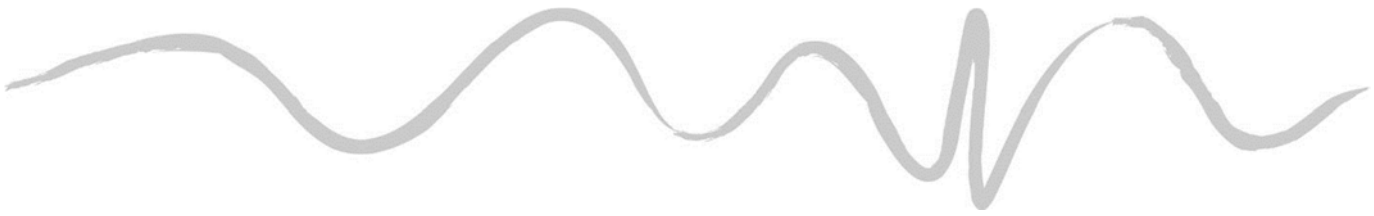
Vegetation Monitoring Report - Baseline

Salty Lagoon



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Vegetation Monitoring Report - Baseline

Salty Lagoon

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Table of Contents

Illustrations

Figures

Tables

Appendices

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; and
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 Salty Lagoon Ecosystem Recovery MPPC (Hydrosphere 2010b).

The key objectives of the Salty Lagoon Ecosystem Recovery 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; and
3. Inform long term strategies with respect to the management of effluent from the Evans Head Sewage Treatment Plan (STP).

The Salty Lagoon Ecosystem Recovery MPPC was initiated in March 2011 and is due to be completed in June 2017. This report is part of the *Ecosystem Health and Trend Assessment* portion of the Salty Lagoon Ecosystem Recovery MPPC and summarises the methods, data, observations and conclusions relating to the vegetation monitoring undertaken prior to the closure of the artificial channel.

1.1.1 Previous Vegetation Monitoring

The aim of the flora and vegetation mapping components of the ERMP was to "*document the status of key ecosystem components as baseline data to inform planning for recovery*" (Hydrosphere 2010a). Field sampling was undertaken 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 (*Lemma* sp.) in the STP channel (drainage channel); and
- 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).

1.1.2 MPPC Vegetation Monitoring

Vegetation monitoring for the MPPC is less intensive than that implemented for the ERMP as a major component of the ERMP was to document baseline data over a broader area than that covered in 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.

1.1.2.1 Predicted Changes to Vegetation Habitat Zones

Vegetation communities are anticipated to change in response to the closure of the artificial channel. 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*) may 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; and
- 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; and
- Sedge Swamp.

1.1.2.2 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.

2 Methodology

2.1 Vegetation Transects

2.1.1 Timing

Vegetation sampling was undertaken over four days on 14 March, 13 April, 20 April and 21 April 2011.

Water levels at the time of sampling varied substantially. On 13 April 2011 water levels were very low and the area of open water consisted of a single channel that meandered through the central portion of the Salty Lagoon basin area. Large areas of open sand/ mud were exposed. Water levels on the remaining days of sampling were much higher, with very little open areas of sand/ mud exposed and standing water extended through much of the Fringing Marsh on the western side of the lagoon.

2.1.2 Vegetation Habitat Zones

Vegetation transects and quadrats were established according to the proposed methodology outlined in Hydrosphere (2010b).

The boundaries of the vegetation are 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 for the pre-closure survey 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 locate this boundary (refer to Appendix A [Table A1]).

Six transects were established in total; four on the western side of the lagoon and two on the eastern side (refer to Illustration 2.1).

Transects 1-3 are 400-600 m in length and each extends across the following three distinct vegetation habitat zones of Fringing Marsh, Swamp Forest and Sedge Swamp. Two quadrats (10 m x 10 m) were established 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 global positioning system (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) was established 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 includes:

- 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;
- diameter at breast height (DBH - recorded at 1.25 m above the ground) for each stem greater than 10 cm DBH;
- Description of vegetation health; and
- Photos taken from the north-east corner of each quadrat.

Table 2.1 Modified Braun-Blanquet Cover Classes

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

2.1.2.1 Field Marking

Transects were marked at 20 m intervals in the field using stakes in the open areas (i.e. Fringing Marsh) and flagging tape on established trees in the forested areas.

Quadrats were marked utilising transect stakes in open areas and flagging tape on established trees in the forested areas. The quadrat code was written onto the top, southern side of the stake. The corner points of the quadrats were not permanently marked in the field, however in some instances temporary flagging was used to define the quadrat corners. Trees with DBH >10 cm in quadrats along Transects 4-6 were permanently marked in the field using metal tags and wire. Trees with DBH >10 cm along Transects 1-3 were not permanently marked in the field, however for future reference, quadrats were divided into four quarters (quadrants) and tree counts started 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 that will be useful for identifying changes that may occur in vegetation habitat zones once the artificial channel is closed. These indicator species have been 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 included also.

2.1.4 Melaleuca Dieback/ Recolonisation Transects

Melaleuca dieback transects and quadrats (10 m x 10 m) were established according to the proposed methodology outlined in Hydrosphere (2010b). Three transects were established corresponding with those previously established for the ERMP sampling (refer to Figure 2 in Hydrosphere 2010a). These transects

correspond with Transects 1-3 established to measure vegetation habitat zone changes (refer to Illustration 2.1). Quadrats were established along Transects 1-3 corresponding with the Fringing Marsh/ Swamp Forest boundary. Quadrats are located at 20 m intervals and are marked utilising transect stakes as the central point. The central stake is marked with a metal tag and wire and the quadrat code is written on the top, southern side of the stake.

The waypoints identifying the location of each quadrat is provided in Appendix A (Table A3).

Data recorded at Melaleuca dieback quadrats includes:

- 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 with >10 cm DBH (and the DBH of each stem >10cm);
- Number of small trees (i.e. height <1.5 m and DBH >5 cm);
- Number of seedlings (i.e. height <0.5 m);
- Condition of trees within the quadrat using the following categories:
  - unaffected/ full recovery;
  - resprouting;
  - dead.

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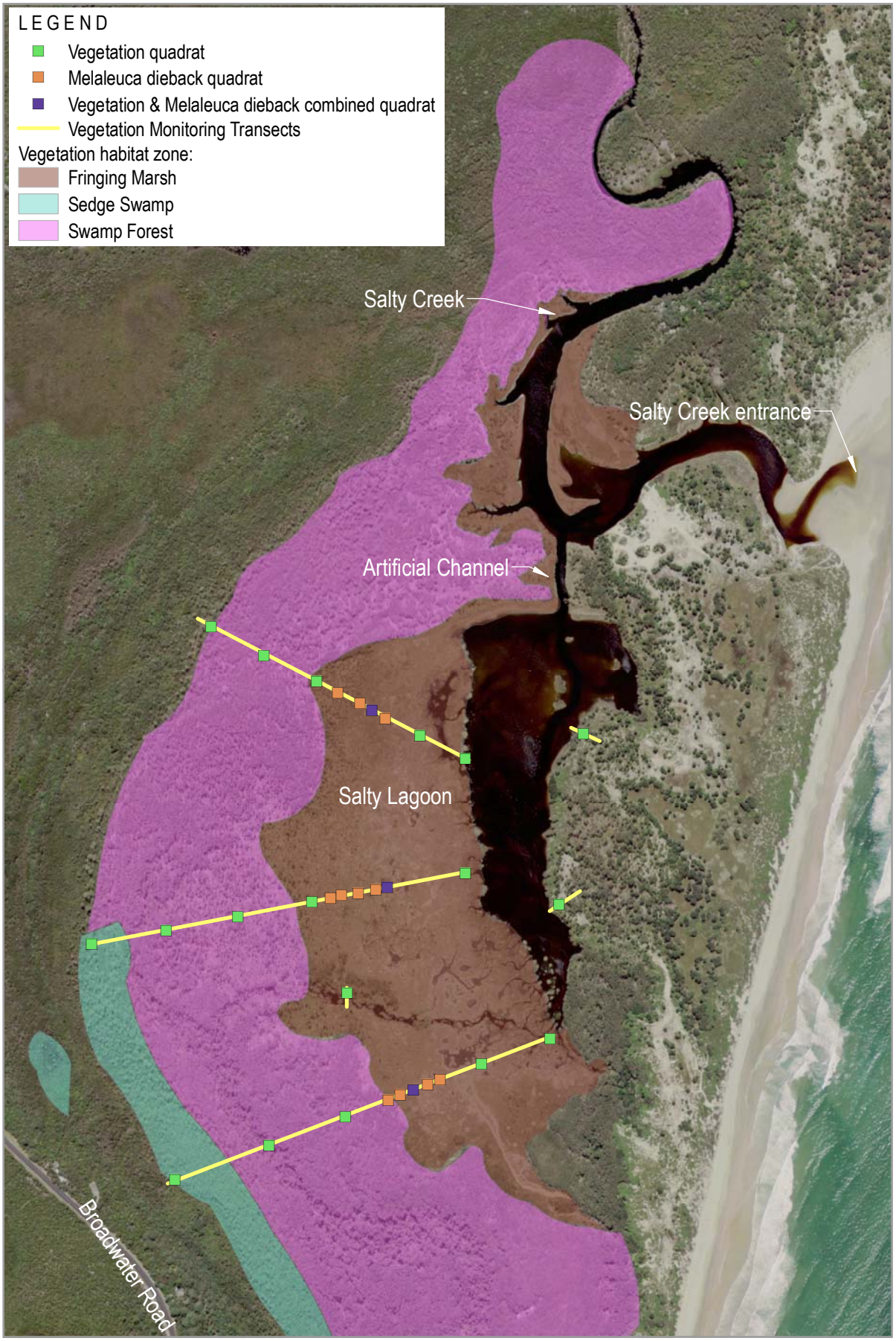
Source of base data: Richmond Valley Council



