Translocation Performance Report for *Macrozamia pauli-guilielmi* and *Acacia attenuata*

ROAD 166 - Maryborough-Cooloola Coast Road, Wide Bay

EPBC Approval 2012/6297

Prepared for

Department of Sustainability, Environment, Water, Population and Communities
Department of Transport and Main Roads

12 February 2013

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Document Information

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1 Introduction

Translocation works were undertaken as part of the Transportation Network Reconstruction Program (TNRP) implemented by the Queensland Department of Transport and Main Roads to repair the State road network, damaged by flood events during 2010-2011. Neumann Contractors are the Managing Contractor for this and other roads.

Neumann Contractors engaged Vegetation Matters as the Translocation Contractor responsible for translocating a number of *Macrozamia pauli-guilielmi* (Pineapple Zamia) and a single *Acacia attenuata* (Whipstick Wattle) from the Maryborough-Cooloola Coast Road (Road 166), in the Wide Bay region during 2012.

Final road design plans did not extend (as previously anticipated) into the area where *Boronia rivularis* occurred; therefore, no *B. rivularis* needed to be translocated. During the recent monitoring period, the boronias did not appear impacted in any discernible manner from the construction works. Inspection of these plants will continue for the entirety of the monitoring programme.

Approval for this translocation work was granted by the Federal Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC), for a controlled action relating to proposed impacts on a nationally listed threatened species through realignment of the sections of Road 166 (EPBC Approval 2012/6297).

This report has been prepared to meet 'Conditions attached to this approval' number six (6):

> "The person taking the action must prepare two (2) Translocation Performance Reports (TPRs) and submit them to the Department. The first report must be provided to the Department within three (3) months of the conclusion of the translocation process, and the second must be provided to the Department within three (3) months of the completion of the maintenance period".
>
> "These TPR must include, but not be limited to the following:
>
> - Detailed discussion of any Macrozamia pauli-guilielmi deaths suffered as a result of the translocation process;
> - Discussion of the adequacy of the Macrozamia pauli-guilielmi Management Plan (MPMP): and
> - An evaluation of the strengths and weaknesses of the translocation process, including recommendations for future translocation processes."
>
> (DSEWPaC 2011)

The maintenance period is for two (2) years following the conclusion of the *Macrozamia pauli-guilielmi* translocation process. Translocation of one hundred and forty three (143) *M. pauli-guilielmi* began in July 2012 and concluded several months later, on 28 October 2012.

2 Methodology

Vegetation Matters undertook the translocations in accordance with established policies, protocols, publications and guidelines and consultation including:

- Consultation with Dr Paul Forster (Cycadaceae taxonomist), Qld Herbarium;
- A translocation protocol for cycads in Queensland (Forster 2004);
- *Macrozamia pauli-guilielmi* Management Plan (Opus 2012);
- Guidelines for the Translocation of Threatened Plants In Australia (Vallee et al., 2004); and
- National Multi-species Recovery Plan for the Cycads, *Cycas megacarpa, Cycas ophiolitica, Macrozamia cranei, Macrozamia lomandrioides*, *Macrozamia pauli-guilielmi* and *Macrozamia platyrhachis* (Forster and Holland 2007.

As the harvesting license holder, Caroline Haskard, principal botanist-ecologist of Vegetation Matters, managed and directed the translocation process and is a specialist who has been involved with the translocation of multiple threatened species in Queensland, including cycads other than *M. pauli-guilielmi.*

First-hand skills and knowledge acquired through these experiences were beneficial to this translocation process, particularly when dealing with the varying conditions associated with the project. The translocation protocol for cycads was followed for its twenty (20) steps, despite no obvious sign of insects or insect damage. See Appendix 1 for the complete protocol.

The *Acacia attenuata* was translocated following the general guidelines of Vallee et al (2004) and the practitioner's experience and knowledge of successful landscape horticultural practices used in previous translocation processes.

3 *Acacia attenuata*

A. attenuata (Whipstick Wattle) is a slender shrub to approximately 5 metres tall and can be distinguished from many other locally occurring acacias by the retention of juvenile bipinnate foliage throughout its lifespan. It is a vulnerable species, endemic to lowland coastal forests and heaths in high rainfall areas of southeast Queensland.

