Banksia Beach Borefield

Annual Compliance Report 2017-2018

1st December 2018

SOURCE STORE SUPPLY

Contents

1. Executive Summary

This annual compliance report encompasses the fourth monitoring period of operation and management of the Banksia Beach Water Treatment Plant and Borefield under the Borefield Environmental Management Plan (BEMP) between the 1st September and 31st August 2018. This report addresses the requirements of conditions applied to the project under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).

A detailed review of the previous monitoring program, incorporating the recommendations of the three-year review and the subsequent GDE orientated review of the monitoring network, was presented to the Commonwealth Department of the Environment (DotE) in January 2014. The EPBC approval 2007/3396 was updated and approved to reflect the changes to the BEMP with the new approval conditions activated on the 17th April 2015. On the 3rd of August 2015 Seqwater submitted the updated and revised BEMP to DotE and was approved by DotE on the 18th August 2015.

During this reporting period (2017–2018) all 6 conditions for the controlled action were active. The Banksia Beach Water Treatment Plant has not been operational since April 2014 and has subsequently triggered the cold standby shutdown (shutdown >12months) monitoring and sampling regime as outlined within the BEMP. Therefore, no extraction from the Borefield has occurred. The conditions active during this reporting period (2017–2018) have been assessed for compliance. A summary of the results is presented in Table 1 and more detailed descriptions of the compliance assessment are presented in Sections 2.1 - 2.7.

The outcomes of the compliance assessment indicate no instances during this reporting period of any significant impact on EPBC Act listed species. Further, no incidents requiring notification to DotE have occurred during this reporting period (2017–2018). All ongoing active EPBC conditions of approval will continue to be implemented and audited during the operational phase of Banksia Beach Water Treatment Plant and Borefield.

2. Introduction

The Queensland Government mandated the implementation of a series of water infrastructure projects as part of a regional drought management strategy in response to the millennium drought (2001-2009) and the lack of security of potable water supplies in South East Queensland (SEQ).

In 2006, a new Part 8 was inserted in the *Water Regulation 2002*, outlining measures to be undertaken and outcomes to be achieved by service providers to ensure security of essential water supplies for the SEQ Region. One of the specified measures was the development of underground water resources at Bribie Island and in the area around Brisbane. Schedule 10B of the *Water Regulation 2002* required that this measure with respect to Bribie Island be completed by 31 December 2007, with the initial outcome of 10 megalitres (ML) of water production per day.

Investigation of the aquifer and groundwater modelling for Bribie Island clearly demonstrated that the sustainable combined production level at the proposed Banksia Beach water treatment plant (WTP) and the then existing Woorim WTP is limited to about 8 ML/d. The Queensland Government acknowledged this and the proposed extraction rate for the northern and southern borefields was formally revised on the 2nd November 2007 to 5 ML/day.

The Banksia Beach WTP was therefore developed for production of water not exceeding 4.32 ML/day (annual daily average) at a maximum daily rate of 5ML/day and totaling no more than 1580ML/year. The WTP sources water from the associated northern borefield via a reticulation pipeline to convey water extracted from the lower (regional) sand mass aquifer. The WTP at Woorim was decommissioned in 2008 by Seqwater due to poor infrastructure condition and poor source water quality to the plant. The balance of supply to Bribie Island is dictated by the regional supply model which outlines the supply and bulk water transfer arrangements intended to meet forecast demands, water security and cost. This plan ensures supply on the island is adequately met via the Banksia Beach WTP, the bulk water supply network or a combination of the two depending on the current grid arrangement.

As this development lies in close proximity to a site of national environmental significance, namely the Moreton Bay Ramsar Wetland, the project was referred to the Commonwealth Department of the Environment and Water Resources (DEWR) (Subsequent to the Referral the Department of the Environment, Water, Heritage and the Arts (DEWHA) pursuant to the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act). Subsequently, DEWHA became the Department of Sustainability, Environment, Water, Populations and Communities - DSEWPaC, then, as of September 2013, became the Department of the Environment (DotE). The EPBC Act referral comprised a comprehensive Review of Environmental Factors. The DEWHA declared the project a controlled action under the *EPBC Act section 95a* under the controlling provision – Wetlands of international importance (sections 16 and 17B).

3. Conditions of Compliance

To demonstrate compliance with the individual EPBC Act conditions of approval, Table 1 summaries each condition number as per the controlled action approval notice of 17th April 2015. For Table 1, the status of the condition compliance is provided as well as a summary of condition compliance status. Further details of compliance status have been provided below this table. Please note that in some instances the conditions presented in Table 1 have been separated into lettered bullet points for erase of reference and visual presentation, the conditions may differ to the determination notice.

Table 1: Reference Table for EPBC Act Controlled Action Conditions

Condition Number	Condition/Requirement	Status	Compliance assessment
EPBC 1	The approval holder must submit for approval by the Minister a BEMP designed to protect the ecological character of the Moreton Bay Ramsar wetlands. Once approved, the BEMP must be implemented. The approved BEMP must be published on the approval holder's website, with a location and/or metadata that enables easy discovery by relevant web searches, within one month of approval by the Minister. The approval holder must notify the Department within 5 business days of publishing the BEMP on its website. The BEMP must remain on the website for the period the approval has effect.	Ongoing	Compliant.
EPBC 2	In accordance with the yield identified in the BEMP, the approval holder must limit groundwater extraction from the Northern Borefield to no greater than an annual average of 4.32ML/day, at a maximum daily rate of 5ML/day and totalling no more than 1580ML/year, subject to the requirements of conditions 1,4 & 5.	Ongoing	Compliant.
EPBC 3	The approval holder must maintain accurate records of all measures taken to implement the BEMP according to conditions of this approval, and must make these records available to the Department on request. Within 3 months of every anniversary of the commencement of the action, the approval holder must publish a Compliance Report on its website addressing the implementation of the BEMP. The approval holder must also notify of any non-compliance with this approval to the Department in writing within 10 business days of becoming aware of the non-compliance. The approval holder must continue to annually publish the Compliance Report until such time as agreed in writing by the Minister. Such records may be subject to audit by the Department or be used to verify compliance with the conditions of the approval.	Ongoing	Compliant.
EPBC 4	If the approval holder wishes to carry out any activity otherwise than in accordance with the BEMP, the person taking the action must submit to the Department for the Minister's written approval a revised version of the BEMP. The varied activity shall not commence until the Minister has approved the revised plan in writing. If the Minister approves the revised plan, that plan must be implemented in place of the plan originally approved. All revised plans approved by the Minister must be published on the approval holder's website within one month of their approval by the Minister.	Noted – general obligation condition	Compliant.
EPBC 5	If the Minister believes that it is necessary or convenient for the better protection of the relevant matters of environmental significance to do so, the Minister may request the approval holder to make specific revisions to the BEMP and submit the revised plan for the Minister's written approval. Once approved, the revised plan must be implemented. Unless the Minister has approved the revised plan, the approval holder must continue to implement the originally approved BEMP, as specified in the conditions.	Noted – general obligation condition	Compliant.
EPBC 6	Upon the direction of the Minister, the approval holder must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the Minister. The independent auditor and audit criteria must be approved by the Minister prior to the commencement of the audit. The audit report must address the criteria to the satisfaction of the Minister.	Noted – general obligation condition	Compliant.

3.1 EPBC Condition 1

On the 3rd of August 2015 Seqwater submitted the updated and revised BEMP, designed to protect the ecological character of the Moreton Bay Ramsar wetlands. This was approved by DotE on the 18th August 2015. Implementation of the specific monitoring programs and other requirements can be found section 3.

The BEMP was amended in February/March 2016 to include changes when the BBWTP is in cold standby shutdown (shutdown >12months) which are;

- No quarterly operational reports
- No CRG meetings unless specific issues arise
- No SWL and EC monitoring
- No quarterly assessment of meteorological data

Continuation of vegetation transects surveys, soil moisture monitoring and NDVI will occur until baseline is established (Note: baseline established once information from any future differential changes can be statistically assessed).

The changes to the monitoring requirements in the BEMP published on Seqwater's website on the 30th March 2016 within one month of receiving approval form DotE (23rd March 2016). Notification to DotE occurred on the 30th of March 2016 within 5 days of publishing the BEMP on Seqwater's website. In accordance to condition 1 of the EPBC approval the BEMP is now available on Seqwater's website at http://www.seqwater.com.au/about/publications

Status – Compliant

3.2 EPBC Condition 2

The BBWTP has not been operational since April 2014 and has subsequently triggered the cold standby shutdown (shutdown >12months) monitoring and sampling regime as outlined within the BEMP. No extraction from the borefield has occurred between the reporting period.

Status – Compliant

3.3 EPBC Condition 3

This Annual compliance report fulfills the requirement of EPBC condition 3 addressing implementation of the BEMP within 3 months of the anniversary date. For the purposes of this report the anniversary date is September 1st with the Annual Compliance report due December 1st.

Status – Compliant

3.4 EPBC Condition 4

No activities otherwise than those in accordance to the BEMP were undertaken between the period of September 2017 and August 2018.

Status – Compliant.

3.5 EPBC Condition 5

No requests for revision of the BEMP by the Minister were received between the period of September 2017 and August 2018.

Status – Compliant.

2.6 EPBC Condition 6

No requests for an independent audit by the Minister were received between the period of September 2017 and August 2018.

Status – Compliant.

4. Implementation of the BEMP

a. Annual Monitoring Report

The Banksia Beach Water Treatment Plant has not been operational since April 2014 and has subsequently triggered the cold standby shutdown (shutdown >12months) monitoring and sampling regime as outlined within the BEMP. Therefore, an annual vegetation monitoring report on the groundwater dependant ecosystems (GDE's) was prepared covering the period from September 2017 to August 2018.

As the cold standby shutdown (shutdown >12months) has been triggered, it is expected that the ongoing vegetation monitoring events will establish baseline vegetation condition and determine the natural range of variation that occurs in terms of structure, composition and condition. There was a statistically significant reduction in the diversity of shrubs in the >0.5m size class, however this was observed at both the impacted and controlled sites. Overall the surveys to date reveal that there is a broader similarity in structural and floristic attributes between the impact and control sites.

Whilst there was an overall reduction in floristic species diversity in 2017, 2018 floristic diversity remained stable following slightly below average rainfall during the assessment period. It is likely that long term monitoring will enable further understanding of the vegetation dynamics and ecological trends.

The full monitoring report can be found in Appendix B.

b. Community Reference Group (CRG)

The BEMP was amended in February/March 2016 to include changes when the BBWTP is in cold standby shutdown (shutdown >12months) which resulted in the CRG only being required to meet unless specific issues arise during cold standby shutdown.

No CRG meetings were held during the reporting period 2017-2018.

5. Conclusion

The BBWTP has not been operational since April 2014 and has subsequently triggered the cold standby shutdown (shutdown >12months) monitoring and sampling regime as outlined within the BEMP. Therefore no extraction from the borefield has occurred between the period of September 2017 and August 2018. No instances occurred during this reporting period that had the potential to significantly impact EPBC Act listed species or matters of national significance.

Annual compliance reports will continue to be published on Seqwater's website in accordance to condition 1 of the EPBC approval. The required monitoring outlined within the BEMP will be collected by Seqwater and presented within the next annual compliance report to demonstrate continued compliance with the EPBC Act conditions of approval.

6. Appendix A – EPBC Approval Conditions (2007/3396)

Australian Government
Department of the Environment

EPBC: 2007/3396

Contact Officer: Penny Godwin
Telephone: (02) 6275 9516
Facsimile: (02) 6274 1878
Email: post.approvals@environment.gov.au

Mr Daniel Spiller
General Manager – Asset Portfolio Development and Delivery
Seqwater
PO Box 16146
City East QLD 4002

Dear Mr Spiller

Banksia Beach Water Treatment Plant and Borefield (EPBC 2007/3396)
Variation to Conditions of Approval

I write in relation to the proposed variation to the conditions of approval for *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) approval 2007/3396.

Officers of the department have considered your request, and have found that it is in accordance with the requirements of section 143(1)(c) of the EPBC Act; being that the proposed variation is necessary or convenient for the protection of a matter of national environmental significance.

As delegate of the Minister for the Environment, I have decided to approve the variation to the conditions of the approval in accordance with the provisions of the EPBC Act. The action must now be undertaken in accordance with the varied conditions specified in the enclosed variation notification.

I note that the variation of conditions requires that a Borefield Environmental Management Plan (BEMP) is submitted for approval. I am advised that a BEMP was submitted to the Department in January 2015 and that this plan will require some minor amendments to meet the requirements of the varied approval conditions.

The variation of conditions of approval does not relieve the person to whom it has been granted from an obligation to comply with any other law of the Commonwealth, State or Territory that is applicable to do the action and to have any right, title or interest that is required to access land or waters and to do the action.

If you have any enquiries in relation to this matter, please contact Penny Godwin on 02 6275 9516.

S. Gaddes

Shane Gaddes
Assistant Secretary
Compliance & Enforcement Branch
Environment Assessment and Compliance Division

10 April 2015

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Australian Government
Department of the Environment

CORRECTION NOTIFICATION

VARIATION TO CONDITIONS ATTACHED TO APPROVAL
Banksia Beach Water Treatment Plant and Borefield, Bribie Island
(EPBC 2007/3396)

The variation to conditions attached to approval signed on 10/4/2015 contained an error.

The notice incorrectly stated "insert conditions 1-7".
The notice should read "insert conditions 1-6".

Person making correction

Name and position	Shane Gaddes Assistant Secretary Compliance and Enforcement Branch
signature	S.Gaddes
date of correction	17 April 2015

Australian Government
Department of the Environment

VARIATION TO CONDITIONS ATTACHED TO APPROVAL

Banksia Beach Water Treatment Plant and Borefield, Bribie Island (EPBC 2007/3396)

This decision to vary a condition of approval is made under section 143 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Approved action

Person to whom the approval is granted	Queensland Bulk Water Supply Authority **ABN 75 450 239 876**
Approved action	The Extraction of groundwater from Bribie Island to supply an incremental 5ML per day of drinking water to the existing Caboolture Shire Council delivery network, Queensland, (EPBC 2007/3396)

Variation

Variation of conditions of approval	The variation is: Delete conditions 1-8 and definitions and annexure 2 attached to the approval dated 7 April 2008, subsequently varied on 6 September 2011, and insert conditions 1-7 and definitions specified below
Date of effect	This variation has effect on the date the instrument is signed

Person authorised to make decision

Name and position	Shane Gaddes Assistant Secretary Compliance & Enforcement Branch
Signature	SGaddes
Date of decision	10 April 2015

Conditions attached to the approval

1. The **approval holder** must submit for approval by the **Minister** a **BEMP** designed to protect the ecological character of the Moreton Bay Ramsar wetlands. Once approved, the **BEMP** must be implemented. The approved **BEMP** must be published on the **approval holder's** website, with a location and/or metadata that enables easy discovery by relevant web searches, within one month of approval by the **Minister**. The **approval holder** must notify the **Department** within five **business days** of publishing the BEMP on its website. The BEMP must remain on the website for the period the approval has effect.

2. In accordance with the yield identified in the **BEMP**, the **approval holder** must limit groundwater extraction from the **Northern Borefield** to no greater than an annual average of 4.32ML/day, at a maximum daily rate of 5ML/day and totalling no more than 1580ML/year, subject to the requirements of conditions 1, 4 and 5.

3. The **approval holder** must maintain accurate records of all measures taken to implement the **BEMP** according to the conditions of this approval, and must make these records available to the **Department** on request. Within 3 months of every anniversary of the commencement of the action, the **approval holder** must publish a Compliance Report on its website addressing implementation of the **BEMP**. The **approval holder** must also notify any non-compliance with this approval to the **Department** in writing within 10 business days of becoming aware of the non compliance. The **approval holder** must continue to annually publish the Compliance Report until such time as agreed in writing by the **Minister**. Such records may be subject to audit by the **Department** or be used to verify compliance with the conditions of the approval.

4. If the **approval holder** wishes to carry out any activity otherwise than in accordance with the **BEMP**, the person taking the action must submit to the **Department** for the **Minister's** written approval a revised version of the BEMP. The varied activity shall not commence until the **Minister** has approved the revised plan in writing. If the **Minister** approves the revised plan, that plan must be implemented in place of the plan originally approved. All revised plans approved by the **Minister** must be published on the **approval holder's** website within one month of their approval by the **Minister**.

5. If the **Minister** believes that it is necessary or convenient for the better protection of the relevant matters of environmental significance to do so, the **Minister** may request the **approval holder** to make specific revisions to the **BEMP** and submit the revised plan for the **Minister's** written approval. Once approved, the revised plan must be implemented. Unless the **Minister** has approved the revised plan, the **approval holder** must continue to implement the originally approved **BEMP**, as specified in the conditions.

6. Upon the direction of the **Minister**, the **approval holder** must ensure that an independent audit of compliance with the conditions of approval is conducted and a report submitted to the **Minister**. The independent auditor and audit criteria must be approved by the **Minister** prior to the commencement of the audit. The audit report must address the criteria to the satisfaction of the **Minister**.

Definitions

Approval Holder – means the person to whom the approval is granted

BEMP – means the Borefield Environmental Management Plan, as required under condition 2 and as amended in accordance with condition 4 or condition 5. The BEMP must include detailed management arrangements for ongoing ecological and groundwater monitoring, and reporting to the Department.

Department – means the Australian Government Department responsible for administration of the *Environment Protection and Biodiversity Conservation* Act 1999.

Minister – means the Minister responsible for administration of the *Environment Protection Biodiversity Conservation* Act 1999.

Northern Borefield – means the area identified as the northern borefield in the BEMP.

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7. Appendix B – Vegetation Surveys of the Groundwater Dependent Ecosystems (GDE)

Refer to report prepared by the consultant 3D Environment (Rex D18/165991).

3D Environmental
vegetation analysis and mapping specialists

Bribie Island Borefield:

Groundwater Dependent Ecosystems - Annual Vegetation Monitoring Report 2018

Prepared for Seqwater
by
3D Environmental

Final - November, 2018

Document Control

Project No. 2018_193
Project Manager: David Stanton
Client: Seqwater
Purpose: Annual vegetation monitoring report for Groundwater Dependent Ecosystems – Bribie Island Borefield – 2018 Survey

Draft	Date Issued	Issued By.	Purpose
Draft 1	30 October 2018	David Stanton	Initial draft
Final Report	16 November 2018	David Stanton	Final report following Seqwater and peer review

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1.0 Introduction

3d Environmental has been engaged by Seqwater to complete the 2018 annual monitoring report for groundwater dependent vegetation (otherwise referred to as groundwater dependent ecosystems or GDEs) for Seqwater's Banksia Beach Borefield and Water Treatment Plant on Bribie Island. The Water Treatment Plant has not been operational since April 2014 and no water extraction has occurred. This shutdown in operations has triggered a requirement for the long-term shutdown monitoring and sampling regime as outlined within the Borefield Environmental Management Plan (BEMP). This assessment forms a component of the Annual Compliance Report for the borefield, the first of which was issued in December 2015 to address conditions of approval under the Commonwealth Environmental Protection and Biodiversity Conservation Act (EPBC Act 1999). This report follows an initial GDE monitoring survey report prepared by Jacobs (2015) for the 2014 – 2015 reporting period and two subsequent reports prepared by 3d Environmental for the 2016 and 2017 reporting periods being:

1. Bribie Island Borefield – Groundwater Dependent Ecosystems Annual Vegetation Monitoring Report 2016 (3d Environmental 2016)

2. Bribie Island Borefield – Groundwater Dependent Ecosystems Annual Vegetation Monitoring Report 2017 (3d Environmental 2017).

1.1 Previous Work and Assessment Approach

Two sites were selected for ongoing GDE vegetation monitoring in the Groundwater Model Refinement, GDE Assessment and Monitoring Review (SKM, 2013). One of these sites is located in an area where drawdown in the shallow aquifer potentially may occur (Site 6 or the 'Impact Site') and the second site is located in an area outside the predicted drawdown zone (Site 5 or the 'Control Site). Jacobs (2015) established two permanent vegetation monitoring sites at both impact and control localities. These were subsequently assessed for floristic composition and structure during two monitoring events completed in September 2014 and February 2015. These events were timed to coincide with the latter part of the dry season and the wet season respectively to account for seasonal responses in vegetation. Ongoing vegetation monitoring events have occurred subsequent to the initial vegetation survey with a specific aim to establish baseline vegetation condition and determine the natural range of variation that occurs in terms of vegetation structure, composition and condition.

1.2 Purpose of Assessment and Scope

The overarching purpose of the vegetation monitoring program is to provide a temporal analysis of natural variations in the structural and floristic composition of coastal heathland. This information is to provide a baseline against which the impacts of possible future groundwater abstraction on groundwater dependent vegetation can be measured. To accomplish this, the scope of the current assessment includes:

1) The field assessment of the existing vegetation monitoring sites established by Jacobs (2015) and 3d Environmental (2016) utilising methods compatible with previous assessments.
2) Facilitate capture of NDVI imagery to coincide with the two current survey events (April 2018 and September 2018).

3) Analyse floristic data collected during the current survey in conjunction with complementary datasets (NDVI and Soil Moisture) to determine condition of vegetation at the control and impact sites as well as assesses seasonal variability. Comparison is to be made with previous monitoring survey results, primarily Jacobs (2015), 3d Environmental (2016) and 3d Environmental (2017) to assist the baseline characterisation

1.3 Background and Ecological Context

The monitoring sites assessed in this survey are located in 'wet heath' being allocated to Regional Ecosystem 12.2.12 (closed heath on seasonally waterlogged sand plains), which has a "Least Concern" status under Queensland's Vegetation Management Act. Heaths are essentially treeless plant communities dominated by low shrubs and various other ground flora. Australian heaths are invariably associated with oligotrophic (low nutrient) soils deficient in phosphorus and nitrogen (DERM 2010). Wet heaths rely on shallow groundwater for maintenance of their unique structure and composition and the shallow soil profile is likely to be saturated over a considerable proportion of the year. Knowledge of vegetation dependence on groundwater is relatively undeveloped in the Australian context. Recent studies in coastal heathlands in eastern Australia indicate a need for longer term monitoring before definitive statements on the response of vegetation to groundwater drawdown can be made (Griffith et al 2015). Many inferences can however be drawn from Western Australian examples where monitoring of coastal heath vegetation in the groundwater abstraction area of the Swan Coastal Plain has been continuous for a period of several decades (Froend and Summer 2010; Froend et al 2004, Groom 2004, Groom 2003; Groom et al 2001; Groom 2000). Such studies make the following key points:

- The response of terrestrial phreatophytes (species dependent on groundwater for survival) to declines in groundwater levels are unpredictable and variable.
- Phreatophytes associated with formerly shallow stable groundwater sources are likely to be more sensitive to groundwater decline than trees exposed to variable groundwater regimes.
- Rapid declines in groundwater are more likely to accelerate vegetation response with a threshold breach and rapid coversion of vegetation to an alternative ecohydrological state.
- Gradual reductions provide greater opportunity for recharge to occur and promotes gradual floristic transition.
- Protracted extreme groundwater decline may result in a change in species composition, as groundwater sensitive phreatophytes are replaced by species with a greater ability to adapt to a drying sub-surface environment, or those species with deeper rooting systems.

In the context of Bribie Island, the shallow-rooted heath vegetation will be formed by a mix of both phreatophytes and facultative phreatophyes (i.e utilise groundwater although can survive without it). Wet heath vegetation typically has rooting material, mostly from sedges herbs and small shrubs concentrated in the upper 15 cm of soil, the portion of the profile most exposed to periodic cycles of wetting and drying in response to rainfall. There are also a number of deeper rooted species such as *Banksia aemula* and broad-leaf paperbark (*Melaleuca quinquenervia)* with the ability to adapt relatively rapidly to changing groundwater levels through accelerated root growth (Griffith et al 2015). The predicted shallow groundwater level reductions created as a result of borefield abstraction for both the average and dry weather conditions are relatively limited with maximum predicted drawdowns of 0.2 m and 0.3 m respectively and drawdown impacts of 0.1 m extending into the eastern Ramsar area towards Welsby and South Welsby lagoons (Seqwater 2015). Based on Western Australian case studies where groundwater drawdown of several metres over a protracted period was required to illicit a

measurable response in vegetation (Groom et al 2000a, 2000b, Groom 2003, 2004, Froend et el 2010), such minor reduction in groundwater levels are unlikely to promote any noticable shift in the ecological state of vegetation within the drawdown area in the short term with detectible impacts likely over decadal cycles.

On North Stradbroke Island, a monitoring program between 1988 and 2006 in 18 Mile Swamp demonstrated some vegetation composition and structural changes associated with water extraction (Specht & Stubbs 2011). They found broad-leaf paperbark trees expanded into heath and sedgeland areas when water table levels fluctuated in response to drought and water extraction. The paperbarks rapidly grew in height and out competed sedges and smaller shrubs, such as *Leptospermum juniperinum*, thought to have shallower roots (Specht & Stubbs 2011).

2.0 Methods

2.1 Field Survey

Timing: Field survey was completed over on the on the 27th and 28th of April for the post-wet survey and on September 14th for the dry season survey.

Transect Methods: Methods for vegetation assessment followed those documented in Jacobs (2015) which was adapted from the Biocondition Methodology (Eyre et al 2015) to provide an assessment of vegetation composition and structure. Each survey locality (plot) was formed by a central 50m transect marked with star pickets and a 50m tape measure stretched tightly between end points. The transect was extended 5m either side of the centreline to provide a 50 m x 10 m plot (0.05ha). Four transects (Plots 5a, 5b, 6a 6b) were established in September 2014 (each had a third star picket placed at the transect mid-point). An additional two transects (5c and 6c) were established in April 2016 although a central picket was not used for these. Specific details of data collected at each plot is provided below with deviations from the methods of Jacobs (2015) identified and discussed in the following sections:

- Canopy intercept of woody species over a measured centre line, from 0 to 50m separated into:
    - Tree (T1) structural layer being trees > 6m height.
    - Upper shrub (S1) structural layers, being shrubs > 1m height.
    - Lower shrub (S2) structural layers being shrubs in the height range of 0.5 to 1m[1].
    - Ground (G) being floristic life forms <0.5m height.
- Species richness for all floristic lifeforms within each 0.05 ha plot totalled for the two survey events. Lifeforms allocated in the assessment are:
    - Trees (single stemmed woody plants > 6m).
    - Shrubs (woody multi-stemmed vegetation)
    - Forbs (herbaceaous vegetation that is not a grass or other life form)
    - Native perennial grass / sedge / rush (includes graminoids such as sedges, tussock grasses and restionaceae species. Lomandra spp[2] have also included in this category).
    - Grasstree[3] (Xanthorrhoea spp.)

[1] Shrubs in the 0.5 to 1m height range were included in the Ground (G) structural layer in Jacobs 2015.
[2] Included in the shrub category in Jacobs (2015) although overall cover very low.
[3] Not included in the biocondition methodology

- Counts of woody species within the survey plots within height classes (Trees T1; Shrubs S1 and S2). Stem counts were completed in a 2m wide belt transect positioned either side of the centreline tape. This narrow width allows for the accuracy in stem counts required in repeat measure monitoring surveys.
- Groundcover of floristic lifeforms within 10 x 1m^2 quadrats placed at 10m intervals along the tape measure with the initial quadrat position (Q1) at the 4 – 5m interval on the left side of the tape measure and flipped to measure Q2 on the right. The final quadrats Q9 and Q10 were positioned at 44 – 45m on the left and right side of the transect respectively. Cover measurements utilised the Braun-Blanquet method including % proportions of:
    - Native Shrubs < 0.5m. (Specht & Stubbs 2011).
    - Native perennial grass/ sedge/ rush
    - Native forbs
    - Grasstrees
    - Exotic shrubs
    - Leaf litter (% of dead leaf matter)
    - Bare ground (exposed sand).
- Canopy heights were recorded for all canopy intercepts in the T1, S1 and S2 structural layers.

GPS localities of start and end points were recorded in the field and photographs were taken at the transect centre point from centre to start, centre to end, centre to north (right), centre to left. . A generalised plot layout is shown in **Figure 1.**

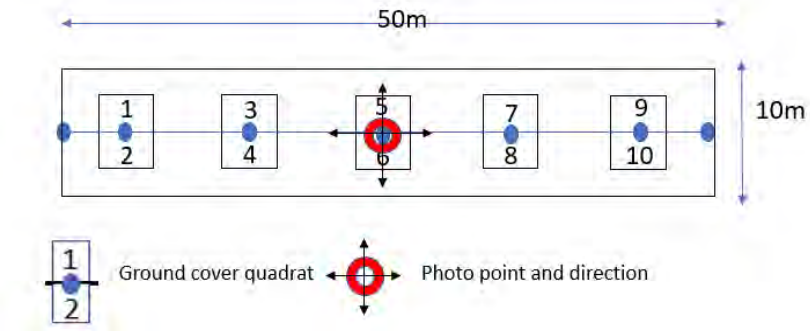


Figure 1. Survey plot layout.

In regard to the assessment of shrub cover, all shrubs >0.5 m height were attributed to the shrub layer and <0.5m to the ground layer, consistent with methods described in Neldner et al (2012). Previous surveys by Jacobs (2015) included shrubs <1m height to the groundlayer, although this was considered impractical in this assessment due to the strong stratification of other groundcover components into the a dense clumping cover typically < 0.5m height.

A total of six plots have been established throughout the course of the survey with plots 5a, 5b, 6a and 6b established by Jacobs (2015) in the previous survey event and an additional two sites (5c and 6c) established in by 3d Environmental during the 2016 survey event. A summary of all sites is provided in **Table 1** with location of transect centrelines provided in **Figure 2**. Floristic and structural data from all transects is provided in **Appendix A**.

Table 1. Monitoring sites established in the study area.

