Duneland Health State of the Environment monitoring programme

Annual data report, 2017/18 and 2018/19

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GW/ESCI-T-19/126

November 2019

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The report may be cited as:

Uys R and Crisp P. 2019. Dune*land Health State of the Environment monitoring programme: Annual Data Report 2017/18 and 2018/19.* Greater Wellington Regional Council, Publication No. GW/ESCI-T-19/126, Wellington.

Contents

1. Introduction

This report summarises the results of the Duneland Health State of the Environment (SoE) monitoring programme for the period 1 July 2017 to 30 June 2019 inclusive. The Duneland Health monitoring programme has been designed to survey the main dunelands in the Wellington Region over a 5 year timeframe. The sites surveyed include five large duneland Key Native Ecosystem (KNE) sites and 11 small coastal sand dunes. One large and two or three small sites are surveyed each year to determine their indigenous plant dominance, pest animal populations and overall condition. This report details the results of the first two years of Duneland Health SoE monitoring. In the first year (2017/2018) monitoring was undertaken inside and outside of the KNE site at Peka Peka Coast and at the coastal dunes at Makara Bay, Red Rocks and Whitireia Park. In the second year (2018/2019) monitoring was undertaken at the KNE sites at Otaki Coast and Tora Coast Bush and at the coastal dunes at Mukamukaiti.

2. Overview of the Duneland Health SoE monitoring programme

Dunelands are recognised by the Greater Wellington Regional Council (GWRC) as an ecosystem type that has undergone a major decline. Active sand dunes are estimated to have decreased nationally by approximately 80 percent between their pre-human extent and 2008 (Ministry for the Environment & Stats NZ 2018). This decline has led to both active and stabilised sand dunes being listed as Nationally Threatened: Endangered ecosystems (Ministry for the Environment & Stats NZ 2018).

The extensive loss of natural coastal dune ecosystems has primarily resulted from sand stabilisation. This was required by the Sand Drift Acts of 1903 and 1908 that facilitated the conversion of natural duneland for agriculture (Hilton et al 2000). Dunes have also been lost to property development in the Wellington Region, particularly along the west coast of the region. Dune stabilisation was mostly achieved using marram grass (*Ammophila arenaria*). This exotic species, along with other exotic pest plants, such as tree lupin (*Lupinus arboreus*), has not only impacted the biodiversity but also the ecosystem services of coastal dunes. For example, the indigenous grass spinifex (*Spinifex sericeus*) and sedge pingao (*Ficinia spiralis*) typically support gentle sloping foredunes. In contrast, exotic marram grass builds steeper dunes that can collapse in coastal storms (Esler 1970), failing to protect coastal infrastructure.

The main impacts on natural dune communities are caused by pest species and human activity, but mining and dumping activities also have negative effects on these ecosystems. Exotic animals, including hedgehogs, lagomorphs (rabbits and hares), mustelids (ferrets, stoats and weasels), possums and rodents (rats and mice) eat indigenous plants and animals; while vehicles, foot traffic and dogs cause extensive physical damage and disruption to the plant and animal communities if not controlled (Stephenson 1999). More recently, there has been a growing appreciation of the threats posed by sea level rise and increased coastal storm surge that are predicted to occur as a result of climate change.

The Duneland Health SoE monitoring programme was established to monitor the state and trend of dunelands in the region, as well as providing a feedback mechanism for management effectiveness. State and trend information is intended to inform both GWRC and territorial authorities about the effectiveness of coastal management policies (eg those detailed in the proposed Natural Resources Plan) and the impacts of climate change on dunelands. GWRC also has a Key Native Ecosystem (KNE) programme that aims to improve ecological outcomes at selected high value ecological sites in the Wellington Region. The KNE program includes 15 sites that contain coastal dunes. Five KNE sites with the largest dunelands have been included in this monitoring program along with three smaller KNE sites. These selected sites are spread around the coast to detect the impacts of climate change, as well as to provide information about the effectiveness of GWRC's management interventions.

2.1 Monitoring objectives

The aim of the Duneland Health SOE monitoring programme is to measure the state and trend of duneland health across the Wellington Region. The work described here aims to monitor:

1. the state and trend of duneland health in the Wellington Region,
2. the outcomes of management at selected duneland KNE sites, and
3. the impacts of sea level rise and increased storm surges resulting from climate change.

2.2 Monitoring network

The monitoring network includes 16 coastal dunelands spread around the Wellington Region coast (Figure 2.1, Table 2.1). This represents approximately a quarter of the coastal dunelands in the Wellington Region. The monitoring network includes the five largest remaining dunelands which are also KNE sites. These five large sites are termed sampling nodes, while the remaining 11 smaller sites are termed satellites. Three of these satellites are also KNE sites. The Peka Peka KNE was surveyed both inside (Peka Peka KNE) and outside (Peka Peka north) of the KNE for a direct comparison of the management effectiveness. The remaining eight satellites have been selected to provide a spread of sites around the coast across which the impacts of climate change could be monitored.

In the first season (summer of 2017/18) monitoring was conducted inside and outside of the KNE site at Peka Peka Coast and at the coastal dunes at Makara Bay, Red Rocks and Whitireia Park. In the second season (summer of 2018/2019) monitoring was undertaken at the KNE sites at Otaki Coast and Tora Coast Bush and at the coastal dunes at Mukamukaiti.

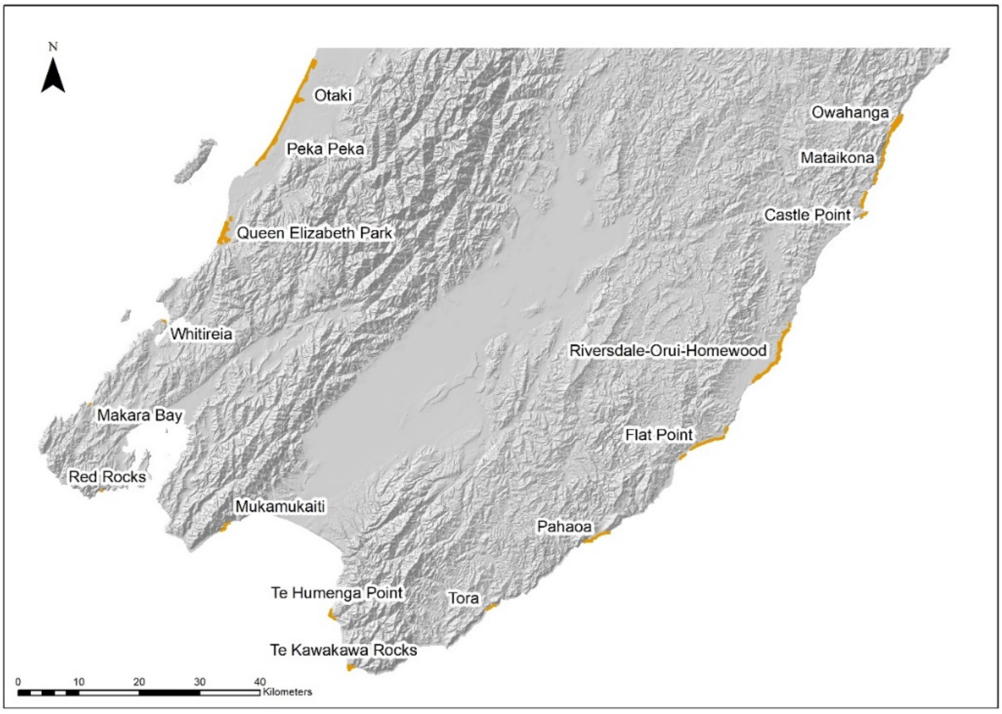

Figure 2.1: Coastal dunelands to be surveyed in the Duneland Health SoE monitoring program

Table 2.1: Extent and sampling schedule of coastal dunelands to be surveyed in the Duneland Health SoE monitoring program

Site name	KNE name	Type	Length (km)	Sample year
Ōtaki	Ōtaki Coast	Node	>3	2
Peka Peka	Peka Peka Coast	Node	>3	1
Queen Elizabeth Park	Queen Elizabeth Park	Node	>3	5
Whitireia Park	Whitireia Coast	Satellite	<0.5	1
Mākara Bay	Nil	Satellite	<0.5	1
Red Rocks	Nil	Satellite	<0.5	1
Mukamukaiti	Nil	Satellite	>0.5 to <3	2
Te Humenga Point	Nil	Satellite	>0.5 to <3	5
Te Kawakawa Rocks	Nil	Satellite	>0.5 to <3	5
Tora	Tora Coast Bush	Satellite	>0.5 to <3	2
Pahaoa	Pahaoa Scientific Reserve	Satellite	>0.5 to <3	4
Flat Point	Nil	Satellite	>0.5 to <3	4
Riversdale-Orui-Homewood	Riversdale-Orui Coast	Node	>3	4
Castle Point	Nil	Satellite	>0.5 to <3	3
Mataikona	Mataikona Coast	Satellite	>0.5 to <3	3
Owahanga	Owahanga	Node	>3	3

2.3 Monitoring variables

Vegetation, animal pests and the condition of the duneland were examined at each site. Vegetation monitoring provided measures of the indigenous dominance of the species richness and aerial cover, the proportion of bare ground and the canopy height of the vegetation. Animal pest monitoring was limited to chew track cards which detect the presence of hedgehogs, possums and rodent pests, but not lagomorphs or mustelids (the other main animal pests in dunelands). Duneland condition was scored for each site based on a method developed by a collection of regional councils. The monitoring methodology is outlined below and provided in more detail in the draft Tier II dune monitoring protocol (Uys 2018).

