



Red Ash
Consulting



Cooroy to Curra (Section D)

***Macrozamia pauli-guilielmi* Translocation Monitoring -
Year 2 Event 1 (June 2022)**

**Department of Transport and Main Roads
August 2022**

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Executive Summary

The Department of Transport and Main Roads (TMR) is upgrading and realigning a 26 km section of the Bruce Highway from Woondum Road to Curra within the Gympie Regional Council area, Queensland. Targeted flora surveys identified two conservation significant flora species within the project footprint, namely *Macrozamia pauli-guilielmi* and *Leichhardtia coronata* (formerly *Marsdenia coronata*). Translocation of both species was undertaken by TMR to mitigate against impacts to local populations from vegetation clearing for the project.

Red Ash Consulting was engaged by TMR to undertake biannual monitoring of the translocation program over a five year period from May 2021 to April 2025. The monitoring program for each species is reported on separately, with this report pertaining only to the monitoring of *M. pauli-guilielmi*.

Translocation of *M. pauli-guilielmi* plants commenced in spring 2020, with a total of 40 adults and 242 seedlings translocated between August and December 2020. Plants were salvaged from two sites within the Contract 2 area and replanted directly at Recipient Site B, located approximately 14 km north of the central business district of Gympie. All translocated adult plants were included in the monitoring program and two quadrats (measuring approximately 10 x 10 m) were established to monitor a subset of translocated seedlings. Each quadrat contained 20 *M. pauli-guilielmi* seedlings. The following is a brief summary of outcomes from the third monitoring event (Event 3) undertaken on 23 June 2022:

- Most (90.7%) of the translocated adult plants were alive at the time of the third monitoring event.
- Of the alive adult plants, just over half (56.8%) were considered to be in good health, with many individuals showing signs of stress such as leaf discolouration or necrosis. Seedlings were typically in better health than adults, with 73.5% of alive seedlings in good health.
- A total of five adult plants (14%) were coning at the time of monitoring, one of which was male and four of which were female. No seedlings were coning which is expected given the young age of plants.
- All adults and seedlings showed low rates of insect predation.
- No fauna or erosion impacts were evident.
- Weeds levels were generally low across the site.
- NDLC data indicates that six adult plants (15%) sustained stem or root damage during translocation operations. Of those, four (66.7%) were alive and two were dead (33.3%) at the time of monitoring. By way of comparison, 94.3% of undamaged plants remained alive. Continued monitoring will be required to determine if damage sustained during translocation operations has any long-term effect on plant survival. No damaged seedlings were present in the monitoring quadrats so an analysis of translocation damage was not undertaken.

Trend analysis

- The only statistically significant change recorded over the monitoring period was plant health χ^2 (4, N = 202) = 23.25, $p = .00011$, whereby the total number of plants exhibiting good health increased from 19 at Event 1 to 45 at Event 3.

Conclusion

The translocation program is largely on track apart from the following:

- Four adults and six seedlings are lacking above ground vegetative material and are assumed to be dead. Supplementary planting will be required to compensate for these losses.
- Nearly half (34.9%) of the plants surviving (adults and seedlings combined) had 5% or more of the plant showing leaf discolouration or exhibiting necrosis.

NDLC should continue to monitor plant health during maintenance inspections and attempt to identify causes of stress leading to leaf drop so that corrective actions can be undertaken in a timely manner.

Acronyms

Acronym	
DCCEEW	Commonwealth Department of Department of Climate Change, Energy, the Environment and Water
DES	Queensland Department of Environment and Science
DGPS	Differential global positioning system
DoR	Queensland Department of Resources
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
EVNT	Critically endangered, endangered, vulnerable, near threatened
GPS	Global positioning system
NC Act	Queensland <i>Nature Conservation Act 1992</i>
NDLC	Noosa District Landcare Group
TMR	Department of Transport and Main Roads

1. Introduction

1.1 Background

The Department of Transport and Main Roads (TMR) is upgrading and realigning a 26 km section of the Bruce Highway from Woondum Road to Curra within the Gympie Regional Council area, Queensland. The realigned section will pass to the east of the Gympie township and will comprise a four lane divided highway with a posted speed limit of 110 km/hr. The project is termed the Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) Works Package and is the final stage of a broader upgrade of the Bruce Highway from Cooroy to Curra. Section D of the project (the project) comprises two stages, namely Contract 1 (Woondum Interchange to Sandy Creek Road) and Contract 2 (Sandy Creek Road to Curra Interchange).

Targeted flora surveys for the project identified two conservation significant flora species located within the construction footprint, namely *Macrozamia pauli-guilielmi* (pineapple zamia) and *Leichhardtia coronata* (slender milkvine) (formerly *Marsdenia coronata*). *M. pauli-guilielmi* is listed as endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Queensland *Nature Conservation Act 1992* (NC Act) whilst *L. coronata* is listed as vulnerable under the NC Act.

GHD prepared the *Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) Detailed Design Job No. 232/10A/7, Invitation No. WBYD – 1335 Impact Management Plan* (GHD, 2018) on behalf of TMR to detail proposed measures to manage impacts to both species from the project. A key mitigation measure proposed in the plan was the translocation of both species. The overarching objective of the translocation is to maintain the existing viability of the local populations of both species by re-establishing impacted individuals within nearby suitable sites where pollination transfer and other ecological processes can continue unimpeded.

Long-term monitoring of the translocation program is an essential component of the translocation plan and allows for timely and effective adaptive management should the monitoring detect emerging risks to translocation success. Monitoring and reporting of translocation success is also captured in approval conditions imposed by both the Commonwealth Department of Environment and Energy (now Department of Climate Change, Energy, the Environment and Water (DCCEEW)) and the Queensland Department of Environment and Science (DES) (refer Section 1.3).