Monitoring Transect No.	Purpose of Site	Lat. / Long. Start	Lat. / Long. Centre	Lat. / Long. Finish	Date Established
5a	Control	-26.9942/ 153.1587	--26.9942/ 153.15905	-26.9942/ 153.15932	26 September 2014
5b	Control	-26.9943/ 153.15879	-26.9944/ 153.15898	-26.9944/ 153.159319	26 September 2014
5c	Control	-26.9946/ 153.15883	NA	-26.9944/ 153.15929	April 4 2016
6a	Impact	-26.985 / 153.15404	-26.9849 / 153.15425	-26.9847/ 153.154487	26 September 2014
6b	Impact	-26.9852/ 153.15415	-26.985 / 153.154376	-26.9849 / 153.15458	26 September 2014
6c	Impact	-26.9852/ 153.15415	NA	-26.9849 / 153.15458	April 4 2016

2.2 Data Analysis

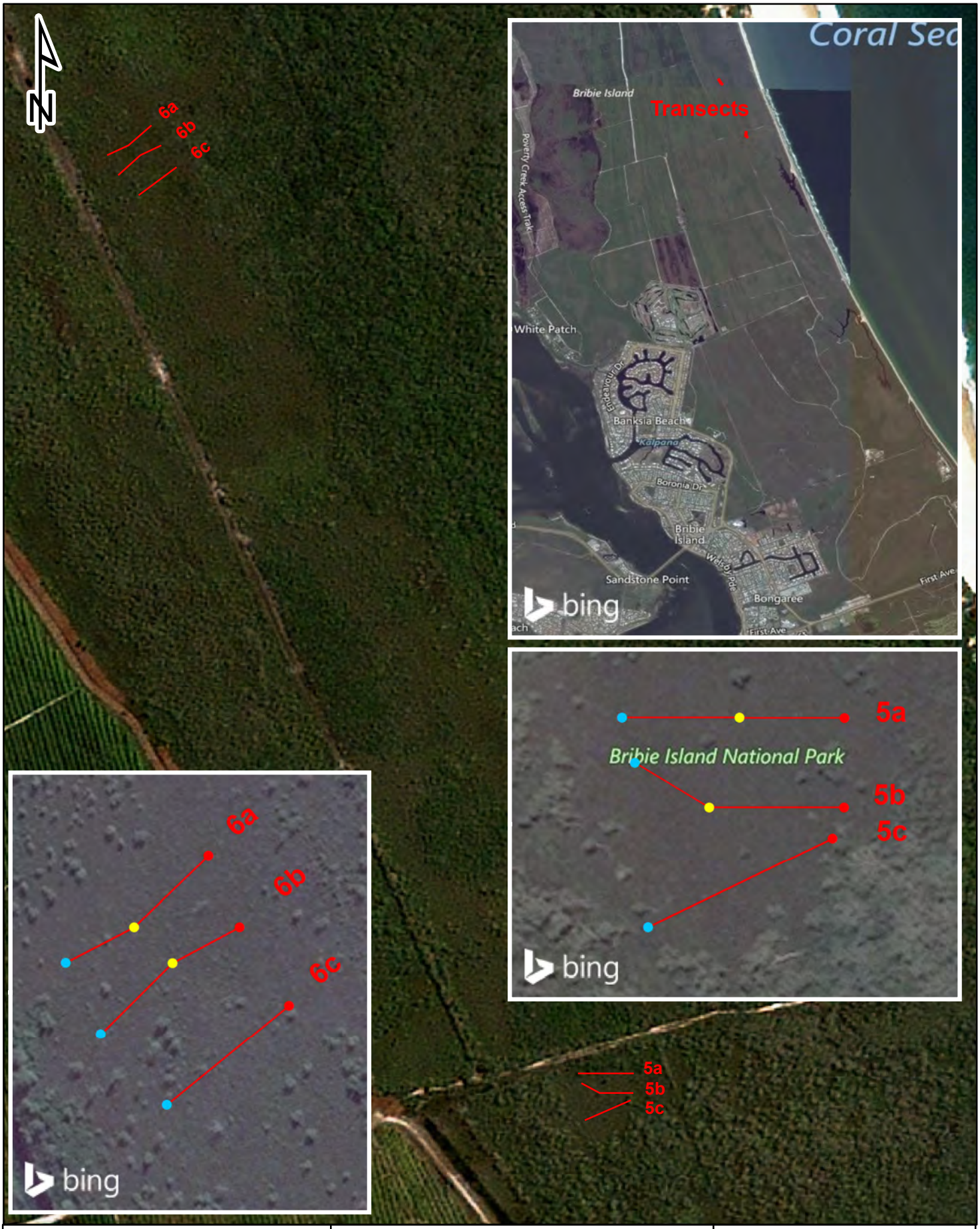
Field data was entered into biocondition datasheets for each individual transect with data summaries to calculate total cover of shrub layers, shrub density as well as components of the ground cover attributed to growth form, leaf litter and bare ground. Data from both April and September 2018 survey events is compiled onto individual datasheets for ready comparison. Rather than the lumping of data from plots into impact and controls sites, all transects were treated individually, to allow an assessment of the natural variability of habitats within the two areas (impact and control) to be made. A Levene's test to test for homogeneity of Variances was completed on all data across all structural parameters. Statistical analysis was undertaken using the Q-macros (2017) extension in Microsoft Excel. Analysis of Variance (ANOVA) was completed on a number of parameters where Levene's test indicated equal variance. This was used to determine the significance of any differences identified between mean values for structural and floristic features recorded during the data collection process. A Repeat Measures ANOVA, using data from the six 2016, 2017 and 2018 survey was undertaken to evaluate the statistical significance of any changes over time in plant cover and richness data. It also allowed an assessment of whether there are consistent differences in any plant group abundance between Sites 5 and 6. Repeat Measures ANOVA was completed using the Q-macros extension in Excel under the 'ANOVA – Two Factors Without Replication' command. A raw data summary of all statistical calculations is provided in **Appendix C**. As standard practice, p-value < 0.05 was considered indicative of a significant difference in mean values or variance.

2.3 NDVI Analysis

Fresh capture Spot 6 (SPOT6 1.5m Panchromatic 4-band Pan + Bundle imagery) imagery from Geoimage Pty Ltd was acquired to coincide as far as possible with the timing of the field survey events. Images capture was completed on the 27th April and 8th September 2018 corresponding with periods that were relatively cloud free. Raw data from the two Spot 6 images were processed using the ArcGIS image server applying the following equation as standard process:

> ***NDVI = arctangent((IR – R)/(IR+R))*** where IR = pixel values from the infrared band, and; R = pixel values from the red band.

This produced a single-band dataset with negative values generated from water (and clouds), bare soil producing values of 0 and higher values produced by green/ living vegetation with greater NDVI values corresponding to varying abundance of green leafy biomass. NDVI values were measured in 1.5 m intervals along each transect for the April and October period with the same interval applied to previous capture periods to ensure consistency between datasets. All values were compiled into an Excel database for interrogation and graphical representation.



Legend

Site

- Start Point
- Centre Point
- End Point
- Transects

Figure 2. Survey plot localities

Client: Seqwater

0 60 120 180 240

Metres

Scale	Drawn By	Checked	File Path	Date	
1:5,612	DG	DS	C:\Users\Owner\Documents\Clients\3D Environmental\Bribie\3d_Bribie_A4P.mxd	09-Nov-16	A4

3D Environmental

Vegetation Assessment
& Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Phone: (07) 3411 9072
Phone: (07) 3878 4344
Mobile: 0447 8227 119
Mobile: 0409 426 916
www.3denvironmental.com.au

C:\Users\Owner\Documents\Clients\3D Environmental\Bribie\3d_Bribie_A4P.mxd

2.4 Climate Data

Automated weather stations are positioned at two locations on Bribie Island being:

- National Park Weather Station (AWS Bribie NP) located at -27.028674°, 153.158484°
- WTP Weather Station at Bore 9 (AWS BBWTP) located at -26.968238°, 153.109549°

Rainfall data from both the Bribie NP and AWS BBWTP were considered for the assessment although the extremely low rainfall recorded in the AWS BBWTP (103mm) for the period from September 2017 to October 2018 suggest the data is erroneous. Hence, data was not considered further during the assessment. .

Data from the dedicated Bribie Island weather stations was compared with annual and long-term rainfall averages collected from Beerburrum Forest (-26.96, 152.967), a Bureau of Meteorology station located approximately 10km west of the Island. Annual rainfall averages for this weather station, recorded back to 1898, were utilised during analysis of the climate data and to supplement any identified information gaps.

2.5 Soil Moisture Data

Automated soil moisture loggers installed at the location of the control and impact monitoring sites were used to measure soil moisture in the shallow soil profile. The utility of this data is that it provides additional context to any changes in vegetation condition that could be attributed to seasonal cycles of wetting and drying. Sensors were installed to depths of 0 mm (surface), 15mm, 350mm, 650 mm, 950 mm and 1250 mm with automated readings provided between September 1st 2017 and August 31st 2018.for the northern impact site (Northern SMP). The soil moisture logger installed at the southern control site (Southern SMP) did not log any information prior to 6th December 2017 although from this date to the end of the assessment period, soil moisture data was recorded without interruption.

3.0 Results

Results of the assessment are detailed below and provide analysis of those factors considered critical to the assessment of vegetation condition, structure and floristic change. The analysis includes assessment of:

- Climate data
- Soil moisture data
- Shrub cover and stem density
- Groundcover composition
- Species richness; and
- NDVI Analysis.

Comparisons between control and impact sites are made and where possible, comparisions between the current and previous survey events back to the 2015 survey period are made.

3.1 Climate and Soil Moisture

Rainfall and soil moisture data are intimately linked and are dealt with consecutively in this section. As previously discussed in **Sections 2.4** and **Sections 2.5**, some datasets were incomplete and hence have not been used in the analysis.

3.1.1 Climate data

Reference to **Figure 3** indicates that October 2017, December 2017 and February 2017 all had well above average rainfall while other months were average or below average. Overall, the rainfall for the period from 1st September 2017 to 30th August 2018 was slightly below average with 1293mm falling at the AWS Bribie NP compared to the long term average of 1406mm recorded for Beerburrum Forest Station (BOM 2018). The months of March 2018 through to August 2018 were all extremely dry recording below average rainfall. The last period of above average rainfall occurred in 2015 when 1538mm fell. The subsequent years of 2016 and 2017 were both extremely dry.

It should be noted that rainfall for the period, although below average, was a significant increase on rainfall recorded between September 2016 and August 2017 where 930mm was recorded at the AWS Bribie NP and 1158 mm recorded at AWS Bribie Island NP for the period from September 2015 to August 2016.

3.1.2 Soil moisture data

Figure 4 from the northern SMP and **Figure 5** from the southern SMP show relatively sustained periods of saturation in the shallow (15cm) profile following 20mm of precipitation falling in the latter part of February. At both SMPs, saturation of the shallow soil profile was sustained through to the April survey event when the upper soil profile began to dry. At 35cm, the northern SMP showed sustained periods of saturation (approximately 40% soil moisture content) with soil moisture content dropping only after long periods with limited rainfall. Generally soil moisture recharge occurred rapidly following rainfall. The soil profile at the southern SMP appears much drier than the north with extended periods of several weeks where shallow soil moisture (measured at 15cm and 35cm) dropped below 20% total moisture content.

At both sites, permanent saturation was recorded at 95cm depth in the soil profile with the interval between 65cm and 95cm likely to represent the capillary fringe.

3.2 NDVI data analysis

The average of NDVI values at each monitoring site is represented in **Figure 6** which provides comparison between the 2016, 2017 and 2018 survey periods. Full data plots for individual monitoring sites are provided in **Figure 7**. NDVI values have been consistently increasing in the more recent capture events. This trend contined in the 2018 monitoring assessment period with the September 2018 Spot capture recording the highest average NDVI values of any monitoring event at all sites. The possible reasons for the increasing NDVI values will be discussed in following sections.

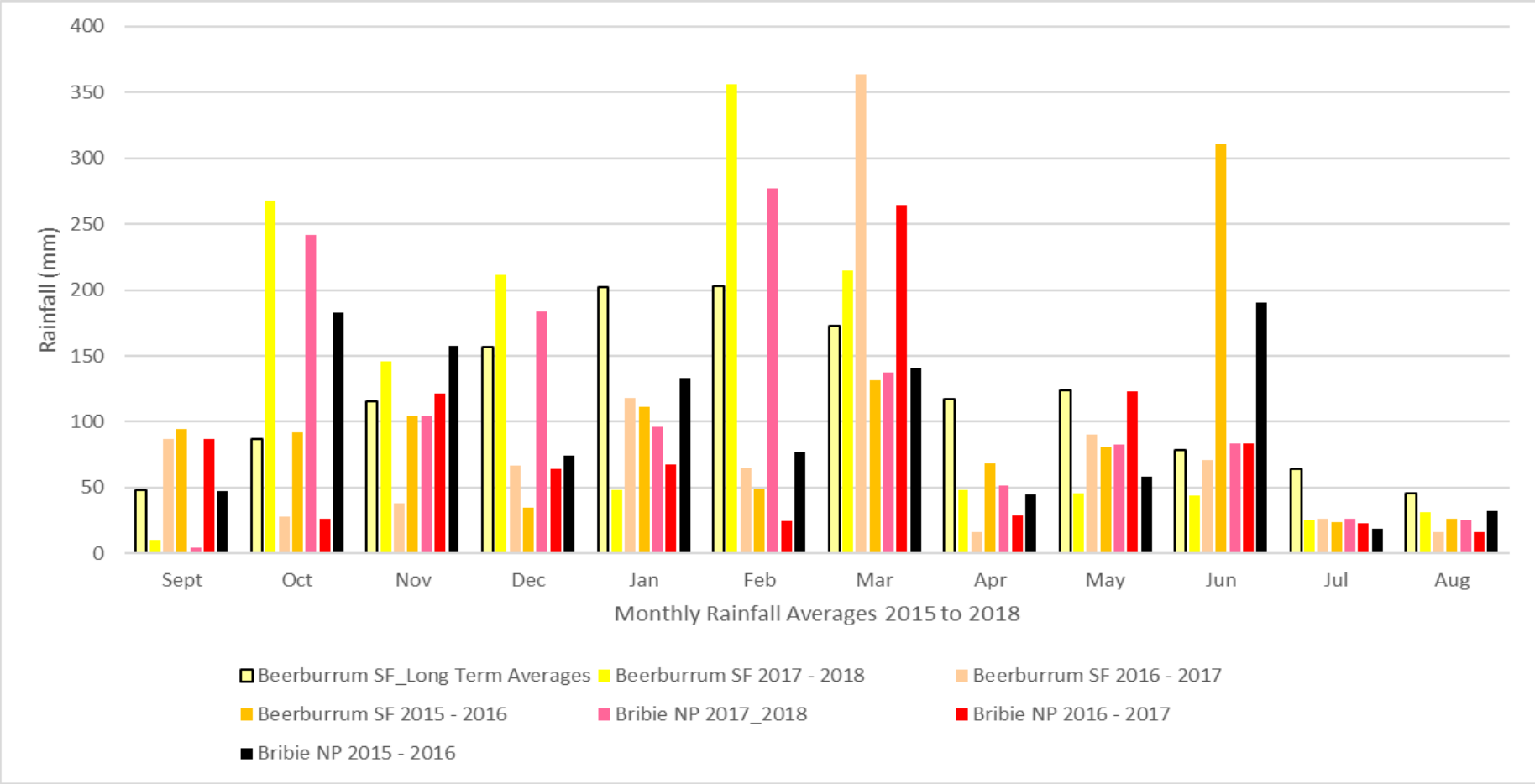


Figure 3. Monthly rainfall for the period from September 2014 to September 2016.

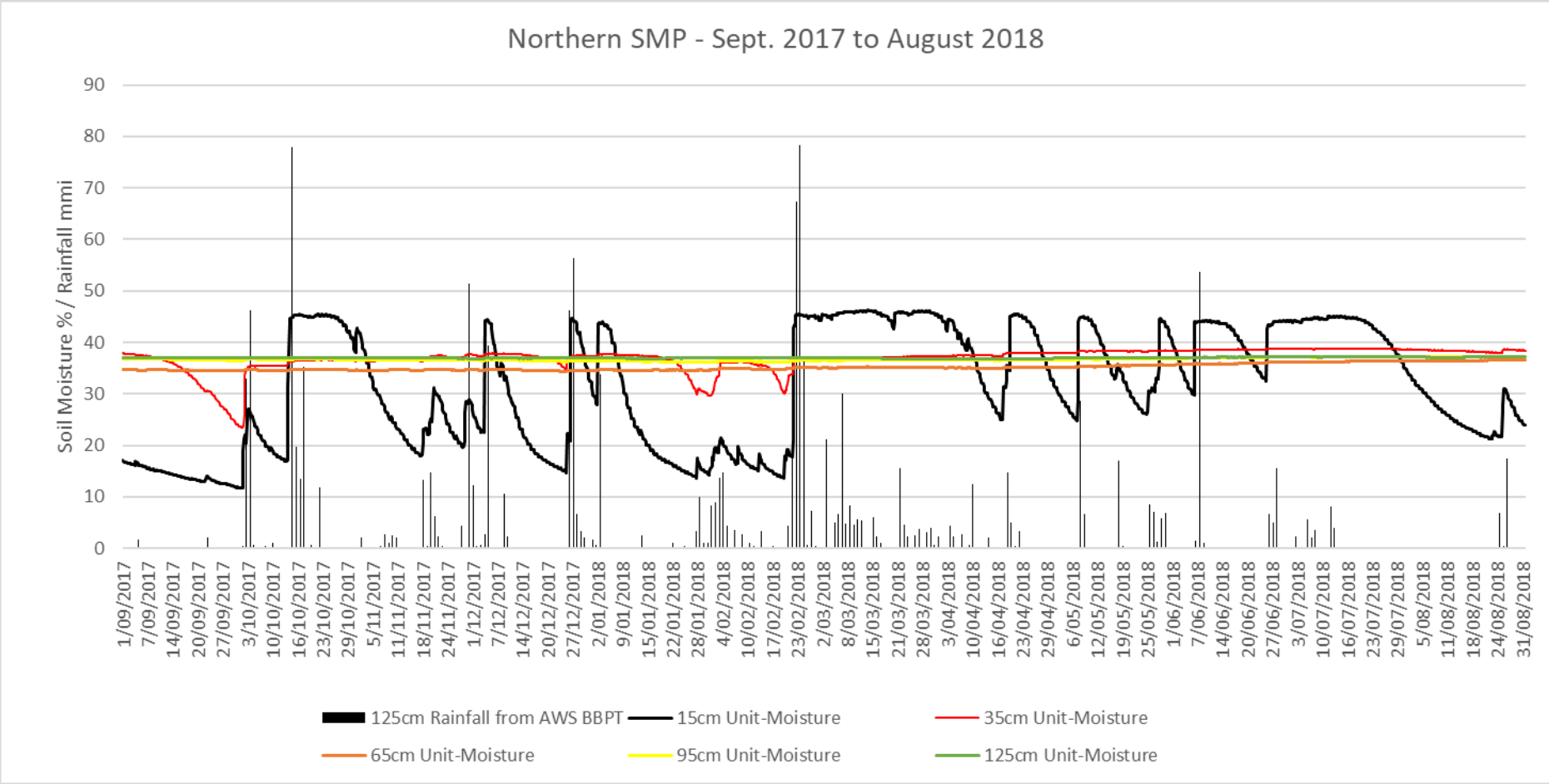


Figure 4. Soil moisture data from the Northern SMP, in the vicinity of the impact monitoring plots (Plot 6a to 6c).

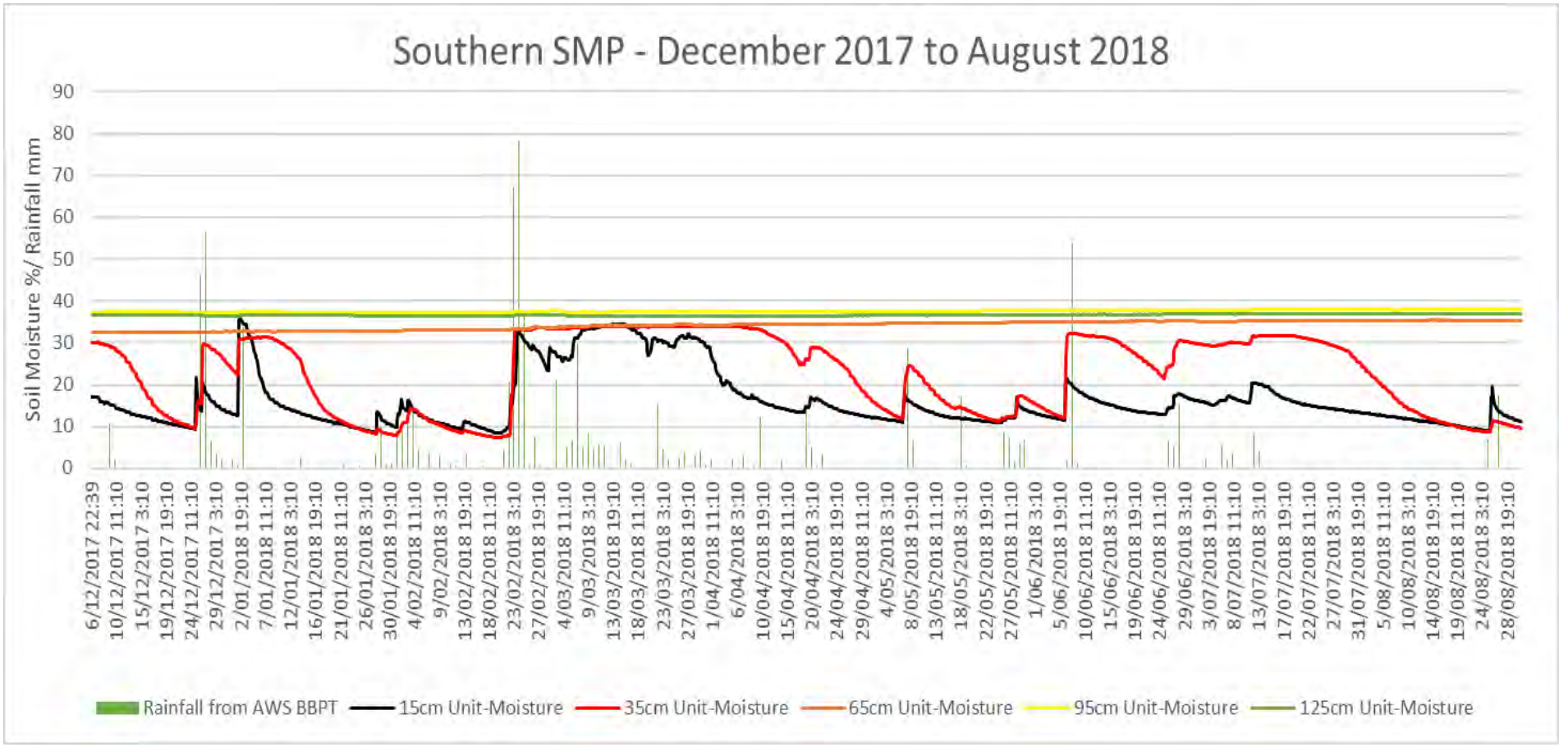


Figure 5. Soil moisture data from the Southern SMP, in the vicinity of the control monitoring plots (Plot 5a to 5c).

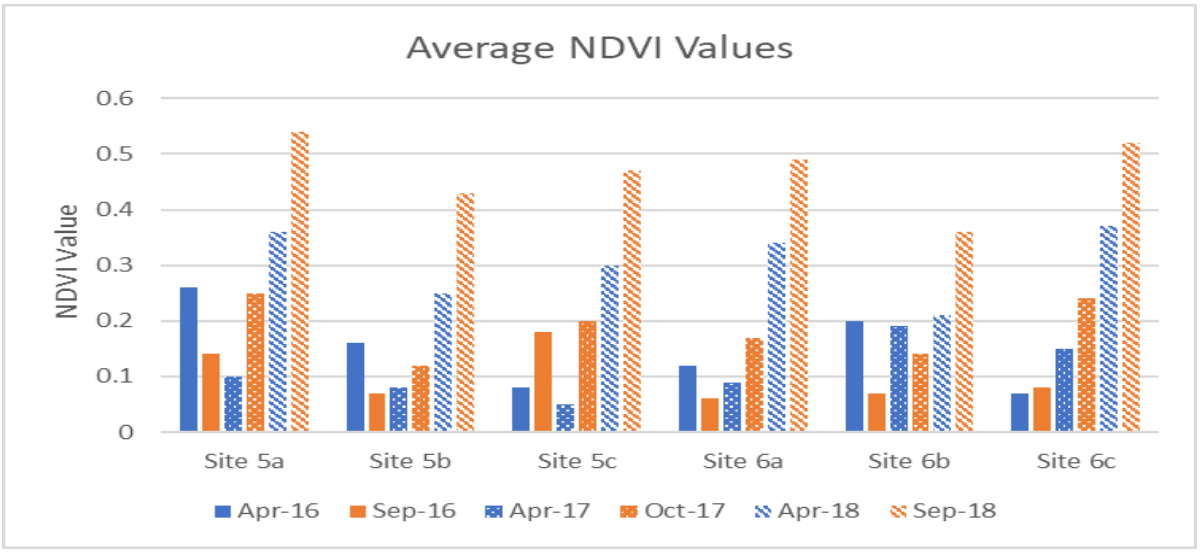


Figure 6. Average NDVI Values for the 2016, 2017 and 2018 survey periods.

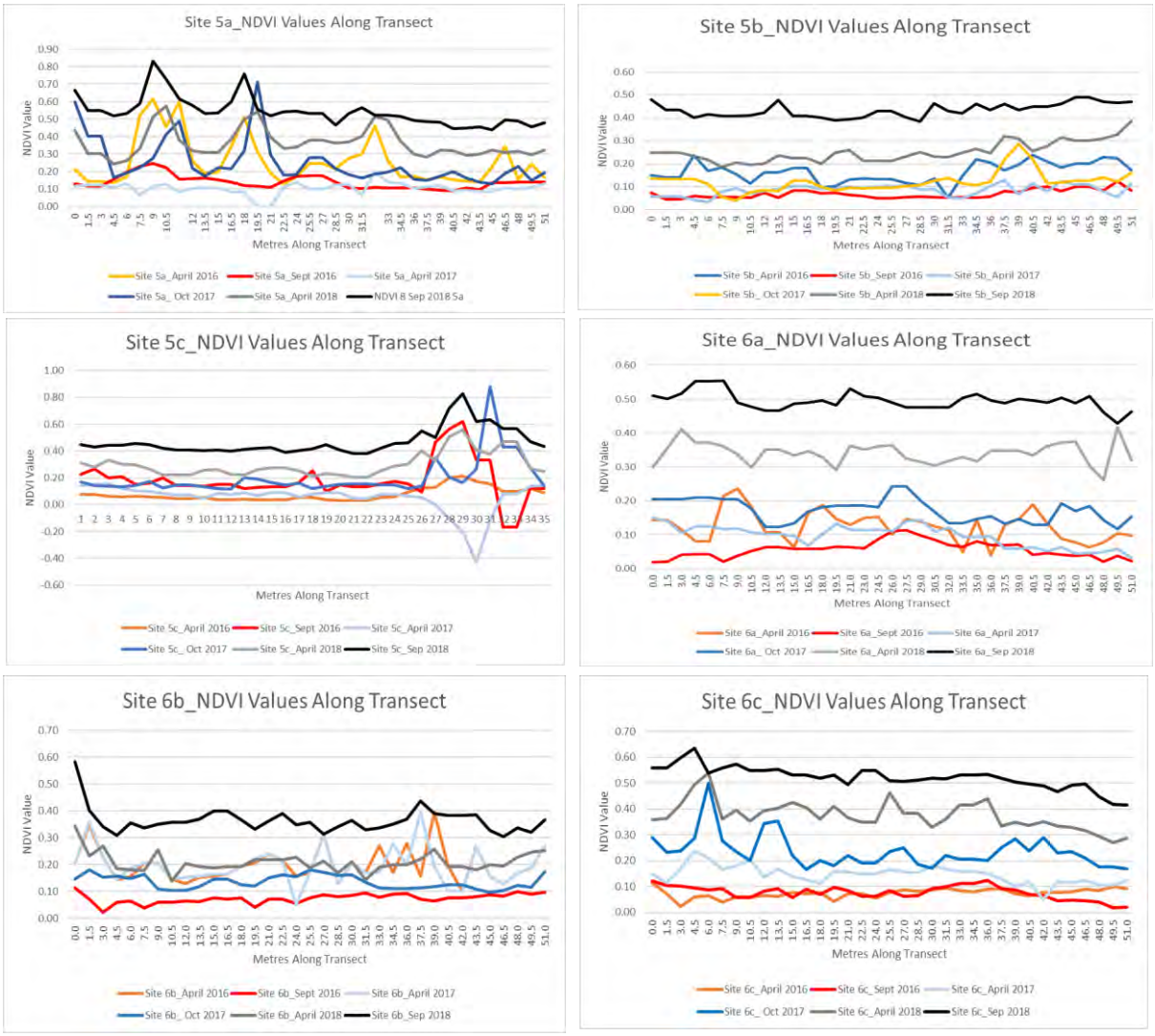


Figure 7. NDVI profiles for individual survey plots at different capture periods.

3.3 Shrub Cover and Stem Density

There is considerable variation in the cover of shrubs >1m tall evident between survey periods for all survey sites (see **Figure 8**). A Levene's test applied to both the control and impact sites indicates that across all sites that Variance is equal. A Repeat Measures ANOVA indicates that the temporal variation in shrub cover demonstrated between survey events is not statistically significant for either control ($F_{2,10}$ = 1.6639, P = 0.23) or impact sites ($F_{2,10}$ = 1.922, P = 0.177) (see **Appendix C**). The potential source of structural variation is unclear although from the large number of broken limbs on many shrubs, it is possible that heavy utilisation by kangaroos may be having a significant impact on shrub structure. Both sites appeared heavily utilised by macropods with abundant droppings and tracks crossing many of the survey localities. Similar results are indicated for shrubs 0.5m to 1m tall with a Repeat Measures ANOVA indicating that temporal variations between survey periods are not statistically significant for either control sites ($F_{5,10}$ = 0.777, P = 0.588) or impact sites ($F_{5,10}$ = 1.892, P = 0.183) despite an apparent trend toward decreasing shrub cover at the impact site (See **Figure 9**).

As noted previous assessments, **Figure 10** indicates that sites associated with the impact area (6a, 6b, 6c) have a much higher stem density than those sites associated with the control areas (5a, 5b and 5). There is also an apparent consistent decrease in stem density that has occurred over the 3 survey events. Repeat Measures ANOVA indicates that the measured decrease in stem density between survey periods is statistically significant for both the impact sites ($F_{5,10}$ = 3.82, P = 0.034) and the control sites ($F_{5,10}$ = 66.62, P = 0.00) suggesting that the reduction in stem density is a real and ongoing structural change (see **Appendix C**).

