



Red Ash
Consulting



Cooroy to Curra (Section D)

***Macrozamia pauli-guilielmi* Translocation Monitoring -
Year 1 Event 2 (November 2021)**

**Department of Transport and Main Roads
November 2021**

Disclaimer

This report has been prepared on behalf of and for the exclusive use of the Department of Transport and Main Roads and is subject to and issued in connection with the provisions of the agreement between Red Ash Consulting Pty Ltd and the Client. Red Ash Consulting Pty Ltd accepts no liability or responsibility for or in respect of any use of or reliance upon this report by any third party.

The purpose of this report and the associated services performed by Red Ash Consulting Pty Ltd is to provide a Plant Translocation Monitoring Report in accordance with the scope of services set out in the contract between Red Ash Consulting Pty Ltd and the Client. That scope of services was defined by the requests of the Client, by the time and budgetary constraints imposed by the Client, and by the availability of access to the site.

Red Ash Consulting Pty Ltd derived the data, opinions, conclusions and/or recommendations in this report primarily from visual inspections, examination of records in the public domain, interviews with individuals and previous works undertaken for the Project. The passage of time, manifestation of latent conditions or impacts of future events may require further exploration at the site and subsequent data analysis, and re-evaluation of the findings, observations and conclusions expressed in this report.

In preparing this report, Red Ash Consulting Pty Ltd has relied upon and presumed accurate certain information (or absence thereof) relative to the site provided by government officials and authorities, the Client and other identified herein. Except as otherwise stated in the report, Red Ash Consulting Pty Ltd has not attempted to verify the accuracy or completeness of any such information. Red Ash Consulting Pty Ltd assumes that all information obtained by Red Ash Consulting Pty Ltd from sources outside Red Ash Consulting Pty Ltd was correct at the time the information was issued. Red Ash Consulting Pty Ltd does not accept liability for errors or omissions in the report which resulted from errors or omissions in that information.

Document Status

Revision Number	Date	Author/s	Technical Review
Draft	20 November 2021	P. Moonie	C. Sugars
Rev 0	30 November 2021	P. Moonie	C. Sugars

Contents

Executive Summary	4
Acronyms	6
1. Introduction	7
1.1 Background	7
1.2 Report purpose.....	8
1.3 Relevant approval conditions	8
1.4 Translocation activities	9
1.5 Recipient Site B description	9
2. Monitoring methodology	12
3. Monitoring results	13
3.1 Survival.....	15
3.2 Health	16
3.3 Reproductive capacity.....	16
3.4 Insect predation.....	16
3.5 Fauna and erosion impacts.....	16
3.6 Weeds	16
3.7 Effects of translocation damage.....	17
4. Trend analysis	17
5. Management triggers.....	19
6. Conclusion.....	19
7. References	20
Appendix A – Raw data.....	21
Appendix B – Representative photographs.....	23

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 second monitoring event (Event 2) undertaken on 12 November 2021:

- Most (94.7%) of the translocated adult plants possessed above ground vegetative material at the time of the second monitoring event. It is unknown if the adults and seedlings without leaves were alive or dead as it is possible that plants may resprout from underground stems in future growing seasons.
- Of those adult plants with above ground vegetative material, only one-third (33.6%) were considered to be in good health, with most showing signs of stress such as leaf discolouration or necrosis. In contrast to the previous monitoring event, seedlings were in better health than adults, with 53.2% of seedlings possessing above ground vegetative material in good health.
- A total of nine adult plants (20.7%) were coning at the time of monitoring, four of which were male and five 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.
- Noosa District Landcare Group (NDLC) data indicates that 15% of adult plants sustained stem or root damage during translocation operations. Of those adults damaged during operations, 83.3% had above ground vegetative material at the time of monitoring. By way of comparison, 97.1% of undamaged plants had above ground vegetative material present. 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 $\chi^2(2, N=132) = 5.08, p = .079.$, whereby the total number of plants exhibiting good health increased from 19 to 35 individuals.

Conclusion

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

- 16.4% of plants (adults and seedlings combined) are lacking above ground vegetative material. It is unknown if these plants are alive or dead as it is possible that plants may resprout from underground stems in future growing seasons.
- Nearly half (46.8%) of the plants possessing above ground vegetative material (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.

