State and trends in the diversity, abundance and distribution of birds in Wellington City

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State and trends in the diversity, abundance and distribution of birds in Wellington City.

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Cover Image: Female New Zealand falcon (*Falco novaeseelandiae*) perched with tail fanned, Wellington August 2011. Image courtesy of Steve Attwood, Auldwood Photography, www.flickr.com/photos/stevex2/.

ABSTRACT

Five-minute bird counts have been carried out at 100 bird count stations in forest habitat throughout Wellington City's parks and reserves network each year between 2011 and 2015. The aim of these surveys is to monitor trends in the diversity, abundance and distribution of native forest birds throughout Wellington City's reserve network, to provide a measure of local biodiversity management outcomes.

Between 29 and 33 bird species have been detected during these bird counts each year, including 3-6 'Nationally Threatened' or 'At Risk' species, 10-13 native species ranked as 'Not Threatened' and 14-15 'Introduced and Naturalised' species. The mean number of native forest bird species being detected per five-minute bird count has risen significantly since 2011, likely caused by an ongoing expansion in the spatial distribution of species such as kaka and red-crowned parakeet in the city.

Mean encounter rates for tui, grey warbler, kaka and red-crowned parakeet have increased significantly between 2011 and 2015, suggesting that these species have increased in abundance and/or conspicuousness over this time. Because careful efforts have been made to standardise the survey methodology used and many of the environmental variables that may influence bird conspicuousness, it's likely that these changes in encounter rates reflect an increase in the abundance of these species over time. This suggests that ongoing improvements in efforts to control mammalian predators in Wellington City are benefiting these forest bird species.

Several bird species recently re-introduced to Zealandia continue to have very localised distributions in Wellington City, suggesting that mammalian predators are still likely to be limiting the establishment of populations beyond Zealandia's predator-proof fence. Further work to identify and quantify the causes of nest failure and adult mortality in these species would be useful to help devise specific management actions to improve the likelihood that these species establish in other Wellington parks and reserves.

By combining this five-minute bird count dataset with citizen science data sourced from the New Zealand eBird database, we've been able to map the distribution of bird species in Wellington City in much greater detail than previously. One relatively common, resident native bird remains poorly-known however. Morepork aren't detected during daytime five-minute bird counts and are seldom reported by local citizen scientists. Therefore, as well as recommending that these five-minute bird counts be continued on an annual basis, we also recommend that a citizen-science project aimed at describing the distribution and abundance of morepork in Wellington City be developed.

Keywords: Wellington City, five-minute bird count, bird abundance, encounter rate, Zealandia, citizen science, eBird.

1 INTRODUCTION

Over the past decade there has been a conspicuous increase in the diversity, abundance and distribution of native forest bird species in Wellington City (Miskelly et al, 2005). These changes are likely to be a consequence of two improvements in the management of indigenous forest habitats in and around Wellington City. Firstly, a series of species re-introductions to local predator-free sites such as Zealandia (the Karori Wildlife Sanctuary), Matiu/Somes Island and Mana Island have successfully established healthy source populations from which previously locally-extinct or near-extinct bird species have been dispersing into nearby forested reserves (Miskelly & Powlesland, 2013). These species include kaka (*Nestor meridionalis*), red-crowned parakeet (*Cyanoramphus novaezelandiae*) whitehead (*Mohoua albicilla*) and bellbird (*Anthornis melanura*) (Miskelly et al, 2005; Froude, 2009; McLaughlin & Harvey, 2013). Secondly, ongoing multi-species predator control being carried out by Wellington City Council, Greater Wellington Regional Council and community conservation groups in many Wellington City parks and reserves has resulted in local increases in resident native bird species such as tui (*Prosthemadera novaeseelandiae*) (Bell, 2008; Froude, 2009; Brockie & Duncan, 2012) and is creating an opportunity for recently re-introduced species to establish functional populations away from their original re-introduction sites.

Further improvements in efforts to protect and restore Wellington City's indigenous habitats are likely to result in additional changes to the abundance and distribution of local native bird populations in the near future. Over 100 community restoration groups are now active in Wellington City and in 2014 these groups contributed a combined total of 34,611 volunteer hours towards local environmental restoration activities (WCC, 2015). Initiatives such as the "Enhancing the Halo" project[1], the creation of New Zealand's first pest-free suburb in Crofton Downs[2] and a long-term goal of Wellington City Council to create a second pest-free urban area on Miramar Peninsula (WCC, 2015) will likely result in further improvements in the distribution and abundance of species that are currently locally-rare or locally-extinct in Wellington City.

Monitoring ongoing changes to native bird populations in the city provides a useful means by which the outcome of the considerable time and effort being spent on improving Wellington City's biodiversity can be measured. For this reason, Wellington City Council has identified a need to monitor local bird populations to provide one measure of the success or otherwise of their recently adopted Biodiversity Strategy & Action Plan (WCC, 2015). Goal 4.2.2a of this Biodiversity Strategy involves setting up a "consistent terrestrial outcome monitoring framework…incorporating existing monitoring work in a collaborative approach with other key organisations" (WCC, 2015).

Five-minute bird count monitoring has been carried out between 2001 and 2009 in nine selected parks and reserves in Wellington City by Pacific Eco-Logic Ltd (Froude, 2009). These counts were successful in detecting substantial increases in the local abundance of tui at a key time during which a large expansion in pest control efforts in Wellington City was underway. These counts also provided some of the earliest evidence that bird species re-introduced to Zealandia were dispersing and settling in nearby reserves (Froude, 2009).

In 2011 this bird monitoring programme was replaced with a new survey designed to monitor changes in the distribution and abundance of native forest birds across the entire network of Wellington City parks and reserves, rather than a selected subset of reserves (McArthur et al, 2012). Tui were chosen

[1] A joint initiative between the Morgan Foundation, Wellington City Council, Department of Conservation and Greater Wellington Regional Council (http://halo.org.nz/; accessed 24/06/2016)

[2] http://halo.org.nz/remarkable-achievement-new-zealands-first-predator-free-community/; accessed 24/06/2016

as a key focal species for this survey design due to their conspicuousness and popularity with the general public. Based on a power analysis of the pre-2011 Wellington City bird survey data, a sample size of 200 five-minute bird counts carried out at 100 locations across the city's parks and reserves network was chosen to ensure that this new design had sufficient statistical power to detect a 10% or more change in the relative abundance of tui in Wellington City reserves from one year to the next.

These counts have now been carried out each year since 2011, and have demonstrated the important influence that Zealandia has on the native forest bird community in the wider Wellington City. Around 33% of the native forest bird species detected in Wellington City parks and reserves each year are species that have been re-introduced to Zealandia and have subsequently expanded their range to include a number of other parks and reserves in the city (McArthur et al, 2012; 2013a; 2015). Many of these species were found to have very localised distributions beyond Zealandia's predator-proof fence however, indicating that mammalian predators are likely to still be significantly limiting the ability of these species to colonise other native forest habitats in the city's parks and reserves (McArthur et al, 2015).

Another key result is that some species, notably tui, undergo substantial fluctuations in abundance and/or conspicuousness from one year to the next. These large, short-term fluctuations appear to be driven by local changes in tui distribution in response to changes in local food supply (McArthur et al, 2015). This in turn suggests that it may take a number of years for longer-term trends in some bird populations to become apparent above and beyond these short term, annual fluctuations currently being observed.

The incorporation of bird distribution data collected by local 'citizen scientists' into the distribution maps created as part of this bird monitoring programme has allowed us to map the distribution of native birds in Wellington City in unprecedented detail. These maps have helped document the range expansion of recently re-introduced species such as kaka and red-crowned parakeet in Wellington City virtually in real-time, and have documented a number of local re-colonisation events that have occurred in recent years in several individual parks and reserves (McArthur et al, 2015).

This report provides an update on the emerging trends in the diversity, abundance and distribution of birds throughout Wellington City, by analysing and reporting a fifth year of five-minute bird counts and another year of citizen-science data collected since the publication of the previous bird monitoring report in October 2015.

2 METHODS

2.1 Five-minute bird count data collection

One hundred bird count stations were established at random locations in forest habitat in Wellington City parks and reserves in November 2011 and have been surveyed annually between 2011 and 2015 (Figure 2.1). Bird count stations were established at a minimum distance of 200 metres from one another and no less than 50 metres from the nearest forest edge. Each station was marked with either a blue triangle affixed to a living tree, or with pink flagging tape if situated in plantation forest.

Two five-minute bird counts were carried out at each station each year, with each count being carried out on a different day. All counts were carried out in November or early December each year and counts were made only on fine, calm days between 1.5 hours after sunrise and 1.5 hours before sunset (approximately 7.30 am to 6.30 pm). At each station, an observer spent five minutes recording the number of individuals of all species seen or heard from the count station (i.e. an unbounded count as per Dawson & Bull, 1975 and Hartley & Greene, 2012). Care was taken not to record the same bird twice during a count. Two experienced observers were employed to conduct the counts each year, with each observer surveying approximately half of the bird count stations each.

Bird conspicuousness can vary in response to a number of external variables such as time of year, weather, time of day and change in observer (Bibby et al, 2000). Because of this, every effort was made to standardise or sample the range of variation in each of these factors to ensure that as much as possible any changes in the mean number of birds counted per station from one year to the next would more likely reflect changes in bird abundance rather than conspicuousness. Precautions taken include carrying out these counts during the same months each year and in similar weather conditions. Counts were carried out throughout the day, so sampled any variation in bird conspicuousness that occurred during the day.

Observer-related variation can have a substantial impact on five-minute bird count results, and can sometimes either mask or be mistaken for true changes in bird abundance or conspicuous from one survey to the next (McArthur et al, 2013a). For this reason, we've endeavoured to minimise the number of observers used to collect this five-minute bird count data, with only two changes being made so far during the five year duration of this project. In each case, when one observer has been replaced with another, the second observer has remained the same across both years, thus providing us with some ability to differentiate observer-related variation in bird encounter rates from those caused by true changes in bird conspicuousness or abundance from one year to the next.

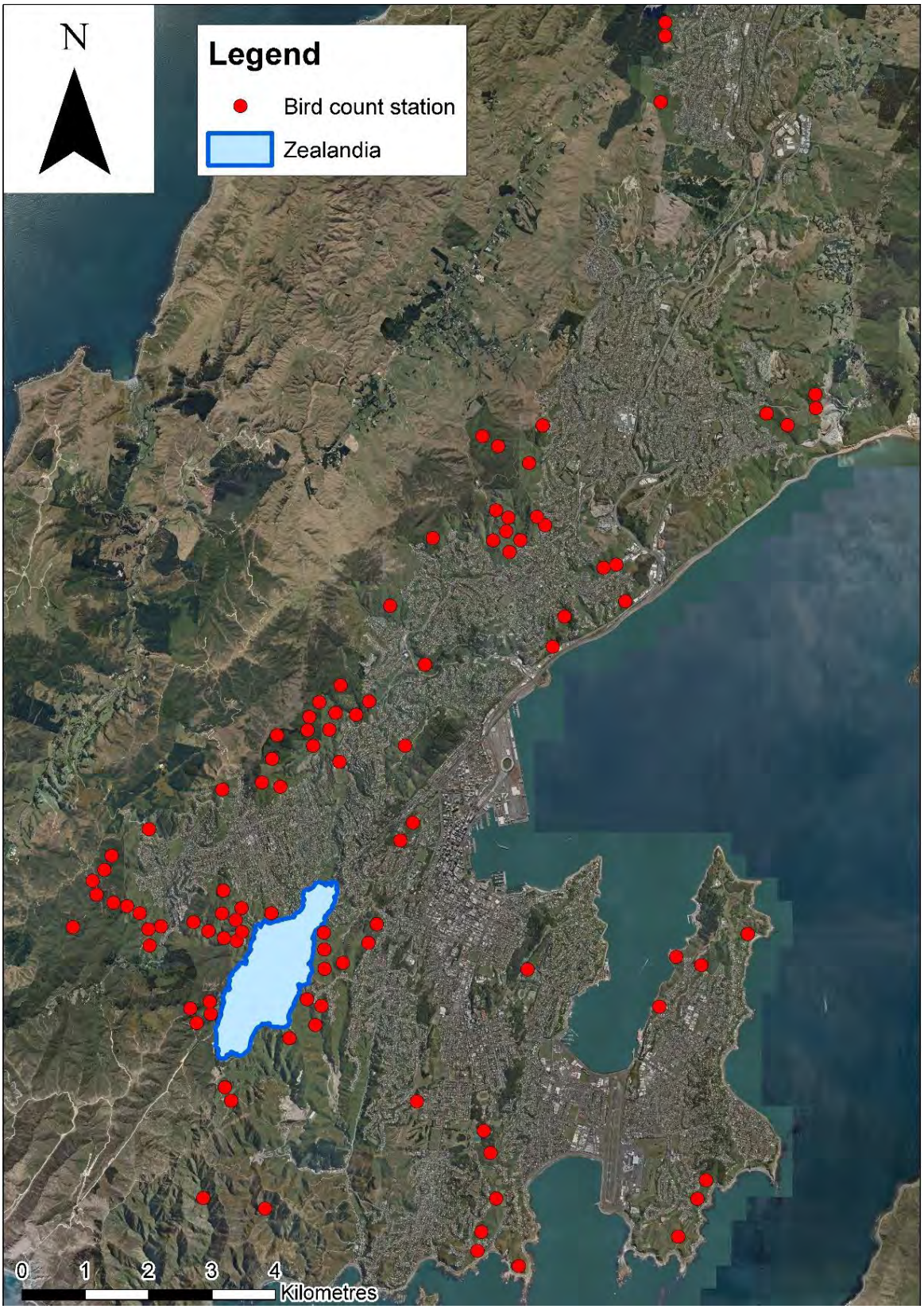

Figure 2.1: Locations of five-minute bird count stations established in Wellington City parks and reserves in 2011

2.2 Five-minute bird count data analysis

The Wellington City five-minute bird count data were entered into a Microsoft Excel spreadsheet, along with five-minute bird count data collected from Upper Hutt (n=90 counts) and south Wairarapa (n=45 counts) reserves as well as Porirua Scenic Reserve (n=45 counts), all of which were also surveyed between 2011 and 2015. Details of the survey design, location and number of reserves sampled in Upper Hutt can be found described in McArthur et al, 2013b). The south Wairarapa reserves sampled included O'Connor's Bush in Greytown Memorial Park, Tauherenikau Bush at the Tauherenikau Racecourse and Waihora Bush (Waihora Stream on NW boundary of Aorangi Forest Park).