2.3.1 Vegetation

Natural duneland vegetation was surveyed using $1m^2$ quadrats spaced 4m apart along transects established at right angles to the prevailing coastline. Transects were randomly selected from a master set of transects created across the length of the duneland at 10m, 50m or 100m apart depending on the length of the duneland along the coast (<0.3km, 0.3 to 3km or > 3km long respectively, see Table 2.1). At least 10 transects were surveyed at each site, but the number of quadrats on each transect varied according to the width (from the beach inland) of the duneland being sampled. Transects began inland where the landcover type changed from natural duneland to another landcover type, typically to exotic grassland. Transects were extended seaward until further quadrats would only record bare ground (i.e. on the beach). All of the vascular plant species were recorded in each $1m^2$ quadrat. The aerial cover was estimated in 5 percent increments for bare ground and all plant species. Cover scores were allocated to a total cover score of 100 percent. This included provision for plant species that individually represented less than 5 percent of the aerial cover. The average canopy height of the vegetation was also measured to provide a physiognomic description of community gradient across each transect.

2.3.2 Animal pests

At least one line of 10 corflute plastic chew cards (loaded with peanut butter) was set up at each site over three fine nights. Chew cards were spaced between the transect lines (i.e. at 10m, 50m or 100m) along the centre of the duneland parallel to the coast. Additional lines of chew cards were deployed if the duneland was long enough to accommodate them with a minimum of 200m between lines. At smaller sites, where chew cards were spaced at 10m intervals, the results were only indicative of the species present. At larger sites, where tunnels were spaced 50m or 100m apart (and were therefore considered independent), the results provided an indication of relative abundance.

2.3.3 Duneland condition

The state of and pressures on dunelands were scored for the whole duneland at each site based on the criteria outlined in Appendix A. Sites with little pressures and good state received high scores.

3. Results

3.1 Vegetation

Of the eight sites monitored, only Makara Bay was the only site dominated by indigenous species (69 percent). On average, two-thirds of the species sampled in each quadrat ($1m^2$) were exotic in the remainder of the sites. Red Rocks was the outlier in this regard, with 88 percent of the species recorded in the $1m^2$ quadrats being exotic (Figure 3.1).

The aerial cover of the plots followed a similar pattern to the species richness with an average of two thirds of the vegetated cover being composed of exotic species (Figure 3.2). Makara Bay and Mukamukaiti had large proportions of bare ground (42 and 52 percent, respectively). Red Rocks and Tora were the outliers, with 88 and 90 percent (respectively) of the aerial cover of the vegetated area being dominated by exotic species. In contrast, only 14 percent of the vegetated cover at Makara Bay was exotic.

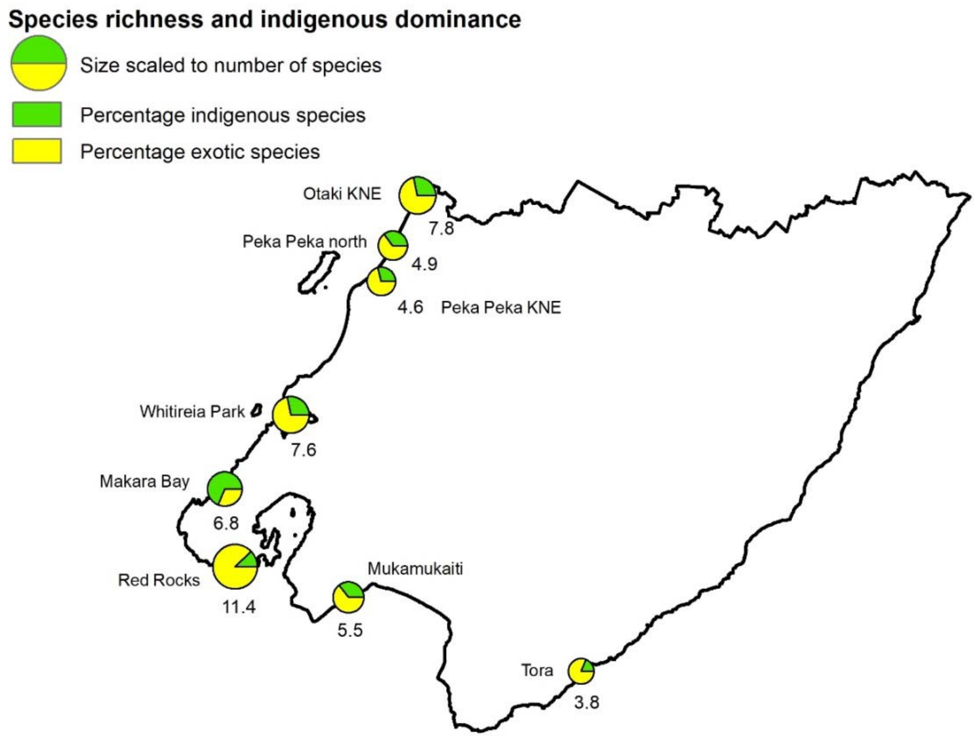

Figure 3.1: Average plant species richness (numbers below points) and indigenous dominance in $1m^2$ quadrats surveyed at each site in the spring/summer of 2017/2018 and 2018/2019

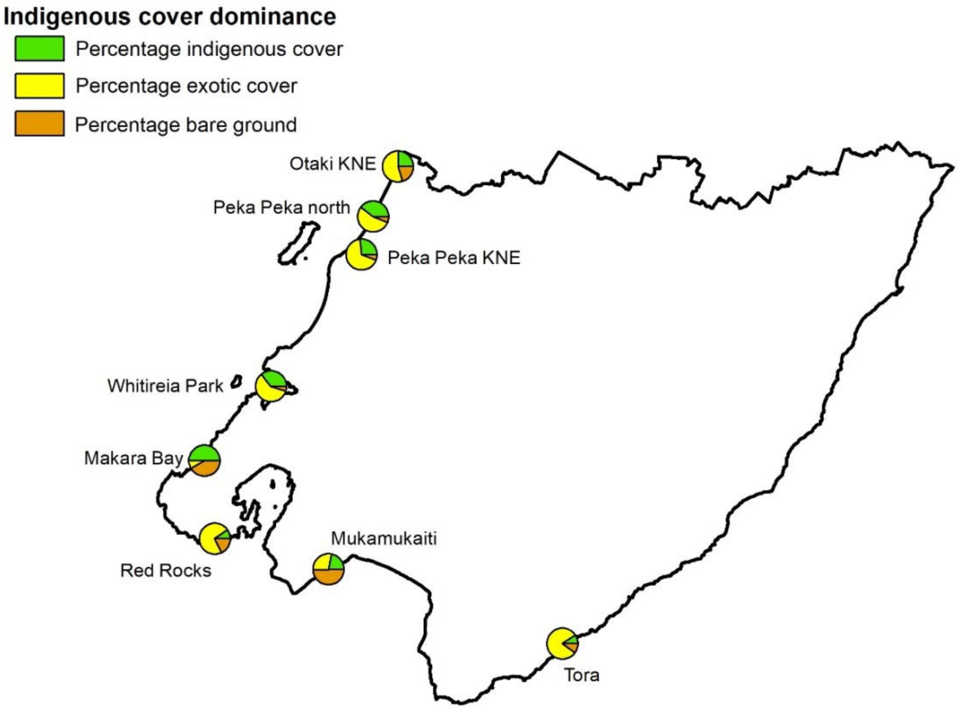

Figure 3.2: Average percentage of aerial cover dominated by indigenous species in $1m^2$ quadrats surveyed at each site in the spring/summer of 2017/2018 and 2018/2019

3.2 Animal pests

Mice were the most abundant of the three pest animal species typically encountered using peanut butter filled chew cards (Figure 3.3). Rats were in low abundance where encountered and may have been present at sub-detectible levels at other sites. Similarly, hedgehogs may have been present in low numbers at more sites than they were detected. No possums were detected at any of the sites despite having been observed during camera trap studies in dunelands in the Wellington Region (Uys per. obs.).

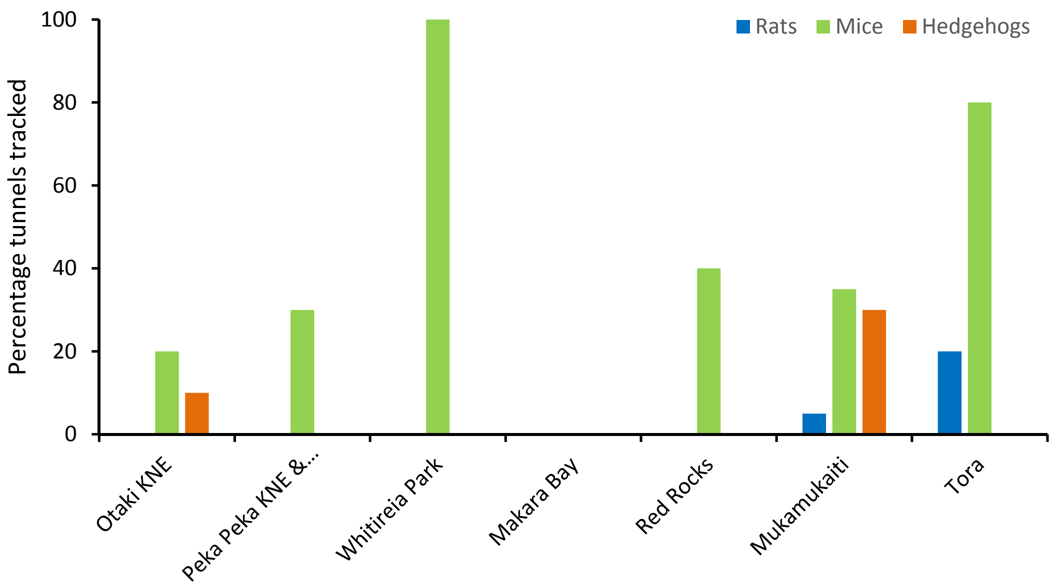

Figure 3.3: Percentage of tunnels tracked by rats, mice and hedgehogs

3.3 Duneland condition

The dunelands at Makara Bay and Mukamukaiti had the highest scores for their state. Makara Bay had the highest level of indigenous dominance in its plant community, while Mukamukaiti had some buffering of natural land cover that was not present at most of the other monitored duneland sites. (Figure 3.4, Appendix D). The Mukamukaiti site also had a number of threatened species present and is in a relatively natural state, but the indigenous cover score was affected by the presence of exotic grass species.