Red Ash Consulting has been engaged by TMR to undertake biannual monitoring of the translocation program over a five year period from May 2020 to April 2025. The monitoring program for each species is reported on separately, with this report pertaining only to the monitoring of *M. pauli-guilielmi*.

Monitoring of the translocated *M. pauli-guilielm* plants commenced in May 2021 with the first monitoring report issued in July 2021 (refer Table 1).

Table 1. Previous monitoring activities

No	Event	Monitoring date	Report title/date
Contract 2			
1	Year 1 Event 1	4 May 2021	Cooroy to Curra (Section D) Macrozamia pauli-guilielmi Translocation Monitoring -Event 1 (May 2021) July 2021
2	Year 1 Event 2	12 November 2021	Cooroy to Curra (Section D) Macrozamia pauli-guilielmi Translocation Monitoring -Event 1 (November 2021) November 2021

1.2 Report purpose

The purpose of this report is to document the results of the third monitoring event of the monitoring program, undertaken on 23 June 2022. Data presented will provide a platform for future monitoring activities and allow an accurate assessment of translocation success over time.

1.3 Relevant approval conditions

The commitment to translocate potentially impacted plants was formally conditioned by the Commonwealth Department of Environment and Energy (now DCCEEW) under EPBC Approval EPBC 2017/7941 and by DES under Clearing Permit Number WA0014813v3.

Specific conditions cited in Commonwealth and State approval documentation in relation to translocation activities are provided in Table 2.

Table 2. Approval conditions

Condition	Description
Translocation Conditions - EPBC 2017/7941	
Item 5	<i>Prior to translocation of Pineapple zamia plants, the approval holder must:</i> <ol style="list-style-type: none"> <i>Record the number of viable adult Pineapple zamia plants at the impact site;</i> <i>Collect enough seeds from Pineapple zamia plants at the impact site and, if necessary, from alternative sites, to enable replacement of no less than 48 percent of the number of adult Pineapple zamia plants at the impact site;</i> <i>Legally secure the translocation site.</i>
Item 6	<i>Prior to commencement of Contract 2, the approval holder must translocate every Pineapple zamia plant from the impact site to the translocation site. Within 20 business days of removing the last Pineapple zamia plant from the impact site, the approval holder must notify the Department of the date of the last Pineapple zamia plant was removed and the total number of Pineapple zamia plants removed (specifying the number of adult Pineapple zamia plants removed and the number of seedling Pineapple zamia plants removed).</i>
Item 7	<i>The approval holder must ensure any adult Pineapple zamia plant that suffers mortality at the translocation site within 5 years of the date the last Pineapple zamia plant was removed from the impact site, is replaced by 4 Pineapple zamia plants. Replacement plants must be sourced from propagation of seeds collected from the impact site or from alternative sites. Replacement plants must be planted within 3 years of the mortality of the plant they are replacing.</i>
Item 8	<i>By one year before the end date of this approval, the approval holder must ensure that the number of Pineapple zamia plants that exist at the translocation site is at least 1.5 times the number of Pineapple zamia plants translocated from the impact site, as reported under condition 6.</i>
Translocation Conditions - Clearing Permit Number WA0014813v3	

PPCLR06	Where monitoring by the permit holder of impact management actions with respect to endangered, vulnerable or near threatened species in the clearing area identifies that those actions appear to be unsuccessful or failing, the permittee must notify DES immediately in order to discuss the significant residual impact of the clearing and furthermore discuss any potential implementation of an offset action in accordance with the Queensland Environmental Offset Policy. This requirement may be found in Section 284(1) of the Nature Conservation (Wildlife Management) Regulation 2006
PPC001	Activities relating to the impact of EVNT species under this permit must be in accordance with the procedures and actions outlined in the following document, except where conditions below indicate otherwise: Protected Plant Clearing Permit Application and supporting documents lodged in Connect on 05/02/19.
PPC004	Impact management is to be undertaken in accordance with the following documents: <ol style="list-style-type: none"> 1. Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) Detailed Design Job No. 232/10A/7, Invitation No. WBYD - 1335 - Impact Management Plan and associated appendices. 2. The letter 'Bruce Highway (Cooroy to Curra), Section D: Woondum to Curra - Protected Plant Clearing Permit (WA0014813), received on 16 July 2019, signed by Justin Sanderson. 3. Email received on 24 July 2019 showing Plate 2 and Plate 5 recipient sites for Lot 3/SP302524 and Lot 878/MCH1061.
PPC005	No individuals of the endangered and vulnerable species <i>Macrozamia pauli-guilielmi</i> and <i>Marsdenia coronata</i> are to be taken. All individuals within the clearing footprint are to be translocated in accordance with the submitted Translocation Management Plans. Total numbers of plants to be translocated are to be as per the letter 'Bruce Highway (Cooroy to Curra), Section D: Woondum to Curra - Protected Plant Clearing Permit (WA0014813), received on 16 July 2019, signed by Justin Sanderson.
PPCM09	Rehabilitation and/or translocation reporting must be maintained from the commencement date of clearing and continue for a minimum period as described in the impact management plan. The written report (including advice on each monitoring period) must be lodge with the Wildlife Assessment Team, Department of Environment and Science, via an email to wildlife@des.qld.gov.au , within 10 business days after each annual period.