Once entered, these bird count data were used to calculate the mean number of native forest bird species detected per five-minute bird count for each reserve network and each year, in order to examine temporal and spatial patterns in the diversity of resident native species. For the purposes of this analysis, we defined a "native forest bird" as any native species capable of maintaining a functional population entirely within native forest habitat, and therefore likely to be a resident rather than transitory species in this habitat. We also used these data to calculate the mean number birds of each species recorded per count for each network and year, to create indices of the relative abundance and/or conspicuousness of each bird species in the Wellington City reserves network (Dawson & Bull, 1975).

Because these raw data consist of relatively low counts which are naturally truncated at zero, the data is too skewed to conform to a normal distribution, a key assumption for many parametric tests for statistical significance. To deal with this, we first added a value of 1.0 to the number of species and individuals recorded during each count in order to remove zero values from the dataset, then applied an *a priori* square root transformation to the data to ensure that they were approximately normally distributed and with approximately equal sample variances before we proceeded with any further analyses. Once we were satisfied that our transformed data met these assumptions, we used one-way analyses of variance (ANOVA) to test for statistically-significant differences in mean species diversity values and abundance indices in Wellington City between years. To test for differences in mean values between years and reserve networks, we used two-way ANOVAs. However, because two-way ANOVAs require sample sizes to be equal, we performed the test on a random sub-sample of 90 Wellington City bird counts in order to compare mean values with those calculated from the Upper Hutt City bird count data. In cases where the results of our ANOVAs did indicate that mean values varied significantly, we then applied two-tailed *z*-tests to the transformed dataset to determine which of the mean values in each group varied significantly from each other (Fowler & Cohen, 1995). Both the ANOVAs and *z*-tests are important because a statistically significant result indicates that any difference between the two or more means being compared is very unlikely to have occurred due to chance sampling error, so instead is assumed to represent a real difference in the diversity or abundance of native forest birds between years, or between one or more of the four reserve networks/sites that we surveyed.

Patterns in the distribution of native birds among Wellington City reserves were examined by mapping the relative frequency at which each native forest bird species was detected at each bird count station using ArcMap version 10.4. Although this technique does not explicitly take into account relative differences in abundance (less common species present within sight or earshot of a bird count station are less likely to be detected) or variation in detection probabilities between species (less conspicuous species will also be less likely to be detected), it should be sufficient to detect relatively large changes in species' distributions (Mackenzie et al, 2006).

2.3 Citizen science data analysis

The New Zealand eBird database (http://ebird.org/content/newzealand/) is a citizen science enterprise run by the Cornell Lab of Ornithology in partnership with Birds New Zealand (formerly the Ornithological Society of New Zealand). The eBird database provides a facility for recreational birdwatchers to permanently record their bird observation in a standard format and in one centralised location and to make these observations available to researchers, conservation managers and environmental policy-makers (Scofield et al, 2012). Globally, the eBird database is now the largest and fastest growing biodiversity database in the world, with over 316,000 unique users having so far contributed over 330 million bird records describing the distribution of 98% of the world's bird species (Sullivan et al, 2014; http://ebird.org/content/ebird/news/333million/, accessed 24/06/2016).

The New Zealand eBird database now contains in excess of 165 000 bird records recorded by citizen scientists in the Wellington region. Automated data filters and an expert review process ensures that these data are of relatively high quality and accuracy (Sullivan et al, 2014). We used eBird's "download data" tool to access the May 2016 release of the eBird Basic Dataset (EBD) and to build custom datasets containing citizen science records of all native forest bird species recorded in Wellington City between 2011 and 2015. We formatted these datasets using Microsoft Excel, including removing any extraneous data fields and converting latitude/longitude coordinates to NZTM coordinates. We then saved these files as tab-delimited text files so that they could be imported into ArcMap and converted into shapefiles. Once in ArcMap, we visually inspected these eBird records to locate and remove any records containing obvious location errors (e.g. records placed offshore, or for which location descriptions didn't match the coordinates provided) before adding these records to the distribution maps created from the five-minute bird count data.

A key difference between these eBird datasets and the five-minute bird count data is that the temporal and spatial distribution of search effort spent by citizen scientists contributing to the EBD varies unpredictably from year to year, whereas this search effort is standardised during these five-minute bird counts. Nonetheless, verified bird records submitted to eBird have the potential to complement distribution data derived from our five-minute bird count dataset by providing information describing the presence of native forest birds at locations and in habitats not sampled by these five-minute bird counts.

3 RESULTS

3.1 Species diversity

The total number of bird species detected during these five minute bird counts has varied little between 2011 and 2015, with between 29 and 33 bird species detected each year (Figure 3.1). Between 10% and 19% of these species detected each year are native species ranked as either Nationally Threatened or 'At Risk' under the New Zealand Threat Classification System and a further 32% to 41% are native species ranked as Not Threatened (Robertson et al, 2013). Between 42% and 48% of species detected are listed as Introduced and Naturalised (see Appendix).

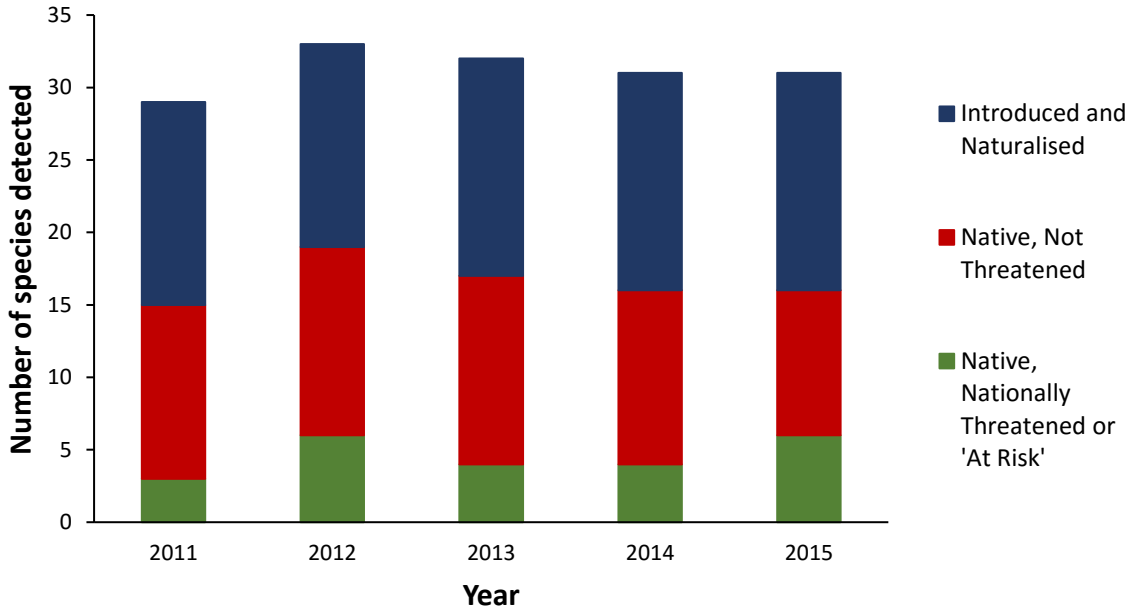

Figure 3.1: Total number of bird species detected during five-minute bird counts carried out in Wellington City parks and reserves, 2011-2015.

Fourteen of the native bird species detected between 2011 and 2015 were species that are typically found in native forest habitat and it is these species for which trends in relative abundance and distribution have been reported below. The remaining nine native species recorded were either open-country or coastal species such as Australasian harrier (*Circus approximans*), paradise shelduck (*Tadorna variegata*) or red-billed gull (*Larus novaehollandiae*) and are not included in any further analyses.

Between 2011 and 2015 there has been a significant increase in the mean number of native forest birds detected per bird count station in Wellington City reserves, despite some year-to-year variation ($F_{4,995} = 11.63$, $p = 3.1 \times 10^{-9}$; one-way ANOVA). In contrast, there has been no consistent trend in the mean number of native forest bird species detected in Upper Hutt City and South Wairarapa reserves and in Porirua Scenic Reserve over the same period of time (Figure 3.2). The average number of native

forest bird species recorded per count station in Upper Hutt City reserves continues to be significantly higher than those recorded in Wellington City each year (F_1 = 176.30, P = 7.71 x 10^{-37}; two-way ANOVA).

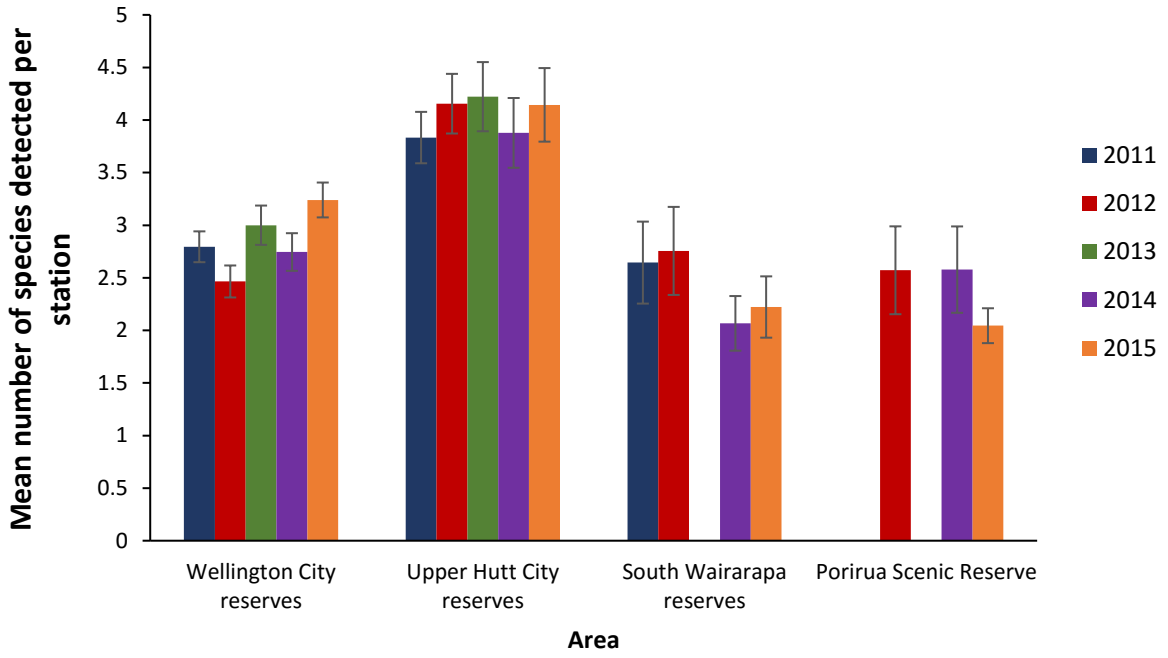

Figure 3.2: Mean number of native forest bird species recorded per count station in Wellington City (n=200), Upper Hutt City (n=90), south Wairarapa (n=45) reserves and in Porirua Scenic Reserve (n=45) between 2011 and 2015 (error bars represent 95% confidence limits). NB: south Wairarapa reserves weren't monitored in 2013 and Porirua Scenic Reserve wasn't monitored in 2011 or 2013.

3.2 Bird abundance

Silvereye (*Zosterops lateralis*), tui, grey warbler (*Gerygone igata*), fantail (*Rhipidura fuliginosa*) and shining cuckoo (*Chrysococcyx lucidus*) have been the five most frequently-encountered native forest bird species recorded in Wellington City reserves each year between 2011 and 2015. Silvereye has been the most frequently encountered species most years, with between 1.9 and 2.4 individuals recorded per count station between 2011 and 2015. A significant increase in the silvereye encounter rate observed between 2011 and 2012 (z = 1.96, p = 0.0028; two-tailed z-test) was likely to be a consequence of a change in observer between these two surveys (McArthur et al, 2013a) and no further changes in silvereye abundance have been detected during subsequent years (Figure 3.3). Tui has been the second most frequently-encountered species in most years, but there has been a significant increase in the tui encounter rate between 2011 and 2015 ($F_{4,995}$ = 26.85, p = 3.55 x 10^{-21}; one-way ANOVA) despite some substantial year-to-year variation in mean counts. Mean numbers of tui encountered per count stations have increased from a low of 0.8 birds in 2012 to a high of 2.6 birds in 2015. Numbers of grey warblers encountered per station have been less variable, but there has been a similarly significant increase in the grey warbler encounter rate between 2011 and 2015 ($F_{4,995}$

= 9.99, p = 6.30 x 10^{-8}; one-way ANOVA). Mean numbers of grey warblers encountered per count station have increased from a low of 0.8 birds in 2011 to a high of 1.5 birds in 2015. A significant increase in the grey warbler encounter rate between 2011 and 2012 (z = 1.96, p = 0.00015; two-tailed z-test) was also likely to be due to the change in observer between these two surveys (McArthur et al, 2013a) No significant variation in the abundance of fantails ($F_{4,995}$ = 2.58, p = 0.065; one-way ANOVA) or shining cuckoos ($F_{4,995}$ = 0.89, p = 0.467; one-way ANOVA) have been detected between 2011 and 2015, with 0.2 - 0.3 and 0.2 birds counted per station for these species respectively each year.

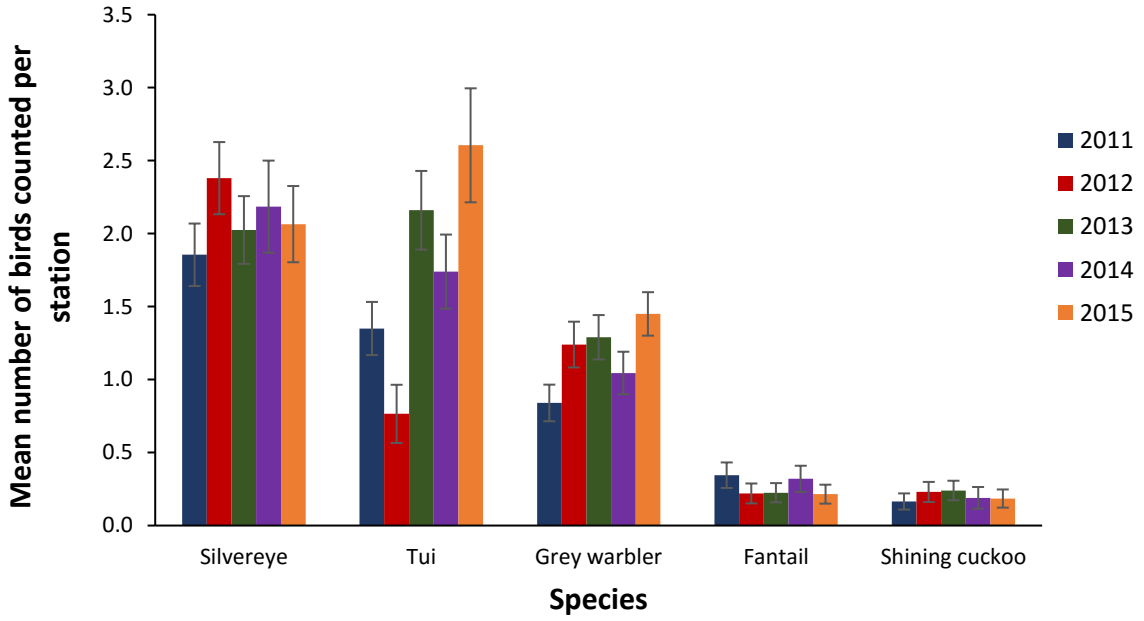

Figure 3.3: Mean number of birds recorded per count station for relatively common or conspicuous native forest bird species recorded in Wellington City reserves between 2011 and 2015 (error bars represent 95% confidence limits).