Indicative Vegetation Sampling Sites selected for the Monitoring Program and Broad Vegetation Habitat Zones (based in Figure 2 in Hydrosphere 2010a)

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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 boundary between these vegetation habitat zones was established and recorded by GPS. A refined map of the vegetation habitat zone boundaries along these transects is shown in Illustration 3.1. The relative distance occupied by the vegetation habitat zones along each transect is detailed in Table 3.1.

Note that due to the presence of an ecotone between the Swamp Forest and Fringing Marsh vegetation habitat zones along Transect 2, the extent of these vegetation habitat zones is provided as a range. The edges of this ecotone area are defined by:

- Western edge – Broad-leaved Paperbark total cover ≈10%.
- Eastern edge - re-shooting Broad-leaved Paperbark and the majority of dead/ alive trees end. Individuals east of here are isolated and total cover ≤10%.

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

Transect	*Extent of Fringing Marsh (m)*	*Extent of Swamp Forest (m)*	*Extent of Sedge Swamp (m)*	*Total Length (m)*
Transect 1	255	199	136	590
Transect 2	258-164	226-322	62	548
Transect 3	182	100	156	438

3.1.1.2 Species Composition of Vegetation Habitat Zones

In total, 73 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 Swamp - 28 species;
- Swamp Forest – 36 species;
- Sedge Swamp – 40 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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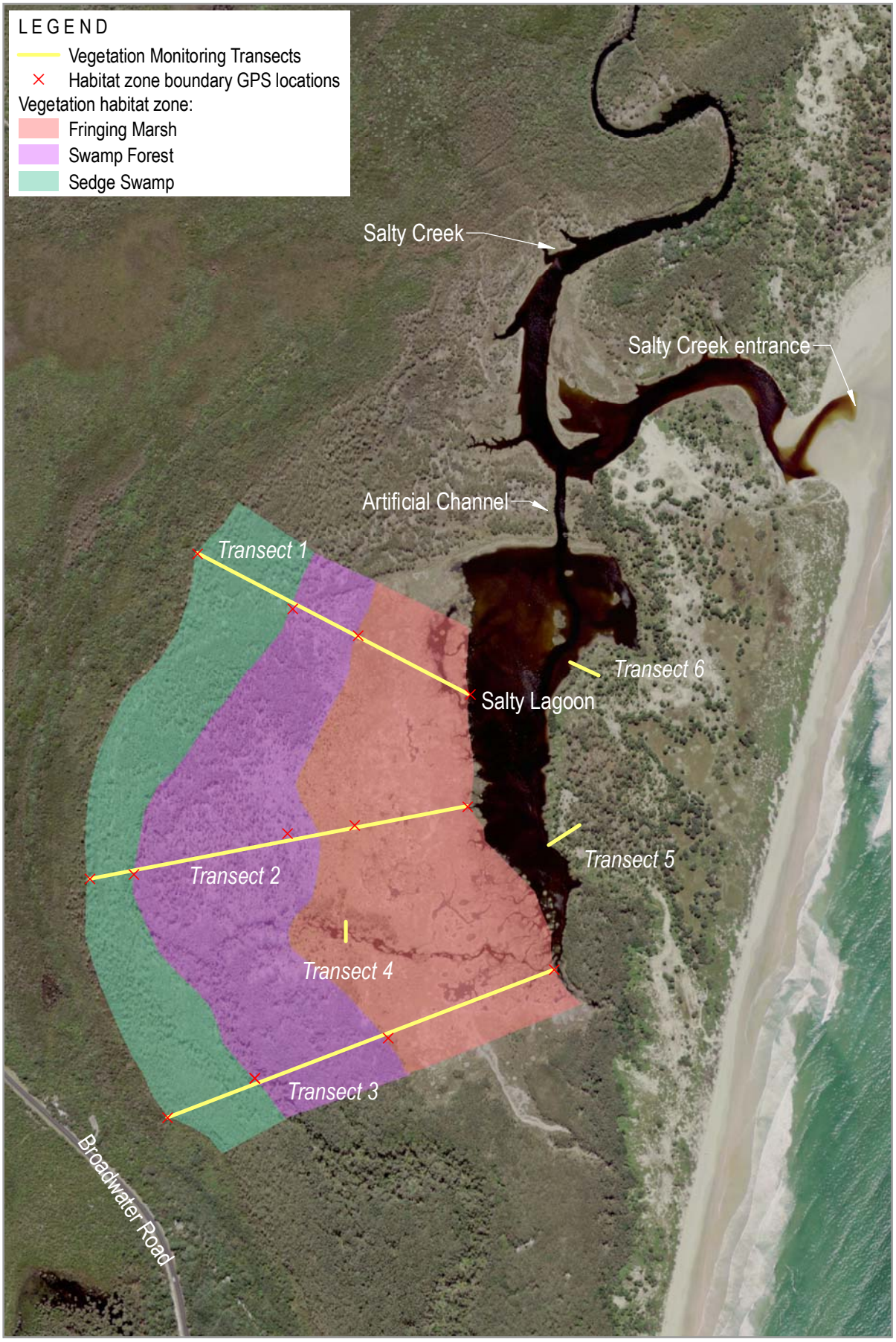
Information shown is for illustrative purposes only

Drawn by: TJP Checked by: MVE Reviewed by: DGH Date: July 2012
Source of base data: Richmond Valley Council



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Location of Vegetation Habitat Zone Boundaries

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

	Common Name	*Botanical Name*	*Fringing Marsh*	*Swamp Forest*	*Sedge Swamp*
Transect 1	Quadrat A1 easting 541564 northing 6783237				
	Grass Tree	*Xanthorrhoea* sp.			4
	Weeping Baeckea	*Baeckea frutescens*			3
	Plume Rush	*Baloskion tetraphyllum*			3
	Prickly Tea Tree	*Leptospermum juniperinum*			3
	Broad-leaved Paperbark	*Melaleuca quinquenervia*			3
	Quadrat A2 easting 541579 northing 6783231				
	Grass Tree	*Xanthorrhoea* sp.			4
	Plume Rush	*Baloskion tetraphyllum*			5
	Prickly Tea Tree	*Leptospermum juniperinum*			3
	Broad-leaved Paperbark	*Melaleuca quinquenervia*			3
	Quadrat B1 easting 541699 northing 6783134				
	Bare Twig-rush	*Baumea juncea*		5	
	Broad-leaved Paperbark	*Melaleuca quinquenervia*		3	
	Saltwater Couch	*Paspalum vaginatum*		3	
	Quadrat B2 easting 541743 northing 6783114				
	Sea Rush	*Juncus krausii* subsp. *australiensis*		6	
	Broad-leaved Paperbark	*Melaleuca quinquenervia*		3	
	Quadrat C1 easting 541832 northing 6783076				
	Sea Rush	*Juncus krausii* subsp. *australiensis*	6		
	Saltwater Couch	*Paspalum vaginatum*	4		
	Quadrat C2 easting 541885 northing 6783044				
	Sea Rush	*Juncus krausii* subsp. *australiensis*	4		
	Saltwater Couch	*Paspalum vaginatum*	5		

