Bird Counts 2020-2021

Cape to City Project, Hawke's Bay

A report prepared for the Cape to City Project Management Team

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1. Introduction

This is the third and the final report on bird counts in the Cape to City footprint and its immediate surrounds. The baseline results and the follow up results of the previous surveys are available on the Cape to City website (https://www.pfhb.nz/resources/).

The previous counts were undertaken in three areas: in the 2600ha Cape Sanctuary on the Cape Kidnappers Peninsula; in the 26,000 ha Cape to City footprint with predator control; and in a 20,000 ha non-treatment area on the western side of the Cape to City footprint. The location and boundaries of these three areas are shown in McLennan (2017).

This report presents the results of counts in native and exotic forests after 42 months of extensive top-predator control and localised rat control in the Cape to City footprint. This examines variation in bird abundance in each of the three project areas over time and evaluates whether treatment effects resulting from the Cape to City management programme are emerging in the footprint area.

2. Methods

2.1 Counting methods and location of transects.

The methods used to count birds and the locations of count sites were described by McLennan (2017). The same 5-minute bird count method, a road-transect and wetland counts used in the previous surveys were repeated. The counting sites were same as ones used in previous surveys in the 2015/16 and 2017/18 seasons.

Several of the original count sites in pine forests were affected by logging and were removed from this survey. These include four sites in the Cape to City footprint (Julian Gully, Frederick Pines x 2, Craggy Range) and two lines in the non-treatment area (Anglican Pines x 2). The number of 5-minute counts by year is shown in Table 1.

Table 1: Number of 5-minute counts by year and counting area.

Counting Area	2015	2016	2017	2018	2020	2021
Cape Sanctuary	95	170	248	96	96	96
Cape to City footprint	130	628	357	146	134	119
Non-treatment Area	100	158	110	20	60	55

2.2 Statistical analysis

Differences between means on untransformed data were tested with ANOVA using the programme Systat®.

3. Results

3.1 Variation in bird abundance in the three counting areas over time, as measured by 5-minute counts in forests

3.1.1 Abundance changes in native bird species

Native bird abundance in each of the three counting areas (Cape Sanctuary, Cape to City footprint and non-treatment area) is shown in Table 2a, 2b, and 2c, respectively. Within each counting area, the counts are analysed in relation to time (Period 1: 2015-2016, Period 2: 2017-18, Period 3: 2020-21). In two of the counting areas (Cape to City footprint and non-treatment area), the counts are also analysed in relation to habitat type (pine forest and indigenous forest) as described in previous reports (McLennan 2017, McLennan & Nakagawa 2019).

Table 2a: Native bird abundance in Cape Sanctuary in Period 1 (2015/2016), Period 2 (2017/2018) and Period 3 (2020/2021). Numbers are mean numbers of individuals seen and heard per 5-minute count ± standard deviation.

Species	N	Period 1	N	Period 2	N	Period 3	ANOVA and significance
Robin	263	0.37 ±0.76	344	0.53 ± 0.74	192	0.95 ± 1.08	f = 14.28, p<0.000
Tomtit	263	0.31 ±0.59	344	0.16 ± 0.41	192	0.53 ± 0.83	f = 12.21, p<0.000
Whitehead	263	0.41 ±1.0	344	0.36 ± 0.97	192	0.81 ± 1.29	f =6.40, p<0.000
Grey Warbler	263	1.22 ±1.23	344	1.48 ± 1.22	192	2.53 ± 1.43	f = 34.2, p<0.000
Fantail	263	0.38 ±0.71	344	0.43 ± 0.70	192	0.37 ± 0.78	f = 8.4, p<0.000
Silvereye	263	0.55 ±1.14	344	1.69 ± 2.25	192	1.29 ± 1.78	f = 21.67, p<0.000
Bellbird	263	2.68 ±2.26	344	2.83 ± 2.32	192	1.25 ± 1.51	f = 17.97, p<0.000
Tui	263	2.15 ±1.97	344	1.24 ± 1.56	192	1.85 ± 1.74	f = 21.45, p<0.000
Kereru	263	0.17 ±0.51	344	0.13 ± 0.42	192	0.35 ± 0.81	f = 5.91, p<0.000
Kakariki	263	0.29 ±0.71	344	0.72 ± 1.13	192	0.12 ± 0.42	f = 16.25, p<0.000
Kaka	263	0.14 ±0.49	344	0.07 ± 0.32	192	0.73 ± 1.23	f = 29.8, p<0.000
Kingfisher	263	0.39 ±0.67	344	0.08 ± 0.32	192	0.32 ± 0.63	f = 21.67, p<0.000
Shining cuckoo	263	0.19 ±0.39	344	0	192	0.1 ± 0.36	f = 18.56, p<0.000

Table 2b: Native bird abundance in the Cape to City footprint in Period 1 (2015/2016), Period 2 (2017/2018) and Period 3 (2020/2021). Conversions as for Table 2a.