It is also recommended that seed be collected from coning adult plants during March - June 2022 and propagated in preparation for supplementary planting. Dead leaves present should be pruned by NDLC during the next maintenance activity.

Acronyms

Acronym	
DAWE	Commonwealth Department of Agriculture, Water and the Environment
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 Agriculture, Water and Environment (DAWE)) 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-guilielmi* plants commenced in May 2021 with the associated 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

1.2 Report purpose

The purpose of this report is to document the results of the second monitoring event of the monitoring program, undertaken on 12 November 2021. 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 DAWE) 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	<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</i>

	<i>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>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>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>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 <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.</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 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).

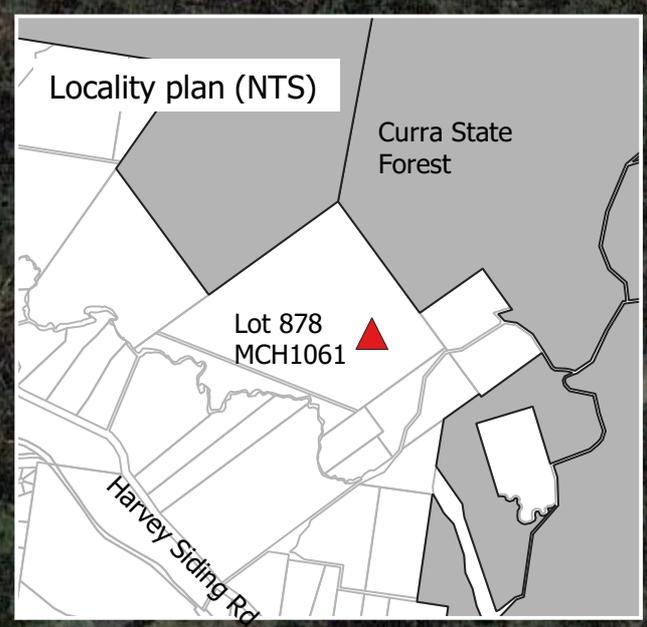
1.5 Recipient Site B description

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.



Red Ash
Consulting

-  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

This plan was produced for the exclusive use of the Department of Transport and Main Roads for the purposes specified within the report in which it is contained. Red Ash Consulting accepts no liability or responsibility for or in respect of any use of or reliance upon this report by any third party.

2. Monitoring methodology

The current monitoring event (Event 2) was undertaken by Red Ash Consulting principal ecologists, Peter Moonie and Carly Sugars, on 12 November 2021. 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	Gullying 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		
Survival				
Alive	24(96%)	14(93.3%)	38	19(94.7%)
Unknown	1(4%)	1(6.7%)	2	1(5.3%)
Health				
Poor	7(29.2%)	7(50%)	14	7(39.6%)
Moderate	6(25%)	4(28.6%)	10	5(26.8%)
Good	11(45.8%)	3(21.4%)	14	7(33.6%)
Reproduction				
Coning	7(28%)	2(13.3%)	9	4.5(20.7%)
Nil	18(72%)	13(86.7%)	31	15.5(79.3%)
Insect predation				
Low predation	24(100%)	14(100%)	38	19(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	24(100%)	14(100%)	38	19(100%)
Erosion impacts				
Low	24(100%)	14(100%)	38	19(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%)	12(60%)	29	14.5(72.5%)
Unknown	3(15%)	8(40%)	11	5.5(27.5%)
Health				
Poor	2(11.8%)	1(8.3%)	3	1.5(10%)
Moderate	3(17.6%)	2(16.7%)	5	2.5(17.2%)
Good	12(70.6%)	9(75%)	21	10.5(72.8%)
Reproduction				
Coning	0(0%)	0(0%)	0	0(0%)
Nil	20(100%)	20(100%)	40	20(100%)
Insect predation				
Low predation	17(100%)	12(100%)	29	14.5(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%)	12(100%)	29	14.5(100%)
Erosion impacts				
Low	17(100%)	12(100%)	29	14.5(100%)
Medium	0(0%)	0(0%)	0	0(0%)
High	0(0%)	0(0%)	0	0(0%)

