Aotea Bird Count

Results from the December 2021 Survey

Prepared by George Perry, July 2022

Aotea Great Barrier Environmental Trust
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Acknowledgements

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Front cover: *Kākā at Fitzroy* (Stuart Farquhar)

Summary

This report presents an analysis of the Aotea Bird Count (ABC) data collected in 2021, the third iteration of this project. The bird count is organised by the Aotea Great Barrier Environmental Trust, Auckland Council and the sanctuaries located on Aotea, and is carried out by community volunteers. The objective of the ABC is to establish longitudinal monitoring of species abundances in response to management interventions and pressures. The ABC employs a standard five-minute bird count method, following a technique widely employed in New Zealand. In this report, the analysis of the bird count data focus on:

- Island-wide species abundances.
- Site-level species abundance, richness and diversity.
- Site-level abundances of four key target species (kākāriki, kākā, tūī and kererū).
- Differences in species composition among sites.

Analysis of the data highlight some key patterns in bird abundance (number of observations) across Aotea-Great Barrier Island:

- The most frequently observed species on the island in the 2021 survey were kākā, tūī, kingfisher (kōtare), grey warbler (riroriro), and fantail (piwakawaka).
- The number of individuals observed (seen and heard) among sites ranged between 62 at Te Paparahi and 309 At Windy HIll. Species richness (number of species present) ranged from 7 (Cooper's Castle and Te Paparahi) to 24 (Medlands), and species diversity ranged between 1.52 (Cooper's Castle) and 2.80 (Medlands). These numbers are remarkably similar to those of 2020.
- Of the four target species, kākā and tūī were observed widely across Aotea. Kererū were present in low abundances at most sites, and kākāriki were observed at Okiwi and Glenfern (in the 2019 and 2020 surveys, they were only recorded at Okiwi).
- Species composition is not homogeneous across the sites and forms three loose groups ([a] Rakitū, [b] Kaitoke and Medlands, and [c] all other sites) based on statistical analyses for site similarity.
- A graphical comparison of changes in species richness and diversity between 2019, 2020, and 2021 is presented and shows no consistent trends.

Data from the ABC are a valuable source of information on species abundances and diversity across Aotea. If repeated at regular intervals, data from the ABC will provide the basis for tracking species abundances through time and space, especially of vulnerable endemic species such as kākāriki. Additionally, such data can inform the success of management interventions such as the iwi-lead Tū Mai Taonga project, which aims to restore lost species such as kōkako and tīeke and promote the recovery of species, including black petrel (tāikoketai) and pāteke.

Contents

1 – Introduction

This report is the third in a series describing the outcomes of the Aotea Bird Count (ABC) survey, mainly based on the data collected in 2021. In structure, it is intentionally similar to previous reports (Asena, 2021; Simmonds, 2020) and uses the reproducible workflow developed by Asena (2021). This report focuses on analysing the data from 2021 because meaningfully analysing patterns of change require longer time-series of data. Thus, the data collected by the ABC will become more valuable over time. However, visualisations of species richness and diversity changes between data from the previous surveys are presented. In the longer term, the ABC will be a valuable dataset describing changes in the abundance and distribution of the birds of Aotea. In addition, data from the ABC can contribute to the development and evaluation of management interventions designed to, for example, increase the abundance of key species in managed areas of the island.

1.1 – Aotea, Great Barrier Island

Aotea, Great Barrier Island (henceforth Aotea) is a island (c. 27,761 ha) located approximately 17 km northeast from the North Island of New Zealand (Figure 1). It includes many small surrounding islands, two of which – Rakitū and Motu Kaikoura – were included in the 2021 survey. A range of habitats are present on Aotea, including wetlands, coastal cliffs, forests, paddocks and cleared land, and dunes, making it home to diverse animal and plant life including some species at risk on or absent from the mainland (Armitage, 2001; Ogden, 2001). A central ridge of mountains reaching an elevation of 627 m.a.s.l (Hirakimata) runs down the centre of the island. Aotea is the largest area of Aotearoa that is free of mustelids, ungulates and possums.

Predator control projects have been implemented on Aotea, with Glenfern sanctuary (83 ha; part of the larger managed area on the Kotuku Peninsula) established as a restoration area in the late 1990s, and Windy Hill sanctuary (800 ha), established in 2000 (Ogden & Gilbert, 2009, 2011). In addition, the Tū Mai Taonga project, lead by the Ngāti Rehua Ngātiwai ki Aotea Trust has begun in the north of Aotea, with the intent to remove feral cats and reduce rat numbers, with the goal of eradicating them from the whole of Aotea. The project's vision is for our mokopuna to hear the birdsong that their tupuna once heard. Community projects control rats in some locations, including Okiwi, Awana, Windy Hill Sanctuary and Oruawharo Medlands, and Auckland Council and the Department of Conservation carry out feral cat control on roadsides, on Hirakimata and in the Whangapoua basin. Private landowners control rats on some large land blocks and the Aotea Trap Library supports residents with free traps, boxes and advice.

1.2 – Birds of Aotea

Aotea is home to many native and endemic bird species, including seabirds, waders, wetland species, species that favour open country, and forest species. Notable species include the tākoketai (black petrel), blue penguins (kororā), Australasian gannets (tākapu), pāteke, banded rails (moho pererū), tomtits (miromiro), Australasian bittern (mātuku), NZ Dotterel (tūturiwhatu) and the iconic

tūī, kākā and kākāriki (Armitage, 2001). This diverse group of species is key to both the cultural heritage and biological importance of Aotea.

Fortunately, some of the predatory mammals, such as the Norway rat (*Rattus norvegicus*) and mustelids (weasels, stoats and ferrets) brought to New Zealand by Europeans, never became established on Aotea (Armitage, 2001). The absence of mustelids is important to the persistence of species still on the island today but absent or vulnerable on the mainland, such as pāteke, kākā and banded rail. Cats (*Felis catus*) and ship rats (*Rattus rattus*) are believed to have been rare or absent from Aotea in the mid-19th century. Thus, species vulnerable to mammalian predation, such as kākāriki, persisted on Aotea more successfully than on the two main islands of New Zealand after European arrival (Armitage, 2001). However, while many introduced vertebrate pests did not establish on Aotea, two species of rat (*Rattus rattus* and *Rattus exulans*), mice (*Mus musculus*), rabbits (*Oryctolagus cuniculus*), feral cats (*Felis catus*), and pigs (*Sus scrofa*) threaten the island's birdlife (Ogden & Gilbert, 2009, 2011). The last remaining kōkako on Aotea were translocated to nearby predator-free Hauturu (Little Barrier) in 1994, and several bird species, including the tomtit and kākāriki are at risk of local extinction (Russell & Taylor, 2017). Much of the loss of the native and endemic birdlife was probably due to the introduction of the Polynesian rat (*Rattus exulans*) and dogs (*Canis familiaris*) that accompanied the first human settlers of Aotea, and the loss of forest due to fire and logging during Māori (since the late 13th / early 14th century) and European settlement periods (Ogden et al., 2006; Perry et al., 2010).

1.3 – Key target species

Stakeholders on Aotea have identified four bird species as focus species for the ABC (Simmonds, 2020): kākā (*Nestor meridionalis*), kererū (*Hemiphaga novaeseelandiae*), kākāriki (*Cyanoramphus novaezelandiae*), and tūī (*Prosthemadera novaeseelandiae*).

Kākāriki are a small (75 g) endemic parrot now almost absent from New Zealand's two main islands. The kākāriki has a national conservation status of a 'relict' population (Robertson et al., 2017); Okiwi is the sole confirmed breeding population on Aotea (Simmonds, 2020). Highly vulnerable to rat predation because they nest in cavities in old trees such as pūriri, the presence of kākāriki is an indicatior of lower rat densities.

Kererū are an endemic pigeon, widespread throughout New Zealand. They are the fifth heaviest pigeon in the world (c. 650 g), and feed on fruits, flowers, and leaves (Wotton & Kelly, 2012). Kererū are considered to be 'keystone' seed dispersers feeding on at least 70 different plant species (McEwen, 1978) and, due to their large size, they can swallow large fruits and have a long seed retention time (Clout & Hay, 1989; Kelly et al., 2010). Kererū inhabit a variety of forest types, including native forest and exotic plantations. They are important to forest regeneration as the germination of seeds of species such as taraire, tawa and miro be enhanced by passing through the stomach of kererū.

