Kaituna River Re-diversion and Maketū Estuary Enhancement Project

Vegetation Monitoring Report for Ford Island and Te Paika

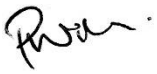
For Bay of Plenty Regional Council

Land Management

October 2021

REPORT INFORMATION AND QUALITY CONTROL

Prepared for:	Michael Tyler Land Management Bay of Plenty Regional Council

Author:	Hamish Dean Principal Ecology Consultant	
Reviewer/Approver:	Dr Pete Wilson Principal Ecology Consultant	

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1 BACKGROUND AND INTRODUCTION

In early 2021, Bay of plenty Regional Council fully commissioned the Kaituna River Re-diversion and Maketū Estuary Enhancement project. This project has restored 20% of the Kaituna River's flow into the Maketū Estuary and recreated 20 ha of estuarine wetland. The Resource Consent for the project (67958) included a condition (34) requiring that marginal vegetation be monitored to determine the effects of the project on terrestrial and wetland vegetation. In total, 11 transects were established to meet this condition. Transects 1 – 8 were established during the Assessment of Environmental Effects stage of the consent application process and are situated at various points around the estuary and adjacent to the river. Later, Transects 10 and 11 were established on the land to the north of the Ford's Cut channel (known as Te Paika) which is being converted from grazed pasture to estuarine wetland. In 2020 an additional transect was established on Ford Island (Transect 9).

4Sight Consulting were engaged to re-measure transects 9 – 11 and report on the findings to satisfy Condition 34 of the Resource Consent. For a full background on the monitoring and history of the project and area see MacGibbon (2014), Wildland Consultants (2018, 2020) and the documentation for Bay of plenty Regional Counsil Resource Consent 67958. At the request of the client, this information has not been repeated here.

2 METHODS

2.1 Field methods

The methodology used in this assessment was consistent with the approach of Wildland Consultants (2018, 2020), which was based on the original method described by MacGibbon (2014).

Vegetation plots on Ford Island (Transect 9) and Te Paika wetland (Transects 10 and 11) were remeasured in August and September 2021. The transects were established in 2018 (Te Paika) and 2020 (Ford Island) by Wildland Consultants, following the same methodology that was used to establish eight other transects around Maketū Estuary during the Assessment of Effects stage of the re-diversion consenting. At the establishment phase, transects were placed to maximise coverage of the space and then random points were generated within 50 m of each transect line. Random numbers were used to select points for quadrat placement. Transects 10 and 11 each had 12 quadrats established, while Transect 9 had eight quadrats.

Each quadrat in Te Paika was marked with two wooden 50 mm x 50 mm posts, one at the southwest and one at the northwest corner along one side of the quadrat (Figure 1). On Ford Island, the posts were placed on the diagonal; one at the southwest corner and one at the northeast corner. In all cases, the post in the southwest corner was marked with a tree tag with a unique identifier nailed either on the side or on the top of the post.

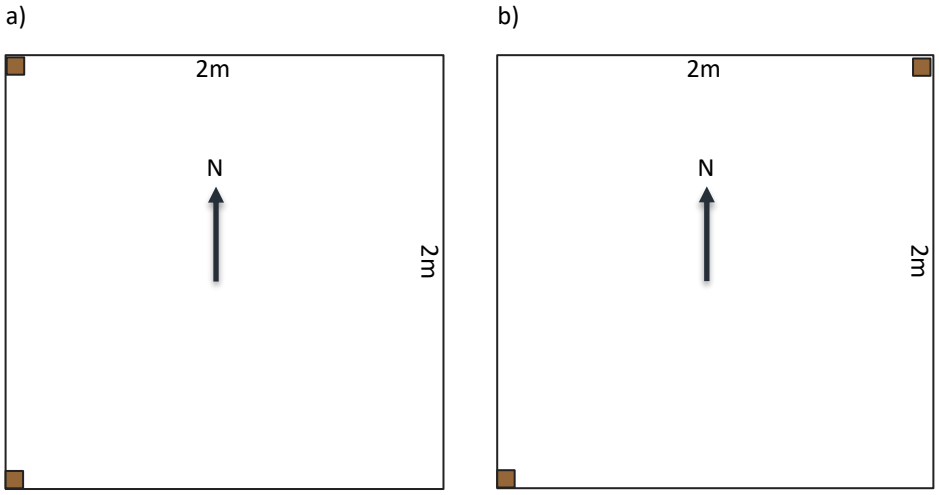

Figure 1: Quadrat layout and orientation for a) Transects 10 and 11 (Te Paika), and b) Transect 9 (Ford Island).