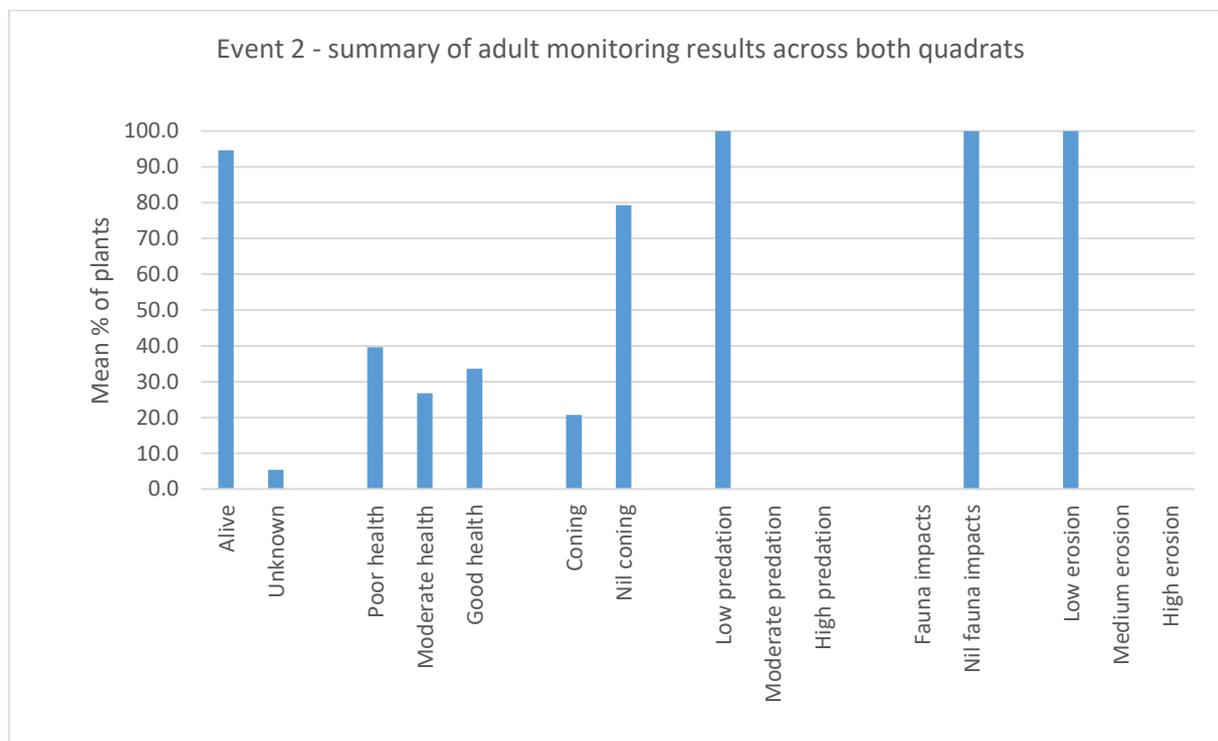


Figure 2. Mean percent of adult plants across quadrats for each measured parameter

