REMEASUREMENT OF VEGETATION MONITORING PLOTS IN ŌHOPE SCENIC RESERVE, JULY 2018

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REMEASUREMENT OF VEGETATION MONITORING PLOTS IN ŌHOPE SCENIC RESERVE, JULY 2018

Wildlands team members measuring one of the 20 × 20 metre plots at Ōhope Scenic Reserve, July 2018.

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CONTENTS

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1. INTRODUCTION

Ōhope Scenic Reserve (489 hectares) is located near Ōhope township in the Eastern Bay of Plenty. The reserve contains coastal and semi-coastal forest, nationally significant pōhutukawa (*Metrosideros excelsa*; Threatened-Nationally Vulnerable) forest, several other threatened plant species, and populations of threatened birds, including North Island brown kiwi (*Apteryx mantelli*; At Risk-Declining) and North Island weka (*Gallirallus australis greyi*; At Risk-Recovering). The reserve is therefore of high ecological importance.

To protect and enhance the ecological values at the reserve, a number of ongoing pest animal and pest plant control projects have been conducted at the site over the past few decades. These include possum (*Trichosurus vulpecula*), rat (*Rattus* species) and mustelid control, pest wasp (*Vespula* species) control, periodic invasive ungulate control, and pest plant control.

Coupled with these pest animal and pest plant control projects, ongoing monitoring activities are being undertaken to assess changes in indigenous plant cover and indigenous bird populations. As part of this work, 12 permanent 20 × 20 metre vegetation monitoring plots, that occur in three forest types (pōhutukawa/mixed broadleaved forest, rewarewa/mixed broadleaved forest, and mixed broadleaved forest), were established in 2007 and remeasured in 2011 (Dean 2011). In 2018 Bay of Plenty Regional Council commissioned Wildland Consultants to remeasure the plots and summarise important trends in indigenous vegetation composition at the reserve.

2. SITE INFORMATION

Ōhope Scenic Reserve is administered by the Department of Conservation and jointly managed with Ngāti Awa by the management committee, Te Tapatoru ā Toi. The reserve is located in Taneatua Ecological District in the coastal and semi-coastal bioclimatic zone and comprises coastal cliffs and hill country that becomes steeper further inland. Coastal areas of the reserve contain nationally significant examples of pōhutukawa forest while the inland areas of hill country contain rewarewa (*Knightia excelsa*)-kānuka (*Kunzea robusta*)-pōhutukawa forest (Beadel *at al*. 1999).

The reserve also provides habitat for three threatened plant species, including *Pimelea tomentosa* (Threatened-Nationally Vulnerable), *Peperomia tetraphylla* (At Risk-Naturally Uncommon), and poroporo (*Solanum aviculare* var. *aviculare*; At Risk-Declining). In addition, the reserve provides habitat for eight indigenous species in the Myrtaceae family that have been given elevated threat classifications (as per de Lange *et al*. 2018) as a precautionary measure based on the potential threat posed by myrtle rust (*Austropuccinia psidii*). These eight species are:

- Aka (*Metrosideros perforata*; Threatened-Nationally Vulnerable)
- Kānuka (Threatened-Nationally Vulnerable)
- Maire tawake (swamp maire, *Syzygium maire*; Threatened-Nationally Critical)
- Mānuka (*Leptospermum scoparium*; At Risk-Declining)

- Pōhutukawa (Threatened-Nationally Vulnerable)
- Ramarama (*Lophomyrtus bullata*; Threatened-Nationally Critical)
- Rātā (*Metrosideros diffusa*; Threatened-Nationally Vulnerable)
- Rātā (*Metrosideros fulgens*; Threatened-Nationally Vulnerable)

Indigenous fauna species (as per Robertson *et al*. 2017) that are present at or near the reserve include (based on Wildland Consultants 2010):

- Banded rail (*Gallirallus philippensis assimilis*; At Risk-Declining)
- Karearea (NZ falcon, *Falco novaeseelandiae*; At Risk-Recovering)
- Long-tailed cuckoo (*Eudynamys taitensis*; At Risk-Naturally Uncommon)
- North Island brown kiwi (At Risk-Declining)
- North Island fernbird (mātātā, *Bowdleria punctata vealeae*; At Risk-Declining)
- North Island kaka (*Nestor meridionalis septentrionalis*; At Risk-Recovering)
- North Island weka (At Risk-Recovering)

Pest mammal species threaten the ecological values present within Ōhope Scenic Reserve through the predation of indigenous fauna and indigenous plant seeds, herbivory of indigenous plants, and by competing with indigenous fauna for resources. Pest plants directly compete with indigenous plant species for habitat, and in some cases, pollinators and seed dispersers. Ōhope Scenic Reserve and adjacent sites (Mokoroa Scenic Reserve, Kōhi Point Scenic Reserve, Ngāti Awa Kawenata, and Dodds Covenant) are subject to pest animal and plant control activities that include (BOPRC 2018):

1. Possum and rat control using a network of bait stations.
2. Controlling mustelids using traps.
3. Limited live cat (*Felix silvestris catus*) trapping.
4. Goat (*Capra hircus*), red deer (*Cervus elaphus*) and feral pig (*Sus scrofa*) control.
5. Common wasp (*Vespula vulgaris*) and German wasp (*Vespula germanica*) control.
6. Control operations of target pest plants, initially targeting containment weed species.

To determine if pest animal and pest plant management activities are meeting operational targets, ongoing monitoring activities are occurring at the reserve. These monitoring activities are as follows (BOPRC 2018):

1. The establishment and remeasurement of twelve permanent 20 × 20 metre vegetation plots to monitor long-term changes in vegetation composition and structure.
2. Foliar Browse Index (FBI) to measure the effects of possum control on palatable canopy species.
3. Small bird monitoring using slow walk transects and five-minute bird counts to assess bird species presence and population trends.
4. Kiwi call counts and kiwi chick survival to monitor population dynamics.

3. METHODS

3.1 Plot relocation

Twelve vegetation monitoring plots were established in June 2007 and were subsequently remeasured during June-July 2011. All twelve plots were relocated between 3 and 27 July 2018 using handheld GPS units. The locations of these plots are illustrated in Figure 1. Geographical plot characteristics (location, altitude, landform, slope, and aspect) are summarised in Appendix 1.

3.2 Plot measurement

Plot measurement followed the methods in Hurst and Allen (2007).

A standard permanent plot reconnaissance (Recce) plot sheet[1] was completed for each plot. As well as plot characteristics (e.g. slope, aspect, drainage, layout), groundcover variables (litter, bare ground, rock, total vegetation, non-vascular vegetation), fauna, and vegetation browse, the relative abundance (in six cover classes) of each plant species present in seven vegetation tiers (<30 cm, 0.3-2 m, 2-5 m, 5-12 m, 12-25 m, >25 m and epiphytes) was recorded.