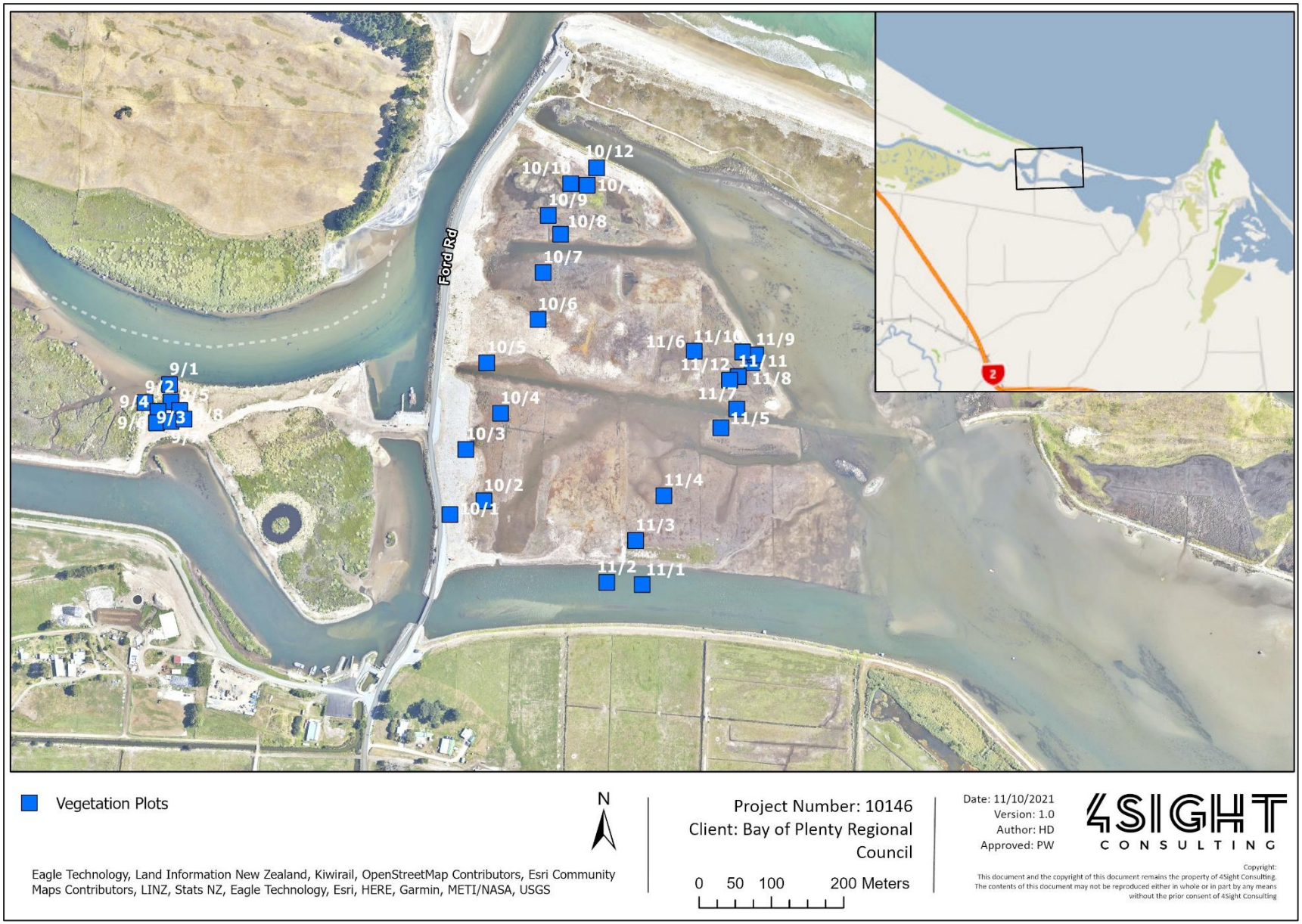

Figure 2: Plot locations

Plots were located using a handheld GPS unit and aerial photography (Figure 2) and identified using the tree tag recorded against that quadrat. Where the original plot could not be located it was re-established at the same location with new posts and a new tree tag.

Each plot was 2m x 2m and was delineated using a quadrat made from PVC pipe.

For each plot location, altitude, and whether the plot was wetland or dryland was recorded (see plot sheet in Appendix C). A brief vegetation description was written following the system developed by Atkinson (1985). Maximum and average vegetation heights were recorded.

Percent foliar cover of each species of vascular plant was estimated in three height classes: < 30 cm, 30 – 100 cm, and 100 – 200 cm. Cover of woody stems and the culms of rushes were not recorded as foliar cover so that if a plant had its natural spread of foliar cover in the 30 – 100cm height class, for example, percent cover was recorded in that class but the cover of the vertical stems through the < 30cm class was not recorded.

Cover of bare ground, leaf litter, woody debris, animal faeces, and algae was also recorded. Total vegetation cover was calculated for each plot from the cover of each species across all tiers, as was the proportion of indigenous vegetation cover.

2.2 Data analysis

Data were analysed at the transect level and focussed on the changes in vegetation composition since the plots were established.

Data were summarised in Microsoft Excel and species richness, total vegetation cover, native richness, and native dominance were calculated at the transect level. Although species richness provides an indication of the changes at the transect level it does not take into account the abundance or distribution of species. These are best accounted for with diversity indices.

Simpson's Index of Diversity (1-D) was calculated on the raw data (no transformation) in Microsoft Excel using the formula $1 - D = 1 - \frac{\Sigma\, c(c-1)}{C(C-1)}$ where c = the total cover (%) of a particular plant species and C = the total cover of all plant species in the transect. Simpson's index (D) measures the likelihood that two individuals randomly selected will be of the same species and 1-D gives a value between 0 and 1 where 0 is 100% probability that the two species will be different, and 1 is 0% probability (i.e. low diversity). Simpson's Diversity measure emphasises common species and the presence of rare species does not affect the results to any great degree (McCune & Grace 2002).

The Shannon-Wiener Index is also a diversity index but is based on the uncertainty in predicting the species in a random sample and is better at taking rarer species into account than Simpson's Diversity Index (McCune & Grace 2002). The Shannon-Weiner Index was calculated using the Vegan package in *R* (Oksanen *et. al.* 2020, R Core Team 2021) using cover data as the abundance measure.

Nonmetric Multidimensional Scaling was carried out on the original and remeasured transect data, using the metaMDS function in the Vegan package in *R* (Oksanen *et. al.* 2020, R Core Team 2021). Data were standardised using a Wisconsin double standardisation and a square root transformation and Bray-Curtis dissimilarity was used as the distance measure. The ordination was allowed up to 1,000 runs in two dimensions.

3 RESULTS

Of the 32 plots originally established on the tree transects, 15 could not be located and had to be re-established. All but one of these was on Te Paika and is the result of the extensive re-contouring and vegetation clearance work that has occurred at the site since the plots were originally established. On Ford Island, some of the plots are very exposed to vehicle traffic and vegetation management has occurred, which resulted in one plot being lost.

In addition, Plots 1 and 2 on Transect 11 were abandoned because they are now within the widened Ford's Cut channel.

Of the 30 plots that were re-measured, 18 were wetland and 12 were dryland, which was similar to 2018/20 when 18 were recorded as wetland while 14 as dryland. Ten plots were completely unvegetated compared with just one (on Ford Island) during the plot establishment.

Details of plot locations and vegetation types from the current re-measurement are presented in Table 1.

Table 1: 2021 plot details.

