



Red Ash
Consulting



Cooroy to Curra (Section D)

***Macrozamia pauli-guilielmi* Translocation Monitoring -
Year 4 Event 1 (September 2024)**

**Department of Transport and Main Roads
October 2024**

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Document Status

Revision Number	Date	Author/s	Technical Review
Draft	September 2024	P. Moonie	C. Sugars
Final	October 2024	P. Moonie	C. Sugars

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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 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 sixth monitoring event (Event 6) undertaken on 20 September 2024:

- Most translocated plants (82.5%) were alive at the time of the sixth monitoring event. This is a substantial improvement on the previous year, where only 47.5% of plants were reported to be alive. The greatest improvement in survival was observed within the seedling cohort, with a 45 percentage point increase recorded between November 2022 and December 2023. Survival across the adult population increased by 25 percentage points.
- Of the alive adult plants, just over one-third (38.9%) were considered to be in good health, with many individuals showing signs of stress such as leaf discolouration or necrosis. Quadrat B2-3 had a substantially higher proportion of plants in poor health (57.1%) compared to B2-2 (13.6%), suggesting that the former is at greater risk of further plant death. Seedlings were typically in better health than adults, with over half (60%) of alive seedlings in good health.
- No adult plants were coning at the time of monitoring. No seedlings were coning which is expected given the young age of plants.
- Most plants showed low rates of insect predation, apart from quadrat B2-S2, where 20% of seedlings showed evidence of high predation.
- No impacts from fauna diggings or erosion were observed in any of the quadrats.
- Weeds levels in all monitoring quadrats were low, typically less than 1% cover.
- Noosa and District Landcare Group (NDLG) data indicates that six adult plants (15%) sustained stem or root damage during translocation operations. Of those, two-thirds (66.7%) were alive at the time of monitoring. By way of comparison, 94.1% of undamaged adult plants remained alive. No damaged seedlings were present in the monitoring quadrats so an analysis of translocation damage on seedling survival was not undertaken.

Trend analysis

- A statistically significant change ($p < .05$) has occurred in plant survival over the monitoring program, $\chi^2(5, N=480) = 50.609, p < .00001$. This change is attributed to lower survival recorded in December 2023.
- Although there has been a statistically significant change recorded in plant health over the monitoring program, $\chi^2(10, N = 371) = 25.44, p = .0046$, plant health has tended to fluctuate over time, rather than trending upwards or downwards.

- There has been a statistically significant change in the prevalence of coning over the monitoring program, $\chi^2(5, N = 400) = 9.398, p = .0942$. This is principally attributed to the absence of cones observed during the September 2024 monitoring event.
- There has been significant change in insect predation over the monitoring program, $\chi^2(10, N=394) = 27.74, p = .002$, with an increased incidence of high predation recorded in 2024.
- No statistically significant changes were observed for the remaining parameters assessed.

Conclusion

The translocation program is at risk of not meeting the plant establishment target conditioned under EPBC Approval EPBC 2017/794 (i.e. at least 1.5 times the number of plants translocated from the impact site). It is recommended that the following corrective actions are implemented:

- Weather forecasts and rainfall events to be closely monitored and watering be instigated where dry conditions (i.e. below average rainfall over two months or more) are experienced over the next two to three years and/or plants show signs of water stress.
- A seaweed based treatment (e.g. Seasol) to be applied to all plants if not applied following the 2023 monitoring event.
- An insecticide treatment should be applied to those plants showing signs of insect damage.
- Additional seed collection activities should be scheduled for Autumn 2025 to bolster *M. pauli-guilielmi* greenstock held at the contracted nursery.
- Supplementary planting is recommended to be undertaken at the start of the wet season (late spring/early summer) in 2024/25 to compensate for losses and meet replacement targets. Rainfall data should be monitored to ensure soil moisture is adequate for planting.

Acronyms

Acronym	
DCCEEW	Commonwealth Department of Department of Climate Change, Energy, the Environment and Water
DESI	Queensland Department of Environment, Science and Innovation
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>
NDLG	Noosa and 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 (now Department of Environment, Science and Innovation (DESI)) (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 December 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-guilielmi* plants commenced in May 2021 with the first monitoring report issued in July 2021 (refer Table 1). This is the sixth monitoring report in the series.

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 2 (November 2021) November 2021
3	Year 2 Event 1	23 June 2022	Cooroy to Curra (Section D) Macrozamia pauli-guilielmi Translocation Monitoring -Event 3 (June 2022) August 2022
4	Year 2 Event 2	11 November 2022	Cooroy to Curra (Section D) Macrozamia pauli-guilielmi Translocation Monitoring -Event 4 (November 2022) January 2023
5	Year 3 Event 1	7 December 2023	Cooroy to Curra (Section D) Macrozamia pauli-guilielmi Translocation Monitoring – Year 4 Event 1 (December 2023) January 2024

1.2 Report purpose

The purpose of this report is to document the results of the sixth monitoring event of the monitoring program, undertaken on 20 September 2024. 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	<p><i>Prior to translocation of Pineapple zamia plants, the approval holder must:</i></p> <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	<p><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></p>

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	<i>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</i>
PPC001	<i>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.</i>
PPC004	<i>Impact management is to be undertaken in accordance with the following documents:</i> <ol style="list-style-type: none"> <i>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.</i> <i>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.</i> <i>3. Email received on 24 July 2019 showing Plate 2 and Plate 5 recipient sites for Lot 3/SP302524 and Lot 878/MCH1061.</i>
PPC005	<i>No individuals of the endangered and vulnerable species Macrozamia pauli-guilielmi and Marsdenia coronata are to be taken. All individuals within the clearing footprint are to be translocated in accordance with the submitted Translocation Management Plans.</i> <i>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.</i>
PPCM09	<i>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.</i>

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 and District Landcare Group (NDLG). 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 NDLG 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* (NDLG, 2021).