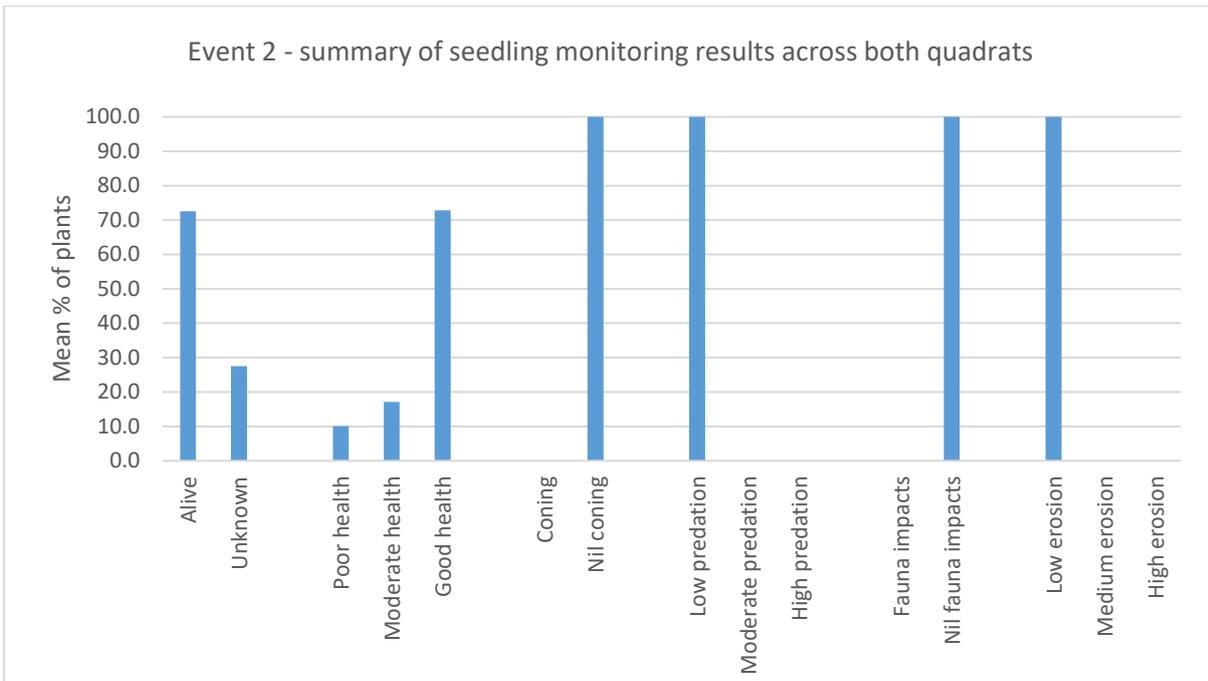


Figure 3. Mean percent of seedlings across quadrats for each measured parameter

3.1 Survival

Results indicate that most (94.7%) of the translocated adult plants possessed above ground vegetative material at the time of the second monitoring event, with minimal variation recorded across the two planting areas (B2-2 – 96%, B2-3 – 93.3%) (Figure 4 (alive category)). The proportion of translocated seedlings with above ground vegetative material (72.5%) was lower than for that recorded for adults. This was due to the much lower percentage of seedlings with above ground vegetative material recorded in quadrat B2-S3 (60%) compared to B2-S3 (95%). It is unknown if the adults and seedlings without leaves were alive or dead as it is possible that plants may resprout from underground stems in the future.