The kākā is an endemic hole-nesting parrot (c 360 g) that is reasonably frequently observed across common throughout Aotea, although at the national-level they are classed as an at risk, recovering species (Robertson et al., 2017). Kākā now occupy only a fraction of their former range due to predation and habitat loss (Moorhouse et al., 2003). Their abundance on Aotea is likely due to the absence of stoats (*M. erminea*) and Norway rats (*R. norvegicus*), to which their nests are vulnerable (Armitage, 2001).

The tūī (c. 100 g) is an endemic species that is widespread across New Zealand other than Canterbury. Tūī are honeyeaters feeding primarily on nectar, fruit and invertebrates (Stewart & Craig, 1985). Windy Hill bird count data collected over two decades showed tūī benefit from lower rat densities and this makes them a good indicator species for the effectiveness of rat control measures (Ogden 2019).

1.4 – Objectives of the Aotea Bird Count

The ABC is a collaborative citizen-science project intended to provide an island-wide assessment of the abundance and distribution of bird species on Aotea. It is envisaged that the ABC will be be repeated biannually or annually, building a dataset that provides information and context about changes in species abundance and distribution over time. This supports sanctuaries, community projects, iwi, Department fo Conservation and Auckland Council projects by providing long term monitoring of the outcomes of their management effort to protect Aotea's birds.

Such information will be invaluable in informing and evaluating management interventions (e.g., pest control), changes in bird populations across the island, and tracking the abundance of four focus species. Although concerns are sometimes raised about the 'reliability' of such citizen projects, when conducted carefully and appropriately analysed they can provide robust and reliable information (Kosmala et al., 2016).

2 – Methods

2.2 – Data collection

Eighteen sites across Aotea (Figure 1) were surveyed using the five-minute bird count method (Hartley, 2012). Each of the sites consisted of five survey locations approximately 200 metres apart each of which was surveyed twice with at least a one-hour interval between replicates. Groups of up to three observers undertook the surveys with at least one person (the lead) experienced in bird identification, and all members receiving basic bird count training. At each point in the site, the species, number of birds seen or heard, and distance from the observers (inside or outside of a 25-metre radius) were recorded for five minutes. Counting started after two minutes of silence to reduce the disturbance caused by the observers; additional data on birds flying overhead or observed between the survey locations were also recorded. Finally, the group noted each replicate's local conditions (wind, rain, noise and temperature).

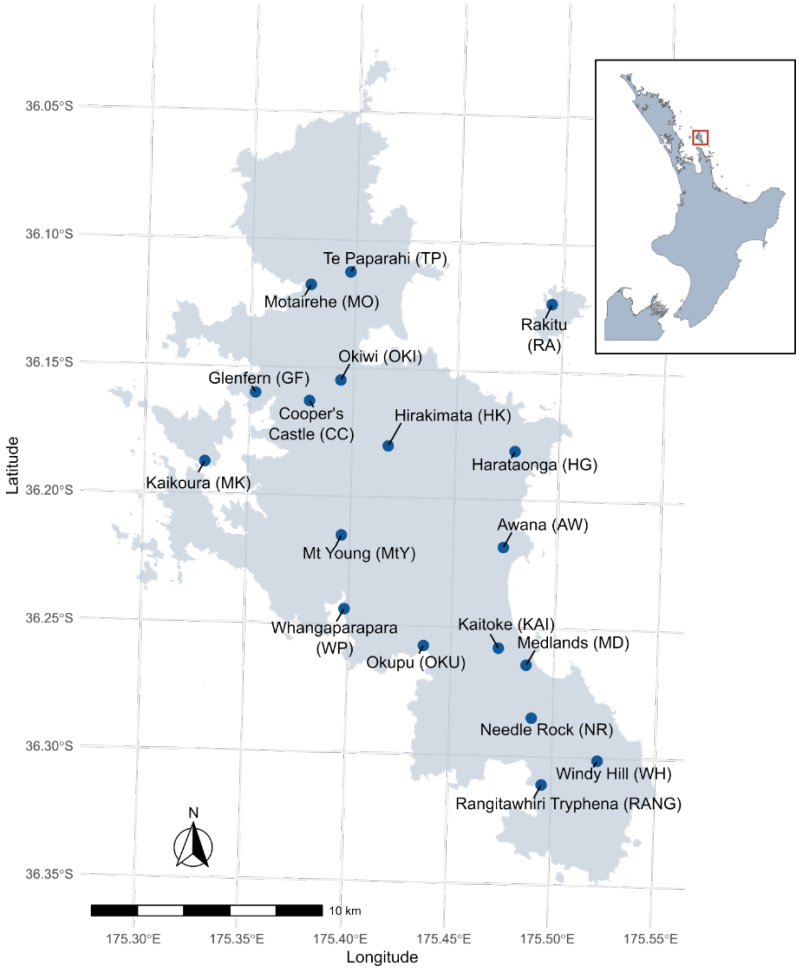

Figure 1: Locations of the 18 sites surveyed in 2021 on Aotea, Great Barrier Island. Abbreviations are used in some subsequent illustrative material.

A list of birds observed including their Te reo Māori, Latin, and European names is provided in Appendix A.

2.3 – Analysis

The main goal of the analyses was to describe patterns in the distribution of bird species across the island and differences in richness and composition among sites. Observations including the seen and heard birds identified by the surveyors were used in the analyses. Some records of unknown species or species not identified to the species level (e.g., 'finch', which could be one of several potential species) were filtered from the data and excluded from analysis. Data were analysed at the island-level, site-level, and for differences among sites:

- First, total bird counts were calculated across the island by summing the counts of each species across all sites.
- Second, bird counts were analysed at the site-level by calculating species richness and diversity. Additionally, the occurrence and abundance of the four target species (kākāriki, kākā, tūī and kererū) are shown for each site.
- Finally, the dissimilarity among the sites was calculated from differences in their species composition.

All analyses were conducted in R version 4.2.1 (R-Development-Core-Team, 2020). The vegan package version 2.6-2 (Oksanen et al., 2022) was used to calculate the Bray-Curtis index and Shannon's diversity index (described below). The data and scripts used in this report are reproducible and stored on a public repository (available at: https://doi.org/10.17608/k6.auckland.20523765.v1).

Richness and diversity

For each of the 18 sites, the richness and diversity of species present were calculated. Species richness is the number of species present (and is a fundamental descriptor of biodiversity), while species diversity describes the species relative abundances. For example, if 100 individuals across ten species were observed, richness would be 10; diversity would vary from highest if all ten species had ten individuals or lowest if one species accounted for 91 individuals and the other nine just one. Species diversity was calculated using Shannon's H index (Magurran, 2004). Species richness and diversity were mapped by site to visualise the results. Additionally, a visual comparison of species richness and diversity between 2019 and 2020 count data is shown for all species and the four focus species.

Total count and target species

For each of the 18 sites, the total bird count (i.e., number of individuals observed) and the counts of the four target species (kākāriki, kākā, tūī and kererū) were calculated. Count data mapped onto Aotea provides an overall picture of the bird abundance at each site, complementing richness and diversity measures.

Hierarchical cluster analysis

Additionally, we were interested in how different the species composition is among the 18 sites. The Bray-Curtis dissimilarity index is commonly used in ecology to quantify the difference between sites based on their species composition (Faith et al., 1987). Hierarchical cluster analysis groups (classifies) sites into units based on their similarity. To group the sites into clusters, we used the unweighted pair group method with arithmetic-mean method. In short, hierarchical cluster analysis is a bottom-up (agglomerative) clustering method that successively groups similar sites until all of them have been placed into a group.

3 – Results

3.1 – Overall observations 2021

Across the 18 sites, 2837 individuals were counted and identified across 43 species (excluding some unknown or unidentified to the species level). Of the 43 species, the majority were either native or endemic (17 of the top 25), with the most frequently observed species being kākā, tūī, kotāre, riroriro, and piwakaka (Figure 2). Counts for all 43 species are provided in Appendix B.

