Baseline Bird Monitoring for the Aongatete Forest Project

BAY OF PLENTY REGIONAL COUNCIL TOI MOANA

For the Bay of Plenty Regional Council

August 2023

REPORT INFORMATION AND QUALITY CONTROL

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Document Name	R_12806_Kaimai Bird Monitoring_V1.0 with community data

Version History:	V1.0–Draft for Client Review	14 April 2023
	V1.0 – Community data added	16 August 2023

CONTENTS Page

List of Tables

List of Figures

List of Appendices

1 INTRODUCTION

1.1 Background

The Aongatete Forest Project was initiated in 2006 by the Tauranga branch of Forest and Bird as well as the Katikati Rotary Club, with support from Ngai Tamawhariua, volunteers and landowners. The primary objective of the project is to restore the abundance of native wildlife to a 500 ha section of the Kaimai Mamaku Conservation Park and demonstrate the positive impacts of pest control (and the difficulty of ground based control) to better inform wider-scale pest control in the Kaimai Mamaku Conservation Park. This is being undertaken through the implementation of intensive pest control measures targeting rats, possums and mustelids (Forest and Bird, 2018).

The Bay of Plenty Regional Council (BOPRC) provides funding to the Aongatete Forest Project through an Environmental Programme which includes a bird monitoring component. The monitoring areas are in the vicinity of Aongatete, approximately 15 - 25 km northeast of Tauranga, within the Western Bay of Plenty District and Bay of Plenty Region. A map showing the locality of the monitoring areas is provided in Figure 1, below. The two areas used as the control were treated as one site throughout the analysis. The control area at Aongatete and the layout of the pest control devices is shown in Figure 2.

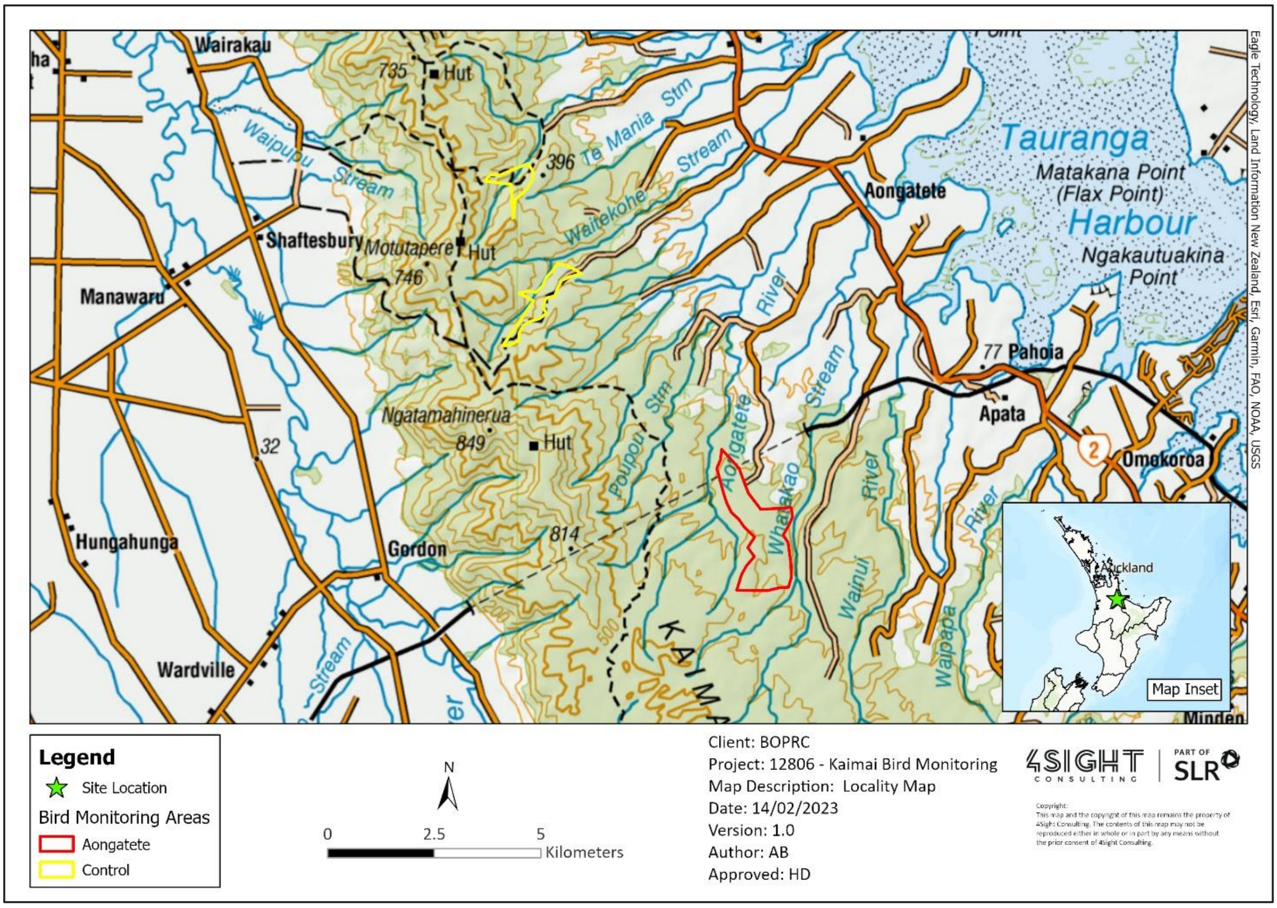


Figure 1: Locality map for the bird monitoring areas.

While volunteers have been undertaking bird counts at 10 stations on the long loop track for a number of years, this is the first occasion that monitoring of this scale has been undertaken for the project. The data collected will provide the baseline data for monitoring going forward and will assist stakeholders in gauging the potential successes or shortcomings of the pest management initiatives.

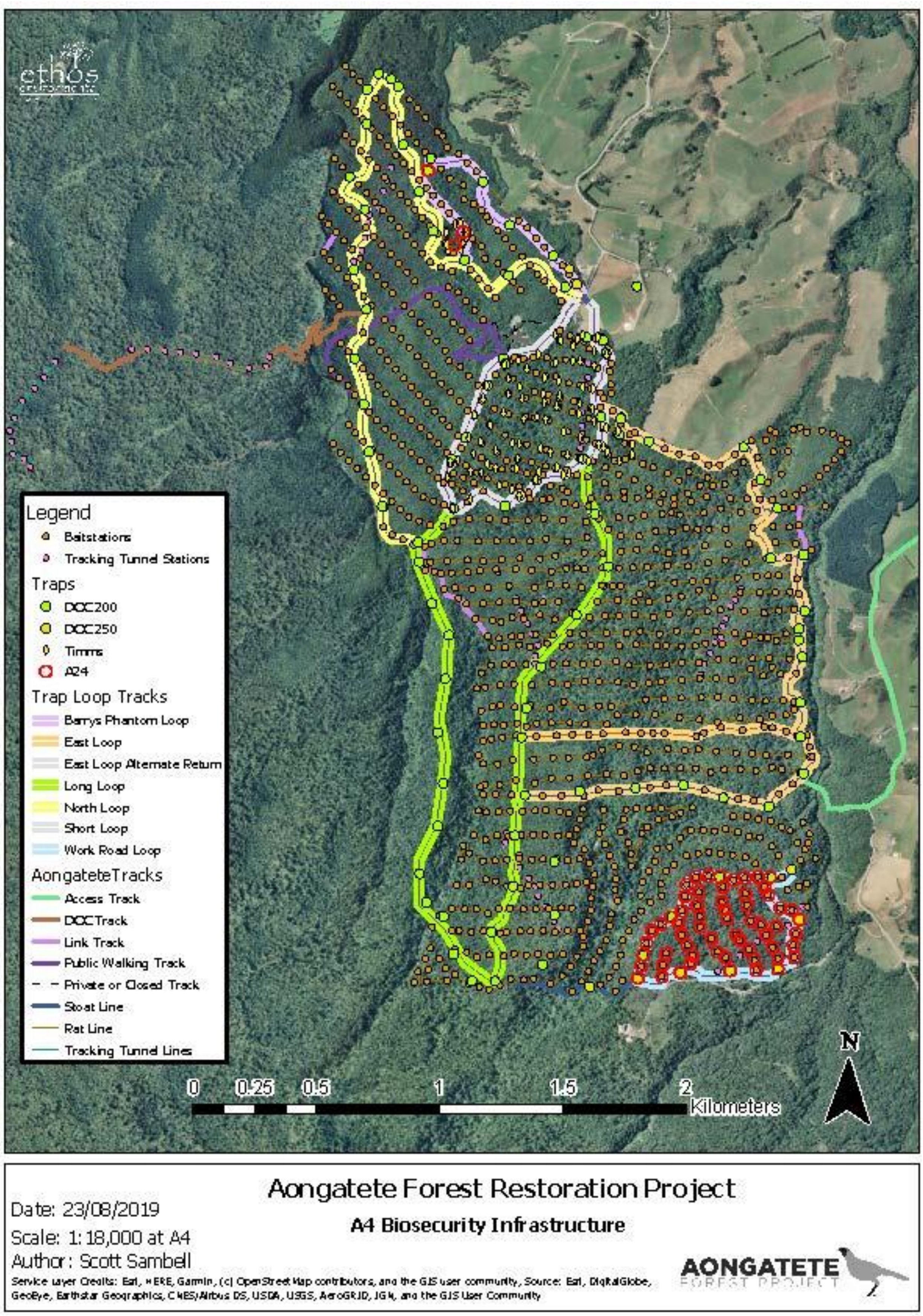


Figure 2: Pest control operational area at Aongatete.

1.2 Report purpose

The purpose of this report is to provide an assessment of the relative abundance and diversity of forest birds in the Aongatete Forest, through comparisons to nearby non-treatment areas, in order to assess outcomes of animal pest control. The birds were surveyed using five-minute bird counts (5MBC) along pest control lines throughout the Aongatete forest and public walking tracks in two control sites (Eliza Mine / Thompsons Tracks and Tuahu / Sentinel Rock Tracks).

