

Vegetation Monitoring Report 2017

Salty Lagoon



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1. Introduction

1.1 Background

GeoLINK has been engaged by Richmond Valley Council (RVC) to implement the Salty Lagoon Ecosystem Recovery Monitoring Program: Pre-Post Closure of the artificial channel (MPPC). This engagement is part of a detailed rehabilitation strategy for Salty Lagoon that has been implemented by RVC.

The rehabilitation strategy comprises three parts:

- Part 1: Issues evaluation and information gap analysis.
- Part 2: Rehabilitation and management options assessment.
- Part 3: Implementation strategy.

A comprehensive description of the rehabilitation strategy is provided in the Salty Lagoon Rehabilitation Plan (Hydrosphere 2011).

Prior to this current engagement, RVC implemented the Salty Lagoon Ecosystem Recovery Monitoring Program (ERMP). In brief, the ERMP aimed to monitor the ecological health of the system for a two year period, and to collect data across a range of disciplines to allow for further planning to be undertaken in accordance with the broader aims of the rehabilitation strategy. This work included a flora and vegetation mapping component and was completed in March 2010 (Hydrosphere 2010a).

The current engagement is part of the final phase of work (Part 3) which documents the implementation strategy and deals specifically with the closure of the Artificial Channel and associated actions. As part of this strategy, RVC are implementing the MPPC (Hydrosphere 2010b).

The key objectives of the MPPC are to:

1. Confirm positive predicted changes in Salty Lagoon ecological and cultural values, particularly in response to the closure of the artificial channel.
2. Provide adaptive management response mechanisms before and after closure to inform future stages of the rehabilitation strategy.
3. Inform long term strategies with respect to the management of effluent from the Evans Head Sewage Treatment Plan (STP).

1.1.2 ERMP Vegetation Monitoring

The aim of the flora and vegetation mapping components of the ERMP is to “*document the status of key ecosystem components as baseline data to inform planning for recovery*” (Hydrosphere 2010a). Field sampling to allow the production of a base map and a transect and quadrat-based sampling program designed to facilitate future detection of changes to vegetation boundaries, structure and floristics was implemented. The program was particularly designed to monitor the following potential changes:

- Condition of the Broad-leaved Paperbark (*Melaleuca quinquenervia*) dieback zone (referred to herein as the Melaleuca dieback zone).

- Changes to the extent of Broad-leaved Cumbungi (*Typha orientalis*) and Duckweed (*Lemna* sp.) in the STP channel (drainage channel).
- Changes to the vegetation on banks of the lower reaches of Salty Creek.

A comprehensive description of methods and results from the ERMP monitoring is provided in Hydrosphere (2010a).

1.1.3 MPPC Vegetation Monitoring

The MPPC was initiated in March 2011 and is due to be completed in June 2017 (i.e. at the completion of this current monitoring event). Vegetation monitoring is part of the Ecosystem Health and Trend Assessment of the MPPC.

The focus for the vegetation component of the MPPC monitoring is identifying and documenting the occurrence of the predicted changes in the vegetation habitat zone boundaries below 2 m AHD. The other major component is to document any re-colonisation or reduction within the Melaleuca dieback zone on the western side of the lagoon.

1.1.3.1 Predicted Changes to Vegetation Habitat Zones

Vegetation communities are anticipated to change in response to the closure of the artificial channel (this closure occurred in June 2012). A description of the potential changes is described in Hydrosphere (2010b) and in further detail in Hydrosphere (2011). The area of open water is predicted to increase. Giant Waterlilies (*Nymphaea gigantea*) were predicted to colonise the central portions of the lagoon and are also expected to occur on the fringes. Mixed sedges and rushes such as *Juncus* spp. and *Baumea* spp. are expected to dominate the western area currently occupied by Fringing Marsh. Broad-leaved Paperbark may also expand to the east.

Other predicted changes include:

- Establishment of *Gahnia* spp. and Broad-leaved Cumbungi in the deeper depressions that occur on the western shore.
- Drier extremities of the lagoon, where water levels will be less than 0.1 m deep are likely to remain unchanged.
- Other vegetation habitat zones that occur below 2 m AHD will also be potentially affected along the drainage channel (Sedge Swamp/open water) and along the eastern edge of the lagoon (Fringing Marsh and Banksia Woodland).

A detailed vegetation map showing the predicted water level and vegetation habitat zones is provided in Hydrosphere (2011).

Methods that will be used to monitor changes to the location of vegetation habitat zone boundaries include recording floristic composition within each of the three main vegetation habitat zones below the 2 m AHD level, and recording and mapping the location of the current vegetation habitat zone boundaries. The three main vegetation habitat zones that potentially will be affected by the closure of the channel are located predominantly on the western side of Salty Lagoon and comprise the following:

- Fringing Marsh.
- Swamp Forest.
- Sedge Swamp.



1.1.3.2 Re-colonisation of Broad-leaved Paperbark and a Reduction in the Area of Dieback

Historical information and evidence on site (i.e. several large tree stumps in the lagoon) indicates that Broad-leaved Paperbark once occurred further east, closer to the lagoon.

Potential re-colonisation of Broad-leaved Paperbark will be monitored using three of the four transects that were established for the ERMP to allow for comparison with ERMP data and assessment for longer term changes at these locations.

1.1.3.3 Pre-closure Baseline Vegetation Monitoring

Baseline vegetation monitoring for the MPPC at Salty Lagoon pre-closure of the artificial channel was undertaken in March-April 2011 by GeoLINK. This is referred to in this report as 'baseline vegetation monitoring'. For specific details of the methodology and findings of the baseline vegetation monitoring refer to GeoLINK (2012).

1.1.4 Purpose of this Report

The purpose of this report is to document the state of vegetation at the Salty Lagoon site in 2017 post-closure of the artificial channel, and compare these findings with the findings from the baseline vegetation monitoring undertaken in 2011. The 2017 vegetation monitoring event was the final vegetation monitoring event for the MPPC project.



2. Methodology

The following section details the methodology used for the 2017 vegetation monitoring. This methodology follows the methods used for the baseline vegetation monitoring and is summarised where appropriate to reduce repetition with the baseline vegetation report. More detail on methodology can be found in that report (GeoLINK 2012).

2.1 Vegetation Transects

2.1.1 Timing

Vegetation sampling was undertaken over two days on 23 March and 24 March 2017.

Water levels at the time of sampling were very high, as a result of significant rainfall in the week prior to sampling. Water levels ranged from approximately 0.05 m depth at the western edge of the site (i.e. within the sedge swamp) to approximately 0.8 m deep at the eastern end of Transect 1-3 (i.e. within the open water of Salty Lagoon). It should be noted that some of the monitoring quadrats on the western fringe of Salty Lagoon were covered by open water at the time of the 2013 and 2015 vegetation monitoring, and the water level was substantially higher for all three sampling events (2013, 2015, 2017) than that in the 2011 vegetation monitoring event, which was prior to closure of the artificial channel.

2.1.2 Vegetation Habitat Zones

The boundaries of the vegetation were evidenced in the field by the following criteria:

- **Sedge Swamp/Swamp Forest:** Sedge Swamp has a clearly defined edge and generally comprises a dense thicket dominated by *Gahnia sieberiana*, which occurs in all strata including the upper stratum (generally <3 m in height). Emergent Broad-leaved Paperbark and Tea Tree can be present.
- **Swamp Forest/Fringing Marsh:** The edge of the Swamp Forest is poorly defined due to the zone dominated by dead/dying Broad-leaved Paperbark. The point at which the boundary was defined was where percentage foliage cover (PFC) of the Broad-leaved Paperbark greater than 3 m in height was >10%. The recorded way points should be used to accurately relocate this boundary (refer to **Appendix A** [Table A1]).

Transects in which data was collected for this monitoring are the same as those used for baseline vegetation monitoring, as outlined below.

Transects 1-3 are 400-600 m in length and each extends across the three distinct vegetation habitat zones of Fringing Marsh, Swamp Forest and Sedge Swamp. Two quadrats (10 m x 10 m) are located in each vegetation habitat zone along each transect (i.e. total of six quadrats per transect). Quadrats are orientated generally in an east-west direction and run from the open water at the eastern end through the Sedge Swamp to the heathland boundary to the west. The location of the boundary of each of the vegetation habitat zones was recorded via GPS (refer to **Appendix A** [Table A1]).

Transects 4-6 are between 20-60 m in length and each comprise two distinct vegetation habitat zones. One quadrat (10 m x 10 m) is located in each vegetation habitat zone along each of these transects (i.e. total of two quadrats per transect).

Transect 4 traverses the drainage channel (i.e. channel from the STP) and is orientated generally in a north-south direction. The two vegetation habitat zones sampled include Sedge Swamp/open water and Swamp Forest. Transect 5 and Transect 6 are located on the eastern side of Salty Lagoon. These transects are less than 20 m in length and are orientated generally in an east-west direction. The vegetation habitat zones sampled at both transects include Fringing Marsh and Banksia Woodland.

GPS waypoints identifying the location of vegetation quadrats along transects 1-3 are provided in **Appendix A** [Table A2]).

Data recorded for vegetation quadrats included:

- Description of vegetation by stratum (height and total percentage cover) (modified Braun-Blanquet scale; refer to **Table 2.1**).
- Floristic composition with cover abundance for each species.
- Tree species and diameter at breast height (DBH - recorded at 1.25 m above the ground) for each stem greater than 10 cm DBH.
- Number of small trees, saplings, seedlings (i.e. trees with DBH<10cm).
- Description of vegetation health.
- Photos taken from the north-east corner of each quadrat.

Table 2.1 Modified Braun-Blanquet Cover Classes

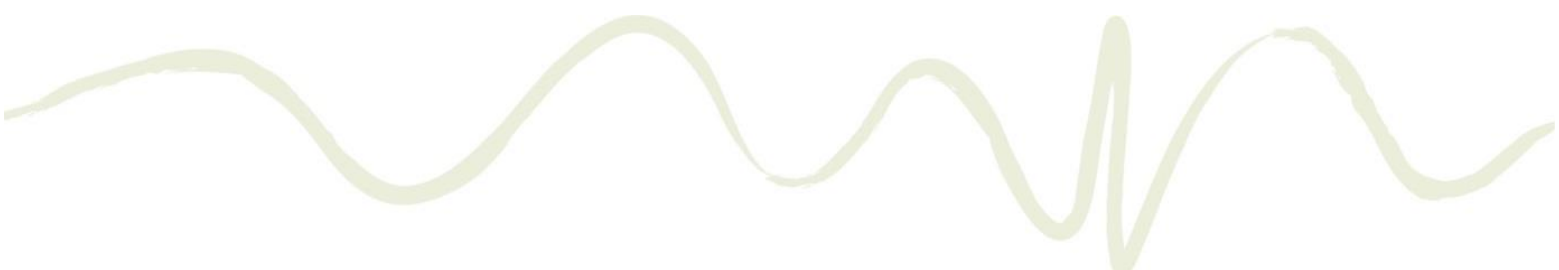
<i>Class</i>	<i>Percentage Cover</i>
1	<5% sparse
2	<5% common
3	5-25%
4	26-50%
5	51-75%
6	76-100%

Trees with DBH >10 cm along Transects 1-3 are not permanently marked in the field, however to facilitate relocation of individual trees, quadrats are divided into four quarters (quadrants) and tree counts start in the north-west corner of the quadrat, moving in a clockwise direction.

2.1.3 Selection of Indicator Species

Indicator flora species were identified in the baseline vegetation monitoring on the basis that will be useful for identifying changes that may occur in vegetation habitat zones once closure of the artificial channel has occurred. These indicator species were selected based on the following methodology:

- Identified in the predicted changes to the Salty Lagoon flora in Hydrosphere (2010b) (refer to **Section 1.1.2.1** of this report); and/or
- Dominant in a vegetation habitat zone, as identified in the cover abundance data collected; and
- Primarily associated with a single habitat vegetation zone.



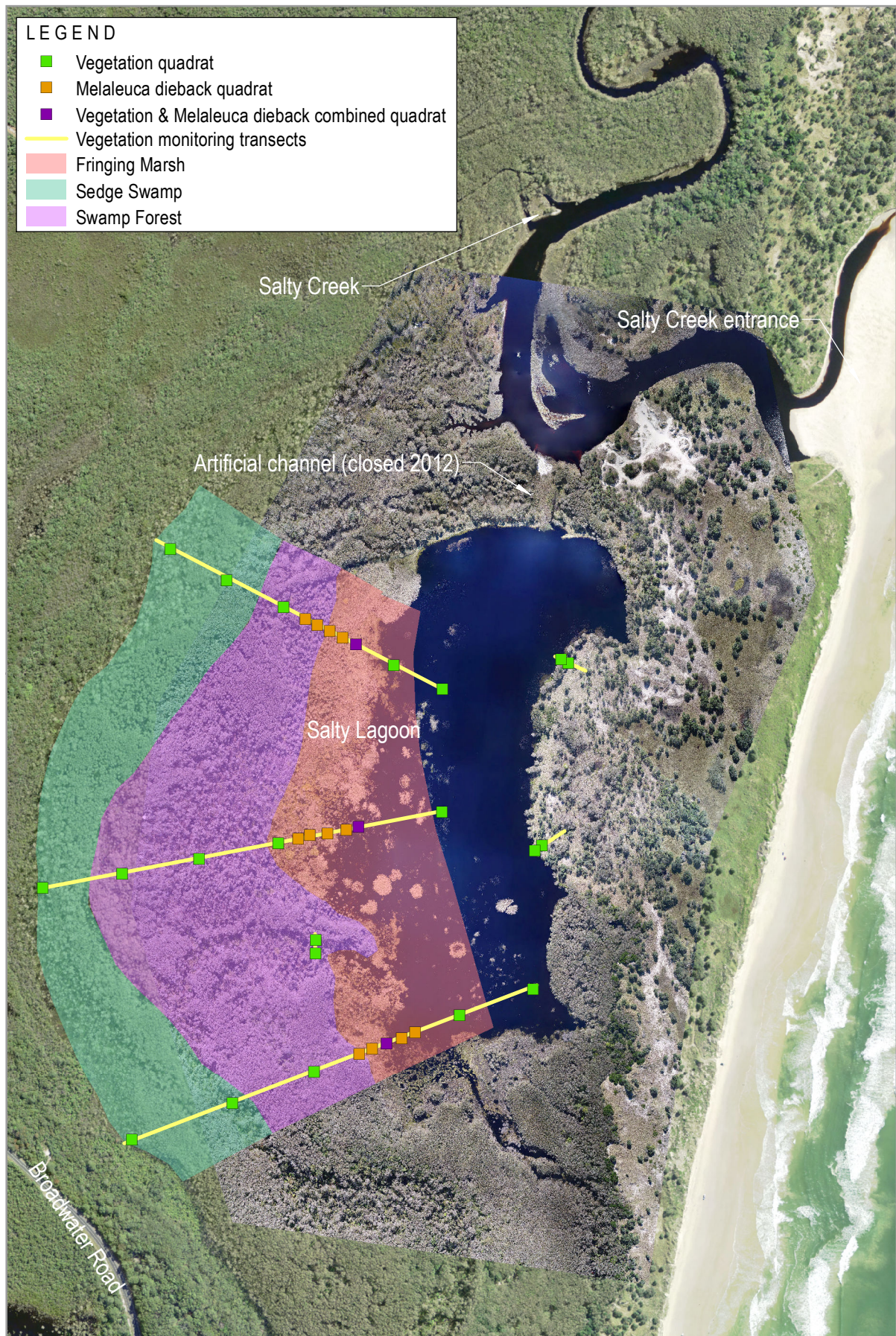
The distribution of these indicator species is expected to change over time and therefore these changes should be reflected in the cover abundance scores of the quadrat data. However, if it is apparent after a number of monitoring events that additional species should be included as indicator species it is recommended that these are also included.

2.1.4 Melaleuca Dieback/ Recolonisation Transects

Melaleuca dieback transects and quadrats (10 m x 10 m) were established for the baseline vegetation monitoring according to the proposed methodology outlined in Hydrosphere (2010b). Three transects correspond with those previously established for the ERMP sampling (refer to Figure 2 in Hydrosphere 2010a). These transects are located along Transects 1-3 established to measure vegetation habitat zone changes (refer to **Illustration 2.1**) and quadrat locations correspond with the Fringing Marsh/Swamp Forest boundary.

The waypoints identifying the location of each quadrat are provided in **Appendix A** (Table A3). Data recorded at Melaleuca dieback quadrats included:

- Vegetation description by stratum (height and total percentage cover).
- Floristic composition with cover abundance for each species (modified Braun-Blanquet scale; refer to **Table 2.1**).
- Description of vegetation health (presence of necrotic spots on leaves, galls on small branches).
- Photos taken from the north-east corner of each quadrat.
- Number of trees (DBH >10 cm).
- Number of small trees (DBH <10 cm >5 cm).
- Number of saplings (DBH <5 cm; height >0.5m).
- Number of seedlings (height <0.5 m).
- Number of dead trees.
- Condition of trees within the quadrat using the following categories:
 - Unaffected/ full recovery.
 - Resprouting.
 - Dead.



Indicative Vegetation Sampling Sites selected for the Monitoring Program



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Illustration 2.1



3. Findings and Observations

3.1 Vegetation Habitat Zonation

3.1.1 Transects 1-3

3.1.1.1 Boundaries of Vegetation Habitat Zones

Transects 1-3 extend across the three distinct vegetation habitat zones of Fringing Marsh, Swamp Forest and Sedge Swamp. The location of the vegetation habitat zone boundaries along these transects is shown in **Illustration 3.1**.

Note that since the baseline vegetation monitoring the total length occupied by the vegetation habitat zones along the transects has decreased due to a substantial amount of Fringing Marsh being converted to open water as water levels in the lagoon have risen since closure of the artificial channel in 2012. Additionally, the extent of Fringing Marsh has varied depending on the extent and depth of standing open water at the time of survey.

The relative distance occupied by the vegetation habitat zones along each transect is detailed in **Table 3.1**.

Table 3.1 Extent of Vegetation Habitat Zones along Transects 1-3

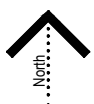
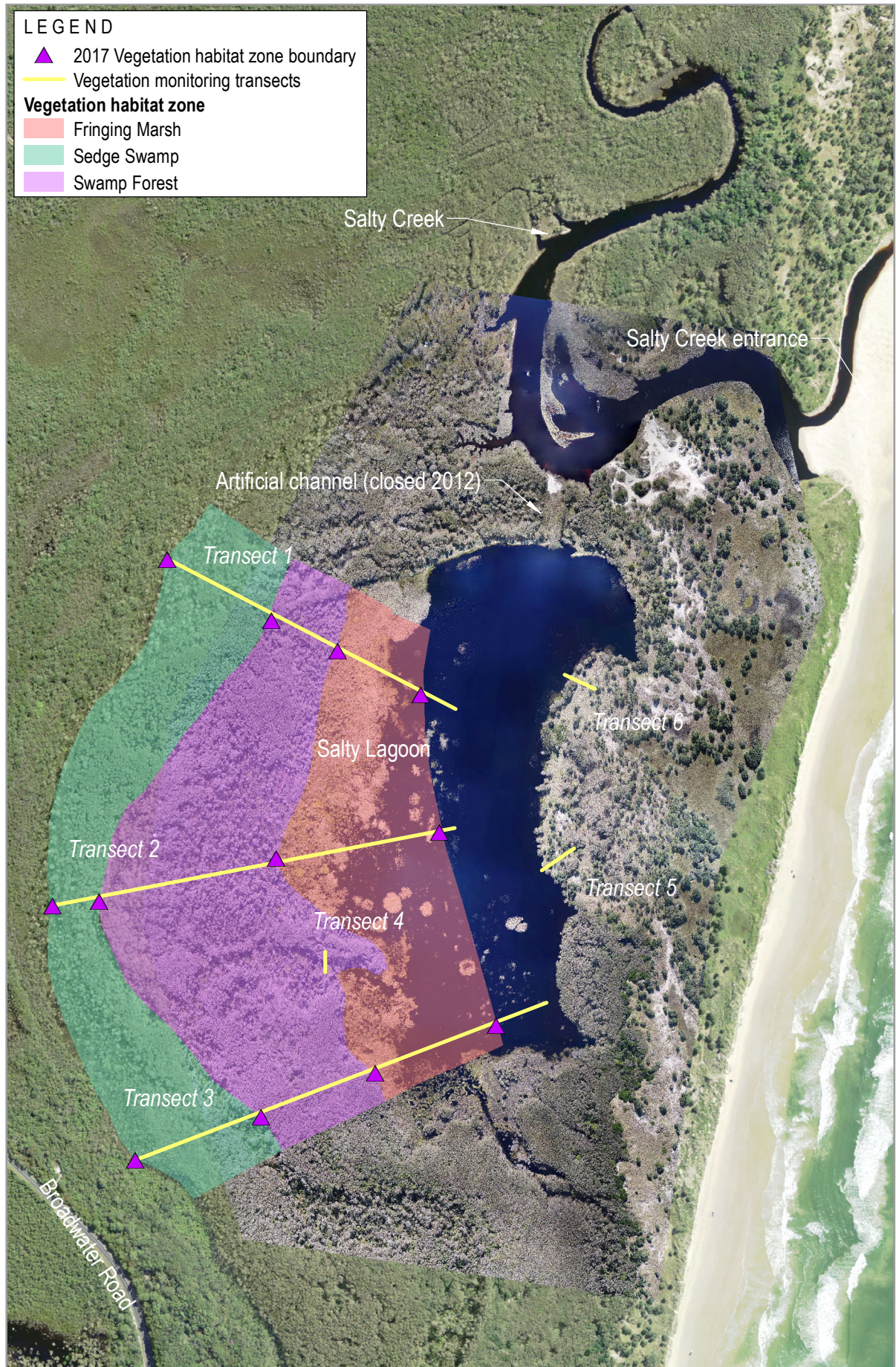
<i>Transect</i>	<i>Extent of Fringing Marsh (m)</i>	<i>Extent of Swamp Forest (m)</i>	<i>Extent of Sedge Swamp (m)</i>	<i>Total Length (m)</i>
Transect 1	125	98	160	383
Transect 2	220	242	62	524
Transect 3	172	162	178	512

3.1.1.2 Species Composition of Vegetation Habitat Zones

In total, 58 flora species (both native and exotic) were recorded from the three vegetation habitat zones. The breakdown of species by vegetation habitat zones was as follows:

- Fringing Marsh – 16 species.
- Swamp Forest – 29 species.
- Sedge Swamp – 31 species.

