Department of Conservation
Te Papa Atawhai

Internal Correspondence

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Subject: **Heaphy Management Area Bird Survey - September 2019.**

Summary

This report presents results from bird population monitoring in the lower altitudes (500m asl) of the Heaphy valley. The monitoring was undertaken to assess management efficacy, as the Heaphy area is managed for biodiversity enhancement in compensation for biodiversity losses incurred due to coal mining on the Denniston Plateau. We conducted five-minute bird counts and distance sampling on randomly placed monitoring grids to assess the status and trend of the local bird populations between 2015 and 2019. The five-minute bird count data detected increasing relative abundance for several native forest species (bellbird, fantail, grey warbler, kakariki, robin, silvereye, tomtit, tui and weka). The distance data also suggested increasing population densities for bellbird, fantail, silvereye, tui and weka. The results are encouraging, as the intensive predator management implemented in the area appears to benefit the local bird populations. We recommend continuing with the annual monitoring to gain confidence in the results and establish the long-term outcomes of the management. Both methods, five-minute bird counts, and distance sampling should continue to be used to align the present study with the Department's national biodiversity monitoring system.

Introduction

The Heaphy area in Kahurangi National Park has long been recognised as a place with high conservation values. The area was initially a regionally highly ranked management unit where possum vulnerable plants and threatened endemic land snail species (*Powelliphanta*) were managed for persistence. In 2011, the area was selected as a nationally representative Ecosystem Management Unit (Department of Conservation 2013).

Since 2014, Buller Coal Limited (BCL) provides compensation funding to the Department for the loss of biodiversity resulting from the Escarpment Mine operation on the Denniston Plateau. A portion of the compensation funds is specifically designated to enhance, for 35 years, biodiversity values within a management area centred on the Heaphy Valley.

The compensation management area lies within Kahurangi National Park, in the north-west of the South Island. It extends from the Moutere River in the north to the Kohaihai River in the south and east to the Gunner and Gouland Downs. It is approximately 29,000ha in size with a core area of about 13,000ha encompassing the lower and mid Heaphy Valley and the Iwituaroa Range. The core area is surrounded by a 3km wide buffer zone to minimise reinvasion of pest species and thus increase effectiveness of pest management in the core area.

Pest control in the Heaphy area was initiated in 1993/94 with localised ground control of possums along the coast and on the Heaphy Valley flats, and a small-scale aerial 1080 operation also targeting possums south of the Heaphy River (Department of Conservation 2020). Since then, pest control efforts have increased with the first full scale aerial 1080 operation over the entire management area, targeting rats and possums, conducted in 2007/08. Subsequent full-scale aerial operations occurred in 2012/13, 2014/15 and 2016/17. Since November 2017, all areas below 500m asl in the Heaphy catchment have received annual aerial pest control to suppress the local rat population. In November 2019, the Heaphy and Gunner sections of the Aorere and Karamea operational blocks were treated (Figure 1).

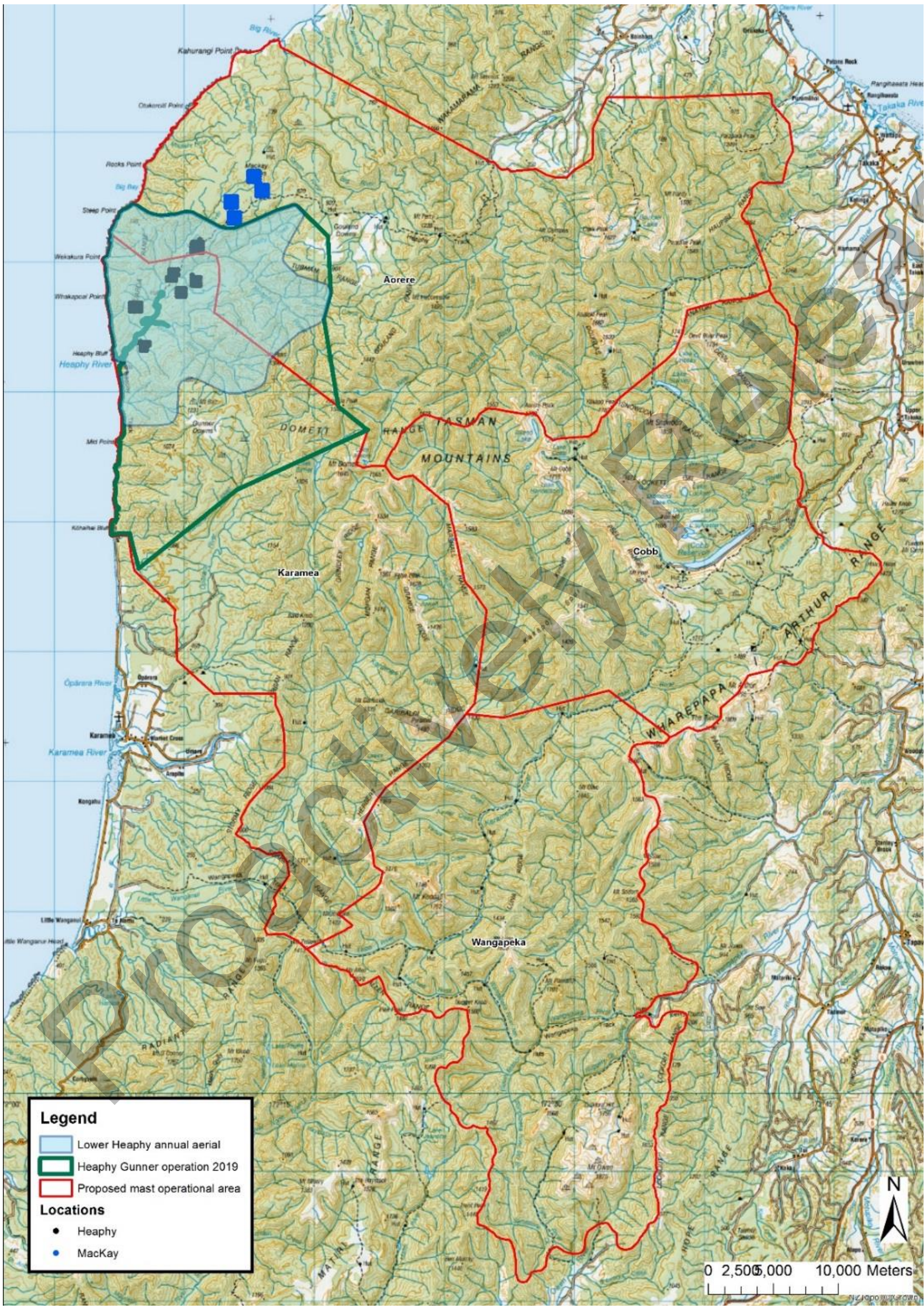

Figure 1. Kahurangi National Park. Extent of aerial pest control operations. The proposed full operational area to be treated after a beech mast is outlined in red. The green outline shows the treatment area following the 2019 mast. Annual operations cover the area below 500m asl in the Heaphy valley (light blue). The grey squares show the location of the Lewis bird monitoring grids and the blue squares show the MacKay grids (see Methods section).