Maps depicting the tracks and monitoring sites are provided in Appendix A.

1.3 Site description

The Aongatete Forest site is located within the Kaimai Mamaku Conservation Park, and comprises predominantly forest mapped as WF13; tawa (*Beilschmiedia tawa*), kohekohe (*Dysoxylum spectabile*), rewarewa (*Knightia excelsa*), hinau (*Elaeocarpus dentatus*) podocarp forest, with a small area of MF20; hard beech forest (Singers and Rogers, 2014). The non-treatment site is located approximately 5 km to the northwest of Aongatete and is mapped as WF13. Although most these areas are mapped as WF13, there is considerable variation in the vegetation resulting from local landform, aspect, and disturbance history. The Aongatete site comprises rolling terrain, with steep gullies in the Whatakao catchment in the eastern part of the site, and is situated between 160 m and 320 m elevation. The control sites are generally steeper and cover a wider altitudinal range from 180 m to 500 m above sea level. Both sites are within the semi-coastal and lowland bioclimatic zones.

The Aongatete Forest site is located within the Otanewainuku Ecological District (ED), whilst the two control sites are within the Te Aroha ED. Forest habitat within the Otanewainuku ED is dominated by podocarp-hardwood species including rimu, tawa, kamahi and tawari (*Ixerba brexioides*) whilst the Te Aroha ED comprises variable podocarp-hardwood forest types with the most southern extensive stands of kauri (*Agathis australis*).

Figure 3: Aongatete forest with the Te Hanga Ridge beyond.

2 METHODOLOGY

2.1 Sampling

A total of fifty bird count stations were set up in the Aongatete project area and a similar number in the control non-treatment) area. For Aongatete, stations were located at existing bait stations, while the stations within the non-treatment area were located at set distances along the walking tracks.

For Aongatete, a 100m buffer inside the project boundary was drawn in ArcGIS Pro and no bird count stations were placed within this area. A 200m buffer was then drawn on all bait stations in the GIS layer provided. Points representing bird count stations were then placed systematically, starting in the southwest corner of the site at the first bait station point outside the 100m internal buffer. Each station was visually placed so that the maximum number of points possible could be placed within the project area, while maintaining 200m distance from any other point. Each of the 67 resulting points were then given a random number using the random function in the ArcGIS field calculator and the smallest 50 values were selected as the final bird count locations. This resulted in 50 stations with good spread across the whole project area.

For the control sites the approach was simpler. Because the available area of WF13 forest was relatively limited and it was desirable to utilise walking tracks for practicality, the first point on each of the walking tracks was placed subjectively just within the WF13 boundary in the case of the Tuahu Track, and just off the road end in the case of Thompsons Track. A 200m buffer was then placed around this first point and the next point was placed just beyond the 200m buffer, further along the track. This process was repeated until all the available track within the WF13 type was used. This process resulted in 41 stations.

Station locations and relevant base map information were published to ArcGIS Field Maps for use in the field. For the Aongatete site, the observers walked by the shortest route to the bait station which was used as a bird count station whereas in the control area Field Maps was used to navigate to the location of the bird count station, within +/- 5m. Stations in the control sites were not physically marked, and it is intended that when re-measured the same process of navigating to the point using GPS will be used.

2.2 Bird counts

Two five-minute bird counts were conducted at each station between November 8th and December 6th 2022, one in the morning and one in the afternoon of a different day, and each station was visited once by each of two observers. For example, if a station was visited by one observer in the morning of one day, the second count was conducted by the other observer on the afternoon of a different day. We planned each day so that each observer would start their day at the station that the other observer had finished just before midday the previous day. This way, we reduced the chance that a station would be measured twice in the middle period of the day when there is typically less bird call activity. No counts were undertaken within 1.5 hours after sunrise, or 1.5 hours before sunset and counts were not conducted in heavy rain or strong wind.

The counts were conducted in line with the original methodology published by Dawson and Bull (1975), where all birds seen or heard over a five-minute period were recorded, however birds were recorded within distance bands (<25 m, 25–100 m, and >100 m) consistent with Department of Conservation Tier 1 methods (DOC 2019).

Care was taken not to record individual birds twice, although this cannot be categorically discounted given the density of forest cover and the general mobility of birds.

Data recorded in the field sheets included:

- The date, time, monitoring station identification value and observer name;
- current site / weather conditions (minutes of bright sun, broad temperature range, wind speed according to a modified Beaufort scale, ancillary noise as well as the characteristics of precipitation);
- Bird species;
- Whether the bird was sighted or heard; and
- Approximate distance of bird sighting / call from monitoring point.

An example of a raw data sheet utilised during the site assessment has been provided in Appendix B.

2.3 Community data

In this second version of this report, community-collected bird and pest data was included and analysed alongside the 2022 survey data. Data was obtained from Warwick Buckman, who manages an annual bird count in the Kaimai Mamaku Conservation Park and adjacent areas as well as from the Aongatete Forest Project.

2.3.1 Community bird data

Data has been collected by volunteers from up to 10 stations on the Long Loop Track at Aongatete and from up to 10 stations on the Tuahu Track (in the control site)since 2009. This survey is once per year, each station is only measured once, and the survey follows the standard 5MBC methodology. Data was obtained for 2009 – 2014, and 2018 – 2022 for both sites, although 2022 data was excluded in favour of the data from the current study.

2.3.2 Community pest data

Data from pest animal monitoring was obtained from the Aongatete Forest Project. This comprised limited data from 2010 and 2016, and a more complete dataset from 2018 – 2020. Data included rat and possum indexes derived from tracking tunnel monitoring before and after toxin operations.

2.4 Data analysis

For this analysis the near, far, very far, seen and heard observations were combined to give a species total for each count. The average number of birds of each species at each station was calculated from the two 5MBC (e.g., if 1 tui was counted in the morning and none in the evening, the average bird count at that station is 0.5), and these data were used for all further analysis.

T-tests were used to test statistical significance, and analysis using station means (comparison of counts per area for all, native, and key species) were conducted using non-transformed data. The raw data were approximately normally distributed data, whereas square root or $\log_{10}$ transformed data were not. An alternative approach using Poisson regression (which is suitable for count data) or, in this case, quasi-Poisson regression due to high variance in the data, was also run on all tests and always agreed with the t-test results. Non-transformed and transformed data were both used and results generally were similar.

Variables assessed included grouped abundance data, grouped species richness, native bird abundance, bird species diversity, indicator bird species observations per site as well as bird community distribution between Aongatete and nearby control sites.

Nonmetric Multidimensional Scaling (NMDS), using Bray-Curtis dissimilarity was conducted to visualise the dissimilarities of bird species composition within each of the assessed areas. Both square root transformed and non-transformed data was used in this analysis but the results were very similar (both NMDS stress and PERMANOVA) so non-transformed data is reported here.

Long-term trend analysis was conducted on all birds, native-only and exotic-only for both the project site and the non-treatment area using the Mann-Kendall Trend Test.

All data analysis was done using R (R Development Core Team 2013).

3 RESULTS

Sections 3.1 to 3.4 present data from the current 2022 survey while Section 3.5 presents community bird and pest data.

3.1 Observed Species

A total of 33 bird species were recorded during the current study, comprising 15 Introduced & Naturalised species, 15 Not Threatened native species, one At Risk - Recovering native species and two At Risk - Declining native species (see Table 1, below).

Table 1: Bird records from the monitoring sites.

No.	Common Name	Scientific Name	Threat Status (Robertson *et al.* 2021)	Monitoring Site		
				Pest Management	No Pest Management (Control)	
				Aongatete	Eliza Mine / Thompsons Tracks	Tuahu / Sentinel Rock Tracks
1	Australian magpie | Makipai	*Gymnorhina tibicen*	Introduced: Naturalised	X		
2	Bellbird | Korimako	*Anthornis melanura melanura*	Not Threatened	X	X	X
3	California quail | Tikaokao	*Callipepla californica*	Introduced: Naturalised	X		
4	Chaffinch | Pahirini	*Fringilla coelebs gengleri*	Introduced: Naturalised	X	X	X
5	Common myna | Maina	*Acridotheres tristis tristis*	Introduced: Naturalised	X		
6	Domestic hen	*Gallus gallus domesticus*	N/A	X		
7	Dunnock	*Prunella modularis*	Introduced: Naturalised	X	X	
8	Eastern rosella | Kākā uhi whero	*Platycercus eximius*	Introduced: Naturalised	X	X	X
9	Eurasian blackbird | Manu pango	*Turdus merula merula*	Introduced: Naturalised	X	X	X
10	Eurasian skylark | Kairaka	*Alauda arvensis*	Introduced: Naturalised	X		
11	European goldfinch | Kōurarini	*Carduelis carduelis britannica*	Introduced: Naturalised	X		X
12	European greenfinch	*Chloris chloris*	Introduced: Naturalised	X	X	X
13	Grey warbler | Riroriro	*Gerygone igata*	Not Threatened	X	X	X
14	Kākā | Kaka	*Nestor meridionalis*	At Risk: Recovering		X	
15	New Zealand fantail | Pīwakawaka	*Rhipidura fuliginosa placabilis*	Not Threatened	X	X	X
16	New Zealand pigeon | Kererū	*Hemiphaga novaeseelandiae*	Not Threatened	X	X	X
17	North Island robin | Toutouwai	*Petroica longipes*	At Risk: Declining	X	X	X
18	Paradise shelduck | Pūtangitangi	*Tadorna variegata*	Not Threatened	X	X	X
19	Peafowl | Pīkao	*Pavo cristatus*	Introduced: Naturalised	X		
20	Rifleman | Tītitipounamu	*Acanthisitta chloris granti*	At Risk: Declining	X	X	X