Transect.Plot	Easting	Northing	Plot re-established or original	Wetland /Dryland	Vegetation description
9.1	1900431	5816190	Original	Dry	Gorse litterfield
9.2	1900397	5816165	Original	Dry	rarahu - (tall fescue) fernland
9.3	1900433	5816166	Original	Dry	Gorse litterfield
9.4	1900415	5816153	Original	Dry	soft rush - Yorkshire fog rushland
9.5	1900445	5816154	Re-established	Dry	Soft rush dirtfield
9.6	1900413	5816137	Original	Dry	Soft rush dirtfield
9.7	1900433	5816139	Original	Dry	Soft rush dirtfield
9.8	1900451	5816142	Original	Dry	soft rush dirtfield
10.1	1900819	5816010	Re-established	Dry	cabbage tree - toetoe shrubland
10.2	1900866	5816029	Re-established	Wet	Mudfield
10.3	1900841	5816100	Re-established	Dry	harakeke mulchfield
10.4	1900889	5816150	Re-established	Wet	searush mudfield
10.5	1900870	5816220	Re-established	Wet	sea rush mudfield
10.6	1900941	5816280	Re-established	Dry	[karo] - [taupata] - [ngaio] - [akeake] / [narrow-leaved carpet grass] - [bachelors buttons] dirtfield
10.7	1900948	5816345	Original	Wet	Mudfield
10.8	1900972	5816398	Re-established	Wet	[sea rush] - [bachelors buttons] sandfield
10.9	1900955	5816424	Original	Wet	sandfield
10.10	1900986	5816468	Re-established	Wet	Sea rush rushland
10.11	1901009	5816466	Re-established	Wet	Mudfield
10.12	1901022	5816490	Re-established	Dry	[manuka] - [ngaio] / yorkshire fog grassland
11.3	1901077	5815973	Re-established	Wet	Sea rush / saltwater paspalum rushland
11.4	1901115	5816036	Re-established	Wet	Mudfield
11.5	1901194	5816130	Original	Wet	Mudfield
11.6	1901157	5816236	Original	Wet	Mudfield
11.7	1901216	5816156	Re-established	Wet	Mudfield
11.8	1901237	5816224	Original	Wet	Sea rush rushland
11.9	1901242	5816231	Re-established	Wet	Mudfield
11.10	1901225	5816235	Original	Wet	*Gracilaria* mudfield
11.11	1901222	5816198	Original	Wet	Sea rush mudfield
11.12	1901206	5816193	Original	Wet	Mudfield

3.1 Vegetation Cover

Vegetation cover in individual plots ranged from 0 – 117.5%, noting that total cover can exceed 100% because of the tiered vegetation. At the transect level, average vegetation cover reduced slightly from 30.38% to 27.75% on Ford

Island (Transect 9) but there were also considerable decreases at Te Paika. In 2018, Transect 10 had 54.63% vegetation cover which dropped to 15.75% in 2021. Vegetation cover on Transect 11 dropped from 67.92% in 2018 to 16.76% in 2021.

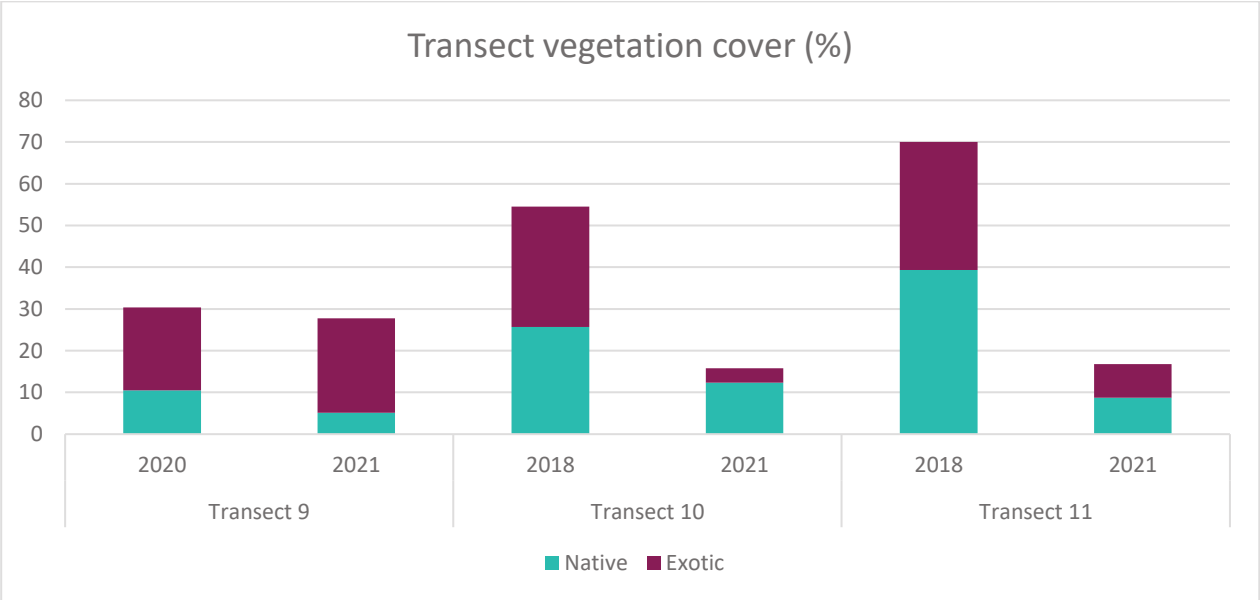

Figure 3: Average vegetation cover of each of the three transects at plot establishment and in 2021.

The proportion of indigenous cover on Transect 9 decreased from 33% in 2020 to 20% in 2021 (Figure 4), while it increased on Transect 10 from 47% to 74%. Very little change occurred on Transect 11 (52% to 50%).

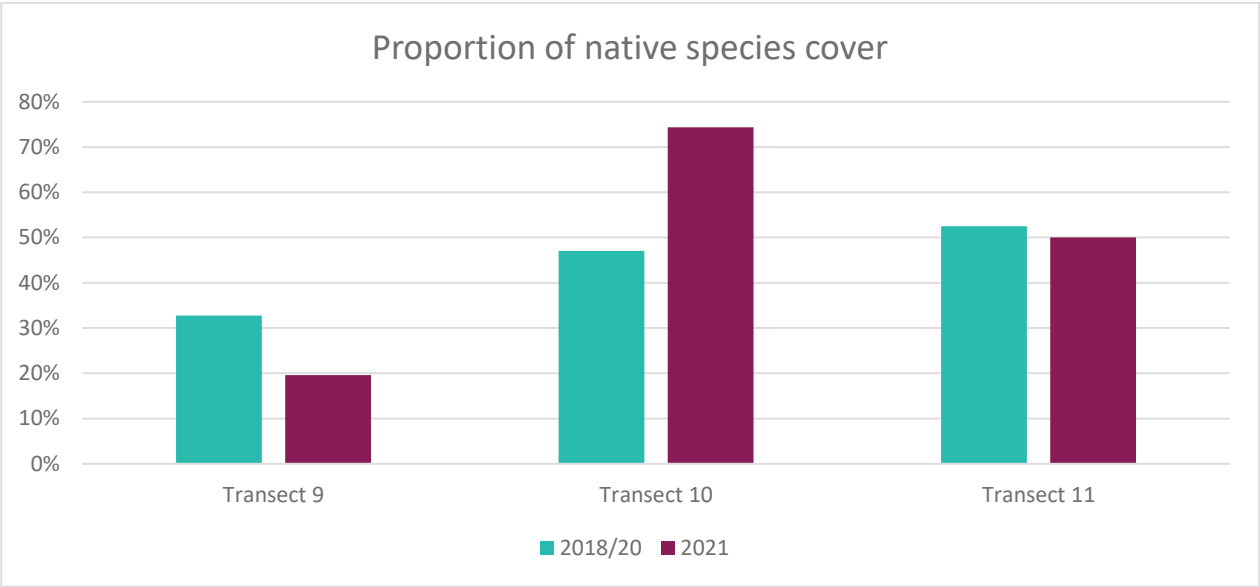

Figure 4: Indigenous vegetation cover as a proportion of total vegetation cover for the three transects at establishment and in 2021.

