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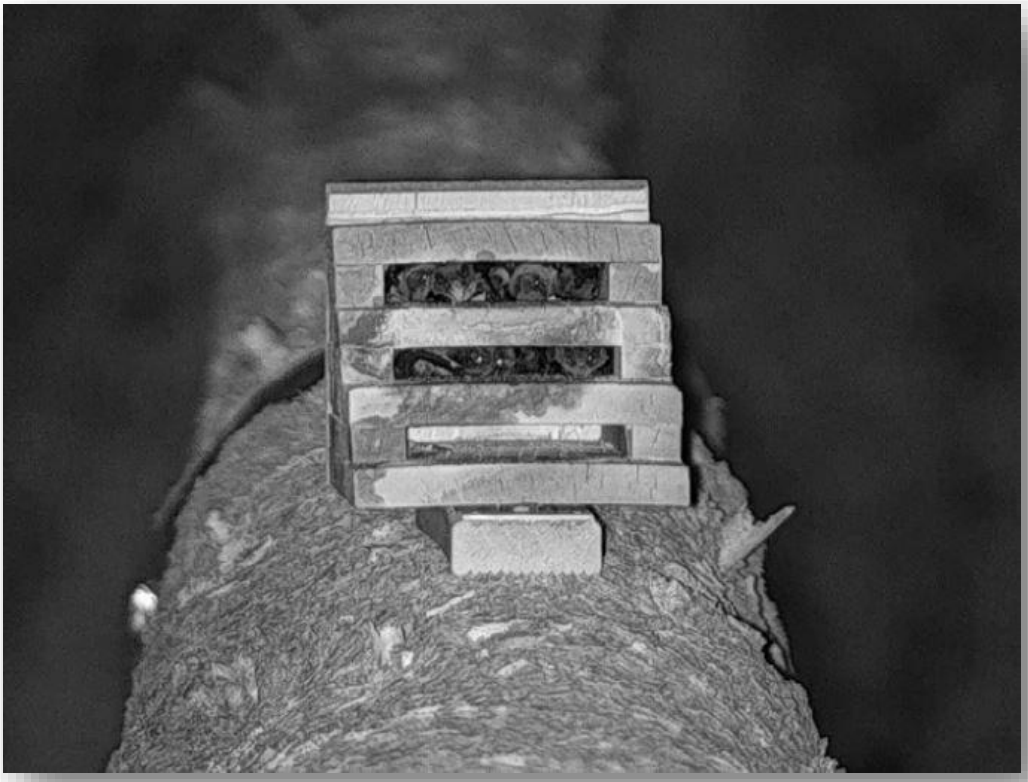
Hamilton City Long-tailed Bat Survey:
Annual monitoring report, 2022



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Report prepared for Project Echo
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Cover photo: Long-tailed bats roosting in a Hamilton City bat box. Photo: Aimee O'Sullivan

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Executive Summary

Deforestation, urbanisation and the introduction of mammalian predators has resulted in a significant decline of New Zealand's long-tailed bat (*Chalinolobus tuberculatus* or pekapeka-tou-roa), which is currently classified as threatened, nationally critical. Hamilton City is one of three urban areas with confirmed long-tailed bat populations. Since 2016, annual city-wide surveys have been conducted by Project Echo, a multi-agency advocacy group for Hamilton City bats. The purpose of the annual surveys is to monitor for changes in bat activity and habitat use throughout Hamilton City, this report presents findings from the 2022 survey.

A total of 72 automatic bat monitors (ABMs) were deployed across 20 historically monitored sites and 52 spatially distributed sites, as specified by a Master Sample design. Acoustic bat monitors (Model AR4) were deployed for approximately 3 weeks, however, only 14 ABMs remained operational for the full 3-weeks, with 30 units failing to operate for more than 4 days. ABM failure was ascribed to the use of older rechargeable batteries. Despite this, a total of 6,734 bat passes were detected from 19 sites, compared to detections at 18 sites from 64 deployments in the 2021 city survey. Similar to previous years, most bat activity was recorded in the south of the city, in close association with the Waikato River and the Mangakotukutuku gully system. There were also six passes recorded in the central city (Site 67, Tristram Street) along with multiple detections in the Hillcrest, Fairfield and Melville residential areas. This data supports the continued use of the Master Sample survey design for the selection of survey sites. While it is advantageous to retain a proportion of previously monitored sites (~25%) for continuity of data, the Master Sample design has improved the proportion of habitats surveyed with greater coverage of residential areas and the inclusion of commercial and industrial areas which have rarely been surveyed.

The reduced number of operational ABM nights is likely to have substantially reduced the sensitivity of the survey to identify locations of low bat activity, as well as the magnitude of detections in high activity areas. Therefore, it is recommended that the data be treated with caution if making comparisons to previous or similar surveys. On-going annual city-wide bat surveys will help identify key habitat areas for conservation and enhancement, in addition to helping understand the effects of urban development and intensification. This is of particular importance given the ongoing and proposed future development in the south of the city, which raises concerns for the preservation of current bat habitats and their connectivity to the city.

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Introduction

New Zealand has only two extant native species of terrestrial mammal, the long-tailed bat (*Chalinolobus tuberculatus*; pekapeka-tou-roa) and the short-tailed bat (*Mystacina tuberculata*). The long-tailed bat is a small (8–11 g), aerial insectivore that preferentially forages around the edges and gaps between forests (O'Donnell, 2000). Since the arrival of humans, long-tailed bat populations have declined substantially and are now classified as threatened, nationally critical, the highest threat classification given by the Department of Conservation (O'Donnell et al. 2017). Deforestation, the introduction of predatory mammals and increasing urbanisation have been identified as the major threats to long-tailed bat survival (Pryde et al. 2005; O'Donnell et al. 2017).