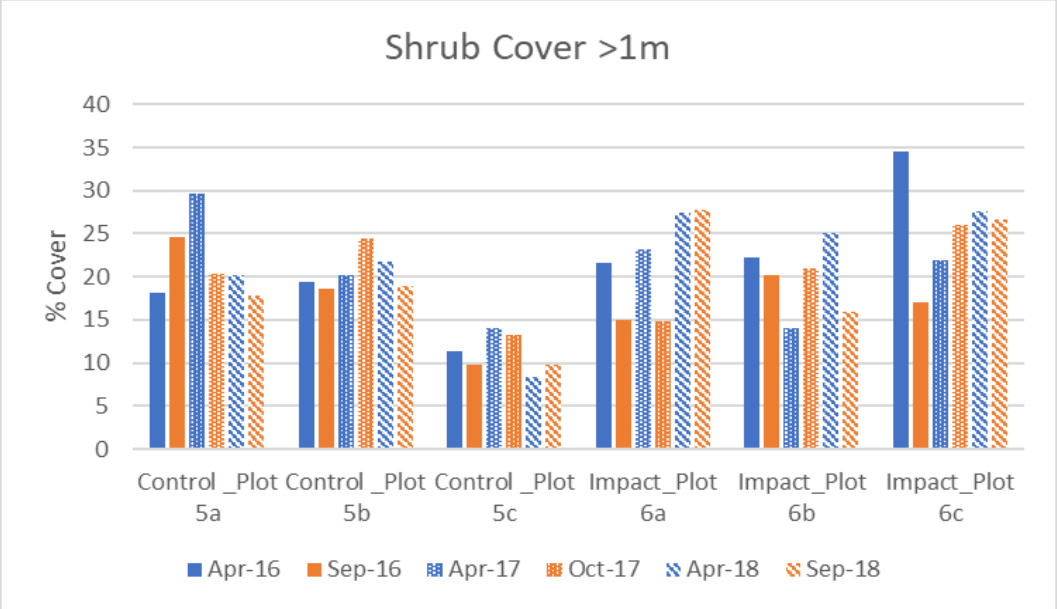


Figure 8. Projected shrub cover for stems > 1m tall.

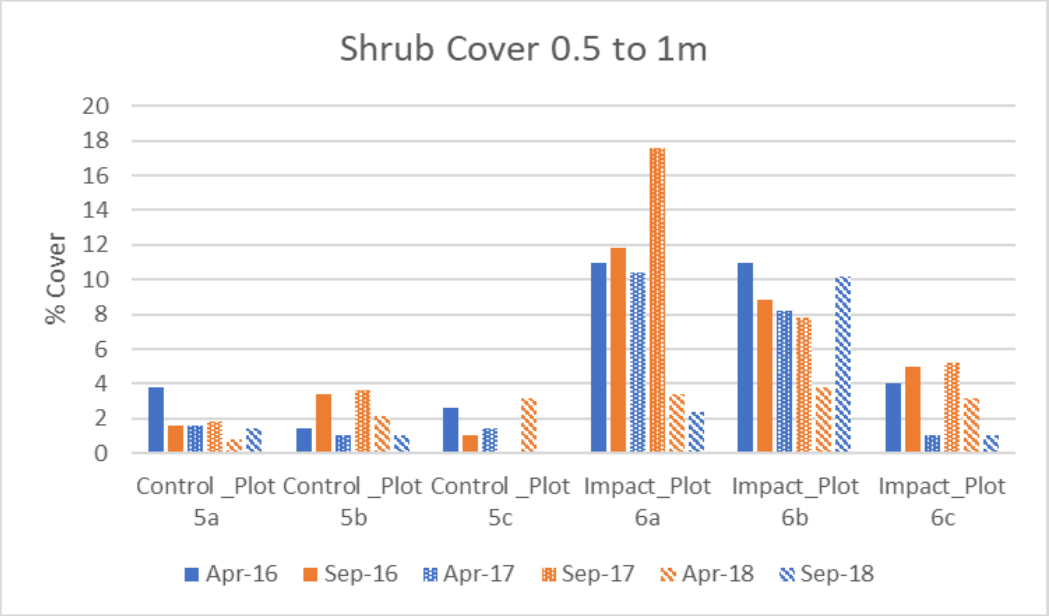


Figure 9. Projected cover for shrubs >0.5m and <1m.

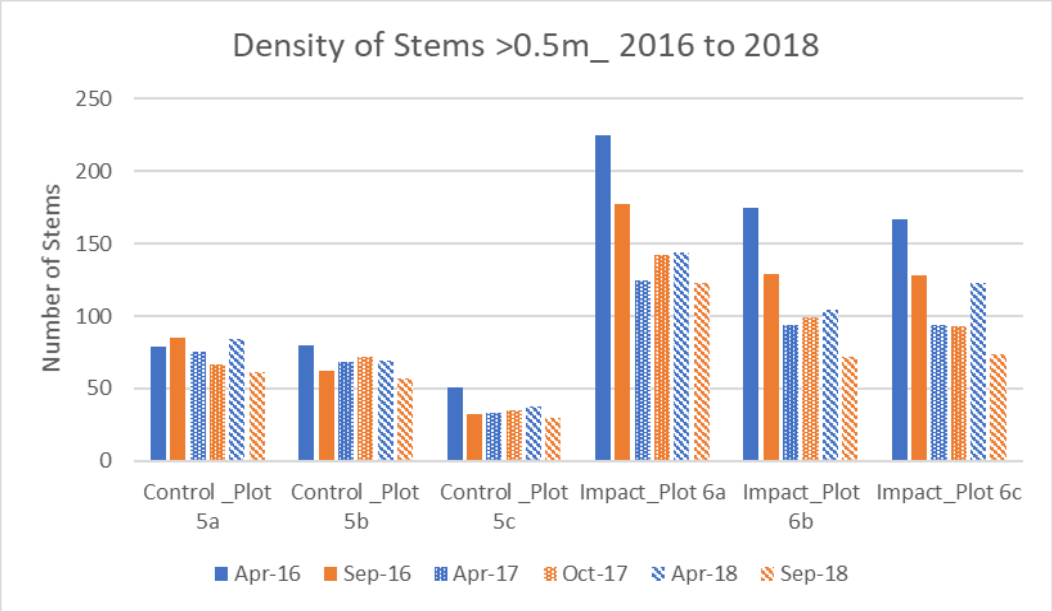


Figure 10. Shrub stem density at impact and control sites.

3.4 Composition and Nature of Groundcovers

The vegetation at both impact and control sites exists in largely natural condition, lacking any significant elements of degradation that may be prompted through changes to hydrological regime, land disturbance and pervasive invasion of exotic species. It is thus considered that control and impact sites are readily comparable. Soil moisture data (see **Section 3.1.2**) does however suggest that the upper soil profile of the control site drains and dries more rapidly after rainfall than the impact site with shorter periods of saturation. These minor hydrological differences in the upper soil profile would be expected to impart subtle differences in vegetation composition between sites, particularly in the shallow rooted groundcover layers which would be most exposed to drying in the upper soil profile. **Sections 3.4.1** to **Section 3.4.6** provides an analysis of the composition, structure and floristic trends of groundcover

components of the monitoring site. A statistical summary is provided in **Table 2** for all survey localities and contribution to total cover of various lifeforms over the 2016, 2017 and 2018 survey periods.

3.4.1 Native perennial grass / sedge / rush cover

The cover of living grass, sedge and rushes has changed subtly over a number of assessment periods (see **Figure 11)** indicating that the dominant rush species *Sporodanthus interruptus, Caustis recurvata* and *Baloskion tenuiculme* are relatively resilient despite an extended dry period spanning the 2016, 2017 and 2018 assessment periods. Levene's test indicates equal variance in sedge/ rush cover values over the three survey periods. Repeat Measures ANOVA applied to data for the 2016, 2017 and 2018 survey events suggests that the minor differences in cover detected between survey plots over time at both control and impact sites, are not significant and would be expected in line with natural variation ($F_{5,25}$ = 1.38, P = 0.264) (see **Appendix C**),.

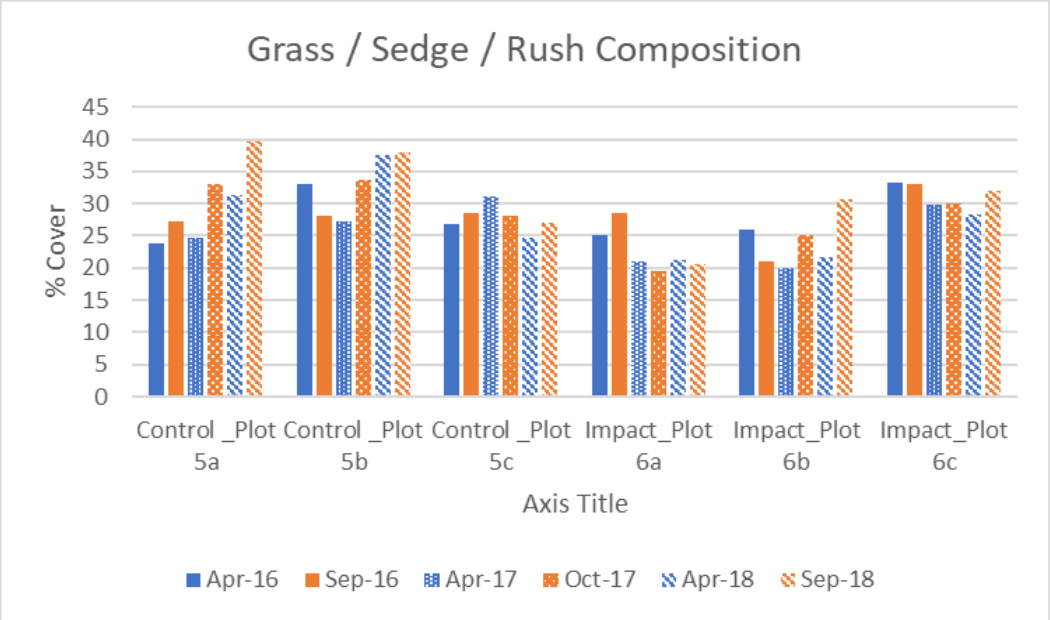


Figure 11. Cover of native grass/ sedge/ rush with comparison between survey events.

3.4.2 Groundcover shrubs

Minor variations in the abundance of native shrubs in the groundcover (i.e <0.5m) are detected between survey events for all plots. From **Figure 12**, the highest cover of shrubs in the ground cover layer recorded in the 2016 survey event with a decline in 2017 followed by a relative plateau recorded in the 2018 monitoring effort.. Application of Levene's Test indicates that Variance between sites is equal. A Repeat Measures ANOVA applied to the impact site (Site 6) suggests that the observed reduction in shrub cover measured between the 2016 and 2018 surveys events is statistically significant ($F_{5,10}$ =6.47, P = 0.006) although the changes are not considered statistically significant at the control site ($F_{3,6}$ =2.24, P = 0.13) (**Appendix C**).

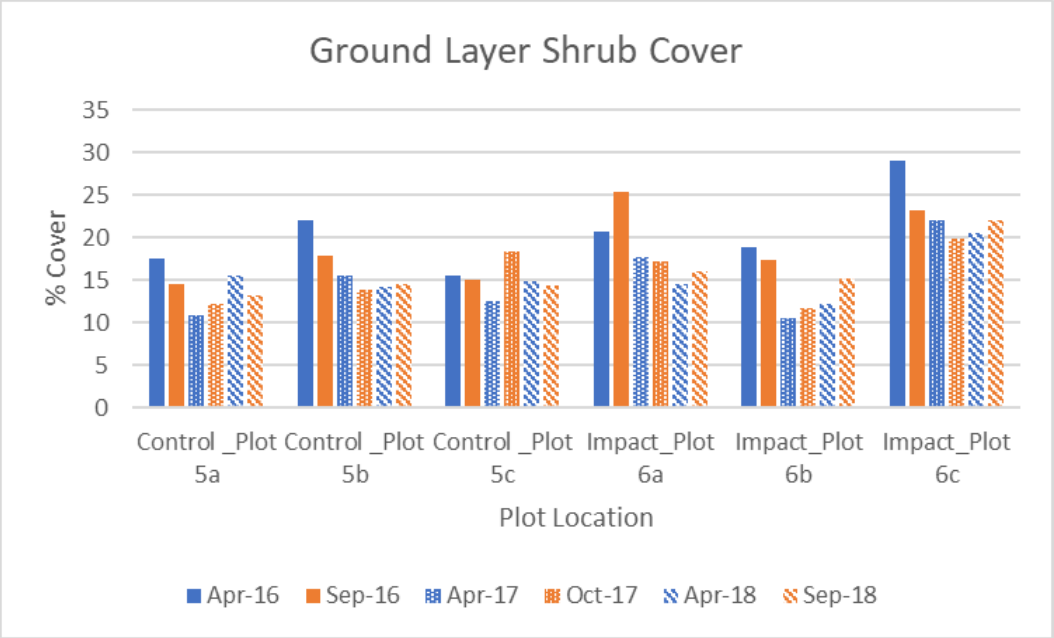


Figure 12. Composition of groundcover shrubs with a comparison made between survey events.

3.4.3 Groundcover forbs

Groundcover forbs form a relatively small proportion of the total groundcover. Due to a general preference for mesic conditions, it is expected that forb diversity and cover will often be highly sensitive to droughting and will vary markedly according to seasonal conditions. **Figure 13** shows the highest cover of forbs in all sites was recorded in the 2016 survey event which followed an extremely wet year in 2015. Forb cover in subsequent survey events has been lower although variable within a reasonably consistent range of values. A Levene's test applied to both April and September 2018 data indicates forb cover Variance is equal across all sites while a Repeat Measures ANOVA indicates that the measured variation in forb cover between survey events for all sites is not significant ($F_{5,25}$ = 2.19, P=0.086). There is considerable variation in the diversity and composition of forbs between survey event however and this is discussed further in **Section 3.4.6**.

3.4.4 Grasstree cover

There is considerable variation in grasstree cover between sites as well as variation between survey events. It is however difficult to identify any firm trends and the variability in grass tree cover values appears independent of site locality and seasonal survey effort (see **Figure 14**). Application of a Levene's test indicates that Variance in grasstree cover values is the equal across all site localities (see **Appendix C**) whilst a Repeat Measures ANOVA suggests that the variation in grasstree cover between seasonal survey efforts spanning the 2016, 2017 and 2018 survey periods is statistically significant. This suggests that the extent of grasstree cover is responding to seasonal conditions ($F_{5,25}$ =4.95, P=0.003).

Table 2. Summary of groundcover contribution by various lifeforms over the 2016 and 2017 survey periods.

Plot Location / Survey Event	Forb % Cover	Sedge / Rush/ Grass % Cover	Shrub % Cover	Grasstree % Cover	Bare % Cover	Leaf % Cover	Exotics % Cover	Total % Cover
Plot 5a_April 2018	0.3	31.35	15.55	27	2.1	23.7	0	100
Plot 5a_September 2018	1.15	39.8	13.1	17.5	4.85	23.6	0	100
Plot 5a_April 2017	0.15	24.75	10.81	25.5	1.5	37.29	0	100
Plot 5a_October 2017	0.4	34	12.25	15	1.95	36.4	0	100
Plot 5a_April 2016	0.6	27.35	17.4	26	0.35	28.3	0	100
Plot 5a_September 2016	1.15	27.2	14.45	17.5	2.6	37.1	0	100
Plot 5b_April 2018	0.7	37.65	14.2	11	2	34.45	0	100
Plot 5b_September 2018	0.85	38	14.45	11.25	4.5	30.95	0	100
Plot 5b_April 2017	0.4	29.1	15.45	10.7	1.25	43.1	0	100
Plot 5b_October 2017	0.2	33.7	13.8	7	4.5	40.6	0.2	100
Plot 5b_April 2016	0.35	45.05	22	5.5	4	23	0.1	100
Plot 5b_September 2016	1.2	28.55	17.85	6.75	4.25	40.65	0.75	100
Plot 5c_April 2018	0.8	24.65	14.85	24	0	35.7	0	100
Plot 5c_September 2018	0.2	27	14.4	23.5	2.5	32.3	0.1	100
Plot 5c_April 2017	1.05	31.1	12.5	28	0	27.35	0	100
Plot 5c_October 2017	0.7	28	18.3	10.7	1.5	40.7	0.1	100
Plot 5c_April 2016	2	28.5	15.5	21.25	0.5	32.25	0	100
Plot 5c_September 2016	1.2	28.45	15.05	24	1.2	30.05	0.05	100
Plot 6a_April 2018	1.1	21.2	14.45	29.75	0	33.5	0	100
Plot 6a_September 2018	1	20.5	16	31	0	32	0	100
Plot 6a_April 2017	0.65	23	17.75	23.5	0	35.1	0	100
Plot 6a_October 2017	1.5	19.45	17.2	19.5	1	41.35	0	100
Plot 6a_April 2016	2.9	25.06	20.71	17.51	0	33.82	0	100
Plot 6a_September 2016	1.8	26.05	25.3	19.5	0.2	27.15	0	100
Plot 6b_April 2018	1.25	21.7	31.35	30	1.25	33.7	0	100
Plot 6b_September 2018	1.75	30.65	24.1	22	3.25	27.25	0	100
Plot 6b_April 2017	0.85	29.8	22.05	16.5	0	30.65	0.15	100

Plot Location / Survey Event	Forb % Cover	Sedge / Rush/ Grass % Cover	Shrub % Cover	Grasstree % Cover	Bare % Cover	Leaf % Cover	Exotics % Cover	Total % Cover
Plot 6b_October 2017	1.2	30	19.8	14.5	0.75	33.75	0	100
Plot 6b_April 2016	1.51	27.05	18.36	26	0	27.08	0	100
Plot 6b_September 2016	2.3	21.3	17.35	16	0.5	42.55	0	100
Plot 6c_April 2018	1.3	28.35	20.5	31.35	0.5	18	0	100
Plot 6c_September 2018	0.95	31.95	22	24.1	3.5	17.5	0	100
Plot 6c_April 2017	0.85	29.8	22.05	16.5	0	30.8	0	100
Plot 6c_October 2017	1.2	30	19.8	14.5	0.75	33.75	0	100
Plot 6c_April 2016	0.85	33.15	37.15	9.5	0.25	19.1	0	100
Plot 6c_September 2016	1.8	33.1	21.2	13	0.2	30.6	0.1	100

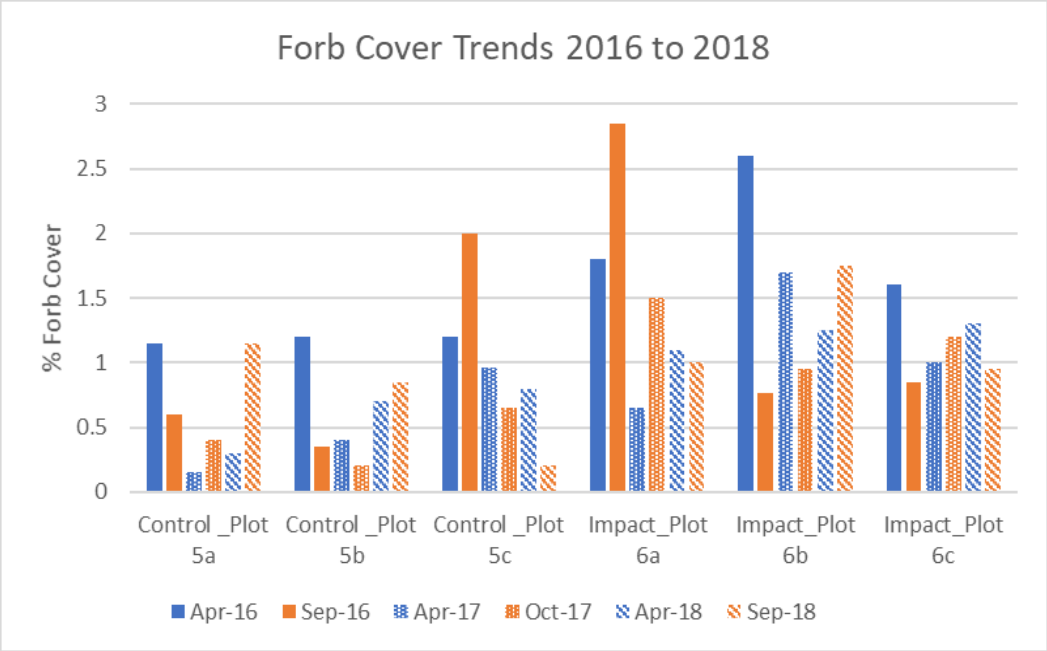


Figure 13. Comparison between native forb groundcovers for impact and control monitoring sites.

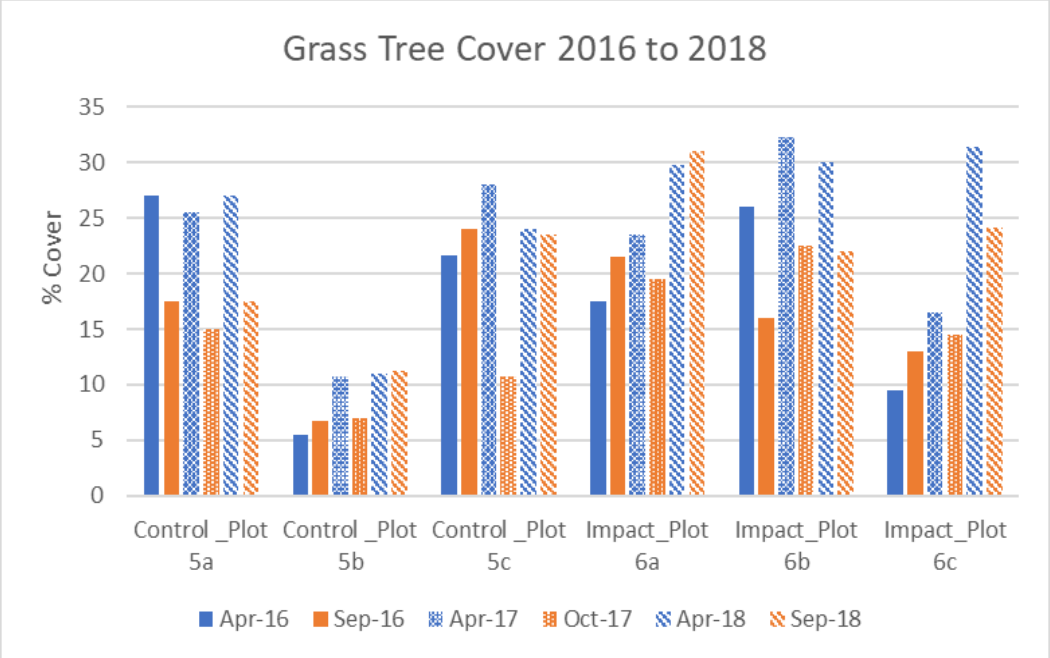


Figure 14. Xanthorrhoea cover comparisons for impact and control sites and survey events.

3.4.5 Living groundcover and leaf litter

Total living groundcover represents the portion of the groundcover that is living with capacity for photosynthesis. Living groundcover values are balanced by leaf litter and small patches of bare ground (humic sand) which form a minor cover component at some sites (as per **Figure 15**). Total living groundcover can be used as a measure of the health or vigour of a vegetation community at a given point in time. The proportion (%) of living groundcover compared to leaf litter and bare ground for impact (Site 6) and control (Site 5) sites is provided in **Figure 15** and **Figure 16** respectively. Conitinuing ongoing trends observed during previous assessment periods, subtle variations occur between survey events at all survey localities although it is difficult to identify any strong links to seasonality or differences between impact and control sites.

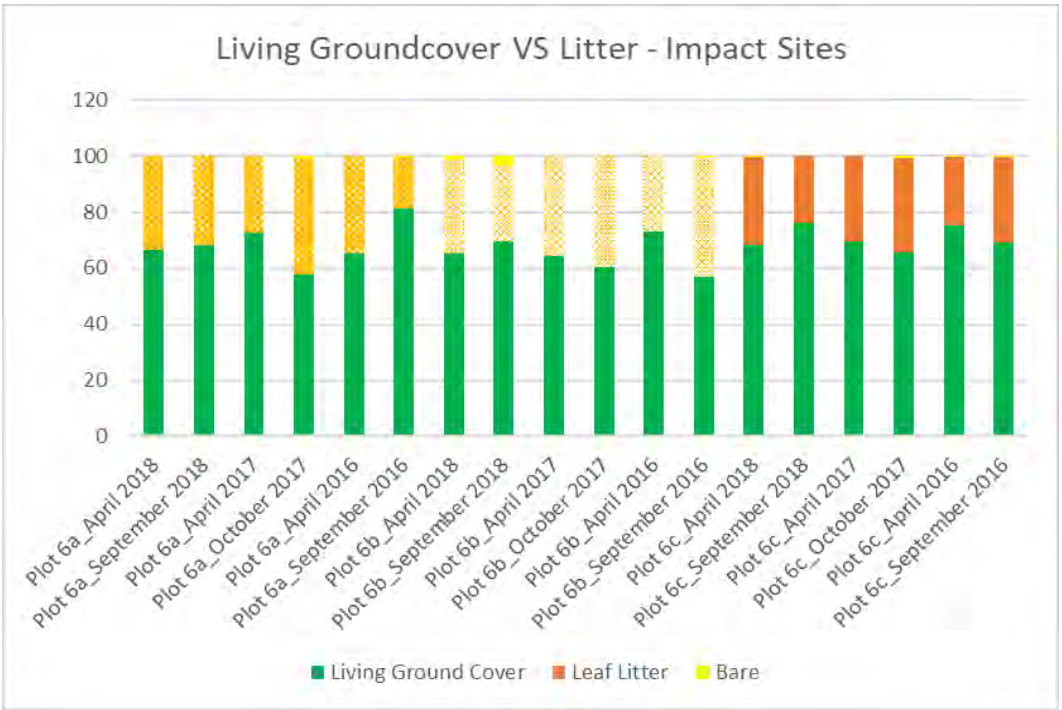


Figure 15. Total living groundcover values for all impact sites (Site 6) with comparison between survey events.

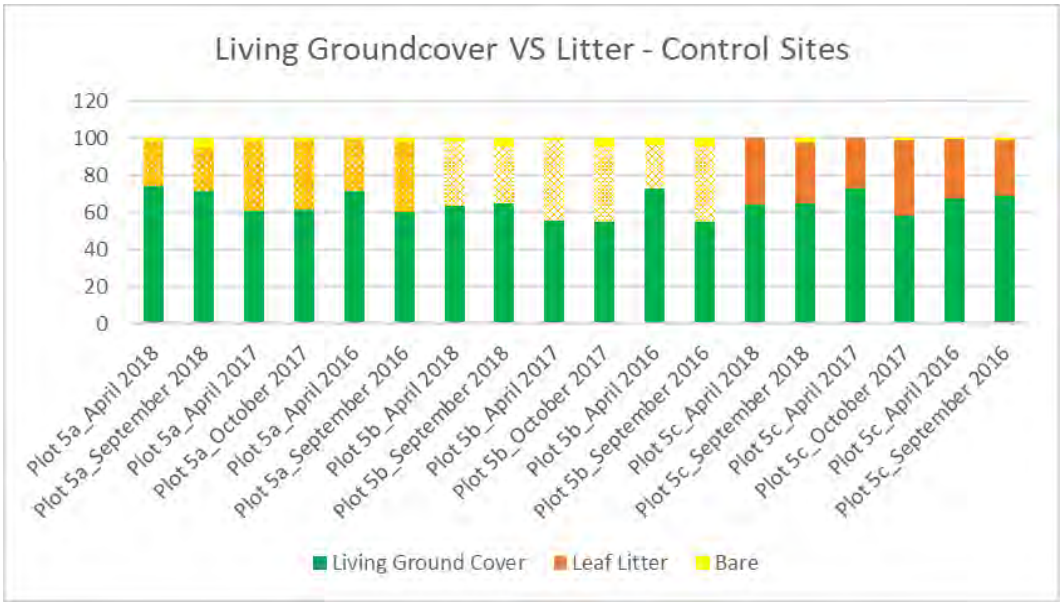


Figure 16. Total living groundcover values for all control sites (Site 5) with comparison between survey events.

3.4.6 Species richness

Species richness has been calculated through combination of seasonal data for the 2016, 2017 and most recent 2018 assessment periods. For all sites, the highest species diversity was recorded in the September 2016 survey event (see **Figure 17** and **Figure 18**). Species diversity suffered a dramatic decline in April 2017 survey although this decline had largely stabilised throughout the 2018 survey period. As noted during the 2017 survey event, the decline in species diversity recorded between September 2016 and April 2017 was typically in the range of 20 to 25% with a total of 43 species recorded in Survey Plot 6c (the most floristically diverse survey plot) in the September 2016 survey period, dropping to 32 species recorded in the April 2017 survey. In the 2018 survery period, the

species diversity of Site 6c was 26 species indicating that ongoing declines are still occurring in some survey localities. However at most sites, species declines in the 2018 survey event are much more subtle. The decline in species diversity is attributed to a decrease in nearly all life forms including forbs, shrubs and sedges. The decrease in species diversity recorded between survey events is statistically significant for both the impact and control sites when Repeat Measures ANOVA is applied ($F_{17, 102}$ = 3.78, P = 0.00 for impact sites, $F_{17, 102}$ = 3.44, P = 0.00 for control sites) (see **Appendix C**). A list of species recorded during the 2016, 2017 and 2018 survey periods attributed to individual survey plots is provided in **Appendix B**.

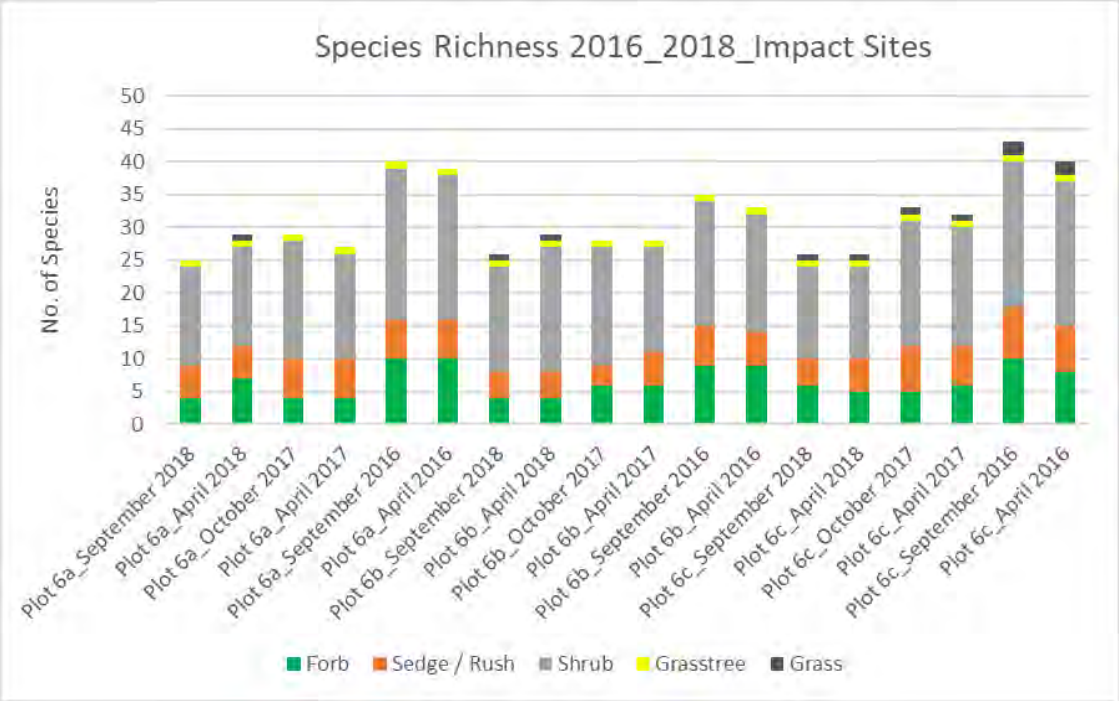


Figure 17. Species richness per life form and overall species richness for impact plots.