The management plan for the Heaphy compensation project (Department of Conservation 2013; DOC-1226988) includes a comprehensive biodiversity monitoring programme that aims to assess the effectiveness of management, identify possible improvements to management practices and enable reporting on biodiversity enhancements achieved over time. This monitoring programme includes the monitoring of local bird populations, as intensive predator control is hoped to benefit these.

This report presents the results of annual bird counts done in the lower altitude area (< 500m asl) of the Heaphy management area over the last five years. Using distance sampling and five-minute bird count data, it reports on species richness, frequency of occurrence, distribution, relative abundance and estimated population densities of bird species within the survey area over time.

Methods

Six monitoring grids, each with 25 systematically arranged sample points (Figure 2) were available for survey in the lower Heaphy area (< 500m asl, subsequently called 'Lewis'). Within each grid, sample points were located 200m apart (as measured by a GPS) to ensure independence of individual counts. Each grid was set up in a north-south/east-west orientation based on a random starting point (aligned with the Department's spatially balanced Tier 2 monitoring master sample). Grids and points within grids were mapped using ESRI ArcMap 10.3.1 prior to the first field visit.

During the first visit, not all 25 sample points in each grid were surveyed because of unsafe terrain (e.g., sinkholes, bluffs, windfall) or time constraints. In subsequent years, some sample points were added, but others not measured, again due to time constraints or additional hazards, e.g., slips (Table 1).

Table 1. The number of sample points by survey year.

Year	Number of points visited
2015	106
2016	113
2017	115
2018	111
2019	111

At each sample point, distance sampling (Buckland et al. 2001, 2004) and standard five-minute bird counts (Dawson and Bull 1975) were undertaken. We followed the methodology currently used in the Department's Tier 1 monitoring programme (DOC-828397). This means, at each sample point, birds were surveyed for a total of ten minutes: distance sampling was conducted during the first five-minutes followed by a standard five-minute bird count during the second five-minute period. Both types of counts were unbounded, and birds were recorded within predefined distance categories. The distance sampling counts used the following distance categories: 0-8m, 9-16m 17-25m, 26-45m, 46-100m and >100m. The five-minute bird counts used three, coarser categories: Near (0-25m), Far (26-100m) and >Far (100m+). Environmental variables (temperature, wind, noise, minutes sunshine and precipitation type and amount) were also recorded. Incidental observations, i.e. outside the formal count periods, were recorded for any additional species observed. Both, native and introduced bird species were included.

The main difference between distance sampling and five-minute bird counts is that distance sampling aims to record a snapshot in time of bird presence and location. This means that the recorded distances are supposed to reflect the location of each bird at one point in time, taken to be the start of the five-minute observation period. Birds moving into or over the sample area during this period are not recorded. Five-minute bird counts, in contrast, record all birds seen or heard during the survey period. Both, distance sampling and five-minute bird counts attempt to record each individual only once.

The first three years of monitoring in the Heaphy area (2015-2017) are considered a baseline assessment against which future assessments could be compared. In these years, monitoring was done in the Lewis as well as the MacKay Downs area (Heaphy catchment > 500m asl). Subsequently, the Lewis area was surveyed annually, while the MacKay area was put on a three-year re-measurement cycle. The annual monitoring in the Lewis area hopes to detect a trend in the local bird populations in response to the more intensive, annual predator control in the area.