Hamilton City is one of three urban centres with confirmed populations of long-tailed bats. However, increasing urban expansion and roading development has resulted in the loss of roosting habitat and foraging areas (Dekrout et al. 2014; Le Roux & Le Roux, 2012). Semi-annual city-wide surveys have been conducted from 2012-2021 to monitor changes in the Hamilton long-tailed bat population (Le Roux & Le Roux, 2012; Mueller et al., 2017; van der Zwan, 2018; van der Zwan and Mueller, 2019; Dumbleton and Montemezzani, 2020; Aughton, 2021). The first city-wide survey was conducted by Project Echo and Kessels Ecology in 2012, and reported the presence of long-tailed bats in 16 out of 62 urban greenspace sites, sparking interest in the distribution and occupied habitats of the species (Le Roux & Le Roux, 2012). Bat activity was primarily observed in areas with lower density housing, roads and street lights. The three highest activity sites shared a common characteristic of mature exotic and native trees, seen as ideal roosting environments (Le Roux & Le Roux, 2012). Since 2016 Project Echo has conducted annual city-wide surveys with assistance from the Department of Conservation, Waikato Regional Council, Hamilton City Council and community volunteers coordinated by GoEco. These surveys have consistently reported that bat activity was most prevalent in the parks and gully areas in the south of Hamilton City, with some areas recording mean bat pass rates of >100 passes/night (i.e., Dumbleton and Montemezzani, 2020; Aughton 2021). Land to the south of Hamilton City has recently been consented or is pending consent for large scale housing development and associated roading infrastructure. This is expected to affect bat populations as vegetation clearance removes suitable roosts and decreases connectivity between habitats (van der Zwan & Mueller, 2019).

Long-term monitoring of bat activity in the greater Hamilton City area will help identify changes in habitat use by long-tailed bats and potential anthropogenic impacts on the population. This report details the findings of the 2022 annual acoustic monitoring survey, and is the sixth consecutive annual survey since 2016. It details the survey methodology, survey results and provides a short comparison to previous years.

Methods

Study site

Sitting in a largely agricultural catchment, Hamilton City is located in the Waikato region of the North Island of New Zealand, it has an urban area of 11,037 ha and a population of 178,500. The Hamilton Ecological District has undergone significant deforestation and drainage of wetland areas since the arrival of Europeans, with 2.1% of the city remaining in indigenous vegetation (Clarkson et al., 2006). Most of this vegetation is located in the extensive network of branching gullies covering approximately 770 ha (Cornes et al., 2012). The Mangakotukutuku and Mangaonua gullies situated along the southern urban-rural interface of Hamilton City are the largest of the four gullies, and together with the Waikato River, form the single largest and most continuous ecotone in Hamilton. Conversely, the Kirikiriroa and Waitawhiriwhiri gullies are situated within the highly developed areas in the northern part of the city. The Peacocke's suburb is a planned residential area on agricultural land to the south of Hamilton City, and has been identified as containing numerous long-tailed bat roosts (Davidson-Watts, 2019). Urban development and associated infrastructure for this area is planned over the next 30 years, and is expected to contain more than 8000 houses for approximately 20,000 people (HCC, 2019).

Survey design and implementation

In order to minimise site selection bias and provide a more even assessment of bat activity across the city landscape, the design of the 2021 city-wide survey was modified to follow a more spatially distributed model (see Aughton, 2021). A total of 113 potential survey locations were generated following the Master Sample Design of van Dam-Bates et al., (2018) (Appendix 1). The Master Sample design does not require that all sites be monitored, and allowed for the integration of 20 historical sites (Sites 1–20) to provide continuity between past surveys and the updated survey design.

For the 2022 survey, a total of 72 automated bat monitors (ABMs) (Model AR4, Department of Conservation Electronics Workshop) were deployed, 52 at the same locations as the 2021 survey, and 20 at new locations from the master sample design. Monitors were deployed from the 28th of February to the 25th of March and were programmed to record bat activity from 1-hour before sunset to 1-hour after sunrise. Recordings from the ABMs were individually analysed using BatSearch software (v3.12, Department of Conservation) following protocols described by Lloyd (2017). The data was then tabulated using Microsoft Excel and mapped as a graphical representation of activity over the city using ArcGIS (v.10.8).

Air temperature (°C), daily total precipitation (mm) and maximum windspeed (m/s) for the monitoring period were sourced from the NIWA Cliflo database, Ruakura EWS weather station, network number C75734.

Results

A total of 6,734 echolocation passes were recorded from 19 of 72 monitored sites, with a mean of 0.082 passes/night/site. Of the 72 ABMs, one was lost (Site 1), 11 failed to log any data files, and a further 19 failed after less than 5 days of deployment. Only 14 ABMs remained operational for the full 3-week deployment, with the remaining ABMs failing after various time intervals prior to the survey's end. ABM failures were attributed to power loss from the rechargeable batteries. A comparison was made to the 2021 survey to determine if the ABM failures and changes in ABM locations had resulted in differences in the proportion of habitat locations surveyed and the number of sites with bat detections (Figure 1). There were no significant differences in the proportion of habitat types surveyed (Chi-squared; d.f. = 3, $p > 0.05$) or the proportion of sites with bat detections (Chi-squared; d.f. = 3, $p > 0.05$) between the 2021 and 2022 surveys.