	Common Name	*Botanical Name*	*Fringing Marsh*	*Swamp Forest*	*Sedge Swamp*
Transect 2	Quadrat A1 easting 541411 northing 6782754				
	Weeping Baeckea	*Baeckea frutescens*			3
	Plume Rush	*Baloskion tetraphyllum*			3
	Heath-leaved Banksia	*Banksia ericifolia*			3
	Broad-leaved Paperbark	*Melaleuca quinquenervia*			3
	Zig-zag Bog-rush	*Schoenus brevifolius*			3
	Quadrat A2 easting 541453 northing 6782756				
	Bare Twig-rush	*Baumea juncea*			5
	Broad-leaved Paperbark	*Melaleuca quinquenervia*			4
	Sand Couch	*Sporobolus virginicus*			3
	Quadrat B1 easting 541523 northing 6782775				
	Broad-leaved Paperbark	*Melaleuca quinquenervia*		4	
	Saltwater Couch	*Paspalum vaginatum*		3	
	*Whiskey Grass	*Andropogon virginicus*		3	
	Ivy-leaved Violet	*Viola hederacea*		3	
	Quadrat B2 easting 541646 northing 6782802				
	Bare Twig-rush	*Baumea juncea*		5	
	Broad-leaved Paperbark	*Melaleuca quinquenervia*		4	
	Saltwater Couch	*Paspalum vaginatum*		3	
	Quadrat C1 easting 541833 northing 6782839				
	Saltwater Couch	*Paspalum vaginatum*	5		
	Shore Club-rush	*Schoenoplectus subulatus*	4		
	a Rush	*Cyperus* sp.	3		
	Quadrat C2 easting 541927 northing 6782849				
	Saltwater Couch	*Paspalum vaginatum*	4		
	Sea Rush	*Juncus krausii* subsp. *australiensis*	3		
	Common Finger-rush	*Fimbristylis ferruginea*	3		
	Rice Grass	*Diplachne fusca*	3		

	Common Name	*Botanical Name*	*Fringing Marsh*	*Swamp Forest*	*Sedge Swamp*
Transect 3	Quadrat A1 easting 541559 northing 6782425				
	Swamp Twig-rush	*Baumea arthrophylla*			6
	Broad-leaved Paperbark	*Melaleuca quinquenervia*			4
	Bryophyte (a moss) sp.	*unknown*			4
	Quadrat A2 easting 541588 northing 6782425				
	Swamp Twig-rush	*Baumea arthrophylla*			6
	Broad-leaved Paperbark	*Melaleuca quinquenervia*			4
	Bryophyte (a moss) sp.	*unknown*			4
	Swamp Selaginella	*Selaginella uliginosa*			3
	Quadrat B1 easting 541697 northing 6782464				
	Wild Violet	*Viola banksii*		5	
	Broad-leaved Paperbark	*Melaleuca quinquenervia*		4	
	Tall Sedge	*Carex apressa*		4	
	a Speedwell	*Veronica* sp.		3	
	Pennywort	*Hydrocotyle peduncularis*		3	
	Quadrat B2 easting 541784 northing 6782504				
	Broad-leaved Paperbark	*Melaleuca quinquenervia*		4	
	Ivy-leaved Violet	*Viola hederacea*		4	
	Bare Twig-rush	*Baumea juncea*		4	
	*Groundsel Bush	*Baccharis halimifolia*		3	
	Quadrat C1 easting 541895 northing 6782543				
	Saltwater Couch	*Paspalum vaginatum*	6		
	Sea Rush	*Juncus krausii* subsp. *australiensis*	3		
	Bacopa	*Bacopa monnieri*	3		
	Quadrat C2 easting 542002 northing 6782591				
	Bore-drain Sedge	*Cyperus laevigatus*	5		
	Sea Rush	*Juncus krausii* subsp. *australiensis*	5		
	Saltwater Couch	*Paspalum vaginatum*	5		

Note: indicator species shown in **bold**

The cover abundance score for all flora species recorded within quadrats along Transects 1-3 is provided in Appendix B (Table B1). Ranges are given for cover abundance scores of species that occur in two quadrats of a particular vegetation habitat zone within a given transect.

3.1.1.3 Vegetation Habitat Zone Descriptions

Fringing Marsh

Fringing Marsh is dominated by Saltwater Couch (*Paspalum vaginatum*) and Sea Rush (*Juncus kraussii*), with these species occurring in all six quadrats. Shore Club-rush (*Schoenoplectus subulatus*) also occurs commonly being recorded in low-moderate density in four out of six quadrats. Broad-leaved Paperbark and Common Reed (*Phragmites australis*) were all present in low abundance in one quadrat only. A variety of herbs such as *Viola* sp. and Pennywort (*Hydrocotyle peduncularis)* were also present in moderate abundance.

Swamp Forest

Swamp Forest is dominated by Broad-leaved Paperbark and Bare Twig-rush (*Baumea juncea*). Saltwater Couch and Sea Rush were also present in moderate abundance in four and three of the quadrats respectively. *Gahnia* spp. occurred at moderate abundance in three quadrats and Common Reed occurred in low-moderate abundance in two quadrats.

Sedge Swamp

Sedge Swamp is dominated by Plume Rush (*Baloskion tetraphyllum*), which occurred in four out of six of the quadrats. Red-fruit Saw-sedge (*Gahnia sieberiana*), Weeping Baeckea (*Baeckea frutescens*), Grass Tree (*Xanthorrhoea* sp.) and Heath-leaved Banksia (*Banksia ericifolia* subsp. *macrantha*) were also present in moderate abundance, each being present in three out of six quadrats.

Indicator Species

Based on the expected changes from Hydrosphere (2010b and 2011) and the quadrat data collected along Transects 1-3 the following species were selected as indicator species:

- Sea Rush (*Juncus krausii* 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.
- Shore Club-rush (*Schoenoplectus subulatus*): 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.

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

Vegetation characteristics recorded within quadrats along Transects 1-3 is shown 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.