No.	Common Name	Scientific Name	Threat Status (Robertson *et al.* 2021)	Monitoring Site		
				Pest Management	No Pest Management (Control)	
				Aongatete	Eliza Mine / Thompsons Tracks	Tuahu / Sentinel Rock Tracks
21	Ring-necked pheasant	*Phasianus colchicus torquatus*	Introduced: Naturalised	X		X
22	Ruru | Morepork	*Ninox novaeseelandiae novaeseelandiae*	Not Threatened	X		
23	Sacred kingfisher | Kōtare	*Todiramphus sanctus vagans*	Not Threatened	X	X	X
24	Shining cuckoo | Pīpīwharauroa	*Chrysococcyx lucidus*	Not Threatened	X	X	X
25	Silvereye	*Zosterops lateralis lateralis*	Not Threatened	X	X	X
26	Song thrush | Manu-kai-hua-rakau	*Turdus philomelos clarkei*	Introduced: Naturalised	X		X
27	Spur-winged plover	*Vanellus miles novaehollandiae*	Not Threatened	X		
28	Swamp harrier | Kāhu	*Circus approximans*	Not Threatened	X		X
29	Tomtit | Miromiro	*Petroica macrocephala toitoi*	Not Threatened	X	X	X
30	Tūī	*Prosthemadera novaeseelandiae novaeseelandiae*	Not Threatened	X	X	X
31	Welcome swallow | Warou	*Hirundo neoxena neoxena*	Not Threatened			X
32	Whitehead | Pōpokotea	*Mohoua albicilla*	Not Threatened	X		X
33	Yellowhammer | Hurukōwhai	*Emberiza citrinella caliginosa*	Introduced: Naturalised	X		

Figure 4: Titipounamu in the southern part of the Aongatete Forest Project.

3.2 Bird abundance

The average number of bird counts per station, by area (i.e. the mean abundance of two 5MBCs per station, averaged within each area), are shown in Figure 5, below. These results showed that riroriro, silvereye and tui were the most prevalent across the study sites with the highest mean counts per station being attributed to tui within Aongatete.

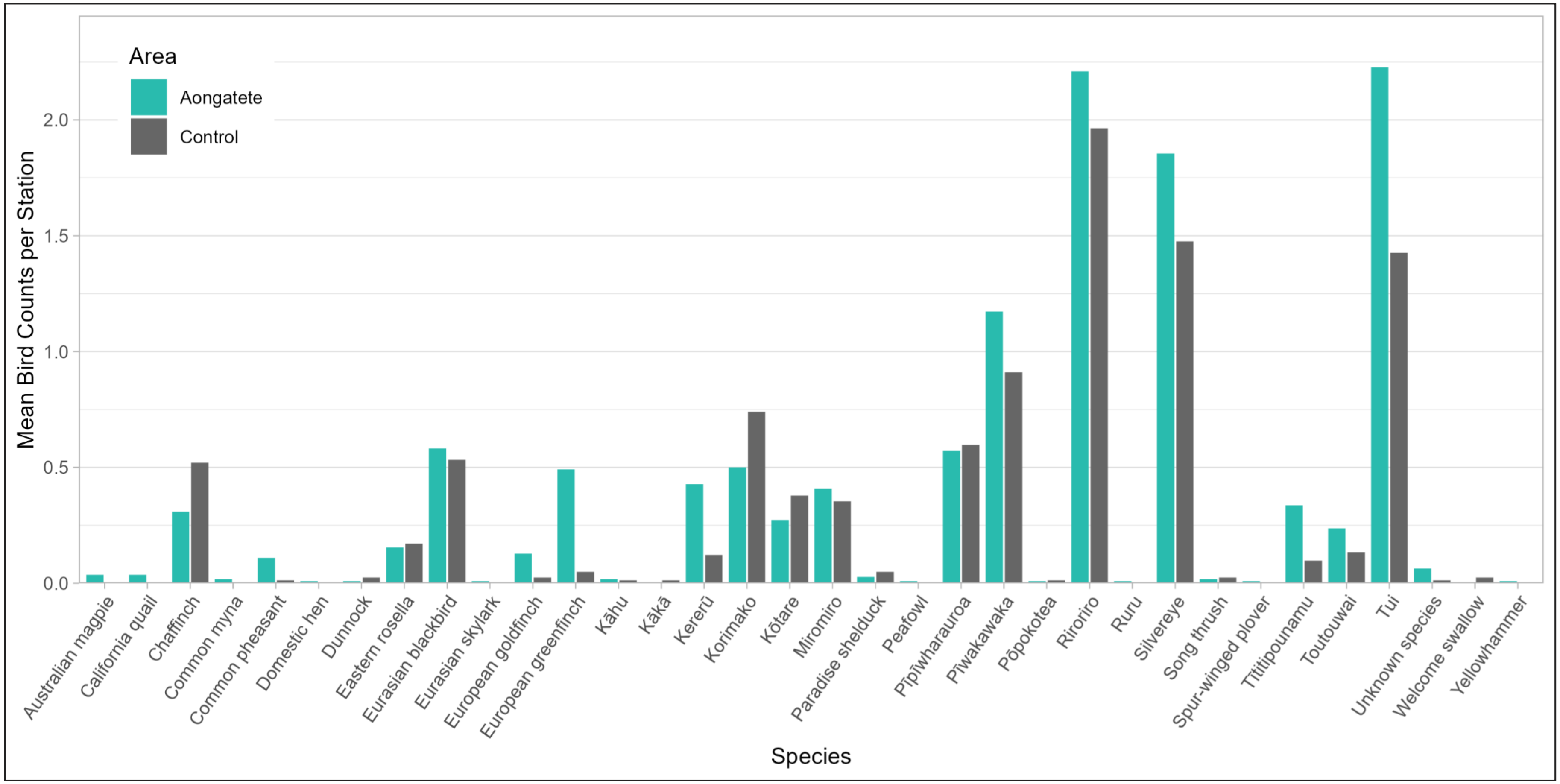


Figure 5: Mean number of bird counts per station within each monitoring area in 2022

Twenty-two species averaged higher counts per station at Aongatete (Table 2), but only seven of those differences were statistically significant: California quail, common pheasant, European goldfinch, European greenfinch, kererū, tui and titipounamu.

Table 2: Mean bird counts per station in each area shown visually in Figure 1. Statistically significant differences are highlighted in teal (t-test; p value < 0.05).

Species	Aongatete	Control	P-value
Australian magpie	0.04	0.00	0.103
California quail	0.04	0.00	0.044
Chaffinch	0.31	0.52	0.104
Common myna	0.02	0.00	0.159
Common pheasant	0.11	0.01	0.039
Domestic hen	0.01	0.00	0.322
Dunnock	0.01	0.02	0.559
Eastern rosella	0.15	0.17	0.824
Eurasian blackbird	0.58	0.53	0.610
Eurasian skylark	0.01	0.00	0.322
European goldfinch	0.13	0.02	0.035
European greenfinch	0.49	0.05	0.001
Kererū	0.43	0.12	0.000
Korimako	0.50	0.74	0.166
Kāhu	0.02	0.01	0.735
Kākā	0.00	0.01	0.323

Species	Aongatete	Control	P-value
Kōtare	0.27	0.38	0.200
Miromiro	0.41	0.35	0.587
Paradise shelduck	0.03	0.05	0.547
Peafowl	0.01	0.00	0.322
Pīpīwharauroa	0.57	0.60	0.854
Pīwakawaka	1.17	0.91	0.156
Pōpokotea	0.01	0.01	0.839
Riroriro	2.21	1.96	0.184
Ruru	0.01	0.00	0.322
Silvereye	1.85	1.48	0.139
Song thrush	0.02	0.02	0.822
Spur-winged plover	0.01	0.00	0.322
Toutouwai	0.24	0.13	0.138
Tui	2.23	1.43	0.001
Tītitipounamu	0.34	0.10	0.016
Unknown species	0.06	0.01	0.078
Welcome swallow	0.00	0.02	0.323
Yellowhammer	0.01	0.00	0.322

Comparisons of total bird counts per station (Figure 6), native bird counts per station (Figure 7), and non-native bird counts per station (Figure 8) show significantly more total birds, native birds, and non-native birds per station at Aongatete than in the control (non-treatment) areas. Total number of birds averaged 12.3 per station at Aongatete compared with 9.7 in the control sites (T-test: $t(94) = 3.15$, $p = 0.002$), whereas for native birds only, the mean was 8.4 birds per station at Aongatete compared with 6.9 in the control sites (T-test: $t(86) = 2.44$, $p = 0.02$). Non-native birds showed a slightly larger difference than native, with a mean of 4.5 birds per station at Aongatete compared with 2.8 birds per station in the control areas (T-test: $t(89) = 5.10$, $p < 0.001$). Quasi Poisson regression agreed in both cases ($p = 0.003$ for total counts, $p = 0.01$ for native birds, and $p=<0.001$ for non-native birds).