Species	Habitat	N	Period 1	N	Period 2	N	Period 3	ANOVA and significance
Robin	Pine	530	0.02±0.17	275	0.14±0.43	97	0.05±0.22	f =8.90, p<0.000
	Native	228	0.11±0.4	228	0.53±0.80	156	0.81±1.17	f =16.54, p<0.000
Tomtit	Pine	530	0.006±0.08	275	0.004±0.06	97	0	f =0.39, p=0.858

	Native	228	0	228	0	156	0.02±0.14	f =4.23, p=0.001
Whitehead	Pine	530	0.004±0.006	275	0	97	0	No variation
	Native	228	0	228	0	156	0	No variation
Grey Warbler	Pine	530	0.96±1.36	275	2.32±1.36	97	1.35±1.23	f =47.45, p<0.000
	Native	228	2.24±1.62	228	1.73±1.42	156	2.58±1.61	f =17.59, p<0.000
Fantail	Pine	530	0.48±0.83	275	0.98±1.07	97	0.74±0.97	f =16.09, p<0.000
	Native	228	0.48±0.77	228	0.50±0.73	156	0.58±0.90	f =3.06, p<0.000
Silvereye	Pine	530	0.39±1.06	275	1.64±1.82	97	1.07±2.0	f =27.92, p<0.000
	Native	228	1.69±2.06	228	1.83±1.82	156	1.39±1.63	f =9.61, p<0.000
Bellbird	Pine	530	0.14±0.56	275	0.36±0.69	97	0.22±0.48	f =7.86, p<0.000
	Native	228	0.43±0.77	228	0.45±0.88	156	0.15±0.40	f =6.93, p<0.000
Tui	Pine	530	0.64±1.31	275	1.66±1.99	97	0.71±1.23	f =18.52, p<0.000
	Native	228	3.57±1.76	228	3.20±1.98	156	3.46±2.07	f =3.83, p=0.002
Kereru	Pine	530	0.07±0.44	275	0.13±1.99	97	0.07±0.36	f =0.58, p=0.715
	Native	228	1.32±1.1	228	1.04±1.27	156	0.96±1.11	f =5.56, p<0.000
Kingfisher	Pine	530	0.19±0.47	275	0.12±0.37	97	0.31±0.7	f =9.46, p<0.000
	Native	228	0.25±0.57	228	0.17±0.50	156	0.14±0.41	f =7.15, p<0.000
Shining cuckoo	Pine	530	0.04±0.24	275	0	97	0.04±0.20	f =44.56, p<0.000
	Native	228	0.11±0.33	228	0	156	0.08±0.33	f =13.40, p<0.000

Table 2c: Native bird abundance in the non-treatment area in Period 1 (2015/2016), Period 2 (2017/2018) and Period 3 (2020/2021). Conversions as for Table 2a.

Species	**Habitat**	**N**	**Period 1**	**N**	**Period 2**	**N**	**Period 3**	**ANOVA and significance**
Robin	Pine	156	0	80	0	80	0	No variance
	Native	60	0	50	0	35	0	No variance
Tomtit	Pine	156	0	80	0	80	0	No variance
	Native	60	0	50	0	35	0	No variance
Whitehead	Pine	156	0	80	0	80	0	No variance
	Native	60	0	50	0	35	0	No variance
Grey Warbler	Pine	156	1.72±1.26	80	1.70±1.29	80	2.54±1.45	f =34, p<0.000
	Native	60	2.17±1.58	50	1.92±1.32	35	2.54±1.60	f =12.76, p<0.000
Fantail	Pine	156	0.50±0.78	80	0.59±0.69	80	0.41±0.61	f =14.82, p<0.000
	Native	60	1.50±1.27	50	1.30±1.25	35	1.29±1.18	f =9.62, p<0.000