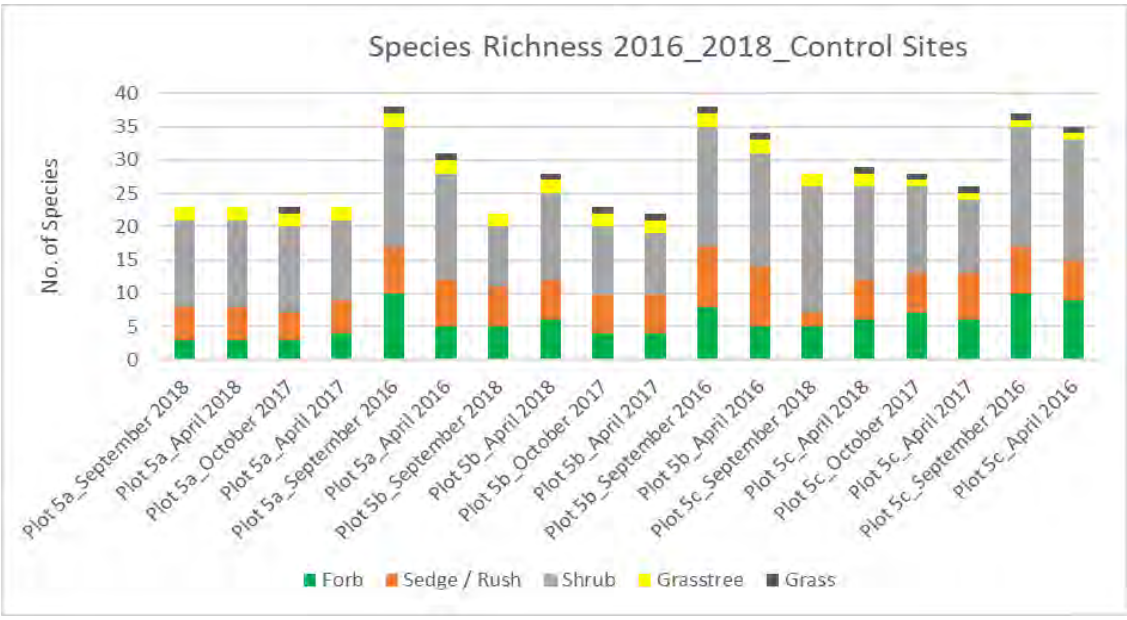


Figure 18. Species richness per life form and overall species richness for all survey plots .

4.0 Discussion and Summary

This is the fourth year of vegetation monitoring assessment undertaken at the Banksia Beach Borefied. .and the third to be undertaken by 3d Environmental on behalf of Seqwater. Spanning the four years of assessment, the major structural trends identified in the heathland monitoring sites include :

1. A strong increase in floristic diversity noted in the 2016 survey event when compared to 2015. This coincided with a very wet 2015 where 1538mm fell at the AWS Bribie NP compared to a long term average rainfall of 1406mm.

2. A subsequent strong decrease in floristic diversity is noted in the 2017 surveys coinciding with below average rainfall recorded in 2016 and 2017 survey periods (1158mm and 930mm of rainfall falling respectively). Floristic diversity in 2018 was relatively stable following slightly below average rainfall (1293mm) falling during the assessment period.

3. A statistically significant decrease in the density of shrubs in the >0.5m size class has been ongoing over multiple assessment periods at both impact and control sites.

4. A statistically significant reduction in the cover of groundcover shrubs has been occurring over multiple assessment periods at the impact site (Site 6). Although there is some evidence that shrub densiites are decreasing at the control site, the reduction in groundcover shrub values is not considered statistically significant.

There is also considerable variability across a range of measured structural and floristic parameters including sedge and rush cover, grasstree and forb cover. This variability occurs between individual sites as well as between seasonal survey efforts and often shows little consistency and is considered an intrinsic feature of coastal heathland habitats which respond in a complex manner to varying stimuli including rainfall, fire and their interaction with the soil seed bank.

As discussed in **Section 3.4.6,** there are statistically significant changes in species richness occurring between seasonal survey efforts. Statistically significant changes are identified in shrub ($F_{5, 25} = 7.52$, $P = 0.00$), forb ($F_{5, 25} = 7.79$, $P = 0.011$) and sedges and rushes ($F_{5, 25} = 4.55$, $P = 0.004$). It was suggested in the 2017 monitoring assessment report that as floristic diversity was decreasing across a range of lifeforms, there may be more entrenched changes in species composition occurring than can be explained by the transitory influence of sporadic rainfall or changes to soil moisture content. Consistent with this observation, it is considered that the compounding influences of varying seasonal rainfall, drought, plus long term absence of fire from the heathland habitat are likely to be influencing floristic diversity.

Rainfall and Soil Moisture: There are some differences in the behaviour of the shallow soil moisture profile emerging between the impact and control sites. Saturation of the shallow soil profile (i.e 15cm and 35cm depth) appears more sustained at the impact site (northern SMP) while at the control (southern SMP), drainage and drying occurs more rapidly and the upper soil profile exhibits prolonged periods of relative dryness. At both sites, permanent saturation is recorded at 95cm which is considered to represent the water table while the capillary fringe occurs between 65 and 95cm depth. In the Banksia Beach Borefield, it is likely to be the larger, deeper rooted shrubs that are permanently tapping groundwater sources. Forbs, sedges and rushes and the more delicate representations of shrubs are

likely to be exposed to fluctuations in soil moisture in the shallow soil profile and would therefore be much more sensitive to seasonal and annual drying cycles. Furthermore, the comparative dryness of the upper soil profile at the control site would render this location much more sensitive to fluctuations in rainfall than the impact site. The drier soil profile is considered to be a possible causal factor for the lower measured floristic diversity at the control site.

NDVI Data: The relationship between NDVI signature, vegetation structure and floristic diversity remains unclear. The incremental increase in NDVI signatures measures between the 2017 and 2018 assessment periods has no immediate explanation as it cannot be correlated readily to any change in floristic attributes. It can only be suggested that the measured NDVI value is responding to the 'greenness' or productivity of the living biomass, or possibly one particular species rather than the total living vegetative cover.

Summary: Ecological data collected over several survey periods spanning 2014 to 2018 indicates that the control (Site 5a to 5c) and impact sites (Site 6a to 6c) are broadly similar in structural and floristic attributes. As identified at the end of the 2017 assessment, the major structural differences are a significantly higher shrub cover and stem density for shrubs in the 0.5m to <1m size class at the impact site. The general trend toward a reduction in shrub cover in the lower size class at the impact site, coupled with a statistically significant decline in stem density over several survey periods has persisted into the current survey event.

The major trend identified at completion of the 2017 survey was a dramatic reduction in species diversity initiated during the 2016 survey event. The loss of diversity impacted forb, shrub and sedge / rush lifeforms with statistically significant reductions in species numbers recorded at both the impact and control sites. Despite average rainfall occurring during the 2018 survey period, there was no perceptible rebound in floristic diversity. As postulated in the 2017 vegetation monitoring report, it is considered that the compounding influences of a relatively dry climatic cycle, prolonged drying of the shallow soil profile, coupled with a long-term absence of fire are all influencing the structure and floristic diversity of coastal heathland in the Banksia Beach Borefield assessment area.

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6.0 Appendix

Appendix A - Monitoring Transects

Survey Locality 5a

Date of Assessment: 27 /04 / 2018.
Plot Size:50 m linear transect (Canopy Cover); 50 x 4m transect for S2 shrubs >0.5m; 10 x 1m x 1m quadrats for Ground Cover.
Location (Plot Centreline): *Start* -26.9942/ 153.158764; *Centre* –26.9942/ 153.1590571; *Finish* -26.9942/ 153.15932
Structure: Heath

Shrub Cover – Canopy Intercept (>50cm)** (summarised 50 m transect)
April 2018

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
2.5 – 3.6	*Persoonia virgata*	1.1	2		
5.0 – 5.4	*Boronia falcifolia*			0.4	0.6
9.0 – 11.3	*Persoonia virgata*	2.3	1.5		
13.4 – 13.9	*Persoonia virgata*	0.5	1.1		
14.8 – 16.0	*Persoonia virgata*	1.2	1		
36.8 – 38.1	*Persoonia virgata*	1.3	1.6		
38.6 – 39.0	*Persoonia virgata*	0.4	1.1		
40.3 – 41.6	*Persoonia virgata*	1.3	1.9		
42.1 – 43.6	*Persoonia virgata*	1.5	2.0		
47.0 – 47.5	*Persoonia virgata*	0.5	2.0		
Total Cover		**10.1**		**0.4**	
Average Height			**1.58**		**0.6**

* Projected over 100 m; ** Shrubs > 1m

September 2018

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
2.4 – 3.3	*Persoonia virgata*	0.9	2.2		
8.5 – 9.7	*Persoonia virgata*	1.2	2.2		
10.0 – 11.0	*Persoonia virgata*	1	1.5		
13.2 – 14.3	*Leucopogon leptospermoides*	1.1	1.5		
17.0 – 17.7	*Leptospermum semibaccatum*			0.7	0.6
23.6 – 24.7	*Leucopogon leptospermoides*	0.9	1.5		
37.0 – 37.8	*Persoonia virgata*	0.8	1.8		
41.2 – 42.4	*Persoonia virgata*	0.8	1.6		
43.0 – 43.6	*Persoonia virgata*	0.6	2.0		
44.8 – 45.7	*Persoonia virgata*	0.9	1.8		
47.3 – 48.0	*Persoonia virgata*	0.7	2.0		
Total Cover		**8.9**		**0.7**	
Average Height			**1.65**		**0.6**

* Projected over 100 m; ** Shrubs > 1m
* Projected over 100 m; ** Shrubs > 1m

Stem Counts (50 x 4) – Shrubs > 0.5m
April 2016

Species	50 m x 4 m Stems (50x4m) April 2018	50 m x 4 m Stems (50x4m) September 2018
	S2	
Persoonia virgata	54	39
Boronia falcifolia	1	
Leptospermum semibaccatum	8	5
Dilwynnia floribunda	1	
Agiortia pedicellata	5	4
Baeckea frutescens	3	
Leucopogon leptospermoides	9	11
*Pinus elliottii***	2	
Epacris pulchella		
Leptospermum polygalifolium	2	2
Melaleuca quinquenervia	1	
Totals	**84**	**61**

**projected count over 50 x 10m

Ground Cover %- 1 x 1m Sub-plots

April 2018

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean April 18
Native perennial grass / sedges	*Caustis recurvata*	15	10	5	10	10	5	40	10	15	15	**31.35**
	Sporodanthus interuptus	5	15	15	20	5	10	15	10	10	10	
	Lomandra elongata		5		2.5		5		2.5	10	2.5	
	Lomandra sp.											
	Baloskion tenuiculme	1		10	20	5						
Native forbs and other spp.	*Pimelea liniifolia*	1		0.5								**0.3**
	Cassytha glabella								0.5			
	Drosera binata	1										
Native shrubs ,<1m	*Leucopogon leptospermoides*				0.5	5	0.5	1	5		30	**15.55**
	Baeckea imbricata	0.5	5	0.5								
	Homoranthus virgatus											
	Baeckea frutescens				5			1		5		

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean April 18
	Strangea linearis		5		2.5			5		1	5	
	Epacris pulchella								1			
	Leptospermum semibaccatum					5		20	50			
	Agiortia pedicellata											
	Persoonia virgata											
	Dilwynnia floribunda										1	
	Ochrosperma lineare	1										
Grass Tree	*Xanthorrhoea fulva*	60	25	50		30	60	5		30	10	**27**
Cryptogams												
Bare Ground		5			5	5		5	1			**2.1**
Exotic Shrubs												
Leaf litter		10.5	35	19	34.5	35	19.5	8	20	29	26.5	**23.7**
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100%**

September 2018

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	
Native perennial grass / sedges	*Caustis recurvata*		18	10	15	25		30	10	10	30	**39.8**
	Sporodanthus interuptus	30	25	20	25	10	10	10	10	10	15	
	Lomandra elongata		2.5	15	2.5				5	15	15	
	Lomandra sp.											
	Baloskion tenuiculme		10			5	15			10		
Native forbs and other spp.	*Pimelea liniifolia*	5	1	1								**1.15**
	Cassytha glabella											
	Pattersonia sericea	2.5										
	Burchardia umbellata	1	1									
Native shrubs ,<1m	*Leucopogon leptospermoides*			0.5	0.5	5	10	1	10	5		**13.1**
	Baeckea imbricata	0.5										
	Homoranthus virgatus		2.5				2.5	2.5				
	Baeckea	5									2.5	

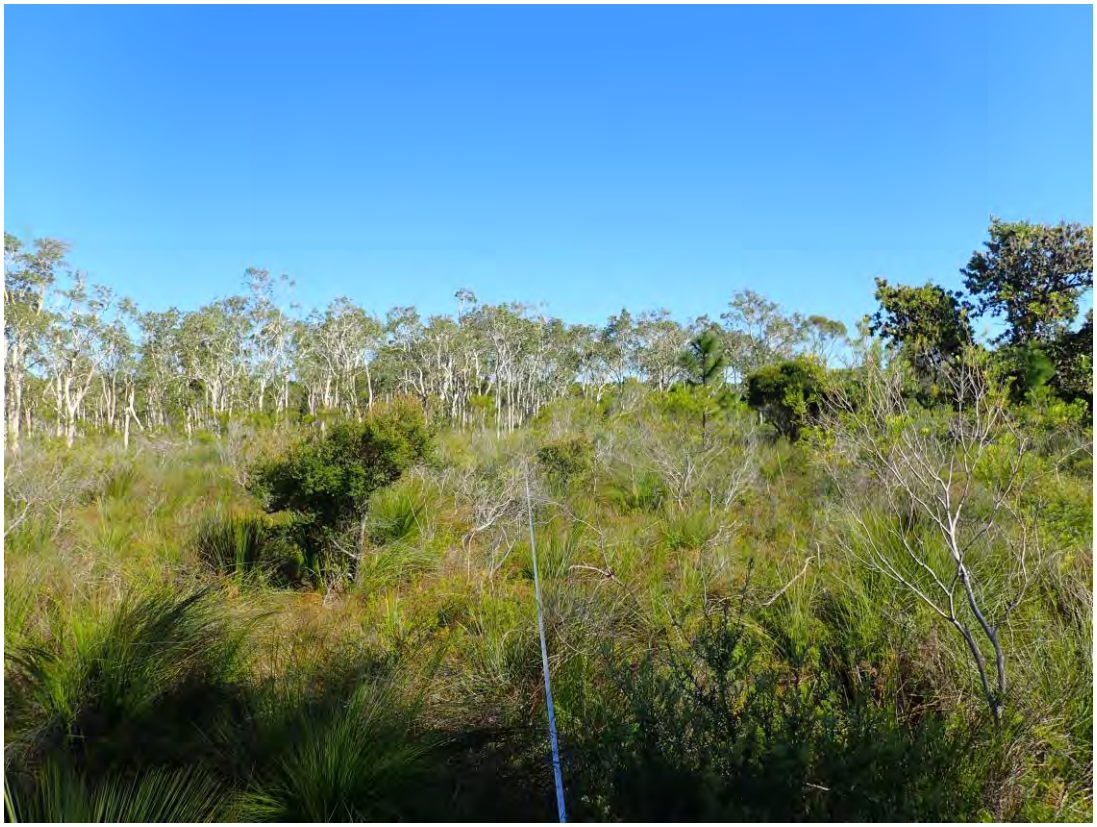
Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	
	frutescens											
	Strangea linearis	2.5		10	5			5				
	Epacris pulchella											
	Leptospermum semibaccatum		2,5		5	10	5	2.5	30			
	Ochrosperma lineare		2.5		2.5		1					
Grass Tree	*Xanthorrhoea fulva*	20	30	15	25	25	30	5		15	10	**17.5**
Cryptogams												
Bare Ground		3.5	5	10		5	10	5	5	5		**4.85**
Exotic Shrubs												
Leaf litter		30	10	18.5	19.5	15	16.5	39	30	30	27.5	**23.6**
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Additional Species (50 x 50m plot) recorded in April and September surveys: *Sprengelia sprengelioides, Epacris pulchella, Patersonia sericea, Aotus lanigera, Cassytha glabella, Boronia falciformis* (both April and September surveys).

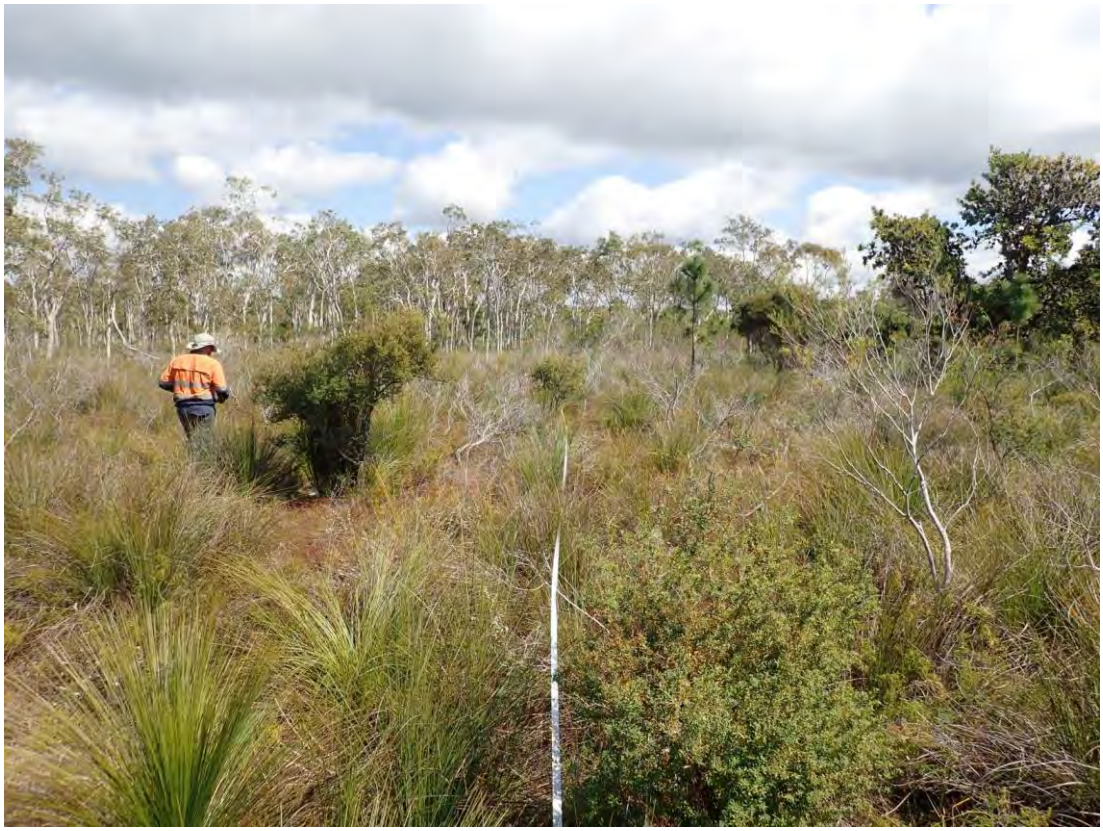
Structural / Floristic Summary

BioCondition Attribute		April 2018	September 2018
Native Plant Species Richness	Tree:		
	Shrub:	13	
	Grass Tree	1	
	Grass / Sedge / Rush	5	
	Forbs and other:	3	
Total Species No.**		**22**	
Native Shrubs	Projected Canopy Cover – Shrubs > 1m (%)	20.2	17.8
	Projected Canopy Cover – Shrubs >0.5 to <1m (%)	0.8	1.4
	Average Height >1m	1.58	1.65
Native Ground cover (%):	Native perennial grass / sedge cover (%):	31.35	39.8
	Native shrubs (%)	15.55	13.1
	Grass tree	27	17.5
	Organic litter cover (%):	23.7	23.6
	Native forb cover	0.3	1.15
Coarse woody debris:	Total length (m) of debris ≥ 10cm diameter and ≥0.5m in length per hectare	0	0
Non-native plant cover	Non-native Grasses	0	0
	Non-native shrubs	0	0

****Excludes Exotic Species**

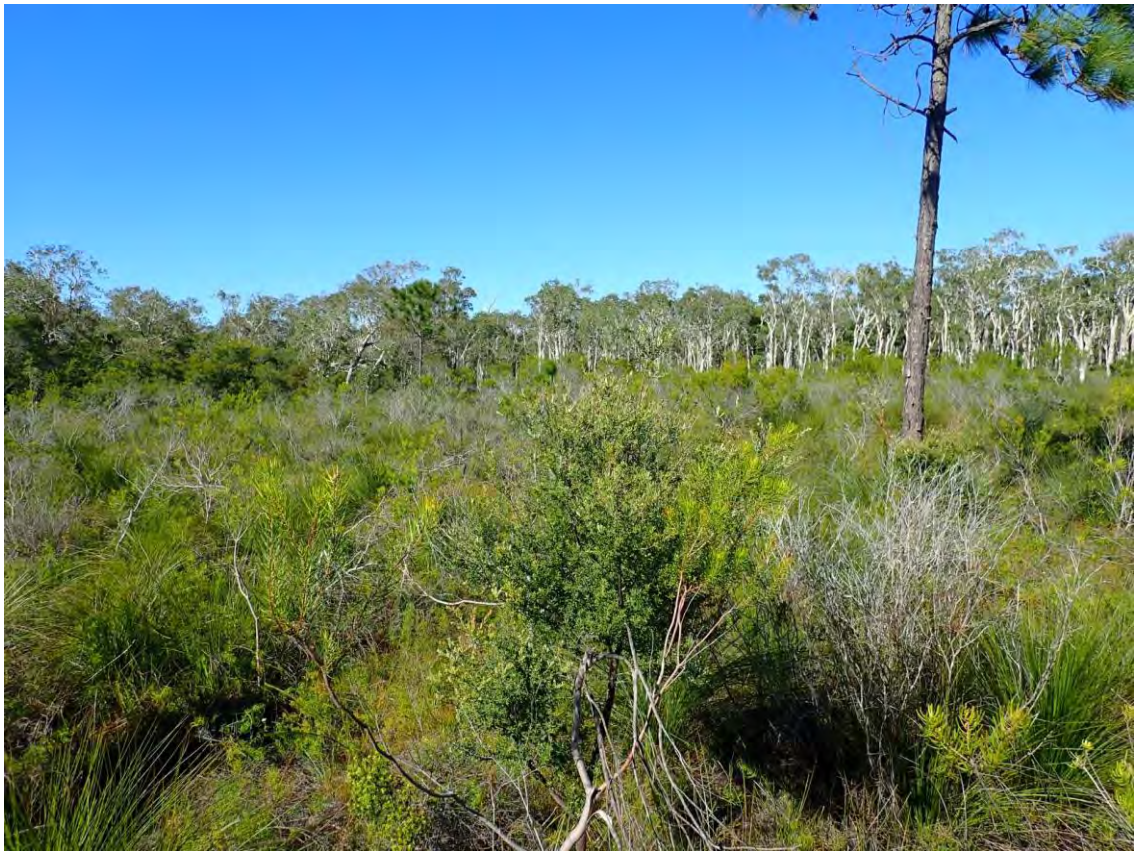


Plot 5a – Centre to Start; April 2018 (Above) and September 2018 (Below).



Plot 5 – Centre to End; April 2018 (above) and September 2018 (below).

Plot 5a – Centre to Left; April 2018 (Above) and September 2018 (Below).



Plot 5a – Centre to Right: April 2018 (Above) and September 2018 (Below).

Survey Locality 5b

Date of Assessment: 27.04.2018; 15:09.2018
Plot Size:50 m linear transect (Canopy Cover); 50 x 4m transect for S2 shrubs >0.5m; 10 x 1m x 1m quadrats for Ground Cover.
Location (Plot Centreline): *Start* -26.9943/ 153.1587965; *Centre -26.9944*/ 153.1589816; *Finish* -26.9944/ 153.1593191
Structure: Heath

Shrub Cover – Canopy Intercept (>50cm)** (summarised 50 m transect)

April 2018

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
3.3 – 4.3	*Persoonia virgata*	1	1.8		
7.3 – 9.2	*Persoonia virgata*	1.9	1.7		
15.9 – 16.8	*Persoonia virgata*	0.9	1.2		
21.7 – 23.2	*Persoonia virgata*	1.5	1.8		
23.4 - 24.8	*Persoonia virgata*	1.4	1.8		
30.1 – 30.3	*Leucopogon leptospermoides*			0.2	0.6
30.7 – 31.6	*Leptospermum semibaccatum*			0.9	0.6
33.8 – 35.0	*Persoonia virgata*	1.2	1.5		
36.2 – 38.0	*Persoonia virgata*	1.8	1.6		
43.3 – 44.8	*Persoonia virgata*	0.6	2.3		
45.0 – 45.6	*Strangea linearis*	0.6	2.2		
Total Cover		**10.9**		**1.1**	
Average Height			**1.76**		**0.6**

** Shrubs > 1m

September 2018

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
1.0 – 1.9	*Persoonia virgata*	0.9	1.5		
3.2 – 4.6	*Persoonia virgata*	1.4	1.8		
7.8 – 9.0	*Persoonia virgata*	1.2	1.6		
12.1 – 12.6	*Leucopogon leptospermoides*			0.5	0.8
16.0 – 16.3	*Persoonia virgata*	0.3	1.2		
22.0 – 23.0	*Persoonia virgata*	1	1.3		
34.3 – 35.2	*Persoonia virgata*	0.9	1.6		
36.6 – 38.0	*Persoonia virgata*	1.4	1.6		
43.5 – 45.0	*Persoonia virgata*	1.5	2.5		
45.3 – 46.2	*Persoonia virgata*	0.9	2.2		
Total Cover		**9.5**		**0.5**	
Average Height			**1.8**		**0.8**

** Shrubs > 1m

Stem Counts (50 x 4) – Shrubs > 0.5m

Species	50 m x 4 m Stems (50x4m) April 2018	50 m x 4 m Stems (50x4m) September 2018
	S2	**S2**
Persoonia virgata	44	48
Leucopogon leptospermoides	8	2
Ochrosperma lineare		
Boronia falcifolia		
Leptospermum semibaccatum	7	2
Sprengelia sprengelioides		
Strangea linearis	2	
Acacia flavescens	1	1
Epacris pulchella		
Agiortia pedicellata	3	1
Baeckea frutescens	3	1
Xanthorrhoea johnsoni (from top of trunk	1	1
Homoranthus virgatus		
Totals	**69**	**57**

**projected count over 50 x 10m

Ground Cover %- 1 x 1m Sub-plots

April 2018

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean April 17
Native perennial grass / sedges	*Caustis recurvata*	20	5	10	30	30	0	10	25	20	10	**37.65**
	Sporodanthus interruptus	25			2.5	10	10	10		20	40	
	Baloskion tenuiculme		20	10	15	5					5	
	Lomandra elongata		10		1		10					
	Lomandra sp.											
	Eriachne pallescens var. gracilis		2									
	Hypolaena fastigiata			1	5	2.5	2.5	2.5	5	2.5		
Native forbs and other spp.	*Pimelea liniifolia*					1						**0.7**
	Cassytha glabella											
	Pattersonia sericea											
	Drosera binata	1			1						1	
	Pseudanthus orientalis										1	
Native shrubs ,<1m	*Leucopogon leptospermoides*	10	2.5		2.5	1		10				**14.2**
	Strangea linearis					2.5		10	1		5	
	Epacris pulchella							1	1			
	Leptospermum semibaccatum			10	20	2.5	15	15	20	1		
	Dilwynnia floribunda	1	1		1					1		

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean April 17
	Baeckea frutescens	1	1				2.5			2.5		
Grass Tree	*Xanthorrhoea fulva*	20	10	30		20	10	5		10	5	**11**
Cryptogams												
Bare Ground			5	10	2.5		2.5					**2**
Exotic Shrubs	*Pinus elliottii***											
Leaf litter		21	43.5	29	19.5	26.5	46.5	36.5	47	43	33	**34.45**
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100%**

September 2018

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean April 17
Native perennial grass / sedges	*Caustis recurvata*	20	10	10	25	20	2.5	2.5	30	10		**38**
	Sporodanthus interruptus	10				10	10	25		20		
	Baloskion tenuiculme	25	25		20	10	10			15	20	
	Lomandra elongata		15	10	5	2.5			2.5			
	Eriachne pallescens var. gracilis											
	Hypolaena fastigiata			5		2.5		2.5	2.5	2.5		
Native forbs and other spp.	*Pimelea liniifolia*			1			1				1	**0.85**
	Pattersonia sericea		5									
	Pseudanthus orientalis										0.5	
Native shrubs ,<1m	*Leucopogon leptospermoides*	10			10							**14.45**
	Homoranthus virgatus			5	2.5				5			
	Ocrosperma lineare						1	1		2.5		
	Pseudanthus orientalis											
	Strangea linearis											
	Epacris pulchella											

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean April 17
	Leptospermum semibaccatum			10	2.5	5	20	20	15	2.5	10	
	Dilwynnia floribunda											
	Baeckea frutescens					10						
	Leptospermum polygalifolium									2.5		
Grass Tree	*Xanthorrhoea fulva*	25	10	20	5	20	20			2.5	10	**11.25**
Cryptogams												
Bare Ground		5	10		5		10	10	5			**4.5**
Exotic Shrubs	*Pinus elliottii***											
Leaf litter		5	25	39	25	20	25.5	39	40	42.5	48.5	**30.95**
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100%**