This wattle bears cream flowers in globular heads (ballflowers) mostly during winter, with seedpods generally produced during spring. Each pod bears between 6-10 (12) seeds, dispersed primarily by ants or by gravity or floodwaters (Brownlie et al 2010).

A single mature specimen of *A. attenuata* was translocated on 11 October 2012. Successful translocation of mature acacias of this stature is unknown, and the recent monitoring period 15-16 January 2013, was too early to make a claim either way with any certainty (as to death or resprouting). To offset and supplement the potential loss of this mature individual, seedlings are on order with a local community nursery.

Recent flooding in southeast Queensland from 26-30 January 2013 will ensure that the translocated specimen, should it survive, in its often-waterlogged environment, will never require follow-up watering.

4 *Macrozamia pauli-guilielmi*

Macrozamia pauli-guilielmi is an endangered species restricted to coastal lowland forests in the Wide Bay district on sandy or loamy soils. This species, like all cycads, loses its leaves over a period of several years as they are shed and renewed (Forster and Holland 2007), generally during spring.

This is a small cycad with an underground trunk (caudex) to approximately 30 cm and strongly spirally twisted leaf stems, which may be sparsely hairy towards the base, with shiny mid to dark green new foliage; leaves fade to dull green with age (Hyslop and Haskard 2005). Mature leaves usually number 2-8 and may reach 1 m or more, with numerous thickened leaflets.

Coning appears to be irregular, occurring once every 4-6 years (Jones 2002). Male and female cones are borne on separate plants, each up to 20 cm; female cones may be larger and stouter than those of males, which are narrower and generally curved. Seeds in female cones become orange to bright red and enlarged when mature and force cones apart ready for dispersal.

Seeds may be numerous (up to 40 or more) and rarely dispersed far from the parent plant (Primack and Miao 1992); however, to a limited degree native rodents and marsupials (and occasionally, other animals) disperse seed locally, less than 100 m from the parent, (Cain et al 2000).

5 Translocation monitoring data and results

5.1 Field data

Many cycads were in a poor condition prior to translocation due to slashing, vehicular traffic, grading, and spraying with herbicide as a result of regular road verge maintenance activities. Neumann Contractors water trucks were in the vicinity when the latter took place and were able to hose the herbicide off in time to save dozens of cycads (once the parties responsible had left).

No insects or insect damage was observed or noticeable during the translocation period (August-October 2012) perhaps because of how poor many affected plants already appeared. Again, during the first monitoring period (15-16 January 2013), other than a single caterpillar, no insects or insect-damage was observed or noticeable. Therefore, no information is present in the following tables.

The field data collected prior and post translocation presented here in table format is for direct comparison over time. The second and final report due in eighteen (18) months from now will provide comprehensive monitoring information based on data collected at three-monthly intervals during that period.

The descriptions of the original leaves and/or leaflets (foliage) were condition-based due to the abundance of dead and dying leaves (pre-existing). The condition of the foliage on many translocated cycads reflected the biology of this species, as leaves are shed and renewed over several years (Jones, 2002), usually in flushes during spring (Forster and Holland, 2007).

The numbers of resprouts and/or new leaves in translocated plants is the simplest and surest method (in addition to new cones or seedlings) to measure survival rates and the overall success of the translocation project. This is discussed further in section 7, ‘The translocation process’.

5.2 Plant numbering

Cycads for translocation were GPSed, tagged and labelled over a period of several days; occasionally some additional plants were located amongst thick grass or dense vegetation and processed in situ during actual translocation.

At times, this numbering occurred simultaneously at different locations under the supervision of different team technicians, thus making continuity of numbering a difficult process.

Additionally, for example, not all tagged and labelled plants were translocated, and more plants were translocated than were originally tagged, some plant numbers were doubled up across different sites, and then there was contending with on-going road design changes and labels damaged by wildlife such as crows.

Labels also fade and are lost over time as they biodegrade, so when a numbering oversight occurred at the Poona Creek recipient site, plant numbering was reformatted into chronological order, superseding the original numbering. Reformatting of plant numbers is complete for both recipient sites, benefiting comparative data collection for the ongoing monitoring period (eighteen months).