Makara Bay had the lowest pressure score as it was highly managed. Mukamukaiti, in contrast, had a high pressure score, in part due to the uncontrolled access of livestock to the site (Figure 3.5, Appendix D). The Otaki KNE site had the lowest state score and the highest pressure score due to the dominance of exotic plant species and uncontrolled access of dogs, pedestrians and vehicles across the site.

As evidenced by the vegetation surveys (Section 3.1), most sites lost points on their state score due to the invasion of exotic species. Most sites' state scores were also lowered by a lack of buffering of natural land covers around the site.

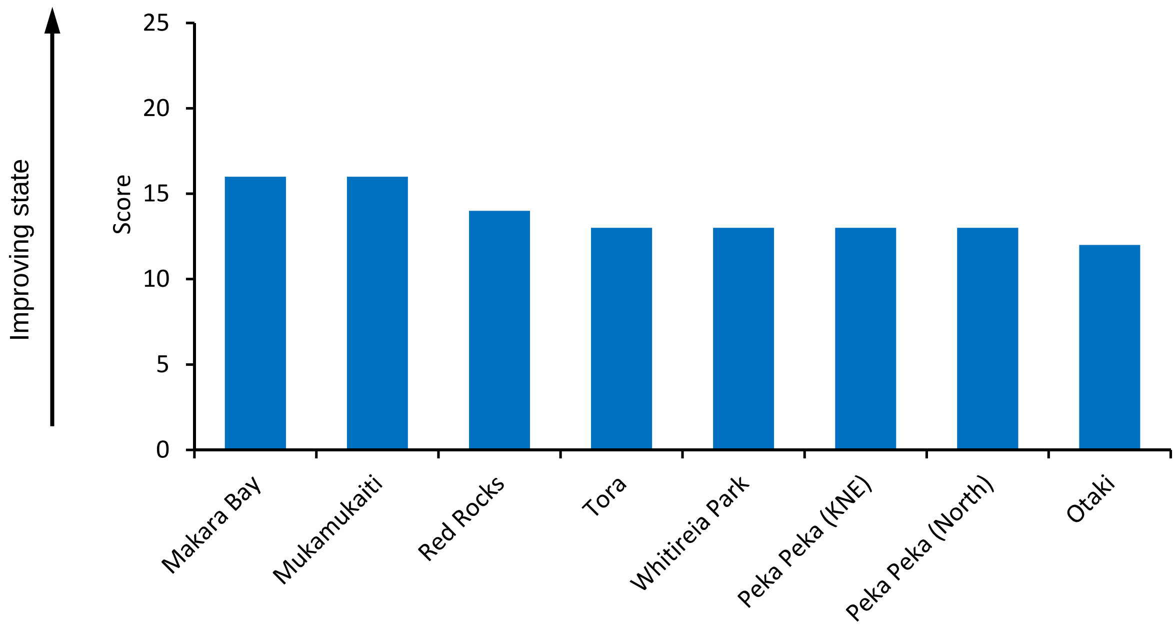

Figure 3.4: Dune condition state scores (out of 25), ranked according to the state

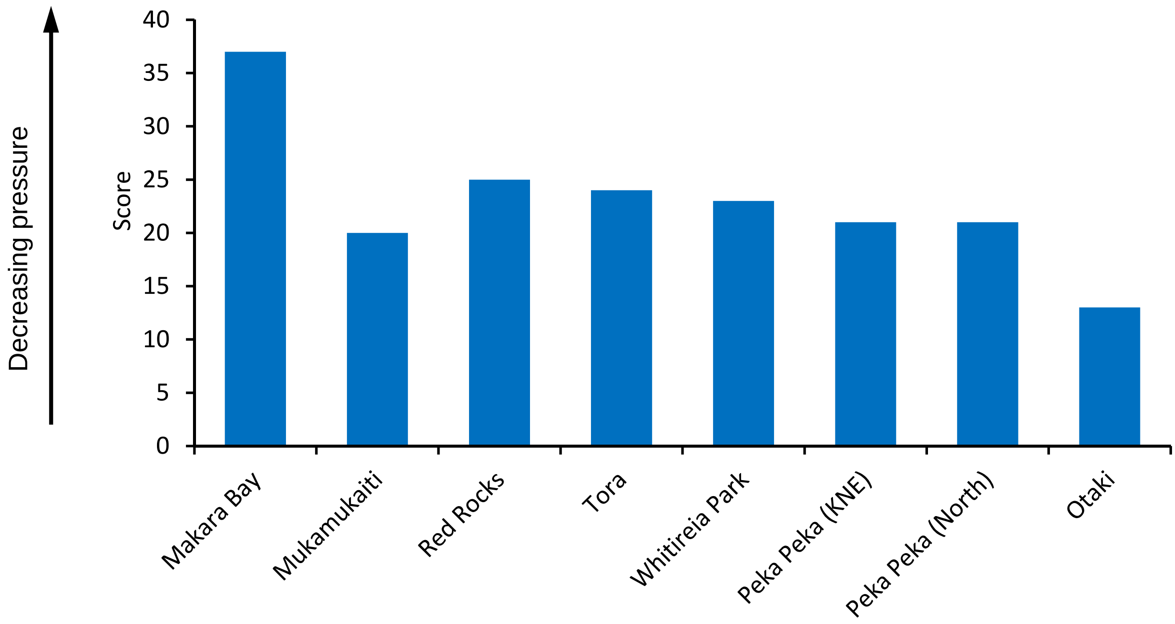

Figure 3.5: Dune condition pressure scores (out of 40), ranked according to the state

4. Discussion

Overall, the dunelands sampled were in moderate to poor condition. All of the sites surveyed were exposed to moderate levels of pressure and none had good quality states. On average, two thirds of the species richness and aerial cover (sampled using $1m^2$ quadrats) was dominated by exotic species. Despite management efforts, the KNE sites scored no higher than comparable sites; as can be seen in the Peka Peka results where the condition was scored the same inside and outside of the KNE.

Intensive management at the Makara Bay site (i.e. active weeding) resulted in greater indigenous dominance of the vegetation. The site was however poorly buffered by the surrounding land use which, like most of the sites, lowered its overall condition score. The overall state score at Makara Bay was also affected by the abundance of exotic bird species, which is partly a reflection of the surrounding land use. The low indigenous dominance of the vegetation at Red Rocks was attributable to the site having previously been disturbed when quarrying was undertaken in the area allowing a range of exotic species to establish. Tora, however, was dominated by marram grass that had developed a solid canopy over 1m deep in places, which excluded indigenous species from 90 percent of the vegetated aerial cover.

Hedgehog and rat abundance was relatively low, while the abundance of mice ranged from low to high, with moderate numbers being recorded at most sites. This is not surprising as long-term monitoring at East Harbour Regional Park Baring Head and Queen Elizabeth Park KNE sites shows widely fluctuating mice populations in coastal ecosystems, with low rat numbers (Uys 2019). It has also been noted from camera trap studies at Queen Elizabeth Park that some rats will approach, but not chew on chew cards (Uys pers. obs.). Thus, there may still have been some rats present at sites where none were recorded.

The indicators selected for the dune condition index make it particularly challenging to show noticeable improvements with management. For example, most of the problem plants were represented by exotic pasture grasses. These are difficult to control in dune ecosystems and management priority is often given to shrubby species such as boneseed (*Chrysanthemoides monilifera*) and box thorn (*Lycium ferocissimum*) that are seen to overtop and shade out indigenous vegetation leading to physiognomic changes in the community. In this case neither the management priority nor the condition indexes are wrong. This merely serves to illustrate the amount of effort required to affect real ecological improvement in these ecosystems. In the same way, most of the management effort in dunelands tends to be focussed on the dunes themselves and little change is made to the surrounding landcover types. This is a reality of what is often practical to achieve, given limited resources and surrounding landowner objectives (e.g. farmers wanting to maintain productive pasture). Ecologically though, connectivity to the wider landscape remains important for supporting the natural processes that maintain biodiversity.

From the sites surveyed, the indicators most likely to show noticeable improvements to the duneland condition scores are those related to the control of access. The exclusion of vehicles and control of pedestrians, dogs and livestock through the use of physical barriers (e.g. fences) and education (e.g. signage) are tangible changes that can be achieved to raise condition scores. Reducing these pressures will help address the state of unnatural vegetation disturbance. This may, however, require rehabilitation plans to loosen compacted tracks and reintroduce appropriate vegetation to speed up recovery.

Using the highly managed dunes at Makara Bay as an example, it may be impractical to aim for complete eradication of exotic plants and animals. A 75 percent indigenous dominated vegetation community is achievable even if little can be done about the exotic birds whose presence will be determined by the management of the broader landscape.