The dominant flora species by average cover abundance (three and above) within quadrats along Transects 1-3 is represented in **Table 3.2**.



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Location of Vegetation Habitat Zone Boundaries

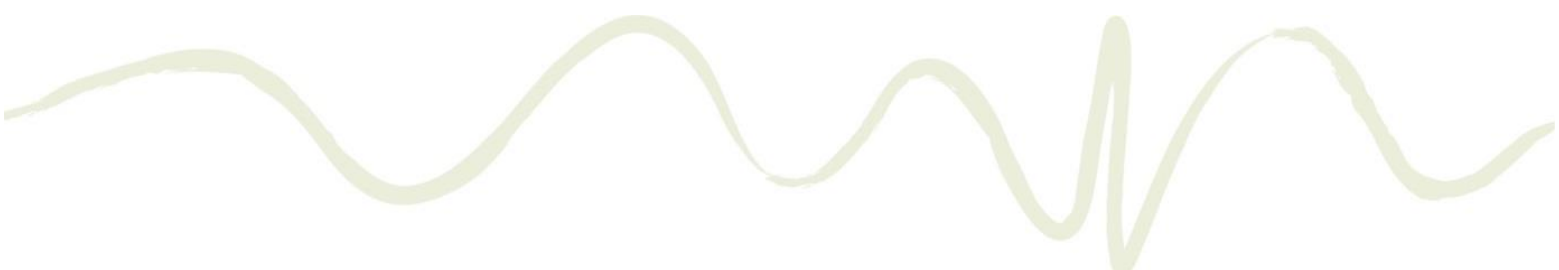
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Illustration 3.1

Table 3.2 Dominant Flora by Cover Abundance (modified Braun-Blanquet Cover Classes) in Quadrats along Transects 1-3

	Common Name	Scientific Name	Fringing Marsh	Swamp Forest	Sedge Swamp
Transect 1	Quadrat A1				
	Weeping Baeckea	<i>Baeckea frutescens</i>			3
	Plume Rush	<i>Baloskion tetraphyllum</i>			5
	Red-fruited Saw-sedge	<i>Gahnia sieberiana</i>			3
	Broad-leaved Paperbark	<i>Melaleuca quinquenervia</i>			3
	Quadrat A2				
	Plume Rush	<i>Baloskion tetraphyllum</i>			5
	Grass Tree	<i>Xanthorrhoea</i> sp.			3
	Broad-leaved Paperbark	<i>Melaleuca quinquenervia</i>			4
	Tantoon	<i>Leptospermum polygalifolium</i>			4
	Quadrat B1				
	Bare Twig-rush	<i>Baumea juncea</i>		6	
	Broad-leaved Paperbark	<i>Melaleuca quinquenervia</i>		3	
	Quadrat B2				
	Broad-leaved Paperbark	<i>Melaleuca quinquenervia</i>		3	
	Bare Twig-rush	<i>Baumea juncea</i>		6	
	Quadrat C1				
	Saltwater Couch	<i>Paspalum vaginatum</i>	3		
	Common Reed	<i>Phragmites australis</i>	6		
	Quadrat C2				
	A sedge	<i>Cyperus polystachyos</i>	3		
	Fringe Rush	<i>Fimbristylis ferruginea</i>	4		
	Enydra	<i>Enydra fluctuans</i>	3		
	Brown Beetle Grass	<i>Diplachne fusca</i>	3		
Transect 2	Quadrat A1				
	Weeping Baeckea	<i>Baeckea frutescens</i>			4
	Dillwinia	<i>Dillwinia retorta</i>			4
	Sellaginella	<i>Sellaginella uliginosa</i>			3
	Zig-zag Bog-rush	<i>Schoenus brevifolius</i>			3
	Cassytha	<i>Cassytha filiformis</i> .			3
	Quadrat A2				
	Bare Twig-rush	<i>Baumea juncea</i>			6
	Broad-leaved	<i>Melaleuca</i>			3

	Common Name	Scientific Name	Fringing Marsh	Swamp Forest	Sedge Swamp
	Paperbark	<i>quinquenervia</i>			
	Saltwater Couch	<i>Paspalum vaginatum</i>			3
	Quadrat B1				
	Jointed Twig Rush	<i>Baumea articulata</i>		3	
	Broad-leaved Paperbark	<i>Melaleuca quinquenervia</i>		4	
	Bare Twig-rush	<i>Baumea juncea</i>		4	
	Gahnia	<i>Gahnia clarkei</i>		3	
	Tall Sedge	<i>Carex appressa</i>		3	
	Quadrat B2				
	Broad-leaved Paperbark	<i>Melaleuca quinquenervia</i>		4	
	Bare Twig-rush	<i>Baumea juncea</i>		3	
	Quadrat C1				
	A sedge	<i>Cyperus polystachyos</i>	4		
	Brown Beetle Grass	<i>Diplachne fusca</i>	3		
	Fringe Rush	<i>Fimbristylis ferruginea</i>	3		
	Saltwater Couch	<i>Paspalum vaginatum</i>	3		
	Broadleaf Cumbungi	<i>Typha orientalis</i>	3		
	Quadrat C2				
	A sedge	<i>Cyperus polystachyos</i>	4		
	Brown Beetle Grass	<i>Diplachne fusca</i>	3		
	Fringe Rush	<i>Fimbristylis ferruginea</i>	3		
Transect 3	Quadrat A1				
	Swamp Twig-rush	<i>Baumea arthropphylla</i>			3
	Broad-leaved Paperbark	<i>Melaleuca quinquenervia</i>			4
	Cassitha	<i>Cassitha filiformis.</i>			3
	Pouched Coral Fern	<i>Gleichenia dicarpa</i>			3
	Zig-zag Bog-rush	<i>Schoenus brevifolius</i>			6
	Quadrat A2				
	Swamp Twig-rush	<i>Baumea arthropphylla</i>			3
	Broad-leaved Paperbark	<i>Melaleuca quinquenervia</i>			4
	Zig-zag Bog-rush	<i>Schoenus brevifolius</i>			6
	Quadrat B1				
	Water Hyssop	<i>Bacopa monnieri</i>		3	
	Broad-leaved Paperbark	<i>Melaleuca quinquenervia</i>		4	
	Tall Sedge	<i>Carex appressa</i>		5	
	Hydrocotyle	<i>Hydrocotyle peduncularis</i>		3	



	Common Name	Scientific Name	Fringing Marsh	Swamp Forest	Sedge Swamp
	Enydra	<i>Enydra fluctuans</i>		3	
	Quadrat B2				
	Groundsel Bush	<i>Baccharis halimifolia</i> *		3	
	Bare Twig-rush	<i>Baumea juncea</i>		4	
	Broad-leaved Paperbark	<i>Melaleuca quinquenervia</i>		4	
	Spiny-headed Mat-rush	<i>Lomandra longifolia</i>		3	
	Zig-zag Bog-rush	<i>Schoenus brevifolius</i>		4	
	Quadrat C1				
	A sedge	<i>Cyperus polystachyos</i>	4		
	Brown Beetle Grass	<i>Diplachne fusca</i>	3		
	Quadrat C2				
	Brown Beetle Grass	<i>Diplachne fusca</i>	3		

Note: indicator species shown in **bold** and exotic species are marked with *

The cover abundance score for all flora species recorded within quadrats along Transects 1-3 is provided in **Appendix B** (Table B1).

3.1.1.3 Vegetation Habitat Zone Descriptions

Fringing Marsh

Dominant flora species within the Fringing Marsh quadrats (refer to **Table 3.2**) consisted of:

- *Cyperus polystachyos* and Brown Beetle Grass (*Diplachne fusca*); occurring in a moderate density in five out of six quadrats.
- Fringe Rush (*Fibrostylus ferruginea*); occurring in moderate density in three out of six quadrats.
- Saltwater Couch (*Paspalum vaginatum*); occurring in a moderate density in two out of six quadrats.
- Common Reed (*Phragmites australis*); occurring in a moderate to high density in two out of six quadrats.
- Sea Rush (*Juncus kraussii* subsp. *australiensis*), Shore Club-rush (*Schoenoplectus subulatus*), Broadleaf Cumbungi (*Typha orientalis*) and Enydra (*Enydra fluctuans*); occurring in a moderate density in one out of six quadrats.

Swamp Forest

Dominant flora species within the Swamp Marsh quadrats (refer to **Table 3.2**) consisted of:

- Broad-leaved Paperbark (*Melaleuca quinquenervia*); occurring in a moderate density in all quadrats.
- Bare Twig-rush (*Baumea juncea*); occurring in a moderate to high density in five out of six quadrats.
- Tall Sedge (*Carex appressa*); occurring in a moderate density in two out of six quadrats.

- Groundsel Bush (*Baccharis halimifolia**), Water Hyssop (*Bacopa monnieri*), Jointed Twig-rush (*Baumea articulata*), Enydra (*Enydra fluctuans*); *Hydrocotyle peduncularis*; Spiny-headed Mat-rush (*Lomandra longifolia*); Common Reed (*Phragmites australis*); *Schoenus brevifolius* all occurring at a moderate density in one out of six quadrats.

Sedge Swamp

Dominant flora species within the Sedge Swamp quadrats (refer to **Table 3.2**) consisted of:

- Broad-leaved Paperbark (*Melaleuca quinquenervia*); occurring in a moderate density in five out of six quadrats.
- Zig-zag Bog-rush (*Schoenus brevifolius*); occurring in a moderate to very high density in three out of six quadrats.
- Swamp Twig-Rush (*Baumea arthropphylla*); occurring in a high density in two out of six quadrats.
- Plume Rush (*Baloskion tetraphyllum*); occurring in a moderate to high density in two out of six quadrats.
- Bare Twig-rush (*Baumea juncea*); occurring in a high density in one out of six quadrats; Weeping Baeckea (*Baeckea frutescens*) and Cassytha (*Cassythea filiformis*); occurring in a moderate density in two out of six quadrats.
- Dillwinia (*Dillwinia retorta*); Red-fruited Sword-sedge (*Gahnia seiberana*), Grass Tree (*Xanthorrhoea* sp.), Pouched Coral Fern (*Gleichenia dicarpa*), Tooton (*Leptospermum polygalifolium*), Selaginella (*Selaginella uliginosa*) and Saltwater Couch (*Paspalum vaginatum*); occurring in a moderate density in one out of six quadrats.

Vegetation characteristics recorded within quadrats along Transects 1-3 are detailed in **Table 3.3**. Characteristics recorded include vegetation habitat zone, vegetation structure and the species and dimensions of all trees >10 cm DBH. Broad-leaved Paperbark was by far the most common tree species recorded.

Indicator Species

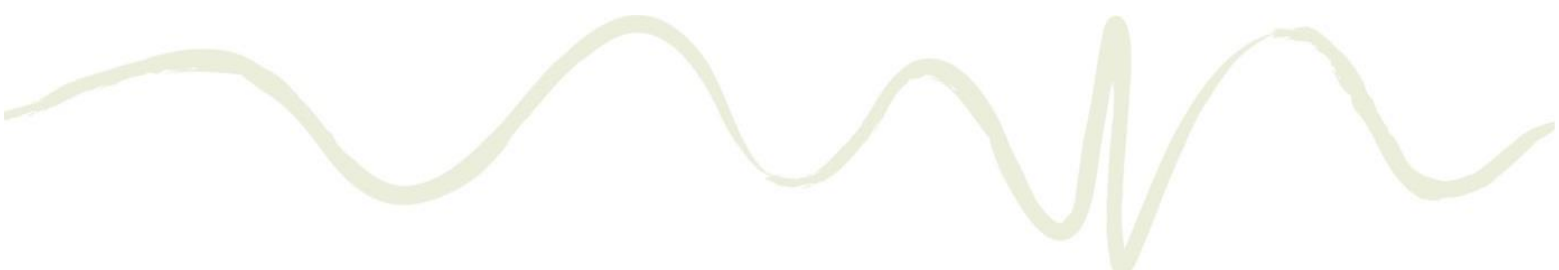
Based on the expected changes to vegetation identified in Hydrosphere (2010b and 2011) and previous monitoring reports by GeoLINK (2011, 2013, 2015), the following species were identified as indicator species for transects 1-3:

- Sea Rush (*Juncus kraussii* subsp. *australiensis*): expected to decrease in the area currently occupied by Fringing Marsh and Swamp Forest.
 - Saltwater Couch (*Paspalum vaginatum*): expected to decrease in the area currently occupied by Fringing Marsh and Swamp Forest.
 - Bare Twig-rush (*Baumea juncea*): expected to increase in the area currently occupied by Fringing Marsh.
- Broad-leaved Paperbark (*Melaleuca quinquenervia*): expected to increase in the area currently occupied by Fringing Marsh.

Plume Rush (*Baloskion tetraphyllum*) was also identified after the baseline surveys as a potential indicator species, as it was detected in the Sedge Swamp in all three transect.

The average cover abundance value for each of these indicator species in the vegetation habitat zones is graphically represented in **Figure 3.1**.

In relation to the indicator species, the results of the monitoring indicate the following:

- 
- Sea Rush (*Juncus kraussii* subsp. *australiensis*): Continues to occur in the Swamp Forest however the number of quadrats in which it was recorded and cover abundance has reduced. Continues to occur in only one quadrat within the Fringing Marsh. Not recorded in the Sedge Swamp.
 - Saltwater Couch (*Paspalum vaginatum*): Continues to occur at low-moderate density in two of the six quadrats in both the Sedge Swamp and Swamp Forest. Occurring at a low-moderate density in four out of six quadrats in the Fringing Swamp.
 - Bare Twig-rush (*Baumea juncea*): Occurring in all quadrats in the Swamp Forest, predominantly at a moderate to high density (i.e. five out of six quadrats). Occurring in one quadrat only in the Sedge Swamp, and at very high density. Not recorded in the Fringing Swamp.
 - Broad-leaved Paperbark (*Melaleuca quinquenervia*): Continues to persist in all quadrats in the Sedge Swamp and Swamp Forest, however only occurs in one quadrat within the Fringing Marsh.
 - Plume Rush (*Baloskion tetraphyllum*): Persists at very high density in the Sedge swamp in Transect 1 and to a lesser degree in the Swamp Forest, however no longer detected in the quadrat on Transects 2 or 3.

The occurrence of, and changes to, indicator species in relation to the results of previous vegetation monitoring are discussed in more detail in **Section 4**.

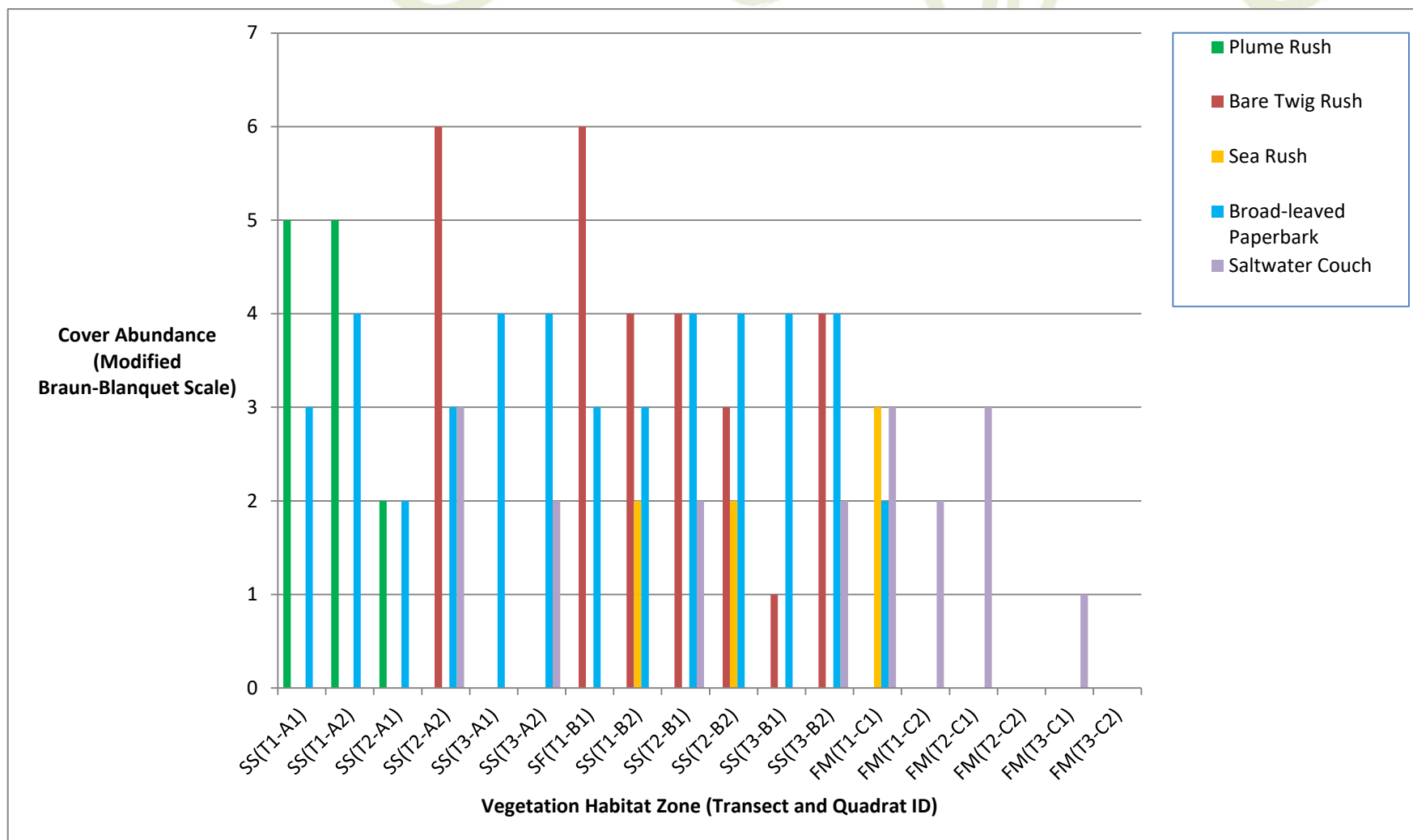


Figure 3.1 Cover Abundance Scores for Indicator Species in Vegetation Habitat Zones of Transects 1-3

Figure abbreviations – SS = Sedge Swamp, SF = Swamp Forest, FM = Fringing Marsh, T = Transect number, A, B etc. = Quadrat ID)

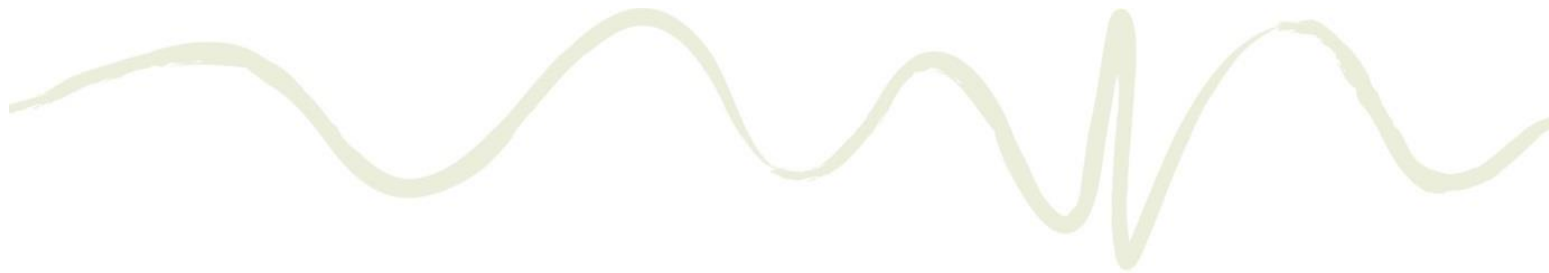
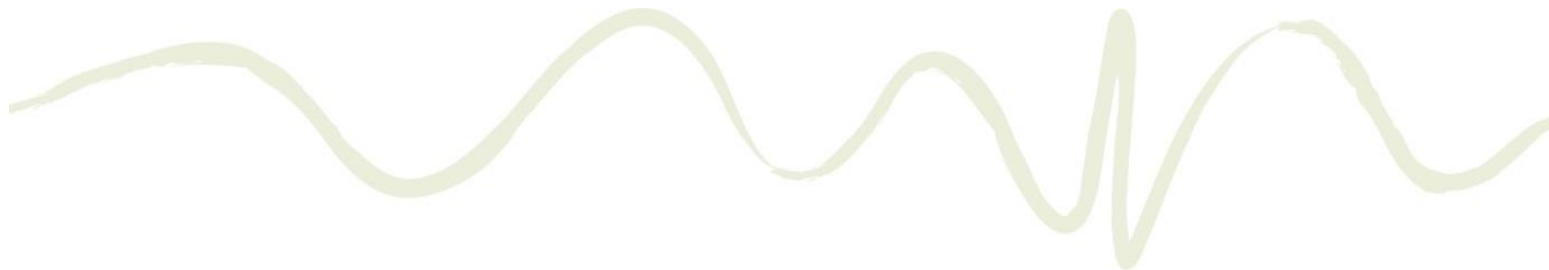
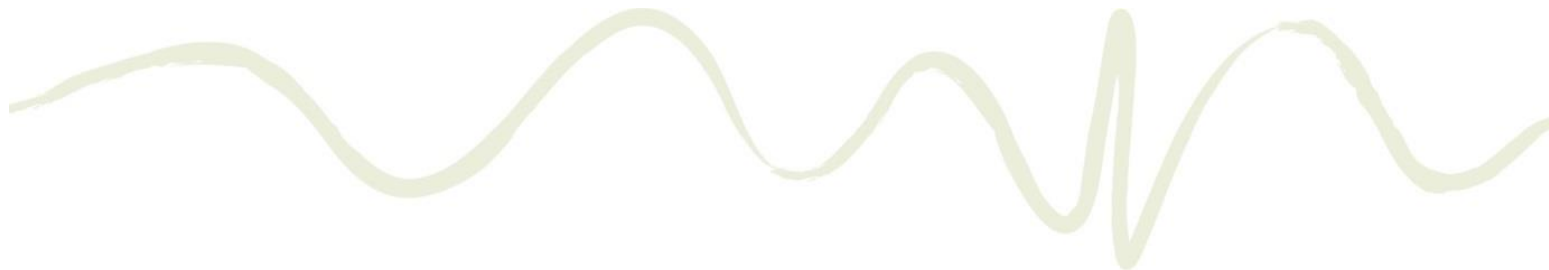


Table 3.3 Vegetation Structure and Characteristics - Quadrat Data for Transects 1-3