K Stephens

Tagged, trimmed and treated - large female macrozamia, complete with seed, awaits translocation

Table 1 Primary recipient site 12 October 2012

Location/CH	Hole No.	Number of plants	Original Plant No.	Foliage	Male/female	Fruit (cones)	Insect damage	**New seedlings**
12 October 2012								
Primary recipient site								
NB. Plant No.* = new plant located at time of translocation; not previously tagged or GPSed								
GPS location of hole #1 [redacted]								
LHS	1	[redacted]	[redacted]	multiple dead leaves				
RHS	2	[redacted]	[redacted]	reasonable condition				
RHS	3	[redacted]	[redacted]	multiple dead leaves				
RHS	4	[redacted]	[redacted]	poor condition				
LHS	5	[redacted]	[redacted]	poor condition				
LHS	6	[redacted]	[redacted]	poor condition				
LHS	7	[redacted]	[redacted]	poor condition				
LHS	8	[redacted]	[redacted]	poor condition				
RHS	9	[redacted]	[redacted]	healthy				
LHS	10	[redacted]	[redacted]	some dead leaves				
LHS	11	[redacted]	[redacted]	poor condition				
RHS	12	[redacted]	[redacted]	reasonable condition				
RHS	13	[redacted]	[redacted]	multiple dead leaves	male	old cones		
RHS	14	[redacted]	[redacted]	unhealthy				
LHS	15	[redacted]	[redacted]	some dead leaves				
RHS	16	[redacted]	[redacted]	unhealthy				
LHS	17	[redacted]	[redacted]	some dead leaves				
RHS	18	[redacted]	[redacted]	unhealthy				

Location/CH	Hole No.	Number of plants	Original Plant No.	Foliage	Male/female	Fruit (cones)	Insect damage	**New seedlings**
LHS	19	[redacted]	[redacted]	unhealthy				
RHS	20	[redacted]	[redacted]	some dead leaves				
RHS	21	[redacted]	[redacted]	unhealthy				
LHS	22	[redacted]	[redacted]	unhealthy				
LHS	23	[redacted]	[redacted]	reasonable condition				
RHS	24	[redacted]	[redacted]	some dead leaves	male	old cone		
LHS	25	[redacted]	[redacted]	healthy	male	old cone		
LHS	26	[redacted]	[redacted]	some dead leaves				
LHS	27	[redacted]	[redacted]	unhealthy	male	old cone		
RHS	28	[redacted]	[redacted]	reasonable condition				
LHS	29	[redacted]	[redacted]	healthy				
RHS	30	[redacted]	[redacted]	most leaves dead				
RHS	31	[redacted]	[redacted]	poor condition				
RHS	32	[redacted]	[redacted]	unhealthy				
LHS	33	[redacted]	[redacted]	healthy				
LHS	34	[redacted]	[redacted]	poor condition				
LHS	35	[redacted]	[redacted]	healthy				
RHS	36	[redacted]	[redacted]	healthy				
RHS	37	[redacted]	[redacted]	one dead leaf	male	old cone		
LHS	38	[redacted]	[redacted]	healthy	male	old cone		
RHS	39	[redacted]	[redacted]	some dead leaves				
RHS	40	[redacted]	[redacted]	unhealthy				
LHS	41	[redacted]	[redacted]	poor condition				
RHS	42	[redacted]	[redacted]	reasonable condition				
RHS	43	[redacted]	[redacted]	reasonable condition	male	old cone		
LHS	44	[redacted]	[redacted]	healthy				
LHS [redacted]	45	[redacted]	[redacted]	unhealthy	male	old cone		

Location/CH	Hole No.	Number of plants	Original Plant No.	Foliage	Male/female	Fruit (cones)	Insect damage	**New seedlings**
LHS	46			multiple dead leaves	female	with seed		
LHS	47			one dead leaf				
LHS	48			two dead leaves	female, male	with seed, old cone		
LHS	49			unhealthy				
LHS	50			unhealthy				
RHS	51			healthy				
RHS	52			reasonable condition				
RHS	53			reasonable condition	male	old cone		
LHS	54			multiple dead leaves	male	old cone		
LHS	55			some dead leaves				
RHS	56			healthy	female	with seed		
RHS	57			reasonable condition				
Total								