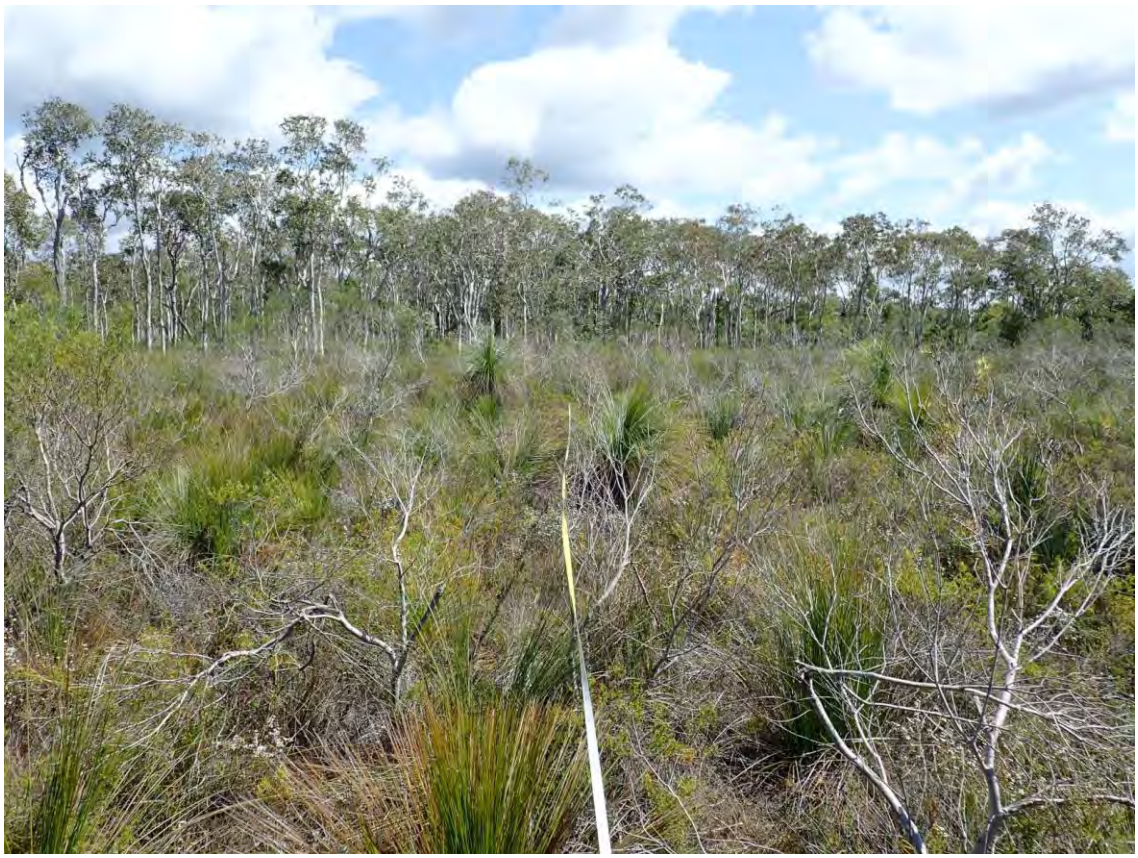
Additional Species: *Mirbelia rubifolia, Cassytha glabella, Pinus elliotii***

Structural / Floristic Summary

BioCondition Attribute		April 2018	September 2018
Native Plant Species Richness	Tree:		
	Shrub:	13	
	Grass Tree	2	
	Grass / Sedge	7	
	Forbs and other:	6	
Total Species No.**		**28**	
Native Shrubs	Projected Canopy Cover – Shrubs > 1m (%)	21.8	19
	Projected Canopy Cover – Shrubs >0.5 to <1m (%)	2.1	1.0
Native Ground cover (%):	Native perennial grass / sedge cover (%):	37.65	38
	Native shrubs (%)	14.2	14.45
	Grass tree	11.0	11,25
	Organic litter cover (%):	34.45	30.95
	Native forb cover (%)	0.7	0.85
Coarse woody debris:	Total length (m) of debris ≥ 10cm diameter and ≥0.5m in length per hectare	0	0
Non-native plant cover	Non-native Grasses	0	0
	Non-native shrubs	0	0

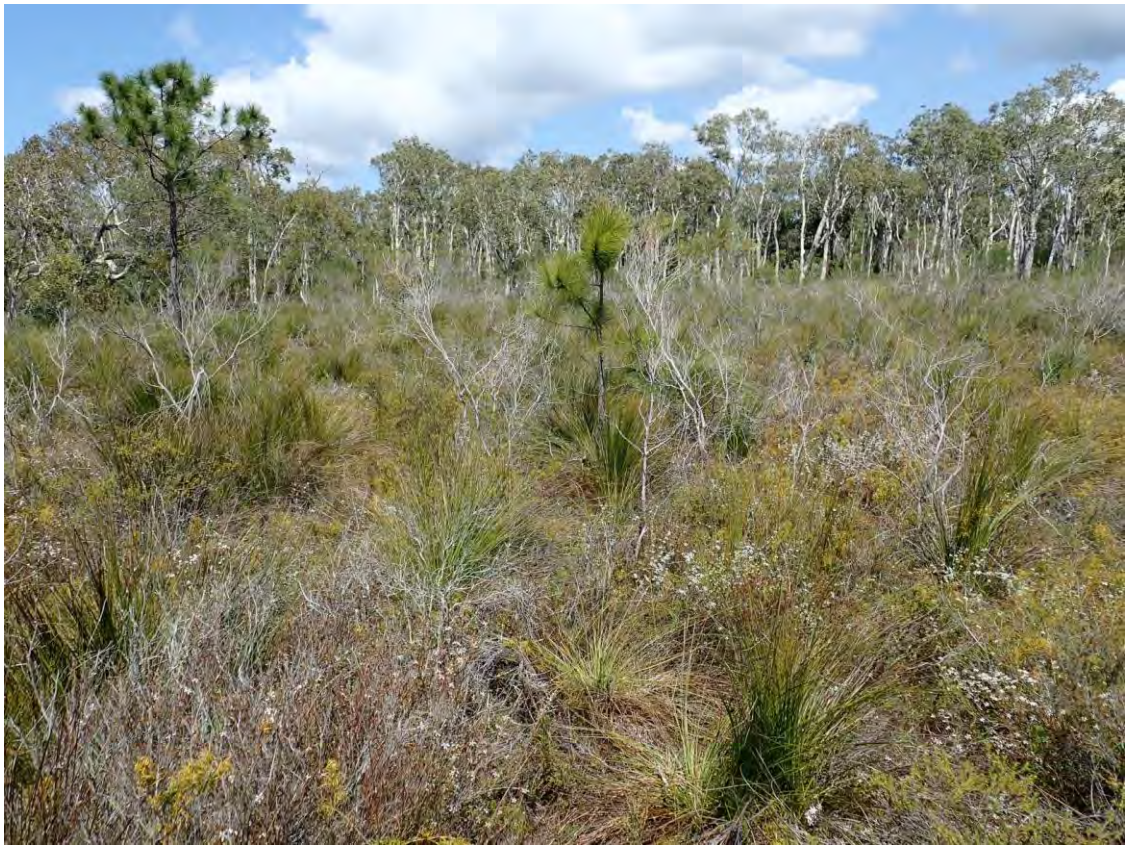
**** Excludes Exotic Species**

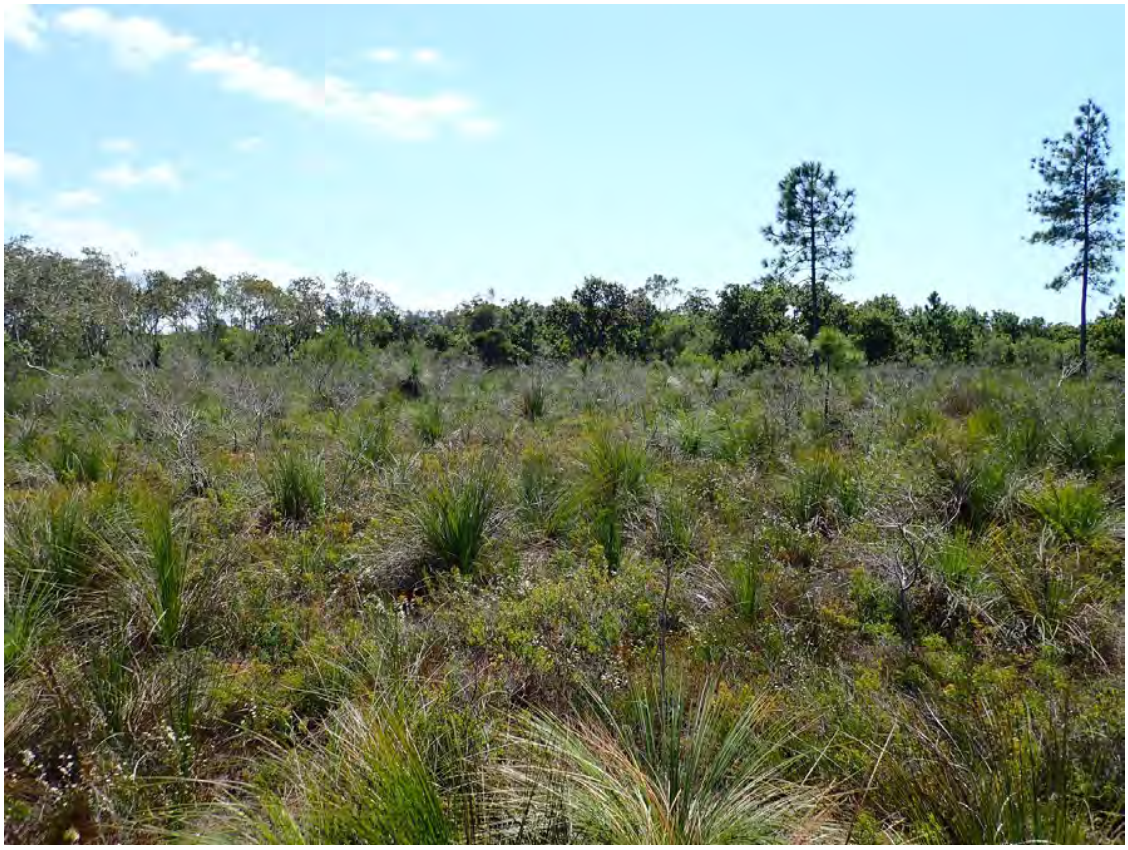
Plot 5b Centre to Start: April 2018 (left) and September 2018 (right).



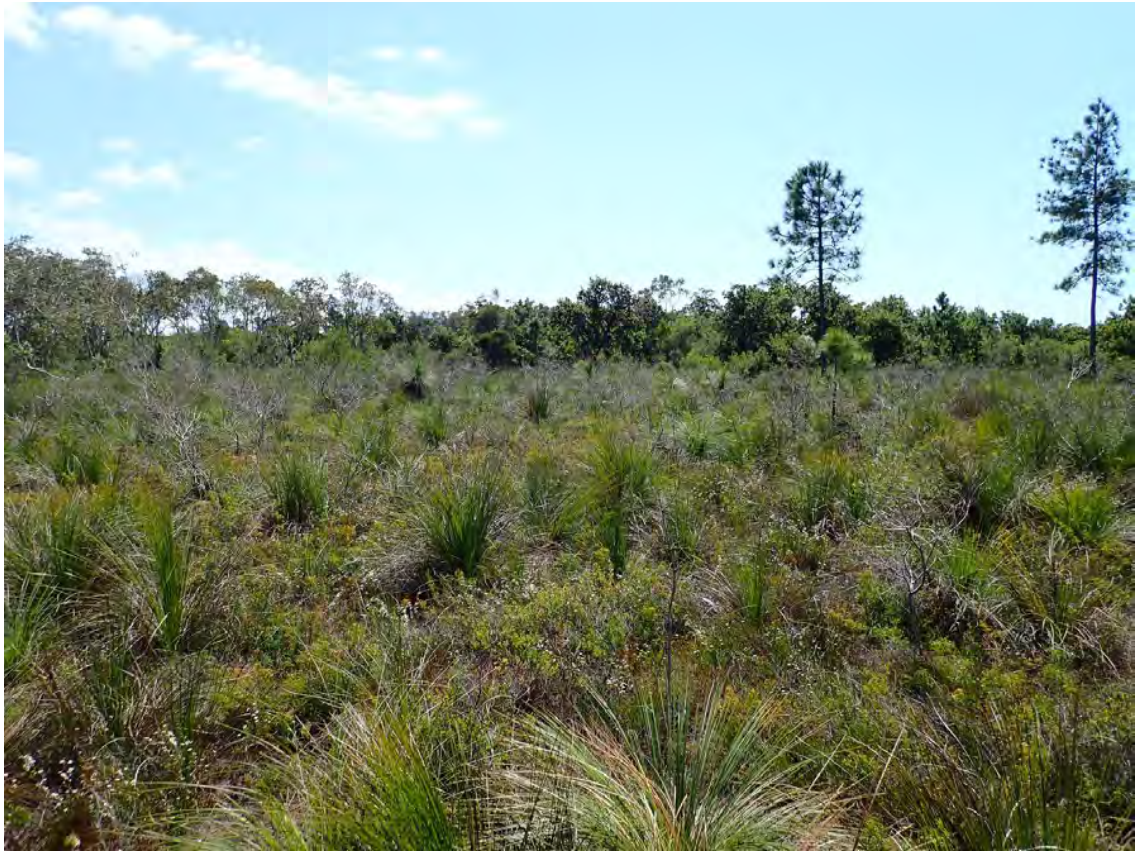
Plot 5b – Centre to End: April 2017 (Above) and October 2017 (Below).

Plot 5b – Centre to Right; April 2017 (left) and October 2017 (right).





Plot 5b – Centre to Left: April 2016 (Above) and September 2016 (Below).



Survey Locality 5c

Date of Assessment: 27.04.2018; 14:09.2018
Plot Size:50 m linear transect (Canopy Cover); 50 x 4m transect for S2 shrubs >0.5m; 10 x 1m x 1m quadrats for Ground Cover.
Location (Plot Centreline): *Start* -26.99467/ 153.15883; *Finish* -26.99447/ 153.15929
Structure: Heath

Shrub Cover – Canopy Intercept (>50cm)** (summarised 50 m transect)

April 2018

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
8.8 - 10	*Persoonia virgata*	1.2	1.8		
12.9 – 14.0	*Persoonia virgata*	1.1	1.8		
15.2 – 16.3	*Persoonia virgata*	1.1	1.3		
37.4 – 37.9	*Leptospermum polygalifolium*			0.5	0.6
38 – 38.6	*Leucopogon leptospermoides*			0.6	0.5
41.4 – 42.2	*Persoonia virgata*	0.8	2.2		
47.4 – 47.9	*Persoonia virgata*			0.5	0.6
Total Cover		**4.2**		**1.6**	
Average Height			**1.7**		**0.6**

*** Tree not included in cover calculation

September 2018

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
8.7 – 9.6	*Persoonia virgata*	0.9	1.1		
13.0 – 14.1	*Persoonia virgata*	1.1	1.6		
15.1 – 16.4	*Persoonia virgata*	1.3	1.6		
38.1 – 38.7	*Leucopogon leptospermoides*	0.6	1		
41.6 – 42.1	*Persoonia virgata*	0.5	2.2		
48.2 – 48.7	*Persoonia virgata*	0.5	1.6		
Total Cover		**4.9**			
Average Height			**1.5**		

*** Tree not included in cover calculation

Stem Counts (50 x 4) – Shrubs > 0.5m

Species	50 m x 4 m Stems (50x4m) April 2018	50 m x 4 m Stems (50x4m) September 2018
	S2	
Persoonia virgata	21	24
Leucopogon leptospermoides	7	3
Leptospermum semibaccatum	3	2
Dillwynia floribunda	3	
Strangea linearis		
Epacris pulchella		

Agiortia pedicellata	1	
Leptospermum polygalifolium	1	1
Baeckea frutescens	1	
Melaleuca pachyphyllus	1	
Totals	**38**	**30**

Ground Cover %- 1 x 1m Sub-plots

April 2018

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean April 16
Native perennial grass / sedges	*Caustis recurvata*			5	2.5	15	10	30	30	25	10	**24.65**
	Hypolaena fastigiata							1	1	1	1	
	Gahnia seiberiana		15									
	Sporodanthus interruptus		2.5	10	15	10	15	2.5	10		5	
	Baloskion tenuiculme											
	Lomandra elongata			15	1							
	Lomandra sp. (Strappy)											
	Eriachne pallescens var. gracilis	2.5		10		1	0.5					
Native forbs and other spp.	*Pimelea liniifolia*	1						0.5		1		**0.8**
	Cassytha glabella							1				
	Hibbertia salicifolia		2.5									
	Cryptostylis erecta											
	Drosera bipinnata			0.5		1						
	Stackhousia nuda											
	Pseudanthus orientalis							0.5				
Native shrubs ,<1m	*Leucopogon leptospermoides*			0.5	0.5		5	5		1	10	**14.85**
	Strangea linearis			2.5		5	1	1		2.5	2.5	

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean April 16
	Epacris pulchella						2.5					
	Leptospermum semibaccatum				2.5	10	2.5	30	10	10	20	
	Baeckea frutescens	15	5	2.5								
	Ochrosperma lineare				1							
	Leptospermum polygalifolium									1		
Grass Tree	*Xanthorhoea johnsonii*										15	**24**
	Xanthorrhoea fulva	30	40	10	30	20	40	15	20	20		
Cryptogams												
Bare Ground												
Exotic Shrubs	*Pinus elliottii***											
Leaf litter		51.5	35	44	47.5	38	23.5	13.5	29	38.5	36.5	**35.7**
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100%**

September 2018

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean Sept 18
Native perennial grass / sedges	*Caustis recurvata*			10	25	15		10	30	15		**27**
	Hypolaena fastigiata							5	2.5	5	5	
	Gahnia seiberiana		30									
	Sporodanthus interruptus	10	10	20	20	10	10	10		10	15	
	Baloskion tenuiculme						2.5					
Native forbs and other spp.	*Pimelea liniifolia*			1			1					**0.2**
	Cassytha glabella											
	Hibbertia salicifolia											
	Cryptostylis erecta											

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean Sept 18
	Drosera bipinnata											
	Stackhousia nuda											
Native shrubs ,<1m	*Leucopogon leptospermoides*			1		10			2.5		10	**14.4**
	Ochrosperma lineare			2.5								
	Strangea linearis					5	1		5			
	Epacris pulchella						2.5					
	Leptospermum semibaccatum			2.5		5	2.5	20	10	15	20	
	Baeckea frutescens	5	5									
	Homoranthus virgatus						1	5	10			
	Sprengelia sprengelioides						1					
	Boronia falcifolia							2.5				
Grass Tree	*Xanthorrhoea fulva*	60	40	20	30	20	15		5	25	20	**23.5**
Cryptogams												
Bare Ground						5		15	15			**3.5**
Exotic Shrubs	*Pinus elliottii***						1					**0.1**
Leaf litter		25	15	43	25	30	62.5	32.5	30	30	30	**32.3**
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100%**

Additional Species: *Baeckia imbricata, Austromyrtus dulcis, Blechnum cartilagineum, Banksia aemula, Melaleuca quinquenervia, Drosera binnata, Melaleuca pachycalyx, Epacris pulchella, Cassytha glabella, Conospermum taxifolium, Leptospermum polygalifolium, Pinus elliottii***

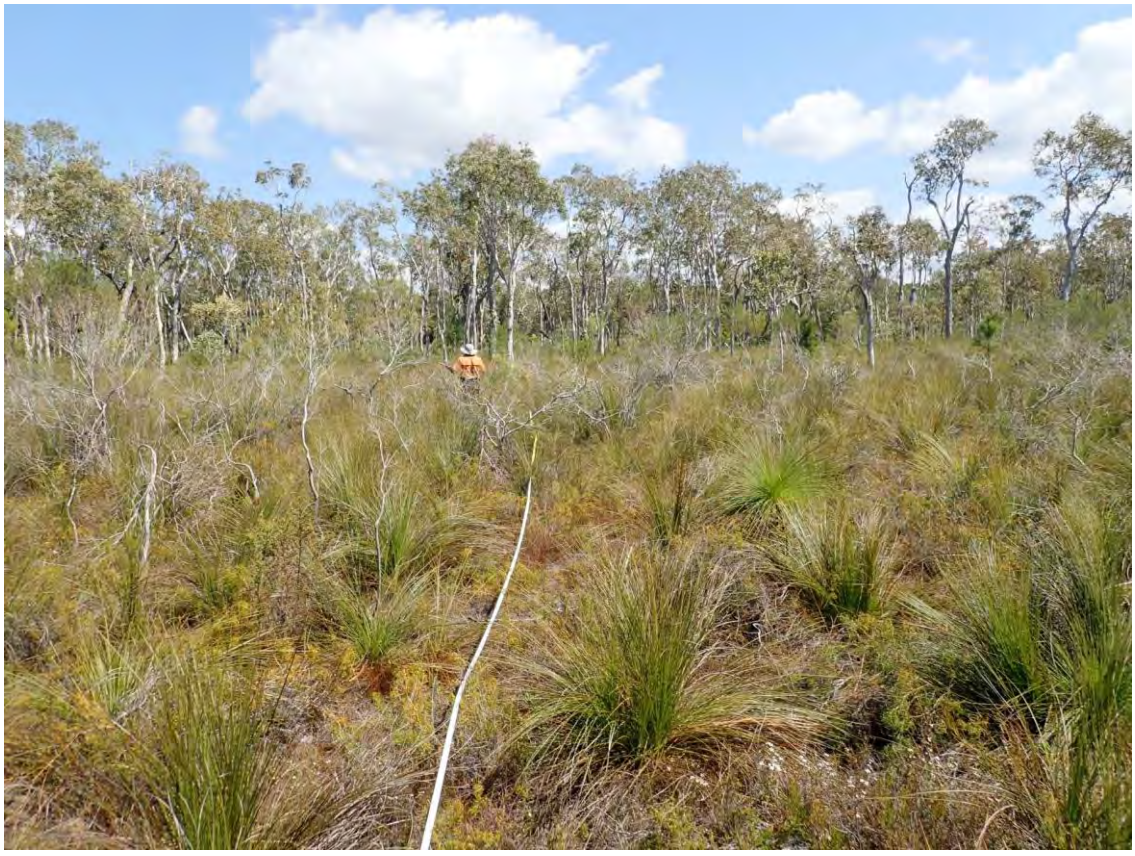
Structural / Floristic Summary

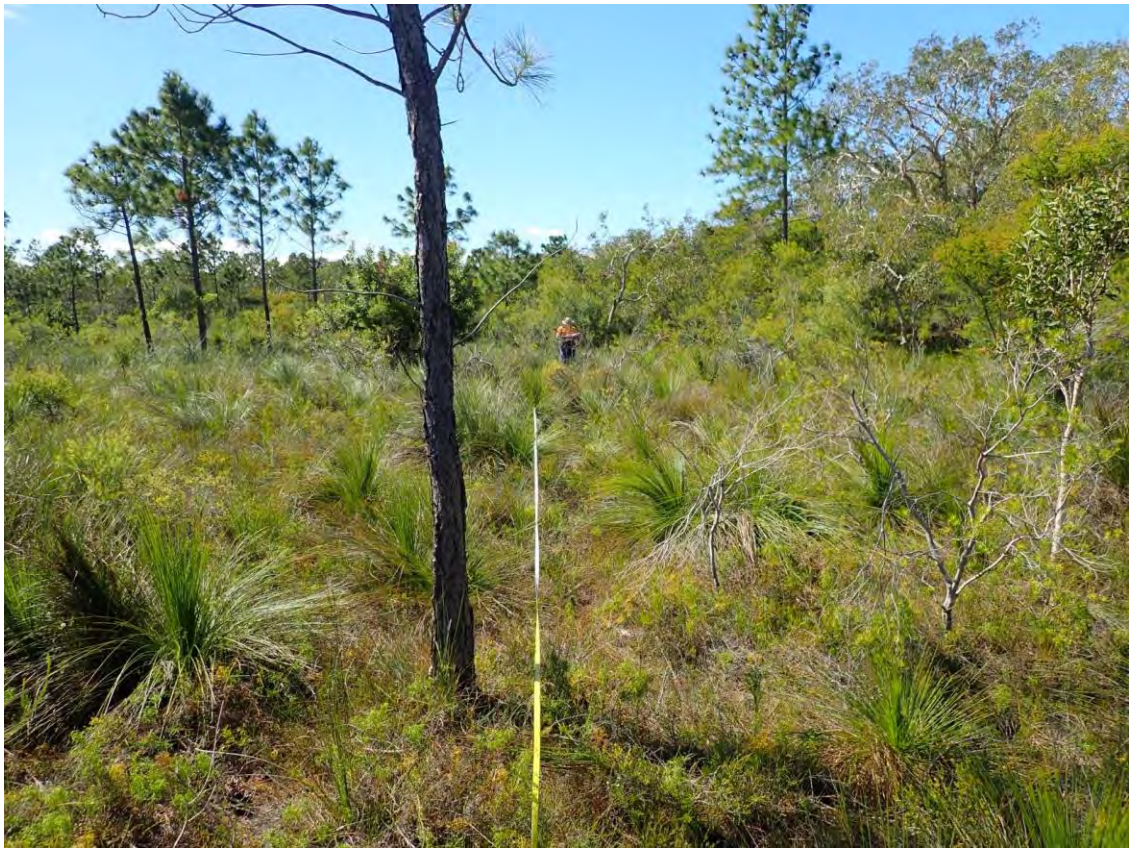
BioCondition Attribute		April 2018	September 2018
Native Plant Species Richness	Tree:	. .	
	Shrub:	19	
	Grass Tree	2	
	Grass / Sedge	7	
	Forbs and other:	6	
Total Species No.**		**34**	
Native Shrubs	Projected Canopy Cover – Shrubs > 1m (%)	8.4	9.8
	Projected Canopy Cover – Shrubs >0.5 to <1m (%)	3.2	0

BioCondition Attribute		April 2018	September 2018
Native Ground cover (%):	Native perennial grass / sedge cover (%):	24.65	27
	Native shrubs (%)	14.85	14.4
	Grass tree	24	23.5
	Organic litter cover (%):	35.7	32.3
	Native forb cover (%)	0.8	0.2
Coarse woody debris:	Total length (m) of debris ≥ 10cm diameter and ≥0.5m in length per hectare	0	0
Non-native plant cover	Non-native Grasses%	0	0
	Non-native shrubs %	0	0

**** Excludes Exotic Species**

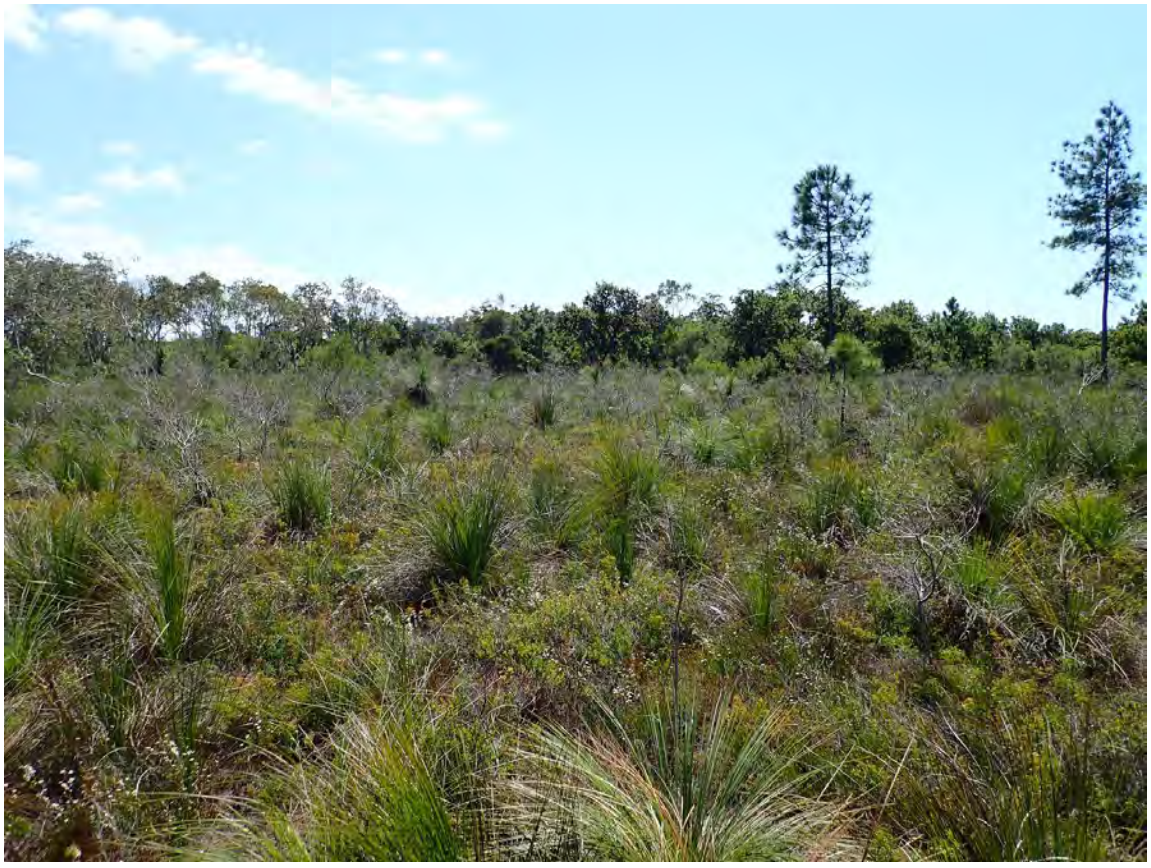
Plot 5c – Centre to Start: April 2017 (Above) and October 2017 (Below).





Plot 5c – Centre to End: April 2017 (Above) and October 2017 (Below).

Plot 5c – Centre to Right: April 2017 (Above) and October 2017 (Below).



Plot 5c – Centre to Left: April 2017 (Above) and October 2017 (Below).