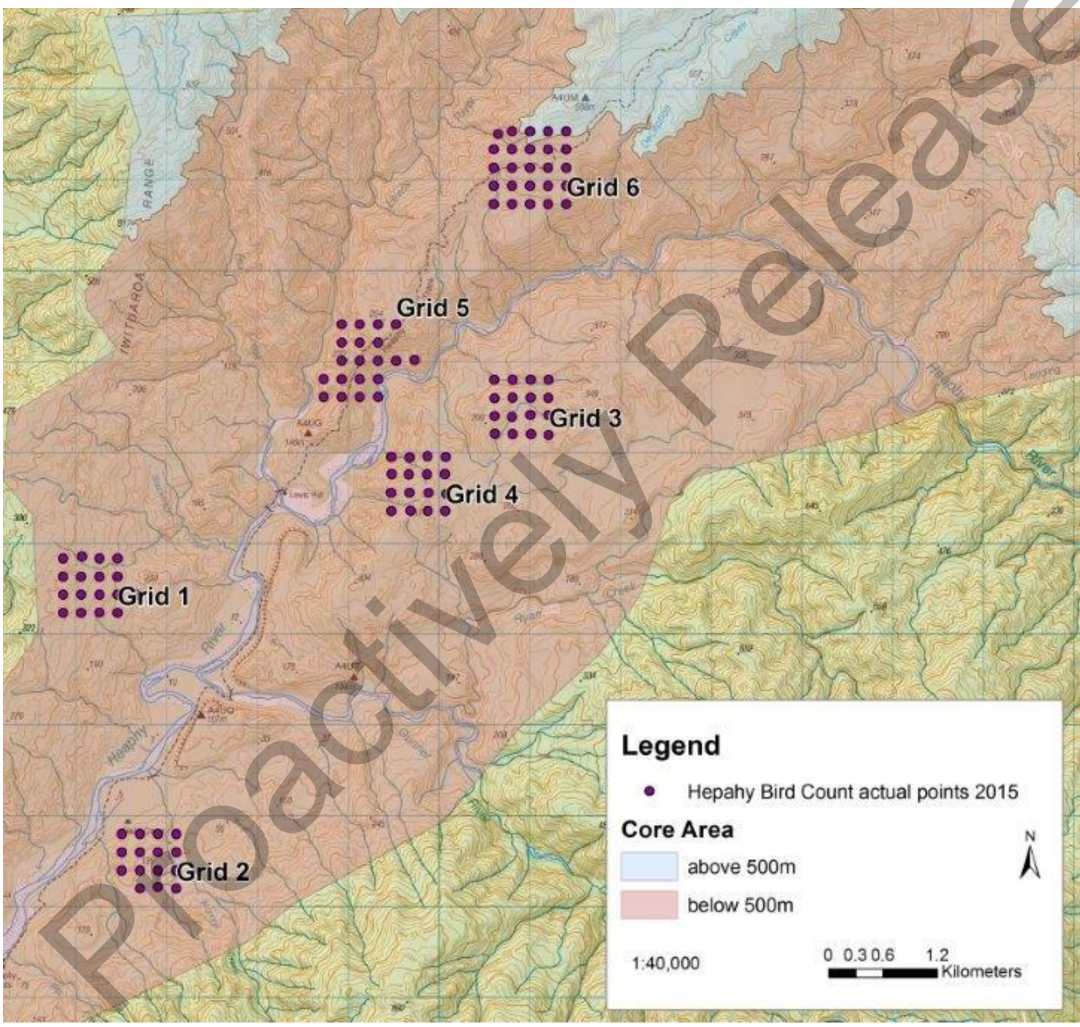

Figure 2. Location of the five-minute bird count and distance sampling grids and points in the Heaphy management area in the area below 500m asl (Lewis) as measured in 2019.

The monitoring was undertaken by experienced bird observers in September or October of each year. Counts were completed between 8am and 4pm. The field data sheet template can be found in DOCDM-828398. A post-operational report detailing the logistics of the field work is stored in S:\3_Tech Support\WAM\Post operational summaries\2019_20.

Analysis

Species richness reports the total number of bird species detected within the survey area during the entire survey, i.e. including distance sampling, five-minute bird counts and incidental observations. This is to capture the full complement of species present in the area.

We analysed five-minute bird count data for all species for which at least 30 individuals had been recorded over the five survey years. The frequency of detection for each species was calculated as the percentage of sample points at which a species was encountered. This provides a measure of how widespread the species occurred throughout the survey area. To analyse this geographically, we mapped bird distribution using ArcMap 10.3.1 GIS software. Species were mapped at each station where they were recorded as present. Definition queries were used to map the species by year and display the number of individuals recorded.

Relative abundance, defined as the mean number of individuals of a given species detected per sample point, was also calculated using the five-minute bird count data. It provides a simple index of species abundance (Dawson and Bull 1975). We analysed the trend over time for species using generalised linear mixed effects models. We assumed that the bird counts followed a Poisson distribution and analysed the data for each species separately. Models allowed for random effects of observer, grid and sample points within grids. Environmental variables (temperature, wind, noise, sunshine, precipitation type and amount) were included as covariates and eliminated by backwards selection. Year of measurement remained in the model as change over time was our main interest. An effect was deemed significant when the relevant p-value was < 0.05. We identified the favoured model based on the lowest AIC. The five-minute bird count data were analysed using Excel 2007 and R statistical software (R Core Team 2016).

Distance sampling data allows estimation of population densities in the survey area as the number of individuals per ha. The analysis models the probability of detecting an individual bird as a function of its distance from the observer (detection function). This detection function is then used to calculate population densities. A minimum of about 80 counts per species is required to attain reasonably accurate and precise estimates of population density (Buckland et al. 2001). The distance sampling data were analysed using the programme Distance 6.0 (Thomas et al. 2010, 2018). After the five survey years, distance sampling provided sufficient data to estimate population densities for nine species (Table 2).

Table 2. The nine species for which distance sampling provided enough data to estimate detection functions and population densities in the 2015 – 2019 surveys with the total number of counts achieved over this period.

Species	Total counts 2015 - 2019
Bellbird	1570
Fantail	289
Grey Warbler	599
Rifleman	73
Robin	221
Silvereye	267
Tomtit	483
Tui	346
Weka	106

For all nine species, a global detection function was used based on the pooled 2015 – 2019 data for each species, with estimates of density obtained separately for each year, as well as for the entire monitoring period (2015-2019). The sample points were used as the basic sampling unit, as they were deemed to represent independent measurements. Sampling effort was included in the analysis as the number of counts undertaken at each survey point during each survey year.

Cluster data was entered for all species, but the impact of clusters on population density estimates was thought to be minimal for all species, as most occurred as individuals. We therefore present individual density, rather than cluster density.

Selection of the best model for the detection function in each analysis was guided by AIC, Chi-square model fit statistic, coefficient of variation and visual inspection of probability density plots (Buckland et al. 2001, 2004).

The five-minute bird count data are stored electronically in DOC-2600272, the distance sampling data in DOC-2608373. Raw data for both are held in a box file in the Hokitika office of the Department's Biodiversity Monitoring Team. Relevant R-code can be found in S:\3_Tech Support\WAM\1. R\Bird\Heaphy\2019. The Distance analysis projects are stored in Q:\GIS_Users\Hokitika\Data\Biodiversity\Biodiversity_Monitoring_Team\NHT Heaphy -02-16-51\bird counts\Analysis\Distance analysis\2019. Excel based analyses, graphs and pivot tables can be found in DOC-6140179.

In the following, we only use common names for the bird species observed during our survey. The corresponding scientific names and species' threat statuses are tabled in Appendix 1.

Results

Species richness

Overall, 31 bird species were observed during the five years of bird surveys in the Lewis area. Of these, eight species are introduced – blackbird, chaffinch, dunnock, goldfinch, greenfinch, redpoll, skylark and song thrush (Table 3). Five are listed as threatened or at risk – New Zealand falcon, fernbird, kaka, kea and great spotted kiwi (Robertson et al. 2013). While most of the threatened or at risk species were only observed occasionally, the increase in kaka observations in 2019 was notable.

Frequency of detection and species distribution

Frequency of detection was highest for bellbird which was detected at almost all sample points in every survey year (Figure 4). Grey warbler was the second most frequently observed species. Silvereye, tui and weka showed a notable increase in their frequency of detection over time.

Some species did not seem evenly distributed across the survey grids. Robin were most frequently observed in the highest altitude grid (Grid 6), although frequency of detection in the other grids appeared to increase over time (Figure 5). Rifleman and brown creeper were only found in the Grid 6. Grey warbler occurred with lower frequency in Grid 1.