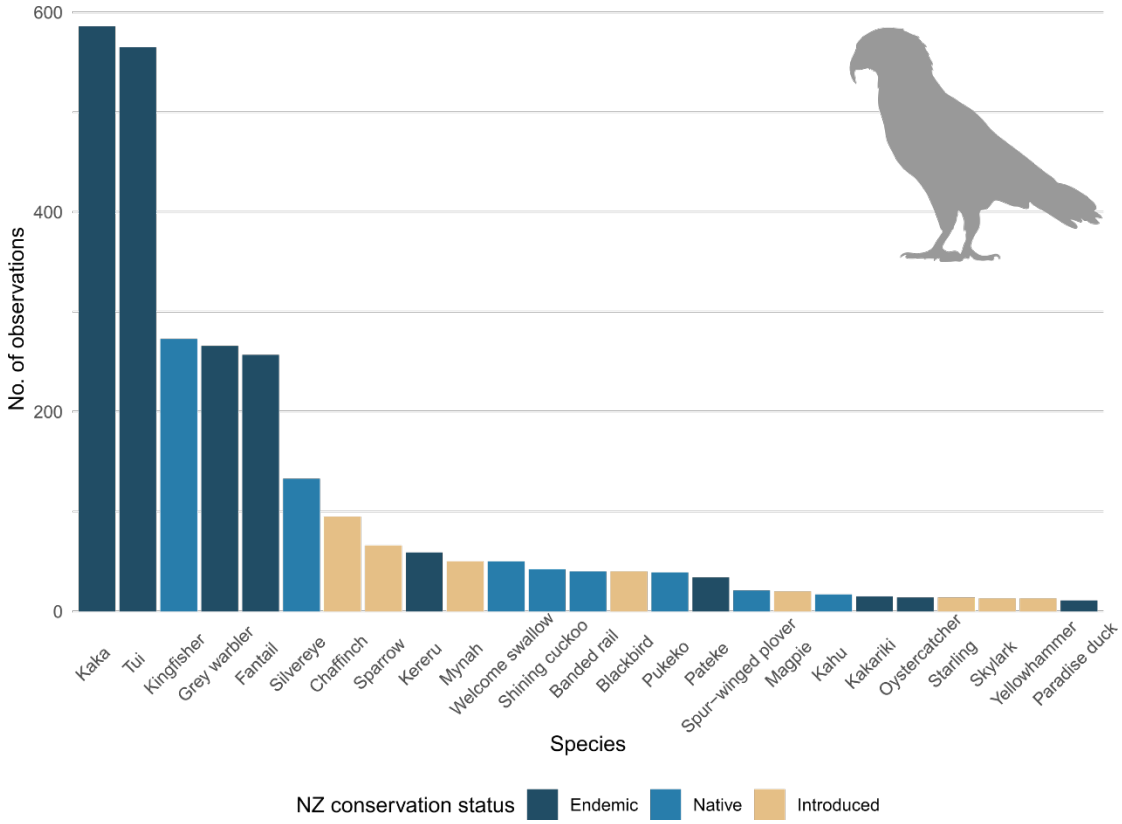

Figure 2: Total counts of the 25 most frequently observed (seen or heard) species across all 18 sites. Forty-one species were observed across 2837 individuals.

3.2 – Richness and diversity

Species richness and diversity do not vary much across the seventeen survey sites (Figures 3 and 4). The highest species richness occurred at the Medlands site, followed by Whangaparapara and Motu Kaikoura; the highest diversity occurred at Medlands, followed by Kaitoke and Kaikoura (Figure 4 and Table 1; see Figure 1 for mapped site names). The lowest levels of richness and diversity were observed at Cooper's Castle, Te Paparahi, and Awana (mirroring the 2020 survey).

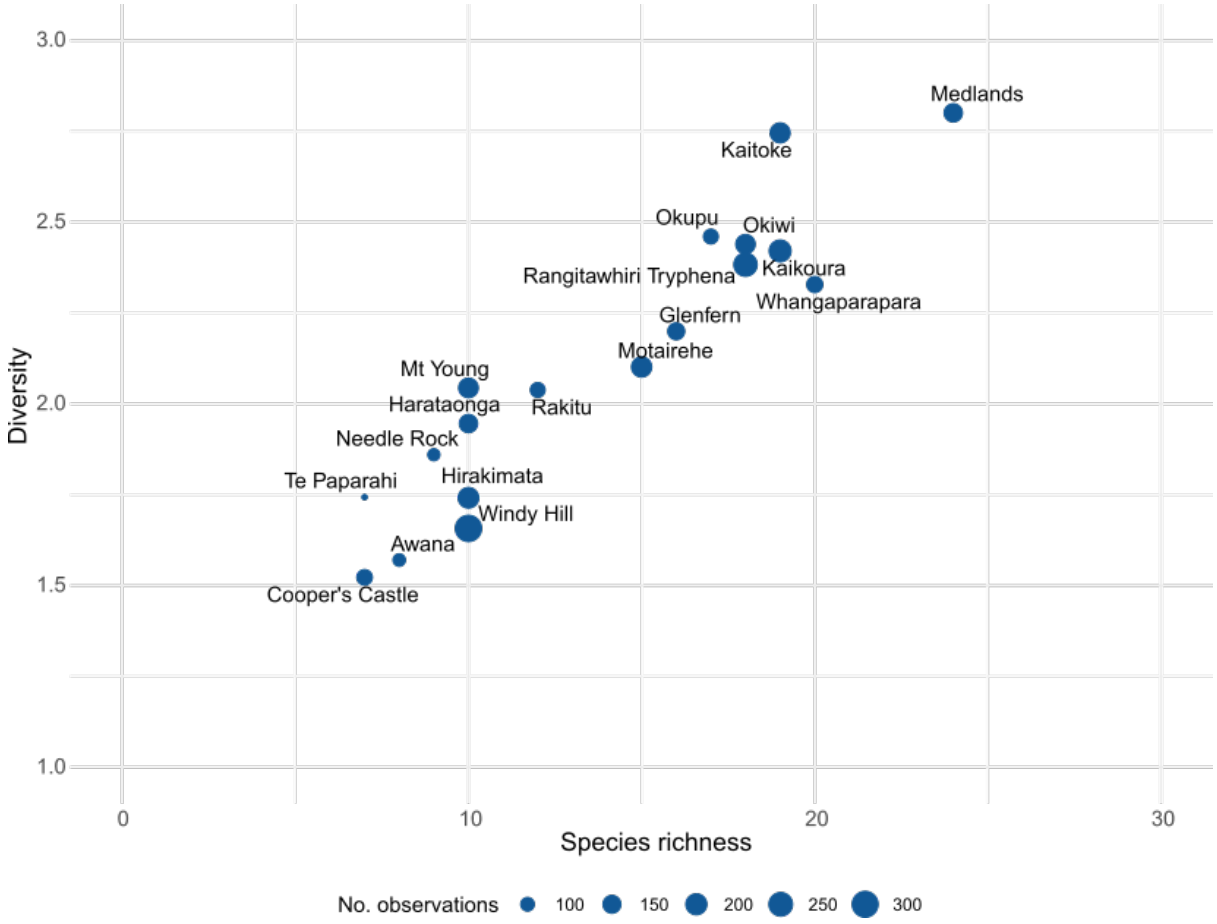

Figure 3: Richness and diversity across the 18 sites surveyed in the 2021 ABC. Circle size denotes number of observations at the site.