Silvereye	Pine	156	0.20±0.61	80	0.86±1.82	80	0.56±0.98	f =7.99, p<0.000
	Native	60	1.0±1.75	50	1.48±1.75	35	0.66±1.11	f =4.74, p=0.001
Bellbird	Pine	156	0.03±0.16	80	0.05±0.27	80	0	f =1, p=0.04
	Native	60	0.12±0.37	50	0	35	0.09±0.28	f =6.75, p<0.000
Tui	Pine	156	0.27±0.54	80	0.11±0.36	80	0.75±0.95	f =16.18, p<0.000
	Native	60	3.82±1.87	50	3.28±1.76	35	2.17±1.32	f =10.94, p<0.000
Kereru	Pine	156	0.004±0.07	80	0.006±0.08	80	0.05±0.27	f =3.89, p=0.04
	Native	60	1.45±1.7	50	0.78±1.09	35	1.74±1.54	f =4.97, p<0.000
Kingfisher	Pine	156	0.13±0.42	80	0.20±0.46	80	0.38±0.7	f =3.93, p=0.004
	Native	60	0.75±0.86	50	0.32±0.55	35	0.63±0.88	f =4.63, p=0.001
Shining cuckoo	Pine	156	0.16±0.55	80	0	80	0	f =2.36, p=0.053
	Native	60	0.02±0.16	50	0	35	0.06±0.24	f =15.13, p<0.000

Notable changes in bird abundance over the years are summarised in Table 3. All three counting areas experienced different degrees of variation in bird abundance over time. At Cape Sanctuary, robin, tomtit, whitehead, greywarbler, kereru and kaka increased and bellbird and kakariki decreased. At the Cape to City footprint, robin and tomtit in native forest and king fisher in pine forest increased, and bellbird and kereru in native forest decreased. At the non-treatment area, an increase was observed in greywarbler (pine and native), king fisher (pine), tui (pine) and kereru (pine), while fantail (pine and native), silvereye (native), bellbird (pine) and tui (native) decreased.

Robin is showing significant increase at Cape Sanctuary. In the Cape to City footprint, robins are also present in the area where both top predators and rats are controlled, indicating their positive response to management. Robins continue to grow in numbers at 100 Acre Bush and Mohi bush, with dispersing birds sighted at nearby Maraetotara Scenic Reserve for the first time in February 2021. Translocated tomtits failed to establish a population at Maraetotara Plateau although they are still abundant in very low numbers within the footprint area: a male tomtit was also sighted at Te Mata Peak in this survey period. Another male tomtit was seen at 100 Acres Bush outside survey in 2020.

It is worth noting that bellbird significantly decreased in all three areas over time. We can only speculate that some environmental or climate factors must have affected their breeding and survival.

Logging of pine trees that occurred between Period 1 and Period 3 appear to have affected bird abundance, particularly in the footprint area. This includes robin, tui, greywarbler, fantail, kereru, silvereye, king fisher and bellbird. In non-treatment area, logging affected silvereye and tui abundance.

Table 3: Summary of abundance changes of native birds in the three counting areas between Period 1 and Period 3. Red indicates a decline, green an increase and white no change.

Species	Cape Sanctuary	Cape to City footprint	Non treatment
Robin	Overall increase	Overall increase in native	Not present
Tomtit	Overall increase	Present but extremely scarce	Not present
Whitehead	Overall increase	Not present	Not present
Grey warbler	Overall increase	Fluctuating over time	Increase in pine and native
Fantail	No change	No change in native, but fluctuating in pine	Decline in pine and native
Silvereye	Fluctuating over time	No change in native, but fluctuating in pine	No change in pines, but decline in native
Bellbird	Overall decline	Overall decline in native	Decline in pines and fluctuating in native
Tui	Fluctuating over time	No change in native, but fluctuating in pine	Increase in pines and decline in native
Kereru	Overall increase	Overall decline in native	Increase in pines and native
Kakariki	Overall decline	Not detected	Not present
Kaka	Overall increase	Not detected in the surveys, but sightings reported	Not present
Kingfisher	Fluctuating over time	Overall increase in pines	Increase in pines and fluctuating in native
Shining cuckoo	Fluctuating over time	No change	No change in pines and native

3.1.2 Abundance change in introduced bird species

The abundance of introduced birds in the three counting areas in Periods 1, 2 and 3 are shown in Tables 4a (Cape Sanctuary), 4b (Cape to City footprint), and 4c (non-treatment area).