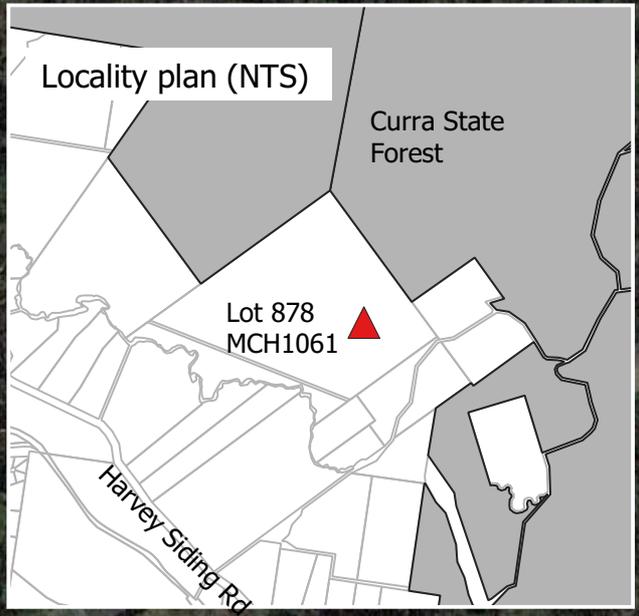
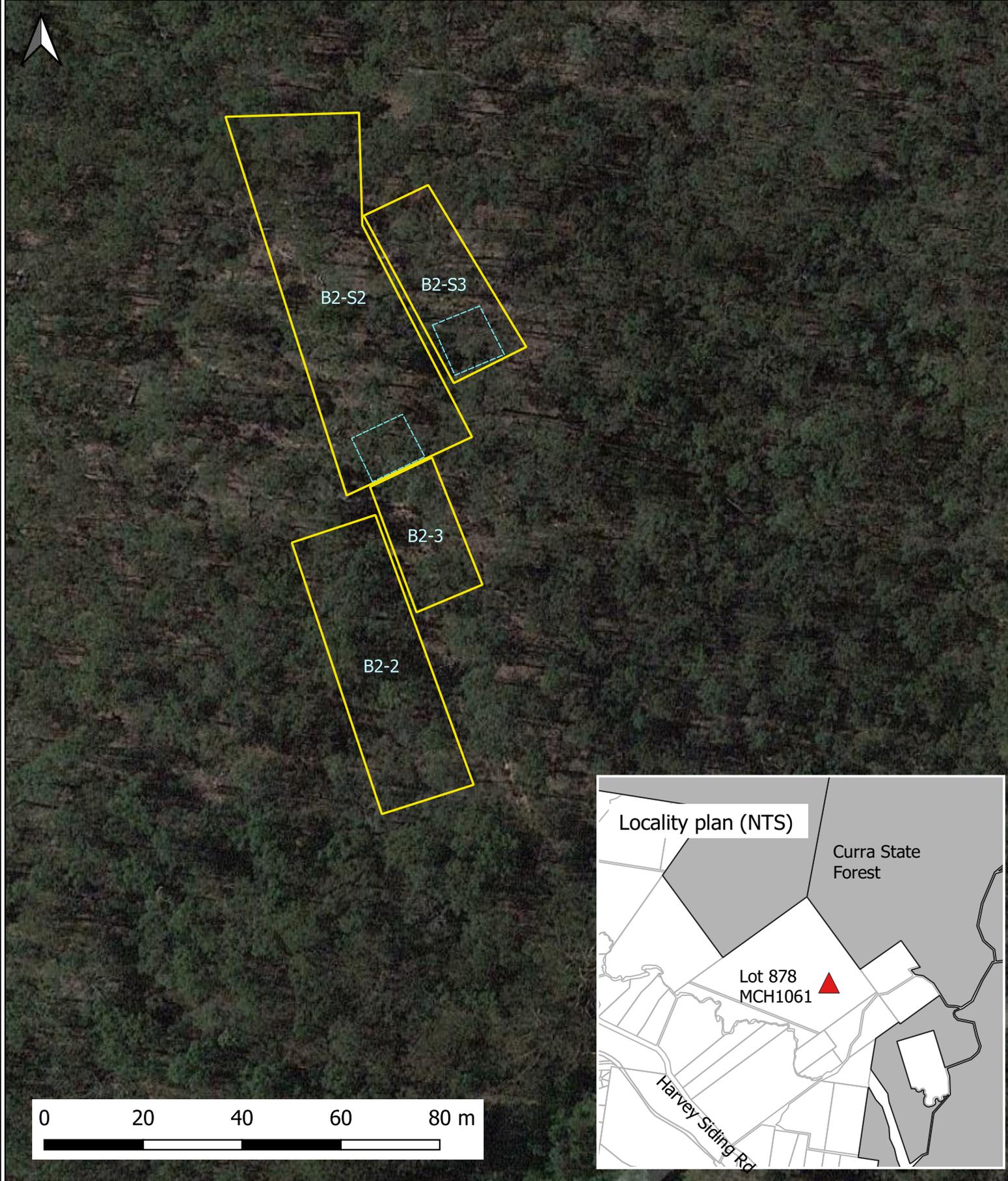
1.5 Recipient Site B description