3.2 Species Richness and Diversity

In total, species richness increased on Transect 9 between 2020 and 2021 from 15 to 22 species (Figure 5) and native species also increased marginally. Species richness decreased in Transect 10 but there was a substantial increase in indigenous species in that transect. The number of species recorded on Transect 11 decreased dramatically between 2018 and 2021.

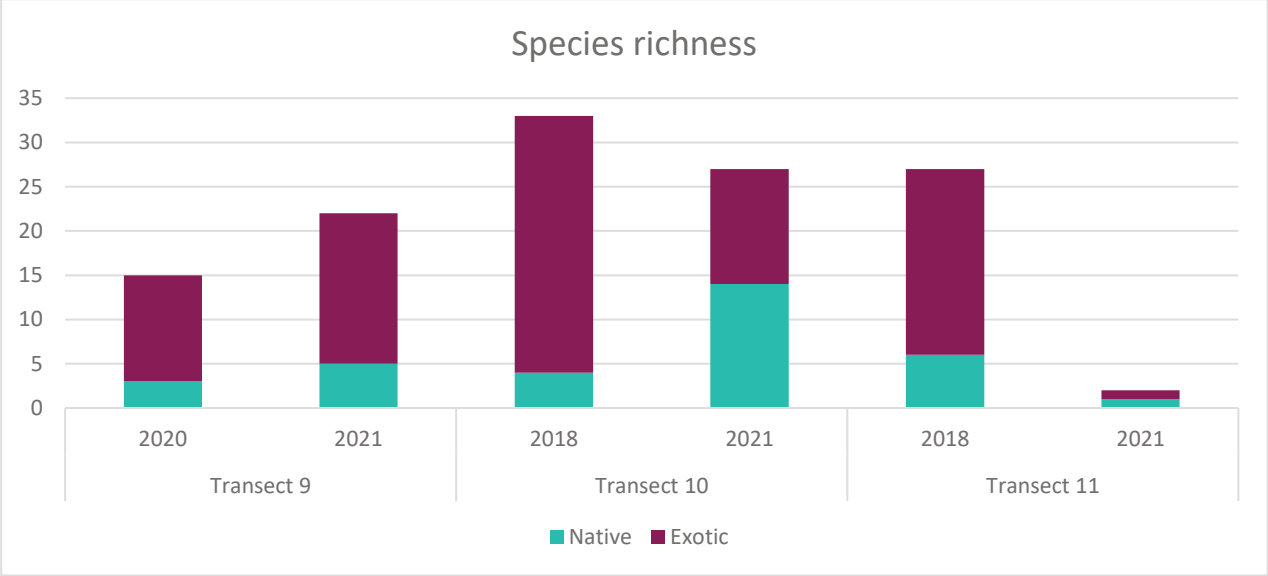

Figure 5: Species richness for each transect at establishment and in 2021. Bars show the proportion of indigenous vs exotic species.

Both the Simpson's and the Shannon-Wiener diversity indices show notable changes in the diversity of the plant community between transects and between measures. There was a small increase in diversity on Ford Island, a similar increase on the western side of Te Paika (Transect 10) and a considerable decrease in diversity on Transect 11.

Table 2: Diversity indices for each of the three transects over the two remeasurements.

	Simpson's diversity index 1-D		Shannon-Wiener Index	
	2018/20	**2021**	**2018/20**	**2021**
Transect 9	0.847	0.886	0.591	0.811
Transect 10	0.851	0.946	0.878	0.904
Transect 11	0.892	0.533	0.946	0.029

3.3 Dominant Species

The average cover of the most abundant species across each of the three transects and two measurements is presented in Table 3 below. In Transect 9, bracken was the most abundant plant by canopy cover in 2020 and although less abundant was still the second most abundant in the 2021 re-measure. Inkweed and paspalum decreased considerably between remeasurements. Overall, the composition of the plant community sampled on Transect 9 did not substantially change over time.

Table 3: Top five most abundant species in each transect across both measurements. Abundance is based on % canopy cover and tiers have been disregarded.

	2020				2021		
Transect 9	Pteridium esculentum	Indigenous	6.3		Juncus effusus var. effusus	Exotic	7.3
	Phytolacca octandra	Exotic	5.3		Pteridium esculentum	Indigenous	3.8
	Paspalum dilatatum	Exotic	3.3		Holcus lanatus	Exotic	3.1
	Ulex europaeus	Exotic	1.9		Ulex europaeus	Exotic	2.3

	Dactylis glomerata	Exotic	0.8		Agrostis stolonifera	Exotic	2.1
			17.4				18.5
Transect 10	**2018**				**2021**		
	Cenchrus clandestinus	Exotic	15.1		Juncus krausii subsp. australiensis	Indigenous	3.0
	Triglochin striata	Indigenous	11.8		Cordyline australis	Indigenous	2.1
	Cynodon dactylon	Exotic	6.7		Holcus lanatus	Exotic	2.0
	Cotula coronopifolia	Indigenous	6.3		Austroderia fulvida	Indigenous	1.3
	Spergularia tasmanica	Indigenous	4.5		Phormium tenax	Indigenous	1.3
			44.4				9.8
Transect 11	**2018**				**2021**		
	Triglochin striata	Indigenous	13.5		Juncus krausii subsp. australiensis	Indigenous	8.0
	Cynodon dactylon	Exotic	10.3		Paspalum vaginatum	Exotic	8.0
	Juncus krausii subsp. australiensis	Indigenous	9.8				
	Spergularia tasmanica	Indigenous	6.4				
	Cynosurus cristatus	Exotic	4.3				

Transect 10 changed substantially between 2018 and 2021. The 2018 community is that of a salt-adapted sea meadow or modified pasture with exotic grasses. In 2021, the community represents planted revegetation species and overall, a much lower canopy cover.

Similarly, Transect 11 changed significantly from a sea meadow with sea rush to only having two species at very low abundance.

