Warrell Creek to Nambucca Heads Upgrade of the Pacific Highway

Threatened Flora Translocation Project

Annual Monitoring Report – Year 2

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Cover Plate: Rusty Plum (*Niemeyera whitei*) transplant at Receival Site 1 showing vigorous new shoot growth after two years.

EXECUTIVE SUMMARY

This report describes the implementation and results of threatened flora translocations carried out for the Warrell Creek to Nambucca Heads (WC2NH) upgrade of the Pacific Highway over two years (Feb 2015 to January 2017). The translocation project was implemented by Ecos Environmental for Pacifico (Acciona - Ferrovial joint venture) based on the Warrell Creek to Urunga Threatened Flora Management Plan (ECOS Environmental Ver. 4 (24/12/2014) and Ver. 5 (1/7/2016)). Five threatened species were translocated from the highway corridor to adjoining bushland: *Marsdenia longiloba* (Slender Marsdenia), *Tylophora woollsii* (Woolls' Tylophora), *Dendrobium melaleucaphilum* (Spider Orchid), *Niemeyera whitei* (Rusty Plum) and Floyds Grass (*Alexfloydia repens*). One nationally rare species, *Artanema fimbriata* (Koala Bells) was also translocated.

The translocation project aimed to establish populations of the impacted species in habitat adjacent to the highway corridor. To achieve this aim, the translocation program had three components:

- salvage transplanting of impacted individuals from the construction footprint;
- population enhancement by introduction of additional plants propagated from locally collected seed, to promote population establishment and long-term viability; and
- restoration of good quality habitat to the receival sites.

Potential receival sites were assessed according to physical, biotic and logistical criteria set out in the management plan. Nine receival sites were selected spread out along the road corridor to provide habitat suited to each species and to minimise the distance plants were moved from the donor sites. Eight were in the road reserve and one on adjoining RMS property. Receival sites were selected with a buffer of forest ~20 metres wide within the Road Reserve and with State Forest on the other side, to provide microclimatic protection.

Salvage of impacted plants was carried out by direct transplanting. Two years after translocation, all species had a survival rate greater than 80% with the exception of Koala Bells (see Table 1 below). The overall survival rate of Slender Marsdenia, the main species requiring translocation was 82% (173 individuals translocated). This survival rate is higher than achieved for Slender Marsdenia after two years on NH2U project (71.2%). Plants were transplanted directly to the new sites, watered in and given follow-up watering. Fertilisers were not applied.

Spider Orchid flowered in spring in Year 1 and 2 but no seed pods formed. Koala Bells started to flower a month after transplanting and set seed, then declined in Year 2 apparently due to its short life cycle. A novel approach was used to prepare the receival site for Floyds Grass which was heavily infested with Broad-leaved Pasplaum and other weeds. Ground layer vegetation and the top 10cm of soil containing most of the soil seedbank were stripped off using an excavator, creating largely weed free soil conditions for Floyds Grass to establish in. Nearly all Floyds Grass clumps survived (95%+) and produced substantial growth in Year's 1 and 2.

Assessment of the translocation outcomes after two years according to the performance criteria in Appendix 11 of the WC2U Threatened Flora Management Plan (Ver. 4 24/12/2014) found that all performance criteria had been met.

Table 1: WC2NH threatened flora translocation results – number of plants of each species translocated and percent survival rate after 6 months, 1 year and 2 years to 17/1/2017 (see Excel spreadsheet for all results recorded at each monitoring event).

Species/Receival Site	Number of plants	% survival		
		Aug 2015 (~6 mths)	Feb 2016 (~1 Year)	Jan 2017 (~2 Years)
Slender Marsdenia (*Marsdenia longiloba*)				
Receival Site 1 - Cockburns Lane	27	93	93	75
Receival Site 2 (3) – Old Coast Rd	15*	100	91	93
Receival Site 3 (5a) – Old Coast Rd	22	81	81	91
Receival Site 4 (5b) – Old Coast Rd	16	100	94	81
Receival Site 5 (7a) – Old Coast Rd	57	90	90	72
Receival Site 6 (8a) – Old Coast Rd	8	88	75	75
Receival Site 8 (8c) – Old Coast Rd	28	93	100	86
Total	173		91	82
Rusty Plum (*Niemeyera whitei*)				
Receival Site 1 - Cockburns Lane	7	100	100	88
Wooll's Tylophora (*Tylophora woollsii* – unconfirmed)				
Receival Site 6 (8a) – Old Coast Rd	6	100	100	100
Spider Orchid (*Dendrobium melaleucaphilum*)				
Receival Site 5 (7a) – Old Coast Rd	2	100	100	100
Floyds Grass (*Alexfloydia repens*)				
Receival Site 9 – Warrell Creek	54 clumps	100	94	94
Receival Site 9a – Warrell Creek	61 clumps			98
Koala Bells (*Artanema fimbriatum*)				
Receival Site 7 (8b) – Old Coast Rd	16	75	63	25

* increase as additional plants translocated due to design modification

1 INTRODUCTION

1.1 Background

This report documents the implementation and results of threatened flora translocations conducted for the Warrell Creek to Nambucca Heads (WC2NH) project, a 23.6 km section of the Pacific Highway upgrade on the Mid North Coast. The translocations were carried out by Ecos Environmental for Pacifico (Acciona and Ferrovial joint venture), the principal contractor for the WC2NH project. Implementation of the translocations followed the Warrell Creek to Urunga Threatened Flora Management Plan (ECOS Environmental Ver. 4 (24/12/2014) and Ver. 5 (1/7/2016)), as required by condition B7 of the project approval in relation to flora listed in the NSW *Threatened Species Conservation Act* 1995. Referral and approval was also required in relation to threatened plant species listed under the Commonwealth *Environmental Planning and Biodiversity Conservation Act* 1999, as indicated below.

The WC2NH project is the southern half of the Warrell Creek to Urunga section of the Pacific Highway upgrade, the northern half being the Nambucca Heads to Urunga project. Both projects are covered by the Warrell Creek to Urunga Threatened Flora Management Plan (TFMP). The structure of the translocation section of the TFMP was based on the ANPC (2004) guidelines for planning threatened flora translocation in Australia. (The TFMP also deals with management of in situ threatened flora in close vicinity to the new highway.)

Five threatened and one nationally rare plant species were translocated: -

Threatened

- Slender Marsdenia (*Marsdenia longiloba*) (TSC Act, EPBC Act) (Plate 1)
- Woolls' Tylophora (*Tylophora woollsii*) (TSC Act, EPBC Act) (Plate 2)
- Rusty Plum (*Niemeyera whitei*) (TSC Act) (Plate 3)
- Spider Orchid (*Dendrobium melaleucaphilum*) (TSC Act) (Plate 4)
- Floyds Grass (*Alexfloydia repens*) (TSC Act) (Plate 5)

Nationally Rare

- Koala Bells (*Artanema fimbriatum*) (Plate 6)

An additional threatened species *Maundia triglochinoides* (TSC Act) was translocated on the initiative of the principal contractor although this was not required by the Threatened Flora Management Plan.

This is the second annual monitoring report and describes results and implementation of the WC2NH translocation project from February 2015 to January 2017.

1.2 Strategy and Objectives

The overall strategy of the translocation project was to salvage individuals of threatened and rare species from the highway footprint and use these individuals plus additional propagated plants to re-establish compensatory populations adjacent to the highway corridor. To achieve this aim the translocation program had three components:

- salvage transplanting of impacted individuals from the construction footprint into receival sites containing similar habitat to the impact/donor sites;
- population enhancement by introduction of additional plants propagated from locally collected seed, to promote population establishment and long-term viability; and

- restoration of good quality habitat to the receival sites.