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 6) was undertaken by Red Ash Consulting principal ecologists, Peter Moonie and Carly Sugars, on 20 September 2024. 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 NDLG 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 monitoring events. Such plants will be monitored and if no growth appears after three events, 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	Gullying or rills present, undermining of tubers, major impacts to root zone

3. Monitoring results

3.1 Overview

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 (relative %)
	B2-2	B2-3	
Survival			
Alive	22(88%)	14(93.3%)	36(90%)
Dead/Unknown	3(12%)	1(6.7%)	4(10%)
Health			
Poor	3(13.6%)	8(57.1%)	11(30.6%)
Moderate	9(40.9%)	2(14.3%)	11(30.6%)
Good	10(45.5%)	4(28.6%)	14(38.9%)
Reproduction			
Coning	0(0%)	0(0%)	0(0%)
Nil	22(100%)	14(100%)	36(100%)
Insect predation			
Low predation	15(68.2%)	10(71.4%)	25(69.4%)
Moderate predation	6(27.3%)	4(28.6%)	10(27.8%)
High predation	1(4.5%)	0(0%)	1(2.8%)
Fauna impacts			
Yes	0(0%)	0(0%)	0(0%)
No	25(100%)	15(100%)	40(100%)
Erosion impacts			
Low	25(100%)	15(100%)	40(100%)
Medium	0(0%)	0(0%)	0(0%)
High	0(0%)	0(0%)	0(0%)

Table 6. Seedling monitoring results for each parameter

Parameter	Number of seedlings (relative %)		Seedling total (relative %)
	B2-S2	B2-S3	
Survival			
Alive	15(75%)	15(75%)	30(75%)
Unknown	5(25%)	5(25%)	10(25%)
Health			
Poor	3(20%)	3(20%)	6(20%)
Moderate	0(0%)	6(40%)	6(20%)
Good	12(80%)	6(40%)	18(60%)
Reproduction			
Coning	0(0%)	0(0%)	0(0%)
Nil	15(100%)	15(100%)	30(100%)
Insect predation			
Low predation	12(80%)	15(100%)	27(90%)
Moderate predation	0(0%)	0(0%)	0(0%)
High predation	3(20%)	0(0%)	3(10%)
Fauna impacts			
Yes	0(0%)	0(0%)	0(0%)
No	20(100%)	20(100%)	40(100%)
Erosion impacts			
Low	20(100%)	20(100%)	40(100%)
Medium	0(0%)	0(0%)	0(0%)
High	0(0%)	0(0%)	0(0%)