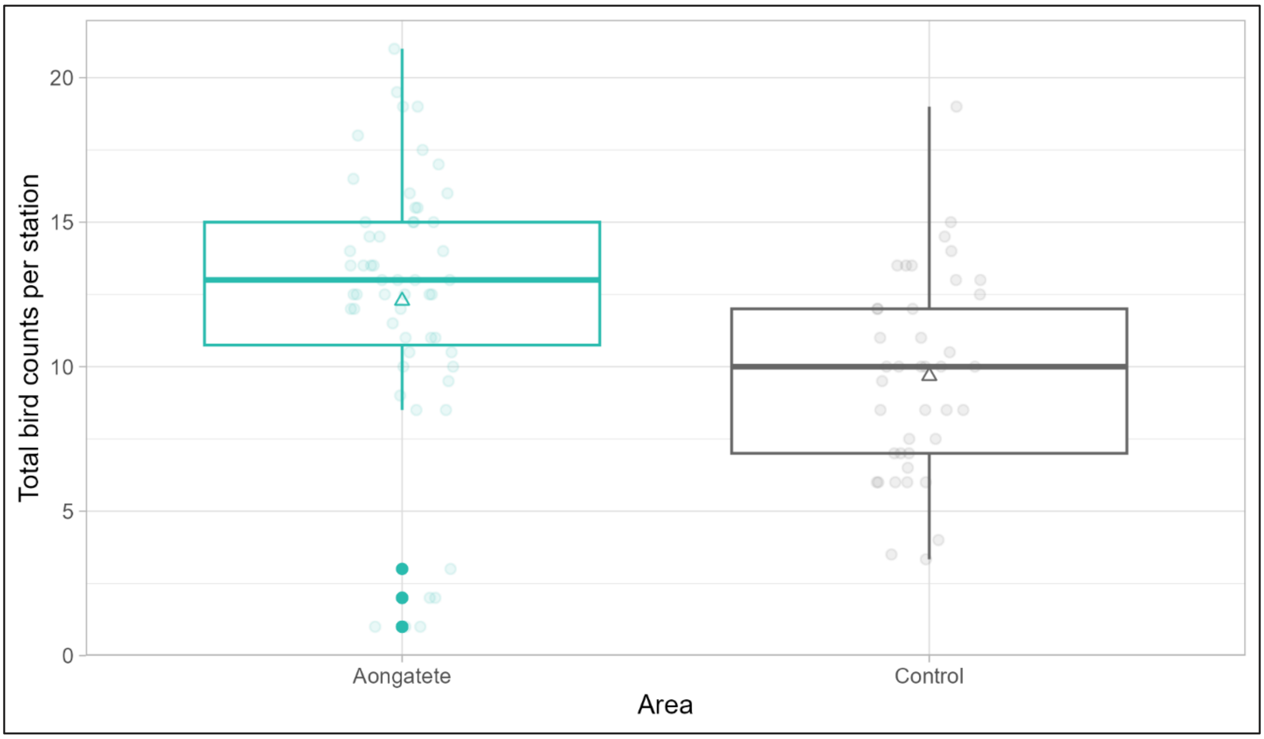


Figure 6: Boxplot summary of total bird counts per station in each area. The mean of the data is shown by a triangle. Individual data points are shown by the points overlying the boxplot and are spread to show overlapping points.

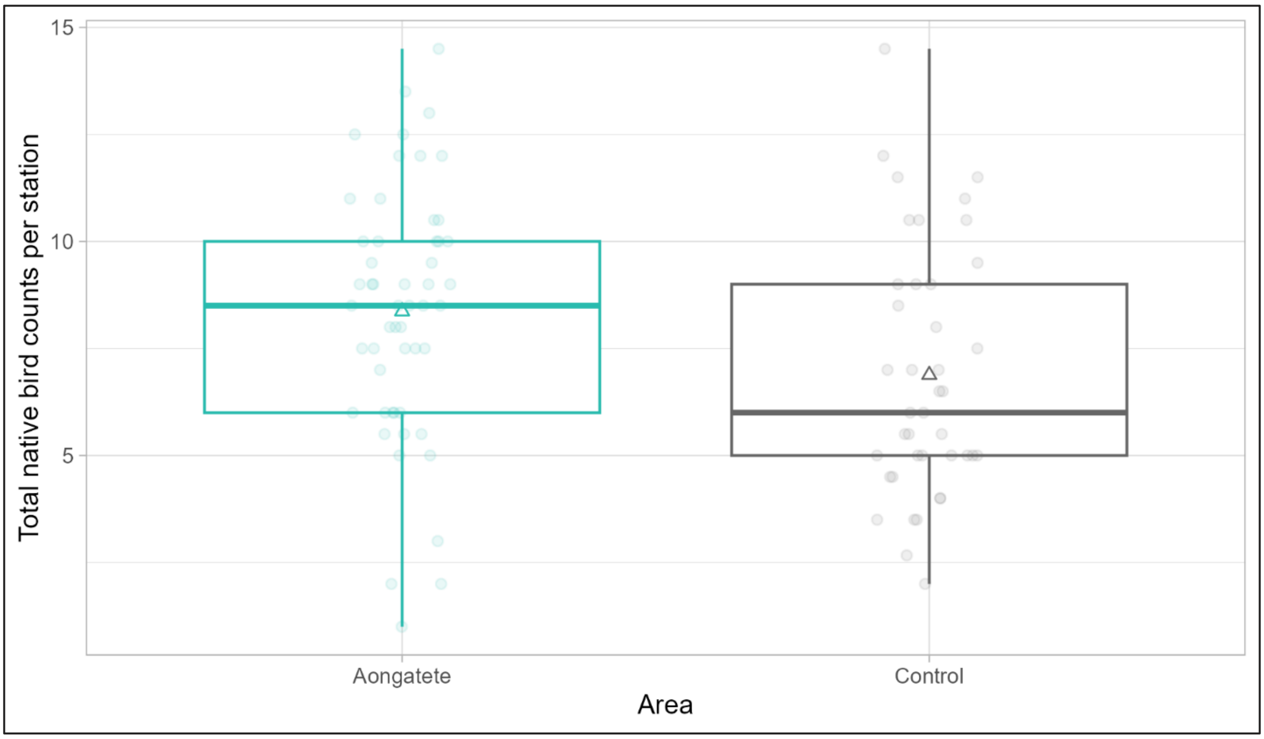


Figure 7: Boxplot summary of mean native bird counts per station in each area. The mean of the data is shown by a triangle. Individual data points are shown by the points overlying the boxplot and are spread to show overlapping points.

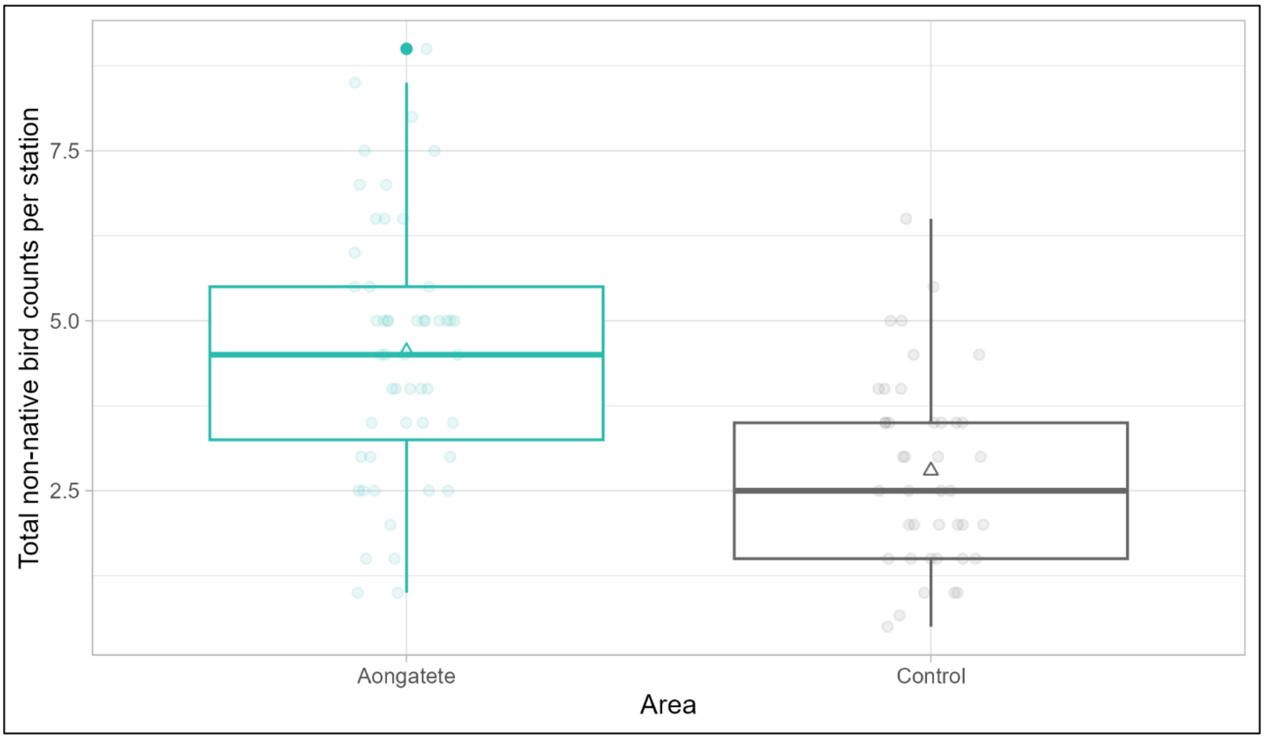


Figure 8: Boxplot summary of mean non-native bird counts per station in each area. The mean of the data is shown by a triangle. Individual data points are shown by the points overlying the boxplot and are spread to show overlapping points.

3.3 Species richness and diversity

Although species richness (Figure 9) was higher at Aongatete (9.04 bird species per station) compared to the control sites (8.0 bird species per station) the difference was not statistically significant (T-test: $t(86) = 1.84$, $p = 0.07$). Quasi Poisson regression on species richness was also not significant ($p = 0.09$).