5. Acknowledgements

Matthew Ward was the lead botanist, supported by Rob Craven and Roger Uys who also monitored the pest animals. Roger Uys completed the dune condition index assessments. Chris Horne assisted at Makara Bay where he, with the late Barbara Mitcalf, has been a guardian of this duneland, controlling exotic plant invasions.

6. References

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Appendix A: Duneland condition index

Table A1: Scoring system for State of dunelands

Score	Indigenous cover dominance (%)	Indigenous animal dominance (%)	Unnatural vegetation disturbance (% bare sand)	Buffering – State of surrounding land cover	
				(% indigenous land cover)	(% indigenous cover dominance)
0	≤5	≤5	>20	<50	NA
1	6 – 25	6 – 25	16 – 20	≥50	≤25
2	26 – 50	26 – 50	11 – 15	≥50	>25
3	51 – 75	51 – 75	6 – 10	≥75	>50
4	75 – 95	75 – 95	1 – 5	≥90	>75
5	>95	>95	<1	100	>95

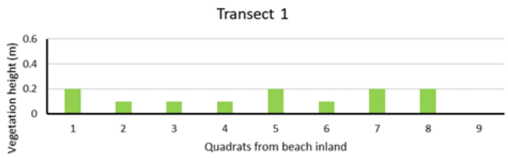
Table A2: Scoring system for Pressures on dunelands

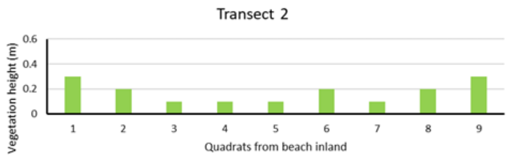
Score	Ungulates	Lagomorphs & possums	Predators	Dogs	Problem Plants (% aerial cover)	Uncontrolled Pedestrians (% area accessed)	Vehicles (% area accessed)	Mining (% area disturbed)
0	Animals or sign regularly seen	Animals or sign regularly seen	>10% tracking Index	No control of dog access	>30	>30	>30	>30
1	-	-	-	-	20 - 30	20 - 30	20 - 30	20 - 30
2	Animals or sign occasionally seen	Animals or sign occasionally seen	<10% tracking Index	Mostly under control	10 - 20	10 - 20	10 - 20	10 - 20
3	-	-	-	-	5 - 10	5 - 10	5 - 10	5 - 10
4	Rare incursion	Rare incursion	<5% tracking index	Rare incursion	1 - 5	1 - 5	1 - 5	1 - 5
5	None	None	None	None	<1	<1	<1	<1

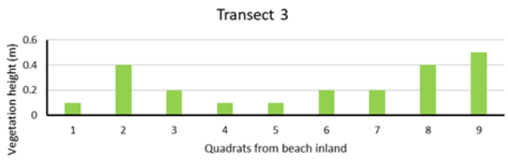
Appendix B: Vegetation height along transects

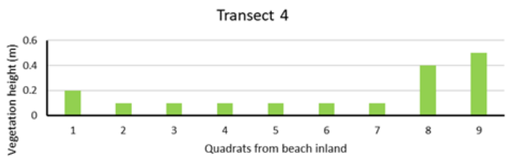
Note that transects are ordered in terms of their geographical position rather than the order they were surveyed in.