Table 3: Species observed during five-minute bird counts (5MBC) and distance sampling in the Lewis area 2015-2019 with the number of individuals detected in each year. No additional species were recorded incidentally. For a list of scientific species names and threat statuses see Appendix 1.

Species	5MBC					Distance sampling				
	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Bellbird (mainland)	354	304	212	395	432	331	271	204	360	404
Blackbird*	2	8	3	12	11	1	8	3	7	8
Brown Creeper	5		10	10	7	6	2	7	11	5
Chaffinch*		19	7	5	12		15	7	3	13
Dunnock* (Hedge Sparrow)		1								
Long Tailed Cuckoo										1
Falcon, NZ		1			3		2			3
Fantail, South Island	39	29	65	84	76	41	27	69	65	87
Fernbird, South Island	1				1	1			2	
Goldfinch*					7					5
Greenfinch*		4		1	10				1	4
Grey Warbler	108	117	114	137	156	112	102	115	126	144
Harrier			1	1	7				1	4
Kaka, South Island				1	5					5
Kea	1	1	2	4	4	1		1	3	
Kereru		3		2	6	3	4		4	4
Kingfisher				1					1	
Kiwi, Great Spotted			1					1		
Morepork									1	
Paradise Shelduck			2	5	2		1	2	1	3
Parakeet/Kakariki spp	6	19	1	12	38	4	11	1	9	21
Redpoll*		10			6		10			1
Rifleman, South Island	31	13	9	11	23	23	13	8	10	19
Robin, South Island	26	48	63	30	63	28	40	65	29	59
Skylark*					1					1
Silvereye	3	74	64	38	152	2	61	49	35	120
Swallow, Welcome				2	2					1
Thrush, Song*	6		2	4	13	6		2	2	6
Tomtit, South Island	76	70	117	115	118	76	66	121	117	103
Tui	15	55	25	128	213	17	39	23	97	170
Weka, Western	3	19	19	19	63	4	16	19	14	53
Grand Total	676	797	717	1016	1431	656	688	698	902	1245

* - introduced species

For weka and tui, the observed increase in frequency of detection seemed relatively evenly spread over the six survey grids, although in the 2019 measure only three weka were observed in Grid 2 compared to 23 in Grid 6 (Figure 6). Tui were present in all grids in 2019, with highest numbers found in Grids 3 and 4 (Figure 7). Kakariki have been found in all grids over the survey period. In 2019, they were not observed in Grid2, while Grid 1 and 4 recorded the highest numbers (Figure 8).

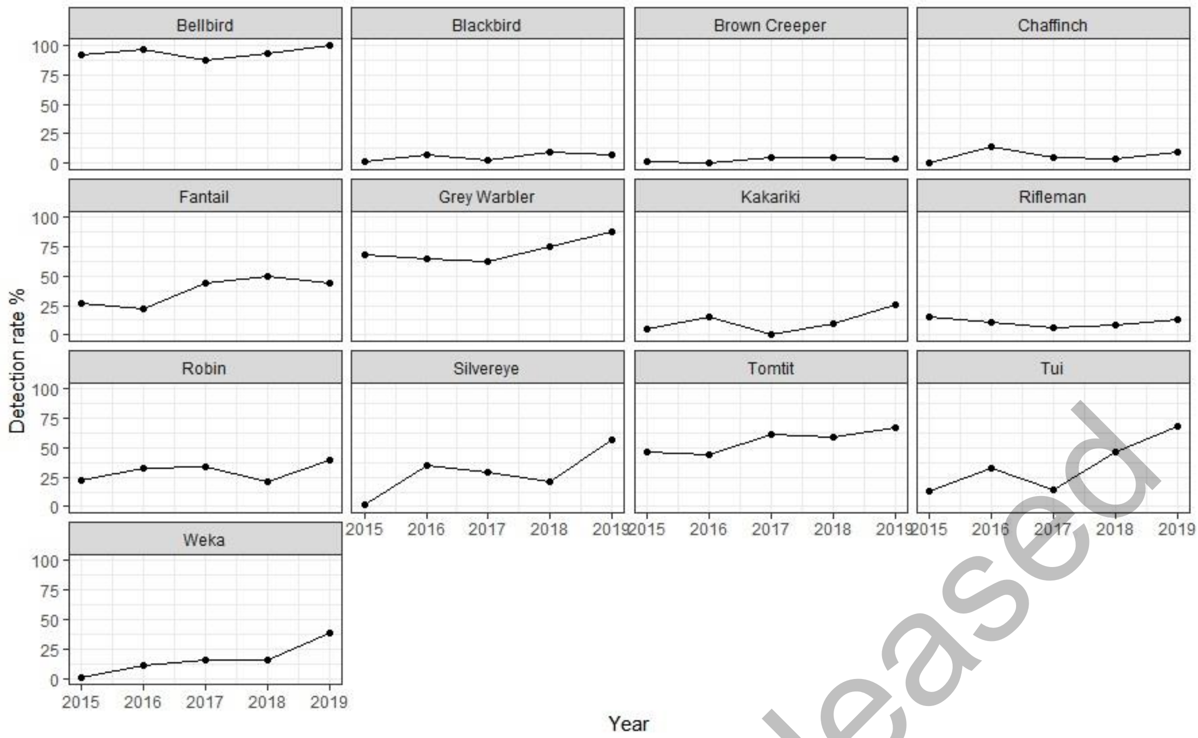

Figure 4. Frequency of detection (detection rate %) by survey year (201 20 9) based on the five-minute bird count data for the most frequently observed species.