Table 2 Primary recipient site 15-16 January 2013

Location/CH	Hole No.	Number of plants	Plant No.	Foliage	Male/female	Fruits (cones)	Insect damage	**New seedlings**
15-16 January 2013								
Primary recipient site								
NB. Plant No.* = new plant located at time of translocation; not previously tagged or GPSed								
South end start track, travelling north (anticlockwise around site)								
GPS location of hole #1 [redacted]								
LHS	1	[redacted]	[redacted]	3 x no change, 1 x dead leaves				**2**
RHS	2	[redacted]	[redacted]	no change				
RHS	3	[redacted]	[redacted]	2 new leaflets, no change				
RHS	4	[redacted]	[redacted]	some leaflet growth				
LHS	5	[redacted]	[redacted]	no change				
LHS	6	[redacted]	[redacted]	no change				
LHS	7	[redacted]	[redacted]	some leaflet growth				
LHS	8	[redacted]	[redacted]	4 new leaves, no change				
RHS	9	[redacted]	[redacted]	some leaflet growth				
LHS	10	[redacted]	[redacted]	some leaflet growth				
LHS	11	[redacted]	[redacted]	2 new leaves				
RHS	12	[redacted]	[redacted]	some leaflet growth, 4 leaves alive				
RHS	13	[redacted]	[redacted]	most leaves dead, some leaflet growth	male	old cones		

Location/CH	Hole No.	Number of plants	Plant No.	Foliage	Male/female	Fruits (cones)	Insect damage	**New seedlings**
RHS	14			no change				
LHS	15			no change				
RHS	16			no change, leaf dieback				
LHS	17			dead				
RHS	18			5 x no change, new leaf, dead				
LHS	19			no change, new leaf				
RHS	20			no change, dieback				
RHS	21			dead				
LHS	22			no change				
LHS	23			no change				
RHS	24			some leaves broken	male	old cone		
LHS	25			no change	male	old cone		
LHS	26			no change, dead				
LHS	27			some dieback	male	old cone		
RHS	28			no change				
LHS	29			some leaflet growth				
RHS	30			no change				
RHS	31			dead				
RHS	32			dead				
LHS	33			some leaflet growth				
LHS	34			some leaflet growth				
LHS	35			some leaflet growth, dead, no change				
RHS	36			2 x leaflet growth, dead				
RHS	37			some leaflet growth	male	old cone		
LHS	38			some leaflet growth	male	old cone		
RHS	39			some leaflet growth				

Location/CH	Hole No.	Number of plants	Plant No.	Foliage	Male/female	Fruits (cones)	Insect damage	**New seedlings**
RHS	40			no change, dead				
LHS	41			no change, some leaflet growth				
RHS	42			no change, some leaflet growth				
RHS	43			no change	male	old cone		
LHS	44			no change				
LHS	45			dead, 3 x no change	male	old cone		**1 x resprout?**
LHS	46			2 x new leaves, 3 x some leaflet growth	female	with seed		
LHS	47			no change, new leaf, some leaflet growth				
LHS	48			no change, new leaflet growth	female, male	with seed, old cone		
LHS	49			little change				
LHS	50			new leaf, dead, no change				
RHS	51			dieback				
RHS	52			dead				
RHS	53			some leaflet growth	male	old cone		
LHS	54			some dieback	male	old cone		
LHS	55			no change				
RHS	56			no change	female	with seed		
RHS	57			2 x no change, dead				**3**
Sub-totals								**5 + 1 resprout?**
Total								

Table 3 [redacted] recipient site 12 October 2013

Location/CH	Hole No.	Number of plants	Original Plant No.	Foliage	Male/female	Fruit (cones)	Insect damage	**New seedlings**
12 October 2012								
[redacted]								
NB. Plant No.* = new plant located at time of translocation; not previously tagged or GPSed								
Location starting clockwise from road								
GPS location of hole #1 [redacted]								
LHS	1	[redacted]	[redacted]	1 motley leaf, dead, mostly dead				
LHS	2	[redacted]	[redacted]	1 motley leaf				
LHS	3	[redacted]	[redacted]	1 leaf, 1 leaf				
LHS	4	[redacted]	[redacted]	3 leaves, 3 leaves				
LHS	5	[redacted]	[redacted]	3 leaves, none				
LH end	6	[redacted]	[redacted]	2 motley leaves				
RH end	7	[redacted]	[redacted]	2 motley leaves, dead				
RHS	8	[redacted]	[redacted]	seedling, motley, motley, dead, dead				
RHS	9	[redacted]	[redacted]	2 leaves, 3 leaves				
RHS	10	[redacted]	[redacted]	healthy, dead				
RHS	11	[redacted]	[redacted]	2 leaves, 3 leaves, 3 leaves				
Total		[redacted]						