The nine remaining native forest bird species have all been encountered at a rate of less than 0.3 birds per count station each year (Figure 3.4). There has been a significant increase in the encounter rate for kaka between 2011 and 2015 ($F_{4,995}$ = 4.33, p = 0.0017; one-way ANOVA), with much of this increase occurring between 2014 and 2015. The mean number of kaka encountered per count station each year has increased from a low of 0.07 birds in 2012 to a high of 0.24 birds in 2015. Encounter rates for red-crowned parakeets have also increased significantly over the past five years ($F_{4,995}$ = 6.30, p = 5.22 x $10^{-5;}$ one-way ANOVA), with much of this increase occurring since 2013. Encounter rates for this species have varied from an average of 0.01 birds recorded per count station in 2011-2013 to 0.08 birds per station in 2015. North Island saddleback encounter rates (*Philesturnus rufusater*) have also shown significant variation between years, with numbers of saddleback encountered per station significantly lower during the years 2012-2014 than in 2011 or 2015 ($F_{4,995}$ = 3.31, p = 0.011; one-way ANOVA). Several other species have not been detected during all five annual surveys. North Island robins (*Petroica longipes*) weren't detected during five minute bird counts in 2014 despite being recorded each other year between 2011 and 2015. Similarly, both bellbird and New Zealand falcon (*Falco novaeseelandiae*) weren't detected in 2011 but have been recorded during five-minute bird counts in most subsequent years.

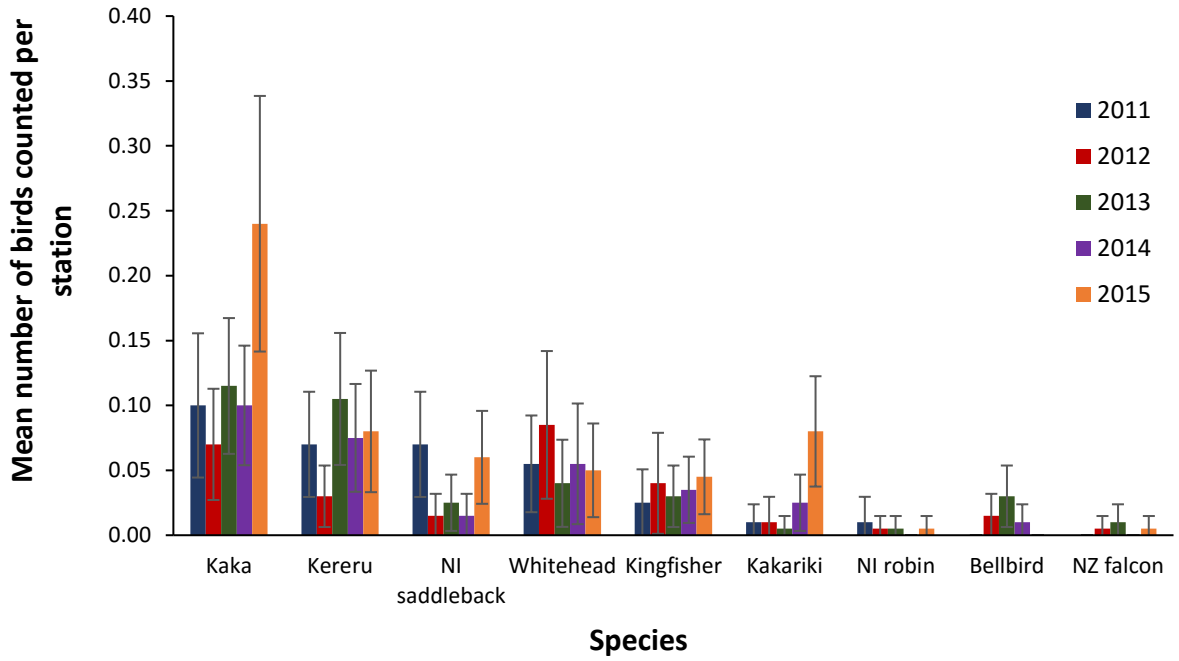

Figure 3.4: Mean number of birds recorded per count station for relatively rare or inconspicuous native forest bird species recorded in Wellington City reserves between 2011 and 2015 (error bars represent 95% confidence limits).

Blackbird (*Turdus merula*), chaffinch (*Fringilla coelebs*), starling (*Sturnus vulgaris*), house sparrow (*Passer domesticus*) and dunnock (*Prunella modularis*) have been the five most frequently-encountered introduced bird species recorded in Wellington City reserves between 2011 and 2015. Blackbird has been the most abundant and/or conspicuous species, with encounter rates exceeding those of even the most common native bird species detected during these surveys. Moreover, the mean number of blackbirds encountered per bird count station has increased significantly between 2011 and 2015, from a low of 2.3 birds counted per station in 2011 to a high of 3.0 bird per station in 2014 ($F_{4,995}$ = 4.89, p = 0.00066; one-way ANOVA). Encounter rates for chaffinch have not changed significantly between 2011 and 2015, with a mean of 0.9 – 1.1 birds detected per count each year ($F_{4,995}$ = 1.54, p = 0.187; one-way ANOVA). Starlings on the other hand varied from 0.2 – 0.4 birds per count each year, with a significant decrease in encounter rate observed between 2012 and 2013 (z = 1.96, p = 0.00173; two-tailed z-test). Both house sparrow and dunnock encounter rates have been significantly and consistently higher in 2012-2015 than in 2011, however this is likely to be a consequence of the change in observers that occurred between the 2011 and 2012 counts (McArthur et al, 2013a).

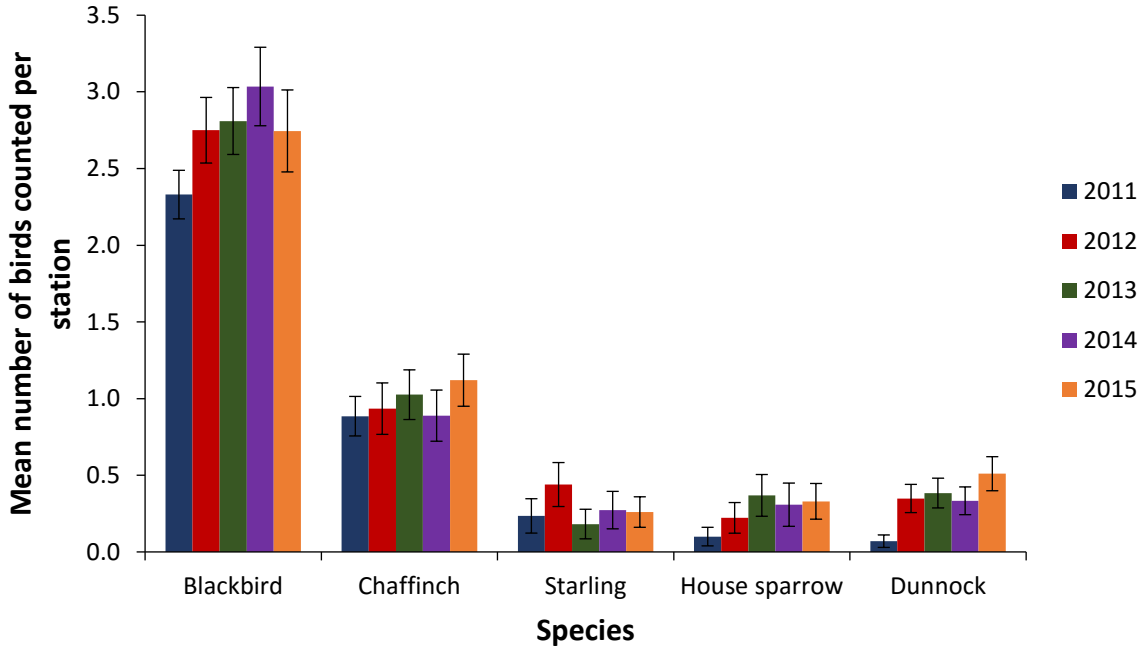

Figure 3.5: Mean number of birds recorded per count station for relatively common or conspicuous introduced bird species recorded in Wellington City reserves between 2011 and 2015 (error bars represent 95% confidence limits).

The remaining introduced bird species that have been recorded between 2011 and 2015 were all encountered at a rate of less than 0.6 birds per count station (Figure 3.6). Mean encounter rates for goldfinch (*Carduelis carduelis*) and yellowhammer (*Emberiza citrinella*) remained significantly higher in 2012-2014 than in 2011, likely to be a result of the previously-described observer effect (McArthur et al, 2013a). Redpolls (*C. flammea*) and feral chickens (*Gallus gallus*) continued to be encountered each year between 2012 and 2014, despite neither species having been detected during the 2011 counts.

No crimson rosellas (*Platycercus elegans*) have been detected during any of the five-minute bird counts carried out over the past five years. A small population of crimson rosellas became established in western and north-western suburbs of Wellington City around 1963, with credible sightings of birds occurring as recently as the mid-1990s (Galbraith, 2013; Heather & Robertson, 2015; New Zealand eBird database, http://ebird.org/content/newzealand/; accessed 24/06/2016). This result provides additional confirmation that this crimson rosella population has now apparently either died out or has become absorbed into the local eastern rosella (*P. eximius*) population.

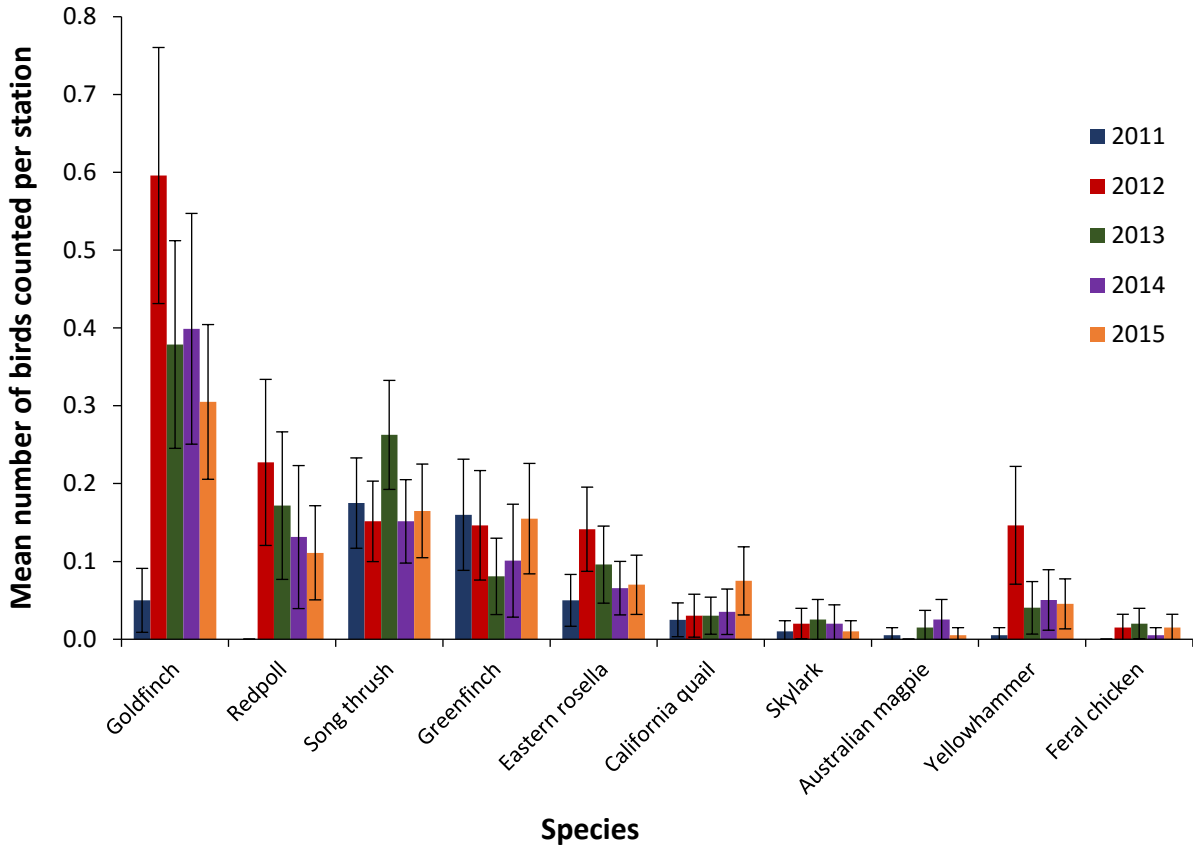

Figure 3.6: Mean number of birds recorded per count station for relatively rare or inconspicuous introduced bird species recorded in Wellington City reserves between 2011 and 2015 (error bars represent 95% confidence limits).

3.3 Native bird distribution

Tui continue to be widespread across Wellington City, despite being a relatively rare and infrequent visitor to many parts of the city as recently as 10 - 15 years ago (Figure 3.7; Bell, 2008). Tui have been detected at every one of the 100 five-minute bird count stations that have been surveyed between 2011 and 2015. The proportion of counts during which tui have been detected has generally been higher at count stations in western and northern suburbs of the city, and at stations within 1 km of Zealandia's predator-proof fence. In contrast, detection rates have tended to be lower in eastern suburbs and on Miramar Peninsula, although the large number of tui records submitted by citizen scientists from these eastern suburbs suggest that tui are resident or regular visitors to this part of the city as well (Figure 3.7). The combination of five-minute bird count records and citizen science observations show that tui are utilizing a range of habitats in Wellington City, including forest and shrub land habitats in Wellington's parks and reserve network as well as adjacent urban and suburban habitats.

In contrast, bellbirds remain much more sparsely distributed and have only been detected at 10% of the five-minute bird count stations surveyed between 2011 and 2015 (Figure 3.8). A concentration of bellbird detections at count stations in Khandallah Park suggests that a small resident population may now be established in this reserve. Bellbird detections in George Denton Park, the Wellington

Botanical Gardens and at Makara Peak are perhaps most likely to be birds dispersing from Zealandia, whereas several records in Tawa may represent birds dispersing south from the nearby source population in Porirua Scenic Reserve.