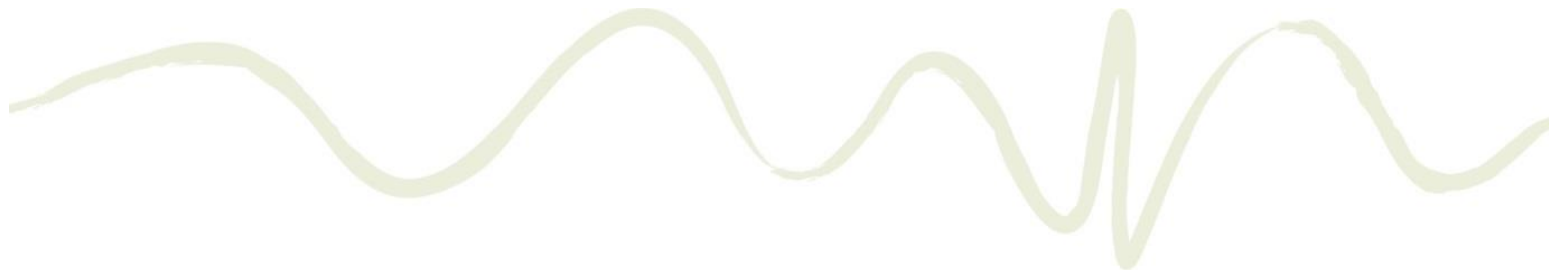
Transect	Quadrat	Vegetation Habitat Zone	Vegetation Structure								Tree Characteristics			Saplings	Comments on Vegetation Health												
			Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Quadrant of Quadrat (Q1 = NW, Q2 = NE, Q3 = SE, Q4 = SW)	Tree Species	DBH of trees (mm) (/ indicates multiple trunks)														
			Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class																	
Transect 1	A1	Sedge Swamp	6	3	-	-	3	2	<2	6	Q2	<i>Eucalyptus robusta</i>	100/ 90	0	<i>Melaleuca quinquenervia</i> look healthy, sparse foliage – no dead branches, galls etc												
												<i>Eucalyptus robusta</i>	170														
												<i>Melaleuca quinquenervia</i>	210														
											Q3	<i>Melaleuca quinquenervia</i>	140	0		<i>Banksia ericifolia</i> x 2 dead within quadrat. 1 x dead Xanthorrhoea No standing water											
												<i>Melaleuca quinquenervia</i>	200														
												<i>Melaleuca quinquenervia</i>	310														
												<i>Melaleuca quinquenervia</i>	130														
											Q4	<i>Melaleuca quinquenervia</i>	110	0													
											A2	Sedge Swamp	6	4			-	-	3	2	<1	6	Not recorded	<i>Melaleuca quinquenervia</i>	415	0	<i>Melaleuca quinquenervia</i> look healthy, sparse foliage – no dead branches, galls
																								<i>Melaleuca quinquenervia</i>	110		
<i>Melaleuca quinquenervia</i>	100																										



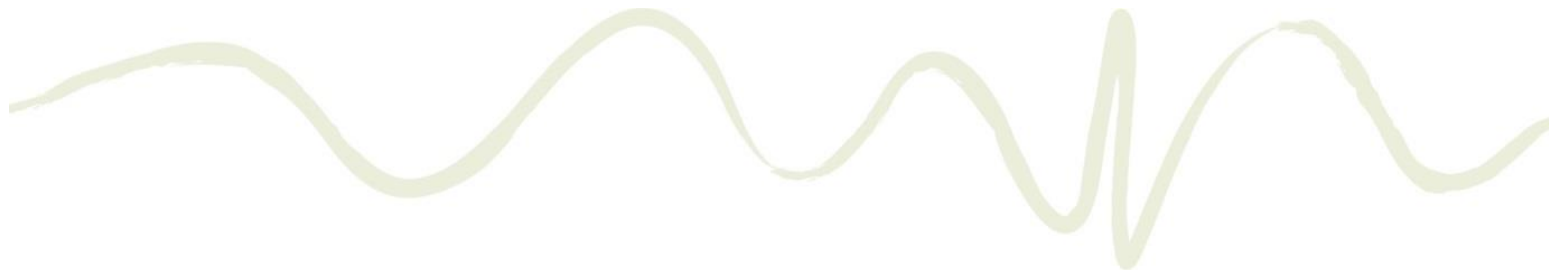
Transect	Quadrat	Vegetation Habitat Zone	Vegetation Structure								Tree Characteristics			Saplings	Comments on Vegetation Health
			Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Quadrant of Quadrat (Q1 = NW, Q2 = NE, Q3 = SE, Q4 = SW)	Tree Species	DBH of trees (mm) (/ indicates multiple trunks)		
			Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class					
												<i>Leptospermum polygalifolium</i>	100		etc General increase in trunk diameter of trees and increase in percentage cover Two additional trees present No standing water
	B1	Swamp Forest	8-10	3	-	-	-	-	<1.2	6	Q2	<i>Melaleuca quinquenervia</i>	220	0	Approx. 7 <i>Melaleuca quinquenervia</i> now dead Foliage of <i>Melaleuca quinquenervia</i> notably thicker than in Sedge Swamp
											Q3	<i>Melaleuca quinquenervia</i>	220/ 150	0	
											Q4	<i>Melaleuca quinquenervia</i>	150	0	
												<i>Melaleuca quinquenervia</i>	190		



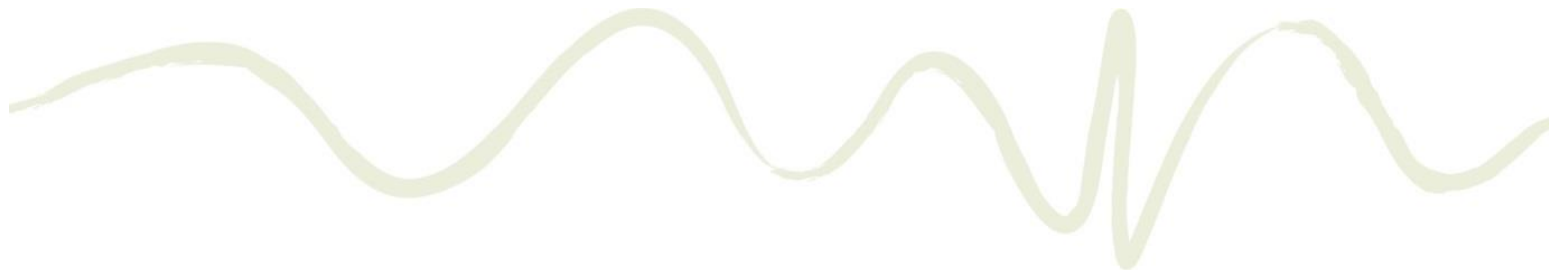
Transect	Quadrat	Vegetation Habitat Zone	Vegetation Structure								Tree Characteristics			Saplings	Comments on Vegetation Health
			Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Quadrant of Quadrat (Q1 = NW, Q2 = NE, Q3 = SE, Q4 = SW)	Tree Species	DBH of trees (mm) (/ indicates multiple trunks)		
			Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class					
												Melaleuca quinquenervia	220		Slight increase in percentage cover of lower stratum and DBH of some trees Standing water depth 0.35 m
												Melaleuca quinquenervia	140/185		
												Melaleuca quinquenervia	220		
	B2	Swamp Forest	5	3	-	-	-	-	<1.2	4	Q1	Melaleuca quinquenervia	155	0	Melaleuca quinquenervia healthy with new growth, no dieback or galls Increase in DBH Standing water depth 0.5 m
											Q2	Melaleuca quinquenervia	115	0	
	C1	Fringing Marsh	3	2	-	-	-	-	2	6	-	-	-	3	3 small Melaleuca quinquenervia present Standing water



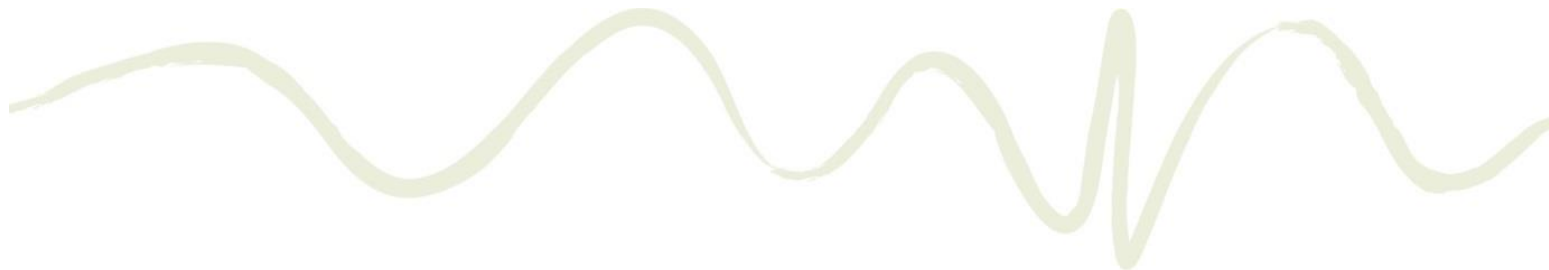
Transect	Quadrat	Vegetation Habitat Zone	Vegetation Structure								Tree Characteristics			Saplings	Comments on Vegetation Health
			Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Quadrant of Quadrat (Q1 = NW, Q2 = NE, Q3 = SE, Q4 = SW)	Tree Species	DBH of trees (mm) (/ indicates multiple trunks)		
			Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class					
															depth 0.65 m
	C2	Fringing Marsh	-	-	-	-	-	-	1.5	5	-	-	-	0	n/a - treeless vegetation/ open water Standing water depth 0.75 m
Transect 2	A1	Sedge Swamp	10	3	-	-	-	-	<1.2	6	-	Melaleuca quinquenervia	110	0	Upper stratum trees occur outside quadrat One additional tree present Standing water depth 0.05 m
	A2	Sedge Swamp	10-12	3	-	-	-	-	<1.2	6	Q1	Melaleuca quinquenervia	200/120	0	Melaleuca quinquenervia healthy with new growth, no dieback or galls
												Melaleuca quinquenervia	160		
											Q2	Melaleuca quinquenervia	320	0	Increase in



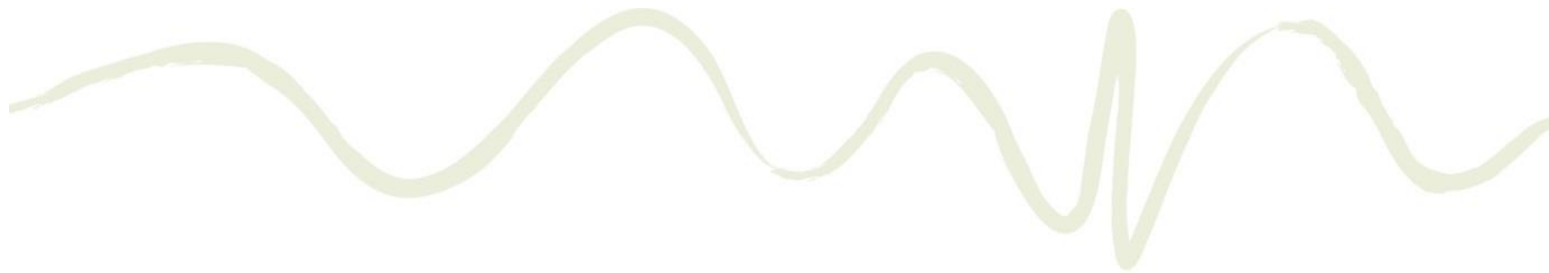
Transect	Quadrat	Vegetation Habitat Zone	Vegetation Structure								Tree Characteristics			Saplings	Comments on Vegetation Health
			Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Quadrant of Quadrat (Q1 = NW, Q2 = NE, Q3 = SE, Q4 = SW)	Tree Species	DBH of trees (mm) (/ indicates multiple trunks)		
			Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class					
												Melaleuca quinquenervia	170/ 140	0	DBH One additional tree present
											Q3	Melaleuca quinquenervia	250		
											Melaleuca quinquenervia	480			
											Melaleuca quinquenervia	150			
	B1	Swamp Forest	10-12	4	-	-	-	-	1 – 1.5	6	Q1	Melaleuca quinquenervia	370	2	Melaleuca quinquenervia is in good health, and with no dead branches or galls Increase in DBH Standing water depth 0.3 m
												Melaleuca quinquenervia	420		
												Melaleuca quinquenervia	170/ 140		
											Q2	Melaleuca quinquenervia	225	0	
												Melaleuca quinquenervia	480		
												Melaleuca	120		



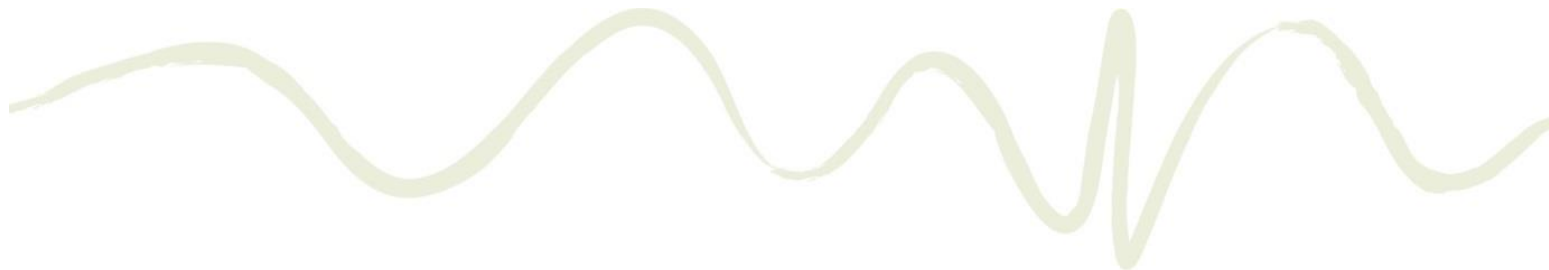
Transect	Quadrat	Vegetation Habitat Zone	Vegetation Structure								Tree Characteristics			Saplings	Comments on Vegetation Health
			Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Quadrant of Quadrat (Q1 = NW, Q2 = NE, Q3 = SE, Q4 = SW)	Tree Species	DBH of trees (mm) (/ indicates multiple trunks)		
			Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class					
												<i>quinquenervia</i>			Seven trees recorded in 2015 in the 100-140 DBH range are now dead. Remaining trees are relatively healthy (no dead branches, evidence of dieback or galls)
												<i>Melaleuca quinquenervia</i>	200		
												<i>Melaleuca quinquenervia</i>	370		
											Q4	<i>Melaleuca quinquenervia</i>	350	0	
	B2*	Swamp Forest	10	4	-	-	-	-	2	4	Q1	<i>Melaleuca quinquenervia</i>	180	0	
												<i>Melaleuca quinquenervia</i>	110		
												<i>Melaleuca quinquenervia</i>	115		
												<i>Melaleuca quinquenervia</i>	115		
												<i>Melaleuca quinquenervia</i>	120		
												<i>Melaleuca quinquenervia</i>	295		



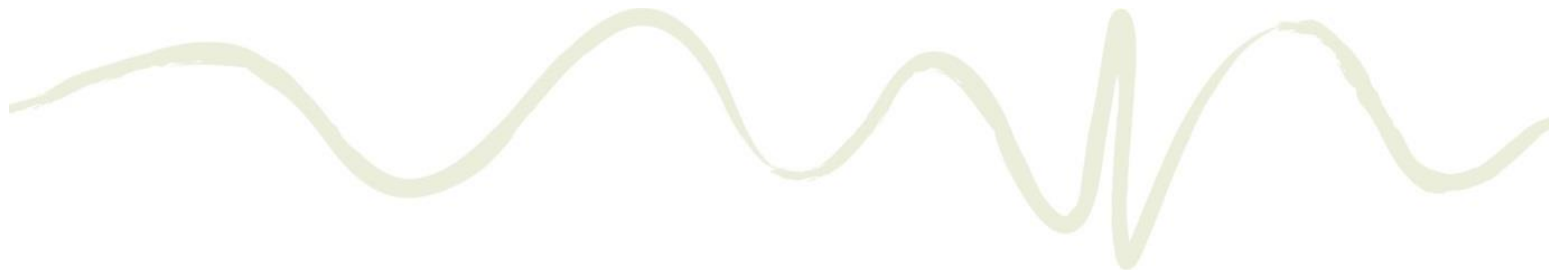
Transect	Quadrat	Vegetation Habitat Zone	Vegetation Structure								Tree Characteristics			Saplings	Comments on Vegetation Health
			Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Quadrant of Quadrat (Q1 = NW, Q2 = NE, Q3 = SE, Q4 = SW)	Tree Species	DBH of trees (mm) (/ indicates multiple trunks)		
			Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class					
												Melaleuca quinquenervia	140/ 240		Increase in height and percentage cover of upper stratum Standing water depth 0.5 m
											Q2	Melaleuca quinquenervia	120	0	
												Melaleuca quinquenervia	180		
												Melaleuca quinquenervia	180		
												Melaleuca quinquenervia	200		
												Melaleuca quinquenervia	205		
												Melaleuca quinquenervia	155/140(d)		
											Q3	Melaleuca quinquenervia	295	0	
												Melaleuca quinquenervia	230/ 150		
											Q4	Melaleuca	160/ 155/	0	



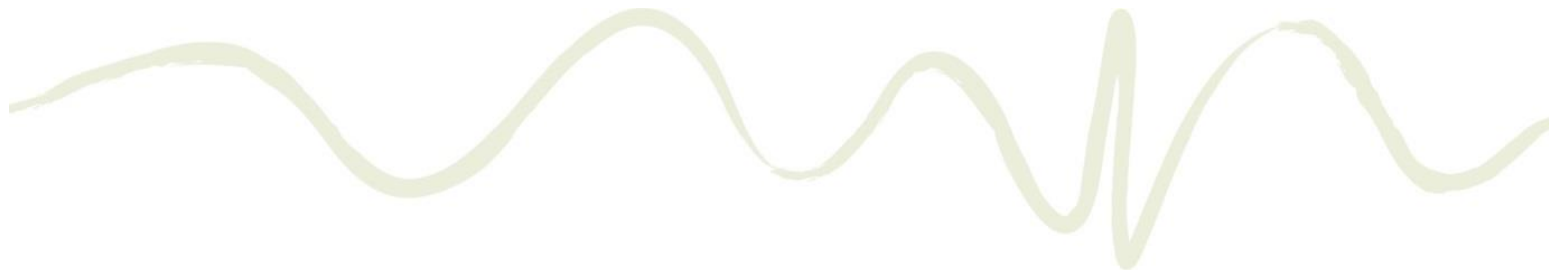
Transect	Quadrat	Vegetation Habitat Zone	Vegetation Structure								Tree Characteristics			Saplings	Comments on Vegetation Health
			Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Quadrant of Quadrat (Q1 = NW, Q2 = NE, Q3 = SE, Q4 = SW)	Tree Species	DBH of trees (mm) (/ indicates multiple trunks)		
			Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class					
												<i>quinquenervia</i>	140		
												<i>Melaleuca quinquenervia</i>	185		
												<i>Melaleuca quinquenervia</i>	300		
												<i>Melaleuca quinquenervia</i>	200		
												<i>Melaleuca quinquenervia</i>	175		
												<i>Melaleuca quinquenervia</i>	140		
	C1	Fringing Marsh	-	-	-	-	-	-	2	4	-	-	-	0	n/a - treeless vegetation/ open water Standing water depth 0.55 m
	C2	Fringing Marsh	-	-	-	-	-	-	2	3	-	-	-	0	n/a - treeless vegetation/ open water Standing water



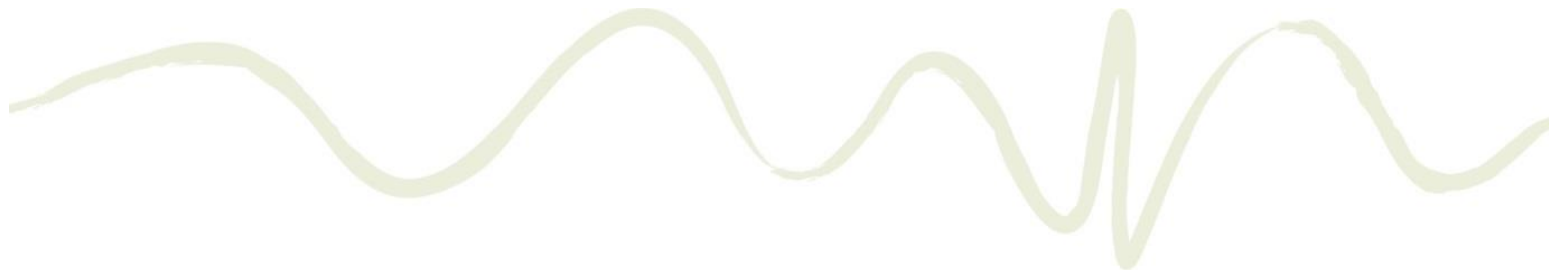
Transect	Quadrat	Vegetation Habitat Zone	Vegetation Structure								Tree Characteristics			Saplings	Comments on Vegetation Health
			Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Quadrant of Quadrat (Q1 = NW, Q2 = NE, Q3 = SE, Q4 = SW)	Tree Species	DBH of trees (mm) (/ indicates multiple trunks)		
			Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class					
															depth 0.8 m
Transect 3	A1*	Sedge Swamp	12-14	4	-	-	2.5	3	<1.5	6	Q1	Melaleuca quinquenervia	150(d)/130	10	Melaleuca quinquenervia trees are relatively healthy (no dead branches, evidence of dieback or galls) Notable occurrence of Melaleuca quinquenervia saplings Standing water depth 0.05 m
											Melaleuca quinquenervia	130/200			
											Melaleuca quinquenervia	160/165			
											Melaleuca quinquenervia	200			
											Melaleuca quinquenervia	170			
											Melaleuca quinquenervia	125/185			
											Melaleuca quinquenervia	110/110			
											Q2	Melaleuca quinquenervia	180	0	
											Melaleuca quinquenervia	140			