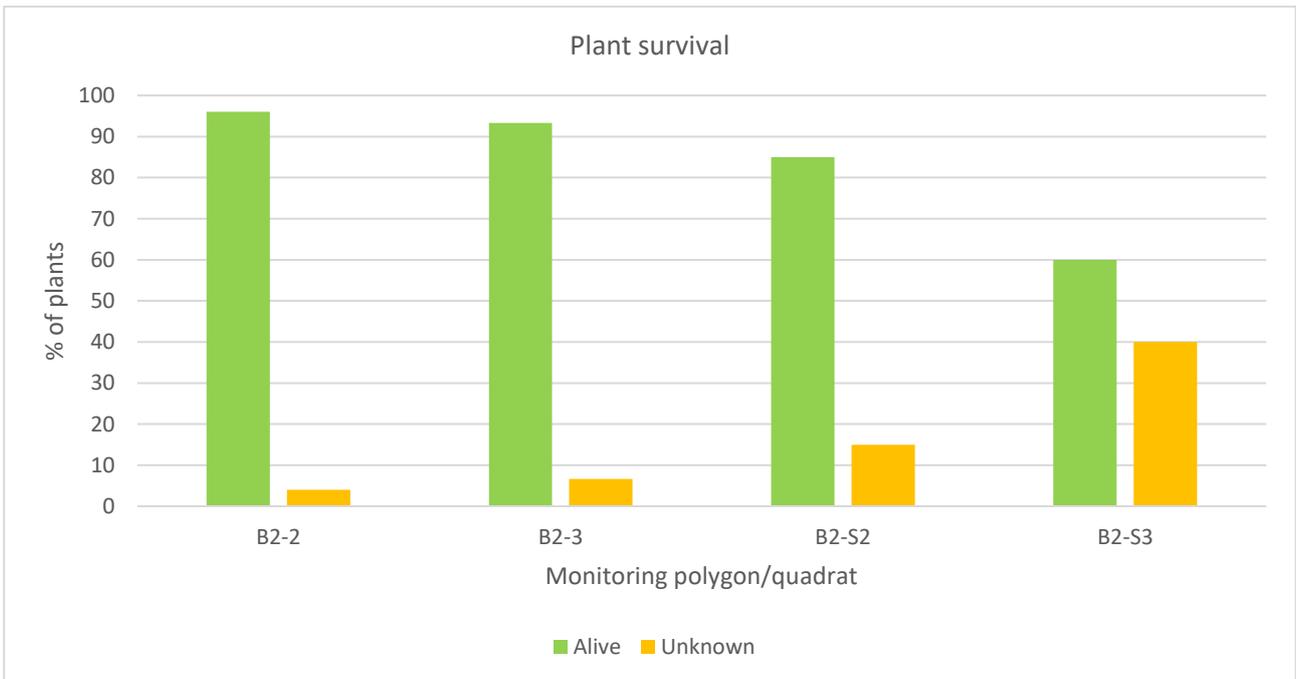


Figure 4. Plant survival within each monitoring quadrat

3.2 Health

Of those adult plants with above ground vegetative material, only one-third (33.6%) were considered to be in good health, with most showing signs of stress such as leaf discolouration or necrosis. Substantial variation was observed across the planting areas, with a lower proportion of adults from Salvage Site 3 (21.4%) being in good health compared to Salvage Site 2 (45.8%) (Figure 5).

Seedlings were typically in better health than adults, with 53.2% of seedlings with above ground vegetative material in good health. Minimal variation in seedling health was recorded across the two monitoring quadrats (B2-S2 and B2-S3).

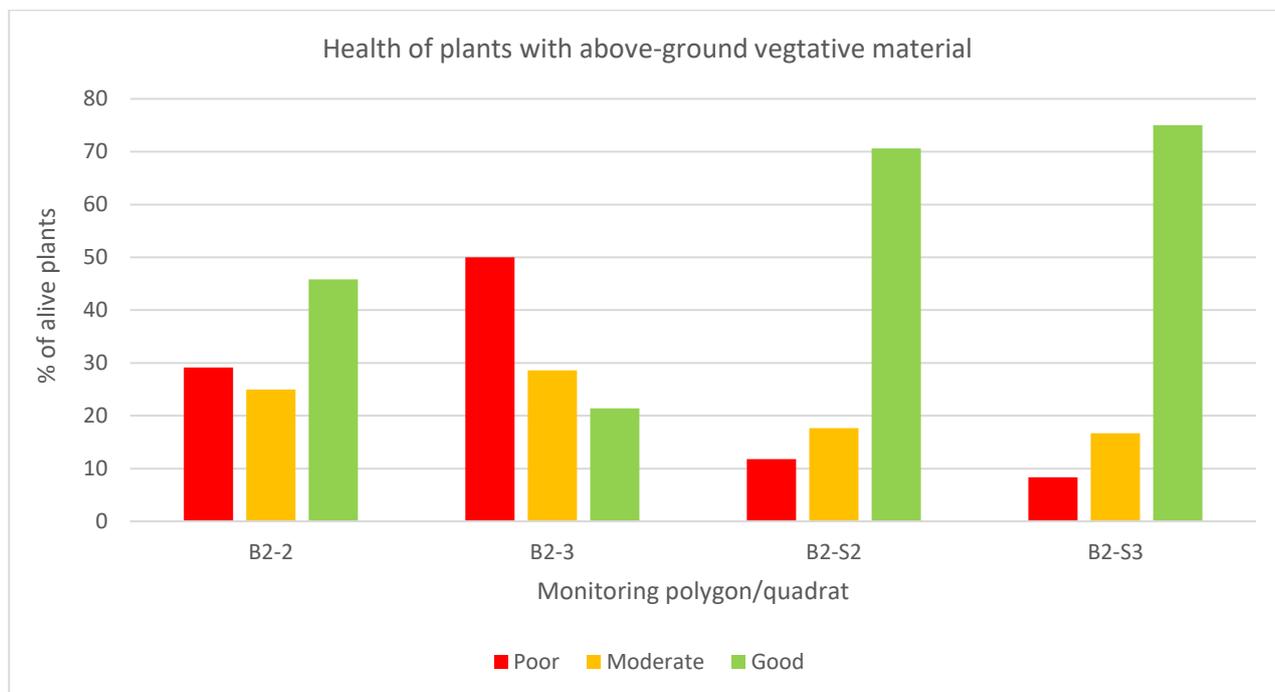


Figure 5. Plant health within each monitoring quadrat

3.3 Reproductive capacity

Of those translocated adult plants with evidence of past or fresh cones, 13 were identified as female (54.2%) and 11 were identified as male (45.8%). A total of nine adult plants (20.7%) were coning at the time of monitoring, four of which were male and five of which were female. No seedlings were coning which is expected given the young age of plants.

