection of at least some favourable habitat (i.e. Line C)	**Fair**	Bushfire in Nov 2019 caused substantial contraction of the area covered by the translocated population. Having survived bushfire, drought and floods over five years, remaining plants have a good chance of persisting.
Unexpected finds	Bundjalung Nat Pk Area 2 (Mororo Rd)	Transplanted	4350 fronds 174 trays 0.3 ha	Survival and crown cover good on both Lines and Patches.(see Table 10)	**Good**	Survival and crown cover on Line A increased relative to pre-fire. Remaining plants likely to persist.
Singleton Mint Bush	Tabbimoble Triangle	Soil seedbank	609 plants 0.424 ha	Total number of SMB in recipient site approx. 350, but only ~10% of these of translocated origin, including final planting in 2021	**Fair**	Bushfire in Nov 2019 caused the translocated population to contract to a narrow section of habitat within the recipient site comprising sandier soil on the natural levee of Tabbimoble Ck. where a small population of SMB was present at the start. Low seedling recruitment and resprouting of translocated plants, and a final round of planting, resulted in minor augmentation of the existing population, but no increase in area.
Weeping Paperbark	Offset property Tabbimoble Ck.	Seed	1700 2.761 ha	~700	**Good**	Population regenerated after the Nov/2019 fire by resprouting, with near 100% survival of 2.5 year old plants. In 2021, plants healthy and population number and area
	Tabbimoble Triangle					

Species	Recipient Site	Source of plants	Target	Number surviving Nov 2021	Establishment: Good, Fair Poor, Failed	Comment
						adequate for self-sustaining population. Likelly to persist over the long term due to ability to resprout vigorously if stem killed. No flowering recorded or canopy seedbank formed.
Tall Knotweed (incl. unexpected finds)	Yaegl Nat. Res. (centre-north)	Transplanted & Soil Seedbank	(20) 350 (most seedlings)	163 plants in original plots and surrounding to maximum distance of approx. 10 m	**Fair/Good**	Recruitment occurring each year, plants maturing and setting seed. Numbers increased in 2021 compared to previous. Persisted through drought events.
Four-tailed Grevillea	Quarry Rd (Sec.3)	Seed	(3) 15	14	**Good**	Plants vigorous, setting seed.
Stinking Cryptocarya	Lumley's Lane	Transplanted	(41) 24	6	**Fair**	Below target but survivors healthy.
	Coolgardie Rd	Seed		25	**Good**	High survival, slow but steady growth.
Rusty Green-leaved Rose Walnut	Lumley's Lane	Transplanted	(3) 6	1	**Fair**	Below target but survivors healthy.
	Coolgardie Rd	Seed		18	**Good**	High survival, slow but steady growth.
Red Lilly Pilly	Lumley's Lane	Seed	6	10	**Good**	High survival, slow but steady growth.
	Coolgardie Rd	Seed & Transplanted		5	**Fair**	Low survival, slow but steady growth.
White Laceflower	Lumley's Lane	Transplanted	(1) 8	2	**Good**	High survival, steady growth.
	Coolgardie Rd	Transplanted		6	**Good**	High survival, steady growth.
Rough-shelled Bush Nut	Coolgardie Rd	Seed	10	7	**Good**	High survival, steady growth.
Hairy Joint Grass - Section 10	Lumley's Lane	Transplanted	348 (1.3ha)	Population in receival site decreased but increased in surrounding BOS 22 paddock	**Good**	Biomass reduction each year essential for persistence