Stem diameter and sapling plot sheets[2] were also completed for each plot. Plots were divided into 16 square subplots. In each subplot, each stem >2.5 cm diameter at breast height (dbh) was identified to species, tagged, and dbh was measured. The number of saplings (woody species >1.35 m tall and <2.5 cm dbh) of each species in each subplot was also counted. Stems that were not found from the 2011 survey were recorded as not found.

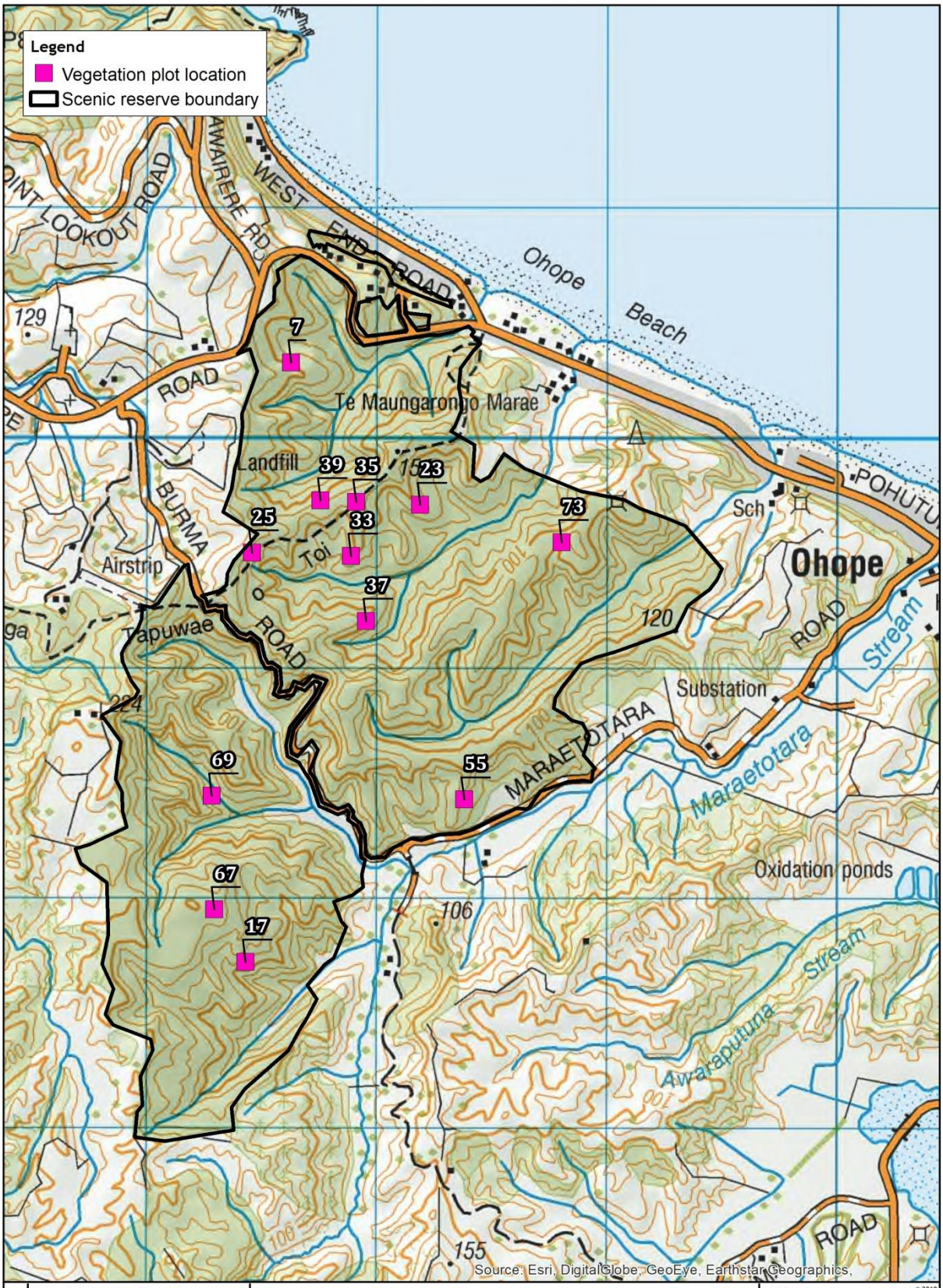
Understorey subplot sheets[3] were completed for 24 circular subplots (each 0.75 m^2) located on the midpoints of stem diameter and sapling subplot boundaries. The presence of every plant species <15 cm tall, and counts of each woody plant species present in four other height tiers (16-45 cm, 46-75 cm, 76-105 cm, 106-135 cm), were recorded for each subplot. Non-woody species and lianes >15 cm tall were recorded as present, rather than counted, in the four height tiers in which they occurred.

Additionally, a photograph was taken at each plot corner, facing towards the centre of the plot (Appendix 2).

3.3 Definitions of seedling and sapling

The term seedlings, within the context of this report, is used to describe any woody plants that were recorded in understorey subplots that are between 15 cm and 135 cm tall. Although, in a biological sense, these are technically not seedlings, within this report seedlings is used to define and separate this height class from understorey woody plants that are >135 cm tall. Saplings are defined here as woody stems that are <135cm tall and have stem diameters < 2.5cm.

[1] Available at: https://nvs.landcareresearch.co.nz/Content/PermPlot_RecceSheet.pdf.
[2] Available at: https://nvs.landcareresearch.co.nz/Content/PermPlot_StemDiameter_SaplingSheet.pdf.
[3] Available at: https://nvs.landcareresearch.co.nz/Content/PermPlot_UnderstoreySubplotSheet.pdf.



Data Acknowledgment

Imagery sourced from Taupo Disrtict Council.
Imagery date: April 2016

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File: Ohope scenic reserve - Topo.mxd

Figure 1. Location of 20 x 20m plots at Ohope Scenic Reserve

0 550 1,100 m

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Scale:	1:22,000
Date:	30/10/2018
Cartographer:	KM
Format:	A4

3.4 NVS database

All plot data was entered into NVS Express ready for uploading to the NVS database (Bay of Plenty Regional Council provided the metadata).

3.5 Statistical analysis

Mann-Whitney U tests were used to determine if there were significant differences in mean vegetation cover on the ground surface in the plots between the sampling years.