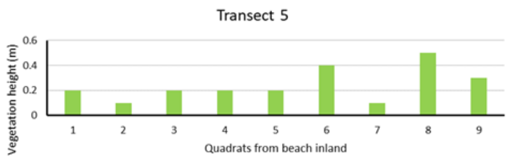
Appendix B1: Makara Bay

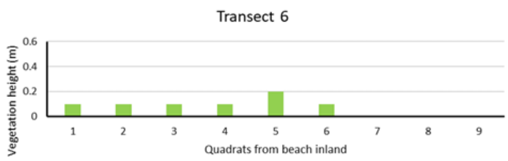




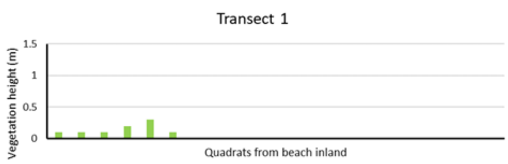


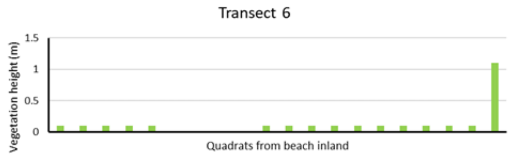


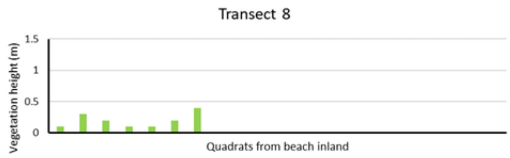


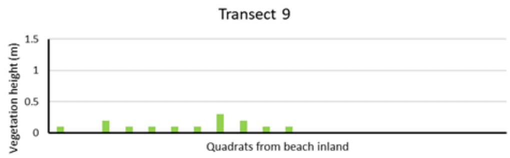


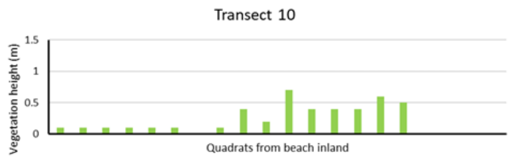
Appendix B2: Mukamukaiti

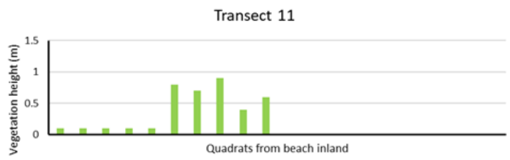


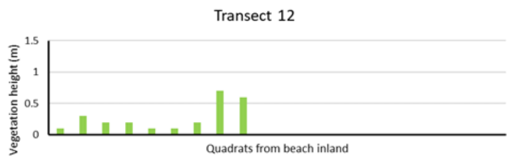


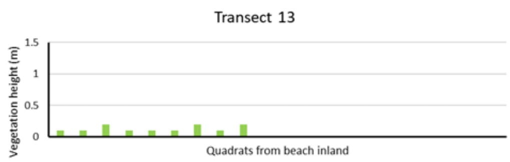


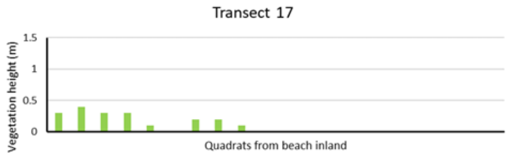




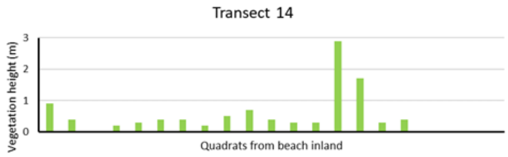


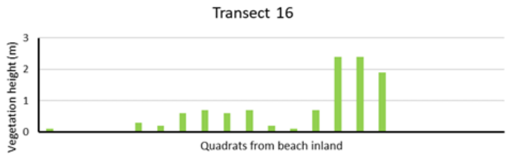


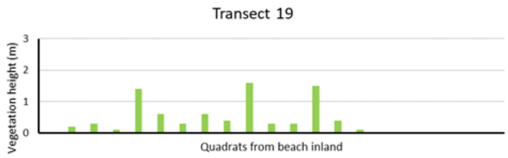


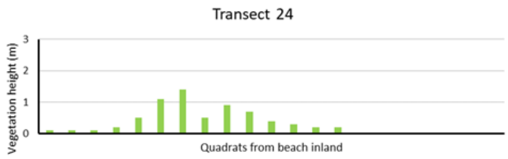


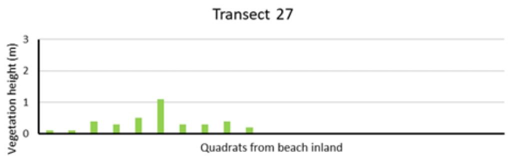
Appendix B3: Otaki KNE

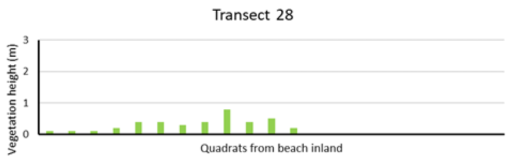


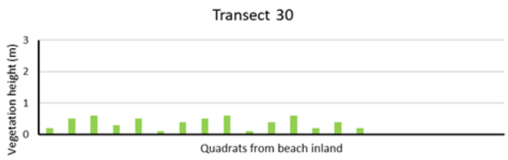


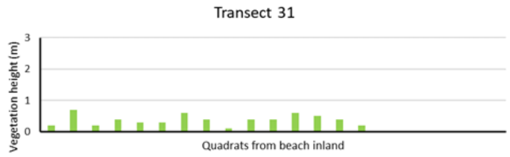


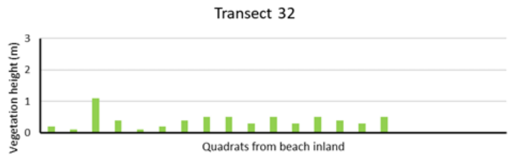


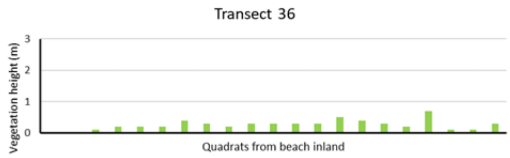




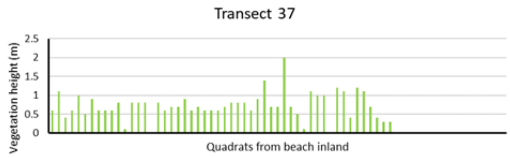


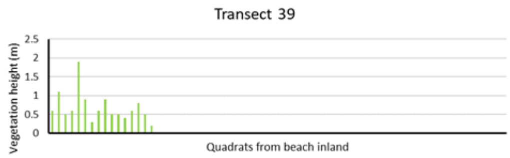


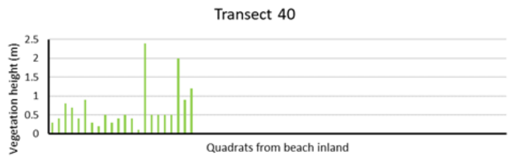


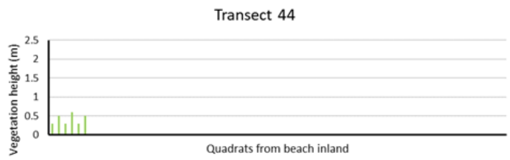


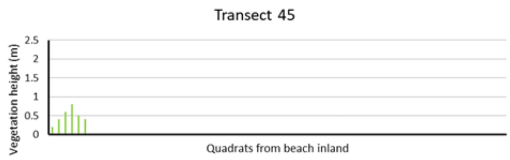
Appendix B4: Peka Peka KNE

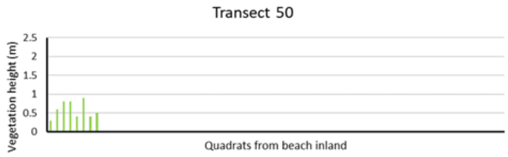


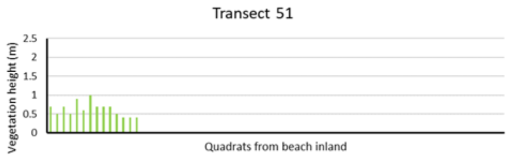


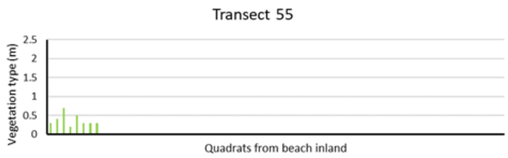


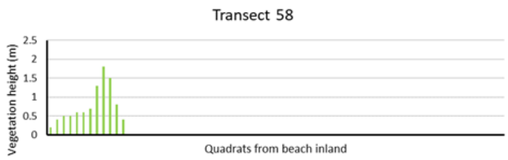


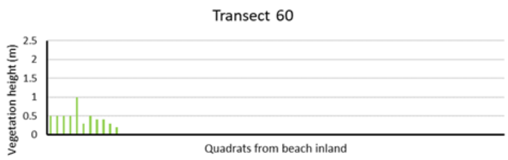


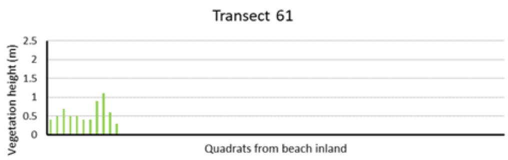


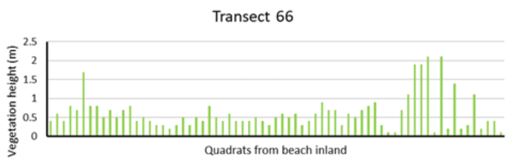




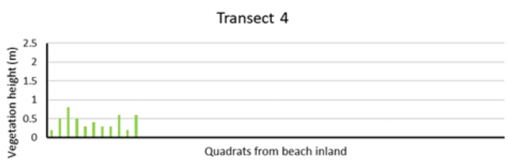


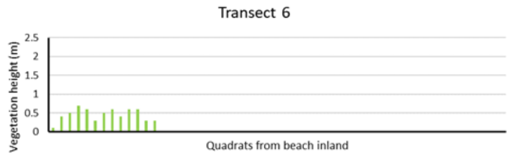


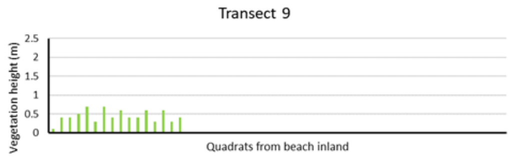


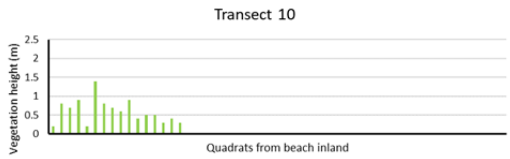


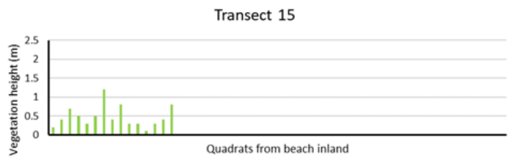
Appendix B5: Peka Peka north

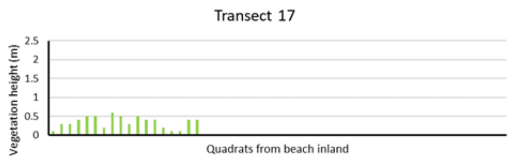


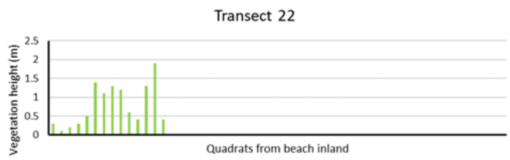


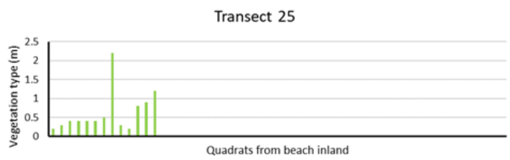


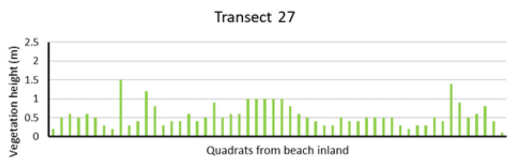


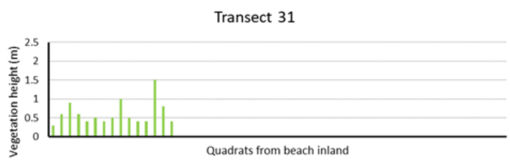






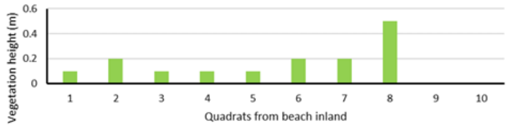