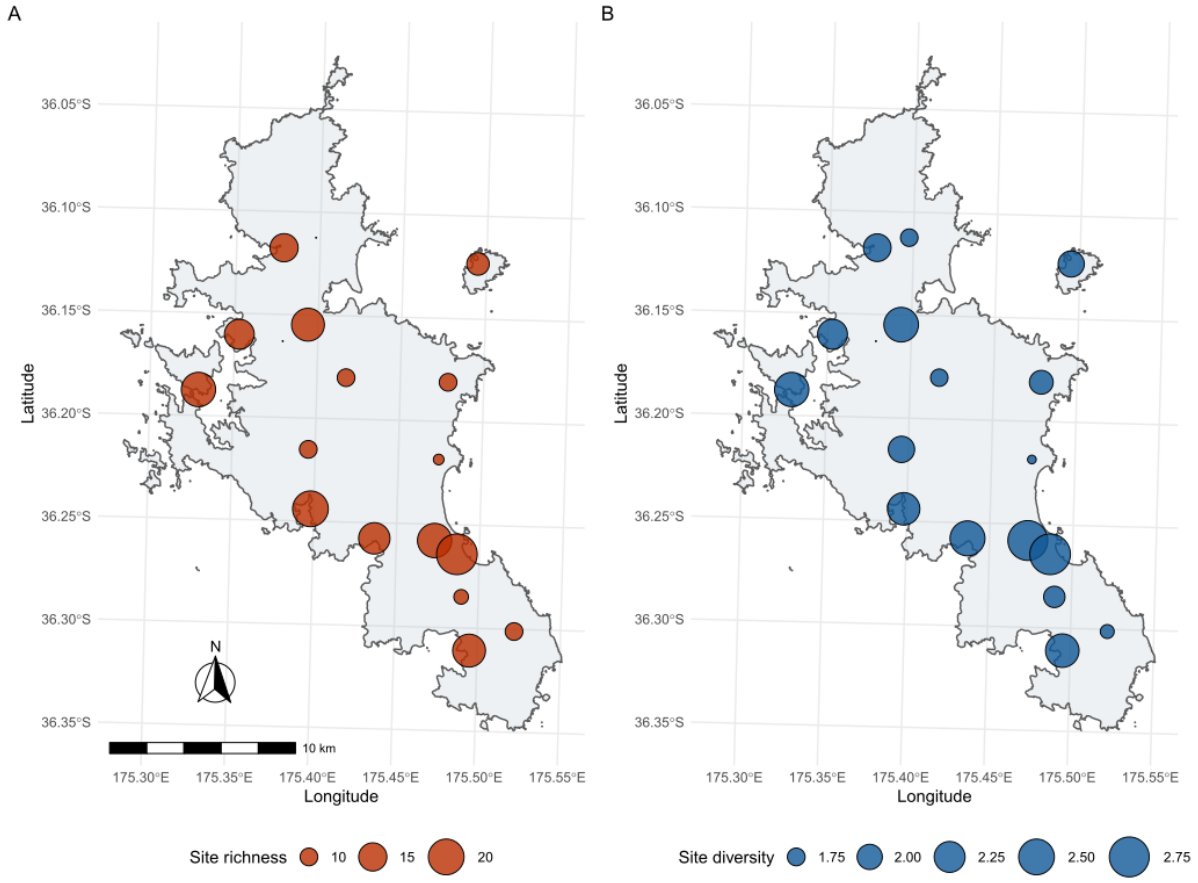

Figure 4: The species richness (A) and diversity (B) of the 18 sites across Aotea. The size of the data points is scaled by value, with larger points indicating a higher value.

The number of observations, species richness, diversity and total counts vary across sites with ranges of [62, 309], [7, 24], and [1.52, 2.80], respectively (values inside the square brackets indicating the minimum and maximum; Table 1). Of course, some variation is expected due to local conditions during the bird counts and among observer groups. Species richness is likely to increase with the number of individuals counted at a given site; while statistical tools can, to some extent, correct for this, we did not use them here.

Table 1: Species richness, diversity and count for the 18 sites.

Site	Richness	Diversity	No. observations
Awana	8	1.57	90
Coopers Castle	7	1.52	120
Glenfern	16	2.20	137
Harataonga	10	1.95	155
Hirakimata	10	1.74	193
Kaikoura	19	2.42	216
Kaitoke	19	2.75	183

Medlands	24	2.80	156
Motairehe	15	2.10	186
Mt Young	10	2.04	176
Needle Rock	9	1.86	87
Okiwi	18	2.44	173
Okupu	17	2.46	112
Rakitu	12	2.04	112
Rangitawhiri Tryphena	18	2.38	244
Te Paparahi	7	1.74	62
Whangaparapara	20	2.33	126
Windy Hill	10	1.66	309

3.3 – Total counts

The highest total number of observations was at Windy Hill (309; Figure 5 A and Table 1), although it did not have the highest species richness (*S* = 10). At Medlands, which had the highest richness and diversity, 153 observations were made. Kākāriki were observed at the Okiwi site, where a breeding population is known to be established, and at nearby Glenfern; in 2019 and 2020 kākāriki were seen only at Okiwi (Asena, 2021; Simmonds, 2020). There has been a substantial investment in predator control at Okiwi to maintain the existing kākāriki population (Simmonds, 2018).

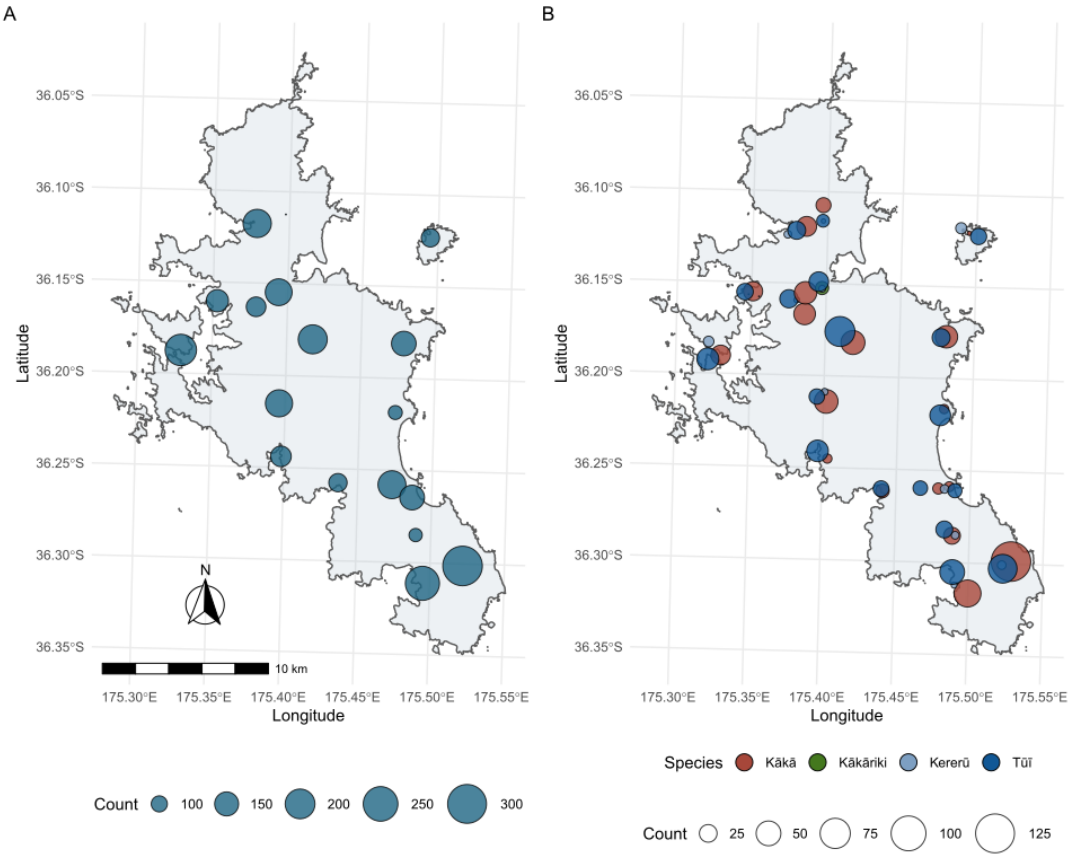

Figure 5: Total number of observations by site (A) and total number of observations of the four target species (kākāriki, kākā, tūī and kererū) by site (B).

Of the four target species (kākāriki, kākā, tūī and kererū), kākā and tūī were observed at almost every site, except for Kaitoke, where no kākā were observed (Figures 5 and 6 and Table 2). Kererū were observed at 11 of the 18 sites, although in lower numbers than kākā or tūī. Fifteen observations of kākāriki were made, 14 at Okiwi and one at Glenfern (Figure 4 B and Table 2). There is no trend apparent in the number of observations of the four target species over the three surveys (Figure 5B).