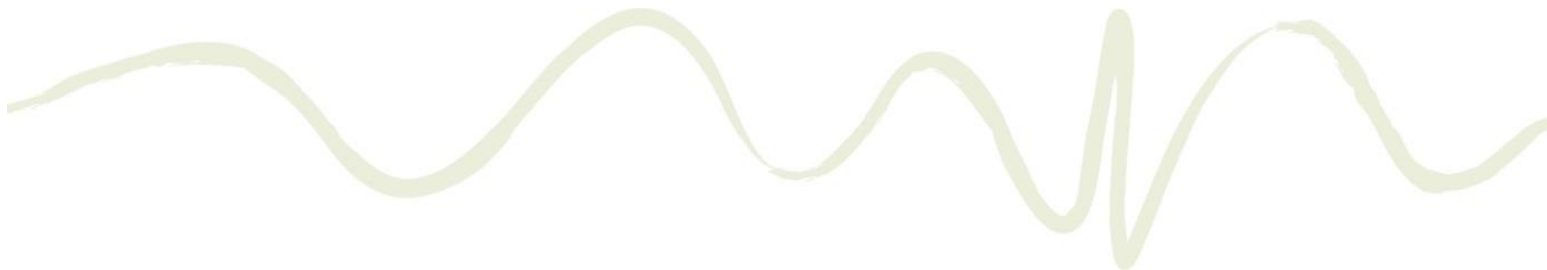
Transect	Quadrat	Vegetation Habitat Zone	Vegetation Structure								Tree Characteristics			Saplings	Comments on Vegetation Health
			Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Quadrant of Quadrat (Q1 = NW, Q2 = NE, Q3 = SE, Q4 = SW)	Tree Species	DBH of trees (mm) (/ indicates multiple trunks)		
			Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class					
												Melaleuca quinquenervia	130		
											Q3	Melaleuca quinquenervia	175		
												Melaleuca quinquenervia	150		
												Melaleuca quinquenervia	170/125/195		
												Melaleuca quinquenervia	220		
												Melaleuca quinquenervia	270		
												Melaleuca quinquenervia	210/160		
												Melaleuca quinquenervia	200		
											Q4	Melaleuca quinquenervia	150		
												Melaleuca	275		



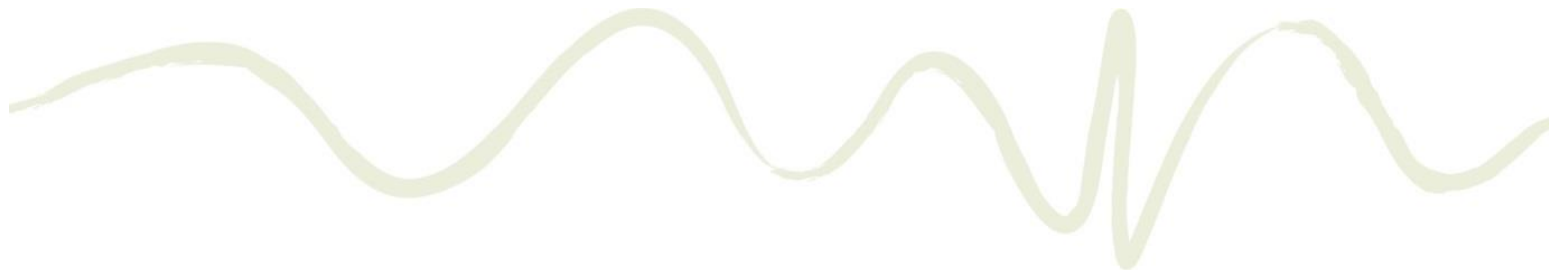
Transect	Quadrat	Vegetation Habitat Zone	Vegetation Structure								Tree Characteristics			Saplings	Comments on Vegetation Health
			Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Quadrant of Quadrat (Q1 = NW, Q2 = NE, Q3 = SE, Q4 = SW)	Tree Species	DBH of trees (mm) (/ indicates multiple trunks)		
			Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class					
												<i>quinquenervia</i>			
												<i>Melaleuca quinquenervia</i>	230		
												<i>Melaleuca quinquenervia</i>	110		
	A2*	Sedge Swamp	12-15	3	-	-	-	-	<1.2	6	Q1	<i>Melaleuca quinquenervia</i>	160	0	<i>Melaleuca quinquenervia</i> trees are relatively healthy (no dead branches, evidence of dieback or galls) Standing water depth 0.05 m
												<i>Melaleuca quinquenervia</i>	130		
												<i>Melaleuca quinquenervia</i>	205		
												<i>Melaleuca quinquenervia</i>	130		
												<i>Melaleuca quinquenervia</i>	185		
												<i>Melaleuca quinquenervia</i>	120		
												<i>Melaleuca quinquenervia</i>	240		



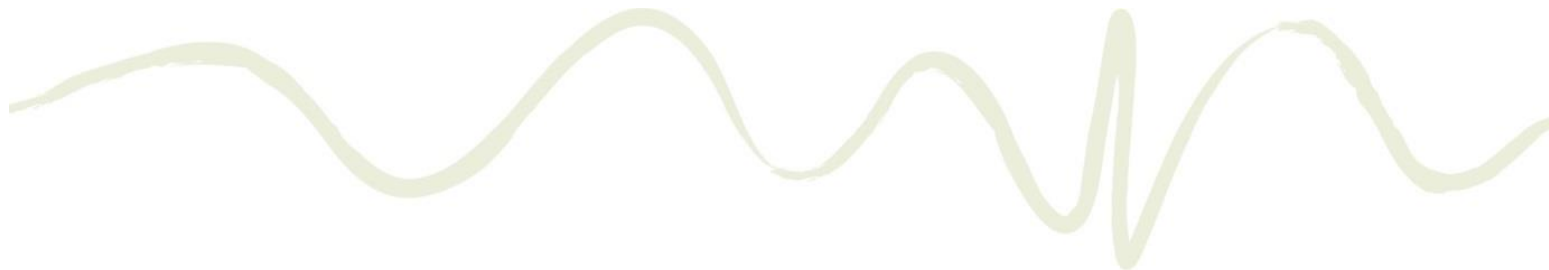
Transect	Quadrat	Vegetation Habitat Zone	Vegetation Structure								Tree Characteristics			Saplings	Comments on Vegetation Health
			Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Quadrant of Quadrat (Q1 = NW, Q2 = NE, Q3 = SE, Q4 = SW)	Tree Species	DBH of trees (mm) (/ indicates multiple trunks)		
			Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class					
												Melaleuca quinquenervia	245		
											Q2	Melaleuca quinquenervia	310	0	
												Melaleuca quinquenervia	190		
												Melaleuca quinquenervia	180		
												Melaleuca quinquenervia	250		
												Melaleuca quinquenervia	240		
												Melaleuca quinquenervia	190		
												Melaleuca quinquenervia	300		
											Q3	Melaleuca quinquenervia	195	0	
												Melaleuca	130		



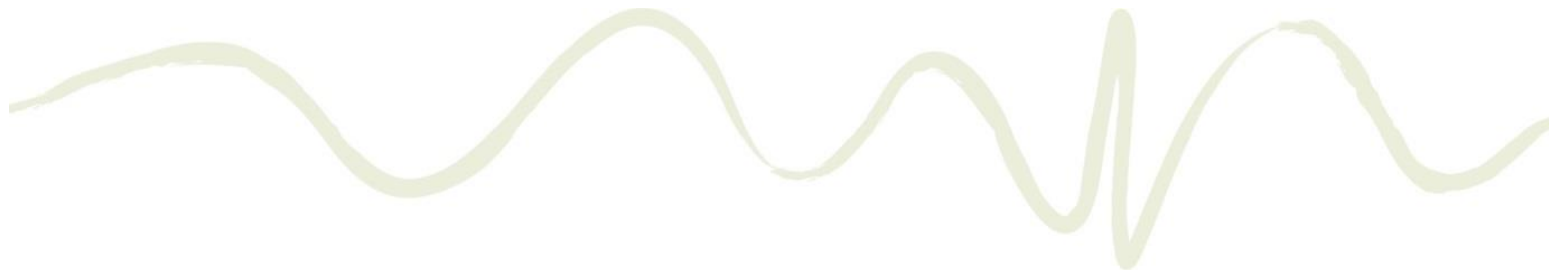
Transect	Quadrat	Vegetation Habitat Zone	Vegetation Structure								Tree Characteristics			Saplings	Comments on Vegetation Health
			Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Quadrant of Quadrat (Q1 = NW, Q2 = NE, Q3 = SE, Q4 = SW)	Tree Species	DBH of trees (mm) (/ indicates multiple trunks)		
			Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class					
												quinquenervia			
												Melaleuca quinquenervia	240		
												Melaleuca quinquenervia	200		
												Melaleuca quinquenervia	175		
											Q4	Melaleuca quinquenervia	230	0	
												Melaleuca quinquenervia	240		
												Melaleuca quinquenervia	145		
												Melaleuca quinquenervia	160		
												Melaleuca quinquenervia	195		
												Melaleuca quinquenervia	240		



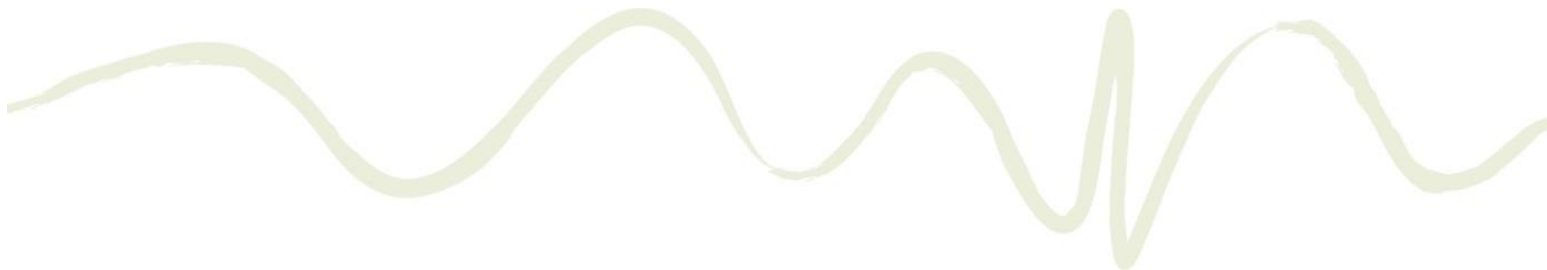
Transect	Quadrat	Vegetation Habitat Zone	Vegetation Structure								Tree Characteristics			Saplings	Comments on Vegetation Health
			Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Quadrant of Quadrat (Q1 = NW, Q2 = NE, Q3 = SE, Q4 = SW)	Tree Species	DBH of trees (mm) (/ indicates multiple trunks)		
			Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class					
												Melaleuca quinquenervia	170		
												Melaleuca quinquenervia	280		
												Melaleuca quinquenervia	220		
												Melaleuca quinquenervia	265		
												Melaleuca quinquenervia	260		
												Melaleuca quinquenervia	190		
												Melaleuca quinquenervia	240		
	B1*	Swamp Forest	12-15	4	-	-	-	-	1-1.5	4	Q1	Melaleuca quinquenervia	220	0	Melaleuca quinquenervia trees are relatively healthy (no dead
												Melaleuca quinquenervia	150		
												Melaleuca quinquenervia	105		



Transect	Quadrat	Vegetation Habitat Zone	Vegetation Structure								Tree Characteristics			Saplings	Comments on Vegetation Health
			Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Quadrant of Quadrat (Q1 = NW, Q2 = NE, Q3 = SE, Q4 = SW)	Tree Species	DBH of trees (mm) (/ indicates multiple trunks)		
			Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class					
												Melaleuca quinquenervia	220		branches, evidence of dieback or galls) Standing water depth 0.1m
												Melaleuca quinquenervia	310		
												Melaleuca quinquenervia	260		
												Melaleuca quinquenervia	275		
												Melaleuca quinquenervia	180		
											Q2	Melaleuca quinquenervia	120		
												Melaleuca quinquenervia	185		
											Q3	Melaleuca quinquenervia	210		
												Melaleuca quinquenervia	155		
											Q4	Melaleuca quinquenervia	250		
												Melaleuca quinquenervia	340		
												Melaleuca quinquenervia	240		



Transect	Quadrat	Vegetation Habitat Zone	Vegetation Structure								Tree Characteristics			Saplings	Comments on Vegetation Health
			Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Quadrant of Quadrat (Q1 = NW, Q2 = NE, Q3 = SE, Q4 = SW)	Tree Species	DBH of trees (mm) (/ indicates multiple trunks)		
			Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class					
												Melaleuca quinquenervia	610		
	B2	Swamp Forest	10	3	-	-	-	-	<1.2	5	Q1	Melaleuca quinquenervia	840	0	Noticeably denser foliage on <i>Melaleuca quinquenervia</i> compared with quadrats A1 and A2 <i>Melaleuca quinquenervia</i> is in good health, and with no dead branches or galls Standing water depth 0.1m
											Melaleuca quinquenervia	110			
											Melaleuca quinquenervia	200/90			
											Melaleuca quinquenervia	205			
											Melaleuca quinquenervia	140			
											Melaleuca quinquenervia	200			
											Melaleuca quinquenervia	330			
											Q3	Melaleuca quinquenervia	230	0	
											Melaleuca quinquenervia	230/230			



Transect	Quadrat	Vegetation Habitat Zone	Vegetation Structure								Tree Characteristics			Saplings	Comments on Vegetation Health
			Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Quadrant of Quadrat (Q1 = NW, Q2 = NE, Q3 = SE, Q4 = SW)	Tree Species	DBH of trees (mm) (/ indicates multiple trunks)		
			Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class					
												Melaleuca quinquenervia	120		
											Melaleuca quinquenervia	165			
											Melaleuca quinquenervia	285			
											Q4	Melaleuca quinquenervia	190	0	
	C1	Fringing Marsh	-	-	-	-	-	-	<1.2	3	-	-	-	0	n/a - treeless vegetation/ open water Standing water depth 0.3m
	C2	Fringing Marsh	-	-	-	-	-	-	-	-	-	-	-	0	n/a - open water Standing water depth 0.7m

Notes:

(d) dead trunk

* The number of trees detected in these quadrats in 2015 appears to be inconsistent with that from baseline (2011), 2013 and 2017 data

3.1.2 Transects 4-6

3.1.2.1 Vegetation Habitat Zone Boundaries

Transects 4-6 each traverse the following two distinct vegetation habitat zones:

- Transect 4: Sedge Swamp/Open Water and Swamp Forest.
- Transect 5 and 6: Fringing Marsh and Banksia Woodland.

The location of the monitoring transects is shown in **Illustration 3.1**.

Transect 4 traverses the drainage channel (i.e. channel from the STP) and is orientated generally in a north-south direction while Transects 5 and 6 lie generally east-west and are located behind the dune system, immediately to the east of Salty Lagoon.

The vegetation habitat zone boundaries along Transects 5 and 6 were fairly well defined in the field at the time of survey. However, as the level of the lagoon has increased following the artificial channel closure, the extent of the Fringing Marsh community has decreased substantially, being replaced by open water.

3.1.2.2 Species Composition of Vegetation Habitat Zones

In total, 41 flora species (both native and exotic) were recorded from the four vegetation habitat zones. The breakdown of species by vegetation habitat zones was as follows:

- Sedge Swamp/ Open Water – 7 species.
- Swamp Forest – 13 species.
- Fringing Marsh – 20 species.
- Banksia Woodland – 24 species.

The dominant flora species by average cover abundance (three and above) within quadrats along Transects 4-6 is represented in **Table 3.4**.

Table 3.4 Dominant Flora by Cover Abundance (modified Braun-Blanquet cover classes) in Quadrats along Transects 4-6

	Common Name	Scientific Name	Sedge Swamp/Open Water	Swamp Forest	Fringing Marsh	Banksia Woodland
Transect 4	Quadrat A1					
	Shore Club-rush	<i>Schoenoplectus subulatus</i>	5			
	Quadrat B1					
	Jointed Twig Rush	<i>Baumea articulata</i>		3		
	A sedge	<i>Cyperus polystachyos</i>		3		
	Shore Club-rush	<i>Schoenoplectus subulatus</i>		3		
	Bare Twig-rush	<i>Baumea juncea</i>		6		
	Saltwater Couch	<i>Paspalum vaginatum</i>		4		

	Common Name	Scientific Name	Sedge Swamp/Open Water	Swamp Forest	Fringing Marsh	Banksia Woodland
	Broad-leaved Paperbark	<i>Melaleuca quinquenervia</i>		3		
Transect 5	Quadrat A1					
	Broad-leaved Paperbark	<i>Melaleuca quinquenervia</i>			3	
	Bare Twig-rush	<i>Baumea juncea</i>			3	
	Watermilfoil	<i>Myriophyllum sp.</i>			3	
	Quadrat B1					
	Coast Banksia	<i>Banksia integrifolia</i> subsp. <i>integrifolia</i>				3
	Bitou Bush	<i>Chrysanthemoides monilifera</i> subsp. <i>rotunda</i> *				3
	Indian Pennywort	<i>Centella asiatica</i>				6
	Blady Grass	<i>Imperata cylindrica</i>				6
	Snake Vine	<i>Stephania japonica</i>				3
Transect 6	Quadrat A1					
	Fringe Rush	<i>Fimbristylis ferruginea</i>			3	
	Broad-leaved Paperbark	<i>Melaleuca quinquenervia</i>			3	
	Shore Club-rush	<i>Schoenoplectus subulatus</i>			3	
	Quadrat B1					
	Blady Grass	<i>Imperata cylindrica</i>				6
	Coast Banksia	<i>Banksia integrifolia</i> subsp. <i>integrifolia</i>				3

Note: indicator species shown in **bold**

The cover abundance score for all flora species recorded within quadrats along Transects 4-6 is provided in **Appendix B** (Table B2).

3.1.2.3 Vegetation Habitat Zone Descriptions

Transect 4

Sedge Swamp/ Open Water

Dominant flora species within the Sedge Swamp/Open Water quadrat (refer to **Table 3.4**) consisted of:

- Shore Club-rush (*Schoenoplectus subulatus*) which occurs at a high density.

Swamp Forest

Dominant flora species within the Swamp Forest (refer to **Table 3.4**) consisted of:

- Bare Twig-rush (*Baumea juncea*); occurs at very high density.
- Jointed Twig rush (*Baumea articulata*), *Cyperus polystachyos*, Broad-leaved Paperbark (*Melaleuca quinquenervia*), Saltwater Couch (*Paspalum vaginatum*), Shore Club-rush (*Schoenoplectus subulatus*) all occur at moderate density.

Transects 5

Fringing Marsh

Dominant flora species within the Fringing Marsh (refer to **Table 3.4**) consisted of:

- Broad-leaved Paperbark (*Melaleuca quinquenervia*), Bare Twig-rush (*Baumea juncea*) and Watermilfoil (*Myriophyllum sp.*); all occurring at a moderate density.

Banksia Woodland

Dominant flora species within the Banksia Woodland (refer to **Table 3.4**) consisted of:

- Blady Grass (*Imperata cylindrica*) and Indian Pennywort (*Centella asiatica*); occur at very high density.
- Coast Banksia (*Banksia integrifolia* subsp. *integrifolia*), Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotunda**), Snake Vine (*Stephania japonica*) and *Cyperus stradbokensis*; all occurring at a moderate density.

Transect 6

Fringing Marsh

Dominant flora species within the Fringing Marsh (refer to **Table 3.4**) consisted of:

- Broad-leaved Paperbark (*Melaleuca quinquenervia*), Fringe Rush (*Fimbristylis ferruginea*) and Shore Club-rush (*Schoenoplectus subulatus*); occur at moderate density.

Banksia Woodland

Dominant flora species within the Banksia Woodland (refer to **Table 3.4**) consisted of:

- Blady Grass (*Imperata cylindrica*), occurring at a high density.

3.1.2.4 Indicator Species

Based on the expected changes to vegetation identified in Hydrosphere (2010b and 2011) and previous monitoring reports by GeoLINK (2011, 2013 and 2015), the following species were identified as indicator species for transects 4-6:

- Sea Rush (*Juncus kraussii* subsp. *australiensis*): prediction was that this species will decrease in the area currently occupied by the Gahnia sedge/ open water habitat zone along Transect 4.
- Saltwater Couch (*Paspalum vaginatum*): prediction was that this species is expected to decrease in the area currently occupied by the Swamp Forest along Transect 4 and Fringing Marsh along Transect 5.
- Shore Club-rush (*Schoenoplectus subulatus*): prediction was that this species is expected to decrease in the area currently occupied by Fringing Marsh vegetation habitat zone along Transects 5 and 6.

- Saw-sedge (*Gahnia* spp.): prediction was that this species is expected to increase in the area currently occupied by Sedge Swamp/open water in Transect 4.
- Coast Banksia (*Banksia integrifolia* subsp. *integrifolia*): prediction was that this species is expected to retain current density within the Banksia Woodland with expected water level changes.

Vegetation characteristics recorded within quadrats along Transects 4-6 are detailed in **Table 3.5**. Characteristics recorded include vegetation habitat zone, vegetation structure and the species and dimensions of all trees >10 cm DBH.

The cover abundance value for each of these indicator species in the vegetation habitat zones is shown in **Appendix B** (Table B1).

In relation to the indicator species, the results of the monitoring indicate the following:

- Sea Rush (*Juncus kraussii* subsp. *australiensis*): In Transect 4 there was a reduction in density from medium to low in the Sedge Swamp/Open Water quadrat. Reduction from moderate density in the Swamp Forest quadrat to no longer occurring.
- Saltwater Couch (*Paspalum vaginatum*): Although predicted to reduce in density in the Swamp Forest along Transect 4, Saltwater Couch still occurs at medium density in this location. No longer occurs in the Fringing Marsh along Transect 5.
- Shore Club-rush (*Schoenoplectus subulatus*): Continues to persist at medium to high density in the Sedge Swamp/Open Water at Transect 4 and medium density in the Fringing Marsh in Transect 6. No longer occurs in the Fringing Marsh in Transect 5.
- Saw-sedge (*Gahnia* spp.): Occurs at very low density in the Swamp Forest in Transect 4 and the Banksia Woodland in Transect 6.
- Coast Banksia (*Banksia integrifolia* subsp. *integrifolia*): Continues to persist at medium density in Transect 5 and has reduced in density at Transect 6 from medium to very low.

The occurrence of, and changes to, indicator species in relation to previous vegetation monitoring results are discussed in **Section 4**.