Table 4 [redacted] recipient site 28 October 2012

Location/CH	Hole no.	Number of plants	Original Plant no.	Foliage	Male/female	Fruit (cones)	Insect damage	**New seedlings**
28 October 2012								
[redacted]								
8 plants translocated by [redacted] into existing recipient area - no details of precise location amongst existing holes recorded								
no biological data recorded								
GPS data from tagged plants only (originally excluded from translocation) - no data collected for other 3 plants								
Plant tag numbers not recorded with GPS data								
	Unknown	[redacted]	[redacted]					
	Unknown		[redacted]					
	Unknown		[redacted]					
	Unknown		[redacted]					
	Unknown		[redacted]					
	Unknown		[redacted]					
	Unknown		[redacted]					
	Unknown		[redacted]					
	Unknown		[redacted]					
Total		[redacted]						

Table 5 [redacted] recipient site 16 January 2013

Location/CH	Hole No.	Number of plants	Plant No.	Foliage	Male/female	Fruit (cones)	Insect damage	**New seedlings**
16 January 2013								
With no absolute location data and no numbers for plants for translocated plants of 28 October 2012, original plant (if available) numbers were dropped for monitoring purposes. Hole and plant numbers reworked (below) for monitoring consistency 16 January 2013								
[redacted]								
[redacted]								
NB. Plant numbers from 12 and 28 October 2012 reformatted 16 January 2013								
LHS	1	[redacted]	[redacted]	1 new leaf, some leaflet growth, some dieback				
LHS	2	[redacted]	[redacted]	some dieback				
LHS	3	[redacted]	[redacted]	little change, some dieback, some dieback				
LHS	4	[redacted]	[redacted]	some dieback; some leaflet growth, some dieback; some leaflet growth				
LHS	5	[redacted]	[redacted]	dead, some dieback and some leaflet growth				
LHS	6	[redacted]	[redacted]	dead, 1 new leaf, dead, some leaflet growth	female		new cone	
LH end	7	[redacted]	[redacted]	little change/some dieback				

Location/CH	Hole No.	Number of plants	Plant No.	Foliage	Male/female	Fruit (cones)	Insect damage	**New seedlings**
RH end	8	[redacted]	[redacted]	dead, new leaf				
RHS	9	[redacted]	[redacted]	dead, some leaflet growth				
RHS	10	[redacted]	[redacted]	leaf stubs, 3 new leaves, dead, dead				
RHS	11	[redacted]	[redacted]	dead, some leaflet growth				
RHS	12	[redacted]	[redacted]	no change				
RHS	13	[redacted]	[redacted]	no change, no change, dead				
RHS	14	[redacted]	[redacted]	dead, dead, no change, some leaflet growth				
Sub-total		[redacted]						**1**
Total		[redacted]						

6 *Macrozamia pauli-guilielmi* Management Plan

The *Macrozamia pauli-guilielmi* Management Plan and Addendum Rev. B hereafter referred to as MPMP, was prepared to comply with the conditions of approval granted under sections 130 (1) and 133 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) for a controlled action relating to proposed impacts on a nationally listed threatened species (Opus 2012).

The MPMP clearly sets out the background, parameters and scope of work for the project, the context and strategy for translocation, and the roles and responsibilities of individual parties. The translocation strategy section is particularly useful as it provides systematic guidelines for the entire process from translocation to monitoring and reporting.

This Plan is the best tool for field and office as it covers every useful aspect of translocating cycads sourced from various well-known and well-credentialed resources. It is not too prescriptive, leaving the field operator plenty of scope for latitude when required to respond rapidly to changing environmental factors, workplace situations and permit or license requirements.

The MPMP also broke down the 20 steps of the cycad translocation protocol into the steps associated with particular tasks - e.g., during removal, planting, and maintenance - this would be appreciated greatly by anyone who has not translocated cycads (or other plant species) before.