Paired t-tests were used to compare differences between sampling years for the following parameters:

- Mean species per plot.
- Mean stem diameter per plot for stems >2.5 cm.
- Mean stems per plot for stems >2.5 cm.
- Mean total saplings per plot.

In addition, a two sample t-test was used to compare mean seedlings per plot between the three sampling years.

We used McNemar's test to determine if seedling and sapling frequencies of each species within plots significantly differed between the sampling years.

To determine if there were changes in tree diameter (DBH) in select indigenous tree species between the three sampling years, we used a linear mixed effects model using plots as the repeated measure variable. Eight species with the largest mean stem diameters that are either preferred or avoided by possums (Allen *et al*. 2009), or are otherwise unclassified, were assessed. These species were:

- Kāmahi (*Weinmannia racemosa*; preferred).
- Kohekohe (*Dysoxylum spectabile*; preferred).
- Māhoe (*Melicytus ramiflorus* subsp. *ramiflorus*; preferred).
- Mangeao (*Litsea calicaris*; unclassified).
- Pōhutukawa (unclassified).
- Ponga (*Cyathea dealbata*; avoided).
- Porokaiwhiri (*Hedycarya arborea*; avoided).
- Rewarewa (unclassified).

Statistical tests were carried out in R version 3.5.0 (R Core Team). In all cases, the results of statistical tests were considered significant if $p \leq 0.05$. Means are presented with ±1 standard error (SE).

4. RESULTS

4.1 Ground cover, mean top height, and canopy cover

Ground cover vegetation increased significantly between 2007 and 2011. However, there was no significant difference between 2011 and 2018 for this parameter. Bare ground in 2007 was relatively lower than in 2011 and 2018. Conversely, canopy cover in 2011 was noticeably higher than in the two other sampling years. Although the differences recorded between the sampling years for these parameters (and particularly for canopy cover) may represent actual cover change, it might also be due to different field teams conducting the sampling. The remaining parameters (leaf litter, non-vascular ground cover, rock, mean top canopy height) have remained relatively unchanged in the plots between the three sampling years.

Table 1: Ground cover (±SE), mean top height, and canopy cover in 12 permanent vegetation monitoring plots at Ōhope Scenic Reserve.

Parameter	Cover (%)					
	2007		2011		2018	
	Mean	Range	Mean	Range	Mean	Range
Bare Ground	2.8 ± 1.7	0-20	7.5 ± 2.8	0-25	6.1 ± 2.3	0-25
Leaf litter	92.1 ± 2.1	80-99	85.3 ± 4.8	45-100	92.7 ± 2.4	75-99
Non-Vascular	0.09 ± 0.09	0-1	0.08 ± 0.08	0-1	1.0 ± 0	1
Rock	0.09 ± 0.09	0-1	0		0.3 ± 0.2	0-2
Vegetation	6.3 ± 1.7	1-20	35.8 ± 6.1	2-70	39.6 ± 7.0	5-75
Mean top Height (m)	15.6 ± 1	8-20	15.7 ± 1.3	6-20	14.8 ± 1.3	7-20
Canopy Cover (%)	61.3 ± 3.8	45-80	80.4 ± 3.5	50-95	60.8 ± 3.1	35-75

4.2 Vegetation at plots

In general, vegetation cover within each plot comprises one of three broad vegetation types:

1. Pōhutukawa/mixed broadleaved forest (denoted as 1 in Table 2)
2. Rewarewa/mixed broadleaved forest (denoted as 2 in Table 2)
3. Mixed broadleaved forest (denoted as 3 in Table 2).

Table 2: Vegetation types in 12 permanent vegetation monitoring plots at Ōhope Scenic Reserve, July 2018.

Plot	Broad Vegetation Class-Vegetation Type
7	Pōhutukawa-(rewarewa)/mixed broadleaved forest (1)
23	(Pūriri-rewarewa)/pōhutukawa-porokaiwhiri-ponga-nīkau forest (1)
33	Pōhutukawa-tawa-pūriri-rewarewa forest (1)
35	Pōhutukawa-rewarewa/mixed broadleaved species forest (1)
39	Pōhutukawa/kānuka-broadleaved species forest (1)
55	Pōhutukawa-kohekohe/ponga forest (1)
25	Rewarewa/kāmahi-mamaku forest (2)
37	Rewarewa/mixed broadleaved-treefern forest (2)
69	(Rewarewa)/māhoe-supplejack-nīkau-ponga forest (2)
73	Rewarewa/mangeao-mahoe-puriri forest (2)
17	Mixed broadleaved species forest (3)
67	Mixed broadleaved forest (3)

4.3 Number of vascular plant species

The mean number of vascular plant species (both indigenous and non-native) recorded in plots in 2018 was 36.9 ± 2.5 species. This was not significantly different from the mean number of species recorded in 2011 (38.8 ± 3.1). However, the mean number of species recorded in both 2011 and 2018 were both significantly higher (14% in 2011, 11% in 2018) than in 2007 (33.3 ± 2.9).

4.4 Number and proportion of non-native plant species

The number of non-native plant species within plots appears to be increasing over time, with 13 non-native plant species occurred in the plots in 2018, six species in 2011[1], and two species in 2007 (Table 3). The mean percentage of pest plant species in plots was 3.2 ± 1.5% in 2018, 1.7 ± 0.6% in 2011, and 0.5 ± 0.5% in 2007. The number of plots that non-native plants occurred in 2018 (six plots in total) was unchanged from 2011. However, only one plot contained a non-native plant species in 2007. The majority (approximately 60%) of the non-native plant species are ruderal dicotyledonous herbaceous perennials that will mostly have low ecological impacts, but several of the remaining species (for example, climbing asparagus, *Asparagus scandens*; Kahili ginger, *Hedychium gardnerianum*; woolly nightshade, *Solanum nigrum*) are aggressive pest plants.

4.5 Seedlings

Three hundred and fifty one seedlings, representing 30 indigenous vascular plant species, were recorded in the understorey subplots in the 12 plots in 2018. The mean number of seedlings per plot was 29 ± 4.6, which was not significantly different from the mean seedlings per plot recorded in 2011 (27.3 ± 4.4). However, the mean seedling counts per plot were significantly different in both 2011 and 2018 when compared to 2007 (51.3 ± 9.2). Hangehange (*Geniostoma ligustrifolium* var. *ligustrifolium*) was the most common species (81 seedlings total in all plots), followed by nīkau (*Rhopalostylis sapida*; 55 seedlings), karamū (*Coprosma lucida*; 42 seedlings), and porokaiwhiri (24 seedlings). Table 4 provides further details regarding the species composition and frequency of the most frequently recorded species.