Survey Locality 6a

Date of Assessment: 28.04.2018: 15:09.2018
Plot Size:50 m linear transect (Canopy Cover); 50 x 4m transect for S2 shrubs >0.5m; 10 x 1m x 1m quadrats for Ground Cover.
Location (Plot Centreline): *Start* -26.985 / 153.1540431; Centre -26.9849 / 153.1542562 *Finish* - 26.9847/ 153.1544874
Structure: Heath

Shrub Cover – Canopy Intercept (>50cm)** (summarised 50 m transect)

April 2018

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
3.4 – 5.5	*Banksia aemula*	2.1	2.4		
10.8 – 11.4	*Baeckea frutescens*	0.6	1		
12.0 – 13.0	*Baeckea frutescens*	1	1		
15.3 – 16.5	*Baeckea frutescens*	1.2	1		
17.7 – 18.8	*Banksia oblongifolia*			0.1	0.8
21.4 – 23.5	*Banksia oblongifolia*	2.1	1		
28.3 – 28.8	*Leptospermum liversedgeii*		1		
29.9 – 31.6	*Persoonia virgata*	1.7	1.8		
32.0 – 33.1	*Persoonia virgata*	1.1	2.3		
34.7 – 35.3	*Leptospermum liversedgeii*	0.6	1.4		
37.9 – 38.2	*Boronia falcifolia*			0.3	0.6
38.3 – 39.8	*Persoonia virgata*	1.5	1.8		
40.3 – 41.5	*Persoonia virgata*	1.2	1.8		
46.0 – 46.9	*Banksia oblongifolia*			0.9	0.9
48.4 – 48.8	*Leptospermum liversedgeii*			0.4	0.6
49.4 – 50.0	*Persoonia virgata*	0.6	1.6		
Total Cover		**13.7**		**1.7**	
Average Height			**1.5**		**0.7**

*** Tree not included in cover calculation

September 2018

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
3.5 – 5.6	*Banksia aemula*	2.1	3		
12.2 – 13.2	*Baeckea frutescens*	1	1		
15.4 – 16.6	*Baeckea frutescens*	1.2	1		
21.5 – 21.8	*Leptospermum liversedgeii*			0.5	0.8
22.8 – 24.4	*Banksia oblongifolia*	1.6	1		
27.6 – 28.3	*Banksia oblongifolia*			0.7	0.7
28.6 – 29.1	*Aotus lanigera*	0.5	1		
30.0 – 32.0	*Persoonia virgata*	2	1.6		
32.1 – 34.0	*Persoonia virgata*	1.9	2.8		
38.6 – 40.3	*Persoonia virgata*	1.7	2		
40.6 – 41.7	*Persoonia virgata*	1.1	2		
46.1 – 46.6	*Boronia falcifolia*	0.5	1		
49.6 – 50.0	*Persoonia virgata*	0.4	2		
Total Cover		**13.9**		**1.2**	
Average Height			**1.5**		**0.8**

Stem Counts (50 x 4) – Shrubs > 0.5m

Species	50 m x 4 m Stems (50x4m) April 2018	50 m x 4 m Stems (50x4m) September 2018
	S2	
Persoonia virgata	36	35
Banksia aemula	1	1
Banksia oblongifolia	18	12
Epacris pulchella		3
Leptospermum liversidgei	34	
Leptospermum semibaccatum		
Boronia falcifolia	40	59
Sprengelia sprengeliodes		
Leucopogon leptospermoides	4	4
Baeckea frutescens	8	6
Dilwynnia floribunda	3	
Epacris obtusifolia		
Olax retusa		
Phyllota phyllocoides	3	
Aotus lanigera	2	3
Pultenaea palacea	1	
Totals	**144**	**123**

Ground Cover %- 1 x 1m Sub-plots

April 2018

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean April 18
Native perennial grass / sedges	*Caustis recurvata*	2.5	2.5	10	10	5	5		10			**21.2**
	Sporodanthus interruptus	30	25	25	25	15	15	2.5	10			
	Lomandra longifolia											
	Lomandra elongata			10	2.5							
	Hypolaena fastigiata	2.5	1									
	Eriachne pallens				2.5		1					
Native forbs and other spp.	*Pimelea liniifolia*	1						1			1	**1.1**
	Cassytha glabella							0.5			0.5	
	Hibbertia salicifolia									1		
	Drosera binata	1	0.5	2.5		1	0.5					
	Stackhousia nuda						0.5					
Native shrubs ,<1m	*Boronia falcifolia*						0.5			1		**14.45**
	Baeckea imbricata			10	2.5		1	5		1		
	Leucopogon leptospermoides		10									
	Banksia oblongifolia						10	10				
	Strangea linearis		2.5		2.5	1						
	Leptospermum liversidgei									10	10	
	Leptospermum semibaccatum	15		5	15		1`					
	Sprengelia sprengelioids		2.5									
	Olax retusa						0.5					
	Dillwynia floribunda	1		1		1						
	Persoonia virgata											
	Homoranthus virgatus											
	Epacris pulchella						2.5					
	Baeckea frutescens								10-	5	10	
Grass Tree	*Xanthorrhoea fulva*	2.5		5	15	50	15	60	50	50	50	**29.75**

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean April 18
Cryptogams												
Bare Ground												
Exotic Shrubs												
Leaf litter		45.5		31.5	25	27	48.5	21	20	32	28.5	**33.5**
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100%**

September 2018

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean April 17
Native perennial grass / sedges	*Caustis recurvata*	2.5	5	5	10		2.5					**20.5**
	Sporodanthus interruptus	30	10	50	25	10	20	5	10		5	
	Lomandra longifolia			10								
	Lomandra elongata		2.5									
	Hypolaena fastigiata		2.5									
Native forbs and other spp.	*Pimelea liniifolia*	1	2.5							1		**1**
	Hibbertia salicifolia								1	1	1	
	Pattersonia sericea					2.5						
Native shrubs ,<1m	*Boronia falcifolia*				2.5	1			2.5	10	2.5	**16**
	Baeckea imbricata			10	2.5							
	Leucopogon leptospermoides		5			2.5						
	Banksia oblongifolia											
	Strangea linearis	5			2.5	5	1					
	Leptospermum liversidgei											
	Leptospermum semibaccatum	25	5	2.5	5		2.5					
	Sprengelia sprengelioids		1									
	Homoranthus virgatus		1									
	Epacris pulchella						2.5				2.5	
	Banksia oblongifolia						10		10			
	Persoonia virgata						1					

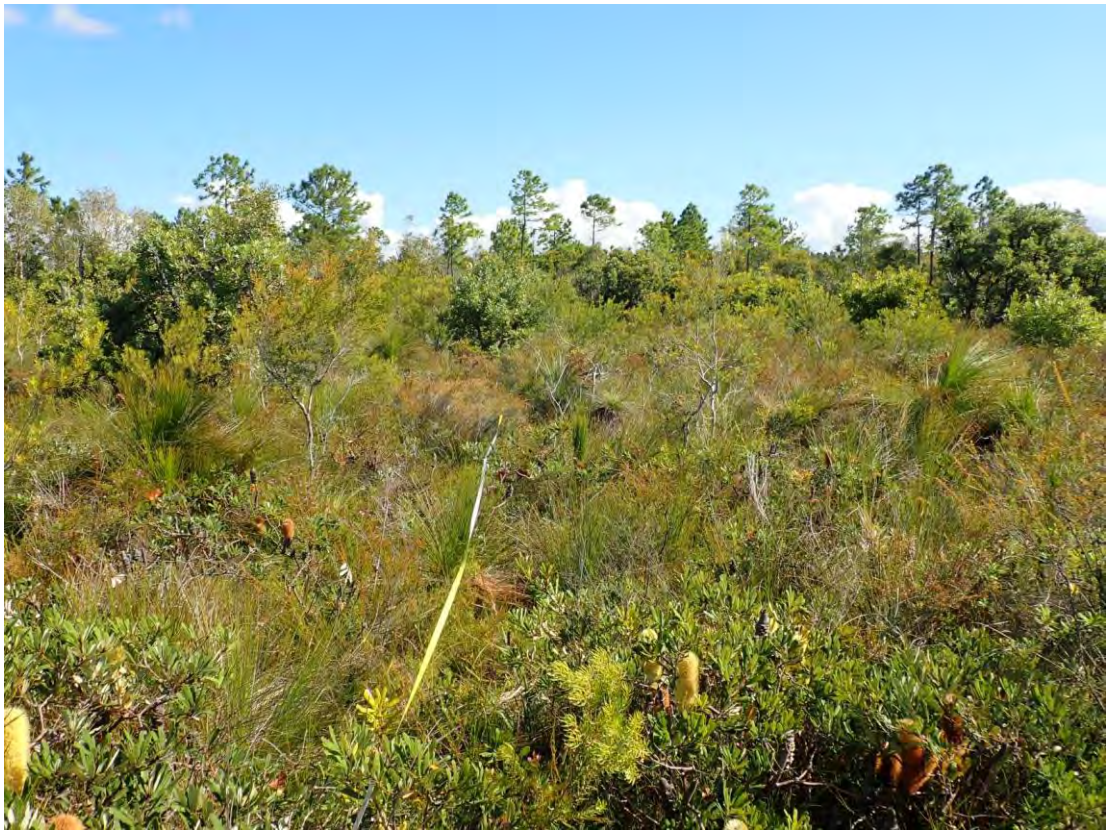
Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean April 17
	Baeckea frutescens							10	10	15	5	
Grass Tree	*Xanthorrhoea fulva*	5			15	50	25	70	30	50	60	**30.5**
Cryptogams												
Bare Ground					5							**0.5**
Exotic Shrubs												
Leaf litter		31.5	65.5	22.5	32.5	29	35.5	15	36.5	23	24	**31.5**
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	

Additional Species: *Dillwynia retorta, Epacris oblongifolia, Lomandra longifolia, Selaginella uliginosa, Olax retusa, Cassytha glabella*

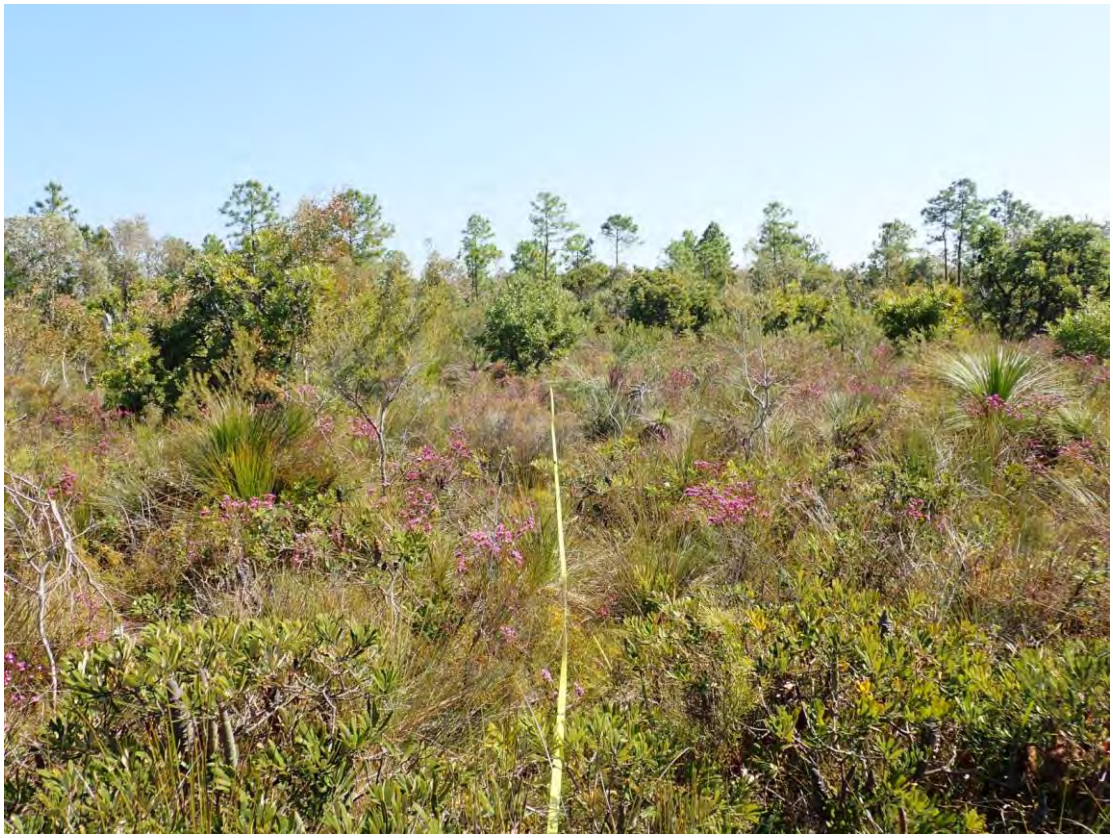
Structural / Floristic Summary

BioCondition Attribute		April 2018	September 2018
Native Plant Species Richness	Tree:		
	Shrub:	16	
	Grass Tree	1	
	Grass / Sedge	6	
	Forbs and other:	7	
Total Species**		**30**	
Native Shrubs	Projected Canopy Cover – Shrubs > 1m (%)	27.4	27.8
	Projected Canopy Cover – Shrubs >0.5 to <1m (%)	3.4	2.4
Native Ground cover (%):	Native perennial grass / sedge cover (%):	21.2	20.5
	Native shrubs (%)	14.45	16
	Grass tree	29.75	31
	Organic litter cover (%):	33.5	31.5
	Native forb cover (%)	1.1	1
Coarse woody debris:	Total length (m) of debris ≥ 10cm diameter and ≥0.5m in length per hectare	0	0
Non-native plant cover	Non-native Grasses%	0	0
	Non-native shrubs %	0	0

****Excludes Exotic Species**



Plot 6a – Centre to Start; April 2017 (Above) and October 2017 (Below).



Plot 6a – Centre to End: April 2017 (Above) and October 2017 (Below).

Plot 6a – Centre Left: April 2017 (Above) and October 2017 (Below).

Plot 6a – Centre to Right: April 2017 (Above) and October 2017 (Below).

Survey Locality 6b

Date of Assessment: 28.04.2018; 15.09.2018.
Plot Size:50 m linear transect (Canopy Cover); 50 x 4m transect for S2 shrubs >0.5m; 10 x 1m x 1m quadrats for Ground Cover.
Location (Plot Centreline): *Start* -26.9852/ 153.1541529; Centre -26.985 / 153.1543768 *Finish* - 26.9849 / 153.1545859
Structure: Heath

Shrub Cover – Canopy Intercept (>50cm)** (summarised 50 m transect)

April 2018

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
1.8 – 2.8	*Banksia oblongifolia*			1.0	0.8
2.5 – 4.3	*Banksia oblongifolia*	1.8	2.2		
7.9 – 9.7	*Persoonia virgata*	1.9	2.0		
16.3 – 17.7	*Banksia oblongifolia*	1.4	1.0		
17.7 – 18.3	*Persoonia virgata*	0.6	2.0		
18.6 – 19.3	*Leptospermum polygalifolium*			0.7	0.7
21.2 – 21.6	*Baeckea frutescens*			0.4	0.7
21.6 – 21.9	*Boronia falcifolia*			0.3	0.6
25.0 – 25.6	*Persoonia virgata*	0.6	1.3		
26.0 – 27.7	*Persoonia virgata*	1.7	1.5		
29.4 – 30.5	*Persoonia virgata*	1.1	2.0		
34.4 – 34.9	*Leptospermum liversedgei*			0.5	0.5
36.5 – 37.5	*Banksia oblongifolia*	1.0	1.0		
38.1 – 39.0	*Persoonia virgata*	0.9	1.8		
39.6 – 40.6	*Persoonia virgata*	1.0	1.2		
47.8 – 48.3	*Leucopogon leptospermoides*	0.5	1.0		
Total Cover		**12.5**		**1.9**	
Average Height			**1.54**		**0.7**

*** Tree not included in cover calculation

October 2018

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
2.0 – 2.9	*Banksia oblongifolia*			0.9	0.8
3.7 – 4.3	*Banksia oblongifolia*			0.6	0.8
8.0 – 8.2	*Persoonia virgata*	0.2	2		
16.3 – 17.4	*Banksia oblongifolia*			1.1	0.7
17.4 – 18.5	*Persoonia virgata*	1.1	1.8		
18.5 – 19.5	*Leptospermum polygalifolium*			1.0	0.8
20.9 – 22.0	*Boronia falcifolia*			1.1	0.7
24.8 – 25.9	*Persoonia virgata*	1.1	1.3		
28.6 – 30.8	*Persoonia virgata*	2.2	2		
30.8 – 31.2	*Boronia falcifolia*			0.4	0.8
37.2 – 37.9	*Boronia falcifolia*	0.7	1		
40.0 – 40.7	*Persoonia virgata*	0.7	2		
Total Cover		**8.0**		**5.1**	
Average Height			**1.6**		**0.8**

Stem Counts (50 x 4) – Shrubs > 0.5m

Species	50 m x 4 m Stems (50x4m) April 2018	50 m x 4 m Stems (50x4m) September 2018
	S2	
Persoonia virgata	38	29
Banksia aemula	1	1
Banksia oblongifolia	13	6
Leptospermum liversidgei	12	12
Boronia falcifolia	10	11
Leucopogon leptospermoides	6	4
Baeckea frutescens	13	4
Dilwynnia floribunda	2	
Epacris pulchella	0	2
Epacris obtusifolia	0	
Phyllota phyllocoides	6	
Leptospermum polgalifolium	3	1
Aotus lanigera	0	2
Totals	**104**	**72**

Ground Cover %- 1 x 1m Sub-plots

April 2018

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean April 16
Native perennial grass / sedges	*Caustis recurvata*		5									**21.7**
	Sporodanthus interruptus	15	30	30	30	35	30	2.5	5		2.5	
	Lomandra sp. (divided)	5	10			2.5	10	2.5				
	Lomandra elongata											
	Eriachne pallens					1	1					
Native forbs and other spp.	*Pimelea liniifolia*									1		**1.25**
	Burchardia umbellata											
	Cassytha glabella											
	Hibbertia salicifolia							2.5	2.5	2.5		

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean April 16
	Stackhousia nuda											
	Selaginella uliginosa											
	Drosera binata			1	1	1	1					
Native shrubs ,<1m	*Boronia falcifolia*				2.5	5						**12.1**
	Baeckea imbricata						1					
	Persoonia virgata											
	Leucopogon leptospermoides			2.5	2.5	2.5	10					
	Banksia oblongifolia	5	10									
	Strangea linearis											
	Leptospermum liversidgei								5			
	Leptospermum semibaccatum	2.5		20	2.5	2.5						
	Sprengelia sprengelioids								2.5			
	Phylota phylicoides							1				
	Baeckea frutescens				15			10		2.5	15	
	Aotus lanigera										0.5	
Grass Tree	*Xanthorrhoea fulva*	40		10	15	10	5	60	50	70	40	**30**
Cryptogams												
Bare Ground				2.5	5	5						**1.25**
Exotic Shrubs												
Leaf litter		32.5	45	34	26.5	35.5	42	21.5	35	24	41	**33.7**
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100%**

October 2018

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean April 16
Native perennial grass / sedges	*Caustis recurvata*	10	5	2.5			5					**30.65**
	Sporodanthus interruptus	15	50	22	40	35	40	35	15	10	10	
	Lomandra sp. (divided)				1							

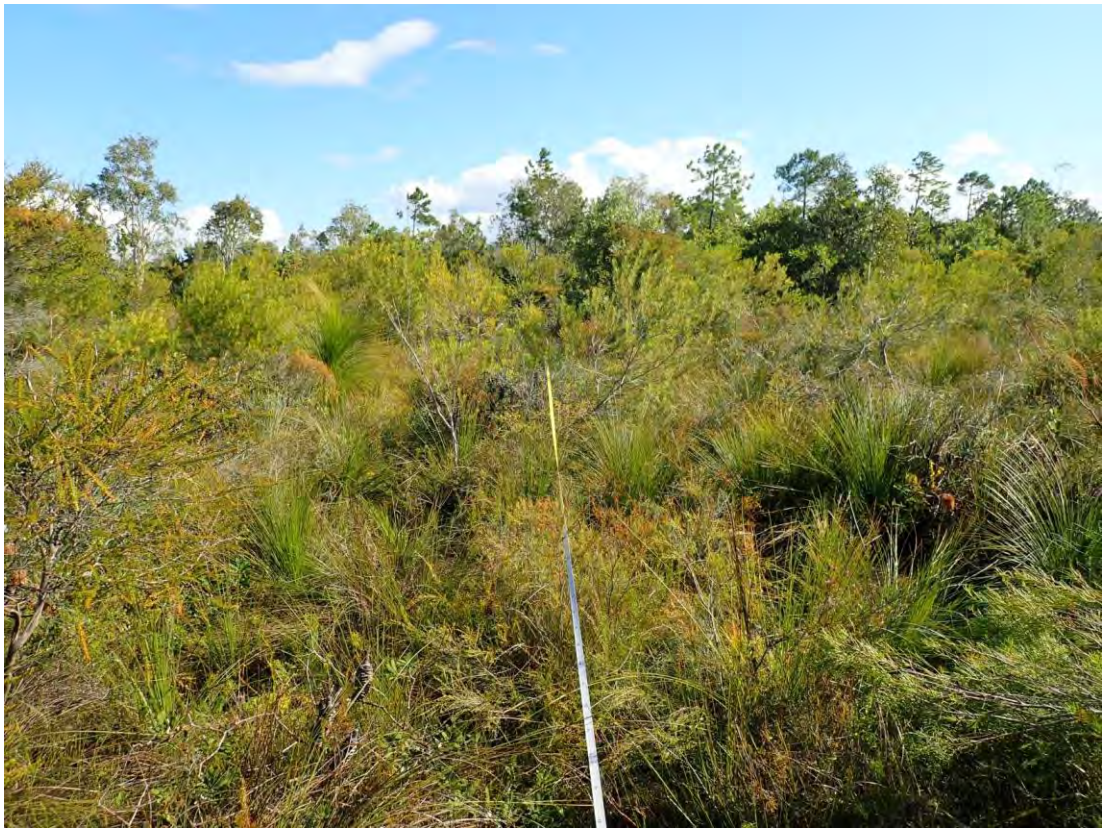
Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean April 16
	Lomandra elongata											
	Lomandra longifolia	5	5									
	Eriachne pallens					1						
Native forbs and other spp.	*Pimelea liniifolia*			1		1						**1.75**
	Hibbertia salicifolia									2		
	Stackhousia nuda											
	Selaginella uliginosa					1						
	Pattersonia sericea					2.5	10					
Native shrubs ,<1m	*Boronia falcifolia*				1	10	5	5	10		1	**15.1**
	Baeckea imbricata										1	
	Persoonia virgata			10		1						
	Leucopogon leptospermoides	5		2	2.5	2.5						
	Banksia oblongifolia		10	5	2.5							
	Strangea linearis			2.5								
	Leptospermum liversidgei						2.5	15				
	Leptospermum semibaccatum			25	2.5	2.5	5					
	Epacris pulchella					2.5						
	Homoranthus virgatus						2.5					
	Baeckea frutescens						2.5			5	10	
	Leptospermum polygalifolium											
Grass Tree	*Xanthorrhoea fulva*	30	5	5	25	5	5	25	30	50	40	**22**
Cryptogams												
Bare Ground				10	2.5	10		5	5			**3.25**
Exotic Shrubs												
Leaf litter		35	25	15	23	26	22.5	15	40	33	38	**27.25**
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Additional Species: *Melaleuca quinquenervia, Selaginella uliginosa, Pultenaea palaceae., Olax retusa, Ochrosperma lineare, Strangea linearis, Cassytha glabella*

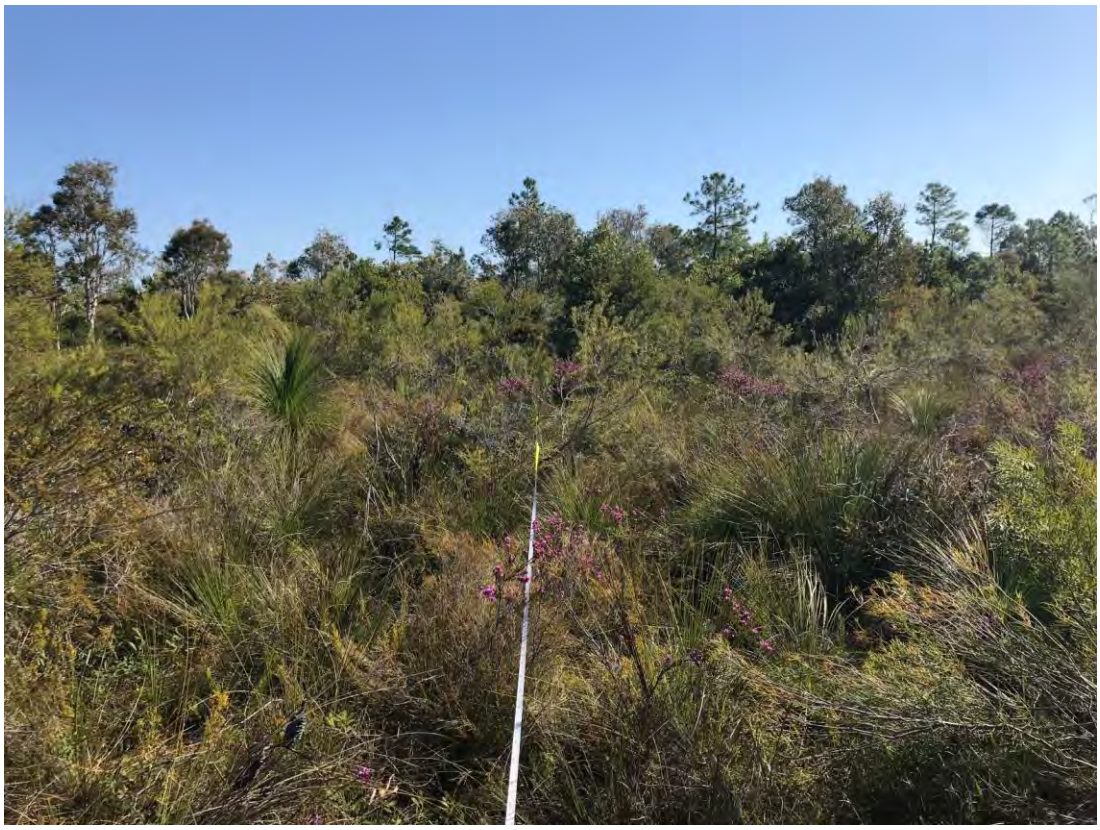
Structural / Floristic Summary

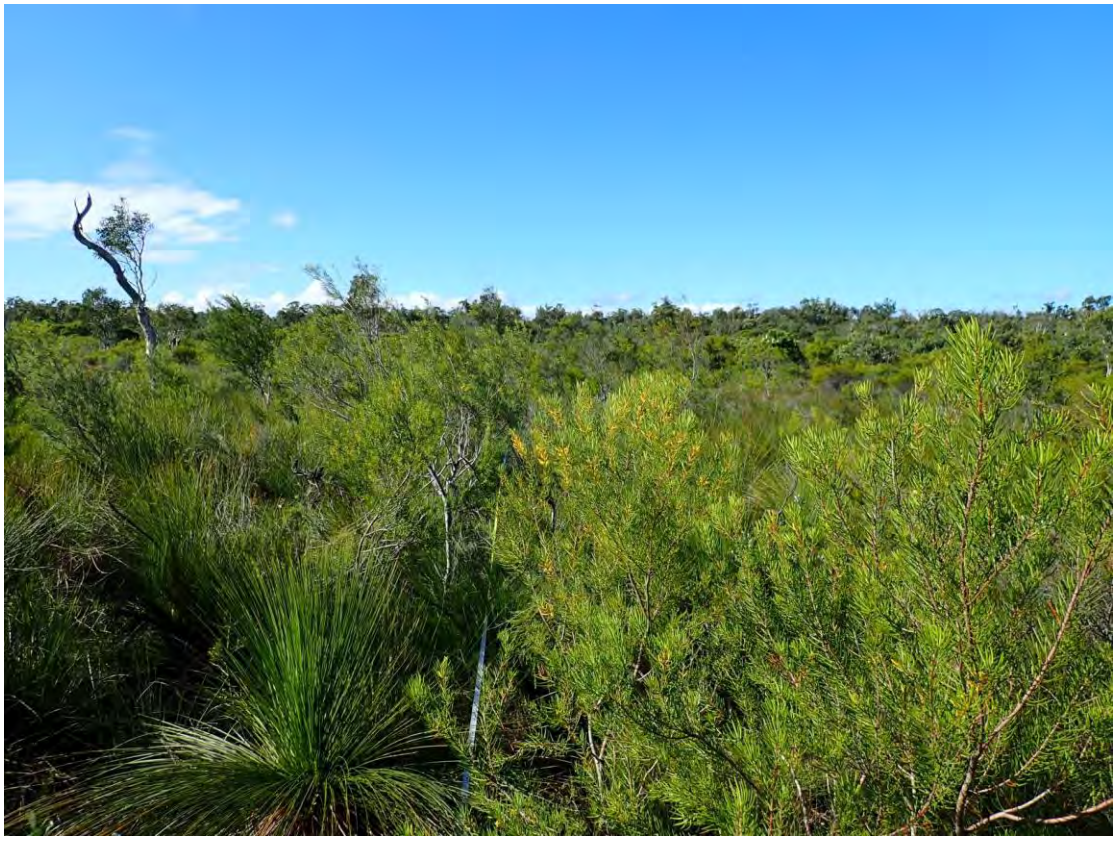
BioCondition Attribute		April 2018	September 2018
Native Plant Species Richness	Tree:		
	Shrub:	20	
	Grass Tree	1	
	Grass / Sedge	5	
	Forbs and other:	6	
Total Species No.**		**32**	
Native Shrubs	Projected Canopy Cover – Shrubs > 1m (%)	25	16
	Projected Canopy Cover – Shrubs >0.5 to <1m (%)	3.8	10.2
Native Ground cover (%):	Native perennial grass / sedge cover (%):	21.7	30.65
	Native shrubs (%)	12.1	15.1
	Grass tree	30	22
	Organic litter cover (%):	33.7	27.25
	Native forb cover (%)	1.25	3.25
Coarse woody debris:	Total length (m) of debris ≥ 10cm diameter and ≥0.5m in length per hectare	0	0
Non-native plant cover	Non-native Grasses%	0	0
	Non-native shrubs %	0	0

**** Excludes Exotic Species**

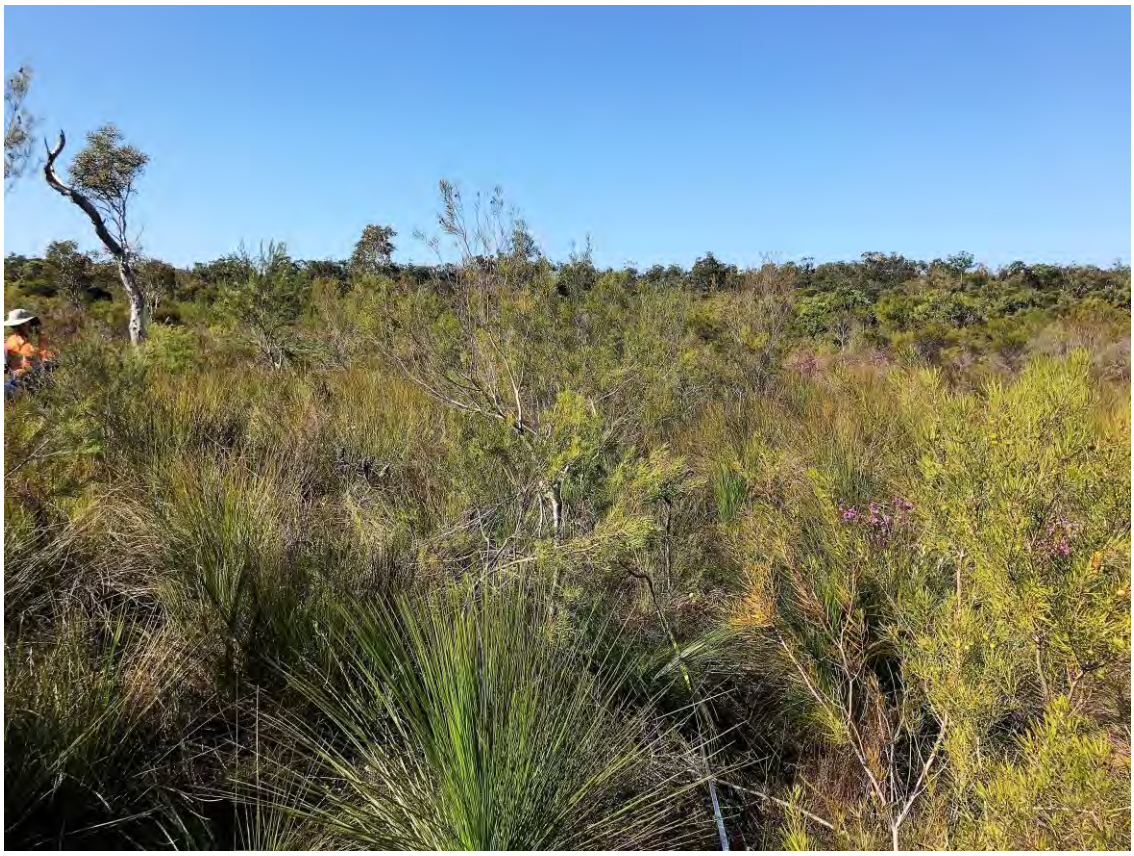


Plot 6 b Centre to Start: April 2017 (Above) and October 2017 (Below).