Species	Recipient Site	Source of plants	Target	Number surviving Nov 2021	Establishment: Good, Fair Poor, Failed	Comment
Hairy Joint Grass - Section 3	Mitchells Rd	Transplanted	1000	Scattered plants present	**Fair**	Biomass reduction each year essential for persistence
Species Unexpected and Additional to the Translocation Strategy			Target= no. impacted			
Richmond Birdwing Vine	Coolgardie Rd	Cuttings	5	11	**Good**	
Lindernia	Mitchells Rd (Sec.3)	Transplanted	30	0	**Failed**	
Square-fruited Ironbark	Offset land, Sunnyside Rd	Transplanted	8	6	**Good**	Main translocation at Sunnyside Rd offset site, Sect 1& 2 translocation
Weeping Paperbark (note – also above)	Offset land, Sunnyside Rd	Transplanted	1	1	**Good**	
Hairy Melichrus	Offset land, Pillar Valley (Mahogany Drive)	Transplanted	1	2	**Good**	
Rotala	Offset land Tabbimoble Ck	Transplanted & Division	20	15	**Good**	Survived drought, flood and bushfire.

Table 14: W2B Sections Sections 1-2 and EWSSTA - overall results after 4 Years. Each species translocation to each recipient site is treated as a separate translocation. Targets are according to RMS (2015b) The second last column gives the total number or amount alive in July 2019. The last column (Satisfactory/ Failure/ Equivocal) is an overall assessment of the translocations in meeting targets.

Species	Recipient Site	Method	Target	Number surviving Aug 2020	Establishment: Good, Fair Poor, Failed	Comment
Hairy Joint Grass	Kangaroo Trail	Transpl/Soil Seed	2	0	**Failed**	
	Trustrums Hill	Transpl/Soil Seed	38	0	**Failed**	Insufficient biomass reduction
Lindernia	Kangaroo Trail	Cuttings	1811	0	**Failed**	Microhabitat non-matching
	Halfway Ck Crossing	Cuttings		0	**Failed**	Microhabitat non-matching
	Yuragir NP	Transpl/Soil Seed		0	**Failed**	Microhabitat non-matching
Moonee Quassia	Dirty Creek Road Reserve	Cuttings	73		**Failed**	Cuttings did not strike
Slender Screw Fern	Kangaroo Trail	Transplanted	45 slabs	8	**Fair**	14% survival of plants between yr3 and yr5
Square-fruited Ironbark	Pillar Valley	Pillar Valley	823	~950	**Good**	900 planted Oct/20 by Ecos Enviro
Square-stemmed Spike Rush	Halfway Ck Crossing	Halfway Ck Crossing	253	0	**Failed**	SoS project underway
Tall Knotweed	Yaegl NR	Yaegl NR	37	0	**Failed?**	Patch observed north of recipient site.
Lepidosperma sp. 'Coaldale'	Mahogany Drive	Mahogany Drive	35	0	**Failed**	

Table 15: Assessment of Translocation Outcomes on Sections 3-11 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
1	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.
1	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
1	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
1	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*
1	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 receiving site populations. Collect seed nursery propagate or clump transplant. Re-evaluate site moisture gradients to best target suitable planting sites.	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
	Evaluation and actions	Performance criteria met. Salvaged plants in good condition, more than tripled in size since introduction, flowering. Large mature plants after 4 years, seeding. Adjacent population enhanced.	Performance criteria met. Population numbers and genetic diversity maintained by salvage from footprint and propagation. Above target, plants increasing in height. Adjacent population enhanced.	Performance criteria met. Existing population augmented. Annual life cycle completed in Years 1-4. Persistence depends on biomass reduction. Adjacent population declined so translocation area helping in maintaining local population.	Performance criteria met. Total number introduced well above target, survival rate low but above target. Adjacent population enhanced.	Performance criteria met. 7 seedlings propagated, target 10, growth satisfactory. Established new sub-population at Coolgardie Road adjacent to donor site.	Performance criteria met. Large number of seedlings propagated from soil seedbank and established on the recipient site after 2.5 years. Bushfire reduced translocated populatoin, renewed naturally occurring population at recipient site and on western side of highway, stimulating germination of thousands of seedlings.
2	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
2	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.
2	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.
2	Threshold	Reporting incomplete	Reporting incomplete	Reporting incomplete	Reporting incomplete	Reporting incomplete	Reporting incomplete
2	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
2	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	Performance criteria met. Knowledge of species life cycle and translocation potential increased – e.g. species hardy, resilient, will recruit in degraded regenerating habitat. Can be translocated by salvage or propagation from seed, seedlings grow slowly.	Performance criteria met. Knowledge of species increased – e.g. species life cycle re-confirmed as annual. Sensitive to dominance by tall exotic grasses. Co-exists with native Foxtail Grass	Performance criteria met. Knowledge of species life cycle and translocation potential increased. Limited translocation potential using propagation	Performance criteria met. Knowledge of species life cycle and translocation potential increased	Performance criteria met. Experiments and general observation increased knowledge of species life cycle, habitat requirements and translocation potential.
3	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
3	Objectives	Original number of individuals and area re-established	Equivalent original number of individuals re-established. following guidelines for	Original number of individuals and area re-established	Equivalent original number of individuals re-established. following guidelines for	Equivalent original number of individuals re-established. following guidelines for	Original number of individuals re-established