1.4 Translocation activities

A total of 40 adults and 242 seedlings were translocated from two salvage sites (i.e. Site 2 and Site 3) within the Contract 2 area between August and December 2020 by Noosa District Landcare Group (NDLC). All salvaged plants were replanted directly at Recipient Site B, located approximately 14 km north of the central business district of Gympie (refer Section 1.5 and Figure 1). All plants were labelled with an orange flag and a metal identification tag with a unique identity number. Locations of plants were also recorded by NDLC with a differential global positioning system (DGPS). On-ground translocation activities undertaken over the period are detailed in the *Bruce Highway – Cooroy to Curra (Section D: Woondum to Curra) Macrozamia pauli-guilielmi Translocation Final Report* (NDLC, 2021).

1.5 Recipient Site B description

Recipient Site B is located within Lot 878 on MCH1061 at Curra, approximately 14 km north of the central business district of Gympie. The site occurs on the western extent of a series of vegetated rolling hills with dissected drainage. The vegetation community present comprises a woodland dominated by *Corymbia citriodora* and *E. racemosa* subsp. *racemosa* with a median canopy height of 20 m with approximately 40 percent canopy cover, 20-40 percent shrub layer cover and 10 percent ground layer cover (Plate 1). The site has been divided into the following sub-sites for the purposes of translocation (Figure 1):

- B2-2 – planting area for adults from Salvage Site 2
- B2-3 – planting area for adults from Salvage Site 3
- B2-S2 – planting area for seedlings from Salvage Site 2





- B2-S3 – planting area for seedlings from Salvage Site 3



Plate 1. Representative photograph of Recipient Site B.



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-  Monitoring quadrats
-  Site B polygons
-  Recipient Site B
-  Property boundaries

Imagery source: Google
(high res) via QVeg/QGIS

FIGURE 1 - Recipient Site B Locations
Macrozamia pauli-guilielmi

Project:	Cooroy to Curra Section D Translocation Monitoring
Location:	Lot 878 on MCH1061
Client:	Department of Transport and Main Roads
Date:	June 2021

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2. Monitoring methodology

The current monitoring event (Event 3) was undertaken by Red Ash Consulting principal ecologists, Peter Moonie and Carly Sugars, on 23 June 2022. Monitoring activities were undertaken in general accordance with the translocation plan. All translocated *M. pauli-guilielmi* adults were monitored in the nominated planting areas/polygons and two quadrats (measuring approximately 10 x 10 m) were established to monitor a subset of translocated seedlings. The two quadrats captured approximately 16.7% of all translocated *M. pauli-guilielmi* seedlings, which was considered to provide an adequate sample size for monitoring purposes.

A description of each quadrat is provided in Table 3. Adult planting areas/polygons and quadrat locations within the seedling planting areas are shown in Figure 1.

Table 3. Monitoring quadrats

Quadrat ID	Central coordinates	Quadrat size	n*	Description
B2-S2	-26.0613, 152.6250	10 x 10 m	10	Located immediately east of access track on ridge slope.
B2-S3	-26.0691, 152.6252	10 x 10 m	10	Located approximately 12 m northeast of B2-S2.

*n – number of *M. pauli-guilielmi* individuals planted in quadrat

Parameters assessed during the monitoring event, together with assigned categories are outlined in Table 4. General observations of weed species and densities across the site were also made. Plant health and insect predation were only assessed for plants with above-ground vegetative material present.

GPS coordinates of plants were not recorded during the monitoring event as plants were appropriately labelled and able to be easily located in the field. GPS coordinates were also previously recorded by NDLC during translocation operations.

Table 4 . Monitoring parameters

Attribute	Assigned categories	Description
Mortality	Alive	Above ground vegetative material present
	Unknown	Given the underground stem possessed by the species, a lack of leaves is not necessarily indicative of plant mortality. Consequently, plants without leaves will be assigned a category of unknown for the first three years. Such plants will be monitored and if no growth appears after three seasons, underground stems of several plants will be inspected to determine if the plant has died.
	Dead	Plant unviable (vascular transport in stem and roots ceased)
Health	Good	<5% of leaves showing signs of stress
	Moderate	5-25% of leaves showing discolouration/necrosis
	Poor	>25% of leaves showing discolouration/necrosis
Reproductive output	Coning	Fresh cones present
	Nil	No fresh cones present
Insect predation	Low	<5 % of leaves predated
	Moderate	5-25% of leaves predated

	High	>25% of leaves predated
Fauna impacts	Yes	Fauna digging or grazing impacting rootzone or plant
	No	No evidence of fauna digging or grazing
Erosion impacts	Low	Minor rills present but not affecting root zone
	Moderate	Moderate rilling present, impacts to root zone evident
	High	Gullyng or rills present, undermining of tubers, major impacts to root zone

3. Monitoring results

Results of the monitoring event for each parameter for adults and seedlings are provided in Tables 5 and 6 respectively and displayed graphically in Figures 2 to 6. Raw data is provided at Appendix A. Representative photographs are provided at Appendix B. Parameters are assessed individually in sub-sections 3.1 to 3.5. An analysis of the effects of translocation damage on plant survival is provided in sub-section 3.7. A comparison of results across monitoring events (i.e. trend analysis) is provided in Section 4.