The objectives of the translocation project set out in the Warrell Creek to Urunga Threatened Flora Management Plan are as follows:-

- To salvage and re-establish impacted individuals of threatened (TSC/EPBC Act) species.
- To re-establish species at a relocation site in close proximity to the original site with closely matching habitat and long-term security of tenure.
- To enhance the size and genetic diversity of the translocated population by propagation and introduction of individuals additional to those salvaged from the road footprint.
- To maintain good quality habitat to the relocation site(s).
- To preserve individuals of threatened species in situ wherever possible and limit transplanting to plants within the highway footprint and construction buffer.

1.3 Reporting Requirements

The reporting requirements for the annual translocation monitoring report are specified in Section 4.8.5 of the TFMP The table below indicates the sections where reporting requirements are addressed.

Reporting requirement	**Where addressed in the annual monitoring report?**
Background and description of the translocation project;	Section 1, 2 and 3
Implementation of the translocation project;	Section 3
A description of monitoring methods;	Section 3.8
An analysis of monitoring data on a species by species basis;	Section 4
An assessment of causes of plant mortality;	Section 4
A record of the plants transplanted and propagated;	Section 3 Excel spreadsheet appended to report
A description of the population enhancement program;	Section 3
An assessment of the success or failure of the translocation based on criteria set out in the WC2U TFMP Ver.5 (Appendix 11 and Section 4.8.6);	Section 5
An evaluation of the methods and cost-effectiveness of the translocation project; and	Section 5
Work plan for the next twelve months.	Section 5

Plate 1: Slender Marsdenia (*Marsdenia longiloba*) produces umbels of white flowers in the leaf axils. Leaves are similar to Woolls' Tylophora, both species have clear sap.

Plate 2: Woolls' Tylophora (*Tylophora woollsii*) has purplish flowers arranged in a short cymose panicle in the leaf axil.

Plate 3: Rusty Plum (*Niemeyeria whitei*) is a medium sized rainforest tree.

Plate 4: Spider Orchid (*Dendrobium melaleucaphilum*) produces large, vanilla scented flowers in August and September.

Plate 5: Floyds Grass (*Alexfloydia repens*) a rare mat-forming grass found along creeks between Coffs Harbour and Warrell Creek

Plate 5a: Koala Bells (*Artanema fimbriatum*). An annual or short-lived perennial herb found in grassy forest on coastal floodplains.

2 RECEIVAL SITES

2.1 Site Selection

As offset lands had not been designated by the start of construction and residual parcels of RMS land outside the project boundary were generally cleared, selection of translocation receival sites focused on forest habitat within the Road Reserve next to the new highway. The Road Reserve includes all land between the property boundaries of the road corridor, including any strips of forest or other vegetation either side of the road. Where the WC2NU corridor was cleared through Nambucca State Forest, a strip of uncleared forest from 20 to 40+ metres wide generally remained within the Road Reserve next to State Forest after clearing. Small sections of forested road reserve adjoining private property were also available south of Warrell Creek.

Potential translocation receival sites in the Road Reserve were identified by desktop review of aerial photography overlaid with the road design, topography and vegetation communities. Approximately 20 sites were inspected and assessed according to selection criteria in the TFMP (Section 4.3.3; Table 2 below). In terms of number of individuals, Slender Marsdenia was the main species requiring translocation. As this species was impacted at several locations scattered along the full length of highway corridor, several receival sites were selected to maintain a distribution similar to the original one. Nine receival sites were selected, seven in the road reserve where the highway corridor crosses Nambucca State Forest. The other two were in the road reserve at the southern end of the project and on RMS land adjacent to the new highway bridge at Warrell Creek outside the project boundary.

Table 1: Translocation Receival Sites.

Receival Site	Species
1	Slender Marsdenia, Rusty Plum
2	Slender Marsdenia
3	Slender Marsdenia
4	Slender Marsdenia
5	Slender Marsdenia
6	Slender Marsdenia, Woolls' Tylophora(?)
7	Koala Bells
8	Slender Marsdenia
9	Floyds Grass

Receival sites were selected that contained similar habitat to the donor sites. The sites generally contained mature regrowth forest selectively logged 30-50 years ago. Understorey species composition and soil type were similar to the donor sites. All receival sites for Slender Marsdenia and Woolls' Tylophora were selected in moist open forest on lower to mid hill slopes with an east to southeast aspect. Dominant/canopy species included Grey Gum (*E. propinqua*), Ironbark (*E. siderophloia*), Tallowwood (*E. microcorys*), White Mahogany (*E. acmenoides*), Pink Bloodwood (*Corymbia intermedia*), Blackbutt *(E. pilularis*) and Turpentine (*Syncarpia glomulifera*), proportions varying from site to site.

A receival site was selected for Floyds Grass on alluvial soil next to Warrell Creek in semi-intact riparian forest with a weedy understorey of Broad-leaved Paspalum (*Paspalum mandiocanum*) and Lantana. This was the only site available with the requisite soil type and topography typical of Floyds Grass habitat. A novel approach was trialled to remove the Broad-leaved Paspalum and restore native species to the

ground layer, as described belowl. A gully floor site with seasonally waterlogged soil was selected for Koala Bells.

Brief descriptions of the nine receival sites are provided below. Photos of the receival sites are included with the plates at the end of the report.

2.2 Receival Site 1

Receival Site 1 is located in the road reserve on the eastern side of the highway alignment adjacent to Cockburn's Lane at the southern end of the project. The road reserve is relatively narrow at this point and exposed to the west, although timbered on the eastern side, giving reasonable microclimatic protection. The soil type is a red loam formed on a black, glassy rock different to the metasediment geology along the rest of the alignment (Nambucca Beds). Slender Marsdenia and Rusty Plum impacted at Cockburns Lane were translocated to adjacent Receival Site 1 which has the same red loam soil type. A buffer of forest approximately 20m wide separates the receival site from the cleared road corridor.

2.3 Receival Site 2 (3)

(Note – the original numbering for the site selection process is shown in brackets).

Receival Site 2 is located north of the Nambucca River in a strip of forest between Old Coast Road and the highway alignment. The site faces east and is located on a mid slope. A buffer of forest approximately 30m wide separates the translocation area from the cleared road corridor.

2.4 Receival Site 3 (5a)

Receival Site 3 is located on the western side of the alignment in a narrow strip of forested road reserve. As the site adjoins Nambucca State Forest on the western side, which extends upslope for more than 100 metres, the site is relatively protected. The site aspect is east and the topographic position lower-slope. A buffer of forest approximately 15m wide separates the translocation area from the cleared road corridor.

2.5 Receival Site 4 (5b)

Receival Site 4 is located about 100 metres north of site 3 on the other side of a gully which intersects the alignment at right angles (site 3 being on the southern side of the gully). A buffer of forest approximately 30m wide separates the translocation area from the cleared road corridor.

2.6 Receival Site 5 (7a)

Receival Site 5 is located further north between Old Coast Road and the highway alignment, adjacent to the turn-off to the Council waste recycling depot. This site has similar aspect and topographic position to site 3 and is well protected on the western side by a wide strip of Nambucca State Forest between Old Coast Road and the new highway.

2.7 Receival Site 6 (8a)

Receival Site 6 is located a few hundred metres south of where the alignment crosses Old Coast Road just south of Nambucca Heads. The site is located in the road reserve in a narrow strip of forest next to an easement with a fiber-optic cable and water main, close to the road reserve boundary, again on the western side of the

highway. The site aspect is east and topographic position lower slope. There is a forested buffer approximately 20 metres wide between the site and the highway. The site is well protected on the western side by Nambucca State Forest.