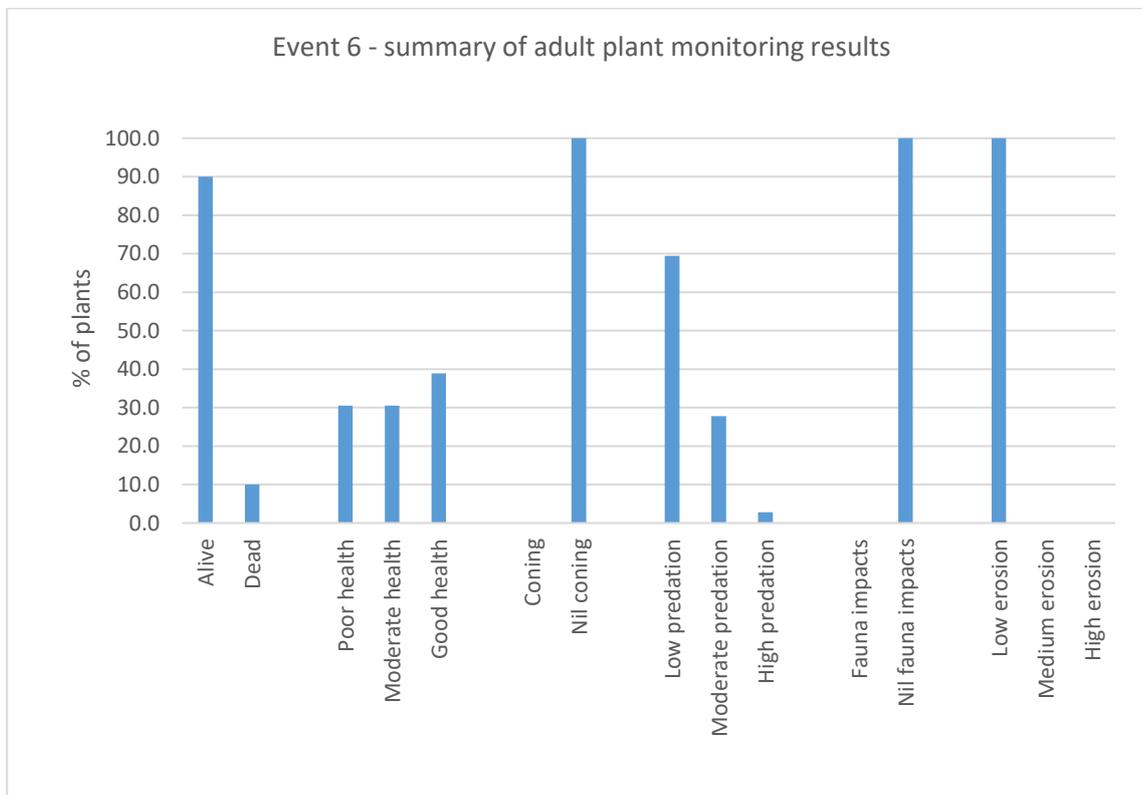


Figure 2. Percent of adult plants for each measured parameter

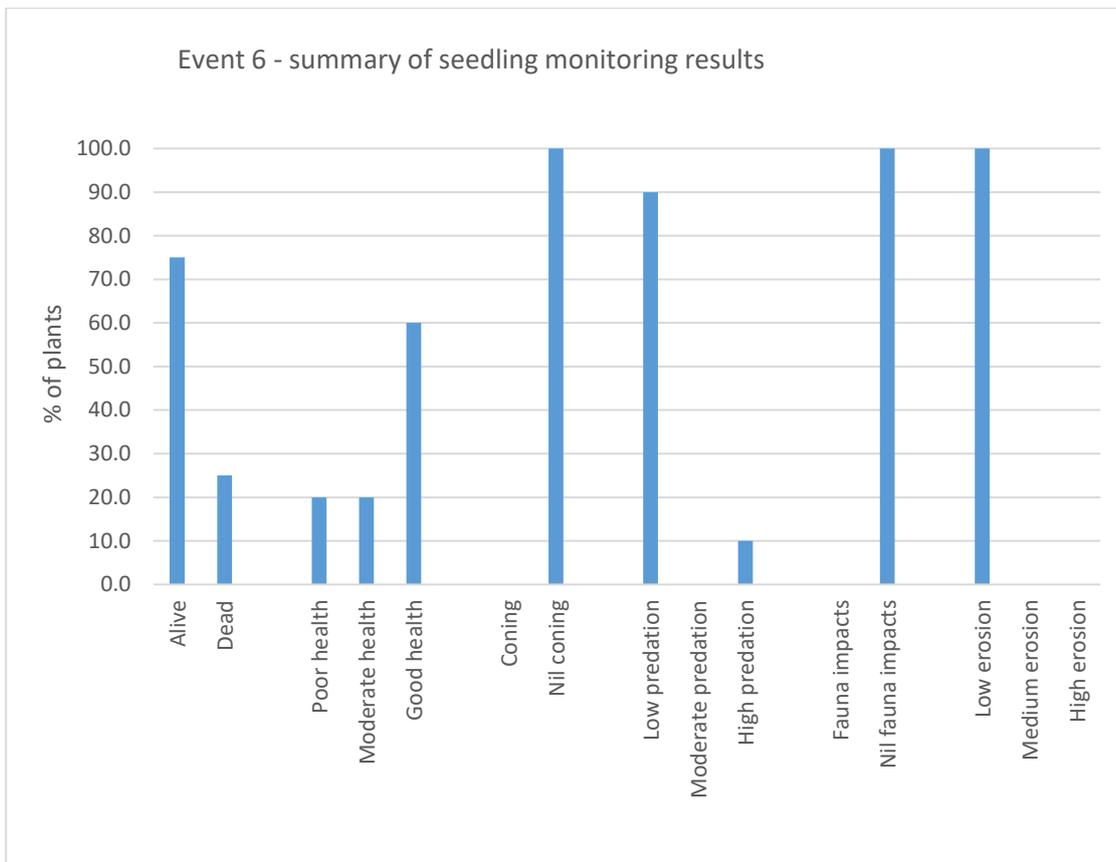


Figure 3. Percent of seedlings for each measured parameter

3.2 Survival

In terms of overall survival, most translocated plants (82.5%) were alive at the time of the sixth monitoring event. This is a substantial improvement on the previous year, where only 47.5% of plants were reported to be alive. It appears that many of those plants recorded as dead in 2023 (due to a lack of surface vegetative material), have resprouted from their underground stems in response to more favourable growing conditions experienced in 2024. In fact, the total number of alive plants (n=66) was the same as that recorded in November 2022, prior to the onset of persistent dry conditions experienced in the spring/summer period of 2023.

The greatest improvement in survival was observed within the seedling cohort, with a 45 percentage point increase recorded between December 2023 and September 2024. Interestingly, the number of seedlings resprouting (presumed dead in December 2023) in each of the two seedling quadrats (B2-S2 and B2-S3) was the same (n=9).

Survival across the adult population also improved but to a lesser degree than the seedling cohort, with survival increasing by 25 percentage points. Adult survival was slightly higher in quadrat B2-3 (93.3%) compared to that recorded in B2-2 (88%) (Figure 4).