Several other native species such as silvereye, grey warbler and fantail are also relatively widespread in Wellington City and have been detected at a large proportion of the five-minute bird count stations between 2011 and 2015 (e.g. Figure 3.9). As with tui, the proportion of counts during which fantails are detected appears to be higher at count stations situated in western and northern suburbs and within 1 km of the Zealandia boundary fence.

In contrast, kereru appear to be much more patchily distributed in Wellington City and have only been detected at around 30% of the five-minute bird count stations surveyed between 2011 and 2015 (Figure 3.10). Kereru appear to be mainly restricted to patches of relatively mature native forest, including Otari-Wilton Bush, Khandallah Park and Zealandia and are sparse or absent from reserves with shorter, shrubby vegetation such as Wright's Hill and Makara Peak.

Of the several native species that have been re-introduced to Zealandia, North Island kaka have been the most successful at utilizing habitats in surrounding parts of Wellington City (Figure 3.11). NI kaka have been detected at 30% of the five-minute bird count stations surveyed between 2011 and 2015, most of which are either within 1 – 2 km of Zealandia, or situated in areas of relatively mature native forest such as Otari-Wilton, the Wellington Botanical Gardens and Trelissick Park. Being such a conspicuous and recognisable species, NI kaka are frequently reported by local citizen scientists, with several thousand records now having been submitted either to the Zealandia "report a bird" webpage, to the New Zealand eBird database or to Birds New Zealand. These observations demonstrate that kaka are regular visitors to suburban habitats in western and southern parts of Wellington City, but for a number of years appeared to be restricted to parts of the city to the south of Ngaio Gorge and to the west of Miramar Peninsula. Over the past 12 months however, several citizen science records of kaka on Miramar Peninsula and at sites on the eastern side of Wellington Harbour, including in East Harbour Regional Park and the Wainuiomata Mainland Island (GWRC, unpublished data) suggest that the range of this species is continuing to expand eastwards.

Red-crowned parakeets also appear to be re-establishing rapidly in Wellington City (Figure 3.15). Between 2011 and 2014, red-crowned parakeets had only been recorded at 6% of the five-minute bird counts stations surveyed, however in 2015 this jumped to 16% of stations with birds detected at a number of new locations in Wright's Hill, George Denton Park, Wellington Botanic Gardens and Otari-Wilton Bush. Although still a relatively rare bird in Wellington City, red-crowned parakeets have also been reported by citizen scientists from many additional locations across the city, including in both parks and reserves and in suburban gardens. Clusters of records from Otari-Wilton Bush, Khandallah Park and Trelissick Park and in forested reserves in the Tawa area suggest that small resident populations may now be established at these locations. While many of these more southern 'satellite' populations are likely to have been founded by birds dispersing from Zealandia, some of these populations may also be receiving immigrants from Matiu/Somes Island. Red-crowned parakeet populations in the Tawa area may similarly be receiving immigrants from the apparently healthy source population now established in Porirua Scenic Reserve.

A number of other species that have been re-introduced to Zealandia remain largely restricted to Zealandia itself or to adjacent parks and reserves. Whitehead for instance are seldom recorded more than 1 – 2 km from the Zealandia boundary fence, although they do appear to have now colonised Trelissick Park, some 3.8 km to the north (Figure 3.12). North Island saddleback show a similar pattern, typically only encountered in reserves such as George Denton Park and Wright's Hill, immediately adjacent to Zealandia. One NI saddleback however, was recorded at a five-minute bird count station in Te Kopahou Reserve 2.4 km south of the boundary fence in 2012 (Figure 3.13).

Despite having been well-established in Zealandia for a relatively long time, North Island robins have not yet spread very far beyond the boundary fence. Robins have only been detected at one of the Wellington City five-minute bird count stations surveyed between 2011 and 2015 (in George Denton Park) and have only been reported by local citizen scientists from locations within 1 km of Zealandia's boundary (Figure 3.14).

Several other native forest species are still sufficiently rare in Wellington City that they have barely been detected (if at all) during the five-minute bird counts carried out between 2011 and 2015. New Zealand falcons have only been detected at three of the 100 bird count stations surveyed over the past five years, but being relatively conspicuous and distinctive birds they are regularly reported by local citizen scientists at locations throughout Wellington City (Figure 3.16). NZ falcons are also known to breed in Wellington City's parks and reserves, including one pair that nested on Te Ahumairangi Hill in Thorndon in October 2015[3]. Similarly, hihi (*Notiomystis* cincta) have not yet been detected at any Wellington City five-minute bird count stations, but local citizen scientists have reported sightings of hihi from reserves adjacent to Zealandia on a number of occasions (Figure 3.17). Long-tailed cuckoos (*Eudynamys taitensis*) have also occasionally been recorded by citizen scientists since 2011, but the scarcity of these records, and the total absence of detections during these five-minute bird counts suggests that this species is either a vagrant or very rare annual visitor to Wellington City at the present time (Figure 3.18). Long-tailed cuckoos are annual visitors to other forest habitats in the Wellington region, including Kapiti Island, Akatarawa and Pakuratahi Forests, East Harbour Regional Park and the Tararua and Rimutaka Forest Parks. All of these forest areas have large, resident whitehead populations however, so the absence of long-tailed cuckoos from Wellington City is presumably a consequence of the absence of whiteheads from Wellington City forests until comparatively recently.

Morepork (*Ninox novaeseelandiae*) also haven't yet been detected during these five-minute bird counts. Citizen science records submitted since 2011 show that morepork are present in parks, reserves and suburban habitats throughout the city, but the sparseness of these records suggests that moreporks are either relatively uncommon in Wellington City, or perhaps more likely that citizen scientists are under-reporting this nocturnal species (Figure 3.19). It's possible therefore that morepork is now the most common and widespread resident native bird species in Wellington that we know relatively little about.

[3] http://www.stuff.co.nz/dominion-post/news/73108561/Council-warning-threatened-falcon-species-launch-fists-of-fury-against-walkers; accessed 24/06/2016

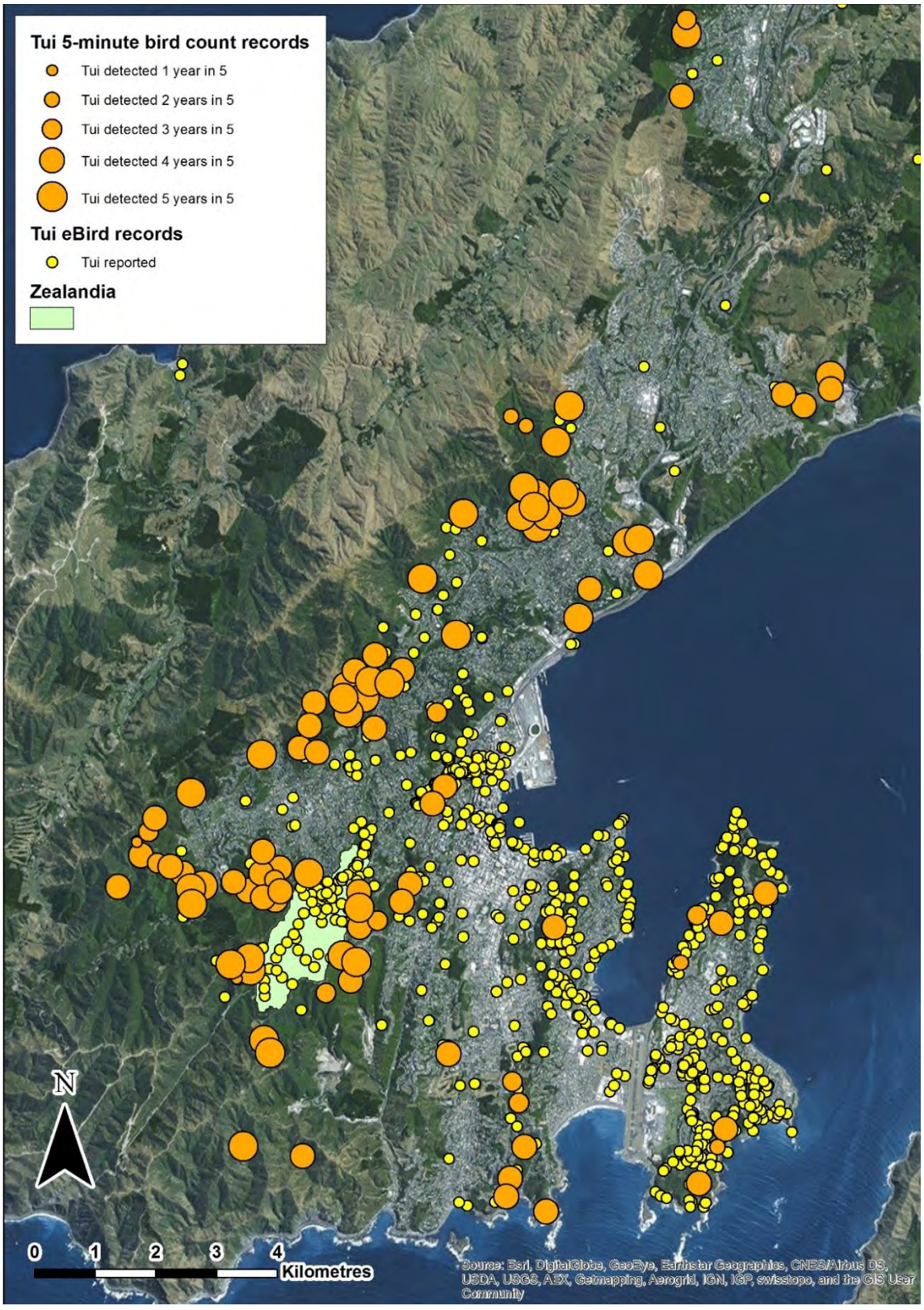

Figure 3.7: Distribution of tui in Wellington City between 2011 and 2016. Orange circles represent tui detections at five-minute bird count stations, with the size of the circle corresponding to relative detection frequency. Yellow circles represent tui observations sourced from the New Zealand eBird database (http://ebird.org/content/newzealand/; accessed 23/06/2016).

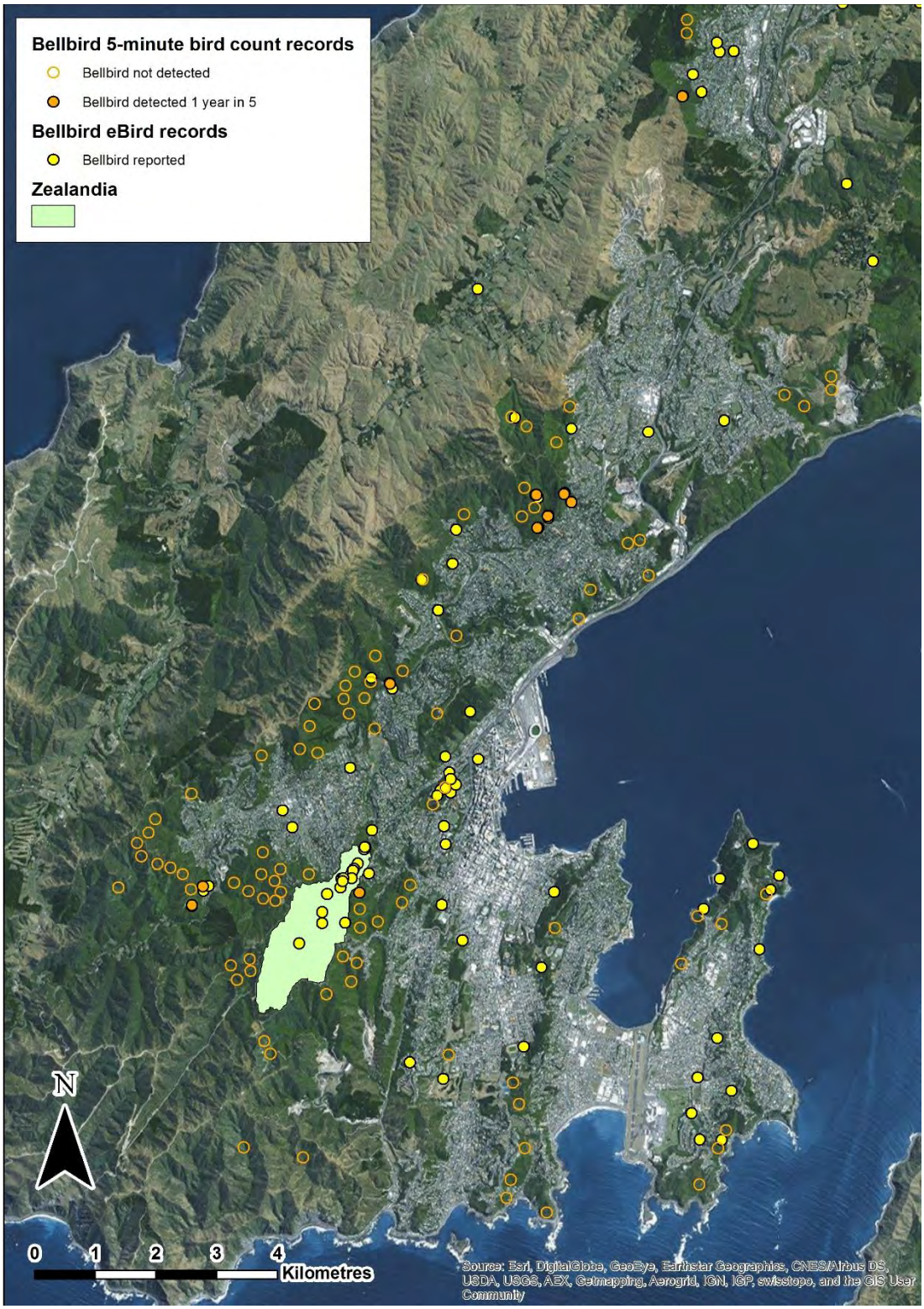

Figure 3.8: Distribution of bellbird in Wellington City between 2011 and 2016. Orange circles represent bellbird detections at five-minute bird count stations, with the size of the circle corresponding to relative detection frequency. Yellow circles represent bellbird observations sourced from the New Zealand eBird database (http://ebird.org/content/newzealand/; accessed 23/06/2016).