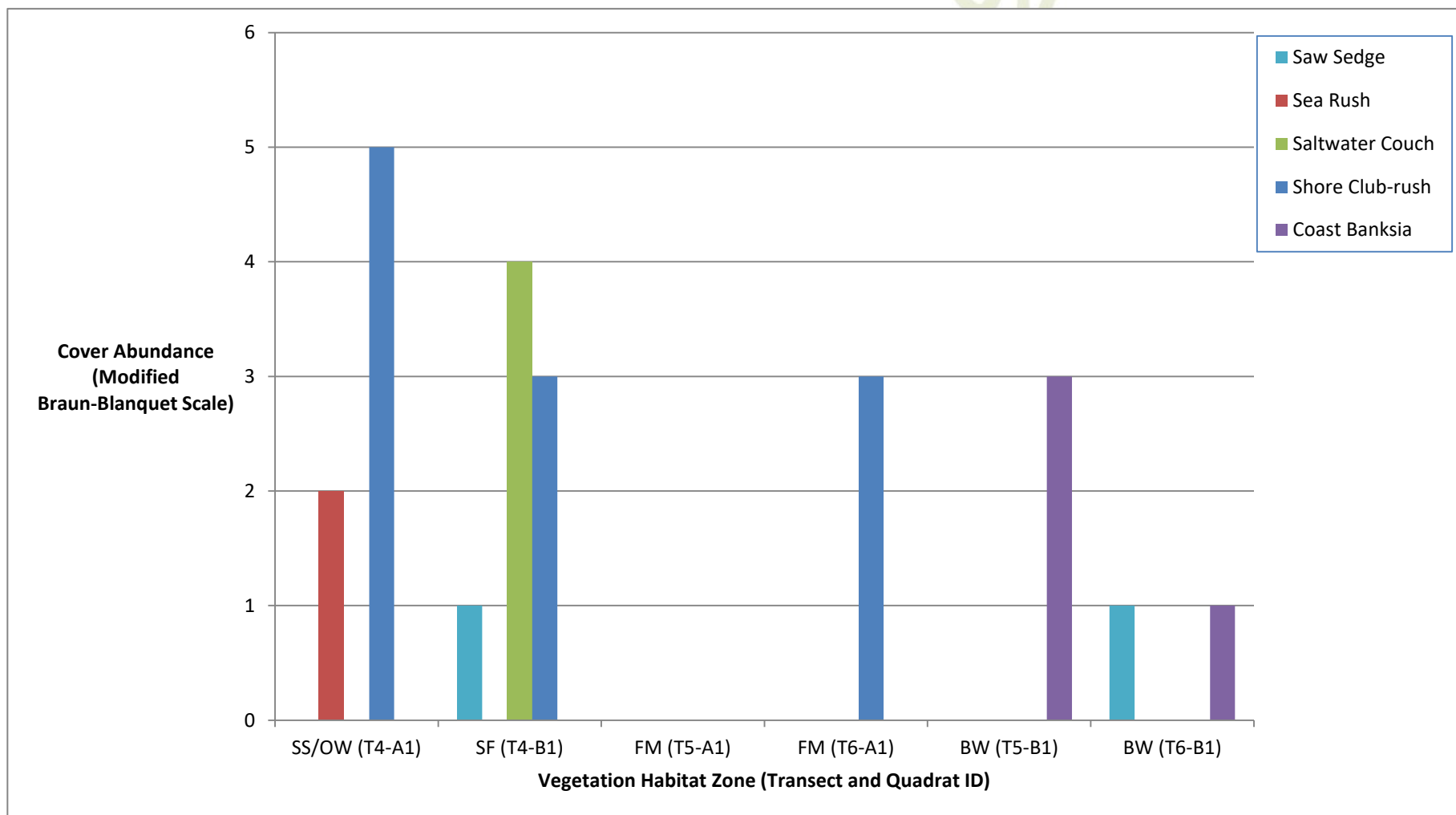


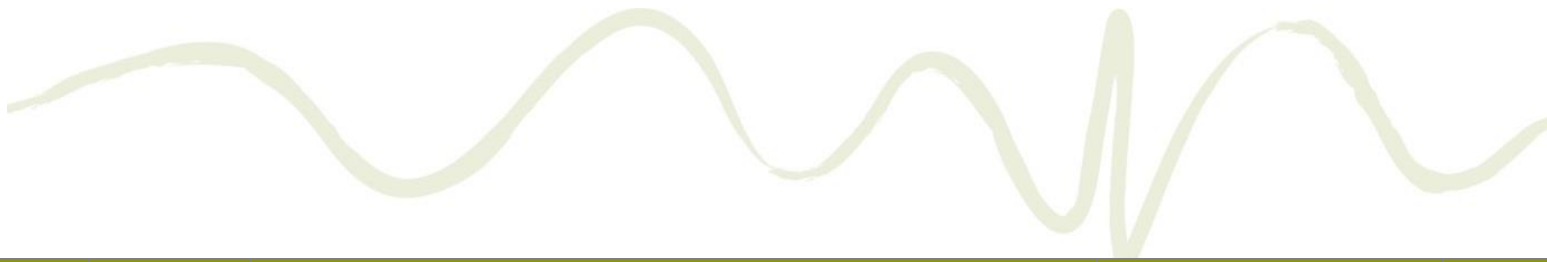
Figure 3.2 Cover Abundance Scores for Indicator Species in Vegetation Habitat Zones of Transects 4-6

Figure abbreviations – SS = Sedge Swamp, OW = Open Water, SF = Swamp Forest, FM = Fringing Marsh, BW =Banksia Woodland, T = Transects number, A, B etc. = Quadrat ID

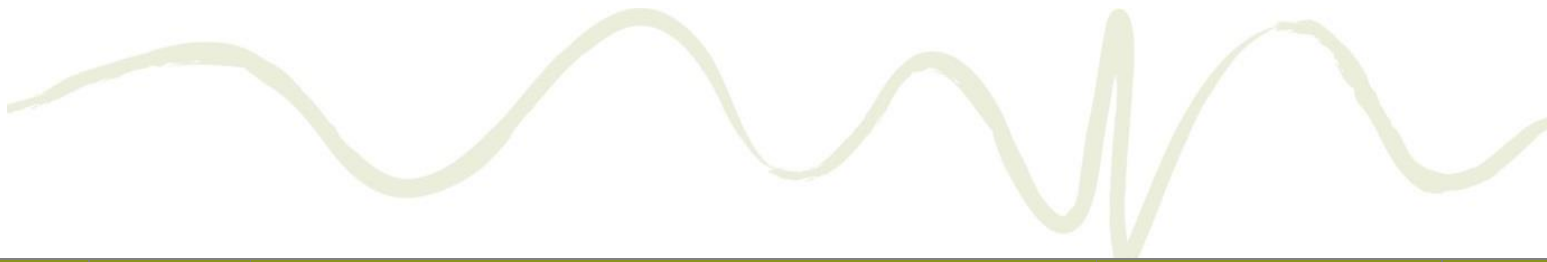


Table 3.5 Vegetation Structure and Characteristics - Quadrat Data for Transects 4-6

Transect	Quadrat	Vegetation Habitat Zone	Vegetation Structure								Tree Characteristics		Saplings	Comments on Vegetation Health
			Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Tree Species	DBH of trees (mm) (/ indicates multiple trunks)		
			Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class				
Transect 4	A1	Sedge Swamp/ Open Water	-	-	-	-	-	-	<2	6	-	-	0	Water depth 0.6 m
	B1	Swamp Forest	14	3	-	-	-	-	2	6	Melaleuca quinquenervia	275	8	Melaleuca quinquenervia trees are relatively healthy (no dead branches, evidence of dieback or galls) Increase in DBH 8 seedlings <0.5 m high detected Water depth 0.25 m
											Melaleuca quinquenervia	430		
											Melaleuca quinquenervia	330		
											Melaleuca quinquenervia	275		
											Melaleuca quinquenervia	310/ 245		
											Melaleuca quinquenervia	220		
Transect 5	A1	Fringing Marsh	6	3	-	-	-	-	0.5	4	Melaleuca quinquenervia	340	0	Melaleuca quinquenervia tree is relatively healthy (no dead branches, evidence of dieback or



Transect	Quadrat	Vegetation Habitat Zone	Vegetation Structure								Tree Characteristics		Saplings	Comments on Vegetation Health
			Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Tree Species	DBH of trees (mm) (/ indicates multiple trunks)		
			Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class				
														galls) Water depth >0.5 m
	B1	Banksia Woodland	5	4	-	-	-	-	0.3	6	<i>Banksia integrifolia</i> subsp. <i>integrifolia</i>	170	0	<i>Banksia integrifolia</i> trees are relatively healthy (no dead branches, evidence of dieback or galls)
											<i>Banksia integrifolia</i> subsp. <i>integrifolia</i>	170		
											<i>Banksia integrifolia</i> subsp. <i>integrifolia</i>	115		
											<i>Banksia integrifolia</i> subsp. <i>integrifolia</i>	110		
											<i>Banksia integrifolia</i> subsp. <i>integrifolia</i>	220/ 230		
											<i>Banksia integrifolia</i> subsp. <i>integrifolia</i>	120/125		



Transect	Quadrat	Vegetation Habitat Zone	Vegetation Structure								Tree Characteristics		Saplings	Comments on Vegetation Health
			Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Tree Species	DBH of trees (mm) (/ indicates multiple trunks)		
			Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class				
											<i>Banksia integrifolia</i> subsp. <i>integrifolia</i>	110		
Transect 6	A1	Fringing Marsh	6	3	-	-	-	-	<1.2	4	<i>Melaleuca quinquenervia</i>	300/ 450	0	<i>Melaleuca quinquenervia</i> trees are relatively healthy (no dead branches, evidence of dieback or galls) Water depth ~0.5 m
											<i>Melaleuca quinquenervia</i>	300/ 300		
											<i>Melaleuca quinquenervia</i>	340		
	B1	Banksia Woodland	6	1	-	-	-	-	<1.2	6	<i>Banksia integrifolia</i> subsp. <i>integrifolia</i>	320	0	<i>Banksia integrifolia</i> is relatively healthy (no dead branches, evidence of dieback or galls)



3.2 Melaleuca Dieback/ Recolonisation Monitoring

Results from the Melaleuca dieback quadrats are shown in **Table 3.6**. Dead trees occurred in 4 of the 15 quadrats only. Each Transect supported at least 1 quadrat with dead trees. All dead trees occurred in quadrats located either within the Swamp Forest or in the Swamp Forest/ Fringing Marsh ecotone. Notably in one quadrat (e.g. T2 – E) a number of trees (<130 mm DBH) recorded previously in 2015 no longer occur. The trunks are not present as standing dead trees nor were they detectable on the ground. It should be noted that there was approximately 0.45 m of standing water present.

A relatively low proportion of quadrats contained regenerating Melaleuca seedlings (4 out of 15), saplings (6 out of 15) or small trees (5 out of 15). Numbers in 2015 were similar: seedlings (4 out of 15), saplings (5 out of 15) and small trees (6 out of 15).

Where living Melaleuca was present, in general the health appeared good, with thick foliage and no presence of necrotic spots on leaves or galls on small branches. This too was the case during the previous monitoring in 2015.

Although recruitment is not significant, in some quadrats the small trees (e.g. T1-A; T1-B) and trees (e.g. T1-C) that were recorded in 2015 have grown in height substantially.

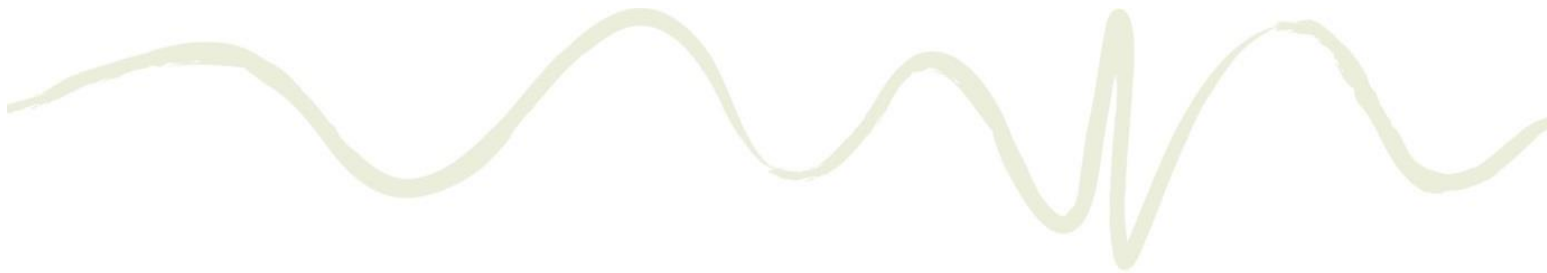
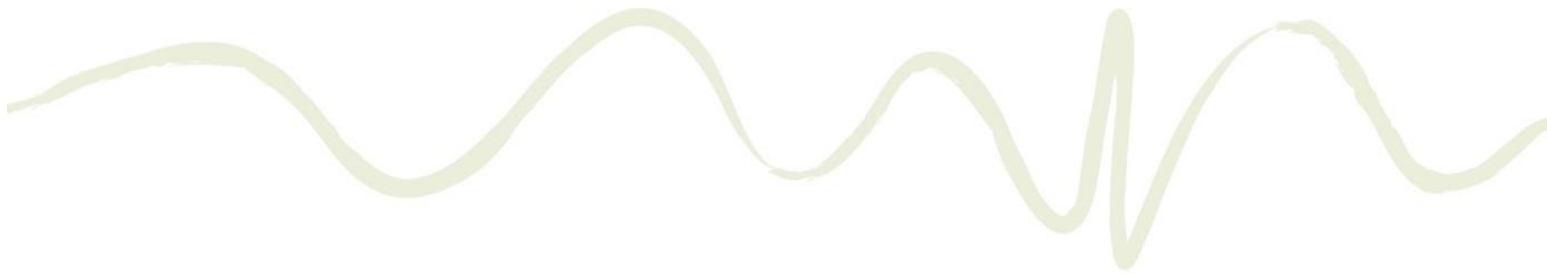
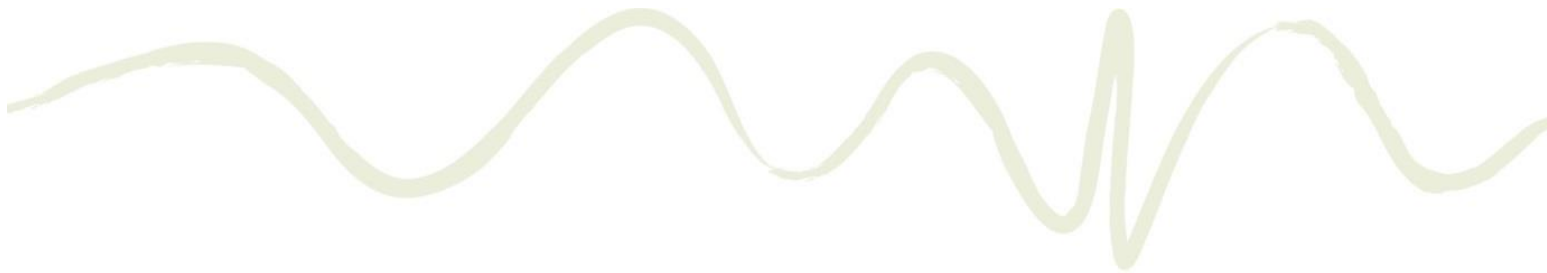


Table 3.6 Melaleuca Dieback Quadrat Data

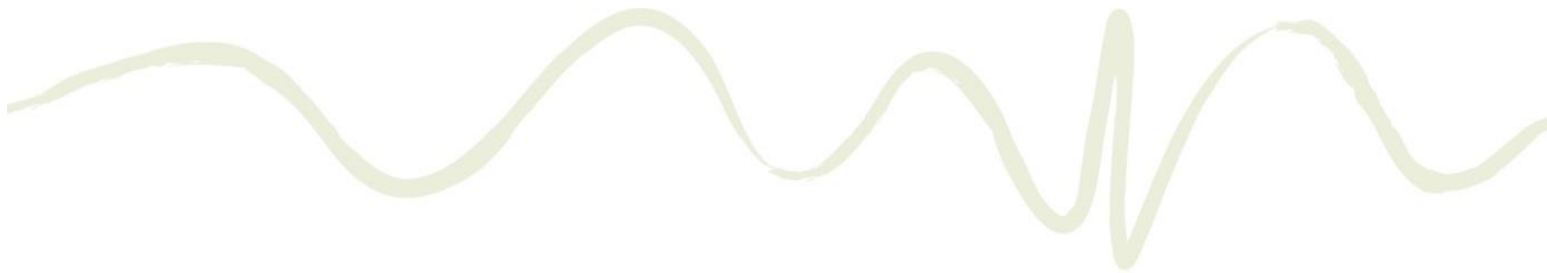
Transect	Vegetation Habitat Zone	Vegetation Structure								Melaleuca Counts					Tree Diameter DBH (mm) of trees >100 mm (/ indicates multiple trunks)	Condition
		Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Trees#	Small Trees^	Seedlings*	Saplings^	Dead Individuals		
		Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Trees Count	Small Trees Count	Seedling Count	Sapling Count	Dead Individuals Count		
Transect 1	Quadrat A															
	Fringing Marsh	3	2	-	-	-	-	2	6	0	3	1	0	0	-	3 small (dbh<10cm) <i>Melaleuca quinquenervia</i> present, 1 more than in 2015 Standing water depth 0.65 m
	Quadrat B															
	Fringing Marsh/ Swamp Forest	4	1	-	-	-	-	2	6	0	5	0	1	0	-	5 small (dbh<10 cm) <i>Melaleuca quinquenervia</i> present, 3 more than in 2015 Trees are healthy. Standing water depth 0.6 m
	Quadrat C															
	Fringing	3-5	3	-	-	-	-	2	4	3	2	0	0	0	110	3 of the 4



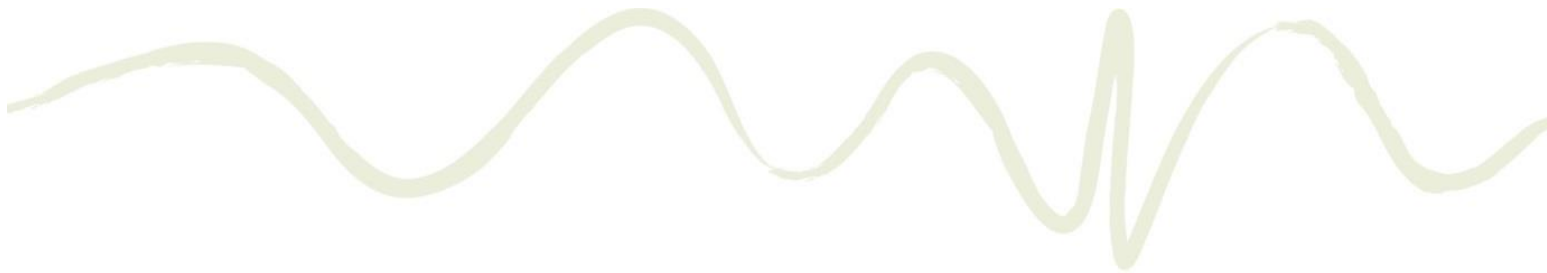
Transect	Vegetation Habitat Zone	Vegetation Structure								Melaleuca Counts					Tree Diameter DBH (mm) of trees >100 mm (/ indicates multiple trunks)	Condition
		Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Trees#	Small Trees^	Seedlings*	Saplings^	Dead Individuals		
		Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Trees Count	Small Trees Count	Seedling Count	Sapling Count	Dead Individuals Count		
	Marsh/ Swamp Forest														130	saplings recorded in 2015 are now recorded as trees Trees appear healthy with thick foliage Increase in height of existing trees Standing water depth 0.6 m
															130	
Quadrat D																
	Fringing Marsh/ Swamp Forest	6	4	-	-	-	-	1-1.2	5	6	9	0	1	2	165	6 small <i>Melaleuca quinquenervia</i> present, 2 more than in 2015 The number of surviving saplings has reduced from 14 to 9 trees
															110	
															110	
															100	
															100	



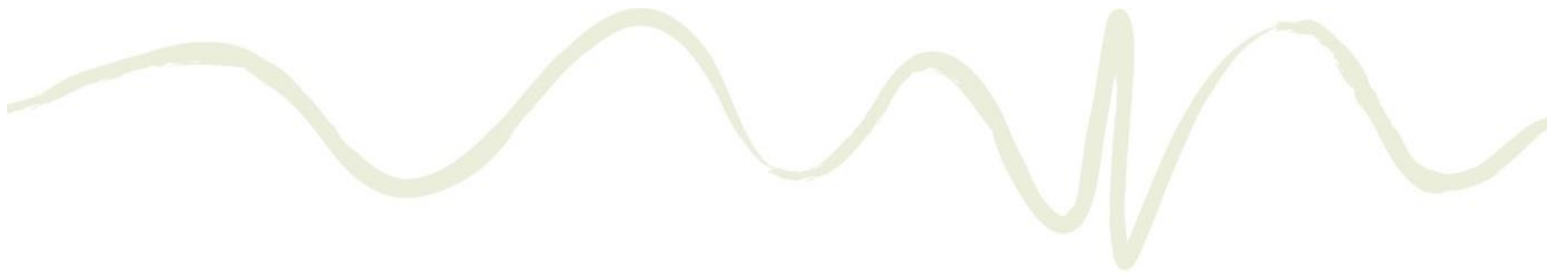
Transect	Vegetation Habitat Zone	Vegetation Structure								Melaleuca Counts					Tree Diameter DBH (mm) of trees >100 mm (/ indicates multiple trunks)	Condition
		Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Trees#	Small Trees^	Seedlings*	Saplings^	Dead Individuals		
		Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Trees Count	Small Trees Count	Seedling Count	Sapling Count	Dead Individuals Count		
															115	<p>Trees appear healthy with thick foliage and currently flowering</p> <p>Increase in height of existing trees</p> <p>Standing water depth 0.6m</p>
Quadrat E																
	Fringing Marsh/ Swamp Forest	6	1	-	-	-	-	1-1.2	6	1	1	4	4	0	240	<p>Increase from 2015 in the number of seedlings from 1 to 4 and saplings 2 to 4</p> <p>Increase in height in existing tree</p> <p>Trees appear healthy with thick foliage and currently flowering</p>