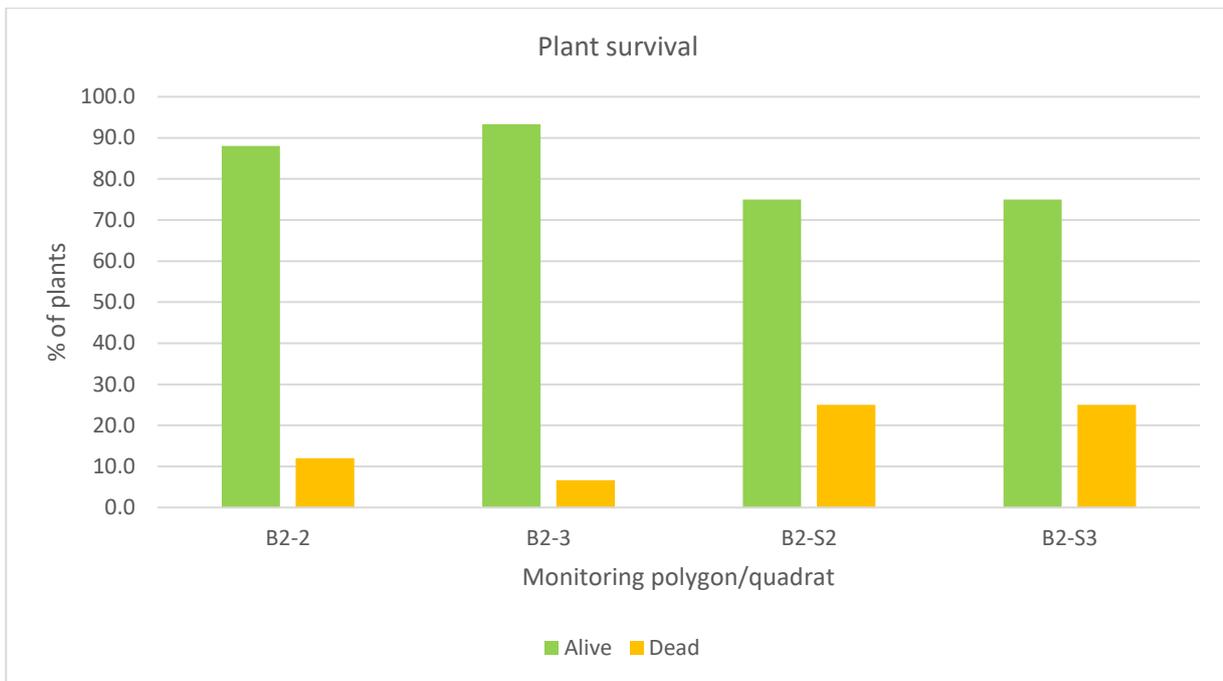


Figure 4. Plant survival within each monitoring quadrat

3.3 Health

Of the alive adult plants, just over one-third (38.9%) were considered to be in good health, with many individuals showing signs of stress such as leaf discolouration or necrosis. Quadrat B2-3 had a substantially higher proportion of plants in poor health (57.1%) compared to B2-2 (13.6%), suggesting that the former is at greater risk of further plant death. Reasons for this disparity are unclear.

Seedlings were typically in better health than adults, with over half (60%) of alive seedlings in good health. Quadrat B2-S2 had twice as many seedlings in good condition (n=18) compared to B2-S3 (n=9), however the total number of plants in either good or moderate condition within each quadrat was the same.

The proportion of seedlings in poor health was the same across both seedling quadrats (20%), suggesting that the risk of further mortality across both quadrats is similar.