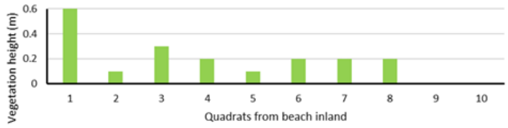


Appendix B6: Red Rocks

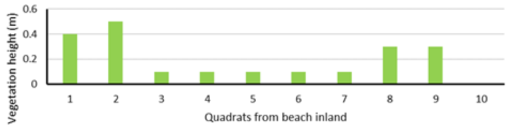
Transect 2



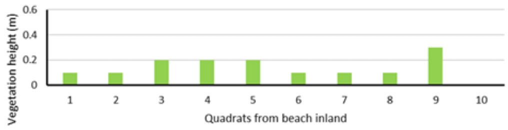
Transect 3



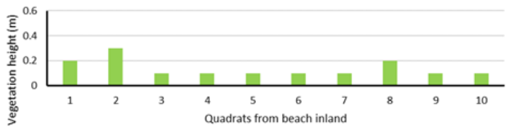
Transect 6



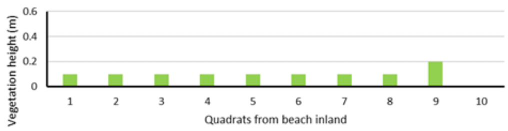
Transect 9



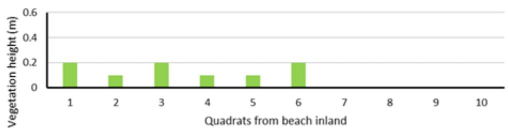
Transect 12



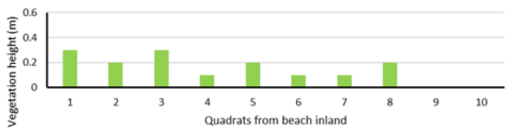
Transect 14



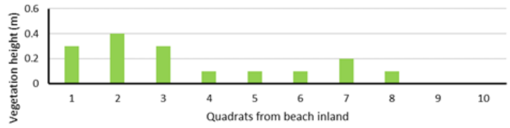
Transect 19



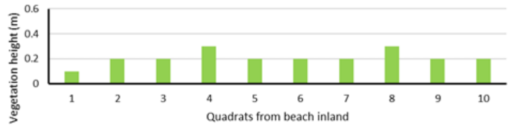
Transect 20



Transect 21

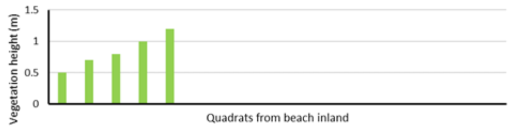


Transect 23

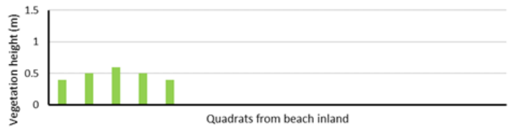


Appendix B7: Tora

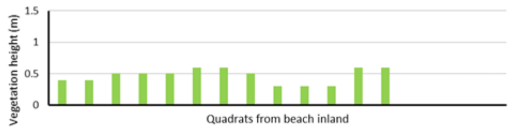
Transect 7



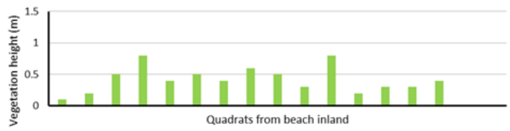
Transect 9



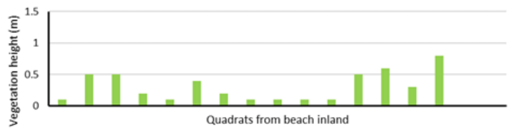
Transect 10



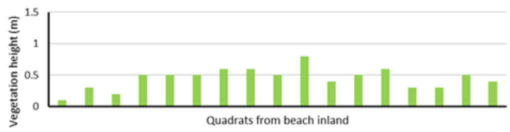
Transect 11

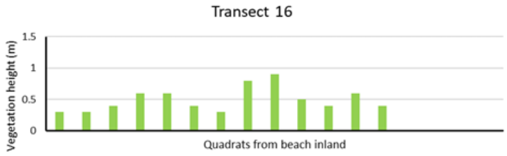


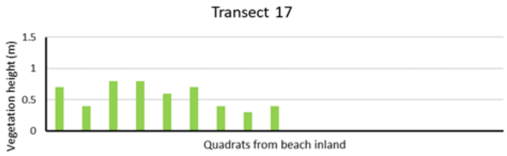
Transect 13

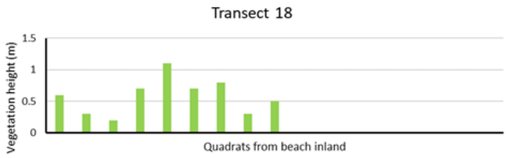


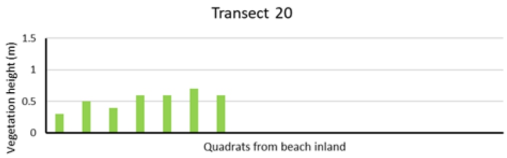
Transect 14



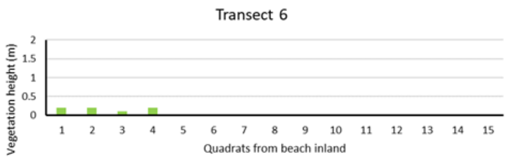


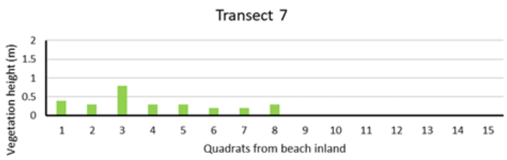


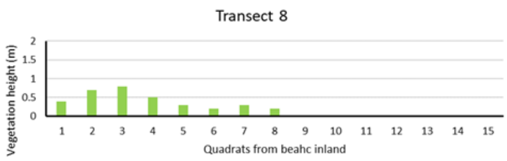


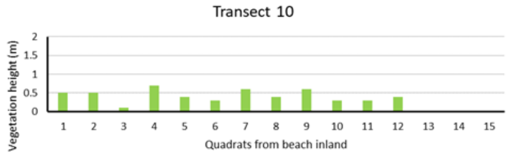


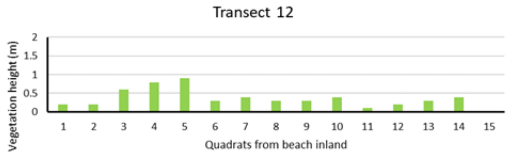
Appendix B8: Whitireia Park

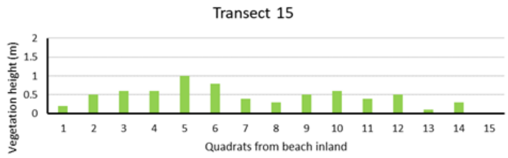


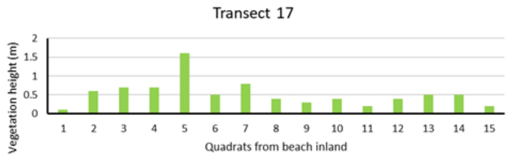


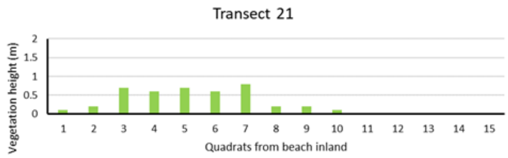


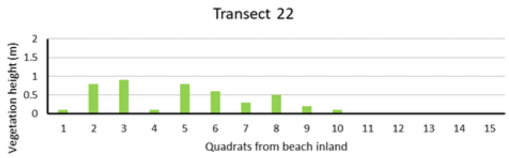


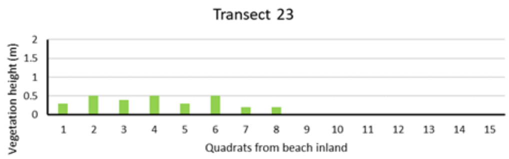










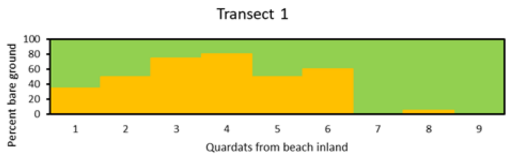


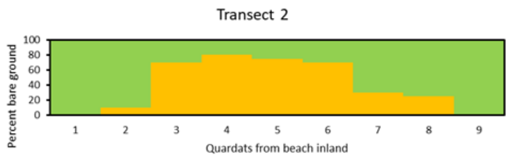
Appendix C: Percentage of bare ground along transects

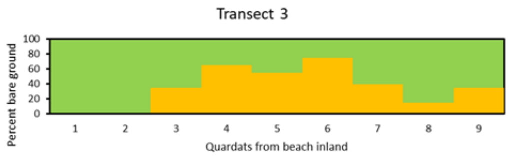
In the figures below the green area represents the percentage of ground that was vegetated and the orange area the percentage of ground that was bare.

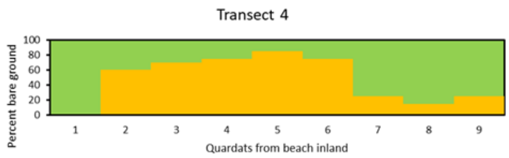
Note that transects are ordered in terms of their geographical position rather than the order they were surveyed in.