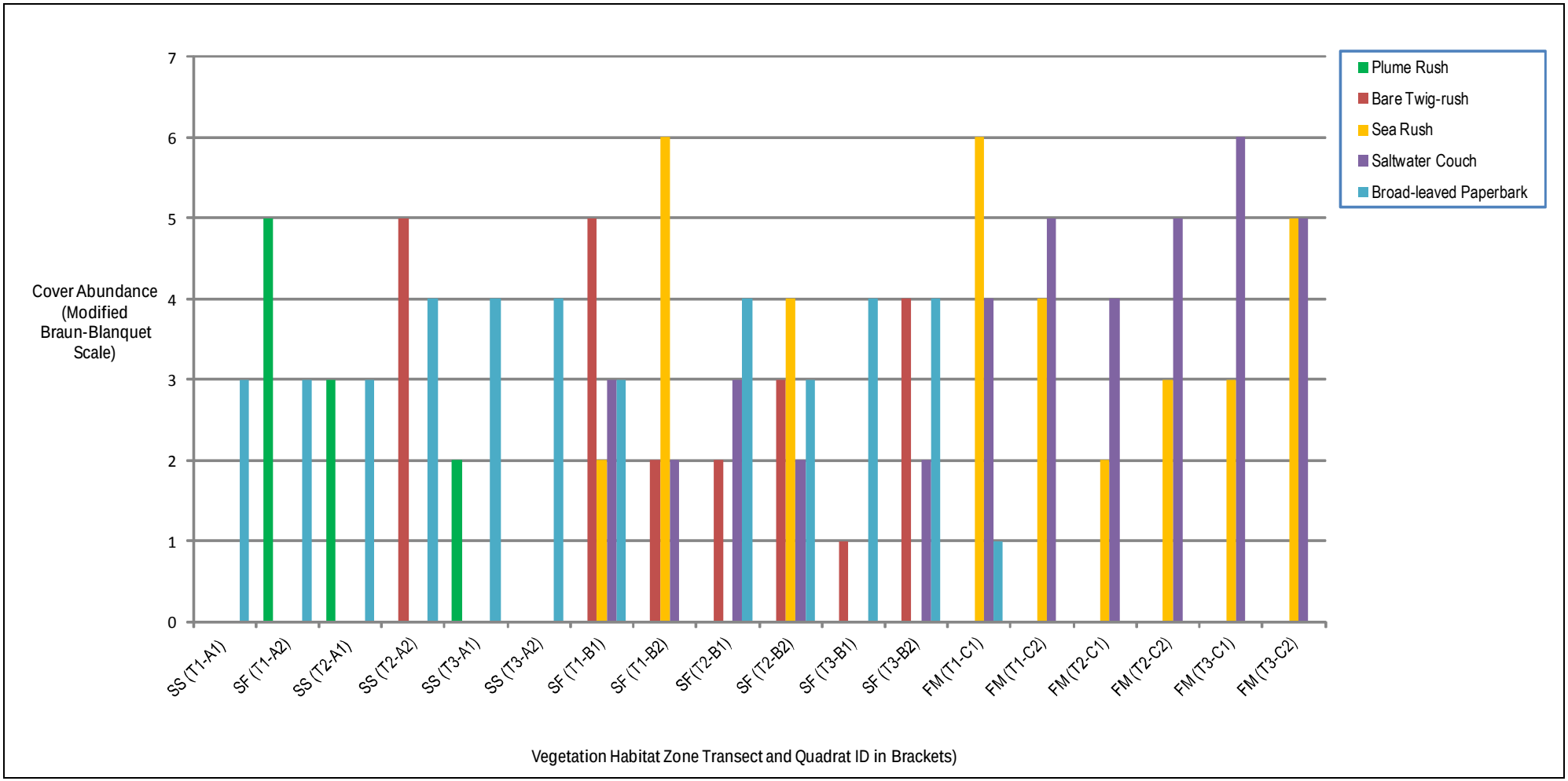

Figure 3.1 Cover Abundance Scores for Indicator Species in Vegetation Habitat Zones of Transects 1-3

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*		*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	Cover Class	Height	Cover Class	Height	Cover Class	Height	Cover Class				
Transect 1	A1	Sedge Swamp	6	3	-	-	3	3	<2	6	Q3	*Eucalyptus robusta*	130/ 110	
												Eucalyptus robusta	170	
											Q4	*Melaleuca quinquenervia*	200	
												Melaleuca quinquenervia	120	
												Melaleuca quinquenervia	200	
												Melaleuca quinquenervia	310	
												Melaleuca quinquenervia	100	
	A2	Sedge Swamp	6	3	-	-	3	2	<1	6	Not recorded	*Melaleuca quinquenervia*	480	
												Melaleuca quinquenervia	100	
	B1	Swamp Forest	8-10	3	4-6	2	-	-	<1.2	5	Q3	*Melaleuca quinquenervia*	170	Numerous dead *Melaleuca quinquenervia* in quadrat. Foliage sparse.
												Melaleuca quinquenervia	200	

Transect	*Quadrat*	*Vegetation Habitat Zone*	*Vegetation Structure*									*Tree Characteristics*		*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	Cover Class	Height	Cover Class	Height	Cover Class	Height	Cover Class				
											Q4	*Melaleuca quinquenervia*	190/ 150	
												Melaleuca quinquenervia	180	
												Melaleuca quinquenervia	120	
												Melaleuca quinquenervia	130	
												Melaleuca quinquenervia	180	
												Melaleuca quinquenervia	110/ 140	
	B2	Swamp Forest	-	-	-	-	4	3	<1.2	6	Q2	*Melaleuca quinquenervia*	130	
	C1	Fringing Marsh	-	-	-	-	-	-	<1.2	6	-	-	-	
	C2	Fringing Marsh	-	-	-	-	-	-	<1.2	6	-	-	-	
Transect 2	A1	Sedge Swamp	10	2	5	3	2-3	3	<1.2	6	Not recorded	*Banksia ericifolia*	110	Foliage on *Melaleuca quinquenervia* yellow/ red and relatively sparse. *Banksia ericifolia* unhealthy with
												Banksia ericifolia	130	
												Melaleuca quinquenervia (south of central tree)	140	

Transect	*Quadrat*	*Vegetation Habitat Zone*	*Vegetation Structure*									*Tree Characteristics*		*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	Cover Class	Height	Cover Class	Height	Cover Class	Height	Cover Class				
														dead leaves.
	A2	Sedge Swamp	10-12	4	6	2	-	-	<1.2	6	Q1	*Melaleuca quinquenervia*	150/ 120	Foliage of *Melaleuca quinquenervia* has good amount of growth but leaves are discoloured.
												Melaleuca quinquenervia	130	
											Q2	*Melaleuca quinquenervia*	300	
												Melaleuca quinquenervia	120/ 120	
												Melaleuca quinquenervia	120	
												Melaleuca quinquenervia	140	
											Q3	*Melaleuca quinquenervia*	430	
												Melaleuca quinquenervia	340	
											Q4	*Melaleuca quinquenervia*	120	
	B1	Swamp Forest	10-12	4	6-8	2	-	-	<1.2	6	Q1	*Melaleuca quinquenervia*	340	No standing water in quadrat but nearby within 15 m
												Melaleuca quinquenervia	360	

Transect	*Quadrat*	*Vegetation Habitat Zone*	*Vegetation Structure*									*Tree Characteristics*		*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	Cover Class	Height	Cover Class	Height	Cover Class	Height	Cover Class				
												Melaleuca quinquenervia	140/ 110	where dead *Melaleuca quinquenervia* start. Foliage is dense and healthy. Some galls presents. Dead trees are not conspicuous.
											Q2	*Melaleuca quinquenervia*	180	
												Melaleuca quinquenervia	350	
											Q4	*Melaleuca quinquenervia*	280	
												Melaleuca quinquenervia	340	
	B2	Swamp Forest	8-10	3	6	2	-	-	<1.2	3	Q1	*Melaleuca quinquenervia*	130	Foliage looks healthy, small amount of discoloured leaves and necrotic spots. Galls not obvious. Trees flowering. New growth conspicuous and dense. Numerous dead *Melaleuca quinquenervia* in
												Melaleuca quinquenervia	140	
												Melaleuca quinquenervia	170	
												Melaleuca quinquenervia	100/ 100	
											Q2	*Melaleuca quinquenervia*	170	
												Melaleuca quinquenervia	200/ 100	
												Melaleuca quinquenervia	120	

Transect	*Quadrat*	*Vegetation Habitat Zone*	*Vegetation Structure*									*Tree Characteristics*		*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	Cover Class	Height	Cover Class	Height	Cover Class	Height	Cover Class				
												Melaleuca quinquenervia	100	quadrat. Standing water throughout quadrat (over ankles).
												Melaleuca quinquenervia	140/ 120	
												Melaleuca quinquenervia	140	
												Melaleuca quinquenervia	110	
											Q3	*Melaleuca quinquenervia*	140	
												Melaleuca quinquenervia	110	
												Melaleuca quinquenervia	140	
												Melaleuca quinquenervia	100	
												Melaleuca quinquenervia	160	
											Q4	*Melaleuca quinquenervia*	160/ 140	
												Melaleuca quinquenervia	200	
												Melaleuca quinquenervia	150	

Transect	*Quadrat*	*Vegetation Habitat Zone*	*Vegetation Structure*									*Tree Characteristics*		*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	Cover Class	Height	Cover Class	Height	Cover Class	Height	Cover Class				
												Melaleuca quinquenervia	150	
	C1	Fringing Marsh	-	-	-	-	-	-	<1.2	6	-	-	-	
	C2	Fringing Marsh	-	-	-	-	-	-	<1.2	6	-	-	-	
Transect 3	A1	Sedge Swamp	15-18	4	6-8	2	<1.2	2	<1.2	6	Q1	*Melaleuca quinquenervia*	230	Sparse foliage on *Melaleuca quinquenervia*. Galls present & obvious leaf discolouration on saplings. Numerous dead trees (~80 cm DBH). Some trees flowering. Sedges healthy.
												Melaleuca quinquenervia	200	
												Melaleuca quinquenervia	140/ 140	
												Melaleuca quinquenervia	130 (dead)	
												Melaleuca quinquenervia	170	
												Melaleuca quinquenervia	170/ 150	
												Melaleuca quinquenervia	120/ 210	
											Q2	*Melaleuca quinquenervia*	180	
												Melaleuca quinquenervia	190/ 110/ 210	

Transect	*Quadrat*	*Vegetation Habitat Zone*	*Vegetation Structure*									*Tree Characteristics*		*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	Cover Class	Height	Cover Class	Height	Cover Class	Height	Cover Class				
												Melaleuca quinquenervia	130	
												Melaleuca quinquenervia	120	
												Melaleuca quinquenervia	130	
												Melaleuca quinquenervia	160	
												Melaleuca quinquenervia	160/ 120	
												Melaleuca quinquenervia	110/ 110	
												Melaleuca quinquenervia	190	
												Melaleuca quinquenervia	150	
											Q3	*Melaleuca quinquenervia*	170/ 140	
												Melaleuca quinquenervia	160	
												Melaleuca quinquenervia	120	
												Melaleuca quinquenervia	180/ 140	