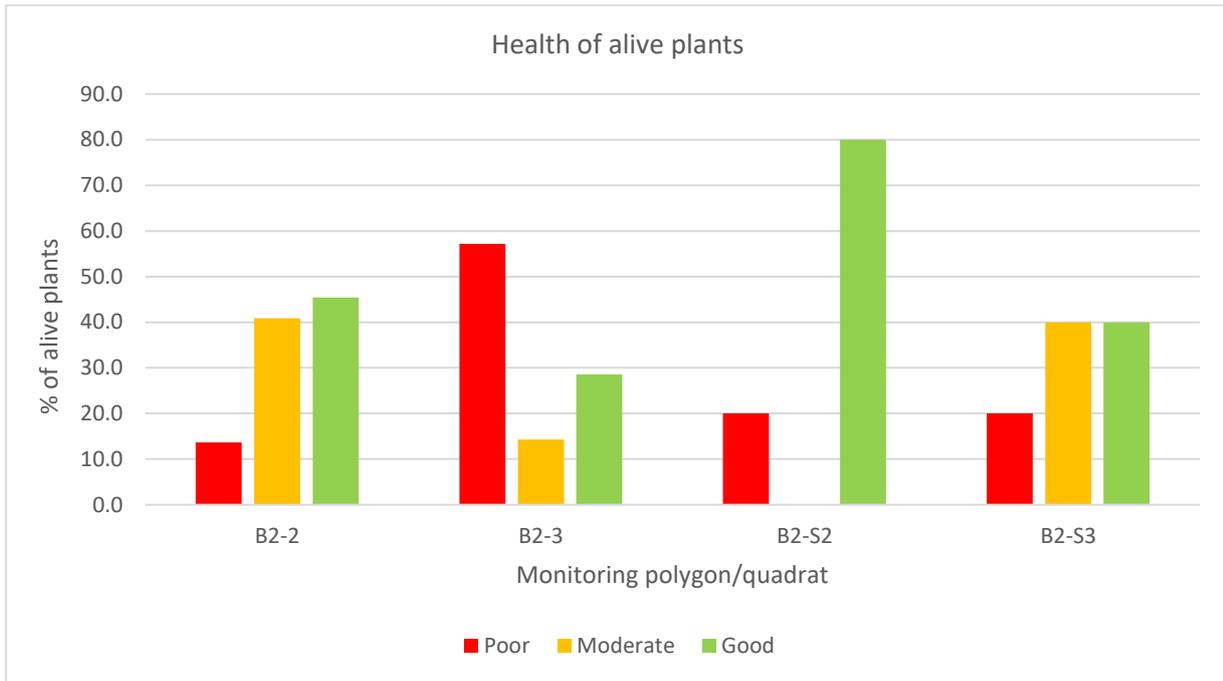


Figure 5. Plant health within each monitoring quadrat

3.4 Reproductive capacity

Of those translocated adult plants with evidence of past or fresh cones, 20 were identified as female (64.5%) and 11 were identified as male (35.5%). No adult plants were coning at the time of monitoring. No seedlings were coning which is expected given the young age of plants.

3.5 Insect predation

Most plants showed low rates of insect predation, apart from quadrat B2-S2, where 20% of seedlings showed evidence of high predation.

3.6 Fauna and erosion impacts

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

3.7 Weeds

Weeds levels in all monitoring quadrats were low, typically less than 1% cover.

3.8 Effects of translocation damage

NDLG data indicates that six adult plants (15%) sustained stem or root damage during translocation operations. Of those, two-thirds (66.7%) were alive at the time of monitoring (Table 7). By way of comparison, 94.1% of undamaged adult plants remained alive. No damaged seedlings were present in the monitoring quadrats so an analysis of translocation damage on seedling survival was not undertaken.

Table 7. Effects of translocation damage on adult survival

Attribute	Alive (relative %)	Dead (relative %)	Total
Damage	4 (66.7%)	2 (33.3%)	6 (100%)
Nil damage	32 (94.1%)	2 (5.9%)	34 (100%)

4. Trend analysis

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

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

Parameter	Event 1- May 2021 (Mean %)	Event 2 – Nov 2021 (Mean %)	Event 3 – June 2022 (Mean %)	Event 4 – Nov 2022 (Mean %)	Event 5 – Dec 2023 (Mean %)	Event 6 – Sep 2024 (Mean %)
Survival						
Alive	80.92	83.58	87.83	83.33	46.33	82.83
Dead/Unknown	19.08	16.42	12.17	16.67	53.67	17.17
Health						
Poor	40.10	24.82	8.47	28.23	30.90	27.69
Moderate	30.12	21.97	26.36	19.32	29.51	23.80
Good	29.78	53.21	65.17	52.46	39.58	48.51
Reproduction						
Coning	11.00	10.33	6.98	12.14	8.68	0.00
Nil coning	89.00	89.67	93.02	87.86	91.32	100.00
Insect predation						
Low predation	88.35	100.00	100.00	98.75	95.49	79.90
Moderate predation	6.37	0.00	0.00	1.25	4.51	13.96
High predation	5.28	0.00	0.00	0.00	0.00	6.14
Fauna impacts						
Yes	0.00	0.00	0.00	0.00	8.67	0.00
No	100.00	100.00	100.00	100.00	91.33	100.00
Erosion impacts						
Low	100.00	100.00	100.00	100.00	100.00	100.00
Medium	0.00	0.00	0.00	0.00	0.00	0.00
High	0.00	0.00	0.00	0.00	0.00	0