		Four-tailed Grevillea	Green-leaved Rose Walnut	Hairy Joint-grass	Red Lilly Pilly	Rough-Shelled Bush Nut	Singleton Mintbush
			replacement of mature trees by seedlings/cuttings i.e ten seedlings established for any mature trees lost five seedlings established for any saplings lost.		replacement of mature trees by seedlings/cuttings i.e ten seedlings established for any mature trees lost five seedlings established for any saplings lost.	replacement of mature trees by seedlings/cuttings i.e ten seedlings established for any mature trees lost five seedlings established for any saplings lost.	
3	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
3	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*
3	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
3	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. Local population reduced but maintained.	Performance criteria met. Total number translocated is above target (although high mortality of propagated seedlings).	Performance criteria met. Translocated number currently 70% of target number.	Performance criteria met. Bushfire reduced translocated population, but renewed naturally occurring population at recipient site and on western side of highway, stimulating germination of thousands of seedlings.
4	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
4	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.
4	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

		Four-tailed Grevillea	Green-leaved Rose Walnut	Hairy Joint-grass	Red Lilly Pilly	Rough-Shelled Bush Nut	Singleton Mintbush
4	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
4	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
4	Evaluation and actions	Performance criteria met. All small plants salvaged, soil seedbank collected.	Performance criteria met. Saplings and juveniles transplanted. Cutting propagation not undertaken as past results poor. Seed collected and propagated.	Performance criteria met. Large number of immature plants salvaged. BOS22 offset site conserves large HJG habitat area.	Performance criteria met. Available seed used, cutting material unsuitable for propagation.	Performance criteria met. Propagated from locally collected seed.	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
1	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.
1	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.
1	Performance criteria	Plants complete their lifecycle and regenerate successfully	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.	At least 30 plants germinate and set seed each year	At least 50 plants germinate and set seed each year from Year 2	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 20 plants establish flower and set seed each year from Year 2
1	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*