3.4 Insect predation

All adults and seedlings showed low rates of insect predation.

3.5 Fauna and erosion impacts

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

3.6 Weeds

Weeds levels in all monitoring polygons and quadrats were low.

3.7 Effects of translocation damage

NDLC data indicates that 15% of adult plants sustained stem or root damage during translocation operations. Analysis was undertaken to determine if such damage affected the retention of above ground vegetative material. Of those adults damaged during operations, 83.3% had above ground vegetative material at the time of monitoring (Table 7). By way of comparison, 97.1% of undamaged plants had above ground vegetative material present. 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	Above ground material retained (relative %)	Above ground material not retained (relative %)	Total [#]
Damage	5 (83.3%)	1 (16.66%)	6 (100%)
Nil damage	33 (97.1%)	1 (2.9%)	34 (100%)

4. Trend analysis

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

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

Parameter	Event 1- May 2020 (Mean %)	Event 2 – Nov 2020 (Mean %)
Survival		
Alive	80.92	83.58
Dead/Unknown	19.08	16.42
Health		
Poor	40.10	24.82
Moderate	30.12	21.97
Good	29.78	53.21
Reproduction		
Flowering	11.00	10.33
Fruiting	89.00	89.67
Nil		
Insect predation	88.35	100.00
Low predation	6.37	0.00
Moderate predation	5.28	0.00
High predation		
Fauna impacts	0.00	0.00
Yes	100.00	100.00

Parameter	Event 1- May 2020 (Mean %)	Event 2 – Nov 2020 (Mean %)
No		
Erosion impacts	100.00	100.00
Low	0.00	0.00
Medium	0.00	0.00
High	80.92	83.58