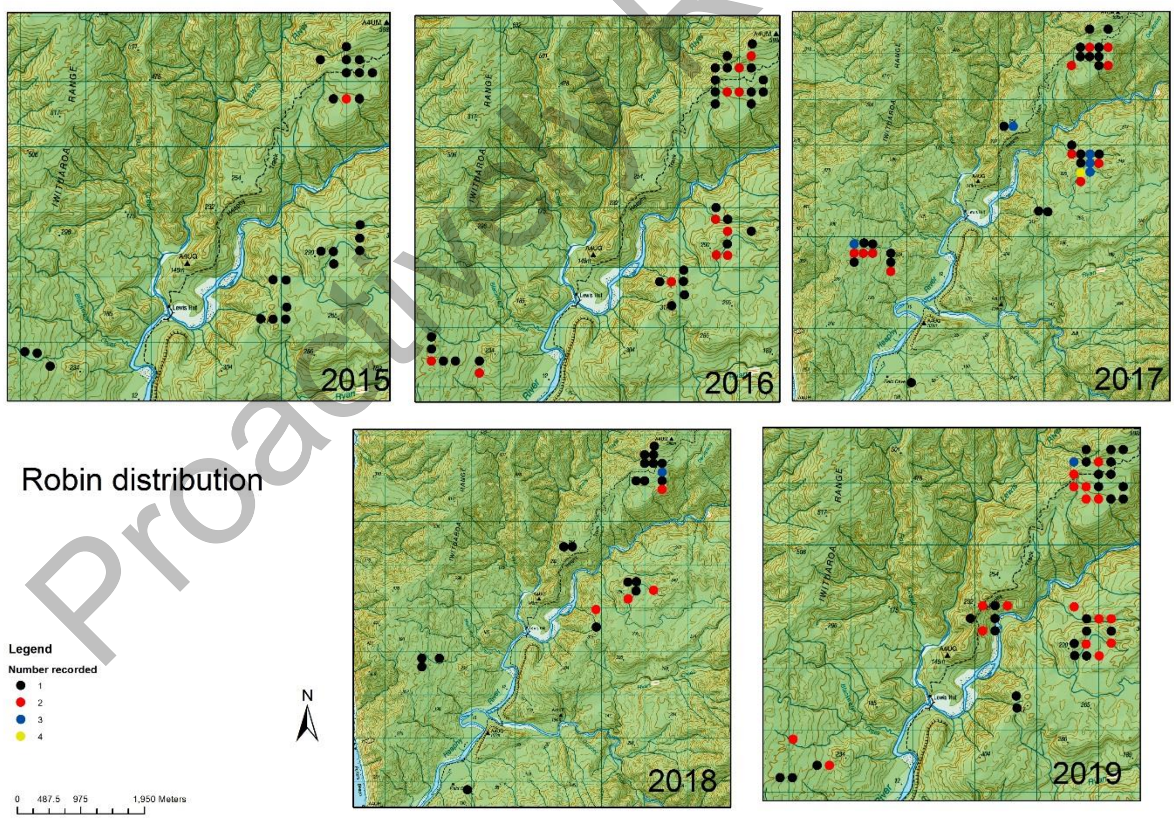

Figure 5. Robin distribution in the Lewis monitoring grids 2015-2019.

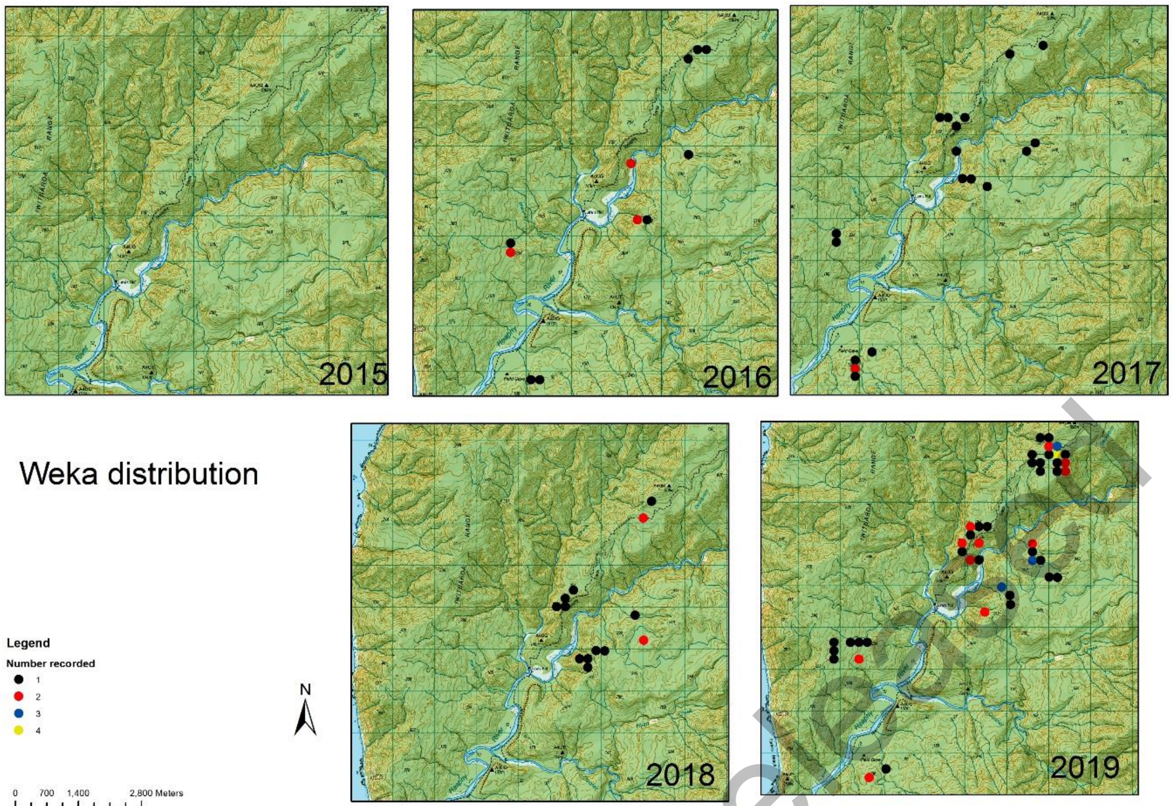

Figure 6. Weka distribution in the Lewis monitoring grids 2015-2019.