Table 5. Adult plant monitoring results for each parameter

Parameter	Number of adult plants (relative %)		Adult total	Adult Mean (relative %)
	B2 2	B2 3		
Alive	22(88%)	14(93.3%)	36	18(90.7%)
Unknown	3(12%)	1(6.7%)	4	2(9.3%)
Health				
Poor	2(9.1%)	1(7.1%)	3	1.5(8.1%)
Moderate	6(27.3%)	6(42.9%)	12	6(35.1%)
Good	14(63.6%)	7(50%)	21	10.5(56.8%)
Reproduction				
Coning	3(13.6%)	2(14.3%)	5	2.5(14%)
Nil	19(86.4%)	12(85.7%)	31	15.5(86%)
Insect predation				
Low predation	22(100%)	14(100%)	36	18(100%)
Moderate predation	0(0%)	0(0%)	0	0(0%)
High predation	0(0%)	0(0%)	0	0(0%)
Fauna impacts				
Yes	0(0%)	0(0%)	0	0(0%)
No	22(100%)	14(100%)	36	18(100%)
Erosion impacts				
Low	22(100%)	14(100%)	36	18(100%)
Medium	0(0%)	0(0%)	0	0(0%)
High	0(0%)	0(0%)	0	0(0%)

Table 6. Seedling monitoring results for each parameter

Parameter	Number of seedlings (relative %)		Seedling total	Seedling Mean (relative %)
	B2 S2	B2 S3		
Survival				
Alive	17(85%)	17(85%)	34	17(85%)
Unknown	3(15%)	3(15%)	6	3(15%)
Health				
Poor	3(17.6%)	0(0%)	3	1.5(8.8%)
Moderate	3(17.6%)	3(17.6%)	6	3(17.6%)
Good	11(64.7%)	14(82.4%)	25	12.5(73.5%)
Reproduction				
Coning	0(0%)	0(0%)	0	0(0%)
Nil	17(100%)	17(100%)	34	17(100%)
Insect predation				
Low predation	17(100%)	17(100%)	34	17(100%)
Moderate predation	0(0%)	0(0%)	0	0(0%)
High predation	0(0%)	0(0%)	0	0(0%)
Fauna impacts				
Yes	0(0%)	0(0%)	0	0(0%)
No	17(100%)	17(100%)	34	17(100%)
Erosion impacts				
Low	17(100%)	17(100%)	34	17(100%)
Medium	0(0%)	0(0%)	0	0(0%)
High	0(0%)	0(0%)	0	0(0%)

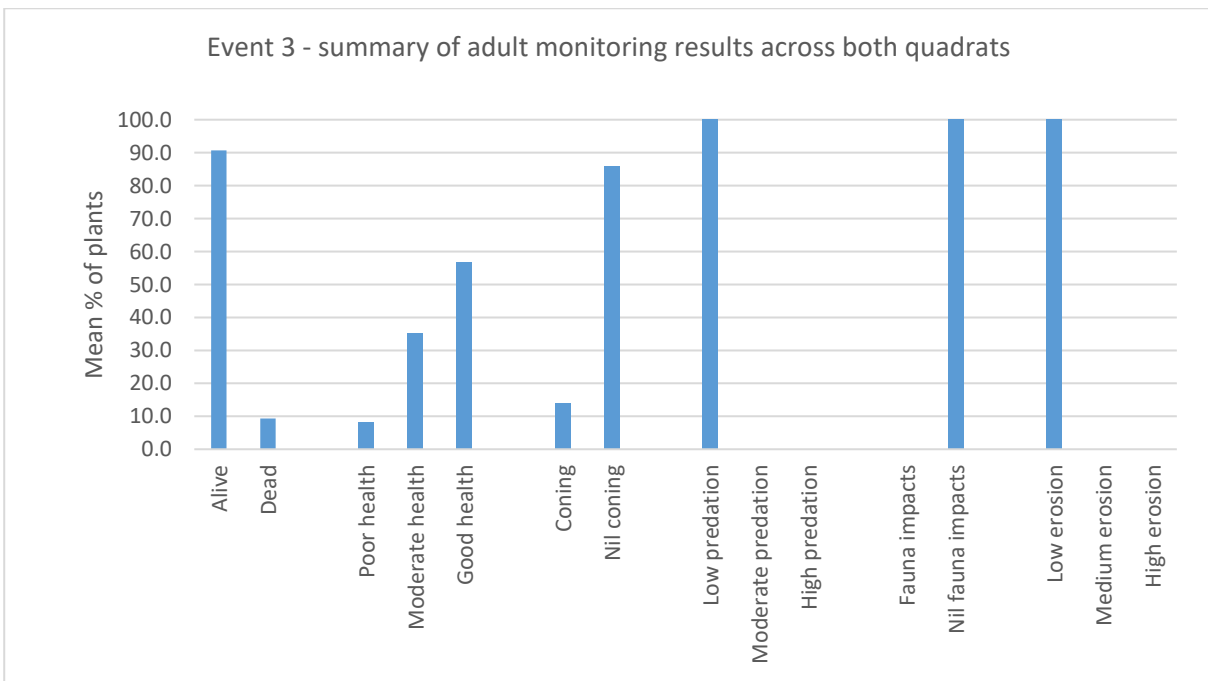


Figure 2. Mean percent of adult plants across quadrats for each measured parameter