In summary, at Cape Sanctuary, chaffinch, goldfinch and starling increased over time.
At the footprint, chaffinch, goldfinch, starling increased overall in both pines and native forests. Also, blackbird showed overall increase in pine forest. Blackbird and thrush decreased overall in native forests. At non-treatment area, an increase was seen in chaffinch (pine & native) and magpie (native) and decrease was seen in greenfinch (pine & native) and house sparrow (pine).

Table 4a: Abundance of introduced birds in Cape Sanctuary in Period 1 (2015/2016), Period 2 (2017/2018) and Period 3 (2020/2021). Conversions as for Table 2a.

Species	N	Period 1	N	Period 2	N	Period 3	ANOVA and significance
Chaffinch	263	1.85±1.77	344	1.67±1.61	192	2.86±2.7	f =37.6, p<0.000
Greenfinch	263	1.21±1.73	344	0.04±0.25	192	0.35±0.90	f =13.81, p<0.000
Goldfinch	263	0.41±0.90	344	0.48±0.94	192	0.63±1.04	f =10.32, p=0.002
House sparrow	263	0.27±1.04	344	0.12±0.53	192	0.22±0.78	f =0.009, p=0.93
Blackbird	263	0.46±0.80	344	0.22±0.49	192	0.5±0.87	f =22.4, p<0.000
Thrush	263	0.05±0.24	344	0.003±0.05	192	0.05±0.27	f =7.64, p=0.006
Magpie	263	0.8±1.06	344	1.25±1.33	192	0.8±1.2	f =9.46, p=0.002
Starling	263	0.06±0.45	344	0.041±0.23	192	0.32±0.88	f =7.10, p=0.008
Myna	263	0	344	0	192	0	No variance
Californian quail	263	0.01±0.10	344	0	192	0.06±0.55	f =1.113, p=0.293
Pheasant	263	0.103±0.32	344	0.02±0.61	192	0.06±0.27	f =1.74, p=0.189

Table 4b: Abundance of introduced birds in the Cape to City footprint in Period 1 (2015/2016), Period 2 (2017/2018) and Period 3 (2020/2021). Conversions as for Table 2a.

Species	Habitat	N	Period 1	N	Period 2	N	Period 3	ANOVA and significance
Chaffinch	Pine	530	1.82±2.19	275	2.72±2.16	97	3.65±2.79	f =19.42, p<0.000
	Native	228	0.78±1.11	228	1.04±1.29	156	1.16±1.83	f =13.26, p<0.000
Greenfinch	Pine	530	1.22±1.86	275	0.32±0.85	97	0.53±1.52	f =56.62, p<0.000
	Native	228	0.39±0.77	228	0.22±1.47	156	0.16±0.57	f =4.96, p<0.000
Goldfinch	Pine	530	0.48±1.03	275	0.54±0.94	97	0.72±1.12	f =6.46, p<0.000
	Native	228	0.26±0.67	228	0.46±0.99	156	0.62±1.15	f =2.65, p=0.022
House sparrow	Pine	530	0.27±1.04	275	0.04±2.81	97	0.69±1.75	f =10.27, p<0.000
	Native	228	0.05±0.30	228	0	156	0.04±0.30	f =2.76, p=0.018
Blackbird	Pine	530	0.61±1.25	275	0.67±0.97	97	1.04±1.24	f =5.33, p<0.000
	Native	228	1.22±1.44	228	1.09±1.31	156	0.92±1.16	f =11.94, p<0.000
Thrush	Pine	530	0.04±0.26	275	0.04±0.24	97	0.05±0.22	f =12.42, p<0.000
	Native	228	0.15±0.54	228	0.08±0.34	156	0.03±0.20	f =3.56, p=0.004
Magpie	Pine	530	0.87±1.39	275	2.03±1.69	97	1.43±1.30	f =25.38, p<0.000
	Native	228	0.89±1.13	228	1.24±1.32	156	1.12±1.65	f =4.33, p=0.001
Starling	Pine	530	0.12±0.49	275	0.06±0.33	97	0.20±0.69	f =5.41, p<0.000
	Native	228	0.14±0.53	228	0.42±0.91	156	0.69±1.32	f =11.60, p<0.000
Myna	Pine	530	0	275	0	97	0	No variance
	Native	228	0	228	0	156	0	No variance
Californian Quail	Pine	530	0.004±0.06	275	0.02±0.24	97	0	f =0.542, p=0.745
	Native	228	0.004±0.67	228	0	156	0	f =2.38, p=0.038
Pheasant	Pine	530	0.08±0.36	275	0.04±0.23	97	0	f =2.69, p=0.02
	Native	228	0	228	0.01±0.09	156	0	f =1.22, p=0.301

Table 4c: Abundance of introduced birds in the non-treatment area in Period 1 (2015/2016), Period 2 (2017/2018) and Period 3 (2020/2021). Conversions as for Table 2a.