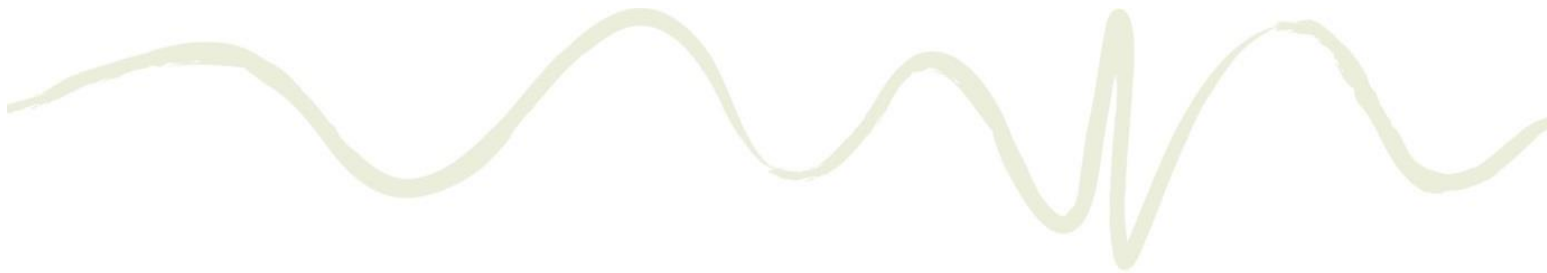
Transect	Vegetation Habitat Zone	Vegetation Structure								Melaleuca Counts					Tree Diameter DBH (mm) of trees >100 mm (/ indicates multiple trunks)	Condition
		Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Trees#	Small Trees^	Seedlings*	Saplings ⁺	Dead Individuals		
		Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Trees Count	Small Trees Count	Seedling Count	Sapling Count	Dead Individuals Count		
																Standing water depth 0.5 m
Transect 2	Quadrat A															
	Fringing Marsh	-	-	-	-	-	-	2	4	0	0	0	0	0	-	No <i>Melaleuca quinquenervia</i> present Standing water depth 0.65 m
	Quadrat B															
	Fringing Marsh	-	-	-	-	-	-	2	4	0	0	0	0	0	-	No <i>Melaleuca quinquenervia</i> present. 3 small trees recorded in 2015 no longer present Standing water depth 0.65 m
	Quadrat C															
	Fringing Marsh	-	-	-	-	-	-	1.5-2	6	0	0	0	1	0	-	2 small trees recorded in 2015 no longer



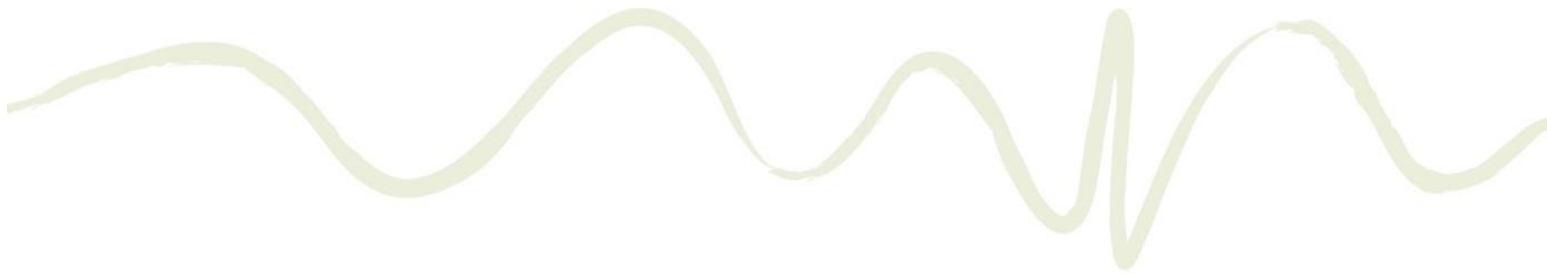
Transect	Vegetation Habitat Zone	Vegetation Structure								Melaleuca Counts					Tree Diameter DBH (mm) of trees >100 mm (/ indicates multiple trunks)	Condition
		Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Trees#	Small Trees^	Seedlings*	Saplings^	Dead Individuals		
		Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Trees Count	Small Trees Count	Seedling Count	Sapling Count	Dead Individuals Count		
																present 1 sapling present Standing water depth 0.65 m
Quadrat D																
Fringing Marsh	6	2	-	-	-	-	-	1.2	3	3	0	3	1	2	110	Increase from 2015 in the number of trees from 2 to 3 and saplings from 0 to 1 Reduction in number of seedlings from 6 to 3 Standing water depth 0.5 m
															110	
															110/ 150/ 150	
Quadrat E																
Fringing Marsh/ Swamp Forest	4	1	-	-	-	-	-	<1.2	3	2	0	5	2	6	190	Reduction from 2015 in number of trees from 8 to 2, small
															130/ 140/ 140	



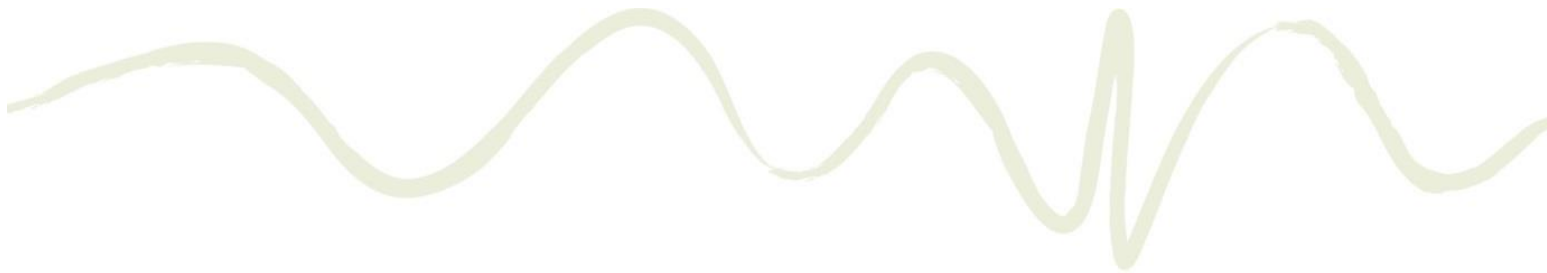
Transect	Vegetation Habitat Zone	Vegetation Structure								Melaleuca Counts					Tree Diameter DBH (mm) of trees >100 mm (/ indicates multiple trunks)	Condition
		Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Trees#	Small Trees^	Seedlings*	Saplings ⁺	Dead Individuals		
		Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Trees Count	Small Trees Count	Seedling Count	Sapling Count	Dead Individuals Count		
																<p>trees from 6 to 0.</p> <p>Increase in saplings from 1 to 2 and the number of seedlings remains the same at 5.</p> <p>Trees appear healthy with thick foliage.</p> <p>Standing water depth 0.45 m.</p>
Transect 3	Quadrat A															
	Fringing Marsh	-	-	-	-	-	-	0.3	5	0	0	0	0	0	0	<p>No Broad-leaved Paperbark present</p> <p>Standing water depth 0.65 m</p>



Transect	Vegetation Habitat Zone	Vegetation Structure								Melaleuca Counts					Tree Diameter DBH (mm) of trees >100 mm (/ indicates multiple trunks)	Condition
		Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Trees#	Small Trees^	Seedlings*	Saplings^	Dead Individuals		
		Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Trees Count	Small Trees Count	Seedling Count	Sapling Count	Dead Individuals Count		
	Quadrat B															
	Fringing Marsh	-	-	-	-	-	-	0.3	4	0	0	0	0	0	0	No Broad- leaved Paperbark present Standing water depth 0.3 m
	Quadrat C															
	Fringing Marsh	-	-	-	-	-	-	0.3	5	0	0	0	0	0	0	No live Broad- leaved Paperbark present Standing water depth 0.65 m
	Quadrat D															
	Fringing Marsh	-	-	-	-	-	-	<1.2	6	0	0	0	0	0	0	No live Broad- leaved Paperbark present Standing water depth 0.5 m



Transect	Vegetation Habitat Zone	Vegetation Structure								Melaleuca Counts					Tree Diameter DBH (mm) of trees >100 mm (/ indicates multiple trunks)	Condition
		Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Trees#	Small Trees^	Seedlings*	Saplings^	Dead Individuals		
		Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Trees Count	Small Trees Count	Seedling Count	Sapling Count	Dead Individuals Count		
	Quadrat E															
Swamp Forest	12-14	5	-	-	-	-	-	1.2	6	22	0	0	0	18	260	At least 5 trees have recently died (bark still present) Trees appear healthy with thick foliage
															120/160/115/ 160/145	
															140	
															110	
															100	
															145	
															220/170	
															150	
															120	
															115	
															145	
															160	



Transect	Vegetation Habitat Zone	Vegetation Structure								Melaleuca Counts					Tree Diameter DBH (mm) of trees >100 mm (/ indicates multiple trunks)	Condition
		Upper Stratum		Upper-mid Stratum		Mid Stratum		Lower Stratum		Trees#	Small Trees^	Seedlings*	Saplings ⁺	Dead Individuals		
		Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Trees Count	Small Trees Count	Seedling Count	Sapling Count	Dead Individuals Count		
															110/150	
															110/160	
															155	
															205	
															150	
															140	
															140	
															160/105/175	
															100/70/135/1 10	
															135/140	

- # Trees – DBH of each stem >10 cm
 ^ Small trees –DBH <10cm >5 cm
 + Saplings – DBH>Seedlings – <5cm; height >0.5m
 * Seedlings - height <0.5 m.



3.3 Photo Point Monitoring

Photographs taken at photo monitoring points in March 2017 are shown in **Appendix C**.



4. Discussion and Comparison with Previous Monitoring

4.1 Vegetation Habitat Zonation

4.1.1 Transects 1-3

The reduction in the extent of the Fringing Marsh community was noted in the 2015 report (Geolink 2015). Large areas of this community have been replaced, particularly the eastern extent, by open water as a result of the closing of the artificial channel in 2012.

The extent of Fringing Marsh/Open Water present during any one sampling period since the infilling of the artificial channel is partially reliant on the amount of rainfall in the period prior to sampling. Concurrently, taller species such as Common Reed (*Phragmites australis*), Broadleaved Cumbungi (*Typha orientalis*), Fringe Rush (*Fimbristylis ferruginea*) and Shore Club-rush (*Schoenoplectus subulatus*) have established within this community. These species, along with lower growing plants that can tolerate extended periods of inundation, such as *Cyperus polystachyos* and Brown Beetle Grass (*Diplachne fusca*) are allowing the Fringing Marsh community to extend further east into the lagoon area.

Due to the occurrence of this vegetation, the Fringing Marsh/Open Water Boundary occurred between approximately 79-139 m further east of where the boundary was detected in the 2015 monitoring event. This can be seen in **Illustration 3.1**.

As described in the 2015 report, the variation in the extent of Sedge Swamp and Swamp Forest since baseline monitoring has not been significant, reflecting that the primary driving factor for vegetation change to date is related to the rising water level in Salty Lagoon and associated lowering of salinity levels as the system changes to being more freshwater dominated.

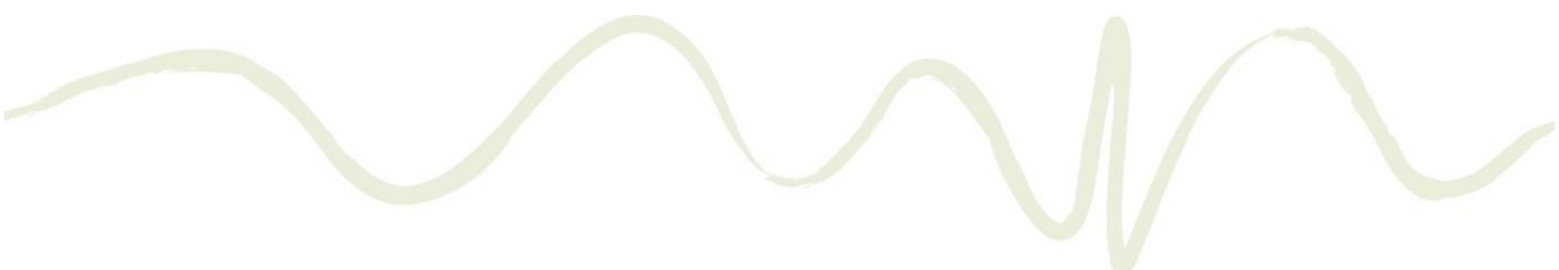
4.1.1.1 Species Composition of Vegetation Habitat Zones

There was a marginal increase in the overall number of flora species recorded in the three vegetation communities along Transects 1-3 with 58 species detected overall. This is the first increase in species diversity since the baseline monitoring was undertaken in 2011 and is attributed to the lower water levels during the current monitoring event. Species diversity previously comprised 47 in 2015, 55 in 2013 and 73 in 2011.

There was an increase in species recorded in all three communities, in particular the Fringing Marsh (5 additional spp.) and Sedge Swamp (5 additional spp.).

Additional species detected within the Fringing Marsh include wetland plants such as Enydra (*Enydra fluctuans*), Frogsmouth (*Philydrum lanuginosum*) and Water Snowflake (*Nymphaeoides indica*).

Additional species detected in the Sedge Swamp were general cryptic species that are hard to detect unless flowering, such as the Trigger Plant (*Stylidium* sp.) and Sun Orchid, although other additional species that are generally conspicuous during surveys, such as Blueberry Ash (*Elaeocarpus reticulatus*) have simply germinated since the previous monitoring event.



Additional species in the Swamp Forest comprise relatively inconspicuous plants such as Melaleuca Mistletoe and Wiry Panic (*Entolasia stricta*).

As discussed in the 2015 report, the regular inundation of large portions of all three communities may discount the occurrence of a range of smaller herbaceous species recorded previously in the lower stratum. Although this may still be the case, potential does exist for other species more tolerant of prolonged inundation by freshwater to become established. Although the majority of the additional species were detected at only very low density, such as Frogsmouth and Water Snowflake, the mere occurrence of these plants for the first time suggests that conditions are becoming favourable for the establishment of plants more indicative of stable freshwater environments.

4.1.1.2 Species Dominance

Fringing Marsh

A further slight reduction in the previously dominant species within the Fringing Marsh community, Sea Rush (*Juncus kraussii* subsp. *australiensis*) and Saltwater Couch (*Paspalum vaginatum*), was further detectable during this current monitoring event.

- Sea Rush was detected as a dominant species in only one of the two quadrats in the Fringing Marsh community in Transect 1 and was not detected within this community at all on Transect 2 or Transect 3. Previously (2015) it was detected on Transect 1 and Transect 3.
- The reduction in dominance of Saltwater Couch is even less pronounced, and it still occurs in low to moderate density in four out of the six quadrats within this community. A reduction in dominance from moderate to low was however detected in two of the four quadrats in which it still occurs.

The increase in cover of Common Reed (*Phragmites australis*) was noted in the 2015 report and this species was again detected at a moderate to high density in two out of six quadrats.

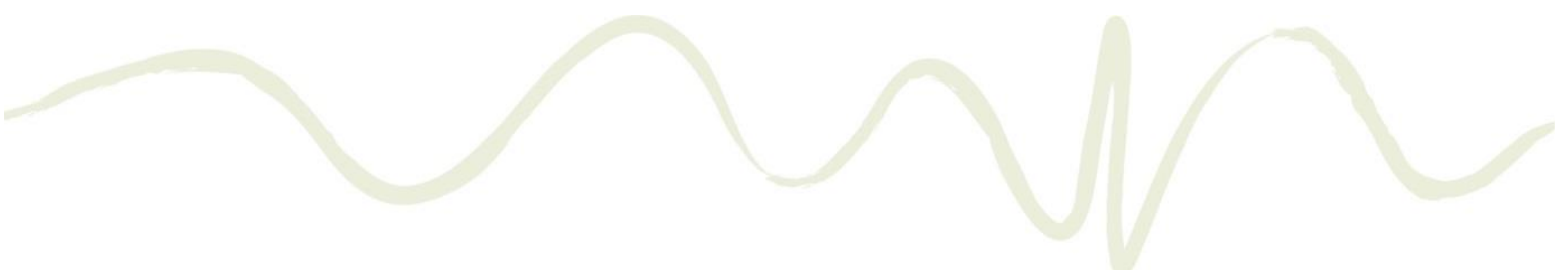
Other species detected at moderate to high densities included the following:

- Fringe Rush (*Fibrostylus ferruginea*): Occurring at moderate density in three out of six quadrats.
- Shore Club-rush (*Schoenoplectus subulatus*), Broadleaf Cumbungi (*Typha orientalis*) and Enydra (*Enydra fluctuans*): Occurring at a moderate density in one out of six quadrats.
- *Cyperus polystachyos* and Brown Beetle Grass (*Diplachne fusca*): Occurring at a moderate density in five out of six quadrats.

Notably in 2015 there were two quadrats that did not contain any species with a moderate or higher density, these quadrats being dominated by open water. This was not the case in the current monitoring event, with all quadrats supporting at least one plant at moderate density cover. Again this was attributed to the lower water levels in the period leading up to the current monitoring event, allowing plants to germinate. Overall, species dominance within the Fringing Marsh has shifted from saltmarsh/salt tolerant species to freshwater species.

Swamp Forest

Broad-leaved Paperbark continues to occur in every quadrat within the Swamp Forest community. Bare Twig-rush (*Baumea juncea*) has increased in density slightly and now occurs at moderate to high density in five out of the six quadrats, where it was previously dominant (2015) in only four of the six quadrats. Tall Sedge (*Carex appressa*) continues to occur as a dominant species in two of the six quadrats.



In 2015 a further four species occurred at a moderate density in one out of six quadrats. In the current monitoring an additional three species were detected, hence a further seven species now occur at a moderate density in one out of six quadrats, additional to those mentioned above.

Sedge Swamp

There was little change in the species composition or density cover of dominant species within the Sedge Swamp community from those detected in 2015 monitoring.

4.1.1.3 Predicted Changes and Indicator Species

The following predicted changes were listed in the baseline vegetation monitoring report. These are discussed in turn.

1. Sea Rush (*Juncus krausii* subsp. *australiensis*): Expected to decrease in the area currently occupied by Fringing Marsh and Swamp Forest.

Sea Rush (*Juncus krausii* subsp. *australiensis*): Continues to occur in the Swamp Forest however the number of quadrats in which it was recorded and cover abundance has reduced. It continues to occur in only one quadrat within the Fringing Marsh. While the overall occurrence of this species has reduced significantly since closure of the artificial channel, periods of low water levels and saltwater ingress events from Salty Creek into Salty Lagoon appears to have sustained this species within the lagoon system.

2. Saltwater Couch (*Paspalum vaginatum*): Expected to decrease in the area currently occupied by Fringing Marsh and Swamp Forest.

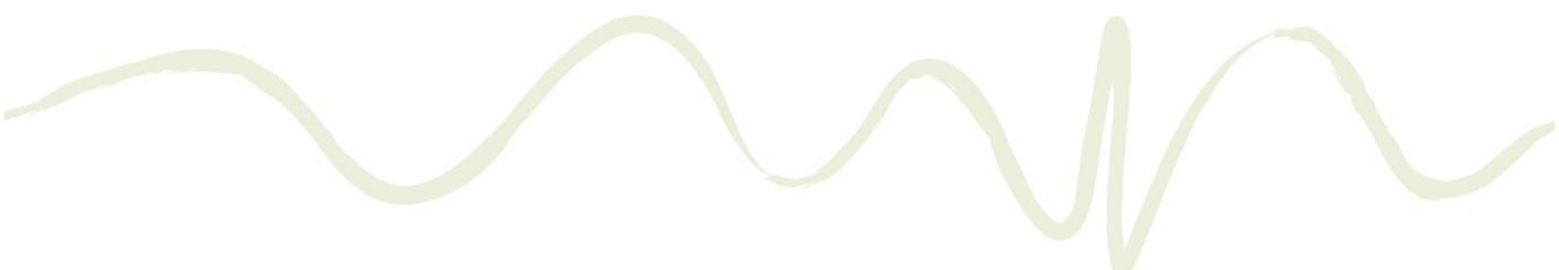
Saltwater Couch (*Paspalum vaginatum*): continues to occur at low-moderate density in two of the six quadrats in both the Sedge Swamp and Swamp Forest. It was not recorded in 2015 in the Swamp Forest community, however being a grass it can grow quickly in response to localised conditions. It occurs at a low-moderate density in four out of six quadrats in the Fringing Swamp.

This species was observed as being relatively widespread within the Fringing Marsh community and its persistence within the inundated areas of the Site indicates that it is relatively tolerant of prolonged inundation by fresh water. Although there has been a slight reduction in its occurrence over the course of the monitoring period (i.e. not detected in the Swamp Forest in 2015), its widespread occurrence, even after prolonged inundation and the absence of saline influence, indicates that it may persist at the Site into the future.

3. Shore Club-rush (*Schoenoplectus subulatus*): Expected to decrease in the area currently occupied by Fringing Marsh and Swamp Forest.

In the MPCC vegetation monitoring report, Shore Club-rush (*Schoenoplectus subulatus*) was identified as a potential indicator species that was expected to decrease in the area currently occupied by Fringing Marsh and Swamp Forest. This species has been recorded at a low density in the Swamp Forest community in all previous monitoring events and at a low to moderate density in the Fringing Marsh community, with no substantial decrease occurring in the area currently occupied by this species since channel closure. It is particularly common through the central portion of the Site on Transect 2 at the Swamp Forest/ Fringing Marsh ecotone.

4. Bare Twig-rush (*Baumea juncea*): expected to increase in the area currently occupied by Fringing Marsh.



The monitoring results indicate that Bare Twig-rush has not substantially increased in the Fringing Marsh community since 2011. It has however increased substantially in the Swamp Forest community and commonly occurs at a moderate density within the Melaleuca dieback monitoring quadrats within the Swamp Forest/ Fringing Marsh ecotone.

5. Broad-leaved Paperbark (*Melaleuca quinquenervia*): Expected to increase in the area currently occupied by Fringing Marsh.

Broad-leaved Paperbark is still yet to substantially extend into the Fringing Marsh.

Although a small amount of recruitment was detected in some quadrats, the absence of trees, saplings or seedlings detected in previous monitoring events indicates that not all trees that germinate persist into larger trees. Although the extent of recruitment within the quadrats is minimal, some evidence of recruitment was observed elsewhere around the periphery of the Fringing Marsh. Small trees and the occasional sapling were observed just south of the main channel that feeds into the lagoon from the west. Other small Broad-leaved Paperbark trees were observed to the south of the lagoon.

The cover of Broad-leaved Paperbark continues to remain relatively stable in and around the edge of the Swamp Forest community without any obvious decline in the health of the trees that occur.

The opportunity for Broad-leaved Paperbark to germinate has been somewhat reduced due to the more regular and extensive inundation that now occurs at the Site. The ongoing establishment of vegetation such as Broad-leaved Cumbungi and Common Reed may help recruitment in the future, as sediments accumulate around the base of this vegetation.

Monitoring over a longer period of time than that which has been undertaken may be required to detect any future recruitment into the Fringing Marsh area.

4.1.2 Transects 4-6

Vegetation habitat zonation has not changed significantly in Transect 4 due to the well-defined channel edge dividing the Open Water/ Sedge Swamp community from the Swamp Forest community.