Plot 6b – Centre to End: April 2016 (Above) and September 2016 (Below).



Plot 6b – Centre to Left: April 2017 (Above) and October 2017 Below).

Plot 6b – Centre to Right: April 2017 (Above) and October 2017 (Below).

Survey Locality 6c

Date of Assessment: 28.04.2018: 15.10.18
Plot Size:50 m linear transect (Canopy Cover); 50 x 4m transect for S2 shrubs >0.5m; 10 x 1m x 1m quadrats for Ground Cover.
Location (Plot Centreline): *Start* -26.9852/ 153.1541529; *Finish* -26.9849 / 153.1545859
Structure: Heath

Shrub Cover – Canopy Intercept (>50cm)** (summarised 50 m transect)

April 2018

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
4.8 – 5.3	*Aotus lanigera*			0.5	0.9
9.1 – 10.1	*Baeckea frutescens*	1.0	1.3		
12.2 – 13.0	*Persoonia virgata*	0.8	1.3		
13.6 – 14.5	*Persoonia virgata*	0.9	1.7		
17.2 – 18.0	*Persoonia virgata*	0.8	1.5		
18.0 – 19.0	*Agiortia pedicellata*	1.0	1.3		
22.2 – 24.4	*Melaleuca quinquenervia*	2.2	3.0		
25.0 – 25.5	*Banksia oblongifolia*			0.5	0.6
30.8 – 31.6	*Leptospermum liversidgei*	0.8	1.5		
33.5 – 34.9	*Persoonia virgata*	1.4	2.4		
36.6 – 38.2	*Persoonia virgata*	1.4	1.5		
41.7 – 43.0	*Leptospermum liversidgei*	1.3	1.4		
43.5 – 44.3	*Leptospermum polygalifolium*	0.8	1.1		
45.1– 46.2	*Leptospermum liversidgei*	1.1	1.3		
47.4 – 47.8	*Boronia falcifolia*			0.4	0.8
48.5 – 48..8	*Leptospermum liversidgei*	0.3	1.2		
48.8 – 49.0	*Boronia falcifolia*			0.2	0.9
49.5 – 50.0	*Leptospermum liversidgei*			0.5	0.9
Total Cover		**13.8**		**1.6**	
Average Height			**1.6**		**0.8**

October 2017

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
4.8 – 5.3	*Aotus lanigera*			0.5	0.8
12.1 – 13.0	*Persoonia virgata*	0.9	1.5		
17.2 – 18.8	*Baeckea frutescens*	1.6	1.6		
21.4 – 24.0	*Melaleuca quinquenervia*	2.6	3.5		
29.5 – 31.4	*Leptospermum polygalifolium*	1.9	1.5		
36.4 – 37.8	*Persoonia virgata*	1.4	1.5		
43.3 – 44.1	*Leptospermum polygalifolium*	0.8	1.3		
44.2 – 45.0	*Persoonia virgata*	0.8	1.8		
45.0 – 45.9	*Leptospermum liversidgei*	0.9	1.2		
48.1 – 48.4	*Leptospermum liversidgei*	0.3	1		
48.4 – 48.9	*Boronia falcifolia*	0.5	1		
49.0 – 49.8	*Leptospermum liversidgei*	0.8	1.5		
49.2 – 50.0	*Banksia aemula*	0.8	3.5		

Intercept (m)	Species	Shrubs > 1m		Shrubs >0.5 to <1m	
		Intercept S1	Height (M)	Intercept S1	Height (M)
Total Cover		**13.3**		**0.5**	
Average Height			**1.6**		**0.8**

Stem Counts (50 x 4) – Shrubs > 0.5m

Species	50 m x 4 m Stems (50x4m) April 2018	50 m x 4 m Stems (50x4m) September 2018
	S1 – S2	
Persoonia virgata	25	17
Banksia oblongifolia	12	4
Leucopogon leptospermoides	5	6
Boronia falcifolia	12	7
Phyllota phyllocoides	14	0
Baeckea frutescens	12	4
Leptospermum liversidgei	30	23
Leptospermum polygalifolium	6	2
Eleocarpus reticulatus	1	1
Melaleuca quinquenervia	2	3
Aotus lanigera		5
Epacris oblongifolia	2	
Agiortia pedicellata	2	2
Totals	**123**	**74**

Ground Cover %- 1 x 1m Sub-plots

April 2018

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean April 16
Native perennial grass / sedges	*Caustis recurvata*	15		5		10		2.5	15	20	20	**28.35**
	Sporodanthus interruptus	20	30	10	30	5	10	20	15	20		
	Eriachne pallens							5			2.5	
	Lomandra sp. (divided)				2.5	1					2.5	
	Lomandra longifolia						5			2.5		

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean April 16
	Lomandra elongata				5							
	Baloskion tenuiculme									5	5	
Native forbs and other spp.	*Pimelea liniifolia*				1		2.5					**1.3**
	Cassytha glabella	0.5										
	Stackhousia nuda		1						1			
	Drosera binata		1		1		1	1	1		1	
	Pseudanthus orientalis						1					
Native shrubs ,<1m	*Boronia falcifolia*											**20.5**
	Baeckea imbricata									1		
	Baeckea frutescens			40			10				2.5	
	Leucopogon leptospermoides				10			1		2.5		
	Banksia oblongifolia		2.5	10				15	30	15		
	Strangea linearis	5			10	2.5						
	Leptospermum liversidgei											
	Leptospermum semibaccatum	10	15				10					
	Dilwynnia floribunda									1		
	Epacris pulchella											
	Sprengelia sprengellioides											
	Olax retusa											
	Epacris oblongifolia	1										
	Boronia falcifolia				1							
	Leptospermum poligalifolium							10				
Grass Tree	*Xanthorrhoea fulva*	15	20			60	15	10	20	15	25	**18**
Bare Ground		2.5		2.5								**0.5**
Leaf litter		31	30.5	32.5	39.5	21.5	45.5	35.5	18	18.5	41.5	**31.35**
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100%**

September 2018

Ground Cover Type	Species	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Mean September 2018
Native perennial grass / sedges	*Caustis recurvata*	20	5	2.5		10		5	5	10	20	**31.95**
	Sporodanthus interruptus	20	30	10	30	10	45	25	20	31	10	
	Lomandra longifolia					2.5	2.5		5			
	Baloskion tenuiculme		1									
Native forbs and other spp.	*Pimelea liniifolia*						1		1			**0.95**
	Cassytha glabella										1	
	Patersonia sericea				1							
	Sellaginella uliginosa				1		1					
	Pseudanthus orientalis							1				
	Patersonia sp.									2.5		
Native shrubs ,<1m	*Boronia falcifolia*											**22**
	Baeckea imbricata						2.5		2.5	1		
	Baeckea frutescens		1	40	2.5		5				10	
	Leucopogon leptospermoides				10		1	1		10		
	Banksia oblongifolia		2.5	20				15	35	10		
	Strangea linearis	5			10	2.5						
	Leptospermum liversidgei										10	
	Leptospermum semibaccatum	2.5										
	Dilwynnia floribunda		1								2.5	
	Leptospermum polygalifolium							10	5			
	Ochrosperma lineare								2.5			
Grass Tree	*Xanthorrhoea fulva*	20	20		5	40	30	5	10	15	30	**17.5**
Bare Ground		5	5	5	5	5				5	5	**3.5**
Leaf litter		27.5	34.5	22.5	35.5	30	12	38	14	15.5	11.5	**24.1**
Timber (>/= 10cm)												
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

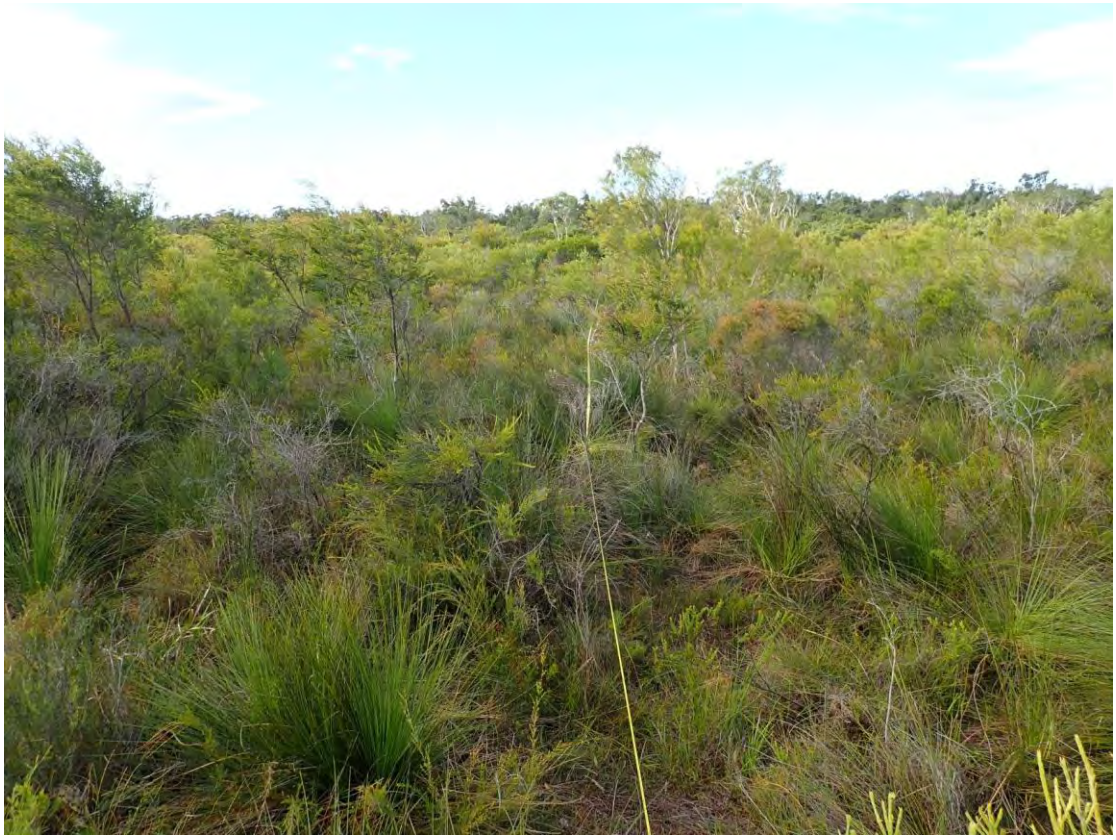
Additional Species: *Pinus elliotii***, *Drosera binata, Cassytha glabella, Hypolaena fastigiata, Xyris complanata, Homoranthus decumbens*

Structural / Floristic Summary

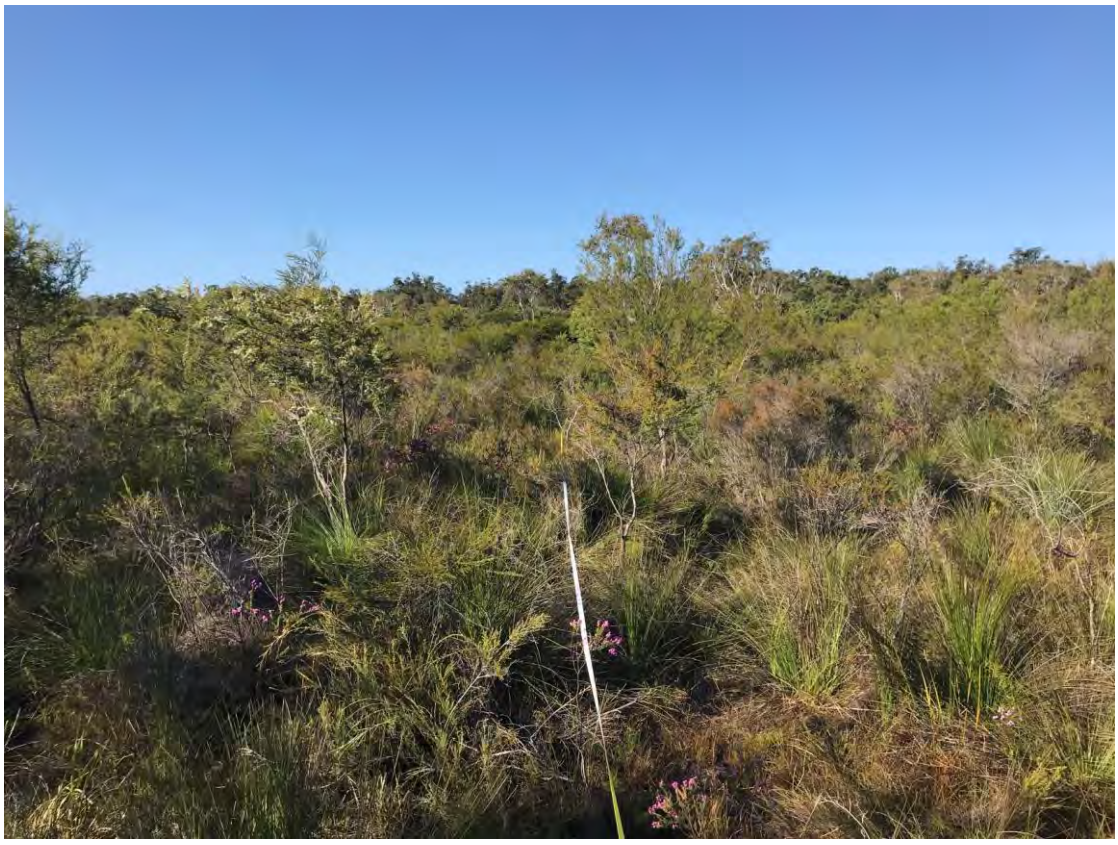
BioCondition Attribute		April 2018	October 2018
Native Plant Species Richness	Tree:	.	.
	Shrub:	21	
	Grass Tree	1	
	Grass / Sedge	7	
	Forbs and other:	8	
Total Species No**		**37**	
Native Shrubs	Projected Canopy Cover – Shrubs > 1m (%)	27.6	26.6
	Projected Canopy Cover – Shrubs >0.5 to <1m (%)	3.2	1.0
Native Ground cover (%):	Native perennial grass / sedge cover (%):	28.35	31.95
	Native shrubs (%)	20.5	22
	Grass tree	18	17.5
	Organic litter cover (%):	31.35	24.1
	Native forb cover (%)	1.3	0.95
Coarse woody debris:	Total length (m) of debris ≥ 10cm diameter and ≥0.5m in length per hectare	0	0
Non-native plant cover	Non-native Grasses%	0	0
	Non-native shrubs %	0	0

****Excludes Exotic Species**

Plot 6c – Centre to Start: April 2018 (Above) and September 2018 (Below).



Centre to End - April 2018 (Above) and September 2018 (Below).



Plot 6c – Centre to Left: April 2018 (Above) and September 2018 (Below).

Plot 6c – Centre to Right: April 2018 (Above) and September 2018 (Below).

Appendix B – Site / Species Table

Habit	Family	Species	Site 5a_April 2018	Site 5b_April 2018	Site 5c_April 2018	Site 6a_April 2018	Site 6b_April 2018	Site 6c_April 2018	Site 5a_September 2018	Site 5b_September 2018	Site 5c_September 2018	Site 6a_September 2018	Site 6b_September 2018	Site 6c_September 2018
Forb	Blechnaceae	*Blechnum cartiligineum*			*						*			
Forb	Colchicaceae	*Burchardia umbellata*							*					
Forb	Dilleniaceae	*Hibbertia acicularis*												
Forb	Dilleniaceae	*Hibbertia salicifolia*			*	*	*					*	*	
Forb	Droseraceae	*Drosera binata*	*	*	*	*	*	*			*			
Forb	Fabaceae	*Mirbellia rubiifolia*		*						*				
Forb	Iridaceae	*Patersonia sericea (fragilis)*	*	*		*			*	*		*		*
Forb	Lauraceae	*Cassytha glabella*		*	*	*		*		*	*	*	*	*
Forb	Laxmanniaceae	*Laxmannia compacta*												
Forb	Laxmanniaceae	*Sowerbaea juncea*												
Forb	Orchidaceae	*Cryptostylis erecta*												
Forb	Phormiaceae	*Dianella caerulea (sic)*												
Forb	Picrodendraceae	*Pseudanthus orientalis*		*	*			*		*	*			*
Forb	Polygalaceae	*Commosperma sphaericum*												
Forb	Selaginellaceae	*Selaginella uliginosa*				*	*						*	*
Forb	Stackhousiaceae	*Stackhousia nuda*				*		*						
Forb	Thymeleaceae	*Pimelea linifolia*	*	*	*	*	*	*	*	*	*	*	*	*
Forb	Xyridaceae	*Xyris complanata*												*
Grass	Poaceae	*Eriachne pallescens var. gracillis*		*	*	*	*	*					*	*
Grass	Poaceae	*Themeda triandra*												
Grass tree	Xanthorrhoeaceae	*Xanthorrhoea fulva*	*	*	*	*	*	*	*	*	*	*	*	*
Grass tree	Xanthorrhoeaceae	*Xanthorrhoea johnsonii*		*	*					*	*			
Sedge / Rush	Cyperaceae	*Cyperus sp. (gracilis?)*												
Sedge / Rush	Cyperaceae	*Gahnia seiberiana*			*						*			
Sedge / Rush	Cyperaceae	*Hypolaena fastigiata*		*	*	*				*	*	*		*

Habit	Family	Species	Site 5a_April 2018	Site 5b_April 2018	Site 5c_April 2018	Site 6a_April 2018	Site 6b_April 2018	Site 6c_April 2018	Site 5a_September 2018	Site 5b_September 2018	Site 5c_September 2018	Site 6a_September 2018	Site 6b_September 2018	Site 6c_September 2018
Sedge / Rush	Cyperaceae	*Schoenus calostachys*												
Sedge / Rush	Laxmanniaceae	*Lomandra elongata*	*	*	*	*	*	*	*	*	*	*	*	
Sedge / Rush	Laxmanniaceae	*Lomandra longifolia*	*	*	*	*	*	*	*	*	*	*	*	*
Sedge / Rush	Restionaceae	*Baloskion heterophylla*												
Sedge / Rush	Restionaceae	*Baloskion tenuiculme*	*	*				*	*	*				
Sedge / Rush	Restionaceae	*Caustis recurvata*	*	*	*	*	*	*	*	*	*	*	*	*
Sedge / Rush	Restionaceae	*Leptocarpus tenax*												
Sedge / Rush	Restionaceae	*Sporodanthus interuptus*	*	*	*	*	*	*	*	*	*	*	*	*
Shrub	Ericaceae	*Agiortia pedicellata*	*	*	*			*	*	*	*			
Shrub	Ericaceae	*Epacris obtusifolia*				*		*						
Shrub	Ericaceae	*Epacris pulchella*	*	*	*	*		.	*		*	*		*
Shrub	Ericaceae	*Leucopogon leptospermoides*	*	*	*	*	*	*	*	*	*	*	*	*
Shrub	Ericaceae	*Monotoca scoparia##*												
Shrub	Ericaceae	*Sprengelia sprengelioides*	*	*		*	*		*		*	*		
Shrub	Fabaceae	*Aotus lanigera*					*	*	*				*	
Shrub	Fabaceae	*Dillwynia floribunda*	*	*	*		*				*			*
Shrub	Fabaceae	*Phyllota phylicoides*					*	*						
Shrub	Fabaceae	*Pultenaea palaceae*				*	*					*	*	
Shrub	Fabaceae	*Pultenaea robusta*												
Shrub	Mimosaceae	*Acacia baueri*												
Shrub	Mimosaceae	*Acacia flavesecens*		*						*				
Shrub	Mimosaceae	*Acacia sp,*												
Shrub	Myrtaceae	*Austromyrtus dulcis*			*						*			
Shrub	Myrtaceae	*Baeckea frutescens*	*	*	*	*	*	*	*	*	*	*	*	*
Shrub	Myrtaceae	*Baeckea imbricata*	*			*	*	*	*		*	*	*	*

Habit	Family	Species	Site 5a_April 2018	Site 5b_April 2018	Site 5c_April 2018	Site 6a_April 2018	Site 6b_April 2018	Site 6c_April 2018	Site 5a_September 2018	Site 5b_September 2018	Site 5c_September 2018	Site 6a_September 2018	Site 6b_September 2018	Site 6c_September 2018
Shrub	Myrtaceae	*Homoranthus virgatus*	*	*					*	*	*	*		*
Shrub	Myrtaceae	*Leptospermum liversidgei*				*	*	*				*	*	*
Shrub	Myrtaceae	*Leptospermum polygalifolium*		*	*		*	*		*	*		*	*
Shrub	Myrtaceae	*Leptospermum semibaccatum*	*	*	*	*	*		*	*	*	*	*	*
Shrub	Myrtaceae	*Melaleuca pachyphyllus*			*						*			
Shrub	Myrtaceae	*Melaleuca quinquenervia*			*		*	*			*		*	
Shrub	Myrtaceae	*Ochrosperma lineare*	*	*	*		*		*	*	*			*
Shrub	Olacaceae	*Olax retusa*				*	*					*	*	
Shrub	Proteaceae	*Banksia aemula*			*	*	*	*			*	*	*	
Shrub	Proteaceae	*Banksia oblongifolia*				*	*	*				*	*	*
Shrub	Proteaceae	*Conospermum taxifolium*									*		*	
Shrub	Proteaceae	*Persoonia virgata*	*	*	*	*	*	*	*	*	*	*	*	
Shrub	Proteaceae	*Strangea linearis*	*	*	*	*	*		*		*	*	*	*
Shrub	Rutaceae	*Boronia falcifolia*	*			*	*	*	*		*	*	*	*
Tree	Elaeocarpaceae	*Elaeocarpus reticulatus*						*						*
Tree	Pinaceae	*Pinus elliottii***									*			

Appendix C – Statistical Analysis Summary and Raw Data

Shrub Cover

Levene's Test_Shrubs > 1m

Data1	Data2	Data3	Data4	Data5		Data6		*Data1*	*Data2*	*Data3*	*Data4*	*Data5*	*Data6*
18.2	24.6	29.6	20.4	20.2		17.8	Median	21.6	18.6	22	21	25	19
19.4	18.6	20.2	24.4	21.8		19	Mean	6084.057	6102.743	6135.571	6161.257	6188.771	6208.714
11.4	9.8	14	13.2	8.4		9.8	Variance	2.57E+08	2.59E+08	2.62E+08	2.64E+08	2.66E+08	2.68E+08
21.6	15	23.2	14.8	27.4		27.8	n	7	7	7	7	7	7
22.2	20.2	14	21	25		16	df	6	6	6	6	6	6
34.6	17	22	26	27.6		26.6		Levene's					
Apr-16	**Sep-16**	**Apr-17**	**Oct-17**	**Apr-18**		**Sep-18**	Test	0.000					
							p	1.000		Cannot Reject Null Hypothesis because p > 0.05 (Variances are the same)			
							a	0.05					

Levene's Test_Shrubs >0.5 to <1m

Data1	Data2	Data3	Data4	Data5	Data6		*Data1*	*Data2*	*Data3*	*Data4*	*Data5*	*Data6*
3.8	1.6	1.6	1.8	0.8	1.4	Median	4	5	1.6	5.2	3.2	1.4
1.4	3.4	1	3.6	2.1	1	Mean	6070.686	6092.229	6121.371	6145	6172.5	6194.286
2.6	1	1.4	0	3.2	0	Variance	2.57E+08	2.59E+08	2.62E+08	2.64E+08	2.66E+08	2.68E+08
11	11.8	10.4	17.6	3.4	2.4	n	7	7	7	7	7	7
11	8.8	8.2	7.8	3.8	10.2	df	6	6	6	6	6	6
4	5	1	5.2	3.2	1		Levene's					
Apr-16	**Sep-16**	**Apr-17**	**Sep-17**	**Apr-18**	**Sep-18**	Test	0.000					
						p	1.000		Cannot Reject Null Hypothesis because p > 0.05 (Variances are the same)			
						a	0.05					

Levene's Test_Shrubs >0.5m – Stem Density

Data1	Data2	Data3	Data4	Data5	Data6		*Data1*	*Data2*	*Data3*	*Data4*	*Data5*	*Data6*
79	85	75	67	84	61	Median	123.5	106.5	84.5	82.5	94	66.5
80	62	68	72	69	57	Mean	129.5	102.1667	81.5	84.66667	93.66667	69.5
51	32	33	35	38	30	Variance	4751.9	2763.767	956.3	1300.267	1460.267	935.5
225	177	125	142	144	123	n	6	6	6	6	6	6
175	129	94	99	104	72	df	5	5	5	5	5	5
167	128	94	93	123	74		Levene's					
						Test	2.849					
						p	0.032		Reject Null Hypothesis because p < 0.05 (Variances are Different)			
							a	0.05				

Repeat Measures ANOVA_Shrubs > 1m Control

	Data1	Data2	Data3	Data4	Data5	Data6	Anova: Two Factor Without Replication	a	0.05					
Control _Plot 5a	18.2	24.6	29.6	20.4	20.2	17.8								
Control _Plot 5b	19.4	18.6	20.2	24.4	21.8	19	*SUMMARY*	*Count*	*Sum*	*Average*	*Variance*			
Control _Plot 5c	11.4	9.8	14	13.2	8.4	9.8	Control _Plot 5a	6	130.8	21.8	20.432			
							Control _Plot 5b	6	123.4	20.56667	4.806667			
							Control _Plot 5c	6	66.6	11.1	4.716			
							Data1	3	49	16.33333	18.61333			
							Data2	3	53	17.66667	55.41333			
							Data3	3	63.8	21.26667	61.69333			
							Data4	3	58	19.33333	32.21333			
							Data5	3	50.4	16.8	53.56			
							Data6	3	46.6	15.53333	25.01333			
							ANOVA							
							Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*	
							Rows	411.2578	2	205.6289	25.15167	0.000	4.102821	Reject Null Hypothesis because p < 0.05 (Means are Different)
							Columns	68.01778	5	13.60356	1.66393	0.230	3.325835	Cannot Reject Null Hypothesis because p > 0.05 (Means are the same)
							Error	81.75556	10	8.175556				
							Total	561.0311	17					

Repeat Measures ANOVA_Shrubs > 1m Impact

	Data1	**Data2**	**Data3**	**Data4**	**Data5**	**Data6**	Anova: Two Factor Without Replication	a	0.05					
Control_Plot 6a	21.6	15	23.2	14.8	27.4	27.8								
Control_Plot 6b	22.2	20.2	14	21	25	16	*SUMMARY*	*Count*	*Sum*	*Average*	*Variance*			
Control_Plot 6c	34.6	17	22	26	27.6	26.6	Impact_Plot 6a	6	129.8	21.63333	32.88667			
							Impact_Plot 6b	6	118.4	19.73333	16.49067			
							Impact_Plot 6c	6	153.8	25.63333	34.61467			
							Data1	3	78.4	26.13333	53.85333			
							Data2	3	52.2	17.4	6.88			
							Data3	3	59.2	19.73333	25.01333			
							Data4	3	61.8	20.6	31.48			
							Data5	3	80	26.66667	2.093333			
							Data6	3	70.4	23.46667	42.17333			
							ANOVA							
							Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*	
							Rows	108.84	2	54.42	2.541249	0.128	4.102821	Cannot Reject Null Hypothesis because p > 0.05 (Means are the same)
							Columns	205.8133	5	41.16267	1.922172	0.177	3.325835	Cannot Reject Null Hypothesis because p > 0.05 (Means are the same)
							Error	214.1467	10	21.41467				
							Total	528.8	17					

Repeat Measures ANOVA_Shrubs >0.5 to <1m Control

	Data1	Data2	Data3	Data4	Data5	Data6	Anova: Two Factor Without Replication	a	0.05					
Control _Plot 5a	3.8	1.6	1.6	1.8	0.8	1.4								
Control _Plot 5b	1.4	3.4	1	3.6	2.1	1	*SUMMARY*	*Count*	*Sum*	*Average*	*Variance*			
Control _Plot 5c	2.6	1	1.4	0	3.2	0	Control _Plot 5a	6	11	1.833333	1.046667			
							Control _Plot 5b	6	12.5	2.083333	1.369667			
							Control _Plot 5c	6	8.2	1.366667	1.750667			
							Data1	3	7.8	2.6	1.44			
							Data2	3	6	2	1.56			
							Data3	3	4	1.333333	0.093333			
							Data4	3	5.4	1.8	3.24			
							Data5	3	6.1	2.033333	1.443333			
							Data6	3	2.4	0.8	0.52			
							ANOVA							
							Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*	
							Rows	1.587778	2	0.793889	0.529063	0.605	4.102821	Cannot Reject Null Hypothesis because p > 0.05 (Means are the same)
							Columns	5.829444	5	1.165889	0.776971	0.588	3.325835	Cannot Reject Null Hypothesis because p > 0.05 (Means are the same)
							Error	15.00556	10	1.500556				
							Total	22.42278	17					