Transect	*Quadrat*	*Vegetation Habitat Zone*	*Vegetation Structure*									*Tree Characteristics*		*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	Cover Class	Height	Cover Class	Height	Cover Class	Height	Cover Class				
											Q4	*Melaleuca quinquenervia*	260	
												Melaleuca quinquenervia	110/ 120/ 140	
												Melaleuca quinquenervia	240	
												Melaleuca quinquenervia	140	
	A2	Sedge Swamp	15-18	4	8	1	<1.2	2	<1.2	6	Q1	*Melaleuca quinquenervia*	130	Foliage on *Melaleuca quinquenervia* obviously sparse. No saplings. Galls conspicuous. Some leaf discolouration.
												Melaleuca quinquenervia	190	
												Melaleuca quinquenervia	110	
												Melaleuca quinquenervia	230	
												Melaleuca quinquenervia	160	
												Melaleuca quinquenervia	190	
												Melaleuca quinquenervia	160	
												Melaleuca quinquenervia	150	

Transect	*Quadrat*	*Vegetation Habitat Zone*	*Vegetation Structure*									*Tree Characteristics*		*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	Cover Class	Height	Cover Class	Height	Cover Class	Height	Cover Class				
												Melaleuca quinquenervia	250	
												Melaleuca quinquenervia	210	
												Melaleuca quinquenervia	200	
												Melaleuca quinquenervia	130	
												Melaleuca quinquenervia	130	
												Melaleuca quinquenervia	170/ 130	
											Q2	*Melaleuca quinquenervia*	200	
												Melaleuca quinquenervia	130	
												Melaleuca quinquenervia	180	
												Melaleuca quinquenervia	160	
												Melaleuca quinquenervia	190	
												Melaleuca quinquenervia	220	

Transect	*Quadrat*	*Vegetation Habitat Zone*	*Vegetation Structure*									*Tree Characteristics*		*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	Cover Class	Height	Cover Class	Height	Cover Class	Height	Cover Class				
											Q3	*Melaleuca quinquenervia*	140	
												Melaleuca quinquenervia	190	
												Melaleuca quinquenervia	180	
												Melaleuca quinquenervia	140	
											Q4	*Melaleuca quinquenervia*	160	
												Melaleuca quinquenervia	250	
												Melaleuca quinquenervia	20	
												Melaleuca quinquenervia	23	
												Melaleuca quinquenervia	180	
												Melaleuca quinquenervia	180	
												Melaleuca quinquenervia	170	
												Melaleuca quinquenervia	110/ 150	

Transect	*Quadrat*	*Vegetation Habitat Zone*	*Vegetation Structure*									*Tree Characteristics*		*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	Cover Class	Height	Cover Class	Height	Cover Class	Height	Cover Class				
	B1	Swamp Forest	18	4	8-12	2	<1.2	1	<1.2	5	Q1	*Melaleuca quinquenervia*	190	Necrotic spots conspicuous on saplings. Galls conspicuous. Foliage on *Melaleuca quinquenervia* noticeably denser than quadrats A1 and A2.
												Melaleuca quinquenervia	240	
												Melaleuca quinquenervia	220	
												Melaleuca quinquenervia	200	
												Melaleuca quinquenervia	100	
												Melaleuca quinquenervia	170	
												Melaleuca quinquenervia	110	
												Melaleuca quinquenervia	220	
											Q2	*Melaleuca quinquenervia*	480	
											Q4	*Melaleuca quinquenervia*	100	
												Melaleuca quinquenervia	140/ 110	
												Melaleuca quinquenervia	220	

Transect	*Quadrat*	*Vegetation Habitat Zone*	*Vegetation Structure*									*Tree Characteristics*		*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	Cover Class	Height	Cover Class	Height	Cover Class	Height	Cover Class				
												Melaleuca quinquenervia	150	
												Melaleuca quinquenervia	190	
												Melaleuca quinquenervia	160	
												Melaleuca quinquenervia	140	
												Melaleuca quinquenervia	190	
												Melaleuca quinquenervia	230	
	B2	Swamp Forest	12	4	6	2	<1.2	2	<1.2	not recorded	Q1	*Melaleuca quinquenervia*	170	
												Melaleuca quinquenervia	180	
												Melaleuca quinquenervia	110	
												Melaleuca quinquenervia	170	
												Melaleuca quinquenervia	840	
											Q2	*Melaleuca quinquenervia*	170	

Transect	*Quadrat*	*Vegetation Habitat Zone*	*Vegetation Structure*									*Tree Characteristics*		*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	Cover Class	Height	Cover Class	Height	Cover Class	Height	Cover Class				
												Melaleuca quinquenervia	170	
												Melaleuca quinquenervia	120	
												Melaleuca quinquenervia	150	
												Melaleuca quinquenervia	170	
											Q3	*Melaleuca quinquenervia*	210	
												Melaleuca quinquenervia	160	
												Melaleuca quinquenervia	180	
												Melaleuca quinquenervia	110	
												Melaleuca quinquenervia	120	
												Melaleuca quinquenervia	140	
											Q4	*Melaleuca quinquenervia*	230	
												Melaleuca quinquenervia	120	

Transect	*Quadrat*	*Vegetation Habitat Zone*	*Vegetation Structure*									*Tree Characteristics*		*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	Cover Class	Height	Cover Class	Height	Cover Class	Height	Cover Class				
	C1	Fringing Marsh	-	-	-	-	-	-	<1.2	6		-	-	
	C2	Fringing Marsh	-	-	-	-	-	-	<1.2	6		-	-	

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3.1.2 Transects 4-6

3.1.2.1 Vegetation Habitat Zone Boundaries

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. Transects 5 and 6 traverse two vegetation habitat zones, namely Fringing Marsh and Banksia Woodland.

A relatively narrow band of reeds, rushes and sedges occurs at the northern edge of the channel and this point is considered to be the boundary of the two vegetation habitat zones (i.e. Sedge Swamp/ open water and Swamp Forest).

The vegetation habitat zone boundaries along Transects 5 and 6 were well defined in the field at the time of survey.

3.1.2.2 Species Composition of Vegetation Habitat Zones

In total, 32 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 – 15 species
- Swamp Forest – 13 species
- Fringing Marsh –14 species
- Banksia Woodland – 14 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	*Botanical Name*	*Sedge Swamp/ Open Water*	*Swamp Forest*	*Fringing Marsh*	*Banksia Woodland*
Transect 4	Quadrat A1 easting 541785 northing 6782669					
	Broad-leaved Cumbungi	*Typha orientalis*	3			
	A sedge	*Cyperus* sp.	3			
	Sea Rush	*Juncus krausii* subsp. *australiensis*	3			
	Quadrat B1 easting 541783 northing 6782683					
	Saltwater Couch	*Paspalum vaginatum*		5		
	Broad-leaved Paperbark	*Melaleuca quinquenervia*		4		
	Sea Rush	*Juncus krausii* subsp. *australiensis*		3		
Transect 5	Quadrat A1 easting 541783 northing 6782683					
	Saltwater Couch	*Paspalum vaginatum*			3	
	Broad-leaved Paperbark	*Melaleuca quinquenervia*			3	

	Common Name	*Botanical Name*	*Sedge Swamp/ Open Water*	*Swamp Forest*	*Fringing Marsh*	*Banksia Woodland*
	Bare Twig-rush	*Baumea juncea*			4	
	Shore Club-rush	*Schoenoplectus subulatus*			3	
	Quadrat B1 easting 542072 northing 6782821					
	Coast Banksia	*Banksia integrifolia*				4
	Bitou Bush	*Crysanthemoides monilifera*				4
	Blady Grass	*Imperata cylindrica*				3
Transect 6	Quadrat A1 easting 542109 northing 6783073					
	Broad-leaved Paperbark	*Melaleuca quinquenervia*			4	
	Sea Rush	*Juncus krausii* subsp. *australiensis*			4	
	Shore Club-rush	*Schoenoplectus subulatus*			4	
	Quadrat B1 easting 542118 northing 6783068					
	Coast Banksia	*Banksia integrifolia*				3
	Blady Grass	*Imperata cylindrica*				4
	Bare Twig-rush	*Baumea juncea*				4
	Bitou Bush	*Crysanthemoides monilifera*				5

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

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

- Transect 4: Sedge Swamp/ open water and Swamp Forest; and
- Transect 5 and 6: Fringing Marsh and Banksia Woodland.