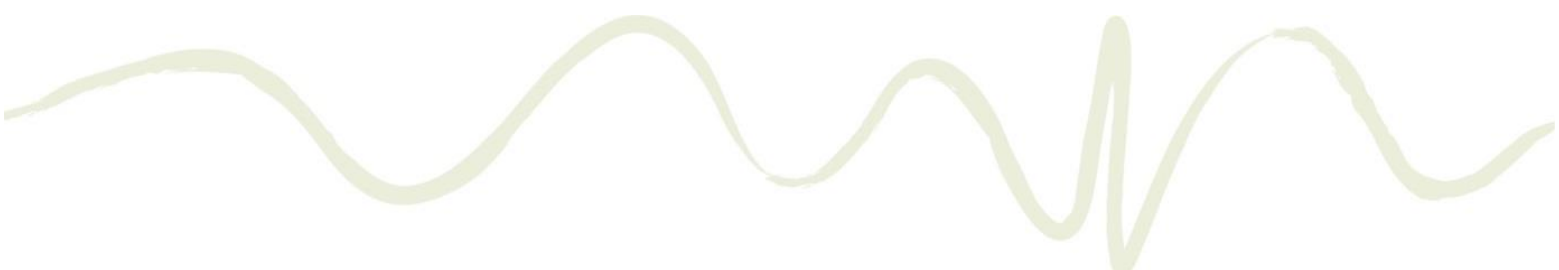
Although it is a similar situation with Transects 5 and 6, as was documented in the 2015 report, the increased water level has caused a shift in species composition of the Fringing Marsh communities in these transects. The Banksia Woodland communities however have been far less affected by comparison, as would be expected.

4.1.3 Species Composition of Vegetation Habitat Zones

The overall number of species recorded in the vegetation communities along these transects increased substantially to 41 species (both native and exotic). In comparison 32 species were recorded in 2011 and 28 species in 2015.

There was a reduction in the number of species detected in the Open Water/ Sedge Swamp community from 13 in 2015 to 7 in the current monitoring. This is likely attributable to the increase in depth of the water in this quadrat and the absence of species that would otherwise be associated with more brackish water.

An additional ten species were detected in the Banksia Woodland community from that detected in 2015. These include a mix of grasses (*Digitaria didactyla*), sedges (*Cyperus stradbokensis*), Knobby



Club-rush (*Ficinia nodosa*), twiners (*Glycine* sp.), mistletoes (*Notothyxos* sp.) and shrubs (Coastal Wattle *Acacia sophorae*).

A number of weeds were also detected including Cape Gooseberry (*Physalis peruviana**), Five-leaved Morning Glory (*Ipomea cairica**) and Cockspur Coral Tree (*Erythrina crista-galli**). Cockspur Coral Tree was detected growing along the eastern shore of the lagoon in proximity of Transect 5. Numerous trees approximately 2-3 m in height occur in this location.

4.1.4 Species Dominance

Species dominance was relatively stable between monitoring events, with the exception of the Fringing Marsh community in which the dominant species have shifted from Saltwater Couch and Shore Club-rush in 2011 to Shore Club-rush (*Schoenoplectus subulatus*) in fringing areas. This reflects the higher water levels and associated stronger freshwater influence following channel closure.

Blady Grass and Coast Banksia remain dominant species in the Banksia Woodland community.

4.1.5 Predicted Changes and Indicator Species

The following predicted changes were identified in the 2011 monitoring. These are discussed in turn.

1. Sea Rush (*Juncus kraussii* subsp. *australiensis*): Expected to decrease in the area currently occupied by the Gahnia sedge/ open water habitat zone along Transect 4.

Sea Rush had not shown any detectable reduction in cover between the 2011 monitoring and the 2015 monitoring event. However, this species was no longer occurring in the Swamp Forest community and had reduced in cover density from medium to low during the current monitoring period.

2. Saltwater Couch (*Paspalum vaginatum*): Expected to decrease in the area currently occupied by the Swamp Forest along Transect 4 and Fringing Marsh along Transect 5.

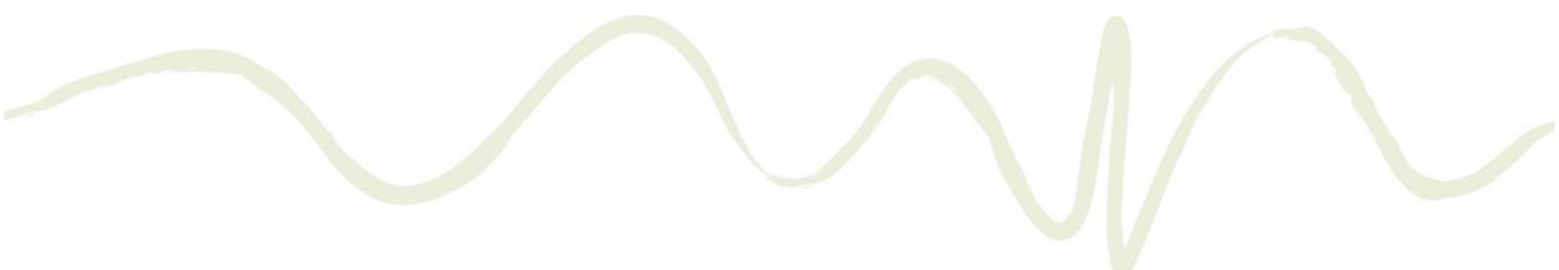
Saltwater Couch continues to occur at medium density within the Swamp Forest community at Transect 4. Although it appears that there was some reduction in its density cover during the previous monitoring in 2015, the species continues to persist at this location. As has been mentioned previously, being a grass this species is capable of increasing in cover fairly rapidly if suitable conditions occur.

As was the case in the 2015 monitoring, Saltwater Couch was not detected in the Fringing Marsh community of Transect 5.

3. Shore Club-rush (*Schoenoplectus subulatus*): Expected to decrease in the area currently occupied by Fringing Marsh vegetation habitat zone along Transects 5 and 6.

Shore Club-rush was not detected within the Fringing Marsh community along Transect 5 and Transect 6 in the 2015 monitoring. However, although this remains the case at Transect 5, it does occur as a moderate density at Transect 6.

It was suggested in the 2015 report that the water depth during the 2015 monitoring in these locations may have been too deep to allow this species to occur. This is plausible, as the water depth in the lagoon prior to the current sampling was relatively low, which may have allowed the species to regenerate at Transect 6, which is shallower than that at Transect 5. While the overall occurrence of this species has reduced significantly since closure of the artificial channel, periods of low water levels



and saltwater ingress events from Salty Creek into Salty Lagoon appears to have sustained this species within the lagoon system.

Regardless of the reason for its occurrence, this species persists at numerous other locations on the western side of the lagoon also.

4. Saw-sedge (*Gahnia* spp.): Expected to increase in the area currently occupied by Sedge Swamp/open water in Transect 4.

Data from the current monitoring period correlates with that from the 2015 monitoring, in that there has been no detectable increase in density cover of Saw Sedge along Transect 4. Saw Sedge does however appear to be increasing in distribution in both the Sedge Swamp and Swamp Forest communities, as evidenced by its detection in an increased number of quadrats over previous years.

5. Coast Banksia (*Banksia integrifolia* subsp. *integrifolia*): Expected to retain current density within the Banksia Woodland with expected water level changes.

The density of Coast Banksia at Transects 5 and 6 maintained a similar cover between the 2011 monitoring and the current monitoring event.

4.1.6 Melaleuca Dieback/ Recolonisation Monitoring

As was the case at the conclusion of the 2015 monitoring event, there is little evidence of recolonisation of Broad-leaved Paperbark or any further dieback occurring. The overall health of the trees continues to be good, with thick foliage throughout and no signs of stress detected on any trees.

Although recruitment is not significant, in some quadrats the small trees and trees that were recorded in 2015 have grown in height substantially.

The following was postulated in 2015:

...that with the generally elevated water level in Salty Lagoon following closure of the artificial channel, suitable conditions for recolonisation by Broad-leaved Paperbark may now occur less frequently (assuming that for germination to occur, seeds must be able to contact with moist, bare soil). Suitable conditions for germination may now occur only during prolonged dry periods when the lagoon recedes. Such prolonged dry conditions would be expected to occur relatively infrequently, and consequently, substantial recolonisation of the lagoon edge by Broad-leaved Paperbark may only be apparent after several years or even decades have elapsed (significantly longer than the timeframe of the monitoring program which ends in 2017).

At the completion of the 2017 monitoring, this theory remains valid. Additionally however, there is evidence that emergent vegetation is migrating east into the area now occupied by open water. The growth of large amounts of vegetation in this zone (i.e. Broad-leaved Cumbungi, Common Reed) may facilitate the build-up of sediments and further facilitate the potential for recolonisation of this area by Broad-leaved Paperbark.



5. Summary and Conclusion

GeoLINK has been engaged by Richmond Valley Council to implement the Salty Lagoon Ecosystem Recovery Monitoring Program: Pre-Post Closure of the artificial channel (MPPC). This 2017 vegetation monitoring report provides the final vegetation monitoring event for the project.

The focus for the vegetation component of the MPPC monitoring was to identify and document the occurrence of the predicted changes in the vegetation habitat zone boundaries below 2 m AHD. The other major component is to document any re-colonisation or reduction within the *Melaleuca* dieback zone on the western side of the lagoon.

A description of the potential changes is described in Hydrosphere (2010b) and in further detail in Hydrosphere (2011). In summary, the following changes were anticipated:

- The area of open water is predicted to increase.
- Giant Waterlilies (*Nymphaea gigantea*) were predicted to colonise the central portions of the lagoon and are also expected to occur on the fringes.
- Mixed sedges and rushes such as *Juncus* spp. and *Baumea* spp. are expected to dominate the western area currently occupied by Fringing Marsh.
- Broad-leaved Paperbark may also expand to the east.

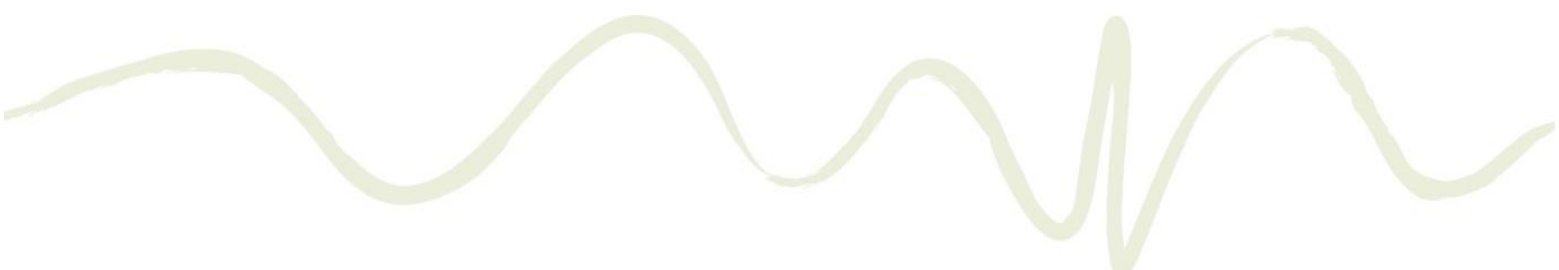
Other predicted changes include:

- Establishment of *Gahnia* spp. and Broad-leaved Cumbungi in the deeper depressions that occur on the western shore.
- Drier extremities of the lagoon, where water levels will be less than 0.1 m deep are likely to remain unchanged.
- Other vegetation habitat zones that occur below 2 m AHD will also be potentially affected along the drainage channel (Sedge Swamp/ open water) and along the eastern edge of the lagoon (Fringing Marsh and Banksia Woodland).

The results of the vegetation monitoring indicate that vegetation change has occurred around the lagoon, particularly in the Fringing Marsh community. At the conclusion of the 2015 monitoring, the area occupied by this community had retracted west as water levels in the lagoon rose and the amount of open water increased. Additionally, species known to rely on saltwater influence, such as Sea Rush (*Juncus kraussii* subsp. *australiensis*), reduced significantly in cover abundance and have progressively been replaced by a range of other species. The persistence of salt tolerant species is attributed to periods of lower water levels and infrequent saltwater ingress events from Salty Creek into Salty Lagoon.

Results from the 2017 monitoring indicate that emergent vegetation, comprising species such as Broad-leaved Cumbungi (*Typha orientalis*), Common Reed (*Phragmites australis*) and Fringe Rush (*Fibrostylus ferruginea*), is becoming more abundant in the areas of open water resulting in the Fringing Marsh community expanding back towards the east. These outcomes are in general accordance with the predicted changes. Overall, species dominance within the Fringing Marsh has shifted from saltmarsh/salt tolerant species to freshwater species.

Vegetation change has also occurred in areas of the Swamp Forest, albeit to a far lesser degree than that which has occurred in the Fringing Marsh. Some lower stratum species such as Bare Twig Rush (*Baumea juncea*) and Saw Sedge (*Gahnia* spp.) have increased in cover abundance whilst saline



dependant species such as Sea Rush (*Juncus kraussii* subsp. *australiensis*) continues to decline. Changes in the Sedge Swamp community and the Banksia Woodland community have been even less pronounced, this outcome is also in line with the predicted outcomes.

The results of the monitoring associated with *Melaleuca* recolonisation indicate that although little recruitment or recolonisation appears to have occurred within the monitoring quadrats, the existing trees remain healthy with dense foliage and no signs of stress. Although some trees within the quadrats have died, overall the population of trees being monitored appears to be relatively stable, with those dying generally being replaced with smaller trees that have grown up from a lesser size class. General observations of the Fringing Swamp area outside of the monitoring quadrats suggest that some recruitment of *Melaleuca* is occurring, albeit sparsely and in scattered locations.

5.1 Future Monitoring

Future vegetation monitoring would allow for longer-term observation of the impact of the channel closure on the Salty Lagoon system, particularly in relation to predictions of Broad-leaved Paperbark expansion. Should future vegetation monitoring be undertaken, the following recommendations are provided for consideration:

- Utilisation of the existing quadrats to record cover abundance would allow species composition to be monitored over time. Quadrats to be monitored could be reduced of those within the Swamp Forest and Fringing Marsh only on the basis that little change has occurred (as per predictions) in the Sedge Swamp and Banksia Woodland.
- Recording of the number of *Melaleuca quinquenervia* seedlings, saplings and small trees in each of the existing quadrats would continue to provide an indication of the level of recruitment/recolonisation occurring over time.
- Utilisation of a belt transect across the Fringing Marsh into the Swamp Forest would be useful for monitoring the recruitment/ recolonisation of *Melaleuca quinquenervia*. A transect approximately 150 m in length by 2 m wide is recommended and could be installed along the existing transects, with the addition of one transect running north-south at the southern end of the lagoon.



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Appendix A

GPS Locations of Vegetation Habitat Zone Boundaries and Monitoring Quadrats

Table A.1 Waypoints Defining the Boundaries of the Three Vegetation Habitat Zones along Transects 1-3

<i>Transect</i>	<i>Vegetation Habitat Zone</i>	<i>Easting</i>	<i>Northing</i>
1	Sedge Swamp (western boundary)	541564	6783212
1	Sedge Swamp/ Swamp Forest	541703	6783131
1	Swamp Forest/ Fringing Marsh	541791	6783090
1	Fringing Marsh/ Open Water	541902	6783032
2	Sedge Swamp (western boundary)	541411	6782750
2	Sedge Swamp/ Swamp Forest	541473	6782756
2	Ecotone between Swamp Forest and Fringing Marsh	541709	6782814
2	Fringing Marsh/ Open Water	541927	6782849
3	Sedge Swamp (western boundary)	541521	6782411
3	Sedge Swamp/ Swamp Forest	541689	6782469
3	Swamp Forest/ Fringing Marsh	541841	6782527
3	Fringing Marsh/ Open Water	542002	6782591

Table A2 Location of Vegetation Habitat Zone Quadrats

<i>Transect Number</i>	<i>Quadrat Number</i>	<i>Vegetation Habitat Zone</i>	<i>Easting</i>	<i>Northing</i>
1	A1	Sedge Swamp	541564	6783237
	A2	Sedge Swamp	541579	6783231
	B1	Swamp Forest	541699	6783134
	B2	Swamp Forest	541743	6783114
	C1	Fringing Marsh	541832	6783076
	C2	Fringing Marsh	541885	6783044
2	A1	Sedge Swamp	541411	6782754
	A2	Sedge Swamp	541453	6782756
	B1	Swamp Forest	541523	6782775
	B2	Swamp Forest	541646	6782802
	C1	Fringing Marsh	541833	6782839
	C2	Fringing Marsh	541927	6782849
3	A1	Sedge Swamp	541559	6782425
	A2	Sedge Swamp	541588	6782425
	B1	Swamp Forest	541697	6782464
	B2	Swamp Forest	541784	6782504
	C1	Fringing Marsh	541895	6782543
	C2	Fringing Marsh	542002	6782591
4	A1	Sedge Swamp Open Water	541785	6782669
	B1	Swamp Forest	541783	6782683
5	A1	Sedge Swamp Open Water	542090	6782821
	B1	Banksia Woodland	542072	6782821
6	A1	Sedge Swamp Open Water	542109	6783073
	B1	Banksia Woodland	542118	6783068

Table A3 Location of Melaleuca Dieback Quadrats

<i>Transect Number</i>	<i>Quadrat Number</i>	<i>Vegetation Habitat Zone</i>	<i>Easting</i>	<i>Northing</i>
1	A	Fringing Marsh	541828	6783071
	B	Fringing Marsh	541811	6783082
	C	Fringing Marsh/ Swamp Forest	541795	6783092
	D	Fringing Marsh/ Swamp Forest	541796	6783092
	E	Fringing Marsh/ Swamp Forest	541760	6783108
2	A	Fringing Marsh	541833	6782839
	B	Fringing Marsh	541817	6782833
	C	Fringing Marsh	541790	6782829
	D	Fringing Marsh	541767	6782824
	E	Fringing Marsh	541751	6782825
3	A	Fringing Marsh	541909	6782556
	B	Fringing Marsh	541895	6782543
	C	Fringing Marsh	541871	6782545
	D	Fringing Marsh	541853	6782532
	E	Swamp Forest	541835	6782524

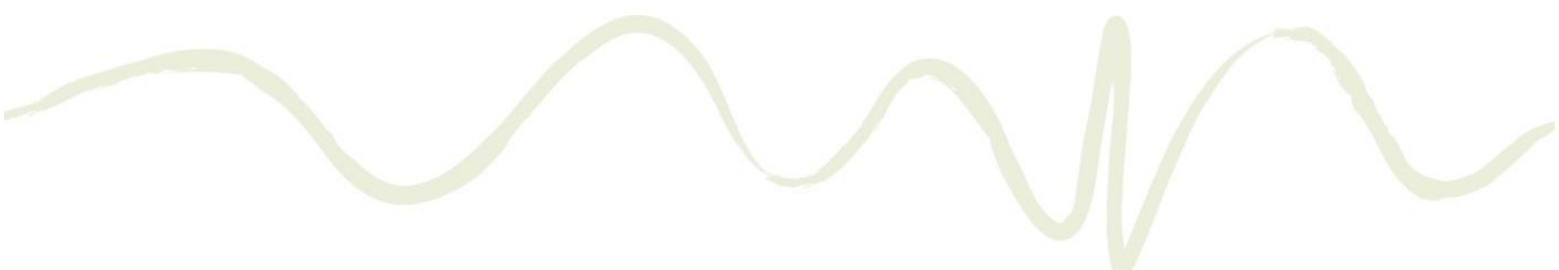


Appendix B

Cover Abundance of Flora Species

Table B1 **Transect 1 Cover Abundance of Flora Species**

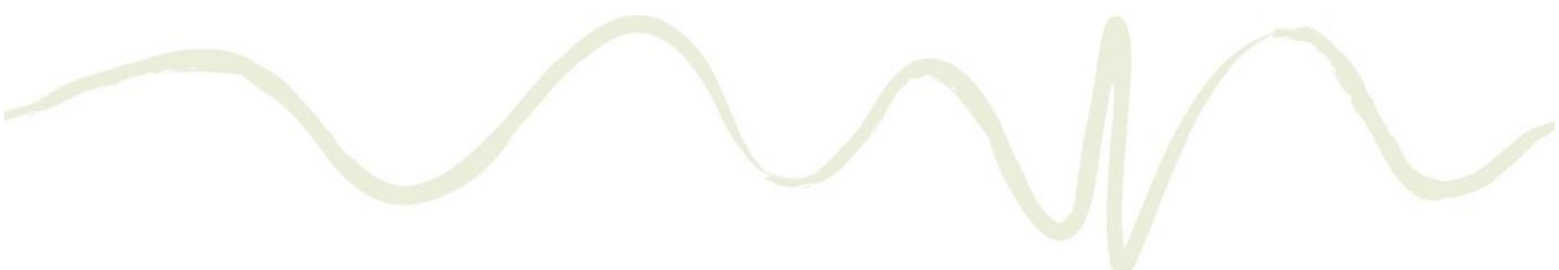
Scientific Name	Common Name	A1	A2	B1	B2	C1	C2
<i>Acacia disparrima</i>							
<i>Acacia sauveolens</i>							
<i>Acacia sophorae</i>	Coast Wattle						
<i>Andropogon virginicus</i> *	Whisky Grass						
<i>Austromyrtus dulcis</i>	Midgen Berry	1	1				
<i>Azolla filiculoides</i>	Red Azolla						2
<i>Baccharis halimifolia</i> *	Groundsel Bush						
<i>Bacopa monnieri</i>	Water Hyssop						
<i>Baeckea frutescens</i>	Weeping Baeckea	3	1				
<i>Baloskion pallens</i>							
<i>Baloskion tetraphyllum</i>	Plume Rush	5	5				
<i>Banksia integrifolia</i>	Coast Banksia						
<i>Baumea arthropphylla</i>							
<i>Baumea articulata</i>	Jointed Twig Rush			2			
<i>Baumea juncea</i>	Blue Coastal Sedge			6	4		
<i>Carex appressa</i>							
<i>Cassytha filiformis</i>	Dodder Laurel	1	2				
<i>Centella asiatica</i>	Indian Pennywort						
<i>Chrysanthemoides monilifera</i> subsp. <i>rotunda</i> *	Bitou Bush						
Climber sample #2							
<i>Conzys bonariensis</i> *	Flax-leaf Fleabane						
<i>Cyperus licudus</i>	A Sedge					1	1
<i>Cyperus polystachyos</i>	A Sedge						3
<i>Cyperus stradbrokeensis</i>	A Sedge						
<i>Digitaria didactyla</i>							
<i>Dillwynia</i> sp.							
<i>Diplachne fusca</i>	Brown Beetle Grass						3
<i>Eleocharis reticulatus</i>			1				
<i>Entolasia stricta</i>							
<i>Enydra fluctuans</i>	Enydra					1	3
<i>Erythrina crista-galli</i> *	Cockspur coral tree						
<i>Eucalyptus robusta</i>	Swamp Mahogany	1					
<i>Ficinia nodosa</i>	Knobby Clubrush						
<i>Fimbristylis ferruginea</i>	Fringe Rush						4
<i>Gahnia clarkei</i>	Saw Sedge						
<i>Gahnia sieberiana</i>	Red-fruited Saw-sedge	3			1		
<i>Gleichenia dicarpa</i>	Coral Fern						
<i>Glycine</i> sp.							
<i>Hibbertia scandens</i>	Climbing Guinea Flower		1				
<i>Hydrocotyle peduncularis</i>							
<i>Hydrocotyle verticillata</i>					1		
<i>Hypolepis muelleri</i>	Harsh Ground Fern						
<i>Imperata cylindrica</i> var. <i>major</i>	Blady Grass						
<i>Ipomea cairica</i> *							
<i>Juncus kraussii</i>	Sea Rush				2	3	
<i>Lemna</i> sp.						2	2
<i>Leptocarpus tenax</i>							
<i>Leptospermum juniperinum</i>							
<i>Leptospermum liversidgei</i>	Olive Tea-tree						
<i>Leptospermum polygalifolium</i>	Tantoon	1	4				
<i>Lepyrodia interrupta</i>			1				
<i>Leucopogon linearis</i>		1	2				
<i>Lobelia alata</i>	Angled Lobelia						
<i>Lomandra longifolia</i>	Spiny-headed Mat-Rush						
<i>Lophostemon suaveolens</i>	Swamp Box						