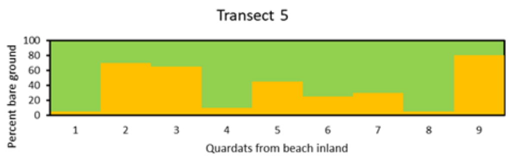
Appendix C1: Makara Bay

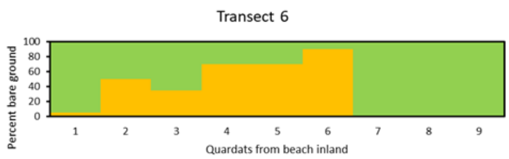


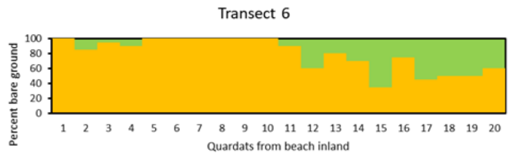


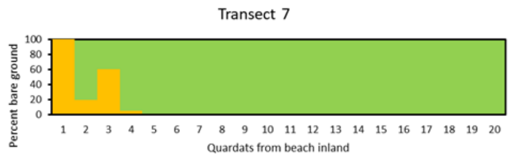


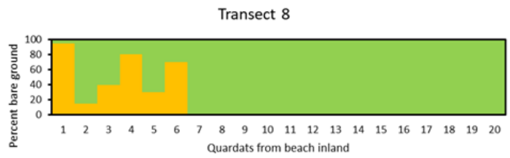


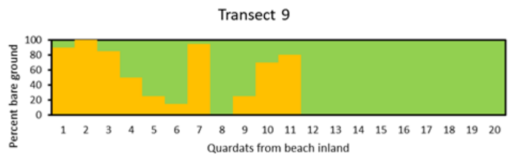


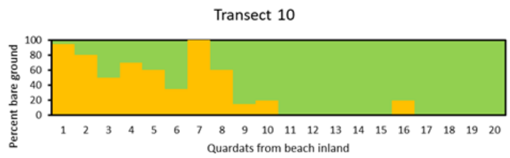


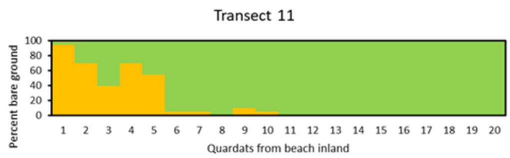


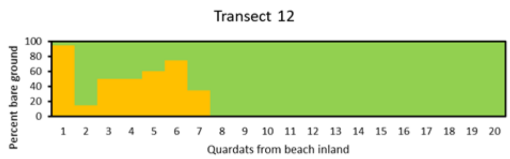




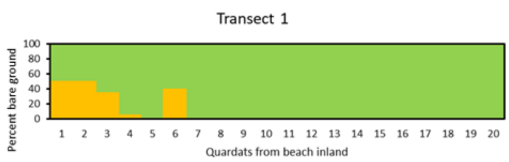


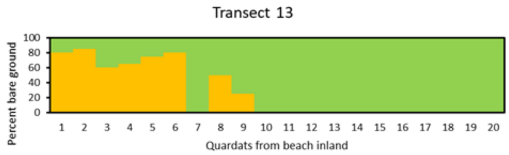


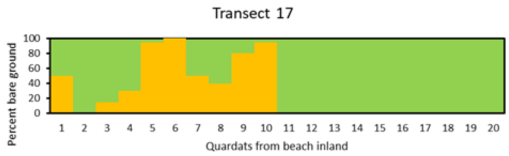




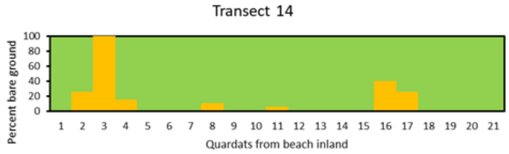
Appendix C2: Mukamukaiti

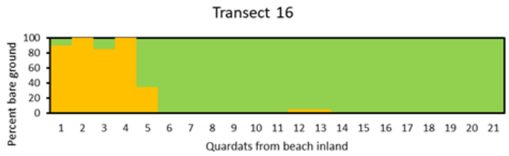


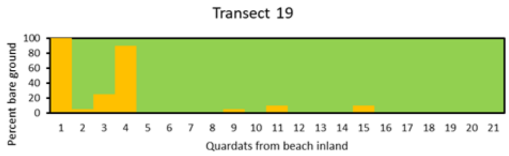


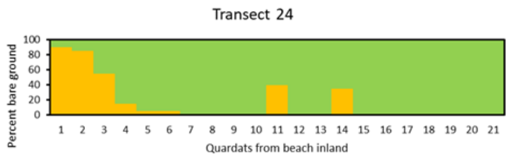


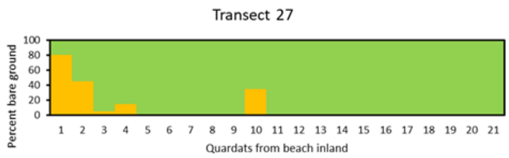
Appendix C3: Otaki KNE

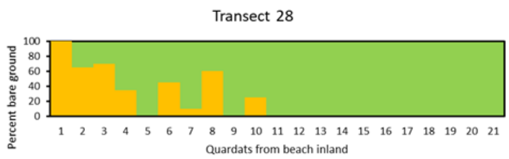


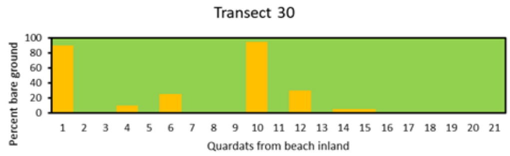


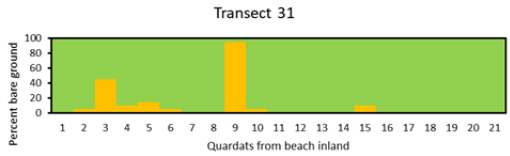


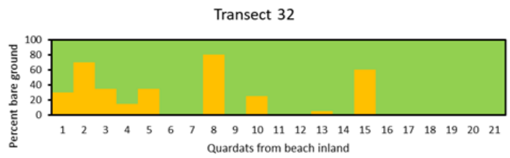


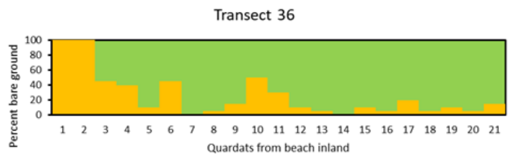




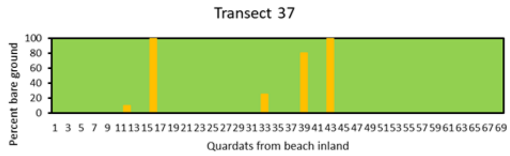


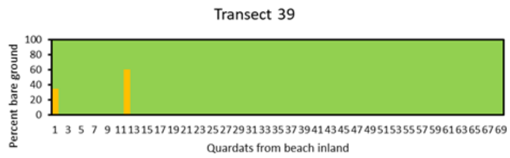


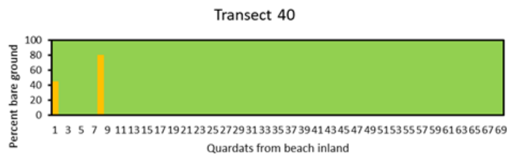


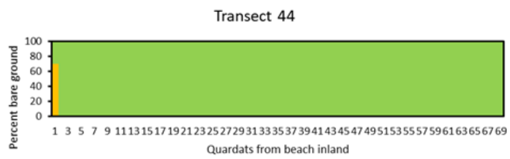


Appendix C4: Peka Peka KNE









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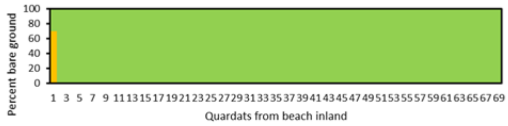

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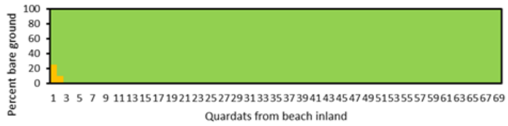

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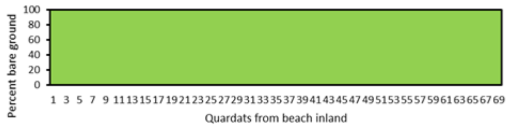

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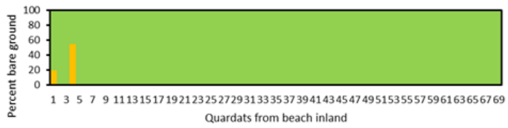

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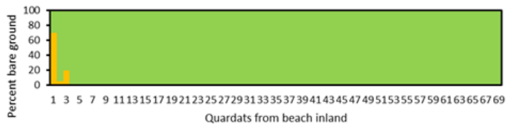

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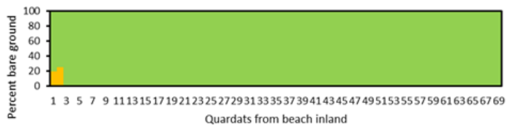

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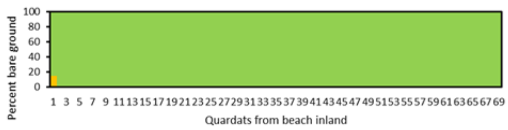

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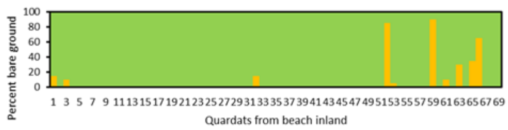

Appendix C5: Peka Peka north

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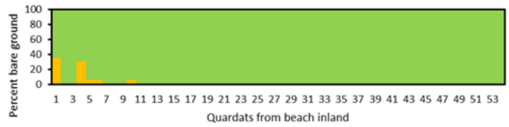

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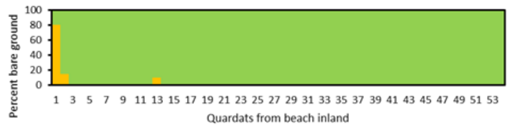

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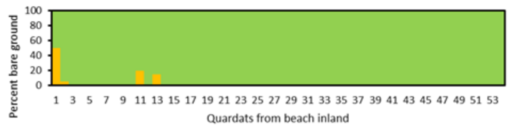

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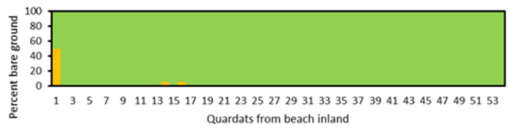

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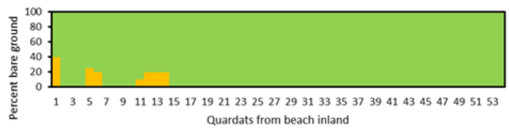

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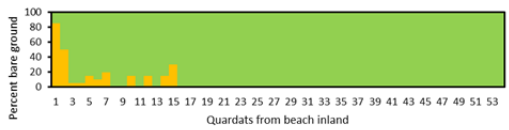

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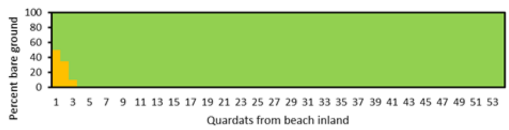

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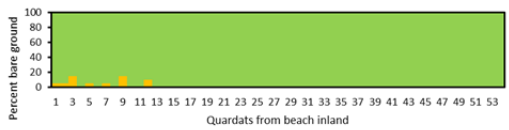
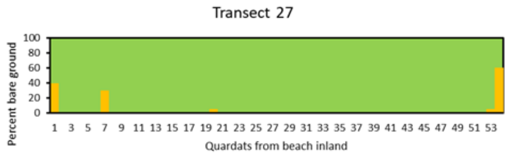
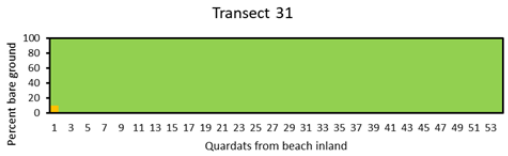
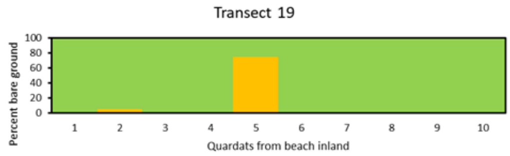
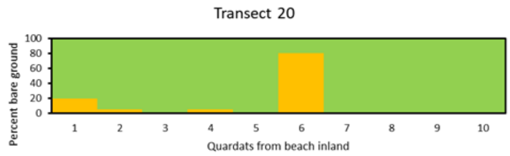
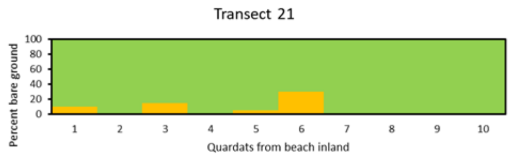