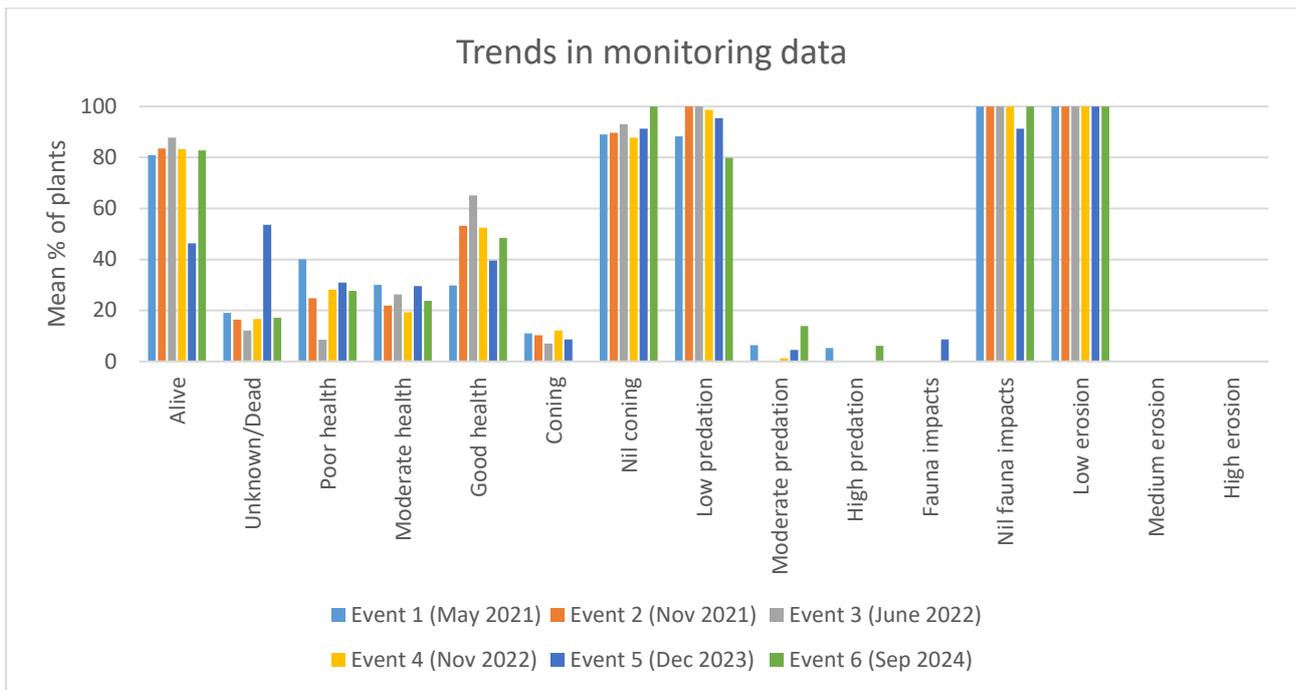


Figure 6. Mean % of plants for each measured parameter over the five monitoring events

A chi-square test was performed to determine if any observed changes over the six monitoring events were significant ($p < .05$)¹. Results are summarised below:

- There has been a significant change in plant survival over the monitoring program, $\chi^2(5, N=480) = 50.609, p < .00001$. This significant change is attributed to lower survival recorded in December 2023. Changes are not statistically significant when results from 2023 are excluded from the data set.
- Although there has been a statistically significant change recorded in plant health over the monitoring program, $\chi^2(10, N = 371) = 25.44, p = .0046$, plant health has tended to fluctuate over time, rather than trending upwards or downwards. This change may be in response in part to varying seasonal conditions.
- There has been a statistically significant change in the prevalence of coning over the monitoring program, $\chi^2(5, N = 400) = 9.398, p = .0942$. This is attributed to the absence of cones observed during the September 2024 monitoring event.
- There has been significant change in insect predation over the monitoring program, $\chi^2(10, N=394) = 27.74, p = .002$.
- Erosion has not impacted plants at any time throughout the monitoring program. Changes in fauna impacts have been negligible.

¹ Chi-square tests were not conducted for fauna or erosion parameters given the nil values recorded for all or most categories/levels over time.

5. Management

An assessment against the adaptive 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	Assessment	Corrective action recommended
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 not impacting plant survival.	Ongoing weed monitoring.
Insect herbivory has removed greater than 25% of fresh leaf of any plant	A total of four plants were recorded having greater than 25% of fresh leaf material impacted.	Ongoing pest monitoring. An insecticide treatment should be applied to those plants showing signs of insect damage.
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 and fuel reduction actions where necessary.
Evidence of plants dug up and removed by poachers	Nil.	No action necessary.
Failure to meet agreed plant replacement establishment ratio (i.e. at least 1.5 times the number of plants (adults and seedlings) translocated from the impact site).	<p>Translocation program not on track to meet agreed plant replacement establishment ratio.</p> <p>Plant establishment below that required, with only 82.5% of translocated plants alive at the time of monitoring.</p> <p>Insufficient greenstock available to meet supplementary planting targets (total of 423 plants successfully established).</p> <p>No supplementary planting conducted to date.</p>	<p>Weather forecasts and rainfall events to be closely monitored and watering be instigated where dry conditions (i.e. below average rainfall over two months or more) are experienced over the next two to three years and/or plants show signs of water stress.</p> <p>A seaweed based treatment (e.g. Seasol) to be applied to all plants.</p> <p>Additional seed collection activities should be scheduled for Autumn 2025 to bolster <i>M. pauli-guilielmi</i> greenstock held at the contracted nursery.</p> <p>Supplementary planting is recommended to be undertaken at the start of the wet season (late spring/early summer) in 2024/25 to compensate for losses. Rainfall data should be monitored to ensure soil moisture is adequate for planting.</p> <p>Discussions to be held with DCCEEW to adjust the agreed plant establishment ratio, commensurate with current expectations (i.e. no net loss).</p>

6. Conclusion

An assessment of the translocation goals and adaptive management triggers suggests that the translocation program is at risk of not meeting the plant establishment targets conditioned under EPBC Approval EPBC 2017/794. It is recommended that corrective actions listed in Table 10 are implemented.

7. References

GHD (2018a) 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 (2018b) 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.

Bruce Highway – Cooroy to Curra (Section D: Woondum to Curra) *Macrozamia pauli-guilielmi* Translocation Final Report (NDLG, 2021). Unpublished report for the Department of Transport and Main Roads.