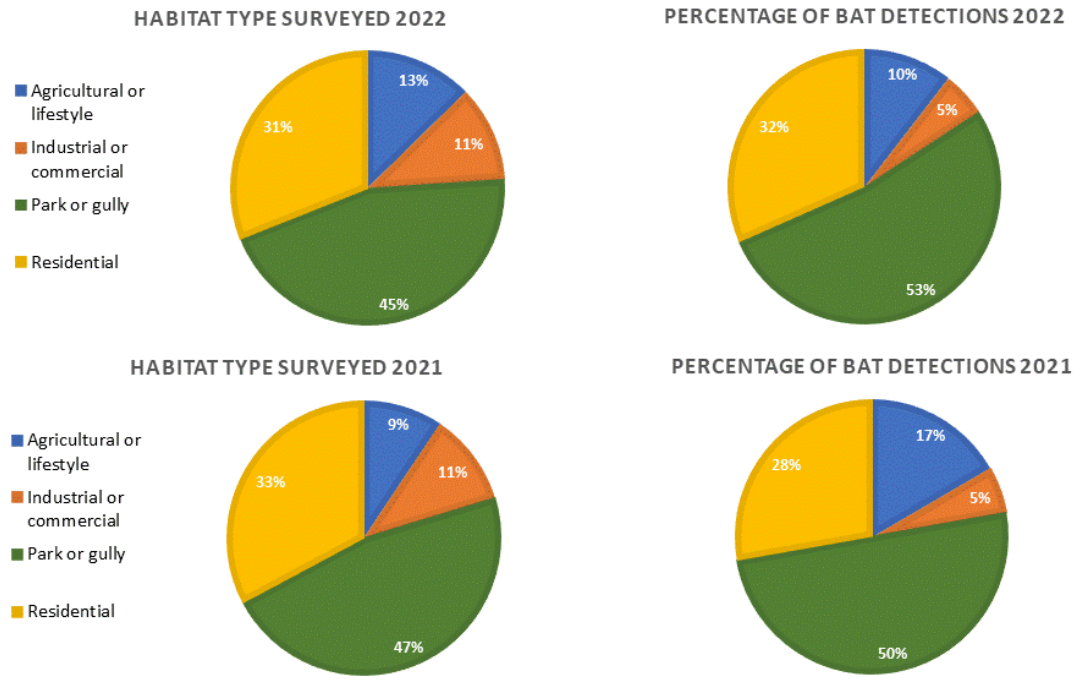

Figure 1. Comparison of the percentage of surveyed habitat types and percentage of total bat detections in each habitat type between the 2021 and 2022 surveys.

Hammond Park (Site 4) had the highest activity with a mean 258.4 passes/night, followed by Hayes Paddock (Site 2) with 90 passes/night (Figure 2). Hammond Park (Site 16), Lake Rotoroa (Site 37) and Peacocke (Site 39) all averaged above 10.0 passes/night (Figure 2). The northernmost detection was at Site 9 along the Waikato River Trail. Of the 20 sites that were not monitored in 2021, five recorded detections (Sites 37, 53, 67, 68 and 111). Of these, Site 37 located near Lake Rotoroa had the highest mean number of passes (12.3 pass/night). Also of note, Site 67, located at Tristram Street in the central city, recorded 6 passes over 24 nights (0.3 passes/night).

