What we learnt

Seedlings planted close to established vegetation did not survive, presumably due to water stress and competition from mature plants.

- Plants need to be watered through the first two summers.
- Guards are essential as the plants are highly palatable and seemingly targeted for 'rubbing' by herbivores.
- 2017 saw very high seed production across Monarto, and collections were made from all sites. Testing indicates that this seed is highly viable. Subsequently 1000 plants have been propagated from seed, for translocation in June 2018.
- Seed collection should be timed during high seed production years to achieve higher seed viability.

Editor's note: This is the second article to be published by APC on translocation of Prostanthera eurybioides *in recent times. You may also be interested in the article on* Prostanthera eurybioides *translocation by Manfred Jusaitis in the previous issue of APC (27-1).*

References and further reading

Ainsley, P., Ottewell, K., Thorpe, M. and Lowe, A. (2008a). *The Monarto Mintbush: A Threatened Species Being Impacted By Climate Change?* Proceedings of the 2nd World Scientific Congress Challenges in Botanical Research Climate Changes, 29th June - 4th July 2008, Delft, Netherlands.

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Threatened plant translocation case study:

Translocation of threatened flora for the Warrell Creek to Urunga upgrade of the Pacific Highway, Mid North Coast NSW

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The Species

Six threatened species impacted by the highway upgrade were translocated:

- *Marsdenia longiloba* (Slender Marsdenia).
- *Dendrobium melaleucaphilum* (Large-flowered Spider Orchid).
- *Alexfloydia repens* (Floyds Grass).
- *Niemeyera whitei* (Rusty Plum).
- *Hickesbeachia pinnatifolia* (Red Bopple Nut).
- *Artanema fimbriatum* (Koala Bells) (recommended for threatened species listing).

Threatening Processes

Threatening processes affecting these species include habitat clearing, timber harvesting, small population size, poor understanding of species life cycle and ecology, plant collectors (Spider Orchid) and sea level rise (Floyds Grass).

Deciding to translocate

A translocation feasibility assessment was undertaken before deciding to translocate each species. The main factors considered were:

- Technical feasibility, including previous translocation results for the same or similar species.
- Potential for generation of new and useful scientific information.
- Availability of receival sites with suitable habitat and security of tenure.

Aim of the translocation

The purpose of translocating threatened species in a developmental context is to avoid decline in population number and genetic diversity as a result of development impacts. The overall aim of translocation is to establish new or enhanced populations that are self-sustaining over the long term. This is usually effected by a combination of salvage transplanting, propagation and introduction, and habitat restoration. As well as assisting the maintenance of population number and genetic diversity, translocation can improve understanding of threatened species' life history and ecology, through attempts to manipulate and maintain populations by different treatments. A further aim is to develop reliable translocation/introduction methods for each species.

Figure 1. Excavating a soil-root ball around a small Rusty Plum tree during transplanting. Photo: Andrew Benwell

Translocation working group and key stakeholders

NSW Roads and Maritime Services (RMS), NSW Office of Environment and Heritage, Commonwealth Department of Environment and the Principal Contractors (Pacifico (Aciano – Ferrovial Joint Venture) and Lend Lease), and Ecos Environmental Pty Ltd.

Biology and Ecology

- Slender Marsdenia – small vine inhabiting the lower and mid strata of moist open forest; population structure partly clonal, seed production rare and possibly disrupted by decline in pollinators.
- Large-flowered Spider Orchid – epiphytic orchid found in swamp forest and rainforest.
- Floyds Grass – perennial, stoloniferous grass inhabiting the margins of coastal estuarine creeks.
- Rusty Plum – medium-sized rainforest tree of lowland rainforest and margins of moist open forest.
- Red Bopple Nut – small rainforest tree of lowland rainforest.
- Koala Bells – annual to short-lived perennial herb of coastal floodplain forest.