3.4 Ordination

The ordination reached a solution after 780 runs which suggests noisy data and only weak ties and resolved with a stress value of 8%[1]. The 2D plot produced from the Nonmetric Multi-Dimensional Scaling (NMDS) is shown in Figure 6 below. As expected, Transects 10 and 11 are relatively tightly clustered in ordination space for the 2018 measurement but display more spread for the 2021 measurement. The changes in individual plots on Transect 9 are apparent (particularly 3 and 6) but for both years the overall spread and shift are not decidedly different.

[1] Stress values <20% are considered appropriate for this type of analysis.

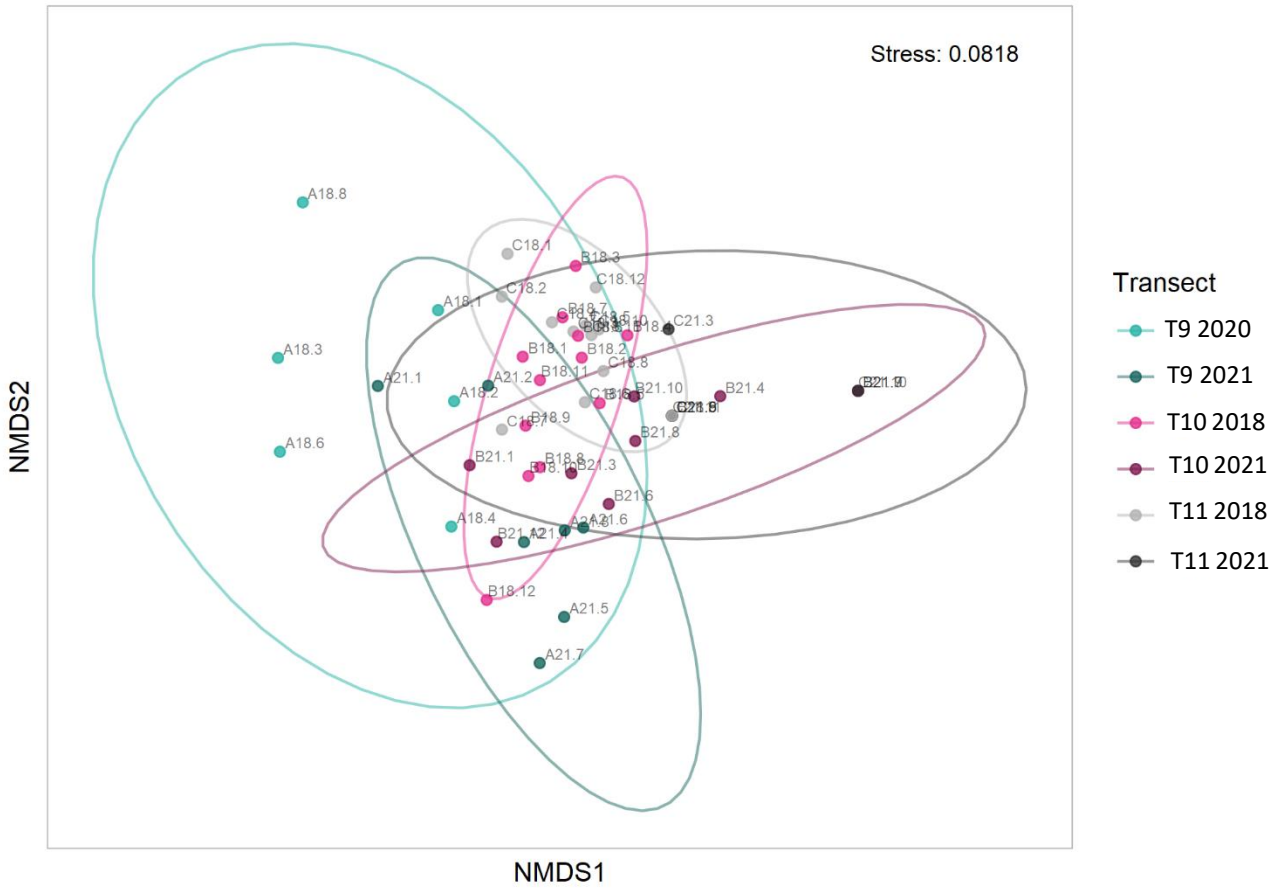

Figure 6: NMDS ordination plot of all three transects and both measurement years.

4 DISCUSSION

It is important to note that both Ford Island and Te Paika have undergone considerable change since the vegetation monitoring was established and that this change is the result of direct management, rather than the environmental change brought about by the re-diversion of more freshwater into the Maketū Estuary. In 2019, Te Paika underwent complete re-contouring as part of the re-diversion project. Excess soil from the re-diversion channel was deposited at the western edge of the site and earth was excavated from other parts of the site to create a more natural landform that would be partially flooded at high tide. This earthwork resulted in the complete removal of the majority of vegetation on the site, although in places mature sea rush were left and some of those have survived the significant change in hydrological regime. These earthworks were conducted as part of the restoration of saltmarsh to the area and, since that time, large areas have been planted with indigenous saltmarsh and coastal forest species. At Ford Island, the changes have been less drastic but are still the direct result of management, rather than environmental change brought about by the re-diversion of the Kaituna River itself. There, vegetation has been removed by mulching with a digger and by herbicide application.

4.1 Te Paika

The results show the early-stage outcomes from the wetland recreation and restoration project. Although there is limited vegetation present, it is anticipated that saltmarsh and sea meadow vegetation will naturally regenerate. Ten plots on Te Paika that were previously vegetated, mostly with exotic species, were completely devoid of vegetation in 2021 but this is to be expected given that the restoration process started with recontouring and is only in the early stages. The expectation is that many of these bare plots will gradually develop vegetative cover although some will not because of the depth of water and wave energy.

While the overall cover of indigenous and exotic species on Te Paika decreased considerably, the proportion of indigenous vegetation increased on Transect 10. This is likely the result of the revegetation plantings on the site, which were identified on the southern and northern ends of the transect, unlike Transect 11 on which only plot 3 was planted.

The substantial changes as a result of earthworks and vegetation clearance on Te Paika are reflected to a lesser extent in species richness, which suggests, at least for the western side of the site (Transect 10), that although the vegetation cover decreased dramatically, plantings and natural re-colonisation have returned some of the richness and increased the diversity. In the eastern half of Te Paika, where there has been less planting and saline water has limited natural regeneration, cover, species richness, and diversity have decreased significantly.