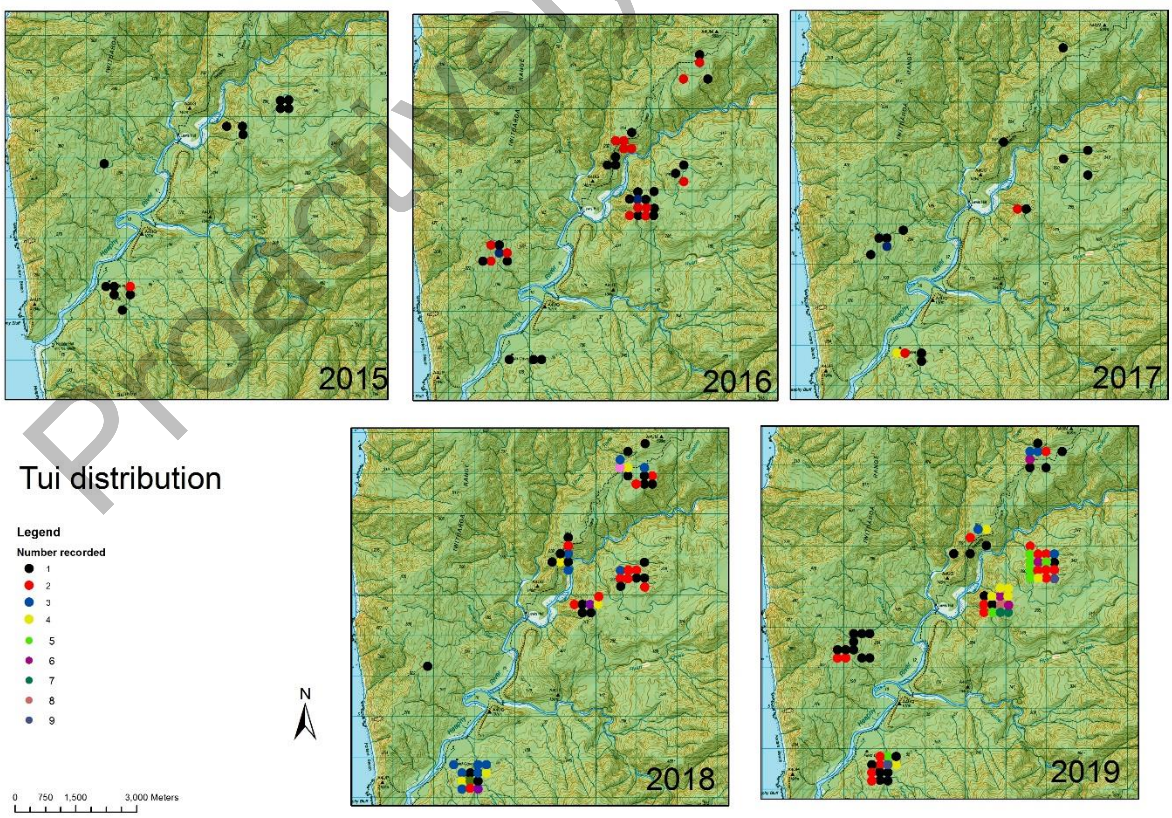

Figure 7. Tui distribution in the Lewis monitoring grids 2015-2019.

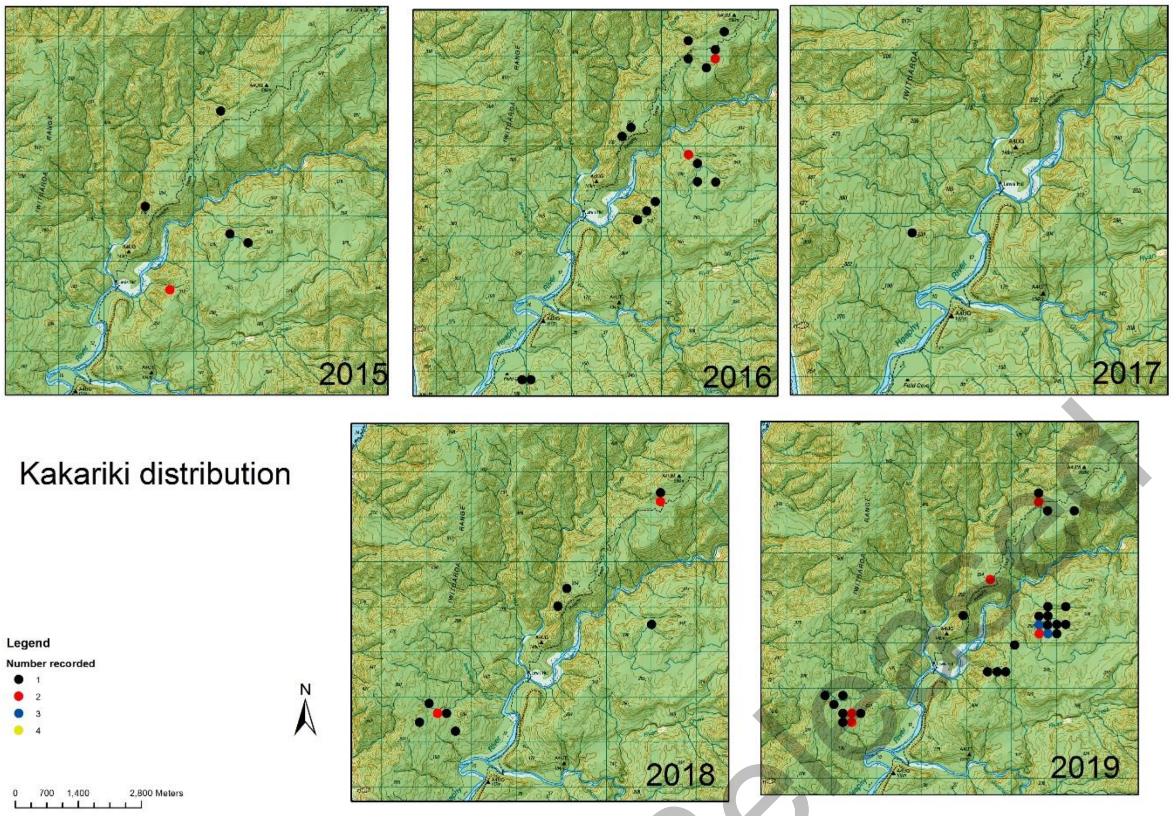

Figure 8. Kakariki distribution in the Lewis monitoring grids 2015-2019.

Relative abundance

The relative abundance of bird species provided a similar picture. Bellbird were by far the most abundant species, with nearly four individuals per sample point in 2019. All native species bar rifleman and brown creeper showed a significant upward trend over time (Figure 9, Table 4).