Four of the ten indigenous plant species with the greatest number of recorded seedlings, averaged across all years, are palatable to possum browse (Table 2). These species were hangehange, the species with the greatest number of seedlings recorded in each of the three sampling years, as well as karamū, māpou (*Myrsine australis*), and māhoe.

[1] *Senecio bipinnatisectus*, recorded in 2011, has recently been recognised as indigenous (de Lange *et al*. 2018). This species was therefore not included within the analysis of non-native plants.

Table 3: Pest plant species recorded in 12 permanent vegetation monitoring plots at Ōhope Scenic Reserve.

Species	Common Name	RPMP	National Pest Plant Accord	Number of Plots		
				2007	2011	2018
Asparagus scandens	climbing asparagus	Restricted pest	Unwanted Organism	1	1	1
Cirsium vulgare	Scotch thistle	Containment pest			1	2
Cortaderia selloana	pampas	Restricted pest	Unwanted Organism			1
Crepis capillaris	hawksbeard					1
Digitalis purpurea	foxglove					1
Erigeron sumatrensis (syn. *Conyza albida*)	broad-leaved fleabane			1	3	2
Hedychium gardnerianum	Kahili ginger	Containment pest	Unwanted Organism			1
Hypochaeris radicata	catsear					2
Leontodon saxatilis	hawkbit				1	
Phytolacca octandra	inkweed					1
Prunus species	cherry				1	1
Solanum mauritianum	woolly nightshade	Containment pest	Unwanted Organism			1
Solanum nigrum	Black nightshade					1
Sonchus oleraceus	sow thistle					1
Sonchus species	sow thistle				1	

Based on the results of the McNemar's test, only two species (mangeao and kawakawa; *Piper excelsum* subsp. *excelsum*) had significant differences in seedling frequencies in the plots between sampling years. Both species significantly declined in the number of plots in which they were recorded when comparing seedling frequencies between 2007 and 2018, and between 2011 and 2018. However, there was not a significant difference when comparing seedling frequencies between 2007 and 2011.

4.6 Saplings

A total of 1,736 saplings were counted within the plots in 2018, with a mean of 144.7 ± 24.5 saplings per plot (Table 5). This compares to 1,660 (mean: 138 ± 53.8) in 2011 and 2,248 (mean: 187 ± 89.5) in 2007, respectively (Table 5). There were no significant differences in mean sapling counts recorded in the plots when comparing each of the sampling years.

Across all three sampling years, saplings of hangehange were the most common species (Table 3). This was followed by karamū, ponga, porokaiwhiri, māhoe, and rangiora (*Brachyglottis repanda*) (Table 5). Three of the five most frequently measured sapling species are highly palatable and preferred by possums (Table 5). Although the species listed above, and mangeao and kawakawa, occurred in at least seven or more of the plots in each of the three sampling years, in general, there is wide variation in sapling counts of all species between each of the twelve plots. For example, sapling counts of hangehange within the plots ranged from 0 to 160 in 2018. All remaining sapling species occurred in six or fewer of the plots, with the majority occurring in fewer than four plots.

Overall, there were only relatively small changes in the mean saplings per plot, and by inference; the number of saplings per hectare, between the sampling years for the majority of the species (Table 5). Based on the results of the McNemar's test, no species had a significant decrease in sapling frequency between plots when comparing data from each of the sampling years.

4.7 Stem diameter and basal area

Overall, total basal area for all species was lower in 2018 (52.8 m^2/ha) compared to 2011 (56.3 m^2/ha) and 2007 (56.5 m^2/ha). Rewarewa had the largest mean basal area of all species measured in 2018 (17.5 ± 3.1 m^2/ha). This mean basal area was slightly lower than in 2011 and 2007 (Table 6). The ten indigenous plant species with the largest mean basal area are listed in Table 4. The majority of these species have either slightly increased or decreased in mean basal area between the three sampling years. Of particular note is the decrease in basal area of pōhutukawa between the three sampling years.

There was no significant difference when comparing mean stem diameters >2.5 cm plot between 2018 (n=1,581 stems; mean DBH: 9.7 cm ± 0.3) and 2011 (n=1,589 stems; mean DBH: 10.0 cm ± 0.3) (Table 6). However, there was a significant difference in mean stem diameters per plot between these two years and 2007 (1,312, mean DBH: 11.2 cm ± 0.3). Similarly, there was no significant difference in the mean number of stems per plot between 2018 (131 ± 20.7) and 2011 (132 ± 21.1). However, there was a significant difference in the mean number of stems per plot when both of these years were compared to 2007 (109 ± 15.2).

Māhoe was the most frequent species with stem diameters <2.5 cm across all three of the sampling years, followed by porokaiwhiri, rewarewa, ponga, and mangeao (Table 6). By contrast, pōhutukawa had the largest mean stem diameter of the species that were measured (79.2 ± 17.1 cm in 2018; 72.9 ± 17.0 cm in 2011; 84.3 ± 17.8 cm in 2007) (Table 6). This was followed by kāmahi, rewarewa, ponga, and mamaku (*Cyathea medullaris*) (Table 6). There was no significant difference in mean stem diameter between years for any of the eight species that were tested using a linear mixed effects model.

Table 4: Numbers of seedlings recorded in 12 permanent vegetation monitoring plots at Ōhope Scenic Reserve. Seedlings per hectare (± SE) are extrapolated from plot counts. Only the 20 most abundant species (across all plots) are listed.