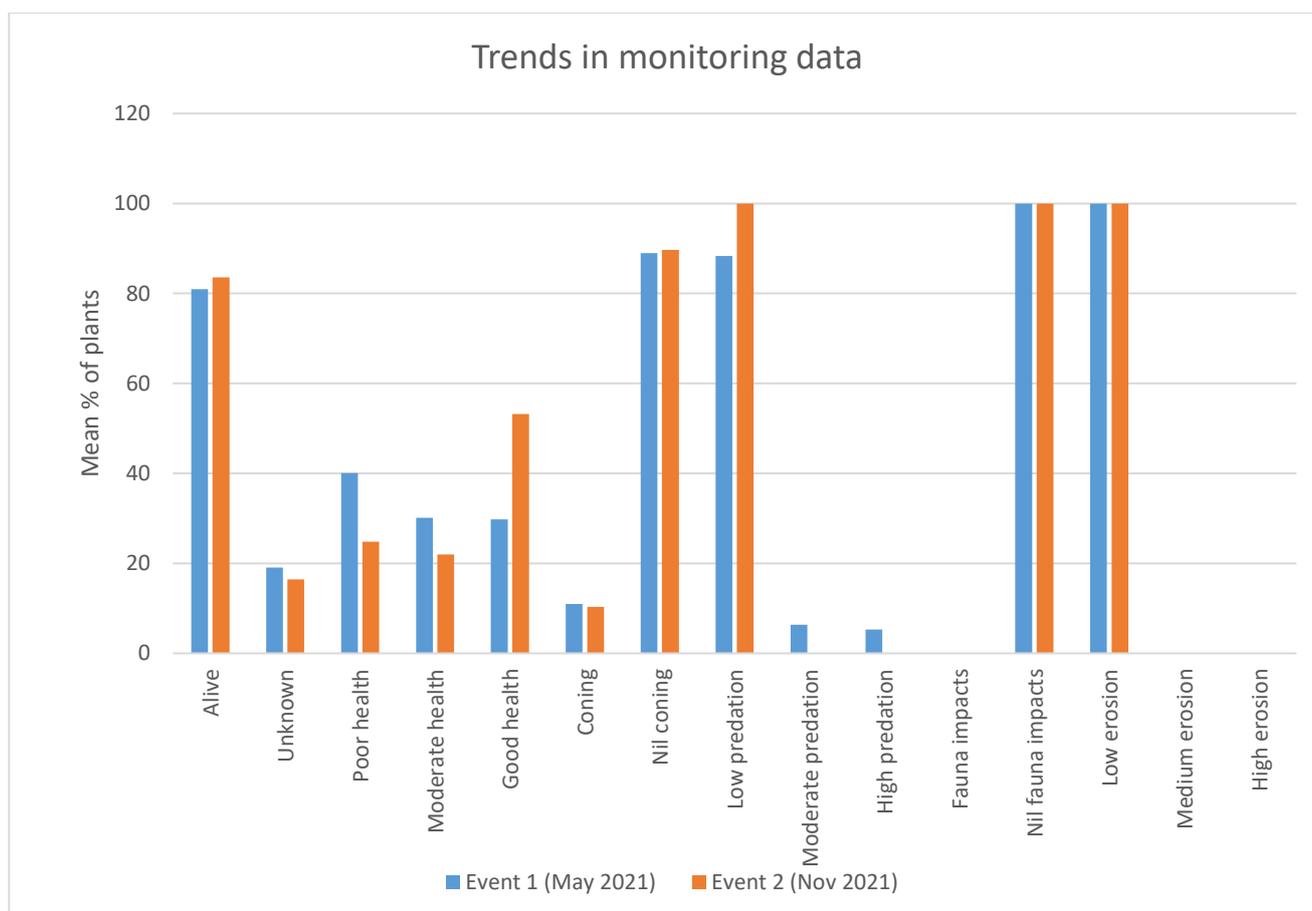


Figure 6. Mean % of plants for each measured parameter over the two monitoring events

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

- The number of plants possessing above vegetative material increased slightly over the monitoring period; however, the observed change was not statistically significant, $\chi^2(1, N=160) = .17, p = .677$.
- There was a statistically significant change recorded in plant health during the monitoring period, $\chi^2(2, N = 132) = 7.24, p = .027$. In particular, the total number of plants (adults and seedlings) exhibiting good health increased from 19 at Event 1 to 35 at Event 2.
- Insect predation decreased over the monitoring period; however, the observed change was not statistically significant, $\chi^2(2, N=132) = 5.08, p = .079$.
- No changes were observed in the prevalence of coning or in the number of plants impacted by fauna or erosion.

5. Management triggers

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 8.

Table 9. Assessment against management triggers

Management trigger	Assessment	Corrective action required
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	83.6% of translocated plants possessed above ground vegetative material at the time of monitoring. It is unknown if the remaining plants were alive or dead as it is possible that plants may resprout from underground stems in future growing seasons.	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.

6. Conclusion

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

- 16.4% of plants (adults and seedlings combined) are lacking above ground vegetative material. It is unknown if these plants are alive or dead as it is possible that plants may resprout from underground stems in future growing seasons.
- Nearly half (46.8%) of the plants possessing above ground vegetative material (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.

It is also recommended that seed be collected from coning adult plants during March - June 2022 and propagated in preparation for supplementary planting. Dead leaves present should be pruned by NDLC during the next maintenance activity.

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.