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

Transect 4

Sedge Swamp/ Open Water

Sedge Swamp/ open water is dominated by Cumbungi, Sea Rush and sedges, with moderate densities being recorded in the quadrats along this transect. Tall Saw-sedge (*Gahnia clarkei*) is present in this community at a low-moderate density. The narrow band of reeds, rushes and sedges occurring at the northern edge of the channel is considered to be the boundary between this community and adjacent Swamp Forest.

Swamp Forest

Swamp Forest in this location is dominated by Broad-leaved Paperbark in the upper stratum and Saltwater Couch in the lower stratum. Sea Rush is also relatively common and a number of sedges are also present.

Transects 5 and 6

Fringing Marsh

Fringing Marsh consists of a variety of sedges and rushes with a scattered Broad-leaved Paperbark overstorey. Bare Twig-rush, Shore Club-rush and Saltwater Couch and Broad-leaved Paperbark occur in both quadrats at a moderate density, while Sea Rush is also present in moderate density, but only in the quadrat located along Transect 6.

Banksia Woodland

This relatively low diversity vegetation habitat zone consists of an open canopy of Coast Banksia with an understorey dominated by Blady Grass. The quadrats also were significantly infested with the exotic weed Bitou Bush.

3.1.2.4 Indicator Species

Based on the expected changes from Hydrosphere (2010b and 2011) and the quadrat data collected along Transects 4-6 the following species were selected as indicator species:

- Sea Rush (*Juncus krausii* subsp. *australiensis*) (expected to decrease in the area currently occupied by the Gahnia sedge/ open water habitat zone along Transect 4)
- 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).
- Shore Club-rush (*Schoenoplectus subulatus*) (expected to decrease in the area currently occupied by Fringing Marsh vegetation habitat zone along Transects 5 and 6).
- Saw-sedge (*Gahnia* spp.) expected to increase in the area currently occupied by Sedge Swamp/ open water in Transect 4).
- Coast Banksia (*Banksia integrifolia* subsp. *integrifolia)* (expected to retain current density within the Banksia Woodland with expected water level changes).

The average cover abundance value for each of these indicator species in the vegetation habitat zones is shown in Figure 3.2.

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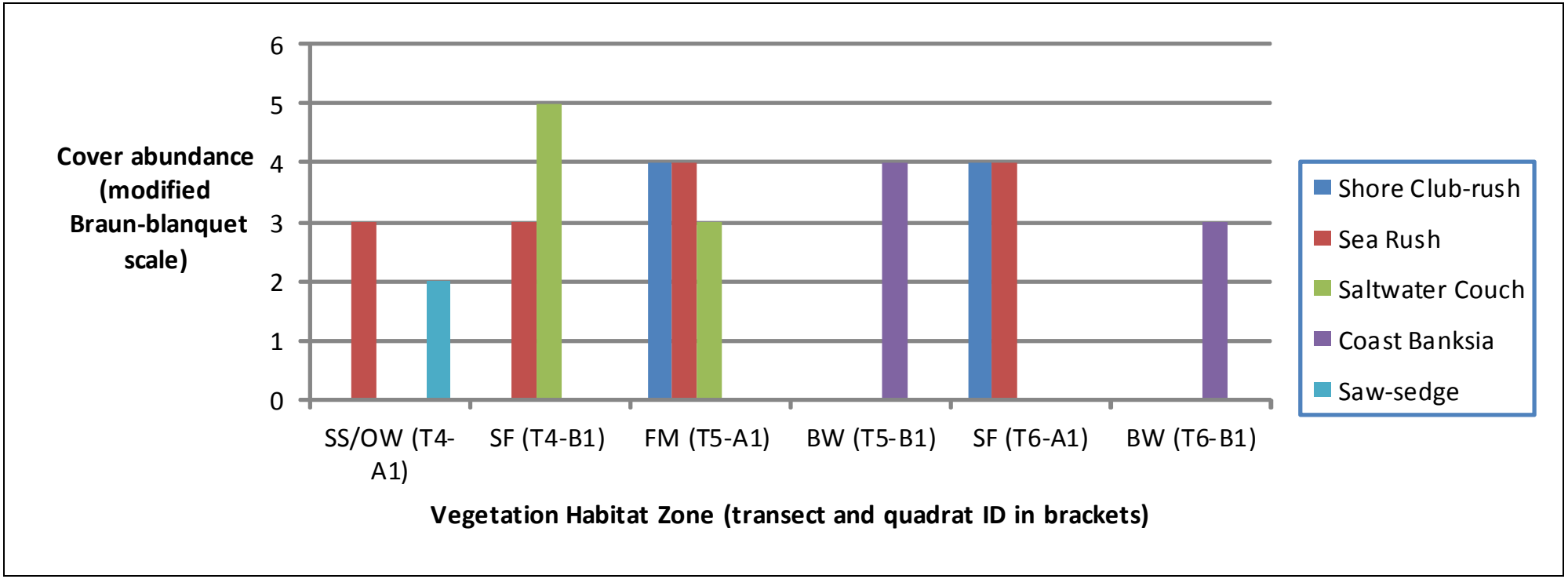

Figure 3.2 Cover Abundance Scores for Indicator Species in Vegetation Habitat Zones of Transects 4-6

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

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3.2 Melaleuca Dieback/ Recolonisation Monitoring

Results from the Melaleuca dieback quadrats are shown in Table 3.5. Less than half of the quadrats contained dead Melaleuca individuals (7 out of 15), with the least dieback being recorded in the quadrats located along transect 1. This reflects a very low general occurrence of Melaleuca (living or dead) in Melaleuca dieback quadrats along this transect. Most of the dieback recorded was located far in quadrats furthest from the edge of the lagoon where most Melaleuca is present and where salt-tolerance is low. The results are consistent with the Melaleuca dieback data collected at the same locations for the ERMP (Hydrosphere 2010).

General observations of vegetation health (presence of necrotic spots on leaves, galls on small branches) for Broad-leaved Paperbark at the Salty Lagoon site was recorded as part of the vegetation zonation quadrats along Transects 1-3 (refer to comments in Table 3.4). Melaleuca dieback quadrats were located in close proximity to the vegetation zonation quadrats (and occasionally used the same quadrat). Therefore, assessment of Melaleuca dieback/ recolonisation monitoring should also use these baseline observations.

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Table 3.5 Melaleuca Dieback Quadrat Data

Transect	*Vegetation Habitat Zone*	*Vegetation Structure*								*Melaleuca Counts*				
		Upper Stratum		*Mid-upper Stratum*		*Mid-stratum*		*Lower Stratum*		*Trees#*	*Small Trees^*	*Seedlings**	*Dead Individuals*	*Condition*
		Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Trees Count	Small Trees Count	Seedling Count	Dead Individual Count	
Transect 1	Quadrat A (easting 541828 northing 6783071)													
	Fringing Marsh	-	-	-	-	-	-	<1.2	6	0	5	0	0	Unaffected
	Quadrat B (easting 541811 northing 6783082)													
	Fringing Marsh/ Swamp Forest	-	-	-	-	-	-	1 - 1.2	6	0	3	2	0	Unaffected
	Quadrat C (easting 541795 northing 6783092)													
	Fringing Marsh/ Swamp Forest	2.5 - 3	2	-	-	-	-	1.2	6	0	12	3	1	Unaffected (small trees and seedlings). Dead - one tree
	Quadrat D (easting 541796 northing 6783092)													
	Fringing Marsh/ Swamp Forest	3 - 4	4	-	-	-	-	<1.2	6	4	13	1	0	Unaffected
	Quadrat E (easting 541760 northing 6783108)													
	Fringing Marsh/ Swamp Forest	2.5 - 3	1	-	-	-	-	1 - 1.2	6	1	0	2	0	Unaffected
Transect 2	Quadrat A (easting 541833 northing 6782839)													
	Fringing Marsh	-	-	-	-	-	-	<1.2	6	0	0	0	0	No Broad-leaved Paperbark present
	Quadrat B (easting 541817 northing 6782833)													
	Fringing Marsh	-	-	-	-	>1.2	1	<1.2	6	0	0	0	2 (both <10 cm DBH)	Dead (2 small trees)
	Quadrat C (easting 541790 northing 6782829)													
	Fringing Marsh	-	-	-	-	-	-	<1.2	6	0	0	0	2 (both <10 cm DBH)	Dead (2 small trees)
	Quadrat D (easting 541767 northing 6782824)													
	Fringing Marsh	-	-	3	1	-	-	<1.2	6	0	0	0	6 (1 multi-branched >10 cm DBH; 5 small trees <10 cm)	Dead (1 tree and 5 small trees)