Species	Common Name	Palatability[1]	2007			2011			2018		
			Total	Mean (per plot)	Seedlings/ ha	Total	Mean (per plot)	Seedlings/ ha	Total	Mean (per plot)	Seedlings/ ha
Geniostoma ligustrifolium var. *ligustrifolium*	Hangehange	Preferred	141	11.8 ± 4.2	6528 ± 2313	75	6.3 ± 2.3	3472 ± 1257	81	6.8 ± 2.2	3750 ± 1219
Rhopalostylis sapida	Nīkau	Unclassified	28	2.3 ± 0.9	1296 ± 490	14	1.2 ± 0.5	648 ± 263	55	4.6 ± 1.5	2546 ± 813
Coprosma lucida	Karamū	Preferred	57	4.7 ± 2.7	2639 ± 1541	32	2.7 ± 1.5	1481 ± 860	42	3.5 ± 1.6	1944 ± 893
Hedycarya arborea	Porokaiwhiri	Avoided	75	6.3 ± 2.0	3472 ± 1090	38	3.2 ± 1.1	1759 ± 595	24	2.0 ± 0.7	1111 ± 416
Piper excelsum subsp. *excelsum*	Kawakawa	Unclassified	28	2.3 ± 0.7	1296 ± 406	17	1.4 ± 0.6	787 ± 317	23	1.9 ± 0.6	1065 ± 309
Myrsine australis	Māpou	Preferred	26	2.2 ± 0.8	1204 ± 468	17	1.4 ± 0.6	787 ± 331	15	1.3 ± 1.0	694 ± 552
Coprosma spathulata subsp. *spathulata*		Unclassified	49	4.1 ± 3.9	2268 ± 2169	23	1.9 ± 1.8	1065 ± 1015	14	1.2 ± 1.2	648 ± 0
Cyathea dealbata	Ponga	Avoided	33	2.8 ± 1.2	1528 ± 660	16	1.3 ± 0.6	741 ± 330	12	1.0 ± 0.4	556 ± 216
Melicytus ramiflorus subsp. *ramiflorus*	Māhoe	Preferred	33	2.8 ± 1.0	1528 ± 581	18	1.5 ± 0.6	833 ± 317	12	1.0 ± 0.5	556 ± 256
Litsea calicaris	Mangeao	Unclassified	62	5.2 ± 1.6	2870 ± 914	34	2.8 ± 1.1	1574 ± 619	10	0.8 ± 0.3	463 ± 179
Dysoxylum spectabile	Kohekohe	Preferred	4	0.3 ± 0.2	185 ± 104	2	0.2 ± 0.1	93 ± 62	8	0.7 ± 0.3	370 ± 172
Ripogonum scandens	Supplejack	Preferred	6	0.5 ± 0.4	278 ± 199	-	-	-	8	0.7 ± 0.7	370 ± 0
Beilschmiedia tawa	Tawa	Avoided	17	1.4 ± 0.8	787 ± 435	8	0.7 ± 0.4	370 ± 197	7	0.6 ± 0.4	324 ± 199
Olearia rani	Heketara	Preferred	5	0.4 ± 0.3	231 ± 187	2	0.2 ± 0.2	93 ± 0	6	0.5 ± 0.3	278 ± 145
Brachyglottis repanda	Rangiora	Preferred	15	1.3 ± 0.5	694 ± 257	8	0.7 ± 0.3	370 ± 158	4	0.3 ± 0.2	185 ±104
Coprosma grandifolia	Kanono	Preferred	3	0.3 ± 0.2	139 ± 100	2	0.2 ± 0.1	93 ± 62	3	0.3 ± 0.2	139 ± 100
Pseudopanax arboreus	Whauwhaupaku	Preferred	7	0.6 ± 0.4	324 ± 199	5	0.4 ± 0.2	231 ± 127	3	0.3 ± 0.2	139 ± 100
Knightia excelsa	Rewarewa	Unclassified	1	0.1 ± 0.1	46 ± 0	-	-	-	2	0.2 ± 0.1	93 ± 62
Alectryon excelsus subsp. *excelsus*	Tītoki	Preferred	-	-	-	-	-	-	2	0.2 ± 0	93 ± 0
Freycinetia banksii	Kiekie	Unclassified	-	-	-	-	-	-	2	0.2 ± 0	93 ± 0
Total (All Species)			**615**	**51**	**28,472**	**327**	**27**	**15,137**	**351**	**29**	**16,250**

[1] Palatability to possums (Allen *et al*. 2009).

Table 5: Number of saplings recorded in 12 permanent vegetation monitoring plots at Ōhope Scenic Reserve. Saplings per hectare (±SE) are extrapolated from plot counts. Only the 20 most abundant species (across all plots) are listed.

Sapling Species	Common Name	Palatability[1]	2007			2011			2018		
			Total	Mean (per plot)	Saplings/ha	Total	Mean (per plot)	Saplings/ha	Total	Mean (per plot)	Saplings/ha
Geniostoma ligustrifolium var. *ligustrifolium*	hangehange	Preferred	412	34.3 ± 9.2	858.3 ± 229.1	418	34.8 ± 9.1	870.8 ± 227.8	474	39.5 ± 12.8	987.5 ± 321.1
Coprosma lucida	karamū	Preferred	299	24.9 ± 13.1	622.9 ± 327.6	266	22.2 ± 12.1	554.2 ± 302.2	239	19.9 ± 10.3	497.9 ± 256.3
Cyathea dealbata	ponga	Avoided	181	15.1 ± 4.0	377.1 ± 99.0	178	14.8 ± 3.3	370.8 ± 82.9	237	19.8 ± 5.6	493.8 ± 140.1
Hedycarya arborea	porokaiwhiri	Avoided	189	15.8 ± 6.7	393.8 ± 166.7	187	15.6 ± 6.0	389.6 ± 150.6	146	12.2 ± 3.0	304.2 ± 75.0
Melicytus ramiflorus subsp. *ramiflorus*	māhoe	Preferred	142	11.8 ± 2.9	295.8 ± 73.0	124	10.3 ± 3.0	258.3 ± 74.8	92	7.7 ± 1.8	191.7 ± 44.3
Brachyglottis repanda	rangiora	Preferred	109	9.1 ± 2.8	227.1 ± 70.5	89	7.4 ± 2.2	185.4 ± 54.5	85	7.1 ± 2.0	177.1 ± 48.9
Piper excelsum subsp. *excelsum*	kawakawa	Unclassified	52	4.3 ± 1.5	108.3 ± 38.5	60	5.0 ± 1.5	125.0 ± 36.8	77	6.4 ± 1.6	160.4 ± 39.2
Rhopalostylis sapida	nīkau	Unclassified	45	3.8 ± 2.4	93.8 ± 60.8	58	4.8 ± 2.8	120.8 ± 70.2	74	6.2 ± 3.4	154.2 ± 85.0
Myrsine australis	māpou	Preferred	40	3.3 ± 2.3	83.3 ± 58.3	44	3.7 ± 2.5	91.7 ± 61.4	71	5.9 ± 3.9	147.9 ± 98.3
Pseudopanax arboreus	whauwhaupaku	Preferred	45	3.8 ± 1.7	93.8 ± 42.5	51	4.3 ± 2.0	106.3 ± 50.5	42	3.5 ± 1.9	87.5 ± 46.8
Litsea calicaris	mangeao	Unclassified	70	5.8 ± 1.8	145.8 ± 45.0	47	3.9 ± 1.1	97.9 ± 27.8	35	2.9 ± 0.8	72.9 ± 20.5
Coprosma grandifolia	kanono	Preferred	20	1.7 ± 0.9	41.7 ± 23.5	16	1.3 ± 0.6	33.3 ± 15.2	32	2.7 ± 1.1	66.7 ± 28.3
Coprosma spathulata subsp. *spathulata*		Unclassified	32	2.7 ± 0	66.7 ± 0	29	2.4 ± 2.4	60.4 ± 0	30	2.5 ± 2.4	62.5 ± 60.3
Olearia rani	heketara	Preferred	23	1.9 ± 1.3	47.9 ± 32.6	23	1.9 ± 1.2	47.9 ± 30.5	20	1.7 ± 0.8	41.7 ± 20.5
Dysoxylum spectabile	kohekohe	Preferred	15	1.3 ± 0.5	31.3 ± 12.7	15	1.3 ± 0.6	31.3 ± 14.8	11	0.9 ± 0.5	22.9 ± 11.3
Beilschmiedia tawa	tawa	Avoided	16	1.3 ± 0.7	33.3 ± 18.0	14	1.2 ± 0.6	29.2 ± 15.9	10	0.8 ± 0.5	20.8 ± 13.4
Coprosma arborea	tree coprosma	Unclassified	-	-	-	-	-	-	10	0.8 ± 0.7	20.8 ± 18.7
Coprosma robusta	karamū	Unclassified	6	0.5 ± 0.3	12.5 ± 8.4	5	0.4 ± 0.3	10.4 ± 7.2	8	0.7 ± 0.4	16.7 ± 10.4
Schefflera digitata	patē	Preferred	5	0.4 ± 0.3	10.4 ± 8.4	11	0.9 ± 0.7	22.9 ± 17.3	7	0.6 ± 0.6	14.6 ± 0
Melicope ternata	wharangi	Unclassified	6	0.5 ± 0.4	12.5 ± 10.4	3	0.3 ± 0.3	6.3 ± 0	6	0.5 ± 0.5	12.5 ± 0
Total (All Species)			**2248**	**187 ± 89.5**	**4683**	**1660**	**138 ± 53.8**	**3458**	**1736**	**145 ± 24.5**	**3617**