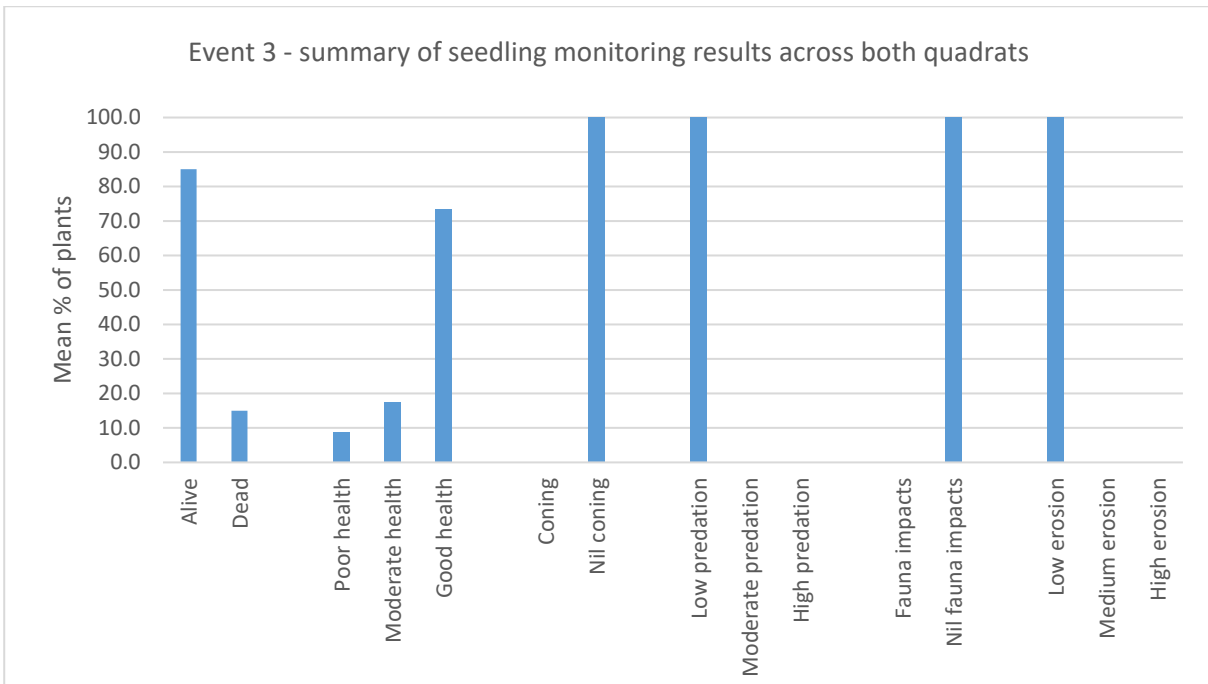


Figure 3. Mean percent of seedlings across quadrats for each measured parameter

1.6 Survival

Results indicate that most (90.7%) of the translocated adult plants were alive at the time of the third monitoring event, with minimal variation recorded across the two planting areas (B2-2 – 88%, B2-3 – 93.3%) (Figure 4). The proportion of translocated seedlings that were alive was the same across both seedling planting areas (85%) and was slightly lower than for that recorded for adults (Figure 4).

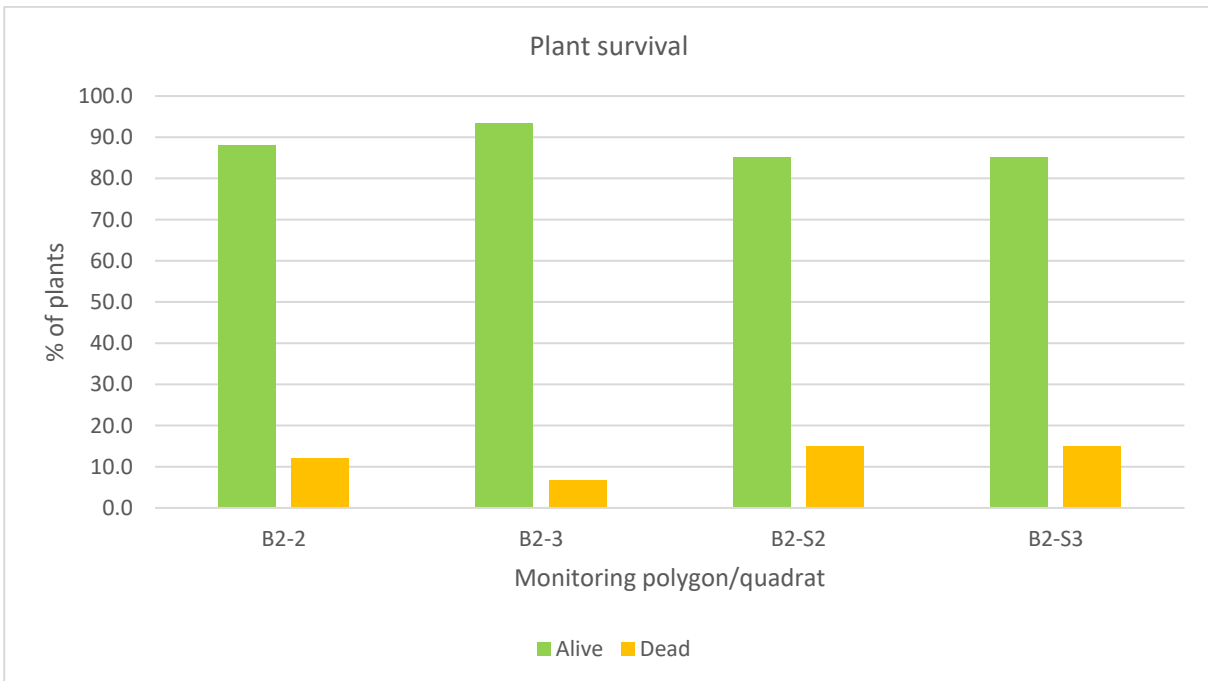


Figure 4. Plant survival within each monitoring quadrat

1.7 Health

Of the alive adult plants, just over half (56.8%) were considered to be in good health, with many individuals showing signs of stress such as leaf discolouration or necrosis. Seedlings were typically in better health than adults, with 73.5% of alive seedlings in good health (Figure 5).