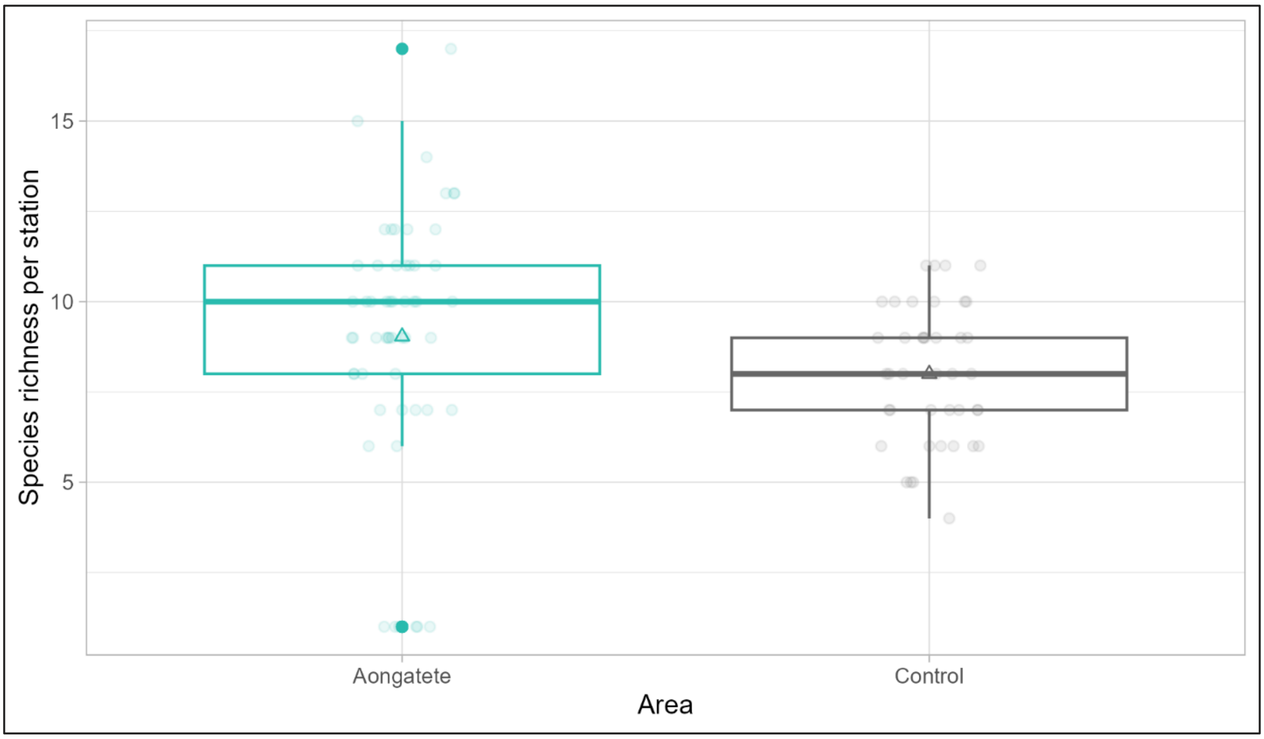


Figure 9: Species richness per station.

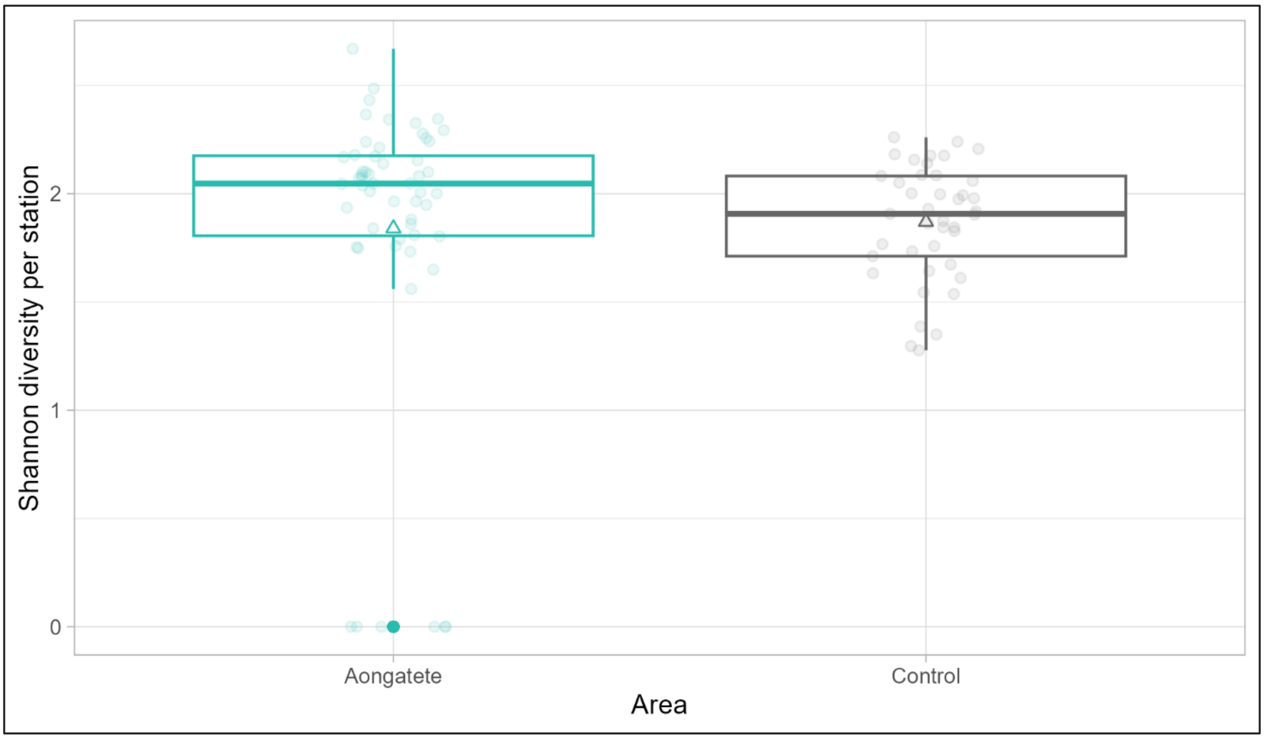


Figure 10: Shannon diversity index per station.

The results show no significant difference (T-test: t(74) = 0.30, p = 0.77) between Shannon diversity index at Aongatete (mean = 1.84) compared to the control sites (mean = 1.87)(Figure 10). Quasi Poisson regression on species diversity was also not significant (p = 0.79).

3.4 Community composition

The NMDS plot below (Figure 11) shows a representation of the community composition at each of the two sites. Although the two communities appear relatively closely aligned, Permutational Multivariate Analysis of Variance (PERMANOVA) determined that there was a statistically significant difference in the community composition between Aongatete and the control areas.

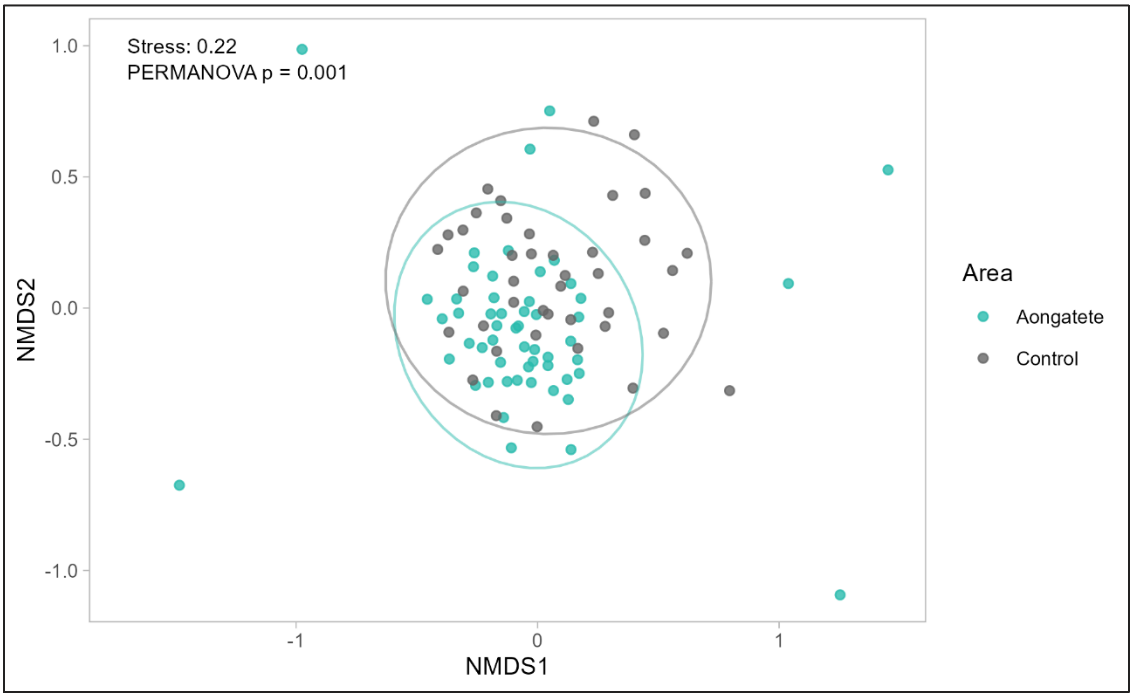


Figure 11: Nonmetric multidimensional (NMDS) scaling plot visualising the dissimilarity of the bird community composition measured during each survey in each of the monitoring areas.

3.5 Community Data

Figures 11,12, and 13 represent mean birds counted per station and area from 2009 to 2022. Aongatete had higher mean bird counts (all birds, Figure 12) than the non-treatment area for all years except 2010, with the differences in 2013 – 2021 being the most marked. Native birds (Figure 13) showed similar results except in 2009 when numbers were markedly lower and the difference between the two sites less obvious.