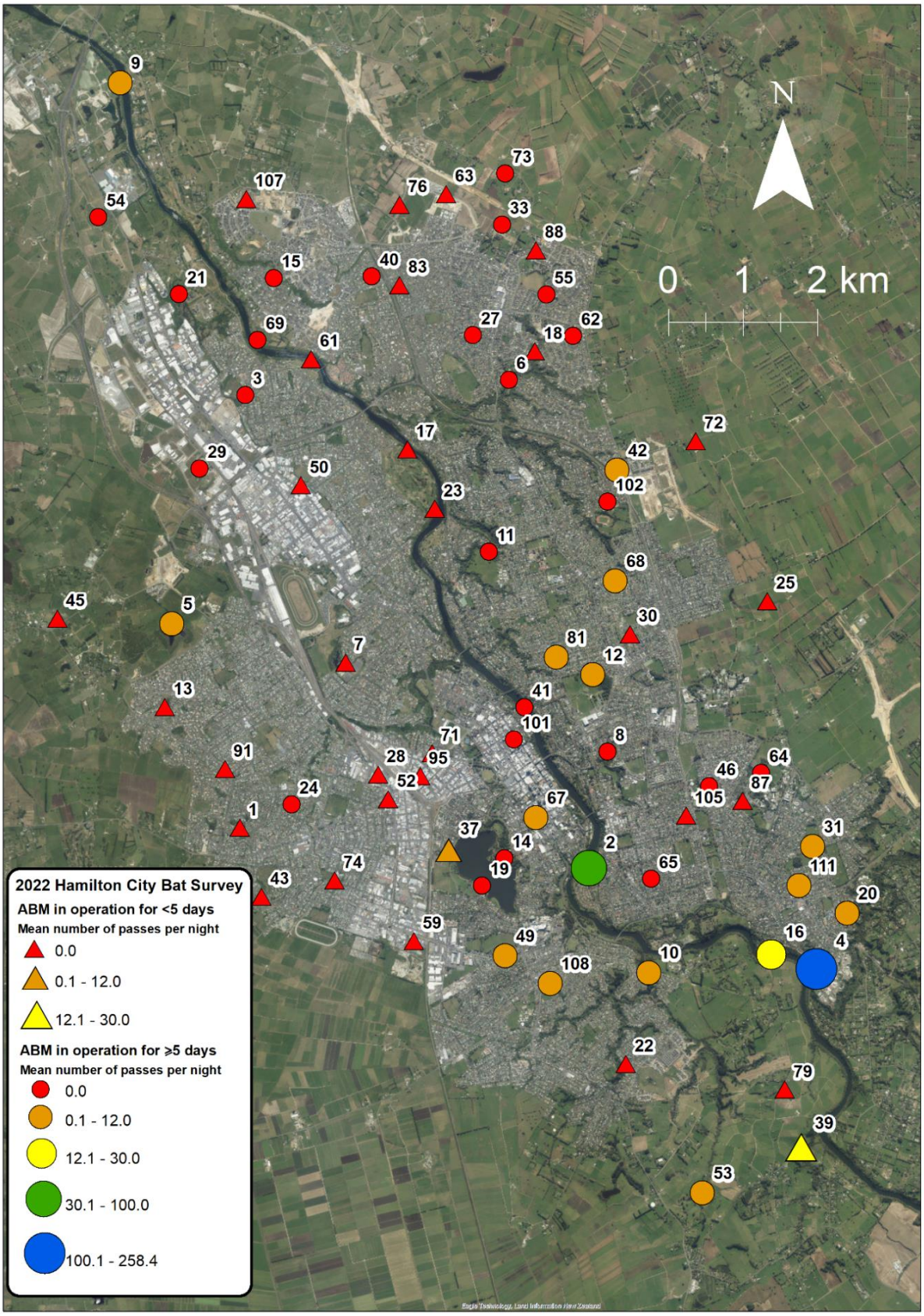

Figure 2. Locations of ABM deployments and bat detections from the 2022 Hamilton City bat survey. Triangles indicate the ABM failed to operate for a minimum of 5 nights, circles indicate the ABM operated for ≥5 nights.

Seven sites (14, 19, 22, 64, 71, 72 and 95) recorded passes in the 2021 survey (range of means 0.05–4.2 passes/night), but not in the 2022. Four of these sites (14, 19, 22, 64) were located in park or gully habitat, and one each in residential (71), agricultural or lifestyle (72), and industrial/commercial areas (95). Full tabulated results for each site are presented in Appendix 2.

During the 3-week deployment period, air temperature ranged between 9.3°C to 28.2°C with an average maximum temperature of 25.3°C and an average minimum temperature of 13.3°C. Precipitation occurred on 5 days, with one of significant rainfall (56.2 mm) event above 10 mm. Winds were generally low–moderate with gusts averaging 8.8 m/s and one 24-hour period experiencing a maximum gust of 15.4 m/s (Appendix 3).

Discussion

Since 2016, annual surveys of Hamilton City have been undertaken to monitor for changes in habitat use by long-tailed bats. As a fragmented, nationally critical species, long-tailed bats are vulnerable to habitat loss from urban development. Beginning in late February 2022 and conducted over 3 weeks, 72 automated bat monitors were deployed across a range of habitat areas based on the master sample design of van Dam-Bates et al. (2018). The failure of approximately one-third of the ABMs to operate for more than 5 days likely reduced the sensitivity of the survey, particularly in more industrial and continuously lit habitat areas that previous surveys have shown to have less bat activity. However, the average number of passes per night appears to be broadly similar to previous years, with high activity recorded in the south of the city, in areas such as Hammond Park and Peacocke's. Although the ABM only recorded for 7 days, Hayes Paddock (Site 2) had a large increase in the mean number of bat passes (90 passes/night) compared to the 2020 (mean 0.27 passes/night) and 2021 (0.48 passes/night) surveys. The activity at Hayes Paddock was consistent for each night the ABM was functioning, suggesting that the increase in activity was not an isolated anomaly.

Previous surveys have recorded low activity at Claudelands Bush (< 1 pass/night), with the current survey recording similar activity levels at Claudelands Bush (Site 12), as well as activity in nearby Fairfield residential areas (Sites 68 and 81) for the first time (Dumbleton and Montemezzani, 2020; Aughton 2021). Similar low-level activity was recorded in the Hillcrest and Melville suburbs in 2021 and again in 2022, demonstrating the value of the Master Sample survey design (Dumbleton and Montemezzani, 2020; Aughton, 2021). This is also supported by the fact that previously unsurveyed areas in the central city also recorded low activity (< 1 pass/night) in the Frankton commercial area (Sites 71 and 95) during the 2021 survey, and the central city (Site 67) in 2022. This indicates that bats may occasionally pass over these areas on their way to foraging and roosting habitats in parks, gullies and Lake Rotoroa.

The change in location of 20 survey sites between 2021 and 2022 did not result in a notable difference in the proportion of habitat types surveyed (Figure 1). In addition, the total number of sites with detections was similar between years (i.e., 19 in 2022 c.f. 18 in 2021) despite the wide-spread failure of ABMs. However, seven sites failed to record any passes in the 2022 survey after bats were detected in the 2021 survey. This can be attributed to ABM failure as four failed to record more than one night and the remaining three ABM recorded for no more than 12 nights, likely resulting in lower total site detections. However, the eight additional ABMs deployed in the 2022 survey appears to have partially compensated for the disparities between the 2021 and 2022 surveys. The continuing year-on-year increase in the number of ABMs deployed during the annual survey has provided increasing resolution regarding bat activity across the city, this is helping to identify key habitat areas.