[1] Palatability to possums (Allen *et al*. 2009).

Table 6: Stem diameters and basal areas (±SE) of selected species across all permanent vegetation monitoring plots at Ōhope Scenic Reserve.

DBH of Select Species	Common Name	Palatability[1]	2007				2011				2018			
			Number of Stems >2.5cm dbh	Max Diameter (cm)	Mean Diameter (cm)	Basal Area (m²/ha)	Number of Stems >2.5cm dbh	Max Diameter (cm)	Mean Diameter (cm)	Basal Area (m²/ha)	Number of Stems >2.5cm dbh	Max Diameter (cm)	Mean Diameter (cm)	Basal Area (m²/ha)
Knightia excelsa	Rewarewa	Unclassified	141	83	23.7 ± 1.2	17.7 ± 3.7	143	83	23.6 ± 1.2	18.0 ± 3.8	134	82.9	24.4 ± 1.2	17.5 ± 3.1
Melicytus ramiflorus subsp. *ramiflorus*	Māhoe	Preferred	249	44.6	8.2 ± 0.4	4.2 ± 1.8	284	44.6	7.9 ± 0.4	4.6 ± 1.9	297	44.5	7.6 ± 0.3	4.5 ± 1.8
Cyathea dealbata	Ponga	Avoided	116	35.5	19.5 ± 0.4	7.5 ± 1.4	117	30.3	19.1 ± 0.39	7.3 ± 1.3	114	23.7	19.5 ± 0.4	7.4 ± 1.5
Hedycarya arborea	Porokaiwhiri	Avoided	152	30.7	7.1 ± 0.3	1.7 ± 0.4	176	32	6.9 ± 0.3	1.9 ± 0.5	191	34.0	7.1 ± 0.3	2.2 ± 0.5
Litsea calicaris	Mangeao	Unclassified	65	121.1	14.2 ± 2.1	4.8 ± 2.3	70	13.2	13.2 ± 1.5	3.8 ± 1.2	38	80.7	15.6 ± 2.6	3.1 ± 1.3
Dysoxylum spectabile	Kohekohe	Preferred	25	36.9	12.8 ± 1.6	0.9 ± 0.9	28	37.4	12.2 ± 1.6	0.98 ± 0.9	29	37.7	11.9 ± 1.6	1.0 ± 0.9
Cyathea medullaris	Mamaku	Unclassified	32	33.7	16.9 ± 1.1	1.7 ± 0.8	33	34.5	16.5 ± 1.1	1.7 ± 0.8	25	33.1	17.3 ± 1.3	1.4 ± 0.7
Beilschmiedia tawa	Tawa	Avoided	18	48.8	16.1 ± 3.5	1.4 ± 0.8	20	48.8	15.5 ± 3.3	1.4 ± 0.9	21	50.1	16.1 ± 3.2	1.6 ± 0.9
Metrosideros excelsa	Pōhutukawa	Unclassified	7	143.5	84.3 ± 17.8	10.3 ± 4.3	8	129	72.9 ± 17.0	9.6 ± 3.8	6	134.5	79.2 ± 17.1	7.6 ± 3.5
Weinmannia racemosa	Kāmahi	Preferred	12	42	25.4 ± 3.2	1.5 ± 0.8	12	42.2	25.5 ± 3.2	1.5 ± 0.8	8	42.6	28.6 ± 3.8	1.2 ± 0.7
Total (All Species)			**1,312**		**11.2 ± 0.3**	**56.5**	**1,589**		**10.0 ± 0.3**	**56.3**	**1,581**		**9.7 ± 0.3**	**52.8**

[1] Palatability to possums (Allen *et al*. 2009).

4.8 Browse

Fourteen indigenous plant species showed evidence of browse by insects, mammals (most likely possums), or ungulates (Table 7). Insect browse was noted in nine plots, mammal browse in three plots, and ungulate browse in four plots. Of the 32 incidences of browse, 27 (84%) were considered to be low, four (13%) were medium, and one (3%) case was high. Two of the incidences of medium browse were by ungulates on māhoe, while the remaining cases were by insects on individual kawakawa and titipo (*Pteris macilenta*). The one incidence of high browse was by an unidentified mammal (possibly possum) on a kanono (*Coprosma grandifolia*).

Table 7: Type and severity of browse recorded at Ōhope Scenic Reserve during the 2018 plot measurements. The numbers of plots in which browse was recorded are shown.