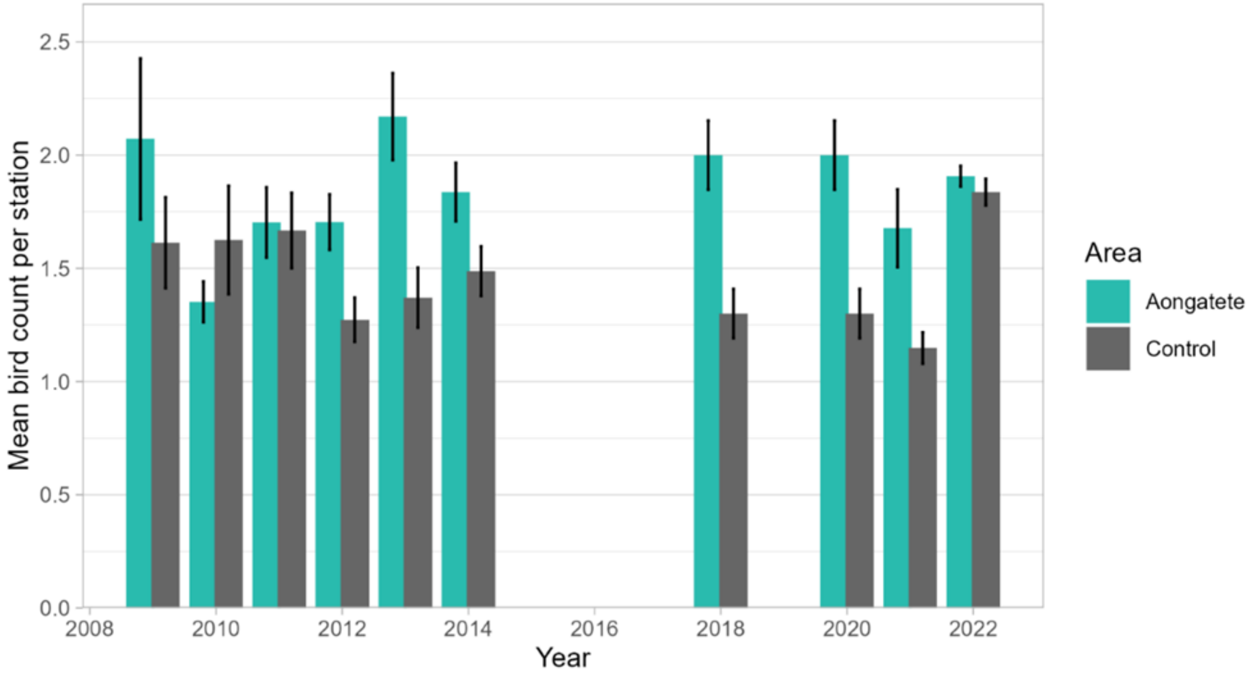


Figure 12: Mean birds per station and area from 2009 to 2022. Error bars show the standard error or the mean.

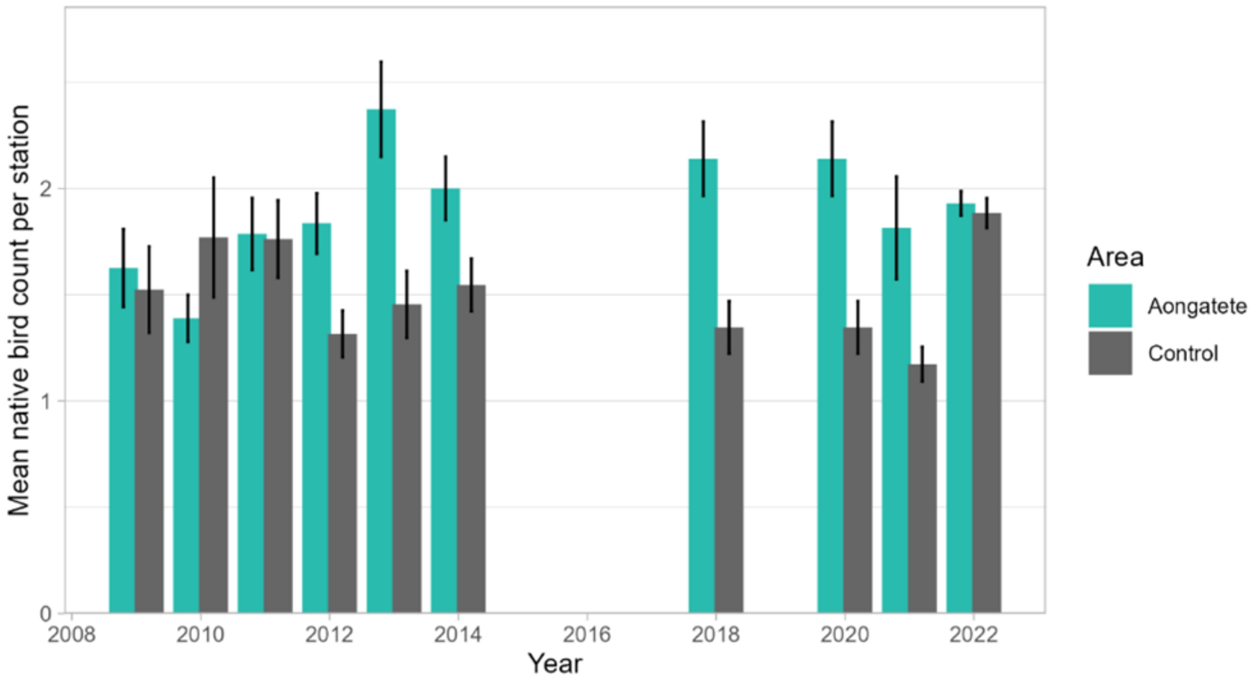


Figure 13: Mean native birds per station and area from 2009 to 2022. Error bars show the standard error or the mean.

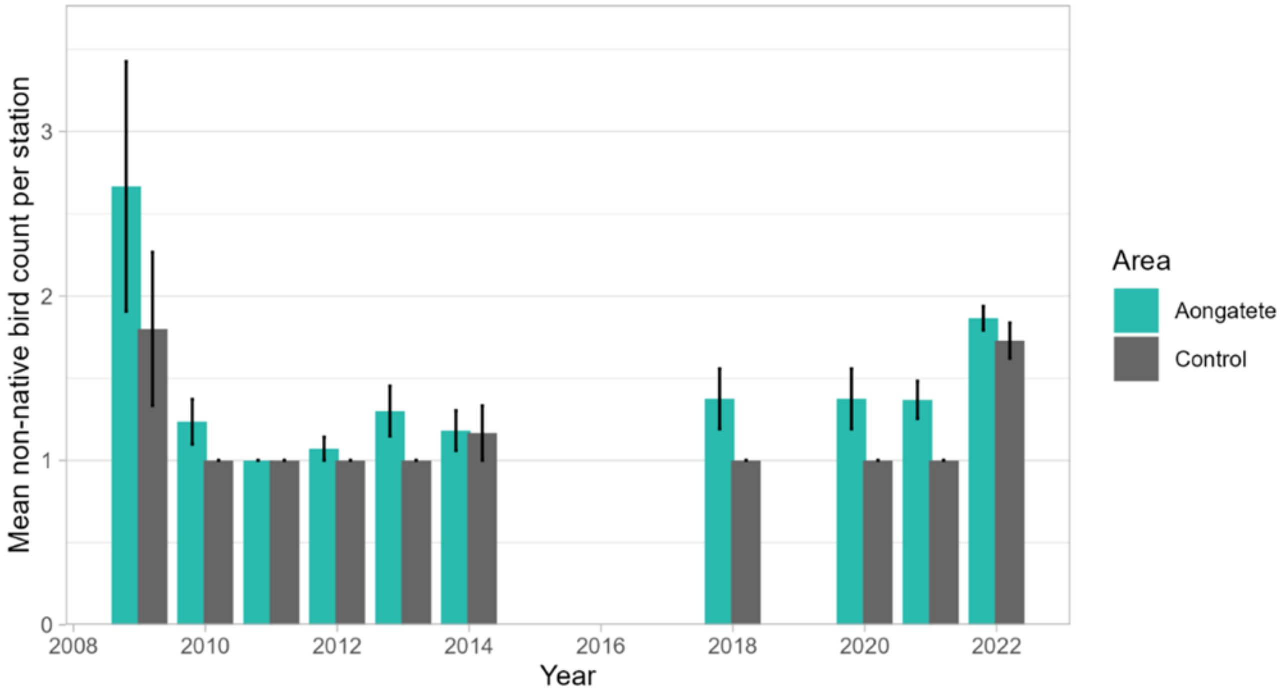


Figure 14: Mean non-native birds per station and area from 2009 to 2022. Error bars show the standard error or the mean.

Long-term trend analysis indicates that both native and non-native birds are likely or very likely to be increasing at Aongatete (Table 3) with native birds showing a 2.05% annual increase. In contrast, birds in general, and non-native birds are trending downwards at the control (non-treatment) site.

Table 3: Summary of long-term trend analysis (Mann Kendall) for mean bird counts per station (2009-2022).

Grouping	Area	Trend direction	% Annual change	Trend confidence
All birds	Aongatete	Increasing	0.47	As likely as not
	Control	Decreasing	-1.94	Likely
Native birds	Aongatete	Increasing	2.05	Very likely
	Control	Decreasing	-1.16	Likely
Non-native birds	Aongatete	Increasing	1.62	Likely
	Control	No trend	0	As likely as not

Pest animal monitoring data shows no clear trend but the ups and downs associated with pulsed toxin-based control operations are clearly seen in the data (Figure 14). Although this was not statistically tested there does not appear to be any relationship between the pest and bird data during this short period of time.

Figure 15: Top; mean bird count per station from 2018 to 2022 (data in 2022 collected by 4 Sight). Bottom; rat and possum pest index from 2018 to 2022.

4 DISCUSSION

The predation of avian nests has been identified as the primary factor for the observed reduction of forest bird abundance, as well as the continued risk to endemic bird extinction, throughout New Zealand (Innes *et al*. 2010; Innes *et al*. 2015). Animal pests, and particularly possums and rats, also compete with birds for food and impact on forest composition and health which in turn can impact food sources for birds. The comprehensive bird monitoring survey undertaken during this study was intended to detect any changes in bird abundance and population structure at Aongatete as a result of pest animal control. Pest monitoring data from the Aongatete Forest Project (Figure 14) shows that, although there is no clear long-term trend, pest control is effective at reducing rat and possum numbers and as the timing of these operations is designed to result in low pest numbers for the bird breeding season, they should be effective at protecting birds from predation.