Figure 2. The Rusty Plum in figure 1 was pruned back to a bare trunk. This is the same tree two years later showing vigorous regrowth. Photo: Andrew Benwell

Site selection

Plants were sourced from sites impacted by the Warrell Creek to Urunga upgrade of the Pacific Highway, Mid North Coast NSW. The most important criterion in selecting recipient sites for each species was close resemblance between habitat at the recipient and original (donor) sites, including soil, topography, vegetation type and microclimate. All sites were located in the forested road reserve or other RMS property and spread out along the 42 km project corridor. Numbers of recipient sites established for each species were as follows: Slender Marsdenia, 7 (including an experimental area divided into different treatment blocks); Rusty Plum, 2; Red Bopple Nut, 1; Floyds Grass, 2; Spider Orchid, 2; and Koala Bells, 4.

Translocation proposal

The translocation proposal described actions to salvage impacted individuals of threatened species, re-establish them in corresponding habitat, enhance translocated populations (where possible) by introducing additional propagated plants and restore/maintain good quality habitat. A Translocation Plan (Ecos Environmental 2014, 2016) was prepared, including pre-translocation assessment of the site and each species, translocation proposals for each species, and post-translocation measures such as maintenance and monitoring.

The project would run for five years and results would be assessed before deciding whether to continue monitoring and maintenance. RMS divided the highway project into northern and southern stages for construction by different contractors. Construction and translocation began about 18 months apart in the two stages, in 2013 and 2015.

Pre-translocation preparation, design, implementation and ongoing maintenance

Salvage translocation was carried out using the direct transplanting method, which involves excavation, transport to the recipient site and replanting in one action rather than as a gradual process. Excavation is carried out with an excavator or with hand tools if plants are small. The objective is to remove the shoot system and enough of the root system to enable regeneration and plant survival. Basic horticultural measures such as pruning and watering are applied to minimise transpiration stress and maximise survival.

Site preparation included marking out planting areas and removal of weeds such as Lantana where present. The Floyds Grass site was covered by exotic grass under a canopy of native trees. To prepare this site, ground layer plants and topsoil seedbank were stripped off with an excavator to a depth of 5-10 cm to minimise weed competition. Enough alluvial topsoil remained for plants to establish.

Previous translocations of Slender Marsdenia suggested this species was negatively affected by addition of fertiliser in the field, although it responded positively to fertiliser under pot cultivation. To investigate this observation under controlled conditions, a field experiment was designed to measure the performance of Slender Marsdenia plants introduced with and without addition of fertiliser. The fertiliser treatment was compared in direct transplants and plants propagated from seed and vegetatively (Table 1).

An effective method was developed for translocating epiphytic orchid species that consisted of moving orchid plants with a section of the bark or branch substrate so a substantial amount of the root system remained intact. This was carried out with a saw or hammer and chisel.

The piece of bark or branch was then attached to a suitable tree trunk or branch with wire. Using this simple method, the orchids continued to grow and flower without any sign of adverse effects.

Figure 3. Slender Marsdenia stem shoot 3 years after being transplanted. The wire cage is to exclude herbivorous marsupials, provide an initial climbing frame and facilitate monitoring. This individual is in the experimental area and received fertiliser (12 month slow release for natives). Photo: Andrew Benwell

Figure 4. Spider Orchid removed with roots intact on its bark substrate and reattached to bark of the same species at the recipient site. Photo: Andrew Benwell

Table 1. Treatments applied to Slender Marsdenia.

Treatments	Factor 1 introduction mode	Factor 2 fertiliser treatment	Factor 3 propagation type
Treatment 1	direct transplant	no fertiliser	n/a
Treatment 2	propagated	fertiliser	seedling
Treatment 3	propagated	fertiliser	vegetative
Treatment 4	propagated	no fertiliser	seedling
Treatment 5	propagated	no fertiliser	vegetative

As previous results suggested that fertiliser had a negative effect, fertiliser was not applied to direct transplants of Slender Marsdenia. This was done to maximise survival rate, a key objective of the translocation project. Results were compared with previous translocations where fertiliser was applied.

Subsequent actions

Follow-up watering was carried out for three months and shade screening was erected to protect Rusty Plum. Monitoring was conducted 3 monthly in the first year and 6-monthly thereafter. Data recorded included plant height, insect grazing, disease, new shoot growth, flowering, recruitment and plant condition on a scale of 0-5. Weed removal and thinning of native regrowth were carried out every six months at the Floyds Grass site.