Species	Common Name	Palatability[1]	Herbivore	Low	Medium	High
Blechnum novae-zelandiae	Kiokio	Unclassified	Ungulate	1		
Brachyglottis repanda	Rangiora	Preferred	Insect	2		
Coprosma arborea	Tree coprosma		Insect	1		
Coprosma grandifolia	Kanono	Preferred	Mammal			1
Coprosma lucida	Karamū	Preferred	Insect	2		
Geniostoma ligustrifolium var. *ligustrifolium*	Hangehange	Preferred	Insect	2		
			Mammal	1		
Hedycarya arborea	Porokaiwhiri	Avoided	Insect	2		
			Mammal	1		
Melicytus ramiflorus subsp. *ramiflorus*	Māhoe	Preferred	Insect	2		
			Ungulate	1	2	
Metrosideros excelsa	Pōhutukawa	Unclassified	Insect	1		
Piper excelsum subsp. *excelsum*	Kawakawa	Unclassified	Insect	7	1	
Pteris macilenta	Titipo	Unclassified	Insect		1	
Rhopalostylis sapida	Nīkau	Unclassified	Ungulate	1		
Ripogonum scandens	Supplejack	Preferred	Insect	1		
			Mammal	1		
Schefflera digitata	Patē	Preferred	Insect	1		
Total (All Species)				**27**	**4**	**1**

4.9 Fauna

Incidental observations of fauna at plots (See Table 6 for a list of bird species) identified 19 species of birds (14 indigenous, five introduced) in 2018. This compares to 16 bird species (ten indigenous, six introduced) in 2011 and 13 bird species (ten indigenous, three introduced) in 2007 (Table 8). Of note in this year's survey was the presence of North Island robin (*Petroica longipes*; At Risk-Declining[2]) at seven plots, and North Island weka (*Gallirallus australis greyi*; At Risk-Recovering) at three plots. Both species are vulnerable to predation by introduced mammalian predators

[1] Palatability to possums (Allen *et al*. 2009).
[2] Indigenous bird threat classification follows Robertson *et al*. (2017).

and it is likely that their presence in the plots is attributable to ongoing predator control activities within Ōhope Scenic Reserve.

Deer (*Cervus* sp.) pellets were recorded in one plot, and feral pig rooting was recorded in two plots.

Table 8: Indigenous and introduced birds recorded at Ōhope Scenic Reserve. The numbers of plots in which birds were recorded are shown for each sampling year.

Species	Common Name	Indigenous or Introduced	Conservation Status	Number of Plots		
				2007	2011	2018
Anthornis melanura melanura	Korimako; bellbird	Indigenous	Not Threatened	4	12	10
Acridotheres tristis	Myna	Introduced			1	
Circus approximans	Kāhu; swamp harrier	Indigenous	Not Threatened	4	2	1
Gerygone igata	Riroriro; grey warbler	Indigenous	Not Threatened	7	8	6
Gymnorhina tibicen	Australian magpie	Introduced		1	1	2
Hemiphaga novaeseelandiae	Kererū	Indigenous	Not Threatened	8	8	8
Mohoua albicilla	Pōpokotea; whitehead	Indigenous	At Risk-Declining	3		
Passer domesticus	House sparrow	Introduced			1	
Petroica macrocephala toitoi	Miromiro; pied tomtit	Indigenous	Not Threatened	3	4	9
Phasianus colchicus	Common pheasant	Introduced		1		3
Platycercus eximius	Eastern rosella	Introduced			1	3
Prosthemadera novaeseelandiae novaeseelandiae	Tūī	Indigenous	Not Threatened	9	11	12
Prunella modularis	Dunnock	Introduced			1	
Rhipidura fuliginosa placabilis	Pīwakawaka; North Island fantail	Indigenous	Not Threatened	8	7	8
Tadorna variegata	Pūtangitangi; paradise shelduck	Indigenous	Not Threatened	1	1	5
Todiramphus sanctus vagans	Kōtare; sacred kingfisher	Indigenous	Not Threatened		1	2
Turdus merula	Blackbird	Introduced		1	2	3
Petroica longipes	Toutouwai; North Island robin	Indigenous	At Risk-Declining			7
Vanellus miles	Spur-winged plover	Indigenous	Not threatened			2
Turdus philomelos	Song thrush	Introduced				1
Gallirallus australis greyi	North Island weka	Indigenous	At Risk-Recovering			3
Ninox novaeseelandiae	Ruru; morepork	Indigenous	Not threatened			1
Zosterops lateralis lateralis	Tauhou; silvereye	Indigenous	Not threatened	1	5	3

5. DISCUSSION

5.1 Number of vascular plant species

The mean number of vascular plant species recorded within monitoring plots was similar in 2018 and 2011. By contrast, these two years had significantly higher mean plant species per plot than in 2007. The changes in the number of vascular plant species that occurred between 2007 and the two other sampling years is at least partly explained by the larger number of non-native species that were recorded in 2011 and 2018. Increases in the number of indigenous plant species recorded during 2011 and 2018 may represent successional changes within the forest, but may also be due to increased search effort during the past two surveys.

5.2 Number and proportion of non-native plant species

Although the number of non-native plant species appears to be increasing within the plots over time, they remain a relatively small component of the total vascular plant diversity. The small increases in the number of non-native plant species may be due to changes in the disturbance regimes associated with factors such as climatic events or tree fall, thereby providing microsites for non-native plants to colonise. For example, the increase in the number of non-native plants between 2011 and 2018 was primarily driven by the collapse of a mature pōhutukawa tree near one plot (Plot 55). Alternatively, and as Bellingham and Mason (2012) also suggest, the differences in the total number of non-native plant species recorded between the sampling years may have resulted from varying levels of search effort.

Should pest plants such as Kahili ginger continue to increase in frequency within the plots over time, wider pest plant surveys may be required to map and identify management options for these pest plant species.

5.3 Seedlings

Seedling counts between years suggest that indigenous species that are palatable to possums (and by inference, other vertebrate herbivores) are germinating and surviving within the plots. This indicates that the reproduction of these species is not being severely limited by vertebrate herbivore browse, as might be expected if vertebrate herbivore densities were high (c.f. Wilson *et al.* 2003, Husheer 2007). Variation in seedling densities between sampling years at Ōhope Scenic Reserve (for example, the total number of seedlings per hectare in 2007 compared to 2011 and 2018; Table 2) is therefore most likely the result of factors other than vertebrate herbivory, and probably reflects population dynamics associated with a number of factors, such as: seasonal variation in climate (particularly summer drought, which can have severe effects on seedling and young sapling survival), successional stage of the vegetation, individual species reproductive efforts, and the soil seedbank. Nevertheless, ongoing vertebrate herbivore control efforts in the reserve have likely ensured that palatable species are sufficiently common within the reserve to maintain healthy seedbanks.