2.8 Receival Site 7 (8b)

Receival Site 7 is located about 50 metres south of site 6 in a stand of Paperbark swamp forest on the flat gully floor. This was the only site found with swamp forest vegetation similar to the type of habitat preferred by Koala Bells. Being in a narrow section of the road reserve and close to a utilities easement the site was not ideal, but was the best that could be found within the road reserve. (Note – Koala Bells (*Artanema fimbriatum*) is not a listed threatened species, although regarded as rare and would probably qualify for listing as a threatened if nominated. Translocation of this species was not essential and undertaken more as a pre-cautionary measure. Koala Bells was translocated on other highway upgrade projects because of its rarity.)

2.9 Receival Site 8 (8c)

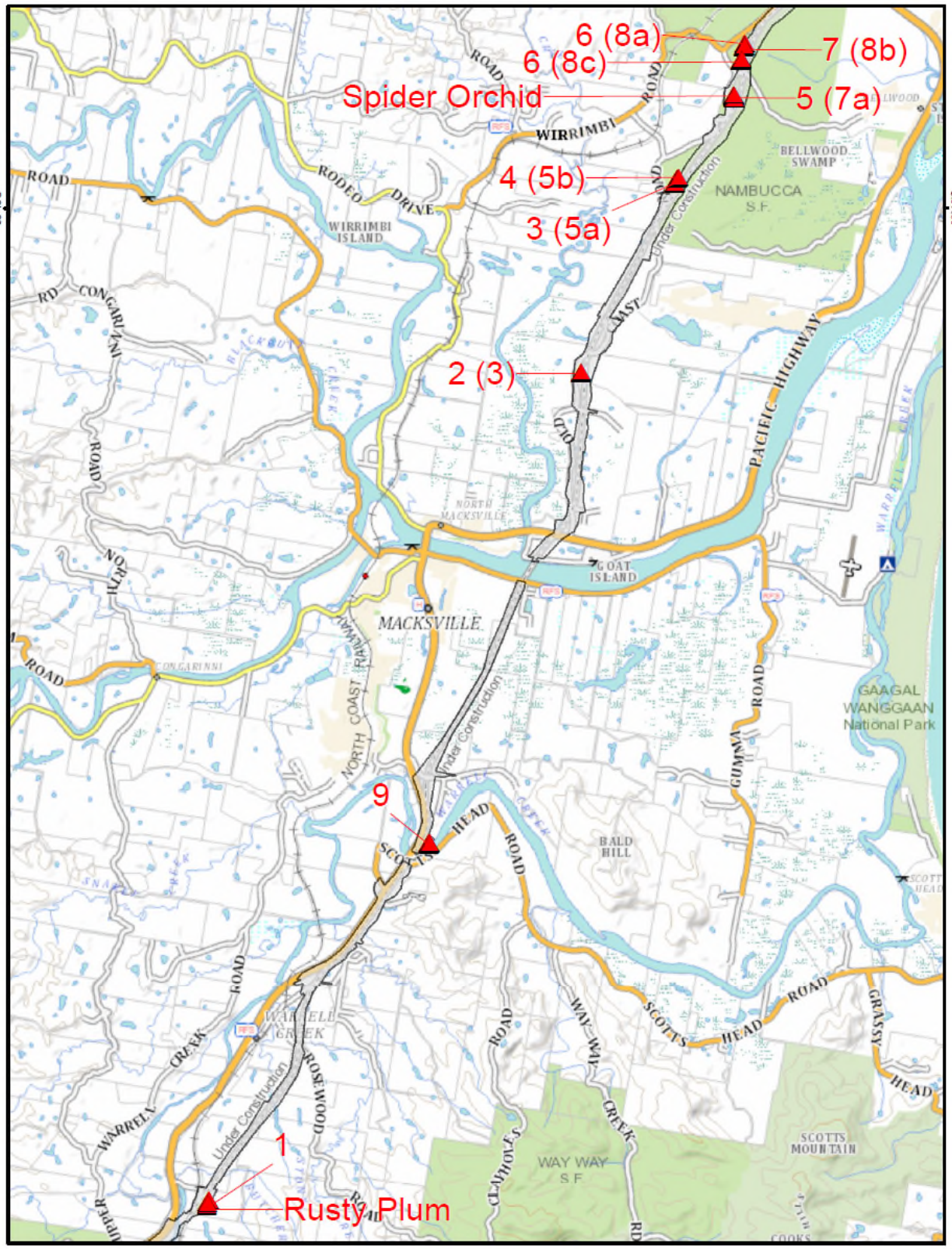
Receival Site 8 is located further south adjacent to the same utilities easement as sites 6 and 7. The site is well protected on the western side by Nambucca State Forest. The site aspect is east and topographic position lower slope. A buffer of forest approximately 30m wide separates the translocation area from the cleared road corridor.

2.10 Receival Site 9

Receival Site 9 selected for Floyds Grass is approximately 100 metres north of the donor site on the northern bank of Warrell Creek. Floyds Grass is usually found in open riparian forest within 30 metres of coastal waterways. Plant communities include swamp sclerophyll forest dominated by Swamp Sheoak (*Casuarina glauca*) and moist open forest dominated by Flooded Gum (*Eucalyptus grandis*), *Melaleuca* spp. and rainforest species, the latter type being found in Receival Site 9. Suitable habitat for Floyds Grass is fairly extensive on the northern side of Warrell Creek, but overrun with Broad-leaved Paspalum (*Paspalum mandiocanum*), which required fairly intensive weed removal and habitat restoration. Two areas were selected for planting at Receival Site 9, each covering approximately 30 m x 20 m. Receival Site 9 is located on RMS land outside the project boundary and has been identified for ecological restoration after the completion of road construction.

Table 2: Site attributes of the nine receival sites selected for translocation of threatened species on the WC2NH project

Receival Site/ Site Attributes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Physical									
slope aspect (S-south,E-east)	S	E	E	E	E	E	E	E	flat
slope angle (m-low to mod.)	m	m	m	m	m	m	m	m	flat
topographic position	mid	mid	lower	lower	lower	lower	lower	lower	plain
landform	hills	hills	hills	hills	hills	hills	hills	hills	plain
geology (✓ matching donor site)	✓	✓	✓	✓	✓	✓	✓	✓	✓
soil (✓ matching donor site)	✓	✓	✓	✓	✓	✓	✓	✓	✓
proximity to donor site (✓ <1km)	✓	✓	✓	✓	✓	✓	✓	✓	✓
area of potential habitat available (✓ adequate)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Vegetation									
plant community (✓ matching donor site)	✓	✓	✓	✓	✓	✓	✓	✓	✓
threatened species already present (p-possible)	p	p	p	p	p	p	p	p	n
invasive/difficult to control weeds present (y-yes; n-no)	n	n	n	n	n	n	n	n	y
Logistical									
accessibility (g-good; f-fair; p-poor)	g	f	f	f	f	g	g	g	g
available water source (y-yes; n-no; water cart)	n	n	n	n	n	n	n	n	n
distance to water source	kms	kms	kms	kms	kms	kms	kms	kms	kms
likelihood of disturbance during construction (u-unlikely; p-possible)	u	u	u	u	u	u	u	u	u
Tenure/conservation									
land ownership/ protection mechanism	RMS	RMS	RMS	RMS	RMS	RMS	RMS	RMS	RMS
potential disturbance by future road widening (p – possible)	p	p	p	p	p	p	p	p	p
other project conservation uses (y-yes, forest habitat)	y	y	y	y	y	y	y	y	y



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Receival Sites: Ecos Environmental 2015
Background topographic map: NSW Land & Property Information 2015
Road Design detail and corridor: RMS 2014

This plan is based on or contains data provided by others. ECOS Environmental gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of privacy laws.