		Slender Screw Fern	Stinking Cryptocarya	Tall Knotweed	Weeping Paperbark	White Laceflower	Yellow-flowered King of the Fairies
1	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.
1	Evaluation and actions	Performance criteria met. Sec3-11: Salvaged population maintained at recipient site for 3 years. Population reduced by bushfire in year 4, viable population appears to survive in parts of the two recipient areas. Sec 1-2: Results poor, small population surviving after 5 years, weeds a threat.	Performance criteria met. Lumleys Lane: transplanting results poor. Coolgardie Rd: Propagated seedlings introduced, growing slowly, good survival.	Performance criteria met. Annual species, translocated population has produced a small cohort of seedlings each year for 4 years. Large amount of seed produced in Year 1-2. Translocated population shows initial evidence of self-perpetuation in damper micro-habitat. However, numbers at any one time small so far.	Performance criteria met. Two large stands established, plants over 2m, recovered well from bushfire, good prospects to become self-sustaining. Third younger, stands also resprouted after fire, recovering.	Performance criteria met. Both transplants and propagated plants growing well.	Performance criteria met. Transplanting results good at Evans Head recipient site. Some plants producing seed pods. Plants at Lumleys Lane site stolen.
2	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
2	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.
2	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 establishment as relevant.	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 establishment as relevant.	Reporting to Include e.g. detail of growth and seeding periods and results of nursery tasks.
2	Threshold	Reporting incomplete	Reporting incomplete	Reporting incomplete	Reporting incomplete	Reporting incomplete	Reporting incomplete
2	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
2	Evaluation and actions	Performance criteria met. Knowledge of species' ecology, particularly life history, population dynamics and environmental interactions increased, as well as translocation methods.	Performance criteria met. Knowledge of species' ecology, particularly life history, population dynamics and environmental interactions increased, as well as translocation methods.	Performance criteria met. Knowledge of species' ecology, particularly life history, population dynamics and environmental interactions increased, as well as translocation methods.	Performance criteria met. Knowledge of species' ecology, particularly life history, population dynamics and environmental interactions increased, as well as translocation methods.	Performance criteria met. Knowledge of species' ecology, particularly life history, population dynamics and environmental interactions increased, as well as translocation methods.	Performance criteria met. Knowledge of species' ecology, particularly life history, population dynamics and environmental interactions increased, as well as translocation methods.

		Slender Screw Fern	Stinking Cryptocarya	Tall Knotweed	Weeping Paperbark	White Laceflower	Yellow-flowered King of the Fairies
3	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
3	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.
3	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.
3	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
3	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	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 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	Consider options for alternative research partners
3	Evaluation and actions	Performance criteria met. Bushfire substantially reduced extent of the translocated population but healthy population survives in reduced areas.	Performance criteria met. Translocated number currently equal to or greater than target/impact number.	Performance criteria met. . Population established. Criteria difficult to assess as species annual, and fluctuates with weather conditions.	Performance criteria met. On track to establish populations/stands at 3 sites.	Performance criteria met. On track to achieve no net loss.	Performance criteria met. Evans Head – clump size increased, seed production occurring.
4	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
4	Objectives	All available plants and associated soil harvested and	Trees and saplings transplanted. Suitable cutting material for predicted requirements x 2	All available plants and associated soil harvested and	Available seed is harvested for nursery propagation.	Trees and saplings are transplanted. All potential cutting material (and seeds if	All available plants translocated to new hosts

		Slender Screw Fern	Stinking Cryptocarya	Tall Knotweed	Weeping Paperbark	White Laceflower	Yellow-flowered King of the Fairies
		transplanted to best extent practical	harvested seeds if available for nursery propagation.	transplanted to best extent practical		available) harvested for nursery propagation.	
4	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
4	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
4	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
4	Evaluation and actions	Performance criteria met. All in situ plants salvaged to the recipient site.	Performance criteria met. Attempt made to transplant all saplings.	Performance criteria met. Seedlings, sub-adults and mature plants salvaged, Seedlings grown in nursery and introduced.	Performance criteria met. Seed collected from cross-section of trees in the impacted population.	Performance criteria met. All plants at impact sites were salvaged. Some seed collected.	Performance criteria met. All plants at impact sites were salvaged.

Table 16: Evaluation of Translocation Outcomes on Sections 1-2 & EWSSTA, as reported in Landmark Ecological Services 2017 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
1	**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)
1	**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
1	**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
1	**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
1	**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.
1	**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.	Two large plantings all dead. No seedlings observed to date.	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. . 950 additional plants propagated and planted in October 2020.	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
2	**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
2	**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.
2	**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.
2	**Threshold**	Reporting incomplete	Reporting incomplete	Reporting incomplete	Reporting incomplete	Reporting incomplete	Reporting incomplete
2	**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
2	**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
3	**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
3	**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
3	**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
3	**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
3	**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
3	**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. All plants from two large plantings dead. Cover zero.	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, 950 additional plants propagated planted in October 2020.	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