Scientific Name	Common Name	A1	A2	B1	B2	C1	C2
<i>Maclura cochinchinensis</i>	Cockspur thorn						
<i>Marsdenia rostrata</i>							
<i>Melaleuca quinquenervia</i>	Broad-leaved Paperbark	3	4	3	3	2	
<i>Mistletoe sp.</i>	Mistletoe sp.			1	1		
<i>Myriophyllum sp.</i>	Watermilfoil						
<i>Nymphoides indica</i>	Water Snowflake						
<i>Parsonsia straminea</i>	Common Silkpod	1					
<i>Paspalum vaginatum</i>	Saltwater Couch					3	2
<i>Patersonia sp.</i>	Sample #1						
<i>Philydrum lanuginosum</i>	Frogsmouth						
<i>Phragmites australis</i>	Common Reed				3	6	
<i>Physalis peruviana*</i>	Cape Gooseberry						
<i>Schoenoplectus subulatus</i>	Shore Club-rush						3
<i>Schoenus brevifolius</i>							
<i>Selaginella uliginosa</i>		2	2				
<i>Stephania japonica</i>	Snake Vine						
<i>Stylidium sp.</i>	Trigger Plant	1	1				
<i>Thelymitra sp.</i>	Sun Orchid		1				
<i>Typha orientalis</i>	Broadleaf Cumbungi						
<i>Vigna marina</i>	Dune Bean						
<i>Xanthorrhoea sp.</i>		2	3				

Table B2 **Transect 2 Cover Abundance of Flora Species**

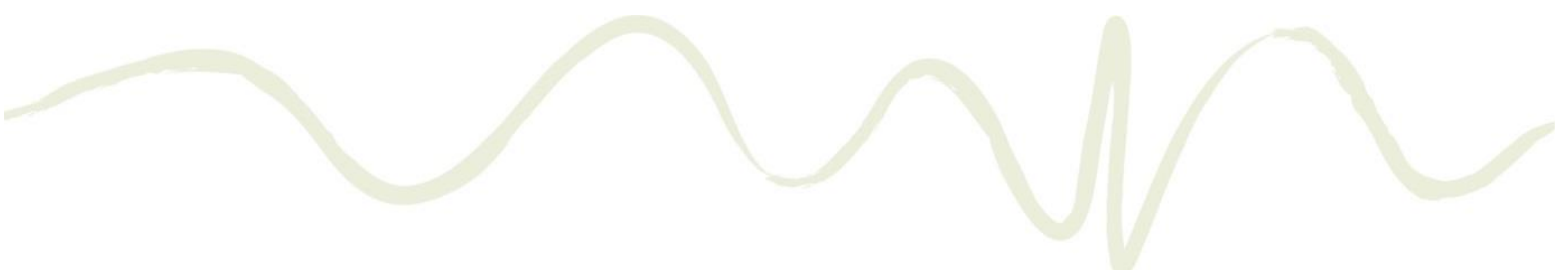
Scientific Name	Common Name	A1	A2	B1	B2	C1	C2
<i>Acacia disparrima</i>							
<i>Acacia saueolens</i>							
<i>Acacia sophorae</i>	Coast Wattle						
<i>Andropogon virginicus</i> *	Whisky Grass						
<i>Austromyrtus dulcis</i>	Midgen Berry						
<i>Azolla filiculoides</i>	Red Azolla						
<i>Baccharis halimifolia</i> *	Groundsel Bush						
<i>Bacopa monnieri</i>	Water Hyssop					2	2
<i>Baeckea frutescens</i>	Weeping Baeckea	4					
<i>Baloskion pallens</i>		1					
<i>Baloskion tetraphyllum</i>	Plume Rush	2					
<i>Banksia integrifolia</i>	Coast Banksia						
<i>Baumea arthropophylla</i>			2				
<i>Baumea articulata</i>	Jointed Twig Rush			3	2		
<i>Baumea juncea</i>	Blue Coastal Sedge		6	4	3		
<i>Carex appressa</i>				3			
<i>Cassytha filiformis</i>	Dodder Laurel	3					
<i>Centella asiatica</i>	Indian Pennywort						
<i>Chrysanthemoides monilifera</i> subsp. <i>rotunda</i> *	Bitou Bush						
Climber sample #2		1					
<i>Conzya bonariensis</i> *	Flax-leaf Fleabane						
<i>Cyperus licudus</i>	A Sedge						
<i>Cyperus polystachyos</i>	A Sedge					4	4
<i>Cyperus stradbokensis</i>	A Sedge						
<i>Digitatia didactyla</i>							
<i>Dillwynia</i> sp.		4					
<i>Diplachne fusca</i>	Brown Beetle Grass					3	3
<i>Eleocarpus reticulatus</i>							
<i>Entolasia stricta</i>							
<i>Enydra fluctuans</i>	Enydra				1	2	
<i>Erythrina crista-galli</i> *	Cockspur coral tree						
<i>Eucalyptus robusta</i>	Swamp Mahogany						
<i>Ficinia nodosa</i>	Knobby Clubrush						
<i>Fimbristylis ferruginea</i>	Fringe Rush					3	3
<i>Gahnia clarkei</i>	Saw Sedge	2	1	3	2		
<i>Gahnia sieberiana</i>	Red-fruited Saw-sedge						
<i>Gleichenia dicarpa</i>	Coral Fern						
<i>Glycine</i> sp.							
<i>Hibbertia scandens</i>	Climbing Guinea Flower						
<i>Hydrocotyle peduncularis</i>							
<i>Hydrocotyle verticillata</i>							
<i>Hypolepis muelleri</i>	Harsh Ground Fern						
<i>Imperata cylindrica</i> var. <i>major</i>	Blady Grass						
<i>Ipomea cairica</i> *							
<i>Juncus kraussii</i>	Sea Rush				2		
<i>Lemna</i> sp.							2
<i>Leptocarpus tenax</i>		2					
<i>Leptospermum juniperinum</i>							
<i>Leptospermum liversidgei</i>	Olive Tea-tree						
<i>Leptospermum polygalifolium</i>	Tantoon						
<i>Lepyrodia interrupta</i>							
<i>Leucopogon linearis</i>							
<i>Lobelia alata</i>	Angled Lobelia						
<i>Lomandra longifolia</i>	Spiny-headed Mat-Rush						
<i>Lophostemon suaveolens</i>	Swamp Box						



Scientific Name	Common Name	A1	A2	B1	B2	C1	C2
<i>Maclura cochinchinensis</i>	Cockspur thorn						
<i>Marsdenia rostrata</i>							
<i>Melaleuca quinquenervia</i>	Broad-leaved Paperbark	2	3	4	4		
<i>Mistletoe sp.</i>	Mistletoe sp.						
<i>Myriophyllum sp.</i>	Watermilfoil						
<i>Nymphoides indica</i>	Water Snowflake						
<i>Parsonsia straminea</i>	Common Silkpod	1	1				
<i>Paspalum vaginatum</i>	Saltwater Couch		3	2		3	
<i>Patersonia sp.</i>	Sample #1	1					
<i>Philydrum lanuginosum</i>	Frogsmouth					1	
<i>Phragmites australis</i>	Common Reed			2			3
<i>Physalis peruviana*</i>	Cape Gooseberry						
<i>Schoenoplectus subulatus</i>	Shore Club-rush					2	
<i>Schoenus brevifolius</i>		3	2				
<i>Selaginella uliginosa</i>		3					
<i>Stephania japonica</i>	Snake Vine						
<i>Stylidium sp.</i>	Trigger Plant						
<i>Thelymitra sp.</i>	Sun Orchid						
<i>Typha orientalis</i>	Broadleaf Cumbungi					3	
<i>Vigna marina</i>	Dune Bean						
<i>Xanthorrhoea sp.</i>		2					

Table B3 Transect 3 Cover Abundance of Flora Species

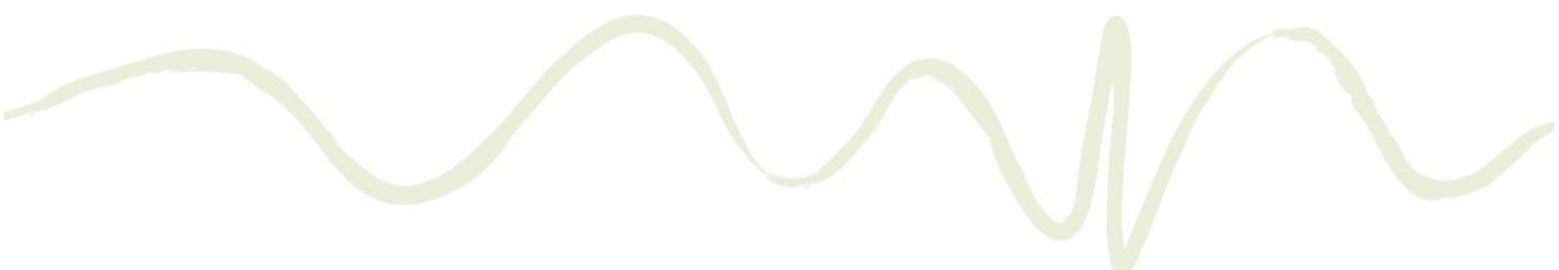
Scientific Name	Common Name	A1	A2	B1	B2	C1	C2
<i>Acacia disparrima</i>					1		
<i>Acacia saueolens</i>			1				
<i>Acacia sophorae</i>	Coast Wattle						
<i>Andropogon virginicus</i> *	Whisky Grass				2		
<i>Austromyrtus dulcis</i>	Midgen Berry		1				
<i>Azolla filiculoides</i>	Red Azolla						
<i>Baccharis halimifolia</i> *	Groundsel Bush			1	3		
<i>Bacopa monnieri</i>	Water Hyssop			3			
<i>Baeckea frutescens</i>	Weeping Baeckea						
<i>Baloskion pallens</i>							
<i>Baloskion tetraphyllum</i>	Plume Rush						
<i>Banksia integrifolia</i>	Coast Banksia						
<i>Baumea arthrophylla</i>		3	3				
<i>Baumea articulata</i>	Jointed Twig Rush						
<i>Baumea juncea</i>	Blue Coastal Sedge			1	4		
<i>Carex appressa</i>				5			
<i>Cassytha filiformis</i>	Dodder Laurel	3			2		
<i>Centella asiatica</i>	Indian Pennywort						
<i>Chrysanthemoides monilifera</i> subsp. <i>rotunda</i> *	Bitou Bush						
Climber sample #2							
<i>Conzya bonariensis</i> *	Flax-leaf Fleabane						
<i>Cyperus licudus</i>	A Sedge						1
<i>Cyperus polystachyos</i>	A Sedge					4	4
<i>Cyperus stradbokensis</i>	A Sedge						
<i>Digitatia didactyla</i>							
<i>Dillwynia</i> sp.		2					
<i>Diplachne fusca</i>	Brown Beetle Grass					3	3
<i>Eleocharis reticulatus</i>							
<i>Entolasia stricta</i>					1		
<i>Enydra fluctuans</i>	Enydra			3	2		
<i>Erythrina crista-galli</i> *	Cockspur coral tree						
<i>Eucalyptus robusta</i>	Swamp Mahogany						
<i>Ficinia nodosa</i>	Knobby Clubrush						
<i>Fimbristylis ferruginea</i>	Fringe Rush						2
<i>Gahnia clarkei</i>	Saw Sedge			2	2		
<i>Gahnia sieberiana</i>	Red-fruited Saw-sedge	2	2				
<i>Gleichenia dicarpa</i>	Coral Fern	3					
<i>Glycine</i> sp.							
<i>Hibbertia scandens</i>	Climbing Guinea Flower				1		
<i>Hydrocotyle peduncularis</i>				3	2		
<i>Hydrocotyle verticillata</i>				1			
<i>Hypolepis muelleri</i>	Harsh Ground Fern						
<i>Imperata cylindrica</i> var. <i>major</i>	Blady Grass				2		
<i>Ipomea cairica</i> *							
<i>Juncus kraussii</i>	Sea Rush						
<i>Lemna</i> sp.				1			1
<i>Leptocarpus tenax</i>							
<i>Leptospermum juniperinum</i>			2				
<i>Leptospermum livesidgei</i>	Olive Tea-tree	2					
<i>Leptospermum polygalifolium</i>	Tantoon				1		
<i>Lepyrodia interrupta</i>							
<i>Leucopogon linearis</i>							
<i>Lobelia alata</i>	Angled Lobelia						
<i>Lomandra longifolia</i>	Spiny-headed Mat-Rush				3		
<i>Lophostemon suaveolens</i>	Swamp Box				1		



Scientific Name	Common Name	A1	A2	B1	B2	C1	C2
<i>Maclura cochinchinensis</i>	Cockspur thorn						
<i>Marsdenia rostrata</i>					2		
<i>Melaleuca quinquenervia</i>	Broad-leaved Paperbark	4	4	4	4		
<i>Mistletoe sp.</i>	Mistletoe sp.						
<i>Myriophyllum sp.</i>	Watermilfoil						
<i>Nymphoides indica</i>	Water Snowflake					1	
<i>Parsonsia straminea</i>	Common Silkpod	2	2	1	1		
<i>Paspalum vaginatum</i>	Saltwater Couch		2		2	1	
<i>Patersonia sp.</i>	Sample #1						
<i>Philydrum lanuginosum</i>	Frogsmouth						
<i>Phragmites australis</i>	Common Reed						
<i>Physalis peruviana*</i>	Cape Gooseberry						
<i>Schoenoplectus subulatus</i>	Shore Club-rush						2
<i>Schoenus brevifolius</i>		6	6	2	4		
<i>Selaginella uliginosa</i>		2	2		2		
<i>Stephania japonica</i>	Snake Vine						
<i>Stylidium sp.</i>	Trigger Plant						
<i>Thelymitra sp.</i>	Sun Orchid						
<i>Typha orientalis</i>	Broadleaf Cumbungi						
<i>Vigna marina</i>	Dune Bean						
<i>Xanthorrhoea sp.</i>							

Table B4 **Transects 4, 5 and 6 Cover Abundance of Flora Species**

Scientific Name	Common Name	Transect 4		Transect 5		Transect 6	
		A1	B1	A1	B1	A1	B1
<i>Acacia disparrima</i>							
<i>Acacia sauveolens</i>							
<i>Acacia sophorae</i>	Coast Wattle						1
<i>Andropogon virginicus</i> *	Whisky Grass						2
<i>Austromyrtus dulcis</i>	Midgen Berry						1
<i>Azolla filiculoides</i>	Red Azolla						
<i>Baccharis halimifolia</i> *	Groundsel Bush						
<i>Bacopa monnieri</i>	Water Hyssop		2	1			
<i>Baeckea frutescens</i>	Weeping Baeckea						
<i>Baloskion pallens</i>							
<i>Baloskion tetraphyllum</i>	Plume Rush						
<i>Banksia integrifolia</i>	Coast Banksia				3		1
<i>Baumea arthropophylla</i>							
<i>Baumea articulata</i>	Jointed Twig Rush		3				
<i>Baumea juncea</i>	Blue Coastal Sedge		6	3		2	2
<i>Carex appressa</i>			1	1			
<i>Cassytha filiformis</i>	Dodder Laurel						
<i>Centella asiatica</i>	Indian Pennywort			2			
<i>Chrysanthemoides monilifera</i> subsp. <i>rotunda</i> *	Bitou Bush				3		3
<i>Climber sample #2</i>							
<i>Conzys bonariensis</i> *	Flax-leaf Fleabane				2		2
<i>Cyperus licudus</i>	A Sedge						
<i>Cyperus polystachyos</i>	A Sedge	1	3	2		2	1
<i>Cyperus stradbokensis</i>	A Sedge				3		
<i>Digitaria didactyla</i>					2		
<i>Dillwynia</i> sp.							
<i>Diplachne fusca</i>	Brown Beetle Grass						
<i>Eleocharis reticulatus</i>							
<i>Entolasia stricta</i>							
<i>Enydra fluctuans</i>	Enydra	2	2	2		2	
<i>Erythrina crista-galli</i> *	Cockspur coral tree			1	1		
<i>Eucalyptus robusta</i>	Swamp Mahogany						
<i>Ficinia nodosa</i>	Knobby Clubrush						1
<i>Fimbristylis ferruginea</i>	Fringe Rush					3	
<i>Gahnia clarkei</i>	Saw Sedge		1				1
<i>Gahnia sieberiana</i>	Red-fruited Saw-sedge						
<i>Gleichenia dicarpa</i>	Coral Fern						
<i>Glycine</i> sp.							1
<i>Hibbertia scandens</i>	Climbing Guinea Flower						1
<i>Hydrocotyle peduncularis</i>					2		1
<i>Hydrocotyle verticillata</i>			2	2		1	
<i>Hypolepis muelleri</i>	Harsh Ground Fern	2					2
<i>Imperata cylindrica</i> var. <i>major</i>	Blady Grass			4	6		6
<i>Ipomea cairica</i> *				1			
<i>Juncus kraussii</i>	Sea Rush	2					
<i>Lemna</i> sp.		1		1		2	
<i>Leptocarpus tenax</i>							
<i>Leptospermum juniperinum</i>							
<i>Leptospermum liversidgei</i>	Olive Tea-tree						
<i>Leptospermum polygalifolium</i>	Tantoon						
<i>Lepyrodia interrupta</i>							
<i>Leucopogon linearis</i>							
<i>Lobelia alata</i>	Angled Lobelia			2			
<i>Lomandra longifolia</i>	Spiny-headed Mat-Rush						



Scientific Name	Common Name	Transect 4		Transect 5		Transect 6	
		A1	B1	A1	B1	A1	B1
<i>Lophostemon suaveolens</i>	Swamp Box						
<i>Maclura cochinchinensis</i>	Cockspur thorn						1
<i>Marsdenia rostrata</i>				1	1		1
<i>Melaleuca quinquenervia</i>	Broad-leaved Paperbark		3	3	1	3	
<i>Mistletoe sp.</i>	Mistletoe sp.				1		
<i>Myriophyllum sp.</i>	Watermilfoil			3		2	
<i>Nymphoides indica</i>	Water Snowflake			2			2
<i>Parsonsia straminea</i>	Common Silkpod						
<i>Paspalum vaginatum</i>	Saltwater Couch		4				
<i>Patersonia sp.</i>	Sample #1						
<i>Philydrum lanuginosum</i>	Frogsmouth						
<i>Phragmites australis</i>	Common Reed						
<i>Physalis peruviana</i> *	Cape Gooseberry		1				
<i>Schoenoplectus subulatus</i>	Shore Club-rush	5	3			3	
<i>Schoenus brevifolius</i>							
<i>Selaginella uliginosa</i>							
<i>Stephania japonica</i>	Snake Vine			2	3		2
<i>Stylidium sp.</i>	Trigger Plant						
<i>Thelymitra sp.</i>	Sun Orchid						
<i>Typha orientalis</i>	Broadleaf Cumbungi	2	2				
<i>Vigna marina</i>	Dune Bean			1			
<i>Xanthorrhoea sp.</i>							



Appendix C

Photo Point Monitoring



Transect 1 quadrat A1



Transect 1 quadrat A2



Transect 1 quadrat B1



Transect 1 quadrat B2



Transect 1 quadrat C1



Transect 1 quadrat C2



Transect 2 quadrat A1



Transect 2 quadrat A2



Transect 2 quadrat B1



Transect 2 quadrat B2



Transect 2 quadrat C1



Transect 2 quadrat C2



Transect 3 quadrat A1



Transect 3 quadrat A2



Transect 3 quadrat B1



Transect 3 quadrat B2



Transect 3 quadrat C1



Transect 3 quadrat C2



Transect 4 quadrat A1



Transect 4 quadrat B1



Transect 5 quadrat A1



Transect 5 quadrat B1



Transect 6 quadrat A1



Transect 6 quadrat B1



Melaleuca Dieback Transect 1 quadrat A



Melaleuca Dieback Transect 1 quadrat B



Melaleuca Dieback Transect 1 quadrat C



Melaleuca Dieback Transect 1 quadrat D



Melaleuca Dieback Transect 1 quadrat E



Melaleuca Dieback Transect 2 quadrat A

No photo taken

Melaleuca Dieback Transect 2 quadrat B



Melaleuca Dieback Transect 2 quadrat C



Melaleuca Dieback Transect 2 quadrat D



Melaleuca Dieback Transect 2 quadrat E



Melaleuca Dieback Transect 3 quadrat A



Melaleuca Dieback Transect 3 quadrat B



Melaleuca Dieback Transect 3 quadrat C



Melaleuca Dieback Transect 3 quadrat D



Melaleuca Dieback Transect 3 quadrat E