WC2NH-SOUTHERN-RECEIVAL-SITES-OVERVIEW-160224

0 1 2 Kilometers
A4 Scale 1:60,000
Coordinate System: GDA 1994 MGA Zone 56 Projection: Transverse Mercator

Receival Sites
WC2NH road corridor

Receival Sites for the WC2NH Threatened Flora Translocation Project

3 TRANSLOCATION METHODS

3.1 General

Salvage transplanting was carried out in February 2015 before the start of clearing with the exception of Floyds Grass translocated in July 2015. There was minimal risk of frost damage to Floyds Grass by transplanting in winter as the receival site was next to a large water body (Warrell Creek) and there was partial tree cover. All species were translocated by direct transplanting, a method for salvaging wild plants designed to be fast and cost-effective, whilst achieving good survival rates. Excavation, transport and replanting are carried out as quickly as possible. Pruning and thorough watering are essential for good rates of survival. This approach minimises risk of disease and pest transfer to the wild as a result of holding plants in a nursery or exposing transplants to extraneous materials (e.g. soil mixes etc).

Shaded positions were selected for planting, or shade screens were erected if transplants were exposed to full sun. Slender Marsdenia were set out in rows at roughly equal spacing to assist with relocating and monitoring. No fertilisers were applied with the exception of Floyds Grass which was given 'Seasol' twice. This treatment had been applied at Bonville with good results. As the soil surface at the Floyds Grass site was initially bare (see below), the site was lightly mulched with cane mulch to minimise erosion and raindrop compaction. Rusty Plum was mulched with cane mulch and leaf litter was spread over the soil for other species. Translocation methods applied to each species are described in more detail below.

Translocation methods applied to each species are described in more detail below with some general plates showing examples of translocated individuals in Appendix 1.

3.2 Slender Marsdenia

3.2.1 Salvage Transplanting

Transplanting of Slender Marsdenia was carried out by tracing stems to the ground and marking the base with pink tape, then digging out a section of the root system about 40cm wide to a depth of about 20cm with a spade. Usually each mapped point represented more than one stem, each stem being one individual and all were salvaged. The excavated plants and soil were kept wet, transported to the receival site and planted in approximate rows at points pre-marked with pink tape. As clearing had not started, the clearing limit and project boundary were pegged out beforehand by surveyors to ensure plants were not placed in the clearing zone or outside the project boundary.

A total of 169 Slender Marsdenia plants were salvaged and planted at seven of the nine receival sites in Table 1, in February 2015. A few additional plants were translocated in Year 2 due to a design modification for off-ramps adjacent to the southern end of Old Coast Road. Any additional plants found during translocation work not specified in the TFMP were also salvaged. This is no uncommon with Slender Marsdenia as plants are often missed during surveys due to the cryptic nature of the plant.

Water was applied straight after transplanting to saturate the soil then once every second day for a week and once a week for four weeks. Chicken wire cylinders were installed around each individual to prevent damage by animal digging and grazing, to act as a climbing frame and make small plants and fine stems easier to see during

monitoring. Flagging tape was attached to the base of each stem just above the ground to assist with finding an individual if it had died back. Flagging tape with the individual's monitoring number and source identification code as per the TFMP was attached to each wire cage. Multiple individuals from the same mapped flora point were indicated by an additional suffix on the source identification code – e.g. Ml46-7

3.2.2 No use of fertiliser

No fertiliser was applied to Slender Marsdenia transplants on the WC2NH project as previous translocations of this species for the Bonville and NH2U projects indicated that fertiliser (slow release pellets) has an adverse effect on growth and survival. Experimental comparisons of fertiliser and no fertiliser treatments on the NH2U project confirmed that even relatively light applications of slow release fertiliser resulted in depressed plant growth (Ecos Environmental 2016).

By contrast, translocation experience has shown that most other species respond positively to fertiliser application, particularly tree and shrub species, although there are exceptions here also.

3.2.3 Propagation of population enhancement plants

The strike rate of rhizome cuttings of Slender Marsdenia on the NH2U project was less than 10% and the propagated plants grew slowly and lacked vigour. Seed propagation was more successful, as approximately 100 seedlings were propagated from one Slender Marsdenia seed pod. The seedlings grew rapidly in the nursery and after planting-out (Ecos Environmental 2016). Seed propagation was therefore the preferred method of propagation for the WC2NH project, but finding seed pods of Slender Marsdenia has proven difficult. Genetic analysis showed that out-crossing in Slender Marsdenia must occur fairly often, which implies that seed production occurs quite frequently, or used to in the recent past (Shapcott et al. 2016). The apparent rarity of pods could be due to them forming on larger vines in the forest mid-stratum, where the vine plant and any flowers and pods are well camouflaged and hard to see.

On the NH2U and S2W projects, Slender Marsdenia were recorded flowering in November and ripe pods were collected in December (only one pod each project). It is not known if pods form quickly (i.e. one or two months after flowering) or take longer. Large plants of Slender Marsdenia along the Nambucca Heads to Urunga and Sapphire to Woolgoolga projects and in Nambucca State Forest were searched unsuccessfully for pods in December 2016.

Propagation of Slender Marsdenia from seed to seedlings about 30cm tall ready for planting-out takes about 8 months (Ecos Environmental 2016).

3.3 Woolls' Tylophora

3.3.1 Species Identification

Woolls' Tylophora has not been positively identified on the WC2NH project, although a few translocated plants were thought to be possibly this species based on slight hairiness and purplish tinges to the leaves. The leaves of Slender Marsdenia vary in shape and some have leaves similar to Woolls Tylophora, as in Plate 2, a specimen of Woolls' Tylophora photographed during the Bonville project with flowers and leaves. Typical Slender Marsdenia has a more elongated leaf, pinnate venation,

cordate leaf base, paler green colour and is glabrous (without hairs). Woolls' Tylophora has a broader leaf with purplish tinges, tending to 3-veined at base and is sparsely hairy. Woolls' Tylophora from the Bonville project flowered in late August, whereas Slender Marsdenia flowers mainly in November.

About 10 flowering vines were positively identified as Slender Marsdenia on the WC2NH corridor. No flowering plants of Woolls Tylophora have been found so far indicating the latter species if present is rarer than Slender Marsdenia. Woolls' Tylophora if present would have been translocated along with Slender Marsdenia as it was identified as the latter species.

3.3.2 Salvage Transplanting

Woolls' Tylophora(?) was transplanted using the same method applied to Slender Marsdenia as both species are vines with elongated tuberous roots.

Plants identified in the TFMP as possibly Woolls' Tylophora were translocated to Receival Site 8a, which also contains translocated Slender Marsdenia.

3.3.3 Propagation of population enhancement plants

A possible *Tylophora woollsii* plant with one pod was found in the Boambee State Forest in April 2015 during other survey work. This location is a possible source of seed for propagation.

3.4 Rusty Plum

3.4.1 Salvage Transplanting

Tree and sapling sized Rusty Plums were translocated by direct transplanting. The largest Rusty Plums (~10m high) were trenched around to form a soil-root ball about 1 metre wide and 0.7m deep. After undercutting the root ball, the tree was leaned to the side for pruning. The trunk-branch system was cut back at least 50% and all foliage removed. Depending on the size and intactness of the root ball, the trunk was reduced further. Previous transplanting had shown that a good survival rate was dependent on reducing the trunk length to bring the shoot system into balance with the relatively small root ball.

All Rusty Plums were translocated from the footprint at Cockburn's Lane at the southern end of the project. These were transplanted into Receival Site 1 in the Road Reserve. Several in-situ Rusty Plums also remained in the Road Reserve at this location. The transplants received additional watering for a month. Sugar cane mulch was spread around each plant and hessian barriers erected for additional shade as the site is exposed to the afternoon sun. No fertilisers were used.