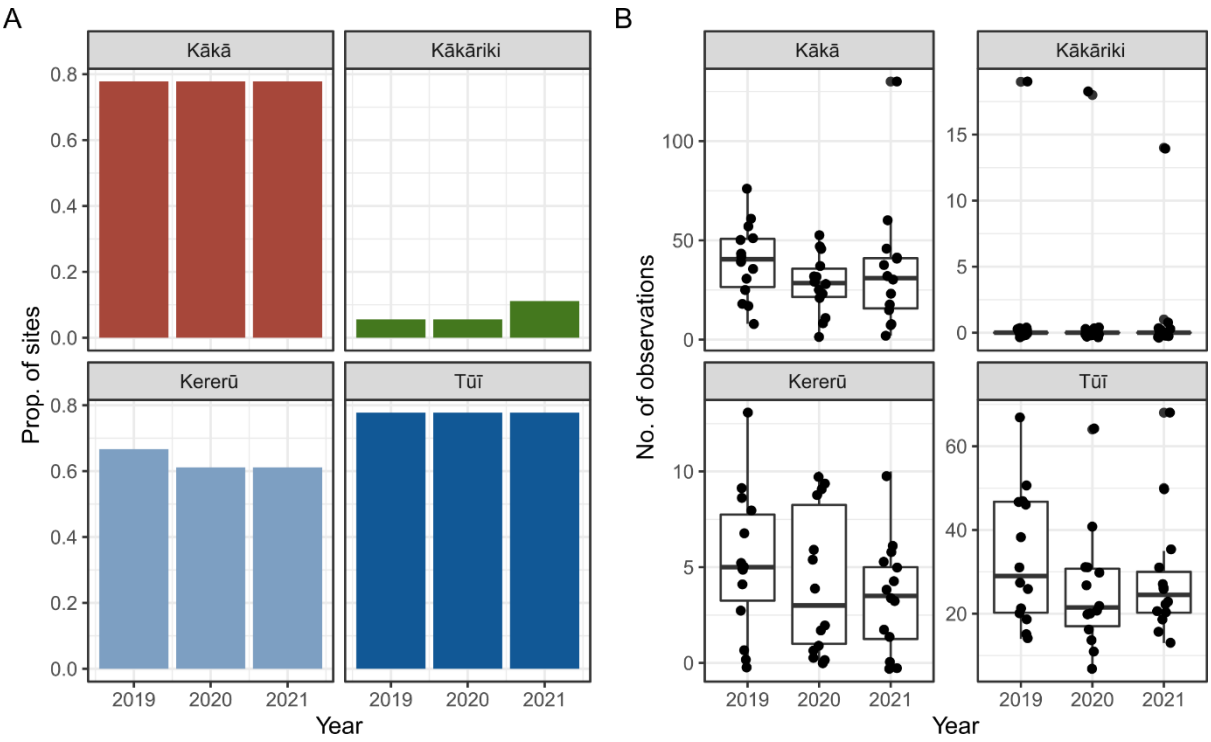

Figure 6: Proportion of sites that the four focal species were observed at (A) and number of observations for the four species in 2019, 2020, and 2021 (B). Note that the number and identity of sites surveyed varied slightly between the surveys.

Tūī and kākā were observed frequently at Windy Hill and Haratonga; Okiwi had high abundances of all four species (Figure 5B and Table 2).

Table 2: Total counts of the four target species at each site.

Site	Tūī	Kākā	Kākāriki	Kererū
Awana	35	7	0	0
Cooper's Castle	27	38	0	3
Glenfern	22	30	1	1
Harataonga	26	41	0	0
Hirakimata	74	47	0	0
Kaikoura	39	31	0	9
Kaitoke	17	10	0	0
Medlands	16	8	0	6

Motairehe	26	32	0	5
Mt Young	19	46	0	4
Needle Rock	23	23	0	5
Okiwi	31	41	14	4
Okupu	20	15	0	0
Rakitu	21	2	0	10
Rangitawhiri Tryphena	50	60	0	3
Te Paparahi	13	18	0	2
Whangaparapara	38	7	0	1
Windy Hill	68	130	0	6

3.4 – Community composition across sites

Two primary groups of bird community emerge from the cluster analysis. Two of the most diverse and species-rich sites – Medlands and Kaitoke – are separated from the other sites (Figure 7; red branches). Rakitu is different from all other sites due to the presence of weka, which was only recorded there (green branch), and the remaining sites form a single large cluster (blue), indicating that they are similar in species composition. In short, this analysis suggests that the bird community across Aotea is reasonably unstructured with little clear evidence of differences as a function fof habitat (although see recommendations).

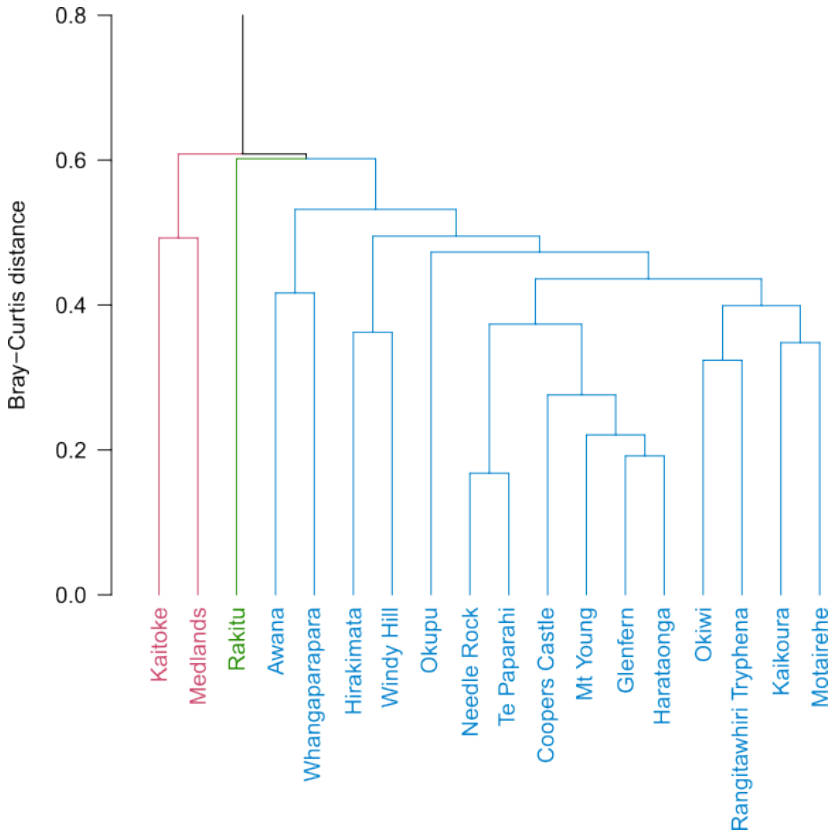

Figure 7: Hierarchical cluster analysis of sites using Bray-Curtis distance and unweighted pair group method; colours denote clustering. Rakitu is different from all other sites, Kaitoke and Medlands are similar and different from the other sites, and the remaining groups form a loose cluster.

3.5 – Comparison between 2019, 2020, and 2021

In the long term, this bird count data can be used to monitor the trajectory of populations and specific species across Aotea. Graphical comparisons of the change in species richness (Figure 8) and the number of observations (Figure 9) show some differences in sites over the three surveys; however, differences in site conditions and observers will also contribute to this variation. Overall, greater species richness was observed in 2019 than in 2020, with a slight increase from 2020 to 2021 (Figure 8). Medlands has consistently increased and is the most species-rich site, while Te Paparahi and Cooper's Castle are consistently low in richness. The number of observations was higher in 2021 than in 2020, but, again, shows a mix of increases and decreases among sites between years (Figure 9). These patterns need to be interpreted with caution because trends based on short-term data are inherently uncertain.