Species	Habitat	N	Period 1	N	Period 2	N	Period 3	ANOVA and significance
Chaffinch	Pine	198	3.38±2.05	80	4.15±2.10	80	6.91±3.11	f =80.42, p<0.000
	Native	60	1.93±1.94	50	1.66±1.29	35	2.17±2.43	f =4.79, p<0.000
Greenfinch	Pine	198	1.63±1.97	80	0.76±1.66	80	0.75±1.51	f =35.93, p<0.000
	Native	60	0.18±0.77	50	0.10±0.42	35	0.03±0.17	f =0.897, p=0.485
Goldfinch	Pine	198	0.62±1.13	80	0.77±1.17	80	0.65±0.93	f =1.555, p=0.186
	Native	60	0.58±1.15	50	0.28±0.61	35	0.49±1.01	f =2.19, p=0.059
House sparrow	Pine	198	0.37±2.21	80	0.25±2.24	80	0.19±1.68	f =1.311, p=0.265
	Native	60	0.40±1.17	50	0.04±0.28	35	0.29±1.27	f =2.347, p=0.044
Blackbird	Pine	198	2.12±1.84	80	2.55±1.94	80	1.63±1.46	f =5.21, p<0.000
	Native	60	1.22±1.46	50	0.78±0.95	35	1.03±1.32	f =3.986, p=0.002
Thrush	Pine	198	0.21±0.57	80	0.06±0.291	80	0.14±0.38	f =3.881, p=0.004
	Native	60	0.03±0.18	50	0.24±0.59	35	0.03±0.17	f =4.606, p=0.001
Magpie	Pine	198	0.82±1.25	80	1.41±1.34	80	1.11±1.19	f =19.37, p<0.000
	Native	60	0.85±1.27	50	1.30±1.15	35	1.63±1.68	f =3.991, p=0.002
Starling	Pine	198	0.03±0.24	80	0	80	0.29±0.46	f =22.2, p<0.000
	Native	60	1.12±1.50	50	2.38±1.6	35	1.26±1.54	f =13.71, p<0.000
Myna	Pine	198	0	80	0	80	0	No variance
	Native	60	0	50	0	35	0	No variance
Californian Quail	Pine	198	0.005±0.07	80	0	80	0	f =0.807, p=0.484
	Native	60	0	50	0	35	0	No variance
Pheasant	Pine	198	0.005±0.07	80	0	80	0	f =0.867, p=0.484
	Native	60	0	50	0	35	0	No variance

Table 5: Summary of changes for introduced birds in the three counting areas between Period 1 and Period 3.

Species	Cape Sanctuary	Cape to City Footprint	Non-treatment
Chaffinch	Overall increase	Overall increase in pines and native	Overall increase in pines and native
Greenfinch	Fluctuating	Fluctuating in pines and decline in native	Decline in pines and native
Goldfinch	Overall increase	Increase in pines and native	No change in pines, slight fluctuation in native
House sparrow	Fluctuating	Fluctuating in pines and no change in native	Decline in pines and fluctuating in native
Blackbird	Fluctuating	Increase in pines and decrease in native	Slight decline in pines and fluctuating in native
Thrush	Fluctuating	No change in pines and decline in native	Fluctuating in pine and native
Magpie	Fluctuating	Fluctuating in pines and native	Fluctuating in pine and increase in native
Starling	Overall increase	Fluctuating in pines and increase in native	Fluctuating in both pine and native
Myna	Not present	Not present	Not present
Californian quail	No change	No change	Not detected in surveys
Pheasant	No change	No change	Not detected in surveys

3.2 Variation in bird and mammal abundance in the Cape to City footprint and non-treatment area, as measured by road counts.

The abundance of farmland birds fluctuated significantly in both the footprint and non-treatment areas among Period 1, Period 2 and Period 3 (Table 6a and 6b). In the footprint, overall decline was seen in pheasant, Californian quail and ducks. In non-treatment area, pukeko increased and pheasant and ducks declined overall.