Figure 5. Red Bopple Nut showing vigorous regrowth from the end of pruned branches 3 years after transplanting. Photo: Andrew Benwell

Outcomes

Survival rates after three years were high for all species except for Koala Bells, but the life cycle of this species appeared to be essentially annual, or occasionally perennial, and disturbance (baring of soil) was required to stimulate regeneration from seed. Flowering and seed production were observed in transplants of all species within three years, Koala Bells within three months.

After 3 years, slow release fertiliser had a negative effect on the survival of Slender Marsdenia and plants propagated from seed had a higher survival rate than vegetatively propagated plants.

Propagation and introduction for population enhancement were implemented for four of the six species, where seeds or cuttings were available. Longer term outcomes remain to be monitored (Table 2).

Figure 6. Floyds Grass recipient site 3 years after removal of exotic grass ground cover and restoration of native species including Floyds Grass indicated by pink tags. Photo: Andrew Benwell

Table 2. Survival and flowering/seeding rates, according to species.

Species	Northern stage Survival 3 yrs	*N*	Southern stage Survival 3 yrs	*n*	Flowering/ seeding	Population enhancement
Slender Marsdenia	68%	104	74%	175	1 plant	implemented
Spider Orchid	95%	55	100%	2	yes	
Floyds Grass	-	0	94%	54	yes	implemented
Rusty Plum	100%	3	88%	7	no	implemented
Red Bopple Nut	100%	1	-	0	yes	
Koala Bells	3%	35	13%	16	yes	implemented

What we learned

- The species translocated can be re-established with high survival rates using the direct transplanting method.
- Results of the Slender Marsdenia experiment supported the hypothesis that addition of fertiliser negatively affects growth and survival in translocated plants of this species.
- Other aspects of Slender Marsdenia life cycle and response to transplanting remained enigmatic. Twelve different response syndromes in transplanted individuals were identified, but are difficult to explain. Seedlings grew much more strongly than vegetatively propagated plants.
- Floyds Grass is relatively easy to translocate, although a poor competitor with the native grass *Ottochloa gracillima* which limits its spread locally; survives flooding and king tide inundation.
- An effective method was developed for translocating epiphytic orchid species.
- Koala Bells is a disturbance regenerator with an annual or occasionally short-lived, perennial life cycle.

References and further reading

Ecos Environmental (2014, 2016). *Warrell Creek to Urunga Upgrade of the Pacific Highway Threatened Flora Management Plan*. Report to Roads and Maritime Services, Grafton, NSW.

Figure 7. Koala Bells. This is a propagated population enhancement plant, which typically flowered within 3 months of being introduced. Recruitment was recorded at one of the recipient sites with sections of bare soil. Photo: Andrew Benwell

Threatened plant translocation case study:

Involvement in the Royal Botanic Gardens Victoria's Orchid Conservation Program by volunteers from the Australasian Native Orchid Society Victoria Group

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Orchids

Orchids are one of the most charismatic and diverse plant families with over 26,000 species worldwide (WSPF 2018). Australia is home to more than 1800 (Backhouse *et al.*, 2016) species and subspecies of orchid, with the majority being terrestrial species found predominately in the temperate south. Victoria has in excess of 400 species of native orchids with many occurring nowhere else on Earth. Orchid habitat in Victoria varies from alpine peaks to semi-arid mallee, swamps, native grasslands, heath lands, and eucalypt forests of all types. The majority of our native orchids emerge from an underground tuber in autumn, flower in late winter-spring and set seed before the summer, when they retreat back to their underground tuber. All orchids are reliant on one or more species of mycorrhizal partner (Rasmussen 1995) to germinate in the wild, and are often pollinated by only one or a few species of insect (Tremblay *et al.* 2005). Successful conservation translocations (supplementations, reintroductions and introductions) of these plants typically require a thorough understanding of their ecology including pollinators and mycorrhizal fungi (Reiter *et al.* 2016).