4	**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
4	**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
4	**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
4	**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.
4	**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
4	**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 (as reported in Landmark 2016 with some additional comment by Ecos Environmental)

	Species	Hairy joint-grass	Tall knotweed
1	Aim	Create a self-sustaining population	Maintain a self-sustaining population.
1	Objectives	Plants complete their lifecycle and regenerate successfully	Plants complete their lifecycle and regenerate successfully
1	Performance criteria	At least 50 plants germinate and set seed each year	At least 30 plants germinate and set seed each year
1	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
1	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.
1	Evaluation and actions	Site 1 No plants observed in Year 5 Site 2 No plants observed in Year 5	Landmark reported after two years that plants had died back and two short-lived seedlings were observed. No seedlings or regrowth of Tall Knotweed were recorded in the recipient site by Ecos Environmental in Years 3-5 although one patch of plants was recorded north of the recipient site in 2020.
2	Aim	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species
2	Objectives	Relevant project results and observations documented.	Relevant project results and observations documented.
2	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.
2	Threshold	Reporting incomplete	Reporting incomplete
2	Corrective action	Project manager to address with sub-contractors	Project manager to address with sub-contractors
2	Evaluation and actions	Reported in 2016 and current annual reports	Reported in 2016 and current annual reports

3	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
3	Objectives	Original number of individuals and area re-established	Original number of individuals and area re-established
3	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
3	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
3	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
3	Evaluation and actions	Landmark reported in the first two years that at 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. In years 3-5, Ecos recorded that plants had died out at both sites. In situ HJG in the adjoining powerline easement were increased by biomass reduction implemented by Ecos Environmental.	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.
4	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
4	Objectives	Soil associated with above-ground plants transplanted	All available plants and associated soil harvested and transplanted to best extent practical
4	Performance criteria	No unsalvaged material present on ground inspection	No unsalvaged material present on ground inspection
4	Threshold	More than 10% of the original material present.	More than 10% of the original material present
4	Corrective action	Project manager to address with contractors	Project manager to address with contractors
4	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 and Work Required in 2022

No corrective actions are proposed for translocated species on Sections 3-11 of the W2B project.

Further monitoring and maintenance is required to meet the five year requirements for unexpected find species that were translocated a year later and have been so far been monitored for 3.5 to 4 years (introduced at slightly different times). These species include:

- Slender Screw Fern
- Singleton Mint Bush
- Stinking Cryptocarya (Coolgardie Rd Rainforest Species Translocation Area)
- Red Lily Pilly (Coolgardie Rd Rainforest Species Translocation Area)
- Rusty Rose Walnut (Coolgardie Rd Rainforest Species Translocation Area)
- White Laceflower (Coolgardie Rd Rainforest Species Translocation Area)
- Rough-shelled Bush Nut (Coolgardie Rd Rainforest Species Translocation Area)
- Lindernia
- Rotala
- Richmond River Birdwing Vine
- Four-tailed Grevillea

In the works schedule, there is provision for monitoring and maintenance in year 6. This will cover monitoring and maintenance requirements of the unexpected find species in 2022. As the unexpected finds make up the majority of species translocated on Sections 3-11, it is proposed to include all the translocations in the annual monitoring carried out 2022.

6.0 References

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Appendix 1: Photographs Sections 3-11

Plate 1: Translocated Slender Screw Fern (*Lindsaea incisa*) in Area 1 Recipient Site, Bundjalung National Park, two years after the Nov/19 fire and four years after transplanting from construction footprint. *L. incisa* regenerated after the moderate to high intensity bushfire by resprouting from its rhizomes which are only 2-3mm in diameter and spread horizontally through the topsoil. This clump is on 'a patch' introduced from unexpected finds in 2017 (four trays per patch). Nov/2021