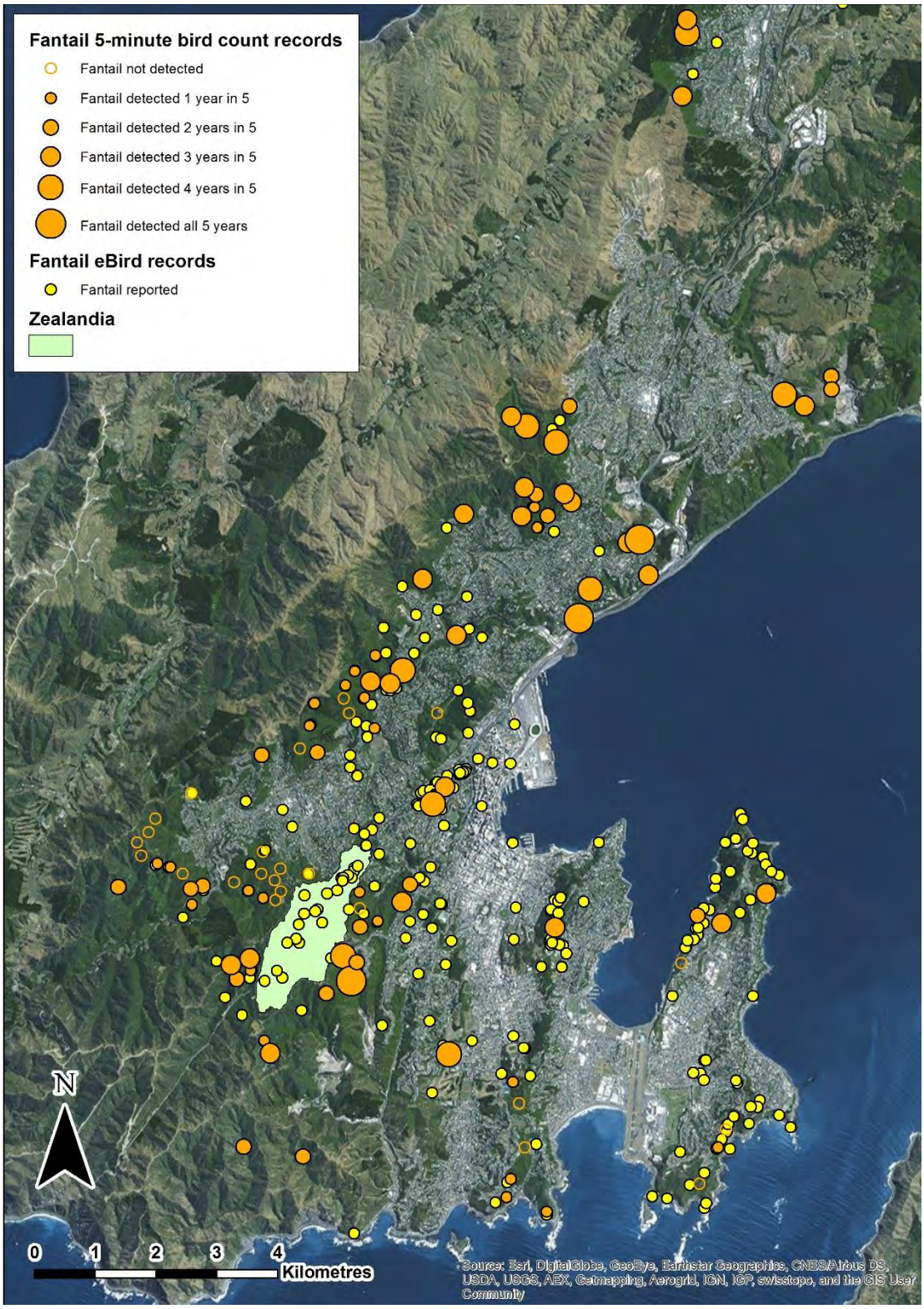

Figure 3.9: Distribution of fantail in Wellington City between 2011 and 2016. Orange circles represent fantail detections at five-minute bird count stations, with the size of the circle corresponding to relative detection frequency. Yellow circles represent fantail observations sourced from the New Zealand eBird database (http://ebird.org/content/newzealand/; accessed 23/06/2016).

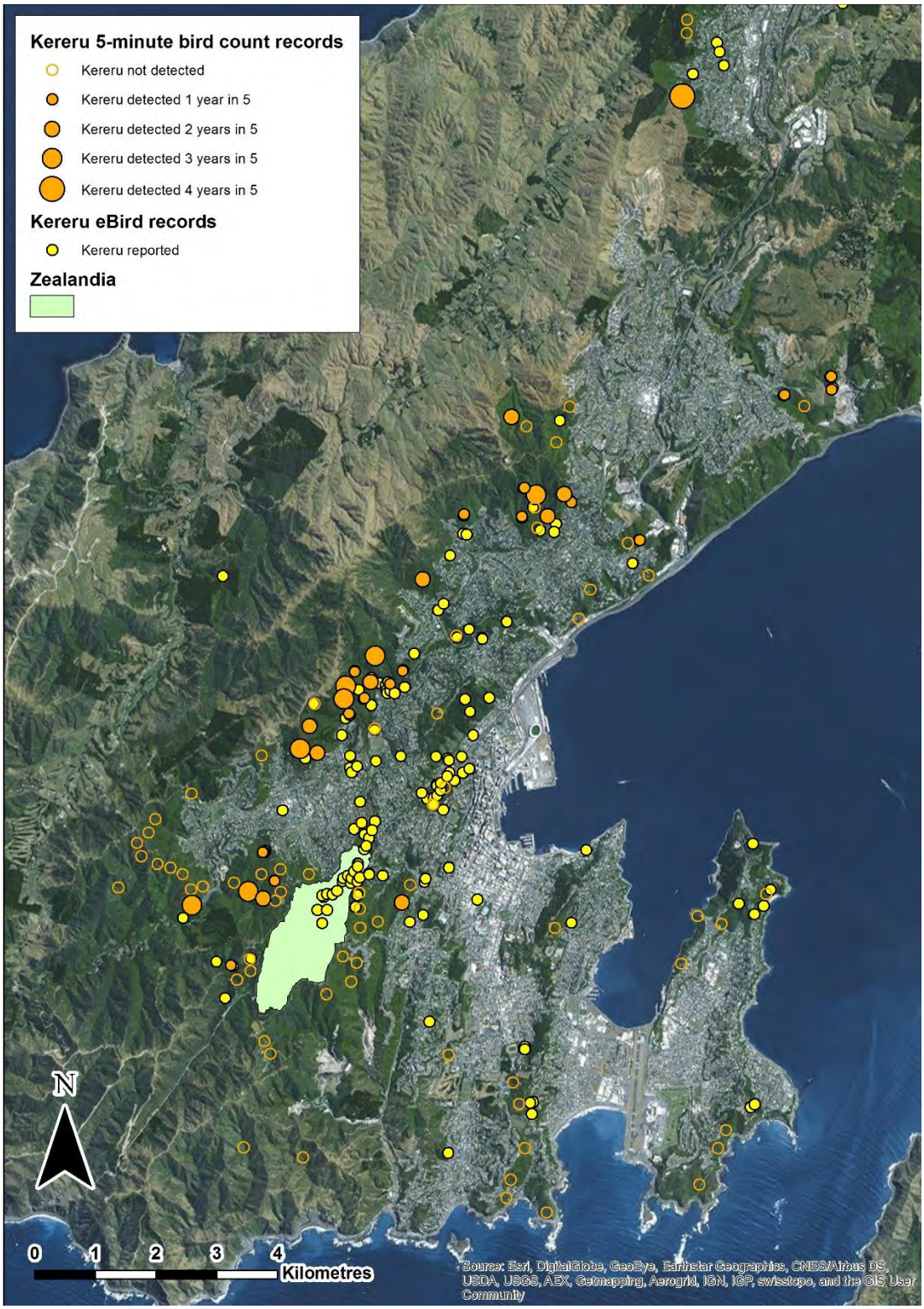

Figure 3.10: Distribution of kereru in Wellington City between 2011 and 2016. Orange circles represent kereru detections at five-minute bird count stations, with the size of the circle corresponding to relative detection frequency. Yellow circles represent kereru observations sourced from the New Zealand eBird database (http://ebird.org/content/newzealand/; accessed 23/06/2016).

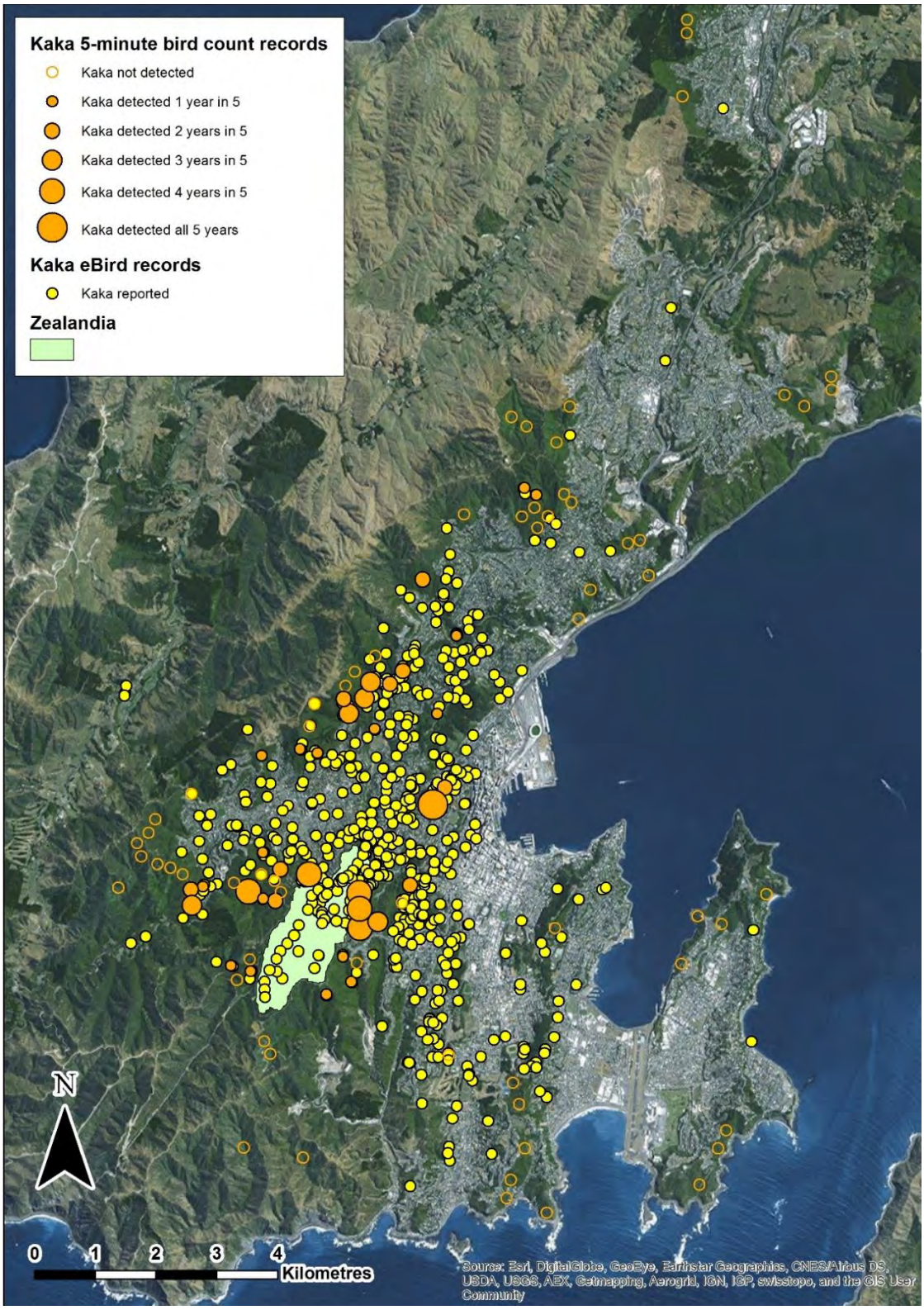

Figure 3.11: Distribution of kaka in Wellington City between 2011 and 2016. Orange circles represent kaka detections at five-minute bird count stations, with the size of the circle corresponding to relative detection frequency. Yellow circles represent kaka observations sourced from the New Zealand eBird database (http://ebird.org/content/newzealand/; accessed 23/06/2016).

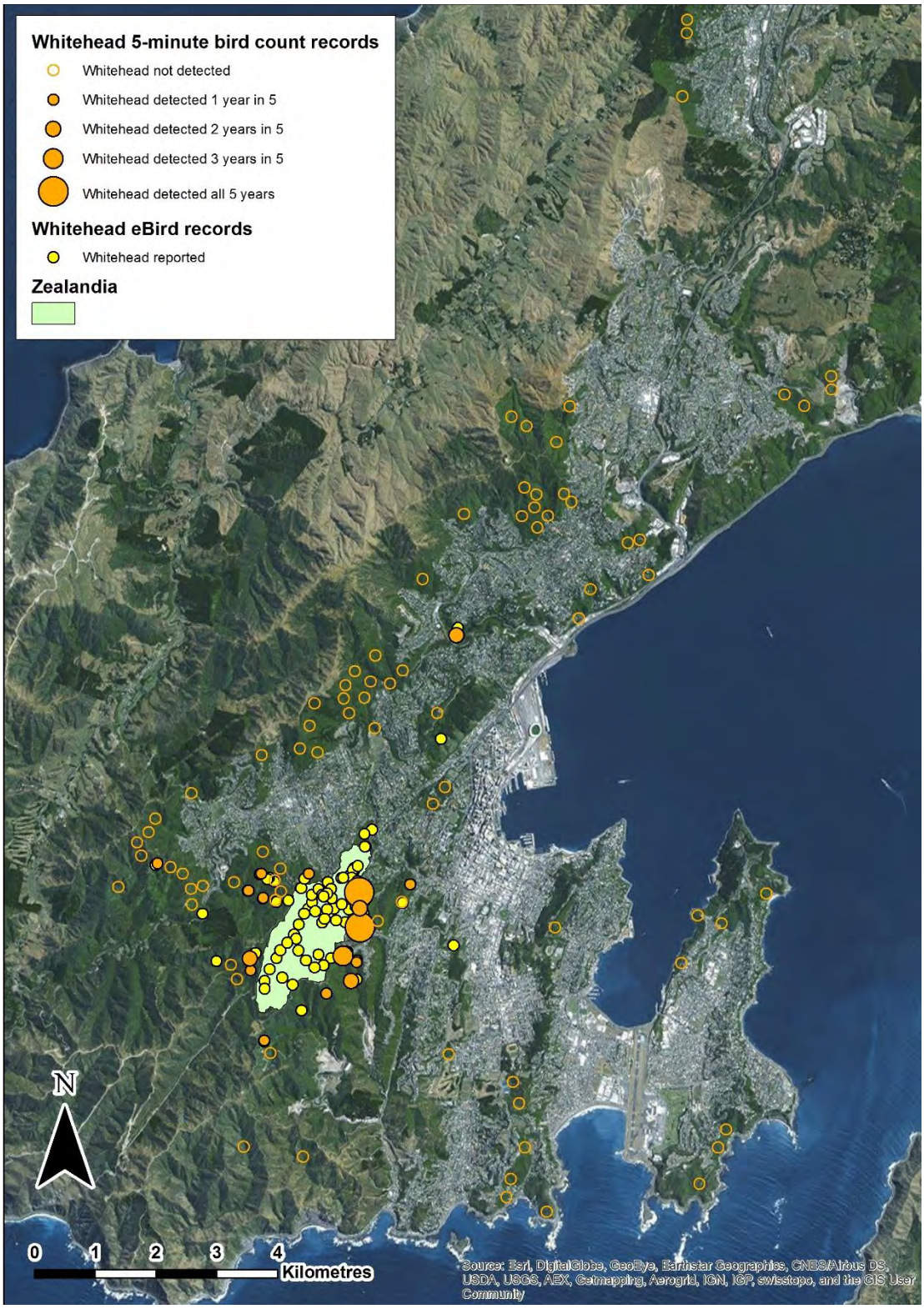

Figure 3.12: Distribution of whitehead in Wellington City between 2011 and 2016. Orange circles represent whitehead detections at five-minute bird count stations, with the size of the circle corresponding to relative detection frequency. Yellow circles represent whitehead observations sourced from the New Zealand eBird database (http://ebird.org/content/newzealand/; accessed 23/06/2016).