Bruce Highway – Cooroy to Curra (Section D: Woondum to Curra) Macrozamia pauli-guilielmi Translocation Final Report (NDLC, 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	Sex	No. seed collected/ spread
B2-2	254	2	A	G	L	N	L	N	F	N
B2-2	255	2	A	G	L	N	L	N	M	N
B2-2	256	2	A	M	L	N	L	N	M	N
B2-2	257	2	A	M	L	N	L	N	U	N
B2-2	258	2	A	M	L	N	L	Y	M	N
B2-2	259	2	U	NA	NA	NA	NA	N	M	NA
B2-2	260	2	A	P	L	N	L	N	U	N
B2-2	261	2	A	G	L	N	L	N	U	N
B2-2	262	2	A	P	L	N	L	N	F	N
B2-2	263	2	A	M	L	N	L	N	F	N
B2-2	264	2	A	M	L	N	L	N	F	N
B2-2	265	2	A	G	L	N	L	Y	M	N
B2-2	266	2	A	G	L	N	L	N	U	N
B2-2	267	2	A	G	L	N	L	Y	F	N
B2-2	268	2	A	G	L	N	L	N	U	N
B2-2	269	2	A	M	L	N	L	N	U	N
B2-2	270	2	A	P	L	N	L	Y	F	N
B2-2	271	2	A	P	L	N	L	Y	F	N
B2-2	272	2	A	P	L	N	L	N	M	N
B2-2	273	2	A	G	L	N	L	N	U	N
B2-2	274	2	A	G	L	N	L	N	U	N
B2-2	275	2	A	G	L	N	L	Y	F	N
B2-2	276	2	A	P	L	N	L	Y	F	N
B2-2	277	2	A	G	L	N	L	N	F	N
B2-2	278	2	A	P	L	N	L	N	U	N
B2-3	243	3	A	M	L	N	L	Y	M	N
B2-3	243a	3	A	P	L	N	L	N	U	N
B2-3	244	3	A	P	L	N	L	N	M	N
B2-3	245	3	A	M	L	N	L	N	F	N
B2-3	246	3	A	P	L	N	L	Y	M	N
B2-3	247	3	A	M	L	N	L	N	U	N
B2-3	248	3	A	G	L	N	L	N	U	N
B2-3	249	3	A	P	L	N	L	N	F	N
B2-3	249a	3	A	P	L	N	L	N	U	N
B2-3	249b	3	U	NA	NA	NA	NA	N	U	NA
B2-3	249c	3	A	M	L	N	L	N	U	N
B2-3	250	3	A	G	L	N	L	N	M	N
B2-3	251	3	A	G	L	N	L	N	M	N
B2-3	252	3	A	P	L	N	L	N	U	N
B2-3	253	3	A	P	L	N	L	N	F	N
B2-S2	55	2	A	G	L	N	L	N	U	N

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	M	L	N	L	N	U	N
B2-S2	70	2	A	M	L	N	L	N	U	N
B2-S2	51	2	A	G	L	N	L	N	U	N
B2-S2	56	2	A	G	L	N	L	N	U	N
B2-S2	68	2	A	P	L	N	L	N	U	N
B2-S2	58	2	U	NA	NA	NA	NA	N	U	NA
B2-S2	95	2	A	P	L	N	L	N	U	N
B2-S2	97	2	A	G	L	N	L	N	U	N
B2-S2	81	2	A	G	L	N	L	N	U	N
B2-S2	100	2	A	G	L	N	L	N	U	N
B2-S2	53	2	A	G	L	N	L	N	U	N
B2-S2	94	2	U	NA	NA	NA	NA	N	U	NA
B2-S2	87	2	A	G	L	N	L	N	U	N
B2-S2	54	2	A	M	L	N	L	N	U	N
B2-S2	91	2	A	G	L	N	L	N	U	N
B2-S2	52	2	A	G	L	N	L	N	U	N
B2-S2	77	2	U	NA	NA	NA	NA	N	U	NA
B2-S2	93	2	A	G	L	N	L	N	U	N
B2-S2	101	2	A	G	L	N	L	N	U	N
B2-S3	111	3	A	M	L	N	L	N	U	N
B2-S3	132	3	U	NA	NA	NA	NA	N	U	NA
B2-S3	160	3	A	G	L	N	L	N	U	N
B2-S3	222	3	A	G	L	N	L	N	U	N
B2-S3	146	3	A	G	L	N	L	N	U	N
B2-S3	136	3	U	NA	NA	NA	NA	N	U	NA
B2-S3	156	3	U	NA	NA	NA	NA	N	U	NA
B2-S3	224	3	A	G	L	N	L	N	U	N
B2-S3	133	3	A	G	L	N	L	N	U	N
B2-S3	123	3	A	G	L	N	L	N	U	N
B2-S3	157	3	A	P	L	N	L	N	U	N
B2-S3	221	3	U	NA	NA	NA	NA	N	U	NA
B2-S3	110	3	A	G	L	N	L	N	U	N
B2-S3	124	3	A	G	L	N	L	N	U	N
B2-S3	159	3	U	NA	NA	NA	NA	N	U	NA
B2-S3	219	3	U	NA	NA	NA	NA	N	U	NA
B2-S3	138	3	U	NA	NA	NA	NA	N	U	NA
B2-S3	121	3	U	NA	NA	NA	NA	N	U	NA
B2-S3	220	3	A	G	L	N	L	N	U	N
B2-S3	218	3	A	M	L	N	L	N	U	N

Appendix B – Representative photographs



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



Plate 3. Healthy adult at planting area B2-2.