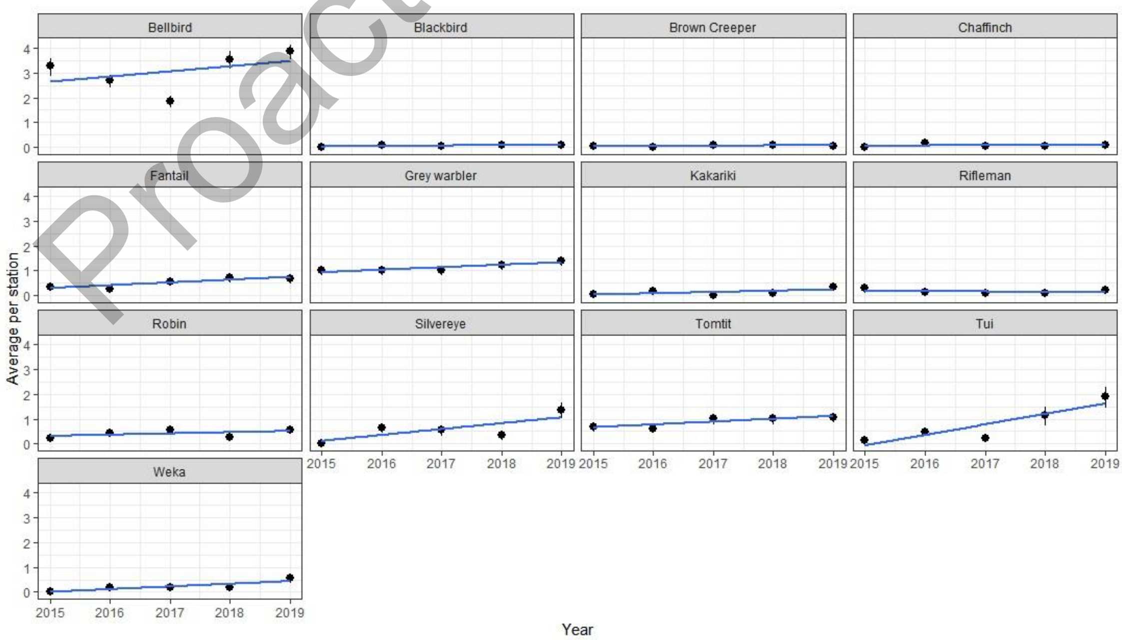

Figure 9. Relative abundance (+/- 95% Confidence Interval) for the bird species most frequently detected during five-minute bird counts.

Table 4. Estimated annual change in relative abundance with 95% confidence intervals and p-values from generalised linear mixed effects models accounting for random effects of observer, grid and sample point as well as effects of environmental covariates.

Species	Estimated annual change	95% Confidence Interval	p-value
Bellbird	0.086	0.06 to 0.11	**<0.001**
Fantail	0.228	0.17 to 0.282	**<0.001**
Grey Warbler	0.10282	0.06535 to 0.14029	**0.00607**
Kakariki	0.297	0.1915 to 0.4025	**0.00487**
Rifleman	-8.709e-02	0.238e-02 to -17.60e-02	0.33033
Robin	0.14157	0.08531 to 0.19783	**0.011863**
Silvereye	0.43029	0.38798 to 0.4726	**<0.001**
Tomtit	0.10951	0.06633 to 0.15269	**0.011204**
Tui	0.62364	0.54615 to 0.70113	**<0.001**
Weka	0.54291	0.46378 to 0.62204	**<0.001**

Population density

In the analysis of the distance sampling data, the preferred detection function for all species was a hazard rate function. The estimated mean population densities in 2019 were higher than those in previous years for all species but tomtit and robin (Figures 10). Many species displayed an increasing trend over time, particularly fantail, silvereye, weka and tui.

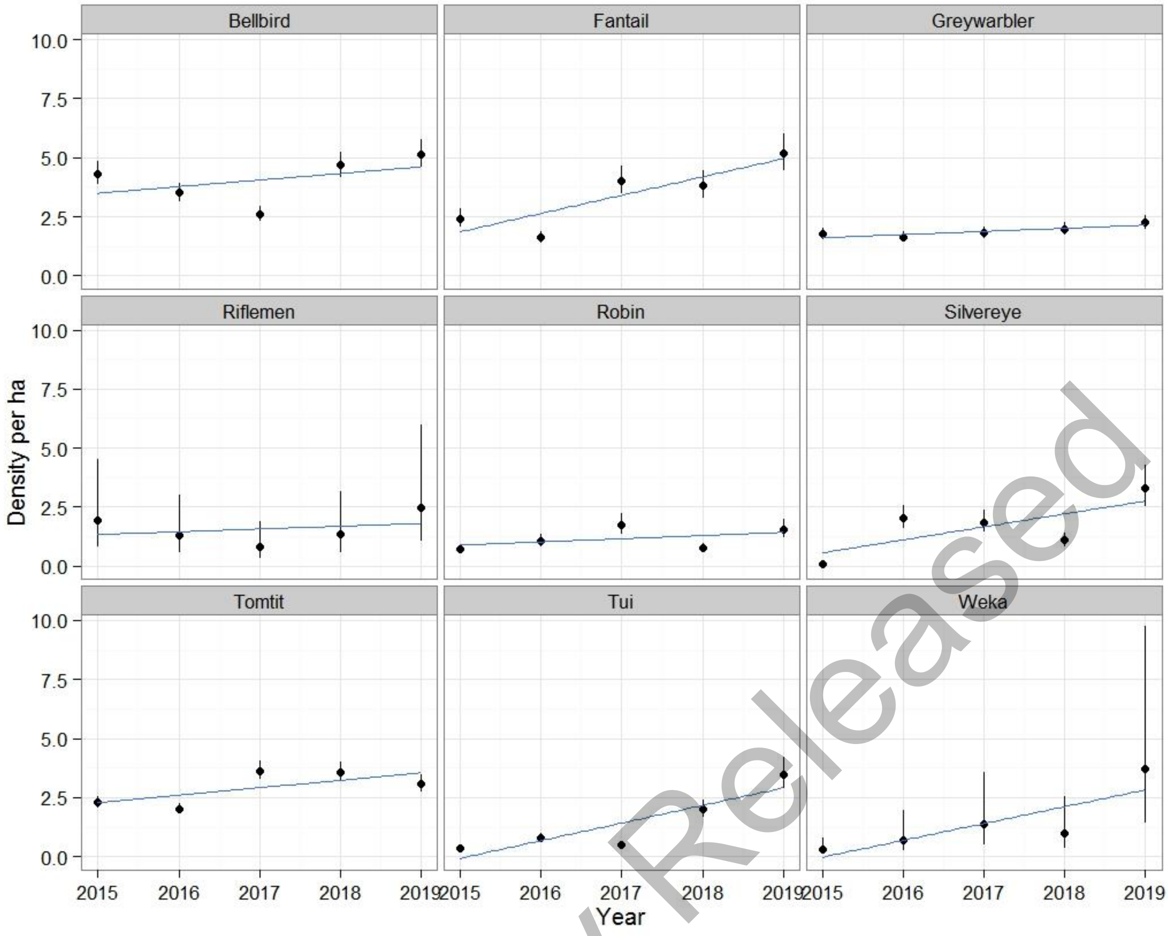

Figure 10. Population densities (individuals/ha) for birds in the Lewis area over time. The blue line represents a simple linear regression model for the overall trend over time.