This study utilised a control site in lieu of time-series data from the project area itself which although useful, does not provide definitive information on the effectiveness of the pest control so only broad inferences can be made. An annual bird count survey using the standard 5MBC method has been conducted throughout the Kaimai Range since at 2009 by Forest & Bird volunteers, which includes a series of 10 stations along the long loop track at Aongatete, and 10 sites on the Tuahu Track. The addition of this community-collected bird count data helps to enhance the picture, but data quality is limited and it does not include counts from before pest control was started. The 2022 survey data indicates a significant difference in bird abundance and community composition between the Aongatete site, which has been subjected to pest control since 2006, and nearby control sites where there has been no pest control. It is highly likely that targeted animal pest control initiatives have had a positive impact on local birds nesting and recruitment success, which is commensurate with similar studies globally and in New Zealand (e.g. Smith *et al.* 2010; Starling-Windhof *et al.* 2010, and; Innes *et al*. 2015), resulting in higher overall bird abundances within Aongatete.

Continual increases in native and non-native bird abundance are anticipated whilst predator control continues at Aongatete, especially as pest control has now been expanded further northwest as part of the Manaaki Kaimai Mamaku project. Native bird assemblages have been documented to recover more rapidly than introduced species as a result of pest control where it has been suggested that introduced birds are inherently more adaptive to non-native predation (e.g. Starling-Windhof *et al*. 2010). Accordingly, it is expected that native bird abundance will increase at a greater rate compared to introduced species and this is reflected in a minor way in the data when the community-collected counts are included, with a trend of 2.05% annual increase for native species and a 1.62% annual increase for non-native species.

The significantly higher abundance of native bird species within Aongatete compared to the control sites is a key finding for the project (see Figure 7), with kererū, tui and tītitipounamu (rifleman) exhibiting particularly encouraging numbers within the pest control area. The improved nesting success of birds including kererū and tui as a result of predator control, during known important nesting periods, has been documented in previous studies (e.g. Innes *et al*. 2015). Although native species abundance may be increasing at a greater rate, higher abundances of birds in general were observed within Aongatete compared to the control sites in the current survey (see Table 2), indicating favourable conditions for all birds and not necessarily just indigenous forest habitat specialists. Community data collected from the Aongatete Forest Project appears to be capturing similar results as seen in the data collected by 4Sight, with the data showing a general increase in both native and non-native birds in the predator control areas.

Species richness and diversity were not significantly different between the two sites, but the overall community composition was, likely because of the presence of a few less commonly encountered species at one site and not the other, rather than a significant improvement in the native species community at Aongatete. These less commonly recorded species were mostly species associated with nearby farmland at Aongatete, including Australian magpie, California quail, domestic hen, Eurasian skylark and peafowl for example.

While significant differences in abundance between Aongatete and the control sites, and a trend of increasing bird numbers at Aongatete were detected, 16 years of pest control could be expected to result in a greater difference in bird abundance, and specifically native bird abundance, and a plateauing of bird numbers as carrying capacity is reached. This lower magnitude of difference may be due to the fact that pest control at Aongatete has slowly evolved over time through expansion and changes in methods and intensity. When it first started in 2006 control was only done in a 140 ha area north of the Short Loop Track and the focus was rats. This then expanded further south to cover 250 ha in 2013, and then an additional 250 ha was added both north and south to cover the current extent. So, some parts of the site that were surveyed have had pest control for much less than 16 years.

In earlier years the methods used may have been less effective which could explain a slower than expected recovery. The current pest control regime includes toxin operations targeting rats and possums multiple times during the year, as well as trapping for possums, rats and mustelids in certain areas. This appears to be a comprehensive programme and rat tracking post-control has shown indexes of less than 5% which is a commonly adopted and general accepted target (e.g. Elliot & Kemp 2016).

Despite the controls put in place in the current survey to account for variation in bird detectability resulting from time of day, observer, and weather conditions, some variability still exists. Habitat heterogeneity between Aongatete and the control sites may have an influence on direct comparison of results, and the control sites had a higher number of sites that were subject to noise from streams which was not ideal. These sites could be dropped in future monitoring, especially if additional sites can be added. However, ongoing regular monitoring within Aongatete (as well as the control sites, if possible) will allow for thorough empirical comparisons and conclusions to be drawn relating to the successes or shortcomings of the predator control initiatives.

It is recommended that bird monitoring should continue every 2 – 3 years in order to comprehensively measure the response of the local bird population to pest control measures. Intermittent external environmental issues may cause unforeseen fluctuations of recorded data in a short period of monitoring whilst population dynamics of certain species such as bellbird, have been known to vary (e.g. GWRC, 2007).

5 SUMMARY

This study sought to quantify differences in bird communities between the Aongatete Forest Project area and a control site about 5 km to the north along the Kaimai Range, with the intention of assessing the effectiveness of predator control on bird populations. With the later addition of the community bird count data an additional goal was to detect any trends in bird abundance over time.

At Aongatete, 50 bird count stations were established and a further 41 were established in the control area; each were measured twice. Community bird data comprised counts conducted by volunteers at 10 stations on the Long Loop Track at Aongatete and 10 stations on the Tuahu Track (in the control site) from 2009 to 2021. Pest animal monitoring data from the Aongatete Forest Project was also included.

Results showed significantly higher counts of seven bird species in Aongatete which notably included kererū, tui, and titipounamu. Comparisons of total bird counts showed that Aongatete had significantly higher numbers, indicating higher bird abundance overall as well as higher native bird abundance. Multivariate analysis showed a significant difference in the bird community composition although this may be largely attributable to a low number of occurrences of exotic open country species at the Aongatete site that were not recorded at the control site.

Addition of the community-collected bird count data allowed detection of trends of increasing bird abundance at Aongatete and a decline at the control site.

Although the apparent higher abundance of birds in the Aongatete project area cannot be definitively linked to the pest control work through this survey, it is highly likely that 16 years of pest animal control has played an important part in the higher overall bird count numbers at Aongatete than were found in similar forest with no pest control.

6 REFERENCES

Dawson, D. G., and Bull, P. C. 1975. Counting Birds in New Zealand Forests. Notornis, 22:101 – 109.

DOC 2019. Field protocols for Tier 1 monitoring - invasive mammal, bird, bat, RECCE surveys. Version 14. Department of Conservation, Wellington.

Ebird. 2023. Observations for the Northern Kaimai Mamaku Forest Park: 2014-2023. Available at https://ebird.org/newzealand/region/NZ-BOP?yr=all Accessed 15th February 2023.

Elliott, G., Kemp, J. 2016. Large-scale pest control in New Zealand beech forests. Ecological Management and Restoration 17, 200–9.

Forest and Bird. 2018. Aongatete Forest Project. Available at: https://www.forestandbird.org.nz/projects/aongatete-forest-project Accessed: 15th February 2023.

GWRC (Greater Wellington Regional Council). 2007. Native Bird Monitoring: Regional Report. Report compiled by Sara Moylan and Murray Hudson - Monitoring and Investigations. August 2007.

Innes, J., Kelly, D., Overton, J.Mc.C., Gillies, C. 2010. Predation and other factors currently limiting New Zealand forest birds. New Zealand Journal of Ecology 34: 86–114.

Innes, J., King, C., Bartlam, S., Forrester, G., & Howitt, R. 2015. Predator control improves nesting success in Waikato forest fragments. New Zealand Journal of Ecology, 39(2): 245-253.

PRIMER-E. 2008. PERMANOVA and PRIMER 6. PRIMER-E, Lutton, Ivybridge.

R Development Core Team. 2013. R 3.0.1. R Development Core Team, Vienna, Austria. ISBN 3-900051-07-0.

Robertson, H.A., Baird, K.A., Elliott, G.P., Hitchmough, R.A., McArthur, N.J., Makan, T.D., Miskelly, C.M., O'Donnell, C.F.J., Sagar, P.M., Scofield, R.P., Taylor, G.A., Michel, P. 2021: Conservation status of birds in Aotearoa New Zealand, 2021 . New Zealand Threat Classification Series 36. Department of Conservation, Wellington. 43 p.

Singers, N.J.D. 2014. A potential ecosystem map of the Bay of Plenty Region: Explanatory information to accompany the map. Prepared for the Bay of Plenty Region. Nicholas Singers Ecological Solutions August 2014, Contract report number 16/2014-2015.