The ordination plot and the similar diversity indices for both transects show that the composition and structure of the vegetation across the site in 2018 was reasonably uniform, but the spread on the ordination plot and divergence in diversity indices indicate a more heterogeneous vegetation composition and structure in 2021 which was evident from site observations. Although some of these early indications for the eastern end of Te Paika could be interpreted that saltmarsh is not establishing, it is too early to draw any conclusions and subsequent monitoring will continue to track progress. The ordination used here utilises existing vegetation groupings (transects) but for future measurements of these plots, and for the original eight transects around the estuary margin, it would be useful to stratify the plots by community type or potential community type based on physical attributes like water depth or elevation. On Te Paika, because of the extensive re-contouring that has happened, this would involve establishing more plots so that there is a relatively even distribution of sampling points in at least two habitat zones.

4.2 Ford Island

Overall, only small changes in vegetation were observed on Ford Island. This is expected given that only one year has passed since the plots were established and that the management has been confined to exotic vegetation control. The decrease in overall cover is likely to be the result of vegetation dieback, which was evident during the remeasurement of the plots (Figure 7). This may be because of herbicide use or the particularly dry conditions experienced over the past year. The increase in species richness and diversity is likely to be, at least in part, because of the natural establishment of exotic rushes and grasses (e.g. *Juncus effusus* var. *effusus*) in plots 4 – 8, which were relatively devoid of living vegetation in 2020. The soil in plots 5 – 8 is very compacted and it was difficult to hammer the wooden stakes into the ground. This will undoubtedly be impacting the re-establishment of vegetation of any kind and could be easily

remedied. Although limited conclusions can be derived from just one year of data, the existing vegetation community is unlikely to transition to an indigenous dominated one without further active restoration.

Figure 7: Plot 1 on Transect 9 (Ford Island) showing the effects of herbicide on vegetation cover.

5 RECOMMENDATIONS

The entire landform of Te Paika has changed since the monitoring was established in 2018. This means that any changes in vegetation detected by the current monitoring cannot be linked with the effects of the re-diversion itself. However, it will still be very useful as a method to monitor long-term restoration success, especially if additional plots are added and stratification applied to capture the various habitat types. On Te Paika, plots should be established in the shrub planting zone (mostly at the western and northern ends), the planted estuarine margin, and the unplanted mudflats. Ideally, new plots and stratification would be installed at a time that would allow alignment with the monitoring of Transects 1 – 8 so that data across the whole project could be compared.

Ford Island would benefit from more restoration effort. In addition to the planting, remediation of the soil would be hugely beneficial as it is heavily compacted and likely to impede plant growth. Ripping with a bulldozer or digger to at least 30cm deep would help with both natural regeneration and with the establishment of plantings.

Saltwater paspalum was establishing around the estuarine margins on Te Paika and should be controlled or eradicated as soon as possible to prevent it adversely affecting the restoration and natural regeneration of the saltmarsh.

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Appendix A: 2021 Plot Data

Transect 9 Plot Data

Transect.Plot	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8
Tag number	P 791	WC8602	W9 3056	P 871	NE 685	W9 3119	WB 2473	WB 9996
Easting	1900431	1900397	1900433	1900415	1900445	1900413	1900433	1900451
Northing	5816190	5816165	5816166	5816153	5816154	5816137	5816139	5816142
Date established	24/06/2020	24/06/2020	24/06/2020	24/06/2020	24/06/2020	24/06/2020	24/06/2020	24/06/2020
Date surveyed	3/09/2021	3/09/2021	3/09/2021	3/09/2021	3/09/2021	3/09/2021	3/09/2021	3/09/2021
Plot re-established or original	Original	Original	Original	Original	Re-established	Original	Original	Original
Altitude	2	2	2	2	2	2	2	2
Recorders	HAD	HAD	HAD	HAD	HAD	HAD	HAD	HAD
Wetland/Dryland	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Vegetation description	Gorse litterfield	rarahu - (tall fescue) fernland	Gorse litterfield	soft rush - Yorkshire fog rushland	Soft rush dirtfield	Soft rush dirtfield	Soft rush dirtfield	soft rush dirtfield
Max vegetation height (cm)	80.5	103	80	105	45	41	58	5
Average vegetation height (cm)	50	40	60	25	25	5	5	2
Vegetation cover (%)	15	75	5	75	2	10	35	5
Proportion of veg cover indigenous (%)	0	40	0	15	0	<1	0	0
Groundcover species cover (%)								
Agrostis stolonifera		15		2				
Austroderia fulvida								
Axonopus fissifolius								
Bare ground				10	98	90	70	95
Cenchrus clandestinus								1
Coprosma repens								
Cordyline australis								
Cotula coronopifolia						0.5		0.5
Crepis capillaris				1				
Cynadon dactylon							1	
Daucus carota								
Dodonaea viscosa								
Ficinia nodosa								
Unidentified grass								
Gracilaria algae								
Holcus lanatus		4		20				
Hypocharis radicata				2				
Inorganic rubbish	5							
Isolepis prolifer							1	
Juncus effusus var. effusus				25	1	10	20	2
Juncus krausii subsp. australiensis								
Jucus pallidus				1				
Leontodon saxatilis								
Litter / dead vegetation	90	30	100	15				
Lolium arundinaceum subsp. arundinaceum		10						
Lolium perenne					1			2
Lotus pedunculata								
Myoporum laetum								
Ozothamnus leptophyllus								
Paspalum dilatatum	0.5	1						
Paspalum vaginatum								
Phormium tenax								
Pittosporum crassifolium								
Plantago lanceolata		0.5						
Portulaca oleracea				0.5				
Rumex acetosella				0.5			10	
Sonchus oleraceus								
Spergularia marina						0.5	1	
Stenotaphrum secundatum								
Symphyotrichum subulatum								
Thyridia repens								
Trifolium repens								
Woody debris (incl mulch)								
Canopy Species / Other (30 - 100 cm) % cover								
Agrostis stolonifera		5						
Austroderia fulvida								
Coprosma repens								
Cordyline australis								
Cortaderia selloana			2					
Dodonaea viscosa								
Holcus lanatus		5						
Juncus effusus var. effusus				5	0.5	0.5	5	
Juncus krausii subsp. australiensis								
Jucus pallidus				5				
Leptospermum scoparium								
Lolium arundinaceum subsp. arundinaceum		2						
Myoporum laetum								
Paspalum dilatatum		2						
Phormium tenax								
Phytolacca octandra (dead)			5					
Pittosporum crassifolium								
Plantago lanceolata		1						
Pteridium esculentum		30						
Ulex europaeus	15		3					