3.4.2 Population Enhancement

Searches were conducted for seed of Rusty Plum in State Forest in November 2016 at locations where seed has been collected before but were unsuccessful. Rusty Plum produces a large black fruit containing a single seed about the size of a golf-ball, which ripens in November. A large tree in the Coffs Harbour Botanical Gardens that had fruited before was also checked. Lack of seed production in 2016 may be due to intermittent seed production determined by inherent factors, or it may be a response to below average rainfall between August and December 2016.

Approximately 30 Rusty Plums are required for introduction to the road reserve near Receival Site 1.

3.5 Spider Orchid

3.5.1 Salvage Transplanting

Two mature Spider Orchid plants were salvaged from the highway footprint from Prickly Paperbark (*Melaleuca stypheloides*) trees. The orchids were translocated by cutting out the host stem or branch section supporting the orchid. These were tied onto the trunk of rainforest trees in a gully at Receival Site 7a. Apart from watering during transport, no additional watering or other treatments were applied.

3.5.2 Population Enhancement

The TFMP aims to propagate additional Spider Orchid plants for population enhancement. As there are not be enough wild plants to use for vegetative division without depleting populations, it was proposed to propagate from seed. Both of the translocated plants flowered in September 2015 and 2016, but no seed pods were formed. On the NH2U project, one seed pod was formed in a translocated population of 55 Spider Orchids in spring 2016, but the pod opened in November between site visits before the seed could be collected. Further monitoring of flowering and seed production will be carried out in 2017.

3.6 Koala Bells

3.6.1 Salvage Transplanting

Transplanting of Koala Bells was carried out by digging out plants in a block of soil 30-40 cm square with a spade, pruning, and planting into a shaded site and watering. Receival Site 8b was the only site found in the road reserve with habitat similar to the Koala Bells donor sites. Follow-up watering was carried out. No fertilisers were applied.

3.6.2 Population Enhancement

Cuttings of Koala Bells were propagated in summer 2015/2016 at Ecos Environmental's nursery and grown-on in large pots during 2016, as a receival site for the population enhancements had not been finalised. The plants grew rapidly and flowered in summer-autumn 2016, died back over winter then reshot in spring/2016. The regrowth was less vigorous than the first year's growth and small adventitious shoots were also produced around the edge of the pots. Twenty of these plants were introduced to the Floyds Grass receival site (Area 2) at Warrell Creek in January 2017. This site is on alluvial soil and has open ground layer habitat with little competition other plants except Floyds Grass.

3.7 Floyds Grass

3.7.1 Site Preparation

The receival site for Floyds Grass at Warrell Creek was heavily infested with Broad-leaved Paspalum (BLP) and it was necessary to remove this exotic grass before translocating Floyds Grass to the site. Killing BLP with herbicide would still leave the

weed seedbank in the soil to contend with. Follow-up spraying of weed germination was impractical as it was impossible to spray small weeds without hitting Floyds Grass which sends out long runners.

To create conditions suitable for establishment of Floyds Grass, BLP and the uppermost topsoil seedbank was stripped off using an excavator bucket. As the site was on a floodplain with relatively deep topsoil, sufficient depth of topsoil remained for Floyds Grass to establish after carrying out the stripping operation. Preparation of the site was carried out as follows. Firstly, BLP was scrapped off with the excavator bucket. After exposing the soil surface, the top 10cm of soil was scrapped off and placed to the side of the site and flattened out. Topsoil beneath the uppermost 10cm was slightly more clayey in texture, but had reasonable soil texture and drainage. Sed fencing was installed around the site to prevent run-off of sediment to Warrell Creek.

3.7.2 Salvage Transplanting

Small clumps of Floyds Grass approximately 10cm square were dug up with a spade and planted at the receival site. The clumps were watered thoroughly and sugar cane mulch (weed free) spread lightly over the soil surface to prevent raindrop compaction. Follow-up watering was carried out as conditions were dry. 'Seasol' seaweed and fish emulsion fertiliser was applied two weeks after introduction to stimulate growth. As the site was exposed to the afternoon sun, shade-cloth fences approximately 1m high and running N-S were erected to provide additional shade (Plates 35-37).

3.7.3 Population Enhancement

To promote population establishment and long-term viability, approximately 100 additional Floyds Grass plants were propagated and planted out in a second area at Receival Site 9 in March 2016. The plants were propagated from small pieces of runner that broke off plants during transplanting. As Area 2 was more exposed than Area 1 and had little shade, the shade cloth fences erected to protect from the afternoon sun, also had a roof to protect from the overhead sun (Plates 37 & 40). Hand weeding to remove competing exotic and native species was carried out by Pacifico workers under the supervision of the plant ecologist, as in Area 1.

3.8 Monitoring and Data Processing

Each individual was identified by a source identification code as per the TFMP and a monitoring number. Different individuals from the same donor point site were indicated by an additional suffix on the source identification code – e.g. MI46-7

Monitoring of transplants was required every 3 months during the first year and six months in the second year. As the spring monitoring session was missed in year 1, an additional monitoring session was carried out in the second year.

Data were recorded as per Section 3.8 of the WC2U TFMP. The main data fields recorded were as follows:-

> <u>Slender Marsdenia and other species except Spider Orchid:</u> Monitoring Number, Date, Line, Source Label, Species (Translocation Plan Label), Species (Current ID), Condition, Height (cm), New Shoots (Y/N), Comment, sig. growth (+) or sig. dieback (-), Waypoint, Coordinates

Spider Orchid: Monitoring Number, Date, Source Label, Species, Number of pseudobulbs with leaves, Length of the longest pseudobulb, New growth, Condition, Waypoint, Coordinates

All field data can be found in the Excel file appended to this report. Note – the gps coordinates of each translocated individual are provided in the spreadsheets labelled Feb 2016.

The key attribute for evaluating species performance, health and survival is Condition, which was scored on a scale of 0 to 5. The scale is defined slightly differently for different species, as indicated in Tables 3-5 below.

Species Percent Survival is calculated as follows:
number of individuals in condition classes (2+3+4+5/total)*100.

Means species height was averaged over all plants present at the start of monitoring in June 2015. Calculation of mean height at subsequent dates included plants that had died back to ground level (i.e. height = 0; condition class 1).

Table 3: Condition scores applied to Slender Marsdenia and Woolls' Tylophora

Score	Condition
0 dead	dead, no sign of reshooting after 1 year
1 poor	stem died back to ground level, possibly dead; live stem stub may be present
2 fair	plant < 75 cm tall; with leaves or leafless, new shoots/ active growth present or absent
3 good	plant > 75 cm tall, stem with leaves, new shoots/active growth present or absent; if stem leafless or leaves discoloured score as 2
4 advanced	plant > 1.5m tall with > 15 leaves, plant nearing maturity
5 mature	mature; plant flowering or seeding

Table 4: Condition scores applied to Rusty Plum and Koala Bells

Score	Condition
0	dead
1	leafless and no sign of re-shooting
2	pruned foliage retained, or small amount of re-shooting after defoliating, or foliage sparse/discoloured (<40 cm tall Koala Bells)
3	vigorous re-shooting (>40 cm tall Koala Bells)
4	crown recovering, foliage healthy
5	growing actively, flowering or seeding recorded

Table 5: Condition scores applied to Spider Orchid

Score	Condition
0	dead
1	pseudobulbs discoloured/grazed/withering, no new growth
2	pseudobulbs healthy in colour, not withering, no new growth
3	plant small, not many healthy pseudobulbs, new growth occurring
4	several healthy pseudobulbs present, new growth occurring
5	several good sized, healthy pseudobulbs, flowering or seeding recorded

4 RESULTS

4.1 Summary

Two years after translocation, all species had a survival rate greater than 80% with the exception of Koala Bells (Table 6). Survival rates were similar to the NH2U project where all species were translocated except Floyd Grass. Growth and survival of the latter species was similar to the translocation for the Bonville project.