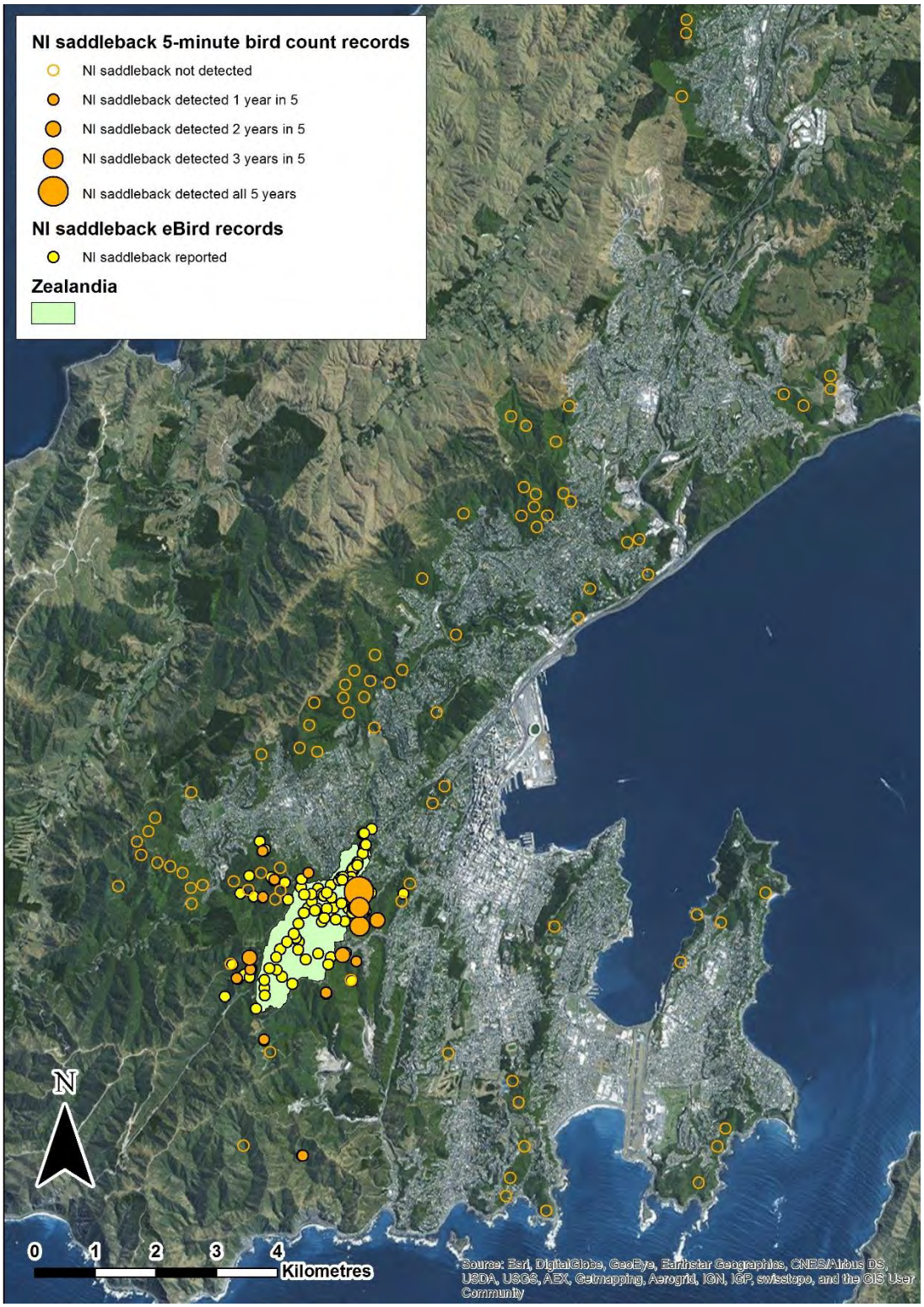

Figure 3.13: Distribution of NI saddleback in Wellington City between 2011 and 2016. Orange circles represent NI saddleback detections at five-minute bird count stations, with the size of the circle corresponding to relative detection frequency. Yellow circles represent NI saddleback observations sourced from the New Zealand eBird database (http://ebird.org/content/newzealand/; accessed 23/06/2016).

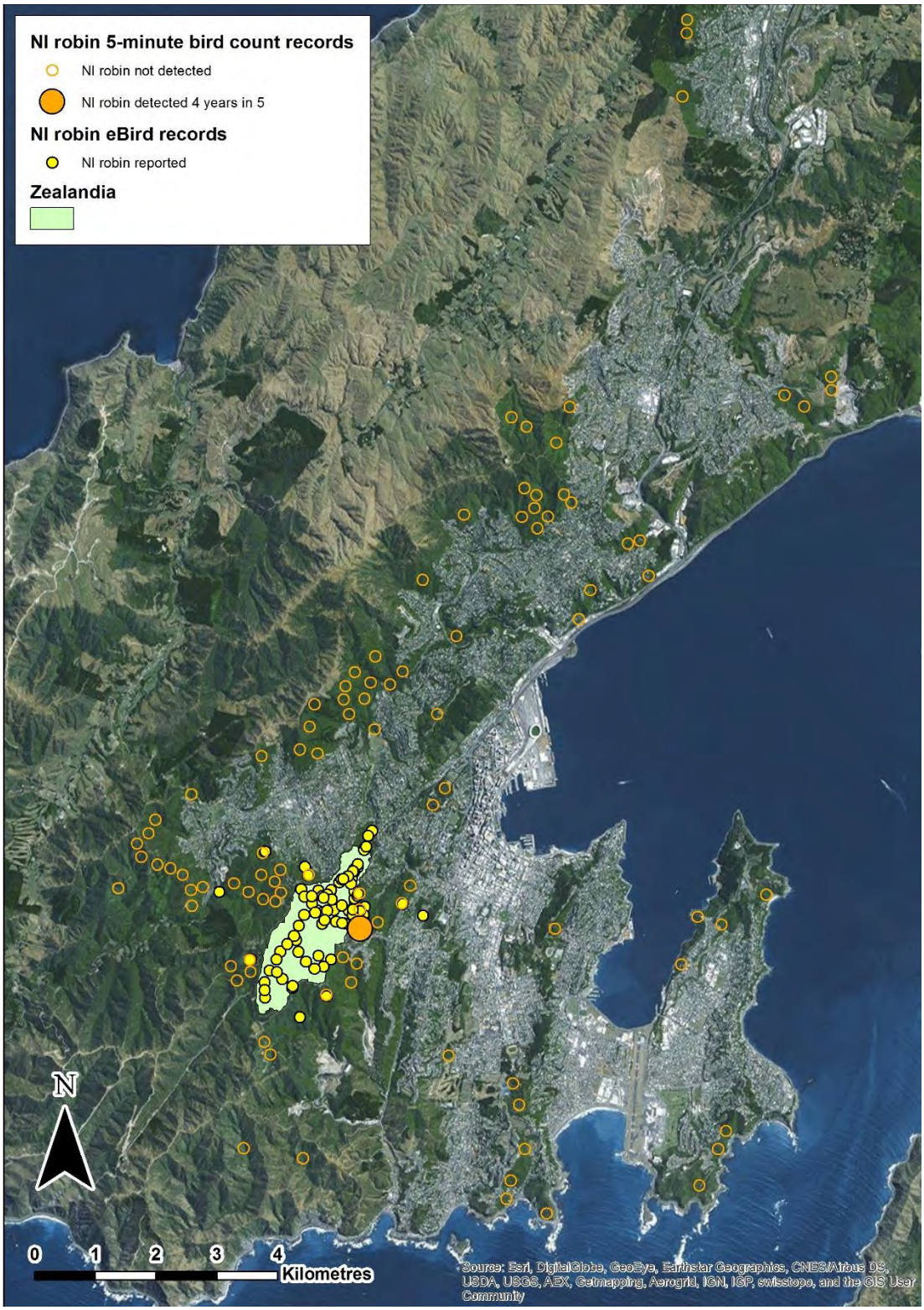

Figure 3.14: Distribution of NI robin in Wellington City between 2011 and 2016. Orange circles represent NI robin detections at five-minute bird count stations, with the size of the circle corresponding to relative detection frequency. Yellow circles represent NI robin observations sourced from the New Zealand eBird database (http://ebird.org/content/newzealand/; accessed 23/06/2016).

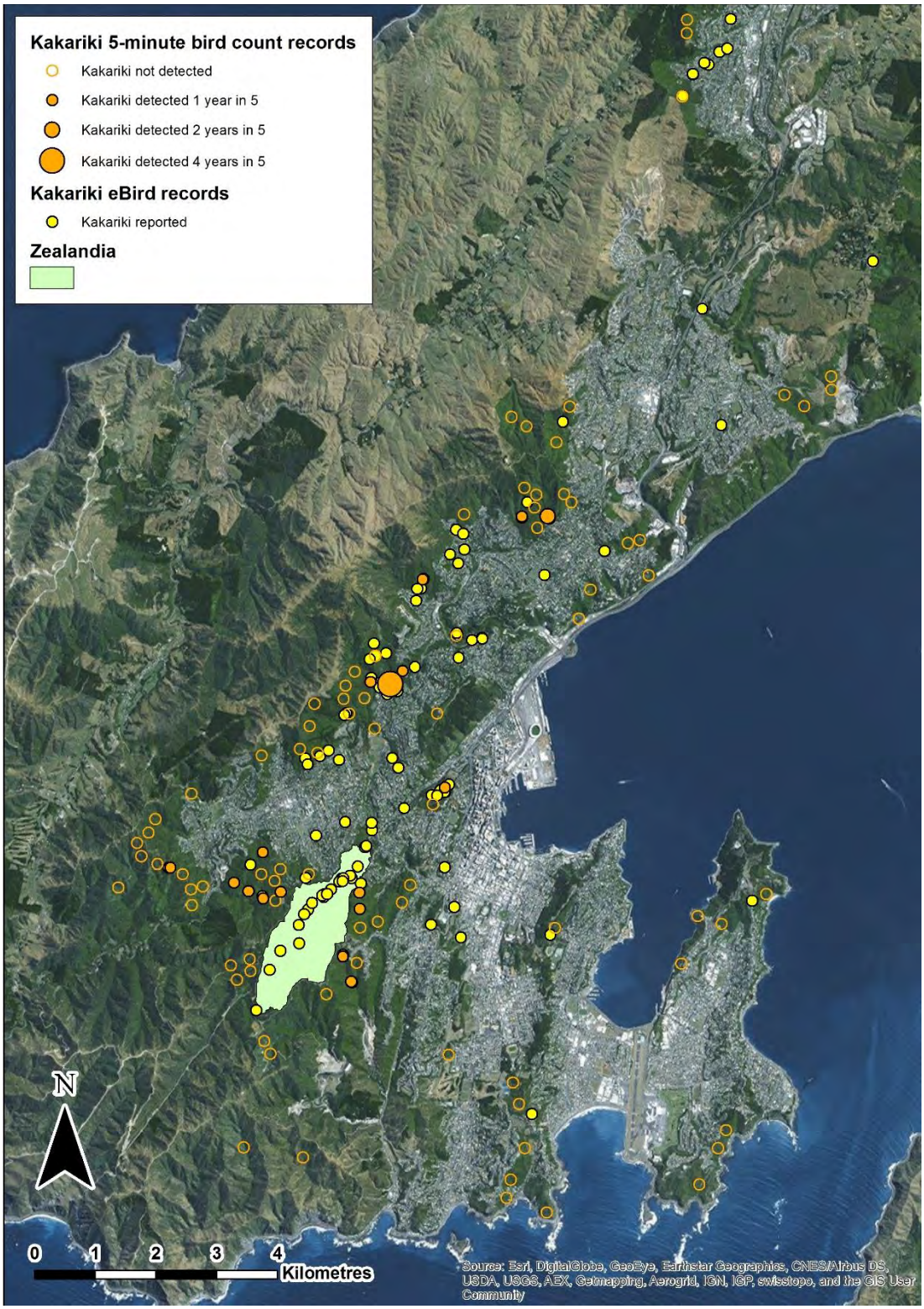

Figure 3.15: Distribution of red-crowned parakeet in Wellington City between 2011 and 2016. Orange circles represent red-crowned parakeet detections at five-minute bird count stations, with the size of the circle corresponding to relative detection frequency. Yellow circles represent red-crowned parakeet observations sourced from the New Zealand eBird database (http://ebird.org/content/newzealand/; accessed 23/06/2016).