Plate 2: Stakes mark Slender Screw Fern in the Area 1 Recipient Site, Bundjalung National Park, amongst dense ground layer regrowth two years after the Nov/19 fire. Clumps of Slender Screw Fern that resprouted after the fire were re-staked and given a new identification number for monitoring. We were able to allocate clumps of fern to the Lines of introduced plants set out in 2016 and 2017 before the fire, to estimate and compare crown cover pre- and post-fire. Nov/2021

Plate 3: Slender Screw Fern in Area 2 Recipient Site, Bundjalung National Park, two years after the Nov/19 fire. Slender Screw Fern on Line A in Area 2 responded positively to fire, increasing in cover-abundance two years after fire compared to pre-fire (cover 6.6% vs 13%, Table 8). Nov/2021

Plate 4: Slender Screw Fern in the Area 2 Recipient Site, Bundjalung National Park, two years after the Nov/19 fire. Clumps of Slender Screw Fern resprouting after the fire were re-staked and given a

f plots

Plate 5: *Melaleuca irbyan*a saplings two years after the Nov 2021 fire. The fire killed the stem which reshot from the ground. Height in 2021 averaged about 2m or about the same height as before the fire. This is the Area 2 Receival Site on 0ffset land south of Tabbimoble Creek.

Plate 6: *Melaleuca irbya*na Recipient Site on northern end of Tabbimoble Triangle two years after planting. The ht. The

Plate 7: Lopping competing saplings of Eucalyptus and Casuarina at *Melaleuca irbya*na Recipient Site B south of Tabbimoble Creek. This was the third treatment since seedlings were planted in 2017.

Plate 8: *Melaleuca irbyana* recipient A on offset land south of Tabbimoble creek, after lopping competing saplings (see on the ground). The dead standing stem in centre is a *M. irbya*na stem killed by fire. The live stem next to it reshot near the base of the dead stem and is approx. 2 m high, two

Plate 9: *Melaleuca irbyana* sapling two years after fire at the Tabbimoble Triangle recipient site. Sapling stems were killed by fire, but >90% regenerated by resprouting at ground level. Some reshot to more than their pre-fire height in two years. This species was translocated by propagating from

seed collected at the rescue site at New Italy. This species is easy to propagate from seed, fast growing when planted-out and a vigorous post-fire resprouter, which begs the question, why does it

Plate 10: Tall Knotweed (*Persicaria elatior*), Yaegl Nature Reserve Recipient Site flooded in March/2022 with Tall Knotweed plants growing in standing water 0.5 m deep along the edge of the Paperbark swamp. Plants of this short-lived, annual species are nearly always in flower.

Plate 12: Yaegl Swamp Recipient Site showing effects of long flood season in summer 2021-22. Herbaceous vegetation dominated by the exotic *Paspalum conjugatum* is dead and bare ground should encourage Tall Knotweed recruitment from seed. A plot stake can be seen with pink tape.

Plate 13: Tall Knotweed in plot – see stake – these plants had leaves above the water level so were not killed (see Plate 14). Pink flowers can be seen.

Plate 14: A dead Tall Knotweed plant identified from the swollen nodes along the main stem and dead leaves with glandular hairs (hand lens needed). If fully submerged, Tall Knotweed dies, but if

Plate 15: Hairy Joint Grass clump at Lumleys Lane, Section 10, growing in large, cleared paddock.

Plate 16: Hairy Joint Grass (grass with short leaf blades) in flower at Lumleys Lane Recipient Site

Plate 17: In Situ Hairy Joint Grass (grass with short leaf blades) in flower at Lumleys Lane, growing in a large, ungrazed paddock. No cows have been in the paddock for about 5 years, since construction of the project started in 2015-6. A very large population of HJG was present in the paddock when the cows were taken off, as non-intensive grazing usually promotes HJG by keeping pasture relatively low with plenty of gaps where annual recruitment can occur. HJG cover decreased after the cows removed but annual slashing reduced biomass enough for HJG to persist as a smaller population. Recently it appears to have increased again due to maintenance slashing around some eucalypts planted in the lower part of the Lumleys Lane paddock (BOS 22).