Discussion

The increases in relative abundance and population densities observed for several of the monitored bird species in the Lewis area could be a first indication that the intensive, annual predator management in the area is benefitting the local bird populations.

It has been documented elsewhere that predation by introduced predators can lead to the decline of local bird populations including species generally regarded as common or widespread (Elliott et al. 2010, Innes et al. 2010), and that sustained control of these predators in turn can induce the recovery of these species (Beagley et al. 2019, Elliott & Kemp 2016, O'Donnell & Hoare 2012, Moorhouse et al. 2003).

The monitoring in the Lewis area was set up to assess the difference made for local biodiversity, as any improvements here are intended to compensate for biodiversity losses elsewhere. When the compensation programme started in 2015, it was assumed that improvements would have to be made from a relatively high baseline, because sustained predator control had already been in place in the area for over 20 years. The first bird survey in 2015 suggested that the local bird community was relatively intact. It was dominated by native species and otherwise widespread introduced species were largely absent. However, particularly predator-sensitive native species, such as kaka, were notably sparse or absent (McArthur & Gruner 2016).

After five years of monitoring, the results are encouraging. Several of the common and widespread species appear to be increasing both in numbers and in distribution. For the first time, kaka were repeatedly encountered during the survey. The results still need to be treated with caution. Five-minute bird count and distance sampling data are characterised by large variability, as counts are strongly influenced by factors such as weather or observer experience. However, despite accounting for these factors in the relative abundance model, observed trends were deemed significant.

The positive trends could be the result of the increasingly intensive predator management implemented in the area. Since 2012/13, predator control operations have occurred every two years; since 2017, every year. This is to reduce the otherwise continuously high rat numbers in the lowland forests of the Heaphy catchment. Mast years, in which the dominant beech trees produce vast amount of seeds triggering irruptions of predator populations, present another serious threat that is managed with targeted predator control. However, these control operations have not always been successful. The last two operations following beech mast years (2016 and 2018) did not achieve their control targets. This means predation levels remained higher than intended.

Long-term bird monitoring in another beech forest area, the Te Maruia management area, has shown that while the sustained predator control there benefits local bird populations, it is not quite enough to reverse declining trends for all species (Stephens 2018). It is recommended to continue with the annual bird monitoring in the Lewis area to gain more confidence in the observed trends and understand their long-term trajectories. Only this will allow us to reliably assess whether the intended biodiversity compensation is achieved.

Five-minute bird counts and distance sampling appear to yield similar results. It is questionable whether both methods need to continue. However, the present study is tied into the Department's wider national biodiversity monitoring system. The sample is aligned with the national monitoring master sample to allow comparisons and potential pooling of data. For this reason, the use of both methods should continue until a decision in favour of one of the methods is made at the national level.

Acknowledgements

This report was peer reviewed by [redacted], Senior Ranger Kawatiri Buller office, and signed off for release by [redacted], Biodiversity Monitoring Ranger. Staff that conducted the field work over the five survey years were [redacted], [redacted], [redacted], [redacted], [redacted], [redacted], [redacted], [redacted], [redacted], [redacted], [redacted], [redacted], [redacted], [redacted], [redacted], [redacted], [redacted], [redacted] and [redacted].

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Appendix 1

Bird species observed during bird surveys in the Heaphy management area 2015 – 2019.
Threat status according to Robertson et al. (2013).

Common name	Scientific name	Threat status
Bellbird (mainland) /korimako	*Anthornis melanura melanura*	Not threatened
Blackbird *	*Turdus merula*	Introduced
Brown Creeper/pipipi	*Mohoua novaeseelandiae*	Not threatened
Chaffinch *	*Fringilla coelebs*	Introduced
Dunnock (Hedge sparrow) *	*Prunella modularis*	Introduced
Falcon, NZ/kārearea	*Falco novaeseelandiae*	Nationally vulnerable
Fantail, South Island/piwakawaka	*Rhipidura fuliginosa fuliginosa*	Not threatened
Fernbird, South Island/matata	*Bowdleria punctata punctata*	Declining
Greenfinch *	*Chloris chloris*	Introduced
Grey Warbler/riroriro	*Gerygone igata*	Not threatened
Harrier	*Circus approximans*	Not threatened
Kākā, South Island	*Nestor meridionalis meridionalis*	Nationally vulnerable
Kea	*Nestor notabilis*	Nationally endangered
Kereru/New Zealand Pigeon	*Hemiphaga novaeseelandiae novaeseelandiae*	Not threatened
Kingfisher	*Todiramphus sanctus*	Not threatened
Kiwi, Great Spotted	*Apteryx haastii*	Nationally vulnerable
Morepork/ruru	*Ninox novaeseelandiae*	Not threatened
Paradise Shelduck	*Tadorna variegata*	Not threatened
Parakeet /kakariki spp.	*Cyanoramphus spp.*	Not threatened
Redpoll *	*Acanthis flammea*	Introduced
Rifleman, South Island/titipounamu	*Acanthisitta chloris*	Not threatened
Robin, South Island/toutouwai	*Petroica australis australis*	Not threatened
Silvereye/touhou	*Zosterops lateralis lateralis*	Not threatened
Swallow, Welcome	*Hirundo neoxena*	Not threatened
Thrush, Song *	*Turdus philomelos*	Introduced
Tomtit, South Island /ngiru ngiru	*Petroica macrocephala macrocephala*	Not threatened
Tui	*Prosthemadera novaeseelandiae novaeseelandiae*	Not threatened
Weka, Western	*Gallirallus australis australis*	Not threatened

* - introduced species