Transect.Plot	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8
Canopy Species / Other (100 - 200 cm) % cover								
Austroderia fulvida								
Cordyline australis								
Juncus krausii subsp. australiensis								
Jucus pallidus				0.5				
Pteridium esculentum		1						

Transect 10 Plot Data

Transect.Plot	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	10.9	10.1	10.11	10.12
Tag number	NE 580	1369	NE 672	NE 683	NE 242	NE 2697	3271	NE 579	NE 6088	NE 6086	NE 589	NE 668
Easting	1900819	1900866	1900841	1900889	1900870	1900941	1900948	1900972	1900955	1900986	1901009	1901022
Northing	5816010	5816029	5816100	5816150	5816220	5816280	5816345	5816398	5816424	5816468	5816466	5816490
Date established	8/06/2021	8/06/2018	11/06/2018	11/06/2018	11/06/2018	11/06/2018	11/06/2018	11/06/2018	11/06/2018	11/06/2018	11/06/2018	11/06/2016
Date surveyed	2/09/2021	2/09/2021	11/09/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021	2/09/2021
Plot re-established or original	Re-established	Re-established	Re-established	Re-established	Re-established	Re-established	Original	Re-established	Original	Re-established	Re-established	Re-established
Altitude	2	1	2	1	1	1	0	1	0.5	1	0	2
Recorders	HAD	HAD	HAD	HAD	HAD	HAD	HAD	HAD	HAD	HAD	HAD	HAD
Wetland/Dryland	Dry	Wet	Dry	Wet	Wet	Dry	Wet	Wet	Wet	Wet	Wet	Dry
Vegetation description	cabbage tree - toetoe shrubland	Mudfield	harakeke mulchfield	searush mudfield	sea rush mudfield	[karo] - [taupata] - [ngaio] - [akeake] / [narrow-leaved carpet grass] - [bachelors buttons] dirtfield	Mudfield	[sea rush] - [bachelors buttons] sandfield	sandfield	Sea rush rushland	Mudfield	[manuka] - [ngaio] / yorkshire fog grassland
Max vegetation height (cm)	190	N/A	100	120	2	55	N/A	2	N/A	78	N/A	85
Average vegetation height (cm)	90	N/A	20	70	1	20	N/A	1	N/A	50	N/A	20
Vegetation cover (%)	50	N/A	20	5	< 0.5	20	0	3	0	30	0	40
Proportion of veg cover indigenous (%)	80	N/A	90	100	100	90	0	100	0	100	0	35
Groundcover species cover (%)												
Agrostis stolonifera												
Austroderia fulvida	5											
Axonopus fissifolius						1						
Bare ground		100		95	98	97	100		85	80	100	
Cenchrus clandestinus			0.5									
Coprosma repens						0.5						1
Cordyline australis	2											
Cotula coronopifolia			0.5			2		0.5		0.5		
Crepis capillaris												
Cynadon dactylon												
Daucus carota	1											
Dodonaea viscosa						0.5						
Ficinia nodosa												1
Unidentified grass	0.5											
Gracilaria algae				3			1		0.5			
Holcus lanatus	4		0.5									20
Hypocharis radicata	3		1									1
Inorganic rubbish												
Isolepis prolifer												
Juncus effusus var. effusus												
Juncus krausii subsp. australiensis			0.5	2	< 0.5			2		0.5		
Jucus pallidus												
Leontodon saxatilis			1									
Litter / dead vegetation									15			
Lolium arundinaceum subsp. arundinaceum												
Lolium perenne												
Lotus pedunculata	0.5		1									0.5
Myoporum laetum						1						
Ozothamnus leptophyllus						0.5						
Paspalum dilatatum												
Paspalum vaginatum												
Phormium tenax			2									
Pittosporum crassifolium						2						
Plantago lanceolata	1											
Portulaca oleracea												
Rumex acetosella												
Sonchus oleraceus			0.5									
Spergularia marina												
Stenotaphrum secundatum												3
Symphyotrichum subulatum	0.5		0.5									
Thyridia repens								0.5				
Trifolium repens												0.5

Transect.Plot	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	10.9	10.1	10.11	10.12
Woody debris (incl mulch)		0.5	75		2					4		
Canopy Species / Other (30 - 100 cm) % cover												
Agrostis stolonifera												
Austroderia fulvida	15											1
Coprosma repens						0.5						
Cordyline australis	25											
Cortaderia selloana												
Dodonaea viscosa						0.5						
Holcus lanatus												
Juncus effusus var. effusus												
Juncus krausii subsp. australiensis			4	5						25		
Jucus pallidus												2
Leptospermum scoparium	0.5											3
Lolium arundinaceum subsp. arundinaceum												
Myoporum laetum						2						10
Paspalum dilatatum												
Phormium tenax			15									
Phytolacca octandra (dead)												
Pittosporum crassifolium						3						
Plantago lanceolata												
Pteridium esculentum												
Ulex europaeus												
Canopy Species / Other (100 - 200 cm) % cover												
Austroderia fulvida	1											
Cordyline australis	10											
Juncus krausii subsp. australiensis				0.5								
Jucus pallidus												
Pteridium esculentum												

Transect 11 Plot Data

Transect.Plot	11.3	11.4	11.5	11.6	11.7	11.8	11.9	11.1	11.11	11.12
Tag number	NE 594	NE 579	3283	NE 6084	NE 596	3281	NE 6087	NE 6085	3278	3277
Easting	1901077	1901115	1901194	1901157	1901216	1901237	1901242	1901225	1901222	1901206
Northing	5815973	5816036	5816130	5816236	5816156	5816224	5816231	5816235	5816198	5816193
Date established	8/06/2018	8/06/2018	8/06/2018	8/06/2018	8/06/2018	8/06/2018	8/06/2018	8/06/2018	8/06/2018	8/06/2018
Date surveyed	2/09/2021	2/09/2021	2/09/2021	11/08/2021	2/09/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021	11/08/2021
Plot re-established or original	Re-established	Re-established	Original	Original	Re-established	Original	Re-established	Original	Original	Original
Altitude	2	1	1	0	1	0	0	0	0	0
Recorders	HAD	HAD	HAD	HAD	HAD	HAD	HAD	HAD	HAD	HAD
Wetland/Dryland	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet
Vegetation description	Sea rush / saltwater paspalum rushland	Mudfield	Mudfield	Mudfield	Mudfield	Sea rush rushland	Mudfield	Gracilaria mudfield	Sea rush mudfield	Mudfield
Max vegetation height (cm)	105	N/A	N/A	N/A	N/A	110	N/A	N/A	85	N/A
Average vegetation height (cm)	20	N/A	N/A	N/A	N/A	85	N/A	N/A	70	N/A
Vegetation cover (%)	95	0	0	0	0	35	0	0	10	0
Proportion of veg cover indigenous (%)	30	0	0	0	0	100	0	0	100	0
Groundcover species cover (%)										
Agrostis stolonifera										
Austroderia fulvida										
Axonopus fissifolius										
Bare ground	5	100	100	99	100	80	100	90	97	100
Cenchrus clandestinus										
Coprosma repens										
Cordyline australis										
Cotula coronopifolia										
Crepis capillaris										
Cynadon dactylon										
Daucus carota										
Dodonaea viscosa										
Ficinia nodosa										
Unidentified grass										
Gracilaria algae								10		
Holcus lanatus										
Hypocharis radicata										
Inorganic rubbish										
Isolepis prolifer										
Juncus effusus var. effusus										
Juncus krausii subsp. australiensis	2					2			1	
Jucus pallidus										
Leontodon saxatilis										