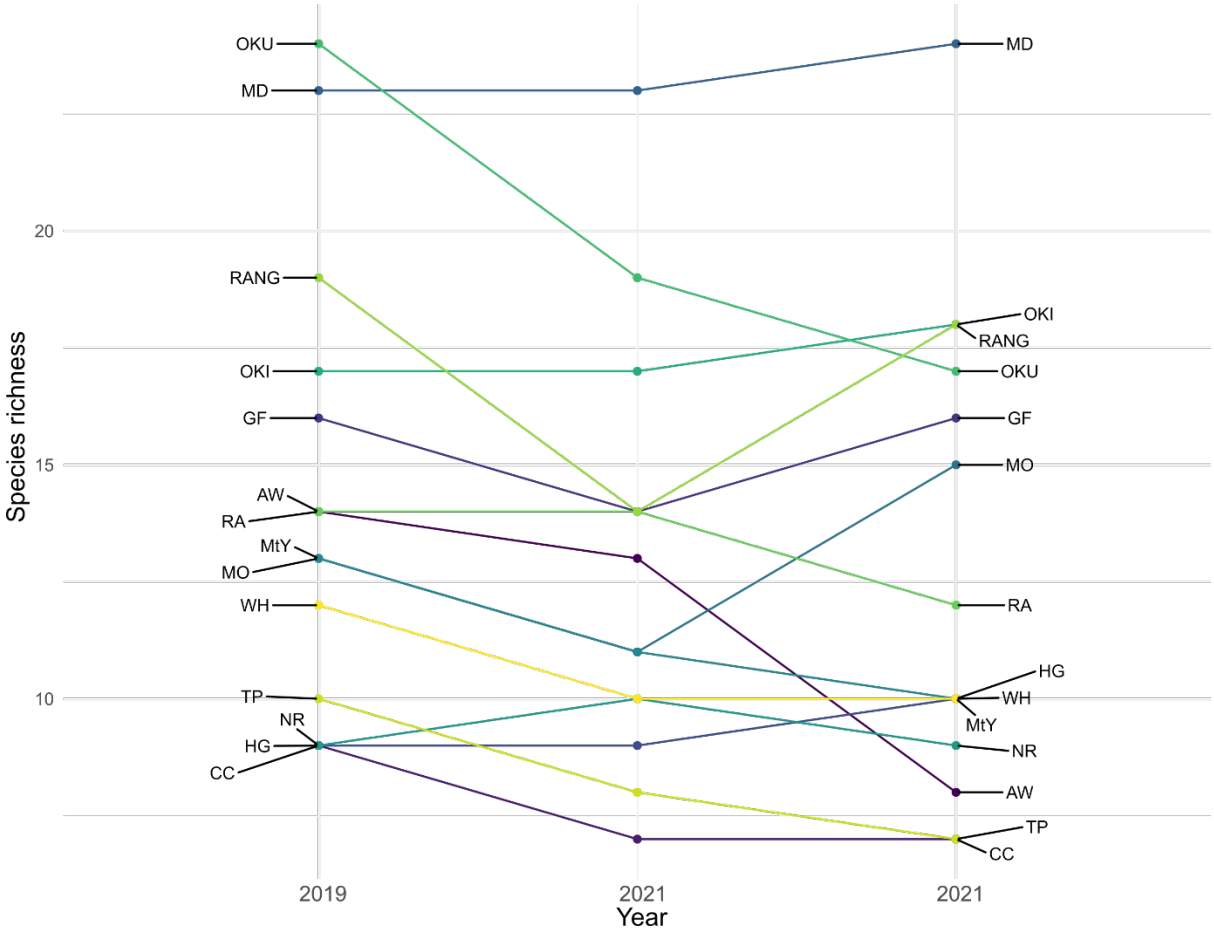

Figure 8: Bump plot of the change in species richness from 2019-2021; only sites included in all three surveys are shown.

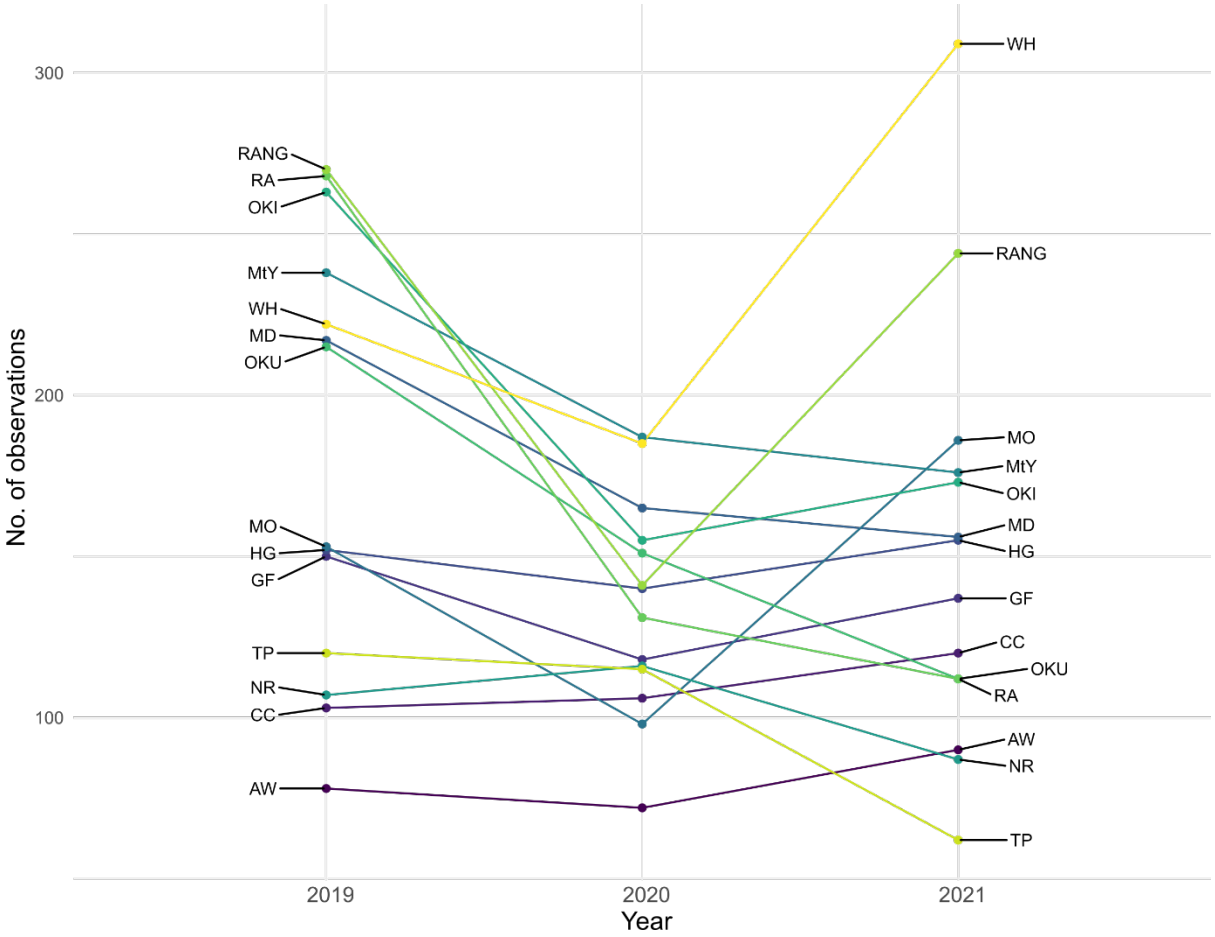

Figure 9: Bump plot of the change in number of observations 2019-2021; only sites included in all three surveys are shown.

Focusing on the four target species (kākā, kakariki, kereru, and tūī) again shows a range of responses across the sites (Figure 10). There was a dramatic increase in kākā observations at Windy Hill in 2021 but otherwise the number of kākā observations are reasonably consistent. There is some hint of a decline in the number of observations of kererūu from 2020 to 2021 but this is (i) a single year trend and (ii) the sedentary nature kererū can make them difficult to detect. Tūī show increases and decreases depending on site.