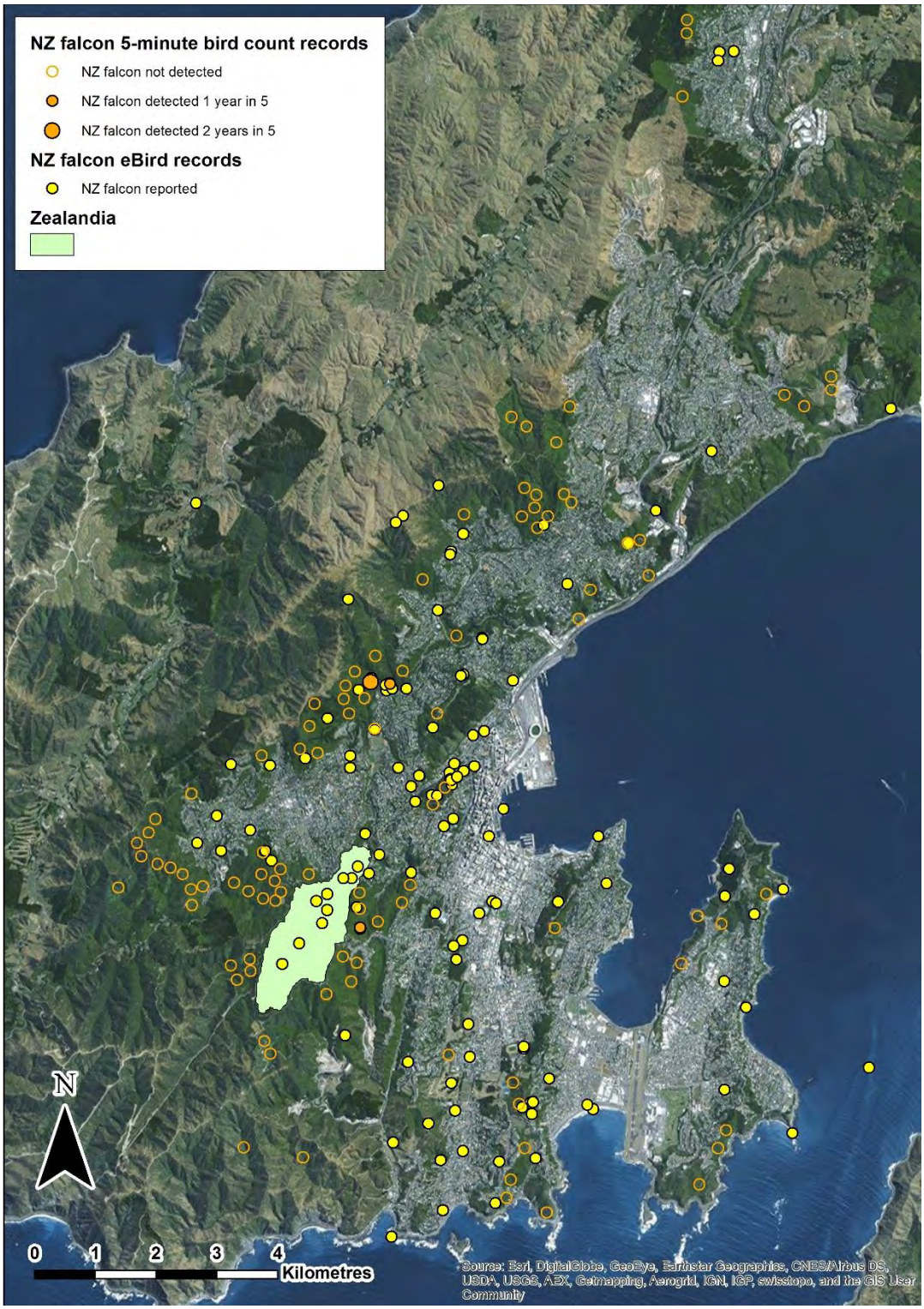

Figure 3.16: Distribution of NZ falcon in Wellington City between 2011 and 2016. Orange circles represent NZ falcon detections at five-minute bird count stations, with the size of the circle corresponding to relative detection frequency. Yellow circles represent NZ falcon observations sourced from the New Zealand eBird database (http://ebird.org/content/newzealand/; accessed 23/06/2016). NB: the falcon record in Wellington Harbour to the east of Miramar Peninsula is a valid record – this was a falcon spotted flying across the harbour by a passenger on a Cook Strait ferry.

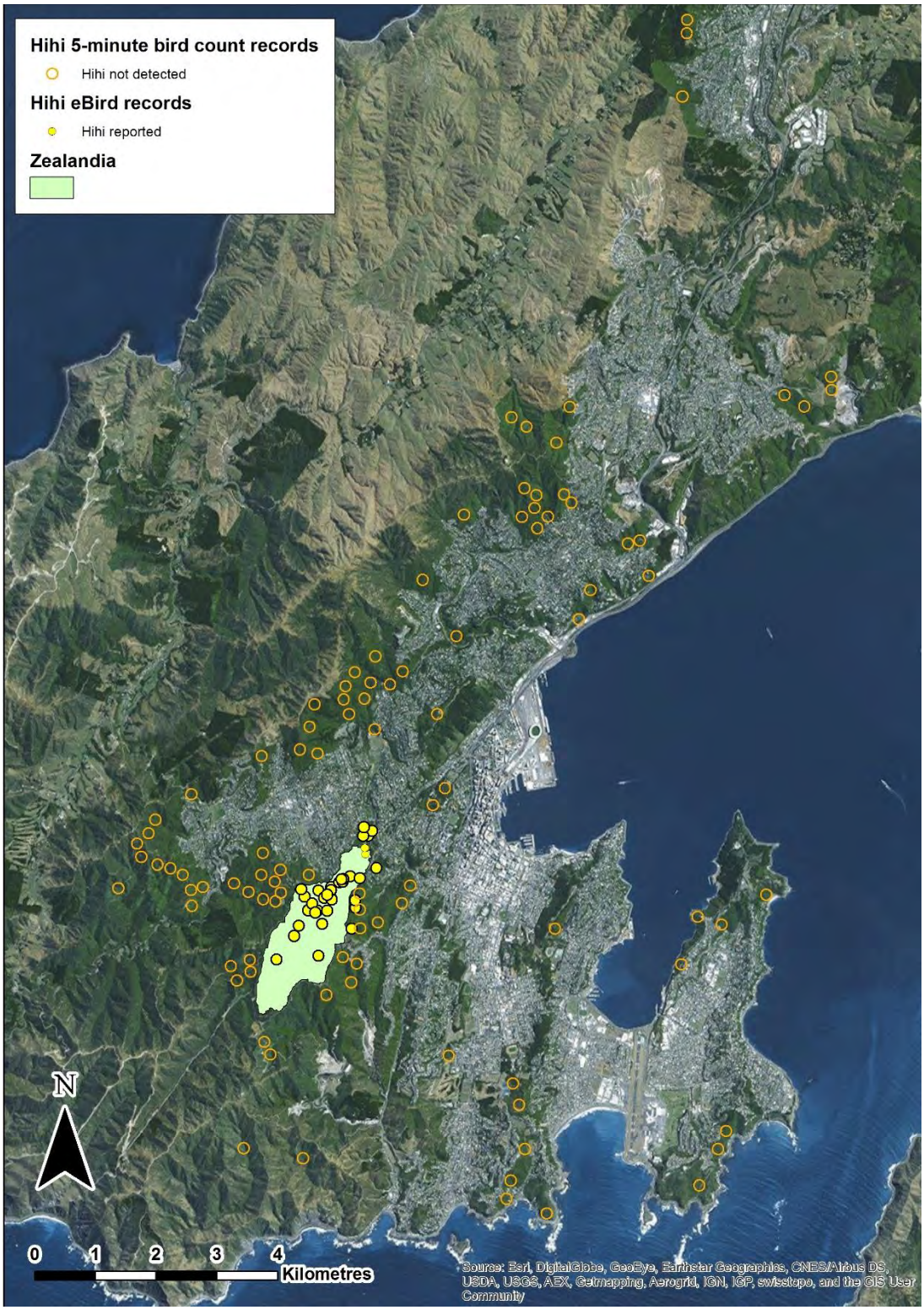

Figure 3.17: Distribution of hihi in Wellington City between 2011 and 2016. Hihi have not yet been detected during these five-minute bird counts, but are reported occasionally by local citizen scientists. Yellow circles on the map represent hihi observations sourced from the New Zealand eBird database (http://ebird.org/content/newzealand/; accessed 23/06/2016).

Figure 3.18: Distribution of long-tailed cuckoo in Wellington City between 2011 and 2016. Long-tailed cuckoos have not yet been detected during these five-minute bird counts, but are reported occasionally by local citizen scientists. Yellow circles represent long-tailed cuckoo observations sourced from the New Zealand eBird database (http://ebird.org/content/newzealand/; accessed 23/06/2016).

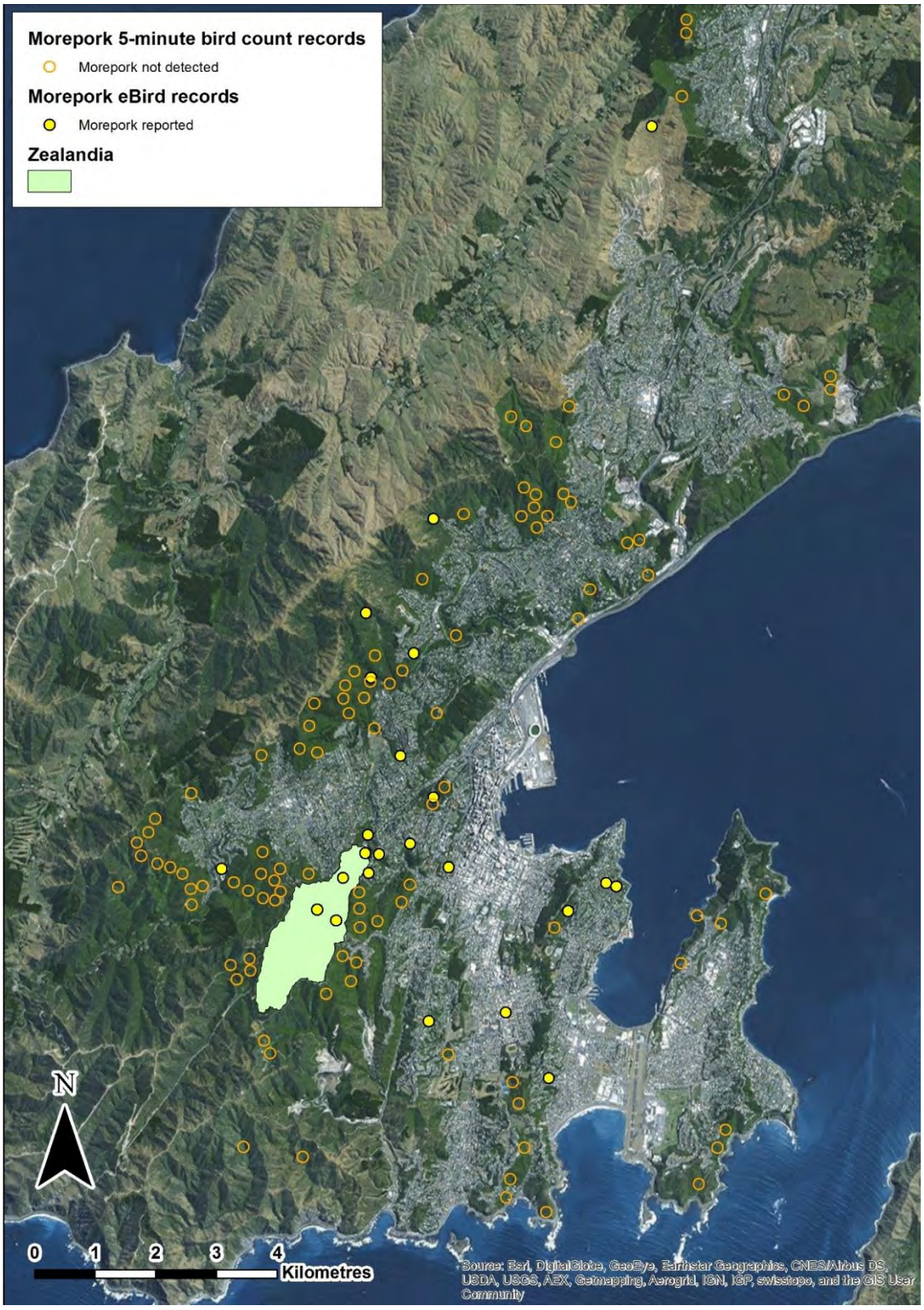

Figure 3.19: Distribution of morepork in Wellington City between 2011 and 2016. Moreporks have not yet been detected during these five-minute bird counts, but are reported occasionally by local citizen scientists. Yellow circles represent morepork observations sourced from the New Zealand eBird database (http://ebird.org/content/newzealand/; accessed 23/06/2016).

4 DISCUSSION

4.1 Species diversity

Since 2011 there has been a significant increase in the mean number of native forest bird species detected per five-minute bird count station in Wellington City. Over this time period however, the total number of native forest bird species detected each year has remained unchanged, with 14 species recorded each year. This increase in the mean number of species counted per station therefore reflects an expansion in the spatial distribution of several of forest bird species already present in Wellington City since 2011, including kaka and red-crowned parakeet. This trend is likely a consequence of both the proximity of large, productive source populations of these species at sites such as Zealandia and on Matiu/Somes Island, together with ongoing improvements in the extent and intensity of mammalian predator control in Wellington City.

Between 2011 and 2015 the mean number of forest bird species recorded per count station was significantly lower in Wellington City than in Upper Hutt reserves each year, and was not significantly different from the mean number of species recorded per station in south Wairarapa reserves or Porirua Scenic Reserve. This pattern is most likely caused by the fact that at least a quarter of the bird species recorded in Wellington City reserves continue to have relatively localised distributions (centred on Zealandia), so are only recorded at a relatively small proportion of the bird count stations surveyed. In contrast, almost all of the species recorded in Upper Hutt and south Wairarapa reserves, and in Porirua Scenic Reserve were widely distributed and were recorded at a large proportion of the bird count stations surveyed.

Zealandia continues to have an important influence on the diversity of native forest bird species present in Wellington City. Around one third of the native forest bird species detected during the five-minute bird counts carried out between 2011 and 2015 were present largely as a consequence of birds dispersing from source populations in Zealandia. These species include North Island robin, whitehead (both re-introduced to Zealandia in 2001), kaka and North Island saddleback (both re-introduced in 2002) (Miskelly & Powlesland, 2013).

Both kaka and whitehead have been recorded in Wellington City prior to their re-introduction to Zealandia (Miskelly et al, 2005). However, the current distributions of these two species (centred on Zealandia; see Figures 3.11 and 3.12) suggest that the majority of the birds encountered during these bird counts have originated from this predator-free sanctuary. In the case of kaka, many of the birds recorded in Wellington City parks and reserves over the past decade appear to be birds that breed within Zealandia, but have home ranges that extend across Wellington City that enable the birds to exploit locally-available food sources (Zealandia, unpublished data). In more recent years however kaka have been recorded nesting elsewhere in Wellington City, including a pair that successfully fledged a chick in Prince of Wales Park (Mt Cook) in January 2013 (M. Booth, pers. comm.) and a fledgling caught and killed by a dog in Huntleigh Park (Ngaio) in February 2015 (http://wellington.govt.nz/your-council/news/2015/02/dog-kills-kaka-in-huntleigh-park; accessed 28/09/2015).