Transect.Plot	11.3	11.4	11.5	11.6	11.7	11.8	11.9	11.1	11.11	11.12
Litter / dead vegetation										
Lolium arundinaceum subsp. arundinaceum										
Lolium perenne										
Lotus pedunculata										
Myoporum laetum										
Ozothamnus leptophyllus										
Paspalum dilatatum										
Paspalum vaginatum	80									
Phormium tenax										
Pittosporum crassifolium										
Plantago lanceolata										
Portulaca oleracea										
Rumex acetosella										
Sonchus oleraceus										
Spergularia marina										
Stenotaphrum secundatum										
Symphyotrichum subulatum										
Thyridia repens										
Trifolium repens										
Woody debris (incl mulch)				1						
Canopy Species / Other (30 - 100 cm) % cover										
Agrostis stolonifera										
Austroderia fulvida										
Coprosma repens										
Cordyline australis										
Cortaderia selloana										
Dodonaea viscosa										
Holcus lanatus										
Juncus effusus var. effusus										
Juncus krausii subsp. australiensis	35					35			10	
Jucus pallidus										
Leptospermum scoparium										
Lolium arundinaceum subsp. arundinaceum										
Myoporum laetum										
Paspalum dilatatum										
Phormium tenax										
Phytolacca octandra (dead)										
Pittosporum crassifolium										
Plantago lanceolata										
Pteridium esculentum										
Ulex europaeus										
Canopy Species / Other (100 - 200 cm) % cover										
Austroderia fulvida										
Cordyline australis										
Juncus krausii subsp. australiensis	0.5					2				
Jucus pallidus										
Pteridium esculentum										

Appendix B:

Plot Photos

TRANSECT 9

Plot 1

Plot 2

Plot 3

Plot 4

Plot 5

Plot 6

Plot 7

Plot 8

TRANSECT 10

No photo for Plot 1

Plot 2

Plot 3

Plot 4

Plot 5

Plot 6

Plot 7

Plot 8

Plot 9 No photo

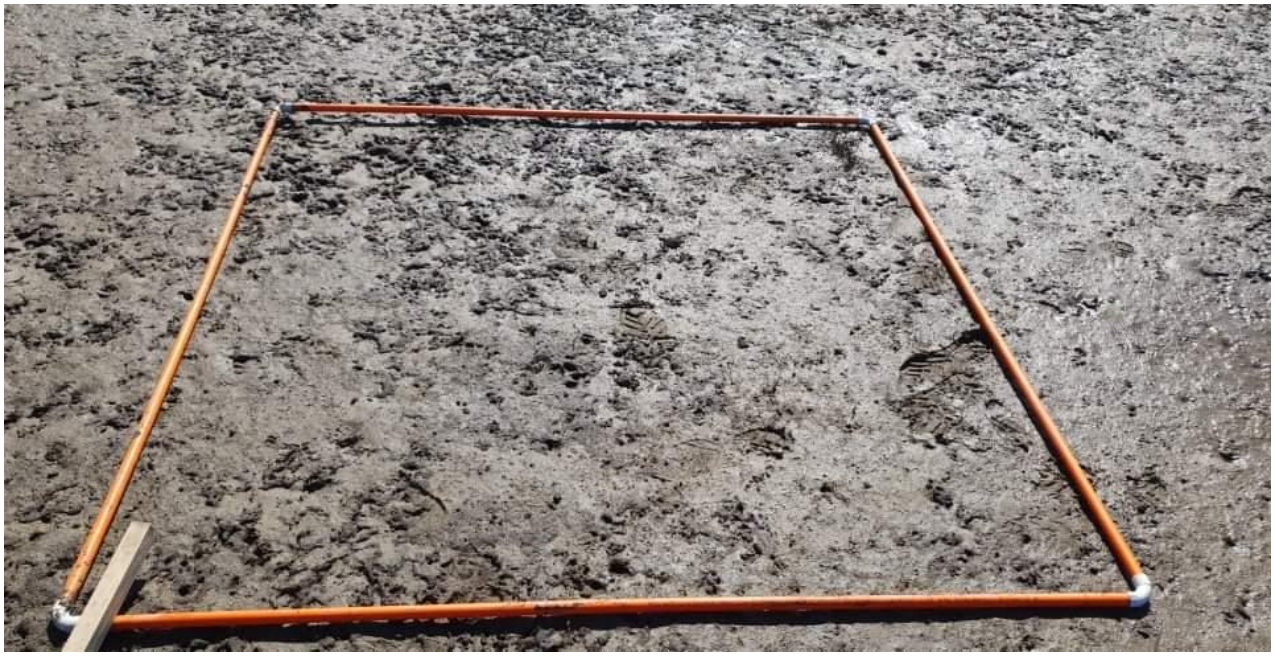
Plot 10

Plot 11

Plot 12

TRANSECT 11

Plot 3



Plot 4

Plot 5

Plot 6

Plot 7

Plot 8

Plot 9

Plot 10

Plot 11

Plot 12

Appendix C:

Plot Sheet

Transect		Quadrat		Date Established	
Tag Number		Coordinates		Date Surveyed	
Altitude		Recorders		Wetland/Dryland	
Vegetation description					

Maximum vegetation height		Average vegetation height	
Vegetation cover (%)		Proportion of vegetation cover that is indigenous (%)	
Ground species / other (<30 cm)	Cover %	Canopy Species / Other (30-100 cm)	Cover %
		Canopy Species / Other (100 - 200 cm)	Cover %