Plate 18: Red Lilly Pilly in wire cage to prevent wallaby grazing at the Lumleys Lane rainforest species recipient site. This species had a much higher survival rate at the latter site compared to the Coolgardie Rd rainforest species recipient site, probably because of differences in soil texture and drainage, as geology, landform and maintenance regimes were similar at both sites. Growing tips are infected with red tip (turned dark brown at this site) and leaves are unhealthy. Although survival rate was relatively high after five years, only one or two plants were reasonably healthy. Mar/2022.

Plate 19: Red Lilly Pilly at Lumleys Lane recipient site. This leggy plant is about 1.4 m high after 5 years but has few leaves. It looks healthy enough and may survive and grow on into a mature tree, a first for translocation of this species in my experience.

Plate 20: Red Lilly Pilly at Lumleys Lane recipient site. This plant (no. 10) is the healthiest of 13 at the site and about 1 m high. The new leaves are healthy in contrast to leaves lower down. New leaves have grown out of the top of the red tip 'cap', which was left in place rather than picking it off. This growth that looks like a disease may actually provide a protective shield against insects. Picking it off removes apical buds as well, so no new leaf is produced, and plant condition declines.

Plate 21: Close up of red tip 'disease' on Red Lilly Pilly. Several infected shoots can be seen in one leaf axil and scars where previous red tip shoots were picked off during maintenance. They are brittle and easily break off. New shoots grew from below the break and a new hardened red tip formed. The red tip appears to require several months or a year before leaves are produced out of the top of the hardened cap. The poor condition of old leaves, possibly 3 or 4 years old can be seen.

Plate 22: Singleton Mint Bush (SMB) at the recipient site in Tabbimoble Triangle. These translocated plants over 2 m high have been pushed over by a recent flash flood. They survive flood and produce new vertical shoots. The grey leaves are dead and green stems still alive, and can reshot. Most SMB plants at the recipient site were in similar condition, in contrast to the reference site (Plates 25&26).

Plate 23: SMB recipient site where Transect C of the experimental plantings is located, showing dense post-fire regrowth dominated by Trema tomentosa. A few SMB survived in these plots by resprouting and the few seedlings that germinated after the fire were dead after two years. The translocated population contracted to the creek levee where soil is sandier. March/2022.

Plate 24: A SMB plant affected by 'grey wilt' after a recent flash flood and period of saturated soil, during the long rainy season of summer-autumn 2021/2022. This condition appears to be related to the disease that killed young seedlings during the first translocation attempt in 2017. The stem has wilted as well as the leaves, which indicates the root system is not taking up water to maintain cell tugor which keeps stems rigid. This may be caused by the soil pathogen *Phytophthora cinnamomii* infecting root hairs and should be flagged for further research, as it could reveal how plants are able to develop resistance to this devastating disease, as appears to happen with SMB. March/2022.

Plates 25&26: SMB in reference area on west side of the highway. A high density of seedlings regrew after the Nov/21 fire and are 1-2+ m high. Grey wilt affects ~10% of plants compared to ~75% of plants at recipient site. Plates shows healthy tips after similar flood depth (stems bent over by force of water). Like the Recipient Site, SMB here prefers sandier soil on the creek levee. March/22.

Plates 27&28: Top plate shows creeping reddish stems of *Rotala tripartita* growing along the left hand (east) side of the pond in the lower plate. Rescued in 2017, they were planted in pots in 2018 to allow adjustment in position. Proved to be a hardy species, spreads by stolons. Aug/21

Plates 29: *Rotala tripart*ita had a decumbent to prostrate growth habit at the recipient site on the edge of a pond constructed on the offset land south of Tabbimoble Creek. The plant redness is due to recent soil dryness and frost, which the plant survived. The plants flowered but no seedlings were recorded. Pots were moved up and down as water level in pond changed, but the first position on upper part of bare edge (see Plate 28) proved best. This species appears to die if submerged for more than a week or two and may survive dry seasonal conditions as a dormant stolon. Aug/21.