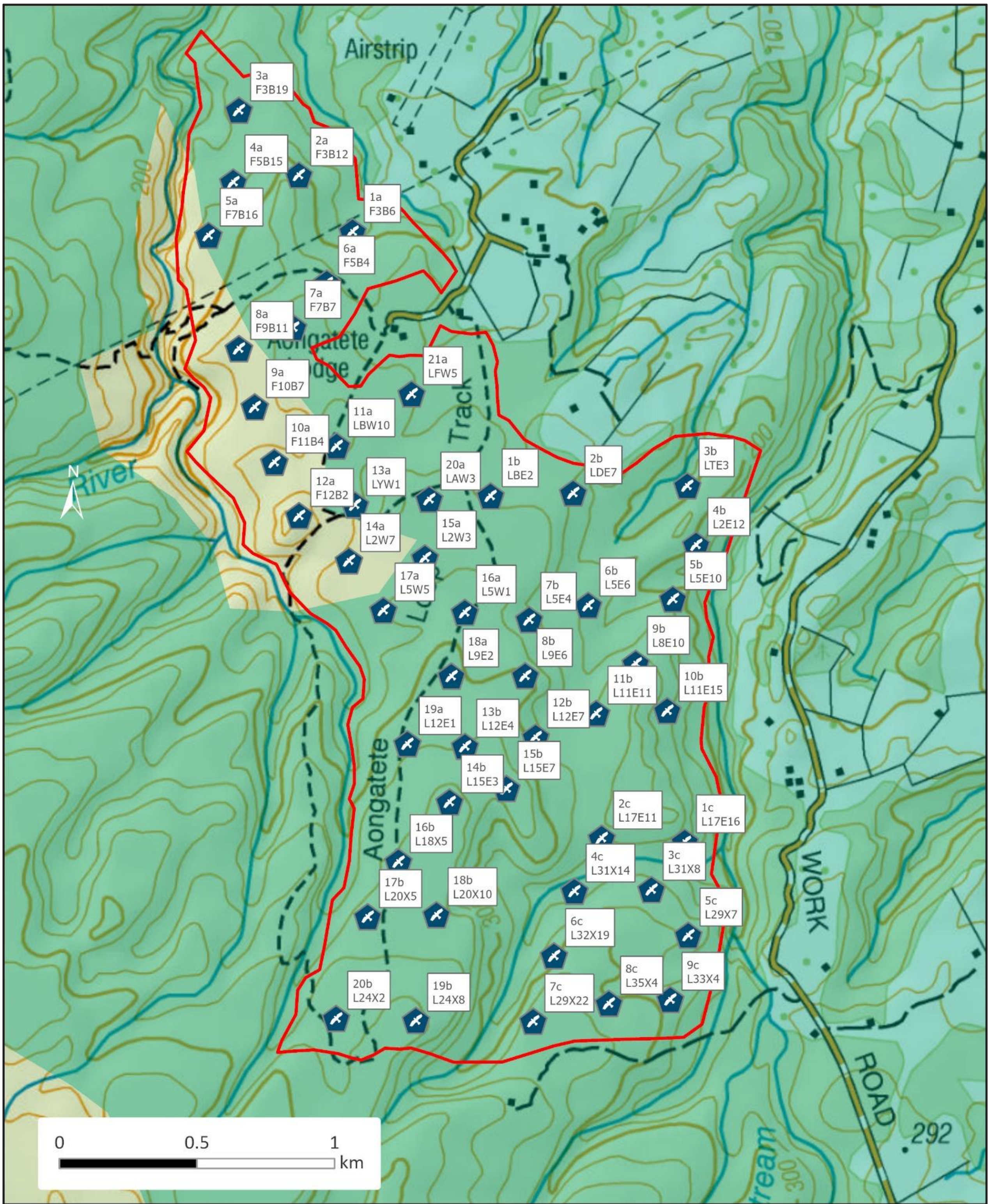
Singers, N.J.D.; Rogers, G.M. 2014: A classification of New Zealand's terrestrial ecosystems. Science for Conservation 325. Department of Conservation, Wellington. 87 p.

Smith, R. K., Pullin, A. S., Stewart, G. B., Sutherland, W. J. 2010. Effectiveness of predator removal for enhancing bird populations. Conservation Biology, 24(3): 820-829.

Starling-Windhof, A., Massaro, M., & Briskie, J. V. (2011). Differential effects of exotic predator-control on nest success of native and introduced birds in New Zealand. Biological Invasions, 13: 1021-1028.

Appendix A:

Aongatete Forest and Control Areas Maps



Legend

Bird Count Stations

Aongatete Project Area

WF13

Client: BOPRC

Project: Aongatete Bird Monitoring

Map Description: Aongatete Project stations

Date: 14/04/2023

Version: 1.0

Author: HD

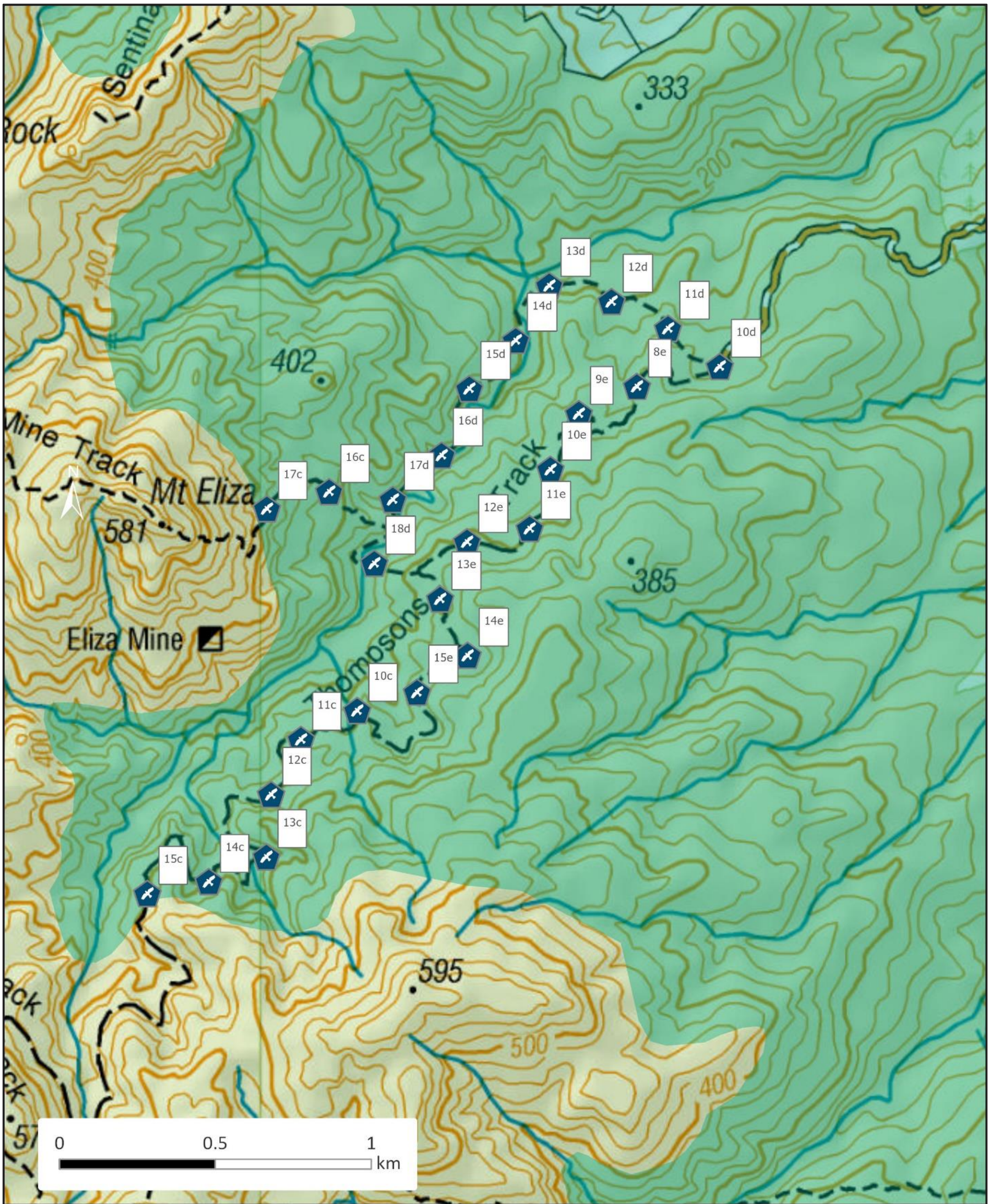
Approved: PW

Legend

Bird Count Stations

WF13

Client: BOPRC
Project: Aongatete Bird Monitoring
Map Description: Tuaha Track stations
Date: 14/04/2023
Version: 1.0
Author: HD
Approved: PW



Legend

Bird Count Stations

WF13

Client: BOPRC
Project: Aongatete Bird Monitoring
Map Description: Thompsons Track stations
Date: 14/04/2023
Version: 1.0
Author: HD
Approved: PW

Appendix B:

Raw Bird Monitoring Data Sheet

5MBC Data Record Sheet **Project:** 13014 - Aongatete bird monitoring

Date: **Time:** **Conditions:** **Date:** **Time:** **Conditions:**

Station: **Observers:** **Station:** **Observers:**

	Near (0-25m)		Far (21 – 100m)		Very far (>100m)		Near (0-25m)		Far (21 – 100m)		Very far (>100m)	
Species	Seen	Heard	Seen	Heard	Heard	Seen	Heard	Seen	Seen	Heard	Seen	Heard

*Record species even if bird is observed at a new station. E.g bird recorded at previous site flies into new station area.
**Record any incidental sightings within the sampling area
*** Record any threatened / note worthy species outside sampling area
**** If species or distance is unknown record as 'UNK sp. / dis'

5MBC Data Record Sheet **Project:** 13014 - Aongatete bird monitoring

Station:		
Temp:		
Wind:		
Other noise:		
Sun:		
Precipitation type:		
Precipitation type:		
Other comments:		

Sun (0-5) Record approximate duration, in minutes, of bright sun on the canopy immediately overhead		*Seen and Heard* Birds that are first heard should be entered under **H** (even if they are later seen), birds that are first seen should be entered under **S**. Adding H and S should give the total number of birds observed		
Time 24 hour clock, at the beginning of each count		*Unbounded* Counts are unbounded		
Temperature **1** freezing < 0°C **2** cold 0-5 °C 3 cool 6-10 °C **4** mild 11-15 °C 5 warm 16-22 °C 6 hot > 22 °C	*Wind* The average for each five-minute count on a modified Beaufort scale: **0** Leaves still or move without noise (Beaufort 0 and 1) **1** Leaves rustle (Beaufort 2) **2** Leaves and branches in constant motion (Beaufort 3 and 4) 3 Branches or trees sway (Beaufort 5, 6 and 7)	*Other Noise* i.e. Other than wind the average for the five minutes **0** not important **1** moderate **2** loud	*Precipitation type* Average for each count N None M Mist R Rain H Hail S Snow	*Precipitation value* 0 None 1 Dripping foliage 2 Drizzle 3 Light 4 Moderate 5 Heavy

*Record species even if bird is observed at a new station. E.g bird recorded at previous site flies into new station area.
**Record any incidental sightings within the sampling area
*** Record any threatened / note worthy species outside sampling area
**** If species or distance is unknown record as 'UNK sp. / dis'

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