Current research by the University of Waikato and monitoring by other Project Echo members have not directly studied the impacts of urban development on bats, although it is expected that increased development in the south of the city will impact bat populations. Infrastructure and housing development have already commenced in the planned Amberfield suburb of the Peacocke's development area, as well as ongoing housing intensification throughout the rest of the city. Infrastructure and housing developments are expected to affect the resident bat population through vegetation clearance reducing roost availability, loss of connectivity between different habitat areas, and habitat avoidance due to increased light and noise. However, the cumulative effects on bat populations are currently poorly understood. Spatially consistent annual monitoring with the same monitoring devices (i.e. AR4 monitors) will provide more certainty with regards to monitoring changes in habitat use. Continuing surveys will provide valuable information on bat distribution and possible effects associated with ongoing urban development on activity levels and bat distribution.

Conclusions

Long-tailed bat activity was detected in several suburbs of Hamilton City with calls being also recorded in the north of the city. However, the failure of the majority of ABMs to record over the full 3-week survey period substantially reduced the sensitivity and magnitude of detections, especially in areas with normally low activity. Therefore, caution should be employed when comparing these results to past or future surveys. Ongoing long-tailed bat management should remain a priority as the city continues development to reduce the negative impacts on bat movements, habitats and population numbers, this is particularly important in the Peacocke's area. Monitoring Peacocke's and surrounding sites, as well as the installed bat boxes, will be beneficial to assess how, or if, long-tailed bats will adapt to the new infrastructure.

Acknowledgements

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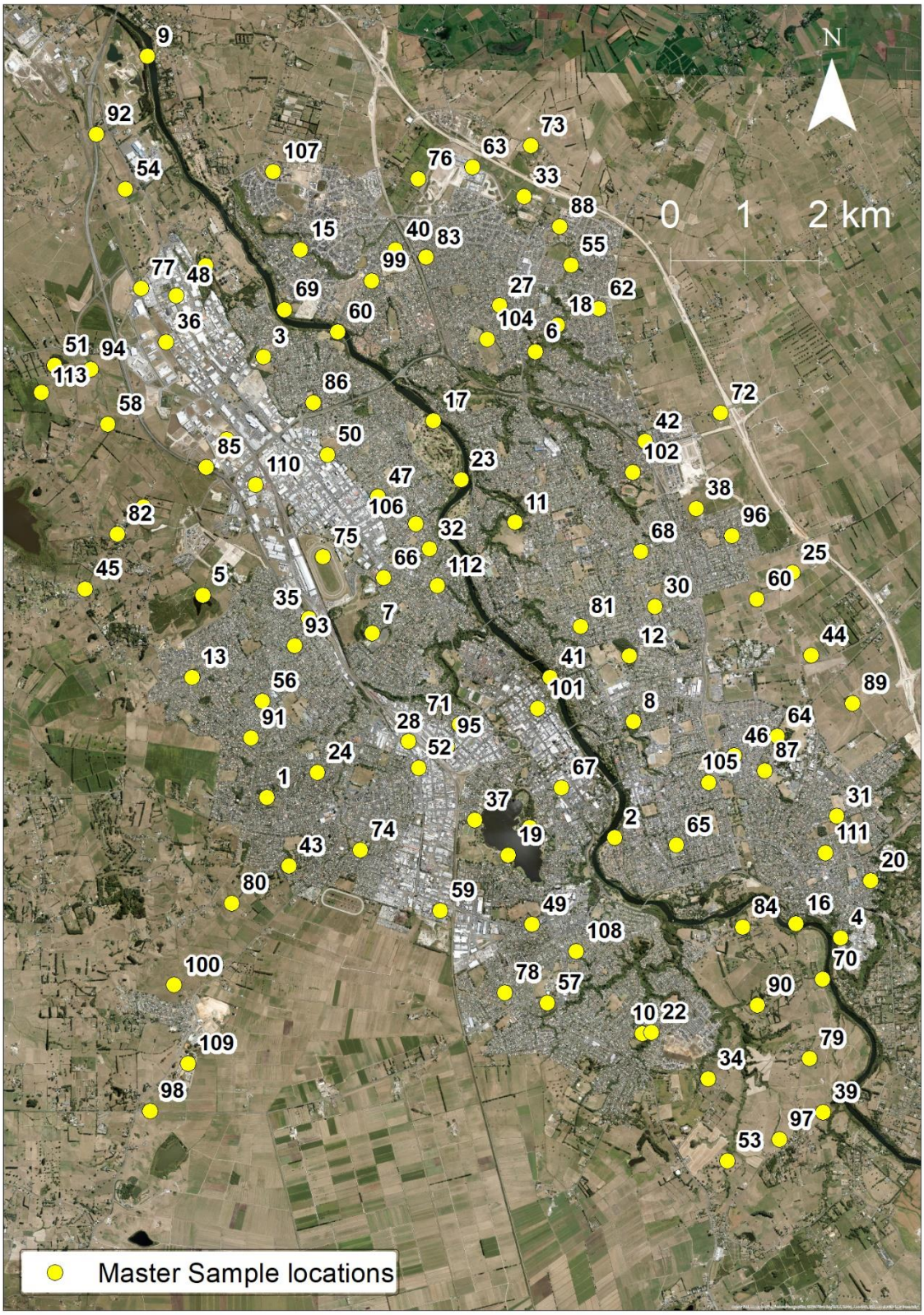
Appendices

Appendix 1. Locations for ABM deployment were drawn from the Master Sample list. Sites 1-20 represent previously monitored locations that were included into the Master Sample design for continuity.



Appendix 2. ABM deployments and results of the 2022 survey with comparison to the 2021 survey. N/A indicates ABM was lost, N/D indicates no ABM was deployed at that location.