Table 6a: Abundance of birds in farmland in the Cape to City footprint in Periods 1, 2 and 3.

Species	N	Period 1	N	Period 2	N	Period 3	ANOVA and significance
Magpie	48	4.2±3.9	40	9.0±5.7	19	6.53±5.63	f =5.079, p=0.001
Harrier	48	0.33±0.63	40	0.75±0.9	19	0.47±0.61	f =1.897, p=0.117
Turkey	48	3.1±5.9	40	4.6±9.4	19	2.53±3.9	f =1.032, p=0.395
Feral goose	48	0.58±3.17	40	1.5±5.5	19	0	f =0.688, p=0.602
Pheasant	48	0.56±1.58	40	0.47±1.0	19	0.26±0.73	f =0.495, p=0.74
Californian quail	48	2.2±6.0	40	1.40±4.2	19	0.37±0.9	f =0.517, p=0.723
Pukeko	48	2.9±6.0	40	3.9±7.0	19	1±2.73	f =0.763, p=0.552
Duck	48	2.0±4.7	40	0.65±1.95	19	0.05±0.23	f =1.521, p=0.202
Paradise duck	48	1.5±2.38	40	2.1±3.8	19	0.95±2.07	f =0.836, p=0.505

Table 6b: Abundance of birds in farmland in the non-treatment area in Periods 1, 2 and 3.

Species	N	Period 1	N	Period 2	N	Period 3	ANOVA and significance
Magpie	56	5.3±6.1	40	9.1±8.3	17	4.5±3.6	f =2.67, p=0.036
Harrier	56	0.56±1.07	40	1.1±1.6	17	0.35±0.7	f =1.928, p=0.111
Turkey	56	1.2±3.0	40	2.9±5.4	17	0.41±1.7	f =1.653, p=0.166
Feral goose	56	1.6±7.0	40	4.7±11.7	17	1.9±7.3	f =1.025, p=0.398
Pheasant	56	0.23±0.60	40	0.15±0.67	17	0.06±0.24	f =0.711, p=0.586
Californian quail	56	0.84±1.6	40	1.3±3.2	17	0.47±0.94	f =0.534, p=0.711
Pukeko	56	0.16±0.56	40	0.2±7.0	17	0.53±0.94	f =0.967, p=0.429
Duck	56	1.4±3.7	40	0.65±1.95	17	0	f =1.121, p=0.35
Paradise duck	56	4.5±13.7	40	4.8±13.65	17	2.7±6.1	f =0.768, p=0.548

Mammal sightings during road counts are generally limited due to low encounter rate. In the Cape to City footprint area, there were no statistically significant changes in predator sightings overall, except very low detection of all mammals in Period 3 (Table 7a & 7b). In the non-treatment area, mammal sightings were slightly higher than the footprint area in general. There was slight decline of hare and hedgehog sightings and slight increase of cat sightings.

Table 7a: Abundance of selected mammals in farmland in the footprint in Periods 1, 2 and 3.

Species	N	Period 1	N	Period 2	N	Period 3	ANOVA and significance
Rabbit (seen)	48	1.4±2.4	40	1.0±1.7	19	0	f =2.015, p=0.098
Rabbit (killed)	48	0.25±0.53	40	0.3±0.6	19	0.26±0.93	f =0.449, p=0.773
Hares (seen)	48	0.6±1.7	40	0.62±1.14	19	0	f =0.962, p=0.432
Possums (killed)	48	0.2±0.58	40	0.15±0.42	19	0	f =0.702, p=0.592
Stoat (seen)	48	0.1±0.37	40	0	19	0	f =0.577, p=0.68
Cat (seen)	48	0.1±0.37	40	0	19	0.05±0.23	f =1.174, p=0.327
Hedgehog (killed)	48	0.06±0.24	40	0.10±0.3	19	0	f =0.901, p=0.466

Table 7b: Abundance of selected mammals in farmland in the non-treatment area in Periods 1, 2 and 3.