Two further species recorded during these bird counts (bellbird and red-crowned parakeet) appear to be present as a result of a combination of birds dispersing from source populations within Zealandia as well as from source populations from nearby inshore islands and other mainland reserves. Radio-tracking data together with sightings of banded birds have confirmed that bellbirds disperse readily from Zealandia to other parts of the city, including the Wellington Botanical Gardens, hampering

efforts to re-establish a self-sustaining population in the sanctuary (R. Empson pers. comm). However, both bellbird and red-crowned parakeet have also been recorded in Wellington City prior to their re-introduction to Zealandia in 2001 and 2010 respectively (Miskelly et al, 2005; Froude, 2009). This, together with their relatively strong dispersal abilities suggests that both species may also be dispersing into Wellington City from other nearby source populations such as Mana Island (bellbird), Matiu/Somes Island (red-crowned parakeet) and Kapiti Island (both species). Indeed, several colour-banded bellbirds transferred from Kapiti Island to Mana Island in July 2012 were subsequently re-sighted in Wellington City, including one female that made several attempts to breed at Zealandia (McLaughlin & Harvey, 2013; M. Booth pers. comm.). This demonstrates that under certain (albeit artificial) circumstances, bellbirds are capable of dispersing from these islands and into Wellington City.

4.2 Bird abundance

Now that five consecutive years of five-minute count data has been collected, longer-term trends in species' encounter rates are now emerging above and beyond the year-to-year variation in counts also being observed. Since 2011 there has been a significant increase in the encounter rates of tui, grey warbler, kaka and red-crowned parakeet and blackbird. Because these counts are carried out in consistent weather conditions, at the same time of year and usually by the same observers, these increases in encounter rates likely represent a true increase in the abundance of this species in Wellington City parks and reserves between 2011 and 2015 (Bibby et al, 2000). This result indicates that these five species are benefitting from the ongoing improvements in mammalian pest control efforts in the city.

Tui encounter rates have continued to vary substantially from year to year between 2011 and 2015. These varying encounter rates are usually matched by substantial changes in the distribution of tui in Wellington City reserves from one year to the next, so are likely to represent year-to-year difference in habitat use by tui in Wellington City, probably reflecting annual differences in the local availability of food resources. In 2012, for instance relatively high numbers of tui encountered at bird count stations in southern and western parts of the city appeared to be linked to the prolific fruiting of Darwin's barberry (*Berberis darwinii*) at the time (McArthur et al, 2013a).

In contrast, these counts suggest that there has been no significant increase in the abundance of any of the other bird species recently re-introduced to Zealandia in surrounding parks and reserves over the past five years. This result indicates that one or more factors continue to limit these species' ability to establish functional populations beyond Zealandia's predator-proof fence. For example, NI robins are known to be relatively strong dispersers, with juvenile birds capable of dispersing up to 11 km from their natal territories in forested habitat (Oppel & Beaven 2004; Richard 2007). Despite this, and despite the fact that a large and highly productive NI robin population has been present in Zealandia since at least 2003 (McGavin 2009; Empson & Fastier 2013), NI robins have only been detected at a single five-minute bird count station over the past five years and are seldom reported by local citizen scientists at distances greater than around 1 km from Zealandia (Figure 3.14).

The most likely factor limiting the establishment of these species beyond the boundaries of Zealandia is the presence of mammalian predators including both domestic and wild cats (*Felis catus*), rats (*Rattus* spp.), possums (*Trichosurus vulpecula*), hedgehogs (*Erinaceus europaeus*) and mustelids (*Mustela* spp.). Although considerable effort is being invested in reducing populations of a number of these species in Wellington City, cats are typically not targeted due to the risks that existing control methods pose to domestic pets. Recent camera-trapping work carried out by researchers at Victoria University of Wellington has shown that cats accounted for a relatively large proportion of the

approximately 22, 000 animal 'detections' collected from several Wellington City reserves over a five-month period in 2014 (http://identifyanimals.co.nz/; accessed 24/09/2015), suggesting that they occur at relatively high densities in the parks and reserves that were sampled.

To confirm whether or not introduced predators are continuing to limit the establishment of native birds emigrating from Zealandia, further research quantifying the survival and reproductive rates of these bird species in reserves adjacent to Zealandia and identifying causes of adult mortality and nest failure would be useful. Identifying any causes of adult mortality (in particular detecting the identity of predators from DNA samples collected from freshly-dead birds) and nest failure (through the use of trail cameras) will help inform decisions regarding future pest control priorities aimed at improving the abundance and distribution of native forest birds in Wellington City reserves. We suggest that these research efforts should be focussed on NI robins, NI saddleback and kaka, as each of these three species are relatively easy to monitor, yet fairly susceptible to the impacts of mammalian predators (e.g. Powlesland, 1997).

4.3 Native bird distribution

Both kaka and red-crowned parakeet appear to be continuing to expand their range in Wellington City. For several years kaka appeared to be restricted to parts of Wellington City south of Ngaio Gorge and to the west of Miramar Peninsula, but during the last couple of years' kaka have been reported by citizen scientists from a number of locations in suburbs to the north of Ngaio and on Miramar Peninsula. Red-crowned parakeets are similarly being reported from more and more locations in the city, and were detected at a substantially greater proportion of five-minute bird count stations in 2015.

Other than these changes, the distribution of native forest birds in Wellington City parks and reserves has not changed substantially from that reported previously (McArthur et al, 2012; McArthur et al, 2013a and McArthur et al, 2015). Those species with the strongest dispersal abilities, or those that are least susceptible to the impacts of mammalian predators (including silvereye, tui, grey warbler and fantail) continue to have the most widespread distributions in Wellington City parks and reserves. Those species with more limited dispersal abilities, or greater susceptibility to depredation by mammalian predators (including NI robin and NI saddleback) have more localised distributions, typically centred on key source populations now established in predator-free Zealandia.

The accumulation of five years of five-minute bird count data combined with the ever increasing quantity of citizen science bird observations accumulating in the New Zealand eBird database has allowed us to detect several species re-colonisation events that have occurred in Wellington City reserves within the last 4-5 years. Both whiteheads and red-crowned parakeets for example now appear to be resident in Trelissick Park, some 3.8 km north of the nearest source populations in Zealandia. Similarly, resident populations of both bellbirds and red-crowned parakeets now appear to have established in Khandallah Park, 5.7 km north of Zealandia and red-crowned parakeets are now well established in Otari-Wilton Bush, 1.7 km north of Zealandia.

The incorporation of eBird data into the distribution maps provided in this report continues to enable us to map bird distribution in Wellington City to a high level of detail. In this particular case, the Wellington City five-minute bird count dataset and the eBird Basic Dataset appear to be highly complementary. The original aim of this Wellington City five-minute bird count monitoring programme was to sample bird populations in forested habitats in Wellington City's parks and reserve network, so it isn't designed to provide any information on bird distribution in other habitats in the city such as suburban backyards. The majority of bird observations submitted to eBird however are from these suburban habitats, so combining these two datasets provides a much more detailed and

complete picture of bird distribution in Wellington City than either of these datasets can provide on their own.

Although the incorporation of citizen science data sourced from the New Zealand eBird database into this monitoring programme has already substantially improved our ability to describe the distribution of birds in Wellington City, more work could be done to improve this picture even further. Firstly, not all of the locally-available citizen science data has been incorporated into the maps contained in this report yet, due to time constraints and the fact that this data is currently scattered across a number of databases and reporting platforms. Further work could be done therefore to amalgamate bird distribution data we've already sourced from the New Zealand eBird database with additional datasets available from the NatureWatch NZ website, the Garden Bird Survey, the Great Kereru Count and Zealandia.

Although our knowledge of the distribution of diurnal, or day-active bird species in Wellington City has improved substantially the past five years, the distribution of our one relatively widespread nocturnal species is very poorly understood. Morepork may well be relatively common in Wellington City, and could provide an additional measure of the outcomes of local pest control efforts. An opportunity exists therefore, to fill this knowledge gap by running a citizen-science project specifically aimed at mapping the distribution of morepork in Wellington City and quantifying encounter rates as an indirect measure of abundance. We suggest that such a project could be modelled on the 2011 Hamilton City morepork survey, whereby volunteers were assigned to a pre-defined set of survey locations over a period of five consecutive nights (Morgan & Styche, 2012). This project would also serve a secondary purpose of providing Wellington City residents with an additional opportunity to engage with their surrounding natural environment, learn more about the birds around them and improve their skills as citizen-scientists.

5 Recommendations

Based on the results described in this report, we suggest that Wellington City Council considers adopting the following recommendations:

- That the Council continues to undertake this five-minute bird count monitoring programme on an ongoing, annual basis, to provide a consistent, repeatable measure of the state and trends in the diversity, distribution and abundance of birds in Wellington City parks and reserves, in order to contribute towards objective 4.2.2a of WCC's Biodiversity Strategy and Action Plan (WCC, 2015).

- That Wellington City Council considers initiating an investigation aimed at identifying the environmental factors currently limiting the establishment of native forest bird species recently re-introduced to Zealandia in suitable habitat beyond Zealandia's predator-proof fence, to inform future biodiversity management decision-making (objective 1.2.2c of WCC's Biodiversity Strategy and Action Plan (WCC, 2015).

- That the Council considers investing additional time and resources into amalgamating citizen-science bird data available from other sources (including NatureWatch, Zealandia, the Garden Bird Survey and Great Kereru Count) with the data available in the New Zealand eBird database, and if possible, create a single, centralised Wellington City citizen-science bird distribution dataset in a single accessible location (objective 4.3.3a of WCC's Biodiversity Strategy and Action Plan (WCC, 2015).

- That the Council considers designing and carrying out a Wellington City morepork distribution survey similar to that run in Hamilton City in October 2011. This would involve recruiting a team of volunteers to visit a network of pre-selected locations throughout Wellington City after dark and recording the presence, direction and calling times of any moreporks detected (objective 3.3.4b of WCC's Biodiversity Strategy and Action Plan (WCC, 2015).

6 Acknowledgements

This work was instigated by Myfanwy Emeny, Team Leader, Urban Ecology at Wellington City Council and by Philippa Crisp, Team Leader, Terrestrial Ecosystems and Quality, Greater Wellington Regional Council. We would like to thank Mark McAlpine for assisting with data collection in Wellington City reserves in 2011, and to Jono Walter, Susanne Govella, Delia Small, James Graham, Steve Playle and Joanna McVeagh for collecting the bird count data sourced from Upper Hutt and south Wairarapa reserves and Porirua Scenic Reserve. We also extend our thanks to Raewyn Empson (Zealandia/Karori Sanctuary Trust) for providing us with access to bird distribution data held by the Karori Sanctuary Trust, and to the growing group of dedicated & skilled Wellington-based citizen scientists collecting and sharing high-quality bird observations via the New Zealand eBird database, the Zealandia website or via other citizen-science bird monitoring projects. Local resident Peter Hodge in particular has contributed a very high proportion of the citizen science bird records that appear on the maps in this report. Thanks also to Li Loo, Richard Farrell, Luke Crouch and Grant Redvers for assisting with the data entry and to Mike Bell and Philippa Crisp for providing useful comments on earlier drafts of this report. And lastly, thanks very much to Steve Attwood for kindly granting us permission to use his spectacular New Zealand falcon photograph on the front cover of this report.

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8 APPENDIX

This appendix contains a list of all of the bird species encountered in Wellington City parks and reserves during five-minute bird counts carried out between 2011 and 2015 (P = species present). Species names and taxonomic order are as per Gill et al (2010). Threat classification rankings are as per Robertson et al (2013): NV = Nationally Vulnerable; RC = At Risk, Recovering; RE = At risk, Relict; NT = Not threatened; I = Introduced and Naturalised; N/A = Not applicable.

Scientific Name	Common Name	Threat Ranking	2011	2012	2013	2014	2015
Callipepla californica	California quail	I	P	P	P	P	P
Gallus gallus	feral chicken	N/A[4]	P	P	P	P	P
Tadorna variegata	paradise shelduck	NT		P	P		
Anas platyrhynchos	mallard	I					P
Phalacrocorax varius	pied shag	NV					P
Egretta novaehollandiae	white-faced heron	NT			P		
Circus approximans	swamp harrier	NT	P	P		P	
Falco novaeseelandiae	New Zealand falcon	NV		P	P		P
Haematopus unicolor	variable oystercatcher	RC		P		P	P
Vanellus miles	spur-winged plover	NT				P	
Larus dominicanus	southern black-backed gull	NT	P	P	P	P	P
L. novaehollandiae	red-billed gull	NV		P	P		
Hemiphaga novaeseelandiae	New Zealand pigeon (kereru)	NT	P	P	P	P	P
Nestor meridionalis	kaka	NV	P	P	P	P	P
Platycercus eximius	eastern rosella	I	P	P	P	P	P
Cyanoramphus novaezelandiae	red-crowned parakeet	RE	P	P		P	P
Chrysococcyx lucidus	shining cuckoo	NT	P	P	P	P	P

[4] Feral chicken is not recognised as a naturalised species in New Zealand (Gill et al, 2010) and therefore does not have a New Zealand Threat Classification System ranking (Robertson et al, 2013).

Scientific Name	Common Name	Threat Ranking	2011	2012	2013	2014	2015
Todiramphus sanctus	New Zealand kingfisher	NT	P	P	P	P	P
Philesturnus rufusater	North Island saddleback	RC	P	P	P	P	P
Gerygone igata	grey warbler	NT	P	P	P	P	P
Anthornis melanura	bellbird	NT		P	P	P	
Prosthemadera novaeseelandiae	tui	NT	P	P	P	P	P
Mohoua albicilla	whitehead	NT	P	P	P	P	P
Gymnorhina tibicen	Australian magpie	I	P		P	P	P
Rhipidura fuliginosa	New Zealand fantail	NT	P	P	P	P	P
Petroica longipes	North Island robin	NT	P	P	P		P
Alauda arvensis	skylark	I	P	P	P	P	P
Zosterops lateralis	silvereye	NT	P	P	P	P	P
Hirundo neoxena	welcome swallow	NT	P				
Turdus merula	Eurasian blackbird	I	P	P	P	P	P
T. philomelos	song thrush	I	P	P	P	P	P
Sturnus vulgaris	common starling	I	P	P	P	P	P
Passer domesticus	house sparrow	I	P	P	P	P	P
Prunella modularis	dunnock	I	P	P	P	P	P
Fringilla coelebs	chaffinch	I	P	P	P	P	P
Carduelis chloris	greenfinch	I	P	P	P	P	P
C. carduelis	goldfinch	I	P	P	P	P	P
C. flammea	common redpoll	I		P	P	P	P
Emberiza citrinella	yellowhammer	I	P	P	P	P	P