		NZTM			2022 Survey results				2021 Results
Site	Location	Northing	Easting	Habitat type	Number of Nights Deployed	Number of Nights Recorded	Total No. of bat passes	Mean Number of Passes/Night	Mean Number of Passes/Night
1	Dinsdale	5814702	1796937	Park or gully	N/A	N/A	N/A	N/A	0
2	Hamilton East	5814165	1801611	Park or gully	18	7	632	90.3	0.5
3	Pukete	5820500	1797005	Park or gully	22	21	0	0	0
4	Riverlea	5812814	1804658	Park or gully	22	22	5684	258.4	166.3
5	Baverstock	5817435	1796025	Park or gully	21	19	8	0.4	0
6	Rototuna	5820703	1800537	Park or gully	21	15	0	0	0
7	Forest Lake	5816913	1798356	Park or gully	22	1	0	0	0
8	Hamilton East	5815726	1801863	Park or gully	21	18	0	0	0
9	Horotiu	5824681	1795332	Park or gully	21	19	5	0.3	0
10	Melville	5812764	1802414	Park or gully	18	17	36	2	75.3
11	Fairfield	5818403	1800272	Park or gully	22	12	0	0	0
12	Claudelands	5816756	1801665	Park or gully	21	21	1	0.05	0
13	Grandview Heights	5816321	1795932	Park or gully	22	2	0	0	0
14	Hamilton	5814296	1800476	Park or gully	19	12	0	0	4.2
15	Flagstaff	5822067	1797387	Park or gully	21	19	0	0	0
16	Riverlea	5813007	1804055	Park or gully	22	11	179	16.3	11.6
17	St Andrews	5819769	1799182	Park or gully	22	0	0	0	0
18	Rototuna	5821083	1800890	Park or gully	21	3	0	0	0
19	Hamilton	5813930	1800181	Park or gully	19	7	0	0	1.7
20	Hillcrest	5813560	1805074	Park or gully	21	5	32	8	0
21	Pukete	5821853	1796121	Park or gully	22	22	0	0	0
22	Glenview	5811539	1802111	Park or gully	20	0	0	0	1.5
23	St Andrews	5818975	1799548	Park or gully	24	2	0	0	0
24	Dinsdale	5815018	1797627	Residential	21	18	0	0	0
25	Ruakura	5817737	1804004	Agricultural or lifestyle	19	0	0	0	N/D
27	Rototuna	5821304	1800058	Residential	23	21	0	0	0
28	Frankton	5815415	1798790	Industrial and commercial	22	1	0	0	0
29	Te Rapa	5819517	1796394	Industrial and commercial	23	17	0	0	N/D
30	Enderley	5817295	1802164	Residential	23	1	0	0	0
31	Hillcrest	5814454	1804610	Park or gully	21	12	2	0.2	0.1
32	Beerescourt	5818033	1799088	Residential				N/D	0
33	Rototuna	5822782	1800447	Residential	22	16	0	0	0
35	Nawton	5817148	1797534	Industrial and commercial				N/D	0
36	Te Rapa	5820686	1795731	Industrial and commercial				N/D	0
37	Hamilton	5814402	1799735	Park or gully	20	3	37	12.3	N/D
39	Peacocke	5810424	1804455	Agricultural or lifestyle	22	3	90	30	10.4
40	Rototuna	5822091	1798701	Residential	22	5	0	0	0
41	Claudelands	5816319	1800746	Park or gully	22	22	0	0	0
42	Chedworth	5819492	1801990	Residential	21	20	1	0.1	0.05
43	Dinsdale	5813780	1797226	Residential	19	3	0	0	N/D
45	Rotokauri	5817505	1794492	Agricultural or lifestyle	21	0	0	0	N/D
46	Hillcrest	5815264	1803222	Residential	29	7	0	0	N/D
47	Te Rapa	5818747	1798444	Residential				N/D	0