Species	N	Period 1	N	Period 2	N	Period 3	ANOVA and significance
Rabbit (seen)	56	1.6±2.4	40	0.8±1.0	17	0.71±1.5	f =4.73, p=0.001
Rabbit (killed)	56	0.26±0.69	40	0.28±0.51	17	0.35±0.7	f =0.78, p=0.529
Hares (seen)	56	0.21±0.49	40	0.25±0.55	17	0.06±0.24	f =0.555, p=0.696
Possums (killed)	56	0.2±0.13	40	0.05±0.22	17	0.29±0.59	f =1.379, p=0.246
Stoat (seen)	56	0	40	0	17	0	No variance
Cat (seen)	56	0	40	0.03±0.16	17	0.06±0.24	f =1.673, p=0.162
Hedgehog (killed)	56	0.24±0.54	40	0.18±0.45	17	0	f =0.786, p=0.537

3.3 Wetland bird abundance in Cape Sanctuary, the Cape to City footprint, and the Cape to City non-treatment area

A mix of waterfowl, waders and wetland birds were recorded in the counts (Table 9a, b). The number of individual birds recorded in a single count varied from 0 to 447, with large wetlands having more birds overall, and more species, than small ones. Wetland complexity, season and sanctuary status (hunting allowed or not) also influenced wetland bird abundance. Simple comparison of species abundance in each treatment area were confounded by pond size, with the footprint and non-treatment areas having larger ponds than Cape Sanctuary.

Mallard ducks remained the most numerous species of duck in the counting areas (51.3% of 1453 ducks recorded) followed by paradise shelduck (14.2%), New Zealand scaup (11.4%), Australasian shoveler (9.2%), grey teal (6.7%), pateke (5.6%) and grey duck (1.6%).

Pateke has significantly declined overall in all three counting areas (Table 8). Dabchick, on the other hand, increased in abundance and range at Cape Sanctuary. Dabchick counts were lower in the footprint and non-treatment areas but were more widespread in Period 3.

Table 8: Pateke and dabchick abundance (total recorded) in the three counting areas, in Period 1 (2015/16) and Period 3 (2020/21). P = proportion of wetlands present.

Species	Period	Cape Sanctuary		C2C Footprint		C2C Non-treatment	
		N	Sum, P	N	Sum, P	N	Sum, P
Pateke	1	20	187, 0.9	24	6, 0.12	47	3, 0.06
	3	18	87, 0.33	17	0	24	0
Dabchick	1	20	13, 0.4	24	48, 0.23	47	29, 0.29
	3	18	16, 0.5	17	27, 0.35	24	10, 0.4

Common waterfowl numbers generally increased in the Cape to City footprint between Period 1 and Period 3, except grey teal, Australasian shoveler, and little shag (Table 9a). In the non-treatment area, scaup and black swan increased overall, and mallard, paradise shelduck, grey teal, Australasian shoveler, and little shag all declined (Table 9b).

Table 9a: Abundance of common species of waterfowl and wetland birds in the Cape to City footprint.

Species	Period 1 (2015/2016) N = 24	Period 3 (2020/2021) N= 17	ANOVA and significance
Mallard	16.7±35.9	22.6±36.0	f = 0.660, p=0.622
Paradise shelduck	7.58±21.3	11.35±30.57	f =0.436, p=0.782
Grey teal	12.8±49.9	4.18±9.16	f =1.251, p=0.299
Australasian shoveler	3.17±10.1	2.0±2.65	f =0.998, p=0.416
NZ scaup	2.25±7.79	8.65±23.79	f =0.523, p=0.719
Black swan	7.90±21.5	11.06±28.10	f =0.357, p=0.838
Little shag	0.08±0.28	0	f =1.699, p=0.162

Table 9b: Abundance of common species of waterfowl and wetland birds in the non-treatment area.

Species	Period 1 (2015/2016) N = 47	Period 3 (2020/2021) N= 24	ANOVA and significance
Mallard	20.1±26.5	13.79±17.0	f =4.21, p=0.003
Paradise shelduck	0.3±1.0	0.21±1.02	f =1.26, p=0.289
Grey teal	5.9±16.9	1.08±2.8	f =2.19, p=0.075
Australasian shoveler	5.2±17.9	4.17±11.81	f =1.571, p=0.187
NZ scaup	0.06±0.32	0.33±1.13	f =0.797, p=0.529
Black swan	8.0±23.3	9.79±31.0	f =0.832, p=0.507
Little shag	1.5±2.5	0.29±0.69	f =4.055, p=0.004

4. Discussion

Almost all translocated native birds have increased significantly at Cape Sanctuary in the last five years. The sudden decline in kakariki detection rate at the Sanctuary during this survey period may be simply due to their inconspicuousness after regular supplementary feeding had ceased. Low kakariki detection within the Sanctuary could also be due to dispersal, although the movement of kakariki from the Sanctuary to the footprint has been infrequent and slow. No kakariki were recorded in counts in the footprints but they are occasionally seen in Te Awanga (directly outside Cape Sanctuary) by various landowners. Avian or mammalian predators may have contributed to the decline of kakariki population as seen similarly in pateke population at the Sanctuary.