Table 6: WC2NH threatened flora translocation results – number of plants of each species translocated and percent survival rate after 6 months, 1 year and 2 years to 17/1/2017 (see Excel spreadsheet for all results recorded at each monitoring event).

Species/Receival Site	**Number of plants**	**% survival**		
		Aug 2015 (~6 mths)	**Feb 2016 (~1 Year)**	**Jan 2017 (~2 Years)**
Slender Marsdenia (*Marsdenia longiloba*)				
Receival Site 1 - Cockburns Lane	27	93	93	75
Receival Site 2 (3) – Old Coast Rd	15*	100	91	93
Receival Site 3 (5a) – Old Coast Rd	22	81	81	91
Receival Site 4 (5b) – Old Coast Rd	16	100	94	81
Receival Site 5 (7a) – Old Coast Rd	57	90	90	72
Receival Site 6 (8a) – Old Coast Rd	8	88	75	75
Receival Site 8 (8c) – Old Coast Rd	28	93	100	86
Total	173		91	82
Rusty Plum (*Niemeyera whitei*)				
Receival Site 1 - Cockburns Lane	7	100	100	88
Wooll's Tylophora (*Tylophora woollsii* – unconfirmed)				
Receival Site 6 (8a) – Old Coast Rd	6	100	100	100
Spider Orchid (*Dendrobium melaleucaphilum*)				
Receival Site 5 (7a) – Old Coast Rd	2	100	100	100
Floyds Grass (*Alexfloydia repens*)				
Receival Site 9 – Warrell Creek	54 clumps	100	94	94
Receival Site 9a – Warrell Creek	61 clumps			98
Koala Bells (*Artanema fimbriatum*)				
Receival Site 7 (8b) – Old Coast Rd	16	75	63	25

* increase as additional plants translocated due to design modification

4.2 Slender Marsdenia (*Marsdenia longiloba*)

Combining results for the seven Slender Marsdenia receival sites (173 individuals) the survival rate after 2 years was 82%. Survivorship per site varied from 72% to 93% (Table 6).

Data for mean height and frequency of active shoot growth indicate general growth and increase in plant size since the start of translocation in five out of seven sites. In the other two sites, mean height declined or increased slightly (Table 2 – sites 4 and 6). Survival decreased in sites 1, 4, 5 and 8 with loss of ~15-20% of plants since introduction to the receival sites 2 years ago.

Survival increased in sites 2 and 3 as some individuals that had died back to the ground at the end of Year 1 (condition class 1), reshot in Year 2. A small minority of apparently dead plants (condition class 1) reshot again. (Note - an individual was classed as dead (condition class 0) if it died back to the ground and did not reshot after one year.) The percentage of plants in condition class 3 or higher was 30% after 2 years.

There was very little insect grazing of leaves, no disease was recorded, leaf discolouration was occasional and generally preceded leaf fall, and no flowering or seed production were recorded.

Causes of mortality

Mortality since introduction was ~15-20% in four of the seven sites, over two years. In the other three sites, survival was roughly constant or even increased slightly as plants recorded in condition class 1 reshot during the next 6 month period. Mortality generally occurred in small plants in condition class 2, although occasionally taller plants in condition class 3 died back to ground level.

In the first annual monitoring report, possible reasons for mortality included failure to recover from root system damage during transplanting. Mortalities in Year-2, after plants had survived the initial transplanting, were more likely due to processes that are part of the species' natural population dynamics. These include interspecific competition, environmental stresses and inherent demographic processes. An influx of new individuals in natural situations to a population or habitat area will generally be followed by thinning down of the population due to factors that affect survival such as competition, water availability, sun exposure, insect grazing and so on.

Within an area of generally suitable habitat, a central factor determining whether a translocated individual survives or not is the microsite or point at which it happens to be planted. This is particularly the case for small plant species. Natural habitats generally have high microsite heterogeneity. Selection of planting points within a generally suitable area of habitat is a largely random process although ones in the shade, near rooting logs and away from tree trunks etc were preferred. Perhaps this was a mistake and points next to large trees and away from rotting logs would have been better. Regardless of slight biases in choice of site, microsite patterning will be heterogeneous, so a degree of thinning or population decrease over time is inevitable. Naturally occurring Slender Marsdenia populations are very sparse, suggesting that the specific type of microsite favoured by this species is also sparse. Without knowing what the specific indicators of a favourable microsite are, the selection of planting points is essentially a random procedure.

The demographic changes that occur in a cohort of plants over time are summarised as a transition matrix and exhibits as changes in population structure and percent survival over time. Species exhibit different transition matrices depending on life cycle and environmental factors. Environment factors including rainfall and temperature extremes, and the successional state of vegetation, whether open, occupied or closed and preventing colonisation and establishment, have significant effects on establishment. In the case of the Slender Marsdenia translocation, plants were introduced to mature, established forest (with a newly created forest edge nearby). This type of habitat was appropriate for Slender Marsdenia which is a relatively small vine that appears to occur only in the understorey of mature forest and not in disturbed or regenerating forest. By contrast, tree and many shrub species tend to produce a higher survival rate and faster growth if introduced to an open, disturbed site with low inter-specific competition.

Assigning a survival rate as a performance measure (see Table 8) needs to be realistic in terms of the rate of natural thinning or mortality observed in nature populations. Unfortunately, this information is not readily available and guesstimates of what seems reasonable given the species and the type of site must be used

Table 7: Mean height (cm) of Slender Marsdenia transplants 6, 12 and 24 months after translocation (± standard error) and the percentage change in height during this period.

Receival site	n	June 2015 (6 months)	Feb 2016 (12 months)	Jan 2017 (24 months)	% change in height 15/17
Receival Site 1	27	26.51±6.48	39.0±10.43	39.26±10.60	48.1%
Receival Site 2	11	25.64±10.09	60.82±15.50	67.27±13.57	162.4%
Receival Site 3	22	29.29±7.46	49.76±11.16	46.41±9.51	58.5%
Receival Site 4	16	38.69±11.44	47.00±14.84	29.44±9.45	-34.2%
Receival Site 5	57	29.54±3.72	51.74±6.78	47.74±7.62	61.6%
Receival Site 6	8	55.13±22.24	53.00±17.92	60.57±17.55	9.9%
Receival Site 8	28	43.68±6.39	69.57±9.16	50.82±5.29	16.4%
Total	169				

4.3 Rusty Plum (*Niemeyera whitei*)

Seven out of eight transplants survived after 2 years and there was a substantial amount of new shoot growth on larger individuals. Small plants showed some new shoot growth. Withholding mulch from one individual showed that mulching with sugar cane mulch stimulated reshooting and produced much healthier foliage compared with individuals that did not receive mulch. Shadecloth was installed as a result of previous monitoring actions, as recommended in the previous monitoring report.

Causes of mortality

The single mortality was due to Pacifico workers installing a shade cloth shelter and including a roof so the plant was completely enclosed. The shade cloth was dense and let in little light. This appeared to cause a fungal rot as the plant failed to reshoot after removal of the roof.

4.4 Wooll's Tylophora (*Tylophora woollsii* – unconfirmed)

Six possible Woolls' Tylophora in Receival Site 6 were all still alive after 2 years and are in reasonable condition.

Causes of mortality
See Slender Marsdenia above.

4.5 Spider Orchid (*Dendrobium melaleucaphilum*)

The two translocated Spider Orchid plants survived after two years and are in good condition, demonstrating the effectiveness of the minimal disturbance transplanting method used. Both flowered in spring 2015 and 2016, but no seed pods were formed. New pseudobulbs (stem units) have been produced since translocation.

Causes of mortality
No morality recorded.