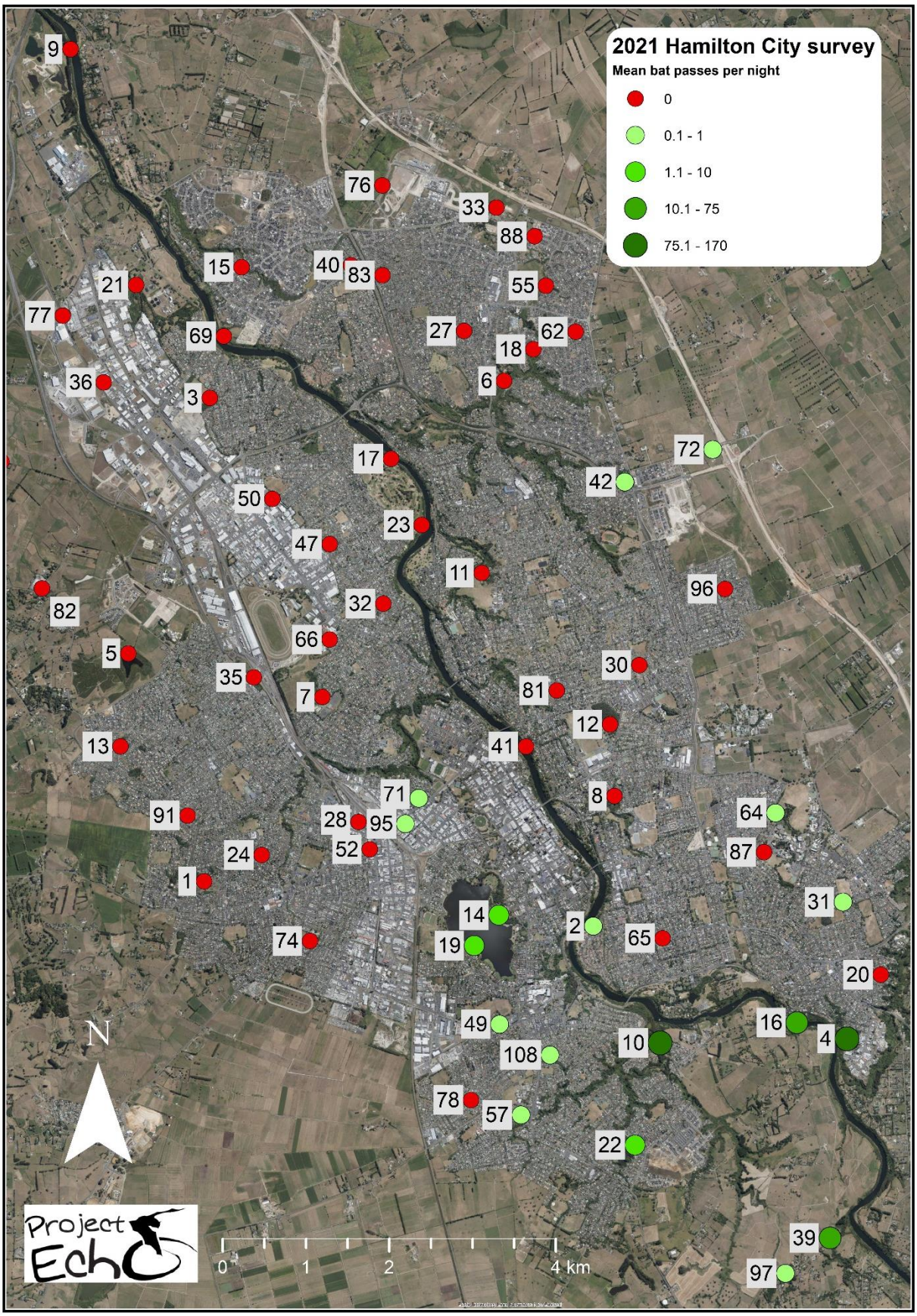
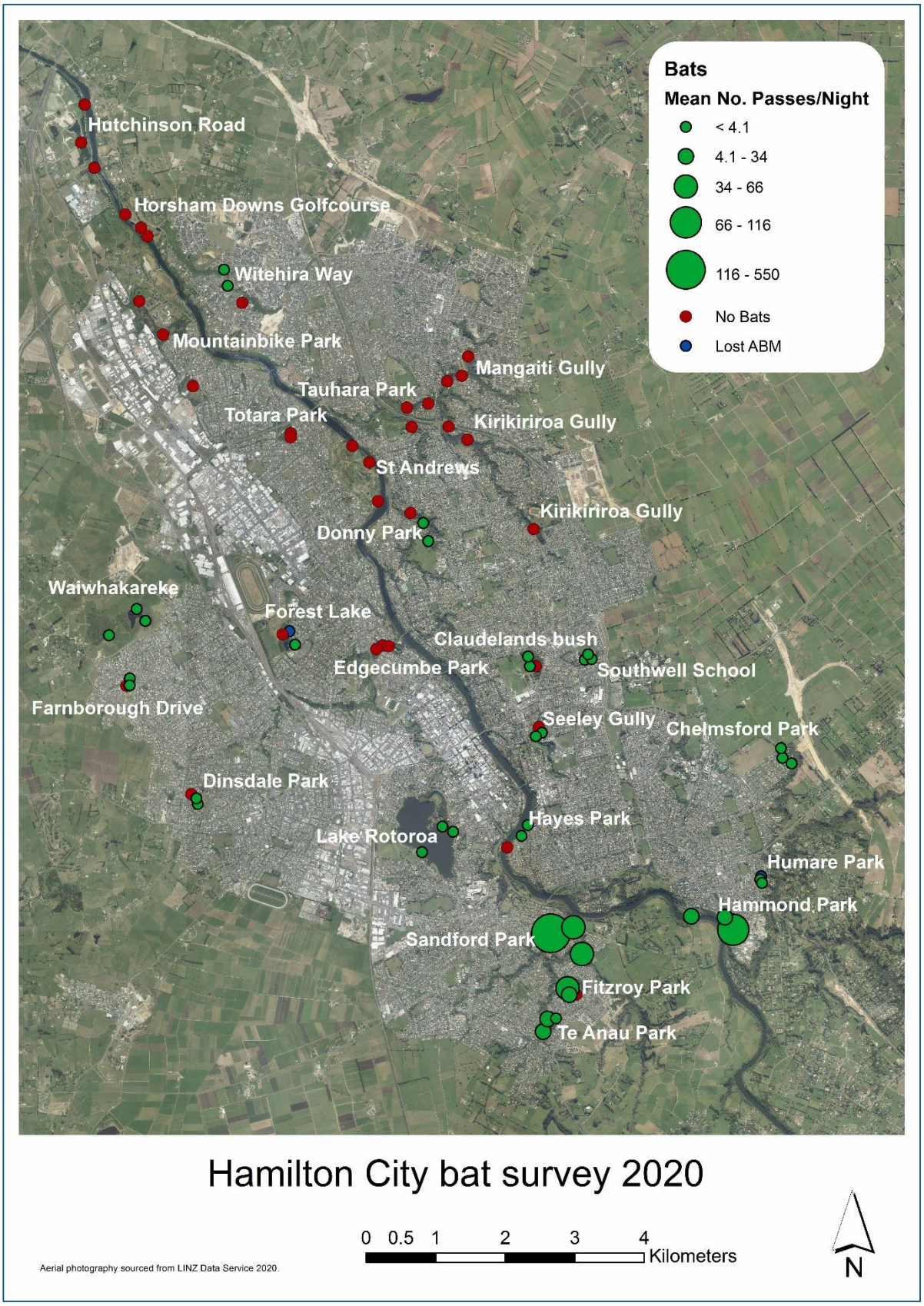
49	Melville	5812988	1800486	Residential	22	12	2	0.2	0.05
50	Te Rapa	5819289	1797755	Park or gully	22	3	0	0	0
51	Burbush	5820666	1794206	Agricultural or lifestyle				N/D	0
52	Frankton	5815085	1798926	Industrial and commercial	20	1	0	0	0
53	Peacocke	5809813	1803129	Agricultural or lifestyle	23	7	9	1.3	N/D
54	Horotiu	5822884	1795037	Agricultural or lifestyle	23	22	0	0	N/D
55	Rototuna	5821846	1801041	Park or gully	23	17	0	0	0
57	Dinsdale	5811975	1800719	Residential				N/D	0.3
58	Burbush	5819711	1794618	Agricultural or lifestyle				N/D	0
59	Frankton	5813185	1799269	Industrial and commercial	21	0	0	0	N/D
61	Pukete	5820979	1797891	Park or gully	24	3	0	0	N/D
62	Huntington	5821293	1801398	Industrial and commercial	23	21	0	0	0
63	Rototuna North	5823190	1799703	Agricultural or lifestyle	24	0	0	0	N/D
64	Hillcrest	5815442	1803921	Park or gully	23	11	0	0	0.05
65	Hamilton East	5814020	1802442	Residential		13	0	0	0
66	Forest Lake	5817602	1798443	Residential				N/D	0
67	Hamilton Central	5814839	1800899	Industrial and commercial	28	24	6	0.3	N/D
68	Fairfield	5818010	1801964	Residential	23	22	2	0.1	N/D
69	Flagstaff	5821240	1797173	Park or gully	23	22	0	0	0
71	Frankton	5815699	1799515	Residential	24	1	0	0	0.8
72	Chedworth	5819881	1803046	Agricultural or lifestyle	22	0	0	0	0.1
73	Horsham Downs	5823470	1800487	Agricultural or lifestyle	23	20	0	0	N/D
74	Frankton	5813997	1798208	Park or gully	21	0	0	0	0
76	Rototuna	5823048	1799077	Residential	24	2	0	0	0
77	Te Rapa	5821486	1795239	Industrial and commercial				N/D	0
78	Melville	5812085	1800144	Residential				N/D	0
79	Peacocke	5811195	1804238	Agricultural or lifestyle	21	0	0	0	N/D
81	Fairfield	5816990	1801172	Residential		17	1	0.1	0
82	Baverstock	5818214	1794990	Agricultural or lifestyle				N/D	0
83	Rototuna	5821971	1799078	Residential	20	2	0	0	0
87	Hillcrest	5815062	1803674	Park or gully	21	3	0	0	0
88	Rototuna	5822438	1800906	Residential	22	0	0	0	0
91	Western Heights	5815490	1796738	Residential	19	2	0	0	0
95	Frankton	5815392	1799354	Industrial and commercial	22	1	0	0	0.1
96	Fairview Downs	5818222	1803195	Residential				N/D	0
97	Peacocke	5809997	1803911	Agricultural or lifestyle				N/D	1
101	Hamilton Central	5815886	1800608	Industrial and commercial	21	10	0	0	N/D
102	Chedworth	5819075	1801861	Residential	21	15	0	0	N/D
105	Hillcrest	5814865	1802917	Residential	21	2	0	0	N/D
107	Rototuna North	5823123	1797024	Residential	22	0	0	0	N/D
108	Melville	5812619	1801092	Residential		5	5	1	0.19