The majority of seedlings present in plots in all three sampling years were broadleaved subcanopy tree and shrub species. However, seedlings of the two dominant canopy species, rewarewa and pōhutukawa, are either very rare (rewarewa)

or totally absent (pōhutukawa) within the plots over the three sampling years. Both species prefer to colonise ecologically disturbed sites (Atkinson 2004). Therefore, the lack of seedlings of these species within the plots may be the result of the lack of disturbance within these sites, rather than reproductive failure due to possum herbivory or other factors.

Overall, the seedling counts, and by extrapolation, the seedlings/hectare, for all species measured in Ōhope Scenic Reserve are much lower than those reported at Pūtauaki (Wildland Consultants 2015), located approximately 30 kilometres southwest of Ōhope. This may reflect the successional status of each respective forest; much of Pūtauaki is in the early stages of succession, while Ōhope Scenic Reserve is in a more advanced successional state. However, this could also reflect differences in climate, soil type, and propagule pressure from both indigenous and introduced plant species between the two sites.

5.4 Saplings

Although the total sapling counts are fairly similar between 2011 and 2018, when compared to 2007, there was no significant difference in mean sapling counts per plot when comparing each of these three years. This relative stability in sapling populations between sampling years suggests that herbivory by introduced mammals is not negatively impacting overall sapling density within the plots. Ongoing remeasurement of the plots in the future is needed to determine if this trend continues.

Both palatable and non-palatable species appear to be recruiting from seedlings into the sapling class without significant impediments; both total and mean sapling and seedling counts for all species within sampling years closely parallel one another. Palatable species account for six of the ten most frequently sampled sapling species in each of the sampling years, with hangehange and karamū the two most common recorded species in all years. The abundance of these species could be attributed to control of possum and ungulates, but may just reflect the current successional state of the wider forest.

There have been no significant changes in sapling frequencies for almost all species between sampling years. The small variations in sapling counts between years are most likely the result of factors such as small-scale disturbance and interspecific and intraspecific competition between saplings.

The sapling counts for individual species at Ōhope Scenic Reserve are generally higher than those recorded at Pūtauaki (Wildland Consultants 2015). For example saplings/hectare for hangehange at Ōhope Scenic Reserve were over four times higher in each of the sampling years compared to Pūtauaki. Again, this may reflect the successional stage of the two forests, but could also be due to the absence of pest mammal control at Pūtauaki.

5.5 Stem diameter and basal area

The significant increase in the number of stems and the lower mean stem diameter recorded in 2011 and 2018, when compared to 2007, was likely driven by the pulse of saplings recorded in 2007 that had reached <2.5 cm diameter in the subsequent two

sampling periods. Like the trends for seedlings and saplings, the similarity of the 2011 and 2018 measurements suggests that the vegetation within the plots has undergone a rapid successional change (between 2007 and 2011), which now appears to have begun to stabilise as the successional cohort ages.

Of the two dominant canopy species (rewarewa and pōhutukawa), the mean stem diameter and basal area of rewarewa has changed minimally across the sampling years. By contrast, the mean diameter of pōhutukawa has varied appreciably between sampling years. This was primarily due to a new stem recruiting within one of the plots in 2011 that was subsequently not recorded in 2018, and the collapse of a large pōhutukawa in 2018. The death of this large tree primarily explains the lower total basal area for all species reported in 2018.

Neither of the two palatable species that were tested (māhoe and kohekohe) had statistically significant changes in mean diameter between the three sampling years, implying that there has been only limited loss of larger trees of either species. These lack of detectable statistical changes in the mean stem diameter are despite large increases in the number of new stems <2.5 in the plots in each of the successive sampling years (Table 6). Another palatable species (kāmahi) could not be tested statistically due to the small sample size of this species. However, the increase in stem diameter of kāmahi in 2018 was due to the death of four small trees in the plots since 2011. Whether the loss of these trees is the result of localised disturbance events or reflects an overall decline in this species across the wider forest is unclear. The general population trends of this palatable species should be tracked during further remeasurements.

5.6 Browse effects and fauna

Casual observations of the effects of mammal browse during 2018 suggest that in most cases browsing pressure was low. However, like the faunal observations, these records are not a substitute for regular, more detailed surveys that use standardised methodology (for example, FBI sampling), which are being carried out at Ōhope Scenic Reserve (BOPRC 2018).

The casual fauna observations made during this and previous sampling years are inadequate for providing any indication of population trends. However, they do provide evidence of presence of species within the reserve. Ongoing targeted surveys of indigenous and introduced fauna species should be used to gauge changes in population trends of specific species, as is occurring on a periodic basis (BOPRC 2018).

6. CONCLUSIONS

The remeasurement of permanent vegetation plots at Ōhope Scenic Reserve in 2018 has allowed ongoing trends in vegetation change to be assessed and compared to the two previous sampling years, conducted in 2011 and 2007. Comparisons of vegetation metrics between these years suggests that, using the parameters that were analysed, there have been only relatively small changes in vegetation between 2011 and 2018. By contrast, there were appreciable differences in most vegetation measurements

when these two years were compared with the 2007 data. These changes are primarily thought to have resulted from rapid recruitment and growth of understorey species as a result of succession within the forest.

Based on the results of this and previous sampling years, recruitment and survival of palatable indigenous plant species is taking place within the plots. This suggests that current levels of herbivory by introduced mammals are unlikely to be causing declines of palatable indigenous plant species within the wider forest. These findings lend support to the ongoing rat, possum and ungulate control efforts that are taking place within Ōhope Scenic Reserve.

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GEOGRAPHICAL CHARACETERISTICS OF THE 12 VEGETATION MONITORING PLOTS AT ŌHOPE SCENIC RESERVE

Plot Number	Coordinates (NZTM)		Altitude (m asl)	Landform	Slope (°)	Aspect (°)
	Easting	Northing				
7	1953623	5790330	100	Face	30	343
17	1953429	5787725	140	Gully	30	200
23	1954185	5789712	60	Face	17	170
25	1953454	5789504	120	Face	30	120
33	1953885	5789490	110	Face	35	250
35	1953906	5789725	130	Face	35	195
37	1953951	5789207	100	Face	30	130
39	1953752	5789731	110	Face	20	330
55	1954378	5788432	60	Face	35	110
67	1953292	5787953	190	Face	5	170
69	1953281	5788447	40	Ridge	25	55
73	1954801	5789551	110	Gully	15	220

SITE PHOTOGRAPHS

Plate 1: Measuring tapes laid out to demarcate Plot 73. Subdividing the plots in this way makes remeasurement more efficient. 24 July 2018.

Plate 2: A fallen pōhutukawa in Plot 23. The lower basal area recorded for all tree species in 2018 was primarily due to the death of this tree. 5 July 2018.

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