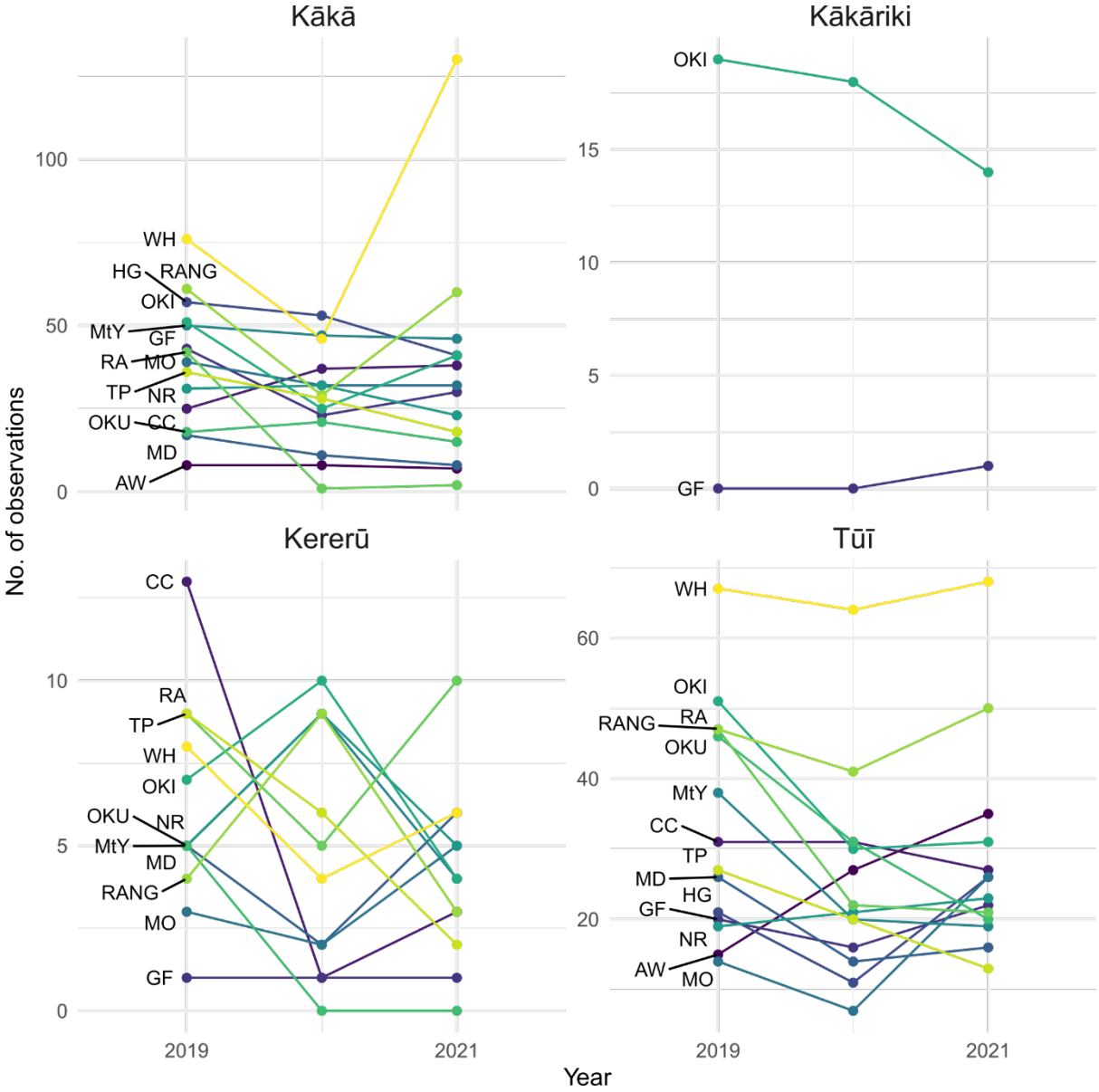

Figure 10: Bump plot of the change in number of observations for the four focal species, 2019-2021. The figure includes only those sites surveyed in all three years and where the species of interested was recorded at least once.

If repeated on an annual or bi-annual basis, bird count data from the ABC can highlight long-term trends in richness and diversity and inform the success of management interventions. Additionally, statistical methods that require more than three years of data can be applied to the data in the future (e.g., trajectory analysis – De Cáceres et al., 2019). ***Thus, it is recommended that ABC surveys continue to build an evermore valuable long-term dataset.***

4 – Discussion

We analysed the ABC data for the primary, island-wide patterns of abundance; site-specific patterns of abundance, richness, and diversity; and site dissimilarity. Analysis of the aggregated data shows the most frequently observed species on Aotea during the ABC-2021 were kākā, kōtare, tūī, grey warbler, and fantail (Figure 2). Of course, bird species are not uniformly distributed across the island, although it is not easy to predict this variation. For example, Kaitoke had relatively few observations of tūī and the only observations of kākāriki were at Okiwi and Glenfern. The hierarchical cluster analysis assesses the differences in species composition among the sites. The community composition across sites is not clearly structured, other than the different communities observed at Medlands, Kaitoke and Rakitū. The Medlands survey location is wetland habitats (coastal paddocks), hence the lack of bush birds with high counts of pāteke, pūkeko, and kōtare (see also Anderson & Ogden, 2003). As noted below, data describing the habitat at each survey point would be informative for future analysis.

Of the four target species, tūī and kākā were common in all the sites of the large cluster identified by the cluster analysis (Figure 7, blue branches). Although present at most sites, lower counts of kererū were recorded across Aotea, with highest abundances on Rakitū and Motu Kaikoura (Table 2). Kākāriki were absent from all sites apart from Okiwi and Glenfern (one observation at the latter), highlighting the dependence of kākāriki on intensive pest management for their persistence. Comparisons of species richness and diversity between surveys from 2019 and 2020 must be interpreted cautiously since variability is to be expected in the data. However, they provide examples of how the data can be used to highlight trends if repeat surveys are conducted biannually or annually.

In the interests of reproducible data analyses and use for the analyses of future bird counts, both the data and the scripts are archived in an online repository. Data can be found at: https://doi.org/10.17608/k6.auckland.14865372.

4.2 – Limitations

Some sources of uncertainty exist in the data collection methods that must be accounted for during analysis and interpretation (see MacLeod et al., 2012 for a detailed comparison of methods). The primary limitations in the data are:

- *Location bias*: survey locations are typically along a track or accessway. Bird counts from such locations may not be closely representative of the true abundance of a given area. It would be useful to supplement the ABC points with more detailed habitat and vegetation information to contextualise them more effectively.

- *Detection bias*: birds species are not all equally likely to be observed due to size, sound and behavioural differences. Some birds, such as tūī and kākā, are conspicuous and loud, while others, such as the tomtit, are small and inconspicuous. Kererū, in particular, can be hard to

detect meaning the possible decline in the number of observations needs to be treated with caution.

- *Identification bias*: not all bird species are equally identifiable visually or audibly. For example, some species such as the kererū are visually easy to identify, while ones such as the yellowhammer may be more easily confused with another such as the goldfinch. In the future recording as many details as possible about the species observed is important.

While some limitations exist (as with any observational ecological data), some can be mitigated. For example, survey groups should continue to have at least one trained observer to reduce identification error, and statistical methods exist to correct observation bias in data analysis. Thus, despite sources of uncertainty, important patterns can be derived from the data.

4.3 – Conclusion

Counts from the ABC offer valuable insights into patterns of species richness, diversity and abundance. If repeated annually or biannually, data from the ABC can also be analysed for change over time in the abundance and distribution of species. Thus, it is recommended that the ABC is repeated at regular intervals to build a reliable long-term dataset. Two other recommendations are:

- To supplement the ABC points with vegetation / habitat information – the PCQ method described by Perry et al. (2010) or standard recce methods (Hurst & Allen, 2007) could be used for this purpose
- Explore supplementing survey point data with island-wide rodent monitoring data as a measure of rodent densities at each point, and the type of control methods in place (eg eradicated, low densities, some control, no control)
- To continue to maintain continuity of counting team members at individual sites as far as practical and to ensure counters are trained in the ABC observations recording process
- Ensure as much detail as possible is recorded about the species observed to avoid species being unable to be analysed as they are ambiguous (e.g., 'gull')

It is also important that data and code used in analysis are archived so that they are easily accessible to interested stakeholders and researchers. This process was started in 2021 and the data and code used in this report are available at: https://doi.org/10.17608/k6.auckland.20523765.v1. Such data can help track changes in the abundance of species (especially endemic declining species such as the pāteke) and the success of management interventions.

We note that the Tū Mai Taonga project has indicated they would like to add new five minute bird count sample points in Te Paparahi to the ABC set of sites in December 2022. A review of the sample points may be considered in 2023 to ensure the sustainability of the count over time and the usefulness of the data to decision makers.

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Appendix A

Table 3: List of names and conservation status of birds observed in the 2021 ABC survey, including their Māori, Latin, and European names. Note some species have multiple Māori or European names that are not included. Names are sourced from New Zealand Birds Online (New Zealand Birds Online, 2013).