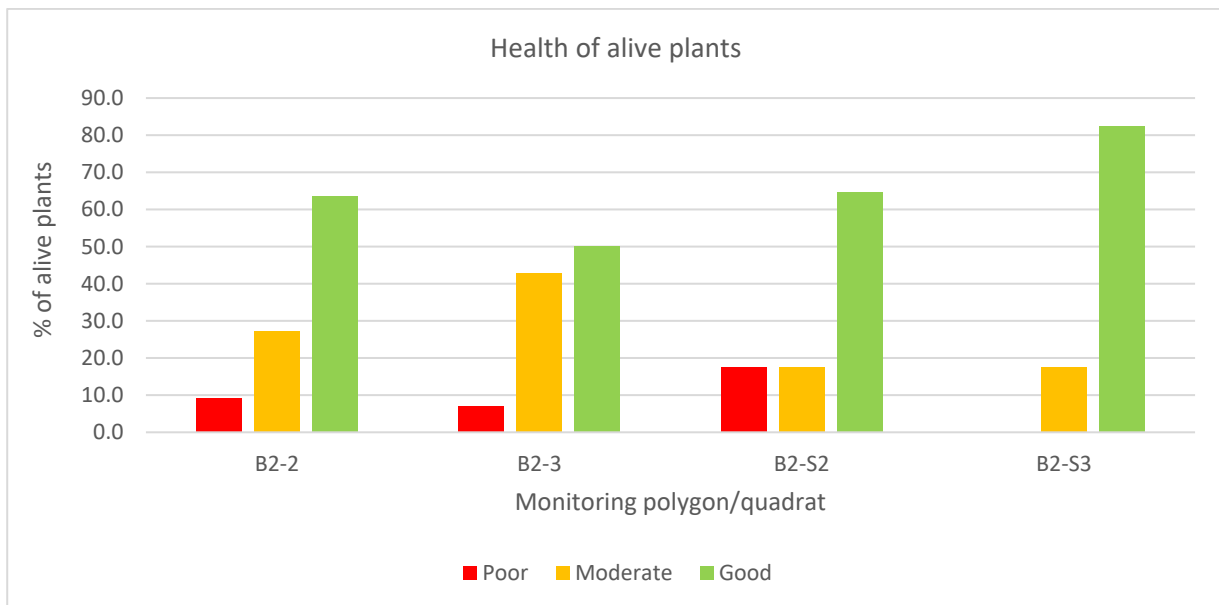


Figure 5. Plant health within each monitoring quadrat

1.8 Reproductive capacity

Of those translocated adult plants with evidence of past or fresh cones, 16 were identified as female (61.5%) and 10 were identified as male (38.5%). A total of five adult plants (14%) were coning at the time of monitoring, one of which was male and four of which were female. No seedlings were coning which is expected given the young age of plants.

1.9 Insect predation

All adults and seedlings showed low rates of insect predation.

1.10 Fauna and erosion impacts

No fauna or erosion impacts were observed in any of the quadrats.

1.11 Weeds

Weeds levels in all monitoring polygons and quadrats were low.

1.12 Effects of translocation damage

NDLC data indicates that six adult plants (15%) sustained stem or root damage during translocation operations. Of those, four (66.7%) were alive and two were dead (33.3%) at the time of monitoring (Table 7). By way of comparison, 94.3% of undamaged plants remained alive. Continued monitoring will be required to determine if damage sustained during translocation operations has any long-term effect on plant survival.

No damaged seedlings were present in the monitoring quadrats so an analysis of translocation damage was not undertaken.

Table 7. Effects of translocation damage on the retention of leaf material in adults

Attribute	Alive (relative %)	Dead (relative %)	Total [#]
Damage	4 (66.67%)	2 (33.33%)	6 (100%)
Nil damage	32 (94.12%)	2 (5.88%)	34 (100%)

4. Trend analysis

Average percentages calculated for each parameter over the three monitoring events are presented in Table 8 and are displayed graphically in Figure 6.

Table 8. Sample means for each parameter over the three monitoring events.

Parameter			
Alive	80.92	83.58	87.83
Dead/Unknown	19.08	16.42	12.17
Poor	40.10	24.82	8.47
Moderate	30.12	21.97	26.36
Good	29.78	53.21	65.17
Coning	11.00	10.33	6.98
Nil coning	89.00	89.67	93.02
Insect predation			
Low predation	88.35	100.00	100.00
Moderate predation	6.37	0.00	0.00
High predation	5.28	0.00	0.00
Yes	0.00	0.00	0.00
No	100.00	100.00	100.00
Erosion impacts			
Low	100.00	100.00	100.00
Medium	0.00	0.00	0.00
High	0.00	0.00	0.00