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 (Y,N)	Sex (M,F)	No. seed collected/ spread
B2-2	254	2	A	M	M	N	L	N	F	0
B2-2	255	2	A	M	L	N	L	N	M	0
B2-2	256	2	A	G	L	N	L	N	M	0
B2-2	257	2	A	G	L	N	L	N	U	0
B2-2	258	2	A	P	M	N	L	N	M	0
B2-2	259	2	A	G	L	N	L	NA	M	NA
B2-2	260	2	A	P	H	N	L	N	U	0
B2-2	261	2	A	M	M	N	L	NA	U	NA
B2-2	262	2	A	G	L	N	L	N	F	0
B2-2	263	2	A	G	L	N	L	Y	F	0
B2-2	264	2	D	NA	NA	N	L	N	F	0
B2-2	265	2	D	NA	NA	N	L	NA	M	NA
B2-2	266	2	A	M	M	N	L	N	F	16
B2-2	267	2	A	M	L	N	L	NA	F	NA
B2-2	268	2	A	G	L	N	L	Y	F	0
B2-2	269	2	A	G	L	N	L	N	F	0
B2-2	270	2	D	NA	NA	N	L	Y	F	0
B2-2	271	2	A	P	L	N	L	NA	F	NA
B2-2	272	2	A	M	L	N	L	NA	M	NA
B2-2	273	2	A	G	L	N	L	Y	F	0
B2-2	274	2	A	M	M	N	L	N	U	0
B2-2	275	2	A	G	L	N	L	N	F	1
B2-2	276	2	A	M	L	N	L	N	F	0
B2-2	277	2	A	G	L	N	L	NA	F	NA
B2-2	278	2	A	M	M	N	L	N	F	0
B2-3	243	3	A	G	L	N	L	NA	F	NA
B2-3	243a	3	A	P	M	N	L	NA	U	NA
B2-3	244	3	A	G	L	N	L	NA	M	NA
B2-3	245	3	A	P	L	N	L	N	F	0
B2-3	246	3	A	P	L	N	L	N	M	0
B2-3	247	3	A	P	L	N	L	NA	U	NA
B2-3	248	3	A	P	L	N	L	N	F	0
B2-3	249	3	A	G	L	N	L	N	F	0
B2-3	249a	3	A	P	M	N	L	N	U	0
B2-3	249b	3	D	NA	NA	N	L	NA	U	NA
B2-3	249c	3	A	M	M	N	L	NA	U	NA
B2-3	250	3	A	M	L	N	L	N	M	0
B2-3	251	3	A	P	M	N	L	Y	M	0
B2-3	252	3	A	G	L	N	L	NA	M	NA
B2-3	253	3	A	P	L	N	L	N	F	0
B2-S2	55	2	A	G	L	N	L	N	U	NA

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 (Y,N)	Sex (M,F)	No. seed collected/ spread
B2-S2	86	2	A	G	L	N	L	N	F	0
B2-S2	70	2	A	P	H	N	L	N	M	NA
B2-S2	51	2	A	G	L	N	L	N	M	NA
B2-S2	56	2	A	P	H	N	L	N	U	0
B2-S2	68	2	A	G	L	N	L	N	M	NA
B2-S2	58	2	A	G	L	N	L	N	M	NA
B2-S2	95	2	A	G	L	N	L	N	U	0
B2-S2	97	2	A	G	L	N	L	N	U	0
B2-S2	81	2	A	G	L	N	L	N	F	0
B2-S2	100	2	A	G	L	N	L	N	F	0
B2-S2	53	2	A	P	H	N	L	NA	F	NA
B2-S2	94	2	D	NA	NA	N	L	NA	M	NA
B2-S2	87	2	D	NA	NA	N	L	N	F	0
B2-S2	54	2	A	G	L	N	L	N	F	0
B2-S2	91	2	D	NA	NA	N	L	N	F	0
B2-S2	52	2	A	G	L	N	L	N	F	0
B2-S2	77	2	D	NA	NA	N	L	NA	F	NA
B2-S2	93	2	A	G	L	N	L	N	F	0
B2-S2	101	2	D	NA	NA	N	L	N	M	NA
								N	F	0
B2-S3	111	3	A	G	L	N	L	N	U	0
B2-S3	132	3	D	NA	NA	N	L	N	F	0
B2-S3	160	3	A	M	L	N	L	N	F	0
B2-S3	222	3	A	M	L	N	L	N	F	0
B2-S3	146	3	A	G	L	N	L	N	F	0
B2-S3	136	3	A	P	L	N	L	N	F	0
B2-S3	156	3	D	NA	NA	N	L	N	U	0
B2-S3	224	3	A	G	L	N	L	N	M	NA
B2-S3	133	3	A	M	L	N	L	N	F	0
B2-S3	123	3	A	M	L	N	L	N	M	NA
B2-S3	157	3	A	G	L	N	L	N	U	0
B2-S3	221	3	A	G	L	N	L	N	F	0
B2-S3	110	3	D	NA	NA	N	L	N	F	0
B2-S3	124	3	A	P	L	N	L	N	U	0
B2-S3	159	3	D	NA	NA	N	L	NA	U	NA
B2-S3	219	3	A	M	L	N	L	N	U	0
B2-S3	138	3	D	NA	NA	N	L	N	M	NA
B2-S3	121	3	A	G	L	N	L	N	M	NA
B2-S3	220	3	A	P	L	N	L	N	M	NA
B2-S3	218	3	A	M	L	N	L	N	F	0

Appendix B – Representative photographs



Plate 1. Resprouting seedling at the B2-S2 planting area. Presumed dead in December 2023.



Plate 2. Seedling in poor health at the B2-2 planting area.



Plate 3. Adult in moderate health in quadrat B2-2, with leaves showing signs of stress.



Plate 4. Adult in poor health in quadrat B2-2.