In previous surveys, pateke and dabchick were identified as potential indicators of the success of the Cape to City management programme (McLennan 2017, McLennan & Nakagawa 2019). Unfortunately, pateke at Cape Sanctuary has experienced dramatic decline in recent years, and their dispersal to the footprint area was very limited. Anecdotal evidence suggests that predation was the main cause. High rabbit density within the fenced off area continue to attract both mammalian and avian predators into the Sanctuary, and pateke appears much more susceptible to predation than other native species. Ongoing rabbit and top-predator controls beyond current level are recommended if we seek pateke population recovery within Cape Sanctuary and their dispersal and survival in the footprint area.

On the other hand, the distribution of dabchick across wetlands increased in both the footprint and non-treatment areas, while dabchick increased in abundance within Cape Sanctuary. Dabchicks are capable of flying long distance at night (Marchant & Higgins 1990), and it is possible that the large-scale predator control of Cape to City programme assisted dabchick dispersal from Cape to the footprint and from the footprint to non-treatment areas.

The majority of native species in the Cape to City footprint is positively responding to the predator control programme. Effects of predator control were evident in key sites within the footprint, such as Te Mata Peak, Frederick Pines, 100 Acre Bush and Mohi Bush, where both top predators and rats were controlled. Waterfowls in the footprint areas also experienced increased breeding and survival, most likely due to the low predator abundance. Predator control also resulted in reduced mammal abundance in road survey.

A new robin population has now successfully established in Maraetotara Plateau after several translocations. A majority of robins seen at Mohi Bush and 100 Acres Bush are unbanded, indicating successful breeding. As long as rat control continues in these targeted areas, robin will continue to flourish.

However, loss of pine forests had significant effects on bird abundance and dispersal in the footprint area. Insectivore species such as robin, tomtit and whitehead were occasionally recorded outside Cape Sanctuary. Unfortunately, loss of habitat (i.e., logging) and the lack of corridors between these bush patches and other suitable habitats meant that these birds remained isolated or led to gradual disappearance. Significant pine forest cover was lost at Te Awanga and Craggy Range, stopping further dispersal of spillover species from Cape Sanctuary into wider regions. Species such as kakariki and kaka which can fly long distance may overcome such challenges in the future when their numbers grow and disperse.

5. Conclusion

John McLennan (2017) pointed out four key factors for successful establishment of threatened species in the Cape to City footprint. These include:

1) *the success of the predator control programme,*
2) *the quantity and quality of habitats available for occupation within the footprint itself,*
3) *the ability and propensity of individual species to disperse over open farmland from Cape Sanctuary to isolated patches of forest within the C2C footprint; and*
4) *the extent to which the sanctuary generates a supply of potential colonists for the C2C footprint.*

This report confirms that predator control is meeting target level in key sites within the footprint. In particular, it benefitted wetland birds in general and native bird diversity in Maraetotara Plateau. However, a lack of suitable habitats and limited supply of potential colonists have resulted in failed natural establishment of threatened species in the management period.

As mentioned in McLennan (2017), scheduled indigenous plantings within the footprint will not be sufficient to offset the removal of mature exotic plantations of *Pinus Radiata* already undertaken, but will provide additional habitat for native birds. Such planting must be done strategically to create permanent corridors between Cape Sanctuary and Maraetotara Plateau. If mammalian predators could be suppressed to protect these native corridors through ongoing control, we will start seeing spillover species from Cape Sanctuary again.

The degree of colonization of threatened species from Cape Sanctuary will depend on each species. Insectivores such as robin, tomtit and whitehead will continue to disperse if there are suitable habitats. Kakariki and pateke will take time before they build up in numbers as they do not appear to be responding to the current level of control within the Sanctuary. Kaka may become increasing common in Hawke's Bay in not-so-distant future as the Cape Sanctuary population seems rapidly growing. It would be interesting to see the similar bird survey repeated in 5-10 years' time for further progress at Cape Sanctuary and the footprint area.

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