Repeat Measures ANOVA_Shrubs >0.5 to <1m Impact

	Data1	Data2	Data3	Data4	Data5	Data6	Anova: Two Factor Without Replication	a	0.05					
Impact_Plot 6a	11	11.8	10.4	17.6	3.4	2.4								
Impact_Plot 6b	11	8.8	8.2	7.8	3.8	10.2	*SUMMARY*	*Count*	*Sum*	*Average*	*Variance*			
Impact_Plot 6c	4	5	1	5.2	3.2	1	Impact_Plot 6a	6	56.6	9.433333	32.31067			
							Impact_Plot 6b	6	49.8	8.3	6.332			
							Impact_Plot 6c	6	19.4	3.233333	3.510667			
							Data1	3	26	8.666667	16.33333			
							Data2	3	25.6	8.533333	11.61333			
							Data3	3	19.6	6.533333	24.17333			
							Data4	3	30.6	10.2	42.76			
							Data5	3	10.4	3.466667	0.093333			
							Data6	3	13.6	4.533333	24.57333			
							ANOVA							
							Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*	
							Rows	130.7911	2	65.39556	6.038247	0.019	4.102821	Reject Null Hypothesis because p < 0.05 (Means are Different)
							Columns	102.4644	5	20.49289	1.892195	0.183	3.325835	Cannot Reject Null Hypothesis because p > 0.05 (Means are the same)
							Error	108.3022	10	10.83022				
							Total	341.5578	17					

Repeat Measures ANOVA_Shrubs Stem Density > 0.5m

Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Anova: Two Factor Without Replication	a	0.05					
79	85	75	67	84	61								
80	62	68	72	69	57	*SUMMARY*	*Count*	*Sum*	*Average*	*Variance*			
51	32	33	35	38	30	79	5	372	74.4	109.8			
225	177	125	142	144	123	80	5	328	65.6	36.3			
175	129	94	99	104	72	51	5	168	33.6	9.3			
167	128	94	93	123	74	225	5	711	142.2	469.7			
						175	5	498	99.6	419.3			
						167	5	512	102.4	511.3			
						Data2	6	613	102.1667	2763.767			
						Data3	6	489	81.5	956.3			
						Data4	6	508	84.66667	1300.267			
						Data5	6	562	93.66667	1460.267			
						Data6	6	417	69.5	935.5			
						ANOVA							
						Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*	
						Rows	71779.95	5	14355.99	4.162013	0.007	2.58679	Reject Null Hypothesis because p < 0.05 (Means are Different)
						Columns	40922.25	4	10230.56	2.96599	0.038	2.742594	Reject Null Hypothesis because p < 0.05 (Means are Different)
						Error	89681.55	26	3449.29				

Ground Cover

Levene's Test_Grass, Sedges, Shrubs

Data1	**Data2**	**Data3**	**Data4**	**Data5**	**Data6**		***Data1***	***Data2***	***Data3***	***Data4***	***Data5***	***Data6***
23.75	27.2	24.65	33.1	31.35	39.8	Median	26.4	28.25	25.95	29	26.5	31.3
33.05	28.05	27.25	33.7	37.65	38	Mean	27.96833	27.725	25.625	28.24167	27.48333	31.31667
26.75	28.45	31.1	28	24.65	27	Variance	16.81802	15.14075	20.91875	28.61842	40.00367	50.62267
25.06	28.55	21	19.45	21.2	20.5	n	6	6	6	6	6	6
26.05	21	19.95	25.2	21.7	30.65	df	5	5	5	5	5	5
33.15	33.1	29.8	30	28.35	31.95		Levene's					
						Test	0.753					
						p	0.591		Cannot Reject Null Hypothesis because p > 0.05 (Variances are the same)			
							a	0.05				

Levene's Test_Groundcover Shrubs

Data1	Data2	Data3	Data4	Data5	Data6		*Data1*	*Data2*	*Data3*	*Data4*	*Data5*	*Data6*
17.5	14.45	10.81	12.25	15.55	13.1	Median	20.76	17.85	15.45	17.2	14.85	15.1
22	17.85	15.45	13.8	14.2	14.45	Mean	6083.517	6103.879	6130.723	6157.429	6183.236	6205.579
15.45	15.05	12.5	18.3	14.85	14.4	Variance	2.57E+08	2.59E+08	2.62E+08	2.64E+08	2.66E+08	2.68E+08
20.76	25.3	17.75	17.2	14.45	16	n	7	7	7	7	7	7
18.86	17.35	10.5	11.65	12.1	15.1	df	6	6	6	6	6	6
29.05	23.15	22.05	19.8	20.5	22		Levene's					
Apr-16	**Sep-16**	**Apr-17**	**Oct-17**	**Apr-18**	**Sep-18**	Test	0.000					
						p	1.000		Cannot Reject Null Hypothesis because p > 0.05 (Variances are the same)			
							a	0.05				

Repeat Measures ANOVA -_Grass, Sedges, Shrubs

	Data1	Data2	Data3	Data4	Data5	Data6	Anova: Two Factor Without Replication	a	0.05					
Control _Plot 5a	23.75	27.2	24.65	33.1	31.35	39.8								
Control _Plot 5b	33.05	28.05	27.25	33.7	37.65	38	*SUMMARY*	*Count*	*Sum*	*Average*	*Variance*			
Control _Plot 5c	26.75	28.45	31.1	28	24.65	27	Control _Plot 5a	6	179.85	29.975	36.59875			
Impact_Plot 6a	25.06	28.55	21	19.45	21.2	20.5	Control _Plot 5b	6	197.7	32.95	20.933			
Impact_Plot 6b	26.05	21	19.95	25.2	21.7	30.65	Control _Plot 5c	6	165.95	27.65833	4.579417			
Impact_Plot 6c	33.15	33.1	29.8	30	28.35	31.95	Impact_Plot 6a	6	135.76	22.62667	12.06047			
							Impact_Plot 6b	6	144.55	24.09167	16.10142			
							Impact_Plot 6c	6	186.35	31.05833	3.875417			
							Data1	6	167.81	27.96833	16.81802			
							Data2	6	166.35	27.725	15.14075			
							Data3	6	153.75	25.625	20.91875			
							Data4	6	169.45	28.24167	28.61842			
							Data5	6	164.9	27.48333	40.00367			
							Data6	6	187.9	31.31667	50.62267			
							ANOVA							
							Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*	
							Rows	491.9967	5	98.39933	6.67359	0.000	2.602987	Reject Null Hypothesis because p < 0.05 (M
							Columns	102.1277	5	20.42553	1.38529	0.264	2.602987	Cannot Reject Null Hypothesis because p >
							Error	368.6147	25	14.74459				
							Total	962.739	35					

Repeat Measures ANOVA -_Ground Cover Shrubs – Impact Site

	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Anova: Two Factor Without Replication	a	0.05					
Impact_Plot 6a	20.76	25.3	17.75	17.2	14.45	16								
Impact_Plot 6b	18.86	17.35	10.5	11.65	12.1	15.1	*SUMMARY*	*Count*	*Sum*	*Average*	*Variance*			
Impact_Plot 6c	29.05	23.15	22.05	19.8	20.5	22	Impact_Plot 6a	6	111.46	18.57667	15.24347			
							Impact_Plot 6b	6	85.56	14.26	11.4058			
							Impact_Plot 6c	6	136.55	22.75833	10.93342			
							Data1	3	68.67	22.89	29.3617			
							Data2	3	65.8	21.93333	16.91083			
							Data3	3	50.3	16.76667	34.07583			
							Data4	3	48.65	16.21667	17.33083			
							Data5	3	47.05	15.68333	18.78083			
							Data6	3	53.1	17.7	14.07			
							ANOVA							
							Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*	
							Rows	216.6832	2	108.3416	24.414	0.000	4.102821	Reject Null Hypothesis because p < 0.05 (Means are Different)
							Columns	143.5366	5	28.70732	6.468987	0.006	3.325835	Reject Null Hypothesis because p < 0.05 (Means are Different)
							Error	44.37683	10	4.437683				
							Total	404.5966	17					

Repeat Measures ANOVA -_Ground Cover Shrubs – Control Site

	Data1	Data2	Data3	Data4	Data5	Data6	Anova: Two Factor Without Replication	a	0.05					
Control _Plot 5a	17.5	14.45	10.81	12.25	15.55	13.1								
Control _Plot 5b	22	17.85	15.45	13.8	14.2	14.45	*SUMMARY*	*Count*	*Sum*	*Average*	*Variance*			
Control _Plot 5c	15.45	15.05	12.5	18.3	14.85	14.4	Control _Plot 5a	6	83.66	13.94333	5.776867			
							Control _Plot 5b	6	97.75	16.29167	9.939417			
							Control _Plot 5c	6	90.55	15.09167	3.535417			
							Data1	3	54.95	18.31667	11.22583			
							Data2	3	47.35	15.78333	3.293333			
							Data3	3	38.76	12.92	5.5147			
							Data4	3	44.35	14.78333	9.875833			
							Data5	3	44.6	14.86667	0.455833			
							Data6	3	41.95	13.98333	0.585833			
							ANOVA							
							Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*	
							Rows	16.54668	2	8.273339	1.824087	0.211	4.102821	Cannot Reject Null Hypothesis because p > 0.05 (Means are the same)
							Columns	50.90244	5	10.18049	2.244571	0.130	3.325835	Cannot Reject Null Hypothesis because p > 0.05 (Means are the same)
							Error	45.35606	10	4.535606				
							Total	112.8052	17					

Levene's Test_Groundcover Forbs

Data1	Data2	Data3	Data4	Data5	Data6		*Data1*	*Data2*	*Data3*	*Data4*	*Data5*	*Data6*
1.15	0.6	0.15	0.4	0.3	1.15	Median	1.4	0.805	0.805	0.8	0.95	0.975
1.2	0.35	0.4	0.2	0.7	0.85	Mean	1.591667	1.235	0.81	0.816667	0.908333	0.983333
1.2	2	0.96	0.65	0.8	0.2	Variance	0.312417	0.95075	0.296	0.242667	0.146417	0.249667
1.8	2.85	0.65	1.5	1.1	1	n	6	6	6	6	6	6
2.6	0.76	1.7	0.95	1.25	1.75	df	5	5	5	5	5	5
1.6	0.85	1	1.2	1.3	0.95		Levene's					
						Test	0.545					
						p	0.741		Cannot Reject Null Hypothesis because p > 0.05 (Variances are the same)			
							a	0.05				

Repeat Measures ANOVA -_Ground Cover Forbs

	Data1	Data2	Data3	Data4	Data5	Data6	Anova: Two Factor Without Replication	a	0.05					
Control _Plot 5a	1.15	0.6	0.15	0.4	0.3	1.15								
Control _Plot 5b	1.2	0.35	0.4	0.2	0.7	0.85	*SUMMARY*	*Count*	*Sum*	*Average*	*Variance*			
Control _Plot 5c	1.2	2	0.96	0.65	0.8	0.2	Control _Plot 5a	6	3.75	0.625	0.186675			
Impact_Plot 6a	1.8	2.85	0.65	1.5	1.1	1	Control _Plot 5b	6	3.7	0.616667	0.138667			
Impact_Plot 6b	2.6	0.76	1.7	0.95	1.25	1.75	Control _Plot 5c	6	5.81	0.968333	0.367617			
Impact_Plot 6c	1.6	0.85	1	1.2	1.3	0.95	Impact_Plot 6a	6	8.9	1.483333	0.608667			
							Impact_Plot 6b	6	9.01	1.501667	0.445017			
							Impact_Plot 6c	6	6.9	1.15	0.076			
							Data1	6	9.55	1.591667	0.312417			
							Data2	6	7.41	1.235	0.95075			

							Data3	6	4.86	0.81	0.296			
							Data4	6	4.9	0.816667	0.242667			
							Data5	6	5.45	0.908333	0.146417			
							Data6	6	5.9	0.983333	0.249667			
							ANOVA							
							Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*	
							Rows	4.659092	5	0.931818	3.679881	0.012	2.602987	Reject Null Hypothesis because p < 0.05 (Means are Different)
							Columns	2.783092	5	0.556618	2.198164	0.086	2.602987	Cannot Reject Null Hypothesis because p > 0.05 (Means are the same)
							Error	6.330492	25	0.25322				
							Total	13.77268	35					

Levene's Test_Grass Tree Cover

Data1	Data2	Data3	Data4	Data5	Data6		*Data1*	*Data2*	*Data3*	*Data4*	*Data5*	*Data6*
27	17.5	25.5	15	27	17.5	Median	19.55	16.75	24.5	14.75	28.375	22.75
5.5	6.75	10.7	7	11	11.25	Mean	17.85	16.45833	22.74167	14.86667	25.51667	21.55833
21.6	24	28	10.7	24	23.5	Variance	77.315	37.96042	62.04042	31.82667	57.45667	44.46042
17.5	21.5	23.5	19.5	29.75	31	n	6	6	6	6	6	6
26	16	32.25	22.5	30	22	df	5	5	5	5	5	5
9.5	13	16.5	14.5	31.35	24.1		Levene's					
						Test	0.315					
						p	0.900		Cannot Reject Null Hypothesis because p > 0.05 (Variances are the same)			
							a	0.05				

Repeat Measures ANOVA _Grass Tree Cover

	Data1	Data2	Data3	Data4	Data5	Data6	Anova: Two Factor Without Replication	a	0.05					
Impact_Plot 6a	17.5	21.5	23.5	19.5	29.75	31								
Impact_Plot 6b	26	16	32.25	22.5	30	22	*SUMMARY*	*Count*	*Sum*	*Average*	*Variance*			
Impact_Plot 6c	9.5	13	16.5	14.5	31.35	24.1	Impact_Plot 6a	6	142.75	23.79167	30.16042			
							Impact_Plot 6b	6	148.75	24.79167	34.91042			
							Impact_Plot 6c	6	108.95	18.15833	65.40642			
							Data1	3	53	17.66667	68.08333			
							Data2	3	50.5	16.83333	18.58333			
							Data3	3	72.25	24.08333	62.27083			
							Data4	3	56.5	18.83333	16.33333			
							Data5	3	91.1	30.36667	0.740833			
							Data6	3	77.1	25.7	22.17			
							ANOVA							
							Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*	
							Rows	153.4711	2	76.73556	3.44272	0.073	4.102821	Cannot Reject Null Hypothesis because p > 0.05 (Means are the same)
							Columns	429.494	5	85.89881	3.853827	0.033	3.325835	Reject Null Hypothesis because p < 0.05 (Means are Different)
							Error	222.8922	10	22.28922				
							Total	805.8574	17					

Repeat Measures ANOVA _Species Richness for All Sites

	Data1	Data2	Data3	Data4	Data5	Data6	Anova: Two Factor Without Replication	a	0.05					
Plot 5a_September 2018	3	5	13	2	0	0								
Plot 5a_April 2018	3	5	13	2	0	0	*SUMMARY*	*Count*	*Sum*	*Average*	*Variance*			
Plot 5a_October 2017	3	4	13	2	0	1	Plot 5a_September 2018	6	23	3.833333	23.76667			
Plot 5a_April 2017	4	5	12	2	0	0	Plot 5a_April 2018	6	23	3.833333	23.76667			
Plot 5a_September 2016	10	7	18	2	0	1	Plot 5a_October 2017	6	23	3.833333	22.16667			
Plot 5a_April 2016	5	7	16	2	0	1	Plot 5a_April 2017	6	23	3.833333	20.16667			
Plot 5b_September 2018	5	6	9	2	0	0	Plot 5a_September 2016	6	38	6.333333	47.46667			
Plot 5b_April 2018	6	6	13	2	0	1	Plot 5a_April 2016	6	31	5.166667	34.96667			
Plot 5b_October 2017	4	6	10	2	0	1	Plot 5b_September 2018	6	22	3.666667	13.06667			
Plot 5b_April 2017	4	6	9	2	0	1	Plot 5b_April 2018	6	28	4.666667	23.06667			
Plot 5b_September 2016	8	9	18	2	0	1	Plot 5b_October 2017	6	23	3.833333	13.76667			
Plot 5b_April 2016	5	9	17	2	0	1	Plot 5b_April 2017	6	22	3.666667	11.46667			
Plot 5c_September 2018	5	2	19	2	0	0	Plot 5b_September 2016	6	38	6.333333	46.66667			
Plot 5c_April 2018	6	6	14	2	0	1	Plot 5b_April 2016	6	34	5.666667	41.46667			
Plot 5c_October 2017	7	6	13	1	0	1	Plot 5c_September 2018	6	28	4.666667	52.66667			
Plot 5c_April 2017	6	7	11	1	0	1	Plot 5c_April 2018	6	29	4.833333	26.56667			
Plot 5c_September 2016	10	7	18	1	0	1	Plot 5c_October 2017	6	28	4.666667	25.06667			
Plot 5c_April 2016	9	6	18	1	0	1	Plot 5c_April 2017	6	26	4.333333	19.06667			
Plot 6a_September 2018	4	5	15	1	0	0	Plot 5c_September 2016	6	37	6.166667	49.36667			
Plot 6a_April 2018	7	5	15	1	0	1	Plot 5c_April 2016	6	35	5.833333	47.76667			

Plot 6a_October 2017	4	6	18	1	0	0	Plot 6a_September 2018	6	25	4.166667	32.56667			
Plot 6a_April 2017	4	6	16	1	0	0	Plot 6a_April 2018	6	29	4.833333	32.16667			
Plot 6a_September 2016	10	6	23	1	0	0	Plot 6a_October 2017	6	29	4.833333	47.36667			
Plot 6a_April 2016	10	6	22	1	0	0	Plot 6a_April 2017	6	27	4.5	37.5			
Plot 6b_September 2018	4	4	16	1	0	1	Plot 6a_September 2016	6	40	6.666667	79.86667			
Plot 6b_April 2018	4	4	19	1	0	1	Plot 6a_April 2016	6	39	6.5	73.5			
Plot 6b_October 2017	6	3	18	1	0	0	Plot 6b_September 2018	6	26	4.333333	35.46667			
Plot 6b_April 2017	6	5	16	1	0	0	Plot 6b_April 2018	6	29	4.833333	50.96667			
Plot 6b_September 2016	9	6	19	1	0	0	Plot 6b_October 2017	6	28	4.666667	47.86667			
Plot 6b_April 2016	9	5	18	1	0	0	Plot 6b_April 2017	6	28	4.666667	37.46667			
Plot 6c_September 2018	6	4	14	1	0	1	Plot 6b_September 2016	6	35	5.833333	54.96667			
Plot 6c_April 2018	5	5	14	1	0	1	Plot 6b_April 2016	6	33	5.5	49.9			
Plot 6c_October 2017	5	7	19	1	0	1	Plot 6c_September 2018	6	26	4.333333	27.46667			
Plot 6c_April 2017	6	6	18	1	0	1	Plot 6c_April 2018	6	26	4.333333	27.06667			
Plot 6c_September 2016	10	8	22	1	0	2	Plot 6c_October 2017	6	33	5.5	51.1			
Plot 6c_April 2016	8	7	22	1	0	2	Plot 6c_April 2017	6	32	5.333333	45.46667			
							Plot 6c_September 2016	6	43	7.166667	68.96667			
							Plot 6c_April 2016	6	40	6.666667	67.06667			
							Data1	36	220	6.111111	5.187302			
							Data2	36	207	5.75	2.135714			
							Data3	36	578	16.05556	13.13968			
							Data4	36	50	1.3888	0.2444			

										89	44			
							Data5	36	0	0	0			
							Data6	36	24	0.666667	0.342857			
							ANOVA							
							Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*	
							Rows	201.8287	35	5.766534	1.886527	0.004	1.490573	Reject Null Hypothesis because p < 0.05 (Means are Different)
							Columns	6510.245	5	1302.049	425.9666	0.000	2.265761	Reject Null Hypothesis because p < 0.05 (Means are Different)
							Error	534.9213	175	3.056693				
							Total	7246.995	215					

Repeat Measures ANOVA _Species Richness for Control Sites

	Data1	Data2	Data3	Data4	Data5	Data6	Data7	Anova: Two Factor Without Replication	a	0.05					
Plot 5a_September 2018	3	5	13	2	0	0	23								
Plot 5a_April 2018	3	5	13	2	0	0	23	*SUMMARY*	*Count*	*Sum*	*Average*	*Variance*			
Plot 5a_October 2017	3	4	13	2	0	1	23	Plot 5a_September 2018	7	46	6.571429	72.28571			
Plot 5a_April 2017	4	5	12	2	0	0	23	Plot 5a_April 2018	7	46	6.571429	72.28571			
Plot 5a_September 2016	10	7	18	2	0	1	38	Plot 5a_October 2017	7	46	6.571429	70.95238			
Plot 5a_April 2016	5	7	16	2	0	1	31	Plot 5a_April 2017	7	46	6.571429	69.28571			
Plot 5b_September	5	6	9	2	0	0	22	Plot 5a_September 2016	7	76	10.85714	182.8095			

2018															
Plot 5b_April 2018	6	6	13	2	0	1	28	Plot 5a_April 2016	7	62	8.857143	124.4762			
Plot 5b_October 2017	4	6	10	2	0	1	23	Plot 5b_September 2018	7	44	6.285714	58.90476			
Plot 5b_April 2017	4	6	9	2	0	1	22	Plot 5b_April 2018	7	56	8	97			
Plot 5b_September 2016	8	9	18	2	0	1	38	Plot 5b_October 2017	7	46	6.571429	63.95238			
Plot 5b_April 2016	5	9	17	2	0	1	34	Plot 5b_April 2017	7	44	6.285714	57.57143			
Plot 5c_September 2018	5	2	19	2	0	0	28	Plot 5b_September 2016	7	76	10.85714	182.1429			
Plot 5c_April 2018	6	6	14	2	0	1	29	Plot 5b_April 2016	7	68	9.714286	149.2381			
Plot 5c_October 2017	7	6	13	1	0	1	28	Plot 5c_September 2018	7	56	8	121.6667			
Plot 5c_April 2017	6	7	11	1	0	1	26	Plot 5c_April 2018	7	58	8.285714	105.5714			
Plot 5c_September 2016	10	7	18	1	0	1	37	Plot 5c_October 2017	7	56	8	98.66667			
Plot 5c_April 2016	9	6	18	1	0	1	35	Plot 5c_April 2017	7	52	7.428571	82.95238			
								Plot 5c_September 2016	7	74	10.57143	176.9524			
								Plot 5c_April 2016	7	70	10	161.3333			
								Data1	18	103	5.722222	5.153595			
								Data2	18	109	6.055556	2.643791			
								Data3	18	254	14.11111	10.9281			
								Data4	18	32	1.777	0.183			

											778	007			
								Data5	18	0	0	0			
								Data6	18	13	0.722 222	0.212 418			
								Data7	18	51 1	28.38 889	33.78 105			
								ANOVA							
								Source of Variation	*SS*	*df*	*MS*	*F*	*P-Valu e*	*F crit*	
								Rows	328.1 587	17	19.30 345	3.447 199	0.00 0	1.723 833	Reject Null Hypothesis because p < 0.05 (Means are Different)
								Columns	11117 .11	6	1852. 852	330.8 811	0.00 0	2.188 761	Reject Null Hypothesis because p < 0.05 (Means are Different)
								Error	571.1 746	10 2	5.599 751				

Repeat Measures ANOVA _Species Richness for Impact Sites

	Dat a1	Dat a2	Dat a3	Dat a4	Dat a5	Dat a6	Dat a7	Anova: Two Factor Without Replication	a	0.0 5					
Plot 6a_September 2018	4	5	15	1	0	0	25								
Plot 6a_April 2018	7	5	15	1	0	1	29	*SUMMARY*	*Count*	*Su m*	*Avera ge*	*Varian ce*			
Plot 6a_October 2017	4	6	18	1	0	0	29	Plot 6a_September 2018	7	50	7.1428 57	89.142 86			
Plot 6a_April 2017	4	6	16	1	0	0	27	Plot 6a_April 2018	7	58	8.2857 14	110.23 81			
Plot 6a_September 2016	10	6	23	1	0	0	40	Plot 6a_October 2017	7	58	8.2857 14	122.90 48			
Plot 6a_April 2016	10	6	22	1	0	0	39	Plot 6a_April 2017	7	54	7.7142 86	103.57 14			
Plot 6b_September	4	4	16	1	0	1	26	Plot 6a_September 2016	7	80	11.428 57	225.28 57			

2018															
Plot 6b_April 2018	4	4	19	1	0	1	29	Plot 6a_April 2016	7	78	11.14286	212.1429			
Plot 6b_October 2017	6	3	18	1	0	0	28	Plot 6b_September 2018	7	52	7.428571	96.61905			
Plot 6b_April 2017	6	5	16	1	0	0	28	Plot 6b_April 2018	7	58	8.285714	125.9048			
Plot 6b_September 2016	9	6	19	1	0	0	35	Plot 6b_October 2017	7	56	8	117.6667			
Plot 6b_April 2016	9	5	18	1	0	0	33	Plot 6b_April 2017	7	56	8	109			
Plot 6c_September 2018	6	4	14	1	0	1	26	Plot 6b_September 2016	7	70	10	167.3333			
Plot 6c_April 2018	5	5	14	1	0	1	26	Plot 6b_April 2016	7	66	9.428571	149.619			
Plot 6c_October 2017	5	7	19	1	0	1	33	Plot 6c_September 2018	7	52	7.428571	89.95238			
Plot 6c_April 2017	6	6	18	1	0	1	32	Plot 6c_April 2018	7	52	7.428571	89.61905			
Plot 6c_September 2016	10	8	22	1	0	2	43	Plot 6c_October 2017	7	66	9.428571	150.619			
Plot 6c_April 2016	8	7	22	1	0	2	40	Plot 6c_April 2017	7	64	9.142857	139.4762			
								Plot 6c_September 2016	7	86	12.28571	240.9048			
								Plot 6c_April 2016	7	80	11.42857	214.619			
								Data1	18	117	6.5	5.205882			
								Data2	18	98	5.444444	1.555556			
								Data3	18	324	18	8.117647			
								Data4	18	18	1	0			
								Data5	18	0	0	0			
								Data6	18	11	0.611111	0.486928			

								Data7	18	568	31.55556	32.14379			
								ANOVA								
								Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*	
								Rows	312.254	17	18.36788	3.781744	0.000	1.723833	Reject Null Hypothesis because p < 0.05 (Means are Different)
								Columns	14832.3	6	2472.05	508.9678	0.000	2.188761	Reject Null Hypothesis because p < 0.05 (Means are Different)
								Error	495.4127	102	4.856987				

Repeat Measures ANOVA _Forb Species Richness for All Sites

	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Anova: Two Factor Without Replication	a	0.05					
Sep-18	3	5	5	4	4	6								
Apr-18	3	6	6	7	4	5	*SUMMARY*	*Count*	*Sum*	*Average*	*Variance*			
Oct-17	3	4	7	4	6	5	Sep-18	6	27	4.5	1.1			
Apr-17	4	4	6	4	6	6	Apr-18	6	31	5.166667	2.166667			
Sep-16	10	8	10	10	9	10	Oct-17	6	29	4.833333	2.166667			
Apr-16	5	5	9	10	9	8	Apr-17	6	30	5	1.2			
							Sep-16	6	57	9.5	0.7			
							Apr-16	6	46	7.666667	4.666667			
							Data1	6	28	4.666667	7.466667			
							Data2	6	32	5.333333	2.266667			
							Data3	6	43	7.166667	3.766667			

							Data4	6	39	6.5	8.7			
							Data5	6	38	6.333333	5.066667			
							Data6	6	40	6.666667	3.866667			
							ANOVA							
							Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*	
							Rows	121.5556	5	24.31111	17.81759	0.000	2.602987	Reject Null Hypothesis because p < 0.05 (Means are Different)
							Columns	25.88889	5	5.177778	3.794788	0.011	2.602987	Reject Null Hypothesis because p < 0.05 (Means are Different)
							Error	34.11111	25	1.364444				
							Total	181.5556	35					

Repeat Measures ANOVA _ Sedge/ Rush and Grass Species Richness for All Sites

	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Anova: Two Factor Without Replication	a	0.05					
Sep-18	5	6	2	5	4	4								
Apr-18	5	6	6	5	4	5	*SUMMARY*	*Count*	*Sum*	*Average*	*Variance*			
Oct-17	4	6	6	6	3	7	Sep-18	6	26	4.333333	1.866667			
Apr-17	5	6	7	6	5	6	Apr-18	6	31	5.166667	0.566667			
Sep-16	7	9	7	6	6	8	Oct-17	6	32	5.333333	2.266667			
Apr-16	7	9	6	6	5	7	Apr-17	6	35	5.833333	0.566667			
							Sep-16	6	43	7.166667	1.366667			
							Apr-16	6	40	6.666667	1.866667			

							Data1	6	33	5.5	1.5			
							Data2	6	42	7	2.4			
							Data3	6	34	5.666667	3.466667			
							Data4	6	34	5.666667	0.266667			
							Data5	6	27	4.5	1.1			
							Data6	6	37	6.166667	2.166667			
							ANOVA							
							Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*	
							Rows	32.25	5	6.45	7.247191	0.000	2.602987	Reject Null Hypothesis because p < 0.05 (Means are Different)
							Columns	20.25	5	4.05	4.550562	0.004	2.602987	Reject Null Hypothesis because p < 0.05 (Means are Different)
							Error	22.25	25	0.89				
							Total	74.75	35					

Repeat Measures ANOVA _ Groundcover Shrub Species Richness for All Sites

	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Anova: Two Factor Without Replication	a	0.05					
Sep-18	13	9	19	15	16	14								
Apr-18	13	13	14	15	19	14	*SUMMARY*	*Count*	*Sum*	*Average*	*Variance*			
Oct-17	13	10	13	18	18	19	Sep-18	6	86	14.33333	11.06667			
Apr-17	12	9	11	16	16	18	Apr-18	6	88	14.66667	5.066667			
Sep-16	18	18	18	23	19	22	Oct-17	6	91	15.16667	13.36667			
Apr-16	16	17	18	22	18	22	Apr-17	6	82	13.66667	12.26667			
							Sep-16	6	118	19.666	5.0666			

										67	67			
							Apr-16	6	113	18.833 33	6.5666 67			
							Data1	6	85	14.166 67	5.3666 67			
							Data2	6	76	12.666 67	16.266 67			
							Data3	6	93	15.5	10.7			
							Data4	6	109	18.166 67	12.566 67			
							Data5	6	106	17.666 67	1.8666 67			
							Data6	6	109	18.166 67	12.966 67			
							ANOVA							
							Source of Variation	*SS*	*df*	*MS*	*F*	*P-Value*	*F crit*	
							Rows	192.88 89	5	38.577 78	9.1176 47	0.000	2.6029 87	Reject Null Hypothesis because p < 0.05 (Means are Different)
							Columns	161.22 22	5	32.244 44	7.6207 98	0.000	2.6029 87	Reject Null Hypothesis because p < 0.05 (Means are Different)
							Error	105.77 78	25	4.2311 11				
							Total	459.88 89	35					