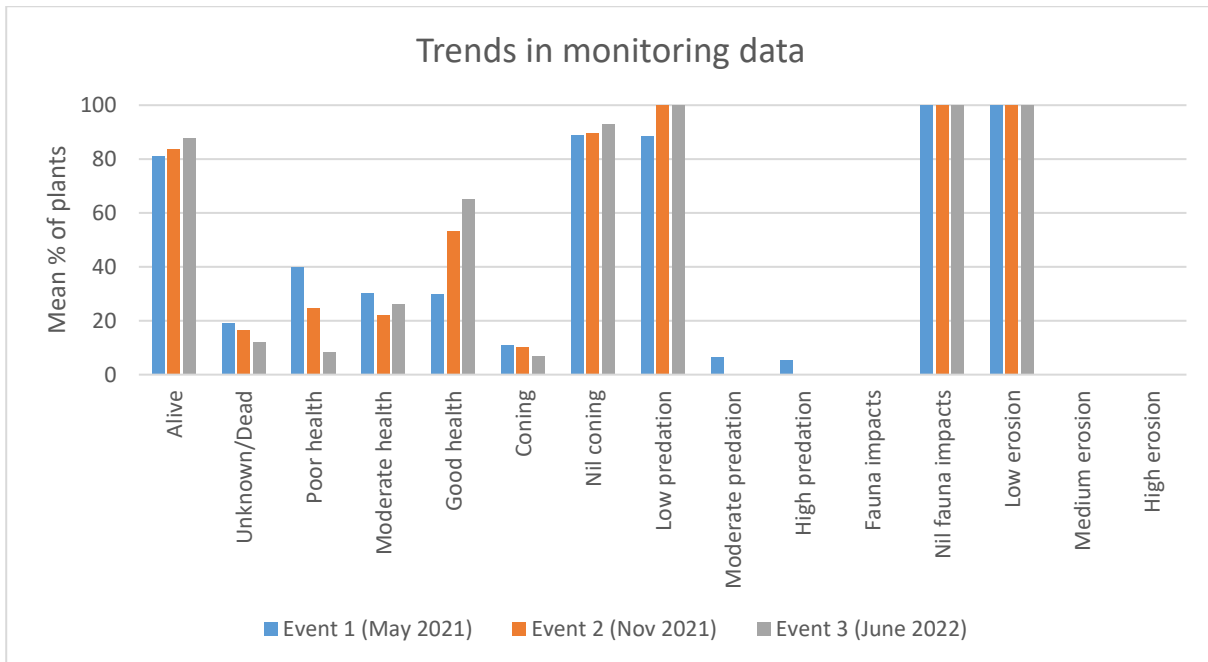


Figure 6. Mean % of plants for each measured parameter over the three monitoring events

A chi-square test was performed to determine if any observed changes over the three monitoring events were significant ($p < .05$). Results are summarised below:

- The number of alive plants increased slightly over the monitoring program; however, the observed change was not statistically significant, $\chi^2(2, N=240) = 1.19, p = .552$.
- There was a statistically significant change recorded in plant health during the monitoring program, $\chi^2(4, N = 202) = 23.25, p = .00011$. In particular, the total number of plants (adults and seedlings) exhibiting good health increased from 19 at Event 1 to 45 at Event 3.
- Insect predation decreased over the monitoring period; however, the observed change was not statistically significant, $\chi^2(4, N=202) = 8.72, p = .069$.
- No changes were observed in the prevalence of coning or in the number of plants impacted by fauna or erosion.

5. Management

An assessment against the adaptative management triggers documented in the *Bruce Highway - Cooroy to Curra (Section D: Woondum to Curra) Macrozamia pauli-guilielmi Translocation Management Plan November 2017* is presented in Table 9.

Table 9. Assessment against management triggers

Management trigger		
Presence of damage from feral animals (e.g. pigs)	No damage evident	Nil.
Presence of declared and environmental weeds within 20 m of the planting area	Weeds levels low, not impacting plant survival.	Ongoing weed monitoring and control by NDLC.
Insect herbivory has removed greater than 25% of fresh leaf of any plant	No plants recorded having greater than 25% of fresh leaf material impacted.	Ongoing pest monitoring and control by NDLC.
Vegetation growth within a 1 m radius of seedling and juvenile plants causing an increase in fuel loads around plants sensitive to fire	Excessive fuel loads not present.	Ongoing monitoring by NDLC and fuel reduction actions where necessary.
Evidence of plants dug up and removed by poachers	Nil.	No action necessary.
Mortality or loss of adult plants translocated to the recipient site	87.8% of translocated plants alive at the time of monitoring.	Corrective action not required at this time. Monitor plants and if no growth appears after three years, expose stems to determine if the plant is viable or has died. Supplementary planting may be required to compensate for losses. Collect seed in March - June 2022 from coning plants and propagate.

A total of 10 seeds were collected from two adult plants within quadrat B2-3 and respread approximately 1 m downslope from the parent plants.

6. Conclusion

An assessment of the translocation goals and adaptative management triggers suggests that the translocation program is largely on track apart from the following:

- Four adults and six seedlings are lacking above ground vegetative material and are assumed to be dead. Supplementary planting will be required to compensate for these losses.
- Nearly half (34.9%) of the plants surviving (adults and seedlings combined) had 5% or more of the plant showing leaf discolouration or exhibiting necrosis.

NDLC should continue to monitor plant health during regular maintenance inspections and attempt to identify causes of stress leading to leaf drop so that corrective actions can be undertaken in a timely manner.

7. References

GHD (2018) Bruce Highway Cooroy to Curra (Section D: Woondum to Curra) Detailed Design Job No. 232/10A/7, Invitation No. WBYD - 1335 - Impact Management Plan.

GHD (2018) Bruce Highway - Cooroy to Curra (Section D: Woondum to Curra) *Macrozamia pauli-guilielmi* Translocation Management Plan November 2017. Unpublished report for the Department of Transport and Main Roads.