The MPMP as the framework for managing *M. pauli-guilielmi* translocations, was found to be sufficient for the purpose for which it was prepared and in the opinion of the author, does not require revision or expansion.

Macrozamias being tagged and labelled prior to translocation

7 The translocation process

7.1 Cycad survival

It is not yet possible to discuss *Macrozamia pauli-guilielmi* deaths as a result of this translocation, because it is not yet certain that there are any.

Given the nature of the species, with their perennial shedding and growth of new leaves during spring (Jones 2002, Forster and Holland 2007), deaths if any, will not be apparent for some time - possibly not until the spring of 2013 at the earliest or perhaps not until as late as spring of 2014.

Female macrozamia with a freshly emerged cone -note all leaves are dead

With cycads it can be difficult to attribute the cause of leaf death with any reliability, as foliage may die back, or die completely as a direct result of translocation and the resultant shock to plants (even when treated with anti-transpirant), or foliage death could be natural senescence hastened by translocation.

7.2 Evaluation of the process

M. pauli-guilielmi is documented as being relatively easy to transplant (Jones 2002) and being very tough (Forster, P. I. 2012 pers. comm., 19 June). Previous first-hand experience with translocating macrozamia bears this out, yet it is also well known amongst field practitioners that some challenges for successful translocation of *M. pauli-guilielmi* include:

- The sandy nature of the soil, which can lead to difficulty in retaining soil around the rootball during excavation; and
- The size of the underground stem, which must be carefully assessed [*sic*] before excavation to avoid damage;
- Fast moving insect plagues; and
- The optimal time for translocation is in the cooler months prior to new leaf flushes and masting in spring.

Successes

The first two and the last above points were experienced during this translocation. The first two were expected given the nature of the road environment and the soil types encountered, which were mostly sandy, but in some places were transitioning into sedimentary geology and had developed into 'coffee rock' (rock-like formations of indurated sands or soils) - indurated, being hardened by extremes of climate.

Due to sound knowledge and experience, the translocator was ready for such eventualities, which did enhance the success of at-times moving very large blocks of caudex and soil root mass weighing more than 100 kg.

In other instances, the sand was so loose that it was not possible to retain any soil mass around the roots. At times though, this was actually beneficial when extracting the roots of large cycads, where excavations had to go below 2 m.

Damaged roots were surgically trimmed and treated with Banrot® 400WP prior to packing with some of their own sand and wrapped in hessian sacking ready for transportation to the recipient site. Retaining sand from the cycads soil root mass is critical when conducting translocations because of associated and/or mutualistic organisms, let alone those with symbiotic relationships.

In one instance during extraction, the junction of the caudex and taproot of a cycad cracked severely when unexpectedly knocked with the excavator bucket. This cycad was not visible aboveground, so it became an unexpected addition to the project. A photograph on the following page shows the finishing touches with surgical dressing being applied after cleaning, trimming, and dusting with Banrot® 400WP.

As discussed previously, many cycads were in a poor condition prior to translocation and the difficulty of handling some of the large soil root masses has resulted in foliage damage and death for approximately fifteen per cent of cycads.

However, due to species toughness, it is unlikely that any more than a very few actual plant deaths will occur. Natural germination of seedlings at the recipient sites will more than offset such deaths - the extra time spent soil seed searching is already paying off after the conclusion of only one of approximately four-six monitoring periods.

During translocation, collection of soil-borne seed obvious on or within the A-horizon (topsoil), as just mentioned above has already brought forth some young seedlings, recorded as per the tables in section 5.2. Most likely, this seed is from last or recent seasons that were waiting for good rains to fall before germinating.

Deliberate effort went into retaining as much noticeable seed as possible during translocation and transportation and the resultant germination of seedlings is already very successful. Additionally, spring 2013 will bring forth cyclic leaf flushes and some dead-looking plants will 'spring' back into apparent life.

K Stephens

Cracked caudex-taproot junction being 'dressed' prior to covering with sand and wrapping ready for transport

Augmenting pre-existing cycad populations through this translocation, across a spectrum of generations may help address some of the localised fragmentation of the extant metapopulation.

Having recipient sites in areas of remnant vegetation, affording some level of protection from clearing is definitely a success factor for translocation. The downside can be competition and the risk of fire if the area remains dry.