111	Hillcrest	5813931	1804428	Residential	21	6	2	0.3	N/D

Appendix 3. Summary of 24-h weather conditions during the survey period. Data obtained from NIWA Cliflo climate database. Ruakura EWS weather station, network number C75734.

Date	Maximum Temperature (°C)	Minimum Temperature (°C)	Precipitation (mm)	Maximum windspeed gust (m/s)
28/02/22	26.0	13.8	0	6.7
01/03/22	24.7	14	0	7.7
02/03/22	26.1	11.6	0	8.2
03/03/22	25.8	11.1	0	8.2
04/03/22	23.7	12.5	0	5.7
05/03/22	24.9	11.8	0	7.7
06/03/22	25.0	11.9	0	7.7
07/03/22	25.5	11.7	0	5.1
08/03/22	27.5	14.5	0	9.8
09/03/22	26.7	14.3	0	7.2
10/03/22	26.8	13.9	0	7.7
11/03/22	26.1	13.2	0	8.2
12/03/22	23.1	12.5	0	7.7
13/03/22	25.1	16.2	0	8.8
14/03/22	25.5	10.3	0	7.2
15/03/22	27.4	12.2	0	9.8
16/03/22	28.2	13.2	0	9.8
17/03/22	25.2	9.6	0	6.7
18/03/22	25.1	11.6	0	7.2
19/03/22	23.9	9.3	0	9.3
20/03/22	24.2	13.0	3.2	13.4
21/03/22	22.5	16.3	8.2	12.9
22/03/22	24.0	14.3	56.2	10.8
23/03/22	27.3	17.1	0	7.7
24/03/22	24.1	16.6	0.4	15.4
25/03/22	22.5	18.0	2.4	12.9

Appendix 4. 2021 city-wide bat survey results (Aughton, 2021)



Appendix 5. 2020 city-wide bat survey results (Dumbleton and Montemezzani 2020)