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Appendix A – Raw data

Site	UIN	Impact Site	Dead/Alive (D,A,U)	Health (G,M,P)	Insect predation (L,M,H)	Fauna digging (Y/N)	Erosion impacts (L,M,H)	Fresh cones	Sex	No. seed collected/ spread
B2-2	254	2	A	G	L	N	L	N	N	F
B2-2	255	2	A	G	L	N	L	M	Y	M
B2-2	256	2	A	G	L	N	L	N	N	M
B2-2	257	2	A	G	L	N	L	N	N	U
B2-2	258	2	A	G	L	N	L	N	N	M
B2-2	259	2	D	NA	NA	NA	NA	NA	NA	M
B2-2	260	2	A	P	L	N	L	N	N	U
B2-2	261	2	A	G	L	N	L	N	N	U
B2-2	262	2	A	M	L	N	L	N	N	F
B2-2	263	2	A	M	L	N	L	N	N	F
B2-2	264	2	D	NA	NA	NA	NA	NA	NA	F
B2-2	265	2	A	G	L	N	L	N	N	M
B2-2	266	2	A	G	L	N	L	N	N	U
B2-2	267	2	A	G	L	N	L	N	N	F
B2-2	268	2	A	M	L	N	L	N	N	U
B2-2	269	2	A	M	L	N	L	F	Y	F
B2-2	270	2	A	M	L	N	L	N	N	F
B2-2	271	2	A	P	L	N	L	F	Y	F
B2-2	272	2	A	M	L	N	L	N	N	M
B2-2	273	2	A	G	L	N	L	N	N	U
B2-2	274	2	A	G	L	N	L	N	N	U
B2-2	275	2	A	G	L	N	L	N	N	F
B2-2	276	2	D	NA	NA	NA	NA	NA	NA	F
B2-2	277	2	A	G	L	N	L	N	N	F
B2-2	278	2	A	G	L	N	L	N	N	U
B2-3	243	3	A	G	L	N	L	F	Y	F
B2-3	243a	3	A	M	L	N	L	N	N	U
B2-3	244	3	A	P	L	N	L	N	N	M
B2-3	245	3	A	G	L	N	L	N	N	F
B2-3	246	3	A	G	L	N	L	N	N	M
B2-3	247	3	A	M	L	N	L	N	N	U
B2-3	248	3	A	M	L	N	L	F	Y	F
B2-3	249	3	A	M	L	N	L	N	N	F
B2-3	249a	3	A	G	L	N	L	N	N	U
B2-3	249b	3	D	NA	NA	NA	NA	NA	NA	U
B2-3	249c	3	A	M	L	N	L	N	N	U
B2-3	250	3	A	G	L	N	L	N	N	M
B2-3	251	3	A	G	L	N	L	N	N	M
B2-3	252	3	A	M	L	N	L	N	N	U
B2-3	253	3	A	G	L	N	L	N	N	F
B2-S2	55	2	A	G	L	N	L	N	N	U

Site	UIN	Impact Site	Dead/Alive (D,A,U)	Health (G,M,P)	Insect predation (L,M,H)	Fauna digging (Y/N)	Erosion impacts (L,M,H)	Fresh cones	Sex	No. seed collected/spread
B2-S2	86	2	A	G	L	N	L	N	N	U
B2-S2	70	2	A	G	L	N	L	N	N	U
B2-S2	51	2	A	G	L	N	L	N	N	U
B2-S2	56	2	A	G	L	N	L	N	N	U
B2-S2	68	2	A	G	L	N	L	N	N	U
B2-S2	58	2	A	P	L	N	L	N	N	U
B2-S2	95	2	A	G	L	N	L	N	N	U
B2-S2	97	2	A	G	L	N	L	N	N	U
B2-S2	81	2	A	G	L	N	L	N	N	U
B2-S2	100	2	A	G	L	N	L	N	N	U
B2-S2	53	2	A	M	L	N	L	N	N	U
B2-S2	94	2	D	NA	NA	NA	NA	NA	NA	U
B2-S2	87	2	A	G	L	N	L	N	N	U
B2-S2	54	2	A	P	L	N	L	N	N	U
B2-S2	91	2	D	NA	NA	NA	NA	NA	NA	U
B2-S2	52	2	A	M	L	N	L	N	N	U
B2-S2	77	2	D	NA	NA	NA	NA	NA	NA	U
B2-S2	93	2	A	M	L	N	L	N	N	U
B2-S2	101	2	A	P	L	N	L	N	N	U
B2-S3	111	3	A	G	L	N	L	N	N	U
B2-S3	132	3	D	NA	NA	NA	NA	NA	NA	U
B2-S3	160	3	A	G	L	N	L	N	N	U
B2-S3	222	3	A	G	L	N	L	N	N	U
B2-S3	146	3	A	G	L	N	L	N	N	U
B2-S3	136	3	A	G	L	N	L	N	N	U
B2-S3	156	3	D	NA	NA	NA	NA	NA	NA	U
B2-S3	224	3	A	G	L	N	L	N	N	U
B2-S3	133	3	A	G	L	N	L	N	N	U
B2-S3	123	3	A	G	L	N	L	N	N	U
B2-S3	157	3	A	M	L	N	L	N	N	U
B2-S3	221	3	A	G	L	N	L	N	N	U
B2-S3	110	3	A	G	L	N	L	N	N	U
B2-S3	124	3	A	G	L	N	L	N	N	U
B2-S3	159	3	A	M	L	N	L	N	N	U
B2-S3	219	3	A	G	L	N	L	N	N	U
B2-S3	138	3	D	NA	NA	NA	NA	NA	NA	U
B2-S3	121	3	A	G	L	N	L	N	N	U
B2-S3	220	3	A	M	L	N	L	N	N	U
B2-S3	218	3	A	G	L	N	L	N	N	U

Appendix B – Representative photographs



Plate 2. Female cone on transplanted adult at planting area B2-3



Plate 3. Spreading of collected seed for burial.