Transect	*Vegetation Habitat Zone*	*Vegetation Structure*								*Melaleuca Counts*					
		Upper Stratum		*Mid-upper Stratum*		*Mid-stratum*		*Lower Stratum*		*Trees#*	*Small Trees^*	*Seedlings**	*Dead Individuals*		*Condition*
		Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Trees Count	Small Trees Count	Seedling Count	Dead Individual Count		
	Quadrat E (easting 541751 northing 6782825)														
	Fringing Marsh	-	-	3	1	-	-	<1.2	6	0	0	0	24 (8 trees & 16 small trees)	DBH (mm) of trees >100 mm (/ indicates multiple trunks)	Dead (8 trees and 16 small trees)
													Q1	120	
														110/100	
														110	
													Q2	100	
														130	
													Q3	100	
														120	
														130	
Transect 3	Quadrat A (easting 541909 northing 6782556)														
	Fringing Marsh	-	-	-	-	-	-	<1.2	6	0	0	0	0		No Broad-leaved Paperbark present
	Quadrat B (easting 541895 northing 6782543)														
	Fringing Marsh	-	-	-	-	-	-	<1.2	6	0	0	0	0		No Broad-leaved Paperbark present
	Quadrat C (easting 541871 northing 6782545)														
	Fringing Marsh	-	-	-	-	-	-	<1.2	6	0	0	0	3	DBH (mm) of trees >100 mm (/ indicates multiple trunks)	Dead (3 trees)
													Q1	100	
														120/ 130	
														110/ 130/ 160	

Transect	*Vegetation Habitat Zone*	*Vegetation Structure*								*Melaleuca Counts*							
		Upper Stratum		*Mid-upper Stratum*		*Mid-stratum*		*Lower Stratum*		*Trees#*		*Small Trees^*	*Seedlings**	*Dead Individuals*		*Condition*	
		Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Height (m)	Cover Class	Trees Count		Small Trees Count	Seedling Count	Dead Individual Count			
	Quadrat D (easting 541853 northing 6782532)																
	Fringing Marsh	-	-	-	-	-	-	<1.2	6	0		0	0	0		No Broad-leaved Paperbark present	
	Quadrat E (easting 541835 northing 6782524)																
	Swamp Forest	10	3	6	1	>1.2	1	>1.2	5	16	DBH (<10 cm) (/ indicates multiple trunks)	0	0	9	DBH (mm) of trees >100 mm (/ indicates multiple trunks)	Dead (9 trees)	
										Q1	130/ 100/ 120/ 90/ 100			Q1	110		
										Q3	100			Q2	110		
											100				130		
											100				130		
											110				120		
											150/ 130			Q3	100		
											100				100		
											110/ 100				100		
											110				100		
											120						
											100/ 140						
											110						
											130						
											130						
											160/ 130						
											110						
											130						
											100						

 # Trees –DBH of each stem >100mm

^ Small trees - DBH 50 mm - 100 mm

** Seedlings - height <0.5 m*

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3.3 Photo-point Monitoring

Photos taken at photo monitoring points are shown in Appendix C. The methodology for taking these photos should be replicated in future monitoring events for comparison to detect vegetation changes.

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4 Future Monitoring

4.1 Summary of Protocol

Subsequent monitoring will aim to replicate as closely as possible the methodology adopted for this baseline vegetation data collection.

Key factors that will be assessed and compared to this data are:

- changes in vegetation habitat zone boundaries;
- changes in species composition within quadrats (reflecting changes in vegetation community);
- changes in the location and dominance of indicator species; and
- decrease (or increase) in the incidence of Melaleuca dieback.

Photo-point monitoring will be compared with previous photographs in Appendix C to provide a visual record of vegetation changes.

Transects and quadrats will be relocated using the GPS waypoints provided in Appendix A.

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Project Team

The project team members included:

Tom Pollard
Ecologist

Tony Coyle
Ecologist

David Andrighetto
Ecologist

David Havilah
Ecologist / Associate

Veronica Silver
Senior Associate / Ecologist / Planner

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References

Hydrosphere (2010a). *Salty Lagoon Ecosystem Recovery Monitoring Program (ERMP).* A report by Hydrosphere Consulting to Richmond Valley Council. Hydrosphere Consulting, Ballina.

Hydrosphere (2010b). Salty Lagoon Ecosystem Recovery Monitoring Program Pre-Post Closure (MPPC). A report by Hydrosphere Consulting to Richmond Valley Council. Hydrosphere Consulting, Ballina.

Hydrosphere (2011). *Salty Lagoon Rehabilitation Plan.* A report by Hydrosphere Consulting to Richmond Valley Council. Hydrosphere Consulting, Ballina.

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Appendix A

GPS Locations of Vegetation Habitat Zone Boundaries and Monitoring Quadrats

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Table A1 Waypoints Defining the Boundaries of the Three Vegetation Habitat Zones along Transects 1-3

Transect	*Vegetation Habitat Zone*	*Easting*	*Northing*	*Comment*
1	Sedge Swamp (western boundary)	541564	6783213	
1	Sedge Swamp/ Swamp Forest	541699	6783134	
1	Swamp Forest/ Fringing Marsh	541792	6783096	
1	Fringing Marsh/ Open Water	541952	6783012	
2	Sedge Swamp (western boundary)	541411	6782750	
2	Sedge Swamp/ Swamp Forest	541473	6782756	
2	Swamp Forest/ Fringing Marsh	541692- 541787	6782815- 6782826	Ecotone – location of edges is given as two figures
2	Fringing Marsh/ Open Water	541948	6782852	
3	Sedge Swamp (western boundary)	541521	6782411	
3	Sedge Swamp/ Swamp Forest	541645	6782467	
3	Swamp Forest/ Fringing Marsh	541835	6782524	Edge of forest supporting foliage
3	Fringing Marsh/ Open Water	542071	6782621	

Table A2 Location of Vegetation Habitat Zone Quadrats

Transect Number	*Quadrat Number*	*Vegetation Habitat Zone*	*Easting*	*Northing*
1	A1	Sedge Swamp	541564	6783237
	A2		541579	6783231
	B1	Swamp Forest	541699	6783134
	B2		541743	6783114
	C1	Fringing Marsh	541832	6783076
	C2		541885	6783044
2	A1	Sedge Swamp	541411	6782754
	A2		541453	6782756
	B1	Swamp Forest	541523	6782775
	B2		541646	6782802
	C1	Fringing Marsh	541833	6782839
	C2		541927	6782849
3	A1	Sedge Swamp	541559	6782425
	A2		541588	6782425
	B1	Swamp Forest	541697	6782464
	B2		541784	6782504
	C1	Fringing Marsh	541895	6782543
	C2		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

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

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Appendix B

Cover Abundance of All Flora Species

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Table B1 Cover Abundance of All Flora Species Occurring in Transects 1-3

		Transect 1			*Transect 2*			*Transect 3*		
Common Name	*Species Name*	*Fringing Marsh*	*Swamp Forest*	*Sedge Swamp*	*Fringing Marsh*	*Swamp Forest*	*Sedge Swamp*	*Fringing Marsh*	*Swamp Forest*	*Sedge Swamp*
a Wattle	*Acacia* sp.								1	
Lesser Joyweed	*Alternanthera denticulata*				1					
*Whiskey Grass	*Andropogon virginicus*					3				
*Redhead Cottonbush	*Asclepius curassavica*								1	
Midgin Berry	*Austromyrtus dulcis*			1						
Azolla	*Azolla filiculoides*					2				
*Groundsel Bush	*Baccharis halimifolia*								2-3	
Bacopa	*Bacopa monnieri*	1-2	1		2	1		3	2	
Weeping Baeckea	*Baeckea frutescens*			1-3			3			
Didgery Sticks	*Baloskion fallens*						2			
Plume Rush	*Baloskion tetraphyllum*			3-5			3			2
Heath-leaved Banksia	*Banksia ericifolia* subsp. *macrantha*			1			3			1
Swamp Twig-rush	*Baumea arthrophylla*									6
Bare Twig-rush	*Baumea juncea*		2-5			2-3	5		1-4	
Swamp Water Fern	*Blechnum indicum*									1
Tall Sedge	*Carex apressa*					2		1	4	
Dodder	*Cassytha* sp.								2	2
*Spear Thistle	*Cirsium vulgare*	1						1		
*Flaxleaf Fleabane	*Conyza bonariensis*				1-2					
	Cyperus eglobosus						1			