Te reo name	**Latin name**	**European name**	**Conservation status**	Biogeographic **status**
-	*Acridotheres tristis*	Mynah	Introduced and Naturalised	Introduced
Kaireka	*Alauda arvensis*	Skylark	Introduced and Naturalised	Introduced
Pāteke	*Anas chlorotis*	Brown teal	Recovering	Endemic
-	*Anas platyrhynchos*	Mallard Duck	Introduced and Naturalised	Introduced
-	*Ardea cinerea*	Grey Heron	Vagrant	Native
-	*Carduelis carduelis*	Goldfinch	Introduced and Naturalised	Introduced
-	*Chicken*	Chicken	Introduced	Introduced
-	*Chloris chloris*	European greenfinch	Introduced and Naturalised	Introduced
Pipiwharauroa	*Chrysococcyx lucidus*	Shining Cuckoo	Not Threatened	Native
Kāhu	*Circus approximans*	Harrier Hawk	Not Threatened	Native
Kākāriki	*Cyanoramphus novaezelandiae*	Redcrowned parakeet	Relict	Endemic
-	*Emberiza citrinella*	Yellowhammer	Introduced and Naturalised	Introduced
Pahirini	*Fringilla coelebs*	Chaffinch	Introduced and Naturalised	Introduced
Weka	*Gallirallus australis*	Woodhen	Not Threatened	Endemic
Moho pererū	*Gallirallus philippensis*	Banded Rail	Declining	Native
Riroriro	*Gerygone igata*	Grey Warbler	Not Threatened	Endemic
Makipae	*Gymnorhina tibicen*	Magpie	Introduced and Naturalised	Introduced
Tōrea pango	*Haematopus unicolor*	Oystercatcher	Recovering	Endemic
Kererū	*Hemiphaga novaeseelandiae*	Wood Pigeon	Not Threatened	Endemic
Warou	*Hirundo neoxena*	Swallow	Not Threatened	Native
Taranui	*Hydroprogne caspia*	Caspian Tern	Nationally vulnerable	Native
Karoro	*Larus dominicanus*	Blackbacked Gull	Not Threatened	Native
Tarapunga	*Larus novaehollandiae*	Redbilled Gull	Declining	Native
Takapu	*Morus serrator*	Gannet	Not Threatened	Native
Kākā	*Nestor meridionalis*	Brown Parrot	Recovering	Endemic
Rārā	*Ninox novaeseelandiae*	Morepork	Not Threatened	Native
Tūī	*Passer domesticus*	Sparrow	Introduced and Naturalised	Introduced
Toutouwai	*Petroica longipes*	NI robin	Declining	Endemic
Ngirungiru / Miromiro	*Petroica macrocephala*	Tomtit	Not Threatened	Endemic
Māpunga	*Phalacrocorax carbo*	Black Shag	Relict	Native
Kawau tūī	*Phalacrocorax sulcirostris*	Little Black Shag	Naturally Uncommon	Native

Kāruhiruhi	*Phalacrocorax varius*	Pied shag	Recovering	Native
Pūkeko	*Porphyrio melanotus*	Purple Swamphen	Not Threatened	Native
Tākoketai	*Procellaria parkinsoni*	Black petrel	Nationally vulnerable	Endemic
Tūī	*Prosthemadera novaeseelandiae*	Parson Bird	Naturally Uncommon	Endemic
Piwakawaka	*Rhipidura fuliginosa*	Fantail	Not Threatened	Endemic
-	*Sturnus vulgaris*	Starling	Introduced and Naturalised	Introduced
Putangitangi	*Tadorna variegata*	Paradise Duck	Not Threatened	Endemic
Kōtare	*Todiramphus sanctus*	Sacred Kingfisher	Not Threatened	Native
Manu pango	*Turdus merula*	Blackbird	Introduced and Naturalised	Introduced
-	*Turdus philomelos*	Song Thrush	Introduced and Naturalised	Introduced
-	*Vanellus miles*	Spurwinged Plover	Not Threatened	Native
Tauhou	*Zosterops lateralis*	Silvereye	Not Threatened	Native

Appendix B

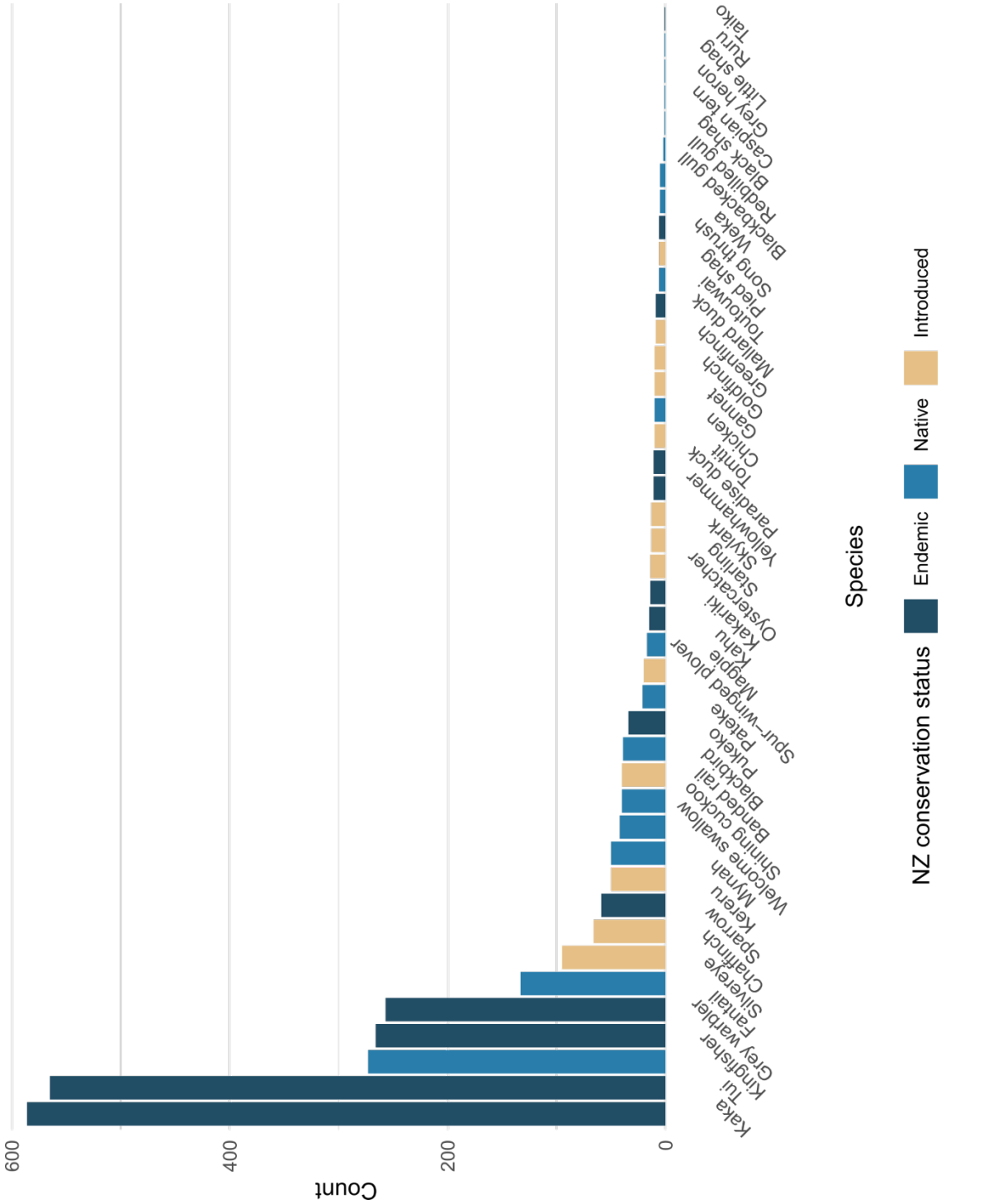

Figure 3: Counts of all 42 species identified summed across all 17 sites.

Number of observations of each of the 43 species recorded in the ABC 2021 (excluding unambiguous observations). Colours indicate their New Zealand conservation status (native, endemic, introduced species level).