4.6 Floyds Grass (*Alexfloydia repens*)

The survival rate of 54 clumps of Floyds Grass translocated to Area 1 in Receival Site 9 was the same as the first year annual monitoring (94%). The clumps sent out long runners in first 6-12 months and had coalesced to form a semi-continuous cover after two years in rows 1-3 closest to the creek. In rows 4-7, Floyds Grass was patchier and some section had been overrun by native Ottochloa grass at the 16/1/2017 monitoring. Pacifico is currently weeding out Ottochloa from these sections.

In Area 2 planted in March 2016 (~10 months ago), the clumps have established well with minimal mortality and are sending out runners (Plates 36 and 38).

The results showed that Floyds Grass can rapidly colonise bare soil stripped of other ground layer vegetation and with only a light litter layer. A similar response was recorded on the Bonville project where Floyds Grass was translocated to a site cleared of dense Lantana under Swamp Oak (*Casuarina glauca*) (Ecos Environmental 2013). The growth of Floyds Grass tends to be slowed dramatically when it encounters the native grass *Ottochloa gracillima*. Once Floyds Grass becomes well established as a thick mat it can resist this species. Weeding out competing species is important to get good establishment of Floyds Grass

Causes of mortality
The little mortality recorded were probably due to water and heat stress as the receival site is relatively exposed and there have been long periods of hot dry weather over the last two years.

4.7 Koala Bells (*Artanema fimbriatum*)

The survival rate of Koala Bells in Receival Site 7 was 76% after six months, 63% after one year and 25% after two years, although the later includes several individuals transplanted later by Pacifico to site 7. At least half the transplants flowered and produced seed in Year 1. A fairly rapid decline was recorded in Year 2 similar to the pattern of survival of this species on the NH2U translocation project.

Causes of mortality

Koala Bells generally flowers and sets seed in the first six months, after transplanting in spring or summer, then it gradually dies back in autumn and winter. The plant may die completely or reshoot the following spring. This appears to be the plant's natural life cycle rather than a factor related to translocation. Koala Bells can appear suddenly on disturbed sites such roadsides in State Forest and then disappear. Some populations have been observed persisting for more than one year, so longevity can apparently vary depending on site conditions, but overall Koala Bells is a relatively short-lived species. Observations on translocated plants indicate that plants that survive into the second year often grow from adventitious shoots produced from lateral roots.

Fertiliser addition during translocation appears to speed up the life cycle, causing plants to flower and seed prolifically then die out in the first year, leaving behind dormant seed in the soil. However, no fertilizer was added on the WC2NH project. Receival Site 7 for Koala Bells was not ideal habitat and a possible reason for some of the mortality recorded.

4.8 Maundia (*Maundia triglochinoides*)

Maundia a sedge-like plant found in freshwater swamps and streams is listed as Vulnerable under the TSC Act. This species was originally included in the WC2U TFMP but was taken out as it was not considered to warrant translocation on the Frederickton to Eungai (F2E) project. This was partly because large stands of Maundia were present both within and adjacent to the F2E project in 2012, although earlier targeted surveys conducted during the millennium drought (when the species was first recorded on F2E) found the species was very rare in the same area. Translocation on F2E did not seem to be warranted as the species had built up a large population which extended well beyond the F2E corridor, but also because a previous attempt to translocate Maudia by the Royal Botanic Gardens (Sydney) by propagation of seedlings and planting out had failed (Ecos Environmental 2012).

Smaller occurrences of Maundia were present within the WC2NH corridor and larger stands just outside the alignment. Pacifico undertook translocation of Maundia from the Williamson's Creek bridge site south of Warrell Creek following discussions with Ecos Environmental on the practicality of translocating this species. As Maundia grows from a network of rhizomes in the bottom mud, it was considered feasible to translocate this species by scooping up the plant with its rhizomes with an excavator bucket and depositing them in suitable wetland habitat. If the leaves were damaged the plant would most likey regrow from the rhizomes.

Pacifico initially translocated Maundia to a site downstream of the Williamson's Creek bridge site. The clumps survived and grew, but it became necessary to move them again. This time they were transplanted to a nearby sedimentation basin where the water level was managed to maintain a suitable depth for Maundia. The plants thrived while being held in the sedimentation basin and have since been planted back into Williamson's Creek. Five patches of Maundia have been established over a distance of approximately 30 metres along the creek and plants are growing well (Plate 6). The results show that Maundia can be translocated with a high success rate by direct transplanting of rhizome material and muddy substrate.

Plate 6: Clumps of Maundia (the sword-leaved aquatic plant) reinstated along Williamson's Creek two years after salvaging Maundia from the creek prior to construction of a new bridge and stabilisation of the creek banks.

4.9 Habitat Restoration

4.9.1 Site 9 - Floyds Grass

Habitat restoration was required mainly for the Floyds Grass site covered by dense Broad-leaved Paspalum (BLP). Although the topsoil seedbank was removed, some weed growth occurred from seed blown onto the site, carried on boots etc, or deeply buried seed (particularly *Phytolacca octandra* – Ink Weed). Both exotic and native species regenerating from seed tend to reduce the growth of Floyds Grass by competing for space, light and nutrients. Fortunately, the level of weed regeneration was low after removing ground layer vegetation and the top 10cm of soil, so that it was practical to weed out competing exotic and native species to maintain Floyds Grass expansion.

No maintenance was carried out in first six months after introduction (to February 2016). After six months the most abundant weeds in terms of crown cover were Ink Weed (*Phytolacca octandra*) and Tobacco Bush (*Solanum mauritanicum*). Ink Weed had grown 1-1.5 metres tall and covered most of the site, but caused little if any damage to Floyds Grass, which can grow in the shade or full sun. Other common species included the native grass *Ottochloa gracillima* and herb *Commelina cyanea*. These species germinated at low density but grew rapidly. Ottochloa is difficult to weed out as it produces runners that root at nodes and its leave look very similar to Floyds Grass. Red Ash (*Alphitonia excelsa*) and *Acacia floribunda* also germinated across the site at low density and were removed with other native species. Seedlings of the above species germinated from seed buried deeper than 10cm in soil, possibly by ants. Very little Broad-leaved Paspalum germinated indicating that nearly all of its seedbank had been removed..

Two days of hand weeding by two people were carried out in February 2016 to remove six months of weed and native species regeneration. Ink Weed and Tobacco Bush were removed in a couple of hours by hand pulling. Removal of the native grass Ottochloa and other native herbs took longer. These species would have been left if the aim was simply to regenerate native bush, but as Ottochloa competes strongly with Floyds Grass it is best to remove it.

Swamp Oak (*Casuarina glauca*) in six inch pots were planted over the site three months after introduction. These were heavily grazed by wallabies, killing most of them. The site has now been fenced with chicken wire and star pickets to keep wallabies out. Wallabies did not graze Floyds Grass.

Weeding of the Floyds Grass areas is currently being carried out once ever six months by a team of two people from Pacifico (trained by Ecos Environmental) over 2-3 days.

The pattern of native plant regeneration recorded after removal of BLP, other weeds and the topsoil seedbank to a depth of 10cm indicates how the same method could be used to rehabilitate native vegetation at this location, which has apparently been identified by RMS for ecological restoration after completion of construction.

4.9.2 Site 1 (Rusty Plum and Slender Marsdenia)

Receival Site 1 was moderately infested with Lantana. This has been removed by hand, requiring half a day by one person once a year. Some weed spraying of BLP near the transplanted Rusty Plums was also carried out.

5 ASSESSMENT

5.1 Introduction

This section assesses the outcomes of the WC2NH translocation project after two years according to performance criteria in Section 4.8.6 and Appendix 11 of the Warrell Creek to Urunga Threatened Flora Management Plan Ver. 5 (1/7//2016) (TFMP).