Common Name	Species Name	Transect 1			Transect 2			Transect 3		
		Fringing Marsh	Swamp Forest	Sedge Swamp	Fringing Marsh	Swamp Forest	Sedge Swamp	Fringing Marsh	Swamp Forest	Sedge Swamp
Bore-drain sedge	*Cyperus laevigatus*	2			2			5		
	Cyperus polystachyos								1	
a Rush	*Cyperus* sp.	1			3	2	2	1-2		
a Parrot-pea	*Dillwynia* sp.						1			
Rice Grass	*Diplachne fusca*	2			3			2	1	
Swamp Mahogany	*Eucalyptus robusta*			1						
Common Finger-rush	*Fimbristylis ferruginea*	3			3			2	2	
Tall saw-sedge	*Gahnia clarkei*									2
Red-fruit Saw-sedge	*Gahnia sieberiana*			2			1			2
Pouched Coral Fern	*Glichenia dicarpa*									2
	Glycine sp.								1	
*a Cottonbush	*Gomphocarpus* sp.				1			1		
a Goodenia	*Goodenia* sp.					2			1	1
Purple Coral Pea	*Hardenbergia violacea*	1					1			
Climbing Guinea Flower	*Hibbertia scandens*			1					3	
Pennywort	*Hydrocotyle peduncularis*		1		2	2	1	1		
Harsh Ground Fern	*Hypolepis muelleri*					2			2	
Blady Grass	*Imperata cylindrica*								3	
*Coastal Morning Glory	*Ipomoea cairica*	1			1					
Sea Rush	*Juncus krausii* subsp. *australiensis*	4-6	2-6		2-3	4		3-5		
Grey Rush	*Lepironia articulata*					2				

Common Name	Species Name	Transect 1			Transect 2			Transect 3		
		Fringing Marsh	Swamp Forest	Sedge Swamp	Fringing Marsh	Swamp Forest	Sedge Swamp	Fringing Marsh	Swamp Forest	Sedge Swamp
Slender Twine-rush	*Leptocarpus tenax*						2			1
Prickly Tea Tree	*Leptospermum juniperinum*			3						
Olive Tea Tree	*Leptospermum liversidgei*									1
a Tea Tree	*Leptospermum* sp.						1		1	
Angled Lobelia	*Lobelia anceps*	1	1		2	2		1-2	2	
Spiny-headed Mat-rush	*Lomandra longifolia*								1	
Milk Vine	*Marsdenia* sp.						1		4	4
Broad-leaved Paperbark	*Melaleuca quinquenervia*	1	3	3		3-4	3-4		5	1
	Melichrus sp.									1
Duckweed	*Myriophyllum* sp.				2	2				
Creeping Beard Grass	*Oplismenus imbecillis*								1	
Monkey Rope	*Parsonsia straminea*						1		2	
Saltwater Couch	*Paspalum vaginatum*	4-5	2-3		4-5	2-3		5-6		
Common Reed	*Phragmites australis*	2	2			2				1
Bush-pea	*Pultenaea* sp.									1
a Buttercup	*Ranunculus* sp.				1					
Shore Club-rush	*Schoenoplectus subulatus*	2			2-4			2	1	3
Zig-zag Bog-rush	*Schoenus brevifolius*						3			
a Bog-rush	*Schoenus* sp.				2					2-3
Swamp Selaginella	*Selaginella uliginosa*			1			2			
*Fireweed	*Senecia madagascariensis*							1		

Common Name	Species Name	Transect 1			Transect 2			Transect 3		
		Fringing Marsh	Swamp Forest	Sedge Swamp	Fringing Marsh	Swamp Forest	Sedge Swamp	Fringing Marsh	Swamp Forest	Sedge Swamp
a Fireweed	*Senecio* sp.				2					
*Glossy Nightshade	*Solanum americanum*	1								
*Common Sowthistle	*Sonchus oleraceus*				1					
Knotted Scale-rush	*Sporadanthus interruptus*			1-2						
Sand Couch	*Sporobolus virginicus*						3			
Broad-leaved Cumbungi	*Typha orientalis*									4
Bryophyte (moss) sp.	*unknown*						1		3	
a Speedwell	*Veronica* sp.				2	2		1-2	2-5	
Wild Violet	*Viola banksii*								4	
Ivy-leaved Violet	*Viola hederacea*	1	1			3	2	2		
Grass tree	*Xanthorrhoea* sp.			2-4			1			

* *Denotes exotic species*

Table B2 Cover Abundance of all Flora Species Occurring in Transects 4-6

		Transect 4		*Transect 5*		*Transect 6*	
Common Name	*Species Name*	*Sedge Swamp/ Open Water*	*Swamp Forest*	*Fringing Marsh*	*Banksia Woodland*	*Fringing Marsh*	*Banksia Woodland*
	ASTERACEAE sp.				1		
Azolla	*Azolla filiculoides*	2					
*Groundsel Bush	*Baccharis halimifolia*	1	2				
Coast Banksia	*Banksia integrifolia* subsp. *integrifolia*				4		3
Jointed Twig-rush	*Baumea articulata*	2					
Bare Twig-rush	*Baumea juncea*	2	2	4	2	2	4
	Brachyscome sp.		1				
Gotu Cola	*Centella asiatica*			1			1
*Flaxleaf Fleabane	*Conyza bonariensis*		1		1		
*Bitou Bush	*Crysanthemoides monilifera*		1	3	4	2	5
	Cyperus odoratus				2		
	Cyperus polystachyos	3	2				
Rice Grass	*Diplachne fusca*	1					
Knobby Club-rush	*Ficinia nodosa*			2	2	2	1
Tall saw-sedge	*Gahnia clarkei*	2					
	Glycine sp.			1			
Pennywort	*Hydrocotyle peduncularis*	2	2			1	
Harsh Ground Fern	*Hypolepis muelleri*	2					
Blady Grass	*Imperata cylindrica*			1	3	1	4
*Coastal Morning Glory	*Ipomoea cairica*			1			1
Sea Rush	*Juncus krausii* subsp. *australiensis*	3	3	2		4	
Angled Lobelia	*Lobelia anceps*		1	1		1	1
Broad-leaved Paperbark	*Melaleuca quinquenervia*		4	3		4	

		Transect 4		Transect 5		Transect 6	
Common Name	*Species Name*	*Sedge Swamp/ Open Water*	*Swamp Forest*	*Fringing Marsh*	*Banksia Woodland*	*Fringing Marsh*	*Banksia Woodland*
Duckweed	*Myriophyllum* sp.	2					
Saltwater Couch	*Paspalum vaginatum*	1	5	3		1	1
Shore Club-rush	*Schoenoplectus subulatus*	2		1		4	
Swamp Selaginella	*Selaginella uliginosa*			1	1		
*Fireweed	*Senecia madagascariensis*		1				
Snake Vine	*Stephania japonica* var. *discolor*				1		
Broad-leaved Cumbungi	*Typha orientalis*	3					
Ivy-leaved Violet	*Viola hederacea*		2				
Prickly Couch	*Zoysia macrantha*	1					

* *Denotes exotic species*

Appendix C

Photo-point Monitoring Results

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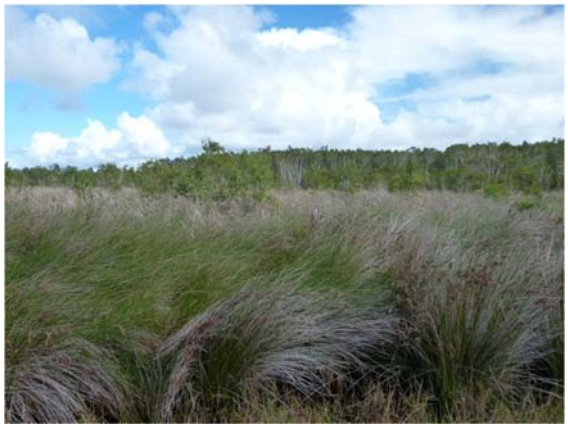
Transect 1 quadrat A1

Transect 1 quadrat B1

Transect 1 quadrat A2



Transect 1 quadrat C1

Transect 1 quadrat B1

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 C1

Transect 3 quadrat A1

Transect 3 quadrat A2

Transect 3 quadrat B1

Transect 3 quadrat B2

Not recorded

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

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