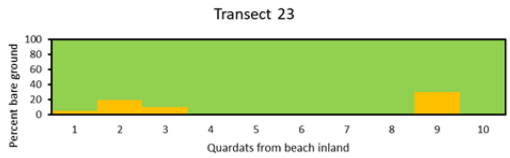




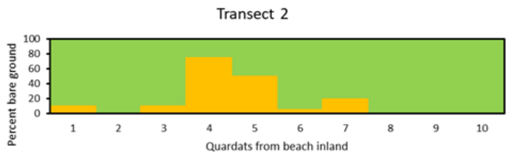


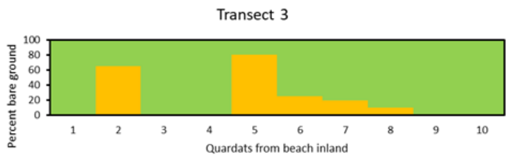


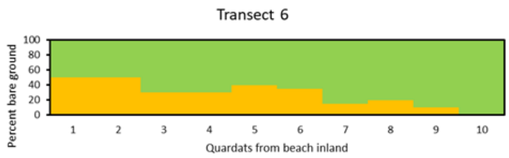


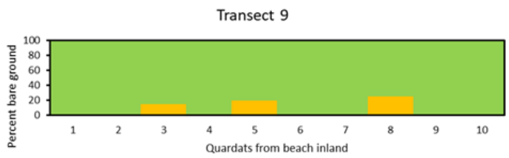


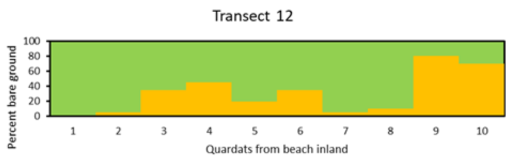
Appendix C6: Red Rocks

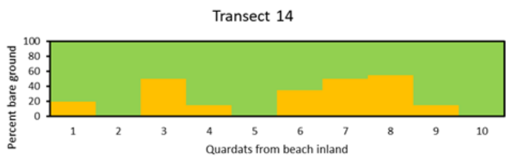




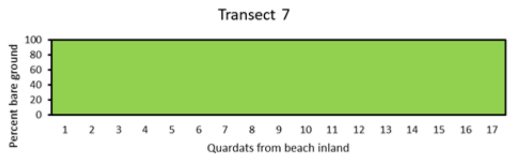


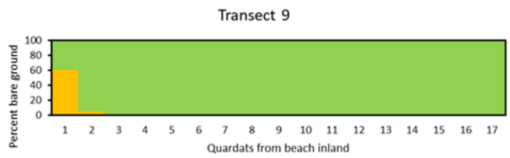


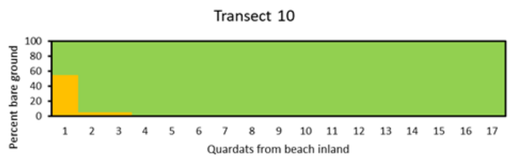


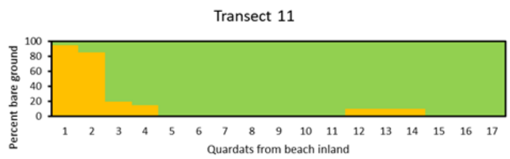


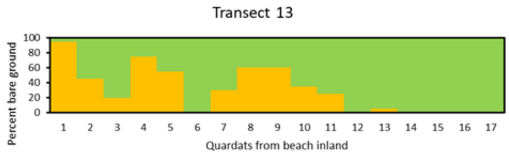
Appendix C7: Tora

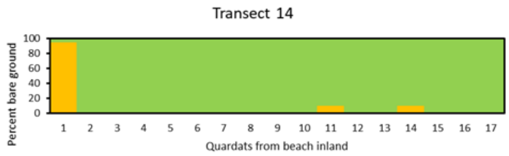


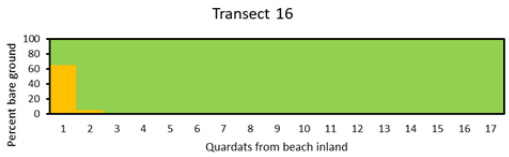


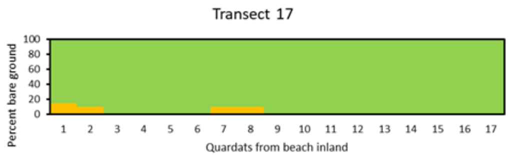


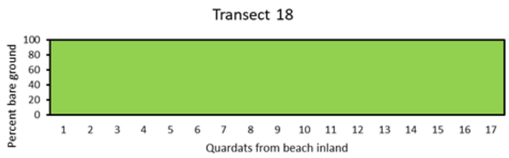


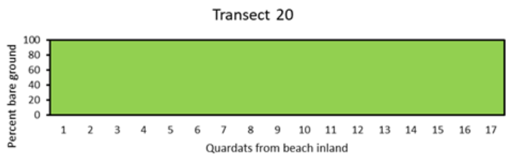


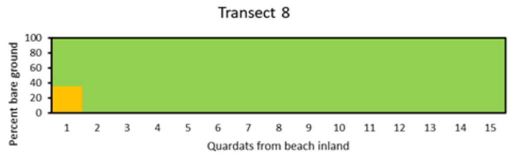


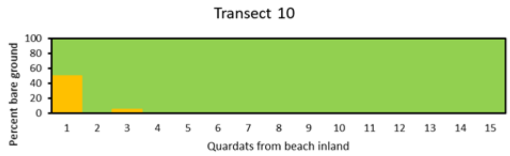


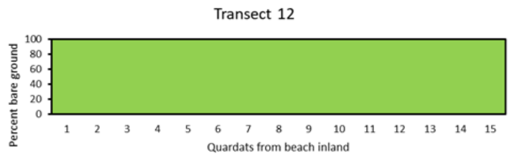


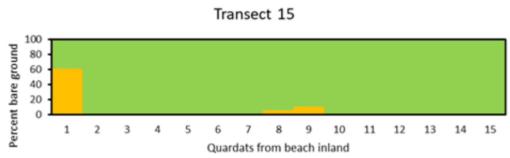


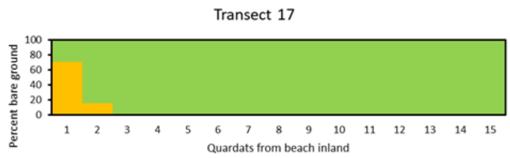


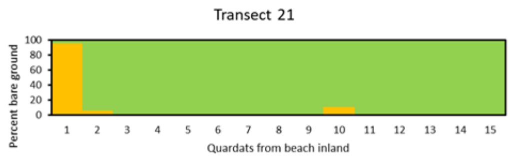


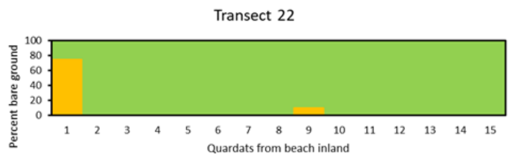


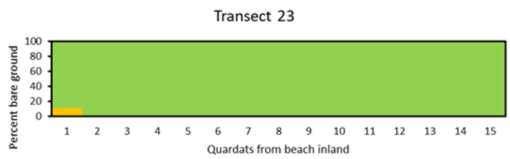




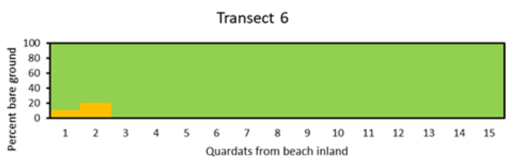


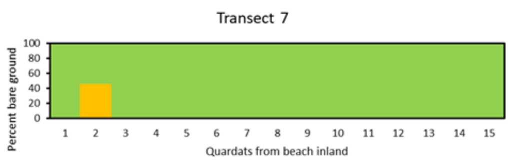






Appendix C8: Whitireia Park





Appendix D: Dune condition scores

Table D1: Dune State scores

Site name	Indigenous cover dominance	Indigenous bird dominance	Indigenous reptile dominance	Unnatural vegetation disturbance	Buffering	TOTAL
Makara Bay	4	2	5	5	0	16/25
Mukamukaiti	1	3	5	5	2	16/25
Otaki KNE	1	2	5	4	0	12/25
Peka Peka KNE	2	2	5	4	0	13/25
Peka Peka north	2	2	5	4	0	13/25
Red Rocks	1	2	5	4	2	14/25
Tora	1	3	5	4	0	13/25
Whitireia Park	2	2	5	4	0	13/25

Table D2: Dune Pressures scores

Site name	Ungulates	Lagomorphs & possums	Predators	Dogs	Problem Plants	Uncontrolled Pedestrians	Vehicles	Mining	TOTAL
Makara Bay	5	4	4	4	5	5	5	5	37/40
Mukamukaiti	0	0	0	5	1	5	4	5	20/40
Otaki KNE	4	2	2	0	0	0	0	5	13/40
Peka Peka KNE	5	4	0	0	0	2	5	5	21/40
Peka Peka north	5	4	0	0	0	2	5	5	21/40
Red Rocks	5	4	4	2	0	0	5	5	25/40
Tora	0	2	4	4	0	5	4	5	24/40
Whitireia Park	5	4	2	0	2	0	5	5	23/40