Good rains did eventually come during November 2012, followed by the flood event of January 2013. This will ensure that unless an extended drought period follows this wet period, these plants will never need watering again (based on average seasonal rainfall data).

Given the recent flood events and the prospect of a reasonable rainy season, the recipient sites should remain protected from fire long enough for the translocated cycads to become established and to recover fully their inherent fire-resistant capabilities.

Masting (synchronous cone formation) is known to follow fire events (Forster 2004), but recipient sites remaining unburnt for some will give young seedlings a chance develop and survive in their fire-prone habitat.

An online weather site is observed weekly to monitor daily and seasonal weather conditions with rainfall data recorded for watering purposes and for calculation of the fire hazard at the recipient sites (Willy Online 2013).

Conducting the translocations with Neumann Contractors water trucks on-site was critical to foster successful outcomes (survival rates and seedling germinations) at the recipient sites until good rains fell in early-mid November 2012, although watering resumed from then until the end of the calendar year.

Table 6 Tin Can Bay rainfall records July 2012-Febraury 2013

MACROZAMIA PAULI-GUILIELMI TRANSLOCATION - TIN CAN BAY RAINFALL RECORDS	
Date	**Rainfall (mm)**
26/07/2012	0.2
28/07/2012	0.2
Total	**0.4**
27/08/2012	0.6
17/09/2012	9.2
19/09/2012	0.4
22/09/2012	1
25/09/2012	7.2
26/09/2012	6
Total	**24.4**
2/10/2012	1.6
3/10/2012	4.6
9/10/2012	0.8
12/10/2012	8.2
29/10/2012	2.2
31/10/2012	0.4
Total	**17.8**
1/11/2012	1
4/11/2012	4
10/11/2012	0.2
11/11/2012	42.8
12/11/2012	30.8
18/11/2012	0.4
19/11/2012	49.2
27/11/2012	35
Total	**163.4**

MACROZAMIA PAULI-GUILIELMI TRANSLOCATION - [redacted] RAINFALL RECORDS	
Date	**Rainfall (mm)**
7/12/2012	6.2
12/12/2012	4.6
13/12/2012	1.2
14/12/2012	0.8
18/12/2012	0.2
29/12/2012	3.4
Total	**16.4**
11/01/2013	9.8
15/01/2013	3.2
22/01/2013	0.4
24/01/2013	2.4
25/01/2013	120.8
27/01/2013	126.8
Total	**263.4**
2/02/2013	0.6
3/02/2013	1.2
Running total	**485.8**

This cycad near [redacted] had the deepest root system found, possibly because it was on top of a high bank of dry, very loose sand

Ultimately, translocation is about survival of the plants and doing the best from humanly inseparable perspectives of subjectivity and objectivity to achieve the best results. The big *and* is the translocator having the capacity to implement intuitively the best landscape horticultural and ecological practices in situ.

Using experienced successful operators is not only a major strength of translocation projects, but is critical to translocation success.

Flaws

The flaws in this translocation process are limited to red tape holding up the process for so long that the plants were not translocated during the cooler months prior to spring as planned for. The later translocation meant that the ongoing spring flush was interrupted for numerous cycads as they were shifted under hot late spring conditions, just prior to flushing.

If there had been time to translocate all of the cycads during the cooler months, it would have allowed them time to become well-settled in their new environment with minimum interruption to their reproductive biology.

It was not possible to delay translocation until the following year because road network reconstruction was time bound and critical infrastructure for the state.

K Stephens

Some cycads were extracted with the soil root mass intact (because of compacted soils) at times weighing 100 or more kilograms, making them very difficult to handle and transfer from ground to sling to truck and back again at the recipient site

Recommendations

At this early stage, the recommendations are that referrals be time bound to the reproductive biology of the species concerned and that the monitoring period is too short. It is recommended that in future translocations of *M. pauli-guilielmi* that at the end of a two-year period (such as this project) that an additional three (3) annual monitoring events take place.

Longer monitoring periods would be better given the reproductive maturity of the species and would be a better demonstration of survival of the translocated population. However, commercial reality must be considered, therefore the recommendation for three only additional annual monitoring events.

K Stephens

Heavy canvas slings with stainless steel cables, hooks and eyes were purpose built to deal with heavy weights that could never be manhandled without breaking

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