5.2 Performance Assessment

Table 8: Assessment of outcomes of the threatened flora translocation project after two years according to performance criteria in TFMP.

Project Phase	**Were Performance Criteria Met?**
Pre-construction phase (Appendix 11, Table 1)	
• Salvage translocation (transplanting) of all directly impacted threatened flora completed according to the TFMP, Sections 4.5, 4.6 & 4.7.	Yes - all directly impacted individuals were translocated, including all tagged individuals and additional individual found during pre-translocation surveys and while transplanting
• No loss or damage to threatened flora occurs prior to translocation being implemented.	Yes - no loss or damage prior to translocation
Construction phase (Appendix 11, Table 2)	
• All translocation actions required during the construction phase are implemented including monitoring and preparation of the annual monitoring report.	Yes – maintenance, monitoring and reporting implemented. The monitoring schedule was changed from four times in Year 1 and twice in Year 2 to three times in both years in Ver. 5 of the TFMP.
• Annual monitoring report provides full description of management plan implementation and results, as per the required contents in Section 4.8.5, and an evaluation of outcomes according to criteria listed in Section 4.8.6 of the TFMP.	Yes - annual reports including detailed descriptions of plan implementation, results and an evaluation of outcomes according to criteria in the TFMP were prepared.
Summary (Appendix 11, Table 4)	
1. All recorded directly impacted individuals are translocated.	Yes
2. At least 60% of transplant and enhancement individuals are surviving after the first year, 50% after five years and 40% after eight years.	Yes – survival rate greater than 60%
3. At the end of the monitoring program at least 50% of surviving individuals have a Condition Class of 3.	not applicable yet

5.3 Evaluation of Methods and Cost-effectiveness

The translocation methods applied for the WC2NH threatened flora translocation achieved relatively high survival rates for all species after two years (>80%) for all threatened species. The general approach to translocation was based on the ANPC guidelines for the translocation of threatened plants in Australia (ANPC 2004). Methods were developed for WC2NH taking into consideration the results of previous translocation projects involving the subject threatened species, including the NH2U, Bonville and S2W threatened flora translocation projects.

Methods were applied that aimed to achieve a satisfactory translocation outcome while keeping costs to a reasonable level. A full evaluation of the costs of the project would require an analysis of input to the threatened flora translocation project by ECOS Environmental, Geolink and Pacifico which is beyond the scope of this report.

5.4 Work Plan for Year 3 (February 2017 – February 2018)

Task	**Time**
Monitoring	
Monitoring (once a year)	November 2017 (to coincide with flowering of Slender Marsdenia and Rusty Plum)
Population enhancement	
Seed collection Rusty Plum	November 2017
Seed collection Slender Marsdenia and Woolls Tylophora – if possible	December 2017 possibly into 2018 if pods not ripe
Seed collection Spider Orchid – if possible	November - December 2017
Maintenance	
Weeding – Floyds Grass site	May 2017, November 2017
Reporting	
Supply monitoring summary	November 2017
Prepare Year-3 annual monitoring report	January 2018

6 REFERENCES

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APPENDIX 1: Photographs (Plates 7-40) of the translocation receival sites and translocated individuals taken in January 2017 at the 2-Year monitoring visit.

Plate 7: Receival Site 1 in the Road Reserve at the southern end of the project. Moist open forest with a leaf litter and light fern dominated ground layer. 16/1/2017

Plate 8: Receival Site No. 1. Plant no. 14. A small shoot of Slender Marsdenia. 16/1/2017

Plate 9: Receival Site No. 1. Plant no. 15. Slender Marsdenia climbing wire cage. 16/1/2017

Plate 10: Receival Site No. 1. Plant no. 21. Small shoot of Slender Marsdenia. 16/1/2017

Plate 11:::Receival site no. 1, Rusty Plum reshooting vigorously from trunk pruned down to 1.3 metres after the tree was excavated with little root ball. 16/1/2017

Plate 12 : Receival site no. 1, small Rusty Plum with new growth. 16/1/2017

Plate 13: Receival site no. 2 adjacent to Old Coast Rd, highway corridor in background. Wire cages contain transplanted Slender Marsdenia. 16/1/2017

Plate 14: Receival site no. 2, plant no. 2, Slender Marsdenia climbing out of wire cage. This site is relatively exposed to NE to SE winds due to the cleared road corridor, but there are no obvious adverse effects on Slender Marsdenia. 16/1/2017

Plate 15: Receival Site no. 3 habitat showing same type of open litter and fern covered ground layer in moist open forest favoured by Slender Marsdenia. 17/1/2017

Plate 16: Receival site no. 3, plant no. 13. Small shoot of Slender Marsdenia. 17/1/2017

Plate 17: Receival site no. 3, plant no. 18. Slender Marsdenia. 17/1/2017

Plate 18: Receival site no. 5 adjacent to Old Coast Rd. Habitat overview. 17/1/2017

Plate 19: Receival site no. 5, plant no. 4. Slender Marsdenia climbing out of cage. A long thin leader stem can be seen drooping down to the left. Leaders die back if they cant find something to grasp onto so they can climb higher. 17/1/2017

Plate 20: Receival site no. 5, plant no. 5. The other identifier is the source/donor site code. 17/1/2017

Plate 21: Receival site no. 5, plant no. 8. Another plant consisting of a small shoot, generally produced after a previous stem died back. 17/1/2017

Plate 22: Receival site no. 5, plant no. 23 consisting of two small shoots produced after a previous stem died back. 17/1/2017

Plate 23: Receival site no. 5, plant no. 40. A fine leader stem can be seen ascending into the vegetation above. 17/1/2017

Plate 24: Receival site no. 5. The larger of two Spider Orchid clumps translocated to site 5. The plant consists of numerous angled pseudobulbs produced on wiry stems, with a pair of leaves at the end. Flowers are produced from the apex between the leaves. The section of branch/stem of the host tree supporting the orchid plant and its roots that extend for some distance along the stem was tied onto the trunk of a rainforest mid-stratum tree in a shaded gully with nylon rope. 17/1/2017

Plate 25: Receival site no. 6 for Slender Marsdenia and Woolls Tylophora, habitat overview. 17/1/2017

Plate 26: Receival site no. 6, plant no. 4, possible Woolls Tylophora. 17/1/2017

Plate 27: Receival site no. 6, plant no. 6. 17/1/2017

Plate 28: Receival site no. 6, plant no. 7. 17/1/2017

Plate 29: Receival site no. 7, Koala Bells, habitat overview, translocated plants on left hand side. 17/1/2017

Plate 30: Receival site no. 7, Koala Bells with flower buds. 17/1/2017

Plate 31: Receival site no. 8, habitat overview. 17/1/2017

Plate 32: Receival site no. 8, plant no. 14. Slender Marsdenia with long leader arching down over top of cage which has stopped growing and died off (turned brown). 17/1/2017

Plate 33: Receival site no. 8, plant no. 20. Slender Marsdenia

Plate 34: Receival site no. 8, plant no. 21

Plate 35 :Receival site no. 9 for Floyds Grass, Area 1, habitat overview. 17/1/2017

Plate 36:Receival site no. 9 for Floyds Grass, Area 1. Rows 1-3 closest to the creek on the left hand side had a good cover of Floyds Grass after 1.5 years. 17/1/2017

Plate 37: Receival site no. 9 for Floyds Grass, Area 2, habitat overview. 17/1/2017

Plate 38 :Receival site no. 9 for Floyds Grass, Area 2. Floyds Grass runner extending from pink tag to under shade cloth to the right after 9 months. 17/1/2017

Plate 39: Receival site no. 9. One year old Koala Bells plant introduced to site 9 in January 2017.

Plate 40: Receival site no. 9, Area 2. Koala Bells planted in a row marked by bamboo stakes with Floyds Grass. 17/1/2017.